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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 the present document is to examine the advanced technical issues relating to dual-mode (combined DECT/GSM) terminals in order to provide a basis for future work in this area. The present document proposes what could be standardized in order to establish type approval procedures for advanced dual-mode terminals that goes beyond the existing type approval procedures for DECT and GSM terminals.

The main contents of this report is:

- Radio, network and service aspects of dual-mode terminals that can be registered in two networks, and maybe be in active communication, at the same time via both DECT and GSM radio interfaces. Special focus is put on the reception of SMS in DECT mode and handover between DECT and GSM modes.

- DECT/GSM dual-mode operation where the terminal connects to the same network (GSM PLMN) in both modes using only a single subscription.

1 Scope

To investigate radio and network aspects and clarifying the possibilities, problems and needs for new standardization related to advanced dual-mode terminals for DECT and GSM. The present document will identify the needed contents of the necessary standards that will form the basis for the second edition of Harmonized Standard EN 301 439 [18], i.e. dual-mode terminals that cannot be type approved according to existing TBRs and Harmonized Standards and that may operate in both modes at the same time or using only a single subscription. Basic dual-mode terminals, i.e. terminals consisting of one DECT part and one GSM part and that can be type approved according to existing TBRs and Harmonized Standards, were considered in another ETR (TR 101 072 [16]). The same consideration should be made for dual-mode terminals and infrastructure for DECT/DCS1800 as well as dual-mode/dual-band terminals DECT/GSM/DCS1800. The term GSM is considered to cover all the frequency bands, and combinations of frequency bands, allowed for GSM type equipments, 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 dual-mode terminal.

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

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

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

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

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

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

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

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

[9] ETS 300 370: "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)".

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

[11] ETS 300 787: "Digital Enhanced Cordless Telecommunications / Global System for Mobile communications (DECT/GSM); Integrated Services Digital Network; DECT access to GSM via ISDN; General description of service requirements".

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

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

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

[15] ETR 185: "Digital European Cordless Telecommunications (DECT); Data Services Profile (DSP); Profile overview".

[16] TR 101 072: "Digital Enhanced Cordless Telecommunications/Global System for Mobile Communications (DECT/GSM); Integration based on dual-mode terminals".

[17] EN 301 242: "Digital Enhanced Cordless Telecommunication (DECT); Global System for Mobile communications (GSM); DECT/GSM integration based on dual-mode terminals".

[18] EN 301 439: "Digital European Cordless Telecommunications (DECT); Global System for Mobile communications (GSM); Attachment requirements for DECT/GSM Dual-Mode Terminal (DMT) equipment".

[19] ETR 350: "Digital cellular telecommunications system (Phase 2+); Abbreviations and acronyms (GSM 01.04 version 5.0.1)".

[20] GTS GSM 03.09: "Digital cellular telecommunications system (Phase 2+); Handover procedures (GSM 03.09 version 5.1.0)".

[21] ETS 300 930: "Digital cellular telecommunications system (Phase 2+); Functions related to Mobile Station (MS) in idle mode and group receive mode (GSM 03.22 version 5.2.1)".

[22] ETR 366: "Digital cellular telecommunications system (Phase 2+); Multiband operation of GSM/DCS 1800 by a single operator (GSM 03.26 version 5.1.0)".

[23] ETS 300 940: "Digital cellular telecommunications system (Phase 2+); Mobile radio interface; Layer 3 specification (GSM 04.08 version 5.6.3)".

[24] ETS 300 921: "Digital cellular telecommunications system; Service accessibility (GSM 02.11 version 5.0.1)".

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

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

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

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

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

[30] 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".

[31] TBR 32: "Digital cellular telecommunications system (Phase 2); Attachment requirements for mobile stations in the DCS 1 800 band and additional GSM 900 band; Telephony".

[32] TBR 36: "Digital Enhanced Cordless Telecommunications (DECT); Global System for Mobile communications (GSM); DECT access to GSM Public Land Mobile Network (PLMNs) for 3.1 kHz speech applications".

[33] EN 301 440: "Digital Enhanced Cordless Telecommunications (DECT); Integrated Services Digital Network (ISDN); Attachment requirements for terminal equipment for DECT/ISDN interworking profile applications".

3 Definitions, symbols and abbreviations

3.1 Definitions

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

active communication: A state, where a communication link has been established between the DMT and a fixed part in either GSM or DECT mode.

NOTE 1: When the DMT is in active communication in a mode, it has left the idle state of that mode.

active mode: GSM or DECT mode after being selected and switch on procedures for that mode being performed.

NOTE 2: For GIP/GSM DMTs, registration is not performed in both modes.

background scanning: The process whereby a basic DMT attempts to identify the existence of stable networks in the mode other than the one it is in to which the terminal has access rights.

basic dual-mode terminal: A DMT that can only be in one mode at the time and that can be switched either manually or automatically between modes. The basic DMT is always in one mode.

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

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

call (DECT): All of the layer 3 processes involved in one layer 3 peer-to-peer association.

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 Mobile Station (DMS): A GIP/GSM DMT that operates using only a GSM subscription.

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

GAP/GSM DMT: A dual-mode terminal where the DECT part is compliant with any DECT profile(s) except the DECT/GSM InterWorking Profile.

GIP/GSM DMT: A dual-mode terminal where the DECT part is at least compliant with the DECT/GSM InterWorking Profile.

GSM: In the present document, the GSM part of a DMT can be GSM 900, Digital Cellular System 1800 (DCS 1800) or GSM/DCS dual-band.

GSM coverage: The sum of all GSM Public Land Mobile Network (PLMN) coverages where the DMT has at least limited service.

mode selection: A DMT based procedure, whereby operating mode, GSM or DECT, is chosen.

NOTE 4: Mode selection only applies for type 2 DMTs, type 3, 4, and 5 DMTs operate in both modes.

mode: A basic DMT is in either of the two modes GSM and DECT. In GSM mode the DMT behaves as a GSM Mobile Station (MS) and in DECT mode the DMT behaves as a DECT Portable Part (PP).

NOTE 5: More advanced DMTs can be active in both modes. The grade of service available in the two modes depend on the terminal type.

Portable Part (PP) (DECT Portable Part): 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.

PLMN selection: A GSM procedure defined in [21] where the DMT identifies and selects the PLMN to which it may register.

NOTE 6: For GIP/GSM DMTs, both radio interfaces may be involved in the PLMN selection.

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

NOTE 7: Specific GSM abbreviations may be found in ETR 350 [19]. Specific DECT definitions and abbreviations are found in EN 300 175-1 [1].

3.2 Abbreviations

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

ARI	Access Rights Identifier
CAP	CTM Access Profile
CTM	Cordless Terminal Mobility
DAM	DECT Authentication Module
DECT	Digital Enhanced Cordless Telecommunications
DMS	Dual-Mode Mobile Station
DMT	Dual-Mode Terminal
ETR	ETSI Technical Report
ETS	European Telecommunication Standard
ETSI	European Telecommunications Standards Institute
FP	Fixed Part
FT	Fixed Termination
GAP	Generic Access Profile
GIP	DECT/GSM Interworking Profile
IMEI	International Mobile Equipment Identity
IPEI	International Portable Equipment Identity
IPUI	International Portable User Identity
ISDN	Integrated Services Digital Network
LAI	Local Area Identifier
LE	Local Exchange
MMI	Man Machine Interface
MSC	Mobile Switching Centre
PABX	Private Automatic Bransch Exchange
PBX	Private Bransch Exchange
PLMN	Public Land Mobile Network
PP	Portable Part
PSTN	Public Switched Telephone Network
PT	Portable Termination

RES	Radio Equipment and Systems
RFP	Radio Fixed Part
SIM	Subscriber Identity Module
SMS	Short Message Service
TBR	Technical Basis for Regulation

4 Reference configurations and scenarios

4.1 Terminal Configurations

A Dual-Mode Terminal (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 dual-mode terminals is shown in figure 1.

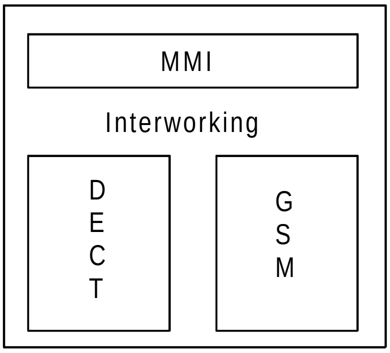


Figure 1: Reference configuration for DMT

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. The exact functionality of the interworking function will depend on the terminal configuration.

4.1.1 Terminal states

A DMT can operate in two modes: DECT and/or GSM. In each mode the terminal can be in different states of operations at a lower layer (MAC layer for DECT and RR layer for GSM).

4.1.1.1 DECT Terminal states

The DECT mode of a DMT behaves as a DECT Portable Part (PP). A PP can exist in one of the following MAC layer states (see EN 300 175-3 [3], subclause 4.3.1).

1) **Active_Locked:** where the PP is synchronized to at least one RFP transmission and has one or more connections in progress.

2) **Idle_Locked:** where the PP is synchronized to at least one RFP transmission. It is able to make or receive connections, but has no connections in progress.

3) **Active_Unlocked:** where the PP is not synchronized to any RFP transmissions, and is unable to make or receive connections. The PP makes occasional attempts to detect a suitable RFP and enter the Idle_Locked state.

4) **Idle_Unlocked:** the PP is not synchronized to any RFP and does not attempt to detect RFPs.

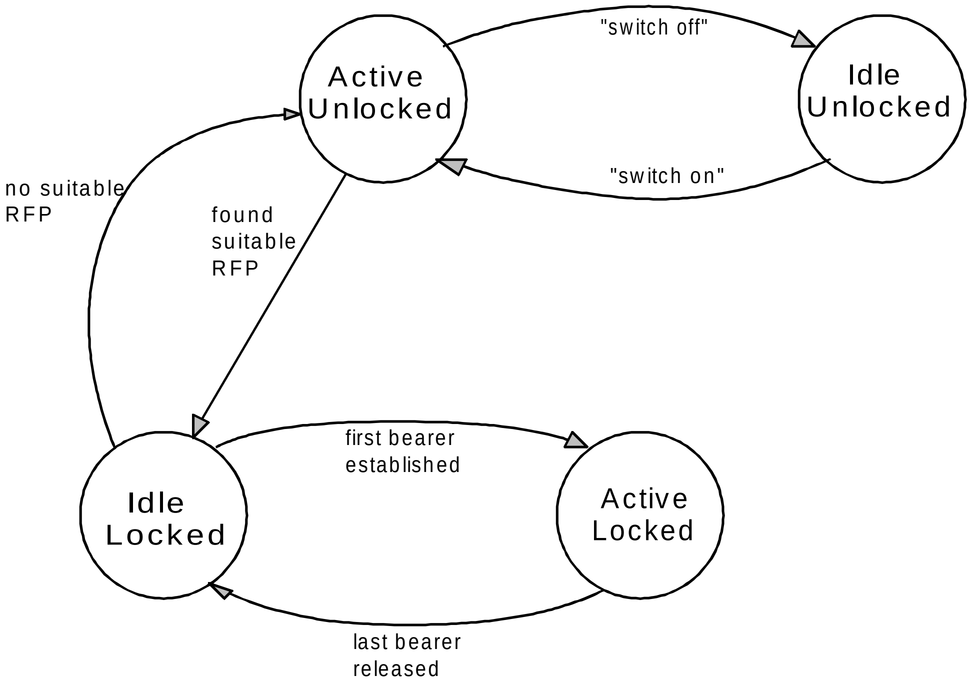


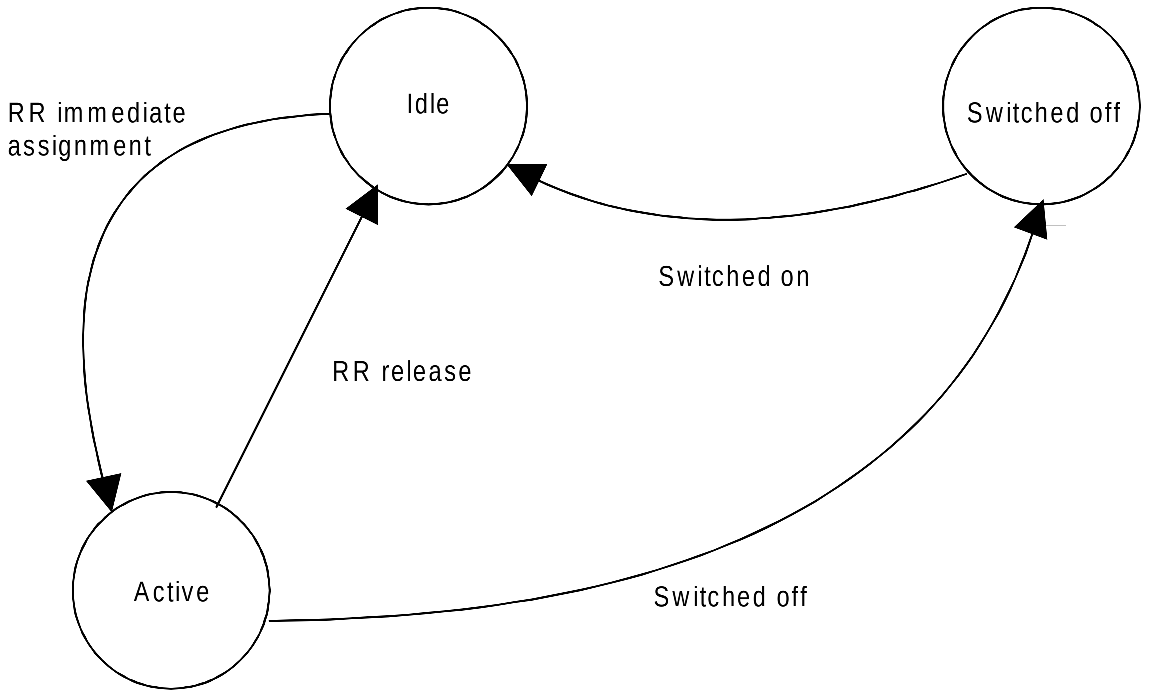
Figure 2: DECT mode state diagram (see EN 300 175-3 [3])

The DECT idle unlocked state corresponds to the GSM idle state.

