The Internet bubble

the impact on the development path of the telecommunication sector

Wolter Lemstra

The Internet bubble
and the impact
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Voor mijn ouders,

die studeren stimuleerden en mogelijk maakten.

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Preface

In the aftermath of the Internet bubble the opportunity arose to pursue a PhD research project. The idea of an PhD was already planted by Prof. Jan de Kroes in 1978 when I graduated as an electrical engineer specialized in the field of telecommunications. As a participant in the development of the recent financial bubble I observed how expectations changed business practices and affected behaviour at the supply side of the telecom industry. A singular view on the future of the industry became so pervasive and powerful that alternative perspectives were suppressed. It appeared as if meeting sales targets unabatedly obviated the need for strategic reflection. Hence, the topic of the research project became an obvious one: obtaining an understanding of the occurrence of bubbles and their operating principles and to assess the impact on the development of the telecom sector. Recognizing that as a consequence the research would be a reflection on recent history, the aim of the project was to use the insights obtained to explore the implications for strategy and policy formation.

After leaving Lucent Technologies, Prof. Bill Melody provided an intellectual home for my telecom interests through an engagement with LIRNE (Learning Initiatives for Reforms in Network Economies)[1]. My long term relationship with Prof. Bob de Wit, developed through a joint involvement in Delft TopTech[2], provided me with the opportunity to continue my involvement in the field of strategy as part of the Strategy Academy. The wish to expand my telecom horizon to include regulation brought Prof. Jens Arnbak, former Chairman of OPTA - the Dutch National Regulatory Agency, into the fold. I discussed my ideas to pursue a PhD project with them. I still recall one of the first questions: “Are you sure that you want to pursue this idea?” In fact I was sure, but in hindsight I have to admit it was based on what economists would call a significant degree of ‘information asymmetry’.

The Section Economics of Infrastructures became my home for the following four years. Their commitment to academic excellence, their interest in experience from the field, and their practice of intensive peer reviews made it possible for me to complete the project. Through their open minded approach to scientific research it became possible to establish the bridge between the physical and the social sciences.

The change in work rhythm, the weekly trips to Delft replacing the intensive traveling which I had become used to in business, implied a greater opportunity for participation in home life. A side effect that became much appreciated by my loving family Eline, Charlotte and Ingeborg. Although quickly the question was raised whether and when I could be released from the PC. Moreover a new nick name emerged: “stuudje”. Without their support the project would not have been possible.

[1] LIRNE is a cooperation between the Section Economics of Infrastructures at the TUDelft, the Centre for Information and Communication Technologies (CICT) at the Technical University in Denmark, the media@lse center at the London School of Economics, and the LINK center at the University of Witwatersrand in South Africa. More recently regional centers have been established in Sri Lanka and in Uruguay.

[2] Delft TopTech is associated with the TUDelft and provides post graduate executive education. Our engagement was related to the Master of Business in Telecom program.

I like to thank Prof. Bill Melody for accepting me, just in time, as PhD student; setting me off on the right track and providing essential guidance at critical junctures in the process. Prof. John Groenewegen for providing stimulating guidance and insights into the theoretical foundations of economics. And Rolf Künneke, as Head of the Section Economics of Infrastructure, for providing intellectual and financial support, and allowing me to enjoy academic life.
An intellectual and personal welcome home was also provided by Bob de Wit and colleagues at the Strategy Academy. I thank Bob, Ron Meyer, Martijn Rademakers, Peer Ederer, Casper van der Veen, Karin Feteris and others, for the opportunity provided at the many (off-site) meetings to present my findings and for providing critical but always constructive feedback.
I am indebted to many other (former) colleagues and friends who provided valuable input and support. These include Aad Correljé, who provided the perspective of a political economist, Hendrik Rood who surprises me again and again with his broad knowledge of the telecom industry, Andrew Barendse as comrade in arms, Alexander Verbraeck to raise the right questions at the right time, Vic Hayes, the 'Father of Wi-Fi', and in the early days of the project: Amy Mahan, Divakar Goswami and Hens Runhaar. One MSc student deserves special attention, Anne Boelsma, who supported this project by making an extensive range of literature accessible by summarizing the content, finding meaningful relationships and patterns that would describe the paradigm shift. I like to acknowledge the time and effort as well as the value of the critical questions raised by the participants in the review sessions at ABN-AMRO, BIPT Belgium, Capgemini, Essent Kabelcom, the Dutch Ministry of Economic Affairs, the LINK Center at Wits University, Rabo-Bank, VKA, Vodafone; and representatives from Alares, Ajempo, BT, Comparc, Imtech, IT-Help, KPN, Stratix, Triarii, the University Twente, and WMC having participated in the sessions conducted at the TUDelft. Of special importance have been the very stimulating interactions with Carlota Perez.
I wish to thank Victor Wentink on the many hours of stimulating philosophical discussions on the role of technology firms in the *avant garde* of society, and for taking the time and effort to create an image for the cover of this book that fits its content. And I thank Winny Meissner, my mother-in-law, for the many hours spent in reviewing this voluminous text.
A special "thank you" is due to my great friend Dr. Tapas Sen and his family. Since we met at the Salzburg Seminar in Session 155 on the topic "economic and social implications of telecommunications" in 1987, many hours have been spent during visits to the USA discussing the issues of internationalization of AT&T and later Lucent Technologies, of business leadership and US politics.
I like to formally acknowledge the support provided by KMI Research for making available market data on the development of Pan European optical networks. And I like to express my gratitude to Lucent Technologies, for the opportunity provided to have enjoyed the boom of the bubble, and for releasing me in time to also enjoy the bust, through the execution of this research project.

Wolter Lemstra
Eemnes, August 2006

Table of contents

1

Introduction

Purpose, research questions and research methodology, outline of the study

Table of Contents

"Every cloud has a silver lining."

1 Context

In the period 1950-1970 the developments in the telecom sector are best characterized by the terms: stable, steady and predictable. In terms of change this was truly *evolutionary.* However, a new period started in the '80-ties: a period of *revolutionary* change. Initiated by de-regulation in the '70-ties[1], the introduction of new technologies, such as cellular and fiber optic communications, and fuelled by the widespread use of the Internet an e-world was emerging that seemed unprecedented in terms of growth. The growth attracted many and big money was flowing into the ICT sector. New e-world "click & order"- companies quickly surpassed the old-world "bricks & mortar" - companies in share value. Many new businesses were started through fresh inflow of venture capital. Wave after wave of new telecom operators emerged to challenge the *status quo* of the incumbents. Investments in the industry soured. Being a player in the future of the mobile e-world became a must. Auctions for 3G radio spectrum became huge cash generators for national governments.
Until the wisdom behind these huge valuations became questioned; when Return on Investment was re-visited and Return on Vision became out of vogue, the boom period came to an end. In April 2000 the Internet bubble collapsed, having started in 1995.[2]
To adjust company operations to the new realities of the market over 485,000 jobs have been eliminated or announced to be eliminated in the telecommunications industry for the period July 2000 until February 2002 (Financial Times, 2002).[3] Measured from 2000 until 2002, 94 telecommunications companies defaulted (OECD, 2003 p16), including big first-wave new entrants such as Global Crossing and established firms such as WorldCom, the single largest default at approx. US$ 31.8 billion. And the impact has not remained restricted to the telecom and internet sector. As major institutional investors, such as mutual funds and pension funds, have participated in the bubble, the fall-out is affecting the public at large.[4]

From the perspective of a free market economist, bubbles are to be considered as natural market phenomena, and the crash is expected to provide for the necessary correction on the excesses that were part of the boom period. Hence, the recovery should run its course without intervention.
However, recognizing the special features of telecommunications as a network infrastructure, a *laissez-faire* attitude may not be the most desirable policy to be pursued. Consider in this respect the high expectations that surrounded the recent liberalization of the telecom sector. Politicians may perceive the current state of affairs in the sector as a 'market failure' and may be inclined to intervene, as has been the case in other liberalized infrastructure industries.[5] Furthermore, European government leaders agreed to a long-term goal of establishing the EU as a leading region in the global Information Society.[6] The related Action Plan calls for the formulation and implementation of national policies that aim at the realization of an ubiquitous broadband infrastructure with access for all European citizens. The

realization of this Plan may be frustrated by the recessive period that followed the crash.

Therefore examining and assessing the impact of the Internet bubble on the development path of the telecom sector and exploring the implications for the aftermath is expected to provide valuable insights for policy makers and strategists participating in the sector.[7] That is the ‘external’ aim of this research project. The ‘internal’ or scientific aim is to contribute to the understanding of sector development, the phenomenon of bubbles and the long wave in economic development.[8]

For the purpose of this project the telecom sector is defined as the collective of establishments concerned with: telecom equipment, including the related software and services, telecom (network) operations and telecom services provisioning. A reference to the Internet implies the infrastructure, consisting of transmission paths, access equipment and routers, that connect all types of computers and appliances, and that use the Internet Protocol (IP) for the purpose of information exchange. It implies the application of the world-wide-web (the Web), the associated hypertext mark-up language (html), the browsers and search engines, as well as the associated cultural aspects such as ‘always online’.

2 Exploring the nature of the project

As a first order of approximation explaining the impact of the Internet bubble on the development path of the telecom sector can be considered as “a bubble superimposed on an otherwise normal course of development”. This would suggest a focus of the research project on the bubble phenomenon, assuming the ‘normal’ course of development being commonly understood. However, this approach defies reality.

Firstly, the bubble coincided with a process of major change in the institutional environment: the process of liberalization of the telecom services sector, and in particular the privatization of the incumbent telecom operators in Europe.[9] The process of privatization changed the ‘rules of the game’ for the managers in the firms affected. They became subject to the expectations of the ‘stock market’ and were rewarded accordingly. Moreover, the opening up of the local access through the Telecom Law of 1996 in the US[10] and EU Council Directives of 1996, aiming at full competition by January 1998[11], significantly lowered the entry barriers to the sector and this resulted during the boom period in many new operators entering the market.

Secondly, advances in telecom technology have caused and are causing major shifts in the industry, from fixed to mobile, from circuit switching to packet switching, and from copper to fiber. Moreover, in the mobile sector handsets became subject to fashion and evolved to life-style products, further increasing the rate of innovation. These regime changes or paradigm shifts have a significant affect on the prevailing business models in the industry.

Thirdly, the bubble is not necessarily an isolated phenomenon, but can be considered part of a broader process of change. The nature of the telecom industry

with deep investments and long pay-back times, suggest that the industry is in principle susceptible to an industry cycle (De Wit, 1994). Considering the very recent liberalization of the telecom services industry, this phenomenon can only be emergent. An assessment of a possible cyclical nature of the industry may inform us on the development path of the sector in the aftermath of the bubble.
A further study of cycles and waves brings us to the notion of the Kondratieff cycle and its relation to technological innovation. The Kondratieff cycle or Long Wave is of particular interest through the interpretation by Freeman, Louçã and Perez (Freeman and Louçã, 2001; Perez, 2002). The model of the 'Great Surges'[12] puts the Internet bubble at the end of the 'installation period' of the new techno-economic paradigm of the Fifth Wave. The period we are in currently is the 'transition period' characterized by instability and recession. This period will give way to the 'deployment period' in which the full potential of the new techno-economic paradigm will be exploited, and this may give rise to a period of prosperity - a Golden Age. Whether this prospect will materialize is considered subject to the actors establishing the necessary adjustments of the institutional environment conducive for the new paradigm to be fully deployed.[13] "As each technological revolution is different, each paradigm unique, each set of solutions needs to be coherent with the problems to overcome and with the logic of the techno-economic paradigm, its opportunities and its best practices" (Perez, 2002 p 170), an analysis of the transition from the 'old' to the 'new' paradigm may provide an appropriate context for policy development in the aftermath of the Internet bubble.

In observing reality, in particular during a dynamic period, the cause-and-effect flow is not always unambiguous, i.e. what should be attributed to the 'normal' development path and what should be attributed to the bubble phenomenon. The use of controlled experimentation, as would be the standard approach in such cases in the physical sciences, is not feasible in the social realm as it tends to influence the outcome. Therefore the availability of a 'stylized model of euphoria' is expected to support the examination and assessment of the impact of the Internet bubble on the development path of the telecom sector. Such a 'stylized model' will be developed as part of this research project, using concepts from literature and historical information on bubbles. This 'stylized model' can subsequently be used to describe and explain the Internet bubble and to explore its impact on the development path of the sector.
While all bubbles have had a significant impact on the financial economy, only a few have had an impact on the production economy in general and on the development of network infrastructures in particular.[14] The Rail Road mania around 1840 provides a striking parallel with the recent bubble developments, and will be explored to provide further insights into the development path of the telecom sector in the aftermath of the Internet bubble.[15]

What the important implications of the Internet bubble on the development path of the telecom sector are may be perceived differently depending on the vantage point of the various actors involved in the sector. A distinction can be made

between policy makers, at the regional, national and local level, and strategists, within the various firms participating in the telecom sector, such as equipment suppliers, network operators and services providers.
As the results of policy making are ultimately determined by the outcome of the actions that the firms take, we will first address the perspective and information needs of the strategist.

2.1 Perspective of the firm strategist.

In the field of strategy there are many different schools reflecting the different perspective or emphasis being given to the strategy formation process. Mintzberg for instance distinguishes 10 different schools (Mintzberg, Ahlstrand et al., 1998).[16] Prevailing in the industry practice are the more formal and analytical processes of strategy formation. Central in these approaches is the assessment of the position of the firm in its environment. Porter provides a useful tool for the industry level analysis, based on the five competitive forces that determine the level of industry profitability (Porter, 1980). According to Porter: “An effective competitive strategy takes offensive or defensive action in order to create a *defendable* position against the five competitive forces.” (italics in original, Porter, 1980 p29). This approach to strategy formation, where the market is considered to be leading, is being called the ‘outside-in’ approach (De Wit and Meyer, 2004 p231-96). More recently the attention has turned toward the resources and competences of a firm as the source for the creation of sustainable competitive advantage.[17] This ‘inside-out’ approach emphasizes the creation of markets, rather than the adaptation to markets, as the focus of competitive strategy. See e.g. (Prahalad and Hamel, 1990; Barney, 1991; Hamel and Prahalad, 1994). Moreover, firms are becoming more dependent on other organizations in realizing their strategic objectives, e.g. as competition is moving from singular products to systems, and through the increase in subcontracting arrangements (Lorenzoni and Baden-Fuller, 1995; Shapiro and Varian, 1999), These inter-organizational relationships or eco-systems expand the strategy formation beyond the boundaries of the firm.

2.2 Perspective of the government policy maker

While the objective of strategy makers is in achieving the firms objectives, the definition of strategy, broadly defined by De Wit & Meyer as “a course of action for achieving the organisation’s purpose” (2004 p50), can be applied equally to policy formation, as for instance reflected by Parsons: “Policy is the strategy by which goals are reached”. (1995 p42). To distinguish the public from the private domain, Parsons provides the following guidance: “The idea of public policy presupposes that there is a sphere or domain of life which is not private or purely individual, but held in common. The public comprises that dimension of human activity which is regarded as requiring governmental or social regulation or intervention, or at least common action.” (p3). While the parallel may be extended further, to e.g. the development of the strategy and policy ‘agenda’, there are also many fundamental differences, e.g. with respect to the role perception of governments. Traditionally two principle forms of coordination could be distinguished: centrally coordinated or planned economies and market economies. Today, with a prevalence of capitalistic market economies, the differences are more gradual, whereby a distinction can be made between the regulatory state and the developmental state. In both the market is centre point, in the regulatory model the government is focused on the proper functioning of the market process, while in the developmental model the outcome of the process is important. In the developmental model a government also develops explicit targets and plans for economic development in general, and articulates the desirable developments at sector level (Groenewegen, 1989 p76). Common to both models is for policy makers to assure a proper functioning of the markets. Therefore, one of the more fundamental tasks of governments is the establishment and maintenance of a formal institutional environment that is conducive to the proper functioning of the markets, e.g. in terms of the operation of a system of property rights, the legal system, and the monetary system. Moreover, governments may wish to intervene if markets are considered to be failing.[18] Market failure is said to occur "…when markets fail to allocate scarce resources efficiently in and through the pursuit of monetized private interest." (Jessop, 2005 p7). Wolf argues that this criterion should be applicable to both static, or allocative, efficiency and to dynamic efficiency (Wolf Jr., 1990 p17-8).[19] Furthermore, Wolf adds 'distributional inequity' of income or wealth as a possible market failure (p28-9). He distinguishes two sources of potential market failure, i.e. specific characteristics of the goods (p20-9):

- externalities, with the extreme case of public goods, and
- increasing returns,

and market imperfections:

- where price, information and mobility characteristics are departing significantly from 'perfect' markets.

A monopoly or a natural monopoly situation would be an example of such departure. White, in addressing public policy toward network industries, identifies also compatibility and standards as possible sources of market imperfection (White, 1999 p17-8). Aalbers points to asset specificity and rent seeking behaviour as other sources of potential market failure (Aalbers, Dijkgraaf et al., 2002 p17-21). Like Wolf, he also points to the potential failure of government intervention, and identifies information asymmetry and the principle-agent problem as potential causes.

These general causes for potential market failure are applicable to telecommunications, which is an economic activity with "spillovers" that benefit society at large, that is subject to positive externalities and increasing returns, and is subject to a high degree of asset specificity.

2.2.1 Telecom reform

Next to these aforementioned general principles and interests of governments in market developments, the ongoing reform process in the telecom services industry is an important reason for a high level of involvement of governments in the developments of the sector. The process of telecom reform is aimed at obtaining the benefits of a competitive market regime in telecom. This implies a transition from public to private ownership of the incumbent telecom firm and the

modification of the licensing regime to allow the entry of new firms. Recognizing that the starting position of the incumbent operator under the new regime is that of a monopolist, an *ex-ante* regulatory regime is considered essential to pre-empt the misuse of significant market power by the incumbent operator and to set rules and regulations to facilitate the entry of new telecom services providers. National Regulatory Agencies (NRAs) have been established to implement and monitor the implementation of these new rules and regulations.
In the perspective of many policy makers these arrangements would be temporary, i.e. for the duration of the transition process. Standard competition law, with an *ex-post* enforcement regime, would become applicable once the transition would be completed successfully. The completion of the transition process is subject to the developments in the sector, i.e. the result of the undertakings of the entrepreneurs in the industry.

2.2.2 Lisbon Agenda

In March 2000 the European Council stated its ambition to become "the most competitive and dynamic knowledge-based economy in the world by 2010." (European Commission, 2000). The Lisbon Agenda includes the following key political objectives to realize this ambition:

- To establish an inclusive, dynamic and knowledge based economy,
- To produce accelerated and sustained economic growth,
- To restore full employment as the key objective of economic and social policy, and reduce unemployment to the levels already achieved by the best performing countries,
- To modernize our social protection system.

The associated *e*-Europe Action Plan states as the mid-term target (European Commission, 2002 p3):

By 2005, Europe should have:
- modern online public services,
- a dynamic e-business environment,

and, as enabler for these
- widespread availability of broadband access at competitive prices,
- a secure information infrastructure.

Using the distinction made by Groenewegen with respect to the role perception of governments, the Lisbon Agenda reflects more of a 'developmental' approach, rather than a 'regulatory' approach. This is suggesting a keen interest of policy makers in the development of the telecom sector.

2.3 Industry development and the 'development path'

The development of an industry can be described and explained using different approaches, depending on the situation in the industry and the research objective. In a relatively stable environment and industry structure, static theories, concepts and models can be used, e.g. the Structure-Conduct-Performance paradigm (Bain, 1956), and the Five-Force Model by Porter (Porter, 1980). If industry development over a longer period is considered, evolutionary models become relevant, e.g. the Technology and Product Life Cycle concept (Kotler, 1997), and the Dynamic Market Theory by de Jong (De Jong, 1996). If innovation is playing a significant role, the application of dynamic or even revolutionary theories, concepts and models is required, e.g. the concept of ‘creative destruction’ by Schumpeter (1911; 1942). These different perspectives can be related to the strategic management view of firms, whereby firms are either adapting to their environment or moving beyond adapting to shaping their environment (De Wit and Meyer, 2004 p421). The latter is typically associated with industry development. This takes us to the core of our research project, the understanding of the ‘development path’ of the telecom sector.[20] The ‘development path’ of an industry can be described as the sequence of ‘states’, whereby the transition from one ‘state’ to the other is the combined result of the ‘drivers of industry development’ and the ‘inhibitors of industry development’ enacting upon the industry. The ‘dimensions of industry development’ are considered to be the key structural dimensions along which industry development can be mapped. De Wit & Meyer distinguish the following dimensions of industry development, considered most important for the strategist (p422-4):

- Convergence-divergence, of business models employed in the industry,
- Concentration-fragmentation, of the market,
- Vertical integration-fragmentation, of value-adding activities,
- Horizontal integration-fragmentation, with respect to business boundaries,
- International integration-fragmentation, of boundaries separating geographic segments,
- Expansion-contraction, of demand.

For the policy maker the prime interest is macro-economic development. Hence, the dimension of investment and innovation needs to be added to the list:

- Expansion-contraction of investments, directed at innovation and asset deployment.

The development path of an industry can be mapped relative to the dimensions listed.
The drivers of industry development are the internal and the external change drivers as identified in the market-based view (Porter, 1980) and resource-based view of the firm (Prahalad and Hamel, 1990), as well as the contextual-drivers, identified in the SEPT-model as the socio-cultural, economic, political/regulatory and technological forces of change (Wheelen and Hunger, 1983 p79).
The inhibitors of industry change are essentially the sources of industry rigidity, making the industry rules more difficult to bend or break.

What characterizes the period of the Internet bubble is a high intensity of new product introductions, in fact an emergence of new industries based on new technologies and novel ways of using existing technologies. Many firms apply the

'industry creation' or 'industry leadership' perspective in their strategic efforts. Collectively they are changing the 'industry recipes', e.g. from circuit mode to packet mode, from fixed to mobile, from no web to web enabled. There is evidence of change of the dominant business models in the sector. [21]
Following Dosi, these phenomena can be traced back to the changes in the technological paradigms and technological trajectories (Dosi, 1982), or regime changes as described by Nelson & Winter (1982 p255-62). Recognizing the long-term impact of technological paradigms on the behaviour of actors in an industry, and the opportunity they create for new business models to emerge, paradigm changes are considered fundamental to the description and analysis of the development path of the telecom sector and hence will require special attention in this research project.
The same applies for the process of liberalization of the telecom sector, as a major change in the institutional environment, of which some major events coincided with the Internet bubble period, e.g. the enacting of the US Telecom Act in 1996, the introduction of full competition in the EU in 1998, the inclusion of telecom services within the scope of the WTO, and the start of the auction process for 3G or UMTS licenses. See also Figure 1, in which these events are shown against the development of the Dow Jones Industrial Average (DJIA), the Nasdaq and the Telecom Industry Index (Financial Times, 2003).

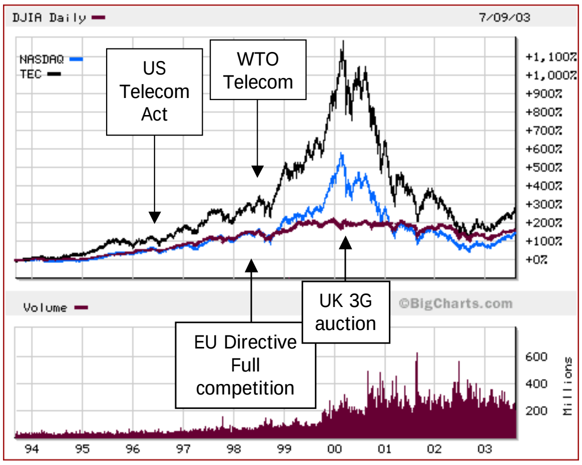


Figure 1. Telecom reform and the Internet bubble

2.4 Summary

From the high level analysis of perspectives and information needs of strategists and policy makers it can be concluded that insights in the development path of the telecom sector is a fundamental requirement for both groups of actors. Moreover, common elements can be discerned in their information needs. These elements relate to technological developments, the development of markets and of institutions, and to the interdependencies between these three dimensions. This is a situation typical for infrastructure-based network industries, as argued by Firth, Boersma and Melody (2000). The dynamics in the development of the telecom sector can be captured through the concept of the product life cycle or industry life cycle, where the change is evolutionary. The concept of paradigm changes provides a way of capturing the more revolutionary types of changes that are taking place in the sector. The concept of techno-economic paradigm changes, which according to Perez are fundamental to the Long Waves in economic development, provides the broader context for socio-economic change, and will allow us to link the Internet bubble more intrinsically to the development path of the sector.[22] Perez also provides a useful integrative framework that captures the tensions between the three dimensions of change: the technological, the economical or market (the firm dimension), and the institutional environment (the policy dimension).

A model closely related to the idea of co-evolution of the five semi-autonomous subsystems of society presented by Freeman and Louçã (2001 p123-30). The link between technology, institutions and innovation in relation to economic performance is also emphasized by Nelson (Nelson and Sampat, 2001; Nelson and Nelson, 2002) and by Groenewegen in *Designing markets in infrastructures: from blueprint to learning* (2005).

3 The research problem and research question

The point of departure for constructing the research problem may vary, from concepts and theories, methodological considerations, the opportunity of a field study or an area of interest. This project started from an area of interest: the Internet bubble.[23] Hence, the theme of the research now has to be refined towards a research problem that can be elaborated in terms of theories, methodologies, and directed on the basis of the availability of data and the opportunities for field study.

Readily observable facts show that the Internet bubble has had a major impact on the development path of the telecom sector. Although infrastructure sectors have been subject to euphoria, this has not happened before to the telecom sector. As success and failure stories related to euphoria speak to the imagination of many onlooker, these are extensively documented, in particular in (investigative) journalistic accounts. Also the impact of euphoria on the financial economy is a topic of many scholarly works. However, only a few occurrences of euphoria have had a major impact on the production economy; the Internet bubble is one of those occurrences. The link between production economy and euphoria is far less developed in academic literature.[24] And only few attempts have been made to predict the impact of euphoria on economic developments in the aftermath – in the sector that has been subject to euphoria. Therefore the topic of this research project is the Internet bubble, and the aim of this knowledge project is to examine and asses the impact of the Internet bubble on the development path of the telecom sector and to explore the implications in the aftermath.

The principle research question can be formulated as:

> **What is the impact of the Internet bubble on the development path of the telecom sector, and what are the implications for policy and strategy formation?**

Taking the research design considerations into account, this question will be addressed by responding to the following set of sub-questions:

> **Q1: How can 'bubble phenomena' be described and explained?**
>
> **Q2: Should the Internet bubble be considered a stand-alone event or should it be explained as part of a broader phenomenon?**
> **If affirmative, how should it be described and explained?**
>
> **Q3: How can the industry development be described and explained? How can the development be mapped onto a 'development path'?**
>
> **Q4: How can the Internet bubble be described and explained?**
>
> **Q5: What has been the impact of the Internet bubble on the 'development path' of the telecom sector?**
>
> **Q6: What are the implications for policy and strategy formation in the aftermath?**

3.1 Linking the 'bubble to the path'

What links the 'bubble to the path' is the entrepreneur in the telecom sector.[25] An entrepreneur that we have put central in our research project, directly in relation to strategy formation, and indirectly in relation to policy formation; as we have defined the success of policy as the results of the actions being taken by the entrepreneurs, either individually or collectively.

In a practical sense there is a link between the combined notions of expectations + confidence and monetary expansion + investments. Entrepreneurship means taking actions aimed at the future. As the future is intrinsically unknown, expectations play a crucial role. The higher the confidence with respect to these expectations, the more decisive the actions 'to shape the future of the firm' will be. Decisions with respect to 'shaping the future' tend to revolve around investments. Investment decisions with respect to e.g. expanding the production capacity, and/or investing in innovation, and/or investing in new markets. Investments tend to require funding, either internally generated or externally acquired. Euphoria are typified by positive and growing expectations on the one hand and monetary expansion on the other. The sector that becomes subject to euphoria tends to 'rush to the future'. The natural 'checks and balances' present in the system become ineffective, and 'consensual' vision takes over. Euphoria and entrepreneurship become a 'marriage made in heaven', until the spell is broken; what follows is the rude awakening as a result of the crash.

In the aftermath many of the actions undertaken during the boom are being undone, often at considerable cost. Other actions can not be undone and will influence the developments in the sector for many years to come. Our interest is focused at the latter category, as we are interested in the impact on strategy and policy formation for the long-term, and less so in the immediate tactical response by firms for survival in the aftermath of the bubble.
Economic, strategic management and innovation literature point in this respect to the importance of industry structure and the role of paradigms and technological trajectories in shaping the development path of an industry. Industry structure and technological paradigms are understood to condition the behaviour of industry actors, while they are, at the same time, subject to transformation by these same actors. This conditioning tends to lead to gradual or also called evolutionary change of industry structure. Notwithstanding, the industry structure can be changed through e.g. deliberate policy actions. The telecom reform process is a case in point. Even without deliberate intervention, the industry development is not always gradual. History has shown recurring periods of so called ‘clustered innovation’ that have led to technological revolutions. Revolutions that have resulted in the emergence of a new techno-economic paradigm, affecting economy and society at large. These are periods of revolutionary change. Periods in which industry structure is profoundly affected, and the strategy formation process is affected most prominently.
In the change of the techno-economic paradigm and in the notion that euphoria are a recurring element in the process of diffusion of a new technological revolution, we find another link between the ‘bubble and the path’.

3.2 Scope and focus of the project

In this research project, which is aimed at the identification, explanation and exploration of the impact of the Internet bubble on the development path of the telecom sector, and the implications for policy and strategy formation, it is important to focus on the enduring changes affected by the bubble, in particular paradigmatic changes and changes in the industry structure.

To make this research project feasible and practical the scope, so far indicated as the telecom sector, will have to be narrowed. The telecom sector *in extenso* would include: the telecom equipment, software and services segments, the telecom infrastructure operator segment, and the telecom services provider segment, as well as the content and application provider segment. Considering the nature of the industry, it would have to address the developments globally.
The focus chosen for this project is the development path of the telecom sector in general and the infrastructure-based services operator and the telecom equipment providers in particular.[26]
While the telecom sector is global in nature, the major developments were triggered primarily by events in the USA and Europe, and increasingly by events in Japan and Korea, e.g. with respect to mobility and broadband, and by developments in China and India, through their influence as emerging markets. Recognizing that the Internet bubble had its origin in the USA and has had major

impact on the developments in Europe,[27] the emphasis in the project will be focused on the USA and Europe, in terms of geographical scope. In the quantitative assessment we will include information on Japan and Korea.

3.3 Positioning of the project

While the research project is positioned at the intersection of technology, policy and management in the domain of telecommunications, it is in essence a project within the field of economics, i.e. within the realm of the social sciences. It is concerned with the role of technology, among other things, on the (collective) outcome of firm behaviour in the telecom sector (the development path) under changing conditions (regulatory reform) and very special circumstances (the Internet bubble), which will be interpreted in a historical context (the broader phenomenon of cycles and waves in economic development).

Although the general definition of economics as provided by Robbins, as quoted in Lawson (1997 p95)[28], applies: "Economics is the science which studies human behaviour as a relationship between ends and scarce means which have alternative uses", the related 'core' of economic theory as summarized by Lawson falls short of our needs, economic 'theory' being perceived as: "…a body of substantive thought that, amongst other things, focuses upon individuals rather than collectivities; upon exchange activities rather than production or distribution; upon optimising (maximising or minimising) behaviour rather than satisficing or habit following; upon conditions of perfect competition rather than oligopoly or monopoly; upon structures facilitating constant (or decreasing) returns to scale rather than increasing returns; upon presumptions of perfect knowledge and foresight or 'rational expectations' rather than uncertainty or ignorance; upon end-states, fixed points, or equilibria, rather than processes in time; upon functions (utility, cost, preference, profit) that are well behaved (where appropriate, convex, differentiable, fixed, well ordered over all the arguments, etc.) rather than otherwise." (p87). The principle research question puts us largely at the 'rather than' side of this summary: e.g. the role of production and investment in the telecom firms over time, in a period of transition from service monopolies to a competitive market, exhibiting a herd like behaviour during the bubble. Hence, the topic of our research requires a more in depth analysis of what economic theories provide the best 'explanatory power'. For a better understanding of what economic theories as part of the social sciences are about, creating a contrast with research methods in the natural sciences is considered useful, as this represents my personal point of departure. This investigation is addressed in a separate document *Research in the physical and social sciences: a comparison of methodology* (Lemstra, 2005). In the following Section we will summarize the findings and make use of the conclusions derived with respect to this research project.

4 Methodological considerations

Essentially each profession, each discipline, has its own 'way-of-working', its own methods. Methods that have evolved and improved over many years of practice and in the process have become engrained. They have become part of the habits and the routines, and they are readily transferred to new students of the profession. In short, one could say each profession has its own paradigm, in the meaning of paradigm as ‘the way in which problems are being solved’. This applies for engineers, but also for researchers.

The primary aim of research in the field of natural sciences is to uncover the ‘laws of nature’, gravity being a good example. The confirmation of these ‘laws-to-be’ is through experimentation. Because the laws of nature can not be ‘switched-off at will’, carefully controlled experimental environments are required to isolate the phenomenon to be studied from other influences. The basic assumption underlying most of these experiments is that the underlying ‘law’ yields a predictable outcome. Moreover, as a necessary requirement for the experiment to qualify as scientific, the outcome should be the same if the experiment is being executed under the same conditions, but by different (groups of) researchers (Chalmers, 1999).

In the social sciences ‘intentional human agency’ plays a central role in the research. And to qualify as ‘social’, the focus is not the study of the individual behaviour in isolation, but the behaviour of humans in their environment. Herein lies a fundamental difference with the research in the natural sciences. The system that is being studied in the social sciences is an open system, rather than a closed one as in the natural sciences. The outcomes are not law-like, imposed on the subject matter irrespective, but a result of wilful action. Although the human agency is conditioned in many ways, and similar incentives may result in similar behaviour, humans are no automata, that will always yield the same outcome as a result of the same stimuli provided under the same conditions. Furthermore, the nature of the social systems does not facilitate controlled experimentation, an essential part of the methodology in the natural sciences (Lawson, 1997).

Considering these, in my view, fundamental differences, a straight forward application of the methods typical for the natural sciences to the social sciences appears to be ill advised. A reflection on the appropriate method is deemed necessary when a change in subject matter is involved. In this respect we call upon the support of the philosophy of science to facilitate this discussion at the metaphysical level. In essence we are engaged in an epistemological questioning, whereby epistemology is being understood as “…the study of knowledge, and so of science: the study of its nature, its validity and value, its methods and its scope.” (Girod-Sévilee and Perret, 1999 p13).

4.1 Similarities in and differences between the physical and social sciences

Recognizing that our research project is at the intersection of technology, policy and management, a comparison of the natural and social sciences will inform the choice of our research method.

Applicable equally to both research areas is the application of logical reasoning and for that matter the conclusion drawn, e.g by Chalmers, on the powers and the limitations of inductivism and deductivism. Lawson, however, suggests that the usefulness of the deductivist conception of explanation, which is prevalent in the natural sciences, is highly circumscribed in the social sciences (Lawson, 1997 p20).[42] He concludes that the prevailing method in the physical sciences, using the deductivist mode of explanation – 'whenever event x then event y'– essentially describes a closed system, while in the social sciences we are faced with an open system (p19-24). Diesing, in his description of research practices being applied in the social sciences, points to the error that is often made by confusing the outcome of formal theoretical models with the empirical reality, that these models are supposed to reflect; in essence by ignoring the 'rules of correspondence' (Diesing, 1971). This is an issue applicable to both research areas, but is more pronounced in the social sciences. With respect to the differences between physical and the social sciences, Chalmers in his remarks implied the holistic nature of social sciences, the need to consider the system as a whole, rather than through the isolation of a specific phenomenon. The latter not being feasible without affecting the functioning of the system, thereby defying the purpose of isolating a particular phenomenon; a common practice in the physical sciences. Wilbur and Harrison, in their assessment of methodology in economics, conclude that at the heart of the great controversy over the process of explanation in science is the issue that modern sciences are differentiated only by differences in subject matter, not in method. They argue that a change in subject matter requires a change in method (Wilber and Harrison, 1978 p62).

Lawson points to the need to identify the underlying perception(s) of reality, or ontology. He claims that the historical conception of science stems from the notion of positivism, as theory of knowledge. Thereby an account of reality is consisting of the objects of experience or impression, constituting atomistic[29] events; and knowledge is the elaboration of patterns of association of these events (Lawson, 1997 p19).[30] This explanation of reality is considered to be rooted in Hume's analysis of causality. From the positivist perspective, Lawson is arguing that if science is to be at all possible, it must take the form of elaborating regularities of the type 'whenever event x then event y'. Implied in this concept is the notion of 'constant event conjunction'. This perspective of reality has been denoted also as 'empirical realism'.[31]
What Lawson argues, and what is also evident from the exposé by Chalmers, is that the conditions upon which the methods in the natural sciences rest are *grosso modo* not available within the realm of the social sciences. Lawson in particular refers to the conditions implied by the deductivist approach prevalent in the natural sciences and also in main stream economics. Deductivism rests upon the adherence to the metaphysical thesis that is referred to as 'regularity determinism'. In short this thesis asserts that "…for every economic event or state of affairs y there exists a set of events or conditions x_1, $x_2 \ldots x_n$, such that y and x_1, $x_2 \ldots x_n$ are regularly conjoined under some (set of) formulation(s)." (p98). This set of formulations is referred to as the intrinsic and extrinsic conditions for closure. The intrinsic closure conditions are satisfied "…if any and every relevant individual is characterised atomistically, as in effect lacking intrinsic structure. For then each reaction is only and always but a passive response to external impinging, forces or

stimuli." (p98-9). This requirement defies the notion of human intentional agency as the foundation of the social sciences. The extrinsic closure condition is straightforwardly satisfied "…where the actions of the relevant individuals are physically isolated from all the (non-constant) conditions not explicitly set out." (p99). This is a condition typically arranged through experimental set-ups in the physical sciences. However, "[t]he social world is highly interdependent: social structure depends upon (always potentially transformative) human intentional agency and cannot be separately isolated under experimental control, or any other conditions. At the same time, human intentional agency, which includes the power of choice, can itself be exercised only via the means, media and resources of existing structures and conditions. Meaningful experimentation in economics… …appears to be infeasible." (p125). See also Table 1 for a comparison between the natural and social sciences.[32]

Dimension:	The Natural Sciences:	The Social Sciences
Topic of study:	Nature	Human behaviour
Experimentation:	Feasible, controlled environment Isolated individual mechanisms - atomistic	Not feasible, (knowledge produced) affects the outcome Interdependence - choice
Observer:	Independent of the subject matter	Often participative
Environment:	Closed – Stable "Whenever event x then event y"	Open – Unstable Intentional human agency, always potentially transformative

Table 1. Comparing the natural and social sciences

4.2 Transcendental realism as alternative to empirical realism

The alternative conception to 'empirical realism' that Lawson is arguing is being systemised under the heading of 'transcendental realism'. In this view "…the world is composed not only of events and states of affairs and our experiences or impressions, but also of underlying structures, powers, mechanisms and tendencies that exists, whether or not detected, and govern or facilitate actual events. Moreover, the different levels of reality [*empirical*, *actual* and *real*] are out of phase with each other." (Lawson, 1997 p21). The elaboration by Lawson can be summarized as follows (p21-3):

> The world is considered to be: "…composed in part of complex things (including systems and complexly structured situations) which by virtue of their *structures*, possess certain powers – potentials, capacities, or abilities to act in certain ways and/or to facilitate various activities and developments." In many cases the potential of things can be derived from the knowledge of its structure.[33] "A *mechanism* is basically a way of acting or working of a structured thing." Mechanisms act as causal powers of things, usually exercised as a result of some input, to determine the actual phenomena of the world. In this world three domains of reality are distinguished: "…the *empirical* (experience and impression), the *actual* (actual events and states of affairs in addition to the empirical) and the *real* (structures, powers, mechanisms and tendencies, in

> addition to actual events and experiences).” These domains are “…ontologically distinct and irreducible and notably their characteristic components (mechanisms, events and experiences) are unsynchronised or out of phase with one another. This non-isomorphism of ontologically distinct items is the second contrast with empirical realism.” The notion of structures, powers, mechanisms and tendencies, existing in addition to events and states of affairs and our experiences or impressions, being the first. “Events… …are conjointly determined by various, perhaps countervailing, influences so that the governing causes, though necessarily ‘appearing’ through, or in, events can rarely be read straight off… …Characteristic ways of acting or effects of mechanisms which may not be actualised because of the openness of the relevant system are conceptualised… …as *tendencies*. It is the idea of *continuing activity* (as distinct from enduring power *per se*) that the notion of tendency is designed to capture.”

Lawson concludes that; “[s]cience, on this transcendental realist view, is no longer confined to, or even dependent upon, the seeking out of constant event conjunctions, but aims at identifying and illuminating the structures and mechanisms, powers and tendencies, that govern or facilitate the course of events. The scientific objective is to identify relatively enduring structures and to understand their characteristic ways of acting. Explaining… …entails providing an account of those structures, powers and tendencies that have contributed to the production of, or facilitated, some already identified phenomenon of interest. It is by reference to enduring powers, mechanisms and associated tendencies, that the phenomenon of the world are explained.” (p23).

4.3 Critical realism and economics

In developing his alternative to the ontology of social atomism and related methodological individualism in mainstream economics, Lawson starts his proposition on social theory with the observation that human life is highly *routinised*. From routines he moves the argument to social rules and subsequently to social relations and positions, to social systems, to conclude with the role of agency in effecting social change (Lawson, 1997 p158-73).

A routine, being understood to mean: “…simply a regular course or manner of proceeding or going on, a recurrent performance of particular acts”, is a generalized feature of experience being pervasive in social life, across people, time and space. The pervasiveness of routines presupposes the existence of widely known or shared generalized procedures of action, procedures that can be referred to as *social rules*. These rules “under a suitable transformation at least, can be expressed as injunctions of the form: ‘if x do y under conditions z’.” This formulation is general and intended to apply: “equally to semantic, moral, constituitive, regulative, etc. forms, or aspects, of rules alike.” It is the normative or legitimating or facilitating aspect of rules that makes them distinct from representations of event regularities found in experimental situations; and hence it is not a prediction. Next to being rule-governed, another general feature of experience is that social life is “highly *relational* and, in part, constituted by *positions* which people occupy”. We can also observe that "…practices routinely followed by an occupant of any position tend to be oriented towards some other group(s)." Hence, the "basic building block of society are positions, involving, depending upon, or constituted according to, social rules and associated tasks, obligations, and prerogatives, along with the practices they govern, where such positions are both defined in relation to other positions and are immediately occupied by individuals." Social systems or collectivities, such as the economy, the state, companies, households, can now be understood as "…an ensemble of networked, internally-related, positions with their associated rules and practices." Along these lines *institution* is "…most usefully viewed as a social system that has been found to be (relatively) enduring."

Social structure depends upon human beings. And human beings are able to act intentionally, to exercise choice. Thus, structure can hardly be regarded as fixed, as externally coercive, and so reified." This conclusion on social structure forces a shift from "…traditional conceptions of creation and determinism to notions of *reproduction* and *transformation*." "..[I]ndividual agents draw upon social structure as a condition of acting, and through the action of individuals taken in total, social structure is reproduced or (in part at least) transformed… …Only at the moment of acting can [the social structure] be interpreted as given to any individual. Reproduction or transformation of structure may be intentionally, as in learning a language, respectively in changing the legal system, however, "…it is likely that most structural reproduction and/or transformation arise as an unintended product, whether or not desired or even recognized." In this conception "[s]tructure is both condition and consequence, while the consequences of action (including inaction) are both motivated and unmotivated." As a consequence "[c]hange… …(as with continuity) is endemic to social life. Systems and structures… …are constantly evolving. In consequence, a social object such as the market is not usefully regarded as something that exists and as something that experiences change, as if its existence and change were two entirely separate aspects of it. Similarly, change cannot be reduced merely to contrasting states of affairs such as structures of market prices on different days… Rather, social items such as markets, political systems and households must be understood as processes, as reproduced structures of interaction, with change recognized not as (or only as) an external happening, the result of an external or exogenous shock, but as an integral part of what the system or object in question is."

4.4 Research methodology

The research methodology that results from the above and as outlined by Lawson can be summarized as follows (1997 p191-237).

The broad aim of the social sciences, including economics, can be defined as: "…to describe the structural conditions for some manifest social phenomenon (including some relevant set of practices or activities) to be possible, recognising that the situation in question may not be adequately comprehended by the individuals involved." Stated in other words: "…the *explananda* of the social realm, the phenomena to be explained, are the practices in which people engage, and the *explanan*s are the physical, social and psychological conditions of the relevant actions." Considering the importance of social structure the more interesting aspect of social science is: "…the uncovering of particular social structures of significance."

Hence, the first step of any economic investigation is the identification of a set of human activities regarded as being of economic significance. Once established, it will be necessary to "…determine how and/or why they are undertaken, especially if any corresponding practices adopted elsewhere, or previously, are different in some significant way." The specific explanatory task will include "…uncovering the physical and social structural conditions of the practices in question, tacit skills drawn upon and possibly unconscious as well as conscious motivations." Once an explanation has been achieved, it in turn becomes the object to be explained, a step in the research process that is equally applicable to the natural and social sciences. However, "…as social structure is dependent on human agency, social forms cannot be expected to endure in the sense (or to the degree) that many natural structures and mechanisms do." "In consequence, social explanation will usually need to include an explicit account of the agent-dependent manner of reproduction and/or transformation including the possible demise (and perhaps also the genesis) of any set of social structures identified as explanatory significant."

The central question of methodology in social science is how to manage without the possibility of experimental control. Experimental control meaning the ability to intervene in the world so that certain causal mechanisms can be more easily identified or related theories more easily being tested. The mechanism being investigated needs thereby to be enabled or triggered and countervailing mechanisms prevented from interfering. The underlying assumption in experimentation is the endurability of the phenomenon being investigated. Although social structures and mechanisms cannot be intentionally activated (without affecting the outcome) it does not mean they cannot be detected. It implies, however, that explanatory research is necessarily backward looking. And "[a]lthough the social world is open, dynamic and changing, certain mechanisms may, over restricted regions of time-space, be reproduced continuously and come to be (occasionally) apparent in their effects at the level of actual phenomena, giving rise to rough and ready generalities or partial regularities, holding to such a degree that *prima facie* an explanation is called for." These partial regularities, or demi-reg, is a "…partial event regularity which *prima facie* indicates the occasional, but less than universal, actualization of a mechanism or tendency, over a definite region of time-space. The patterning observed will not be strict if countervailing factors sometimes dominate or frequently co-determine the outcomes in a variable manner. But where demi-regs are observed there is evidence of relatively enduring and identifiable tendencies in play." "…[m]ost social demi-regs capture reasonably systematic differences (or more generally patterns) at the level of actual outcomes between two groups[34] whose causal histories are such that the outcomes in question might reasonably have been expected to be broadly the same… …[but] which is systematically at odds with what we observe." The difference in empirical facts in a relationship leads to the notion of *contrastive social demi-regs*. The detection of such *contrastives* is a typical starting point for social, as well as natural, scientific investigations; "…by their nature, by the fact that they are patterned at all, they reveal something in turn of the nature of the tendency in play." [35] It follows that explanatory projects are inherently dependent on the interest of the researcher, not only through the choice of phenomenon to be explained, but "…also by selecting the contrast, the particular explanatory mechanism to be researched."

Following the identification of the demi-reg is the investigation into the underlying causal factors. The reasoning by which causal hypotheses are obtained is retroduction, rather than deduction or induction. "The aim is not to cover a phenomenon under a generalization… …but to identify a factor responsible for it, that helped produce, or at least facilitated, it. The goal is to posit a mechanism (typically at a different level to the phenomenon being explained) which, if it existed and acted in the postulated manner, could account for the phenomenon singled out for explanation."

The process of retroduction proceeds through analogy and metaphor, and is influenced by the investigator's perspectives, beliefs and experience.

Given that testing of an hypothesis in social sciences is not available, event-predictive accuracy can not be used as criterion for theory selection. Hence, theories have to be appraised based on their explanatory power. This appraisal can be based on deduction followed by an empirical assessment to "…search out that theory whose consequences appear mostly born out and which illuminates the widest range of empirical phenomena including any intersection upon which all competing theories have some possible bearing." Also a single maintained hypothesis can be "…continually assessed, by examining the range of phenomena it bears upon." A third step in the process involves explaining the explanation, including "…identifying the conditions of any explanatory mechanism and checking they are or were operative." "In the social realm… …if structures and mechanisms endure over stretches of time-space it can only be by way of human action. If then we wish to explain some relatively enduring contrastive demi-reg, a full understanding of the situation requires that the mode of reproduction of the identified causal mechanism be itself investigated.

"In order to account for the range of actual phenomena [in a continuum from closed systems of constant conjunctions of events to an inchoate random flux, with contrastive demi-regs lying between these extremes] it is necessary that economic explanation be divided into two relatively distinct movements or separate modes of activity." On the one hand "…*pure* or *abstract* or *theoretical* explanation, the identification of underlying structures, powers, mechanisms and their tendencies", and on the other hand *applied* or *concrete* or *practical* explanation." The latter being used if concrete phenomena or experience are "…relatively unique or novel, being conjunctures of numerous countervailing tendencies, their explanation entails drawing upon *antecedently established knowledge* of relatively enduring structures and mechanisms (rather than revealing them), and investigating the manner of their joint articulation in the production of the novel event in question." "Applied explanations… …are characteristically *resolutive* and *retrodictive*. They entail, first of all, the resolution of conjunctions or complexes, and the redescription of their components. This is followed by the determination (retrodiction) of possible

antecedents of these components, and the empirical elimination of possible causes." Our research project falls in the category of *applied* explanation.
Lawson further argues that: "In order to illuminate a structure responsible for the production of some phenomenon of interest it is necessary to identify connections and relations essential both to that structure's efficacy and to its existence and mode of reproduction. A comprehension of any (set of) structure(s) will entail identifying the nature of its internal relatedness as well as its particular history."
The research approach as elaborated can be summarized in five steps as depicted in Table 2.

Step:	Activity:
1.	Identification of an interesting (contrastive) *demi-reg*
2.	Investigation into the underlying causal factors using retroduction and to posit a mechanism that could account for the phenomenon singled out
3.	Appraising the alternative theories on the basis of their explanatory power
4.	Explaining the explanation, "…identifying the conditions of any explanatory mechanism and checking they are or were operative."
5.	Identification and illumination of the mode of reproduction or transformation

Table 2. Critical realism - research approach summary

4.5 Critical realism and policy

According to Lawson the critical realism approach provides a much more meaningful contribution to economic policy than the mainstream economics project (Lawson, 1997 p275-81)[36]:
"[T]he most that supporters of the traditional, positivistic, constant-conjunction view of science can sustain with any consistency is the goal of *control* along with the *amelioratio*n of events and states of affairs, the critical realist perspective instead offers the real possibility of human *emancipation* through *structural transformation*. For if according to the former view the (only conceivable) point is to (attempt to) fix a set of events x in order to determine and thereby control a dependent set of events y, on the critical realist understanding a feasible aim is to transform real social structures in order to facilitate alternative opportunities. There thus arises the possibility of enhancing the scope for human potentials to be realised, of broadening human opportunities; it is feasible to think in terms of replacing structures that are unwanted, unneeded and restrictive by those that are wanted, needed and empowering."
Two scenarios can be distinguished, one whereby there is no misunderstanding of the nature of the structures or mechanisms involved, and a more interesting one which is referred to as *explanatory critique*. "This is a situation in which beliefs are shown to be inadequate to their situation. This scenario focuses on a critical possibility, available only to the social (i.e. not natural) science, wherein it may be possible to transform a set of structures through facilitating change in the manner in which each is understood." In other words; "..it lies within the potential of social science both to identify discrepancies between social objects and general beliefs

about and expectations of, or relevant to, those objects and also to provide an explanation of such discrepancies, i.e. to identify the social causes responsible. When this is achieved the basis is clearly laid for the possibility (although it will never be sufficient for the realisation) of rational, intentional, social transformation, in particular through a modification of the practices on which the structures of relevance depend."

This perspective facilitates the understanding of euphoria. Moreover, it provides a linkage between policy formation and the occurrence of technological revolutions and changes in the techno-economic paradigm, of which historical analysis has shown that the actors involved will adjust structures, institutions and governance regimes, to achieve a better fit with the new paradigm.

4.6 Critical realism and forecasting

Lawson's argumentation is that success in economic forecasting is unlikely, is not essential and hence is not wanted (Lawson, 1997 p282-9). An observation that has a significant bearing on our aim to articulate the 'impact for policy and strategy in the aftermath'.

He claims that: "If the predictive goal is the successful forecasting of scientifically significant economic *events* or *states of affairs* then an implication [of the above] is that such a goal is likely to be only rarely realised, at least in an unqualified form. Prediction of non-experimental events rests upon spontaneous occurrences of constant event conjunctions which… …are not widely in evidence in the social realm and seem unlikely to be." This does not exclude the possibility of "…predictable tendencies, or on occasion to anticipate limits to, or bounds on, the range of realisable outcomes… ...and other context-specific mechanisms may be known." Lawson argues that event prediction is not required for a successful science of economics: "For… …the primary aim of science is not the illumination or prediction of events at all but the identification and comprehension of the structures, powers, mechanisms and tendencies which produce or facilitate them. And this understanding is all that is required for policy analysis and (where feasible) effective action."

He concludes his project with: "If event prediction is neither possible nor necessary, it is equally undesirable. For the possibility of successful prediction, turning as it does on the existence of constant conjunctures of events, would mean either that the future is already determined, or, if exogenous variables could be fixed by us, open to social control. Either way the situation would be inconsistent with the possibility of generalized human choice and freedom. An attraction of the theory of reality and science defended here is that human choice, and indeed emancipation are sustained as real possibilities. From this perspective if follows that policies and strategies can be formulated with the objective not merely of ameliorating a greater or more desirable or equitable distributed range of human opportunities. Rational, intentional, emancipatory, real change is no longer found to be, as in positivism, in contradiction with the explanatory function of science including economics – indeed, it is recognised as being a very condition of science, properly conceived. Rather, critical realism provides a perspective of science, nature, society and economy that is not only explanatory powerful but also able to preserve the intuition that human social history is explicable and yet actively made."

5 Research design

The assessment of the impact of the Internet bubble on the development path of the telecom sector and the assessment of the implications for policy and strategy formation, in the view of critical realism, is hence not a quest for the identification of 'constant event conjunctions', but rather an effort to uncover particular social structures of significance. Structures to be understood to include rules, positions and relations; and structures to be understood to be constantly reproduced through human action, but also transformed through these actions. The phenomena to be explained are the practices in which people engage, how and/or why they are undertaken, given the physical, social and psychological conditions of the relevant actions.

This research approach appears to provide an almost natural fit for addressing research sub-question #1, which calls for the explanation of bubble phenomena, in terms of explaining 'the practices in which people engage, how and why they are taken, given the physical, social and psychological conditions of the relevant actions'. The related 'social structures of relevance', that are at the focal point in this project, are the entrepreneur, the management, the firm[37], the industry and the institutions[38], in their relation to the telecom sector. The inclusion of the management, as the lowest level of abstraction in terms of 'social structures of relevance', is considered important as it allows us to address more appropriately the social and psychological conditions for action during euphoria.

The same applies for research sub-question #2, which is directed at the uncovering of a potential broader phenomenon of which the bubble might be considered a part. The same social structures remain relevant –the firm, the industry, the institutions– but they are being considered at a higher level of abstraction, i.e. at the level of the economy and society at large.

Industry development resulting in a 'development path' of a sector or industry, the topic of research sub-question #3, and as defined in Section 2.3, is not a social structure, but a reflection of the results of the actions undertaken by the actors in the industry, measured at an aggregate level along a selected set of dimensions. The dimensions of the path provide a way of observing and interpreting the developments in an industry, an important input for policy and strategy formation.

Research sub-question #4 is aimed at the application of the stylized models developed as part of questions #2 and #3 to the Internet bubble, i.e. the re-occurrence of a 'demi-regs'.

The assessment of the impact of the bubble on the development path of the telecom sector, research sub-question #5 is, hence, first and foremost a matter of assessing the impact of the relevant actions, considered part of the bubble phenomenon, on the 'social structures of relevance', i.e. the management, the firm, the industry and the related institutions. These are considered the "points of interlock" between the bubble phenomenon and the developments in the telecom sector.

As we are interested ultimately, research sub-question #6, in the implications for policy and strategy formation, of particular importance are considered those actions, that, at an aggregate level, represent a transformation of social structure, rather than mere reproduction. As transformation may imply discontinuities or major shifts they form as such a trigger for the reassessment of current policy and strategy.
Policy and strategy formation can be considered as ‘social structures of significance’ in their own right, in particular when viewed as a ‘practice’ (Whittington, 2002a; Whittington, 2002b). Each involves a process in the social domain, with a content and a context dimension. These ‘social structures’ are not the topic of research in this project *per se*, but are covered to the extent necessary to address the potential implications on policy and strategy formation.
In reflecting on the implications for policy formation it is of interest to note that the critical realist perspective offers the real possibility of human *emancipation* through *structural transformation* (Lawson, 1997 p275-81). “There […] arises the possibility of enhancing the scope for human potentials to be realised, of broadening human opportunities; it is feasible to think in terms of replacing structures that are unwanted, unneeded and restrictive by those that are wanted, needed and empowering.” This is of particular interest as the assessment of the Internet bubble in the context of the broader phenomenon of Long Waves and Great Surges, research question #3, indicates potential benefits of facilitating the full deployment of a new techno-economic paradigm for the economy and society at large.

The research project thus described can than be considered as three intersecting trajectories. One trajectory addressing the ‘principles of euphoria’ as stand-alone phenomena (research sub-questions #1 – Chapter 2), a second trajectory addressing euphoria as part of a broader process of economic change, in particular within the concepts of the Long Wave and Great Surges (research sub-question #2 – Chapter 3). The third trajectory addresses the principles of industry development and the mapping onto the ‘development path’ (research sub-question #3 and #5 – Chapter 4, 5 and 7). These trajectories will be developed from general to specific. For the ‘principles of euphoria’ it implies the development of a ‘stylized model’ based on historical information on euphoria. The findings will be used to describe and explain the Internet bubble (research sub-questions #4 – Chapter 6). For the ‘development path’ this implies a starting point related to general theories of industry development, both static and dynamic, to be refined toward the application to network industries and subsequently the telecom sector. The implication of the bubble on the ‘development path’ of the telecom sector (research sub-question #5 – Chapter 7) will be derived through an assessment of the impact on the drivers and inhibitors of industry development. This will be preceded by an assessment of the path leading up to the bubble period (Chapter 5). The implications for policy and strategy (research sub-question #6 – Chapter 8) will be developed on the basis of the theoretical and empirical findings in each of the trajectories.
The three trajectories will be linked at the theoretical and empirical level using a *critical realist* view.

The overall flow of the research project is depicted in the *Framework of analysis* shown in Figure 2. It should be noted that the direction of the arrows in the figure only illustrates how the research questions in terms of information flow are linked. In practice the execution of the research project has been through many iterations.

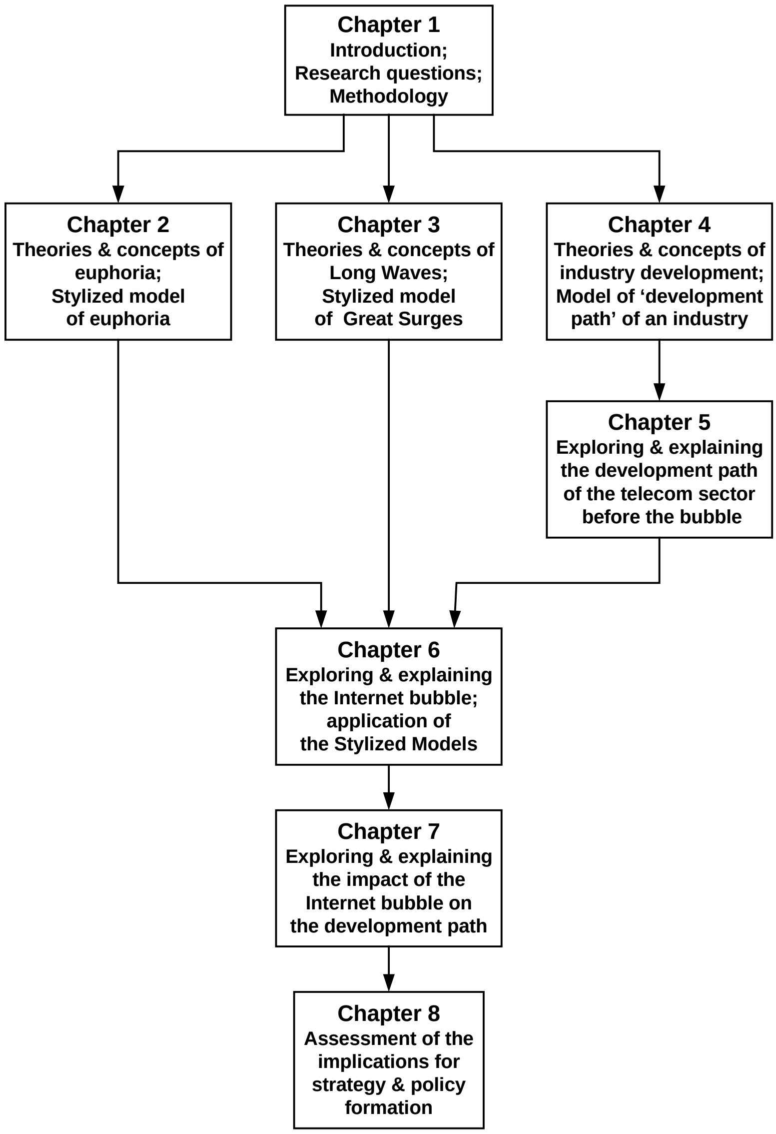


Figure 2. Research project flow

Considering the potential broad application of the research findings, as illustrated in Section 2 '*Exploring the nature of the project*', the implications of the Internet bubble on the development path of the telecom sector will be explored and

assessed at the sector level. Where feasible and appropriate the implications will be addressed for specific industry segments, e.g. telecom services, telecom equipment manufacturing. The focus of the research will be on the exploration and assessment of qualitative change, which will be supported where appropriate quantitatively.
This process is expected to provide the necessary input to generate the answer(s) to the research question:

> **What is the impact of the Internet bubble on the development path of the telecom sector, and what are the implications for policy and strategy formation?**

6 Data representation and sources

Following Baumard, "'[d]ata' is conventionally seen as forming the premises of theories. Researchers seek out and gather information -data- which can then be processed, using methodical instrumentation, to produce results and to improve on or to replace existing theories." Baumard considers this perception questionable as it assumes (1) that data precedes theory and (2) that data exists independently of the researchers. He argues that "[d]ata is both a repository for and a source of theorization. Above all, the datum is a premise; a statement in the mathematical sense, or an accepted proposition. Its acceptance can be stated openly or implicitly – information can be presented in such a way that it implicitly carries the status of truth." "Individual data items are [also] accepted representations of a reality that we are not able to grasp empirically (through the senses) or theoretically (through abstract thought)." (Baumard and Ibert, 2001 p69).
A data set can be compiled directly from events that are observable, or indirectly where it relates to representations of behaviour or attitudes, for which instrumentation is required to translate these phenomena into a set of measurements. See also Figure 3 (p70). In this research project we will use both the direct and indirect representation. This project is built on data acquired as a participant in the industry[39] and on secondary information sources. Preference is thereby given to sources with a global or regional orientation and with a high quality standing, such as the FCC, the ITU, the OECD, the World Bank and the EC.[40] More in depth sector specific information is derived from data provided by marketing research firms, company supplied information and sector specific literature sources. For the part on euphoria primarily scholarly literature has been used, and where appropriate use is made of more popular accounts of euphoria.

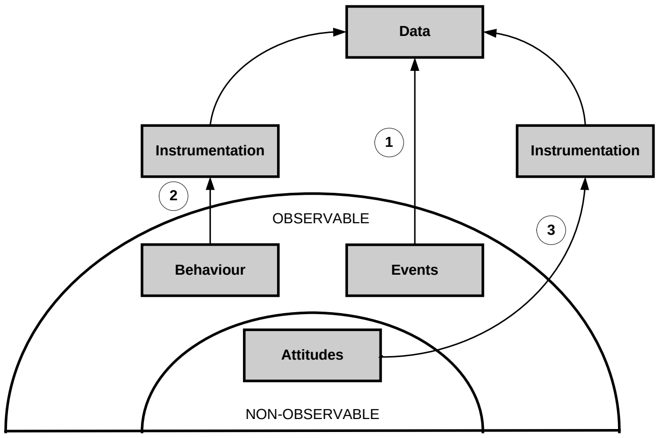


Figure 3. Three ways of compiling data

7 Quality assurance of the research

Four tests have evolved as standard practice to assure the quality of empirical social research, as stated by Yin (1989 p34), with reference to Kidder & Judd[41]:

- Construct validity: establishing correct operational measures for the concepts being studied,
- Internal validity (for explanatory or causal studies only, and not for descriptive or exploratory studies): establishing a causal relationship, whereby certain conditions are shown to lead to other conditions, as distinguished from spurious relationships,
- External validity: establishing the domain to which a study's findings can be generalized,
- Reliability: demonstrating that the operations of a study – such as the data collection procedures – can be repeated, with the same results.

As in the social sciences research often draws upon abstract concepts that are not always directly observable, the concept of construct validity is of special importance (Drucker-Godard, Ehlinger et al., 2001 p197). The guidelines as provided by e.g. Miles & Huberman (1994), Yin (1989), and Thietart (2001) will be applied in this project and are made explicit where appropriate.

In this Chapter we have introduced the topic of the research project, defined the research questions, and elaborated the research methodology. In the following Chapter we will explore the theories, concepts and models that provide an explanation of euphoria.

8 Notes for Chapter 1

[1] The first major landmark in the de-regulation of the telecom sector is considered to be the 1968 “Carterfone” decision by the FCC, allowing terminals supplied by other parties than AT&T to be connected to the AT&T network. To be followed in 1974 by MCI challenging AT&T’s monopoly in the long distance network (Brock, 1994).

[2] The Internet bubble is considered to have started in 1995, the year of the ‘displacement’ that triggered the boom period. See Chapter 6 Section 1.3.

[3] Stiglitz refers to two million jobs being lost in a twelve month period since the crash. In the USA the unemployment rate jumped from 3.8 percent to 6.0 percent (Stiglitz, 2003). See also Annex 4 *Downsizing in the aftermath*.

[4] According to Stiglitz: “…roughly a third of the worth of America’s individual retirement accounts, IRA and 401(k) plans, simply vanished.” (Stiglitz, 2003)

[5] For instance in the electricity sector: the intervention of the US government in the California energy crises, and the near-intervention by the Norwegian government as spot prices soured due to a lack of sufficient hydro-power (Midttun, 2003).

[6] The so called Lisbon goals were agreed in 2000 and are to be realized in 2010 (European Commission, 2000).

[7] The research project will reveal that next to the Internet bubble, a Telecom bubble has developed, or more precisely a series of telecom bubbles.

[8] The academic community is considered the primary audience for the scientific contribution of this research project. This community is expected to be interested in both the process and the content of the project. The policy makers and strategists are expected to be interested primarily in the content of the project.

[9] In the USA most operators were already private entities listed at the stock-market, albeit operating under a tight regulatory regime. In Europe the privatization started in 1984 in the UK, to be followed by Denmark in 1991. By 2000 most of the European incumbents were fully or partially privatized. See also Chapter 6 Section 2.1.2.

[10] Pub. L. 104-104, 110 Stat. 56 (1996). Telecommunications Act. See for instance (Neuchterlein and Weiser, 2005).

[11] Commission Directive 96/19/EC of 13 March 1996 amending Directive 90/388/EEC with regard to the implementation of full competition in telecommunications markets, and Commission Directive 96/2/EC of 16 January 1996 amending Directive 90/388/EEC with regard to mobile and personal communications

[12] Terminology used by Perez to denote the periodic technological revolutions.

[13] The prospect of a Golden Age does not imply that it will occur under all conditions. The Great Depression, following the crash of 1929, is a case in point.

[14] Perez points to the occurrence of bubbles as an intrinsic part of the establishment of a new techno-economic paradigm, and hence re-occurring with each Great Surge (Perez, 2002).

[15] This exploration will be based on secondary literature, primarily Chancellor, Freeman & Louçã, and Grote Lewin (Grote Lewin, 1968; Chancellor, 1999; Freeman and Louçã, 2001).

[16] Mintzberg distinguishes the following Schools with their particular emphasis in the strategy formation process: Design School – Conception; Planning School – Formal process; Positioning School – Analytical process; Entrepreneurial school – Visionary process; Cognitive School – Mental process; Learning School – Emergent process; Power School – Process of negotiation; Cultural school – Collective process; Environmental school – Reactive process; Configuration school – Process of transformation (Mintzberg, Ahlstrand et al., 1998).

[17] Resources are considered to include: tangible (land, buildings, materials, money) and intangible resources, the latter to include relational resources (relationships, reputation) and competences (knowledge, capabilities, attitude) (De Wit and Meyer, 2004).
[18] The implied suggestion is that governments can remedy market failure. However, there is also 'non-market' failure. For government intervention to be legitimate from an economic point of view, the cost of intervention should be lower than the cost of the market failure. See for a more extensive review e.g. Markets or Governments by Wolf (Wolf Jr., 1990).
[19] Static or allocative efficiency: resources are being allocated to the production of the goods and services most valued by society. Dynamic efficiency: relates to the time, effort and resources applied to innovation or the renewal of products and production processes.
[20] For the moment we will be ignoring the notion that the telecom sector includes multiple industries. While these industries are closely linked their development paths are distinct.
[21] A dominant business model refers to a situation whereby many competitive firms apply the same principles in the way they approach the market in terms of pricing, the products and/or services they provide, the production resources they deploy, the direction of R&D they pursue.
[22] Andersen denotes these Schumpeterian techno-economic paradigms as 'meta-paradigms' (Andersen, 1998).
[23] The development of the Internet bubble and its collapse have been experienced first hand from the perspective of a senior manager and executive in a telecom equipment, software and services supply company. The notion of having been 'subject' of the bubble, has stimulated the idea to make the bubble 'object' of study.
[24] Notably Perez distinguishes between financial capital and production capital, and links these to the different phases of the Great Surges (Perez, 2002).
[25] In this context we refer to the entrepreneur as in the encompassing view of Casson: "An entrepreneur is someone who specializes in taking judgmental decisions about the coordination of scarce resources." A definition that is considered to include Knight's notion of 'willing to tolerate uncertainty', Kirzner's notion of 'alertness', Schumpeter's notion of 'ruthless capability to smash the opposition' and Shackle's notion of 'creative imagination'. We refer to both the entrepreneur within the incumbent firm, as well as the new entrant. Whereby the latter may be considered innovative and rule breaking, as emphasized in the Schumpeterian view of the entrepreneur (Ricketts, 2002).
[26] This choice is influenced by considerations of importance of the various segments, as well as by the 25 years of accumulated experience of the researcher in the telecom equipment segment of the industry, through engagements with Philips, AT&T and Lucent Technologies.
[27] See Chapter 6 Section 2.3.2.
[28] Page 16 in: Robbins, L. (1932). An essay on the nature and significance of economic science. London: Macmillan.
[42] While Lawson makes a comparison between the natural and the social sciences, the distinction is even more pronounced for the physical and the social sciences.
[29] An atomistic ontology is related to the notion of reductionism as in classical mechanics (Davis, Hands et al., 1998).
[30] Nobel Laureate Laughlin argues that also in physics reductionism (atomism) falls short of providing the fundamental explanation of many phenomena. He argues that many phenomena are emergent (Laughlin, 2005).
[31] Here Lawson follows the lead provided by Bhaskar and others. Chalmers points in this respect to the fact that science not just describes the observable world but also the world that lies behind the appearances, a notion that is emphasized in *realism* (Chalmers, 1999).
[32] The Tables are constructed by the author, unless stated otherwise.

[33] Lawson provides the examples of a bicycle having the capability to facilitate a ride, gunpowder of causing an explosion.
[34] Lawson draws a parallel with the use of a primary and a control group in many experiments in the natural sciences.
[35] Statistical techniques may be used to investigate the nature of these regularities, the parallels and contrasts.
[36] Wilson observes that Lawson's critique on the mainstream economics project, and its reliance on 'constant event conjunctions', should be considered next to the emphasis placed in *critical realism* on the research of 'demi-regs'. Wilson asserts that 'demi-regs' are a limited form of 'constant event conjunctions', those that are limited in place and time, i.e. that represent only a local closure. He points to the hypothesis of 'structural change' as an alternative explanation for many of the failures of econometrics. He also argues that the philosophical underpinnings of mainstream economics are Newtonian and Cartesian, rather than rooted in Humean ideas of causality (Wilson, 2005).
[37] The term firm is used in a generic sense, i.e. to include pure hierarchies as well as loosely coupled networks of organizations.
[38] Institutions in this context are considered to include: the government, national regulatory agencies (NRAs), the stock market, the legal system, the monetary system.
[39] This covers a period of 25 years at the supply side of the telecom industry, in functions ranging from systems engineering, product management, business management and marketing to business development and strategy. The most recent period as Vice President and Member of the Management Team responsible for the region Europe, Middle East and Africa.
[40] As Baumard argues the objectivity of this published information should not be taken at face value (Baumard and Ibert, 2001).
[41] Kidder, L . and Judd, C.M. (1986). Research methods in social relations (5th ed.). New York: Holt, Rinehart & Winston.
[42] While Lawson makes a comparison between the natural and the social sciences, the distinction is even more pronounced for the physical and the social sciences.

2

A stylized model of euphoria

A synthesis of concepts, models and historical data

Table of Contents

"The circumstances that induce the recurrent lapses into financial dementia have not changed in any truly operative fashion since the Tulipomania of 1636-1637."
Galbraith[1]

1 Introduction

To facilitate the description and explanation of the so-called Internet bubble, the topic of Chapter 6, we will derive in this Chapter a stylized causal model of euphoria, following the guidelines provided by Thietart et al. (2001 p267-92). This model will be based on an exploration of the literature on the topic of bubbles, mania's and crashes and developed by identifying the common patterns or 'demi-regs' of similar human behaviour during different periods of euphoria.

2 Principles of bubbles

A broad range of terms, often with a highly emotional connotation, is being used to indicate periods of considerable growth, combined with financial speculation that concluded with a crash: bubbles, manias, delusions, irrational exuberance. Although conveying a strong message, these terms are rather imprecise. In the analogy with a bubble, the emphasis is put on the bursting aspect. Use of the word mania puts the emphasis on the period prior to the crash. In this project the term euphoria[2] will be used, following the lead by Galbraith in A short history of financial euphoria (Galbraith, 1990).

Recognizing that we are concerned with asset price bubbles the definitions as relayed by Meltzer will be used as starting point. The standard model values the asset as: "…the present value of the stream of dividends that the owner expects to receive. If prices conform to this expectation, the rational expectations equilibria are said to be driven by fundamentals, if not they are called "bubble solutions" or bubbles."[3] Nonrational bubbles can be loosely defined as: "…a rise in the price of an asset or asset class that generates additional increases, a rapid upward price movement based on exaggerated beliefs about the potentials of a new technology or organizational structure to generate earnings. The rise is followed by a collapse (Meltzer, 2003 p24-6).
Shiller observes that this explanation seems very unsatisfactory as: "…there obviously will be some foolish people who might be vulnerable to exaggerated expectations in response to past price increases, but, there are also some very smart people who seem to be going along with the bubbles, not betting heavily against them. Thus, it does not seem right to attribute foolish behaviour to the market." (Shiller, 2003 p35). He emphasises the difficulty to explain the stock market phenomenon, and points to the many contributing factors that have been brought forward, and in his view these need to be integrated to provide a more holistic explanation.
In the short history by Galbraith, in which he describes the phenomena of financial euphoria that have occurred in the past three centuries, it becomes apparent that 'euphoria' are not unique, but have common characteristics and are similar in their

'principle of operation', although the source of the euphuism may vary widely, from tulip bulbs and real estate to oil and junk bonds (Galbraith, 1990). He summarizes the principle operation as follows: "Individuals and institutions are captured by the wondrous satisfaction from accruing wealth. The associated illusion of insight is protected, in turn, by the oft-noted public impression that intelligence, one's own and that of others, marches in close step with the possession of money. Out of that belief, thus instilled, then comes action -the bidding up of values....The upward movement confirms the commitment to personal and group wisdom. And so on to the moment of mass disillusion and the crash" (p106). Galbraith identifies four common factors contributing to speculative euphoria, which can be summarized as follows (p12-24):

<u>Extreme brevity of the financial memory</u>.
History shows that financial disaster is quickly forgotten. This allows for euphoria to recur under often similar circumstances, presented as brilliant innovations by a 'supremely self-confident generation'.

<u>Specious association of money and intelligence</u>.
The rule derived from the case histories is: 'financial genius is before the fall'. With 'money as the measure of capitalist achievement', the possession of large amounts is often, but mostly unjustifiably, associated with some 'special genius'.

<u>Something new</u>.
Uniformly all euphoria are based on something new in the world, ranging from the 'seeming wonders of the joint-stock company' to the introduction of the 'free enterprise vision'.

<u>The (re-)discovery of leverage</u>.
Galbraith claims the rule that financial operations do not lend themselves to innovation. The proclaimed innovations are small variations on an established design, i.e. the 'creation of debt secured in greater or lesser adequacy by real assets'. He concludes: "All crises have involved debt that, in one fashion or another, has become dangerously out of scale in relation to the underlying means of payment." (p20).

Kindleberger (2000) uses a more formal economically driven model as a basis to describe general financial crises in his book Mania's, panics and crashes. In the Chapter 'Anatomy of a Typical Crisis' the starting point for Kindleberger is the Financial Instability Model developed by Minsky.[4] Minsky places the emphasis on the instability of the credit system and attaches great importance to "the role of debt structures in causing financial difficulties, and especially debt contracted to leverage the acquisition of speculative assets for subsequent resale" (p14). In the Kindleberger-model "events leading up to a crisis start with a 'displacement' or exogenous, outside shock to the macroeconomic system…If the source of displacement is sufficiently large and pervasive, it will alter the economic outlook by changing profit opportunities in at least one important sector of the economy. Displacement brings opportunities for profit in some new or existing lines and closes out others. As a result, business firms and individuals with savings or credit seek to take advantage of the former and retreat from the latter. If the new opportunities dominate those that lose, investments and production pick up. A boom is under way".[5]

In the model, the boom is than fed through the expansion of bank credit. Kindleberger expands on this notion by including other forms of monetary extensions, such as new credit instruments and expansion of personal credit outside of banks. Kindleberger then assumes that the urge to speculate is always present. And as demand grows faster than supply, this is leading to increasing prices. This in turn is leading to greater profit opportunities and to new investments, a positive feedback loop is developing. This may lead to 'euphoria' with speculation for price increases added to the investments for production and sale (p15). The ensuing 'boom' is further fuelled through the overestimation of prospective returns and the use of excessive gearing. "As the speculative boom continues, interest rates, velocity of circulation, and prices all continue to mount. At some stage, a few insiders decide to take their profits and sell out. At the top of the market there is hesitation…There may then ensue an uneasy period of "financial distress"…As distress persists, speculators realize, gradually or suddenly, that the market cannot go higher. It is time to withdraw. The race out of real or long-term financial assets and into money may turn into a stampede." (p17).

Displacements as "some outside event that changes horizons, expectations, profit opportunities, behavior" are many times events of war or significant political change[6] (p38-9). Examples of major displacements that are considered part of the model are: deregulation of banks and financial institutions.

Objects of speculation can be manifold. From the overview provided by Kindleberger (p41-3) the majority is of financial nature. About euphoria related to infrastructures only two objects of speculation are included:

- Canals: in Britain in 1793 and 1820, and in France in 1823;
- Railroads: in Britain in 1836 and 1847, in France in 1847 and 1857, and in the US in 1857 and 1873.

In his 1999 book Devil take the hindmost Chancellor subscribes to the economic model provided by Kindleberger, but proposes to add two conditions for the development of euphoria, one social and one political (Chancellor, 1999 p55-6):

- "that self-interest should be the principal economic motivation, since manias are less likely when society has other priorities" and
- "…speculation should be unchecked by government interference."

Shiller in his analysis of the most recent bubble in Irrational Exuberance (Shiller, 2001) explores in particular the 'ideology and psychology' of the market and provides additional inputs to the Minsky model. He identifies twelve factors that have a precipitating effect on the development of the most recent financial bubble:

1. The arrival of the Internet,
2. Triumphalism and the decline of foreign economic rivals,
3. Cultural changes favouring business success or the appearance thereof,
4. A Republican Congress and capital gains tax cuts,
5. The baby boom and its perceived effects on the market,
6. An expansion in media reporting of business news,
7. Analyst's increasingly optimistic forecasts,
8. The expansion of defined contribution pension plans,
9. The growth of mutual funds,
10. The decline of inflation and the effects of money illusion,
11. Expansion of the volume of trade: Discount brokers, day traders, and twenty-four-hour trading,
12. The rise of gambling opportunities.

Many of these factors are specific to the Internet bubble (1,4,5,8,9,12) other factors have been applicable to bubbles in general, albeit in varying forms (2,3,6,7,10,11). Most factors address the dimension of growing confidence, other the availability of credit or the opportunity for speculation.

Brenner in analyzing the US boom provides the economic backdrop against which the Internet bubble has developed (Brenner, 2002). His core arguments on the US boom evolve around the underlying dynamics of manufacturing over-capacity and the related lack of profitability in manufacturing, combined with the role of exchange rates in export oriented interdependent economies. Additional factors identified by Brenner that have driven the recent bubble are:

- the ample availability of liquidity and credit,
    - through a shift from savings to spending and borrowing,
    - through the availability of venture capital and IPO based financing,
- the role of real interest rates,
- a US policy shift from supporting the manufacturing sector to primarily supporting the financial sector,
- a shift from government debt to the use of private debt being used to pull the economy from stagnation,
- the role of the FED by not preventing but using the bubble to stimulate the continuing growth of the US economy,
- the wealth effect,
- the management of the volume of tradable shares to influence share prices.

The analysis by Brenner largely confirms the driving factors 1, 4, 8, 9 (Internet bubble specific) and 11 (common driver) as identified by Shiller.

In the collapse essentially the same positive feedback loops that have inflated the bubble, precipitate the crash, but much faster than the boom has been able to develop.
In the literature very little evidence is provided on the crash and the aftermath of bubbles. Galbraith provides a commentary: "After 1987 and still at this writing,

there are the heavy residue of debt from the exercise of leverage, the claims of interest as opposed to those of productive and innovative investment, and the trauma of bankruptcy. And there are the remaining effects of the losses by individuals and pension funds to the junk bonds." (Galbraith, 1990 p108).

2.1 Efficient market theory

The above exposé has assumed the existence of bubbles. According to the collegial definition used for bubbles, "any deviation from fundamentals", the market is expected to become inefficient when it 'looses its fundamentals'. This perspective is at odds with the efficient market theory that "asserts that all financial prices accurately reflect all public information at all times. Price may *appear* to be too high or too low at times, but… this appearance must be an illusion" (Italics in original, Shiller, 2001 p171). According to this theory stock prices approximately describe "random walks through time" (p171). Shiller claims that this theory has been statistically rejected many times, although as it is nevertheless described by some interpretations as "approximately true", it cannot be rejected out of hand. He develops his argumentation around four themes, that can be summarized as follows:

<u>The principle of 'smart money'</u>.
A compelling argument in support of the efficient market theory can be derived from the observation that it seems difficult to make a lot of money by buying low and selling high, at least with a consistent degree of success. The reasoning is that making money requires competing against some of the smartest investors. Or against so-called 'smart money'. This 'smart money' is always in search of a profitable trade and hence would drive asset prices to their true values.
As Shiller claims, the efficient markets theory does not exclude the possibility of stock markets going through periods of significant mispricing, as 'smart money' may not identify or exploit such opportunity rapidly enough to remove the uncertainty about pricing out of the market (p172-3).

<u>The notion of 'mispricing'</u>.
There are many salient examples given of apparent mispricing in an attempt to defeat the efficient market theory. These cases have been defended by others to demonstrate that these prices may not be wrong if considered over the long run. An analysis of the so-called Nifty-Fifty by Siegel[7] is a case in point. And also the analysis of the prices for rare tulips during the Dutch Tulip-mania as documented by Garber (2000).
There is also systematic evidence on firms that have performed poorly after a period of 'overpricing' when measured by conventional standards. The review by Shiller suggests that mispricing cannot be excluded (Shiller, 2001 p175-80).

<u>The linkage between earnings changes and price changes</u>.
The case that stock prices track earnings over time, i.e. price-earnings ratios have remained within a relatively narrow range despite great fluctuations in earnings, would suggest that the market is basically efficient. The evidence on this point is mixed. One can find historical periods in which the case seems to hold, but in

general price growth and earnings growth do not track well. The observed co-movement of stock prices and dividends is not consistent either, and as dividend levels are set by managers, they could be influenced by the same market perceptions (Shiller, 2001 p180-3). Data provided by Brenner on the recent years, to be discussed later, supports this conclusion.

The role of excess volatility.
In search of evidence in support of the efficient market theory, Shiller c.s. hypothesized a correspondence between the volatility of stock prices and the variability of dividends over long intervals of time. They concluded that "no movement of U.S. aggregate stock prices beyond the trend growth of prices has ever been subsequently justified by dividend movements.." (p183-5). The paper stating their findings apparently unleashed a lot of criticism, which they addressed and "felt that [they] had established in a fairly convincing way that stock markets do violate the efficient markets model" (p189).

2.2 Rationality of the individual, irrationality of the market

Mania's and panics, Kindleberger observes, are associated on occasion with general irrationality and mob psychology (2000 p 26). Next to mob psychology he identifies a number of other phenomena that are interrelated and contribute to the development of euphoria:

- While people are starting "…rationally and, gradually at first, then more quickly, losing contact with reality."
- "Rationality will differ among different groups of traders, investors, or speculators….",
- "All will succumb to the 'fallacy of composition' where the whole is other than the sum of its parts",
- "There will be failure of a market with rational expectations, as to the quality of a reaction to a given stimulus to estimate the right quantity; especially when there are lags between stimulus and reaction" [Italics in original],
- "Irrationality may exist insofar as economic actors choose the wrong model, fail to take account of a particular and crucial bit of information, or go so far as to suppress information that does not conform to the model implicitly adopted",
- "The irrationality of the gullible and greedy in succumbing to swindlers and defalcators".

Mob psychology he ascertains is well established as an occasional deviation from rational behavior, with the 'demonstration effect' examples in economics and the 'bandwagon effect' in politics.
Moreover, there are many manias that are examples of destabilizing 'cobweb' responses to exogenous shocks (p 32). See further Section 3.3.1 *Psychological factors and herd behavior*.

2.3 Speculative nature of the financial industry

Minsky in his interpretation of Keynes' General Theory points out the inherently speculative nature of the banking sector: "Whereas classical and the neoclassical synthesis are based upon a barter paradigm – the image is of a yeoman or a craftsman trading in a village market – Keynesian theory rests upon a speculative-financial paradigm – the image is of a banker making his deals on a Wall Street." (Minsky, 1975 p57-8). He further adds that: "Bankers can be speculators, just like other business men. In fact, because bankers' liabilities are demand, or short-term, deposits and their assets are mainly dated, term, or short loans, bankers are always speculators. They are always speculating in their ability to refinance their positions in assets as withdrawals of deposits take place." (p121). He observes that the message implied in the work by Keynes was neglected: "it is finance that acts as the sometimes dampening, sometimes amplifying governor for investments. As a result, finance sets the pace for the economy." (p130).

3 A stylized model of euphoria

For the purpose of our research a stylized model of euphoria has been derived from the principles and concepts presented in the literature, mainly Kindleberger (2000), Galbraith (1990), Chancellor (1999), Shiller (2001) and Brenner (2002). In the following sections the basic principles of the model will be elaborated and illustrated on the basis of historical bubbles. To facilitate the initial explanation this model is highly simplified. In Chapter 6 we will address the application of this model to the Internet bubble.

3.1 Operating sequence

Assume the economy is operating under normal conditions. At a certain moment a significant event or change occurs affecting a particular sector of the economy, the displacement. This outside event changes the horizons, the expectations, the profit opportunities and the behaviour in the sector. Following the displacement a typical pattern starts to evolve that can be generalized as follows:

The expectations for the businesses involved are improving, resulting in accelerated investments by the insiders. The confidence in the future of the sector spreads and more entrepreneurs take part and more money to invest is made available by the financial industry, expansion of the sector occurs. The valuations of companies in the sector are growing. Share prices appreciate unabated and speculation on price increases is developing. The apparent easy way to gain wealth attracts outsiders to speculate. Companies downstream and in adjacent sectors of the economy are affected, contagion occurs.
At a certain point the confidence starts to erode as a result of unfavourable developments, distress starts to build. Insiders start to withdraw. The financial industry tightens credit conditions and speculators are forced to sell, the market starts to collapse. The process accelerates and results in a crash.

The sequence described is summarized in Figure 1. In parallel with this sequence the line of changing expectations is running. Expectations, as related to confidence, are playing a major role in the explanation of euphoria. While expectations refer to the unfolding of events in the future, by first approximation it can be viewed as the first derivative (as in differential calculus) of the valuation of the assets that are subject to expansion, speculation and decline.[8] From the moment of displacement expectations are positive and confidence is growing. It reaches a peak during the speculative phase. From than on the sign changes, confidence is not growing anymore. From the point of distress confidence is decreasing even more rapidly, only to recover slowly in the aftermath.

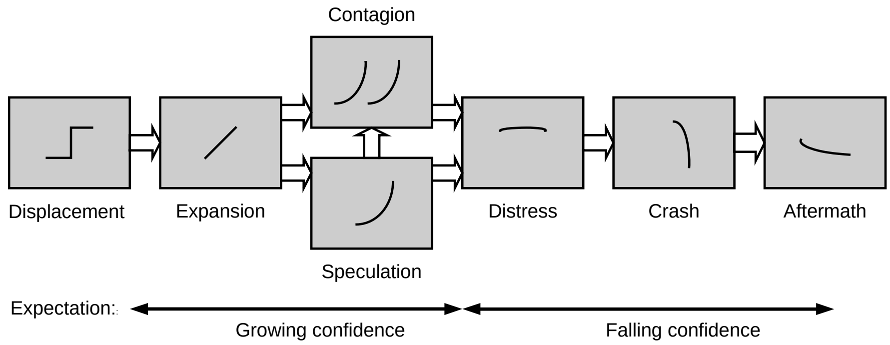


Figure 1. Typical operating sequence of euphoria

3.2 General operating principle of euphoria

On the principle that 'money walks' to find the best return against perceived risks, the boom develops on the basis of growing confidence. The growing confidence in the sector widens the availability of credit and reduces its costs, a process subject to a –first– positive feedback loop. Improving performance leads to higher valuations. Increases in stock prices attracts more investors and increases the available funds, another process that is subject to a –second– positive feedback loop. A side effect is that the rising stock prices have an expanding 'wealth effect' on corporate investment and on household consumption. This increase in paper wealth allows for increasing participation in the economy and hence leads to growth which in turn improves firm performance and subsequently firm valuations, a –third– positive feedback loop.

Financial leverage is the most powerful mechanism driving euphoria during the speculative phase. Contagion allows the process to spread wider in the economy. In the collapse the positive feedback loops accelerate the decline and the financial leverage precipitates the crash.

3.3 Feedback theories of euphoria

The operating principle of euphoria is often linked to positive feedback. See Section 3.3.2 for a further explanation on the theory of feedback loops. The most popular version according to Shiller is based on adaptive expectations, where "the feedback takes place because past price increases generate expectations of further price increases." (Shiller, 2001 p 60). In another version it is related to investor confidence which increase in response to past price increases, not so much sudden increase as well as a pattern of consistency in price increases. Other forms of feedback mentioned by Shiller occur when the “frame of mind reduce investors’ inclination to sell after a price increase, thus amplifying the effects of the precipitating factors on price.” (p 61). These are:

- “playing with the house’s money”,
- habit formation, in relation to higher consumption levels possible with higher prices.

While Shiller on the one hand claims that it is hard to prove that a simple price-based feedback mechanism is a factor in financial markets (p 64), he argues that the burden of proof is on the sceptics to provide evidence as to why Ponzi-like speculative bubbles cannot occur (p 67). Here he positions that speculative feedback loops are in effect naturally occurring Ponzi-schemes, which do arise from time to time without the contrivance of a fraudulent manager. The success of the Ponzi-scheme is that others have made a lot of money - “evidence that outweighs even the most carefully reasoned argument against the story.” (p 66). A further explanation for positive feedback to develop can be found in a range of social and psychological factors often referred to as ‘herd behaviour’.

3.3.1 Psychological factors and herd behavior

“A fundamental observation about human society is that people who communicate regularly with one another think similarly.” (Shiller, 2001 p148). Shiller explains this in part by pointing to the fact that people react to the same publicly available information. He also points to the famous experiments by the (social) psychologists Asch, Deutsch and Gerard, and Milgram. They demonstrated, according to the interpretations of their experiments, respectively the power of social pressure on individual judgement, the reaction of individuals on the information that a large group had reached a judgement different from theirs, and the power of authority over the human mind. He observes that: “given the kind of behaviour observed…it is not at all surprising that many people are accepting of the perceived authority of others on such matters as stock market valuation.” (p151). In this context also the common denominator for euphoria identified by Galbraith should be reiterated: “the specious association of money and intelligence” (Galbraith, 1990 p13-4).

Herd like behaviour is considered to arise from a so-called information cascade. According to this theory individuals, that may be completely rational, may prefer to follow others in their behaviour rather than exercising their own judgement. By ignoring the information that others may have, information cascade theories “…are theories of failure of information about true fundamental value to be disseminated and evaluated.” (Shiller, 2001 p152). This herd behaviour may be better understood if considered in the light of other traits typical of our species: our ability to effectively communicate important facts from one person to another, our incessant exchange of information and our tendency to pay more attention to interpersonal communications as compared to other forms of communication (p153-7). Another reason forwarded by Shiller for the contagion of ideas to happen quickly is the assumption that the ideas in question are already in our minds, even when they are conflicting. Our culture is said to transmit a number of supposed facts, and views that we think we have heard before, endorsed by experts.

Moreover, we appear to "…pay attention to many of the same things that others around us are paying attention to." But when asked what changed the focus of our attention, we appear to have difficulty to explain our changed behaviour. "This social basis for attention allows individuals who recognize the importance of some information to bring it to the attention of other members of the community. Such a view and information set allow the community to act well in concert." (p165). Galbraith describes crowd psychology as a broad and binding rule that is very hard to resist by any individual: "They will be required to resist two compelling forces: one, the powerful personal interest that develops in the euphoric belief, and the other, the pressure of public and seemingly superior financial opinion this brought to bear on behalf of such belief. Both stand as proof of Shiller's dictum that the crowd converts the individual from reasonably good sense to the stupidity against which, as he also said, "the very Gods Themselves contend in vain." (Galbraith, 1990 p5). He summarizes as follows: "The euphoric episode is protected and sustained by the will of those who are involved, in order to justify the circumstances that are making them rich. And it is equally protected by the will to ignore, exorcise, or condemn those who express doubts." (p11).[9]

3.3.2 The principle of feedback loops

To appreciate the notion of positive feedback a small side step into the field of control engineering is considered useful at this point. In the field of control engineering feedback loops play a major role in assuring that systems or processes demonstrate the desired output given a certain change in the input, even under unfavourable external conditions (Van Nauta Lemke, 1972). To generate this behaviour the output of the system is fed back and compared to the input, to generate an error-signal, see Figure 2. This signal is subsequently used to drive the system as quickly as possible, or alternatively with least cost, to generate the desired output.

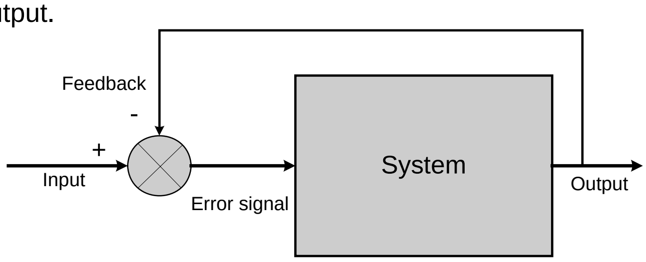


Figure 2. System with feedback loop

Systems with feedback are called closed systems, those without are denoted open systems. When the feedback signal has a different sign then the input, this is called negative feedback. Under these conditions the systems output will show an attenuation relative to the input signal. When the feedback signal has the same sign as the input signal this is called positive feedback. In this case the input signal will be amplified.[10]

The 'system at hand' is one of a complex nature with multiple inputs driving multiple outputs. The system is not only time dependent, but time dependent with delay, i.e. the changes in the input are not necessarily immediately reflected in the output. Moreover, the comparison and the integration of the input signal and the feedback signal is often a human affair. Hence, the system is typically non-linear and difficult to model with any precision. Moreover, in control engineering the system design is optimised to achieve a predefined goal, in the 'system at hand' there are many different actors pursuing a variety of goals. Hence, the analogy with control engineering can only be applied loosely and only where it serves explaining the phenomena observed.

In the following Sections we will first pay attention to the characterisation of the sub processes and on the understanding of the direction of change, the speed of change and the nature of the feedback. They will be described in a stylized form and treated as independent. In the application of the model, in Chapter 6, the attention will shift to the interrelationships and the relative importance of the different sub processes and feedback loops.

3.4 The displacement

At any point in time a displacement may occur that changes 'the horizons, the expectations, the profit opportunities and the behaviour in the sector'. This may be the discovery of profit potential in rare tulip species, trading profits from the new colonies, the appeal of new building sites, a new form of transport e.g. canals and railroads, and many more. Kindleberger provides a broad overview of the euphoria for the period 1618-1998 (2000 p223-32). This overview provides further insights in the economic or socio-political circumstances to which the displacement was related. For 50% of the cases this appears to be the end of war or hostilities, or relates to a boom period that followed the end of war, see Table 1. The next most significant category is related to major events in the financial markets, representing just over 25% of the total count of 38 events.

Period observed: 1618-1998 **Displacement related to:**	**Event count:**
War or hostility related, incl. post war boom	16
Financial market related, e.g. decline in interest rates, cut off of foreign lending	10
Political event, e.g. constitution adopted, campaign fraud exposed	3
Royal event, e.g. death of a king	2
Crop outcome, e.g. textile boom, wheat failure	2
Access to minerals and crop in colonies	2
Corporate structure, e.g. introduction of limited liability company	1
Other	2
Total	**38**

Table 1. Categories and count of displacements for the period 1618-1998

3.5 The expansion phase

According to Kindleberger speculation often develops in two stages: "In the first, sober stage of investment, households, firms, investors, or other actors respond to a displacement in a limited and rational way; in the second, capital gains play a dominating role." (Kindleberger, 2000 p27). The first phase, which we will call the expansion phase, is about changing expectations and profit opportunities, whereby participants will start to benefit from the improved business and market conditions, leading to a different behaviour in the sector. Already in this phase a first mechanism, that is subject to positive feedback and that drives the expansion phase, can be identified, i.e. the ‘cost of capital’.

3.5.1 Positive feedback in the expansion phase

Cost of capital:
In the context of capital investment considerations, the cost of capital is a factor subject to positive feedback, albeit within bounds. The cost of capital is firm specific and relates to how “…creditors and shareholders expect to be compensated for the opportunity cost of investing their funds in one particular business…” (Copeland, 1990 p171). For companies listed at the stock market, the share value reflects the cost of equity. Another indication of a firms cost of capital is reflected in the bond ratings it receives from the financial agencies, such as S&P and Moody’s. As the performance of the business improves, the valuations and the ratings improve, capital becomes less expensive and hence the ability to attract capital for investments that improve the performance of the business becomes cheaper and easier and thus the ability to generate positive cash flow larger, etc. This positive feedback loop operates within bounds as the costs are relative to the alternative use of capital in the market, and as firm performance is relative to other firms in the market. Also the reverse applies: if the performance of the business deteriorates, the ratings will start to fall and subsequently the cost of capital will increase, which will impact the performance of the business negatively. It should be noted that these values and ratings include an element of the future, i.e. it involves expectation, as the future position of a firm is being assessed, e.g. in relation to the ability to repay its debts. As an illustration, the valuation of the firm as expressed through its stock market value is considered to reflect its future potential to generate the expected return on investment. The market capitalization can be viewed as the discounted value of these returns, whereby the uncertainty of future returns is reflected in an increasing discount over time.

3.6 The speculative phase

In the speculation phase market participation is driven primarily by the anticipated increases in asset values, i.e. assets are being bought with the objective of a profitable resale. In terms of positive feedback during the speculative phase Galbraith provides a succinct description of the main feedback mechanism : “The speculation building on itself provides its own momentum.” (Galbraith, 1990 p3). He distinguishes two types of participants: “Those who are persuaded that some new price-enhancing circumstance is in control, and they expect the market to stay up and go up, perhaps indefinitely” and those “who perceive or believe themselves to perceive the speculative mood of the moment. They are in to ride the upward wave; their particular genius …will allow them to get out before the speculation runs its course.” (p3-4).

Following the displacement, the subject of speculation can be manifold as the historical analysis shows, see Table 2 (derived from the overview in Kindleberger, 2000 p223-32).

Period observed: 1618-1998 **Countries/Regions observed:** **NL, UK, FR, USA, D, IT, Australia, Europe, World** **Object of speculation, through contagion multiple objects possible:**	**Event count:**
Housing and building sites	10
Crop, e.g. cotton, wheat	9
Railways	9
Shares in shipping and trading companies, e.g. related to the colonies	7
Canals	5
Commodities	5
Land	5
Securities	5
Shares	4
Foreign exchange	3
Mining	3
Banks, e.g. stocks, loans	3
Export e.g. to colonies	2
Financial deregulation,	2
Government debt	2
Manufacturing	2
Transport e.g. tankers, aircraft, ships	2
Real estate	1
Tulips	1
New companies	1
Lotteries	1
Roads	1
Bonds, e.g. related to the colonies	1
Companies going public	1
Precious metals	1
Inventories	1
Oil	1
Other	2
Total	**90**

Table 2. Objects of speculation for the period 1618-1998

Real estate related bubbles form the largest category with 16 cases or 18% of the total of 90 observed bubbles. Infrastructure, e.g. road, canal and railway, related bubbles include 15 cases, to which one could add 2 transport related bubbles. It should be noted that while contagion may have set off a bubble in multiple countries, in this survey each country is counted individually.
In the speculative phase multiple processes with positive feedback are active, first and foremost:

- financial leverage, but also
- the wealth effect.

3.6.1 Financial leverage

"Credit was the Siamese twin of speculation; they were born at the same time and exhibited the same nature; inextricably linked, they could never be totally separated." Here Chancellor refers to the English goldsmiths who had taken on the function of bankers, making loans and creating a market for merchants' bills of exchange or credit notes, after the Civil War of 1642-51 (Chancellor, 1999 p32). "…[T]his new form of credit had many properties in common with money. Yet credit, unlike gold, could be created and destroyed. It had no utility and its value depended on an act of belief from which it derives its name."
Using the overview provided by Kindleberger it shows that the sources of monetary expansion have been predominantly the banks, accounting for 25 cases out of 54 observed over the period 1618-1998, (2000 p323-32). See for a tabulation Table 3.

Period observed: 1618-1998 **Countries/Regions observed:** **NL, UK, FR, USA, D, IT, Australia, Europe, World** **Monetary expansion through, multiple causes:**	**Event count:**
Banks, incl. regional, country, joint-stock, industrial, broker, construction, named	25
Capital inflows from abroad	7
Debasement of coins	3
Wisselruiterij (chain of accommodation bills)	3
Clearinghouses	2
Securities bought on margin	2
Down payment in kind	1
Bonds sold in instalments	1
Retention of silver	1
Instalment sale of railway securities	1
Gold discoveries	1
Bank mergers	1
Joint-stock discount houses	1
Monetary contraction	1
Trust companies	1
Interest rate reduction	1
Other	2
Total	**54**

Table 3. Sources of monetary expansion

Monetary expansion as the major driver of euphoria points to increasing availability of money as the bubble builds: "Monetary expansion is systemic and endogenous rather than random and exogenous." (Kindleberger, 2000 p50). But, as Kindleberger observed money is "…an elusive construct, difficult to pin down and to fix in some desired quantity for the economy." (p53).[11]
As the stylized model of euphoria is qualitative rather than quantitative, we will side- step the debate on how to account for money and follow the description by John Stuart Mill, as quoted by Kindleberger (p54):

> "The purchasing power of an individual at any moment is not measured by the money actually in his pocket, whether we mean by money the metals, or include bank notes. It consists, first, of the money in his possession; secondly, of the money at his banker's, and all the other money due to him and payable on demand; thirdly of whatever credit he happens to posses." [12]

Table 3 eludes to various forms of monetary expansion, which can be further categorised, based on Kindleberger (2000 p49-64), as:
issuance of currency by private, country and joint-stock banks in the form of:

1. bank notes, representing promises to pay on demand,
2. bills of exchange, a claim for payment in the future made by a seller of goods on the buyer, used as a direct payment,
3. call money, or money lent to brokers by bankers “on call” that is, for one day,
4. capital inflow from abroad,

direct leverage is being created through:

5. delayed payment, or payment by instalments,
6. debt creation against limited assets, e.g. printed bank notes in excess of hard money deposited; gold-exchange standard; bonds against stocks, bonds against the credit of companies to be acquired (so called ‘junk bonds’),
7. financial intermediation, borrowing reserves by selling bonds in a foreign market and then holding the resulting currency as part of its central-bank reserves,

and indirectly leverage is being created through:

8. bills of exchange that represented debt in excess of debtor’s wealth.

Despite efforts of banking authorities to control and limit the money supply, e.g. by limiting the right to issue currency to central banks, setting reserve requirements, etc., each new euphoria has found its own “new’ way of leverage. As Galbraith noted: “…experience establishes a firm rule, …. The rule is that financial operations do not lend themselves to innovation. What is recurrently so described and celebrated is, without exception, a small variation on an established design, one that owes its distinctive character to the [aforementioned] brevity of the financial memory.” (Galbraith, 1990 p19).
Chancellor adds to the notion of speculation: “It is often said that speculation never changes because human nature remains the same. “Avarice, or desire of gain, is a universal passion which operates at all times, in all places, and upon all persons,” wrote David Hume in the eighteens century. To this we might add that the fear of loss, emulation of one’s neighbour, the credulity of the crowd, and the psychology of gambling are equally universal…These emotions are unleashed during moments of speculative euphoria.” (Chancellor, 1999 p57).

3.6.2 Other forms of positive feedback during the speculative phase

<u>The wealth effect</u>
During the boom period and in particular during the speculative episode, the rising stock prices have an expanding ‘wealth effect’ on corporate investment and on household consumption. This increase in paper wealth allows for increasing

participation in the economy and hence leads to growth which in turn improves firm performance and subsequently firm valuations.

Self-fulfilling psychology
Shiller identifies, in relation to the bubble of the late Nineties, twelve factors that he claims have "…contributed to the self-fulfilling psychology of a roaring stock market. It is the self-fulfilling psychology that –at least for now– binds the bubble." (Shiller, 2001 p19). See also the overview of the twelve precipitating factors (not necessarily with positive feedback) in Section 2 Principles of bubbles.

3.6.3 Euphoria and swindles

As noted by Kindleberger "the propensity to swindle and be swindled run parallel to the propensity to speculate during a boom." (Kindleberger, 2000 p73). But, not all bubbles are swindles nor will all swindles turn into bubbles. Salient examples of swindles are:

- John Law and the Mississippi System in 1716,
- George Hudson chairman of the York and North Midland railway in 1846,
- Charles Ponzi and the 'Ponzi' schemes in 1920.

It suffices here to refer to the accounts of swindles documented in e.g. *Extraordinary popular delusions and the madness of crowds* (Mackay, 1841), *Devil take the hindmost* (Chancellor, 1999) and *Manias, panics, and crashes* (Kindleberger, 2000).

3.7 Contagion

The quote of John Stuart Mill, cited by Chancellor, implies the notion of contagion as part of speculative euphoria: "Some accident which excites expectations of rising prices…sets speculators at work…In certain states of the public mind, such examples of rapid increase of fortune call forth numerous imitators, and speculation not only goes much beyond what is justified by the original grounds for expecting a rise of price, but extends itself to articles in which there never was any such ground; these however, rise like the rest as soon as speculation sets in. At periods of this kind, a great extension of credit takes place." (Chancellor, 1999 p53-4). The transmission mechanism responsible for contagion between international markets are manifold: "arbitrage in commodities or securities (and marking up or down prices in one market when they change in another, without actually buying or selling), movements of money in various forms – specie, bank deposits, bills of exchange, interest rates changed through uncovered arbitrage, cooperation among monetary authorities, and, readily neglected, pure psychology." (Kindleberger, 2000 p119). In summary: "In boom, speculative markets rise together." (p111).

Through the overview of topics of speculation, provided by Kindleberger, some insights are provided in the related areas of speculation, e.g. in England 1836: cotton and railroads; in the U.S. in 1837: cotton and land. In Table 4 examples of national contagion are summarized.

Examples of national contagion:	Euphoria:
Shares Dutch East India Company – tulip bulbs – canals	Dutch Republic – 1636-1637
East India Company – treasure – new companies – lotteries	England – 1690-1696
Housing – turnpikes – canals	Britain – 1772
Latin American bonds – mines – cotton	England – 1825
Canals – cotton – building sites	France – 1828
Cotton – railroads	England – 1836
Cotton – land	U.S. - 1837
Railroads – public lands	U.S. – 1848
Securities – ships – commodities – inventories	Britain & U.S. 1920 – 1921
Stocks – REITs – office buildings – tankers – Boeing 747s	U.S. – 1974 - 1975

Table 4. Examples of contagion

3.8 Distress

A change in expectations from a state of confidence to one lacking confidence in the future is considered central to the phase of distress. This phase may be different across euphoria as "[e]xpectations in the real world may change slowly or rapidly, and different groups may wake up to the realization – sometimes at different rates and sometimes all at once – that the future will be different from the past." (Kindleberger, 2000 p91). The phase of distress essentially reflects that "the credit mechanism has been stretched taut, beyond normal limits." (p96). Or in the words of Shiller: "Regardless of which feedback theory applies, the speculative bubble cannot grow forever. Investors' demand for a stock cannot grow forever." (Shiller, 2001 p61). If there is no panic the period of distress may subside, there may also be multiple short periods of distress, or it may be concentrated into a few days. The signal for panic, turning the distress into the crash, is often the revelation of some swindle, theft, embezzlement, or fraud (Kindleberger, 2000 p73).

3.9 The crash

"When [the crash] comes, it bears the grim face of disaster. That is because … participants in the speculative situation are programmed for sudden efforts at escape." (Galbraith, 1990 p4). "A crash", according to Kindleberger, "is a collapse of the prices of assets, or perhaps the failure of an important firm or bank. A panic…may occur in asset markets or involve a rush from less to more liquid assets. Financial crisis may involve one or both, and in any order." (Kindleberger, 2000 p105).
The underlying operating principle is again one of positive feedback, in the form of a chain effect. As prices fall the value of the collateral drops and banks will recall loans. The repayment of loans will force the sale of securities and other assets, bringing further down the prices. This will lead to further liquidation. As a result firms may fail and bank loans go bad. This may lead to banks failing, leading depositors to withdraw their money. All crises, according to Galbraith, have involved "debt that, in one fashion or another, has become dangerously out of scale in relation to the underlying means of payment." (Galbraith, 1990 p20).

There is an ongoing debate whether in such cases the market should run its course and purge the system or there should be intervention to, at least an attempt to, halting a possible deflationary panic, that may spread and wipe out sound investments that may not be able to obtain the loans necessary to ensure survival. (Kindleberger, 2000 p139-144). The ensuing discussion on the role of the so called ‘lender of last resort’ to mitigate the impact of a crash will not be discussed here.

3.10 The aftermath

In the aftermath of the speculative period another common feature of euphoria becomes apparent. According to Galbraith: “This [period], invariably, will be a time of anger and recrimination and also of profoundly unsubtle introspection. The anger will fix upon the individuals who were previously most admired for their financial imagination and acuity. Some of them…will…have gone beyond the law, and their fall and, occasionally, their incarceration will now be viewed with righteous satisfaction.” (Galbraith, 1990 p22).

In the aftermath there will be talk of regulation and reform. But what apparently will not be discussed is the speculation itself or the optimism that lay behind it. “Nothing is more remarkable than this: in the aftermath of speculation the reality will be all but ignored.” He states two reasons for this: one can attribute the error to individuals or individual firms but not to a whole community, certainly not to the whole financial community; and a theological reason that is that “…the market is a neutral accurate reflection of external influences; it is not supposed to be subject to an inherent internal dynamic of error.” He concludes to say: “Markets in our culture are a totem; to them can be ascribed no inherent aberrant tendency or fault.” (Galbraith, 1990 p22 & 24).

3.11 Observations

In the analysis of euphoria the contribution to economic development is in general perceived as negative. The impact of the crash in terms of financial losses, bankruptcies, loss of employment, as well as the unraveling of swindles dominate the perceptions in the aftermath, the period in which the evaluation tends to take place. Indeed during euphoria the allocation of resources may appear optimal for a number of actors for a certain period of time, it surely is not efficient when considered at the collective level and over a longer period of time. However, in particular in the sector in which the euphoria starts the extra financial stimulus may have some positive side effects. More funds become available for experimentation and innovation. New concepts may be developed and tested in the market, that otherwise would not have received the required funding.

Moreover, funds may become available for investment in projects that would otherwise fail the cut. Specially projects with a high upfront investment barrier and a high risk profile may benefit from the positive expectations and the increased financial opportunities. Infrastructure related projects are a case in point.

Considering that euphoria are a returning phenomenon of the capitalistic model and innovation being the engine of growth, euphoria may be further distinguished by the nature and extend of innovation and investment that is taking place during the expansive and speculative phases.

3.12 Mode of reproduction and transformation

As elaborated in Section 2 and 3 successive occurrences of euphoria have developed along the same operating principles. The main difference is the subject of euphoria. Hence, within the perspective of critical realism, they demonstrate a strong degree of reproduction.

4 Summary and conclusions

In this Chapter we have provided the answer to research sub-question #1: “How can ‘bubble phenomena’ be described and explained?”.

We have explored historical occurrences of ‘bubble phenomena’ and developed a ‘stylized model’ to describe and explain euphoria. The principle operating mechanism can be summarized as follows: Euphoria are triggered by a significant outside event that changes perceptions and expectations leading to expansion in a particular sector. Expansion evolves into speculation as assets are being bought and sold in anticipation of price increases. The principle mechanisms behind the boom are positive feedback loops of which the expansion of credit and the self-fulfilling prophecy are considered the most important ones. Precipitating factors further contribute to the acceleration process. During the frenzy swindles and malpractices start to occur. At the height of the boom expectations start to change often triggered by a notable event. Once the spell is broken the principle of leverage precipitates the crash.

The analysis of euphoria has revealed that expectations, in a much amplified way, play a key role in bubble phenomena. It is these expectations that link bubbles to the ‘development path’ of the telecom sector. It is not so much the actual values of the dimensions of the path that matter during bubble periods, but the expectations regarding the direction and pace of development of these dimensions that drive behaviour in the related industry, and in the financial sector. Hence, the colloquial definition of bubbles as ‘a deviation of fundamentals’. The key operating principle of euphoria are positive feedback loops, that operate either in an upward (boom period – growing confidence) or in a downward direction (crash – falling confidence). They operate in the financial and psychological domain and lead to monetary expansion, self-fulfilling prophecy and herd behaviour. Of interest for our research project is therefore to understand what the impact is of the growing confidence during the boom period and falling confidence during the crash. If the changes are of a temporary nature the long-term impact on the ‘development path’ may be expected to be small, and the impact for policy and strategy formation minor. However, if the impact is more pronounced, (e.g. a significant gap between capacity and demand) or impacting the industry structure, the development path will be affected on the long-term and potentially fundamentally. We will explore this notion in more depth in Chapter 6 *The Internet bubble explained*.

5 Notes for Chapter 2

[1] (Galbraith, 1990)
[2] According to Webster: Euphoria from the Greek *euphoros* healthy; a feeling of well being or elation.
[3] Meltzer further explores the notion of rationality in bubbles and concludes that: "At this stage in the development of economic theory, we must regard the rational bubble hypothesis as devoid of empirical content, or empty." (Meltzer, 2003).
[4] Minsky has reinterpreted the works by Keynes, in particular *The General Theory of Employment, Interest, and Money*, to conclude that: "Keynes's theory is an investment theory of the [business] cycle, in which consumption is treated initially as determining a passive amplifier, so that aggregate fluctuations are determined by investment fluctuations." This in contrast to the neo-classical synthesis that the *General Theory* presents an equilibrium model (Minsky, 1975). Following Minsky in his 1992 definition of the Financial Instability Hypothesis: "The [FIH] is a theory of the impact of debt on system behavior and also incorporates the manner in which debt is validated… …The first theorem of the [FIH] is that the economy has financing regimes under which it is stable, and financing regimes in which it is unstable. The second theorem of the [FIH] is that over periods of prolonged prosperity, the economy transits from financial relations that make for a stable system to financial relations that make for an unstable system." (Minsky, 1992).
[5] The emphasis placed by Kindleberger on the exogenous nature of the displacement can not be traced back to the (later) works of Minsky, which emphasizes the endogenous nature of the fragility or instability of the economy. Although, this work emphasizes the boom and bust of the business cycle, based on the notion of hedge, speculative and Ponzi "units", it does not address the occurrence or absence of bubbles at the end of a boom period *per se* (Minsky, 1975; Minsky, 1992). See also (Argitis, 2002).
[6] Kindleberger considers war together with maladroit recoinage and conversions as exogenous events, and hence are considered to be outside the model.
[7] The Nifty Fifty being a group of glamorous stocks in the early 1970's; in (Siegel, 2002).
[8] This stylized model describes, as if observed in hindsight, the aggregate performance of the sector subject to speculation.
[9] This topic is further addressed and explored in *Choices, values and frames* (Kahneman and Tversky, 2000) and *Alchemies of the Mind – rationality and the emotions* (Elster, 1999).
[10] A salient example of positive feedback occurs when a microphone, the input device, is held closely to the loudspeaker, the output device, of an audio amplifier.
[11] Kindleberger refers to the debate between the currency school and the banking school: "The two schools are locked in dialectical symbiosis. Coexisting at least since the seventeenth century and probably even earlier, the conflict continues today." (Kindleberger, 2000)
[12] J.S. Mill, in *Westminster Review*, vol. 41 (1844), pp 590-1, quoted in Jacob Viner, *Studies in International Trade*, p. 246.

3

Euphoria as part of a technological revolution

A stylized model of historical regularity

Table of Contents

"There can be understanding only if one is in tune with change."
Galbraith, 1987.[1]

1 Introduction

In the previous Chapter we have developed a stylized model of euphoria. Thereby we have considered euphoria as singular events. From the information provided by Kindleberger on the occurrence of euphoria we may conclude that euphoria are a frequent returning phenomenon of economic development (Kindleberger, 2000). Economic developments are in general characterized by ups and downs, as reflected in the business cycle. Kindleberger observes that euphoria are typically associated with the upswing of the business cycle. Porter argues that fluctuation in economic conditions over the business cycle are of tactical rather than strategic importance, as these short-run factors influence nearly all firms in many industries (Porter, 1980 p6), However, as De Wit observes, certain sectors of economic activity are more susceptible to economic fluctuations than others (De Wit, 1994 p1-2). Swings in demand will be transmitted along the value chain, and due to time, delays will be amplified. This applies in particular to 'durable consumer goods' industries, but also to e.g. the airline industry and the semi-conductor industry. The latter industries are characterized by deep investments and long pay-back times, which are not only influenced by the business cycle, but tend to exhibit a sector specific cycle, which is referred to as the industry cycle.
The nature of the telecom industry characterized by deep infrastructure investments and long pay-back times, suggest that the industry is in principle susceptible to an industry cycle. Considering the very recent liberalization of the telecom services industry, this phenomenon can only be emergent. See Annex 8 for an elaboration of the industry cycle in relation to the telecom industry.

