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Technical Report

3rd Generation Partnership Project (3GPP); Technical Specification Group (TSG) Terminals; Multi-mode UE issues Categories, principles and procedures (Release 1999)



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Foreword

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

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

Version m.x.y

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-mode UEs, combining e.g. second-generation radio access system with UMTS, are necessary. The present document describes issues concerning multi-mode UEs from a service and a terminal point of view.

1 Scope

This 3GPP Technical Report identifies multi-mode User Equipments categories. This technical report also describe the general principles and procedures for the multi-mode operation standardised in the 3GPP specifications. In particular, this TR is focused on a type 2 UE, as defined in Clause 4 in the present report. This type of UE can when utilising one mode, perform monitoring of another mode and report it utilising the current mode. This type of UE does not support simultaneous reception or transmission through different modes.

The scope of this TR is the type of terminal implemented with at least the following modes:

- UTRA FDD and/or TDD mode
- GSM mode

Regarding the GSM mode, it encompasses the capabilities offered by the GSM technical specifications, e.g, Circuit Switched and Packet Switched services using either GMSK or 8-PSK modulation in the frequency bands specified in the GSM specifications.

The present report is built on and references specifications/reports being produced in 3GPP or within other relevant foras e.g. ETSI SMG.

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 23.122: "NAS Functions related to Mobile Station (MS) in idle mode" v3.2.0
- [2] 3G TS 25.304: "UE Procedures in Idle Mode" v1.2.0
- [3] 3G TS 22.129: "Handover Requirements between UMTS and GSM or other Radio Systems" v3.2.0
- [4] 3G TR 21.905: "Vocabulary for 3GPP Specifications " v1.0.0
- [5] 3G TS 22.011: "Service accessibility" v3.1.0
- [6] 3G TS 25.303: "UE Functions and Interlayer Procedures in Connected Mode" v3.0.0
- [7] TS GSM 05.08: " Digital cellular telecommunications system (Phase 2); Radio subsystem link

3 Definitions, symbols and abbreviations

3.1 Definitions

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

Active communication: a UE is in active communication when it has a CS connection established. For PS active communication is defined by the existence of one or more Activated PDP contexts. Either one or both of the mentioned active communications may occur in the UE.

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. See 3G TS 23.122 [1] and 3G TS 25.304 [2].

Multi-mode UE: 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. [3]

Radio Access Mode: Mode of the cell, FDD or TDD [4]

Radio Access Technology: UMTS, GSM etc [4]

3.2 Abbreviations

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

CC	Call Control
CS	Circuit Switched
FFS	For Further Study
GMM	GPRS Mobility Management
HO	Handover
LA	Location Area
LU	Location Update
MM	Mobility Management
MMI	Man-Machine Interface
PS	Packet Switched
RA	Routing Area
RAT	Radio Access Technology
RR	Radio Resource
RRC	Radio Resource Control
SM	Session Management
URA	UTRAN Registration Area

Additional definitions and abbreviations can be found in TR 21.905 [4].

4 General Aspects

In the context of this Technical Report a multi-mode UE is considered to be a UE with at least one UMTS part (UTRA FDD and/or TDD). In addition, the multi-mode UE supports one or more other radio systems, e.g., GSM CS/PS. Generally multi-mode UEs can be split in two categories based on the number of subscriptions. Either they have one and only one subscription, which is common for all modes of operation, or they have several subscriptions typical one per mode of operation. The first case with only one subscription is considered to be the typical case where the different modes are related to different radio access technologies on the same type of core network, e.g., UTRA FDD/TDD and GSM radio on a MAP based core network.

This report deals only with the case of multi-mode UEs with one and only one subscription. The case of multiple subscriptions can either be very simple or very complex. The modes can either work fully independently in which case each mode just would have to comply with the relevant standard or there are dependencies on the states between modes which makes the operation of this type of equipment in relation to the networks very complicated. Therefore the latter case is for the time being not considered of interest.

This report will mainly deal with the interworking of UMTS and GSM, as the standards provides support for dual-mode of operation for these two radio access technologies.

4.1 Types of UEs

As stated earlier, this technical report only considers multi-mode UEs with a single common subscription for all of the supported modes. For Multi mode UEs with a single common subscription different types of UEs can be imagined and are briefly introduced in the following. In the descriptions of the types the term mode is used as short term for both Radio Access Technology and Radio Access Mode.

4.1.1 Type 1

This type of UE operates in each of the supported modes as a single mode UE, i.e., when in a given mode the UE does not scan for or monitor any other mode. Change of mode is based on manual selection of a new mode. Manual selection of mode is understood to be a selection with user interaction. In the case this process is automated, the automated process shall use a timer to avoid repeated change of mode (ping-pong).

When in a given mode the UE shall comply with the standard for that mode. When a new mode is selected, the mobile shall react towards the old mode as a single mode UE which is being switched off and towards the new mode as a single mode UE which is being switched on in that mode.

4.1.2 Type 2

This type of UE can when utilising one mode, perform monitoring of another mode and report it utilising the current mode. The UEs monitoring and reporting capabilities can be considered to fulfil the specified behaviour for Multi-mode operation of the respective modes. When in a given mode, this type of UE shall comply with the standard for that mode including its specified multi-mode operation. An overview of Multi-mode UMTS GSM operation can be found in clause 5 of this technical report. This type of UE does not support simultaneous reception or transmission through different modes. If the UE supports manual selection of mode, and manual selection of mode is activated, the UE shall behave as a UE of Type 1.

4.1.3 Type 3

For multi-mode in general a Type 3 UE, which can receive simultaneously in more than one mode, but not transmit simultaneously in more than one mode has been suggested. Utilisation of the additional capabilities of the Type 3 UE compared to the Type 2 UE is considered complex due to the cross impact of the two receptions. The current UMTS standard do not provide specific support for this type of UE. Therefore this technical report does not further treat this type of terminal.

4.1.4 Type 4

For multi-mode in general a Type 4 UE, which can receive and transmit simultaneously in more than one mode has been suggested. Utilisation of the additional capabilities of the Type 4 UE compared to the Type 2 UE is considered complex due to the cross impact of the two receptions and/or transmissions. The current UMTS standard do not provide specific support for this type of UE. Therefore this technical report does not further treat this type of terminal.

5 Multi-mode operation

This clause provides an overview of the multi-mode operations as specified in the standard. Throughout this clause the UE is assumed to be a UE of type 2 as defined in clause 4.

5.1 Multi-mode operation of UMTS and GSM

5.1.1 Principles

Considering that the UMTS and GSM standards are using a common core network specification and that UMTS is seen as a natural evolution path for GSM operators, it has been a requirement through the standardisation to provide for multi-mode UMTS GSM operation. This clause describes the basic principles for the multi-mode of operation as specified in the UMTS and GSM standards.

Multi-mode operation is based on a separation of the PLMN selection from the mode and cell selection. Meaning the PLMN is chosen first and, once the PLMN is selected, the choice of the mode has to be decided among the ones offered by the chosen PLMN as a part of the cell selection/reselection process, and thus is controlled by the selected operator through the parameter setting. The PLMN can be chosen by the user/application, but once the PLMN is selected, the user only provides wishes of the requested services and has no capability to actually choose the serving cell or the Radio Access Technology and its mode.

5.1.2 PLMN selection

The procedures for PLMN selection at power on and when recovering from lack of coverage is described in 3G TS 22.011 [5] and 3G TS 23.122 [1]. Two procedures are specified for the PLMN selection, manual selection and automatic selection. The manual selection is a PLMN selection, which is based on user interaction, e.g. the user actively chooses a PLMN from a list of available PLMNs, refer 3G TS 22.011 [5] for the detailed specification. The automatic PLMN selection is based on specified procedure by which the UE first search for the last registered PLMN and if that is not available then it search for the HPLMN followed by a search for other PLMNs. In automatic mode the search order for the PLMNs can be controlled by the prefer PLMN lists, see 3G TS 22.011 [5] and 3G TS 23.122 [1], When a suitable cell (see 3G TS 23.122) of a PLMN is found, the UE attempts to register on that PLMN. If the registration is successful, the UE camps on a cell of the PLMN and enters the cell re-selection procedures.

5.1.3 Control of Radio Access Technology and Mode used

When the UE has registered on a PLMN, the serving network (PLMN) is in control of any change of mode. In idle mode this is controlled through the cell selection parameters provided to the UE. When the UE is engaged in active communication the change of mode is controlled by the network through the parameters provided to the UE and/or the information about surrounding cells provide to the network by the UE, see 3G TS 25.303 [6], 3G TS 25.304 [2] and TS GSM 05.08 [7].

When a connection is being established, it is up to the network to allocate the resources appropriate for the connection in the radio access technology and mode decided by the network. E.g., if the UE is responding to paging on a GSM cell and the incoming connection is a video conference call, then the network can assign or handover the UE to a cell of a Radio Access Technology and Mode with the appropriate capabilities, such as UTRA FDD or TDD.

Similarly if one connection already exists between the UE and the network and a second connection is to be established which requires capabilities not provided by the mode currently used, it is up to the network to handover the mobile station to a cell of a Radio Access Technology and Mode with the appropriate capabilities to support both connections.

In case where the network is not able to allocate resources with the capabilities needed for the connection requested, mechanisms exist which allows the network to negotiate the type of connection/service and thereby change the required capabilities.

5.1.4 Handover between Radio Access Technologies and Modes

Handover between Radio Access Technologies/modes may be initiated for the following reason:

- A service demanding specific capabilities,
- The UE losing coverage of the active mode,
- The UE coming into coverage of a mode which by the network is considered better for the service used,
- Due to traffic reasons,

The initiation of the handover between radio access technologies/modes is done similarly to the handover within a radio access technology.

At handover between radio access technologies/modes the service continuity is dependent on whether the UE and the network supports the equivalent service in the new mode. E.g., if a parallel CS and PS connection exist in a UMTS mode, then both of these sessions can only be maintained if the UE is either GSM Dual Transfer Mode capable or supports GSM/GPRS class A mode of operation. For cases where the service and the communication are maintained through handover the change in e.g. service capabilities, speech codecs, data rates or QoS might be apparent to the user.

5.1.5 Mobility Management aspects

While camped on a cell of a given Radio Access Technology/Mode all MM procedures of that mode shall apply. The UE only perform location update when the new cell is in a new location area irrespectively of whether cell changes imply a change of Radio Access Technology/Mode. Similarly apply to the routing area update. For the detailed specification see 3G TS 23.122 [1].

Change history

Change history							
Date	TSG #	TSG Doc.	CR	Rev	Subject/Comment	Old	New
15/03/00	7	TP-000027			Presented for approval to TSG-T#7. Not approved and renamed from 21.910 to 21.810	2.0.0	2.0.0
					Major changes in the structure and content of the report. The scope, section 4 and 5 redrafted and section 6 deleted. The former annex A deleted and replaced with section 7 as an informative annex. Editorial changes in the definitions and the references for cleaning up.	2.0.0	2.1.0
					The main body of the report moved to the 900-series in TR 21.910 leaving annex A in TR 21.810. The TR 21.910 has continued with the version numbering from the last approved version of this report, before it was moved to the 800-series.	2.0.0	2.1.0