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1 INTRODUCTION

The all dominant position of traditional public switched telephone networks (PSTN) as the basis for electronic communication is no longer just challenged, but threatened and disappearing. This is caused by the emergence of innovative technologies triggering a shift of no longer not only data but also voice traffic to alternative Internet Protocol (IP) networks. The emergence of the new technologies has been driven by a combination of trends within technology, regulation and business models.

The major new trends have been within NGN, VoIP related to broadband Internet access, advanced wireless systems - including third-generation mobile (3G) and wireless LANs/ WiFi and increasingly also at the edges of the systems incl. consumer devices.

The development has been associated with a diminishing role of the traditional telecom operators due to not only the emergence of new alternative networks but also to the operators diminishing activity within research and development. NGN is, however, the vision of telecom operators on how to stay competitive using IP based technology (IP multimedia subsystem, IMS) to deliver new applications combining voice and data and enable fixed-mobile convergence. The IMS network architecture is cheaper and more powerful than the traditional PSTN and therefore embodies the strategic reaction of the incumbents to the emerging VoIP-based alternative operators. Even if it may be argued, that the result of this struggle is not settled on the actor side, then it is quite clear that the era in communications of the stand alone, all dominating voice service is gone. The user will have access to multimedia applications regardless of the device used or the type of network connected to. The components, the structures and the value complex producing electronic communication are changed – the change is clearly disruptive.

2 INNOVATION ECONOMICS, SOME DEFINITIONS

The disruptive changes are often seen as explained by the idea of 'disruptive innovation'. A disruptive innovation is generally conceived as a technological innovation, product, or service that eventually overturns the existing dominant technology or product in the market. The term disruptive innovation was phrased by Clayton Christensen. In *The Innovator's Dilemma* he investigated why some innovations that were radical in nature reinforced the incumbent's position in a certain industry, contrary to what previous models would predict. It is, however, a technology centric/ deterministic theory/ construction where the interplay between technology, economics and policy/ regulation, which is central to the current development in communication/ voice services, is non-existent. It therefore seems more fruitful to turn to innovation economy tradition for a theoretical discussion.

Innovation economy is one of the lines of techno-economic theories that discusses the effects, drivers and barriers of technological changes. In a general sense, innovation is a process of taking new ideas through to the market. It is the conversion of new knowledge into new products and services. The theoretical discussion of this area was started in the 1960's and included among the authors economists as Edwin Mansfield and evolutionists as Chris. Freeman[1] and has developed into a very rich tradition.

Evert Rogers[2] defined in 1962 innovation as a process: Starting with an invention of a new element, going through practical development of this element and finally the commercial use of it. In this context it is important to denote that this new element can be a combination of already existing elements. When the innovation process is fulfilled then a diffusion process with the traditional S-curve characteristic starts.

According to Dosi[3] innovation encompasses a number of processes related to new products: the search, the discovery, experimentation, development, imitation and adoption of new products and further new production processes and new organisation set-ups. In this definition it is underlined that the innovation is not limited to product innovation, it relates also to the process innovation and strategically aspects (organisational set-up).

In connection with the technological paradigms a differentiation between *incremental* and *radical* innovations is presented. The radical innovations result in qualitatively different elements, where the incremental innovations are small improvements that result in new elements.

Henderson et. al[4] suggest following categorization of innovation: Incremental, modular, architectural and radical innovation. The definition is depicted on the following table:

Table 1.1: Categorisation of innovation

		Effects on links between components	
		Yes	*No*
Effects on components	*Yes*	**Radical**	**Modular**
	No	**Architectural**	**Incremental**

The strength of the definition regarding service innovation is that it involves the link between components opening for discussion and clarification of role of different aspects and dynamics. But it may not catch or stress sufficiently the dynamics of the relation between the components and links that is crucial in the development of electronic communication.

The technological change in electronic communication can against this background be characterized by three waves of fundamental change. The first wave of basic technological change includes Digitalization, Computerization and Packet-based Switching. It was generally unfolding its potential during the latter part of the 20th century. In a technical sense the changes on each area were fundamental and radical following the above classification as they affected components and their links. Further this wave was basic in the sense that it has provided the foundation for the next wave, and in the sense that it is by now established as a global trajectory that only to a very limited extent can be influenced by current political/ regulatory initiatives.

The second wave of changes includes the Internet, Mobile Communication, Next Generation Networks (NGN) and Convergence – e.g. VoIP. It is currently more open to political/ regulatory initiatives both because it is yet technologically less developed and therefore the trajectory is less fixed, but also because it is by its technological characteristics more connected to specific national implementations. It affects more components and changes links between them broadly and profoundly and is in this sense even 'more radical'.

The third wave of changes is related to the use of ICT as a generic technology to redesign and rationalize production, administration and transaction processes, and to create new products and processes, i.e. to create the information society as described for the EU in the goals of the Lisbon Agenda[5] or more generally in the targets of the World Summit on the Information Society (WSIS)[6]. These changes depend heavily on the foundational developments with the first and second wave technologies. The third wave of changes is still in a very early stage of development and therefore subject to the greatest direct influence by policy and regulation. The 'radical potentials' of the third wave changes is closely related to the dynamic relations between components and links as this is determining the rate and extent of the penetration and thus the effect of redesign and rationalization.

3 THE INTERNET AND THE INTERNET PROTOCOL (IP)

The emergence of the Internet, which interconnects billions of IP based devices like computers to each other, may be seen as one of the most important changes in the ICT sector in recent times. The internet was in the beginning primarily used for data services. E-mail and World Wide Web (WWW) were the most important services on the Internet. In the further development, however, the number of services over the Internet has expanded, and today these include a variety of audio/video services like Internet radio and TV, B-logs, computer games, etc. The next development we are witnessing is the emergence of 'Internet of things', which is mainly connected to the development of RFID technology and ‘sensor networks’. While a number of issues related to the organization of the general Internet are in place[7], there are a number of unsolved problems and challenges related to the ‘Internet of things’ which will be on the political agenda in the coming years.

