Telecommunications : understanding the dynamics of the organization of the industry

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Abstract:
This paper focuses on the evolution of the telecommunications industry. Within the economic literature, different analytical assumptions are proposed, from a global sustainability of competition to the re-emergence of a stable oligopoly generated by a process of shakeout through mergers and acquisitions. In a nutshell, then, the understanding of the dynamics of the organization of the industry is still an open question with a multiplicity of answers. The main purpose of this paper is to clarify this timely debate, and to sustain that the organization of the industry is progressively evolving towards an oligopoly structure. The specificities of the argument developed in this paper are the following. Firstly, the paper confronts different analytical frameworks, namely mainstream and evolutionary-based, on key questions such as the successful entry and long term sustainability of new telecommunications carriers, as well as new actors such as Internet-related companies. Secondly, the paper analyses the industry as a broad system called 'info-communications' and composed of 'vertically-related' subsystems such as equipment suppliers, telecommunications carriers, Internet access and service providers, broadcasting and middleware groups. Thirdly, the paper analyzes past and current restructurings observed within this industry over the last twenty years, in order to infer reliable conclusions on the future evolution of this industry. Fourthly, the paper advocates that the evolution of the organization of the industry is mainly driven by the characteristics of the innovative process and by the conditions of its implementation.

Key words:
Innovation, competition, shakeout, telecommunications, info-communications and Internet.

JEL Codes:
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1. Introduction

The historically-based analysis of the telecommunications industry is not in coherence with the general teachings of industry life cycle models in which market structures are intrinsically connected to the stages of evolution of a new product (Fransman, 1998). Within the life cycle framework, a stable oligopoly is supposed to characterize the market structure in the maturity stage as soon as a standard or a dominant design emerges, implying that product innovations are progressively replaced by process innovations (Klepper, 1997). The telecommunications industry, which could have been considered as an industry reaching its phase of maturity and consequently as a specific domain of application of life cycle models, is now faced with new entries, and more generally with a critical process of restructuring driven by a redefinition and an increasing diversification of the uses and products. As a matter of fact, the recent history of the telecommunications industry thus sheds a new light on how processes of innovation and processes of competition are articulated over time.

Different analytical assumptions can be elaborated on this puzzling situation which profoundly questions the theory of industry life cycles. The first (extreme) assumption is a global refutation based on the evidence collected from this industry of the statistical life cycle models. The second one is a major technological discontinuity occurring within the telecommunications life cycle, and related to the emergence of a new technological trajectory driven by the Internet. The third one refers to a transitory turbulence in the organization of the industry, with a subsequent predominance of a stable oligopoly at the end of a (rather) conventional process of shakeout. The purpose of this article is to give content to this third assumption.

We present in a first step the concrete features of the telecommunications industry, as well as major analytical characterizations available in the economic literature of both firms' strategies and organization of the industry. From this selective rather than exhaustive survey, we emphasize the divergent conclusions that can be derived from mainstream and evolutionary approaches on the key question of the evolution of the telecommunications industry (section 2). To proceed the argument further, and to analyze whether the industry evolves towards a competitive or an oligopoly structure, we stress that the industry has to be conceived as a broad system composed of 'vertically-related' subsystems such as equipment

suppliers, telecommunications carriers, Internet access and service providers, broadcasting and middleware groups. This new definition of the industry is useful to analyze the transition from the old telecommunications industry to the new info-communications industry in which activities such as the Internet, computing, software, middleware and broadcasting activities are crucial. Clearly, what occurs within a subsystem is highly dependent on what happens among other (upstream or downstream) subsystems. But, more importantly, this new definition clarifies the challenges related to innovation which is a recurrent phenomenon in this industry. In our perspective, the organization of the industry must be considered as a means of making viable innovation processes, essentially by providing appropriate incentives and adaptability conditions. Firstly, the organization of the industry has to favor the entry of new firms into the different subsystems on behalf of an expected relative consistency of investments implemented by each firm. Secondly, some competitive adjustments mechanisms have to appear over time in order to reduce the impact of unexpected disequilibria, e.g. disequilibria which occur despite the desired consistency of investments (section 3). We will build on this basis an analysis of the current evolution of the info-communications at the age of high speed Internet and 3G mobile phones. We will conclude that the latest evolutions observed within the info-communications industry seem to validate the assumption of shakeout – obtained either through a massive process of mergers and acquisitions or by the exit of some firms – is likely to prevail and leads to the emergence of a new oligopoly structure (section 4).

2. Characteristics of the telecommunications industry: facts and theories

An increasing number of publications is dedicated to the characterization of major technological and institutional changes that occurred within the telecommunications industry (Fransman, 2000, 1998; Laffont and Tirole, 2000; Armstrong, 1998; Katz, 1996; Tannenbaum, 1996; Armstrong, Cowan and Vickers, 1994; Baumol and Sidak, 1994; Ungerer, 1988; Temin, 1987; Brock, 1986[1]). These contributions provide an in-depth analysis of the implications of these changes on the industry structure over the 1980's and 1990's, using different analytical frameworks – namely mainstream or evolutionary. Nevertheless, the

[1] We should also mention numerous bulletins and reports published by regulators, especially FCC in the US, OFTEL in the UK and ART in France.

conclusions derived from these analytical frameworks regarding the evolution of the industry are divergent, and this involves further investigations.

2.1. From monopoly to competition

Until the 1980's, the industry of telecommunications is characterized by the following elements. The industry is composed of telecommunications carriers which are monopolies (generally, state-monopolies), and have a full control over the infrastructures and services in their respective countries. The technologies are based on circuit-switched systems – which means that a leased line is pre-allocated by the telecommunications carrier to the end-users for all the duration of the connection – and provides a well-defined and closed set of applications, namely the transmission of voice calls (local, long distance and international) and the fax[2]. These monopolies can either be vertically-integrated with their equipment providers (this is the case of ATT in the US), or connected with a group of both competitive and cooperative equipment suppliers (this is the case of NTT with a group of four different equipment suppliers), or intrinsically linked with them through a bilateral monopoly structure (this is the case of Deutsche Telekom with Siemens, and France Telecom with Alcatel)[3]. The industry is considered as globally efficient in the sense that recurrent cost decreases were echoed on the final market by decreases in prices[4]. The industry is highly innovative, mainly on the specific domain of the technologies of telecommunications networks, and these innovations are the product of an intensive technological competition between research laboratories, directly

[2] Generally termed as 'POTS', for Plain Old Telecommunications Services.

[3] The observed differences between a pure vertical integration and vertical restraints are not significant because, within this specific organization of the industry, equipment suppliers only had one customer (the monopoly carrier). However, the 1995 divestiture of ATT – that led to the upstream creation of a new equipment supplier Lucent Technologies – occurred in a period of a new competition between operators. More generally, as shown by Fransman (1998), the specific relationships between operators and equipment suppliers play a determinant role on the process of competition within the telecommunications industry.

[4] Voices, however, started to advocate that telecommunications carriers were not always endowed with the adequate incentives to minimize costs and, more importantly, that large disparities in final prices remained from one country to the other. In Europe, a gap of up to 100% (sometimes more) in prices was observed for similar connections. In 1986, for instance, the price for a standard communication (3 minutes) towards any EC country was : 1,62 Ecus for Germany ; 1,65 Ecus for UK ; 2,05 Ecus for France ; 2,92 Ecus for Italy ; 3,15 Ecus for Spain ; and 3,47 Ecus for Irland (Cf. Eurodata Foundation Voicebook, 1986 ; reprinted in Ungerer, 1988).

linked with telecommunications operators[5]. The industry is highly involved in cooperative research projects at the international level[6].

In the recent years, and mainly over the 1990's, the telecommunications industry has incurred many changes, and can thus be characterized by the following elements. The incumbent monopoly firms are privatized, and markets are deregulated in the US or legally liberalized in Europe by a series of EC directives. At that time, the telecommunications industry cannot be reduced to telecommunications carriers and equipment suppliers anymore. Telecommunications has now more intimate connections with connected activities such as computing, software, semiconductors, the Internet and e-commerce, and the media. Consequently, firms which undertake these activities are now closely involved in the evolution of the telecommunications industry. A massive process of entry occurs then with widely different firms arriving in the industry: from small new start-ups to subsidiaries of large incumbent firms previously installed in other industries or countries. Most of them successfully enter the market with no specific competence in telecommunications. In fact, they elaborate some joint-ventures agreements with incumbent telecommunications operators, develop capabilities linked to marketing and retailing activities that progressively became strategic in the telecommunications industry, or even acquire over time telecommunications firms through stock-for-stock transactions.

On the technology side, the industry is faced with recurrent and major technological innovations, the most drastic one being the packet-switched technology which implies that messages, decomposed in packets, are sent all over the Internet network and further reassembled at termination. The development of high capacity and intelligent networks has involved a multiplication as well as a qualitative diversity of applications (either effective, such as toll-free numbers, name or number identification, voice messaging, routing of calls, data transfer, home banking, video on demand, videoconferencing, online services; or in

[5] These laboratories and research centres developed the main technologies that carriers used to connect people and to ensure the exchanges of information through different applications (telephony, fax and 0800 services): RTC, RNIS. More recently ADSL/XDSL systems were developed to ensure a broadband traffic for voice, data and video through the existing infrastructures of telecommunications operators. Nevertheless, the IP technologies directly linked with the development of Internet networks were generally neglected by these research centres, or not considered as a priority by incumbent (ex-monopolies) telecommunications operators.

[6] See, for instance, EC Programs such as ESPRIT for research and development in the domain of the information technologies, RACE for large band integrated communications in Europe, and STAR for the development of high tech services and network in low performing regions in Europe, but also EVE, INSIS and CADDIA.

development, such as telephony over the Internet, online services over mobile phones)[7]. The increasing number of networks supporting these technological innovations are then induced to develop a global inter-compatibility to connect end-users: public switched telecommunications networks for local, long distance and international calls operated by incumbent firms require to be interconnected with new entrants' networks, namely mobile networks, cable TV networks, digital technologies for local area network and wide area network – LAN and WAN – and more generally IP technologies for the Internet. Moreover, entrants build and extend their networks progressively and are generally obliged – at least for a certain period of time – to lease the existing networks operated by incumbents. The specificity here is that the equipment suppliers are the main technology providers. Incumbents massively disengage from R&D activities to focus on the operation and management of the network and on the provision of associated services.

On the market side, the industry has to deal with an explosion of new uses that refer to an increasing diversification and differentiation of demand (real or potential) for products and services in the global domain of information and communication. One can cite, for instance, the development of the multimedia which implies the management and end-to-end transfer of an open set of communications applications such as voice, texts, graphs, sounds, fixed images or videos; the emergence of communications between groups of users based on new patterns of infrastructures and services; the need for end-users friendliness, reliability and safety relying on high performance networks; the choice for mobility of the equipment premise, of the end-user, of the services, of the different elements within the network. The specificity here is that these new market opportunities are not captured initially by existing firms but by new entrants. New firms are then able to analyze customers' attempts in terms of technologies and associated services generally better than what the incumbents used to do. Finally, significant decreases in price are registered in most countries[8].

