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Enhancements for Rel-15 eMTC/NB-IoT

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Main directions of evolution

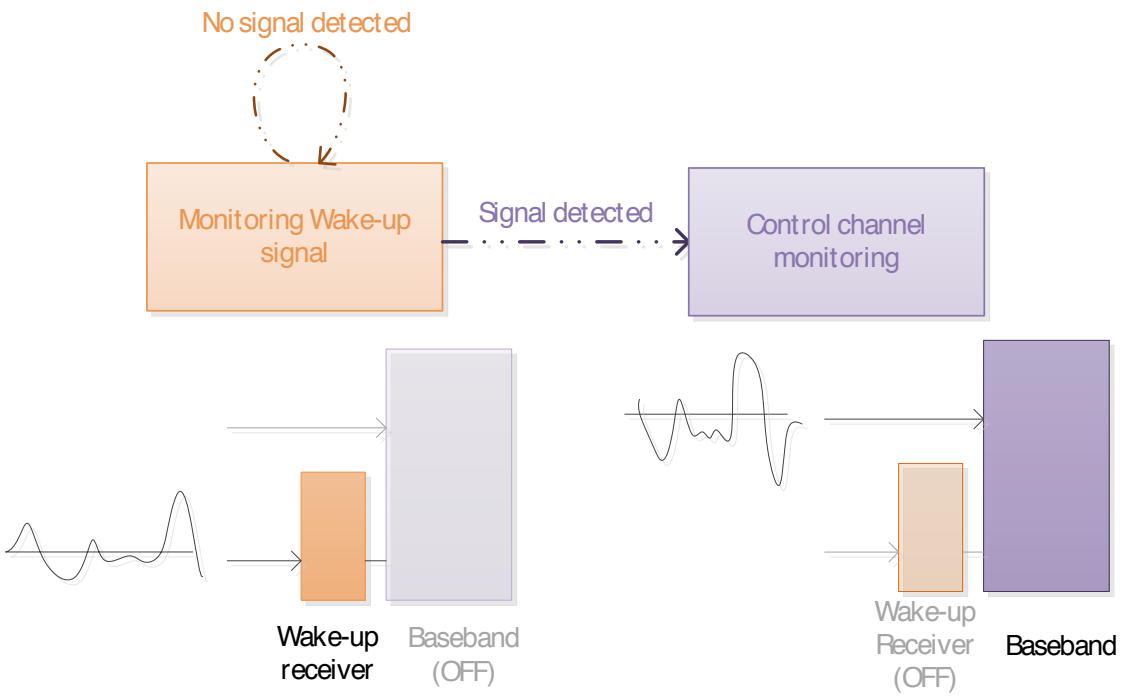
- **Power consumption reduction:**
  - Design of wake-up signals that can be monitored with a low power receiver
  - Enable low power mode for higher category UEs
    - Reduced number of receive antennas and reduced bandwidth

- **Latency and overhead reduction**
  - Enable transmission in earlier stages of random access procedure (e.g. msg2 or msg3)
  - Study grant-free uplink transmission (connected and idle mode)

- **General enhancements for increased spectral and power efficiency:**
  - Physical layer enhancements to increase coverage, spectral efficiency, and power efficiency.
  - HARQ-ACK bundling for NB-IoT
  - Support of large cell radius for NB-IoT

