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DECT NR+ Webinar Series

26 September 2023, 3 PM CEST

DECT NR+ webinar series

- Welcome from the DECT Forum!
- Third webinar in the series covering the DECT NR+ technology upper layers
- Speakers today:

Host Roel Ottink
DECT Forum

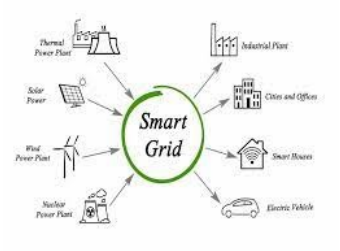
Juho Pirskanen
Wirepas

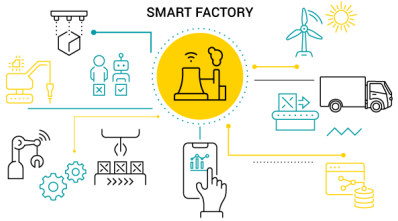
Some notes

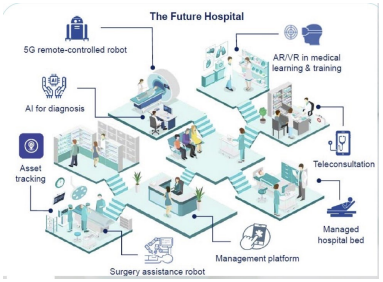
- The presentations will take around 40 minutes
- Questions:
  - Can be asked by using the ‘Questions’ button in the bottom righthand corner
  - Will be answered after the presentations
  - If there are too many to answer in today’s webinar then they will be answered afterwards
- The webinar will be recorded and made available to all who have registered
- FAQ page: https://www.dect.org/news.aspx?id=390

Purpose with the webinars

Applications and use cases







Features and benefits

Mesh networking

High density (mMTC)

Ultra Low Latency and reliability (URLLC)

Licenced & licence free operation

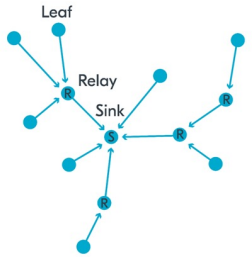
Dedicated frequency band

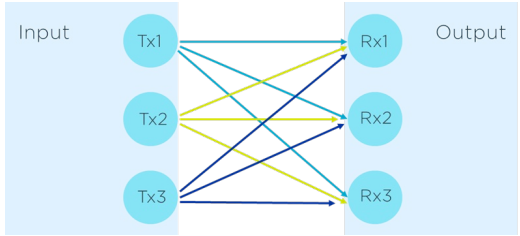
Private networking

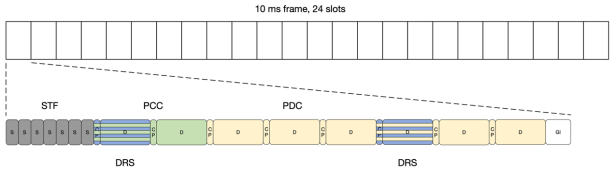
Self-healing and robust

Range

Technology foundation







What are we covering today

Technology – upper layers: Radio protocols

- System topologies and deployments for the use cases
- Forming and routing in a mesh network
- End-to-end protocol functions
- Link specific functions
- Details on channel access

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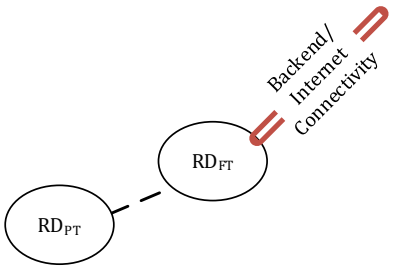
System topologies

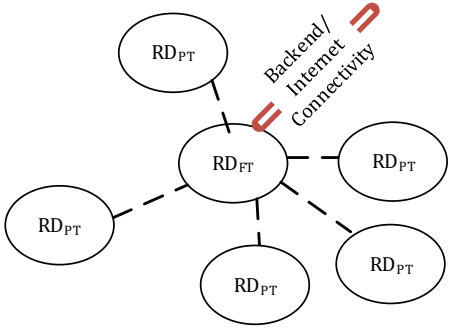
System topologies – Network Identification

- **Network identification is done by using a 24-bit Long NW ID**.
  - **Enables** Radio Devices (RD) to associate correct network.
- **Multiple networks may overlap.**
- No need for **administration of network IDs.**
  - Approx. 16,77 Mil globally unique networks
- **Additionally, an 8-bit Short NW ID** is used for identifying own network traffic from overlapping NWs at the physical layer.

