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Technical Specification

Universal Mobile Telecommunications System (UMTS);
Service aspects;
Handover Requirements between UMTS and GSM or other Radio Systems
(UMTS 22.29 version 1.0.0)

UMTS

Universal Mobile

Telecommunications System

ETSI

European Telecommunications Standards Institute

ETSI Secretariat

Postal address

F-06921 Sophia Antipolis Cedex
- FRANCE

Office address

650 Route des Lucioles - Sophia
Antipolis
Valbonne - FRANCE
Tel.: +33 4 92 94 42 00   Fax:
+33 4 93 65 47 16
Siret N° 348 623 562 00017 - NAF 742
C
Association à but non lucratif
enregistrée à la
Sous-Préfecture de Grasse (06) N°
7803/88

X.400

c= fr; a=atlas; p=etsi;
s=secretariat

Internet

secretariat@etsi.fr
http://www.etsi.fr

Contents

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Foreword

This Technical Specification (TS) has been produced by ETSI Special Mobile Group (SMG).
This document states requirements for the creation of standards which provide technical means whereby UMTS and related systems can fulfil the service requirements it describes. The requirement to develop standards to support a service requirement does not imply that the support of such service requirement is mandatory in every UMTS system, unless this is explicitly stated.
The contents of this TR is subject to continuing work within SMG and may change following formal SMG approval. Should SMG modify the contents of this TR, it will be re-released by SMG with an identifying change of release date and an increase in version number as follows:

Version x.y.z

where:

x the first digit:

1 presented to SMG for information;

2 presented to SMG for approval;

3 Indicates SMG approved UMTS document.

y the second digit is incremented for all other types of changes, i.e. technical enhancements, corrections, updates, etc.

z the third digit is incremented when editorial only changes have been incorporated in the specification;

1 Scope

The scope of this document includes service requirements for handover and roaming (terms that are defined below) within UMTS systems and between UMTS, other IMT-2000 family members and 2nd generation systems. Particular emphasis has been placed on the description of requirements for handover between UMTS and GSM but requirements specific to other systems are incorporated as required.

UMTS is a "third generation" mobile cellular radio telecommunications system which provides telecommunication and information services to wireless terminals. Mobile cellular systems have the defining characteristic that they are capable of maintaining continuity of service to a wireless terminal as it moves between the radio coverage area, or "cells", associated with different base station sites . This functionality is called "handover". Handover can also occur due to change of radio resource providing a service without necessarily any change of the base stations involved. In particular, when the radio resources providing a service change from one of the UTRA modes to the other (UTRA-FDD and UTRA-TDD), this is regarded as handover.

It is a key requirement of UMTS that it allows for dual or multi-mode (eg UMTS/GSM) terminals to handover traffic from UMTS to other radio systems such as GSM and visa versa. This document describes the service requirements for intra- and inter- system handover that shall be used by other SMG STCs to guide the implementation of UMTS-to-(eg) GSM handover specifications. It defines requirements for the enhancement of the GSM specifications to allow GSM-to-UMTS handover.

The following subject areas are within the scope of these service requirements.

   User perceived performance that may be influenced by handover.

   Operational requirements relating to handover.

   Security requirements.

The requirements set forth in this document are service requirements, in that they fulfil the following:

   The requirements are independent of the implementation of the URAN.

   The extent to which the requirements are met are in principle verifiable using observables that are not internal to the URAN.

1.1 Situations in which Service Requirements apply

The service requirements in this document are as far as possible independent of the implementation of the UTRA. They therefore apply to situations where handover would occur regardless of how the UTRA is implemented. Situations envisaged are

   Handover within UMTS due to change of radio resource caused by UE movement between areas covered by different transmitters.

   Handover within UMTS due to change of UTRA mode.

   Handover due to change of radio system (eg UMTS to GSM).

