8 User Equipment

Objectives:
After this chapter the student will be able to:
- outline the architecture and interfaces within the UE
- describe the user equipment capabilities
- understand the structure of the USIM
- be aware of the multimedia terminal standards

8.1 The UMTS User Equipment in the UMTS Architecture

The following figure shows the basic domains in UMTS as described in this section.

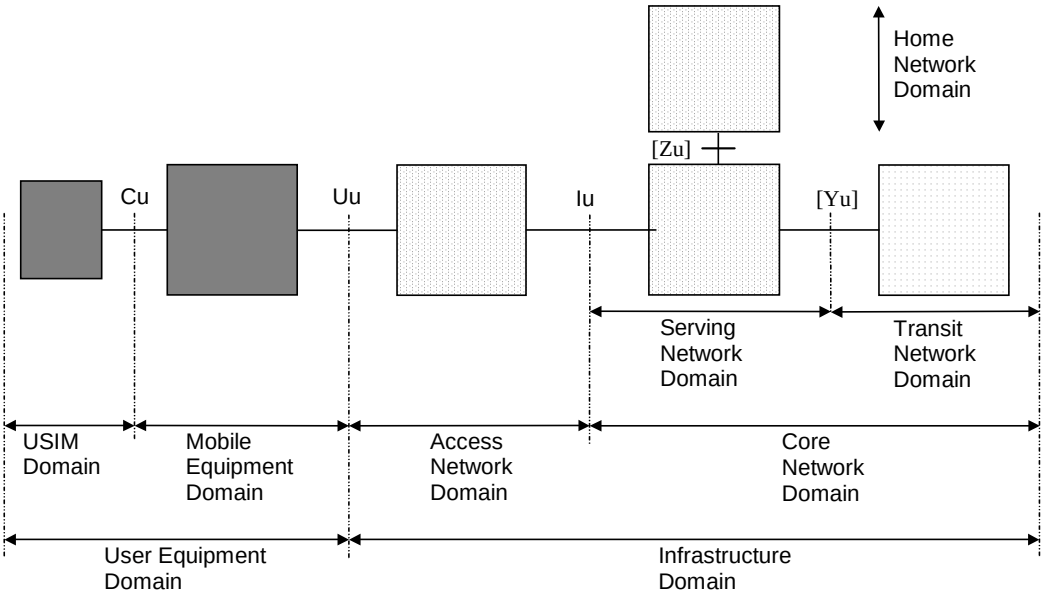


Figure 1: UMTS domains and reference points

Cu	= Reference point between USIM and ME
Iu	= Reference point between Access and Serving Network domains
Uu	= Reference point between User Equipment and Infrastructure domains, UMTS radio interface
[Yu]	= Reference point between Serving and Transit Network domains
[Zu]	= Reference point between Serving and Home Network domains

A basic architectural split is between the user equipment (terminals) and the infrastructure. This results in two domains: the **User Equipment Domain** and the **Infrastructure domain**. User equipment is the equipment used by the user to access UMTS services. User equipment has a radio interface to the infrastructure. The infrastructure consists of the physical nodes which perform the various functions required to terminate the radio interface and to support the telecommunication services requirements of the users. The infrastructure is a shared resource that provides services to all authorised end users within its coverage area. The reference point between the user equipment domain and the infrastructure domain is termed the "Uu" reference point (UMTS radio interface).

User Equipment Domain

This domain encompasses a variety of equipment types with different levels of functionality. These equipment types are referred to as user equipment (terminals), and they may also be compatible with one or more existing access (fixed or radio) interfaces e.g. dual mode UMTS-GSM user equipment. The user equipment may include a removable smart card that may be used in different user equipment types. The user equipment is further sub-divided in to the **Mobile Equipment Domain**

(ME) and the **User Services Identity Module Domain** (USIM). The reference point between the ME and the USIM is termed the "Cu" reference point.

