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Next Generation Network: An Overview

A Future Telecom Network

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***Abstract*— Next Generation Network (NGN) completely redefines our traditional telecommunication system. The general idea behind the NGN is convergence in which one network transports all information and services (voice, data and all sorts of media) by encapsulating these into packets. It has a layered structure modeled to support technical innovations and the development of high-speed diverse services. In this paper we are going to present the overview of NGN with its need in future networking, its basic architecture and applications.**

Keywords—NGN; Internet Protocol(IP); Gateway; Exchanges; Quality of Service(QoS)

I. INTRODUCTION

An intense competition in the telecommunication market has emerged over the last decades and is expected to grow continuously and rapidly. Therefore, it is essential for those network companies involved in the telecommunication market to gain advantage of their core competencies by adopting appropriate strategies or positioning themselves properly in the market. This change in industry is basically driven by demand of new services from subscriber's side and urge to reduce CAPEX (Capital Expenditure) and OPEX (Operational Expenditure) from carrier side. So, to meet these requirements NGN is the next step in world communication. NGN is the culmination of 100 years of telecommunication evolution, combining the scalability and reliability of the public telephone network with the reach and flexibility of the internet. The NGN seamlessly blends the Public Switched Telephone network (PSTN) and the Public Switched Data Network (PSDN), creating a single multiservice network.

II. BACKGROUND OF TELECOMMUNICATION NETWORKS

A. Conventional System

Presently, all telecommunication systems employ one of the three types of following networks based on the end-users requirements. Those are:

1) *PSTN:* Public Switch Telephone Network (PSTN) was basically developed and engineered for giving voice connectivity to the wire line subscribers. The network consists of local exchanges as a part of access network and TAXs as a part of core network. Already the huge amount money has been invested in PSTN setup. Because of tough competition from mobile and voice over IP, it is becoming white elephant day-by-day for the operators. Another fact about PSTN is that most of its equipments are going to exhaust their lives in coming years.
2) *PLMN:* Public Land Mobile Network (PLMN) has been developed to provide voice services for wireless subscribers. PLMN includes BTSs/BSCs as an access network and MSCs as a core Network.
3) *PSDN:* This network was basically designed for accessing remote files and servers for defense people and universities but now-a-days nobody can think of living with data network services. The basic and most popular application of data networks is the Internet. Other applications include E-commerce, online banking, online gaming, E-shopping, IPTV, Video on demand and many more. Data network is an assembly of routers, which are responsible for forwarding information from one end to other

B. Bottlenecks of Conventional Systems

- Traditional networks are slow to develop new technologies.
- These networks are not compatible for IP platform.
- There are no convergence features.
- It requires high CAPEX & OPEX due to maintenance of different networks for different services.
- There are Large Power and Cooling requirements.
- As data traffic is increasing day-by-day these networks are going to be complex and are needed to be consolidated.

C. New Proposed System

The proposed system is a single converged network that supports all telecom requirements like voice, data, mobility, video etc. and works on packet switching technology and is IP compatible. This emerging network for Telecommunications is called as Next Generation Network (NGN).

III. WHAT IS NEXT GENERATION NETWORKS (NGN)?

Next Generation Network (NGN) is a term that describes the evolution and migration of fixed and mobile network infrastructures from distinct proprietary networks to converged networks based on IP. It is conceived to be an interworking environment of heterogeneous networks of wired and wireless access networks, PSTN, satellites, broadcasting, etc. The concept of this network will not only bring wide range of possibilities to introduce new and existing technologies in field of information transmission and processing, but also many possibilities especially in the branch of network services.

A. Definition of NGN

- As per ITU, "A Next Generation Network (NGN) is a packet-based network able to provide Telecommunication Services to users and able to make use of multiple broadband, QoS-enabled transport technologies and in which service-related functions are independent of the underlying transport-related technologies. It enables unfettered access for users to networks, competing service providers and to the services of their choice. It supports generalized mobility, which will allow consistent and ubiquitous provision of services to users."

- As per ETSI, "NGN is a concept for defining and deploying networks, which due to their formal separation into different layers and planes and use of open interfaces, offer service providers and operators a platform, which can evolve in a step-by-step manner to create, deploy and manage their innovative services."

B. Features of NGN

- NGN works on Packet based transferring.
- There is an automatic separation of control functions among bearer capabilities, call/session and application/service.
- Decoupling of service provision from network and provision of open interface is also available under NGN.
- It supports a wide range of services, applications and mechanisms based on service building blocks.
- The network has Broadband capabilities with end-to-end QoS and transparency.
- This network also has a feature of interworking with legacy networks via open interfaces.
- It provides the advantage of general mobility.
- It provides unrestricted access by users to different service providers.
- It also provides variety of identification schemes which can be resolved to IP addresses for the purpose of routing in IP network.
- It is composed of Unified service characteristics for the same services as perceived by the user.
- The future telecom will give converged services between fixed and mobile.
- There is independence of service related functions from the underlying transport technologies in NGN.

IV. ARCHITECTURE AND ELEMENTS OF NGN

The NGN has a simplified architecture which involves few typical elements that are essential for its operation and working. The architecture and typical elements of NGN are explained below:

A. Architecture of NGN

The complete Next Generation Networks are divided into two typical constituents those are Access and Core networks. The Fig. 1 shows the two network components.

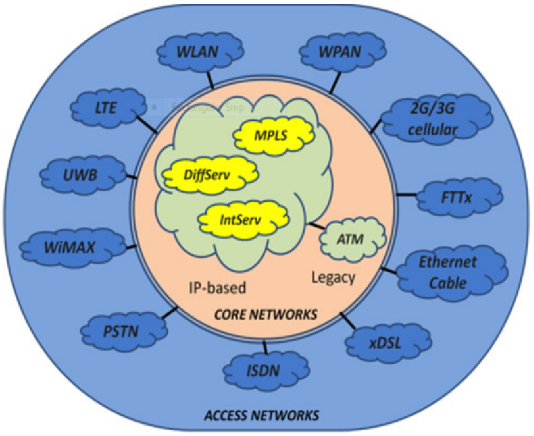

Fig. 1: Access and Core Networks of NGN

The end users have direct access to the Access network that is shown by an external circle in the figure and it provides a common service to both the wire line and wireless service users. The core networks take care to carry the data across the network. They include legacy technologies such as Asynchronous Transport Mode (ATM) and the modern family of IP based core. IP based technologies such as Multi-Protocol Label Switching (MPLS) possess two QoS models standardized by IETF, the Differentiated Services and the Integrated Services models. NGN provides end-to-end communication and employs multiple services at a time.

But, this multi-tasking feature of NGN makes it somewhat complex network with the requirement to provide proper internetworking and interconnection between the different users and telecommunication operators. With the aim to create a logical framework for NGN, the functional model is mainly organized in three layers: the Transport layer, the Service Control layer and the Application layer as shown in Fig. 2.

1) *Transport Layer:* Transport Layer of NGN is based on IP and can utilize the advantage of MPLS. Transport Layer forms the core of the Network. It basically consists of an assembly of Routers with optical network, which are responsible for carrying traffic originated by access layer. As the same core network is going to be used for all kinds of subscribers enjoying different kind of real time and non real time services, it should be able to make use of bandwidth policies and QoS policies. Operator has to think of managed Network for its subscribers. The underlying packet transport and media infrastructure are grouped under Transport layer which also interworks with circuit- switched (PSTN) network through Media Gateways so that existing networks can co-exist and need not be scrapped.

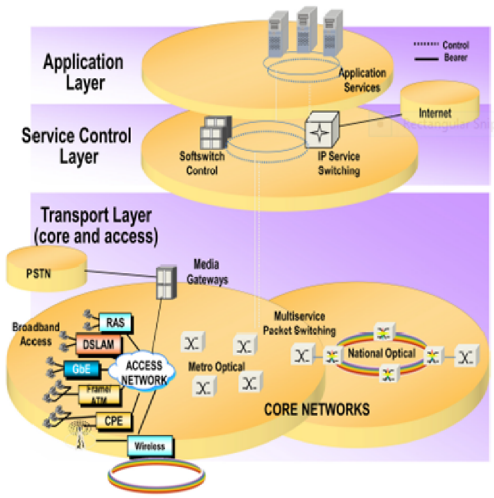

Fig.2: Layered Architecture of NGN

2) *Service Control Layer:* It consists of call servers where all information of the network resides and these servers are responsible for call setting up and routing, modifying, charging, tear down of the calls and controls some other activities within NGN environment. The Service Control layer consisting of Soft Switches, Media Gateway Controllers and IMS performs the functions of authentication, accounting, maintaining QoS, security and network management. NGN may work on soft switch principle. It consists of MGC (Media Gateway Controller) as an overall controller and MGs (Media Gateway) for termination of traffic. MGC is basically a server and it is having all the necessary information of network. MGC instructs MGs for establishing the call. Under the control of MGC, MG performs different call related tasks such as connection, modification and termination of media streams, packetization of media etc.

