

10 Core Network

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10.1 UMTS Core Networks Based on GSM

The UMTS core network will be based in the existing GSM core network, or GSM Network Switching System (GSM NSS).

Keeping GSM as the core network for the provision of third-generation wireless services has distinct commercial advantages: protecting the investment of existing GSM operators; helping ensure the widest possible customer base from day one; and fostering supplier competition through the continuous evolution of GSM systems.

A wide customer base from day one is achieved with the help of dual mode GSM/UMTS mobile terminals, full roaming and hand-over from one system, and with mapping of services between the two systems as far as possible. The use of dual mode mobiles in the early phases of introduction of third-generation systems will ensure that UMTS subscribers will be able to enjoy roaming and interworking with the global GSM community.

The GSM standard offers a sound base for UMTS core networks, whether as evolved GSM core networks or as newly-built pure UMTS networks (albeit with different topology and physical implementation).

10.2 GPRS – an important stepping stone towards a UMTS Core Network

The real point of moving to third generation systems is to give users high speed access to wireless multimedia services and other wireless data services. Bearing this in mind it is worth noting that today's wireless data market is still in its infancy: among wireless subscribers, penetration of wireless datacom services is still less than three per cent, excluding Short Message Service (SMS). The problem is that current wireless networks are not best equipped to deal with these new forms of data use, and do not meet the UMTS requirements. As circuit switched networks, they are inefficient at handling small, frequent data calls and bursty IP traffic.

General Packet Radio Service (GPRS), the packet-based data bearer service for GSM, offers current GSM operators an opportunity to kick-start the predicted mass market for wireless data services. And important to note, it is a relatively small step from building a core network capable of delivering GPRS services to enhancing it to meet the requirements of UMTS.

In other words, implementing GPRS will provide a core network platform for current GSM operators not only to expand the wireless data market in

preparation for the introduction of third-generation services, but also to build upon for IMT-2000.

GPRS will provide end-to-end packet switching capability from the mobile terminal upwards, enhancing GSM data services significantly, especially for bursty Internet/intranet traffic. Call set-up will be almost instantaneous and users will be charged on the basis of actual data transmitted, rather than connection time. GPRS does not require any end-to-end connection and only uses network resources and bandwidth when data is actually being transmitted. This makes extremely efficient use of available radio bandwidth and allows a given amount of radio bandwidth to be shared between many users. All the widely-used data communication protocols, including IP will be supported by GPRS, so it will be possible to connect with any data source from anywhere in the world using a GPRS mobile terminal. By providing seamless interconnection with existing data services, via for example TCP/IP and X.25 interfaces, GPRS will support applications ranging from low-speed short messages to high-speed corporate LAN communications.

The introduction of GPRS is one of the key staging posts in the evolution of GSM networks to third-generation capabilities. GPRS can therefore help remove the network barriers to large-scale take-up of wireless data services by allowing familiar, user-friendly interfaces like the Internet to be used, permitting volume-based charging and providing high-speed user data rates.

So what needs to happen in the core network to support the move to GPRS and, ultimately, UMTS?

Upgrading the GSM Core for GPRS

Compared with establishing a completely new communications system, building GSM-UMTS infrastructure based on an existing GSM network will be a relatively fast exercise. An intermediate move to a GSM-GPRS network will make the transition even easier.

While GPRS will require new functionality in the GSM network, with new types of connections to external packet data networks, it will essentially be an extension of GSM. Moving to a GSM-UMTS core network will likewise be an extension of this evolved network.

GPRS will be implemented simply by adding new packet data nodes and upgrading existing nodes to provide a routing path for packet data between the wireless terminal and a gateway node. The gateway node will provide interworking with external packet data networks for access to the Internet, intranets and databases, for example.

New Nodes for Packet Data

Two new logical nodes will be introduced to handle GPRS applications in the GSM:

- Serving GPRS Support Node (SGSN)
- Gateway GPRS Support Node (GGSN)

The SGSN will provide packet routing, including mobility management, authentication and ciphering, to and from all GPRS subscribers located in the SGSN service area. A GPRS subscriber may be served by any SGSN in the network, depending on location. The traffic is routed from the SGSN to the Base Station Controller (BSC) and to the mobile terminal via the Base Transceiver Station (BTS).