Mobile Equipment Domain

The Mobile Equipment performs radio transmission and contains applications. The mobile equipment may be further sub-divided into several entities, e.g. the one which performs the radio transmission and related functions, **Mobile Termination,** MT, and the one which contains the end-to-end application or (e.g. laptop connected to a mobile phone), **Terminal Equipment.** TE. This separation is used in the description of the functional communication in figure 3 but no reference point is defined in this specification.

USIM Domain

The USIM, User Services Identity Module, contains data and procedures which unambiguously and securely identify itself. These functions are typically embedded in a stand alone smart card. This device is associated to a given user, and as such allows to identify this user regardless of the ME he uses.

8.2 User Equipment Capabilities

UMTS aims to offer service capabilities that enable a wide variety of services to be implemented. Such services range from simple services like speech, to complex multimedia services containing several simultaneous media components that place totally different requirements on the system and on the terminal equipment. By standardising service capabilities rather than actual services, more flexibility is available for service providers/network operators to create unique services. The same principle also applies for UMTS terminals, i.e. the types of terminals are not standardised and are therefore not limited in any way. A wide range of terminal types is likely in the UMTS environment, e.g. speech only terminals, videophones, data terminals, wideband data terminals, fax terminals, multi-band/multi-mode terminals and any combination of the aforementioned.

Although no UMTS User Equipment types will be standardised there is a need for different power classes for cell planning reasons. The following four classes are defined:

1. 2 W
2. 0.5 W
3. 0.25 W
4. 0.125 W

The maximum power will affect a User Equipments possibilities to support the upper range of bit rate services over the UMTS coverage area. Cell

planners will plan for achieving coverage for higher bit rates on the cell border primarliy for power class 1 user equipments.

Since no terminal types are standardised, a user equipment must indicate to the network a set of terminal capabilities in order to be handled properly by the UTRAN and the Core Network. The set of terminal capabilities include for instance radio capabilities, multimedia capabilities and speech coders/decoders that are supported by the user equipment. The radio parts of a user equipment can support any combination of GSM circuit switched radio, GSM packet switched radio, UMTS FDD-mode and UMTS TDD-mode, and additionally other radio access modes. Multimedia capabilities may include which type of display and which coders/decoders that are supported for video and audio. Finally, GSM and UMTS networks and terminals include a number of different speech coders:

1. GSM Full Rate
2. GSM Half Rate
3. GSM Enhanced Full Rate
4. GSM Full Rate Adaptive Multi-Rate
5. GSM Half Rate Adaptive Multi-Rate
6. UMTS Adaptive Multi-Rate

The default speech codec for the UMTS user equipment is the UMTS Adaptive Multi-Rate (AMR) codec which generates a variable rate bitstream of bitrates between 4.75 – 12.20 kbit/s depending on the characteristics of input speech signal.

8.3 Users Service Identity Module

The UMTS user service identity module (USIM) shall contain sufficient information to identify the user and service provider. USIM is a UMTS specific application residing on an removable IC card and is required for service provision. Authentication and ciphering functionality may be part of USIM or some other application on the same or different IC card. The UMTS IC card could also support applications other than UMTS USIM application in order to allow more versatile UMTS IC card functionality such as access to value-adding services.

The mandatory requirements for IC Cards used for holding USIM application are related to the need to have one USIM application on the IC card, as well as to the security issues. The following functionality is required from the IC card holding a USIM application:

- Physical characteristics same as used for GSM SIM (note that the standard supports inserting a GSM SIM card into a UMTS user equipment which will enable access to the GSM set of services, i.e. no UMTS specific services)

- The support of at least one USIM application (several USIM applications

belonging to different UMTS service providers may reside on the same IC card).

- The support of one or more user profile on the USIM
- Possibility to update USIM specific information over the air, (e.g. such information as service profile information, algorithms, etc.) in a secure and controlled manner.
- Security mechanisms to prevent USIM application specific information from unauthorised access or alteration. Verification of the access privilege shall be performed on the card itself and not delegated to another entity (for example the terminal).
- User authentication.