It is possible that handover (ie change of radio resource) will occur in other situations, for example the technical implementation of the URAN may necessitate it or O&M procedures initiated by the operator may force it. Requirements for these situations are not within the scope of this document, with the exception of two remarks:

{your editor has come up with better phrasing than his first try....}

   Where the technical implementation of the URAN necessitates handover as a matter of normal operation (ie not related to the above situations), then services shall in no way be degraded or adversely affected.

   The service requirements for handover occurring in situations such as O&M activity are outside the scope of this document.

1.2 Scope of Roaming Requirements

Roaming is the capability which enables a user to obtain UMTS services from a telecommunications network other than the UMTS home network .

As a family member of IMT-2000, defined by the ITU as global third generation system, standardisation of the capability to roam between UMTS networks other than the home network, and between UMTS and different IMT-2000 family members is required. The following subject areas are within the scope of these service requirements:

Operational requirements relating to roaming.

System requirements for Roaming between UMTS and IMT-2000 family members

Security requirements.

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]   ETS 300 911 (GSM 05.08): "GSM Digital cellular telecommunications system (Phase 2+); Radio subsystem link control"

[2]

3 Definitions and Abbreviations

3.1 Definitions

For the purposes of the present document, the following definitions apply:

Connection mode : characterizes the type of association between two endpoints as required by the bearer service for the transfer of information. A bearer service is either connection-oriented or connectionless. In a connection oriented mode, a logical association called *connection* needs to be established between the source and the destination entities before information can be exchanged between them. Connection oriented bearer services lifetime is the period of time between the establishment and the release of the connection.

In a connectionless mode, no connection is established beforehand between the source and the destination entities ; the source and destination network addresses need to be specified in each message. Transferred information cannot be guaranteed of ordered delivery. Connectionless bearer services lifetime is reduced to the transport of one message.

GSM coverage: an area where mobile cellular services are provided in accordance with GSM standards

UMTS coverage: an area where mobile cellular services are provided in accordance with UMTS standards.

{even better text courtesy Vodafone…}

Multi mode terminal: UE that can obtain service from at least one mode of UMTS, and one or more different systems such as GSM bands or possibly other radio systems such IMT-2000 family members.

Handover: The process changing the network radio resources that are used to provide the bearer services for active connection mode teleservice.

Intra system handover: Handover within the same radio network.

Inter system handover: Handover between different radio networks, irrespective if within or between MSC or CN.

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:
UE   User equipment

4 General Principles governing handover requirements

This section describes the general principles governing the operation of UMTS when preparing for and executing handover both within UMTS and to another radio system such as GSM. It also describes the additional concepts required to be included in GSM to allow preparation for and handover to UMTS. As a principle, the requirements on handover characteristics should be according to the network to which the handover is made.

The handover matrix

handover possible?	to UMTS	to GSM-cs	to GSM-GPRS	to IMT2000 ≠ UMTS
from UMTS	1	1	1	x
from GSM-cs	1	oos	oos	oos
from GSM-GPRS	1	oos	oos	oos
from IMT2000 ≠ UMTS	x	oos	oos	oos

oos = out of scope of UMTS specifications
1= supporting standards required for UMTS phase 1
x= supporting standards required, not necessarily for phase 1

4.1 Requirements for Service Capabilities

UMTS standardises service capabilities, not services. As part of the service capabilities it is envisaged that applications may wish to respond to events related to handover that either has occurred, is about to occur or could potentially occur. The service capabilities described in this section should be available at least to UE hosted applications.

The following list is of uses is exemplary and is not intended to be exhaustive:

An application may wish to accept or reject offered QoS.

An application may wish to cope to the effect that handover has on a service, for example facsimile retransmission.

An application may with to preferentially choose radio resources, for purposes such as SoLSA.

It is therefore required that the service capability set available to an application be able to provide an indication that handover has occurred or could occur with information about the type of handover and radio resources involved. The service capabilities should support QoS negotiation.

