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Digital Enhanced Cordless Telecommunications/ Global System for Mobile Communications (DECT/GSM); Integration based on dual-mode terminals

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Foreword

This Technical Report (TR) has been produced by ETSI Project Digital Enhanced Cordless Telecommunications (DECT).

Introduction

The primary objective of this document is to examine the technical issues relating to dual mode (combined Digital Enhanced Cordless Telecommunications/Global System for Mobile communications (DECT/GSM)) terminals in order to guide future work in this area.

The substantive clauses of this document are as follows:

Clause 5 examines the various configurations and scenarios foreseen for Dual Mode Terminals (DMTs). The following aspects are considered:

- the constraints resulting from the radio system architecture employed;
- the different combinations of subscription types that may be used;
- the possible network configurations which may be used to support a dual mode service;
- the different service packages that an operator may provide to its customers.

Clauses 6, 7, 8 and 9 attempt to identify the technical areas that has to be addressed by the TBR for DMTs.

Clause 6 addresses the requirements for protection of the spectrum.

Clause 7 addresses the requirements for protection of the network.

Clause 8 examines general protocol issues which need consideration in order to ensure interoperability.

Clause 9 considers the telephony requirements which have to be met.

Clause 10 concludes on type approval aspects basic DMTs.

1 Scope

To investigate radio and network aspects and clarifying the possibilities as well as the problems related to dual-mode terminals. This document focuses on possible early implementations and will form the basis for the first edition of TBR 39 [28] in the sense that it identifies how basic Dual Mode Terminals (DMTs) can be type approved using existing TBRs. For Global System for Mobile communications (GSM), both phase 1 and phase 2 specifications are considered.

Basic DMTs are considered to comprise of both Digital Enhanced Cordless Telecommunications (DECT) and GSM parts of which only one at the time is to be active. Advanced dual-mode terminals, where the DECT and GSM parts are further integrated or where the DECT and GSM parts can be active at the same time, will be considered in DTR/DECT-010096 [35].

The same considerations apply for dual-mode DECT/DCS1800 terminals and for DECT/GSM/DCS1800 dual mode/dual band terminals. The term GSM is considered to cover all the frequency bands, and combinations of frequency bands allowed for GSM type equipment, i.e. P-GSM, E-GSM, R-GSM, DCS1800 or dual band GSM/DCS.

NOTE: A terminal comprising multiple GSM parts operating on different frequency bands is considered as a dual band terminal. A terminal comprising both DECT and GSM parts is referred to as a DMT. A dual mode/dual band terminal is a terminal comprising a DECT part and a GSM/DCS1800 dual band part.

This document states the assumptions to be made for the first edition of TBR 39 [28] and attempts to identify if further dual mode standardization is needed.

2 References

References may be made to:

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

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

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

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

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

[1] ETS 300 175-1: "Digital Enhanced Cordless Telecommunications (DECT); Common Interface (CI); Part 1: Overview".

[2] ETS 300 175-2: "Digital Enhanced Cordless Telecommunications (DECT); Common Interface (CI); Part 2: Physical layer (PHL)".

[3] ETS 300 175-3: "Digital Enhanced Cordless Telecommunications (DECT); Common Interface (CI); Part 3: Medium Access Control (MAC) layer".

[4] ETS 300 175-4: "Digital Enhanced Cordless Telecommunications (DECT); Common Interface (CI); Part 4: Data Link Control (DLC) layer".

[5] ETS 300 175-5: "Digital Enhanced Cordless Telecommunications (DECT); Common Interface (CI); Part 5: Network (NWK) layer".

[6] ETS 300 175-6: "Digital Enhanced Cordless Telecommunications (DECT); Common Interface (CI); Part 6: Identities and addressing".

[7] ETS 300 175-7: "Digital Enhanced Cordless Telecommunications (DECT); Common Interface (CI); Part 7: Security features".

[8] ETS 300 175-8: "Digital Enhanced Cordless Telecommunications (DECT); Common Interface (CI); Part 8: Speech coding and transmission".

[9] ETS 300 085 (1990): "Integrated Services Digital Network (ISDN); 3,1 kHz telephony teleservice Attachment requirements for handset terminals" (Candidate NET 33).

[10] ETS 300 370: "Radio Equipment and Systems (RES); Digital Enhanced Cordless Telecommunications / Global System for Mobile communications (DECT/GSM) inter-working profile; Access and mapping (Protocol/procedure description for 3,1 kHz speech service)".

[11] ETS 300 434-2: "Digital Enhanced Cordless Telecommunications (DECT) and Integrated Services Digital Network (ISDN) interworking for end system configuration; Part 2: Access profile".

[12] ETS 300 444: "Digital European Cordless Telecommunications (DECT); Generic Access Profile (GAP)".

[13] ETS 300 535: "Digital cellular telecommunications system (Phase 2); Functions related to Mobile Station (MS) in idle mode (GSM 03.22)".

[14] GSM TS 03.50: "European digital cellular telecommunications system (Phase 1); Transmission Planning Aspects of the Speech Service in the GSM PLMN System".

[15] ETS 300 540: "Digital cellular telecommunications system (Phase 2); Transmission planning aspects of the speech service in the GSM Public Land Mobile Network (PLMN) system (GSM 03.50)".

[16] ETS 300 577: "Digital cellular telecommunications system (Phase 2); Radio transmission and reception (GSM 05.05)".

[17] GSM TS 11.10: "European digital cellular telecommunications system (Phase 1); Mobile Station Conformity Specification".

[18] ETS 300 607: "Digital cellular telecommunication system (Phase 2); Mobile Station (MS) conformance specification; (GSM 11.10)".

[19] ETS 300 824: "Digital Enhanced Cordless Telecommunications (DECT); Cordless Terminal Mobility (CTM); CTM Access Profile (CAP)".

[20] TBR 5: "European digital cellular telecommunications system; Attachment requirements for Global System for Mobile communications (GSM) mobile stations; Access".

[21] TBR 6: "Digital Enhanced Cordless Telecommunications (DECT); General terminal attachment requirements".

[22] TBR 9: "European digital cellular telecommunications system; Attachment requirements for Global System for Mobile communications (GSM) mobile stations; Telephony".

[23] TBR 10: "Digital Enhanced Cordless Telecommunications (DECT); General terminal attachment requirements; Telephony applications".

[24] TBR 19: "European digital cellular telecommunications system (Phase 2); Attachment requirements for Global System for Mobile communications (GSM) mobile stations; Access".

[25] TBR 20: "European digital cellular telecommunications system (Phase 2); Attachment requirements for Global System for Mobile communications (GSM) mobile stations; Telephony".

[26] TBR 22: "Attachment requirements for terminal equipment for Digital Enhanced Cordless Telecommunications (DECT) Generic Access Profile (GAP) applications".

[27] TBR 31: "Digital cellular telecommunications system (Phase 2); Attachment requirements for mobile stations in the DCS 1 800 band and additional GSM 900 band; Access".

[28] TBR 39: "Digital Enhanced Cordless Telecommunications (DECT); Global System for Mobile communications (GSM); DECT/GSM dual-mode terminals".

NOTE: TBR 39 will be produced in 2 editions, edition 1 will cover terminal type 2 (and may include terminal type 1), and edition 2 will include terminal types 3, 4 and 5.

[29] ETR 100: "European digital cellular telecommunications system (Phase 2); Abbreviations and acronyms (GSM 01.04)".

[30] ETR 159: "Digital European Cordless Telecommunications (DECT); Wide area mobility using the Global System for Mobile communications (GSM)".

[31] ETR 246: "Digital European Cordless Telecommunications (DECT); Application of DECT Wireless Relay Station (WRS)".

[32] ETR 308: "Digital Enhanced Cordless Telecommunications (DECT); Services, facilities and configurations for DECT in the local loop".

[33] ETR 310: "Digital Enhanced Cordless Telecommunications (DECT); Traffic capacity and spectrum requirements for multi-system and multi-service DECT applications co-existing in a common frequency band".

[34] ETR 341: "Digital Enhanced Cordless Telecommunications / Global System for Mobile communications (DECT/GSM) interworking profile; Profile overview".

[35] DTR/DECT-010096: "Digital Enhanced Cordless Telecommunications (DECT); Global System for Mobile communications (GSM); DECT/GSM advanced integration of dual-mode terminals".