NOTE: Compared to the GSM case, a DECT PP can go to the switched off state via the active state (e.g. in the GIP and CAP cases) but also directly from the idle state (as e.g. in the GAP case).

4.1.1.2 GSM Terminal states

A switched on DMT in GSM mode can be in either idle state or active state at the RR layer [23]:



1) Idle state: where the MS is switched on and is in GSM idle mode but is not in active communication.
2) Active state: where the MS has initiated an RR immediate assignment and left the idle state.

NOTE: The idle state here should not be mixed with the idle mode. In GSM idle mode, the following steps are covered that corresponds to the DECT finding of suitable RFP: PLMN selection , Cell selection/re-selection (identification of suitable, or any, cell), Camping (tuning to the BCCH of the selected cell) and Location registration (for those services that requests registration).

Figure 3: GSM mode state diagram (based on the description in ETS 300 940 [23])

4.2 Specific terminal configurations

Five general terminal configurations have been identified in TR 101 072 [16]. These are denoted types 1-5. The type 3 terminal where subdivided into type 3a and type 3b. The different terminal types are described in the following subclauses.

Table 1: Summary of terminal types

Number	Description
type 1	single active mode - manual switch
type 2	single active mode - automatic scan (manual or automatic switch)
type 3	dual idle mode (double registration, listen in both modes)
type 3a	simultaneous receive (two transceivers)
type 3b	time multiplexed receive (one transceiver)
type 4	single transmit - dual receive (listen to one radio interface even when active on the other)
type 5	dual active mode (simultaneous transmit/receive in both modes)

Terminal types 1 and 2 where analysed in TR 101 072 [16] and the basis for automatic background scanning and automatic switching between modes (type 2 DMTs) where given in EN 301 242 [17]. The present document covers the terminal types 3-5 and develops further on single-subscription type 2 DMTs.

4.3 Subscription configurations

A dual-mode terminal may contain different subscriptions related to each radio interface or could have a single subscription which could be used in both the DECT and the GSM air interface. The same subscription configurations as for basic DMTs applies here. Two different types must be distinguished in the context of advanced dual-mode terminals:

- single subscription operation where the GSM identity is used to access GSM service also in DECT mode (i.e. the DECT part is GIP compliant);
- multiple subscription operation where the DECT part uses other DECT profile(s) than GIP and at least one DECT subscription in addition to the GSM subscription. (This type of operation also covers the theoretical possibility to use the IPUI-R, containing the IMSI, to connect to other telephony networks than GSM PLMN using another DECT profile than GIP. It also covers the case were both GIP and other DECT profiles are used in the DECT part).

NOTE: Since the GIP is GAP compatible, a GIP portable (and a GIP/GSM DMT) may use both a DECT and a GSM identity depending on which it operates according to (i.e. depending in which environment it is active).

A DMT where the DECT part is compliant with at least the DECT/GSM Interworking Profile is sometimes called a GIP/GSM DMT while DMTs based on other DECT profiles than GIP sometimes are generically called GAP/GSM DMTs. A GIP/GSM DMT that operates only on a single subscription (the GSM subscription), i.e. the DECT part is based only on GIP, will be called a Dual-Mode Mobile Station (DMS).

Basic dual-mode terminals were considered in EN 301 242 [17] for the cases where the DECT part is compliant with the Generic Access Profile, EN 300 444 [12], the CTM Access Profile, ETS 300 824 [13] or the ISDN Access Profile, ETS 300 434-2 [14]. The present document elaborates further on the single subscription operation of types 2-5 DMTs where the DECT part is compliant with the DECT/GSM Interworking Profile, ETR 341 [10] and on multiple subscription operation of DMTs based on types 3-5 DMTs where the DECT part is compliant with other DECT profiles than GIP (possibly in addition to GIP in which case also type 2 DMTs are covered).

4.4 Network configurations

4.4.1 GIP/GSM

For the first phase of dual-mode standardization (see TR 101 072 [16]), it was assumed that the portable supports at least basic speech services. For the GIP/GSM case, the connection between DECT access network and PLMN network could be either via an A interface, ETS 300 370 [9] or via an ISDN interface, ETS 300 787 [11].

Support of other (non basic-speech) GSM services is considered in this report. Clearly when additional services are added they must be supported within the networks. Currently support for SMS and other GSM services is only defined for the A interface. Plans exist for implementing support for all GSM services also on the ISDN interface.

Plans for enhancements of the DECT/GSM Interworking Profile with respects to enhanced bearer services and interworking to GSM phase 2+ services HSCSD and GPRS exists.

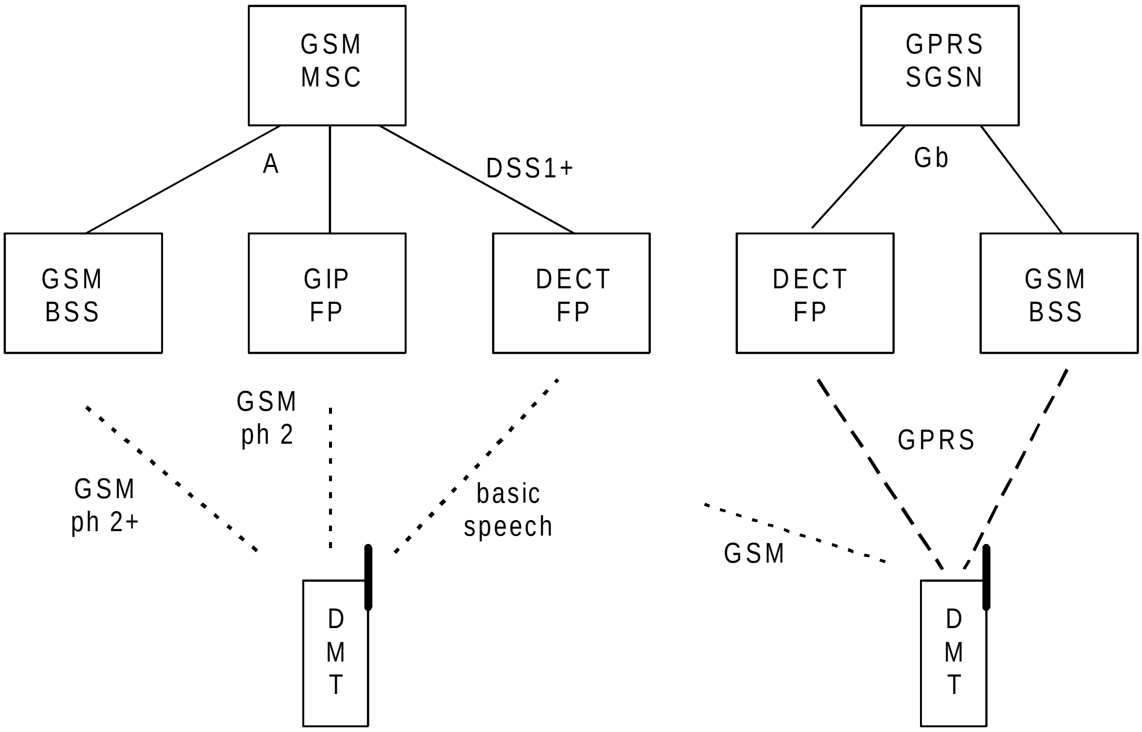


Figure 4: Some examples of network configurations related to GIP/GSM dual-mode terminals

4.4.2 GAP/GSM

For the cases where the DECT part of the DMT is not using GIP, several network configurations can be identified, e.g.:

- a DECT FP in a private system can be connected to both the PABX and data network, e.g. a LAN;
- a residential DECT FP can be connected to a local exchange in the public network;
- a DECT FP can be connected to both private and public CTM networks.

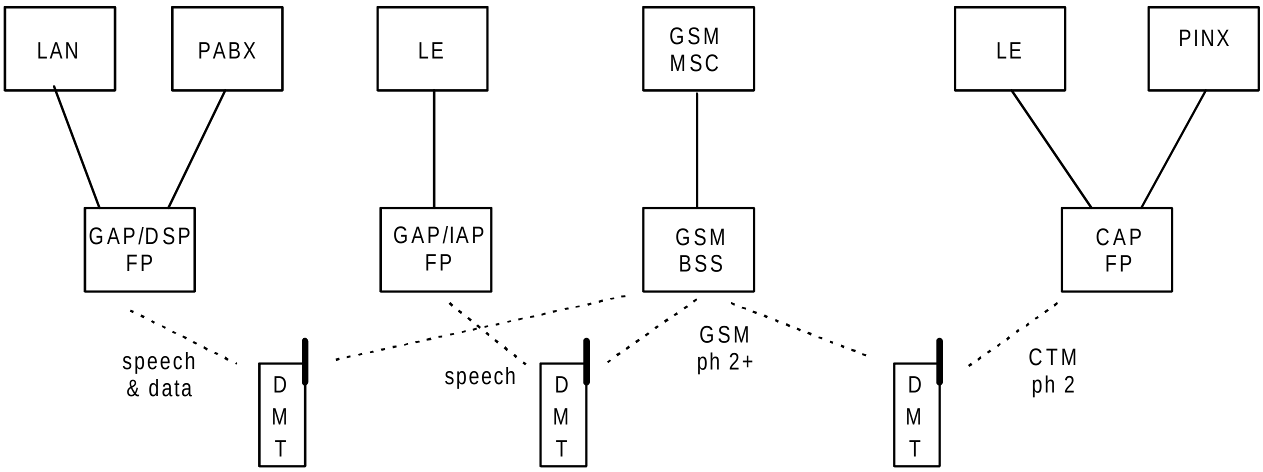


Figure 5: Some examples of network configurations related to GAP/GSM dual-mode terminals

4.5 Service scenarios

In addition to the service scenarios identified for basic dual-mode terminals (see TR 101 072 [16]), i.e. speech service on both GSM and DECT radio interfaces, the examples in this subclause are relevant for advanced GAP/GSM DMTs.

NOTE: The service scenario for GIP/GSM DMTs is covered mainly in clause 6.

Two main applications are identified for double location registered terminals:

- to be reachable on both fixed and mobile telephone numbers at the same time;
- multiple service execution (e.g. simultaneous speech and data).

4.5.1 Simultaneous speech calls

For example, while in the office, the DMT is simultaneously registered via a GSM radio interface to a GSM PLMN and via a DECT radio interface to an Access Rights Identifier (ARI) B network. In the home environment the scenario is the same and DMT is registered in both a GSM PLMN and an ARI A RFP. The DMT is simultaneously reachable on both the PSTN and the GSM numbers.

A type 3 or 4 DMT will be active in a call only on one radio interface at the time. It listens for incoming calls on both radio interfaces but can only answer one at the time.

A type 5 DMT can be active in calls on both radio interfaces at the same time. Support of a conference call involving both modes may not be possible but a terminal based call completion (call waiting/call hold) feature would be possible and could have the same user interface as the corresponding network based services.

4.5.2 speech + data

When active in data call in one mode, a double location registered DMT of type 4 or 5 could be reachable also for incoming speech calls in the other mode.

A type 5 DMT could be considered to operate a data call on one radio interface and one speech call on the other radio interface. It is believed that the data call would then most likely be on the DECT link. The DECT part of the DMT would then have to support one DECT data profile [15] in addition to GAP. In the future there may even be multi mode terminals optimized for data services that only supports a data profile on the DECT part.

