The Standards People

DECT Standardisation

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For: ETSI TC DECT

28/09/2023

Agenda

- Highlights from 1992 to 2022
- DECT Evolution by Heinz Thuerauf
- DECT-2020 New Radio by Jussi Numminen

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Highlights from 1992 to 2022

- 1992 DECT Base Standard
- 1995 Generic Access Profile
- 2000 IMT-2000 approval by ITU-R
- 2007 New Generation DECT
- 2013 DECT Ultra Low Energy (ULE)
- 2019 Low Complexity Communication Codec Plus
- 2020 DECT-2020 NR Specifications (Release 1)
- 2022 Advanced Audio Profile
- 2022 IMT-2020 approval by ITU-R

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DECT Evolution

LC3plus

Advanced Audio Profile

New Work Items

Low Complexity Communication Codec Plus LC3plus

Standard TS 103 634 published in 2019, updated in 2021

Improved quality compared to legacy codecs:

- Introduces SWB quality for voice services, with improved packet loss concealment and reduced bit errors (FEC)
- LC3plus WB at 32kbit/s matches or exceeds G.722 WB quality at 64 kbit/s, enabling higher DECT system capacity
- Scales up for excellent music quality, including a high-resolution mode (24/32 bit, 96 kHz)

Used in:

- TS 102 527-3 DECT “Extended wideband speech services“
- TS 103 706 DECT “Advanced Audio Profile (AAP)”

Bluetooth uses a feature reduced and modified version, LC3BT

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Low Complexity Communication Codec Plus LC3BT vs LC3plus

	LC3BT	LC3plus
Specification	BT SIG Low Complexity Communication Codec V1.0.0	ETSI TS 103 634
Published Reference Code	X	ETSI TS 103 634
Advanced Packet Loss Concealment	X	✓
Frame length (Algorithmic Delay)	10.0 ms (12.5 ms) 7.5 ms (11.5 ms)	10.0 ms (12.5 ms) 5.0 ms (7.5 ms) 2.5 ms (5.0 ms)
High Resolution Mode (48 kHz, 96 kHz, up to 32-bit)	X	✓

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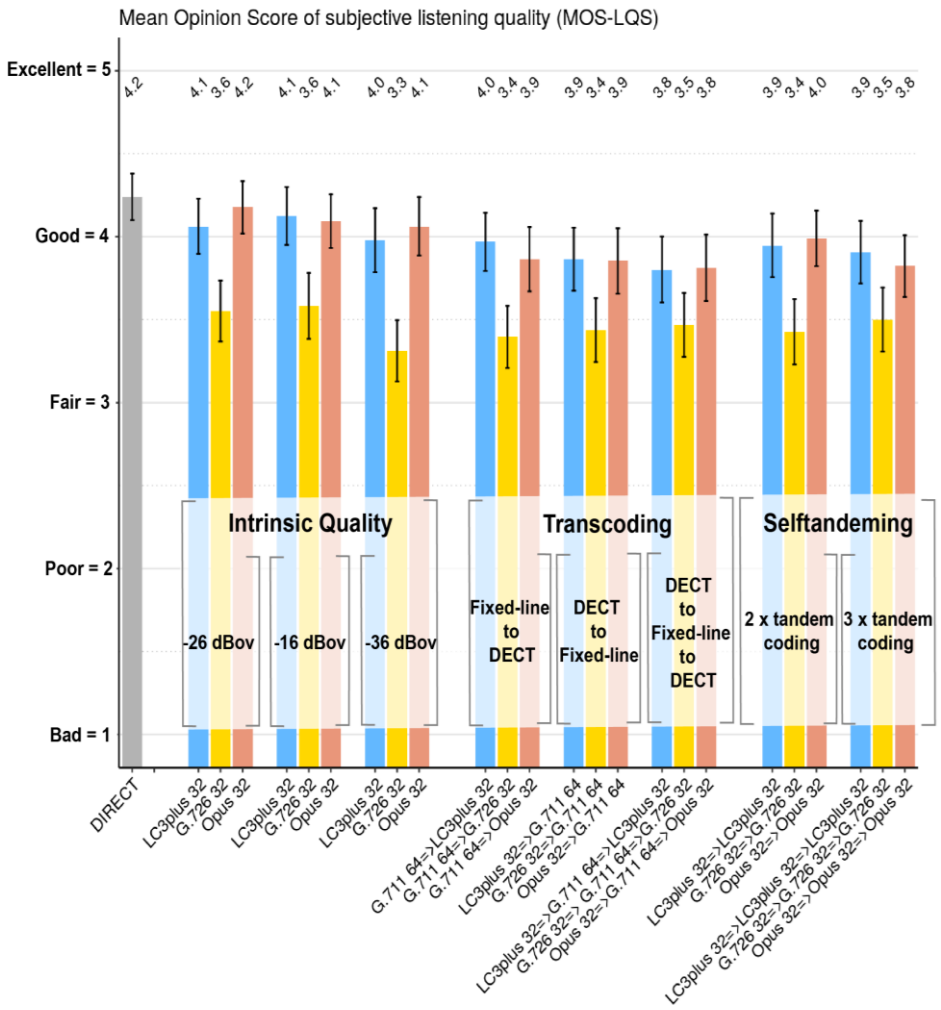
Low Complexity Communication Codec Plus Narrowband Speech (error-free channel)



