Mobile Systems Challenges in Next Generation Networks

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Abstract: Customary network migration to Next Generation Networks (NGN) is due to service integration and low cost of the offered services in NGN. NGN is based on an IP/MPLS backbone through which all traffics pass. Besides, different mobile generations up to R99 UMTS are all based on the circuit switch systems. Thus the connections to NGN may cause some challenges. In this paper, to provide these connections, we review mobile systems characteristics in addition to a new Base Station System by the name Base Station Gateway.

Keyword: NGN, migration, mobile challenges.

1 Introduction

We know NGN as a convergence of communication networks which tries to reduce costs and offers integrated services via a common IP Technology backbone. NGN includes three advantages: layered structure, standard interfaces and multi-service [1]. NGN functions are in several layers: access, transport, control and application [2]. Mobile communication networks also contain several generations which are based on circuit switch, packet and their mixed systems [3]. It is intended that mobile networks to be connected to NGN via mobile media gateways and common backbone. This connection is controlled via a management and maintenance network. In this paper while we study mobile networks and NGN briefly, we pay attention to the mobile to NGN connection challenges. In line with that we mention mobile generations briefly in section 2 and NGN in section 3. In section 4 we pay attention to NGN deployment methods and in section 5 we study the criteria of selecting the mobile networks for NGN. Finally we draw the conclusion.

2 Mobile Telephony and moving Toward NGN

Since 2000 European countries began to grant the 3G radio frequencies based on 3GPP and UMTS standards. According to the above standards moving toward 3G is done gradually in three phases [4].

Phase one: is based on second generation GSM and circuit switching technology and is very similar to PSTN and includes the limitations that PSTN has in data transmission (Fig. 1). As we see a customary mobile network include AUC, HLR, BSC, BTS, MSC/VLR, GMSC and EIR nodes which are interconnected via hierarchical digital links. GSM was originally designed for speech and not for data transmissions. The basic user data rate in GSM is 9.6 kbps and is suitable for only a limited numbers of data services. The GSM data rate can be enhanced with High Speed Circuit Switched Data (HSCSD) technology in which multiple traffic channels can be allocated to one user. With HSCSD the user data rate can be up to 64 kbps. One of the drawbacks with HSCSD is that used channels remains allocated during the session even if no data is transmitted.

Phase two: is constituted of 2.5 generation of GSM and GPRS. It includes both circuit switch and packet switch systems. Data rate is 171kbps in this technology. It is also connected to the data network through GPRS support Node (GSN) which is constituted of two GGSN and SGSN nodes (Fig. 1).

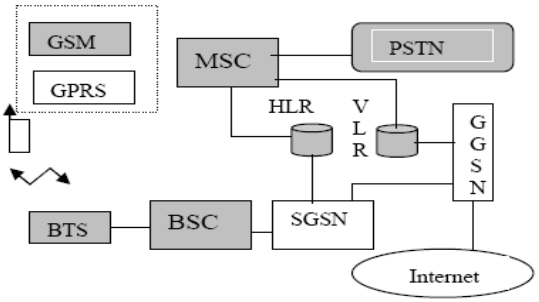


Fig. 1 GSM and its GPRS deployment [5]

With GPRS, the possibility for volume based charging opens up i.e. a user will only pay for the actual amount of transmitted data and so the packet switching is more suitable for bursty traffic like interactive Internet services in this technology [5].

Enhanced Data rates for Global Evolution (EDGE) systems have the same configurations but as result of some additional variations in the physical layer are capable to carry data rate of 384kbps.

Phase three: Third generation system is deployed based on 3GPP and is called UMTS. Release 99 of UMTS has been deployed in separate packet and circuit switch systems. But the only difference with the previous generations is in its radio interface. Release 5 and later releases of UMTS are all based on a common IP backbone. Network operators experience much voice calls but they don't earn much money from them, on the other hand, although operators don't earn revenue from data services but most of them agree with the next wireless technologies (such as 3G, WLAN and WiMax) development. We should note that data services occupy wider spectrum than the voice services. Fig. 2 depicts revenue of next services of mobile systems by 2010. As it is shown income slope curve of TV, game and music services are positive and high but income slope curve of other services such as voice is positive and low.

