Definitions for disruptive innovation in telecommunication technologies

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Every industry at a given moment reaches its end of development, a tipping point where the saturation of the market by products, services and technologies is inevitable. This article analyzes the term innovation and its specific application in the telecommunication industry. The difference between the terms idea, invention and innovation is taken into consideration as a starting point for all the other researched definitions. Furthermore, not only the difference between most popular incremental and disruptive innovations was evaluated but also some other concepts were identified in order to add gradation in between. Some of the answers we're looking for were related to the innovation as more targeted search for changes compared to the post-factum result of a change? Can we say the innovation is more technological rather than business related activity? And finally, specific technological innovations are considered, which are expected to have a key impact on the industry in terms of identifying their destructive characteristics. The outcomes are grouped in different categories so that everyone can easily apply them in any innovation process.

Keywords – Disruptive, Innovation, Radical, Technologies, Telecommunication.

Определения за разрушителна иновация в телекомуникационните технологии (Цветослава Кьосева). *Всяка индустрия в даден момент достига момент на своето развитие, където насищането на пазара с продукти, услуги и технологии е неизбежно. Тази статия анализира термина иновация и специфичното му приложение в телекомуникационната индустрия. Разликата между термините "идея", "изобретение" и "иновация" бяха разгледани като отправна точка за всички останали изследвани дефиниции. Нещо повече, не само разликата между най-популярните надграждащи и разрушителни нововъведения беше оценена, но и някои други концепции бяха идентифицирани, за да се добави градация между тях. Някои от отговорите, които търсихме са свързани с иновациите като целенасочен процес на търсене на промени в сравнение с това те да са резултат от случайна промяна? Можем ли да кажем, че иновацията е по-скоро технологична, отколкото свързана с различни бизнес аспекти? И накрая се разглеждат специфични технологични нововъведения, които се очаква да имат ключово въздействие върху индустрията по отношение на идентифицирането на техните разрушителни характеристики. Резултатите са групирани в различни категории, така че всеки да може да ги прилага по-лесно в който и да е иновационен процес.*

Introduction

Nowadays, the telecom industry is one of the fastest growing in the ICT sector. Furthermore, the boundaries between this sector and its competitors in adjacent markets, like Internet providers, are becoming more and more indistinct. This forces the telecoms to implement different innovation programs for diversification and sustainable economic development. The topic becomes more and more within the agenda of telecommunication providers and even during their regular ITU meeting in 2013 it was clearly stated that a massive disruption in the industry has reached its point, where new models for radical shift that corresponds to the exponential technological and societal changes are needed [1]. But what kind of innovations really can contribute to these goals?

There are not so many concepts that could be defined as hard as the concept for innovation. Since innovation can be used in different aspects, it may acquire different meanings. The term innovation may refer to the process of introducing new products, i.e.

the same invention can lead to a variety of innovations in its availability in the market. Also, innovation can have the status of organizational structure, especially the goal of a company department and cannot differ in meaning from the concept of managing the change.

Idea, Invention and Innovation

Last decades of the 20th century finally the scientific and technological progress approved to be one of the most important factors for economic development on companies' competitiveness on the market and further impacted the industries and national economies growth. In the global economy of the future development and survival of organizations central role is assigned to innovation. Innovation and relations to innovative systems are assumed to be crucial for economic growth of the developed market economies.

When it comes to innovation it is very important the difference between idea, invention and innovation to be clarified [2]. The innovation process always starts with an idea that someone is coming up with. But the idea itself does not directly mean anything related to innovation, because it has to be realized. Very important step in the realization is assigned to the invention. On the other side, it has to be highlighted that not every invention leads to innovation phase. In order an invention to be transformed into innovation, it has to be marketed in a proper way and accepted by the customers. Croslin in his book "Innovate the future" categorizes the types of terms, with which the consumers describe the difference between invention and innovation [2]. This distribution of wordings through the discovery, as well as the utilization among the invention phase, and incremental and disruptive in the innovation phase, is shown on Figure 1. His consideration is that inventions always happen with discoveries that lead to a new technology, designing a new methodology, and fulfill a perceived need at end of this step.

When the discovery is seen as a potential value, the owners of the discovery could utilize their invention by creating a product or a process, and turn it into an intellectual property, like trademarks, patents, valuable assets, etc. Once the invention is realized and launched on the market, it still may not be considered as an innovation. The tipping point for becoming a true innovation is the customer acceptance of this new product, process, methodology, or functionality. Usually the underlying issue for acceptance stays in identified limitation like those in design or marketing specifics, while the invention still retains innovation potential. The transformable value that moves the invention on the other side of the border and turns it into an innovation is only after it has been used and accepted by the consumer and s/he perceives the original invention as an "innovative" product.

