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Technical Report

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Contents

Foreword

This Technical Specification has been produced by the 3rd Generation Partnership Project, Technical Report Group Terminals.

The contents of this TR may be subject to continuing work within the 3GPP and may change following formal TSG approval. Should the TSG modify the contents of this TR, it will be re-released with an identifying change of release date and an increase in version number as follows:

Version m.t.e

where:

- m indicates [major version number]
- x the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.
- y the third digit is incremented when editorial only changes have been incorporated into the specification.

Introduction

When UMTS is launched the coverage will be very limited in many areas while several second-generation systems will have a very wide coverage. To make UMTS useful for a wide range of users from the start, multi-system terminals, combining e.g. second-generation systems with UMTS, are necessary. In the longer term, combinations with other systems, such as HiperLAN or other cordless systems, could also be interesting and convenient. This technical report describes all relevant issues concerning multi-system terminals from a service and a terminal point of view.

1 Scope

The purpose of this 3GPP Technical Report is to describe work done on multi-system related issues and to identify areas that need additional treatment to facilitate efficient multi-system usage. The report outlines definitions specifically important for usage of multi-system terminals and scenarios describing the concept. The report refers, as far as possible, to existing specifications/reports or to specifications/reports being produced in 3GPP or within other relevant foras.

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] 3G TS 22.135: “Multicall, Stage 1”

[2] 3G TS 25.303: “UE Functions and Interlayer Procedures in Connected Mode”

[3] 3G TR 23.920: “Evolution of the GSM platform towards UMTS”

[4] 3G TS 22.129: Handover Requirements between UMTS and GSMor other Radio Systems

[5] 3G TS 25.304: “UE Procedures in Idle Mode”

[6] 3G TS 23.121: “Architectural Requirements for Release 1999”

[7] 3G TR 25.990: “Vocabulary”

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions apply.

Multi-call: a function that makes it possible for a terminal to have several CS and PS-connections/calls active at the same time. For further description, please refer to [1]

Multi-mode terminal: a terminal that has the ability to communicate with and switch between the different modes (FDD and TDD) within UTRAN.

Multi-system terminal: a terminal that has the ability to communicate with and switch between different types of access networks (e.g. a terminal that can communicate with both UMTS and GSM and/or HiperLAN2).

Active communication: a terminal is in active communication when a CS connection or a PS session is ongoing.

Camping on a cell: The UE is in idle mode and has completed the cell selection / reselection process and has chosen a cell. The UE monitors system information and (in most cases) paging information. Note that the services may be limited, and that the PLMN may not be aware of the existence of the UE within the chosen cell. [5]

Multi-band: when a certain type of radio technology/radio interface is used in different frequency bands (e.g. GSM for both 900 and 1800 MHz).

3.2 Symbols

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

<symbol> <Explanation>

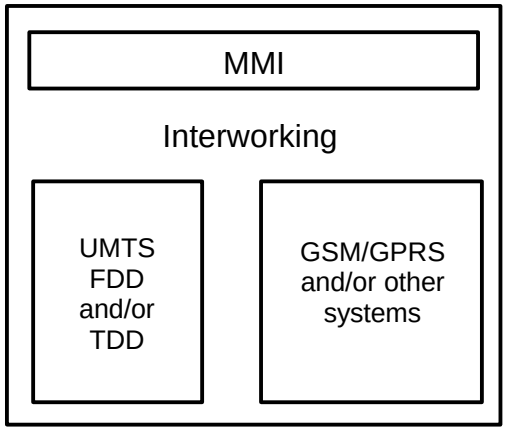
3.3 Abbreviations

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

PS	Packet Switched
CS	Circuit Switched
RR	Radio Resource
RRC	Radio Resource Control
URA	UTRAN Registration Area
LU	Location Update
LA	Location Area

4 General Aspects

A Multi-system Terminal for UMTS and GSM/GPRS or other systems is considered to be a terminal with at least one UMTS part (FDD and/or TDD) and with one part supporting some other system, e.g. GSM / GPRS. This is controlled by a common Interworking Unit which also controls one common MMI (keypad, display and menu functions). A reference configuration for Multi-system terminals is shown in figure 1.



MMI: Man-Machine Interface

Figure 1: Reference configuration for Multi-system terminals

Some parts in the terminal, such as the microphone and the loudspeaker, could be reused by both the UMTS and the other system's parts or could be implemented separately. Integration of some RF parts is also foreseen.

This report will mainly deal with the interworking between UMTS and 2nd generation systems, mostly GSM/GPRS, as much standardisation work considering the connection between these two systems is already done.

4.1 Types of Terminals

In different situations, it is feasible to study the services considering different types of terminals. From a user and operator/service provider perspective it is also important that different types of terminals exist so that customers can be offered a great variety of services through the terminals.

The type of subscription the user is having may affect the usage of types of terminals. In this report it was decided to take this aspect into account when describing the scenarios (see section 4.2).

For all types of terminals both manual and automatic switching shall apply. Definitions on the different switching modes can be found below.

Manual Switching Definition

This operation is initiated by the user or defined by a user setting to allow the terminal to scan for all the available systems and/or networks at predefined occurrences, e.g. when entering a new roaming area. The terminal shall present a list of the available networks and/or systems to the user for their selection of the network and/or system service. Registration to the new network and/or system cannot be done without the user's consent.

Automatic Switching Definition

The automatic switching will identify when at the necessary points in time when the terminal shall scan for other networks and/or systems and shall register onto the preferred option. This can occur without the user's knowledge and the terminal does not have to request the user's permission to change, add or remove a connection to a network and/or system.

4.1.1 Type 1

This type of terminal can be described as two or more single-system terminals in the same shell. The MMI for the different systems are the same but no other functions are shared between the different systems of the terminal. This also implies that the terminal can camp on only one cell and be active in only one system at the same time. An example of a combination of systems that could benefit from this type is a PDC/UMTS terminal where the different radio access techniques are connected to different core networks. The user will then carry both terminals around but in one shell and when one system is registered and active the other is totally blocked.

No simultaneous activity is supported with this type of terminal. No simultaneous system connections are supported with this type of terminal.

4.1.2 Type 2

This type of terminal can be described as two or more terminals in the same shell. The MMI for the different systems are the same but no other functions are shared between the different systems of the terminal. This also implies that the terminal can camp on only one cell and be active in only one system at the same time. When the terminal is active on one system the terminal shall be able to listen to the other systems and make e.g. measurements reports on this system and send them to the network, but no active communication shall be possible. This will allow the terminal to make measurement reports about the other system through the active system.

No simultaneous activity is supported with this type of terminal. No simultaneous system connections are supported with this type of terminal.

4.1.3 Type 3

Type 3 terminals can camp on different cells in several systems at the same time but active communication is only possible in on system at the same time. The camping could be done either simultaneously or virtually simultaneously, by e.g. time multiplexing. When the terminal is in active mode on one system it can listen and respond to paging on the other system. The terminal can also be registered in several systems at the same time (may be applied when the systems are belonging to different operators/service providers).

