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Part 2: Home Automation Network (phase 2)

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Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Digital Enhanced Cordless Telecommunications (DECT).

The present document is based on ETSI EN 300 175 parts 1 [1] to 8 [8], ETSI EN 300 444 [9], ETSI EN 301 649 [16] and ETSI TS 102 939-1 [12].

The present document has been developed in accordance to the rules of documenting a profile specification as described in ISO/IEC 9646-6 [i.1].

The present document is part 2 of a multi-part deliverable covering Machine to Machine Communications based on DECT Ultra Low Energy (ULE), as identified below:

Part 1: "Home Automation Network (phase 1)";

Part 2: "Home Automation Network (phase 2)".

Further phases with additional functionality may be defined in the future by other parts of this multi-part deliverable.

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

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Introduction

DECT Ultra Low Energy (ULE) is based on the DECT base standard ETSI EN 300 175 parts 1 [1] to 8 [8], and the DECT Packet Radio Service (DPRS) ETSI EN 301 649 [16]. However, DECT ULE includes substantial differences from its parent technology in order to achieve Ultra Low Power consumption.

From the point of view of DECT standardization DECT ULE is an Application Profile (AP) based on the DECT base standard (ETSI EN 300 175, parts 1 [1] to 8 [8]). This application profile may reuse definitions and procedures defined in other DECT applications profiles when needed or convenient. This is the case, for instance, of the DECT Generic Access Profile (GAP) ETSI EN 300 444 [9], the DECT Packet Radio Service (DPRS) ETSI EN 301 649 [16] and DECT Ultra Low Energy (ULE) Part 1 [12].

All DECT devices claiming to be compliant with this Application Profile will offer at least the basic services defined as mandatory. In addition to that, optional features can be implemented to offer additional DECT ULE services.

The aim of the DECT ULE standard is to guarantee a sufficient level of interoperability and to provide an easy route for development of DECT ULE applications. The DECT ULE standard also guarantees compatibility between DECT ULE applications and existing DECT applications (such as GAP or NG-DECT) running over the same spectrum and even in the same device.

1 Scope

The present document covers the following DECT ULE services and features:

- Back-compatibility with ULE Phase 1 [12].
- Regional variants of ULE for US and Japan.
- Support for hybrid devices which utilize ULE and non-ULE services (such as voice).
- Software Update Over The Air (SUOTA), compatible with the same feature as defined in New Generation DECT Part 4 [13].
- Compatibility mode for FTs that also support No-Emissions Mode (NEMo [13]).
- Connectionless Downlink, which is the capability to transmit ULE messages to multiple devices.
- Repeater compatibility support for FP and PP.

The set of DECT ULE services and features defined in the present document is named "Home Automation Network (phase 2)", and is primarily targeted to provide a global M2M solution within domestic scenarios. However, this does not prevent the use of the present document in other scenarios.

2 References

2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the reference document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are necessary for the application of the present document.

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

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

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

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

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

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

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

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

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

[10] ETSI TS 102 527-3: "Digital Enhanced Cordless Telecommunications (DECT); New Generation DECT; Part 3: Extended Wideband Speech Services".

[11] ETSI TS 102 527-1: "Digital Enhanced Cordless Telecommunications (DECT); New Generation DECT; Part 1: Wideband speech".

[12] ETSI TS 102 939-1 (V1.1.1): "Digital Enhanced Cordless Telecommunications (DECT); Ultra Low Energy (ULE); Machine to Machine Communications; Part 1: Home Automation Network (phase 1)".

[13] ETSI TS 102 527-4: "Digital Enhanced Cordless Telecommunications (DECT); New Generation DECT; Part 4: Light Data Services; Software Update Over The Air (SUOTA), content downloading and HTTP based applications".

[14] ETSI TS 102 497: "Digital Enhanced Cordless Telecommunications (DECT); DECT in the 1 920 MHz to 1 930 MHz Unlicensed Personal Communications Services (UPCS) frequency band; Specific requirements".

[15] ARIB STD-T101: "Radio Equipment Used For TDMA Digital Enhanced Cordless Telecommunications"; (English version).

[16] ETSI EN 301 649: "Digital Enhanced Cordless Telecommunications (DECT); DECT Packet Radio Service (DPRS)".

[17] ETSI EN 300 700: "Digital Enhanced Cordless Telecommunications (DECT); Wireless Relay Station (WRS)".

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the reference document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] ISO/IEC 9646-6: "Information technology - Open Systems Interconnection - Conformance testing methodology and framework - Part 6: Protocol profile test specification".

[i.2] Recommendation ITU-T G.726 (12/1990): "40, 32, 24, 16 kbit/s Adaptive Differential Pulse Code Modulation (ADPCM)".

[i.3] Recommendation ITU-T G.711 (11/1988): "Pulse code modulation (PCM) of voice frequencies".

[i.4] Recommendation ITU-T G.722 (11/1988): "7 kHz audio-coding within 64 kbit/s".

[i.5] Recommendation ITU-T G.729.1 (05/2006): "G.729 based embedded variable bit-rate coder: An 8-32 kbit/s scalable wideband coder bitstream interoperable with G.729".

[i.6] ISO/IEC JTC1/SC29/WG11 (MPEG): International Standard ISO/IEC 14496-3:2009: "Information Technology - Coding of audio-visual objects - Part 3: Audio".

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in ETSI TS 102 939-1 [12], ETSI TS 102 527-1 [11], ETSI TS 102 527-4 [13] and the following apply:

circuit mode: DECT connections involving setup of the MAC connection using Basic Connection control or Advanced Connection control, but not the "expedited" setup messages

NOTE: Such connections generally last of the order of several seconds (or several minutes for voice calls).

hybrid device: ULE device supporting voice and/or non-ULE data service

Last Minute Scan (LMS): RSSI scan which is generally performed at the last opportunity before transmission (e.g. in the frame before transmission)

Least Interfered Channel (LIC): slot/carrier pair which has the lowest level of interference, usually within a certain level of tolerance or range of values

NOTE: Calculation of the LIC generally requires a full matrix RSSI scan of all available slot/carrier combinations.

packet mode: DECT connections involving setup of the MAC connection using the Advanced Connection control "expedited" messages

NOTE: Such connections generally last of the order of a few frames only.

Personal Handy-phone System (PHS): cordless network telephony system operating in the 1 880 - 1 930 MHz frequency band

NOTE: PHS is used mainly in Japan, China, Taiwan, and some other Asian countries and regions.

3.2 Symbols

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

BA (bits)	B-field identification bits, the bits from the A-field header that provide indication for the content of the B-field of one MAC layer packet
BCK	bit used for I_P channel flow control in MAC I_P error correction services
B_S	Slow Broadcast channel
B_U	ULE Broadcast channel
C	for conditional to support (process mandatory)
C	higher layer control Channel (see C_S and C_F)
C_F	higher layer signalling Channel (Fast)
C-plane	Control plane
C_S	higher layer signalling Channel (Slow)
E+U	Mode of the B-field E/U multiplexer carrying U-plane data and signalling
G_F	higher layer information control channel (fast) (a logical channel to the MAC layer)
G_{FA}	higher layer information control channel (slow) (a logical channel to the MAC layer)
I	for out-of-scope (provision optional, process optional) not subject for testing
I	higher layer Information channel (see I_N and I_P)
I_N	higher layer Information channel (unprotected)
I_P	higher layer Information channel protected (in general, any variant)
I_{PF}	higher layer Information channel (protected) transported multiplexed with signalling in the E+U type slots
I_{PM}	higher layer Information channel, multi-subfield (protected) B-field with error detection only

I_{PMR}	higher layer Information channel, multi-subfield (protected) B-field with MOD-2 protected channel operation (ARQ)
I_{PQ}	higher layer Information channel (protected) with single subfield format and error detection only
I_{PQR}	higher layer Information channel (protected) with single subfield format and error correction using MOD-2 retransmission mechanism
LAPC	DLC layer C-plane protocol entity
Lc	a DLC layer C-plane protocol entity
LU	DECT DLC U-Plane Service
M	for mandatory to support (provision mandatory, process mandatory, see clause 6.2.1).
M	MAC control channel
M0	RFP channel pre-selection algorithm for ULE
M1	PP channel selection algorithm for ULE
M2	PP collision handling and avoidance algorithm for ULE
M_T	MAC control channel on A-tail field, or one message on such channel
M_U	MAC control channel on B-field for ULE
N	identities channel
N/A	for not-applicable (in the given context the specification makes it impossible to use this capability, see clause 6.2.1)
N_S	split identities channel on B-field for ULE
N_T	identities information channel or one message in such channel
O	for optional to support (provision optional, process mandatory, see clause 6.2.1)
O.x	option comprising number of items
P	Paging channel
P_T	one P-channel message
P_U	ULE Paging channel on B-field
Q	system information channel
Q_C	compound System Information Channel of B-field for ULE
Q_H	Q field header
Q_T	system information and Multiframe marker
RN	Received sequence Number
RR	a frame type of the DLC C-plane entity
Rx	Receiver side
S/T	ISDN S/T Interface
SI_P	higher layer connectionless channel (protected)
Tx	Transmitter side
U	ISDN U-Interface
X	excluded, not allowed
ZAP	ability first to assign and then to re-program the account data held in the PP

3.3 Abbreviations

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

AAC-LD	Advanced Audio Coding - Low Delay profile
AC	Authentication Code
ADPCM	Adaptive Differential Pulse Code Modulation
AES	Advanced Encryption Standard
AP	Application Profile
ARIB	Association of Radio Industries and Business
ARQ	Automatic Retransmission reQuest
BCK	B-field aCKnowledgement
B_U	ULE Broadcast channel
C/L	ConnectionLess
CA	Channel Active
CC	Call Control

NOTE: A NWK layer functional grouping.

CCM	Counter with CBC-MAC
C_F	higher layer signalling Channel (fast)
CI	Common Interface
CISS	Call Independent Supplementary Services
CL	Connection-Less
CLIP	Calling Line Identification Presentation
CLMS	ConnectionLess Message Service
CNIP	Calling Name Identity Presentation
CRC	Cyclic Redundancy Check
CRFP	Cordless Radio Fixed Part
C_S	higher layer signalling Channel (slow)
DECT	Digital Enhanced Cordless Telecommunications
DLC	Data Link Control
DPRS	Data Packet Radio service
DSAA	DECT Standard Authentication Algorithm
DSAA2	DECT Standard Authentication Algorithm #2
DSC	DECT Standard Cipher (algorithm)
DSC2	DECT Standard Cipher #2 (algorithm)
DTMF	Dual Tone Multi-Frequency
EFREL	Enhanced Frame RELay service
ER	Error Resilient
FCC	Federal Communications Commission
FCNT	Frame CouNTer
FP	Fixed Part
FREL	Frame RELay service
FT	Fixed radio Termination
GAP	Generic Access Profile
G_F	higher layer information control channel (fast), (a logical channel to the MAC layer)
G_{FA}	higher layer information control channel (slow), (a logical channel to the MAC layer)
GFSK	Gaussian Frequency Shift Keying
HAN	Home Automation Network
HTTP	HyperText Transfer Protocol
IE	Information Element
IP	Internet Protocol
I_{PF}	higher layer Information channel protected, transported multiplexed with signalling in the E+U
I_{PQ}	higher layer Information channel protected, with single subfield format
ISDN	Integrated Services Digital Network
IWU	InterWorking Unit
L	Length
LA	Location Area
LAPC	a DLC layer C-plane protocol entity
LBN	Logical Bearer Number
LCE	Link Control Entity
LDS	Light Data Service
LIC	Least Interfered Channel
LMS	Last Minute Scan
LU	DECT DLC U-Plane Service
MAC	Medium Access Control
MAC	Message Authentication Code (CCM)
MBC	Multi Bearer Control
ME	Management Entity
MFN	MultiFrame Number
MIC	Message Integrity Code (CCM)
MM	Mobility Management
MOD	MODulus
MPEG	Motion Picture Experts Group
MS	Management Server
M_T	MAC control channel on A-tail field
MTU	Maximum Transmission Unit
M_U	MAC control channel on B-field for ULE
NEMo	No Emission Mode
NG	New Generation

NG-DECT	New Generation DECT
N_T	identities information
NWK	NetWorK
PAP	Public Access Profile
PCM	Pulse Code Modulation
PHL	PHysical Layer
PHS	Personal Handy-phone System
PHY	PHYsical
PMID	Portable part MAC IDentity
PP	Portable Part
PPP	Point of Presence Protocol
PSCN	Primary receiver Scan Carrier Number
PSTN	Public Switched Telephone Network
PT	Portable radio Termination
PVC	Permanent Virtual Circuit
Q_H	Q_T Header
Q_T	system information and multiframe marker
RF	Radio Frequency
RFP	Radio Fixed Part
RPN	Radio fixed Part Number
RSSI	Radio Signal Strength Indicator
Rx	Receiver
SAP	Service Access Point
SARI	Secondary Access Rights Identity
SDU	Service Data Unit
SIP	Session Initiation Protocol
S_{IPQ}	U-plane packet (SI_P channel) single subfield format
SUOTA	Software Update Over The Air
TBC	Traffic Bearer Control
TDMA	Time Division Multiple Access
TRUP	TRansparent UnProtected service
Tx	Transmitter
U	ISDN U-Interface
ULE	Ultra Low Energy
U-plane	User-plane
VC	Virtual Call
WRS	Wireless Relay Station

4 Description of services and features

4.1 DECT Ultra Low Energy

4.1.0 General

DECT ULE provides bi-directional radio communication with medium range, data protection, and Ultra Low Power consumption features between different types of Portable Devices and Radio Fixed Parts.

The present document is part 2 of a multi-part deliverable intended to cover the Machine to Machine communications based on DECT Ultra Low Energy (ULE). Part 1 of this multi-part deliverable (also referred to as ULE Phase 1) defines core features for applications. The present document (also referred to as ULE Phase 2) defines additional features suitable for a broader range of application scenarios.

The set of features defined in part 1 and part 2 are primarily targeted to provide a global M2M solution within domestic scenarios (often referred to as "Home Automation Network" or HAN). However, this does not prevent the use of the present document in other scenarios.

See ETSI TS 102 939-1 [12], clause 4 for a description about ULE Phase 1 services and features.

4.1.1 Back-compatibility with ULE Phase 1

ULE Phase 2 devices are back-compatible with ULE Phase 1 devices. This means, with regards to the Phase 1 functionality, a Phase 1 PT will be able to function correctly with a Phase 2 FT. Similarly, with regards to the Phase 1 functionality, a Phase 2 PT will be able to function correctly with a Phase 1 FT. Obviously, Phase 2 features are not expected to work with a Phase 1 device.

4.1.2 Coexistence with other DECT services

DECT ULE has been designed to be coexistent with other DECT systems (including GAP or NG-DECT). Different types of DECT devices may be used over the same spectrum, and mixed devices supporting DECT ULE and other DECT applications may be built. It is foreseen that the majority of DECT ULE RFPs and some DECT ULE PPs will be mixed devices.

4.1.3 Example applications covered by ULE Phase 2

4.1.3.0 General

Examples of the applications that can be built with ULE Phase 2 are the following:

- **Simple medical pendant alarms**
  These devices may have some sensing ability (for instance to monitor heart rate or movement), as well as possessing an alarm button in case the wearer is in distress. They may also have additional voice capability, allowing the wearer to make a telephone call to a medical monitoring centre.

- **Lighting control**
  Using the Message Broadcast feature, a ULE FT can simultaneously communicate the same message to many ULE PTs with low latency. This could be used to control numerous lights simultaneously.

- **Residential hub/gateway**
  A residential hub/gateway can still support NEMo for legacy handsets, whilst providing ULE services for other applications.

- **Intercoms and other M2M devices with audio capability**
  ULE devices with integrated speaker and/or microphone and the capability to establish an audio communication (in addition to ULE data transport). These devices allow the user to establish a voice communication with another terminal that may be in the same Home Automation Network, or connected via an external network. Examples of such devices are intercoms, entry-phones and any similar M2M device with audio capability.

This list is not exhaustive and further applications may be developed by device vendors based on the present document.

4.1.3.1 Simple medical pendant alarms

Figure 1 shows a typical use-case scenario for a medical pendant system. The user will often wear the device, so that if they require assistance then can easily activate the alarm button and get connected to a carer or medical professional. The diagram shows the ULE base station connected to the Internet, but this could also be used with a telephone network by using a pre-programmed number and message.

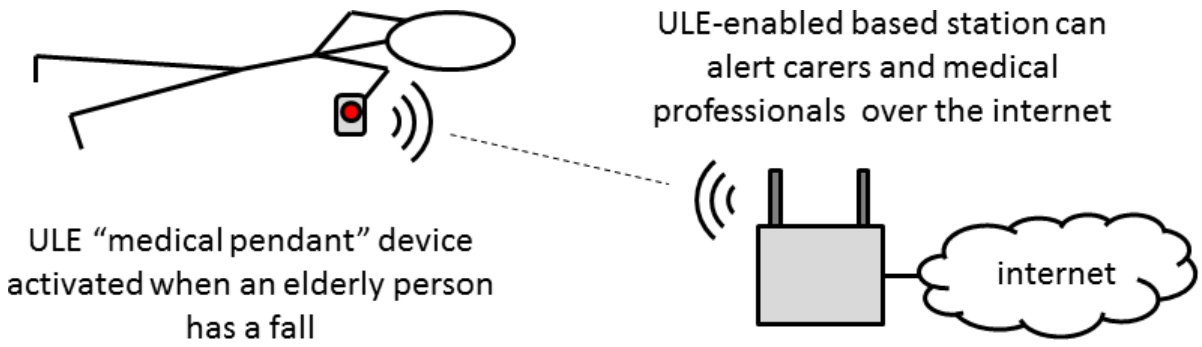

Figure 1: Medical pendant use-case scenario

4.1.3.2 Software Upgrade Over The Air

SUOTA allows a ULE device to download and upgrade its software from a remote server over the air using the DECT services. An instance of the DPRS LU10 is used for the transport layer. C-plane interactions are used to control the process, e.g. to specify the software version number and URL of the download server. The SUOTA process itself is not required to be low-power since it is used infrequently. Compatibility with NG-DECT standard for SUOTA is of greater importance.

A typical application scenario for SUOTA is shown in Figure 2.

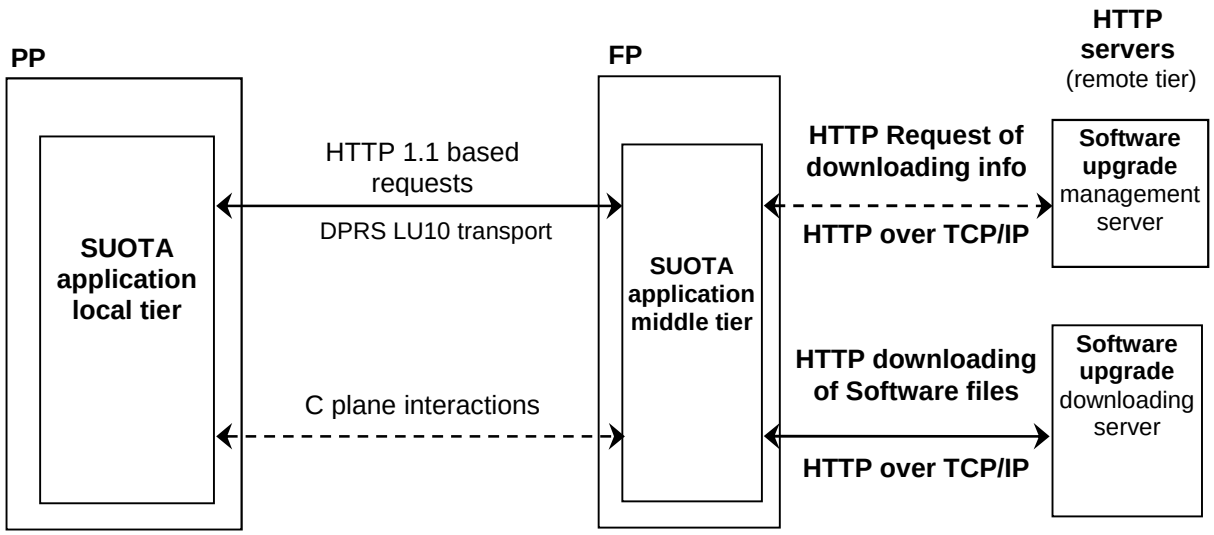

Figure 2: Application scenario for Software upgrade over the air (SUOTA)

4.1.3.3 M2M devices with audio capability

ULE phase 2 adds audio transmission to ULE devices. This allows the design of devices with integrated speaker and/or microphone and the capability to establish an audio communication (in addition to ULE data transport). The audio communication may be established to either:

- Regular DECT handsets (GAP or NG-DECT) in the same DECT Network
- External terminals connected via PSTN, ISDN or Internet
- Other M2M devices with audio capability

Specific mechanisms have been included to allow the simultaneous transport of ULE data when an audio communication is active. Audio communication capability includes the support of complete telephony and VoIP signalling, allowing the establishing of communications to external terminals interconnected via PSTN, ISDN or Internet.

4.2 Requirements for ULE Phase 2

4.2.1 Device types

4.2.1.0 General

In addition to the device types defined by ULE Phase 1, ULE Phase 2 also supports the following types of devices:

- RFP with support of ULE Phase 2
- PP type IV: "hybrid device with voice/data support"

4.2.1.1 ULE Phase 2 RFP

4.2.1.1.1 General description

A ULE Phase 2 RFP supports the services and features described in the present document.

The RFP will typically support other DECT services such as GAP or New Generation DECT; however, this is not mandatory.

4.2.1.1.2 Requirements

A ULE Phase 2 RFP has the following requirements.

General coexistence requirement:

- The RFP can support at the same time, ULE Phase 1, ULE Phase 2 and DECT voice services (e.g. GAP or New Generation DECT).

Specific ULE Phase 2 requirements:

- All RFPs compliant with the present document shall be able to support all the defined types of ULE Phase 1 PPs, and ULE Phase 2 PPs.

4.2.1.2 PP type IV: hybrid device with voice/data support

4.2.1.2.1 General description

ULE PP type IV devices are generally battery powered, with strong power saving requirements, and the occasional requirement to be used in voice/data-mode. In general ULE PP device types can be combined, and so for example, a hybrid device may be combined with a ULE sensor type, or a ULE actuator type.

Typical examples are "medical pendant alarms", "intercom door bells", "talking smoke alarms", etc.

4.2.1.2.2 Requirements

ULE type IV PPs shall have some or all of the following specific requirements:

- The ability to transfer ULE data during a voice call
- The ability to carry voice during a ULE data transfer
- The ability to switch between voice and ULE data modes
- The ability to use ULE paging to initiate a voice call

4.2.2 U-plane interworking and protocol architecture

U-plane interworking and protocol architecture is defined in ETSI TS 102 939-1 [12].

4.2.3 Performance Objectives

Performance objectives are defined in ETSI TS 102 939-1 [12].

4.3 Services and features implemented by ULE phase 2

4.3.0 General

In addition to the core services and features defined by DECT Ultra Low Energy (ULE) Part 1 (ETSI TS 102 939-1 [12]), the present document also provides the enhanced services and features described in clause 4.3.1 to clause 4.3.7.

4.3.1 MAC/PHY layer

- Enhanced ULE paging support, including index-based paging identifiers, optimized paging descriptors and specific descriptors for advanced features (e.g. connectionless downlink, hybrid voice, etc.)
- Connectionless downlink multi-cast paging support
- Support for US and Japan regions
- Long-slot (j = 640), which can be used for hybrid devices (e.g. wideband voice or SUOTA)
- Advanced Connection Control for hybrid devices (e.g. wideband voice or SUOTA)
- Various optional features to support SUOTA/LDS (e.g. multi-bearer connections)
- "No-emissions" compatibility mode
- Inter-cell bearer handover for "circuit mode" connections
- Inter-cell bearer replacement for "packet mode" connections
- Support for repeaters

4.3.2 DLC layer

- LU1 Transparent Unprotected service for "hybrid voice" systems
- LU10 Enhanced Frame Relay service for SUOTA/LDS
- Connectionless downlink multi-cast channel
- Inter-cell connection handover for "circuit mode" connections

4.3.3 NWK layer

- Incoming calls for "hybrid voice" devices
- Handling interactions of "packet mode" and "circuit mode" operation
- General Purpose Service Channel (i.e. ULE data transport over C-plane)
- Various basic telephony features (e.g. on-hook/off-hook, dialled digits, alerting, etc.)
- Codec negotiation/codec switching for "hybrid voice" devices
- Various features for SUOTA/LDS (e.g. FT-initiated virtual call, PT-initiated virtual call, LDS procedures, SUOTA C-plane procedures, push mode)
- Support for repeaters (transfer of cipher keys)

4.3.4 Interworking and Application layer

- Support for "hybrid voice" devices
- Support for "hybrid data" devices
- Support for SUOTA/LDS
- General Purpose Service Channel (i.e. ULE data transport over C-plane)

4.3.5 Security

- Management of cipher keys for connectionless downlink multi-cast channels
- Ciphering of connectionless downlink multi-cast channels
- Ciphering of General Purpose Service Channel (i.e. ULE data transport over C-plane)

4.3.6 Management Entity

- Physical channel selection for US
- Physical channel selection for Japan
- DPRS management (class 4 mandatory)

4.3.7 Speech services and codecs

- Narrowband and wideband codecs and speech services for "hybrid voice" devices

5 Service and feature definitions

5.1 ULE Phase 2

5.1.1 PHL service definitions

For the purposes of the present document, all definitions of ETSI TS 102 939-1 [12], clause 5.1.1, ETSI TS 102 527-1 [11], clause 5.5 and ETSI TS 102 527-4 [13], clause 5.1.1 apply.

5.1.2 MAC service definitions

For the purposes of the present document, all definitions of ETSI TS 102 939-1 [12], clause 5.1.2, ETSI TS 102 527-1 [11], clause 5.4, ETSI TS 102 527-4 [13], clause 5.1.2 and the following apply:

U-plane C/L downlink multicast service [ULE1-M.28]: Simplex service from FT to PT that provides U-plane transmission using C/L bearers from the FT sends to a group of PTs. The service has MAC layer error detection capability and may operate in acknowledged or unacknowledged modes. It uses the DLC services LU13 or LU14, but over separate instances and Access Points compared to C/O service. When LU14 is used, the communication is CCM encrypted.

Quiet Channel Indication [ULE1-M.29]: This service provides indication of the presence of very quiet channels in the FT's local RF environment. The service may be used by some regional variants, such as US.

PHS Detection Indication [ULE1-M.30]: This service provides indication of the presence of a PHS system, which may be present in some regional variants, such as Japan. The presence of a PHS system restricts the use of some carriers.

extended frequency allocation [ULE1-M.31]: Service which allows a FT to support frequencies in addition to the standard DECT frequencies.

Long slot (j = 640) [ULE1-M.32]: Support of the physical packet P00j (j = 640) and appropriate D-field mapping according to modulation type (D32a for GFSK modulation).

"No-emission" compatibility mode [ULE1-M.33]: Compatibility mode which allows the FT to support NEMo enabled handsets.

Bearer handover (intra-cell) [ULE1-M.34]: Internal MAC process whereby data transfer (C channel and I channel) is switched from one duplex bearer to another in the domain of the same cell while maintaining the service to the DLC layer. This process only applies to "circuit mode" connections.