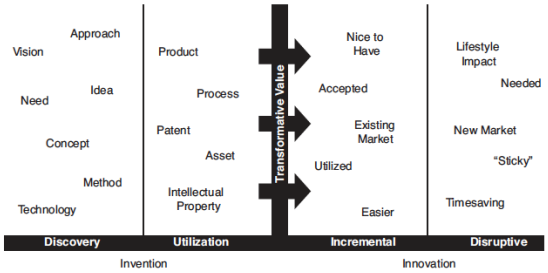

Fig.1. Invention vs. Innovation, consumer definitions (Source: Croslin D., Innovate the future).

Croslin also explains the different steps through an innovation lifecycle, which overview is presented of Figure 2 [2]. The sequences of different stages towards the innovation are considered to be as follows:

1. Product invention always should start with identifying the perceived customer value and based on it to determine the market needs. As a result, the basic product is defined.
2. Disruptive innovation would happen on the next stage only in case the consumer purchases the product, which could be as a result of a high enough transformative value. The highest is this value the highest is the market penetration of the new product. The lifecycle of the innovation could be very short due to an incorrect marketing campaign, which could destroy the consumer attitude before the launch. This could happen when the product fails to deliver subsequently the expectations that had been raised.
3. Incremental invention is associated with adding new functionality or features to the initial product or process that had been realized as a disruptive one. It is considered that consumers may accept those improvements as positive transformable value till certain point.
4. Positive incremental innovation could lead to extended transformative value only.
5. The stages from 3 to 5 are repeated until transformative value is not possible to be increased anymore.
6. Negative incremental invention appeared when continuing to add new functionalities or features to the foundational product till the level after which it is considered rather negative than

positive, as the product appeared to be too complex. Negative incremental invention could lead to commodized products.

7. Stage 6 is repeated until transformative value is one and the same for all competitors on the market.
8. Destructive inventions happen when any further activities trigger the decrease of the transformative value.

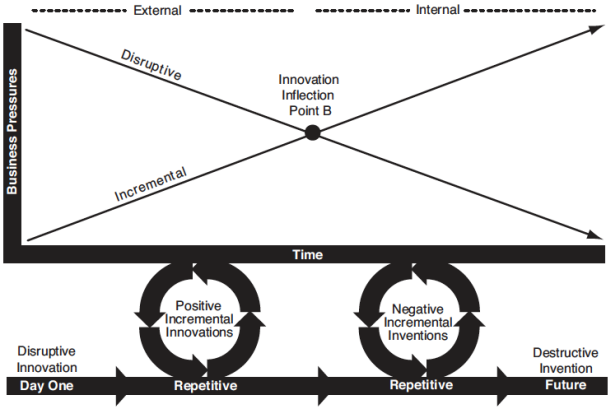

Fig. 2. Innovation lifecycle and their business pressure (Source: Croslin D., Innovate the future).

In general, the understanding about disruptive innovation is for a new product that creates totally new market or radical shift in the existing market. On the other side the incremental innovation is something that is usually preceded by disruptive innovation and adds inexistent value to an existing product or service.

One of the first fundamental step in the study of innovation and its role in economic development has been made by the Austrian economist Joseph Schumpeter, which is also considered as a father of the theory of innovation processes in the modern-day interpretation. Schumpeter was also the first who explores the relation between the long waves and the scientific and technical progress, and set basis for the basic concepts of the innovation process. It also looks at innovation as changes in technology and changes in the management, as well as in new combinations of resource utilization. Schumpeter is the one who devotes considerable attention to the role of the entrepreneur in the innovation process, as it is the last link between the invention and the innovation [3].