The GGSN will provide the gateway to external ISP networks, handling security and accounting functions as well as dynamic allocation of IP addresses to served mobile terminals. From the external IP networks point of view, the GGSN is a host that owns all IP addresses of all subscribers served by the GPRS network.

The nodes will be interconnected by an IP backbone network. The SGSN and GGSN functions may be combined in the same physical node, or separated, even residing in different mobile networks.

A key requirement for these new nodes is that they are scalable, so that GSM operators can start to offer high-speed packet data services using small nodes in selected areas cost-effectively, and add extra capacity as it is needed. The SGSN and GGSN should also support several radio networks (those with compliant open interfaces) at the same time.

Upgrades to Existing GSM Nodes

Few or no hardware upgrades will be needed in the existing GSM nodes, and the same transmission links will be used between BTSs and BSCs for both GSM and GPRS. A special interface will be provided between the MSC/Visitor Location Register (VLR) and the SGSN to co-ordinate signalling for mobile terminals that can handle both circuit-switched and packet-switched data. The HLR will contain GPRS subscription data and routing information, and will be accessible from the SGSN. The HLR will also map each subscriber to one or more GGSNs. The BSC will require new capabilities for controlling the packet channels: new hardware in the form of a Packet Control Unit (PCU) and new software for GPRS mobility management and paging. The BSC will also have a new traffic and signalling interface from the SGSN.

of a a able for circuit-switched GSM.

The BTS will have new protocols supporting packet data for the air interface, together with new slot and channel resource allocation functions. The utilization of radio channels will be optimized through dynamic sharing between the two traffic types (circuit and packet switched traffic), handled by the BSC.

10.3 netMoving to UMTS in the GSM/GPRS Core

UMTS will have an evolved GSM core network, which will be backward-compatible with the GSM network in terms of network protocols and interfaces (MAP, ISUP etc.). This core network will support both GSM and UMTS, with hand-over and roaming between the two. UMTS Terrestrial Radio Access Network (UTRAN) will be connected to the GSM-UMTS core network using a new multi-vendor interface (the I_u). The transport protocol within the new radio network and to the core network will be ATM. There will be a clear separation between the services provided by the UTRAN and the actual channels used to carry these services. All radio network functions (such as resource control) will be handled within the radio access network, and clearly separated from the service and subscription functions in the core network.

The GSM-UMTS network will consist of three main parts:

- GSM-UMTS core network
- UMTS Radio Access Network (URAN)
- GSM Base Station Subsystem (BSS).

Like the GSM-GPRS core network, the GSM-UMTS core network will have two different parts: a circuit switched part (MSC) and a packet-switched part (GSN). The core network access point for GSM circuit switched connections is the GSM MSC, and for packet switched connections it is the SGSN. GSM-defined services (up to and including GSM Phase 2+) will be supported in the usual 'GSM' way. The GSM-UMTS core network will implement supplementary services according to GSM principles (HLR-MSC/VLR).

Modifications to support UMTS will be required in all core network nodes. MSC and SGSN must be upgraded to handle the new signalling and traffic protocols towards UTRAN. Furthermore, HLR and VLR must be modified to store UMTS service profiles and subscription data. Last but not least, all nodes must be upgraded to handle the new range of data rates and the concept of quality of service negotiation and re-negotiation.

Apart from the new range of higher data rate bearer services and more advanced QoS procedures, the UMTS core network introduces a third major novelty - as compared to pre-UMTS networks – in how services will be handled.

Pre-UMTS systems have largely standardized the complete sets of tele services, applications and supplementary services which they provide. As a consequence, substantial re-engineering is often required to enable new services to be provided and the market for services is largely determined by operators and standardization. This makes it more difficult for operators to differentiate their services. UMTS shall therefore standardize service capabilities and not the services themselves. Service capabilities consist of bearers defined by QoS parameters and the mechanisms needed to realise services. These mechanisms include the functionality provided by various network elements, the communication between them and the storage of associated data. It is intended that these standardised capabilities should provide a defined platform which will enable the support of speech, video, multi-media, messaging, data, other teleservices, user applications and supplementary services and enable the market for services to be determined by users and home environments.

New services, beyond GSM Phase 2+, will thus no longer be standardized. Instead they will be created using new the service capabilities (which are standardized) mentioned above. These service capabilities may be seen as 'building blocks' that provide service mechanisms in the UMTS network and UMTS mobile terminal that can be used for service creation. They include for instance:

- Bearers defined by quality of service (QoS) parameters
- Intelligent network functionality
- Mobile Equipment Execution Environment (MEXE)
- WAP and Telephony Value-Added Services
- SIM Application Toolkit
- Location servers
- Open interfaces to mobile network functions
- Downloadable application software.

So, in addition to new services provided by the GSM-UMTS network itself, many new services and applications will be realized using a client/server approach, with servers residing on service LANs outside the GSM-UMTS core network. For such services, the core network will simply act as a transparent bearer. The core network will ultimately be used for the transfer of data between the end-points, the client and the server.

Cell-based transport network

To make the most of the new UTRAN capabilities, and to cater for the large increase in data traffic volume, ATM (Asynchronous Transfer Mode) will be used as the transport protocol within the UTRAN and towards the GSM-UMTS core network. The combination of ATM and UTRAN capabilities and the increased volume of packet data traffic over the air interface will mean a saving of at least 50% in transmission costs, compared with equivalent current solutions. ATM, with the newly-standardized AAL2 adaptation layer, provides an efficient transport protocol, optimized for delay-sensitive speech services and packet-data services. Introducing ATM as a transport protocol does not, however, imply a completely new transport infrastructure: the ATM could well be run over existing STM lines.

10.4 UMTS Core Network Phase 1 (Release 99) Requirements

In the first phase of UMTS, the UMTS core network capabilities are a superset of the phase 2+ release 99 GSM core network capabilities. The additional requirements for the phase 1 UMTS core network are the following :

- 1) The phase 1 UMTS core network shall support circuit switched data service capability of at least 64 kbit/s per user. This shall not limit the user from choosing lower data rates.
- 2) The phase 1 UMTS core network shall support packet switched data service capabilities of at least 2 Mbit/s peak bit rate per user. This shall not limit the user from choosing lower data rates.
- 3) The phase 1 UMTS core network shall enable set-up, re-negotiation and clearing of connections (i.e. CS calls or PS sessions) with a range of traffic and performance characteristics. The re-negotiation of QoS attributes for a bearer service may be caused by an application or the user via an application. It shall be possible to apply traffic policing (e.g. connection admission control, flow control, usage parameter control...) on a connection during its set-up and lifetime.
- 4) The phase 1 UMTS core network shall support a range of traffic and performance characteristics for connectionless (e.g. unicast, broadcast, and multicast) traffic.
- 5) The range of traffic and performance characteristics that shall be supported by the phase 1 UMTS core network shall be at least those of GPRS phase 2+ release 99. This means that the support of the full set of bearer services defined in the UMTS specifications is not required for the phase 1 UMTS core network.

- 6) Established bearers shall not prevent the set-up of a new bearer. These new bearers can be of any type (e.g. PS, CS). It is nevertheless expected that the terminal and network capabilities will put some limitations on the number of bearer services that can be handled simultaneously. It shall be possible for each bearer to have independent traffic and performance characteristics.
- 7) In order to facilitate the development of new applications, it shall be possible to address applications to/from a phase 1 UMTS mobile termination (e.g. the notion of Internet port).
- 8) Operator specific services based shall be supported by the phase 1 UMTS core network. This functionality could be provided through available toolkits (such as IN, MExE, WAP and SIM Toolkit).
- 9) The phase 1 UMTS core network shall support interworking with PSTN, N-ISDN, GSM, X.25 and IP networks with their respective numbering schemes.
- 10) It shall be possible for the standardised classes of phase 1 UMTS mobile terminals supporting the GSM BSS and UTRAN radio interfaces to roam in GSM networks and receive GSM services.
- 11) Standardised protocols shall be defined for the operation, administration and maintenance of the UMTS phase 1 core network in cooperation with relevant groups within ETSI.