3) *Application Layer:* The Application layer makes use of the capabilities provided by other functional layers to provide multimedia services and applications based on Open Architecture of Application Programming Interfaces (APIs). The enhanced services to the subscribers will be provided with the help of application servers. It may include Prepaid servers, Announcement servers, Service servers etc. Hence NGN is making service separation from Network. Any service can be introduced with the help of server at any time without any modifications in the control, transport or access layers.

B. *Typical Elements of NGN*

The NGN consists of some typical elements which contribute as the backbone of this giant network. These elements are shown in Fig.3 and are explained below:

1) *Soft Switch:* A Soft Switch (software switch) is a device independent software platform designed to facilitate telecommunication services in an IP network. Thus, it is the architecture and not a box. Since, it is the main component in the whole network which performs the task of establishing the call and transmitting the voice media. It is also known as 'Call Agent' or 'Media Gateway Controller'. It communicates with signaling gateway via Session Initiation Protocol (SIP).

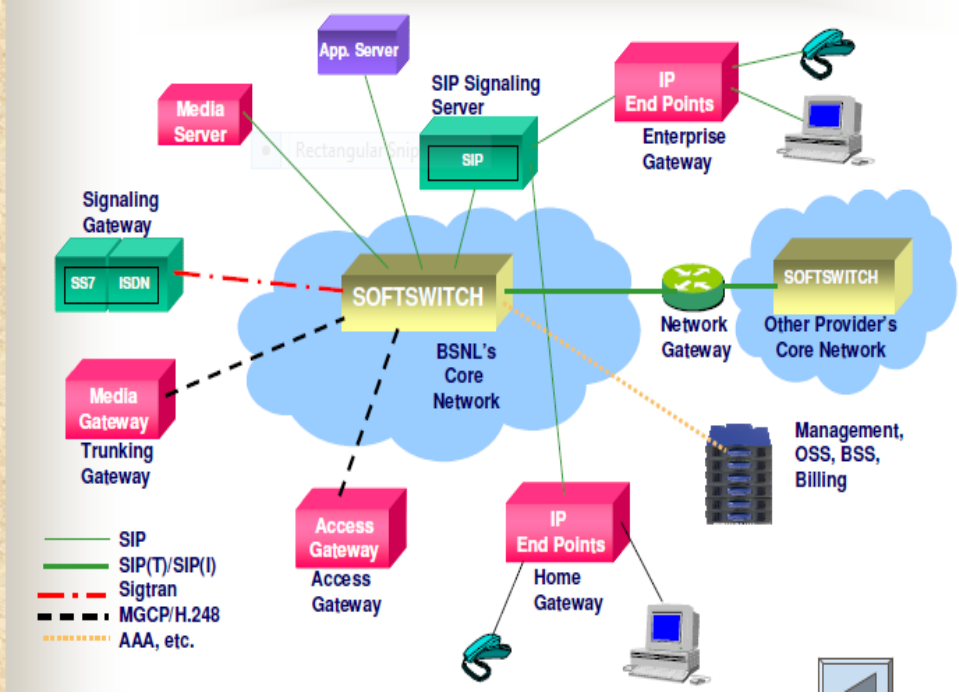

Fig 3: Elements of NGN

2) *Signaling Gateway:* The Signaling Gateway performs the work of transmitting all the signals required during call processing. It communicates with the Soft Switch via Signal Transport Protocol (SIGTRAN) which is equivalent to CCS#7 protocol used in traditional systems.

3) *Media Gateways:* Media Gateways are classified into Trunk Media Gateways (TMGs) and Access Media Gateways (AMGs). These act as Customer Equipment (CE) and provide the edge functionality. AMGs will replace Level2 local TAXs in phase 2 and will provide direct access to the end users while TMGs will replace the Level1 TAXs and will provide interconnection between the end users and the core network. It performs the functions of Voice encoding & Compression, Packetization of voice channels, CNF (Comfort Noise Generation), VAD (Voice Activity Detection) and Echo Cancellation.

