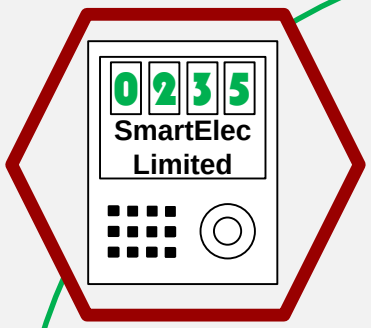
RWS-180023
Workshop on 3GPP Submission Towards IMT-2020
24-25 October 2018
Brussels, Belgium

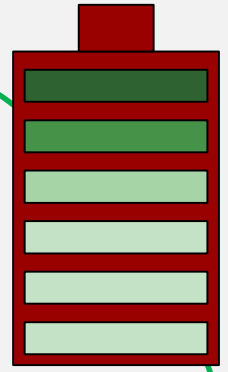
3GPP's Low-Power Wide-Area IoT Solutions: NB-IoT and eMTC

Low-power wide-area IoT

Connection density

1 000 000 UEs/km^2





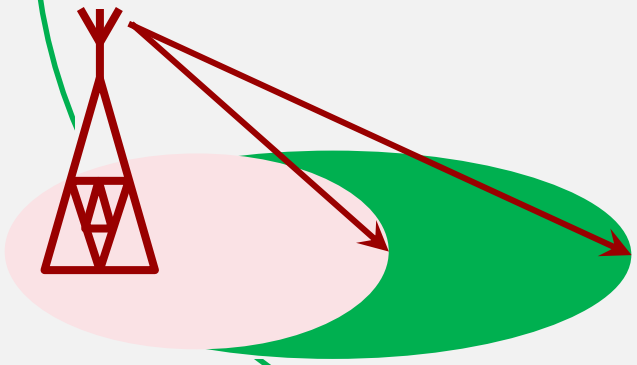
UE battery life

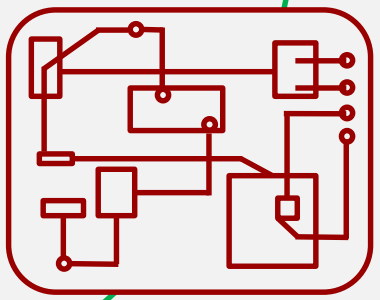