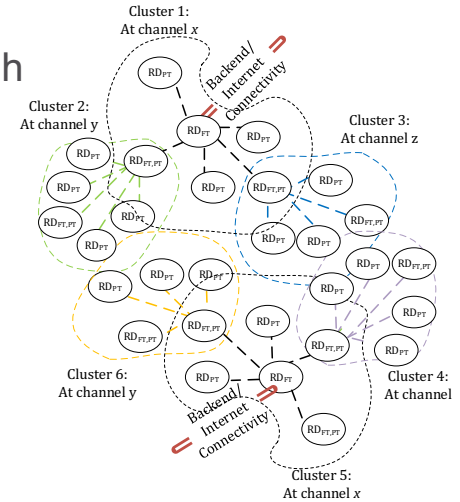
Point-to-Point



Star



Mesh

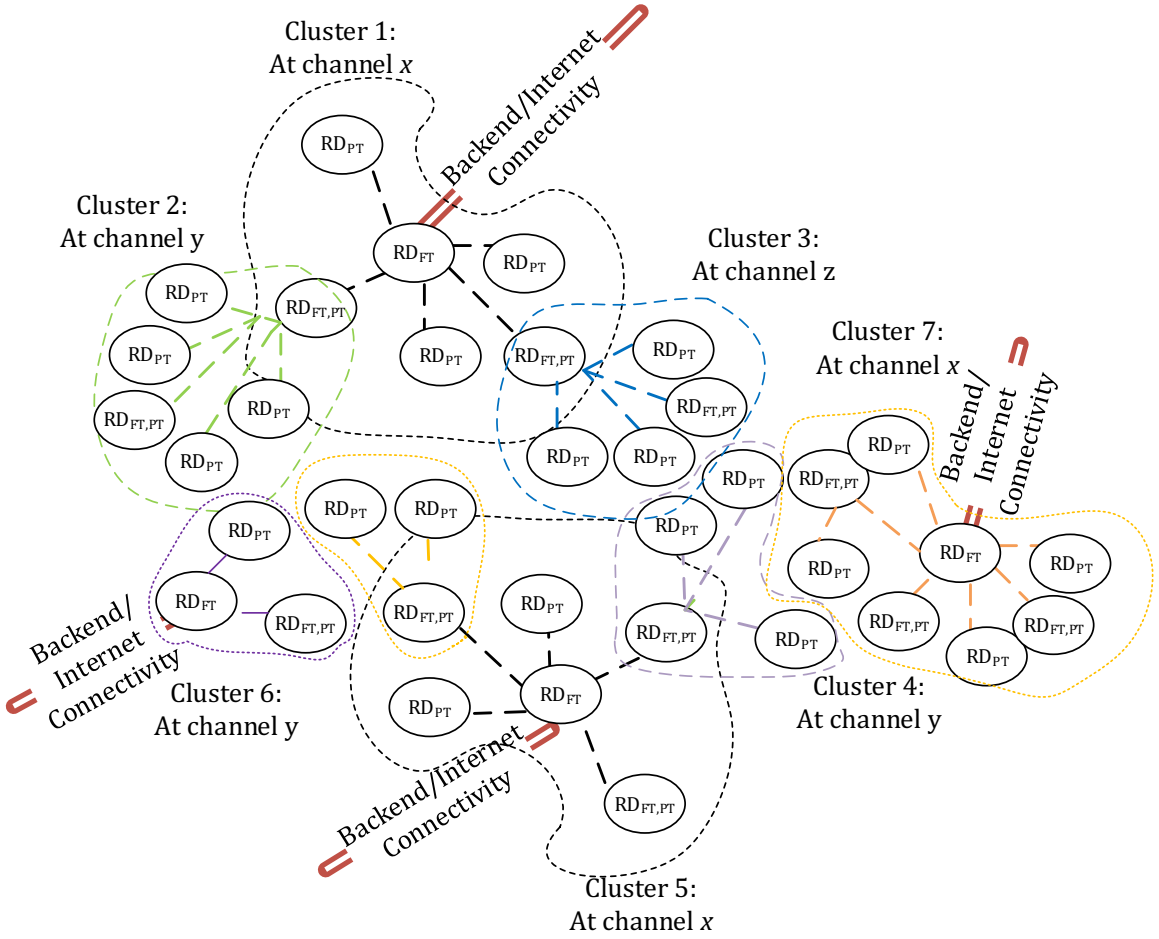


System topologies – Radio device Identification

- **Radio device identification is done by** a 32-bit Long RD ID.
  - Unique identifier of the RD in a Network.
- **32-bit Long RD ID** supports more than **4B unique devices** in a single network.
  - Used for packet Routing.
  - Special addresses are reserved for Broadcast and Backend.
  - A set of addresses can be assigned for multicast.
- Additionally, a **16-bit Short RD ID** is used for identifying other device's traffic at the PHY layer.

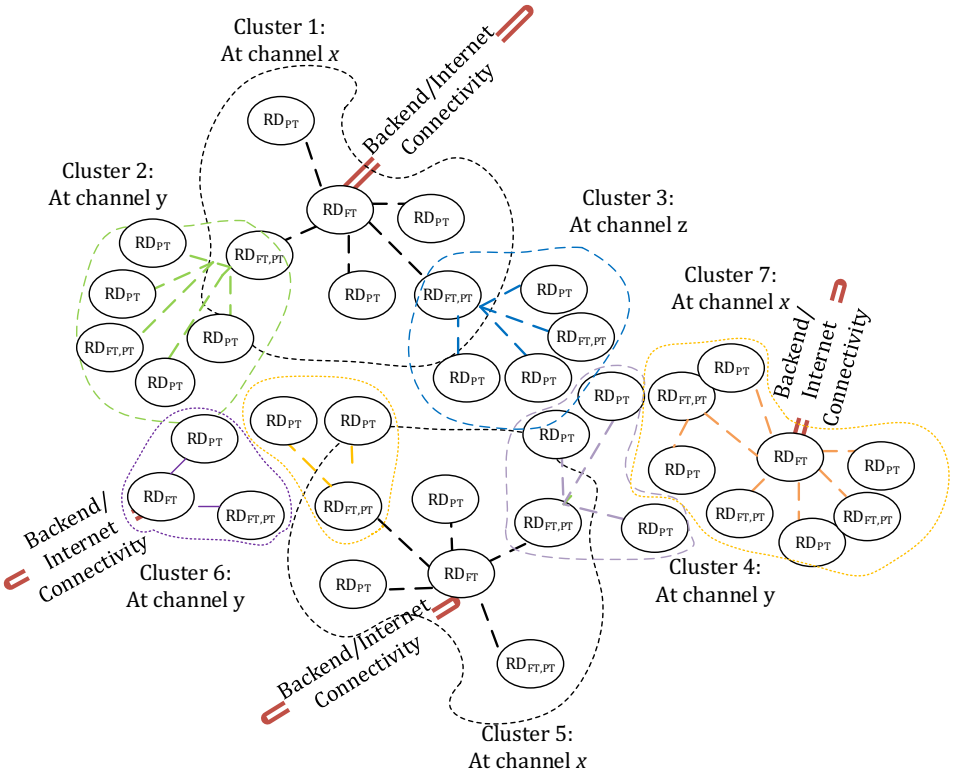
System topologies – Mesh Network

- **Cluster tree** mesh network architecture
- **A Single Network** can extend its operations to **different channels**.
- **Independent** from the backend/ internet connectivity solution.
- **Unlimited number** of Backend/ Internet connectivity points.
- **A simple** to increase capacity or extend the network



