ETSI TR 103 513 V1.1.1 (2019-11)

Digital Enhanced Cordless Telecommunications (DECT);
DECT Technology Roadmap

Reference
DTR/DECT-00314

Keywords
DECT, evolution

ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° 7803/88

Contents

Intellectual Property Rights

Essential patents

IPRs essential or potentially essential to normative deliverables may have been declared to ETSI. The information pertaining to these essential IPRs, if any, is publicly available for **ETSI members and non-members**, and can be found in ETSI SR 000 314: *"Intellectual Property Rights (IPRs); Essential, or potentially Essential, IPRs notified to ETSI in respect of ETSI standards"*, which is available from the ETSI Secretariat. Latest updates are available on the ETSI Web server (https://ipr.etsi.org/).

Pursuant to the ETSI IPR Policy, no investigation, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in ETSI SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document.

Trademarks

The present document may include trademarks and/or tradenames which are asserted and/or registered by their owners. ETSI claims no ownership of these except for any which are indicated as being the property of ETSI, and conveys no right to use or reproduce any trademark and/or tradename. Mention of those trademarks in the present document does not constitute an endorsement by ETSI of products, services or organizations associated with those trademarks.

Foreword

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

Modal verbs terminology

In the present document "**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).

"**must**" and "**must not**" are **NOT** allowed in ETSI deliverables except when used in direct citation.

1 Scope

The present document gives a brief overview and history of the DECT standards, followed by current and future standardization actives, and a roadmap for the short-to-medium term for the DECT technology.

2 References

2.1 Normative references

Normative references are not applicable in the present document.

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

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

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

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

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

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

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

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

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

[i.10] 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".

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

[i.12] ETSI TS 102 527-2: "Digital Enhanced Cordless Telecommunications (DECT); New Generation DECT; Part 2: Support of transparent IP packet data".

[i.13] ETSI TS 102 527-3: "Digital Enhanced Cordless Telecommunications (DECT); New Generation DECT; Part 3: Extended wideband speech services".

[i.14] 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".

[i.15] ETSI TS 102 527-5: " Digital Enhanced Cordless Telecommunications (DECT); New Generation DECT; Part 5: Additional feature set nr. 1 for extended wideband speech services".

[i.16] ETSI TS 102 939-1: "Digital Enhanced Cordless Telecommunications (DECT); Ultra Low Energy (ULE); Machine to Machine Communications; Part 1: Home Automation Network (phase 1)".

[i.17] ETSI TS 102 939-2: "Digital Enhanced Cordless Telecommunications (DECT); Ultra Low Energy (ULE); Machine to Machine Communications; Part 2: Home Automation Network (phase 2)".

[i.18] ETSI TR 103 422: "Digital Enhanced Cordless Telecommunications (DECT); DECT evolution technical study; Requirements and technical analysis for the further evolution of DECT and DECT ULE".

[i.19] Recommendation ITU-R M.2410-0: "Minimum requirements related to technical performance for IMT-2020 radio interface(s)".

[i.20] ETSI TR 103 514: "Digital Enhanced Cordless Telecommunications (DECT); DECT-2020 New Radio (NR) interface; Study on Physical (PHY) layer".

[i.21] ETSI TR 102 185: "Digital Enhanced Cordless Telecommunications (DECT); Data Services Profile (DSP); Profile overview".

[i.22] ETSI EN 301 240: "Digital Enhanced Cordless Telecommunications (DECT); Data Services Profile (DSP); Point-to-Point Protocol (PPP) interworking for internet access and general multi-protocol datagram transport".

[i.23] ETSI EN 301 239: "Digital Enhanced Cordless Telecommunications (DECT); Data Services Profile (DSP); Isochronous data bearer services for closed user groups (service type D, mobility class 1)".

[i.24] ETSI EN 301 238: "Digital Enhanced Cordless Telecommunications (DECT); Data Services Profile (DSP); Isochronous data bearer services with roaming mobility (service type D, mobility class 2)".

[i.25] ETSI EN 301 649: "Digital Enhanced Cordless Telecommunications (DECT); DECT Packet Radio Service (DPRS)".

[i.26] ETSI EN 301 908-10: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Base Stations (BS), Repeaters and User Equipment (UE) for IMT-2000 Third-Generation cellular networks; Part 10: Harmonised Standard for IMT-2000, FDMA/TDMA (DECT) covering the essential requirements of article 3.2 of the Directive 2014/53/EU".

[i.27] ETSI TR 103 635: "Digital Enhanced Cordless Telecommunications (DECT); DECT-2020 New Radio (NR) interface; Study on MAC and higher layers".

[i.28] ETSI TR 103 637: "DECT-2020 radio interface; Stage 2: security architecture DECT-2020 radio interface; Stage 2: security architecture".