Application Server: Application server is a specified unit and is not a tool. Actually, an application server is a set of different parameters providing connection between various parts that are dealing with network problems such as third parties and developers. And it has many advantages in NGN network. This structure has the most important task of providing various services and the new services can be added using it at low expenses and modification in this unit is independent of deeper layer protocols.

V. MIGRATION TO NGN

The planning for migration from current network to NGN can be achieved via many scenarios based on many factors which are required for that. The whole aim of the telecomm network advancing is to reduce the CAPEX and OPEX with ensuring the high QoS and IP based network.NGN network is IP based to support the voice, video and data. Good planning and design of the network could avoid many complexities and yield with a good target planned and designed network with high efficiency which supports many services.

A. Migration from PSTN to NGN

PSTN is a circuit-switched based telephone network. Currently telecommunication services are mostly provided by the service providers through PSTN. Next generation network (NGN) is the future frame-wok network for all types of communication services along with the support to other services in advance which are based on IP. While migrating from PSTN to NGN we are trying to reuse maximum existing equipment's and going to replace the life ended equipments. In PSTN we are using the copper wires which are having small bandwidth, less efficiency and are large in size. Instead of copper wire we will use the optical fibers which are having the large bandwidth and we will use various services on it. In NGN there will be SIP phones which are based on IP numbers. Conversion of the TDM network to the NGN is done in different phases as below:

1) Migration of TAX to TMG: In implementing the NGN, we are going to replace the transit network by the soft-switch network. Currently, Local Exchanges (LE) are

connected with TAX and in turn TAXs are connected with PSTN backbone which carry the traffic originated by subscribers. In first phase of migration Local TAXs get replaced by the Trunk Media Gateways for transportation of various types of media and there will be Signalling Gateways for signalling transport. In this phase, when user will call anyone then PSTN will send the CCS#7 signalling to the signalling gateway and then messages will be forwarded to the soft-switch which is media gateway controller. After receiving signalling from SG, MGC instruct originating and terminating media gateways to establish the desired call. After that Call disconnection is informed by the concerned SG to MGC/SS then MGC/SS gives instructions to both the MGs to disconnect the Real Tme Protocol (RTP) link.

2) Phase II: Migration of Local Exchanges to AMG: In this Local Exchanges (LEs) will get replaced by the Soft-switch and Access Gateways (AGW) with same services. Soft-switch is common control element which is software based control. Various types of access to the subscribers are provided by the Access Gateways that connect them to IP core network for onward process and services.

3) Migration of Services: While migrating from PSTN to NGN, all PSTN services will be available to the PSTN users over the same CPE with same look. In future new services like IN and value added services which are the IP based can be implemented and connected with the soft-switch via the SIP protocol. The services which are not IP based they are converted into the IP based using the converters. In this way we are going to replace TDM trunks with IP trunks and telephone exchanges with telephone server platform.

The complete system after migration can be shown with the help of Fig.4 which is depicted below:

B. *Migration of Mobile to NGN*

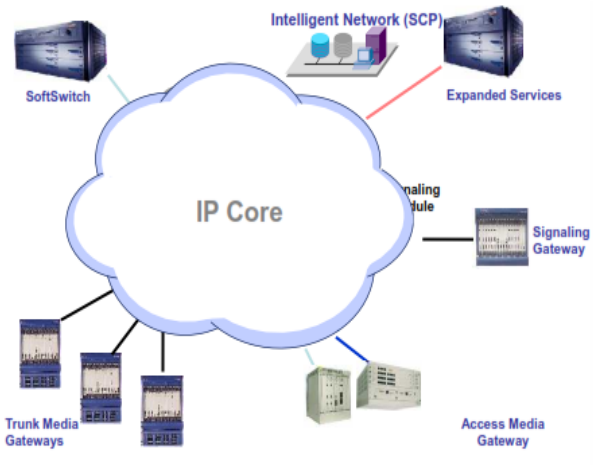

Fig.4: Next generation network for PSTN

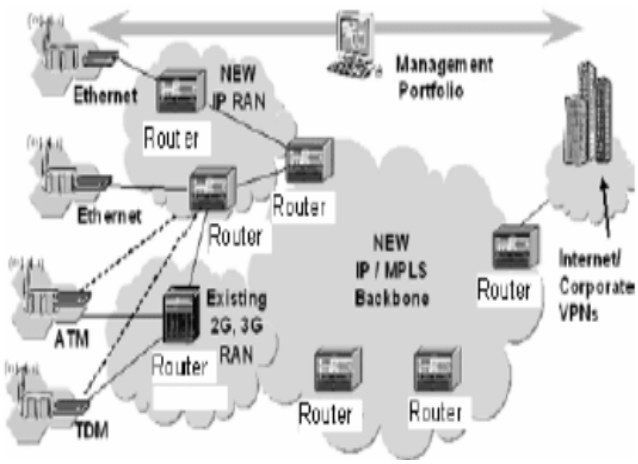

Fig.5: Mobile migration to NGN

GSM is bascially circuit switch based and is low capacity per user technology, so to increase user capacity and provide multimedia service GPRS was deployed. Nextly came EDGE system with GPRS configuaration but with little modification and higher data rate. After that packet based 3G network with data rate 2Mbps higher than previous generation was deployed. so it is suitable to use in NGN. To connect this system to NGN there is a need of media gateways i.e. Base Station Gateways(BSG). It contains a router/switch and a multiplexer. It is capable to convert circuit switch protocol to packet switch IP protocol and viceversa. BSG may be a router with various TDM and Ethernet inputs and it takes traffic from them to convey it to the IP network. Fig.5 depicts NGN connection of the wireless systems by TDM, Ethernet and ATM protocols to IP/MPLS core network. As it is shown in the figure this connection is feasible by the routers with the mentioned properties, i.e., a BSG has been replaced by a router.

VI. APPLICATIONS, ADVANTAGES AND DISADVANTAGES OF NGN

The various applications, advantages and disadvantages of NGN are explained below:

A. *Applications of NGN*

- Voice Telephone services
- Multimedia services
- Data services
- Push to talk over NGN (PoN)
- Content delivery services
- Global mobility services
- Virtual Private Services (VPNs)
- Broadcasting/Multicast services
- e- commerce and m- commerce
- Session Controller based Internet services
- Third party/OSA based services
- 3D Imaging
- Machine to Machine communication
- Data Augmentation

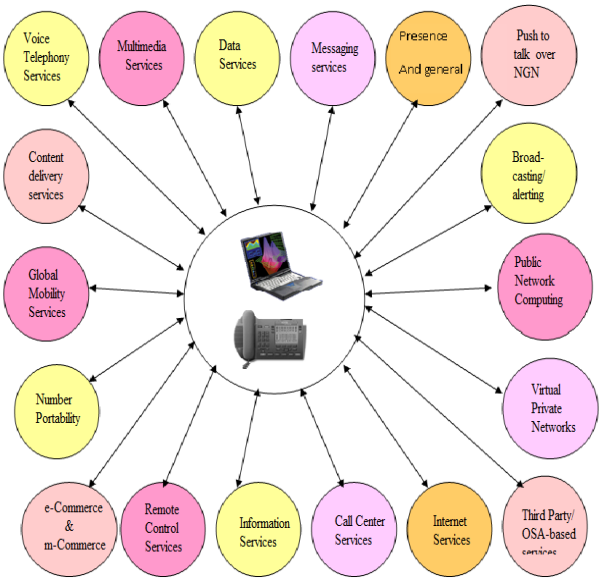

Fig.6 Applications of NGN

B. *Advantages of NGN*

NGN makes use of the best of both the worlds i.e. flexibility, efficiency & innovativeness of IP and QoS, Security, Reliability, Customer-friendly features of proven PSTN. Besides this it has following advantages:

- It generates additional revenue streams for new IP/Ethernet services.
- It fulfils customer's demand for high bandwidth, Ethernet/ IP solutions.
- It diminishes expertise in legacy.
- It gives End of Life/ End of Service vendor notification.
- Users can choose multiple service providers to take maximum advantage of competitive offers but may get single bill.

C. *Disadvantages of NGN*

Though having huge advantages and applications, NGN is having some major loopholes which are stated as follows:

- Migration complexities
- Not all legacy services can be replaced with new alternatives
- Not all existing infrastructure can be shut down
- Regulatory restrictions for critical services

VII. WAY FORWARD

From the complete study of NGN it is clear that it can help the operators to fulfill their needs and will surely help them to save OPEX and CAPEX but at the same time they need to be conscious to invest in it wisely since some past technologies couldn't make up to it.

This migration is needed to be a smooth process rather than to be an immediate process as there is no option then to migrate to NGN for survival as well as for customer's welfare, as they say "**Packetize or Perish**".

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