The above description implies that simultaneous attach, simultaneous activation and simultaneous monitoring is supported. No simultaneous traffic is supported but the terminal can initiate/receive connections in different systems sequentially.

4.1.4 Type 4

Terminals of type 4 can camp on cells in several systems at the same time and also be in active communication in several systems at the same time. No switching between systems is necessary.

This implies that simultaneous attach, simultaneous activation, simultaneous monitoring, simultaneous invocation and simultaneous traffic is supported.

In Table 1 the types of terminals are collected and pictured with respect to registration, paging and measurements. The table is divided into requirements for the terminal and the network. In respect to the network the requirements are divided according to if the same operator (PLMN) or different operators run the networks.

Table 1: Types of terminals clarified according to registration, paging and measurements

			Registration	Paging	Measurements
Type 1	Terminal		***Only in one system***	Receive in the active system	Measurement reports only in the registered/active system
	Network	Same PLMN	Only in one system	Receive in the active system	Evaluate measurements from only one system
		Diff. PLMN	Only in one system	Receive in the active system	Evaluate measurements from only one system
Type 2	Terminal		Only in one system	Receive in the active system	Ability to measure on several systems, even when active in one.
	Network	Same PLMN	One registration valid in all systems	Paging co-ordination	Evaluate measurement reports from several systems
		Diff. PLMN	Only in one system	Paging through the system of that operator	Evaluate measurements from only one system
Type 3	Terminal		Several systems	Receive and answer pagings in all systems (camping in all systems)	Ability to measure on several systems, even when active in one.
	Network	Same PLMN	One registration valid in different systems	-	-
		Diff. PLMN	One registration for each system	Paging through the system of that operator	Evaluate measurements from only one system
Type 4	Terminal		Several systems	Receive and answer pagings in all systems	Measurement reports in all systems, both when active and idle.
	Network	Same PLMN	One registration valid in different systems	Paging through the relevant system	Evaluate measurement reports from several systems
		Diff. PLMN	One registration for each system	Paging through the system of that operator	Evaluate measurements from only one system

- No specific requirements.

4.2 Scenarios

This section provides some scenarios describing the usage and behaviour of multi-mode terminals in special situations from a technical and service point of view. These scenarios will then be the guideline when over-viewing the work and identifying additional work.

4.2.1 UMTS complemented with 2nd generation or another system from the same operator

This scenario describes the case when an operator operates an UMTS-network as islands in a sea of this operator's own 2nd generation network and/or in combination with another system. The user has just one number and calls can be initiated by using this number, irrespective of in which system the user is currently registered.

4.2.1.1 Power on

The terminal shall search for all available systems.

The choice of access network should be made according to a priority list or according to in which system the terminal was registered in last time.

The terminal shall register through the access network chosen. This registration will also apply for the other access system and when a location update is made for one system it can apply for the other as well.

It should be possible to transfer terminal capability information in connected mode as well as in idle mode.

Ther are no differencies between Terminal types at Power on

4.2.1.2 Incoming call/connection

4.2.1.2.1 Terminal type 1

4.2.1.2.1.1 Idle mode

If the incoming connection is in the registered system the connection can be set up. If the connection belongs to another system than the registered the user can not be reached.

4.2.1.2.1.2 Connected mode

The terminal can just be reached in the registered mode and the call can not be set up, unless it belongs to UMTS and multicall is applied.

4.2.1.2.2 Terminal type 2

4.2.1.2.2.1 Idle mode

If the terminal is in the right system for receiving the connection, the connection can be set up. If the terminal is in an other system than the incoming connection (e.g. the terminal is in the 2nd generation system but the incoming connection is a videoconference) the network shall page the terminal through the active system and a handover to a suitable system shall be performed.

The calling party shall be informed only if the connection fails completely or a degradation in the connection has taken place (e.g. a videoconference has been degraded to a speech call).

4.2.1.2.2.2 Active mode

As this type of terminal is just able to receive pagings and be in active communication in one system at the same time, it would sometimes be desirable to page the terminal through the active system about an incoming connection in another system. This could for example be the case if the terminal is active in a PS-connection (e.g. webb-surfing in UTRAN) and the incoming connection is a CS-connection in another system (e.g. a speech call in GSM).

For other situations, e.g. the terminal is active in one mode in UTRAN and the incoming connection is coming in this system, the normal procedure for this system shall apply. For UTRAN multicall may for example be applied. [1]

4.2.1.2.3 Terminal type 3

This type of terminal is most interessting when having different operators for the systems included in the terminal. As this is the case the descritption of these situations can be found in ch. X.y.z.

4.2.1.2.4 Terminal type 4

4.2.1.2.4.1 Idle mode

The connection can be set up.

4.2.1.2.4.2 Active mode

In most cases the incoming connection can be set up at once, but there might be some exceptions. One of them is when the incoming connection is in the same system as the active connection and the active system not is able to deal with several active connections at the same time. Then the incoming connection may then be re-routed to another system so that both connections can be active at the same time.

4.2.1.2.5 Clarifying tables

When a user is moving around with a terminal, different areas can be entered. Either an area with just UMTS or GSM coverage can be entered or an area where both systems are available. This is depicted in Fig. 1 and the areas are denoted:

A UMTS area with just UMTS coverage

B Common area where both UMTS and GSM is available

C GSM area with just GSM coverage

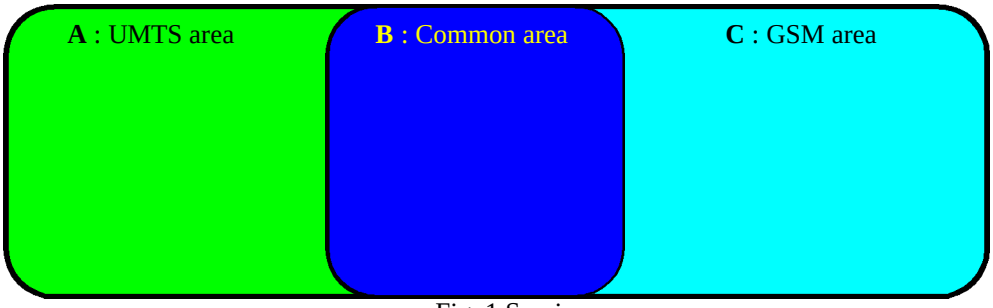


Fig. 1 Service area

According to the terminal types, described in section 4.1, the situation can be summarised as in Table 2. The table describes in which systems the terminal can be registered and if it can be in active communication in just one, one at a time or both systems simultaneously.

Table 2: Terminal situation

Terminal Type	Service area	Registered system	Active communication systems
1	A	UMTS	UMTS
	B	UMTS or GSM	UMTS or GSM
	C	GSM	GSM
2	A	UMTS	UMTS
	B	UMTS or GSM	UMTS or GSM
	C	GSM	GSM
3	A	UMTS	UMTS
	B	UMTS and GSM	UMTS or GSM
	C	GSM	GSM
4	A	UMTS	UMTS

B	UMTS and GSM	UMTS and GSM
C	GSM	GSM

Table 3 describes the different situations when an incoming connection is received by a terminal in active communication.

