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*Technical Specification*

**3rd Generation Partnership Project;  
Technical Specification Group Services and System Aspects  
Service aspects;  
Handover Requirements between UMTS and GSM  
or other Radio Systems  
(3G TS 22.129 version 3.0.0)**

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**3GPP**

Postal address

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3GPP support office address

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650 Route des Lucioles - Sophia Antipolis  
Valbonne - FRANCE  
Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Internet

---

<http://www.3gpp.org>

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# Foreword

This Technical Specification has been produced by the 3GPP.

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of this TS, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version 3.y.z

where:

- x the first digit:
  - 1 presented to TSG for information;
  - 2 presented to TSG for approval;
  - 3 Indicates TSG approved document under change control.
- y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.
- z the third digit is incremented when editorial only changes have been incorporated in the specification;

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# 1 Scope

The scope of this document includes service requirements for handover (terms are defined below) within UMTS systems and between UMTS, other IMT-2000 family members and 2<sup>nd</sup> 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:

- where the technical implementation of the URAN necessitates handover as a matter of normal operation (i.e. 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.

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## 2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, 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] GSM 05.08: "GSM Digital cellular telecommunications system (Phase 2+); Radio subsystem link control".

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## 3 Definitions and Abbreviations

### 3.1 Definitions

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

**Connection mode (for a bearer service):** 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.

**Connectionless (for a bearer service):** In a connectionless bearer, 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.

**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 network handover:** Handover within the same radio network.

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

**Inter system handover:** Handover between networks using different radio technologies, e.g. UMTS – GSM.

### 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 release 99.

x= supporting standards required, not necessarily for release 99.

For UMTS release 99 means shall be defined which:

- 1) enable handover to a GSM network from a UMTS network;
- 2) enable handover to a UMTS network from a GSM network.

In both the cases above the GSM network may be operated by either the same network operator as the UMTS network or a different network operator.

### 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 wish 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

Handovers between GSM and UMTS networks operated by different operators should remain an optional feature to implement. It is envisaged that handover would take place due to changing radio conditions caused eg by movement of the terminal causing it to leave the coverage area of a network.

The following networks may be involved with an inter-network handover procedure. These concepts are illustrated in Annex A:

- the user's *home network*, i.e. the operator where the user's subscription may be found;
- the user's *visited network* where the subscriber user is currently registered, i.e. the network where the subscriber user has performed the last successful update location procedure. As long as the subscriber user is roaming within the home network, home and visited network are identical.
- the user's *serving network* covering the cell that serves the subscriber. After successful completion of the update location update procedure, the serving network is identical with the visited network. After an inter-network handover, the visited network is different from the serving network until a location update procedure has been successfully completed (excepted the case that the subscriber returns into the visited network).
- the *target network* covering candidate target cell(s) for inter-network handover. The target network has overlapping radio coverage with the serving network but not necessarily with the visited network.

The minimum requirements for inter network HO are:

- continuity of an *active call* across the handover procedure, where this would be possible for intra-operator handover;
- charging, billing and accounting for inter-network handover should be according to the principles defined in UMTS 22.15. For R'99 the mechanisms currently used in GSM should be provided as a minimum (charging for handover leg is based on visited network tariff, etc., settlement between operators is based on bulk metering, etc.);
- the ability to check with the home network whether the user is permitted to handover from the visited network to a target network;
- the decision whether the handover request is accepted must be taken by the target network;
- invocation of the handover procedure only occurs if the target network provides the radio channel type required for the respective call;
- the avoidance of "network hopping", i.e. successive handover procedures between neighbouring networks for the same call;
- the possibility of user notification of inter network HO (eg possible tariff change) when it occurs.

### 4.2.3 Charging and Network Management

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 afterhandover.

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

Security requirements relating to handover shall be elaborated in a separate document (UMTS 33.21, security requirements), but should embody the principle that handover shall not compromise the security of: the network providing the new radio resources; the (possibly different) network providing the original radio resources; and the terminalUE. The security mechanisms should also cater for appropriate authentication processes and meet the requirements of national administrations in terms of lawful interception.

