

# Telecommunications Network and Service Architectures

## Principles, Concepts and Architectures

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The telecommunications infrastructure of a network operator consists of a set of networks (transmission network, switching network, access network, signaling network, mobile network, intelligent network, management network), each performing a particular function towards the provision of the service to the customer. With the evolution towards IP-based network, the circuit switched network is migrating towards a new architecture called Next Generation Network (NGN) which emulates the behavior of circuit switching. With the advent of broadband access networks, the core network evolves towards IP Multimedia Subsystem (IMS) which provides IP-based multimedia services.

The objective of this tutorial is to briefly introduce the telecommunication network structure to acquire the vocabulary of the field, understand the several types of networks involved in the operator's "Telecommunication Network", and gain knowledge on how these networks interface and interoperate. The various services supplied by each type of network are also emphasized. Another important objective of the tutorial is to introduce the evolutions of these networks and services on the medium and long terms.

A Telecommunication network consists of two parts:

- the "network" (transmission, switching, access, signaling, mobile, intelligent network)
- the "business and technical information system" which consists of OSS (Operating Support System) and BSS (Business Support system).

## 1 Public Switched Telephone Network (PSTN)

PSTN is the fixed voice network. It consists of the transmission, switching, signaling and intelligent networks.

The **transmission network** enables carrying all kinds of traffic (voice, video, data). It consists of nodes called multiplexers and links among multiplexers. The goal of the multiplexer is to multiplex/demultiplex traffic onto/from the link. There exists three multiplexing technologies : PDH, SDH and D-WDM. The link technology is generally optic fiber but may also be coax, radio, etc. A transmission network generally consists of hundreds of multiplexers and tens of thousands of kilometers of optic fiber.

The **switching network** enables switching the traffic from the sender to the appropriate destination. A switching network consists of switches. All switches rely on the transmission network which provides digital trunks. A switch receives traffic from the transmission network at input ports, applies the switching function which forwards the traffic to output port. Then, the switch relies on the transmission network to send the traffic to an adjacent switch. The voice network is using the circuit switching technology which provides voice services.

A switching network operates in a connection oriented mode. That means that prior to enabling users exchanging their traffic, there is a need of reserving resources on the path between the sender/caller and the receiver/callee. To reserve resources, all switches on the path exchange signaling information. Signaling information is data. In the case of circuit

switching, signaling data is carried over a separate network, i.e., a **signaling network** called Signaling System 7 (SS7). This is out-of-band signaling.

The **intelligent network** is used in the voice network for the provisioning of services such as freephone, premium rate, virtual private network, account card calling, etc. It consists of a set of application servers containing service logic and service data.

The **access network** is the network which enables attaching the user equipment to the switching/transmission network. The subscriber has a subscriber line, which may be an analog line, an ISDN line, a leased line, an ADSL line, etc., to connect to the PSTN.

EMSs (Element Management Systems) are sold with the equipment by the telecom vendor. EMSs enable operators to manage their equipment.

The OSS (Operation Support System) is the management of the network and the services.

The BSS (Business Support System) is the interface to and the management of the customer.

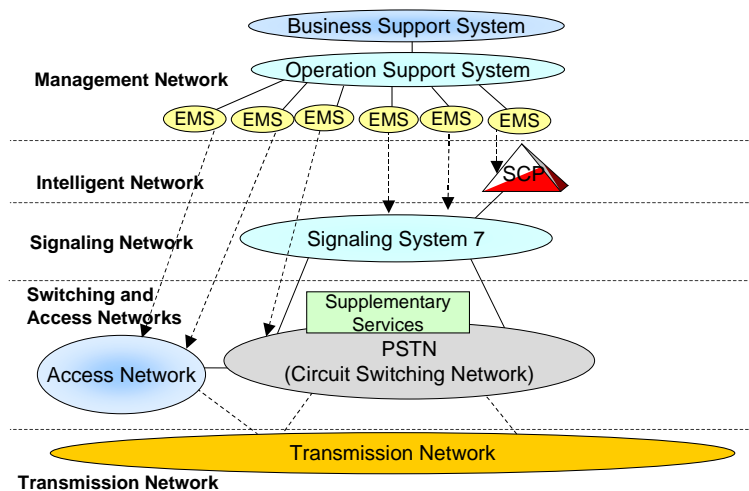


Figure 1 : Fixed Voice Network : PSTN (Public Switched Telephone Network)