Table 3: The situation for a terminal in active communication when receiving an incoming connection

Terminal system		GSM								UMTS							
Connected system		CS				PS				CS				PS			
Add connection from system		GSM		UMTS		GSM		UMTS		GSM		UMTS		GSM		UMTS	
		C	P	C	P	C	P	C	P	C	P	C	P	C	P	C	P
Type	Service area																
1	A (UMTS)	-	-	-	-	-	-	-	-	X	X	O	O	X	X	O	O
	B (Common)	-	O	-	X	O	O	X	X	X	X	O	O	X	X	O	O
	C (GSM)	-	O	-	X	O	O	X	X	-	-	-	-	-	-	-	-
2	A (UMTS)	-	-	-	-	-	-	-	-	X	X	O	O	X	X	O	O
	B (Common)	X	O	S	S	O	O	S	S	S	S	O	O	S	S	O	O
	C (GSM)	-	O	X	X	O	O	X	X	-	-	-	-	-	-	-	-
3	A (UMTS)	-	-	-	-	-	-	-	-	X	X	O	O	X	X	O	O
	B (Common)	X	O	S	S	O	O	S	S	S	S	O	O	S	S	O	O
	C (GSM)	-	O	X	X	O	O	X	X	-	-	-	-	-	-	-	-
4	A (UMTS)	-	-	-	-	-	-	-	-	X	X	O	O	X	X	O	O
	B (Common)	X	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
	C (GSM)	-	O	X	X	O	O	X	X	-	-	-	-	-	-	-	-

C= circuit switched
P= packet switched
- = not possible
X= possible if direct re-direction of the connection in the CN. Applicable both for connections and signalling.
O= added connection OK if the terminal can support it and the network allows it
S= the terminal can be paged in the active system about the connection. For S to be possible the operators should have the different systems in their network. Changing of systems depends of the setting of the terminal. (manually/automatically switched).

For idle mode the table becomes much easier. Only two situations when the incoming connection maybe not can be received are identified, and these are when a terminal of type 1 and 2 is used and the incoming connection not is in the registered system.

Table 4: The situation for a terminal in idle mode when receiving an incoming connection

Registered sytem	**GSM**		**UMTS**	
Incoming connection	**GSM (CS or PS)**	**UMTS**	**GSM (CS or PS)**	**UMTS**
Type of terminal				
1	**OK**	**X**	**X**	**OK**
2	**OK**	**X**	**X**	**OK**
3	**OK**	**OK**	**OK**	**OK**
4	**OK**	**OK**	**OK**	**OK**

X= only possible if paged through the registered system and re-routed to this system.

4.2.1.3 Outgoing connection

When initiating a connection, the service may affect the choice of system. The service may just be supported in one system or the capabilities for the service may be better in a specific system.

4.2.1.3.1 The terminal in idle mode

If the appropriate system for this connection is present, the connection can be set up. If a service is required by the user that the registered system does not support or have limited support to, the network should hand over the terminal to the access system that supports the requested service. This means that the ME requests the call on the system in which it is registered and the network hand it over to the system that supports the service.

If the necessary system is not present, the service may be connected with limited capabilities in the present system.

One exception from this may be with usage of terminal of type 1. As the terminal is not able to make measurements on other systems when registered in one system, it is not possible for this type of terminal to scan its surroundings. A handover may in this case consume a great deal of time and the user may not be positive to that. Then it might be better to set up the connection with limited capabilites, as the latter suggestion above describes.

4.2.1.3.2 The terminal in active mode

4.2.1.3.2.1 Terminal type 1

No more connections, belonging to different systems, can be set up. In UMTS multicall is still possible.

4.2.1.3.2.2 Terminal type 2

No more connections, belonging to different systems, can be set up. In UMTS multicall is still possible.

4.2.1.3.2.3 Terminal type 3

In some cases it might be desirable to put the active connection on hold to set up another connection for a while. An example of this is when the terminal is busy with a data session in one system and the user wants to make a speech call in another system. The data connection can then be set on hold to make the user able to perform the speech call and after that resume the data session.

4.2.1.3.2.4 Terminal type 4

The connection can be set up.

4.2.1.4 Inter-system handover

This is the only handover that is interesting for this report. Other transactions such as to/from idle mode and to/from multicall is out of scope of this report.

Inter-system handover may occur due to undesirable circumstances e.g. loss of coverage or as a preferred option e.g. entering own private system area.

Handover may be initiated by:

- A service demanding a specific system
- The terminal loosing coverage of the active system
- The terminal coming into coverage of a higher preferred system, e.g. LSA concept
- The operator changing the system of usage due to traffic reasons

A handover may occur due to preferences of GSM usage rather than UMTS usage. Weather this handover shall be terminal or network initiated is FFS.

How to distinguishe between system selection and cell re-selection has to be considered here.

4.2.1.5 For mobility management

A LU from one system may be made valid in other systems as well.

Combining LU for different systems/networks, e.g. the terminal is registered in GSM and UTRA but still it is enough with one LU.

Combined LA or signalling between entities that makes it possible to direct a call or ask the terminal/user to change mode/system.

4.2.1.6 Roaming

When roaming, system should be choosen according to the preferred and forbidden network lists.

4.2.1.7 Loss of coverage

When the terminal is beginning to loose coverage it has to search for new networks to camp on.

To get the knowledge of other systems, two principles can be applied. Either the network tells the terminal to make a scanning of the surroundings because another system is available or the terminal continuously searches for other systems and tell the network when an interessting system is becoming available.

For the first alternative, knowledge of the different systems and the locations of their cells have to reside within the network.

With the last alternative, the search may be restricted to be performed if the terminal not is camping on and is registered in the highest prioritised network.

4.2.2 UMTS and 2nd generation or another system operated by different operators.

This scenario describes the case when the UMTS operator does not operate a 2nd generation system but has to rely on roaming agreements.

FFS

For this situation most of the things mentioned in the above chapters can be applied. Just the differences will be marked out in this chapter.

4.2.2.1 Power on

FFS

4.2.2.2 Incomming call/connection

When the user is choosen different operators for the systems in the terminal, a type 3 terminal might be the most interessting type of terminal.

4.2.2.2.1 Terminal type 3

When this type of terminal is in active communication, it can receive and answer pagings in the system(s) that is not in active communication. This implies that an indication can be given to the user that an incoming connection exists

in another system and the user can then choose to set up this connection or stay to the connection already in active communication. If the user chooses to change to the incoming connection, a hand over to the system where the incoming connection resides should be made.