In this Chapter we will investigate whether historical regularities can provide further insights into the potential impact of the Internet bubble on the development path of the telecom sector.

2 The business cycle

Fluctuations in economic activity measured at the macro-economic level are referred to as business cycle or trade cycle. When GDP is used as the aggregated measurement of economic activity, any regularity of economic development remains illusive, as for instance the official data on the turning points for the US economy over the period 1969-1991 illustrates. See Table 1. (Sherden, 1998 p72).
As national economies are becoming more and more globally connected, fluctuations tend to appear across the globe, albeit with some time delay and sometimes with regional specific overtones. See Figure 1 (OECD, 2003). Notwithstanding the lack of regularity, GDP development plays an important role in the telecom industry as demand for telecommunications service is strongly correlated with GDP, as suggested by the regression line in Figure 2 (Siemens, 1992).

Date of turning point	Direction of turning point	Number of month between turning points
December 1969	Peak	-
November 1970	Through	11
November 1973	Peak	36
March 1975	Through	16
January 1980	Peak	58
July 1980	Through	6
July 1981	Peak	12
November 1982	Through	16
July 1990	Peak	91
March 1991	Through	8

Table 1. Turning points in the economic cycle - USA 1969-1991

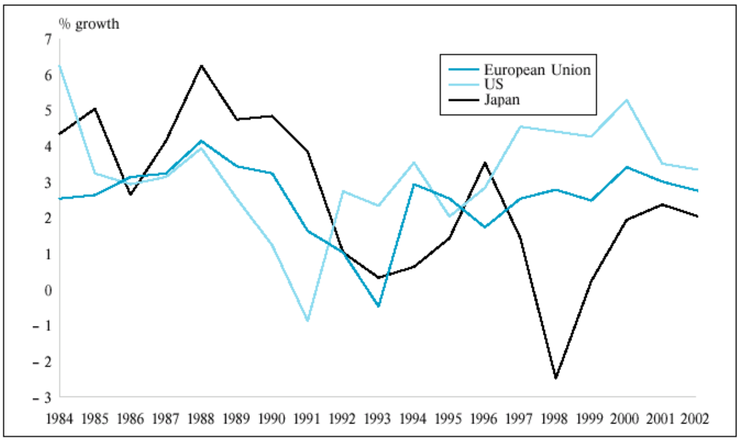


Figure 1. Regional GDP growth 1984-2002

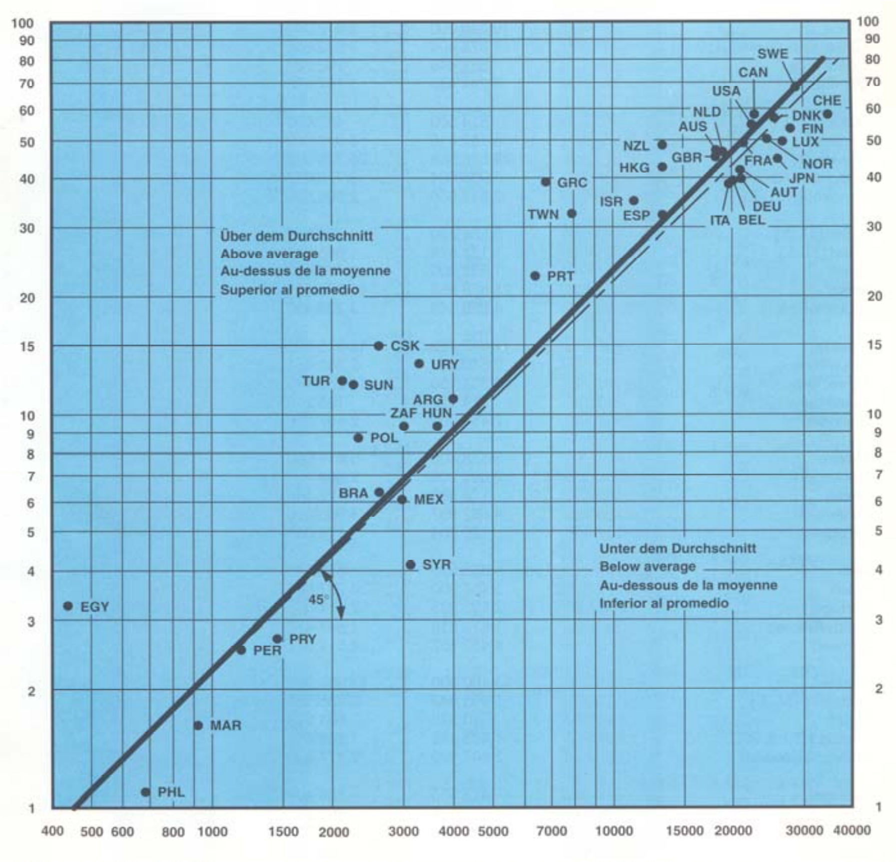
The relationship shown in the graph is represented by the following equation, as identified by Analysys[2]:

> Lines per Capita = 0.8*ln(GDP)+0.06*(legal&market index)+0.03*year –6.64[3]
> R^2 statistic=0.86,
> whereby the legal&market index has an average of 7.0 and a maximum of 8.5 for the period 1975-1990.

The strong relationship between GDP and teledensity is most dramatically illustrated for the period of the Great Depression, when teledensity declined in absolute terms. The direction of causality has remained subject of much debate.

Research executed by Naumov suggest that teledensity developments and in particular early developments, when considered at a country level, typically reflect a logistic or S-curved pattern. A pattern that is almost identical across countries when re-based to account for different starting points of development.[4]

Main lines per 100 inhabitants



GDP per capita US$

Figure 2. Teledensity and GDP per capita

Figure 3 shows the development of teledenstity for Western Europe over the period 1981-2000 (ITU, 2002). With the population growing over the period with a factor 1.11 and the number of lines doubling, teledensity has increased from 31 to 55. It can be noted from the graph that the developments in terms of fixed lines have been relatively smooth over the period of 20 years considered. An important development that has taken place in this period is the emergence of mobile communications. Figure 4 shows the development for Western Europe, whereby mobile penetration has surpassed fixed penetration in 2000, twenty years after the introduction of cellular telephony and less than ten years after the introduction of GSM - digital cellular. We will return to the topic of mobility in Chapter 7.

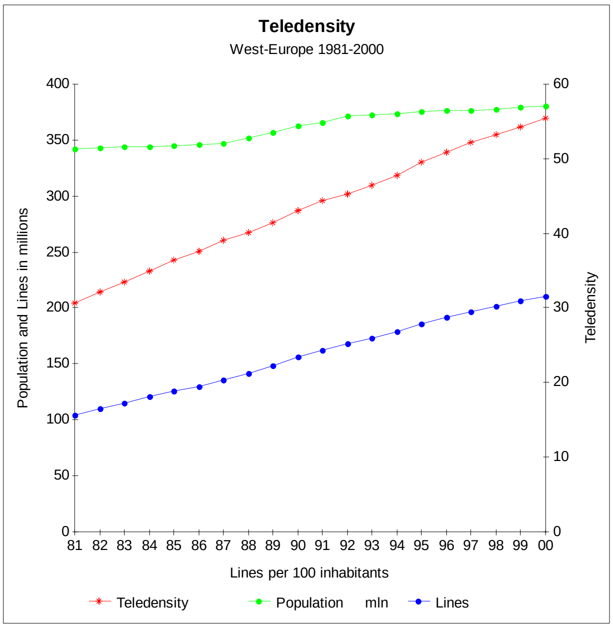


Figure 3. Teledensity in Western Europe, 1981-2000

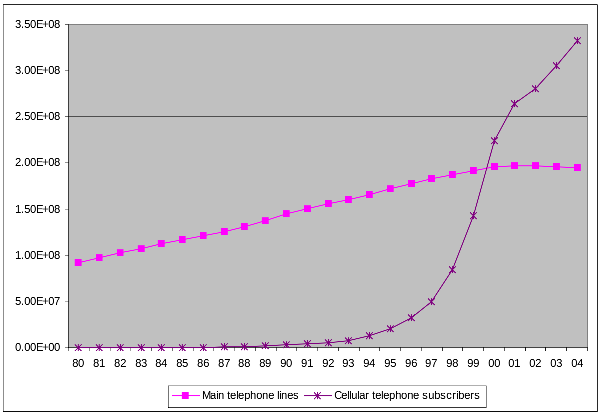


Figure 4. Fixed and mobile users - Western Europe 1981-2000

3 Regularities in history

Historical regularities in the form of cycles or waves reflect primarily the changes in demand and are mainly explained by changes in the level of investments, e.g. in the form of the Kitchin cycle (inventory), the Juglar cycle (business cycle or capital goods cycle), the Kuznets cycle (building construction). See also Table 2 (De Wit, 1994 p67).

Cycle	Topic	Periodicity
Kitchin	Inventory	4-5 years
Juglar	Capital goods investments	7-11 years
Kuznetz	Construction	15-25 years
Kondratieff	Innovation	40-60 years

Table 2. Economic cycles

The Kondratieff cycle or Long Wave is of particular interest, as in the causal analysis the regularity observed over periods of 50-60 years became linked to innovations occurring in clusters.[5] In *Kondrafieffs Zyklen der Wirtschaft* Freeman provided a summary of the early development of the long wave causality towards the link made by Schumpeter to innovation. See Table 3 (Freeman, 1998).

Übersicht: Frühschriften und -theorien	
Hyde Clark, 1847	Stichwort Krise
Karl Marx, um 1850 (vgl. Kuczinski, 1985)	Stichwort Krise
William Stanley Jevons, 1884	Stichwort Krise
Parvus, 1901	Entwicklungen in Technologie, Finanzen, Handel und Kolonien “hebe die gesamte Weltproduktion auf eine neue Grundlage
Tugan-Baranowski, 1901	“Loanable Funds” und Zinssätze
Pareto, 1913	Internationale Handelsstatistiken
Van Gelderen (Fedder), 1913	Gezeiten von Flut und Ebbe; Neue Industrien, neue Territorien, Preise, Production, Handel, Finanzen
De Wolff, 1915, 1924, 1929	“Echo replacement”, Investition in langlebige Infrastruktur
Kondratieff, 1922-29	Investitionen in Infrastruktur; Goldfunde; neue Märkte; Innovationsdiffusion
Casel, 1932, Dupriez, 1935	Geldmenge, Goldangebot
Schumpeter, 1939	Innovationen; neue Industrien

Table 3. Early long wave theories

The clustering or discontinuities in technical innovation would act as the driving force behind the long wave in economic life (Kleinknecht, 1987 p3-4). Kleinknecht also points to other, complementary forces that are driving the long wave, identified by Van Gelderen and De Wolff : “In each upswing of the long wave, the production of investment goods will expand more rapidly than the production of consumer goods.” And the hypothesis by Van Gelderen on the availability of cheap loan capital together with a low price level at the end of a long wave depression (p5-6).[6]
The concept of the long waves is not without its critics, in particular where empirical evidence could not be provided for the claims being made. Kleinknecht refers to the critique by Kuznetz in his review of Schumpeter’s ‘Business cycles’ (1939) and cites two basic questions posed by Kuznetz (p8-12, 197):

- Is there any evidence of Kondratieff long waves in important indicators of general economic activity?
- Is there any evidence of a bunching of Schumpeter’s heroic innovations (and if yes: what is the theoretical explanation)?

From his research Kleinknecht concludes that Schumpeter's hypothesis about long waves in economic life and an uneven distribution over time of radical innovations can be defended, not only in time but also in certain sectors. The theoretical explanation is to be found in the: "…reallocation of R&D and other investments towards new technological paradigms in response to the *rien ne va plus* during the long wave depression" combined with "...an endogenously caused over-expansion and depreciation of capital stock… [that] is caused by an expansionary self-ordering feedback loop: to satisfy demand for investment goods from the consumer goods sector, the capital goods producing sector itself has to expand its capacity, ordering capital goods for the production of capital goods." Furthermore, Kleinknecht argues, "…the hypothesis seems plausible that prolonged depressions not only trigger a reallocation of innovative resources but also create strong pressure towards social, political and institutional change" (p197-213).
Freeman and Soete argue for a broader perspective that: "…clusters of radical technical innovations do also lead to major disruptions not just in the production sphere but also in the broad social, institutional and organizational sphere." (Freeman and Soete, 1997 p330).
Of particular interest in our project is the link between Schumpeterian innovation, the emergence of new industries and the building of new related infrastructures, a link provided by De Wolff. This linkage is made more explicit through the interpretation of regularities in history by Freeman, Louçã and Perez.

4 Theory of Reasoned History

Freeman and Louçã have further explored the notion of Long Waves and thereby argued a case for the application of 'reasoned history' as "…an approach to economic history including technological innovations, structural changes, and the co-evolution of economic and social movements within the framework of institutional settings and modes of regulation." (Freeman and Louçã, 2001 p123). They present the idea of the co-evolution of five semi-autonomous subsystems of society of which the coordination processes are considered the crucial causal determination for the business cycle and the long wave movements in real historical development. The basic hypothesis is:

> "(1) The social subsystems (science, technology, economy, politics, culture) generate a large number of irregular fluctuations namely cyclical and wave-like movements with different approximate periodicities, caused either by specific subsystem cycles (political business cycles, technological trajectories, cultural movements, life-cycles of products or industries, etc.) or by the lags and feedback in the inter-subsystems connections.
> (2) Those streams are combined in some bands of fluctuation by specific coordination processes emerging after structural crises." (p121).

They claim three central innovative features in this approach:

> "(1) It is a description based on the overlapping of subsystems, since their relationship is more adequate to explain reality than the artificially isolated description of each of the subsystems.

(2) It analyses the crises and phase transitions from the viewpoint of the lack of synchronicity and maladjustment between subsystems, which defines the time band of major fluctuations.
(3) The social conflicts of all types are generated and articulated by the coordination process, that is by power under all its forms, from the production of legitimacy to strict coercion. This coordination process proceeds at several simultaneous levels. The first level is that of the actions embodied in the social working of the economic system, the tension to integrate the conflicts, the conventions, and the institutions, and the second level is that of power, strategy, and domination." (p121-2).

On the basis of the Theory of Reasoned History[7], Freeman and Louçã explore recurrent phenomena in history, i.e. the successive Industrial Revolutions. In doing so, they caution the reader: "we should re-emphasize here our belief that this recurrence is limited in scope and content. Each technological revolution and each phase of economic growth has its own unique features. This does not mean, however, that we cannot learn a great deal from even this limited recurrence as well as from unique events…. …The work of Carlota Perez (1983, 1985, 1988) on long waves has shown that, even if identical behaviour is ruled out, as it must be, there may still be striking similarities or dissimilarities and some hidden ones too, which are helpful in understanding the phenomena and even in making probabilistic forecasts and indications for policy." (p130-1).

4.1 Successive industrial revolutions

With the notion of Schumpeter that 'any satisfactory explanation of the evolution of capitalist economies must place innovations, their profitability, and their diffusion at the center of analysis' Freeman and Louçã characterize the five cycles of the Kondratieff wave to date. See the first two columns in Table 4. (2001 p141).
The notion of 'cluster of innovation' evolved through the work of Freeman, Perez and others, to the concept of 'New Technology Systems' denoting "the pervasive nature of some processes of technical change, the discontinuities they entailed, the structural changes in the economic system, and patterns of employment and the long time scales involved in these processes of *system* diffusion." (italics in original, p144). The systemic nature of innovation has been underscored by the emerging notion of 'General Purpose Technologies' (Lipsey, Carlaw et al., 2005). According to Freeman et al: "[Perez] was particularly notable for her emphasis on institutional as well as on technical changes. As she has consistently argued, system changes cannot take place except through a combination of profound social and organizational, as well as technical, innovations, and this necessarily takes a long time." (Freeman and Louçã, 2001 p144).
The entire life cycle of a technology system extends well beyond the length of the Kondratieff wave, of roughly a half-century. Freeman and Louçã identify the following six phases in the life cycle of a technology system, see also the discussion of the product life cycle and regime changes in Chapter 4:

1. The laboratory-invention phase, with early prototypes, patents, small scale demonstrations and early applications;
2. Decisive demonstrations of technical and commercial feasibility, with widespread potential applications;

Constellation of technical and organizational innovations	Examples of highly visible, technically successful, and profitable innovations	"Carrier' branch and other leading branches of the economy	Core input and other key inputs	Transport and communications infrastructures	Managerial and organizational changes	Approx. timing of the 'upswing' (boom) / 'down swing' (crisis of adjustment)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1. Water-powered mechanization of industry	Arkwright's Cromford mill (1771) Henry Cortt's 'puddling' process (1784)	Cotton spinning Iron products Water wheels Bleach	Iron Raw cotton	Canals Turnpike roads Sailing ships	Factory systems Entrepreneurs Partnerships	1780s-1815 1815-1848
2. Steam-powered mechanization of industry and transport	Liverpool-Manchester Railway (1831) Brunel's 'Great Western'Atlantic steamship (1838)	Railways and railway equipment Steam engines Machine tools Alkali industry	Iron Coal	Railways Telegraph Steam ships	Joint stock companies Subcontracting to responsible craft workers	1848-1873 1873-1895
3. Electrification of industry, transport and the home	Carnegie's Bessemer steel rail plant (1875) Edison's Pearl St. New York Electric Power Station (1882)	Electrical equipment Heavy engineering Heavy chemicals Steel products	Steel Copper Metal alloys	Steel railways Steel ships Telephone	Specialized professional management systems 'Taylorism' giant firms	1895-1918 1918-1940
4. Motorization of transport, civil economy, and war	Ford's Highland Park assembly line (1913) Button process for cracking heavy oil (1913)	Automobiles Trucks Tractors, tanks Diesel engines Aircraft Refineries	Oil Gas Synthetic materials	Radio Motorways Airports Airlines	Mass production and consumption 'Fordism' Hierarchies	1941-1973 1973-
5. Computerization of entire economy	IBM 1401 and 360 series (1960s) Intel microprocessor (1972)	Computers Software Telecommunica-tion equipment Biotechnology	'Chips' (integra-ted circuits)	'Information Highways' (Internet)	Networks; internal local, and global	??

Table 4. Condensed summary of the Kondratieff waves

3. Explosive take-off and growth during a turbulent phase of structural crisis in the economy and a political crisis of coordination as a new regime of regulation is established;
4. Continued high growth, with the system now accepted as common sense and as the dominant technological regime in the leading countries of the world economy; application in a still wider range of industries and services;
5. Slow-down and erosion of profitability as the system matures and is challenged by newer technologies, leading to a new crisis of structural adjustment;
6. Maturity, with some 'renaissance' effects possible from fruitful co-existence with newer technologies, but also the possibility of slow disappearance.

Freeman and Louçã identify Perez as the person first suggesting that some technologies are so pervasive that they dominate the behaviour of the whole economy for several decades and influenced major social and political changes. She also suggested the following characterization for each long wave (Perez, 1983; Freeman and Louçã, 2001 p147-8), see also columns 3-6 in Table 4:

1. Key factors (core inputs) becoming so cheap and universally available leading to a wide range of new factor combinations;
2. Key factors plus complimentary inputs would lead to new products, which would give rise to the emergence of fast growing new industries (carrier branches), that would give a major impetus to the growth of the entire economy;
3. A new type of infrastructures would serve the needs of the new industries and in turn stimulate the development of the new industries;
4. The structural transformation invoked by the new technologies, industries, products and services would lead to organizational innovations needed to design, use, produce, and distribute them.
5. The transformation process from the application of old to new technologies, processes and organizational forms will not be smooth, there will be a transitional period of structural adjustment.

The new approach to management and organization has been described by Perez: "…variously as a 'new technological style' and a 'new techno-economic paradigm'." (Freeman and Louçã, 2001 p147). An insight that evolved from the role of innovation (Schumpeter), through the 'clustering of innovation' or notion of 'constellation' (Keirstead), and through 'technological trajectories' (Nelson and Winter) and technological paradigms (Dosi) to 'technology systems' (Freeman, Clarke and Soete) (Freeman, 1998 p135-7). And according to Freeman et al: "Schlieβlich blieb es aber Carlota Perez (1983) vorbehalten, über alle diese fragmentarisschen und embryonalen Näheringsversuche hinaus zu ihren umfassenden "techno-ökonomischen Paradigmen" vorzustoβen." (p137).

4.2 Degree of replacement and accumulation

If we consider the sequence of waves or surges the idea is that one technological revolution succeeds the other. Although the new techno-economic paradigm takes over from the old, it is a matter of degree whether it also replaces the 'core inputs' and 'carrier branches'. In the transition from the First to the Second Wave replacement has been the case to a large extent: water power was being replaced by steam; canals replaced by railways, albeit inland shipping has remained important in some countries, but not in Britain; sailing ships were replaced by steam ships.
From the Second to the Third Wave the electrical engines replaced steam engines, albeit steam plays still an important role in the generation of electricity, as well as in steam turbines used for propelling ships. Moreover, coal remained a very important input for electricity generation. Steel replaced iron. The telephone replaced the telegraph. Railways remained.
In the transition from the Third to the Fourth Wave automobiles and trucks overtook in importance the railways, albeit these remained to play an important role in long distance haulage. Aircraft replaced passenger transport by ship, except for leisure purposes. Steel ships remained for the transport of cargo. The telephone remained.

'Chips' are added as core input in the transition from the Fourth Wave to the current Fifth Wave. Chips that add processing power or intelligence to virtually all artefacts that have survived from the previous waves. A process much similar to the electrification process, providing 'power' everywhere, even in a 'canned' form. In fact 'chips' will not function without electricity, in this respect the Fifth Wave is cumulative upon the Third Wave and very much complementary to the Fourth Wave. Information highways and byways exist next to and are essential for, among other, the efficient operation of railways, roadways and airways. It should be noted that tele-communication and tele-working may reduce the need for transport, as will the consumption of information goods. Although the process of consumption of information goods will need the facilitation by very tangible ICT products.
In the following Section we will further explore the characteristics of the Long Wave or 'Great Surge' as denoted by Perez.

5 The Great Surge model

In her 2002 contribution 'Technological revolutions and financial capital: The dynamics of bubbles and golden ages', Perez has expanded on her suggestions captured by Freeman. In observing the 'boundless rise of two forces: the information revolution and financial markets' in the last quarter of the twentieth century, she argues that: "productivity explosions and bursts of financial excitement leading to economic euphoria and subsequent collapse of confidence have occurred together before. They are interrelated and interdependent phenomena; they share the same root cause and are in the nature of the system and its workings. They originate in the way technologies evolve by revolutions, in the peculiar manner in which these great upsurges of wealth creating potential are assimilated by the economic and social system and in the functional separation of financial and production capital." (Perez, 2002 pxvii). Based on historical analysis she shows that the sequence of 'technological revolution – financial bubble – collapse – golden age – political unrest', is recurring about every half century. This recurrence is considered to be based on: "causal mechanisms that are the nature of capitalism, which stem from the features of the system, which interact with and influence one another:

1. The fact that technological change occurs by clusters of radical innovations forming successive and distinct revolutions that modernize the whole productive structure;
2. The functional separation between financial and production capital, each pursuing profits by different means; and
3. The much greater inertia and resistance to change of the socio-institutional framework in comparison with techno-economic sphere, which is spurred by competitive pressures." (p5-6)

The ensuing life cycle of a technological revolution is shown in Figure 5 (p30).
In the early phases there is the battle of the new paradigm with the power of the old paradigm, which is "ingrained in the established production structure and embedded in the socio-cultural environment and in the institutional framework."

(p36). When this battle is won the new paradigm diffuses across the whole of the economy and society. Hence, the diffusion of the new paradigm can be seen as two distinct periods, the ‘installation period’ and the ‘deployment period’, both typically lasting 20-30 years. The ‘turning point’ from the installation to the deployment is “usually a period of serious recession, involving a recomposition of the whole system, in particular of the regulatory context that enables the resumption of growth and the full fructification of the technological revolution.” (p36).

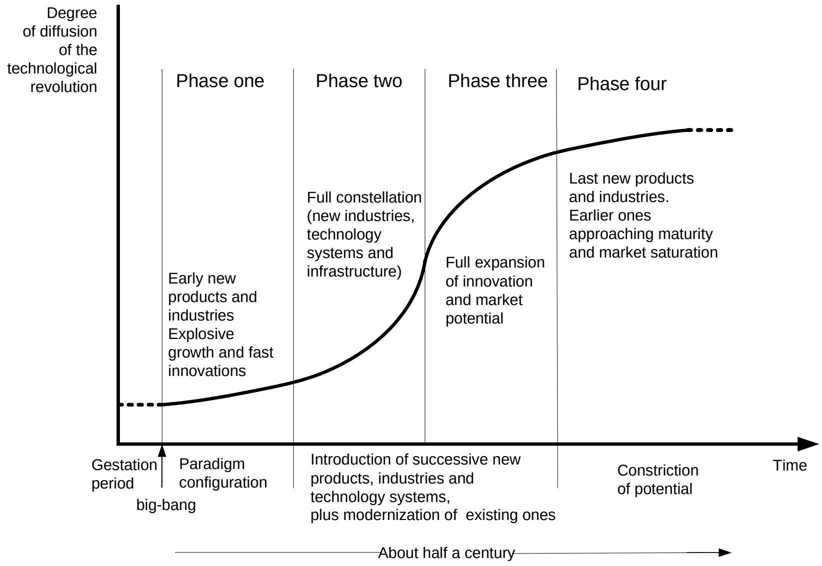


Figure 5. The life cycle of a technological revolution

Typically at the end of the installation period, there is “frantic investments in the new industries and the new infrastructure, stimulated by a stock market boom that usually becomes a bubble that inevitably collapses..” (p36).
The model of the ‘Great Surges’ puts the Internet bubble at the end of the ‘installation period’ of the Fifth Surge. See Figure 6 (p48). Hence, ahead of us is the ‘deployment period’.

5.1 Infrastructure related euphoria

The Great Surge model points to a certain degree of regularity in terms of the occurrence of euphoria. It also points to the fact that these euphoria are often infrastructure related. As such the Great Surge model captures regularities observed in relation to previous euphoria that may have implications for the aftermath of the Internet bubble. Figure 7 (Perez, 2002 p78) shows the euphoria as part of the periods of frenzy for each of the five Great Surges, each period of frenzy ending with a major crash.
In the First Surge it was the development of the canal infrastructure in Britain that became subject to euphoria, which became known as Canal Mania. Following Chancellor (1999 p122-6): The first canals provided clear benefits to the textile

industry and hence the returns on capital were tremendous and large dividends were paid. About 25 years after the first canal was completed in 1767, popular speculation started.

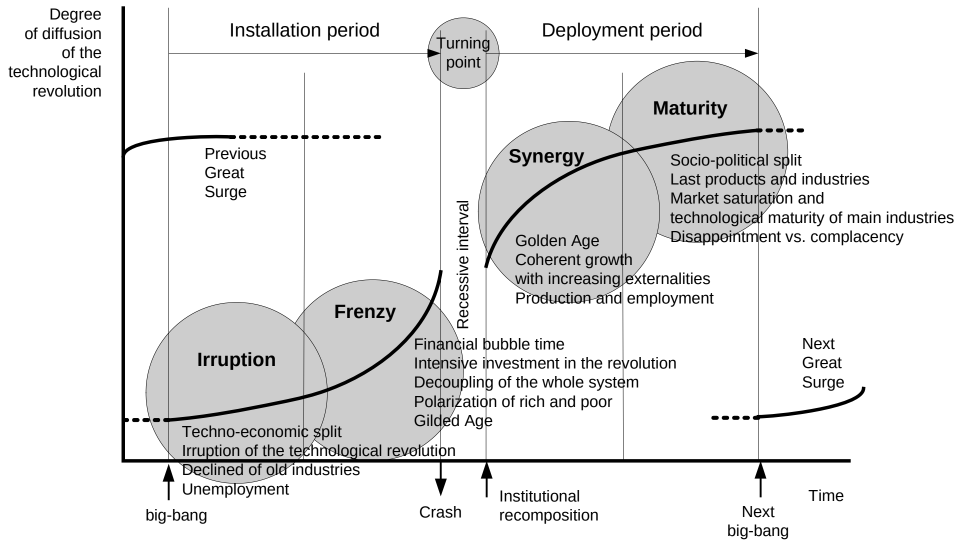


Figure 6. Great Surge model

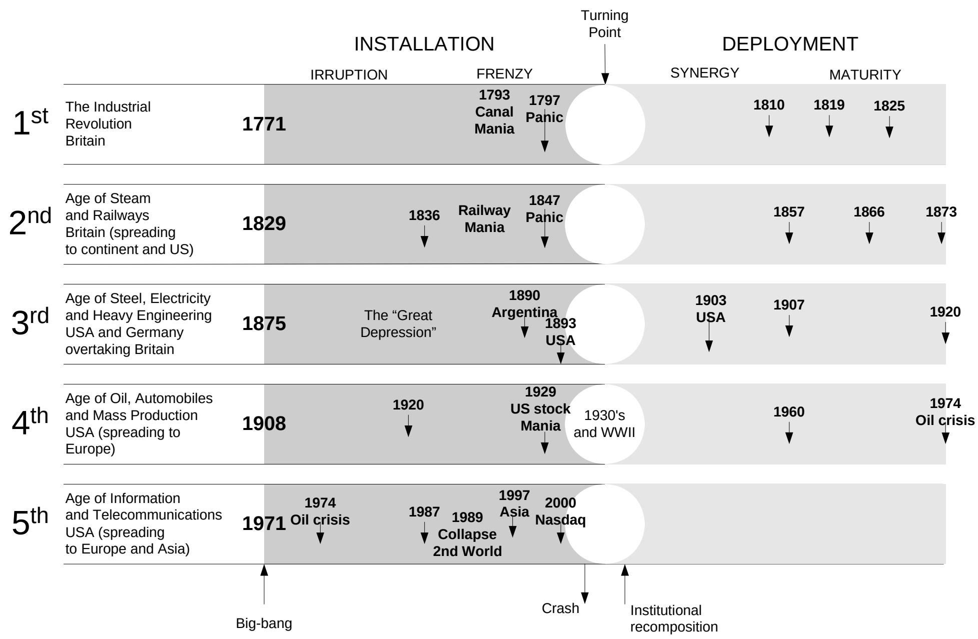


Figure 7. Financial crisis during the Great Surges

The number of parliament acts, required to approve the construction of a canal, increased dramatically: 50 new acts in less than 5 years, double the number of requests approved in the preceding 50 years. The canal mania was short-lived. It reached its peak in 1792-93 and "came to an abrupt end with the commercial crisis of 1793, brought on by the outbreak of the French revolutionary wars." The return on capital had dropped from 50% before to 5% after the mania, to stay at levels comparable to that of risk-free government bonds. After 25 years one in five canals was still not able to pay a dividend.

In the Second Surge the development of the rail road infrastructure[8] became the topic of speculation. This period provides a striking parallel with the developments during the Internet bubble. Following Chancellor (1999 p127-51): The introduction of the railway was met with much opposition from those having an interest in the canal and coach system and those concerned with the environment. The first, very short, railway fever was linked to the opening of the first steam railway from Stockton to Darlington in 1825. The opening in 1831 of the Liverpool and Manchester Railway established the superiority of steam. The company paid dividends of 10%, its market value doubled and it triggered the second period of railway fever. This ended in a bust in 1837 as part of the general collapse of a broader speculative period. By 1840 railway shares traded below their issue price. In 1842 another speculative period started, "…the profound changes wrought by the railways began to grip the public mind.". By June of 1845 plans for 8000 miles of new track, four times the size of the existing network were under consideration by the government. By August over a hundred acts were passed, which represented 3000 miles of new railway track. By September 450 new schemes were registered. In November 1845 the Times projected the railway speculation to include 1200 railways at an estimated cost of £560 million. The outstanding liabilities were estimated at £600 million, thereby exceeding the national income. The 'normal' level of railway spending was being estimated at £20 million a year. "As construction got underway, railway companies raised funds by "calling" some of the remaining capital on their shares." By early October shares were sliding and at October 14th the first suicide connected to the railway speculation occurred. The Bank of England, "worried by a slight decline in their reserves", raised interest rates from 2.5 to 3 %; "…it signaled the end of the railway fiesta." "In the general revulsion, even the market for the established dividend-paying railways dried up." See for a more extensive summary Annex 3 *Rail-Road Mania in the 19th century*.
Railway mania also developed in 1844 in Prussia, but was effectively suppressed by the government; in France in 1847 and 1857, although "military engineers decided on railway routes before construction was put to tender"; and in the US in 1857 and 1873.

The Third Surge is related to the creation of transcontinental networks of steel railways that "…together with the steel steamships and worldwide telegraph, facilitated the functioning of truly international markets." (Perez, 2002 p15). The Third Surge also features the introduction of electricity as major source of energy supply, the building of the electricity grid and the establishment of a new industry. By 1920 electric motors represented 50% of 'mechanical drive' in the manufacturing industries in the USA (Schurr, Burwell et al., 1990 p37). It also related to the creation of telephone networks, following the invention of the telephone by Bell in 1876 and the first automatic exchange in 1889 by Strowger (Van Hilten, 1981). The topic of speculation is more extensive, and linked to the 'new territories' Argentina, Brazil, Australia and the related land and mining developments.

In the Fourth Surge the emphasis is on the motorization of transport, and the creation of motorways and airports. The frenzy period ends with the collapse of the US stock market in 1929, an event with global impact.

In the current and Fifth Surge follows the accelerated build out of the telecom infrastructure in support of the Internet. The Internet and telecommunications become the topics of speculation, leading to what is also known as the Internet mania.

5.2 Summary and conclusions

In the stylized model developed by Perez each technological revolution, or Great Surge, is characterized by an installation period of approximately 25-30 years, which is followed by a deployment period of similar length. The installation period typically ends with a period of frenzy in which a major bubble develops, and that ends with a major crash. This bubble tends to develop around the new technology firms and their associated new infrastructure.
The Internet bubble, and the context in which it has developed, fits this pattern of historical regularity and hence it may be explained as part of this broader phenomenon. To facilitate the explanation in Chapter 6 we will capture in the next Section the main attributes of the stylized model of technological revolutions as introduced by Perez.

6 Stylized model of Great Surges

6.1 General principles

A technological revolution can be defined as "…a powerful and highly visible cluster of new and dynamic technologies, products and industries, capable of bringing about an upheaval in the whole fabric of the economy and of propelling a long-term upsurge of development." (Perez, 2002 p8). Moreover, "[e]ach technological revolution results from the synergistic interdependence of a group of industries with one or more infrastructural networks." (p13).

A techno-economic paradigm is "…a best-practice model made up of a set of all-pervasive generic technological and organizational principles, which represent the most effective way of applying a particular technological revolution and of using it for modernizing and rejuvenating the whole economy. When generally adopted, these principles become the common-sense basis for organizing any activity and for structuring any institution." (p15)[9].

The emergence of a new techno-economic paradigm "…affects behaviours related to innovation and investment in a way that could be compared to a gold rush or the discovery of a vast new territory. It is the opening of a wide design, product and profit space that rapidly fires the imagination of engineers, entrepreneurs and investors, who in their trial and error experiments applying the new wealth-creating potential, generate the successful practices and behaviours that gradually define the new best-practice frontier. The action of these pioneering agents blazes the trail, giving rise to increasing externalities and conditionings – including production experience and the training of consumers – that make it easier and easier for others to follow suit. Their success becomes a powerful signal in the direction of the most profitable windows of opportunity. That is how the new paradigm eventually becomes the new generalized 'common sense', which gradually finds itself embedded in social practice, legislation and other components of the institutional framework, facilitating compatible innovations and hindering incompatible ones." (Perez, 2002 p15-6).

6.2 The periods and phases of a technological revolution

With reference to Figure 5, the different periods and phases in the life-cycle of a technological revolution can be described (Perez, 2002 p29-59)[10]. It should be noted that Perez points out that the model that is being constructed, is:

> "…a heuristic device. Not a straitjacket to force upon history. In spite of regularities and the isomorphism the model claims to be identifying, there is full awareness that the subject matter rebels and refuses. It is full of exceptions and of huge independent events that constantly twist and break the proposed regularity. Wars, droughts and gold discoveries, are not included in the 'clean' model, nor are many other significant social and political occurrences. The sequence has been stripped of all those events not causally related to the absorption of technologies, which leads inevitably to streamlined simplifications that hardly ever occur as such. Nevertheless, this risky attempt at gleaming the strains of causal order underlying chaos, at structuring the unwieldy mass of historical events into a meaningful sequence, is still worthwhile. After the job is done – if it ever can be – the infinite enrichment of real life can be brought back in, but this time with the benefit of an organizing background, which highlights even more all the unique unexplained events." (p49).[11]

<u>Gestation period</u>

Preceding the 'big bang' or public landmark that signifies the start of a new technological revolution, there is a period of gestation in which the ideas and inventions happen that will become central to the new revolution.

<u>Installation Period</u>

<u>Phase one - Irruption</u>

- This is the period in which the new paradigm is configured. It is characterized by explosive growth and fast innovations in the new industries, introducing new products.
- The exhaustion of the old paradigm brings with it both the need for radical entrepreneurship and the idle capital to take the high risks of trial and error.

The idle money in the hands of non-producers looking for a profit, starts a 'love affair' with the new technological revolution.
- A fast learning process takes place among engineers, managers, sales and service people and obviously consumers, about the production and use of the new products. Learning involves acquiring the new organizational notions embodied in the new paradigm. At the same time a mismatch between the old socio-institutional framework and the requirements of the new paradigm is becoming apparent.
- Production infrastructure is becoming focused on the realities of the new paradigm.

Phase 2 - Frenzy
- This is the period of fast diffusion of the new technologies, the introduction of successive new products, industries and technology systems, plus the modernization of existing ones. In this period a full constellation of the new industries, technology systems and infrastructure is in place.
- Financial capital takes over; its immediate interests overrule the operation of the whole system. The paper economy decouples from the real economy, finance decouples from production while there is a growing rift between the forces in the economy and the regulatory framework, turned impotent. The financial frenzy is a powerful force in propagating the technological revolution, in particular its infrastructure.
- A time of speculation, corruption and unashamed (even widely celebrated) love of wealth.
- Diverging and explosive growth in the new industries in stark contrast with the decline in the industries tight to the old paradigm.
- Mismatch of the old socio-institution framework with the new paradigm.

Turning point
- A conceptual device, denoting the transition between the installation and deployment period of a new technological revolution. With the collapse of the bubble, which ends the period of frenzy, comes recession and sometimes depression, which brings financial capital back to reality. Together with mounting social pressure this creates the conditions for institutional restructuring and for re-routing growth onto a sustainable path. A swing of the pendulum from the extreme individualism typical for the frenzy period to giving greater attention to collective well being.

Deployment Period

Phase 3 - Synergy
- In this period we see the full expansion of innovation and market potential offered by the new technologies, yielding fast growth. There is the introduction of successive new products, industries and technology systems, plus the modernization of existing ones.
- Production rules, financials are linked again to production realities.

- The socio-institutional framework is being adapted to and shaping the new paradigm.
- Converging growth in most of the industries aligned with the new paradigm.

Phase 4 - Maturity

- In this period we see a diminished potential offered by the new, now old, paradigm. The last introduction of new products and industries occurs. Earlier ones are approaching maturity and market saturation sets in.
- Idle finance is looking for new opportunities.
- A mature production infrastructure is looking for market opportunities.
- While the signs of prosperity and success are still around social dissatisfaction sets in, the qualities of the system are being questioned.

6.3 Paradigm transitions

In the transition from the old to the new techno-economic paradigm a new constellation of technologies, products and industries with wide generic applicability takes the fore front in economic growth and productivity improvement. The new paradigm also affects the industries that were part of the old paradigm and influences the direction of new industries.[12]

In Chapter 6 we will use our findings and apply the stylized model of technological revolutions in explaining the Internet bubble, and in Chapter 8 to assess the implications for policy and strategy formation.

6.4 Reflections on paradigm changes

In Chapter 4 Section 4.6.1 we will address the notion and implications of paradigm changes. We will develop the notion from Kuhn's contribution on the role of paradigms in scientific development, to be followed by Dosi and Nelson and Winter in linking paradigms to technological development (regimes and techno-logical trajectories). Perez has introduced the notion of a combined techno-economic paradigm to show not only the co-evolution of technology and economy, but the economic change that technological change appears to enforce. She also links this to the co-evolution of institutions. A theme that has been addressed also by Nelson and Nelson (2002), and by Nelson and Sampat (2001). In introducing the notion of tension between the two elements in the co-evolution she captures the force field that will drive the co-evolution, or if the tension becomes to large a co-revolution may evolve. Alternatively if the tension can be sustained the benefits of the new paradigm may not be exploited to the full extent, as the institutional environment, developed to optimally support the old paradigm, provides restrictions to the deployment of the new paradigm.

Groenewegen, Künneke and Fens take the notion of co-evolution of technology and institutions to reflect tensions that may be or may become incompatibilities in development (Groenewegen and Künneke, 2005; Künneke, 2005; Künneke and Fens, 2005). Their thesis is that technology and institutions are closely linked in their development, and hence a change forced in the institutional arrangement (e.g. unbundling through reform) must be compatible with the technological arrangement or otherwise the combination will generate tensions that ultimately will lead to systems that may perform sub-optimal or in the worst case become unstable, unless adjustments are made to the arrangements institutional or technological, or trigger technological innovations, or a combination thereof.

6.5 Reproduction and transformation

Freeman & Louçã have tested and clarified the characterization of the long wave, and thereby its reproduction in terms of *critical realism*, through:

> "(1) assembling and analyzing the empirical and historical data for each wave to see whether they do indeed support or refute the… …propositions; this involve[d] both quantitative and qualitative analysis at the level of firms, industries, technologies, and countries;
> (2) developing an 'appreciative' historical description which takes account of the unique features of each wave and demonstrates how each new 'constellation' of innovations was developed and was promoted (or hindered) by the technological, scientific, economic, political, and cultural environment through its rise to dominance and its maturity... …It is necessary both for plausibility and to avoid those teleological interpretations that assume the pre-existence of a paradigm and portray its diffusion in idealistic rather than evolutionary terms. It recognizes that each new paradigm may have a very different combination of favorable influences and that its diffusion is an untidy and uncertain historical process."

See for the evidence Freeman and Louçã (2001 p153-370).

7 Summary and conclusions

In this Chapter we have provided the answer to research sub-question #2: "Should the Internet bubble be considered a stand-alone event or should it be explained as part of a broader phenomenon? If affirmative, how should it be described and explained?". The answer to the question is affirmative. As an infrastructure related period of euphoria, the Internet bubble is comparable to similar historical periods, e.g. the canal mania and the rail-road mania, and can thereby be considered part of the diffusion process of successive technological revolutions.
In this Chapter a stylized model of technological revolutions or Great Surges is provided that can subsequently be used to describe and explain the Internet bubble.

This concludes our investigation into theories, concepts and models that explain the development and operation of euphoria, as a stand-alone phenomenon and as part of the diffusion process of technological revolutions. In Chapter 6 we will be using the two stylized models that have been compiled to explore and explain the Internet bubble. In the closing Chapter 8 we will refer back to these models in assessing the implications for policy and strategy.
In the following Chapter we will explore the theories, concepts and models that provide an explanation of industry development.

8 Notes for Chapter 3

[1] In: *A history of economics – the past and the present*. Hardmondsworth: Penguin.
[2] The equation has been taken from a presentation made by Analysys during a conference in London in 1995.
[3] The quality of the regression line is $R^2 = 0.86$.
[4] This unpublished research has been executed at AT&T in 1995, as part of an investigation into the development of telecom infrastructures in Central and Eastern Europe.
[5] Trough the interpretation of Freeman, Louçã and Perez Kondratieff waves have become related to investments in infrastructure. See Section 5.1.
[6] According to Kleinknecht, Van Gelderen anticipated almost everything that is now being rediscovered and rewritten with respect to the phenomenon of the long wave, predating the classic study by Kondratieff of 1926. ("Springvloed. Beschouwingen over industriële ontwikkeling en prijsbeweging", articles published in 1913) Van Gelderen and De Wolff worked at the University of Amsterdam.
[7] With respect to methodology Freeman & Louçã use the following objectives as critical for the validity of their theory: "A theoretical framework for the history of economic growth should satisfy four main requirements. First, it should provide a plausible explanation and illumination of the stylized facts, which summarize the main features of the growth of the world economy, especially over the last two centuries, but ideally for a much longer period. Second, it should do this for the three main categories identified by Abramovitz (1986): forging ahead, catching up, and falling behind. Third, it should identify the major recurrent phenomena in each category to pave the way for generalizations, which should of course be constantly tested against new historical evidences, as well as newly unfolding events. Finally, it should provide a framework for analyzing and reconciling the research data, case studies, and generalizations emerging from the various sub disciplines of history: the history of science and of technology, economic history, political history, and cultural history." (Freeman and Louçã, 2001).
[8] In parallel to the rail roads the telegraph system developed.
[9] See for the general notion of paradigms also Chapter 4 Section 4.6.1. *Paradigms and regime changes*.
[10] As acknowledged by Perez, these phases are similar to the product life-cycle theory being addressed in Chapter 4.
[11] Perez also points to the uneven development and time-lags in the diffusion of technological revolutions across different countries and regions.
[12] The rejuvenation of old industries is also known as the 'sailing ship effect'. (See e.g. De Liso and Filatrella, Technological Competition: A formal analysis of the sailing-ship effect, 23 July 2003.)

4

Industry development and the ‘development path’

Critical review and selection of theories, concepts and models

Table of Contents

1 Introduction

The purpose of this research project is to explore and explain the impact of the Internet bubble on the 'development path' of the telecom sector, and to assess the implications for policy and strategy formation in the aftermath. In Chapter 1 we have introduced the concept of 'development path' as: "a sequence of 'states', whereby the transition from one 'state' to the other is the combined result of the 'drivers of industry development' and the 'inhibitors of industry development' enacting upon the industry." To be able to describe the result of the combined forces of drivers and inhibitors, we will need to explore and explain these forces as part of the process of industry development. As indicated, the development of an industry can be described and explained using different approaches, depending on the situation in the industry. In a relatively stable environment and with a stable industry structure, industry development is gradual and static theories, concepts and models can be used to explain the behaviour of industry actors. If industry development over a longer period is considered, evolutionary models become relevant, in this respect technology life cycles and product life cycles become important concepts to explain the differences of behaviour of firms at different phases of the life cycle. If innovation is playing a significant role, the application of dynamic or even revolutionary theories, concepts and models is required. The concepts of paradigms and technological trajectories, and in particular paradigm shifts, are important concepts to explain the behaviour of industry actors in this situation.

Our research project covers a significant period of time, and covers both relatively stable and highly dynamic periods. Hence, in this Chapter we will explore a range of theories, concepts and models which are static, evolutionary, dynamic or revolutionary. Subsequently, we will select those theories, concepts and models that are considered most relevant for our project, to be applied in Chapter 5 and 7.

As an introduction we will first provide a definition of the telecom sector and the Internet. Subsequently we will explore the characteristics of the telecom sector.

To assure the investigation has the proper focus we will assess the perspectives of the strategy and policy maker in further detail, to be able to decide whether a common approach for both groups of end-users of this project can be applied.

Following the definition of the 'development path' proper, we will identify and critically review the theories, concepts and models that have a bearing on explaining industry development in general, followed by a more specific application to the telecom sector.

With respect to critical realism as the underlying methodological framework, in this Chapter the emphasis will be focused on the industry and the firm as 'social structures of relevance', and on processes of transformation.

2 Exploring the characteristics of the telecom sector

In this Section we will explore the characteristics of the telecom sector, the related industries, and the products and services involved. An initial impression of the sector in terms of size will be provided.[1] The sector will be described in further detail in Chapter 5.

2.1 Definition of the telecom sector and industries

In the colloquial definition of the telecom sector, the sector would be comprised of establishments concerned with: telecom equipment, including the related software and services, telecom (network) operations and telecom services provisioning.
De Wit & Meyer define an industry as “a group of firms making a similar type of product or employing a similar set of value-adding processes or resources.” (2004 p233).[2] Product similarity is considered the simplest way to draw an industry boundary. The two approaches that appear most logical to apply in the context of this project are the industry classification as used for (macro-)economic analysis, and the classification as used in the financial industry. The US Standard Industrial Classification standard (SIC) captures the telecom sector under two divisions: manufacturing and services. See Table 1 and (SIC, 2005) for the details.[3]

Division	**D: Manufacturing**
Major group	36: Electronic and other electrical equipment and components except computer equipment
Industry group	*Subset only:* 3661: Telephone and telegraph apparatus 3663: Radio and television broadcasting and communications equipment 3669: Communications equipment, not elsewhere classified
Division	E: Transportation, communications, electric, gas and sanitary services
Major group	48: Communications
Industry group	481: Telephone communications 482: Telegraph and television broadcasting stations 483: Radio and television broadcasting stations 484: Cable and other pay television services 489: Communication services, not elsewhere classified

Table 1. US Standard Industry Codes for Telecom

The Dow Jones Global Classification Standard, as utilized by e.g. the New York Stock Exchange (NYSE), shows the telecom sector under two economic sectors: Technology and Telecommunications services. See Table 2 (Dow Jones, 2003).
The major distinction to be made in this project is between the telecom manufacturing or equipment industries as a group and the telecom services industries as a group. If necessary a further distinction will be made, primarily in relation to changing technologies and in relation to different applications. Within the project a wide range of specialized information sources will necessarily be used. While consistency of information between the sources will be pursued, the project will not attempt to force or consolidate the information into a single framework.[4]

Economic sector	Technology (TEC)		
Market sector	Technology (TEC)		
Industry group	Communications Technology (CMT)		
	Semiconductors (SEM)		
	Software (SOF)		
	Technology Hardware & equipment (THQ)	**Sub-group**	Computers(CPR)
			Office equipment (OFF)
	Technology services (TSV)	**Sub-group**	Internet services (ISV)
			Diversified technology services (TSX)
Economic sector	Telecommunications (TLS)		
Market sector	Telecommunications (TLS)		
Industry group	Wireless communications (CTS)		
	Fixed-line communications (FTS)		

Table 2. Dow Jones Global Classification Standard for Telecom

2.2 An impression of the size of the telecom sector

In this Section the size of the telecom sector will be presented to provide a general orientation on the importance of the sector. The information will be provided, as far as data sources are available, for the OECD, the EU15[5], Japan, Korea, the USA, the UK and The Netherlands. The choice of the five individual countries follows from the country related developments to be discussed later in this study.

In 2002, one year after the collapse of the Internet bubble, the Technology – Media – Telecommunications (TMT) sectors represented globally $5.1 trillion by market capitalization, or 19% of the total world equity market, according to the NYSE TMT Index (NYSE, 2003)[6].

The Western European TMT sector represents €1,300 billion in revenues for the year 2001 (EITO, 2003). The division includes roughly ¼ telecom, ¼ media & publishing and ¼ computer systems and services. For the distribution across the sectors see Figure 1 (EITO, 2003).

2.3 Definition of the Internet

The formal definition of the Internet as adopted by the U.S. Federal Networking Council in 1995 states (FNC, 1995):

> "Internet" refers to the global information system that —
> 1. is logically linked together by a globally unique address space based on the Internet Protocol (IP) or its subsequent extensions/follow-ons;
> 2. is able to support communications using the Transmission Control Protocol/Internet protocol (TCP/IP) suite or its subsequent extensions/follow-ons, and/or other IP-compatible protocols; and
> 3. provides, uses or makes accessible, either publicly or privately, high level services layered on the communications and related infrastructure described herein.

Meanwhile, the Internet has become an all encompassing notion for accessing and exchanging information, the related tools and communicating infrastructure. The Internet is for many also associated with a culture, which includes the notion of 'always online' communication.

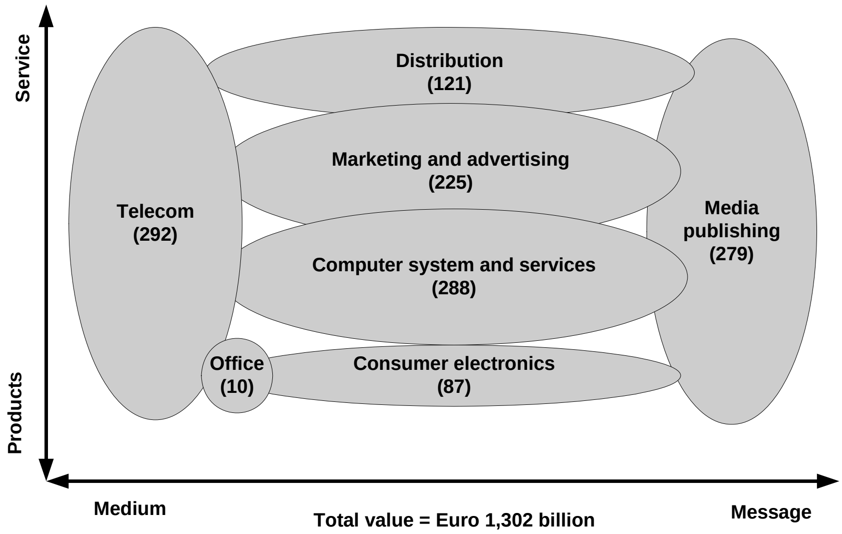


Figure 1. West European TMT business in perspective 2001

For the purpose of this project the Internet is considered to imply the infrastructure, consisting of transmission paths, access equipment and routers, that connect all types of computers and digital appliances, that use the TCP/IP protocol suite for the purpose of information exchange. It implies the application of the world-wide-web (the Web), the associated presentation languages, such as hyper text mark-up language (html), the browsers and search engines.

2.4 The telecom services

In Section 2.1 we used the definition of the telecom sector as comprising the establishments concerned with: telecom equipment, including the related software and services, telecom (network) operations and telecom services provisioning. For their interrelationship these industries can best be viewed as part of the telecom sector value chain. In simplified form this is reflected in Figure 2.[7]

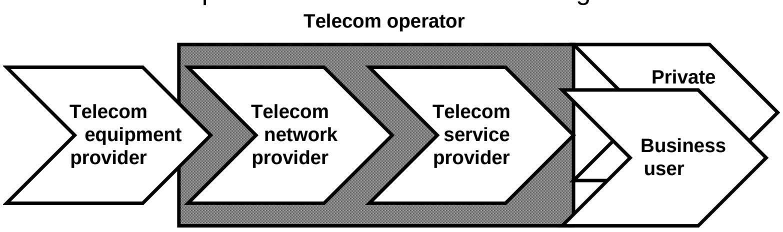


Figure 2. Telecom value chain, simplified

The core business of the telecom operator is to provide communications services to end users, business and private consumers, based on the exploitation of a telecommunications network infrastructure build from the equipment, software and services, which are provided by the telecom equipment providers. The telecom service provider may thereby exploit his own infrastructure, or use (in part) the facilities provided by a telecom network provider. Business users may deploy a corporately owned communications network, that they exploit for their own purposes. Business users may outsource the operation and/or provisioning to a third party, such as a telecom operator.

Communication services, originally associated with the telegraph and the telephone, can be distinguished on the basis of the location or the source of information (individual or central) and the control regime under which the communication is taking place (individual or central), thus generating four generic types of communication patterns. See Table 3 (adapted from Dutch original, Arnbak, Van Cuilenburg et al., 1990 p8).

	Information source	
Control regime	*Individual*	*Central*
Individual	Conversation	Consultation
Central	Registration	Allocution

Table 3. Communication patterns

Telephony and email are typically tele-conversation services, whereas on-line database retrieval is an example of tele-consultation. Tele-registration would apply to remote data-sensing or telemetry, and tele-allocution includes radio and television broadcasting.

Telecom operators were typically licensed to provide telephony services, and later also data communication services. Cable operators are typically licensed to provide radio and television broadcasting services. Through the recent liberalization process of communication services provisioning, telecom operators and cable operators are more and more considered as competitive providers of the same services; initially Internet access, followed by telephony and increasingly in broadcasting services. The actual situation differs per country and will be discussed in further detail in Chapter 5 and 7.

Communication services may be provided through a fixed and/or mobile network infrastructure. The actual service provisioning will depend on the characteristics of the connection from the end user to the network (local access – first/last mile; fixed/mobile, bandwidth) and the terminal device utilized (voice or data appliance, fixed/mobile, functionality).

The connection to the communications network is historically provided at a rental basis, while the utilization of the network is charged on a per call basis, typically dependent on the duration, distance and bandwidth utilized. Increasingly 'flat fee' charging is deployed, e.g. a monthly charge for Internet access services, only dependent on the bandwidth provided; or 'service bundles' with a fixed charge for a 'bucket' of call minutes per month.[8] Additionally to these post-pay schemes, pre-

paid schemes are widely deployed for mobile communications and special categories of international calling.
End-to-end communication services are facilitated through the interconnection of networks and the cooperation of the owners of these networks. International networks (submarine cables, satellites) were historically owned by consortia of national operators. In recent years national operators have extended their network infrastructure beyond national borders and specialized long distance carriers are providing for international connectivity.

Historically and for technical reasons networks were optimized for a specific type of communication service (telegraph, telephone, RTV-distribution). While the physical medium determines the transmission properties and hence the protocols on the lower layers of the OSI-stack, increasingly a range of communication types are migrating toward the use of the Internet Protocol suite (TCP/IP) at the intermediate layer, viz. Voice-over-IP (VoIP), IP-TV.
In the (terrestrial) telecom networks a typical distinction is made between 'inside plant', the switching and transmission equipment housed in buildings, and the 'outside plant', primarily the cable plant with the transmission repeater equipment, and the microwave radio towers. 'Customer premises equipment' (CPE) includes the corporate networks (PABX-es, LANs, routers) and the cable terminations and modem equipment, as well as terminal equipment at the workplace or at home. With the advent of computer controlled switching and transmission equipment also operations and maintenance became increasingly automated and remote controlled. Together with billing and 'customer care' systems this is the category of Operation, Administration and Maintenance (OAM) systems, which are essentially large specialized IT systems.[9]
Telecom equipment providers tended to specialize on a specific type of equipment (public or private network equipment, switching or transmission), large 'system houses' would provide a broad portfolio of equipment and associated software and services.

2.5 The telecom firm

The establishments that undertook the first communication services were either state owned entities, as in the case of the telegraph service (with a strong military interest), or private entities, as in the case of telephony service (De Wit, 1998).[10] In the early part of the 1900s, for reasons of achieving interconnectivity and universal service most private enterprises became state owned and state run monopolies (dominant model in Europe), or became private monopolies under close state supervision (dominant model in the USA) (Melody, 1999). The scope and territory of operations was being defined through the licensing process. Starting in the 1980's and continuing till today, the reform process, involving privatization (Europe), liberalization and re-regulation, has made the private firm operating in a competitive market the preferred model for the provisioning of telecom services. In Chapter 5 and 7 more details are provided on the reform process, including the results to date.

The provisioning of telecom equipment has historically been closely associated with the provisioning of services. In some countries they were provided by the same company (USA-AT&T) or a close cooperation existed between the two (Europe). Essentially the market was a national one, in particular for the large switching and transmission systems. With some (over)simplification one could speak of: 'one country – one operator – one supplier'.[11] The recent advances in technology, silicon and computer control, have lowered the market entry barriers significantly and the recently gained 'independence' of incumbent telecom operators together with the emergence of many new operators has stimulated the entry of new telecom equipment, software and service providers.

The close cooperation between service and equipment provider implied a close cooperation on R&D. Telecom related R&D was an important element of the National Innovation System, consider for instance the national role and contributions of Bell Labs in the USA, and of the CNET in France. The reform process, resulting in increasing competition, and the advances in technology have changed the innovation system from being concentrated around a few entities to a more dispersed innovation system with a larger role for small enterprises. Many incumbent telecom operators have significantly downsized their R&D operation, sometimes through outsourcing. Many new entrants are not engaged in significant in-house R&D activities.

2.6 Telecommunications - a network industry

In this Section the characteristics that sets the telecom industry apart from other industries and in the same group with other network based industries, will be explored.

"A common and defining feature of network industries is the fact that they exhibit increasing returns to scale in consumption, commonly called network effects." (Economides, 2003 p3).[12] A market is considered to have network effects when the value to a buyer of an extra unit is higher when more units are sold, or expected to be sold, *ceteris paribus*.[13] Network effects arise because of complementarities, which can be either direct or indirect. The telecom network is a prime example of direct positive network effects, where the addition of one new user adds 2*n* new communication possibilities to the existing *n* users.[14] Indirect network effects can also occur in one-way networks, such as in the case of complimentary goods.[15] The relation between mobile standards and compatible handsets is a typical example in the case of telecom. The network effect leads to a positive feedback loop that is only constrained by the downward slope of the demand curve (p4-6). As a result the diffusion of a new good with network effects is much faster.

Network effects may also originate from the expectations of agents, e.g. in their anticipation of platform dominance, or be stimulated through the coordination among agents, e.g. by producers in coordinating standards efforts or by buyers teaming up. Moore explores this notion and provides evidence from the IT industry (Moore, 1995).

Markets that exhibit strong network effects and where firms can chose or set their own technical standards are 'winner-take-most' markets. The market share of the 'winner' can be a multiple of the second largest, and so on. The low market share firm is not necessarily driven out of the market as that would require too low a price by the high share firm (p11-2). Economides points to the implication of network effects: "…because inequality is natural in the market structure of network industries, there should be no presumption that anti-competitive actions are responsible for the creation of market share inequality or very high profitability of a top firm. Thus, no anti-competitive acts are *necessary* to create this inequality. (italics in original, Economides, 2003 p14-5). Moreover, "[I]n network industries, free entry brings into the industry an infinity of firms, but it fails miserably to reduce inequality in market shares, prices and profits." (p15).

Economides identifies a further implication for industries exhibiting network effects in that competition 'for the market' takes precedence over competition 'in the market'. As he concludes: "In network industries, there is typically an intense race to be the dominant firm. In network industries, we often observe Schumpeterian races for market dominance." (p16).

Furthermore the presence of network effects implies the importance of 'path dependence', whereby the past choices of producers and consumers influence their future options.

2.7 The telecom equipment industry

The telecom equipment industry has historically been highly R&D intensive.[16] The application of electronic circuits in harsh outdoor environments required specialized design and engineering skills. The challenges were to cover ever faster transmission distances with increasingly higher bandwidth at lower costs. The transition from the early manual to the automatic telephone switching systems required 'switching in real time', i.e. the controllers had to receive information from the telephone sets and from other switching systems without loss of information. This spurred the development of specialized controllers, and eventually the development of dedicated real-time computer systems. The controllers directed first electromechanical switches and later on analogue switching matrices, followed by fully digital ones. The design rules were voice centric, i.e. a two way circuit was set up for the duration of the call. The transmission links were optimized for the transfer of the human voice. Good audibility required a bandwidth of 3kHz or 64 kb/s when digitally encoded. Through analogue and digital multiplexing techniques multiple calls were transmitted simultaneously over a particular transmission link; twisted pair copper cable, coax cables, microwave links and more recently optical fibers and cellular radio. The telecom industry evolved based on the 'circuit mode' paradigm. Telephony networks are essentially optimized, based on the calling pattern of telephony users. Albeit the transmission links are increasingly carrying data communication traffic.

The use of computer control implied a shift from a hardware oriented industry to a software driven industry, in particular in the field of switching. Business models became increasingly based on revenues from the exploitation of the installed base through software upgrades. The hardware-software paradigm and indirect network effects are characterizing today's industry.

While voice traffic can be characterized by a Poison distribution of arrival times, and network resources can be dimensioned for a certain level of congestion using the Erlang and Engset formula[17], the data communication traffic between computers has a totally different characteristic. While the communication is also two-way, most of the time the data transfer rates in either direction differ significantly (down- loading of files from a server versus up-loading). Moreover, there is a variety of applications generating a range of traffic patterns (bursty low intensity email and ‘chat’ traffic, continuous streaming audio and video, mixed with high volume file transfer between servers). The packet-based transfer of data in computer networks is much more efficient for this type and mix of communication needs. Hence, the computer communication industry evolved based on the ‘packet mode’ paradigm. While the hardware-software paradigm is also applicable in the computer communication industry, the push for ever increasing data transfer rates is driving the implementation increasingly into (programmable) hardware based solutions.

We will further explore the equipment industry in Chapter 5.

2.8 Connectivity and the role of standards

The telephony network has been called the ‘world’s biggest machine’, with more than a billion users connected.[18] This worldwide network is realized through interconnectivity of hundreds of networks owned by related but independent firms, private and state owned. The observation made by Economides that: “[i]n networks of interconnected networks, there are large social benefits [to be gained] from the interconnection of the networks and the use of common standards” (2004 p22), is well recognized within the telecom industry and firmly embedded in the formal and informal institutions. This applies in a similar vain for the fact that, “[i]n a network where complementary as well as substitute links are owned by different firms, the questions of interconnection, compatibility, interoperability, and coordination of quality of services become of paramount importance.” (Economides, 1996 p6). In each field, voice and data communications, specialized institutions engaged in standards setting have evolved. The convergence of voice and data communication implies a ‘coming together’ of these two different worlds. See further Chapter 5.

2.9 The role of the institutional environment

With reference to the definition of institutions provide by North, see Section 5.2.4, formal institutional arrangements play a crucial role in the telecom industry. Through national (and regional) legislation the rules and regulations are provided under which telecom operators are licensed to provide (a range of) telecom services. Many of these rules have been adapted as part of the reform process aimed at introducing the ‘powers of the market’ in the field of telecom services.

By removing formal entry barriers and by anticipating a stimulus from advances in technology and from the financial markets, competition was expected to emerge, which would provide the telecom users with a wider choice, lower prices and higher quality of services. The reform process culminated in the Telecom Act of 1996 in the USA and the liberalization of the network access in the EU in 1998. These major events coincided with the boom period of the Internet bubble period as illustrated in Figure 1 Chapter 1. We will expand on this topic in Chapter 5 and 7.

3 Revisiting the strategy and policy perspectives.

In Chapter 1 we have identified the firm strategists and government policy makers as the external users of this research project and the academic community as the internal user. We also identified the firm as the primary actor, as the results of policy are to be achieved through the (strategic) actions of the firms aimed at realizing their firms' objectives. Hence, in our research we will respond to the needs of the strategist and draw upon theories, concepts and models that have been developed within the strategic management discipline, where they relate to the topic of our research, i.e. the development path of the telecom sector.
We have identified the primary role of policy makers in this context as providing for the proper functioning of markets.[19] One of the more fundamental tasks of governments is the establishment and maintenance of an appropriate formal institutional environment for the markets to function properly and to prevent and/or to resolve market failure.
On the one hand the institutional environment is conditioning the behavior of market participants, while on the other hand these institutions develop under the influence of the market participants. In considering the development path of the telecom sector, the institutional arrangements play an important role, in particular through the process of regulatory reform. The objective of the reform process is to create a properly functioning market for telecom services, avoiding market failure in the transition from the original (state) monopoly situation. Therefore we will respond to the needs of the policy maker and draw upon institutional economic theories and concepts of regulatory reform.
This proper functioning of markets is a primary concern for economists, in their pursuit of arrangements that achieve static and dynamic efficiency of markets. As the telecom sector is subject to major technological changes for the period being considered, we will be drawing in particular upon the more dynamic economic theories, concepts and models to describe and assess the development path of the telecom sector.

In the following sections we will expand on the strategy and policy perspectives presented in Chapter 1, to subsequently be able to identify and select the theories, concepts and models that can be used best to describe and assess the development path of the telecom sector. We will also identify commonalities among these perspectives, to allow us to simplify the research effort.

3.1 The perspective of the firm strategist

As stated in Chapter 1 the objective of strategy making is in achieving the firms objectives, and the definition of strategy can be broadly defined as "a course of action for achieving the organisation's purpose". The strategy formation process links the organizational purpose as the input to the content of strategy, i.e. the output. The process is executed within the strategy context that conditions the strategy activities. See Figure 3 (De Wit and Meyer, 2004 p5).
With respect to the content of strategy De Wit & Meyer make a distinction between four levels at which the strategy effort can be aimed: the functional level (e.g.

functional areas such as marketing, operations and R&D), the business (unit) level, the corporate level, and the network level, where various firms work together to create economic value. (2004 p231-417).

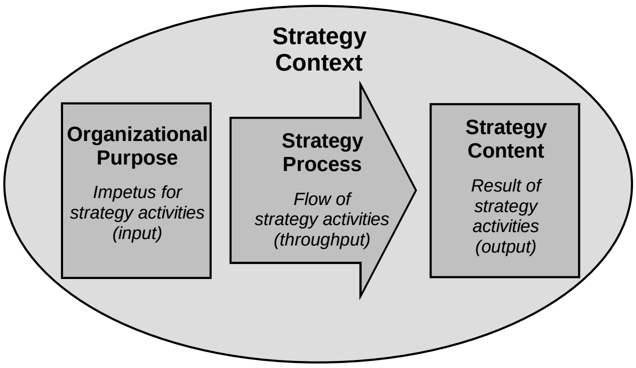


Figure 3. Dimensions of strategy

Recognizing that strategic management is concerned with relating the firm to its environment, the strategy context is another important factor to be taken into account. Considering the environment from the manager's perspective, the strategy context can be distinguished in the organisational context (concerned with the sources, the levels and the arena of leadership influence)[20], the industry context, and the international context (p420). All of this then depends on how the organisation perceives its purpose, and what is considered important. Is that pure financial in terms of shareholder value or should attention be given to the interest of all stakeholders?

Prevailing in the industry practice are the more formal and analytical processes of strategy formation.[21] Typically a strategy formation process evolves in two stages: defining and solving, and in four steps: identifying, diagnosing, conceiving and realizing. See Figure 4 (De Wit and Meyer, 2002). Although depicted as a circular process, in practice there are iterations between the various steps.

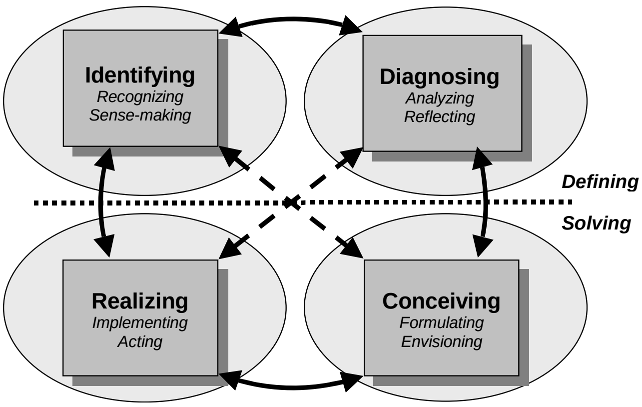


Figure 4. Strategy cycle

Central in these analytical approaches is the need for the strategist to understand the 'rules of the game' in his/her industry.[22,23] These rules are the demands imposed by the industry context upon the firm. They determine under what conditions the competitive game will be played and they limit the potential strategic behaviours (p422). These industry rules are considered to arise from the industry structure. Porter captures the impact of the industry structure through the five competitive forces, that determine the profitability potential of an industry. See Figure 5 (Porter, 1980 p3-33). According to Porter: "An effective competitive strategy takes offensive or defensive action in order to create a defendable position against the five competitive forces." (p29). This approach to strategy formation, where the market is considered to be leading, is being called the 'outside-in' approach. More recently the attention has turned toward the resources and competences of a firm as the source for the creation of sustainable competitive advantage.[24] This 'inside-out' approach emphasizes the creation of markets, rather than the adaptation to markets, as the focus of competitive strategy. See e.g. (Prahalad and Hamel, 1990; Hamel and Prahalad, 1994), (Barney, 1991). Moreover, firms are becoming more dependent on other organizations in realizing their strategic objectives, e.g. as competition is moving from singular products to systems, and through the increase in subcontracting arrangements (Lorenzoni and Baden-Fuller, 1995; Shapiro and Varian, 1999). These inter-organizational relationships or eco-systems expand the strategy formation beyond the boundaries of the firm. In formulating an appropriate course of action the strategist is challenged by the tension that exist between the need to comply with the industry rules and regulations on the one hand, and the desire to gain competitive advantage by breaking the rules on the other. De Wit & Meyer identify this strategic challenge as the paradox of compliance and choice (2004 p429-40).

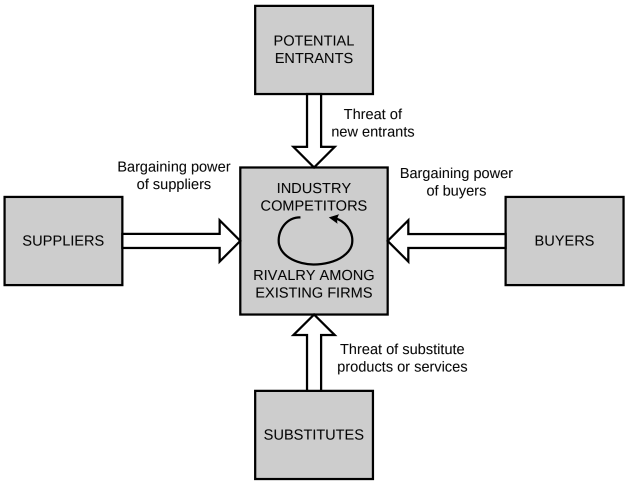


Figure 5. Forces driving industry competition

The compliance perspective is typically reflected by the concept of industry evolution, following the product life cycle curve (Kotler, 1980 p289-309; Porter, 1980 p156-90; Kotler, 1997 p343-71). De Jong has embraced this concept and made it the core of the Dynamic Market Theory to explain the changes in industry structure, in particular horizontal and vertical concentration and fragmentation (De Jong, 1996). The revolutionary perspective is more akin to what has been happening during the Internet bubble and described by e.g. Moore (2000). Here the changes in the industry structure are more radical and hence the rules of competition change more fundamentally. Paradigm changes or regime changes are typical examples leading to broad and fundamental changes of the industry structure (Dosi, 1982; Van de Poel, 1998).

If strategists want to formulate a proper plan of action they need to understand how the industry structure is changing or will change, what attributes cause these changes and what the nature of these changes is. “A process of slow and moderate industry change will demand a different strategic reaction than a process of sudden and dramatic disruption of the industry rules.” (De Wit and Meyer, 2004 p422).

3.2 The perspective of the policy maker

As identified in Chapter 1 a strong parallel can be observed between strategy and policy formation. Obviously the content element is different: private versus public. Parsons emphasizes the tensions that have always existed (and will remain to exist) between what is held to be ‘public’ and what ‘private’ (Parsons, 1995 p3). The way this tension is being resolved depends on the societal model and the role perception of governments. On one end of the spectrum we find the (pure) market economies, based on the idea that through market forces the maximization of individual interest could best promote the ‘public interest’. On the other end of the spectrum we find the centrally coordinated or planned economies, where the private interests are considered best served through the public domain. Today, with a prevalence of capitalistic market economies, the distinction is more gradual.[25]

In the (pure) market model the role of the state and politics is minimal, i.e. to secure a framework of law, rights and order for the market to be able to function properly. As history showed, this ideal model based on an equilibrium outcome of self-interest, did not necessarily deliver on the expectation in all areas of social life, such as education, health, welfare, housing, etc. A more knowledgeable form of governance was considered the key to resolving the conflict between the claims of the private and the public (p4-6). A shift away from the extreme of the spectrum occurred. However, in the 1970s “[t]he claim that knowledgeable governance could better ‘solve’ or mediate the relationship between public and private interest began to sour in the era of stagflation” (p6). The pendulum swung back, and the virtues of the market mechanism were promoted anew.

One may conclude that next to the role of government in facilitating the markets for private goods, it has an obligation to supply what is considered to be public goods.[26] As indicated above, the demand for and what is to be considered a good to be supplied through government intervention is fluctuating in response to the interaction of the stakeholders: voters, government, civil service and producers (p11). ‘The conscious awareness of choice between two main alternatives for steering societies’ is what Dror calls policy-making (Reference made to Dror in

Parsons, 1995 p13). Policy is understood to have become a term expressing political rationality. “To have a policy is to have rational reasons or arguments which contain both a claim to understanding of a problem and a solution. It puts forward what is and what ought to be done. A policy offers a kind of theory upon which a claim for legitimacy is made.” (p15).

As in the field of strategy, different perspectives have evolved as to what should be considered important in policy-making: from a ‘policy science’ approach by Lasswell, the introduction of ‘bounded’ rationality by Simon to a ‘political systems’ approach by Easton, which evoked the criticism by Lindblom, who emphasized the dimensions of power and interaction between phases and stages of the policy-making process, and the notion of incrementalism or the ‘science of muddling through’ (Hogwood and Gunn, 1994 p42-64; Parsons, 1995 p16-22).
Based on the systems approach, a framework for policy-making is provided by Easton, whereby policy-making can be considered as a process in terms of: “…received inputs, in the form of flows from the environment, mediated through input channels (parties, media, interest groups); demands within the political system (withinputs) and their conversion into policy outputs and outcomes.” (p24).
From the review of theories provided by Sabatier, we may conclude that also in the field of policy formation many ‘schools’ exist (1999).[27]
While subject to critique, the policy life cycle model, or stagist model, remains a broadly recognized model for describing the cyclical nature of the policy making process. See Figure 6 (Parsons, 1995 p77).[28] This model has a high degree of similarity with the model used by strategists as depicted in Figure 4.

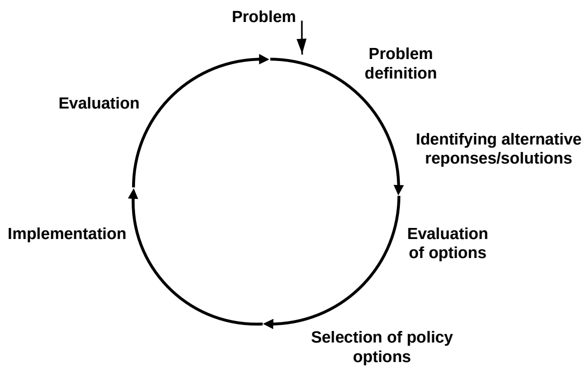


Figure 6. The policy life cycle

The parallel with strategy making may be extended further, to e.g. the development of the strategy ‘agenda’ and the policy ‘agenda’, as well as the attention to the ‘practice’ of strategy and policy making[29], and in the distinction between process, content and context.[30]
Next to the attention to the proper functioning of national and international markets and the deregulation of network sectors, policy makers are concerned with regional policy issues, such as the EU agreement to establish Europe as a leading region in the information economy. This agreement calls for e.g. the development and

implementation of policies, at Member State level, to realize an ubiquitous broadband network with access for all European citizens. This implies an interest on the part of the policy makers in the rate of renewal of the telecom infrastructure.
Moreover, with the general recognition that innovation is an important driver of economic growth, governments tend to pursue active innovation policies, that stimulate innovation in general or direct and stimulate the research and development of specific technologies. Depending on the role perception of the government (regulatory or developmental state (Groenewegen, 1989 p76)), an industry policy may be pursued, facilitating investments in a particular sector or in specific industries.
Also in the implementation of telecom policy a perspective on the further development of the sector is considered beneficial, as the National Regulatory Agencies (NRAs) in the EU are required to apply a forward looking stance in the assessment of Significant Market Power (SMP).

3.3 Conclusions

For the strategist the understanding of the industry structure is important as it determines the 'rules of the game' to achieve business success. Hence, the understanding of changes in industry structure, in particular radical changes, is of particular importance. As the changes in the industry structure may be a result of actions within the industry, or invoked by events in adjacent industries, or a consequence of changes in the institutional environment, a holistic and integrative perspective is required.
For the policy-maker the proper functioning of markets is a key concern. Therefore any changes in the industry structure that may impact on the potential of market failure is important to understand. This also applies for changes that may require adaptation of the institutional environment for the markets to continue to function properly.
Recognizing that the telecom sector is subject to the process of reform, an *ex ante* rather than an *ex post* perspective is required on the proper functioning of markets. This requires a forward looking stance on the impact of changes in the industry structure and an anticipation of the potential impact on the behaviour of the actors. Moreover, given the shared objective for the EU to become a leading region in the knowledge-based information economy and the facilitating role of telecom therein, policy-makers have a keen interest in understanding the pace of modernization of network infrastructures.
Considering these common needs of the strategist and the policy-maker, our research into the development path of the telecom sector will be executed with a focus on the structure of the telecom industry and the changes therein.

In the following section we will first refine our definition of the 'development path'.

4 Exploring the 'development path' of the sector

In everyday practice the terms telecom sector and telecom industry are used interchangeably. In more formal sense, the use of the term sector implies a reference to the highest level of aggregation of economic activity, covering many

industry groups. See also Section 2.1. In the literature on management science a distinction is made between the firm level and the industry level of analysis. In this branch of social sciences, the industry is considered to include the firms operating in the same market. The market, for products or services, the boundaries being determined by the principle of substitution. In this project the distinction between sector and industry will be maintained and the typical connotation will be addressed explicitly where necessary.
In Chapter 1 we have used the definition of the 'development path' of a sector as a 'sequence of states'. In the following section we will further elaborate on this definition.

4.1 Defining the development path

Industry development means essentially that the structure of the industry is changing, and the development path can be considered to reflect this change. As introduced in Chapter 1, the development path of an industry can be described as the sequence of 'states', whereby the transition from one 'state' to the other is the result of the 'drivers of industry development' and the 'inhibitors of industry development' enacting upon the industry. The 'dimensions of industry development' are the key structural dimensions along which industry development can be mapped. See also Figure 7 (De Wit and Meyer, 2004 p423).

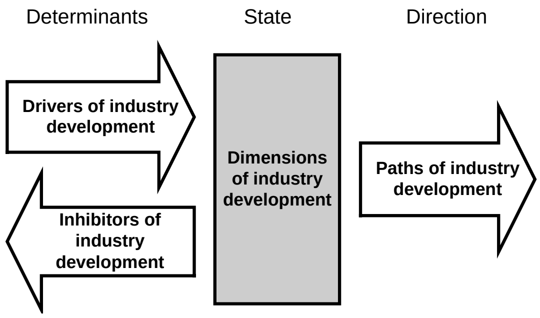


Figure 7. Industry development path

The development path of an industry can be mapped relative to the following dimensions:

1. Expansion-contraction of demand,
2. Concentration-fragmentation of the market,
3. Convergence-divergence of business models employed in the industry,
4. Expansion-contraction of investment, directed at innovation and assets,
5. Vertical integration-fragmentation of value-adding activities,
6. Horizontal integration-fragmentation with respect to business boundaries,
7. International integration-fragmentation of boundaries separating geographic segments.

Obtaining an insight in these dimensions of industry development will inform policy and strategy, both in terms of formation as well as in the tracking of implementation. In the interpretation of the findings it should be noted that the actors in the industry are both conditioned by the developments happening in the industry, as well as contributing to these same developments. Moreover, the interpretation of the findings will differ depending on the perspective of the strategist, e.g. in striving for business success by following the industry in an industry compliant mode, or by pursuing opportunities through the creation of new markets, and possibly a new industry. This also applies for the role perception of the policy maker, following either a regulatory or a developmental model. To be able to act upon the information provided in this aggregated view of industry development, requires the actor to investigate the underlying drivers and inhibitors of change.

4.1.1 Implications of changes in the 'development path'

For an appreciation of the dimensions of industry development, a 'short hand' interpretation of each dimension of the development path is provided. This list is not meant to be limitative or exhaustive, but rather illustrative:

<u>In the context of policy formation and implementation tracking:</u>
Expansion of demand makes the market attractive for new entry, an objective of the telecom reform process.
Concentration of the market increases the market power in the hands of a few firms, which may increase the risk of inappropriate use of market power.
Convergence of business models may lead to a dominant business model in the industry, which in turn may become an inhibitor of industry change.
Expansion of investment suggests growth in the long-term and hence a positive contribution to macro-economic developments.
Vertical integration of value adding activities suggest more power being wielded by fewer firms over the developments in the industry.
Horizontal integration of business boundaries provides for opportunities to expand into adjacent businesses within the industry. A process that may result in increased competition.
International integration of boundaries separating geographic segments suggests that developments occurring globally will affect the industry locally. This will improve international trade.

<u>In the context of strategy formation by the incumbent and implementation tracking:</u>
Expansion of demand provides opportunities for growth, an objective under the new stock market regime.
Concentration of the market tends to improve the position of the incumbent, however it also limits its options to enter new markets abroad.
Convergence of business models provides for further economies of scale and scope, which may improve the position of the incumbent, provided the firm operates under the prevailing business model. The emergence of a new, potentially dominant, business model, can be very disruptive to the position of the incumbent.
Expansion of investment reflects a positive expectation by the incumbent and reflects his strategic intent.

Vertical integration of value adding activities allows the incumbent to capture a bigger portion of the value being created in the industry.
Horizontal integration of business boundaries provides for growth opportunities through more easily expansion into adjacent businesses within the industry.
International integration of boundaries, that are separating geographic areas, provides opportunities for expansion of the business across the border.

<u>In the context of strategy formation by the potential entrant:</u>
Expansion of demand facilitates the entry into the industry.
Concentration of the market tends to concentrate power in the hands of the incumbent. Retaliation upon entry may be more severe.
Convergence of business models suggests clear ‘rules of the game’ in this industry. To be followed or broken as part of the entry strategy.
Expansion of investment reflects a positive expectation by the industry and suggest that the market is attractive. Albeit, the competitive game may have to be played on different terms if the investment is directed at innovation.
Vertical fragmentation of value adding activities facilitates entry, as the new entrant is provided with more opportunities to capture a part of the value chain.
Horizontal integration of business boundaries suggest easier access to the market. Although the competition may come from multiple angles.
International integration of boundaries separating geographic segments provide opportunities for entry in foreign markets.

4.1.2 Dimensions of the ‘development path’

The dimensions of the ‘development path’ are being elaborated in the following Sections, where considered necessary.

4.1.2.1 Expansion-contraction of demand

Let’s begin with the most fundamental dimension of the ‘development path’ of an industry i.e. the demand life cycle to be described in Section 5.1.2 and reflected in Figure 13. The demand life cycle can be considered as the human need to communicate. Initially these needs were satisfied through face-to-face communication and story telling. Messaging was used to bridge larger distances, using couriers and mail coaches. Telegraphy provided the first means to transfer messages over large distances electrically encoded. Telephony provided the ability to transmit voice directly. Advances in mobile technology and products have made voice communication over distances a ‘whenever wherever’ phenomenon. Moreover, computer mediated communication has resulted in a rebirth of message communication through email.
Next to human communications increasingly human artifacts are designed to communicate, in the form of computer-to-computer or client-to-server communication. This generates a new demand life cycle.
Demand in telecommunications can be measured through connectivity and traffic volume. Connectivity can be measured in terms of the number of access paths to the network. These paths need to be qualified as either fixed or mobile, and with the transition from narrowband to broadband, bandwidth has become an important indicator. Traffic volume in relation to telephony is expressed in terms of the

number of calls and the duration of calls, the required network capacity being fixed as bi-directional at 64 kb/s. Traffic volume in relation to data communication is typically defined in terms of up-stream and down-stream bandwidth, in terms of average and at peak loads, and in terms of latency (transfer delays).

4.1.2.2 Concentration-fragmentation of the market

In the static economic theory concentration is considered to result from the notion that long-run average cost curves are L-shaped, that is fixed cost are pushing up the average costs at small levels of output and at higher outputs the average costs will fall, but at a diminishing rate. Where the curve flattens out is termed the ‘minimum efficient scale’ (MES) of production, determined by the indivisible costs (Stead, Curwen et al., 1996 p30). In equilibrium, the market will be divided between firms operating at the MES level, which thereby will determine the level of concentration.
In dynamic economic theory the concentration levels are considered also to be determined by the phase of the product life cycle. See further the discussion of the Dynamic Market Theory in Section 5.1.3.

Concentration is mostly measured in terms of company size relative to the market size. This can be done using a multiplicity of indicators, such as revenues, employment, assets or value added. Inequality in firm size can be shown using the Lorentz curve (cumulative percentage of firms versus cumulative percentage of market share). The degree of concentration can be reflected in the Concentration Ratio N (CRn) or the market share assumed by the largest n-firms. The Hirschmann-Herfindahl index (HHI) reflects concentration as the sum of the squared market shares of all firms in the industry (Stead, Curwen et al., 1996 p26-7). For the purpose of this research project the assessment of market concentration will be qualitative and directional.

4.1.2.3 Convergence or divergence in business models

For an appreciation of the dimensions of industry development, a ‘short hand’ interpretation of each dimension of the development path is provided. This list is not meant to be limitative or exhaustive, but rather illustrative:

For an assessment of the degree of either convergence or divergence in business models used in the telecom sector, we will first have to provide a definition of a business model that can be operationalized for our research purposes. A useful starting point is provided by De Wit and Meyer with the notion of a business system, which is comprised of three components: the resource base, the activity system and the product offerings. See also Figure 8 (De Wit and Meyer, 2004 p232). While all firms combine elements of the business system, it is the particular combination that makes the firm unique, and it is the commonality across the firms that gives meaning to the notion of convergence and fragmentation of business models. Firms that operate in the same industry, i.e. making a similar type of product or employing a similar set of value-adding processes or resources, will have a number of elements of the business system in common. Nevertheless, firms differ in endowments, the type of resources acquired and the way resources are being deployed, and the choices made in relation to the markets being served.

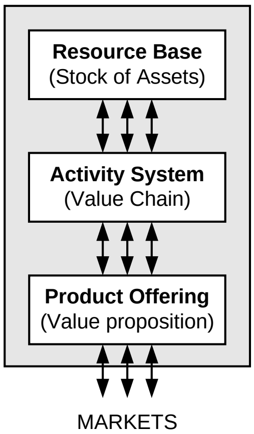


Figure 8. Business system

The firm resource base includes the tangible and the intangible resources, which can be categorized as shown in Table 4 (p243).

Firm Resources		
Tangible resources	**Intangible resources**	
	Relational resources	**Competences**
Land	Relationship (e.g. contracts)	Knowledge (e.g. patents)
Buildings	Reputation (e.g. brands)	Capabilities (e.g. programs)
Materials		Attitude
Money		

Table 4. Firm resources

For the description of the activity system we can use the generic value chain as provided by Porter, see Figure 9 (Porter, 1985 p37).

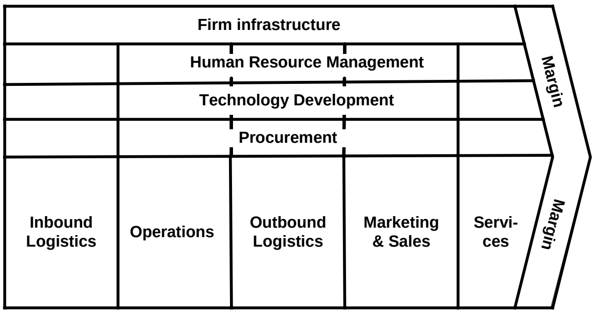


Figure 9. Generic value chain

The product offering is relating to the choice the firm has made in terms of products they wish to produce and markets they wish to serve.

When firms have a comparable resource base, are using the same technologies, one may infer that the firms have a similar cost structure, in terms of fixed and variable costs.[31] Given a certain degree of transparency in the market, this may lead to a high degree of similarity in the business models being deployed. If a certain proportion of firms is operating based on essentially the same business model we may conclude that the industry is being characterized by a dominant business model.

4.1.2.4 Vertical integration-fragmentation of value-adding activities

Using the definition by Porter vertical integration is: “the combination of technologically distinct production, distribution, selling, and/or other economic processes within the confines of a single firm.” (Porter, 1980 p300). The alternative to integration is contracting through the market. Vertical integration can be executed in the forward and in the backward direction of the value chain. The generic benefits from integration include: economies of combined operation, of internal control and coordination, of information, of avoiding the market[32]. The costs of integration include: overcoming the mobility barrier, increasing the operating leverage, higher exit barriers, higher capital requirements. reducing the flexibility to change partners (p303-11).

4.1.2.5 Horizontal integration-fragmentation of business boundaries

For this dimension of the industry development path we follow the definition provided by De Wit & Meyer: “Where the boundaries between different businesses in an industry become increasingly fuzzy, the industry is said to be developing towards a more horizontally integrated structure. Conversely, where firms become more strictly confined to their own business, the industry is said to be moving towards a more segmented or horizontally fragmented structure.” (De Wit and Meyer, 2004 p424).

4.2 Drivers of industry development

The drivers of industry development can be categorized in three classes:

- The contextual drivers,
- The industry drivers,
- The internal drivers.

The contextual drivers are reflecting the external environment that influences the behaviour of the industry players, the incumbent rivals and the (potential) new entrants, as well as the buyers and suppliers. In capturing the environmental dynamics Freeman and Louçà distinguish five semi-independent social subsystems: science, technology, economy, politics and culture (Freeman and Louçã, 2001 p120-3). Perez identifies three ‘subsystems of change’: technological, economic and institutional (Perez, 2002 p156). The Four Layer Model by Williamson (see Chapter 2 Section 4.8.1) can be seen as making a distinction in the ‘rate of change’, with science and culture as the more ‘permanent’ dimensions. In the strategic literature a similar distinction in four categories is made under the acronym of SEPT, sometimes extended with another E for Environmental[33]:

- Socio-cultural,
- Economic,
- Political/regulatory and
- Technological.

In this study we will use this four dimension model, albeit in a different order. The focus will be turned to those aspects that have a direct bearing on the development of the telecom sector.

The industry drivers are applicable to the telecom sector in general and may be specific for the telecom services industry or the telecom equipment industry.
The industry drivers can be summarized through the Five Forces identified by Porter.[34] The Five Forces are reflecting the underlying industry structure and are collectively determining the profit potential of the industry. And consequently they drive the strategic behaviour of the incumbent rivals (Porter, 1980 p3-29) (see also Figure 5):

- Bargaining power of buyers,
- Bargaining power of suppliers,
- Threat of new entrants,
- Threat of substitutes and
- Intensity of rivalry.

The internal drivers are related to the resource-based view of the firm. The resources can be categorized in tangible and intangible, whereby for the latter a distinction can be made between relational resources and competence. See for a listing Table 4.
As the internal drivers are related to the resource base of the firm, they tend to be firm specific. As in this study we are mainly interested in the developments at the industry level, we will consider this dimension where there is commonality of resources across the industry, or when the resource–base is used to change the ‘rules of the game’.
It should be noted that in the quest by strategists to achieve sustainable competitive advantage the aim is to pursue opportunities provided by the heterogeneity of the firm resources, and in particular the imperfectly imitable resources.

Figure 10 provides an overview of the resulting force field (De Wit and Meyer, 2004 p427).

4.3 Inhibitors of industry development

The inhibitors of industry change are essentially the sources of industry rigidity, making the industry rules more difficult to bend or break. De Wit & Meyer identify the following categories of inhibitors (2004 p427-8):

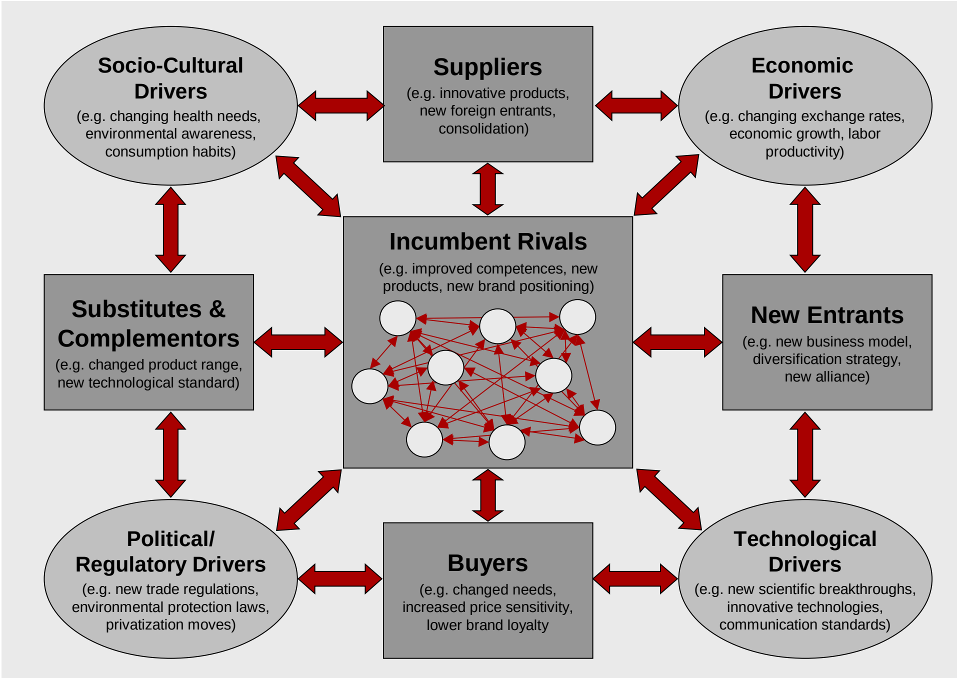


Figure 10. Drivers of industry development

- Underlying conditions, e.g. economies of scale,
- Industry integration, in terms of (complex) linkages between various aspects of the industry,
- Power structures, e.g. desire to maintain the status quo by incumbents,
- Risk averseness, e.g. uncertainties about investment payoff,
- Industry recipes, e.g. in the form of cognitive maps shared across the industry,[35]
- Institutional pressures, e.g. applied by governments or interest groups.[36]

To the examples of "underlying conditions" should be added: path dependence and lock-in. These are of particular importance for network industries.
Of special interest as an inhibitor of industry development in the context of our research project are 'industry recipes' or cognitive maps that are shared across the industry. Cognitive maps are related to the prevailing technological regime and the paradigms operating in the industry. For our purpose it is useful to recall the definition of technological regime provided by Rip & Kemp and cited by Van de Poel: "A technological regime is the rule-set or grammar embedded in a complex of engineering practices, production process technologies, product characteristics, skills and procedures, ways of handling relevant artefacts and persons, ways of

defining problems - all of them embedded in institutions and infrastructures." (Van de Poel, 1998 p15). The difficulty or inability for an industry to adopt change through the fixation on a particular paradigm is called by Barker: 'paradigm paralysis' (Barker, 1986). See also Section 5.2.2 *Paradigms and technological trajectories*.

The above categories are partly determined by technological characteristics, e.g. economies of scale, but to a large extent evolved as a part of the development of the industry. As such they condition the behaviour of the actors in the industry and are shaped, as a collective outcome, by these same actions.

4.3.1 Simultaneity of determinant of industry structure and driver

From the above one may conclude that the same determinants are used to denote on the one hand a notion of stability, *in casu* industry structure, and on the other hand the notion of change, in the form of driver of industry development. This appears as a contradiction. Let's review the case.

The 'Webster' provides for the term 'structure' the following explanations, among others (Woolf (Ed.), 1977):

- something arranged in a definite pattern of organization,
- arrangement of interrelation of parts as dominated by the general character of the (economic -) whole,
- the composition of conscious experience with its elements and their combination (Gestalt).

As structure in our case is related to social structure, the observation made by Lawson applies: "…because social structure is dependent upon human agency, it follows that it is open to transformation through changing human practice…" (Lawson, 1998). Boudon provides a general sociological framework to study these systems of interaction. He distinguishes between three processes of social change: reproductive, cumulative innovation and transformation (Boudon, 1981a). See also Figure 11.

The 'system of interaction' represents the actors and the relations between them (the structure of the situation). The environment includes the actors who are not directly involved in the system under consideration, but are influencing the behaviour of the system through causal link (A). Following Van der Steen a second-order environment or force field can be distinguished represented by actors more remote and by the institutions that influence the behaviour of the actors within the system (Van der Steen, 1999 p135-7). The distinction between the three process types of social change is based on the presence or absence of feedback loops.

In our case the 'system of interaction' consists of the firms in the industry (the incumbent rivals as reflected in Figure 10). The first-order environment includes the actors generating four out of the five primary driving forces of change: buyers, suppliers, new entrants, providers of substitutes. The second-order environment includes the forces identified in the SEPT-model, including the institutional forces: socio-cultural, economic, political/regulatory and technological.

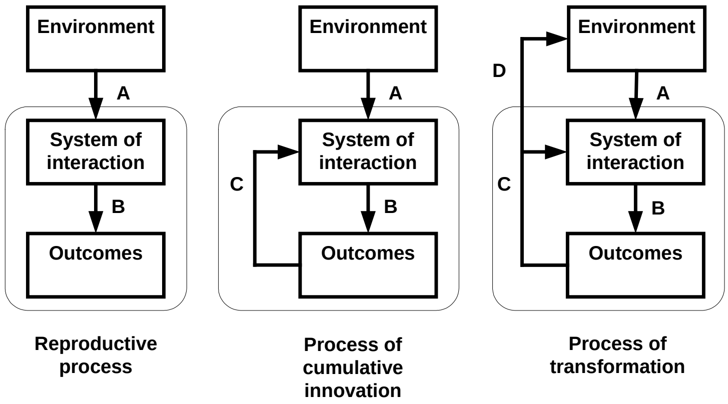


Figure 11. Processes of social change

The outcome in this model is the path of industry development as represented by one or more of the dimensions of industry development identified above. In our case there are clear interactions between the outcome of the system and the ‘system of interaction’, i.e. feedback loop (C) is present. This is the quintessence of the five forces model by Porter. Also feedback loop (D) is present as for instance firm behaviour influences the political environment, or invokes changes in the governance regime. Hence, the third case applies: the process of transformation.[37] Based on this model of social change there is not necessarily a conflict between a factor being simultaneously a determinant of industry structure and a determinant of change of that same structure. This notion is consistent with the *critical realist* emphasis on reproduction and transformation of ‘social structures of importance’.

5 Industry development and industry structure

Considering that the industry structure determines, through the (strength of the) Five Forces, the external drivers of industry development, and to a large extend the resource base of the firm, as well as influencing the political/regulatory context, a further exploration of what determines the industry structure appears to be a logical next step. We will base our review on the determinants of industry structure identified in the strategic and the economic literature.

5.1 From a static to an evolutionary perspective

Leading in the strategy field is the contribution by Porter on industry structure analysis (Porter, 1980 p5-29; Porter, 1985 p4-11). In his view the intensity of competition is rooted in the underlying economic structure of an industry, which goes beyond the behaviour of current competitors. The state of competition is dependent on the five forces that collectively determine the profit potential of the industry. The structural features of the industry are determining the strength of these competitive forces. In the framework introduced by De Wit & Meyer this is considered the industry evolution perspective, where the compliance with the ‘rules of the game’ in the industry is emphasize. (De Wit and Meyer, 2004 p421-76).

In the static economic market theory, it is the industry structure that is considered to explain the performance of an industry, as reflected in the Structure-Conduct-Performance (SCP) paradigm.

5.1.1 The SCP paradigm

The SCP paradigm has been introduced by Mason (Van Gent and Van Bergeijk, 2000 p165-7). Performance is thereby defined as production and allocative efficiency, progress, full employment and equity (Groenewegen, 1989 p76). Mason identified three key determinants for market structure: concentration ratio of the firms in an industry, the type and degree of product differentiation and the entry barriers (Van Gent and Van Bergeijk, 2000 p213-24). Groenewegen points to the contribution made by Scherer by extending the model to better reflect reality in distinguishing between basic conditions (of supply and demand) and the structure of the market, and through introducing feedback loops between the various stages of the model, reflecting the behaviour of the actors. This extended and 'dynamized' model is depicted in Figure 12 (Groenewegen, 1989 p56-7).
In the evolution of the SCP-paradigm it is now being positioned with multi-causality and including feedback, based on the recognition of strategic behaviour and interdependency of firms in the industry. Shepherd for instance pointed to market share as an important structural determinant, reflecting market power that will allow a firm to act independently from others (Van Gent and Van Bergeijk, 2000 p237-60).

As a typical example of the contemporary use of the SCP paradigm, Economides includes the following attributes (Economides, 2005):

Under basic conditions:

- Technology,
- Economies of scale,
- Economies of scope,
- Location,
- Unionisation,
- Raw materials,
- Substitutability of the product,
- Own elasticity,
- Cross elasticities,
- Complementary goods,
- Location,
- Demand growth.

And under structure the attributes:

- Number and size of buyers and sellers,
- Barriers to entry,
- Product differentiation,
- Horizontal integration,
- Vertical integration,
- Diversification.

In addressing networks and telecommunication economics, Economides has added the dimension of Government Policy (antitrust, regulation, taxes, investment incentives, employment incentives, macro policies) to the SCP-model.

In Table 5 the determinants of industry structure are listed as perceived from a predominantly static perspective (industry evolution within the strategy field and static market theory in the economic field). The listing is based on the five dimensions of the Porter model. For the economists' perspective a composite view 'Mason through Economides' is used.

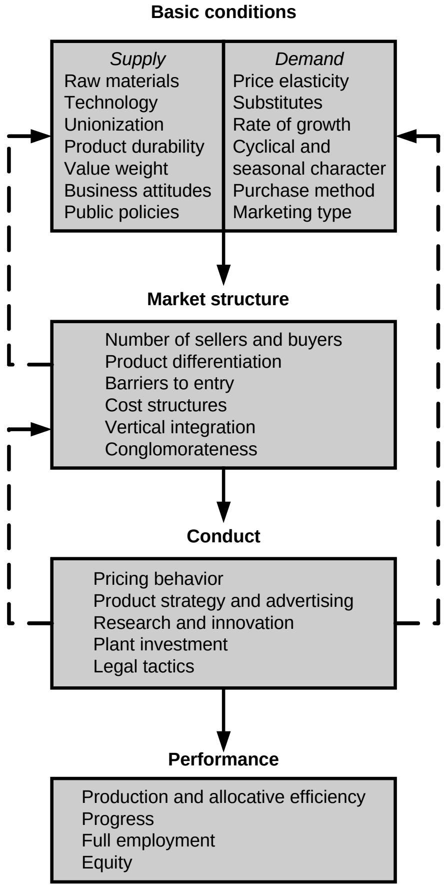


Figure 12. SCP paradigm by Scherer

From the overview we conclude that the dimensions identified within the perspective of the economists are consistent with the dimensions included in the perspective of the strategists. We will use the somewhat more extensive model used in the strategist' perspective as the basis for the elaboration in Chapter 5 and 7.

Strategy field		Economic field
Five Forces Model by Porter		**SCP paradigm by Mason thru Economides**
Determinants		**Determinants**
Entry barriers:	Properties of entry barrier are influenced by technology e.g. through patent expiry and innovation	Barriers to entry Technology Research and innovation
Economies of scale	Also experience	Economies of scale / Cost structure
	Proprietary product differentiation	Product differentiation
	Brand identity	
	Capital requirements	Cost structure
	Switching costs	Price elasticity
	Access to distribution channels	
Absolute cost advantages	Proprietary learning curve, access to necessary inputs, proprietary low-cost product design	Location / Cost structure
	Government policy	Public/Government policies
	Expected retaliation	
Threat of substitution:	Products that have the same function	Substitutes
	Relative price performance of substitutes	Cross elasticities
	Switching costs	Price elasticity
	Buyer propensity to substitute	
Buyer power:		
	Bargaining leverage:	
	Buyer concentration versus firm concentration	
	Buyer volume	
	Buyer switching costs relative to firm switching costs	
	Buyer information	
	Ability to backward integrate	
	Substitute products	
	Pull through	
	Price sensitivity	Price elasticity
	Price/total purchases	Value weight
	Product differences	
	Brand identity	
	Impact on quality/performance	Product durability
	Buyer profits	
	Decision makers incentives	
Supplier power:	Labour is also a supply factor	Unionization Purchase method
	Differentiation of inputs	Raw materials / Complementary goods
	Switching costs of suppliers and firms in the industry	
	Presence of substitute inputs	
	Supplier concentration	
	Importance of volume to supplier	
	Cost relative to total purchases in the industry	
	Impact of inputs on costs of differentiation	
	Threat of forward integration relative to threat of backward integration by firms in the industry	Vertical integration
Rivalry:	Dependent on maturity of the industry and subject to M&A activity	
	Industry growth	Demand growth / Rate of growth / Own elasticity
	Fixed (or storage) costs / value added	
	Intermittent overcapacity	Cyclical and seasonal character
	Product differences	Product differentiation
	Brand identity	Marketing type
	Switching costs	Price elasticity
	Concentration and balance	Number and size distribution of sellers and buyers / Horizontal integration
	Informational complexity	
	Diversity of competitors	Vertical integration / Conglomorateness / Diversification
	Corporate stakes	
	Exit barriers	

Table 5. Determinants of industry structure compared

5.1.2 The product life cycle perspective

A common denominator in the literature on the evolution of industries is the notion of a product life cycle (PLC) (Porter, 1980; Kotler, 1997; Tidd, Bessant et al., 1997, 2001; Malerba, 2002).

As Kotler points out the PLC relates to its parent concept of the demand/technology life cycle: "For each need, there is a stage of emergence (E), followed by stages of accelerating growth (G_1), decelerating growth (G_2), maturity (M) and decline (D)."[38] Once the need is identified it will be served by some technology, following a similar pattern. Within a technology cycle a succession of product forms that satisfy the need will emerge. See Figure 13 (Kotler, 1997 p344).[39] Although this model can be seen as evolutionary, by capturing technology life cycles and product life cycles it already captures more of the dynamic aspects of an industry.

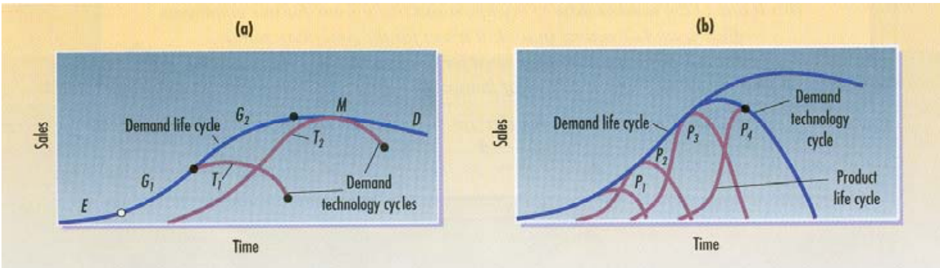


Figure 13. Demand/Technology/Product Life Cycles

The Product Life Cycle is typically divided in four phases: introduction, growth, maturity and decline. Porter has related the four phases to the nature of competition and how this should affect strategies, which he derived from a wide range of sources. See Table 6 for a summary (adapted from Porter, 1980 p159-61). As Porter indicates the PLC concept has attracted some legitimate criticism as (1) the duration of the stages varies widely from industry to industry, (2) industry growth does not always go through the S-shaped pattern, (3) Firms can affect the shape of the growth curve, e.g. through innovation, (4) the nature of competition associated with each stage of the PLC is different for different industries (Porter, 1980 p158 & 162). Hence, the PLC concept should be used diligently, as a tool to interpret product and market dynamics, as a planning and control tool (Kotler, 1997 p362) and not as a predictor of industry evolution as it suggest one type of pattern is to occur (Porter, 1980 p162).[40] The focus should be on the underlying forces that are 'shaping the curve'.

	Introduction	Growth	Maturity	Decline
Buyers and buyer behaviour	High income purchaser Buyer inertia Buyers must be convinced to try the product	Widening buyer group Consumer will accept uneven quality	Mass market Saturation Repeat buying Choosing among brands is the rule	Customers are sophisticated buyers of the product
Products and product change	Poor quality Product design and development key Many different product variations; no standards Frequent design changes Basic product designs	Products have technical and performance differentiation Reliability key for complex products Competitive product improvements Good quality	Superior quality Standardization Less rapid product changes-more minor annual model changes Trade-ins become significant	Little product differentiation Varying product quality
Marketing	Very high advertising/sales Creaming price strategies High marketing costs	High advertising, but lower percent of sales than introductory Most promotion of ethical drugs Advertising and distribution key for nontechnical products	Market segmentation Efforts to extend life cycle Broaden line Service and deals more prevalent Packaging important Advertising competition Lower a/s	Low a/s and other marketing
Manufacturing and distribution	Overcapacity Short production runs High skilled-labor-content High production costs Specialized channels	Undercapacity Shift toward mass production Scramble for distribution Mass channels	Some overcapacity Increasing stability of manufacturing process Lower labour skills Long production runs with stable techniques Distribution channels par down their lines High physical distribution costs due to broad lines Mass channels	Substantial overcapacity Mass production Specialty channels
R&D	Changing production techniques			
Overall strategy	Best period to increase market share R&D, engineering are key functions	Practical to change price or quality image Marketing the key function	Bad time to increase market share Particularly if low-share company Having competitive cost becomes key Bad time to change price image or quality image Marketing effectiveness key	Cost control key
Competition	Few companies	Entry Many competitors Lots of mergers and casualties	Price competition Shakeouts Increase in private brands	Exits Fewer competitors
Risk	High risk	Risks can be taken here because growth covers them up	Cyclicality sets in	
Margins and profits	High prices and margins Low profits Price elasticity to individual seller not as great as in maturity	High profits Highest profits Fairly high prices Lower prices than introductory phase Recession resistant High P/E's Good acquisition climate	Falling prices Lower profits Lower margins Lower dealer margins Increased stability of market shares and price structure Poor acquisition climate – tough to sell companies Lowest prices and margins	Low prices and margins Falling prices Prices might rise in late decline

Table 6. Product Life Cycle in relation to strategy, competition and performance

The emphasis so far has been on the actions of firms in an industry and the effects on competition. The table also reflects the notion of industry entries early in the life cycle and exits late in the life cycle. Hence, a link can be established between the PLC concept and the degree of concentration of firms in an industry. This is the core notion of the Dynamic Market Theory as developed by De Jong which we will discuss in the following Section.

5.1.3 The Dynamic Market Theory

Although captured under the general heading of *static-evolutionary perspective* the Dynamic Market Theory can not be categorized as a static model. On the other hand, it does not capture radical change either, which in this project is captured under the *revolutionary-dynamic perspective* in Section 5.2. Let's review the DMT on its merits rather than on its classification.

Taking the lead provided by Groenewegen (1989 p57-9), the Dynamic Market Theory (DMT) by de Jong can be summarized as follows (1996):

The dynamic market theory explains the development of horizontal and vertical concentration–fragmentation in an industry on the basis of entrepreneurial behaviour in the various stages of the product life cycle. In the theory four principle driving forces are identified:

- technological developments,
- market saturation level,
- activities of the entrepreneurs as a group and
- external factors.

It should be noted that market structure in the DMT has a more limited definition than applied in the extended SCP Paradigm. Market structure within the DMT includes the following attributes:

- the number of firms in the market,
- the firm size, the size distribution,
- the intensity of rivalry,
- the degree of collusion and
- the degree of cooperation.

Other factors that characterize the market are captured under the DMT definition of market condition.[41] The market condition is the composite of supply and demand factors that defines the market for a specific product at a specific point in time or during a short period of time. These factors include:

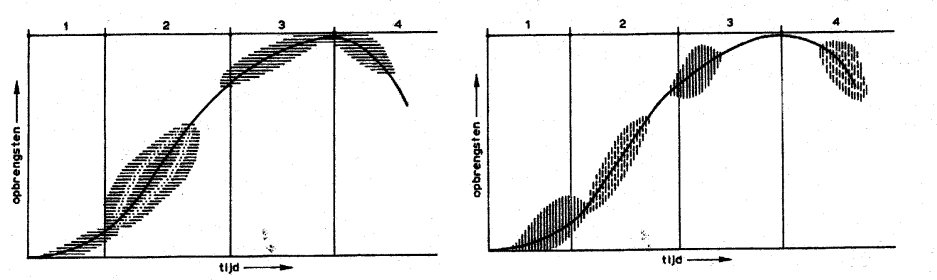
- product differentiation,
- entry barriers,
- etc.

At these points of time or during these short periods of time these market factors are considered to condition the behaviour of the entrepreneurs, i.e. constrain their ability to change these market factors. On the other hand entrepreneurs have the ability to influence the market structure over longer periods. See also Section 4.3.1. Market development is defined as a sequence of market conditions along the product life cycle.[42] Whereby the development along the product life cycle is distinguished in four main phases, with some refinement:

- introduction, trial production phase and commercial production phase,
- expansion, initial and progressive/declining,
- maturity and
- stagnation/decline.

A few remarks, following De Jong, on the four principle driving forces:
Technology: Technological developments have an impact on the supply side of the market. An impact that is present over the full product lifecycle. From the early impact on product innovation, it subsequently influences process innovation and leads to the growth of capital assets, forcing the optimal firm size upward as we proceed along the product lifecycle.
Market saturation level: As we progress along the product lifecycle market saturation will occur,
Activities of the entrepreneurs as a group: The entrepreneurs constantly shape and reshape the market structure. Through this shaping process they collectively drive the development of the market in line with technology, the market saturation level and the external factors.
External factors: Factors outside the industry may influence the developments in the industry under consideration, e.g. through innovations in the supply side of the industry.

During the phases of the product life cycle entrepreneurs are motivated to strive for horizontal concentration or fragmentation and vertical integration or des-integration based on the market opportunity or lack thereof and the competitive forces. The degree to which this, in general, will occur is reflected in Figure 14 (De Jong, 1996 p106 & 110).



Note: Vertical axis: volume; horizontal axis: time

Figure 14. Industry concentration - fragmentation, horizontal (left) and vertical (right)

The motivations are summarized in Table 7 together with a high level characterization of the market (p 103-13).

Product Life Cycle Phase	Concentration – Fragmentation	Characterization and motivation
Introduction		Innovators monopoly.
Early – trial production	Horizontal integration	Complementary cooperation to resolve production, financing, commercial or organisational issues or to reduce competition through imitation.
Late – commercial production	Vertical integration	To resolve input factor or distribution issues.
Expansion		
Early	Horizontal fragmentation and vertical des-integration	Increase in volume provides the means to operate stand-alone, while competitive entry through imitation is increasing.
Late		
Maturity		
Early	Horizontal concentration and vertical integration	Demand saturation and production overcapacity, while effect of price competition is minimal. Product differentiation.
Late	Horizontal concentration	Positioning for survival in declining market.
Stagnation/decline		Oligopolistic – monopolistic market structure
Early	Horizontal concentration	Declining demand, increasing losses due to overcapacity.
Late	Vertical des-integration	End-of-life squeeze.

Table 7. Market dynamic: concentration - fragmentation

In the case of strong network effects, see for an elaboration Section 2.6, Economides argues that it is in the interest of the innovator-monopolist to invite competitors and even to subsidize them on the margin to induce them to increase production (Economides, 1996 p23).

The predictive power of the DMT, with regard to the strategic behaviour of entrepreneurs, is based on a comparison between the structural concentration ratio and the actual concentration ratio. The structural concentration ratio is an indicator of the number of firms that the market can support, considering the optimal firm size and the market size. If the actual ratio exceeds the norm, concentration will follow enforced through e.g. price competition, mergers and acquisitions. In the reverse situation barriers of entry appear to be effective. This is summarized by Groenewegen and reflected (Groenewegen, 1989 p59).

	Introduction	Expansion	Maturity	Stagnation/decline
Type of product	New	Mass product	Mass product	Mass product
Actual concentration ratio	High	Low (declining)	High	High
Structural concentration ratio	Low	Declining to become stable	Sharply increasing	High
Economic type of organization	Monopoly, vertical integration, joint venture	Some loose cooperation	Collusion - cartels	Rationalisation - cartel
Type of competition	Competition through innovation	Competition through imitation	Competition through differentiation	Ruinous competition

Table 8. DMT actual and structural concentration

Groenewegen (1989 p59-60) concludes with the notion that the DMT poses challenges in the application of the model, e.g. in terms of the definition of the relevant market, and the calculation of the concentration ratios. However, he perceives the value of the DMT as a concept that will allow for the analysis of strategic behaviour of firms in relation to the structure of the market. The concept recognizes technology as an important exogenous factor, and shows on the one hand how the entrepreneur is conditioned by the market and on the other hand how their collective behaviour changes these market conditions. Unlike the SCP model that operates on the basis of one causal decision rule generating unconditional outcomes, the DMT results in conditional statements.
In this project we will build upon the qualitative notions of the DMT model, rather than a quantitatively driven application.

5.1.4 Revisiting the dimensions of the industry development path (1)

In Section 4.1 we have identified the following seven dimensions that characterize the development path of an industry:

1. Expansion-contraction, of demand.
2. Concentration-fragmentation, of the market,
3. Convergence-divergence, of business models employed in the industry,
4. Expansion-concentration of investment, directed at innovation and assets,
5. Vertical integration-fragmentation, of value-adding activities,
6. Horizontal integration-fragmentation, with respect to business boundaries,
7. International integration-fragmentation, of boundaries separating geographic segments.