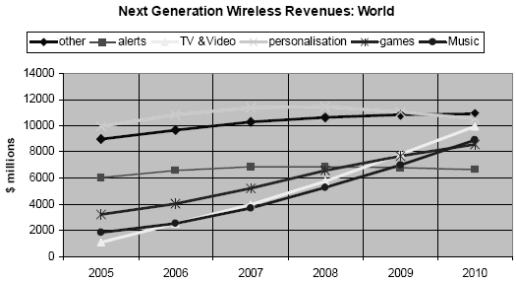


Fig. 2 Revenues from some of the various mobile services

3 NGN networks and technologies used in it

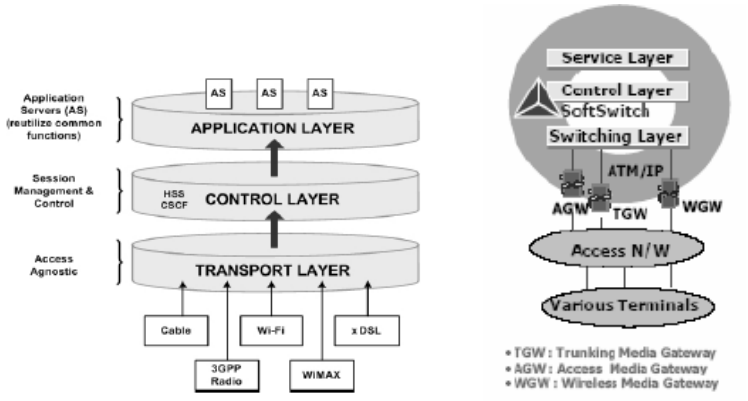
NGN was established in order to converge all the communication networks toward IP technology and users widespread access to the network and its integrated services. Indeed increasing growth of Internet users and their better QoS demands made the service providers to offer NGN deployment. Instead of the existing individual networks all services such as voice, data, mobile and video will be offered in a unique NGN deployment. It is also capable to provide such new high data rate services as moving pictures and also reduces service costs for users. Internet and its capabilities have been resulted in new IP based services. Indeed new fixed and mobile service integrations have resulted in NGN deployment. In general motivation for telecommunication network to migrate to NGN is defined as:

- cost reduction in backbone
- fast and new service creation
- controlling QoS of the services
- applicability of the services in both fixed and wireless networks
- Central management of whole of the network

The above capabilities need a vast traffic volume in the forward link and backhaul. Cost of capacity increase in the backbone by E1/T1 has been evaluated up to 25% of capacity of the total network cost [6].

As it was said before NGN is deployed based on the three bases as layered structure, standard interface and multi-service and is deployed in the access, transport, control and application layers (Fig. 3). Softswitch is an intelligent node in the NGN application layer that controls call admission and session for telephony and multimedia services. In the layered structure we can optimize each layer independent of the other layers [2], [7]. NGN architecture provides itself change and scalability features and also provides flexibilities which reduce the service creation time. Each layer relates to the next layer by the standard interfaces which enables the service provider to provide various services and extend NGN coverage for the network. Contrary to customary networks which have been developed for only one service type, NGN multiservice property enables the service providers to offer various

integrated new services and also enables the users to access the various desired services.



(a) (b)

Fig. 3 NGN architecture [2], [7]

Fig. 4 Compares customary and next generation mobile networks.

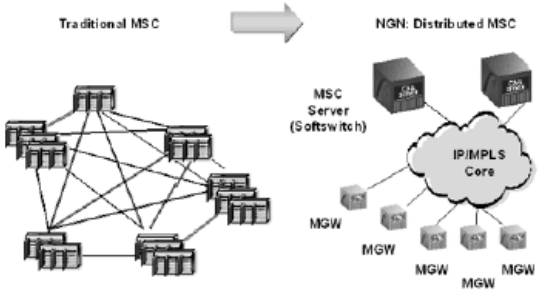


Fig. 4 Comparison of customary and next generation mobile networks

As it is shown, in the customary networks, network elements are connected to each other directly via digital links while they are connected via a common backbone in NGN. We can use all mobile telephony technologies such as

- 2G and 2.5 mobile
- 3G mobile
- WLAN
- WiMax

to access multimedia services in a NGN deployment. Besides we see MSC server switch is directly connected to the core network and various air interfaces technologies are also connected to core network by their media gateways.

4 NGN deployment methods in the network

There are three main ideas for NGN deployment by the names of: Revolution, Evolution and Overlay methods which here we explain each briefly [8].

In the revolution or replacement method by replacing the equipments we can provide new services and technologies in a short time. Replacing the NGN equipments is the main challenge in this method since although legacy equipments should be replaced after their life times but the other existing equipments should be capable to interwork with each others according to ITU-T standards. Thus if the decision is not on time and suitable, this method may damage the network. On the other hand, different types and dispersion of switches both increases the work and the investment. Besides since users don't know the new services we may encounter some problems.

In the second method we apply the evolution and migration idea. In this method to realize a reliable NGN we intend to reduce the operation cost and to maximize the usage of the existing network investment. Therefore the network architecture doesn't encounter vast variations and network reliability doesn't lower in this method. In this method we use customary PSTN. In order to save huge old investments we maintain the customary PSTN in NGN (CAPEX). This method is completely in line with offered method by the ITU-T Focus Group NGN (FGNGN). In this method we may begin to convert from the upper plane switches (e.g. Transit Switches inter or intra cities) to packet switches and reach the lower planes. Thus we need a protocol conversion in the gateway equipment.

In the third method by the name overlay, NGN is deployed beside the customary existing network and is connected to it by media gateways. Then the customary network gets out of circuit gradually while NGN develops. Here we should note that the network doesn't encounter service disturbance. Besides the new and old networks interwork well. In this method we must not offer new services in the customary networks instead offer new services in NGN.

In the two last methods we can evaluate the NGN equipments while offering limited services. Besides we can develop various services while evaluating users demand to services.

5 Mobile network selection criteria for NGN

GSM is basically a circuit switch and low capacity per user technology. Since in this system data transmission rater is 9.6kbps, it is not cost effective to use GSM in the NGN. As said before, to increase the user capacity and provide the multimedia services, GPRS system deployed. EDGE system has GPRS configuration but with a little modification in the physical layer which has provided it higher data rates. 3G networks have higher data rates (2Mbps) than the previous generations and so are more suitable to be connected to NGN. As we said before, to connect radio interfaces of the mobile systems to NGN we need media gateways. Fig. 5 depicts a BSC architecture and its connection capabilities to NGN. Thus this BSC is called a Base Station Gateway (BSG). It should include a switch/router and a multiplexer. Besides

it is capable to converts circuit switch protocols to packet switch IP protocols and vice versa. Traffic can be carried from/to 2.5G, 3G, WiFi and WiMax radio interfaces (Fig. 5). Fig. 5 depicts a BSG as a package that is capable to handle traffics from

- GSM/GPRS (TDM on T1/E1).
- UMTS R99 and R4, (ATM on the T1/E1, DS3 and Sonet/SDH).
- R5 and later releases of UMTS, (ATM and IP/MPLS on T1/E1, POS and Ethernet).
- CDMA2000 (HDLC on T1/E1).
- 1*EvDo, IS-856, (IP on T1/E1 and Ethernet).

and convey them to IP network. BSG may be a router with various TDM and Ethernet inputs.

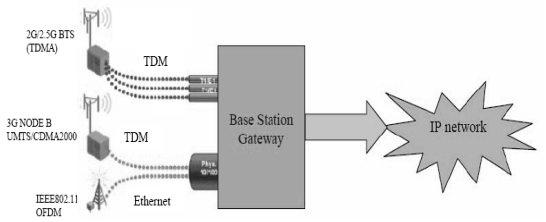


Fig.5 Modified architecture b- different type of media gateway toward the core network

Thus NGN deployment is capable to handle all wireless traffic types. Besides, Base Stations play an important role. Fig. 6 also depicts NGN connection of the wireless systems by TDM, Ethernet and ATM protocols to the IP/MPLS core network. As it is shown this connection is feasible by the routers with the mentioned properties, i.e., a BSG has been replaced by a router [9].

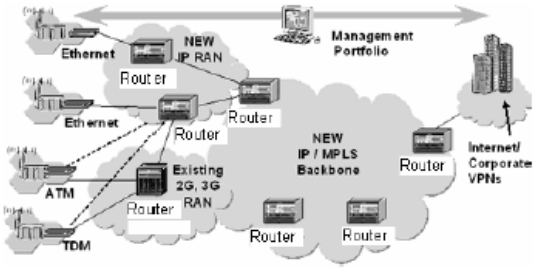


Fig. 6 Mobile migration to NGN

6 Conclusion

Although NGN development enables the telecommunication companies to gain new resources and revenues from data, voice and video integrations, but there isn't a unique and complete solution for establishing and developing a NGN deployment. To achieve such networks we need a change strategy which is different according to the

type and characteristic of the existing network. GSM connection to NGN not only doesn't help to mobile networks and NGN but also may increase problems and dissatisfaction, since the GSM services are very limited and NGN services are very widespread.

Thus after upgrading the mobile systems to 2.5G and assuming a complete and extended fiber optic transport network and access, we can follow the following procedure:

- selecting a smooth replacement strategy to access NGN. It should be noted that we can connect all IP based wireless networks directly to a NGN deployment.
- Upgrading (or modifying) BSCs so as to support layer two protocol in addition to the customary BSC role. This BSC can be a router.

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