3.1 IP

Internet protocol (IP) was first developed in the mid-1970s, when the Defense Advanced Research Projects Agency (DARPA) became interested in establishing a packet-switched network that would facilitate communication between dissimilar computer systems at research institutions. With the goal of heterogeneous connectivity in mind, DARPA funded research by Stanford University and Bolt, Beranek, and Newman (BBN) [8]. The result of this development effort was the Internet protocol suite, completed in the late 1970s. TCP/IP was later included with Berkeley Software Distribution (BSD), UNIX, and has since become the foundation on which the Internet and the World Wide Web (WWW) are based.

The IP packets contain all the addressing information, which is necessary to be routed in IP networks. The IP routers transmit the IP packets within the network based on the destination address available in the IP packet in a connection-less manner. This reduces network complexity immensely. However, to provide services in the IP network, connection oriented protocols like TCP and UDP must be implemented to establish a session and make sure that it functions properly.

IP technology is designed in a way that enables a radically different environment for service development, innovation and competition, when it comes to infrastructure platforms and service development platforms. In the following some of the important characteristics of the IP platforms are outlined:

- Separation between network technology and services
- End-to-End architecture, and extension of intelligence from the core to the edge of a network
- Scalability
- Distributed design and decentralized control

The separation between the underlying network technology and the services removes entry barriers for the service providers. The only precondition for service provision is access to the network. This has created a huge dynamic in the service development within the Interne, but it also creates a problem of revenue sharing between the owners of the network infrastructures and the service/content provider. This is more obvious in the broadband IP infrastructures that are mainly provided by the telecom operators. Especially because the flat rate billing for connectivity has become the dominant business model, it is obvious that the development in value proposition is mainly concentrated in service provision.

End-to-End architecture and extension of intelligence from the core to the edge of a network is another factor that moves the development and innovation activities to the edge of the network. The concept was first introduced in a paper named: ‘End-to-End argument in system design’[9]. The main argument here is that an efficient network design can be based on ‘dumb core network’, where processing is moved to the edge of the network.

Scalability is another main feature of the IP design. One of the barriers for further scalability is the shortage of address room in the current IP version 4 (IPv4) systems. As discussed in the section on IP version 6 (IPv6) the shortage of address room is a big problem for developing countries, mainly due to uneven allocation of the IPv4 address room.

Distributed design and decentralized control is another characteristic that obviously has improved conditions for the development of services, innovations and creations of new businesses. Different networks can easily connect to other IP networks, including the Internet and obtain value-add from network effects, etc.

These characteristics of the technology create good conditions for development and competition where several actors can be involved in service creation and provision. The general Internet is the major IP network in the world but it is far from the only IP network. In recent years, several private IP networks have been established and utilized for both corporate and residential services, and the future of communication platforms, like the Next Generation Network architecture is based mainly on IP technology. However, when it comes to NGN, the level of competition or monopolistic characteristics depends heavily on the chosen architecture for the deployment of NGN.

3.1.1 Managed IP networks

When data is transported over an IP network, the content is sent in a consecutive flow of packets between the sender and receiver. Irregularities in transmission properties, such as packet loss and variance in packet delay can cause unwanted breaks or decrease perceptual quality of the content. In managed IP networks the network access providers can control transmission properties within the boundaries of their own network, in contrast to the public Internet, which is a "best effort" network where no guarantees can be provided for end-to-end quality of service.

There are several advantages in providing IP services over managed IP networks. Apart from higher transmission quality level, advanced transmission functionality such as multicasting can reduce network load. Depending on business model applied, the tight relationship between network access providers and customers can be utilised in service provisioning. Furthermore, intellectual property rights can be guarded better when the flow and access to content can be monitored, resulting in more simple Digital Rights Management / Conditional Access systems. Along with tighter participation of the networks access provider in offering IPTV, comes a larger role in the value chain, e.g. through revenue sharing.

3.1.2 IP version 6 (IPv6)

The current Internet Protocol, which is primarily based on IPv4 (IP version 4) has had a rapid growth both when it comes to the number of IP enabled devices and when it comes to applications and services. IPv4 suffers from major weaknesses when it comes to dealing with the rapid growth in the number of devices connected to the Internet and the new applications and services. This has resulted in standardization of a new version of Internet Protocol, IPv6 (IP version 6), to cope with the shortcomings of IPv4.

One of the main weaknesses of IPv4 is the amount of IP addresses available globally. The IPv4 address consists of 32 bits meaning that there are about 4 billion addresses available. On the one hand, it is obvious that 4 billion addresses are not enough in a world, where more and more devices and terminals become IP enabled. On the other hand, even the current addresses available are allocated so unevenly that many of the developing countries lack IP addresses to develop their ICT infrastructures. For example, according to a consultation paper on 'Issues relating to transition from IPv4 to IPv6 in India'[10]: 'India has merely 2.8 million IPv4 addresses compared to 40 million acquired by China'. Here it is important to note that any common US university has more IP addresses than the total of India, and that a US ISP, Level-3, alone has more IP addresses than China. The distribution is much worse when it comes to the least developed countries, where, e.g., Bangladesh has about 150.000 IP addresses.

IPv6 extends the address room to128 bits meaning that the number of IP addresses will not be any problem in the foreseeable future. This gives the possibility for allocating more addresses to different countries and regions. Allocation of IPv6 addresses can be done more evenly as it does not suffer from the historical matters that resulted in the uneven allocation of IPv4 address room. In the future development, where we are surrounded by the 'Internet of Things'[11], there will be an even greater need for IP addresses.

The other issues that are dealt with in IPv6 are the QoS and security issues. QoS is important in relation to real time services, and security at IP level will generally be required by a number of services in the future.

4 NEXT GENERATION NETWORKS (NGN)

The NGN concept is mainly used in two ways: 1) A broad concept encompassing the whole development of new network technologies, new access infrastructures and even new services, and 2) A focused concept of specific network architecture and related equipments, with one common IP core network deployed for the entire legacy, current and future access networks. ITU defines NGN as: "a packet-based network able to provide telecommunication services and able to make use of multiple broadband, QoS-enabled transport technologies and in which service-related functions are independent from underlying transport related technologies. It enables unfettered access for users to networks and to competing service providers and/or services of their choice. It supports generalized mobility which will allow consistent and ubiquitous provision of services to users”[12].