From the discussion of the product life cycle concept we may conclude that dimension (1) is essentially an input, it provides an initial view on the position on the product life cycle curve. Initial, as the future trajectory of the curve is difficult to predict with any degree of precision. Moreover, demand may be latent and can be stimulated by the industry actors, or remain unserved. Dimension (2) relates to the size distribution and intensity of rivalry as discussed by Porter and De Jong. Dimension (4) relates to economies of scale and scope, and is an element of the conduct dimension in the SCP paradigm as it relates to research and innovation.
Dimension (5) is the vertical concentration factor and is the same as in the DMT. Dimension (6), albeit referring to horizontal concentration-fragmentation, puts the emphasis on the business boundary, which suggests a link to: product differentiation, market segmentation and specialization. Also the notion of complementors falls in this category. The discussion in relation to the PLC concept, has shown, that these four dimensions are interrelated.
That leaves dimension (3) and (7), relating to business models and geographical boundaries, to be addressed. The development of an industry can lead to a particular business model becoming the dominant design around which the rest of the industry converges (De Wit and Meyer, 2004 p424-5). Geographical boundaries have significance in terms of markets being served and how these are served in terms of production and distribution.[43] The strategic challenge is whether to pursue global synergies or to emphasize the need for local adaptation.[44] But

geography plays also an important role in terms of the innovation system. We will address these aspects as part of the dynamic-revolutionary perspective in Section 5.2.

5.1.5 Conclusion

At this point we conclude that from a static-evolutionary perspective the SPC model and the Porter Five Forces model have relevance in explaining the 'development path' of an industry. This also applies for Product-Life-Cycle and the Dynamic Market Theory, which already capture more of the dynamic nature of an industry. Compared to the SCP model, the Porter model appears to be somewhat more extensive, and hence the Porter model will be used for the industry analysis and to assess the drivers and inhibitors of industry development, from a static-evolutionary perspective. To capture the external environment the extension with the SEPT-dimensions will be applied. The PLC and DMT models will be used to highlight specific developments. The findings thus obtained will be used to establish the 'development path' along the seven dimensions identified.

5.2 From a dynamic to a revolutionary perspective

Next to the industry evolution perspective, which is based on compliance with the industry rules and regulations, there is the opposite view of 'rule breaking' firms, which is associated with the industry leadership perspective as articulated by De Wit & Meyer: "Of course, in industries… …some rules are immutable. Certain economic, technological, social and political factors have to be accepted as hardly changeable. But the remaining environmental factors that can be manipulated leave strategists with an enormous scope for moulding the industry of the future." "To actually change the rules of the competitive game in an industry, a firm must move beyond a compelling vision, and work out a new competitive business model. If this new business model is put into operation and seems to offer a competitive advantage, this can attract sufficient customers and support to gain 'critical mass' and break through as a viable alternative to the older business models. To shape the industry, the firm will also need to develop the new competences and standards required to make the new business model function properly." (2004 p435-6). In the words of Baden-Fuller and Stopford: "The crucial battles amongst firms in an industry are often centered around differing approaches to the market. Even in the so-called mature industries, where incumbent strategies have evolved and been honed over long time periods, it is new ideas that displace existing leaders. Traditional wisdom has overstated the power of the generic approach and underplayed the role of innovation." (Baden-Fuller and Stopford, 1992 as summarized in De Wit & Meyer 2004).

The major distinction between the static and the dynamic views in economics is in the role of innovation. In the static view innovation is an exogenous factor, in the dynamic view innovation is endogenous. It has been Schumpeter who introduced the concept of innovation as the central explaining variable of economic progress, arguing that business cycles are caused by the occurrence of innovations and in particular through the process of 'creative destruction' (Schumpeter, 1911; Schumpeter, 1942 p81-6). In his earlier work Schumpeter emphasizes the importance of the entrepreneur in the process of innovation. In his later work he shifted the emphasis to the role of the larger corporation, having the means to engage in capital and resource intensive processes of innovation. Nelson and Winter have modelled the so-called Schumpeterian competition. Their modelling is aimed at exploring the relationship between innovation and imitation policies, industry structure and industry output (Nelson and Winter, 1982 p275-307).[45] Industry structure relates in this context to concentration, the number and size distribution of firms, including entries and exits. One of the identified key dimensions of industry development path, see Section 4.1. From their modelling efforts they conclude that: "Schumpeterian competition is, like most processes we call competitive, a process that tends to produce winners and losers. Some firms track emerging technological opportunities with greater success than other firms; the former tend to prosper and grow, the latter to suffer losses and decline. Growth confers advantages that make further success more likely, while decline breeds technological obsolescence and further decline. As these processes operate over time, there is a tendency for concentration to develop even in an industry initially composed of many equal-sized firms." (p325). Following Van der Steen, it has been Winter who in subsequent work has extended the model with endogenous entry and adaptive R&D strategies of firms (Van der Steen, 1999 p41). Thereby Winter linked the role of the entrepreneur, in the early Schumpeter view on innovation, to industry entry and the later view, emphasizing the role of corporate R&D in innovation, to a change in the behavioural rules within larger corporations, whereby the 'routine-search' mode becomes the prevailing model of innovation, as part of the normal business practice. In the work of Malerba and Orsenigo the differences in innovation regime have been elaborated further based on the combination of four factors: opportunity conditions, appropriability conditions, knowledge diffusion and cumulativeness of innovation (p41-2).

In addressing innovation management and the development of innovation strategies, Tidd, Bessant & Pavitt state, with reference to Teece & Pisano, that: "[f]irm's [innovation] strategies are strongly constrained by their current position and by the specific opportunities open to them in future: in other words, they are path dependent. At any point in time, two sets of constraints make path-dependency in corporate innovation strategy inevitable: those of the present and likely future state of technological knowledge, and those of the limits of corporate competence." (Tidd, Bessant et al., 1997, 2001 p111). From the notion of path dependence, they argue, comes the notion of technological trajectories (Nelson and Winter, 1977), (Dosi, 1982). A technological trajectory is defined by Dosi as: "the pattern of 'normal' problem solving activity [in the Kuhnean sense] on the ground of a technological paradigm." A technological paradigm is being defined as: "a 'model' and a 'pattern' of solution of *selected* technological problems, based on *selected* principles derived from natural sciences and on *selected* material technologies." (italics in original, Dosi, 1982 p152). As such the paradigm determines broadly the trajectory in which a firm or industry is developing. However, the development of a particular product does involve multiple technologies, which makes creating a linkage between technological trajectories and firm strategic analysis complicated.

5.2.1 Paths of industry development

The development path of an industry can be mapped along the dimensions identified in Section 4.1, e.g. demand or concentration-fragmentation of business models. As stated earlier, the development of an industry can lead to a particular business model becoming the dominant design around which the rest of the industry converges. In that case, and synonymous with the product life cycle, we may use the term industry life cycle. “A strategic relevant development occurs when the dominant business model is replaced by a new business model that offers customers higher value.” (De Wit and Meyer, 2004 p425).
A change in business model implies a change in the ‘rules of the game’. In the cases of gradual and continuous development, adaptation will not become a major issue. However, in the case of discontinuous development, the change in rules will be more dramatic and firms introducing the new model will have large advantage over the incumbents. In the case of hyper-competition the rules are changing constantly and make it difficult to create a sustainable dominant position (p425-6).
Of particular interest are changes of the business model that are based on (fundamental) changes in the deployment of technology. This would signify a transition in the technology cycle, as discussed in Section 5.1.2, and affect the ‘rules of the game’ not only in sales and marketing, but also in R&D and production. This would mean a revolutionary rather than evolutionary change.
Such changes put particular emphasis on the introductory phase of the product life cycle. Moore emphasizes in this respect the value disciplines that have to be mastered in the different phases of the product life cycle: product leadership in the early adopter phase, product leadership and customer intimacy to ‘cross the chasm’[46], product leadership and operational excellence in the early mass market phase, operational excellence and customer intimacy in the maturity phase (Moore, 1995).

5.2.2 Paradigms and technological trajectories

Earlier we used a quote from Baden-Fuller and Stopford: “The crucial battles amongst firms in an industry are often centered around differing approaches to the market. Even in the so-called mature industries, where incumbent strategies have evolved and been honed over long time periods, it is new ideas that displace existing leaders. Traditional wisdom has overstated the power of the generic approach and underplayed the role of innovation.” This notion is contrasted by Tidd *et al*: “Like many mainstream industrial economics, Porter’s framework underestimates the power of technological change to transform industrial structures, and over-estimates the power of managers to decide and implement innovation strategies. Or, to put it another way, it underestimates the importance of *technological trajectories*, and of the firm-specific *technological and organizational competencies* to exploit them.” (Tidd, Bessant et al., 1997, 2001 p79).
Technological trajectories relate to the emergence of technological regimes and thereby to technology. Following the lead by Van de Poel: Technology can be defined as the “…alignment between technical configurations and functions”. Functions and technical configurations are aligned to each other in a design process, which typically results in an artefact, the embodiment of function and

physical properties. The translation of functions into working technical configurations is made with the help of knowledge (experience) and design tools. "If the forms of knowledge and the design tools used in a local design process are shared over different locales and if this results in a certain regularity in how functions and technical configurations are aligned in a specific technological domain one can speak of a technological regime." (Van de Poel, 1998 p12-3).[47]
Nelson & Winter refer to regime as: "The sense of potential, of constraints, and of not yet exploited opportunities, implicit in a regime focuses the attention of engineers on certain directions in which progress is possible, and provides strong guidance as to the tactics likely to be fruitful for probing in that direction. In other words: a regime not only defines boundaries, but also trajectories to those boundaries." (Nelson and Winter, 1977 p57). In Section 5.2 we already referred to the definition by Dosi of technological trajectory: "the pattern of 'normal' problem solving activity [in the Kuhnean sense] on the ground of a technological paradigm." A technological paradigm is being defined as: "a 'model' and a 'pattern' of solution of *selected* technological problems, based on *selected* principles derived from natural sciences and on *selected* material technologies." (italics in original, Dosi, 1982 p152). For our purpose the definition of technological regime by Rip & Kemp, cited by Van de Poel, is very appropriate: "A technological regime is the rule-set or grammar embedded in a complex of engineering practices, production process technologies, product characteristics, skills and procedures, ways of handling relevant artefacts and persons, ways of defining problems - all of them embedded in institutions and infrastructures." (Van de Poel, 1998 p15).[48]
Next to understanding how paradigms and regimes condition the actors in an industry it is of interest to understand how the process of regime change occurs. Essentially the same principle of social change applies as elaborated in Section 4.3.1., of particular interest is the process of transformation. Boudon identifies two modes of feedback that may lead to transformation: aggression toward the environment and demand upon the environment (Boudon, 1981b p128). A typical example for insiders to resolve tensions within the regime is to call upon outsiders to resolve the identified problems. Also outsiders may make latent problems and tensions in a regime manifest (Van de Poel, 1998 p23-4). Outsiders are considered "…those people who do not share the rules existing in a technological regime, … and behave in a deviant way." (p25). Outsiders may in this sense be labelled as deviant while being part of a firm that is considered to be part of the regime.

5.2.3 Revisiting the dimensions of the industry development path (2)

From the analysis of static-evolutionary theories we conclude that the development path of an industry is essentially a trajectory resulting from the response by firms in an industry to the demand cycle through a sequence of products using a certain technology or set of technologies. In case of a dominant business model or dominant design, an industry life cycle may become apparent.
The dynamic-revolutionary theories point to the role of innovation and the transition from one dominant business model or design to another, typically based on a change in the underlying technologies. Hence, for the exploration and explanation of the 'development path' of the telecom sector a distinction is to be made in the

periods “within the cycle” and “between the cycles”. In terms of change a distinction can be made between (1) the relatively fast changing sequence of product transitions, the product life cycles, (2) the slower changing industry life cycle, and (3) the technology life cycle. Albeit, in the extreme case changes in all three may coincide. Within the cycle, many factors that are determining the development path are relatively stable or change in an evolutionary sense. The technological regime and related trajectory are conditioning the change process in the industry.

In the transition between dominant business models and between technologies, the ‘rules of the game’ change radically. Competitors will have to adapt to survive, also a tension may arise between the new business model or the new ‘rules of the game’ and the operative formal or informal institutional arrangements. To optimally support the new business model the institutional arrangements may need adjustment. Depending on the tension and the type of institution, the time it will take for the adjustments to take place may vary.

5.2.4 The processes of change

In Section 4.3.1 we have already discussed the generic model of social change provided by Boudon. This model that also provides insights in the transition of technological regimes is described in Section 5.2.2.

Williamson has provided a model of social analysis that provides a linkage between transaction costs, governance, institutions, and social embeddedness. He thereby provides a link to the process and the periodicity of social change (Williamson, 1998). For his definition of institutions Williamson quotes North as the “humanly devised constraints that structure political, economic, and social interactions. They consist of both informal constraints (sanctions, taboos, customs, traditions, and codes of conduct), and formal rules (constitutions, laws, property rights)” and “institutions consist of a set of moral, ethical, behavioral norms which define the contours and that constrain the way in which the rules and regulations are specified and enforcement is carried out.” (p27). In his framework Williamson distinguished four levels of social analysis each with a different ‘constancy’ providing constraints to the level below, but at the same time being influenced by it through feedback.[49]

Level 1 is the social embeddedness level related to e.g. norms, customs, mores, and traditions. This level is considered to be primarily associated with social theory, and is considered to provide the informal constraints for economic activity. The formal rules are located at Level 2, the level of the institutional environment. The structures that can be observed at this level are the product of politics and they provide the ‘rules of the game’ within which economic activity is being organized. Included are the polity, the judiciary and the bureaucracy of government. The economics of property rights is the leading theory at this level. Level 3 is related to the ‘play of the game’ or the alignment of the modes of organization, e.g. markets, hybrids, and hierarchies. Here we find the alignment of governance structures with transactions, using transaction cost economics as the leading theory. Located at Level 4 are the resource allocation and employment, subject to ‘marginal analysis’, with neo-classical economics and agency as leading theories. See also Figure 15 (p26-9).

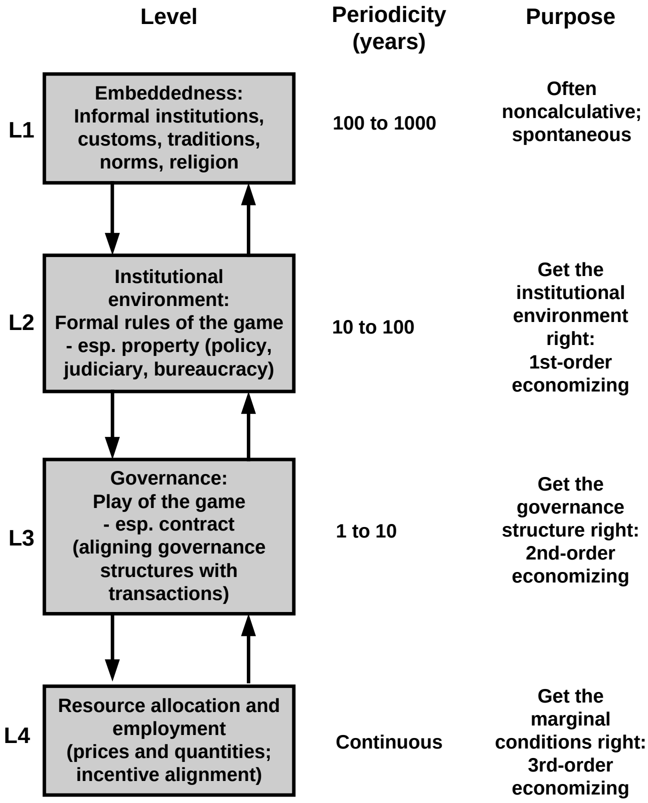


Figure 15. Economics of institutions

The linkage between institutions and the periodicity of change in relation to transaction costs is of importance for our project as the Internet is significantly changing the costs and benefits of transacting. Kaplan distinguishes five ways the Internet can potentially change transaction costs (Kaplan, 2003 p392):

1. Changes/improves business processes,
2. Changes the nature of the marketplace, e.g. through virtual markets,
3. Changes decisions, as indirect effects of lowering transaction costs,
4. Changes the degree of information incompleteness/asymmetry,
5. Changes the ability to commit, e.g. through standardization of the process and leaving an electronic trail; by disintermediation.

In addressing economic development Freeman and Louçã identify five semi-autonomous subsystems of society – science, technology, economy, politics, and culture – and the co-evolution thereof (Freeman and Louçã, 2001 p121).
Perez, in exploring the nature of techno-economic paradigm shifts, simplifies the model to a relationship between technological, economic and institutional change, emphasizing the tensions that develop between the subsystems. A process that

she describes as being in “constant reciprocal interaction”. See Figure 16. (Perez, 2002 p156).

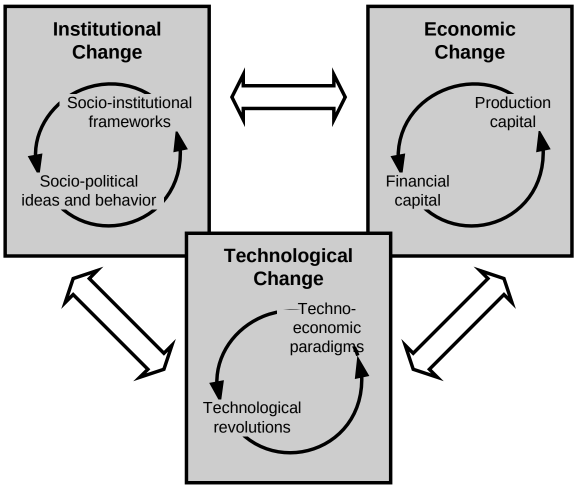


Figure 16. Three spheres of change in constant reciprocal action

In Chapter 3 on technological revolutions and techno-economic paradigms, we have elaborated on the models by Freeman and Louçã, and Perez. In Chapter 6 and 8 we will apply these models to capture change in relation to the introduction of new paradigms, and in particular to capture the relation between technological change and institutional change.

5.3 The development path of the sector and euphoria

Euphoria are typically associated with the upswing of the business cycle (Kindleberger, 2000). Porter argues, that fluctuation in economic conditions over the business cycle are of tactical rather than strategic importance, as these short-run factors influence nearly all firms in many industries (Porter, 1980 p6). He emphasizes the importance of industry structure, which shifts, in general, only gradually over time. Euphoria, however, start typically in one sector and through contagion will in a later phase influence the economy at large. Moreover, the financial leverage that drives euphoria may be of considerable strength, increasing the pace of industry development and potentially change the industry structure.

The description and analysis of the impact of the Internet bubble on the development path of the telecom sector will thus require us to analyze the relationship between euphoria and the dimensions of the development path of the industry. Following Porter, the emphasis should be on the relationships that have an impact on the industry structure, and hence will have a lasting effect.

In Chapter 5 we will identify the major features of the telecom industry structure and in Chapter 2 we have identified the major forces driving euphoria and develop a ‘stylized model of euphoria’. In Chapter 3 we have linked euphoria to the recurring patterns in economic development. In Chapter 7 we will combine these elements and explore the impact of the Internet bubble on the development path of the telecom sector.

5.4 Forecasting the future direction of the industry

Our exploration of theories, models and concepts to explore and explain the development path of the telecom sector has shown that some regularities can be observed and hence some statements on the direction of future developments can be made. However, most models are stylized representations of reality and do not claim any predictive accuracy. In reflecting on future developments the framework provided by Williamson, see Section 5.2.4, provides some useful guidance, as it suggests different rates of change for the different levels of institutional arrangements. Porter suggests not to attempt to predict industry evolution, but to explore the processes that lay underneath and drive the industry development (Porter, 1980 p162). To which he adds: “Because innovation, technological developments, and the identities (and resources) of the particular firms either in the industry or considering entry into it are so important to evolution, industry evolution will not only be hard to forecast with certainty but also an industry can potentially evolve in a variety of ways at a variety of different speeds, depending on the luck of the draw.” (Porter, 1980 p163). In Chapter 6 Section 3 we will elaborate these observations.

While models that try to capture regularities may fall short in predictive accuracy, when considered for the long run they may provide valuable insights on the most likely direction of the developments. This applies for instance for the Theory of Reasoned History addressing the topic of economic growth, developed by Freeman, Louçã, Perez, c.s., which provides for a framework of recurrent phenomena that can inform us on the aftermath of the Internet bubble (Freeman and Louçã, 2001; Perez, 2002). It should be noted that Freeman and Louçã do not attempt to predict the exact shape of the unfolding ‘information society’, as they recognize the ‘purposeful activity’ of human beings in shaping the future. With Castells they share the view that “the culture of the ‘network society’ may be different from earlier periods of history and may reciprocally have a powerful influence on the ways in which the whole of society evolves.” (Freeman and Louçã, 2001 p134). This suggests that Level-1 of the Williamson framework is affected. See also Chapter 3 *The Internet bubble as part of a technological revolution*.

Following the perspective of *critical realism*, explored in Chapter 1 Section 4, the lack of accurate predictive capacity is not at issue, as the aim of science is: “…not the illumination or prediction of events at all but the identification and comprehension of the structures, powers, mechanisms and tendencies which produce or facilitate them. And this understanding is all that is required for policy analysis and (where feasible) effective action.” (Lawson, 1997 p282-9).

To the extend this research project may inform policy makers and firm strategists in dealing with uncertainty about the future, ‘scenario planning’ as methodology may be applied. Through the development of a set of (orthogonal) scenarios the robustness of policies and strategies can be tested under varying conditions (Schwartz, 1991; Van der Heijden, 1996). In this way the value of the outcome of this knowledge project may be further enhanced.[50]

6 Summary and conclusions for the research focus

In this Chapter we have provided the answer to research sub-question #3: "How can the industry development be described and explained? How can the developments be mapped onto a 'development path'?"
For a description and explanation of industry development under relatively stable conditions the use of static and evolutionary theories, concepts, and models are appropriate. These range from the Structure-Conduct-Performance paradigm, the Five-Forces model for industry analysis, to the concepts of Technology and Product Life cycles, and the Dynamic Market Theory. However, if the industry structure is affected more dynamic or revolutionary theories, concepts and models are required, such as the innovation notion of 'creative destruction', and the role of paradigms shifts and technological trajectories. From the review of theories, concepts, and models it has been concluded that for the purpose of the telecom industry analysis over the period considered the use of the Five-Forces model, extended with the SEPT dimensions, and the use of the concept of Paradigm Shifts as the primary concepts and models is appropriate.
The 'development path' of an industry has been identified as the result of the drivers and inhibitors of industry development. Industry development will be mapped on seven dimensions, which are related to demand, the market, business models, investments, vertical value-adding activities, horizontal business boundaries, and internal geographical boundaries.

With respect to the research focus, we have introduced in Chapter 1 the government policy maker and the firm strategist as the external users of the results of this research project. Hence, they determine the focus of the project, and their needs will have to guide us in exploring those dimensions of the 'impact of the bubble on the path' that are to be considered as the most relevant.

In relation to the topic of this research project and considering the prevailing role perception of governments[51], the main interests of the policy maker are considered to be[52]:

In general:

- Assuring the proper functioning of markets, by providing the appropriate institutional arrangements,

For the telecom sector in particular:

- Assuring the proper transition of the telecom services sector to a competitive market driven regime,

From a European regional policy perspective:

- Implementation of EU directives and policy guidelines.

Reflecting on the dimensions of the development path, as identified in Section 4.1, the most informative dimensions for the policy maker are, in a first approximation of importance:

1. Concentration-fragmentation of the market,
2. Expansion-contraction of investment, directed at innovation and assets,
3. Vertical integration-fragmentation of value-adding activities,
4. Convergence-divergence of business models employed in the industry,
5. Expansion-contraction of demand,
6. Horizontal integration-fragmentation with respect to business boundaries,
7. International integration-fragmentation of boundaries separating geographic segments.

Considering the prevailing role perception of strategists[53], the main interests of the strategist are considered to be[54]:

In general:

- Achieving the goals of the firm in line with the organizational purpose,

More specifically:

- Achieving financial targets,
- Achieving strategic market positioning targets.

Reflecting on the dimensions of the development path, the most informative dimensions for the strategist are, in a first approximation of importance:

1. Expansion-contraction of demand,
2. Concentration-fragmentation of the market,
3. Expansion-contraction of investment, directed at innovation and assets,
4. Vertical integration-fragmentation of value-adding activities,
5. Convergence-divergence of business models employed in the industry,
6. Horizontal integration-fragmentation with respect to business boundaries,
7. International integration-fragmentation of boundaries separating geographic segments.

The dimensions of the development path are metrics at an aggregate level, of which the actual values can only be determined with a, sometimes significant, time delay and often only approximately. For the policy maker, and even more so for the strategist, it is important to understand the underlying changes in the drivers and inhibitors of industry development. Any changes in directions or fundamental shifts, in particular of industry structure, are important to identify, as these instances may require a, sometimes fundamental, change in policy or strategy. An early detection and understanding of this changes may lead to the formation of more successful policies and strategies. We will therefore focus on the identification of structural change and in particular paradigmatic changes in the period considered.

It is important to note that the behaviour of firms is essentially driven by expectations. Expectations on demand (growth), economic developments, financial markets, strategic moves of the competitor, changes in rules and regulations by the government, etc. The assessment of expectations are driving the decisions within the firm with respect to the allocation of resources, in particular financial resources in terms of (strategic) investments.
The analysis of euphoria has revealed that expectations, in a much amplified way, also play a key role in bubble phenomena. The expectations are linking ‘bubbles to the path’. Hence, it is not so much the actual values of the dimensions of the path that matter during bubble periods, but the expectations regarding the direction and pace of development of these dimensions that drive behaviour in the related industry, as well as in the financial sector. Hence, the colloquial definition of bubbles as ‘a deviation of fundamentals’.

In the following Chapter we will explore and explain the development path of the telecom sector leading up to the bubble period using the theories, models and concepts discussed in this Chapter.

7 Notes for Chapter 4

[1] This Section may appear to be 'light' on references, which is mainly due to the use of industry insights gained by the author over a period of 25 years in the telecom industry.
[2] It should be noted that strategists like to challenge existing definitions of an industry to create new business opportunities. Moreover, while an economist may consider Swatch, Rolex and Citizen watches to be all part of the watch industry, a strategist may consider Swatch to be in the fashion accessory industry, Rolex in the luxury goods industry and Citizen in the watch industry (De Wit, 2006).
[3] The Standard Industrial Classification has been replaced by the new North American Industry Classification System (NAICS), but several data sets are still available with SIC-based data. Both SIC and NAICS classify establishments by their primary type of activity.
[4] To better capture the developments in the ICT sector and the Information Society the OECD has provided a guide for its measurement (OECD, 2005a).
[5] The EU has grown from the original 6 countries (Belgium, Germany, France, Italy, Luxembourg, The Netherlands) to include Denmark, Ireland and the UK in 1973, Greece in 1981, Spain and Portugal in 1986 and Austria, Finland and Sweden in 1995, creating the so called EU-15. Ten member states joined as of January 2004 to create the EU-25: Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovenia, Slovakia.
[6] NYSE TMT Index as of May, 31st 2002. The Index tracks the top 100 technology, media and telecommunications stocks listed on the NYSE. The companies represented have a market capitalization of $ 2.3 trillion, which covers 45.7% of the entire market capitalization of TMT companies globally.
[7] The Figures are constructed by the author, unless stated otherwise.
[8] In the USA a 'flat fee' scheme for local calls has been common practice.
[9] Customer care includes the complaint, service and repair handling.
[10] Following the invention of the telephone by Alexander Graham Bell in 1876, the Bell interests were "…originally organized as a patent association. Manufacturers of telephone equipment were licensed, phones and private lines were leased, and local-exchange companies were franchised." When the fundamental patents expired in 1894, more than 3000 commercial entrants emerged during the following nine years (Vietor, 1994).
[11] The Netherlands – now KPN – then Philips; France – now France Telecom – now Alcatel; Germany – now Deutsche Telecom – Siemens; United Kingdom – now BT – then Plessey/GEC.
[12] Arthur already pointed to the effects of increasing returns and path dependence in the economy in his 1994 and 1996 work. Network effects can be observed also in credit card networks, ATM networks, computerized reservation systems, railroads, airlines, health care (Katz and Shapiro, 1998).
[13] In contrast with the case of non-network goods whereby the willingness to pay for the last unit of a good is considered to decrease with the number of unit sold (Economides, 2003).
[14] Consider a two-way (in terms of call set-up direction) network of n users. A communication 'good' being defined as either the origination or the reception of a communication. Thus the n^{th} user represent a total of 2n(n-1) 'goods'. Each additional user thus adds 2n new 'goods' (Economides, 2003).
[15] Consider m VCR players compatible with n VHS video tapes generating mn composite 'goods'. An extra (compatible) VHS video increases the demand for the complementary 'good' VCR recorder and *vice-versa*.
[16] We skip here for simplicity the developments related to the telegraph system.
[17] See for instances (Siemens, 1970; Bear, 1976).

[18] As of 2003 there are worldwide 1383 mln cellular users, and within the OECD area 600 mln fixed lines (OECD, 2005b).
[19] Other roles may be defined as assuring equity in terms of income and welfare.
[20] Sources are considered to be coercive, expert, legitimate, referent and reward power; the levels are: input, output and throughput control; the arena: cultural, political and psychological (De Wit and Meyer, 2004).
[21] Personal experience has shown that a more pluralistic view on strategy is important to enforce success in business. The recognition that strategic issues are often issues of a paradoxical nature has provided important insights to improve the way strategic issues are addressed. The paradox perspective on strategy is the approach advocated by De Wit & Meyer (De Wit and Meyer, 2004; De Wit and Meyer, 2005).
[22] The choice of industry is another important matter for strategist (Rumelt, 1991, March).
[23] Considering that the strategist is not our primary object of research we will not address issues of self interest or 'principle-agent' issues, such as 'the strategist as an agent for the CEO' or 'the strategist as an agent for the company owner'.
[24] Resources are considered to include: tangible (land, buildings, materials, money) and intangible resources, the latter to include relational resources (relationships, reputation) and competences (knowledge, capabilities, attitude) (De Wit and Meyer, 2004).
[25] In terms of government styles Van der Steen identifies four organizational forms: the non-state (or pure market) model, the regulatory state model, the co-operative exchange model and the public model (Van der Steen, 1999). Within the model of market economies Groenewegen distinguishes between two ideal types: the developmental state and the regulatory state. In the first governments pursues specific objectives with respect to structural developments and intervenes to achieve these objectives. In the latter the government only assures the proper functioning of the markets (Groenewegen, 1989).
[26] "A public good is a 'good' or service which is available to all. Pure public goods are those which are produced by the state, rather than by the market. Pure private goods are those which are consumed by choice and only those who pay for them may consume them. Samuelson (1954) suggests that the main characteristic of public goods is that they are indivisible, namely that they are available for all, and that they are non-excludable, unlike private goods which are, by definition exclusive. Public goods are paid for by taxes and borrowing , and their price may be expressed in the level of taxation required to finance their production. Private goods are paid for through a price system operated in a market… …In other words, the public and private sectors, when considered from the point of view of a theory of goods, reveal themselves as overlapping and interacting, rather than as well-defined categories. The public sector is a mix of public and private and of public goods which are rationed through a toll or by a criterion of merit." (Parsons, 1995).
[27] Sabatier reviews: the stages heuristic, institutional rational choice, multiple-streams framework, punctuated-equilibrium framework, advocacy coalition framework, policy diffusion framework and the funnel of causality framework. Moreover, identified but not discussed are: arenas of power, cultural theory, constructivist frameworks, and the policy domain framework (Sabatier, 1999).
[28] The critique mainly focuses on the suggested linear flow and the omission of the interactions that occur in reality.
[29] Research into the topic of 'practice' is relative new in the field of strategy, see for instance (Whittington, 2002a; Whittington, 2002b), while this appears to be a topic of broad attention within the field of policy making, see for instance (Parsons, 1995).
[30] Parsons identifies six main approaches for the context of policy making, albeit less strictly defined as in the case of strategy by De Wit & Meyer: stagist approaches, pluralist-elitist

approaches, Neo-Marxist approaches, sub-system approaches, policy discourse approaches and institutionalism (Parsons, 1995).
[31] In this simplified approach we are ignoring the notion of Minimum Efficient Scale (MES) in production.
[32] Avoiding the market may, ultimately, lead to a loss of efficiency.
[33] The SEPT model, also denoted as SEPTember, is a well established way of capturing the environment, see e.g. (Wheelen and Hunger, 1983)
[34] Porter's Five-Forces model has been subject to critique as it does not capture the influence of e.g. government on industry development. By extending the model with the SEPT dimensions we have acknowledged and accommodated this critique.
[35] We will revisit industry recipes as part of paradigms.
[36] In more general terms, institutions are considered to condition the behavior of the actors involved. See also Section 4.7.
[37] Van der Steen applies the framework to the evolution of institutional frameworks in the context of national innovation systems (Van der Steen, 1999). Van de Poel uses the framework in the context of transformation of technological regimes (Van de Poel, 1998).
[38] Kotler draws from Ansoff, H.I. (1991). Implanting Strategic Management, 2d. ed. Engelwood Cliffs, NJ, Prentice Hall.
[39] Distinct from the product PLCs are the style, fashion and fad life cycles (Kotler, 1997). See also: *Why yesterday tells of tomorrow* (Gaus, 2001).
[40] Kotler identifies a few common patterns: growth-slump-maturity, cycle-recycle and scalloped pattern (Kotler, 1997).
[41] De Jong uses the Dutch terminology of: 'markstructuur' and 'marktsituatie'.
[42] Compare the use of states by De Wit & Meyer (De Wit and Meyer, 2004).
[43] And consequently there is a relation with the organizational structure.
[44] De Wit & Meyer refer to the international context of strategy and the global convergence and international diversity perspective (De Wit and Meyer, 2004).
[45] The model is based on the following main characteristics: a number of firms produce a single homogeneous product, the industry faces a downward sloping demand curve, each firm operates a single technique – the best it knows, all techniques are characterized by constant returns to scale and fixed input coefficients, a firm will use its best technique to the maximum level permitted by its existing stock of capital, purchasing needed complementary inputs on factor markets, factor supplies are perfectly elastic and factor prices are constant over the period. The technique used by each firm thus determines the unit costs. Given each firm's capital stock and its technique, industry output and product prices are determined (Nelson and Winter, 1982).
[46] In 'crossing the chasm' Moore refers to the difficulty to move products from the early adopter phase into the mass market phase (Moore, 1991).
[47] Van de Poel refers in this context to Disco, Rip & Van der Meulen (Disco, Rip et al., 1992).
[48] Original in (Rip and Kemp, 1998).
[49] Williamson does not explore these feedback mechanisms.
[50] The underlying strategy and policy issues are recognized as complex issues of organized complexity. See for instance Mason, R & Mitroff, I. (1981). Complexity: The nature of real world problems as summarized in (De Wit and Meyer, 2004). Further insights may be obtained through the modeling and the analysis of strategic behavior. See for instance Infrastratego (Ten Heuvelhof, De Jong et al., 2003).
[51] Henceforth an EU context is presumed.
[52] In this context we ignore the self interests of the policy maker with respect to career advancement, etc.
[53] The prevailing emphasis on a planning versus incrementalism in strategy is assumed.

[54] In this context we ignore the self interests of the strategist with respect to aspects such as career advancement.

5

The development path of the telecom sector before the bubble

An industry exploration and explanation

Table of Contents

1 Introduction

The purpose of this Chapter is to describe and explain the development path of the telecom sector leading up to the Internet bubble, using the theories, models and concepts as identified in Chapter 4.
In Chapter 6 we will determine the beginning of the Internet bubble to be 1995. For a good understanding of the developments in the telecom sector leading up to this date, the historical developments will be summarized, with an emphasis on developments related to the industry structure. To appreciate trends emerging prior to 1995 but extending beyond this date, some observations based on more recent data will be included.

In Chapter 2 Section 4 we have introduced the definition of the 'development path' of an industry as a sequence of 'states', whereby the transition from one 'state' to the other is due to the combined result of the 'drivers of industry development' and the 'inhibitors of industry development' enacting upon the industry. The drivers of industry development were identified as the internal and the external change drivers identified in the market-based view and in the resource-based view of the firm, combined with the contextual-drivers, i.e. the socio-cultural, economic, political/regulatory and technological forces of change; see also Chapter 4 Figure 8. The inhibitors of industry change are essentially the sources of industry rigidity, making the industry rules more difficult to bend or break, or the industry structure more difficult to change.

In the following Sections we will first address the drivers of change in the telecom industry followed by the inhibitors of change, leading up to the Internet bubble period starting in 1995. This elaboration will be mostly qualitative. Subsequently we will describe and explain the resulting 'development path' of the telecom sector, using the qualitative indicators that will be used to describe the 'development path' throughout the four periods considered: before the bubble, during the boom and the bust, and in the aftermath. The aim is to create a comprehensive summary of industry development, using position information and direction of change, following the structure as shown below.

Industry development	**Position; direction of change**
Drivers of change; contextual drivers:	
Technology:	
Political/regulatory:	
Geopolitical:	
Socio-economic:	
Drivers of change; industry drivers:	
At the entry barrier:	
Substitutes:	
Buyer power:	
Supplier power:	

Rivalry:	
Inhibitors of change:	
Economies of scale:	
Industry integration:	
Power structures:	
Risk averseness:	
Institutional pressure:	
Cognitive maps:	
Dimensions of the 'development path':	
Demand:	
Market:	
Business models:	
Investments:	
Vertical value-adding activities:	
Horizontal business boundaries:	
International geo-boundaries:	

2 The drivers of industry development

2.1 Contextual drivers

2.1.1 Technological drivers

Fundamentally the expansion of the Technology Media and Telecommunications (TMT) sector is a result of a set of closely related technologies and the principle of digitisation that is leading to the convergence of the computing, telecommunication and media industries. The digitisation goes back to the invention of digital computing, using binary coding of information. Digital encoding is providing for an uniform way of dealing with information along the chain 'from author to consumer': i.e. in the generation, processing, storage, retrieval and in transport. The 'miniaturisation through integration' of the transistor and the laser are behind the exponential growth in performance in computing, and in optical and mobile communications. As the production cost is coming down in roughly the same pace, it is a fundamental driver for the growth in the TMT-sector. In the following sections these technologies will be explored in greater detail to understand their contribution as an important driver of industry development.

2.1.1.1 Semiconductor technology

The invention of the transistor in 1947 in Bell Labs gave birth to what would become the semiconductor industry (Lucent Technologies, 2003). Further R&D efforts led to the development of the microprocessor in 1971 by Intel and the introduction of the first PC by Apple in 1977, to be followed by the IBM-PC in 1981 (Ceruzzi, 1998 p217-8, p264, p268). The phenomenal growth of the semiconductor industry became characterized by Moore's Law, after Gordon Moore, the co-founder and former chairman of Intel. This Law stipulates that over time the number of transistors will grow exponentially in relation to the surface they occupy on a silicon wafer (Moore, 1965). See also Figure 1 (Intel, 2003).

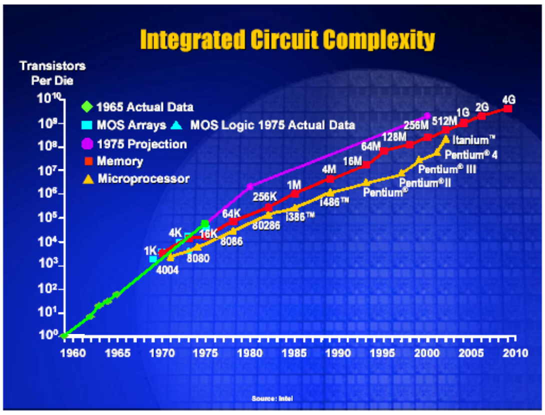


Figure 1. Technology advances for integrated circuits, 1960-2010

Moore's Law can roughly be translated in: the performance of silicon, in terms of processing power, doubles roughly every 18-24 month. Essentially this translates in an exponential performance improvement curve over time, with technological limits still in the distant future.[1]

The use of microprocessors has not remained limited to computers. It has become the 'intelligent controller' of virtually every piece of domestic or industrial equipment. The use of the microprocessors in appliances already outnumbers that of PCs. One could argue that microprocessors are 'doing to control' what electronic motors have 'done to propulsion'.

The technological progress in silicon has resulted in ever decreasing prices for ICT equipment and services. Or, what is happening in practice is: for the same amount of money ever more powerful equipment can be purchased. See also Figure 2 (OECD, 2000 p58).

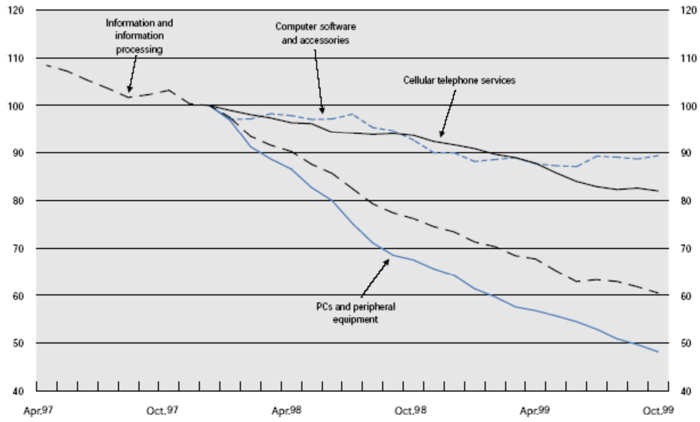


Figure 2. US consumer price index for selected ICT equipment and services, 1997-1999

2.1.1.2 Optical technology

The invention of the laser in 1958 in Bell Labs provided for a similar case history as that of the transistor (Lucent Technologies, 2003). The equivalent of Moore's Law for fibre optics suggests a doubling in transport capacity roughly every 18 month. See Figure 3 (Lucent Technologies, 2000).

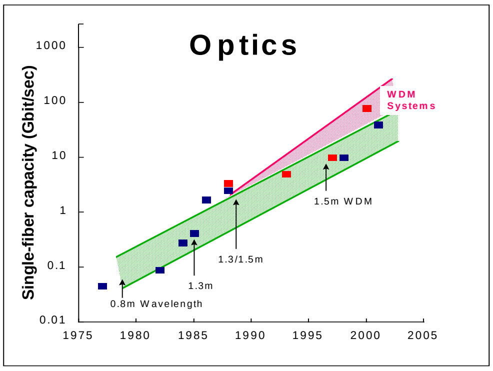


Figure 3. Advances in optical technology 1975-2005

An impressive example of the impact of optical communication was the laying of the first transatlantic optical cable in 1988 (TAT-8) which by itself almost doubled the transmission capacity of all the cables laid in the previous period. This was achieved using a cable with two working pairs of fibre, and one pair as spare, providing 40,000 channels (Wikipedia, 2006). Today the application of wavelength division multiplexing (WDM) or Dense-WDM increases the transmission capacity of a single fibre manifold.

2.1.1.3 Radio transmission technology

The concept of cellular communication was created by Bell Labs in 1947 (Meurling and Jeans, 1994 p17). The equivalent of Moore's Law for mobile communications suggests a doubling in transmission capacity about every 12 month. See Figure 4 (Lucent Technologies, 2000).

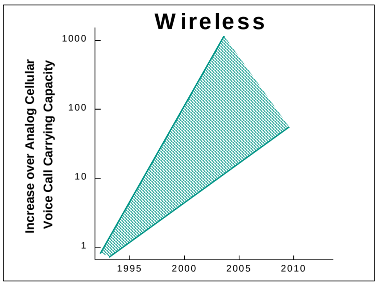


Figure 4. Technology advances for wireless, 1995-2010

This progression in performance is the result of a combination of technologies being applied, such as: advanced compression techniques, directional antennae, application of smaller cell sites, a shift from circuit switching to packet switching.
With the introduction of GSM in 1992 we are as yet in the early phases of mobile developments.

2.1.1.4 Software technology

The production of software is not subject to the equivalent of Moore's Law. Productivity has steadily increased through modular design and re-use, the automation of testing and automatic code generation. The increasing use of (standard) software platforms has facilitated the more effective development of applications. The role of software in the TMT sector has increased significantly; as an illustration: 80% of the activities within Bell Labs at the end of the 1990's were related to software.[2]

In conclusion: The progress in the basic technologies is providing for a constant stream of improvements in telecom products. New generations of products are substantially more powerful and far less expensive. Hence, new entrants to the telecom services market, applying the latest technologies, always have an advantage over the incumbents, from a technological point of view.

2.1.2 Political/regulatory drivers

Governments are major actors in the shaping of the telecom sector, as they are setting the boundary conditions under which the telecom services operators have to conduct their business. Of particular interest is the role of governments in determining the governance structure of the sector and the sector specific *ex-ante* regulation of competition, which is being employed in the transition from a public to a private market regime.

2.1.2.1 Telecommunication reform

Following the invention of the telephone in 1876 by Alexander Graham Bell[3], a multiplicity of telephone networks have been built by private entrepreneurs around the turn of the century, mainly city based. In the course of the early 1900's these networks transitioned almost entirely into governmental hands. The main and publicly stated arguments provided at the time were: assuring connectivity between rival networks and providing services outside the major cities.
In the USA the telecom operations became government-controlled, but remained in private ownership. In return the company, *in casu* AT&T, received a monopoly position in telephony (Melody, 2002 p7). In many other countries the telephony service started as a governmental initiative and was operated as a department of the government. Until the early 1960's very little changed in the industry structure. The conventional wisdom was that "…telecoms was an example of 'natural monopoly, that is due to increasing returns to scale…[T]elecoms services could only be provided efficiently by a monopoly provider." (Fransman, 2001 p8).
In the late 1960's and early 1970's the development of new equipment such as microwave, satellites, switching and computer terminal equipment and their applications, presented major challenges to the boundaries of the telecom industry

monopoly, represented by AT&T and GTE (Melody, 1999 p7-34). This did not lead to a "…fundamental restructuring of the sector, but rather the gradual removal of specific monopoly restrictions that prevented other firms from participating in the marketplace." (p9). In 1968 through the Carterfone decision (Melody, 2002 p22) the entry policy for the customer terminal market was formalized, and based on compatibility and safety standards. In 1969 the FCC allowed the competition to enter the long distance services market, through the famous MCI decision (p22). The competitive pressures mounted in the ensuing years and led to the AT&T *Divestiture* of Jan 1st 1984, also known as the Modified Consent Degree. *Divestiture* entailed a break-up of the company organisationally and geographically: into a long distance – international services division combined with a telecom equipment division, and seven regional holding companies (RHCs). This break-up was not a true liberalization of the market, as the RHC were essentially monopolists in their geographic regions.[4] Further liberalization of the telecom services market would come with the Telecom Act of 1996, liberalizing the local distribution services.

In Europe telecommunications services had remained firmly in the hands of the national operators, but this would change with the 1987 landmark document "Green Paper on the development of the common market for telecommunications services and equipment" (European Commission, 1987). The first and politically acceptable step in the process of liberalization was aimed at introducing competition in terminal equipment and at the services level, while the infrastructure could remain under monopolistic control. A series of directives followed that would provide the legislative framework for the implementation of this first phase of liberalization on the national level (Cawley, 2001)[5]:

- 1988: Competition in the markets in telecommunication terminal equipment,
- 1990: Competition in the markets for telecommunication services,
- 1990: Establishment of the internal market for telecommunications services through the implementation of open network provisioning.

But, "[t]he Commission recognised that the gains in innovation, productivity improvements and price re-structuring would only come about through competitive entry in infrastructure, be it at a local level by up-grading cable networks or building new ones, or more immediately through alternative backbone investments." (Cawley, 2001 p4). Following the publication of the *Bangeman Report* (Bangeman Group, 1994) addressing the implications of the 'information society' early in 1994, the European Council by the end of 1994 officially recognized the principle that telecommunications infrastructures should be liberalized and January 1st 1998 was the date set "by which all remaining restrictions on services competition would be lifted." (Cawley, 2001 p4).

In conclusion: The reform process removed the legal barrier for entrants to the public telecommunication services market, and many players did emerge using the opportunities that new technologies were offering. The process of reform furthermore resulted in a break with the tradition of tight links between the national incumbent operator and the domestic supplier of telecommunications equipment.[6] This opened new opportunities for existing and new suppliers to enter the lucrative market represented by the domestic operators as well as that offered by the new entrants. The results of the reform process are elaborated in Section 4.

2.1.3 Economic and socio-cultural drivers

As discussed in Chapter 3 Section 2 there is a strong correlation between teledensity and GDP per inhabitant. This relationship has been a strong argument for investment in telecom infrastructure in support of economic development.

In terms of economic and socio-cultural change in the period considered, Castells provides a very insightful perspective, which is also addressed by others, albeit with different emphasis (Shapiro and Varian, 1999; Castells, 2000; Castells, 2001; Florida, 2002; Mansell, 2002; Mansell and Steinmueller, 2002). Castells argues that a fundamental process of restructuring of the capitalist system is happening from the 1980s onward on the basis of an information technology revolution. (Castells, 2000 p13). For the purpose of understanding this restructuring and the emergence of a new social structure, he distinguishes between two modes of production (capitalism, statism) and two modes of development (industrialism, informationalism). In this respect societies are understood to be:

> "…organized around human processes of *production*, *experience* and *power*. *Production* is the action of humankind on matter (nature) to appropriate it and transform it for its benefit by obtaining a product, consuming (unevenly) part of it, and accumulating surplus for investment according to a variety of socially determined goals. *Experience* is the action of human subjects on themselves, determined by the interaction between their biological and cultural identities, and in relationship to their social and natural environment. It is constructed around the endless search for fulfilment of human needs and desires. *Power* is that relationship between human subjects which, on the basis of production and experience, imposes the will of some subjects upon others by the potential or actual use of violence, physical or symbolic. Institutions of society are built to enforce power relationships existing in each historical period, including the controls, limits, and social contracts achieved in the power struggles." (italics in original, p14-5).

The revolution is related to the changes that are taking place in the social relationships of production, and thus the mode of production, which determine the appropriation and uses of surplus:

> "In the industrial mode of development, the main source of productivity lies in the introduction of new energy sources, and in the ability to decentralize the use of energy throughout the production and circulation processes. In the new, informational mode of development the source of productivity lies in the technology of knowledge generation, information processing, and symbolic communication. To be sure, knowledge and information are critical elements in all modes of development, since the process of production is always based on some level of knowledge and in the processing of information. However, what is specific to the informational mode of development is the action of knowledge upon knowledge itself as the main source of productivity. Information processing

> is focused on improving the technology of information processing as a source of productivity, in a virtuous circle of interaction between the knowledge sources of technology and the application of technology to improve knowledge generation and information processing: this is why…I call this new mode of development informational, constituted by the emergence of a new technological paradigm based on information technology." (p16-7).

The structurally determined performance principle associated with industrialism is economic growth, is maximizing output:

> "..[I]nformationalism is oriented toward the accumulation of knowledge and towards higher levels of complexity in information processing. While higher levels of knowledge may normally result in higher levels of output per unit of input, it is the pursuit of knowledge and information that characterizes the technological production function under informationalism." (p17).

The restructuring of capitalism and the diffusion of informationalism have given rise to the emergence of an 'information society' to a 'network society', with cultural and institutional diversity.

In conclusion; Advances in basic technologies, silicon, optics, radio and software, are providing for a constant source of change in the telecom industry. The Telecom Reform process constitutes a fundamental shift in the institutional environment and the governance structure of the telecom services industry. The 'information technology revolution', of which telecommunication is an important part, is causing changes in the mode of production, experience and power in society. The pursuit of knowledge and information will increasingly characterize the technological production function. The analysis of the contextual drivers suggests that in the period leading up to 1995 changes are taking place at all levels of the Williamson model. See Chapter 4 Section 4.4.4.

2.2 Industry drivers of development

In the SCP-paradigm structure determines performance, and in the Porter model structure determines industry profitability. In this sense structure suggests replication or *status quo*, inhibitor rather than driver of industry development. However, if there is, in the sense of the Five Forces model, a change on either side of e.g. the 'barrier to entry' there will be a resulting force that will drive industry change. In a more strict sense a difference in 'power', occurring between the two sides of the 'interface', will yield a resulting force vector that will drive the change.
In the following Section we will review the determinants of industry structure as reflected in Chapter 4 Table 5 that generate the Five Forces, and identify whether they act as drivers of change or as inhibitors during the period leading up to 1995.

2.2.1 Changing forces at the entry barrier

The telecom reform process is removing step by step the formal barrier to entry into the telecom services industry. At the time the opportunity to enter is opening up, the industry is considered attractive: relatively high profit levels, only one or a few incumbent players. The incumbent operators are state monopolies; they are in general large entities and considered to be slow in customer response, lacking innovation, and slow in adopting new technologies. However, the non-formal

barrier to entry is high. Participation in the industry requires in general a significant investment outlay with long payback times. Most attractive are the high volume long-distance transmission routes, where new optical technology provides an attractive alternative for the coax based line transmission systems. Business areas with high traffic intensity, such as financial districts in the major cities, are also very attractive to serve. Through so-called 'cream skimming' a new entrant can create the necessary economies of scale. New entrants can be selective in their choice of business area, as typically the incumbents have the burden of the Universal Service Obligation (USO).
The advantage of new entrants over incumbent players is also valued by the financial industry for which the opening up of the telecom services industry is providing a highly attractive new market.
Retaliation is expected to be low, as incumbent players are carefully watched by the newly established regulators, assuring that former monopolists do not inappropriately use their significant market power. Albeit, history has shown that there are many ways to frustrate new entrants, e.g. in the negotiations over interconnection agreements, co-location, etc.
Being provided with a choice of suppliers is attractive for many consumers, in particular business users. This also applies for telecom operators themselves, who are now provided with a choice of carrier for the handling of long-distance traffic, the so-called carrier's carrier.

In conclusion: As discussed in Section 2.1.2.1, the institutional environment and governance structure that are controlling the developments of the telecom services sector through legislation and licensing, represents a major inhibitor of change keeping the entry barrier high. However, the telecom reform process is a major change agent and driver of industry development by lowering the entry barrier. The progress in technology, together with new business opportunities, the support of the financial industry and high customer expectations are the supporting drivers of change.

2.2.2 Changing forces regarding substitutes

For communications services suppliers, which might be called the 'on-line services' providers, the threat of substitutes has many times been coming from the off-line alternatives. The telecom industry can thus be seen as competing with the consumer products industry and with the information technology industry. For instance, the pay-per-view model has been strongly promoted at the time when cable-TV was being introduced. This on-line model found its major competitor in the off-line side in the video cassette and the related video rental business. The more recent case involves the DVD. In the media industry the battle between off-line and on-line viewing is even more pronounced.
Another example is the location of intelligence, which was at the core of the early battle between AT&T and IBM: should the intelligence be concentrated in the network or provided at the periphery.

From the perspective of the provider of telephony service over a fixed infrastructure, the introduction of mobile-cellular telephony and mobile-satellite based telephony should be considered as substitutes. Initially both new forms of telephony service were considered complementary (a new emerging market segment), rather than substitutes to the fixed network as there was a high willingness to pay by specific users groups. Albeit, with increasing penetration of cellular and satellite-based services they have become direct competitors in common serving areas. The large economies of scale that have been reached in cellular have frustrated the business plans of the providers of satellite-based mobility services, in particular the networks of low orbiting satellite systems.[7]

In conclusion: the number of substitute products and services are increasing. Mobile communications are a case in point. Albeit, in the period leading up to 1995 mobile services are complimentary rather than a substitute in the market for existing fixed services.

2.2.3 Changing forces regarding buying power

One could argue that buyer power is essentially non-existent if there is only one provider of a particular product or service. However, the history of reform, in particular the USA, shows that the erosion of the AT&T monopoly started at the buyer side. Although the pressure did not emerge from the individual users, but from firms engaged in supplying (computer) equipment to be connected (by the users) to the network, hitherto a monopoly of AT&T. See further Section 2.1.2.1 *Telecommunication reform*.

With the introduction of competition, buyers are being provided with choice and hence become aware of their power, they can ‘vote with their feet’. As a consequence customer acquisition cost and churn were concepts to be introduced to the telecom services industry.

Most of the buyer power is concentrated in the hands of the large business customers. Typically business connections represent 20% of termination points on the fixed network, the remaining 80% being private consumers. The business users, however, typically represent the majority of revenues being generated. Hence, business users are the first being provided with choice and hence this segment becomes a focal point of competition. Business users are price sensitive and as a result, high revenues are not associated anymore with high margins. Moreover, business users tend to be part of users groups and hence through information sharing the bargaining power of this group has been further increased.[8]

Buyer power increases in absolute sense when the volume of products and services procured is increasing. In this respect both the number of users connected to the network and the utilization of the network are important. See further Section 4.1 *Expansion-contraction of demand*.

In considering buying power a distinction should be made between private consumers and business users, as to the budget principles involved. For private consumers communication costs are an expense item, while for business users communication is, next to an expense, often a tool for business development (e.g. in sales, marketing, services) and in many industries increasingly a means of production (e.g. for call centers, in the financial industry, in e-markets). In the consumer market communication spending competes with other forms of information supply and leisure for the available ‘free spending power’. Arnbak *et al* refer to the 'principle of relative constancy', referring to an almost constant ratio of media spending over total consumptive spending, which has been for the Netherlands 3.3% for the period 1978-1987 (Arnbak, Van Cuilenburg et al., 1990 p24). More recent data for the OECD area shows that for the period 1990 to 2000 the proportion of communications spending has increased 150%. See Figure 5 (OECD, 2003 p31)[9]. It is worthwhile to note that an acceleration in spending is coinciding with the beginning of the Internet bubble.

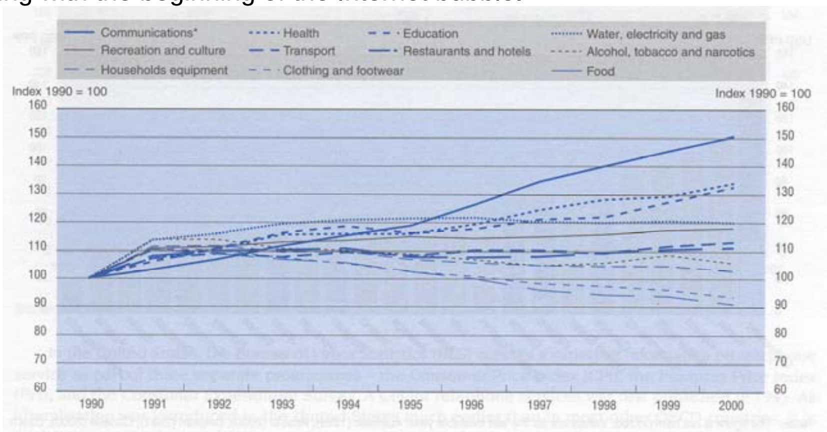


Figure 5. Changes in the proportion of communication in disposable household income

Buyer power is further determined by the cost associated with switching to alternative products or services. High switching costs are often referred to as 'lock-in'. The 'opportunity to switch' is relatively low in the case of fixed networks, as few alternatives are provided for the twisted-pair copper cable of the incumbent. If alternatives are provided, mostly to business users, the costs of switching are relatively low for the buyer of telecom services, as connectivity is based on recognized standards. Albeit, there are ancillary costs associated with number change. Moreover, large business users make use of multiple suppliers for redundancy/reliability reasons and they want to have the opportunity to benefit from the most attractive tariffs at any point in time.

For many business users telecommunications has become a part of the 'means of production' (consider the financial industry, call centres) and hence dependency of suppliers is increasing. On the other hand, alternative sourcing reduces this dependency.

While the virtues of competition in general increase the buyer power, not all consumers are being situated within a serving area of the new entrant(s). Hence, they are prone to incumbent suppliers exploiting their power of 'control' over the access to the telecom network. On the other hand universal service obligations imposed on the incumbent, including a price regime, and the supervision by the regulatory authorities are expected to mitigate this threat.

The threat of backward integration is in general not very large, although some specific large users have large private networks that provide opportunities for commercial exploitation. Examples are the energy utilities and the railway companies. See for the ensuing developments Chapter 7.

In conclusion: the buying power of telecom users is increasing in absolute terms in all dimensions discussed. Buying power has become an important driver of change.

2.2.4 Changing forces regarding supplier power

In assessing the forces of change with respect to supplier power, we should in principal address all input factors, raw materials, intermediate goods, labor and capital. In the period leading up to the Internet bubble the role of intermediate goods or the supply of telecom equipment appears as the most important factor of change. Capital will play a prominent role during the bubble period.
As the technological advances in silicon, fibre and radio, as well as software are brought to the market through the products and services of telecom equipment suppliers, their force of change is very significant.
In the telecommunications industry “[a] pattern of close, long-term, obligatory co-operation emerged as the dominant form of economic organisation between the monopoly operator and the specialist technology suppliers.” (Fransman, 2001 p8). This form of cooperation strongly influenced the balance of power between the operator, as the buyer, and the equipment vendor, as the supplier. The telecom reform process changed this relationship towards a more open and competitive one: in the USA it is marked by the divestiture of AT&T, effective January 1st 1984. In Europe the disentanglement process worked out more gradual, a result of privatisation of the incumbents and the emergence of new service providers. In the USA alternative equipment suppliers build their position primarily through the so-called independent telco’s.[10] With the opening up of the telecom services market new entrants provided a way-in for these alternative as well as emerging equipment providers. A typical example is the relationship between MCI and Nortel in digital switching (Fransman, 2001 p14), later to be followed by Cisco in routing.
In the area of switching, more so than in the area of transmission, the ‘switching costs’ are high due to the complexity and the long life-time of the products. A change or addition of suppliers would typically occur only when a new generation of equipment should be introduced. Moreover, the large installed base of network switches, which derive their value increasingly from software, provides for economics of scale in terms of regular software upgrades, representing a powerful customer lock-in. Because each customer, in general, would require significant dedicated development efforts, there was always a preferred customer who would receive the new functionality first. Hence, the large equipment providers typically depended for the majority of their revenues on a small set of large customers and so a form of mutual dependence remained.

In conclusion: telecom equipment suppliers provide a powerful driver of change through the supply of their equipment. The dependency of service providers on their suppliers is increasing and hence the supplier power increases.

2.2.5 Changing forces regarding rivalry

The rivalry in an industry is a result of the nature of the industry, either determined directly through the type of products, the prevailing business model, the 'rules of the game', or indirectly through the determinants of industry structure, discussed in the previous Sections. In this respect it is worthwhile to recall the description of the telecom industry as a network industry in Chapter 4 Section 2.6.

The prevailing business model in the telecom services industry, leading up to the beginning of the Internet bubble in 1995, can *grosso modo* be described as 'infrastructure based'. The telecom operator is essentially an entity licensed to provide a certain (range of) communication service(s) in a designated geographical area, in which it owns and operates an infrastructure to provide these services. Prior to the Telecom Reform there was only cooperation and no competition in the services industry. Telecom operators cooperated in handling traffic flows across borders. Any unbalance between originating and terminating traffic volumes was accounted for through so-called settlement payments. For intercontinental traffic flows in particular, operators would cooperate and invest jointly in the provision of undersea cables and satellite communication networks. While satellites are competing with undersea cables in the provisioning of long distance connectivity, they are also complementary as they provide a form of diversity, an alternative means of connection, thereby improving the overall network availability. Furthermore, satellites provide additional deployment flexibility, demonstrated through the uptake of VSAT communication by business users.

Rivalry as a force of industry development emerged with the introduction of competition as part of the Reform process. See for more details Section 2.1.2.1 *Telecommunication reform.*

The infrastructural nature of the industry implies a high fixed cost structure. Infrastructural costs are to a large extent sunk costs (in part also literally), having a high degree of asset specificity. They present the telecom firms with a high exit barrier.

The cost of building an access network are high, specially in relative terms, as less and less of the plant can be shared among multiple users, when we move closer toward a singular home or business premise.

In conclusion: Rivalry is an important driver of change, being facilitated through the other four forces. We will discuss the intensity of the rivalry in further detail in Section 4.2 *Concentration-fragmentation in the telecom services market*.

2.2.6 Determinants of telecom equipment industry structure

While the telecom equipment industry was addressed as supplier to the telecom services provider, the equipment industry does warrant an additional description and explanation in terms of its structure. Albeit, we will not pursue a full fledged Five forces analyses of the equipment industry. From its inception in the latter part of the 19th century, the equipment industry became a highly specialized industry. The real-time requirements in signal processing had led to the development of dedicated telecom hardware and later software, even specialized computers used for the control of switching systems at the nodes of the network were developed. Equipment, software and services were essentially provided by the same systems

vendor. Vendors that typically tailored their products to the specific requirements of the national telecom operators. The close relationship between the incumbent supplier and the incumbent operator formed a major barrier to entry. The industry specific requirement for backward compatibility and the deep investments required for the development of a new generation of telecommunications systems represented a major financial hurdle. However, this hurdle was much higher for switching systems than for transmission equipment and hence in the 1980s there were only few switching systems suppliers globally and many more transmission systems suppliers.[11]
With the advent of powerful microprocessors as general purpose controllers, telecommunications systems became more alike computer systems, using standard computing platforms and operating systems on top of which the telecommunications applications were running. Computers further permeated the telecom industry for functions such as network management, and in operations systems, such as billing and customer care. These systems and applications were increasingly provided by specialized IT providers. These advances in technology were allowing, among other, the increasing use of standard IT platforms, which contributed to a lowering of the barrier to entry. The relationship between the equipment supplier and the incumbent operator was further eroded through the process of liberalisation. Although path-dependence and lock-in occurred, the barrier to entry came down significantly.

In conclusion: The position of the telecom equipment supplier has changed significantly in relation to the telecom services provider. It has remained a specialized industry, but it has become more dependent on in-feeding from the IT industry. Moreover, the IT industry has obtained a position in IT-intensive application niches.

2.3 Internal drivers of industry development

The internal drivers of industry development are considered the forces of industry change that emerge at the firm level. To the extend that these forces are common across the industry they have or should have been captured in previous Sections, as part of the industry level review. If the force is unique to the firm, but has the potential of changing the industry structure, this is a force to be reckoned with. However, in general these forces can only be identified with hindsight.
As not all firms within the industry are operating from the same resource base, differences therein may generate a force of industry change. In this context the possession of ‘rights-of-way’ is such a distinctive force. Traditionally utilities have been granted these rights, which electricity and railway companies can now exploit as alternative providers of telecom services. In this project we will not elaborate on this dimension.

3 The inhibitors of industry development

Examples of the inhibitors of industry development were given in Chapter 4 Section 4 as:

- Underlying conditions, e.g. economies of scale, path dependence and lock-in,
- Industry integration, in terms of (complex) linkages between various aspects of the industry,
- Power structures, e.g. desire to maintain the status quo by incumbents,
- Risk averseness, e.g. uncertainties about investment payoff,
- Industry recipes, e.g. in the form of cognitive maps shared across the industry,
- Institutional pressures, e.g. applied by governments or interest groups.

The telecom services industry in the period up to the 1990-ties is reflecting many of these inhibitors of change, e.g. economies of scale through the infrastructural nature of the industry; the close linkages between operators and equipment providers, and the close linkages between the operator and the government; the monopoly position; the risk averseness and the high degree of planning in the business; the institutional arrangements in which governments closely control or supervise the firms in the industry.
The process of telecom reform, through privatization of the incumbent operator and the liberalization of the market, affects all of these inhibitors, albeit it does not remove them. The infrastructural nature of the industry remains, but allowances are made for services re-sale and for ‘virtual network’ operators (e.g. in mobility). More open competition characterizes the telecom equipment market, but the importance of the installed base remains. Governments reduce their direct involvement, but remain closely engaged through newly established National Regulatory Agencies. Monopolies whither, but significant market power remains. Through privatization and firm entry the entrepreneurship and risk-taking in the industry is increasing.

Most important inhibitors of industry development are considered the institutional structure and governance regime, path dependence, and the role of ‘industry recipes’, cognitive maps or paradigms that are shared across the industry. The first two aspects have been addressed in Section 2.1.2.1 *Telecommunication reform*. The other aspects will be elaborated in the following Sections.

3.1 Technological regimes: the circuit mode and packet mode paradigm

The prevailing paradigm for this period in the telecom industry is ‘circuit switched voice’. Its main attributes are summarized in Table 1, left-hand column. The circuit mode paradigm originated with the invention of the telephone and evolved from an analogue to a digital form of transmission and switching of the voice signal. Computer communications evolved in a distinctly different sphere, i.e. within the corporations using Local Area Networks (LANs). For long-distance connectivity the public network was used, either on a more permanent basis by using leased-lines, or in a dial-up mode through the Public Switched Telephony Network (PSTN). A LAN environment typically involves short distances (10-100m), and hence the copper cable can be used for a much wider bandwidth, while retaining the quality of transmission. Moreover, specially developed cables for in-house wiring allowed further expansion of bandwidth capacity. Typical for a LAN is the shared use of the physical medium, in a bus or ring configuration.[12] A wide range of protocols were being developed to facilitate computer communication on LANs.[13] The Ethernet protocol would emerge as the most widely deployed.

Determinants:	Paradigm attributes The existing voice communication paradigm: **Circuit mode**	The emerging computer communication paradigm: **Packet mode**
Service focus:	Voice telephony	Data communication between computers
Principle:	Two way symmetrical and synchronous connection for the duration of the call	Two way asymmetrical and asynchronous communication - Always On
Technology:		
Principle:	Circuit switched	Packet switched – store & forward
Bandwidth:	Analogue – 3 kHz	Bandwidth/throughput time determined by capacity of the transmission links and the capacity of the routers
Digital encoding:	8 bit voice sample every 125 μs generating a 64 kb/s digital stream (USA: 7 bits in 64 kb/s)	
Primary multiplex:	30x64 kbit/s + overhead: 2Mb/s (USA 24x64: 1.5 Mb/s)	
Higher order multiplexing:	Typical data rates in Mb/s: 8, 34 (45), 140 (155), 565 (622); in Gb/s: 2.5, 10, 40	
Connection control:	PSTN: Call set-up through in-band signalling in the access network	Routing information in the packet header
	Trunk signalling out-of-band or through common channel signalling	No link or end-to-end signalling
Network design:		
Design assumption:	Bandwidth is expensive	Bandwidth is cheap
Principle:	Hierarchical, static routing	Non-hierarchical; dynamic routing;
Intelligence:	In the network	In the equipment at the periphery of the network
Business model:		
Principle:	Usage based	Capacity based
	Tariff based on: time, duration and distance	Flat fee based. Inspired by the LAN model: driven by infrastructure cost.
Network interconnection:	Volume based; bilateral arrangements based on 'half-circuit'	Based on peering; sender-keeps-all, with transit payment for backbone traffic
Innovation:	Corporate labs drive the research agenda; agreements based on (ex-ante) negotiations and patenting	University labs drive the research agenda; agreements based on rough consensus and functional code; wide publishing and peer review
Institutions:	Associations of telecom operators or government representatives; voting based on membership	Open conventions; voting based on participation
Standardization:	CEPT (later ETSI)	IETF
Industry coordination:	ITU, CEPT (Europe) / ANSI (USA)	IEEE, RIPE, ARIN, APNIC
Frame of mind:	"Bell Heads"	"Net Heads"

Table 1. Paradigm attributes - circuit and packet mode

For the transmission over the PSTN the computer signals were encoded to fit within the voice band. In this way the circuit mode paradigm was imposed on computer communication. An obvious mismatch, as data communication between computers is totally different in character from voice, being very bursty, and widely

varying in message size. The telephony call set-up time, of hundreds of milli-seconds, is often far exceeding the data connection time required.
In 1960 packet switching has been invented as a more appropriate way for handling computer communication. In packet mode each message would be cut in fixed length packets, and to each packet addressing information would be added that would facilitate the routing of the packet through the network, consisting of transmission links and switching nodes.
Recognizing the vulnerability of hierarchically network structures for outages of a single node, e.g. through hostile acts, the US Department of Defence started to fund the Advanced Research Projects Agency (ARPA) to develop a more robust network topology. Using a fully interconnected (mesh) network, multiple routes would be available between any combination of source and destination. In popular terminology: the packets would seek their way through the network, using the available links and nodes. The packet mode of communication would become the prevailing mode for data communication using the public network. The attributes of the packet mode paradigm are summarized in Table 1, right-hand column. The ARPA research efforts along the packet mode paradigm would become the basis of what is today known as the Internet.

The engineers adhering to the telecom paradigm were denoted “Bell Heads”, reflecting their (supposed) affiliation with the Bell System, and those following the packet paradigm as Net Heads, after the Internet. During the Internet bubble period both worlds would collide.[14]

The differences between the two paradigms are also reflected in the way services can be provided and managed. Table 2 shows, by way of illustration, the differences between the circuit mode and the packet mode implementation of telephony (adapted from: McGarty, 2001 p56).

3.2 Governance structures and institutional environments: public and private

The Layered model by Williamson, introduced in Chapter 4 Section 4.4.4, provides important clues to the ‘constancy’ of the environment in which transactions take place. From the transactions considered at Level-4 to the informal institutions at Level-1 the rate of change diminishes, from continuous to a process of social change at the cultural level, taking 100 or even 1000 years. Layers 2-4 are facilitating, but also conditioning the activities in an industry.[15] The higher we move in the layered model the more implicit the conditioning becomes and the more difficult it is to affect change.
The telecom reform process moves the telecom services industry from the public domain to the private domain. This is a change process at Level-2, the institutional environment, and at Level-3, the governance structures. No new fundamental principles need to be developed, public markets and private markets are existing and their governance structures and institutional environments are well understood. The actors at Level-4 that are the subjects of change. Being conditioned by the public domain model, they now need to adjust to the private domain model and

become familiar with 'new' ways of allocating resources, different incentive schemes, a different governance model and another institutional environment.

Element	Telephony	
	Circuit mode	**Packet mode**
Security	Very secure from external attack	Highly vulnerable access and control
Latency	Traffic engineered for low latency	Unpredictable latency
Availability	High availability due to the controlled environment	Uncertain availability since there are multiple elements that cause outages, lost packets, and other failure mechanisms
Accessibility	Need points of connection or "meet" points for dedicated circuits	Easily accessible from any location with a telephone line
Costs	Low costs depending on amount of traffic.	Low costs since they depend on fixed costs per port per month and may actually be usage independent.
Control	Control via embedded network operations centre (NOC) facilities	Little control. May have SNMP access via TCP/IP at end points
Management	Controllable at NOC level	Management at best at end points. Otherwise unmanageable
Provisioning	Complex provisioning of circuits and at meet points. May take weeks to month	Readily provisioned. Can be implemented in a few hours (assumes basic connection is in place)
Speed/data rate	Totally under control of a telephone network connection	Can use whatever speed the Internet allows at the time controlled by the speed of the end circuit
Flexibility	Flexible in the context of a telephone network connection	Flexible in the context of an Internet connection
Interconnectivity	Full interconnectivity to all telecommunication networks	Limited interconnectivity (off-net calls)
Speech quality	Toll-grade quality. Allows for implementation of national as well as international networks	Variable due to latency and transmission reliability problems
Signalling compatibility	Fully compatible. Allows transfer from C7/SS7 and any IP network	Has no ability to cross-transfer traffic from IP to SS7/C7
Standards	Meets all integrated standards	Meets Internet standards

Table 2. Telephony service in circuit and packet mode

Although the change itself, the reform, represents an important driver of industry development, the process of adaptation is for its duration an inhibitor for the development of the sector. The duration of adaptation is influenced by the counter forces that are being invoked by the required changes. These forces depend on the vested interests in the current regime and the economic and political powers that can be generated to resist the change. Table 3 provides an illustration of the major dimensions involved in the regime change as it would affect a typical incumbent telecom operator in Europe.

Attribute:	Public domain regime:	Private domain regime:
Institutional environment		
Ownership:	Central government; Ministry of Finance	Share holders through the stock market
Governance		
	Politics	The market
Purpose of the firm:	Serving the public wisely	Improving shareholder value
Employment		
Contract:	Civil servant	Private contract; mostly with conditions arranged through collective bargaining arrangements
Incentives:	Social recognition related to firm performance	Financial rewards related to firm performance

Table 3. Difference between the public and private domain regime

4 The ‘development path’ of the telecom sector up to 1995

In the previous Sections we have described and explored the drivers and inhibitors of change. In this Section we will describe and explain the effects thereof on the ‘development path’ of the telecom sector leading up to 1995, the beginning of the Internet bubble. We will make use of the seven dimensions identified in Chapter 4 Section 4. In this Section a set of indicators will be identified and applied that will be used also for the description and analysis of the impact of the Internet bubble on the ‘development path’ of the telecom sector, which is the topic of Chapter 7.

4.1 Expansion-contraction of demand

4.1.1 Connectivity

Demand for voice communication has historically been expressed in terms of connectivity to the network and denoted in terms of teledensity or the number of lines per 100 inhabitants.[16] In the early days this would typically equate to the number of homes or businesses served. Demand saturation was considered to occur when 80-90 % of homes was being served. Notwithstanding that in the more prosperous areas or countries homes were being connected with two lines to accommodate the needs of the family members at large.

The introduction of mobile communications implied a return to the true meaning of teledensity, the demand curve would essentially equate to ‘a phone for every individual’.

The telecom network, however, is not only facilitating communication between human beings, but increasingly the communication between machines, *in casu* computers. Initially business to business, but through the Internet increasingly in the private domain: mainly in terms of fixed connections, but more and more through mobile appliances. Hence, the demand curve can be seen as shifting from initially the number of homes, to the number of people, and ultimately to the number of computing appliances.[17] See for an illustration of this developments at the global level Figure 6 (ITU, 2002a p6).

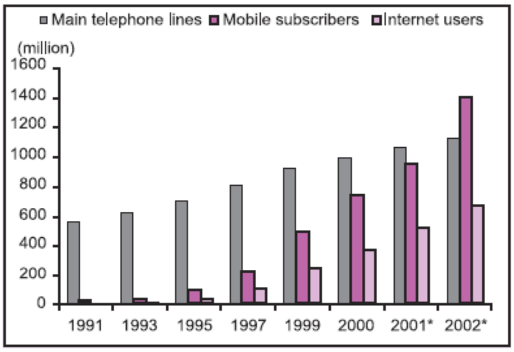


Figure 6. NTPs and communicating entities

The steady growth in main (fixed) telephone lines is occurring primarily in the developing nations. Growth in connectivity in the developed countries is primarily related to cellular.

Essential for the development of computer enabled communication, in particular the Internet, is a wide diffusion of PCs. Figure 7 shows the worldwide penetration for the period 1986-2000 from an early 1996 vantage point. (Meeker and DePuy, 1996 p3-2). The number of Internet users at the time was estimated at 9 mln of which 75% residing in the USA.

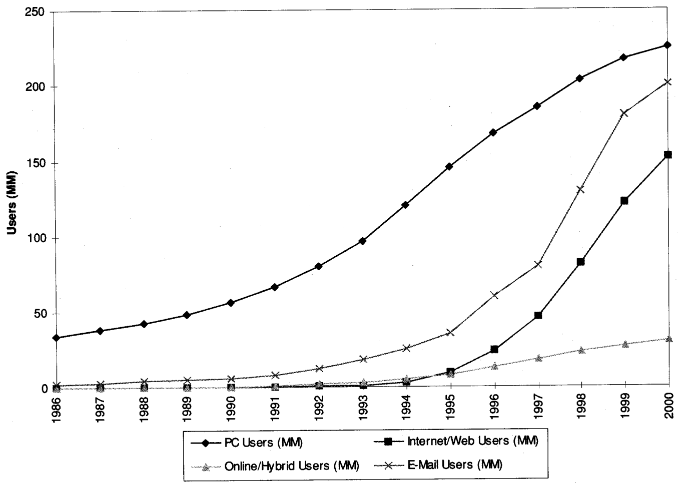


Figure 7. Estimated numbers of Internet, E-mail, PC users worldwide, 1986-2000

4.1.2 Utilization

While connectivity is the necessary condition for communication to happen, the actual utilization determines, to a large extent, the viability of the prevailing telecom business models. Moreover, telephony calling patterns differ significantly across nations.

From this information we may infer that telephone utilization is strongly determined by socio-cultural factors. These different calling patterns imply different values in the distribution of call arrival times and the length of the calls, the two most important telephony network engineering parameters.[18] One design parameter is essentially fixed in the telephony world, i.e. the bandwidth required for the transfer of voice communication. Good audibility requires a bandwidth of 3 kHz or typically 64 kb/s when digitally encoded.[19] This bandwidth is made available in both directions simultaneously for the duration of a telephone call.[20]

In communication between computing appliances the utilization differs widely depending on the type of application requiring communication. In the field of data communication there is a trade-off between bandwidth and transfer time.[21] In the early days computing was primarily based on 'batch processing' and hence communication was not very time critical. Time critical applications, e.g. related to financial transactions, were arranged through dedicated networks based on private or leased circuits. Given the nature of computer-to-computer communication of many short burst of low volume data transfer, packet-mode communication is a much more appropriate model than the circuit-mode telephony model. In the packet-mode model information is divided in fixed length packets[22], to which routing information is added to allow the packets to be sent individually over the network.

Transfer time is directly related to the response time. Hence, time critical applications may require higher bandwidths. But also in terms of human factors, bandwidth needs increase as our appetite for more and more data intensive information increases, e.g. from text-emails, to ppt-emails, to photo-emails and from text-downloads, to music and film-downloads. See also Figure 8 (derived from: OECD, 2006).

Communication needs as described above in communication parameters can also be expressed in monetary terms. As stated in Section 2.2.3 *Changing forces regarding buying power* at the user level a distinction should be made between private consumers and business users, as to the budget principles involved. For private consumers communication costs are an expense, while for business users communication is next to an expense often a tool for business development and in many industries increasingly a means of production. Figure 5 shows data for the OECD area the communications spending as a proportion of disposable household income for the period 1990 to 2000.

Competition and the lowering of the network costs through technological progress have reduced prices of telecommunications services significantly. Business users, representing the major chunk of demand, have been able to exploit the benefits from competition more fully and ahead of the private consumers. See also Figure 9 for the changes in telephone charges (fixed fees and usage related) in the OECD countries, in current (2003) dollars (OECD, 2003 p160-1).

Pricing is linked to demand through the concept of price elasticity. In this respect also pricing structure plays an important role, i.e. the ratio fixed (as in monthly rental) and variable (per call) costs, as well as the payment structure, i.e. post paid or pre-paid. This has become apparent in particular during the period after 1995, in

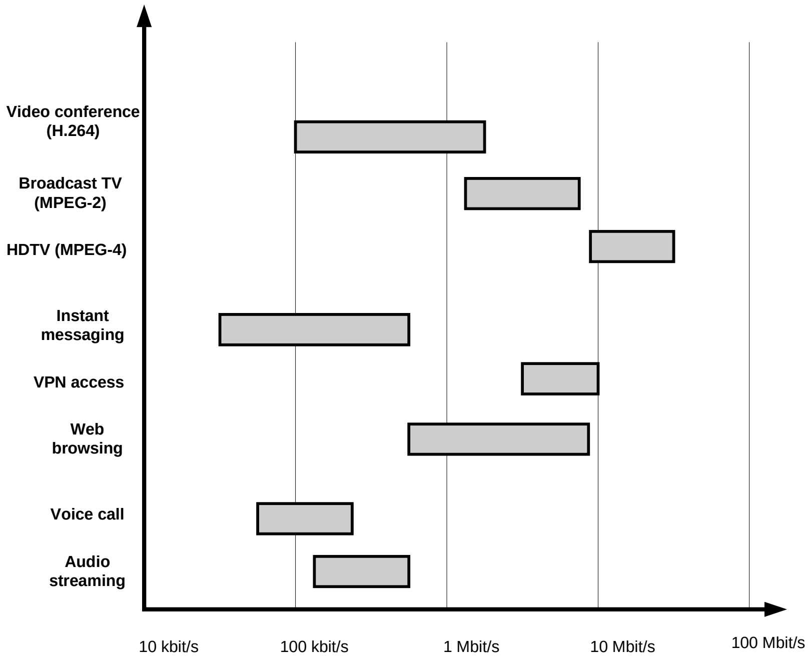


Figure 8. Bandwidth requirements of different services

terms of unlocking new user groups (low income and youth) in mobile, through pre-paid cards, and in Internet access, through flat-fee ADSL-based services.

At the aggregate level telecommunications revenues in the OECD area have stayed constant at roughly 2% of GDP in the period 1985-1992, to slowly increase to 2.2% in 1995. See Figure 10 (OECD, 2003 p61).

4.1.3 Demand for telecom equipment

Using the value chain notion as depicted in Chapter 4 Figure 2 the demand for telecom equipment is in essence the investment made by the telecom operator in telecom equipment.[23] Investment levels by operators are in general available, but they are not always specific with respect to equipment; they may include other investments such as real-estate, car fleet, etc. The collective revenues of the telecom equipment providers are used as the primary source of information. Where necessary the revenues may be split by type of equipment.

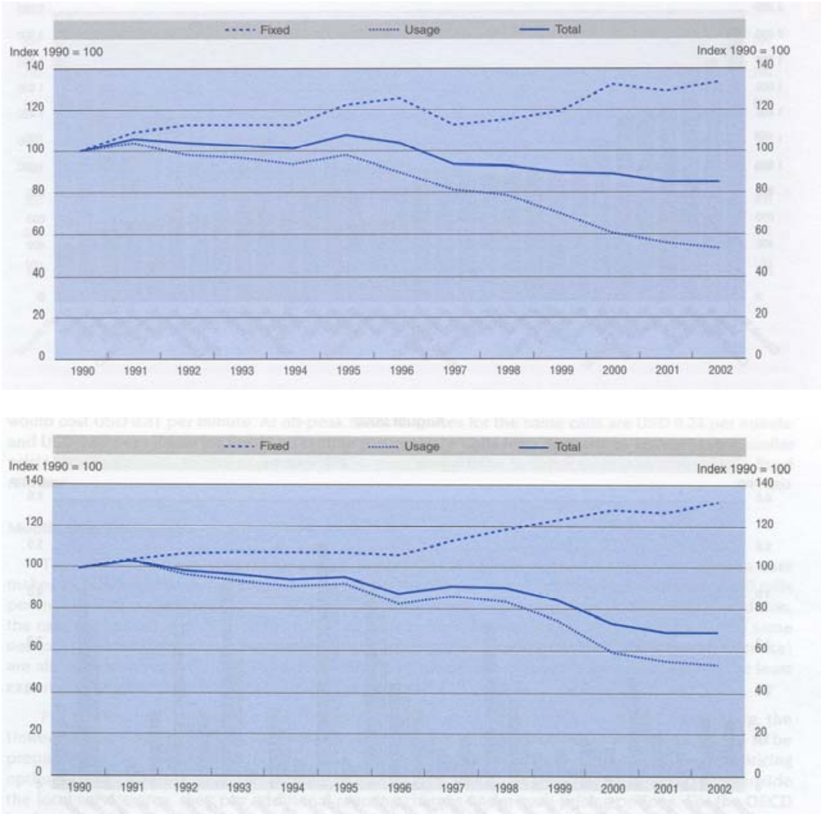


Figure 9. Time series for telephone charges, top - residential and bottom - business

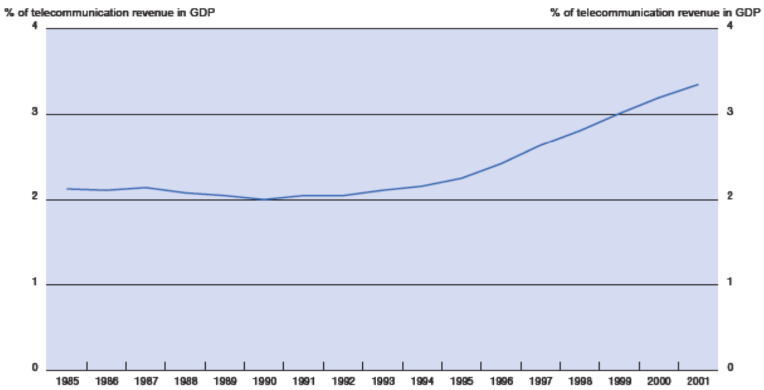


Figure 10. Telecom revenue as a percentage of GDP - OECD 1985-2001

4.2 Concentration-fragmentation in the telecom services market

The telecom reform process, that started in 1968 with the so-called Carter-phone decision by the FCC in the USA, is the driving force behind the fragmentation of the telecom services market. The original AT&T monopoly has eroded step by step as reflected in Figure 11. The figure is showing this development over time, whereby the formal barrier to entry is gradually lowered by the FCC, a result of technological developments and (emerging) competitive pressure. See also Chapter 4 Section 2.5.

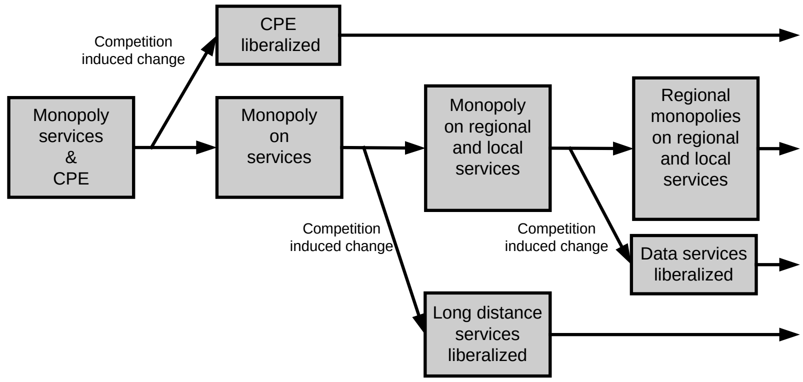


Figure 11. Evolution of the services monopoly in the USA

Note: the indication of the forces of change in the chart are indicative for what is considered the most prominent factor, which may in turn result from other underlying forces of change, such as technology. The indication 'competition induced change' includes the pressure applied prior to market entry.

In Europe the reform process evolved following a similar trajectory, with the distinction that no national long distance market was distinguished. Note that a Pan-European long distance market would emerge much later. See Figure 12.

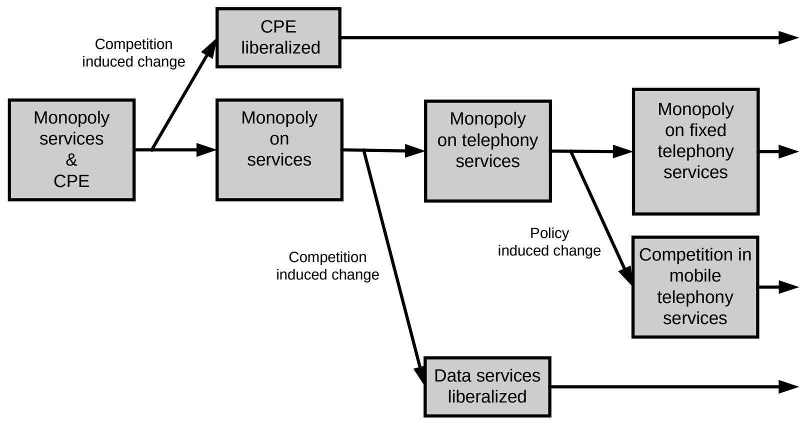


Figure 12. Evolution of the services monopoly in Europe

Competition in the mobile telecommunications market was introduced gradually. After a period in which only the incumbent operator was licensed to provide the service, typically a secondary license was awarded for the analogue cellular system. The introduction of digital systems followed typically a similar pattern. Fast growth in demand facilitated the relatively smooth introduction of additional players. See Figure 13 for the developments in the OECD area, lower part (OECD, 2003 p14). Competition in the fixed network gradually expanded in the years up to 1997. See Figure 13 upper part.

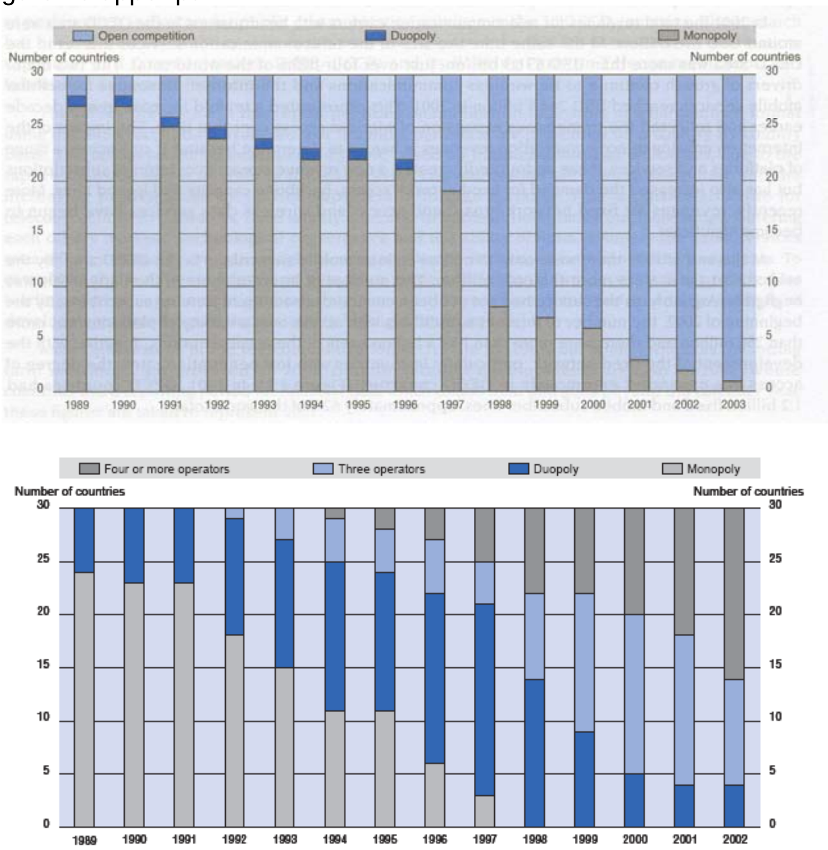


Figure 13. Competition in fixed (upper) and mobile networks (lower)

4.2.1 Concentration-fragmentation in the telecom equipment market

In the 1950-1970's the model in the telecom sector in the USA was highly integrated: AT&T, or the Bell System, provided the nation with telecom services and designed, developed and produced the equipment for its own needs, through its subsidiary Western Electric. In Europe the operators and equipment providers were distinct entities, but closely cooperating. The prevailing model, but highly stylized, was 'one country – one operator – one equipment supplier'. The national champions were mostly full line suppliers, i.e. producers of switching and transmission equipment. In the transmission equipment field there are also many specialized suppliers, in particular in the radio transmission and satellite communication field. While dominant in their domestic market, in particular in switching systems, the equipment providers were competing fiercely in export markets, i.e. countries without an incumbent supplier. In the USA this competition was focussed on the so-called independent operators, not being part of the Bell system. Telecom operators would typically engage in tender process for long-term systems supply contracts, allowing 2-3 providers to share the market, the share being determined mainly by the price differential. The market for transmission equipment was much more segmented with a multitude of suppliers. Albeit, for the main transmission systems procured in large volume a procedure similar to that of switching was applied. In certain markets the competition was 'managed' through the use of extensive cross-licensing arrangements.[24] See also Chapter 4 Sections 2.5 – 2.7.

4.3 Convergence-divergence of business models in the telecom services industry

For the purpose of our research we will focus on a few significant dimensions of the business system that sets apart one business model from the other. These dimensions will be used to assess the degree or trend in convergence-divergence of the business models that can be observed in the telecom sector. These dimensions are:

Governance structure[25]:
- Ownership (public/private),
- Licensed and unlicensed service,

Resource base:
- The use of an own network infrastructure (wholly/in part),
- The type of infrastructure technology being used (e.g. in the access: Twisted Pair, Coax, Fibre, Radio),

Activity systems:
- The role of technology development,

Product offerings:
- Product type: Equipment, Service, Content and Service type (e.g. voice/data, fixed/mobile),
- Revenue model: Wholesale/Retail and Non-usage sensitive/Usage sensitive revenues.

The removal of legal barriers to entry in the telecom services market, was typically preceded by the privatization of the incumbent operator(s), often coinciding with a separation of the telecom and postal activities. See for the developments on the global level Figure 14 (ITU, 2002a p4). In
Table 4 the situation in Europe is depicted in further detail (ITU, 2002a).

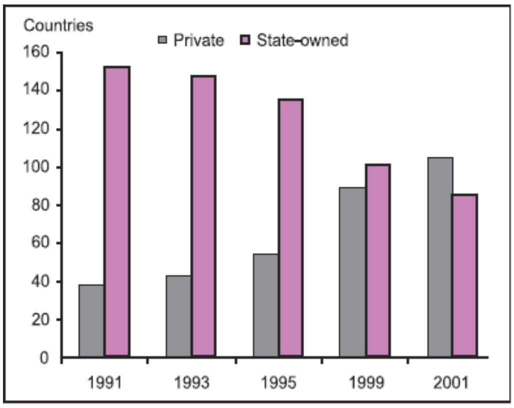


Figure 14. Ownership trends

Country	Incumbent operator	Status as of 2000	Date of first privatisation
United Kingdom	British Telecom Plc	Fully privatised	1984
Denmark	TDC (former Tele Danmark A/S)	Fully privatised	1991
Spain	Telefonica de Espãna	Fully privatised	1992
Hungary	MATAV	Fully privatised	1993
Czech Republic	Cesky Telecom as	Partially privatised	1994
Latvia	Lattelekom	Partially privatised	1994
Netherlands	KPN	Partially privatised	1994
Portugal	PT Communicações, S.A.	Partially privatised	1995
Belgium	Belgacom	Partially privatised	1996
Germany	Deutsche Telecom AG	Partially privatised	1996
Greece	Hellenic Telecommunications Organization S.A. (O.T.E.)	Partially privatised	1996
Ireland	Eircom	Fully privatised	1996
Slovenia	Telekom Slovenje	Partially privatised	1996
France	France Télécom	Partially privatised	1997
Austria	Telekom Austria AG	Partially privatised	1998
Finland	Sonera corporation	Partially privatised	1998
Italy	Telecom Italia	Partially privatised	1998
Lithuania	Lietuvos Telekomas (Lithuanian Telecom)	Partially privatised	1998
Malta	Maltacom	Partially privatised	1998
Poland	Telekomukacja Polska (TPSA)	Partially privatised	1998
Switzerland	Swisscom	Partially privatised	1998
Monaco	Monaco Telecom (Vivendi Universal Group)	Partially privatised	1999
Norway	Telenor	Partially privatised	2000
Slovak Republic	Slovenské telekomunikácie a.s.	Partially privatised	2000
Sweden	Telia	Partially privatised	2000

Table 4. Privatization of the incumbent operators in Europe

The period leading up to 1995 was characterized by a great similarity in business models employed for the provision of telephony services and more recently data services. In the narrow sense there was in essence one operator and hence one model per country. There were no significant differences in the resource base, the activity system or the product offerings. The model was very similar across Europe, i.e. a state monopoly providing the full range of telecom services. In the USA the operators were private entities under close state supervision, providing the full range of services. A somewhat different business model applied to the provisioning of international long distance services, using undersea cables and satellites. These services were provided through dedicated entities in which the incumbent operators were the major share holders.

The product offering was essentially a wholesale model and the resource base differed from the PSTN network exploited by the national incumbent operators.The introduction of mobile cellular communication in the early 1980's implied the addition of a new type of asset to be exploited: radio spectrum. It also implied a new type of consumer equipment: mobile handsets. Using the attributes identified above, commonalities and differences in the original business model are shown in Table 5.

Indicators	Fixed network	Mobile network
Ownership:	State	State and Private
Licensed service:	Yes	Yes
Infrastructure ownership:	Yes	Yes
Infrastructure type:	Fixed	Mobile on top of Fixed
Technology development:	Strong tie operator supplier	Strong tie operator supplier
Product type: Service Equipment	 Telephony (fixed) Data communication Telephone set	 Telephony (mobile) Mobile handset
Revenue model:	Subscription and usage	Subscription and usage
Equipment subsidy:	No	Mobile handsets (at service introduction(s))

Table 5. Comparison of business models Fixed and Mobile

A few remarks about the differences in the business model indicators:
The initial mobile licences were awarded to the incumbent operator. Competition was introduced a few years later with the award of a second licence, mostly to private entities. See also Figure 13. While it is customary to differentiate between fixed and mobile networks, the mobile part is the network access. Hence, mobile communications make extensive use of the fixed backbone network.
Although the market for customer premises equipment (CPE) is liberalized, the initial high cost of mobile handsets prompted operators to subsidize handsets to promote the take-up of the service.
Mobile telephony became a distinct product market, initially complementary to fixed telephony and thereafter as a replacement for fixed telephony.
The telecom reform process has effected the business system through the privatisation of the incumbent operators and the introduction of competition in the fixed network. See also Table 4, Figure 12 and 13. The reform process has led to a re-definition of business goals and priorities. This has led to a different set of incentives and hence business attitudes as well as a different positioning of the products in the market, now being a competitive market.
New entrants in the fixed market had the opportunity to introduce new business models, but *grosso modo* followed the basic principles of the existing service provider model.

Considering Western Europe in the period up to 1995 the most salient difference in business models is the difference in ownership between public and private, combined with the introduction of competition. The evolution of the business models over time is reflected in Figure 15.

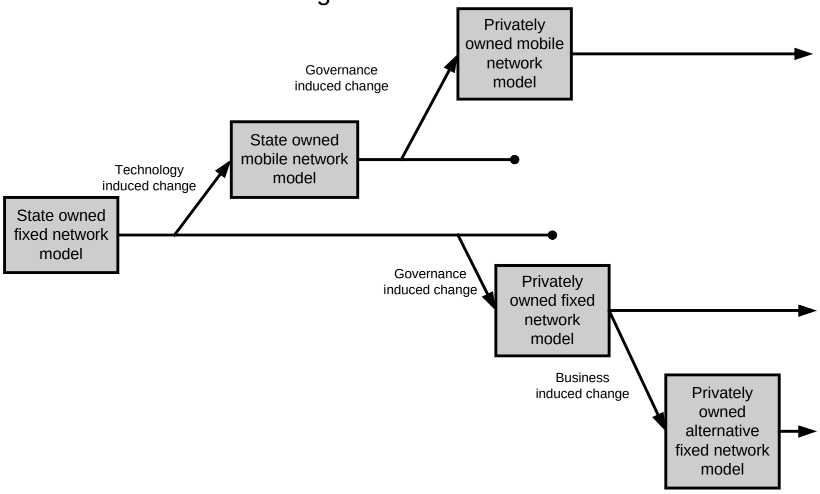


Figure 15. Business model evolution in the services industry

TV and radio distribution services were provided by multiple entities each having a monopoly in their serving area. Signal reception was sometimes combined e.g. for apartment buildings (Dake and Boers, 1999).[26] This evolved to larger cable distribution systems installed and exploited by municipalities, but also incumbent telecom operators were involved in Europe.[27] In the USA private companies would provide for cable-based RTV distribution services.

4.3.1 Convergence-divergence of business models in the telecom equipment industry

As stated earlier, the prevailing model in the 1950-1970's was 'one country – one operator – one equipment supplier'. The cooperation between the telecom operator and the national equipment champion was very close. Specifications for new product development were developed jointly, research was closely coordinated, and production was tuned to nationally planned needs.[28]

The equipment industry was essentially privately owned. As mentioned before, the national champions were mostly full line suppliers, i.e. producers of switching and transmission equipment. In the transmission equipment field also many specialized suppliers were operating, in particular in the radio transmission and satellite communication field. The technological developments were principally done in-house and evolved from electro-mechanical toward fully electronic. With the introduction of stored program controlled (SPC) switching systems in the late 1960's and early 1970's the revenue model became increasingly dependent on the sale of software and the exploitation of the installed base through regular upgrades providing increased functionality. The evolution of the business model up to 1995 is depicted in Figure 16.

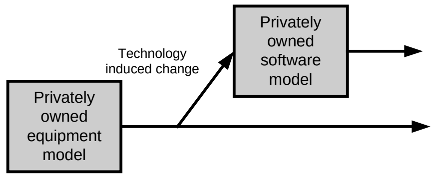


Figure 16. Business model evolution in the equipment industry

4.4 Expansion – contraction of investments in the telecom services industry

An indication of the trend in telecom investment in relation to revenues and the number of access paths is shown in Figure 17, for the OECD area from 1980 onward (OECD, 2003 p60).

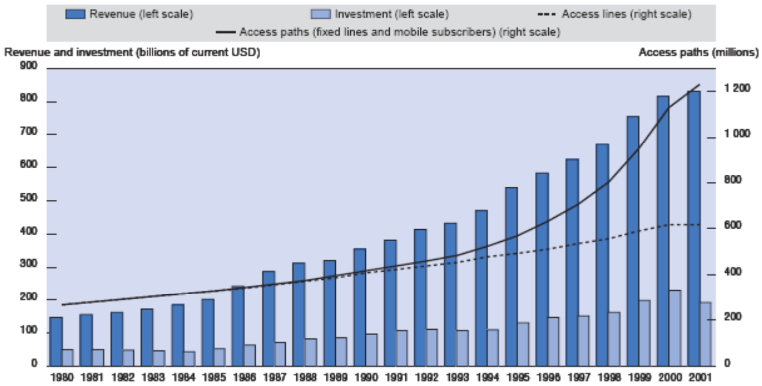


Figure 17. Investments in relation to revenues and access paths

Note to the graph: Access paths include access channels and cellular mobile subscriptions.

The public telecommunication investment per access path for a selected number of countries is shown in Table 6 (OECD, 2003 p117).

	Average investment in US$ per access path		
	1988-90	1991-93	1994-96
Germany	310	425	273
UK	189	133	137
Netherlands	169	208	171
Sweden	178	176	149
USA	174	169	196
Japan	292	341	431
Korea	194	199	222
OECD	224	235	225

Table 6. Investments per access path

Note to the table: Access path include access channels and cellular mobile subscriptions.

Yearly investments per access path is a composite indicator. As the addition of network access points is a rather smooth process, the fluctuations in the investment levels are typically related to major modernization projects. In Figure 18 the major modernization projects in Western Europe are reflected vis-à-vis the investments per (fixed) line and user (derived from: ITU, 2002b).

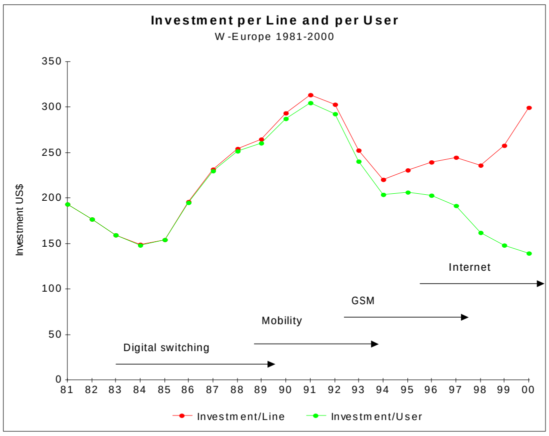


Figure 18. Investments in W-Europe, 1981-2000

Moreover, a shift can be observed in the investment portfolio typically aimed at the acquisition of land, buildings, infrastructure assets, operational assets, and assets associated with the customer interface. Progressive digitisation and miniaturisation generate excess space in most equipment buildings. Computerization facilitates remote operations, administration and management of the network equipment. The centralization, often at the regional level, requires increasing investment in computer based OA&M-systems. Competition for the customer implies the need to improve service levels, hence, investments in automated back-office and front-office systems are the result. The R&D spending by the services operators is reflected in Table 7 for a selected set of companies (OECD, 2003 p80).

Firm:	R&D as % of revenue:		
	1997	1999	2001
AT&T	1.6	0.9	0.6
BT	2.0	1.6	1.7
Deutsche Telekom	1.8	2.0	1.9
France Telecom	3.5	2.2	1.3
KPN	0.8	0.6	0.4
NTT	3.1	3.4	3.3
Korea Telecom	2.2	2.6	2.4
Cable & Wireless	1.2	0.1	
Vodafone	1.4	0.6	0.3

Table 7. R&D expenditure for telecom services firms

Note to the table: R&D is subject to capitalization and amortization in certain countries, which is not reflected in the table.

As an indicator of R&D output, the number of patents granted by the US Patent and Trademark Office (USPTO) is reflected for a selected set of companies in Table 8. (OECD, 2003 p82).

Firm:	USPTO patents granted: 1995	1996	1997	1998	1999	2000	2001
AT&T			46	150	278	294	289
BT	55	48	35	70	77	70	94
Deutsche Telekom	0	0	2	8	9	6	25
France Telecom	35	47	36	63	47	39	35
KPN	0	0	0	0	13	16	1
NTT	3	12	25	49	32	67	78
Korea Telecom	0	1	0	0	4	0	6

Table 8. USPTO patents granted to telecom services firms

Note to the table: Patents granted to AT&T, prior to the divestment of Lucent Technologies in 1996, are combined services and equipment patents.

4.4.1 Expansion – contraction of investments in the telecom equipment industry

Following the value chain model the revenues of the equipment manufactures are a good proxy for the trend in investment by the telecom operators in infrastructure assets. This information is presented for a selected set of companies in(Table 9), together with the R&D spending by the equipment suppliers (OECD, 2003 p81).

	Revenues: US$xmln			R&D expenditures: US$xmln			R&D as % of Revenue		
Firm:	1997	1999	2001	1997	1999	2001	1997	1999	2001
Alcatel	31,955	22,957	22,911	2,844	2,181	2,589	8.9	9.5	11.3
Cisco	8,467	12,138	22,284	1,050	1,663	3,922	12.4	13.7	17.6
Ericsson	21,896	26,256	22,442	3,175	4,201	4,511	14.5	16.0	20.1
Lucent	26,286	26,992	21,333	3,023	3,563	3,520	11.5	13.2	16.5
LG Electronics	9,723	8,825	12,782	457	353	588	4.7	4.0	4.8
NEC	41,142	50,309	42,230	2,880	2,767	2,745	7.0	5.5	6.5
Nortel	15,446	19,597	17,510	2,147	2,724	3,292	13.9	13.9	18.8

Table 9. R&D expenditures for telecom equipment firms

Note to the table: The revenues have been calculated from the R&D expenditure data. The increases in ratio of R&D spending in 2001 is not necessarily a result of increased R&D expenditure, but rather a fall in revenues.

As an indicator of R&D output the number of USPTO patents granted to the same set of companies is reflected in Table 10 (OECD, 2003 p81).
The difference in patents awarded is only indicative for the R&D output. Underlying factors that can in part explain the large differences in the number of patents granted by firm are: the different perception of protection on the one hand and of value on the other represented by the build up of a patent portfolio, and the importance attached to the filing for patents in the USA, not necessarily being the home base of the firm.

Firm:	Patents granted by USPTO:		
	1997	1999	2001
Alcatel	68	115	315
Cisco		45	163
Ericsson	181	657	775
Lucent	768	1152	1109
LG Electronics	110	224	245
NEC	1095	1842	1953
Nortel	64	240	461

Table 10. USPTO patents granted to equipment firms

4.5 Vertical integration-fragmentation of value-adding activities in the telecom services industry

In the USA in the 1950-1970's the model in the telecom sector was a highly integrated one: AT&T provided the nation with telecom services and designed, developed and produced the equipment for its own needs, through its subsidiary Western Electric. The equipment supply remained part of AT&T until the break-up or 'tri-vestiture' in 1996. In Europe the operators and equipment providers were distinct entities, but closely cooperating. See also the elaboration in Section 4.3. The value chain shown in Chapter 4 Figure 2 is a typically representation of the telecom sector in the days of the government controlled telecom utility.

The licensing regime in the telecom sector explains to a large extent the profile of the value chains that can be observed in the sector. Telecommunication licenses have historically been granted on the basis of technological capabilities of the underlying networks. Telephony licenses were linked to the PSTN or parts thereof, broadcasting licenses were linked to specific parts of the radio frequency spectrum. This also applied for the more recently granted licenses to cable operators and mobile telecom service providers. As a result value chains developed 'around' these licensed operators, although large systems providers would supply multiple value chains. The developments toward computer controlled systems and the process of digitization have blurred the boundaries at the equipment side between the communications technology and the information technology industries. The communications industry makes increasingly use of hardware and software platform components provided by the IT industry.

The reform process introducing privatisation and competition resulted in new governance regime for the incumbent telecom operators. Forced by a financial market regime to show year-on-year growth and facing erosion of share in traditional markets, incumbents were being forced to find growth opportunities in new markets. This pressure led to, among other, initiatives to move up in the value chain, into content provisioning.

The reform process also opened up the system for more diversity in business models, initially through the licensing of long distance or back-bone carriers and later through the introduction of a re-sale model. This resulted in a fragmentation of the once highly integrated value chain. However, without the opportunity to trade licenses the value chains remained fairly distinct. Albeit through the shared use of (parts of) the infrastructure, the value chains are highly connected.

The same financial market regime that drives the quest for growth, also forces attention to the cost structure of the firm. During the period of government induced governance, employment opportunities provided by telecom firms were considered a great good. The (financial-)market regime forced the make-or-buy decision to be revisited, resulting in the outsourcing of much of the low value-adding activities, such as installation and engineering.

4.5.1 Vertical integration-fragmentation of value-adding activities in the telecom equipment industry

From the invention of the telegraph and telephone the telecom equipment industry has developed into a highly specialized industry. The characteristics of the transmission medium used, copper cable, radio waves and later optics, required specialized (production) technology to constantly expand bandwidth capacity and the distance to be covered between repeaters. Moreover, switching equipment had to be robust on the one hand, operating at a relatively high voltage level to bridge large distances between the exchange and the customer premise,[29] and able to operate in real-time on the other hand.[30] While standard (first discrete and later integrated) electrical components were used and mechanical components mostly being procured and made-to-measure, the industry provided a high value-added content through production. The industry developed its own digital processors, specialized switches, and integrated circuits, in particular related to signal processing.[31] With the advent of digital technology and ever faster microprocessors the telecom industry was able to shift to standard IT components and software operating systems. As a consequence the value-added through direct labour dropped, as the cost of purchased components and sub-assemblies increased significantly. The improvements in the design of general purpose computer platforms, with respect to reliability and availability, made the telecom industry one of the bigger clients of the computer industry. See also Section 2.1.1 *Technological drivers*.

As described in the previous Section the once very tight relationship with the customer, the incumbent telecom operator, has been replaced by a more open, less dependent market regime. The pressure on telecom operators to optimise the business model, has provided the opportunity for the telecom equipment provider to expand its portfolio in the area of installation, engineering and systems integration. Albeit, mostly in a coordinating role as low value-adding activities tend to be executed by subcontractors.

For telecom equipment providers the ability to supply to multiple clients is essential, hence forward integration is not considered an attractive option.

4.6 Horizontal integration-fragmentation of business boundaries in the telecom services industry

Historically the communications sector has been highly segmented as the provision of services has been linked to specific infrastructures through the licensing process: the provision of telephony being linked to the PSTN, the provision of broadcast Radio and TV linked to licenses permitting the use of a specific range of

radio spectrum, and similarly for e.g. the provision of paging, trunked mobile radio, cable TV and cellular services.
The progressive digitisation of the signals carrying the different services combined with the changing licensing conditions as part of the telecom reform process are causing the business boundaries to become increasingly blurred. In Figure 19 the evolution in licensed services provisioning is illustrated.

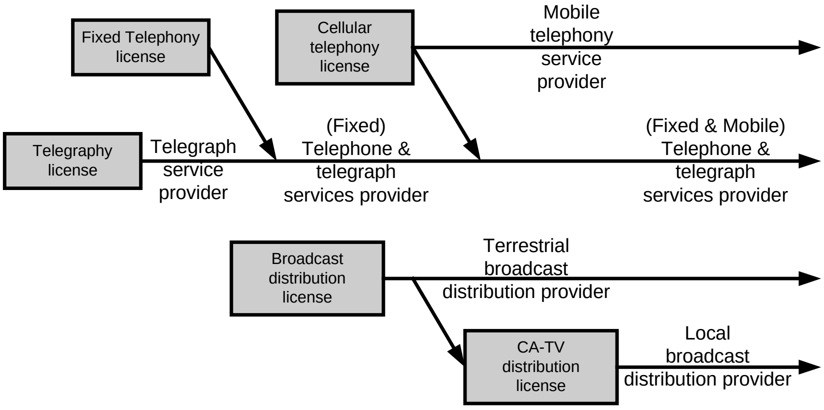


Figure 19. Evolution of licensed services

4.6.1 Horizontal integration-fragmentation of business boundaries in the telecom equipment industry

Earlier attempts of the information technology industry to penetrate the telecom industry have not been very successful.[32] The delineation between the voice communications technology industry and the data communications technology industry is starting to blur with the introduction of TCP/IP enabled services. The first step being data communication switches providing PABX-type services through Voice-over-IP.

4.7 International integration-fragmentation of segment boundaries in the telecom services industry

In the period where the telecom industry was highly vertically integrated the national boundaries were important to protect. The market for services was through legislation and by licensing a typically national affair. International coordination was taking care of cross border issues, such as radio waves not being hindered by political borders. However, the implementation of international agreements remained a national affair.
Although cross border traffic had been important from the early beginning, the governance model was one of bi-lateral settlements, not being considered international trade in the formal sense. As late as 1998 telecom services became part of the WTO agreements.
International coordination took place at the global level within the ITU, as part of the UN, where positions were addressed through government representatives. At the regional level the Administrations (the PTTs as government departments)

would come together to address topics of mutual interest, in case of Europe the CEPT. Both the ITU and CEPT played a major role in the process of telecommunication standardization, with an emphasis on facilitating international traffic flows. Ideally the transmission encoding schemes have to be the same at the sending and receiving end of a connection. Moreover, switching systems at either side of the border should be able to properly interpret the signalling information for the set-up of the connection. In the early days many national standards had evolved for signalling between telephone switches, strongly influenced by the preferences of the incumbent telecom engineers and the technical features introduced by the engineers of the equipment firm. Gradually internationally agreed standards would form the basis for these signalling systems, with an allowance for national implementation variants.

The transition from analogue cellular to digital cellular systems in Europe is a good example of a joint effort to overcome the difficulties that had been arising from fragmented markets, a result of using different standards. The GSM[33] project, which started in 1982, became to serve both the objective of the European governments to create a harmonized telecom market and the industry objective to create a well functioning regional digital cellular system, from a technical as well as from a business perspective.

Through the telecom reform process incumbents were subjected to the financial market regime and forced to show year after year growth. Being faced with erosion of the share in traditional markets, they had to find growth opportunities in new markets. This pressure led to initiatives as to move into markets across the border. Markets that before the reform process started were closed.

These initiatives involved taking a share position in foreign operators as well as starting a new entity in a foreign market to compete with the incumbent player. Albeit, foreign ownership rules do restrict ownership of incumbent firms in many countries. See for further details on ownership (OECD, 2003 p41-6).

4.7.1 International integration-fragmentation of segment boundaries in the telecom equipment industry

The close cooperation between telecom equipment providers and telecom operators made serving and developing the domestic market a number one priority for the equipment provider. To mitigate the dependency on the incumbent supplier, operators tended to allow one or a few alternative suppliers to compete, for a part of the market. These markets became highly competitive. This also applied for those national markets in which no incumbent supplier was present or dominating. The result was a dichotomy of ‘domestic and export’ markets.

Facilitated by the telecom reform process, equipment providers were able to penetrate new markets in the wake of the competitive entry of new telecom operators. Moreover, incumbent operators felt less of an obligation to grant the majority of the business to the incumbent vendor.

Table 11 shows the development of communication equipment exports in monetary terms (OECD, 2003 p245).

		Export volume in US$ millions				
From:	To:	1991	1992	1993	1994	1995
OECD	World	48,747	53,995	58,360	75,547	90,445
OECD	OECD	35,025	37,797	39,745	`50,337	60,631
OECD	Non-OECD	12,808	15,278	17,868	23,896	28,146
OECD	Unrecorded	914	920	748	1,314	1,667

Table 11. Communications equipment exports

Note to the table: Includes television receivers. Data is partial for countries that joined the OECD after 1991

5 Summary and conclusions

In this Chapter we have not directly responded to a research sub-question, but provided the necessary background on the 'development path' of the telecom sector prior to the Internet bubble, to be able to answer in Chapter 7 research sub-question #5: "What has been the impact of the internet bubble on the development path' of the telecom sector?"

