Beyond Pstn: Ngn (Next Generation Network)

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ABSTRACT
This paper describes a review of study of NGN Technology, its needs, its basic concept, layers in NGN architecture, essential components, various applications etc. Today, most of the telecom service providers are in the race of migrating from the Public Switched Telephone Network (PSTN) to the Next Generation Network (NGN), all over the world. NGN is the promising network of future. It is necessary to take proper utilization of the equipments, which are already present in the PSTN because a large amount of money has already been spent on establishing PSTN by the service providers. It also represents that what will be the challenges in near future for the telecom industries, while moving from PSTN to NGN Technology.

KEYWORDS
Challenges; Layers; Next Generation Network; Public Switched Telephone Network; Quality of Service; VoIP

1. INTRODUCTION
PSTN is a circuit switched based telephone network which has been evolving over the last 50 years. Most of the service providers and telecom industries all over the world are still using PSTN for telecommunication services but the success of internet and with development and advancement in telecommunication technologies, life of a human being has been changed to a great extent.
But it is not sufficient to satisfy their demands and to provide QoS. So, it's time to think beyond PSTN i.e. NGN (Next Generation Network) to provide new multimedia services and mobility etc. a new emerging technology or just a network, takes into consideration by telecom industries is NGN (next generation network) Technology which converges and optimizes the operating networks and large expansion of digital traffic in today's world and satisfy the user's demand to a great extent with high QoS.

2. WHY WE NEED NGN
- Need to support both fixed and mobile coverage service.
- As current network use only specific identifiers (i.e. series of digits, characters, symbols etc.) to identify subscriber, user, network elements etc.
- Need to support service based on non-geographic numbers and number portability.
- To make it easier to create new services which are faster than the previous ones.
- To make it simpler to deliver and maintain services.
- Network convergence – one network for voice and data.
- To reduce CAPEX i.e. capital expenditure and OPEX i.e. operating expenditure.
- To reduce power requirements by the use of less equipments.
- To reduce space requirements.

3. BASIC CONCEPT
According to ITU, "NGN is 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 offers unrestricted access by users to different service providers. It supports generalized mobility which will allow consistentently services to users.

A Next generation network (NGN) is a broad term which is used to describe key architectural evolutions in telecommunication core and access network. The general idea behind the NGN is that one network transports all information and services (voice, data, and all sorts of media such as video) by encapsulating these into packets, like it is on the Internet. NGNs are commonly built around the Internet Protocol, and therefore the term "all-IP" is also sometimes used to describe the transformation toward NGN. So we can say that the NGN (Next Generation Network) is an IP based network and use packet switch technology to send data over the network. It is the convergence of service provider networks that includes the public switched telephone network (PSTN), the data network (the Internet) and in some cases, the wireless network as well.
One of the most important features of NGN is a more defined separation between the transport (connectivity) portion of the network and the services that run on top of that transport. This means that whenever a provider wants to enable a new service, they can do so by defining it directly at the service layer without considering the transport layer - i.e. services are independent of transport details.

4. NGN LAYERS
The conceptual basic model of NGN architecture consists of four layers: Access layer, Transport layer, Control layer and Service layer but their functions are different:

Access layer:
The access layer provides the access network between the user and the transport network. It is the lowest layer of the model. It supports infrastructure for access of end user devices, like wireless or standard telephones, mobile or desktop computer etc., to transport network and vice versa. Physical interconnection can be established by different type of transport mediums like standard telephone loopback, fiber and DSL technologies etc. The conceptual layered diagram of NGN is shown below:

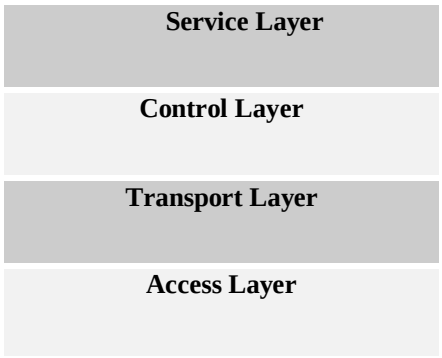

Fig1: NGN Layered Diagram

Transport layer:
The transport layer provides transport between network nodes from which the access networks are connected. Its use is to transfer the data between different nodes of network. It is consisting of one or multiple high-speed backbone packet switched networks. It is possible to serve to a flows of different character with different requirements on quality of transfer i.e. delay, data loss etc. On interface in direction to access networks and to networks of another operators, media gateways (MGW) are situated which routed the data flows between these networks and transport network. Its function is coding, decoding and packetization etc.

Control layer:
The control layer control the communication sessions by connecting and disconnecting of voice etc. Its main function is to control the other layers. It is useful for correct functioning of management of transport layer i.e. MGW/SGW. It controls both service calling i.e. application layer and also manages user's profile i.e. access layer. One of the main principles of NGN architecture is its division of management functions from hardware connection. In PSTN, connection functions of transport layer and functions of management layer, were supported by device known as exchange but in NGN, elements MGW/SGW are used as connection and routing function of exchange. Controlling functions of exchange i.e. processors and memories have been replaced by Servers for controlling of calling i.e. Soft switch.

Service layer:
The service layer provides elementary service functions which can be used by only service providers. It is also common to call it a service layer, because it merges application servers and a media server. It also provides basic blocks of services, from which operators can make their more complex and more usable service. e.g.

- Transmission and routing e.g. establishment of channel in network, routing of communication, limiting of communication to selected networks, QoS and others.
- Communication and provision of informative content e.g. voice management, limiting of access to selected types of services, locating of geographic position of user, determination of connection status of user etc.

5. ESSENTIAL COMPONENTS

NGN (Next Generation Network) architecture breaks the complex architecture of old traditional network into a simple network. Although it consists of lot of components but some of its essential components are discussed below:

- Protocol– H.323 terminals are LAN-based end points for voice transmission. Some common examples of H.323 terminals are a PC running Microsoft NetMeeting software and an Ethernet-enabled phone. All H.323 terminals support real-time, 2-way communications with other H.323 entities.H.323 terminals implement voice transmission functions and specifically include at least one voice CODEC (Compressor / Decompressor) that sends and receives packetized voice. Common CODECs are ITU-T G.711 (PCM), G.723 (MP-MLQ), G.729A (CA-ACELP) and GSM. Codecs differ in their CPU requirements, in the resultant voice quality and in their inherent processing delay. Terminals also need to support signaling functions that are used for call setup, tear down and so forth. The applicable standards here are H.225.0 signaling which a subset of ISDN's Q.931 is signaling; H.245 which is used to exchange capabilities such as compression standards between H.323 entities; and RAS (Registration, Admission, and Status) that connects a terminal to a gatekeeper. The functional block diagram for H.323 terminal is shown below:

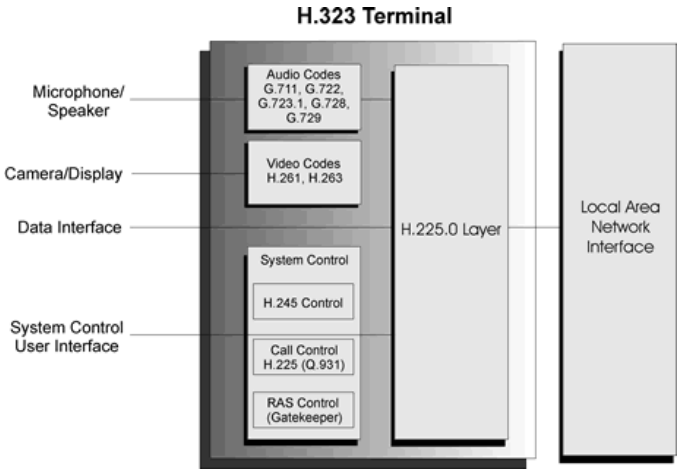

Fig2: Functional decomposition of an H.323 terminal

Initially H.323 was the most popular protocol, though its popularity decreased in the "local loop" due to its original poor traversal of Network address translation (NAT). For this reason as domestic VoIP services have been developed, SIP has been more widely used. SIP stands for "Session Initiation Protocol". SIP is an Internet application layer control protocol that can establish, modify and terminate multimedia session such as VoIP. Media can be added to or removed from existing session. However in voice networks where everything is under the control of the network operator or telecom operator, many of the largest carriers use H.323 as the protocol of choice in their core backbones. With the most recent changes introduced for H.323, it is now possible for H.323 devices to easily and consistently traverse NAT, opening up the possibility that H.323 may again be looked upon more favorably in cases where such devices encumbered its use previously. But most of the telecom companies are extensively researching and supporting IP

Multimedia Subsystem (IMS), which gives SIP as the most widely adopted protocol.

- Soft Switches – It performs the same function in NGN as was performed by exchanges in PSTN. It is a programmable device whose main function are - to control voice over IP (VoIP) calls, to create interface for the existing networks through Signaling Gateways (SG) and Media Gateways (MG) and to enable the correct integration of all the protocols within NGN.
- Gateways - One may quite often find the term Gatekeeper in NGN literature. This was originally a VoIP device, which converted (using gateways) voice and data from their analog or digital switched-circuit form (PSTN, SS7) to the packet-based one (IP). It controlled one or more gateways. As soon as this kind of device started using the Media Gateway Control Protocol, the name was changed to Media Gateway Controller (MGC).

6. APPLICATIONS

As we know that the NGN is IP-based network i.e. packet-switched network which supports a wide variety of services like- VoIP, Videoconferencing, Instant Messaging, e-mail and all other kinds of packet-switched communication services.

VoIP:

Voice over IP (VoIP) refers to transporting the voice communication i.e. telephone calls over IP networks like Internet. In today's market, VoIP is also known as IP Telephony (IPTel). In near future, VoIP can be seen as the right choice for providing voice, video and data communication to customers in NGN. In fact, all of the circuit-switched equipment vendors and service providers around the world are in the planning to migration towards VoIP. The term VoIP seems to be too short to describe the kinds of capabilities which users seek in any sort of next-generation communications system. So we call it as "IPMC" i.e. IP Multimedia Communication because NGN provides much more than simple audio and video facilities
.

Videoconferencing:

It refers to the technology by which we can communicate with each other by both voice and video. Mostly it has been used only over ISDN networks with protocols like H.320 but in NGN, we use the new protocols like H.323 and SIP. Furthermore after that the protocol like H.325 will lead to the development of a third generation multimedia system architectures which will support the emerging media rich applications beyond the old communication systems. Also the inter-communication between systems i.e. Mobile systems can be supported. H.325 is still being defined, so it is very much in transition. It is expected to come in market within upcoming 2 or 3 years.

Instant Messaging:

It is an application which is popular among Internet users. It allows users to send messages instantly between them. A popular commercial product includes AOL Instant Messenger and MSN Messenger. There are two popular standards in the market for instant messaging - one is called as "SIMPLE", which is based on the SIP protocol, and the other is called as "XMPP" (Extensible Messaging and Presence Protocol), which was popularized by Jabber. XMPP was introduced into the market earlier and has a much larger following (as of the time of this writing), allowing people to communicate across corporate boundaries using a number of different client and server software products. Probably most notably, Google Talk uses XMPP and can communicate with any company that operates its own XMPP server. SIP SIMPLE client is a Software Development Kit for easy development of Real Time Applications based on SIP and related protocols for Instant Messaging (IM). It is also used for Audio, File Transfers and Desktop Sharing etc. Other media types can be easily added by using an extensible high-level API. SIMPLE took a number of years to evolve and, as of this writing, was still undergoing development. Worse, it has been said that SIMPLE is far from simple. This suggests that SIMPLE will likely to be used only in environments that must necessarily employ the complex SIP protocol.

