INTRODUCTION

Definition of Next Generation Networks:

According to ETSI:

NGN is a concept for the defining and establishing of the networks, allowing a formal distribution of functionalities into separate layers and planes by using open interfaces, making it possible for the service providers and operators to create a platform which can be gradually developed thanks to creation, implementation and effective management of innovative services.

According to ITU-T:

NGN is a network based on packet transfer, enabling to provide services, including telecommunication services, and is capable of usingseveral broadband transmission technologies allowing guaranteeing QoS.

The functions related to services are at the same time independent of the basic transmission technologies. NGN provides unlimited user access to different service providers. It supports general mobility providing the users with consistency and availability of services.

Changes, Opportunities and Challenges:

1. **Major Life Style Changes: Desktops, Laptops, and Now Handtops:**

   We all know how personal computers (PCs) have changed our lives during the last two decades. First, we started with desktop PCs and then started using more and more laptop PCs, especially in last 10 years or so. Laptops allow us to carry our PC with us anywhere we go and use it. With wireless and mobile Internet access, users access the Internet anywhere and anytime. We can send and receive e - mails and exchange fi les at any time, from anywhere. Voice applications allow us to call and talk with anyone in the world who has a PC or a phone. PC - to - PC calls are free and PC - to - phone calls cost less than traditional calls.

   Many of our traditional daily habits have been changing too — watching, calling, shopping, making payments, and many more. These changes affect the way we do business in many industries.

   It wasn't so long ago that we watched a movie, a video, or a program just using the TV and made phone calls using only wireline phones. Today, we also use PCs to watch programs and wireless phones to make a great many of our phone calls. In more and more families and businesses, wireline phones are used for special cases (conference calls, interviews, other business calls, etc.). Increasingly, people do not have wireline phones. They use their cell phones. They watch TV programs using their laptops and/or "handtops." Handtops are mini personal computers such as iPhones and BlackBerry phones. Even though we refer to them as phones, they are small laptops, used to access the Internet, send/receive e - mails, make phone calls, etc. Millions use the Internet to shop, pay their bills online and manage their bank accounts. As a result, security management (SM) has risen to become a first priority concern. In the future, user - generated content (UGC) will play a major role in designing NGNs, service, and management systems.

2. **Major Network Infrastructure Changes:**

   The first major network infrastructure change was to shift from time - division multiplexing(TDM) to statistical multiplexing. NGNs are now based on packet switchingtechnologies rather than TDM. Internet Protocol (IP) became the winner. Today,NGNs are becoming IP - based packet - switched networks, end - to - end, includingbackbone, metro,

and access networks. This is important because it caused a paradigm shift in Fault, Configuration, Accounting, Performance, and Security (FCAPS)operations and network management applications and in SP concerns.

The second major change is the use of more and more wireless and mobiletechnologies in NGNs. Billions of cellphones are in use worldwide, and the numberwill continue to grow. The concept of telecommunicating (via phone or e - mail) andInternet access at any time and any place has become a reality.

The third major change is just starting and will be rapidly taking place in thenext few years. This change is IP Multimedia Subsystems (IMS) - based signalingand control to replace traditional signaling systems. IMS will provide an end - to – endplatform to offer most new services and, therefore, will eliminate current silos. WithIMS signaling and control, many advanced location - and presence - based serviceswill become a cost - effective reality. IMS is also expected to solve the problem ofrapid introduction of new services at less cost.

Finally, development and deployment of Service Delivery Platforms (SDPs)with open Application Programming Interfaces (APIs) for third - party applicationdevelopment will have major affects in introducing next - generation advanced servicesquickly and in more cost effective ways.

3. Major Home Network (HN) Changes:

Residential customer premises networks, also called Home Networks (HNs), arenow becoming extensions of SPs' networks.Home connectivity is evolving from narrowband to broadband. SPs havedeployed the technology needed to offer larger bandwidth with cable, xDSL, or fibertechnologies. The Internet has been a major driver for evolution to broadband, creatinga new experience for customers and offering new services, such as fast Internetbrowsing, video - on - demand (VoD), online shopping and banking, and digital videorecording (DVR), while providing broadband connectivity among many devices athome such as PCs, TVs, Set Top Box (STBs), DVRs, residential gateways (RGs) /home gateways (HGs), game consoles, etc.