4.1.1 Support of localised service area (SoLSA)

The UMTS service capability set shall support the Localised Service Area (LSA) concept. It shall facilitate the creation of applications that implement user-dependent radio resource selection based on LSA (e.g. when user is located at his office, radio coverage provided with indoor radio solutions should be preferred). This may cause handover to be take place within UMTS or into other radio systems. Corresponding GSM feature has been specified in GSM 02.43.

4.2 General Operational Considerations

4.2.1 Coverage environment

Mechanisms defined to support handover between UMTS and other radio systems (such as other UMTS modes, other IMT 2000 family members, or GSM) should effectively cope with a number of coverage scenarios:

Limited UMTS coverage in a 'sea' of coverage provided by another radio system , or vice-versa.

Selective operation at a geographical boundary, with extensive UMTS coverage on one side and extensive coverage from another radio system on the other side.

Geographically co-located areas of UMTS coverage and another radio system.

However the standards should impose no restrictions or assumptions on how an operator might deploy or operate the network in both GSM and UMTS.

4.2.2 Inter Operator Handover Issues

For UMTS phase 1 means shall be defined which enable handover to and from a GSM network operated by the same network operator as the UMTS network. For later phases means shall be define which enable handover to and from a network operated by a different network operator.

Handovers between GSM and UMTS PLMNs operated by one or several operators should remain an optional feature to implement. However there should not be any technical restrictions in the standards, limiting the possibility for the handover to be an intra-operator or an inter-operator handover.

In case Inter-operator handovers are to be supported, several issues have to be resolved, including:

Operator requirements (regulatory issues, Clearing house requirements, inter-operator requirements, signalling access requirements)

Roaming IN services

End-user services (eg VPN, Prepaid, Numbering, tariffing, zone services, data services)

Optimal routing

MS display aspects

CCBS arrangements and billing principles

Information transfer between the networks or network operators, since both networks need to get up-to-date system information from the other network. Further broadcasting of such an information should be studied.]

4.2.3 Charging and Network Management

Note: standardisation to support requirements in this section is not necessarily required for UMTS phase 1.

Means shall be standardised which allow charging records to record the time of handover in the case of inter network operator handover. Charging records must be able to reflect the level of service , operation mode (eg. FDD or TDD) and network type after handover.

A capability to provide network management information relating to frequency of occurrence and type of handover should be defined.

4.2.4 Cost and efficiency

The UTRAN standards shall facilitate the cost effective implementation both on the network and on the terminal side, of multi mode operation between GSM and UMTS. Impacts on the GSM network shall be minimised. Such handover shall not require user intervention.

4.2.5 Security

Each mobile radio system defines its own security level.

Inter operator handover is not required for UMTS phase 1, which means that both the GSM and the UMTS parts will be operated by the same operator. There is thus no reason to re-authenticate because of the original authentication having been done by another operator.

For future releases after phase 1, mechanisms shall be specified to enable the level of security, after an inter system or inter operator handover, to be equivalent to that normally achieved in the radio network to which handover is done.

The security matrix indicates the security level after handing over

which security level?	To UMTS	to GSM-cs	to GSM-GPRS	to IMT2000 $\neq$ UMTS

from UMTS	U	G	G	*)
from GSM-cs	U or G[1]	oos	oos	oos
from GSM-GPRS	U or G[1]	oos	oos	oos
from IMT2000 ≠ UMTS	U	oos	oos	oos

U: UMTS Security Level.
G: GSM security Level
oos: out of scope of this document
1) U is not envisaged for phase 1 or intra-operator handover
*) security level of specific IMT2000 family member

5   Requirements for Handover from UMTS to UMTS

5.1   Handover due to UE Movement

It should be possible to provide a technical implementation of handover such that there is no measurable impact on the quality of any service when handover due to UE movement occurs. This does not imply that all UMTS handovers will achieve this ideal. However, the standards shall define at least one UTRA mode in which this is possible given the following:

UE speed stays within limits for given service.

UE stays constantly within UMTS coverage of a single UTRAN.

5.2   Handover Between UMTS Modes

The standards shall permit a technical implementation in which service is continued, although there may be a temporary degradation which may affect teleservices at the time of handover.