[i.29] Directive 1999/5/EC of the European Parliament and of the Council on Radio Equipment and Telecommunications Terminal Equipment and the mutual recognition of their conformity.

3 Definition of terms, symbols and abbreviations

3.1 Terms

Void.

3.2 Symbols

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

N_{DBPS}	Number of Data Bits Per Symbol
N_{SS}	Number of Spatial Streams

3.3 Abbreviations

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

BPSK	Binary Phase Shift Keying
DECT	Digital Enhanced Cordless Telecommunications
DLC	Data Link Control
DPRS	DECT Packet Radio System
DSP	Data Services Profile
FB	Full-Band
FEC	Forward Error Correction
GAP	Generic Access Profile
GFSK	Gaussian Frequency Shift Keying
HARQ	Hybrid ARQ
IMT	International Mobile Telecommunications
IoT	Internet of Things
IP	Internet Protocol
LC3plus	Low Complexity Communication Codec plus
MAC	Medium Access Control
MCS	Modulation Coding Scheme
MIMO	Multiple Input Multiple Output
mMTC	Massive Machine-Type Communications
NB	Narrow-Band
NG-DECT	New Generation DECT
NWK	NetWorK
OFDM	Orthogonal Frequency-Division Multiplexing
PABX	Private Automatic Branch eXchange
PDU	Protocol Data Unit
PHL	PHysical Layer
PMSE	Programme-Making and Special Events
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase Shift Keying
RF	Radio Frequency
SUOTA	Software Upgrade Over The Air
SWB	Super-WideBand
TDMA	Time-Domain Multiple Access
ULE	Ultra Low Energy
UPCS	Unlicensed Personal Communications Service
URLLC	Ultra-Reliable Low Latency Communications
WB	Wide-Band
WLL	Wireless Local loop

4 Technology Roadmap

4.1 A Brief History of DECT Standards

Date	Milestone	Comments
1989 - 1992	Development of DECT base standards	• The core standard, developed originally for cordless telephony products, later extended for other applications. • Applications: – Cordless telephony. – Enterprise systems (PABX). – Public access telephony. – Wireless Local Loop (WLL). – Etc. • Main standards: – ETSI EN 300 175 parts 1 [i.1] to 8 [i.8]. • Spectrum: – 1 880 MHz - 1 900 MHz band in Europe. – Other bands possible worldwide.
1995	Release of Generic Access Profile (GAP) standard	• Generic Access Profile (GAP) standard defines a comprehensive feature set for interoperability of cordless telephony devices. • Standard: ETSI EN 300 444 [i.9].
1995 - 2000 (approx.)	Data Services Profile (DSP)	• A range of DECT Data Service Profiles for different services and applications. • Main standards: – ETSI TR 102 185 [i.21]. – ETSI EN 301 240 [i.22]. – ETSI EN 301 239 [i.23]. – ETSI EN 301 238 [i.24]. – Etc.
2000	DECT Packet Radio Service (DPRS) standard	• The DPRS standard defines a features and services at MAC, DLC and NWK layer for data services. • Standard: ETSI EN 301 649 [i.25].
2002	DECT Harmonised Standard for IMT-2000	• Harmonised EN for IMT-2000, FDMA/TDMA (DECT) covering essential requirements of article 3.2 of the "R&TTE Directive [i.29]". • Standard: – ETSI EN 301 908-10 [i.26].
2005	Launch of "DECT 6.0" for North American markets	• Marketing term for DECT devices intended for operation in North America (USA and Canada). • Standard: – ETSI TS 102 497 [i.10]. • Spectrum: – 1 920 MHz - 1 930 MHz UPCS band in North America
2007 - 2014	Development of "New Generation DECT" (NG-DECT) standards	• Extends the basic DECT standards to cover wideband and super-wideband audio, and mandatory interoperability features. Also includes security enhancements and Software Upgrade Over The Air (SUOTA). • Applications: – Wideband cordless telephony. – Wideband cordless headsets. – Etc. • Standards: – ETSI TS 102 527 parts 1 [i.11] to 5 [i.15].

Date	Milestone	Comments
2013 - 2015	Development of "DECT Ultra Low Energy" (ULE) standards	• Enhances DECT to allow ultra-low energy operation suitable for Internet Of Things (IoT), Home Automation and Home Security. • Applications: – Wireless security sensors. – Wireless smoke/fire detectors. – Wireless room temperature sensors. – Wireless actuators. – Wireless "smart plugs". – Etc. • Standards: – ETSI TS 102 939 parts 1 [i.16] to 2 [i.17].

