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Contents

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Foreword

[EDITOR'S NOTE: TEXT BETWEEN SQUARE BRACKETS AND IN COURRIER FONT IS EDITOR'S NOTE]

[THIS DOCUMENT IS OUTPUT VERSION OF THE SMG3SA/UMTS MEETING WHICH TOOK PLACE IN VÉLIZY (FRANCE), ON THE 26-28/08/97.

CHANGES BETWEEN VERSION 0.10.0 AND VERSION 0.9.0 MAINLY AFFECT SECTION 6.5.1 (CORE NETWORK : GENERAL ASPECTS) AND CONCERN HANDOVER BETWEEN AN/CN CONNECTION POINTS OF DIFFERENT ACCESS NETWORK INSTANCES.

TEXT BETWEEN SQUARE BRACKETS IN ARIAL FONT IS INCORPORATED BY THE GROUP IN THIS DOCUMENT AS A BASIS FOR FURTHER COMMENTS.

THE REVISION MARKS ARE SHOWN EVERYWHERE EXCEPT IN THIS PAGE.

A NEW SCOPE FOR 23.05 WILL BE PROPOSED BY THE EDITOR TO AVOID ANY OVERLAP BETWEEN ITS SCOPE AND THE SCOPE OF 23.01 AND 23.10.]

Introduction

1 Scope

This ETS provides a functional description of the different network parts in the UMTS, it defines the network principles for different kinds of UMTS core networks, e.g. ISDN - UMTS and GSM - UMTS (XXX - UMTS refers to the original XXX core network, modified in order to make an efficient use of UMTS capabilities), the interworking unit, the radio access network (in GMM [1], the term "UMTS BSS" is used to refer to both interworking unit and radio access network) and the mobile terminal. For each of these network parts, the operations and procedures, the transport, the user and the control planes are described. Also aspects of interworking between UMTS core network types are analysed. Figure 1 shows the UMTS network parts, which are functionally described in the ETS.
The network support for the different environments envisaged for the different UMTS core networks are outlined with the protocols and network architectures for these being specified.
Detailed specifications of the network aspects for the different network parts of UMTS can be found in other ETSes.

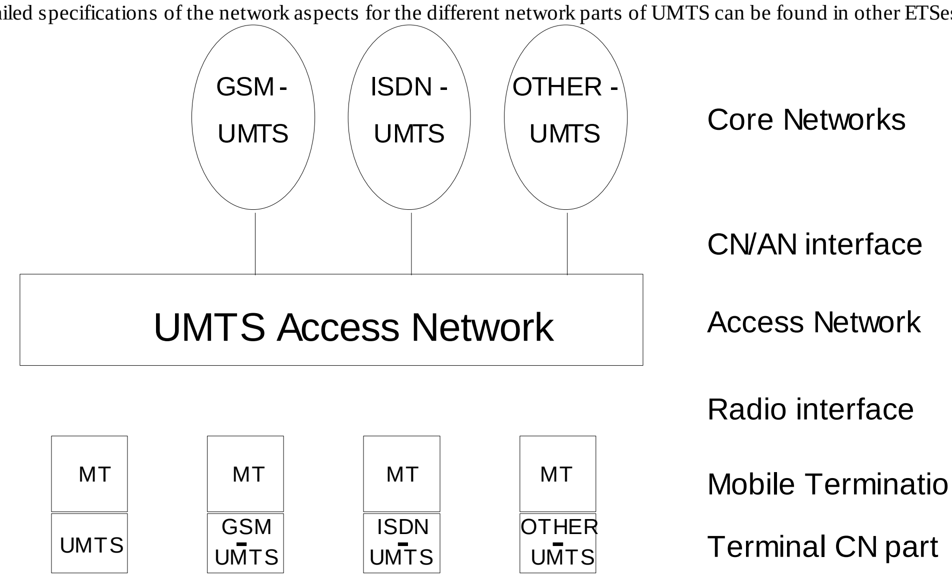

Figure 1: The different modules in the UMTS concept (the core networks shown are examples of core networks).

2 (Normative) references

This ETS incorporates, by dated and undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this ETS only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

[1] ETSI/PAC: Baseline Document on "Global Multimedia Mobility".
[2] UMTS 23.01: "General UMTS Architecture"
[3] ETSI TC-SMG DTR 50102 (UMTS 01-02): "Vocabulary for the UMTS"; v.2.0.0.
[4] ITU TG 8/1: "Draft New Recommendation Vocabulary for FPLMTS (FPLMTS.TMLG)"; v.15/09/95.
[5] ETSI TC-SMG DTR 50303 v.1.2.1 (UMTS 03-03): "Principles for handling of (digital) data services in the UMTS".
[6] ETSI TC-SMG DTR 50301 (UMTS 03-01): "Framework of Network Requirements, Interworking and Integration for the Universal Mobile Telecommunications System (UMTS)".
[7] ETSI TC-SMG UMTS 22-01: "Services Principles ".
[8] ETSI TC-SMG DTR 50105 (UMTS 01-05): "System design methodology for the UMTS".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of this ETS the following definitions apply [23,4]:

Bearer: A bearer provides the capability for information transfer through a network. Consequently, one or more bearer(s) must be set up, modified or released when the corresponding call is set up, modified or released. A bearer is characterized by a class (RT, NRT) and by the values of a list of parameters specific to each class (e.g. for a NRT bearer: BER, CBR, mono/bi/multidirectional, burstiness... and for a RT bearer: BER, CBR, delay,...).

Bearer Control: The Bearer Control is the set of functions used to set up, maintain and release a bearer.

Call: A call is the execution of actions in order to establish/release a communication and the communication itself based on the required service between two or more parties on behalf of an initiating (or originating) party. In this sense, a call can also be referred as a service invocation. A call is characterized by its lower layer attributes (i.e. bearer(s) it uses) and to higher layer attributes on the service level.

Call Control: The Call Control is the set of functions used to process a call, i.e. service negotiation, setup, modifications and release of the call, and management of the establishment, modify and release requests for its related bearer. A CC FE exchanges information:

- with others CC FEs and with the user to define/modify/release a call through a quality of service negotiation,
- with BC FEs for the bearer matter, and
- with the SCF via the SSF for IN applications purpose. The CC tasks are performed by the terminal and by the Core Network.

Connection: A connection is an association of logical channels set up to provide a means for a transfer of information between two or more points in a telecommunications network.

Information transfer mode [5]**:** Specifies the mode for transferring user information (see I.140)

> **circuit mode:** A transfer mode in which transmission and switching functions are achieved by permanent allocation of physical channels/bandwidth between the connections (see I.113).
>
> **packet mode:** A transfer mode in which transmission and switching functions are achieved by packet oriented techniques, so as to dynamically share network transmission and switching resources between a multiplicity of connections (see I.113).

Functional Entity: A Functional Entity (FE) is the set of functions related to a same general goal at a given location (e.g. Call Control FE).

Logical Channel: A Logical Channel is a link whose purpose is to carry a given kind of information (signaling, traffic..). A logical channel may rely on various physical channels as a physical channel may contains various logical channels.

Physical Channel: A Physical Channel is a path through a communication space defined in time, frequency and code, which is established for a given period of time.

Quality Management for Media Components: When limitations are met in the network (the most likely being the radio resource limitations) those bearers/media components which have been previously defined as lowest priority (e.g. at call set-up or in the service profile) can be reduced (possibly to 0).

Session: A Session is when there is a trusted relation between the user and the network that allows the user to further interact with the network (e.g. to set-up calls, modify user profile, etc.). `[Note: this term is for the moment roughly defined. It needs to be eventually clarified and to be cross-checked with ITU vocabulary.]`

Domain: See [2]

Module: See [2]

["STREAMLINING" DEFINITION IS REQUESTED]

3.2 Abbreviations

For the purposes of this ETS the following abbreviations apply.

BC	Bearer Control
BER	Bit Error Rate
BR	Bit Rate
BSS	Base Station Subsystem
CHC	Channel Coding
CC	Call Control
CN	Core Network

CTM	Cordless Telephone Mobility
FE	Functional Entity
FP	Fixed Part (Infrastructure side)
URAN	UMTS Radio Access Network
HLC	Higher Level Control functions
HLT	Higher Level Transport functions
HOC	Handover Control
IL	Interleaving
IWU	InterWorking Unit
LLC	Logical Link Control
MA	Multiple Access
MAC	Medium access control
ME	Mobile Equipment (= TE + TA + MT)
Mod	Modulation
MP	Mobile Part
MPX	Multiplexing
MS	Mobile Station (= ME + USIM)
MT	Mobile Termination
NRT	Non Real Time
PC	Power Control
PG	Paging function
Phys	Lowest part of the physical layer (OSI 1)
PLC	Physical Link Control
QoS	Quality of Service
RAN	Radio Access Network
RBC	Radio Bearer Control
RLC	Radio Link Control
RRC	Radio Resource Control
RSVP	Reservation Setup Protocol
RT	Real Time
Sec	Security control
SIM	Subscriber Identity Module
Sync	Synchronisation
TA	Terminal Adapter (e.g. data card)
TE	Terminal Equipment (e.g. laptop)
TP	Transport control
USIM	UMTS Subscriber Identity Module
VHE	Virtual Home Environment
GMM	Global Multimedia Mobility

4 Basic principles

4.1 Modularity

UMTS must be able to support a wide range of services (using either circuit and packet switched transfer mode) where many of these services today are not possible to predict. Also the usage of the different services are difficult to predict i.e. it is not possible to optimise UMTS to only one set of services. One conclusion of this is that UMTS must be built in such a way that it is flexible and possible to evolve so it will have a long technical lifetime. Therefore a modular approach is recommended when defining the network parts of UMTS. [The relationship between the terminology used here and the one used in the GMM report has to be clarified.] This is in line with the recommendation from GMM, where a module is named domain. In this context a module represents a part of a UMTS network i.e. one or several physical network nodes that together implements some functionality. The modular approach should also make UMTS possible to implement efficiently in different environments.

4.1.1 Flexible call structure

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A hierarchical call model is introduced here to define the different elements involved in the call. Four hierarchical levels are distinguished: the "call" level, which is in charge of providing the QoS negotiation and establishing the selected connection; the "connection" level, which provides specific bearer services (using either packet switched or circuit switched transfer mode), the "logical channel" (LC) level, which provides a transport means for a given kind of information such as traffic or signaling, and finally the "physical channel" (PC) level which is directly related to the physical layer and provides with the actual information transport capability. On a physical implementation point of view, call and connection control are radio access technique independent functions, when LC and PC control are radio dependent functions. LC control takes also care of utilising packet data transfer mode over the radio.

Figure 2 represents this hierarchical view.

