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Technical Report

Universal Mobile Telecommunications System; Requirements for the UMTS Terrestrial Radio Access system (UTRA) (UMTS 21.01 version 3.0.1)

UMTS

Universal Mobile
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Foreword

This ETSI Technical Report (TR) has been produced by ETSI Special Mobile Group (SMG).

This ETSI Technical Report (TR) identifies the general requirements of the radio interface of the Universal Mobile Telecommunications System (UMTS

Introduction

The Universal Mobile Telecommunications System (UMTS) is the third generation mobile telecommunications system which is scheduled to start service in Europe around the year 2000-2005, to provide a range of telecommunications services to mobile and stationary users in a variety of application areas and operating environments. The system will as far as possible extend the services of the fixed networks of the year 2000 to mobile users. UMTS-22.01[7] and 22.05 [8] describe services of UMTS., which must be supported by UTRA.

UMTS is expected to extend outside Europe to provide global roaming for UMTS users and provide roaming with other networks implementing the Recommendations for Future Public Land Mobile Telecommunications Systems (FPLMTS) being developed within International Telecommunication Union (ITU).

Guidelines for the technical evaluation of radio interface technologies aimed to meet the general requirements of this document are presented. in DTR/SMG-023003U [1]; these are based on ITU-R Recommendation M.1225 [9].

1 Scope

This ETSI Technical Report (TR) identifies the general requirements of the radio interface of the Universal Mobile Telecommunications System (UMTS). These requirements are derived from the UMTS services and facilities framework contained within UMTS 22.01 [7] and 22.05 [8], taking into consideration different operational environments, mobility requirements, cell architectures, etc.

2 References

References may be made to:

a) specific versions of publications (identified by date of publication, edition number, version number, etc.), in which case, subsequent revisions to the referenced document do not apply; or

b) all versions up to and including the identified version (identified by "up to and including" before the version identity); or

c) all versions subsequent to and including the identified version (identified by "onwards" following the version identity); or

d) publications without mention of a specific version, in which case the latest version applies.

A non-specific reference to an ETS shall also be taken to refer to later versions published as an EN with the same number.

[1] ETSI TR 101 112 (UMTS 30.03): "Universal Mobile Telecommunications System (UMTS); Selection procedures for the choice of physical radio access principles for the UMTS".

[2] Work item DTR/SMG 103320U (UMTS 33.20): "Special Mobile Group (SMG); Universal Mobile Telecommunications System (UMTS); Security principles for the UMTS".

[3] ITU Radio Regulations (Geneva 1994), ISBN 92-61-05171-5.

[4] CEC Directive 89/336/EEC.

[5] ITU-R Recommendation FPLMTS.RFRQ: “Spectrum considerations for implementation of FPLMTS in the bands 1 885 - 2 025 MHz and 2 110 - 2 200 MHz”.

[6] ETR 309 (UMTS 01.02): “Special Mobile Group (SMG); Vocabulary for the Universal Mobile Telecommunications System (UMTS)”.

[7] Work item DTS/SMG-0102201U (UMTS 22.01): “Universal Mobile Telecommunications System (UMTS); UMTS Service aspects; Service principles”

[8] Work item DTS/SMG-0102205U (UMTS 22.05): “Universal Mobile Telecommunications System (UMTS); UMTS Service aspects; UMTS Service capabilities related to service usage - including bearer capabilities, upper layer capabilities and call handling capabilities”

[9] ITU-R M.1225: Draft recommendations on Guidelines for evaluation of radio transmission technologies for IMT 2000/FPLMTS (“FPLMTS/REVAL”)

[10] ITU-R Circular Letter: “Request for submission of candidate radio transmission technologies for IMT 2000 radio interface”

3 Abbreviations and definitions

3.1 Abbreviations

For the purposes of this TR, the following abbreviations apply:

ARQ	Automatic Repeat request
B-ISDN	Broadband ISDN
BER	Bit Error Ratio
bhca	busy hour call attempts
BS	Base Station
CCIR	Comité Consultatif International des Radiocommunications
CDMA	Code Division Multiple Access
CRC	Cyclic redundancy check
DCA	Dynamic Channel Allocation
DLC	Data Link Control
DTX	Discontinuous Transmission
EMC	Electro-Magnetic Compatibility
ETE	Equivalent Telephony Erlang
ETR	ETSI Technical Report
FEC	Forward error correction
FDMA	Frequency Division Multiple Access
FPLMTS	Future Public Land Mobile Telecommunications Systems
GPRS	General packet radio service (of GSM)
IN	Intelligent Network
IMT 2000	International Mobile Telecommunications system for 2000
ISDN	Integrated Services Digital Network
ITU	International Telecommunication Union
LOS	Line-Of-Sight
MAC	Medium Access Control
MS	Mobile Station
PSTN	Public Switched Telephony Network
QoS	Quality of Service
RACE	Research and development in Advanced Communications technologies in Europe
RLP	Radio link protocolrms root mean square
SW	Software
TDMA	Time Division Multiple Access
UMTS	Universal Mobile Telecommunication System
URAN	UMTS Radio access network
UTRA	UMTS Terrestrial radio access

