

RP-172529

# NB-IoT Rel-16

## Scope of New Work Item

Agenda item: 10.1  
Source: MediaTek Inc  
For Discussion

# Overview

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- Efficiency Enhancements
  - Power Consumption, Efficiency of UL transmission: HARQ-ACK feedback in DL for data transmission in UL
  - Spectral Efficiency: Higher Order modulation for PDSCH and PUSCH
  - Power Consumption, Efficiency of System Information Acquisition, Mobile UEs: Reuse of System Information between cells (as in NR).
  - Better coverage / interference handling, Power consumption: NB-IoT carrier per coverage level.
  - Remains from Rel-15 (if any)
- Mobility Enhancements
  - Support for Mobility during data transmission
  - Support for IRAT Mobility in Idle mode
- NB-IoT joint deployment with NR

# Some Overview Justifications

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- In the “low end” NB-IoT is intended to compete with dedicated LPWA technologies such as LoRa, with 15 years battery life in 164 dB CL coverage conditions. This is very challenging and requires a very high degree of optimization. For meters in 164 dB CL, a dominating source of power consumption is UL transmission.
- In the “higher end” NB-IoT is in many markets replacing GSM/GPRS for IoT usage. In general the traffic models of IoT applications are different, and with varying packet sizes. So far, NB-IoT is mostly optimized towards sparse small packets. There are cases also with larger packet sizes, file downloads, file uploads etc. A natural requirement is that NB-IoT should provide good spectrum efficiency, and good power consumption at least in comparison to GSM/GPRS also in the mixed IoT applications scenario.
- When NB-IoT is deployed on a LTE grid with High Power per PRB in the DL cmp to LTE and with capability of high numbers of repetition, the result is that NB-IoT cells have very large overlap, also at the cell edge the radio quality is good, and an outdoors UE can be connected to another cell while at the cell center of a neighbor cell.
- Current NB-IoT has no support at all for IRAT mobility, meaning that a multi-RAT UE could be stuck forever in bad radio condition even though there may be a better good alternative that could give e.g. better power consumption better efficiency.

# Efficiency: HARQ-ACK feedback in DL for data transmission in UL

- Specify an efficient physical signal/channel/DCI for HARQ-ACK feedback in DL for data transmission in UL
- Motivation
  - The current DCI/PDCCH is power consuming in Deep coverage, with high number of repetitions, especially in joint deployment with LTE where DL power cannot be high
  - The current high cost for DCI/PDCCH leads to a low BLER target to avoid retransmissions to avoid using DCI/PDCCH for HARQ retransmission.
  - Using a low BLER target for UL transmission means that there is high risk of over-doing the blind repetitions. In many cases the UE repeats too many times.
  - With a low cost, more efficient mechanism for HARQ ACK, higher BLER target, with less over-repetition in the UL can be used without incurring excessive time spent for DL HARQ ACK reception, leading to an overall power consumption gain for the UE.
- Expected Benefit
  - Lower UE Power Consumption, especially in bad radio conditions.

# Efficiency: Higher Order Modulation

- Specify support for higher order modulation for PDSCH and PUSCH
- Motivation
  - Use cases for embedded Ues (IoT UEs) are very diverse, the typical amount of data in a transmission varies from application to application.
  - Higher order modulation would be less resource consuming for UEs in good/normal coverage.
  - NB-IoT is used as a replacer of GERAN. For Cells where Deep coverage is not needed, the spectral efficiency should be better than EDGE.
- Expected Benefit
  - Increased Spectral Efficiency, for cells with UEs in Normal Coverage.
  - A likely secondary outcome: Higher bitrate for UEs in Normal Coverage

# Efficiency: System Information Coordination

- Specify support for reusing System Information between cells, as in NR
- Motivation
  - Most system information in NB-IoT is static and can be the same in different cells.
  - Mobile UEs currently need to re-read all system information when a new cell is entered. For the system information that can be the same between cells this can be avoided leading to lower power consumption.
- Expected Benefit
  - Power consumption, for mobile UEs.

# Efficiency: NB-IoT carrier per coverage level

- Specify Support for different coverage level support per carrier for paging.
- Motivation
  - Rmax also for paging can be set low on carriers for normal coverage, leading to low power consumption for PDCCH decoding for Ues in normal coverage (without the additional overhead of WUS).
  - If carriers could be dedicated for normal coverage vs deep coverage, normal coverage UEs can have better QoS without risk for Head of line blocking, due to UEs that need many repetitions.
  - UEs that need deep coverage could use stand-alone carriers, while UEs in good coverage could also use in-band carriers.
- Expected Benefit
  - Better handling of coverage and interference. Avoid that bad coverage Ues blocks good coverage UEs.

# Mobility During Data Transmission

- Specify Support for Mobility during data transmission (other than Radio Link Failure).
- Motivation
  - The relatively low data rates of NB-IoT involves significant transmissions times for e.g. file transfers, configuration files, report files, media files, software upgrade files.
  - With current deployments overlap between cells can be very significant for outdoor UEs.
  - A moving UE in a longer transmission may cause significant interference in neighbor cells.
  - The traditional approach is to keep the UE connected to the best cell, by a mobility mechanism
- Solution approaches
  - Details for further study.
    - E.g. Cell reselection with RRC reestablishment in connected mode.
  - Measurements in Gaps
    - The hardware requirements of the UE shall not be extended by this feature.
    - E.g. DRX gaps, or extended DL UL transmission Gaps.
- Expected Benefit
  - Less Interference, with overall enhanced performance.

# IRAT Idle Mode Mobility

- Specify Support for Inter RAT Cell Reselection (GSM, LTE)
- Motivation
  - To avoid that a multi-RAT UE get stuck in bad radio conditions when better radio coverage is available from another RAT
- Solution
  - Care must be taken to avoid high power consumption due to measurements.
- Expected Benefit
  - Lower UE Power consumption, better efficiency.

# NB-IoT joint deployment with NR

- Specify support for spectrum sharing between NB-IoT and NR
- Motivation
  - In refarming situations NR will replace LTE, and there may be situations where NB-IoT is co-deployed with the refarmed LTE
  - NR will be the high-bitrate RAT also in new spectrum suitable for NB-IoT.
- Expected Benefit
  - Future re-farming of LTE -> NR shall not impact legacy NB-IoT UEs that were using NB-IoT carriers that were co-deployed with LTE.
  - It shall be possible to do future co-deployments NR / NB-IoT without impact to NR UEs or NB-IoT UEs.