## 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. The following are indicative of long term requirements and do not necessarily apply to R99. However, technical standardisation should not preclude the possibility of implementing these requirements.

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

## 5.4 UMTS cell capacity

Consideration must be given services such as multimedia which may involve use of multiple bearers. Due for example to cell loading, it may happen that a target cell cannot support the combination of bearer services provided by the current serving cell. Means shall be provided for the application(s) to indicate minimum acceptable QoS for services continuation after handover. Although all UMTS bearer services may not be handed over, the handover to another UMTS cell should not be precluded.

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# 6 Requirements for Handover from UMTS to GSM

## 6.1 Operational Requirements

### 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

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.

### 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 it is possible to construct networks comprising GSM and UTRA radio resources in such a way that the duration and extent of any degradation of service during handover from UMTS to GSM is no worse than during intra GSM handover.

## 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 messages 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 a facsimile transmission that is active between UE and network at the time of handover from UMTS to GSM completes successfully.

### 6.3.6 Data Bearer Services

Standards shall be defined to permit the possibility of handover of a UMTS connection oriented data bearer service to GSM which shall result in an appropriate GSM/GPRS bearer service. The mapping between UMTS data bearer services and appropriate GSM/GPRS data bearer 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.

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 oriented data bearer service 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.

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.

## 6.4 Requirements on multiple bearer services handover from UMTS to GSM

Consideration must be given to multimedia services which may involve multiple bearer services. The mapping between UMTS data bearer services and GSM/GPRS bearer services will depend upon many factors such as data rate, delay constraints, error rate etc.. Means shall be provided for the application(s) to indicate minimum acceptable QoS for services continuation after handover. In the event certain UMTS bearer services cannot be handed over to GSM/GPRS, the handover of some of the bearers to maintain the service should not be precluded.

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## 7 Requirements for Handover from GSM to UMTS

### 7.1 Operational 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.

#### 7.3.3 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 for further study.

### 7.3.6 Facsimile

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.

### 7.3.7 Circuit switched GSM Data Bearers

Note: the requirements in this section should not delay the release 99 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 oriented data bearer service . 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.

### 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

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.

## 7.4 Requirements on multiple bearer services handover from GSM to UMTS

Consideration must be given to multimedia services which may involve the use of multiple bearer services. For example Class A GPRS terminals will be capable of simultaneously supporting more than one data bearer services. The mapping between GSM/GPRS data bearer services and UMTS bearer services will depend upon many factors such as data rate, delay constraints, error rate etc. Means shall be provided to allow handover of several data bearer services from GSM to UMTS. Means shall be provided for the application(s) to indicate minimum acceptable QoS for services continuation after handover.

## Annex A (informative): Illustration of elements in inter-operator handover

Figure 1 illustrates the above definitions taking an example of European GSM networks. The subscriber's home network is France. The visited network where the subscriber is registered in a VLR is Germany. The signalling connection between HLR and VLR is indicated by dotted lines. The calls for the subscriber are controlled by the MSC collocated to the VLR where the subscriber is registered. This MSC is called "*anchor MSC*".

Handover to a different MSC may occur if the cell serving the subscriber after handover is not controlled by the anchor MSC. This MSC is called the "*serving MSC*". Even after the call has been handed over to a different MSC, the call control function remains in the anchor MSC. The signalling connection and circuit switched connection established between anchor MSC and serving MSC are indicated by a solid line.

When the French subscriber registered in a German network roams near the border to the Netherlands, inter-network handover may occur. In this case a Dutch network is the *target network*. After handover, the anchor MSC located in a German network continues to control the call. The German network remains the *visited network* where the subscriber is registered. The subscriber's location information stored in the HLR remains unchanged. The signalling and circuit switched connections between the anchor MSC and the previously serving MSC in the German network will be released when the Mobile Station (MS) is served by a cell within a Dutch network. The Dutch network becomes the *serving network*. From the Dutch network the subscriber may be handed over to a Belgian network.