Operating modes

- Radio Device in **FT Mode controls** radio resources in the cluster and routes data
- Radio Device in **PT mode selects** which RD in FT mode to connect.
- Radio device can **have both FT and PT modes simultaneously**
  - FT mode to control its own cluster.
  - PT mode to be a member in the next cluster.
- Single HW and SW can provide both functionalities.



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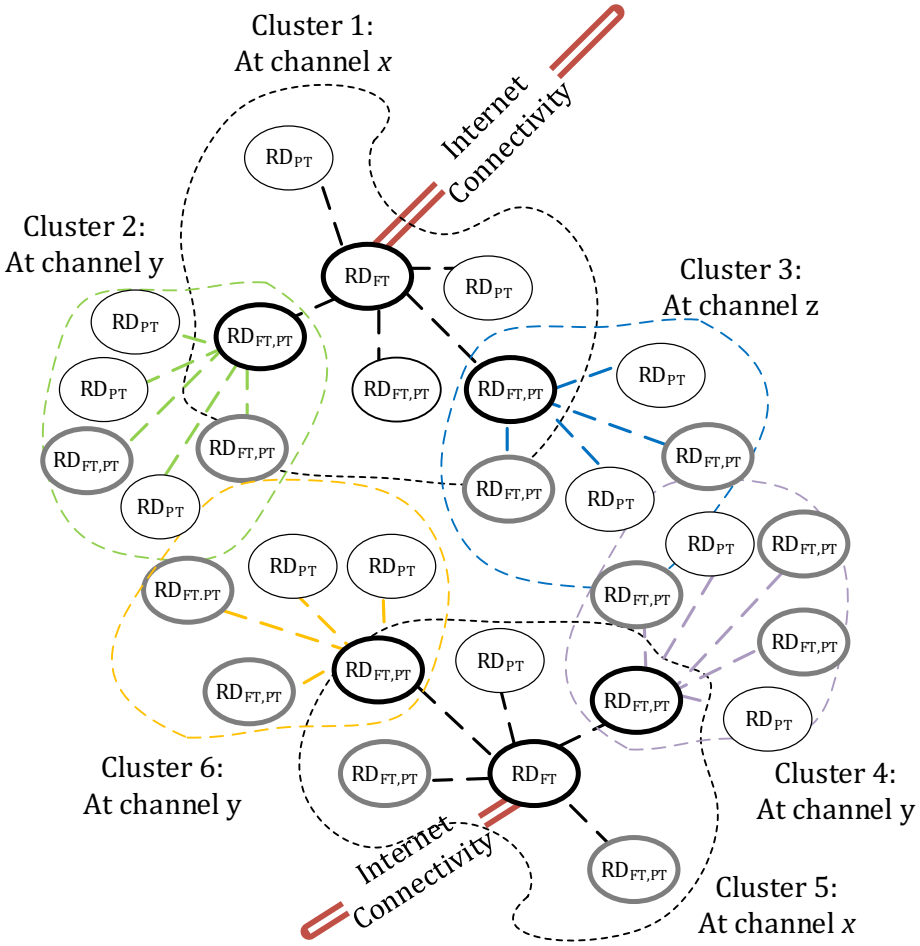
Routing in Mesh network