[36] 89/336/EEC: "Council Directive of 3 May 1989 on the approximation of laws of the Member States relating to Electromagnetic Compatibility (Official Journal L139 of 23/5/89)".

[37] 91/263/EEC: "Council Directive of 29 April 1991 on the approximation of the laws of the Member States concerning telecommunications terminal equipment, including the mutual recognition of their conformity" (Terminal Directive).

[38] CCITT Recommendation P.79 (1989): "Calculation of loudness ratings for telephone sets".

3 Abbreviations and definitions

3.1 Abbreviations

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

ADPCM	Adaptive Differential Pulse Code Modulation
ARI	Access Rights Identifier
BSS	Base Station System
CAP	CTM Access Profile
CTM	Cordless Terminal Mobility
DAM	DECT Authentication Module
DECT	Digital Enhanced Cordless Telecommunications
DMT	Dual Mode Terminal
DFS	DECT Fixed System
DPS	DECT Portable System
FP	Fixed Part
FT	Fixed radio Termination
GAP	Generic Access Profile
GIP	DECT/GSM Interworking Profile
GSM	Global System for Mobile communications
IAP	ISDN Access Profile
IMEI	International Mobile Equipment Identity

IPEI	International Portable Equipment Identity
ISDN	Integrated Services Digital Network
LAI	Local Area Identifier
LE	Local Exchange
LSTR	Listener Sidetone Ratio
MM	Mobility Management
MMI	Man-Machine Interface
MSC	Mobile Switching Centre
NTP	Network Termination Point
PABX	Private Automatic Branch Exchange
PLMN	Public Land Mobile Network
PP	Portable Part
PT	Portable radio Termination
RFP	Radio Fixed Part
SIM	Subscriber Identity Module
SMS	Short Message Service
WAM	Wide Area Mobility
WRS	Wireless Relay Station

3.2 Definitions

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

authentication (user): The process whereby a DECT subscriber is positively verified to be a legitimate user of a particular Fixed Part (FP).

NOTE 1: Authentication is generally performed at call set-up, but may also be done at any other time (e.g. during a call).

call: All of the NWK layer processes involved in one network layer peer-to-peer association.

NOTE 2: Call may sometimes be used to refer to processes of all layers, since lower layer processes are implicitly required.

cell: The domain served by a single antenna(e) system (including a leaky feeder) of one FP.

NOTE 3: A cell may include more than one source of radiated Radio Frequency (RF) energy (i.e. more than one radio end point).

dual band terminal: A terminal comprising multiple GSM parts operating on different frequency bands. For example a terminal comprising of GSM and DCS1800 parts.

Dual Mode Terminal (DMT): A terminal comprising both DECT and GSM parts.

dual mode/dual band terminal: A terminal comprising both DECT and multiple GSM parts operating on different frequency bands. It is considered as a terminal comprising both DECT and dual band (e.g. GSM/DCS1800) parts.

Fixed Part (DECT Fixed Part) (FP): A physical grouping that contains all of the elements in the DECT network between the local network and the DECT air interface.

location registration: The process by which the terminal informs the network of its presence within a particular location area.

Network Termination Point (NTP): Is the point that defines the border between the equipment provided by the network operator and the customer premises equipment.

Portable Part (DECT Portable Part) (PP): A physical grouping that contains all elements between the user and the DECT air interface. PP is a generic term that may describe one or several physical pieces.

Radio Fixed Part (RFP): One physical sub-group of a FP that contains all the radio end points (one or more) that are connected to a single system of antennas.

subscription registration: The infrequent process whereby a subscriber obtains access rights to one or more FPs.

NOTE 4: Subscription registration is usually required before a user can make or receive calls.

subscription load/modify: A procedure of loading subscription registration data in a PP or CTA in real-time over the air interface.

Wireless Relay Station (WRS): a physical grouping that combines elements of both Portable radio Terminations (PTs) and Fixed radio Terminations (FTs) to relay information on a physical channel from one DECT termination to a physical channel to another DECT termination.

NOTE 5: The DECT termination can be a PT or an FT or another WRS.

3.3 GSM abbreviations and definitions

Definition and specific GSM abbreviations may be found in ETR 100 [29].

4 Terminology used in this document

DECT and GSM standards often use different terminology for equivalent functions. Since this document will be read by both experts in GSM and experts in DECT, this clause tries to clarify some of the vocabulary used. Similar DECT and GSM definitions are not necessarily strictly equivalent, it has been chosen sometimes to use general formulations. If dual mode standards are to be produced, a common terminology needs to be defined.

Exact GSM terminology can be found in GSM 03.22 (ETS 300 535 [13]). The DECT terminology can be found in the DECT CI specifications (ETS 300 175, parts 1 to 8 [1] - [8]).

Table 1: Comparison of DECT and GSM terminology as used with respect to DMTs

DECT term	GSM term	Explanation
PP	Mobile station	The combination of mobile termination equipment, subscription identity equipment and any required terminal equipment. Often through this document the word "terminal" is used for those terms.
RFP	Base station	The physical equipment providing the elementary part of coverage. The word "cell" is not used in DECT, but often through this document the word "cell" is used for the coverage area of a RFP/base station.
Active unlocked scan	Network search	The process by which a terminal scans all possible frequencies for available networks (Public Land Mobile Networks (PLMNs) in GSM). Often through this document the word "scanning" is used for those terms.
	Network selection	The process by which a terminal chooses a network. In GSM a Mobile Station manually or automatically chooses a network (PLMN in GSM) from a list of those detected during Network search. In DECT this process is implementation dependant and uses the active unlocked scan. Often through this document the words "network selection".
Location area	Location area	A group of cells all of whose broadcast location identities are the same.
Location registration	Location update	The process by which the terminal informs the network of its presence within a particular location area. Both terms are used through the document.
Attach/Detach	Attach/detach	Attach is the process whereby a terminal within coverage area of a system to which it has access rights, notifies the system that it is operative. The reverse process is detach, which reports the terminal as inoperative (note).
Idle locked	Idle mode	The state a terminal is in when it is operational but is not in any transaction with the network (call, location update, etc.).
Active locked	Dedicated mode	The state a terminal is in when it has started a transaction with the network.
NOTE: There is no procedure over the air interface for detach indication in Generic Access Profile (GAP).		

4.1 Distinguishing access technology from network type

The intention of this subclause is to clearly distinguish between the air interface used and the core network providing mobility.

The word DECT is used to refer to the DECT air interface or the access network related to the DECT air interface.

The word GSM is used to refer to the GSM or DCS1800 air interface and the related access network.

The term Access Rights Identifier (ARI) A/B/C is used to refer to a network subscription that can be accessed using the DECT air interface only. It is also used to refer to a system or network requiring only basic GAP protocols or a closely related protocol such as the Cordless Terminal Mobility (CTM) Access Profile (CAP). An ARI A/B/C subscription cannot be used to access a PLMN.

NOTE 1: The ARI is used by the PT to determine if it has permission to access a FT. Types A, B, C are intended for residential, business and public access applications respectively. ARI D is specifically intended to be used in conjunction with DECT/GSM interworking applications.

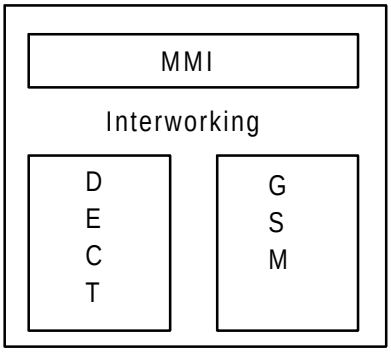
NOTE 2: An ARI A/B/C system or network could be a single FT where the network connection to the FP does not support mobility.

The word PLMN is used to refer to a network subscription that can be accessed using the GSM air interface. The subscription can also be accessed via a DECT air interface by a DMT supporting DECT/GSM Interworking Profile (GIP) protocols (a GIP/GSM DMT) i.e. a PLMN subscription is synonymous with an ARI D subscription. References to a PLMN network have the conventional meaning, but may exclude the air interface access parts.

5 Reference configurations and scenarios

5.1 Terminal configurations

A DMT for DECT and GSM is considered to be a terminal with one GSM part and one DECT part that is controlled by a common Interworking Unit which also controls one common MMI (keypad, display and menu functions). A reference configuration for DMTs is shown in figure 1.



MMI: Man-Machine Interface

Figure 1: Reference configuration for DMT

Some parts in the terminal, such as microphone and loudspeaker, could be reused by both the GSM and DECT parts or could be implemented in two ways. Integration of the RF parts is also foreseen.

