



Motivation for Rel-18 WI on Enhanced RedCap

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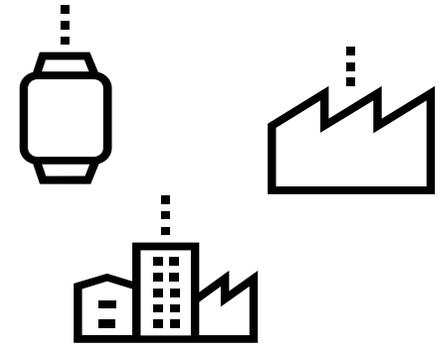


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Use cases



- Support for reduced capability devices was introduced in Rel-17 for addressing use cases that are not best served by 3GPP Rel-16 NR specifications, i.e.:
 - Wearables
 - Industrial wireless sensors
 - Video surveillance
- [Rel-18 can further expand industrial sensors and wearable use cases](#)
 - Support industrial sensor use cases where replacing battery is prohibitively difficult or undesirable
 - Example: large number of sensors deployed for safety monitoring or fault detection in smart factories, infrastructures, or environments
 - Support medical wearable use cases where patients do not need to replace battery themselves (battery lasts between office visits)
 - Support devices capable of harvesting ambient energy for operation (vibrations, heat, light, ...)



Design principles



- Build on Rel-17 RedCap framework and avoid fundamental changes to the basic RedCap UE type defined in Rel-17
- Introduce key enhancements to support the envisioned use cases more efficiently and expand the addressable use cases
- Maintain the integrity of RedCap ecosystem and maximize the benefit of economies of scale
 - Enhancements can be introduced by having new firmware/software running on the same (baseband) hardware platform as Rel-17 RedCap
 - Enhancements can be achieved by enabling a potential companion hardware (e.g., a WUR) working with the same UE platform as Rel-17 RedCap

Improved UE energy efficiency



- Energy harvesting from the environment:
 - Vibrational energy harvesting, outdoor/indoor photovoltaic energy harvesting, thermal-electric generator
- Considerations:
 - Available energy might be highly constrained and varying
 - Devices may be deployed in good coverage scenarios, e.g., in smart factory
 - Devices might be stationary
 - Devices might need to be reachable with reasonable latency
 - How the devices harvest and store energy is outside the scope of 3GPP
 - However, 3GPP needs to enhance the communication protocol to make it possible for such devices to connect to 3GPP network.
- Key 3GPP enablers:
 - Lower UE power class
 - L2/L3 protocol optimizations for highly energy-constrained devices
 - Wake-up radio at least in RRC_IDLE to allow the device to shut down its main receiver and possibly also main processor while maintaining network reachability

Support devices operating on harvested energy



- Considerations:
 - 23-dBm UE power class is not suitable for energy harvesting devices
 - Lower UE power classes might be introduced
 - Assume lower class UEs are deployed in good coverage, so no coverage compensation is needed.
 - Device may not sustain long continuous reception/transmission
 - Variations of amount of harvested energy and traffic can be expected
- WI objective: Specify support for the following to support devices operating on harvested energy:
 - Lower UE power class(es) [RAN4, RAN2]
 - L2/L3 protocol optimizations to consider potential variations of amount of harvested energy and traffic [RAN2]

Enable energy efficient UE wake-up radio



- Considerations:
 - Rel-16/17 NR WUS mainly targets eMBB devices
 - The main receiver may be needed for detecting the WUS
 - Rel-18 RedCap should target energy-harvesting devices
 - The solution should enable energy efficient UE wake-up radio that can operate based on harvested energy
- WI objective: Specify support for the following to enable energy efficient UE wake-up radio:
 - Wake-up signal for low-power wake-up radio at least in RRC_IDLE [RAN1, RAN2, RAN4]
 - Related extensions to the paging protocol [RAN2, RAN3]

Inter-RAT mobility support



- Considerations:
 - Potential leftovers in Rel-17
 - Our preference is to address at least both intra- and inter-frequency mobility in the Rel-17 RedCap WI, but inter-RAT mobility might be postponed to Rel-18
- WI objective: Specify support for the following mobility enhancement [RAN4, RAN2]
 - Inter-RAT mobility to/from LTE

Positioning support



- Considerations:
 - For many applications, accurate positioning is beneficial or even critical. The RAN4 requirements for existing NR positioning methods should be updated to be applicable to RedCap UEs with a reduced number of Rx branches.
- WI objective: Specify support for the following positioning methods [RAN4, RAN2, RAN3]
 - NR E-CID
 - NR DL-TDOA
 - NR DL-AoD
 - NR Multi-RTT