Bearer handover (inter-cell) [ULE1-M.35]: Internal MAC process whereby data transfer (C channel and I channel) is switched from one duplex bearer to another not in the domain of the same cell while maintaining the service to the DLC layer. This process only applies to "circuit mode" connections.

ULE bearer replacement (inter-cell) [ULE1-M.36]: Bearer maintenance procedure by setting up a replacement bearer not on the same RFP. Contrary to conventional voice channel handover, there is no requirement of using identical LBN and maintaining identical data on both bearers. Furthermore, the old bearer is released, before the setup of the new one.

C/O procedures for FT connections with CRFP [ULE1-M.37]: Procedures to provide the means to address CRFPs on one physical relayed connection of an FT with a PT.

Repeater compatibility [ULE1-M.38]: A set of procedures to ensure compatibility and operation with ULE repeaters.

U-NEMo mode [ULE-M.39]: A set of procedures to support co-existence with "no-emissions" mode (NEMo).

5.1.3 DLC service definitions

For the purposes of the present document, all definitions of ETSI TS 102 939-1 [12], clause 5.1.3, ETSI TS 102 527-1 [11], clause 5.3, ETSI TS 102 527-4 [13], clause 5.1.3 and the following apply:

Intra-cell voluntary connection handover [ULE1-D.13]: internal handover process provided and initiated by the DLC layer (e.g. as a result of continued poor quality of service from the MAC layer), whereby one set of DLC entities (C-plane and U-plane) can re-route data from one MAC connection to a second new MAC connection in the domain of the same cell, while maintaining the service provided to the NWK layer. This process only applies to "circuit mode" connections.

Inter-cell voluntary connection handover [ULE1-D.14]: internal handover process provided and initiated by the DLC layer (e.g. as a result of continued poor quality of service from the MAC layer), whereby one set of DLC entities (C-plane and U-plane) can re-route data from one MAC connection to a second new MAC connection not in the domain of the same cell, while maintaining the service provided to the NWK layer. This process only applies to "circuit mode" connections.

5.1.4 NWK feature definitions

For the purposes of the present document, all definitions of ETSI TS 102 939-1 [12], clause 5.1.4, ETSI TS 102 527-1 [11], clause 5.2, ETSI TS 102 527-4 [13], clause 5.1.4 and the following apply:

Security procedures for C/L downlink multicast [ULE1-N.19]: CCM encryption control and synchronization procedures for U-plane C/L downlink multicast channels.

Incoming call for hybrid voice devices [ULE1-N.20]: Hybrid devices support ULE and "circuit mode" features like voice calls. Since many ULE devices will be un-locked, A-field paging is not suitable. For those devices, it is possible to page the PP using ULE B-field paging.

Interaction of ULE and "circuit mode" [ULE1-N.21]: This feature defines how ULE "packet mode" operations and traditional "circuit mode" operations interact. This is generally for use in hybrid systems.

SUOTA push mode for ULE devices [ULE1-N.22]: SUOTA push mode is used when the FP has a new software version available for the PP.

Confidentiality service with a CRFP [ULE1-N.23]: This feature defines the procedure for transferring cipher keys between the FT and a CRFP.

U-NEMo procedures [ULE1-N.24]: This feature defines the use of NWK layer communication to pass U-NEMo parameters between the FT and the ULE device.

5.1.5 Application feature definitions

For the purposes of the present document, all definitions of ETSI TS 102 939-1 [12], clause 5.1.5, ETSI TS 102 527-1 [11], clause 5.7, ETSI TS 102 527-4 [13], clause 5.1.5 and the following apply:

Hybrid device voice service [ULE1-A.4]: Voice support may be narrow band or wideband.

Hybrid device data service [ULE1-A.5]: Data support may be DPRS, Light Data Service, or other connection orientated data service.

Software Upgrade Over The Air for ULE devices [ULE1-A.6]: The service supports download of software/firmware files from a local or remote server.

5.1.6 Management Entity (ME) definitions

For the purposes of the present document, all definitions of ETSI TS 102 939-1 [12], clause 5.1.6, ETSI TS 102 527-4 [13], clause 5.1.6 and the following apply:

ULE Physical Channel Selection for US region [ULE1-ME.3]: This service provides additional or modified channel selection procedures to meet the regulatory requirements of the US region (FCC).

ULE Physical Channel Selection for Japan region [ULE1-ME.4]: This service provides additional or modified channel selection procedures to meet the regulatory requirements of the Japan region (ARIB).

5.1.7 U-plane service and interworking definitions

For the purposes of the present document, all definitions of ETSI TS 102 939-1 [12], clause 5.1.7, ETSI TS 102 527-4 [13], clause 5.1.8 and the following apply:

Configuration and control service channel [ULE1-I.2]: a channel transported over DECT C-plane that provides a pair of end-points accessible to the higher layers where configuration and control protocol messages may be exchanged. This channel is intended to be used during configuration stages to exchange configuration and control information. This channel is not CCM encrypted.

CCM encrypted general purpose service channel [ULE1-I.3]: a channel transported over DECT C-plane and protected by CCM encryption that provides a pair of end-points accessible to the higher layers where application protocol messages may be exchanged. This channel is intended for use when it is not feasible or not convenient to use regular ULE bearers for sending data via U-plane service.

5.1.8 ULE device types

For the purposes of the present document, all definitions of ETSI TS 102 939-1 [12], clause 5.1.8 and the following apply:

RFP with support for ULE phase 2 [ULE1-TYP.6]: A DECT RFP with support of ULE phase 2 specification. Other DECT services, such as GAP or NG-DECT, may also be supported in the same RFP.

PP type IV "hybrid device with voice/data support" [ULE1-TYP.7]: ULE PP devices, generally battery powered, with strong power saving requirements, and the occasional requirement to be used in voice/data mode.

5.1.9 Speech services and speech coding definitions

For the purposes of the present document, all definitions of ETSI TS 102 527-1 [11], clause 5.6, apply.

5.1.10 Call Control (CC) and mobility management service definitions

For the purposes of the present document, all definitions of ETSI TS 102 527-4 [13], clause 5.1.7, apply.

6 Profile specific requirements

6.1 General

Table 1 to Table 21 define the status of all protocol elements (i.e. features, services, and procedures), which can be: mandatory, optional, conditional under the provision of another protocol element, outside the scope of the present document, or not applicable.

Protocol elements defined as mandatory, optional or conditional in clause 6 are further defined in the referenced DECT specification, or, if needed, in clause 7.

6.2 Specific conventions

6.2.1 Use of symbols in support status tables

The symbols defined in this clause are applied for procedures, features, and services in the present document if not explicitly otherwise stated. The interpretation of status columns in Table 1 to Table 21 is as follows:

C	conditional to support
I	out-of-scope
M	mandatory to support
N/A	not applicable
O	optional to support

6.3 DECT ULE phase 1 device types

6.3.1 Types of devices supported by the present document

The following types of DECT ULE devices, described by Table 1, are supported by the present document. Additional device types may be added to further releases of the present document.

Table 1: Types of DECT ULE phase 2 devices

Item	Name of service	Reference	Support status in a ULE system	
			PT	FT
ULE1-TYP.6	RFP with support for ULE phase 2	5.1.8	-	M
ULE1-TYP.2	PP type I "sensor" with paging support	5.1.8 [12]	O (note 2)	-
ULE1-TYP.3	PP type I "sensor" without paging support	5.1.8 [12]	O (note 2)	-
ULE1-TYP.4	PP type II "fast actuator"	5.1.8 [12]	O (note 2)	-
ULE1-TYP.5	PP type III "slow actuator"	5.1.8 [12]	O (note 2)	-
ULE1-TYP.7	PP type IV "hybrid device with voice/data support"	5.1.8	O (note 2)	-
NOTE 1: The reference column refers to the relevant clause in the present document unless a specific reference document is noted. NOTE 2: A PP shall support at least 1 PP type (I, II, III or IV). Some PPs may support multiple PP types.				

6.3.2 Specific procedures for specific device types

All services, features and procedures described in the present document are applicable to all kinds of device types, except when otherwise stated.

The present document defines only one type of RFP [ULE1-TYP.6]. Therefore, the support status of all services, features and procedures for FP is as given in Table 2 to Table 3.

With regards to PP device type IV, the status support of specific procedures is given in Table 2. PP device types I, II and III are defined in ETSI TS 102 939-1 [12], clause 6.3.2.

Table 2: Specific procedures for specific PP device types

Device type	Service or feature	Procedure	Reference	Status	
				PT	FT
PP type IV "hybrid device with voice/data support" [ULE1-TYP.7]:					
	B-field Continuous ULE broadcast [ULE1-M.4]	Operation in unlocked mode	10.5.5 [12]	M	-
	B-field paging broadcast [ULE1-M.5]	P_U Paging Message Formats	10.6.1 [12]	M	-
		Paging Descriptors for ULE Paging	10.6.2 [12]	M	-
		CA mask mechanism	10.6.3 [12]	M	-
NOTE: The reference column refers to the relevant clause in the present document unless a specific reference document is noted.					

6.4 Physical layer (PHL) requirements

6.4.1 Physical layer (PHL) services

ULE Phase 2 devices shall support the PHL layer services described by Table 3.

Table 3: Physical layer service support

Item	Name of service	Reference	Support status	
			PT	FT
ULE1-P.1	GFSK modulation	5.1.1 [12]	M	M
ULE1-P.2	Physical Packet P32	5.1.1 [12]	M	M
ULE1-P.3	Physical Packet P00	5.1.1 [12]	M	M
ULE1-P.4	General PHL	5.1.1 [12]	M	M
ULE1-P.5	ULE Transmitted Power	5.1.1 [12]	M	M
ULE1-P.6	Fast hopping radio	5.1.1 [12]	O	O
NG1.P.3	Physical Packet P64	5.5 [11]	C301	M
C301: If ULE1-M.32 then M else I.				
NOTE: The reference column refers to the relevant clause in the present document unless a specific reference document is noted.				

6.4.2 Modulation schemes

The modulation schemes described by Table 4 and defined by ETSI EN 300 175-2 [2], annex D shall be supported.

Table 4: Allowed combinations of modulation schemes

Modulation scheme	S-field	A-field	B + Z-field	Support status
1a	GFSK	GFSK	GFSK	M

6.4.3 PHL service to procedure mapping

Those PHL layer services that are defined in clause 6.4.1 shall have identical procedure mapping to that defined in their referenced documents.

Table 5: PHL service to procedure mapping

Service	Procedure	Reference	Status	
			PT	FT
This table is intentionally left blank in order to facilitate future modification.				
NOTE: The reference column refers to the relevant clause in the present document unless a specific reference document is noted.				

6.5 MAC layer requirements

6.5.1 MAC layer services

ULE Phase 2 devices shall support the MAC layer services described by Table 6.

Table 6: MAC service support

Item	Name of service	Reference	Support status	
			PT	FT
ULE1-M.1	General	5.1.2 [12]	M	M
ULE1-M.2	A-field Continuous broadcast	5.1.2 [12]	M	M
ULE1-M.3	A-field Paging broadcast	5.1.2 [12]	M	M
ULE1-M.4	B-field Continuous ULE broadcast	5.1.2 [12]	M	M
ULE1-M.5	B-field paging broadcast	5.1.2 [12]	M	M
ULE1-M.6	Basic connection control	5.1.2 [12]	M	M
ULE1-M.7	A-field advanced connection control	5.1.2 [12]	M	M
ULE1-M.8	Expedited operations (advanced connection control)	5.1.2 [12]	M	M
ULE1-M.9	Full slot	5.1.2 [12]	M	M
ULE1-M.10	Short slot	5.1.2 [12]	M	M
ULE1-M.11	I_{PQR}_error_correction MAC service type	5.1.2 [12]	M	M
ULE1-M.12	G_{FA} channel	5.1.2 [12]	M	M
ULE1-M.13	C_S higher layer signalling	5.1.2 [12]	M	M
ULE1-M.14	C_F higher layer signalling	5.1.2 [12]	O	O
ULE1-M.15	Quality control	5.1.2 [12]	M	M
ULE1-M.16	ULE Physical channel selection	5.1.2 [12]	M	M
ULE1-M.17	SARI support	5.1.2 [12]	M	O
ULE1-M.18	ULE Bearer replacement (intra-cell)	5.1.2 [12]	M	M
ULE1-M.19	Dummy Bearer replacement	5.1.2 [12]	M	M
ULE1-M.20	Bearer handover inter-cell	5.1.2 [12]	I	I
ULE1-M.21	Connection handover	5.1.2 [12]	O	O
ULE1-M.22	Encryption activation	5.1.2 [12]	M	M
ULE1-M.23	Encryption deactivation	5.1.2 [12]	C601	C601
ULE1-M.24	Re-keying	5.1.2 [12]	C602	C602
ULE1-M.25	Early encryption	5.1.2 [12]	C603	C603
ULE1-M.26	DSC encryption	5.1.2 [12]	M	M
ULE1-M.27	AES/DSC2 encryption	5.1.2 [12]	O	O
ULE1-M.28	U-plane C/L downlink multicast service	5.1.2	M	M
ULE1-M.29	Quiet Channel Indication	5.1.2	C604	C604
ULE1-M.30	PHS Detection Indication	5.1.2	C605	C605
ULE1-M.31	Extended frequency allocation	5.1.2	M	C606
ULE1-M.32	Long slot (j = 640)	5.1.2	C607	M

Item	Name of service	Reference	Support status	
			PT	FT
ULE1-M.33	"No-emission" legacy mode	5.1.2	I	O
ULE1-M.34	Bearer handover (intra-cell)	5.1.2	M	M
ULE1-M.35	Bearer handover (inter-cell)	5.1.2	M	M
ULE1-M.36	ULE Bearer replacement (inter-cell)	5.1.2	M	M
ULE1-M.37	C/O procedures for FT connections with CRFP	5.1.2	N/A	C613
ULE1-M.38	Repeater compatibility	5.1.2	M	M
ULE1-M.39	U-NEMo mode	5.1.2	O	O
NG1.M.1	I_N_minimum delay symmetric MAC service type	5.4 [11]	C608	M [12]
NG1.M.4	Advanced connections	5.4 [11]	C608	M
DPRS-M.5	B-field advanced connection control	4.3.2 [16]	C610	O
DPRS-M.6	I_{PM}_error_detection	4.3.2 [16]	C609	M
DPRS-M.7	I_{PMR}_error_correction	4.3.2 [16]	C610	O
DPRS-M.16	DPRS Bearer handover	4.3.2 [16]	C609	M
DPRS-M.17	Fast setup	4.3.2 [16]	C611	C611
DPRS-M.18	Connection handover	4.3.2 [16]	C610	O
DPRS-M.19	G_F channel	4.3.2 [16]	C612	C612
DPRS-M.20	I_{PQ}_error_detection	4.3.2 [16]	C610	O
DPRS-M.21	I_{PQR}_error_correction	4.3.2 [16]	C610	O
DPRS-M.23	I_{PF} channel	4.3.2 [16]	C612	C612
DPRS-M.27	Double slot	4.3.2 [16]	C610	O
DPRS-M.28	Multibearer connections	4.3.2 [16]	C611	C611
DPRS-M.29	Asymmetric connections	4.3.2 [16]	C611	C611
DPRS-M.30	Simplified A-field connection control	4.3.2 [16]	C609	M

C601: IF ULE1-N.15 or ULE1-N.16 then M else I.
C602: IF NWK layer procedure "Re-keying during a call" THEN M ELSE I.
C603: IF NWK layer procedure "Early encryption" THEN M ELSE I.
C604: IF ULE1-ME.3 then M else I.
C605: IF ULE1-ME.4 then M else I.
C606: IF ULE1-ME.3 or ULE1-ME.4 then M else O.
C607: IF (ULE1-A.4 and (NG1.2, NG1.3 or NG1.5)) or ULE1-A.5 or ULE1-A.6 then M else I.
C608: IF ULE1-A.4 then M else I.
C609: IF ULE1-A.5 or ULE1-A.6 then M else I.
C610: IF ULE1-A.5 or ULE1-A.6 then O else I.
C611: IF DPRS-M.5 THEN O ELSE I.
C612: IF DPRS-M.29 THEN M ELSE O.
C613: IF ULE1-N.23 THEN M ELSE O [16].

NOTE 1: The reference column refers to the relevant clause in the present document unless a specific reference document is noted.
NOTE 2: See also the DLC service ULE1-D.12 (CCM/AES encryption).

6.5.2 MAC service to procedure mapping

The MAC layer service to procedure mapping described by Table 7 shall apply.

In addition, those MAC layer services that are defined in clause 6.5.1 that do not have explicit procedure mapping described by Table 7, shall have identical procedure mapping to that defined in their referenced documents.

Table 7: MAC service to procedure mapping

Service	Procedure	Reference	Status	
			PT	FT
ULE1-M.2 A-field Continuous broadcast		5.1.2 [12]	M	M
	Downlink broadcast (A-field)	10.3 [12]	M	M
	QT - static system information	10.2.2.1	M	M
	QT - FP capabilities	10.2.2.2	M	M
	Reception of downlink broadcast (A-field)	10.3.3 [12]	M	M
	Higher layer information FP broadcast	12.2.2.1	M	M

Service	Procedure	Reference	Status	
			PT	FT
ULE1-M.5 B-field Paging broadcast		5.1.2 [12]	M	M
	PU Paging Message Formats	10.6.1 [12]	C705	M
	Paging Descriptors for ULE Paging (phase 2)	10.6.2	C705	M
	CA mask mechanism	10.6.3 [12]	C705	M
ULE-M.9 Full slot		5.1.2 [12]	M	M
	General	10.3.1.1	M	M
	D-field mapping for the full slot structure (physical packet P32)	6.2.1.1.2 [3]	M	M
	B-field mapping for the full slot structure (physical packet P32)	6.2.1.3.1.2 [3]	M	M
	Use of full slot in C/O bearers	10.3.1.2	M	M
	Use of full slot in C/L dummy bearers	10.3.1.3	M	M
ULE-M.10 Short slot		5.1.2 [12]	M	M
	General	10.3.2.1		
	D-field mapping for the short slot structure (physical packet P00)	6.2.1.1.3 [3]	M	M
	B-field mapping for the short slot structure (physical packet P00)	6.2.1.3.1.3 [3]	M	M
	Use (transmission) of short slot in C/O bearers	10.3.2.2	O	O
	Reception of short slot in C/O bearers	10.11.2 [12]	M	M
ULE-M.11 I_{PQR}_error_correction MAC service type		5.1.2 [12]	M	M
	Type 4: I_{P}_ error_correction symmetric MAC service	5.6.2.1 [3]	M	M
	Single-subfield protected B-field	6.2.1.3.4 [3]	M	M
	MOD-2 protected channel operation	10.8.2 [3]	M	M
	Protected I channel error_correct mode	10.12.1 [12]	M	M
	Lifetime management with TWO separate maximum MAC packet lifetimes	10.8.1	M	M
ULE1-M.16 ULE Physical channel selection		5.1.2 [12]	M	M
	Channel selection for the ULE packet data connection	10.8.2.1 [12]	M	M
	Exceptional cases	10.8.2.2 [12]	M	M
	Channel selection for the Service Call and other circuit mode connections	10.8.2.3 [12]	M	M
ULE1-M.21 Connection handover		5.1.2 [12]	O	O
	A-field connection handover request	10.9.5 [12]	M	M
ULE1-M.28 U-plane C/L downlink multicast service		5.1.2	M	M
	U-plane C/L downlink multicast unacknowledged	10.5.1	M	M
	U-plane C/L downlink over the dummy bearer	10.5.2	M	M
	U-plane C/L downlink over additional C/L bearers	10.5.3	O	O
	Repetition of U-plane C/L downlink	10.5.4	O	O
ULE1-M.29 Quiet Channel Indication		5.1.2	C701	C701
	Quiet Channel Indication	10.1.1	M	M
ULE1-M.30 PHS Detection Indication		5.1.2	C702	C702
	PHS Detection Indication	10.1.2	M	M
ULE1-M.31 Extended frequency allocation		5.12	M	C703
	Extended frequency allocation	10.16 [9]	M	M
ULE-M.32 Long slot (j = 640)		5.1.2	C704	M
	General	10.3.3.1	M	M
	D-field mapping for the long slot j=640 structure (physical packet P64)	6.2.1.1.4 [3]	M	M
	B-field mapping for the long slot j=640 structure (physical packet P64)	6.2.1.3.1.3 [3]	M	M
	Use of long slot in C/O bearers	10.3.3.2	M	M

Service	Procedure	Reference	Status	
			PT	FT
ULE1-M.33 "No-emissions" legacy mode		5.1.2	I	O
	General	10.4.1	I	M
	Tail identification for "no emission" mode	7.1.2 [3]	I	M
	Extended Physical and Mac layer capabilities (part 2) bit a23	7.2.3.11 [3]	I	M
	Bearer handover/replacement information, multiframe-countdown	7.2.4.3 [3]	I	M
	"no emission" mode sync information	7.3.5.3 [3]	I	M
	"no emission" mode procedures	9.4 [3]	I	M
	Management procedures for "no emission" mode	11.11 [3]	I	M
ULE1-M.34 Bearer handover (intra-cell)		5.1.2	M	M
	A-field bearer handover request	10.9.4 [12]	M	M
ULE1-M.35 Bearer handover (inter-cell)		5.1.2	M	M
	A-field bearer handover request	10.9.4 [12]	M	M
ULE1-M.36 ULE Bearer replacement (inter-cell)		5.1.2	M	M
	ULE bearer replacement (inter-cell)	10.7.6.4	M	M
ULE1-M.37 C/O procedures for FT connections with CRFP		5.1.2	N/A	C706
	Dual C/O bearer setup	10.9.1 [3]	N/A	M
	C/O connection release of connection with CRFP	10.9.2 [3]	N/A	M
	C/O connection suspend and resume	10.9.3 [3]	N/A	M
ULE1-M.38 Repeater compatibility				
	General	10.7.1	M	M
	Identification of a WRS	10.7.2	M	M
	ULE page delay mechanism	10.7.3	M	M
	Roaming	10.7.4	M	M
ULE1-M.39 U-NEMo support		5.1.2	O	O
	General	10.9.1	M	M
	ULE device initiated interaction	9.6.4 [3]	M	M
	FT initiated interaction	9.6.6 [3]	M	M
	Dummy bearer control	9.6.5 [3]	M	M
C701: IF ULE1-ME.3 then M else I. C702: IF ULE1-ME.4 then M else I. C703: IF ULE1-ME.3 or ULE1-ME.4 then M else O. C704: IF (ULE1-A.4 and (NG1.2, NG1.3 or NG1.5)) or ULE1-A.5 or ULE1-A.6 then M else I. C705: Status given in clause 6.3. C706: IF ULE1-N.23 THEN M ELSE O.				
NOTE: The reference column refers to the relevant clause in the present document unless a specific reference document is noted.				

6.6 DLC layer

6.6.1 DLC layer services

ULE Phase 2 devices shall support the DLC services described by Table 8.

Table 8: DLC service status

Item no.	Name of service	Reference	Status	
			PT	FT
ULE1-D.1	LU14 Enhanced Frame RELay service with CCM (EFREL-CCM)	5.1.3 [12]	M	M
ULE1-D.2	LU13 Enhanced Frame RELay service with CRC (EFREL-CRC)	5.1.3 [12]	O	O
ULE1-D.3	LU10 Enhanced Frame RELay service (EFREL) (note 2)	5.1.3 [12]	M	M
ULE1-D.4	FU10a (note 3)	5.1.3 [12]	M	M
ULE1-D.5	FU10d	5.1.3 [12]	M	M

Item no.	Name of service	Reference	Status	
			PT	FT
ULE1-D.6	Data Link Service (LAPC + Lc) class A service	5.1.3 [12]	M	M
ULE1-D.7	DLC Transmission Class 1	5.1.3 [12]	M	M
ULE1-D.8	Lc Frame delimiting and sequencing service	5.1.3 [12]	M	M
ULE1-D.9	Broadcast Lb service	5.1.3 [12]	O	O
ULE1-D.10	Encryption activation	5.1.3 [12]	M	M
ULE1-D.11	Encryption deactivation	5.1.3 [12]	C801	C801
ULE1-D.12	CCM/AES encryption	5.1.3 [12]	M	M
ULE1-D.13	Intra-cell voluntary connection handover	5.1.3	O	O
ULE1-D.14	Inter-cell voluntary connection handover	5.1.3	O	O
NG1.D.1	LU1 Transparent UnProtected service (TRUP) Class 0/minimum_delay	5.3 [11]	C802	M
NG1.D.5	FU1 DLC frame	5.3 [11]	C802	M
DPRS-D.1	LU10 Enhanced Frame RELay service (EFREL) (note 2)	4.3.3 [16]	C803	M
DPRS-D.2	FU10a (note 3)	4.3.3 [16]	C803	M
DPRS-D.3	FU10b	4.3.3 [16]	I	I
DPRS-D.4	FU10c	4.3.3 [16]	C803	M
DPRS-D.9	Inter-cell voluntary connection handover	4.3.3 [16]	C804	O
DPRS-D.10	Connection modification	4.3.3 [16]	C805	C805
C801: IF feature ULE1-N.15 (Encryption deactivation FT initiated) OR ULE1-N.14 (Encryption deactivation PT initiated) THEN M ELSE I. C802: IF ULE1-A.4 then M else I. C803: IF ULE1-A.5 or ULE1-A.6 then M else I. C804: IF ULE1-A.5 or ULE1-A.6 then O else I. C805: If DPRS-M.5 THEN M ELSE O.				
NOTE 1: The reference column refers to the relevant clause in the present document unless a specific reference document is noted. NOTE 2: The LU10 service is used by both ULE and SUOTA/LDS. However, there are some small differences between the feature definitions. ULE shall use ULE1-D.3. SUOTA/LDS shall use DPRS-D.1. NOTE 3: The FU10a frame is used by both ULE and SUOTA/LDS. However, there are some small differences between the feature definitions. ULE shall use ULE1-D.4. SUOTA/LDS shall use DPRS-D.2.				

6.6.2 DLC service to procedure mapping

The DLC layer service to procedure mapping described by Table 9 shall apply.

In addition, those DLC layer services that are defined in clause 6.6.1 that do not have explicit procedure mapping described by Table 9, shall have identical procedure mapping to that defined in their referenced documents.

Table 9: DLC service to procedure mapping

Service	Procedure	Reference	Status	
			PT	FT
ULE1-D.1 LU14 Enhanced Frame RELay service with CCM (EFREL-CCM)		5.1.3 [12]	M	M
	LU14 Enhanced Frame RELay service with CCM (EFREL-CCM)	11.1 [12]	M	M
	LU14 Enhanced Frame RELay service with CCM (EFREL-CCM) for C/L downlink multicast channels	11.1.1.1	C901	C901
ULE1-D.2 LU13 Enhanced Frame RELay service with CRC (EFREL-CRC)		5.1.3 [12]	O	O
	LU13 Enhanced Frame RELay service with CRC (EFREL-CRC)	11.8 [12]	M	M
	LU13 Enhanced Frame RELay service with CRC (EFREL-CRC) for C/L downlink multicast channels	11.1.1.2	C902	C902
ULE1-D.3 LU10 Enhanced Frame RELay service (EFREL)		5.1.3 [12]	M	M
	LU10 Enhanced Frame RELay service (EFREL)	11.2 [12]	M	M
	LU10 Enhanced Frame RELay service (EFREL) for C/L downlink multicast channels	11.1.1.3	C901	C901

Service	Procedure	Reference	Status	
			PT	FT
ULE1-D.4 FU10a		5.1.3 [12]	M	M
	FU10a frame operation	11.3.1 [12]	M	M
	FU10a frame operation for C/L downlink multicast channels	11.1.1.4	C901	C901
ULE1-D.7 DLC Transmission Class 1		5.1.3 [12]	M	M
	General	11.5.1.1 [12]	M	M
	Sending side procedure	11.5.1.2 [12]	M	M
	Receiving side procedure	11.5.1.3 [12]	M	M
	Transmission Class 1 over C/L downlink multicast channels	11.1.1.5	C901	C901
ULE1-D.12 CCM/AES encryption		5.1.3 [12]	M	M
	CCM Authenticated Encryption	11.10.1 [12]	M	M
	CCM activation at Virtual Call setup	11.10.2 [12]	M	M
	Cipher keys for CCM	11.10.3 [12]	M	M
	CCM Authenticated Encryption of C/L downlink multicast	11.1.2.1	C901	[12] C901
	Initialization Vector for multicast channels	11.1.2.2	C901	C901
	Security provisions regarding the key for multicast channels	11.1.2.3	C901	C901
ULE1-D.13 Intra-cell voluntary connection handover			O	O
	Class A basic connection handover	9.7 [9]	M	M
ULE1-D.14 Inter-cell voluntary connection handover			O	O
	Class A basic connection handover	9.7 [9]	M	M
C901: IF ULE1-M.28 (C/L downlink multicast) THEN M ELSE I. [12] C902: IF ULE1-M.28 (C/L downlink multicast) AND ULE1-D.2 LU13 (Enhanced Frame RELay service with CRC) THEN M ELSE I.				
NOTE: The reference column refers to the relevant clause in the present document unless a specific reference document is noted.				

6.7 NWK layer

6.7.1 General

The NWK layer provisions shall include the following entities:

- Call Control (CC).
- Mobility Management (MM).
- Link Control Entity (LCE).
- ConnectionLess Message Service (CLMS).

6.7.2 NWK features

ULE Phase 2 devices shall support the NWK layer features described by Table 10.

Table 10: NWK features status

Feature supported				
Features			Status	
Item no.	Name of feature	Reference	PT	FT
ULE1-N.1	ULE NWK control	5.1.4 [12]	M	M
ULE1-N.2	ULE Service Call	5.1.4 [12]	M	M
ULE1-N.3	Authentication of PP	5.1.4 [12]	M	M
ULE1-N.4	Authentication of user	5.1.4 [12]	O	O
ULE1-N.5	Location registration	5.1.4 [12]	M	M
ULE1-N.6	On air key allocation	5.1.4 [12]	M	M
ULE1-N.7	Identification of PP	5.1.4 [12]	M	O
ULE1-N.8	Service class indication/assignment	5.1.4 [12]	M	O
ULE1-N.9	Encryption activation FT initiated	5.1.4 [12]	M	M
ULE1-N.10	Subscription registration procedure on-air	5.1.4 [12]	M	M
ULE1-N.11	Link control	5.1.4 [12]	M	M
ULE1-N.12	Terminate access rights FT initiated	5.1.4 [12]	M	O
ULE1-N.13	Authentication of FT	5.1.4 [12]	O	O
ULE1-N.14	Encryption activation PT initiated	5.1.4 [12]	O	O
ULE1-N.15	Encryption deactivation FT initiated	5.1.4 [12]	O	O
ULE1-N.16	Encryption deactivation PT initiated	5.1.4 [12]	O	O
ULE1-N.17	Enhanced security	5.1.4 [12]	M	M
ULE1-N.18	AES/DSAA2 authentication	5.1.4 [12]	M	M
ULE1-N.19	Security procedures for C/L downlink multicast	5.1.4	C1002	C1002
ULE1-N.20	Incoming call for "hybrid voice" devices	5.1.4	C1003	M
ULE1-N.21	Interaction of ULE and "circuit mode"	5.1.4	C1005	M
ULE1-N.22	SUOTA push mode for ULE devices	5.1.4	C1013	O
ULE1-N.23	Confidentiality service with a CRFP	5.1.4	N/A	O
ULE1-N.24	U-NEMo procedures	5.1.4	C1014	C1014
NG1.N.1	Codec Negotiation	5.2 [11]	C1003	M
NG1.N.2	Codec Switching	5.2 [11]	C1003	M
GAP.N.1	Outgoing call	4.1 [9]	C1003	M
GAP.N.2	Off hook	4.1 [9]	C1005	M
GAP.N.3	On hook (full release)	4.1 [9]	C1005	M
GAP.N.4	Dialled digits (basic)	4.1 [9]	C1006	M
GAP.N.5	Register recall	4.1 [9]	C1006	O
GAP.N.6	Go to DTMF signalling (defined tone length)	4.1 [9]	C1006	O
GAP.N.7	Pause (dialling pause)	4.1 [9]	C1006	O [12]
GAP.N.8	Incoming call	4.1 [9]	C1004	M
GAP.N.15	Alerting	4.1 [9]	C1006	M
GAP.N.21	Partial release	4.1 [9]	C1006	O
GAP.N.22	Go to DTMF (infinite tone length)	4.1 [9]	C1006	O
GAP.N.23	Go to Pulse	4.1 [9]	C1006	O
GAP.N.24	Signalling of display characters	4.1 [9]	C1006	O
GAP.N.25	Display control characters	4.1 [9]	C1006	O
GAP.N.30	Calling Line Identification Presentation (CLIP)	4.1 [9]	C1006	O
GAP.N.31	Internal call	4.1 [9]	C1006	O
GAP.N.33	Enhanced U- plane connection	4.1 [9]	C1004	O
GAP.N.34	Calling Name Identification Presentation (CNIP)	4.1 [9]	C1004	O
DPRS-N.1	PT initiated virtual call	4.3.4 [16]	C1007	M
DPRS-N.8	FT initiated virtual call	4.3.4 [16]	C1008	O
DPRS-N.33	Dynamic parameters allocation	4.3.4 [16]	C1010	C1010
DPRS-N.34	Service Negotiation at virtual call setup	4.3.4 [16]	C1011	C1011
DPRS-N.35	In call service change	4.3.4 [16]	C1012	C1012
DPRS-N.36	NWK layer management	4.3.4 [16]	C1007	M
DPRS-N.37	Identity assignment	4.3.4 [16]	C1008	O
DPRS-N.38	DECT External handover	4.3.4 [16]	I	I
DPRS-N.39	Message Waiting Indication	4.3.4 [16]	C1008	O [9]
DPRS-N.40	Detach	4.3.4 [16]	C1008	O
DPRS-N.41	Periodic location registration	4.3.4 [16]	C1008	O
DPRS-N.42	On-air modification of user parameters	4.3.4 [16]	C1008	O
NGLDS-N.1	General Light Data Service Procedures	5.1.4 [13]	C1007	M
NGLDS-N.2	Software upgrade over the air, C-plane	5.1.4 [13]	C1009	M

Feature supported				
Features			Status	
Item no.	Name of feature	Reference	PT	FT
C1002: IF MAC service ULE1-M.28 (C/L downlink multicast) THEN M ELSE I. C1003: IF ULE1-A.4 then M else I. C1004: IF ULE1-A.4 then O else I. C1005: IF ULE1-A.4 or ULE1-A.5 or ULE1-A.6 then M else I. C1006: IF ULE1-A.4 or ULE1-A.5 or ULE1-A.6 then O else I. C1007: IF ULE1-A.5 or ULE1-A.6 then M else I. C1008: IF ULE1-A.5 or ULE1-A.6 then O else I. C1009: IF ULE1-A.6 then M else I. C1010: IF (DPRS-ME.2 OR multi-context supported (ETSI TS 102 527-4 [13], clause 7.6.1.2.2) OR Generic multiprotocol supported (ETSI TS 102 527-4 [13], clause 7.6.1.2.3) OR application packet size different from basic service settings; see ETSI EN 301 649 [16], clause 12.22 and clause A.2) THEN M ELSE O. C1011: IF DPRS-ME.2 THEN M ELSE (IF (LU10 Interworking conventions and HTTP profile for enhanced binary content download (ETSI TS 102 527-4 [13], clause 7.6.1.2.2) OR LU10 [16] Interworking conventions and HTTP profile for Generic multiprotocol binary content download (ETSI TS 102 527-4 [13], clause 7.6.1.2.3) THEN O ELSE I). C1012: IF DPRS-ME.2 OR multi-context supported (ETSI TS 102 527-4 [13], clause 7.6.1.2.2) OR Generic multiprotocol supported (ETSI TS 102 527-4 [13], clause 7.6.1.2.3) THEN M ELSE O. C1013: IF ULE1-A.6 then O else I. C1014: IF ULE1-M.39 then M else I.				
NOTE 1: The reference column refers to the relevant clause in the present document unless a specific reference document is noted. NOTE 2: Features with the prefix "GAP" are not defined using that prefix in ETSI EN 300 444 [9]. For example, GAP.N.15 is just defined as N.15 in ETSI EN 300 444 [9]. The feature is identical, the GAP prefix is a convention only.				

6.7.3 NWK features to procedures mapping

The NWK layer feature to procedure mapping described by Table 11 shall apply.

In addition, those NWK layer features that are defined in clause 6.7.2 that do not have explicit procedure mapping described by Table 11, shall have identical procedure mapping to that defined in their referenced documents.

Table 11: NWK feature to procedure mapping

Feature/Procedure mapping				
Feature	Procedure	Reference	Status	
			PT	FT
ULE1-N.1 ULE NWK control		5.1.4 [12]	M	M
	General pre-requisites	12.1.1 [12]	M	M
	Creation of the ULE PVC and states	12.1.2 [12]	M	M
	Allowed CC Operations over the ULE transaction	12.1.3 [12]	M	M
	Service Change "NWK resume"	12.1.3.1 [12]	M	M
	Service Change "NWK suspend"	12.1.3.2 [12]	M	M
	Service Change "other"	12.1.3.3 [12]	M	M
	Allowed parameters in any service change operation	12.1.3.4 [12]	M	M
	Default ULE PVC transaction	12.5.1	M	M
	Initiating part of the Service Change operations	12.1.3.6 [12]	M	M
	Independence of other CC transactions.	12.1.3.7 [12]	M	M
	Default MAC parameters for implicitly created MBC	12.5.2	M	M
	Paging descriptors in suspend and resume states	12.1.3.9 [12]	M	M
	Control procedures for C/L downlink multicast channels	12.1.2	C1104	C1104

Feature/Procedure mapping				
Feature	**Procedure**	**Reference**	**Status**	
			PT	**FT**
ULE1-N.5 Location registration		5.1.4 [12]	M	M
	Location registration	8.28 [9]	M	M
	Location update	8.29 [9]	M	O
	Terminal Capability indication	12.2.1	M	M
ULE1-N.8 Service class indication/assignment		5.1.4 [12]	M	O
	Obtaining access rights	8.30 [9]	M	M
	Terminal Capability indication	12.2.1	M	M
	Authentication of PP using DSAA	8.24 [9]	M	M
	Authentication of PP using DSAA2	8.45.7 [9]	C1103	C1103
ULE1-N.10 Subscription registration procedure on-air		5.1.4 [12]	M	M
	Obtaining access rights	8.30 [9]	M	M
	Terminal Capability indication	12.2.1	M	M
ULE1-N.19 Security procedures for C/L downlink multicast		5.1.4	C1101	C1101
	Cipher keys for CCM encryption of C/L multicast channels	12.1.1.1	M	M
	Multicast encryption parameter assignation procedure, FT initiated	12.1.1.2	M	M
	Multicast encryption parameter retrieval procedure, PT initiated	12.1.1.3	M	M
ULE1-N.20 Incoming call for "hybrid" devices		5.1.4	C1102	M
	General requirements	12.3.1.1	M	M
	Paging descriptors for incoming call	12.3.1.2	M	M [9]
	Incoming call procedure	12.3.1.3	M	M
ULE1-N.21 Interactions of ULE and "circuit mode"		5.1.4	C1105	M [12]
	General requirements	12.3.2.1	M	M
	ULE request whilst "circuit mode" active	12.3.2.2	M	M
	"Circuit mode" request whilst ULE active	12.3.2.3	M	M [9]
	Suspend/resume ULE service	12.3.2.4	O	M
ULE1-N.22 SUOTA push mode for ULE devices		5.1.4	C1106	O
	General requirements	12.4.1	M	M
	Paging descriptors for SUOTA push mode	12.4.2	M	M
	Push mode procedure	12.4.3	M	M
ULE1-N.23 Confidentiality service with a CRFP		5.1.4	N/A	O
	General	7.3.1 [7]	N/A	M
	CRFP initialization of PT cipher key	7.3.2 [7]	N/A	M
ULE1-N.24 U-NEMo procedures		5.1.4	C1107	C1107
	Communication of U-NEMo preferred carrier	12.6.1	M	M
C1101: IF MAC service ULE1-M.28 (U-plane C/L downlink multicast service) THEN M ELSE I. C1102: IF ULE1-A.4 then M else I. C1103: IF feature ULE1-N.18 THEN M ELSE I. C1104: IF MAC service ULE1-M.28 (U-plane C/L downlink multicast service) THEN M ELSE I. C1105: IF ULE1-A4 or ULE1-A.5 or ULE1-A.6 then M else I. C1106: IF ULE1-A.6 THEN O ELSE I. C1107: IF ULE1-M.39 then M else I.				
NOTE: The reference column refers to the relevant clause in the present document unless a specific reference document is noted.				

6.8 Application Layer

6.8.1 Application features

ULE Phase 2 devices shall support the application features described by Table 12.

Table 12: Application features status

Feature supported			Status	
Item no.	**Name of feature**	**Reference**	**PT**	**FT**
ULE1.A.1	AC to bitstring mapping	5.1.5 [12]	M	M
ULE1.A.2	Multiple subscription registration	5.1.5 [12]	O	N/A
ULE1.A.3	Easy pairing registration	5.1.5 [12]	O	O
ULE1-A.4	Hybrid device voice service	5.1.5	O	M
ULE1-A.5	Hybrid device data service	5.1.5	O	M
ULE1-A.6	Software Upgrade Over The Air (SUOTA) support for ULE devices	5.1.5	O	M
NGLDS-A.1	Binary content download	5.1.5 [13]	C1201	M
NGLDS-A.2	Software upgrade over the air	5.1.5 [13]	C1202	M
NGLDS-A.3	HTTP based applications	5.1.5 [13]	C1203	M
C1201: IF ULE1-A.5 or ULE1-A.6 THEN M ELSE I. C1202: IF ULE1-A.6 THEN M ELSE I. C1202: IF ULE1-A.5 or ULE1-A.6 THEN O ELSE I.				
NOTE: The reference column refers to the relevant clause in the present document unless a specific reference document is noted.				

6.8.2 Application features to procedures mapping

The Application layer feature to procedure mapping described by Table 13 shall apply.

In addition, those Application layer features that are defined in clause 6.8.1 that do not have explicit procedure mapping described by Table 13, shall have identical procedure mapping to that defined in their referenced documents.

Table 13: Application feature to procedure mapping

Feature/Procedure mapping			Status	
Feature	**Procedure**	**Ref.**	**PT**	**FT**
Easy pairing registration [ULE1.A.3]		5.1.5 [12]	O	O
	Registration mode automatic access	7.10.1.3.1 [10]	M	N/A
	Base station limited registration mode	7.10.1.2.2 [10]	N/A	M
	Searching mode requests	14.1.1 [12]	M	N/A
	Base station name selection	7.10.1.3.2 [10]	O	O
	Registration user feedback	7.10.1.3.3 [10]	O	O
Hybrid device voice service [ULE1-A.4]		5.1.5	O	M
	General requirements	14.1.1	M	M
Hybrid device data service [ULE1-A.5]		5.1.5	O	M
	General requirements	14.2.1	M	M
Software Upgrade Over The Air (SUOTA) for ULE devices [ULE1-A.6]		5.1.5	O	M
	General requirements	14.3.1	M	M
NOTE: The reference column refers to the relevant clause in the present document unless a specific reference document is noted.				

6.9 Distributed communications

This is not applicable.

6.10 Management Entity (ME)

6.10.1 Management Entity (ME) services

ULE Phase 2 devices shall support the ME services described by Table 14.

Table 14: Management Entity Requirements

Feature supported			Status	
Feature	**Name of feature**	**Ref.**	**PT**	**FT**
ULE1-ME.1	ULE phase 1 Management	5.1.6 [12]	M	M
ULE1-ME.2	ULE Physical Channel Selection	5.1.6 [12]	C1401	C1401
ULE1-ME.3	ULE Physical Channel Selection for US region	5.1.6	C1402	C1402
ULE1-ME.4	ULE Physical Channel Selection for Japan region	5.1.6	C1403	C1403
DPRS-ME.1	Class 1 management	4.3.7 [16]	I	I
DPRS-ME.2	Class 2 management	4.3.7 [16]	C1405	O
DPRS-ME.3	Class 3 management	4.3.7 [16]	C1405	O
DPRS-ME.4	Class 4 management	4.3.7 [16]	C1404	M
C1401: IF implementation is not intended for operation in US or Japan THEN M ELSE O. C1402: IF implementation is intended for operation in US region THEN M ELSE I. C1403: IF implementation is intended for operation in Japan region THEN M ELSE I. C1404: IF ULE1-A.5 or ULE1-A.6 THEN M ELSE I. C1405: IF ULE1-A.5 or ULE1-A.6 THEN O ELSE I.				
NOTE 1: The reference column refers to the relevant clause in the present document unless a specific reference document is noted. NOTE 2: At least one of ULE1-ME.2, ULE1-ME.3 or ULE1-ME.4 shall be supported.				

6.10.2 Management Entity (ME) mode to procedures mapping

The ME service to procedure mapping described by Table 15 shall apply.

In addition, those Management Entity services that are defined in clause 6.10.1 that do not have explicit procedure mapping described by Table 15, shall have identical procedure mapping to that defined in their referenced documents.

Table 15: Management Entity mode to procedures mapping

Feature/Procedure mapping			Status	
Service	**Procedure**	**Reference**	**PT**	**FT**
ULE Physical Channel Selection [ULE1-ME.2]		5.1.6 [12]	C1501	C1501
	Overall architecture of ULE channel selection processes	9.2.1 [12]	M	M
	Process M0 (RFP side pre-selection process)	9.2.2 [12]	M	M
	Broadcast mechanism	9.2.3 [12]	M	M
	Process M1 (PP side channel selection process)	9.2.4 [12]	M	M
	Setup attempt and evaluation of responses	9.2.5 [12]	M	M
	Process M2 (collision handling/collision avoidance process)	9.2.6 [12]	M	M
ULE Physical Channel Selection for US region [ULE1-ME.3]		5.1.6	C1502	C1502
	Overall architecture of ULE channel selection processes	9.3.1	M	M
	Process M0 (RFP side pre-selection process)	9.3.2	M	M
	Broadcast mechanism	9.3.3	M	M
	Process M1 (PP side channel selection process)	9.3.4	M	M
	Setup attempt and evaluation of responses	9.3.5	M	M
	Process M2 (collision handling/collision avoidance process)	9.3.6	M	M
ULE Physical Channel Selection for Japan region [ULE1-ME.4]		5.1.6	C1503 [12]	C1503
	Overall architecture of ULE channel selection processes	9.4.1	M	M
	Process M0 (RFP side pre-selection process)	9.4.2	M	M
	Broadcast mechanism	9.4.3	M	M
	Process M1 (PP side channel selection process)	9.4.4	M	M
	Setup attempt and evaluation of responses	9.4.5	M	M

Feature/Procedure mapping			Status	
Service	**Procedure**	**Reference**	**PT**	**FT**
	Process M2 (collision handling/collision avoidance process)	9.4.6	M	M
C1501: IF implementation is not intended for operation in US or Japan THEN M ELSE O. C1502: IF implementation is intended for operation in US region THEN M ELSE I. C1503: IF implementation is intended for operation in Japan region THEN M ELSE I.				
NOTE 1: The reference column refers to the relevant clause in the present document unless a specific reference document is noted. NOTE 2: At least one of ULE1-ME.2, ULE1-ME.3 or ULE1-ME.4 shall be supported.				

6.11 U-plane services and interworking requirements

6.11.1 U-plane and interworking services

ULE Phase 2 devices shall support the U-plane and interworking services described by Table 16.

Table 16: U-plane services and interworking

Item	Name of service	Reference	Support status	
			PT	**FT**
ULE1-I.1	Transparent U-plane Interworking	5.1.7 [12]	M	M
ULE1-I.2	Configuration and control service channel	5.1.7	M	M
ULE1-I.3	CCM encrypted general purpose service channel	5.1.7	C1601	M
C1601: IF ULE1-A4 or ULE1-A.5 or ULE1-A.6 THEN M ELSE I.				
NOTE: The reference column refers to the relevant clause in the present document unless a specific reference document is noted.				

6.11.2 U-plane and interworking service to procedure mapping

The U-plane and interworking service to procedure mapping described by Table 17 shall apply.

In addition, those U-plane and interworking services that are defined in clause 6.11.1 that do not have explicit procedure mapping described by Table 17, shall have identical procedure mapping to that defined in their referenced documents.

Table 17: U-plane and interworking service to procedure mapping

Service	Procedure	Reference	Status	
			PT	FT
ULE1-I.1 Transparent U-plane Interworking		5.1.7 [12]	M	M
	U-plane procedures	B.2.1 [12]	M	M
	C-plane procedures	B.2.2 [12]	M	M
	Transport of IWU-to-IWU data	13.2.1 [12]	O	O
	IWU procedures for C/L downlink multicast service	13.1.2	C1701	C1701
ULE1-I.2 Configuration and control service channel		5.1.7	M	M
	General concepts	13.1.1.1	M	M
	Configuration and control service channel	13.1.1.2	M	M
	Transport of IWU-to-IWU	13.2.1 [12]	M	M
	ULE Common Control Protocol procedures	13.1.1.2.1	O	O
ULE1-I.3 CCM encrypted general purpose service channel		5.1.7	C1702	M
	General concepts	13.1.1.1	M	M
	Services provided by the DECT sub-system	13.1.1.3.1	M	M
	Transport of the general purpose service channel	13.1.1.3.2	M	M
	Security procedures	13.1.1.3.3	M	M
	Segmentation and reassembling	13.1.1.3.4	M	M
	MAC Release Reason Emulation	13.1.1.3.5	O	O
C1701: IF ULE1-M.28 (U-plane C/L downlink multicast service) THEM M ELSE I. C1702: IF ULE1-A4 or ULE1-A.5 or ULE1-A.6 THEN M ELSE I.				
NOTE: The reference column refers to the relevant clause in the present document unless a specific reference document is noted.				

6.12 Speech Services

6.12.1 Speech Services features

ULE Phase 2 devices shall support the speech service features described by Table 18.

Table 18: Speech services features

Feature supported			Status	
Feature	Name of feature	Ref.	PT	FT
NG1.1	Narrow band ADPCM G.726 [i.2] 32 kbit/s voice service	5.1 [11]	C1801	M
NG1.2	Narrow band PCM G.711 [i.3] 64 kbit/s voice service	5.1 [11]	C1802	O
NG1.3	Wideband G.722 [i.4] 64 kbit/s voice service	5.1 [11]	C1802	M
NG1.4	Wideband G.729.1 [i.5] 32 kbit/s voice service	5.1 [11]	C1802	O
NG1.5	MPEG-4 ER AAC-LD super-wideband [i.6] 64 kbit/s voice service	5.1 [11]	C1802	O
NG1.6	MPEG-4 ER AAC-LD wideband [i.6] 32 kbit/s voice service	5.1 [11]	C1802	O
C1801: If ULE1-A.4 then M else I. C1802: If ULE1-A.4 then O else I.				
NOTE: The reference column refers to the relevant clause in the present document unless a specific reference document is noted.				

6.12.2 Speech Services to procedures mapping

Those U-plane and interworking services that are defined in clause 6.12.1 shall have identical procedure mapping to that defined in their referenced documents.

Table 19: Speech service feature to procedure mapping

Feature/Procedure mapping			Status	
Feature	**Procedure**	**Reference**	**PT**	**FT**
This table is intentionally left blank in order to facilitate future modification.				
NOTE: The reference column refers to the relevant clause in the present document unless a specific reference document is noted.				

6.13 General class/service/interworking support

6.13.1 Class/service support

The service classes and end-user services described by Table 20 shall apply.

Table 20: General class and service support

Item	Name of service	Reference	Support status	
			PT	**FT**
DPRS-G.1	DPRS Class 1	4.3.8 [16]	I	I
DPRS-G.2	DPRS Class 2	4.3.8 [16]	C1802	O
DPRS-G.3	Frame Relay (FREL)	4.3.9 [16] and annex B [16]	C1801	M
DPRS-G.4	Character stream	4.3.9 [16] and annex C [16]	I	I
DPRS-G.5	DPRS Class 3	4.3.8 [16] and annex C [16]	C1802	O
DPRS-G.6	DPRS Class 4	4.3.8 [16] and annex C [16]	C1801	M
C1801: IF ULE1-A.5 or ULE1-A.6 then M else I. C1802: IF ULE1-A.5 or ULE1-A.6 then O else I.				
NOTE: The reference column refers to the relevant clause in the present document unless a specific reference document is noted.				

6.13.2 Protocol interworking support

The protocol interworking modes described by Table 21 shall apply.

Table 21: General service/interworking support

Service	Interworking	Reference	Status	
			PT	**FT**
DPRS-G.3, Frame Relay (FREL)		4.3.9 [16] and annex B [16]	C1901	M
	DPRS-I.1, Ethernet	4.3.9 [16] and B.4 [16]	I	I
	DPRS-I.2, Token Ring	4.3.9 [16] and B.5 [16]	I	I
	DPRS-I.3, IP	4.3.9 [16] and B.6 [16]	I	I
	DPRS-I.4, PPP	4.3.9 [16] and B.7 [16]	I	I
	DPRS-I.5, Generic media encapsulation	4.3.9 [16], B.8 [16] and 7.6.1.2 (see note 2)	M	M
DPRS-G.4, Character stream		4.3.9 [16] and annex C [16]	I	I
	DPRS-I.6, V.24	4.3.9 [16] and C.4 [16]	I	I
C1901: IF ULE1-A.5 or ULE1-A.6 then M else I.				
NOTE 1: The reference column refers to the relevant clause in the present document unless a specific reference document is noted. NOTE 2: The applicable clauses in ETSI TS 102 527-4 [13], clause 7.6.1.2 according to Table 13 of that same document shall apply.				

With regard to the Interworking conventions, the specific interworking requirements described in ETSI TS 102 527-4 [13], clause 7.7 shall also apply.

7 Profile specific procedures description

7.0 General

In addition to the general requirements and procedures defined in clause 7, further profile specific procedures are described in clause 8 to clause 14 of the present document (organized by protocol layers).

7.1 Back compatibility with ULE Phase 1

7.1.0 General

A ULE Phase 2 PP may determine what type of FP it is attached to by the use the Extended Fixed Part Capabilities (Part 2) message (see clause 10.2.2.2.3).

A ULE Phase 2 FP may determine what type(s) of PP(s) are registered to it by the use of the Terminal Capabilities (see clause 12.2.1).

NOTE: ULE Phase 1 FPs and PPs are sub-categorized into devices compliant with ETSI TS 102 939-1 [12] V1.1.1 and devices compliant with later versions of that TS. See ETSI TS 102 939-1 [12] for details.

7.1.1 Back compatibility with a ULE Phase 1 Fixed Part (FP)

In the absence of any specific back-compatibility rules defined in the present document, the PP shall inter-operate with a ULE Phase 1 FP using those procedures defined in ETSI TS 102 939-1 [12]. The PP shall not attempt to use procedures or features that are not supported by the ULE Phase 1 FP.

7.1.2 Back compatibility with a ULE Phase 1 Portable Part (PP)

In the absence of any specific back-compatibility rules defined in the present document, the FP shall inter-operate with a ULE Phase 1 PP using those procedures defined in ETSI TS 102 939-1 [12]. The FP shall not attempt to use procedures or features that are not supported by the ULE Phase 1 PP.

8 Physical Layer (PHL) procedures

There are currently no new PHL layer procedures specifically defined for ULE Phase 2.

9 Management Entity (ME) procedures

9.1 ULE phase 1 Management

The provisions of ETSI TS 102 939-1 [12], clause 9.1 shall apply.

9.2 Channel selection and collision avoidance procedures

The provisions of ETSI TS 102 939-1 [12], clause 9.2 shall apply.

9.3 Channel selection and collision avoidance procedures for US region

9.3.0 General

In addition to the clause 9.3, the provisions of ETSI TS 102 497 [14] shall apply.

9.3.1 Overall architecture of ULE channel selection processes

DECT ULE devices shall implement the Physical channel selection procedures as described in ETSI EN 300 175-3 [3], clause 11.12. The processes and mechanisms described in ETSI EN 300 175-3 [3], clause 11.12.2 shall be implemented.

9.3.2 Process M0 (RFP side pre-selection process)

DECT ULE RFPs shall implement the process M0 (RFP side pre-selection process) as described in ETSI EN 300 175-3 [3], clause 11.12.3.

Implementation at PP side shall consist in the understanding of the RFP algorithm.

The provisions given in ETSI EN 300 175-3 [3], clause 11.12.3 shall be followed.

The following additional provisions shall apply:

- The value of m is 2 (m is a system parameter described in ETSI EN 300 175-3 [3], clause 11.12).
- In order to compile the list of candidate channels, the RFP shall routinely scan all DECT channels (except those impossible to receive by physical limitations) and compute their RSSI.
- In order to consider a given channel as candidate for setup, both simplex bearers of it shall be measured in at least one frame, and the worst (highest) RSSI value shall be used.

The following additional guidelines are given:

- Due to the need to have the RFP receiver listening for possible setups according to the scan sequence, for single transceiver systems, it is assumed that the scan of the uplink simplex bearer will be done, in practice, listening to the scan sequence frequency.
- The scan of the downlink bearers of the channels may be done with the same criteria (listening according to RFP scan sequence), or with a different cycle (implementation choice).
- The measurement of the RSSI should be done assuming that the slot to be used on the transmission will be a full slot.
- Other mechanisms, such as multi-transceiver RFP are possible.
- As general rule, the unnecessary restriction of the offered channels by reserving fixed slots for other services is not recommended.

A possible implementation of algorithm M0 is provided in ETSI TS 102 939-1 [12], clause C.1.

9.3.3 Broadcast mechanism

DECT ULE RFPs shall implement and DECT ULE PPs shall understand the broadcast mechanism described in ETSI EN 300 175-3 [3], clause 11.12.4.

The following additional provisions shall apply:

- The value of m, the time difference between frame that carries the broadcast and the access frame for which the channel selection information refers, shall be equal to 2. Therefore all channel selection information shall refer to frame N+2.

- The FP shall implement the procedure defined in clause 10.1.1 of the present document.
- If the "RFC1" bit (bit 172) of the FP's dummy bearer's subfield 2 is clear (i.e. value 0), then the PP shall perform its own LIC scan, in accordance with the requirements for the US (ETSI TS 102 497 [14]), see note.
- If the "RFC1" bit (bit 172) of the FP's dummy bearer's subfield is set (i.e. value 1), then the PP may attempt to use the channels indicated in the FP's M_U broadcast.
- The RSSI reference level used in ETSI EN 300 175-3 [3], clause 9.5.1.3.1, Table 9.11 is -90 dBm.

NOTE: When the "RFC1" bit (bit 172) is clear, any channels indicated in the M_U cannot be selected directly by the PP. However, the PP implementation might still find the information useful, for example, in prioritizing or refining the channel selection process, etc.

9.3.4 Process M1 (PP side channel selection process)

If the FP does not indicate any channels with RSSI of -84 dBm or less, then the PP shall perform its own Least Interfered Channel (LIC) scan, in accordance with the requirements for the US (ETSI TS 102 497 [14]).

If, during the process of the performing the LIC scan, the PP detects channel(s) with RSSI of -84 dBm or less, then the PP may decide to abort the LIC scan and attempt to utilize the newly detected channel(s). Alternatively, the PP may decide to continue with the LIC scan, since this will provide a larger pool of candidates in case further attempts are required.

If the FP did indicate channels with RSSI of -84 dBm or less, in its M_U broadcast, then the PP may attempt to utilize the indicated channels.

DECT ULE PPs shall implement the process M1 (PP side channel selection process) as described in ETSI EN 300 175-3 [3], clause 11.12.5. The input to process M1 shall be either the output of the PP's LIC scan, or the list of quiet channels (i.e. those less than -84 dBm) as indicated by the FP or discovered by the PP.

Implementation at RFP side shall consist in the understanding of the PP setup process.

The following additional provisions shall apply:

- For PPs without power consumption limitations (fast actuators) higher numbers of n may be used.
- It is allowed to receive and decode the content of channel selection information in the dummy bearer in frames N+1 or N+2, in order to quickly react to the event of repetition of algorithm M1 due to no validation of any candidate channel.
- PP devices without power consumption limitations (fast actuators) may be continuously scanning the dummy bearer channel selection info and continuously performing the RSSI validation (including LIC scan) in order to be ready for a fast response to an event (paging or PP side event) requiring setup.
- The measurement of the RSSI shall be done taken into account the slot type that will be used in the transmission.

In all cases, the Last Minute Scan (LMS) is still required. If the LMS RSSI reading is found to be greater than -84 dBm, then the PP shall not use that channel if it was not discovered without an LIC scan. The PP cannot transmit on the channel if the relevant access criteria is not met (see ETSI TS 102 497 [14]).

9.3.5 Setup attempt and evaluation of responses

PPs shall perform the access request and evaluation or responses as defined in ETSI EN 300 175-3 [3], clause 11.12.6.

Implementation at RFP side shall consist in the understanding of the PP response.

The following additional provisions shall apply:

- The differentiation of error responses compatible and not compatible with collision is optional. If this differentiation is not implemented all error cases shall be followed by execution of algorithm M2.

- In case of impossibility of access due to repetitive lack of channels in the information provided by the base, or impossibility to validate the channels provided, the PP is allowed to perform a regular DECT scan and use regular DECT channel selection mechanisms.

9.3.6 Process M2 (collision handling/collision avoidance process)

DECT ULE PPs shall implement the process M2 (PP side collision handling/collision avoidance process) as described in ETSI EN 300 175-3 [3], clause 11.12.7. The input to process M2 shall be either the output of the PP's LIC scan, or the list of quiet channels (i.e. those less than -84 dBm) as indicated by the FP or discovered by the PP.

Implementation at RFP side shall consist in the understanding of the PP response under potential collision conditions.

The following additional provisions shall apply:

- The value of the parameter b in the equation A of ETSI EN 300 175-3 [3], clause 11.12.7.1, shall be as defined in clause A.1.1.1 of the present document.
- All other parameters of the equations are defined by ETSI EN 300 175-3 [3], clause A.2.1.

9.4 Channel selection and collision avoidance procedures for Japan region

9.4.0 General

In addition to clause 9.4, the provisions of ARIB standard STD-T101 [15] shall also apply.

9.4.1 Overall architecture of ULE channel selection processes

DECT ULE devices shall implement the Physical channel selection procedures as described in ETSI EN 300 175-3 [3], clause 11.12. The processes and mechanisms described in ETSI EN 300 175-3 [3], clause 11.12.2 shall be implemented.

9.4.2 Process M0 (RFP side pre-selection process)

DECT ULE RFPs shall implement the process M0 (RFP side pre-selection process) as described in ETSI EN 300 175-3 [3], clause 11.12.3.

Implementation at PP side shall consist in the understanding of the RFP algorithm.

The guidelines given in ETSI EN 300 175-3 [3], clause 11.12.3 shall be followed.

The following additional provisions shall apply:

- The value of m is 3 (m is a system parameter described in ETSI EN 300 175-3 [3], clause 11.12).

NOTE: The purpose of the value m = 3 is to allow the PP time to perform 2 frames of LMS scan in order to detect the presence of PHS systems, in accordance with the requirements for Japan operation (see ARIB STD-T101 [15]).

- In order to compile the list of candidate channels, the RFP shall routinely scan all DECT channels (except those impossible to receive by physical limitations) and compute their RSSI.
- In order to consider a given channel as candidate for setup, both simplex bearers of it shall be measured in at least one frame, and the worst (highest) RSSI value shall be used.

The following additional guidelines are given:

- Due to the need to have the RFP receiver listening for possible setups according to the scan sequence, for single transceiver systems, it is assumed that the scan of the uplink simplex bearer will be done, in practice, listening to the scan sequence frequency.

- The scan of the downlink bearers of the channels may be done with the same criteria (listening according to RFP scan sequence), or with a different cycle (implementation choice).
- The measurement of the RSSI should be done assuming that the slot to be used on the transmission will be a full slot.
- Other mechanisms, such as multi-transceiver RFP are possible.
- As general rule, the unnecessary restriction of the offered channels by reserving fixed slots for other services is not recommended.

A possible implementation of algorithm M0 is provided in ETSI TS 102 939-1 [12], clause C.1.

9.4.3 Broadcast mechanism

DECT ULE RFPs shall implement and DECT ULE PPs shall understand the broadcast mechanism described in ETSI EN 300 175-3 [3], clause 11.12.4.

The following additional provisions shall apply:

- The value of m, the time difference between frame that carries the broadcast and the access frame for which the channel selection information refers, shall be equal to 3. Therefore all channel selection information shall refer to frame N+3.
- The RSSI reference level used in ETSI EN 300 175-3 [3], clause 9.5.1.3.1, Table 9.11 is -92 dBm.
- The procedure defined in clause 10.1.2 of the present document shall apply.

9.4.4 Process M1 (PP side channel selection process)

DECT ULE PPs shall implement the process M1 (PP side channel selection process) as described in ETSI EN 300 175-3 [3], clause 11.12.5.

Implementation at RFP side shall consist in the understanding of the PP setup process.

The following additional provisions shall apply:

- For PPs without power consumption limitations (fast actuators) higher numbers of n may be used.
- It is allowed to receive and decode the content of channel selection information in the dummy bearer in frames N+1, N+2 or N+3, in order to quickly react to the event of repetition of algorithm M1 due to no validation of any candidate channel.
- PP devices without power consumption limitations (fast actuators) may be continuously scanning the dummy bearer channel selection info and continuously performing the RSSI validation in order to be ready for a fast response to an event (paging or PP side event) requiring setup.
- The measurement of the RSSI shall be done taken into account the slot type that will be used in the transmission.
- The procedure defined in clause 10.1.2 of the present document shall apply.

In all cases, the Last Minute Scan (LMS) is still required. The PP cannot transmit on the channel if the relevant access criteria is not met (see ARIB standard STD-T101 [15]).

9.4.5 Setup attempt and evaluation of responses

PPs shall perform the access request and evaluation or responses as defined in ETSI EN 300 175-3 [3], clause 11.12.6.

Implementation at RFP side shall consist in the understanding of the PP response.

The following additional provisions shall apply:

- The differentiation of error responses compatible and not compatible with collision is optional. If this differentiation is not implemented all error cases shall be followed by execution of algorithm M2.
- In case or impossibility of access due to repetitive lack of channels in the information provided by the base, or impossibility to validate the channels provided, the PP is allowed to perform a regular DECT scan and use regular DECT channel selection mechanisms.

9.4.6 Process M2 (collision handling/collision avoidance process)

DECT ULE PPs shall implement the process M2 (PP side collision handling/collision avoidance process) as described in ETSI EN 300 175-3 [3], clause 11.12.7 [3].

Implementation at RFP side shall consist in the understanding of the PP response under potential collision conditions.

The following additional provisions shall apply:

- The value of the parameter b in the equation A of ETSI EN 300 175-3 [3], clause 11.12.7.1, shall be as defined in clause A.1.1.1 of the present document.
- All other parameters of the equations are defined by ETSI EN 300 175-3 [3], clause A.2.1.

10 MAC layer procedures

10.1 Radio Control Bits

10.1.1 Quiet Channel Indication

If the FP's M0 process detects that there are channels with RSSI of less than -84 dBm, then it may do the following:

- set the "RFC1" bit (bit 172) of the dummy bearer's subfield 2 (see ETSI EN 300 175-3 [3], clause 9.5.1.3); and
- use the M_U broadcast to indicate those channels that have RSSI of less than -84 dBm.

If the FP's M0 process does not detect any channels with RSSI of less than -84 dBm, then it shall do the following:

- clear the "RFC1" bit (bit 172) of the dummy bearer's subfield 2 (see ETSI EN 300 175-3 [3], clause 9.5.1.3); and
- use the M_U broadcast normally, according to ETSI EN 300 175-3 [3], clause 11.12.4.

10.1.2 PHS Detection Indication

Systems operating in Japan have specific requirements for detecting and avoiding PHS systems. The procedure for detecting PHS systems is outside the scope of the present document. The specific requirements are described in ARIB standard STD-T101 [15].

In addition to the provisions of STD-T101 [15], the following shall also apply when the FP has detected a PHS system:

- The "RFC2" bit (bit 173) shall be set (see note 1).
- The FP shall use a modified "RFP idle receiver scan sequence" as shown in Table 22. The FP shall use the modified "RFP idle receiver scan sequence" for all connection setup attempts (expedited and non-expedited). See note 2.

NOTE 1: This bit does not replace the "active carrier" P_T message which is specified by the ARIB standard STD-T101 [15].

NOTE 2: This modification allows the FP to perform additional scanning for setup attempts on frames that would otherwise be unavailable when PHS systems are detected due to the normal PSCN cycle.

NOTE 3: The carrier numbering shown in Table 22 is using the standard ETSI carrier numbering (ETSI EN 300 175-2 [2], clause 4.1.1).

Table 22: Modified "RFP idle receiver scan sequence"

Frame	PSCN	RFP idle receiver scan sequence carrier number	Carrier frequency
n	0	12	1 902,528 MHz
n+1	1	1	1 895,616 MHz
n+2	10	12	1 902,528 MHz
n+3	11	1	1 895,616 MHz
n+4	12	12	1 902,528 MHz

If the PP sees that the "RFC2" bit is set then the following shall apply:

- The PP shall understand that a PHS system has been detected by the FP, and it shall act appropriately according to the provisions of STD-T101 [15].
- The PP may utilize the modified "RFP idle receiver scan sequence" as shown in Table 22.

10.2 Downlink broadcast (A-field)

10.2.0 General

The procedure shall be performed as defined in ETSI EN 300 444 (GAP) [9], clause 10.2 and ETSI EN 300 175-3 [3], clause 9.1.1.

10.2.1 N_T messages

The same message defined in ETSI EN 300 444 (GAP) [9], clause 10.2.1 shall be used.

10.2.2 Q_T messages

10.2.2.1 Q_T - static system information

The FT shall be capable of sending and the PT shall be capable of receiving and processing the Q_T static system information message as defined in ETSI EN 300 175-3 [3], clause 7.2.3.2.

The same contents defined in ETSI EN 300 444 (GAP) [9], clause 10.2.3 shall be supported.

10.2.2.2 Q_T - FP capabilities

10.2.2.2.1 Standard FP Capabilities

The FP shall indicate its standard capabilities using the fixed part capabilities Q_T message as described in ETSI EN 300 175-3 [3], clause 7.2.3.4, with contents as defined in Table 23. The PT shall be able to receive and understand this message.

Table 23: Values used within Standard FP capabilities

MAC message	Field within the message	Standard values within the MAC message	Normative action/comment
<< FP capabilities >>	< Q_H >	3	
	< a_{12} >	1	Extended FP info (Q_H = 4)
	< a_{15} >	[0, 1]	Double slot (optional)
	< a_{17} >	1	Full slot (mandatory to support)
	< a_{23} >	1	Basic A-field setup, mandatory
	< a_{24} >	1	Advanced A-field setup, mandatory
	< a_{26} >	[0, 1]	C_F messages, if PT supports only C_S messages it may ignore this value
	<a_{27}>	1	I_N_minimum_delay
	< a_{30} >	1	I_P_error_correction (mandatory to support)
NOTE: For the higher layer capabilities, bits < a_{32} to a_{47} >, see clause 12.2.2.1.1.			

The MAC extended fixed part information message shall be used and, therefore, bit a_{12} of the fixed part information field shall be set to 1.

Higher layer information: The management entity in the FP supplies the MAC layer with a 16-bit SDU via the Management Entity (ME) SAP. The content of that SDU is placed in bits < a_{32}> to < a_{47}> of the Q_T message. At the PT the MAC layer passes the 16 bits out through the ME SAP to the management entity.

For the setting of the higher layer information bits see clause 12.2.2.1.1.

Wireless Relay Stations (WRSs) shall only indicate support for features that are supported both by itself and the RFP to which it is attached. For example, if an RFP supports double slots, but an attached WRS does not, then the WRS will not indicate support of that feature on its own capability broadcast.

10.2.2.2.2 Extended FP Capabilities

The FP shall indicate its extended capabilities using the Extended fixed part capabilities Q_T message as described in ETSI EN 300 175-3 [3], clause 7.2.3.5, with contents as defined in Table 24. The PT shall be able to receive and understand this message.

Table 24: Values used within Extended FP capabilities

MAC message	Field within the message	Standard values within the MAC message	Normative action/comment
<< FP capabilities >>	< Q_H >	4	
	< a_{12} to a_{13} >	All	CRFP hops: See ETSI EN 300 175-3 [3], clause 7.2.3.5.2.1.
	< a_{14} >	[0, 1]	If ULE1-N.23 then bit a_{14} = 1, else bit a_{14} = 0.
	< a_{22} >	1	I_{PQ} services supported.
	< a_{23} >	1	Extended FP capabilities Part 2.
NOTE: For the higher layer capabilities, bits < a_{25} to a_{47} >, see clause 12.2.2.1.2.			

The MAC extended fixed part capability part 2, information message shall be used and, therefore, bit a_{23} of the extended FP capability field shall be set to 1.

Higher layer information: The management entity in the FP supplies the MAC layer with a 23-bit SDU via the Management Entity (ME) SAP. The content of that SDU is placed in bits <a_{25}> to <a_{47}> of the Q_T message. At the PT the MAC layer passes the 24 bits out through the ME SAP to the management entity.

For the setting of the higher layer information bits see clause 12.2.2.1.2.

Wireless Relay Stations (WRSs) shall only indicate support for features that are supported both by itself and the RFP to which it is attached.

10.2.2.2.3 Extended FP Capabilities part 2

The FP shall indicate its extended capabilities using the Extended fixed part capabilities part 2 Q_T message as described in ETSI EN 300 175-3 [3], clause 7.2.3.11, with contents as defined in Table 25. The PT shall be able to receive and understand this message.

Table 25: Values used within Extended FP capabilities part 2

MAC message	Field within the message	Standard values within the MAC message	Normative action/comment
<< FP capabilities >>	< Q_H >	C (hex)	
	< a_{12} >	1	Long slot support (j = 640), mandatory.
	< a_{18} >	[0, 1]	ULE WRS delayed paging support. See ETSI EN 300 175-3 [3], clause 7.2.3.11.2. If a_{18} = 1, then ULE delayed paging mechanism is not allowed. If a_{18} = 0, then ULE delayed paging mechanism is allowed. See clause 10.7.3 of the present document.
NOTE: For the higher layer capabilities, bits < a_{24} to a_{47} >, see clause 12.2.2.1.3.			

Higher layer information: The management entity in the FP supplies the MAC layer with a 24-bit SDU via the Management Entity (ME) SAP. The content of that SDU is placed in bits <a_{24}> to <a_{47}> of the Q_T message. At the PT the MAC layer passes the 24 bits out through the ME SAP to the management entity.

For the setting of the higher layer information bits see clause 12.2.2.1.3.

Wireless Relay Stations (WRSs) shall only indicate support for features that are supported both by itself and the RFP to which it is attached.

10.3 Slot types and slot use

10.3.1 Full Slot

10.3.1.1 General

The D-field mapping for the full slot structure (physical packet P32), as defined by ETSI EN 300 175-3 [3], clause 6.2.1.1.2 shall be supported.

The B-field mapping for the full slot structure (physical packet P32), as defined by ETSI EN 300 175-3 [3], clause 6.2.1.3.1.2 shall be supported.

10.3.1.2 Use of full slot in C/O bearers

Full slot shall be used for C/O bearers, unless another slot type is explicitly requested (e.g. using Advanced Connection control procedures). Additionally, a short slot may also be used in some cases, see clause 10.3.2.2.

10.3.1.3 Use of full slot in C/L dummy bearers

Full slot shall be used in the dummy C/L bearers in all cases.

10.3.2 Short Slot

10.3.2.1 General

The D-field mapping for the short slot structure (physical packet P00), as defined by ETSI EN 300 175-3 [3], clause 6.2.1.1.3 shall be supported in both PT and FT, at least in receiving mode. Use (transmission) of the slot is optional at both sides.

10.3.2.2 Use of short slot in C/O bearers

In order to further save energy, it is allowed to transmit as short slots frames that do not carry any B-field (BA code = no B-field) in certain cases.

The use of short slots is optional at sending side (transmitter choice). However, its understanding by the receiving side is mandatory.

The rules given in ETSI EN 300 175-3 [3], clause 10.5.1.8.9 shall apply in full.

In addition to that, the following additional rule shall apply:

- After using a short slot, it is not allowed to roll back to full slot. Therefore, all subsequent transmissions shall be short slots and no further U-plane data may be sent to the peer over that TBC.

10.3.3 Long Slot

10.3.3.1 General

The D-field mapping for the long slot structure (physical packet P64), as defined by ETSI EN 300 175-3 [3], clause 6.2.1.1.4 shall be supported.

The B-field mapping for the long slot structure (physical packet P64), as defined by ETSI EN 300 175-3 [3], clause 6.2.1.3.1.3 shall be supported.

10.3.3.2 Use of long slot in C/O bearers

The use of long slot for C/O bearers is required for some services (e.g. wibeband voice). It requires the Advanced Connection control procedures, as defined by ETSI EN 300 175-3 [3], clause 10.

10.4 No-emission legacy mode procedures

10.4.1 General

"No-emissions" mode is not directly compatible with ULE Phase 2. This is for a number of reasons, for example:

- The high power consumption required for "NEMo scanning".
- The additional latency required for "NEMo wakeup".
- Features such as "ULE paging", including ConnectionLess Downlink broadcast will not work effectively when the FP is in "no-emissions" mode.

However, a ULE-capable FP can still be used to support NEMo-capable PPs, according to the following requirements:

- The FP shall not start the power-down negotiation if any registered device is incapable of "no-emissions" mode, as indicated by their Terminal Capabilities bits.

NOTE: The above requirement is the same as already described in ETSI EN 300 175-3 [3], clause 9.4.1.1.

- If there are ULE devices registered to the system and all these devices indicate support for "no-emissions" mode the FT shall not enter "no-emissions" mode (ULE1-M.33); instead it shall enter U-NEMo mode (ULE1-M.39).

The base shall indicate to ULE devices if U-NEMo is possible by broadcasting a flag in subfield 1 of the ULE dummy bearer (see ETSI EN 300 175-3 [3], clause 9.5.1.2).

10.5 U-plane C/L downlink services

10.5.0 General

DECT ULE phase 2 supports C/L U-plane downlink transmission by means of the logical channel SI_P and the procedures described in ETSI EN 300 175-3 [3], clause 9.1.4. Only multicast unacknowledged service is supported. Transmission may be done over the ULE dummy bearer or over additional C/L bearers. Multiple instances of the service may be used to address multiple multicast groups.

10.5.1 U-plane C/L downlink multicast unacknowledged service

10.5.1.0 General

This service allows the transmission in unacknowledged mode of U-plane packets addressed to previously configured groups of PT (multicast groups). The service allows the simultaneous sending of messages to multiple devices and is intended for applications that require synchronized actions in multiple PTs.

10.5.1.1 Logical channels and instance separation

Multiple instances of the service may exist. Each instance corresponds to a separate SI_P channel accessible by the DLC by separate SAPs. Separate DLC LU and IWU instances shall also be used towards the application, which may access the service by means of separate SAPs.

The application decides which messages are routed toward C/L downlink multicast SAP, and which are routed towards the C/O SAP, taking into account the limitations of the C/L downlink multicast service, such as the absence or retransmission capability and the absence of an acknowledgement mechanism.

10.5.1.2 Addressing and management of multicast groups

The addressing system is based on the "X" and "Y" identities described in ETSI EN 300 175-3 [3], clause 9.1.4.7 and is entirely managed by the RFP ME. The RFP ME shall decide the composition of the multicast groups, shall keep the list of subscribed PTs, shall allocate the unique global identity of the group (identity "X") and shall allocate local identifiers ("Y" identities) at each PT.

The subscription process to each multicast group is a NWK layer procedure and is described in clause 12.1.2.

10.5.1.3 Procedure

The provisions given in ETSI EN 300 175-3 [3], clause 9.1.4.3 (Announcement via the B_U paging channel), clause 9.1.4.4 (Routing and instance separation), clause 9.1.4.5 (Additional attributes), clause 9.1.4.6 (Encryption), clause 9.1.4.7.2 (C/L downlink multicast service) and clause 9.1.4.7.3 (Identities in C/L downlink multicast service) shall apply.

10.5.1.4 SI_P subfield format

The U-plane packet (SI_P channel) shall use single subfield (SI_{PQ}) format.

10.5.2 U-plane C/L downlink over the dummy bearer

10.5.2.0 General

Downlink multicast U-plane transmission may happen over the same dummy bearer used to carry the ULE B-field dummy channels. In such a case the transmission interrupts the normal transmission of the dummy and causes a waiting cycle impacting most ULE services. In order to restrict the disturbance to normal ULE operation, the insertion is only allowed following a multiplexing schema described in clause 10.5.2.1.

The ULE paging system should take into account the possible use of the dummy for sending C/L traffic according to the multiplexing schema when allocating paging descriptors and paging sequences.

10.5.2.1 Multiplexing cycle

As given by ETSI EN 300 175-3 [3], frames 1, 5, 9 and 13 may be used for C/L downlink traffic insertion over the dummy bearer. This is the maximum multiplexing cycle possible for the insertions. Within this range, the FT ME shall decide the real multiplexing cycle in the system, taken into account the expected multicast traffic needs, the paging traffic and the tolerable impact in other ULE services. Once this policy is set, it shall be consistently used in the system.

Due to the ULE page delay mechanism, a Wireless Relay Station (WRS) may use different frames for the C/L downlink traffic insertion over the dummy bearer (see clause 10.7.3 of the present document).

The multiplexing cycle does not mean that qualified frames have to carry the C/L downlink insertion in all cases. They may carry regular ULE dummy bearer content when there is no C/L downlink traffic to be sent. On the other hand, it guarantees that the other frames will not carry C/L insertions.

NOTE: It is advisable to reuse the same multiplexing cycle, when there is no C/L downlink traffic, to perform other operations that may interrupt normal dummy bearer transmission, i.e. the periodic RSSI scan of the dummy bearer channel by the FT.

10.5.2.2 Single-burst transmission

Only single burst transmission is supported (see ETSI EN 300 175-3 [3], clause 9.1.4.3). Each segment of C/L downlink transmission shall have an individual announcement via the B_U channel.

10.5.2.3 Identification of C/L downlink insertion

Dummy bearer frames carrying an insertion of C/L downlink traffic are identified by means of the BA bits in the A-field hearer. Such frames shall use the "SI_P"coding as indicated in ETSI EN 300 175-3 [3], clause 9.1.4.1.

10.5.2.4 Announcement via the B_U paging channel and identification of instances

All transmissions of the C/L downlink service over dummy bearers shall be announced by the paging channel B_U as indicated by ETSI EN 300 175-3 [3], clause 9.1.4.3. The following additional provisions shall apply:

The announcement shall be done by means of the paging signal coded by the descriptor "announcement of multicast, unacknowledged", described in clause 10.6.2.5.2.5 of the present document.

This paging descriptor defines the frame and multi-frame timing of the possibility of an "announcement frame". The actual "data transmission" shall always occur on the next possible frame after the announcement, taking into account any frame limitations due to the multiplexing cycle (see clause 10.5.2.1).

For example, if the "announcement frame" was frame 1, then the "data transmission frame" shall be frame 5 (i.e. the next possible frame due to the multiplexing restrictions).

NOTE: The "data transmission frame" is always after the "announcement frame".

Based on previous possibilities, it is allowed to repeat the transmission of the announcement as a protection measure (i.e. redundancy of the announcement).

The paging signal transmitted by the announcement determines the multicast instance that the C/L packet should be routed to.

The announcement shall not be enough to route the B-field received at the expected dummy towards the SI_P channel instance: the BA bits shall also carry the proper BA code.

10.5.3 U-plane C/L downlink over additional C/L bearers

10.5.3.0 General

The Downlink multicast U-plane transmission may happen over additional C/L bearers different from the dummy(ies). In such a case, there is no interruption in the normal transmission of the dummy and no impact in ULE operation.

If this procedure is supported by both peers, the RFP may decide to setup at any time an additional C/L bearer for sending the C/L downlink traffic.

10.5.3.1 Channel selection and transmission start

The RFP shall follow the channel selection rules for the additional C/L bearer as given in ETSI EN 300 175-3 [3], clause 11.4.3 and clause 9.1.1.2).

The RFP may insert the C/L U-plane data directly in the initial setup bearer or wait until a subsequent one (see clause 10.5.3.2).

10.5.3.2 MAC signalling in the additional C/L downlink bearer

The signalling of the additional C/L downlink bearer shall be as described in ETSI EN 300 175-3 [3], clause 9.1.4.2.1 with the following specific provisions:

- Only single-burst transmissions are supported (see clause 10.5.3.3). However, it is allowed to setup the bearer and not send the C/L data in the very first frame(s). In such a case the MAC control message "expedited_access_request" shall be used in the first frame and "expedited_release" in the one carrying the data.
- It is also allowed to send U-plane data in the very first frame. In such a case the MAC control message "expedited_access_request_ready_for_release" shall be used.
- TA and BA coding shall be as described in ETSI EN 300 175-3 [3], clause 9.1.4.2.1.
- BA coding "no B-field" may be used for frames not containing data. However, in this case the B-field shall be transmitted and filled with the DLC filling pattern.
- For the MAC control messages (i.e. "expedited_access_request", "expedited_release" or "expedited_access_request_ready_for_release") the value of the PMID shall be coded as shown in Figure 3.

1 1 1 1	**X**
a_{28} a_{31}	a_{32} a_{47}
NOTE: The "X" field is the system-wide identifier of the multicast channel "X", with the least significant bit situated at bit a_{47}. The unused most significant bits shall be set to '0'.	

Figure 3: Coding for PMID field in MAC control messages

10.5.3.3 Single-burst transmission

From multicast channel perspective, only single burst transmission is supported (see ETSI EN 300 175-3 [3], clause 9.1.4.3). Each segment of C/L downlink transmission shall have an individual announcement via the B_U channel.

However, it is allowed to chain several segments (each one with its own announcement) over the same C/L bearer:

- To do that, the paging mechanism (paging sequences) should be designed accordingly (sequences with repetition rate = 1).
- MAC signalling over the C/L channel shall assume continuity: only the first bearer needs to carry the expedited setup MAC message and the TA code (M_T first transmission).
- It is allowed to route the packets sent in consecutive frames to different multicast contexts.

10.5.3.4 Announcement via the B_U paging channel and identification of instances

All transmissions of the C/L downlink service over additional C/L bearers shall be announced by the paging channel B_U as indicated by ETSI EN 300 175-3 [3], clause 9.1.4.3. The following additional provisions shall apply:

The announcement shall be done by means of the paging signal coded by the descriptor "announcement of multicast, unacknowledged", described in clause 10.6.2.5.2.5 of the present document.

This paging descriptor defines the frame and multi-frame timing of the possibility of an "announcement frame". The actual "data transmission" shall always occur on the next frame after the announcement, even if relative slot positions of the dummy bearer and additional C/L bearer might have allowed the same frame to be used.

NOTE: The "data transmission frame" is always after the "announcement frame", i.e. an announcement sent over B_U in frame N indicates a transmission of the C/L U-plane packet in frame N+1.

The same frame that carries the announcement shall carry the C/L bearer position coded in either index X4 or X10 (therefore at least some of the fields should be in index format).

The provisions of clause 10.6.2.5.4 shall apply regarding the coding of the C/L bearer position.

10.5.4 Repetition of U-plane C/L downlink

This procedure describes a mechanism for repeating C/L downlink U-plane data for the C/L multicast unacknowledged service, which can provide additional robustness to the system, for example in case a PP misses the initial broadcast due to unforeseen circumstances or interference.

When submitting an SDU for transmission over the C/L downlink service, the application may specify that the SDU should be repeated, and how many repetitions are required.

The U-plane data is initially transmitted as normal, i.e. an announcement frame followed by a data transmission either on a dummy bearer or an additional C/L bearer.

However, if repetitions have been specified, then the FP shall retain the U-plane data (for the duration of the re-transmissions), and shall automatically schedule a re-transmission of this data according to the usual timing specified by the particular C/L Downlink service's paging descriptor. The following rules shall apply:

- All re-transmissions of the U-plane data shall follow the normal procedures for C/L downlink multi-cast. i.e. an announcement frame followed by a data transmission either on a dummy bearer or an additional C/L bearer.
- The re-transmitted U-plane data shall have identical content to the originally transmitted U-plane data.
- The FP shall re-transmit the U-plane data for the number of times specified by the application.
- In the event that the application submits an SDU for transmission, for a particular C/L Downlink service for which the MAC layer is still in the process of re-transmitting a previous SDU, then the new SDU takes precedence. The previous SDU shall be discarded, even if there were still some number or repetitions remaining.

NOTE 1: On the PP side, there is no special action required at the MAC layer, and all packets (whether they be the original packet or a re-transmission) are received in the same way.

NOTE 2: The PP DLC can recognize a repeated packet due to it having the same "send sequence number" as a previously received packet, and this will normally be discarded by the DLC (i.e. not passed to the higher layers).

10.6 ULE Paging Procedures (phase 2)

10.6.0 General

Clause 10.6 refers to ULE specific paging capability using B-Field channels over the ULE dummy bearer. Refer to ETSI TS 102 939-1 [12], clause 10.4 for LCE paging using A-field tail.

10.6.1 P_U Paging Message Formats

The provisions of ETSI TS 102 939-1 [12], clause 10.6.1 shall apply.

10.6.2 Paging Descriptors for ULE Paging

10.6.2.1 Basic concepts of the ULE paging system

The concepts defined in ETSI TS 102 939-1 [12], clause 10.6.2.1 shall apply plus the following:

Paging ID: A numeric value that combined with a sequence defines a paging signal. Paging IDs are 9-bit numeric values (between 0 and 511). All values may be transmitted using the index format. Values between 0 and 87 may also been transmitted in bitmap format. There are some restrictions for coding the Paging IDs due to the ULE Dummy Bearer format (see ETSI EN 300 175-3 [3], clause 9.5.1.2 and clause 9.5.1.4).

Master type descriptor: A "master type" descriptor is a descriptor which defines a sequence. I.e. it contains information about repetition rate and offset.

Compound sequence: The sequence obtained by combination of more than one "master type" descriptors with different sequence information.

Slave type descriptor: A "slave type" descriptor is a descriptor which does not contain sequence information (repetition rate and offset) but reuses the sequence given by the "master type" descriptors.

NOTE: The only descriptor defined in ETSI TS 102 939-1 [12] is a "master type descriptor".

10.6.2.2 Basic operation of the descriptors

The provisions of ETSI TS 102 939-1 [12], clause 10.6.2.2 shall apply with the following differences.

The maximum number of master type descriptors that shall be supported by all FT and PT implementations is TWO. Support of higher number of descriptors is optional.

In addition to the master type descriptors, the following "slave type" descriptors shall be supported:

- One instance of "Setup voice call full slot" descriptor if the feature ULE1-A.4 (hybrid device voice call) is supported.
- One instance of "Setup voice call long slot" descriptor if the feature ULE1-A.4 (hybrid device voice call) and feature NG1.2, NG1.3 or NG1.5 (G.711 [i.3], G.722 [i.4] or MPEG-4 ER AAC-LD super-wideband [i.6] voice call) is supported.
- One instance of "Setup SUOTA call" descriptor if the feature ULE1-A.6 (SUOTA) is supported.
- One instance of "announcement of multicast, unacknowledged" descriptor · if the service ULE1.M.28 (U-plane C/L downlink multicast service multicast) is supported.

NOTE: If a PT is assigned to multiple multicast groups, more than one descriptor is needed.

10.6.2.3 Allocation of descriptors

The provisions of ETSI TS 102 939-1 [12], clause 10.6.2.3 shall apply.

10.6.2.4 Format for descriptors in ULE phase 1

10.6.2.4.0 General

Clause 10.6.2.4 describes the formats for the descriptors used in the present document.

The following formats are used in the present document:

- "Format A" that is the same format defined in ETSI TS 102 939-1 [12].
- "Format B" is a new format for slave type descriptors used to carry additional commands such as "setup voice call full slot", "setup voice call long slot" and "setup SUOTA call".

- "Format C" is a new format for slave type descriptors used to carry the announcements of multicast transmissions.

10.6.2.4.1 Master/slave types

In order to simplify the design of the descriptors and the handling of sequences the concept of master and slave descriptors is introduced as follows:

- A "master type" descriptor is a descriptor which defines a sequence, i.e. it contains information about repetition rate and offset.
- Several "master type" descriptors may be combined to synthesize a more complex compound sequence.

NOTE: See ETSI TS 102 939-1 [12], clause C.2.1 for examples of compound sequences.

A "slave type" descriptor is a descriptor which does not contain sequence information (repetition rate and offset) but reuses the sequence given by the "master type" descriptors.

The list of descriptors in use by any PT should include at least one "master type" descriptor.

If there are several "master type" descriptors, the "compound sequence" created by all of them is the sequence to be used by the "slave type" descriptors.

In the present document, the "ULE resume" descriptor is the only master type and at least one instance of this descriptor shall be used by any PT supporting paging.

10.6.2.4.2 CA subscription capability

Refer to ETSI TS 102 939-1 [12], clause 10.6.3 for a description of the CA mechanism.

Since a single descriptor has the capability to subscribe a PT to any combination of CA groups (to one, to several or to none), it is not necessary to include the CA subscription capability in all descriptors.

Only the "ULE resume" master type descriptor has the capability to transmit CA subscription information. All new "slave type" descriptors introduced by the present document do not carry CA subscription information. Such descriptors are considered neutral regarding the CA mechanism.

NOTE: The bits used for CA subscription in the "ULE resume" descriptor are used to extend the range of codes for "descriptor type and command" in the new descriptors.

10.6.2.4.3 Format A

"Format A" is the same format used in ULE phase 1.

The structure and the description of fields for the "format A", as used in the present document, are as shown in Figure 4.

Bit:	8	7	6	5	4	3	2	1	Octet:
	<< ULE-MAC-CONFIGURATION-INFO >>								1
	Length of Contents (L)								2
	1	Coding standard		Control					3

Descriptor format A

	Descriptor type and command			CA	k
	Spare (0)	Relax-ed paging	Paging ID (2 M.S.bits)	Repetition	k+1
	0 spare	Start MFN4			k+2
	Start MFN			Start FCNT	k+3
	0/1	Paging ID (7 L.S.bits)			k+4

Figure 4: Descriptor "format A"

The meaning of the different fields and the allowable values in "format A" are described in Table 26.

Table 26: Descriptor fields in descriptor "format A"

Value	Description	Range
Descriptor type and command	Defines the descriptor type and action. See clause 10.6.2.5 for allowed values and actions	
CA	These 4 bits control the subscription to the groups of the CA mechanism (see ETSI TS 102 939-1 [12], clause 10.6.3) Bit 4 subscribes the PT to CA group 4 and bit 1 to CA group 1. A PP may be subscribed to one, more than one, or may not be subscribed to any CA group. Subscription to more than one CA groups is commanded by setting several CA bits to "1" in the descriptor. See ETSI TS 102 939-1 [12], clause 10.6.3.1 and clause 10.6.3.2	[0-1] x 4
Spare	Spare bit (shall be set to '0'B)	
Relaxed Paging	Defines the significance of the paging signal (0: Normal, 1: Relaxed). Relaxed Paging is intended for ULE devices that can enter U-NEMo mode. Not receiving a paging signal defined by a Relaxed Paging descriptor is normal behaviour, because the ULE base might not have setup the ULE dummy bearer for that paging signal	[0-1]
Paging ID (2 M.S.bits)	The 2 most significant bits of the Paging ID	0 to 511
Start_MFN	Multi-Frame Number of the starting point of the paging sequence	0 to 2 047
Start_FCNT	Frame number of the starting point of the paging sequence	0 to 15
Repetition	Repetition rate (interval in frames between two windows for transmission of the paging signal in the sequence)	2^0 to 2^{15}
Paging ID (7 L.S.bits)	The 7 less significant bits of the Paging ID. The paging signal defined by the descriptor is given by the paging ID combined with the paging sequence 9 bits are used in ULE phase 1 with a theoretical range of 0 to 511. However, value 511 is reserved and shall not be used. Values 0 to 87 can be addressed when using the bit-map scheme, and values 0 to 510 can be addressed when using the index scheme	0 to 511

10.6.2.4.4 Format B

"Format B" is used for slave type descriptors carrying the commands "setup voice call full slot", "setup voice call long slot" and "setup SUOTA call". This format uses two octets per descriptor and does not carry CA subscription information.

The structure and the description of fields for the "format B", as used in the present document, are as shown in Figure 5.

Bit:	8	7	6	5	4	3	2	1	Octet:
	<< ULE-MAC-CONFIGURATION-INFO >>								1
	Length of Contents (L)								2
	1	Coding standard		Control					3

Descriptor format B

	Descriptor type and command	Paging ID (9th bit)	k
	Paging ID (8 L.S. bits)		k+1

Figure 5: Descriptor "format B"

The meaning of the different fields and the allowable values in "format B" are described in Table 27.

Table 27: Descriptor fields in descriptor "format B"

Value	Description	Range
Descriptor type and command (7 bits)	Defines the descriptor type and action. See clause 10.6.2.5 for allowed values and actions	
Spare	Spare bits (shall be set to '0')	
Paging ID (9th bit)	The most significant bit of the Paging ID	0 to 511
Paging ID (8 L.S.bits)	The 8 less significant bits of the Paging ID. The paging signal defined by the descriptor is given by the paging ID combined with the paging sequence. 9 bits are used in ULE phase 1 with a theoretical range of 0 to 511. However, value 511 is reserved and shall not be used. Values 0 to 87 can be addressed when using the bit-map scheme, and values 0 to 510 can be addressed when using the index scheme	0 to 511

10.6.2.4.5 Format C

"Format C" is used for slave type descriptors related to the C/L downlink multicast service. This format uses four octets per descriptor and does not carry CA subscription information.

The structure and the description of fields for the "format C", as used in the present document, are as shown in Figure 6.

Bit:	8	7	6	5	4	3	2	1	Octet:
	<< ULE-MAC-CONFIGURATION-INFO >>								1
	Length of Contents (L)								2
	1	Coding standard		Control					3

Descriptor format C

	Descriptor type and command	Paging ID (9^{th} bit)	k
	Multicast channel local identity (number "Y")	Multicast channel identity (number "X") 4 M.S.B.	k+1
	Multicast channel identity (number "X") 8 L.S.B."		k+2
	Paging ID (8 L.S. bits)		k+3

Figure 6: Descriptor "format C"

The meaning of the different fields and the allowable values in "format C" are described in Table 28.

Table 28: Descriptor fields in descriptor "format C"

Value	Description	Range
Descriptor type and command	Defines the descriptor type and action. See clause 10.6.2.5 for allowed values and actions	
Spare	Spare bits (shall be set to '0')	
Paging ID (9th bit)	The most significant bit of the Paging ID	0 to 511
Multicast channel local identity (number "Y")	The Multicast channel local identity (number "Y"). (see ETSI EN 300 175-3 [3], clause 9.1.4.7 for description of the addressing in multicast channels)	0 to 15
Multicast channel identity (number "X") 4 M.S.B.	The 4 most significant bits of the Multicast channel global identity (number "X"). (see ETSI EN 300 175-3 [3], clause 9.1.4.7 for description of the addressing in multicast channels)	0 to 1 023
Multicast channel identity (number "X") 8 L.S.B.	The 8 less significant bits of the Multicast channel global identity (number "X"). (see ETSI EN 300 175-3 [3], clause 9.1.4.7 for description of the addressing in multicast channels)	0 to 1 023
Paging ID (8 L.S.bits)	The 8 less significant bits of the Paging ID. The paging signal defined by the descriptor is given by the paging ID combined with the paging sequence. 9 bits are used in ULE phase 1 with a theoretical range of 0 to 511. However, value 511 is reserved and shall not be used. Values 0 to 87 can be addressed when using the bit-map scheme, and values 0 to 510 can be addressed when using the index scheme	0 to 511

10.6.2.5 Descriptors in ULE phase 2

10.6.2.5.1 Descriptor codes

The following descriptors shall be supported:

Channel Descriptor Type and command (octet k):

Bits 8 7 6 5 4 3 2 1	**Meaning**	**Format**	**type**
0 0 1 0 x x x x	ULE resume paging	"format A"	master
1 0 0 0 0 0 0 x	Setup voice call full slot	"format B"	slave
1 0 0 0 0 0 1 x	Setup voice call long slot	"format B"	slave
1 0 0 0 0 1 0 x	Setup SUOTA call	"format B"	slave
1 0 0 1 0 1 0 x	"announcement of multicast, unacknowledged"	"format C"	slave

10.6.2.5.2 Descriptor detailed descriptions

10.6.2.5.2.0 General

See conventions and definitions in clause 10.6.2.1 of the present document and in clause 10.6.2.1 of ETSI TS 102 939-1 [12].

10.6.2.5.2.1 ULE resume paging descriptor

The same detailed description given in ETSI TS 102 939-1 [12], clause 10.6.2.5.2.1 shall apply. This descriptor is "master type" and carries CA subscription information.

10.6.2.5.2.2 Setup voice call full slot

- Code = 1 0 0 0 0 0 0 x (the octet does not carry CA subscription information). Bit 1 is used for the 9th bit of paging ID).
- Paging format = format B (see clause 10.6.2.4.4), 2 bytes.
- Positive action = Setup a voice call, full slot: identical response to the reception of a LCE paging over A-field.
- Default and explicit negative actions = no action. This descriptor does not code any specific negative action. Explicit and default negative actions are only commanded by the possible transmission or not transmission of "ULE resume" descriptor in the same frame.

- Paging reception mode = no specific information. Paging reception mode shall be as set by the master type descriptor

10.6.2.5.2.3 Setup voice call long slot

- Code = 1 0 0 0 0 0 1 x (the octet does not carry CA subscription information). Bit 1 is used for the 9th bit of paging ID).
- Paging format = format B (see clause 10.6.2.4.4), 2 bytes.
- Positive action = Setup a voice call, long slot: identical response to the reception of a LCE paging over A-field.
- Default and explicit negative actions = no action. This descriptor does not code any specific negative action. Explicit and default negative actions are only commanded by the possible transmission or not transmission of "ULE resume" descriptor in the same frame.
- Paging reception mode = no specific information. Paging reception mode shall be as set by the master type descriptor.

10.6.2.5.2.4 Setup SUOTA call

- Code = 1 0 0 0 0 1 0 x (the octet does not carry CA subscription information). Bit 1 is used for the 9th bit of paging ID).
- Paging format = format B (see clause 10.6.2.4.4), 2 bytes.
- Positive action = Setup a SUOTA call, full slot: identical response to the reception of a LCE paging over A-field (DPRS setup command).
- Default and explicit negative actions = no action. This descriptor does not code any specific negative action. Explicit and default negative actions are only commanded by the possible transmission or not transmission of "ULE resume" descriptor in the same frame.
- Paging reception mode = no specific information. Paging reception mode shall be as set by the master type descriptor.

10.6.2.5.2.5 Announcement of multicast, unacknowledged"

- Code = 1 0 0 1 0 1 0 x (the octet does not carry CA subscription information). Bit 1 is used for the 9th bit of paging ID).
- Paging format = format C (see clause 10.6.2.4.5), 4 bytes.
- Action at reception of << ULE-MAC-CONFIGURATION-INFO >>: The FT subscribes the PT to the multicast group "X" and allocates a local identity "Y".
- Positive action (at reception of the paging signal) = announces the transmission of a multicast packet (single-burst). This transmission may be either over the dummy or over or over an additional C/L bearer. The discrimination between one and the other case is described in clause 10.6.2.5.5.
- Default and explicit negative actions = no action. This descriptor does not code any specific negative action. Explicit and default negative actions are only commanded by the possible transmission or not transmission of "ULE resume" descriptor in the same frame.
- Paging reception mode = no specific information. Paging reception mode shall be as set by the master type descriptor.

10.6.2.5.3 Additional conventions for ULE phase 2 descriptors

10.6.2.5.3.1 Coding of bit 8 in octet k+4 of format A descriptors

The following rule only applies to type A descriptors (master type descriptors):

- The bit 8 of last octet (k+4) shall be set to '0' for all type A descriptors present in an IE except for the last one. The bit shall be set to '1' for the last type A descriptor. If there is only 1 type A descriptor in the IE, the bit shall be set to '1'.
- The code '1' shall be used for bit 8 of last octet (k+4) of the last type A descriptor irrespective of the presence or not of slave descriptors after this one.

NOTE 1: This rule ensures back-compatibility with Phase 1. See ETSI TS 102 939-1 [12], clause 10.6.2.5.3.1.

The rule does not apply to type B and C descriptors.

NOTE 2: Bit 8 in slave type descriptors is used for the 8^{th} bit of the paging ID.

10.6.2.5.3.2 Order of descriptors in NWK layer messages

Descriptors may be transmitted in the << ULE-MAC-CONFIGURATION-INFO >> IE in any order with the same result. It is also possible to append additional descriptors at any time with the "append descriptor" control command in octet 3 of the IE. The "compound sequence" to be used by all slave descriptors is given by the combined sequence of all "master type" descriptors irrespective of their position in the IE or the time of their transmission.

10.6.2.5.4 Coding of additional C/L bearer position

10.6.2.5.4.0 General

When the signal for "announcement of multicast over additional C/L bearer, unacknowledged" is transmitted, the position of the additional C/L bearer shall be sent in the same bearer of the channel P_U that carries the signal, coded in either index 4 or index 10. The coding will also use the first spare bit following the index and shall be as described in clause 10.6.2.5.4.1 and clause 10.6.2.5.4.2.

10.6.2.5.4.1 Coding in index X4

The coding for index X4 is defined in Table 29.

Table 29: Coding of C/L bearer position in index X4

	Index X4		**pdb**	**pdc**
bitcount	133 to 138	139 to 142		143
content	C/L Downlink Bearer carrier number (6 bits)	C/L Downlink Bearer slot number (4 bits)		'1'
pdb = profile defined bit = bit 142 pdc = profile defined control bit = bit 143				

10.6.2.5.4.2 Coding in index X10

The coding for index X10 is defined in Table 30.

Table 30: Coding of C/L bearer position in index X10

	Index X10		**pdb**	**pdc**
bitcount	293 to 298	299 to 302		303
content	C/L Downlink Bearer carrier number (6 bits)	C/L Downlink Bearer slot number (4 bits)		'1'
pdb = profile defined bit = bit 302 pdc = profile defined control bit = bit 303				

10.6.2.5.5 Discrimination between multicast transmissions over the dummy and over additional C/L bearers

Since the paging signal "announcement of multicast" is common, the discrimination between transmissions over the dummy and over additional C/L bearers is done as follows:

1) If the Paging signal is transmitted in bitmap format, it means that the transmission will be over the dummy

2) If the Paging signal is transmitted in index format over subfield 1, then bit 143 determines if the transmission will be over the dummy or over an additional C/L bearer:

   a) bit b143 set to '0' indicates transmission over the dummy;

   b) bit b143 set to '1' indicates transmission over an additional C/L bearer, whose position is given by index X4+bit 142.

3) If the Paging signal is transmitted in index format over subfield 3, then bit 303 determines if the transmission will be over the dummy or over an additional C/L bearer:

   a) bit b303 set to '0' indicates transmission over the dummy;

   b) bit b303 set to '1' indicates transmission over an additional C/L bearer, whose position is given by index X10+bit 302.

4) If the "announcement of multicast" paging signal is transmitted in both subfields, both signals shall code the same command and, when applicable, the same C/L bearer position. In cases of inconsistency, the receiver shall obey the signal in subfield 1.

10.6.2.5.6 Time references for multicast transmissions

10.6.2.5.6.1 Time reference for transmissions over the dummy

The time reference for transmissions over the dummy is the next possible occurrence according to the multiplexing cycle (see clause 10.5.2.1).

10.6.2.5.6.2 Time reference for the additional C/L bearer position

The time reference for the additional C/L bearer position is the next frame boundary. Therefore, the C/L packet shall be transmitted in the frame following the one that carries the announcement message in the B_U channel.

10.6.3 CA mask mechanism

The provisions of ETSI TS 102 939-1 [12], clause 10.6.3 shall apply.

10.7 Repeater compatibility procedures

10.7.1 General

The range of DECT is very good compared to most other low power wireless systems. However, there are occasions when the range needs to be extended. This is normally achieved by the use of a repeater (more correctly referred to as a Wireless Relay Station). The existing DECT Wireless Relay Station standard (ETSI EN 300 700 [17]) specifies requirements for a regular DECT repeater.

NOTE 1: At the time of writing, there is no equivalent standard specifying the requirements for ULE repeaters. Additional work is required to specify the requirements for a ULE repeater. This might be included as part of ETSI EN 300 700 [17], as part of a future ULE standard, or as a separate standard.

NOTE 2: Furthermore, the existing repeater standard (ETSI EN 300 700 [17]) does not cover all the security requirements for NG-DECT and GAP, e.g. re-keying, early encryption, etc. Therefore, additional work may be required to update the existing repeater standard (ETSI EN 300 700 [17]).

NOTE 3: The present document is primarily concerned with requirements for the FP and the PP, and not with the repeater itself.

The following assumptions about a ULE repeater are made:

- A ULE repeater is slot, frame and PSCN synchronized to the base.
- A ULE repeater is a CRFP (see ETSI EN 300 700 [17]).
- A ULE repeater is a "MAC relay".

10.7.2 Identification of a WRS

The WRS Hop Number (HN) field of the ULE dummy bearer's Subfield 1 indicates the hop distance of a WRS from the "real base" (see ETSI EN 300 175-3 [3], clause 9.5.1.2).

An RFP that is not a WRS (i.e. the "real base") shall always indicate a hop distance of 0. A WRS will indicate a hop distance other than 0, specifically it shall indicate either 1, 2 or 3 depending on cascade depth of the WRS configuration (see ETSI EN 300 175-3 [3], clause 9.5.1.2).

A PP can determine if the RFP that it is attached to is a WRS or the "real base" by examining the Hop Number field.

10.7.3 ULE page delay mechanism

In general, a repeater is not always able to re-transmit information in the same frame that it was received. For example, suppose the repeater's dummy bearer is on slot 2, and the "real base" has its dummy bearer on slot 6 (i.e. after the repeater's), then this repeater could only re-transmit the information in the next frame.

This would present a serious problem for ULE paging, since it uses specific frame numbers on which to receive paging signals. In order to overcome this problem, a repeater has the ability to delay the ULE paging channel information. This enables the repeater to receive the information before it has to transmit it on its own dummy bearer, regardless of the dummy bearer slot positions.

The FP can allow or not allow this ULE page delay mechanism by the use of the "ULE WRS delayed paging support" field (bit a18) of the Extended Fixed Part Capabilities (Part 2) Q_T message (see ETSI EN 300 175-3 [3], clause 7.2.3.11.2). For example, the FP may decide to not allow ULE delayed paging, if there are older ULE Phase 1 devices attached to it via a repeater.

If the ULE page delay mechanism is allowed, then a repeater shall always delay the received paging channel information (B_U and ConnectionLess Downlink service) by 1 frame, regardless of dummy bearer slot position. Repeaters can be cascaded (i.e. chained together), in which case the total page delay compared to the "real base", depends on the cascade depth of the repeater configuration.

NOTE 1: Information broadcast on the regular A-field P_T paging channel is not affected by the ULE page delay mechanism.

The WRS Hop Number (HN) field in the ULE dummy bearer Subfield 1 indicates the hop distance of a repeater from the "real base" from which the "page delay" can be directly obtained (see ETSI EN 300 175-3 [3], clause 9.5.1.2).

A PP shall use the indicated "page delay" to adjust its reception of the paging signal(s), as shown in the following examples:

EXAMPLE 1: If a PP is scheduled to check for paging signals on frame 4 of every 8th multiframe, but the current RFP is broadcasting a "page delay" field value of "01"B (1 frame delay), then the PP will expect the paging signal on frame 5 of every 8th multi-frame instead, i.e. 1 frame later than normal.

EXAMPLE 2: If a PP is scheduled to check for paging signals on frame 14 of every 4th multiframe, but the current RFP is broadcasting a "page delay" field value of "10"B (2 frames delay), then the PP will expect the paging signal on frame 0 of every 5th multi-frame instead, i.e. 2 frames later than normal.

It is left to the PP implementation whether it wakes up at the normal time or the delay-adjusted time. For example, static ULE PPs such as smoke detectors may take advantage of the fact that they are always attached to the same RFP, and therefore always have constant page delay. On the other hand, mobile ULE devices might change between RFPs regularly, and so it is better to wake up at the normal time, and then stay awake an extra frame (or few frames) if it is required.

The ULE page delay mechanism also applies in exactly the same way for the ConnectionLess Downlink service. However, the following additional point also applies:

- The ConnectionLess Downlink service over the dummy bearer uses a multiplex cycle, whereby frames 1, 5, 9 and 13 may be used for the bearer insertion (see clause 10.5.2.1 of the present document). These frames relate to the transmission by the "real base". In the case of re-transmission using the page delay mechanism, other frames may be used. Specifically, in the case of 1 frame delay, frames 2, 6, 10 and 14 may be used; in the case of 2 frames delay, frames 3, 7, 11, 15 may be used; and in the case of 3 frames delay, frames 0, 4, 8 and 12 may be used.

NOTE 2: The ConnectionLess Downlink service is ciphered using the CCM algorithm. This ciphering scheme does not rely on the DECT frame/multiframe number, and so there is no impact due to the additional delay.

10.7.4 Roaming

10.7.4.1 General

Regular DECT PPs can roam between cells of a multi-cell system. The positions of these RFPs (i.e. the slot and carrier of their dummy bearer or other bearers) are normally found by scanning, either as part of regular background scanning or by a dedicated RFP scan. Roaming is achieved simply by switching the position used for receiving the downlink broadcast from one RFP to another RFP. The decision of when to move, and which RFP to move to, is normally based on RSSI level, although it could also take into account other factors such as available slots, "RFP busy", etc. When the DECT handset has an active traffic bearer, an inter-cell handover also usually takes place.

For ULE PPs, the concept of roaming is slightly different:

- A ULE PP can spend a lot of its time in sleep mode, during which time it is not scanning for RFPs. Usually, it is oblivious to the fact that it has been moved, until it wakes up some time later, e.g. the device went to sleep located near "RFP 1", and when it awakes it is located near "RFP 2".

- The RSSI fading conditions that cause a regular DECT handset to require handover to a new cell occur in the time-scale of seconds or tens of seconds. Whereas, a typical ULE communication cycle (i.e. wakeup, send/receive some data, go to sleep) is often only a few frames or tens of frames. Therefore, the fading condition that affect regular handsets might not even be noticeable by a ULE PP.

- ULE PPs are power-sensitive, and performing unnecessary scanning for RFPs should be avoided if possible.

- Many ULE PPs are static, or semi-static, e.g. smoke alarms, door sensors, etc. These devices are not mobile, and "roaming" never occurs, or only very rarely (e.g. when a smoke sensor is reinstalled in a different room).

10.7.4.2 Regular DECT roaming

There are some scenarios where a ULE PP may require regular DECT roaming. For example, when a "circuit mode" connection is active or is required (e.g. for voice calls, ULE service calls, registration procedures, SUOTA, etc.).

Details of the RFP scanning algorithm, deciding when to move, deciding where to move to, etc. are left to the PP implementation.

When inter-cell handover is required, the PP shall use either bearer handover (see ETSI TS 102 939-1 [12], clause 10.9.4) or connection handover (see ETSI TS 102 939-1 [12], clause 10.9.5).

10.7.4.3 ULE roaming

A ULE PP can spend a lot of its time in sleep mode, during which time it is not scanning for RFPs. Usually, it is oblivious to the fact that it has been moved, until it wakes up some time later, e.g. the device went to sleep located near RFP1, and when it awakes it is located near RFP2.

In general, assuming that the device went to sleep attached to "RFP X", the following possibilities could happen:

- When it wakes it can still find "RFP X", and no other RFPs (of the same system) are found. The PP shall stay locked to "RFP X".
- When it wakes it can still find "RFP X", additionally one or more other RFPs (of the same system) are also found. The PP shall either stay locked to "RFP X", or it shall lock to one of the other RFPs. The decision about which one to lock to is left to the PP implementation.
- When it wakes it cannot find "RFP X"; however, one or more other RFPs (of the same system) can be found. The PP shall lock to one of the other RFPs. The decision about which one to lock to is left to the PP implementation.

Since ULE PPs are very power-sensitive, it is not expected to perform regular background scans for suitable RFPs whilst it is awake.

NOTE 1: It is recommended, that scanning for RFPs is only performed if there is an obvious degradation in signal quality. Alternatively, a ULE PP may not scan at all when it is awake, and the decision to lock to a different RFP is only made when it next wakes from sleep mode, as described above.

If it is required to move to a different RFP whilst performing "packet mode" communication, then the inter-cell bearer replacement procedure shall be used (see clause 10.7.4.4 of the present document).

NOTE 2: Due to the short-burst nature of "packet mode" communication, it is generally more efficient to wait for the current communication to finish, and then to select a new RFP when the PP next comes out of sleep mode.

10.7.4.4 ULE bearer replacement (inter-cell)

The PP shall be able to perform inter-cell bearer replacement, by setting up new TBCs within the same logical connection. The following rules apply:

- The bearer replacement shall be always implemented by dropping the existing bearer before establishing the new one.
- There should not be more than one ULE bearer over the air at any time.
- Inter-cell bearer replacement shall only be performed at SDU boundaries.

NOTE: This procedure only applies to ULE packet mode connections.

The quality criteria that cause an inter-cell bearer replacement are left to the implementer.

Prior to performing inter-cell bearer replacement, the PP shall have knowledge of a suitable RFP to move to, and shall have collected sufficient information from the new RFP's dummy bearer in order to establish the new bearer. The exact sequence of events relating to finding a suitable RFP, collection information from the RFP's dummy bearer, etc. is left to the implementer.

10.8 Additional requirements for I channel services

10.8.1 Lifetime management with TWO separate maximum MAC packet lifetimes

10.8.1.0 General

The FT and PT shall operate with TWO separate maximum MAC packet lifetimes, differentiating the maximum lifetime at the bearer (at TBC level) and the maximum lifetime at the MAC layer, as described in ETSI EN 300 175-3 [3], clause 10.8.2.2.1.2 and clause 10.8.2.2.1.3.

The detailed provisions given in ETSI EN 300 175-3 [3], clause 10.8.2.2.1.3 shall apply.

The operation of the counters shall be as described in clause 10.8.1.1 of the present document.

The following specific provisions apply:

- If it is required to change the maximum packet lifetime value at the MAC layer then the NWK layer IE << TRANSIT-DELAY >> shall be used. This IE shall be sent using the Service Change "other" procedure, as described in ETSI TS 102 939-1 [12], clause 12.1.3.3.
- If it is required to change the maximum packet lifetime value at the TBC then the MAC control message "ATTRIBUTES_T" shall be used, as described in ETSI TS 102 939-1 [12], clause 10.7.4.2.3.
- When the maximum TBC lifetime expires, in addition to stopping further re-transmissions over the same TBC, the bearer shall be released and (if allowed by the overall packet lifetime) a new bearer shall be established (bearer replacement) where further re-transmissions may happen. The process of setting up the new TBC (bearer replacement) may start before the expiration of the TBC lifetime.

10.8.1.1 Operation of the counters

The overall MAC packet lifetime counter shall be started for the packet with the defined maximum value when it is delivered to the MAC layer for transmission and shall be decreased with absolute TDMA frames (every 10 ms), irrespective of if there is an active TBC or not. In other words, it shall count during suspension times or during idle periods of time due to execution of channel selection or back off algorithms.

Nevertheless, in applications with ultra-slow paging cycles, such as DECT ULE, it is allowed not to take in consideration the delay due the paging mechanism.

The TBC packet lifetime counter starts to count with the first transmission over the TBC. Thereafter, the TBC packet lifetime counter is decreased with absolute TDMA frames (every 10 ms) for each retransmission by the TBC except under the following circumstances:

- When the PP is attached to a repeater and the retransmission was as a result of the peer requesting the same packet again by use of the BCK mechanism (see ETSI EN 300 175-3 [3], clause 10.8.2.4), in which case the PP's TBC packet lifetime counter is not decremented. See note 2.
- When the FP is configured for use with repeaters and the retransmission was as a result of the peer requesting the same packet again by use of the BCK mechanism (see ETSI EN 300 175-3 [3], clause 10.8.2.4), in which case the FP's TBC packet lifetime counter is not decremented. See note 3.

NOTE 1: The time limit defined by overall MAC layer counter is still applies, even in the case that the TBC packet lifetime was not decremented.

NOTE 2: A PP can determine if it is attached to a repeater as described by clause 10.7.2 of the present document.

NOTE 3: An FP has to be configured in order to use repeaters (e.g. to use correct RPN for multi-cell systems), so it inherently knows when repeaters can be present.

10.9 U-NEMo mode procedures

10.9.1 General

U-NEMo mode allows ULE and no-emission mode (NEMo) to operate together. It allows the dummy bearer transmissions to be suspended for NEMo operation without a major impact on ULE operation. U-NEMo mode can be used when all handsets support NEMo and when all ULE devices support U-NEMo.

U-NEMo is only possible if all the handsets support NEMo mode and all the ULE devices support U-NEMo mode. The possibility for U-NEMo can change within a live system as handsets and devices are added or removed. The base shall indicate to ULE devices if U-NEMo is possible by broadcasting a flag in subfield 1 of the ULE dummy bearer (see ETSI EN 300 175-3 [3], clause 9.5.1.2).

10.9.2 Entering U-NEMo mode

The FT shall control entry to U-NEMo mode.

Before entering U-NEMo mode the FP shall have communicated the preferred carrier to the ULE devices. The U-NEMo preferred carrier is the same carrier as the NEMo preferred carrier; however, since ULE devices do not normally follow the NEMo countdown another method of communicating the carrier needs to be used. The U-NEMo preferred carrier shall be communicated to the ULE device using the ULE-MAC-CONFIGURATION-INFO information element (see clause 12.6.1). It is assumed that this shall be done during the registration of the ULE device.

Entry to U-NEMo mode happens in two steps: the system enters NEMo mode (ETSI EN 300 175-3 [3], clause 9.4); however, at the end of this part of the process the dummy bearer is not removed; it becomes an ID free dummy bearer (ETSI EN 300 175-3 [3], clause 9.6.5.3). The system can remain in this state for an indeterminate period of time, until all ULE activity has ceased. Then the system can enter U-NEMo mode by removing the ID free ULE dummy bearer. In order that the ULE devices can tell the difference between entering U-NEMo mode and losing the dummy bearer the FT shall broadcast a short countdown when it is preparing to remove the ID free dummy bearer (ETSI EN 300 175-3 [3], clause 9.5.1.3), the dummy shall be removed at the end of the countdown. Once the countdown has started it shall not be possible to interrupt this process.

The FT shall maintain the dummy bearer for at least 50 frames after raising it. This will allow additional ULE transactions which may result from the initial request to be performed more efficiently.

If a ULE transaction has ended with the release reason 'come back in N' being sent the FT shall retain the dummy bearer for at least N+50 frames.

10.9.3 Behaviour during U-NEMo mode

The behaviour of the FT and the PTs attached to it (not the ULE devices) shall be as described in ETSI EN 300 175-3 [3], clause 9.4.2 with additions as described in ETSI EN 300 175-3 [3], clause 9.6.3.

There are no additional requirements for the ULE devices beyond those described in ETSI EN 300 175-3 [3], clause 9.5.

10.9.4 ULE device initiated interaction

10.9.4.1 ULE device requests that the base raise a ULE dummy bearer

Figure 7 and the subsequent text illustrates how this shall occur.

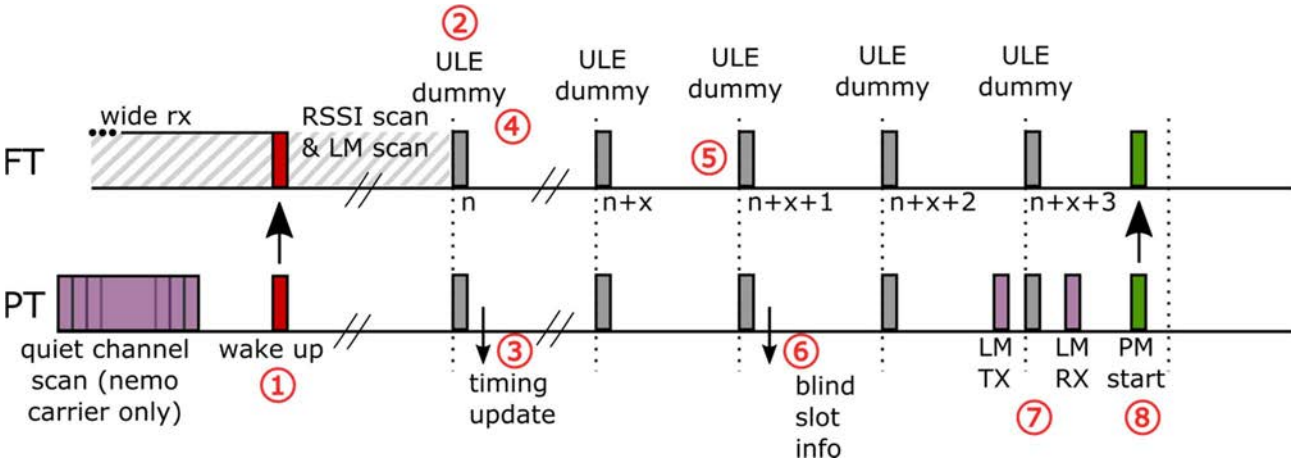

Figure 7

1) The ULE device shall scan for a quiet slot pair and then shall send a wake up request to the FT. The wake up request shall be as described in ETSI EN 300 175-3 [3], clause 9.6.4.

2) The FT shall perform an RSSI scan and a Last Minute scan and establish a dummy bearer. This shall either be an ID free ULE dummy bearer or a NEMo++ dummy bearer (see ETSI EN 300 175-3 [3], clause 9.6.5).

3) The ULE device shall lock to the dummy bearer using the information broadcast in the ULE dummy B-field and it shall adjust its timing to match the FT timing. The ULE dummy B-field indicates if this is a ULE dummy bearer or a NEMo++ dummy bearer using a flag in subfield 1 of the ULE dummy B-field (see ETSI EN 300 175-3 [3], clause 9.5.1.2). The timing adjustment is different for the two types of dummy. The dummy bearer carries a count of the number of frames until a valid blind slot map will be available (see ETSI EN 300 175-3 [3], clause 9.6.5.2) and the ULE device shall consider all slots to be blind until a blind slot map has been received. The ULE device may use this count to optimize its power consumption.

4) The FT begins scanning in order to generate a blind slot map. The scanning will take x frames where x is dependent on the number of carriers available in the system. As scanning progresses the count of the number of frames until a valid blind slot map will decrease and this number shall be given in the dummy bearer broadcast (see ETSI EN 300 175-3 [3], clause 9.6.5.2).

5) The FT has completed its scanning and shall broadcast a blind slot map.

The remaining steps are normal ULE operation, reference should be made to ETSI TS 102 939-1 [12] for detailed information:

1) The ULE device receives a blind slot map. It shall pick a slot pair and prepare for a last minute scan.

2) The last minute scans occur.

3) The access request message is sent to start the packet mode transfer.

If the ULE device is unable to achieve fast sync with the base it shall assume that the request to establish a bearer has failed. The ULE device may retry by sending the requests again but the decision to do this is considered as application dependent and is beyond the scope of the present document.

If the FT does not see a packet mode transfer within a certain time of raising a dummy bearer it shall return to U-NEMo mode (see clause 10.9.2). The specific length of time for this is left to the implementation but in any case shall always be greater than 50 frames.

If the FT is broadcasting an ID free ULE dummy bearer (the handsets remain in NEMo mode) the ULE packet transfer messages shall not carry N_T messages from the FT to the ULE device as the presence of N_T data may unintentionally wake NEMo handsets. They shall be referred to as Identity Free, this is the same term used to describe the ULE dummy bearer used when the NEMo handsets are to remain in NEMo (see ETSI EN 300 175-3 [3], clause 9.6.5.3). The messages used to replace the N_T are left as an implementation decision, it is suggested that a M_T Null value could be used. Whatever the message chosen a valid A-field shall be sent.

10.9.4.2 ULE device initiated interaction when a dummy exists

If a dummy bearer is already present when a ULE device wakes and sends a request to raise a dummy bearer the FT shall ignore the request, in fact it will not actually see the requests since it shall no longer be scanning for setup messages. However, the setup will proceed as described in clause 10.9.4.1 starting at step 3 since a dummy bearer exists.

10.9.5 FT initiated interaction

10.9.5.1 Interaction with ULE devices only

If the FP wishes to interact with ULE devices without waking handsets from NEMo mode it shall raise an ID free ULE dummy bearer. The procedure to raise the dummy shall be as described in ETSI EN 300 175-3 [3], clause 9.6.6.1 with the additional requirement that the FP shall use the NEMo preferred carrier for this dummy bearer.

The FT begins scanning in order to generate a blind slot map. The scanning will take x frames where x is dependent on the number of carriers available in the system. As scanning progresses the count of the number of frames until a valid blind slot map will decrease and this number shall be given in the dummy bearer broadcast (see ETSI EN 300 175-3 [3], clause 9.6.5.2).

The FT has completed its scanning and shall broadcast a blind slot map.

The FT can now page ULE devices as per normal ULE operation or wait for the ULE device to make contact.

The FT will raise the dummy bearer a minimum of 8 frames before paging.

10.9.5.2 Interaction with ULE devices which also wakes NEMo handsets

If the FP wishes to interact with ULE devices and also wake handsets from NEMo mode it shall raise a NEMo++ dummy bearer. The procedure to raise the dummy shall be as described in ETSI EN 300 175-3 [3], clause 9.6.6.2.

The FT begins scanning in order to generate a blind slot map. The scanning will take x frames where x is dependent on the number of carriers available in the system. As scanning progresses the count of the number of frames until a valid blind slot map will decrease and this number shall be given in the dummy bearer broadcast (see ETSI EN 300 175-3 [3], clause 9.6.5.2).

The FT has completed its scanning and shall broadcast a blind slot map.

The FT can now page ULE devices as per normal ULE operation or wait for the ULE device to make contact. The FT will raise the dummy bearer a minimum of 8 frames before paging.

The NEMo handsets can be considered as awake once the NEMo++ dummy bearer has changed to a ULE dummy bearer (see ETSI EN 300 175-3 [3], clause 9.6.5.4).

10.9.6 NEMo handset initiated interaction

When a NEMo handset initiates an interaction the base shall raise the NEMo++ dummy bearer. This allows for ULE interactions in the period during which the system is waking from U-NEMo mode. The procedure to raise the bearer shall be as described in ETSI EN 300 175-3 [3], clause 9.6.5.4.

10.9.7 Leaving U-NEMo mode

The FP can leave U-NEMo mode but remain in NEMo mode, this would allow the base to page ULE devices without interacting with the NEMo handsets. To do this the FP shall raise an ID free ULE dummy bearer as described in ETSI EN 300 175-3 [3], clause 9.6.5.3.

The FP can leave U-NEMo mode and NEMo mode. To do this the FP shall raise a NEMo++ dummy bearer as described in ETSI EN 300 175-3 [3], clause 9.6.5.4.

10.9.8 U-NEMo and ULE paging

10.9.8.1 General

ULE paging procedures are not affected by U-NEMo except in the case where no devices are to be paged on a paging cycle (see clause 10.9.8.3). When it is required to page a device the FT shall raise the ID free ULE dummy bearer and the ULE device will be able to lock onto it and follow normal ULE paging procedures. Once paging is complete, and assuming that all the other conditions are met, the FT shall return to U-NEMo mode.

The base shall raise the dummy bearer at least 8 frames before the paging message in order to allow devices time to lock.

10.9.8.2 Multicast paging

If multicast paging is required when a NEMo++ dummy bearer is being broadcast operation shall be as per clause 10.5.2 with the paging data replacing the ULE B-field in the second part of the long slot B-field.

If multicast paging data is due to be sent in a frame that would be the first full slot ULE dummy broadcast after transitioning from a NEMo++ dummy bearer to a full slot ULE bearer the transition shall be delayed to allow the paging data to be sent in a NEMo++ broadcast. If the multicast paging data is due to be sent on a frame after the first full slot ULE dummy broadcast the transition can occur as normal.

10.9.8.3 Relaxed paging

When an ULE device has been programmed with one or more paging descriptors it expects to be able to see paging information whether or not it is actually being paged. 'Relaxed paging' will allow U-NEMo operation to be maintained when no devices are being actively paged.

The Format A paging descriptor (see clause 10.6.2.4.3) will indicate if a paging channel is normal or relaxed.

For a relaxed paging channel the dummy bearer in the ULE base shall only be raised if there is real paging data to be sent; i.e. at least one device is being paged.

A ULE device waiting for a "Relaxed Page" and not finding an ULE dummy bearer shall report this as a "No page while in U-NEMo mode" event to the application and not as a lock failure.

A ULE device waiting for a normal page and not finding a ULE dummy bearer shall report the lock failure to the application.

The Relaxed Paging is seen as the exceptional case to keep backward compatibility to the current U-NEMo standardization.

11 DLC layer procedures

11.1 Specific procedures for C/L downlink multicast channels

11.1.1 Procedures for C/L downlink multicast channels

11.1.1.1 LU14 Enhanced Frame RELay service with CCM (EFREL-CCM) for C/L downlink multicast channels

The provisions given in ETSI EN 300 175-4 [4], clause 11.16.3.2 "Use over C/L downlink channels: multicast mode" shall apply.

Unacknowledged transmission shall be used.

A single uni-directional link shall be used for each instance of the service.

There may be multiple instances of the service in a system (in general representing different groups of PTs) and a single PT may be subscribed to several instances.

CCM encryption of the multicast link shall be used. The cryptographic procedures given in ETSI EN 300 175-7 [7], clause 6.6.2.7 shall be used for the CCM encryption of multicast channels.

The same provisions regarding SDU sizes applicable to the C/O LU service shall apply for C/L service.

All DLC parameters used by the C/O service are inherited by the C/L service.

- The case of having PTs with different settings in the C/O service subscribed to the same multicast group is not covered by the present document.

11.1.1.2 LU13 Enhanced Frame RELay service with CRC (EFREL-CRC) for C/L downlink multicast channels

11.1.1.2.0 General

The provisions given in ETSI EN 300 175-4 [4], clause 11.15.3.2 "Use over C/L downlink channels: multicast mode" shall apply.

Unacknowledged transmission shall be used.

A single uni-directional link shall be used for each instance of the service.

There may be multiple instances of the service in a system (in general representing different groups of PTs) and a single PT may be subscribed to several instances.

The same provisions regarding SDU sizes applicable to the C/O LU service shall apply for C/L service.

All DLC parameters used by the C/O service are inherited by the C/L service:

- The case of having PTs with different settings in the C/O service subscribed to the same multicast group is not covered by the present document.

11.1.1.2.1 Use of LU13 in multicast links

Since LU13 is not the primary LU in ULE (that is LU14) and is an optional DLC service, LU13 can only be used in a multicast link if all the PT subscribed to such multicast group supports and are using LU13 for the C/O service.