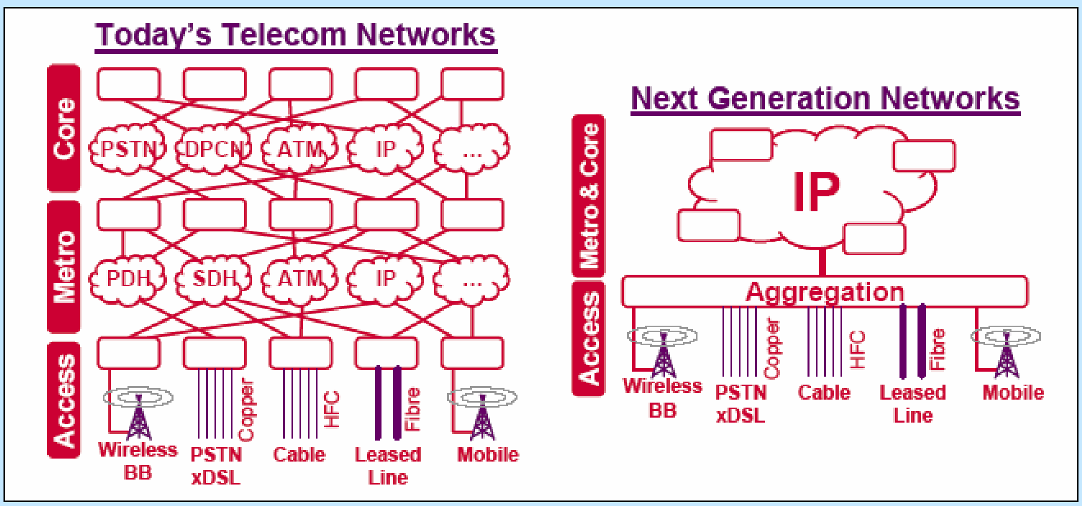
The first definition is so broad that in a sense it covers the whole current chapter on technological trends. The second definition relates to the transition path towards a converged IP based core and access network. In the ITU definition there is a major emphasis on one of the main characteristics of IP platforms namely the separation of network and service layers.

NGN is about transition of current dedicated voice (and radio/TV) networks to the IP based networks. From a technology efficiency point of view this is a natural development of all network technologies, however, there are a number of problems connected to the overall organization of the NGN platforms, which are subject for discussions amongst regulators today. One of the main issues is the interconnection model, which will be used in the NGN. Will this, for example, be dominated by the IP interconnection models like peering and transit or will the PSTN interconnection and tariff regime be modified and used in the future NGN platforms?

The telecom incumbents will see the NGN as means of significantly reducing their network operating costs and complexity, while, amongst others, the market players from the IT world see the NGN as an opportunity for changing and revolutionizing the whole organization model of the future network.

Figure 4.1 illustrates the difference between today’s telecom networks and tomorrow’s NGN platforms. Today, the PSTN, mobile networks, Cable TV networks, Wireless networks, etc. use several dedicated metro and core networks.

Figure 4.1: Next Generation Networks[13]



Source: OFCOM

In the NGN platform all of these different access technologies share the same IP core network. The main arguments for transition to the NGN architecture:

- It is not efficient to maintain several core networks for different access networks. Substantial cost savings can be achieved due to the economy of scope inherent in a single converged network. BT predicts[14] to reduce costs by £1 billion per annum by 2008/2009 as a consequence of migrating to NGN.
- According to BT, NGN enables improved time to market for new services and improve customer experience.
- NGN enables continuation of offering services in the legacy access networks. For example the analogue PSTN access line/service does not need to be changed in transition to NGN. The main changes here are the efficiencies gained in the core network, especially when one operator owns and operates several parallel core networks. The latter is the case for a majority of incumbent operators.

So the operator on the one hand utilizes the backbone efficiency gains and on the other hand continues to make profit from the investments in the access networks.

- NGN enables provision of value added innovative services using the possibility that one core network is connected to and manages different access networks. For example a SMS can be sent to a mobile subscriber to inform the users if there are problems with the operation of DSL.

These arguments show that the implementation of NGN is a radical change in the network architecture of incumbent telecom operators. This raises the question of the role of regulation in this process: Should the regulators get involved in the practical implementation of the NGN? The answer to this question is, no, as it contradicts the new regulatory doctrine of telecom development, where the decision of technological changes is taken on the market and by the market players/industry. However, the regulator must make clear in setting the constraints within which the industry should design their networks.

The role of regulation regarding NGN is on the one hand to make sure that effective competition can take place also in the NGN era, and on the other hand make sure that the consumers and the level of services they receive is not affected in a negative way in this transition.

4.1 Broadband

One of the main challenges of network infrastructures development is efficient deployment of broadband technologies. Broadband is growing fast and its role in creation of values in the new economies is more and more recognized. In the 15 EU member states the number of broadband households has more than doubled in one and a half year, from app. 9 million in mid 2002 to app. 23 million in the beginning of 2004[15]. Also other developed regions especially the US and the South East Asian market have experienced tremendous growth in the penetration of broadband. In South Korea about 96% of online users have broadband connectivity[16]. In Europe the development has been dominated by DSL technology, however other broadband technologies count for a substantial part of broadband households and growth rates. In the developing countries, traditional broadband like DSL will play a minor role and the development of broadband will mainly be influenced by the development of new wireless technologies.

One of the main challenges in the development of broadband has been the ability of regulation to open up the legacy telecom networks for provision of DSL services through, e.g., unbundling and Bit stream access. The open access discussion has further been raised in connection to provision of broadband through cable TV networks. The cable TV open access discussion is mainly important in the US, where the number of cable broadband is many times that of DSL broadband. Also in the European countries cable broadband is becoming an attractive competitor, especially in the era of triple/multi play[17]. Here the open access can spur variety in ISPs and may reduce nominal prices for services[18]. These traditional broadband infrastructures will be further discussed in this section.

