

**Agenda Item: 9.1.1**

**Source: Samsung**

**Title: On the scope of Rel-17 reduced capability NR devices**

**Document for: Discussion and Decision**

## ◇ Industrial wireless sensors:

- ◆ Communication service availability is 99.99% and end-to-end latency is less than 100 ms.
- ◆ The reference bit rate is less than 2 Mbps (potentially asymmetric e.g. UL heavy traffic) for all use cases and the device is stationary.
- ◆ The battery should last at least few years.
- ◆ For safety related sensors, latency requirement is lower, 5-10 ms

## ◇ Video Surveillance:

- ◆ Reference economic video bitrate would be 2-4 Mbps, latency < 500 ms, reliability 99%-99.9%.
- ◆ High-end video e.g. for farming would require 7.5-25 Mbps.

## ◇ Wearables:

- ◆ Reference bitrate for smart wearable application can be 5-50 Mbps in DL and 2-5 Mbps in UL and peak bit rate of the device is higher, up to 150 Mbps for downlink and up to 50 Mbps for uplink.
- ◆ Battery of the device should last multiple days (up to 1-2 weeks).

# Discussion on Cost reduction (1/2)

- ◇ Support Single Rx as mandatory feature for all bands, i.e. reduce 2Rx/4Rx to 1 Rx
  - ◆ Single Rx is a real business demand for wearable devices
  - ◆ Rx reduction contributes most cost reduction: 36.8%~39.7%/56.7% for reducing from 2Rx/4Rx to 1 Rx
  - ◆ The degradation on coverage, capacity and coverage is acceptable
  - ◆ Mandatory supported MIMO layer is same as number of Rx
  - ◆ Potential specification impact:
    - Early indication in PRACH/Msg 3
    - PDCCH blocking rate reduction, e.g., dedicated iBWP, multiple TB scheduling
  
- ◇ Support 20MHz/100MHz bandwidth for FR1/FR2 as mandatory feature
  - ◆ Bandwidth reduction contributes significant cost reduction: 31.9%~33.4%/15.6% for FR1/FR2
  - ◆ Minor or limited performance impact
  - ◆ Larger BW can be optionally report after initial access as optional feature
  - ◆ Potential specification impact:
    - Traffic offloading for initial access, e.g., dedicated/multiple iBWP
    - PDCCH blocking rate reduction, e.g., dedicated iBWP, multiple TB scheduling

# Discussion on Cost reduction (2/2)

- ◇ Support at least Type A HD-FDD (with short switching time)
  - ◆ HD-FDD can provide additional cost saving (6~8%) on top of Rx and BW reduction
  - ◆ Minor or limited performance impact
  - ◆ Potential specification impact:
    - Switching time between UL and DL
    - DL/UL collision handling
    - Applicable bands
  
- ◇ Support relaxation of mandatory modulation order
  - ◆ Limited cost saving can be obtained on top of Rx and BW reduction
  - ◆ Support of 256QAM in DL is optional (instead of mandatory) for a FR1 RedCap UE
  - ◆ Open to support UL modulation order relax for FR 1 and UL/DL modulation order relax for FR2
  - ◆ Limited specification impact

# Discussion on Power Saving

- ◇ Support PDCCH blind decoding reduction scheme(s)
  - ◆ Scheme #1: Reduced maximum number of BD per slot
  - ◆ Scheme #2: Extending the minimum PDCCH monitoring gap to X slots ( $X > 1$ )
  - ◆ Scheme #3: Dynamic adaptation of PDCCH BD parameters
  - ◆ Down select one or multiple schemes in WI phase
  
- ◇ Support enhancement(s) to minimize PDCCH blocking rate and network scheduling impact for RedCap UEs
  - ◆ Rx reduction and BW reduction increase PDCCH blocking rate
  - ◆ PDCCH monitoring reduction increases PDCCH blocking rate
  - ◆ A large number of UE connectivity increases PDCCH blocking rate
  
- ◇ To be updated in # RAN #91-e based on RAN2 recommendation
  - ◆ Extended DRX in RRC\_IDLE and RRC\_INACTIVE
  - ◆ Relaxation of neighbor cells RRM measurements for stationary RedCap UEs in RRC\_IDLE, RRC\_INACTIVE, and RRC\_CONNECTED

# Discussion on Coverage recovery

- ◇ Support RedCap specific UL coverage recovery
  - ◆ UL coverage (PUSCH, Msg 3) is the bottleneck for FR 1
  - ◆ RedCap specific techniques for UL coverage recovery are considered
    - Msg 3 repetition
    - PUSCH freq. hopping across larger bandwidth
    - Other UL coverage enhancements specified in coverage enhancement WI can also be supported by RedCap UE
  
- ◇ Support DL coverage recovery for at least for broadcast PDCCH and Msg 4
  - ◆ PDCCH CSS and Msg 4 need some coverage recovery for FR 1 DL PSD 24dBm/MHz and FR2
  - ◆ Dedicated iBWP may be needed considering the large DL resources for coverage recovery

# Discussion on UE identification and access restrictions

- ◇ Support early UE capability report in RACH procedure, e.g. PRACH, Msg3.
  - ◆ Early UE capability report in RACH procedure is benefit for coexistence with NR UEs
  
- ◇ To be updated in # RAN #91-e based on RAN2 recommendation
  - ◆ Define and constrain reduced capabilities for Redcap UE
  - ◆ Specify functionalities to allow devices with reduced capabilities to be explicitly identifiable to networks and network operators, and allow operators to restrict their access, if desired

# Proposal for WI Scope (1/2)

- ◇ Specify RedCap UE(s) with following UE complexity reduction features:
  - ◆ Reduced number of UE RX/TX antennas
    - Support 1 Rx as mandatory feature for the frequency bands(for both FR1 and FR 2) where a legacy NR UE mandatory to support 2 Rx
    - Support 1 Rx as mandatory feature for the frequency bands where a legacy NR UE mandatory to support 4 Rx
    - Note the supported number of MIMO layer is the same as supported number of antenna
  - ◆ UE bandwidth reduction
    - For FR 1, support 20MHz bandwidth as mandatory feature, and can report 40MHz bandwidth optionally.
    - For FR 2, support 100MHz bandwidth as mandatory feature.
  - ◆ HD-FDD
    - Support Type A HD-FDD
  - ◆ Mandatory modulation order relaxation
    - Support of 256QAM in DL is optional (instead of mandatory) for a FR1 RedCap UE.

# Proposal for WI Scope (2/2)

## ◇ Power saving enhancement

- ◆ Specify PDCCH monitoring reduction scheme(s) to obtain smaller blind decodes (BDs) in connected mode
- ◆ Specify enhancement(s) to minimize PDCCH blocking rate and network scheduling impact for RedCap UEs
- ◆ [Specify extended DRX in RRC\_IDLE and RRC\_INACTIVE]
- ◆ [Specify relaxation of neighbor cells RRM measurements for stationary RedCap UEs in RRC\_IDLE, RRC\_INACTIVE, and RRC\_CONNECTED]

## ◇ Coverage recovery

- ◆ Specify the following features for RedCap specific UL coverage recovery
  - Msg 3 repetition
  - PUSCH freq. hopping across larger bandwidth
  - Note: Other UL coverage enhancements specified in coverage enhancement WI can be considered for RedCap
- ◆ Specify the feature for PDCCH coverage recovery at least for broadcast PDCCH
- ◆ Specify the features for coverage recovery and traffic offloading for DL common message at least including Msg 4

## ◇ UE identification and access restrictions

- ◆ Specify early UE capability report in RACH procedure, e.g. PRACH, Msg3.
- ◆ [Define and constrain reduced capabilities for Redcap UE]
- ◆ [Specify functionalities to allow devices with reduced capabilities to be explicitly identifiable to networks and network operators, and allow operators to restrict their access, if desired]

**THANK YOU**