5.3   Handover Between Environments

UMTS is expected to provide coverage in a number of environments including fixed and mobile. The standard shall enable handover between these environments as described in the table below.

{Nokia remark}
Note that the applicability for this requirement to phase 1 should be clarified.

From \ To	Terrestrial Cellular	Fixed/Cordless	Satellite
Terrestrial Cellular	**Yes**	**Yes**	**Yes**
Fixed/Cordless	**Yes**	**Yes**	**Yes**
Satellite	**Yes**	**Yes**	**No**

6   Requirements for Handover from UMTS to GSM

6.1   Operational Requirements

6.1.1   Security

{rephrasing from Vodafone VOD04 tidies this section up without, I believe, changing its meaning....}
It is presumed that different mechanisms/algorithms will be used in UMTS to provide improved security compared with GSM. Inter network handover may therefore involve operations such as re-authentication, key management etc.. The impact of such operations must be taken into consideration when inter network handover mechanisms are being designed.

6.1.2   GSM bands

The standard shall support handover to any combination of GSM bands supported by the GSM standards.

6.2   Performance Requirements

{Nokia comment, most of the text sounds a bit strange to SMG1 spec. Are you sure that all of these are SMG1 issues.}

{Editor's reply: ALL these requirements are independent of the implementation of UTRA. All these performance criteria are objectively measurable using external observables without knowledge of the implementation of either UTRA or GSM.}.

The following service principles apply to performance requirements:

> When the UE performs handover to GSM then the service requirements of GSM that relate to handover between different cells in different location areas is taken as the benchmark. It is not the intention to set more stringent service requirements for UMTS to GSM handover than are already commonly accepted for handover within GSM.

6.2.1   Detection Time of Potential GSM Handover Candidates

Means shall be defined which allow the UE to achieve as good detection time performance as the GSM benchmark: ie to behave in such a way as to detect potential GSM handover candidates as quickly as a GSM mobile performing an intra GSM handover is required to do so.

{Comment (from Ericsson): We believe this will be difficult to achieve in UMTS. We probably need to relax those requirements. The ambition should be to make the call survive into GSM, then it can be handed over again within GSM to improve quality.}

{Editors Reply: let's give the requirement to SMG2 and see what they say}

6.2.2   Number of GSM handover candidates to detect

Means shall be available which allow UE to detect an equal number of GSM handover candidates relative to the GSM benchmark, ie to behave in such a way as to detect as many potential GSM handover candidates as a GSM mobile performing an intra GSM handover is required to do so.

6.2.3   Probability of Connection Loss

The service requirement is that it should be possible to hand over to GSM from UMTS with a probability of connection loss that fulfils the corresponding service requirement for intra GSM handover.

6.2.4   Temporary degradation of service caused by handover

The service requirement is that means should be defined so that the duration and extent of any degradation of service during handover to GSM from UMTS can fulfil the corresponding service requirement for intra GSM handover.

{Vodafone mentioned that the following is not a service requirement… so it was removed. At the request of Ericcson, I'm putting back as an operational requirement}

It is an operational requirement that the network operator can optimise his network. Therefore the standards may permit the operator to trade off handover performance to GSM against the possibility of improved UMTS network performance, allowing the operator at his discretion not to achieve GSM service requirements for handover performance.

6.3 Specific Requirements for Individual Services from UMTS to GSM

6.3.1 Speech

Handover of a UMTS Speech channel to GSM shall result in a GSM speech teleservice connection. This requirement also applies to emergency calls.

- Any call based on the default UMTS speech codec shall be mapped to the FR GSM speech codec. In the case the terminal and the GSM network support AMR and /or EFR and/or HR, it shall be the operators choice to define the appropriate mapping

Means shall be defined which make it possible to limit any temporary degradation on handover so it meets the performance specified by GSM service requirements for speech handover.

6.3.2 Short Message Service

Handover does not apply to this service since there is no connection context maintained between successive short messags within the UMTS system.