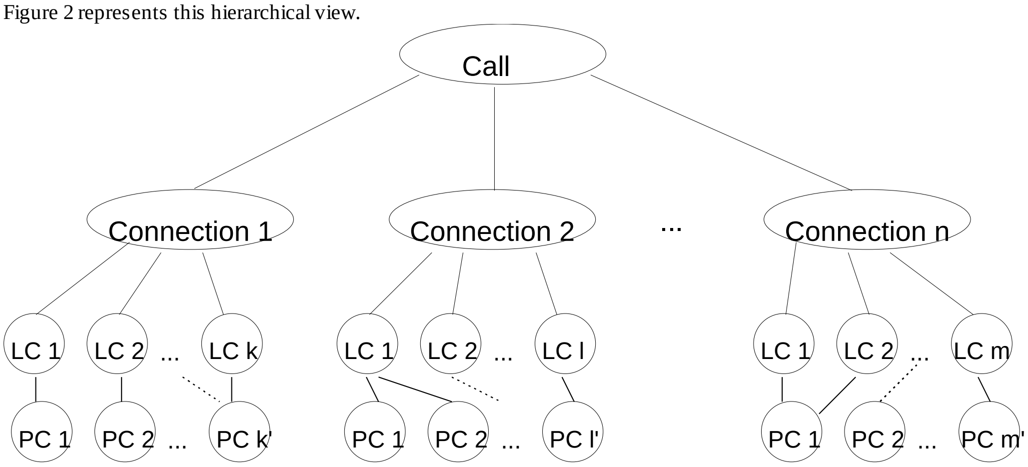

Figure 2: The call hierarchy

A call uses one or more connections, as a connection may be supported by various logical channels. A logical channel may be mapped onto various physical channels as a physical channel may support various logical channels. Moreover, this mapping may change at any time if packet access is used: in this last case, the PCs are dynamically allocated and released by the LCs according to the presence or absence of information to be transferred. Then, two LCs belonging to two different connections or to two different calls may use a same PC.

Figure 3 shows an example of an end-to-end call, where the call, connection and logical channel notions are presented.

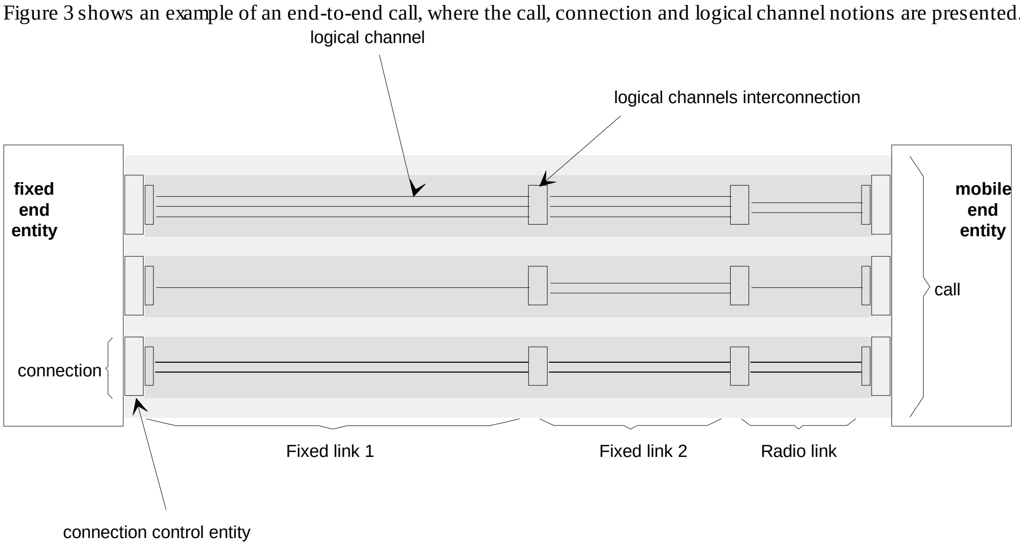

Figure 3: End-to-end diagram of a multi-connection call

The Call and Connection levels have a global significance (along the whole transmission path), whereas Logical and Physical Channel have a local meaning as they depend on the physical medium locally used.
For example, in the case of a videophony call with in-call fax transmission, four connections may be established: two symmetrical ones for voice and video transport (these two connections share a lot of common characteristics, e.g. short delay constraints, relatively high BER allowed), another one, asymmetrical, for data transport, and a fourth one, also asymmetrical, for the signalling related to the call. Each one of the three first connections will use at least one logical channel dedicated to traffic and one other for the signalling related to that connection, whereas the third one will only use signalling logical channel.
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4.1.2 Flexible protocol architecture

UMTS standards should allow for the support of different Core Networks (e.g. GSM, ISDN, ATM-based). Vice versa, it should be possible to connect various radio-interfaces to a Core Network. This implies that transport aspects should be decoupled from control aspects as much as possible. To facilitate this flexibility, the UMTS protocol architecture should be structured according to the OSI layering principles.
Further, UMTS standards should allow for a variety of configurations tailored to the needs of particular environments. To achieve this, the concept of free allocation of (sets of) functions should be applied. Therefore, the OSI Application Layer structure should be used. This structure makes it possible to group functions in modules and to allocate these modules to network entities in a flexible way.
]

4.1.3 Mobility

UMTS specifications will support mobility, at personal and terminals levels, between heterogeneous radio interfaces.
The impact of interworking, that is mobility, between heterogeneous radio interfaces when accessing -or actively engaged in- a service needs to be studied.
[
There exist different kinds of mobility. In this ETS we only elaborate terminal and user mobility.
Within user mobility, the things such as service mobility etc. are included.
As a principle, the terminal mobility in case of radio access is handled by the RAN and its related IWU as long as the UMTS user is roaming inside the domain of one RAN + IWU. If the UMTS user is allowed to roam between different (RAN + IWU)s then the CN must support this roaming capability. This is provided in GSM and will through CTM be introduced in the fixed network. Mobility within the domain of one RAN+IWU, between RAN+IWU and between RANs+IWU connected to different Core Network switches during user communication will require the provision of handover. In the cases of handover between RAN+IWU and between RANs+IWU connected to different Core Network switches, the UMTS supporting Core Networks will need to provide supporting functionality for the handover or re-routing within the network.
Handover decision and execution are handled totally autonomously by the access network and are invisible for the CN, however network functionality will still be required to cater for certain types of inter RAN+IWU and inter Core Network switching handover, either in real time or as a subsequent Core Network streamlining.
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4.3 VHE Virtual Home Environment

There are different approaches towards the realisation of the Virtual Home Environment (VHE). The adopted approach is determined by the implementation, the requested VHE service, etc. Two possibilities currently identified are:

- Execute the services in the home network; (Home network is used in the context of 23.01, Figure 1: UMTS Domains and Strata)
- Download home operator specific services from the home network to either the User equipment and/or the serving network.

The services shall operate in a consistent manner independtly of the underlying transport network.
In order to support the VHE concept, negotiation of service capability requirements should be possible between the serving network and/or the user equipment and/or the home network.

5 [Functions,]Operations and procedures

[Note: This section needs elaboration concerning the provision of asymmetric services (packet switched and circuit switched) and the realisation of the session concept. Furthermore, the influence of quality management for media components on the functional description of UMTS needs clarification. Whether the distinction between connectionless and connection oriented services impacts the description of operations and procedures is for further study.]

5.1 Functions related to overall system access control

System access is the means by which a UMTS user is connected to the UMTS in order to use UMTS services and/or facilities. User system access may occur from either the mobile side, e.g. a mobile originated call, or the fixed side, e.g. a mobile terminated call.

5.1.1 System information broadcasting

This function provides the mobile station with the information which is needed to camp on a cell and to set up a connection. Such information may include access rights, network identification, frequency bands used, configuration of logical channels, etc.

5.1.2 Radio access information monitoring and analysis

This function monitors and analyses radio access related information transmitted from the network to one or more mobile stations. The functionality required for analysing this information resides in the mobile station.
The purpose of the monitoring process is essentially to examine what networks, network operators and service providers are available, and what service capabilities they support. Monitoring the radio access information forms the basis for the analysis related to which cell a mobile station shall camp on, and which channels it will occupy once engaged in dedicated communications. Monitoring relevant parameters implies that the mobile station must scan parts of UMTS frequency bands for information. Relevant information to be monitored may include:

a) UMTS network identity

b) UMTS network operator identity

c) Service provider identity

d) Indication of service capabilities of a cell

e) Subscriber and mobile station access rights

f) Pointers to broadcast channels of neighbouring cells

g) Indication of frequency bands and physical channel configuration to be used in the cell

h) Indication of logical channel configuration of the cell, and the mapping of these to physical channels (particularly the mapping of the Random Access Channel to physical channels)

i) Indication of multiple access technique to be used in the cell

j) Indication of duplexing technique used in the cell

The following information may be required for the MS to prepare a list of candidate cells for access:

a) Type of cell (pico, micro, macro, etc.)

b) Cell identity

c) Cell access category (public, private, residential)

d) Satellite or terrestrial component indicator

e) Access control parameters (e.g. whether the cell is barred for access for all users or for a sub-population of users)

f) Bearer service capabilities of the cell

g) Location information

Once the mobile station has gathered radio access related information, the information should be analysed to determine which cell the mobile station should camp on. Logically, it may be expected that the service provider is selected before the network/network operator, and the network/network operator is selected before the cell.

Selection of service provider and network/network operator is governed by user choice, i.e. by subscription or by real-time choice according to for instance service capabilities, charges, access rights, etc. Therefore, the selection of network/network operator is the result of a list of priorities combined with what is available to the user at the current location.

Note that since several network operators may jointly share the same infrastructure the selection of network operator and selection of network are logically distinct processes.

Based on the selection of network operator made by the mobile termination and based on radio channel measurements of the pilot channels and broadcast control channels of the available cells, the mobile station finally selects a cell on which to camp (the active cell). This is the purpose of the cell selection function. The radio access information analysis function essentially generates appropriate control information to ensure that the mobile station is logged onto a suitable cell, belonging to a suitable network/network operator, where the user has access to the services he wants. The control information is forwarded to lower level functionality in the mobile station.

5.1.3 Cell selection in idle mode

This function is performed in idle mode only. It controls the tracking of the active cell by the mobile station. Based on the selection of network operator made by the *Radio access information and analysis* function and based on the radio channel measurements of the pilot channels and broadcast control channels of the available cells, the mobile station selects a cell to camp on (the active cell). The mobile station will scan and decode the appropriate logical channels at this cell, and also access the network (whenever appropriate) via this cell.

It may be necessary to select a new active cell, e.g. if the mobile station moves, or if the radio channel performance degrades below an acceptable threshold. Therefore, the mobile station may require knowledge of broadcast channels of surrounding cells, at least such knowledge may simplify the scanning process.

Acquisition and selection of surrounding cells involves scanning and decoding pilot channels and relevant control channels of neighbouring cells within the same network as the currently serving cell.