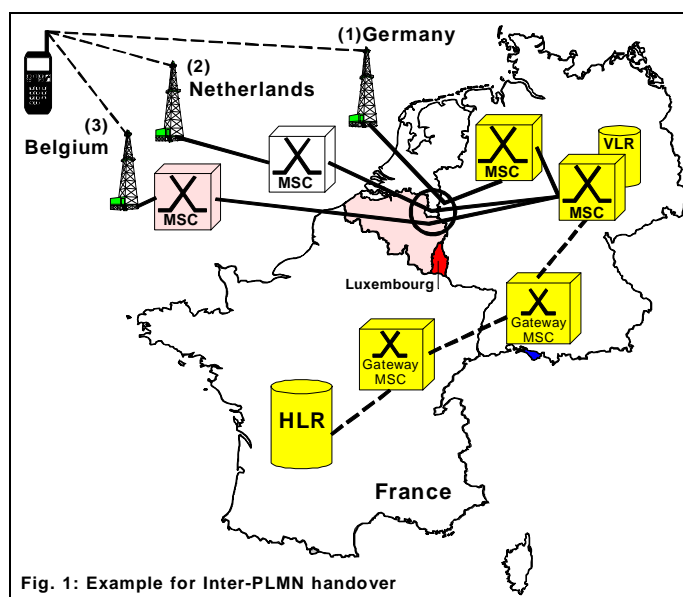


Figure 1: Example for inter-PLMN handover

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## Annex B (informative): Open Points on Inter-Operator Handover

The requirements outlined below are likely to need further elaboration, although these may be outside the scope of service requirements.

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### A.1 Identification of Candidate Cells for Handover

A mechanism is envisaged to support the identification of candidate cells for handover. One or more of the candidate cells may be part of the serving network or part of another network.

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### A.2 Selection of Target Cells for Handover

A mechanism is envisaged to support the selection of the target cell for handover. The target cell may be part of the serving network or part of another network.

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### A.3 Network Information Exchange

A mechanism is envisaged to support the exchange of network information between different operators. Two categories of network information are identified:

- static information, for example, neighbour cell lists, interconnecting traffic and signalling links, etc.;
- dynamic information, for example real-time signalling information related to target cell selection, etc.

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### A.4 Service Requirements

FFS.

[There is a need to identify which services can be maintained during handover and the interactions of services across network boundaries]

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### A.5 Billing, Accounting and Charging Requirements

FFS.



## A.6 Completeness of Service Requirements

The subject areas below have been raised as important issues for inter-operator handover, and some may be developed further at a future time:

- 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);
- continuity of Supplementary Services;
- requirements for network selection criteria in preparation to handover;
- admission control requirements for recipient network.

## History

<b>Document history</b>		
<Version>	<Date>	<Milestone>
0.0.1	29 Oct 98	First Draft for tdoc
0.0.2	5 Jan 98	Evolved from tdoc 3 then 7 of SMG 1 handover ad hoc
0.0.3	6 Jan 98	evolved from tdoc 20 of SMG1 handover ad hoc
0.0.4	7 Jan 98	evolved from tdoc 35 of SMG1 handover adhoc
0.0.5	8 Jan 98	evoloved from tdoc 45 of SMG1 handover adhoc
1.0.0	27 January	To be presented as version 1.0.0 to SMG#28 for Approval
1.1.0	5 Mar 99	- new requirment for inter-operator handover, as demanded by SMG - removes text on security requirements by referencing 33.21 - editorial revisions
1.2.0	22 Mar 99	1 Initial draft for email handover ad hoc 22-27 Mar. -
1.3.0	24 Mar 99	Clarify inter-operator handover requiremetn
1.4.0	26 Mar 99	Proposed as draft version 2.0.0
2.0.0	12 Apr 99	Draft version 2.0.0
2.0.1	12 Apr 99	Editorially equivalent 2.0.0, with editorial comments removed
2.0.2	16 April 99	Editorial review