4.2.2.3 Outgoing connection

FFS

4.2.2.4 Inter-system handover

FFS

4.2.2.5 For mobility management

FFS

4.2.2.6 Roaming

When the terminal comes into an area where no system of the users own operator is present, a system of another operator has to be choosen. The roaming agreements between operators should be the basis of the prefered network/PLMN lists.

FFS

4.2.2.7 Loss of coverage

FFS

4.3 Evaluation

Most work associated with handover between UMTS and GMS/GPRS is already initiated in the standardisation. The work progresses but it is not sure that it will be finalised for R99.

Two independent search mechanisms are needed:

- Manual/automatic system search with a preferred system list
- Manual/automatic network search with a preferred network list / forbidden network list

A function residing within the network that gives the operator the opertunity to move the user/terminal from one system to another is desirable within the network.

An entity that keeps track of in which system the terminal is camping or in active communication for the moment is also desirable.

5 Identities

[Editor's note: in this chapter welldefined identities as MSISDN, IMSI et al, will be used and the combination of them will be discussed.]

Multiple identities, one identity for each system but only one subscriber number.

5.1 Signalling of multiple identities

FFS

5.2 Treatment of multiple identities

In what entity are the identities combined and in what way?

FFS

6 Ongoing work and identified additional work

[The work in all 3GPP WG:s will be reviewed from a multi-system terminal perspective and needed additional work will be identified.]

6.1 TSG SA

6.1.1 SA1

6.1.2 SA2

6.1.3 SA3

6.1.4 SA4

6.1.5 SA5

6.2 TSG RAN

6.2.1 RAN1

6.2.2 RAN2l

6.2.3 RAN3

6.2.4 RAN4

6.3 TSG CN

6.3.1 CN1

6.3.2 CN2

6.3.3 CN3

6.4 TSG T

6.4.1 T1

6.4.2 T2

6.4.3 T3

7 Conclusions

7.1 General

In the work with this report several issues have been found that need additional treatment to make multi-mode terminals usage efficient.

Action points:

1. agree terminal type specifications
2. check that the new terminal definitions are compatible with all the other sections of this document
3. Issue terminal types to RAN, SA and CN about the terminal type description and the impacts on each area, e.g. active call handover implications for signalling through the core network, complete LS by end of next meeting (i.e. September 99)?
4. Consider these scenarios with regards to other access technologies
5. Review the issue related to PS and CS connections

7.2 Identified requirements

A network entitiy that knows the users preferences conserning choice of system. This functionallity is necessary to be able to direct the user to a preferred system and if just network originated handover is possible.

7.3 Identified work items

Annex A: Procedures in connected mode

5.1 General description

A terminal is considered to be in connected mode when at least one signalling/RRC connection is active in one ore several of the modes and or systems.

In the connecting state of a multi-mode terminal it is important to have connections between the different states in which the terminal can be active.

To enable a terminal to move from the idle mode to a connected state it is important for the different modes to be connected:

- to avoid connection failures
- to allow correct call set up according to terminal type
- for allocation of the correct system for the service requested

This section identifies the actions that affect the connected mode of a user, e.g. when they enter new system or mode coverage areas. The addition or modification of bearers to a call will impact the connected mode of the terminal and will become more complex when handovers between systems are designed., particularly if the nature of the bearer is altered e.g. PS to CS. All the possible changes to the connected mode shall be reviewed here and their impact reviewed with each of the terminal types. The figure below identifies the possible changes to the connected mode that shall be discussed, they split into 3 main areas:

- Call set up and termination
- Addition, modification or lose of a bearer
- Handover to another system

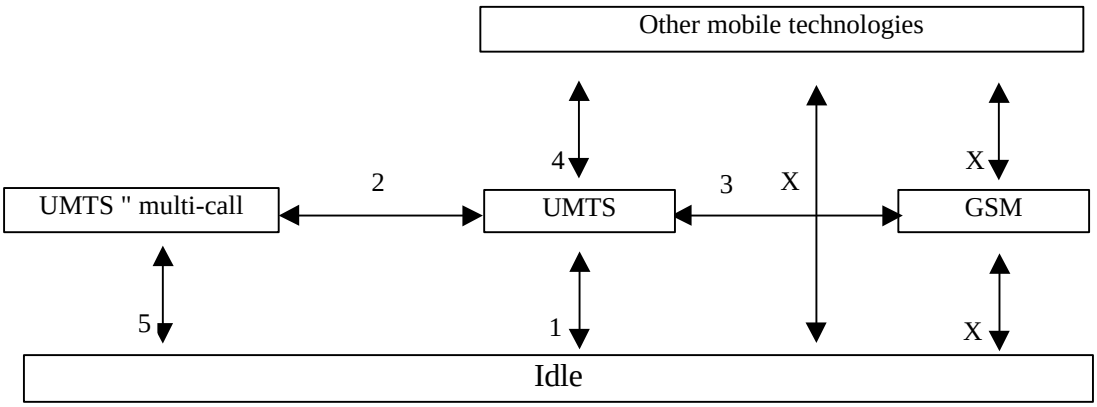


Fig: 5.1.1 - Transition route between systems (the numbering system is discussed below).

Idle mode in the figure 5.1.1 describes the idle mode for any of the systems. All other boxes identify an active call on the specified system. The UMTS Multicall box indicates that the terminal may use more than one bearer, whether these bearers are related or not.

5.1.1 In Scope

A number of connecting states have been identified in the diagram above. The following connecting states shall be considered as in scope for this section of the document:

5.1.2 Transition 1 UMTS - Idle Mode

This deals with the transition of the terminal from the idle mode to the connected state on the UMTS system i.e. call set up or call end,.

5.1.3 Transition 2 UMTS Multicall

During a call on the UMTS system it shall be possible for another call to be established i.e. call waiting, this state allows the user to accept the second call, and clear down as and when necessary. The two bearers may be related (e.g. separate video and audio bearers for video telephony) or independent (e.g. call waiting).

5.1.4 Transition 3 UMTS - GSM

This interface considers the:

- Complete handover of a call to GSM from UMTS or vv
- Addition of a connected state in GSM e.g. a speech call or vv

5.1.5 Transition 4 UMTS to Other Access Technologies

This interface considers the:

Complete handover of a call to other access technologies from UMTS or vv

Addition of a connected state to other access technologies or vv

5.1.6 Transition 5 Idle Mode - UMTS Multiparty

This deals with the call set up or end of multiple UMTS bearers.

5.1.7 Out of Scope

A number of scenarios have been identified as out of scope for this section these include:

Idle mode to GSM or vv

Complete or partial call handover from GSM to other access technologies or vv

Call set up or termination from idle mode to other access technologies

5.1.8 For Further Study

The transition of the same service to another mode, the identified transitions are:

State 1 State 2

UMTS PS UMTS CS

UMTS PS GSM PS

UMTS CS GSM CS

UMTS PS GSM CS

UMTS CS GSM PS

UMTS PS other access technology PS

UMTS CS other access technology CS

UMTS PS other access technology CS

UMTS CS other access technology PS

These transitions can be done in either direction.