5.1.4 Cell selection in dedicated mode

When a mobile terminal is engaged in a circuit-switched connection, it is in *dedicated mode*. When a mobile terminal is in dedicated mode, it may additionally be engaged in a packet data transaction.

The dedicated mode cell selection function enables the mobile terminal to select the preferred cell to which a circuit-switched connection may be accessed or handed over. The cell is selected from a candidate list which the network sends to the mobile terminal. The function involves the measurement and evaluation of signal quality from neighbouring cells, as well as the detection and avoidance of congestion within candidate cells to which access or handover may be requested.

5.1.5 Cell selection in packet data transfer mode

When a mobile terminal is engaged in a packet data transaction but not engaged in a circuit-switched connection, it is in *packet data transfer mode*.

The packet data transfer mode cell selection function enables the mobile terminal to select the best cell to use in establishing a communication path with the UMTS network. This involves the measurement and evaluation of signal quality from neighbouring cells, as well as the detection and avoidance of congestion within candidate cells on which the mobile terminal may register.

5.2 Functions related to location management and MS tracking

Location management or *MS tracking* is a grouping of features/functions necessary to enable the network to locate a mobile terminal in order to establish a connection to it.

Terminal location registration is a feature by which a mobile terminal will notify a network of its existence and of its location within the network. It is normally used when a terminal first appears in a network domain or when no previous location details are known (e.g. after terminal or network failure).

Terminal location updating is a feature by which the location information of the terminal within the network is continuously updated when required.

Paging area is a geographical area within which a single paging procedure is performed (e.g. in parallel over all cells covering the area). It is used for the final locating of the mobile.

A *location area* is a geographical area or a part of a network that is used for the initial locating of the mobile. A location area may consist of one or more paging areas.
Terminal paging or simply *paging* is a feature by which the mobile terminal is finally located to a suitable radio cell for the establishment of a network initiated (mobile terminated) signalling connection to the terminal.

5.2.1 Location registration initiation

By assessing the results of *radio access information monitoring and analysis*, this function will initiate the location registration procedure towards the network.

5.2.2 Location area update initiation

By assessing the results of *radio access information monitoring and analysis*, this function will initiate the location area update procedure towards the network.

5.2.3 Paging area update initiation

By assessing the results of *radio access information monitoring and analysis*, this function will initiate the paging area update procedure towards the network.

Note: The location and the paging area update functions normally recide in the MS. It is for further study whether both functions are required. They may be regarded as a single function in the MS.

5.2.4 Location registration control

This function controls the location registration procedure. It interacts as required with *location data management* and *authentication control* functions.

5.2.5 Location data management

This function is responsible for the management of location area related data in the network. This includes updating of old and new data storage entities as well as initiating the erasure of data from storage entities that are no longer needed.

5.2.6 Paging data management

This function is responsible for the management of paging area related data in the network. This includes updating of old and new data storage entities as well as initiating the erasure of data from storage entities that are no longer needed.

5.2.7 Location area update control

This function controls the location area update procedure. It interacts as required with *location data management* and *authentication control* functions.

5.2.8 Paging area update control

This function controls the paging area update procedure. It interacts as required with *paging data management* and *authentication control* functions.

Note: The location and the paging area update control functions normally recide in the network. It is for further study whether both functions are required. They may be regarded as a single function in the network.

5.2.9 Detach initiation

This function will inform the network that the terminal will be temporarily not reachable (e.g. at switch off).

5.2.10 Attach initiation

This function will inform the network that the terminal is reachable again (after being detached).

5.2.11 Detach control

This function controls the detach and attach procedures. It interacts as required with relevant service and mobility control functions.

5.2.12 Paging initiation

This function will identify the currently registered location area of the MS and initiate the paging procedure in that area.

5.2.13 Paging decision and control

This function will identify the paging area of the mobile terminal and its status (e.g. busy, idle, registered active). Paging of the mobile terminal may or may not be performed depending on the mobile terminal status (e.g., if the mobile is already active in a call, paging may not be needed) or other factors decided by the network operator of the serving system where the mobile is located (e.g., network management conditions such as no available channels, emergency conditions). It should be noted that the paging resources are controlled by the serving system network operator and internetworking issues should be considered. Paging decision and control will also process the paging response from the mobile terminal (containing radio system access information, e.g. cell identity/address) and provide routing information based on this response. Routing information, without radio system access information and without performing paging, may be provided by the serving system network operator in order to progress the call.

5.2.14 Paging execution

This function will execute the terminal paging within its area of responsibility (e.g. group of cells), based on information received from the paging decision and control function. The execution may involve repetitions of the paging.

5.2.15 Paging response detection and handling

When the mobile terminal responds to the paging, this function will detect the response and will pre-process it before it is sent to the paging decision and control function (e.g. mapping a cell identity onto a routing address).

5.3 Functions related to mobile call handling

5.3.1 Provision of terminal capability information

This function will provide the necessary information (terminal capabilities) required by the network to identify what are the functions and the features supported by this terminal.

5.3.2 Service feature analysis

This function will check whether the requested service is compatible with the current subscription. It may also include compatibility checking of the requested service against the capabilities of the terminal.

5.3.3 Request routing information

For mobile terminated calls, this function will request the routing information handling function for relevant routing information.

5.3.4 Routing information handling

For mobile terminated calls, this function will provide the network with relevant routing information for the call to be established.

Note 1: The *routing information handling* function could also be considered to be part of the *location data management* function.

Note 2: The routing information may point to a final routing address or to an entity which will provide further routing information. In the latter case, this entity may trigger paging decision and control.

5.4 Functions related to authentication

5.4.1 Authentication data management

This function controls and manages the authentication parameters required in the network.

5.4.2 Authentication control

Based on parameters received from the authentication data management function, this function will initiate and control the authentication procedure and process the results.

5.5 Functions related to radio channel ciphering

5.5.1 Ciphering key management

This function will provide the necessary information (keys or other parameters to calculate the keys) required for the radio channel ciphering and deciphering. Due to the fact that an operator may not wish to disclose the security algorithms used to other operators, the ciphering key management should be regarded as a centralised function. The ciphering key management is closely related to the authentication mechanisms.

5.5.2 Radio channel ciphering

This function is a pure computation function whereby the radio transmitted data can be protected against a non-authorised third-party. Ciphering may be based on the usage of a session-dependent key, derived through signalling and/or session dependent information.

5.5.3 Radio channel deciphering

This function is a pure computation function which is used to restore the original information from the ciphered information. The deciphering function is the complement function of the ciphering function, based on the same ciphering key.

5.6 Functions related to handover

5.6.1 Radio channel quality estimation

This function performs measurements on radio channels (current and surrounding cells) and translates these measurements into radio channel quality estimates. Measurements may include :

a) received signal strengths (current and surrounding cells),

b) estimated bit error ratios,

c) estimation of propagation environments (e.g. high-speed, low-speed, satellite, etc.),

d) transmission range (e.g. through timing information),

e) Doppler shift,

f) synchronisation status.

In order for these measurements and the subsequent analysis to be meaningful, some association between the measurements and the channels to which they relate should be made in the analysis. Such association may include the use of identifiers for the network, the base station, the cell (base station sector) and/or the radio channel.

5.6.2 Handover decision (quality of service assessment)

This function consists of gathering estimates of the quality of the radio channels (including estimates from surrounding cells) from the measuring entities and to assess the overall quality of service of the call. The overall quality of service is compared with requested limits and with estimates from surrounding cells. Depending on the outcome of this comparison, the *macro-diversity control function* or the *handover execution function* may be activated.

5.6.3 Macro-diversity control

Upon request of the *quality of service assessment function*, this function controls the duplication/ replication of information streams to receive/ transmit the same information through multiple physical channels (possibly in different cells) from/ towards a single mobile terminal.
This function also controls the combining of information streams generated by a single source (diversity link), but conveyed via several parallel physical channels (diversity sub-links). Macro diversity control should interact with channel coding control in order to reduce the bit error ratio when combining the different information streams. This function controls macro-diversity execution which is located at the two endpoints of the connection element on which macro-diversity is applied (diversity link), that is at the access point and also at the mobile termination .
In some cases, depending on physical network configuration, there may be several entities which combine the different information streams, e.g. one entity combines information streams on radio signal basis, another combines information streams on wireline signal basis.

5.6.4 Handover execution

This function is in control of the actual handing over of the communication path. It comprises two sub-processes: *handover resource reservation* and *handover path switching*. The *handover resource reservation* process will reserve and activate the new radio and wireline resources that are required for the handover. When the new resources are successfully reserved and activated, the *handover path switching* process will perform the final switching from the old to the new resources, including any intermediate path combination required, e.g. handover branch addition and handover branch deletion in the soft handover case.

5.6.5 Handover completion

This function will free up any resources that are no longer needed. A re-routing of the call may also be triggered in order to optimise the new connection.

5.7 Functions related to radio resource management and control

Radio resource management is concerned with the allocation and maintenance of radio communication resources. UMTS radio resources must be shared between circuit mode (voice and data) services and other modes of service (e.g. packet data transfer mode and connectionless services).

5.7.1 Radio bearer connection set-up and release (Radio Bearer Control)

This function is responsible for the control of connection element set-up and release in the radio access sub network. The purpose of this function is

a) to participate in the processing of the end-to-end connection set-up and release,

b) and to manage and maintain the element of the end-to-end connection, which is located in the radio access sub network.

In the former case, this function will be activated by request from other functional entities at call set-up/release. In the latter case, i.e. when the end-to-end connection has already been established, this function may also be invoked to cater for in-call service modification or at handover execution. This function interacts with the *allocation and deallocation of physical channels* function.

5.7.2 Reservation and release of physical (radio) channels (Higher Layer Control translation for Bearers (HLC_B))

This function consists of translating the connection element set-up or release requests into physical radio channel requests, reserving or releasing the corresponding physical radio channels and acknowledging this reservation/ release to the requesting entity.
This function may also perform physical channel reservation and release in the case of a handover. Moreover, the amount of radio resource required may change during a call, due to service requests from the user or macro-diversity requests. Therefore, this function must also be capable of dynamically assigning physical channels during a call.

5.7.3 Allocation and deallocation of physical (radio) channels

This function is responsible, once physical radio channels have been reserved, for actual physical radio channel usage, allocating or deallocating the corresponding physical radio channels for data transfer. Acknowledging this allocation/ deallocation to the requesting entity is for further study.

Note: This function may or may not be identical to the function *reservation and release of physical (radio) channels*. The distinction between the two functions is required e.g. to take into account sharing a physical radio channel by multiple users in a packet data transfer mode.

5.7.4 Packet data transfer over radio function

This function provides packet data transfer capability across the UMTS radio interface. This function includes procedures which:

a) provide packet access control over radio channels,

b) provide packet multiplexing over common physical radio channels,

c) provide packet discrimination within the mobile terminal,

d) provide error detection and correction,

e) provide flow control procedures.