10 – 15 years in 164 dB MCL

Four KPIs for 3GPP LPWA IoT solutions

Coverage extension

164 dB MCL @160 bps

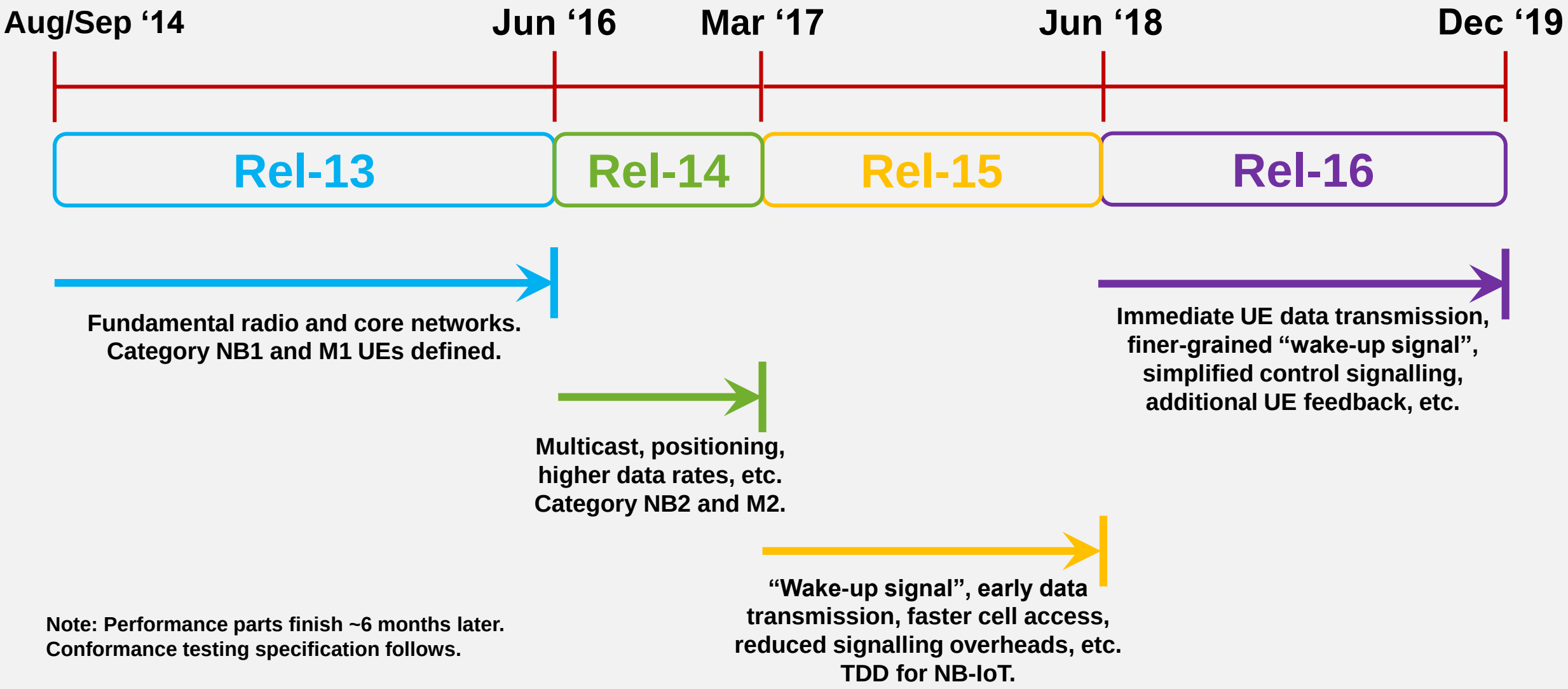




UE complexity and cost

Ultra-low

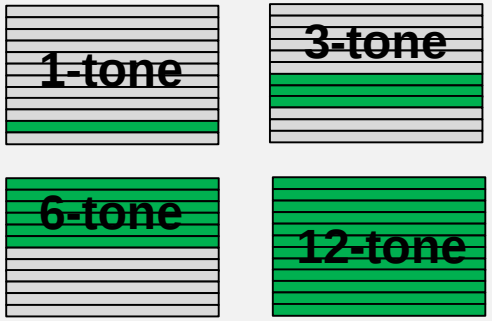
NB-IoT and eMTC project timelines



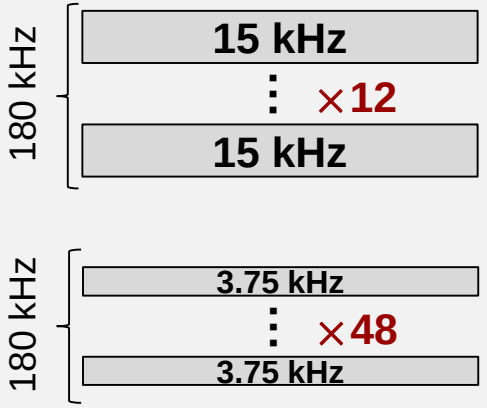
Note: Performance parts finish ~6 months later.
Conformance testing specification follows.