NOTE: This is expected to happen only in special markets.

11.1.1.3 LU10 Enhanced Frame RELay service (EFREL) for C/L downlink multicast channels

The provisions given in ETSI EN 300 175-4 [4], clause 11.15.3.2 "Use over C/L downlink channels: multicast mode" shall apply.

Unacknowledged transmission shall be used.

A single uni-directional link shall be used for each instance of the service.

There may be multiple instances of the service in a system (in general representing different groups of PTs) and a single PT may be subscribed to several instances.

The same provisions regarding SDU sizes applicable to the C/O LU service shall apply for C/L service.

All DLC parameters used by the C/O service are inherited by the C/L service.

- The case of having PTs with different settings in the C/O service subscribed to the same multicast group is not covered by the present document.

11.1.1.4 FU10a frame operation for C/L downlink multicast channels

The following provisions shall apply:

As single uni-directional link using frame type FU10a shall be used for each instance of the service.

Segment size shall be as given in ETSI EN 300 175-4 [4], Table 12.11.1.1, taken into account the subfield format of the MAC service (see clause 10.5.1.4).

11.1.1.5 Transmission Class 1 over C/L downlink multicast channels

The provisions of ETSI EN 300 175-4 [4], clause 14.2.3.2.1.1 "Class 1 over C/L downlink channels: unacknowledged mode" shall apply.

11.1.2 Security procedures for C/L downlink multicast channels

11.1.2.1 CCM Authenticated Encryption of C/L downlink multicast channels

The provisions of ETSI EN 300 175-7 [7], clause 6.6.2.7 shall apply with the following specific provisions:

- Support of multiple instances of multicast channels for a given PT is optional. Only number "Y" = '0' needs to be supported (see ETSI EN 300 175-7 [7], clause 6.6.2.7.1). Support of other values of number "Y" is optional.

11.1.2.2 Initialization Vector for multicast channels

The Initialization Vector described in ETSI EN 300 175-7 [7], clause 6.6.2.7.6 shall be used.

11.1.2.3 Security provisions regarding the key for multicast channels

The following requirements shall apply:

- The FT shall change the key at least one time for a complete round of the CCM sequence numbers.

NOTE 1: It should be noted that for many applications this timer may be irrelevant (it may take years).

- The key shall not be reused for different multicast channels.
- When the PT requests the KEY, by means of the PT initiated procedure, the FT shall authenticate it, by means of an interleaved PT authentication procedure, before sending the {MM-INFO-SUGGEST} containing the key.

NOTE 2: The previous authentication may also be used, but not necessarily, for changing the primary key for CCM or for MAC encryption.

12 NWK layer procedures

12.1 Specific procedures for C/L downlink multicast channels

12.1.1 Security procedures for C/L downlink multicast channels

12.1.1.1 Cipher keys for CCM encryption of C/L multicast channels

The provisions of ETSI EN 300 175-7 [7], clause 6.2.3.2 and clause 6.6.2.7.7 shall apply.

12.1.1.2 Multicast encryption parameter assignation procedure, FT initiated

12.1.1.2.0 General

This will be the normal assignation procedure when the FT subscribes a PT to a multicast channel.

This procedure will typically be executed immediately following the subscription of a PT to a multicast channel. It will be part of a Service Call and shall be executed immediately after the CC Service change that allocates the <<ULE MAC CONFIGURATION>> including the descriptors for the multicast channel.

The procedure allows setting both, the <<KEY>> and the CCM sequence number for the multicast encryption. It is allowed, at RFP choice, to set both parameters in the same procedure or in two executions of the procedure. Both cases should be supported by all PT implementations.

12.1.1.2.1 Procedure description

The provisions of ETSI EN 300 175-7 [7], clause 6.3.8.2 shall apply.

Only multicast instance #0 is mandatory. Support of additional multicast instances other than #0 is optional.

12.1.1.2.2 Security provision

In order to preserve the security of the process, the procedure shall be always executed over encrypted links.

12.1.1.2.3 Coding of the operation messages

This operation is coded as follows:

- Initiating message {MM-INFO-SUGGEST}

- Possible replies:
  - Normal case: {MM-INFO-ACCEPT}
  - Error case {MM-INFO-REJECT}

The message {MM-INFO-SUGGEST} shall be coded as shown in Table 31.

Table 31: Coding of the message {MM-INFO-SUGGEST}

Information element	Field within the information element	Standard values within the field/information element	Normative action/comment
Protocol Discriminator		'0101'B	Mobility Management
Transaction Identifier	Flag	'0'B	The transaction is assumed to be FT originated
	Transaction value	'000'B	'0' only
<<INFO-TYPE>>			Mandatory
	< Parameter type >	'0110101'B	Cipher Key for CCM encryption of multicast channels (see note 1)
		'0110110'B	CCM Sequence number for CCM encryption of multicast channels (see note 1)
		'0111001'B	Multicast channel instance #1 (see note 2)
		'0111010'B	Multicast channel instance #2 (see note 2)
		'0111011'B	Multicast channel instance #3 (see note 2)
		'0111100'B	Multicast channel instance #4 (see note 2)
		'0111101'B	Multicast channel instance #5 (see note 2)
		'0111110'B	Multicast channel instance #6 (see note 2)
		'0111111'B	Multicast channel instance #7 (see note 2)
<<KEY>>			(see note 1)
	<Key type coding> (octet 3):	'10010010'B	'Cipher Key for CCM encryption of multicast channels'
	< Key data field >	all	The cipher key itself (128 bits)
<<RS>>			(see note 1)
	< RS Field >	all	The CCM sequence number (48 bits)
NOTE 1: At least one of them shall be included. NOTE 2: Optional to support. Multicast channel instance #0 shall not be coded.			

The message {MM-INFO-ACCEPT} shall be coded as shown in Table 32.

Table 32: Coding of the message {MM-INFO-ACCEPT}

Information element	Field within the information element	Standard values within the field/information element	Normative action/comment
Protocol Discriminator		'0101'B	Mobility Management
Transaction Identifier	Flag	'1'B	The transaction is assumed to be FT originated
	Transaction value	'000'B	'0' only
<<INFO-TYPE>>			Mandatory
	< Parameter type >	'0110101'B	Cipher Key for CCM encryption of multicast channels (see note 1)
		'0110110'B	CCM Sequence number for CCM encryption of multicast channels (see note 1)
		'0111001'B	Multicast channel instance #1 (see note 2)
		'0111010'B	Multicast channel instance #2 (see note 2)
		'0111011'B	Multicast channel instance #3 (see note 2)
		'0111100'B	Multicast channel instance #4 (see note 2)
		'0111101'B	Multicast channel instance #5 (see note 2)
		'0111110'B	Multicast channel instance #6 (see note 2)
		'0111111'B	Multicast channel instance #7 (see note 2)
NOTE 1: At least one of them shall be included. NOTE 2: Optional to support. Multicast channel instance #0 shall not be coded.			

The message {MM-INFO-REJECT} shall be coded as shown in Table 33.

Table 33: Coding of the message {MM-INFO-REJECT}

Information element	Field within the information element	Standard values within the field/information element	Normative action/comment
Protocol Discriminator		'0101'B	Mobility Management
Transaction Identifier	Flag	'1'B	The transaction is assumed to be FT originated
	Transaction value	'000'B	'0' only
<<INFO-TYPE>>			Mandatory
	< Parameter type >	'0110101'B	Cipher Key for CCM encryption of multicast channels (see note 1)
		'0110110'B	CCM Sequence number for CCM encryption of multicast channels (see note 1)
		'0111001'B	Multicast channel instance #1 (see note 2)
		'0111010'B	Multicast channel instance #2 (see note 2)
		'0111011'B	Multicast channel instance #3 (see note 2)
		'0111100'B	Multicast channel instance #4 (see note 2)
		'0111101'B	Multicast channel instance #5 (see note 2)
		'0111110'B	Multicast channel instance #6 (see note 2)
		'0111111'B	Multicast channel instance #7 (see note 2)
NOTE 1: At least one of them shall be included. NOTE 2: Optional to support. Multicast channel instance #0 shall not be coded.			

12.1.1.3 Multicast encryption parameter retrieval procedure, PT initiated

12.1.1.3.0 General

This is the exceptional procedure used by the PT when it "misses" either the Key or the CCM sequence.

It allows the PT to request either, the <<KEY>> or the CCM sequence number or both.

12.1.1.3.1 Procedure description

The provisions of ETSI EN 300 175-7 [7], clause 6.3.8.3 shall apply.

Only multicast instance #0 is mandatory. Support of additional multicast instances other than #0 is optional.

12.1.1.3.2 Security provisions

In order to preserve the security of the process, the procedure shall be always executed over encrypted links.

If the PT requests the ciphering key, then the FT shall execute a PT authentication procedure between request and response.

If the PT requests only the CCM sequence number, then the FT may (at its choice) execute a PT authentication procedure between request and response or not. The PT shall be ready to support this PT authentication execution.

It the PT authentication procedure is executed, then the FT may decide at its choice to use the procedure for:

1) updating the CCM ciphering for C/O channels;

2) updating the MAC ciphering key; or

3) not updating any key.

12.1.1.3.3 Coding of the operation messages

This operation is coded as follows:

- Initiating message {MM-INFO-REQUEST}
- Possible replies:
  - Normal case: {MM-INFO-SUGGEST}
  - Error case {MM-INFO-REJECT}

The message {MM-INFO-REQUEST} shall be coded as shown in Table 34.

Table 34: Coding of the message {MM-INFO-REQUEST}

Information element	Field within the information element	Standard values within the field/information element	Normative action/comment
Protocol Discriminator		'0101'B	Mobility Management
Transaction Identifier	Flag	'0'B	The transaction is assumed to be PT originated
	Transaction value	'000'B	'0' only
<<INFO-TYPE>>			Mandatory
	< Parameter type >	'0110101'B	Cipher Key for CCM encryption of multicast channels (see note 1)
		'0110110'B	CCM Sequence number for CCM encryption of multicast channels (see note 1)
		'0111001'B	Multicast channel instance #1 (see note 2)
		'0111010'B	Multicast channel instance #2 (see note 2)
		'0111011'B	Multicast channel instance #3 (see note 2)
		'0111100'B	Multicast channel instance #4 (see note 2)
		'0111101'B	Multicast channel instance #5 (see note 2)
		'0111110'B	Multicast channel instance #6 (see note 2)
		'0111111'B	Multicast channel instance #7 (see note 2)
NOTE 1: At least one of them shall be included. NOTE 2: Optional to support. Multicast channel instance #0 shall not be coded.			

The message {MM-INFO-SUGGEST} shall be coded as shown in Table 35.

Table 35: Coding of the message {MM-INFO-SUGGEST}

Information element	Field within the information element	Standard values within the field/information element	Normative action/comment
Protocol Discriminator		'0101'B	Mobility Management
Transaction Identifier	Flag	'1'B	The transaction is assumed to be PT originated
	Transaction value	'000'B	'0' only
<<INFO-TYPE>>			Mandatory
	< Parameter type >	'0110101'B	Cipher Key for CCM encryption of multicast channels (see note 1)
		'0110110'B	CCM Sequence number for CCM encryption of multicast channels (see note 1)
		'0111001'B	Multicast channel instance #1 (see note 2)
		'0111010'B	Multicast channel instance #2 (see note 2)
		'0111011'B	Multicast channel instance #3 (see note 2)
		'0111100'B	Multicast channel instance #4 (see note 2)
		'0111101'B	Multicast channel instance #5 (see note 2)
		'0111110'B	Multicast channel instance #6 (see note 2)
		'0111111'B	Multicast channel instance #7 (see note 2)
<<KEY>>			(see note 1)
	<Key type coding> (octet 3):	'10010010'B	'Cipher Key for CCM encryption of multicast channels'
	< Key data field >	All	The cipher key itself (128 bits)
<<RS>>			(see note 1)
	< RS Field >	All	The CCM sequence number (48 bits)
NOTE 1: At least one of them shall be included. NOTE 2: Optional to support. Multicast channel instance #0 shall not be coded.			

The message {MM-INFO-REJECT} shall be coded as shown in Table 36.

Table 36: Coding of the message {MM-INFO-REJECT}

Information element	Field within the information element	Standard values within the field/information element	Normative action/comment
Protocol Discriminator		'0101'B	Mobility Management
Transaction Identifier	Flag	'1'B	The transaction is assumed to be PT originated
	Transaction value	'000'B	'0' only
<<INFO-TYPE>>			Mandatory
	< Parameter type >	'0110101'B	Cipher Key for CCM encryption of multicast channels (see note 1)
		'0110110'B	CCM Sequence number for CCM encryption of multicast channels (see note 1)
		'0111001'B	Multicast channel instance #1 (see note 2)
		'0111010'B	Multicast channel instance #2 (see note 2)
		'0111011'B	Multicast channel instance #3 (see note 2)
		'0111100'B	Multicast channel instance #4 (see note 2)

Information element	Field within the information element	Standard values within the field/information element	Normative action/comment
		'0111101'B	Multicast channel instance #5 (see note 2)
		'0111110'B	Multicast channel instance #6 (see note 2)
		'0111111'B	Multicast channel instance #7 (see note 2)
NOTE 1: At least one of them shall be included. NOTE 2: Optional to support. Multicast channel instance #0 shall not be coded.			

12.1.2 Control procedures for C/L downlink multicast channels

12.1.2.1 Subscription to C/L downlink multicast channels

The subscription to C/L downlink multicast channels is under control of the FT who should know at any time the list of available C/L downlink multicast channel instances, the destination PTs of each, and the identities allocated to each instance and PT.

Refer to ETSI EN 300 175-3 [3], clause 9.1.4.7 for the description of the addressing system in ULE multicast channels.

The FT may subscribe a PT to any multicast group at any time. The subscription process at NWK layer consists on the sending of the IE << ULE-MAC-CONFIGURATION-INFO >> containing any of the descriptors related to the multicast service. This operation may be performed by any {CC-SERVICE-CHANGE} operation with capability to transport the IE << ULE-MAC-CONFIGURATION-INFO >> and can be done in any state of the C/O VC (suspend/resumed).

The descriptors related to the multicast service are the "announcement of multicast" defined in clause 10.6.2.5.2. They use the descriptor "format C" and carry the multicast identities "X" and "Y".

When a PT receives a multicast descriptor, it is automatically subscribed to the multicast group "X" indicated in the descriptor and receives the local identity "Y". The PT shall then observe the occurrence in the paging channel P_U of the paging ID given in the descriptor (combined with the sequence given by the master type descriptors) and, when happens, shall receive the C/L downlink U-plane packet according to the instructions given by the descriptor.

12.1.2.2 Activation of security procedures

If the multicast transmission is CCM encrypted (service LU14), then the security procedure "Multicast encryption parameter assignation procedure, FT initiated" (clause 12.1.1.2) shall follow the subscription process. U–plane packets can only be successfully received by the subscribed PT after the completion of the security procedure.

12.1.2.3 Un-subscription to C/L downlink multicast channels

The un-subscription to C/L downlink multicast channels can only be performed by means of {CC-SERVICE-CHANGE} operations sending the << ULE-MAC-CONFIGURATION-INFO >> IE with the command "replace all descriptors", and a new descriptor content not including the undesired subscription.

12.1.2.4 Parameters for the C/L downlink multicast service

There is no specific parameter negotiation for the C/L downlink multicast service. The C/L service shall inherit the parameters used by the C/O service when applicable:

- The case of having subscribed to the same multicast group PTs that may have different incompatible settings in the C/O service is not covered by the present document.

12.2 Terminal capabilities and FP broadcasts

12.2.1 Terminal capability indication

The PP shall be able to send the <<Terminal capability>> information element and the FP shall be able to receive it at least in {ACCESS-RIGHTS-REQUEST} and when location registration is supported in the {LOCATE-REQUEST}. The following text together with the associated clauses define the mandatory requirements with regard to the present document.

Terminal capability indication shall be done as defined in ETSI EN 300 444 [9] (GAP), clause 8.17 with the following content (shown in Table 37) in the <<Terminal capability>> information element.

Table 37: Values used within the <<TERMINAL CAPABILITY>> information element

Information element	Field within the information element	Standard values within the field/information element	Normative action/comment
<<Terminal capability>>	<Slot type capability>	'xxx1xXx'B X = [0,1]	Full slot supported. Long slot (j = 640) supported if NG1.2, NG1.3 or NG1.5 supported. All others are optional
	<Profile indicator_1>	'xxxxxXx'B X = [0,1]	GAP and/or PAP supported or not supported (see note 1)
	<Profile indicator_4>	'xxxXxxx'B X = [0,1]	Support or not support of C_F channel (see note 1)
	<Profile indicator_4>	'xx1xxxx'B	I_{PQ} services supported
	<Profile indicator_5>	'xxxxxx1'B	2-level modulation scheme supported (B+Z field)
	<Profile indicator_5>	'xx1xxxx'B	2-level modulation scheme supported (A field)
	<Profile indicator_6>	'xXxxxx'B X = [0,1]	PT with fast hopping radio or not (see note 1)
	<Profile indicator_6>	'0xxxxx'B	"No-emissions" mode is not supported
	<Profile indicator_7>	'xxXxxxx'B X = [0,1]	Support or no support of "Re-keying" and "default cipher key early encryption mechanism" (see notes 1 and 2)
	<Profile indicator_7>	'xxxxxXx'B X = [0,1]	Support or no support of NG-DECT Part 1: Wideband voice supported (ETSI TS 102 527-1 [11] and note 1)
	<Profile indicator_7>	'xxxxXXx'B X = [0x,11]	Support or no support of NG-DECT Part 3: Extended wideband voice supported (ETSI TS 102 527-3 [10] and note 1)
	<Profile indicator_9>	'xxXXXxx'B XXX = [101], note 4	Support for DECT ULE phase 2. See notes 3, 4, 5 and 6
	DSAA2 (Octet 5)	[0,1]	Support (or not support) of the DSAA2 (see ETSI EN 300 175-7 [7] and notes 1 and 2)
	DSC2 (Octet 5)	[0,1]	Support (or not support) of the DSC2 (see ETSI EN 300 175-7 [7] and note 1)

NOTE 1: This bit is only set if the corresponding capability is supported.
NOTE 2: This capability is assumed as the default value (see Table 38) if the <<TERMINAL-CAPABILITY>> information element is omitted.
NOTE 3: Bits 3 to 5 of 'Profile indicator_9' indicate the supported ULE version; 001 indicates ULE Phase 1 (V1.1.1); 011 indicates ULE Phase 1 (V1.2.1 or later), 101 indicates support of phase 2 and 111 is reserved for indicating support of Phase 3.
NOTE 4: PPs compliant with the present documents will always set '101'B (support of ULE Phase 2). However, FPs shall understand all codes.
NOTE 5: Phase 3 PPs are assumed to be back compatible with the present document. When observing this code, the FP shall assume that the PP will behave as a Phase 2 PP.
NOTE 6: Phase 1 V1.1.1 PPs and Phase 1 V1.2.1 or later PPs have some limitations compared to Phase 2 PPs. The FP should be able to understand and handle properly such limitations.

The capabilities shown in Table 38 shall be assumed as default if the following fields in the <<TERMINAL CAPABILITY>> information element are not present.

Table 38: Values assumed as terminal capabilities

Information element	Field within the information element	Standard values within the field/information element	Normative action/comment
<<Terminal capability>>	<Slot type capability>	'xxx1xxx'B	Full slot supported
	<Profile indicator_1>	'xxxxx0x'B	GAP and/or PAP not supported
	<Profile indicator_4>	'xxx0xxx'B	No support of C_F channel
	<Profile indicator_6>	'x0xxxx'B	PT without fast hopping radio
	<Profile indicator_6>	'0xxxxx'B	"No-emissions" mode is not supported
	<Profile indicator_7>	'xx0xxxx'B	No support of "Re-keying" and "default cipher key early encryption mechanism"
	<Profile indicator_7>	'xxxxx0x'B	No support of NG-DECT Part 1: Wideband voice (ETSI TS 102 527-1 [11])
	<Profile indicator_7>	'xxxx00x'B	No support of NG-DECT Part 3: Extended Wideband voice (ETSI TS 102 527-3 [10])
	DSAA2 (Octet 5)	0	No support of the DSAA2 (see ETSI EN 300 175-7 [7])
	DSC2 (Octet 5)	0	No support of the DSC2 (see ETSI EN 300 175-7 [7])

12.2.2 FP broadcasts

12.2.2.1 Higher layer information FP broadcast

12.2.2.1.0 General

The FP and PT shall support the broadcast of Higher Layer capabilities as part of Q_T MAC broadcast messages (see clause 10.2.2.2).

The broadcast attributes are a small set of NWK layer and DLC layer capabilities (jointly known as "higher layer capabilities") that shall be broadcast regularly as part of the MAC layer broadcast service. See ETSI EN 300 175-5 [5], annex F.

RFPs belonging to the same LA shall broadcast the same values of higher layer attributes (see ETSI EN 300 175-5 [5], annex F) at any given time.

The PP shall be capable to read and interpret at least the broadcast attributes codes defined in clause 12.2.2.1.1, clause 12.2.2.1.2 and clause 12.2.2.1.3 during locking procedure. In the locked state the PP may assume them as static.

FP and PT shall support the following values of "Higher Layer capabilities" information attributes.

12.2.2.1.1 Higher layer information in standard FP broadcast (Qh = 3)

The Higher Layer capabilities Fixed Part Information field shall be used to indicate the support of the indicated features, as shown in Table 39. Most bits are not specific of ULE phase 2, but will be set in most RFPs due to the coexistence with voice services.

Table 39: Higher layer information attributes in standard FP broadcast (Qh = 3)

Bit Number	Attribute	Value	Note
< a_{32} >	ADPCM/G.726 [i.2] Voice service	1	Mandatory to support
< a_{33} >	GAP and/or PAP basic speech	1	Mandatory to support
< a_{36} >	DECT Standard Authentication (DSAA) required	1	Mandatory to support
< a_{37} >	DECT Standard Cipher (DSC) supported	1	Mandatory to support
< a_{38} >	Location registration supported	1	See location update procedure in ETSI EN 300 444 [9] (GAP), clause 8.29
< a_{40} >	Non-static FP	[0,1]	A FP which is mounted on a moving vehicle
< a_{44} >	Access Rights requests supported	[0,1]	The FP can toggle this bit to enable or disable on air subscription (see annex A)
< a_{46} >	Connection handover supported	[0,1]	Shall be understood as referring to voice services

12.2.2.1.2 Higher layer information in Extended FP broadcast (Qh = 4)

No Extended higher layer capabilities bits are used by the present document.

12.2.2.1.3 Extended Higher Layer capabilities part 2 (Qh = 11)

The Extended Higher Layer capabilities, part 2, Fixed Part Information field shall be used indicating the support of ULE part 1 (bit < a_{39} >) as well as other services and optional features that may be supported by the RFP, as shown in Table 40.

Table 40: Extended Higher Layer Capabilities part 2 interpretation by the PP

Bit Number	Attribute	Value	Note
< a_{24} >	NG-DECT Wideband voice supported	[0, 1]	See ETSI TS 102 527-1 [11] (see note 1 and note 2)
< a_{29} >	NG-DECT extended wideband voice services supported	[0, 1]	Support (or not support) of ETSI TS 102 527-3 [10] (see note 1 and note 2)
< a_{35} >	"No-emissions" support	[0, 1]	Support (or not support) of "no-emissions" compatibility mode (feature ULE1-M.33). See note 8
< a_{39} to a_{41}>	Support for DECT ULE	101	Support for ULE Phase 2 (the present document). See note 4, note 5, note 6 and note 7
< a_{42} >	Support of 'Re-keying' and 'early encryption'	[0, 1]	Support (or not support) of the 'Re-keying' and 'default cipher key mechanism early encryption' procedures (related to feature [ULE1-N.17])
< a_{43} >	DSAA2 supported	[0, 1]	Support (or not support) of the DSAA2 (see ETSI EN 300 175-7 [7])
< a_{44} >	DSC2 supported	[0, 1]	Support (or not support) of the DSC2 (see ETSI EN 300 175-7 [7] and note 3)

NOTE 1: Value refers to the value to be set by FPs complying with the present document. PPs may need to understand other values due to the compatibility with GAP and NG-DECT Part 1 FPs.
NOTE 2: All equipment compliant with the present document shall broadcast and shall understand the "Extended Higher layer capabilities (part 2)".
NOTE 3: The support of the DECT Standard Cipher #2 (DSC2) requires the support of the DECT Standard Authentication Algorithm #2 (DSAA2).
NOTE 4: Bits a_{39} to a_{41} of 'Extended Higher Layer Capabilities Part 2' indicate the supported ULE version; 100 indicates ULE Phase 1 (version v1.1.1); 110 indicates ULE Phase 1 (version v1.2.1 or later), 101 indicates support of phase 2 and 111 is reserved for indicating support of Phase 3.
NOTE 5: FPs compliant with the present documents will always set '101'B (support of ULE Phase 2). However, PPs shall understand all codes.
NOTE 6: Phase 3 FPs are assumed to be back compatible with the present document. When observing this code, the PP shall assume that the FP will behave as a Phase 2 FP.
NOTE 7: Phase 1 v1.1.1 FPs and Phase 1 v1.2.1 or later FPs have some limitations compared to Phase 2 FPs. The PP should be able to understand and handle properly such limitations.
NOTE 8: Bit a_{35} = "1" indicates, that the system may switch to "no emission" compatibility mode. Bit a_{35} = "0" indicates, that the system shall not switch to "no emission" compatibility mode.

12.3 Specific procedures for "hybrid" devices

12.3.1 Incoming calls for "hybrid voice" devices

12.3.1.1 General requirements

ULE PPs that support regular calls are referred to as "hybrid voice" devices. However, not all hybrid voice devices will need to use incoming calls, for example some may only use outgoing calls. Furthermore, these hybrid voice devices are usually for special applications (e.g. door entry-phone intercoms, medical alarm pendants, etc.), and are generally not intended to be used for answering a regular incoming call on the PSTN or VoIP line.

Ultimately, the decision of when and how to use incoming calls is made by the ULE application.

When the FP is required to initiate incoming calls to ULE devices it shall use the ULE paging mechanism and the procedures defined by clause 12.3.1.2 and clause 12.3.1.3.

Additionally, some devices, such as fast actuators or other devices that are fully locked to the FP dummy bearer, are able to receive regular DECT paging (A-field P_T channel). These devices may use regular DECT incoming call (feature GAP.N.8, see ETSI EN 300 444 [9], clause 8.12).

NOTE: The regular DECT paging (A-field P_T) channel has limited bandwidth and high latency, so the use of ULE paging is preferred.

12.3.1.2 Paging descriptors for incoming calls

ULE Phase 2 paging descriptors for hybrid incoming calls are defined in clause 10.6.2.5 of the present document. There are two types defined for hybrid incoming calls: "Setup voice call full slot" and "Setup voice call long slot" (see clause 10.6.2.5.2.2 and clause 10.6.2.5.2.3).

As with all ULE B-field paging, a "master" descriptor shall be assigned which defines the paging periodicity and one or more "slave" descriptors shall be assigned which determine the type(s) of paging function. The FP shall assign "slave" descriptors of the appropriate type, i.e. "Setup voice call full slot" or "Setup voice call long slot" or both, as appropriate for the supported voice service (narrowband or wideband).