On the other hand, Peter Drucker defines innovation as activity that provides new capabilities of resources for the production of goods. The basis of his reasoning is that innovation is not a post-factum result of a change, but a targeted search for changes that might be used by the entrepreneur. According to him, innovation has two functions: to innovate and to bring the innovations to the market, and all other activities exists to support them. He also proves that innovation is not only technological phenomenon, but a social as well. In his view, the most significant innovations in the last two centuries were social rather than technical. Also, they had been successfully realized, because their success was a result of joint work of all members of society, not of the inventor only. [4]

In terms of different types of innovation, the theory categorizes two major ones: incremental and radical or breakthrough. It is considered that incremental innovations are minor improvements to the available methods, technologies, and products and processes. The other term that is used for this group of innovations is evolutionary or continuous ones. As a result, the products on the market are close substitution of the existing ones. This is possible only when product characteristics could be very well defined and customers know their needs. Quite the opposite is the definition of radical innovation. It is identified as so different and does not have any analog. These types of innovation are associated with entirely novel technologies, new products or services, and even can create new markets or industries. Other term that is popular for this type of innovation is revolutionary or discontinuous innovation. When it comes to the outcome of this innovation it includes huge changes of basic technologies usually done by people or companies that are outside of mainstream market. It is believed that for his type of innovation there is no need for listening and gathering marketing requirements, as customers are not able to assess what still does not exist. Usually all Research & Development (R&D) activities can contribute to this category and could lead to technology-push innovations. But sometimes these innovations could be developed in total disconnection of the real needs of their future users [4].

Looking at the types of innovation, in general four most common could be categorized - product, process, structural or organizational, and even innovation in marketing activities. Furthermore, last couple of years it is more common an innovation in business model to be considered as a result of deliberated process of innovation. The last category could be treated as disruptive as it creates non-existing up to that moment revenue streams for the company, and could be based on significant changes in how the company working process are set.

It also must be taken into account that there are different sources of innovation as well [5]. In this

regards any changes in industry, market structure or any kind of demographics are triggers and basis for an innovation. Once the innovation occurred, it has a different diffusion process and time of acceptance by it users. This is shaped by the so-called S-curve that indicates the different stages of innovation status on the market. In relation to it is the ability of company management to track the economic impact of the innovation.

Definitions of disruptive telecommunication innovations

Historical development of wireless technologies starts in 1980's with First generation (1G) that was introduced as analogues systems for voice service only. After this period, almost each ten-years a new generation is released.

The Second generation (2G) mobile communication system was launched in last years of 1990's and was a total shift to digital era. In addition to the main traditional voice service only SMS and e-mail were offered to the end users.

The Third generation (3G) systems were mainly focused on offering high-speed mobile access to Internet network with IP-based services like wireless web access, multimedia messaging services, email, and video conferencing, while customer experience for having Internet anytime and anywhere regardless the used device. This generation was commercially released in 2000's [6].

Only within next 10 years, in 2010's, the Fourth generation (4G) was introduced to the telecommunication market where the primary services were moving more and more towards IP-based communication with a really high-speed wireless broadband access. The standardizing body in the face of 3GPP pushed the industry towards LTE Advanced technology that is expected to provide same as fixed broadband experience to the users of mobile broadband [7]. What is very specific to this generation is the demanding requirement of the new products for Quality of Service (QoS). A totally new products and services had been developed like video chat, mobile television, high definition content and Digital Video Broadcasting (DVB) [8].

Last couple of years an intensive discussion about Fifth generation (5G) had been started. This generation is expected to be different than 4G with higher number of supported by the network devices, higher number of devices that are connected simultaneously, lower consumption of battery, better network coverage, lower latencies in the communication, lower costs for infrastructure deployment, higher scalability or higher communication reliability. But this is still not standardized generation and only initial steps towards it are taken [9].

In the communication world, nowadays not only mobile technologies exist but also they are coexisting with other wireless standards like ZigBee, Bluetooth, WiFi, etc. Hanrahan researched this link between the standards from the different communication sectors and summarized can be found in Appendix A [10]. As a conclusion, this means that in case telecommunication operators would like to offer one and the same services to different customers, they have to implement it simultaneous for different wireless standards. It has been studied that the operating expenses (OPEX) took considerably higher part of cost of ownership (TCO), ranging from 50% to 85% [11].

Furthermore, the telecom operators are upgrading or moving to the next new technology faster that they are able to get the maximum profit from all the previous technologies. Looking from the business cycle point of view, this reflects the shorter and shorter cycles compared to the speed of new-coming technologies. This accumulated with the time results in the necessity too many technologies to be supported simultaneously, which is directly related to the increase costs over the time. And it is quite normal the telecommunication operators to start either implementing different cost reduction plans or executing totally new innovation programs.