Conclusions:

- LC3plus NB at 32 kbit/s is significantly better than G.726 at 32 kbit/s
- This holds true for different amplitude levels and transcoding scenarios

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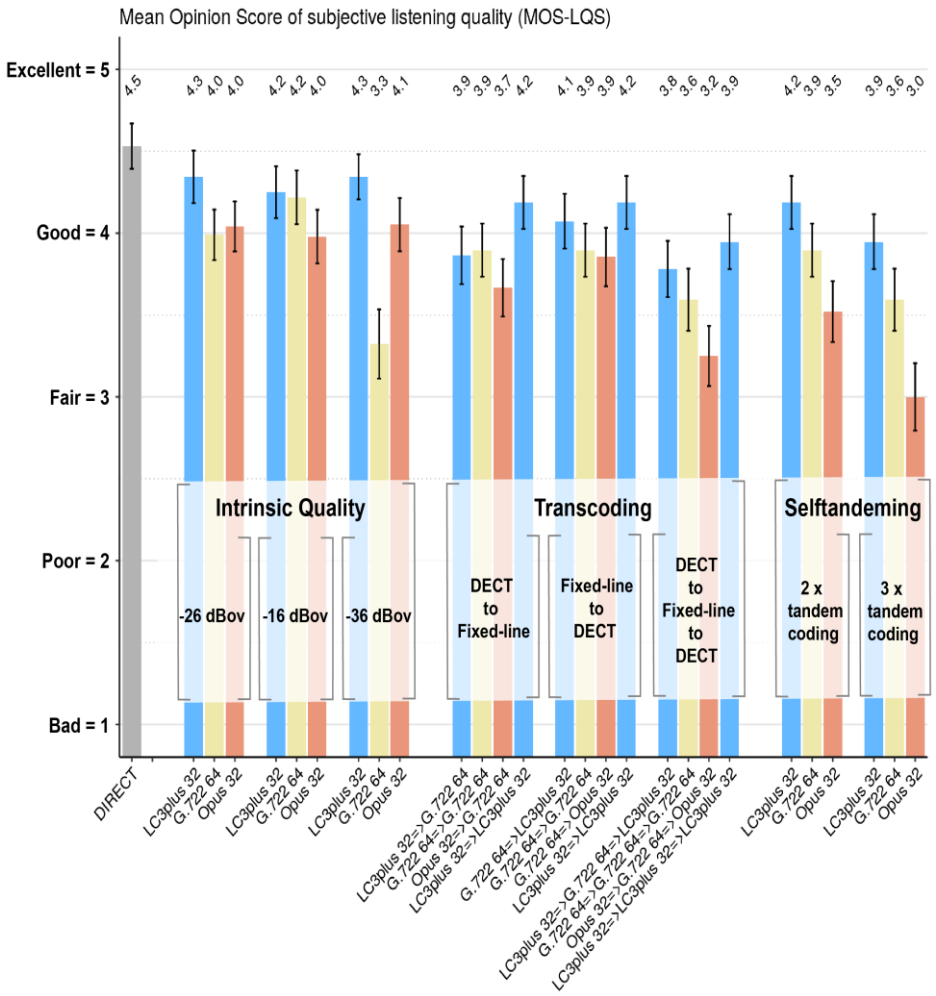
Low Complexity Communication Codec Plus Wideband Speech (error-free channel)



Conclusions:

- LC3plus at 32 kbps provides clearly better quality than G.722 at 64
- LC3plus doubles the DECT capacity for WB
- Improved transcoding
- LC3plus when operating in DECT as well as VoIP provides significant better quality compared to the legacy G.722, Opus or any other combination.

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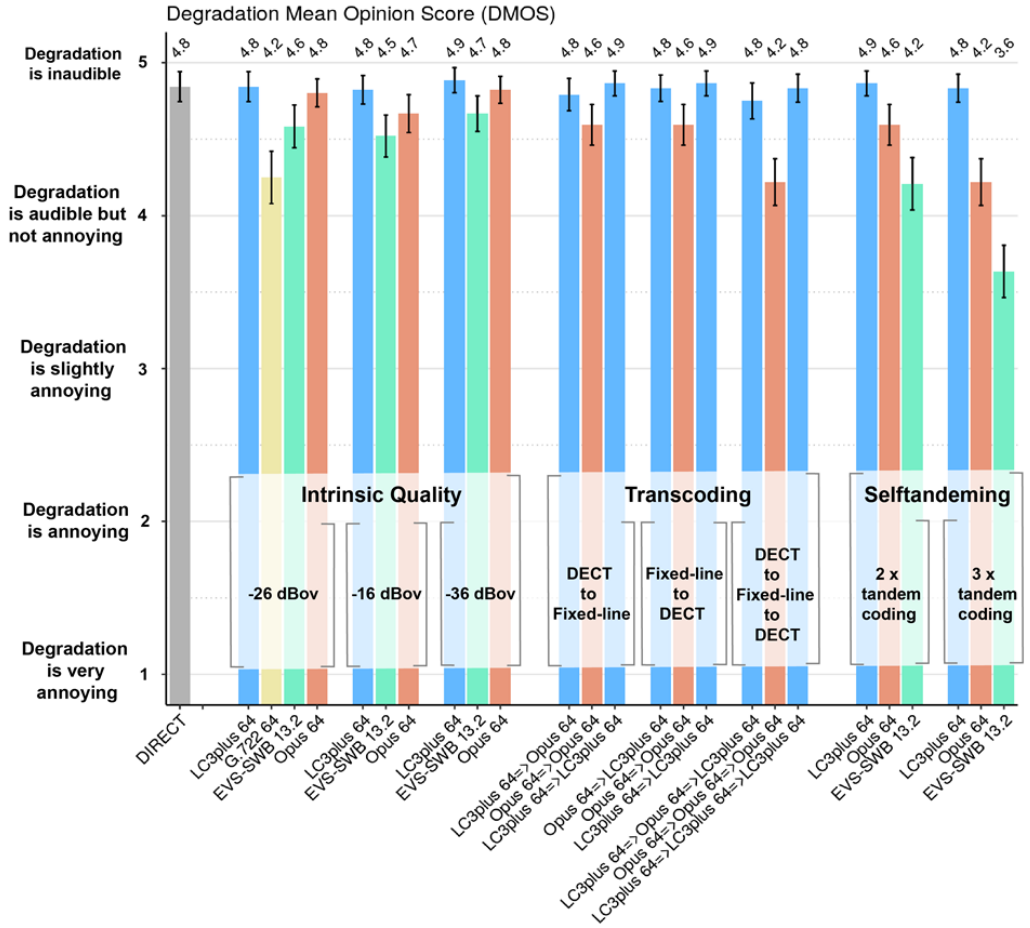
Low Complexity Communication Codec Plus Super-wideband Speech (error-free channel)



