World Class Standards

DECT™ in M2M communication

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Andrea Lorelli
andrea.lorelli@etsi.org

World Class Standards

DECT overview

- The Digital Enhanced Cordless Telecommunications (DECT) is an ETSI technology for wireless telecommunications over unlicensed spectrum
- Provides powerful and reliable radio and protocol capabilities
  - Suitable for voice and data applications
- Spectrum and use model:
  - unlicensed spectrum > no license required
  - technology protected, exclusive band > “clean” spectrum
  - Self planning technology > no frequency planning required

DECT overview

- It supports a number of different applications and services
  - Private residential
  - Private business
  - Public
- It has been designed to provide access to any type of telecommunication network
  - Multiple network access
- Multiple configurations, multiple environments (residential, business, WLL..)
  - Single cell (e.g. domestic FPs)
  - (Large) multiple cell installations

HIGHLY FLEXIBLE

DECT is.....

- member of IMT 2000 (ITU-R M.1457)
- recommended by ITU for worldwide deployment
- worldwide technology: adopted in over 110 countries

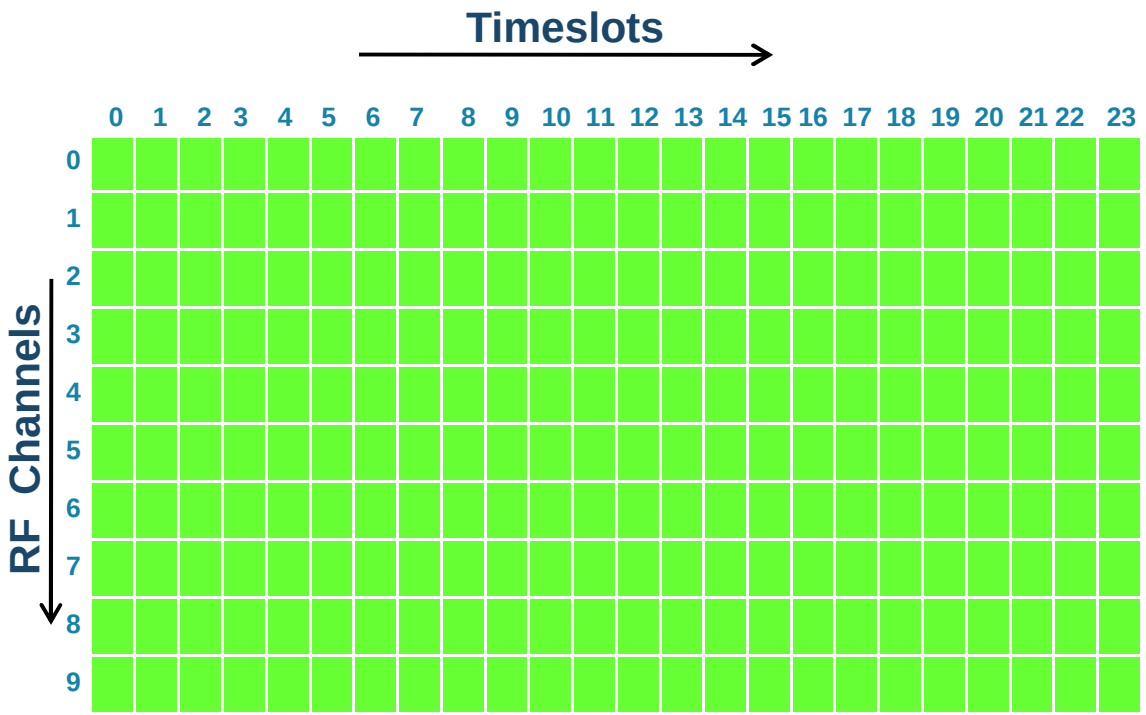
DECT: some figures

- **An ETSI success story:**
  - DECT devices in the market worldwide: 800M
  - DECT devices growth per year worldwide: 80M
  - DECT devices in the CEPT countries: more than 300M
  - DECT devices growth per year CEPT: 45M
  - WLL (Wireless Local Loop): about 7-8M lines
  - The DECT-Market value is going to grow strongly over the next years, increasing from the annual basis of about 1.8B Euros