5.7.5 RF power control

In order to minimise the level of interference (and thereby maximise the re-use of radio spectrum), it is important that the radio transmission power is not higher than what is required for the requested service quality. Based on assessments of radio channel quality, this function controls the level of the transmitted power from the mobile station as well as the base station.

5.7.6 RF power setting

This function adjusts the output power of a radio transmitter according to control information from the *RF power control function*. The function forms an inherent part of any power control scheme, whether closed or open loop.

5.7.7 Signalling compression function

The signalling compression function will optimise use of radio path capacity by transmitting as little of the signalling as possible while at the same time preserving the information contained within it.

5.7.8 Source data compression

The source data compression function will optimise use of radio path capacity by applying data compression to the source data while at the same time preserving the digital information contained within it.

5.7.9 Source dependent coding

This function processes the signal delivered by a digitised source in order to transmit it efficiently over the radio interface. This includes removing or reducing the redundancy of the source to achieve better spectrum efficiency as well as adapting the signal to a particular transmission environment (e.g. pre-emphasis filtering).
The source coding function may also output associated control information, e.g. activity detection information (e.g. VAD and associated comfort noise generation information), information about the particular source coder used (e.g. full or half rate speech coder), etc.

5.7.10 Source dependent decoding

The source decoding function uses the received input data and the associated control information to restore the original source data. The source decoding function is the complement function to the source coding function.

5.7.11 Radio channel coding

This function introduces redundancy into the source data flow, increasing its rate by adding information calculated from the source data, in order to allow the detection or correction of signal errors introduced by the transmission medium. The channel coding algorithm(s) used and the amount of redundancy introduced may be different for the different types of logical channels and different types of data.

5.7.12 Radio channel decoding

This function tries to reconstruct the source information using the redundancy added by the channel coding function to detect or correct possible errors in the received data flow. The channel decoding function may also employ a priori error likelihood information generated by the demodulation function to increase the efficiency of the decoding operation. The channel decoding function is the complement function to the channel coding function.

5.7.13 Channel coding control

This function generates control information required by the channel coding/ decoding execution functions. This may include channel coding scheme, code rate, etc.

5.7.14 Initial (random) access initiation

Due to the multiple access nature of the radio interface (many mobile stations attempting to access common resources in an independent and random way), a specific initial access procedure may have to be used when the mobile station initiates the setting up of a connection. This function will start this procedure when required.

5.7.15 Initial (random) access detection and handling

This function will have the ability to detect an initial access attempt from a mobile station and will respond appropriately. The handling of the initial access may include procedures for a possible resolution of colliding attempts, etc. The successful result will be the request for allocation of appropriate resources for the requesting mobile station.

5.8 Functions related to charging

5.8.1 Charging information generation

At each relevant entity, this function will collect information relevant for charging at call set-up, during the call and at call release. The information is sent to the charging processing function.

5.8.2 Charging processing

This function will process the information received from the charging information retrieval function(s) and provide the billing and accounting functions with relevant parameters.

5.9 Functions related to multimedia service handling

Multimedia services combine two or more media into a single integrated service. A multimedia service may involve multiple parties, multiple connections, the addition/deletion of resources and users within a single communication session.
From the end user's point of view, a mobile multimedia telecommunication service is the combination of UMTS telecommunication capabilities required to support a particular multimedia application. From the UMTS provider's point of view, a mobile multimedia telecommunication service is a combination or set of combinations of two or more media components (e.g. audio, video, graphics, etc.), in such a way as to produce a new telecommunication service.

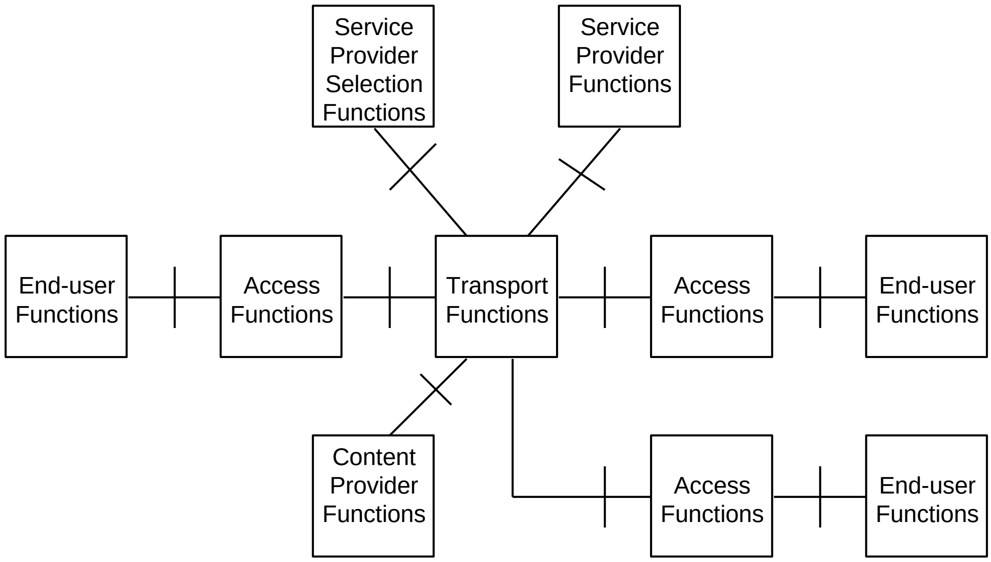

FIGURE 1

Reference model for multimedia services (from ITU-T Rec. I.375)

Mobile multimedia services handling may consist of three consecutive phases: session set-up, active session and session release. Connection establishment is independent of session establishment.

During session set-up there is for example, an exchange of information for application control between the originating user and the content provider via the service provider (e.g. to specify the wanted communication), an exchange of information for system control between the originating user and the service provider, an exchange of information for system access control, a negotiation of session characteristics (e.g. data stream termination) and, when an agreement is achieved, installation of the means required for end-to-end communication.

During the active phase, the actual end-to-end communication takes place. In this phase, it is possible to modify the session characteristics. For instance, negotiate the allocation of a new media or the de-allocation of existing media from the session, add one or more new users to the session, drop one or more users from the session. Also during the active phase, it is possible to modify the characteristics of one or more of the media in response to real time changes in transport availability. This may occur, for example, when there is a change in the capability of the available radio resources as the mobile termination moves in and out of the coverage of different cells.

When the communication is terminated, there is a need for e.g., an exchange of information between user(s), service provider and content provider to establish a state identified as idle by all participants. During the session release phase the resources allocated to the communication are freed.

5.10 Functions related to packet data routing and transfer

UMTS will support point-to-point services (e.g. connectionless and connection-oriented) and point-to-multipoint services (e.g. group call and multicast services).

A *route* is an ordered list of packet switching nodes used for the transfer of packet data messages within UMTS. Each route consists of the originating node, zero or more relay nodes and the destination node. *Routing* is the process of determining and using, in accordance with a set of rules, the route for transmission of a packet within UMTS.

5.10.1 Relay function

The relay function is the means by which a node forwards data received from one node to the next node in the route.

5.10.2 Routing function

The routing function determines the network node to which a packet should be forwarded and the underlying service(s) that must be used to reach that node, using the destination address of the packet. The routing function selects the transmission path for the "next hop" in the route.

5.10.3 Address translation and mapping function

Address translation is the conversion of one address to another address of a different type. Address translation may be used to convert an external network protocol address into an internal network address which can be used for routing packets within UMTS.
Address mapping is used to map a network address to another network address of the same type for the routing and relaying of packets within UMTS, for example to forward packets from one network node to another.

```
 [An alignement between the text in following subsections and the text in
previous subsections has to be performed for next version of 23.05. This
temporary inconsistency results from the inclusion in this version (v.0.8.0) of
previous subsections. In particular, some connections can be found between
following sections:
5.7.1 and 5.13+5.14
5.7.2+5.7.3 and 5.15 to 5.18]
```

[

5.11 Call Establishment

5.11.1 General description

This procedure allows a call to be established. It performs in particular local and end-to-end QoS negotiation, alerting, and triggers the set up of the deduced connections.

5.12 Call Release

5.12.1 General description

This procedure releases an active call and triggers a Connection Release procedure for all its related connections. For connection oriented calls, if the needed connection(s) cannot be established (or if they are lost and cannot be recovered) after a given period of time, then the "Call Release" procedure is launched.

5.13 Connection Establishment

5.13.1 General description

This procedure assigns one or more connection(s) to a given established call. It receives a list of parameters describing the desired characteristics of each connection, like time delay constraints, desired traffic rate and BER, ... Once a connection has been established, the Logical Channel establishment procedure may be triggered as many times as necessary for multiple channels connection. The connection level makes then an adaptation between generic parameters and parameters specific to the level under it, i.e. to the LC.

5.14 Connection Release

5.14.1 General description

This procedure releases an active connection from a call and triggers a LC Release procedure to all its related LCs.

5.15 Logical Channel Establishment

5.15.1 General description

This procedure assigns one or more logical channel(s) to a given established connection. This procedure is called once at the connection establishment and each time the connection characteristics are modified. The Physical Channel Establishment procedure is triggered for the deduced physical channel(s).

5.16 Logical Channel Release

5.16.1 General description

This procedure releases one or more logical channel(s) from a given established connection.

5.17 Physical Channel Establishment

5.17.1 General description

This procedure assigns one or more physical channel(s) (PC) to a given established logical channel utilising either circuit or packet data transfer mode.
In the case of a circuit PC setup, this procedure is called once for all the PC(s) of a given logical channel. This call takes place at the Logical Channel Establishment procedure. The PC(s) are then allocated to a particular logical channel during its whole life time.
In the case of a packet PC setup, this procedure provides the functionality to map multiple packet transfer connections on one physical (radio) channel. It is called each time there is traffic information to be transmitted over the radio interface and is followed by a PC(s) Release procedure when source stops its activity.

5.17.2 Impact on UMTS Network Parts

The Mobile Terminal should be able to reallocate PCs to the same logical channel to enable Packet Radio Access. This will be a low layer system, transparent for the logical channel level, that will release the radio resources while maintaining the logical channel each time there is no traffic information to be transmitted.

5.18 Physical Channel Release

5.18.1 General description

This procedure releases a physical channel from a given established logical channel.

6 Functional description of parts of UMTS

[Note: This section needs further elaboration concerning the realisation of the session concept. Furthermore, the influence of quality management for media components on the functional description of UMTS needs clarification. Whether the provision of asymmetric services (packet switched and circuit switched) and the distinction between connectionless and connection oriented services impacts the functional description is for further study.]