4.1.1 Alternative networks

The mainstream development of infrastructures is dominated by broadband development in the fixed and mobile/wireless environments outlined in the following.

Fixed:

- √ xDSL over telephony network
- √ Cable modem over cable TV networks
- √ New access infrastructures like FWA

Mobile:

- √ Development of 2.5 generation networks, GPRS and EDGE
- √ Establishment of next generation mobile networks

There are structural and technical limitations connected to these developments. The main limitations are that these developments are carried out primarily within the traditional telecom paradigm with its already listed limitations. Even though these networks are opened up to the competitors through interconnection legislations, the structural barriers still exist and are directly connected to the ownership of physical infrastructure. The technical limitation is connected to the capabilities of the 'old' telecom and cable TV access networks to offer real broadband services. This ‘path dependent’ limitation will, at best, facilitate a development of incremental innovations in the network. The radical changes and innovations seem to come from another side, namely development of ‘alternative networks’ as discussed in the following.

The alternative networks’ development is characterized by:

Fixed:

- √ Establishment of LAN in residential areas using a combination of installed ‘dark fibers’ and establishment of new cables and network components
- √ Extension of LAN technology to MAN and WAN, resulting in bypassing traditional telecom
- √ New ownership and business models

Mobile/wireless:

- √ Establishment of wireless IP based network in residential and work environments using, e.g., WLAN
- √ Establishment of wireless hot spots in pubic and private places
- √ Establishment of wireless network in larger geographical places

The LAN technology has, for a number of years, been used in the business sector to interconnect the shared resources and enable communication between the corporate employees. The technology is diffusing to the residential areas as it becomes more mature/robust, cost effective and user friendly. Many housing associations and other organizations deploy LANs to establish real broadband connectivity in local areas. As technologies like Voice-oIP and Video-oIP improve in performance, these networks become capable of offering traditional radio/TV and telephony services.

What is more is that by utilizing the dark fibers (or other technologies) the same ‘LAN technology’ can be deployed to interconnect different LANs in metropolitan areas and also in wider geographical areas. Using gateways to traditional telephony and reception points to broadcast networks, these new networks can offer virtually any information and communication services to their consumers with much lower cost than the traditional telecom, cable TV and ISP environment can deliver.

Similar considerations are valid when it comes to the wireless networks. Using alternative technologies to the traditional mobile development new market potentials are created, however, at least in the beginning, with slightly different scope and scale compared to the wired networks.

These new network technologies open up for radically new conditions for innovations. In the following, a discussion is given on the innovation characteristics of alternative networks and the capabilities of these network technologies in enabling more or less innovative activities.

One of the major parameters determining the extent of innovativeness of the new alternative network technologies in relation to the old telecom paradigm is the technology itself. The alternative networks are based on IP technology, where the structure and intelligence is distributed inside the network, the signalling is not separated from data transmission, the development platform is open, and different services can be integrated in the same network. Consequently, it is easier for small companies and even individuals to develop new services, start a service provisioning business, and establish platforms for development of ‘self organised’ services within these networks. All of these are impossible in traditional centralized telecom network structure.

Mobile and wireless technologies use the radio spectrum resources to offer new narrowband and broadband access technologies. The scarcity of frequency resources put high requirements on efficient utilization of radio spectrum resources, which is partly implemented by development of new technologies and partly by combination of different technologies.

4.1.2 The mobile / wireless platforms

Mobile networks with GSM as the main technology in Europe suffers from the same structural problems as discussed in relation to POTS. PLMN networks are, in a sense, comparable with fixed networks with the ‘only’ difference that the access part of the network is wireless and mobile. Like POTS networks, it is not possible in a basic GSM network to offer new services without having complete control of the network. One major difference between POTS and mobile is that the mobile technology was introduced in a liberalized market and that several licenses have been issued so that there has been several actors competing in different markets from the very beginning.

Furthermore, unbundling and interconnection regulations opens up the market for smaller actors: Mobile Service Providers (MSP)[19] and Mobile Virtual Network Providers (MVNO)[20], which also promotes competition in the mobile market. The SPs and VNOs are, to a high degree, bound to the host networks and are not totally free in their service provision, pricing policies, etc.

Another aspect is the possibility for offering data services in more advanced GSM infrastructures using WAP platforms and the like. Here the conditions for competition are very different and, from a technological point of view, it is possible to offer services without having access to a complete network infrastructure. The barrier for utilizing this possibility has mainly been on the business side, and if an optimal revenue sharing model is implemented, it is possible for small companies to be involved in services provision.

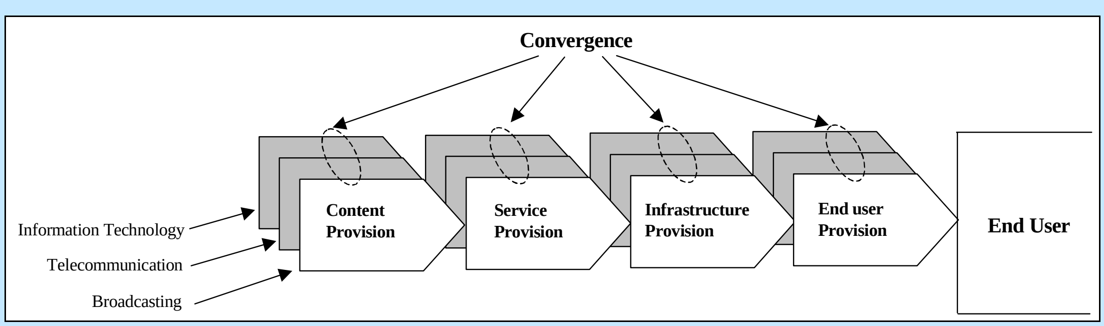
Wireless LANs have, on the other hand, been developed outside the traditional telecom paradigm. The wireless network standard 802.11, which has gained most attention, was published by the Institute of Electrical and Electronics Engineers (IEEE) in 1999. Several variations of the standard have been published since - the best known is IEEE 802.11b, better known to the public as WiFi (Wireless Fidelity). The 802.11b standard uses the unlicensed Industrial, Science and Medical (ISM) band. In the absence of licensing barriers, and because of the simplicity of the technology and its cost effectiveness, WiFi networks have developed rapidly in both industrialized and developing countries.