- **TC DECT: a very active Technical Committee:**
  - 277 deliverables published (EN, TS, TR)
  - DECT Base, DECT New Generation, DECT Advanced

DECT Radio in a nutshell

- *MC/TDMA/TDD*
- *Frame length: 10ms*
- *24 Time Slots*



- Higher data rates are achieved by using more time slots in the TDMA structure
- Spatial re-use operates according to Dynamic Channel Selection (DCS)

DECT Frequencies

- DECT spectrum is allocated on an exclusive protected basis in Europe and in certain other regions (40 countries outside CEPT)
- In United States DECT 6.0 uses the UPCS (Unlicensed Personal Communications Services) band
- DECT Frequency allocation:
  - EMEA: 1880-1900 MHz
  - China: 1900-1920 MHz
  - North America:1920-1930 MHz
  - South America: 1910-1930 MHz

DECT Technology

- DECT standardisation activities
  - DECT Base
  - DECT New Generation (NG-DECT)
  - DECT Advanced
- DECT New Generation adds new features (such as wideband speech, broadband data, audio streaming..) to DECT so as to take into account the advent of new services
- DECT Advanced is the Long Term Evolution of the standard, based on OFDMA + MIMO, backward-compatible with DECT and with very high performance

DECT standard structure

- 1st level: Base standard / Common interface: EN 300 175-x (8 parts) plus DPRS (base standard for packet data): EN 301 649
  - EN 300 175-x: Main DECT library, organized by layers
  - Continuously enhanced from the beginning of the technology. Contains all DECT functions. Last revision: 2009
  - DPRS (DECT Packet Radio Service): it defines the packet data procedures. It can be considered as part of the main DECT library

DECT standard structure

- 2nd level: Profile type standards
  - Define a set of functions and specific procedures for specific applications.
  - Use procedures from base standard and DPRS
  - Guarantee interoperability
  - Profiles for voice services (GAP, NG-DECT 1, NG-DECT 3, CAP, RAP, etc.)
  - Profiles for data services (DMAP, NG-DECT 2, NG-DECT-4, D1/D2, ISDN interworking, LRMS, etc.)
- Testing Standards

DECT standard structure

- There is the option of proprietary applications (no standardized application profiles) based on the standard DECT common interface
  - Such applications are based and take advantage of the DECT technology, but there is no general interoperability (out of the company or group that has defined the proprietary application profile)
    - Example of a case where a proprietary application makes sense: military applications of DECT (operating in military band)
- The market values positively the availability of application profiles created by ETSI
  - Reasons: expectative of mass production, guarantee of several sources (vendors) of products, standard impartiality, no unexpected IPR issues, guarantee of impartial testing.

DECT standard structure

- Overview of (latest) DECT data standards
  - DPRS (EN 301 649): it is the core standard for packet data. Supports multi bearer, asymmetric bearers, efficient packet handling, multi cell systems, high level modulation and the following protocols: IEEE 802.3, IEEE 802.5, IP, PPP, V.24 plus a generic encapsulation mode for transporting other protocols.
    - It can be see as a library. As general rule, only a subset of features would be used for a given application.
  - NG-DECT-2: a subset of DPRS providing LAN IEEE 802.3 service
  - NG-DECT-4: also known “Light data services”. Provides moderate rate data transmission. Used for HTTP browsing and Software downloading
  - D1/D2 profiles : provides circuit mode data transmission

DECT standard structure

- **Overview of (latest) DECT data standards**
  - **LRMS (Low Rate Messaging, previously named E2): transport of SMSs and MMSs over DECT**
  - **ISDN end system and Intermediate systems profiles: used to transport transparently ISDN BRA interfaces over DECT:**
    - **Used in WLL products**
    - **Provides ISDN S/T interfaces at customer premises via DECT radio**
  - ***.....historic ones.....***