The standard should support the following additional functionality for the IC Cards in UMTS environment:

- The support for more than one simultaneous application (Multiple USIM, Ecash and/or some other applications).
- Possibility to have shared applications/files between multiple subscriptions including other user and Service Provider controlled files and data, as well as for as yet undefined applications (including downloadable applications) required by future services. Related security issues have to be analysed.
- Possibility for some applications/files to be restricted to one or some of the subscriptions, under user/SP control, with all applications that are shared, being done so in a secure manner.
- Inclusion of a payment method (electronic money and/or prepaid and/or subscription details)
- An interface allowing highly secure downloading and configuration of new functionality, new algorithms and new applications into the IC card as well as updating the existing applications, algorithms and data.
- Support for storing and possibly executing encryption related information, such as keys and algorithms.
- In multi application cards a functionality to prevent the unauthorised access and alteration of USIM specific information by other applications residing on the card.
- The ability to accept popular value-adding IC card applications, such as digital signature applications, EMV credit/debit card, electronic purses such as Mondex and Visacash, etc. Dynamic addition and deletion of these applications during the lifetime of the card is envisaged.
- Possibility for one UMTS SP to block multiple subscription on the card the SP has issued.

Shared applications could include databases (e.g. telephone books), service profiles (e.g. controlling divert information), users preferences (e.g. short

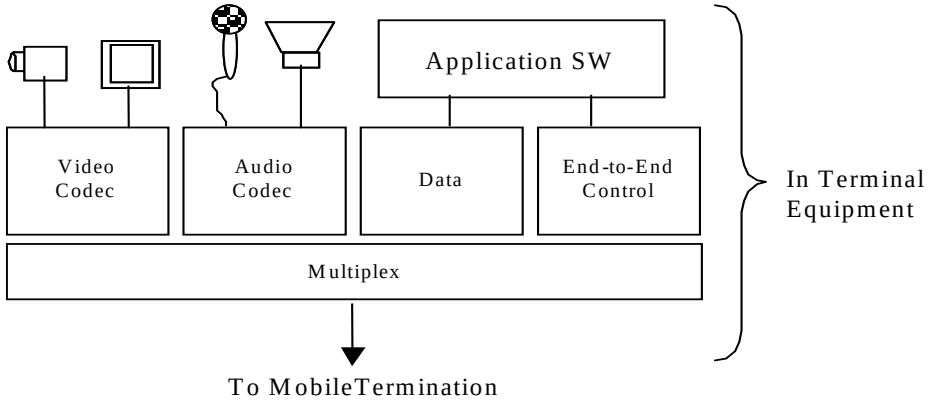
dialling codes) and SP-specific parameters inside a USIM application (e.g. call barring tables).

8.4 Mobile Multimedia Terminals

Mobile multimedia terminals for UMTS are based on existing multimedia terminal standards for the fixed networks. ITU has produced a number of such standards, the so called H-series. Where needed slight modification for the UMTS case are introduced by 3GPP. Moreover, the ITU has developed extensions to the fixed terminal standards to adapt them to mobile communication characteristics such as higher bit error rates.

ITU standards H.323 and H.324 are used for UMTS multimedia terminals. H.324 is the standard for circuit switched multimedia over PSTN while H.323 targets multimedia over packet switched networks with no support of guaranteed Quality-of-Service.

The general architecture of a H.324 multimedia terminal in an UMTS user equipment is shown below.



The Application SW is not part of the standard. It contains the application software, e.g. the user interface, in the terminal for the multimedia application and controls the usage of the other blocks in the figure which implement the H.324 standard components.

The H.324 components are

1. a video coder/decoder that transfers analogue video into a digital bitstream (H.263)
2. the audio coder/decoder that transfers analogue audio into a digital bitstream (G.723.1)
3. data protocols for end-to-end retransmissions and flow control for transfer of user data end-to-end (e.g. LAP-D)

4. control procedures for multimedia session set up and release end-to-end (H.245)
5. all the streams generated by the four entities above are finally multiplexed into one single bitstream according to the H.324 multiplex standard H.223.