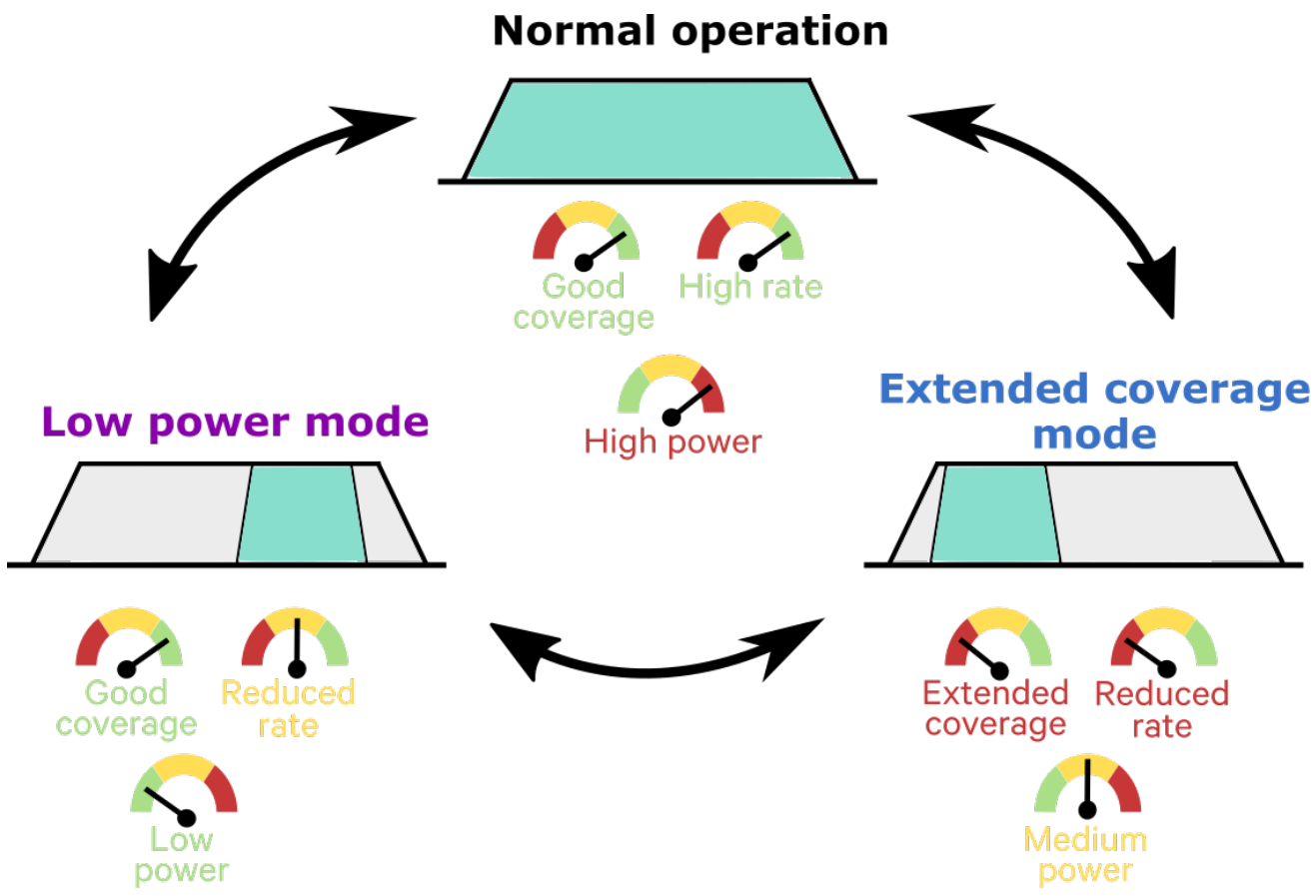
Wake-up signal

- Introduce signals and procedures to enable **wake-up receivers**
  - Two-stage receiver to first receive an ON signal and eventually wake up completely
    - Applicable to paging or connected mode DRX
  - Need to study idle mode and connected mode **procedures** and how to share the processing between the low power and normal baseband receivers