Several possible hardware configurations can be envisaged for a DMT. It is possible for example that the terminal contains two entirely separate transceivers, simply sharing the keyboard, display microphone, earpiece etc. Completely independent operation may then be possible, but there will be difficult technical issues of receiver blocking to overcome. It is also possible for parts of the transceivers to be common, reducing the cost of the terminal, but also limiting the possibilities of simultaneous operation. The exact functionality of the interworking function will depend on the terminal configuration.

The different possible radio configurations may have impact on the networks (see clause 7). The different radio configurations will also affect the performance specifications which the terminals may meet (see clause 6). However, it is undesirable to have different regulatory requirements dependent on the implementation of a DMT, and this should be avoided.

5.2 Specific terminal configurations

Five general terminal configurations denoted as types 1 - 5 have been identified. The essential differences between the terminal types are summarized in table 2. The type 3 terminal is subdivided into a and b categories depending on whether simultaneous receive is supported.

Table 2: Summary of terminal types

Terminal type	Number of location registrations	Air interface selection	Simultaneous receive	Simultaneous dual-mode transmit/receive	Simultaneous transmit
1	1	manual	no	no	no
2	1	automatic	yes or no	no	no
3a	up to 2	automatic	yes	no	no
3b	up to 2	automatic	no	no	no
4	up to 2	automatic	yes	yes	no
5	up to 2	automatic	yes	yes	yes

Of these DMT types, type 1 is the only truly basic type, types 2 and 3 are identified as interesting for early implementations and types 4 and 5 are considered as advanced and for later implementations.

5.2.1 The terminal can only be location registered through one air interface - manual switch - type 1

This terminal type can only be location registered through one air interface at a time. Switching from one air interface to the other is performed manually. No automatic or background scanning of the non-active air interface occurs. This means that the terminal will never operate over DECT and GSM/PCN air interfaces at the same time.

5.2.2 The terminal can only be location registered through one air interface - automatic scan - type 2

This terminal type can only be location registered through one air interface at a time although it shall monitor both to determine which will give the best operation.

Switching between air interfaces is automatic but may be manually overridden.

The intelligent scanning algorithm will entail occasionally switching from the active air interface (the air interface over which the terminal is registered) to the other air interface to listen for broadcast channels. A decision to switch between air interfaces is based on RSSI measurements and access rights. These issues are covered separately in subclause 5.4.2.

Two implementations of type 2 terminals can be envisaged. These are:

- separate GSM and DECT transceivers;
- a single transceiver which is time multiplexed between DECT and GSM.

The first is therefore capable of simultaneous reception, and could, for example, be idle-locked to a DECT bearer and simultaneously perform background scanning of GSM carriers. By contrast, the second implementation has only a single receiver which has to be multiplexed between DECT and GSM air interfaces, and in the above example could only perform GSM background scanning between points in the DECT multiframe where paging messages might be received.

5.2.3 The terminal can be location registered through both air interfaces - type 3

The terminal is simultaneously location registered through both air interfaces. However, if the same subscription information is used on both air interfaces then the terminal (GIP/GSM DMT) shall not attempt to location register on both at the same time.

A type 3a terminal comprises a GSM transceiver and a DECT transceiver, whereas a type 3b terminal consists of a single transceiver which is time multiplexed between DECT and GSM. A type 3b terminal will inevitably miss some paging messages. In addition, if a type 3a or 3b terminal enters active communication over either air interface, then the other will be disabled and this will potentially result in additional missed paging messages.

This is considered to be a technically simple scenario to implement but it requires advanced tests to be investigated and specified. Further study of this configuration will not be considered for the first edition of TBR 39 [28].

5.2.4 The terminal can be location registered through both air interfaces but can be in active communication on only one - type 4

In this scenario, one transceiver may be operational at the same time as the other is scanning (receiving).

This could for instance be the situation for a terminal in active communication in the local DECT system, but at the same time listening for paging on the GSM air interface. Since the terminal cannot respond to paging on the other network whilst still in communication with the first network, this configuration may have little practical value.

This is considered to be a technically difficult scenario to implement. Early DMTs are expected to use one of the radio configurations previously described. Further study of this configuration will not be considered for the first edition of TBR 39 [28].

5.2.5 The terminal can be in active communication on both air interfaces at the same time - type 5

For instance a terminal in active communication in the DECT system can receive and accept a call from the GSM/PCN system at the same time with the option to switch manually to one of the systems while having the other one still active in a hold mode.

This is considered to be a technically difficult scenario to implement. Early DMTs are expected to use one of the radio configurations previously described. Further study of this configuration will not be considered for edition 1 of TBR 39 [28].

5.3 Subscription configurations

A DMT may contain different subscriptions related to each air interface or could have a subscription which could be used in both the DECT and the GSM air interface.

5.3.1 Multiple subscriptions

It is possible to have more than one active subscription at the same time via the same DECT FP. Thus allowing a terminal operating over the DECT air interface and attached to an FP which provides both Private Automatic Branch Exchange (PABX) and GSM services, to be simultaneously location registered with its PABX and GSM subscriptions via the same DECT FP.

It is important that where a subscription can be used on both air interfaces, that the PP does not attempt to simultaneously register, using the same set of subscription data via two air interfaces. A location registration on a second system, with the same set of subscription data will result in the cancellation of the first location registration.

Standardization for DMTs (and associated regulation) needs to allow for the above possibilities.

5.3.2 Subscriptions scenarios

A terminal that can communicate on several systems needs initially to be able to handle several subscriptions related to the various networks it has access to. A DECT/GSM DMT will always have one PLMN subscription. In addition to this it may have one or several GAP subscription.

NOTE: A subscription is a set of identities that enables the terminal access to a system or network and not necessarily a legal contract for charging.

A DECT/GSM DMT consists of two parts, a DECT part and a GSM part. Depending on which DECT air interface profile (see annex B) that is supported in the DECT part there are, at least, two different kinds of dual-mode terminals that need to be distinguished:

- the DECT part shall always be compliant with the GAP but may also in addition comply with the GIP, see subclause 5.3.2.2;
- DMTs where the DECT part is compliant with the CAP or the Integrated Services Digital Network (ISDN) Access Profile (IAP) are from a subscription point of view considered in the same way as DMTs where the DECT part is compliant with GAP only, see subclause 5.3.2.1.

Scenarios where the terminal contains identities related to only one air interface are not considered in this subclause since in this case the DMT acts as a normal single mode terminal (except in the case of emergency calls which is covered in subclause 8.5). The possibility of a DMT with two or more GAP subscriptions to be active through the same FP, at the same time is not considered in this document since it does not imply any change compared to ordinary DECT PPs. Neither is the future possibility of having several GSM subscription (with the same operator) in the DMT considered.

5.3.2.1 GAP/GSM

This subclause addresses DMTs where the DECT part is GAP, CAP or IAP (ARI A/B/C) and does not support the DECT-GSM interworking profile (ARI D).

If the DECT part of the DMT is GAP only, it shall support at least two ARI class A/B/C subscriptions. The DECT subscriptions may relate to a private (residential or business - ARI A/B) DECT system or to a public DECT (ARI C) service.

NOTE: The DECT FP may support access to both ARI class A, B, C and ARI class D networks. A GAP/GSM DMT can access only the ARI class A, B, C network via the DECT FT.

The ARI class A, B, C network may offer varying levels of mobility. If the system is a single FP then only fairly limited mobility is available. The FP may be connected to a corporate network which supports mobility, or a public access network supporting Wide Area Mobility (WAM). The ARI class A, B, C subscription may also allow roaming between public and private DECT networks (e.g. CTM). All these networks fall within the definition of a ARI class A, B, C network as used within this document. These different possibilities will have a major impact on the service seen by the user, and this is considered further in subclause 5.5. From the subscription scenario viewpoint, all these systems are seen simply as a ARI class A, B, C subscription.

The GAP/GSM DMT can be used to access ARI class A, B, C systems via the DECT air interfaces as well as PLMN via the GSM air interface. The DMT has at least two subscriptions, one PLMN, and at least one ARI class A, B, C subscription. This type of DMT can be used in network scenarios where public, business or residential DECT services are combined with WAM through the GSM subscription. Depending on terminal configuration, the GAP/GSM DMT could be registered in several networks at the same time using different subscriptions. Seamless service provision will not be possible but operators can support the GAP/GSM DMT with a one-number service.