DECT maintenance status

- **Main DECT library**
  - The base standard, DPRS and fundamental testing standards have been kept updated though continuous maintenance from the beginning of the technology.
  - Last edition EN 301 175-x: 2009, next edition planned for 2010-01
  - Last edition EN 301 649: 2009-09 (currently in OAP)
  - Last editions regulatory testing standards for radio (European HSs) and audio: 2009
  - Some functions added in last revisions...
    - New audio codecs for standard telephony, wideband and supper-wideband audio (G.722, G.729, MPEG-4)
    - New control functionality for VoIP (SIP, H323) and multiline complex scenarios
    - Detailed electro-acoustic audio models (in cooperation with ETSI TC STQ)
    - Enhanced packet data functions
- **DECT Profiles**
  - DECT profiles in use by the industry are continuously maintained: i.e: GAP
  - New DECT profiles produces in last years: New Generation DECT series (1 to 4)

DPRS (DECT Packet Radio Service)

- Transmission speeds of up to 845 kbit/s asymmetric or 460 kbit/s + 460 kbit/s symmetric with standard DECT GFSK modulation.
- Transmission speeds of up to 5,068 Mbit/s asymmetric or 2,772 Mbit/s + 2,772 Mbit/s symmetric with 64 QAM modulation.
- Four operational modes:
  - Class 1: no CC and MM, PVC (like “Leased Line” in CS domain)
  - Class 2: similar to cellular network, multi bearers, virtual call like PDP context in GPRS/UMTS
  - Class 3 & 4: single bearer
- Five categories, according to data performance objectives
- Handover (MM)
- Encryption (MAC layer)
- Authentication (both PP and FT)

DECT for industrial automation

- **Solutions possible with current standard:**
  - **Option 1: single bearer data link**
    - **51 kbit/s in circuit or packet mode**
  - **Option 2: multi-bearer/full DPRS data link**
    - **840 kbit/sec asymmetric or 460 + 460 kbit/s symmetric data link**
  - **Option 3: High Level modulation**
    - **Up to 5 Mbit/sec with 64 QAM. Channel coding based on turbo codes**

- **Future developments**
  - **Option 4: DECT-Advanced**
    - **4G technology: OFDMA + MIMO**
    - **Scalable architecture: 1 Gbit/s of max data rate**

Option 1: single bearer data link

- **Option 1: single bearer data link**
  - **51 kbit/s circuit-mode or packet mode data link**
  - **Protection in packet mode by ARQ at DLC layer**
    - **(plus possible retransmission at application layer)**
  - **Stacks with and without TCP/IP supported**
    - **Application protocol directly over DPRS or over TCP/IP**
    - **Compatible with multi cell systems**
    - **Supports roaming, handover, authentication, encryption, etc**
  - **Simple implementation**
    - **Identical to the SW download facility that is going to be used by NG-DECT voice terminals**
    - **Implementable with standard lowest cost radio transceivers and MAC ICs intended for voice terminals**
    - **Parts, SW stacks and services available**

Option 2: multi bearer data link

- **Option 2: multi bearer data link**
  - **Full DPRS implementation, standard 2-level (GFSK) modulation**
  - **Protection by ARQ at DLC layer and optionally at MAC layer**
  - **Stacks with and without TCP/IP supported**
    - **Application protocol directly over DPRS or over TCP/IP**
  - **Maximum data rate: 845 kbit/s asymmetric or 460 + 460 kbit/s symmetric**
  - **Implementation**
    - **Implementable with low cost DECT radio chipsets**
    - **Asymmetric or symmetric links possible**
    - **Channel access time in packet mode ≈ 15 ms**
    - **Compatible with multi cell systems**
    - **Supports roaming, handover, authentication, encryption, etc**

Option 3: High Level Modulation

- **Option 3: High Level Modulation**
  - Supported by current standard, but not used in products yet
  - Modulations QPSK, 8PSK, 16 QAM and 64 QAM supported
  - Data rate: 5 Mbit/sec (with 64 QAM) per DECT channel
    - 1.7 Mbit with QPSK, 2.55 Mbit/s with 8PSK, 3.4 Mbit with 16 QAM
  - Protection by channel coding (turbocoding) plus ARQ at DLC layer
    - Channel coding is optional for QPSK and 8PSK and mandatory for 16 and 64 QAM
  - Other features identical to 2-level modulation case
  - Implementation
    - Radio architecture based on DSP plus I/Q modulator
    - Possibility of multichannel transceivers with the same architecture