Power consumption reduction

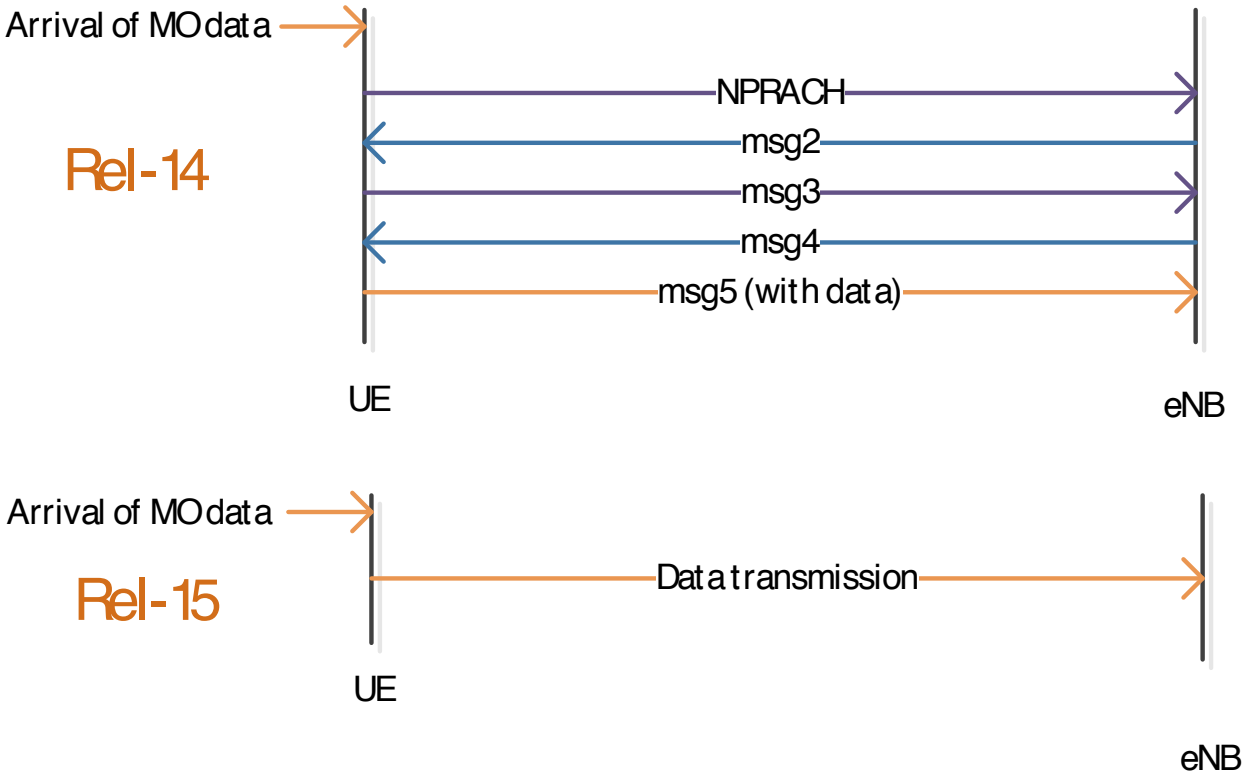
- Possibility to move higher category UEs to **low power mode** (e.g. during DRX ON cycles)
  - Low power mode includes small bandwidth and reduced number of receive chains
  - Reduce power consumption especially for "PDCCH-only" cases
    - Large % of power consumption according to real life testing



- Some of these mechanisms are enabled in Rel-13/14, but **enhancements** are needed to enable bandlimited operation by a UE for low power consumption

Latency and overhead reduction

- Many IoT applications require **short transactions** with **small data**
  - E.g. meter, alarm information.
- In current NB-IoT, it is necessary to exchange 5 messages to transmit the MO data
- Objective: Reduce number of messages
  - **Grant-less transmission** (idle and connected mode)
  - Transmission of data in msg2/3/4



Physical layer enhancements for eMTC

- **Synchronization signal** improvements:
  - The coverage of PSS/SSS/PBCH may be the limiting factor in some scenarios
  - The sync/broadcast channels from NB-IoT are better than the corresponding ones for eMTC
  - Many operators plan to **deploy both eMTC and NB-IoT** to cover different IoT applications
  - Solution: allow an eMTC UE to find/access an eMTC cell by **using NB-IoT sync channels**

- **Multiplexing of multiple UEs** in 1 PRB for uplink transmission:
  - Power limited UEs do not benefit from increased resource allocation
  - Multiplexing multiple UEs in 1 PRB **increases the system capacity** while maintaining each UE data rate

Physical layer enhancements for NB-IoT

- **Enhanced HARQ operation:**
  - Support of HARQ-ACK bundling to reduce overhead and switching time

- **Support of large cell radius:**
  - Current NPRACH and random access procedure do not efficiently support large cell radius
  - LTE supports up to **100km** cell radius, and NPRACH/random access is the limiting factor in supporting it for NB-IoT

Thank you

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