

IOT Evolution - Rel17 Scope

A woman with long dark hair, wearing a light-colored jacket, is looking down at her smartphone in a natural setting. In the foreground, a vibrant blue butterfly is perched on a green plant. The background is a soft-focus field of green foliage.

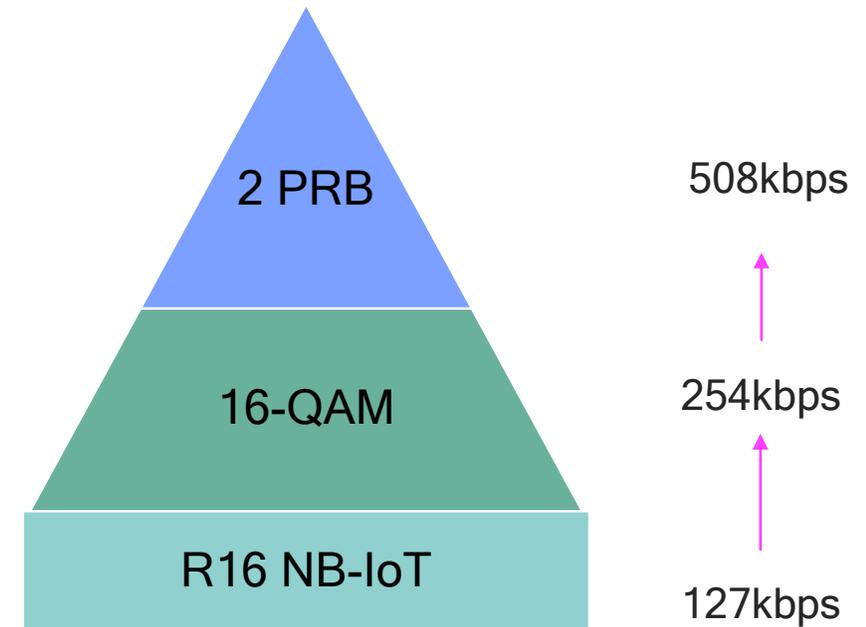
Background

- The mMTC component of 5G systems is based on eMTC/NB-IoT.
- Need to continue evolving these technologies to align with market needs and adapt to new deployment scenarios.
- In this contribution, we present several proposals to evolve mMTC technologies in the following directions
 - Increased data rates and spectral efficiency
 - New functionalities:
 - Support of private networks
 - Support of multicast connected to 5GC
 - Power savings

Increase of data rates

NB-IoT

- NB-IoT throughput is limited by the following factors:
 - QPSK modulation
 - 180kHz bandwidth
- Increasing the modulation order only provides advantage to UE in good SNR conditions
 - Cannot be used to guarantee a service over the whole cell
- Proposed enhancements for downlink:
 - Support of higher order modulation
 - Support of larger bandwidth / carrier aggregation
 - At least 2x180kHz
- Additional input in RP-192685



Increase of data rates (under consideration for TEI16)

eMTC

- Data increase for cat-M1 HD-FDD UEs: Currently limited by cross-subframe scheduling
 - For the first two subframes of a *bundle*, the UE cannot receive data (only control)

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
C	C	C	C	C	C	C	C	C	C							
		D	D	D	D	D	D	D	D	D	D					
													C	C	C	

No data

588kbps
(1000 bits x 10 / 17)

- **Proposal:** Introduce mechanisms to allow for scheduling the first two subframes of bundle
 - 20% data rate increase

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
C	C	C	C	C	C	C	C	C	C							
D	D	D	D	D	D	D	D	D	D	D	D					
													C	C	C	

706kbps (+20%)
(1000 bits x 12 / 17)

Multicast/broadcast for mMTC

- In Rel-16, SA and RAN WG enabled connection of eMTC/NB-IoT to 5GC.
 - This does not include support for multicast/broadcast
- Since Rel-14, eMTC/NB-IoT connected to EPC supports multicast/broadcast services.
- The functionality will be added to 5GS after completion of current SA2 study, and should address also mMTC use cases.
- **Proposal:**
 - Introduce support for multicast/broadcast for eMTC/NB-IoT connected to 5GC