There may be a temporary degradation of service during handover from UMTS to GSM since when the transmission or reception of a short message coincides with handover, the short message transfer in progress might be aborted. [In this case, signalling protocols in the SMS service may automatically attempt to resend the message – see below.]

After handover from UMTS to GSM the service will continue to be provided by means of GSM short message service. Means may be provided to allow the re-transmission without user intervention of any short message transfer that was aborted. This may depend upon whether the SMS was mobile originated or mobile terminated.

6.3.3 Cell Broadcast

There are no requirements related to handover for cell broadcast.

6.3.4 USSD

The technical standards shall provide means to ensure that any handover that occurs during a USSD interaction need no more affect the service than intra-GSM handover.

6.3.5 Facsimile

It is not required that the non transparent facsimile service as defined in GSM 03.46 be supported by UMTS. Support of the transparent facsimile service as defined in GSM 03.45 shall be optional for UMTS networks It is not required that a facsimile transmission that is active between UE and network at the time of handover from UMTS to GSM completes successfully.

{this remark from Nokia}
[Note that is still some disagreement concerning the need for 03.45 in UMTS, this is FFS]

6.3.6 Data Teleservice

{Nokia remark, also Telia and Vodafone: nobody knows what a GSM connection mode teleservice is}
Standards shall be defined to permit the possibility of handover of a UMTS connection mode data teleservice to GSM which shall result in an appropriate GSM/GPRS bearer service. The mapping between UMTS data services and appropriate GSM/GPRS data services will depend upon many factors such as data rate, delay constraints, error rate etc..Means shall be provided for the application to indicate minimum acceptable QoS for service continuation after handover. Consideration must be given to multimedia services which may involve multiple bearers or connections. If this cannot be provided by the GSM/GPRS networks, handover will not take place (which may result in call loss once the UE moves outside UMTS coverage).

Means shall be defined (eg existing GSM flow control mechanisms) which make it possible to limit any temporary degradation on handover so it meets the performance specified by GSM service requirements for connection mode data teleservice handover.

It is required to handover a user context between GPRS and UMTS . Independently of the used air interface, the user shall stay connected to an external network (internet, intranet).

6.3.7   GSM Supplementary Services

Control and *use* of Supplementary Services to be according to GSM or UMTS standard as applicable at the time, although close synergy between these should be encouraged to ensure that handover has no effect on their correct operation or continuity of service.

{Suggestion from Siemens & Editor}

Where a GSM supplementary services is supported in UMTS then the technical standards should allow handover to GSM to have no effect, at least where the GSM and UMTS networks have the same network operator.

7   Requirements for Handover from GSM to UMTS

7.1   Operational Requirements

7.1.1   Security

{Nokia NOKIA 02 points out that need to support GSM SIMs for roaming is in accordance with 22.00....}
UMTS must support GSM security features for GSM SIM card used in dual mode terminals .
For handover from GSM to UMTS, between network parts operated by the same operator, there should be no reason for re-authentication as the UMTS authentication mechanism should be technically at least as secure as for GSM.

7.2   Performance Requirements

The technical standards should ensure that it is possible to handover from GSM to UMTS in such a way that temporary degradations are no worse than GSM to GSM handovers.

7.3   Specific Requirements for Individual Service Handover from GSM to UMTS

7.3.1   Speech

AMR, EFR, FR and HR calls shall be mapped to the default UMTS speech codec.

7.3.2   Facsimile

{new text from Vodafone}
It is not required that the non transparent facsimile service as defined in GSM 03.46 be supported by UMTS. Support of the transparent facsimile service as defined in GSM 03.45 shall be optional for UMTS networks Therefore handover will depend upon whether the UMTS network supports transparent fax as defined in GSM 03.45. It is not required that a facsimile transmission that is active between UE and network at the time of handover from GSM to UMTS completes successfully.