## 2 Global System for Mobile Communications (GSM)

The GSM network is a mobile voice network. It looks similar to PSTN but supports an additional service called terminal mobility. As for PSTN, it consists of a switching plane where Mobile switching Centers (MSCs) may be found. The circuit switched network with MSCs is called NSS (Network Subsystem). The attachment of the mobile terminals to the network is handled by a radio access network (RAN) called BSS (Base Station Subsystem) in case of 2G, and UTRAN (UMTS Terrestrial Radio Access Network) in case of 3G. The BSS/UTRAN consists of base stations and controllers of base stations.

The MSCs of the GSM network interface with the PSTN network to enable communication between mobile and fixed terminals.

Since the GSM network is a voice network, SS7 is used for the transport of signaling information between BSS/UTRAN and NSS and between MSCs within NSS and between NSS and PSTN.

The Intelligent Network is called CAMEL (Customized Application Mobile Network Enhanced Logic). GSM provides terminal mobility and CAMEL provides service mobility. CAMEL

provides services such as short numbers, VPN and Mobile prepaid. With CAMEL, the user may access to her/his services from visited networks, the home network has roaming agreements with.

The management of BSS/UTRAN is handled by OMC-R (OMC Radio). The management of the MSCs is handled by OMC-S (Switching). OMC-R and OMC-S are supplied by telecom vendors together with the equipment those OMCs have to manage.

A mobile service provider builds its OSS and BSS that interface with these OMCs.

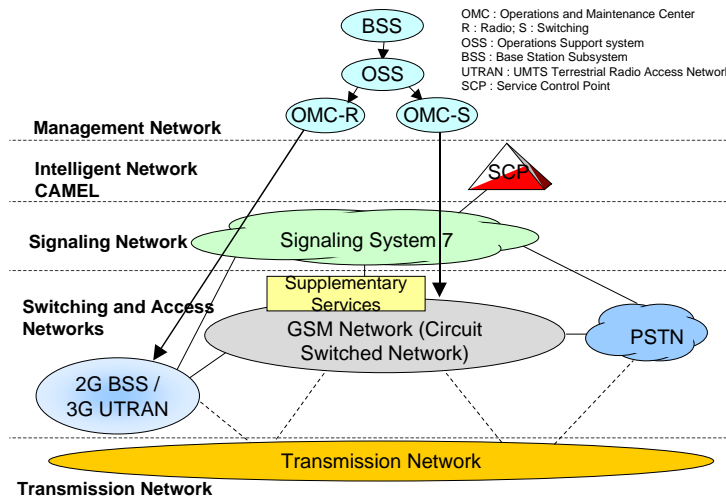


Figure 2 : Mobile Voice Network : GSM (Global System for Mobile Communications)

### 3 General Packet Radio Service (GPRS)

GSM provides voice services. GPRS reuses the existing GSM infrastructure to provide end-to-end packet-switched services, i.e., data services. While the mobile packet core network is called GPRS, the access technologies which may be considered to access to the GPRS network are GPRS (BSS), EDGE (BSS), W-CDMA (UTRAN), HSDPA/HSUPA (UTRAN) .

While a voice communication requires 12 kbit/s at the radio access, GPRS enables access to data services (e.g., WAP) at a bitrate which is associated with the access technology, from 40 kbit/s for GPRS access technology to 1 Mbit/s for HSDPA/HSUPA technologies. Moreover the cost of the data session is not related to the only duration of the session but related to several criteria including volume, duration, event, content, etc.