3.2 Definitions

For the purposes of this TR, the following definitions apply:

Radio interface: The set of radio physical parameters (radio frequency, channel spacing, modulation etc.) and protocols to form the communication link between a mobile equipment and a base station within the combinations of radio operating environment and service environment.

Operating mode: A set of radio interface parameters and protocols needed to support a given combination of service capabilities within the given combination of radio operating environment and service environment.

Definitions of other terms related to UMTS can be found in ETR 309 [6].

4 Bearer capabilities

4.1 Maximum user bit rate

The UTRA should support a range of maximum user bit rates that depend upon a users current environment as follows:

Rural Outdoor: at least 144 kbit/s (goal to achieve 384 kbit/s), maximum speed: 500 km/h

Suburban Outdoor: at least 384 kbps (goal to achieve 512 kbit/s), maximum speed: 120 km/h

Indoor/Low range outdoor: at least 2Mbps, maximum speed: 10 km/h

It is desirable that the definition of UTRA should allow evolution to higher bit rates.

The maximum bit rate requirements shall be met as follows:

Rural Outdoor: The specified bit rate will be available throughout the operator’s service area with the possibility of large cells.

Suburban Outdoor: The specified bit rate will be available with complete coverage of a suburban or urban area

Indoor/Low range outdoor: The specified bit rate will be available indoors and localised coverage outdoors

4.1.1 Bearer Service Attributes

A set of attributes and their possible values are used to describe a bearer capability. This set has been chosen so that a bearer capability can be entirely defined by giving a value to each attribute of the set. In particular, the set and the associated allowed values enable characterisation of future (not yet used or foreseen) transfer needs.

Giving one of the possible values to each attribute defines a possible bearer capability. However, not all combinations are meaningful or necessarily supported by the UMTS system.

UMTS 22.05 [8] defines the following attribute categories that are relevant for radio interface specification work :

Information transfer attributes, which characterise the network transfer capabilities required for transferring user information between two or more access points:

- connection mode attribute;
- symmetry attribute;
- communication configuration attribute;
- information transfer rate attributes (peak bit rate, mean bit rate, occupancy).

Quality of service attributes. The purpose of these parameters is to constrain random variables such as delay and errors distributions:

- delay variation tolerance;
- maximum transfer delay;
- maximum bit error rate;
- error characteristics (uniform/bursty).

4.2 Flexibility

Negotiation of bearer service attributes (bearer type, bit rate, delay, BER, up/down link symmetry, protection including none or unequal protection),
parallel bearer services (service mix), real-time / non-real-time communication modes, adaptation of bearer service bit rate
Circuit switched and packet oriented bearers
Supports scheduling (and pre-emption) of bearers (including control bearers) according to priority
Adaptivity of link to quality, traffic and network load, and radio conditions (in order to optimise the link in different environments).
Wide range of bit rates should be supported with sufficient granularity
Variable bit rate real time capabilities should be provided.
Bearer services appropriate for speech shall be provided.

Each bearer service will be mapped to one or more radio interface logical channels for the purposes of transmission over the UMTS radio interface:

- The UTRA should efficiently support variable data rate bearer services, with rate set at the request of the user, subject to operational constraints.

- The UTRA should efficiently support variable data rate bearer services with rate set at an appropriate rate by the network, subject to operational demands.- The design of UTRA should allow for several radio bearers to be used simultaneously with a single user equipment.

The UTRA will be designed in a flexible way to allow the bearer service attributes to be configured as required on initiation of a service, subject to technical constraints. This is necessary to allow the efficient support of the wide variety of UMTS services, including future services which have yet to be defined.

4.2.1 Minimum bearer capabilities

Giving one of the possible values to each attribute defines a possible bearer service. However, not all combinations are necessarily supported by the UMTS system. The following table shows potential combinations for the most important characterisation attributes, as defined in UMTS 22.05 [8]. Requirements are radio environment dependent.