The main drivers for home networking that exist today are as follows:

1. As media become increasingly digital in nature (online music and video,digital photos etc.), consumers want to share content and listen to or displayit on other, more consumer - friendly devices such as TVs, etc. This requirescustomers to connect their digital content storage devices (e.g., PCs, MP3players, private video recorders (PVRs), and digital cameras/camcorders) totheir entertainment systems over a home network.

2. More and more customers want to use digital voice and video. This is duemainly to the attractive price using triple play services. These new voice andvideo services should be capable of being received on a range of mobile consumerdevices (laptops, mobile phones, etc.).

3. Devices such as laptops that are WiFi - enabled are encouraging consumers toaccess the Internet, work, and/or watch videos wherever it is convenient in thehome.

Management and control of home networks have become a strategic challenge forSPs all over the world. Problems in home networks affect QoS and customers'experiences. Therefore, all SPs have been developing strategies to provide RGs /HGs as part of their triple play services.

4. **Major FCAPS Changes:**

As stated previously, FCAPS stands for Fault Management (FM), Configuration Management (CM), Accounting Management (AM), Performance Management(PM) and Security Management (SM).

In the past, when networks were based on circuit switching, FM was a first -priority application, followed by CM, AM, PM, and SM. PM and SM functions were considered to have least priority in circuit switched/TDM networks. FCAPS has been used for a long time, perhaps implying order of importance. Technically speaking, for packet - based networks, PM applications are now more important than FM. We are going through a transition period. When subscribers start using delay – and quality - sensitive services such as voice over IP (VoIP), IPTV, and VoD, SPs will pay more attention to PM - based applications.

QoS can suffer even if there is no failure in the network due to congestion and/or over - utilized resources such as Central Processor Units (CPUs), buffers, bandwidth, etc., in packet - based networks. Congestion and over - utilization of resources will result in delays, packet loss, and jitter, which greatly affect QoS and customers ' experience, such as snowy screen, unsynchronized voice and picture, longer time to receive a requested video, etc. All of these impairments can be detected and corrected in advance by using PM and SM systems using trend analysis, data correlation, and SLA management (proactive management).

We might want to rethink FCAPS priorities. Security Management is, now, arguably the highest priority. The amount of confidential data that is transmitted, collected, and stored is very large and must be protected. SM needs to take its place as the number one concern followed by PM as opposed to FM and, in turn CM. The order now is probably SPxxx, not FCAPS.

5. **Major Regulatory Changes:**

Regulatory/legal changes greatly affect the types of services offered (e.g., network - vs. home - based video recording), security, copyright, wireless spectrum allocation, content distribution and usage, etc.

The Challenge: System Integration and Interoperability of Disjoined Islands

Since divestures (1984 in the United States), large SP networks all over the world became collections of islands, such as shown in Figure 1:

- Merger and acquisition (M & A) islands (island of formerly different companies)
- Technology islands
- Cultural islands
- Regulatory islands

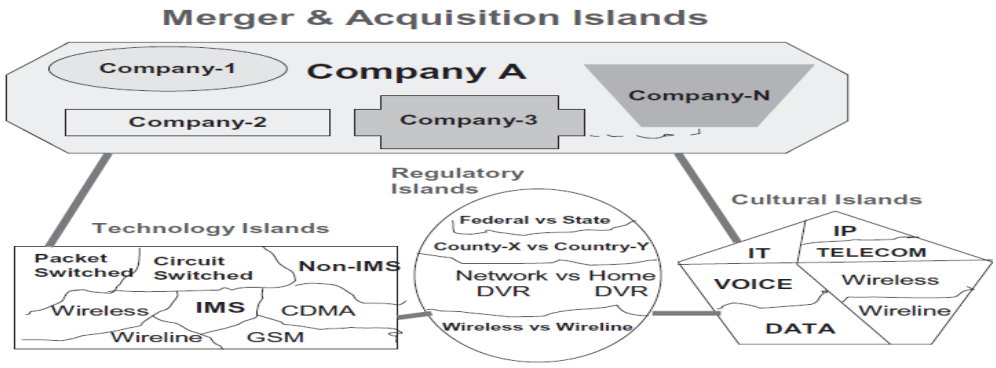


Figure 1: System integration and interoperability of disjoined islands

The grand challenge for SPs is to have end - to - end views and end - to - end management of services. With respect to networks and services management, SPs' networks may consist of disconnected islands.

Some of today's largest SPs, and even some smaller SPs, are the result of M & As.