6.1 Overall network view

6.1.1 User plane

Comment [as1]: oral decision taken on 10/9/96, 14h: "User plane" provides from "Switching", "Transport plane" provides from "Transport" and "Control plane" provides from "intelligence"

The user plane is considered to comprise the highest layers of the OSI reference model. Thus, the realisation of the functions is dependent of the application to some extent.

Figure 4 presents the functional model of the user plane. The rectangle drawn with dashed line indicates the functions that are not needed in the case of speech transmission. The following functional entities are presented:

- **Party** function describing, for example, the application client in the MS and the remote server, or communicating parties.
- **Presentation** function modifies the presentation of the information. Examples of the Presentation function are speech transcoding and video coding methods such as MPEG and H.263.
- **Transport Control** function controls end-to-end data transfer either in circuit or in packet data transfer mode, e.g., by flow control and retransmissions (TCP, RTP etc.). This function may be located only in the end points of the connection or it can be present, e.g., in every router or switch associated with the connection. The latter case is relevant with transport protocols guaranteing reservation of resources for the connection.
- **Proxy Transport Control** function may be needed to adapt the end-to-end functionality of Transport Control to the special requirements set by the radio interface. It takes care of e.g. optimising the transfer mode over the radio. This function may also be located in the BSS [not defined].
- **Tunneling** function provides encapsulation and tunneling of signalling and end-to-end user data in the form of the network layer protocol supported by the URAN + MT. It hides the functionality of the application and transport protocol used from end to end between the remote server and the MS. The Tunneling function may also include some kind of gateway functions, such as message screening.
- **Network** functionality provides routing and addressing functions in the network. The corresponding protocols are, e.g., IP and CLNP.

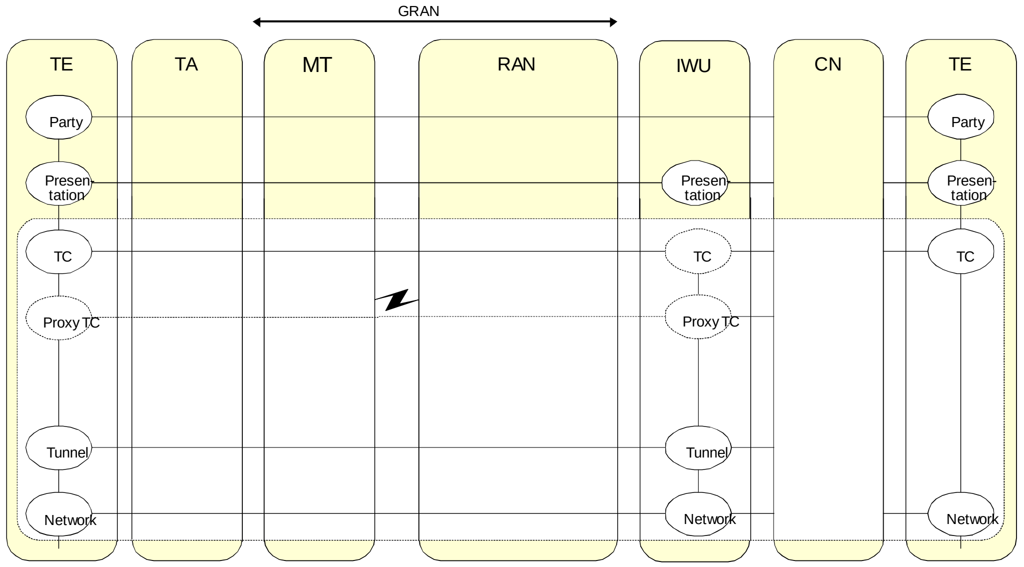

Figure 4: User Plane

6.1.2 Transport plane

The functional model of the transport plane is depicted in Figure 5. For examples of the functional entities, refer to Chapter 9. The following functional entities are presented:

- **Higher Level Transport functions** (HLT) include compression and encryption. The actual location of compression and encryption functions is FFS. If encryption is done in the URAN + MT, it should be specified how the URAN + MT makes use of the ciphering keys provided by the core network. In some cases, the core network does not even provide ciphering keys to the BSS (e.g. in the case of GPRS).
- **Logical Link Control** (LLC) includes, as the RLC function described below, packetising of the data into units of fixed or variable length. LLC function forms a logical link between the peer entities and performs ARQ on that link. It also adds some control information (such as some addressing information in the header of the packet) to be transmitted along with the actual data. The LLC function is performed on many different levels of the data transmission. For example, TP on one side and RLC on the other side contain the packetising function.

- **Soft Mode** includes transport plane functionality for macro diversity and soft handover. The functional relations of Soft Mode function is FFS.
  - **Multiplexing** (MPX) function maps its incoming data streams on a single output stream.
  - **Radio Link Control** (RLC) is basicly the same as LLC function described above. It is, however, more specific to the connection over which it is used. For example, RLC takes into account the high bit error rate of the radio path.
  - **Medium Access Control** (MAC) handles the allocation of transmission resources (e.g., allocates a time slot for a specific user for a specific time) to a certain logical channel. In particular it supports the packet data transfer mode via ***Reservation and release of physical (radio) channels*** (this function consists of translating the connection element set-up or release requests into physical radio channel requests, reserving or releasing the corresponding physical radio channels and acknowledging this reservation/release to the requesting entity. This function may also perform physical channel reservation and release in the case of a handover. Moreover, the amount of radio resource required may change during a call, due to service requests from the user or macro-diversity requests. Therefore, this function must also be capable of dynamically assigning physical channels during a call.) and ***Allocation and deallocation of physical (radio) channels*** (This function is responsible, once physical radio channels have been reserved, for actual physical radio channel usage, allocating or deallocating the corresponding physical radio channels for data transfer. Acknowledging this allocation/deallocation to the requesting entity is for further study.) Note: This function may or may not be identical to the function reservation and release of physical (radio) channels. The distinction between the two functions is required e.g. to take into account sharing a physical radio channel by multiple users in a packet data transfer mode.
  - **Fixed Network Physical Layer** (Phys) comprises the lowest part of the physical layer of a fixed physical interface.
  - **Physical Link Control** (PLC) manages the physical channels mapped on a fixed network physical layer.
  - **Channel Coding** (CHC) adds redundancy to the transferred data by inserting information calculated from the data. This way, the detection of the errors is enabled.
  - **Interleaving** (IL) spreads the bits of consecutive data frames over several frames transmitted over the radio interface.
  - **Multiple Access** (MA) function comprises the frame formatting for the radio interface (e.g., TDMA frame structure with its time slots).
  - **Ciphering** (Ciph) function performs the encryption of the data transmitted over the air interface. This function may be redundant if the encryption is provided by the CN.
  - **Sychronisation** (Sync) adds and processes information that enables synchronisation between the transmitter and the recipient.
  - **Modulation** (Mod) transforms a binary signal into an analogue one at a specific frequency and at a specific time. In the case the air interface contains a CDMA component, the Mod function also includes spreading functionality.

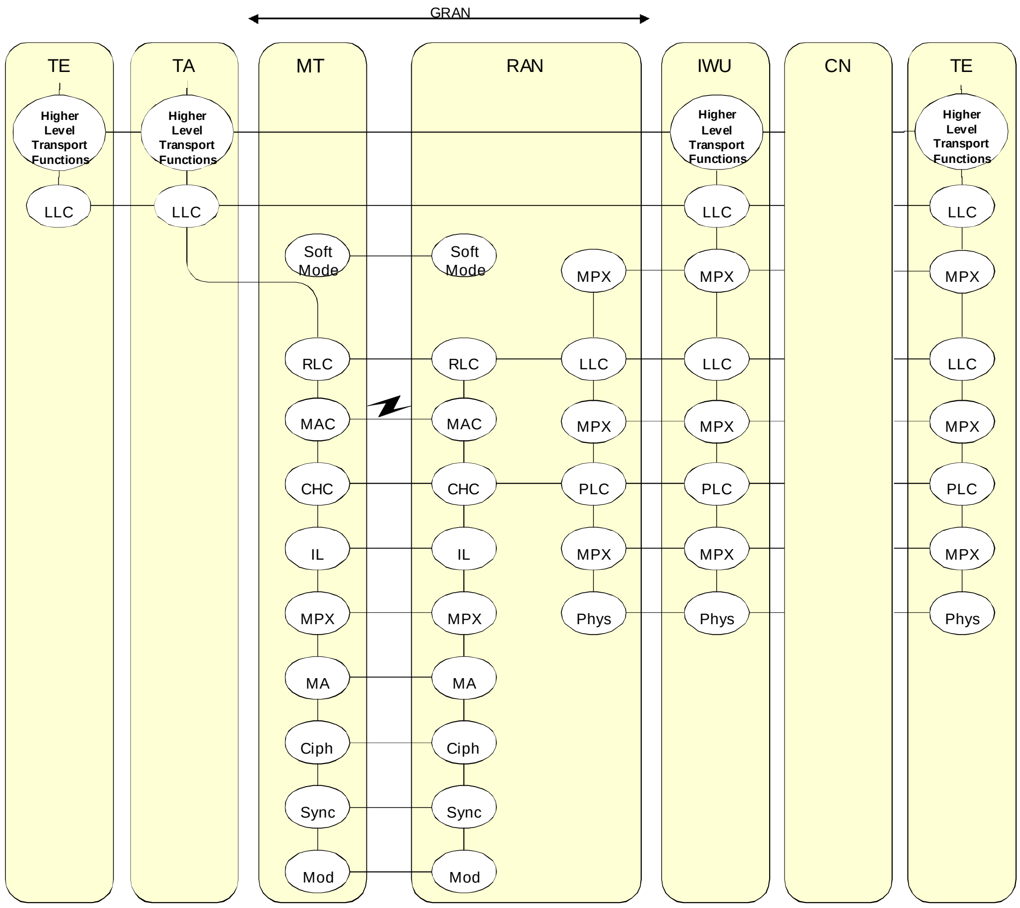

Figure 5: Transport plane

6.1.3 Control plane

The control plane comprises all the functional entities controlling and managing connections as well as handling mobility management, security management and call control. Figure 6 presents the different functional entities and their relations. The functions presented must, however, be further analysed and detailed. It must also be emphasised that in comparison with the circuit switched connection, the control functions of packet transmission may be found to perform quite different tasks when described in more detail.

The following functional entities are identified:

- **Higher Level Control functions CN** (HLC) comprise all higher level control functions located in the TE or TA and the core network respectively. These functions include, e.g., call control and authentication, registration and possible end-to-end encryption control. In the case of packet switched connection, TCP or RSVP may be in charge of call control. For certain handover cases (e.g. between RAN+IWU and between RANs+IWU connected to different Core Network switches), network control functions (HLC functions) may be needed to modify or streamline the path between the Core Network and the Access Network and within the Core Network.

- **Higher Layer Control translation for Bearers** (HLC_B) interprets and translates parameters related to bearers of the CN such as possible QoS or required delay or bitrate values into the form used by the URAN + MT. Hence, it performs mapping of the requirements of the CN to the capabilities provided by the URAN + MT. Additionally HLC_B contains URAN + MT specific control functionalities e.g. support of URAN + MT selection.

- **Bearer Control** (BC) handles set up, maintenance and release of fixed bearers over the URAN - core network interface. It is in charge of bearer negotiation and translation of bearer parameters (e.g. QoS) possibly indicated in the call control messages (included in HLC function above) to the form required by URAN + MT. The bearer control function also includes functionality for encryption and compression control.

- **Radio Bearer Control** (RBC) manages all bearers over the air interface on the URAN + MT as well as all bearers over URAN BSS internal fixed physical interfaces. In this context, the radio bearer control function is considered to include also functionality for paging control.
- **Radio Resource Control** (RRC) contains the functionality for handover control, power control, macro diversity control and measurements. Additionally, the **Packet Transfer over Radio function** resides in the RRC. This function provides packet data transfer capability across UMTS radio interface(s). This function includes control procedures which provide:

- medium access control over radio channels,
- packet multiplexing over common physical radio channels
- packet discrimination within the mobile terminal,
- error detection and correction,
- flow control procedures.

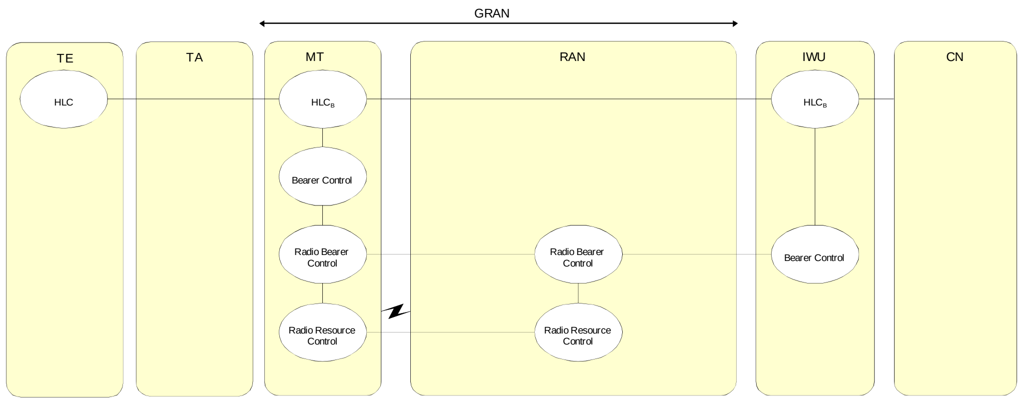

Figure 6: Control plane

6.2 Mobile Station (MS)

6.2.1 User plane in the MS

6.2.2 Transport plane in the MS

[
Independently of the control plane in the terminal, the same transport mechanisms (= lower layers) are to be used with the terminal. A clear interface between the transport and the control parts of the mobile terminal is essential to ensure that different kinds of control (e.g. GSM or ISDN protocol stacks) can be implemented in the terminal. Having the same transport mechanisms for all types of UMTS terminals will enable mass production of this part resulting in low cost terminals.
]

6.2.3 Control plane in the MS

A UMTS terminal should be flexible (supporting from one up to different Core Networks, e.g. GSM - UMTS or ISDN - UMTS). This means that different protocol stacks may be implemented in the mobile terminal.
The control plane in the MS shall comprise all the functional entities controlling and managing functions of the MS, for example idle mode functions. While network selection may be considered as a core network dependent function part of the MM, the UMTS radio access network shall provide appropriate information for network selection to be done by core network dependent functions.
Therefore, information shall be broadcast by the radio access network to provide at least the following information:

- **Information for CN dependent network selection.** In order to make it possible for an MS to select a suitable core network amongst possibly many candidates e.g. while roaming, the radio access network shall provide the following kind of information *related to each* of the connected core networks which are accessible via the radio access network:
    - Core network type information, for example identifiers for GSM, N-ISDN, B-ISDN, PDN etc.
    - Other relevant information for network selection, to be done in CN dependent part of the control plane in MS. This information would contain mobile country code and mobile network code of the connected core network in case of GSM type of core network.

6.3 Radio Access Network (RAN)

6.3.1 User plane in the RAN

6.3.2 Transport plane in the RAN

6.3.3 Control plane in the RAN

Within the RAN, control will be needed of the RAN resources to support handover. Handovers which impact the Core Network will require the control functionality within the RAN to interact with the functionality within the Core Network to support the handover, path re-routing, within the Core Network to be provided.

6.4 Interworking Unit (IWU)

6.4.1 User plane in the IWU

6.4.2 Transport plane in the IWU

6.4.3 Control plane in the IWU

6.5 Core Network (CN)

6.5.1 General Aspects

UMTS Core Networks comprise evolutionary core networks (GSM, N-ISDN, B-ISDN and Internet) the capabilities of which are enhanced in order to cater for UMTS.

A) Call Control aspects

The UMTS Call Control (UMTS CC) has to comply with the following principles [6],[7]:

1. The UMTS CC shall enable connections to be added or removed from a call (enabling parties and/or media components to be added or removed from a call).
2. The UMTS CC protocol should provide an efficient end-to-end user negotiation of services.

3. The dialogue between CC FE and the FEs it communicates with has to be uniform. It means that:
    - the procedures should be the same whatever the user is (a UMTS user or a fixed user), regardless of the lower layers used all along the connection path.
    - the dialogue between CC FE and BC FE has to be independent of the network resources the bearer relies on (wired or wireline support) and so of the radio access technique (CDMA, TDMA,...): this dialogue is made in term of bearer service characteristics, using either a value for each bearer parameter or an equivalent global name (e.g. high quality audio...). For each quantifiable parameter, a "desired" and a "minimum acceptable" values may be given. When the later is no more reached, the BC FE alert the CC FE for a call re-negotiation.
4. The UMTS CC shall be able to modify a call in progress (e.g. add or drop a media component or a party, modify QoS,...) after a BC FE notification, after a user action or after another network element notification (e.g. timer, intelligent peripherical...).
5. The UMTS CC shall enable inter-operability with other second and third generations call controls, e.g. FPLMTS, N/B-ISDN, PSPDN, PSTN, GSM...
6. The UMTS CC procedures shall incorporate the capability of compatibility checking (checking of the requested service against users subscription and/or terminal types) during call establishment.
7. The UMTS CC procedures shall be applicable to all different environments (e.g. domestic, public or business environment).

B) Handover support

The evolution of the identified networks (GSM, N-ISDN, B-ISDN and Internet) to provide the Core Network functionality will require enhancement to provide UMTS mobility management features and handover. While many handovers are provided within the UMTS RAN, the core network may support handover between RANs and subsequent handover streamlining between RANs.
In order to support handover between AN/CN connection points of different URAN instances, which are connected to the core network, the core network shall support signalling between the URANs (it must at least be able to transparently route signalling messages between the instances of the involved access strata).
If the terrestrial path is switched in the old URAN during handover execution the core network must support the establishment of a terrestrial path between the involved URAN's (Figure 7). This is the minimum requirement for any core network.

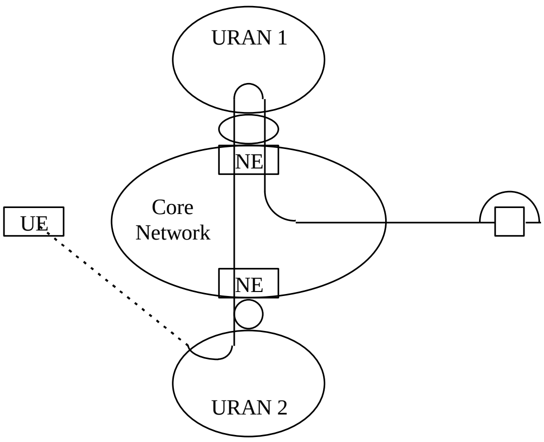

Figure 7: End configuration after "Inter-URAN" handover switched in old URAN

If the terrestrial path is switched in the core network during handover execution the core network shall support the necessary elements for a complete reconfiguration which comprises (Figure 8)

- Identification of a (handover) switch point in the core network
- Establishment of a new path between the new URAN and the switch point in the core network
- Switchover from the old to the new path.
- Release of the old path

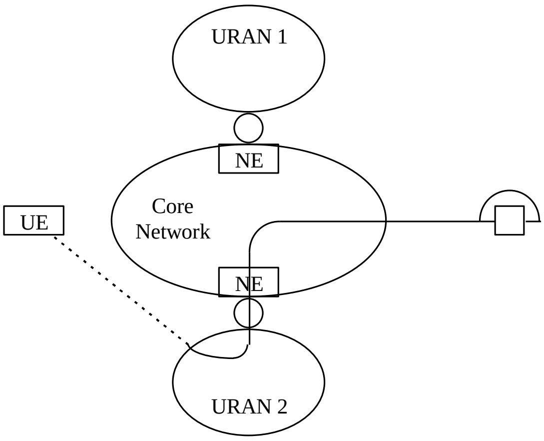

Figure 8: End configuration after "Inter-URAN" handover involving switching in the core network

[Remark: Additional core network requirements for handover may arise from the handover of multiple connections]

Comment [OB2]: Sequence

Comment [OB3]: Also the pictures?

6.5.1.1 Control plane

Comment [as4]: Corrected only on 4/10/96 after following meeting.

6.5.1.2 User plane

6.5.1.3 Transport plane

6.5.2 GSM - UMTS Core Network (GUCN)

In the GSM/UMTS system, the UMTS RAN is interconnected to the evolutionary GSM core network through evolutionary A, Gb or DSS.1+ interfaces, via the appropriate IWU. The terminal is either a multimode terminal (GSM, DCS1800, UMTS) or a single mode UMTS terminal.
While many handovers are provided within the UMTS RAN, the GSM core network will support handover between RANs and [may support] subsequent handover streamlining between RANs.

[THE SQUARE BRACKETS ENCLOSING THE WORDS "MAY SUPPORT" INDICATE THAT THIS POINT IS FFS (CONTRIBUTIONS ARE INVITED ON THIS SUBJECT).]

6.5.2.1 Control plane in the GUCN

6.5.2.2 User plane in the GUCN

6.5.2.3 Transport plane in the GUCN

6.5.3 ISDN - UMTS Core Network (IsUCN)

6.5.3.1 Control plane in the IsUCN

6.5.3.2 User plane in the IsUCN

6.5.3.3 Transport plane in the IsUCN

6.5.4 Internet - UMTS Core Network (ItUCN)

6.5.4.1 Control plane in the ItUCN

6.5.4.2 User plane in the ItUCN

6.5.4.3 Transport plane in the ItUCN

7 Network interworking aspects

[Note: This section needs further elaboration concerning the realisation of the session concept.]