{this remark from Nokia}
[Note that is still some disagreement concerning the need for 03.45 in UMTS, this is FFS]

7.3.3   Short message

No connection is maintained within the UMTS system between successive short messages, so handover of this service is not a meaningful concept.
There may be a temporary degradation of service during handover from UMTS to GSM since when the transmission or reception of a short message coincides with handover, the short message transfer in

progress might be aborted. [In this case, signalling protocols in the SMS service may automatically attempt to resend the message – see below.]

7.3.4 Cell Broadcast

There are no requirements related to handover for cell broadcast.

7.3.5 USSD

In GSM, USSD is a connection mode teleservice according to the definition above: in USSD the association between endpoints is called a 'transaction' (see GSM 03.90). In GSM, USSD transaction from the UE can terminate at the local MSC, the VLR or the HLR. It is not required to standardise means to handover into UMTS of transactions with the local MSC. The need to standardise handover of transactions with the VLR and HLR is ffs.

{nokia point out that GSM connection mode teleservice not defined}

7.3.6 Circuit switched GSM Data Bearers

{By popular demand, I've split up circuit and packet as orginal.This new text in response to Ericsson, HO ERICCSON 04, also Nokia and Vodafone VOD03.}
Note: the requirements in this section should not delay the phase 1 standardisation process and may need review.
Standards shall be defined to permit the possibility of handover of a GSM circuit switched data bearer to UMTS which shall result in a UMTS connection mode teleservice. Means shall be provided for the application to indicate minimum acceptable QoS for service continuation after handover. If this cannot be provided by the UMTS network handover will not take place (which may result in call loss once the UE moves outside GSM coverage).
Means shall be defined which make it possible to limit any temporary degradation on handover so it meets the performance specified by GSM service requirements for circuit switched data handover.
It is required to handover a user context between GPRS and UMTS . Independently of the used radio interface, the user shall stay connected to an external network (internet, intranet).

7.3.7 Packet Switched Data Services

It is required to handover a user context between GPRS and UMTS . Independently of the used radio interface, the user shall stay connected to an external network (internet, intranet). Any change in the QoS shall be seen at the service access points as a network initiated renegotiation of QoS. If the supported QoS is not acceptable, the MS may terminate the connection/context.
Means shall be defined which make it possible to limit any temporary degradation on handover so it meets the performance specified by GSM service requirements for packet switched data handover.

7.3.8 Supplementary services

{Suggestion from Siemens & Editor}

Where a GSM supplementary services is supported in the target UMTS network then the technical standards should allow handover from GSM to UMTS to have no effect on that service, at least where the GSM and UMTS networks have the same network operator.

8 Roaming Requirements

Standards shall be defined to enable roaming of subscribers from different systems (including GSM and non UMTS IMT-2000 family members) from UMTS and vice versa. The following matrix shows the service requirements for roaming. A common authentication, identification and ciphering functionality would be desirable for inter-standard roaming.

{following from Nokia…}
It shall be defined how to deal with calls and sessions adressed to a UMTS user, when the user is roaming in GSM, and vice versa. Sometimes the offered UMTS call/session may have to be dropped or its QoS modified becauseGSM does not support the requested QoS level."
The roaming matrix

roaming possible?	to UMTS	to GSM-cs	to GSM-GPRS	to IMT2000 ≠ UMTS
from UMTS	1	1	1	1
from GSM-cs	1	oos	oos	oos
from GSM-GPRS	1	oos	oos	oos
from IMT2000 ≠ UMTS	x	oos	oos	oos

oos = out of scope this specification

1 = standardisation of this capability is required for UMTS phase 1

x = standardisation of this capability if required, but not necessarily for UMTS phase 1

tab. 1: the roaming matrix

Cost and efficiency

The UTRAN standards shall facilitate the cost effective implementation of multi mode/multi standard mobiles which roam to other IMT-2000 family members. Such roaming shall not require user intervention.

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Editorial Contact:
David Cooper
NEC Technologies
c/o Telecom Modus
Leatherhead KT22 7SA
UK

Tel: +44(0) 1189 654511
david.cooper@t-modus.co.uk