Based on an exploration of the drivers and inhibitors of industry development we described and explained in this Chapter the 'development path' of the telecom sector, leading up to the bubble period, i.e. 1995. The developments have been summarized using the seven dimensions, which have been used to map the 'development path':

Industry development	**Position; direction of change**
Drivers of change; contextual drivers:	
Technology:	Continuous progress
Political/regulatory:	From public to private
Geopolitical:	-
Socio-economic:	-
Drivers of change; industry drivers:	
At the entry barrier:	High – Lowering
Substitutes:	Few – increasing
Buyer power:	Low – increasing
Supplier power:	Balanced – increasing
Rivalry:	Low – increasing
Inhibitors of change:	
Economies of scale:	High – decreasing
Industry integration:	High – decreasing
Power structures:	Important – decreasing
Risk averseness:	High – decreasing
Institutional pressure:	High – decreasing
Cognitive maps:	Stable paradigm

The resulting dimensions of the development path are:

Industry 'development path'

Demand:	Expanding
Market:	Fragmenting
Business models:	Diverging
Investments:	Expanding
Vertical value adding activities:	Fragmenting
Horizontal business boundaries:	Integrating
International geo-boundaries:	Integrating

Fundamental in the development of in the telecom sector are two paradigmatic transitions being underway:

- A paradigm shift in the governance domain: from a public regime to a private regime, and
- A paradigm shift in the technological domain: from circuit mode to packet mode, and from fixed to mobile.

The effects of these transitions and the beginning of the Internet bubble emerged about the same time.

For the policy maker, concerned with the process of telecom reform, the developments in all dimensions are pointing to an improvement of the 'conditions for market entry'.

For the strategist within the new entrant firm these improved entry conditions essentially mean increasing opportunities and increasing attractiveness to enter.
For the strategist of the incumbent firm, the same conditions imply a threat to the current position, but many changes can also be interpreted as expanding opportunities, albeit in a more competitive market.

In Table 12 the information has been summarized.

Summary of the Development path of the telecom sector – Period leading up to 1995				
		Observations and implications		
		Policy	Strategy	
Determinant	Direction	Telecom reform	Incumbent[1]	Potential entrant
Drivers of change:				
Contextual drivers:				
Technology	Continuous progress	Continuing source of renewal	Cost reduction, new products and services	Tool for entry
Political/regulatory		Progressive reform	Ending of monopoly; but access to new markets	Formal entry barriers being removed
Geopolitical		Regionalization of reform		
Economic-social				
Industry drivers:				
At the entry barrier	High - Lowering	Improving entry	Threat to profitability	Facilitating entry
Substitutes	Few - Increasing	Improving entry	Threat & opportunity	Entry opportunity
Buyer power	Low - Increasing	Improving entry	Pressure on margins	Facilitating entry
Supplier power	Balanced - Increasing	Improving entry	Increasing dependency	Increasing dependency
Rivalry	Low - Increasing	Improving entry	Erosion of market share	First mover advantage
Internal drivers:				
Multiple rights-of-way		Improving entry		
Inhibitors of change:				
Economies of scale	High - Decreasing	Restraining entry	Eroding competitive advantage	Barrier to entry
Industry integration	High - Decreasing	Improving entry	Eroding competitive advantage	Facilitating entry
Power structures	High - Decreasing	Improving entry	Eroding competitive advantage	Facilitating entry
Risk averseness	High - Decreasing	Improving entry	Requires attitude change	Facilitating entry
Institutional pressure	High - Decreasing	Improving entry	Increases business latitude	Facilitating entry
Cognitive maps	Stable paradigm	Improving entry	Competitive advantage	Opportunity
Dimensions of the path:				
Demand	Expanding	Improving entry	Growth opportunity	Facilitating entry
Market	Fragmenting	Improving entry	Threat & opportunity	Facilitating entry
Business models	Diverging	Improving entry	Requires adaptation	Increasing entry options
Investments	Flat		.	
Vertical value adding activities	Fragmenting	Improving entry	Opportunity & threat	Facilitating entry
Horizontal business boundaries	Integrating	Improving entry	Threat & opportunity	Facilitating entry
International	Integrating	Improving entry	Threat & opportunity	Increasing entry opportunities

Table 12. Summary of the development path of the telecom sector, for the period leading up to 1995

Note to the table: 1: Includes incumbent telecom and CATV operators

6 Notes for Chapter 5

[1] The limit to Moore's Law is related to the progressive difficulty of miniaturization: "In about a decade or so,… …the transistors will get so small that they will become quantum-mechanical and thus begin making mistakes." (Laughlin, 2005).
[2] Authors observation when engaged at Lucent Technologies.
[3] The telephone instrument has been emerging on different continents in the same period of time, i.e. in Germany by Philip Reis, see (Klein, 1977)
[4] Part of the agreement was that AT&T was allowed to enter into the computer business and to expand oversees. Subsequently it entered into a JV with the public telecommunications division of Philips in 1984 and acquired NCR in 1993.
[5] Additional directives were issued on: satellite communications and broadcasting, Pan European cellular communications.
[6] "This pattern was firmly established in 1880, when the American Bell Telephone Company purchased Western Union's telephone supplying subsidiary Western Electric Company of Chicago. According to an 1882 agreement, American Bell restricted itself to purchasing all its telephone equipment from Western Electric, while the latter agreed to limit its activities to supplying American Bell and its licensees." (Fransman, 1995). Other examples are: Deutsche Telecom and Siemens, British Telecom (formerly BPO) and Plessey/GEC, France Telecom and Alcatel (formerly ITT c.s.)
[7] E.g. Iridium and Globalstar.
[8] Consider for instance INTUG, the international telecommunications user group, and national equivalents, such as the BTG in The Netherlands.
[9] Includes telecommunications equipment and services, and postal services. Index exclusive of Hungary, Norway, Slovak Republic, Switzerland and Turkey.
[10] Independent from AT&T or the 'Bell System'.
[11] In the late 1980s the major switching systems suppliers included: Alcatel, AT&T, Ericsson, NEC, Northern Telecom, Siemens. The major transmission systems suppliers include: the afore mentioned companies and e.g. Marconi, Pirelli, ECI.
[12] The PSTN is based on individual connections from the user to the switch providing the full available bandwidth of the connection to each user at any point in time, provided the call set-up has been successful.
[13] Examples are: token ring, token bus, Ethernet.
[14] The impact of the shift in paradigm is most pronounced at the switching level. The transmission level is essentially transparent, albeit the new developments of Ethernet-over-Fiber make the multiplexing structure based on voice modularity redundant.
[15] The four layer model introduced by Williamson was intended as a static model for comparative analysis. The application of the model in different environments would imply the use of a so called 'shift parameter'.
[16] Considering the period under study we will not address the telegraph services that preceded the telephony service.
[17] Consider in this respect the need for extending the numbering or addressing range of communicating entities, well beyond the originally perceived design boundaries. See for instance the need to introduce IPv6 to meet the fast expanding needs in the Internet.
[18] A third design parameter is related to the level of blocking or congestion of calls in the network.
[19] The 64 kb/s encoding scheme follows from an 8 bit encoding of the amplitude and an 125μs sampling rate a standard that was settled in the early days of digital transmission. Advances in coding techniques have resulted in good quality communications at much lower bit rates, as for instance used in digital mobile communications.

[20] Recognizing that in general there will be at any point in time one speaker and one listener involved in a call, compressions systems have been developed to reduce the required bandwidth, in particular on (expensive) long distance connections.
[21] The bandwidth need is in part determined by the so-called overhead of the communications protocol. This overhead is in part determined by the quality of communication being pursued.
[22] There are also systems that employ a variable length packet structure.
[23] We ignore here the equipment purchases that are expensed, such as consumables.
[24] A typical example was Germany.
[25] Also denoted as 'mode of organization' or 'organizational arrangement', see (Ménard, 2003).
[26] In the Dutch context: Gemeenschappelijke Antenne Inrichtingen (GAI) which were exploited by housing corporations. These systems became linked and grew into Centrale Antenne Inrichtingen (CAI) (Dake and Boers, 1999).
[27] In Germany Deutsche Telecom became the main operator of cable distribution networks.
[28] In the case of PTT-Netherlands and Philips even royalties were paid by the equipment supplier to the operator.
[29] Typically 48V feed, with the ringing current inducing even higher voltages. As a part of the equipment is outdoor and the indoor equipment connected through outdoor cables, special precautions are required to protect against lightning strikes.
[30] In the early signaling systems, e.g. rotary dial or tone pulse at the access side, the information had to be received, recognized and processed in real-time, or otherwise the information would simply be lost and the connection would fail.
[31] As mentioned before the telecom industry provided us for instance with the transistor and the laser.
[32] For instance the attempt by IBM in the 1980's in the field of electronic PABX-es.
[33] GSM originally Groupe Spéciale Mobile, a working party within CEPT, later to be know as Global System for Mobile Communications.

6

The Internet bubble explained

An application of the stylized models of euphoria

Table of Contents

1 Introduction

Explaining the Internet bubble in the aftermath offers the opportunity for an *a-posteriori* analysis. On the other hand the stylized models of euphoria derived in the previous Chapters do suggest an *a-priori* reasoning. Henceforth a combination of the two will be used. Through an *a-posteriori* analysis an approximate delineation of the so-called Internet bubble will be made; roughly determining the timing of the various phases and identifying the major sector(s) in which the expansion took place. This analysis will show the Technology, Media and Telecommunications (TMT) sector to be central in this bubble. In Section 2 the Internet bubble will be explained using the stylized causal model as derived in Chapter 3, and in Section 2.3.1 we will explore in more detail why this bubble has become known as the Internet bubble and also as the Telecom bubble. In Section 3 the Internet bubble will be placed in the broader context of technological revolutions using the stylized model of Great Surges derived in Chapter 3. It is the model of technological revolutions, or Great Surges, that identifies a major bubble as an integral part of each period of ‘frenzy’, and links it to the development of a set of new technologies and related industries. The stylized model of euphoria, based on the Minsky instability hypothesis, is providing the more specific insights in the actuality of the bubble, the displacement as the trigger mechanism and the positive feedback loops and precipitating factors as the major contributors to its development. The two models are linked through (1) the notion that innovation and new technologies are typical sources of speculation, and (2) the timing of the bubble. This makes the two approaches complementary in their explanatory powers, and as such they are used in this Chapter to explain the Internet bubble.

1.1 Declaring the bubble

In hindsight periods of euphoria can be identified with ease. However, identification of asset price bubbles *ex-ante* has been a topic of much debate in particular in relation to the Internet bubble (see e.g.: Hunter, Kaufman et al., 2003). The question is when does a booming period become a bubble. Asset price developments are a first indicator. Figure 1 shows asset price increases for a number of observed peaks in the stock market (Kroszner, 2003 p6). The next step in the identification process would be to look at a deviation from ‘fundamentals’. However, if one of the fundamentals suggests an improvement, such as the non-farm productivity improvement during the recent boom, the issue becomes complicated.[1] See Figure 2 (Kroszner, 2003 p7). If the improvement is potentially structural, the economy could be on a trajectory towards a higher performance level. A development that few would wish to interrupt. While Greenspan, Chairman of the Federal Reserve, acknowledged the potentiality of a bubble developing in his 1997 speech, which became known as the ‘Irrational exuberance’ speech, he would argue in 1998 that the ‘virtues cycle’ of the new economy proved the US economy to be unexpectedly robust, with GDP climbing at an annualized rate of 5.5 percent, despite the set back of the East Asian economies and hence a negative impact on US exports. As Brenner points out, Greenspan failed to observe that while TMT stocks had risen 126% during the period March 1995 and

June-July 1998, earnings had only risen 22%. During the previous year there had been a 41% increase in stocks, and "…earnings had failed to rise at all." (Brenner, 2002 p177-8).

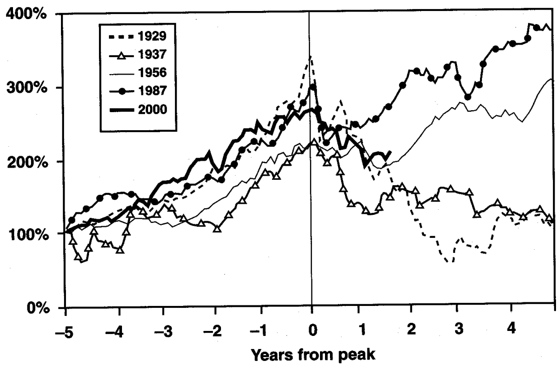


Figure 1. S&P 500: Five years before and after local peak

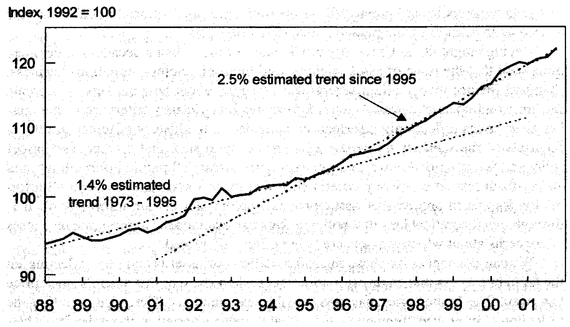


Figure 2. Nonfarm labor productivity, USA 1988-2001

As the purpose of our research project is an *ex-post* explanation of the Internet bubble, we will not pursue this issue of predicting bubbles any further.
Using as the definition for a bubble "any deviation from fundamentals", or deviation in the trend lines of financial metrics, there is ample evidence for a bubble to be declared. A few data samples to illustrate the point:

- Historical high rise in stock values followed by an even faster decline, see Figure 3 (MarketWatch, 2006),
- Significant stock market appreciation, while corporate profits level off, see Figure 4 (Brenner, 2002)[2],
- The valuation of 'click & order' companies in comparison to their 'brick & mortar' equivalents, see Figure 5 (Lucent Technologies, 2005).

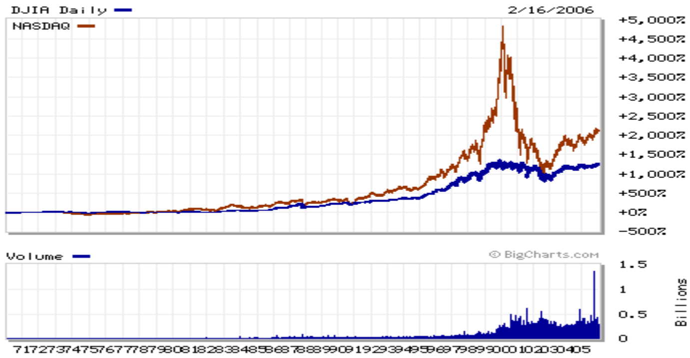


Figure 3. Historical development of the DJIA and the Nasdaq, 1971-2003

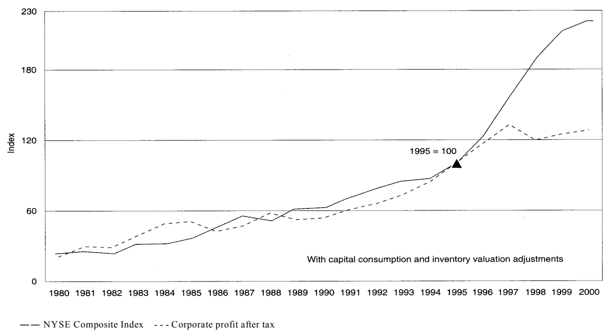


Figure 4. Index Corporate Profits in relation to NYSE Composite Index, 1980-2000

Bricks & Mortar	Market Cap (1/00)	Clicks & Orders	Market Cap (1/00)
BARNES & NOBLE	$1.5B	amazon.com	$22.4B
TOYSRUS.COM	$2.8B	eToys	$2.6B
SOTHEBYS International Realty	$1.6B	ebay	$18.2B
AmericanAirlines	$8.8B	priceline.com	$8.7B
TIME WARNER	$110.8B	AOL.COM	$142.0B
No One???		YAHOO!	$94.2B

Figure 5. Valuations of brick & mortar companies in comparison with click & order equivalents, January 2000

- Another indicator illustrating the growth of paper wealth in relation to real output, based on the creation of goods and services, is the ratio of market capitalization to GDP. For non-financial corporations this ratio grew from 0.9 in 1980 to 1.3 in 1994, to reach 3 early in 2000. This compares to 1.7 in 1968 as the highest level reached in the post-war period (Brenner, 2002 p 182),
- Tobin's *q* is another such 'fundamental', which measures the ratio between company valuations in terms of equity and the cost to replace its plant and equipment and financial capital. Starting at 0.46 in 1986 it reached 1.14 in 1995, to rise to an all time high of 2.06 early in 2000 (p 182-4).

1.2 Exploring the high-tech nature of the recent euphoria

As euphoria are predominantly a financially driven phenomenon, the first step at delineation is taken through an investigation of developments in the stock markets. By way of introduction, Figure 6 shows the development of the Dow Jones Industrial Average (DJIA) and the Nasdaq since the early 1970's. While the stock market crash in 1987 is still vivid in memory, it is dwarfed by the recent boom and bust. These stock market developments should be considered against the general economic development in the USA, which shows an increase in GDP from US$1.588 bln in 1975 to $ 7.342 bln in 1995 and $ 10,208 bln in 2001 (ITU, 2002b; OECD, 2005).
A further exploration of the US stock market shows the role of technology stocks, which have significantly outperformed even the Nasdaq, see Figure 6 (Financial Times, 2003). This applies also to the Internet related stocks.

Figure 6. Technology Index in relation to the DJIA and the Nasdaq, 1994-2003

Figure 7 shows the Internet Industry Index, established in 1996, in relation to the DJIA and the Nasdaq for the period 1994-2003 (Financial Times, 2003). It shows that Internet related companies, as reflected in the index[3], have significantly outperformed the Nasdaq. A further evaluation of the various Industry Indices shows the overall high-tech nature of the bubble.

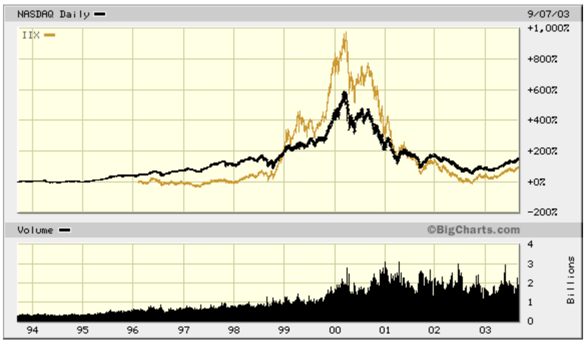


Figure 7. The Internet Index in relation to the Nasdaq and the DJIA, 1994-2003

Taking 1994 as the reference point for comparison, the Technology Index and the Nasdaq are almost 'congruent', with the Technology Index at roughly twice the Nasdaq valuation, see Figure 6. A striking similarity in movement is also apparent in the Wireless Communication Index as shown in Figure 8 (Financial Times, 2003). This would suggest the euphoria is not necessarily restricted to one sector, but part of a broader market movement. Clearly contagion has taken place. The notion that technology is a natural object of speculation is supported by observations by Chancellor (1999 p 122) claiming that: "Inventions and novelties have always excited speculators. The diving machine, fire engine, and burglar alarm companies in the 1690s, and the machine gun and "wheel of perpetual motion" in 1720, are all early examples of speculator's enthusiasm for technological advances." The hypothesis of a high-tech bubble is further supported by the performance of the Semi-conductor Industry Index, as shown in Figure 9 (Financial Times, 2003). Its staggering performance, a rise to 1400% from 1994 compared to the rise of the Nasdaq with 600%, suggest a 'feeding' of multiple sectors subject to great expansion, which includes the TMT-sector, the technology, the media and the telecommunications sectors.

Figure 8. Wireless Communication Industry Index in relation to the Nasdaq and DJIA, 1994-2003

Figure 9. Semi-conductor Industry Index in relation to the Nasdaq and DJIA, 1994-2003

This data is a sharp contrast with the much less pronounced development of the Telecommunication Industry Index, see Figure 10 (Financial Times, 2003). This can be explained by the composition of the index, which includes the major telecom services operators and hence does not reflect the frenzy of new entrants (e.g. the CLEC crisis), or the investment craze in optical networks by Pan-European operators, or the emergence of ISPs that have occurred in this period.

Figure 10. Telecommunications Index in relation to DJIA and Nasdaq, 1994-2003

1.3 Delineating the bubble period

Using the Technology and Internet Indices as the leading indicators, the start of the bubble period can be defined as the moment of trend increase, beginning in early 1998, and to end in the fall of 2002 as the index starts to rise again. The Technology Index suggests that the expansion period already starts in 1995. The Telecommunications Index shows a clear trend increase starting in 1997 and it reaches its current low in the fall of 2002.

Considering the economy at large, Kindleberger points to the possible relation of the boom and the bust with the final upswing and the initial downturn of the business cycle (Kindleberger, 2000 p 13). In using the data provided by Brenner

(2002 p 140) and applying the definition for a bubble as "any deviation from fundamentals", one can conclude that the expansion period already started in 1995 with the widening of the gap between corporate profits and share values. See also Figure 4. The same data suggests the speculative period to start from 1997, when the growth in profit stagnates while the Index continues its growth trajectory.
Additionally the statistics on trading volume, both at the Nasdaq and the DJIA, show a significant increase in the fall of 1999, see Figure 6. This could signify an acceleration in the speculative period. However, the data also shows that the trading volume, on average, increases to a level roughly twice the volume before the bubble period. This may suggest a structural change in the financial industry.
The data reviewed thus far, primarily related to the US market, suggest that the boom period starts in 1995, that it accelerates in 1997 and receives another boost in the fall of 1999. So the question than is what has caused the changes in outlook around 1995. This question will be explored in the following paragraphs.

2 Application of the stylized model of euphoria

In this Section the Internet bubble will be explained using the stylized model of euphoria as described in Chapter 2. That means first of all a search for the displacement factor, then the identification of the processes with positive feedback, in particular the expansion of credit and the financial leverage, followed by the identification of the precipitating factors. In the explanation we will follow the 'sequence of events' and subsequently investigate in more detail the operating principle.

2.1 Displacement

What was the cause or trigger for the euphoria? What was the displacement that set of the speculative period? Was it a single cause and a single sector in which the euphoria started, was it possibly a combination of events or even an event affecting the economy at large? The magnitude of the bubble could suggest a convolution of factors being at work.[4] Did the euphoria start in the USA and was Europe affected through contagion, or were there displacements particular to Europe that caused euphoria to happen?
Based on a review of literature in relation to significant events in the period, the following candidates for displacement have been identified:

1. the Internet, in particular the Netscape IPO,
2. the privatisation of telecom operators in Europe,
3. the final steps of telecommunications reform in the USA and Europe to open up the last entry barrier, i.e. local loop access,
4. the launch of GSM in Europe,

and considering the financial nature of bubbles another candidate is:

5. the change in exchange rate policy by the US government, the "Reverse Plaza Accord".

In the following Sections we will review the displacement candidates in detail.

2.1.1 The Internet

The recent euphoria is often denoted as the Internet bubble, but the Internet has had a long genesis and with its origin in US universities it was far remote from any speculative environment (Abbate, 1999). Although, one might denote the original unconstraint research funding provided by the US government to the Advanced Research Projects Agency (ARPA) as speculative. ARPA's efforts to link computers through packet switching in 1969 is generally considered as the start of what is now called the Internet, this term to be introduced in 1984 (Slater, 2002)[5]. Three major events have been instrumental for the Internet to develop towards its current day popularity:

- the creation of the TCP/IP protocol in 1972 under the personal leadership of Cerf, to be used universally across the Internet for information exchange,
- the creation of the world-wide-web using the principle of hypertext developed in 1989 by Berners-Lee, the application (html) that would unlock information stored in computers on a world wide basis, and
- the introduction of the first popular browser Mosaic by Andreesen in 1993 (Cassidy, 2002 p9-24).
- The transition of the Internet in 1995 from the research and educational domain to the private domain.

It should be noted that fundamental to the development of the Internet has been the popularisation of computing through the invention of the microprocessor in 1971 and the introduction of the PC, notably the Apple in 1977, followed by the IBM PC in 1981. (Ceruzzi, 1998). These developments point to the high-tech nature of the euphoria and hence to the basis for the 'natural' interest of speculators, as identified by Chancellor (1999 p 122).

From 1972 the ARPANET and later the NSFNET formed the backbone network of what would become the Internet. These networks had been run on behalf of the US government to connect regional networks and supercomputer sites for research and education purposes only.[6] See Figure 11 for the 1989 backbone configuration (Abbate, 1999 p193).[7]

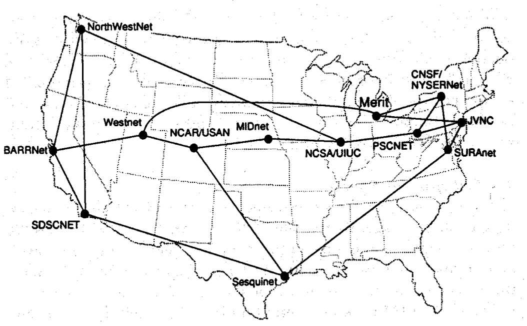


Figure 11. The NSFNET in 1989

In 1989 Performance Systems International (later PSINet) was established, as a 'spin-off' of one of the regional research networks, and started to provide TCP/IP network services to business customers. This was soon followed by other 'regional operators' and long-distance operators, such as AT&T, MCI and Sprint (Abbate, 1999 p197-8). In 1991 PSINet, CERFNet and Alternet joined to create the non-profit organisation Commercial Internet Exchange (CIX), to connect their networks through gateways. The operation was financed through a membership fee, and traffic from any other member network was handled free of charge (p198). RIPE, established in 1989, provided a similar function in Europe (p211).[8] Many networks subsequently joined the CIX and RIPE, and thus a commercial alternative backbone network was formed, on a worldwide basis. In 1994 the implementation of a new very-high-speed Backbone Network Service was being implemented to replace the NSFNET for scientific purposes. This network was connected to the commercial backbone through gateways, which were operated on a contractual basis by four commercial ISPs.

In 1995 the NSFNET backbone, that connected by that time to 22,000 international networks, was retired and the Internet 'transitioned' from the public to the private sector:

> "Commercial on-line services could now offer Internet connections, and the computer industry rushed into the Internet market with an array of new software products and services… …As a flood of new users joined the network, the Internet suddenly became the focus of new social issues involving personal privacy, intellectual property, censorship, and indecency. At the same time, network users created a whole new set of applications (for example, the role-playing games known as "multi-user dungeons") to fulfil their desires for entertainment, social interaction, and self-expression. The Internet became a topic of public discussion, and ordinary people began to debate the advantages and pitfalls of "going on-line." (Abbate, 1999 p199-200).[9]

However, what has captured the imagination of the public at large, and the financial industry in particular, has been the initial public offering (IPO) of Netscape on August 9, 1995. Within one year from its introduction the Netscape Navigator had become the most popular browser, with 5 million users and 60% market share. This popularity was reflected in the development of its stock price. Morgan Stanley had priced the shares of the start-up at US$ 28, but demand was so high that the listing opened at $71 and the company was worth $ 4.4 billion by the end of the first day of trading (Quittner and Slatalla, 1998 p 12). Netscape's founders James Clark and Marc Andreesen became overnight millionaires, with resp. $ 583 mln and $ 59 mln. While preceded by e.g. the IPOs of Cisco and the Internet Service Provider (ISP) Netcom, a string of IPOs followed in the period 1995-1997. Some of the major IPOs were: PSINet, UUNet, Yahoo!, Lucent Technologies, E*trade, Ebay, @Home and Amazon.com. IPOs had been recognized as a major means of financial leverage and it has been one of the major drivers of expansion of the recent bubble, see for an illustration Figure 12 (Brenner, 2002 p 197). While the IPO proceeds are significant, it is probably the notion of personal wealth accrued by the founders of these start-ups that has captured the imagination of many onlooker. 1995 was also the year in which Bill Gates issued the "Internet tidal wave" memo in which Microsoft recognized the importance of the Internet, and which marked the adaptation of its systems to the Net (Fransman, 2001 p37).

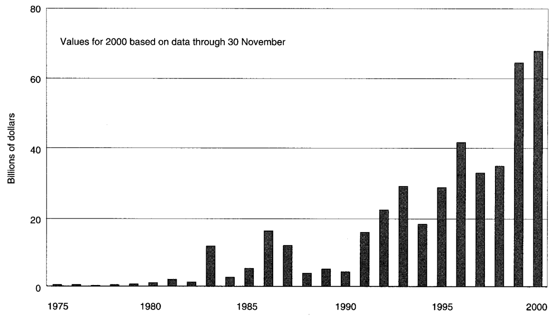


Figure 12. Gross proceeds of initial public offerings, 1975-2000

The Netscape's IPO made the Internet a focal point of the bubble, but should this IPO be considered the outside event that changed expectations? In and around 1995 more was happening.

2.1.2 Telecom privatisation in Europe

Another candidate that could be considered a 'displacement' is the privatisation of telecom operators as part of the ongoing liberalization process and particular in Europe. While the liberalization has started much earlier with the introduction of competition in the terminal market and in the international telephony services market, and to include national long distance services in the USA, it has been the privatisation of the telecom operators that introduced a new element into the game, i.e. 'the telco as object of trade'. An important notion considering the financial nature of euphoria.

Privatisation implied the state to relinquish, albeit gradually, its holding of the national telecom operator through either an IPO and/or the transfer of ownership to a so-called strategic partner. Telecom regulators considered privatisation of the incumbent operator to be essential for an effective liberalization process. Competition and the forces of the capital market were to provide the drivers necessary to provide the users with choice, low price and high quality services. While in the USA the incumbent operators had been private companies, albeit operating under a stringent regulatory regime, in Europe incumbent operators were by and large state owned enterprises. The EU Green Paper on Telecommunication liberalization issued in 1987 had set out the direction of the liberalization and privatisation process (European Commission, 1987). The privatisation of British Telecom Plc preceded this event, many others followed, see Chapter 5 Table 4.

2.1.3 Final step of telecom reform, opening up the local loop

While privatisation of the incumbent telecom operators was considered an essential step in the reform process, the removal of formal barriers to entry allowed competition to emerge.

In the USA competition in the telecommunications services market started with the approval of MCI as competitor to AT&T in 1969, followed by the divestiture of AT&T

in 1984 and the adoption of the Telecom Act of 1996, which had as the primary objective to stimulate competition in the local access. On the road toward adoption of the Act expectations mounted significantly, leading to e.g. a frenzy of entrants in the local access area, the so called Competitive Local Exchange Carriers (CLECs). In Europe competition was first introduced in 1991 through a duopoly of British Telecom and Cable & Wireless. A few other countries followed, but broad market entry occurred only following the EU Directive on full liberalization of 1996, to be effective Jan 1998. See Figure 13 (OECD, 2005 p22).

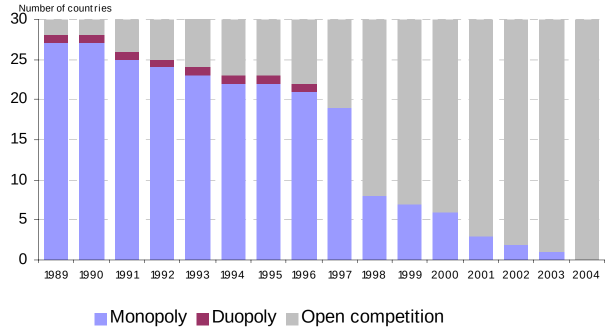


Figure 13. Competition in fixed networks, 1989-2004

While the telecommunications business had traditionally been highly profitable, competition had put margins under pressure, as illustrated in Figure 14 showing the return on sales for West-European operators, derived from the ITU World Telecommunications Statistics (ITU, 2002b).

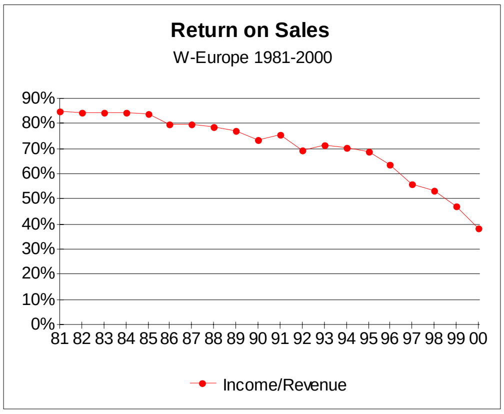


Figure 14. Return-on-Sales for West European telecom services operators, 1981-2000

Still many entrepreneurs believed there was ample opportunity to compete successfully with the incumbent operators, which were considered slow in responding to new market opportunities and inefficient in their operations. As an illustration Table 1 shows the telecom operators in the Netherlands at the peak of the euphoria in 2000 and in 2003. The information is derived from the information included in the telecom operator database maintained by Analysys (2003)[10].

Year	Fixed Network operator	Cellular network operator	Incumbent operator	Alt network operator	Int network operator	Satellite services provider	National network operator	Regional network operator
2000	50	5	1	32	3	4	14	1
2003	34	5	1	22	2	3	11	1
Year	Internet backbone provider	Cable operator	Fixed wireless operator	MAN operator	Light carrier	Local access operator	ISP	Total entries
2000	19	6	2	4	4	18		81
2003	13	6	2	3	2	14	45	62

Table 1. Telecommunications operators in the Netherlands 1995-2003

2.1.4 Digital mobile communications - GSM

While the fixed network traditionally had been in the hands of a (state-)monopoly to be prised open for competition through new legislation, competition in the mobile networks was introduced gradually through the spectrum licensing process. Cellular networks had been built since the late 1970's and early 1980's. These first analogue networks were typically owned by the incumbent operators. The introduction of competition in a growing market being much more feasible, second cellular operators were introduced in the late 1980's and early 1990's. See also Table 2 for an overview of the liberalization of the mobile communications market in Europe (Boyland, 2000 p28).

Country	**Year of liberalization mobile**
United Kingdom	1984
Sweden	1986
France	1989
Germany	1991
Portugal	1991
Denmark	<1992
Finland	<1992
Norway	1992
Greece	1993
Italy	1994
Spain	1994
Netherlands	1995
Austria	1995/96
Belgium	1996
Switzerland	1998

Table 2. Liberalization of the mobile telecom market in Europe

The architecting of the GSM standard in Europe, which started in 1982 under the auspices of the CEPT (Conférence des Administrations Européennes des Postes et Télécommunications), led to a successfully service launch in 1992. That year Telstra, the Australian operator, was the first non-European Administration to sign the GSM Memorandum of Understanding (MoU). In 1995 the MoU was formally registered as an Association in Switzerland. It had 156 members serving 12 million customers in 86 countries. The same year saw the completion of the GSM Phase 2 standardisation and a demonstration of fax, video and data communication via GSM. In November 1995 American Personal Communications launched the first commercial GSM service in the USA (GSM Association, 2004). In 1995 the adoption of mobile communications accelerated significantly, see Figure 15, derived from the ITU World telecommunications statistics (ITU, 2002b).

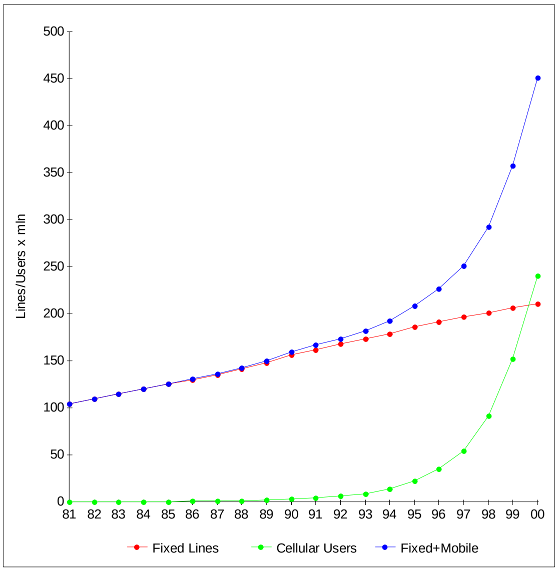


Figure 15. Adoption of mobile services in Western Europe

2.1.5 US Exchange rate policy

A more fundamental trigger may be found outside the telecom sector or the Internet, in the economy at large. Kindleberger already linked the boom and the bust to the business cycle. In his analysis of the US boom and bubble, Brenner provides the underpinning for this linkage (Brenner, 2002). In the analysis of the US economy his starting point is the long downturn beginning in the early 1970's, which followed the post-war boom. The economic expansion in the post-war period was "the ability of the advanced capitalist economies to achieve and to sustain high rates of profit. High rates of profit were fundamental above all because they enabled these economies to generate a relatively large surplus… …for these economies to maintain high rates of investment and thereby the rapid growth of productivity, permitting in turn the accommodation of rapid real wage growth…" (Brenner, 2002 p 9).

The main cause for the persistence of stagnation in the period after 1970 is considered to be the endemic over-capacity in (export-oriented) manufacturing. Recovery of the manufacturing sector in the US started in 1985 facilitated by a deep fall of the dollar, a long period without real wage growth and reduced corporate tax rates since 1981: "[T]he US manufacturing sector, from the latter part of 1993, entered into a period of prosperity and growth…" (p 49). And largely through the recovery of the manufacturing sector, the non-manufacturing part of the economy improved along with it (p 92). Also the financial sector recovered rapidly from the troubled 1980's. Loan demand grew, loan losses plummeted and "the Fed ensured that the gap between what the banks paid for their short-term borrowing and what they received for their long-term lending remained 'unusually wide'." "With the real economy on a firmer footing, the financial sector could finally exploit deregulation, as well as unstinting government subsidy and support." (p 89&92). However, by April 1995 the yen had reached an all-time high, a point where Japanese producers could not even cover their variable costs. The prospect of a Japanese crisis, that would "probably entail the large-scale liquidation of Japan's enormous holdings of US assets, especially Treasury Bonds" could not be ignored by the US government (p 130-1). Henceforth, the US government stopped the campaign to further prise open the Japanese market and entered into arrangements with the Japanese and German governments to bring down the yen through lowering Japanese interest rates and enlarging Japanese purchases of dollar-denominated instruments and the purchase of dollars by the German and Japanese government. In return the US relinquished the revival of the manufacturing sector and obtained the prospect of a huge inflow of investment funds and a flood of cheap imports.

2.1.6 Conclusion

Using the definition of 'displacement' as 'changing the horizons, the expectations, the profit opportunities and the behaviour in the sector', all sector related items are qualifying, albeit to a varying degree. Recognizing the financial nature of euphoria, I would identify these factors in combination with the distinct change in US government exchange rate policy, which became known as the "reverse Plaza Accord of 1995"[11], and which would affect the economy at large, as the 'displacement-combination' that, according to the Minsky model, gave rise to the euphoria at the turn of the last century. The inflow of funds that the Accord triggered links directly to the financial nature of euphoria and the expansion of credits. The liberalisation, the privatisation and the removal of formal barriers to entry in the telecommunications services market provided the perfect setting for a bubble to develop in this particular sector. The advances in information and communications technologies, in particular the prospects of the Internet, provided the opportunity and the means for investors and speculators. In Europe the 'positive outlook' would initially be related to the success of digital cellular communications. In the US this would be the development of the Internet. The Netscape IPO can be considered the 'public' landmark signifying the start of what became known as the Internet bubble.

In the words of Brenner: “The take-off of the stock market run-up is routinely linked to the stunning returns to Netscape’s initial public offering at the start of August 1995, which was taken to be indicative of the enormous promise of the New Economy in general, and information technology in particular. But it is probably more validly attributed to the sudden easing of financial conditions and run-up of the dollar, which occurred at almost precisely the same time, in the wake of the reverse Plaza Accord. Hitherto the growth of equity prices was basically driven by the growth of profits. Henceforth, it would take on a life of its own.” (Brenner, 2002 p142). The USA is thereby identified as the origin of the Internet bubble.

2.1.7 A sequence of related bubbles

As the story of the recent euphoria unfolds in this Chapter, it will become apparent that there has not been just one bubble, but a sequence of related bubbles. What started in 1995 as euphoria around the Internet, and led to the dot.com mania, profoundly affected, through direct contagion, the telecom sector. A sector that provides the connectivity for the Internet to operate. On the other hand, the opening up of the sector to competition in local access in 1996/1998 provided for a sector specific ‘displacement’. The removal of formal barriers to entry, enabled by new technologies combined with the expectation of demand growth linked to the Internet, led to the development of the Telecom bubble. Furthermore, the Telecom bubble is not a singular event of euphuism, but developed in a series of linked bubbles. First in the transmission backbone, and secondly in the access part of the network. In the first case optical technology plays an important role, in the second it is digital subscriber line technology followed by fixed wireless technology. In each of these arena’s the spending binge of the operators triggered the development of a bubble in the equipment sector, which was followed by a bubble at the level of the component industry.

In this research we will use the notion of the Internet bubble to denote the overall euphoric period, and refer to the telecom bubble if we discuss this sector specifically.

2.2 Expansion and speculation phases

Following the ‘stylized model of euphoria’ outlined in Chapter 2 we will explore in the following Sections the development of the Internet bubble during the various phases. This Section will focus on the expansion and speculation phases.

2.2.1 Monetary expansion and positive feedback

As the stylized model of euphoria suggested, monetary expansion is the most important driver for a boom to develop. From the account by Brenner (2002) the following factors driving monetary expansion during the recent bubble can be derived:

- A US policy shift away from supporting the manufacturing sector to the benefit of the financial sector,
- The ample availability of liquidity and credit,
- Through a shift from savings to spending and borrowing,
- The role of real interest rates.

Factors identified that are driving monetary expansion which have a positive feedback effect are:

- IPO based financing and Venture Capital,
- The wealth effect,
- The management of the volume of tradable shares to influence share prices.

In the following Sections these factors will be addressed in further detail.

2.2.1.1 Government support shifting from the manufacturing to the financial sector

As a result of the Plaza Accord of 1985, which was aimed at rescuing the US manufacturing sector, this sector benefited between 1986 and 1995 from export growth on the basis of a falling dollar and a holding down of wage growth and later through investment growth and productivity growth (Brenner, 2002 p127). In 1996-97 the upward momentum of the US manufacturing sector continued with investments at a rate of 9.5% per year, an increase in labour productivity of 3.2 % and real compensation growth at –0.8%. However, to cope with an appreciating dollar at 6% per year, as a result of the Reverse Plaza Accord, export prices declined with 2.6%. As a result the manufacturing profits remained flat. At the same time the non-manufacturing sector, largely immune to international competition, was able to offset increase in costs by a raise in prices and improving profits by 17% between 1995 and 1997 (p135-7). From 1998 the manufacturing rate would be falling sharply (p130).
On the basis of the broad economic recovery the health of the financial sector improved significantly. Loan demand grew rapidly and capitalization of assets improved. The banks were able to exploit the earlier deregulation of the sector.[12] And as mentioned earlier, the "…Fed ensured that the gap between what the banks paid for their short-term borrowing and what they received for their long-term lending remained 'unusually wide' " (p81-9).

2.2.1.2 Growing availability of liquidity and credit

Since the early 1980's the US stock exchange had been ascending, to be interrupted by the crash of 1987. Through the intervention of the Fed, and the support of the Japanese authorities, investor's confidence was restored. There was a further mini-crash in 1990, at which time the Fed brought down the real interest rates from 5% to near zero to rescue debt-burdened corporations and failing banks. And according to Brenner: "The groundwork was thus laid for a huge expansion of liquidity." (Brenner, 2002 p138). The rise of the dollar, triggered by the "reverse Plaza Accord" increased the value of US assets for non-US investors. Moreover, the lowering of the Japanese discount rate to 0.5% "had the effect of pumping up the global supply of credit, as a major portion of the increase of Japanese liquidity leaked out of Japan… through a very profitable 'carry trade' " (p139). This liquidity moved into the 'emerging markets' and into the US stock market. In 1995 the 'Rest of the World' bought US government securities worth $197 bln, two and a half times the average of the previous years. Followed by $ 312 bln in 1996 and $190 bln in 1997. This not only covered new US government debt, but also $266 bln previously held by US citizens (p141). These purchases forced down long term interest rates by close to 25%, with a parallel acceleration of the money supply, see Figure 16 (p 143).

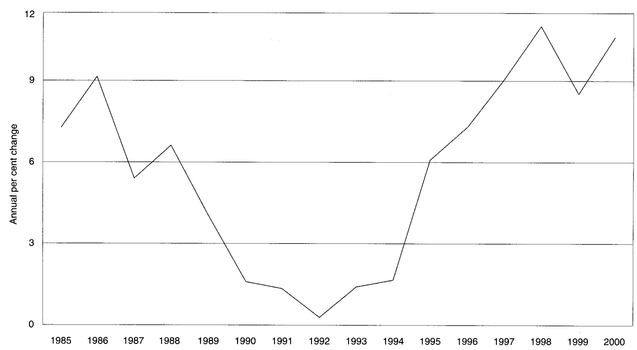


Figure 16. Growth of the US money supply (M3) 1985-2000

To the growth of available liquidity and credit can be added company stocks as payment instrument. The fast appreciation of stock values made stocks highly valuable in particular in the process of acquisitions.

2.2.1.3 IPO based financing and Venture Capital

The proceeds of Initial Public Offerings (IPOs) are an important source of financing for start-up firms that have played a major role in the unfolding of the Internet bubble. The tally based on the data base compiled by Cassidy on 'dot.com'[13] related IPOs shows a dramatic increase over the years, from 2 in 1992 to 249 in 1999[14]. See also Figure 17 (Cassidy, 2002 p370-85).

From an average of US$3 bln. per annum for the period 1980-1994, the gross proceeds jump to $30 bln. for the period 1994-1998 and $60 bln. for the following two years. See Figure 12 (Brenner, 2002 p195, 197). The IPO yields and especially the first-day returns made IPOs a special feature or incentive of the recent euphoria, as "[u]nderwriters reserved Internet IPOs for their most favored clients. Other investors had to wait until trading started on the open market before they could buy any stock." (Cassidy, 2002 p2). See also Figure 18 (US Government, 2001 p110). According to an investment analyst in 1999 quoted by Cassidy: "It doesn't matter what these companies do or how they are priced, each new Internet IPO is nothing more than red meat to the mad dogs." (Cassidy, 2002 p3). The success of the Internet related dot.com IPOs also triggered a wave of emerging telecom operator IPOs. According to Endlich, in 1996 US$ 6.6 bln was raised in public capital for emerging carriers; in 1997 $ 8.2 bln and in 1999 it had exploded to $ 82.2 bln (Endlich, 2004 p86).

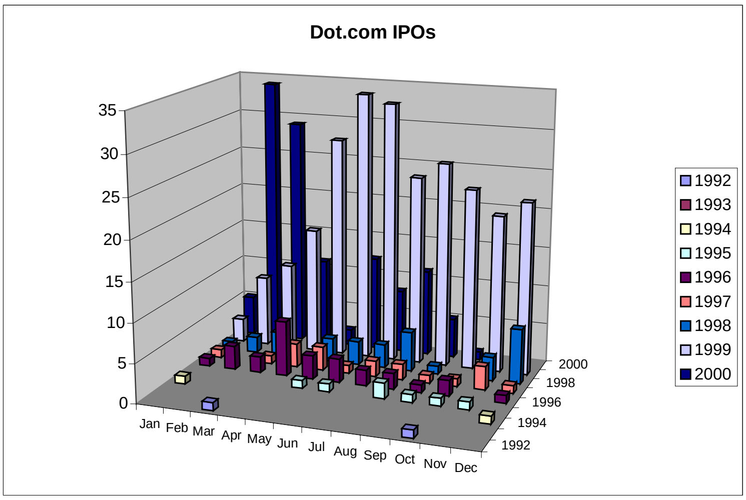


Figure 17. Dot.com IPOs in the USA

This was followed by a wave of network equipment company IPOs in 1999.[15] These were start-up companies in the field of optical transmission and switching, and in packet access systems, switching and routing. They all were providing essential technologies for the Internet to grow and were acquisition targets of the major players in the telecom industry. See Section 2.3.1. The final IPO wave was related to component suppliers to this segment of the industry. See also Annex 2 *Time line of events*.

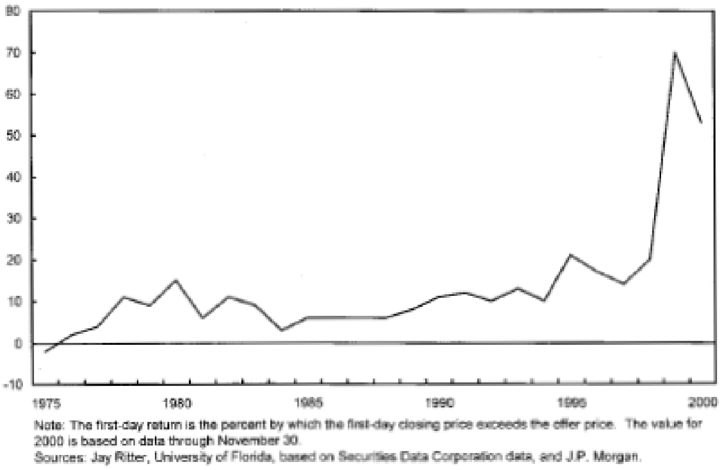


Figure 18. First-day returns for IPOs 1975-2000

These lofty proceeds attracted many venture capitalists and in 1999 at least 50% of the total investments went to Internet related start-ups. Total VC funding rose to a peak of US$ 102 bln. for the year 2000. See also Figure 19 showing US VC investments by quarter (p225, 227).

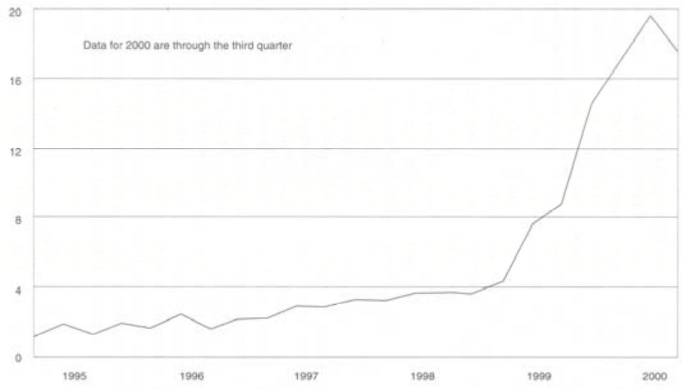


Figure 19. Venture capital investment, 1995-2000

Commenting on the behaviour of VC firms near the peak of the bubble, Cassidy points to the prevailing logic at the time: “The venture capitalists that invested in Pets.com and Webvan didn’t necessarily believe the Internet was the best way to sell pet food and groceries, but they knew that if they didn’t finance these firms their competitors would. If the Nasdaq kept going up, and few doubted that it would, their rivals would be able to cash in their investments at a profit after the planned IPO. In such circumstances, the ‘sensible’ thing to do was to keep pouring money into the Internet sector.” (Cassidy, 2002 p7).

Following the successes of investments in Internet start-ups were the successes of network equipment start-ups, in the field of opts and datacoms. These start-ups became acquisition targets for the big names in the telecom industry such as Lucent technologies, Nortel and Cisco. The acquisition of Cerent by Cisco for US$ 6.9 bln became a landmark deal providing handsome returns for US 8 mln investment in the start-up by Silicon Valley’s leading VC Kleiner Perkins Caufield & Byers (Malik, 2003 p263-5).

2.2.1.4 The role of real interest rates

Lower interest rates reduce the cost of borrowing money to purchase equities. Brenner refers to a 23% fall in interest rates for thirty-year Treasury bonds from 7.85% in January 1995 to 6.05% in January 1996 (Brenner, 2002 p141). The rates in 1995 were not at an all time low, but they were declining. See also Figure 20 (US Government, 2001 p68). At the same time the inflation remained flat with the Consumer Price Index at approx. 3%. See Figure 21 (p70)[16].

By December 1996 Greenspan, Chairman of the Federal Reserve Bank, issued his famous warning about the stock market’s ‘irrational exuberance’. Nevertheless, the Fed raised the Federal Funds target rate only once with 0.25% in 1997 in an attempt to control the expansion. The East Asia crisis prevented any further increase and in fact led to a period of four years, 1995-1999, without the interest rates being raised, only temporarily lowered (Brenner, 2002 p145).

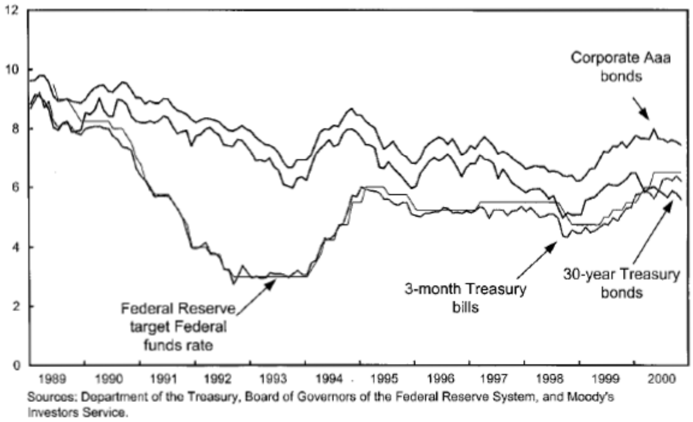


Figure 20. Selected US interest rates and yields

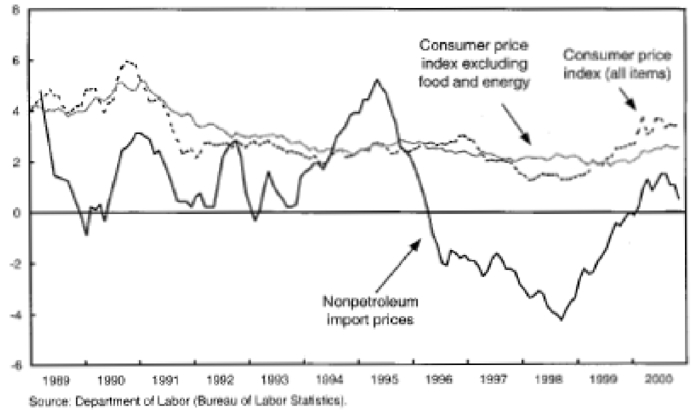


Figure 21. Consumer Price Index 1989-2000

2.2.1.5 The wealth effect

As in every boom period, the rising stock prices have an expanding 'wealth effect' on corporate investment and on household consumption. The perceived new wealth led to a historic erosion of household savings and increase in household borrowing. The resulting increased consumer spending gave a further impetus to the boom. A process that is subject to a positive feedback loop.

The capitalization of shares owned by US households increased from $ 4 trillion in 1994 to $ 12.2 trillion in the beginning of 2000. Resulting in a 32% increase in net worth over disposable income for the period. The 'wealth effect' led to a drop in the household savings rate from 8.7% in 1992 to –0.12% in 2000, its traditional range being from 7.5 to 10.9%. Moreover, outstanding debt reached 97% of personal disposable income, up from an average of 80% for the period 1985-1989 (Brenner, 2002 p189-91).

2.2.1.6 Restricted issue and buy back of stocks

Galbraith identified 'leverage' as one of the common denominators of great speculative episodes (Galbraith, 1990 p18-21). In the recent boom one of the many appearances of leverage is a result of the fact that only a part of the shares that have been issued are being traded. This resulted in a misrepresentation of company valuations or market capitalization, which is equal to the total number of shares outstanding multiplied by its stock price. In the case of Netscape 38 million shares were issued at the Netscape IPO, however, only 5 mln were trading. At the Amazon.com IPO 3 mln out of 23 million were traded at the day of issue. The question is whether the remaining shares when they would be traded on the open market would have received the same price. "The investment bankers knew about this discrepancy, but they didn't publish it. They were more than delighted to see more headlines about Internet stocks." (Cassidy, 2002 p87&149).

The other appearance of leverage are occurring in the buy-back of company stocks. The broad availability of cheap money resulted in many US corporations to "assume additional debt for the express purpose of buying back their own stocks in ever greater quantities so as to directly push up their shares." (Brenner, 2002 p144). This practice grew to a level where US non-financial corporations became the leading net purchasers on the US equity market (72.5% of the value for the period 1983-1990; the earlier part of the period mainly characterized by mergers and acquisitions and leveraged buy-outs). This practice was self-enforcing through the revaluation of the assets.
As corporate cash-flow was just able to cover the capital expenditures, all of the net stock purchases were being financed through increased borrowing and represented 50% of all borrowing of non-financial corporations (p146-52). See also Figure 22 (p196).

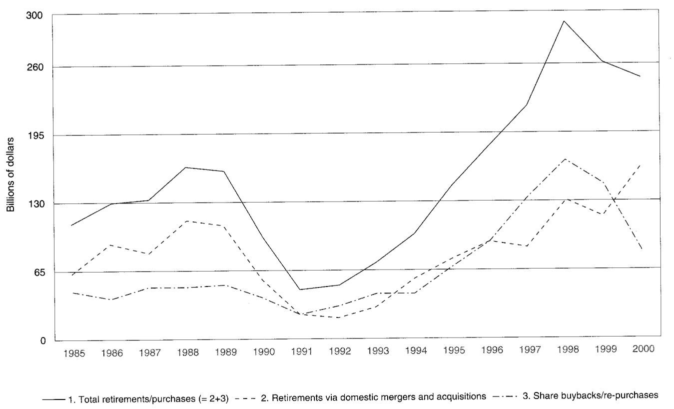


Figure 22. US non-financial corporate gross equity retirements 1980-2000

Based on the argument forwarded by Smithers & Wright[17], Brenner concludes: “Since equity prices were rising rapidly, making it ever cheaper for corporations to raise funds through the issue of shares, it would have been reasonable to expect that, all else being equal, corporations would turn much more to selling shares in order to finance themselves than to buying shares by means of borrowing. [This] confirms that the US non-financial corporations, taken in the aggregate, chose a more costly form…in order to be able to buy back equities [this] confirms the fact that corporate executives were…seeking to maximize shareholder value by directly fattening up share prices.” (p148). For the period 1994-98 the borrowing involved $ 509 bln, a figure equivalent to 37% of net purchases of US equities. “[I]t could not be more evident that corporate share retirements played a fundamental role in manufacturing the stock market bubble.” (p151).
Shiller identifies managers stock option plans as an unusual incentive to substitute share repurchases for a portion of the dividend payout…to increase the value of the managers’ options.” (Shiller, 2001 p24).[18] As the adage goes, “You manage what you measure.” “Executives intent on “managing” their stocks became hypersensitive to a single number: quarterly earnings per share. From an economic perspective, quarterly numbers are virtually irrelevant, because it typically takes years – not months – for business strategies to bear fruit. They are important only on Wall Street, where traders myopically focus on the next scrap of news, the next bit of data – on each ensuing bit of ephemera.” (Lowenstein, 2004 p29-30).
To illustrate the attitude change toward options in the traditional telecom industry, a quotation by Roth, CEO of Nortel, is revealing “When asked about the impact of the Bay Networks acquisition [in 1998 for US 9.1 bln.], Roth told the Wall street Journal that “stock options were probably one of the most significant changes we made.” (Malik, 2003 p211).
As a point of reference: The market value of equities of US non-financial corporations increased from $ 4.8 trillion in 1994 to $ 15.7 trillion in early 2000. The corporate borrowing grew from 3.4% of corporate GDP in 1994, through 3.7% in 1996 to 9.9% in the first half of 2000 (Brenner, 2002 p192).
The pressure on management to produce for stockholders the highest possible returns in the shortest feasible time, combined with the increasing role of stock options in the incentive plans of corporate executives (and employees) are considered the major drivers for this practice. Also the lack of any accounting regulations to report the cost of options and the ability to deduct the cost of the options from the income tax provide a major incentive for the application of this practice (p150-1).

High valued stocks, and appreciating stock values, are hot property for companies owning these stocks; they are providing for purchasing power highly effective in the field of mergers and acquisitions. Many of the acquisitions by telecom operators and equipment vendors involved very high multiples of past revenues streams and hence would have been difficult to realise if cash flow based financing would have been required. Keeping stock value high and growing would become an important driver to assure one is “…not edged out of the acquisition game.” (Endlich, 2004 p195).

2.2.2 Network effects and positive feedback

Additional to the monetary expansion and feedback, network effects provides for a powerful feedback loop in the markets for products and services related to the Internet.

In Chapter 4 we identified markets which exhibit strong network effects and where firms can chose or set their own technical standards as ‘winner-take-most’ markets. Markets for information goods are typically markets that are subject to these network effects. As said, these network effects may be further stimulated, or even originate, through the expectations of agents, e.g. in their anticipation of platform dominance, or be stimulated through the coordination among agents, e.g. by producers in coordinating standards efforts or by buyers teaming up. Economides points to the “…Schumpeterian races for market dominance”, and identifies the competition among the dot.coms in the period 1999-2000 as a salient example. “…[E]conomic models imply a high valuation of the dominant firm compared to other firms in the same network industry. The same perception prevailed on Wall Street. During that period, dot.com firms advertised very intensely and subsidized consumers so as to be able to achieve the coveted dominant position in the market. The easy availability of capital for dot.coms at the time facilitated this behavior as firms ‘burned’ almost all the cash they had in their attempts to get the top market share. Many of the dot.coms failed… …However, all the successful dot.coms, such as eBay, Amazon and Yahoo, also followed this strategy.” (Economides, 2003 p16). The battles for software dominance in the PC-world are another example of this ‘rule of the game’ (Gawer and Cusumano, 2002 p131-162). Also the browser war between Netscape and Microsoft in 1996 was a battle for market dominance. (Quittner and Slatalla, 1998). Albeit, the success of Microsoft shows that in the end having ‘deep pockets’ and having ‘overall clout’ in related markets to be more important than being a ‘first mover’ (Cassidy, 2002 p198).

The ability to distribute software via a communications network, such as the Internet, further accelerates this warfare. Other examples are the adoption of new IT platforms as described by Moore (1995). Moore emphasizes the special dynamic that occurs when new ICT products are being accepted by the ‘infrastructure’ or technical buyers in charge of deploying and maintaining the basic support systems. As ICT managers they are on the one hand responsible for providing reliable and efficient infrastructure, and on the other need to modify and upgrade systems to keep up with end-user demands. If a new paradigm, a discontinuous innovation comes along that promises to break the IT backlog, the big issue is ‘when to move’ (p64-5). As a community, ICT managers tend to follow three principles that mitigate the risks involved in adopting a new paradigm:

1. When it is time to move, let us all move together,
2. When we pick the vendor to lead us to the new paradigm, let us all pick the same one,
3. Once the move starts, the sooner we get it over with the better.

The market consequence of the stampede that follows is that: “…virtually overnight, demand dramatically outstrips supply, and a huge backlog of customers

appears…[S]ince switching costs in high tech are so high, once customers settle on a particular vendor, they rarely switch. So each sale gained in a tornado[19] really should be looked at as an annuity, and the total number of sales a company can garner while the tornado is in process sets the limits of their installed base and thus the boundary conditions on their future revenue from that marketplace." (p66-7).
Moore's account is an example of what Shapiro and Varian describe as the main characteristics of the transition from an industrial economy to an information economy (Shapiro and Varian, 1999).

2.2.3 Consensual vision and positive feedback

In Chapter 2 we observed that "people who communicate regularly… …think similarly". Fransman, in explaining the telecom bubble, refers to the role of cognitive frameworks in shaping the thinking and decision making.[20] A cognitive framework is being defined as "an interrelated set of beliefs, embodied in assumptions and expectations, which serve the purpose of making the world seem intelligible and therefore orienting decision-making." (Fransman, 2002 p8-9). The cognitive frames, or consensual visions in his terminology, as they are being confirmed in reality act as a self-fulfilling prophecy and hence are providing for a positive feedback effect. The 'consensual visions' that are operative during the bubble period are identified by Fransman as:

1. Explosive demand for bandwidth,
2. New telecom operators will out-compete the incumbents,
3. Financial markets will support the fittest new entrants,
4. Technological change will further reinforce the chain of expectations.

The similarity in strategies that are being pursued by the telecom operators and equipment providers is a further indication of 'consensual visions' being operative in the industry. In the following Sections these 'consensual visions', as factors that have contributed to the development of the Internet bubble, will be explained in short.

2.2.3.1 Explosive demand for bandwidth

The explosive demand for bandwidth would follow from the growth of the Internet. The demand growth would result from both an increasing number of users and from an increasing range of bandwidth-intensive applications (Fransman, 2002 p9-10). This dimension will be elaborated in Section 2.2.4.1 *The arrival of the Internet* and Section 2.3 *Contagion.*

2.2.3.2 New telecom operators will out-compete the incumbents

The incumbent operators, although having the benefit of economies of scale and scope, would be severely constrained in meeting the demand of the Internet because of their legacy networks. New entrants would have the benefit of rapid deployment of the latest technologies and thereby create a competitive edge. Moreover, new entrants were considered to have an organisational advantage compared to the large and often bureaucratic incumbents. Furthermore, new

entrants had the opportunity to 'cream skim' and concentrate their investments on the high-usage customers (Fransman, 2002 p10-11).
The legacy networks have been developed to facilitate voice communication i.e. following the circuit-mode paradigm. The Internet is based on the packet-mode paradigm. While the transmissions systems can be used to carry both modes, packet switching and routing requires a different type of equipment, and the engineering of packet networks is distinctly different from the engineering of voice networks. See also Chapter 5 Section 3.1.
Incumbents have traditionally been operating in a public service role, and hence require organisational transformation to be able to compete effectively in an open market. This process of change takes considerable time and effort, an opportunity window that can be exploited by new entrants.
The new telecom regulatory framework typically assigns universal service obligations to the dominant player, i.e. the incumbent. Hence, new entrants have the opportunity for 'cream skimming'.

2.2.3.3 Financial markets will support the fittest new entrants

The notion that the new entrants would out-compete the incumbents resulted in the willingness of the financial sector to support these new players (Fransman, 2002 p11). Incumbents have historically provided steady returns on capital deployed, a typical fit for financing on the long term bond market. New entrants provided the financial industry a wider range and more attractive business opportunities in the form of e.g. IPOs, mergers and acquisitions. While the notion of 'support of the fittest new entrants' may have applied to the first wave of new entrants, the continuing appetite of investors also led to the funding of the second and third wave of new entrants. Entrants with much the same business models and pursuing the same customers, which would not necessarily qualify as 'the fittest new entrant'. The consensual vision during the period of euphoria can be rephrased in hindsight as: 'financial markets will support any new entrant'.

2.2.3.4 Technological change will further reinforce the chain of expectations

Technological change, on which the success of the new entrant in competing with the incumbent was based, would reinforce his position in the financial market and would raise the attractiveness of the new entrant relative to the incumbent. Although technological progress would reduce future prices, and hence could reduce profits, the common view was that price elasticity and a shifting demand curve would allow the revenues and profits to grow continuously (Fransman, 2002 p11-2).
The close relationship that developed between telecom equipment providers and new entrants illustrates this point. See also Section 2.3.1.10.

2.2.4 Precipitating factors – herd behaviour

Shiller argues that "When these [stock market] events move in extreme directions …., it is usually because of a confluence of factors, none of which is by itself large enough to explain these events." (Shiller, 2001 p17). As mentioned in Chapter 2, he identifies twelve factors that have a precipitating effect on the development of the recent bubble:

1. The arrival of the Internet,
2. Triumphalism and the decline of foreign economic rivals,
3. Cultural changes favouring business success or the appearance thereof,
4. A Republican Congress and capital gains tax cuts,
5. The baby boom and its perceived effects on the market,
6. An expansion in media reporting of business news,
7. Analyst's increasingly optimistic forecasts,
8. The expansion of defined contribution pension plans,
9. The growth of mutual funds,
10. The decline of inflation and the effects of money illusion,
11. Expansion of the volume of trade: Discount brokers, day traders, and twenty-four-hour trading,
12. The rise of gambling opportunities.

Many, if not most, of these factors influence the 'state of mind' and thereby contribute to herd behaviour. Collectively they can be considered to be the driving force of the second positive feedback loop.

The factors identified by Shiller are largely confirming the driving factors as discussed by Brenner (items 1, 4, 8, 9 and 11). Shiller concludes that many of the precipitating factors have a self-fulfilling psychology aspect and are thus difficult to capture in predictive scientific explanations. He also does not claim causation, but provides compelling arguments and supporting correlations for these factors to the point they cannot simply be ignored (Shiller, 2001 p17-43). Each factor will be discussed shortly in the following paragraphs.

2.2.4.1 The arrival of the Internet

In Section 2.1 *Displacement* the emergence of the Internet has been identified as an important factor in the development of the bubble. Shiller positions the Internet as a precipitating factor on the basis of its impact on the individual, as a source of entertainment and preoccupation, similar and beyond the introduction of the PC and television as it conveys a sense of a "changed future" (Shiller, 2001 p19). He stresses the point that it is not necessarily the Internet that raises the value of existing companies, which he claims it does not, but "[w]hat matters for a stock market boom is not…the reality of the Internet revolution…but rather the *public impressions* that the revolution creates… Public reaction is influenced by the intuitive plausibility of Internet lore..." (emphasis by the author, p21).

Shiller, in his 'model of euphoria', identifies the Internet as an important but only one of the precipitating factors. Perez in her 'model of technological revolutions' (see Section 3) gives the Internet a much more prominent position, as the essential infrastructure supporting the diffusion of the new techno-economic paradigm. Moreover, the Internet related industry is subject to euphoria. Hence, in this Section we will expand on the role of the Internet in relation to euphoria.

2.2.4.1.1 New era thinking and the new economy

Galbraith already observed that: “In all speculative episodes there is always an element of pride in discovering what is seemingly new and greatly rewarding in the way of financial instrument or investment opportunity.“ (Galbraith, 1990 p18). In this period of euphoria the new element has been the Internet and the association with *new era thinking* and *new era economy* notions that, according to Shiller, had no currency until 1997, when it was attributed to Greenspan and received further credibility through an attack of the new era theory in the Harvard Business Review (Shiller, 2001 p96-9). He further observes: “Although prominent people can certainly move markets, often their wisdom merely tags along with market moves. Nevertheless, the new era thinking they promote is part of the process by which a boom may be sustained and amplified – part of the feedback mechanism that… …can create speculative bubbles.”

The new era thinking or the new economy in relation to the Internet bubble is foremost about a transformation in ‘how business is done’ using the Internet. An account that starts with the notion of *e*-commerce.

2.2.4.1.2 The Internet and e-commerce

In Section 2.1.1 we discussed the emergence of the Internet from the late 1960s. By the 1980’s the infrastructure had grown impressively, but email and file transfer remained the most common activities on the Net (Abbate, 1999 p212). The text based interface greatly contrasted with the graphical interfaces available on PCs, and being used by the on-line service providers, such as CompuServe, America Online and Prodigy. Moreover, information was difficult to locate and retrieve. These issues were addressed and resolved in 1990 through the internet application that became known as the World Wide Web, “…that would lure millions of new users. In 1991 the NSF lifts the restrictions on commercial use of the Internet. The web changed people’s perception of the Internet: Instead of being seen as a research tool or even a conduit for messages between people, the network took on new roles as an entertainment medium, a shop window, and a vehicle for presenting one’s persona to the world.” (p213-4). “[The Web] solidified the Internet’s traditions of decentralization, open architecture, and active user participation, putting in place a radically decentralized system of information sharing. On the Web, links between sites were made laterally instead of hierarchically, and each individual could be a producer as well as a consumer of information.” (p217-8). The introduction of PC based browsers in 1993 and 1994 made that “…laypersons encountering the Web for the first time found it relatively easy to master.”

After the conversion of the 1000 host computers to TCP/IP in 1984, the Net continued its exponential growth to reach 100,000 hosts in 1990, the year the NSF proposed the transition to commercial use of the Internet, and established an acceptable-use policy for commerce on the Internet, which “…paved the way for entrepreneurial engineers to become Internet Service providers (ISPs)” (Spector, 2000 p20). By 1995, the year identified as the beginning of the Internet bubble, the number of host computers had reached the 1,000,000 mark. See Figure 23 (OECD, 2000 p57). America Online, one of the major Internet service providers in the USA, saw its subscribers grow from 1.5 mln in December 1994 to 7 mln in December 1996 to 15 mln in December 1998 (Malik, 2003 p xiii).

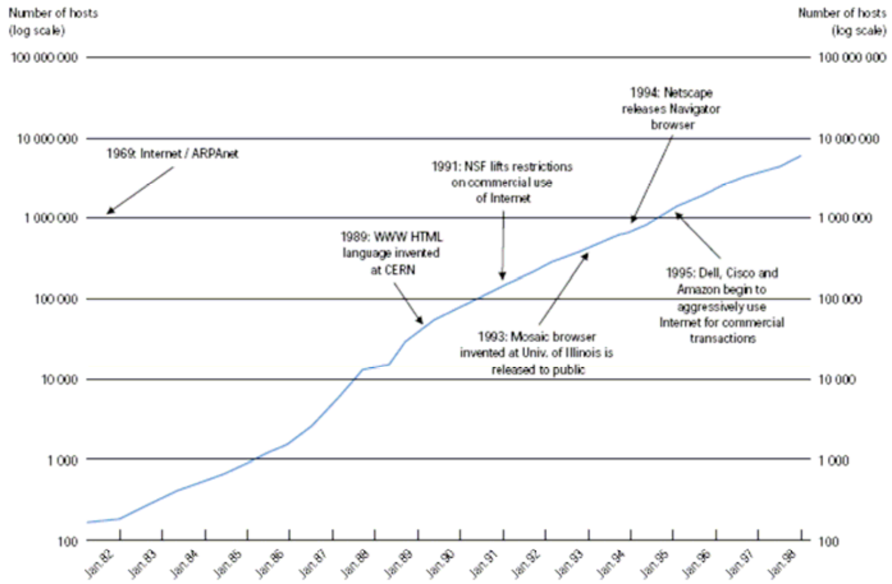


Figure 23. Growth in Internet hosts computers and major e-commerce developments

As a salient example of how the Internet changes business models and operations, Dell introduced in 1995 the on-line configuration of PCs, soon to be followed by on-line completion of the transaction. On-line transactions that reached $1 mln per day in revenues in 1996 and $35 mln in 1999 (Dell and Fredman, 1999 p90).

Cisco, another icon of the Internet era, started operation in 1984 to provide routers for the Internet, it used the Internet in its sales process from its founding onward.[21] In 1989 a customer support site was established facilitating software downloads and upgrades. In 1993 customers could post problems, upon which other customers began responding. Also simple transactions could be completed on-line. In 1994 order status information was provided on-line. In 1996 the 'Cisco Connection On-line' was established, and on-line configuration added. Starting with $75 mln of sales in the first 5 month of operation, in 1999 on-line sales were exceeding $10 bln. "…[A]chieving the status of one of the top revenue-producing Web sites in the world." The website would also save Cisco $250 mln annually in IT services. The linkage with enterprise resource planning (ERP) and manufacturing resource planning (MRP) systems, in which suppliers are linked through the extranet, provide further streamlining and significant savings in operations (Bunnell, 2000 p28&138-48).

In 1995 Amazon.com starts business as an email and Web store, without a history of book selling at High Street.[22] They were preceded in 1991 and 1992 by Computer Literacy clbooks.com, a Silicon Valley bookstore chain, and books.com who started to communicate with users using a bulletin board system. In 1993 books.com enabled users to log in to a remote computer to search its database. In

1994 books.com launched its website and offered 400,000 titles (Spector, 2000 p21-2&29). At its launch Amazon.com claimed 1 mln titles that could be ordered through a simple 'click & buy' using a credit card. "…[O]rders were recorded, registered, and processed at one time in real time. The customer was immediately appraised of the status of the order, how long it would take to ship the book, the amount of shipping costs [that] had to be paid (p78-9).
These examples illustrate the role of the Internet in changing business practices, other typical examples are: Charles Schwab in on-line banking, E*Trade in on-line brokerage, and Ebay an on-line marketplace for buying and selling goods. The opportunity offered to have a storefront or shopping window in every home connected to the Internet, combined with the extended reach, even across borders, is 'an offer business can't refuse', despite the added transparency in terms of pricing. The apparent successes in on-line sales and cost savings achieved by these companies inspired many others to follow suit. As a further illustration Table 3 shows the potential savings from business-to-business e-commerce in the USA (OECD, 2000 p60).[23]

Industry	Potential cost savings	Industry	Potential cost savings
Electronic components	20-30%	Chemicals	10%
Machinings (metals)	22%	MRO	10%
Forest products	15-25%	Communications/bandwidths	5-15%
Freight transport	15-20%	Oil and gas	5-15%
Life science	12-19%	Paper	10%
Computing	11-20%	Health care	5%
Media and advertising	10-15%	Food ingredients	3-5%
Aerospace machinings	11%	Coal	2%
Steel	11%		

Table 3. Potential cost savings in business-to-business e-commerce in the USA

Figure 24 shows the increasing role of the Internet in new low-end business to business projects, for three core business processes (distribution channel, procurement and supply chain) on a worldwide level (p60).

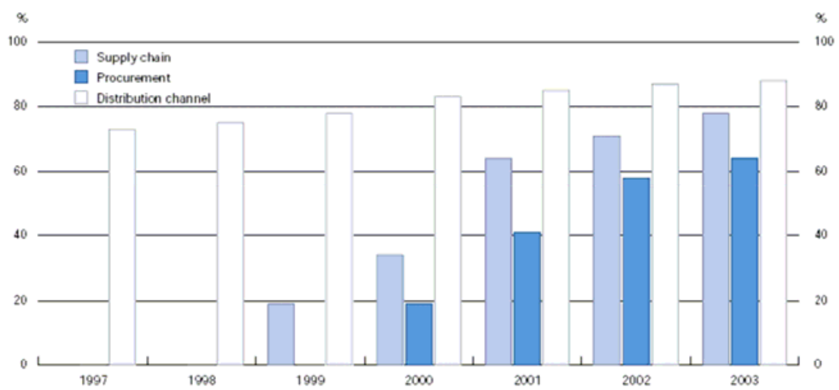


Figure 24. The diffusion of Internet-based applications

In Section 3 *Application of the stylized model of Great Surges* we will return to this topic.

2.2.4.1.3 Internet growth

An industry or sector that has a large potential for growth attracts entrepreneurs and investors alike. If the topic is an infant industry growth numbers are always impressive as getting from 1 to 10 units is 1000% growth. This notion of phenomenal growth has been with the Internet even when a slow down in traffic growth could be measured. Notwithstanding, on many counts the (early) growth of the Internet has been exponential, or doubling annually: in number of hosts connected to the network, the number of users (albeit the actual number of users remains an estimate). As Figure 23 suggests, the period of exponential growth starts around 1982, the time that commercial TCP/IP networks are being introduced next to the Internet, which is at that time still reserved for research and educational use. In the Morgan Stanley Internet Report the number of Internet users in 1995 are estimated at 9 mln interactive users plus 35 million email users, against 144 mln PC users. Internet/Web users were estimated to reach 150 mln by 2000. See Figure 25 (Meeker and DePuy, 1996 p3-2). Meeker & DePuy draw a parallel with the PC industry, which had reached a valuation of US$ 250 billion since its emergence in 1980. They expect the Internet industry could exceed that of the PC industry by 2000 (Meeker and DePuy, 1996 p1-2&3-2). See for the Internet growth drivers they identified Figure 26.

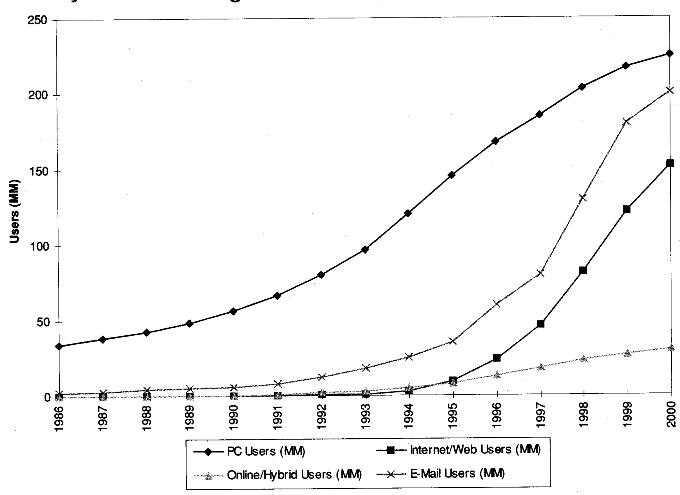


Figure 25. Estimated numbers of Internet, E-mail, PC users worldwide, 1986-2000

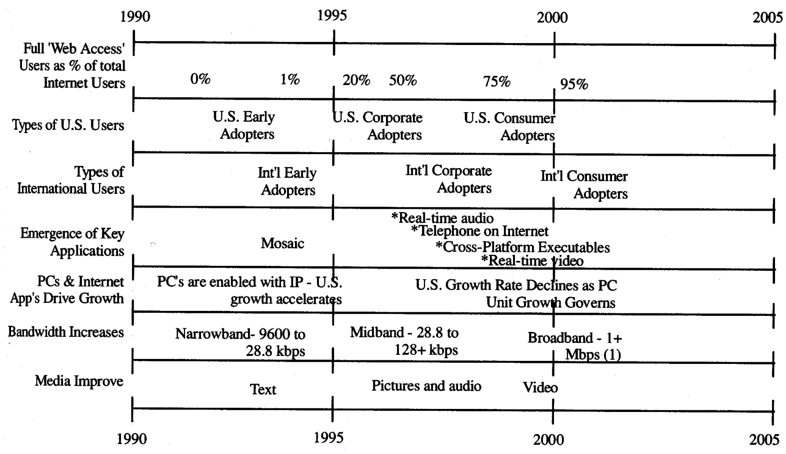


Figure 26. Internet growth drivers 1990-2005

2.2.4.2 Triumphalism and the decline of foreign economic rivals

The fall of the Berlin Wall in 1989 and the break-up of the Soviet Union in 1991 implied a shift toward free markets. Shiller: “The world seems to be swinging our way, and therefore it starts to seem only natural that confidence in the premier capitalist system would translate in confidence in the market, and that the U.S. stock market should be the most highly valued in the world.” (Shiller, 2001 p21). Competition is often depicted in the media as a sports event, where there can be only one winner. “Weakening of the rival is thus viewed simplistically, as good news.”

2.2.4.3 Cultural changes favouring business success or the appearance thereof

A number of factors appear to have contributed to a cultural change in favour of an “individual business-success ethic”: the increase in materialistic values, downsizing in the 1980-90 encouraging workers to take control of their own lives, decline of labour unions, combined with the notion that stocks held out “the possibility of amassing substantial and quick riches.” “By pursuing speculative investments, people in effect create for themselves a second job – one where they are, at last, their own boss. And in many cases it is a job that seems to provide a source of income – income derived from one’s direct interaction with the world at large, not as part of an organisation.” (Shiller, 2001 p22-3). Moreover, compensation packages for managers increasingly rewarded them as investors through employee stock options. In a sample of 144 companies of the largest S&P 500, stock options accounted for over 6% of the outstanding shares. With the prospect of amassing substantial wealth management has an incentive to do everything they can to boost share prices (p23-4).

2.2.4.4 A Republican Congress and capital gains tax cuts

In 1995, as a newly elected Republican Congress took office, proposals to reduce capital gains tax were being introduced. In 1997 a tax reduction from 28% to 20% was enacted, with the notion that these taxes might be cut further. Hence, from 1994 investors were advised to hold on to their long-term capital gains to benefit from the proposed reduction. This had a favourable impact on the stock market, which lasted beyond 1997 as more reductions were being anticipated (Shiller, 2001 p24-5).

2.2.4.5 The baby boom and its perceived effects on the market

The Baby Boom generation born between 1946-1966, and being aged between 30 and 55 at the time of the Internet bubble, is supposedly having a positive effect on the stock market as they are “competing against each other to buy stocks to save for their eventual retirement and bidding share prices up relative to the earnings they generate.” Another theory asserts that the Boomers are less risk averse and have less anxiety about the market and the world as the generations that have experienced the Great Depression or World War II. These theories appear hard to prove scientifically and hence Shiller observes that “[a]lthough there is no doubt at least some truth to these theories of the Baby Boom’s effects on the stock market, it may be public *perceptions* of the Baby Boom and its presumed effects that are most responsible for the surge in the market.” (emphasis by the author, Shiller, 2001 p25-8).

2.2.4.6 An expansion in media reporting of business news

Coverage of news has become a round-the-clock affair since the introduction of CNN in 1980 and coverage of major events such as the Gulf War in 1991. The trend was followed by the business networks CNBC, CNNfn and Bloomberg Television, and also newspapers became more “money” oriented and aimed at the individual investor. “Such enhanced business reporting leads to increased demand for stocks, just as advertisements for a consumer product make people more familiar with the product, remind them of the option to buy, and ultimately motivate them to buy.” (Shiller, 2001 p28-29). But there is a nuance, compared to other periods of optimism such as 1901 and 1929, Shiller concludes that: “…although there is much optimism in the media in the 1990’s, it is usually a matter of background presumption rather than bold assertion. There appears to have been a media attitude change, and optimistic hyperbole was out in the 1990’s.” (p113).
Cassidy, on the other hand, points to a media bubble, and refers to the period of the Rail Road Mania: “The appearance of so many magazines devoted to the same subject [is] a classic sign of a speculative boom approaching its peak.” The major ones being *Wired*, *Fast Company*, *The Industry Standard*, and *TheStreet.com* (Cassidy, 2002 p176-81).[24]

2.2.4.7 Analyst’s increasingly optimistic forecasts

A 1999 survey by Zacks Investment Research, quoted by Shiller, shows from a sample of 6000 companies that analysts are giving: 1 % sell – 30 % holds – 69 % buy recommendations. This data suggests that analysts are reluctant to recommend that investors sell anything. A reason might be "that a sell recommendation might incur the wrath of the company involved." Another reason is "that an increasing number of them are employed by firms that underwrite securities, and these firms do not want their analysts to do anything that might jeopardize this lucrative side of the business." (Shiller, 2001 p30). Cassidy in this context refers to the approach by Meeker and DePuy, analysts at Morgan Stanley:

> "The key to valuing Internet stocks was not current earnings, Meeker and DePuy argued, but earnings potential, which was vast." "This argument would soon be picked up elsewhere on Wall Street and used to justify the unprecedented prices being paid for Internet stocks. In stead of concentrating on earnings and revenues, many analysts would promote "mind share" and "market share" as key valuation indicators.[25] The only way to quantify these concepts was to look at the traffic on a company's Web site. If this appeared to be increasing dramatically, the company was worth more, even if its losses were also rising, as was often the case. The new valuation methodology provided the owners of Internet companies with a peculiar set of incentives. Instead of being rewarded for cutting costs and increasing revenues, like most managers are, they were rewarded for increasing the number of page views. Not surprisingly, many of them would end up spending as much money as possible on marketing and promoting their sites, regardless of costs." (Cassidy, 2002 p95-6).

See also *The Internet Report* by Meeker and DePuy (1996).

"Morgan Stanley's great insight was that the analyst could be used as a competitive weapon – not only to analyse IPOs but to cause them to happen. Mary's [Meeker] thought leadership in the industry helped Morgan Stanley to line up many of the most exciting Internet deals." An observation by McNamee at the investment capital firm Integral Capital as cited by Cassidy (2002 p96-7). The same role was assumed by Grubman at Salomon Smith Barney with respect to telecom related IPOs. On this topic Shiller quotes Grant, a market commentator, as saying: "Honesty was never a profit center on Wall Street, but the brokers used to keep up appearances. Now they have stopped pretending. More than ever, securities research, as it is called, is a branch of sales. Investors beware." This behaviour is reflected also in an upward bias in the prediction of long-term earnings growth and in issuing estimates of the current quarter just short of the actual number (Shiller, 2001 p30-2). Malik observes with respect to Grubman's approach: "The noise around the merger [WorldCom – Sprint] allowed Grubman to change the metrics with which he valued WorldCom. He would change these often, and many overlooked the changes, Jack [Grubman] used forceful phraseology and expressed such apparent conviction that investors forgave the sloppiness behind his ratings and price targets. Just as magicians' scantily clad beauties distract attention from the sleight of hand. Grubman's words distracted readers from his lack of rigor and objectivity." The sleight of hand was related to cash earnings instead of earnings, the former because it does not include noncash expenses such as depreciation (Malik, 2003 p29-30). Figure 27 provides an example of 'stock promotion' by Grubman in the case of Winstar, a fixed wireless operator (Source NASD Department of enforcement v. Jack Grubman and Christine Gochuico, Disciplinary Proceeding number CAF020042, cited in: Malik, 2003 p136).

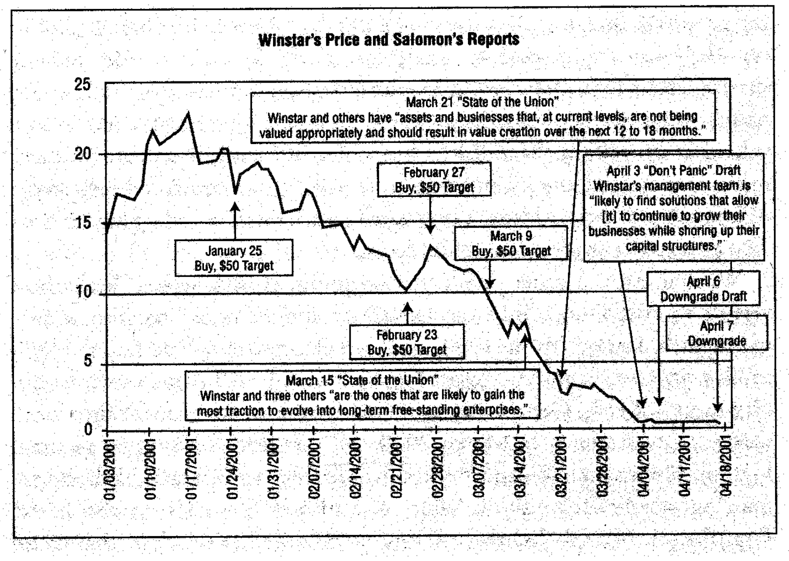


Figure 27. Winstar's price and Salomon's reports

Another contribution to the growing optimism was provided by market research firms, such as RHK (Ryan Hankin and Kent, Inc.) in the field of optical technologies and systems. Their fame started as they predicted the optical equipment market in 1997 to be around US$ 1.5 bln while others predicted $ 300 mln, and the actual appeared to be $ 1.45 bln. (p279). Another famous spokesperson and source of the growth gospel with 65,000 subscribers to his newsletter, was George Gilder, author of *Microcosm*, describing Moore's Law and the world of semiconductors, and *Telecosm*, in which he addresses the world after bandwidth abundance. According to Kedrosky, a professor of business at the University of British Columbia: "What makes Mr. Gilder more than your garden-variety of technology pundit (and therefore more dangerous) is that he knows what he is talking about. His tuff is dense. It's full of technical arcane. It is learned, purposely literate, and it oozes legitimacy." (Cited in: Malik, 2003 p277-8). His ability to move markets became known as the "Gilder Effect." (p283).

2.2.4.8 The expansion of defined contribution pension plans

The direct involvement of employees in owning and managing a stock portfolio has increased significantly with the introduction of the so called 401(k) retirement plans in 1981. Rather than being promised a fixed benefit from a retirement plan of which the reserves are managed by the employer, employees could make contributions to a tax-deferred account, deducted from their pay-checks. They would then own the investment and were thus required to allocate the funds among stocks, bonds and other financial instruments. In practice the investment options offered to employees tend to result in a bias of the portfolio in favour of stocks. The popularity of the plans was further enhanced by tax laws that encourage employers to make matching contributions (Shiller, 2001 p32-5). At the end of 2000 the 401(k) related accounts totalled about $1.7 trillion in assets (Cassidy, 2002 p30).

2.2.4.9 The growth of mutual funds

With the start of the bull market in 1982 the equity mutual funds started to become very popular. According to Cassidy, in 1983, the wealthiest 1 percent of households in America owned 90% percent of all stocks (Cassidy, 2002 p29). Though large advertising efforts and through the popularity of the 401(k) plans, which facilitated investments in mutual funds, the number of funds grew from 340 to 3513 in 1998 and from 6.2 million accounts to 119.8 million accounts (Shiller, 2001 p35-6).

2.2.4.10 The decline of inflation and the effects of money illusion

In the mid 1990's inflation was at a range of 2-3% against an average of 4.4% since 1960. From his surveys Shiller concludes that "low inflation is viewed [by the general public] as a sign of economic prosperity, social justice, and good government. It is not surprising, therefore, that a lower inflation rate boosts public confidence, hence stock market valuations." (Shiller, 2001 p37). This public perception exists despite the evidence that stock markets react inappropriately to inflation as the effect of inflation and real interest rates are not fully understood by investors. This phenomenon has been referred to as "money illusion", in relation to a changing monetary standard (p37-9).

2.2.4.11 Expansion of the volume of trade: Discount brokers, day traders, and twenty-four-hour trading

In the words of Cassidy: "The real coup was marketing Internet stocks to individual investors." (Cassidy, 2002 p125). As can be seen from the charts in e.g. Figure 6 trading volumes have risen significantly at the NYSE and in particular at the Nasdaq since 1995. Increasing turnover rates are caused by the higher interests of the public at large, as illustrated in the previous Sections, but is also a result of declining cost of making a trade and the opportunity offered to 'day traders'. Also on-line trading, facilitated through E*Trade and Ameritrade and other on-line brokerages, has made a significant contribution, supported by the almost real-time availability of investment information through the Internet (Shiller, 2001 p39-40). "People read about Internet stocks on the Internet, talked about Internet stocks on the Internet, and bought Internet stocks on the Internet. The technology at the center of the speculative boom helped to facilitate and sustain the speculation." (Cassidy, 2002 p128-9). "Day trading, after all, was just an extreme form of online trading, which had developed into a national pastime. More than 5 million American households now had online trading accounts, and many had more than one. Charles Schwab, alone, had almost 6 million customer accounts, and it was adding 100,000 every month. A third of retail stock trades were being done online…[in 1998]." (Cassidy, 2002 p233; Kador, 2002 p209-24).

2.2.4.12 The rise of gambling opportunities

Shiller links the legalization and growth of gambling in the US to the stock market as it affects the culture and as it changes the attitudes toward risk taking in other areas. Furthermore, "[a] spillover from gambling to financial volatility may come about because gambling, and the institutions that promote it, yield an inflated estimate of one's own ultimate potential for good luck, a heightened interest in how one performs compared with others, and a new way to stimulate oneself out of a feeling of boredom or monotony." (Shiller, 2001 p41-2).

2.2.5 Euphoria and swindles

Kindleberger observed that "…the propensity to swindle and be swindled run parallel to the propensity to speculate during a boom." To that he adds with respect to the Internet boom: "The last half of 1990s was sufficiently prosperous in the United States to produce a bumper crop of scams, swindles, fraud, or actions of bad judgement or ethical ambiguity." (Kindleberger, 2000 p73&85).
The accounts with respect to Worldcom and Enron are but some of the major examples of this period.
In describing the bandwidth bubble, Malik refers to four reasons that have contributed to the development of the (telecom) bubble, largely in line with the precipitating factors identified by Shiller in the previous Sections (Malik, 2003 p xvi):

1. <u>Fear of the falling stock</u>. Most chief executives were scared to stand in front of the Wall Street community that was valuing them on revenue growth and admit that there was no growth;
2. <u>The cult of the CEO</u>. In the 1990's we made the CEO the new American hero. We put him on the cover of magazines, we celebrated his lifestyle. CEOs forgot that they served the shareholders and not their own bank accounts;
3. <u>CEO salaries and stock options</u>. According to Business Week, the average CEO made 42 times the average hourly workers' pay in 1980, 85 times in 1990, and 531 times in 2000;
4. <u>Hypergrowth</u>. Our society came to expect 20 percent annual returns on investments in an economy that typically grows only 3 percent.

The fear of falling stock forced companies to show earnings growth on a quarter-over-quarter basis. This has led to an earnings management game, whereby reported earnings and analysts' expectations closely match (Collingwood, 2001).[26] While showing attractive growth rates was relatively simple for the small high-tech start-ups, the large established companies, that liked to mirror their behaviour, had far more difficulty in meeting these expectations. Growing through acquisitions provided an attractive path given the 'buying power' of appreciating shares.[27] Telecom equipment providers also used acquisitions extensively, in particular in the race to market with new innovative products, see also Annex 6.[28] The underlying growth principle was: "When a CEO of a company with a large sale and distribution capability bought a small company with a promising technology, the market assumed that the sales of that product would skyrocket. This caused the

stock price of the larger company to rise sharply… …Armed with this higher stock price, the process could be repeated, buying ever-larger companies with ever-more-inflated P/E multiples…" (Endlich, 2004 p98).
Toward the end of the boom, the promises made to Wall Street became more and more difficult to keep. Hence, being in a bind the companies fostered many forms of 'creative accounting'. Examples were: overstating sales contract values; deflating earnings in the period of an acquisition, to inflate earnings in future periods; capitalization of period or regular expenses; using pension funds to improve earnings growth[29]; using capacity swaps on fiber optic networks to boost revenues. Capacity swaps would be revealed involving WorldCom, Global Crossing, Qwest, 360networks, and Enron (Malik, 2003 p33-4 & 59-60 & 82). WorldCom would disclose an amount of US$ 3.8 bln of improperly booked income in June 2002, and US$3.3 bln in August of 2002. November 2002 another US$3 bln in accounting irregularities were unveiled by the bankruptcy court examiner (Jeter, 2003 p x-xi & p121). Qwest had to restate revenues to the amount of US$ 1.2 bln. (Endlich, 2004 p242). In 2000 Lucent Technologies voluntarily restated its earnings by close to US 228 mln and it took back equipment for US$ 452 mln that distributors failed to resell or install. In 2004 the SEC would accuse Lucent of improperly recognizing more than US$ 1.1 bln in earnings (p234). In a different segment of the industry, for example AOL Time Warner took write-downs of US$ 100 bln. (Stiglitz, 2003 p6).
Telecom equipment vendors would also resort to vendor financing to boost sales in order to meet promises made on continuous company growth. See further Section 2.3.1.10.

Through contagion the prospect of huge financial rewards moved from the Internet arena to affect the telecom industry, in particular in the optical and data communications field. See Section 2.3 below. As Malik observes: "It took Rockefeller 25 years to make his first billion; Winnick [CEO of Global Crossing] made six times as much money in two years. It took Bill Gates 15 years to make that much money! But, unlike Rockefeller or Gates, Winnick made his fortune from a house of cards." (Malik, 2003 p73).
As the attention moved from hot internet IPOs to hot broadband networking IPOs big money was made through start-ups. The founders of Juniper Networks, Foundry Networks and Sycamore were each worth more than US$ 2 bln; the founders of Sycamore more than US$ 4 bln. (p242 & 245). Briere and Heckart in *Network World* observed: "The telecom industry surely creates more millionaires per day than any other industry." (Cited in: Malik, 2003 p242).

For further insight into this dimension of euphoria reference is made to e.g. *Disconnected – deceit and betrayal at Worldcom* (Jeter, 2003), *Enron – the rise and fall* (Fox, 2003), *Broadbandits – Inside the $750 billion telecom heist* (Malik, 2003), *Origins of the crash – The great bubble and its undoing* (Lowenstein, 2004).
It is interesting to note the striking parallel with the developments during the Rail Road Mania in the 19ths century, see Annex 3 for a summary, largely based of the account by Chancellor (1999) and Grote Lewin (1968).

2.3 Contagion

While in Section 2.1.6 the Netscape IPO in 1995 was identified as the public landmark signalling the start of the Internet bubble period, the analysis of the stock market growth in Section 1.2 has shown that the Internet bubble has broadly affected the high tech industries, in particular those industries that are part of the communications sector value chain, of which the Internet is a part. See Figure 28.

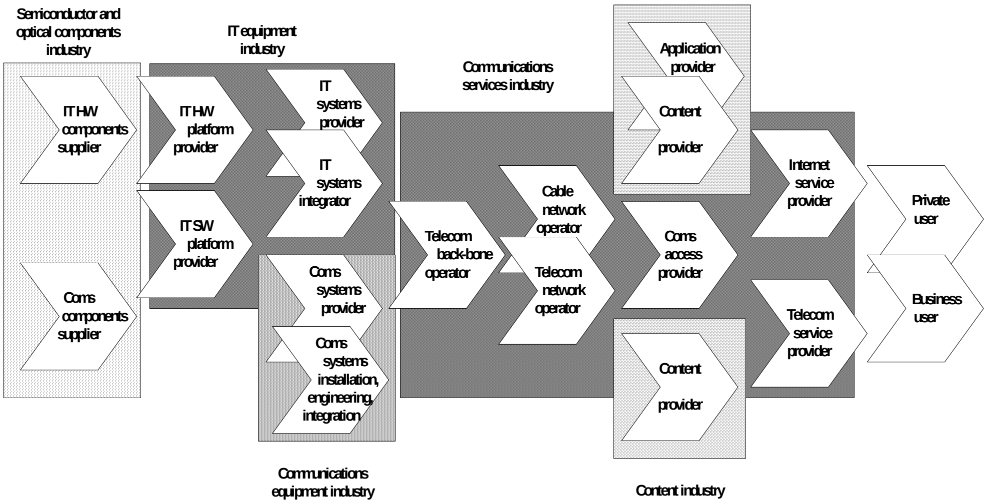


Figure 28. Value chain of the communications sector

The development of the Internet bubble can be described as a process that evolved at two interrelated levels: at the application level and at the infrastructure level. At the application level it is about the use of the Internet by business, by the government, by consumers. This is the *e*-enabled world or the *e*-economy consisting of e.g. *e*-commerce, *e*-business, *e*-auctions, *e*-procurement, *e*-government, *e*-education, *e-anything*. Expectations regarding the application level have a direct impact on the demands on the infrastructure level, which is consisting of computers and modems, providing the access to servers hosting the websites, and the telecommunications network, that provides the connectivity through routers and transmission links. In a competitive environment these demands get amplified as they migrate along multiple, parallel paths backward through the value chain. The throughput delays, e.g. in the form of manufacturing or installation times, which may increase as we move backward through the value chain, result in an assessment of demand even further into the future. A typical self-enforcing process that results in rapid contagion across the industry and along the value chain.

The fact that the Internet provides a common standard to facilitate communication across a wide variety of applications, implied that virtually every business and consumer is somehow effected. From the need to have an electronic storefront to the disintermediation of complete functions in the value chain. Hence, facilitating the contagion across the economy and society. Moreover, many of the precipitating factors discussed in Section 2.2.4 contributed to the process of contagion.

Malik argues that the biggest bubble was not the dot.com bubble but the telecom bubble. "Sure, the Internet boom, and the ensuing bust, was more visible. People actually saw the web sites that sold things like drugs, pet food, and groceries collapse. But the broad-bandits were another story. They were short sighted, greedy, and their financial mismanagement left the telecommunications industry in shambles. Former phone company salesmen, stock market analysts, accidental entrepreneurs, greedy financiers, and executives who made out like bandits are the villains of this drama. Their antics would make Alexander Graham Bell roll over in his grave." (Malik, 2003 p x). But there is a close link with the Internet bubble. He describes the unfolding of the bubble as follows (p xiii):

- Venture capitalists had been putting too much money into dot.coms. Since these dot.coms needed a place to host their websites, web-hosting companies like Exodus Communications were formed and consumed gobs of bandwidth.
- At the same time, companies that promised to deliver high-speed internet access to consumers using digital subscriber line technology (like Covad, NorthPoint Communications and Rhythms NetConnections) were beginning to grow quickly. These companies needed bandwidth to provide their growing customer base.
- Thus Level 3, Qwest, and Global Crossing – all providers of backbone networks to corporations and other phone companies – were born. These fast-growing networks required equipment.
- Enter the telecom hardware makers, like Lucent, Nortel, Cisco and eventually a host of start-ups that raised billions of dollars from venture capitalists eager to unseat the equipment-making incumbents.

As most of these players were starting from a small base the perception of demand for bandwidth was growing and perceived as endless. It gave birth to the notion that "Internet traffic doubles every 100 days." (p13)[30]. Research by AT&T Labs in 1997 by Coffman and Odlyzko revealed that the Internet traffic, according to their measurements and calculations was growing between 70 and 150 percent a year, or roughly doubled once a year (Coffman and Odlyzko, 1998; Malik, 2003 p 13-4)[31]. But, the myth continued to raise expectations in the industry.

The Telecom bubble is showing that entrepreneurs in telecom were not necessarily in business for the long run, to supply society with the means to communicate. While in the case the early competitive entries, such as MCI, the primary purpose could still be perceived as improving communications, the emergence of e.g. LDDS – later WorldCom – is an example of how deal making and personal gain moved to the forefront, and the provision of competitive, good quality telecom services faded into the background.[32] Global Crossing is a salient example of where a shrewd financial dealmaker grabs the opportunity offered by apparently insatiable appetite of investors.[33] The approach to bandwidth trading by Enron moved financial transactions and financial engineering to centre stage, telecommunications being considered just another commodity.[34]

Lowenstein in “*Origins of the crash*” observed: The telecom bubble was less widely chronicled than the dot.com mania, but in terms of the promises made, the dollars invested, the capital employed, and the risks to the economy engendered, it was by far the greater of the two.” (2004 p146-7). [35]

In the following Sections we will explore in further detail the developments in the telecom sector.

2.3.1 The telecom sector

While the developments in the telecom sector are directly related to the development of the Internet, as the communications network is providing the essential connectivity for the Net, the reform process in the telecommunication services sector created a dynamic of its own. The telecom reform process progressively lowered the barriers to entry. Data communication had been liberalized ahead of voice communication. Competition in the local access was being introduced through the Telecom Act of 1996 in the USA and the EU through the Directives to be effective January 1998. The prospective growth of the Internet combined with the increase in available funding gave a huge impulse to competition, through new entries in the sector. The sector developed its own euphoria, in particular in the long-distance infrastructure supporting the Internet (long-distance fiber networks, city-rings, Trans-Atlantic fiber optic routes) and in the competitive local exchange carrier area (CLECs in the USA).

In the following Sections we will address how the Internet euphoria affected the telecom sector. For the telecom industry the Internet means increasing demand on the existing infrastructure and demand for new infrastructures. It also implies the demand for new types of services and the emergence of a new category of service providers.
For every user logging on to the Internet using his/her PC a connection has to be established from the PC to the Internet Service Provider. For businesses wanting to provide e.g. an electronic store front a permanent connection has to be established between the computer hosting the website to the Internet via an ISP. To allow consumers to access the website a connection has to be established between the two, almost always different ISPs over the Internet backbone. These connections are established by routers at the network nodes, which are sending the packets of information over dedicated transmission links to each other. See also Chapter 5 Section 3.1 on packet mode, and the literature for a more extensive description of the Internet architecture, network infrastructure and the use of the Internet protocol stack, e.g. the *ISP survival guide* (Huston, 1999).

2.3.1.1 Internet access

Initially PCs at home were using dial-up connection to access the Internet, using the existing telephone lines. To support this new type of traffic local telephone exchanges would be equipped with ‘modem banks’ to separate and aggregate the Internet traffic. As the Internet traffic would block normal telephone traffic for many hours each day, the demand for second lines started to grow. ISDN provided a neat solution with 2x64 kbit/s channels to the homes, in particular in Europe.[36, 37]

The Morgan Stanley Internet Report predicted four consecutive waves in bandwidth growth, based on the evolving application opportunities and needs. See Figure 29 and Figure 30 (Meeker and DePuy, 1996 p9-2&9-3).

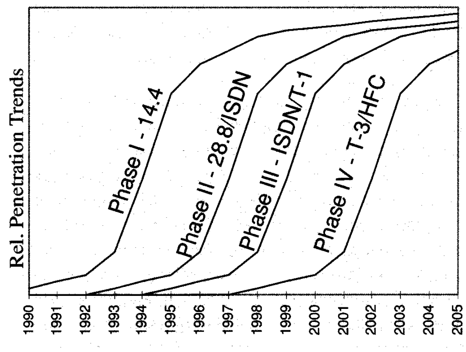


Figure 29. Bandwidth technology adoption to client station

Minimum Acceptable Technology*	File type	File size per page**	Times more than ASCII text	Time to download at 14.4 kbps***	Comments
First Wave					
14.4 kbps modem	B&W ASCII text (or e-mail)	4 kbyte	1	2.2 sec	- approximately a 1:1 ratio between characters and bytes
14.4 kbps modem	Color ASCII text	6 kbyte	1.5	3.3 sec	- requires ASCII control characters to identify following characters' color
Second Wave					
14.4 kbps modem	Typical web page	64 kbyte	16	35.2 sec	- with four 2"x2" .GIF/JPEG images (10% of screen graphics, rest text)
28.8 kbps modem	Complicated interactive web page	220 kbyte	55	122 sec (2 min 2 sec)	-75% of image is detailed graphics
28.8 kbps modem	Sound file attached to web page (e.g. 3Com)	220 kbyte	55	122 sec (2 min 2 sec)	- using RealAudio, 60 second playback, barely discernible AM radio sound quality****
64 or 128 kbps ISDN BRI adapter	Sound file attached to a web page*****	1 MB	250	556 sec (9 min 16 sec)	- 10 to 20 seconds of AM radio sound quality
Third Wave					
128 kbps ISDN BRI adapter	Video clip attached to a web page	3.2 MB	800	1,778 sec (29 min 38 sec)	- low quality, 2" x 2" image, choppy playback, 16 colors video clip, 60 sec playback
fractional T-1 line/ multi-plexed ISDN	Stereo sound file of music	3.7 MB	925	2,056 sec (34 min 16 sec)	- CD quality (digital) playback song of 2 min 30 sec length
T-1 line/PRI ISDN/ADSL	Full screen video (compressed)	11 MB	2,750	6,111 sec (1 hr 42 min)	- TV quality, full screen image, medium playback quality, 256 colors video clip, 60 sec playback
Fourth Wave					
T-1 line/ADSL/ CableModem	Next-generation highly interactive applications	20 to ??? MB	5,000 to ???	11,111 sec (3 hr 5 min)	- TV quality, full screen image, medium playback quality, 256 colors video clip, 60 sec playback

Figure 30. Four waves of bandwidth to the client station

Notes: * uncompressed or nominal data rate; ** based on typical file size; *** with 14.4 kb/s modem; **** considerably better with a 28.8 kb/s modem; ***** or a typical 2-3 page Microsoft Powerpoint slide show.

With growing usage of the Internet and a shift from the exchange of plain text based email to emails with large file attachments, to the downloading of information from websites, the transfer of images, and a trend toward audio and (near real time) video streaming, 56kb/s modems and 64kb/s ISDN lines were considered 'bandwidth bottle necks'. The CA-TV cable networks were able to provide a solution relatively quickly by introducing cable modems, providing speeds of up to 1504 kb/s, downstream.[38] Albeit, as the cable infrastructure is (in part) a 'shared medium' the effective throughput is lower as more users are active at the same time. In countries with a cable infrastructure, cable providers were able to take a lead in providing broadband access to the Internet. Telecom operators followed with the introduction of ADSL modems, providing initial speeds of 128 kb/s downstream and 64 kb/s upstream. In countries or regions with competing infrastructures, the provisioning of Internet access has led to first a 'competition for the market', followed by 'competition in the market'. In an attempt to keep customers increased bandwidth was being provided at essentially the same or lower prices (Van den Berg, 2004).

See Figure 31 for an illustration of the Internet related growth in Western Europe (ITU, 2002b), and Figure 32 for the bandwidth based competition in Internet access in The Netherlands (Van den Berg, 2004 p80).

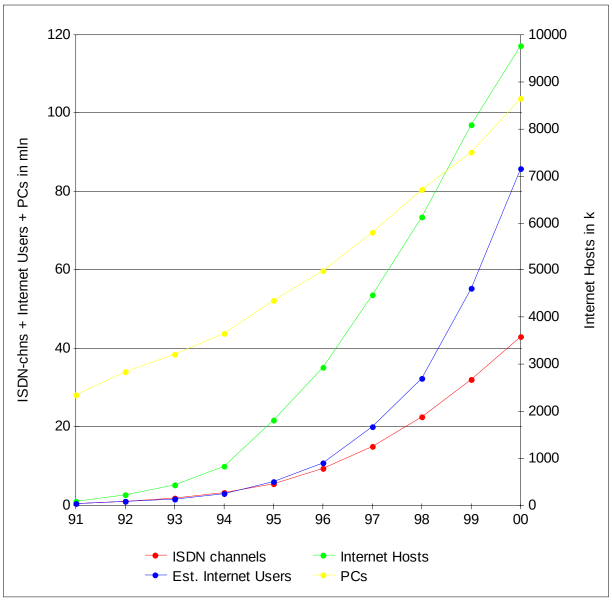


Figure 31. The Internet - Western Europe 1991-2000

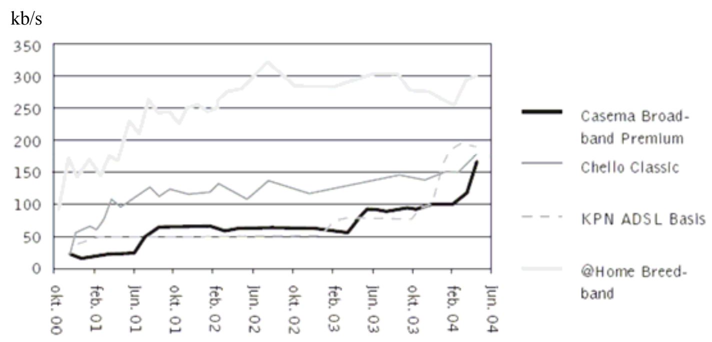


Figure 32. Competition in Internet access in The Netherlands, 2000-2004

The provisioning of Internet access stimulated the use of home networks or small LANs, mostly Ethernet based. Soon to be followed by wireless LANs, or Wi-Fi based networks (Economist, 2004).
Businesses were provided with access to the Internet, depending on their size and intensity of Internet use, in much the same way or through dedicated (leased) lines connecting to their LAN infrastructure. Larger enterprises were connected on the basis of (multiples of) 2Mb/s digital connections. Industrial research labs and university research centers would connect to the Net using digital pipes of 150 Mb/s and more.

2.3.1.2 Internet related service providers

Outside the research and educational community access to the Internet was provided initially to business through TCP/IP based networks that used private facilities or leased capacity from incumbent operators. Netcom, PSInet, UUNet and BBN Planet were some of the early commercial access providers to the Internet (est. 23,400 commercial subscribers and 690,000 individual subscribers by YE1995 (Meeker and DePuy, 1996 p3-9)).
Access for the general public was provided through On-line Service Providers (OSPs), such as America Online, CompuServe, Prodigy (est. 11,000 subscribers by the end of 1995 (p3-9)), soon to be followed and replaced by direct access through Internet Service providers (ISPs), such as the incumbent operators thereby leveraging their ownership of the access network. Cable providers were quick to realise the new services opportunity offered by the Internet. The existing cable network would be able to provide broadband speeds from day-one, albeit the networks required considerable investments to be upgraded to provide for two-way communication. In countries with a broad deployment of CA-TV networks, cable operators were able to take the lead in providing broadband Internet access, e.g. The Netherlands, Belgium, the USA. The introduction of ADSL (Asymmetric Digital Subscriber Line) modem technology provided the incumbent ISPs with an opportunity to compete in the broadband arena.[39] In countries with competing infrastructures, the 'competition for the market' is quickly followed by 'competition in

the market' on the basis of access speeds and costs. The opening of the local access to competition through unbundling, provided an opportunity for the entry of alternative access providers, to compete with incumbent telecom operators in the provisioning of broadband Internet access, mainly based on ADSL technology.

2.3.1.3 The CLEC bubble

The US Telecom Act of 1996 urged the incumbent local telephone companies to open up their networks to new competitors. According to Reed Hunt, chairman of the Federal Communications Commission at that time: "The ultimate judge of our competition policy is the capital markets. If they don't invest in competition, we won't get competition." (Cited in: Malik, 2003 p164). The opening provided by the Telecom Act was grabbed by many entrepreneurial companies – "…within three years, there were over 500 carriers, up from 243 at the time the act was passed." (p164). The incumbent local exchange carriers (ILECs) were forced to sell their services at wholesale rates for resale by the competitive local exchange carriers (CLECs). One of the other opportunities was to provide broadband Internet access. Many Internet users were frustrated by the low speed of Internet access using dial-up modems on telephone lines. Digital subscriber line (DSL) solutions would provide an attractive alternative of high speed and broadband access, at affordable prices. However, the success of companies such as Covad, was frustrated by the incumbent operators who, in protecting their business, were slow in providing access to the local network they owned. The US Supreme Court ruling in 1997 addressed this issue and would force the incumbent local exchange carriers (ILECs) to cooperate in unbundling the local loop and to provide access to other carriers.

Another type of telecom company that emerged after the Telecom Act was the so-called competitive local exchange carrier or CLEC. CLECs would typically provide local, long distance and Internet service to private and to small and medium business users.[40] They would require the cooperation of the incumbents, for interconnection and the co-location of equipment. Metro area network providers would be the next wave of competitive operators.[41] According to Malik:

> "Since the Telecommunications Act of 1996, new-age telecoms had raised about $ 213 billion in debt, and another $ 62 billion in convertible bonds (which are bonds that are convertible into an issuing company's common shares at a pre-set conversion price). This didn't include the debt raise by the likes of AT&T and WorldCom, which totalled a whopping $ 265 billion. In comparison, in the heyday of junk bonds, between 1983 and 1990, the total debt raised was $ 160 billion, and the companies that raised those bonds were mostly cash-flow positive." (Malik, 2003 p174).

As Suria, a convertible bond strategist at Lehman Brothers observed:

> "I don't believe the market would have given these companies all this money if it wasn't for the endgame. The endgame for these companies was always to sell out.[42] Nobody was looking to run a telecom services company 15 years down the line. The money allowed companies to go out and build networks and go after customers in competition with the old-line telecom companies, which had networks that were 30 to 40 years old. The argument of the New Economy

> companies was that the Old Economy companies had the customers and the revenue base, but they didn't have the networks. The new guys said, "We can borrow money from the markets, build out the networks and then sell to the guys who have the customers." ((From an interview by: Fromson, 2001 p5).

But this endgame became less likely as time progressed. The Old Economy companies were merging, bringing the number of potential buyers down from 13 to 7. And, although EBITDA of these companies increased by 65% over the period 1997-2000, interest costs grew by 85% and debt by 140%. In 2000 the credit spreads increased further as the bond market recognized the amounts that had to be spend on 3G wireless, estimated at US$ 300 bln, of which US$ 150 bln was estimated to be spend at spectrum auctions and US$ 150 bln for network upgrades and build-outs. Moreover, the New Economy companies would not be bought if total debt would significantly exceed the value of their plant and equipment. The new Economy companies had debt which was on average 60% more. Technology obsolescence would force amortization faster than expected in the business plans (p6-8):

> "As of the third quarter of [2000], these New Economy companies had $ 55.5 bln in cash… ..Expected interest and dividend payments were about $ 24 bln. The industry as a whole is not expected to get to $ 24 bln of positive cash flow until 2004. In the last 12 months, capital expenditures were about $ 52 bln. So, if the companies slash capex, they have about three or four quarters of cash left. That's why neither the debt nor equity markets are going to give them any more money… …They are not taken over… …They will restructure. You go Chapter 11." (Suria as interviewed by: Fromson, 2001 p8).

The incumbent local operators, after a period of retrenchment, had become aggressive competitors who defended their markets. Without a regular supply of fresh funds the CLECs would be "… gasping for cash. By 2002, only seventy of the three hundred CLECs that had been in operation in 1999 were still in business (Endlich, 2004 p228). See also Annex 5.

2.3.1.3.1 Cable Network providers

The Internet euphoria would also affect the cable sector, the salient example is cable broadband provider @Home. In 1995 TCI, one of the major US cable operators invested in the start up of @Home Corporation, to become a provider of high speed Internet access over the cable network. Later Cox and Comcast joined, providing @Home with exclusive access to 40 out of 105 million homes in the USA. The take-up of the service would be determined by the speed of upgrading the cable network to two-way communication. In 1999 @Home acquires Excite a Web portal. They reached 4.1 mln customers and were the dominant broadband player in the US, when they filed for protection under Chapter 11 in September 2001. According to Malik the cable operators Cox and Comcast made over US$ 3 bln; the Silicon Valley VC firm Kleiner Perkins Caufeld & Byers $ 575 mln; AT&T lost $ 3.3. bln; investors lost U$ 1.25 bln. (exclusive of shares bought at market price) (Malik, 2003 p139-60).

2.3.1.3.2 Wireless access based providers

With ample capacity in the Internet backbone, the local access remained the major bottleneck. With the ownership of the 'first mile' or the 'last mile' cable infrastructure in the hands of the incumbent operators, new entrants were pursuing alternative ways of connecting to the user's home or business. Fixed wireless technologies offered an alternative means of providing broadband access. Fixed wireless has a long record of deployment, specially in sparsely populated regions and in bridging difficult terrain.[43] Teligent started to exploit this opportunity in 1996, and made a very successful IPO in 1997, albeit it hardly had any operational network (Malik, 2003 p115-23). Winstar Communications, originally a reseller of local and long distance phone service, moved also into fixed wireless and was able to raise significant amounts of money from the financial community, as did Advance Radio Telecom (ART). The anticipated needs of the new fixed wireless operators gave a big boost to the equipment providers such as P-com, Netro and Broadband Networks. And many more equipment providers followed, creating a bubble in the fixed wireless market. In the end very few network installations were realised (2003 p123-38).

2.3.1.4 Content providers

In the US, in contrast to most European countries, cable network operation had been linked closely to the provision of content. In the early 1990's the notion of an emerging Information Super Highway, as a precursor to the Internet, had led to a number of 'full service' trials by e.g. Time Warner in Orlando, providing video-on-demand, games and online shopping. AT&T teamed up with Viacom (MTV and Nickelodeon) to build a trial in California, and Microsoft and TCI in Seattle. This teaming up to explore the future led to a bidding war for Paramount Pictures between Viacom and QVC (a home-shopping network), driven by the notion 'content is king'. With Viacom would align Nynex and Bell South (regional telecom operators) and on QVC's side Comcast and Cox (cable operators). At the same time Bell Atlantic (telecom operator) pursued a merger with TCI. (a cable company). Viacom would win the battle and the merger with TCI would be called off (Cassidy, 2002 p47-50). The process of telecom reform had changed the position of the incumbent operators dramatically. As a privatised company they came under the regime of the financial market and were expected to show growth quarter over quarter. Their once 100% market share could only come down, as competition would increase. Moving up the value chain into content was one of the options being pursued, e.g. by KPN, the incumbent operator in The Netherlands. KPN became involved in the set up of a TV-channel dedicated to sports (Sport-7). An initiative that proved to be short lived. At the same time, Telefonica of Spain would acquire Dutch TV producer Endemol Entertainment.

Upon the arrival of the Internet incumbent operators would expand their portfolio to provide Internet access, and become an ISP. Moving up the value chain would imply moving into the content business and linking it to the Web. A few examples: Telefonica would acquire Lycos, a major web search company, in 2000. By the end of 1999 Qwest decided to move into the Web-hosting and software-on-demand business (Malik, 2003 p54). In December 2000 Vivendi, owner of e.g. telecom company Cegetel and European pay-television company Canal Plus, would merge with Seagram's Universal (Johnson and Orange, 2003).

The other direction open to service providers was to become an application service provider or ASP, a logical extension of the ISP model. In the ASP model the service provider would package and be hosting enterprise applications and related services, which would be accessed by customers over the network on a 'rental' basis, thereby offering the customers increasing speed of implementation, and minimizing expense and risk associated with the entire application life cycle (IDC, 2000).[44]

2.3.1.5 Backbone providers

In Section 2.1.1 we already discussed the initial developments of the Internet backbone network, starting in 1982 with the ARPANET, in the military/research domain, and then the NSFNET in the research and educational domain. To be complemented by network developments in the commercial domain, starting with PSINet in 1989 to be followed by the creation of RIPE in 1989 and CIX in 1991 to create a 'network of networks', on a worldwide basis. In 1995 the Internet 'transitioned' from the public to the private sector, with the retirement of the NSFNET backbone. With the growth of voice traffic in the 'single digit' range, the growth and anticipated growth of the Internet, doubling every year, became the main driver for network expansion by the local telecom operators and long distance carriers. Leadership in the Internet arena became a main thrust for existing long distance carriers such as AT&T, MCI and Sprint, and new companies like LDDS, the forerunner of WorldCom.[45]

LDDS, led by Ebbers, build its position in fiber through e.g. the acquisition of WilTel, "…originally established as Williams Oil & Gas, [which] had become the nation's fourth largest fiber network [11,000-mile network] by running single-mode fiber lines down pipelines abandoned as a result of natural gas deregulation in the early 1980's." (Jeter, 2003 p53). In 1996 LDDS acquires MFS communications and thereby Internet giant UUNET (Jeter, 2003 p vii).[46] By 1998 Worldcom had grown its business through 60 acquisitions for a total of US$ 70 bln. By the end of 2001 it would report US$ 35.2 bln in revenues and US$ 30.2 bln in debt; by September 2002 it had US$ 107 bln in assets and US$ 41 bln in liabilities, while goodwill had swelled to US$51 bln. (Jeter, 2003 p157; Malik, 2003 p35). While being recognized as an Internet carrier, in 2000 54% of its revenues were related to voice.

SP Telecom, later Qwest, provides for a similar story line by digging fiber alongside railway lines. SP (Southern Pacific) Telecom, a former subsidiary of the rail road company, would create its optical fiber network (18,500 miles by 1999) 'by dropping a few fiber lines for its own use', while providing construction services to e.g. MCI, Frontier Communications and WorldCom (Malik, 2003 p45-7). Qwest, under the leadership of Nacchio, expanded its network by acquiring in 1998 LCI International, then one of the largest long distance carriers in the U.S., almost 3-times its size in revenue. In 1998 Qwest started to offer long distance phone calls for 7.5 cents a minute, a move that: …pretty much knocked the wind out of the long distance business." (p53). Figure 33 provides a snapshot of the spending on optical by the major operators in the year 2000; the spending reached a total of US$ 80.7 bln, a 38% increase relative to 1999 (Kalla, 2000 p10).

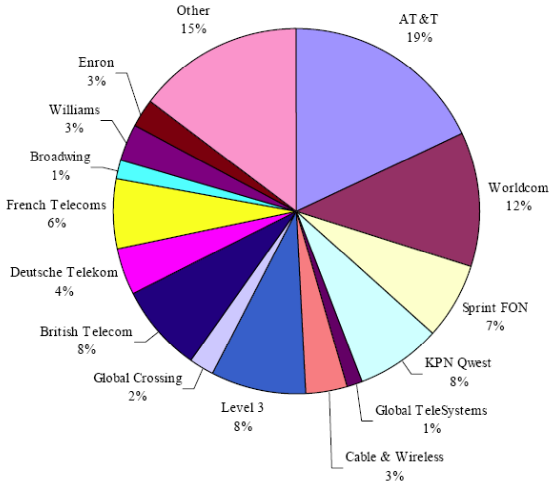


Figure 33. Carrier share in optical spending 2000

Other new players would focus on the US$ 90 bln revenue stream that is linked to the existing submarine cable network. A network that is *grosso modo* built and, often jointly, owned by the incumbent operators.

One of the first grand-scale initiatives was taken in 1989 by FLAG Telecom, led by Tagare, to create a fiber-optic link around the globe. Backed by Nynex, FLAG built a cable system from England to Japan, with a length of 25,000 km. The success of this project led to Project Oxygen, which was launched in 1997. This was a project that would span the globe, a fiber-optic cable network that would span close to 200,000 miles, with a capacity of at least 320 Gb/s. At a big Las Vegas event carriers bought into US$ 3 bln of the planned US$ 7 bln. The project was further backed by equipment providers such as Alcatel Submarine Networks, Tyco Submarine Systems and Lucent Technologies (Malik, 2003 p68-70).

Also in 1997 Winnick starts Global Crossing, together with two former AT&T executives of the Submarine Division, who had devised a plan for the construction of an undersea fiber optic cable connecting the USA to the UK and Germany. “The business plan claimed that a transatlantic network would eliminate a communications bottleneck and allow the company to sell that bandwidth to long distance companies... …Using Global Crossing’s pipe, the costs could go down drastically – to about 38 cents an hour. And that meant phone companies like AT&T and MCI could offer 5-cents-a-minute phone connections to London. Cheaper calls meant more people would talk more, and that in turn would fill up the network, thus forcing phone companies to buy more capacity from Global Crossing.” (p64-7). As Winnick was able to persuade the original backers to change sides, by 1999 Project Oxygen failed. Global Crossing, however, by offering capacity at a strong discount, managed to cover half of the investments before the construction work started. This formula of success would eventually lead

to more than 85,000 miles of Atlantic and Pacific fiber routes being owned by Global Crossing (p67-8). To fill the pipes, Global Crossing in 1999 made a bid for US West and Frontier Communications. Qwest won the ensuing fight for US West, while Frontier was acquired by Global Crossing.
Also in 1997 Level3 Communications was set-up by Crow, a former CEO of MFS and former board member of Qwest. Essentially applying the same business model, the company proposed to build a 16,000 mile long fiber network, including alongside rail road tracks. It would end up with also building 4750 miles of fiber network in Europe (p91-2). As a result the combined investment plans for undersea optical cables doubled in 1999 compared to the three previous years. See also Figure 34, note that the years 2002-2004 are estimates (KMI Research, 2002). See Annex 7 for more details on the build out of optical networks and the carriers and equipment providers involved.

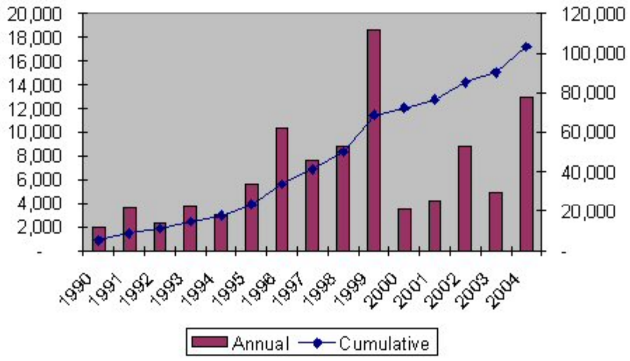


Figure 34. Unrepeatered System Installation in Route-km, 1990-2004

The increase in fiber capacity led to dramatic price erosion in the lease of long distance capacity. Table 4 provides an example for OC-3 (155 Mb/s optical link) lease prices on a number of US domestic routes (Telegeography, 2002).

Route	1Q2000	1Q2001	1Q2002	Change 2000-01	Change 2001-01
LA - NY	1,000,000	600,000	200,000	-70%	-70%
Miami – NY	900,000	200,000	100,000	-80%	-50%
Atlanta – NY	400,000	200,000	70,000	-50%	-70%
Chicago – NY	400,000	200,000	70,000	-50%	-70%
Atl. – Dallas	300,000	200,000	60,000	-30%	-70%
LA – San-Fr.	200,000	90,000	30,000	-60%	-70%
NY – Wash.	200,000	50,000	20,000	-80%	-60%
Boston - NY	100,000	50,000	20,000	-50%	-60%

Table 4. Yearly OC-3 Lease Prices in US$ on Major U.S. Routes

In the end, according to KMI Research, about 80.2 million miles of fiber was installed in the United States between January 1, 1996, and December 31, 2001, which is almost 76 percent of the cumulative installed base of 105 million miles, going back to 1980 (Malik, 2003 p xi).

"In hindsight [Thompson, former chief executive of LCI] pointed out that since new technologies such as Dense Wavelength Division Multiplexing were being developed by companies like Ciena, the market was going to be flooded with bandwidth. This technology allows you to splice the beam of light into many colors and increase bandwidth over existing fiber-optic backbones without installing a new fiber. It was going to make bandwidth a commodity…" (p53).

2.3.1.6 Bandwidth capacity trading

Hitherto the prevailing model for the construction of submarine communication links had been facilitated through consortia of incumbent carriers. Capacity in the jointly owned links would be assigned typically in relation to the individual participation in the funding. A possible mismatch between capacity ownership and capacity needs would be arranged, where possible, trough capacity swaps. These swaps would be concluded through long term contracts or IRUs (Indefeasable Rights of Use), which could run up to 20 years. The introduction of optical technology and competition resulted in rapidly decreasing prices for long distance capacity, which made long term IRUs less attractive. In 1996 an initiative was taken to create a neutral market place to facilitate the trading of capacity; Band-X was established in London as a telecom broker (Malik, 2003 p101). Other exchanges established include Rate Exchange and ArbiNet. However, as these exchanges did not provide for real-time interconnections, there was no real-time settlement or guarantee of delivery (McGarty, 2001 p277).[47]

This idea was picked up by Enron who liked to trade bandwidth as they had done in the oil, gas, and electricity markets. "[I]t should become a disrupter in the bandwidth markets as well." (Malik, p100).[48] In the perspective of Malik: "Enron was one of the many outsiders who jumped onto the broadband business. Its foray and attempts to muscle in on the broadband business were purely opportunistic, for personal gain and as a means to sprinkle some broadband pixie dust on their old-economy stocks. In the process Enron ruined a once thriving market by starting a price war, which brought the telecom industry to its knees." (p100). In December 1999 Enron announced its first bandwidth trade, it bought a forward contract on DS-3 bandwidth between New-York and Los Angeles from Global Crossing. In 2000 it brokered 300 trades (Fox, 2003 p163). "Not satisfied with the price undercutting, Enron decided to make the actual pricing and indices available." This resulted in corporate customers to demand price cuts from their carriers. "Revenues and any notion of profits nose-dived." Later on, the company announced that it would publish the bandwidth prices on the Web, for all to see. "It alienated the company further from potential partners." (Malik, 2003 p100 & 105).

2.3.1.7 Role of the financial industry

As the reform process proceeded, the telecom industry had become an interesting new market opportunity for the financial industry. Privatisation of the telecom operator implied in most cases a listing at the stock market and hence trading in shares, and sometimes an IPO. With the transition from a public entity to a private entity, financing of investment would involve a call upon financial markets, providing the banks with underwriting fees, etc. The need to demonstrate

continuous growth also triggered a growing opportunity in mergers and acquisitions. To meet the growing demands investments needed to be financed. Lowenstein observed: “The cumulative investments marked the greatest binge in the history of private finance. In the half-decade after deregulation, telecom companies borrowed $1.6 trillion from banks and enlisted Wall Street to sell $ 600 billion in bonds. They raised billions more in stock sales.” (2004 p150).[49] The telecom sector became a very important client segment: “[I]nvestment banking fees (including debt, convertibles, and equity-related issues) for the telecom sector increased from a mere $ 1.06 billion in 1996 to $ 4.14 bln in 2000” (Source Thomson Financial data, as cited in: Malik, 2003 p169). Lowenstein observed that: “Wall street’s fees for selling telecom stocks and bonds totalled more than $ 20 billion, vastly more than the bankers’ take on the… …dot-coms.” (2004 p150). The role of analyst cum investment bankers, e.g. Jack Grubman of Salomon Smith Barney, Henry Blodgett of Merill Lynch and Paul Johnston for BancBoston Robertson Stephens, has already been addressed in Section 2.2.4.7. (See e.g.: Malik, 2003 p181-99, 243-4). According to Jeter, Grubman alone would help raise US$ 190 billion for WorldCom, Qwest, Global Crossing, and 78 other telecom companies (Jeter, 2003 p62).
An important element in the game was the competition among bankers. The telecom boom coincided with the repeal of the Glass-Steagall act, which was instigated in 1933 to separate underwriting from banking and insurance. As Stiglitz later observed: “One cannot simultaneously claim that it is important that banks be integrated, to take advantage of what economists call economies of scope….and also that it is important for the parts of a bank to be compartmentalized, to avoid any conflicts of interest.” (as cited in: Lowenstein, 2004 p97).
Malik provides an illustration of the competition, whereby J.P. Morgan Chase’ share of the telecom merger advisory business jumped from the ‘low single digits’ in 1998 to 17% in 2000, mainly through the business from Global Crossing (Malik, 2003 p72).

Depending on the profile of the client and the purpose of the financing, different instruments were being used. A salient example is the high-yield bond market, which was used by many new entrant telecom operators. Between 1996-2000, this market raised $ 502 billion, of which $ 240 billion was for telecom and media. “To put this in perspective, throughout the 1980’s it raised only $ 160 billion. A key difference is that the companies that raised money using junk bonds in the 1980s were industrial companies with hard assets that generated positive cash flow and had products… …So in some ways, the companies that borrowed in the ‘80s were a lot more creditworthy than the companies of the ‘90s.” (From an interview with Suria, a bond strategist at Lehman's: Fromson, 2001 p4). From his analysis Suria concludes: “This industry has by far the most egregious misallocation of capital – of spending money when you are not making money, of borrowing money when you don’t have the ability to pay it back. The sad part is that the industry that has done this never really existed before in the sense that the new companies did not exist before the Telecommunications Act of 1996, and the old guys had been in a regulated environment – i.e., they never borrowed this much money before.” (Fromson, 2001 p11). He concludes: “This time you are borrowing to spend the money and letting loose a bunch of companies in a highly competitive free market under disinflationary pricing and telling them to make enough money to repay the original investment… …This is an experiment that has never been tried before… …It is hard to see a happy ending under the current spending scenario."

See also Section 2.3.1.10 on vendor related project financing.

2.3.1.8 The role of X-over-IP

The transmission of voice using the IP protocol (VoIP) dates back to the early 1980's and was preceded by proprietary applications on computer networks in the 1970's (McKnight, Lehr et al., 2001). As the Internet uses nondeterministic switching (datagrams), real time voice connectivity of reasonable quality could only be provided by overprovisioning of bandwidth. Hence, early applications of Voice over IP (VoIP) could be found within corporate intranets or virtual private networks, primary to save on transmission costs. Also differences in international long distance tariffs were exploited by arbitrage using VoIP. Clark argues that the long term advantages of VoIP are related to computer mediated human communications, the distinguishing characteristic of these applications not necessarily being lower cost but enhanced functions, provided by the computer (or computer based appliance) that provides the enhanced end node functionality (Clark, 2001).[50]

The large scale development of VoIP hinges on the need for devices being used to be 'always on' and the improvement of the quality of service (QoS) through protocol enhancements, such as diffserv and RSVP.[51] The early growth of VoIP is shown in Figure 35 (McKnight, Lehr et al., 2001 p182).

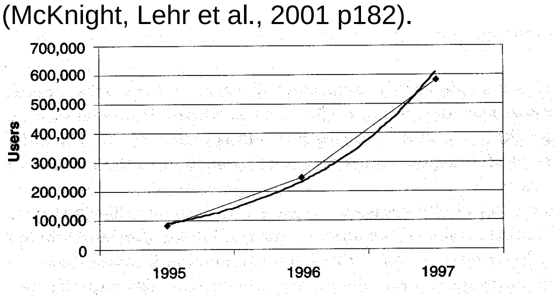


Figure 35. Growth of IP telephony users 1995-1997

2.3.1.9 Telecom equipment providers

As stated earlier the telecom industry had been characterized by a close link between the national operators and their national telecom suppliers. The telecom reform process facilitated the entry of new operators and thereby the entry of existing, but previously excluded equipment providers, and new providers. For instance the entry of Nortel Networks (formerly Bell Northern Telecom, a subsidiary of Bell Canada) into the US transmission systems market has been facilitated through the emergence of MCI and Sprint, as competitor to AT&T and its equipment subsidiary Western Electric. As a more agile company Nortel also used

the transition from analogue to digital switching to force an entry in the so called RBOC (Regional Bell Operating Company) market, to become a second supplier next to AT&T.
In the race toward increasing bandwidth capacity on fiber optic cables AT&T, and later Lucent Technologies, was in competition with in particular Nortel and the new start Ciena, Nortel persuaded new entrants like Qwest and Level3 to adopt their new high end systems (Malik, 2003 p207-8). Global Crossing remained a key customer for Lucent Technologies, always eager to obtain the latest generation of equipment, to be able to play out the advantages of lower cost and higher bandwidth over its rivals. While Lucent had a focus on DWDM to increase the data rate on a single fiber[52], Nortel pushed for higher raw data rates,[53] and also recognized the volume opportunity offered by the expanding markets in short haul, e.g. in metropolitan areas (Endlich, 2004). Figure 36 reflects the estimated optical systems market shares in 2000 and 2001 (Kalla, 2000 p9).

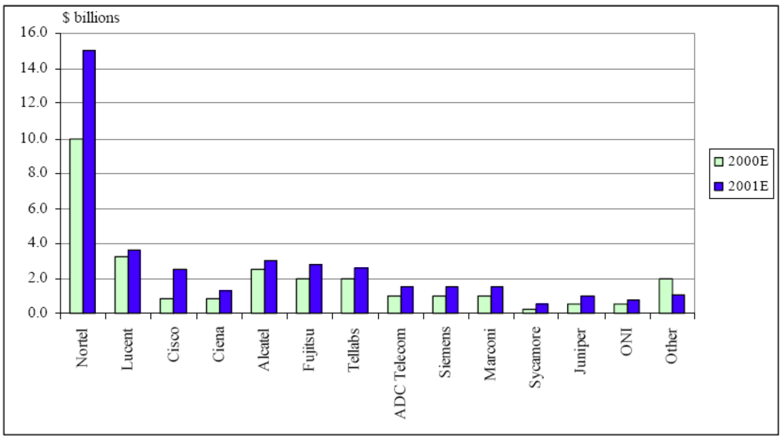


Figure 36. Optical systems market share by vendor 2000-2001

While transmission capacity of existing cables could be expanded manifold, and with relative ease, through the use of wavelength division multiplexing (WDM or DWDM, for Dense WDM), new routes require new fiber cables. In the height of the fiber boom providers of fiber optic cable, such as Corning, Lucent Technologies, Alcatel, Furukawa, were fully exhausting manufacturing capacities, as a result deliveries were on allocation and thereby tying up sales of related transmission equipment. To characterize the situation in the final days of the fiber boom Malik observed : “The entry of companies like Enron and other utility companies into the broadband business was like pouring fuel on the fire. The demand for basic equipment needed, such as optical switches, transport systems, and fiber, went skyrocketing to about $105 billion in North America in 2001.” (Malik, 2003 p107).
The growth of the Internet provided opportunities for new entrants in the equipment industry such as Cisco (founded in 1984), Ascend Communications, Cascade, StrataCom and Bay Networks. These companies focussed on the development of packet switching, routers and access equipment, thereby exploiting the paradigm

shift from circuit-mode communication too packet-mode communication. See also Chapter 5 Section 3.1. In an attempt to bootstrap the in-house capabilities in this new field, incumbent telecom equipment suppliers acquired new start-up data communications companies paying top dollar, albeit mostly in (inflated) shares. In 1996 a trivestiture divided AT&T into: AT&T as the long distance operator, NCR (regaining independence since its acquisition in 1991) and Lucent Technologies the equipment arm. Freed from its linkage with an operator, the company had gained full freedom in addressing opportunities in the telecom market.
In the heat of the battle for supply to the construction of the Internet, Nortel and Lucent Technologies went into an acquisition frenzy. Nortel acquired between 1996 and 2000 18 companies for a total value of US$ 30 bln. (p210). The most significant acquisition for Nortel was Bay Networks in 1998 for US$ 9.1 bln. Between 1996 and 2000 Lucent Technologies acquired 38 networking companies for approx. US$ 43 bln. (p216). Lucent' most significant acquisition was in 1999 when it bought Ascend Communications for US$ 24 bln,
Cisco, an early start-up in the Internet era and leading provider of routers for the Internet, applied a growth strategy through acquisitions. The most significant acquisitions were StrataCom in 1996 for US$ 4.7 bln, Cerent in 1999 for US$6.9 bln[54], and ArrowPoint communication in 2000 for US$ 5.7 bln. Although firmly positioned as provider of routers c.a. for the Internet, initially with a focus on the enterprise market and later the telecom market, optical kit was missing in the Cisco portfolio. Therefore it acquired StratumOne to boost its hardware expertise, followed by Monterey and Cerent (Bunnell, 2000 p193).
Broadview International reported that the total of mergers and acquisitions in the telecom industry in North America and Europe topped at US$ 189 bln of which US$ 71 bln in the year 1999 (Cited in: Malik, 2003 p266). See further Annex 6 *Acquisitions in the telecom sector*.
The success of Cisco, as an independent provider to the Internet, and the amounts paid at the time for acquisition targets, led to a wave of start-ups in the field of optical and packet switching and routing equipment companies. In 1999 followed a wave of IPOs: Extreme Networks, Juniper Networks, Redback Networks, Copper Mountain Networks, Foundry Networks. These companies averaged returns of 240%. Thereafter a wave of start-ups in the field of components followed, e.g., E-Tek Dynamics, SDL, NetOptix. And subsequently in 2000 a wave of IPOs: Corvis, Agility Communications, CyOptics, Lantern Communications, Yipes Communications, Chiaro Networks (Malik, 2003 p267-71). In 1999 also the merger of component makers JDS-Fitel and Uniphase into JDS-Uniphase took place.[55] Upon which also this company went on a buying spree of US$ 61 bln in 3 years, paying hefty premiums of up to 50%. See further Annex 6.

To illustrate the roller coaster ride where the telecom industry was in during the period 1995 - 2002, the financials of a sample set of US telecom equipment companies is shown in Figure 37 (Meeker and DePuy, 1996 p 19-6) and (Capital IQ as cited in: Malik, 2003 p225 & 230).

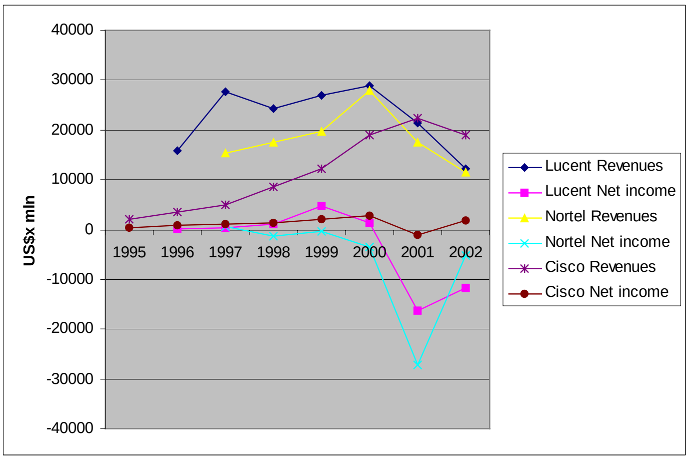


Figure 37. Financials of telecom equipment providers 1995-2002

Notes: Lucent started operating as an independent entity in 1996. Prior data is embedded in the AT&T financials. Lucent' financial year ends September 30. Cisco's financial year ends July 31.

The performance of telecom equipment vendors was directly driven by the capital spending on telecommunications by new and existing carriers. In the period 1996 to 2001 spending would rise at the rate of 30% per year and topped US$ 350 bln. In 2001 the decline sets in, telecom spending decreased by 10 percent; by 2002 the demand crashed with a decline of 43% (Endlich, 2004 p87 & 240).

2.3.1.10 Project financing

At the times telecom operators were by and large state owned, investments had to be internally financed from a positive cash flow. Public funds were not readily available, more often state utilities were expected to shore up the public finances. Once a private company, telecom operators could also approach the private equity and bond market to obtain external funding. This was also presented as a major argument in favour of the telecom reform process. Existing telecom operations would be considered by bankers as a highly stable and predictable business, with low levels of uncertainty or risk attached. Hence, projects that made business sense could be financed with relative ease. Not all operators of interest to telecom equipment providers were in such a comfortable position. Specially when pursuing export sales to developing markets, equipment vendors were invited to assist in the financing of their projects. Often their reputation mattered to financiers, also their ability to assure that projects, once implemented, would be able to generate revenues.[56] Telecom equipment vendors would typically have a Project Financing department to assist in the financial deal making between the customer or prospect and the financial community.

The process of telecom reform opened the market to many new entrants. If these new entrants were subsidiaries of incumbent operators abroad, a financial track record could be shown. However, new entrants not being able to demonstrate a

track record of steady returns, had a harder job of convincing financiers. They had to present more compelling business plans, and point to untapped market demand and assure demand growth. They leveraged their advanced technology choice, which would result in a much lower cost base than the incumbent competitor. And argued their ability to attract new customers or lure them away from the incumbent competitor. During the period of euphoria, when ample funding was available, many new entrants were supported, if not coveted, by the financial industry, in order to earn attractive fees. Competition among bankers in this high stakes game, would typically lead to alignment between an operator and a banking firm.[57]
Recognizing that new entrants represented an increasing share of the market and that this was a 'battle for the market', as very few of them would pursue a multiple sourcing policy, they had to be captured at the point of market entry. Or more precisely before market entry. In this increasingly crowded market, the latest entrant has one advantage over the incumbents, it can exploit the latest generation of equipment on offer, providing ever higher capacities at lower costs. Moreover, vendors typically need the cooperation of operators to test and refine their latest designs in the field. For Nortel Qwest and Level3 were the new entrants providing this role. For Lucent Technologies it was Global Crossing and Winstar.[58] In pursuing its growth through new entrants e.g. Lucent Technologies announced that it would provide US$ 2 bln in equipment and financing to Winstar communications, a provider of fixed wireless broadband, and Siemens Financial would provide US$ 200 mln. Nortel provided US$ 750 mln vendor financing to Teligent (Malik, 2003 p126 & 129 & 135). By the end of 2000 the nine largest telecommunications equipment vendors had US$ 25.6 bln in loans to customers on their books (Endlich, 2004 p155).
The cooperation of an operator is of particular importance to start-ups that have to proof the viability of their first products, and credibility to the financial community. Sycamore and Williams teamed up for this purpose, apparently facilitated through the allocation of IPO shares. A similar partnership evolved between Cosine Communications and Qwest (p246-7).

2.3.2 International contagion

Shiller provides the following general statement on international contagion: "This social basis for attention, operating by word of mouth and facilitated by media transmission of ideas, can generate attention focuses that spread rapidly across much of the world. With a substantial fraction of the human minds on the planet suddenly grabbed by the market, it should not be at all surprising that markets on opposite sides of the globe move together, even if the fundamentals in different countries do not suggest any reason for such co-movement." (Shiller, 2001 p165). This general social principle comes on top of the fact that financial markets are globally connected and that the industries involved in the Internet are globally oriented. Moreover, there is the 'low threshold' nature of the Internet and the difficulty for governments to stop it penetrating their territories, as the role of the Internet in the political developments in Russia and China has demonstrated.

2.3.2.1 International contagion – Europe

Shiller provides the following observation on the contagion effect:

> "The Internet boom, the decline of foreign economic rivals, cultural changes tending to lionize business success, expanded media reporting on financial news, analysts' increasingly optimistic forecasts, the decline of inflation, and the expansion of the volume of stock market trades are all factors in Europe, though often not as strongly felt as in the United states. Although Europe had less of a post-World War II Baby Boom than the United States, it did have a pronounced Baby Bust after the mid-1960's. Europe does not appear to show the same increase in gambling opportunities evident in the United States. Nevertheless, even though not all the precipitating factors are operative in Europe, the strong cultural connection between the United States and Europe, and the effects of U.S. investors' demand for European stocks, should cause a substantial contagion effect." (Shiller, 2001 p263-4).

Moreover, and as noted before, the telecommunication services sector is subject to its own dynamic and became susceptible to euphoria. In Europe, the incumbent telecommunications services firms were privatized and became listed at the stock exchange, and as such became subject to the 'stock market regime', and became objects of trade. New entrants benefited from the improved financial conditions, and as a result competition in the services sector increased. Early players were the utility companies (energy and transport) that could leverage their networks, initially build for internal use, for external customers. Also a new phenomenon emerged: European long-distance carriers. Incumbents and new entrants started to build pan European optical fibre networks, for own use as well as for resale purposes. A 'consensual opinion' (see Section 2.2.3) about the newly created opportunity and the need for a 'winner-takes-most' strategy formed the basis for a European telecom bubble to develop (see Section 2.3.2.1),

2.3.3 Pan European optical network bubble

The full liberalization of the European telecom sector announced in 1996 and to be effective in 1998, led to the opening up of a totally new telecom market segment – Pan European optical fiber networks. Hitherto international traffic within Europe had been handled through bi-lateral agreements between national operators and facilitated primarily through interconnections of national networks.[59] Incumbents and new entrants alike recognized the new business opportunity. Driven by expectations of growing demand and facilitated by optical technology and willing investors, they all started to implement following a very similar business plan: interconnecting the nodes with the highest traffic intensity first. Initially these were the financial centres (London, Frankfurt), the major business centres and capital cities, later followed by the hot spots of web hosting, often in the same cities. Traffic would be aggregate at the city or metropolitan level using fiber ring infrastructures. For an impression of the metropolitan fiber ring networks being build, see Figure 38 and for web hosting see Figure 39 (Lucent Technologies, 2005).

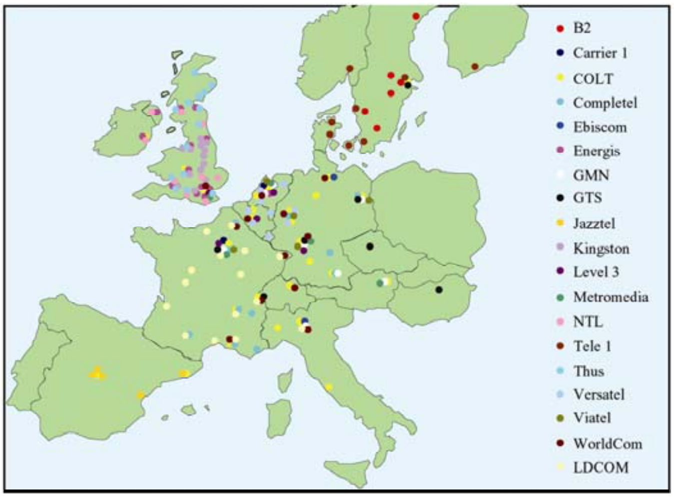


Figure 38. Metro fiber in Europe

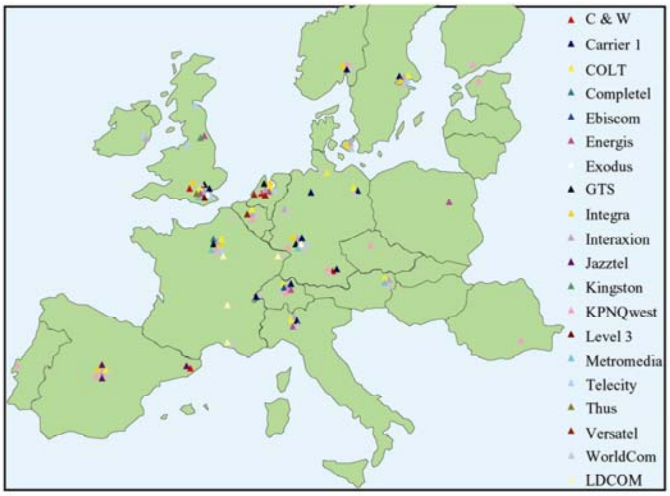


Figure 39. Web hosting in Europe

Although these developments were triggered by the telecom reform process, the frenzy that resulted has clearly been influenced by the developments in the Internet and telecom market in the US. Many of the same new entrant operators are involved (e.g. Global Crossing, Qwest, Level 3, WorldCom, Viatel). In 1999 the joint venture of KPN of The Netherlands with Qwest, as KPNQwest, is another case in point. By 2001 KPNQwest would serve 60% of long distance Internet traffic in Europe (Malik, 2003 p55). Moreover, many of the equipment suppliers involved were closely linked to the US telecom market (e.g. Lucent Technologies, Nortel, Cisco, Corning, SUN). It may be concluded that contagion has played a role in the development of the European telecom bubble.

Figure 40 shows an impression of the Pan European network builds in which Lucent Technologies was involved through the provisioning of either fiber optic cable, optical transmission systems or data communication equipment (Lucent Technologies, 2005).

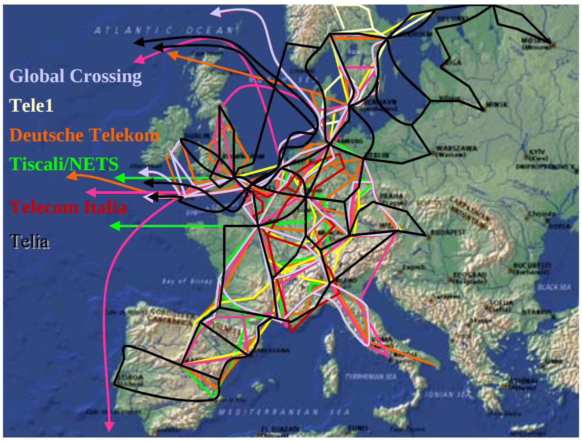


Figure 40. Pan European fiber optic networks

The bubble nature is well illustrated in Figure 41 showing an overview of Pan European fiber deployment for the period 1997 – 2002 (KMI Research, 2001).

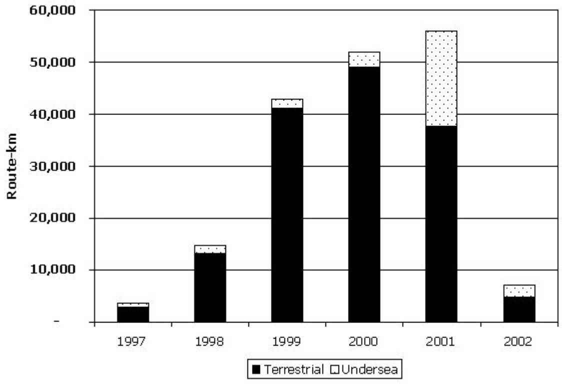


Figure 41. Pan-European Fiber Deployment (Route-km), 1997-2002

See further Annex 7 Optical network build out.

2.3.4 Internet access competition

For a general description of Internet access see Section 2.3.1.1.

2.3.4.1 The mobile Internet

In Section 2.1.4 we already explored the role of GSM as a candidate 'displacement' for the recent euphoria. We concluded that GSM was not the trigger for the euphoria, but in Europe it played an important role in the high-tech boom, the rapid growth of GSM users illustrates the point. See also Figure 15. Future growth was expected to be in data applications, rather than in voice, which has stimulated the industry to pursue solutions to provide data-on-the-move and m-commerce. The deployment of WAP (Wireless Application Protocol) in 1998 was an early attempt to link to the Internet. It links the circuit switched mobile telephony world to the packet switched Internet world. A Wireless Mark-up Language is being used to bridge the differences in terminal capabilities between stationary and mobile terminals (Botto, 2002 p W3-W10). The introduction of GPRS (General Packet Radio Service) is providing for a packet overlay and increasing the user data rate to a maximum of 171 kb/s. GPRS supports applications such as email, Internet browsing, as well as value added services. GPRS has been denoted as 2.5G, or the intermediate step towards broadband mobile communication, to be made possible by the third generation of mobility, 3G or UMTS (Universal Mobile Telephone Service). In 1999 the expectations regarding e-mobility were high. See for an illustration Figure 42 (Lucent Technologies, 2005).

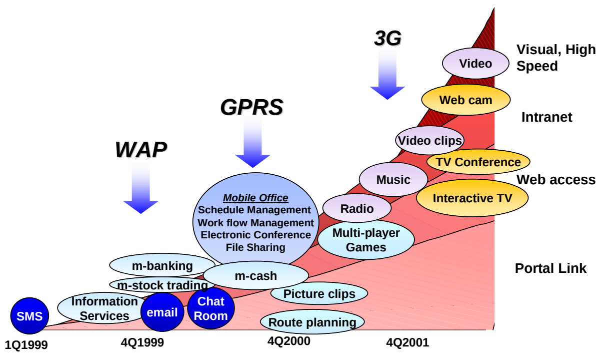


Figure 42. The e-mobility promise

In Japan the introduction of I-mode by NTT DoCoMo in February 1999 showed the potential of mobile communication beyond plain voice. Within six month from the start the 1 million subscriber level was reached. By August 2000 the 10 million mark was reached, by October one third of DoCoMo's mobile subscribers had signed up for i-mode. I-mode offers Internet access and email, as well as access to third-party provided fee-based services (approx. 50% of total I-mode subscribers; the top-3 services are: games, ringtones and karaoke) (Natsuno, 2000 p1-23).
The success story of 2nd generation GSM, combined with the success of the Internet, raised the expectation for mobile broadband communications. This was reflected in the initial willingness to pay at the auctions for 3G-licenses.[60] The first auction was held in the UK where five licenses were on offer.[61] The gross proceeds of the auction amounted to US$ 600 per inhabitant. This auction was held at what

later appeared to be, the peak of the Internet bubble. See also Figure 43 (ITU, 2002a).

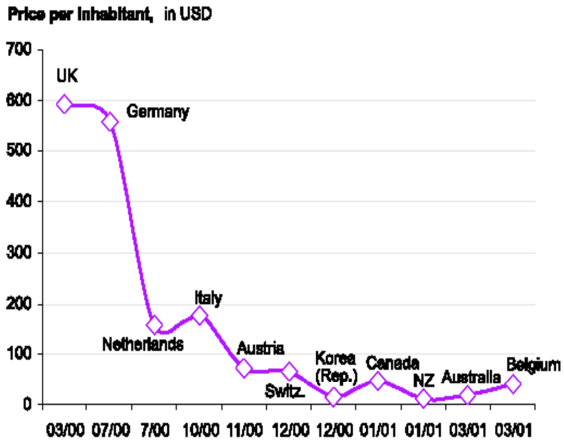


Figure 43. Price per inhabitant for 3-G licenses

2.3.5 Equipment providers in Europe

As stated earlier the telecom industry had been characterized by a close link between the national operators and their national telecom suppliers. This applied to both the US and the European market. Albeit some providers were more export oriented than others. Ericsson having a very small domestic market has always been very much oriented on international markets. Alcatel, and its predecessors, and other French equipment providers traditionally exploited the French political ties internationally. The same can be said about Siemens and Germany, as well as Philips and The Netherlands.

The expansion of AT&T in the international arena, made possible after the divestiture in 1984, had traditionally been focussed on the incumbent operators, partners they knew well from the operator side of the business. As the new entrant operators were competitors of these incumbents, at least AT&T initially hesitated to alienate the incumbents, and hence refrained from aggressively pursuing these new opportunities. Moreover, the new entrants represented only a small market opportunity compared to the procurement budgets of the large incumbent operators. The opportunity provided by the first wave of new entrants in the European market could therefore be utilized by e.g. Nortel, in a way similar to its US market entry. Over time the market opportunity shifted away from the incumbent operator and fixed networks to new entrants and mobile networks. The market research by Lucent Technologies, in cooperation with Telegence, revealed that for instance in Germany in 2001 the split was approximately 1/3-1/3-1/3 incumbent-mobile-other. See also Figure 44 (Lucent Technologies, 2005). As a consequence parts of the organisation became dedicated to the opportunities provided by the new entrants.

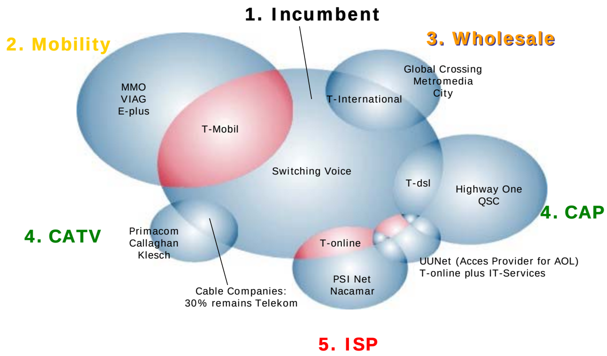


Figure 44. Equipment market assessment Germany 2001

2.4 Distress and the crash

During the Internet bubble 'the madness of crowds' applied, an example: Priceline.com where people could name their price for airline tickets, started operation in 1998, it made a trading loss of over a million, add to that the cost of developing a website and marketing and an operating loss resulted in 1998 of more than $114 mln. The company IPO was priced at $16 per share which jumped at the introduction to $85, valuing the company at close to $10 bln, more than United Airlines, Continental Airlines and Northwest Airlines combined. At the peak of the bubble it reached $150 and the company was worth more than the entire U.S. airline industry (Cassidy, 2002 p3-5&8). An example of a process of valuation increase that simply could not continue.

Brenner provides an insightful account of the period of distress followed by the crash (Brenner, 2002 p244-7):

> "To prevent the expected equity price 'correction' from having serious negative repercussions for the real economy. US policy-makers counted upon the bubble-driven expansion of US corporate investments and household consumption, before petering out, to place the economy on a qualitatively different footing and thereby to ensure a relatively smooth transition from the international crisis of 1997-98 to a prolonged upturn." It seemed that the US economy was developing in the desired direction by the middle of 2000. GDP had grown 5.2% over the previous 12 months, labour productivity had bounded ahead at 4.1%, businesses were able to raise prices, real goods exports expanded with 12.8%, and inflation was at a 2.7% annual rate. To ensure the desired outcome Greenspan "…put in reverse gear his 1998 policy of reducing interest rates to push up equity prices, instead raising the short-term cost of borrowing by a total of 1.75%." "The bubble had… …clearly become a good deal more fragile than Greenspan had realized,

> and correspondingly more dependent upon his patronage and support for it… ...[As] Greenspan continued to insist throughout the first half of 2000 that the Fed would no longer nurture the bubble, equity prices began to drop, even though real short-term interest rates barely moved. E-commerce firms saw their share values collapse first, in spring 2000. From the end of the following summer, the broader markets began to drop alarmingly. By late winter 2001, the technology- and Internet-dominated NASDAQ index, central site of the equity price run-up, had declined by 60 per cent from its peak in early 2000. The S&P 500 was in bear territory, having fallen by more than 20 per cent from its high point. Five trillion dollars in assets had gone up in smoke."

The end of the telecom boom was implied by the collapse of the WorldCom-Sprint merger, announced on July 13th 2000: "With no cash to feed the WorldCom monster, the whole Ponzi scheme was going to break down – it was only a matter of time." - according to Thompson, a former MCI executive, as quoted by Malik (2003 p30). Or in other words: "The desecration of WorldCom shares cost investors nearly US$ 175 billion – almost three times the loss in the Enron implosion – and the SEC filed fraud charges against the most feared telecom company in the world. WorldCom became "WorldCon"." (Jeter, 2003 p176).

As a further data point, in March 2003, when the S&P 500 reached bottom, it had fallen by 50 per cent in real inflation-corrected terms (Shiller, 2005 pxii). And as Brenner observed the crash can be seen as "the wealth effect in reverse" (Brenner, 2002 p250).

2.5 The aftermath

What appeared in the aftermath is that "…much of the hugely increased investment of the bubble years is turning out to be overinvestment. This is because it was enabled, and motivated, not by increased rates of profit, but rather, in spite of decreased rates of profit, by the seemingly endless supply of almost costless capital, made possible via stock issues of overvalued equities and borrowing backed up by inflated assets, as well as the illusion of infinitely expanding consumption, especially of high-technology products." (Brenner, 2002 p250). This "[o]verinvestment by corporations… …led to a collapse of investment spending in the early years of the twenty-first century, and to a worldwide recession." (Shiller, 2005 pxiv).

In the aftermath of the crash telecom operators and equipment makers are struggling to survive. The immediate actions included downsizing and financial restructuring. The Financial Times reported a total of 506,229 job cuts being announced between July 2000 and April 2002, the equipment industry being among the hardest hit industries (Nortel, Lucent Technologies, Motorola, Alcatel, Ericsson). See Annex 4 for more details on downsizing in the industry.

Most of the 'old-world' companies survived based on existing revenues streams that were built before the bubble. Many new-starts, specially those emerging in the final days of the bubble, had to seek bankruptcy protection; in the US this means filing for protection under 'Chapter 11'. Based on information from the archives of Bankruptcy.com, the FCC, Totaltelecom and Telegeography the count is starting

with 7 failures in 1999, 6 in 2000, 43 in 2001, and 58 in 2002. A total of 114 companies. Emerging, eventually restructured or purchased are 35 companies, including WorldCom now renamed to MCI. See also the Annex 2 *General timeline of events* and Annex 5 *Filing for bankruptcy protection (Chapter 11)*.
Expansive strategies deployed during the boom period were replaced with plans for consolidation. For many operators this included a focus on the core business and retreat to the home base, hence attempts to reduce or sell stakes in ventures abroad. For the equipment providers it meant shelving investment plans and a strong rationalization of the portfolio of products and services.

Despite the seriousness of the crash, Shiller, in the second edition of his book *Irrational exuberance* published in 2005, observes: "The stock market has not seen as big a drop as would have been predicted by the extreme overpricing of the market in 2000 – at least not yet… …The stock market has not come down to historical levels: the stock market price-earnings ratio… …is still… …in the mid 20s, far higher than the historical average. " (2005 pxii).

2.6 Summary

Stiglitz has provided a succinct summary of what happened during the period of euphoria:

> "In telecommunications, deregulation unleashed powerful forces, as its proponents claimed. But the forces were not aimed solely at producing better products; they were directed at establishing dominance in one part of the market or another. Deregulation in telecom unleashed a Gold Rush; deregulation in banking allowed the rush to go out of control. Inadequate regulation in accounting allowed the race to go in the wrong direction; in some ways, it became a race to the bottom; those who won in the sweepstakes, at least in the short run, were those who were willing to be less than scrupulous." (Stiglitz, 2003 p93).

In the previous Section we have explained the emergence and development of the Internet bubble using the stylized model of euphoria as a stand alone event, as developed in Chapter 2. In the next Section we will explore the Internet bubble as part of a broader phenomenon, i.e. the Long Waves or Great Surges. We will thereby use the second stylized model of euphoria as derived in Chapter 3. The implications of Internet bubble for the 'development path' of the telecom sector will be the topic of the next Chapter.

3 Application of the stylized model of Great Surges

In this Section we will apply the stylized model of Great Surges, derived in Chapter 3 Section 6, to make explicit the characteristics of the Fifth Surge of which the Internet bubble is considered to be an integral part.

3.1 Recap of the stylized model

In Chapter 3 we have presented the major characteristics of the Long Waves in economic development as identified by Freeman and Louçã; in Table 5 the distinguishing characteristics of the Fifth Wave are summarized.

Constellation of technical and organizational innovations	Examples of highly visible, technically successful, and profitable innovations	"Carrier' branch and other leading branches of the economy	Core input and other key inputs	Transport and communications infrastructures	Managerial and organizational changes	Approx. timing of the 'upswing' (boom) 'down swing' (crisis of adjustment)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
5. Computerization of entire economy	IBM 1401 and 360 series (1960s) Intel microprocessor (1972)	Computers Software Telecommunication equipment Biotechnology	'Chips' (integrated circuits)	'Information Highways' (Internet)	Networks; internal local, and global	??

Table 5. Condensed summary of the Fifth Kondratiev wave

Perez has expanded upon this model and introduced the notion of Great Surges, in essence the development cycle of technological revolutions with the associated development of a new techno-economic paradigm. See Chapter 3 Section 5 and in particular Figure 6, for the stylized model of Great Surges, with the distinction of two phases (installation and deployment) and four periods (irruption, frenzy, synergy and maturity), and the major elements of the model (financial capital, production capital, socio-institutional framework and growth). In this model the bubble is part of the period of frenzy and the crash marks the transition from the installation period to the deployment period.

3.2 The technological revolution of the Fifth Surge

Perez defined a technological revolution as "…a powerful and highly visible cluster of new and dynamic technologies, products and industries, capable of bringing about an upheaval in the whole fabric of the economy and of propelling a long-term upsurge of development." (Perez, 2002 p8). Moreover, "[e]ach technological revolution results from the synergistic interdependence of a group of industries with one or more infrastructural networks." (p13).

For the fifth Surge this 'cluster of new and dynamic technologies' is a combination of computing and communication technologies, which have in common the miniaturization of semiconductor devices, following 'Moore's Law'. See also Chapter 5 Section 2.1.1. *Technological drivers*. The 'core input' (terminology introduced by Freeman and Louçã) of this revolution are the semiconductors. What sets it aside from the semiconductor developments that already started in 1948 with the invention of the transistor in Bell labs, is the invention of the microprocessor by Intel in 1971. This is the landmark or 'big bang' of the Fifth Great Surge. The microprocessor will become 'the heart' of the personal computer or PC, which marks the shift from computers as 'business tools' to 'personal tools', changing the notion of deployment by orders of magnitude. Moreover, the PC will become the device that will provide the access to the Internet. These microprocessors will also become the 'controllers' of the 'switches' and 'routers' that, together with the transmission systems, are part of the worldwide telecommunications network, that will provide the connectivity between the PCs, to facilitate the operation of the world-wide-web. Information Technologies, computers and software, have already had a major impact on the 'fabric of the economy'[62], and combined with 'networked computing' facilitated through the Internet one may speak of an 'upheaval'. See also Table 6 for a comparison between the previous and current technological revolution.

	Technological revolutions	
	Previous	*Current*
Popular name for the period	**Age of Oil**	**Age of Information**
Visible starting point	Ford Model-T	Intel Microprocessor
Date	1908	1971
Main thrust	Motorization of transport	Informatization of the economy
Core inputs	Oil & gas	Chips & fiber
New infrastructure	Motorways & Airways	Internet
Mode of production	Mass production	Flexible production
Organisational mode	Hierarchical organisation	Networked organisation

Table 6. Main characteristics of previous and current technological revolution

3.2.1 Timing of the Fifth Surge

In Figure 45 the timing of the Fifth Surge is reflected vis-à-vis the performance of the NASDAQ (based on Perez, 2002 p119).

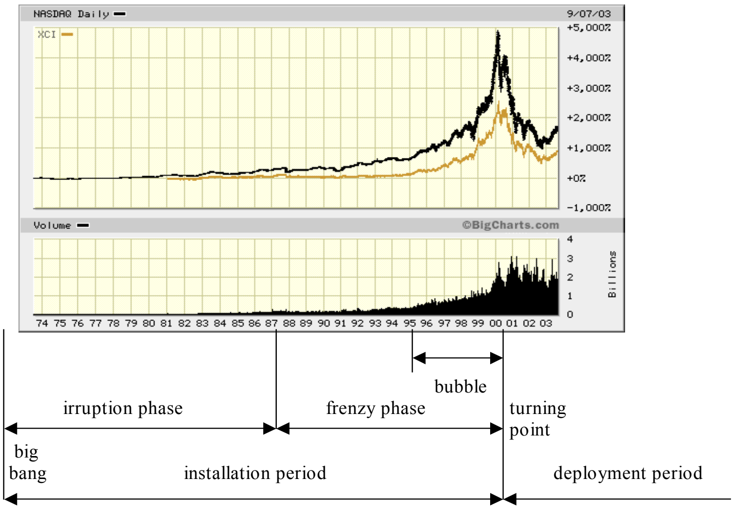


Figure 45. Timing of the Fifth Surge

3.3 The techno-economic paradigm of the Fifth Surge

Perez defined a techno-economic paradigm as "…a best-practice model made up of a set of all-pervasive generic technological and organizational principles, which represent the most effective way of applying a particular technological revolution and of using it for modernizing and rejuvenating the whole economy. When generally adopted, these principles become the common-sense basis for organizing any activity and for structuring any institution." (p15).

The understanding of a new techno-economic paradigm becomes more clear if it is contrasted with the old paradigm. Using the main dimensions identified by Perez, the transitions from the old to the new paradigm are reflected in Table 7 (based on Perez, 2002; Perez, 2004a)**.**

Attribute:	**The ICT driven technological revolution**	
Phasing	**Installation Phase**	**Deployment Phase**
Timing	*Before and during the bubble*	*After the bubble*
Technology	Invention and early adoption	Broad deployment and use
Financing	Financial Capital	Industrial Capital
	Transitions	
ICT use	Automation -> Informatization -> Business process redesign	
ICT solutions	Stand alone -> Networked	
Focus	Technology centric -> User centric	
Scope of ICT issues and solutions	National -> Global	
Focus of learning	About ICT -> Working with ICT -> Innovating with ICT	

Table 7. Attributes of the current technological revolution

In Chapter 3 we have summarized the emergence of a new techno-economic paradigm using quotes from Perez:

> "The appearance of a new techno-economic paradigm affects behaviors related to innovation and investment in a way that could be compared to a gold rush or the discovery of a vast new territory. It is the opening of a wide design, product and profit space that rapidly fires the imagination of engineers, entrepreneurs and investors, who in their trial and error experiments applying the new wealth-creating potential, generate the successful practices and behaviors that gradually define the new best-practice frontier. The action of these pioneering agents blazes the trail, giving rise to increasing externalities and conditionings – including production experience and the training of consumers – that make it easier and easier for others to follow suit. Their success becomes a powerful signal in the direction of the most profitable windows of opportunity. That is how the new paradigm eventually becomes the new generalized 'common sense', which gradually finds itself embedded in social practice, legislation and other components of the institutional framework, facilitating compatible innovations and hindering incompatible ones." (Perez, 2002 p15-6).

In describing a techno-economic paradigm Perez distinguishes three levels (Perez, 2004b):

1. the constellation of technologies, products and industries with wide generic applicability,
2. an organizational model for best practice in all productive activities,
3. a general set of 'common sense' principles for guiding organizational and institutional innovation.

The three levels are characterized for the 4th and 5th techno-economic paradigm in Table 8 (adapted from: Perez, 2004b).

	Techno-Economic Paradigm	
	4th Fordist	**5th ICT**
Level 1	**Technology & Infrastructure**	
A constellation of technologies, products and industries with wide generic applicability, and a supporting infrastructure	Internal combustion engine (for autos, tractors, electricity generation, aeroplanes, etc.)	Micro-processor (as information processing engine)
	Oil and gas as fuels	Data as fuel
	Petrochemical industry (refinery, synthetic materials and chemicals)	Communications and Information Technology industry (hardware, software, services)
	Motorways, airports, airlines	Internet, broadband access
Level 2	**Organization**	
An organizational model for best practice in all productive activities	Dedicated mass production	Adaptable production systems
	Compartmented hierarchical pyramids	Flexible networks, flat and broad ranging
	Materials and energy intensive	Information intensive
Level 3	**'Common sense' principles**	
A general set of 'common sense' principles for guiding organisational and institutional innovation	Centralization	Decentralization
	Separation of work and organizations by function	Re-integration of functions
	Massification	Diversification
	Negotiation of conflicts	Consensus building
	Regulation and supervisory control	Guidelines, trust and monitored control

Table 8. The three levels in the 4th and 5th Techno-Economic Paradigm

Following Perez (2002 p55), the irruption of a new technological revolution "…signals a cleavage in the fabric of the economy along several lines of tension[63]:

- between the new industries and the mature ones,
- between the modern firms – whether new or upgraded by the new methods – and the firms that stay attached to the old ways,
- regionally, between the strongholds of the now old industries and the new spaces occupied or favored by the new industries,
- in capabilities, between those that are trained to participate in the new technologies and those whose skills become increasingly obsolete,
- in the working population, between those that work in the modern firms or live in the dynamic regions and those that remain in the stagnant ones and are threatened with unemployment or uncertain incomes,
- structurally, between the thriving new industries and the old regulatory system, and

- internationally, between the fortunes of those countries that ride the wave of the new technologies and those that are left behind."

The installation period of the new techno-economic paradigm has given us the opportunity to observe the changes and the tensions that the paradigm shift is bringing about. These changes have been summarized and clustered using the Williamson framework introduced in Chapter 4 Section 5.2.4. As this framework links economic activity to governance, the institutional environment and the cultural context, it provides a useful framework to capture the changes a techno-economic paradigm is bringing about. Albeit, it should be noted that the technological dimension is not captured in this framework. The framework facilitates the process of identifying the tensions that emerge between the old institutional environment and the characteristics of the new paradigm. These tensions will be elaborated in Chapter 8 as input to policy and strategy formation. The placement of items is sometimes a forced choice. The compilation of the information has been based on the work by Freeman, Louçã and Perez (Freeman and Louçã, 2001; Perez, 2002; Perez, 2004b), as well as Shapiro and Varian (1999), Tidd et al (1997, 2001), Castells (2000; 2001), Kuhn (1996), Mansell (Mansell, 2002; Mansell and Steinmueller, 2002), Fransman (2002), and was inspired by the philosophical contributions by Wentink (2002; 2004). It builds upon the research executed in relation to the project: "Rethinking the European ICT agenda" for the Dutch Ministry of Economic Affairs (PriceWaterhouseCoopers, 2004) and is expanded through the thesis work performed by Boelsma, which included, in addition, the review of work by Florida (2002), Graham (Graham and Marvin, 2001), (Jonk and Van Velzen, 2002), (De Mul, Müller et al., 2001), (Russell, 1983), (Schaap, 2002), (Trommel, 1999), (Zuurmond, 1994) and others.[64] See Table 9 and Table 10.
The attributes being listed are considered to be linked directly or indirectly to the new techno-economic paradigm. While the new paradigm is an important driver of change, it is not necessarily the only source of change. For the purpose of this project we will not elaborate on the causal links, inclusion is considered more important than origin. For certain attributes the distinction between the paradigms seems more gradual, and increasing over time, as the old paradigm fades to the background.
The paradigm shift from circuit-mode to packet-mode in the telecom sector, as discussed in Chapter 5 Section 3.1. is not reflected in these tables as these tables are intended to reflect the shifts in the economy and society at large.

In the following Sections we will explore the periods and phases of the technological revolution in further detail, and focused on the telecom dimension.

	Periodicity of Change/Topic	4th TEP Fordist Mass production	5th TEP Information and Telecommunication
Level 1	**100 –1000 years**		
Social embeddedness Informal institutions, customs, traditions, norms, religion		Identity is a given	Identity more conscientiously addressed (physical and virtual)
		Traditional role patterns	Individualized role patterns
		Importance of strong ties (primary and secondary relations)	Importance of weak ties (tertiary relations); Networked individualism
		Less segregation	More segregation along various lines (enclaves; creative class; elites)
		Social status and esteem derived from position and wealth (‘conspicuous consumption’)	Additional status in virtual world: derived from contribution to the network ; peer and social reciprocity (‘conspicuous contribution’)
		Pluriformity and reliability of information linked to stratification of society	Abundance but diffuse supply of information; open ‘can be surfed by all’
		Communication primarily based on necessity	Communication also as part of social awareness and consensus building
		Time delays in and between contact and action	Instant contact and action; instant global communication
			Increasingly computer mediated communication; increasingly multi-mode (voice, text, image)
		No environmental concern	Environment as guide to innovation
Level 2	**10-100 years**		
Institutional environment Formal rules of the game, esp. property (policy, judiciary, bureaucracy)	Bureaucracy	Strong bureaucracy	Crumbling bureaucracy; emerging infocracy
		Government control and sometimes ownership	Government information, coordination and regulation
	Policy	Welfare state	Well being and individualized responsibilities
		Keynesian demand management	Minimal government idea
		Universal service	Service differentiation by location/geography (poly-nucleated city)
	Property	Financial divide	In addition Information (digital) divide
		Intellectual property rights an issue for firms (few transactions)	Intellectual property rights an issue for individuals (many transactions; digital rights management)
			Awareness of public versus private ownership of information
	Judiciary	Physical authentication, authorization	Electronic authentication, certification, authorization
		Enforcement within national boundaries	Enforcements requires cross border action (cybercrime; spam)
		Burglary	Cybercrime (privacy, security, identity theft)
	Monetary	Physical and electronic funds transfer	Electronic payment, multiple forms of payment, including micro-payments

Table 9. Paradigm attributes in the Williamson framework, Level 1-2

	Periodicity of Change/Topic	4th TEP Fordist Mass production	5^{th} TEP Information and Telecommunication
Level 3	**1-10 years**		
Governance	Industrial organisation	Large firm dominated (vertical integration)	Networked firms, local & global
Play of the game, esp. contracts (aligning governance structure with transactions)		Economies of scale	Economies of scope and specialization
	Firm organisation	Hierarchies; pyramids	Flat networks; internal & external
		Departmental	Integrated; project orientation
		Automation of separate activities	Systemation, linking activities along the value chain
	Production level	Mass production, standardized goods	Rapid changes in product variety and mix
		Dedicated plant and equipment	Flexible production systems
		Stable routines	Continuous improvement
		Separation of mind and hand	Integration of mind and hand
		Specialized skills	Multi-skilling
		Sequential design	Concurrent engineering
	Market level	Three tier stable market	Highly segmented market; dis-intermediation and re-mediation
		Traditional marketplaces	Increasingly electronic (Internet enabled) marketplaces
		Product competition	Systems competition
		High search costs (access)	Lower search costs (abundance of information) off set by uncertainty in quality (authentication)
		Customer interaction is remote	Customer engagement in product development; in the after-sales process
		Multi-national markets	Global markets
	Business level	Fixed plans	Flexible strategies
		Economies of scale	Economies of scope and specialization
		Mainly competition in the market	Increasingly competition for the market (creating critical mass; network effects)
		Centralized control, vertical information flow	Distributed control, horizontal information flows
		Centralize intelligence	Localized intelligence
		Closed, localized innovation systems (fragmented knowledge base; few innovators)	Open dispersed innovation systems (common knowledge base; many innovators)
		Collectively wage bargaining	More tailored employment contracts
Level 4	**Continuous**		
Resource allocation and employment	Transaction level	Trust embedded by institutions and familiarity with transaction partners	Use of the Internet requires new arrangements to establish and maintain trust
Prices and quantities; incentive alignment		Physical/tangible transactions	Increasingly computer mediated transactions
	Factors of production	Capital, labour, natural endowments	Knowledge, creativity, relations
	Product level	Standardized (limited choice)	Customized (wide choice)
		Highly Tangible	Highly intangible (information goods) with tangible complementarities; Increasingly experience goods
		Product with service	Service with product
		Low degree of network effects; low degree of lock- in	High degree of network effects; high degree of lock-in
	Pricing	Cost based	Value driven (incl. quality and convenience)
	Incentives	Monetary and fixed; social security;	Monetary and variable; high powered; increasing attention to social aspects in job motivation
		Identification with the firm (job-for-life)	Identification with the job; mobile jobs, job migration
		Human resources	Human capital
		Skill specialization	Multi-skilling
		Spatial division of labor	Flexible workplace

Table 10. Paradigm attributes in the Williamson framework. Level 3-4

3.3.1 The 'installation period' of the technological revolution during the Fifth Surge

With reference to the stylized model described in Chapter 2 Section 6, the different periods and phases in the life-cycle of the Fifth Surge can be described, following the lead provided by Perez (2002 p29-59) as follows:

3.3.1.1 The gestation period 1948-1971

Earlier we noted that preceding the 'big bang' or public landmark that signifies the start of a new technological revolution, there is a period of gestation when the ideas and inventions emerge that will become central to the new revolution. In the context of the Fifth Surge this is the period leading up to the invention and introduction of the microprocessor in 1971. One could argue that this period starts with the application of semiconductors, i.e. the invention of the transistor in 1948. Important events that took place during the gestation period are: UNIVAC the first commercial computer introduced by Remington Rand in 1951, the co-invention of the integrated circuit by Texas Instruments and Fairchild in 1957, the invention of packet switching at Rand Corporation and National Physics Labs in the UK in 1960, invention of the mini computer by Cray in 1961, the first stored program controlled switch by AT&T in 1965, the first digital switch Plato by the CNET of France in 1970.[65] See for a general time line of events Annex 2.

3.3.1.2 The installation period 1971-2000

Marked by the launch of the microprocessor, as the major visible event of this technological revolution, the installation period starts in 1971 and runs until the collapse of the Internet bubble in 2000. This is also the time of the famous Carterfone decision (1968), marking the start of the telecom reform process. As well as the emergence of the ARPANET, the first five university nodes being connected – the precursor of the Internet (1970), and the invention of email (1971).

3.3.1.3 Phase one – Irruption 1971-1987

In Chapter 3 we have summarized the characterization of this period by Perez as follows:

- This is the period in which the new paradigm is configured. It is characterized by explosive growth and fast innovations in the new industries, introducing new products.
- The exhaustion of the old paradigm brings with it both the need for radical entrepreneurship and the idle capital to take the high risks of trial and error. The idle money in the hands of non-producers looking for a profit, starts a 'love affair' with the new technological revolution.
- A fast learning process takes place among engineers, managers, sales and service people and obviously consumers, about the production and use of the new products. Learning involves acquiring the new organizational notions embodied in the new paradigm. At the same time a mismatch between the old socio-institutional framework and the requirements of the new paradigm is becoming apparent.

- Production infrastructure is becoming focused on the realities of the new paradigm.

In Chapter 5 Section 2.1.2.1 we addressed the process of telecom reform, which in the USA started with the Carterfone decision in 1968 on connecting computer terminal equipment to the telephone network. This was followed by the FCC decision in 1969 to allow MCI to compete in long distance. And in 1984 by the break-up of AT&T. In the Carterfone case the interests of the telecom and computer industry came to a clash. Data communication between computers, which had developed independently, would not be allowed being subsumed by an industry that was build primarily upon serving voice communication between humans. This event could be identified as the defining moment for a change from the circuit-mode paradigm of the voice world to the packet-mode paradigm of the data world. A shift that would involve in 1984 the transition *en masse* of the then 1000 Internet hosts to TCP/IP. And from 1997 the emergence of VoIP gateways and from 1993 a first Internet based radio station, followed by video streaming, most notably the NetAid webcast in 1999 (Wikipedia, 2006).
The telecom reform process of the 1980's and 1990's, with a focus on the introduction of competition in national networks (Europe) and local networks (USA and Europe), is clearly based on the role new technologies can play in fostering competition.
Investments in the new techno-economic paradigm are illustrated by the private spending in equipment and software, as illustrated for the USA in Figure 46 (OECD, 2000 p49).

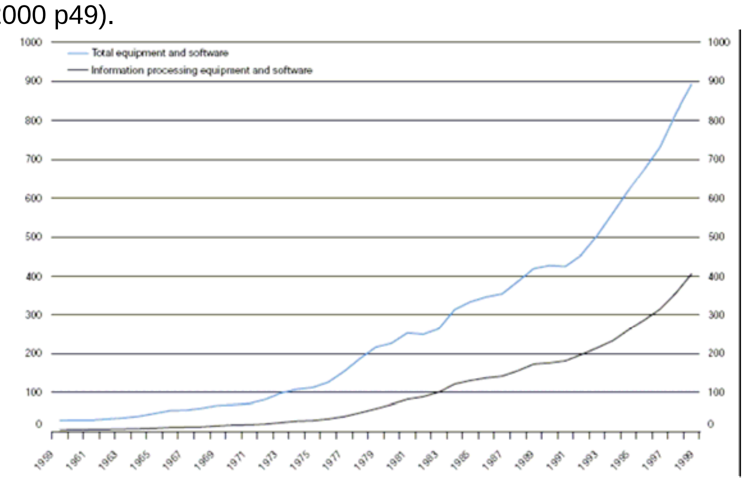


Figure 46. Private investment in equipment and software in the USA ($bln), 1959-1999

The exhaustion of the old Fordistic paradigm can be illustrated by a declining growth rate in labor productivity from the 1950-60's into the 1970-80's (Freeman and Louçã, 2001 p317; Dekker and Kleinknecht, 2003 p12). A number of events occurring in the period illustrate the point: (1) the concerns that arose at the end of the 1960's with respect to the use of natural resources and the growth of world population and consumption, which culminated in the Club of Rome Project and the publication of the report The Limits to Growth in 1972 (Meadows, 1972), (2) the oil crises of 1973 and of 1979.

The early increase in IT investments have, for a variety of reasons, not directly resulted in measurable productivity improvement at the aggregate level, and as a consequence have led to the suggestion of an IT productivity paradox by Roach of Morgan Stanley in 1987 (Brynjolfson, 1992; Brynjolfson and Hitt, 1998).[66] However, firm level data that became available in the early 1990's showed that a dollar of IT capital is associated with a substantial increase in revenue each year. The returns suggest that they represent more than a return on technology, as there are large associated expenditures on training, process redesign and other organizational changes involved (Brynjolfson and Hitt, 1998 p6). The firm level information also showed large variation. Moreover, long-term benefits were substantially larger than short-term benefits, by 2 to 8 times. These long-term benefits are "…not just the returns from IT but from a system of technology and organizational changes. In other words, for every dollar of IT there are several dollars of organizational investments that, when combined, generate the large rise in measured firm productivity and value." (p7).[67] In this respect the authors refer to Drucker's 1988 article on "The coming of the new organization", predicting that "…technology rich firms will increasingly shift to flatter, less hierarchical organizations where highly skilled workers take on increasing levels of decision-making responsibility" and the notion of business process redesign, the shift from 'mass production' to flexible manufacturing (p8).[68] A production infrastructure that exploits the low cost communications and information processing capabilities of the new IT based paradigm.[69]

This 'delay' in productivity improvement to show through should not come as a surprise as in the Third Wave the productivity from electric motors took almost 40 years to emerge. Initially the steam engine was replaced by a large electro motor transmitting power via the existing shafts, pulleys and belts. The big productivity gains came when factories were re-engineered and electric motors were being 'distributed across the factory floor', allowing machines to be arranged in accordance with the logic of the work flow instead of proximity to the once central power unit (David, 1990; Schurr, Burwell et al., 1990 p23 & p37).

The learning process around the new paradigm is twofold, in the information technology environment, and in the telecom environment. In IT the shift from specialists using computers to broad based learning and familiarization with IT applications comes with the introduction of the PC (Apple in 1977, IBM in 1981).[70] It also marks the shift from mainframe based computing to client-server architectures.

The learning around the new communications paradigm starts with the early Internet development in the open environment of university research labs. This is in sharp contrast with the closed environment of the corporate research labs that are focused on the circuit mode paradigm. The new learning mode becomes even more pronounced when Cisco, provider of routers c.a. founded in 1984, starts to engage users in the product development process and starts to publish their product and training manuals, allowing many to participate in the new industry.[71]

The mismatch in the socio-institutional framework becomes apparent with the "coming of the new organization", with a shift from mass production to more flexible production, from hierarchical organizations to flatter organizations increasingly as part of broader and flexible networks of suppliers. The 'Fordist' mass production paradigm gives way to networked organizations with flexible manufacturing processes, providing users with a much wider range of choice in products and services. This shift requires adjustments to create more flexible labor and product markets.

3.3.1.4 Phase two – Frenzy 1987-2000

In Chapter 3 we have summarized the characterization of this period by Perez as follows:

- This is the period of fast diffusion of the new technologies, the introduction of successive new products, industries and technology systems, plus the modernization of existing ones. In this period a full constellation of the new industries, technology systems and infrastructure is in place.
- Financial capital takes over; its immediate interests overrule the operation of the whole system. The paper economy decouples from the real economy, finance decouples from production while there is a growing rift between the forces in the economy and the regulatory framework, turned impotent. The financial frenzy is a powerful force in propagating the technological revolution, in particular its infrastructure.
- A time of speculation, corruption and unashamed (even widely celebrated) love of wealth.
- Diverging and explosive growth in the new industries in stark contrast with the decline in the industries tied to the old paradigm.
- Mismatch of the old socio-institution framework with the new paradigm.

The fast diffusion of the new technologies, PCs – the Internet is for Western Europe illustrated in Figure 31. Compared to other technologies that affect the consumer the Internet penetration is indeed fast: to reach a market in which 50 million people participate it took radio 38 years, television 13 years, and the Internet, once it was open to the general public, just 4 years (Slater, 2002).

In 1984 the Internet is named and the then existing 1000 hosts were converted *en masse* to TCP/IP. In 1990 the WWW application is introduced and in 1993 the Mosaic browser is launched. One could argue that thereby the 'basic constellation' is being in place for the take off of the Internet. In 1984 Cisco is founded, to become the leading provider of routers for the Internet. In 1995 the landmark IPO of Netscape occurs. In the same year Microsoft 'converts' to the Internet and Amazon.com start business and eBay is founded. By this time one could argue that the 'full constellation' is in place.

In Section 1.3 we identified 1995 as the beginning of the Internet bubble and 1997 as the year in which speculation starts for real. In the terminology of Perez, in 1995 'financial capital' takes over, while in 1997 the paper economy takes over from the real economy.

During the unraveling of the bubble a range of inappropriate behaviour has come to the surface, the major cases being the failure of WorldCom and Enron. See also Section 2.2.5.
The observation by Cassidy illustrates the transition: “Like penicillin, electricity, and the jet engine, the Internet had turned into a remarkable technology that many took for granted. Indeed, for frequent users of the network, such as scientists, students and journalists, it was already difficult to imagine existence without email and the World Wide Web. Where the Internet ranked in the history of great inventions remained an open question, but in developed countries, at least, it had insinuated itself into daily life with amazing rapidity.” (Cassidy, 2002 p344).

The paradigm shift from the 4th to the 5th Wave or Surge, as reflected in Table 10 and 11, points to the mismatch between the old socio-institutional framework and the requirements of the new paradigm.

3.3.1.5 The turning point

Perez characterizes the turning point as a conceptual device, denoting the transition between the installation and deployment period, more a notion of transition than an interval or time period *per se*. She characterizes the turning point as follows: With the collapse of the bubble, which ends the period of frenzy, comes recession and sometimes depression, which brings financial capital back to reality. Together with mounting social pressure this creates the conditions for institutional restructuring and for re-routing growth onto a sustainable path. A swing of the pendulum from the extreme individualism typical for the frenzy period to giving greater attention to collective well-being.
Following the crash in 2000 economic growth stagnated. See as an illustration the drop in GDP growth in the USA in Figure 47 (derived from: OECD, 2005).

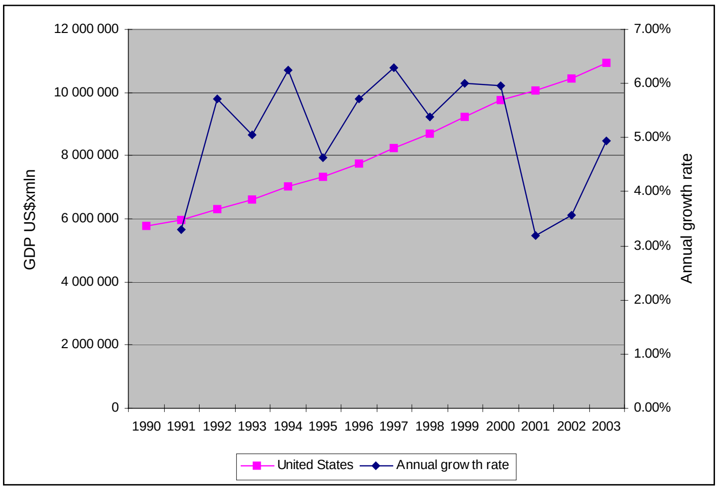


Figure 47. GDP growth USA, 1990-2003

3.3.1.6 The deployment period 2000-….

The deployment period has two Phases Synergy and Maturity.

In Chapter 3 we have summarized the characterization of the Synergy period by Perez as follows:

- In this period we see the full expansion of innovation and market potential offered by the new technologies, yielding fast growth. There is the introduction of successive new products, industries and technology systems, plus the modernization of existing ones.
- Production rules, financials are linked again to production realities.
- The socio-institutional framework is being adapted to and shaping the new paradigm.
- Converging growth in most of the industries aligned with the new paradigm.

Perez points to the fundamental difference in the role capital plays in the 'installation period' versus the 'deployment period': financial capital versus production capital. In that respect she points to the different types of prosperities in the two periods, in particular the 'frenzy phase' and the 'synergy phase'. The 'frenzy phase' is typified by change, instability, and short term gains, while the 'synergy phase' is typified by increasing stability, emerging successful business models, and long-term gains. See Figure 48 for an expansion (Perez, 2004b). As this period is essentially about the future, we will return to this topic in Chapter 8.

3.3.1.7 Gestation period of the new technological revolution

The gestation period of a new technological revolution runs in parallel with the deployment period of the previous one. We may infer that the attention in the next technological revolution will be claimed by bio-technology and bio-informatics.

THE DIFFERENT FEATURES OF THE TWO PROSPERITIES

	FRENZY PHASE: “Bubble economy”		SYNERGY PHASE: “Golden Age”
Industry structure	Fluid, changing, unstable constant challenges to incumbents; many participants	Recession and changeover	Increasingly stable; few firms Successful business models identified; growing barriers to entry
Competition	Very intense, survival of the boldest: exploratory process; definition of dominant designs and best business models		Tempered by stable industry structures; battle for share of a growing market with dominant designs established
Main criteria for investment	Financial; short-term Stock market conscious; rapid capital gains		Long-term growth; production and market expansion Conscious of “fundamentals” and real long-term returns
Innovation	Constant, both real and sham, forced by investor expectations and by fierce competition		Mainly real, in both products and processes; continuous, driven by profit seeking and market expansion requirements

	FRENZY PHASE: “Bubble economy”		SYNERGY PHASE: “Golden Age”
Target markets	Very concentrated on top of the pyramid Increasing sophistication	Recession and changeover	Wider and wider segments (homogenized or diversified depending on the paradigm); increasing functionality
Income distribution	Increasingly polarized (persons and regions): new rich, richer rich, poorer poor		Improving distribution; incorporating more and more layers and regions into prosperity
Social climate	Individualism; complacency of the rich; increasing resentment of the poor; violence brewing		Growing social awareness; increasing “good feeling” opening of opportunities for the excluded. Conditions for peaceful growth
Productivity	Divergent by sectors and within industries Natural consequence of the power of the new paradigm in the new sectors		Converging onto a higher plateau within and across sectors Conscious drive to improve it in all sectors

Figure 48. The different features of the two prosperities

4 Summary and conclusions

In this Chapter we have provided the answer to research sub-question #4: "How can the Internet bubble be described and explained?". Thereby we have used for the description and explanation the stylized model for euphoria as a stand-alone phenomenon as derived in Chapter 2, and the stylized model of euphoria as part of the broader phenomenon of technological revolutions, as derived in Chapter 3.

The bubble is considered to be triggered by the combined effect of the Reverse Plaza Accord, the success of the Internet related IPO's, and the new business opportunities provided by the telecom reform process. While we refer to this period of euphoria as the Internet bubble, in fact it has been a series of bubbles, in dot.coms, in web hosting, in optical networking, in the telecom services industry, in the telecom equipment industry, and in the telecom component industry.
Positive feedback loops, related to monetary expansion, have been the major drivers behind the acceleration during the boom, and they have precipitated the crash. Precipitating factors specific for this bubble have stimulated the development of the bubble, these include: the deregulation of the financial sector, stock options as remuneration instrument, and increased share ownership through pensions plans. Consensual visions have driven the developments in the telecom industry. Through contagion Europe became effected, while the success of digital mobile communication has played an important role in euphoric developments around the auctioning of 3G licenses.
This bubble is special as it is related to infrastructure and infrastructure related investments. This makes this bubble comparable to the periods of canal mania and the rail-road mania, and thereby it becomes part of historical regularity, i.e. the diffusion process of technological revolutions. By placing the bubble in the context of these regularities, we may infer the long-term implications of the bubble, and anticipate future developments.

But, first we will describe and assess the implications of the Internet bubble on the development path of the telecom sector in Chapter 7. In Chapter 8 we will re-visit the implications for policy and strategy formation, with special attention to the tensions that have arisen between the institutional framework that was optimized for the 4th Surge and the requirements put forward by the 5th Surge.

5 Notes for Chapter 6

[1] Until this point the lack of measurable productivity improvement, despite the large scale investments in ICT, has puzzled many economists and his given rise to the notion of the 'productivity paradox'. See also (Brynjolfson and Hitt, 2003). The need to invest in education and training to improve ICT skills, complementary to the investment in tangible assets, suggest a delay in measurable improvements in productivity. The shift in emphasis from mechanization/automation in the early phase of ICT deployments to networked application in the later phase suggests a next step in productivity improvement.
[2] "The fact remains that by the end of 1995…share prices had not outdistanced the growth of corporate profits. …basically reflect[ing] the dramatic recovery of profitability in the US economy…" (Brenner, 2002 p138). The price earnings ratio of just above 15 for the S&P 500 was roughly at the level of the post-war period as a whole, but in 1997 the gap between profits and stock prices started to widen dramatically.
[3] Industry indices reflect the performance of a basket of companies within a particular sector. As the composition of the Index may change, care should be taken in using it for the explanation of phenomenon over a prolonged period of time. In general, the indices reflect the performance of leading companies in the sector, both in absolute size and in share of the market.
[4] When price/earnings ratios are being considered the magnitude the bubble of the late 1990s exceeds the bubble of the late 1920s by a factor of 1.5 (Alleman, 2002).
[5] Cassidy traces the origins of the Internet back to concept of the *Memex* proposed by Bush in 1945, as a precursor of the hypertext principle (Cassidy, 2002 p 9-12)
[6] The backbone network was in the final phase operated by MERIT (Michigan Educational Research Information Triad) in cooperation with MCI (leased lines) and IBM (packet switches), to provide the backbone services (Abbate, 1999).
[7] Since the early 1970s the ARPANET had included sites outside the United States (Abbate, 1999).
[8] RIPE (Réseaux IP Européens) is a collaborative forum open to all parties interested in wide area IP networks. The objective of RIPE is to ensure the administrative and technical co-ordination necessary to enable the operation of the Internet within the RIPE region (RIPE, 2005).
[9] The following is a definition of the Internet taken from the Networking Taskforce of the US Government, as quoted by Meeker & DePuy: "The Internet is a world-wide network of networks with gateways inking organizations in North and South America, Europe, The Pacific Basin and other countries… … The organizations are administratively independent from one another. There is no central, worldwide, technical control point. Yet working together, these organizations have created what to users seems to be a single virtual network that spans the globe." "The networks all use a common suite of networking protocols, TCP/IP. It is because of this commonality of protocols, this commonality of network functionality and interoperability, that the networks provide what appear to be a seamless, integrated virtual network, regardless of the underlying heterogeneity of the underlying computer hardware or communications transport." (Meeker and DePuy, 1996).
[10] Entity count includes operators registered, not yet having an operational network.
[11] In the Plaza Accord of 1985 the G-5 powers agreed, under US pressure, to reduce the dollar exchange rate to rescue the US manufacturing sector (Brenner, 2002)
[12] Through financial deregulation, barriers that had restrained financial institutions to specific functions or geographical region had been removed by the Carter and Reagan administration.
[13] Cassidy uses 'dot.con' in his story of why the Internet bubble burst.

[14] Data set runs from January 1992 to October 2000.
[15] Following its separation from AT&T, Lucent Technologies raised US $ 3.3 bln through an IPO in 1996 (Endlich, 2004).
[16] The graph also shows the impact of the rising dollar as result of the Reverse Plaza Accord on the import prices.
[17] Smithers & Wright (2000): Valuing Wall Street. Protecting wealth in turbulent markets. New York: McGraw Hill.
[18] In this respect one could argue that in particular during periods of euphoria the Incentive-Conduct-Performance paradigm takes over from the Structure-Conduct-Performance paradigm applicable during periods characterized by a stable industry structure.
[19] Tornado and tornado watch are the analogies used by Moore to describe the process of mass market adoption.
[20] Note the close link with paradigms.
[21] Cisco was founded by two ex-Stanford University staff members.
[22] In 1991 computer Literacy a Silicon Valley bookstore chain was the first bookstore to be registered on the Internet. Because of security concerns and the prohibition of commerce on the net there were no on-line transactions, email was used as a step up from mail ordering by telephone (Spector, 2000).
[23] Kaplan positions the improvements attainable through the Internet primarily through reduced transaction costs: 1) changes/improvements of business processes; 2) changing nature of the market place – making it more efficient; 3) changes in decisions – or indirect effects of transaction cost reductions; 4) changes in the degree of information completeness/asymmetry; 5) changes in the ability to commit – e.g. by reducing commitment fees, or through leaving an electronic trail (Kaplan, 2003). Amit and Zott conclude that value creation in e-business hinges on four interdependent dimension: efficiency, complementarities, lock-in, and novelty (Amit and Zott, 2001, June-July).
[24] Also Red Herring belongs in this list (Paltridge, 2006).
[25] Malik adds the observation that financial analysts would count building leases as indicator of growth. Companies created an illusion of revenue growth…This helped them to raise money from the markets and grow bigger…" (Malik, 2003).
[26] Collingwood argues that quarterly management of information has very real costs: "The fetishistic attention to an almost meaningless indicator might be cause for nothing more than amusement, except for one thing: the earnings game does actual harm. It distorts corporate decision making. It reduces securities analysts and investing to a guessing contest. It compromises the integrity of corporate audits. Ultimately, it undermines the capital markets." (Collingwood, 2001).
[27] A typical example is LDDS-WorldCom. See also (Jeter, 2003).
[28] Acquisitions were als attractive through the possibility of "pooling of interest". This method allows the acquired company to take on the books of the buyer at its book value, or historical cost, rather than the actual cost paid. This allows the buyer to hide the premium paid or overpaid sheet (Endlich, 2004). The difference appears as 'goodwill' on the balance and will have to be written off at a future moment.
[29] Pension funds were also used to adjust results. By one estimate, quoted by Stiglitz, 12 percent of earnings growth of 2000 came from pension income (Stiglitz, 2003). In 1998 the pension funds of the S&P500 companies were overfunded by US$ 253 bln, in 2001 assets were roughly equal to the obligations; in 2002 the underfunding was US$ 243 bln. (Endlich, 2004).
[30] The notion is ascribed to Sidgmore and O'Dell at UUNet (Malik, 2003).
[31] "The public internet is currently far smaller, in both capacity and traffic, than the switched voice network. The private line networks are considerably larger in aggregated capacity than

the Internet. They are about as large as the voice network in the U.S., but carry less traffic. On the other hand, the growth rate of traffic on the public Internet, while lower than is often cited, is still about 100% per year, much higher than for traffic on other networks. Hence, if present growth trends continue, data traffic in the U.S. will overtake voice traffic around the year 2002 and will be dominated by the Internet." (Coffman and Odlyzko, 1998 p1).

[32] The LDDS deal making is led by Bernie Ebbers its CEO (Jeter, 2003; Malik, 2003).

[33] The Chairman of Global Crossing Garry Winnick was trained by Michael Milken, the junk bond 'power house' at Drexel Burnham Lambert, to learn the 'art of leverage' (Malik, 2003).

[34] Announcing the first trade raised the stock valuation with US$21 billion. In 2000 only 300 trades were made (Fox, 2003; Malik, 2003).

[35] Lowenstein estimated the investment in telecom at least twenty times greater than in dot-coms (Lowenstein, 2004).

[36] In the introductory phase of ISDN the emphasis had been on the integration of services that would be .supported. At the time of its introduction data communication was primarily handled through low speed dial-up modems or expensive leased lines. The success of ISDN came with the growing demand for Internet access; underscoring the notion that ISDN was essentially 'a 64 kb/s data call at the price of a voice call'. See for a mor4e technical expose (Kahl, 1985; Lemstra and Van der Veer, 1985).

[37] The development of ISDN in the USA was initially hindered by the use of equipment firm specific implementations.

[38] Albeit, cable networks had to be upgraded to make them suitable for two-way communication.

[39] ADSL modems use the frequency spectrum that is available above the voice band in the twisted pair cables that connect the telephone in the home to the nearby telephone exchange (Muller, 2002).

[40] Examples of CLEC included: Allegiance Telecom, Time Warner Telecom, Focal Communication, and McLeodUSA (Malik, 2003).

[41] Examples of metro type CLECs include: Yipes, Teleon, Sigma Networks, Cogent, OnFiber (Malik, 2003).

[42] The success of this model was established by e.g. WorldCom buying MFS in 1996 to acquire its fiber-optic network connecting forty-five US cities, thereby paying US$ 14.4 billion while MFS had only US$ 600 million in revenues, or six times the value of the fiber it had installed. Another example was AT&T acquiring Teleport Communications Group connecting eighty-five cities, for US$ 11 bln and $ 500 mln in revenue (Endlich, 2004).

[43] It has been part of e.g. the US$ multi billion the Telecommunication Expansion Project executed by .Philips and Ericsson in Saudi Arabia in the early 1980's.

[44] Initially email and office applications on a personal basis would be provided, to evolve to enterprise applications including, CRM and ERM applications (IDC, 2000).

[45] Following the 1984 MFJ competitive fiber based companies had expanded from 133 route miles and 7,770 fiber miles in 1987, to 782 route miles in 1989 to 2,071 route miles by 1991. In that year 23 Competitive Access Providers reported an investment total of US$ 82.6 mln and 5,891 customer locations being served. The fiber installation by LEC was 150,000 route miles. Companies included Teleport and MFS (Brock, 1994).

[46] Through MFS it also acquired a fiber network connecting forty-five US cities (Endlich, 2004).

[47] Band X now provides its own interconnection facilities.

[48] Through its acquisition of the energy company Portland General in 1997, Enron had acquired First Point Communications, which had build a fiber optic network along the power lines. This network was extended to three fiber loops (Salt Lake City, Houston, Miami) using Enron's pipeline rights of way (Fox, 2003).

[49] According to Fransman, between 1996 and 2001 $1805 bln was invested in the telecom industry through financial markets ($ 890 bln syndicated bank loans + $ 500 private equity and stock markets +$ 415 bond markets) (Fransman, 2002 p1).
[50] Applications such as Skype and embedded in Microsoft's MSN benefit from the flat fee Internet access only cost structure, i.e. VoIP at zero incremental costs.
[51] Today the use of VoIP is not restricted to locations with computers equipped with audio functionality anymore, as IP-based phones are being offered.
[52] In 2000 Lucent Technologies announced that Bell labs had been able to transmit 1.6 trillion bits over a single optical fiber using dense wavelength division multiplexing (DWDM). A capacity equivalent of 25 million conversations or 200,000 video signal simultaneously (Fransman, 2002).
[53] So called OC192, a 10 Gb/s transmission rate.
[54] Cerent had US$ 10 mln in sales in the first half of 1999, expecting $ 300 mln in the next 12 month (Bunnell, 2000).
[55] Dubbed by Gilder as "the Intel of the Telecoms" (Malik, 2003).
[56] Sometimes financing could be arranged when the future revenue stream could be pledged. In the case of projects in developing countries a foreign (hard currency) revenue stream was thereby preferred. Also barter trade was part of the portfolio of project financing solutions.
[57] In these alignments the financial analyst played a major role and effectively became an investment banker, a blurring of roles and responsibilities typical for the period of euphoria.
[58] In 1996 Lucent Technologies provided US $ 1.8 bln vendor financing to Sprint PCS for a 60% share in a wireless network build-out, with Nortel to obtain 40% (Endlich, 2004).
[59] A process facilitated through the CEPT, in which national operators cooperated.
[60] The UK auction was preceded by awards in Finland in 1999 and Spain in 2000 based on a beauty contest (Financial Times, 2002).
[61] The issue date for the Invitation to Bid was November 1999, the Application Deadline January 2000. The license decision April 2000 (Financial Times, 2002).
[62] Consider here for instance the investments in IT and the link to, and debates about, productivity improvements, and the shift to information goods and the subsequent impact on broad range of industries. See for instance: (Van Ark and Piatkowski, 2004), (Brynjolfson and Hitt, 2003), (Carr, 2004).
[63] Technology driven revolutions can be considered a subset of revolutions in general, they have many lines of tension in common (De Wit, 2006).
[64] In his MSc thesis project Boelsma analyses the potential fit between Tresparc, as a new web-based product, and the new paradigm (Boelsma, 2005).
[65] To this list could be added the invention of the cellular concept by Bell Labs in 1947, albeit the first commercial application is in 1981; and the launch of Sputnik by the USSR in 1957.
[66] Including intangible benefits such as quality, variety and convenience.
[67] The analysis is based on three inputs that influence the firm value-added: ordinary capital stock, computer capital stock and labor. The resulting regression estimates for the computer coefficient (the contribution of computerization to three-factor production growth) range from 0.01 to 0.02 in the first year to 0.04 and 0.05 in the seventh year. The data represents 527 firms and covers the period 1987-1994 (Brynjolfson and Hitt, 2003).
[68] The research showed that firms that couple IT investments with the decentralized work practices are about 5% more productive than firms that do neither. Firm scan be worse off if they invest in computers without the new work systems. The more extensive treatment can be found in (Brynjolfson and Hitt, 2003).
[69] A comparative study on productivity between the USA and the EU shows that the post 1995 acceleration in productivity in the USA is dominated by the ICT producing sectors,

wholesale and retail trade and banking and auxiliary financial services. (O'Mahony and Van Ark, 2003).

[70] The introduction of Windows 95 represents another milestone (Paltridge, 2006).

[71] This is of particular importance in avoiding a resource bottle neck in a high growth industry. A book search on Amazon in December 2005 yields over 1100 books related to Cisco products and training, many for self study. The title of Cisco Certified Engineer and more recent Cisco Certified Network Associate have become valuable tickets in the industry.

7

The impact of the Internet bubble on the 'development path' of the telecom sector

An assessment of industry change

Table of Contents

1 Introduction

In Chapter 5 we have explored, in detail, the development path of the telecom sector leading up to the bubble period, i.e. 1995. Thereby we have identified a number of forces that are affecting the development path of the telecom industry, including more radical ones that have changed the structure of the industry or the prevailing paradigm. In Chapter 6 we have explored and explained the Internet bubble and expanded on the related telecom bubble, both as a stand-alone period of euphoria and as part of a broader phenomenon, the diffusion of technological revolutions. Thereby we have touched upon the major drivers and inhibitors of industry development for the telecom services sector, as well as the telecom equipment sector.

In this Chapter we will use the format introduced and applied in Chapter 5 to describe the impact of the Internet bubble on the 'development path' of the telecom sector. Given that in Chapter 5 each dimension of the development path was introduced and the direction and momentum of the developments described, we will focus in this Chapter on the major changes and provide where necessary a short explanation of the line items in the summary. If considered necessary additional supportive evidence will be provided. As the developments during the boom period 1995-2000 are significantly different, if not counter, to those during the bust period 2000-2001 we will treat each period separately. Moreover, an impression will be provided on the early part of the aftermath 2002-2003.

2 The linkage between the 'bubble and the path'

In Chapter 1 we have introduced the linkages of the 'bubble to the path': "What links the 'bubble to the path' is the entrepreneur in the telecom sector.[1] An entrepreneur that we have put central in our research project, directly in relation to strategy formation, and indirectly in relation to policy formation; as we have defined the success of policy as the results of the actions being taken by the entrepreneurs, either individually or collectively.

In a practical sense there is a link between the combined notions of expectations + confidence and monetary expansion + investments. Entrepreneurship means taking actions aimed at the future. As the future is intrinsically unknown, expectations play a crucial role. The higher the confidence with respect to these expectations, the more decisive the actions 'to shape the future of the firm' will be. Decisions with respect to 'shaping the future' tend to revolve around investments. Investment decisions with respect to e.g. expanding the production capacity, and/or invest in innovation, and/or investing in new markets. Investments tend to require funding, either internally generated or externally acquired. Euphoria are typified by positive and growing expectations on the one hand and monetary expansion on the other. The sector that becomes subject to euphoria tends to 'rush to the future'. The natural 'checks and balances' present in the system become ineffective, and 'consensual' vision takes over. Euphoria and entrepreneurship become a 'marriage made in heaven', until the spell is broken; what follows is the rude awakening as a result of the crash.

In the aftermath many of the actions undertaken during the boom are being undone, often at considerable cost. Other actions can not be undone and will

influence the developments in the sector for many years to come. Our interest is focused on the latter category, as we are interested in the impact on strategy and policy formation in the long-term, and less so in the immediate, tactical response by firms for survival in the aftermath of the bubble.
Economic, strategic management and innovation literature is pointing in this respect to the importance of industry structure and the role of paradigms and technological trajectories in shaping the development path of an industry. Industry structure and technological paradigms are understood to condition the behaviour of industry actors, while they are, at the same time, subject to transformation by these same actors. This conditioning tends to lead to gradual or also called evolutionary change of industry structure. Notwithstanding, the industry structure can be changed through e.g. deliberate policy actions. The telecom reform process is a case in point. Even without deliberate intervention, the industry development is not always gradual. History has shown recurring periods of so called ‘clustered innovation’ that have led to technological revolutions. Revolutions that have resulted in the emergence of a new techno-economic paradigm, affecting economy and society at large. These are periods of revolutionary change. Periods in which industry structure is profoundly affected, and the strategy formation process is affected most prominently.

In the notion that euphoria are a recurring element in the process of diffusion of a new technological revolution, we find another link between the ‘bubble and the path’.

The impact of the ‘bubble on the path’ is introduced in Sections 2.1 through 2.4, for the periods boom, bust and aftermath, using the dimensions of the industry ‘development path’. In Section 3 we will explore these periods in more quantitative detail.

2.1 The nature of the impact of the ‘bubble on the path’ – boom period

From our analysis in Chapter 6 *The Internet bubble explained* it has become apparent that the bubble does not necessarily introduce new elements into the development path of the telecom sector, but has rather accelerated and amplified processes already part of the industry development. In general terms: the positive expectations about the future and the growing confidence regarding these expectations, together with the improved access to and availability of financial funds, has led to accelerated experimentation and innovation, as well as accelerated implementation, e.g. through new products and services.
Processes already well underway before the bubble developed, but upon which the Internet bubble had a profound impact, are:

1. The process of telecom reform, and
2. The new technological revolution.

With respect to the telecom reform process it facilitated and accelerated firm entry, leading to increased competition. Moreover, it facilitated the incumbents to expand

beyond their traditional business boundaries – vertically, horizontally and geographically.
With respect to the new technological revolution, it facilitated and accelerated the 'installation' of the new techno-economic paradigm, including a shift from circuit-mode communication to packet-mode communication as the prevailing paradigm.

The impact of the 'bubble on the path' in the boom period is most prominent with respect to the dimension of demand (Dimension 1, see Chapter 4 Section 4 for the dimensions of the development path). As demand is perceived to be expanding by the incumbent service providers and potential entrants alike, we can observe a fragmentation of the market as a result of firm entry, facilitated by the new technologies (Dimension 2). This is followed by an expansion of investments by both categories of market participants (Dimension 4). The new techno-economic paradigm implies a paradigm shift for equipment providers and infrastructure operators, from a voice dominated world, supported by a circuit-mode technological paradigm, to a data dominated world, supported by a packet-mode paradigm. This implies a shift in business models employed in the industry, i.e. first towards divergence with the introduction of new business models, followed by convergence towards the successful new models (Dimension 3). The introduction of new Internet related services, in essence 'on top of' the communication services, implies a vertical fragmentation of value-adding activities (Dimension 5). The once separated provisioning of communication and broadcasting services, due to dedicated infrastructures, is becoming increasingly integrated, leading to the blurring of horizontal business boundaries (Dimension 6). The telecom reform process, set in motion well before but benefiting from the Internet bubble, has stimulated incumbent operators to expand vertically (Dimension 5), horizontally (Dimension 6), and abroad, leading to an integration of geographical segments (Dimension 7).

2.2 The nature of the impact of the 'bubble on the path' – bust period

In the transition from the boom to the bust period expectations were changing from optimistic to pessimistic and confidence was turning into uncertainty. In response to the crash firms fell into a process of consolidation and rationalization in order to survive.
The impact of the 'bubble on the path' in the bust period is reflected in the different perspective of demand (Dimension 1). Demand expectations are replaced by actual or measured demand (growth/decline). A return to fundamentals. Changing perceptions in demand and lack of funding drive many operators to search protection against bankruptcy. In the USA this implies a filing for protection under Chapter 11. Some companies move subsequently to Chapter 7 and terminate operations, many others re-emerge after restructuring of debt, and as a result change ownership. They continue operation independently or are being acquired. The number of new entrants is extremely low. As a result the market becomes more concentrated at the end of the boom period, but is still much more fragmented than at the beginning of the boom period. This reasoning applies *grosso modo* also to the telecom equipment industry (Dimension 2). The consolidation of the sector led to unsuccessful business models being eliminated. Hence, a further convergence towards the more successful models, albeit with a

larger variety than before the bubble, which is in line with the vertical fragmentation of the industry that has taken place (Dimension 3). The overinvestment during the boom and the battle to survive following the crash make that investments are cut to a minimum (Dimension 4). In the process of consolidation and portfolio rationalization a ‘return to core business’ can be observed. This implies a fragmentation or more distinct boundaries between vertically separated value adding activities (Dimension 5). The integration of the once dedicated infrastructures, separated provisioning of communication and broadcasting services, is of a more permanent nature, leading to integration or the blurring of horizontal business boundaries (Dimension 6). Consolidation and portfolio rationalization also led to a ‘retreat to home base’ for many operators. Hence, a fragmentation or more distinct boundaries with respect to geographical segments (Dimension 7).

The above summaries are necessarily a generalization across the various segments that constitute the telecom industry. For specific segments the change within the ‘dimensions of the path’ will vary. We will address the developments in the segments in greater detail in Section 3.

2.3 The nature of the impact of the ‘bubble on the path’ – the aftermath

While one could argue that the aftermath is not a part of the bubble period, a few observations on this period, which is open-ended, will allow for a comparison with the period before the bubble in terms of a possible return to the ‘natural course of events’ or to the ‘fundamentals’ of the industry.

The aftermath is a period without frenzy, without dramatic downturns. Albeit with some more revelations on the inappropriate business practices, that had developed during the period of frenzy, e.g. at WorldCom, Global Crossing and Enron.

As the business fundamentals can be observed more clearly again, also the lasting changes become more apparent. Paramount is the notion that the Internet is here to stay and expanding its role of transforming the prevailing business models. As such it shows its fundamental role as carrier of the new techno-economic paradigm in the Fifth Surge. The frenzy is being replaced by broader deployment as next to increasing bandwidth being offered in the competition between ADSL and Cable based Internet access providers, also the low end penetration increases through a significant take up of ADSL Lite.[2]

Demand expectations are modest and reflect actual or measured demand (growth/decline). Rivalry in the market has become more intense as former new entrants emergence from bankruptcy with a much lower level of debt[3] and much lower book values of infrastructure assets. Hence, while the degree of concentration/fragmentation of the market does not change significantly, price competition intensifies (Dimension 2). Intensified competition, constrained finances are leading to further streamlining of operations. Very few endeavors of expansion can be observed either in the vertical, horizontal or geographical dimension

(Dimension 3, 5 and 7). Areas of overinvestment are obvious, and hence investments are highly targeted; the financial industry is prudent in terms of making funds available (Dimension 4). The blurring of horizontal business boundaries continues (Dimension 6).

In the terms of Perez, a transition from financial capital to production capital can be observed, with ‘normalized’ expectations regarding return-on-capital.

3 Exploring the development path of the telecom sector during the bubble period 1995-2002

In assessing the impact of the bubble on the ‘development path’ of the telecom sector we are primarily interested in the long lasting impacts rather than the transient ones, as these will have a more profound impact on strategy and policy formation, while the latter are expected to invoke a more tactical response. The review of the economic and strategic management literature, as presented in Chapter 4, has shown that for an appropriate coverage of the topic two complementary perspectives need to be followed: the static and the dynamic. The static perspective assumes that the industry structure is not being affected significantly, or if it is affected is considered a ‘shift parameter’. The dynamic perspective showed that revolutionary, and hence profound and lasting, change occurs in periods of a paradigm transition. The scale of the impact being linked to the scope of the paradigmatic change.
Lasting impact is also to be expected from ‘events that cannot easily be undone’, whereby elements of path dependency in one form or the other are involved. Of particular interest in our case are the capital investments in infrastructures, which are by and large fixed and asset specific.

Using the framework of analysis developed in Chapter 4, we will first capture, at a high level, the developments during the bubble period using the drivers and inhibitors of industry change, subsequently the combined effects are summarized using the seven dimensions of the ‘development path’.

Note: In the following Sections, to the extent possible, a consistent set of data will be used to underscore the argumentation and to illustrate the reasoning provided, primarily derived from the datasets included in the OECD Communications Outlook 2005. The data set consists of a sample set of countries, considered indicative for the developments during the period:

- USA
- Western EU: France, Germany, Italy, United Kingdom, Spain, Sweden and The Netherlands
- Japan
- Korea

In Europe the sample represents approx. 80 % of Western European telecom revenues; Sweden is included because it is reflecting many of the early developments in the field of telecommunication, the Netherlands for domestic reasons. Although Japan and Korea are not discussed as part of the Internet bubble, these countries do represent major developments in the telecommunications sector, in particular in the fields of mobile and broadband.

3.1 The drivers of industry development

The drivers of industry development have been identified in Chapter 4 Section 4.2.

3.1.1 Contextual drivers

3.1.1.1 Technological drivers

The technological drivers explored and described in Chapter 5 are playing a crucial role during the bubble period. Advances in silicon to drive computing power and in optics to increase transmission bandwidth are fundamental. Moore's Law continues to play a major role but also the possible limitations are being perceived and alternatives pursued, in the direction of bio-computing. As an illustration see Figure 1, which compares various forms of computing power; these and the following illustrations were used by Lucent Technologies in customer presentations during the period.[4] (Based on: Kurzweil, 1999 - adaptation courtesy Lucent Technologies Inc.) In Figure 2 a comparison is made between computing power provided by professional image rendering systems, like Silicon Graphics, and the computing power deployed in gaming machines used at home, which we tend to take for granted (Lucent Technologies, 2005).

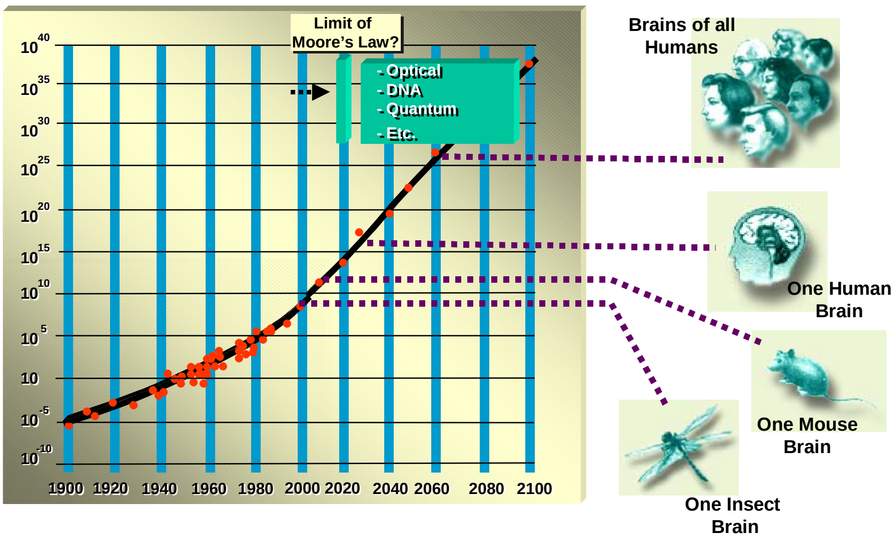


Figure 1. Limits to silicon based processing

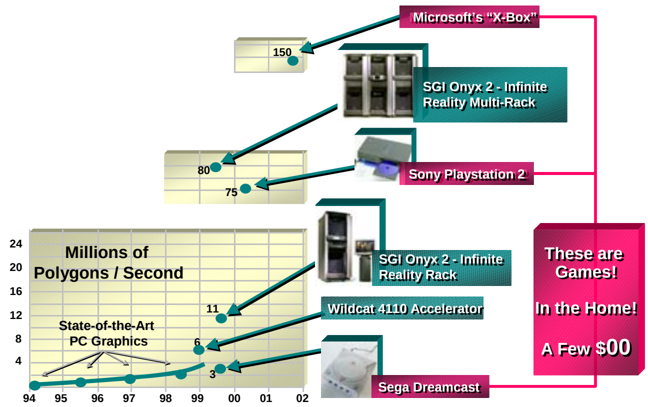


Figure 2. The next level in computing

Optical technology played a major role during the telecom bubble as described in Chapter 6 Section 2.3. The increase in bandwidth that can be provided in comparison with copper cables is enormous. See Figure 3 for an illustration (Lucent Technologies, 2005). The consensual vision during the boom was that an 'all optical' combined with an 'all wireless' world would emerge. Optical capacity was to grow in two ways: an increase of the data rate from typically 2.5 Gb/s to 40 Gb/s, and the use of multiplexing techniques, or wavelength division multiplexing, to reach 80 channels of 2.5 Gb/s or 40 channels of 10Gb/s on a single strand of fiber. Functions traditionally performed in the electrical domain would move to the optical domain. See also Figure 4 (Lucent Technologies, 2005).

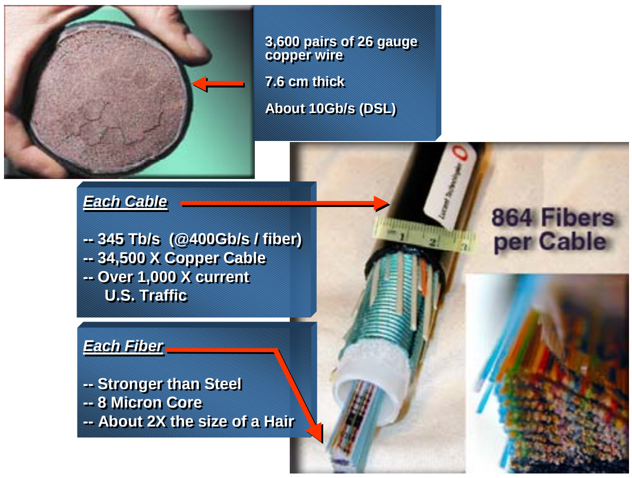


Figure 3. From copper cable to optical fiber

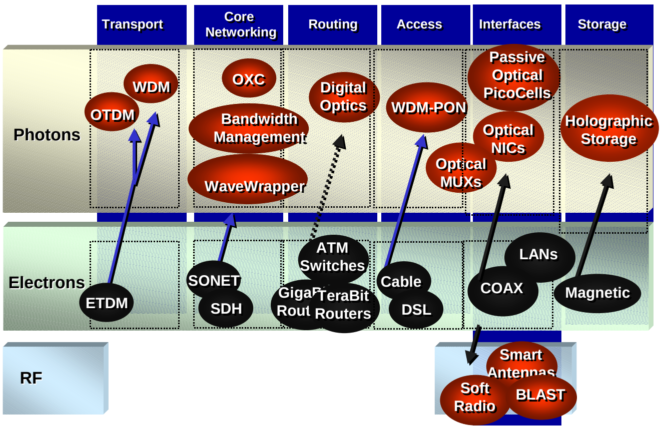


Figure 4. The migration path to an optical world

Transitions between the electrical and optical domains would be minimized, increasing speed and reducing costs, through e.g. MEMS technology (using micro electro-mechanical tilting mirrors) to reflect light between fibers, thereby providing an ‘all optical cross connect’ function, as illustrated in Figure 5 (Lucent Technologies, 2005).

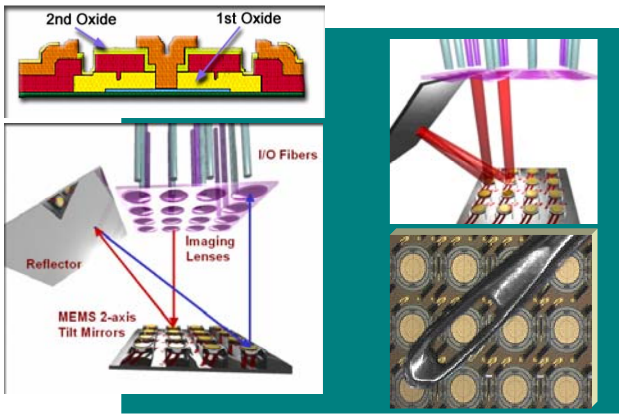


Figure 5. Lucent's MEMs technology

Progress in mobile technologies is mainly aimed at realizing higher spectral efficiencies, and increasing data rates from 100kb/s to 10Mb/s.[5] This is being realized through rate-adaptive shared channels, in combination with intelligent antenna technology. The latter is based on using diversity in multiple antenna configurations and using phased arrays to switch and steer signal beams (Polakos, 2002)[6].

3.1.1.2 The role of telecom firms in technological development

The pace of technological development is essentially determined by the level of R&D spending in the ICT value chain. The spending by the telecom equipment vendors plays thereby a major role, both in direct R&D spending, and in the purchase of ICT components, which in turn funds R&D expenditure at the component level.

In Figure 6 the spending by the telecom equipment vendors over the period 1997-2003 is shown, which clearly reflects the boom and the bust (derived from: OECD, 2005b p87). At the peak in 2001 direct R&D spending by the top 18 vendors was US$ 38.5 bln. The only companies that are defying the bubble trend are focused on mobile equipment: Nokia, Samsung and LG Electronics. This reflects the intense competition in the handset market, which forces a quick succession of new models with increasing functionality. The R&D intensity of the telecom equipment firms is reflected in Figure 7, which shows the ratio of R&D spending to revenue. It should be noted that the slight upward trend in the percentages is a result of falling revenues rather than increasing ratio's. The rapidly falling line represents a start-up in data communications: Juniper Networks (derived from: p87).

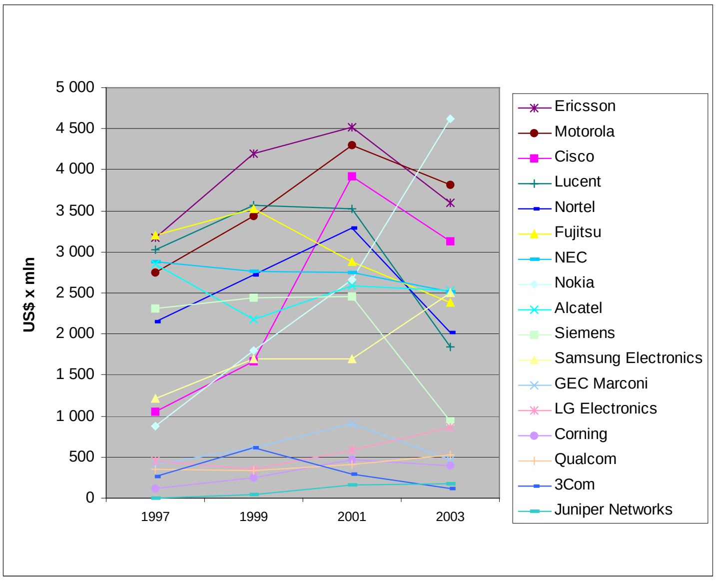


Figure 6. R&D expenditure by telecom equipment vendors, 1997-2003

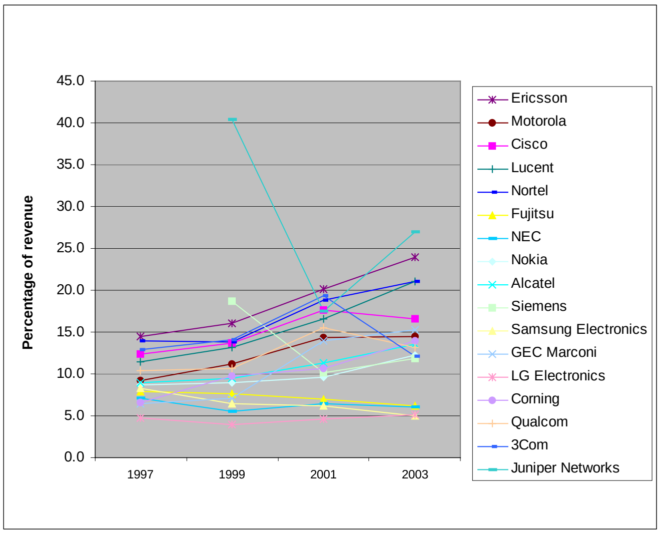


Figure 7. R&D expenditure as percentage of revenue by telecom equipment vendors, 1997-2003

Telecom operators have mainly influenced R&D spending through the procurement of telecom equipment, and by requiring the latest generation of technology, to obtain lower cost and/or enhanced capabilities.[7] The direct R&D spending by the telecom operators, which historically has been very broad based reflecting the profile of their suppliers, has become much more focused on the core business of supplying communications services. Their spending is reflected in Figure 8 (OECD, 2005b p86).

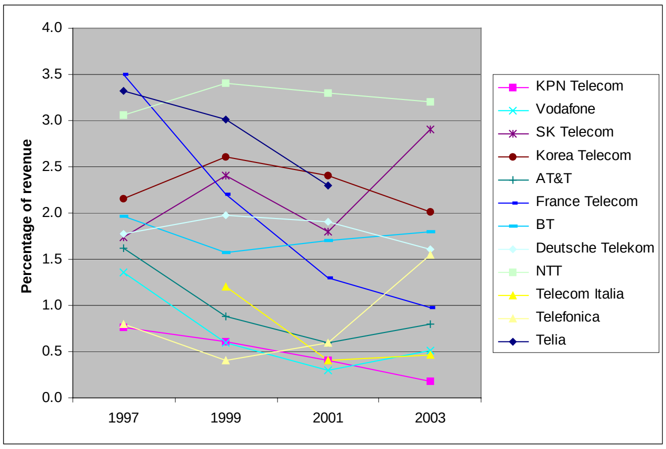


Figure 8. R&D expenditure as percentage of revenues by telecom operators, 1997-2003

Notes: R&D is subject to capitalization and amortization in certain countries, which is not reflected in the charts. Telefonica applied a different accounting method prior to 2001; Telia-Sonera did not specify 2003 R&D expenditure for the merged company; SK Telecom is a Korean mobile operator.

A remarkable drop, to one third, in R&D spending can be observed for AT&T and a cut in half for France Telecom.[8] The graph suggests that the bubble profile applies to only two companies, albeit these are both Korean companies.
The ratio of R&D spending to revenue is showing for the sample set of companies a downward trend. Only 3 companies are reflecting a slight bubble profile; one new entrant defies the trend: SK Telecom, a mobile operator in Korea. It should be noted that high R&D spending by incumbent telecom operators is a legacy from the utility period. Next to reduction in spending also outsourcing of R&D can be observed; KPN Telecom being a typical example. Most new entrant operators have no in-house R&D and have relied heavily on equipment vendors. See also Chapter 6 Section 2.3.

3.1.1.3 Progressive telecommunication reform

During the bubble period we have seen major steps being taken on the road to full liberalization of the telecom services sector:

- 1995 EU CATV Services liberalization, allowing the provisioning of Internet and voice services,
- 1996 US Telecom Act, opening up the local access to competition,
- 1996 EU Mobile telecom liberalization,
- 1998 EU Directive on Full Liberalization, including the PSTN access.

By 1996 resp. 1998 all formal legal barriers to enter the telecom services market had been removed in the USA and the EU. Regulation was put in place to assure a ‘level playing field’ for new entrants, i.e. an ex-ante regime to prevent the use of ‘significant market power’ that incumbents might have obtained during the monopoly period. The principle of ‘unbundling’ was introduced to open up network access to new entrants, to allow business models to develop based on a ‘mix and match’ of own and leased infrastructure elements.
CATV networks were considered as one of the few if not the only alternative infrastructure that would provide for ‘infrastructure based’ competition. In the EU in general the CATV networks remained local monopolies, with a strong linkage between network operation and content provisioning.

3.1.1.4 Economic drivers

The economic developments for the sample set of countries in the period is reflected in Figure 9, showing the GDP at current prices and current exchange rates (derived from: OECD, 2005a). The graph reflects the up and downward momentum of the business cycle.

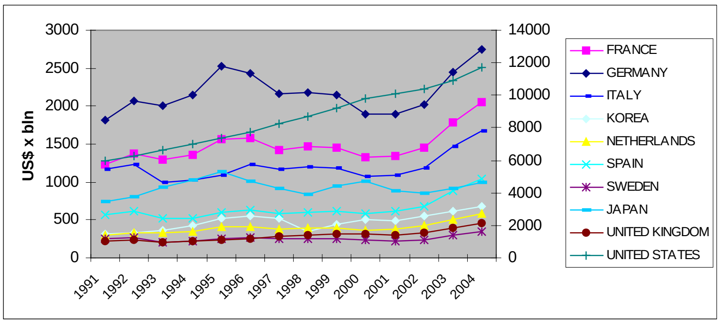


Figure 9. GDP for the period 1990-2004

Note: the USA and Japan are linked to the right hand scale.

In Chapter 3 we have shown the link between telecommunications and GDP. It is worthwhile to note that during the bubble period telecommunication revenues, measured at the OECD level, have increased more than a full percentage point, or 50%, in share of GDP, see Figure 10 (OECD, 2005b p69).

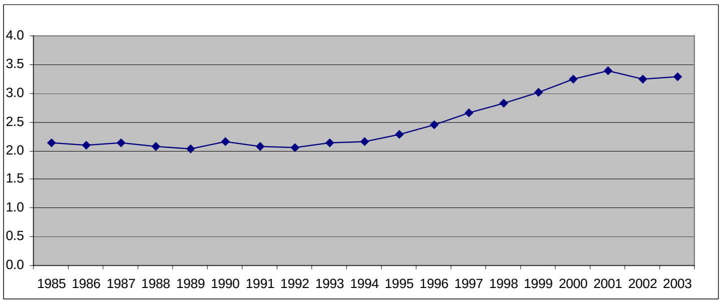


Figure 10. Telecommunications revenues in relation to GDP, 1985-2003

3.1.1.5 Socio-cultural drivers

The explanation provided in Chapter 5 Section 2.1.3 applies also for this period. Telecommunication has moved from a ‘utility’ need to communicate to increasingly a part of social interaction and awareness. The declining cost, the introduction of mobile communication and the Internet have been key drivers in this process of change.

3.1.2 Industry drivers of development

3.1.2.1 Changing forces at the entry barrier

In Section 3.1.1.3 we already discussed the steps taken in the reform process toward the full liberalization of the telecommunications services sector. The progress toward competition on a country level is reflected for fixed networks in Figure 11 and for mobile infrastructure in Figure 12 (OECD, 2005b p22).

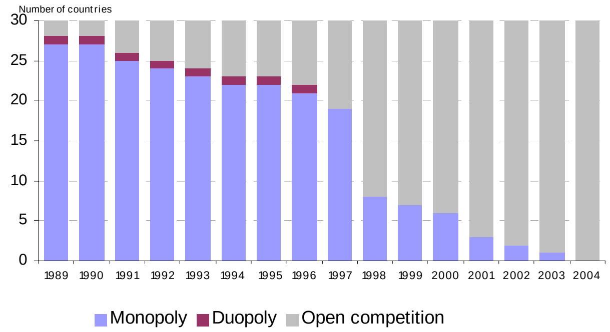


Figure 11. Competition in fixed networks, 1989-2004

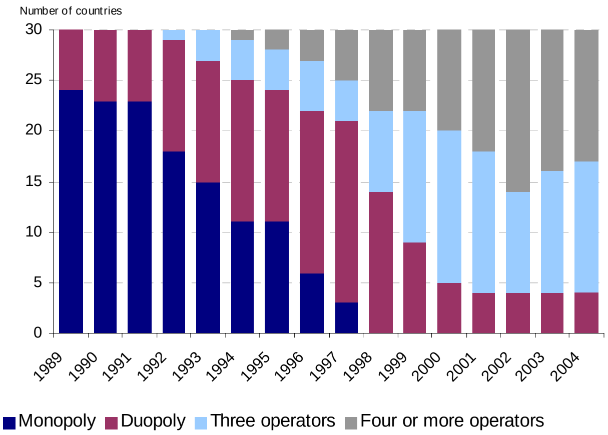


Figure 12. Competition in mobile infrastructure, 1989-2004

Considering that large business users will make use of leased lines in addition to switched traffic, the overall market share of new entrants is expected to be larger, as the long-distance business segment has been the prime target of many new entrants, both facility based and resale.

In line with the progression of reform 'waves of new entrants' can be identified: in long-distance (national and international USA; international Europe), in local access by-pass (USA), in long-distance re-sale (Europe), in Pan-European long distance, in DSL access based on unbundling (USA and Europe), in fixed wireless access (USA). Incumbent operators in Europe expanded abroad to pursue revenue growth, either by taking a share in an existing player or independently as a second operator. As an example Figure 13 depicts the global expansion of Telefonica (Lucent Technologies, 2005). From the chart it becomes clear that the expansion strategy is strongly influenced by cultural and historical factors, a pattern that can be discerned with many incumbent players in Europe.

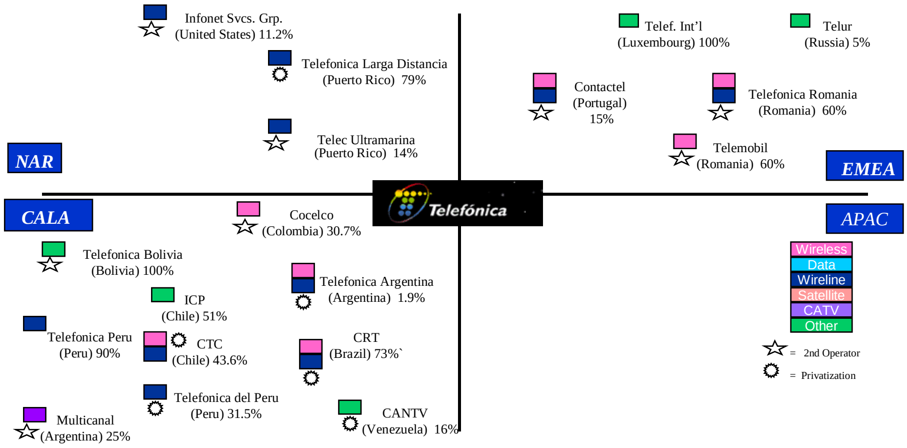


Figure 13. Incumbent operators expanding abroad

Equal access and unbundling lowered the barrier to entry in terms of investments required, through the option to 'mix and match' owned and leased infrastructure elements.

The intensified competition increased the value of brands in the sector and thereby the level of marketing expenditures in the industry.

Assessing the 'level' of the barriers in actuality, or alternatively the evaluation of the effectiveness of the telecom reform process is not the topic of this research project. Hence, we will not pursue the details of the barriers to entry by assessing topics such as 'significant market power'. These are the subject of detailed reviews being executed by the NRAs as part of the implementation of the 2002 EU Directives on Electronic communications networks.

3.1.2.2 Changing forces regarding substitutes

In Chapter 5 we concluded that in the period leading up to 1995 mobile services were complimentary rather than a substitute for existing fixed services. Mobile as a substitute was a driver of change, but not (yet) to the extent of replacement. In contrast, during the considered period we have seen a tremendous growth of mobile users, see Figure 14, as well as a decline in number of fixed connections, see Figure 15 (derived from: OECD, 2005b p102 & 108).

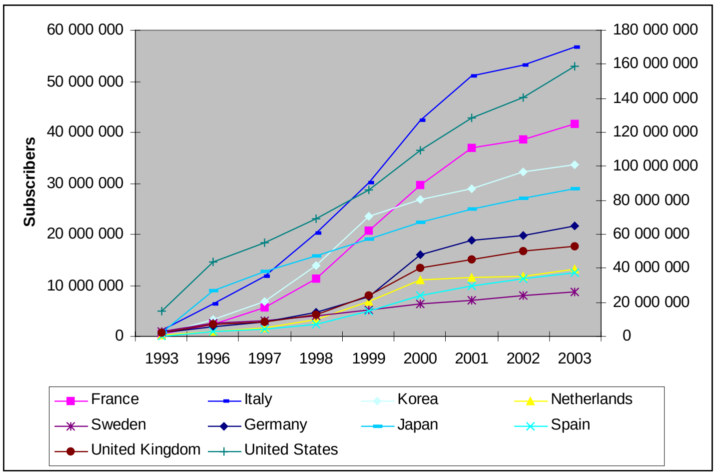


Figure 14. Mobile subscribers, 1993-2003

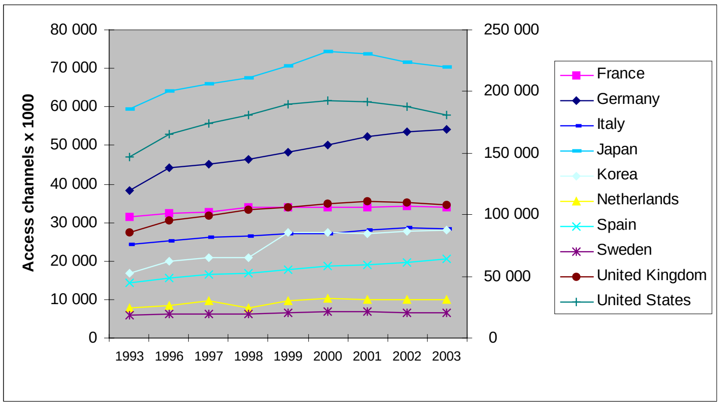


Figure 15. Telecommunications channels-fixed, 1993-2003

The growth of mobile voice communications is for the greater part complementary, essentially changing the notion of teledensity from ‘a phone per home’ to a ‘phone per person’. As illustrated in Figure 16 showing the growth of mobile vis-à-vis fixed in Western Europe (derived from: ITU, 2002).
The rapid success of terrestrial mobile communications has significantly reduced the prospects of a satellite based alternative, such as Iridium and Globalstar. Combined with technical issues these systems have disappeared as viable substitutes, at least in the context considered.

The decline in fixed connections suggests a substitute of fixed-voice by mobile-voice.

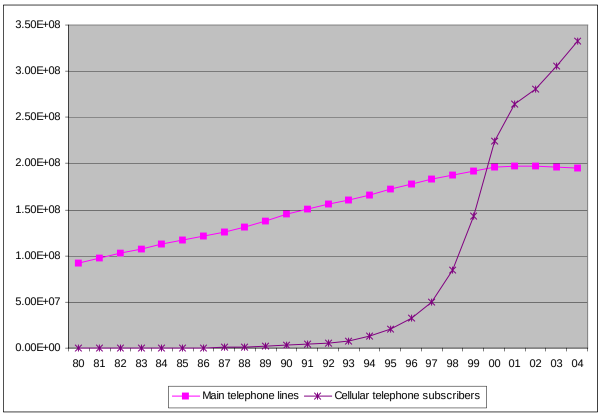


Figure 16. Fixed and mobile users - Western Europe 1981-2000

Note: Including analogue lines and ISDN channels

The factor that deters the drop in fixed line connectivity is the increasing use of broadband Internet access, see Figure 17 for the sample set of countries (derived from: OECD, 2005b p152). This is a more recent phenomenon with densities for DSL-based access ranging between 3-14% (UK-Korea), as compared to a density for access channels in general between 50-70% (Spain-Sweden). See also Figure 18 (derived from: OECD, 2005b p126). Albeit in countries with a well developed CATV infrastructure, cable modems contribute significantly to broadband penetration, notably in the USA, Korea and The Netherlands, with 6-8% percentage points, or 51-58% of the total. In these countries the combination cable-Internet + mobile-voice would provide a credible substitute for the traditional fixed PSTN connection. However, a high level analysis of the data does not yet support this hypothesis. Japan and the USA show a noticeable drop in number of access channels, the UK and Sweden a less pronounced decline, while in Korea and The Netherlands the number of access channels remains flat in recent years. as in Korea and The Netherlands the number of fixed channels remains flat in recent years, Also overall higher broadband density does not necessarily explain the direction of change at this level of analysis.[9]

In terms of implementation the use of Voice-over-IP presents a substitute for voice communication using the PSTN. VoIP also fundamentally changes the business model as it is in general provided as a free software application running ‘on top of’ a broadband ‘flat fee’ subscription, using either ADSL or cable modem.
In case the VoIP call terminates on the PSTN, the ‘off-net’ portion of the call is charged at the PSTN rate.

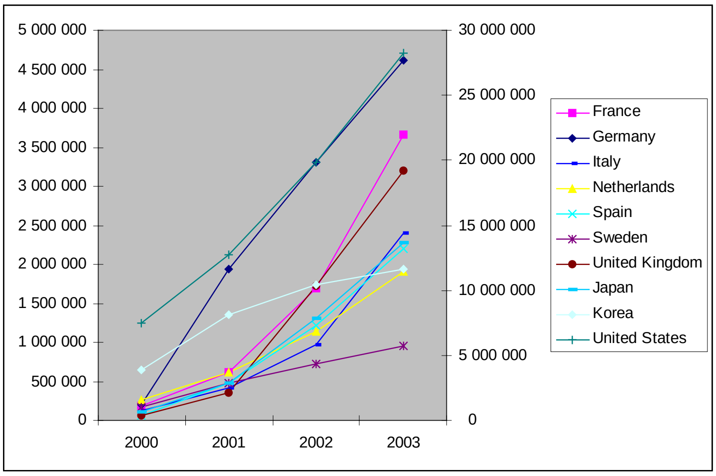


Figure 17. Broadband penetration, 2000-2003

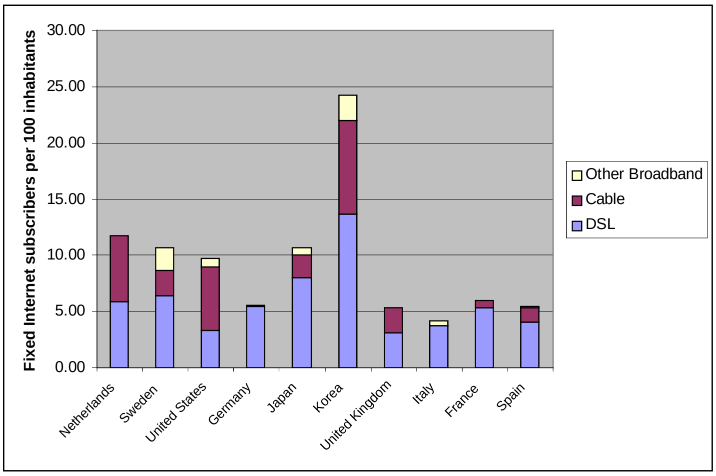


Figure 18. Fixed internet access per 100 inhabitants, 2003

The forerunner of VoIP was introduced on the ARPA net as ‘voice funnel’ as early as 1983. The quality of Vo-IP calls has always been an issue as the Internet provides a ‘best effort’ connection quality. The capacity increase of the Internet infrastructure and the improvements of VoIP protocols have mitigated this issue to a large extent. Also the availability of VoIP phones has extended the usefulness beyond the ‘desktop’. Within private networking VoIP has taken already an important position. Early consumer applications emphasized cheap intercontinental calling. Figure 19 shows the growth of VoIP as part of overall growth of international switched traffic, measured in minutes-of-use (Telegeography, 2005). In the aftermath of the telecom bubble Skype appears to be the leading provider of VoIP.[10] Since its founding in 2003, it claimed to have completed 10 billion Skype-to-Skype call minutes by June 2005. By August of 2005 150 mln downloads of the application software had been completed and 50 mln Skype names were registered (Skype, 2005). A comparison of PSTN and VoIP tariffs suggests a further potential shift towards VoIP, subject to improved quality and convenience, see Figure 20 (OECD, 2005b p167).

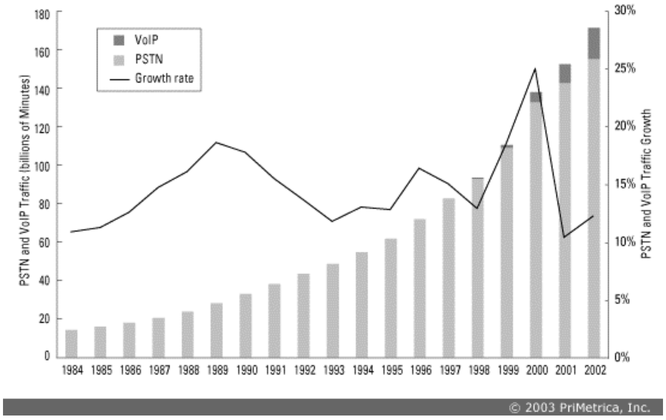


Figure 19. International voice traffic growth, 1984-2002

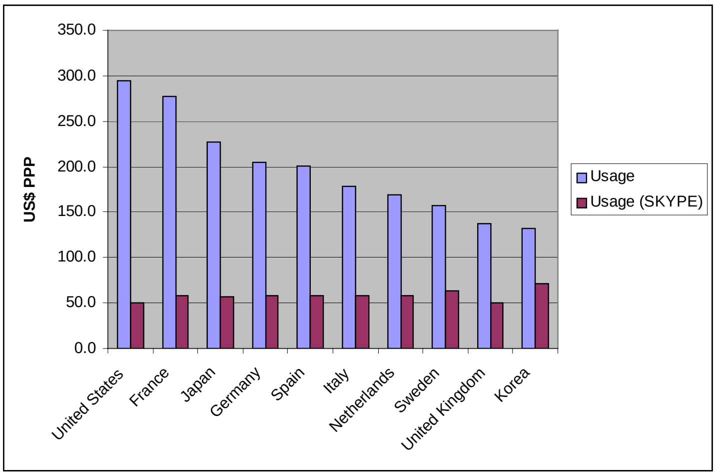


Figure 20. OECD residential usage charges compared to Skype charges, Sept. 2004

With a stalling or decline in number of PSTN connections, and a growth in broadband supporting Internet access, investments by telecom operators in the PSTN infrastructure are capped and the investments have shifted to expanding Internet infrastructure. Recognizing that already during the bubble the expansion of backbone networks took place, the emphasis in the aftermath is centred on the Internet access.

For the traditional telecom equipment providers this shift, which became tangible in a significant decline of revenue by 1999/2000, implied the end of the product cycle of digital switching systems, using the circuit-mode paradigm. The business model would shift toward servicing the installed base of many times hundred million lines.[11] The dynamic market theory, as discussed in Chapter 4 Section 5.1.3, suggests that a horizontal concentration would follow, due to declining demand and increasing losses as a result of overcapacity, However, the proprietary nature of the software deployed in these systems, makes concentration less likely.[12] Typically firms will adjust capacity on an individual basis.

3.1.2.3 Changing forces regarding buying power

In evaluating changes in buying power one has to consider the changes at either side of the 'interface'. At the buyer side telecommunications spending has increased over the period, which would typically lead to an increase in buyer power. Moreover, at the other side of the interface rivalry has also increased through intensified competition on price, as a result of firm entry.

Figure 21 reflects the increasing telecommunications services revenues for the sample set of countries, reflecting increased spending by business users and consumers (derived from: OECD, 2005b p77).[13] Figure 22 shows the revenues as a percentage of GDP, from which one may conclude that communications spending has increased over the period 1984-2003 with a full percentage point, from a range of 1.5-2.5 % to a range of 2.5-3.5% relative to GDP, with the UK at 4.5% exceeding the range at the high end, and France with 2.2% falling just below the range. The OECD average moved from 2.1% to 3.2% (p78). The annual increase is most pronounced from 1997 to 1998; from 2001-2002 a 0.2% dip occurs, while from 2001 onward the trajectory appears to become flat.[14]

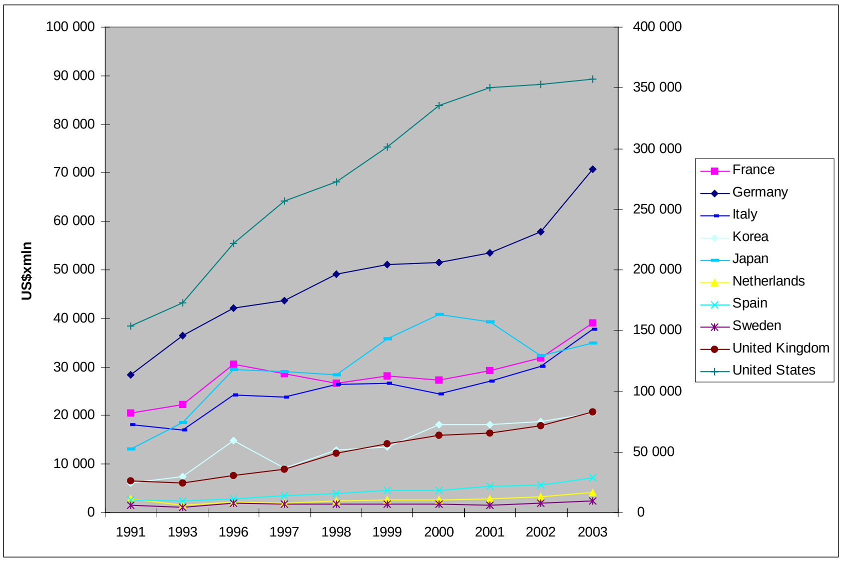


Figure 21. Telecom services revenues, 1991-2003

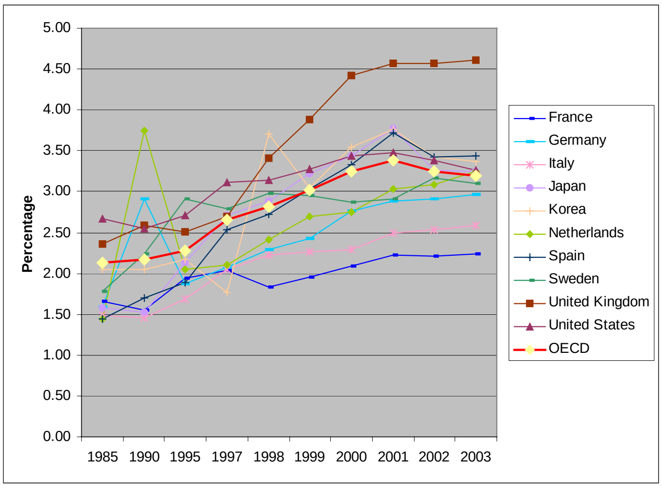


Figure 22. Telecommunication revenue as percentage of GDP, 1985-2003

Another data point is the development of communications spending as a proportion of disposable household income. The communications spending has increased to 134% over the period 1994 – 2001, to show a minor drop of 2% in the aftermath. See Figure 23 (p38)[15].

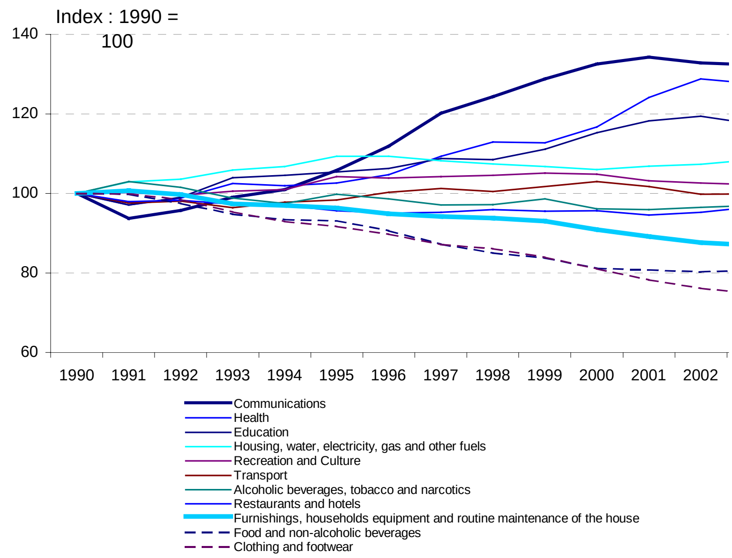


Figure 23. Changes in the proportion of communication in disposable household income, 1990-2003

This relative increase relates to an absolute spending on communications services in 2003 of e.g. US$ 80 per household per month in Sweden, and $ 75 for services and equipment in the UK and $ 76 in the USA (p39). It appears that communication has taken a more prominent place in the household spending pattern. Although business access lines account for only 27% of total lines in Europe in 1999, business represents 50% of revenues; a share that IDC projected to grow to 60% by 2004 (IDC, 2001 p21). Given their increasing dependency on high quality telecom services, the ongoing pressure on costs, and increasing alternatives being offered through new entrants, buyer power is increasing. Business, using corporate networking, were also the first to benefit from technological alternatives, such as VoIP, placing further downward pressure on PSTN prices.
Indirect switching cost have come down as operators are increasingly forced to provide ‘number portability’.
In the field of mobile communication the significant levels of ‘churn’ further illustrate the increased buyer power.

3.1.2.4 Changing forces regarding supplier power

In Section 3.1.1.2 we discussed the decline and shift of R&D by telecom operators. In Chapter 6 we have also seen that new entrants tended to leave R&D to their suppliers. This implies an increase in supplier power. On the other hand, the expansion of the market in the field of optical and data communication has also led to many equipment firms to enter, a phenomenon in line with the dynamic market theory, see Chapter 4 Section 5.1.3. Moreover, transmission and data communication equipment tend to be more standardized than was the case for switching systems. This suggests a reduction in supplier power. Nevertheless, Cisco has been able to emerge as the leading supplier of routers to the Internet, with a market share of 65-75%, suggesting a significant clout translating into supplier power in this important segment of the market.
The investment frenzy in optical networks during the telecom bubble, had shortened significantly the technical life time of the ‘active’ transmission equipment (multiplexers and repeaters; as opposed to ‘passive’ equipment, the fiber optic cables).[16] While, extension and upgrading within a family of equipment provided by a single supplier remained in general more attractive, new entrants had a free choice of the best offer on the market. A phenomenon that decreases supplier power.
As described in Chapter 6, the investment frenzy in optical networks, has led to a shortage of fiber supply and hence provided the equipment providers with significant supplier power. Albeit, this period was very short-lived, and in the aftermath these suppliers were struggling for survival.
While the mobile communications segment survived the crash in the better position, the completion of many new network builds and increased competition has slowed down the business. Delays in the roll-out of 3G networks, due to technical and investment delays, exacerbated the situation. Saturation of the terminal market increased competition in the replacement market. The forceful entry of Korean suppliers increased competition significantly and eroded the margins.[17]

Furthermore, the threat for suppliers from backward integration by the buyer in the telecom industry is low. In fact the industry experience points in the other direction. One may conclude that in the aftermath a 'buyers market' has emerged.

3.1.2.5 Changing forces regarding rivalry

In Section 3.1.2.1 we discussed the barriers to entry, and thereby aspects related to rivalry.

The progressive steps in telecom reform, has led to different types of firm entry, one using infrastructure based competition, and the other services re-sale based competition, or a combination thereof. These models could be observed in the market before the telecom bubble in the area of long distance communications. The telecom reform process, as described for the period in Section 3.1.1.3 and more extensively in Chapter 6, has during the bubble period led to infrastructure based competition in metropolitan areas, mainly aimed at the business access. Although, competition in broadband residential access is significant in countries with an alternative CATV-access infrastructure. See also Figure 18. The 'unbundling' of the local loop is intended to break the incumbent' monopoly on access, created during the utility period. The success of unbundling appears to be mixed. While being a result of demand and supply, there is little incentive for the incumbent operator to support the supply process. See Figure 24 (based on OECD, 2005b p59 & 102).

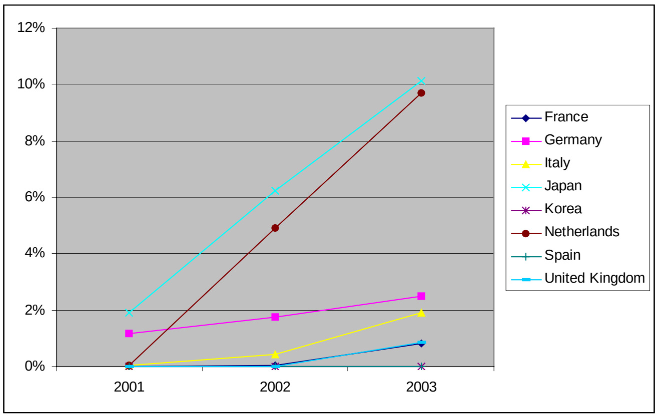


Figure 24. Unbundling, 2000-2003

In a competitive market the development in prices is closely related to the intensity of competition and hence rivalry. The time series of telephone charges for residential and business users are shown in Figure 25 (derived from: OECD, 2005b p171). In particular the charges related to business users are reflecting the effect of competition up to 2000. In the aftermath the index of charges, expressed in current dollars, are remaining essentially flat, hence the actual gains are greater than shown.

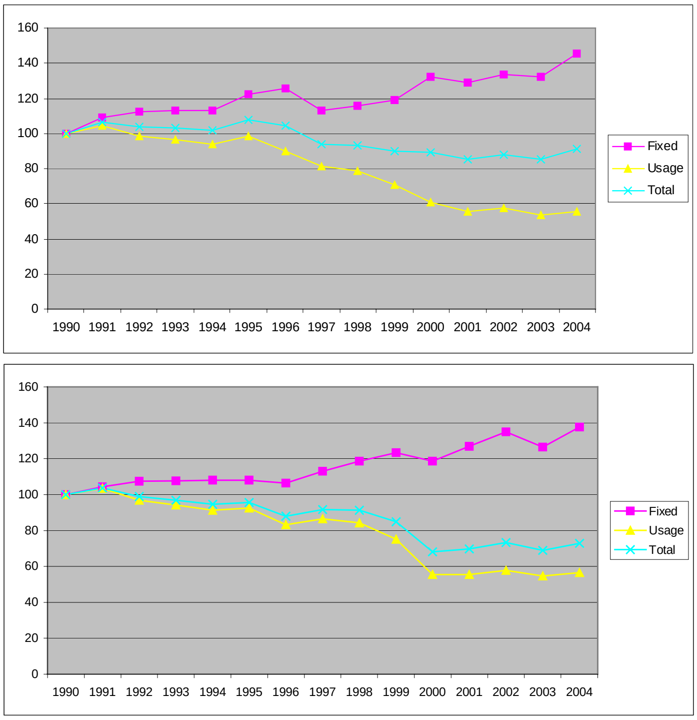


Figure 25. Time series of telephone charges, residential top - business bottom 1990-2004

Note: Data point 2002 for the Netherlands interpolated.

The effect of competition is even more pronounced in the pricing of leased lines, see Figure 26 (derived from: OECD, 2005b p176).

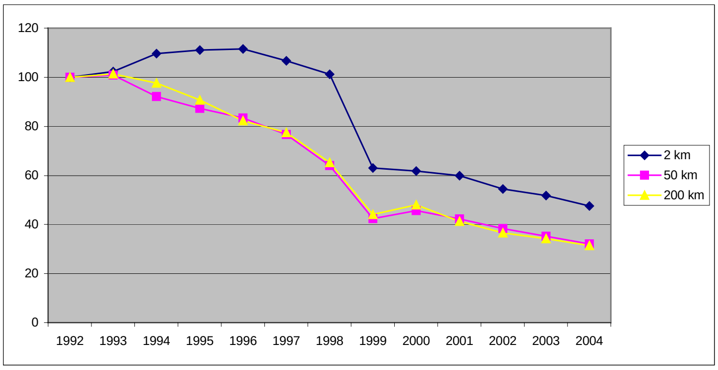


Figure 26. Trends in leased line pricing, 1992-2004

3.1.3 Drivers of telecom equipment industry development

While the telecom equipment industry has been addressed already as supplier to the telecom services provider, the equipment industry does warrant a few additional remarks.

The main feature of the telecom bubble has been the firm establishment of the packet-mode paradigm, as leading paradigm for Internet related infrastructure. The traditional business, related to the circuit-mode paradigm, has moved in its product life cycle from the maturity phase to the phase of decline. Switching cost related to the installed base force operators to retain their original suppliers.

The activity level in the industry in the aftermath of the bubble is back to the level during the early bubble period, 1995-1997. This can be observed in the investment level by the telecom operators as shown in Figure 27 (derived from: OECD, 2005b p116).

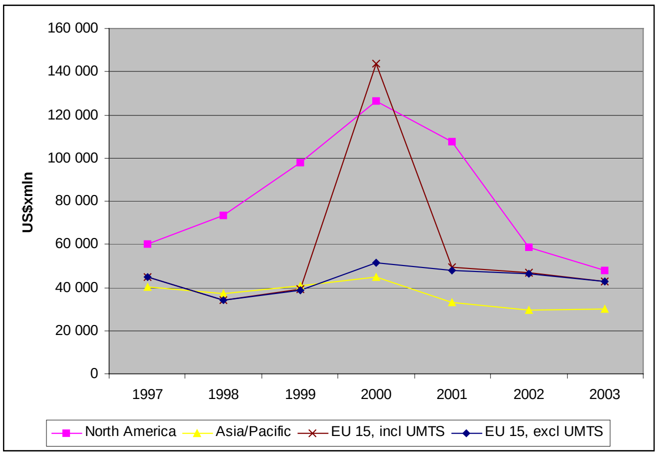


Figure 27. Regional telecom operator investments, 1997-2003

Note: Includes spectrum fees from 1999 onwards; in 2000 in the EU approx. US$ 92 bln

3.1.4 Internal drivers of telecom industry development

The internal drivers of industry development are considered to be the forces of industry change that emerge at the firm level. As not all firms within the industry operate from the same resource base, differences therein may generate a force of industry change.

A typical example for the period is the role assumed by Cisco in the realisation of the infrastructure for the Internet, based on its leadership role in the area of the router. Knowledge of the underlying principles of the Internet set Cisco aside from the traditional telecom companies. The wide sharing of knowledge on its equipment, and engaging customers through the web in complaint filing and in resolving bugs, became new ways of interacting with the user community.

Another example is Nokia in the field of mobile communication, illustrating the importance of brand image in the business of mobile handsets; a phenomenon

hitherto unknown to the telecom industry. According to the Interbrand surveys, Nokia's brand position moved from a tenth position in 1999, with a brand value of US$ 21 bln, to the fifth position in 2001 with a value of $ 35 bln; behind Coca-Cola, Microsoft, IBM and GE (Häikiö, 2001 p220).
The ownership of networks used for internal communications became another internal driver of change, as the telecom reform allowed the exploitation of these networks for third party use. Examples are the energy utilities (e.g. Energis, Enertel) and transport companies (e.g. Telfort). Companies, such as COLT (City of London Telecommunications), exploited the 'rights-of-way' as a distinctive driving force.

3.2 Inhibitors of industry development

Examples of the inhibitors of industry development were given in Chapter 4 as:

- Underlying conditions, e.g. economies of scale,
- Industry integration, in terms of (complex) linkages between various aspects of the industry,
- Power structures, e.g. desire to maintain the status quo by incumbents,
- Risk averseness, e.g. uncertainties about investment payoff,
- Industry recipes, e.g. in the form of cognitive maps shared across the industry,
- Institutional pressures, e.g. applied by governments or interest groups.

The fundamental changes invoked by the process of telecom reform, the rapid technological progress, in particular through high-tech start-ups, and the ample availability of funding has broken, or at least significantly reduced, the spell that many inhibitors had in the development of the telecom industry. The development of the Internet, reflecting the open academic research tradition, resulted in a powerful interest group, which had very few principles in common with the 'telecom establishment'. The period considered is one of transition, from a paradigm related to telephony, honed over more than a hundred years of development, to a paradigm related to data communication which started its live in 1960. The difference between the two paradigms are described in Chapter 5 Section 3.

3.2.1 Governance structures and institutional arrangements

Also governance structures and institutional arrangements can be identified as inhibitors of change. These structures and arrangements have typically developed according to the needs of the industry and/or as a resolution to conflicts between public and private interests. Once established they condition the behaviour of the actors in the industry. See Chapter 4 Section 4.3.1 and 5.2.4.
The privatization of telecom operators as part of the reform process, has for instance forced a change in the position of the employees. They had to relinquish their position as civil servants and accept the 'forces of the market' as their new governance model. See Chapter 5 Section 3.2 for a discussion on the difference between a public domain and a private domain regime.

The ‘power of paradigms’ as an inhibitor of change is for instance reflected in the vested interests that an industry has in its continuation. The battle between the ‘Bell Heads’ and the ‘Net Heads’ is a case in point.
The optimism during the frenzy period suggested that the interests of many, if not all parties were aligned, as the prosperity could be shared broadly. During the crash and in the aftermath it has become apparent that many rules of good governance had been violated in the process ‘to keep up the promises’. Moreover, it appeared that the benefits have been accrued by a small group, and the fall out would affect the society at large. See also Chapter 6 Section 2.2. Also the notion that the management had not necessarily acted in the (long-term) interest of the shareholder had become apparent, thereby the ‘agent’ was violating the ‘contract’ with the ‘principle’. This realization evoked a tightening of the governance regimes. In the USA the Sarbanes Oxley Act was signed in 2002, and in The Netherlands the Tabaksblat Code was accepted in 2003.

4 The ‘development path’ of the telecom sector 1995-2002

In the previous Sections we have described and explored the drivers and inhibitors of industry development. In this Section we will summarize the results in terms of the ‘development path’ of the telecom sector in the period 1995-2002.

4.1 Expansion-contraction of demand

4.1.1 Connectivity

At the OECD level the changes in the connectivity pattern are reflecting the phenomenal growth of mobile communication during the period considered, see Figure 28 (derived from: OECD, 2005b p21).

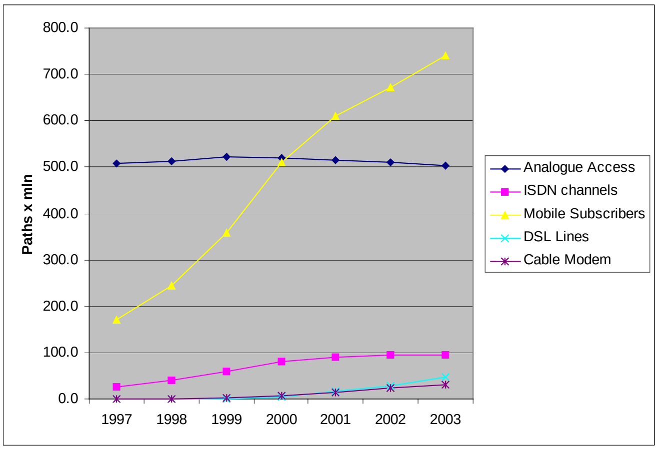


Figure 28. Access paths in the OECD area, 1997-2003

The adoption of mobile technology is exceeding in speed any earlier technology diffusion, such as radio, TVs, and CDs. The introduction of pre-paid has been playing a major role to unlock the potential of new market segments in Europe, in particular the younger generation. See Figure 29 (p 110). The segment is also quickly reaching saturation levels and hence for the countries under consideration the business emphasis will be on replacement and increased functionality rather than plain growth.

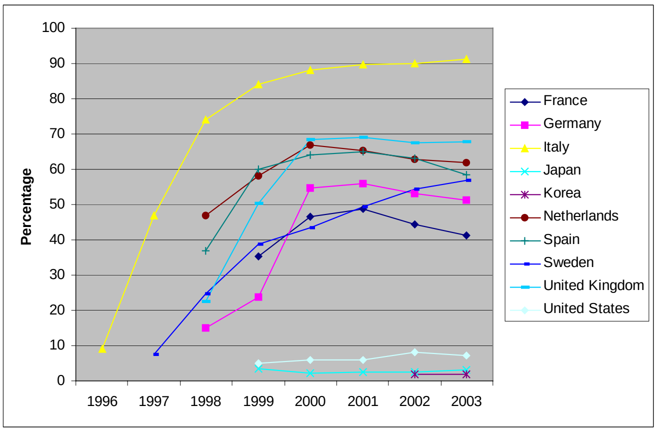


Figure 29. Pre-paid as percentage of total mobile subscriptions, 1996-2003

Figure 30 shows the teledensity for the sample set of countries in terms of fixed, mobile and Internet connections per 100 inhabitants (derived from: p107 & 109 & 148). [18]

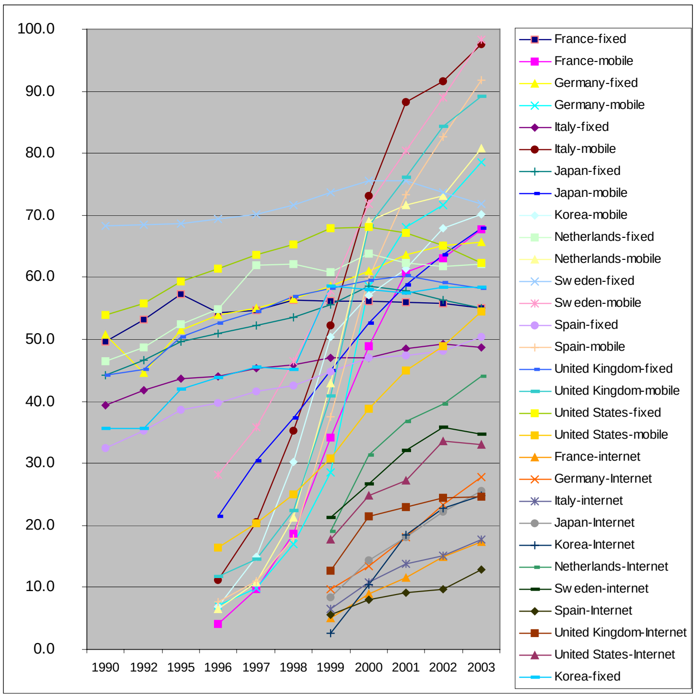


Figure 30. Teledensity fixed, mobile and Internet, 1990-2003

The sample set of countries shows at an aggregate level an increase in fixed channels between 3% and 6% for the period up to 2000. From 2000 to 2001 there is 0% growth, while from 2001 onward there is a drop in access lines by 1% per year.
The growth in broadband penetration is shown in Figure 17, while the use of DSL or cable modem, is illustrated in Figure 18. As most of the Internet traffic is between a PC terminal and a host, the number of hosts is an indicator of connectivity and is shown for the sample set of countries in Figure 31 (derived from: OECD, 2005b p156). Note that the country tally is reflecting the associated top level domain names (TLDs), e.g. nl, uk, de. Hence, the actual number of hosts in a country will be higher, as this will include general TLDs such as com, gov, net, and org. USA and Japan are being shown against the right hand scale. The total tally of hosts and the growth rate is being shown in Figure 32 (derived from: OECD, 2005b p156).

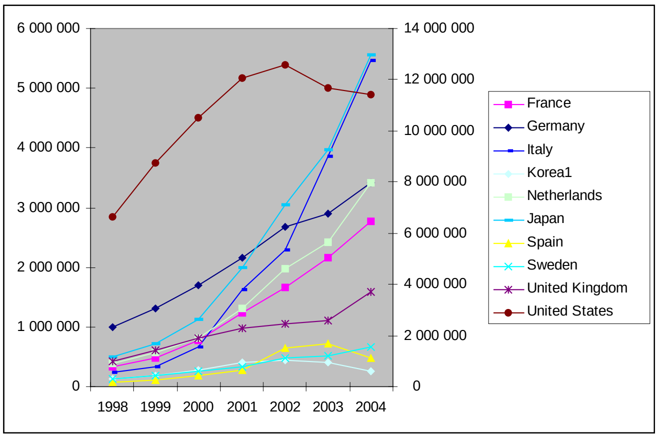


Figure 31. Internet hosts, 1998-2004

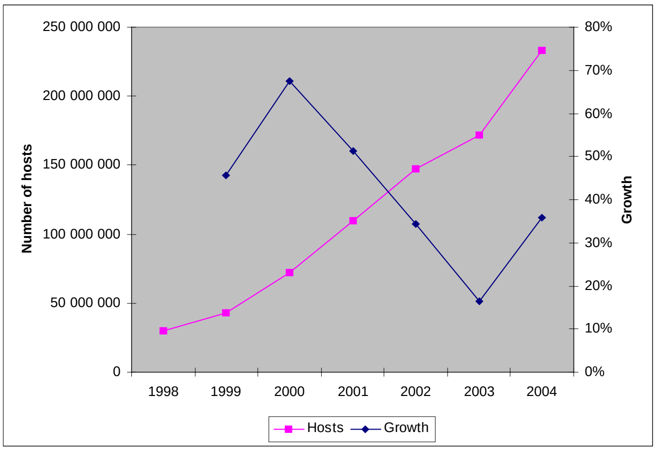


Figure 32. Internet hosts and growth, 1998-2004

For the period 1998-2004 this is reflecting a growth rate of 41%. The host survey count by the Internet Software Consortium is showing a further increase to 350 mln bij July 2005. (Slater, 2005). While the bubble is reflected as an acceleration and deceleration of growth, there is a continuing growth in hosts being connected to the Internet.

4.1.2 Utilization

As a proxy for the utilization of the telecom network telecom revenues can be used. Figure 33 is showing the development of revenues per access path and Figure 34 the revenues per capita (derived from: OECD, 2005b p81).

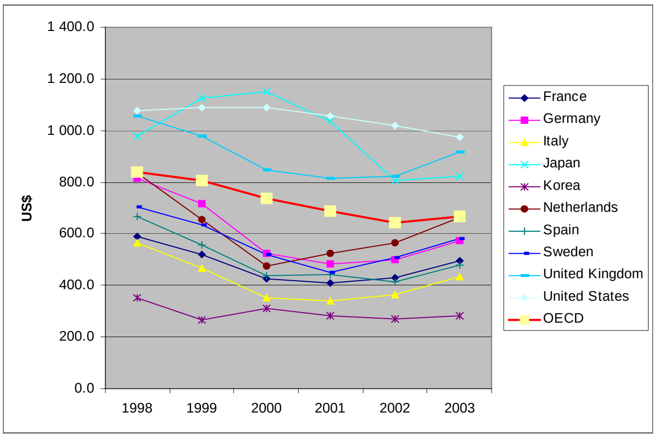


Figure 33. Revenues per access path, 1998-2003

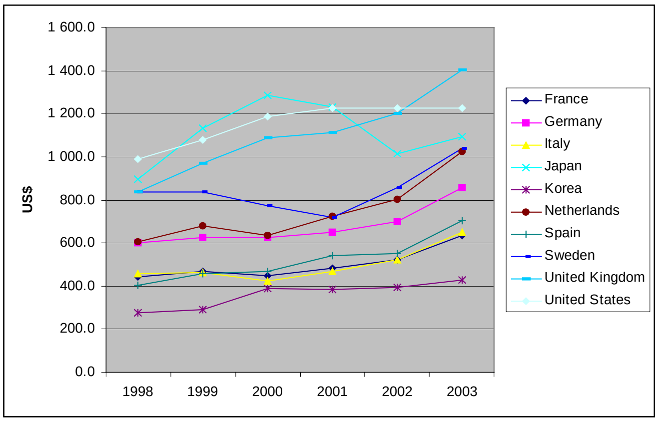


Figure 34. Revenues per capita, 1998-2003

Note: Access paths include fixed and mobile; Fixed is excluding broadband lines.

The data on revenues per access path is suggesting the impact of increasing competition during the boom period, and a gradual recovery in the aftermath. The time series on the USA are deviating from this pattern, with an ongoing decline in revenues per access path. This may be explained by the difference in mobile penetration, and hence the lack of competition between fixed and mobile. See also Figure 30. Figure 35 shows the increasing share of mobile revenues in total telecom operator revenues, whereby Korea and Japan are leading with a 65% and 58% share. Closely followed by Italy with 50% (derived from: OECD, 2005b p80). The data illustrates the increasing importance of the mobile paradigm, albeit this data does not (yet) support the conclusion that the mobile paradigm is leading. The drop in mobile revenues per subscriber, as shown in Figure 36, is reflecting the move towards a mass market product in a competitive environment. The upward tendency in 2003 suggests a maturing of the market.

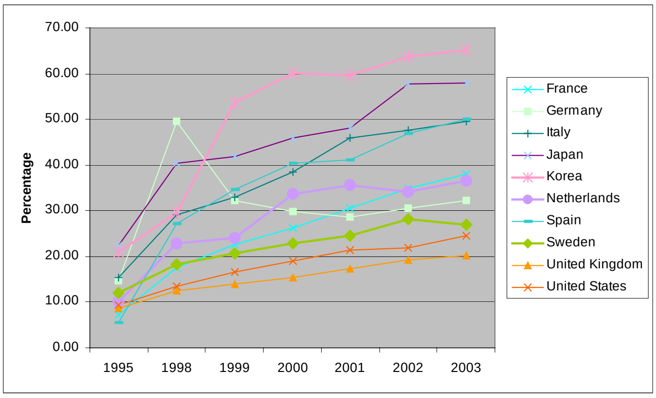


Figure 35. Mobile revenues as share of total revenues, 1995-2003

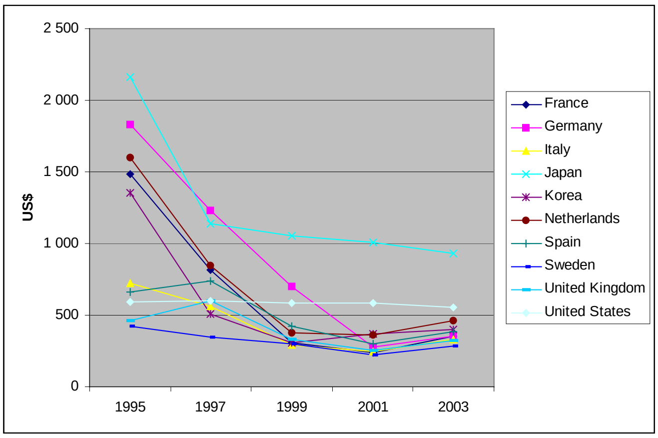


Figure 36. Mobile revenues per subscriber, 1995-2003

The increasing importance of mobile traffic is also shown in the growth of short message service (SMS). Table 1 provides a snapshot of the traffic involved, albeit the data applies only to the aftermath (derived from: OECD, 2005b p152).

Millions of messages	Q1 2003	Q1 2004	CAGR 2003-2004	Includes:			
France	1 904	2 486	30.5	Orange	SFR	Bouygues	
Germany	6 355	6 980	9.8	T-Mobile	E-Plus	Vodafone	O2
Italy	3 138	3 984	27.0	TIM	Wind		
Netherlands	717.0	853.0	19.0	Vodafone	Telfort	KPN	T-Mobile
Spain	2145.0	2355.0	9.8	Telefonica			
Sweden	163.7	247.2	51.0	TeliaSonera			
United Kingdom	5067.0	6122.0	20.8	O2	T-Mobile	Orange	Vodafone

Table 1. SMS traffic, 2003-2004

One of the few datasets that is maintained on telecom traffic is related to international outgoing traffic, in the form of Minutes of Use. The information is shown in Figure 37 for the sample set of countries (derived from: OECD, 2005b p84). This data does not suggest a clear linkage with the bubble, despite the frenzy in building intercontinental undersea cable links. However, Minutes-of-Use are relating to telephone traffic only, and hence Internet traffic carried on leased circuits is excluded from this metric. The data is more a reflection of geographical positioning, international trade and cross-border relationships.

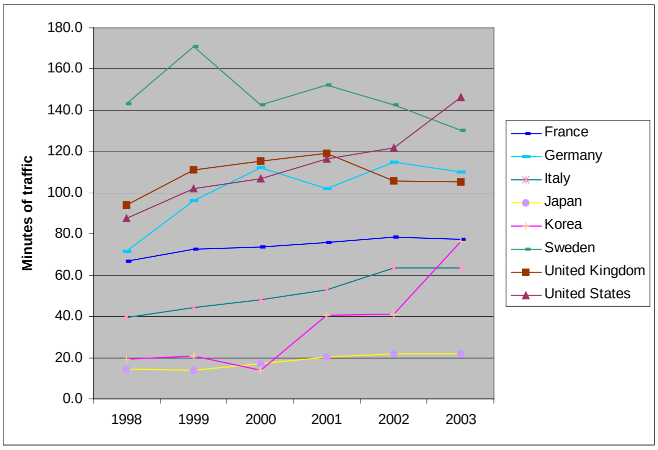


Figure 37. Minutes of outgoing international traffic per capita, 1998-2003

Note: The data set for NL is incomplete and therefore not included.

4.2 Concentration-fragmentation of the telecom services industry

As an item of the discussion of the entry barrier in Section 3.1.2.1, we have already reflected on the process of telecom reform and the consequences in terms of an increase in participants in the telecom services industry. See also Figure 11 and Figure 12. In Chapter 6 we have described the waves of new entrants into the telecom services industry, and the demise during the bust. The listing of filings for bankruptcy protection in Annex 5 shows also that one out of three players are emerging after financial restructuring.

Despite the frenzy, the OECD data on market shares being obtained by new entrants, as reflected in Figure 38, is suggesting that network access is still very much in the hands of the incumbent operator. The best levels of alternate access are to be found in the UK with 16.9%, in the USA with 14.7%, and Korea 13.9%. The growth in market share by the new entrants in the USA from 1997 onward, suggests a linkage to the Telecom Act of 1996 (derived from: OECD, 2005b p42).

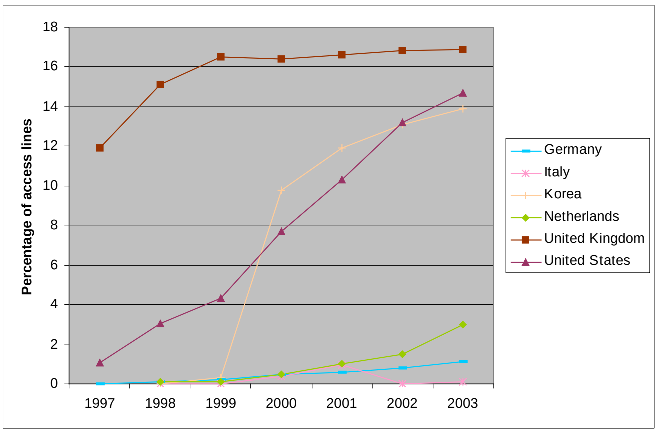


Figure 38. Access line market share of new entrants, 1997-2003

The data shown is a subset of the sample set because of incomplete time series. The few data points that are available on France, Japan and Sweden are suggesting a share below 1%. Competition in the long distance market, however, is much more effective, as reflected by e.g. the market share of new operators in the national switched minutes of traffic. See Figure 39 (p43).

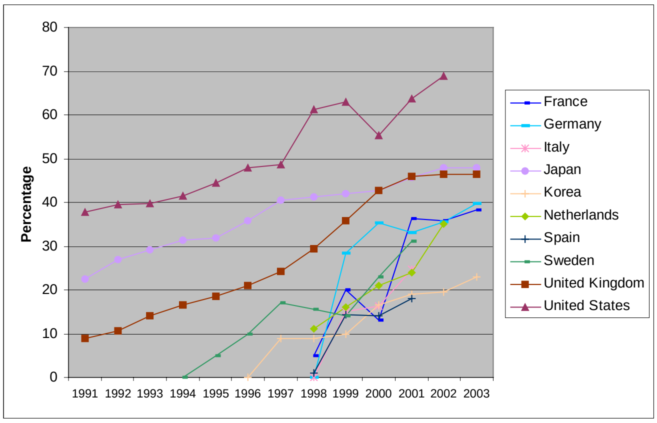


Figure 39. National long-distance market shares of new operators, 1991-2003

Note Figure 38: Data points for NL 2001 and 2002 are interpolated.
Note Figure 39: Data points for Sweden 1998 and Japan 1998 and 1999 are interpolated.

The chart reflects the early start of the USA in terms of long-distance competition, followed by the UK. The data on the USA reflects also a marked increase and drop during the telecom bubble, but appears to resume its growth trend from 2001. From 1998, the market share of new entrants in a number of EU countries starts to grow, which coincides with the 1998 EU Directive for full liberalization. Some of the early entrants were the energy utilities and railroads, which were now in a position to leverage their infrastructure, originally installed for internal use, in the open market. These utility companies have also the competitive advantage of having ‘right-of-way’ in long distance corridors and into the cities.[19]
In the aftermath we may conclude that economies of scale and scope remain important in the telecom services industry, which includes the importance of direct customer contact or ‘customer ownership’. The developments in the USA are a case in point. Through the divestiture of 1984, the 24 Bell Operating Companies (BOCs) were consolidated into 7 Regional BOCs. Since than NYNEX and Bell Atlantic merged with Verizon; SBC acquired Ameritech, Pacific Telesis and independent Southern New England Telephone. During the bubble Qwest acquired US West. This resulted in 4 incumbent players (Goldstein, 2005 p31). Late in 2005 the FCC and the DoJ approved the acquisition of long distance carrier AT&T by SBC, this implies that SBC is acquiring its former parent (SBC, 2005). Also in the fall of 2005 the FCC and the DoJ approved the acquisition of MCI by Verizon (after emerging from Chapter 11 WorldCom assumed the name of MCI, the company it acquired in 1998) (MCI, 2005).

Moreover, the once very fragmented wireless market in the USA is becoming more integrated through consolidation, e.g. through the acquisition in 2004 of AT&T Wireless by Cingular (a joint venture of SBC and Bell South).
In Europe, through the issuance of spectrum licences new players had entered the national mobile markets. The market boundaries shifted from national to regional (Pan European) and partly global, through the acquisition by Vodafone of Airtouch communications in the USA in 1999, and Mannesmann Mobilfunk of Germany in 2000. Because of the success of mobile in Europe, the financial market placed higher valuations on the mobile than on the fixed part of the telecom companies. This triggered the divestiture of mobile divisions: e.g. the sale of O2 by BT in 2001 and the contemplated sale of KPN Mobile. Scale of operations and the ability to provide international network coverage was reflected by the acquisition by DT-Mobile of One2One in the UK in 1999 and Voicestream of the US in 2001; and by the acquisition of UK based Orange by France Telecom in 2000. The debt acquired by these companies in the process of purchaing 3G spectrum licences has changed the attitude of the financial industry to this segment of the telecom industry.
Over the period considered, the US mobile market has become more integrated, while the European market has become ‘dualistic’, with a combination of a strong national player and a few regional players, and one or a few smaller players in each national market.

In part as a result of the relatively low start-up costs the market for Internet access is highly fragmented, albeit incumbents have been able to build strong positions. CATV incumbents have been able to create significant positions in countries with a broad CATV network deployment, e.g. The Netherlands, Korea and the USA. See also Figure 18. A few European regional players have emerged, e.g. Tiscali (Italy) and Wanadoo (France).

In The Netherlands a trend can be observed of consolidation in the CATV market. Originally primarily a municipal affair (78% of the 453 license holders), in the early 1990's consolidation took place. In 2005 three large companies, UPC Nederland, Essent Kabelcom and Casema, have 86% of the market, the remaining 14% being shared among 26 small players (Dake and Boers, 1999; Vecai, 2006).

As indicated earlier, we will not pursue a further detailing of the concentration-fragmentation of the market, and assess topics such as 'significant market power'. These are the subject of detailed reviews being executed by the NRAs as part of the implementation of the 2002 EU Directives on Electronic communications networks.

4.2.1 Concentration-fragmentation in the telecom equipment industry

See also the observation made in Section 3.1.2.4 on the topic of supplier power.
During the boom many new equipment providers emerged, many were absorbed through acquisition by the incumbent vendors, and in the bust many had to foreclose. Incumbent equipment suppliers have downsized and restructured the business and have survived the crash. Best positioned are the suppliers in the Internet and mobile segments of the market.

4.3 Convergence-divergence of business models in the telecom services industry

The process of telecom reform resulted in the emergence of many new business models. These models were different from the fully integrated model of the incumbents, and tuned to the new degrees of freedom, e.g. specialized as long-distance carrier or long-distance reseller. The opening-up of the local access resulted in the emergence of competitive local access providers (CAPs), using alternative infrastructure elements, and of resellers. Business models of the CAPs were in part determined by the infrastructure elements they deployed, e.g. DSL or Fixed Wireless, or using the existing CATV infrastructure. The resale model was of course minutes-of-use based, while the provision of broadband access tended to be offered against a flat fee which depended on the bandwidth provided. The intense rivalry suggested that two distinct classes of business models would emerge, one commodity type model related to the provision of 'bandwidth at least costs' and the other a class of highly specialized business models ultimately aimed at providing tailored services solutions toward specific groups of (business) users, under the notion of Application Service Providers (ASPs). See also Figure 40 (Lucent Technologies, 2005). This vision would imply a concentration of business models at the connectivity end of the spectrum and a divergence at the application end. As an example this market in the Netherlands was projected to grow from zero in 1999 to close to US$ 500 million in 2004, or 7% of the estimated total telecom services market (IDC, 2000 p18; IDC, 2001 p143).[20] Albeit the projections of a booming ASP market would be cut short by the collapse of the bubble.

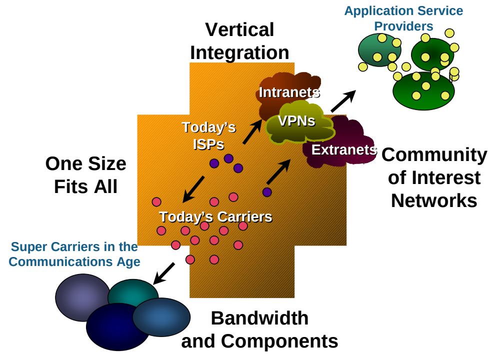


Figure 40. Changing operator business models

On the other hand, the share of mobile revenues in the total of revenues has increased from 5-20% in 1995 to 20-65% in 2003 for the sample set of countries considered, see Figure 35. While, using the IDC forecast for 1999-2004, the data revenues projected for Europe would remain flat at 10% of total telecom services revenues, mainly due to price pressure and shifts from unit based to flat fee based tariffs (IDC, 2001 p20).
Nevertheless the business model of a telecom service provider after the bubble period had become much more diverse than before, which is also reflected in the expanding value chain as depicted in Figure 41.

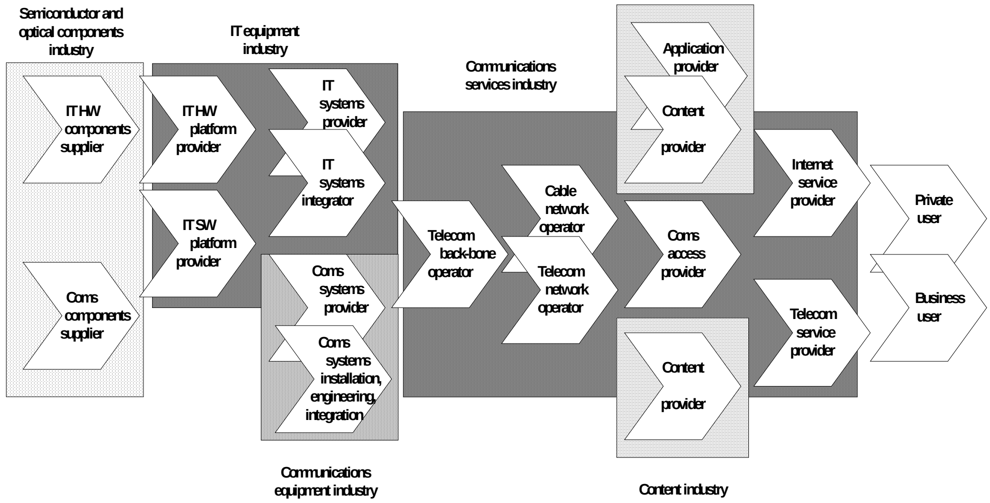


Figure 41. Value chain of the communications sector

In Table 2 a stylized representation is shown of the shifts in business model attributes before and after the bubble. It should be noted that actual business models vary from pure play to a combination of service provider roles. See also Section 4.2.

	Service Provider business model attributes	
Attribute	**Before the bubble**	**After the bubble**
Ownership:	State (Europe) Private (USA)	Private
Licensed service:	Yes	Yes
Infrastructure ownership:	Yes	Yes & No (resale) & Mixed
Infrastructure type:	Fixed	Wireline; Wireless-Mobile; Wireless-Fixed; CA-TV; Broadband access
Technology development:	Strong tie operator supplier	Resides with equipment supplier
Product type:	Telephony	Communications services: - Telephony – fixed & mobile; Access services: - (Broadband) Internet access Application services: - Web hosting
Scope of operations:	National	National Regional
Revenue model:	Subscription and usage	Subscription, flat fee and bundle
Sales and marketing	Nominal	Intense; brand focus Age group and life style focus
Customer churn	None (moves and changes only)	Fixed: includes cancellations Mobile: high
R&D	In house, broad portfolio	Out-sourced/in-sourced, Narrow portfolio

Table 2. Service Provider business model attributes, before and after the bubble

A few additional observations regarding business model attributes for the various market segments:

In the mobile segment:

- Retail outlets are playing an important role in the sales process, either as wholly owned entities or as independent resellers.
- To leverage infrastructure and license investments, virtual mobile operators (VMOs) started to emerge, such as Virgin Mobile in the UK (since 1999), Tele2 and Scarlet in the Netherlands.

In the fixed segment:

- In order to survive after the crash, many incumbent operators have retreated to the ‘home base’, through selling foreign subsidiaries.

4.3.1 Convergence-divergence of business models in the telecom equipment industry

The changes in the business model in the telecom equipment industry are reflecting the progression in the technology and product life cycles. See Chapter 4 Section 5.1.2. The deployment of switching systems based on the circuit-mode paradigm has been capped. Hence, a shift from the phase of maturity to the phase of decline, a process that has been accelerated through the frenzy during the bubble. The focus in the business model will be shifting to the exploitation of the installed base through services and software upgrades.

The accelerated realisation of the Internet infrastructure during the bubble has pushed the related products at an advanced pace through the introduction and the expansion phase.

Table 3 shows the main shifts in business model attributes for the equipment provider.

	Equipment Provider business model attributes		
Attribute	**Before the bubble**	**During the bubble**	**After the bubble**
Ownership:	Private	Private	Private
Scope of operations:	Full line providers (PSTN, incl. CPE) Speciality providers, mainly in transmission and cable systems	Full line providers (PSTN fixed and mobile, incl. CPE) Speciality providers, mainly in transmission and cable systems Entry of Internet providers	PSTN providers Internet providers CPE (modem) equipment outsourced Speciality providers of mobile handset
Revenue model:	PSTN: Hardware and software revenues	PSTN: Hardware and software Internet: Mainly hardware	PSTN fixed: installed base (end-of-life) services PSTN mobile: Hardware and software Internet: Hardware and software
Sales and marketing	PSTN: Network and product focus	PSTN: solution focus Internet: Product focus	Product focus Service focus
Customer relationship	Strong tie with incumbent operator	Focus on prospects Strong tie with leading new entrant	Focus on existing customers
Product portfolio	In house products	Expanded through acquisitions Solutions with partners	Includes resale Includes insourcing
R&D	In house, broad portfolio Shift hardware to software	In house, broad portfolio Acceleration and expansion through acquisition	In house, rationalized portfolio
Manufacturing	In house	Outsourced Final assembly Software factory	Outsourced Final assembly Software factory
Purchasing	Components and subassemblies	Subassemblies and (IT) platforms	Subassemblies and (IT) platforms

Table 3. Equipment provider business model attributes, before and after the bubble

4.4 Expansion – contraction of investments in the telecom services industry

In Section **3.1.1.2** we already discussed R&D investments by telecom operators and equipment providers in reviewing the role of the telecom industry in technological developments.

Figure 42 shows the investments by telecom operators as a percentage of revenues, while in Figure 43 the investments are shown per basic access path (derived from: OECD, 2005b p117 &120). The graph reflects the investment bubble in the USA, with a spending level twice the OECD average in 1999. In the sample set the spending pattern of The Netherlands is also very pronounced for the bubble period. The drop in average investment per access path is remarkable: at the OECD level 60%. This at the time that the number of access paths increased by 90%, and the revenue per path decreased by 20%. An improvement of 11 percentage points in ‘margin’.

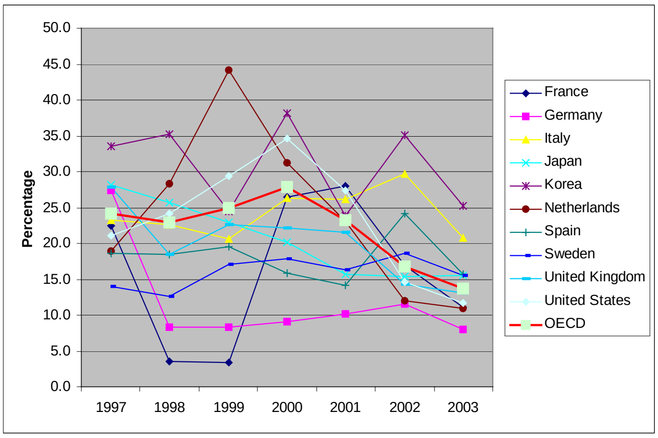


Figure 42. Investment as percentage of telecom services revenues, 1997-2003

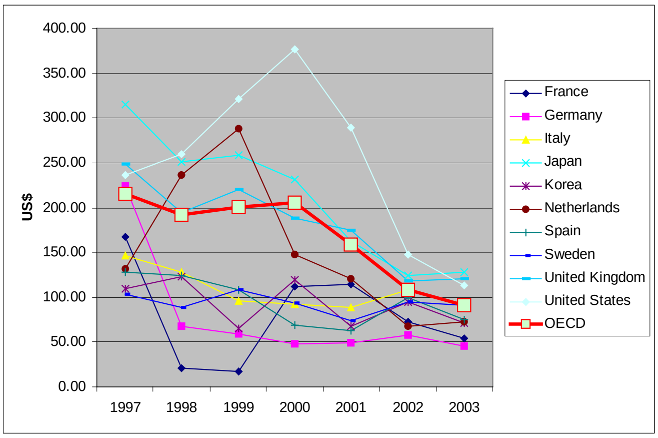


Figure 43. Investments per basic access path, 1997-2003

Yearly investments per access path is a composite indicator. The investment levels are typically reflecting the major modernization projects and new network builds. In Figure 44 these are shown for Western Europe *vis-à-vis* the investments per (fixed) line and user (fixed and mobile) (based on: ITU, 2002). When investments per path are considered there is an investment peak in the years 1999-2000, in particular in the USA. In Western Europe a similar peak occurred in 1991, which can be explained by replacement investments in the transition from analogue to digital switching and the build out of GSM networks, followed by the investments to carry Internet traffic.[21] The GSM investments are a massive fixed investment to obtain national coverage, which is in the later years followed by incremental investments to increase the capacity in line with user growth. Moreover, the competition in mobility has resulted in multiple networks being rolled out at about the same time.

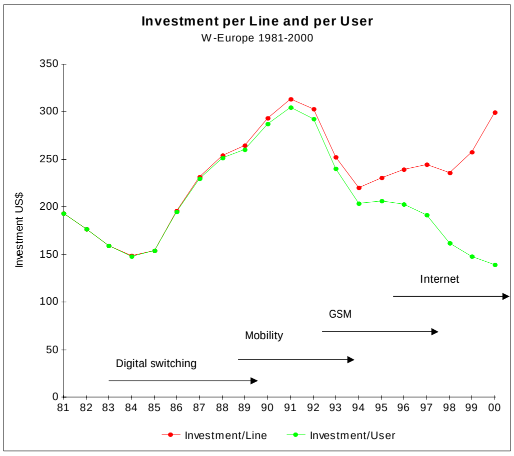


Figure 44. Investments in W-Europe, 1981-2000

4.4.1 Overbuild in optical networking

Since 1998 existing service providers plus more than 40 new telecom carriers went on a network-buildout spree that would double the fiber route miles across the US and Europe. They were being supplied by the existing as well as 50 new optical equipment providers (Kalla, 2000 p5-6). See also Chapter 6 Section 2.3.1.5 and 2.3.3. as well as Annex 7. This overbuild during the boom period is affecting the industry in multiple ways in the aftermath: (1) a dramatic decline of investments in the specific segment; (2) the fight for survival of service providers will intensify competition based on price; (3) in the battle to survive or as part of bankruptcy procedures companies will shed assets, that will be absorbed by other operators or investment companies at prices well below the original costs; (4) the operation of these networks will establish a new but much lower cost base and hence further intensify competition on margin.

4.4.2 Investments in spectrum licenses

A very specific item of investment is the acquisition of spectrum licenses, in particular for 3G mobility. As it happened the UK license award process occurred at the peak of the bubble, and generated the highest amount: € 650 per inhabitant or a total of US$ 33.3 bln (Van Damme, 2001; OECD, 2005b). This was followed by Germany with € 613, Italy € 240, the Netherlands € 171 and France € 169 per inhabitant. See also Figure 45 (derived from: Lennin and Paltridge, 2003 p17; OECD, 2005b p115). Total proceeds in 2000 amounted to approx. US$ 91 bln, against a typical annual level of around US$ 2 bln for the OECD area. The amount involved made that investments in the EU exceeded the investments by telecom operators in the USA at the peak of the bubble, i.e. in 2000. See also Figure 28. The level of proceeds was determined largely by the auction design, but also fed by the promise of the mobile Internet, see also Chapter 6 Figure 42. For a discussion of the topic of license auctions see e.g. Melody (2001) and Van Damme (2001). The purchase of these licenses, sometimes by the same company in multiple countries, has added significantly to the debt position of these firms. Which, in turn, weakened their position in the struggle to survive the crash.

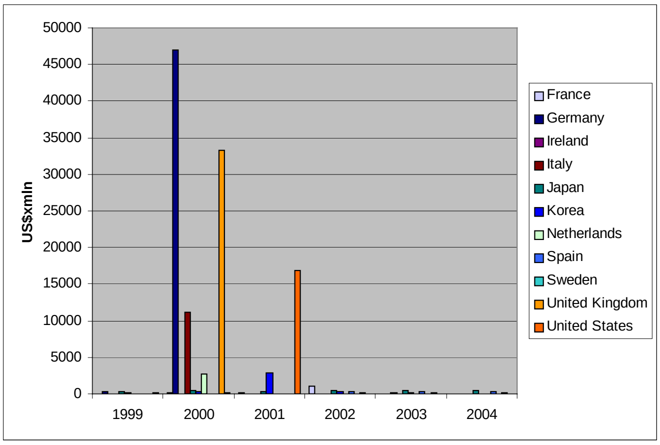


Figure 45. Spectrum licensing revenues, 1999-2004

Note: US data related to PCS licenses

4.5 Vertical integration-fragmentation of value-adding activities in the telecom services industry

As elaborated in Chapter 5 the licensing regime in the telecom sector explains to a large extent the profile of the value chains that can be observed in the sector. Telecommunication licenses have historically been granted on the basis of technological capabilities of the underlying networks. Telephony licenses were linked to the PSTN or parts thereof, broadcasting licenses were linked to specific parts of the radio frequency spectrum. This also applied for the more recently granted licenses to cable operators and mobile telecom service providers. As a result value chains developed ‘around’ these licensed operators, although large systems providers would supply multiple value chains. The reform process introducing privatisation and competition has resulted in a new governance regime for the incumbent telecom operators. Forced by a financial market regime to show year-by-year growth and facing erosion of share in traditional markets, incumbents were being forced to find growth opportunities in new markets. This pressure led to, among other, initiatives to move up in the value chain into content provisioning. The reform process also opened up the system for more diversity in business models, initially through the licensing of long-distance or back-bone carriers and later through the introduction of a re-sale model. See also Section 4.3 *Convergence-divergence of business models.* This resulted in a fragmentation of the once highly integrated value chain. However, without the opportunity to trade licenses the value chains have remained fairly distinct. Albeit, through the shared use of (parts of) the infrastructure, the value chains are highly connected.

With the proliferation and specialization of services, the telecom value chain is further expanding from traditionally the simple combination of network service provider and end-user to include: communication infrastructure providers, communication service providers, and more recently Internet access providers (IAPs), providers of portals to access information on the Internet (ISPs), content providers, and value-added application providers (ASPs). In Figure 41 the resulting, much more expanded, value chain of the telecom sector is being depicted. This divergence is reflecting the decoupling of service provision from infrastructure ownership, facilitated by regulation. Moreover, through the introduction of IP-technology, once a single unified service such as telephony seizes to exist, as “Internet telephony becomes a service built out of software purchased by the consumers, operating over a general (e.g. the Internet) communications infrastructure that is independent of application.” (Clark, 2001 p39).

Given the different technical capabilities in mobile, a similar but distinct value chain is developing from the network through to value added content provisioning. See Figure 46 for an illustration (Lucent Technologies, 2005). The ability to manage over or across the value chain is becoming increasingly important. Moreover, customer ownership, often considered a given by the incumbent in the utility era, is becoming a major source and driver for the appropriation of value.

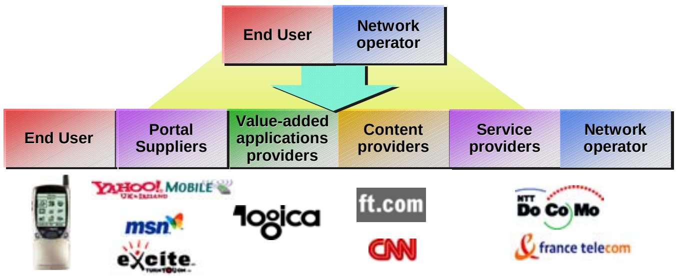


Figure 46. Expanding value chain in the mobile segment

The same financial market regime that is driving the quest for growth, also forces attention to the cost structure of the firm. During the period of government induced governance, employment opportunities provided by telecom firms were considered a great good. The (financial) market regime forced the make-or-buy decision to be revisited, resulting in the outsourcing of much of the low value added activities, such as installation and engineering, and also increasingly R&D activities.

4.5.1 Vertical integration-fragmentation of value-adding activities in the telecom equipment industry

The explanation provided in Chapter 5 Section 4.5.1 applies also for this period. For telecom equipment providers the ability to supply to multiple clients is essential, hence forward integration is not considered an attractive option. In fact the AT&T trivesture in 1996 is an example of removing the conflict of interest embedded in the integrated model.

4.6 Horizontal integration-fragmentation of business boundaries in the telecom services industry

The explanation provided in Chapter 5 Section 4.6 applies also for this period.
In Figure 47 the developments from a license driven service provisioning towards an integrated services provisioning is illustrated.

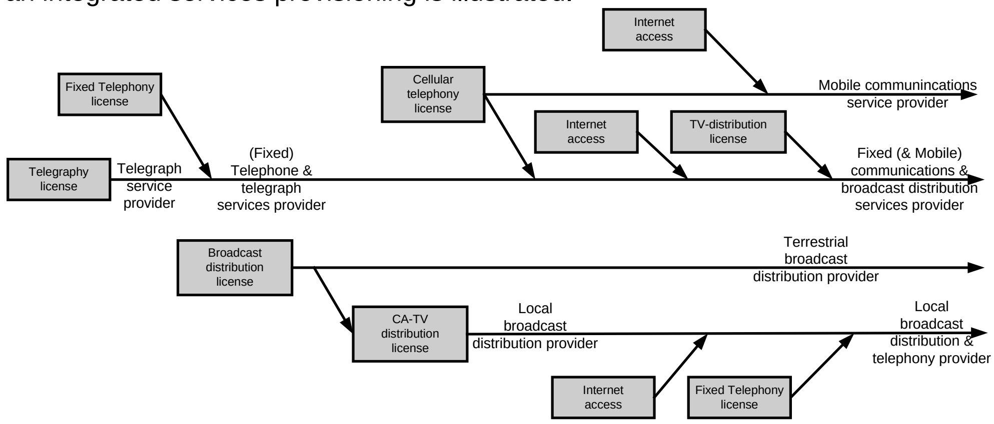


Figure 47. Convergence of licensed services

The Internet is further facilitating the convergence process in the provisioning of communication services. The vision being that any type of communication will ultimately be IP enabled. For an illustration see Figure 48 (Rood, 2005).

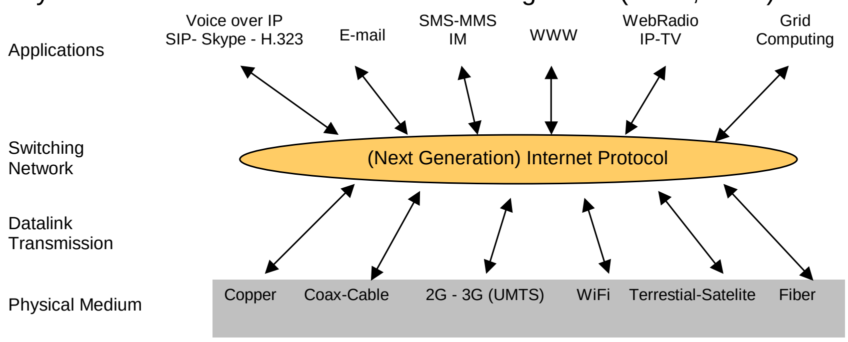


Figure 48. Converging communications environment

4.6.1 Horizontal integration-fragmentation of business boundaries in the telecom equipment industry

With the introduction of IP enabled products and services the delineation between the voice communications technology industry and the data communications technology industry is starting to blur. The first step has been the introduction of IP gateways, routers and switches in the public network, and data communication switches providing PABX services through Voice-over-IP. Also the application of the Ethernet protocol directly 'over fiber' is an example of penetration of the data communications industry in the field of transmission.

4.7 International integration-fragmentation of segment boundaries in the telecom services industry

The explanation provided in Chapter 5 Section 4.7 applies also for this period.
In the EU the process of telecom reform was simultaneously a process of harmonization of the European markets, a goal explicitly stated in the 1987 Green Paper (European Commission, 1987).
The GSM project served both the objective of the European governments to create a harmonized telecom market and the industry objective to create a well functioning regional digital cellular system, from a technical as well as from a business perspective. Table 4 provides a summary of salient facts around GSM, illustrating the shift from regional to global significance of the system (GSM Association, 2004).

Year:	Event:
1982	CEPT initiates GSM project
1984	EC endorses GSM project
1992	GSM-900 operational in Europe
1993	First GSM network operational outside Europe, in Australia
1994	USA licences PCS/GSM-1900
1995	First GSM-1900 network operational in the USA
December 2004	GSM deployment: - 174 countries - 626 networks, of which 136 in Europe - 1266 mln users, of which 486 mln in Europe.

Table 4. Development of GSM

As indicated before, as a result of the telecom reform process incumbents had to find growth opportunities in new markets. This pressure led to initiatives to move into markets across the border. Markets that before the reform process started were closed. These initiatives involved taking a share position in foreign operators as well as starting a new entity in a foreign market to compete with the incumbent player. Albeit, foreign ownership rules do restrict ownership of incumbent firms in many countries. See Figure 49 for details on the globalisation of service provider revenues (derived from: OECD, 2005b p79). In the top league with 50% or more are: Vodafone, Colt and Cable & Wireless, all UK based. The rising star is Tele2 based in Sweden. In the low end range 0-10% are the USA based operators and BT. The OECD data set of 42 companies shows a steady increase from 11% in 1999 to 22% in 2003. See also the remarks made in Section 3.1.2.1.

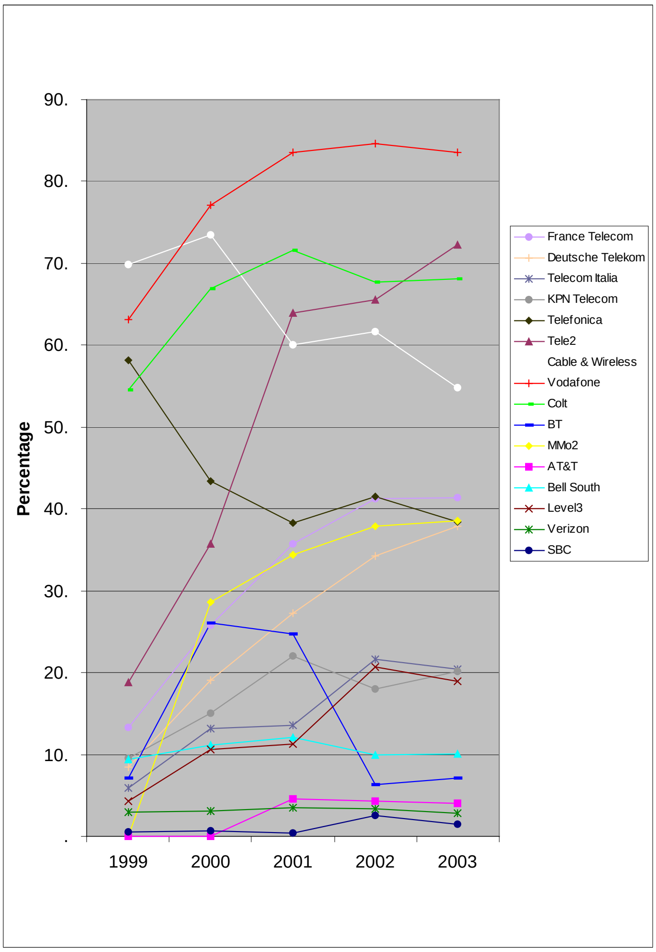


Figure 49. Globalization of service provider revenues, 1999-2003

4.7.1 International integration-fragmentation of segment boundaries in the telecom equipment industry

In the communications equipment trade (the sum of exports and imports) reached US$ 330 bln compared to $ 191 bln in 1996. In the period 1996-2003 the communications equipment trade volume is growing faster than the merchandise trade. See Figure 50 (derived from: OECD, 2005b p269). From this graph we may conclude that the telecom equipment industry is continuing on its path of international integration.

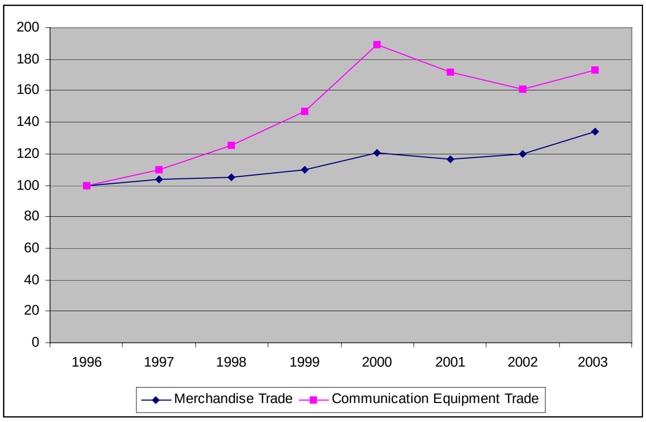


Figure 50. Communication equipment and merchandise trade, 1996-2003

Figure 51 is reflecting the composition of the communications equipment exports, and Figure 52 is showing the communications equipment export by exporting country (derived from: OECD, 2005b p282-3). In the latter chart a few countries have been added to the standard set, these are countries that are having an important position in telecommunication equipment manufacturing: Canada – Nortel; Finland – Nokia; Belgium (in addition to France) – Alcatel. Important to note is the position of Korea with growths over the period from US$ 6 bln to 23 bln in 2003, a CAGR of 21.5%, which puts the country in the number one position, i.e. ahead of the USA. China is the runner-up in communications equipment trade, whereby from 2002 the country may be expected to become a net exporter of telecommunications equipment. See Figure 53 (derived from: p277).[22]

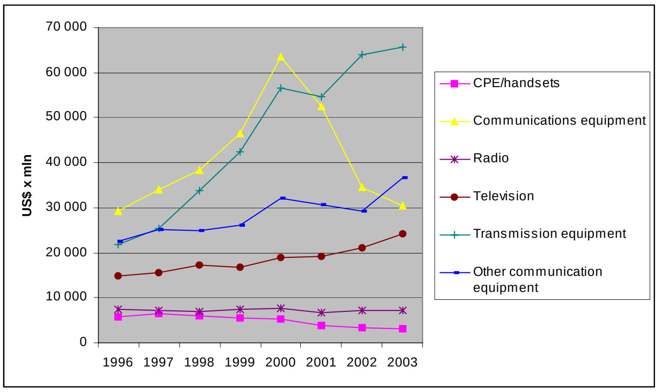


Figure 51. Composition of communications equipment exports, 1996-2003

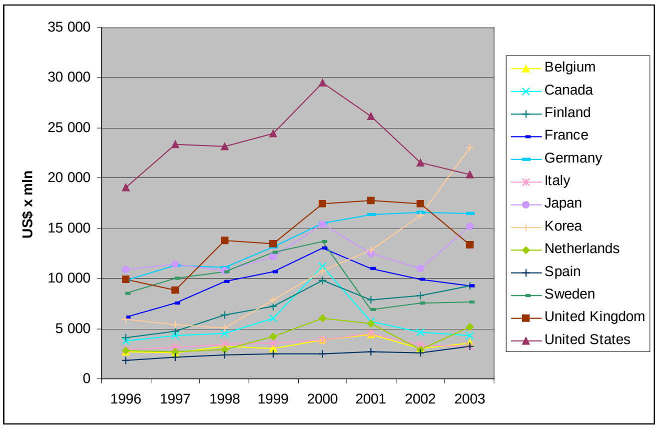


Figure 52. Communications equipment exports, 1996-2003

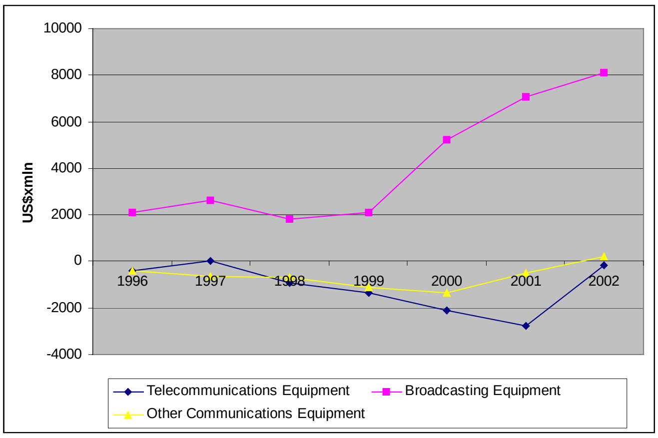


Figure 53. China's balance of trade in communications equipment, 1996-2002

5 Summary and conclusions

In this Chapter we have provided the answer to research sub-question #5: “What has been the impact of the Internet bubble on the ‘development path’ of the telecom sector?” and thereby we have responded to the first part of the main research question. Our findings on the impact of the ‘bubble on the path’ are being summarized in this Section.

The direction of change in the drivers and inhibitors of industry development for the four periods considered, before – boom – bust – aftermath, have been summarized in Table 5, which also shows the resulting directional changes in the dimensions of the ‘development path’.

Summary of the 'development path' of the telecom sector for the full period				
	Direction of development			
	Before	Boom	Bust	Aftermath
Determinant	< 1995	1995-2000	2000-2001	2002-2005
Drivers of change:				
Contextual drivers:				
Technology	Continuous progress	Accelerated progress	Halting progress	Continuous progress
Political / regulatory	Fundamental shift	Progressive reform	Continuity focus	Governance focus
Geopolitical				
Economic-social		Upward business cycle	Down turn	Recession
Industry drivers:				
At the entry barrier	High - Lowering	Lowering	No change	Low
Substitutes	Few - Increasing	Toward IP enabled	Toward IP enabled; mobile for fixed	Toward IP enabled; mobile for fixed
Buyer power	Low - Increasing	Increasing	Increasing	High
Supplier power	Balanced - Increasing	Increasing	Decreasing	Low
Rivalry	Low - Increasing	Rapidly increasing	High	High
Inhibitors of change:				
Economies of scale	High	Decreasing	No change	Increasing
Industry integration	High -Decreasing	Decreasing	Increasing	Increasing
Power structures	High - Decreasing	Decreasing	Increasing	Increasing
Risk averseness	High - Decreasing	Decreasing – low	Low – Rapidly increasing	High
Institutional pressure	High - Decreasing	Decreasing	No change	No change
Cognitive maps	Stable paradigm	Shifting paradigm[1]	Shifting paradigm[1]	New paradigm established
Dimensions of the path:				
Demand	Expanding	Expanding, driven by expectations	Continuous progress, driven by actuals	Modest expansion
Market	Fragmenting	Fragmenting	Concentrating	No change
Business models	Diverging	Diverging	Converging to new	Converging to new and multi-play
Investments	Flat	Expanding driven by expectations	Contracting	Flat; at 1995 level
Vertical value adding activities	Fragmenting	Fragmenting	No change	Integrating
Horizontal business boundaries	Integrating	Integrating	No change	Integrating
International business boundries	Integrating	Integrating	Fragmenting	No change

[1] From circuit-mode to packet-mode.

Table 5. Summary of the Development path of the telecom sector for the full period

It is interesting to assess whether these changes have a permanent or more transitory character, or whether they should be considered part of a cyclical process of economic development.

Based on a cursory glance at the high level indicators one may conclude that the developments in the aftermath are *grosso modo* reflecting the volumes and intensity typical for the period 1995-1997, the early bubble period. However, a detailed assessment reveals some more fundamental changes. Using the general insights into economic development as well as entrepreneurship in assessing the nature of the factors of change involved, the following general conclusion may be drawn:

Structural change, with long-term impact:

Telecom fundamentals

- From households connected to the network, to people being connected,
- More than doubling of the number of network access path (OECD: from 633 mln in 1996 to 1420 mln in 2003),
- Number of mobile access paths exceeds the number of fixed paths (from 2000 onward),
- Telecom spending has increased significantly as proportion of disposable household income (to 130% in 2003 – index 100 in 1990),
- Telecom revenues have increased significantly as part of GDP (OECD: from 2.1 % before 1995 to 3.2 % in 2003; a 50% increase),
- Internet growth rate dropped to 20% in the aftermath, when measured by hosts connected to the network, but bounced back up to 35%, just below the average of 40% in the1998-2004 period,
- Fierce competition has driven prices down significantly (OECD -/- 23%), but revenues per access path are improving in the aftermath,
- Infrastructure capacity in excess of demand, in particular in fiber optic networks, will keep prices under pressure,
- The re-valuation of assets after financial restructuring has created a new, much lower, cost structure for companies exploiting these assets.

Telecom reform:

- Initial massive entry of firms, followed by consolidation. But the number of players in the aftermath is far exceeding the number of players before the bubble,
- This has resulted in rivalry to increase to a very high level in an expanding market to subsequently shift to intense rivalry in a constrained market,
- After initial weak response to competition, the position of the incumbents has been re-enforced over the cycle,
- Although revenues from international operations has doubled, national market boundaries have remained.

Service Provider business model:

- Revenues are increasingly derived from the mobile segment of the market (20-65%),
- Data/Internet dominate traffic growth, but revenues remain flat,
- From one integrated model to a variety of (combination of) business models,
- Infrastructure investment level dropped 10 percent points (OECD: from 25% as percentage of revenue in 1995 to 15% in 2003),
- Infrastructure investment level dropped to 35% when measured per access path (OECD: from US$ 260 in 1995 to $ 90 in 2003),
- R&D expenditure is trending negatively (OECD sample of 28 companies: from 1.7% in 1997 to 1.0% in 2003).

Paradigm shifts:

- From circuit-mode to packet-mode,
- From voice driven to data driven (incl. voice),
- From fixed – narrow band to fixed – broad band, plus mobile – narrow band.

Business cycle change:
In the aftermath the attention is focused on the core business, and frugality and prudence are prevailing. This is reflected in relatively little change in terms of convergence/divergence of business models, integration/ fragmentation of vertical value adding activities, horizontal business boundaries and international segmentation. It may be expected that changes will occur as strategies will be adjusted when the business cycle resumes its upward momentum.

The impact of 'the bubble on the path':
What can be concluded on the 'impact of the bubble on the path'? From the exploration of the bubble and the analysis of the development path of the telecom sector a number of conclusions can be inferred. Albeit, as large scale experimentation in social science is not feasible, we have no alternative ways to know how the path would have developed if the bubble had not occurred. But, in having followed the methodology, as outlined in Chapter 1 Section 4.4, prudently and conscientiously, the following can be inferred with a reasonable level of confidence:

1. The bubble occurred while a technological change process was already under way, i.e. from circuit-mode to packet-mode, and from fixed to mobile,
2. The processes of monetary expansion have funded experimentation, innovation, and installation,
3. The positive feedback loops have helped to overcome the normal countervailing forces,
4. The Internet related e-World vision has raised the expectations regarding demand growth, resulting in investments ahead of actual demand and revenues,
5. The bubble has contributed to the success of the telecom reform process through firm entry during the boom period, facilitated by expectations of demand growth and by monetary expansion,

6. Consensual visions have led to over-investments. The related company defaults and debt restructuring have led to a lower asset cost base, which has intensified competition on margin,
7. Telecommunication services have moved to a higher platform of economic activity, from 2.1% to 3.2% in the OECD area.
8. Investments made during the frenzy period have resulted in a widely deployed broadband infrastructure capable of supporting the diffusion of the techno-economic paradigm into the ‘deployment period’.

The dimensions of the path:

Another way of presenting the developments along the seven dimensions of the ‘development path’ is shown in Figure 54. Thereby, an attempt is made to provide a position of the industry for each dimension of the ‘development path’ and for each period considered. In the graph an expectation is provided for a future period in the aftermath 2005-2010. This has been based on the information provided in Chapter 5-7 and taking into account recent market developments. It should be noted that the purpose of the graph is to reflect positions relative to each other. The distances between the ‘arrows’ are indicative only.

The representations are necessarily a generalization across the various segments that constitute the telecom industry. For specific segments the change within the ‘dimensions of the path’ will vary.

For most dimensions of the ‘development path’ the pattern that is emerging suggest a ‘leap forward’ induced by the boom and a ‘regression’ as a result of the crash. In the aftermath follows a more gradual development, which suggests convergence around successful business models.

Regional comparison

The analysis has revealed similarities as well as differences in the developments in the USA and Europe. Therefore, the two regions have been analyzed along the dimensions: GDP, revenues, investments (excluding license fees), and access paths (derived from: OECD, 2005b). Figure 55 shows the results with the USA data at the left hand side of the Figure, and the sample set of European countries (France, Germany, Italy, the Netherlands, Spain, Sweden, and the United Kingdom) at the right hand side. Note that the data sets are comparable in size.

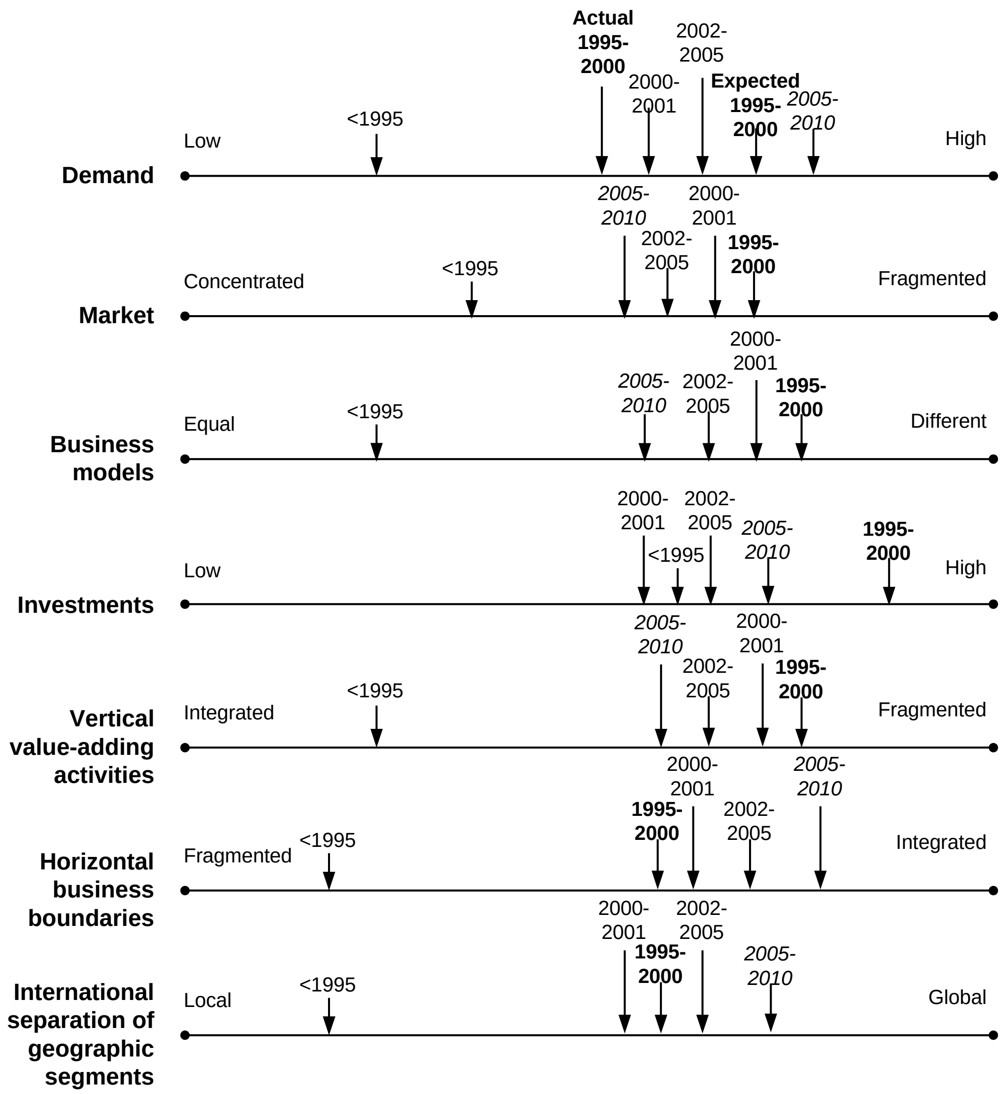


Figure 54. Impact of the Internet bubble on the development path of the telecom sector, summary

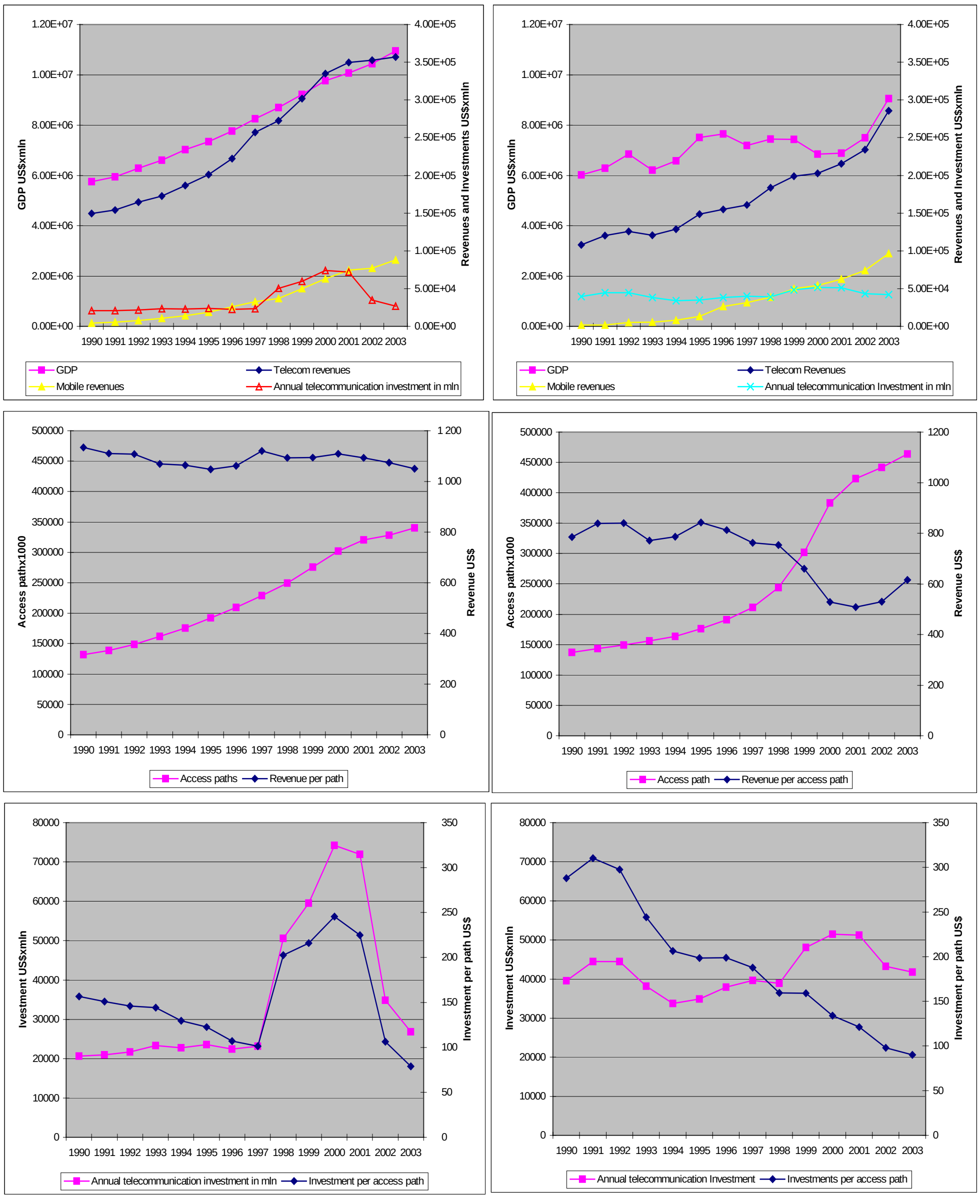


Figure 55. Summary of telecom operator financials, 1990-2003

Note to the graph: USA - left hand graphs; sample European countries - right hand graphs

Interesting observations are:

- The strong GDP growth in the USA compared to Europe,
- The much more pronounced investment bubble in the USA,
- The stronger growth in (mobile) access paths in Europe,
- The much higher revenues per path in the USA,
- The trend toward a similar level of investment per access path.

Ceteris paribus, we may infer that in the USA, or through US corporations, the bubble has resulted in a larger addition to the infrastructural asset base. This addition is now available at a lower cost base, as a result of re-valuation during company restructuring. This may, in comparison, provide for a higher level of profitability.
The relatively higher number of (mobile) access path in Europe provides for more opportunities for communication to take place, the network effect. Hence, in comparison, a higher potential for revenue growth. However, the higher revenues per path in the USA would suggest a higher profit potential.

What has not been shown is these graphs is the investment peak associated with the procurement of 3G licenses in Europe. If included, the investment bubble in Europe and the USA would be of similar size. Albeit, these government proceeds have not been used for productive investments in the telecom sector.

In the following Chapter we will address the implications for policy and strategy formation in the aftermath of the Internet/Telecom bubble. We will return to the ‘development path’ and the fundamental changes as part of the installation of the new techno-economic paradigm, of which telecommunication and the Internet are the core infrastructure.

6 Notes for Chapter 7

[1] In this context we refer to the entrepreneur as in the encompassing view of Casson: “An entrepreneur is someone who specializes in taking judgmental decisions about the coordination of scarce resources.” A definition that is considered to include Knight’s notion of ‘willing to tolerate uncertainty’, Kirzner’s notion of ‘alertness’, Schumpeter’s notion of ‘ruthless capability to smash the opposition’ and Shackle’s notion of ‘creative imagination’. We refer to both the entrepreneur within the incumbent firm, as well as the new entrant. Whereby the latter may be considered innovative and rule breaking, as emphasized in the Schumpeterian view of the entrepreneur (Ricketts, 2002).
[2] The ADSL Lite version provides 256 kb/s downstream and 64 kb/s upstream, and has enticed users away from ISDN.
[3] Most debt restructuring involved a swap of equity for debt.
[4] The inclusion is for illustration purposes; they are considered typical for the period. A more systemic research into the perspectives across firms is considered to be beyond the scope of this project.
[5] These techniques are used complimentary to the traditional techniques to increase network capacity by reducing the coverage and increasing the number of cell sites, and ongoing efforts in reducing bandwidth needs by improving encoding techniques.
[6] According to Lucent Technologies, the next step on this development path is the use of 4-branch diversity in the receive side and 2- 4 branch diversity in the transmit side, implemented at the cell site antenna and at the PC terminal. This would provide for a four fold increase in the data throughput (Polakos, 2002).
[7] Indirect R&D funding amounts to roughly 15% of services revenues, down from 30%, and 12.5 % of product revenues a combined indirect ratio of 2.3% versus 1.5% direct.
[8] Changes in ratios are impacted by e.g. expanding the business outside France for FT, and AT&T buying and selling cable assets and divesting mobile communications (Paltridge, 2006).
[9] A more elaborate analysis would require consideration of the business cycle impacting overall access penetration and a statistical analysis of the time series.
[10] Vonage is an example of another US based supplier.
[11] As an example, Lucent announced the 100 million line milestone for its 5ESS switch in 1997.
[12] The recently announced merger of Alcatel and Lucent would be an example of such consolidation.
[13] For an analysis of the underlying changes in traffic pattern see also Annex 8.
[14] Based on unweighted average.
[15] Includes telecommunications equipment and services, and postal services. Index exclusive of Hungary, Norway, Slovak Republic, Switzerland and Turkey.
[16] At the peak Lucent claimed that the technical life time had dropped to 3.5 years.
[17] More recently also Huawei of China has obtained a foothold in 3G deployment in Europe.
[18] Spurious data point NL fixed teledensity 1998 has been adjusted.
[19] Typical examples were: Enertel (electricity) and Telfort (rail road) in The Netherlands; COLT (transport) and Energis (electricity) in the UK.
[20] Ovum forecasted in 2000 a US$ 60 bln market worldwide (equivalent to 6% of OECD revenues) (Ovum, 2000)
[21] In the transmission segment the long distance carriers drive the innovation cycle. In this segment the transitions have been from FDM to TDM, from coax based systems to optical, successive generations of digital transmission systems doubling or quadrupling the

transmission rate each time, from single wave length to multiple wavelength multiplexing, towards all-optical networking.

[22] For an insightful account of the developments in China, see *China the race to market – What China's transformation means for business, markets and the new world order* (Story, 2003).

8

Implications for policy and strategy formation in the aftermath

An assessment at the industry level

Table of Contents

1 Introduction

In this Chapter we will derive from our findings on the 'development path' of the telecom sector, developed in Chapter 5, 6 and 7, a response to the final research sub-question #6: "What are the implications for policy and strategy formation in the aftermath?" Together with the conclusion derived in Chapter 7 regarding the 'development path', this provides the response to the main research question: "What is the impact of the Internet bubble on the 'development path' of the telecom sector, and what are the implications for policy and strategy formation?"
As this research project has been completed in the spring of 2006, we have progressed five years into the aftermath of the Internet bubble. Therefore our recommendations will be focused on a 'second' period of the aftermath 2006-2010. Preceding we will recap in Section 2 the main strategy and policy developments related to the period 2001-2005.

In Chapter 4 we concluded that for the strategist the understanding of the industry structure is important for achieving business success. This strategic perspective is based on compliance with the prevailing 'rules of the game' and tends to lead to evolutionary developments. More profound changes will occur as a result of changes in paradigms and technological trajectories. For the players in the telecom industry the convergence of voice and data communications represents such a paradigmatic shift, whereby the traditional circuit-mode voice communication paradigm is being replaced by the packet-mode data communication paradigm.[1] These revolutionary changes are involving a fundamental change in the 'rules of the game' of the telecom industry, thus requiring radical changes in strategy for firms in general. These changes started to emerge around 1995 and is now affecting the (core) network modernization strategy of incumbent operators.
Recognizing that the formation of strategy is dependent on the organizational objectives of the firm, our recommendations are at the industry level, whereby where necessary a distinction will be made between incumbent players and the new entrants.

For the policy-maker the proper functioning of markets is a key concern. Therefore it is important to understand any changes in the industry structure that may impact on the potential of market failure. This also applies for changes that may require adaptation of the institutional environment for the markets to continue to function properly. Of particular interest to the policy-maker are the potential implications for the ongoing process of telecom reform.

By putting the bubble in the context of the long wave of economic development, we have on the one hand positioned telecommunications central to policy making, and on the other extended the scope well beyond the telecom sector. As telecommunications and computing are the 'carrier branches' of the new techno-economic paradigm, facilitating their development is considered pivotal to the opportunity of a 'golden age' to develop. As we are entering the deployment phase, the emphasis is shifting from the installation of the new paradigm to deployment and utilization. The rapid technological developments during the 'installation' phase have resulted in tensions emerging in the economic and socio-institutional realm, which are related to the implementation and use of the new paradigm.

Recognizing that the formation of policy and the formation of strategy is very context dependent, our recommendations will be generic rather than specific. Our broader objective is to raise the topics and issues that should feature on the policy and strategy agendas, rather than to resolve these issues. The scope of our recommendations will be limited to the extent that these are informed by this research project, or triggered by the developments described in this project.

2 Strategy and policy perspectives during the bubble period

Before making any recommendations for the future, it is useful to recap and review the development of the industry over the period considered and to make explicit, albeit at a high level, the implications these developments have had for the process of telecom reform and for firm strategy. The implications are summarized for the four periods and from three different perspectives: the perspective of the policy-maker, the perspective of the strategist within the incumbent firm, and the perspective of the strategist associated with a potential entrant.

<u>The ‘development path’ of the sector before 1995 and the implications.</u>
Table 1 provides the summary of the developments in the telecom sector leading up to the bubble period, i.e. before 1995.[2]

<u>The ‘development path’ of the sector during the boom 1995-2000 and the implications.</u>
Table 2 provides the summary of the developments in the telecom sector during the boom period from 1995 until 2000, or more precisely until April 2000 when the bubble collapsed.

<u>The ‘development path’ of the sector during the bust 2000-2001 and the implications.</u>
Table 3 provides the summary of the developments in the telecom sector during the bust period from April 2000, when the bubble collapsed, until 2001.

<u>The ‘development path’ of the sector in the aftermath 2002-… and the implications.</u>
Table 4 provides the summary of the developments in the telecom sector in the aftermath. This period starts in 2002 and is essentially open-ended. In this project information is captured up to and including 2003.

Note: The indication ‘no change’ refers to changes relative to the previous period.

Summary of the Development path of the telecom sector – Period leading up to 1995				
		Observations and implications		
		Policy	Strategy	
Determinant	Direction	Telecom reform	Incumbent[1]	Potential entrant
Drivers of change:				
Contextual drivers:				
Technology	Continuous progress	Continuing source of renewal	Cost reduction, new products and services	Tool for entry
Political/regulatory		Progressive reform	Ending of monopoly; but access to new markets	Formal entry barriers being removed
Geopolitical		Regionalization of reform		
Economic-social				
Industry drivers:				
At the entry barrier	High - Lowering	Improving entry	Threat to profitability	Facilitating entry
Substitutes	Few - Increasing	Improving entry	Threat & opportunity	Entry opportunity
Buyer power	Low - Increasing	Improving entry	Pressure on margins	Facilitating entry
Supplier power	Balanced - Increasing	Improving entry	Increasing dependency	Increasing dependency
Rivalry	Low - Increasing	Improving entry	Erosion of market share	First mover advantage
Internal drivers:				
Multiple rights-of-way		Improving entry		
Inhibitors of change:				
Economies of scale	High - Decreasing	Restraining entry	Eroding competitive advantage	Barrier to entry
Industry integration	High - Decreasing	Improving entry	Eroding competitive advantage	Facilitating entry
Power structures	High - Decreasing	Improving entry	Eroding competitive advantage	Facilitating entry
Risk averseness	High - Decreasing	Improving entry	Requires attitude change	Facilitating entry
Institutional pressure	High - Decreasing	Improving entry	Increases business latitude	Facilitating entry
Cognitive maps	Stable paradigm	Improving entry	Competitive advantage	Opportunity
Dimensions of the path:				
Demand	Expanding	Improving entry	Growth opportunity	Facilitating entry
Market	Fragmenting	Improving entry	Threat & opportunity	Facilitating entry
Business models	Diverging	Improving entry	Requires adaptation	Increasing entry options
Investments	Flat		.	
Vertical value adding activities	Fragmenting	Improving entry	Opportunity & threat	Facilitating entry
Horizontal business boundaries	Integrating	Improving entry	Threat & opportunity	Facilitating entry
International	Integrating	Improving entry	Threat & opportunity	Increasing entry opportunities

Table 1. Summary of the development path of the telecom sector, for the period leading up to 1995

Notes: 1: Includes incumbent telecom and incumbent CATV operators

Summary of the Development path of the telecom sector – Boom period 1995-2000				
		Observations and implications		
		Policy	Strategy	
Determinant	Direction	Telecom reform	Incumbent[1]	Potential entrant
Drivers of change:				
Contextual drivers:				
Technology	Accelerated progress	Continuing source of renewal; improving entry	New products and services; technology race	Tool for entry; technology race
Political/regulatory	Progressive reform	From legislation to facilitating realisation	Ending of monopoly[2]; but access to new markets	Formal entry barriers being removed
Geopolitical		Globalisation of issues		
Economic-social	Upward business cycle			
Industry drivers:				
At the entry barrier	Lowering	Improving entry	Threat to profitability	Facilitating entry
Substitutes	Toward IP enabled	Improving entry	Threat & opportunity	Entry opportunity
Buyer power	Increasing	Improving entry	Pressure on margins, emphasis on marketing and sales	Facilitating entry
Supplier power	Increasing	Improving entry	Increasing dependency	Increasing opportunity
Rivalry	Rapidly increasing	Improving entry	Price, margin and market share erosion	First mover advantage
Internal drivers:				
Multiple rights-of-way		Improving entry	Increasing competition	Facilitating entry
Inhibitors of change:				
Economies of scale	Decreasing	Improving entry	Eroding competitive advantage	Facilitating entry
Industry integration	Decreasing	Improving entry	Eroding competitive advantage	Facilitating entry
Power structures	Decreasing	Improving entry	Eroding competitive advantage	Facilitating entry
Risk averseness[3]	Decreasing - Low	Improving entry	Requires attitude change	Facilitating entry
Institutional pressure	Decreasing	Improving entry	Increases business latitude	Facilitating entry
Cognitive maps	Shifting paradigm[4]	Improving entry	Threat	Opportunity
Dimensions of the path:				
Demand	Expanding, driven by expectations	Improving entry	Growth opportunity	Facilitating entry
Market	Fragmenting	Improving entry	Threat & opportunity	Facilitating entry
Business models	Diverging	Improving entry	Requires adaptation	Increasing entry options
Investments	Expanding, driven by expectations	Improving entry	.	Increasing the stakes
Vertical value adding activities	Fragmenting	Improving entry	Opportunity & threat	Facilitating entry
Horizontal business boundaries	Integrating	Improving entry	Threat & opportunity	Facilitating entry
International	Integrating	Improving entry	Threat & opportunity	Increasing entry opportunities

Table 2. Summary of the development path - Boom period 1995-2000

Notes: 1: Includes telecom and CATV incumbents; 2: CATV remained *grosso modo* a regional monopoly; 3: Including the financial industry; 4: From voice to data, from fixed to increasingly mobile.

Summary of the Development path of the telecom sector – Bust 2000-2001				
		Observations and implications		
		Policy	Strategy	
Determinant	Direction	Telecom reform	Incumbent[1]	Potential entrant
Drivers of change:				
Contextual drivers:				
Technology	Halting progress		Cost reduction	Tool for entry
Political/regulatory	Continuity focus	Mitigation of industry malpractice	End of monopoly[2]	Formal entry barriers removed
Geopolitical				
Economic-social	Down turn			
Industry drivers:				
At the entry barrier	No change			
Substitutes	Toward IP enabled; mobile for fixed		Threat & opportunity	Entry opportunity
Buyer power	Increasing	Improving competitiveness	Pressure on margins	Facilitating entry
Supplier power	Decreasing		Legacy dependency	Decreasing opportunity
Rivalry	High	Improving competitiveness	Price and margin erosion	Late entrant disadvantage
Internal drivers:				
Multiple rights-of-way				
Inhibitors of change:				
Economies of scale	No change			
Industry integration	Increasing	Restraining entry	Improving competitive position[3]	Restraining entry
Power structures	Increasing	Restraining entry	Re-establishing competitive position[3]	Restraining entry
Risk averseness[4]	Low – Rapidly Increasing	Restraining entry	Requires attitude adjustment	Requires attitude adjustment
Institutional pressure	No change			
Cognitive maps	Shifting paradigm[5]	Improving entry	Threat[3]	Opportunity
Dimensions of the path:				
Demand[5]	Continuous progress, driven by actuals	Restraining entry	Increases competitive pressure	Restraining entry
Market	Concentrating	Restraining entry	Increases competitive pressure	.
Business models	Converging to new	Restraining entry	Increases competitive pressure; requires adaptation	Decreasing entry options
Investments	Contracting	Restraining entry	.	Restraining entry
Vertical value adding activities	No change			
Horizontal business boundaries	No change			
International business boundaries	Fragmenting	Restraining entry	Increases competitive pressure	Restraining entry

Table 3. Summary of the development path - Bust period 2000-2001

Notes: 1: Includes recent entrants; 2: CATV remains *grosso modo* a regional monopoly; 3: In particular the ‘old’ incumbents; 4: Including the financial industry; 5: From voice to data, from fixed to increasingly mobile.

Summary of the Development path of the telecom sector – Aftermath 2002 - 2005				
		Observations and implications		
		Policy	Strategy	
Determinant	Direction	Telecom reform	Incumbent[1]	Potential entrant
Drivers of change:				
Contextual drivers:				
Technology	Continuous progress	Continuing source of renewal	Cost reduction, new products and services	Tool for entry
Political/regulatory	Governance focus	Shift from infrastructure to content and consumer focus	"Natural" monopoly positions in access[2]	Formal entry barriers removed
Geopolitical		Globalisation of policies and instruments		
Economic-social	Recession			
Industry drivers:				
At the entry barrier	Low			
Substitutes	Toward IP enabled; mobile for fixed	Improving competition	Threat & opportunity	Entry opportunity
Buyer power	High	Improving competition	Pressure on margins	Facilitating entry
Supplier power	Low		Legacy dependency	
Rivalry	High	Improving competition	Price and margin erosion	Late entrant disadvantage
Internal drivers:				
Multiple rights-of-way				
Inhibitors of change:				
Economies of scale	Increasing	Restraining entry; increasing competition	Increasing competitive advantage	Barrier to entry
Industry integration	Increasing	Restraining entry	Improving competitive position[3]	Restraining entry
Power structures	Increasing	Restraining entry	Re-establishing competitive position	Restraining entry
Risk averseness[4]	High	Restraining entry		Restraining entry
Institutional pressure	No change			
Cognitive maps	New paradigm established[5]	Adjustment required	Adjustment required	
Dimensions of the path:				
Demand	Modest expansion			
Market	Concentrating	Focus on functioning of markets	Increasing competitive pressure	Restraining entry
Business models	Convergence to new and multi-play	Requires adaptation	Increasing competitive pressure; requires adaptation	Decreasing entry options
Investments	Flat; at 1995 level	Focus on modernization rate	.	
Vertical value adding activities	Integrating	Focus on functioning of markets	Increasing competitive pressure	Restraining entry
Horizontal business boundaries	Integrating	Requires adaptation	Increasing competitive pressure; requires adaptation	Restraining entry
International business boundaries	No change			

Table 4. Summary of the development path - Aftermath 2002-2005

Notes: 1: Includes recent entrants; 2: CATV remains *grosso modo* a regional monopoly; 3: In particular the 'old' incumbents; 4: Including the financial industry; 5: Broadband data, and mobile.

For the summary and conclusions regarding the impact of the Internet bubble on the development path of the telecommunication sector reference is made to Chapter 7 Section 5, which covers the topics of:

- structural change, with long-term impact (telecom fundamentals and telecom reform),
- business cycle related change,
- impact of the bubble on the dimensions of the development path, and
- high level regional comparison: EU and USA.

3 Typical policy considerations in the aftermath of bubbles

In this Section we will review policy questions that are typical for the aftermath of bubbles. Although these questions tend to extend beyond the scope of the telecom sector, they are considered relevant to complete the exploration and explanation of the Internet bubble period.

A typical reflex in the aftermath of euphoria is the tightening of the governance regime. In this respect Galbraith observed: "There will be scrutiny of the previously much-praised financial instruments and practices… …There will be talk of regulation and reform. What will not be discussed is the speculation itself or the aberrant optimism that lay behind it." (Galbraith, 1990 p22).

3.1 Governance in relation to bubbles

In the USA the events have led to a governmental plan to improve the corporate financial disclosure and shareholder protection. This 10-point plan calls for providing better information to investors, making corporate officers more accountable, and developing a stronger, more independent audit system (Hunter, Kaufman et al., 2003 p10-3):

1. Each investor should have quarterly access to the information needed to judge a firm's financial performance, condition, and risks,
2. Each investor should have prompt access to critical information,
3. CEOs should personally vouch for the veracity, timeliness, and fairness of their companies' public disclosures, including their financial statements,
4. CEOs or other officers should not be allowed to profit from erroneous financial statements,
5. CEOs or other officers who clearly abuse their power should lose their right to serve in any corporate leadership positions,
6. Corporate leaders should be required to tell the public promptly whenever they buy or sell company stock for personal gain,
7. Investors should have complete confidence in the independence and integrity of companies' auditors,
8. An independent regulatory board should ensure that the accounting profession is held to the highest ethical standards,
9. The authors of accounting standards must be responsive to the needs of investors,
10. Firms' accounting systems should be compared with best practices, not simply against minimum standards.

These objectives became embedded in the 2002 Corporate and Auditing Accountability, Responsibility, and Transparency Act of 2002, also known as the Sarbanes-Oxley Act (AICPA, 2002). Another example of tightening the governance regime is the launch in The Netherlands of the corporate governance code (Tabaksblat Code) in 2003, largely based on best practices, and replacing the code of 1997 (Monitoring Commissie, 2003).

3.2 Constraining the impact of the crash

A typical policy related question is whether the impact of the crash should be mitigated. See also Chapter 6, Section 2.4 indicating the objective of the US policy-makers to 'facilitate a soft landing'.

Kindleberger points to the role that a 'lender of last resort' could play to avoid that a crash leads to a panic in the financial markets and a massive run on the banks for cash. Although such a 'lender of last resort' could stabilize the financial market, the knowledge in the market that such a lender exists will be used and may lead to 'speculation against its intervention'. See for further information (Kindleberger, 2000 p161-206). Shiller in the second edition of *Irrational Exuberance* addresses the topic of 'speculative volatility in a free society' and provides a range of recommendations for improvement (Shiller, 2005 p216-30):

- Investors should diversify,
- There should be an effective plan to increase savings,
- Retirement plans should be put on a sounder footing,
- The design of social security should be improved,
- Monetary policy should gently lean against bubbles,
- Opinion leaders should offer stabilizing opinions,
- Institutions should encourage constructive trading,
- The pubic should be helped to hedge risks.

For a discussion about the role of central banks, see e.g. Hunter, Kaufman et al. (2003 p537-60).

3.3 The mitigation of bubbles

In the aftermath of a bubble the question arises whether the bubble should have been prevented or punctuated. As Stiglitz noted it is often difficult to predict the emergence of a bubble or to predict when it will end, but "…there are, however, certain circumstances that make it more likely that economic crisis or severe recessions will afflict an economy." (Stiglitz, 2003 p87). He points to the notion of too-rapid deregulation of the telecommunications sector, the electricity market, and the deregulation of banking, in particular the repeal in 1999 of the Glass-Steagall Act of 1933, which opened up new opportunities for conflicts of interest to arise between investment banking and commercial banking. Greenspan, Chairman of the Federal Reserve, has repeatedly pointed to the improved performance of the economy (Woodward, 2000). The 'installation' of a new techno-economic paradigm that introduces productivity improvement in and on the basis of a new cluster of related industries would support this notion, albeit each 'installation' period is also characterized by a period of frenzy. With respect to the mitigation of bubbles, Shiller points to the gradual development of bubbles and the 'bluntness' of monetary instruments, such as interest rate policy, that tends to affect the economy at large, rather than the sector subject to euphoria (Shiller, 2005 p224-5). A topic already addressed by Galbraith in his analysis of the 1929 crash: "A bubble can easily be punctuated. But to incise it with a needle so that it subsides gradually is a task of no small delicacy." (1954 p25).

3.4 The role of 'checks and balances'

In the 'normal' mode of business operation the enthusiasm of the entrepreneur and his/her willingness to take risks is typically balanced by the 'conservative' nature of the parties that provide funding. The availability and cost of funding is typically based on the risks and returns perceived. The result is reflected in e.g. the 'cost of capital'. See also Chapter 3 Section 3.5.1. Within corporations the 'cost of capital' is translated in an internal rate of return that is used for the evaluation of projects, and in the creation and maintenance of a portfolio of investments, products or services.[3] The recent bubble has shown that the competition between banks made their interests to become aligned with the interests of the entrepreneurs.[4] Hence, making the process of 'check and balance' inoperative. In this respect the combination of reform in the financial industry, in particular the repeal of the Glass-Steagal Act in 1999, removing the separation between investment banking and commercial banking, and the reform in the telecom industry, in particular the Telecom Act of 1996, provided for an 'explosive combination'.
It is ironic to note that the Glass-Steagal Act was enacted in 1933 in response to the 1929 crash and to avoid some of the excesses that had occurred in the preceding boom period, to be repealed at a point in time it was of utmost relevance.[5]

With respect to the aspect of personal gain history repeats itself. The account of (mal-)practices deployed by Ebbers as CEO of WorldCom reads as an almost direct copy of the account of the (mal-)practices deployed by Hudson, as Board Member of the Midlands Railway in the UK, in the 1840's. See also Annex 3 *Rail Road Mania in the 19th century*.

3.5 The role of private versus government debt

To limit the impact of downswings in economic development it has been general policy to compensate the lack of private investments by an increase in public investments and thereby public debt during periods of stagnation or depression. The idea was that during periods of economic growth public debt could be reduced based on the increase in governments income occurring during the upswing. It is worthwhile to note that in 1998 the US economy has been pulled from stagnation, not through an increase of public debt, but through an increase of private debt (Brenner, 2002 p171-9). This stagnation was a result of the Russian defaults and culminated in the near collapse of the Long-Term Capital Management fund (LTCM), bailed out by a US$ 3.6 bln rescue package. In effect the rising stock prices and the resulting wealth effect were pulling the US economy from stagnation. However, private sector surplus/deficit (household and company borrowing to finance expenditures) dropped 11 percent from a surplus of 5% of

GDP in the early 1990's to a deficit of 6% in 2000.[6] This phenomenon is significantly affecting the resilience of US households to withstand any future downturn or negative developments.
Shiller, in the second edition of *Irrational Exuberance*, suggests furthermore that in many parts of the world there is still overconfidence in the stock market and the housing market, which could lead to instability. Significant further rises could lead to significant declines, which in turn could result in an increased rate of personal bankruptcies, which subsequently could lead up to a string of bankruptcies of financial institutions. (Shiller, 2005 p xiii).
Hence we can conclude that in this respect the resilience of the economic and financial system has deteriorated as a result of the Internet bubble.

3.6 Recommendations

The pattern that is emerging in the aftermath of bubbles is akin to the Dutch saying: "Als het kalf verdronken is dempt men de put", which can be freely translated as: the solution to the problem appears after the harm is done. Hence, the recommendation is to intensify the policing and enforcement of the governance oversight in lock step with growing euphoria, and adjust the rules and regulations in a timely manner when loopholes are detected. This recommendation applies for the 'control' functions performed by governments as well as the oversight functions within firms. Any sign that the normal processes of 'checks & balances' appear to be failing or 'consensual visions' appear to be developing should be interpreted as an 'early warning' signal.
The high intensity of market transactions during periods of euphoria should not be misunderstood as a reflection of properly functioning markets.
Government policy should remain counter cyclical, in principle, to allow support of the economy to be given during periods of stagnation and recession.
Within firms as well as in the financial industry, 'high powered' incentive systems should be reviewed regularly to assess whether they (still) are leading to the desired business outcome.
History shows that at the time the enforcement is most urgently required conflicts of interest can easily arise. Independence, historical awareness and wisdom are required for the right decisions to be taken under these challenging conditions.[7]

4 The implications of the bubble on the telecom sector

As we moved from Chapter 5 to Chapter 7 we have identified the impact of the Internet bubble on the development path of the telecom sector in four distinct periods. By describing and exploring the moves by the operators and equipment vendors, both incumbent and new entrants, during these periods we have addressed the strategic actions by the players in the industry. And in reviewing the development of the telecom reform process, we have captured an important part of policy implementation for the period. In this Chapter we will review the implications for policy and strategy formation – going forward. Before moving to the articulation of recommendations, we will first review a few aspects that 'set the scene' in the industry. These include aspects such as the role of telecommunication in economic development, the attractiveness of the industry for competition to flourish, and the implications of the paradigm shift from circuit to packet. Thereby we will look at the 'broader picture' as provided by the Long Wave perspective of economic development, and the role of telecommunications as the 'carrier branch' of the new techno-economic paradigm therein.

4.1 The pivotal role of the telecom industry in economic development

In Chapter 5 we have argued that the role of telecommunications in economic development extends beyond the sector itself through spill-over effects. Furthermore, we have seen that the telecom reform process is aimed at improving the performance of the sector, and thereby its contribution to economic development. In Chapter 3 and 6 we have shown the importance of telecommunications as the 'carrier branch' of the new techno-economic paradigm of the current Long Wave in economic development. The analysis of the development path of the telecom sector during the frenzy period has shown that the sector has 'played its role' in the 'installation period' of the new paradigm. This may be illustrated by the increase of telecom revenues as share of GDP from 2.1% to 3.2% for the OECD area, and the increase in the relative share of discretionary household spending from index 100 in 1990 to 132 in 2002.
An important question at this juncture is whether it can continue to play that role during the 'deployment period'. The idea is that therefore it will be necessary that the success of the telecom reform process achieved during the frenzy period ought to be retained, and that any related failures can be mitigated. Moreover, the tensions that have grown between the semi-autonomous subsystems of society during the 'installation period' of the new techno-economic paradigm need to be addressed and resolved. The latter will require adjustments of regulations, institutional arrangements and the governance regime to help launch the 'deployment period'.

In the following Sections we will address these issues. The emphasis will first be put on retaining the success of the telecom reform process. Therefore it is important that the industry remains attractive. Attractive for new entrants to challenge the *status quo* and keep the industry competitive and attractive for incumbents and the financial industry, to invest in innovation and in infrastructure deployment including modernization.
Subsequently we will address the telecom related issues linked to the launch of the 'deployment period'. In concluding this Chapter we will touch upon the broader social-economic issues that are triggered by the new techno-economic paradigm.

4.2 Attractiveness of the telecom services industry

In short, the telecom reform process is intended to improve the performance of the sector by introducing competition in order to provide users with choice, improved services and lower cost. The removal of formal barriers to entry would attract new entrants based on increasing demand, technological progress and available funding.
To assess industry attractiveness we have used Porter's framework of industry analysis which links industry structure to the profit opportunity provided by that industry. As we have seen in Chapter 5-7, the reform process, combined with the

technological and financial forces operative during the boom, has affected the industry structure in all five dimensions. Essentially all formal barriers to entry of the fixed network have been removed. Unbundling of the local access is introduced to allow usage of the incumbent' infrastructure.[8] We have observed the fragmentation of the once integrated business model into a wide range of more specialized providers.[9] We have observed the growth in fixed line connections drop to zero and turn negative.[10] We have observed tremendous growth in mobile communication, and seen the mobile phone segment become a life style industry. We observe the market to shift from a set of 'mono plays' to explore the opportunities of 'triple play' and 'multi play' offerings.[11] We have seen the transition of incumbent firms from a utility mindset to a competitive frame of mind and from a technology focus to a customer focus.

We have also seen that the once very attractive industry has become highly competitive and profit margins have been eroding significantly. Figure 1 shows the developments in terms of Return-on-Sales at the aggregate level based on ITU data (ITU, 2002).[12] Although the decline is significant, the end result is a profitability level more akin to other highly competitive industries.[13] The stabilization in the basket of residential and business tariffs are suggesting that price competition has eased.[14] The OECD also reports that the decline in prices for the handling of Internet traffic are occurring at a slower rate (OECD, 2006a).

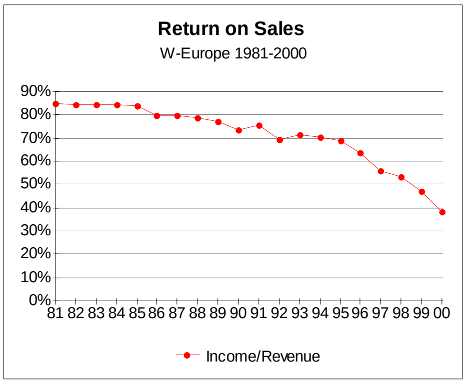


Figure 1. Return-on-Sales for West European telecom services operators, 1981-2000

Compared to the frenzy period growth rates are modest. We have observed the number of communicating entities grow from the 'number of households' connected to the 'number of people' connected. The next step is toward 'the number of appliances' connected.

Compared to the period leading up to the bubble, the portfolio of business opportunities has broadened significantly, to include next to the traditional fixed-voice service: mobile voice, SMS, fixed and mobile data, the Internet supporting email, the web, instant messaging, voice, audio streaming, video, multi-media. We have seen household spending on electronic communication increase and move

from a ‘utility need to communicate’, to include more basic patterns of human interaction and awareness, such as ‘how are you’, ‘where are you’ and ‘what are you doing’.
The 50% increase in share of GDP of telecom services revenues indicates a much more important role for the industry. Increasingly telecommunication services are enabling other business processes. Moreover, telecommunications, including the Internet, has become a means-of-production for a wide range of business.

4.2.1 Financial strength of the telecom services industry

With a certain degree of simplification one could argue that at the beginning of the bubble period the incumbent telecom operators were facing similar financial conditions, as were the new entrants. However, during the bubble the debt position of telecom operators increased significantly and their credit ratings were reduced.[15]
In order to survive most telecom operators pursued financial restructuring in the aftermath of the bubble. Companies that had an existing cash flow could survive that way, however, many new entrants had to file for bankruptcy protection for the lack of customers generating adequate cash flows.[16] In the latter case many companies re-emerged with an improved balance sheet as debt had been transformed into equity. This opportunity for a ‘fresh start’ has not been appreciated by the players that survived on their ‘own strength’, as the end result was considered to be ‘unfair competition’.[17] A similar argument applies to companies that have transferred their assets to new owners at significantly reduced prices compared to the original investment. Earlier we identified this development as leading to increased rivalry. Here we like to emphasise the deterioration of the financial strength of the industry in comparison with the situation before the bubble.

4.2.2 Perception of the telecom services industry by the financial sector

As utilities, before the bubble period, the telecom companies were a good target for investment if steady and low-risk returns were being pursued. New entrants during the boom period, service and equipment providers alike, were considered by the financial markets as growth companies. But at the end of the bubble they are highly leveraged companies, with average growth rates. On the equipment side, the market came to realize that these companies are capital equipment companies; and subject to investment cycles.
The perception of the telecom industry by the financial sector will determine to a large extend the ease or difficulty the players in the industry will have to face in obtaining funding for the investment opportunities they wish to pursue in the aftermath. In the aftermath of the Internet bubble the telecom industry is considered less attractive than before.
Stock valuations provide the indicator for the equity market, while access to and the cost of bond issues can be derived from the ratings by Moody’s, Standard & Poor and Fitch. Figure 2 shows, as an example, the telecommunication share indices for a sample set of telecommunication operators (Lennin and Paltridge, 2003 p9). Figure 3 shows the fall in credit standing for a sample of incumbent players as rated by Moody’s Investor Service (source: Den Besten, 2002).

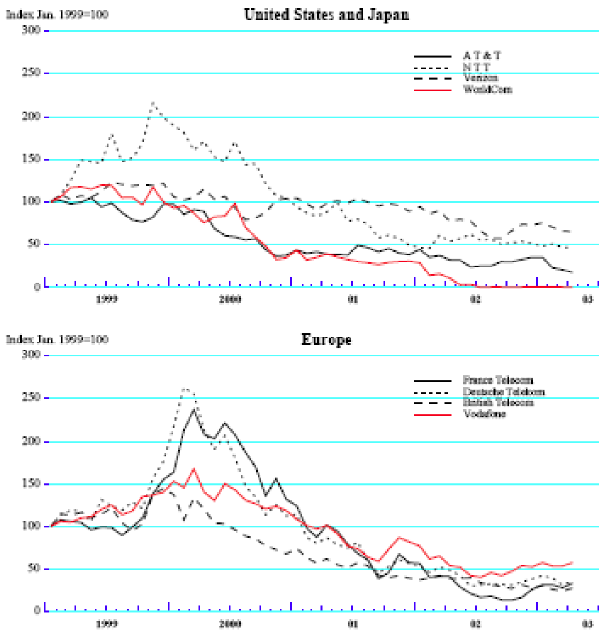


Figure 2. Share price indices of selected telecommunications operators

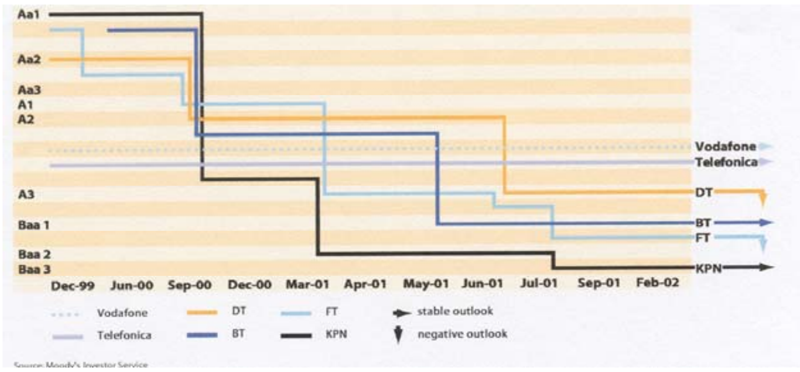


Figure 3. Moody's rating of incumbent carriers, 1999-2002

In the evaluation of investment proposals, the financial industry is more selective and the regulatory regime is an important consideration; e.g. proposals that are subject to (potential) unbundling are considered to be less attractive.[18]

4.2.3 Lasting impact of overcapacity

As we indicated earlier overcapacity in certain parts of the communications network will affect the industry in the long term. A typical example is the intense competition as a result of the Pan-European fiber optic network build-out. See Annex 7 for an

overview. The revaluation of assets as a result of financial restructuring and bankruptcy proceedings sets a new and much lower cost base. According to KMI Research, 12 of the 27 Pan–European carriers had been involved in debt restructuring or bankruptcy proceedings by November 2002; they represented 38% of the total fiber deployment by route-km. There were 9 carriers that had changed ownership, representing 27% of fiber deployment (courtesy: KMI Research, 2002).
The best resolution to the overcapacity will be growing demand. Although the use of the Internet appears to be unabated, and increasingly bandwidth hungry applications are being used (see for an indication the growth in traffic volume at the Amsterdam Internet exchange reflected in Figure 4 (Ams*ix*, 2005; Ams*ix*, 2006)[19]), the raw fiber capacity and the notion that only a small portion of the fibers has been lit does not suggest a short term resolution.

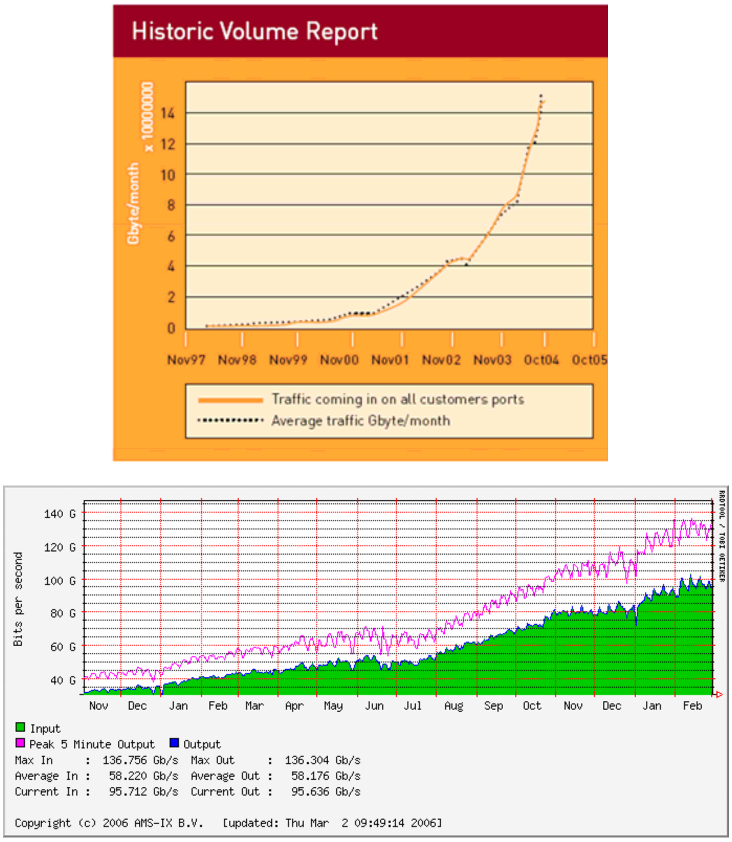


Figure 4. Internet volume growth Amsterdam-IX

Moreover, the limit to capacity use is in the network access, where the competitive battle between ADSL and cable modem determines the pace of further bandwidth expansion, as the business case of fiber-to-the-home (FttH) is as yet not overwhelmingly positive, and financial markets are reluctant to take the risks involved in a broad deployment.[20]

The alternative of abandoning assets is not very likely. Technological obsolescence may play a role, but is not imminent. Moreover, capacity of a single fiber can be enhanced manifold through the use of wave length division multiplexing (WDM or DWDM) equipment.[21] It is not very likely that assets will be 'ignored', as there will always be firms that see ways and means to exploit the remaining value.
As part of the restructuring consolidation of this market segment has taken place, but also new players have emerged acquiring existing network assets, which may prevent further consolidation.

In this respect a parallel can be drawn with the consolidation process during previous infrastructure related bubbles, in particular the aftermath of the rail road mania in Britain. From 1845 onward industry consolidation has taken place. A total of 128 railway start-ups would be absorbed over the period 1845-1850, mostly in a two-step consolidation, by the 5 larger companies that would be serving the nation in 1935 (Great Western; London, Midland & Scottish; London & North Eastern; Southern; Great Southern). Furthermore there were 56 companies which failed due to 'abandonment' or 'powers to construct unexercised'. Together they formed the complete list of 184 new railways incorporated during the mania period 1845-1850. See also Annex 3. Although the parallel is tempting, whereas the situation is similar as railroads were also in private hands, it is different as it is related to the emergence of the railroads. With regard to the latter, the railroad consolidation is more akin to the consolidation of the telecommunication sector between 1900 and 1920, a period in which dispersed networks were interconnected, universal service became a key objective and competition was considered inefficient (Vietor, 1994 p167-85).

4.2.4 Telecommunication demand

From the analysis of a potentially emergent industry cycle in the telecom industry, see Annex 8, it has become apparent that the demand for telecommunications is unabated. The major changes are in the way the demand is being served. See also Figure 4 for an indication of the development in Internet traffic. Add to this the notion that we will observe in the future an increase in computer mediated communication, but not necessarily a diminishing of the volume of voice traffic, the demand for telecommunications, a fundamental industry driver, appears to be robust.

4.2.5 Industry dynamics - contracting between operators

During the 'utility era' the industry structure was very stable and developments rather predictable. Hence benefits could be obtained from long-term, high-volume contracting, e.g. with respect to leasing transmission capacity and handling international traffic flows through 10-20 years IRUs. However, in an environment with rapid price declines and intense competition flexible and short-term arrangements are considered more efficient. The emergence of 'bandwidth exchanges' such as BandX are a case in point. Nevertheless a review of the Pan-European fiber optic network build-out shows that long-term IRUs have been used extensively to extend the footprint beyond the own fiber installations. This applies for the lease of duct capacity as well as dark fiber. See also Annex 7 and KMI Research (2001).

4.2.6 Implications of the circuit to packet paradigm shift

In Chapter 5 Section 3. we described the transition from the circuit-mode voice driven paradigm to the packet-mode data driven paradigm. In Chapter 7 we have elaborated the impact on the development path of the telecom sector. In this Section we will make the implications more explicit for the various actors. See also Table 1 and 2 in Chapter 5 for a summary of the main characteristics of the two paradigms.

4.2.6.1 Implications for telecom operators

Technological progress has hitherto led to primarily the modernization of the core of the telecom network: transmission systems have been upgraded from FDM to PCM; transmission media from copper pairs, to coax, to fiber optics; switching systems have been upgraded from analogue to digital and from SDM to TDM. Moreover, the switching functions and the network operations and management are now software controlled. These changes have *grosso modo* remained undetected by the end user, except for an extension of the type of services (e.g. 0800/0900 numbers[22], call waiting, CLI). The most noticeable change has been the introduction of mobile telephony. Under all these technological changes the basic principles of the telecom business model have remained essentially the same: monthly subscription fees plus usage based call revenues, related to the duration, distance and time of day.[23] Only pre-paid mobile introduced a new element to the mix.

However, the introduction of the Internet, which is synonymous with the new packet-mode paradigm, would change these fundamentals. Initially the provision of Internet access was considered as additional business opportunity in the portfolio of services. Internet access was provided as a dial-in service over the PSTN access line. The Internet access commanded an additional subscription fee and had a usage sensitive element through the dial-up.

However, in those countries and regions in which a CATV network had been deployed the Internet allowed, for the first time, infrastructure based competition in the access. In the initial phase of competition for the market the CATV based operators were in the lead as their coaxial cable systems could more easily provide for broadband access, albeit most networks needed to be upgraded to provide two-way communication. CATV network related services had been subscription based rather than usage sensitive, the provision of Internet access followed that model.[24]

With the introduction of ADSL telecom operators started to regain market share for broadband Internet access, albeit this changed their revenue model to period charging of bandwidth, based on the combination of upstream and downstream capacity. Gradually the battle moved from ‘competition for the market’ to ‘competition in the market’, based on price and bandwidth capacity being provided.

The potential for the Internet of usurping telephony is an opportunity for CATV operators to expand their service portfolio, while it is a threat to the telephony revenue stream of the incumbent telecom operators. It is also an opportunity for the new telecom players that are using the incumbent infrastructure through access unbundling. While packet based voice communication has been demonstrated as early as 1983 as Voice Funnel, the inherent delays in a packet network are at odds with the real-time nature of voice communication, whereby the intelligibility is very sensitive to delays.[25] The Increase of network capacity would mitigate this issue and was made feasible by the reduction in transmission costs through fiber optics. Moreover, in particular segments of the market users would accept lower quality in combination with lower costs, such as in intercontinental calling by consumers. Further improvements have been pursued by distinguishing between types of services being carried and giving priority to or reserve bandwidth for real-time sensitive communication.[26] To achieve the real-time nature of the telephony service, appliances that support voice over the Internet have to be 'always on'. The early dial-in access was not compatible with this requirement, the current ADSL and cable modem solutions are compatible. The issue of the 'PC as handset' is being mitigated with the introduction of new devices such as IP-phones, IP-enabled PDAs and the use of conversion devices that allow the existing in-house telephony equipment to be connected to the network over IP, without changing the user interface.

For VoIP to become a full alternative for the telephony service, certain regulatory requirements have to be fulfilled, such as access to the nearest emergency services. In this respect it is interesting to note that the telephony service has been defined not only for transmitting voice, but also for in-band data communication, such as computer modem connections, fax signals and DTMF tone signals.[27] It appears that the development of VoIP is being aimed at emulating telephony. See also Stratix (2005).[28]

While the direction of the 'development path' is becoming clear, it is not necessarily only downhill for the incumbent players. Existing customer relationship are an important asset. Moreover, the quest of the entrepreneur has always been to achieve sustainable competitive advantage and to use differentiation to prevent commoditization of its product or service. The opportunities provided through TCP/IP convergence to offer e.g. multi-play services is a case in point.

The recognition that the packet-mode paradigm will become the leading communication paradigm, has led a number of incumbent operators to cap the implementation of circuit-mode products and initiate a network overhaul towards full packet-mode communication. A leading example in Europe is BT in the UK (BT, 2004a; BT, 2004b). This is a further demonstration that the circuit-mode products have reached the end of the technology life-cycle.

4.2.6.2 Implications for governance

Governance in the telecom industry has two important dimensions: (1) the internal governance, and (2) the external governance. The first category relates to how players in the industry resolve issues of common interest, e.g. interworking, standardization. The second category refers to the oversight by governments, not

only in facilitating the proper functioning of the industry, but also in guiding the industry in a certain direction, e.g. through the process of telecom reform.
Each industry tends to develop over the years the institutional arrangements and governance structures that best suit their interests. Hence, they become industry specific, albeit within a broader framework of institutions and arrangements that apply to all industries. If two paths of industry development come together, as is the case with the convergence of telecommunications and computing, or more precisely between the voice paradigm and the data paradigm, a tension emerges between the different institutions and their future role, in terms of the internal governance. As the Internet Protocol (TCP/IP) is the linking pin between the tele-transmission world on the one hand and the application world on the other, the IP-model appears as the leading model, and thereby their institutions and institutional arrangements. See for an illustration Chapter 7 Figure 48. However, the IP-world does not address the peculiarities of the different transmission media. In fact the IP layer is intended to decouple the application from the media, thereby, in principle, facilitating the use of any application on any media.
This process of convergence is not necessarily a process of evolution or adaptation, there are tensions arising. In the telecommunication world the role of the government and its agencies has been very pronounced, while in the computing world the industry has been on the forefront.

The implications of the process of convergence are not confined to the telecom industry. The traditional linkage between medium and content is also blurring. Institutional arrangements and governance systems built on these linkage will need to be revisited and reformulated. Not through a straight forward transposition, but informed by the new techno-economic paradigm, in order to reap the full potential of this new paradigm. In Section 5 we will expand on this notion.

4.3 Recommendations regarding telecom reform

Although the attractiveness of the telecom industry at the aggregate has deteriorated in absolute terms, the industry can be considered to remain attractive in relative terms. There is robust underlying demand for the services provided, profitability levels are roughly at par with other comparable industries. The restructuring process has improved the financial position of the incumbent firms. Current technologies represent a lower barrier to entry. Although, the shorter technology cycles are forcing shorter depreciation periods. Moreover, the greater diversity of technology platforms represents an increasing uncertainty about the outcome of future developments and hence business risks are increasing. Furthermore, the single-service based competition appears to be migrating toward increasingly multi-service based competition. The initial infrastructure based competition offering triple-play (Internet-Telephony-Broadcast) is now being extended to include mobile services.[29] The ability to deliver these service 'seamlessly' will be driving industry consolidation, a result of firms trying to obtain, among other, sufficient geographical coverage.
Combined with more realistic perceptions of demand the telecom industry is much less a growth industry than it was being perceived during the frenzy period. Hence,

the willingness for new firms to enter at the infrastructure level is expected to be very modest. The most attractive window of opportunity for entry has passed.
Hence, for the time being, a continuation of the *ex-ante* regulation of the telecommunication sector is recommended, to safeguard the results of the telecom reform process obtained thus far.

4.4 Recommendations regarding telecom sector policy

Considering the importance of the telecom sector for economic development it is recommended that governments monitor closely, and intervene when deemed necessary, the transition from government/operator led to an equipment provider/ industry led governance model. As the data communication paradigm is usurping the voice communication paradigm, the values, norms and objectives embedded in the institutional arrangement of the telecom sector are not automatically carried forward. However, the opportunities offered by the new paradigm should thereby not unnecessarily be curtailed by the legacy of the old paradigm.[30]

4.5 Recommendations regarding industrial policy

Historically research labs of telecom operators and equipment makers have played a significant role as national research champions in the various national innovation systems. In the restructuring of the industry these labs have been reduced significantly in size and have been (re-)focused on the core activities of the firm. The capacity in terms of fundamental research is thereby severely affected, if not eliminated. As a consequence the state has become much more dependent on other sources of fundamental research, and governmental funding will have to be adjusted upward if retaining of a similar level of R&D intensity is desired. Given that innovation occurs more at the fringe of the established industrial network, in start-up companies, the channeling of support and funding will need to be adjusted accordingly.
Also the number of manufacturing and R&D locations has been reduced. As an example in the Netherlands virtually all R&D activities of foreign multinational telecom equipment firms have been dissolved.[31] Hence, as an alternative policy for a country to stay at the forefront of ICT developments it is recommended to strive for a leadership role in services and application development and deployment. For the Netherlands SURFnet and LOFAR are good examples of such projects at the forefront of ICT technology.[32]

4.6 Recommendations regarding services firm strategy

The shift from the circuit-mode paradigm to the packet-mode paradigm has forced a shift in the required skill sets and capabilities within the resource base of the telecom services firms. As this shift also affects the institutional environment and the institutions that matter for the future development of the sector, the telecom services firms will need to adjust their resources, time and attention from a primarily government and governmental agency focus to a more industry focus, in particular if they wish to contribute to the development of the Internet. Consider in this respect the role of the ITU viz-a-viz RIPE and its regional counterparts, and that of ETSI viz-a-viz the IETF.

4.7 Recommendations regarding equipment firm strategy

The dramatic reduction in investments by the service operators has resulted in a significant downsizing of the equipment industry. Moreover, the portfolio has changed, from predominantly circuit-mode products before the bubble, to predominantly packet-mode or IP-related products after the bubble. Firms either adapt to the new reality or will face extinction. Revaluing the resource base of the firm will be required. Surviving on the basis of the installed base of products is an option, albeit the replacement by newer technologies appears to be occurring faster than for previous generations of technology. Consolidation and rationalisation, as has happened for legacy products in the IT industry, is a feasible strategy to pursue. However, the high degree of specialization will be limiting the degree of synergy that can be achieved across multiple product platforms.

The decoupling of the switching and routing functions from the transmission function, facilitated by TCP/IP, is reducing the degree of synergy that can be achieved by fully integrated firms. Divestment and/or specialization is a recommended course of action.

5 Implications emerging from the installation of the new techno-economic paradigm

From the accounts of historical bubbles reviewed in the context of this project it can be concluded that periods of euphoria are a recurring feature of economic development. The brevity of our ‘financial memory’, the wish to nurture economic growth and our tendency as human beings to pursue opportunities for realising quick gains, will stimulate the development of future bubbles.

While from an economic perspective periods of euphoria can be considered inefficient and even wasteful, when they occur in relation to the introduction of a technological revolution and the installation of a new techno-economic paradigm, the over-investments in the related infrastructure are facilitating a new level of productivity.

The productivity improvements related to the current techno-economic paradigm are resulting from two related phases in the current revolution: the information technology revolution and the telecommunications revolution phase.

As discussed, the IT related productivity improvements are a result of investments in hardware and software, complemented by investments in human resources and in organisational change (see Chapter 6 Section 3.3.1). The telecommunications related productivity improvements are related to the lowering of production and transaction costs, facilitated in particular by the Internet (see Chapter 6 Section 2.2.4.1.2). The relationship between investments in ICT-assets, the complementary investment in human resources and the linkage to organizational change, in order to realise the productivity improvements that are embedded in the new technologies, can be considered a ‘best practice’ of the current paradigm. The changing role of information in organizations is another element of ‘best practice’.

The regularity of technological revolutions suggests that the productivity improvements related to the new techno-economic paradigm are not limited to productivity improvements that can be obtained in relation to firms alone, as demonstrated by e.g. Brynjolfson and Hitt (1998; 2003), but that they can be obtained across the economy and society at large. The ICT-driven revolution thereby affects our routines and habits, not only in terms of work routines, but also in the social realm, e.g. in the way we communicate and transact. As a result, transformation is taking place, as in critical realism.

ICT-technologies have changed also the nature of products, from tangible to increasingly intangible. In this respect Shapiro and Varian refer to information goods and experience goods (1999). The change in the nature of products also invokes changes in the way these products are produced and transacted. Replication cost of information goods are extremely low, and communications technologies allow for the instantaneous distribution of these products. This affects the way we tend to deal with products in terms of institutional arrangements and their enforcement, e.g. with respect to ownership, taxation and illegal reproduction. It also affects the 'economic order' as the relatively low entry costs of the ICT-revolution has allowed new regions to participate, as demonstrated by the uptake of IT-related economic growth in e.g. India and China (as illustrated in e.g.: PriceWaterhouseCoopers, 2004). Hence, the impact of the ICT-driven revolution affects economies and societies at large. It has become apparent that the institutional structures and governance arrangements that have been created to facilitate the production, distribution and consumption or use of the very tangible products of the previous 'Fordist'-revolution are not fit for the intangible products of the ICT-driven revolution. Tensions have emerged and are emerging as a result of the 'installation' of the ICT-driven techno-economic paradigm. In Chapter 6 we have described and summarized these tensions between 'best practice' in the Fourth Wave and perceived 'best practice' for the current and Fifth Wave. They also reflect the tensions that have arisen between the vested interests linked to the previous Wave and those emerging in the current Wave.

Perez has captured the phenomena in three spheres of change in constant reciprocal action: the sphere of technological change, the sphere of economic change and the sphere of socio-institutional change. See Figure 5 (Perez, 2002 p156).

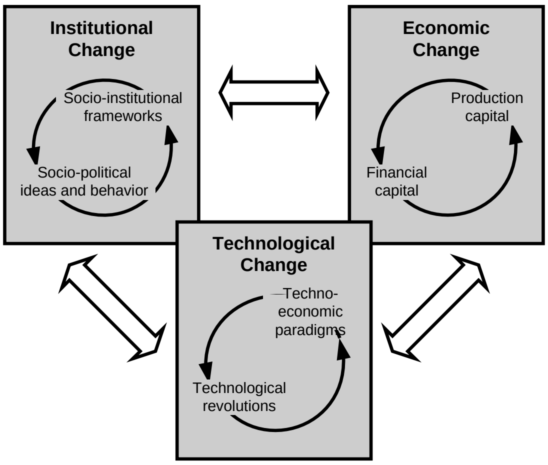


Figure 5. Three spheres of change in constant reciprocal action

As change occurs within the subsystems, these changes affect the other subsystems and tensions will emerge between the subsystems. These tensions are the drivers of change, albeit, if no timely change occurs, tension may grow and conflicts may arise. An optimal performance of the system at large is considered to emerge if the change in the subsystems is based on mutual adaptation. This may be referred to as co-evolution.[33] Freeman and Louçã are referring to the necessity of congruence between the subsystems, in particular for the financing and diffusion of the innovations (Freeman and Louçã, 2001 p177-81).[34]
Historical regularity has shown that (mutual) adaptation has taken place and the benefits of the new techno-economic paradigm have been accrued. However, there is no guarantee that this will happen, as the post 1929 depression period shows. Hence, there is a role for the actors involved to explicitly address the tensions and facilitate the developments, to allow the benefits of the new paradigm to be obtained.

A first essential step is to interpret the tensions in the appropriate context. Using the Perez framework the changes and tensions that the shift in techno-economic paradigm is bringing about, are summarized in the following set of three Tables: Technological change Table 5, Economic change Table 6, and Socio-institutional change Table 7.

Topic	Technological change	
	Fourth TEP	**Fifth TEP**
IT domain	Central processing architecture	Client-server architecture
	Hardware and software closely linked	Hardware and software decoupled, independent suppliers; Operation systems platforms and applications decoupled
	High barrier to entry	Low barriers to entry, in particular in software
		Low reproduction costs of software
		Low reproduction costs of information
Telecom domain	Circuit mode communication	Packet mode communication
	Fixed communication	Mobile communication
	Dedicated networks	IP- centric networks
	Narrowband	Broadband
	Intelligence in the network	Intelligence at the edge
	High barrier to entry	Lower barriers to entry, in particular in content and applications
	Service provisioning linked to infrastructure ownership	Service provisioning decoupled from infrastructure ownership
Applications /services	Voice	Data
		Internet facilitated communication and information exchange
		Computer mediated communication
	Mail, fax	Email, SMS, IM
	Advertising/classifieds	Banners, spamming

Table 5. Technological change

Topic	Economic Change	
	Fourth TEP	**Fifth TEP**
Industrial organisation	Large firm dominated (vertical integration)	Networked firms, local & global
	Economies of scale	Economies of scope and specialization
Innovation system	Closed system	Open system
	Slow, sequential innovation	Rapid, concurrent innovation
	Fragmented knowledge base	Common knowledge base
	Physical prototyping	Simulation and virtual prototyping
	Few innovators	Many innovators
Firm organisation	Hierarchies; pyramids	Flat networks; internal & external
	Departmental	Integrated; project orientation
	Automation of separate activities	Systemation, linking activities along the value chain
Production level	Mass production, standardized goods	Rapid changes in product variety and mix
	Dedicated plant and equipment	Flexible production systems
	Stable routines	Continuous improvement
	Separation of mind and hand	Integration of mind and hand
	Specialized skills	Multi-skilling
	Sequential design	Concurrent engineering
Market level	Three tier stable market	Highly segmented market; disintermediation and re-mediation
	Traditional marketplaces	Increasingly electronic (Internet enabled) marketplaces
	Product competition	Systems competition
	High search costs (access)	Lower search costs (abundance of information) off set by uncertainty in quality (authentication)
Business level	Fixed plans	Flexible strategies
	Economies of scale	Economies of scope and specialization
	Mainly competition in the market	Increasingly competition for the market (creating critical mass; network effects)
	Centralized control, vertical information flow	Distributed control, horizontal information flows
	Centralize intelligence	Localized intelligence
	Closed, localized innovation systems (fragmented knowledge base; few innovators)	Open dispersed innovation systems (common knowledge base; many innovators)
Transaction level	Trust embedded by institutions and familiarity with transaction partners	Use of the Internet requires new arrangements to establish and maintain trust (stranger-to-stranger)
	Physical/tangible transactions	Increasingly computer mediated transactions
	Collectively wage bargaining	More tailored employment contracts
	Customer interaction is remote	Customer engagement in product development; in the after-sales process
	Multi-national markets	Global markets
Factors of production	Capital, labour, natural endowments	Knowledge, creativity, relations
Product level	Standardized (limited choice)	Customized (wide choice)
	Highly Tangible	Highly intangible (information goods) with tangible complementarities; Increasingly experience goods
	Product with service	Service with product
	Low degree of network effects; low degree of lock- in	High degree of network effects; high degree of lock-in

Table 6. Economic change

Topic	Socio-Institutional change	
	Fourth TEP	**Fifth TEP**
Cultural	Identity is a given	Identity more conscientiously addressed (physical and virtual)
	Importance of strong ties (primary and secondary relations)	Importance of weak ties (tertiary relations)
	Less segregation	More segregation along various lines (enclaves; creative class; elites)
	Social status and esteem derived from position and wealth (‘conspicuous consumption’)	Additional status in virtual world: derived from contribution to the network ; peer and social reciprocity (‘conspicuous contribution’)
	Pluriformity and reliability of information linked to stratification of society	Abundance but diffuse supply of information; open ‘can be surfed by all’
	Communication primarily based on necessity	Communication also as part of social awareness and consensus building
	Time delays in and between contact and action	Instant contact and action; instant global communication
		Increasingly computer mediated communication
	No environmental concern	Environment as guide to innovation
Bureaucracy	Strong bureaucracy	Crumbling bureaucracy; emerging infocracy
	Government control and sometimes ownership	Government information, coordination and regulation
Policy	Welfare state	Well being and individualized responsibilities
	Keynesian demand management	Minimal government idea
	Universal service	Service differentiation by location/geography (poly-nucleated city)
Property	Financial divide	Additional Information (digital) divide
	Intellectual property rights an issue for firms (few transactions)	Intellectual property rights an issue for individuals (many transactions; digital rights management)
		Awareness of public versus private ownership of information
Judiciary	Physical authentication, authorization	Electronic authentication, certification, authorization
	Enforcement within national boundaries	Enforcements requires cross border action (cybercrime; spam)
	Burglary	Cybercrime (privacy, security, identity theft)
Monetary	Physical and electronic funds transfer	Electronic payment, multiple forms of payment, including micro-payments

Table 7. Socio-institutional change

In this mapping we have included aspects related to cultural change under the heading of socio-institutional change. As the Fifth Wave has a significant impact on the way communication takes place and on its intensity, the cultural implications are deemed important enough to take into account. The source of the information are the summaries compiled in Table 9-10 in Chapter 6 for the economic and socio-institutional dimension, and Tables 1-2 in Chapter 5 for the technological change.

From the tables it becomes apparent that the implication of the paradigm shift does not remain restricted to the ICT sector, but is affecting essentially all dimensions of economic and social activity. The paradigm shift is affecting many dimensions of the institutional environment. The differences in the dimensions between the Fourth and the Fifth techno-economic paradigm gives an indication of the need for adaptation of the institutional environment. A task in which governments will have to play an important and proactive role.

Note that the shift from the circuit-mode paradigm to the packet-mode paradigm embedded in the technological change from the Fourth to the Fifth Wave can be considered similar to the change from iron to steel in the transition from the Second to the Third Wave.

5.1 Infrastructure of the new techno-economic paradigm

Considering telecommunications and the Internet as the combined infrastructure of the Fifth Wave, investments in telecommunications during the ‘installation period’, in particular during the period of frenzy, have resulted in a much broader and deeper penetration of the communications infrastructure, as illustrated in Table 8, which shows the increase in the number of network access paths, in particular the emergence of mobile communications and the Internet (derived from: OECD, 2005). For an optimal exploitation of the new ICT-driven paradigm the provision of sufficient bandwidth is the next step to providing connectivity.[35]

millions	EU15		OECD		World	
	1970	2003	1970	2003	1970	2003
Fixed channels[1]	43	226	145	601	157	1049[2]
Mobile connectivity	0	324	0	741	0	1384
Internet subscribers[3]	0	92	0	259	0	NA
Broadband access[4]	0	23	0	84	0	NA
Internet hosts[5]	0	21	0	104	0	172[6]

Notes: 1: 64 kb/s equivalents; 2: 2001 data; 3: Connected to the fixed network; 4: Downstream speeds greater than 256 kb/s; 5: January data; 6: Country domain names.

Table 8. Telecom and Internet penetration, 1970-2003

5.2 Implications for policy formation

In addressing the implications for policy, it is useful to recall the approach that we have chosen in the development of this project, namely ‘critical realism’. Within that approach the purpose is not prediction, as this would rely on ‘constant event conjunctions’, but the identification and comprehension of the structures, powers, mechanisms and tendencies which produce or facilitate future events. In this respect historical regularities, or ‘demi-regs’, may provide insights into and an understanding of these structures, powers and mechanisms. As we have argued the concept of Long Waves, and in particular the elaboration thereof by Freeman, Louçã and Perez, provides for such a ‘demi-reg’, including the necessary process of reproduction and transformation.

The ‘critical realist’ perspective offers the “possibility of human emancipation through structural transformation”. It is thereby feasible to consider “replacing structures that are unwanted, unneeded and restrictive” by those structures that are “wanted, needed and empowering”.

In our context this is the framework of institutions and governance regimes that have been optimised to support the previous Fordist Wave, and that need to be adjusted to the ‘best practice’ of the current Wave of Information and Telecommunications. Perez in her analysis of previous Waves observed that: “At the turning point, when the system stalls in recession, the state and other institutional, social and economic actors will establish the regulations and other

changes in the framework, to help launch the deployment period based on the solid expansion of production capital." (Perez, 2002 p156). Moreover, "[i]t is thanks to that restructuring of the context to fit the potential of the revolution that 'golden ages' can occur." (p24).
Recognizing that currently we are at the turning point of the Fifth Wave, and with the prospect of a 'golden age' to develop, it is recommended that policy formation is aimed at facilitating the 'deployment' phase of the ICT-driven techno-economic paradigm.

During the 'installation period' of the current Wave many tensions have become apparent between the existing institutions and governance regimes and the requirements and needs evolving from the new techno-economic paradigm. These have been summarized in Tables 5-7 in Section 5. The differences between the Fourth and the Fifth techno-economic paradigm are considered important sources to inform the policy formation process. It should be acknowledged that many topics identified are already featuring on the political agenda, in one form or the other. However, very few topics have been resolved, which should not come as a surprise when considered in the context of the shift in techno-economic paradigms that is taking place. The contribution of this project should be seen as providing the broader context for the resolution of these issues, and inspire those involved in finding the appropriate solutions, and making their efforts worthwhile, recognizing the prospect of a potential 'golden age' to develop.

Freeman and Soete have argued that the economic and social potential of new clusters of technologies will only be realized over fairly long historical periods, and that through the process of 'learning' the necessary changes in management strategies and institutional environments will occur (Freeman and Soete, 1997 p330). More recent research related to the Solow productivity paradox has shown that the benefits of the new paradigm do not emerge through investments in computer hardware and software alone. Essential is linking these investments in physical assets to investments in human capital and to organisational change.[36]
Perez observed that "…each technological revolution brings with it, not only a full revamping of the productive structure but eventually also a transformation of the institutions of governance, of society and even of ideologies and culture, so deep that one can speak about the construction of successive and different modes of growth in the history of capitalism." (Perez, 2002 p24-5).

Initial analysis of the changes involved by the new techno-economic paradigm suggests that the changes are profound, affecting Layers 1 through 4 of the Williamson Model, that is including culture. Hence, irrespective the differences in role perception of governments, it would not be realistic to expect, if at all desired, that all of the issues that have emerged can be addressed and resolved through government policy alone. However, what may improve the possibility of an 'golden age' to develop, is government policy informed and inspired by this perspective of the future. Assuming that this recommendation will be adopted, the need to understand the techno-economic paradigm shift will follow, as "…each techno-logical revolution is different, each paradigm is unique, each set of solutions needs to be coherent with the problems to overcome and with the logic of the paradigm, its opportunities and its best practices." (p170). Many authors have made contributions towards a better understanding of the new paradigm. In Chapter 6 Table 10 and 11 a perspective on the shift from the old to the new paradigm and the tensions that it evokes has been presented. This could serve as a starting point for sharing the insights obtained across multiple disciplines.

Considering the focus of this research project, in the following Sections some specific observations will be made oriented to the telecommunications sector, primarily in relation to the institutional environment.

5.2.1 Recommendations for telecom sector policy

For a long time telecom services have been delivered by state firms or private firms under close state supervision. Hence, the telecom services industry has received more than the average share of attention given to the industrial sector in general. The telecom reform process is intended to subject telecom firms to the forces of the competitive market, and hence diminishing state involvement. Albeit the transition process has required and still is requiring substantial government involvement, although some of the efforts are channeled through semi-independent regulatory agencies. The most recent step in telecom deregulation of the sector taken by the EU is the introduction of elements of competition law, to be applied *ex-ante*, into the regulation of electronic communication networks. The idea, expressed by some, is that once the reform process has been successfully completed the sector can be supervised in the same way as other sectors. Also the aim of designing technology neutral regulation points in that direction.
Although these are good objectives, the practice shows that electronic communication networks do exhibit elements of 'natural monopoly', also 'control points' with significant market power remain. The industry specific paradigm shift from circuit-mode to packet-mode is invoking the need for governments to revisit current legislation. Moreover, the notion that telecommunication is the infrastructure essential to the deployment of the current techno-economic paradigm ought to provide the telecom sector with a prominent and continuing place on the policy agenda.
Moreover, the ownership and assignment of frequency spectrum is a typical example of topics considered to be and to remain subject of government policy. Albeit, in awarding any future licenses the experience obtained in the auction process of 3G licenses will have to be taken into account. Although the process in it self may have been equitable, the effect of withdrawing approx. € 90 bln from the sector has significantly affected the financial position of the firms involved, and created a comparative disadvantage compared to their US and Asian rivals.

5.2.2 Recommendations for policy related to the circuit to packet paradigm shift

The transition from dedicated networks towards IP-centric electronic communication networks, shows that many notions that once were considered straight forward will need to be revisited and already are being revisited. The IP based implementation of existing services shows that a wide range of service functionality is technology specific and hence, backward compatibility issues are arising and need to be resolved.

A typical example is A-number identification linked to emergency services, a feature that does not come naturally with Voice-over-IP. Another example is the requirement that the telephone service should always remain operable even when the user was experiencing a main power loss. A topic that has been a major issue at the introduction of ISDN, and is becoming increasingly difficult to implement in computer mediated communication. On the other hand, mobile communication provides an almost omnipresent form of ‘diversity’. Hence, the power requirement may have to be reconsidered with the idea that it can be eliminated.

Convergence of communication services is making the linkages explicit that have been made between regulation of a particular service, and the technical implementation at the time. Regulation of telephony has been linked to the PSTN, regulation of broadcasting services has been linked to the distribution networks (terrestrial broadcasting, CA-TV systems). In the case of telephony the content of the messages being conveyed was in principle the concern of the communicating parties, and had to be protected from intrusion by others. In case of broadcasting the distribution of programs has been linked closely to the programming of the content. Unless the use of streaming audio and video remains a straight copy of what is being broadcasted, the emergence of the Internet invokes a reflection on the current regimes going forward. Hence, the rule making on this topic needs to allow on the one hand the opportunities of the new Internet enabled media to be fully developed, and on the other hand to safeguard the objective of diversity/plurality of information sources and the protection of cultural heritage. This will require a redesign rather than a transposition forward, taken the opportunities and limitations of the new media in mind.

5.2.3 Recommendations regarding telecom reform

Once all formal barriers to entry have been removed one might conclude that the reform process has come to an end, the emphasis shifting toward supervising the adherence to the rules and regulations, and the application of remedial action if and when required. In essence, forces in a competitive market will best determine future development and an *ex-post* supervision should suffice, as in other competitive markets. This is of course is subject to industry actors making use of the opportunities provided and a competitive market has developed or is developing. Despite the progress made, as for instance reflected in Chapter 7 Section 3.1.2, the reform process is not considered to be concluded as the current market structure provides for many instances of significant market power. See as an illustration Figure 6 reflecting the assessment of competition in the 18 designated telecom markets in EU (EC, 2006). For instance the market share of the incumbent operators in local access has remained relatively high. See Chapter 7 Section 3.2.[37] This should not come as a surprise as in infrastructure industries there are typically ‘bottle-neck’ resources that give rise to natural monopolies, such as the network access, and specific resources, such as spectrum licenses, that are not freely traded between firms. These are phenomena that require ongoing policy involvement.[38]

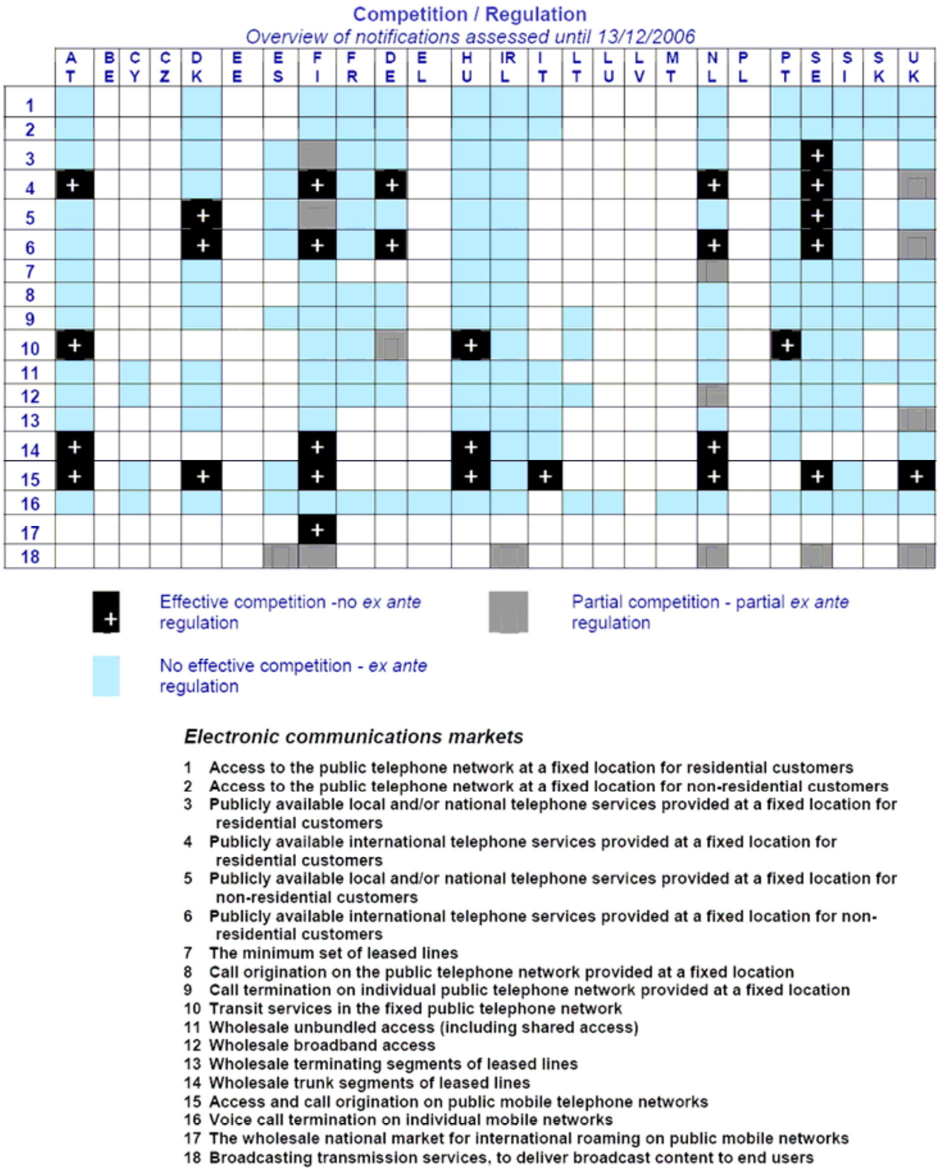


Figure 6. Competition in electronic communication markets EU, 2006

Moreover, the restructuring of the sector in the aftermath has led to significant consolidation and hence diminishing levels of competition, a process that is continuing today. The recent acquisition of MCI by Verizon, and AT&T by SBC are a case in point; both mergers were cleared by the FCC and the U.S. Justice

Department in the fall of 2005 (MCI, 2005; SBC, 2005). Albeit, significant M&A activities have always required an *ex-ante* approval under competition law and hence would not necessarily require sector specific regulation.[39]

Implied reliance on existing institutions and governance structures evolved to meet the needs of the old paradigm should be reviewed in the light of the institutions and governance structures that are related to the new paradigm. In the old paradigm an important role existed for government agencies and representatives, in the new paradigm these roles appear to be assumed by industry players.
The security of supply, once a responsibility embedded in a single firm, has now become an issue that is stretched across a value chain that includes many players. Although considerable resilience is built into the networks, for their proper functioning the economy and society are becoming increasingly dependent on the availability of the communication networks. The bankruptcy of telecom operators as a result of the crash has identified the vulnerability of telecom network operation to this phenomenon, hitherto unknown in the industry.[40]
The security of supply issue has received further impetus as a result of national security concerns in the post-9/11 era, and in relation to recent natural disasters.

Where functions become distributed across the value chain, the functioning of the system tends to become dependent on the coordination between the different players in the value chain. It has become apparent that the proper functioning of the system is highly dependent on the right incentives being in place. This is a particular pressing issue in the modernization of network infrastructures.[41]

Historically also the notion of ‘universal service’ has been translated into an obligation for the incumbent operator.[42] Recent experience from developing countries in particular, shows that universal service may be best implemented through mobile service provisioning. In the developed countries the question arises what should constitute ‘universal service’ in the Internet era. It raises the broader question of public value in the context of new generation communication networks.

To the extent that universal service also suggested the availability of a predictable, reliable and usable service at reasonable cost, the fragmentation of the market leads to a loss of transparency and may confuse the consumer. A notion that could be exploited by market parties. This development suggests that in telecom policy consumer protection will be requiring more attention, as it is not embedded anymore in the regulation of the incumbent operator.

This also applies for a new set of issues that have arisen with the emergence of the Internet. These issues are related primarily to the content of the communication and the fact that our communication is increasingly computer mediated. These issues include security, privacy, identity protection, as well as annoyance and economic losses due to e.g. virus infections, and spam. The ease of distribution of information goods through the Internet has put a different light on e-enabled commerce, e.g. in relation to intellectual property rights and their enforcement, secure electronic payments, and trust in electronic transactions. This is a set of issues that relates to the broader deployment of the techno-economic paradigm, and hence require resolution to allow the full benefits of the paradigm to become available.

One objective of the European telecom reform process is the creation of a harmonized European market for telecommunications. Evaluating the developments in the period considered, the architecting and implementation of the GSM standard is a good example of the creation of a harmonized market. The shift toward the data driven packet-mode paradigm implies a shift away from national specific standards typical for the telecom world, toward industry led standards. Albeit, most of these standards are of US origin and hence do not necessarily contribute to European leadership in the knowledge-based networked economy.
Although foreign ownership of telecom service provisioning has increased, only a few regional players are emerging, such as Vodafone and more recently Telefonica. The recent analysis of telecom markets executed in the context of the new EU communications networks directive, has shown that markets are still very much nationally determined.

5.2.4 Recommended overall approach

While it could be argued that the telecom reform process has run its course, the linkage of the telecommunication infrastructure to the diffusion of the new techno-economic paradigm extends the scope of policy formation from telecom reform, to ICT policy and beyond. Many of the changes the paradigm shift has evoked are still very much emergent, and hence have certainly not led to a full alignment between the technological, economic and social domains. It also appears that many of the issues are being addressed in isolation, i.e. not linked to the broader phenomenon of diffusion of a technological revolution. When considered in isolation a resolution may be problematic as the broader goal that should be pursued is not being perceived. Hence, the results may be suboptimal. Therefore, it is being recommended to revisit the current policy formation process against the back drop of the diffusion process of the 'ICT-driven' technological revolution.
It should be noted that we are at a unique juncture, the transition from the 'installation' phase to the 'deployment' phase of the new techno-economic paradigm. This is a period in which the state, economic and social actors can adjust the rules and regulations to facilitate the solid expansion of production capital, with the prospect of a 'golden age' to develop.
To facilitate this process the following stepwise approach is recommended:

1. to understand and appreciate the attributes of the paradigm shift, using the Techno-Economic Paradigm framework,
2. to understand and appreciate the relationships to economic activity, using the Transaction Costs Economics framework,
3. to identify the tensions between the current institutional framework that has been optimized for the previous 'Fordist'-paradigm and the (emerging) needs of the 'ICT-driven' paradigm,
4. to assess the scope and impact of these tensions,
5. to identify the solution space (local, regional, global),

6. to identify the stakeholders involved (government, industry, and citizens),
7. to engage and resolve the issues, as they relate to policy formation and implementation.

5.3 Implications for strategy formation

In the 'utility era' of the telecom industry the industry structure was relatively stable and developments were evolutionary. Hence the strategic activity was primarily a matter of long-term planning. The process of telecom reform, involving privatization and the introduction of competition, fundamentally changed the 'rules of game' and moved strategy formation to the forefront of corporate activity.

The period of euphoria is characterized by a quickly expanding range of business opportunities. Hence the frequency of the strategy cycle increases and the strategy horizon changes to medium and short-term. In the period of frenzy 'consensual vision' takes over and strategic formation becomes a 'copy-cat' activity. Alternative views on the development of the industry are being suppressed, and in this euphoric period the incentives, in particular stock options, drive the behaviour of managers.

In the crash and into the immediate aftermath strategic activity is aimed at survival. The aftermath provides the opportunity to reflect on the effects of the bubble on the industry 'development path' and the underlying changes in industry structure and paradigms. The changes in industry structure are at large the result of the telecom reform process combined with the technology induced transition from the circuit-mode paradigm to the packet-mode paradigm and from fixed to mobile communication. For the telecom operators these changes resulted in the transition from a prevailing voice-dominated business model to an Internet-dominated business model. Moreover, it implied a change in the institutional environment, from primarily government-driven to primarily industry-driven.

In Tables 1 through 4 the high-level implications of industry development on strategy formation in the four periods considered have been summarized, based on the changes of the industry drivers and inhibitors of change, as well as changes of the seven dimensions of the 'development path' of the telecom sector. These summaries reflect the changes in industry structure, at large the result of the telecom reform process and the technology induced transition from the circuit-mode paradigm to the packet-mode paradigm. The translation of these changes into firm strategy has been and remains the responsibility of the individual firms, recognizing that firms differ in their resource base, in their expectations regarding the future, and in their perspectives on the process of strategy formation.

In Section 4 we have elaborated the impact of the Internet bubble on the telecom sector, and thereby on the strategy of telecom firms in the aftermath of the bubble. The conclusions drawn in Chapter 7 Section 5 on the structural changes in the telecom sector and on the 'development path' have formed thereby a major input.

In Section 5 we have reviewed the implications of the new techno-economic paradigm, which has major implications for strategy formation in terms of its 'best practice'. What is considered of general importance for strategy formation is the shift from an industrial economy to an information economy, or the shift from the

'Fordist' paradigm to the 'Information and Telecommunications' paradigm, of which the essential characteristics are captured in Tables 5-7. Firms that will be able to capitalize on these changes will enjoy a comparative advantage in the 'deployment phase' of the 'ICT-driven' technological revolution.

In the following Sections two remaining items relating to strategy will be discussed.

5.3.1 Implications of cyclicality

Economic activity in general is characterized by ups and downs in the form of the business cycle. Porter argues that fluctuation in economic conditions over the business cycle are of tactical rather than of strategic importance, as these short-run factors influence nearly all firms in many industries (Porter, 1980 p6). However, as De Wit observes, certain sectors of economic activity are more susceptible to economic fluctuations than others (De Wit, 1994 p1-2). Swings in demand will be transmitted along the value chain, and due to time delays will be amplified. This applies in particular to 'durable consumer goods' industries, but also to e.g. the airline industry and the semi-conductor industry. The latter industries are characterized by deep investments and long pay-back times which are not only influenced by the business cycle, but tend to exhibit a sector specific cycle, which is referred to as the industry cycle. The nature of the telecom industry characterized by deep infrastructure investments and long pay-back times, suggests that the industry is in principle susceptible to an industry cycle. Considering the very recent liberalization of the telecom services industry, this phenomenon can only be emergent. The recent up and down swing could coincide with the first cycle of such a recurring pattern. Considering the impact that economic cycles have, or rather ought to have, on strategy formation[43], we have explored in Annex 8 the emergence of an industry cycle in the telecom industry. The initial conclusion of this research suggests that the sector is exhibiting a cyclical nature in terms of investment.[44] A first indication suggests a cyclicality of approx. 10 years. This emerging industry cycle appears to be linked more to a sequence of investment decisions by network operators related to network modernization and service upgrades than to fluctuation in end-user demand. The importance of this industry cycle for strategy formation will increase when the amplitude of the cycle is large in comparison to the investment trend line.

5.3.2 Implications of paradigm shifts

In terms of strategy formation it is worthwhile to note that "…paradigms are a powerful guiding model that it becomes an inclusion-exclusion mechanism, strongly reinforcing by social adaptation and gradual over-adaptation." (Perez, 2002 p34). Perez points to the challenge that the existing firms are facing: "…in technological terms, one could say that the most powerful firms at the time of the exhaustion of a particular paradigm are likely to become the most conservative forces. Although some intelligent firms may make major innovations, their heavy investment in some of the now mature technologies makes them prefer to avoid truly revolutionary change, which might make their equipment and practices obsolete. Yet, ironically, since their productivity, market and profit growth rates are probably stagnating, their main hope for revitalization lies in radical change. Thus, existing large firms are likely to be both agents and victims of paradigm closure." (Perez, 2002 p34-5). The empirical research by Christensen into the adoption of new technological trajectories by firms enforces this observation (Christensen, 1997). Personal experience within the telecom equipment industry confirms this observation.

6 Conclusions for the research project

In this research project we have described and explained the impact of the Internet bubble on the 'development path' of the telecom sector and explored the implications for policy and strategy formation in the aftermath.[45] The analysis has shown the operating principles of bubbles and how these have affected the developments in the telecom industry. It has also shown that the bubble should not be considered as a stand-alone event, but as part of a broader phenomenon of successive technological revolutions. A period of frenzy is typical for each revolution, for the 'installation' of a new techno-economic paradigm. The shift from circuit-mode to packet-mode in the telecom sector is part of this broader paradigmatic shift. Telecommunication and the Internet are to be seen as the infrastructure combination that is facilitating the 'installation' and the 'deployment' of the techno-economic paradigm that is related to the *Age of Information and Telecommunications*. An infrastructure that is critical to our ability to reap the potential benefits of the productivity improvements associated with the new techno-economic paradigm, across the economy and society at large.

The emergence of the new paradigm has invoked many tensions between the technological, economic and socio-institutional subsystems of society. Tensions that are a result of the mismatch between the existing institutional environment and governance regimes, which have developed to optimally support the old 'Fordist' paradigm, and the needs emerging from the new 'networked' ICT paradigm. The challenge and opportunity for government policy makers and firm strategists is to address and resolve these tensions, with the prospect that a 'golden age' may develop.

Assuming this prospect is considered worthwhile to pursue for the actors involved, the recommendation is to reframe the ICT-policy using the stepwise approach outlined above.

The 'installation period' of the new techno-economic paradigm, and in particular the period of Internet bubble, has provided us with the insights into the impact and the significance of the new paradigm. We have learned that the issues being raised are not easy to resolve as these typically extend beyond the scope of our current institutional framework. In the aftermath of the Internet bubble we have had the opportunity to reflect on the impacts of the new paradigm. As we are leaving the 'transition period' and entering the 'deployment period' this is the time to apply the newly gained insights with the objective of realizing as much as possible the prospect of an 'golden age', which is, according to historical regularity, ahead of us.

7 Notes for Chapter 8

[1] It should be noted that the deployment of products based on circuit-mode technology will continue in markets where the provisioning of POTS is the driving force and convergence plays as yet a minor role, in particular in the developing countries. Albeit, increasing opportunities to leap frog developments will be utilized.
[2] This table is equal to Table 13 in Chapter 5, and included here for completeness.
[3] A typical range would be between 12 and 18 percent for the internal rate of return for a firm in the telecom equipment industry. The rate of return for the Iridium project was above 40%.
[4] A process exacerbated by conflicts of interest at the level of the individuals involved.
[5] Another example is the changes in the investment portfolio policy of pension funds, these were relaxed with respect to the percentage of stocks that could be held at the time these long-term oriented protective measures were most needed.
[6] In the period 1960 – 1992 a private surplus was on average 1.1% of GDP, never more than 1.2% in deficit, and deficits did not last more than 1.5 year. According to research by Godley, Jerome Levy Economics Institute of Bard College, as cited in (Brenner, 2002).
[7] As opposed to incentive plans, which are inherently short term, whether financially or politically based.
[8] Although access to incumbent cable networks has as yet not been enforced.
[9] Albeit the portfolio of most of the incumbent operators includes the full range.
[10] In developed countries.
[11] Mono play refers to specialized providers offering a single service. Triple play refers to the combination of Cable-TV + Internet + Telephony. Multi play adds mobile communications, but also suggest a multitude of combinations. See also OECD (2006b).
[12] Return-on-Sales: period revenues divided by period profits. It should be noted that profitability in certain segments differs from the average. Moreover, a firm may through sustained competitive differentiation achieve a profit level well above the industry average. Note; The 2005 version of the ITU Coins database does not include profitability data anymore. As Melody points out the declining sales margins were also associated with reduced capital intensity of mobile and new services providers (Melody, 2006).
[13] BizStats puts telecommunication services average net income as % of revenue at 10.1% for the US. Other related industry examples are: information services and data processing 9.2%; radio & television, cable networks & program distribution 6.4%; computer and peripheral equipment 9.6%; communications equipment 5.4%; semiconductor & other electronics components 4.1%; air transportation 5.7%; rail transportation 3.1%; electric power generation 11.4% (BizStats.com, 2006).
[14] Note this data is at the OECD level. It should be noted that the basket does not capture all developments, as VoIP offers or bundles of services are not included (Paltridge, 2006).
[15] Suria stated in March of 2001: "A lot of European PTTs have been downgraded four credit notches in the past 12 months and are still on credit watch-negative. It probably takes 10 to 15 years of organic growth for a company that size to move up the four credit notches they just gave up. That gives you a sense of the magnitude of the deterioration that has happened to these companies' credit profiles." (Suria as interviewed by: Fromson, 2001).
[16] Some governments, often still holding a minority stake or 'golden share' in the incumbent operator, tended to support their national carriers in the restructuring process.
[17] E.g. Jeter observed: "The other telecom companies would like to see WorldCom liquidated because they say it's not fair for WorldCom to come out of bankruptcy with no debt and to put more pressure on telecom companies that have debt." (Jeter, 2003 p197).

[18] (Potential) Unbundling requirements increase uncertainties and hence the financial risks. An issue that has emerged in relation to e.g. the Fiber-to-the-Home plans in the Netherlands. To stimulate the implementation of FttH the US government has exempted fiber based projects from unbundling.
[19] Outside the USA the Amsterdam IX is the second largest IP Exchange, Seoul is number one and London is number three. The Internet shows continuous growth on the basis of routed IPv4 addresses worldwide: from 1,068 mln in Nov. 1999 to 1,622 mln in May 2005 (OECD, 2006a).
[20] Many fiber based projects are in trial or being contemplated. Alternative deployment scenarios are being pursued by municipalities, often in cooperation with housing corporations. Greenfield situations provide a much better business case result than the overhaul of existing networks.
[21] There is a difference in fiber types deployed. The use of non-zero dispersion-shifted fiber from 1998 onward allows for the use of dense wave length division multiplexing.
[22] Freephone and premium charge numbers, also know as Green Numbers or in The Netherlands 06-numbers.
[23] Here we ignore the US tariff schemes (including flat fee local calling and WATS), the special operator based charging arrangements, and the changes introduced by the 800-service. The latter implied prying open the fixed relation between addressing, numbering and routing.
[24] Despite many attempts to establish 'pay-per-view' as a dominant model.
[25] Another example of speech impairment is transmission delays over satellite links.
[26] E.g. resource reservation protocol (RSVP) and differentiated services (diffserv) as developed under the auspices of the IETF. See e.g. (McKnight, Lehr et al., 2001). Within corporate networks virtual private networks (VPNs) may be used to mange capacity for specific applications.
[27] VoIP providers make available interface boxes that emulate the PSTN and hence allow existing telephony apparatus to be connected to the Internet.
[28] Telegeography reported VoIP subscription growth to 6.9 mln in the USA with 21% growth in 2Q2006 (Telegeography, 2006).
[29] The case for multi-play is argued on the basis of lower prices based on service bundles and convenience for the customer. Whether the combined product offering will be able to compete effectively with more specialized offerings will have to be decided by the market.
[30] The involvement of governments in e.g. WSIS is a case in point.
[31] This applies to Alcatel, Ericsson and Lucent Technologies.
[32] Recommendation as proposed by Van Iersel (2006). See also www.surfnet.nl respectively www.lofar.org and www.astron.nl.
[33] See on the topic of co-evolution in network industries (Groenewegen, 2005; Groenewegen and Künneke, 2005).
[34] For the diffusion of innovations reference is made to (Rogers, 2003)
[35] In line with the increase of communication bandwidth the processing and interface capacity of (shared) Internet servers will have to be increased to provide the user with the expected performance enhancement.
[36] See e.g. (Brynjolfson, 1992; Brynjolfson and Hitt, 1998; Brynjolfson and Hitt, 2003).
[37] See e.g. Crandall: Competition and chaos – U.S. Telecommunications since the 1996 Telecom Act (Crandall, 2005).
[38] Another example having the attention of European regulators is the exclusivity of mobile operators on terminating mobile traffic.
[39] Although NRAs have been involved in the approval process of M&A activities.

[40] The failure of KPNQwest is an example. The commitment of employees to 'keep the network in the air' and the collaboration of operators have prevented a major network failure.
[41] This issue appears to be more pressing in e.g. the electricity network than in telecom.
[42] Albeit different forms of USO funding have been implemented. Moreover, alternative ways of providing the services have been discussed, e.g. through tendering.
[43] De Wit observes that while there is a substantive body of economic literature on economic cycles, the strategy literature is very light on addressing cyclicality and the formulation of implications for strategy formation (De Wit, 1994).
[44] Only one to two cycles can be observed in the data analysed. Hence, no firm conclusions can be drawn.
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Annex-1

List of abbreviations and acronyms

Acronym:	Meaning:	Remark:
2G	Second Generation	Of Mobile Cellular communication
3G	Third Generation	Of Mobile Cellular communication; in Europe also known as UMTS
ADSL	Asymmetrical Digital Subscriber Line	In terms of a difference in the available downstream and upstream bandwidth
APNIC	Asia-Pacific Network Information Centre	For the registration of internet numbers
ARIN	American Registry for Internet Numbers	
ARPA	Advanced Research Projects Agency	US Defence agency
ASCII	American Standard Code for Information Interchange	
AT&T	Brand name of US telecom incumbent operator	Formerly American Telephone and Telegraph
BBN	Bolt, Beranek and Newman	Contractors to ARPA
BOC	Bell Operating Company	Subsidiary of AT&T operating in a specific geographical area
BRI	Basic Rate ISDN	2x64 kb/s channels
C7	Common Channel Signalling System No. 7	
CAP	Competitive Access Provider	
CBA	Cost Benefit Analysis	
CAGR	Cumulative annual growth rate	
CATV	Cable Television	Mainly in reference to the distribution network
CEI	Comparably Efficient Interconnection	Related to FCC Computer III
CEPT	Conférence des Administrations Européennes des Postes et Télécommunications	Association of European Postal and Telecommunications Administrations (PTTs)
CEC	Commission of the European Communities	
CERN	Conseil Européen pour la Recherche Nucléaire	European High Energy Physics Research Centre in Geneva, Switzerland
CIX	Commercial Internet eXchange	
CLEC	Competitive Local Exchange Carrier	US term
CLI	Calling Line Identification	
CPE	Customer Premise Equipment	
CRM	Customer Relationship Management	
CR*n*	Concentration Ratio for n-firms	
diffserv	differentiated services	To distinguish services carried by the Internet
DoJ	Department of Justice	
DS-1	Digital Signal Level 1 (1.544 Mb/s)	

Acronym:	Meaning:	Remark:
DS-3	Digital Signal Level 3 (44.736 Mb/s)	
DSL	Digital Subscriber Line	
DNS	Domain Name System	For the Internet
DMT	Dynamic Market Theory	As articulated by De Jong (1996).
DTMF	Dual Tone Multi Frequency	Access signalling from telephone keypad to the PSTN (also referred to as touchtone)
DWDM	Dense Wavelength Division Multiplexing	
EC	European Commission	
ERM	Enterprise Resource Management	
ERP	Enterprise Resource Planning (system)	
EU	European Union	The EU has grown from the original 6 countries (Belgium, Germany, France, Italy, Luxembourg, The Netherlands) to include Denmark, Ireland and the UK in 1973, Greece in 1981, Spain and Portugal in 1986 and Austria, Finland and Sweden in 1995, creating the so called EU-15. Ten member states joined as of January 2004 to create the EU-25: Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovenia, Slovakia.
ETSI	European Telecommunication Standardization Institute	
EU	European Union	
FCC	Federal Communications Commission	US National Regulatory Agency
FDM	Frequency Division Multiplexing	
FttH	Fiber to the Home	
GATT	General Agreement on Tariffs and Trade	
Gb/s	Gigabit per second	That is 1000 Mb/s
GDP	Gross Domestic Product	
.gif	Graphics Interchange Format	Encoding scheme for graphics and text
GPRS	General Packet Radio Service	
GSM	Groupe Spéciale Mobile, later to be known as Global System for Mobile Communications	Working party of CEPT
H.323	Protocol for Voice over IP	Part of the ITU defined protocol stack
HF	High Frequency	
HHI	Hirschmann-Herfindahl Index	Concentration ratio
HTML	Hypertext Mark-up Language	
ICANN	Internet Corporation for Assigned Names and Numbers	

Acronym:	Meaning:	Remark:
ICT	Information and Communication Technologies	
IETF	Internet Engineering Taskforce	
ILEC	Incumbent Local Exchange Carrier	Telecom operator providing local access services in a designated area, originally part of AT&T
IM	Instant Messaging	
IP	Internet Protocol	For the transfer of information over the Internet
IRU	Indefeasible Right of Use	
IPO	Initial Public Offering	
ISDN	Integrated Services Digital Network	
ISO	International Standardization Organisation	Residing under the UN
IP-TV	TV signal carried over the Internet Protocol	
ISP	Internet Service Provider	
IT	Information Technologies	
ITU	International Telecommunications Union	UN subsidiary having the Administrations as primary members
IXC	Inter-exchange Carrier	Telecom operator providing long-distance services connecting to LECs
JPEG	Joint Photographic Experts Group	Relates to picture encoding scheme
kb/s or kbit/s	Kilobits per second	Transmission speed
LAN	Local Area Network	
LEC	Local Exchange Carrier	Telecom operator providing local access services in a designated area
LTCM	Long-Term Capital Management	Hedge fund
FCC	Federal Communications Commission	US National Regulatory Agency
FDM	Frequency Division Multiplexing	
M1-7	Volume of money volume defined with increasing degree of inclusion of less liquid deposits	
Mb/s or Mbit/s	Megabits per second	Transmission speed
MCI	Brand name of US competitive long distance carrier	
MES	Minimum Efficient Scale	As in production
MFJ	Modified Final Judgement	As it relates to 1956 consent decree between Department of Justice and AT&T
MMS	Multimedia Message Service	Part of cellular services
MoU	Memorandum of Understanding	
MPEG	Moving Pictures Expert Group	

Acronym:	Meaning:	Remark:
MRP	Manufacturing Resource Planning	
MSN	Microsoft Network	
NCSA	National Centre for Supercomputing Applications	USA
NOC	Network Operations Center	
NRA	National Regulatory Agency	
NSF	National Science Foundation	US Government Agency
NTP	Network Termination Point	
NYSE	New York Stock Exchange	
OA&M	Operations, Administration and Maintenance	Support systems to run the network
OC-1	Optical Carrier Signal Level 1 (51.84 Mb/s)	
OC-3	Optical Carrier Signal Level 3 (155.52 Mb/s)	
OC-192	Optical Carrier Signal Level 192 (10 Gb/s)	
ONA	Open Network Architecture	Related to FCC Computer III
ONP	Open Network Provision	
OSI	Open Systems Interconnection	In relation to the 7 layer communications model standardized within ISO
PABX	Private Automatic Branch Exchange	Automatic telephone switch board
PCM	Pulse Code Modulation	As applied in telecom transmission systems
PCS	Personal Communication System	Digital mobile communication standard , to be known as GSM 1900
PDA	Personal Digital Assistant	
PLC	Product Life Cycle	
POTS	Plain Ordinary Telephone Service	
PRI	Primary Rate ISDN	USA: 24x56 kb/s channels; Europe: 30x64 kb/s channels
PSTN	Public Switched Telephony Network	
PUC	Public Utility Commission	US state level regulatory agency
R&D	Research and Development	As part of the firm' activities
RBOC	Regional Bell Operating Company	
RHC	Regional Holding Company	A group of Bell Operating Companies after the break-up of AT&T (22 RBOCs into 7 RHCs)
RIPE	Réseaux IP Européens	Organisation of European TCP/IP network operators
RJE	Remote Job Entry	Computer protocol
RSVP	Resource Reservation Protocol	
RTV	Radio and television	
SCP	Structure-Conduct-Performance	As in the SCP paradigm for industry analysis
SDM	Space Division Multiplexing	

Acronym:	Meaning:	Remark:
SEC	Securities and Exchange Commission	US financial market supervisory agency
SIC	Standard Industrial Classification	US
SNMP	Simple Network Management Protocol	
SMS	Short Message Service	Part of cellular services
SPC	Stored Program Control	As applied in telecom switching systems
SS7	Common Channel Signalling System No. 7	
SWOT	Strength & Weakness – Opportunities & Threats	Analysis framework, part of the strategy diagnosis stage in the strategy formation process
S&P500	Standard & Poor top 500 companies	
T-1	Primary Rate PCM Multiplex	USA: 24x56kb/s channels
T-3	Tertiary Rate PCM Multiplex	USA: 8x8x24x56 kb/s channels
TCP	Transmission Control Protocol	
TDM	Time Division Multiplexing	
TEP	Techno-Economic Paradigm	
TLD	Top Level Domain name	
TMT	Technology – Media – Telecommunications	Combination of sectors of economic activity
UMTS	Universal Mobile Telecommunication Service	
UN	United Nations	
USPTO	United States Patent and Trademark Office	
USO	Universal Service Obligation	
UUCP	Unix-to-Unix copy	File transfer between Unix based computers
VANS	Value Added Network Services	
VC	Venture Capital (firm)	
VMO	Virtual Mobile Operator	
VoIP	Voice over IP	Voice communication facilitated through the Internet using the Internet Protocol
VPN	Virtual Private Networks	
VRML	Virtual Reality Modelling Language	Facilitating the display of three dimensional scenes
VSAT	Very Small Aperture Terminal	For satellite communications
WAN	Wide Area Network	
WAP	Wireless Application Protocol	
WATS	Wide Area Telephone Service	US flat rate tariff scheme
WDM	Wavelength Division Multiplexing	
Wi-Fi	Wireless Fidelity	Certification mark, denotes compatibility with the IEEE 802.11 standard
WTO	World Trade Organization	Assumes implementation of GATT
WWW	World Wide Web	Application on the Internet

Annex-2

Time line of events

The following time line of events has been constructed to support the research project. In its compilation the intention has been to be illustrative and insightful, not necessarily exhaustive. Dates also appear to vary by source, which can be explained, at least in part, by the different aspects of an event being emphasized. E.g. difference may occur in terms of an announcement date versus an official filing date, or the date that a first working proto-type is demonstrated versus an in-service date.

Date:	**Internet Event:**	**Computing-Technology Event:**	**Technology-Telecom Event:**	**Financial-Economic Event:**	**Social-Political Event:**
1938			Invention of PCM by Reeves		
1940		First electro-mechanical computer created by Project Ultra to decode messages from the Enigma machine			
1941		First programmable digital computer Z-3 developed by Zuse in Germany			
1943		First vacuum-tube based computer Colossus			
1945	Memex, forerunner of www, conceived by Bush	Von Neumann describes the stored-program-control concept	Concept of time-division introduced by Deloraine		Truman President of the USA
			Concept of satellites introduced by Clarke		
1946		First general purpose computer ENIAC by Mauchly and Eckert at University of Pennsylvania			
1947			Invention of the transistor at Bell Labs by Bardeen, Brattain & Schockley		Organization for European Economic Cooperation (OEEC) established
			Introduction of cellular concept by Bell Labs		
1950			First commercial colour television broadcast in the USA		

Date:	Internet Event:	Computing-Technology Event:	Technology-Telecom Event:	Financial-Economic Event:	Social-Political Event:
1951		First commercial computer UNIVAC by Remington Rand			European Coal and Steel Community established; Treaty of Paris
1953					Eisenhower President of the USA
1954					Western European Union established
1955		Schockley's Semiconductor Laboratory founded, starting Silicon Valley			
1956			FCC starts proceedings on allocation of MW frequencies for private line use		
			FCC Hush-A-Phone decision		
1957		Co-invention of the IC by Kilby at Texas instruments and Noyce at Fairchild			European Economic Community established (EEC), Treaty of Rome
		Digital Equipment Corp founded			USSR launches Sputnik
1958	ARPA founded	Cray at CDC builds first fully transistorised super computer			
1959		Kilby and Noyce independently develop the computer chip	Essex project in Bell Labs demonstrating technical feasibility of TDM		
1960		Introduction DEC PDP-1	Invention of packet switching independently at Rand Corporation by Baran and at National Physics Laboratory UK by Davies	First Silicon Valley VC established	European Free Trade Association established

Date:	Internet Event:	Computing-Technology Event:	Technology-Telecom Event:	Financial-Economic Event:	Social-Political Event:
1960			Maimen develops the first laser		
1961		First time-sharing computer developed at MIT			Kennedy President of the USA
					The Berlin Wall is built
					Cuban missile crisis
1963			Nokia starts operations in radiotelephony		President Kennedy assassinated Johnson becomes president
			MCI starts operation		
1964			AT&T demonstrates the video-phone		GATT trade negotiations, Kennedy Round
1965	Hypertext conceived by Nelson	Introduction IBM System/360 mainframe	First SPC analogue switch - No. 1ESS by AT&T		
1967	ARPANET project started				
1968		Intel founded by Moore and Noyce	FCC Carterfone decision		
		First IC based computer DEC PDP-10			
1969		Founding of CompuServe	MCI challenges AT&T's monopoly in court		USA puts 'man on the moon'
					Nixon President of the USA
1970	First five nodes on the ARPANET: –UCLA –Stanford –UC Santa Barbara –U of Utah, and –BBN	Floppy disk introduced	First digital switch Plato (later E10) by CNET		
			FCC sets aside 75 MHz of spectrum for cellular systems		
1971	Email invented by Tomlinson at Bolt Beranek and Newman (BBN)	Invention of microprocessor by Hoff at Intel			

Date:	Internet Event:	Computing-Technology Event:	Technology-Telecom Event:	Financial-Economic Event:	Social-Political Event:
1971		First pocket calculator introduced	FCC final approval of MCI as common carrier		
1972	ARPANET demonstration, first email sent		SPC digital trunk switch – No. 4ESS by AT&T	Bell Northern Telecom becomes public entity	
			E10 introduced		
1973	E-mail introduced on the ARPA net		Digital transmission (PCM) introduced		UK, Denmark and Ireland join the EC
1974	Initial version of TCP specified under the leadership of Cerf at Stanford and Kahn at ARPA	Invention of the PC by Roberts, designer of Altair			Ford becomes President of the USA
1975	Ethernet created by Metcalfe	Founding of Microsoft by Gates and Allen		The SEC approves discount brokerage	
1976				Wall Street tops 1,000	
1977		Modem based file sharing on PCs	First SPC digital local switch – DMS-10 by Northern Telecom (Nortel)		Carter President of the USA
		Launch of Apple II PC by Jobs and Wozniak			
1978	Internet Protocol (IP) established	Sony and Philips unveil the CD			
1979	USENET introduction based on UUCP	Demonstration of VisiCalc by Bricklin & Frankston	Uniphase founded		European Monetary System (EMS) established
					Thatcher prime minister UK
1980		Sony introduces walkman	FCC Computer II, structural separation regulated and unregulated activities (terminal equipment / enhanced services)	Introduction 401k savings plan	
1981	BITNET introduction based on IBM RJE	Launch of IBM PC	System X introduced by Plessay-GEC		Reagan President of the US

Date:	Internet Event:	Computing-Technology Event:	Technology-Telecom Event:	Financial-Economic Event:	Social-Political Event:
1981		Silicon Graphics founded	First cellular system in service, NMT450 in Saudi Arabia		Premiere MTV
			JDS-Fitel founded		
1982	Introduction CSFNET by the NSF, with use restricted to research and education	America Online starts business as a distributor of online video games under the name control Video Corp.	MFJ agreement between DoJ and AT&T on separating long distance from local exchange telephone services		Successive short-term rate reductions by the Federal Reserve; end of the bear market with DJIA at 778 and Nasdaq at 160
	Email exchange between ARPA and other computer networks	Compact Disc introduced	CEC decision on competition in high-speed forwarding of telex messages		Interest rate reduction by 0.5% by the FED; third reduction in 6 week period; end of bear market
			FCC starts acceptance of applications for cellular licences		
			CEPT initiates GSM project		
			France Telecom introduces Minitel		
1983	Voice Funnel, early VoIP	Bulletin boards on PC networks	First cellular system in operation in the USA in Chicago		
	MCI Mail launched	First on-line trading via TradePlus (later E*trade)	MIT Media Lab established		
		SUN Microsystems founded	Introduction of ISDN at McDonalds		
1984	Internet named	Point&Click interface developed by Xerox	MFJ effective; AT&T divestiture effective Jan 1st		
	Domain name system (DNS) established	First Megabit memory chip realised by Bell Labs	LDDS starts operation as WATS reseller		
	Internet with 1000 hosts converts *en masse* to using TCP/IP	Macintosh introduced	Cisco founded		

Date:	Internet Event:	Computing-Technology Event:	Technology-Telecom Event:	Financial-Economic Event:	Social-Political Event:
1984		Dell Computer Corp. established	EC endorses GSM project		
1985		MIT Media Lab founded	FCC permits unlicensed services for spread spectrum devices		European Council agrees creation of single European Market by 1992
					Plaza Accord
1986	Construction of NSFNET as the new (non military) Internet backbone		FCC Computer III, Open Network Architecture (ONA) and cost allocation rules; Comparable Efficient Interconnection		
	BITNET adopts DNS naming		United Telecommunications launches long distance-service as Sprint		
1987	UUNet established a not-for-profit company		EU Green Paper on a Common Market for Telecom		October stock market crash
1988	First international networks connected to NSFNET: Canada, France, Denmark, Finland, Iceland, Norway, Sweden		EU liberalization of terminal equipment market and VANS	Dell IPO	
			Establishment of ETSI		
			First Trans Atlantic Fiber optic cable TAT-8)		
	Mbone, first IP multi-cast application		MFS starts operation as CLEC		
			Southern Pacific (SP) Telecom founded		
1989	IETF established				Fall of the Berlin Wall
	RIPE established				Bush President of the USA

Date:	Internet Event:	Computing-Technology Event:	Technology-Telecom Event:	Financial-Economic Event:	Social-Political Event:
1989	Cisco implements a customer support site for software downloads and upgrades				
	Performance Systems International (later PSINet) established to provide TCP/IP network services to business customers				
1990	Development of HTML and the creation of WWW application by Berners-Lee at CERN		EU ONP Framework Directive	Cisco IPO	
	Close down of ARPANET	Prodigy launched by IBM and Sears	EU liberalization of Value Added services		
	UUNet becomes a for-profit company				
1991	CIX established				Gulf war
	Proposal accepted for a shut down of NSFNET to be replaced by competing commercial networks; creation of very high speed Backbone Network Service for research	Torvalds starts software project to become Linux	UK Duopoly		
1992	E*trade offers stock trading through America Online and Compuserve,	PDA introduced by Apple	FCC ruling on interconnection of CAPs to LECs using private lines	IPO America Online	Treaty on European Union is signed, Maastricht Treaty
			GSM-900 launched		
			EU ONP Leased Line Directive		
			Ciena founded		

Date:	Internet Event:	Computing-Technology Event:	Technology-Telecom Event:	Financial-Economic Event:	Social-Political Event:
1993	Introduction of Mosaic browser at the NCSA by Andreesen	Microsoft initiates project Marvel, to become the precursor of MSN	EU liberalization of switched data services	MFS goes public	Clinton President of the USA
	Wired magazine launched	Intel introduces Pentium processor	FCC ruling on interconnection of CAPs to LECs using switched circuits		White House: Agenda for Action (Information Super Highway)
	First radio station on the Internet		Info Highway Pilots: Time Warner Orlando; AT&T and Viacom – California; Microsoft and TCI – Seattle		
			BT acquires 20% stake in MCI; Concert Communications established		
			Battle for Paramount won by Viacom against QVC.		
			Bell Atlantic –TCI merger proposal		
1994	Introduction Netscape Navigator, includes the exchange of encrypted messages	Chatrooms introduced on Prodigy	EU liberalization of satellite communications	IPO by ISP Netcom based on value per subscriber: $2100	EU Maastricht Treaty
	America Online provides access to the Internet	McCool creates Apache web server software as open source at University of Illinois/NCSA	FCC licences PCS or 1900 MHz GSM		
	First and interactive banner advertising		LDDS acquires IDB WorldCom		
	Yahoo! Provides website listings				
	Launch of www.dell.com				
1995	Close down of NSFNET; the Internet being supported by the private sector	Gates issues memo "The Internet Tidal Wave', Microsoft starts to adapt systems to the Internet	EU Green paper on Telecom infrastructure and CATV networks; liberalizing telecom services on CATV networks	IPO UUNet	Reverse Plaza Accord

Date:	Internet Event:	Computing-Technology Event:	Technology-Telecom Event:	Financial-Economic Event:	Social-Political Event:
1995	CompuServe, America Online and Prodigy provide dial-up service to the Internet	Windows 95 released, including v1.0 of Internet Explorer	SP Telecom buys Qwest	IPO Netscape	WTO assumes implementation of GATT
	Start of Amazon.com	Sony Playstation introduced	First GSM 1900 network operational in the USA	IPO PSINet	
	Ebay founded	SUN's Java software language released		@ Home Corp. founded	
	Yahoo! incorporated	Dell introduces on-line configuration of PCs			
	Real-Audio introduces voice and music over the Web in near real-time	Silicon Graphics releases Web Space, including VRML to display three-dimensional scenes			
1996	MCI starts upgrading the Internet backbone	Release of Palm Pilot PDA	US Telecom Act of 1996 signed; distinguishing regulated 'telecommunications' from unregulated 'information services'	Search engine IPOs: Open Text, Lycos, Excite, Yahoo!	
	DoubleClick founded		AT&T Trivestiture	Lucent IPO	
	Voice on the Net (VON) coalition founded		DSL providers founded: Covad Communications, NorthPoint communications, Rhythms NetConnections	E*trade IPO	
			EU 'Full Competition Directive'	McLeodUSA IPO	
			EU liberalization of mobile communications	VocalTec IPO	
			MFS buys UUNet	eSschwab Internet trading launched	
			LDDS acquires MFS		
			Pre-paid mobile service introduced		
1997			EU Notice: Internet Telephony declared outside definition of 'voice telephony'	@Home IPO	FED interest rate cut

Date:	Internet Event:	Computing-Technology Event:	Technology-Telecom Event:	Financial-Economic Event:	Social-Political Event:
1997			EU Decision on licensing of 3G spectrum	Amazon.com IPO	Greenspan's irrational exuberance speech
			US Supreme Court ruling on ILEC unbundling	Ciena IPO	WTO Basic Telecom Services Agreement
			Level 3 Communications launched	Teligent IPO	
			AT&T sells submarine division to Tyco International	Iridium IPO	
			Global Crossing launched		
			ENRON buys First Point Communication (later ENRON Communications)		
			Lucent launches first IEEE802.11 wireless LAN		
			Corvis founded		
1998		Dept of Justice vs Microsoft for tying the Internet browser to the operating system	EU Jan. 1 target date for opening telecom markets to full competition	Global Crossing IPO	
			WorldCom completes merger with MCI	Level3 publicly listed	
			AT&T to buy Teleport from TCI, Cox and Comcast	eBay IPO	
1999	NetAid webcast		Introduction of GPRS	eToys IPO	Repeal of the Glass-Steagall Act
			Launch of i-mode by NTT-DoCoMo in Japan	Priceline. com IPO	
			Nokia introduces first WAP enabled mobile phone	IPOs of network equipment start ups: Extreme Networks, Redback Systems, Juniper Networks, Copper Mountain Networks, …	
			Vodafone acquires AirTouch		

Date:	Internet Event:	Computing-Technology Event:	Technology-Telecom Event:	Financial-Economic Event:	Social-Political Event:
1999			FCC decision on unbundling HF portion of the local loop	…Foundry Networks, Sycamore	
			KPNQwest joint venture established		
			JDS – Uniphase merger		
			AT&T buys TCI	Netro IPO	
2000	AOL – Time Warner merger	First Bluetooth consumer product introduced	EU Regulation on unbundling	360networks IPO	EU govts agree on Lisbon Agenda
			WorldCom- Sprint merger cancelled	IPOs of optic companies: Corvis IPO, Agility, CyOptics, Lantern Communications, Yipes Communications, Chiaro Networks	April stock market crash
			Qwest – US West merger closed		Fed fund rate raised from 6.0 to 6.5%
			First UMTS auction in the UK		
			Vodafone acquires Mannesmann		
2001	Vonage founded		EU enacted unbundling of the local loop	eToys files for Chapter 11	Bush President of the USA
				Exite@Home files for Chapter 11	Fed fund rate lowered in 0.5% steps from 6.5% to 3.5%
				Fixed wireless operators file for Chapter 11: Teligent, Winstar, ART	9-11 terrorist attack
				Enron files for Chapter 11	Fed fund rate lowered to reach 1.75% by December
				Covad files for Chapter 11	

Date:	Internet Event:	Computing-Technology Event:	Technology-Telecom Event:	Financial-Economic Event:	Social-Political Event:
2002			SEC starts investigation of WorldCom	Global Crossing files for Chapter 11	Sarbanes-Oxley Act signed
			SEC starts investigation of Qwest	WorldCom files for Chapter 11	
			SEC starts investigation of Level3	Globalstar files for Chapter 11	
			EU Regulatory Framework Electronic Networks and Services	Napster files for Chapter 11	
2003	Skype founded		EU Regulatory Framework to be effective in Member States	Allegiance Telecom files for Chapter 11	Tabaksblat Corporate Governance Code published
2005			SBC acquires AT&T		
			Verizon acquires MCI		

Main sources used for the compilation of this table:

(Cassidy, 2002), (Castells, 2000), Castells (1996), (Cawley, 2001), (Ceruzzi, 1998), (Dell and Fredman, 1999), (Bunnell, 2000), (Fransman, 1995; Fransman, 2002), (Gawer and Cusumano, 2002), (Jeter, 2003), (Kador, 2002), (Knieps, 2001), (Kurzweil, 1999), (Malik, 2003), (McKnight, Lehr et al., 2001), (Meeker and DePuy, 1996), Melody (1999), (Melody, 2002), (Meurling and Jeans, 1994), (Muller, 2002), (Scott, 2002), (Slater, 2002), (Spector, 2000), (Steinbock, 2001), (The White House, 2005), and (Quittner, 1998).

Another very insight full and intriguing time line is provided by Kurzweil. It includes many data points on the ICT field and an overview of dates related to computing. It runs from the date the universe is born, 10-15 billion years ago, until 2099, (Kurzweil, 1999 p261-280 and p22-3).

Annex-3

Rail Road Mania in the 19th century

Introduction
There should not have been a reason to be surprised by the development of the Internet bubble if we had known our history well. There is namely a striking parallel between the Internet bubble at the end of the 1900's and the Rail road bubble in the mid 1800's.
Chancellor starts his *exposé* on the rail road mania by two quotes from Schumpeter: "Innovation is the outstanding fact in the economic history of capitalist society" and "Speculators are in the vanguard of the capitalists process" emphasizing the link between innovation and the speculator and making a distinction with the investor which he claims "is more concerned with safety of principle and regularity of income than with capital gains" (Chancellor, 1999 p122-51)[1]. The Rail road mania in Britain was preceded by the canal mania.

Canal Mania in Britain
The first canals provided clear benefits to the textile industry and hence the returns on capital were tremendous and large dividends were paid. About 25 years after the first canal was completed in 1767, popular speculation started. The number of parliament acts, required to approve the construction of a canal, increased dramatically: 50 new acts in less than 5 years, double the number of requests approved in the preceding 50 years. The canal mania was short-lived. It reached its peak in 1792-93 and "came to an abrupt end with the commercial crisis of 1793, brought on by the outbreak of the French revolutionary wars." The return on capital had dropped from 50% before to 5% after the mania, to stay at levels comparable to that of risk-free government bonds. After 25 years one in five canals was still not able to pay a dividend.

Rail Road Mania in Britain
The introduction of the railway was met with much opposition from those having an interest in the current canal and coach system and those concerned with the environment. The first very short railway fever was linked to the opening of the first steam-based railway from Stockton to Darlington in 1825. The opening in 1831 of the Liverpool and Manchester Railway established the superiority of steam. The company paid dividends of 10%, its market value doubled and it triggered the second period of railway fever. This ended in a bust in 1837 as part of the general collapse of a broader speculative period. By 1840 railway shares traded below their issue price. In 1842 again the "profound changes wrought by the railways began to grip the public mind." See also Figure 1 and Figure 2 (Freeman and Louçã, 2001 p189 & 193)[2].
George Hudson, the chairman of the York and North Midland Railway, established in 1842, became the icon of the railway period. By 1844, through establishing new lines and through a series of mergers, he controlled over thousand miles of track, one third of the total in operation. The establishment of a railway was simple: "it required only a few local dignitaries to organize themselves into a committee, for them to register the company provisionally, raise money from the public by advertising subscriptions for shares, employ an engineer to survey the route, and apply to Parliament for a railway bill."

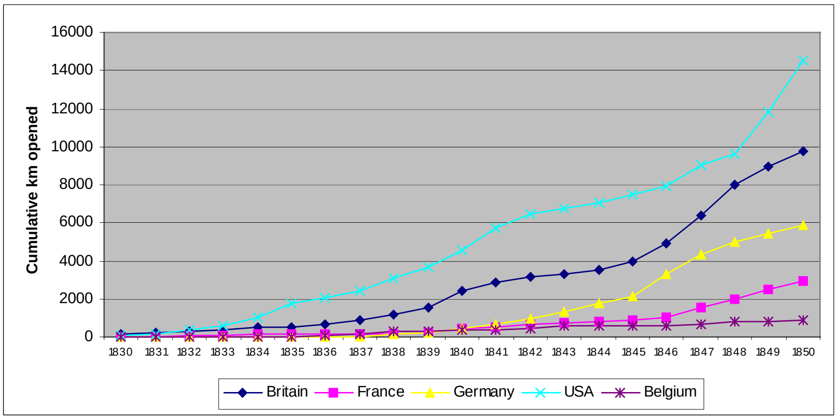

Figure 1. Railway building, 1830-1850

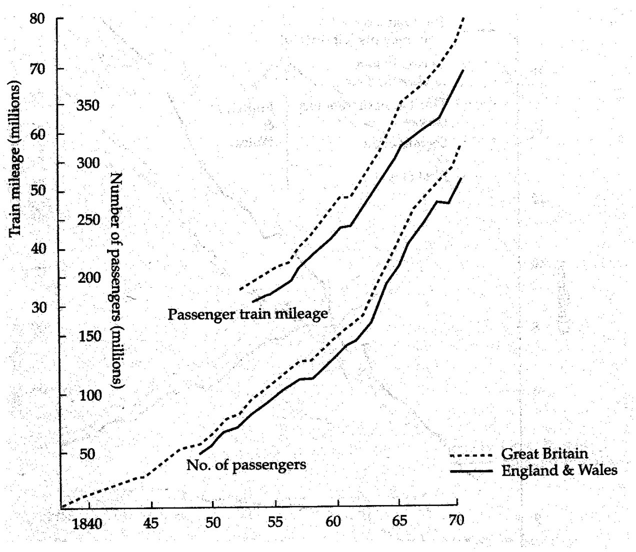

Figure 2. Passenger traffic in Britain, 1840-1870

The subscription certificates required only a 10% payment, the remainder to be 'called' when construction was underway. A principle that would facilitate speculation and would accelerate the crash.

Already during the second railway fever of 1836 the government was called to action to survey the country "so the best routes were chosen for development." However, this call was in effective due to the prevailing laissez faire attitude of the government. It is interesting to note that "in the early days of the railways it was believed that on payment of a certain toll to the proprietor anyone might run a train….and that the railways produce their own competition." In practice the access was not available and railways became natural monopolies.

“Hudson’s management of railways was marked by a combination of ostentation, rule-bending, and penny pinching.” As board member of the Midlands in 1842 he changed the company’s accounting methods. His tight control of costs resulted in critics accusing him of “sacrificing public safety to profitability”. His cost control allowed him to pay higher dividends than the competition. He also admitted to have paid dividend out of capital. Moreover, there were sure signs of insider trading in the merger process.

In early 1844 sixty-six new applications were to be handled by Parliament and a need for new public direction was felt. Anticipated depreciation of railway property provide the support for railway legislation. However, Hudson argued fiercely against and got his way. Through the Railway Act of 1844 a new department would make recommendations on new lines to Parliament, but these recommendations were not binding. An ineffective attempt to reduce the speculative promotions was made by increasing the deposit on new railway schemes from 5 to 10%.

In late 1844 the general economic conditions were favorable: low interest rates, low prices due to a series of excellent harvests. The three largest railway companies were paying dividends of 10%, four times the prevailing rate of interest. “Sensing a groundswell of speculative interest, Hudson purchased large quantities of railway iron for his own account…His judgment was shrewd; within three months its price had tripled.”

“Hudson contrived to associate himself with the advance of the railways and deliberately fanned the public’s growing ardour.” In 1845 he was elected member of Parliament. “The former linen draper, who literally had gone from “rags to riches”, became a living symbol of the get-rich-quick mentality that enthralled the nation. In 1845 he “celebrated his success…by purchasing a twelve-thousand-acres estate…for nearly half a million pounds. For his London residence…he acquired…one of the largest private houses in the capital.”

In January of the same year 16 new railway schemes were projected and by April 50 new companies were established. Advertisements flooded the newspapers. A railway press developed with new papers appearing nearly every week in the mania year of 1845. The standard notice described the benefits of the proposed line and would include promises for “a final dividend of at least 10 percent.” “If the subscription was successful, the committeemen retained a large allocation of stock for themselves and their friends and released only a few shares in the market, thus creating a scarcity…. Once the shares were trading at a premium, the promoters would off-load their retained shares at a vast profit.” By June of 1845 plans for 8000 miles of new track, 4-times the size of the existing network were under consideration by the government.

While the involvement of the public was growing the government remained impassive: “it was easier to point out the difficulty than to suggest the remedy.” The prime minister continued in his laissez-faire attitude, relying on the Bank Act, passed in the previous year, preventing the Bank of England from increasing its note issue above a specified limit, with the aim to “end the periodic sequence of boom and bust by preventing the explosion of credit during a cyclical upturn.” According to the opinion of the Bank of England “raising interest rates in order to dampen railway speculation would only produce a panic.” However, the availability

of credit was extended locally through the establishment of 'Exchange Banks', which provided loans against the collateral of railway shares. Furthermore, in a number of cities and towns new stock exchanges were established to facilitate the trade in railway shares.
By August over a hundred acts were passed, which represented 3000 miles of new railway track. By September 450 new schemes were registered. In November 1845 the Times projected the railway speculation to include 1200 railways at an estimated costs of £560 million. The outstanding liabilities were estimated at £600 million, thereby exceeding the national income. The 'normal' level of railway spending was being estimated at £20 million per year.
"As construction got underway, railway companies raised funds by "calling" some of the remaining capital on their shares." By early October shares were sliding and on October 14 the first suicide connected to the railway speculation occurred. The Bank of England, "worried by a slight decline in their reserves", raised interest rates from 2.5 to 3 %; "…it signalled the end of the railway fiesta." "In the general revulsion, even the market for the established dividend-paying railways dried up."
Extensive litigation resulted as speculators were forced to pay up for their allocation of shares. May 1846, the government passed the Dissolution Act facilitating the closure of railway companies on the basis of the consent of three-quarters of the shareholders. During 1846 over hundred mergers took place and still 270 railway acts were passed by Parliament, building up railway calls with a further £40 million.
As construction was underway railway calls averaged to £5 million a month. In January 1847, the Bank of England raised the interest rate to 4%. The same year "wheat prices fell sharply on the early signs of an abundant harvest." This led to the failure of many corn merchants and mercantile houses in September.
"By early October 1847, dangerous low levels of bullion led the Bank of England to announce it would no longer make advances on public securities. On Monday, 17 October the "week of terror" commenced in the City. On Tuesday, the Royal Bank of Liverpool failed, followed shortly by three other joint-stock banks."
On request, Downing Street authorized the Bank of England to "ignore the terms of the Bank Act and continue its discounting operations. Only three years earlier, the act had been passed with the promise that it would put an end to speculative excesses and financial crisis by making them too painful to endure. Now it was suspended in order to save Britain from economic collapse."
In 1849, Hudson was found responsible for exaggerating revenues and payment of dividends out of capital. Moreover, he was estimated to have embezzled just under £600 million. "In his defence, Hudson claimed that his private affairs and those of his companies had become unfortunately intertwined."

The mania for railway shares led during the boom to the construction of a national network, which in 1846-48 accounted for about half of the total investment in Britain and a labor force of 250,000 people working on construction (Freeman and Louçã, 2001 p197).

The aftermath

Grote Lewin, in his account of The railway mania and its aftermath, sets the stage: "After the crash the railway companies had to work out their own salvation, and their first duty would be to look into their internal administration more closely than had been deemed necessary in the comparatively short period of their working existence to date." (Grote Lewin, 1968 p349)3. The companies could make use of the Dissolution Bill of 1846 and of the Winding Up Acts of 1844 and 1848. In 1848 the main thrust was to restore the confidence of the investing public, and the existing shareholders in the "…inherent soundness of the railway industry." For this purpose the leading companies issued a "general statement" to present their current position and the future prospects, with the objective to take the shareholders more into their confidence. Shareholder committees were formed to inquire into the accounts. These investigations revealed that: "Great discrepancies appeared in the practice of the various companies as to what expenditures should be debited to capital and what to revenue, and cases were discovered in which dividends had been paid in the past in excess of the rue earnings of the company in question."

However, towards the end of the 1840's dividends were only about half the level customary in the early 1840's, the principle cause being the opening of many lines "…upon which traffic was undeveloped, and the increasing competition amongst the companies themselves." This had triggered the movement for a large merger between the London & North Western, the Great Western, and the London and South Western systems. The negotiations broke down on the topic of equal representation in the joint board. Albeit, it was considered doubtful whether such a large combine would have been approved by the legislature.

From 1845 onward industry consolidation has been taken place. A total of 128 railway start-ups would be absorbed, mostly in a two-step consolidation by the 5 larger companies that would be serving the nation in 1935 (Great Western; London, Midland & Scottish; London & North Eastern; Southern; Great Southern) over the period 1845-1850. See also Figure 3 for an impression of the life time of the rail road companies subject to the first and/or second wave of consolidation (derived from: Grote Lewin, 1968 p474-9).[4] Grote Lewin further identifies 56 companies which failed due to 'abandonment' or 'powers to construct unexercised'. Together they formed the complete list of 184 new railways incorporated during the mania period 1845-1850 (p480-3).

Contagion

Railway mania also developed in 1844 in Prussia, but was effectively suppressed by the government; in France in 1847 and 1857, although "military engineers decided on railway routes before construction was put to tender"; and in the US in 1857 and 1873.

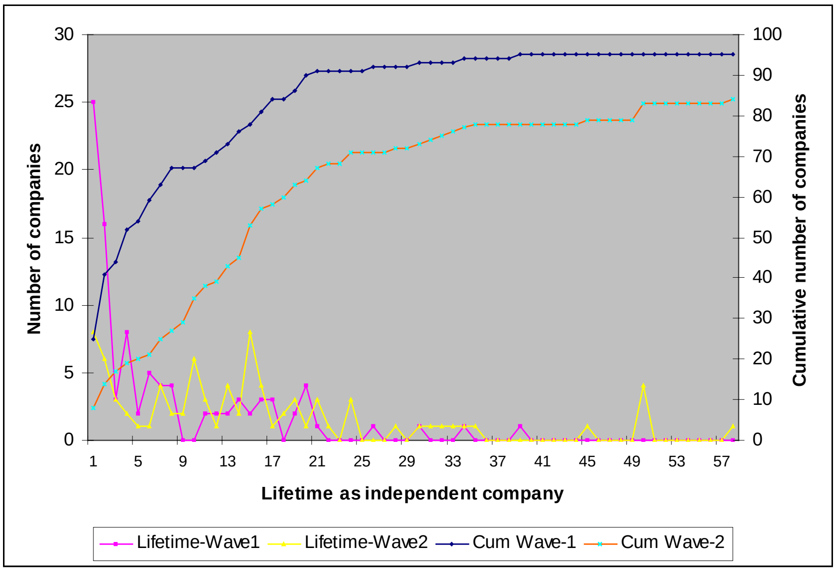

Figure 3. Life time of rail road companies in Britain, 1845-1905

Concluding remarks

The Railway Mania represents the frenzy at the end of the installation period of the Second Great Surge or Kondratiev Wave. A wave that is referred to as the Age of Iron Railways, steam power and mechanization (Freeman and Louçã, 2001 p188). The 'core inputs' of this Wave were coal and iron, the related infrastructure was the iron railways. See also Chapter 4 Section 4.1. The organisational innovation associated with this Wave is considered the American railways providing "…the first example for the whole of the American business community of how to manage and run very large organizations, with attention to long-term costing, maintenance, and depreciation, as well as to the recruitment, training, and deployment of personnel." (p196). The railways also developed methods for controlling operations from a single centre, which was facilitated by the telegraph, "…invented by Wheatstone, a professor at King's college London in 1837 and diffused extremely rapidly alongside the new railway tracks in the late 1840s."