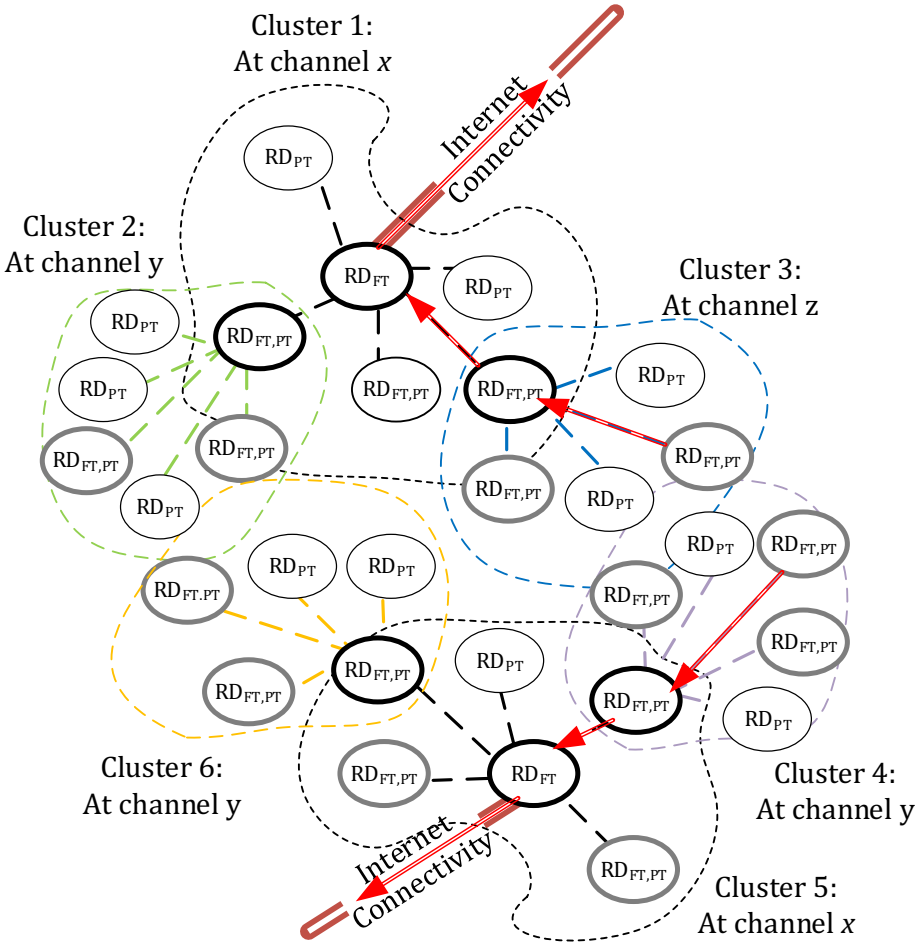
Routing

- Routing using Long RD-ID.
  - Separate source and destination addresses.
- DECT NR+ is a single-hop system for applications including IPv6.
- Different routing directions
  - Uplink, Downlink and RD-to-RD.
  - Each direction is considered independently.
- No mesh coordinator or single point of failure.
- No routing tables assumed.



Routing

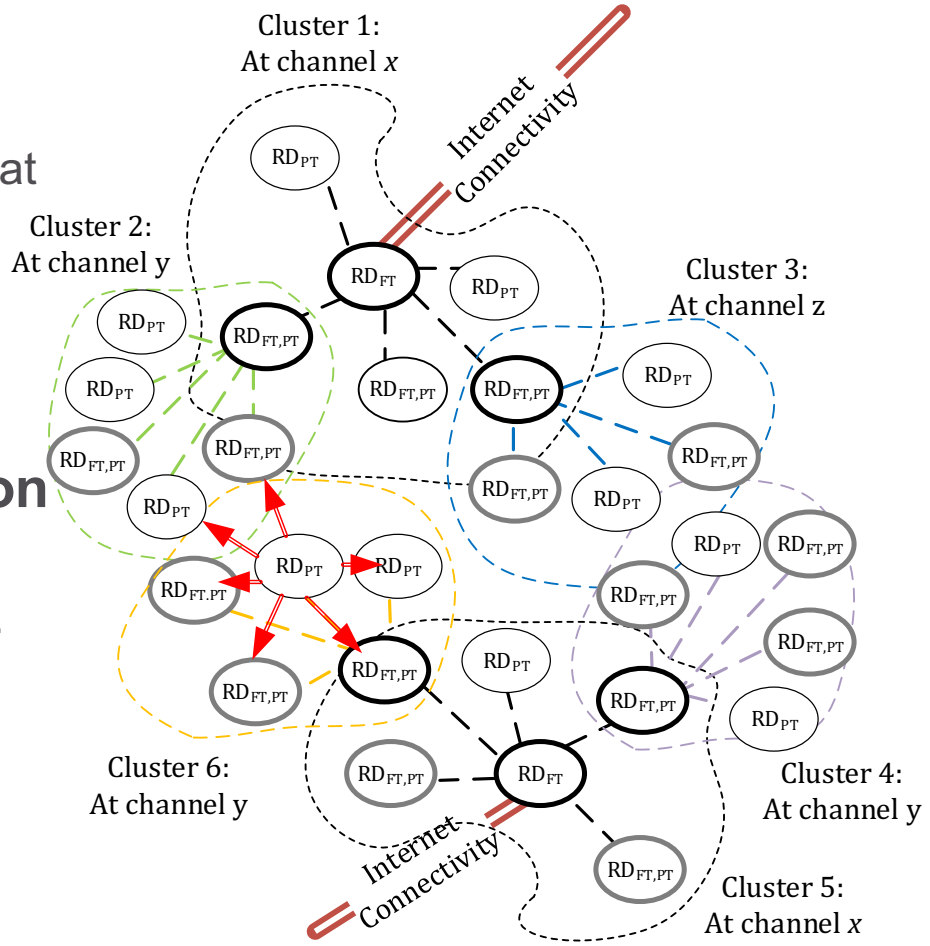
- Uplink based on cluster tree topology
  - RD sends an uplink data to the next hop toward the backend.
  - Sending RD does not know the exact data path.
- Next hop selection based on minimum signal quality and route cost.
  - RD perform regular reevaluation
- Cost calculation may take different aspects.
- Optimum for mMTC data where uplink data is heavily dominated.



Routing

- Downlink based on restricted flooding
  - RD in FT mode sends data to all members that are in FT mode.
  - The distribution tree is pruned whenever possible.

- RD2RD designed for **local communication**
  - Flooding with a limited number of hops
  - Can be one-to-one or one-to-multicast group.
  - Special use cases such as lighting control systems.