7.1 Inter networking between UMTS networks

7.2 Interworking with other networks

8 Environments

8.1 Types of environments

The following types of environments can be distinguished:

Public domain

In the public domain, UMTS service is provided by Public Network Operators and/or Service Providers. In general, service is available to the general public based on subscription or some other form of payment (e.g. pre-paid cards). Further characterisation of the Public Domain can be made based on the type and amount of user traffic supported:

- urban environment
  This environment can be characterised by high volumes of traffic, with relatively low mobility. Micro-cell architectures are likely to be used.
- residential environment
  This environment can be characterised by moderate volumes of traffic and moderate mobility. A mix of macro and micro cells is likely to be used.
- rural environment
  This environment can be characterised by low volumes of traffic and moderate to high mobility. Macro cells are likely to be used.

- high-way environment
  This environment can be characterised by moderate to high traffic (e.g. traffic jams) and high mobility. Both in the cell architecture and the interconnection network advantage can be taken of the predictable direction in which users travel.

Private domain

In the private domain, UMTS services are implemented through private network equipment and/or base stations. In general, service is available to only a restricted group. However, provision of services to visitors of the private network is possible, subject to access rights. This provision of services may be done on a commercial basis (e.g. in hotels, shopping centres). Further characterisation of the Private Domain can be made based on environment:

- domestic environment
  In this environment, UMTS private base stations are used to provide indoor coverage in domestic housing. Simple cordless type base stations are used that should be very easy to install. Traffic volumes are generally low.
- business environment
  In this environment, UMTS private networks and base stations are used to provide wireless PBX services within offices, factories, or other business complexes. Traffic volumes can be very high, with low mobility. Pico cells are likely to be used.

8.2 Inter environment issues

The following inter domain issues are identified:

- inter environment roaming
  Subject to access rights, roaming between private and mobile domains is supported if issues with respect to charging and security are solved.
- access rights to private networks
  Access right will govern the possibility for users to roam into private domains. It is possible to grant access rights on a per case basis or on a long term or permanent basis. It is possible to block access to private networks when no access rights are granted.
- inter environment handovers
  Handovers between different environments are a desired feature in many cases but do not always need to be supported.
- interconnection and interworking
  Private networks are connected to the public network to provide connectivity to users outside the private network. Interworking may be provided between protocols in the private network and the public network when these are different.

8.3 Impact of environments on network design

The main impact of environments on the network design is that the network architecture should be sufficiently flexible to cover the various environments in an efficient way. Different environments may see different cell architectures, interconnection topologies, network architectures, and functional allocations. Still a high reuse of the same or similar type network entities in various environments is desired. Specific network design for each of the environments should be avoided.

The network design should support interfaces between private and public domain. Inter environment issues need to be catered for in control procedures over this interface.

9 UMTS Network architecture(s)

[Note: This section needs further elaboration concerning the realisation of the session concept. Furthermore, the influence of quality management for media components on the UMTS network architectures needs clarification. Whether the provision of asymmetric services (packet switched and circuit switched) and the distinction between connectionless and connection oriented services impacts the network architecture(s) is for further study.]

9.1 Overall network architecture

The intent of this section is to give an overall view of the functional architecture. For this it is proposed to describe on the same picture the different broad functional elements that have been identified in the preceding sections. Such an architecture does not preclude that functional elements identified here cannot be split, but it is intended to give the general idea behind all the detailed functional entity.

9.1.1 Functional elements of the transport plane

For the lower layer transport aspects, the definition of functional elements depends greatly on the modularity to be found in the access network. A simplified model could be to identify two transport elements, one which models a cross connect ($IWU_{transport}$) and another one to terminate the transport network in the base station and to deal with the radio transport functions ($RAN_{transport}$). This last function could further be divided into different function elements (IU and BTSphy see section 0).

$RAN_{transport}$: transport part of the RAN, terminating fixed transport functions and radio link transport functions.

$IWU_{transport}$: transport part of the IWU, it may include simple relay function or higher layer functions.

For a complex transport access network, it may be necessary to identify additional relay functional elements such as the one described here ($IWU_{transport}$).

9.1.2 Functional elements of the user plane

For the user plane part it is possible to identify one single functional element, the Interworking Function Element (IWU_{user}). This IWU_{user} would contain all the present functions in the RAN+IWU described for the user plane.

IWU_{user}: end to end transport control and possibly adaptation of this transport control to the radio conditions.

9.1.3 Functional elements of the control plane

Two main functional elements are defined in the control plane called $RAN_{control}$ in charge of RBC and RRC functions and an other one called $IWU_{control}$ in charge of HLC_B and BC.

Considering BC functions it is clear that in the case of a complex RAN+IWU, in terms of physical equipment, additional BC functional *elements* may be needed. Such a functional element is called BCE (bearer control functional element).

The $IWU_{control}$ is in charge of the fixed connections, that is controlling the transport elements of the access network to establish the connections as requested by the service. The BCE controls the fixed connections and the $RAN_{control}$ the radio ones.

It has to be noted that interactions will exist between functional elements defined for the transport plane and the ones defined for the control plane. For example, the $IWU_{control}$ will interact with the $IWU_{transport}$ and the $RAN_{transport}$ to establish the right connections through the access network. In the same way, the $RAN_{control}$ will interact with the radio part of the $RAN_{transport}$ to allocate radio resources to a communication.

9.1.4 Functional Architecture

The Figure 9 shows an overall picture of UMTS functional architecture for the RAN+IWU part. It contains the functional elements of the 3 planes defined above. For sake of simplicity BTSphy functional element is not shown (see section 0). Similarly only the main functions for each functional entity are shown (for detail see Figure 4, Figure 5 and Figure 6).

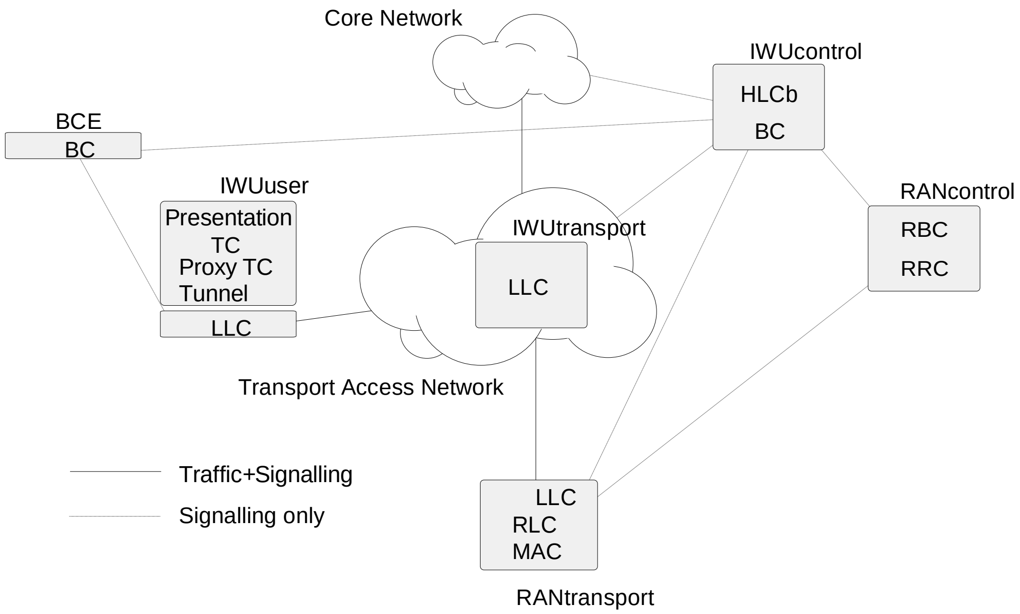

Figure 9: Overall picture of UMTS functional architecture for the RAN + IWU part

On Figure 9, only one BCE is shown but it is clear that a number of BCE can be included, for example in the Transport Access Network. It has to be noted that the interface between BCs is not the same than the one between a BC and an LLC, though it conveys roughly the same information.

9.2 Functional elements of the transport plane

Following the methodology presented in DTR/SMG-050105 [8], the functional entities identified of the transport plane are grouped into sets of functions that are called functional elements. Each functional element is considered to be mapped into a single piece of equipment in all anticipated system implementations, i.e. network architectures.
Figure 10 presents an example of the allocation of functional entities of the transport plane into functional elements. In addition, Table 1 gives a short description of the functional elements. The functional elements take care of both user data and signalling transport.

Functional Element	**Description**	**Functional Entities**
TE/TA	Comprises functionality that may be located in the terminal equipment or the terminal adapter in addition to the MT.	Higher Level Transport functions, Logical Link Control
MT	Comprises all the transport functions of MT. Thus, the functions of the terminal equipment or terminal adapter are excluded.	Higher Level Transport Functions, Radio Link Control, Logical Link Control, Channel Coding, Interleaving, Multiplexing, Multiple Access, Synchronisation, Modulation, Physical Link Control, Phys
BTSPhys(ical)	Comprises the physical layer (according to the OSI model) of the air interface.	Channel Coding, Interleaving, Multiplexing, Multiple Access, Synchronisation, Modulation, Physical Link Control, Phys
Intermediate Unit (IU)	Comprises more complicated functions of the air interface, being thus in charge of “the intelligence” of URAN BSS transport plane.	Higher Level Transport Functions, Radio Link Control, Logical Link Control, Medium Access Control, Physical Link Control, Multiplexing, Phys

Transport Relay (Relay)	Comprises simple relay functionality.	Logical Link Control , Physical Link Control, Multiplexing, Phys
Higher Level Termination (Termination)	Higher Level Termination is a termination point of or the transport plane in URAN (IWU) or core network (either user data or signalling.).	Higher Level Transport Functions, Logical Link Control, Multiplexing, Physical Link Control, Phys

Table 1: Description of the functional elements of the transport plane

In the following, some examples are given in order to further clarify the functions.

- **BTSPhys** contains the basic functionality to enable a base station to act as a simple physical layer relay. In a case of a PCM transmission from the BTS, the PLC function contains the management of the 16 bit/sec PCM subchannel (and implicitly the "multiplexing" into higher bitrates). Then, the MPX function corresponds to the mapping of timeslots to PCM frame, and the Phys to the actual definition of the physical cable (G.703).
  - **Intermediate Unit** contains the intelligence of the URAN BSS transport plane. On one side, it contains the peer entities of the functions described above plus MAC function managing the allocation of transmission resources (e.g., time slots) and RLC function managing the reliable transmission over the radio interface and. On the other side, the highest MPX function can be, for example, ATM FUNI (Frame based User Network Interface) protocol or mapping of AAL-CU microcells into ATM cells. Then, the LLC function corresponds to the ATM Virtual Circuit (VC), and the MPX below the multiplexing of the VCs to the Virtual Path. The PLC function can be, e.g., the path concept of the SDH (in which a part of the STM-1 container is reserved for a certain path). In this scenario, the lowest MPX function equals to the SDH multiplexing, and the Phys to the definition of the actual optical fiber.
  - **Transport Relay** contains the functions needed for a simple transport relay. The functions of the Transport Relay are the peer entities of the functions located in the IU.

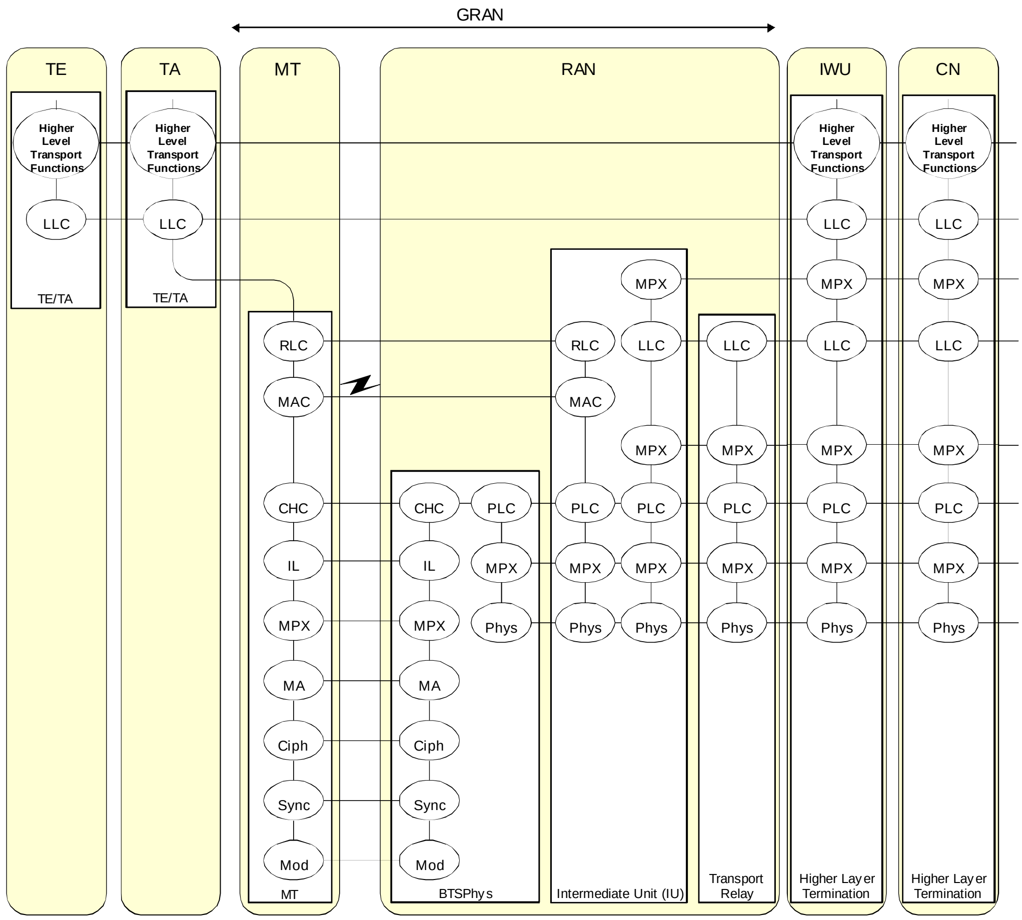

Figure 10: An example of the allocation of the functional entities of the transport plane into functional elements.

9.3 Allocation of functional elements to URAN physical network elements

Figure 11 presents the allocation of the functional elements to a URAN network architecture. The connections between the functions of the control plane are not depicted for clarity. Also, the physical network architecture of the CN is not depicted in detail as it is not in the scope of this chapter. Note that all the functions of the IWU are not contained by a stand-alone network element, but they are considered to be embedded in one or several network elements.
In the scenario, the Base Stations (BS) are simple physical relays as far as transport plane is concerned. Thus, they are cheap to implement as most of the intelligence of the transport functions is located in the network element called Intermediate Unit (IU) (see the description of the IU in the chapter 0). The user data is relayed from the BS to the IU. Alternatively, all the functions of the IU may be embedded in the BS. The IU is connected to the transport network relay, which transports the user data to the IWU and the control signalling to the RNC. The user plane related functions of the IWU (i.e. IWUuser including, e.g., transcoding) are located in a separate network element. In this element, the signalling is not processed by the user plane functions, but is passed through to the CN or to the URAN.
As for the control plane, the IU does not include any control functions. All the intelligence controlling the URAN is located in the Base Station (BS) and the Radio Network Controller (RNC). Thus, the RNC could be, for example, in charge

of switching the user data from ATM virtual circuit to another as the user moves around. The routing of signalling messages in the URAN can be performed by using fixed signalling links or specific routing methods (FFS).
For this scenario, URAN is dedicated to functions strictly related to radio access. Thus, it mainly includes functions for radio resource control (handover, paging) and bearer control (radio bearer control, bearer control). The complicity in the form of, e.g., registers, registration functions and mobility or location management is located in the core network. For example, all signalling due to location updates are considered to be relayed to the core network.

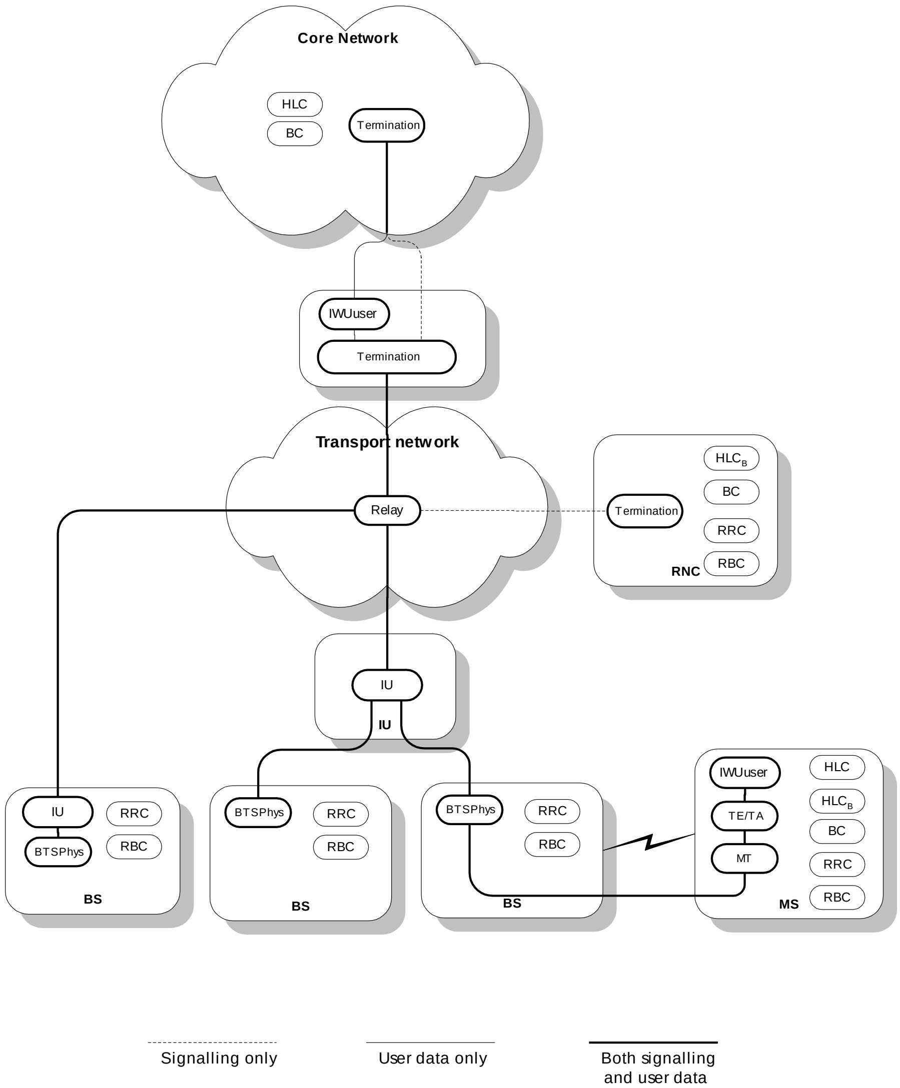

Figure 11: A scenario of allocation of functional elements to URAN physical network elements. Note that the user data is handled by the IWUuser function depicted on the top of the figure, but the signalling is bypassed in the corresponding network element.

10 UMTS Protocol architecture(s)

[Note: This section needs further elaboration concerning the realisation of the session concept. Furthermore, the influence of quality management for media components on the UMTS network architectures needs clarification. Whether the provision of asymmetric services (packet switched and circuit switched) and the distinction between connectionless and connection oriented services impacts the protocol architecture(s) is for further study.]

10.1 UMTS-BSS Protocol Architecture

10.2 GSM/UMTS CN Protocol Architecture

10.3 ISDN/UMTS CN Protocol Architecture

10.4 Other/UMTS CN Protocol Architecture

11 Structure of UMTS network ETS series

12 History

Document history		
<Version>	<Date>	<Milestone>
11 July 1996	Version 0.1.0	SMG 3 WPD #4 meeting output version (Stuttgart, 4-5/7/96).
16 September 1996	Version 0.2.0	SMG3 WPD #5 meeting output version (Den Haag, 10-12/9/96).
18 September 1996	Version 0.2.1	Revised V. 0.2.0
1 October 1996	Version 0.2.2	Clean version (no revision mark)
8 October 1996	Version 0.3.0	SMG3 WPD #6 meeting output version (Bern, 2-3/10/96).
22 November 1996	Version 0.4.0	SMG3 WPD / SMG3 SA 1st joint meeting output version (Ipswich, 18-20/11/96).
30 December 1996	Version 0.4.1	Addition of section 9.3.
24 January 1997	Version 0.5.0	SMG3 WPD / SMG3 SA 2nd joint meeting output version (Wootton Bassett, 8-10/1/97).
24 January 1997	Version 0.5.1	Clean version (no revision mark).
27 February 1997	Version 0.6.0	SMG3 SA/UMTS #1 meeting output version (Bois d'Arcy, 20-21/2/97)
23 April 1997	Version 0.7.0	SMG3 SA/UMTS #2 meeting output version (Sophia Antipolis, 2-4/4/97) Appendix and parts of section 4.1 transferred to new documents.
21 May 1997	Version 0.8.0	SMG3 SA/UMTS #3 meeting output version (Sophia Antipolis, 20-22/5/97)
21 May 1997	Version 0.8.1	Clean version
22 July 1997	Version 0.9.0	SMG3 SA/UMTS #4 meeting output version (Sophia Antipolis, 02-04/07/97)
20 September 1997	Version 0.10.0	SMG3 SA/UMTS #5 meeting output version (Vélizy, 26-28/09/97)