Moreover, the network infrastructure of the telecommunication operators is facing the following challenges:

- Every telecommunication infrastructure has geographical limitations, meaning the territory of the country for example. And at some certain point over the time it is not a completive advantage, while all the competitors have e.g. 100% network coverage over the country.
- Another limitation is coming, when the network architecture reaches it throughput limit. In this case the telecommunication operators have to add additional infrastructure so that the new extensions are to be supported.
- Since that end users are paying fees for being able to use the services provided by the infrastructure providers, there is a strong dependence between the users and the infrastructure providers.
- The number of devices that have to be supported by the infrastructure provider and their variety is increasing tremendously. Just in couple of years

ago, there were mobile phone and computers, but nowadays a totally different type of non-existing before devices could be attached to the network, like tablets, e-book readers, etc.

- Together with the devices usage of mobile applications like mobile social networking has over-exceeded the traditional voice services. The last one triggers a lot of issues on how this mobile data traffic could be supported in urban areas. According to GSMA the worldwide mobile broadband growth in terms of unique users are expected to grow from about 1.6 bn by 2012 to 5,1bn in 2017 resulting in 26% CAGR [12].

All the issues listed above and the lack of adequate response from the telecommunication operators and the industry as a whole, resulted in an appearance of aggressive disruptors of traditional services like voice calls, coming from non-telecommunication sectors.

Christensen was the one that set the concept for disruptive innovation with the analogue disruptive technology with the meaning that the new developed outcome is displacing the existing market through implementing a totally new technology [13]. It has been also analyzed that successful network operators will change their main business model from switching, transmission, and operations systems to routing, transport, and network management [14]. Christensen also did analyses on VoIP as a disruptive technology and explains that the disruptiveness remains in the combination of packet switching, Internet and new business models [13].

However, today's successful companies could have trouble making the needed architectural leap because it requires discontinuous innovation. Continuous innovation is comparably easier as investment is predictable on the current infrastructure, but the new architectures call for significantly different ways of running the telephone and cable businesses. The radical model is to invest in the future by providing today's services more efficiently and effectively. With the more reliable network management in these architectures, service providers can reinforce the public's perception of their quality service [14]. Infrastructure convergence for telecommunications and information services is the long-term objective of next generation networks (NGN). The evolution and migration to a single network with common transport infrastructure where the same service or content can be delivered by different types of infrastructures or media. In the future, it is expected the network to look more like the typical client-server computer network [14].

Different parts of the total infrastructure evolve in a loosely coupled way: core networks, access networks, service architecture and management systems. A modern ICT system relies on the coordinated use of different facilities to provide a service. Over time, facilities evolve and new services are developed from existing services, driven by changes in the environment. Technologies may encounter evolutionary dead-ends at different stages of their lifecycle as it has been analyzed by Hanrahan and presented in Appendix A [10]. A mature technology may not be able to take on more functions, as in the case of circuit-switched voice services. A new architecture may fail to gain acceptance [10]. This could be concluded as an unsuccessful attempt to introduce a new radical technology.

The process of introducing new technologies to take over functions of legacy infrastructure is termed as migration. Another explanation of migration is by referring to the network transformation. Four categories of transformation are could be identified and are summarized in Figure 3 [10].

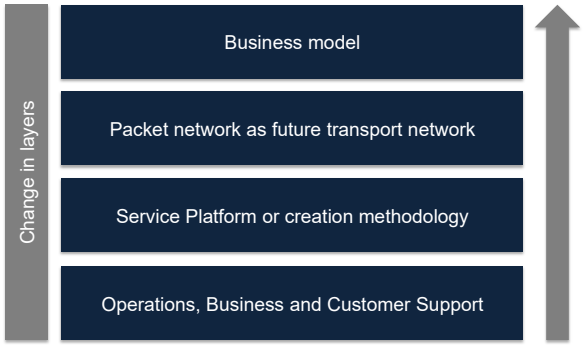

Fig.3. Migration categories as transformation towards innovations

First of them is related to the change of operator's business model, for example a voice service provider is providing a consumer information and entertainment services as well.

Second, transformation could be associated to a packet network with the projection this network to be the only one future transport network.

Third, when the service platforms and the service creation methodology had changed.

Finally, the company operations' support, business support and customer care systems are changed as well [10].

Notwithstanding, Hacklin et al identified the combination of incremental innovation and convergence that leads to a disruptive innovation

[15]. Three types of innovative disruptions based on convergence combinations between known and new technologies could be distinguished – application, lateral and potential, and the result of them is summarized in Figure 4.