GPRS provides interfaces to Intranet and Internet networks.

GPRS does not impact the GSM BSS (Base Station Station) and 3G UTRAN. This is important because 65% of the cost of a mobile network is due to the access network while the remaining 35% is the cost of the core network.

With the GPRS network, the user access to IP-based services, either those of Internet or those of the mobile service provider. Therefore, GPRS provides broad IP-based application support (E-mail, WAP, WEB, instant messaging, multimedia messaging, video streaming, mobile TV, broadband access to the Internet, etc.).

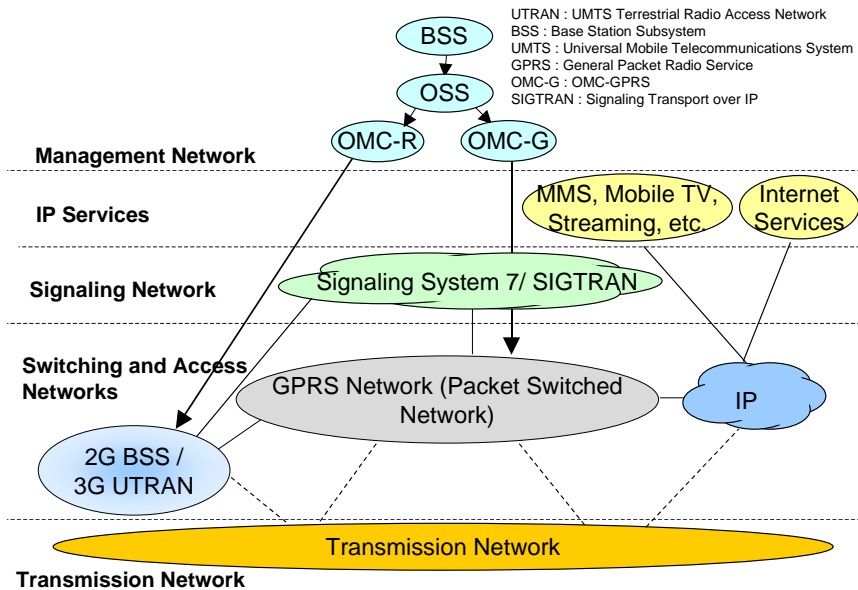


Figure 3 : The Mobile Packet Network : GPRS (General Packet Radio Service)

## 4 Broadband access and broadband services

The trend is to propose broadband access to the customer and an associated bundle of broadband services including IP TV (broadcast TV, video on demand) and IP Telephony. This is true for fixed and mobile accesses. Fixed accesses include FTTH, xDSL, cable, WiMAX technologies while mobile accesses include HSDPA/HSUPA, HSPA+ (3G+), EPS (4G), and EVDO (Evolution Data Only used for supplying high speed data access in CDMA2000-based networks).

The same IP network connects whatever broadband access technology and supports the IP-based service architecture. IMS (IP Multimedia Subsystem) is a standardized service architecture for multimedia services such as IP telephony, IP TV, presence, messaging, IP centrex, Conferencing, etc. Apart from the IP services supplied by the service provider, the user may access to any Internet services (Web, mail, file transfer, streaming, Internet telephony, etc.)

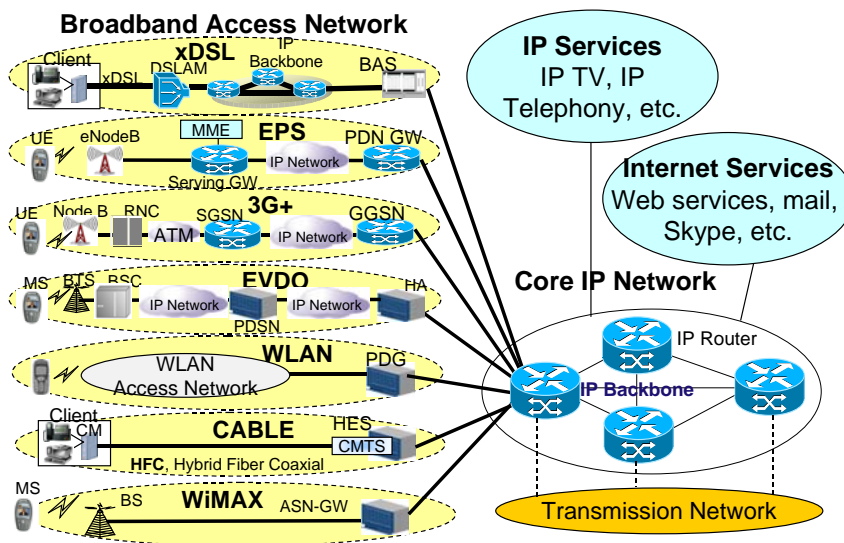


Figure 4 : Broadband access networks and broadband services

## 5 From Circuit Switching to Next Generation Network (NGN)

From the fixed telecommunications circuit-switched network perspective a number of developments has occurred to give operator's greater flexibility in the deployment of networks. Distributed processing has enabled the separation of pure switch/routing functionality away from the control mechanisms. The separation of contemporary switch mechanisms into media gateways (MGWs) (containing switching, transcoding and user-plane transmission aspects) and media gateway control functions (MGCs) (containing switch and service control functionality), connected via standard interfaces (e.g. H.248/Megaco, Media Gateway Control Protocol), enables operators to increase the service delivery and control parts of their networks in relative isolation to the growth of the user traffic parts of the network. The figure below illustrates the concept behind the distributed processing and switching mechanisms offered by H.248/Megaco. This approach also enables procurement towards distributed networks with controller and gateway procured from separate suppliers, enabling a real progression towards call server 'farms' connected to 'pools' of resource control and switching.

The architecture is called Next Generation Network (NGN). This intelligence now resides in MGC also called Softswitch or Call Agent, which acts as the controlling element. Open interfaces towards Intelligent Network (IN) applications and new application servers facilitate rapid service provisioning and ensure a short time to market.

At the media layer, gateways are introduced to adapt voice and other media to the packet transport network (typically IP/Ethernet network).

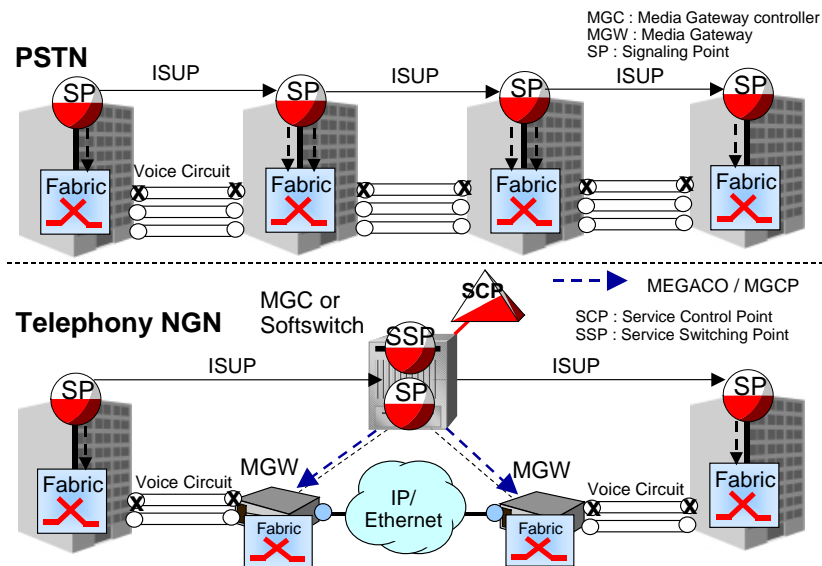


Figure 5 : PSTN versus NGN

The mobile switches of a GSM network may also be replaced by an NGN architecture which is called R4 architecture.

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