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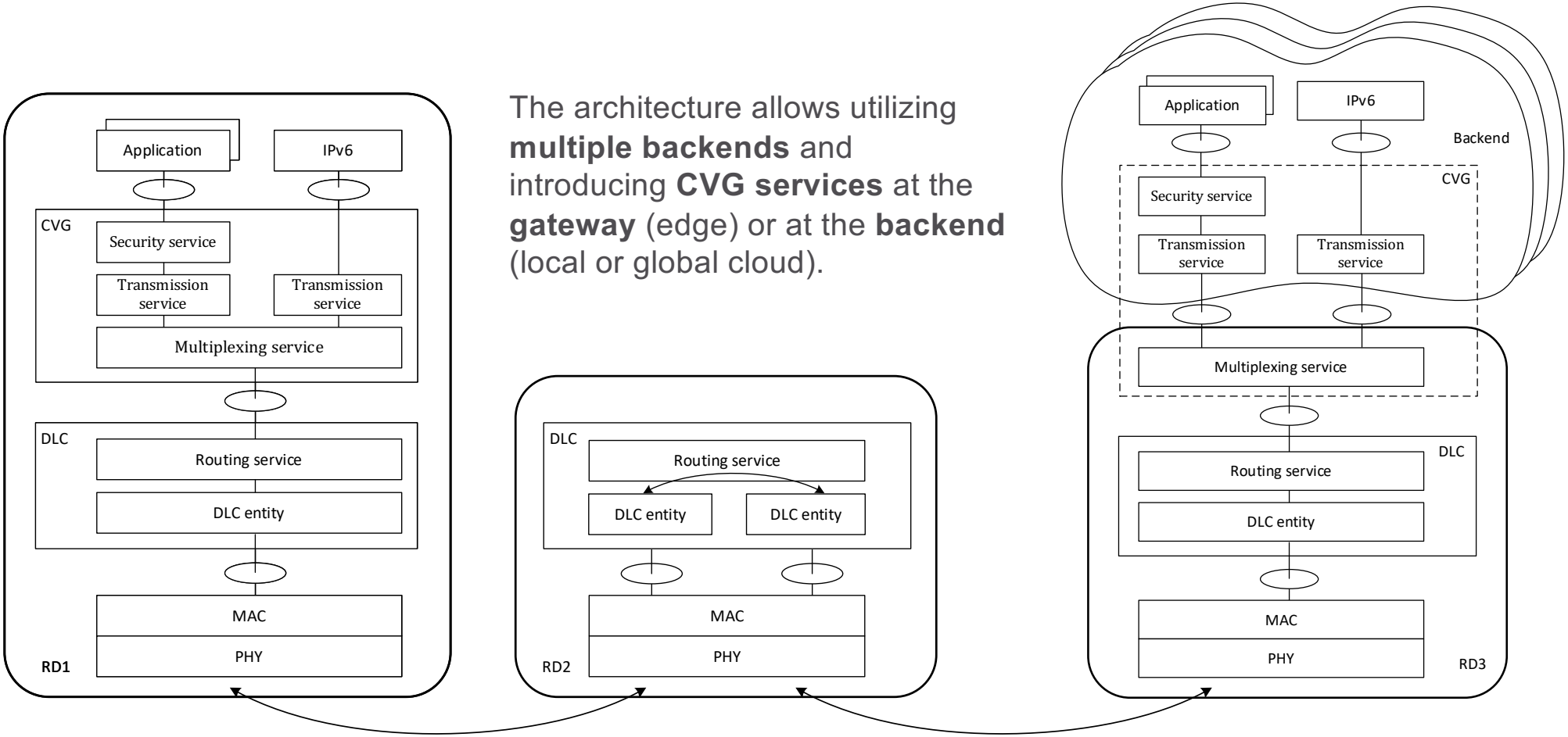
Protocols

