3GPP TSG RAN Meeting #80
La Jolla, USA, June 11 - 14, 2018
Agenda Item: 10.1.3
Document for: Discussion

RP-180877

On NB-IoT evolution in Rel-16

Huawei, HiSilicon

Justification

NB-IoT introduced a new air interface optimized for LPWA to enable an ultra-low cost UE for IoT services. After enhancements in Rel-14 and Rel-15, NB-IoT supports additional functions and scenarios. Power consumption and latency requirements also continue to drive enhancements.

- Positioning: E-CID and OTDOA
- Multi-cast: SC-PTM
- Capacity: Paging and RACH on non-anchor carrier
- Peak data rate: extended TBS and 2 HARQ
- Mobility: optimization for RRC connection re-establishment
- Power consumption and latency further reduction: Wake-up signal、Early data transmission during RACH procedure、Physical layer SR、SPS for BSR
- New scenarios: TDD、Small cell、Stand-alone + in-band/guard-band for multi-carrier
- etc.

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Justification

NB-IoT has been deployed and proven successful for sensor report use cases e.g. metering. It is also used to provide services other than sensor reports, such as shared bicycle, smart streetlight etc. which may have different traffic models, latency/power consumption, capacity and mobility requirements. There are also non-cellular competitors providing simpler solutions than 3GPP for some of the IoT use cases which may result in lower power consumption or lower latency, even though they can not provide telecom level service.

In Rel-16, NB-IoT can continue to enhance aspects which further improve power consumption, latency, efficiency/capacity, mobility etc. to fulfil more strict requirements of new use cases and consolidate competition with non-3GPP technologies.

UL transmission improvement: power consumption and latency even further reduction

Motivation

- UE power consumption is mainly due to the duration of UE Rx/Tx on-time. In Rel-15, an NB-IoT UE in RRC_IDLE mode can transmit ‘early data’ in Msg3.
- Signaling overhead in NB-IoT can still be reduced by comparison to some non-3GPP technologies, whilst still providing a telecoms-grade service.
- Continue to bear down on power consumption and latency simultaneously to support wide range of IoT applications from all spheres. Further improve UL data transmission efficiency in both idle and connected modes.

Main features

- UE in RRC_IDLE can transmit data before Msg3 without UL grant
- UE in RRC_CONNECTED can transmit data without UL grant or with simplified control less grant
- Waveform other than SC-FDMA (e.g. FDMA) requiring less-orthogonality and allowing more-relaxed TA alignment between different UEs can be studied

UL transmission improvement: more dynamic access and scheduling

Motivation

- Introducing UL transmission without grant will lead to colliding transmissions between UEs. Handling of multiplexing on a shared resource needs to be introduced to deal with this.
- New use cases e.g. shared bicycle or smart streetlight may have new traffic characteristics of denser report than daily report sensors which requires more system resource.
    - Relying on static or semi-static configuration of more resource to handle the unexpected application traffic is not efficient. Dynamic schemes for multi-user resource sharing would improve the efficiency of the system.

Main features

- Schemes for multi-user uplink transmissions simultaneously occur on shared resource, e.g. frequency or time domain CDM, MU-MIMO without increase the number of antennas at the UE
- Enhanced eNB receiver to detect multiple users in a resource

DL transmission improvement: more efficient group messages for dense IoT deployment

Motivation

- IoT devices are often deployed as groups with a common application, e.g. smart streetlights. These may be controlled, e.g. on/off by the IoT application layer with a tight response-time window after being paged. The application layer common message can be very small in such cases, but sent to many UEs.
- Using the MBMS service is not efficient to serve such small size DL command message transmissions, and requires many network nodes to be deployed.

Main features

- Support mapping between user groups and group RNTIs.
- Support efficient transmission of DL messages to groups of UEs, at least for paging

Mobility further enhancement: for both idle and connected modes

Motivation

- NB-IoT chipset may be embedded in smart phone for some particular applications (e.g. smart phone turns off voice/eMBB but still have small data packet service requires more coverage and more power saving etc.)
- Some multi-mode chipsets (e.g. NB-IoT/eMTC) are in the market.
- Rich LPWA applications benefit from (enabled by) handover. e.g. low-end wearable devices for old people and children tracking (no voice support), pet tracking, logistics/assets tracking
- Handover is an essential cellular feature which competes with unlicensed LPWA technology
- Some chipset vendors plan to replace GPRS products by NB-IoT
- NB-IoT already supports NRSRP/NRSRQ measurement and report in Msg5 recently
- Introduce handover as an optional feature for NB-IoT to support better mobility

Main features

- Idle mode: inter RAT mobility enhancement.
- Connect mode: support handover as an optional feature.
    - Procedure simplification, e.g. no dedicated signaling for measurement control and report.
    - Time interruption in connected mode needs to be improved e.g. HO to reduce SI reading time.

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Network management tool enhancement: improve UE differentiation

Motivation

- In R15, the UEs can be differentiated according to traffic model (e.g. Periodic communication indicator, Periodic time, Scheduled communication time, Traffic profile), stationary indication and Battery indication.
- There are still some latency sensitive or non-sensitive use cases. The network needs to know the latency requirement for certain UEs and to optimize the usage of radio resource.

Main features

- UE differentiation according to maximal tolerable delay per service.

R15 leftovers

Motivation

- Some features were discussed previously but not specified due to limited time. Some of them could be continue considered in Rel-16.

Main features

- UE sub-grouping for WUS
- Network initiated early data transmission (MT EDT)

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Estimated TU for these proposals

Feature	RAN1 TU	RAN2 TU
UL transmission improvement: transmission without UL grant	6 (6 meeting * 1 TU)	4 (4 meeting * 1 TU)
UL transmission improvement: more dynamic access and scheduling, i.e. multi-user transmissions on shared resource	6 (6 meeting * 1 TU)	2 (4 meeting * 0.5 TU)
DL transmission improvement: DL messages to groups of UEs, at least for paging	0.75 (3 meeting * 0.25 TU)	2 (4 meeting * 0.5 TU)
Mobility further enhancement: for both idle and connected modes	0	2 (4 meeting * 0.5 TU)
Network management tool enhancement: improve UE differentiation	0	1 (4 meeting * 0.25 TU)
R15 leftovers: network initiated early data transmission (MT EDT)	0.5 (1 meeting * 0.5 TU)	2.5 (5 meeting * 0.5 TU)
R15 leftovers: UE sub-grouping for WUS	2 (4 meeting * 0.5 TU)	1 (4 meeting * 0.25 TU)
Total	15.25	14.5

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Thank you !

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