The GAP/GSM DMT can operate the following subscription configurations:

- one PLMN subscription;
- one PLMN + one (or more) ARI class A, B subscription(s);
- one PLMN + one (or more) ARI class C subscription(s);
- one PLMN + one (or more) ARI class A, B subscription(s) + one (or more) ARI class C subscription(s).

All the terminal configurations of subclause 5.2 are relevant to the GAP/GSM DMT.

5.3.2.2 GIP/GSM

This subclause addresses DMTs which support both GAP and GIP.

The GIP is based on the GAP which means that GIP portables can access ARI class A, B, C FPs (if supported by a ARI class A, B, C subscription in the portable). The GIP/GSM DMT, can access a PLMN network either using DECT/GSM access (ARI class D) via an FT with suitable network connections or the GSM air interface, based on a PLMN subscription.

If the DMT supports GIP, the DMT can be used to access PLMNs via the DECT air interface. The DMT needs only one PLMN subscription and seamless service provision is possible. The GIP/GSM DMT cannot be registered via the GSM and DECT air interfaces at the same time with the same subscription, as each location registration via one air interface will result in the cancellation of a previous location registration on the other air interface.

This type of DMT is used in the network scenarios where PLMN-based urban public mobility services are combined with WAM through the GSM subscription or in a scenario where a GSM service is enhanced by a DECT/GSM access.

Since the GIP is based on the GAP, the GIP/GSM DMT could also store ARI class A/B/C subscriptions and behave as a GAP/GSM DMT. It can be used in public, business and residential DECT systems as well as in DECT/GSM access systems and the PLMN network.

The GIP/GSM DMT can operate the following subscription configurations:

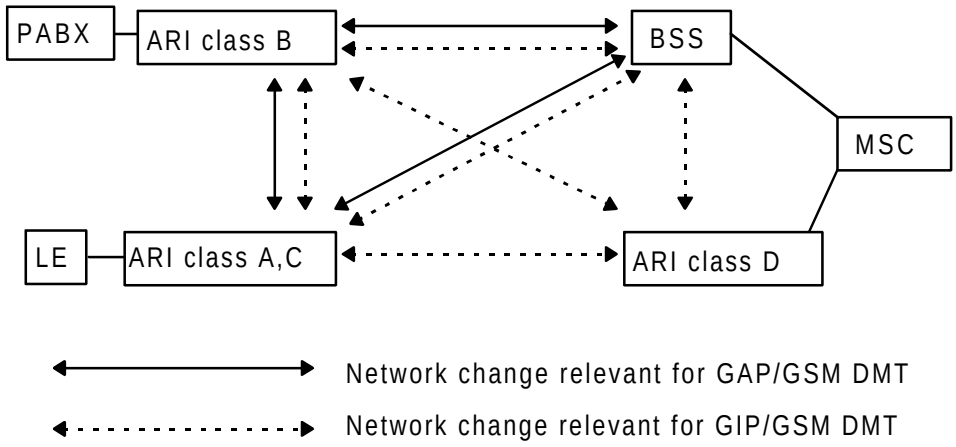
- one PLMN subscription;
- one PLMN subscription + one (or more) ARI class A, B subscription(s);
- one PLMN subscription + one (or more) ARI class C subscription(s);
- one PLMN subscription + one (or more) ARI class A, B subscription(s) + one (or more) ARI class C subscription(s).

Only the first two terminal configurations of subclause 5.2 are relevant for a GIP/GSM DMT with only a PLMN subscription.

5.4 Network configurations

For the first phase of dual mode standardization, it is assumed that the portable supports at least basic speech services. The connection between DECT access network and PLMN network could be either via an A interface or via an ISDN interface. Support of other (non basic-speech) GSM services will be considered at a later stage. Clearly when additional services are added they need to be supported within the networks. Currently, support for Short Message Service (SMS) and other GSM services, is only defined for A interface.

Based on the terminal configurations in subclauses 5.2.1 to 5.2.3 and the subscription scenarios in subclause 5.3.2, the DMT can select and switch to a new access network in several different ways. Depending on the types of the old and the new access network, the are different requirements on how the DMT behaves. The changes of network that are possible for the two types of DMTs are illustrated in figure 2.



BSS: Base Station System
LE: Local Exchange
MSC: Mobile Switching Centre

Figure 2: Possible inter access network roaming scenarios

In figure 2, the ARI class A or C FP connected to the Local Exchange (LE) illustrates the public DECT service while the ARI class B FP illustrates a business DECT system.

The DMT can initiate a change of network (change of active subscription) either manually or automatically.

5.4.1 Manual change of network

When switching manually between networks the user changes mode of the DMT, selects network in the new mode and attaches to that network. Although actual change of network is manually initiated, the actual selection of the network may be automatic, according to users preferences in a priority list. The priority of networks could depend on several parameters, e.g. highest received field strength, home operator or not, home system or visited, available services and call tariffs or just the users explicit personal preferences. Detach from the old network and attach to the new network is, though, always controlled by the user.

5.4.2 Automatic change of network

For automatic switching between networks there are two different behaviours of the DMT. Either:

- it stays locked to the selected system until it leaves the coverage area and then starts selecting the available network with the highest priority; or

- it could continuously scan for available networks and initiate a change of network when it finds one with higher priority than the one presently attached to.

The first alternative is relevant for DMTs only when they are locked to DECT systems and the behaviour is the same as for ordinary GSM MS. The second alternative enables the DMT to be primarily a DECT terminal (always using DECT coverage when within range) which uses GSM as a fall-back to guarantee continuous reachability.

5.5 Service scenarios

Two major types of users of DMTs can be identified: those who use one terminal (the DMT) instead of two (one GSM and one DECT terminal) in order to be reachable on their two official phone numbers and those who access a personal communication (one number) service with a terminal that at every moment enables the best quality, price and degree of service.

Some different types of dual mode scenarios are usually identified, see ETR 159 [19] and ETR 341 [33], on GSM interworking.

5.5.1 Residential/GSM

A user with a GSM subscription and a cordless telephone at his home would see the advantages with a GAP/GSM DMT that enables him to use one terminal both at home and away from home. The DMT makes it possible for the user to make outgoing calls in the most economical way and to be always reachable. The reachability is supported either by the operator through a one-number service or by a DMT that can be registered in the PLMN and the home DECT system (ARI class A) at the same time.

The DMT could be sold to users of a residential DECT system that realizes that they need WAM as well but also in packages together with the residential DECT base station.

5.5.2 Business/GSM

A user with a GSM subscription and a cordless telephone at his work would see the advantages with a GAP/GSM DMT that enables the use of one terminal both at the company premises and when travelling. The DMT makes it possible for the user to make outgoing calls in the cheapest possible way and to be always reachable. The reachability is supported either by the operator through a one-number service or by a DMT that can be registered in the PLMN and the business DECT system (ARI class B) at the same time.

The DMT could be sold to users of a business DECT system that need WAM as well as to companies who use mobile telephones for local mobility. It enables a company to select the most appropriate type of terminal (wired, DECT PPs, GSM MSs and DMTs) to meet the mobility needs of each employee. If the proper service and connection between the corporate network and the PLMN is provided, the user could use the internal numbering plan in conjunction with the GSM air interface.

The use of a DMT in this scenario is particularly powerful if the business system provides DECT access to the PLMN. This connection will probably be based on ISDN interworking. The DMT could then also be a GIP/GSM.

5.5.3 Public/GSM

A user with a public DECT subscription (ARI class C) could see the advantages with a DMT that enables him to still be reachable when outside of the non-continuous DECT coverage of that service. The DMT makes it possible for the user to make outgoing calls in the most economical way and to be always reachable. The reachability is supported either by the operators through a roaming agreement or by a DMT that can be registered in the PLMN and the public DECT system at the same time.

5.5.4 Enhanced GSM

A GSM operator could consider to use DECT technology to enhance the capacity, quality (particularly in indoor environment) and services (higher data rates) of the GSM PLMN. To experience these improvements, the GSM subscriber would need a GIP/GSM DMT that automatically switches to a DECT access network (connected to the PLMN - ARI class D) as soon as there is one available.

This DMT scenario is similar to the use of GSM/DCS dual band mobiles.

5.5.5 One-number services

An operator can support a GAP/GSM DMT with a one number service that delivers incoming calls to the users personal number over the radio interface presently selected by the DMT. The network(s) and the one-number service shall register the (on/off) status of the two parts of the DMT and decide over which air interface the DMT is to be paged. This one-number service can also be offered to users that have two terminals, one GSM MS and one DECT PP. The problem for the networks related to this service is, thus, not related to the DMT and can be expected to be solved by the operator even for the case when the DMT is registered on both air interfaces at the same time.

For a GIP/GSM DMT, a one-number service is already available through a PLMN subscription as described in the previous subclause.

6 Spectrum protection and testing issues

The coexistence criteria for DMTs are assumed to be no more stringent than those between DECT and GSM single mode terminals, which are already encompassed by existing GSM and DECT specifications.

This clause considers potential spectrum protection problems relating to terminal types 1 and 2. Types 3, 4 and 5 terminals are considered to be advanced terminals and are not covered in this document.

6.1 Test philosophy

The basic philosophy concerning physical layer testing of terminal types 1, 2 and 3 is that each mode is tested separately according to the TBR relevant to that mode.

The following paragraphs consider the behaviour and performance of the 3 different types of terminals.

6.1.1 Type 1 terminal

This terminal has only one transmitter or receiver active at a time. Therefore there are no additional spectrum protection problems over and above those of a single mode DECT or GSM terminal.

6.1.2 Type 2 terminal

The reference configuration is the same as a type 1 terminal and therefore the same test philosophy applies. However, if the terminal supports background scanning of the inactive mode, then the scanning shall be enabled during testing.

There is a potential loss of spectrum efficiency due to lost messages (e.g. paging) in the mode where the terminal attached to the network is scanning in the non active mode. This problem can be minimized by intelligent scanning based on the knowledge of the time slots where messages are likely to be received over the active air interface. Therefore DMTs shall be tested to ensure that the probability of missed messages is not (considerably) greater than for single mode terminals. Two types of parameters are identified as relevant for testing with respect to: the maximum probabilities of missed messages and the maximum time for scanning and identifying allowed networks on the non-active air interface.

6.2 Analysis of the requirements

This subclause analyses potential problems due to spurious emissions. In particular, it checks the consequences of the application of the relevant TBRs independently to the GSM and DECT parts of the terminal.

For all the other characteristics there should be no problems in applying the relevant TBR independently to each part of the terminal.

The TBRs relevant to this analysis are TBR 6 [21], TBR 19 [24] (or TBR 5 [20] for GSM Phase 1), and TBR 31 [27] for GSM/DCS1800 dual band.

6.2.1 Emission due to modulation

GSM reference: ETS 300 577 [16] (GSM 05.05), subclause 4.2.1.
DECT reference: ETS 300 175-2 [2], subclause 5.5.1.

The measurements are done only in the DECT frequency band, or in the GSM or DCS bands.

There is no problem for the emission of a DCS transmitter in the DECT band due to the duplex frequency gap.

There is a risk for the DCS reception sensitivity due to the emission in the DECT band. The requirements are covered by the minimum sensitivity.

NOTE: TBR 6 [21], TBR 19 [24] (or TBR 5 [20]) and TBR 31 [27] apply separately.

6.2.2 Emission due to transmitter transient

GSM reference: ETS 300 577 [16] (GSM 05.05), subclause 4.2.2.
DECT reference: ETS 300 175-2 [2], subclause 5.5.2.

The measurements are done only in the DECT frequency band, or in the GSM or DCS band, as in the previous requirement.

There is a risk for the DCS reception sensitivity due to the emission in the DECT band and vice versa. The requirements are covered by the minimum sensitivity.

NOTE: TBR 6 [21], TBR 19 [24] (or TBR 5 [20]) and TBR 31 [27] apply separately.

6.2.3 Emission due to intermodulation

GSM reference: ETS 300 577 [16] (GSM 05.05), subclause 4.7.3.
DECT reference: ETS 300 175-2 [2], subclause 5.5.3.

The requirement for DECT is -30 dBm but it applies only for a FP with several transmitters implemented.

The requirement for DCS is -20 dBm with a transmit signal of 1W (+30 dBm).

There is no requirement for a GSM MS.

There is a risk of an intermodulation product of two DCS signal which could be in the DECT frequency band and vice versa.

NOTE: The only requirement which applies is -20 dBm for a terminal supporting DCS 1800 band. In that case TBR 31 [27] applies.

6.2.4 Spurious emission when allocated a transmit channel

GSM reference: ETS 300 577 [16] (GSM 05.05), subclause 4.3.3.
DECT reference: ETS 300 175-2 [2], subclause 5.5.4.

Roughly the requirements in GSM or DECT are the same, -36 dBm below 1 GHz and -30 dBm above 1 GHz. But some exceptions are included:

- for DECT, there are 5 frequency bands where the maximum is 20 nW (-47 dBm) instead of 250 nW. Those exceptions are related with the potential problems of proximity of a DECT part, to a TV set, a radio set at home, or PMR systems in professional environments. But 2 instances of a continuous wave spurious signal, with a power level of 250 mW instead of 20 mW are permitted for PP;

- for GSM there are stringent requirements in the GSM or DCS reception frequency bands (-79 dBm for 935 - 960 MHz, -67 dBm for 925 - 935 MHz, -71 dBm for 1805 - 1880 MHz), with 5 exceptions where up to -36 dBm are permitted.

NOTE: TBR 6 [21], TBR 19 [24] (or TBR 5 [20]) and TBR 31 [27] apply separately.

6.2.5 Spurious emission when not allocated a transmit channel

GSM reference: ETS 300 577 [16] (GSM 05.05), subclause 4.3.3.
DECT reference: ETS 300 175-2 [2], subclause 6.7.

Requirements for both standards are shown in table 3.

Table 3: Spurious emissions

Frequency band	Spurious emission
from 9 kHz to 1 GHz	-57 dBm (in 100 kHz band)
from 1 GHz to 12,75 GHz	-47 dBm

For the DECT standard, out of the DECT frequency band, there is no protection of the GSM or DCS transmission frequency band.

The DECT specifications requirements are -67 dBm (in 100 kHz band) in the DECT frequency band.

For GSM or DCS standards, out of the GSM or DCS frequency bands, there is no protection of the DECT transmission frequency band.

The GSM or DCS specifications requirements are given in table 4.

Table 4: GSM or DCS specifications requirements

Frequency band	Spurious emission
880 - 915 MHz	-59 dBm
935 - 960 MHz	-79 dBm
925 - 935 MHz	-67 dBm
1 710 - 1 785 MHz	-53 dBm
1 805 - 1 880 MHz	-71 dBm

NOTE: TBR 6 [21], TBR 19 [24] (or TBR 5 [20]) and TBR 31 [27] apply separately.

6.3 Conclusions for the radio requirements, protection of spectrum

For type 1 DMTs the relevant TBRs can always be applied independently.

For type 2 DMTs the relevant TBRs can be applied independently but for some modes of operation, degradation in fulfilling existing requirements have to be considered as well as new requirements for new behaviours.

7 Protection of the network

Due to the fact that one DMT covers two modes and might be present in two networks at the same time or automatically switch between networks, harm to networks has to be considered. This clause covers the behaviour of DMT types 1 and 2 and lists the problems identified.

Identified problems are lost pagings, uncontrolled automatic switching, excessive detach and location registration problems and call forwarding delays and loops. The TBR should address these problems so that DMTs complying to it do as little harm to networks as possible.

7.1 Considerations regarding different DMT types

7.1.1 Type 1 DMT

For type 1 DMTs, switching of mode and network occurs as a result of user action. Therefore the situation is very similar to a user switching a GSM or DECT terminal on and off. It does not cause any additional problems for the network compared to a single mode terminal.

For a two subscription DMT the switching between DECT and GSM means the same as if the user pressed the power buttons on two single mode terminals. This means that there has to be a detach on one system (not if GAP because detach is not mandatory in GAP) and a location update/attach to the other. It does not cause any additional problems for the network compared to two single mode terminals.

7.1.2 Type 2 DMT

The main difference between type 1 and type 2 DMTs is that changes of access network may occur more often for type 2 DMTs because switching is automatic. Additional rules are required to prevent harm to the network from excessive location updates (see subclause 7.2.3).

For a 2 subscription GAP/GSM type 2 DMT the attach/detach requirements are the same as for a type 1 DMT, i.e. detach should be sent when the terminal leaves a network. This is because the impact of automatic switching on the network is the same as with manual switching. By contrast, a single subscription GIP/GSM type 2 DMT should not use detach when changing between DECT and GSM air interfaces because it remains registered on the same PLMN.