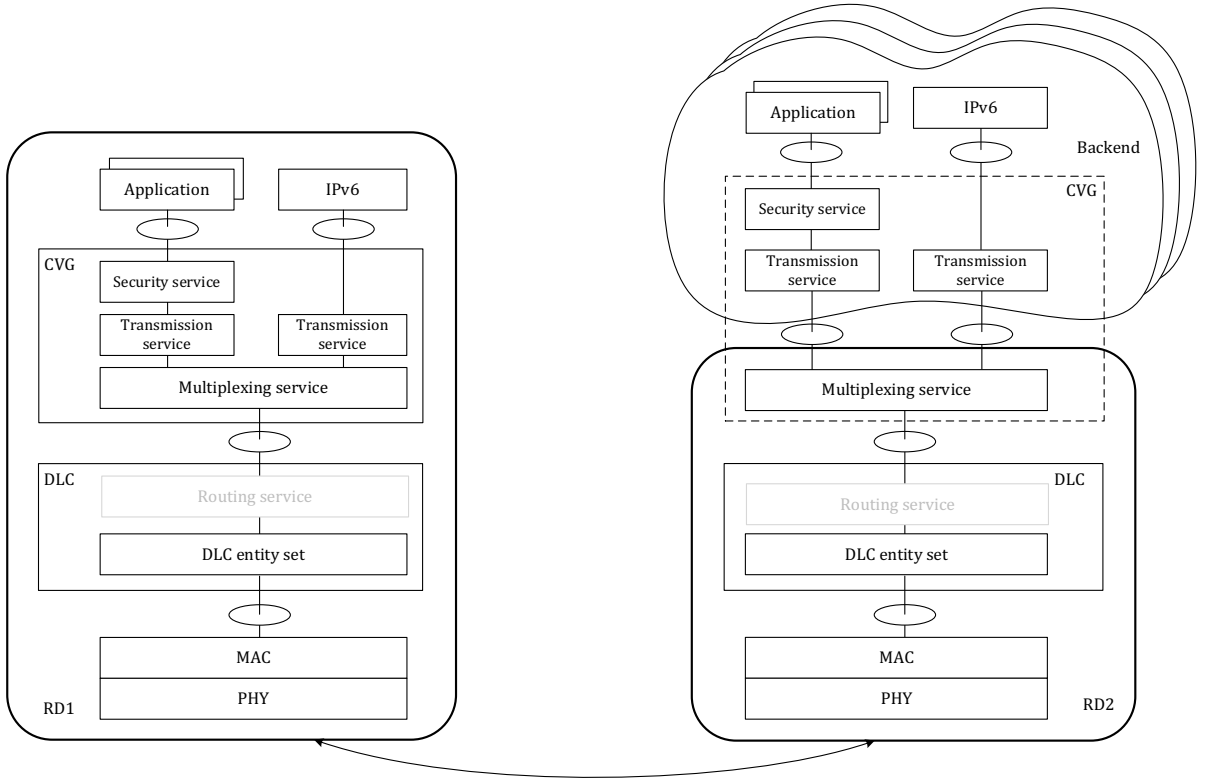
Protocol architecture in Mesh

The architecture allows utilizing **multiple backends** and introducing **CVG services** at the **gateway** (edge) or at the **backend** (local or global cloud).



Protocol architecture – star or single link

- **CVG layer** functionalities remain the same.
- At the **DLC routing** becomes trivial
- Rest of DLC functions are used.
- MAC layer functionalities remain the same.



CVG - End to End protocol functions

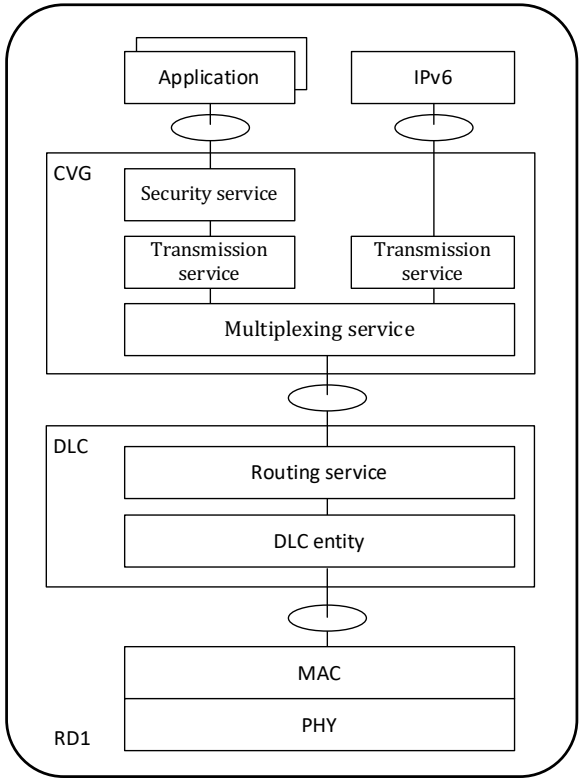
- **Endpoint multiplexing** provides means to identify and multiplex **different applications** with different data types in a **single DECT NR+ network**.
- Application data formats can be based on:
  - Public specification.
  - Company specific.
- For each application, an **Endpoint Multiplexing address** can be allocated.
  - Allocation hosted by ETSI.
  - Allocation of address space includes also address for free use space.
- Flexibility for supporting different application data types **with or without** IPv6.

CVG - End to End protocol functions

- Segmentation and reassembly:
  - PDU size for Routing can be optimized and the IoT system can support e.g. IPv6 MTU sizes.
- End to end Retransmission:
  - Used on top of MAC (HARQ) and DLC re-transmissions.
  - Transmitter can ensure 100% error-free delivery of data by re-sending data missed by the receiver.
- Security service: Ciphering and Integrity protection
  - Provides end-to-end security of the application data.
- All the above functions can be enabled optionally when needed per Endpoint.
- Provides flexibility to support different applications.