Conclusions:

- LC3plus at 64 kbps outperforms EVS-SWB at 13.2 kbps significantly
- LC3plus at 64 kbps is significantly better than G.722 at 64 kbps
- In all transcoding scenarios, LC3plus is significantly better than Opus.

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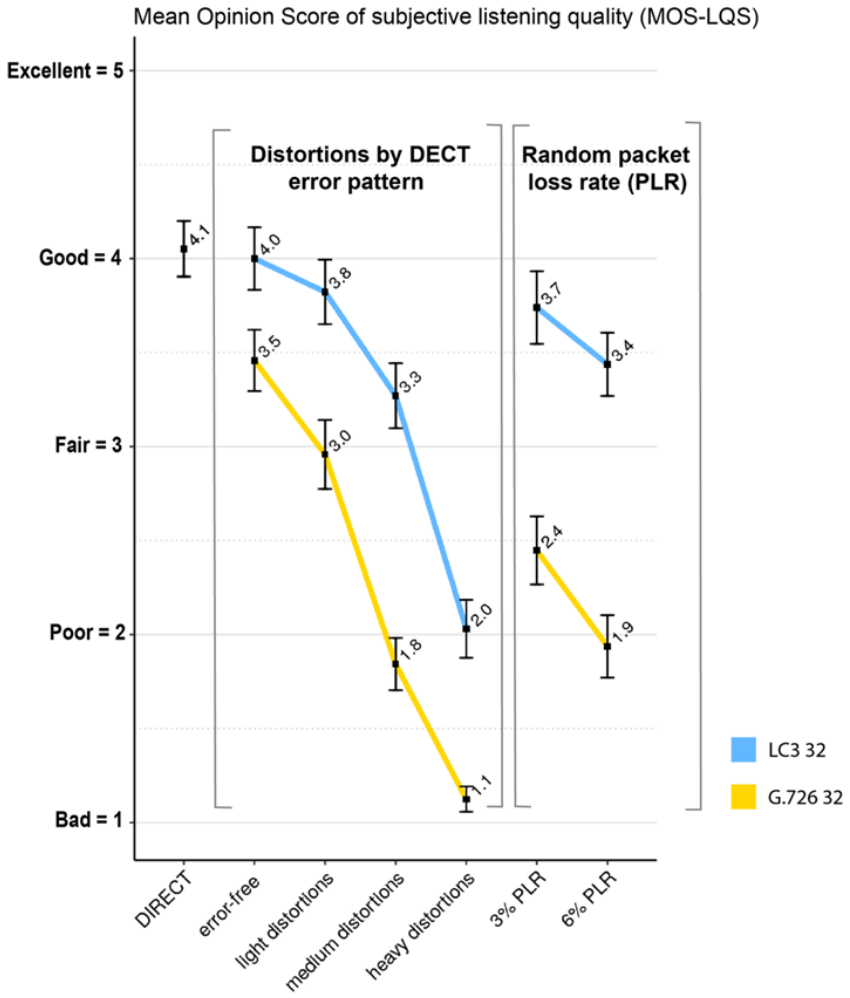
Low Complexity Communication Codec Plus Narrowband Speech (error-prone channel)



Conclusions:

- At all error conditions, LC3plus at 32 kbps provides significantly better audio quality than G.726 at 32 kbps (with G.711Appl-PLC)
- At medium distortions, LC3plus shows a 1.5 higher MOS compared to G.726
- LC3plus clearly improves the robustness compared to a NB legacy DECT system