Notes for Annex 3

[1] This summary of Rail Road mania is derived from Chancellor, unless stated otherwise (Chancellor, 1999 p122-51).
[2] An account of the early developments of the Belgian railway system can be found in (Beulens and Van den Broeck, 2004).
[3] The account of the aftermath is based on (Grote Lewin, 1968 p349-68).
[4] This data set by Grote Lewin follows the companies that started in the years 1845-46.

Annex-4

Downsizing in the Aftermath

COMPANIES	JOBS CUT*	SECTOR
Nortel Networks	49,000	Network equipment
Lucent Technologies	44,910	Network equipment
Motorola	42,900	Wireless technology
China Unicom	34,478	Telecoms operator
Alcatel	33,000	Network and mobile phone equipment
Ericsson	22,000	Mobile phone equipment
Solectron	20,700	Contract network equipment
Siemens	17,000	Mobile phone and network equipment
JDS Uniphase	16,000	Optical network components
Marconi	13,000	Network equipment
Corning	12,000	Fibre-optic components
Telekomunikacja Polska SA	12,000	Telecoms operator
Philips	11,570	Mobile phone equipment
Qwest Communications	11,000	Local telecoms operator
AT&T	10,000	Telecoms operator
ADC	9,500	Broadband equipment
Cisco Systems	8,500	Network equipment
Matsushita	8,000	Mobile phone maker
Worldcom Group	8,000	Alternative telecoms operator
Verizon	7,500	Telecoms operator
Agere Systems	7,300	Network components
KPN	6,800	Telecoms operator
Sprint	6,000	Telecommunications carrier
British Telecommunications	6,000	Telecoms operator
3Com	6,000	Networking components
Cable and Wireless	5,500	Network operator
NTL	5,000	Cable operator
BellSouth	4,200	Telecoms carrier
Epcos	3,190	Mobile phone component
France Telecom	3,000	Telecoms operator
Elcoteq	3,000	Contract mobile phone equipment
Celestica	2,900	Contract network equipment

MMO2	2,550	Interconnection equipment
Molex	2,500	Interconnection equipment
Level 3 Communications	2,150	Broadband network operator
Oki Electric	2,100	Telecoms equipment
McleodUSA	2,075	Alternative telecoms operator
Conexant Systems	2,075	Networking components
Global Crossing	2,000	Network services provider
Mitsubishi Electric	2,000	Mobile phones, semiconductors and electronics
Tellabs	2,000	Networking components
Winstar	2,000	Alternative telecoms operator
Flextronics	1,500	Contract mobile phone equipment
ECI Telecom	1,400	Network equipment
Nokia	1,250	Mobile phone equipment
Covad Communications	1,200	Broadband network operator
Atlantic Telecom	1073	Alternative telecoms operator
Sonera	1,000	Telecoms operator
Vodafone	960	Mobile phone operator
Energis	950	Alternative carrier
Northpoint	948	Alternative telecoms operator
One2One	900	Mobile phone operator
Teligent	900	Alternative telecoms operator
Japan Telecom	850	Telecoms operator
360networks	800	Alternative telecoms operator
Ciena	780	Optical equipment
Genuity	770	Telecoms operator
Optus	700	Telecoms operator
Exodus Communications	675	Internet hosting provider
Gemplus	567	Smartcards and Sim cards
Excite@Home	500	Broadband internet provider
Zarlink (formerly Mitel)	430	Network components
Telenor	420	Telecoms operator

Comverse Technology	400	Networking systems
Pacific Century Cyberworks	340	Telecoms operator
Openwave	300	Communications software and services
Network Access Solutions	295	Alternative telecoms operator
Bookham Technology	250	Optical components
Corvis	250	Communications equipment
Globalstar	175	Satellite mobile phone operator
Vitesse Semiconductor	150	Network components
Juniper Networks	104	Network components
Orchestream	94	Telecoms network software
TOTAL †	**485,979**	**TELECOMS INDUSTRY**

* Plans for job cuts announced since the start of calendar year 2001
† Intended as a guide, not a comprehensive record

Electronic Source:
http://www.FT.com
Telecoms job cuts watch
Published: July 19 2000 08:46 | Last updated: February 8 2002 15:10

Annex-5

Filing for bankruptcy protection (Chapter 11)

This information is compiled for illustration purposes only, and has a US focus. No claim is made for completeness. In case no recent information could be retrieved through the Internet, e.g. using the FCC database and Edgar online for SEC filings, the indication (--) is used in the final column. If evidence of continuing operations was available, however details on the ending of the period of bankruptcy protection could not be retrieved, the indication (+) is used in the final column (Main sources used: Crandall, 2005; Bankruptcydata.com, 2006; FCC, 2006; SEC, 2006).
The table includes 125 filings for bankruptcy protection, of which 2 in 1998, 6 in 1999, 6 in 2000, 43 in 2001, 57 in 2002, and 11 in 2003. A total of 38 (30%) companies discontinued operations; 38 (30%) were acquired; 7 (6%) more were subject to the sale of company assets; 31 (25%) re-emerged under their own (brand)name. This process should be considered in the context of the total number of providers, which for the US is reflected in Figure 1 (FCC, 2006). The main categories shown represent 75-80% of total service provider entities reported. Figure 2 shows the telecom operator defaults as reported by the OECD, involving a total of 142 entities and an amount of US$ 183 bln. (OECD, 2005 p23)..

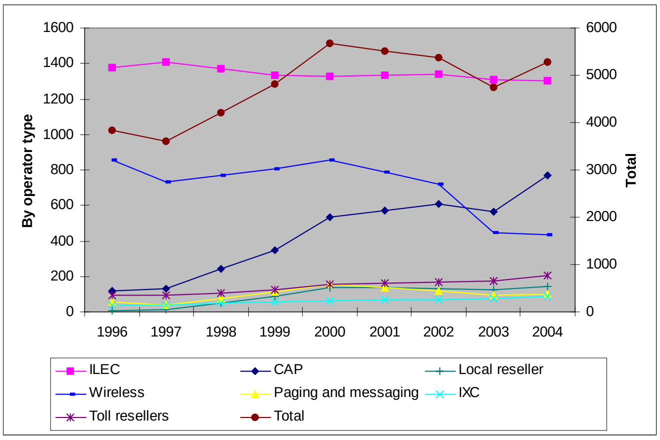

Figure 1. US service providers, 1996-2004

Note: The years 1998 and 2001 are interpolated.

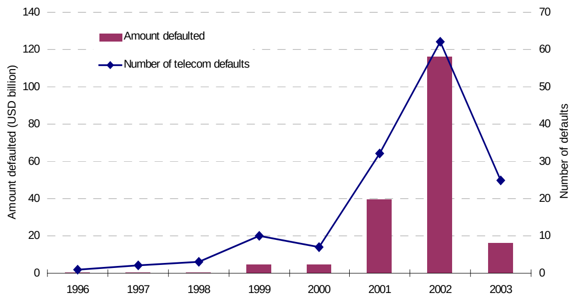

Figure 2. Telecom operator defaults, 1996-2003

The defaults on telecommunications corporate bonds represents the largest cycle of defaults on bonds since the 1930's. Telecommunications represented 56.4% of the US$ 163 billion defaults worldwide. The impact remained limited as telecommunication represented 3.2% of bonds outstanding (Lennin and Paltridge, 2003 p4).

Year	**Company**	**Carrier type**[1]	**Final status / purchaser (of assets)**	**Year**
4Q1998	Ionica	Fixed wireless		--
	NextWave Telecom	Wireless	Cingular acquires spectrum licenses	2Q2004
1Q1999	Telegroup	LD carrier	Primus Telecommunications	2Q1999
	UStel	LD operator	Rocky Mountain Internet	2Q1999
2Q1999	AMNEX		Discontinued ops.	2Q1999
3Q1999	ICO	Satellite	ICO Global Communications	2000
	Iridium LLC	Satellite	Iridium Satellite LLC	4Q2000
	Wireless One	Cable	Discontinued ops.	4Q1999
3Q2000	EqualNet Communications	LD operator	CCC Global Communications	2Q2001
	Orbcom	Satellite	Discontinued ops.	2Q2001
	Paging Network	Wireless	Assets sold	4Q2000
4Q2000	Digital Broadband Communications		Discontinued telecom operations	1Q2001
	ICG Communications	CLEC		4Q2002
	Pacific Gateway Exchange	International carrier		+
1Q2001	Amerivison Communications	LD operator		+
	e-Spire Communications	CLEC	Xspedius	3Q2002
	GST	LD carrier	Time Warner	1Q2001
	NorthPoint Communications	CLEC DSL provider	AT&T	2Q2001
	RSL Communications USA	CLEC LD voice to SMEs		--
	Star Telecommunications	LD operator	Discontinued ops.	3Q2002
2Q2001	Advance Radio Telecom (ART)	Wireless		--
	Allied Riser		Cogent	3Q2001
	Broadband Office	CLEC	Discontinued ops.	3Q2001
	Convergent Communications	CLEC		--

[1] LD carrier notation includes fiber wholesale.

Year	Company	Carrier type[2]	Final status / purchaser (of assets)	Year
2Q2001	eGlobe		Discontinued ops.	4Q2001
	PathNet	CLEC	Discontinued ops.	3Q2002
	PSINet	Internet backbone	Discontinued ops.	2Q2002
	SSE Telecom			--
	Teligent Communications	Wireless	Discontinued ops.	4Q2004
	Telscape International	CLEC	TCP Acquisition	3Q2001
	Viatel	LD carrier	Discontinued ops.	2Q2001
	Winstar Communications	CLEC Wireless	IDT	1Q2002
	World Access	Bundled voice and Internet access	Assets sold	2Q2001
	Zephion	CLEC		
3Q2001	360networks	LD carrier		4Q2002
	Adaptive Broadband	Wireless broadband		--
	Covad	Broadband CLEC		4Q2001
	Exite@home	Cable network		
	Exodus	Internet hosting	Cable & Wireless	1Q2002
	GRG			
	Metricom	Wireless		--
	Pangea	LD carrrier		+
	Rhythms	Broadband CLEC		--
	U.S. Wireless	Wireless		--
	Wavve Telecommunications			
4Q2001	Ardent Communications	Broadband Internet	Discontinued ops.	--
	Digital Teleport		Century Tel	2Q2003
	Ebone/GTS	LD carrier	KPNQwest	4Q2001
	Ennovate Networks			
	Enron Broadband	LD carrier	Discontinued ops.	4Q2002
	Globalstar	Satellite		+
	IBEAM Broadcasting	Internet	Williams Communications	4Q2001
	Net2000	Paging	Assets sold	4Q2001
	NetVoice		Discontinued ops.	2Q2002
	OmniSky	Wireless	Earthlink	4Q2001
	Pensat		Discontinued ops.	1Q2003
	Telergy	LD carrier	Dominion	2Q2002
1Q2002	Aleron	LD carrier	PowerNet	2Q2002
	Carrier 1	LD carrier	Discontinued ops.	--
	Great Plains Telecom	ILEC		+
	Globix	Internet		+
	Global Crossing	LD carrier		4Q2003

[2] LD carrier notation includes fiber wholesale.

Year	Company	Carrier type[3]	Final status / purchaser (of assets)	Year
1Q2002	KPNQwest	LD carrier	Assets sold	--
	Logix Communications		Assets sold	4Q2002
	McLeodUSA	CLEC		+
	Motient	Wireless	Discontinued telecom operations	4Q2001
	Network Plus	CLEC	Broadview Networks	1Q2002
	Sigma Networks	LD carrier	Discontinued ops.	1Q2002
	Sphera	LD carrier	OnFiber Communications	2Q2002
	Storm	LD carrier	Discontinued ops.	3Q2002
	Western Integrated Networks	Broadband	Discontinued ops.	3Q2002
	Wiltel	LD carrier		3Q2002
	WINfirst	CLEC	Discontinued ops.	3Q2002
	Yipes Communications	CLEC		+
2Q2002	Adelphia Communications	CLEC		+
	Advanced Telecom Group		Advanced Telecom Network	+
	BroadLink Wireless			--
	Clarity Telecommunications	LD carrier		+
	Convergent Communications		Assets sold	3Q2001
	FLAG Telecom	LD carrier		3Q2002
	Grapes Communications			+
	Group Telecom		360networks	1Q2003
	Impsat	LD carrier		4Q2002
	ITC Deltacom	CLEC		3Q2002
	Metrocall	Wireless		+
	MFN	CLEC/LD carrier	Renamed Abovenet	3Q2003
	Mpower	CLEC		+
	NEON	LD carrier	Eon Optics	4Q2002
	Network Access Solutions		DSL Net	1Q2003
	NTL	Cable and telecom		+
	Pinnacles Long Distance	LD carrier	Discontinued ops.	3Q2003
	StarBand Communications	Internet via satellite		4Q2003
	Teleglobe	LD carrier	Cerberus	2Q2003
	Velocita	LD carrier	AT&T	4Q2002
	Versatel			1Q2004

[3] LD carrier notation includes fiber wholesale.

Year	Company	Carrier type[4]	Final status / purchaser (of assets)	Year
2Q2002	Williams Communications		Discontinued ops.	4Q2002
	WorldCom	LD carrier	Renamed MCI; acquired by Verizon	1Q2004 4Q2005
	XO Communications	CLEC		1Q2003
3Q2002	Ahead Communications Systems		Subject to Chapter 11 in 2005	
	AT&T Canada	LD carrier	Renamed Allstream	2Q2003
	Birch Telecom			+
	Cambrian	LD and fiber wholesale carrier	PPL Telecom	1Q2003
3Q2002	Century Communications			--
	Integrated Telecom Express		Discontinued ops.	--
	Knology	CLEC		+
	Song Networks (Tele1)	IP backbone	TDC	4Q2004
4Q2002	Asia Global Crossing		Asia Netcom	4Q2002
	CTC Communications	CLEC	Columbia Ventures	4Q2003
	EPIK Communications		Assets sold	4Q2003
	Focal Communications	CLEC		3Q2003
	Genuity	LD carrier	Level 3	4Q2002
	Interoute	LD carrier		4Q2002
	Supra Telecommunications	AP/LEC		+
	United Pan-European Communications			4Q2003
1Q2003	iPCS			+
	NTELOS			+
	STM Wireless	Satellite	Discontinued ops.	1Q2003
	Superior Telecom			+
2Q2003	Allegiance Telecom	CLEC		1Q2004
	ATSI Communications			+
	FASTNET	Internet access	Assets acquired by US LEC	4Q2003
	Swiftcomm			2Q2004
	TouchAmerica	LD carrier	Discontinued telecom operations	1Q2004
3Q2003	Active Link Communications		Under Chapter 11 in 2005	
	Nucentrix Broadband Networks	Wireless internet	Spectrum assets sold to Nextel Spectrum	2Q2004

[4] LD carrier notation includes fiber wholesale.

Annex-6

Acquisitions in the telecom sector

In this Annex the acquisitions by a sample set of companies are documented: in the operator segment: LDDS-WorldCom; in the systems provider segment: Nortel, Lucent Technologies and Cisco; in the component provider segment: JDS-Uniphase.

LDDS to WorldCom		
Preamble		
1983	LDDS starts operation	
Announced Date	**Target**	**Size in US$xmln**
1985	ReTel Communications	
1985	The Phone Company (TPC)	
1987	Southland Systems	
1988	Comlink 21	
1988	Telephone Management Corporation (TMC)	
1989	Advantage Companies, Inc.	
1991	National Telecommunications	
1991	Mid-American Communications	
1992	Prime Telecommunications	
1992	TeleMarketing Investments	
1992	Advanced Telecommunications Corporation	
1993	Dial-Net Inc.	
1993	Metromedia communications Group	
1994	IDB WorldCom	
1995	WilTel	
1996	Stake in Irish Telecommunications (Ireland)	
1996	Choice Cellular	
1996	MFS Communications	
1997	BLT Technologies	
1997	ANS Communications	
1998	Stake in Embratel (Brazil)	
1998	Stake in Avantel (Mexico)	
1998	MCI	
1998	Brooks Fiber	
1998	CompuServe	
1999	`Proceda Technology (Brazil)	
1999	SkyTel Communications	
1999	Wireless One	
2000	Intended merger with Sprint called off	
Total	**29 targets**	

Nortel Networks		
Preamble		
	Bell Northern	
	Northern Telecom	
Announced Date	**Target**	**Size in US$xmln**
May 1996	Micom Systems Inc.	150
April 1998	Aptis Communications, Inc.	305
June 1998	Bay Networks, Inc.	9,100
December 1998	Cambrian Systems	300
April 1999	Shasta Networks, Inc	340
May 1999	X-CEL Communications	N/a
November 1999	Periphonics Corporation	440
January 2000	Qtera Corporation	3,250
February 2000	Dimension Enterprises, Inc.	65
March 2000	Clarify, Inc.	2,100
March 2000	Nortel Networks Broadband Access Inc.	778
March 2000	Xros, Inc.	3,250
April 2000	CoreTek, Inc.	1,430
May 2000	Photonic Technologies	36
July 2000	Archtel Systems Corporation	395
July 2000	Alteon WebSystems, Inc.	7,800
August 2000	Sonoma Systems	540
November 2000	Nortel-Networks High-Speed Networking Card Unit	110
Total	**18 targets**	**30,389**

Lucent Technologies		
Preamble		
1984	Divestiture: Local operating companies spun off from AT&T	
1996	Trivestiture: Lucent spun off from AT&T	
Announced Date	**Target**	**Size in US$xmln**
September 1997	Octel Communications Corporation	980
October 1997	Livingston Enterprises, Inc.	650
January 1998	Promitel Corporation	200
April 1998	Optimay Gmbh	68
August 1998	Lannet Data Communications	117
October 1998	Quadritek Systems, Inc.	55
November 1998	Yurie Systems, Inc.	1,056
March 1999	Enable Semiconductors – Ethernet LAN Division	50
June 1999	Ascend Communications[1]	24,000
June 1999	InterNetworking Systems	24
July 1999	Nexabit Networks	900
July 1999	Mosaix, Inc.	145
October 1999	International Network Services	3,700
November 1999	Xedia Corporation	246
November 1999	Exel Switching Corporation	1,700
February 2000	SpecTran Corporation	99
April 2000	Ortel Corporation	2,789
April 2000	Agere Systems, Inc[2]	443
May 2000	Chromatis Networks, Inc.	4,505
June 2000	Herrmann Technology, Inc.	438
July 2000	Spring Tide Networks, Inc.	1,346
Total	**21 targets**	**43,517**

Cisco Systems		
Preamble		
1984	Cisco founded	
Announced Date	**Target**	**Size in US$xmln**
September 1993	Crescendo Systems	95
July 1994	Newport Systems Solutions	93
October 1994	LightStream Corporation	120
October 1994	Kalpana, Inc.	240
August 1995	Combinet	132
September 1995	Internet Junction	6
September 1995	Grand Junction Networks, Inc.	400
October 1995	Network Translation	32
January 1996	TGV Software	138
April 1996	StrataCom	4,666
July 1996	Telebit Corporations	200
August 1996	Nashoba Networks	100
September 1996	Granite Systems	220
October 1996	NETSYS Technologies	79
December 1996	Metaplex Inc.	2
March 1997	Telesend	6
June 1997	Skystone Systems Corporation	102
June 1997	Global Internet Software Group	40
June 1997	Dagaz	126
December 1997	LightSpeed International	194
February 1998	Wheel Group Corporation	124
December 1999	Pirelli optical Systems	2,150
January 2000	Compatible Systems	N/a
January 2000	Altiga Networks	567
February 2000	Growth Networks, Inc.	355
March 2000	Atlantech technologies Ltd.	180
March 2000	Jetcell, Inc.	200
March 2000	InfoGear Technologies Corporation	301
April 2000	PentaCom Ltd.	118
April 2000	Seagull Semiconductor Ltd.	19
May 2000	ArrowPoint Communicatons	5,700
May 2000	Qeton Systems	800
June 2000	HyNex, Ltd.	127
July 2000	Netiverse	210
July 2000	Komodo	175
July 2000	NuSpeed	450
August 2000	Ipmobile	425
August 2000	PixStream, Inc.	369
September 2000	IpCell Technologies, Inc.	369
September 2000	Vovida Networks	369

Cisco Systems - continued		
Announced Date	**Target**	**Size in US$xmln**
October 2000	CAIS Software Solutions	170
November 2000	Active Voice Corporation	266
November 2000	Radiata, Inc.	295
December 2000	ExIO	155
July 2001	AuroraNetics, Inc.	150
Total	**69 targets**	**34,622**

JDS-Uniphase		
Preamble		
	JDS founded	
1999	JDS-Uniphase merger	
Announced Date	**Target**	**Size in US$xmln**
December 1999	SIFAM	90
March 2000	Cronos Integrated Microsystems, Inc.	750
June 2000	E-Tek Dynamics	19,000
July 2000	SDL Inc.	41,000
December 2001	Int'l Business Machines, Optical	340
April 2002	Scion Photonics	43
Total	**6 targets**	**61,276**

Sources:
Capital IQ as quoted in Malik (2003 p210 & 218 & 286), (Jeter, 2003 p iii-viii), (Malik, 2003 p243), (Paulson, 2001 p 291-4).

Notes for Annex 6

[1] Cascade, manufacturer of frame relay equipment, was bought by Ascend Communications in March 1977 for US$ 3.7 bln. (Malik, 2003).
[2] Agere became the vehicle for the spin-off of the semiconductor and optical components division (former Micro Electronics Division) from Lucent Technologies.

Annex 7

Optical networks build-out

Pan-European fiber deployment
In this Section an overview is presented of the Pan-European fiber build out, a courtesy of KMI Research (a Research Unit of PennWell) who made available for this project the November 2001 report *Fiberoptic networks of Pan-European carriers: Market developments & forecast* and the October 2002 report *Status of Pan-European fiber-optic networks – An overview of the Operating status of Pan-European carriers, including bankruptcies, restructurings and sales of fiberoptic network assets*.

Pan-European networks emerged as a result of the telecom reform process, in particular the 1998 EU directive on full liberalization. Hitherto international traffic had been handled on a bilateral basis between national telecom operators. Traffic would be 'handed over' at the border and terminated locally or transited to another country. The reform process allowed carriers to operate and install networks regionally. In general one of two approaches was followed: (1) incumbents would acquire network companies abroad and link these national networks to build a regional network (typical examples are BT and FT)[1] or (2) carriers would build a new network in a sub-region or across Europe. BT's network coverage through subsidiaries and associated companies would total 54.000 route-km by June of 2001. Considering the state of technology, these would all be optical networks either using single mode or multi-mode fiber.[2] To obtain the desired coverage the own network footprint would be extended with capacity being obtained from competitors, often through a capacity swap, or through long term leases of dark fiber. To accelerate deployment extensive use was made of existing rights-of-way (railways, motorways, utility conduits).

European network deployment started as early as 1996 with the Hermes Rail project, whereby the internal networks of eleven national railway companies were interconnected to form a regional network for the purpose of sending traffic reports, freight messages, consignments, and seat reservations among the participating railway companies. GTS (Global TeleSystems) participated in the venture and would ultimately acquire 99.8% ownership and renamed the network Ebone. In 1997 WorldCom entered the European market through its acquisition of MCI and thereby of MFS (Metropolitan Fiber systems). MFS had built metropolitan networks in major European cities from 1993 onward, including London, Paris, Frankfurt, Amsterdam, Brussels, Stockholm, Zurich. The creation of WorldCom's Pan-European network started with the installation of two fiber rings connecting London, Paris, Amsterdam and Paris, Frankfurt, Amsterdam.
From January 1998 onward 27 carriers would enter the market and build Pan-European networks, in addition to the networks created by the incumbents linking their nationally owned networks to create a Pan-European network. Table 1 shows the time of entry, the fiber deployment and the use of IRUs to increase the network coverage for these players for the period 1998-2001 (based on: KMI Research, 2001; KMI Research, 2002a). The operating status is reflected as of October 2002. Of the 27 carriers 12 have been involved in debt restructuring or bankruptcy proceedings; they represent 38% of the total route-km. There are 9 carriers that have changed ownership, representing 27%.

Year		Company	Network build-out (1998-2001)				Operating status Oct. 2002[1]
			Route-km			Fiber-km	
			Own-built	IRU	Total	Total	
1996		GTS	1.318	16.216	17.534	51.582	March 2002: sells network to KPNQwest
1997		WorldCom	9.938	3,200	13.138	535.104	July 2002; bankruptcy filing Emerging from bankruptcy April 2003 as MCI
1998	1Q	Viatel	7.220	4.822	12.042	589.500	May 2001: bankruptcy filing June 2002; completion financial restructuring
		Song (Tele 1 Europe)	3.890	7.240	11.130	210.060	Sept 2002: Financial restructuring Jan 2002; acquires Enitel leased international fiber network
	2Q	LDCom	8.560		8.560	575.852	
		Carrier 1	2.920	6.632	9.552	236.520	Feb 2002: bankruptcy filing
		COLT	13.710	1.005	14.715	1.480.680	
	3Q	Powercom	4.572	428	5.000	225.288	June 2001: acquired by Telia
		Versatel	3.078	2.210	5.288	254.808	Oct 2001: bankruptcy filing Sept 2002: restart
		MFN	2.350	3.804	6.154	571.050	May 2002: bankruptcy filing
		Eurotunnel Telecom	471		471	60.480	
		Global Crossing	13.372	72	13.444	1.402.476	Jan 2002: bankruptcy filing Emerged December 2003
	4Q	Telia	25.039	4.056	29.095	4.760.604	July 2002: merger with Sonera[2]
		KPNQwest	15.727	4.296	20.023	1.896.924	May 2002: bankruptcy filing[3] Oct 2001; acquires Ebone network from GTS
		Level 3	8.095	490	8.585	871.848	
1999	1Q	Flute					
		Global Connect	1.400	150	1.550	151.200	
		Pangea	1.579	4.444	6.023	75.792	Sept 2001: bankruptcy filing[4]
	2Q	Interoute	15.922		15.922	1.710.600	
		Energis	750	13.227	20.177	39.150	July 2002: acquired by Chelys
2000	1Q	360Networks	1.314	19.569	20.883	319.302	2001: bankruptcy filing Emerged in 2002
		Infigate	2.523	1.443	3.966	272.484	Seized operation
		TyCom (Europe)	16.632	100	16.732	266.112	Absorbed by parent company Tyco international
		Grapes	575	8.970	9.545	15.525	April 2002: bankruptcy filing
	2Q	Ipsaris (Fibreway)	3.500	6.558	10.058	378.000	July 2007: acquired by easynet
		Silk Route	450		450	21.600	
	3Q	Enitel	5.169	4.249	9.418	139.563	Sept 2001: bankruptcy filing
		MTCAG[5]	1.840		1.840	298.080	
		Total	**171.914**	**112.941**	**284.855**	**17.419.184**	

[1] 'Bankruptcy filing' used as short hand for 'filing for bankruptcy protection'.
[2] July 2002: acquires French assets from KNPQwest; Feb 2002; acquires UK network of 360Networks.
[3] Sept 2002: KPN acquires interest in TAT-14; Sept 2002: KPN acquires UK networkAugust 2002: KPN acquires EuroRings in Germany; August 2002: Antel acquires Ebone Central Europe; July 2002: KPN acquires Dutch network; July 2002: Telia acquires French assets; July 2002: Interoute acquires part of Ebone backbone and 8 MANs.
[4] Sept 2002: Song to acquire Arrowhead; July 2002: Arrowhead acquires Pangea's Scandinavian network.
[5] Start date of Memorex Telex Communications AG is 1997, but the start as an Pan-European player is unclear.

Table 1. Pan-European carriers

The fiber deployment in route-km and the use of IRUs over time is shown in Figure 1. The deployment in fiber-km is shown in Figure 2. The deployment by country, for our sample set, is shown in Figure 3 (based on: KMI Research, 2001). Note: The deployment in 2002 is a November 2001 estimate. The largest build-out by country executed by Pan-European carriers is Germany with 35,000 route-km or 20% and France with 32,000 route-km or 18%.

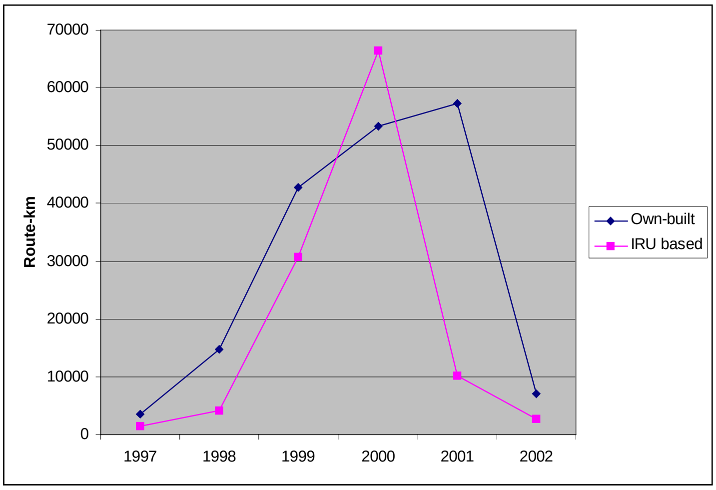

Figure 1. Pan-European fiber deployment and use of IRUs, 1997-2002

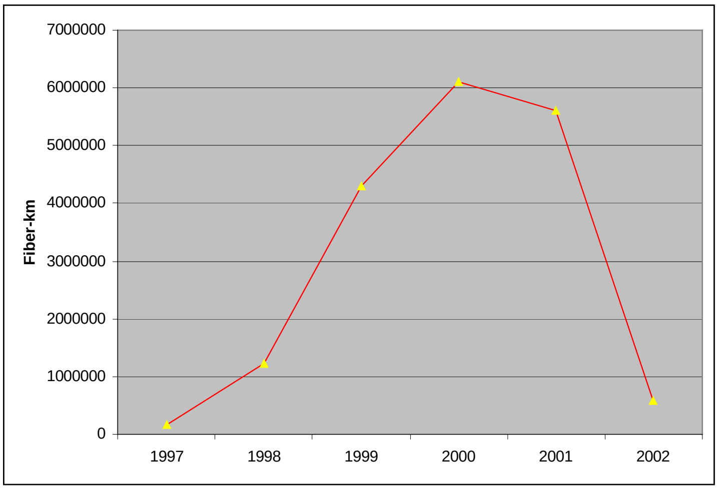

Figure 2. Pan-European fiber-km deployment, 1997-2001

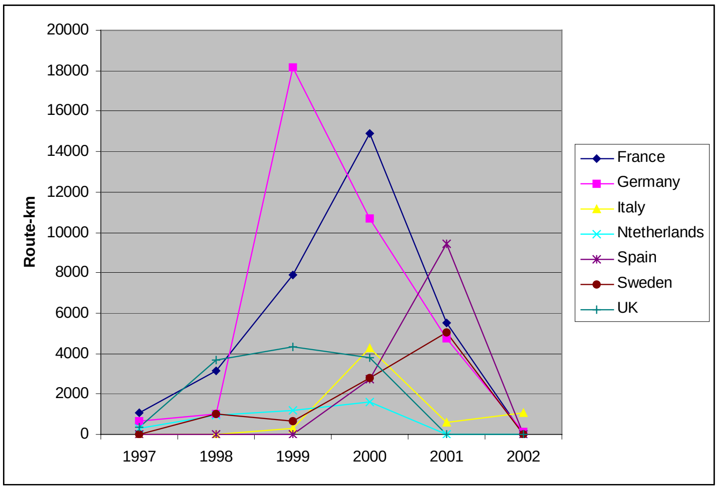

Figure 3. Pan-European fiber deployment by country, 1997-2002

The leading operator in terms of fiber deployment is Telia with 14% or 25,000 route-kilometer and 26.5% or 4.760.600 fiber-kilometer. The Telia network lay-out is shown in Figure 4. In the top bracket are also Interoute, KPNQwest, COLT and Global Crossing, see Figure 5, Figure 6, Figure 7 and Figure 8 (KMI Research, 2001). TyCom belongs also in this bracket, but mainly built undersea connections.

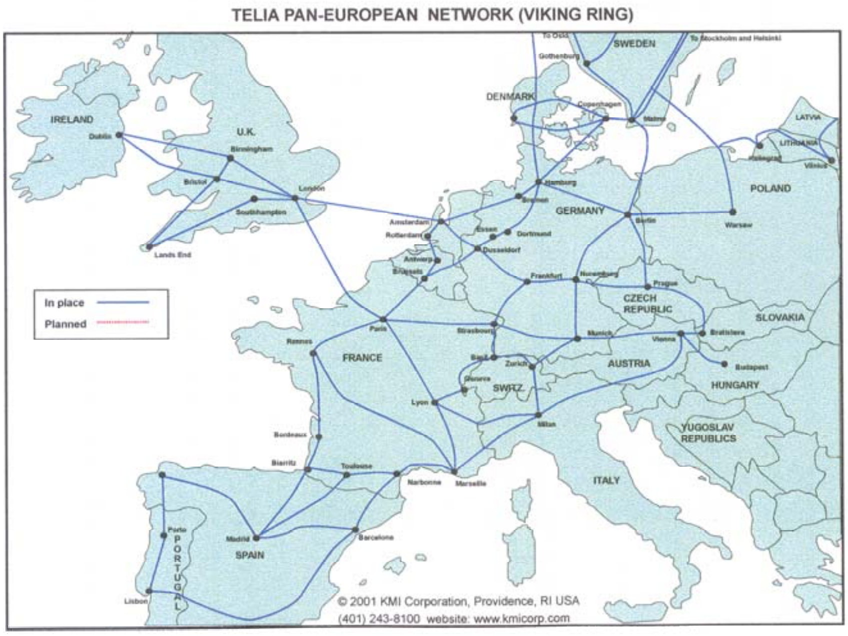

Figure 4. Telia Pan-European network (Viking Ring)

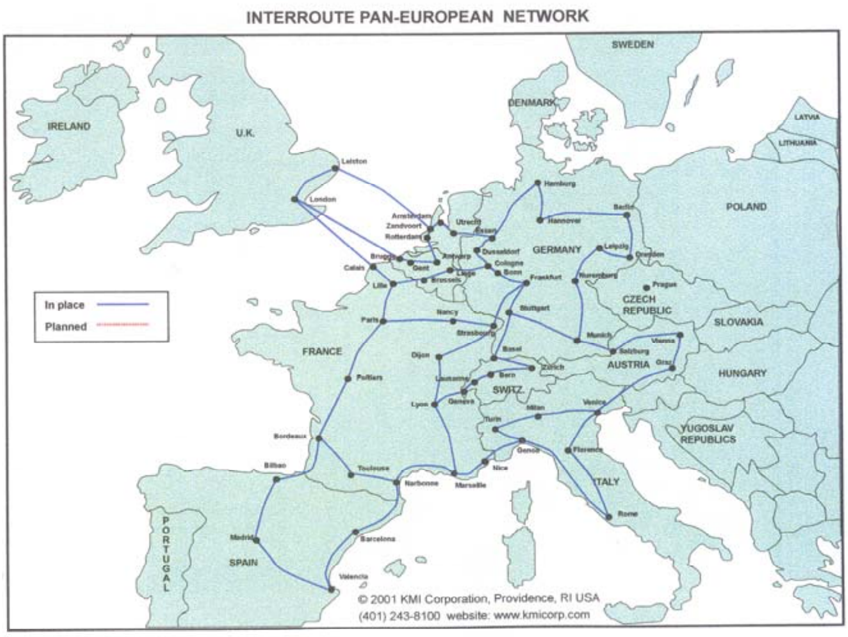

Figure 5. Interroute Pan-European network

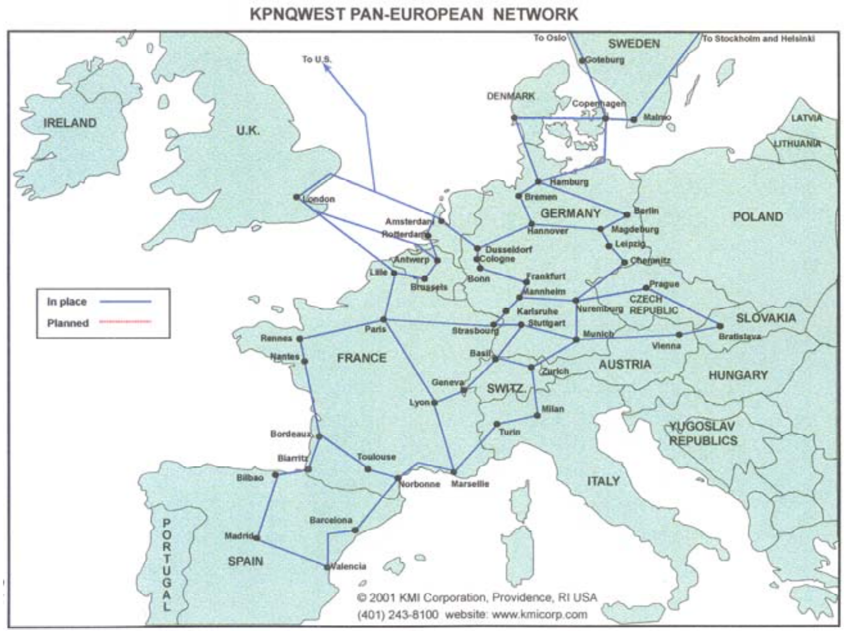

Figure 6. KPNQwest Pan-European network

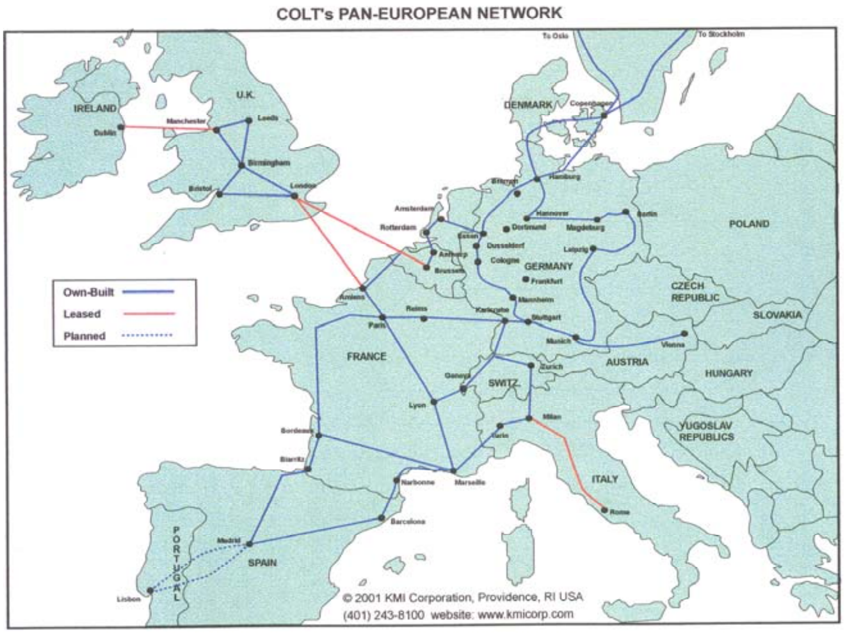

Figure 7. COLT's Pan-European network

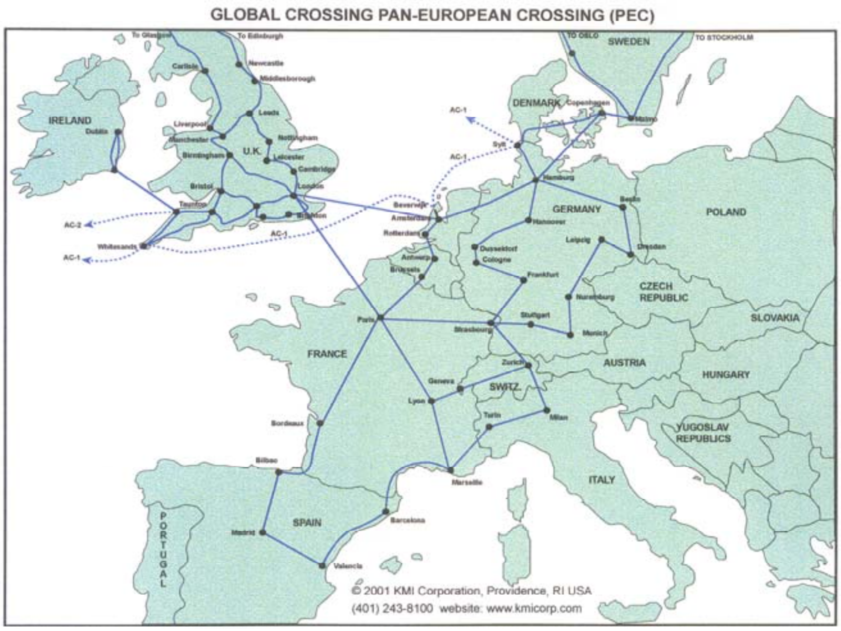

Figure 8. Global Crossing Pan-European Crossing

Metropolitan fiber deployment

Next to Pan-European fiber deployment, in every major city fiber (ring) networks have been built by incumbent and new entrant carriers alike. This market segment will not be explored further.

Fiber deployment in the U.S.A.

The deployment of fiber in the USA for the period 1998-2000 is depicted in Table 2 (based on: Kalla, 2000 p12).

Company	Fiber deployment in route miles				Remarks
	1998	1999	2000E	Total	
AT&T	39576	41000	43000	123576	
MCI WorldCom	27313	37657	48000	112970	
Williams Communciations	19000	25000	33000	77000	
Sprint	23574	25000	26000	74574	
Qwest Communications	12496	18500	25500	56496	
Global Crossing (Frontier)	12261	16131	20000	48392	
Touch America	10000	16000	18000	44000	
Broadwing IXC	9300	15700	18500	43500	
Enron		14000	15000	29000	
Level 3 Communications		9334	15200	24534	Prior to 1999 leased only
McLead USA	4252	7426	10600	22278	
CapRock Communications	800	3000	7500	11300	
GST Telecom	5666	5332		10998	Acquired by Time Warner in 2000
Electric Lightwave	1665	2180	3200	7045	
NEON (North East Optic Network)	505	753	1000	2258	
Norlight Telecommunciations	935	NA	NA	935	
Metromedia Fibernet	300	NA	NA	300	
Subtotal	***167643***	***237013***	***284500***	***689156***	
Other companies	33060	72181	65270	170511	
Total	**200703**	**309194**	**349770**	**859667**	

Table 2. Fiber deployment in the USA, 1998-2000

Notes for Annex 7

[1] The BT led network included: Albacom Italy, BT Belgium, Cegetel France, Sunrise Switzerland, Telfort The Netherlands, Viag Intercom Germany. The FT led network included: Wind Italy, Uni2 Spain, Metropolitan Holdings UK, Mobilix Denmark, E1Tele Norway, Mobistar Belgium, Dutchtone the Netherlands, Multilink Switzerland. DT's Pan-European network consists of leased capacity from Global Crossing in combination with its French network through the acquisition of Siris in 1999.

[2] Multi mode or non-zero dispersion-shifted fiber has been optimized for the use of dense wavelength division multiplexing, related to the G.655 standard. Deployment started in 1998 and exceeded that of single mode according to G.652 in 1999 and 2000. Corning's LEAF was the market leader in the period with 59%, followed by Lucent's TrueWave with 31%. Alcatel's TeraLight reached a 10% share.

Annex-8

A telecom industry cycle

Introduction

Economic activity is in general characterized by ups and downs in the form of the business cycle. Porter argues that fluctuation in economic conditions over the business cycle are of tactical rather than strategic importance, as these short-run factors influence nearly all firms in many industries (Porter, 1980 p6). However, as De Wit observes, certain sectors of economic activity are more susceptible to demand fluctuations than others (De Wit, 1994 p1-2). Swings in demand will be transmitted ‘along the value chain’, and, as many actors tend to translate prospects for demand growth in decisions to invest in approximately the same time frame, increases in demand will cumulate backwards in the value chain. If time delays are involved in satisfying the demand growth, expectations of demand growth may be amplified backward in the value chain. This applies to ‘durable consumer goods’ industries, but also to e.g. the airline industry and the semi-conductor industry. The latter industries are characterized by deep investments and long pay-back times which are not only influenced by the business cycle, but tend to exhibit a sector specific cycle, which is referred to as the industry cycle. The nature of the telecom industry, characterized by deep infrastructure investments and long pay-back times, suggests that the industry is in principle susceptible to an industry cycle. Considering the rather recent introduction of full competition in the telecom services industry, this phenomenon can only be emergent. Considering the impact that industry cycles have or rather ought to have on strategy formation[1], we will explore in this Annex the emergence of an industry cycle in the telecom industry.

The Industry Cycle – a formal definition

According to De Wit, for an industry to be referred to as a cyclical industry, six qualitative conditions have to be satisfied (De Wit, 1994 p75):

- Demand fluctuations should vary substantially, i.e. a strategic action should be triggered,
- The causes of the demand fluctuation should be recurrent in nature, i.e. for the insight to be meaningful in managing the business,
- The causes of fluctuation must be economical factors. This is considered a matter of choice and excludes psychologically and politically driven cycles,
- The causes are non-manipulative external factors, i.e. the external drivers of demand cannot be manipulated,
- The demand fluctuation is unpredictable in timing and amplitude, i.e. to be strategically relevant,
- The production assets have an economic lifespan which is longer than the industry cycle, i.e. the value of production assets is not only determined by depreciation and price of replacement, but also subject to changes in supply and demand over the phases of the industry cycle.

It should be noted that the industry cycle is considered at the aggregation level of the industry, thereby it differs from other investment cycles such as the Kitchen cycle (capital goods investments) and the Kuznetz cycle (construction investments) which are considered at the level of the national economy (De Wit, 2006).

The input data

If reference is made to the fluctuation in demand in telecommunications this is to be interpreted in two steps: demand in terms of users connected to the network, and in demand generated by these users in terms of telecom traffic. Telecom traffic can be described by its characteristics in statistical terms, such as average length of the call, the interval between calls, the probability of congestion, etc. For the purpose of this investigation the more practical metrics are the number of calls and the Minutes-of-Use, the sum of the call duration of all calls made. The demand is measured at the end-user level, on the interface between the service provider and the user - the residential user and the business user. See Figure 1.

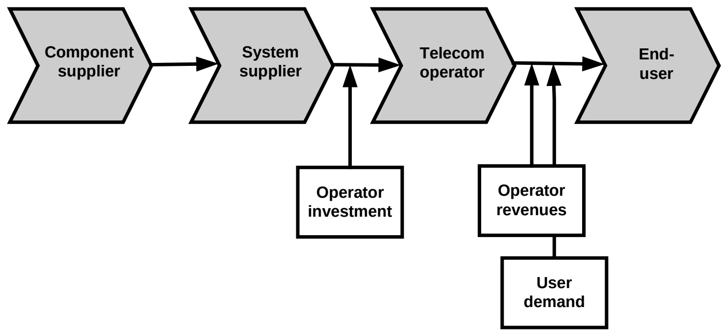

Figure 1. Telecom industry value chain

For this part of the research project use has been made of the database of statistical information retained by the ITU - the International Telecommunications Union in Geneva (ITU, 2002; ITU, 2006)[2]. The data is presented and analyzed for two data sets, Western Europe and the USA. The former (initially) includes the countries: Belgium, Denmark, Finland, France, Germany, Italy, Luxembourg, The Netherlands, Portugal, Spain, Sweden, United Kingdom. In the case of the USA the data has been crosschecked against FCC information (FCC, 2006).

The data for Western Europe

Figure 2 shows the users connected to the network In terms of fixed lines and as mobile users. Figure 3 shows the growth rate for these two categories of network access paths (ITU, 2002).

For our research it is important to be able to link traffic volume to revenue and investments of the operators following the simplified value chain model as shown in Figure 1. In Figure 4 a first indication of the relationship between revenues, income and investment is provided for the set of Western European countries (ITU, 2002).[3]

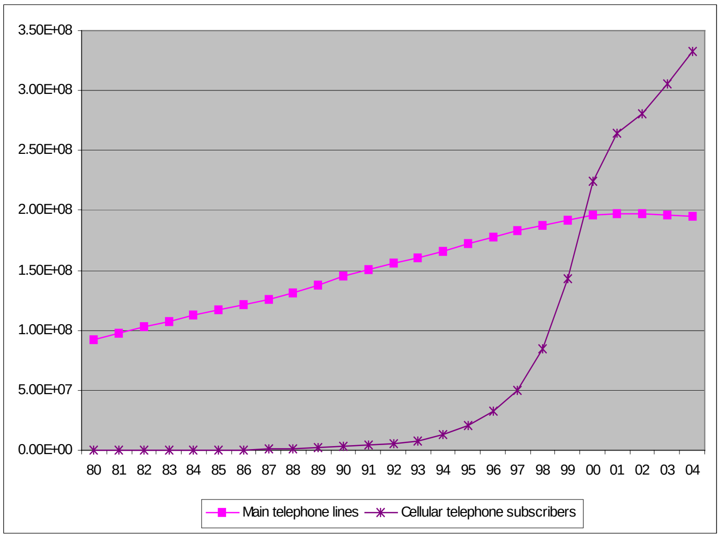

Figure 2. Fixed and mobile users - Western Europe 1980-2004

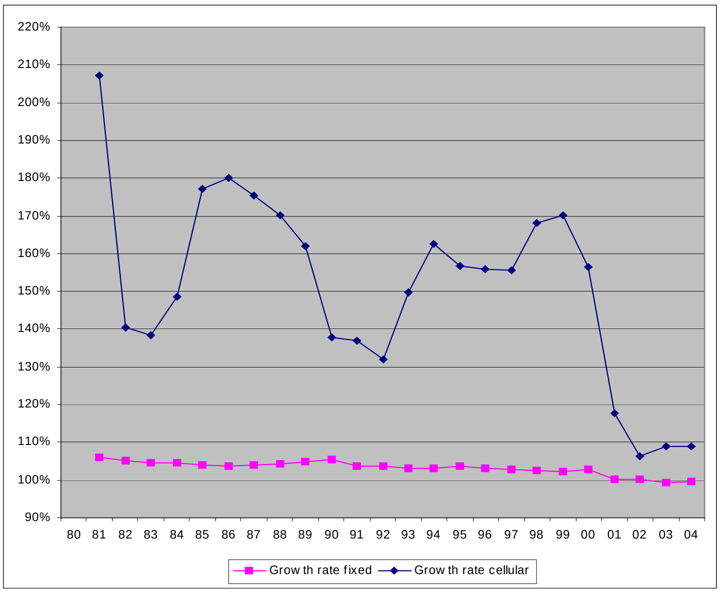

Figure 3. Fixed line and mobile user growth - Western Europe 1980-2004

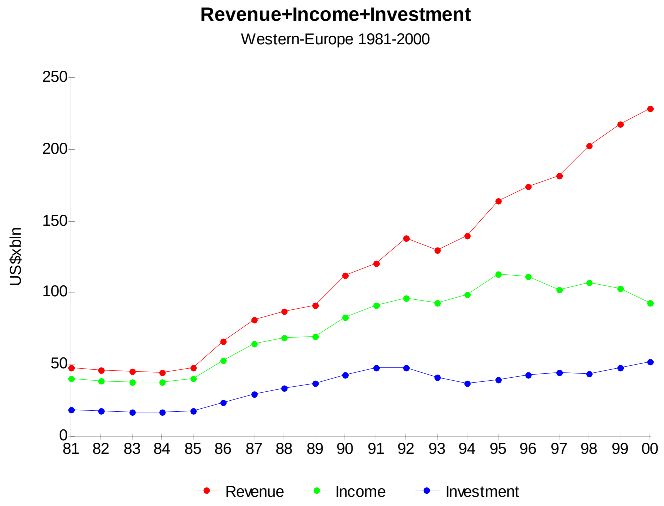

Figure 4. Telecom financials - Western Europe 1980-2000

The revenues shown include all types of revenue streams: installation charges, rental as well as usage. The revenue component related to installation charges is directly related to the growth of network access paths, and the moves and changes requested by the end-users. The revenue stream from rentals is directly related to the number of network access paths.[4]

To obtain a complete and consistent set of related time series, the sample has been reduced to a smaller set of countries, including: France, Spain, Sweden and the United Kingdom. These countries represent close to 45 % of the traffic and revenue volume in Western Europe and can, for the purpose of this first order investigation, be considered as representative for the Western European population. For the same reason the period considered has been reduced to 1989-2002 for the traffic data (ITU, 2006).

In Figure 5 the developments in traffic volume (Minutes-of-Use), revenues and investments are shown over the period for this sample set of countries.

The calculation for the Western European sample

For a proper analysis of the data, and to be able to derive meaningful conclusions in terms of a possible cyclical behaviour of the telecom industry, it is important to make a distinction between the long-term growth trends and the fluctuations along this trend. As a first approximation the trend line is considered to be linear. To determine the trend a linear regression line has been determined for the parameters involved, using the “least squares method”.[5]

In a next step, the yearly increments have been calculated for each variable and a 5-year rolling average[6] has been determined, to ‘smooth’ the data set. The result is considered to reflect the short-term fluctuation. Figure 6 and Figure 7 show the results of the calculation for the primary driver of demand, i.e. network connectivity, respectively in terms of fixed lines and mobile users. Figure 8, Figure 9, and Figure

10 show the results of the calculations for the variables: traffic (minutes-of-use), revenues and investments for the sample set of countries over the period. Subsequently the difference between the yearly increase according to the regression line and the increase according to the 5-years rolling average are calculated for each year of the period and for each variable. In the final step these differences are calculated as a percentage deviation from the trend increase. In Figure 11 the final results are shown.

Note to the graphs: the data and regression line are shown related to the left hand axis; the annual growth information is related to the right hand axis.

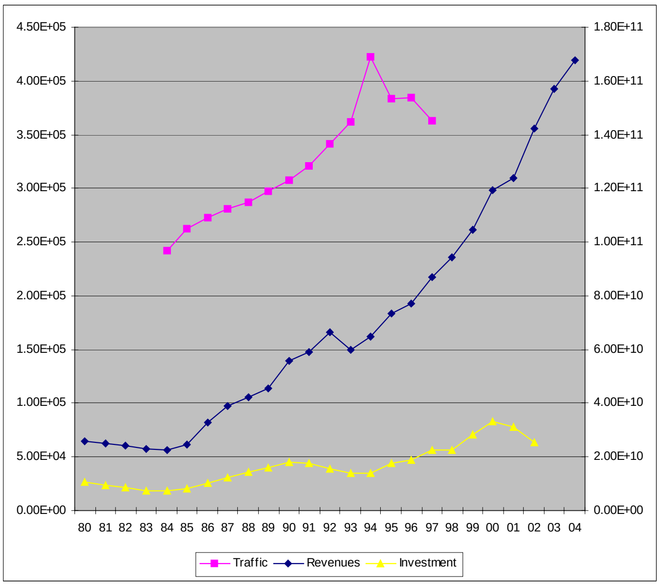

Figure 5. Measurement along the value chain, Western European sample 1980-2004

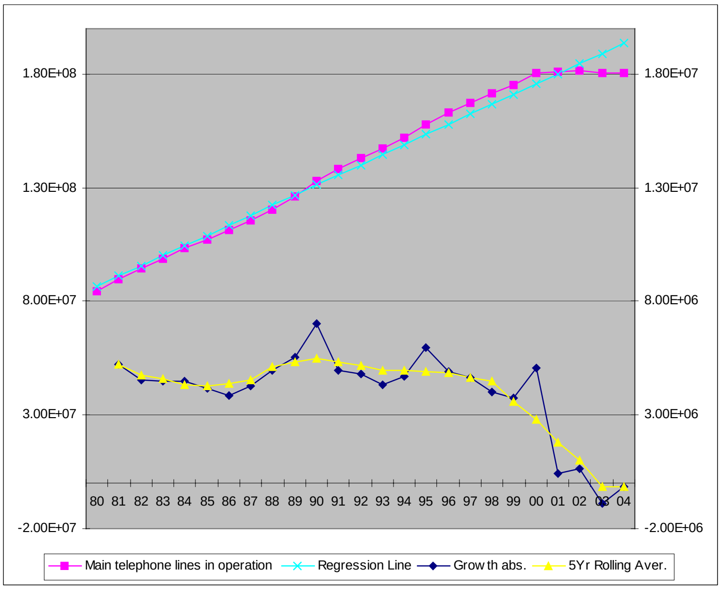

Figure 6. Main telephone lines, Western European sample 1980-2004

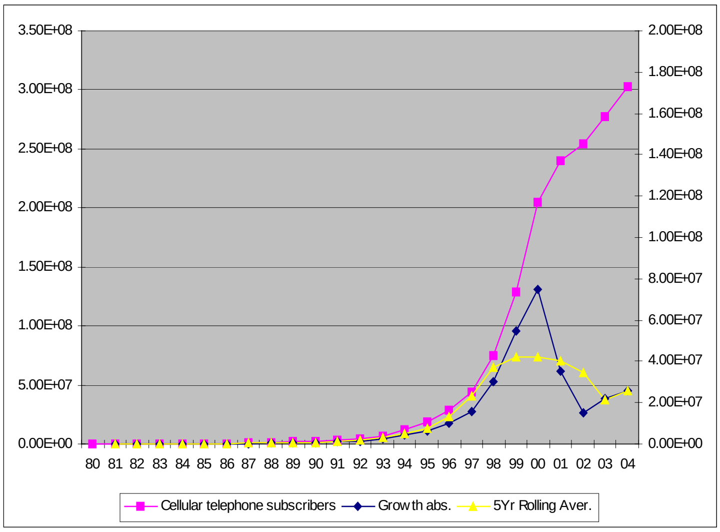

Figure 7. Cellular telephone users, Western European sample 1980-2004

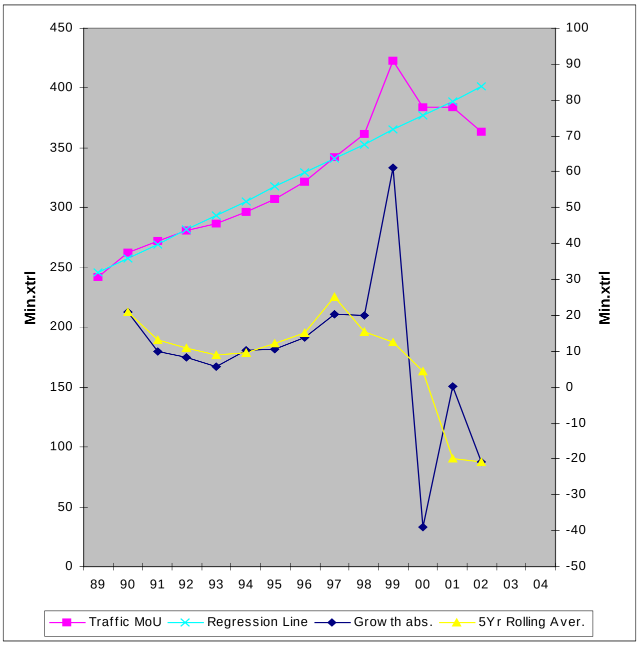

Figure 8. Traffic data, Western European sample 1989-2002

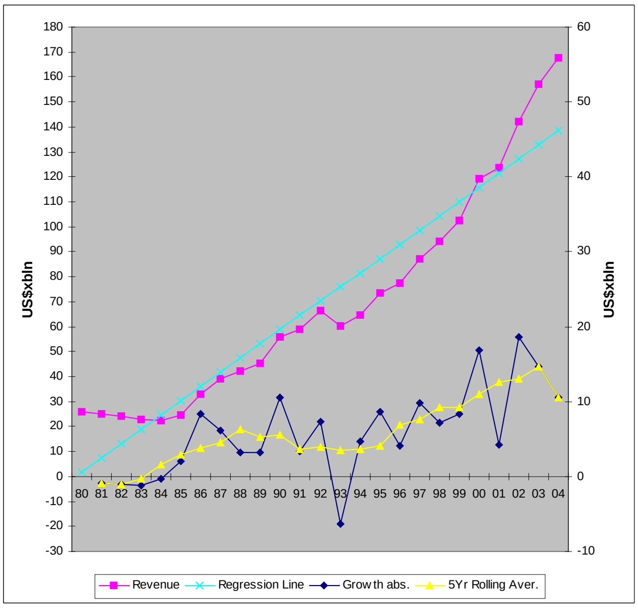

Figure 9. Revenue data, Western European sample 1980-2004

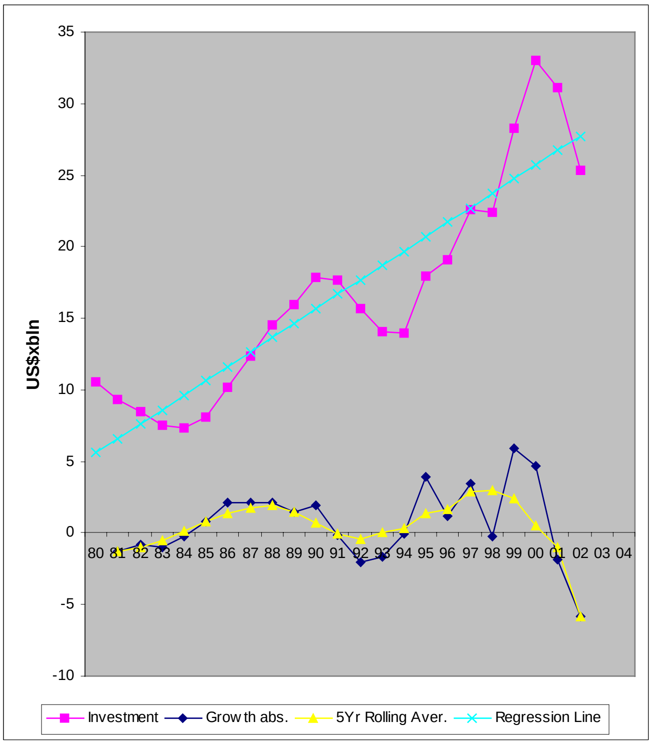

Figure 10. Investment data, Western European sample 1980-2002

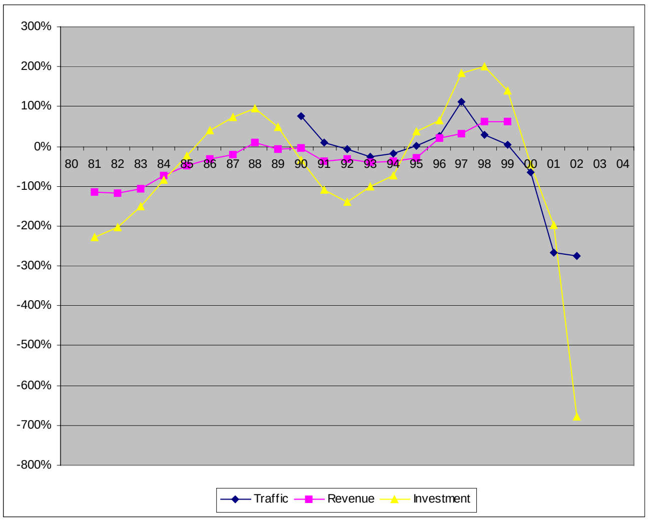

Figure 11. Fluctuation around the trend line traffic, revenues, investments - Western European sample 1981-2002

The data analysis of the Western European sample

The primary variable – Telecommunication demand

From Figure 2 and Figure 3 we may conclude that fixed lines, as a first indicator of communication demand, shows a growth pattern over the period 1980-1990 that can best be approximated by a linear growth curve.[7] The decline that sets in from 1990 is considered to be a result of the increase in mobile penetration, rather than a sign of fluctuating demand.

The Figures are also showing that the growth of mobile users is more akin to an exponential growth curve than to a linear one. The graph of mobile users typically reflects the first two phases and the beginning of the third phase of an S-curve, which is associated with the process of diffusion of a new technology. In such dynamic periods, whereby the amount of network access paths has more than doubled, an end-user demand driven industry cycle in relation to mobility is not apparent. Nevertheless, an exploration may still be valid in relation to other drivers of demand, such as the traffic volume.

The pattern that is emerging with respect to fluctuations in traffic volume, measured in Minutes-of-Use, begins with a smooth cyclical movement around the trend line. In 1999 demand peaks and drops off in 2002. A phenomenon that coincides with the take up of Internet, initially using dial-up modems and later shifting to 'always on' broadband access. See for a more pronounced occurrence of this phenomenon the data on the USA.

The early data shows a fluctuation in demand that might indicate cyclicality. However, the observation period is to short (one cycle), and the impact of the Internet is later-on in the period too powerful for a positive conclusion to be drawn.

The secondary variable – Revenues

A fluctuation around the trend line can be observed.[8] Again, the early data shows a fluctuation in demand that might indicate cyclicality. However, the observation period is to short (one cycle), and the impact of new services, such as mobility and the Internet, are influencing the developments later-on in the period.

The tertiary variable – Investments

The investment data is the most pronounced in terms of cyclicality.[9] Measured over the extremes the cycle time would be 10 years.

The sequence

In the traditional hog cycle increasing demand leads to a relative shortage of supply, and hence increasing prices and increasing revenues. This development triggers investments by the firms involved to enlarge their production capacity. Therefore, a relationship in time between the three variables (demand, revenues, investment) is to be expected. In the model of the industry cycle the delay between the decision to invest and the additional production capacity becoming on line is measured in (many) years. Hence, to meet an anticipated demand growth in a timely manner, demand expectations rather than actual demand are driving the major investment decisions. The infrastructure investments during the Internet bubble period are a case in point. Assuming that demand expectations will reflect actual demand in the future, the investment cycle should precede the demand cycle. Figure 11 suggests that for the period 1988-1996 the investment cycle precedes the demand cycle by two years. However, this observation period is too short for any meaningful conclusions to be drawn.[10]

Summary

The initial observations suggest a weak indication of a end-user demand driven cyclical pattern. A further validation is required, as other causes than a fluctuation in (anticipated) demand may determine the cyclicality in investment. This will be based on a review of the qualitative conditions identified by De Wit (1994), and a context analysis to deepen the understanding of the nature of the changes in demand, revenues and investments. Cause and effect relationships will have to be identified and evaluated, and once-only phenomena will have to be excluded before a conclusion can be derived on a potential industry cycle in the telecom industry.

Qualification of the measurements

Public versus other types of traffic flow

The measurement Minutes-of-Use as reflected in the ITU statistics, reflects the public use of the telecommunications network, and excludes traffic that is carried over leased lines. Albeit, the related revenues are captured. Leased lines are used predominantly as part of private networks, operated by or on behalf of enterprise users. The number of leased lines is estimated at about 1-1.5% of the number of telephone lines[11]. However, the value in revenue terms for leased lines is much higher than for PSTN lines.[4]

Mobile traffic

The metric Minutes-of-Use does capture the mobile calls on the network. Mobility revenues have grown from 2% of the total revenues in 1990, 10% in 1995 to 27% in 2002. However, mobility has required specific investments in the implementation of a new dedicated access network. Significant investments have been required to build the first- and in particular the second generation of mobile networks (GSM) with national coverage. Note that investments related to the procurement of spectrum licenses are not included.

Internet traffic

The metric Minutes-of-Use is also less appropriate for assessing traffic associated with the Internet. The classical voice traffic is carried over a circuit switched connection of 64 kbit/sec and is characterized by an average holding time of 3 minutes[12] and inter arrival times are described in statistical terms by the Erlang Formula. Internet traffic is based on the transfer of data in the form of packets using the Internet protocol (IP). For the connection with the end-user the PSTN line is used, and for in-dialing connections the local call is captured under the metric Minutes-of-Use. However, the national long-distance and international internet traffic aspects are not captured under Minutes-of-Use as this traffic is being carried over dedicated point-to-point IP connections between Internet hosts. The traffic pattern is also totally different from voice calls. The average connection time is 30 minutes or more compared to around 3-4 minutes for voice calls, and most residential Internet calls are made in the evening hours.[13]

If broadband connections are used to access the Internet, through either ADSL over PSTN lines or cable modems connected to the coax network of the CA-TV operators, their usage is not captured in the measurements applied in this research.[14 and 15.] This implies that the actual use of the network will be higher in the later years.

Traffic growth

In developed economies, with teledensity typically above 40, traffic growth has in recent years been primarily a result of the use of the Internet. A case in point is KPN where national and international call volumes have remained flat over the period 1998-2000 while the Internet call volume has grown with 300%; an increase from 2.5% to 32.5% of the total call volume. However in revenue terms the data/IP component (including leased lines) has only grown from 12% in 1998 to 19% in 2000 of the total fixed and data revenues (i.e. excluding mobility and other revenue sources) (KPN, 2001).

Period of measurement

The Internet boom period has occurred in the period 1995-1999. The bust started in 1Q2000, with the most dramatic impact being in 2001 and 2002. Therefore, the data used covers the boom part of the bubble, but very little of the aftermath.

Testing the formal conditions of an industry cycle

1. *Demand fluctuations should vary substantially, i.e. a strategic action should be triggered:*

The notion of “substantial change” will have to be evaluated within the industry specific context. The changes in fixed line demand up to 2000, a minimal change compared to the trend line, will not trigger a change in strategy. Although the drop in demand as from 2000 onward has triggered a change in strategy, the cause is structural and not a result of a potential end-user demand driven industry cycle. The increase in mobile users from approx.1995 onward is technology/service driven, the related investment decisions has led to an upswing in equipment demand.

Small variations in traffic volume will fall within the design parameters of the network and may lead to a temporarily increase in the congestion level. Within the industry practice these changes would be part of the regular demand assessment and investment planning process.[16] However, the significant increase in Internet related traffic as from 1998 has triggered a strategic response from operators; but not as a result of an end-user demand driven industry cycle. Albeit, at the aggregate level the investment decisions of the network operators may result in an investment cycle being perceived by the telecom equipment providers.

Internet traffic is now aggregated at the edge of the network, at the local exchange level, and routed separately from the switched PSTN. It has been the trigger for capping circuit switch based investments and the wide introduction of packet switched networks and interfacing based on the TCP/IP protocol. Moreover it has given a boost to the deployment of ISDN and it now drives the deployment of broadband connectivity to the network through ADSL. This is considered to be a technology/service driven change, a cause for a technology-driven industry cycle to emerge.

At the level of operator investments and thus at the demand level for the telecommunications equipment, software and service vendor, the fluctuations are considered to be significant. These are driven by technology/service changes, rather than fluctuations in end-user demand.

The test result is: negative for an end-user driven industry cycle, but positive for a technology/service driven industry cycle.

2. *The causes of the demand fluctuation should be recurrent in nature, i.e. for the insight to be meaningful in managing the business:*

No cyclical end-user demand fluctuation has been identified. However, demand fluctuations can be discerned based on investment decision related to technology and/or service upgrades.

The test result is: negative for an end-user demand driven cycle, but positive for a technology/service driven industry cycle.

3. *The causes of fluctuation must be economical factor. This is considered a matter of choice and excludes psychologically and politically driven cycles:*

At the primary demand level the driving factors are considered to be broad economic factors, as demand is a reflection of the communication needs of society as a whole. As communications has become an infrastructure critical to the development of the nation and the region, there are a number of politically driven initiatives to promote the development of a high quality, universally available and broadband infrastructure. These initiatives have some impact on the demand, but much more on the investments. The 1983 AT&T Consent Decree, and the European initiatives for (de-)regulation in the early '90-ties, that have been leading to the privatization of the incumbent operator and the introduction of competition, have had a profound effect on investments in the industry. Traditionally investment levels have been high, a result of the prevailing business policy to optimize investments within the restraints of the price-regulation model. In the early '90-ties a significant drop starts, bottoming in the mid '90-ties. See Figure 12 for the investment ratio's (ITU, 2002). This drop coincides with the timing of de-regulation and is considered a natural response of operators to the introduction of competition.

The investment ratio related to income increases significantly from 1995 onward and the ratio related to revenues shows a modest increase as from 1998. This increase can be linked to three phenomena occurring in this time interval: (1) the need to invest to compete effectively, (2) investments in building the second generation mobile network (GSM), and (3) the growth of the Internet requiring significant investments. These phenomena are incidental and, when considered over time, may lead to a cyclical investment pattern for the sector. They are in part strategically driven and in part technology driven. Another way of presenting investments is per line (fixed network only) or per user (fixed plus mobile), see

Figure 13. Also reflected in the Figure are the approximate periods of technology related investment cycles.

The test result is: varied.

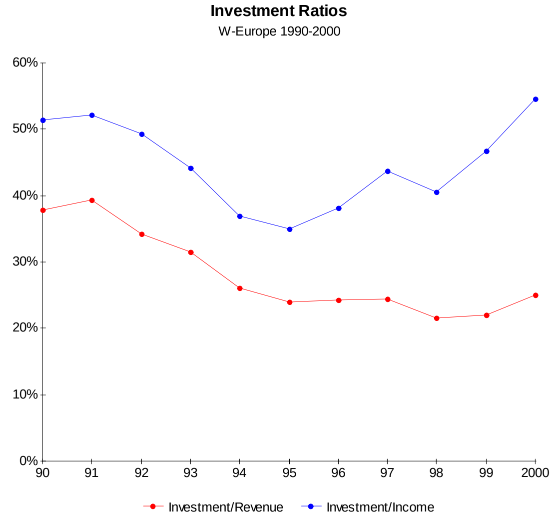

Figure 12. Investment ratio's - Western Europe 1990-2000

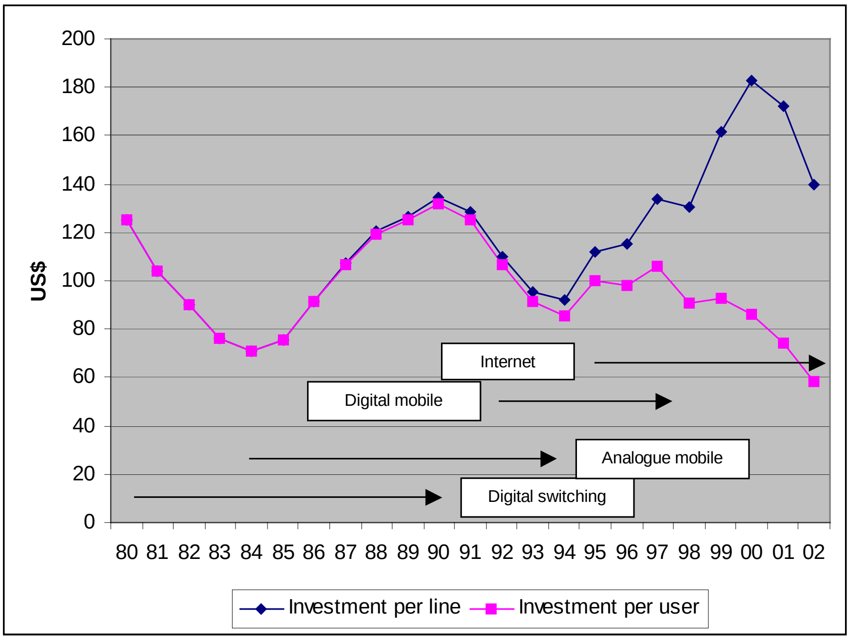

Figure 13. Investments per line and user, Western European sample, 1980-2002

4. *The causes are non-manipulative external factors, i.e. the external drivers of demand cannot be manipulated:*

Grosso modo the same reasoning applies as under item (3). These drivers are considered to be non-manipulative.

The test result is: positive.

5. *The demand fluctuation is unpredictable in timing and amplitude, i.e. to be strategically relevant:*

Based on one (tentative) cycle no firm conclusions can be derived in quantitative terms. The qualitative analysis suggests that the potentially emergent industry cycle is driven by technology and service upgrade decisions. These type of decisions are typically unpredictable in terms of timing and investment level.

Test result: inconclusive.

6. *The production assets have an economic lifespan which is longer than the industry cycle, i.e. the value of production assets is not only determined by depreciation and price of replacement, but also subject to changes in supply and demand over the phases of the industry cycle:*

Taking the tentative periodicity of the investment cycle of 10 years as a guide, the economic life span of the major and the majority of investments in telecom are longer for outside plant, and in the same order of magnitude for inside plant:

- outside plant: copper cables, and ducts: 15-20 years; fiber cables[17] 10 years; radio base stations[18]: 10-20 years; buildings 20+ years.
- inside plant equipment: switching[19] from 20 years down to 5-10 years; transmission[20] 5-20 years; mobile switching systems[21] 10-15 years; network management systems[22] 5-10 years; operations and business support systems[23] 3-10 years.

Test result: positive for outside plant (primarily related to network connectivity); varied for inside plant (related to network connectivity and traffic volume).

Summary

The initial analysis shows that the demand for telecommunications equipment, software and services, as measured through the investments made by the operators, is demonstrating a cyclical behaviour. However, end-user demand fluctuation (in Minutes-of-Use) appears to be small. The investments triggered by political or technological change appear to be more significant. They, together with the investments related to the changes in the type of demand, e.g. mobility and the Internet, appear to have resulted in a cyclical pattern in telecom investments in the sample of Western European countries considered. Variation in the parameters observed shows much less variation in the period prior to privatization and liberalization than in the period thereafter.

More firm conclusions will require further analysis of these factors at the country level. In the remainder of this Annex we will investigate one country in particular: the USA.

The data for the USA

As a first impression the measurement 'along the value chain' for the USA is shown in Figure 14. As indicator of demand, the traffic volume is shown in the number of calls and in the Minutes-of-Use.

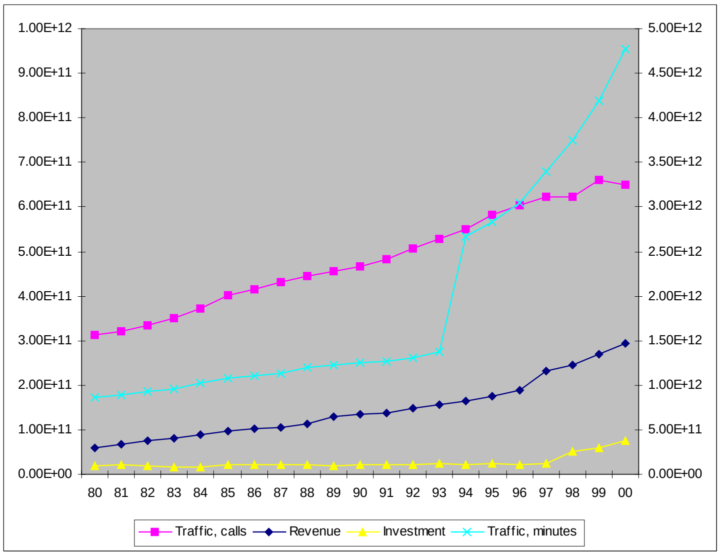

Figure 14. Measurement along the value chain, USA 1980-2000

Note: Calls and revenues are related to the left axis.

A more detailed view of telephone demand is shown in Figure 15 in terms of main telephone lines, and in Figure 16 in terms of mobile users. Figure 17 is reflecting the call volume in the number of calls, and in the number of minutes-of-use. Thereby a distinction is made between local, national long-distance, and international traffic.

Figure 18, Figure 19, Figure 20, and Figure 21 show the data 'along the value chain' for the three variables: traffic, revenue and investment for the USA over the period 1980-2000. The same calculation principles have been applied as for the Western European data set. The percentage deviation from the trend line is reflected in Figure 22.

Note to the graphs: the data and regression line are shown related to the left hand axis; the annual growth information is related to the right hand axis.

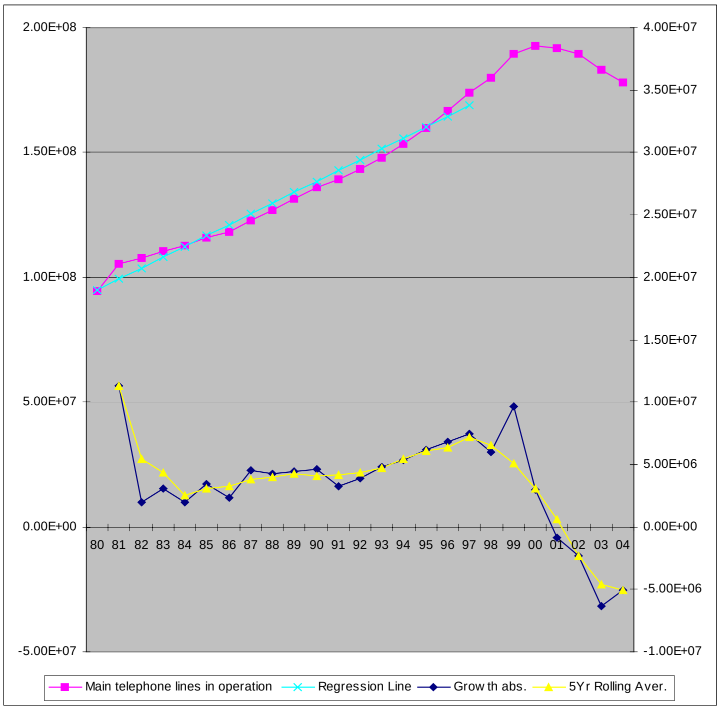

Figure 15. Main telephone lines, USA 1980-2004

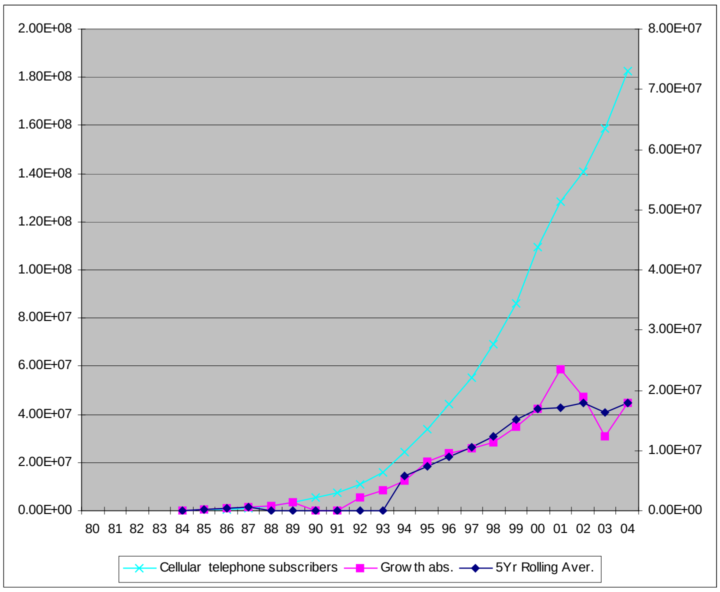

Figure 16. Cellular telephone users, USA 1980-2004

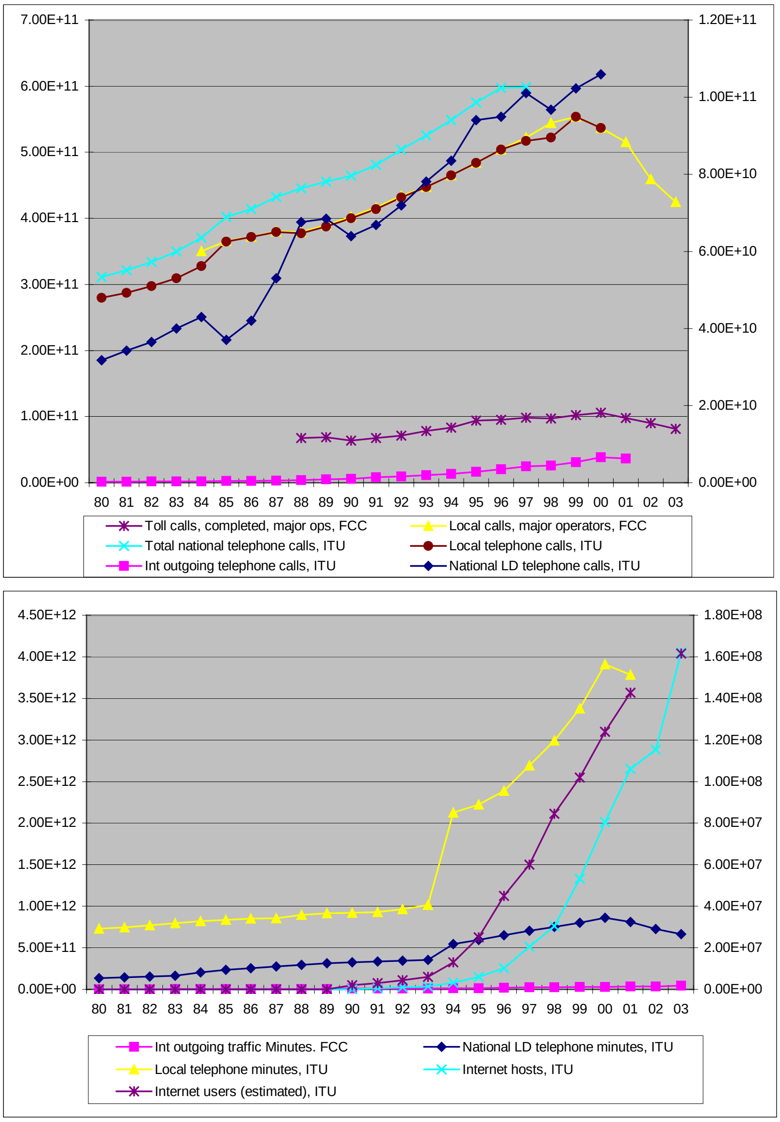

Figure 17. Telephone demand USA, 1980-2003

Notes: Top graph local, toll and national calls are related to the left axis; bottom graph local, national and international outgoing minutes are related to the left axis.

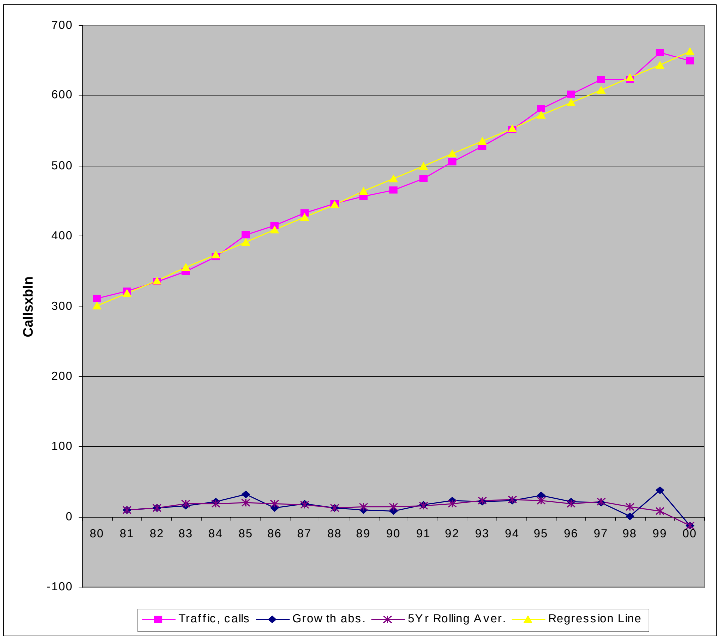

Figure 18. Traffic data - calls USA, 1980-2000

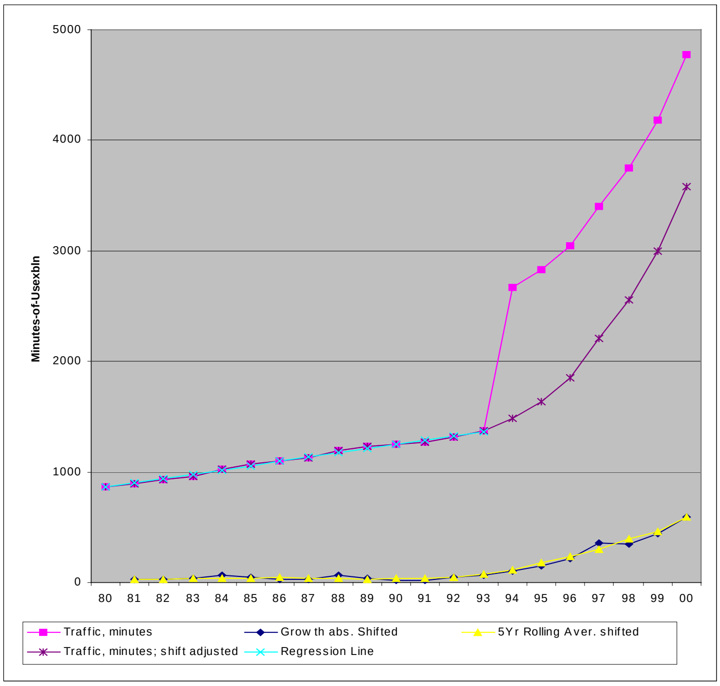

Figure 19. Traffic data - minutes USA, 1980-2000

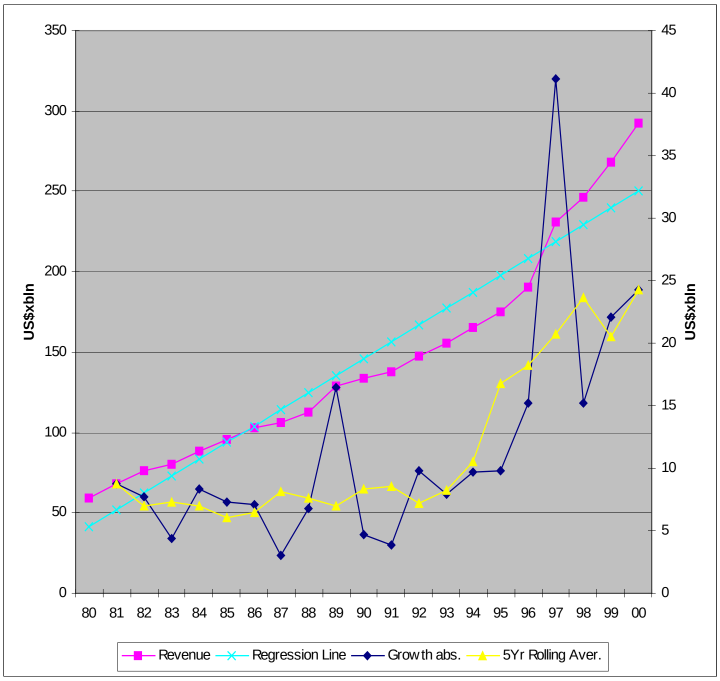

Figure 20. Revenue data USA, 1980-2000

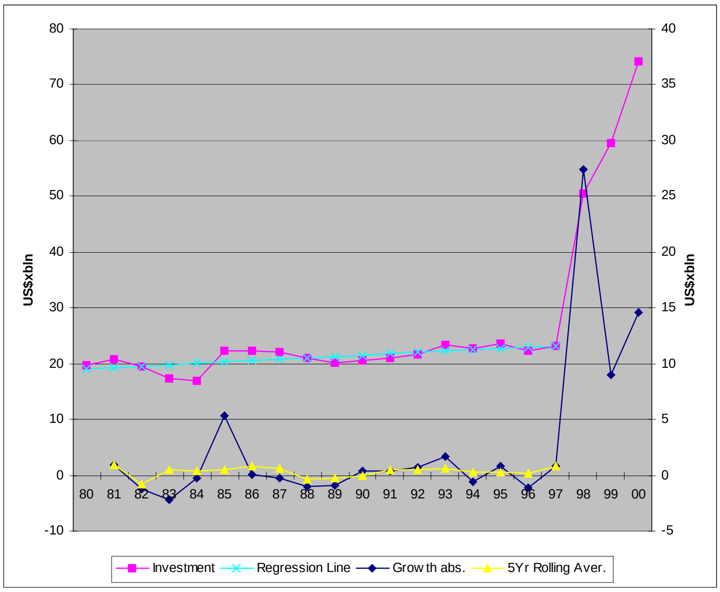

Figure 21. Investment data USA, 1980-2000

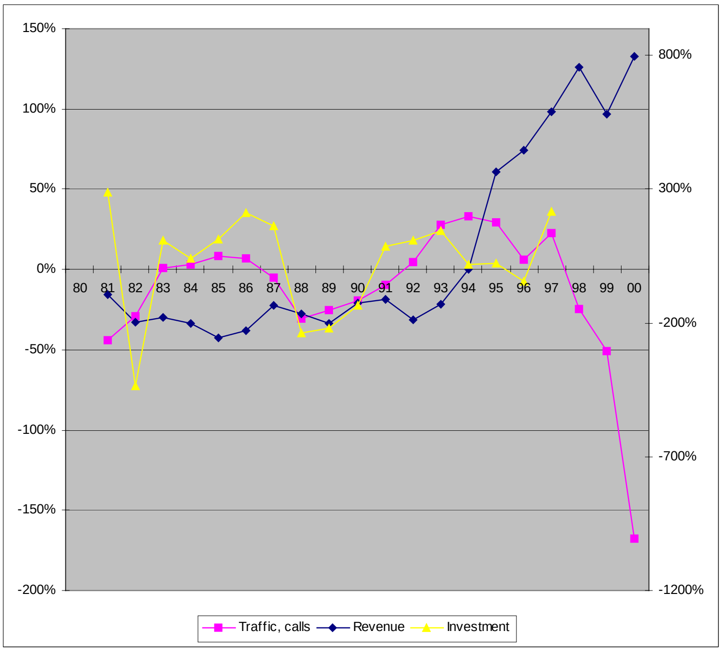

Figure 22. Fluctuation in traffic, revenues, investments - USA 1980-2000

Note: Investment is related to the right hand axis.

Initial observations

The primary variable – Telecommunication demand

From Figure 15 and 16 we may derive the same conclusions with respect to network connectivity and the role of mobility and the Internet as stated earlier for the Western European sample.[24]

From 1993 to 1994 a steep increase in Minutes-of-Use at the local call level can be observed, being followed by an exponential increase, while the number of calls appears to continue along the trend line. This shift and increase in growth rate can be explained by the emergence of the Internet. In the early period Internet access was provided through dial-up access over the telephone line. As in the USA local calls are not individually metered, but charged as part of a fixed monthly fee, the length of the call is not price sensitive. This is in contrast to Europe where Internet access was charged by the minute and hence the phenomenon is far less pronounced in Europe.

The number of calls is showing a cyclical pattern for the period 1981-1996.[25] Albeit the deviation from the trend line increase is minor and will not constitute a strategic trigger.

The secondary variable – Revenues

The revenue data does not reflect a cyclical fluctuation.[26]

The tertiary variable – Investments
The investment data is the most pronounced in terms of cyclicality. Measured over the extremes the cycle time would be 9 years. See further the investment level per line (fixed) and per user (fixed plus mobile) as reflected in Figure 23.

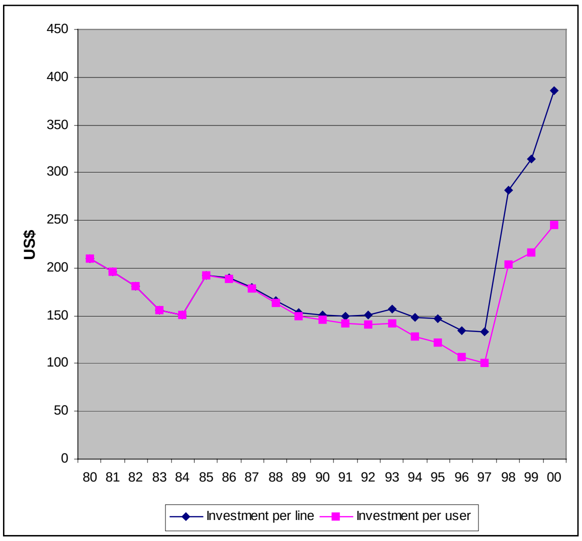

Figure 23. Investment per line and user, USA 1980-2000

Summary and conclusion
Although there is a significant difference in the impact of the Internet between Western Europe and the USA, the analysis suggests that with respect to cyclicality the same conclusions can be drawn, i.e. no end-user driven industry cycle is apparent. However, the demand for telecommunications equipment, software and services, as measured through the investments made by the operators, is demonstrating a cyclical behaviour triggered primarily by technological and service driven change.

Overall, for the periods considered and for the countries analyzed, an emerging industry cycle can be observed for the telecommunication industry with tentatively a cyclicality of approx. 10 years. Albeit, the appearance of one to two cycles is to limited to derive firm conclusions.

Notes for Annex 8

[1] De Wit observes that while there is a substantive body of economic literature on economic cycles, the strategy literature is very light on addressing cyclicality and the formulation of implications for strategy formation (De Wit, 1994).
[2] ITU database of Telecommunications Economic Indicators, COINS. This database is compiled from statistics provided by member countries and associated organizations. It contains telecom industry related information regarding: teledensity, traffic (Minutes-of-Use), revenues, investments, employment; and general indicators such as: GDP, population, and households The time series cover on an annual basis the period 1975-2001 and extend to 1960 in 5 year increments. A total of 209 geopolitical entities are covered, from Afghanistan to Zimbabwe. Not all variables are reported by all geopolitical entities for each year.
[3] The data set for the year 2000 has been completed with revenue for The Netherlands extrapolated using previous years growth (maximum deviation from total <1%); Income for Luxembourg (deviation <<1%) and income for The Netherlands (maximum deviation from total <1%); Investments have been kept flat year afterr year for Germany, The Netherlands, Spain and the United Kingdom. An extrapolation based on annual growth would have yielded an Investment/Income ratio of 62%.
[4] Rentals also include leased line revenues. For the transfer of Internet traffic in the back bone network leased lines are being used. The FCC data shows a revenue growth for international private line service from US$ 336 mln (2.9% of total billed minutes of international service) in 1993, to $ 514 mln (3.2%) in 1995, $ 1480 mln (4.9%) in 2000 to $ 620 mln (1.5%) in 2003 (FCC, 2005b). Long-distance private line revenues were amounting to US$ 3095 mln (4.6% of total telecommunications revenue) in 1993, $ 9719 mln (4.9%) in 1995, $ 16189 mln (5.5%) in 2000 and $ 15108 mln (5.2%) in 2003 (FCC, 2005a).
[5] The application of a linear regression line to approximate the underlying trend is quite appropriate for the traffic variable with R^2=0.948. For the revenue variable R^2=0.931, a good fit. However, for the investment variable R^2=0.559 an acceptable but not a perfect fit.
[6] The 5-year rolling average takes the arithmetic average for the variable over the time periods t-2, t-1, t, t+1,t+2. This average is adjusted for the early and final years.
[7] The indicator of curve-fit R^2 for the full period is 0.983. The standard deviation is 4.41E+06.
[8] The indicator of curve-fit R^2 for the period is 0.911. The standard deviation is 1.34E+10.
[9] The indicator of curve-fit R^2 for the period is 0.819. The standard deviation is 3.27 E+09.
[10] As the investment data used in this calculation is an aggregate of firms across countries, a difference in timing may lead to ‘canceling out’ of ups and downs in the level of investments.
[11] The ITU data on leased lines is very incomplete. A sample of Spain and France over the period 1981-1998 has been used.
[12] Average call duration in 2001 on the KPN network was 250 seconds, including Internet calls (KPN, 2001).
[13] The Internet traffic is becoming a significant portion of the total traffic carried For KPN in 2000 the internet traffic was 32% of the total volume in minutes (KPN, 2001).
[14] The penetration of ADSL in this period is still very low in most countries, with the notable exception of Germany where DT has realized 2.2 mln. connections by the end of the year 2001. This represents 2.3% of DT’s network connections.
[15] It is assumed that the narrowband connectivity provided by CA-TV operators is underrepresented or not represented at all in the ITU statistics, which are traditionally based on data provided by incumbent (PSTN) operators.

[16] Considering the statistical nature of telecommunications traffic, equipment planning has always included a safety margin. However when demand change is minimal for an extended period engineers tend to further optimize the network and make the network more prone to congestion if demand increases unexpectedly. This has been the case in the network of KPN in the 1980's.

[17] Economic life time of fiber cables is yet to be determined. The longest deployed equipment relates to undersea cables. The majority of fiber is now deployed in national and city networks. The life span is being extended through capacity upgrades using newer generations of transmission terminal equipment.

[18] Radio base stations life span is derived from the operational life of analogue cellular radio 1981-1995 (example NMT 450); GSM is deployed from 1992 and will be deployed well beyond the introduction date of 3G, which started in 2003.

[19] Circuit switching economic life span (from introduction to capping): for analogue SPC 1975-1995 (example Philips PRX/A), for digital SPC 1982-2000 (example AT&T 5ESS), for routers being deployed since1985 (example Cisco). As the equipment becomes less dedicated and more general purpose, standard microprocessor based, the life time tends to approaching that of general purpose computers.

[20] Transmission equipment life span varies depending on type of equipment and application: long or short haul – transatlantic or city ring. The first transatlantic cables were in operation for around 20 years. The first optical cables for 14 to 10 years.

[21] Mobile switching equipment see Radio base stations, Note 18.

[22] Network management systems life span is determined primarily by the computing platforms involved. This also applies for the operations and business support systems.

[23] Business and operation support systems see Network management systems.

[24] The indicator of curve-fit R^2 for the period is 0.983. The standard deviation is 3.10E+06.

[25] The indicator of curve-fit R^2 for the period is 0.992. The standard deviation is 1.05E+10.

[26] The indicator of curve-fit R^2 for the period is 0.924. The standard deviation is 1.95E+10.

Summary
Samenvatting

“The Internet bubble and the impact on the development path of the telecommunication sector”

Summary

In this research project the impact of the Internet bubble on the development path of the telecom sector has been explored and explained; the insights thus obtained are used to assess the implications for policy and strategy formation in the aftermath.
The period being addressed is centred around the bubble period 1995-2002, the recommendations are oriented towards the future, from 2006 and beyond. The study links the developments in the communication sector to those in the information technology sector. The geographical focus is oriented to the USA and Europe.

Research approach
The overarching research approach applied is called *critical realism*. The world is thereby perceived as complexly structured, open, intrinsically dynamic and characterized by emergence and hence novelty. The aim of the social sciences is considered as the uncovering of particular social structures of significance, whereby the *explananda* are the practices in which people are engaging, and the *explanans* are the physical, social and psychological conditions of the relevant actions. The purpose within this approach is not prediction, as this would rely on ‘constant event conjunctions’, but the identification and comprehension of the structures, powers, mechanisms and tendencies which produce or facilitate future events. In this respect historical regularities are providing the insights into, as well as the understanding of these structures, powers and mechanisms. Euphoria, separately and also as a part of the broader phenomenon of successive technological revolutions, are bringing about this type of regularity. To assess the long-term impact the focus of the research has been directed to the changes in the industry structure and the role of paradigms and technological trajectories in shaping the development path of an industry.

The impact of infrastructure related periods of euphoria:
From the accounts of historical bubbles reviewed in the context of this project it can be concluded that periods of euphoria are a recurring feature of economic development. The brevity of our ‘financial memory’, the wish to nurture economic growth and our tendency as human beings to pursue opportunities for realising quick gains, will stimulate the development of future bubbles.
From an economic perspective periods of euphoria can be considered inefficient and even wasteful. However, when they occur as part of a new technological revolution, the (over)-investments in the related infrastructure will provide the necessary basis for reaping the potential benefits of the new techno-economic paradigm, including the expected broad-based productivity improvements.
With respect to the productivity improvements, the new ‘Information and Communications’-revolution can be considered to have two ‘installation phases’. In the initial phase the emphasis was on investments in IT. Albeit, these investments

did not yield the anticipated productivity improvement at the aggregate level, and the notion of a productivity paradox emerged. Recent research at firm level has shown that the anticipated productivity improvements only occur over time and if, next to investments in IT-hardware, complementary investments are made in human asset development and in related organizational change.
The second ‘installation phase’ relates to telecommunication, in particular the emergence of the Internet. The Internet leverages the advancements in information and communication technologies and generates productivity improvements through changes in transaction costs, e.g. in terms of changing business models, the changing nature of the market place, and in changes in the degree of information asymmetry. The Internet also places existing institutional arrangements in a new perspective, e.g. in relation to topics such as intellectual property and digital rights management. Moreover, the Internet introduces new technical, economic and social issues to be addressed and resolved. These include issues related to privacy and (virtual) identity, to information security, to phising and spamming, as well as the governance of the Internet.

Implication and recommendation regarding policy:
While it could be argued that the telecom reform process has run its course, the linkage of the telecommunication infrastructure to the diffusion of the new techno-economic paradigm extends the scope of policy formation from telecom reform, to ICT policy and beyond. Many of the changes the paradigm shift has evoked are still very much emergent, and hence have certainly not led to a full alignment between the technological, economic and social domains. It also appears that many of the issues are being addressed in isolation, i.e. not linked to the broader phenomenon of diffusion of a technological revolution. When considered in isolation a resolution may be problematic as the broader goal that should be pursued is not being perceived. Hence, the results may be suboptimal. Therefore, it is being recommended to revisit the current policy formation process against the back drop of the diffusion process of the ‘ICT-driven’ technological revolution.
It should be noted that we are at a unique juncture, the transition from the ‘installation’ phase to the ‘deployment’ phase of the new techno-economic paradigm. This is a period in which the state, economic and social actors can adjust the rules and regulations to facilitate the solid expansion of production capital, with the prospect of a ‘golden age’ to develop.
To facilitate this process the following stepwise approach is recommended: (1) to understand and appreciate the attributes of the paradigm shift, using the Techno-Economic Paradigm framework, (2) to understand and appreciate the relationships to economic activity, using the Transaction Costs Economics framework, (3) to identify the tensions between the current institutional framework that has been optimized for the previous ‘Fordist’-paradigm and the (emerging) needs of the ‘ICT-driven’ paradigm, (4) to assess the scope and impact of these tensions, (5) to identify the solution space (local, regional, global), (6) to identify the stakeholders involved (government, industry, and citizens), and (7) to engage and resolve the issues, as they relate to policy formation and implementation.

The prospect that upon an appropriate adjustment a period of prosperity, a 'golden age', may develop, should present a compelling 'incentive for action' for all actors involved.

Implication and recommendation regarding strategy:
In the 'utility era' of the telecom industry the industry structure was relatively stable and developments were evolutionary. Hence the strategic activity was primarily a matter of long-term planning. The process of telecom reform, involving privatization and the introduction of competition, fundamentally changed the 'rules of game' and moved strategy formation to the forefront of corporate activity.
The period of euphoria is characterized by a quickly expanding range of business opportunities. Hence the frequency of the strategy cycle increases and the strategy horizon changes to medium and short-term. In the period of frenzy 'consensual vision' takes over and strategic formation becomes a 'copy-cat' activity. Alternative views on the development of the industry are being suppressed, and in this euphoric period the incentives, in particular stock options, are driving the behaviour of managers.
In the crash and into the immediate aftermath strategic activity is aimed at survival. The aftermath provides the opportunity to reflect on the effects of the bubble on the industry 'development path' and the underlying changes in industry structure and paradigms. The changes in industry structure are at large the result of the telecom reform process combined with the technology induced transition from the circuit-mode paradigm to the packet-mode paradigm and from fixed to mobile communication. For the telecom operators these changes resulted in the transition from a prevailing voice-dominated business model to an Internet-dominated business model. Moreover, it implied a change in the institutional environment, from primarily government-driven into primarily industry-driven.
The translation of these changes into firm strategy has been and remains the responsibility of the individual firms, recognizing that firms differ in their resource base, in their expectations regarding the future, and in their perspectives on the process of strategy formation.

Wolter LEMSTRA
Eemnes, August 2006

“De Internet bubbel en de invloed op de ontwikkeling van de telecommunicatie sector”

Samenvatting

In dit onderzoeksproject wordt de invloed van de Internetbubbel op de ontwikkeling van de telecommunicatiesector verkend en verklaard; deze inzichten worden vervolgens gebruikt om de gevolgen voor strategieontwikkeling en beleidsvorming in de nadagen van de Internetbubbel in te schatten.
De periode die wordt bestudeerd is gecentreerd rond de bubbelperiode, van 1995-2002, de aanbevelingen betreffen de toekomst, vanaf 2006 en verder. De studie legt een verband tussen de ontwikkelingen in de communicatie sector en de ontwikkelingen in de informatie technologie sector, gericht op de VS en Europa.

Wijze van onderzoek
De gebruikte wijze van onderzoek is gebaseerd op de benadering die bekend staat als *critical realism.* De wereld wordt daarbij gezien als complex van structuur, open, intrinsiek dynamisch en gekarakteriseerd door vernieuwing. Het doel van onderzoek in de sociale wetenschappen wordt beschouwd als het ontdekken van belangrijke sociale structuren, waarbij de *explenandum* betrekking heeft op de activiteit van de mens en de *explenans* op de fysieke, sociale en psychologische condities van deze als relevante geachte activiteit. Binnen deze aanpak is het doel niet het doen van voorspellingen gebaseerd op mathematisch georiënteerde deductie, daar dit slechts gebaseerd kan zijn op de veronderstelling dat de toekomst gedetermineerd is, maar het identificeren en begrijpen van de structuren, krachten en mechanismen die verantwoordelijk zijn voor het ontstaan van toekomstige gebeurtenissen. In dit verband zijn terugkerende verschijnselen in historisch verband van groot belang. Dit betreft bubbelverschijnselen, zowel afzonderlijk beschouwd en als onderdeel van opeenvolgende technologische revoluties. Voor de inschatting van de invloed op langere termijn ligt het onderzoeksaccent op veranderingen in de structuur van de telecommunicatie-industrie en op de rol van paradigma’s en technologische veranderingen in de ontwikkeling van de industrie. In dit deel van het project is de onderzoeksbenadering meer eclectisch, waarbij de begrippen reproductie en transformatie de verbinding leggen met de overkoepelende aanpak op basis van *critical realism*.

De invloed van infrastructuur gerelateerde perioden van euforie
Op basis van de in de context van dit onderzoek onderzochte historische bubbels kan geconcludeerd worden dat perioden van euforie een terugkerend verschijnsel zijn in de economische ontwikkeling. De kortheid van ons ‘financieel geheugen’, de wens om te komen tot economische groei en onze neiging om mogelijkheden tot snel gewin uit te buiten, zal leiden tot de ontwikkeling van bubbels in de toekomst.
Vanuit een economisch perspectief kunnen perioden van euforie gezien worden als inefficiënt en zelfs als verspillend. Echter, als deze plaatsvinden als onderdeel van een nieuwe technologische revolutie, dan zullen de (over-)investeringen in de

gerelateerde infrastructuur de benodigde basis bieden voor het benutten van de potentiële voordelen die het nieuwe techno-economische paradigma met zich meebrengt, inclusief de verwachte breed georiënteerde productiviteitsverbetering.
Met betrekking tot de productiviteitsverbetering kenmerkt de 'Informatie- en Communicatie Revolutie' zich door twee 'installatieperiodes'. In de eerste periode lag de nadruk op investeringen in de IT. Echter, deze investeringen leidden in het begin niet tot de verwachte productiviteitsverbeteringen op geaggregeerd niveau en dit had het ontstaan van de zogenaamde productiviteitsparadox tot gevolg. Recent onderzoek op bedrijfsniveau heeft aangetoond dat de verwachte productiviteitsverbetering alleen op treedt na verloop van tijd en indien, naast de investeringen in IT-apparatuur, aanvullende investeringen plaatsvinden in de ontwikkeling van het 'menselijke kapitaal' en in gerelateerde organisatorische veranderingen.
De tweede 'installatieperiode' heeft betrekking op de telecommunicatie, in het bijzonder het ontstaan van het Internet. Het Internet, gebaseerd op de ontwikkelingen in de informatie- en communicatietechnologieën, draagt bij aan productiviteitsverbetering door een verandering in de transactiekosten, bijv. in termen van verandering in het bedrijfsmodel, in veranderingen in de karakteristieken van de markt en in veranderingen in de mate van informatie-asymmetrie. Het Internet plaatst ook de bestaande institutionele omgeving in een ander perspectief, bijv. met betrekking tot intellectuele eigendomsrechten. Bovendien introduceert het Internet nieuwe technologische, economische en sociale problemen die opgelost moeten worden. Deze hebben betrekking op zaken zoals privacy en (virtuele) identiteit, op informatie beveiliging, op 'phising' en 'spamming', maar ook op de beheersstructuur van het Internet.

De implicaties en aanbevelingen met betrekking tot beleid
Hoewel men zou kunnen beargumenteren dat het hervormingsproces in de telecommunicatiesector is voltooid, zorgt de samenhang van de telecommunicatie-infrastructuur met de verspreiding van het nieuwe techno-economisch paradigma voor een uitbreiding van het beleidsterrein van telecommunicatie naar die van de ICT en daar voorbij. Veel van de veranderingen die door de paradigma-verschuiving tot stand worden gebracht, zijn nog steeds in beweging. Bovendien lopen de ontwikkelingen op het technologische, economische en sociale domein niet parallel. Het lijkt dat veel van de ontstane problemen op zichzelf worden behandeld, dat wil zeggen niet gerelateerd aan het bredere fenomeen van technologische revoluties. Indien de problemen geïsoleerd worden beschouwd is het vinden van een oplossing mogelijkerwijs problematisch aangezien het hogere doel niet wordt herkend. Derhalve kan het resultaat onder de maat blijven. Daarom is de aanbeveling om het huidige beleidsvormingsproces opnieuw te bezien in het licht van het diffusieproces van de door ICT gedreven technologische revolutie.
Het is daarbij van belang te constateren dat we ons bevinden op een belangrijk beslissingsmoment, de overgang van de 'installation' periode naar de 'deployment' periode van het nieuwe techno-economisch paradigma. Dit is een periode waarin de staat, alsmede economische en sociale actoren de mogelijkheid hebben om

regels en de regelgeving aan te passen met het oog op de ontwikkeling van een periode van economische groei, mogelijkerwijs een nieuwe ‘gouden eeuw’.
Om dit proces mogelijk te maken wordt de volgende stapsgewijze aanpak aanbevolen: (1) het leren begrijpen en waarderen van de aspecten in de verandering van het paradigma, op basis van het raamwerk van Technologisch-Economische Paradigma’s, (2) het leren begrijpen en waarderen van de relaties tot het economisch handelen, op basis van het Transactiekosten-model, (3) het identificeren van de spanningen tussen het huidige institutionele raamwerk dat is geoptimaliseerd voor het vorige ‘Fordist’-paradigma en de vereisten van het op de ICT gebaseerde paradigma, (4) het inschatten van de reikwijdte en de invloed van deze spanningen, (5) het bepalen van de oplossingsruimte (lokaal, regionaal, globaal), (6) het bepalen van de belanghebbenden (overheid, industrie, en bevolking), en (7) het aanpakken en oplossen van de problemen met betrekking tot beleidsvorming en beleidsuitvoering.
Het vooruitzicht dat bij een juiste aanpassing een periode van economische bloei kan ontstaan, een nieuwe ‘gouden eeuw’, wordt verondersteld voor velen een ‘uitnodiging tot actie’ te zijn.

De implicaties en aanbevelingen met betrekking tot strategie
In de periode dat het telecommunicatiebedrijf werd gezien als een utiliteitsbedrijf was de industriestructuur relatief stabiel en waren de ontwikkelingen evolutionair. Derhalve was de strategische activiteit vooral een kwestie van lange termijn planning. Het proces van ‘telecom reform’, met daarbij de privatisering en de invoering van concurrentie, heeft de spelregels fundamenteel veranderd, dientengevolge is strategievorming een zeer belangrijke bedrijfsactiviteit geworden. De periode van euforie wordt gekenmerkt door een snelle verbreding van mogelijkheden voor de ondernemer. Derhalve versnelt de strategiecyclus en verandert de strategische horizon naar de middellange en korte termijn. In de ‘frenzy’ periode neemt éénvormigheid van visie op de toekomst de overhand en wordt strategieontwikkeling een kwestie van kopiëren. Alternatieve gezichtspunten omtrent de ontwikkeling van de industrie worden onderdrukt, en in de periode van euforie sturen de beloningsinstrumenten, met name de aandelenopties, het gedrag van de managers.
Gedurende het klappen van de bubbel en in de directe nadagen is de strategische activiteit gericht op overleven. In de nadagen is er gelegenheid om zich te bezinnen op de effecten van de bubbel op het ontwikkelingspad van de industrie en de onderliggende verandering in de industriestructuur en in de paradigma’s. De veranderingen in de industriestructuur zijn in belangrijke mate het gevolg van het ‘telecom reform’ proces in combinatie met de technologisch gedreven verandering van het ‘circuit-geschakelde’ paradigma naar het ‘pakket-geschakelde’ paradigma en de overgang van vaste naar mobiele communicatie. Voor de telecommunicatie-dienstverlener resulteerden deze veranderingen in de overgang van een met name op spraak georiënteerd bedrijfsmodel naar een Internet gedreven bedrijfsmodel. Verder betreft het een verandering in de institutionele omgeving, van grotendeels gedreven door de overheid tot voornamelijk gedreven door de industrie.

De vertaling van deze veranderingen naar de bedrijfsstrategie blijft de verantwoordelijkheid van de individuele onderneming, met name omdat bedrijven verschillen in de ‘resource base’, in het beeld dat zij van de toekomst hebben en in het perspectief betreffende het proces van strategievorming.

Wolter LEMSTRA
Eemnes, Augustus 2006

Curriculum Vitae

Curriculum Vitae

Wolter Lemstra was born in Roodeschool, the Netherlands, on the 4th of December 1951. After graduating from the ‘Prins Bernhard HBS’ in IJmuiden in 1970, he studied Electrical Engineering at the Delft University of Technology (TUDelft). He received his ‘Ingenieurs’-degree Cum Laude in 1978 and started his professional career with Philips Telecommunicatie Industrie. More recently he held various senior management and executive positions at AT&T and later Lucent Technologies.

Since 1995 he has been a Faculty Member of Delft TopTech, the School for post graduate and executive education at the TUDelft. In 2001 he joined LIRNE as Director Corporate Liaison (LIRNE is a cooperation on ‘Learning Initiatives on Reform of Network Economies’ between the TUDelft, TU-Denmark, the Media Centre at the London School of Economics, and the University of Witwatersrand in South Africa).

In 2001 he left Lucent Technologies and founded Industry-Insights BV, an executive consulting firm. In 2003 he joined, in a part-time capacity, the Faculty Technology, Policy and Management of the TUDelft as a Senior Research Fellow.

He is also a lecturer in strategy at the Strategy Academy, Rotterdam, and a faculty member of the e-Governance Executive Masters program at École Polytechnique Fédérale de Lausanne (EPFL), Switzerland.

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In this book the impact of the Internet bubble on the development path of the telecommunication sector is being explored and explained. The insights obtained are used to provide recommendations for the formation of government policy and firm strategy in the aftermath.

Periods of euphoria are a recurring feature of economic development and the brevity of our ‘financial memory’ and our tendency to pursue quick gains will stimulate the development of future bubbles. While periods of euphoria are inefficient and even wasteful, when they occur as part of the diffusion of a new technological revolution the over-investments in the related infrastructure will provide the basis for reaping the benefits of the new techno-economic paradigm, including its productivity improvements.

The process of Telecom Reform has fundamentally changed the ‘rules of the game’ in the sector and has moved strategy formation to the forefront of corporate activity. The Internet bubble period is characterized by a quickly expanding range of business opportunities and an accelerated shift from circuit-mode to packet-mode and from fixed to mobile communication. In the period of frenzy ‘consensual vision’ was taking over. In this euphoric period the incentives appear to have driven the behaviour of managers.

The linkage of telecommunication to the diffusion of the new techno-economic paradigm is extending policy formation from Telecom Reform, to ICT policy and beyond. Many of the changes the paradigm shift has evoked are still very much emergent, and have not led to a full alignment between the technological, economical and social domains. Hence, the potential benefits are not yet realized. Therefore, it is recommended to revisit the current policy formation process against the back drop of the diffusion process of the ‘ICT-driven’ technological revolution. The prospect that upon an appropriate adjustment of the institutional environment a period of prosperity, a ‘golden age’, may develop, should present a compelling ‘incentive for action’ for all actors involved.