5.2 Connecting State

The following figure describes the connecting states in UMTS and GSM/GPRS and the interworking between them.

In Figure 5.2.1 the connecting states for a terminal capable of CS connections is shown. It includes the CS part of UTMS and the part of GSM that is connected to PSTN/ISDN only.

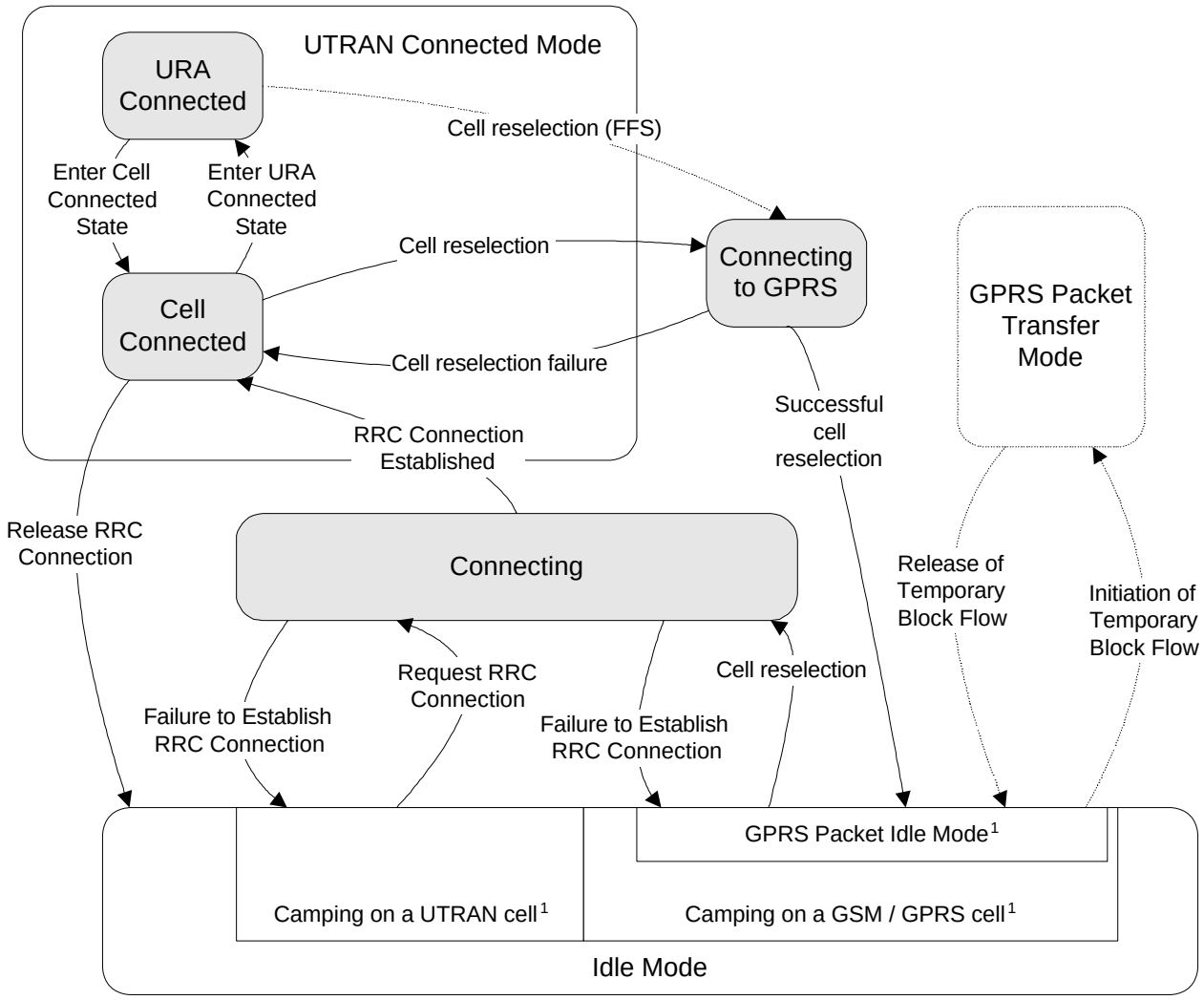
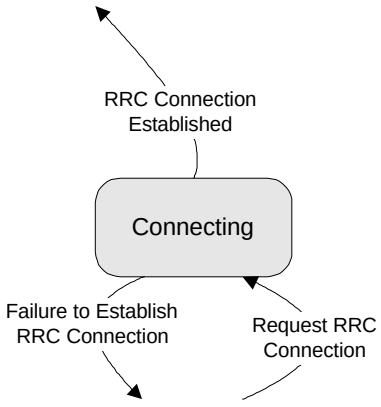


Figure5.2.1: UE RRC states and State Transitions including GSM/GPRS (IP only)

[[1]: The indicated "Radio access modes" in Idle Mode are only included for clarification and shall not be interpreted as states.]

5.2.1 Transition to Connected Mode

The following transitions will apply to the scenarios discussed below, but each scenario may have its own specialised requirements.



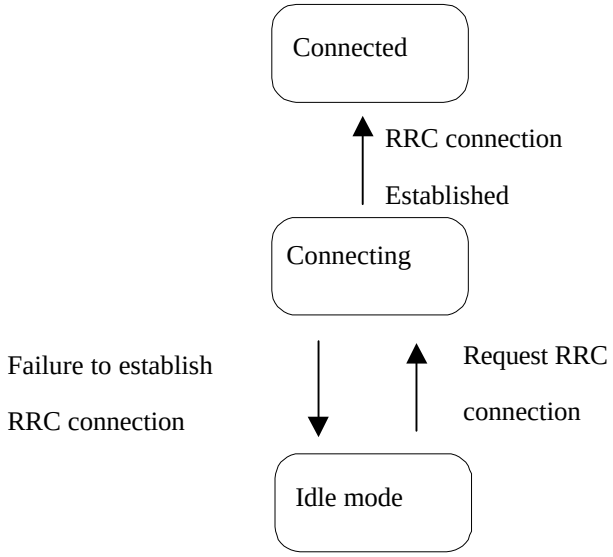


Figure 5.2.1.1 - Transition route to connected mode.

5.2.1.1 Transition 1

The terminal can move from the idle mode to the connecting mode by receiving a paging requesting or by a mobile originated service request. If the connection request is successful the terminal shall move into the connected state, but if the request fails the terminal shall move back to the idle mode, see figure 5.2.1.1.

5.2.1.2 Transition 2

If the terminal requests or receives a request to set up another connection that is independent of the existing connection the transition process described in point 1 applies. The set up of the new connection shall not affect the existing connection whether the new connection succeeds or fails.

If the terminal requests to enhance or modify the bearer connection that is currently in use then this shall be done, and if completed successfully the existing bearer may be modified or added to.

If the connection request fails the call shall return to its previous state and not to the idle mode (i.e. a call drop).

5.2.1.3 Transition 5

This connection route shall be taken when a user requests a service that needs 2 or more separate bearers to support it, e.g. video telephony where the speech and video bearers are independent, but some synchronisation between the 2 is required. If the request succeeds the call shall move into the connected state. If the request fails the terminal shall move back to the idle mode. This can be considered an enhanced version of transition 1.

5.2.1.4 Transition to Idle Mode

The terminal shall return to the idle mode when:

- a request to establish a call has failed and there are no other connections currently being used
- any of the parties involved with the call requests a call termination
- the call is transferred (i.e. a handover) to another system from the UMTS system, the connection with the UMTS system shall return to the idle mode

5.3 Inter system Handover

5.3.1 Transitions 3 & 4

Establishing connections with non-UMTS systems from their respective idle modes is out of scope for this document as these procedures are described in other standards, e.g. SMG for establishing a full rate call on GSM. This section shall only consider the handover of a service from the UMTS system to the GSM/GPRS or any other system, or vv. This handover may occur due to undesirable circumstances e.g. loss of coverage or as a preferred option e.g. entering own private system area.

Handover may be initiated by:

- A service demanding a specific system
- The terminal loosing coverage of the active mode
- The terminal coming into coverage of a higher preferred system, e.g. LSA concept

5.3.2 UMTS to GSM

The requirements state that handover shall be included in R99. This section considers the handover of an active call whether from UMTS to another system or vv. The terminal may have a number of bearers active at one time and may hand one or more of these over. The figure below describes the basic procedure that the handover would take and the possible outcomes.

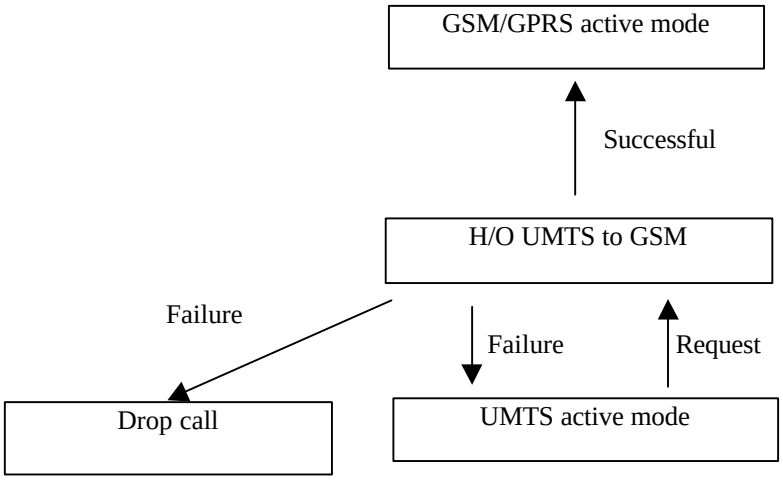


Fig. 5.3.2.1 - UMTS to GSM Handover

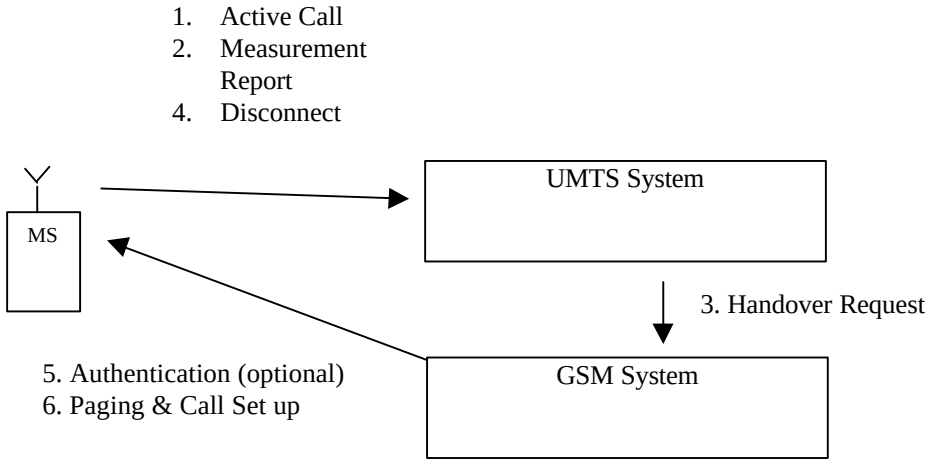
5.3.3 Terminal Originated Handover

A terminal originated handover may occur due to the user preferring to use the GSM service than UMTS e.g. it is cheaper for a speech call on GSM than UMTS.

5.3.4 Terminal Type I

If terminal shall requests a handover to GSM and the network permits this, the terminal shall make a measurement report about the GSM system. (The terminal shall only make a handover request if it can see a GSM network.) The measurement report shall be passed to the network in the active call. The UMTS network shall inform the GSM system about the handover request and the GSM network shall start the process of connecting a call through its system. The terminal shall then disconnect from the UMTS system, then register with the GSM system and listen for

the paging messages and establish a call, if both systems are controlled by the same Network Operator authenticating



the terminal onto GSM is optional. This will help reduce the handover time. This is shown below:

Fig. 5.3.4.1 - Call handover sequence from UMTS to GSM.

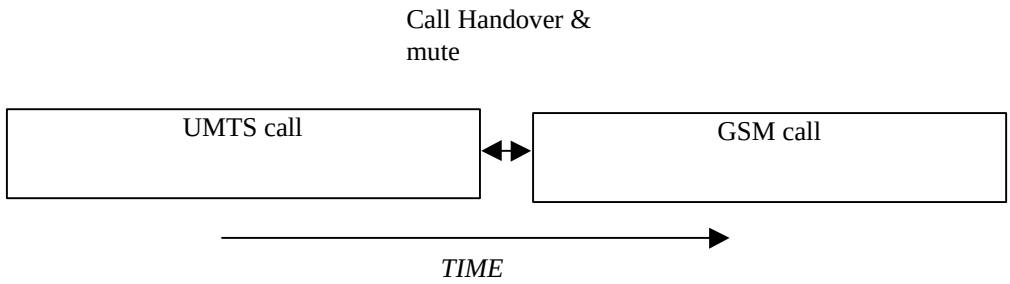


Fig. 5.3.4.2 - Time sequence of active calls.

If the handover fails, the network should attempt to re-establish the call on the UMTS system, if this fails the call will drop.

A number of issues are highlighted below with the handover:

The delay between the disconnection of the UMTS call and the connection of the GSM call may lead to poor user experience if not handled correctly

The signalling may become complex in the networks

This could be difficult to perform whilst e.g. roaming as the 2 operators may be different companies - this will lead to issues over call routing and hence more complexity for the core network

5.3.5 Terminal Type II

This process is similar to the type I terminals. The only change is that the type II terminal can be already be registered on the GSM network and be able to listen and respond to paging messages on the GSM that are used for call handover. The terminal will only listen for and respond to paging messages that are related to the call handover.

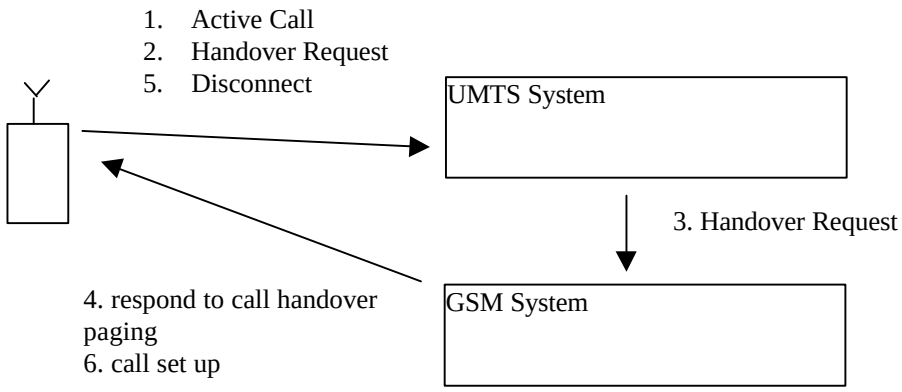


Fig. 5.3.5.1 - Call handover sequence from UMTS to GSM.

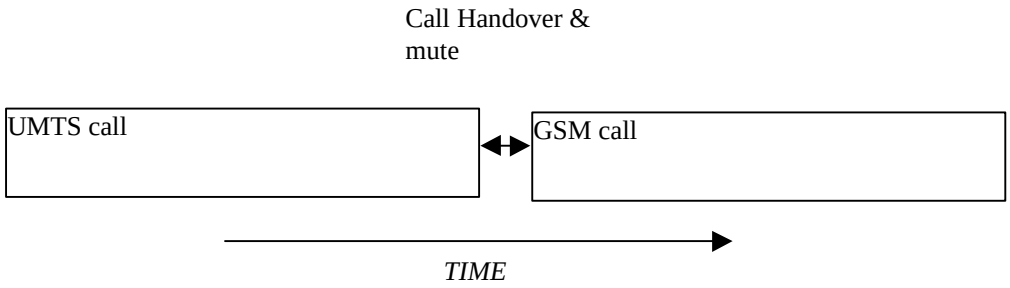


Fig. 5.3.5.2 - Time sequence of active calls.

The time elapse for terminal type II at handover shall be shorter than that of terminal type I. If the handover fails, the network should attempt to re-establish the call on the UMTS system, if this fails the call will drop.

5.3.6 Terminal Type III

The terminal shall request a handover to GSM via the UMTS system, the terminal shall be aware if GSM coverage is available hence stopping unnecessary handover requests. The terminal shall then be paged from the GSM network and the terminal shall respond. Once a connection has been established with the GSM system the UMTS connection shall return to its idle mode. So if the GSM connection cannot be made the call reverts back to UMTS.

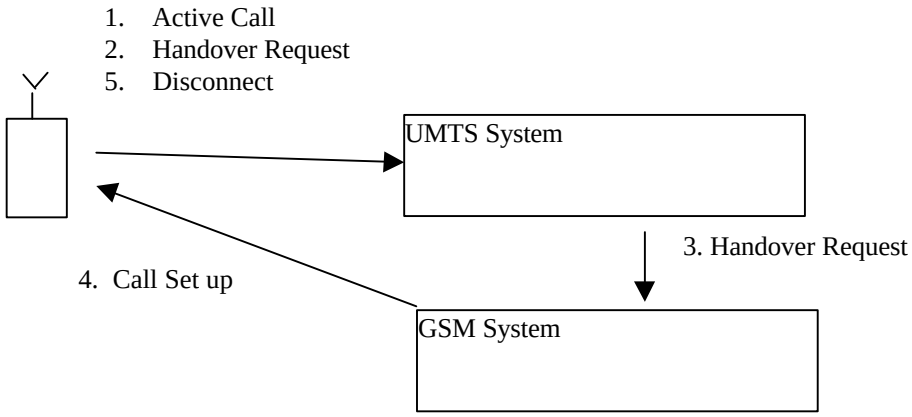


Fig. 5.3.6.1 - Call handover sequence from UMTS to GSM.

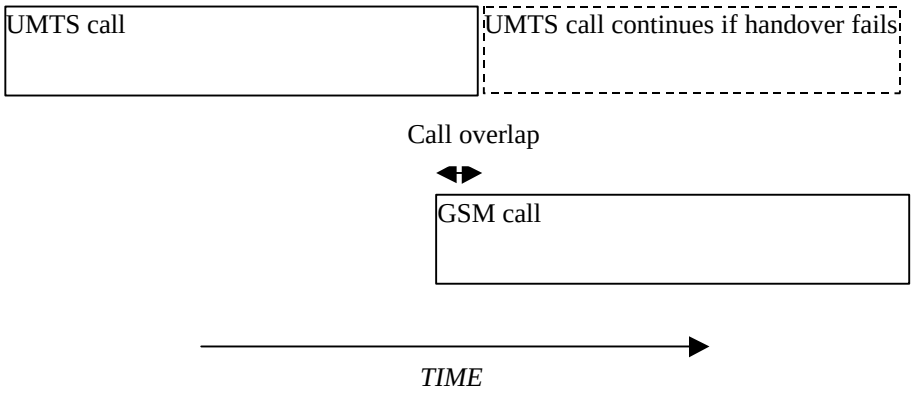


Fig. 5.3.6.2 - Time sequence of active calls.

The GSM call shall be established before the UMTS call is terminated, this will allow a true seamless handover. If the call handover fails then the call will remain on the UMTS system.

5.3.7 Network Originated Handover

This scenario may occur when the terminal is on the edge of UMTS coverage with an active UMTS call. The terminal will make measurement reports to the UMTS system about its environment, the UMTS system may decide that a handover to GSM is required to maintain the call. The UMTS network shall then inform the terminal to make the handover. The procedure to perform this handover then follows the same route as described for the terminal originating handover cases above.

5.3.8 General Issues identified to be considered for each scenario identified above and FFS:

Complexity issues - signalling in the network, complexity of the terminal

Delay requirements - at handover between UMTS and GSM systems, particularly for terminal types I & II, and call types i.e. more delay can be tolerated when web surfing than a speech call

Roaming - handover becomes more complex, and these issues need to be considered

5.3.9 GSM to UMTS

The process of handover from GSM to UMTS will in principle be similar to the handover from UMTS to GSM. There will have to be further study into this area once the UMTS to GSM handover has been clarified. Note: there will be issues over bearer selection, QoS issues etc at the point of handover.

5.3.10 UMTS to other systems

TS [23.121], 7.7 – Alternate Access technologies to UTRAN (BRAN/HiperLAN)

This type of handover will mainly be used for corporate and home environments. There are 2 possible network architectures to take into account:

- both systems are managed by the same operator
- both systems are managed by different operators

In the first case the handover may be simple as all the mobility management and signalling is managed by a single core network, this will allow a fast handover of the call. The network will make the handover more reliable as it will be able to force the terminal back to the original connection if the handover fails.

In the second scenario the handover will be slower as location information, signalling and routing of the call has to be transferred completely to another network. If the handover has failed and the first network has passed the call to the other operator there is no chance to re-establish the call.

The complexity of the call handover will vary depending on the other access technology used, e.g. DECT, BRAN, HiperLAN.

5.4 Evaluation

Most work associated with handover between UMTS and GMS/GPRS is already initiated in the standardisation. The work progresses but it is not sure that it will be finalised for R99.

6. agree terminal type specifications
7. check that the new terminal definitions are compatible with all the other sections of this document
8. Issue terminal types to RAN, SA and CN about the terminal type description and the impacts on each area, e.g. active call handover implications for signalling through the core network, complete LS by end of next meeting (i.e. September 99)?
9. Consider these scenarios with regards to other access technologies
10. Review the issue related to PS and CS connections

Annex B: Procedures in idle mode

RAN2 is working with a specification that outlines how the terminal (UE) shall work in idle mode, [25.304]. In this specification the general description of idle mode is described and three different procedures for idle mode are identified. These three procedures are: PLMN Selection and Reselection, Cell Selection and Reselection and Location Registration. It is said in the beginning that the idle mode of GSM should be included in this specification, but so far no details are included. As far as SWG5 can realise, the Radio Access mode selection and reselection has to be included too. This has been included in earlier versions of the document but was then taken away as it was identified as FFS.

For the purpose of being able to make a suggestion to RAN2 and other groups, on how to proceed in this area, this section was produced.

6.1 General description of idle mode

Definition of idle mode:

The UE is in idle mode when the connection of the UE is closed on all layers, e.g. there is neither an MM connection nor an RRC connection.

6.2 Radio access mode selection and reselection

The radio access mode selection and reselection may differ from what kind of terminal used. Although there are some common functionalities that are desirable. They are described in the text below.

For the procedure of radio access mode selection and reselection it is assumed that the terminal frequently searches for available systems/PLMN:s. The procedure may differ between types of terminals. How this is performed in detail is FFS.

After a registration in a desired system (depending on the user settings for preferred system/network), the terminal shall stay in this system unless a system selection/reselection is initiated either by the terminal or the network, the network is lost or a certain service that requires a specific system is chosen.

If no network is available within the same system, the terminal shall search for other systems for suitable networks. For the choice of systems a preferred system list should reside within the terminal. This list could be changed by the user or the operator and should reside on the USIM-card.

If the terminal is set to automatic system search and it is registered in a not preferred system, i.e. at a low priority in the preferred system list, the terminal shall switch to another system, as soon as the more preferred system is available. When moving at the borders of different systems, timers should be set to minimise the ping-pong effect that could occur when no system has good coverage.

While registered to a system, all MM procedures of that system shall apply.

6.2.1 Terminal type I

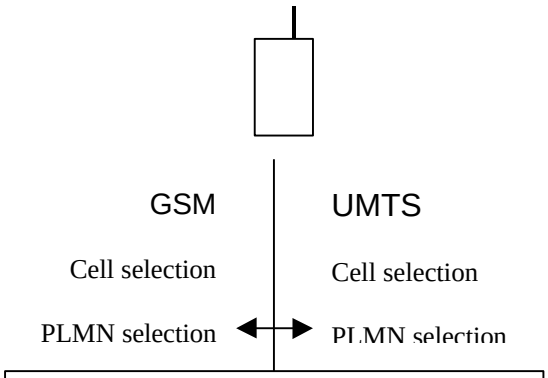


Figure 0: Idle mode procedures for a type I terminal

In case of a type I-terminal the selection of the system is depending on the terminal settings (e.g. UMTS-system preferred stored in the terminal and changeable by the user). It the operator wants to direct the terminal to a special system (due to e.g. congestion) a reject message should be sent to the terminal while trying to register. This implies new signalling in GSM and UMTS.

If the PLMN is lost for this type of terminal, the terminal should go for PLMN search within all systems, depending on if the terminal settings tell the terminal to stay in the preferred system or to search for PLMN in other systems too.

6.2.2 Terminal type II and III

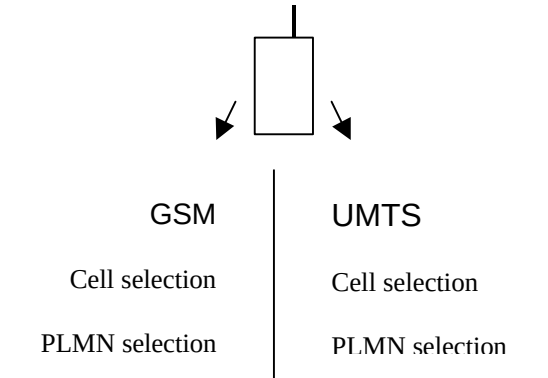


Figure 1: Idle mode procedures for a type II and III terminal

In case of a type II- and a type III-terminal, the idle mode procedures for each system applies. The motivation for this is that the terminal is registered in both modes and is able to follow the procedures for them. If all systems are run by the same operator, the terminal shall have a preferred mode, in which the signalling of location updating and registration is performed.

6.3 PLMN selection and reselection

After a power off/on the terminal shall always first look for the last network in the last system in which it was registered for the new registration procedure.

If the network is lost, the terminal shall search for a suitable network within the same system first (presuming the user has set the terminal to automatic switching with a preferred network list).

Otherwise the PLMN selection/reselection shall follow the specifications of the registered systems.

6.4 Cell selection and reselection

This should be performed according to the specification in the registered system.

6.5 Evaluation

In the referenced document, created by RAN2, the choice of radio access mode/system is still FFS and in this area there need to be some work done.

Two independent search mechanisms are needed:

- Manual/automatic system search with a preferred system list
- Manual/automatic network search with a preferred network list / forbidden network list

Bibliography

The following material, though not specifically referenced in the body of the present document (or not publicly available), gives supporting information.

<Publication>: "<Title>"

History

Document history		
V 0.1.0	1999-04	First draft (scope, definitions, structure) proposed by editor
V 0.2.0	1999-05	Updated draft (types of terminals and scenarios) proposed by the editor
V 0.3.0	1999-07	Updated draft, according to discussion on the last meeting in Miami.
V 0.4.0	1999-08	Updated draft, according to discussions on the last meeting in Malmö
V 0.5.0	1999-09	Updated draft, according to discussions on the last meeting in Helsinki. The many detailed descriptions have been excluded and instead the main points have been put in the scenarios. They should be considered as a basis for a future requirement document for multi-system terminals.
V 0.6.0	1999-10	Updated draft, according to discussion on the T2 meeting in Kyongju. The structure of the report is now considered that stable that it can be presented for T2 to be raised to version 1.0.0 and for TSG T for informaion.
v 1.0.0	1999-10	Presented to TSG-T#5 for information

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