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Technical Report

**ElectroMagnetic Compatibility and Radio Spectrum Matters (ERM); System Reference document (SRdoc); DECT operating in the 1 900 MHz - 1 920 MHz band**

Reference
DTR/ERM-318

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# Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio spectrum Matters (ERM).

# Executive summary

The Digital Enhanced Cordless Telecommunications (DECT) system has started its operation in Europe in the band 1 880 MHz - 1 900 MHz. It has spread around the globe and has become the most successful digital cordless telephone system in the world. DECT has also been approved by the ITU as one of the International Mobile Telecommunications (IMT) systems. Today the majority of the applications are speech focused and are used in two different market segments. One is the domestic home market where low cost single cell devices are used. The other is the business market, which requires multi-cell systems with more complex functionality.

With the introduction of 'DECT New Generation' internet connectivity is provided to the user. Together with voice over IP high quality wide band and super wide band speech codecs have been introduced in DECT. Several supplementary services as well as headset management have been standardized. For applications with increased security requirements additional authentication and encryption algorithms have been defined in the standard. With the publication of the 'Ultra Low Energy' (ULE) Technical Specification DECT will support a new range of applications mainly in the area of machine-to-machine communication.

More than 820 million DECT devices have now been sold worldwide, which continues to increase by over 100 million per annum (Source: MZA).

**Why more spectrum is needed**

DECT was initially primarily a 3,1 kHz telephony service conveyed over radio links. Recent new developments such as DECT New Generation now also offer wideband 7 kHz voice transmission, a super-wideband 14 kHz service, different data services and video surveillance. While these technological advances are well received, because they are reflecting the general trend towards multimedia devices, they are also requiring a lot more bandwidth.

The use of softphones as a telephony solution in the business market is increasing in all regions worldwide with annual growth figures > 10 %. This steady migration from traditional desk based telephones does result in users adopting new device solutions for their audio connectivity. The wireless headset is now a prime audio device chosen by softphones users. Therefore, such users who may not be on an active telephony call may still be in a wideband audio media link between telephony calls.

As DECT is a very efficient, reliable and cost effective system, new applications are being developed using this technology. One new feature of DECT is the 'Ultra Low Energy' (ULE) operation mode which has been developed during 2012. This allows battery operated devices to work for up to 10 years without changing the battery. The ULE mode, together with the other DECT properties, make this technology ideal for use in various machine-to-machine applications, which will increase the number of DECT terminals massively.

The combined effect of successful softphone adoption, wideband telephony, music at work and deployment of wireless devices is today already causing density issues within the existing available spectrum leading to deployments being affected or restricted. In addition new services are starting to be deployed such as video applications, and data applications e.g. for home control. The current limitation of the DECT band will become an increasing inhibitor to the further growth of the technology. The new products will only be successful, if adequate spectrum is available.

**Advantages of the band 1 900 MHz - 1 920 MHz**

Most technical documents are already available. The carrier numbers and positions for the use of DECT in the 1 900 MHz - 1 920 MHz band are already defined (see EN 300 175-2 [i.2] annex F) as a consequence of the IMT allocation. The Harmonized standard for DECT over this band is already available as part of the IMT-2000 set. It is the EN 301 908-10 [i.22] (latest release, V4.1.1).

Immediate implementation is possible. It should be noted that the frequencies 1 900 MHz - 1 930 MHz are already in use by DECT in non EU countries and that there are already products (> 100 million of devices) in operation over these frequencies. Nearly all DECT chipset and RF parts vendors are already providing components compatible with the proposed new allocation. There is no other band where the DECT extension is as simple and immediate. This, combined with the proposed license exempt regime, will make possible the real usage of the band by the public in the very short term.

The allocation of adjacent band 1 900 MHz - 1 920 MHz to DECT will provide a single continuous block of 40 MHz. This would provide the possibility of the further evolution of the standard towards broadband services with higher bandwidth than today.

If a continuous 40 MHz DECT allocation is given, two additional carriers can be obtained from the guard space. Therefore, twelve new carriers, instead of ten, will be added with the 20 MHz extension.

# Introduction

The present document has been developed to support the co-operation between ETSI and the Electronic Communications Committee (ECC) of the European Conference of Post and Telecommunications Administrations (CEPT).

### Status of pre-approval draft

The present document was developed by **TC DECT** and approved by ERM at its [**#50** meeting, 24-28.6.2013]. It contains final information.

| Target version | Pre-approval date version (see note) | | | | |
|---|---|---|---|---|---|
| | a | s | m | Date | Description |
| V1.1.1 | 0 | 0 | 1 | 2013-01-10 | First draft |
| V1.1.1 | 0 | 0 | 2 | 2013-04-03 | Stable draft |
| V1.1.1 | 0 | 0 | 3 | 2013-04-11 | Stable draft (TR number added) |
| V1.1.1 | 0 | 0 | 4 | 2013-05-02 | Stable draft<br>Update of summary and clause 8 |
| V1.1.1 | 0 | 0 | 5 | 2013-05-28 | Stable draft<br>Annex A with simulation results added |
| V1.1.1 | 0 | 0 | 6 | 2013-06-06 | Final draft |
| NOTE: See EG 201 788 [i.21] (V2.1.1), clause A.2. | | | | | |

# 1 Scope

The present document describes DECT operating in the frequency band 1 900 MHz - 1 920 MHz.

It includes in particular:

- Market information;
- Technical information;
- Regulatory issues.

# 2 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.

## 2.1 Normative references

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

Not applicable.

## 2.2 Informative references

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 300 176 (all parts): "Digital Enhanced Cordless Telecommunications (DECT); Test specification".

[i.10] Recommendation ITU-R M.1457-10: "Detailed specifications of the radio interfaces of International Mobile Telecommunications-2000 (IMT-2000)".

[i.11] ERC Report 31 (June 1994): "Compatibility between DECT and DCS1800".

[i.12] ERC Report 100 (February 2000): "Compatibility between certain radio communications systems operating in adjacent bands, evaluation of DECT / GSM 1800 compatibility".

[i.13] ECC Report 96 (March 2007): "Compatibility between UMTS 900/1800 and systems operating in adjacent bands".

[i.14] ECC Report 146 (June 2010): "Compatibility between GSM MCBTS and other services (TRR, RSBN/PRMG, HC-SDMA, GSM-R, DME, MIDS, DECT) operating in the 900 and 1800 MHz frequency bands".

[i.15] CEPT Report 41 (November 2010): "Compatibility between LTE and WiMAX operating within the bands 880-915 MHz / 925-960 MHz and 1710-1785 MHz / 1805-1880 MHz (900/1800 MHz bands) and systems operating in adjacent bands".

[i.16] ERC Report 65 (November 1999): "Adjacent band compatibility between UMTS and other services in the 2 GHz Band".

[i.17] CEPT Report 39 (June 2010): "Report from CEPT to the European Commission in response to the Mandate to develop least restrictive technical conditions for 2 GHz bands".

[i.18] ETSI TR 103 089: "Digital Enhanced Cordless Telecommunications (DECT); DECT properties and radio parameters relevant for studies on compatibility with cellular technologies operating on frequency blocks adjacent to the DECT frequency band".

[i.19] Recommendation ITU-R M.1036-3: "Frequency arrangements for implementation of the terrestrial component of International Mobile Telecommunications-2000 (IMT 2000) in the bands 806 960 MHz, 1 710-2 025 MHz, 2 110 2 200 MHz and 2 500-2 690 MHz".

[i.20] ITU Radio Regulations.

[i.21] ETSI EG 201 788 (V1.2.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Guidance for drafting an ETSI System Reference document (SRdoc)".

[i.22] 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: Harmonized EN for IMT-2000, FDMA/TDMA (DECT) covering essential requirements of article 3.2 of the R&TTE Directive".

[i.23] ETSI TR 101 310: "Digital Enhanced Cordless Telecommunications (DECT); Traffic capacity and spectrum requirements for multi-system and multi-service DECT applications co-existing in a common frequency band".

[i.24] ETSI EN 300 444: "Digital Enhanced Cordless Telecommunications (DECT); Generic Access Profile (GAP)".

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

[i.26] ETSI TS 102 527-1: "Digital Enhanced Cordless Telecommunications (DECT); New Generation DECT; Part 1: Wideband speech".

# 3 Abbreviations

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

| | |
|---|---|
| AGR | Average Growth Rate |
| AM | Amplitude Modulation |
| BER | Bit Error Rate |
| CEPT | European Conference of Post and Telecommunications Administrations |
| DECT | Digital Enhanced Cordless Telecommunications |
| DPRS | DECT Packet Radio Service |
| ECC | Electronic Communications Committee |
| $F_C$ | Carrier Frequency |
| $F_L$ | Lower Frequency |
| $F_U$ | Upper Frequency |
| GAP | Generic Access Profile |
| GIA | Global Industry Analysts |
| GoS | Grade of Service |
| iDCS | instant Dynamic Channel Selection |
| IMT | International Mobile Telecommunications |
| IP | Internet Protocol |
| IT | Information Technology |
| ITU | International Telecommunications Union |
| ITU-R | International Telecommunication Union - Radiocommunication sector |
| M2M | Machine to Machine |
| MAC | Medium Access Control |
| NTP | Normal Transmitted Power |
| OFDMA | Orthogonal Frequency Division Multiple Access |
| PC | Personal Computer |
| PP | Portable Part |
| QAM | Quadrature Amplitude Modulation |
| RF | Radio Frequency |
| RFP | Radio Fixed Part |
| RLL | Radio Local Loop |
| SRdoc | System Reference document |
| TDD | Time Division Duplex |
| TDMA | Time Division Multiple Access |
| UL/DL | UpLink/DownLink |
| ULE | Ultra Low Energy |
| WRS | Wireless Relay Station |

# 4 Comments on the System Reference Document

No ETSI members raised any comments.

# 5 Presentation of the system or technology

DECT is a general radio access technology for wireless telecommunications, for cell radii ranging from a few meters to several kilometres, depending on application and environment. The DECT technology provides a comprehensive set of protocols which provide the flexibility to interwork between numerous different applications and networks. The standard specifies a high capacity TDMA/TDD radio interface supporting symmetric and asymmetric connections, connection oriented and connectionless data transport and provides security and confidentiality services. The mandatory instant Dynamic Channel Selection (iDCS) messages and procedures provide effective co-existence of uncoordinated private and public systems on the common designated DECT frequency band and avoid any need for traditional frequency planning.

The first version of the multipart DECT base standard EN 300 175 was published in 1992. In the same year the first DECT speech and data products appeared on the market. Three years later the EN 300 444 [i.24], the 'Generic Access Profile' (GAP), was completed, which is an interoperability profile for DECT speech products.

In the year 2000 the ITU approved DECT as an air-interface of IMT-2000 and the technology was included in the corresponding Recommendation ITU-R M.1457-10 [i.10]. In the same year the DECT Packet Radio Service (DPRS) specification EN 301 649 [i.25] was published. In 2003 high level modulation modes with a rate of up to ~7 Mbit/s and turbo coding were introduced in the base standard.

With the introduction of 'DECT New Generation' internet connectivity is provided to the user. Together with voice over IP high quality wide band and super wide band speech codecs have been introduced in DECT. TS 102 527-1 [i.26] was first published in 2007. In later parts several supplementary services as well as headset management and software update over the air have been standardized. For applications with increased security requirements additional authentication and encryption algorithms have been defined.

In 2012, TC DECT continued to work on a new application of DECT for a completely different market - Ultra Low Energy (ULE). The low power consumption of ULE technology extends battery life (typically up to ten years) and, with New Generation DECT, connectivity to the Internet is already available, which makes the technology ideal for sensors, alarms, machine-to-machine applications and industrial automation.

# 6 Market information

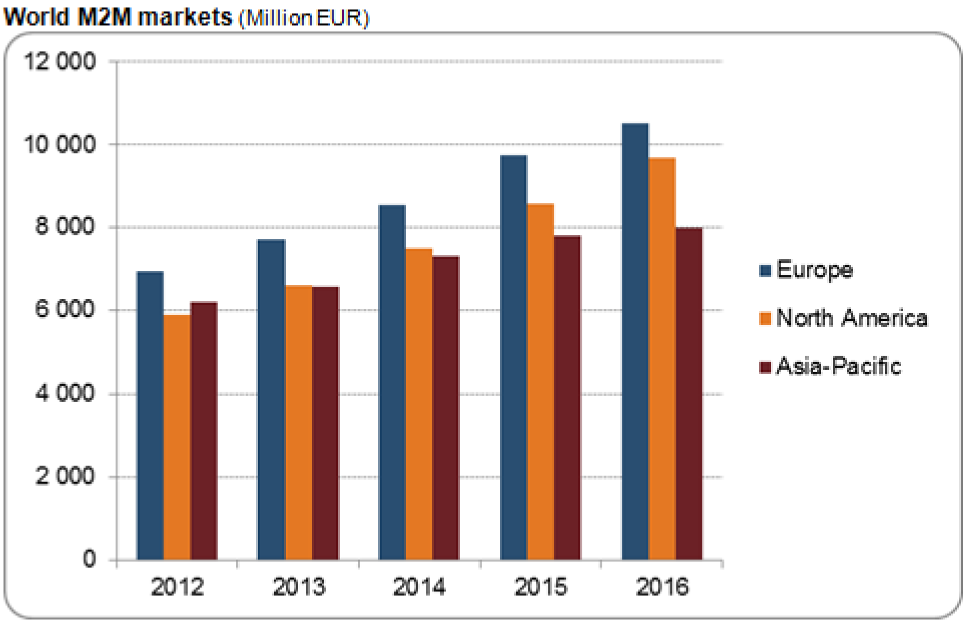
## 6.1 The DECT market today

With over 820 million devices installed throughout the world, ETSI's DECT specification is the leading standard worldwide for digital cordless telecommunications for both cordless voice and broadband home communication. The system has been adopted in over 110 countries and every year more than 100 million new devices are sold. DECT products now account for more than 80 % of the world market. DECT systems are very often deployed indoors.

## 6.2 The M2M market

"The M2M market is growing very fast but its development is not spread out homogeneously over the verticals markets," says Samuel Ropert, project manager and senior consultant at IDATE. He adds: "Take the automotive industry worldwide: in volume we predict an average growth rate (AGR) of 40 % until 2016. In parallel, the Consumer Electronics industry has an AGR of 15 % and will represent barely a third of the M2M volume for the automotive industry in 2016".

The M2M market is growing very fast. In 2012, the cellular market is expected to represent 140 million modules worldwide for a total market of 22 billion EUR (of which 5,1 billion EUR for connectivity). The annual growth of the M2M market was around 14 % in value and 36 % in volume. Most revenues will come from software and IT services (around two-thirds of total market value). The world M2M market should grow by 30 % in volume, to represent almost 370 million modules in 2015. Asia-Pacific should dominate Europe and North America in volume only. Europe should still lead in value, followed by North America.




Source: IDATE

According to oneM2M the number of worldwide M2M connections is growing exponentially, with some forecasts as high as 50 billion by 2020. These connections will reside within virtually every major market category, and oneM2M will play a vital role to ensure that these industries - from healthcare to transportation and energy to agriculture - can benefit fully from the economic growth and innovation opportunities that M2M communications presents.

According to a press release from Lisa Arrowsmith, 1st of November 2012: A new study from IMS Research, recently acquired by IHS (NYSE: IHS), projects that the global market for smart home devices will more than quadruple in the coming five years, growing from less than 20 million nodes this year, to more than 90 million in 2017. While ZigBee and Z-Wave dominate the managed service market today, a range of other low-power wireless technologies, such as EnOcean and DECT ULE are set to take the stage as shipments of these technologies gain traction. Arrowsmith continues, "The energy-harvesting properties of EnOcean can be attractive for service providers and consumers alike, reducing maintenance and support costs. DECT ULE will also see significant uptake in managed systems, as it can enable existing DECT gateway customers to add home control functionality via an over-the-air software upgrade."

# 7 Technical information

## 7.1 Detailed technical description

A detailed technical description can be found in the DECT base standard EN 300 175 parts 1 [i.1] to 8 [i.8] and in the test specifications EN 300 176 parts 1 and 2 [i.9].

## 7.2 Technical parameters and implications on spectrum

### 7.2.1 Status of technical parameters

#### 7.2.1.1 Current ITU and European Common Allocations

Relevant documents are the ITU Radio Regulations [i.20] and the Recommendation ITU-R M.1036-3 [i.19].

#### 7.2.1.2 Sharing and compatibility studies already available

The following documents, which include compatibility studies concerning DECT, have been identified and may be used by CEPT for their sharing and compatibility studies.

- ERC Report 31 [i.11].
- ERC Report 100 [i.12].
- ECC Report 96 [i.13].
- ECC Report 146 [i.14].
- CEPT Report 41 [i.15].
- ERC Report 65 [i.16].
- CEPT Report 39 [i.17].
- ETSI TR 103 089 [i.18].

#### 7.2.1.3 Sharing and compatibility issues still to be considered

None.

### 7.2.2 Transmitter parameters

#### 7.2.2.1 Transmitter Output Power/Radiated Power

The NTP is the transmitted power averaged from the start of symbol p0 of the physical packet, to the end of the physical packet. The NTP should be less than 250 mW (24 dBm) per simultaneously active transceiver at extreme conditions.

Typically the fixed part is transmitting at a constant power level, but this power may be less than the maximum allowed value. For the portable part a power control algorithm has been defined and normally the portable part will adjust the transmit power to the required level.

**Table 1: Emissions due to modulation**

| Emissions on RF channel "Y" | Maximum power level |
|---|---|
| Y = M ± 1 | 160 µW |
| Y = M ± 2 | 1 µW |
| Y = M ± 3 | 80 nW |
| Y = any other DECT channel | 40 nW |
| NOTE: For Y = "any other DECT channel", the maximum power level should be less than 40 nW except for one instance of a 500 nW signal. | |

The power in RF channel Y is defined by integration over a bandwidth of 1 MHz centred on the nominal centre frequency, Fy, averaged over at least 60 % but less than 80 % of the physical packet, and starting before 25 % of the physical packet has been transmitted but after the synchronization word.

The power level of all modulation products (including Amplitude Modulation (AM) products due to the switching on or off of a modulated RF carrier) arising from a transmission on RF channel M should, when measured using a peak hold technique, be less than the values given in table 2. The measurement bandwidth should be 100 kHz and the power should be integrated over a 1 MHz bandwidth centred on the DECT frequency, Fy.

**Table 2: Emissions due to transmitter transients**

| Emissions on RF channel "Y" | Maximum power level |
|---|---|
| Y = M ± 1 | 250 µW |
| Y = M ± 2 | 40 µW |
| Y = M ± 3 | 4 µW |
| Y = any other DECT channel | 1 µW |

### 7.2.2.1a Antenna Characteristics

The antenna gain should be equal or less than 6 + X dBi. X is the difference in dB between 24 dBm and the NTP expressed in dBm for any one active transmitter. Smart antennas may be used.

NOTE: This corresponds to 1 W effective isotropic radiated power. In addition the maximum value for the normal transmitted power is 250 mW.

### 7.2.2.2 Operating Frequency

The carrier frequencies are defined by:

- Fc = F9 + c × 1,728 MHz

Where:

- F9 = 1 881,792 MHz; and
- c = 11, 12, 13, ..., 21.

**Table 3: Carrier frequencies**

| Carrier number c | Rf-band number | Carrier frequency (MHz) |
|---|---|---|
| 11 | 00001 | 1 900,800 |
| 12 | 00001 | 1 902,528 |
| 13 | 00001 | 1 904,256 |
| 14 | 00001 | 1 905,984 |
| 15 | 00001 | 1 907,712 |
| 16 | 00001 | 1 909,440 |
| 17 | 00001 | 1 911,168 |
| 18 | 00001 | 1 912,896 |
| 19 | 00001 | 1 914,624 |
| 20 | 00001 | 1 916,352 |
| 21 | 00001 | 1 918,080 |

### 7.2.2.3 Bandwidth

The typical bandwidth is 1 MHz.

### 7.2.2.4 Unwanted emissions

The peak power level of any RF emissions outside the radio frequency band allocated to DECT, as defined in clause 7.2.2.1, when a radio end point has an allocated physical channel, should not exceed 250 nW at frequencies below 1 GHz and 1 µW at frequencies above 1 GHz. The power should be defined in the bandwidths given in table 4. If a radio end point has more than one transceiver, any out of band transmitter intermodulation products should also be within these limits.

**Table 4: Measurement bandwidth for the spurious emissions**

| Frequency offset, fo From edge of band | Measurement bandwidth |
|---|---|
| 0 MHz ≤ fo < 2 MHz | 30 kHz |
| 2 MHz ≤ fo < 5 MHz | 30 kHz |
| 5 MHz ≤ fo < 10 MHz | 100 kHz |
| 10 MHz ≤ fo < 20 MHz | 300 kHz |
| 20 MHz ≤ fo < 30 MHz | 1 MHz |
| 30 MHz ≤ fo < 12,75 GHz | 3 MHz |

Measurements should not be made for transmissions on the RF channel closest to the nearest band edge for frequency offsets of up to 2 MHz.

In addition, not regarding up to 2 instances of a continuous-wave spurious signal for PPs for which the total peak power level should be less than 250 nW as measured in a 3 MHz measurement bandwidth, the peak power level should be less than 20 nW in a 100 kHz measuring bandwidth for the following broadcast bands:

- 47 MHz to 74 MHz;
- 87,5 MHz to 108 MHz;
- 108 MHz to 118 MHz;
- 174 MHz to 230 MHz;
- 470 MHz to 862 MHz.

## 7.2.3 Receiver parameters

### 7.2.3.1 Radio receiver sensitivity

The radio receiver sensitivity should be -83 dBm (i.e. 60 dBμV/m), or better.

### 7.2.3.2 Receiver intermodulation performance

With a call set up on a particular physical channel, two interferers are introduced so that they can produce an intermodulation product on the physical channel already in use.

If RF carrier number "d" is in use, a reference DECT interferer and a continuous wave interferer are introduced on DECT carriers "e" and "f" to produce an intermodulation product on carrier "d". Neither "e" nor "f" should be adjacent to "d".

The received level of carriers "e" and "f" should be -48 dBm and the received level of carrier "d" should be -80 dBm.

With "e" and "f" being received 32 dB greater than "d", and "d" being received at -80 dBm, the receiver should still operate with a BER of less than 0,001 in the D-field.

### 7.2.3.3 Radio receiver interference performance

With a received signal strength of -73 dBm (i.e. 70 dBμV/m) on RF channel M, the BER in the D-field should be maintained better than 0,001 when a modulated, reference DECT interferer of the indicated strength is introduced on the DECT RF channels shown in table 5.

**Table 5: Receiver interference performance**

| Interferer on RF channel "Y" | Interferer signal strength | |
|---|---|---|
| | (dBμV/m) | (dBm) |
| Y = M | 59 | -84 |
| Y = M ± 1 | 83 | -60 |
| Y = M ± 2 | 104 | -39 |
| Y = any other DECT channel | 110 | -33 |
| NOTE: The RF carriers "Y" should include the three nominal DECT RF carrier positions immediately outside each edge of the DECT band. | | |

#### 7.2.3.4 Radio receiver blocking

With the desired signal set at -80 dBm, the BER should be maintained below 0,001 in the D-field in the presence of any one of the signals shown in table 5.

The receiver should operate on a frequency band allocation with the low band edge $F_L$ MHz and the high band edge $F_U$ MHz.

**Table 6: Receiver blocking**

| Frequency (f) | Continuous wave interferer level | |
|---|---|---|
| | For radiated measurements dB μV/m | For conducted measurements dBm |
| 25 MHz ≤ f < $F_L$ - 100 MHz | 120 | -23 |
| $F_L$ - 100 MHz ≤ f < $F_L$ - 5 MHz | 110 | -33 |
| $\lvert f - F_C \rvert$ > 6 MHz | 100 | -43 |
| $F_U$ + 5 MHz < f ≤ $F_U$ + 100 MHz | 110 | -33 |
| $F_U$ + 100 MHz < f ≤ 12,75 GHz | 120 | -23 |

### 7.2.4 Channel access parameters

#### 7.2.4.1 Frame length

The frame length is 10 ms.

#### 7.2.4.2 Channel selection

The channel selection is described in clause 11.4 of the MAC layer specification [i.3].

Before initiating a radio transmission it is required to select the least interfered channel. This is achieved by measuring the field strength on each channel or if a channel is found, whose signal level if below a defined value that indicates that this channel is free. During a radio transmission the signal quality is continuously monitored and if the signal is interfered or if a better channel becomes available, then a seamless handover is performed. This means that the DECT system is always optimizing the channel usage in order to achieve the optimum overall transmission quality.

## 7.3 Information on relevant standard(s)

Relevant standards are:

- ETSI EN 300 175-1 [i.1]
- ETSI EN 300 175-2 [i.2]
- ETSI EN 300 175-3 [i.3]
- ETSI EN 300 175-4 [i.4]

- ETSI EN 300 175-5 [i.5]
- ETSI EN 300 175-6 [i.6]
- ETSI EN 300 175-7 [i.7].
- ETSI EN 300 175-8 [i.8].
- ETSI EN 300 176 (all parts) [i.9].
- Recommendation ITU-R M.1457-10 [i.10].
- ETSI EN 301 908-10 [i.22].

# 8 Radio spectrum request and justification

## 8.1 Why additional spectrum is needed

DECT technology has over 820 million of accumulated devices since its introduction in the market. The accumulated number of DECT devices grows at a rate of over 100 million devices per year. This is far more than initially expected and is supported by only 20 MHz of allocation. While the operation of the technology is currently successful, it appears prudent to assign additional bandwidth for further expansion of the technology.

DECT was initially primarily a 3,1 kHz telephony service conveyed over radio links. Recent new developments such as DECT New Generation now also offer wideband 7 kHz voice transmission, a super-wideband 14 kHz service, different data services and video surveillance. While these technological advances are well received, because they are reflecting the general trend towards multimedia devices, they are also requiring a lot more bandwidth.

The use of softphones as a telephony solution in the business market is increasing in all regions worldwide with annual growth figures > 10 %. By the year 2017, the Global Industry Analysts (GIA) group project market adoption of 2,9 million units [GIA online, 2011]. This steady migration from traditional desk based telephones does result in users adopting new device solutions for their audio connectivity. The headset is now a prime audio device chosen by softphones users as PCs are not shipped with the traditional handset that a desk based hard phone would be supplied with. Whether it be in a contact centre environment or office environment, the use of PC based telephony which delivers wideband audio is leading to behaviour change within these organizations. Users equipped with headsets that deliver enhanced (wideband) audio may use the same devices to stream music from their connected PCs. Therefore, such users who may not be on an active telephony call may still be in a wideband audio media link between telephony calls.

DECT technology is used in wireless headsets solutions. Many large Enterprises recognize the benefits that these wireless devices bring and promote deployment of them within their businesses for their office users as well as for their more traditionally contact centre users. Such large enterprises may occupy single buildings with staff levels in excess of 500 users, each one requiring a wireless device. Within city business areas, adjacent large organizations may also seek to use the same wireless technology.

As DECT is a very efficient, reliable and cost effective system, new applications are being developed using this technology. One new feature of DECT is the 'Ultra Low Energy' (ULE) operation mode which has been developed during 2012. This allows battery operated devices to work for up to 10 years without changing the battery. The ULE mode, together with the other DECT properties, make this technology ideal for use in various machine-to-machine applications, which will increase the number of DECT terminals massively.

The combined effect of successful softphone adoption, wideband telephony, music at work and deployment of wireless devices is causing already today density issues within the existing spectrum available leading to deployments being affected or restricted. In addition new services are starting to be deployed such as video applications and data applications like home control. The current limitation of the DECT band will become an increasing inhibitor to the further growth of the technology. The new products will only be successful, if adequate spectrum is available.

## 8.2 What are the specific advantages of the band 1 900 MHZ - 1 920 MHz

Most technical documents are already available. The carrier numbers and positions for the use of DECT in the 1 900 MHz - 1 920 MHz band are already defined (see EN 300 175-2 [i.2] annex F) as a consequence of the IMT allocation. The Harmonized standard for DECT over this band is already available as part of the IMT-2000 set. It is the EN 301 908-10 [i.22] (latest release, V4.1.1).

Immediate implementation is possible. It should be noted that the frequencies 1 900 MHz - 1 930 MHz are already in use by DECT in non EU countries and that there are already products (> 100 million of devices) in operation over these frequencies. Nearly all DECT chipset and RF parts vendors are already providing components compatible with the proposed new allocation. There is no other band where the DECT extension is as simple and immediate. This, combined with the proposed license exempt regime, will make possible the real usage of the band by the public in the very short term.

The allocation of adjacent band 1 900 MHz - 1 920 MHz to DECT will provide a single continuous block of 40 MHz. This, in combination with the use of already defined High Level Modulation (up to 64 QAM) would make possible the introduction of broadband services to DECT. This would make also possible the further evolution of the standard towards OFDMA. A maximum bitrate of 1 Gbit/sec is theoretically achievable over the combined 40 MHz block using already proposed evolutions of the standard.

If a continuous 40 MHz DECT allocation is given, TWO additional carriers providing 24 DECT full-slot duplex-channels can be obtained from the guard space. Therefore, twelve new carriers, instead of ten, will be added with the 20 MHz extension.

## 8.3 The request

It is proposed to change the regime for DECT in the 1 900 MHz - 1 920 MHz band to allow license exempt operation, in the same way as in the original DECT band (1 880 MHz - 1 900 MHz). If this change is approved, a significant and immediate use of the band by the public (via new DECT products) should be expected as explained in the clauses 8.1 and 8.2.

# 9 Regulations

## 9.1 Current regulations

Relevant documents are the ITU Radio Regulations [i.20] and the Recommendation ITU-R M.1036-3 [i.19].

## 9.2 Proposed regulation and justification

Proposed is the allocation of the band 1 900 MHz - 1 920 MHz for license exempt operation of DECT. This band is adjacent to the existing DECT band and can therefore be considered as an extension of the existing band. This maximizes the spectrum efficiency as no guard band is needed between two DECT bands and therefore two additional carriers become available.

# Annex A: Simulation results for wireless office systems

This annex is based on results which have been published in the TR 101 310 [i.23]. The main assumptions and results of the simulations carried out for wireless office systems are summarized. First the simulation scenario is described and then the reported results are presented.

# A.1 Simulation scenario

Terminals are randomly positioned (with uniform distribution) within a reference three-storey building 100 m × 100 m × 9 m, in which 16 base stations are regularly spaced on each storey (figure A.1). Each terminal generates 0,2 E of traffic and the mean duration of the call is 120 s.

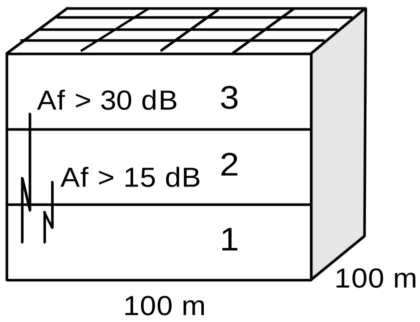



**Figure A.1: Reference building**

Two different radio propagation models have been considered:

The ETSI model assumes a propagation exponent accounting for the path loss equal to 3,5, an attenuation between floors of 15 dB, and a shadow margin factor uniformly distributed in the range ±10 dB.

$$l(d) = 30 + 35 \log(d) + 15 \times (\text{number of floors})$$

A model for more heavy construction buildings, the Ericsson loss Model, has also been used.

Ericsson-in-Building loss model:

$$l(d) = 38 + 30 \log(d) + 15 \times (\text{number of floors}) \qquad d < 20\text{ m}$$

$$l(d) = -1 + 60 \log(d) + 15 \times (\text{number of floors}) \qquad 20\text{ m} < d < 40\text{ m}$$

$$l(d) = -97 + 120 \log(d) + 15 \times (\text{number of floors}) \qquad d > 40\text{ m}$$

The shadowing margin is modelled with a log-normal law with zero mean and a standard deviation of 8 dB.

In both the models the Rayleigh fade margin is 10 dB, when antenna diversity is applied; the C/I threshold is 11 dB, so the call set-up threshold is 21 dB.

The system spectrum allocation, the radio parameters, such as transmitted power, receiver noise floor, adjacent channel rejection factors, etc. and the call procedures, such as set-up and handover for both single and multi-bearer channel allocation models, are in accordance with the DECT specifications (see EN 300 175-3 [i.3]). Base station blind slot information is available at the PPs for the simulations in clause A.2, whilst not in clause A.2.2.

The aim of this work is to evaluate the GoS versus the average traffic per base station and the total number of available DECT carriers (total spectrum). GoS is defined as follows:

$$GOS = \frac{\text{number of blocked calls} + 10 \times \text{number of interrupted calls}}{\text{total number of calls}}$$

In simulation works dealing with DECT performance (TR 101 310 [i.23]) the desired GoS should be less than 1 %.

# A.2 Simulation results

For the simulations in this clause, DECT capacity in offices, intracell and intercell handover is provided and 20 % of the users are moving. The capacity is expressed in average speech traffic (Erlangs) per base station, as a function of the number of carriers that has been allocated to the system. Each base station contains two radios and the portable parts use uplink power control, in order to be able to support 12 wideband voice channels per base station. Table A.1 provides a summary for the 1 % blocking case using the ETSI loss model. Table A.2 is the same summary for a heavy construction building where the Ericsson Loss model has been used.

**Table A.1: Average traffic per base station (at 1 % blocking probability) in an office application as a function of total number of DECT access channels (the ETSI loss model has been used)**

| No. of carriers/ access channels | Average traffic per base station | Average number of users (at 0,2 E) per base station | Traffic/km²/floor, if 625 m² per base station (25 m separation) |
|---|---|---|---|
| 4/24 | 1,3 E | 7 | 2 100 E |
| 8/48 | 3,2 E | 16 | 5 100 E |
| 12/72 | 4,5 E | 23 | 7 200 E |
| 16/96 | 5,3 E | 27 | 8 500 E |
| 20/120 | 5,6 E | 28 | 9 000 E |

It can be seen from table A.1 that the capacity is C/I limited up to about 12 carriers. For higher number of carriers the capacity becomes trunk limited (maximum 12 simultaneous calls per base station). For table A.2 the limit is at 8 to 10 carriers.

**Table A.2: Average traffic per base station (at 1 % blocking probability) in an office application as a function of total number of DECT access channels (the Ericsson loss model has been used)**

| No. of carriers/access channels | Average traffic per base station | Average number of users (at 0,2 E) per base station | Traffic/km²/floor, if 625 m² per base station (25 m separation) |
|---|---|---|---|
| 4/24 | 2,1 E | 11 | 3 400 E |
| 8/48 | 4,4 E | 22 | 7 000 E |
| 12/72 | 5,5 E | 26 | 8 800 E |
| 16/96 | 6,1 E | 31 | 9 800 E |
| 20/120 | 6,1 E | 31 | 9 800 E |

Regarding capacity calculations, the figure average traffic (E) per base station is the essential parameter. The traffic density figures, traffic/km$^2$ and number of users per floor, depend directly on the base station density (base stations per km$^2$ or per floor). The results below may be extended to cover other base station densities, by varying the base station density, but keeping the E/base figures from the tables. We may conclude that with about 25 m base station separation 20 carriers (40 MHz) will provide about 10 000 E/km$^2$.

## A.2.1 Capacity in large office landscapes with soft partitioning

Simulations have also been made for a very large single floor 300 × 300 m office landscape with semi-high soft partitionings, but without interior walls. The propagation model is:

$$L = 41 + 20\log(d) + \Gamma \times \mathrm{Max}\left[0, (d-10)\right] \mathrm{dB}, \quad \text{where } \Gamma \text{ is } 0{,}37\ \mathrm{dB/m} \text{ or } 0{,}59\ \mathrm{dB/m}.$$

The higher attenuation figure corresponds to a high density of partitions.

The results are summarized in table A.3.

**Table A.3: Average traffic per base station (at 0,5 % blocking probability) in a large (300 m x 300 m) office landscape with soft partitioning as a function of total number of DECT access channels and as a function of total traffic**

| No. of carriers/ access channels (Γ) | Average traffic per base station | Number of base stations (base station separation, rectangular grid) | Traffic/km² (total traffic in the office) |
|---|---|---|---|
| 20/120 (0,37 dB/m) | 4,2 E | 12 (87 m) | 556 E (50 E) |
| 20/120 (0,37 dB/m) | 6,9 E | 36 (50 m) | 2 778 E (250 E) |
| 20/120 (0,37 dB/m) | 7,8 E | 64 (38 m) | 5 556 E (500 E) |
| 20/120 (0,37 dB/m) | 5,9 E | 169 (23 m) | 11 111 E (1 000 E) |
| 20/120 (0,59 dB/m) | 2,5 E | 20 (67 m) | 556 E (50 E) |
| 20/120 (0,59 dB/m) | 6,9 E | 36 (50 m) | 2 778 E (250 E) |
| 20/120 (0,59 dB/m) | 7,8 E | 64 (38 m) | 5 556 E (500 E) |
| 20/120 (0,59 dB/m) | 6,4 E | 156 (24 m) | 11 111 E (1 000 E) |

We see that the installation is range limited for the low traffic cases, and starts to become interference limited for the high traffic density cases. We also see that with about 24 m base station separation 20 carriers (40 MHz) will provide about 10 000 E/km$^2$, as for the simulations at the beginning of clause A.2.

## A.2.2 Interference to and from offices

The potential Interference to and from different wireless office systems in the same building has also been analysed. Below the main results are presented.

Two different scenarios are taken into account:

a) a single system in the building;

b) three different unsynchronized systems (one per floor).

As a first assumption, systems are considered unsynchronized, i.e. frames are not aligned; the shift between the first time-slot of the frames of each system is not greater than one time-slot as shown in figure A.2.

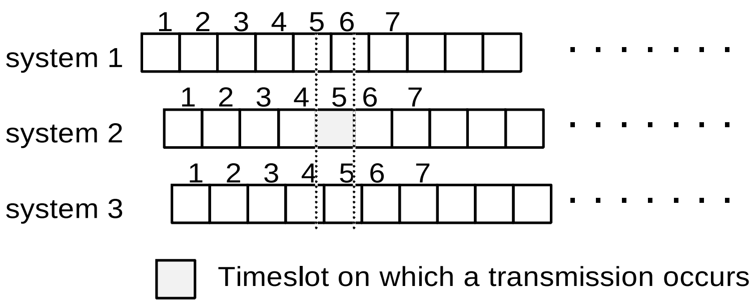



**Figure A.2: Three unsynchronized systems in the building**

When a single wireless office system is introduced in the building with a floor attenuation of 15 dB, the maximum capacity of the system in terms of Erlangs per RFP reached with a GoS equal to 1 % is about 5,6 E, that corresponds to 9 000 E/km$^2$/floor; if a higher separation between floors is introduced (i.e. Af = 20 dB), this value becomes 6 E, that is 9 600 E/km$^2$/floor. Note that blind slot information is not provided in this simulation. This explains the slight discrepancy with the results of clause A.2.

In the second scenario, a different wireless office system is positioned on each floor of the building; terminals can only set-up a call and make handovers with base stations of their system, that is of their floor. Two values on floor attenuation are taken into account: The different systems are unsynchronized. The comparison among the scenarios is shown in figure A.3.

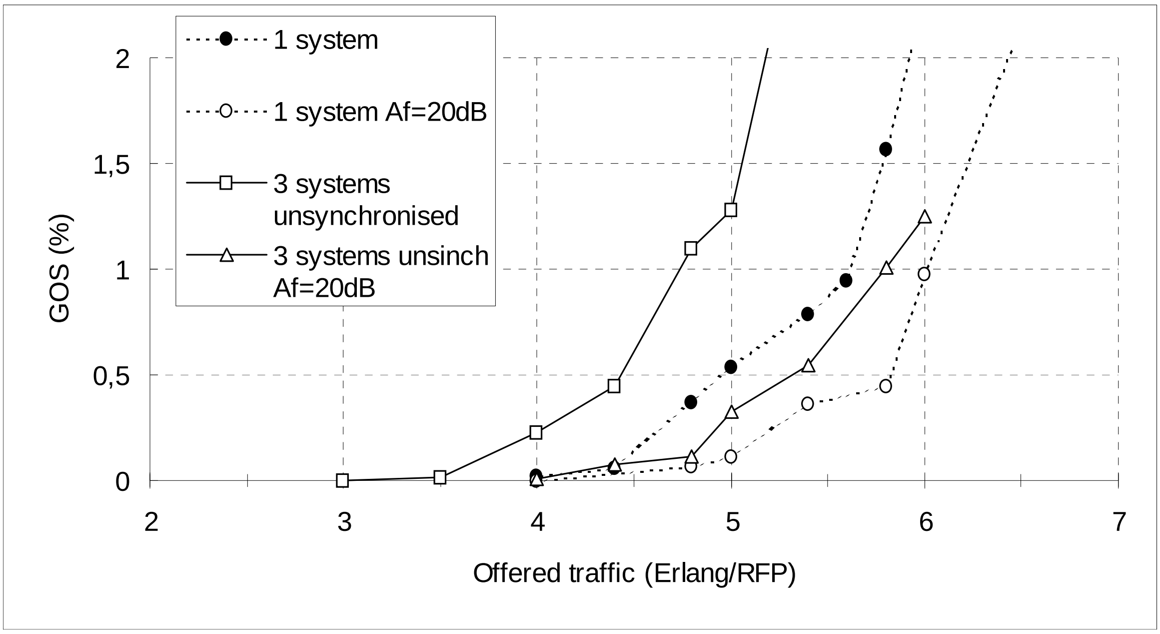



**Figure A.3: Offered traffic per RFP with one and three systems in the building**

The results obtained by simulations show that coexistence of different wireless office systems, also unsynchronized, is possible with a loss in capacity, in the worst case, less than 20 %; in fact the total capacity obtained is about 7 400 E/km$^2$/floor, instead of about 9 000 E/km$^2$/floor for the reference case of 1 system in the building with Af = 15 dB.

Better performance is obtained when the physical separation between different systems is higher, that is when the floor attenuation considered is 20 dB. In fact, in that case, the loss in capacity when 1 system in the building is substituted by 3 unsynchronized systems is almost negligible: The total capacity decreases from 9 600 E/km$^2$/floor to 9 300 E/km$^2$/floor.

Table A.4 summarizes the simulation results.

**Table A.4: Summary of comparison of capacity for unsynchronized office systems**

| System types | Af (dB) | Erlangs/RFP | Erlangs/km²/floor |
|---|---|---|---|
| 1 system on three floors | 15 | 5,6 | 9 000 |
| | 20 | 6 | 9 600 |
| 3 systems unsynchronized | 15 | 4,6 | 7 400 |
| | 20 | 5,8 | 9 300 |

# A.3 The impact of up-link power control

## A.3.1 Introduction

Power control of subscriber units has in the DECT standards been added to the Instant Dynamic Channel Selection (iDCS) procedures. It is called PP power control. It is required, if more than one radio is implemented in the base station. In addition it provides a number of advantages including increased capacity where the DECT environment is dominated by uncoordinated single cell systems.

## A.3.2 Power saving

PP power control increases the talk time of subscriber units. For this reason a number of manufacturers of residential DECT systems have already since many years used a simple (two step) open loop power control procedure.

## A.3.3 Control of maximum interference and cell sizes

DECT RFP down-link per connection power control is not possible due to the iDCS procedure. It is however possible to have a static reduced power for all down-link transmissions from a specific RFP. A DECT system may have the same reduced power on all RFPs, or have different power on different RFPs, which will result in different "cell sizes". Information on reduced RFP power may need to be broadcast to PPs using open loop power control.

By introducing PP power control no more power will be emitted during a call than what is needed.

## A.3.4 Capacity impact

### A.3.4.1 Single-radio RFPs and WRSs

#### A.3.4.1.1 Residential single cell systems

A number of adjacent residential systems appear as a set of mutually unsynchronized RFPs or cells. Since they are unsynchronized, the (in average) lower PP power will reduce the average level of mutual interference and thus reduce the local load on the spectrum.

#### A.3.4.1.2 Multi-cell systems

Multi-cell systems have all their RFPs synchronized. Since the down-link power is not changed, the down-link capacity will not be changed. Therefore the system capacity is not expected for be very much influenced by the PP power control, which has been confirmed by simulations.

### A.3.4.2 Multi-radio RFPs and WRSs

The total capacity of a single-radio RFP is trunk (slot) limited to about 5 or 6 E. A single-radio WRS is trunk limited to about 2 E. The way to increase the local capacity without increasing the number of RFP sites, is the use multi-radio RFPs and WRSs.

In a multi-radio RFP (or WRS) the same time slots will be used simultaneously on different carriers. Therefore it is important to have enough adjacent channel selectivity/power suppression not to cause interference in the RFP between channels using the same time slot. This is not a problem for the down-links, because the down-link power is constant on channels of all radios, and the actual isolation between the channels will be equal to the specified adjacent channel selectivity of the receiver. However, there will be a problem for the up-link when constant up-link power is used, because one subscriber unit can be close to the RFP and another close to the cell range. Therefore the up-link signals received at the RFP on the same time slot (but on different carriers) could differ e.g. 30 dB in field strength, and the specified adjacent channel selectivity will not be sufficient to avoid the weaker signal to be blocked. Thus multi-radio RFPs will not be able to utilize all channels, unless up-link power control is implemented, so that all the up-links are received with equal power at the RFP/WRS.

With PP power control it is feasible to increase capacity by placing several synchronized RFPs or WRSs on the same site or spot, as long as they have the same UL/DL slot notations. This could be useful in office and residential environments. But the for RLL systems where the RFP/WRS sites are very expensive, multi-radio RFPs or collocated RFPs are required, and here the capacity increase by introduction of PP power control becomes important.

# A.4 Summary and conclusions

In order to support wide band speech links in dense wireless office systems with a target traffic of 10 000E/km$^2$/floor 120 channels will be required. One carrier can provide up to 6 wideband calls. Therefore 20 carriers will be required, corresponding to a spectrum of 40 MHz.

# Annex B: Bibliography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# History

| Document history | | |
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