3GPP TSG RAN #93-e

13th – 17th September 2021

RP-212343

Rel-18 RedCap Enhancement

Agenda Item: 9.0.2

Source: Intel Corporation

Document for: Discussion

intel®

Cellular IoT: A spectrum of requirements

- Cat M (eMTC) and NB-IoT remain as suitable options for the most cost- and power-sensitive LPWA market with very low data rate requirements *(e.g., typically < 1 Mbps, no more than ~4/7 Mbps in DL/UL for Cat M2)*
  - Use cases include: smart meters, basic inventory/asset trackers, etc.
- Rel-17 NR introduces a framework for NR IoT with introduction of Reduced Capability (RedCap) NR devices
  - BW limited to 20 MHz (in FR1) and 100 MHz (in FR2)
  - Peak rates of 80~200 Mbps in the DL and around ~90 Mbps in the UL
- While offering potential reduction in device cost/complexity and power consumption compared to "eMBB" or "URLLC/IIoT" UEs, Rel-17 NR RedCap offers a considerable over-design in terms of device cost/complexity or power consumption for IoT use cases demanding peak rates of a few Mbps *(e.g., 1~20 Mbps)*
  - Use cases include: wireless sensors, low-end wearables, basic (SD) video surveillance, asset trackers (with mobility support), IoT use-cases with human-machine interfaces involving voice (VoIP), etc.
  - Currently, these use cases are mostly served by Cat 1, Cat 1bis, or Cat M UEs
  - This category of IoT devices offers the largest potential volume for NR IoT, second only to LPWA
- It would be imperative to specify NR IoT solutions to better address IoT use cases with 1~20 Mbps data rates with higher sensitivity to cost/complexity and UE power consumption to enable migration of Cat 1/Cat 1bis based solutions to NR
  - This can further facilitate towards enabling an eventual migration of LTE-based IoT solutions to NR, possibly including Cat M.

Addressing lower data rates and high sensitivity to cost/complexity in Rel-18

- Following cost/complexity reduction features are commensurate to the max BW reduction to 5 MHz, and facilitate an **overall cost/complexity reduction by 20~25% compared to Rel-17 RedCap**:
  - Relaxed UE processing times
  - Reduced number of HARQ processes
  - Reduced peak rates (e.g., TBS restrictions)
  - Type B HD-FDD
- Bulk of **UE power consumption** can be reduced with reduction in UE BW from 20 MHz to 5 MHz
- On **market fragmentation**: At the price-point for low-end IoT, the sensitivity to cost is high
  - **20~25% cost/complexity reduction w.r.t. Rel-17 RedCap is significant**
  - The bulk of the volume for NR IoT is expected to be drive by use cases with reduced QoS requirements but high sensitivity to cost and power consumption
  - Optimizing for the category corresponding to **bulk of the NR IoT volume** allows 3GPP to offer meaningful solutions against competing non-3GPP solutions – and can offset the detriments from apparent market fragmentation
- "Patch-work" should be avoided
  - E.g., only restricting peak rates via scaling factor is a "patch" with rather limited impact on cost/complexity reduction as PHY features cannot be simplified for a 20 MHz UE (compared to UE max BW reduction).
- **Further reducing max UE BW to around 5MHz is critical in realizing meaningful solutions for low-end NR IoT design.**

UE power savings for RedCap

Support of separate ultra-low power WUR

- A careful study is necessary on the feasibility, applicability, and power saving gains from support of separate ultra-low power Wake-Up Receiver (WUR) for paging-related monitoring by utilizing new Wake-Up Signal (WUS) designs.
- Practical challenges include considerations on:
  - Mobility support
  - Coverage
  - Inter-cell interference
- While there is high relevance to to RedCap, other non-RedCap use-cases can be considered as part of the study.
  - In such a case, a separate SI may be more appropriate to study ultra-low power WUR support

Energy harvesting

- Support for UEs operating on energy harvesting from environment as the primary energy source for existing RedCap UE types needs further justifications
  - Practicality of use-cases for UEs with 20 MHz BW and peak rates of the order of 100 Mbps, but battery-less and running only on harvested energy is unclear
- Support of energy harvesting should be considered in context of passive IoT use-cases that require careful study to determine the target use-cases and associated performance requirements (that are expected to be very different from Rel-17 RedCap) and the means to achieve them
  - If energy harvesting support is to be considered a separate SI should be pursued, just L2/L3 protocol adjustments are neither justified nor sufficient.

Summary of Proposals on Rel-18 eRedCap

- A new class of RedCap NR devices with lower device cost/complexity and power consumption compared to Rel-17 NR, targeting data rates [1~20] Mbps
  - BW reduced from 20 MHz → 5 MHz
  - Limited to FR1 bands only, and at least with 15 kHz SCS
  - Further complexity reduction on features/PHY procedures commensurate to the BW reduction
  - Means of coverage and spectral efficiency recovery (mainly in DL) as justified

Proposed Rel-18 WI objectives on cost/complexity reduction

- *Further reduced UE bandwidth of 5 MHz*
  - *Study and specify means to support further reduced max UE BW of 5 MHz with minimal impact to network.*
  - *Further complexity reduction schemes for UEs with 5 MHz BW:*
    - *Reduced peak data rates*
    - *Relaxed UE processing times*
    - *Reduced number of HARQ processes*
    - *Type B HD-FDD*

- Separate ultra-low power WUR
  - Careful study to establish feasibility, applicability, and power saving gains from new designs needed.
  - Non-RedCap UE may be studied in addition to RedCap use-cases (primary targets remain low/no mobility use-cases) – in such a case, a separate Rel-18 SI is more appropriate.
- Devices on energy harvesting as primary power source
  - Careful study is necessary to identify use-cases, performance requirements, and solutions – a separate SI that includes support of passive IoT devices is more appropriate.
  - Only L2/L3 protocol changes to address intermittent power outage at UE is NOT sufficient and should NOT be pursued.

intel®