4.2 Standards Roadmap

Date	Milestone	Comments
2018-2019	Development of "DECT Evolution" standard	• Evolves DECT standard by the implementation of a number of technical enhancements, whilst still using the DECT "classic" radio interface (Gaussian Frequency Shift Keying (GFSK)): – Audio enhancements (new codecs, e.g. LC3plus). – Low latency audio (< 10 ms). – Enhanced support of advanced chipset features such as higher modulation rates and channel coding. • Applications: – Professional audio microphones and in-ear headsets, etc., for Programme-Making and Special Events (PMSE). – Wireless Hi-Fi/audio equipment (e.g. wireless speakers, etc.). • Standards: – ETSI EN 300 175 parts 1 [i.1] to 8 [i.8] (due Q3 2019).
2019-2020	Enhancements for DECT Evolution	• Additional work to further standardize high-rate asymmetric audio links. For example asymmetric audio: high bandwidth downlink/low bandwidth uplink; or low bandwidth downlink/high bandwidth uplink. Also, high fidelity, massive audio broadcast capability. • Optimizations, e.g. allowing double simplex bearers without the need for dedicated duplex bearer (i.e. shared duplex bearer for control). • Applications: – Smart speakers/voice-assistants. – Audio broadcast to multiple headsets (e.g. tour guide applications. • Standards: – TBD (due Q4 2020).

Date	Milestone	Comments
2019-2020	Development of DECT-2020 standards	• Standardization of new PHL and MAC layers and architecture with the intention of meeting some of the requirements of ITU-R IMT-2020, specifically Ultra-Reliable Low Latency Communications (URLLC) and Massive Machine-Type Communications (mMTC). The PHL and MAC architecture provides massively higher data rates (compared to legacy DECT), as well as higher reliability, and lower latency. • Utilizing OFDM, FEC, HARQ, MIMO, etc. • Targeting low latency and high reliability. • Applications: – Traditional cordless telephony, PABX, etc. – Home Automation/Security, IoT, etc. – Industrial Automation – Mesh-based networks, asset tracking, etc. – Etc. • Standards: – TBD (due 2020-2021). • Spectrum: – 1 880 MHz - 1 900 MHz band in Europe. – Other IMT bands may be possible.

5 Technology Overview

5.1 DECT Evolution

The ETSI technical report ETSI TR 103 422 [i.18] describes the outcome of a series of studies identified by ETSI TC DECT and required for the short and mid-term evolution of DECT and ULE technologies.

These enhancements are collectively referred to as "DECT Evolution" - the goal of which is to address new applications and markets for DECT and ULE, whilst primarily still utilizing existing silicon and RF implementations.

One of the main application areas for DECT Evolution was high-end and professional audio systems, such as used by PMSE industry, where audio streaming with higher data rates and very low latency is essential.

The initial phase of DECT Evolution has focussed on the following aspects:

- Improvements to the MAC design to allow low latency asymmetric connections:
  - Latency of < 1 ms as target.
  - Overhaul of MAC messages and procedures for double-simplex bearers, asymmetric bearers, etc.
  - The focus has primarily been on low-latency microphones, which requires up-link bandwidth.
- Additional MAC procedures and messages for "handover with tolerance":
  - Allows connections consisting of multiple double-simplex bearers to be "re-structured" with minimal impact on audio throughput due to seamless operation.
- Improved support for higher modulation rate chipsets:
  - Additional MAC procedures and messages to allow specification of Modulation and Coding Scheme(MCS) to be specified by "index" value more conveniently.
  - Overhaul of some related MAC messages and procedures.
- Support for new "LC3plus" codec:
  - This codec supports Narrowband (NB), Wideband (WB), Super Wideband (SWB) and Fullband (FB) with good data rates and excellent quality.

  - Operating at sample rates 8 kHz, 16 kHz, 24 kHz, 32 kHz and 48 kHz. It is designed for very high quality communication application including all kind of audio signals, e.g. speech and music. It provides an audio bandwidth of up to 16 kHz in super-wideband mode and an audio bandwidth of up to 20 kHz in fullband mode. The codec also contains error protection capabilities and a very performant packet loss algorithm.

- Higher layer modifications (NWK layer):
  - Modifications of NWK messages and IEs to support these advanced connection types.
  - Modifications of NWK messages and IEs to support the new code types.

A second phase of DECT Evolution will cover the following aspects:

- Low latency audio for down-link applications (e.g. professional in-ear headsets, Hi-Fi speakers).
- Low latency audio for both up-link and down-link applications (e.g. smart speakers, voice assistants).
- Low latency for non-streaming applications.
- Massive audio broadcast capability (e.g. for tour guides, conferences, etc.).
- Optimizations, e.g. double simplex bearers without the need for dedicated duplex bearer (i.e. shared duplex bearer for control).

5.2 DECT-2020

DECT-2020 is a major standardization activity, primarily in the PHL and MAC layers and architecture with the intention of meeting some of the requirements of Recommendation ITU-R M.2410-0 [i.19], specifically Ultra-Reliable Low Latency Communications (URLLC) and Massive Machine-Type Communications (mMTC).

There are 3 usage scenarios defined for IMT-2020 are:

- Enhanced Mobile Broadband (eMBB).
- Massive Machine-Type Communications (mMTC).
- Ultra-Reliable Low Latency Communications (URLLC).

The 13 technical performance requirements defined in Recommendation ITU-R M.2420-0 [i.19] are:

- Peak data rate.
- Peak spectral efficiency.
- User experienced data rate.
- 5^{th} percentile user spectral efficiency.
- Average spectral efficiency.
- Area traffic capacity.
- Latency:
  - User plane latency.
  - Control plane latency.
- Connection density.
- Energy efficiency.
- Reliability.

- Mobility.
- Mobility interruption time.
- Bandwidth.

Not all of these requirements are mandatory for all of the 3 usage scenarios (eMBB, mMTC, URLLC). In fact, assuming that DECT-2020 is only intended for the URLLC and mMTC usage scenarios, then only the following requirements are mandatory:

- User plane latency:
  - The minimum requirements for user plane latency is 1 ms for URLLC assuming unloaded conditions (i.e. a single user) for small IP packets (e.g. 0 byte payload + IP header), for both downlink and uplink.
- Control plane latency:
  - The minimum requirement for control plane latency is 20 ms. Proponents are encouraged to consider lower control plane latency, e.g. 10 ms.
- Reliability:
  - The minimum requirement for the reliability is $1\text{-}10^{-5}$ success probability of transmitting a layer 2 PDU (protocol data unit) of 32 bytes within 1 ms in channel quality of coverage edge for the Urban Macro-URLLC test environment, assuming small application data (e.g. 20 bytes application data + protocol overhead).
- Mobility interruption time:
  - The minimum requirement for mobility interruption time is 0 ms.
- Bandwidth:
  - The requirement for bandwidth is at least 100 MHz.
- Connection density:
  - The minimum requirement for connection density is 1 000 000 devices per km^2.

The primary spectrum is the core DECT frequency band (1 880 MHz - 1 900 MHz). However, other bands may be possible worldwide, including allowed IMT bands. There is also the possibility of utilizing 1 900 MHz - 1 920 MHz as a "DECT extension band".

NOTE: When operating in the core DECT frequency band, it is important to coexist with legacy DECT devices, and so the basic frequency channel and TDMA frame structure is similar to legacy DECT.

State-of-the-art PHL design utilizing OFDM, MIMO and HARQ will be used to allow much higher data rates, lower latency and reliability compared to legacy DECT.

The proposed PHL layer supports up to 8 spatial streams, with Modulation and Coding Schemes (MCS) up to 1024-QAM with 5/6 coding rate, variable length slots and the ability to aggregate standard DECT channels (i.e. multiples of the legacy 1 728 MHz bandwidth).

For example, Table 1 shows the raw data rate for a single spatial stream, using 1 DECT channel (i.e. 1 728 MHz bandwidth), for various MCS configurations.

Table 1: Raw data rate for single spatial stream (N_{SS} = 1), 1 728 MHz bandwidth

MCS	Modulation	R	N_{DBPS}	Data rate (kbits/s)
0	BPSK	1/2	26	624
1	QPSK	1/2	52	1 248
2	QPSK	3/4	78	1 872
3	16-QAM	1/2	104	2 496
4	16-QAM	3/4	156	3 744
5	64-QAM	2/3	208	4 992
6	64-QAM	3/4	234	5 616
7	64-QAM	5/6	260	6 240
8	256-QAM	3/4	312	7 488
9	256-QAM	5/6	-	-
10	1024-QAM	3/4	390	9 360
11	1024-QAM	5/6	-	-

In Table 1, R is the coding rate and N_{DBPS} is the number of data bits per symbol.

The data rate given in Table 1 is the raw data rate in kbits/sec. For example, for MCS 0 the N_{DBPS} is 26 data bits persymbol and there are 10 symbols per slot, 24 slots per 10 ms frame and 100 frames per second, so the raw data rate is 26 × 10 × 24 × 100 = 624 000 bits/sec = 624 kbits/sec.

ETSI TR 103 514 [i.20] describes the detailed principals of the PHL layer. Further technical reports ETSI TR 103 635 [i.27] (on the MAC and higher layers) and ETSI TR 103 637 [i.28] (on security architecture) will also be published in 2019. Actual specifications for the new DECT-2020 standard will take some time, with priority given to the PHL and MAC layers initially (target 2020), and higher layers being completed thereafter.

History

Document history		
V1.1.1	November 2019	Publication