7. FUTURE CHALLENGES

The movement of current PSTN towards NGN is due to the growth of data services and of the Internet also. The volume of data traffic already exceeds that of voice traffic and it keeps on growing. But this movement cannot be succeeded without meeting some preliminary challenges. Some of them are discussed below:

Quality of Service:

Integrating voice in a data network requires that one have to carry the voice stream as a succession of no. of data packets. But the data networks were not designed specifically to carry voice and the Internet routers don't make any special attempt to guarantee that a specific voice call will receive a regular and sufficient amount of service. They don't even try to identify individual calls or connections. They simply route the packets as fast as they can. So, as a result of this, individual packets experience different transmission delays and may sometimes be lost. Hence in the absence of special treatment, the different delays would distort the voice. There will be intermittent cracks of noise due to loss of packets. So, QoS will be great challenge for us while moving into NGN.

The Management Challenge:

Today, everybody depends heavily on the telephone network and we want the guarantee that the telephone network will be "always there". In case of any emergency, we can immediately call the police, the fire department or an ambulance but some of us would trust their live to the Internet and we have seen that many servers remains unreachable for arcane reasons, too many times of network failures due to electric power outages. In fact, one of the primary design goals of the Internet Protocol was reliability i.e. to performs end to end transmission which means that they will be available as long as the two end of the connection are up then during that period the network is capable of sending some data. The only condition is that the two ends must be available at all. But obviously, if your phone is broken, you will not be able to communicate through it. This architecture, however, keeps the network simple, making it easy to automatically correct failures.

Reliability is only one part of the management challenge. As the network grows, the number of user grows, operation procedures can easily become a bottleneck. An Internet Service Provider that only serves a few thousands customers can relay on manual operation, letting staff to organize delivery of connections, change of subscription parameters or network maintenance etc. But we have seen over the years that growing to a large size requires well specified procedures. These procedures enhance the network operation, increases reliability and reduce service delays as well as the cost of operation also. As a result of this, the productivity of the telephone companies also increases. Obviously, one would not want to lose this high productivity when moving to next generation network architecture. So, the management challenge is very important but no doubt that it will be solved.

The Security Challenge:

The security challenge consists of many aspects like Authentication, Data confidentiality, Communication security, Data Integrity, Availability and Privacy etc.

The security challenge is in part caused by the layering of applications. In the case of the PSTN, commands are exchanged through a separate signaling network. This kind of separated design is not really possible in the NGN because by definition, all gateways must be able to carry voice and data over the Internet. Even if we sent network configuration commands over a separate network, we would only have the illusion of separation, since this separate network would have thousands of contact points with the Internet (one for each gateway). If a network element such as gateway is accessible through the Internet then there is a risk of attacks. In addition to traditional attacks against the gateways, we must also deal with attacks against the voice channels. These attacks fall under several categories such as denial of service attacks, monitoring attacks and voice insertion attacks.

Denial of service attacks try to disrupt voice conversations e.g. by creating spots of congestion on the network paths used by the voice packets. Protection against this kind of attacks is in under the "quality of service" problem.
Monitoring attacks are performed by obtaining a copy of the voice packets, in order to listen the conversation. This copy can be obtained either by monitoring a communication channel or by somehow instructing an intermediate router to duplicate packets. The protection against monitoring attacks needs the encryption of the voice packets i.e. the partners in the communication can securely negotiate a session key at the beginning of the conversation.

The voice insertion attacks are specific to the packet networks. They are achieved by sending to the gateways voice packets whose headers have been forged to appear as if they belonged to an existing conversation. It is very hard for gateways to check the source address of packets. In some call set up procedures, it is desire to "open the circuit" as soon as possible. This means that gateways may in some cases have to accept the packets without even knowing the identity of their partners. Hackers could wait for that moment and insert an offensive message during the first seconds of a call. In addition, in the absence of cryptographic procedures, it is very difficult to authenticate the source of a packet. Protection against these attacks require that the partners in a conversation exchange keys before exchanging voice packets and use these keys to authenticate their messages.
The NGN security will require deployment of cryptography to protect the network infrastructure, the signaling protocols, and to assure the privacy of communications. Once proper technologies such as IP security are deployed then the NGN will be more robust than the current telephone network and the privacy of communications will be much better protected.