2.2. Structure and evolution of the industry

What are then the implications of these new specificities on the strategies of firms and further on the whole organization of the industry? Within the economic literature, two main different interpretations are available. The first one focuses on the structure of the industry,

[7] Pretty Amazing New Services, or PANS.

[8] When liberalization was introduced in France in 1998, the average price per month decreased by 5,5% for residential users and 10,8% for enterprises (cf. ART, 1998, *Annual Report*).

especially on its impact on prices and further on the whole efficiency of a network industry. The second one aims at characterizing the main driving forces of the evolution of the industry.

2.2.1. Structure of the industry and pricing issues

Mainstream industrial organization focuses on the pricing rules that are required in a context of transition from a monopoly structure to a competitive structure occurring especially in network industries. Laffont and Tirole (2000), for instance, analyze the different pricing regimes imposed by regulators mainly in the US telecommunications industry. The authors examine in turn the respective characteristics of a *performance-based pricing system* in which the regulator makes the incumbent telecommunications carriers accountable for a higher fraction of their costs, a more *business-oriented pricing structure* in which the regulator fixes an average level price called 'price cap', and the *current flexible pricing regime*[9]. They focus on the new competitive game between incumbents who own or control the facilities-based infrastructure through the development of proprietary networks, and entrants who do not own nor control such a complete network. In this context, three main strategies can be implemented by entrants. Firstly, they can choose to *build their own network*. This duplication of the infrastructure requires a high level of investment, and may imply at the same time important losses in economies of scale and scope[10]. In most cases, however, this strategy which is capital and time-consuming is complemented by other solutions dedicated to connect the entrants' customers through the incumbents' existing infrastructures. The second and third strategies – resale and unbundling – are possible complements in this context. *Resale* implies that the entrant buys the incumbent's services (mainly the local loop services) at a discount rate and resells these services to its own end-users customers. Finally, *unbundling* corresponds to a situation in which the entrant can lease only some elements of the incumbent's infrastructures and services[11]. These different strategies require the implementation of specific pricing rules, namely cost-based pricing (such as *total element long run incremental cost*) or opportunity costs pricing (such as *efficient component pricing rule*). In any case, however, the main problem is the elaboration of pricing agreements between incumbents and entrants, and this requires an in-depth analysis of the incentives of

[9] These systems are part of the « incentive or performance-based reform ».
[10] This element justified for a long time the predominance of a natural monopoly for the telecommunications industry.
[11] In this case, and in most countries, regulators impose to the incumbents a list of the unbundled elements to be leased by the entrants : local loops, switching, interoffice transmission facilities, databases and signaling systems, operator services and directory assistance (see Laffont and Tirole, ibid, p. 24). Regulators protect entrants from specific incumbents' behaviors, such as 'ties', 'bundling' or 'requirements contracting'.

the different players involved in the competitive game. The specificity here is that, in most cases, the traditional marginal cost pricing does not involve sufficient incentives for firms involved in long term investments or in business segments requiring large joint and common costs. In this context, some price discrimination implemented either at the retail level or at the wholesale level (access pricing) tend to reduce pricing distortions.

The main implication for the organization of the industry is then the multiplication of agreements between incumbents and entrants in order to favor a global interconnection between networks. These agreements can generate in turn a more concentrated organization of the industry if pricing strategies occur in a context of conflicting incentives, implying processes of merger and acquisition between incumbents and entrants. Mergers and acquisitions can be considered as optimal strategies to endogeneize a (negative) externality such as double marginalization, price distorsion, opportunism or asymmetry of information. The increasing involvement of regulation authorities in the specific domain of interconnection shows that the relationship between incumbents and entrants is certainly a conflicting one. Moreover, the fact that mergers and acquisitions are increasingly observed in practice gives evidence that this kind of strategies can solve conflicts of interest between incumbents and entrants, and sometimes bypasses the role of the regulator.

2.2.2. Evolution of the industry and sources of change

More evolutionary-based analyses of the changing nature of the telecommunications industry are also available. Within this framework, the strategies of firms, and further the evolution of the telecommunications industry, cannot be reduced to pricing issues. According to Fransman (1998, 2000), the problem is to define "the main driving forces of the evolution of the industry" (Fransman, 1998, p. 5)[12]. More specifically, instead of considering that the new competition between incumbents and entrants is a basic given fact, the author focuses on the different processes by which new firms successfully entered the industry. Four major

[12] The author refers directly to the 'prime movers', 'fundamental impulses' or 'engines' formerly emphasized by Schumpeter (1966). According to Fransman « It is not claimed, however, that this approach offers a panacea. Apart from the additional complexity that it adds, it raises the difficult problem of how the industry's dynamics or driving forces are to be identified. At present, the author's only answer to this problem is that a good deal of knowledge of the industry is necessary. But this, clearly, is inadequate in view of the interpretative ambiguity that is likely to arise, even among those knowledgeable about the industry, regarding what *the* driving forces of the industry are ». (Fransman, 1998, p. 5, author's emphasis). The analysis developed by this author is not reduced to evolutionary frameworks : it deals also with post-marshallian notions developed by Penrose or Richardson. This is why his analysis is termed here as « evolutionary-based », rather that purely « evolutionary ».

drivers are then listed and analyzed by the author (ibid, p. 11-35). The first one refers to *the quasi-vertical specialization between telecommunications carriers and equipment suppliers*. Over the recent years, equipment suppliers significantly increased their expenses in R&D in order to satisfy new emerging demands from the new telecommunications carriers. This implied that the traditionally high barriers to entry involved by the need to elaborate a productive capacity were significantly lowered: new entrants could enter the industry without any R&D expenses. This quantitative change in the strategy of equipment suppliers was also complemented by a significant qualitative change involved by the necessity to acquire new capabilities related to the development of Internet and software equipment dedicated to the new entrants in telecommunications (see Annex 1). Secondly, *the process of competition occurring between incumbents and entrants is a complex phenomenon in which the assets, technologies, networks and services offered and used by each specific actor play a crucial role*. Incumbents already operate an existing infrastructure (circuit-switched / copper cable) and control an existing set of consumers, and their strategy over the recent years mainly concerned the upgrading of their network (by developing, for instance, data compression techniques such as DSL technologies), associated with a more efficient use of this network through a price competition. New entrants were then induced to use new technologies (packet-switched / IP or cable technologies) supported by alternative networks (optical fiber or cable TV) and dedicated to provide high quality services[13] (see Annex 2). Thirdly, *high performances on stock markets – and, more generally, privileged relationships with financial institutions - favored the emergence and the competitiveness of new firms within the telecommunications industry*. This, in turn, had a decisive impact over the characteristics and mechanisms of the labor market: new entrants could acquire competences and labor force from stock-for-stock transactions (see Annex 3). Fourthly, *the increasing segmentation of consumer demand and rapid change in the communications services created market niches for new firms*. The strategies of these new firms is not to be confined to specialized market segments. Over time, they tend to offer a larger set of services (see Annex 4).

These four major forces give a specific profile of evolution to the telecommunications industry, characterized by the following elements. Firstly, the telecommunications industry does not necessarily evolve towards an oligopoly structure. Both the existence of a vertical

[13] As a matter of fact, the new competition between incumbents and entrants implies that the strategies are now moving "away from equipment-oriented R&D towards the achievement of other objectives such as service

specialization between carriers and equipment suppliers and the increasing diversification of demand imply that entry is profitable, and that a long-term sustainability of latecomers is possible. Exits at the moment are quasi-inexistent and, as such, the end of the story can be different from a traditional shakeout. Secondly, evidence shows that incumbents and original new entrants do not necessarily enjoy a "first movers' competitive advantage", related to the fact that they own or control the essential facilities or enjoy a larger consumer base than latecomers. Especially in the US, latecomers such as Worldcom tended to perform better than established firms, and eventually had the opportunity to acquire original new entrants such as MCI. Thirdly, product innovation coexists with process innovation. An extended set of radically new products and services is proposed to end-users over the recent years. At the same time, recurrent process innovations are provided to improve the quality, the rapidity and the reliability of transmissions over the network. Fourthly, because markets are in constant evolution, we cannot observe a perfect stabilization in market shares. Fifthly, no dominant design is emerging, rather a competition between different standards is observed.

2.2.3. Summing up

The following table summarizes the main problems and results from both mainstream or evolutionary-based analyses of the telecommunications industry.

differentiation (that may depend on software development), speed of response to market opportunities, reliability of services, etc." (Fransman, 1998, p. 17).

	Key questions	Strategies of firms	Implications for the organization of the industry
Mainstream	Definition of (optimal) pricing regimes in a context of the emergence of competition in a network industry	Bilateral level (incumbent and entrant): • Building essential facilities • Resale • Unbundling	Emergence of a globally interconnected network: • Pricing agreements in case of converging incentives • Integration/emergence of oligopoly in case of conflicting incentives
Evolutionary -based	Definition of the drivers of the evolution of the industry: from the 'old' to the 'new' organization of the industry in telecommunications	Multilevel, including: equipment suppliers, telecommunications carriers, Internet access and service providers, broadcasting and middleware groups • Vertical specialization of equipment suppliers • Competition for technologies, networks, services • High performances on stock markets • Increasing diversity of demand	Sustainability of competition: • No shakeout/no oligopoly • Multiplication of products and services • Volatility of market shares • Coexistence of products and process innovations • Shared leadership between incumbents, entrants and latecomers • No dominant design or standardization

Table 1: Synthesis of mainstream and evolutionary-based analysis of the telecommunications industry

These contributions stress the crucial issue of the stability of the current organization of the industry. On the one hand (mainstream), the industry tends to be transformed into a global interconnected network, with a potential domination of an oligopoly composed of firms owning or controlling the essential facilities (i.e. incumbents and original new entrants). On the other hand (evolutionary-based), the evolution of the industry is driven by different forces, and the competitive structure obtained through processes of liberalization and technological innovation can be sustained over time. In both cases, then, the question does not involve a definite answer. In fact, the assumption that oligopoly will be the dominant structure is not less nor more probable than the reverse assumption of the sustainability of competition.

The divergent conclusions of these contributions are quite natural, especially if we look at the key questions they address respectively. In one case, the problem is the definition of an optimal pricing regime in a context of the emergence of competition in a network industry. In the other case, the key issue is the definition of the drivers of the evolution of the industry, that is the underlying economic forces that transformed the telecommunications industry over the recent years. This involves radically different visions of both the strategies

of firms and the organization of the industry, and the opposition between these different visions can generate further teachings about what needs to be investigated.

Firstly, the level of analysis is different. The first approach focuses on bilateral relationships (the incumbent and the entrant), or trilateral relationships (the incumbent, the entrant and the regulator). The interaction between these different entities is given and, in any case, the question of how a new entrant with no specific competence in telecommunications (being initially a software company, an information service provider, a media group, or an infrastructure owner such as electricity, gas, water, railroad companies) could enter the industry and compete with the incumbents is completely neglected. In the second approach, this question is central and involves the analysis of multilateral relationships. Depending on their technological background, their structure, their date of entry, their competences, their strategies, their specific relationships with upstream and downstream firms, some new entrants did better than their competitors, better than established firms. Moreover, key variables are different. In conventional analyses, variables such as the increasing diversity of demand, or the role of high performances in stock markets, are neglected, or at least taken as 'external' (given) features. In evolutionary-based approaches, these variables are key elements in the analysis of the long-term viability of entrants. Especially, helped by a rapidly rising share price, latecomers could successfully enter the market because they could buy the technology to the equipment suppliers, and develop new commercial practices adapted to the increasing diversification of demand.