Table 1: Minimum bearer capabilities for UMTS

	Real Time/Constant Delay		Non Real Time/Variable Delay	
Operating environment	**Peak Bit Rate**	**BER / Max Transfer Delay**	**Peak Bit Rate**	**BER / Max Transfer Delay**
Rural outdoor **(terminal speed up to 500 km/h) (notes 1, 5)**	at least 144 kbit/s (preferably 384 kbit/s) granularity 16 kbit/s or better (note 3)	delay 20 - 300 ms BER 10^{-3} - 10^{-7} (note 4)	at least 144 kbit/s (preferably 384 kbit/s)	BER = 10^{-5} to 10^{-8} Max Transfer Delay 150 ms or more (note 2)
Urban/ Suburban outdoor **(Terminal speed up to 120 km/h)**	at least 384 kbit/s (preferably 512 kbit/s) granularity 40 kbit/s or better (note 3)	delay 20 - 300 ms BER 10^{-3} - 10^{-7} (note 4)	at least 384 kbit/s (preferably 512 kbit/s)	BER = 10^{-5} to 10^{-8} Max Transfer Delay 150 ms or more (note 2)
Indoor/ Low range outdoor **(Terminal speed up to 10 km/h)**	2 Mbit/s granularity 200 kbit/s or better (note 3)	delay 20 - 300 ms BER 10^{-3} - 10^{-7} (note 4)	2 Mbit/s	BER = 10^{-5} to 10^{-8} Max Transfer Delay 150 ms or more (note 2)

Both Real-Time and Non-Real-Time cases may include packet or circuit type of connections.

Speech bearers shall be supported in all operating environments.

NOTE 1: The value of 500 km/h as the maximum speed to be supported by UTRA in the rural outdoor environment was selected in order to provide service on high speed vehicles (eg trains). This is not meant to be the typical value for this environment.

NOTE 2: The maximum transfer delay value should be regarded as the target value for 95% of the data.

NOTE 3: A first estimation of the expected granularity is proposed for each radio environment.

NOTE 4: There is likely to be a compromise between BER and delay.

NOTE 5: Evaluation of radio performance as specified in UMTS 30.03 [1] will focus on more typical speeds for the rural outdoor environment (including at 250 km/h).

4.2.2 Service traffic parameters

UMTS will be used in various environments where the traffic densities range from very low to very high . The traffic mix is also highly variable and will change as new services emerge and UMTS user base increases. It is required that UTRA should adapt flexibly into these changes and should have the capability to serve a variety of traffic densities (up to very high densities) and a variety of traffic mixes in an economical way.

4.2.3 Performance

Overall UMTS Quality of Service (QoS) is dealt within in UMTS 22.05 [8] and other future UMTS standards. Multiple access techniques may be compared on their inherent transmission delay and level of traffic blocking and on the variability of these quantities. Comparisons may also be made based on the variation of transmission quality with increasing traffic load and on the handover performance of the various techniques (e.g. impairments during a handover, possibility of incorrect or failed handover). Comparison may also be made on the transmission quality and the performance of handover in different radio propagation environments. The ability to vary quality of service dependant on network demand may be desirable.

Evaluation of radio interface technologies is described in UMTS 30.03 [1].

4.2.4 Configuration management

In order to meet the requirements for flexibility and dynamic re-configurability the following aspects shall be defined in UTRA:

- a minimum set of bearer capabilities, operating modes and features to ensure that inter-operability is always possible;
- specific control channels shall be defined which:

  a) support enquiries concerning terminal capabilities and the local radio environment;

  b) allow features to be controlled and parameters set.

  The potential size of the feature set should be unconstrained;
- continuity of operation during dynamic updating of terminal capabilities.

4.2.5 Evolution and modularity

The UTRA shall be designed such that it is service independent (except for any services defined in clause 10). This will allow easy implementation of new services.

The UTRA shall be defined so that UMTS can be implemented in phases with increasing functionality (for example making use of new technology), while allowing the maximum possible backwards compatibility.

The UTRA shall be defined in terms of an open modular architecture for mobile terminals, with a corresponding architectural approach for base stations. This shall be designed in such a way that it allows the implementation of software downloading of radio interface features.

4.3 Handover

Provide seamless (to user) handover between cells of one operator.

The UTRA should not prevent seamless HO between different operators or access networks.

Efficient handover between UMTS and 2nd generation systems, e.g. GSM, should be possible.

The UTRA should support user mobility within and between radio operating environments.

In support of terminal mobility, handover is necessary to prevent the call to a mobile terminal being released when crossing cell boundaries. In the most general sense, a handover is considered to be the changing of physical channels (potentially both radio and fixed network connections) involved in a call whilst maintaining the call. This definition includes both intra- (within a cell) and inter- (between cells) cell handovers.

4.3.1 Overall handover requirements

The overall requirements on UMTS handover are:

- from the users point of view, it is desirable for handover to be unnoticeable (seamless). However, the requirement for seamless handover is service dependent: for example, a speech call requires a quick handover and may be able to tolerate loss of information to a certain degree whereas a data service may allow a temporary break in the connection but not loss of information.;
- handover which is user discernible (non-seamless) should be provided where seamless handover is not feasible (for instance, it is possible that inter-operator handover cannot always be made seamless);
- handovers should not increase the load on the fixed network significantly;
- the level of security should not be affected by handovers.

At least at the early stage of the UMTS network installation a complete UMTS radio coverage might not be provided in the whole operation area. To support user mobility in the whole operation area, the UTRA should support efficient handover of a dual mode terminal between UMTS and a second generation system (which would provide a good radio coverage), for services which can be supported by both.

NOTE: The impact of this on the UTRA (if any) requires further study.

4.3.2 Handover requirements with respect to the radio operating environments

This subclause deals with handover between physical channels within different radio operating environments.

- handover between terrestrial environments should be seamless within the same network
- bearer services cannot be handed over between two environments if they are not supported in both. However, handover to an alternative bearer offering reduced capabilities should be possible where this is supported by the service in use.
- the radio interface should have the capability to provide for handover and roaming between networks run by different operators.

5 Operational requirements

5.1 Compatibility with services provided by present core networks

ATM bearer services
GSM services
IP (Internet Protocol) based services
ISDN services

5.2 Operating environments

The operational scenario for UMTS includes international operation across various UMTS radio operating environments, operation across multiple UMTS operators and multiple types of UMTS operators, operation over a terrestrial component and a satellite component, and across different regulatory regimes. Further, UMTS will support a range of different MS types and a variety of services with a range of bit rates. This subclause gives scenario requirements on the UMTS radio interface.

Fixed wireless access should also be considered in so far that this does not burden UTRA with unnecessary complexity or performance degradation.

5.2.1 Support of multiple radio operating environments

The UTRA should be capable of supporting the requirements of the radio operating environments.

5.2.2 Support of multiple equipment vendors

The UTRA specification should be sufficiently complete that all terminal equipment can operate with all infrastructure which can offer suitable bearer services..

The UTRA should be specified so that infrastructure equipment from different suppliers can be interconnected at all specified interfaces.

5.3 Radio Access network planning

If radio resource planning is required automatic planning shall be supported

UMTS spectrum management refers to the assignment of frequency blocks.

Spectrum management can be performed either during the initial commissioning of a radio system (usually manually) or during normal system operation (usually by the system itself). It is desirable for access techniques to facilitate both these processes. Spectrum management can occur within countries or regions or between countries or regions to facilitate international roaming.

The design of the UMTS radio interface should be such that a minimum of planning and co-ordination is required to perform spectrum management.

UMTS networks may need the ability to re-configure their use of assigned frequency blocks in response to changing traffic, service requirements or spectrum allocations. This ability will also be required in the office and residential environments. UMTS terminals may also include frequency agility capability to allow use over non-overlapping allocations across regions or countries. Access techniques may be compared on their ability to perform such reconfigurations easily.

5.4 Public, Private and residential operators

It shall be possible to guarantee pre-determined levels of quality-of-service to public UMTS network operators in the presence of other authorised UMTS users.

The radio access scheme should be suitable for low cost applications where range, mobility and user speed may be limited.

Multiple unsynchronised systems should be able to successfully coexist in the same environment.

It should be possible to install basestations without co-ordination.

Frequency planning should not be needed.

There are three distinct classes of UMTS operator (network operator and/or service provider):

- public UMTS operators;
- private UMTS operators;
- residential UMTS operators.

The purpose of defining distinct classes of UMTS operator is to identify scenarios which, from a radio perspective, may impose different requirements on the radio interface.

UTRA should support, in a mutually non-destructive way, multiple public and private networks.

5.4.1 Public UMTS operators

Uniquely defined public operators, with wide-area networks generally available to any roaming user. These operators would typically require a licence in accordance with the requirements of the country of operation, which may specify a frequency range of operation or other technical conditions. They would typically be limited in numbers, and may need some form of co-ordination.

5.4.2 Private UMTS operators

Defined private operators, with local area networks generally available only to closed user groups. These operators would typically be private companies offering services to their own employees. They could in principle be unlimited in numbers, and would typically be uncoordinated.

Private UMTS operators may operate clusters of base stations within a restrictive area. It is essential that clusters can be installed without any cell planning or co-ordination with other clusters, and it is desirable that this is not needed within a cluster.

5.4.3 Residential UMTS operators

These are residential users defined by a user identity rather than an operator identity, but may be regarded as residential UMTS operators. These operators would generally provide service only to one or a few residential users associated with a main residential user (the residential UMTS operator).

Residential UMTS operators will typically operate a single base station. It is essential that residential base stations can be installed without any cell planning or co-ordination. It is assumed that residential UMTS operators would not require any form of permit to install or operate a base station.

6 Efficient spectrum usage

6.1 Spectral Efficiency

High spectrum efficiency for typical mixtures of different bearer services.

Spectrum efficiency at least as good as GSM for low bit rate speech.

The radio interface should be designed to maximise spectral efficiency.

The third generation systems have spectrum efficiency as an important objective for capacity needs and also to lower the investment in spectrum resource.

Services provided by GSM (speech in particular) shall be supported in a spectrally efficient manner (at least as efficiently as in GSM) for the same quality of service.

6.2 Variable asymmetry of total band usage

Variable division of radio resource between uplink and down link resources from a common pool (NB: This division could be in either frequency, time, or code domains)

6.3 Spectrum utilisation

Allow multiple operators to use the band allocated to UMTS without co-ordination[1].

It should be possible to operate the UTRA in any suitable frequency band that becomes available such as first & second generation system's bands

It is unlikely that large contiguous bands will be available for UMTS use on a world-wide basis. Moreover, multi-operator considerations might favour splitting the UMTS spectrum into even narrower bands . This has the following implications on the radio interface:

- candidate radio interfaces should be compared on their ability to support the UMTS service capability requirements contained in UMTS 22.05 [8] in these relatively narrow spectrum bands;
- the radio interface should be sufficiently adaptable to deal with the differing regional spectrum availability, and market driven adjustments of the frequency allocations, for example refarming of first & second generation system's bands .

6.4 Coverage/capacity

The system should be flexible to support a variety of initial coverage/capacity configurations and facilitate coverage/capacity evolution

Flexible use of various cell types and relations between cells (e.g. indoor cells, hierarchical cells) within a geographical area without undue waste of radio resources.

Ability to support cost effective coverage in rural areas

[1] NOTE: The feasibility of spectrum sharing requires further study.

6.4.1 Development and implementation risk

The UMTS radio interface should be designed in such a way that the risk in development and implementation of the radio interface technology is kept at an acceptable level.

6.4.2 Flexibility of radio network design

The system should offer the capability for flexible, economic deployment to meet the varying and evolving needs.

6.4.2.1 Cell size flexibility

The UTRA should be sufficiently flexible to support a wide range of cell sizes. Cell types which should be supported include:

- picocells (mainly indoor cells with radii typically below 50 m);
- microcells (outdoor cells with radii of up to 1 km, typically with low elevation antennas e.g. in lamp posts);
- macrocells (outdoor cells with radii typically of up to a few tens of km, mounted for example on towers/building tops).

These cell types can be assigned to the radio operating environments shown in table 2.

Table 2: Cell types applicable to each environment

Radio operating environment	Cell type
business indoor	pico
neighbourhood indoor/outdoor	micro
home environment	micro or pico
urban vehicular outdoor	macro
urban pedestrian outdoor	macro or micro
rural outdoor	macro
fixed outdoor	macro
local high bit rate	pico or micro
vehicle with mobile base station	pico

The UTRA should be designed in such a way that several cell types can be used simultaneously in the same geographical area (e.g. as umbrella cells), with handover possible between layers. The UTRA should also support the use of several cells of the same type in the same geographical area (e.g. from different network operators).

6.4.2.2 Cell location flexibility

The UTRA should be flexible with respect to the exact location of cell sites, such that significant system or capacity impairments due to non-ideal site locations are not risked. Such flexibility is also desirable for operators who wish to migrate from second generation systems with minimum investment. However, this requirement should not unnecessarily overload the design of the radio interface in terms of cost and complexity.

6.4.4 Synchronisation

Time synchronisation between different UMTS networks should not be a mandatory requirement.

6.4.5 Repeaters and relays

The ability to exploit the use of repeaters and/or relays is desirable in order to achieve swift and economic deployment to provide coverage. One possible application is less favoured regions and developing countries.

6.4.5.1 Vehicle with mobile BS operating environment

The support of the Vehicle with mobile BS operating environment may require repeaters which are "intelligent", ie they are able to identify the cells which should be used for communication, and handover between them. This may require the BS in the vehicle to monitor a control channel from another (fixed) BS, and perhaps to perform frequency conversion between the other (fixed) cell and the coverage area within the vehicle.

6.4.6 Very large cell sizes

The ability to exploit techniques for providing very large cell sizes is desirable in order to economically provide the full UMTS capability for sparsely populated areas and developing areas, including developing countries. Very large cells may incorporate adaptive antennas, long radio range base stations, RF repeater stations or remote antennas (also called remote RF heads) associated into a single base station. However, the link between remote RF-head and BS is outside the scope of the UMTS radio interface.

The ability for a UMTS RF carrier to be frequency converted within a RF repeater is a desired feature.

6.4.7 Evolution requirements

6.4.7.1 Coverage evolution

The radio coverage for the UMTS may be:

- contiguous coverage;
- island coverage;
- spot coverage.

The UTRA should be sufficiently flexible to support a variety of initial coverage configurations and facilitate coverage evolution. The UTRA should therefore require a minimum of planning and operations in order to install new cells to extend system coverage. It is desirable to be able to deploy UMTS reusing cellsites from second generation systems in order to achieve fast roll-out.

6.4.7.2 Capacity evolution

The UTRA should require a minimum of planning and operations in order to install new cells to increase system capacity in areas where coverage is already provided.

The UTRA should facilitate the implementation and use of appropriate capacity improvement techniques, if applicable, in the various UMTS radio operating environments.

It is desirable that the appropriate capacity improvement techniques can be implemented in the initial radio interface or be easily added to existing UMTS radio interface (eg adaptive antennas).

It is desirable that the UTRA does not depend on the implementation of these techniques, but that they are capacity improvement options. It is desirable that they do not significantly add complexity or cost to the infrastructure or MSs.

7 Complexity / cost

7.1 Mobile Terminal viability

Handportable and PCMCIA card sized UMTS terminals should be viable in terms of size, weight, operating time, range, effective radiated power and cost.

Handportable UMTS terminals are expected to be widely used. The system should therefore economically support the extensive use of hand portable terminals. The viability of hand portable terminals can be determined by:

- size and weight;
- operating time;
- radio range;
- cost.

These factors are strongly related to the radiated RF power, signal processing for radio transmission and radio resource management functions which are required for establishing and maintaining a radio link between MS and BS, and should be considered in the selection and design of the radio interface. Additionally, the foreseeable implementations should be considered.

7.2 Network complexity and cost

The development and equipment cost should be kept at a reasonable level, taking into account the cost of cell sites, the associated network connections , signalling load and traffic overhead (e.g. due to handovers).

It is strongly desirable to have one radio interface (see subclause 3.2) which can be adapted to all operating environments.

It may prove necessary for UTRA to have more than one operating mode (see subclause 3.2) in order to meet the pre-defined radio operating environment and service environment needs. However, in this case:

- the number of operating modes should be minimised;
- if multiple operating modes are required the degree of commonality between them should be maximised.

One way to manage this effectively is to adopt the concept of a core interface with appropriate extensions for specific applications.

In order to maximise the commonality and allow flexibility it is anticipated that layered and building block approaches will be applied to the development of the radio interface. It is further anticipated that UMTS radio adaptation functionalities will be defined to allow and manage the provision of multiple services in a number of environments, possibly via more than one operating mode.

The overall cost of UMTS is influenced by the technology chosen and the desired quality and reliability. There are four main elements to the overall cost of the UMTS:

- development cost;
- equipment (hardware and software) cost;
- deployment cost;
- operational cost.

When considering the design of the radio interface of UMTS it is desirable to minimise the overall system cost.

Migration from second generation systems should be considered in development, equipment and deployment costs (although this should not constrain UMTS capabilities).

7.3 Mobile Station types

It should be possible to provide a variety of Mobile Station types of varying complexity, cost and capabilities in order to satisfy the needs of different types of users.

The UMTS radio interface should be capable of supporting a variety of UMTS MS types. These include UMTS MSs with different output power classes, MSs with different service access configurations or different access capabilities, and even mobile base stations.

8 Requirements from bodies outside SMG

8.1 Alignment with IMT 2000

UTRA shall meet at least the technical requirements for submission as a candidate technology for IMT 2000 (FPLMTS).

These are described in [10].

8.2 Minimum bandwidth allocation

It should be possible to deploy and operate a network in a limited bandwidth

It is unlikely that large contiguous bands will be available for UMTS use on a world-wide basis. Moreover, multi-operator considerations might favour splitting the UMTS spectrum into even narrower bands . This has the following implications on the radio interface:

- candidate radio interfaces should be evaluated on their ability to support the UMTS service capability requirements in UMTS 22.05 [8] in these relatively narrow spectrum bands;
- the radio interface should be sufficiently adaptable to deal with the differing regional spectrum availability, and market driven adjustments of the frequency allocations.

8.3 Electromagnetic compatibility

The peak and average power and envelope variations have to be such that the degree of interference caused to other equipment is not higher than in today's systems.