For each case of an M & A, the former companies had their own networks, management systems, organizations, and cultures. They may also be using different architectures, technologies, standards, and products from many different equipment vendors.

The second important class of islands is the technology island, such as:

- Circuit switched networks and packet switched networks
- ATM networks and non - ATM networks
- CDMA networks and GMS networks
- Wireless and wire line networks
- IMS and non - IMS networks, etc.

Third, and perhaps the most important class of islands, is culture. In our professional backgrounds (e.g., Telecom, IT, IP, voice, data, etc.), we worked in different cultures. M & As can fail due to cultural differences. These islands must be connected and/or interwork with each other in order to provide end - to - end services, meet QoS requirements, and satisfy customers ' expectations and experiences.

NEXT GENERATION NETWORK CONCEPT

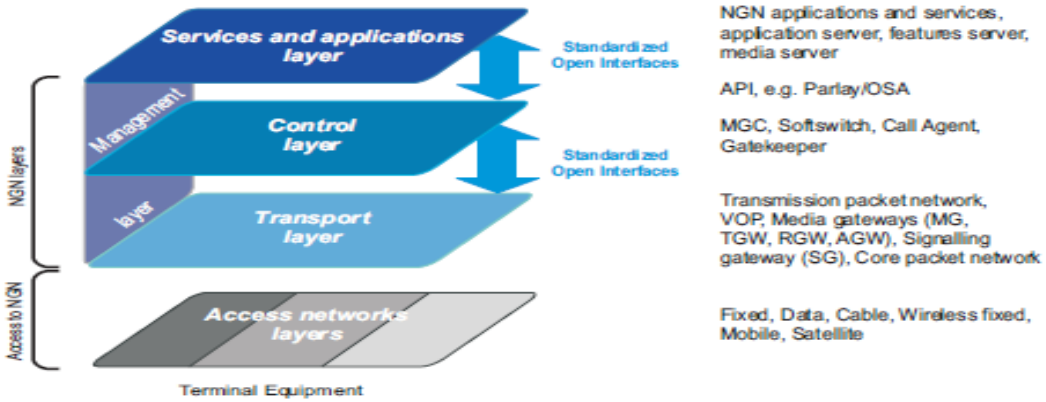
Requirements for NGN:

- High-capacity packet transfer within the transmission infrastructure, however, with a possibility to connect existing and future networks (be it the networks with packet switching, circuit switching, connection-oriented or connectionless, fixed or mobile).
- Separation of managing functions from transmission features. Separation of service provisioning from the network and ensuring the access via an open interface and thus a flexible, open and distributed architecture.
- Support for a wide range of services and applications by using the mechanisms based on the modular and flexible structure of elementary service building blocks.
- Broadband capabilities, while complying with the requirements for QoS (*Quality of Services*) and transparency. Possibility of a complex network management should be available.
- Various types of mobility (users, terminals, services). Unlimited access to a variety of service providers.
- Various identification schemes and addressing which can be translated to the target IP address for the purposes of routing in the IP network. (Flexible addressing and identification, authentication).
- Converged services between fixed and mobile networks (as well as voice, data and video convergence). Various categories of services with the need of different QoS and *classes of services* (CoS).
- Conformance to the regulation requirements, such as emergency calls and security requirements in terms of personal data protection.
- Cheaper and more effective technologies if compared to the current technologies.

Design Issues of NGN:

- Existing networks migration towards NGN,
- Development in the field of access technologies,
- Connection of other networks to IP networks,
- Provision of services and development of new ones,
- Interworking in the area of addressing,
- Interworking of signaling systems,
- Roaming and mobility.

NGN Conceptual Model:



NGN Conceptual model and its functional layers

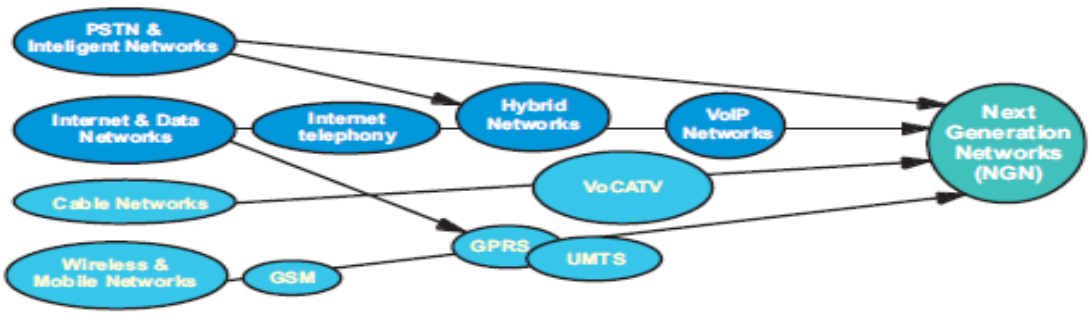
- **The access layer** provides the infrastructure, for example an access network between the end user and the transport network. The access network can be both wireless and fixed and it can be based on various transport media.
- **The transport layer** ensures the transport between the individual nodes (points) of the network, to which are connected access networks. It connects physical elements deployed in the individual layers It also enables the transport of different types of traffic, media (signaling, interactive data, real-time video, voice communication, etc.)
- **The control layer** includes the control of services and network elements. This layer is responsible for set-up/establishing, control and cancelling of the multimedia session. It ensures the control of sources as well, depending on the service requirements. One of the fundamental NGN principles is the separation of control logic from the switching hardware.
- **The service layer** offers the basic service functions, which can be used to create more complex and sophisticated services and applications. It controls the progress of the service based on its logic.

Functions of NGN Conceptual model:

- Resource management (capacity, ports, and physical elements) and QoS in access to the network and in the transport network, as necessary.
- Various media processing, encoding, data transfer (information flows).
- Management of calls and connection. Management and interworking of all elements of the reference architecture.
- Service control.

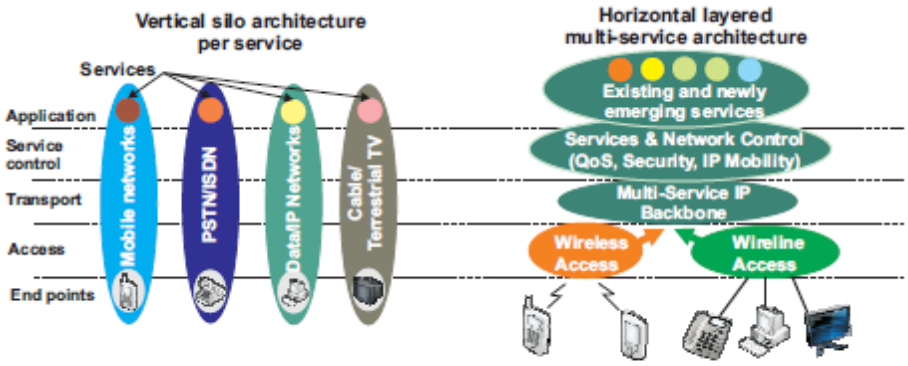
NGN evolutional scenarios and multimedia services:

The next generation networks are a vision of a converged network, meeting all the requirements for a converged universal packet network of the future. The main aim is to explain the deployment and functions of the individual components within the network intelligence and to give a brief characteristic of the individual layers of an NGN conceptual model. After introducing the first real solutions, the next generation networks are becoming a reality, not just a concept. That is why it is appropriate to look into their evolution and to outline their future trends and the open issues to be solved as well. Migration scenarios of different types of networks platforms are based on the idea to integrate TDM (*Time Division Multiplexing*) and IP (*Internet Protocol*) platforms into one converged NGN platform (from the point of network infrastructure, as well as services, Figure below). The separation of processes of service control and providing from the physical network architecture and extension of telephone and multimedia services are two different NGN aspects.



Migration scenarios

Therefore operators can move from vertical silo architecture where each type of service has dedicated access, transport, and control and application infrastructure per service to horizontally oriented architecture more independent from provided services. The main idea of NGN based IPTV is to include functionalities and infrastructure required for any of multimedia NGN services specially here the IPTV type of services to NGN architecture.



From vertical silos to horizontal NGN architecture

Comparison of PSTN/IN, Internet and NGN:

	PSTN/IN	Internet	NGN
Multimedia services	NO	YES	YES
QoS support	YES (Voice)	NO	YES
Network intelligence	YES	NO	YES
Intelligent terminal equipment	NO	YES	YES
Integrated supervision and control	YES	NO	YES
Reliability	high	low	high
Service creation	complex	ad-hoc	systematic
Simplicity of services use	medium	high	high
Modularity	low	medium	high
Time of service introduction	long	short	short
Openness of architecture	small	high	high