This first point shows that the evolution of the telecommunications industry cannot be reduced to the sole interaction between telecommunications carriers, namely incumbents and entrants. The analytical framework within which this evolution has to be studied has to include other sets of activities. Especially, this framework has to include upstream and downstream firms who play a direct role on the current competition between incumbents and entrants at the network operator level.

Secondly, assumptions on cost and demand functions are different. Conventional approaches generally focus on problems of price competition in a stable environment, e.g. in a context where cost and demand functions are observable by firms, though not perfectly observable by third parties (the regulator). Evolutionary-based analyses sustain however that this price competition appears as a specific facet of a more complex rivalry in which

disequilibria prevail. These disequilibria are generated by a constant discovery of new technology and market opportunities which implies that cost and demand functions are subject to radical and persistent change.

From this second point, what needs to be investigated is precisely how these disequilibria are generated and what is their impact not only over time, but also at each moment in time. Clearly, any engagement in an innovative process has an impact over the long term market structure, but also over the current market structure as reflected in variations of prices and wages or in the implementation of specific organizational arrangements and restructurings. The feasibility of an innovation, seen as an endogenous change, depends first on the coordinated engagement of the firm with its suppliers and customers, and second on the competitive adjustment mechanisms implemented either endogenously (by firms within the industry) or exogenously (by regulation and competition authorities) to prevent or reduce the effect unexpected disequilibria at each stage of development of the innovation.

These two points will structure the analytical framework we propose to develop in the next section.

3. Innovation and competition in the info-communications industry

Apparently, the literature does not provide a clear answer to the question of the stability of the organization of the telecommunications industry. Part of the problem is that the outcome is highly uncertain, and that the attempt to understanding a reality which is evolving every day is necessarily a complex issue. But, on the other hand, we can also advocate that what is needed to clarify this timely debate is a better characterization of what the telecommunications industry really is, and how innovation proceeds within this industry and affects competition. In what follows, the telecommunications industry now called info-communications will be characterized as a broad system composed of vertically-related subsystems. This definition of the industry allows us to stress that what is occurring within a specific subsystem is highly dependent on what happens within and between the other subsystems. Innovation requires the coordinated engagement of different types of firms, generally involved in different subsystems. Despite the desired consistency of investments of the different firms, this ex-ante coordination does not prevent nevertheless the occurrence of

disequilibria. This requires the step by step implementation of competitive adjustments from price and wage variation, to restructurings, mergers and acquisitions and exits of firms. We provide an illustration of this argument on the basis of a reinterpretation of the 1980's and 1990's waves of liberalization.

3.1. Definition of the industry in terms of vertically-related subsystems

In the literature, some contributors decompose the telecommunications industry into different layers (Noam, 1983; Kavassalis, Lee, Bailey, 1998). However, what these authors mainly emphasize in the definition of the different layers is their technological characteristics. Here, following Fransman (2000)[14], we will stress that the different layers or subsystems refer more importantly to different domains of economic activities. As such, a subsystem regroups firms undertaking some activities which require the same pool of competence in their implementation. If the activities undertaken by firms do not require similar capabilities, but rather complementary (e.g. vertically-related) ones, different vertically-related subsystems can be defined. In this perspective, the main problem is to understand how a given firm can be present in different subsystems, and what is the opportunity for that firm to move from one subsystem to the other. Because economic activities are generally separable, though related, and evolving, firms can enter in some of these activities, and outsource others through market or cooperation agreements in order to evolve and progressively adapt themselves to economic changes.

In this perspective, we propose a decomposition of the telecommunications industry into the following different subsystems (Fransman, 2000 ; Fransman and Krafft, 2001):

1. The *equipment provision subsystem*: regroups firms (equipment suppliers) specialized in the development of switches, transmission equipment, routers, servers, billing software.

2. The *network operation/management and associated services subsystem*: regroups network operators (telecommunications carriers) involved in fixed and mobile telephony.

3. The *Internet connectivity and associated services subsystem*: regroups firms (Internet access providers and Internet service providers) involved in Internet backbone provision, e-mail, and web hosting.

[14] See also www.Telecomvisions.com.

4. The *navigation and middleware subsystem*: regroups firms involved in search engines, browsers, security electronic payment services.

5. The *content subsystem*: regroups firms involved in web design, online services, broadcasting services.

The link between these different subsystems is obviously a technical one: to operate a network, network and customer promise equipments are needed. In turn, Internet access and services, and further content and security, are provided on the basis of a network. Nevertheless and more importantly, these different subsystems are also linked from an economic point of view. Subsystem 1 provides most of the R&D on products and processes, Subsystem 2 essentially products telecommunications services, Subsystem 3 commercializes Internet services, Subsystem 4 provides additional services concerning selection and security of information, and Subsystem 5 provides end-users with a larger set of applications and content. The whole system, decomposed into five subsystems, corresponds to an 'extended production process' in which activities of conception, production, commercialization and marketing are present.

3.2. Coordination, competitive adjustments and incentives: the nature of an innovative choice

The characteristics of the telecommunications industry is to be recurrently faced with major changes due to innovative choices. Innovation has two main specificities (Amendola and Gaffard, 1988). Firstly, the process of innovation is at the same time one of development of the technology and of transformation of the productive structure of the economy. As such, the environment itself changes together with the technology as the process of innovation goes on. Secondly, the process of innovation is not linear. It is characterized by a continuous feedback between technology and the environment. Especially, permanent feedbacks occur within the different (vertically-related) subsystems, each of which plays a specific role in the different phases of development of the innovation (from the R&D stage to the marketing stage).

An innovative choice implies the breaking up of the existing industrial structure and a modification of the market conditions, followed by a gradual reshaping which reflects the changes in cost conditions, in profitability and in relative prices, the modifications of the consumers' preference system, and all the other events that represent the specific episodes

that mark the actual profile of the process of innovation. Innovation thus appears as a process of research and learning which results in the appearance of new productive options, and further in the modification of the environment itself. Technology is then the result of the process of innovation, and not a pre-condition of it; the process of innovation is a process of 'creation of technology' which, when successfully brought about, makes it possible to obtain increasing returns. Thus defined, innovation is an essentially sequential process which takes (and can change) form, content and direction at each successive step. The problem of technological change does not consists so much in the choice between given alternatives (whether based on complete or incomplete information), rather it is a search for coordinating as well as possible the innovation process. Accordingly the economic aspect of this problem is no longer represented by the 'rationality' of the choice between known alternatives, but by the 'viability' of the process through which a different alternative is brought about. This viability depends on how coordination problems are dealt with step by step, that is, on how the process of competition takes place.

For a process of change to take place investments must be decided and actually undertaken in a coordinated way. After a phase of construction, these investments will result into a new productive capacity to be matched by a corresponding demand for final output during the phase of utilization. As Richardson (1990) puts it, the profitability of any investment project depends on the setting up of a satisfactory amount of both complementary and competitive investments along the way. The volume of competitive investment must not exceed a critical limit set by the demand available, and the volume of complementary investment has to go beyond a minimal threshold for the investment project considered to be feasible. This means that the innovative firm has to control and coordinate the further implementation of complementary investments engaged by clients, suppliers or partners in order to sustain the in-process investments, but also to limit the engagement of competitive investments by rivals. Clearly, at any point in time, the cost and demand functions of the innovative firm and thus the feasibility of the innovative choice are highly dependent on what other firms do, either within the same subsystem or in upstream and downstream subsystems. A coordination within and between subsystems sustains the innovative process. Of course if firms immediately had a complete information on all existing investment projects no coordination problem would arise, and eventually there would be no imbalance between supply and demand on the market for final output. However "it seems more reasonable to assume that entrepreneurs will generally learn of the investment commitments of others only

after a certain period of time which, for convenience, will be called the transmission interval" (ibid. p.51). A specific coordination problem emerges, a problem that becomes effective if we also take into account another delay, the delay of construction, which characterizes the production process. The problem of coordination arises then at the junction of these two lags: the delay of construction of productive capacity - which entails sunk costs - and the delay of transmission of information - which implies uncertainty (Krafft and Ravix, 2000)[15].

The coordination problem, however, is a recurrent one. It re-emerges at each step of the sequence of the innovative process and cannot be solved once for all by an appropriate incentive scheme. Even if an ex-ante coordination of the investment decisions was achieved, we cannot neglect that any technological change results in unexpected disequilibria. One reason is that human and financial resources constraints necessary emerge, and this generates distortions in the balance of the production process between construction and utilization phases. Another reason is that production and information delays necessarily generate market imbalances. These distortions and imbalances induce discrepancies between costs and proceeds. According to Alchian, costs depend not only on the current output, but also on the total volume of output, the moment at which the first unit of output is to be completed, and the length of the interval over which the output is made available (Alchian 1959, p. 24). In this perspective, it is no longer possible to separate the phase of construction from the phase of utilization of production processes. For instance, sunk costs which are nothing but adjustment costs interfere along the way with price and output decisions. The problem is how to deal with these discrepancies between costs and proceeds, in fact how to prevent them from being cumulative.

These considerations lead to reconsider what incentives really are. In the literature, incentives issues are linked with productivity issues in the following sense. Productivity can be determined either exogenously or as a mechanical result of the amount of R&D spending. In this latter case, incentives play a role: R&D expenditures are highly dependent on the players' incentives to engage them. Nevertheless, these incentives essentially express the

[15] Both lags must be taken into account in the analysis, because cancelling one of them also cancels the co-ordination problem. Thus absence of the latter lag guarantees the equilibrium between supply and demand in each period of the sequence through which a superior technique is adopted by the economy. While overlooking of the lag represented by the construction phase, even in presence of incomplete information leading to mistakes in investment, allows not only a revision of plans, but this to be instantaneous, so as to cancel imbalances at the very moment of their appearance.

strategic interdependencies between players on the basis of a given technology or the expected result of a given technological change. Incentives are basically evaluated with respect to market imperfections: market imperfections can weaken the incentives to innovate but, on the other hand, incentives schemes may compensate the effects of market imperfections (among them asymmetries of information). However, incentives can be analysed in a different perspective, especially if we consider the conditions by which innovation processes actually take place and productivity gains are really obtained. In this perspective, the productivity level does not pre-exist; rather it is the result of an economic process, i.e. the way in which coordination problems are dealt with *along the way*. Incentives are intrinsically linked to the *time profile* of production costs. This means that for making viable innovation processes and for creating appropriate incentives, a consistency between the nature of technological change (identified by the frequency of innovations, the costs and the duration of construction and utilisation of new productive capacities), and the current organisational arrangements (restructurings, exits, mergers and acquisitions) have to be maintained either by firms or by specific authorities. In this context, the problem is to build an appropriate innovation system, which is a blend of market and organisation elements (Amendola and Gaffard 1992, 1994, Amendola, Gaffard and Musso 2000 a, b, c; Krafft, 2000).

3.3. The impact of the incentive reform: a revised interpretation of liberalization

A focus on the different waves of liberalization in the 1980's and 1990's is useful to illustrate how firms and regulation or competition authorities interacted in the development of new activities on behalf of an expected relative consistency of investments, and also in the implementation of competitive adjustment mechanisms to reduce the impact of unexpected disequilibria. Moreover, this illustration shows that although the first wave of liberalization was mainly developed in order to correct market imperfections in a given technological context, the second wave of liberalization produced incentives to develop viable innovation processes sustained by specific organizational arrangements.

The official rationale of liberalization was the introduction of a price competition and the achievement of an increased customers surplus in a context which was characterized, in a former analysis, by a relative stability of the structure of the industry, if not of the

technology[16]. Liberalization was introduced through different decisions by regulators: the divestiture of ATT, but also the entry of a limited number of original new entrants, such as MCI and Sprint in the United States or Mercury in the UK. The underlying argument of these decisions was that, in the case of contestable markets, a natural structure of the industry would emerge with a double effect: the predominance of a technological efficiency (e.g. the minimization of the costs of the industry), and the implementation of optimal prices. Within the regulators' vision of the telecommunications industry, the nature of end-users' requirements was to some extent pre-established (exogenous), and liberalization was intended to favor the emergence of a less concentrated industrial structure to sustain technological efficiency. To illustrate that point, we should mention the role of price caps, one of the major tool implemented within this first wave of liberalization. Telecommunications carriers, namely incumbents such as ATT in the US and original new entrants such as MCI and Sprint, were induced to adjust their price below a certain average level fixed by the regulator, the individual prices being intended to reflect costs and demand elasticities. This pricing regime was implemented to encourage companies to (1) improve their efficiency by developing profit-making incentives to decrease costs, (2) invest efficiently in new plants and facilities, and (3) develop and deploy innovative service offerings.

Nevertheless and over time, US regulators recognize that if points (1) and (2) were achieved, price caps did not provide firms with sufficient incentives to achieve point (3). Recent decisions by the FCC were intended to significantly change the former orientation towards price caps: "The Commission found that (…) the rate structure imposed a costly, time-consuming, and unnecessary burden on incumbent LECs and significantly impeded the introduction of new services". Moreover, "As the market becomes more competitive, such constraints can be counter-productive. We recognize that the variety of access services available on a competitive basis has increased significantly since the adoption of our price cap rules. Therefore, in response to changing market conditions, we grant price cap LECs immediate flexibility to deaverage services in the trunking basket and to introduce new services on a streamline basis"[17].

[16] The stability of the industry is here to be taken in a Marshallian sense, that is in reference to the satisfaction of consumers needs.

[17] FCC 5th report and Order and further notice of proposed rule making (1999), pp. 11-12. This point is also emphasized in Telecommunications Act (1996) (L 104-104), and Access Reform 1st Report and Order (1997) (12 FCC Rcd at 15985, 16094).

This situation produced a second wave of liberalization. Regulators sustained a new organization of the industry in which new entrants were given incentives to implement viable innovative processes.

For these new entrants such as Worldcom, any competitive advantage could not be obtained by replicating the competitive model of established firms (incumbents and original new entrants from the first wave of liberalization), based on technological efficiency under pricing constraints. New entrants were then induced to create their own competitive model to enter the market and further ensure a long term leadership. Their strategy was the exploration of new market opportunities, especially by considering that customers' demand was not standardized but rather diversified and evolving. Specific 'downstream' complementary investments concerning new marketing practices appeared within the telecommunications industry, such as billing systems, management data systems, calling centers, etc. The sunk costs related to these investments were supported by new entrants but also by firms specialized in the Internet, computing and middleware (Subsystem 3 and 4). The development of these new activities required the implementation of mergers and acquisitions to ensure the consistency of investments. Eventually, these mergers and acquisitions were authorized by competition authorities when they were intended to consolidate complementary investments (see for instance Worldcom-UUNet, Worldcom-MCI[18]). Nevertheless, on some occasions, mergers and acquisitions were prohibited (see Worldcom-Sprint): although Worldcom's attempt was to consolidate its end-to-end connectivity network, this acquisition would bring dramatic disequilibria in the mobile market, the second core of activities of Sprint.

New entrants' strategy was also the utilization of new technologies such as IP or cable modems, namely alternative technologies to those that established firms used to employ, and this required the engagement of adequate 'upstream' complementary investments. Especially, new equipment suppliers (Subsystem 1) specialized in IP or cable modems technologies, coming from the computer industry, entered the telecommunications industry and supported the R&D sunk costs. In this case, vertical specialization between Subsystem 1 and 2 seems to provide an adapted organizational arrangement sustaining processes of innovation and competition. However, we should note that this vertical specialization, in which equipment suppliers and telecommunications carriers remain legally independent, is sustained by

[18] Note that this acquisition involved important divestitures especially of Internet activities by MCI.

competitive adjustment mechanisms implemented by firms. Clearly, the fact that equipment suppliers send their labor force to operate and manage the networks within the telecommunications carriers structures (see for instance Cisco-Worldom), or plan some financial contributions in the case of UMTS licenses (see for instance Alcatel, Ericsson and Nokia's recent declarations) is not neutral to the viability of the innovation process, and further to the competitiveness of the current organization of the industry.

In conclusion, what appears then is that the main effect of deregulation was not so much the adaptation of the industrial structure to the new characteristics of the technology than the creation of new market opportunities which were corresponding to the evolving end-users needs for telecommunications networks and services. From an analytical point of view, an essential dimension of the liberalization was the exhibition, or even the creation of a market information (on demand and on market behaviors of the different actors involved in the telecommunications industry) in order to ensure a suitable coordination of complementary and competitive investment and, further, the implementation of these investments to provide firms with the adequate incentives to innovate. Liberalization allowed the entry of new firms which had a profound impact on the evolution of the telecommunications industry which now depends on activities such as Internet, computing, software, and broadcasting. Overtime, competitive adjustment phenomena will proceed in the form of mergers and acquisitions, restructurings, and even exits of some firms. In the next section, we study how these phenomena operate in the domain of high speed Internet and 3G mobile phones.

4. Stability in the organization of the info-communications industry

The different waves of liberalization, combined with the recurrent trends of technological innovation, have produced a new organization of the industry in which a large number of new entrants were registered, as well as the development of new activities such as the Internet, computing, software, middleware and broadcasting. This new organization of the industry, now called info-communications, was represented in a framework composed of different vertically-related subsystems. In this section, we will analyze the stability of this new organization of the industry with respect to subsequent competitive adjustments. In other words, we will investigate what kind of disequilibria may appear over time, and especially what type of solution will be implemented to limit the impact of these in-process

disequilibria. We will focus especially on two cases. The first one is the domain of the end-to-end connectivity, in which the emergence of the high speed Internet involves a transition from narrowband access and service provision to broadband set of activities, and further causes the predominance of some firms and eventually the exit of others. The second one is the domain of the 3G mobiles in which the UMTS auction system may generate turbulence in the organization of the industry[19].

4.1. The economics of the Internet

4.1.1. Origins and evolution

In the 1980's, the Internet was primarily used to connect universities and research groups[20]. Within this period, 'packet switched' technologies, together with the generalization of URL addresses and Hypertext links, led to concrete applications, especially the real-time transfer of documents and e-mails between dispersed groups of scientific users. At this stage, however, Internet applications were not yet market-driven. Even if private telcos provided Internet backbone, the global operation and management of the Internet was undertaken by a public Internet service provider. In the US, with the administrative and technical assistance of ANS (a joint venture of IBM and MCI), the National Science Foundation created NSFNet, a network connecting research groups at a local, regional and national level.

In the 1990's, the development of the World Wide Web allowed a multiplicity of new services such as data transmission, e-commerce and the development of web sites which are now profitable commercial opportunities. With the viability of the Internet having been established, and with the traffic increasing, the NSF decided in 1995 to leave the management and operation of the Internet to private firms. This was the opportunity for telcos, already present in the 1980's as Internet backbone providers, to expand their markets through the extension and upgrading of their network and to provide a large spectrum of Internet services. This also favored the entry of a large number of new firms which are often referred as Internet Access Providers (IAP) and Internet Service Providers (ISP). The IAPs carry the Internet packets as facilities-based companies; the ISPs are facilities-less companies which offer value-added services to customers.

[19] We should note that these two domains are closely linked, because both of them relate to the new competition between fixed and mobile telecommunications carriers at the age of the Internet.

[20] See Abbate (1999) and Antonelli (2000) for further details on the development and generalization of the Internet.

For the 2000's, the use of the Internet is now widespread, with constant technological innovations (e.g. high capacity and intelligent networks) and open-ended applications more and more related to content and middleware activities (e.g. videoconferencing, e-commerce, IP telephony, web design, broadcasting services). For IAPs and ISPs, new challenges appear to sustain their long term viability.

4.1.2. Innovation and coordination

Initially, the entry of new firms in Subsystem 3 was possible because they simply had to lease the infrastructure of a network operator (Subsystem 2), or develop on it some POPs to connect their customers end-to-end. But soon, these firms increasingly extand their activities, and penetrate other subsystems. For instance, large facilities-based IAPs are more and more affiliated to telecommunications carriers (Subsystem 2) looking for a diversification into a value-added activity to recover the sunk costs involved by the development of their backbone network. Large ISPs are also increasingly linked with firms operating in middleware and content activities (Subsystem 4 and 5). Nevertheless, smaller IAPs/ISPs remain exclusively specialized in Subsystem 3. Different strategies can thus be defined, supporting different scenarios at the age of the high speed Internet.

The first scenario is integration between Subsystem 2 and Subsystem 3. This first scenario is well documented in both academic papers (Srinagesh, 1997; Gong and Srinagesh, 1996, 1997; Kavassalis et alii., 1998) and practice (acquisition by Worldcom of UUNet, MCI, and eventually Sprint before being thwarted by the US regulator). This scenario essentially expresses a global integration/consolidation process from telecommunications carriers to IAPs/ISPs, i.e. big telcos extend their competitive advantage on Internet activities[21]. These telcos develop and upgrade their networks to meet the demand for high speed Internet and associated applications, and appear then as major Internet backbone providers. By the integration of ISPs, telcos can accumulate a larger consumer base in order to provide new high speed Internet services at reasonable price.

The second scenario is integration between Subsystem 3, Subsystem 4 and Subsystem 5. This scenario is an integration/consolidation from IAPs/ISPs to the related content and

[21] The reverse scenario – integration from Subsystem 3 towards Subsystem 2 – is less documented, but cannot be neglected if we consider market capitalization of Internet-related companies.

middleware activities (a typical example is AOL's acquisition of Time Warner and the browser Netscape). This means that big IAPs/ISPs progressively extend their competitive leadership on related activities such as software, middleware, broadcasting. By the integration of firms located in Subsystem 4 and 5, big IAPs/ISPs accept to bear high sunk costs in the perspective of high marginal revenues from the determinant role they will have the opportunity to play in the new uses of high speed Internet.

The third scenario is an exclusive specialization in Subsystem 3. This third scenario is a specialization of firms as IAPs/ISPs (Kavassalis et alii., 1998). In fact, despite the consolidation and integration moves previously described, there still are a large numbers of small IAPs/ISPs who specialize in end-to-end connectivity and associated services. Nevertheless, there is a good deal of debate regarding their long term viability.

4.1.3. The process of competition in the Internet

The future economics of the Internet will apparently be driven by two consolidated blocs which are, on the one hand, the global integration between Subsystems 2 and 3 and, on the other hand, the consolidation between Subsystem 4 and 5. Presumably, small ISPs exclusively specialized in Subsystem 3 will not play a dominant role. Clearly, the viability of these small-narrowband Internet companies is highly questioned at the age of high speed Internet. Part of the problem is that Internet access and many Internet services (such as e-mails and web hosting) is becoming a commodity business driven by economies of scale and scope, mainly captured by Subsystem 2 companies. Another problem is that free Internet is robbing ISPs of much of their revenues, making it increasingly difficult to differentiate themselves. While content may be a key differentiator, the cost of differentiated high demand content corresponding to the high speed Internet premises is prohibitively high for many small ISPs. The end-result, very likely is significant shakeout through exit, merger and acquisition, and falling new entry. These IAPs/ISPs have played a key role in the development of the Internet, especially in its commercial uses, as well as in pushing the trend towards free Internet charges. As such, they highly contributed to the radical innovation of the Internet. Nevertheless, for those who did not anticipate the new challenges of high speed Internet, and further did not coordinate complementary and competitive investments, important disequilibria are expected, and this may lead to non-viability.

4.2. The economics of 3G mobiles

4.2.1. Origins and evolution

In the 1980's, mobile telecommunications were essentially used by a limited number of end-users, on a very restricted market area. 1G mobile phones were based on analogue systems which provided low quality transmission services at a very high price. Different standards were offered, depending on the different regions or countries in which mobile telecommunications were developed: NMT and TACS in Europe, NTT system in Japan, AMPS in the US. At that time, only few firms were competing.

In the 1990's, the traffic suddenly explodes and this explosion corresponds to significant cost reduction as well as improved security and voice quality made available by the development of digital 2G mobile systems. Two different types of 2G systems emerged, and each of them generated a set of competing standards. The first system, the cellular mobile system, gave birth to different standards: GSM in Europe, PDC in Japan, and ANSI-136 or ANSI-95 in the US. The second system, the personal communications system, generated DECT in Europe, PHS in Japan, as well as seven different standards in the US. Many new firms were now competing, and the role of Nordic equipment suppliers such as Nokia and Ericsson was boosting the industry.

In the 2000's, a new step is achieved by the development of 3G mobile systems. This new system provides a higher data speed for Internet and multimedia applications. Moreover, this system is intended to favor a world compatibility which was inexistent before, on the basis of a unique standard, the IMT-2000 or UMTS. Different issues are driving the future evolution of mobile telecommunications. First, firms already present in 2G have to decide how to organize the transition towards 3G. Second, because 3G combines highly evolving technologies, the Internet and the mobile, each of them providing an open set of applications, the end-result of this combination is highly uncertain. Clearly, the viability of 3G requires a coordination between firms involved in Subsystem 2, 3, 4 and 5. Finally, while 1G and 2G licenses were allocated according to a beauty contest procedure, many countries – not all – decided that the allocation procedure for 3G would be based on a license auction system. Very high sunk costs are thus involved, and this may produce unpredictable effects on the viability of firms, as well as a large heterogeneity between them.

4.2.2. Innovation and coordination

3G mobile operators are thus concerned with an innovative choice which depends on at least two requirements:

1. to engage the (sunk) costs of the investment in a UMTS license. This primarily requires financial plans such as bank loans, or stock market capitalization. Some equipment suppliers such as Ericsson, Nokia and Alcatel (Subsystem 1) have already announced that the price of the license will be too high for mobile operators and that they certainly will have to elaborate some arrangements with them, and eventually finance in part the investment.

2. to deal with these sunk costs. This means that:
    a. mobile operators have to develop 3G mobiles from a technical point of view (especially the transition 2G-3G), and this involves the active participation of the equipment suppliers (Subsystem 1), especially for R&D expenses.
    b. mobile operators have to create market opportunities for 3G mobiles, and this involves directly Internet access and service providers (Subsystem 3) and content and middleware groups (Subsystem 4), especially for the provision of an extended set of applications and services at a reasonable price.
    c. mobile operators have to face the competition from direct competitors, especially lower costs competitors coming from countries in which a beauty contest was preferred for the allocation of licenses.

In fact the problem of mobile operators is to control the level of complementary and competitive investments, and to elaborate a coordination between these different investments. Points 1, 2a and 2b refer to the coordination of complementary investments: mobile operators enter the new 3G domain if a relative consistency of action between suppliers, clients and partners is achieved. This consistency can be obtained by the continuation of specific relationships with equipment suppliers, and also by the development of portals in collaboration with firms in Subsystem 3, 4 and 5 (see for instance 'i-mode' in Japan, or 'vizzavi' in Europe). Here also, different scenarios can be proposed (see Kano, 2000): from vertical integration into Subsystem 2, 3, 4 and 5, to an exclusive specialization in Subsystem 2 complemented by a geographical expansion. Point 2c essentially refer to the potential limits

that mobile operators can impose on competitors. This latter issue which deals with the process of competition in 3G mobiles is not obvious however and requires a deeper investigation.

4.2.3. The process of competition in 3G mobiles

We would like to tackle this question by analyzing some of the key points that are much debated right now.

The first point is the impact of auctions on the price consumers will have to pay for 3G services. For some economists (see for instance Klemperer, 2000; Cave and Valetti, 2000), the sunk costs involved by the auction system is just 'water under the bridge'. This means that the final price to the consumer will never reflect the sunk costs involved by the price of the license. Namely, a rational firm only takes account of its own forward looking costs and revenues and the likely behavior of firms and, in this context, the license fee which is a sunk cost for all firms does not affect price. Clearly, this statement is in contradiction with the different declarations of top executives of major mobile operators. More importantly, this statement can only be sustained on the basis of specific assumptions. Firstly, all firms in the world are supposed to support similar license fee. This is untrue: the level of licenses were generally high, but not similar among countries; moreover, a number of countries decided not to implement an auction system and preferred a beauty contest. As a consequence, competition will eventually proceed among firms with widely different characteristics and this fact may question this first assumption. Secondly, firms in a rational setting are supposed to constantly behave as if productive choices did not affect market choices not only over time but also at each moment in time. This second assumption is contested by authors such as Richardson and Alchian we mentioned earlier. As a consequence, different firms will presumably bear different sunk costs, and this will constantly interfere along the way with price and output decisions. To us, the major problem for these firms will be to deal with the gap between costs and proceeds, and to prevent these gaps from being cumulative.

The second point is the impact of the auction system on the rolling out of 3G mobile phones. On the one hand, operators have shelled out for licensing billions of euros, which have the status of sunk costs. These costs can only be carried if 3G services quickly start contributing a significant amount of revenues. This means new equipments will have to be delivered as soon as possible. Nokia and Ericsson, which are the main suppliers of the 2G,

clearly have difficulties for meeting demand. Nevertheless, equipment suppliers that lost out the GSM (the 2G challenge), such as Lucent, Nortel, Siemens or Alcatel, have already acquired the required competencies in the field of new network infrastructures[22]. In other words, complementary investments have been or should be realized on time, at the appropriate level. Moreover, these investments could sustain and make viable the more recent innovation process. Competitive adjustments could appear in the form of fluctuations in market shares of equipment suppliers[23], the former 2G leaders being dismissed by new 3G challengers. Apparently, competition in the different subsystems could favour a higher innovation frequency, which appears as a crucial element of the viability of the process. Summing up, because operators cannot afford to delay the recovery of licenses' huge costs, 3G systems could be developed quickly and, presumably at a competitive price[24]. On the other hand, however, it is also possible that, given the change in costs conditions implied over time by expensive licenses, operators could charge higher prices, with the consequence of slowing down the growth of final demand (and its diversification). In this perspective, once again, the complex interaction between low price operators from the beauty contest and high price operator from the spectrum auction may produce very uncertain results, and potentially competitive adjustments in the organization of the industry.

5. Concluding remarks

One key question of this paper was the re-emergence of a shakeout after a period of turbulence observed in the organization of the industry. To us, the shakeout may proceed in two complementary forms. Firstly, shakeout occurs because mergers and acquisitions are necessary to ensure the consistency of different types of investments, namely the complementary and the competitive ones. Secondly, shakeout may be obtained by exits of firms when unexpected disequilibria emerge despite the relative consistency of investments.

[22] e.g. Alcatel has acquired Newbridge and Assured Access, which have developed skills in transmission of data (Internet Protocol) and concluded an alliance with Fujitsu specialized in radio transmission.
[23] e.g. Nortel has contracted with British operators, Cellnet and British Telecom, and with the Spanish Airtel
[24] Paradoxically, the choice of the beauty contest to the detriment of auction bidding in France, while it should result in lower fees for the licenses, could be a threat for the viability of the innovation process, because it delays the adoption of the new technology.

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Annex 1 : R&D Expenses – Quantitative and qualitative changes

1) Quantitative changes : increases in R&D investments engaged by equipment suppliers
(data : companies' annual reports)

Name of companies	1999	1998	1997
Lucent Technologies			
• R&D expenses	4150 M $	3903 M $	3185 M $
• Increase per year	+6%	+22%	n.c.
• In % of revenue	11,8%	12,3%	11,5%
Nokia			
• R&D expenses	1755 M d'euros	1100 M d'euros	870 M d'euros
• Increase per year	+59,5%	+26,4%	n.c.
• In % of revenue	8,9%	8,6%	8,7%
Ericsson			
• R&D expenses	3337 M d'euros	2970 M d'euros	2465 M d'euros
• Increase per year	+12,3%	+20,5%	n.c.
• In % of revenue	14%	13,7%	12,5%
Motorola			
• R&D expenses	3438 M $	2893 M $	2748 M $
• Increase per year	+18,8%	+5%	n.c.
• In % of revenue	9%	9,8%	9,2%
Nortel Networks			
• R&D expenses	2910 M $	2450 M $	2150 M $
• Increase per year	+18,7%	+13,9%	n.c.
• In % of revenue	13,1%	14%	13,9%
Alcatel			
• R&D expenses	2067 M d'euros	1809 M d'euros	1775 M d'euros
• Increase per year	+14,2%	+2%	n.c.
• In % of revenue	10,1%	8,5%	8,2%
NEC			
• R&D expenses	3194 M $	3517 M $	3220 M $
• Increase per year	-0,09%	+9,2%	n.c.
• In % of revenue	7%	8%	7%
Cisco			
• R&D expenses	1594 M $	1026 M $	702 M $
• Increase per year	+55%	+46%	n.c.
• In % of revenue	13,1%	12,1%	10,9%
Oracle			
• R&D expenses	0,85 M $	0,72 M $	0,55 M $
• Increase per year	+17%	+29,5%	n.c.
• In % of revenue	9,5%	10%	9,7%

Table a : Equipment Suppliers – Expenses in R&D

Name of companies	1999	1998	1997
AT&T			
• R&D expenses	n.c.	662 M $	851 M $
• Increase per year.		-22%	n.c.
MCI-Worldcom-Sprint			
• R&D expenses	n.c.	429 M $	n.c.
Deutsche Telekom			
• R&D expenses	n.c.	664 M d'euros	613 M d'euros
• Increase per year.		+0,08%	n.c.
British Telecom			
• R&D expenses	439 M d'euros	503 M d'euros	477 M d'euros
• Increase per year.	-12,7%	+0,05%	n.c.
France Telecom			
• R&D expenses	n.c.	769 M d'euros	827 M d'euros
• Increase per year.		-0,07%	n.c.
Bouygues Telecom			
• R&D expenses	n.c.	11 M d'euros	n.c.

Table b : Telecommunications Carriers – Expenses in R&D

The comparison of Table a and Table b exhibits the following results.

- R&D expenses are rising in a significant manner (from +2% to +60%) for equipment suppliers, except for Oracle and NEC.
- R&D expenses are generally stable for telecommunications carriers from 1997 to 1998, but are severely decreasing from 1998 to 1999. The same trend is observed for incumbents and entrants. For instance, ATT's (incumbent, US) investments in R&D recently decreased by 22%, and MCI-Worldcom-Sprint (entrant, US) spent in R&D 66,6% of its revenue 1996, but only 21,1% in 1998. This important decline occurs generally in a context of a redeployment of expenses towards selling and administrative activities (S&A), as shown in the following examples :

  France Telecom (incumbent, F) spent 5860 M euros in 1997 for S&A, and 6710 M euros in 1998 (+12,5%).

  In 1998, Bouygues Telecom (entrant, F) spent 11 M euros in R&D, but 89 M euros in S&A.

  Colt (entrant, UK) increased significantly its S&A expenses : 30 000 $ in 1997, 70 000 $ in 1998, and 120 000$ in 1999.

  GTS (entrant, US), which recently acquired Esprit (entrant, UK) and Omnicom (entrant, F), spent 97 M $ in 1997 in S&A, and 199 M $ in 1998.

  Other new entrants, such as Mercury (now Cable&Wireless, entrant, UK) or Cégétel (Vivendi, entrant, F), do not mention any R&D expenses in their financial statements, but hold nevertheless an important position on the market.

This significant change in the origins of technological generation – technological innovations were before liberalization one of the specificity of incumbent telecommunications carriers – favored the successful entry of new telecommunications carriers (Fransman, 1998, 2000). This quantitative change expressed by an increase of R&D investments was complemented over the recent years by a qualitative change in the equipment suppliers' strategies, namely the acquisition through mergers and acquisitions of new competences related to the development of the Internet.

2) Qualitative changes : mergers and acquisitions among equipment suppliers

The turn that occurred in telecommunications – from circuit-switched systems to packet-switched systems – also involved drastic changes in the nature of the equipment suppliers' strategies. Namely, the 'IP turn' implied for traditional equipment suppliers to be able to elaborate switches, transmission equipment, servers and routers for the new emerging demands of entrants in the telecommunications carriers market, related to the development of the Internet. Traditional equipment suppliers (such as Nothern Telecom, now Nortel, Lucent Technologies and Alcatel) successfully challenged these new market opportunities through a massive process of mergers and acquisitions of new equipment suppliers (such as BayNetworks, Ascend and Xylan) which were specialized in these emerging activities coming from the computer industry. Integration (and more specifically stock-for-stock transactions) appeared then as an adapted organizational form to acquire these new competences related to the development of an Internet network.

Merger	**Traditional equiment suppliers** **Core-competences and activities: switching and transmission for traditional telecommunications infrastructures (technologies: RTC, RNIS, ADSL,XDSL)**	**New equipment suppliers** **Core-competences and activities: switching and transmission for new telecommunications infrastructures (technologies: IP, ATM, cable)**
Nortel August 1998 6,9 B$	Northern Telecom	BayNetworks
Alcatel April 1999 2 B$	Alcatel	Xylan
Lucent August 1999 20 B$	Lucent Technologies	Ascend

Table c: Significant mergers and acquisitions among equipment suppliers

Annex 2 : Competing technologies, networks and services
– The strategies of incumbents and entrants and their evolution over time

Incumbent telecommunications have traditionally used, from the very beginnings of telephony in 1920's, a wireline transmission technology made of a twisted pair of copper wires in order to connect the customer premises to a remote terminal or a central office. This technology was dedicated and perfectly adapted to the transfer of voice. The emergence of new requirements from the end-users customers, namely the opportunity to carry data and to develop the Internet, involved the definition of new technologies dedicated to sustain these new applications. The strategy of incumbents was then to elaborate data compression techniques to be used through their existing copper wireline network. For instance, incumbents progressively replaced the basic RTC technologies with new ones such as RNIS in order to upgrade the existing infrastructures. More recently, technologies such as ADSL, and variants called XDSL, appeared. For instance, ADSL allows a high speed transmission (8 Mbit/s from the network to the end-user and 768 kbit/s from the end-user to the network, for a local loop ranged between 2 to 5 kms) ; HDSL provides a high speed downstream and upstream transmission (1,544 Mbit/s, for a local loop between 3 to 5 km) ; SDSL provides also a high speed downstream and upstream transmission (1,544 Mbit/s, for a local loop from 3 to 5 km) ; VDSL is dedicated to complement ADSL with higher bit rates (52 Mbit/s downstream, 2 Mbit/s upstream, for limited local loop of 0,3 km).
Entrants, who do not control the same productive capacity, developed innovative technologies and infrastructures generated by the emergence of packet-switched systems. Three different technologies are available : Frame Relay, IP and ATM. Frame Relay provides transmissions from 6 to 10 kbit/s ; IP, from 18 to 24 kbit/s ; ATM, from 10 to 80 kbit/s. Cable TV companies also entered the telecommunications market by offering high speed transmissions (from 2,5 to 56 Mbit/s downstream, and 64 kbit/s uptsream) to end-users.

Two remarks can be derived from that description.

Firstly, these competing technologies are dependent on the nature of infrastructure networks developed by incumbents and entrants, but also on their possible range of associated services. Namely, a higher speed of transmission allows a larger set of applications, together with a higher quality of service in terms of reliability and security. Especially, technologies such as ADSL-XDSL provide a whole set of applications (including the most sophisticated ones such as Videoconferencing, voice on Internet), with a quality in terms of rapidity which is much higher than alternative technologies. IP or cable TV modems are competitive because they offer a significant set of applications for a relatively low price and provide end-users with a significant degree of reliability and safety. At the moment, thus, a market segmentation exists, implying that both technologies (and further firms operating and using these technologies, namely incumbents and entrants) are viable. Nevertheless, differences in price may be smoothed over time as well as qualitative characteristics in terms of reliability and safety, and market segmentation may also disappear under the pressure of a dominant technology supported by a dominant firm (or a group of dominant firms).

Secondly, the distinction between incumbents and entrants from the technologies employed is also reflected at the upstream level, namely at the level of equipment suppliers. In fact, on the one hand, traditional equipment suppliers such as Lucent, Nortel or Alcatel used to provide incumbent telecommunications carriers (ATT, RBOCs, France Telecom, BT, Deutsche Telekom) with switching and transmission technologies such as RTC and RNIS, but played also a determinant role in the development of ADSL and more generally XDSL. On the other hand, entrants in the telecommunications carriers market (Worldcom, Colt, GTS-Esprit-Omnicom) became the privileged customers of new type of equipment suppliers (such as Ascend, BayNetworks, Cisco), connected more specifically to the computer industry.
As a consequence, and until very recently, one could consider that the industry was composed of two main competitive vertical structures: on the one hand, the 'traditional telecommunications structure' and, on the other hand, the 'new telecommunications structure' (see Table d below). Over the last two years, however, these competitive vertical structures evolved in a significant manner, especially by the fact that traditional equipment suppliers entered the specific market niches of the new equipment suppliers generally through a massive process of mergers and acquisitions (see for instance, the case of Lucent with Ascend or Nortel with BayNetworks, already mentioned in Annex 1).

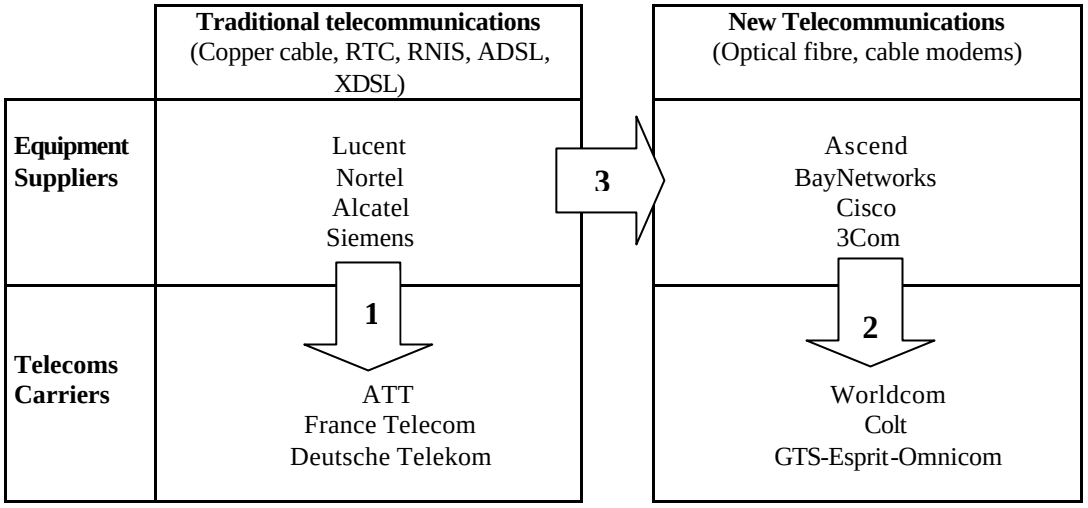

Table d: Competing vertical structures – characteristics and evolution

The different arrows contribute to explain the different stages of evolution of the vertical structures between telecommunications carriers and equipment suppliers. The first stage (Arrow 1) describes the former vertical structure in which traditional equipment suppliers at the upstream level only have one category of customers, namely the telecommunications carriers at the downstream level. Note that, at this stage, ATT and Lucent are the same company. The second stage (Arrow 2) characterizes the role played by new telecommunications equipment suppliers on the entry of new firms at the downstream level. The third stage (Arrow 3) represents the strategy (which is essentially a merger strategy) developed by traditional equipment suppliers to have access to the core-competences of new equipment suppliers, and further to their market segment (new telecommunications carriers).

Over the recent years, then, a complex competition is occurring between technologies, and further networks and services. Future market performances of incumbents and entrants are in close relationship with this competition for technological innovations and associated services for end-users. Recent studies exhibit the following results.

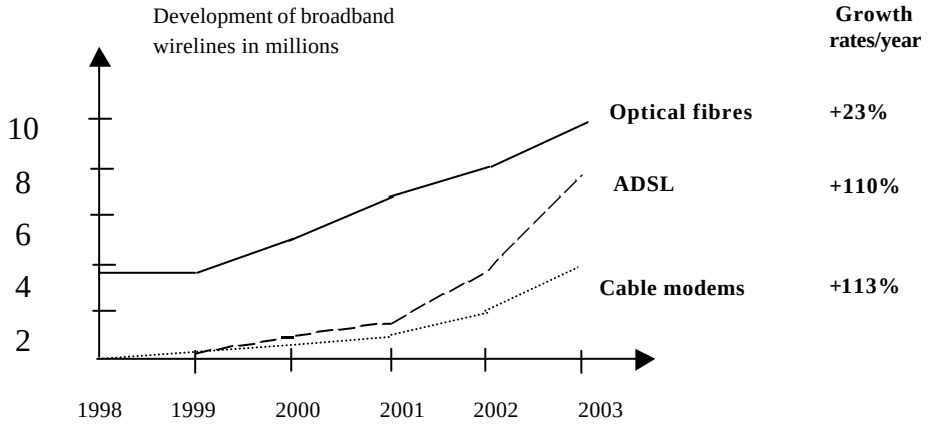

Figure a: New broadband wirelines in the world
(Ovum/Ernst&Young, reprinted in Réseaux et Télécoms, 1999, 22 Octobre, n°153)

From Fig. a, Optical fibre tend to be the dominant technology, but ADSL and Cable modems are also increasingly developed to connect businesses and residential users. At the moment, then, entrants specialized in IP technologies enjoy a technological and competitive advantage, the sustainability of which depends of course on what will be the strategy of telecommunications incumbents or cable TV entrants in the next few years.

In Western Europe, especially, an increasing number of subscribers (especially the enterprises) are expected to choose ADSL technologies rather than alternative technologies.

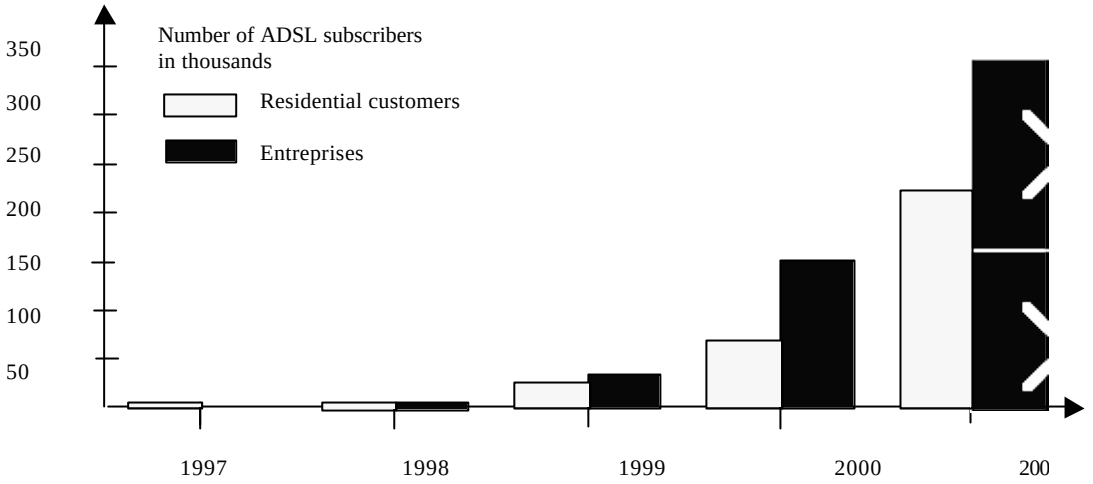

Figure b: ADSL subscribers (residentials and enterprises) in Western Europe
(IDC, reprinted in Réseaux et Télécoms, ibid)

If the trend becomes effective, vertical structures defined in Table d will certainly be changed drastically. Especially, incumbents may capture the technological and competitive advantage for their own benefit and, as a consequence, challenge significantly the entrants' viability. Here again, traditional equipment suppliers may play a key role in this process, especially equipment suppliers such as Alcatel which at the moment do not hold a leader position in the current organization of the industry (see Fig. c for a presentation of the ADSL market in the US).

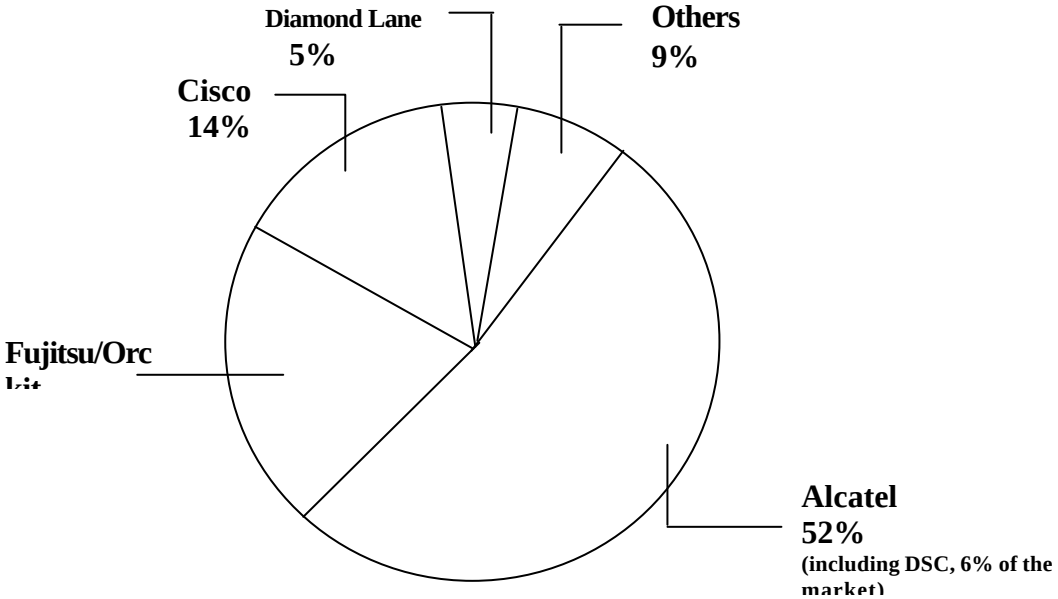

Figure c: ADSL market in the US in 1998
(RHK, reprinted in Réseaux et Télécoms, ibid)

Annex 3 : Corporate governance and shareholder value
- some implications for the telecommunications industry

High performances on stock markets are generally directly connected with the implementation by firms in most industries, but especially in telecommunications, of a system of corporate governance oriented towards the maximization of the shareholder value. Namely, the characterization of the performances of firms through criteria such as Economic Value Added and Market Value Added (EVA-MVA, popularized by Stern Stewart Consulting) are determinant in this mechanism. In fact, EVA corresponds to the net profit less the income generated by equity capital, and MVA is the discounted value of future expected EVA:

EVA = (P-rD) – rF = (ρ-r) K, et MVA = EVA/r = (ρ/r – 1) K,
With P, the gross profit ; r, the cost of capital ; D, the debt ; F, the net assets ; ρ, the economic return of capital ; and K, the amount of invested capital.
Therefore, we have : MVA = EVA/r.

Different rankings are available concerning firms' performances in terms of EVA-MVA. Table e and f below stress some results of the Stern-Stewart ranking, by focusing especially on telecommunications firms (equipment suppliers, carriers and ISPs) :

Ranking in terms of MVA			**Company**	**MVA (en M$)**	**EVA (en M$)**	**Capital (en M$)**	**Return[t] of capital (%)**	**Cost of capital (%)**
1999	1998	1997						
8	14	17	Cisco	135,650	1,849	9,509	38.2	13.1
9	25	--	Lucent	127,265	1,514	31,448	17.5	11.6
19	19	25	SBC	79,956	2,219	53,120	13.9	8.4
20	82	332	Worldcom	77,032	3,585	86,364	6.0	12.6
22	30	31	Bellsouth	74,322	1,122	38,297	11.3	8.2
23	113	615	AOL	70,861	38	2,334	18.9	16.7
24	29	8	ATT	66,667	1,314	68,916	7.9	9.8
27	17	24	Bell Atlantic	59,705	1,366	53,613	10.6	7.9
32	36	44	Ameritech	52,330	1,120	27,250	13.4	8.8
40	88	158	EMC	38,933	512	3,733	31.0	14.0
41	39	22	GTE	38,854	1,163	47,779	10.7	8.1
45	54	48	Oracle	36,740	879	4,787	36.7	13.8
50	63	35	Airtouch	30,706	94	17,052	10.4	9.7
54	87	682	Sun	27,650	557	5,359	26.2	12.9
64	105	56	US West	23,385	645	20,065	11.2	7.7
83	71	16	Motorola	17,254	2,830	26,216	0.1	11.3
84	72	66	Sprint	17,241	317	18,222	10.4	8.6
109	171	--	Qwest	12,427	62	7,864	9.9	11.4
114	96	362	3Com	11,904	96	3,630	11.4	14.8
119	283	--	Ascend	11,319	108	2,999	17.8	12.9

Tableau e : EVA-MVA rankings of US firms – Extracts concerning telecommunications companies (Fortune, 22/11/99)

Ranking in terms of MVA			**Company**	**MVA (en M$)**	**EVA (en M$)**	**Capital (en M$)**	**Return of capital (%)**	**Cost of capital (%)**
1999	1998	1997						
	1	4	France Telecom	304,279	1,958			
	4	13	Vivendi	132,282	-392			
	33	193	Bouygues	8,152	-1005			
	69	111	Omnicom	1193	-84			
	165		Alcatel	-43,576	-12,980			

Tableau f : EVA-MVA rankings of French firms – Extracts concerning telecommunications companies (Les Echos, 11/99)

A brief look at tables e and f shows that telecommunications firms are generally at the top of rankings in terms of EVA-MVA. However, important disparities are observable.

In the US, some entrants in the telecommunications carriers market (such as Worldcom), as well as some RBOCs (SBC and BellSouth), do better than the incumbent ATT. In France, on the contrary, the incumbent France Telecom is number one, and entrants either appear in the top 10 (Vivendi, a group diversified in telecommunication and owner of SFR and Cegetel, is n° 4) or in the medium places of the ranking (Bouygues, a group diversified in telecommunications and owner of Bouygues Telecom and 9Telecom, is n° 33; Omnicom, a french start up is n° 69).
Concerning the equipment suppliers, the disparity is even wider. No clear result can be inferred among new and traditional equipment suppliers: Cisco is just before Lucent (n° 8 and 9), while Ascend and 3Com are below the 100^{th} ranking (n° 114 and 119). But, among traditional equipment suppliers, differences are significant: Lucent is in the top 10, while Alcatel is at the very bottom of the French ranking (n°165).

In fact, EVA-MVA rankings induce firms to adopt the same type of behavior. For each firm, the problem is to increase the return on capital (ρ in the previous equation) and to decrease simultaneously the cost of capital (r), for a given amount of invested capital (K).
Companies of the 'old economy' generally focus their efforts on r decreases, generally obtained by a reduction of inventories, by outsourcing practices, by modifications of remuneration schemes.
Within the 'new economy', and especially among telecommunications companies, opportunities to increase ρ are also possible. The implementation of mergers and acquisitions, for instance, imply a positive effect on the expected return of capital if the buyer already controls the invested capital and is able to engage a stock-for-stock transactions. The cost of the invested capital depends on the rate of exchange of common stocks between the buyer and the acquired firm.

Disparities among equipment suppliers in terms of EVA-MVA can be explained on this basis. These disparities illustrate that managers' choices, made within the economic sphere, are intrinsically connected to investors' choices, made within the financial sphere. The economic challenge for traditional equipment suppliers such as Lucent, Nortel and Alcatel concerned their ability to enter new technologies and associated markets, previously developed by new equipment suppliers such as Ascend, BayNetworks and Cisco. Managers implemented different organizational choices to deal with this economic challenge, and investors reacted. Table g summarizes.