The penetration in the business and residential areas has been high and actors from telecom and non-telecom sectors have been involved in the establishment of these networks. To what degree WiFi will compete with the developments towards 3G and to what degree it can be seen as a supplement to general development of PLMN networks is still an open question. In a competition discussion this is especially important as the conditions for entering the WiFi markets are fundamentally different. While entering the 3G market has required paying license fees and living up to specified obligations, the WLAN actors can establish networks without any permission.

5 CONVERGENCE AND CONVERGED SERVICES

The traditional broadcasting and telecommunication industries have co-evolved with the developing Internet, but the technological development is making this current sectoral distinction un-sustainable. Content and service provision has already taken place across the traditional sectoral boundaries for some time. Different services can be carried on different infrastructures and the end users' access equipment will be designed to communicate with different services. This process of fusion of content, service, infrastructure and end user equipment is denoted as convergence[21]. This convergence process is illustrated in the following figure.

Figure 5.1: Convergence



According to the European Commissions Green Paper on convergence[22], convergence can be expressed as:

- “The ability of different network platforms to carry essentially similar kinds of services

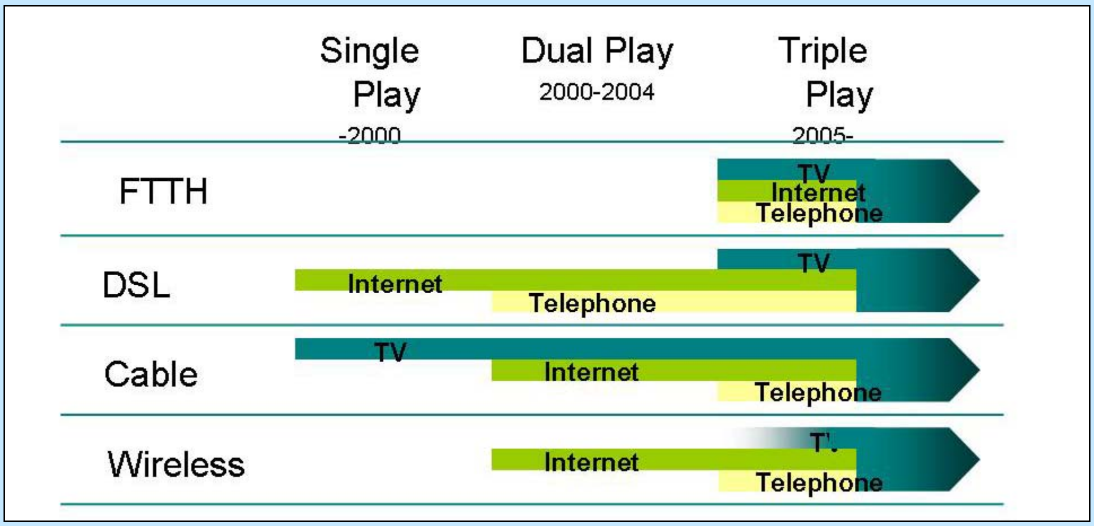
and

- the coming together of consumer devices such as the telephone, television and personal computer”.

In the Green Paper it is furthermore stated “Convergence is not just about technology. It is about services and about new ways of doing business and of interacting with society“. This approach is interesting regarding the objective of this project to identify broader implication of the technological parameters on market development.

Following figure shows the development from single play towards triple play on a time line.

Figure 5.2: From single play towards triple play



Note: Based on Henrik Clausen, IDC Telecom Conference 2006

5.1 VoIP

For a long time, POTS (Plain Old Telephony Services) was seen as a natural monopoly. In the new regulatory paradigm, it is generally accepted that the networks must be opened up for competition through unbundling and interconnection regulation. However, within the traditional telecom paradigm, competition will at best exist between a few actors in an oligopolistic market. The central reason for this has its roots in the technological architecture of infrastructure and service development platforms.

The POTS network is a dedicated network, which is optimized for voice communication. Because of the deployed technology and the way POTS services have historically been organized, a centralized structure has been implemented to offer POTS. Two network layers are deployed in parallel in order to establish a network connection and to transmit services between point A and B, the so called transport and signaling/control layers. Consequently, service creation and provision require access to both the control/signaling layer and the transport layer of the network, which in turn requires access to the whole telecom infrastructure. Even though interconnection to the POTS networks is possible, there are still large entry barriers for newcomers to offer services in the POTS networks. The precondition for service provision in POTS is access to all infrastructure and services development platforms, which requires huge investments.

Using VoIP has gradually changed this situation and through the convergence process has opened up new conditions for service development. Using VoIP technology and the general Internet as backbone, new providers can offer competitive prices, particularly for long distance and for international calls. The transmission of the service over long distances within the Internet is much cheaper than keeping the service within POTS with its distance-related cost structure and interconnection pricing schemes. The entry barriers for these service providers are lower and the number of them is increasing, contributing to the overall competition in the public voice market.

5.1.1 VoIP signalling standards

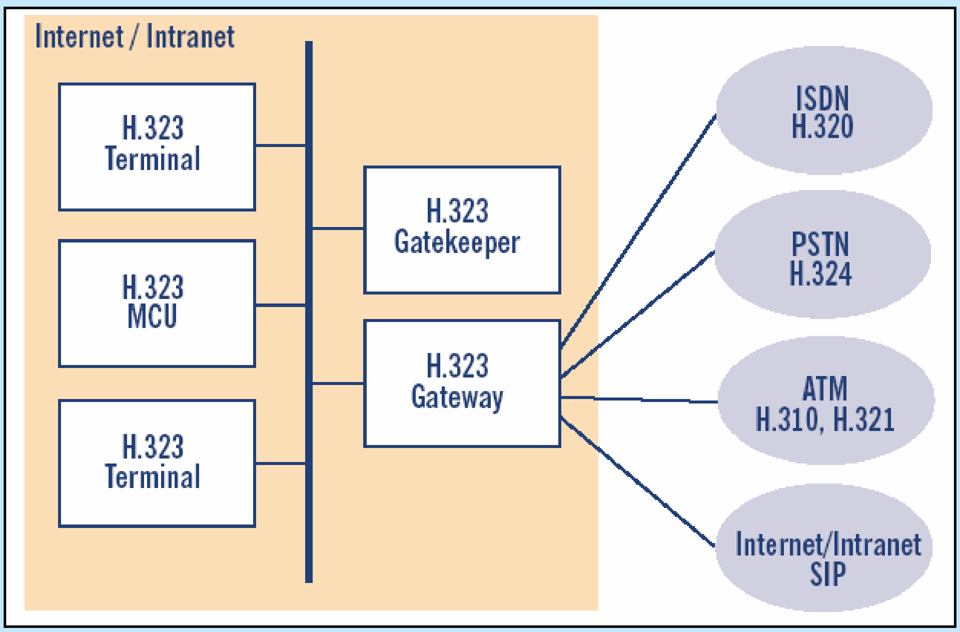
The main signaling standards in VoIp are H323 and SIP, which are described in the following

H323

H323 is an ITU-T umbrella standard released in 1996, which consists of signaling and transport and coding protocols. H323 is a multimedia conferencing standard and mainly used in professional video conferencing systems, but also used for pure VoIP applications. Part of the design is to specifically tackle the interconnection with PSTN by means of a gateway.

A simple set-up of H323 is depicted in the following figure.

Figure 5.3: Set-up of H323



As seen in the figure the main components of a H323 system are:

- H323 terminals
- PSTN gateway for connectivity to PSTN
- Gatekeeper, which is the H323 IP telephony server
- MCU (Multipoint Control unit), which is a switch for establishing several node communication

SIP

SIP stands for Session Initiation Protocol. It is an application-layer control protocol that has been developed and designed within the IETF. The protocol has been designed with easy implementation, good scalability, and flexibility in mind. SIP was originally defined in RFC 2543.

Opposed to H323 which is an umbrella standard, the purpose of SIP is just to make the communication possible. The communication itself must be achieved by other means and protocols/standards. SIP has been designed in conformance with the Internet model. It is an end-to-end -oriented signaling protocol which means that all the logic is stored in end-devices (except routing of SIP messages).

Interoperability between SIP and H323

The interoperability between SIP and H323 can be established either by using proxies and gatekeepers which can handle both standards, or by using standard gateways depicted in the following figure.

Other standards

SIP and H323 are the dominant standards but also other signaling standards are available on the market. The important ones are MGCP and SCCP.

MGCP (Media gateway Control protocol) operates at the backbone of the network and typically used by network elements like call agents which routes calls between gateways and media gateways. MGCP is documented in RFC2705.

SCCP (Skinny Client Control Protocol) is a proprietary protocol used by Cisco systems. It is a signaling protocol for Skinny clients, like Cisco hard phones and the Cisco call manager which connects the clients

5.1.2 VoIP deployment scenarios

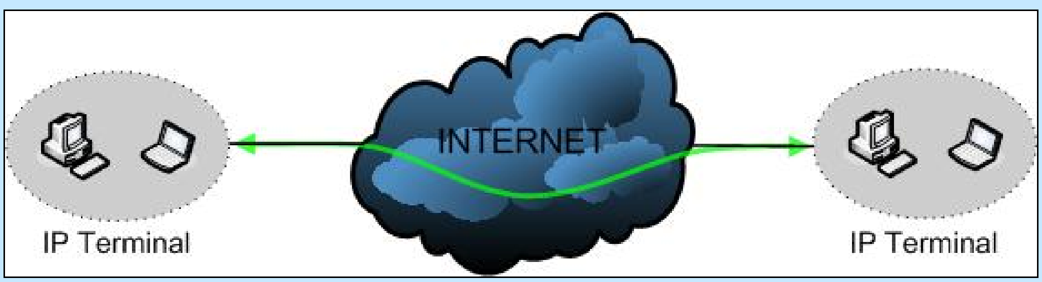
Scenario 1

The first scenario depicted in the following figure is the VoIP between two Computers or other IP terminals. The communication takes mainly place over the Internet but also over closed IP networks. This is the oldest implementation of VoIP.

Major characteristics of this scenario:

- Relative small amount of VoIP communication. Mainly early adopters.
- Terminals are mainly computers
- Calls can only placed within IP networks, but are free of charge
- Only basic signaling systems are deployed
- Providers are Messenger, Skype, Teamspeak, ICQ etc.

Figure 5.4: VoIP scenario 1



Scenario 2

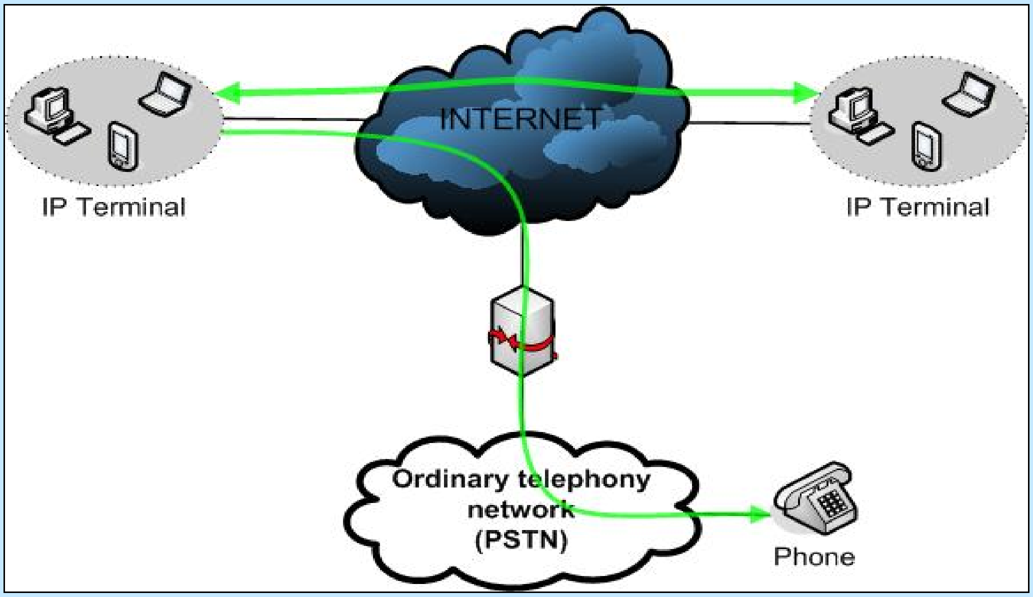
Second scenario is depicted in the following figure. The difference between this scenario and the former one is that here it is possible to call from IP to PSTN, using a gateway.