The Economic Challenge:

The NGN architecture produces an economic challenge to the service providers. The root of the problem is the constant drop in the price of bandwidth. In earlier years, the capacity of data networks was, in about equal to the capacity of the phone network. But with passage of time the capacity of data networks doubles every day and these progress in capacity is accompanied by a drop in prices. This drop in price is not a problem for data network providers, as the volume of business would be multiplied in the same period, while the price of the equipment would drop. But it is definitely a problem for the companies that derive most of their revenues from the voice service. Today, with similar installed capacity, the voice revenues are about 9 times the data revenues, which implies that a bit of voice is resold for about 9 times the price of a bit of data. This situation cannot last, especially on an NGN where voice is carried as yet another data application.
But it is very clear that the industry will have to develop new services, in order to compensate a potential lack in revenues. Wireless communication is one type of new service, but the NGN should open the gates to much more. A number of services such as "call waiting" or "voice mail" that were developed in the "Intelligent Networking" architecture. The existing industry could benefit greatly from the NGN, if it provides these new services to the users. But the NGN architecture removes the automatic linkage between networks and applications. However, this is still a big challenge.

8. CONCLUSIONS

According to above analysis, we conclude that now it is time to change i.e. to move towards NGN from old PSTN. Now, we have a great opportunity to invent the telecommunication services. But it would not be so easy and we have to pay a lot for this. We have to reinvent the telecommunications service. While doing so, we should not only have to provide high bandwidth, smooth transition, managed networks but also have a better security for everyone. There would be no. of challenges as discussed above but a challenge always motivates research. So in that respect, Next Generation Networks are great motivator. Some of the challenges like Quality of Service are in fact already being resolved. We should not miss the opportunity to immediately deploy the next generation networks. There is no need to repeat a stepwise development. Let's jump immediately in the future.

9. REFERENCES

[1] ITU-T, *General principles and general reference model for Next Generation Networks*, ITU-T Recommendation Y.2011, Std., Oct. 2004.

[2] C.A. Eldering, M.L. Sylla, J.A. Eisenach, *"Is There a Moore's Law for Bandwidth?"* IEEE Communications Magazine, October 1999, Vol. 37 No. 10.

[3] Christian Huitema, Jane Cameron, Petros Mouchtaris, Darek Smyk, *"An Architecture for Residential Internet Telephony Service."* IEEE Internet Computing, Volume 3, Number 3, May-June 1999.

[4] *Next Generation Networks working definition, ITU-T 2004* website: http://www.itu.int/ITUT/studygroups/com13/ngn2004/working definition.html ,July 2009.

[5] C. R. Johnson, Y. Kogan, Y. Levy, F. Saheban, P. Terapore (AT&T Labs), VoIP reliability: a service provider's perspective, IEEE Communication magazine, July 2004.

[6] Multiservices Switching Forum," *System Architecture Implementation Agreement*," MSF-ARCH-001.00-FINAL

[7] G. Camarillo, W. Marshall, and J. Rosenberg," *Integration of Resource Management and Session Initiation Protocol (SIP)*," RFC 3312, IETF, Oct. 2002.

[8] Q.Wang,"*Cross-Layer Signaling for Next-Generation Wireless Systems*"

[9] J. Song, M. Y. Chang, S. S. Lee, and J. Joung, "Overview of ITU-T NGN QoS Control," IEEE Communication Magazine, Vol.45, No.9, September 2007, pp. 116-123.

[10] J. Rosenberg, et al., "*SIP: Session Initiation Protocol*," Technical Report RFC 3261, Internet Engineering Task Force (IETF), June 2002.