As the DMT knows when to expect pagings in the active mode, this type of terminal should not miss paging messages (see also subclause 6.1.2).

7.2 Identified problems

7.2.1 Idle mode issues

DMTs type 2 use a single time multiplexed receiver and hence cannot simultaneously receive in both DECT and GSM.

There are a number of processes that DMT needs to carry out in idle locked mode on an active air interface, in particular:

- cell re-selection processing;
- decoding of broadcast information;
- listening to paging messages.

On the inactive interface the type 2 DMT has to check for service availability. This requires measurements of received radio signal strength and access rights evaluation.

For type 2 terminals, two potential consequences of the need of background scanning of the inactive mode have been identified:

a) there is potential loss of idle locked mode performance over the active air interface compared with a single mode phone which may result in:
   - some loss of paging messages (see also subclause 7.2.2);
   - reduced update rate of broadcast information;
   - delayed cell re-selection;

b) there is also an increase in the detection time of service availability from the inactive air interface compared with a single mode phone.

It is desirable that idle locked performance of the active air interface not be degraded. However this may not be practical. If so, the maximum acceptable level of degradation of each of the parameters discussed in a) needs to be defined and a balance struck between these effects and the increase of service detection time mentioned in b).

This is an area where new requirements may need to be set.

7.2.2 Missed pagings

Pagings being missed by the DMT will force the networks to take actions as if the terminal is not reachable even if it is generally present. Pagings may be missed by a type 2 DMT when it is scanning the other air interface. This problem could be reduced by intelligent scanning i. e. not scanning when expecting a paging on the other interface. See also subclause 6.1.2.

The consequence of the scanning of the other air interface is that, for type 2 DMTs, the pageability is degraded. This degradation ought to be limited by setting an upper limit for the pagings allowed to get lost. This upper limit has to take into account operators needs as well as manufacturers possibilities.

7.2.3 Uncontrolled automatic network selection

There is a need to prevent excessive switching between the two air interfaces (while not preventing it when it is technically advantageous in order to provide better service to the user).

For type 2 DMTs, there may be a need to take into account the consequences of roaming between DECT networks and GSM networks. Principles of the network selection between DECT and GSM may be different than within GSM only: it is expected that one of its characteristics could be to use DECT coverage when possible. Two types of consequences are to be considered:

a) after leaving one network, either unnecessary pagings may occur (like when out of coverage) or detach procedures are used (which opens the possibility to route call directly to the right coverage). If detach is used for this purpose, the frequency of such detach should be limited in order not to overload the networks with excessive attach/detach signalling when moving on the border between two networks. When the DMT loses DECT coverage, no detach can be expected to be sent.

   Another reason for restricting the attach/detach frequency is that during the detach and attach procedures, the DMT will be unreachable for some time on the other air interface;

NOTE: Detach is mandatory in GIP and CAP but not in GAP. Single subscription GIP/GSM DMTs should not send detach when changing between DECT and GSM radio interfaces in the same GSM location area. In GSM attach/detach procedures are controlled by a broadcast parameter to be taken into account by the GSM part of the DMT.

b) the exact network selection process probably does not need to be specified. Still limits should be given so that excessive switching do not occur in order to protect network against location updating (and possibly detach) load implied, e.g. when coming from one GSM network, a DECT coverage is selected quickly, and as long as this coverage is existing the terminal should not go back to the previous GSM network before a certain duration has elapsed.

Examples of rules that could be specified are given below:

- before the DMT switches to a new network, the new network has to have been available for **X** time units;
- if the DMT has switched to a new network, it shall wait **Y** time units before switching back to the one previously attached to;
- if the DMT has switched to a new network and then back to the old network again, it shall wait for **Z** time units before switching to that new network again.

If the DMT loses coverage before it is allowed to switch, it should give an alert indicating loss of coverage; then it could be manually switched back.

The last two of these rules are thought to be advantageous because they give DMTs the chance to quickly select the new mode once it is available (although preventing to many attaches to DECT networks from moving DMTs) and yet hinders the DMT from excessive switching. The lower limits of time parameters **X**, **Y** and **Z** will have to be fixed and it is expected that they will relate to each other as $\mathbf{X} \leq \mathbf{Y} \leq \mathbf{Z}$. The last two of these rules are thought to be advantageous because they give DMTs the chance to quickly select the new mode once it is available and yet hinders the DMT from excessive switching.

The different above considerations show that extra specification of the DMT is necessary with regards to those problems.

7.2.4 Call forwarding problems for a one number service

Call Forwarding supplementary services can be used to realize a one number service. If a DMT is not reachable for incoming calls in one mode or has detached, call forwarding might be activated to the other mode. Some problems could then occur:

a) if the DMT is not within DECT coverage but has not detached from the DECT system, there will be a call forwarding on not reachable instead of an immediate call redirection to the GSM mode;

b) call forwarding loops may occur if the DMT is unreachable in both modes;

c) if the Subscriber Identity Module (SIM) card is removed from the DMT, the user will experience the same problems as when using two single mode terminals to access a one number service.

These problems cause more harm to the service and to the user than to the network. The operators are expected to handle these problems, e.g. by the use of intelligent network technology.

8 Protocol interworking requirements

8.1 Mapping of terminal equipment identities - International Portable Equipment Identity/International Mobile Equipment Identity (IPEI/IMEI)

Since the terminal contains both GSM and DECT air interface functionality, it will have both an IMEI and an IPEI. When operating in using the DECT air interface (including when a PLMN subscription is used) the IPEI is used. There is no mechanism to carry an IMEI across the DECT air interface. In the case of DECT-GSM interworking, a mapping between IPEI and IMEI will occur at the FT. The IMEI derived from the IPEI will not match the terminal IMEI used when operating using the GSM air interface, i.e. a single terminal, using two air interfaces, can access the same network, but have a different equipment identity for each air interface. It has not yet been determined if this causes problems within GSM networks.

8.2 Air interface protocol

Dual mode portables shall conform to the DECT-GSM interworking profile when operating in DECT mode with a GSM subscription (as defined by use of ARI-D). Transparent use of GSM protocols across the DECT air interface may be studied for later versions of TBR 39 [28].

The DMT provides 3,1 kHz speech telephony service. It is therefore subject to TBR 22 [26] and is required to interwork with GAP FTs as are all other DECT profiles providing 3,1 kHz services.

8.3 External handover between air interfaces

External handover between air interfaces (i.e. from DECT to GSM or vice-versa) is considered as an advanced dual mode issue and will be covered in DTR/DECT-010096 [35].

8.4 Subscriber Identity Module / DECT Authentication Module (SIM/DAM) card issues

A SIM functionality is required since the terminal acts as a GSM terminal. The card used could be either a SIM card, or a multi-application card with both SIM and DAM functionality.

It may be possible for a terminal acting in DECT mode with a non-PLMN subscription to utilize some of the GSM Telephony application files on a SIM card, for example stored phone numbers. These possibilities require further study, for example: since the different networks that the phone may access may have different numbering plans then some translation function for stored numbers is required in the terminal.

8.5 Emergency call requirements

One issue that has been identified is that a DMT with only an ARI A/B/C subscription should still be capable of making an emergency call using the GSM air interface. The opposite may also be possible.

9 Telephony requirements

9.1 Testing philosophy

The basic principle is as follows:

- when operating in DECT mode, the Adaptive Differential Pulse Code Modulation (ADPCM) codec is used and the requirements of TBR 10 [23] apply;
- when operating in GSM mode TBR 9 [22] (phase 1) or TBR 20 [25] (phase 2) applies.

In principle there should be no contradiction relating to the telephony requirements of the terminals.

Testing a terminal to both TBR 10 [23] and TBR 20 [25] would result in some duplication of tests. Possible consolidation of the requirements is analysed below.

It is foreseen that the physical design of early DMT will be based on phase 1 GSM terminals. Since telephony requirements are closely related to physical design of the terminal casings and the common audio circuits, it may be difficult to meet all TBR 10 [23] requirements.

Later DMTs will be based on phase 2 GSM terminals, or completely new designs. These later terminals should fully comply with the TBR 10 [23] and TBR 20 [25] requirements.

9.2 Comparison between GSM and DECT requirements

The paragraph compares the requirements needed for DECT PP and for a phase 2 GSM MS. For GSM Phase 1 MS, the requirements given in GSM 11.10 [17] phase 1 are exactly the same as the requirements in GSM 11.10 phase 2 (ETS 300 607 [18]) with the exception of Listener Sidetone Ratio (LSTR), which is not tested in GSM 11.10 [17] phase 1. The same LSTR requirement does, however, exist in both phase 1 (GSM 03.50 [14]) and phase 2 (ETS 300 540 [15]) versions of the GSM telephony requirements.

Table 5 lists the differences between the two standards. All the other performances not indicated are strictly the same. It should be additionally be noted that TBR 9 [22] and TBR 20 [25] do not require type approval testing of all GSM 11.10 phase 2 requirements (ETS 300 607 [18]). The tests not included are also indicated in table 5.

Table 5: GSM and DECT requirement comparison

Parameters	DECT Requirements in TBR 10 [23]	GSM Phase 2 Tests in ETS 300 607 [18] (GSM 11.10)	Conclusion
Sending frequency response	Subclause 7.7.1 lower limits: 300 Hz -14 dB 1 000 - 3 000 Hz -8 dB 3 400 Hz -11 dB	Subclause 30.1 lower limits: 300 Hz -12 dB 1 000 - 3 000 Hz -6 dB 3 400 Hz -9 dB	- Same upper limits - GSM specifications are more restrictive for the lower limits ➪ GSM requirements are more stringent than DECT requirements.
Sending loudness rating	Subclause 7.9 SLR = 7 ± 3,5 dB	Subclause 30.2 SLR = 8 ± 3 dB	Gain in GSM is larger than in DECT, but difference is limited to 0,5 dB (could not be heard by a listener) ➪ GSM requirements are recommended.
Receiving sensitivity frequency response	Subclause 7.8 lower limits: 300 Hz -9 dB 1 000 - 3 000 Hz -7 dB 3 400 Hz -12 dB	Subclause 30.3 lower limits: 300 Hz -7 dB 1 000 - 3 000 Hz -5 dB 3 400 Hz -10 dB	- Same upper limits - GSM specifications are more restrictive for lower limits ➪ GSM requirements are more stringent than DECT requirements.
Receiving loudness rating	Subclause 7.9 RLR = 3 ± 3.5 dB	Subclause 30.4 RLR = 2 ± 3 dB (nominal) = -13 dB ± 3 dB at maximum volume	Gain in GSM is smaller than in DECT, but maximum difference is limited to 1,5 dB (could not be heard by a listener) ➪ GSM requirements are recommended.
Talker sidetone	Subclause 7.11 STMR = 10 - 18 dB with nominal value of 13 dB according to ITU-T P79 (1993)	Subclause 30.5 STMR = 13 ± 5 dB according to CCITT Recommendation P.79 [38]	Same nominal value, tolerances are larger for GSM (lower limit) but formulas and parameters are slightly different. ➪ no straight away comparison.
Listener sidetone	Subclause 7.12: - LSTR ≥ 10 dB - or for PP with noise rejection capability LSTR ≥ 15 dB	Subclause 30.5 This test is included in ETS 300 607 [18] (GSM 11.10) but not TBR 20 [25]. The requirements are included in ETS 300 540 [15] (GSM 03.50) and ETS 300 085 [9] LSTR ≥ 15 dB	The GSM requirements are more stringent than DECT requirements.
Telephone acoustic coupling loss	Subclause 7.13 - Option 1 > 46 dB at nominal volume setting and > 35 dB for all volume settings - Option 2: > 34 dB	Subclause 30.6.1 GSM > 46 dB at maximum volume setting	The GSM requirements are much more stringent than DECT requirements.
Stability margin	Subclause 7.15 and 7.16 Stability margin ≥ 6 dB	Subclause 30.6.2 Stability margin ≥ 6 dB	Same requirements.
Sending distortion	Subclause 7.17 Input: -4,7 dBPa Ratio of signal (nominal value) to total distortion ≤ 33 dB	Subclause 30.7.1 Input -10 dBmO Ratio of signal (nominal value) to total distortion ≤ 33,7 dB performances between -45 dBmO and 0 dBmO: 17,5 dB up to 33,7, then 25,5 dB	GSM requirements are more stringent than DECT requirements.
Receiving distortion	Subclause 7.18 Input -4,7 dBPa Ratio of signal (nominal value) to total distortion ≤ 33 dB	Subclause 30.7 This test is not included in TBR 20 [25]. Input -10 dBmO Ratio of signal (nominal value) to total distortion ≤ 33,5 dB Performances between -45 dBmO and 0 dBmO: 17,5 dB up to 33,5, then 25,5 dB	GSM requirements are more stringent than DECT requirements.

(continued)

Table 5 (concluded): GSM and DECT requirement comparison

Parameters	DECT Requirements in TBR 10 [23]	GSM Phase 2 Tests in ETS 300 607 [18] (GSM 11.10)	Conclusion
Sidetone	Subclause 7.19 Third harmonic distortion ≤ 10%	Subclause 30.8 This test is not included in TBR 20 [25]. Third harmonic distortion ≤ 10%	Same requirements.
Sending out of band signals	Subclause 7.20 sine wave: limits: 4,6 kHz 30 dB 8 kHz 40 dB	Subclause 30.9.1 This test is not included in TBR 20 [25]. sine wave: limits: 4,6 kHz 30 dB 8 kHz 40 dB	Same requirements.
Receiving out of band signals	Subclause 7.21 sine wave: limits 4,6 kHz -35 dBmO 8 kHz -45 dBmO	Subclause 30.9.2 This test is not included in TBR 20 [25]. sine wave: limits: 4,6 kHz -35 dBmO 8 kHz -45 dBmO	Same requirements.
Sending idle channel noise	Subclause 7.23 ≤ -64 dBmOp	Subclause 30.10.1 This test is not included in TBR 20 [25]. ≤ -73 dBmO	GSM requirement are more stringent than DECT requirements.
Receiving idle channel noise	Subclause 7.24 ≤ -54 dBPa at nominal value control volume	Subclause 30.10.2 This test is not included in TBR 20 [25]. ≤ -57 dBPa at nominal value control volume. ≤ -54 dBPa at maximum value control volume	GSM requirement are more stringent than DECT requirements.

10 Principles for type approval of DMTs

NOTE: In this clause GSM means all GSM, E-GSM, DCS combinations as defined in the "GSM" standards.

Three stages of type approval are foreseen:

- type approval for type 1 implementations based on existing standards and CTRs;
- TBR 39 [28] edition 1, covering terminal type 2 (and possibly type 1);
- TBR 39 [28] edition 2, covering terminal types 3, 4 and 5.

The TBR 39 [28] edition 1 is expected to reference existing DECT and GSM type approval specifications extensively. For type 1 DMTs, existing DECT and GSM type approval specifications can be applied independently to the respective parts of the DMT. For type 2 DMTs, extra requirements are necessary to:

- specify a maximum acceptable level of mobility signalling when roaming (specify network selection rules that minimizes the attach/detach frequency when changing network);
- specify the maximum time taken to recognise presence of alternative air interface;
- specify a maximum acceptable level loss of idle-locked mode performance (missed pages, delayed cell re-selection, reduction in rate of broadcast information update.

These new requirements for type 2 DMTs could be specified in a new standard which will then form the basis for TBR 39 [28] edition 1. The items which this standard should cover are discussed in more detail in subclause 7.2.

The TBR 39 [28] edition 2 will be based on standard which will cover aspects of advanced DMTs identified by DTR/DECT-010096 [35].

Annex A:
GSM micro-cellular architectures

This annex examines some methods used in GSM micro-cellular architectures to see if they may be adapted for use in DECT/GSM interworking with DMTs. The protocols used in micro-cellular environments to control whether a terminal locks to a large or small cell should be investigated.