Support of private networks

NB-IoT and eMTC

- Current NB-IoT/eMTC does not support connectivity to Standalone Non-Public Networks (SNPN) or PLMN integrate Non-Public Networks (PNI-NPN), although this limitation is not observed from system architecture perspective.
- NB-IoT in SNPN/PNI-NPN may be needed for 3GPP to provide a complete solution for example in the factory automation case, where some low-cost sensors may be based on NB-IoT/eMTC (making them based on NR may not be cost-efficient)
- **Proposal:** Introduce support for SNPN/PNI-NPN in NB-IoT and eMTC
- NOTE: This can be part of RAN2 NPN work item, additional views in RP-192422

Power enhancements

Relaxation of monitoring of paging/WUS

- Current requirements for detection of WUS/PDCCH is 1% BLER
 - Due to lack of diversity of the system, for a given operating SNR, typically reaching 1% BLER requires many more repetitions (up to 4x) than 10% BLER
- An overall 1% error with the same delay can be also achieved by:
 - Changing paging error probability from 1% to 10%
 - Reducing DRX cycle by a factor of 2
- Due to the decorrelation of the channel between DRX cycles, the overall power consumption will be lower (also the network resources will be reduced)
- **Proposal:**
 - Introduce **relaxation for WUS/paging monitoring** (up to 10% error rate)

Paging carrier optimizations

NB-IoT

- In NB-IoT, paging carrier selection is based on UE_ID, but RRM measurements are always made in anchor carrier.
- Thus, if a UE is in a bad quality non-anchor, the UE may not be able to decode paging messages but will not trigger cell reselection.
- **Proposal:** Allow for mechanisms to avoid consistent interference in paging non-anchor carriers.

Additional reference symbols

- In low SNR regimes, the performance of physical data channels is limited by channel estimation.
- We observe **substantial gains (up to 3dB) in low SNR** by adding additional reference symbols for demodulation of PDSCH.
 - Potential to reduce the number of repetitions by half in low SNR.
- **Proposal:** introduce additional reference signals for demodulation of physical channels.

PDSCH Repetition	SNR gain
16	0.57
32	1.09
64	2.09
128	2.54
256	2.80
512	2.91

Neighbor cell assisted search

eMTC

- Current neighbor cell search in eMTC is “blind”, i.e., the UE searches for all possible cell ID in all possible timings.
- In some scenarios (especially in very low SNR), detecting a cell may take a very long time, impairing the UE power consumption
- **Proposal:** Introduce signaling to reduce the cell search hypothesis in idle and connected mode.

Scenario	Baseline	Assisted
2 cell	-7.3dB	-12.6dB
4 cell	-4.8dB	-10.5dB

Required SNR for 90% detection probability with different number of neighbor cells. We observe gains of **up to ~6dB** by adding assistance information to reduce the number of hypotheses.

Front-loaded DMRS for MPDCCH

eMTC

- In LTE, a UE not detecting PDCCH in the first few symbols of the subframe may turn off the RF for the remaining of the subframe (thus reducing the power consumption).
- For MPDCCH, the UE has to wait until the end of the subframe to decode, thus not enabling micro-sleep.
- **Proposal:** Front-load the DMRS of the MPDCCH, such that a UE can perform DMRS detection and sleep for the rest of the subframe if it is not detected.
 - We observe gains of >10% power consumption in connected mode by introducing this technique.

Summary of proposals

- For Rel-17 IOT, specify the following enhancements:
 - 16-QAM and bandwidth of 2 PRBs for downlink
 - Higher data rates for eMTC (if not done in Rel-16 TEI)
 - Broadcast/multicast for 5GC
 - Support of private networks
 - Relaxation of paging monitoring
 - Mechanisms to avoid interference in paging carrier for NB-IoT
 - Additional reference symbols
 - Neighbor cell assisted search for eMTC
 - Front-loaded DMRS for MPDCCH in eMTC



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