Regarding UE cost reduction

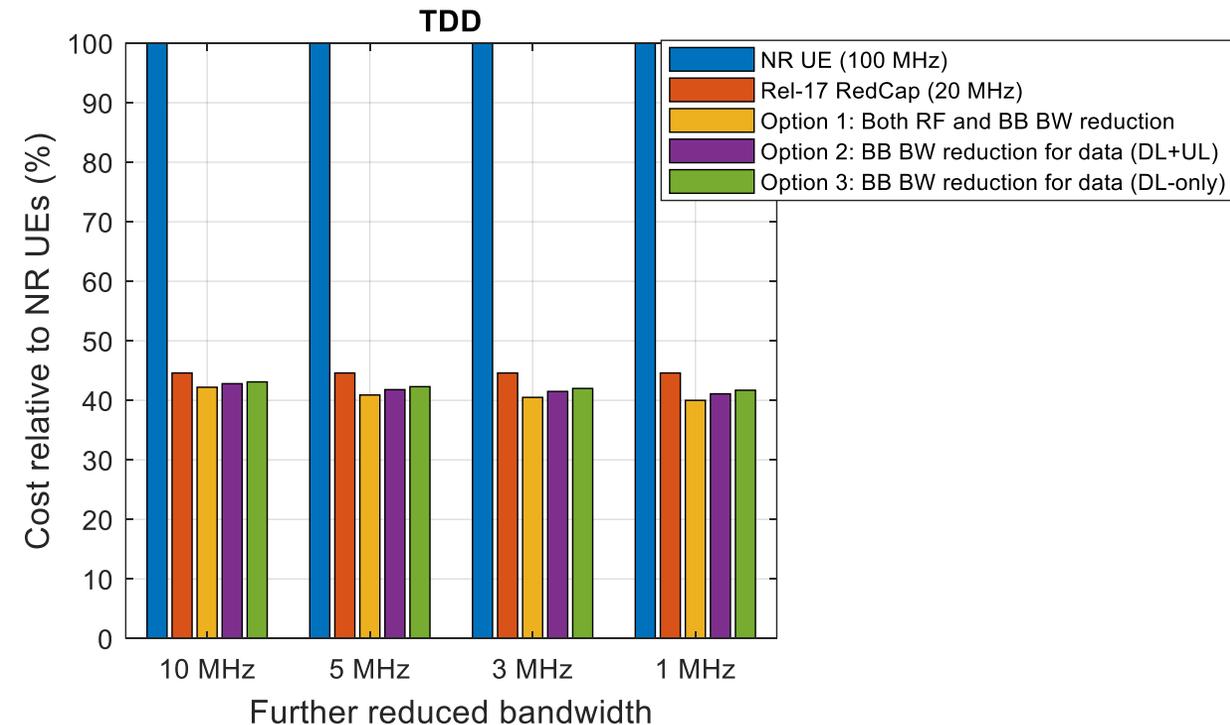


- Rel-17 RedCap achieves significant UE cost reduction
 - 65%-70% cost reduction according to the methodology adopted in TR 38.875
 - Maximum UE bandwidth 20 MHz in FR1 and 100 MHz in FR2
 - Minimum number of Rx branches and DL MIMO layers is 1
 - Support of 256QAM in DL is optional
 - Support of HD-FDD operation type A
- Not much room for further complexity/cost reduction without significant specification impacts

Further bandwidth reduction has diminishing return



- Three options for further bandwidth reduction
 - Option 1: Both RF and baseband (BB) bandwidth reduction
 - Option 2: Only BB bandwidth reduction for data channels (both DL and UL)
 - Option 3: Only BB bandwidth reduction for DL data channel
- Option 1 requires major specification work
- Options 2 and 3 achieve similar cost reduction benefits as Option 1 while avoiding major specification work
 - UE can receive control channel and synchronization block (i.e., no issue with reception of CORESET#0 and SSB)
- If further complexity reduction is desired, Options 2 and 3 are preferred over Option 1.



Regarding relaying



- Specification impact: major specification work foreseen
- Deployment considerations:
 - The operator gives permission to deploy a relay, but the actual deployment is not under operator control.
 - Its location may in best case be optimized locally, and in worst case not at all. → Creating interference scenarios that is hard to manage
 - Not an attractive deployment option for operators
- UE aspects:
 - The required sidelink support impacts the relay cost/complexity and its power consumption
- Commercial viability:
 - Alternative technologies based on unlicensed band operation exist
 - E.g., over-the-top solutions using Wi-Fi, BLE, or NR-U
 - Hard to justify use of licensed spectrum
- Do not include sidelink based relay for Rel-18 eRedCap