DECT data profiles and DECT/GSM specific enhanced bearer services may also be considered to be implemented in type 1-3 DMTs but for these type there are no aspects of simultaneous service execution to consider.

4.5.3 speech/data + SMS

Double location registered DMTs (i.e type 3-5) are able to send and receive SMS over both radio interfaces in the same way as they are able to initiate and receive speech and data calls over both radio interfaces. (For the DECT part the SMS capability depends on which profile the DECT part is based on.) Only a DMT type 5 is able to handle SMS PTP in one mode while being in active communication in the other mode. The delivery of an SMS to type 3 and 4 DMTs would be delayed in one mode until the communication in the other mode is completed. A type 4 DMT can receive SMS CB in one mode even when it is in active communication in the other mode.

Table 2: SMS capability in one mode of a double location registered DMT depending on activity in the other mode

Activity in the other mode DMT type	idle	active
type 3	yes	no
type 4	yes	CB only
type 5	yes	yes

For GAP/GSM DMTs used for single number applications there is a need for the user to always receive GSM short messages. Since DECT access networks cannot necessarily deliver SMSs, the only way to guarantee that SMSs are delivered to the DMT is that the DMT can receive a SMS over the GSM radio interface even when the DMTs is locked to a DECT system. A DMT type 5 meets this requirement. A type 3 or 4 DMT is probably sufficient from the users point of view since it would receive an incoming SMS rather soon after a DECT call is completed.

NOTE: Repetition of paging for SMS is network dependent.

In case the continuous SMS reception is to implemented without having the missed pagings problem of type 3 and 4 DMT, a few options exist:

1) a type 2 DMT could be set to change mode regularly to check for eventual incoming SMS. E.g. the DMT could leave DECT mode once every 15 minutes and go into GSM mode for a minute or so and then go back into DECT mode. This behaviour would not make more harm to networks than what is already allowed for type 2 DMTs (see EN 301 242 [17]);

2) a type 3 DMT could be set to be reachable only for GSM SMS when in DECT coverage. It would then be reachable for incoming telephone calls only from one system at the time in the same way as a type 2 DMT. When in GSM mode and a DECT scanning has identified a suitable DECT network, the DMT would activate the Call Forwarding Unconditional SS (for all services but SMS) and lock to the DECT system. When leaving the DECT coverage the DMT would just deactivate the CFU service.

4.5.4 speech/data + supplementary service transaction

DMTs that are registered in two networks simultaneously (i.e. types 3-5), could be expected to perform a supplementary service transaction, or other signalling, in one mode even when being active in a call (speech or data) in the other mode. Only a type 5 DMT can meet this requirement. Type 3 and 4 DMTs would fail to do this in the same way as they would fail to receive a second incoming call.

5 Double location registered terminals

Type 3, 4 and 5 DMTs are here analysed in the same way as type 1 and 2 DMTs were in TR 101 072 [16].

As a terminal of type 3, 4 and 5 can be simultaneously registered in both systems, the GSM and DECT specifications should be simultaneously met to an extent that needs to be defined.

Due to the different capabilities of the three terminals types, there have to be different requirements for each type of terminal.

5.1 General on testing issues

The basic principle for type testing of advanced dual-mode terminals should be that all relevant TBRs and Harmonized Standards apply simultaneously, and that the terminals need to comply to all those TBR and Harmonized Standard requirements. It is, however, obvious that it may be physically impossible to fulfil them all. If, for instance, the transmitters in both modes are transmitting at the same time, the DECT uplink signal would have to be regarded as an unwanted radiation (not fulfilling the requirements) in the GSM specification, and vice versa. There need therefore to be exceptions or replacements to the existing requirements.

If not all requirements can be fulfilled, at least the general principle must be that all the primary requirements (meaning the requirements which directly degrade/influence the effectivity of the networks or/and the effective use of the RF spectrum and the requirements which have direct influence on the terminal behaviour as seen from the user) shall be fulfilled.

The secondary requirements (meaning requirements which only in very special scenarios, and only with small probabilities degrade the network, the use of the spectrum, or the terminal behaviour) must be fulfilled to a reasonable extent. In this case the principle must be that the most relaxed of the specifications applied simultaneously applies. Therefore the primary and secondary requirements must be identified:

Primary requirements:

- sensitivity;
- pageability;
- unwanted radiation in the GSM/DCS 1800 receive band;
- immunity to in band interference;
- transmit power;
- transmitter modulation parameters;
- timing parameters;
- spurious response rejection/blocking including 3rd order (out of band) intermodulation phenomina.

Secondary requirements:

- unwanted radiations (out of band);
- transmitter intermodulation products.

The requirements regarding unwanted transmitter emissions in the GSM/DCS 1800 receive bands are very severe. There is no reason that a DECT transmitter should not fulfil the GSM requirements, but there may be problems about the DCS 1800 requirements because the DECT band is very close to the DCS 1800 receive band. All such cases must be described in a separate standard, which must then serve as the basis for a TBR or Harmonized Standard together with the relevant standards for DECT and GSM family terminals.

5.2 DMT of type 3 and 4

DMTs of type 3 and 4 can be simultaneously location registered via different radio interfaces but cannot be in active communication in both modes at the same time. When registered in two networks simultaneously (one PLMN and one ARI A, B or C network) the terminal is listening on both radio interfaces at the same time. Location registration procedures work independently and are controlled by the handset.

5.2.1 Idle mode issues

For a type 3 (particularly type 3b) there is a potential loss of idle mode performance compared with single mode terminals, e.g. due to parallel reception or processing in the two modes, which may result in:

- loss of paging messages;
- reduced update rate of broadcast information;
- delayed cell re-selection;
- delayed cell selection;
- delayed location update.

It is desirable that idle mode performance is not degraded. However this may not be practical. If so, the maximum acceptable level of degradation of each of the parameters given needs to be defined. This is an area where new requirements need to be set.

A type 4 DMT will likely not have these idle mode problems.

5.2.1.1 Missed pagings

Pagings being missed by the DMT will force networks to take actions as if the terminal is not reachable even if it is generally present. Pagings on one radio interface may be missed in certain situations:

a) when scanning the other radio interface. This situation is relevant for type 3b DMTs. This could be reduced by intelligent scanning i. e. not scanning when expecting a paging on the other interface;

b) when expecting paging at the same time on both radio interfaces. It could be decided that systematic priority is given to one air interface in this case, e.g. GSM, or to rely on repeated pagings to reach the terminal (this will be the case on the second interface, when the first has priority). The probability of such collisions is expected to be very low;

c) when in active communication on the other interface. When the terminal is in active communication on one radio interface, the other radio interface is blocked. Attach/detach procedures could be used for long periods of active communications such as calls but probably not for short periods of active communications such as location updating or supplementary services. The impact of the time taken to perform detach and attach procedures needs to be considered. If the signalling load is considered too high it could be decided to forbid the use of attach/detach procedures in such cases.

The consequence of the above considerations, is that for type 3 and 4 DMTs, the pageability is degraded. This degradation ought to be limited:

- in case a) and b), an upper limit for the pagings allowed to get lost should be set. This upper limit has to take into account operators needs as well as manufacturers possibilities;

- for b) and c), extra specification of the DMT is necessary if some behaviour is unwanted or if another is preferred.

NOTE: In GAP there is no detach procedure. GSM networks indicate if attach/detach procedures are allowed or not by a broadcast parameter.

5.2.1.2 Automatic network selection

A type 3 and 4 DMT that is double location registered does not switch between the modes, both are active at the same time. It may, though, still be advantageous to say that one of the two active modes is the preferred mode. This would mean the mode in which network selection is performed first and where outgoing calls are set up.

5.2.1.3 Location registration

Considerations of how many subscriptions that are simultaneously active in a DMT are made in TR 101 072 [16]. For DMT type 3 and 4 normally 2 subscriptions, one DECT and one PLMN, will be active at the same time. This could cause problems to the networks as they have no information on whether a DMT is simultaneously registered in another network. These problems are expected to be solved by the operators, e.g. by some intelligent network architecture.

A special situation is a GIP/GSM DMT where a single subscription is used to access a PLMN both via DECT and GSM air interfaces. Simultaneous location registration attempts via both radio interfaces must here be avoided, as each location registration on one air interface overrules the previous registration on the other radio interface.

5.2.2 Active mode issues

When a DMT type 3 and 4 is in active communication in one mode, there is the same loss of idle mode performance in the other mode as described in subclause 5.2.1.

When the type 3 DMT is in active communication (e.g. channel request, call, mobility management operation) on one radio interface, it is not able to receive on the second radio interface. This means e.g. that when the DMT is active in one mode, pagings will be missed in the other mode and the DMT will appear as if it was out of coverage (not reachable) in the other mode. During a call, the synchronization or coverage of the network in the other mode may be lost and a new network may be found after the call is completed.

When the type 4 DMT is in active communication on one radio interface, it is able to receive on the second radio interface. This means e.g. that when the DMT is active in one mode, pagings will be received in the other mode but the DMT may not be able to take any action and may thus also appear to be out of coverage in the other mode. During a call, the synchronization of the network in the other mode is kept and broadcasted information and SMS CB is received. It could be possible for a type 4 DMT to suspend the active service while answering the paging in the other mode and then try to resume the first connection after the call in the second mode is completed (e.g. reception of a SMS). It is probably not possible for the DMT to switch the transmitter between the modes and thus achieve a terminal based call waiting/hold feature.

5.2.3 Call forwarding for a one number service

Type 3 and 4 DMTs have no major advantage or drawbacks compared to type 2 DMTs for access to one number services.

5.2.4 Principles for type approval of type 3 and 4 DMTs

The new requirements for type 3 and 4 DMTs are different from those for type 2 DMTs (see EN 301 242 [17]). Special concern has to be put on finding the acceptable levels of degradation related to idle mode issues and non reachability in one mode when active in the other.

5.3 DMT of type 5

A type 5 DMT is able to be in active communication in both modes at the same time. The advantages of this type of terminal are:

- implementation of a terminal based call hold/waiting feature is possible;
- reception of GSM SMS while the DMT is in active communication in DECT mode is possible;
- running a data call in one mode and a speech call in the other mode at the same time is possible.

5.3.1 Spectrum protection

5.3.1.1 Intermodulation interference

Calculations indicate that there are no 1st - 3rd order intermodulation interference between GSM+DCS and the basic DECT band.

5.3.1.2 Adjacent channel interference

The radio problem for dual active mode terminals is about the adjacent channel interference from DECT to DCS - the DCS receiver may be blocked due to a DECT transmission. (Since the upper DCS band is downlink, there is no interference from DCS to DECT.) To overcome this problem, two solutions were identified:

1) no degradation is accepted - good enough attenuation by, e.g. additional isolators and filters, has to be built (may take considerable time to realize and certainly costs). The guard band between the 1 880,928 MHz (lower DECT) and 1 879,9 MHz (upper DCS 1800) does not give sufficient attenuation. The minimum attenuation from DECT Tx to DCS 1 800 Rx is 64 dB, see figure 6;

2) some kind of degradation is accepted: the DCS sensitivity level can be decreased or, preferably, reduced DECT output power can be used in the lowest DECT frequency channel. A reduction of the power from 24 dBm to 10 dBm in the lowest channel, correspondingly reduce the minimum attenuation from 64 to 50 dB.

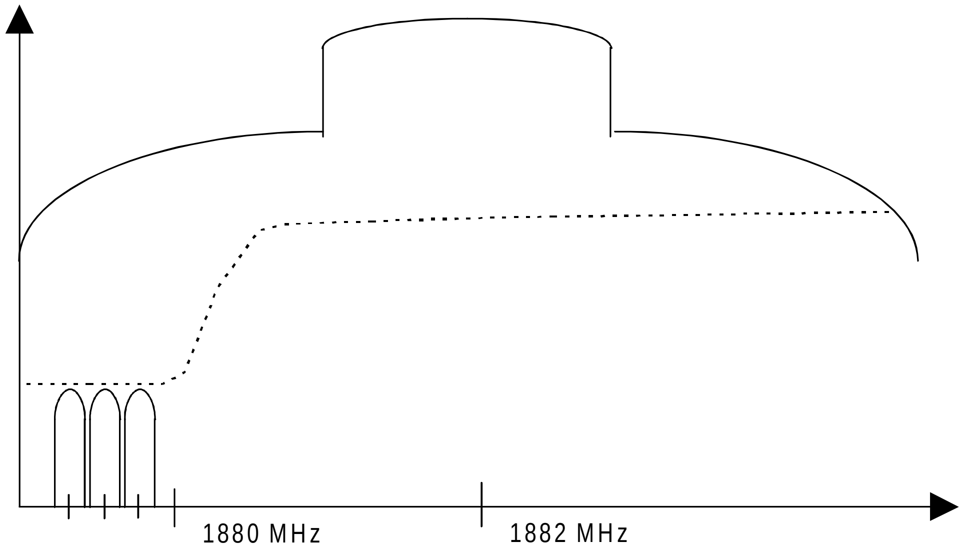


Figure 6: Transmitted DECT spectrum for channel 9 (power 24 dBm) and the three upper DSC1800 receive channels (sensitivity level -100 dBm).