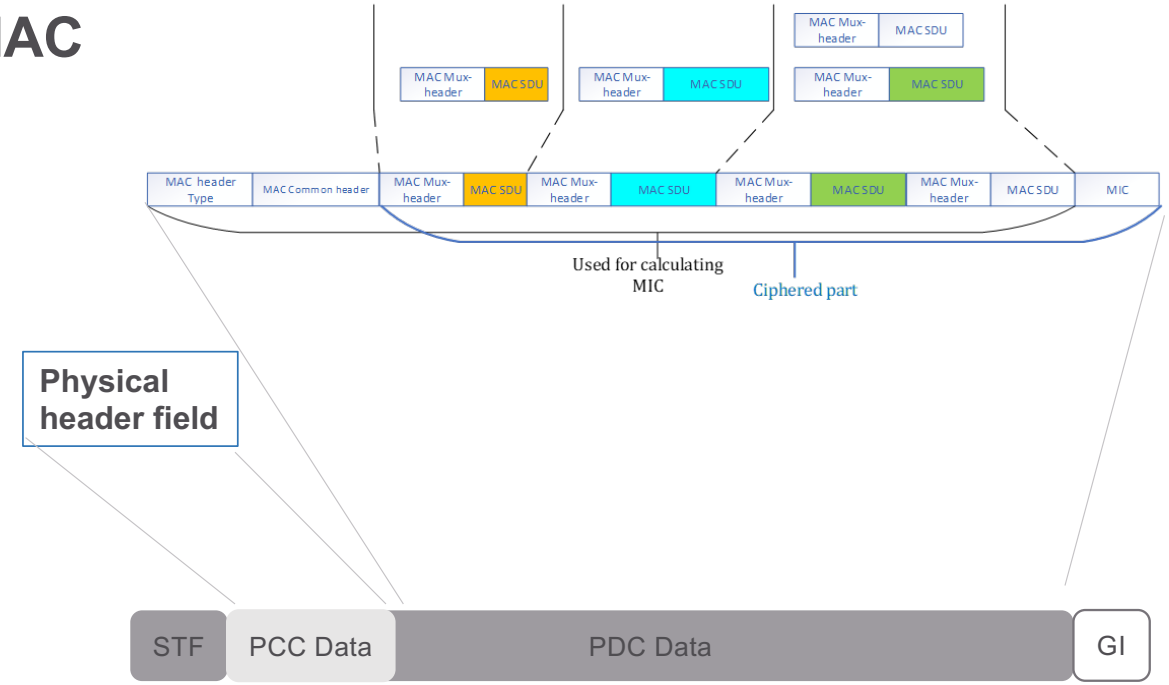
Data link Control layer - DLC

- **Routing Service:**
  - Decision-making process
  - Based on Long RD-ID included routing header of the PDU.
- **Routing Service Provides:**
  - QoS
  - Cumulative Delay
  - Cumulative hop count
  - Hop limit
- **DLC entity with DLC service types**:
  - Segmentation and reassembly
  - ARQ operation with the interaction of MAC
  - Maximum lifetime control



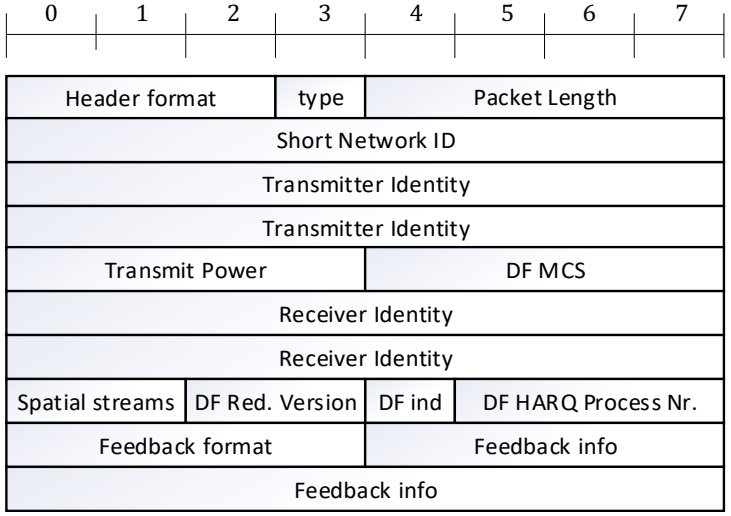
MAC data units and functions

- **Multiplexing** of different data into **MAC PDU** transmitted on **PDC**.
- **MAC security** for MAC PDU
  - AES-128 counter mode for ciphering
  - OMAC-1 message integrity protection
- Transmission parameter selection
  - Setting Physical header field bits transmitted on PCC
- Error correction through HARQ
  - Sending ACK/NACK
  - Initiating HARQ re-transmission
- Channel quality and buffer status reporting



Physical Header field in PCC

- The physical layer supports two sizes
  - 40 bits for beacon transmissions
  - 80 bits for data transmission
- MAC controls transmissions by.
  - Length of the transmission
  - RD Short Identities
  - TX power
  - Modulation coding scheme
  - MiMo settings
  - HARQ control information:
    - process number, redundancy version,
    - New data indicator.
  - Feedback Info used for
    - HARQ ACK/NACK, Buffer status, CQI,
    - MIMO Precoding and channel Rank information



Physical header field bits

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Radio access

Radio resource management

- RD in **FT Mode controls** radio resources in the cluster:
  - Selects operating channel(s) with the lowest interference.
  - Sends Network and Cluster beacons
  - Operating channel(s) may change
  - Provides connection for RDs in PT mode.
  - Manages Random Access and Schedules of dedicated radio resources.
  - Can perform local synchronization with other FTs.

- Radio Device in **PT mode selects** which RD in FT mode to connect:
  - Network scanning and finding neighbours.
  - Selects next hop based signal quality and route cost
  - Initiates association with selected RD in FT mode
  - Associates with new RD in FT mode when conditions change.
  - Transmits and receives resources provided by FT.

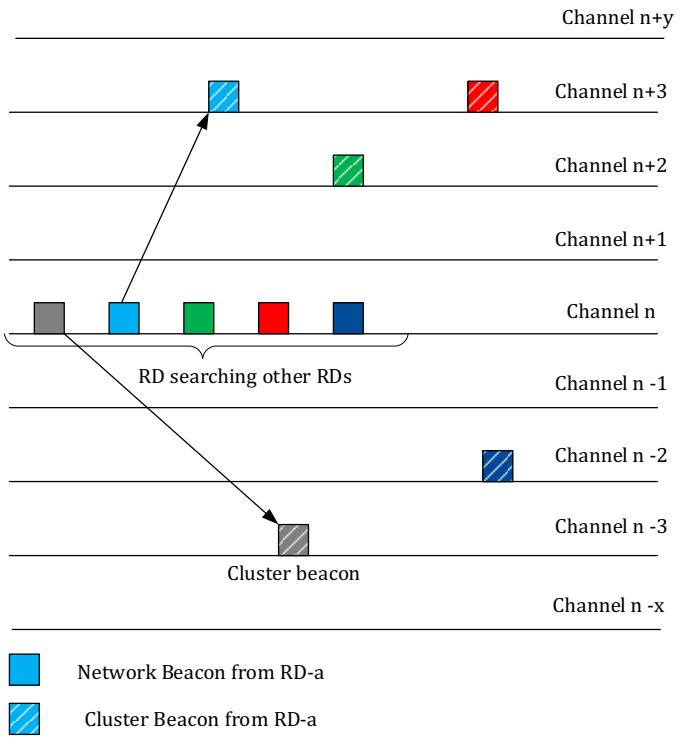
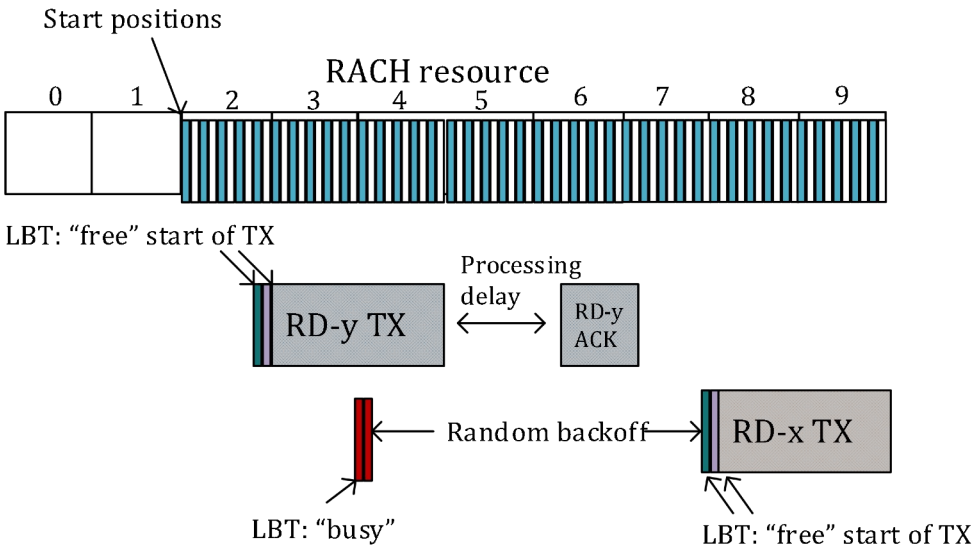