Major characteristics of this scenario:

- Amount of pure VoIP communication (scenario I) grows primarily due to reduced costs.
- IP terminals are now mainly computers and some PDA’s
- Calls can be placed to a traditional PSTN telephone from an IP terminal, but not the other way around.

- Calls are free of charge within the IP networks. Calls to the PSTN network can be placed through service providers, at reduced cost.
- Providers are Net2Phone, Callserve, Skype out, etc.

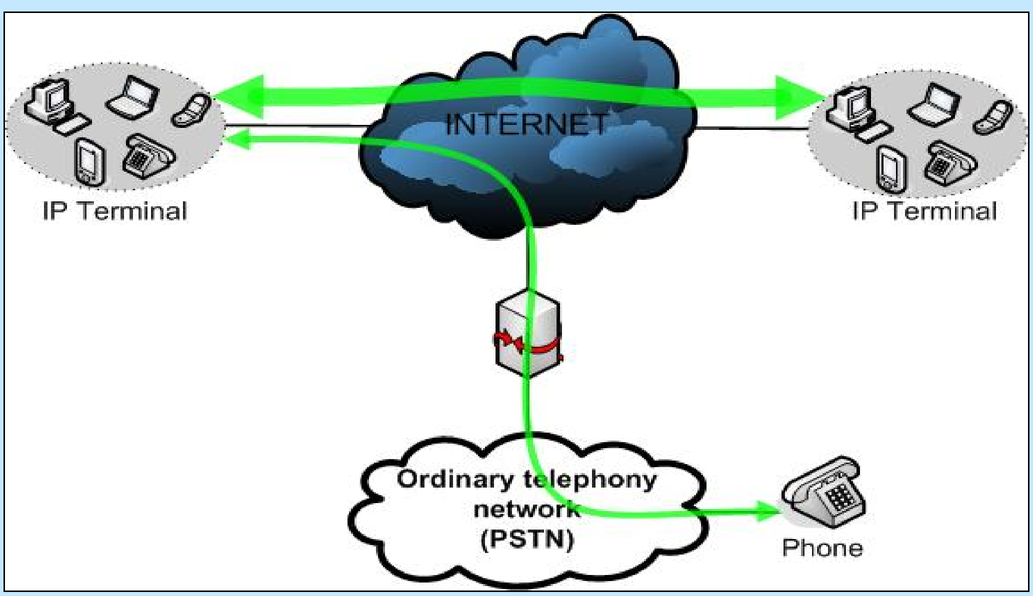
Figure 5.5: VoIP scenario 2



Scenario 3

Third scenario is depicted in the following figure. The difference between this scenario and the former one is that here it is possible to also call from PSTN to IP, using a gateway.

Figure 5.6: VoIP scenario 3



Major characteristics of this scenario:

- Amount of pure VoIP communication (scenario I) grows continually.
- IP terminals are both computers, mobile phones PDA's and dedicated IP phones.
- Calls can be placed both to and from a traditional PSTN telephone.
- Traditional telephony systems are now being replaced by VoIP solutions.
- Value-add services appear.
- More advanced signaling systems is being used (e.g. H.323 and SIP).

5.2 IPTV and VOD

IPTV and IP-VoD started by offering different services using streaming TV over the Internet. In the last 5-6 years, we have been witnessing the emergence of a huge amounts of '*on demand*' video services on the Internet, specific 'Internet TV' channels, and '*time shifted*' versions of part of programming from traditional broadcasters. This development has been intensified in the recent years, where the quality of streaming video signals are getting better and approaching the quality levels known from traditional TV services. Furthermore, in recent years, broadband operators deliver IPTV services in their managed IP networks. Here, it is possible to deliver even better quality than traditional broadcast TV and many broadband operators have plans for the provision of HDTV based in IPTV technology. Also in the managed IP networks a great deal of video content, mainly feature movies is available in the VoD provisions. The IP-VoD is mainly based on client server architectures, but in the future development P2P can be used as a more efficient content organisation architecture.

Three observations are important in this development: 1) IP platforms, especially broadband platforms, are becoming a competing infrastructure for delivering of TV services. Until now, terrestrial, satellite and cable network have been the main delivery platforms and the main development has been towards digitalisation. 2) IP platforms, due to the inherent interactive component, are changing 'broadcast' in a fundamental way from a broadcast service to an *on demand* service. 3) The content providers can bypass service providers and directly offer services to the end consumers.

Regarding the first aspect, a number of broadband providers simply copy the business model from the multi-channel platforms like cable TV and satellite TV and offer services in different packages: Basic package, optional package, premium package, etc. They simply build up a head-end like cable TV, take feeds from different TV station, generate live stream, form different packages and send them to the consumers. The consumers must have IP set-top boxes that convert the IPTV to regular TV and send it to the TV. This model is used on many broadband platforms, mainly as a part of 'triple play' services.

The reasons for this development is directly connected to the IP design characteristics and the wide spread use of IP and Internet. Furthermore, IP enables interoperability and synergy in content adaptation and service development, which is vital, especially in the multi platform environment of media technologies.

The second aspect, *on demand* transformation, is important because the characteristics of IP platforms are used to add value to broadcast services. If we look at the composition of TV programs, we can see that the majority of programs are not live and are distributed at certain times by the broadcasting station due to some planning considerations. In IPTV provision, this type of content can be put on a server so that users can use them when they want. Of course when the main value of a program is connected to the ability to receive it live, IPTV must use its capability to offer it as live stream.

The third aspect, bypassing the service provider, is not a new thing. In traditional analogue terrestrial broadcasting and Free-To-Air satellite broadcasting, there is no service provider. The programs are sent to the transmitters (satellite or terrestrial) by the broadcasters and received by the users. The service or *bouquet* providers emerged in the era of multi-channel TV platforms like cable and satellite. To establish a business model, the service/bouquet providers form different packages of TV channels and sell them to the end users. On the IP platforms, it is possible to continue using this model, and as seen above this is done by several broadband providers. It is, however, also possible for the broadcaster to bypass this service provider function and sell the services directly to the users.

6 ACTORS IN THE INNOVATIVE PROCESS

In the old telecom structure the incumbents completely dominated both the markets for and the esearch and development of equipment, networks and services. There was, however, a certain division of labor in R&D. The incumbents concentrated on networks and services including basic and long term research whereas their - typically domestic and closely connected selected - suppliers took care of development and production of equipment.

This structure was changed by liberalization and competition giving the equipment producers the main role in develoment also of networks and new services. This change lowered the barriers of entry to a complicated market and was an important factor in opening the telecom market to the emerging alternative operators. The tight connections between the incumbents and domestic suppliers were loosened and disappeared during the 1990's together with the incumbents basic and long term research and development activities. The equipment suppliers emerged in collaboration with universities as dominating global actors in research and development.

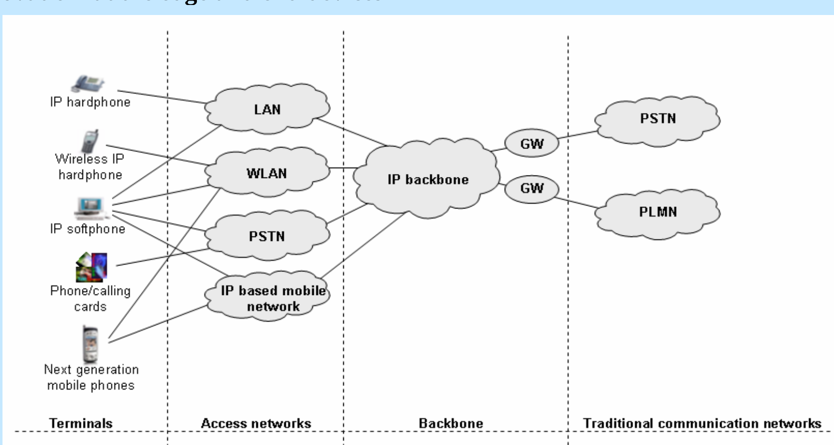
Table 6.1: Research and development % of turn over

Company	1987*)	1999**)
AT&T	9,8	1,6
BT	2,1	1,9
NTT	3,8	3,7
TDC	2,4§)	1,2§)
Ericsson	9,1	14,5
Nortel	12,3	13,9
Nokia	n.a.	10,4
Cisco	n.a	18,7

Note: SPU_note) M.Fransmann i G.Pogorel; Global Telecommunications Strategies and Technological Changes, Amsterdam 1994, p. 280. **) M.Fransman, Telecoms in the Internet Age, Oxford 2002, p. 49 §) Interview with TDC Director of R&D in Ingeniøren 18.03.1998*

This R&D structure is still changing as producers of consumer electronics is moving into the area as discussed above.

Figure 6.1: Innovation at the edge and end devices



7 CONCLUSION

The technical changes in electronic communication enable new business opportunities and are associated with new business models changing the role and importance of the 'actor groups' in the value complex delivering voice communication. There are incremental changes as, e.g., actors doing Internet and electronic commerce business can by modification of their service adopt them to the digital broadcasting platforms and increase their consumer base rapidly. And there are radical changes as the shift in roles of telecom operators, equipment suppliers and producers of consumer items in the innovative process.

The changes are driven not only by technology, but also by changes on the markets and in policy/ regulation and by the dynamics of relations between these areas.

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[5] http://www.euractiv.com/en/agenda2004/lisbon-agenda/article-117510

[6] http://www.itu.int/wsis/tunis/newsroom/background/wsis-stocktaking.html

[7] The current organization is subject for discussion; one of the main problems is the dominance of the US in the organization of the Internet and the skew allocation of number resources. For more discussions on this see the part on IPv6 later in this chapter.

[8] See amongst others: Cisco: Internetworking Technology Overview, June 1999

[9] Jerome H. Saltzer, David P. Reed, and David D. Clark, 'End-to-end argument in system design', 1981

[10] TRAI: Consultation paper no. – 8/2005, TRAI, 'issues relating to transition from IPv4 to IPv6 in India, August 26, 2005

[11] See amongst others the ITU Internet report 2005: the Internet of Things

[12] ITU-T Recommendation Y.2001

[13] Ofcom: Next Generation Networks: Further Consultation, Issued: 30 June 2005, Closing date for responses: 12 August 2005

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[15] COCOM 2004

[16] ITU 2003

[17] Provision of three main services, Internet, VoIP and IPTV in broadband networks is denoted as triple play. The term multi play refers to broadband networks which offer additional services to the triple play.

[18] See amongst others Bittlingmayer G. et al 2002

[19] MSP is a retailer of SIM cards from the host network and does not have any operator code or own termination technology.

[20] MVNO terminates the calls to its own subscribers and has an operator code. The MVNO uses the network of the mother company to implement its own virtual network.

[21] See among others: Baldwin, T.F., McVoy, D.S. and Steinfield C.: "Convergence. Integrating Media, Information & Communication. Thousand Oaks: Sage Publications, Inc., 1996.OR Winseck, D.:" Reconvergence. A Political Economy of Telecommunications in Canada. Cresskill, N.J.: Hampton Press, Inc, 1998.

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