Application convergence, where due to combination of more than two existing technologies, the disruption resulted in a new added application value because of the innovator's ability to mix the right technologies.

Lateral convergence, where more than two well know technologies merged to a new one, leading to more appealing solutions to customers by bringing new features to existing solution.

Potential convergence could appear when more than two new technologies are merged but in their basis, none of them have the potential to be disruptive.

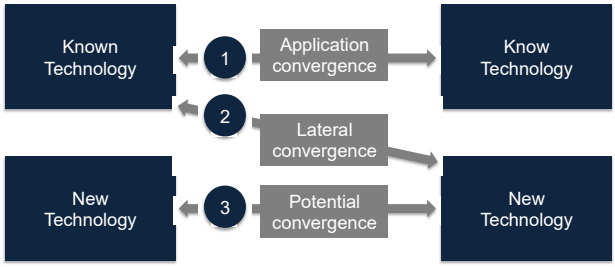

Fig.4. Types of convergence innovations based on used technology newness

But the convergence is one of the several patterns observed in the evolution of ICT and its applications [10]. A second pattern of technology development was identified by Ferguson in the context of the development of transmission systems in three phases depicted in Figure 5. First one is the opportunity identification. During this phase, it is stressed that an opportunity for new service is identified but the existing technologies simply do not support it. An example that had been elaborated by Hanrahan refers to the Voice over IP service that uses Internet as a technological network, but the last one is not designed to support the delivery of a service in real time due to its best-effort character. The next phase is the adaptation of the existing facilities to accommodate the demands of the new service. Hanrahan also relates the Voice over IP example to the development of a new protocol, named Real Time Protocol (RTP) that in the Internet framework is able to improve the quality of the offered service. The third stage is to specify, design and implement infrastructure that provides proper support for the service [10]. The extension of the Voice over IP example resulted in a delivery of totally new network called managed network that incorporates Internet network as well.

Fig. 5. Convergence patterns for development of transmission systems

Furthermore, two types of disruptive technologies could be observed. One displaces an incumbent technology in a phase transition, during which users adopt the new technology over a period of time. The second type creates a new market or capability where none had previously existed. [16] Even more, the disruptive technologies are analyzed into the context of whether the displacements of old by new technologies or services are followed by the displacement of leading companies [17]. And it was concluded by Latzer that the communication networks are into a constant disruption because of the improvements into the component technologies [17].

As a business result for the disruptive technology, six distinct categories were identified and overview of them is categorized as follows [16]:

- First type makes possible one or more new technologies, processes, or applications and is named "Enablers".
- Second is the so-called "Catalysts", which alter the rate of change of a technical development or the rate of improvement of one or more technologies.
- "Morphers" are the third category and could happen when a combination with another technology triggers the delivery of one or more totally new technologies.
- The next group is named "Enhancers" and brings modifications of existing technology, so that interest could exceeds a critical threshold.
- Another group renders the existing technology and exchanging it with a new one that is superior like better, faster, cheaper, or more capable and is named "Superseders".
- And the last group changes a fundamental understanding of nature or enabler and is called "Breakthroughs".

In addition, a disruptive technology could have the following characteristics according to [16]:

- When a key element, like performance, cost, etc., is put against the time factor there is a discontinuity.

- The impact over other technology should be constant over time but not an incidental event.
- When a cross-technology is targeted there should be a convergence of more than a single discipline.
- Disruption should lead to a profit for the company but not to threaten the corporation.

Boccardi does another analysis on future disruptive potential of still not standardized technology like 5G [18]. It summarizes the impact of new technologies and is grouped based on the two categories of changes, meaning architectural and component elements:

- Design evolution, where very small changes on both categories exist.
- Component changes only that results in disruptive changes in the design of component elements.
- Architectural changes that have disruptive changes in system architecture.
- Radical changes, which results in disruption in both architecture and network elements.

However, this model originates from Henderson and Clark innovation concept for distinguishing between component and system, which has four innovation types [19]:

- Incremental innovation;
- Modular innovation;
- Architectural innovation;
- Radical innovation.

The model is presented on Figure 6 and what is very important to be highlighted is that Henderson and Clark introduced two medium stages between incremental and radical innovation, namely modular and architectural innovations.