Multiple descriptors can be assigned, as defined by the present document.

12.3.1.3 Incoming call procedure

The procedure for incoming call to a hybrid device is different to the normal LCE indirect FT initiated link establishment mechanism.

The general approach is to page the PP using ULE B-field paging, on receiving the page the PP then starts an outgoing call, finally the FP maps this outgoing call onto the awaiting incoming call. This method is analogous to that used for "collective ringing" in DECT (see ETSI EN 300 175-5 [5], clause 14.4). The approach simplifies the design since LCE and Call Control timers do not have to be changed to accommodate the variable (and often long) latencies of ULE B-field paging. The details are show below.

When the FP is required to initiate an incoming call to a PP, it shall start paging using the ULE paging mechanism (see clause 10.6.1 and clause 10.6.2 of the present document) using an appropriate paging descriptor (i.e. one that has been defined for incoming calls, see clause 12.3.1.2).

When the PP receives a paging signal on the paging channel that was defined for "incoming calls" it shall do the following:

- Leave ULE sleep mode, and remain locked to the base using normal duty cycle or low duty cycle for the duration of the call.

When the PP application accepts the incoming call (e.g. user activates "off-hook") it shall do the following:

- Trigger an outgoing call request (NWK feature GAP.N.1) (see ETSI EN 300 444 [9], clause 8.2):
  - The call shall follow the Codec Negotiation rules (NWK feature NG1.N.1) (see ETSI TS 102 527-1 [11], clause 7.3.2 and clause 7.3.3).
  - Channel selection procedures shall follow the normal rules for "circuit mode" operation (see ETSI TS 102 939-1 [12], clause 10.8.2.3):
    - If the paging channel is defined as "Setup voice call full slot" then channel selection and MAC bearer establishment shall use a full slot. Basic Control shall be used.
    - If the paging channel is defined as "Setup voice call long slot" then channel selection and MAC bearer establishment shall use a long slot. Advanced Control shall be used.
    - If there are no free long slots, then the MAC bearer establishment shall use a full slot. Basic Control shall be used.
  - Ultimately, the procedure results in the establishment of a link and a CC-SETUP message being sent from the PP to the FP.

On receipt of the CC-SETUP message at the FP side it shall do the following:

- An MNCC_SETUP-ind primitive shall be sent to the F-IWU.
- At the F-IWU this outgoing call is directly mapped to the awaiting incoming call.

- An MNCC_CONNECT-req primitive shall be issued to the FP which shall send a CC-CONNECT message to the PP:
  - The call shall follow the Codec Negotiation rules (NWK feature NG1.N.1) (see ETSI TS 102 527-1 [11], clause 7.3.2 and clause 7.3.3).

Once connected, the call shall proceed as normal.

If the PP application does not accept the incoming call, then no action shall be taken by the PP, and the call remains unanswered.

12.3.2 Interactions of ULE and "circuit mode"

12.3.2.1 General requirements

In general ULE data transfers ("packet mode") and regular calls ("circuit mode") should run independently using separate MAC bearers, channel selection procedures and higher layers (DLC and NWK). This simplifies the design and implementation. Another reason for keeping the "packet mode" and "circuit mode" separate is that they have very different characteristics in terms of call duration and call frequency.

In the scenario where both "packet mode" and "circuit mode" are actually required simultaneously, then this will consume additional resources (i.e. a physical slot/carrier). However, in general this scenario is low probability, and so the overall impact on the system should be low.

If it is not possible to use separate MAC bearers (e.g. no available slot/carrier on the system), then various mitigation strategies are possible, as described in clause 12.3.2.2 to clause 12.3.2.4.

12.3.2.2 ULE request whilst "circuit mode" active

If a ULE PP has an active "circuit mode" call (e.g. voice call) and a request for ULE data transfer occurs, then the following shall apply:

- If there are no resources for the ULE data transfer, then according to the requirements of the application, one of the following shall apply:
  - The ULE data transfer request is delayed until the "circuit mode" connection has ended.
  - The ULE data transfer is handled by sending the data over the C-plane (General Purpose Service Channel, see clause 13.1.1.3).
  - The "circuit mode" call is terminated (i.e. release of the call), so that the ULE data transfer can proceed.

The choice of action taken when there are no resources is left to the application, and depends on the application and urgency of the respective calls. For example, delaying a ULE data transfer for a room thermometer reading might be entirely acceptable. However, if the ULE data transfer was a for a triggered smoke alarm it would probably not be acceptable.

12.3.2.3 "Circuit mode" request whilst ULE active

If the ULE PP has an active ULE data transfer ("packet mode") and a request for a "circuit mode" call (e.g. voice call) occurs, then the following shall apply:

- If there are no resources for the "circuit mode" call, then according to the requirements of the application then one of the following shall apply:
  - The "circuit mode" call is delayed until the ULE data transfer has ended.
  - The ULE data transfer is interrupted (i.e. the MAC is suspended by use of expedited release message at next SDU boundary), so the "circuit mode" call can proceed.

The choice of action taken when there are no resources is left to the application, and depends on the application and urgency of the respective calls. However, since ULE data transfers are usually very short duration, simply waiting for it to end is often the best solution.

12.3.2.4 Suspend/resume ULE service

Some applications might want to disable ULE data transfer whilst performing extended "circuit mode" operations. For example, when performing Software Download Over The Air, or when the nature of the hybrid device is modal (e.g. operating as either ULE or regular device, but not both at the same time). These applications may use the NWK Suspend/NWK Resume procedures to suspend/resume the ULE data transfer service.

ULE data transfers over the U-plane are not possible when the VC (Virtual Circuit) is in NWK suspended state.

See ETSI TS 102 939-1 [12], clause 12.1.3.1 and clause 12.1.3.2.

12.4 SUOTA push mode

12.4.1 General requirements

In addition to the PP periodically checking for a new software version, it is also possible for a new version to be "pushed" from the Management Server.

The "push mode" procedure as defined by NG-DECT Part 4 [13] using the {FACILITY} message is normally sent using CISS procedures. However, because ULE devices are often unsynchronized and can be asleep for long periods, the use of the A-field paging and LCE indirect FT initiated link establishment mechanism is problematic.

Therefore, a different strategy is used for ULE devices, utilizing ULE paging when "push mode" is required.

12.4.2 Paging descriptors for SUOTA push mode

ULE Phase 2 paging descriptor for SUOTA is defined in clause 10.6.2.5 and specifically in clause 10.6.2.5.2.4 of the present document.

As with all ULE B-field paging, a "master" descriptor shall be assigned which defines the paging periodicity, and one or more "slave" descriptors shall be assigned which determine the type(s) of paging function. The FP shall assign a "slave" descriptor for SUOTA setup.

12.4.3 Push mode procedure

When the FP is required to initiate SUOTA "push mode", it shall start paging using the ULE paging mechanism (see clause 10.6.1 and clause 10.6.2 of the present document) using an appropriate paging descriptor (i.e. one that has been defined for SUOTA push mode, see clause 12.4.2).

The behaviour of a PP receiving a "SUOTA push mode" paging signal, is similar to that of an NG-DECT Part 4 device receiving a {FACILITY} message with the <<Events Notification>> indicating "Firmware upgrade" (see ETSI TS 102 527-4 [13], clause 7.5.6). Specifically, it shall do the following:

- The PP shall attempt a Software upgrade Over The Air (see ETSI TS 102 527-4 [13], clause 7.6.2) when receiving the paging signal. However, the exact behaviour is left up to the PP vendor. More specifically, a "Handset Version Indication" command could be sent anytime afterwards, or not be sent at all.

12.5 Additional requirements for ULE NWK Control

12.5.1 Default ULE PVC transaction parameters

The default parameters for ULE PVC transactions are as described in ETSI TS 102 939-1 [12], clause 12.1.3.5, with the exception of the value(s) given in Table 41.

Table 41: Specific default ULE PVC transaction parameters

Information element	Field within the information element	Default values	Normative action/comment
<< TRANSIT-DELAY >>	Overall DECT system maximum Delay	Not applicable	
	Overall MAC layer maximum lifetime	25	25 frames = 250 ms

The default value of the <<TRANSIT-DELAY>> as shown above shall apply in all cases, unless another value is explicitly negotiated, e.g. by use of the Service Change procedure (see ETSI TS 102 939-1 [12], clause 12.1.3.3).

12.5.2 Default MAC parameters for implicitly created MBC

When a pair of MAC MBCs is created without an explicit exchange of MAC signalling, i.e. as result of the procedure described in ETSI TS 102 939-1 [12], clause 12.1.3.1.3.2, case "b", then the default parameters are as described in ETSI TS 102 939-1 [12], clause 12.1.3.8.

12.6 U-NEMo procedures

12.6.1 Communication of U-NEMo preferred carrier

The U-NEMo preferred carrier shall be passed from the base to the ULE device using a <<ULE-MAC-CONFIGURATION-INFO>> Information Element (see ETSI TS 102 939-1 [12], clause A.2.1). This operation may be performed by any {CC SERVICE CHANGE} operation with the capability to transport the << ULE-MAC-CONFIGURATION-INFO >> IE that is not already carrying a << ULE-MAC-CONFIGURATION-INFO >> IE for another purpose: i.e. a << ULE-MAC-CONFIGURATION-INFO >> IE carrying the U-NEMo preferred carrier shall be the only << ULE-MAC-CONFIGURATION-INFO >> IE in the message.

13 Services and Interworking procedures

13.1 Specific procedures for ULE phase 2

13.1.1 Service channels transported via <<IWU-to-IWU>> IE

13.1.1.1 General concepts

In the context of the present document a "service channel" is defined as any point to point channel able to carry higher layer data different from regular U-plane transmission.

All service channels defined by the present document are bidirectional and transported via C-plane procedures using the IE <<IWU-to-IWU>> as container.

Therefore, the operation of the service channels requires the establishment of a MAC connection with capability to transport C-plane messages, typically via channel C_S.

Service channels are accessible via specific endpoints (SAPs) at both ends separate from regular U-plane C/O service endpoints. The application makes the decision about which information should be exchanged via the service channels, and when to do so.

The present document provides two service channels:

- A service channel intended for the exchange of configuration and control protocols (not CCM encrypted).
- A CCM encrypted service channel intended for the exchange of application protocol messages. Such messages may be identical or not to the messages exchanged via the regular C/O service.

13.1.1.2 Configuration and control service channel

13.1.1.2.0 General

This service channel is identical to the one defined in ETSI TS 102 939-1 [12], clause 13.2.1.

It is intended to be used to exchange configuration and control information.

The configuration and control information is transported in an <<IWU to IWU>> Information Element, contained inside an IWU-INFO message, as described in ETSI TS 102 939-1 [12], clause 13.2.1. The message contents are described in ETSI TS 102 939-1 [12], clause A.2.3. The Information Element contains a protocol discriminator which allows various protocols (including application-specific and proprietary protocols) to be transported.

NOTE 1: Application-specific and proprietary protocols are not described in the present document.

The configuration and control service channel is unencrypted at DECT DLC layer (CCM).

NOTE 2: However, it may be MAC encrypted using DSC or DSC2. Encryption is normally done via DSC. DSC2 may be used if service ULE1-M.27 is supported by both peers.

The provisions of ETSI TS 102 939-1 [12], clause 13.2.1 shall apply.

The transport of this channel shall be done as described in ETSI TS 102 939-1 [12], clause 13.2.1.3.

The IWU-INFO messages shall be transported over the C-plane of an existing DECT link. Furthermore, the type and state of the DECT link used for this purpose is restricted, as defined below:

- The link shall have an existing CC transaction, for example ULE Service Call, or voice call.
- The state of the existing CC transaction shall not be "NULL (T-00 or F-00) or "RELEASE PENDING" (T-19 or F-19) (see ETSI EN 300 175-5 [5], clause 9 for details of the CC state machine states).

These IWU-INFO messages shall use the special Transaction Value of 5, as described in ETSI TS 102 939-1 [12], clause 12.1.2.2.

The exchange of this channel is allowed in both "NWK resumed" and "NWK suspended" states of the ULE CC transaction (TV=5).

13.1.1.2.1 ULE Common Control Protocol procedures

One of the protocols that can be transported by the Configuration and Control Service Channel is the ULE Common Control Protocol. This may be used to send configuration and control information.

The message is coded in to an <<IWU to IWU>> Information Element contained in an IWU-INFO message. It is sent using the configuration and control service channel procedures as defined in clause 13.1.1.2.

The basic format of the message is as defined in ETSI TS 102 939-1 [12], clause A.2.3, with the protocol discriminator type (octet 4) set to 0000000'B (ULE Common Control Protocol), and an "op-code" defined by octet 5. The remaining content and structure of the Information Element depends on the op-code value.

NOTE: The list of supported op-codes is defined in ETSI TS 102 939-1 [12], clause A.2.3.3.

13.1.1.3 CCM encrypted general purpose service channel

13.1.1.3.0 General

This service channel provides a pair of end-points accessible to the higher layers where application protocol messages may be exchanged.

This channel is intended for use when it is not possible nor convenient to utilize regular ULE bearers for sending data via U-plane service. An example of such situation is when a circuit mode call, such as a voice call, is established and the implementation does not support simultaneous ULE packet mode and circuit mode bearers. A similar case may happen when a long duration packet mode call, such as a SUOTA downloading, is in progress.

Service channels are accessible via specific endpoints (SAPs) at both ends, separate from regular U-plane C/O service endpoints. The application makes the decision about when information should be exchanged via the service channels, and when to use the regular U-plane channel.

The transport of this channel shall be done as described in clause 13.1.1.3.2.

13.1.1.3.1 Services provided by the DECT sub-system

The DECT system provides the following features and services regarding the general purpose service channel.

- A pair of SAPs, accessible directly by the application, separated from regular U-plane service SAPs.
- CCM encryption of the messages using the same key used by regular U-plane service, but a different Initialization Vector (IV).
- Segmentation of the messages, if needed, and re-assembling at destination.
- Transparent transport of the segments using CC {IWU-INFO} messages and the IE <<IWU-to-IWU>> as a container.
- Retransmission capability using the MAC procedures used for C_S (or C_F) channels.
- Data integrity by means of the CCM MIC.

13.1.1.3.2 Transport of the general purpose service channel

Data shall be sent using <<IWU-to-IWU>> Information Element contained within one or more {IWU-INFO} Call Control (CC) message. The general format of the message is shown in Table 42.

These IWU-INFO messages shall use the special Transaction Value of 5, as described in ETSI TS 102 939-1 [12], clause 12.1.2.2.

The IWU-INFO messages shall be transported over the C-plane of an existing DECT link. Furthermore, the type and state of the DECT link used for this purpose is restricted, as defined below:

- The link shall have an existing CC transaction, for example ULE Service Call, or voice call.
- The state of the existing CC transaction shall not be "NULL (T-00 or F-00) or "RELEASE PENDING" (T-19 or F-19) (see ETSI EN 300 175-5 [5], clause 9 for details of the CC state machine states).

The exchange of this channel is only allowed in the "NWK resumed" state of the ULE CC transaction (TV=5).

Table 42: Values used within the {IWU-INFO} message

Information element	Field within the information element	Standard values within the field/IE	Normative action/comment
Protocol Discriminator	Protocol Discriminator	3H	Call Control (CC) messages
Transaction Identifier	Flag	[0,1]	Transaction is FT initiated
	TV	5H	TV = 5
Message Type	Message Type	96H	{IWU-INFO}
<<IWU-to-IWU>>	<Length of content>	L	Length of content
	<S/R bit>	1	Transmission of message
	<Protocol Discriminator>	12H	ULE CCM encrypted service channel AUX0
	IWU-TO-IWU INFORMATION	. . .	A segment of payload (see clause 13.1.1.3.4)

13.1.1.3.3 Security procedures

13.1.1.3.3.1 CCM encryption

If DLC service is LU14 [ULE1-D.1] then, the service channel shall also be CCM encrypted. To encrypt the channel, each message before segmentation shall be CCM encrypted according to the provisions given in ETSI EN 300 175-7 [7], clause 6.6.2.8.

The following specific provisions shall apply:

- Encryption shall be done with the same encryption key used for CCM encryption of the primary C/O service and a different Initialization Vector (IV). The initialization vector coding "AUX0" as defined in ETSI EN 300 175-7 [7], clause 6.6.2.8.1 shall be used.
- Service channel encryption uses a different CCM context and an independent CCM sequence.
- The CCM sequence has 6 bytes. The seven less significant bits of the CCM sequence shall be the sequence number given by the IWU segmentation facility to the first segment of the message, as described in clause 13.1.1.3.4. Therefore, the CCM sequence numbers are, in general, not consecutive.
- The sequence (both CCM sequence and IWU sequence numbers) is reset each time the ULE VC's NWK layer state is resumed. Therefore, the NWK suspension and resume is the mechanism to reset the sequence, together with the primary sequence of the LU14 transmission. The key is also updated in this process. There is no other mechanism to reset the sequence.

The resulting packet consisting of the original message received from the application plus the 4 bytes of MIC added by the CCM, will be the input packet to the segmentation process:

- At the receiving side, the reassembled segments (based on the "M" bit, see next clause 13.1.1.3.4) shall be CCM decoded and, if correct, passed to the application via the Service channel SAP.
- In case of CCM decoding error, the wrongly decoded message shall be discarded and its parts shall not be revealed to the application. However, an indication of the error may be passed to the application.

13.1.1.3.3.2 Other encryption procedures

In addition to CCM encryption, the general purpose service channel may be MAC encrypted using DSC or DSC2.

The general encryption rules for channel C_S (or C_F) shall apply with no difference compared to other C-plane transmission.

NOTE 1: The keys for CCM and MAC encryption are different.

NOTE 2: Encryption is normally done via DSC. DSC2 may be used if service ULE1-M.27 is supported by both peers.

13.1.1.3.4 Segmentation and reassembling

13.1.1.3.4.0 General

The external message will be CCM encrypted and the MIC of 4 octets shall be added at the end of the message, as described in clause 13.1.1.3.3.

If needed, the resulting structure shall be segmented in to pieces of "N" bytes or less, where the value of "N" is chosen as the maximum value that allows the segment to fit into an {IWU-INFO} message without the need of further segmentation at either, NWK or DLC layers.

For each segment, a header of one octet containing a sequence number of 7 bits and a "M" bit is added at the beginning. The format of the header is described in clause 13.1.1.3.4.1.

NOTE 1: The header octet is not CCM encrypted.

The actual payload data for the message is defined on a ULE Application Protocol specific basis, and is not defined in the present document.

The resulting segment (including the header) is the segment of payload to be inserted in the < IWU-TO-IWU INFORMATION> field of the <<IWU-to-IWU>> IE as shown in Table 42.

At receiving side the opposite operations are done. The last segment of the message is identified by the "M" bit.

This procedure mimics the segmentation and reassembling done by LU10/FU10a. All provisions given for LU10 process, such as the discarding of uncompleted packets due to irrecoverable segments, shall apply.

If the link is terminated during the transport of a multi-segment message, then any partially received segments shall be discarded. The receiving side may inform the higher layers of the error. The sending side may inform the higher layers of the error.

NOTE 2: The sending side could delay initiating a link release if it knows that it in the process of sending ULE data over the C-plane using this channel. This would be an implementation decision.

13.1.1.3.4.1 Format of the header octet

The format of the heading octet is shown in Figure 8.

Bit:	8	7	6	5	4	3	2	1	Octet:
	M	Send Sequence number, bits ES7 to ES1							1

Figure 8: Segment header octet

Description:

Send sequence number is a 7 bit (modulus 128) consecutive sequence number.

The sequence number of the first segment of any message is also the explicit part of the CCM sequence number (see clause 13.1.1.3.3).

"M" is a "more" bit that is set as follows:

M = "1" indicates that the information field only contains part of a message, i.e. there is more to follow.

M = "0" indicates one of two things:

a) that the information field contains a complete message, provided that the M bit of the previous segment was also set to "0";

b) that the information field contains the last segment of a message, provided that the M bit of the previous segment was set to "1".

13.1.1.3.5 MAC Release Reason Emulation

The regular ULE U-plane data service has a "back-channel" by virtue of the "release reason" mechanism. This provides "reason" and "info" fields. These fields can be used to feed-back information regarding the link and/or requested next action, for example requesting the PP to "set-up again". However, when ULE data is sent over the C-plane, i.e. using the CCM encrypted general purpose service channel, there is no explicit back-channel available.

This procedure uses the ULE Common Control Protocol (see clause 13.1.1.2.1) to partially emulate this "back-channel" functionality, as described below.

After receiving a message via the CCM encrypted general purpose service channel, the receiving side may respond with a "back-channel" message. The message is coded using the ULE Common Control Protocol (see clause 13.1.1.2.1), with an "op-code" value (octet 5) set to 0000000'B (MAC Release Reason Emulation). The specific structure and contents of the message is as shown in Figure 9.

Bit:	8	7	6	5	4	3	2	1	Octet:
	1	0	0	0	0	0	0	0	4
	1	0	0	0	0	0	0	0	5
	spare		Reason						6
	spare		Info						7

Figure 9: IWU-to-IWU definition for the "MAC Release Reason emulation" message

Discriminator type (octet 4, bits 1 to 7):

The "Discriminator type" as defined in ETSI TS 102 939-1 [12], clause A.2.3.1. The value of 0000000'B means ULE Common Control Protocol.

"Op-code" (octet 5, bits 1 to 7):

The "Op-code" as defined in ETSI TS 102 939-1 [12], clause A.2.3.3. The value of 0000000'B means MAC Release Reason Emulation.

Reason (octet 6, bits 1 to 6):

This field is identical to the "reason" code of an expedited release or expedited ready for release message, as defined in ETSI TS 102 939-1 [12], clause 10.10.2.3.

Info (octet 7, bits 1 to 6):

This field is identical to the "info" code of an expedited release or expedited ready for release message. The actual value and meaning is dependent on the "reason" value, as defined in ETSI TS 102 939-1 [12], clause 10.10.2.3. Not all release reasons use the Info field, and in this case the bits shall be set to "0".

"spare":

Spare bits, are generally indicated as being set to "0". In order to allow compatibility with future implementations, elements should not be rejected if these spare bits are set to "1".

Not all Release Reasons have a valid meaning for MAC Release Reason Emulation. The supported reasons are defined in Table 43 (see ETSI TS 102 939-1 [12], clause 10.10.2.3) for specific details of these release reason codes).

Table 43: Supported "reason codes" in "MAC Release Reason Emulation" message

Release code	Meaning	Notes
001010	Base station busy	
001111	Stay in LCE paging detection mode	See note 1
010001	Stay in higher paging detection mode	See note 1
010010	Setup again after n frames	See note 1
010101	LU13/LU14 error	See note 2
NOTE 1: The specified mode shall be activated after the current link has been released. NOTE 2: The LU13/LU14 error relates to the CCM encrypted general purpose service channel.		

13.1.2 IWU procedures for C/L downlink multicast service

13.1.2.1 General

IWU instances for the C/L downlink multicast service are independent from the instance used by the C/O service and are acceded by the application towards independent SAPs.

The application decides which messages are routed toward C/L downlink multicast SAP, and which are routed towards the C/O SAP, taking into account the limitations of the C/L downlink multicast service, such as the absence of retransmission capability and the absence of an acknowledgement mechanism.

13.1.2.2 U-plane procedures

The service is uni-directional. Otherwise, there is no difference compared to C/O service. Transparent IWU does not add any header to the U-plane format and is not used for identification of instances. Separation of instances (usually allocated to multicast groups) is done by the different SAP towards the application layer. It is up to the application the routing of the packet to the proper SAP.

13.1.2.3 C-plane procedures

There are no specific C-plane procedures for the C/L downlink multicast service. The service inherits all attributes negotiated by means of C-plane procedures for the C/O service, such as the maximum MTU/SDU size, and the identification parameters of the transported protocol. See ETSI TS 102 939-1 [12], clause B.2.2.

- The case of having subscribed to the same multicast group PTs that may have different incompatible IWU settings in the C/O service is not covered by the present document.

14 Application procedures

14.1 Hybrid device voice service

14.1.0 Introduction

ULE devices that also support a voice service are known as "hybrid" devices. Devices such as medical alarm pendants and door entry-phone intercoms fall under this category.

Many hybrid devices will not have keypad and display, or only have very limited keypad and display, (e.g. 1 button and 1 LED). Additionally, some devices might only support voice in one direction (e.g. speaker but no microphone).

Hybrid devices are usually for special applications and are generally not intended to be used for answering a regular incoming call on the PSTN or VoIP line.

14.1.1 General requirements

The specific requirements for hybrid voice devices are defined by the feature/service support tables in clause 6.4, clause 6.5, clause 6.6, clause 6.7, clause 6.8, clause 6.10, clause 6.11 and clause 6.12.

14.2 Hybrid device data service

14.2.0 Introduction

ULE devices that also support an additional (non-ULE) data service are "hybrid" devices. The particular data service is non-specific, and could for example be DPRS, Light Data Service, or other connection-orientated data service. The key distinction is that this data services uses traditional DECT procedures (referred to as "circuit mode"), and not the Ultra-Low Energy procedures (referred to as "packet mode").

The NG-DECT Part 4 [13] features SUOTA (Software Upgrade Over The Air) and LDS (Light Data Service) are specific examples of a data service that may be supported by a ULE hybrid devices.

Hybrid data devices may support other data services which are not specified in the present document.

14.2.1 General requirements

The specific requirements for hybrid data devices are defined by the feature/service support tables in clause 6.4, clause 6.5, clause 6.6, clause 6.7, clause 6.8, clause 6.10, clause 6.11 and clause 6.13.

14.3 Software Upgrade Over The Air (SUOTA) for ULE devices

14.3.0 Introduction

The Software Upgrade Over The Air (SUOTA) is a specific use-case of hybrid device with data service. It is such a significant feature that it has its own application layer feature definition. However, a device supporting SUOTA is still classed as a hybrid data device.

14.3.1 General requirements

The specific requirements for SUOTA are defined by the feature/service support tables in clause 6.4, clause 6.5, clause 6.6, clause 6.7, clause 6.8, clause 6.10, clause 6.11 and clause 6.13.

The SUOTA process can be initiated from the PP or the FP. For example, the PP may periodically check for the availability of new software versions (e.g. once per week). The FP may also attempt to "push" a version (usually as a result of an indication from the Management Server).

Annex A (normative): Parameters and Information Elements

A.1 Constants, variables and operating parameters

A.1.1 Operating parameters

A.1.1.1 Channel selection algorithms

- b (a parameter of the channel selection algorithm M2):
  - 6
- m (delay between frame carrying the MU channel selection information and the access frame):
  - 2 frames

For operation in US region (feature ULE1-ME.3), the following channel selection parameters shall be used:

- m = 2 frames.

For operation in Japan region (feature ULE1-ME.4), the following channel selection parameters shall be used:

- m = 3 frames.

A.1.1.2 MAC layer

Several MAC layer parameters are negotiable by means of MAC or NWK messages. Their default values are provided in clause 12.5.1 and clause 12.5.2.

A.1.1.3 DLC layer

Maximum SDU size with mandatory support at FP side: 500 octets

NOTE: Other DLC parameters are negotiable by means of NWK messages. Their default values are provided in ETSI TS 102 939-1 [12], clause 12.1.3.5.

History

Document history		
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