UMTS equipment should comply with CEC Directive 89/336/EEC [4] and other relevant international EMC requirements.

8.4 RF Radiation effects

UMTS shall be operative at RF emission power levels which are in line with the recommendations related to electromagnetic radiation.

UMTS equipment should meet the requirements of the relevant European and international safety requirements and legislation.

In particular, in determining the radio link budget for the UMTS handset, the maximum power into the antenna and the antenna gain should be such that the user of the apparatus is not subjected to any dangerously large field strengths. This is of particular importance for hand held portables where the antenna will be close to the head and eyes of the user. No common internationally agreed safety limits exist so far. The overall requirement for UMTS is to ensure that emerging safety limits will not be exceeded

8.5 Security

The UMTS radio interface should be able to accommodate at least the same level of protection as the GSM radio interface does.

Security encompasses the concepts of registration, authentication, privacy and fraud prevention. The UMTS radio interface should be designed such that the security requirements detailed for UMTS [2] can be supported in as efficient and effective a manner as possible.

8.6 Co-existence with other systems

The UMTS Terrestrial Radio Access should be capable to co-exist with other systems within the same or neighbouring band depending on systems and regulations

Interference immunity is an important consideration.

The types of interference immunity that should be considered when evaluating multiple access methods include the effect of external systems or sources in the same or adjacent bands on the UMTS and vice versa.

Spectrum sharing refers to the sharing of spectrum between the UMTS and other existing systems.

As the basic radio parameters of FPLMTS/UMTS are to be defined, the spectrum sharing studies are on very general level. The FPLMTS/UMTS bands are currently used by radio relay links (fixed service). First studies indicate that the unrestricted introduction of FPLMTS/UMTS using same frequencies as the fixed service and in areas close to the fixed service beam may cause unacceptable degradation of performance to the fixed service and vice versa.

The design of the UMTS radio interface should be such that coexistence with other systems (particularly first and second generation cellular systems) continuing to use the adjacent or same spectrum does not unduly affect the performance of either system.

9 Multimode terminal capability

It should be possible to implement dual mode UMTS/GSM terminals cost effectively.

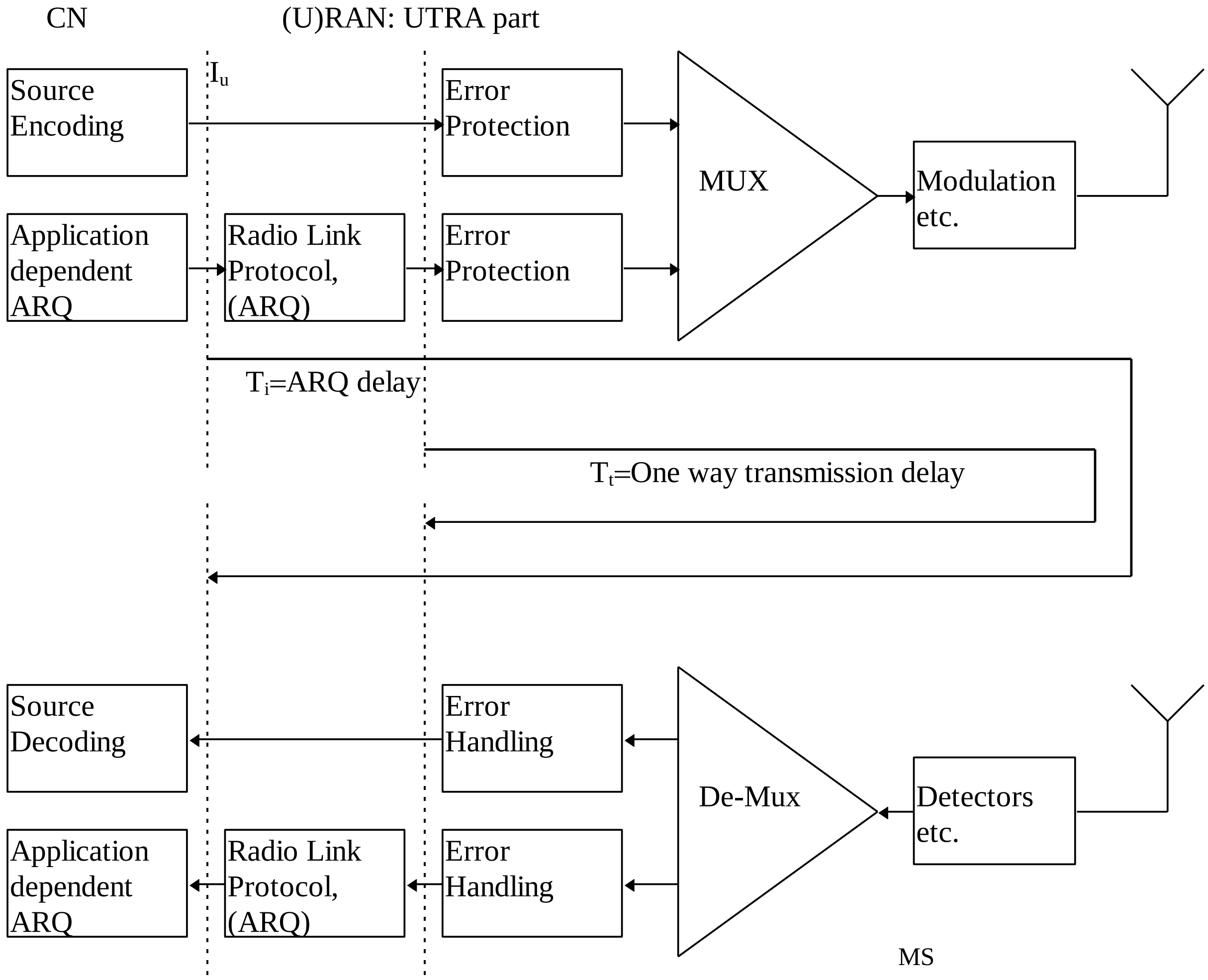
10 Services supported by the radio interface

10.1 Location service

The UTRA shall support the capability for user position location. It is desirable to be able to determine the location to within 50m.

Annex A: Reference Model for Transmission Delay

A simple model of the radio transmission and receiving chain is given here for use as reference model for delay calculation. Source encoding is only used as an example of the type of real-time service and is here placed in the core network part for simplicity reasons:



- The error protection contains any FEC, CRC, interleaving, ARQ coding schemes and macro-diversity processing which are part of the UTRA concept. ARQ is included if and only if it is defined for the real-time (non-delay variant) services.
- For non-real time (delay variant) services, as shown by the lower branch in the figure, an ARQ protocol can be used, similar to GSM's RLP or GPRS. The delay for this service is variable and the total delay is Ti + packet delay.
- Inter-node delays in the UMTS radio access network (URAN) are not taken into account
- Implementation overheads, such as processing time, are not included
- Speech encoding is not included in the radio transmission chain since it is assumed there will be bearer definitions applicable for speech transmission, as well as for video compression etc.

NOTE: The one-way delay figures are only applicable for defining the radio technology bearers and not for defining the complete access delay for the radio access network. This means that the total delay will be larger. Thus the figures Tt and Ti must be lower than the requirement for total delay in the access network.

For evaluation of the radio transmission technologies the figures Tt and/or Ti should be specified. Different figures may apply for uplink and downlink.

Annex B: Bibliography

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ETR 291: “UMTS system requirements”.

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CCIR Recommendation 687: "Future Public Land Mobile Telecommunication Systems (FPLMTS)".

ITU-R Recommendation FPLMTS.RREQ: “Requirements for the radio interfaces for FPLMTS”.

ITU-R Recommendation FPLMTS.RFMK: “Framework for the radio interfaces and radio subsystem functionality for FPLMTS”

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ITU-R Recommendation M.1035: “Framework for the radio interfaces and radio subsystem functionality for the FPLMTS.

ITU-R Recommendation M.1036: “Spectrum considerations for the implementation of FPLMTS in the bands 1885 - 2025 MHz and 2110 - 2200 MHz”

ITU-R: Framework for modularity within IMT 2000/FPLMTS”.

Annex A: Document history

Document history		
Date	**Status**	**Comment**
Dec'94	SMG5 approved	v. 2.0.0.
Jun'95	Presentation to SMG comments of SMG2 and SMG3 considered, as v 2.1.0	V 2.1.0
September 1996	SMG5 Review	V 2.2.0
10 - 13 December 1996	SMG5 review for SMG2 endorsement and approval	V 2.30
16 - 20 December 1996	Modifications by the editor at SMG2#20	V2.4.0,
3 - 7 March 1997	Re-structuring in line with SMG 2 TDoc 96/97	V 2.5.0
1 April 1997	Changes of V 2.5.0 incorporated and minor formatting changes	V.2.5.1
April 1997	Incorporation of modifications agreed at SMG2 UMTS ad hoc#2, SMG1 input and minor revisions	
16 May 1997	Approved at SMG #22	V 2.6.0
18 May 1997	minor editorial and formatting	v 2.6.1
29th May 1997	minor editorial and ETSI formatting	v 2.6.2
22nd June 1997	SMG#22 approved renumbered and version update	v.3.0.0

History

Document history		
V3.0.1	October 1997	Publication