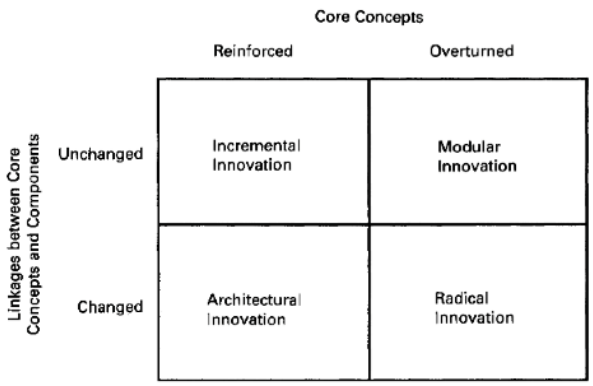

Fig.6. Henderson and Clark framework for defining innovation

Although the literature information about analysis on disruptive innovations is infinity, the executed overview is treated as quite enough to be a basis for defining patters for technological and business characteristics of disruptive innovations.

Outcome and conclusions

This article looked at the various definitions of the term innovation. The difference between idea, invention and innovation was analyzed. As a result, it can be summed up that innovation definition may have different meanings depending on the criteria used to define it. The consumer's perspective was also examined, namely what terms the end-user denotes the difference between discovery and innovation. It can be concluded that inventions happen through discoveries that lead to the emergence of a newer technology. Once the invention has been implemented and marketed, it still cannot yet be considered an innovation.

A theoretical distinction between product invention, radical innovation and the emergence of a subsequent disruptive invention was studied in detail. An adverse effect point was identified, after which each subsequent upgrading innovation would have a largely negative impact on consumer attitudes, as the product turned out to be too complex.

All the definitions discussed can be combined around the fact that upgrading innovations are small improvements to existing products, processes, methods or technologies. On the other hand, radical innovations are mainly associated with entirely new products, services or technologies, the root cause of emerging new markets or industries. In this connection, the life cycle of an innovation in S-curve shape was also considered.

As a continuation of the theoretical overview, the term innovation was also addressed in the context of the telecommunication industry. Here, it can be concluded that all the models under consideration aiming at disruptive innovation are based on combinations of different elements. Such are the types of convergence as a combination of existing and new technologies. In general, this type of technological development can follow three phases: identifying opportunities for realization, adapting existing facilities, and the emergence of an entirely new network or infrastructure.

Based on the relation between architecture and its components, a model with two intermediate milestones was introduced between upgrading and radical innovation, namely modular and architectural innovations.

Finally, it should be noted that several key features of breakthrough innovations have been

identified, namely that the change of each key element should be matched to the time factor and that the impact should be purposeful and sustainable over time. They will be used later in defining a hypothesis for standards that identify potential disruptive innovations in the telecommunication industry.

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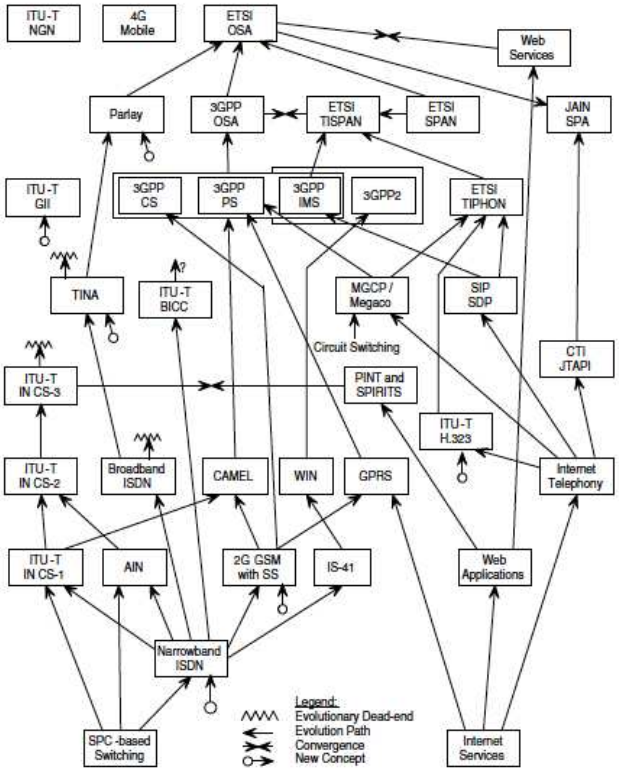
APPENDIX A – EVOLUTION PATHS IN TELECOMMUNICATIONS



Evolution paths for call control, services and applications

(Source: Hanrahan H., Network Convergence – Services, Applications, Transport, and Operations Support, Wiley, 2007)

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