Figure: Optimized scanning strategy

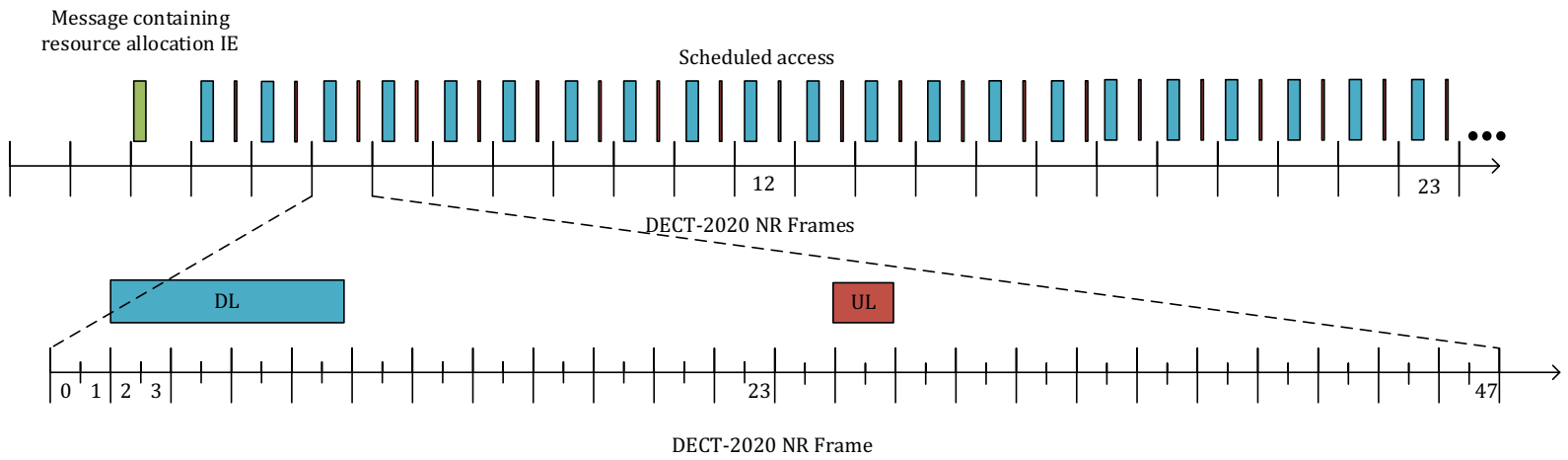
Random Access Transmissions



ETSI TS103.636-4 defines **busy** level to be dependent on used maximum TX power.
With 23 dBm TX power, the Busy level is -75dBm.

- Basic transmission mode to:
  - Establish association
  - Send any sporadic data
- Before transmission to RACH, an RD measures whether the channel is busy.
  - If the channel is **not busy**, RD initiates the transmission.
  - If the channel is **busy**, RD waits for random backoff time before measuring the channel again.
- If a collision is detected, the random backoff value is doubled.
  - reducing the probability of new collision

Scheduled Transmission



- Use case:
  - Realtime Audio, phone call
  - Video transfer, industrial control logic
  - Generic data transfer including low power IoT devices.
- FT signals transmission and reception resources to PT(s)
- Transmission and reception occurs in periodic time moments.
  - FT may share the same resource with multiple PTs in the time domain.
- Duration of the scheduled connection may be different:
  - Minutes or hours for audio or video
  - A few hundred ms for IoT

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Summary & Questions

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Topics in the webinar series

	Topics	Dates
#1	Introduction to NR+ and DECT Forum	20 April
#2	Applications and use cases	15 June
#3	The technology (upper layers)	26 September
#4	The technology (lower layers)	19 October
#5	How to get started with NR+	9 November
#6	Recap and panel discussion	December

DECT NR+ webinar series

- We hope you enjoyed this webinar!
- Be part of shaping the NR+ journey and join us at the DECT Forum!

  https://www.dect.org/application-for-membership.aspx
- Contact roel.ottink@dect.org for information
- Question time


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