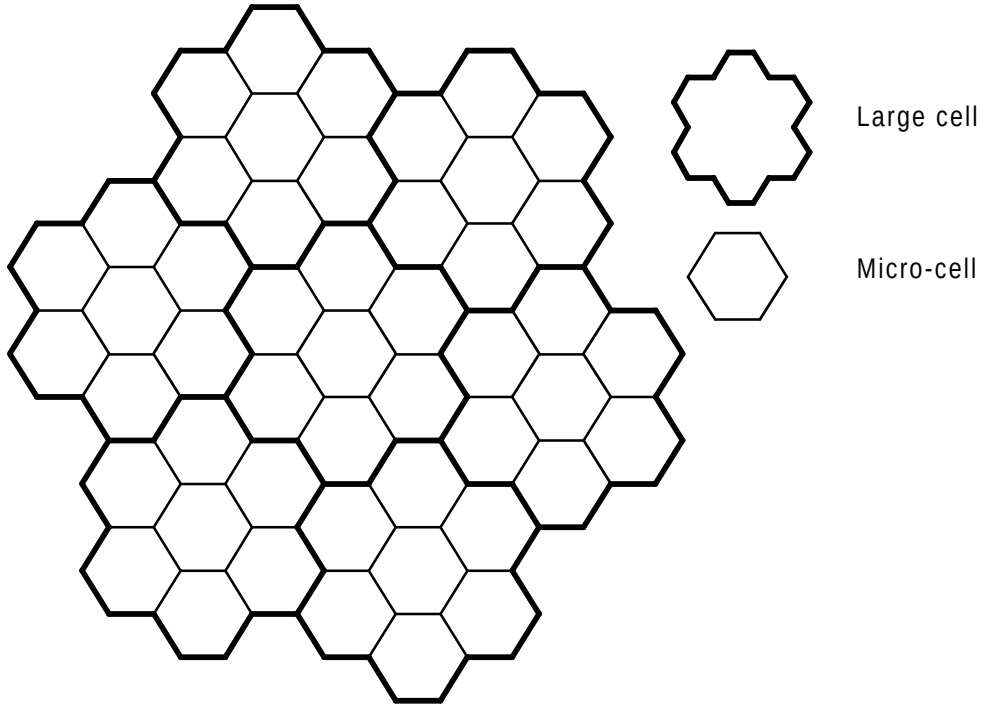


Figure 3: Micro-cellular architecture

Figure 3 represents all the cells belonging to one location area within a PLMN network. It consists of several large cells, and a multitude of much smaller cells operating at lower powers.

All the cells illustrated are part of the same location area, and broadcast the same location area identities on their broadcast channels. Incoming calls will result in paging in all the cells. Moving between any of the cells illustrated does not result in a location registration procedure. The micro-cellular architecture therefore provides greater user density without significantly affecting location registration signalling. Paging is required on a larger number of base stations, which increases the amount of network signalling, but as the base stations are operating at lower power and cover smaller areas does not significantly increase the spectrum load.

To provide better density of coverage, it is preferable that terminals lock to the micro-cells. However for fast moving terminals it is clearly better to lock to a larger cell, or a very large number of handovers will be required if a call takes place. The decision on whether to lock to a large or small cell is made by the terminal based on certain parameters broadcast by the base stations. These parameters may indicate that a terminal should not lock to a micro-cell until it has been in range of the cell for a certain period (indicating that the terminal is not moving very fast).

The parameters mentioned are not supported within the current DECT standards. To introduce a pico-cellular layer to a PLMN network using DECT technology and the exact same scheme architecture as above may require the additional information to be broadcast by DECT RFPs. The DECT Local Area Identifier (LAI) has to be closely tied to GSM location area identifiers. Other possibilities do exist, but they may be less efficient in terms of network signalling bandwidth.

It may be necessary to introduce a more general rule like the one described in subclause 7.2.3. For a user with only a PLMN subscription entering the coverage area of a DECT FP connected to a PLMN, this is not a major problem. If the DMT additionally has a GAP subscription, it will result in a delay before it can receive incoming calls from the GAP network.

Annex B:
Basic differences between GIP, GAP, CAP and IAP

B.1 The GIP

The GIP, ETS 300 370 [10], has been developed as an extension of GAP offering mobility of cordless terminals within and between GSM networks. GIP defines both air interface protocol requirements and details of how the DECT protocols are mapped to the GSM A interface protocols. From an interworking point of view, the DECT FP is connected via an IWU to the GSM PLMN network, which will see a DECT user as a GSM subscriber. Interworking with GSM networks adds requirements in addition to GAP:

- the PP has to support GSM PLMN authentication algorithms, which are different from the standard DECT authentication algorithms;
- the GSM PLMN cipher keys have to be used;
- GSM PLMN identities have to be used;
- the DECT PP shall accept a GSM SIM or a multi-application card with DAM and SIM applications;
- interworking of GSM procedures to DECT procedures adds some protocol additions (compared to GAP) to the DECT FP and PP.

It is a requirement that PPs intending to interwork with a GSM PLMN are still capable of interoperating with GAP FPs. The converse, GAP PP interoperating with FPs connected to a GSM PLMN, is not a requirement, since the additional protocol elements of GIP are essential to interworking with such an FP.

ETS 300 370 [10] covers basic telephony (3,1 kHz speech). Other standards define how GSM bearer services, SMS, facsimile and supplementary services may be supported across a DECT air interface.

B.2 The GAP

The GAP, ETS 300 444 [12], contains a subset of DECT features and procedures that guarantees interoperabilty between DECT PPs and DECT FPs of various manufacturers concerning the basic service telephony. Most features can roughly be classified into four categories:

- features necessary for subscription and authentication;
- features for setting-up, maintaining and release of speech connections;
- security features;
- basic mobility features.

It is of importance for DMTs, that within the coverage of a location area the FP has no knowledge about the actual location of a PP that has itself location registered. The PP will be paged by all RFPs belonging to the location area of the FP. Besides a FP does not know whether a PP is still in its coverage area and ready for connection.

Physical mobility within one or between different location areas of one FP is supported by various handover procedures on layer one and two, allowing the change of transmission channels during a connection according to the quality of the transmission channel.

Because of the minimum of two ARI A, B, C subscriptions and the secondary ARI support (only optional for FPs), mobility in the sense of allowing access to different networks (FPs) is possible, e.g. by using the PLI, but as above the FPs have no knowledge where to reach the PP exactly. Secondary ARIs, that are broadcast less frequently than the primary ARIs, can be used to reflect an operator agreement.

Encryption activation initiated by the FP is mandatory for public FPs and PPs.

B.3 The CAP

The CAP, ETS 300 824 [19], is developed as an extension of GAP offering mobility of cordless terminals within and between networks. The following features, in addition to the above described GAP features, support mobility:

- external handover;
- detach;
- periodic location registration; and
- the tertiary ARI support.

With exception of the optional tertiary ARI support, the above features are mandatory for public FPs and PPs and only optional to residential and business bases.

The feature external handover allows the change of an existing transmission channel not only between location areas of one FP but also between the coverage of two FPs, if supported by the network instance connecting the FPs.

Detach and enhanced location registration are features giving the network information whether the PP is reachable. Detach can be used by the PP to notify of not being accessible anymore. By using the enhanced location registration procedure the network can inform a PP, after what time the location registration of the PP becomes invalid, forcing the PP to register in regular time intervals.

The Tertiary ARI support can be used - as the secondary ARIs- to reflect an operator agreement. The PP might request access to a RFP using a TARI, hoping that this TARI is stored somewhere in the FP.

Besides CAP contains some more features being mandatory for the PP and the public FTs offering further services: CLIP, emergency call, display management, MWI and on-air modification of user parameters. Whereas CLIP is listed as an optional feature in GAP, all other features are new in CAP.

Great significance can be attached to the feature emergency call, because the owner of the PP is put in the position to carry out an emergency call to a local emergency centre, independently whether there exists a valid subscription or location registration for the PP.

B.4 The ISDN access profile

The DECT ISDN end system reference configuration is used where the DECT Fixed System (DFS) and DECT Portable System (DPS) together form an End System with the behaviour of an ISDN terminal equipment. The ISDN end system defines detailed interworking mappings between the DECT protocols on the air interface and the ISDN protocols at the network interface.

The ISDN Access Profile (IAP), ETS 300 434-2 [11], for the end system defines how particular ISDN services are supported, so that inter-operability of DECT equipment can be achieved at the air interface for these services. The following ISDN bearer services are covered:

- speech;
- 3,1 kHz audio; and
- unrestricted digital information 64 kbit/s.

The mandatory features in the IAP are: off hook, on hook, dialled digits basic, incoming call and at least one of the ISDN bearer services above. In the case of speech, the mandatory features in the IAP are included in the GAP. The FP provides interworking between a GAP PP and ISDN.

The support of ISDN supplementary services is optional. Mobility Management (MM) such as location registration, and subscription registration is outside the scope of this document.

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