NOTE The maximum interference power for the highest DCS1800 channels is indicated by a dashed line. The minimum additional attenuation is given by the difference between this level and the DECT output power spectrum

5.3.1.3 Blocking requirements

An interesting idea that would enable an early software radio realization of dual-mode terminals is to harmonize the blocking levels requirements so that the DCS value (-25 dBm) applies also for the GSM part (otherwise -13 dBm). Hence, the 12 dB dynamic range reduction, corresponding to 2 bits in a software dual-band/dual-mode ADC, is promising for this implementation.

5.3.2 Protection of network

5.3.2.1 Sensitivity

Most of the issues in subclause 5.2 applies to the protection of network. Two of the main parameters is probably the sensitivity and blocking. When the advanced dual-mode terminal is in active communication in both modes, the two transmitters are active at the same time, and both receivers must fulfil the sensitivity requirements at the same time. As the operators are depending on the sensitivity in their cell planning and link budgets, it seems reasonable to maintain the receiver sensitivity requirements also for an advanced dual-mode terminal.

5.3.2.2 Network selection

A major subject relevant for the protection of the networks is the network selection behaviour of the terminal - an issue similar to the type 2 and 3 or 4 terminal. Even if a type 5 DMT is registered in two networks simultaneously, and thus does not need to switch mode, it is important that correct networks are selected so that there is no excessive switching between available networks.

5.3.2.3 Missed pagings

For DMT type 5 will not miss pagings.

5.3.3 Principles for type approval of type 5 DMTs

The simplest approach for type 5 DMTs is to say that they should comply with both GSM and DECT specifications even when they are in active communication in both modes. Some concern is needed for the formulation of test cases.

A level with weaker requirements would be to say that both GSM and DECT specifications should be met when both modes are in idle mode but that some decreased sensitivity is accepted in one mode when the DMT is in active communication in the other mode. From a network operators cell planing point of view, it is though reasonable to maintain the receiver sensitivity requirements.

5.4 Telephony requirements

There are no other issues related to speech requirements for advanced DMTs than already handled for basic DMTs [18].

5.5 Handover between DECT and GSM

This subclause covers aspects of handover between DECT and GSM systems for DECT systems that are not directly connected to GSM networks. (i.e. the DECT systems are not GIP systems. GIP/GSM handover is covered in clause 6.) The DECT FP is considered to be connected to an exchange, a public Local Exchange (LE) or a private PABX, as illustrated in figure 7.

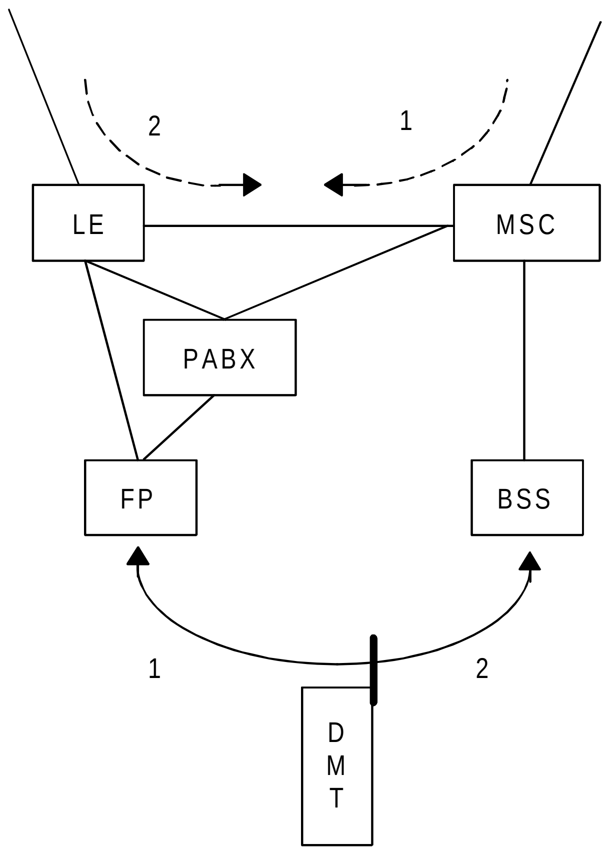


Figure 7: Reference configuration for DECT/GSM handover. The DECT FP is connected to a public LE or to a private PABX which in turn can be connected to an LE or to an MSC

Handover between DECT and GSM in this case requires procedures for handing over calls between two networks. A fully efficient automatic procedure requires that a common control node for the two networks is defined and that procedures are specified for handing over of the connection between exchanges. No standard for inter-network handover is available at the moment. The generic handover mechanism intended for UMTS could be used for the DECT/GSM handover when available.

For early implementations, a simple procedure based on third party connections could be possible. For DMT types 1-3, this procedure will lead to interruptions in the communications when the terminals switches mode and registers in the new network. For type 4 DMTs, only the transmission from the terminal is interrupted if the DMT is already registered in the new network. The DMT would, when it identifies that a change of mode is necessary or preferred, first initiate the setup of a third party connection between the fixed exchange and the MSC. Then the DMT registers in the second network using the other mode (if necessary) and a mobile terminated call set-up is initiated before the first link is released.

For DMT type 5, the handover may be seamless since both terminal and networks can handle simultaneous connections.

6 GIP/GSM dual-mode operation based on a single subscription

The purpose of this clause is to describe the functionality of a GIP/GSM dual-mode network operated by a single operator and the DMS, a GIP/GSM DMT with a single subscription). The DMS uses a single GSM subscription to access a single PLMN both via the GSM and the DECT radio interfaces in a way similar to how a GSM/DCS multiband MS accesses a single PLMN both via GSM 900 and DCS 1800 frequency bands, see ETR 366 [22].

As before, the GSM part of a DMT is considered to have GSM/DCS multiband functionality, i.e. in GSM mode the DMT can operate as a GSM/DCS multiband MS as well as a single band GSM 900 and DCS 1800 MS.

The DECT/GSM Interworking Profile (GIP), ETR 341 [10] defines how GSM services can be supported on the DECT radio interface and how DECT and GSM can be interworked at layer 3 so that a DECT access network can be connected to a GSM PLMN via the A-interface and a user can access GSM phase 2 services using a DECT portable.

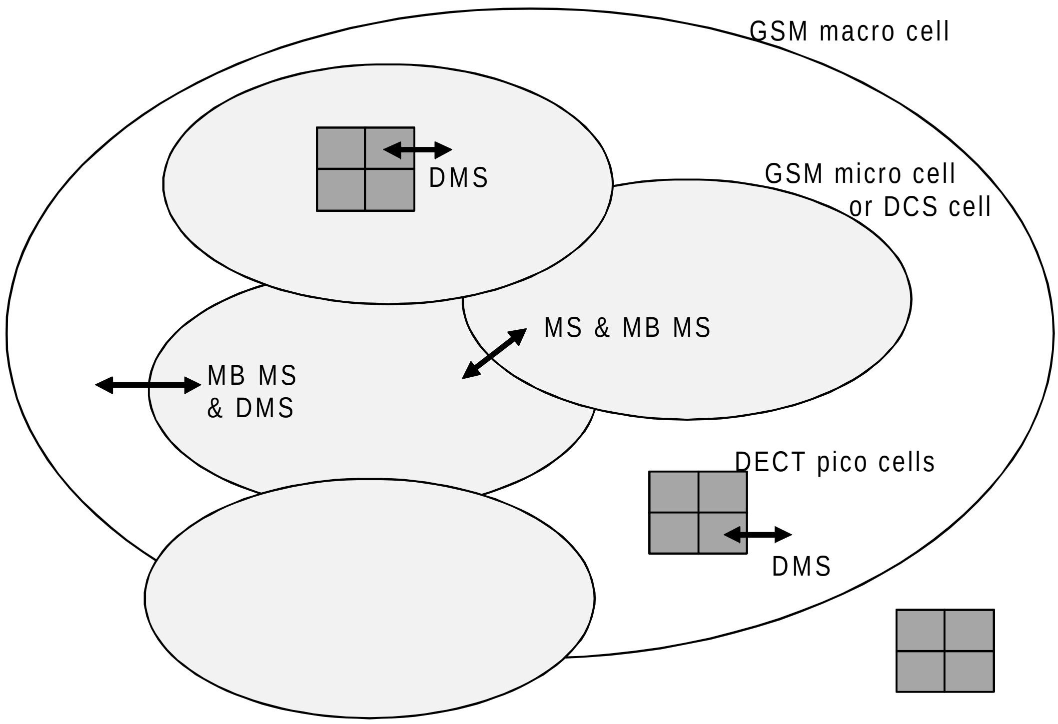


Figure 8: Illustration of a possible dual-mode network with GSM macro cells, GSM micro cells, DCS cells and DECT (GIP) pico cells

- the types of terminals that can move between the different cell layers are also indicated. MB MS: GSM/DCS multi band mobile station;
- DMS: GIP/GSM dual-mode terminal.

Two different approaches can be taken for the integration of the GIP access network with the GSM PLMN in order to support GIP/GSM dual-mode operation:

- approach 1: enables optimum combined usage of the two technologies that benefits from their specific features. E.g. the DMS would choose to work in DECT or GSM mode based on that a prefered mode is defined, either by the user or the network. Idle mode procedures could be based on that a prefered mode is defined. System information would need to be collected over both radio interfaces. This approach leads to a minimum of additional specifications and amendments. This approach is analogue to the one used for basic dual-mode terminals (see EN 301 242 [17]).

- approach 2: efforts are made to make the DECT access to behave as if it was a GSM access. E.g. the PLMN must be able to tune cell re-selections and handovers and a DECT cell must mimic a GSM cell. Idle mode procedures would be based on information from both types of cells. The DMT would chose to work in DECT or GSM mode based mainly on radio parameters that has to be made comparable. System information would be broadcasted over both radio interfaces. This approach would likely imply considerable amendments to both GSM and DECT standards.

The purpose of DECT/GSM interworking is to complement GSM systems with the DECT access and not to introduce a competing application. In this clause only approach 1 in considered since it enables an optimum combined usage of the two technologies that benefits from their specific features which approach 2 does not.

The primary use of GIP/GSM dual-mode operation is likely to increase capacity in hot-spots (e.g. city centres), extend coverage for GSM services to indoor environments and enhance the service level with higher data rates. To achieve these benefits, DECT should be set as the preferred mode of the DMS.

The use of GIP does not imply changes of the pricing of the GSM service even when accessed through DECT. The call pricing for the DECT access could, though, be set higher than for GSM calls in case of an increased service level (e.g. higher data rate services) but also lower than GSM in order to attract new types of users.

6.1 General

GIP/GSM dual-mode operation by a single operator enables an operator, with license(s) to frequencies specified in the GSM specifications, to support the use of three types of terminals (MSs, PPs and DMSs) and to extend the PLMN with respect to capacity, quality, services (higher data rates) and coverage (e.g. indoor environments).

A DMS is a GIP/GSM DMT operating with a single subscription, the GSM subscription. It has the functionality to access a single PLMN, and get GSM services delivered, via both GSM and DECT radio interfaces and may be able to perform handover, channel assignment, cell selection and cell re-selection between DECT and GSM modes of operation within one PLMN, i.e. when one PLMN code is used in both modes.

NOTE: The functionality to perform handover between modes depend on which type of DMT is used, type 5 is required for a "seamless" handover. Basic DECT/GSM DMTs, as defined in EN 301 242 [17], can use both the GSM and the DECT frequency bands but can not access GSM services in DECT mode.

The DMS has the functionality to make PLMN selection in either mode of operation. The DMS shall meet all requirements for each individual-mode and the extra functional requirements for the DMS to handle the priorities related to selection of HPLMN and use of preferred mode.

6.1.1 Frequency bands of operation

GIP/GSM dual-mode operation shall be possible with any combination of the DECT frequency band and the frequency bands specified in the GSM specifications. No frequency band needs to be treated as a primary band. The user or the operator may, however, use control mechanisms to make the DMSs treat one of the modes (DECT or GSM) as the preferred mode.

As a first implementation of GIP/GSM dual-mode operation only operation with GSM 900, DCS 1800 and DECT frequency bands is included. The proposed procedures should, however, make it possible for operation between other bands if such are included in the core specifications in the future.

6.1.2 Backwards compatibility

GIP/GSM dual-mode operation should be specified to be backwards compatible so that no harm is made to existing networks and so that GSM phase 2 single mode mobiles, GSM/DCS multi band mobiles and DECT GIP portables will work in a GIP/GSM dual-mode network.

DECT GIP PPs and DMSs are based on GSM phase 2 and backward compatibility with GSM phase 1 and 2 single band mobiles and GSM/DCS multi band mobiles are ensured by the GSM specifications. A GIP/GSM dual-mode PLMN shall therefore, in addition to support of DMSs, be able to support the use of single mode terminals for each of the modes of operation. Single mode signalling will be present as well as dual-mode signalling.

Backward compatibility by the DMSs must also be ensured. The DMSs shall therefore be able to, functionally, work as single mode terminals in single mode networks (DECT or GSM).

6.1.3 PLMN codes

Dual-mode operation of GIP/GSM by a single operator, with handover and assignment between the bands, implies that only one PLMN code is used in all bands of operation. Handover and assignment between PLMNs is not considered.

6.1.4 Other systems

GIP/GSM dual-mode operation by a single operator does not include multi mode operation, i.e. handover assignment or roaming between DECT or GSM and systems covered by other specifications or standards. The amendments of the DECT and the GSM specifications for GIP/GSM dual-mode and GSM/DCS multiband operation may however be done in a flexible way so that future multi mode operation can make use of the same procedures.

6.1.5 Multiple service execution

The possibility to run several services simultaneously, e.g. GSM speech at the same time as a DECT/GSM enhanced bearer service over DECT, exists for a DMT type 5 based DMS. This may require modifications in the network to allow multiple services but may become possible if e.g. the DECT part of the DMS can interwork to GPRS.

6.1.6 DMT type considerations

The consequence for service and network performance of GIP/GSM dual-mode operation depends on which DMT type the DMS is based on. This subclause describes the main differences between the service levels offered by the different DMS types.

6.1.6.1 DMS type 1

No difference from having one GIP portable and one mobile station operating using the same SIM except that the user only needs to carry one terminal instead of two (and of course does not have to remove/reinsert the SIM).

No handover is possible between the GIP and GSM PLMN coverage.

6.1.6.2 DMS type 2

A type 2 DMS may be based on the "basic dual-mode procedures" (preferred mode) or on a new procedure that mixes mode and PLMN selection. It may be able to identify available GSM cells using a background scanning procedure.

GIP to GSM seamless handover in the same PLMN can be performed if the DMS can perform the background scanning while in active communication.

6.1.6.3 DMS type 3

If same LAI is used in GIP access network as in surrounding GSM area, there is no need for mode switching as for type 2 DMS because paging will be done on both radio interfaces.

6.1.6.4 DMS type 4

A type 4 DMS can perform seamless handover between GIP and GSM PLMN coverage. Furthermore in the case of multiple service while in activity in one coverage it can support a receive-only service in the other (e.g. a speech call in GIP while receiving a SMS Cell broadcast message in GSM).

A type 4 terminal compared to types 2 and 3 has the advantage to maintain the system synchronization with both GSM and DECT coverage.

6.1.6.5 DMS type 5

A type 5 DMS can perform seamless handover between GIP and GSM PLMN coverage. Furthermore it can provide execution of multiple services simultaneously.

6.2 Requirements

6.2.1 User requirements

No special actions by the user shall be necessary to use a DMS. The possibility for the user to manually select the mode of operation must, however, be supported. The user may also choose which mode is the preferred one, as in EN 301 242 [17]. Indications should also be given to the user of which mode is being used.

The user of a DMS shall be able to roam between PLMNs operating in any of the DMS's frequency bands of operation. The DMS shall therefore, at PLMN selection, present all available PLMNs within its frequency bands of operation.

6.2.2 Operator requirements

The use of GIP/GSM dual-mode operation is optional for the operator. DMSs must therefore be able to, functionally, work as single mode terminals in single mode networks.

When GIP/GSM dual-mode operation is used, it shall be possible to provide coverage in one frequency band independently of the coverage in the other frequency band(s).

Operators may benefit from the advantages of having a picocellular access network without the need to plan that part of the network with the same accuracy as the micro and macro cellular parts of it. Instead they would make use of the fact that there is no need for detailed frequency planning of the DECT access network and the fact that the DECT access may be implemented in specific environments. The full possibility of forcing the DMS into a specific cell, band or mode in the same way as it is for a MB MS is then not required. Possibly a mechanism that makes it possible for the network to indicate preferred mode is sufficient.

6.2.3 DMT specific requirements

The radio requirements for DECT and GSM differs. A DMS and the GIP/GSM dual-mode network shall meet the requirements for each mode of operation respectively. Type approval of DMSs will be covered by the respective test specifications and some additional test for the dual-mode functionality. The radio requirements for DMTs are covered in TR 101 072 [16], EN 301 439 [18], and clause 5. No new requirements are identified for DMSs.

The DMS supports frequency hopping in GSM mode and dynamic channel selection in DECT mode. Frequency hopping and dynamic channel selection between the modes can not be supported.

6.2.4 Security requirements

It has to be ensured for GIP/GSM dual-mode operation that the same level of security is maintained over the DECT mode as is specified for the GSM mode. This is ensured by GIP since this profile is specified to meet the security requirements of GSM (see ETS 300 370 [9]).

6.3 Functional description

To identify the necessary amendments of the DECT and GSM phase 2 specifications, functional descriptions of different procedures and solutions are given below.

6.3.1 Idle mode procedures

The idle mode procedures will not be different for GIP/GSM terminals or networks when the DMS is in either DECT or GSM mode. Only the fact that operation in more than one mode may be available has to be taken into account. Specific DMS idle mode procedures are needed for switching between DECT and GSM modes.

6.3.1.1 PLMN and Mode selection

Different PLMN and mode selection procedures have to be defined for the different DMS types.

For DMSs of type 1 (manual switching between the two modes) the user first selects mode. PLMN selection is then performed in the selected mode as defined in ETS 300 930 [21].

For DMSs of type 2 a parameter value must be set for which mode (DECT or GSM) is the preferred mode [17]. The preferred mode is automatically selected if there is a network available to which the terminal has access rights. The preferred mode parameter can be set by the user. If the operator needs to be able to control the mode selection for the DMS, this can be done by simply introducing ways to transport a value for the preferred mode parameter from the GIP/GSM dual-mode network to the DMS. This mechanism is much simpler to implement than enforcing the network to handle DECT cells in the same way as DCS and GSM micro cells are prioritized in GSM multi band operation.

In the selected mode the type 2 DMS listens to the radio interface and collects the available PLMNs in a list: if the HPLMN is available, the mode is the preferred one and the selected PLMN is the HPLMN. If the HPLMN is not available in the preferred mode, the DMS switches to the non preferred mode and collects the available PLMNs in a list: if the HPLMN is available, the mode is the non preferred one and the selected PLMN is the HPLMN. If the HPLMN is not available in the non preferred mode either, the DMSs compares the two lists of PLMNs available in the two modes and selects a PLMN as described in ETS 300 930 [21]. If the selected PLMN is available in the preferred mode, this mode is selected.

NOTE: The DMS may also use background scanning to look for HPLMN in the mode other than the one it is in.

After selecting PLMN and mode, PLMN re-selection (as specified in ETS 300 921 [24] and ETS 300 930 [21]) is performed only in the active mode. If no PLMNs are found in the active mode, the DMS switches to the non preferred mode and performs PLMN selection.

For DMSs of type 3, 4 and 5 (which can listen to both radio interfaces) the PLMN and mode selection can be performed as follows:

- the DMS listens to both radio interfaces and collects list of available PLMNs in both modes;
- the DMS selects a PLMN following the procedures defined in ETS 300 930 [21] based on a common list of PLMNs available in both modes. For PLMNs that normally has equal priority in the PLMN selection procedure, a higher priority can here be given to those PLMNs that are available in the preferred mode;
- if the selected PLMN is available in both modes, the preferred mode is selected.

NOTE: For a type 3-5 DMS, to select the preferred mode means that actually only one of the modes is used for execution of the GSM services. The other mode may be on in order for the DMT to be prepared for a mode handover or PLMN reselection.

6.3.1.2 Cell selection

The DMS would select the mode to operate in, as indicated in the previous subclauses, and then select a suitable cell in that mode. The DMS would need to be locked to a DECT cell and camped on a GSM cell at the same time, e.g. in order to receive suitable DECT handover candidates and GSM neighbour cells in case a handover becomes necessary.

After a suitable cell has been selected, any necessary registration will be performed.

6.3.1.3 Cell re-selection

The DMS will cell re-select according to which mode it is in.

In the case of DMS of type 3, 4 and 5, if a preferred suitable cell is found in the other mode the DMS may change mode automatically based on the timer similar to the one defined in [17] or, in case different location areas, the GSM hysteresis parameter CRH may used also for change of mode. Decision of preferred cell could be based on the DECT radio parameters if these are made comparable to the GSM field strength and priority parameters.

NOTE 1: Similar considerations could seem to apply also for type 2 DMSs but the difference between type 2 and 3 in this case is that a type 2 DMS is not required to perform more idle mode procedures than just network identification.

NOTE 2: There is no need to generalise the neighbourhood cell list concept and mix GSM and DECT cell identities and channels.

6.3.1.4 Location areas

No special requirements are specified for the allocation of location areas among the cells in a GIP/GSM dual-mode network. It shall therefore be possible to use the same or different location areas for cells in different frequency bands irrespective of their location. Location areas for GSM micro cellular architectures were very briefly discussed in TR 101 072 [16].

Several possibilities for relating the DECT RFPs to GSM location areas exist:

- the RFPs of a single FP may relate to several GSM location areas;
- all RFPs of a single FP relate to the same GSM location area but different FPs relate to different GSM location areas;
- several FPs relate to the same GSM location area but this location area contain only DECT cells;
- a GSM location area contain both DECT and GSM cells.

The advantage of having DECT and GSM cells in the same location area is that the DMS would (usually) not cause any extra signalling in the PLMN due to a change between DECT and GSM mode. As long as the terminal knows which its preferred mode is, it would respond to pagings in this preferred mode.

The advantage of having DECT and GSM cells in separate location areas is that there would be a natural hysteresis when the DMS changes between DECT and GSM mode. Even if the DMS may be locked to DECT cell and camped on a GSM cell at the same time, it shall not perform location registration in both location areas. When the location areas of the DECT and GSM cells are different, a change of mode should be based on the CRH (CELL_RESELCT_HYSTERESIS) parameter (see ETS 300 930 [21]) rather than on the principle of preferred mode as in EN 301 242 [17].

6.3.2 Connected mode procedures

6.3.2.1 Monitoring

The DMS shall use the normal GSM monitor and reporting procedures when in GSM mode. Even if the DMS can listen on both radio interfaces, it may need to report only on GSM channels using the normal GSM monitor and reporting procedures.

6.3.2.2 Handover

Handover between DECT and GSM modes of a DMS in a GIP/GSM dual-mode network can be described based on the GIP external handover procedure in ETS 300 370 [9] and the GSM basic external intra-MSC handover procedure in GSM 03.09 [20]. Handover examples are illustrated in annex A.

Handover is initiated by the DMS based on identification of a bad radio link or identification of a much better one. As in GIP, ETS 300 370 [9], the portable initiation leads to a handover command from the network.

Any DMS will only send measurement reports from cells within its modes of operation. Handover commands to cells outside the modes of operation will therefore not occur.

6.3.3 Frequency and power capabilities

The network should be informed by the DMS of its frequency and power capabilities to ensure that all procedures, e.g. the handover algorithm, gets accurate information.

6.4 Technical realization and amendments

The technical realization and the identified modifications/amendments of existing standards necessary to support DMSs and GIP/GSM dual-mode operation are given here.

6.4.1 Handover

Type 5 DMT is not required for GIP-GSM handover. Type 2 is enough for GIP→GSM handover and type 4 is enough for GSM→GIP handover (or at least the possibility to evaluate link quality of the second mode and transport these measurements on the first link).

GSM handover candidate identities are included in handover candidate procedure.

If GSM identities are to be included in the handover candidate messages only to DMSs (and not to GIP PPs), the network (at least FPs) must know that the terminal is a DMS. It must be possible for the network (at least FPs) to identify terminal capabilities (at least distinguish PPs from DMSs).

DMS shall interpret handover candidate indication as HO command.

6.4.2 Identities

For a GIP PP, the IPEI is mapped to the IMEI [9] and the PP identity can be handled in the EIRs in the same way as the identities of the GSM MSs. The only difference is that the first two digits of the TAC in the IMEISV are coded as 10 making it possible to distinguish GIP PPs from GSM MSs. I would be possible assign DMSs IMEISVs either as for GSM MSs or as for GIP PPs but it will then not be possible to distinguish a DMS from a GSM MS or a GIP PP, at least not from the IMEISV.

The problem of identifying the different future types of multi mode terminals, where one of the modes is GSM, should be considered in general.

7 Network selection for multi-subscription DMTs

This clause covers the general network selection problem that occurs for a terminal with several subscriptions, on what principles should it operate when selecting mode/network/subscription/service? Neither the existing basic dual-mode procedure (based on the definition of a preferred mode) nor the existing PLMN selection procedure is capable of handling network and mode selection simultaneously. The considerations is based on the most general case; a GIP/GSM DMT with both GSM and DECT (ARI class A,B,C) subscriptions.

One way to achieve a mixed mode/network selection would be to first create a list of the subscriptions in the DMT arranged in order of priority. Either the priority could be fully according to the users preferences or a default order could be used, e.g.

1) residential DECT subscriptions (ARI class A);

2) business DECT subscriptions (ARI class B);

3) public DECT subscriptions (ARI class C);

4) GSM subscription (ARI class D or PLMN).

At power up, the DMT type 2 would go into the preferred mode and select the network on which it can use the subscription with highest priority. In case the subscription in use does not have the highest priority, the DMT would perform background scanning looking for a network in the other mode on which it can use a subscription with higher priority. Among the subscriptions with the same priority, network selection would be performed according to DECT or GSM principles.

Type 3-5 DMTs would scan both radio interfaces and compare the networks available in both modes and select mode and network according to where it can use the subscription with the highest priority.

Use of the GSM subscription in the HPLMN would be handled as a subscription with higher priority than the use of the GSM subscription in a VPLMN. Similarly in case a DECT IPUI is paired with several PARKs, then one of the IPUI-PARK pairs could be considered to be of higher priority.

8 Conclusions

8.1 Remarks on dual-mode terminal types 3, 4 and 5

In the following paragraph the functional behaviour of the three types of advanced dual-mode terminals is summarized. The advantages / disadvantages with respect to reachability and handover between DECT and GSM are discussed and compared to a basic type 2 DMT.

8.1.1 DMT Type 3

This terminal is able listen in both modes at the same time but in case the DMT is in active communication in one mode the other mode is blocked. To the network, such a terminal would then seem to be out of coverage in one mode.

Compared to a type 2 DMT, the type 3 DMT offers the user the possibility to be reachable on two telephone numbers at the same time. To guarantee full reachability even when the DMT is in active communication in one mode, "call forwarding on not reachable" will have to be permanently activated as it may not be possible for the terminal to react on an incoming call.

A DMT type 3 can be used to enhance a type 2 DMT with SMS capabilities.

The handover capabilities are the same for a type 2 and type 3 terminal.

8.1.2 DMT Type 4

A type 4 terminal is able to listen in both modes at the same time. In case of active communication in one mode the other mode can still listen. Unless the terminal is able to react to an incoming call on the non-active radio interface via the active radio interface, this terminal will appear to be out of coverage just like a type 3 terminal. But such a solution seems not reasonable. It is more practical and requires less changes to implement a common IN functionality behind the DECT / GSM networks to support reachability via DECT or GSM for a type 4 terminal.

While in active communication on one side, measurement results for the non-active air interface could be sent via the active air interface. This means that a seamless handover between DECT and GSM could be possible. The type of handover would have to be serial, like in GSM.

8.1.3 DMT Type 5

This type is capable of handling the complete functionality of both modes at the same time. Concerning reachability call forwarding is still needed in situations where there is only coverage in one mode. But the terminal offers the possibility to be in active communication in both modes at the same time (e.g. multiparty between different modes/ speech and data) and is more flexible than a type 4 terminal concerning handover DECT / GSM.

So this is the most promising type of DMT if it were not for the potential cost of such a terminal.

8.1.4 Commonalities

Finally, it turns out that all types of terminals have to rely on call forwarding to offer continuous reachability of the user. Therefore the only real disadvantage of a type 2 terminal seems to be its missing capabilities for a seamless handover between DECT and GSM and its lack of ability to receive GSM SMS in DECT mode. These features may be offered by a type 3, 4 or 5 terminal.

Besides the application of the advanced terminals as double location registered terminal these terminals could also be used like a type 2 terminal but capable of performing a seamless DECT / GSM handover and receiving GSM SMS.

8.2 Acceptance of degradations

Regarding the acceptable degradation the idea should be to keep everything as close to existing requirements as possible. Of course, almost every shortcoming of a particular type of terminal could be cured by some network settings but it should be avoided that operators have to base their network planning on the functionality of dual-mode terminals.

One particular problem is the out of coverage behaviour for type 3 and type 4 terminals while in active communication in one mode. Whereas in case of a type 2 terminal the operator could rely on attach / detach to save spectrum, in case of a double location registered terminal (except type 5) he may not be able to rely on this. From the users point of view a DMT type 3 or 4 with out-of-coverage behaviour may be acceptable since the user can rely on call forwarding on not reachable.

In case a DMT of type 3- 5 is not used as a double location registered terminal but as a type 2 terminal which is capable of performing a handover between DECT and GSM or is capable of receiving GSM SMS in DECT mode, the necessary degradations are less severe.

8.3 Further standardization

The following requirements were identified that needs to be specified in a new dual-mode standard (or to be included in existing standards) which must then serve as the basis for a TBR or Harmonized Standard together with the relevant DECT and GSM standards:

A service description for type 3-5 DMT functionalities should be written that goes into greater detail than the basic dual-mode standard, EN 301 242 [17].

The requirements on acceptable degradation, e.g. decreased pageability, for double location registered terminals (type 3, also 4 and 5) must be described.

The requirements for DMTs type 4 and 5 regarding unwanted transmitter emissions in the GSM/DCS 1800 receive bands must be described.

New procedures for network/mode selection for multiple subscription terminals and for multiple registrations are required.

The requirements for GIP/GSM dual-mode operation concerning the idle mode procedures (cell selection, cell re-selection, location area management) and active mode procedures (e.g. handover) has to be described in a specific standard or as an update of the GIP standards (see ETR 341 [10]). The GSM standards are likely to be affected as well.

8.4 Testing and type approval

Type approval and testing issues have already been looked at in clause 5. It is important that a type 3, 4 or 5 DMT, when manually switched to DECT or GSM mode, meets all of the type approval requirements associated with a single mode DECT PP or GSM MS. However, the principle followed for type approval of type 2 DMTs, that of type approving each mode separately, with minimum testing of the automatic mode selection mechanism, would not be sufficient. This is particularly the case for type 5 DMTs.

8.4.1 Radio testing and type approval

8.4.1.1 Type 3 DMTs

Type 3 DMTs may exist in two radio configurations: type 3a, which has dual transceivers, and therefore is able to simultaneously receive when idle in both modes, and type 3b, which has only one transceiver, and which is therefore not able to simultaneously receive when idle in both modes.

A type 3 DMT is the most straightforward of the advanced DMTs to type approve, in that it will require little or no modification of the existing type approval requirements for DECT, GSM, and type 2 DMTs. The approach adopted could be very similar to that of type 2 DMT. Since type 3 terminals do not receive in one mode when transmitting in the other, unless performing background scanning, existing receiver sensitivity requirements could be met for both modes. In any case, receiver sensitivity can only be tested when the DMT is in active communication, which for type 3 DMTs means that the other mode is no longer receiving, unless performing background scanning, which is similar to type 2 DMTs.

A type 3 DMT should not emit more spurious emissions than a type 2 DMT performing background scanning. It would be acceptable to test spurious emissions when manually switched to each mode, as for type 2 DMTs (except when performing background scanning while in active communication, in which case the same test conditions as for type 2 DMTs would apply). EMC emissions/immunity can also be tested exactly as for type 2 DMTs. This avoids attempting to combine the DECT and GSM spurious emissions tests, which is just as difficult and unnecessary for type 3 DMTs as it is for type 2.

In conclusion, for radio type approval, a type 3 DMT can be treated exactly as a type 2 DMT, in that the existing radio essential requirements of TBR 6 [25], TBR 19 [27], TBR 31 [30] and Harmonized Standard EN 301 439 [18] would apply without modification.

8.4.1.2 Type 4 DMTs

A type 4 DMT, in terms of radio configuration, is one which has 2 transceivers, which is capable of receiving on one mode while transmitting on the other, but which is incapable of transmitting on both simultaneously. Radio testing could, for the most part, be performed separately for each mode when manually switched to that mode.

Since a type 4 DMT is registered to a network on both modes at the same time, the receiver sensitivity of both receivers should meet the existing requirements for DECT and GSM, whether or not the DMT is transmitting in one of the modes. However, it is only possible to test receiver sensitivity using the existing TBR and Harmonized Standard tests while the DMT is transmitting (loopback is required). Therefore, the existing tests give no indication as to the performance of a receiver of one mode while the other mode is transmitting. The existing receiver sensitivity tests can be used, but will need to be executed while the DMT is receiving in both modes (not manually switched to one mode). Consideration will need to be given to the need to develop a receiver sensitivity test which does not involve transmission of the DMT, in order to verify that receiver sensitivity requirements are met at all times.

For testing spurious emissions requirements, it should be sufficient to test each mode separately, while manually switched. While the DMT is (transmitting in one mode and) receiving in both modes, there will be some additional spurious emissions compared with when the DMT is manually switched one mode, for the simple reason that there are two receivers active as opposed to one. These extra emissions must be allowed for, so the existing DECT or GSM tests can not be run when receiving in both modes. The risk associated with these emissions does not justify the complication of writing combined DECT/GSM spurious emissions tests to allow for this.

EMC tests should be performed while the DMT is receiving in both modes, and not when manually switched to one mode.

In conclusion, for radio type approval, the existing tests of TBR 6 [25], TBR 19 [27] and TBR 31 [30] should be applied separately while manually switched to each mode, except: EMC and receiver sensitivity tests should be tested while receiving in both modes, and the need for a new test method for receiver sensitivity, not involving loopback or transmission, should be considered.

8.4.1.3 Type 5 DMTs

Type 5 DMTs, which have dual transceivers which can be active simultaneously, will require significant investigation, and modification, of existing type approval requirements for DECT and GSM. Therefore they will be the most costly to type approve.

Transmitter requirements of DECT and GSM could, in theory, be tested while manually switched to each mode. But it may be considered necessary to test each transmitter while both are active. While the existing requirements should not be relaxed in this case, there may be a need for extra requirements, and there will almost certainly be a need to modify the existing DECT and GSM test cases to take account of the new test environment of having two transmitters active. In this case, it would not also be necessary to apply the existing tests while manually switched to each mode.

Existing receiver requirements of DECT and GSM should not be relaxed. However, each receiver should be tested while both transmitters are active. Existing test methods may need to be modified because of the new test environment. New requirements will almost certainly be necessary, to sufficiently protect each receiver from the other mode's transmitter in very close proximity. It should not be necessary to also apply the existing receiver tests while manually switched to each mode.

Spurious emissions requirements and tests of both DECT and GSM will need to be combined. New maximum limits will need to be devised, with suitable protection of each mode's operating frequencies from the other. Maximum emissions outside the DECT and GSM bands (from whichever transmitter source) will probably need to be less than the sum of the exiting limits for DECT and GSM, but may need to be greater than the existing DECT or GSM limits in order to avoid prohibitively extra expense in designing a type 5 DMT.

EMC requirements and tests will need a similar combination, but this should be easier as they are already almost identical. In particular, the maximum emissions may need to be revised.

In conclusion, much standardization work is required before type approval of type 5 DMTs can proceed. There is no technical reason which should prohibit type approval of this type of DMTs. The problem is simply that much more standardization is required, which will involve compromise.

8.4.2 Acoustic and telephony testing and type approval

There are no additional acoustic or telephony requirements, or tests, which are necessary for type approval of advanced DMTs. Existing type approval requirements in TBR 10 [26], TBR 20 [28] and TBR 32 [31] will be applied without modification. Wheras it might be necessary to relax certain DECT acoustic requirements for type approval of early type 1 or type 2 DMTs, this should not be necessary for types 3, 4 or 5, (or later type 1 or 2 designs) as DMT manufacturers should develop the capability of designing DMTs to meet both the DECT and GSM requirements.

8.4.3 Protocol testing and type approval

8.4.3.1 Type 3 DMTs

It is possible to design a type 3a DMT which does not degrade idle mode performance on either air interface. If initial registration on each mode is performed sequentially, the type 3a DMT will behave like a normal single mode terminal, responding immediately to the first paging which occurs on either air interface. It will probably be designed to behave like an out of coverage MS or PP while the DECT or GSM mode respectively is transmitting. Performing the complete registration procedure on one mode first, and then on the other, is necessary, because registration usually involves several idle mode procedures which can not be interrupted.

A type 3b DMT will miss paging messages more frequently than a type 3a DMT, and will possibly have a reduced update rate of broadcast information, due to its need to switch its single receiver between DECT and GSM. However, the impact that this will have on the performance of type approval tests under laboratory conditions is not clear. A type 3b DMT which is tested when registered on both modes may perform better than a type 3b DMT which is only registered on the mode being tested, as it may not need to scan the other mode as thoroughly when it knows on which timeslot and frequency to find the broadcast information of the network it is registered to. On the other hand, a type 3b DMT which is only registered in one mode will probably behave similarly to a type 2 DMT, in that it will perform background scanning for the other mode.

In summary, it should be possible to perform the existing protocol tests in TBR 19 [27], TBR 22 [29], TBR 31 [30] and Harmonized Standard EN 301 440 [33] on both type 3a and type 3b DMTs. Investigations need to be made concerning the tests performed following power on. Some relaxations of response timing requirements may have to be made for both modes. It might be sufficient to test Layer 3 or NWK layer of the protocol while subscribed on both modes, and the lower layers when manually switched to one mode at a time. A special test may need to be written to ensure that a type 3 DMT behaves correctly in one mode when a call is made/answered in the other. If it is to behave as though it is out of coverage, it should be verified that location updating is performed if the periodic location update timer (if running) expires during the call, for example.

There is no need to test type 3 DMTs against type 2 requirements on excessive signalling due to switching between networks, because if it is registered on two networks, and looses coverage in one, it does not as a result perform any extra signalling in the other.

8.4.3.2 Type 4 DMTs

Type approval of type 4 DMTs should be similar to that of type 3a DMTs, where protocol requirements are concerned. Some relaxations of response timing requirements necessary for type approval of type 3 DMTs may not be necessary for type 4 DMTs. Since a type 4 DMT, with two receivers always active, will be able to monitor information broadcast in one mode while in active communication in the other, therefore it may be able to apply procedures such as location updating or cell re-selection slightly faster than a type 3 DMT.

8.4.3.3 Type 5 DMTs

A type 5 DMT should be able to meet all of the existing DECT and GSM protocol requirements in TBR 19 [27], TBR 22 [29], TBR 31 [30] and Harmonized Standard EN 301 440 [33], while registered in both modes. In particular, it should be able to meet all the requirements of one mode while there is signalling being performed or a call active on the other (worst case scenario) There should be no need for a compromise on protocol requirements with type 5 DMTs.

An extra test case may need to be performed to verify correct handling of an incoming voice call in one mode while a voice call is already active in another. The exact handling of the call may vary from terminal to terminal, or may be user configurable - it may involve auto-answering or simply alerting, and providing call waiting notification to the user, or it may involve release or rejection because the user is busy, but in each case the appropriate protocol signalling shall be performed - it shall not be acceptable to ignore the pagings, like a type 4 DMT.

8.4.3.4 DECT GIP/GSM DMTs

A single mode DECT PP which implements the DECT/GSM Interworking Profile as contained in ETS 300 370, is required to be type approved according to TBR 6 [25], TBR 10 [26], TBR 22 [29] (for GAP operation) and TBR 36 [32] (for GIP operation). A DECT GIP PP is required to support GAP. TBR 22 [29] is applied when the GIP PP has a normal DECT subscription, and TBR 36 [32] is applied when the GIP PP has a SIM card inserted with a valid or test GSM subscription.

DECT GIP/GSM dual-mode terminals, regardless of the type of DMT, will need to be type approved according to TBR 36 [32]. TBR 36 [32] should be applied in the same manner, and under the same test conditions (manually/automatically switched, with one or two subscriptions etc.), as TBR 22 [29] will be applied. Indeed, the type approval according to TBR 36 [32] may be more straightforward than for TBR 22 [29], as there are no lower layer test suites in TBR 36 [32].

DECT GIP/GSM DMTs which have a single subscription (DMSs) will certainly have additional requirements concerning mode and PLMN selection, cell selection and re-selection, and handover between modes (on the same PLMN). There may be requirements on the possibility of being location registered on both modes. These requirements may vary according to the type of DMT on which the DMS is based. None of these possible requirements have been elaborated. Many of them are likely to be considered essential to the operation of the DMS and to the protection of the PLMN, and therefore may be included in the essential requirements of a TBR or Harmonized Standard, with an associated test.

Annex A: GIP/GSM external handover

The reference configurations for GSM, GIP and GIP/GSM external handovers are given in figure A.1.

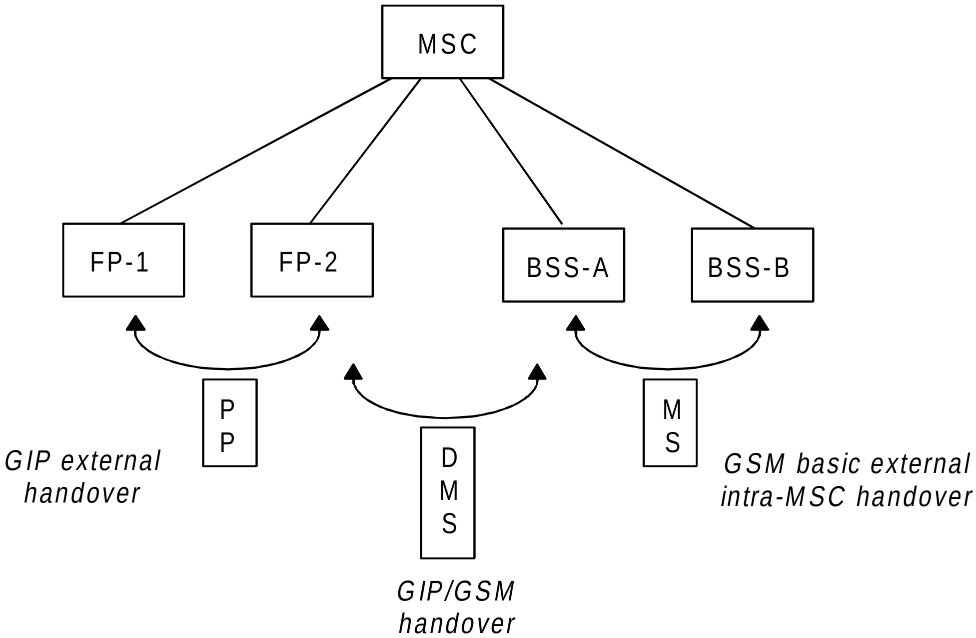


Figure A.1: Illustration of external handovers related to GIP/GSM

The information flows for the successful external handover procedures are given in clauses A.1 to A.3.

A.1 Basic external intra-MSC handover procedure

The following figure is the same as figure 4 of GSM 03.09 [20] (v5.0.0) and describes the procedure for a successful basic external intra-MSC handover.

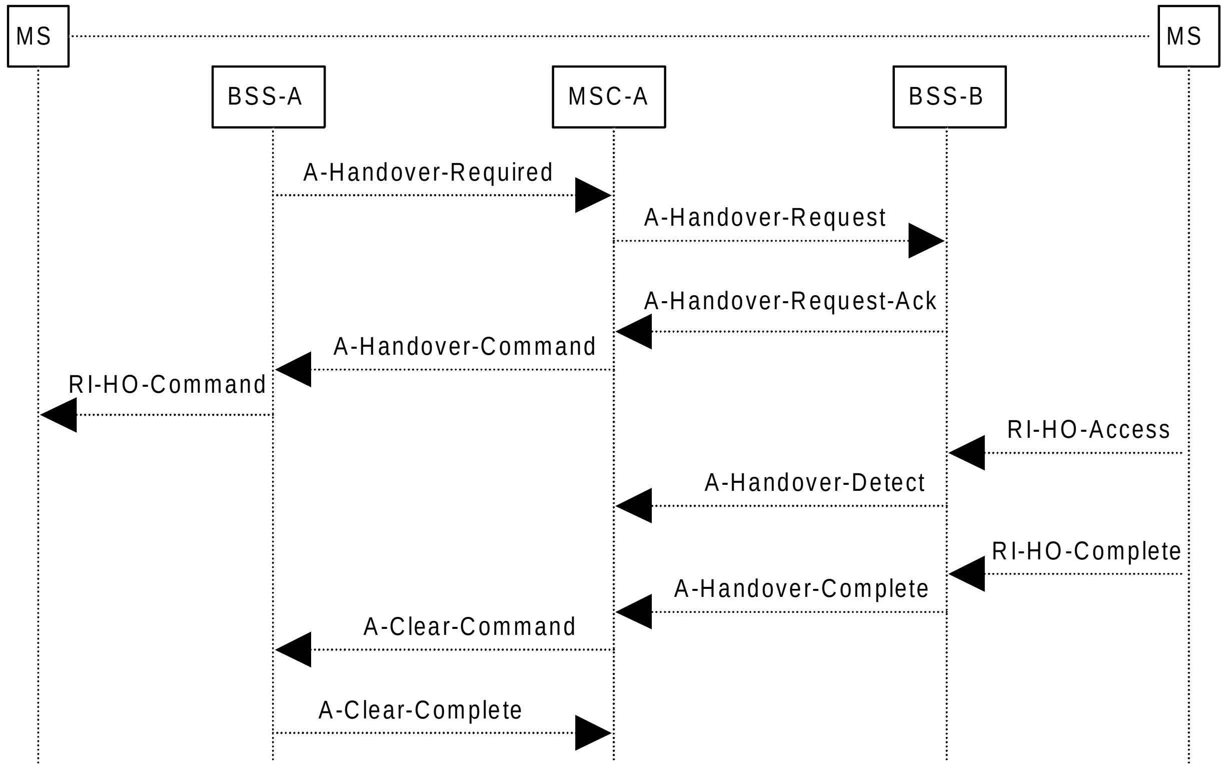


Figure A.2: Basic external intra-MSC handover procedure

A.2 DECT/GSM interworking profile external handover overview

The following figure is the same as figure 30 of ETS 300 370 [9] (2nd ed) and gives an overview of DECT/GSM external handover.

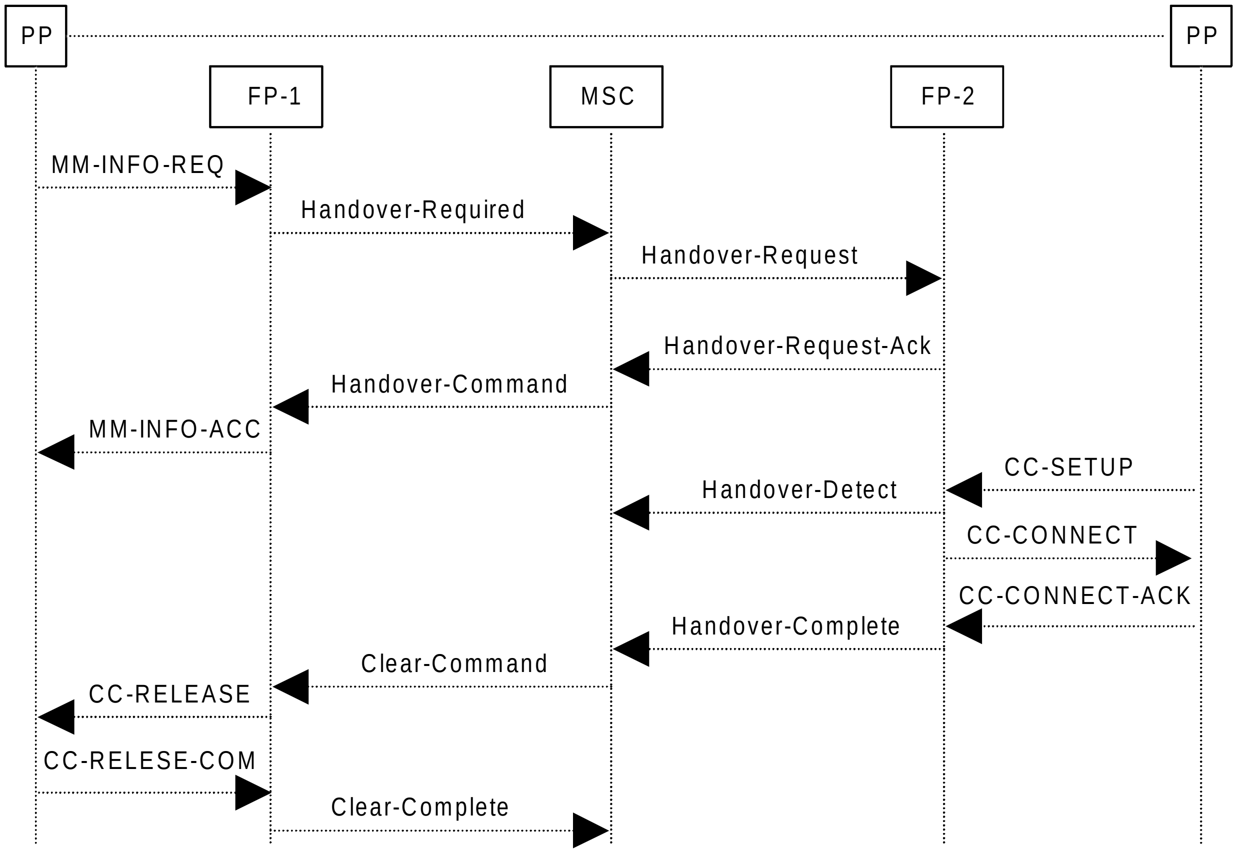


Figure A.3: DECT/GSM interworking profile external handover overview

A.3 GIP/GSM handover

A procedure for handover from GIP to GSM can be defined using the first half of the GIP external handover procedure before the second half of the GSM basic external intra-MSC handover procedure, see A.3.1, and a procedure for handover from GSM to GIP can be defined using the first half of the GSM basic external intra-MSC handover procedure before the second half of the GIP external handover procedure, see A.3.2.

Since the GSM handover is serial (first link dropped before second link established) and GIP handover is parallell (first link not released until setup of second link is confirmed), GIP/GSM handover can actually be performed by a type 2 DMT if some restrictions is imposed on the GIP part of the procedure. Due to different synchronization and cell broadcasting mechanisms a DMT at least type 4 would be beneficial for an efficient GIP/GSM handover.

A.3.1 GIP to GSM handover

Two cases are distinguished depending on the capabilities of the DMS to operate in one or two modes simultaneously. The information flow in figure A.4 is relevant for both cases.

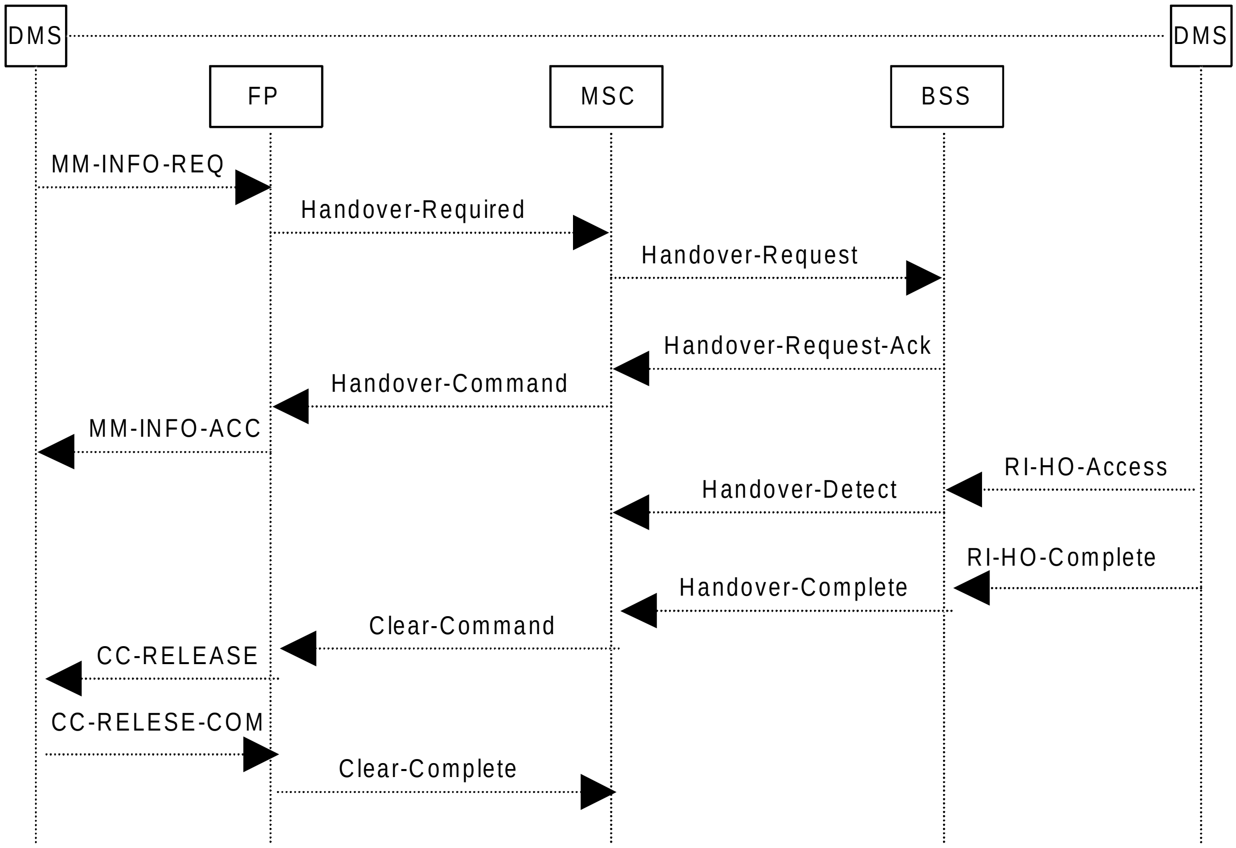


Figure A.4: GIP to GSM handover

NOTE: The term handover candidate is used in the DECT sense, i.e. a potential new FP or GSM cell.

A.3.1.1 Basic procedure - DMT type 2

The DMS is locked to a GIP system. It continuously measures the quality of the received signal field strengths and identifies that it needs to change from the current FP. The decision is based on that the DECT link becomes too bad.

Prior to initiation of GIP/GSM handover, the DMS should obtain handover candidates from the current FP. This enables the DMS to determine to which BSS a GIP/GSM handover may be attempted.

The DMS requests from the FP a handover reference. This request implicitly informs the FP that an external handover is about to take place. As a result of this indication, the FP requests for a handover attempt by signalling to the MSC. The request contains information, available in the FP, on what target cell has been chosen as most appropriate.

The MSC allocates the network resources needed at the terrestrial links as well as in the handover candidate BSS. Upon successful completion of the resource allocation, the MSC informs the FP that resources were allocated and the handover attempt may continue. The FP returns the previously requested information (information on the GSM base station and frequency) to the DMS which then switches mode and initiates a setup to the handover candidate BSS.

It must be ensured that the same level of ciphering is enabled on the new link.

With a successful connect procedure, the BSS informs the MSC about the handover in the access part. As a result, the MSC switches the network connection to the BSS and initiates a release of the link to the FP which initiates a call release to the DMS. The type 2 terminal will not be able to receive, and confirm, the release command but this does not affect any connection at this point.

The above case describes a portable initiated handover, i.e. what is most efficient when the DMS leaves DECT coverage and needs to change to the GSM radio interface in order to continue.

Network initiated GIP/GSM handover can be performed using the DECT handover candidate indication procedure (the DMS must interprete this as a command to make handover to the indicated BSS).

A.3.1.2 Advanced procedure - DMT type 4 and 5

Prior to initiation of GIP/GSM handover, the DMS should obtain handover candidates from those broadcasted by the serving GSM cell. This enables the DMS to determine to which GSM cell a GIP/GSM handover may be attempted.

The DMS continuously measures the quality of the received signal field strengths of both the DECT and the GSM systems. Based on these measurements, the DMS or the FP identifies that the DMS needs to change mode. The decision can be based either on that the DECT link becomes too bad or that a GSM link would better (i.e. means to compare DECT and GSM link qualities must be defined).

The DMS requests from the FP a handover reference. This request implicitly informs the FP that an external handover is about to take place. The request contains information on what target cell has been chosen as most appropriate. As a result of this indication, the FP requests for a handover attempt by signalling to the MSC.

The MSC allocates the network resources needed at the terrestrial links as well as in the handover candidate BSS. Upon successful completion of the resource allocation, the MSC informs the FP that resources were allocated and the handover attempt may continue. The FP returns the previously requested information to the DMS which then initiates a setup to the handover candidate BSS.

It must be ensured that the same level of ciphering is enabled on the new link.

With a successful connect procedure, the BSS shall inform the MSC about the handover in the access part. As a result, the MSC switches the network connection to the BSS and initiates a release of the link to the FP which initiates a call release to the DMS. (Only a type 5 DMT can then confirm the release of the DECT link).

The above case describes again a portable initiated handover. The decision to make the handover is based on a comparison between the qualities of the DECT and GSM links. The comparison can be made either in the terminal (as in DECT) or in the FP (as in GSM) if the GSM measurements are transferred over the DECT link.

Network initiated GIP/GSM handover can be performed using the DECT handover candidate indication procedure (the DMS must interprete this as a command to make handover to the indicated BSS).

A.3.2 GSM to GIP handover

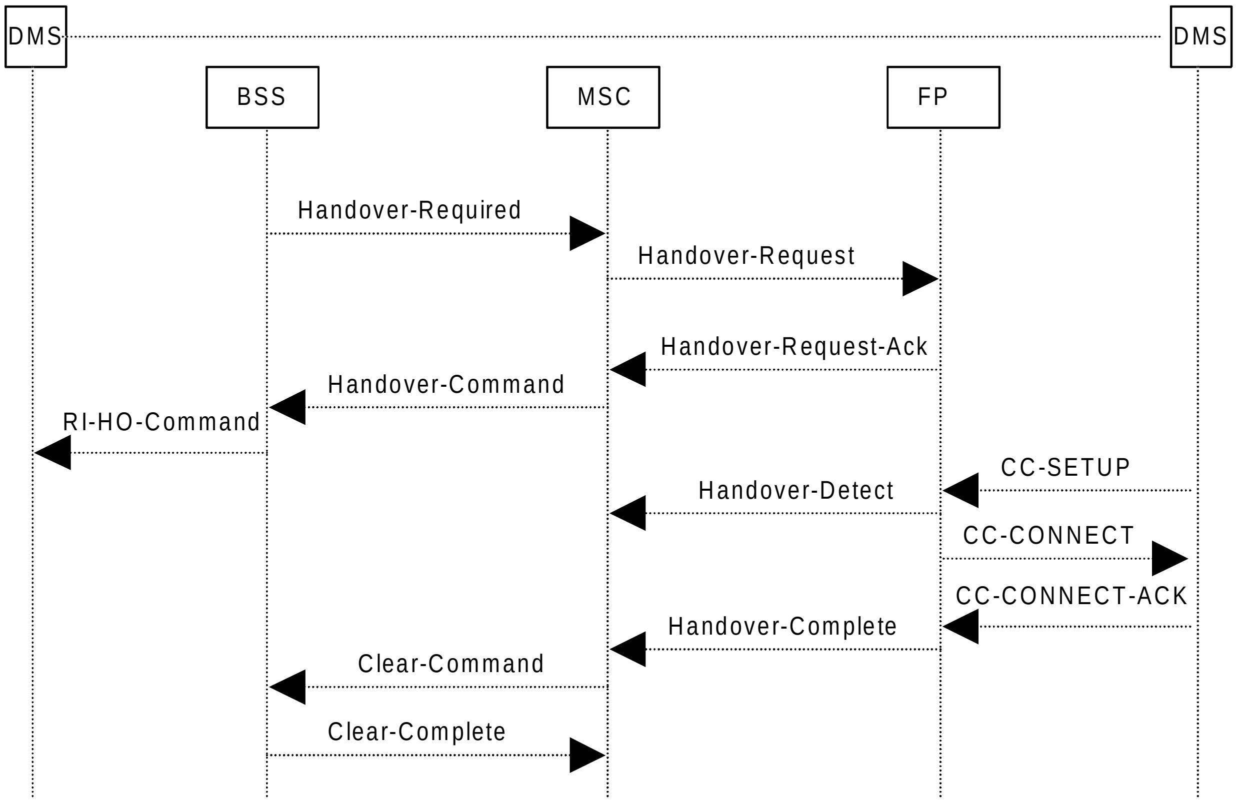


Figure A.5: GSM to GIP handover

For a GSM to GIP handover to be possible, the DMS must be able to measure the quality of the received field strength of also the DECT links when active on a GSM link. For this a DMT of at least type 4 is needed.

The serving GSM cell could indicate that DMSs should evaluate also DECT cells for future handover purposes and the DMS then reports also these measurements back to the GSM BSS which decides if to initiate the handover. Even if DMSs can be made to evaluate DECT cells without being ordered to do it, the BSS is only prepared to receive measurements on DECT cells that are being covered by the serving GSM cell.

If a handover is required by the BSS, the MSC sets up the terrestrial links to the FP and a GSM handover command is sent to the DMS. The DMS then switches to DECT mode and initiates a call set-up to the FP. The FP indicates the detection and completion of the handover to the MSC which initiates a release of the connection to the BSS.

History

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