Organizational design implemented by the manager	**Specific characteristics of the organizational design**	**Impact of the manager's strategy on net income and stock market**	**Analysis of the strategy by investors and financial analysts**
1) Merger: Northern Telecom and BayNetworks	Date : august 1998 Amount : 6,9 billions $ Rate of stock exchange : 1 of BayNetworks = 0,66 of Nortel	Losses : 470 M$, -0,71$/stock for 1999, compared to : 32 m$, -0,06$/stock for 1998	Positive impact on ρ Negative impact on r
2) Merger: Lucent Technologies and Ascend	Date: august 1999 Amount : 20 billions $ Rate of stock exchange : 1 of Ascend = 1,66 of Lucent	Increases: 4766 M$, +1,52$/stock for 1999, compared to : 1035 M$, +0,34$/stock for 1998	Positive impact on ρ Positive impact on r
3) Cooperation Alcatel-BayNetworks Alcatel-Ascend Alcatel-Cisco	Date: 1998	Drastic losses: -50% on stock market in september 1998	Negative impact on ρ Negative impact on r

Table g: managers' strategies and investors' reactions

In the Lucent-Ascend merger, the consolidation of capabilities and activities was considered as a very positive element by financial markets, and this was expressed by a high level of ρ. The stock-for-stock transaction, moreover, was in favor of the buyer, Lucent (1 stock of Ascend = 1,65 stock of Lucent), and implied for investors a reasonable level of r.

In the Northern Telecom-BayNetworks merger (now Nortel), the stock-for-stock transaction was not in favor of the buyer Northern Telecom (1 stock of BayNetworks = 0,66 stock of Northern Telecom). Investors considered that the merger had a positive impact ρ, but that the cost of capital was too high.

In the case of Alcatel, the elaboration of cooperation agreements with firms specialized in IP technologies (Cisco, Ascend and BayNetworks) was privileged in a first step. Moreover, Alcatel engaged a merger strategy, but mainly dedicated to consolidate its existing core-competences: in september 1998, Alcatel acquired one of the leader of the ADSL technologies in the US market, DSC. The cooperation agreements being highly questioned by the fact that Ascend and BayNetworks were acquired by Alcatel's competitors, and the focus of activities being too narrowly defined on the core technologies of Alcatel, the strategy of Alcatel was finally penalized by low performing results on stock markets (Alcatel lost 50% of its stock value in fifteen days in September 1998). Alcatel was then obliged to replicate its competitors strategy: Alcatel engaged a strategy of acquisitions of IP equipment suppliers, such as Xylan, and over the last year Alcatel significantly improved its results.

Annex 4 : Impact of new communications services in Europe and the US – Focus on the mobile and the Internet

		United Kingdom	France	Spain	Germany	Sweden	USA
ENTERPRISES	Companies having a web site (in %) ∗	51 (••)	25 (••)	16 (••)	48 (••)	54 (•)	54 (•)
	Companies doing e-commerce (in %) ∗	9 (••)	3 (••)	9 (••)	9 (••)	10 (•)	12 (•)
	Value of products sold online (in millions of euros)	5300 (••)	3400 (••)	400 (•)	3600 (••)	700 (•)	15300 (•)
	Companies having an intranet (in %)	30 (••)	18 (••)		30 (••)	100∗	29
	Companies having an extranet (in %)	5 (••)	4 (•)		8 (••)	61∗	8
RESIDENTIALS	Residential customers having a PC (in % of total population)	37,3 (••)	26,6 (•)	27,4 (•)	35 (••)	64 (•)	51 (•)
	Residential customers having an Internet connexion (in % of total population)	26,6 (••)	9,9 (•)	10,5 (••)	14,5 (••)	49 (•)	39 (•)
	Number of residential customers having a connexion to the Internet (in million)	9,8 (•)	4,6 (•)	2,9 (••)	9,2	3,5 (•)	70,1 (•)
	Penetration rate of mobile phones (in %)	42,9 (••)	36,2 (••)	40,1 (••)	24,5 (•)	57,9 (••)	32 (••)
	Internautes doing e-commerce (in %)	34,8 (••)	26 (•)	9 (••)	33,4 (••)	15 (••)	28,4 (••)

Table h: General information on market growth: Internet and mobile
(Datas: E-index, Connectis-Les Echos, April 28, 2000)

∗ % of a sample composed of big companies

• medium growth

•• significant growth

	United Kingdom Utilisation of the Internet (% of population)	France Utilisation of the Internet (% of population)	Spain Utilisation of the Internet (% of population)	Germany Utilisation of the Internet (% of population)	Sweden Utilisation of the Internet (% of population)	USA Utilisation of the Internet (% of population)
40						
30						
20						
10						
0						
	March99 Jan00	March99 Jan/Feb00	Feb99 Nov99	March99 Jan00	Jan99 Dec99	March99 Jan00

Table i: Market growth of the Internet
(Datas: E-index, Connectis-Les Echos, April 28, 2000)

	United Kingdom Top 10 of web sites	France Top 10 of web sites	Spain Top 10 of web sites	Germany Top 10 of web sites	Sweden Top 10 of web sites	USA Top 10 of web sites
1	Yahoo.co.uk (portal)	Wanadoo.fr (portal)	Terra.es (portal)	T-online.de (ISP)	MSN.se (portal)	Yahoo.com (portal)
2	MSN.co.uk (portal)	Yahoo.fr (portal)	Yahoo.com (portal)	Yahoo.de (portal)	Passagen.se (portal)	MSN.com (portal)
3	Microsoft.com(softwareditor)	Voila.fr (portal)	Elpais.es (information)	MSN.com (portal)	Microsoft.se(softwareditor)	AOL.com (ISP)
4	Freeserve.co.uk (ISP)	MSN.fr (portal)	Altavista.com (portal)	Lycos.de (portal)	Tele2.se (portal)	Microsoft.com(softwareditor)
5	Lycos.co.uk (portal)	Multimania.fr (Comm.)	Recoletos (information)	AOL.com (ISP)	AOL.com (ISP)	Netscape.com (softwareditor)
6	AOL.com (ISP)	Microsoft.fr (software editor)	Latinmail.com (e-mail)	Microsoft.com(softwareditor)	Yahoo.com (portal)	Go.com (portal)
7	Excite.co.uk (portal)	Grolier.fr (portal)	Ya.com (portal)	Netscape.com (softwareditor)	Altavista.com (portal)	Lycos.com (portal)
8	Demon.net (ISP)	Ibazar.fr (online selling)	MSN.com (portal)	Altavista.de (portal)	Telenordia.se (telecoms)	Passport.com (comm.)
9	Tripod.lycos.com (comm.)	Libertysurf.fr (ISP)	El-mundo.es (information)	Tripod.lycos.com (comm.)	Aftonbladet (information)	Hotmail.com (e-mail)
10	Altavista.com (portal)	Lycos.com (portal)	Hispavista.com (portal)	Fireball.de (portal)	Telia.se (telecoms)	Amazon.com (online selling)

Table j: Top 10 of the most popular web sites
(Datas: E-index, Connectis-Les Echos, April 28, 2000)

Table j shows the great diversity of the major actors of the Internet. Among the top 10 of the most popular web sites, some actors are related to the telecommunications industry, the computer industry or the information and communication industry. Moreover, some actors are portals while others are Internet service providers. Further elements can be derived from table h and i. For instance, within countries were the Internet is not completely developed (even if the growth rates are important), telecommunications carriers (especially incumbents) are dominant. See for instance in France where Wanadoo and Voila are directly related to France Telecom; in Germany where T-online is related to Deutsche Telekom. In countries where the size of the market is larger, a wider range of actors is observable. Especially independent ISPs such as Yahoo, AOL, Excite, Altavista are in the top of the ranking.

The relative absence of new (entrants) telecommunications carriers in the rankings can be explained. In fact, new entrants especially in France but also in Germany focused on the mobile activities. The growth of this market segment was high and favored entry. Nevertheless, this relative specialization on mobile activities may over time be extended to other activities, especially in the Internet domain. Recent technological developments (UMTS, WAP, 3G mobile phones) are establishing a bridge between Internet and mobile activities. New entrants in mobile activities prepare their entry in the Internet on behalf of these technological innovations still in emergence. The relative delay in the entry on the Internet segment may then be completed progressively. The following table k gives some information about the French situation, in which there is an intricate competition between the incumbent France Telecom and its major competitors Cegetel and Bouygues. This competition has to be considered in regard to the global evolution of the mobile market (fig. d)

Name of the company and market share	**Number of customers**	**Net growth**			
		Per month	**In %**	**Over the last 6 months**	**In %**
France Telecom (48,2%)	10 926 400	199 500	+1,9%	2 942 200	+37%
Cegetel (35,6%)	8 069 600	149 300	+1,9%	2 193 200	+37%
Bouygues (16,1%)	3 649 600	95 700	+2,7%	1 288 700	+50%
TOTAL	22 645 600	444 500	+2,0%	6 424 100	+40%

Table k: Mobile operators in France
(datas: ART, 31 march 2000)

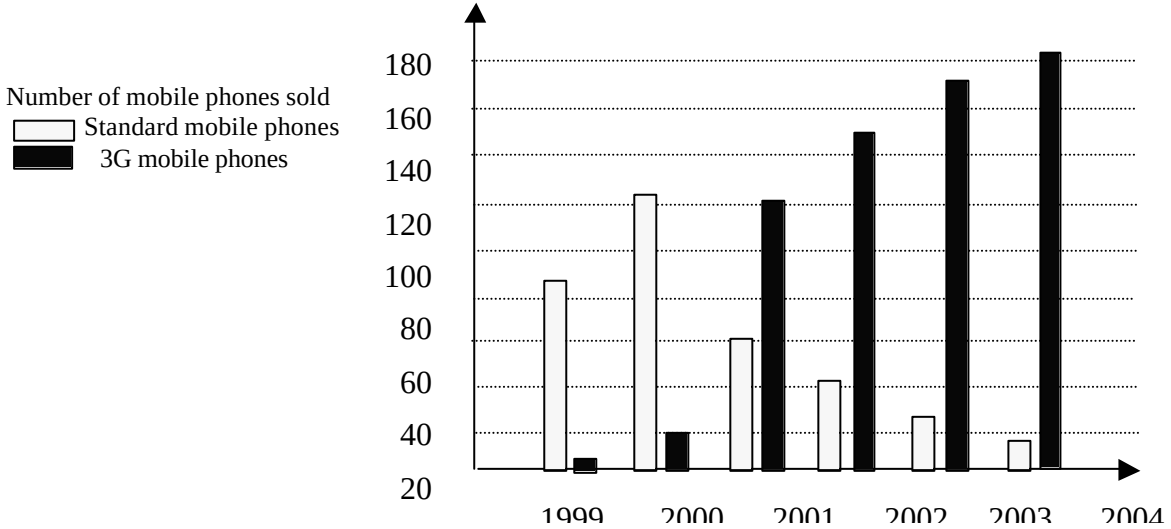

Figure d: Evolution of the mobile market in Europe
(datas: Dataquest, reprinted in Réseaux et Télécoms, 9 june 2000)