mMTC connection density

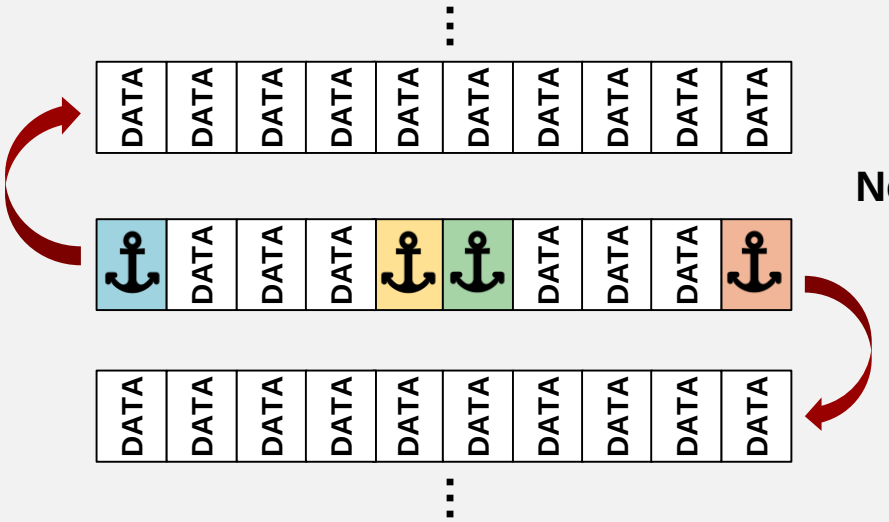
NB-IoT



Single-tone and 3/6/12-tone UL allocations

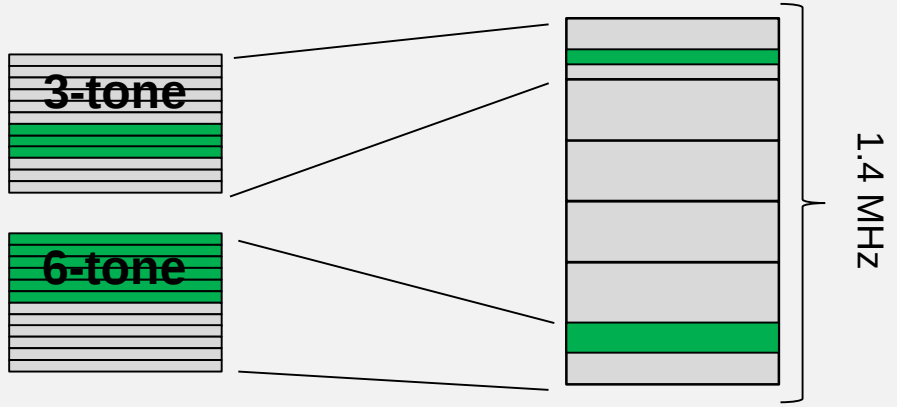


Dense subcarrier spacing

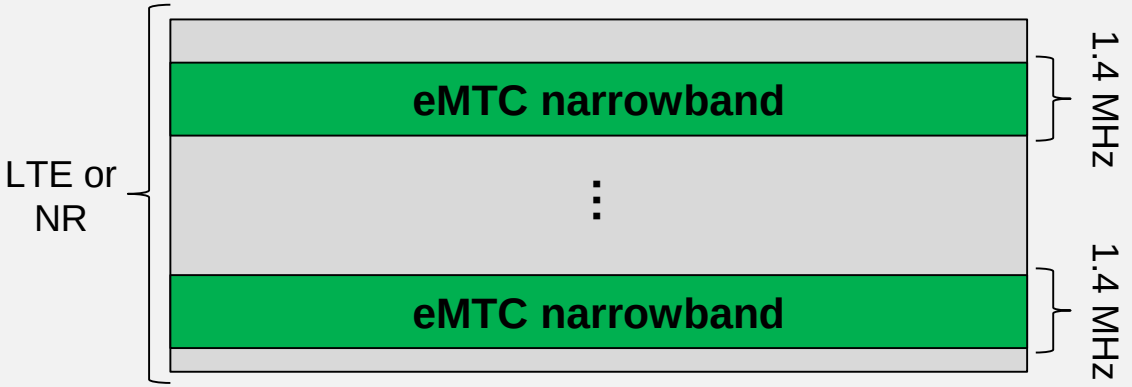


Non-anchor carriers for capacity and load-balancing

eMTC

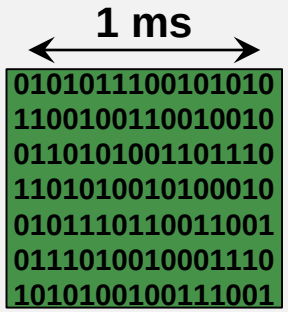


3- and 6-tone allocations within a PRB of a 1.4 MHz narrowband



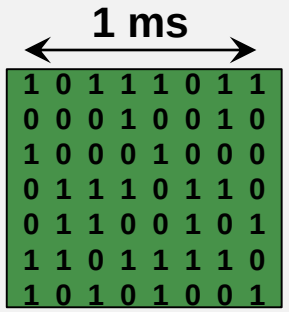
Deploy multiple independent eMTC narrowbands within LTE/NR bandwidth

Ultra-low UE complexity: Signal processing simplifications



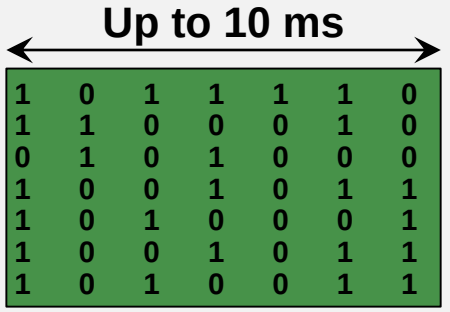
Cat. 1 data

10 000 bits / ms



Cat. M1 data

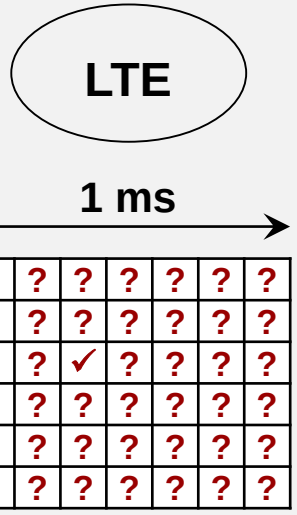
1000 bits / ms



Cat. NB1 data

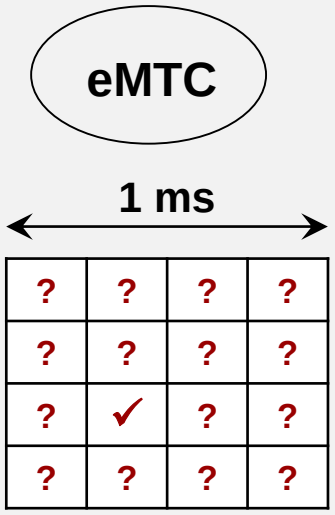
UL: 1000 bits / up to 10 ms

DL: 680 bits / up to 10 ms



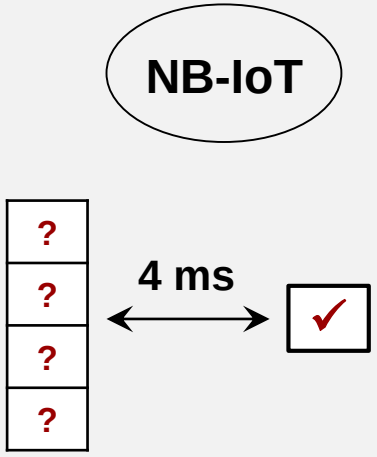
Control channel

~40 candidates / ms



Control channel

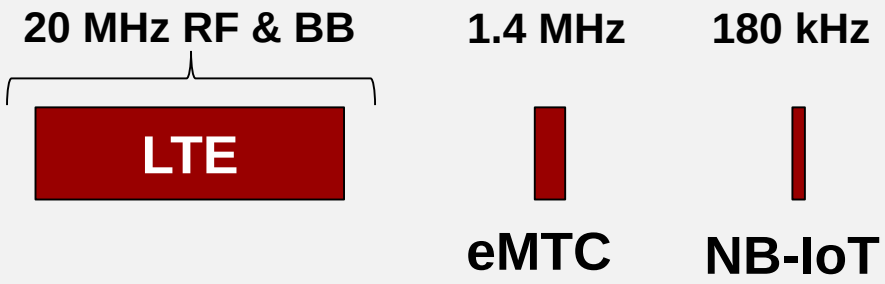
~16 candidates / ms



Control channel

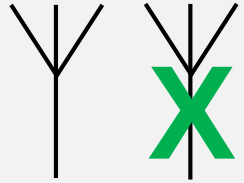
~1 candidate / ms

Ultra-low UE complexity: Hardware simplifications

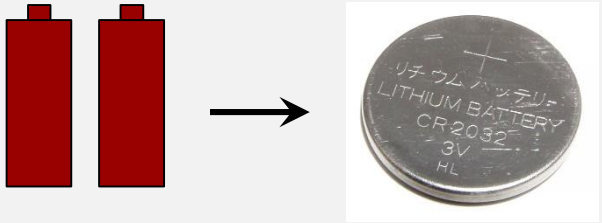


RF bandwidth ⇒ RF hardware cost

BB bandwidth ⇒ signal processing cost

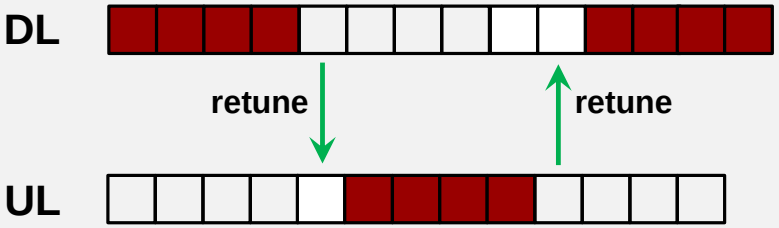


Single receive RF chain for UE



20 dBm and 14 dBm UE transmit power classes

Lower peak current requirement allows cheaper, smaller batteries

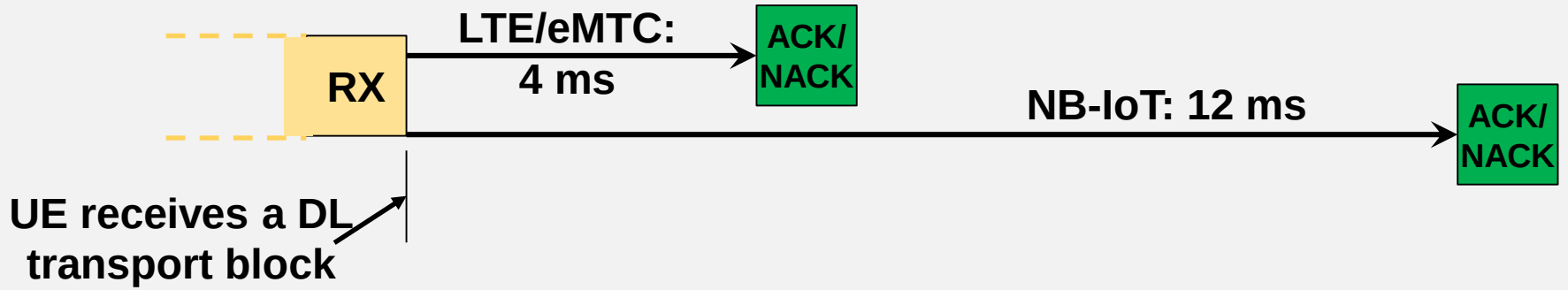


Half-duplex operation allows removal of duplexer from UE

(Mandatory NB-IoT, optional eMTC)

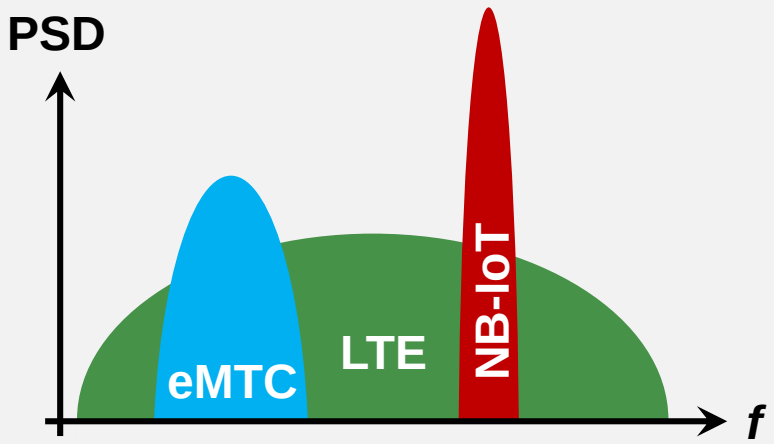
Ultra-low UE complexity: Further steps in NB-IoT

- NB-IoT takes additional steps to allow low-cost hardware:
  - Downlink uses convolutional encoding, removing need for turbo decoder in UE
  - 1 or 2 HARQ processes, instead of 8 in LTE/eMTC, reduces memory for data buffering
  - Synchronization signals with low complexity, optimised for reception in deep coverage
  - Maximum modulation is QPSK instead of 16-QAM, lessening EVM requirements
  - UE is allowed a much longer time to decode a reception before reacting to it, e.g. for DL:

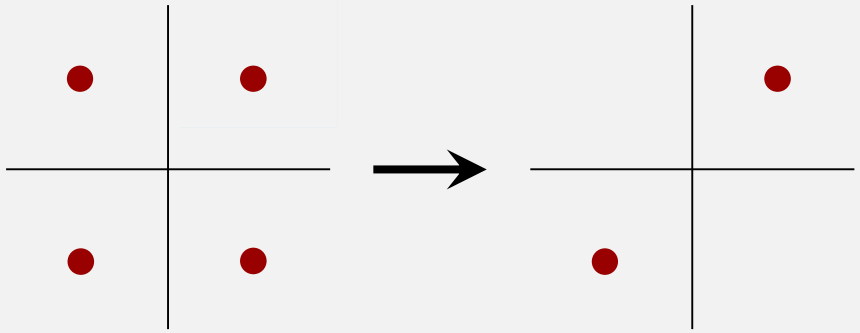


  - 40 ms gap after each 256 ms of transmission during UL, allowing UE to re-sync to DL
    - Allows lower-cost non-temperature compensated crystal oscillators to be used in chipsets
    - Mandatory in NB-IoT UEs, optional for eMTC

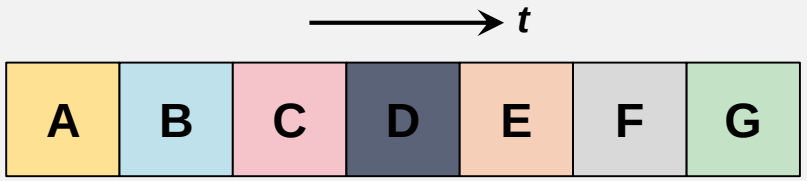
Coverage extension



PSD boost in bandwidth as small as 3.75 kHz

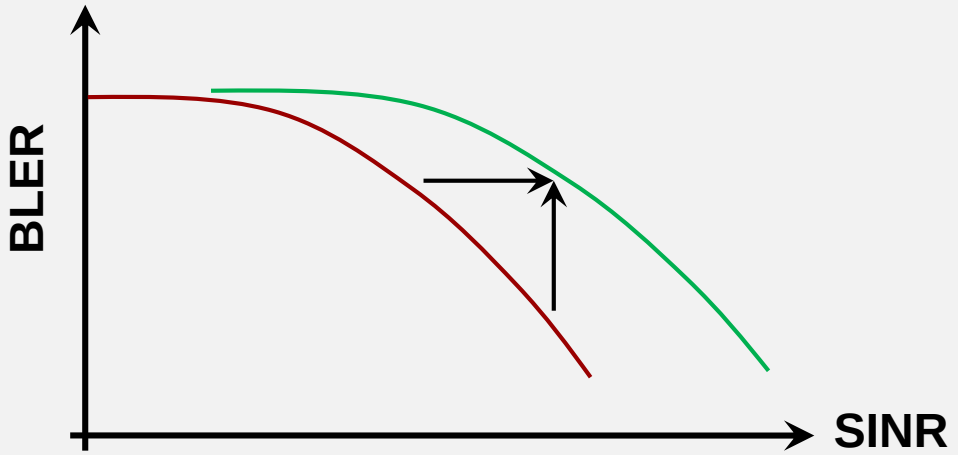


Low-PAPR $\pi/2$-BPSK modulation
(and $\pi/4$-QPSK in NB-IoT)



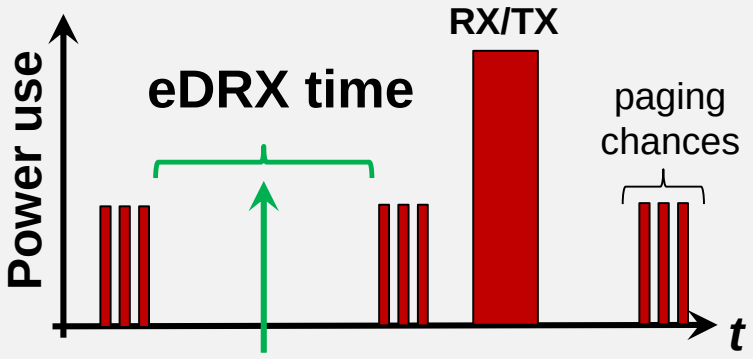
LTE uses single-subframe transmission

NB-IoT and eMTC repeat same transmission to accumulate RX'd power



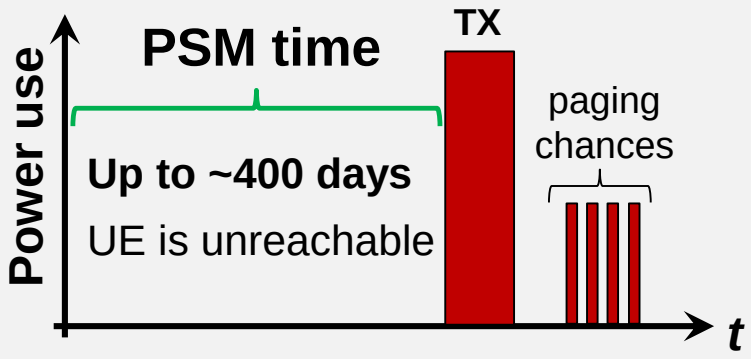
Relaxed requirements to tolerate lower SINR regimes

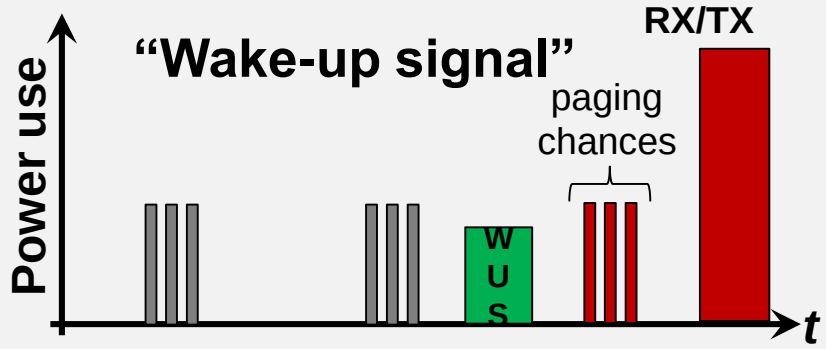
Battery life 10 – 15 years

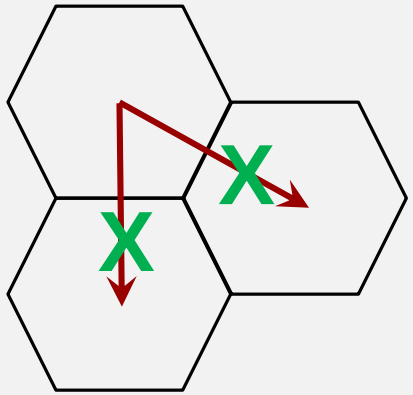


NB-IoT: ≤ 3 hr

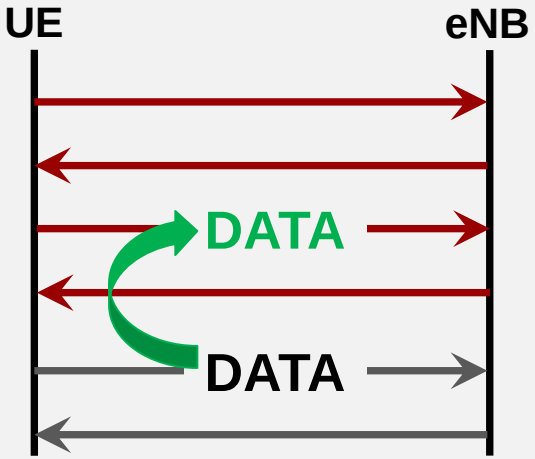
eMTC: ≤ 40 min



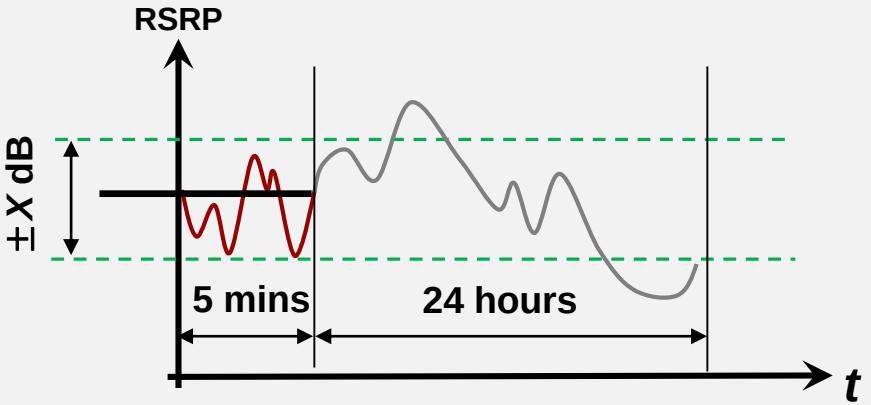




NB-IoT: No handover measurements / signalling



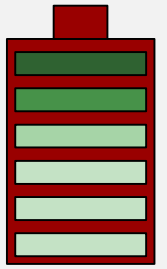
Earlier data transmission, without tx/rx'ing to complete connection



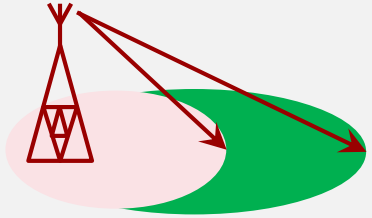
Stationary UE can suspend measurements of neighbour cells

Hallmarks of 3GPP LPWA IoT technologies

Battery life of 15 years or more on 2AA cells (5 Wh)



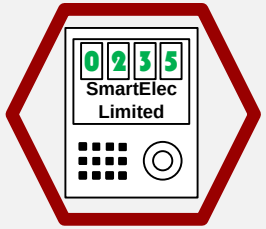
- Optimised for small infrequent packet transmissions e.g. 50-200 bytes few times/day
  - Transfer data earlier with fewer transmissions, and less battery consumption
- Maximise time UE can spend in low-power states and eliminate avoidable UE RX/TX



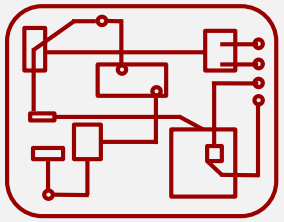
Support for normal to moderate coverage and deep coverage scenarios

- Repetition, PSD boosting, and low-PAPR transmissions
- In good coverage, NB-IoT and eMTC do not need repetitions

mMTC connection density of ≥1 000 000 UE/km^2



- Small resource allocations, 3.75 kHz subcarriers (NB-IoT), scalable network capacity
- Reduced signalling overhead to free-up resources for connecting more devices per cell



Complexity and cost is much lower than MBB devices

- Reduced RF and baseband bandwidths of 1.4 MHz for eMTC and 180 kHz for NB-IoT
- Relaxed signal processing requirements, with further relaxations in NB-IoT

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THANK YOU

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