In order to function properly the single bitstream from the multiplexer requires a bitrate of at least 32 kbit/s.

3GPP has added the ETSI AMR speech coder/decoder to the list of possible audio codecs for the purpose of mobile-to-mobile multimedia calls. The G.723.1 speech codec has to be supported by UMTS multimedia terminals for interworking with terminals in the fixed network. Additionally, the video codec MPEG-4, standardised by the International Standardisation Organisation for all types of video applications, i.e. not only videotelephony, can be supported.

The five entities in the H.324 terminal part reside in the Terminal Equipment part of the UMTS User Equipment. The single bitstream from the multiplexer is sent to the Mobile Termination part of the User Equipent for transparent transport over the radio interface an onwards. (The core network will be aware of the fact that the call is a H.324 call in order to activate specific rate adaption functions in the so called Interworking Function in the MSC).

Annex A
Mobile Terminal Technology

2nd generation digital cellular terminals already contain considerable complexity. There are two main reasons for this. Firstly, cellular systems themselves require a huge amount of functions to be fulfilled, from channel and speech coding to signalling and data protocols. In addition to those functions, all terminals have their own mobile system independent features, sometimes also called as Value Adding features. Examples of these are, memory databases, speech recognition, messaging features, display functions, and different source coding methods (e.g., JPEG). Terminal development trends for today's terminals are mainly towards higher integration levels resulting in smaller size. The goal of "four 100's" has been a rule of thumb target for handsets, i.e., 100 hour standby, 100 cc size, 100 gram weight and also 100 MIPS performance. The size targets have already been achieved and any requirement for smaller terminals is questionable from the usability and physical size limitations perspective. The other target parameters have no maximum limitations. On the other hand, we can see the following further trends for near future terminals:

- Application specific terminals (smart traffic, vending machine radio, etc.);
- Increased number of value adding features (graphics, smart messaging, PC connectivity and compatibility);
- Support for higher number of source codecs (several speech codecs);
- Multiband terminals (e.g., GSM in 900MHz and DCS1800);
- Multimode terminals (e.g., GSM/DECT dualmode terminal);
- Dynamic SW configurability;

These trends are more than likely to continue in the future. Multiband and multimode terminals with high integration levels would be preferred by the users. Technological development of these terminals relies on new packaging and interconnection technologies, as well as technological steps like SW-radio. The concept trends of mobile handheld terminals is likely to diverge from simple speech terminals towards a variety of different types, e.g., communicators, wearable phones, data terminals, etc. The dominant role of speech terminals will be challenged in the future by these new data- and multimedia-oriented terminals.

The trend for IC cards (used for the USIM) is similar to that for terminals. The next generation of IC cards will be multi-application cards capable of supporting several applications simultaneously. Furthermore, applications could be downloaded to and removed from these cards, both at the time of issuing and during the card's lifetime The advent of these virtual machine cards, e.g. Java cards and Multos cards, will change the roles of the card issuers and application providers, and will enable IC cards to be much more flexible in the future.

New radio-interface and system capabilities will enable higher quality multimedia services to be provided and therefore new terminal concepts to evolve. The variety of terminals in the UMTS environment will evidently be large. Terminal implementation technologies, such as digitalisation providing programmability and terminal configurability, VLSI, and display technologies, have developed a lot recently and will undergo further development in the future. Processing power, implementation architectures, IC and passive integration, and memory technologies are developing rapidly and will facilitate an increase in terminal functionality that will enable higher integration of terminals, as well as the integration of more functionality into smaller terminals. It can be clearly seen that the technical development of IC card technology increases the available possibilities for IC cards in the UMTS context. Compared to current IC cards (e.g. GSM Phase 2 SIM cards), the amount of memory and processing power will increase significantly. These development trends will meet the requirements of UMTS and should be taken into account while defining the features and functions of UMTS IC card.