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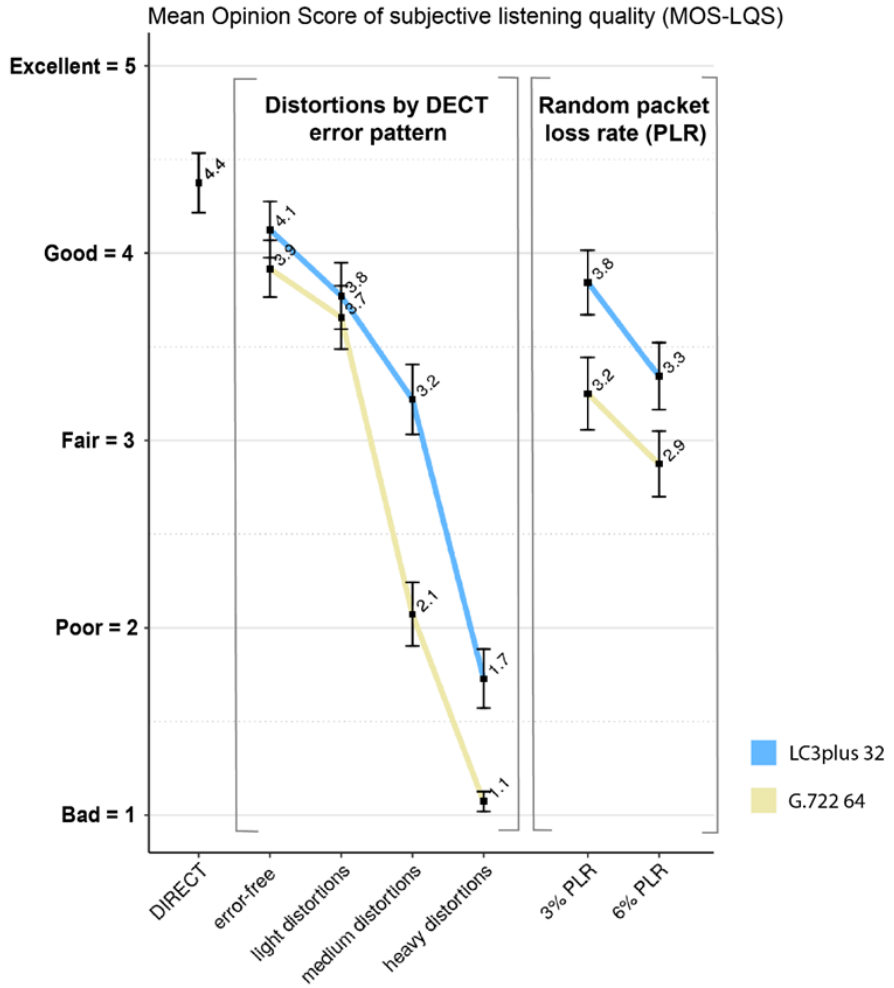
Low Complexity Communication Codec Plus Wideband Speech (error-prone channel)



Conclusions:

- At all error conditions, LC3plus at 32kbps provides better audio quality than G.722 at 64kbps (with G.722AppIV-PLC)
- At medium distortions, LC3plus shows a 1.1 higher MOS compared to G.722
- LC3plus clearly improves the robustness compared to a WB legacy DECT system while doubling the capacity

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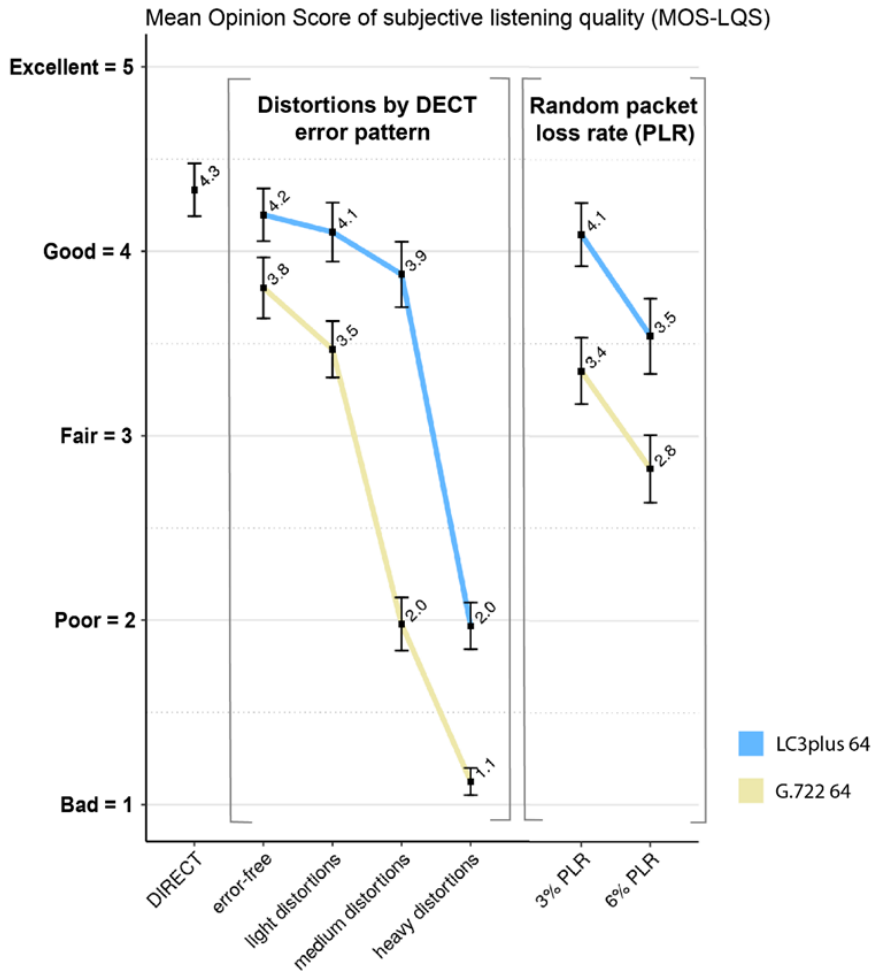
Low Complexity Communication Codec Plus Super-wideband Speech (error-prone channel)



Conclusions:

- At all error conditions, LC3plus SWB at 64 kbps provides significantly better audio quality than G.722 WB at 64 kbps
- At medium distortions, LC3plus shows a 1.9 higher MOS compared to G.722
- LC3plus, by enabling SWB in DECT, clearly provides a quality boost compared to a legacy WB DECT system.
- LC3plus clearly improves the robustness compared to a WB legacy DECT system

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Advanced Audio Profile

New DECT profile TS 103 706 published in 2022

Uses LC3plus codec to support new product types such as:

- Wireless Speakers
- Wireless Headphones
  - Fullband LC3plus
  - High-resolution LC3plus
- Wireless Gaming Headsets
- Wireless Smart Speakers
- Professional Microphones

The profile uses improvements introduced previously in the base standard to enable lower latency data transfer.

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Advanced Audio Profile Codec Configurations

A large variety of codec data rates and codec frame durations are supported:

Codec	Data Rate* (kbit/s)	Frame duration* (ms)
Single channel	32, 64, 96, 128, 160, 192, 256	2.5, 5, 10
Single channel: high resolution	128, 160, 192, 256, 320	10
Single channel: low frequency element	32, 64	5, 10
Two channel	128, 256, 320, 512	2.5, 5, 10

* Not all combinations of data rate and frame duration are supported

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Advanced Audio Profile
End-to-End Delay, Head Tracking

Maximum end-to-end* delay is defined as

- 2.5 ms + (4 * codec frame duration)

In addition to the audio channels, a data channel for 16 or 32 kbit/s head tracking information with 10 ms period is also supported

*from LC3plus encoder input to LC3plus decoder output

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New Work Item: ULE Enhancements

New work item recently started to introduce improvements in the ULE standard

Main focus areas are improvements in robustness and further reducing power consumption

First change proposals are in areas relating to:

- Paging robustness
- Use of short slots to reduce power in some cases

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New Work Item: DECT Low-Rate Audio

New work item recently started to investigate the possibility of supporting lower rate DECT audio

Data rates in the region of 8-16 kbit/s are envisaged

Could enable the use of half slots or a new slot format to reduce power consumption and/or increase system capacity

Scope includes:

- Codec requirements
- Channel coding requirements
- Impact of potentially higher delay
- Optimization of DECT slot formats

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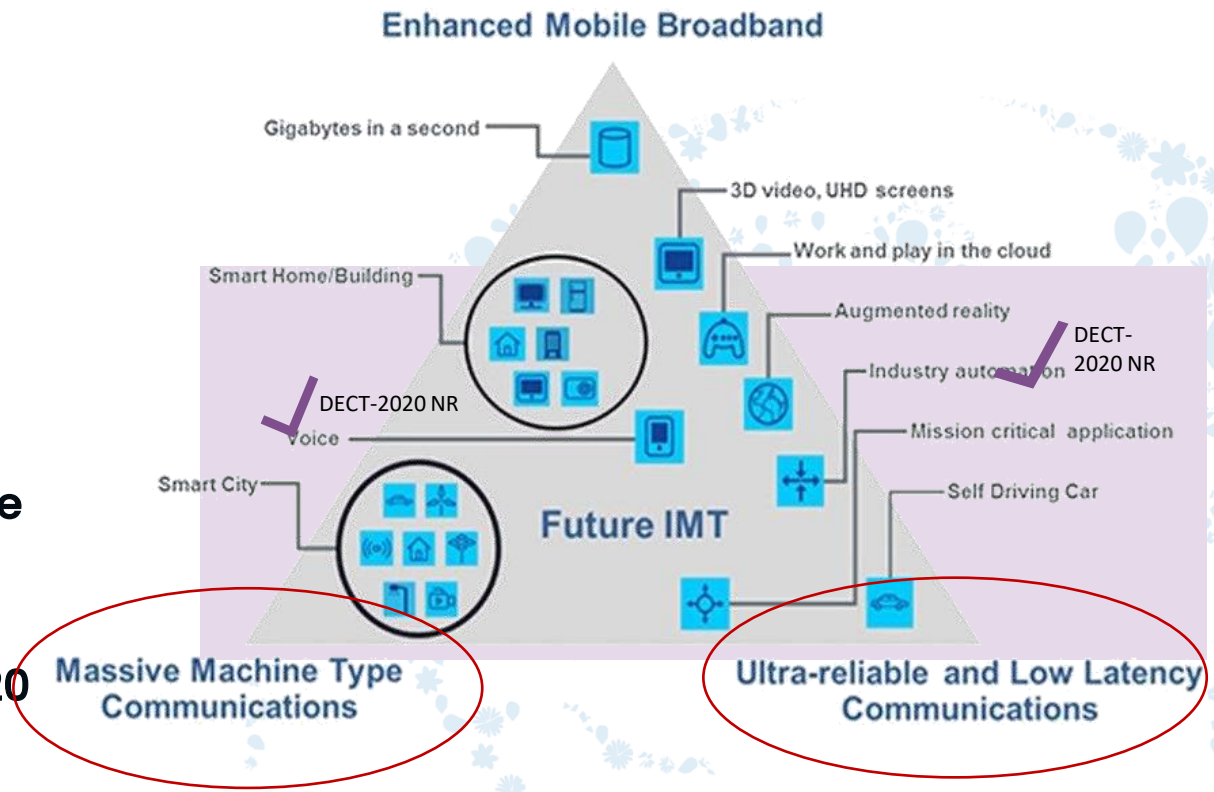
DECT-2020 New Radio

- DECT-2020 NR introduction
- DECT-2020 NR System architecture
- DECT-2020 NR Key Features

DECT-2020 NR design objectives

- DECT-2020 NR design objective has been to create a wireless communication technology which can be deployed by anyone, be operated by anybody, and used anywhere. Its operation must be simple, autonomous and able to co-exist with other local networks in the same area sharing the spectrum. Technology is easy to introduce into new frequency bands.
- It should be **application agnostic** enabling rapid adoption of different use cases and fostering digitalization. It should focus on **ultra-reliable low latency communication** and **massive scale machine communication** networks **exploiting mesh** communication.
- **ITU-R adopted DECT-2020 NR as part of the IMT-2020 family, also known as 5G. ITU-R technology recommendation M.2510-1**



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TC DECT DECT-2020 NR activity

Standards and publications for release 1:

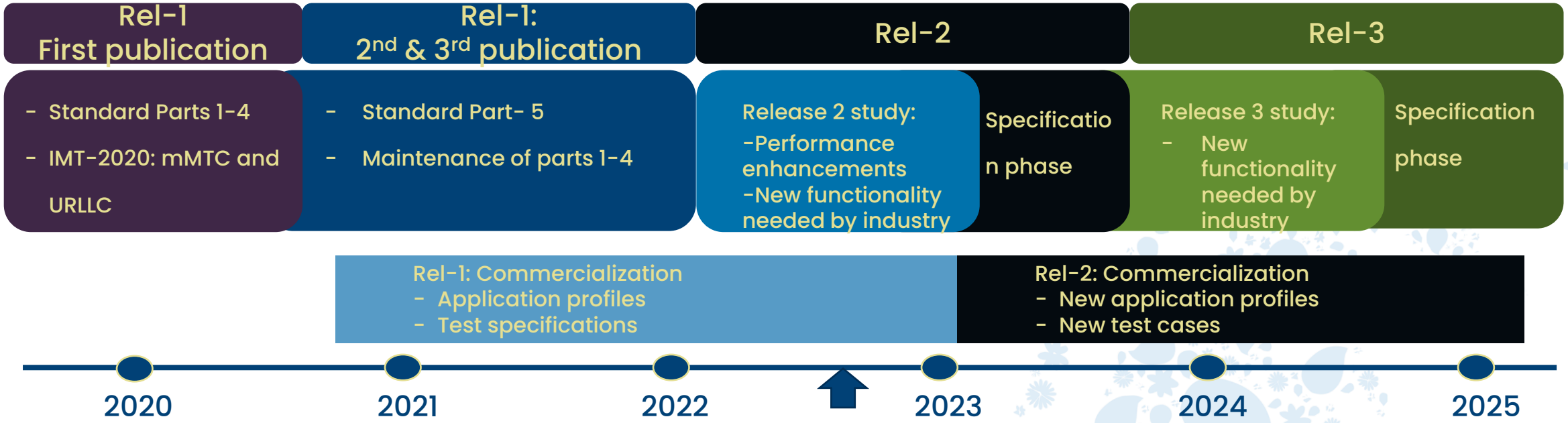
- ETSI TS 103 636-1 V1.3.1 DECT-2020 New Radio (NR); Part 1: Overview; Release 1
- ETSI TS 103 636-2 V1.3.1 DECT-2020 New Radio (NR); Part 2: Radio reception and transmission requirements; Release 1
- ETSI TS 103 636-3 V1.3.1 DECT-2020 New Radio (NR); Part 3: Physical layer; Release 1
- ETSI TS 103 636-4 V1.3.1 DECT-2020 New Radio (NR); Part 4: MAC layer; Release 1
- ETSI TS 103 636-5 V1.3.1 DECT-2020 New Radio (NR); Part 5: DLC and Convergence layers; Release 1
- ETSI TR 103 810 V1.1.1 ETSI Evaluation Group; Final Evaluation Report on DECT-2020 NR

Ongoing activities for release 1:

- A harmonized standard (EN 301 406-2) for DECT-2020 NR
- Access profile standards

Release 1 standards series V1.4.1 publication by eof 2022.

DECT-2020 NR future evolution



- TD DECT Technology roadmap TR 103 513, updating ongoing
- Study of future releases TR 103 777, new features' introduction
  - DECT-2020 NR Uplink data without association
  - DECT-2020 NR Configuration data distribution
  - Access without security credentials to enable RD authentication and key distribution

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DECT-2020 NR systems Architecture

Supports multiple deployment scenarios

- **Wider area network** with Mesh topology based on Radio Device (RD) to RD communication, **Local area network** (Star Topology) and **Direct P2P** and P2M connections

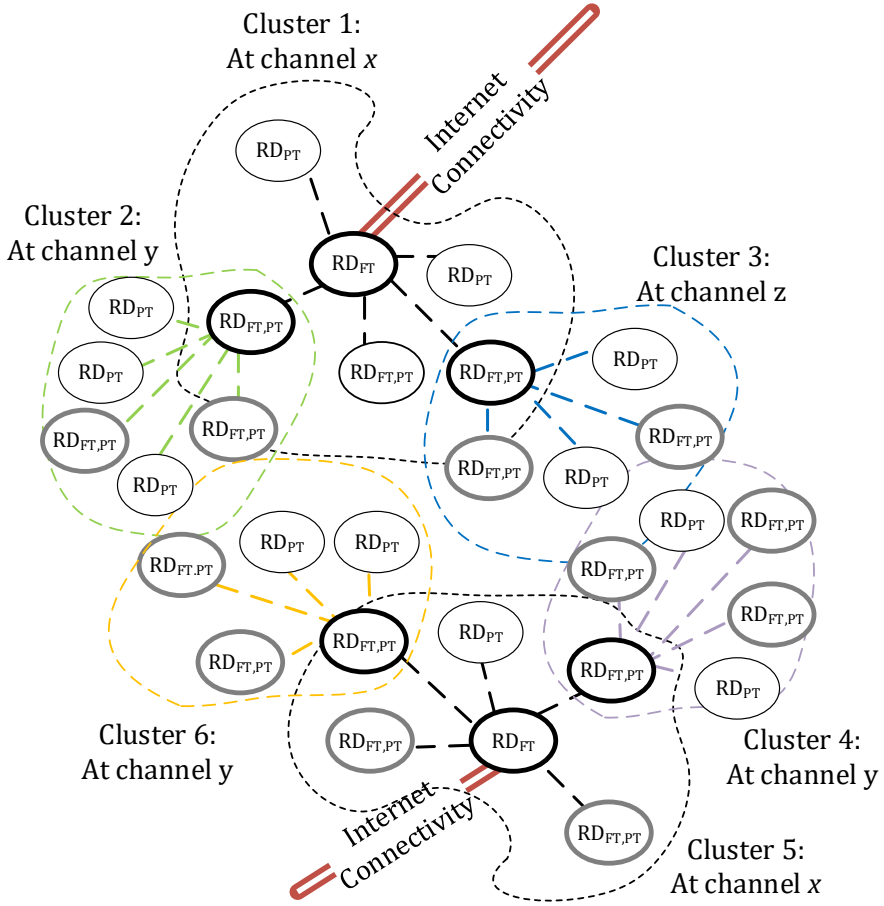
State of art co-existence capabilities to support multiple networks in the same area sharing spectrum

Device-centric, decentralized decisions, enable autonomous operation fostering industry digitalization.

- Autonomous operation minimized network planning effort
- Over-the-air synchronization locally between different DECT-2020 NR equipment.

Symmetric uplink (TX) and downlink (RX) radio access support cost-effective equipment designs.

Multiple gateways operation support for high capacity/ wide area network.



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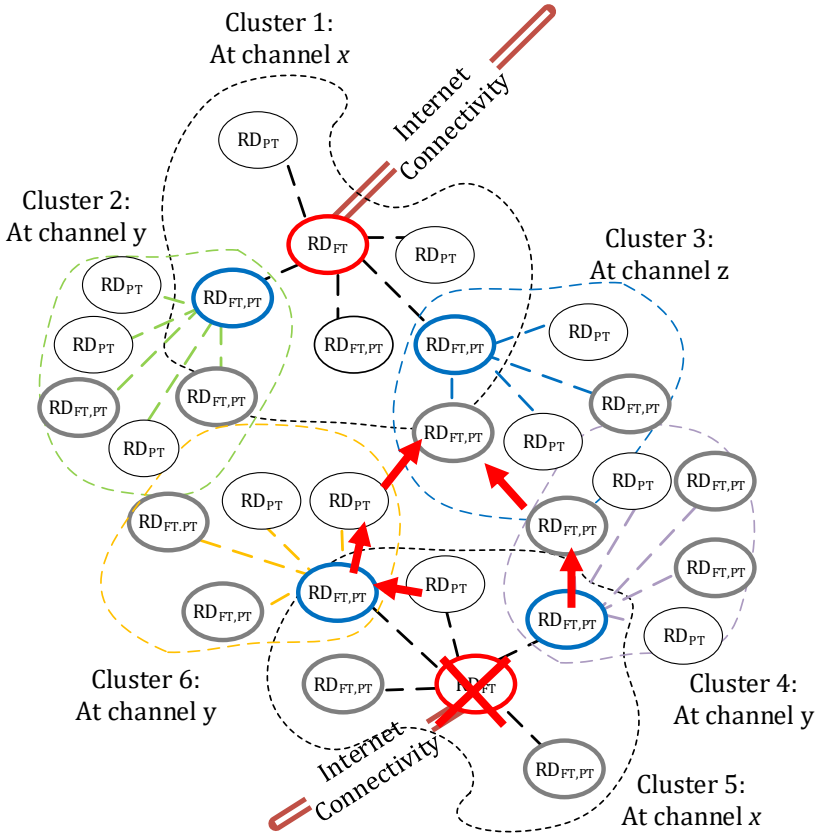
De-centralized and autonomous operation

1. Radio access and device autonomy
   - DECT-2020 NR supports **autonomous device operation**. Each **device can choose its role** in the communication network, whether they are routing data or not. A device may change its role autonomously when radio conditions or network deployment is changing or due to device failure.
   - **Each device makes independent decisions on associations** with other devices based on **local radio conditions and mobility**.
   - **Device autonomy takes care of reliable radio communication and data routing** between devices as well as between devices and the back-end system.
2. System autonomy
   - DECT-2020 NR supports **flat radio architecture** enabling connection to multiple types on back-end systems with varying deployment constraints (public or on-premise cloud).
3. Application autonomy
   - DECT-2020 NR is **agnostic to application** datagrams and can support e.g. non-IP and IP-based applications.



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DECT-2020 NR key features

- Applies modern OFDM Physical layer combined with advanced channel coding and Hybrid ARQ providing state-of-the-art performance
  - Direct device-to-device communication, low latency operation, and low power consumption for battery-operated applications.
  - Dual mode MAC architecture supporting scheduled (deterministic time use case) and unscheduled services (event-based use cases).
  - Seamless handover due to multiple associations
  - MIMO for exploiting multiple channels for high-bit-rate applications.
- Flexible radio access technology with dynamic channel selection based on cognitive radio (spectrum sensing with LBT and frequency scanning)
  - No frequency planning, ideal for local network deployments
  - Very advanced coexistence for multiple overlaying DECT-2020 NR networks in the same area
  - Compatible with legacy DECT technology including uncoordinated systems
- Up-to-date security based on AES and CCM

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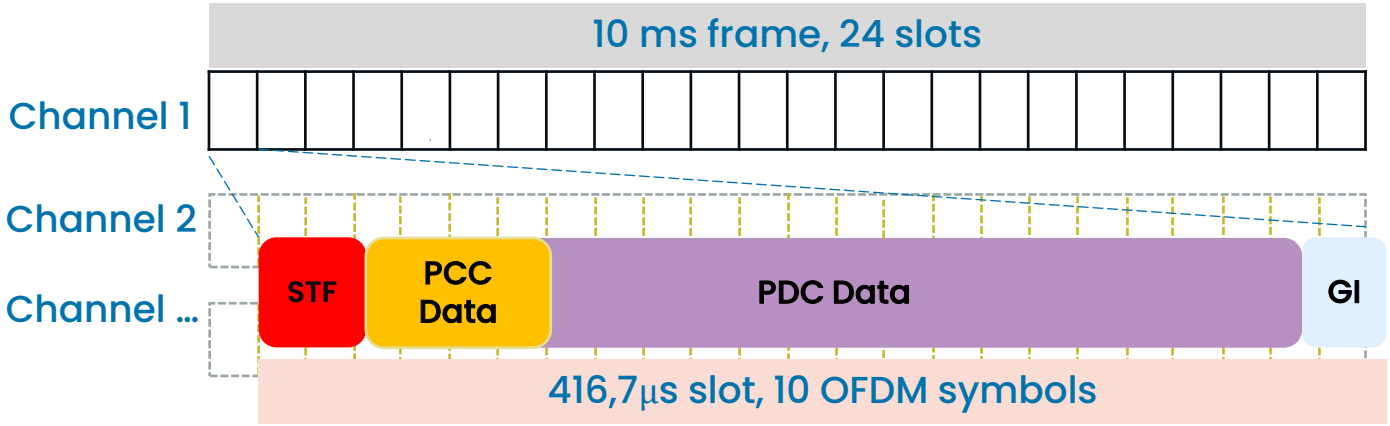
DECT-2020 NR technical characteristics

- 1.9 GHz frequency bands and in principle IMT-bands below 6 GHz, depending on national regulation.
- TDMA/FDMA based channel access with frame length 10 ms, split into 24 slots and sub-slots.
- Basic channel width is 1.728 MHz, with scalable bandwidth support up to 221 MHz
  - Sub-carrier spacing (SCS) is 27 kHz with 2^{μ} scaling options up to 216 kHz
- Adaptive Modulation and Channel coding supporting BPSK to 1024 QAM and turbo coding.
- Data rates: 120 kbps to 1.1 Gbps with 27 kHz sub-carrier spacing, with 216 kHz SCS up to 8.6 Gbps.



- Transmitter power up to 23 dBm, reference sensitivity -99 dBm@1,728 MHz with HARQ.
- Very short latency in communication with minimum transmission unit is a sub-slot, length is between 26 us – 208 us.
- Very low latency Hybrid ARQ support, latency after 1st retransmission can be less than 2.5 ms with 27 kHz SCS.

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DECT-2020 NR live demo during DECT meeting # 94 June 2022!

- Demonstrates operation in a DECT-2020 NR radio cluster.
  - RD_{FT} sends cluster beacon
  - RD_{PT} receives a beacon and sends a packet using RACH to RD_{FT}.
  - Using commercially available chipset HW
  - PHY and MAC operations based on TS 103 636-3 and ETSI TS 103 636-4

Proofing the technology feasibility and short time to market.

Thank you for your attention

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Any further questions?

Contact us:

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