Option 4: DECT Advanced

- **DECT Advanced**
  - **Future evolution of the DECT standard**
  - **Technology based on OFDMA plus MIMO**
    - **Proposed subcarrier spacing: 37,5 kHz. Frame structure TDD**
    - **MAC based on scheduling algorithm (instead of contention)**
    - **Channelization scalable and compatible with DECT classic**
  - **Scalable data rate up to 1 Gbit/sec**
  - **Different concept from WIFI**
    - **Larger cells, better radio reliability, better multipath protection, support of circuit mode and packet mode channels, MAC bases on scheduling algorithm (instead of contention), support of QoS.**
    - **Backward compatible with DECT**

Option 4: DECT Advanced

- **DECT Advanced**
  - **Different concept from LTE**
    - Unlicensed spectrum, larger subcarrier spacing, less range, higher MIMO efficiency
  - **Initially intended for professional and public environments (building coverage, factories, ports, airports, railways, WLL)**
    - Coverage range suitable for factories and industrial premises

Latency and Jitter...

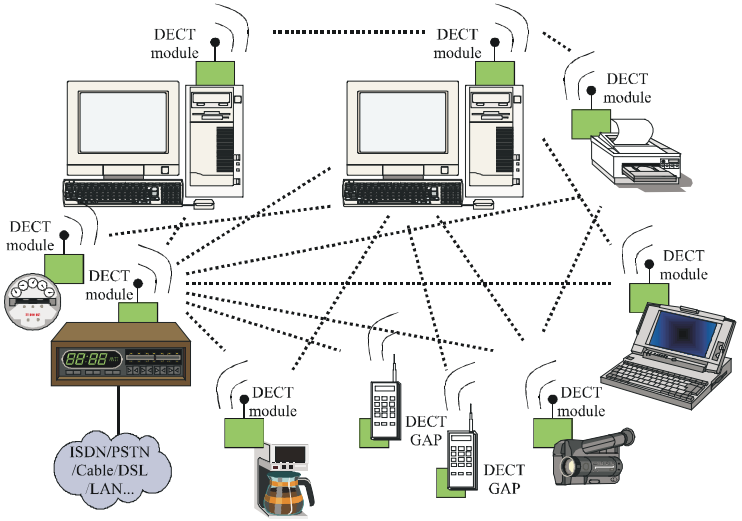
- **Latency**
  - **DECT "classic"**
    - MAC service "minimum delay" => average latency = 5 ms, but variable (max = 10 ms)
    - MAC service "normal delay": latency = 10 ms fixed
    - ARQ protection in packet mode: minimun retransmission time = 1 frame (10 ms)
  - **DECT advanced: 5 ms**
    - Delays < 5 ms require specific solutions and have to be considered in the technology from the beginning.
    - In DECT advanced, there would be the possibility of using some subcarriers for transmitting absolute time signals, or slow rate critical channels with reduced delay.
- **Jitter**
  - There is no inherent jitter in circuit mode links using the MAC service "In normal delay" (in this mode the MAC layer compensates the changes in slot position due to possible handovers)
  - It is also possible to operate with ARQ and using a buffer to compensate for jitter due to retransmission
    - This mode is used for the transmission of ISDN digital unrestricted 64 kbit/s bearers
    - Used in WLL products

...Power

- DECT “classic”
  - Average transmission power for the PP: 10 mW (250 mW peak) in Europe, 4 mW (100 mW peak) in the US
  - Average transmission power for the FP less than 3W
  - Less power consumption than WiFi

- DECT-Advanced:
  - no information available. It will depends on many decisions not taken yet.

DECT...DECT...DECT



Wireless Factory: DECT for M2M

DECT for M2M: Conclusions

- DECT is a well-consolidated technology
- All the potentialities/possible applications of this technology are still to be fully exploited: M2M communication is already part of the technology!
- “Wireless Factory” can be definitely the natural extension of “Wireless Home”
- The technology is already there and it can be easily “tuned” to “factory requirements”

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Thank you for your attention!

TC DECT Chairman:
Kleindl Günter
guenter.kleindl@siemens.com

TC DECT Technical Officer:
Andrea Lorelli
andrea.lorelli@etsi.org

http://portal.etsi.org/dect

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Slide heading

- First level text
  - Second level text
    - Third level text: