

**3GPP TSG RAN Meeting #97-e
Electronic Meeting, September 12-16, 2022**

RP-222256

Agenda Item: 9.2.10

Source: Xiaomi

Title: Views on Rel-18 RedCap WI scope

Document for: Discussion and decision

Rel-18 RedCap: Motivation



- Motivation for further Reduced Capability (RedCap) NR devices
 - To further expand the market for RedCap use cases with relatively low cost, low energy consumption, and low data rate requirements, e.g., industrial wireless sensor network use cases
 - Support of low-tier devices between existing LPWA UEs and the capabilities of Rel-17 RedCap UEs with peak data rate targeting to 10Mbps

Rel-18 SI on RedCap: Summary(1/4)



- Rel-18 study on RedCap has been completed in RAN1
- Most of companies in RAN1 recommend a single option is down-selected from a list of options as the main Rel-18 RedCap UE complexity reduction option at RAN plenary. The list includes the following options:
 - Option BW3:
 - 5MHz BB bandwidth only for PDSCH (for both unicast and broadcast) and PUSCH with 20 MHz RF bandwidth for UL and DL
 - The other physical channels and signals are still allowed to use a BWP up to the 20MHz maximum UE RF+BB bandwidth
 - Option PR3:
 - Restriction of maximum number of PRBs (25 for 15KHz SCS, 11 or 12 for 30KHz SCS) for PDSCH and PUSCH
 - The restricted number of PRBs in Option PR3 is a hardcoded limit

Rel-18 SI on RedCap: Summary(2/4)



■ Some companies also wanted to include one or both of the following options in above list for RAN plenary to assess the trade-off degree of complexity reduction and specification impact.

- Option PR1:
 - Relaxation of the constraint $(v_{Layers}^{(j)} \cdot Q_m^{(j)} \cdot f^{(j)} \geq 4)$ for peak data rate reduction, e.g., 1 (instead of 4)
- Option BW1:
 - Both RF and BB bandwidths are 5MHz for UL and DL

■ Furthermore, RAN1 recommend that whether or not to also introduce support for option PT1 and/or PT2 for a Rel-18 RedCap UE can be decided at RAN plenary.

- Option PT1:
 - Relaxation of UE processing time for PDSCH/PUSCH in terms of N1 and N2 (as defined in TS 38.214) compared to those of UE processing time capability 1
- Option PT2:
 - Relaxation of UE processing time for CSI in terms of Z and Z' compared to the values defined in TS 38.214 clause 5.4

Rel-18 SI on RedCap: Summary(3/4)



■ Detailed observations on potential solutions for Rel-18 RedCap

● Complexity/cost saving gain

Option	FD-FDD 1Rx	TDD 1Rx	HD-FDD 1Rx	FD-FDD 2Rx	TDD 2Rx	HD-FDD 2Rx
BW3	8.02%	7.66%	8.90%	8.72%	7.68%	9.19%
PR3	7.06%	6.74%	8.12%	9.81%	6.59%	7.98%
PR1	4.13%	4.02%	4.99%	5.36%	3.73%	4.74%
BW1	11.85%	11.25%	14.06%	14.31%	13.42%	14.79%
BW3+PT1	8.70%	7.84%	10.15%	12.48%	8.98%	10.77%
BW3 + PT1 + PT2	11.55%	11.50%	12.92%	14.59%	10.82%	12.76%
PR3 + PT1	7.69%	7.23%	9.32%	11.49%	8.11%	9.67%
PR3 + PT1 + PT2	10.22%	10.70%	12.07%	13.55%	9.88%	11.60%

● Coverage impacts

— In urban scenario@2.6GHz,

- Observation 1: With 3-dB UE antenna efficiency loss, **PDCCH CSS with AL2** has worse coverage by less than 1dB than the bottleneck channel for the reference NR UE
- Observation 2: With 3-dB UE antenna efficiency loss, **SIB1(>5MHz)** has worse coverage by less than 1dB than the bottleneck channel for the reference NR UE

— In rural scenario@0.7GHz,

- Observation 1: With 3-dB UE antenna efficiency loss, for **Msg3**, its coverage is slightly worse than the bottleneck channel for the reference NR UE

Rel-18 SI on RedCap: Summary(4/4)



- Detailed observations on potential solutions for Rel-18 RedCap
 - Performance degradation

Coverage difference in urban scenario@2.6GHZ(dB)	Comparison with Rel-15 Reference UE (MIL)			Comparison with Rel-17 RedCap UE (MIL)				Coverage Difference in rural scenario@0.7GHZ(dB)	Comparison with reference Rel-15 NR UE (MIL)		Comparison with reference Rel-17 RedCap UE (MIL)			
	5MHz UE with soft/selective combining with RF retuning	PDCCH CSS AL16	SIB1 > 5MHz	5MHz UE with soft/selective combining with RF retuning	PDCCH CSS (48 RBs) with 1% BLER	SIB1 (>5 MHz) with 10% BLER	SIB1 (<5 MHz) with 10% BLER		PDCCH CSS AL16	SIB1 > 5MHz	PDCCH CSS (48 RBs) with 1% BLER	PDCCH CSS (24 RBs) with 1% BLER	SIB1 (>5 MHz) with 10% BLER	SIB1 (<5 MHz) with 10% BLER
		5MHz-UE (BW1, 11 PRBs; CORESET: 2 symbols, 48 PRBs; AL16)	5MHz-UE (BW1, 11 PRBs; SIB1 BW > 5 MHz; TBS 1256 bits)		5MHz-UE (BW1, 11 PRBs; CORESET: 2 symbols, 48 PRBs; AL16)	5MHz-UE (BW1, 11 PRBs; SIB1 BW > 5 MHz; TBS 1256 bits)	5MHz-UE (BW1, 11 PRBs; SIB1 BW < 5 MHz; TBS 1256 bits)		5MHz-UE (BW1, 25 PRBs; CORESET: 2 symbols, 48 PRBs; AL16)	5MHz-UE (BW1, 25 PRBs; SIB1 BW > 5 MHz; TBS 1256 bits)	5MHz-UE (BW1, 25 PRBs; CORESET: 2 symbols, 48 PRBs; AL16)	5MHz-UE (BW1, 25 PRBs; CORESET: 2 symbols, 24 PRBs; AL8)	5MHz-UE (BW1, 25 PRBs; SIB1 BW > 5 MHz; TBS 1256 bits)	5MHz-UE (BW1, 25 PRBs; SIB1 BW < 5 MHz; TBS 1256 bits)
Representative value (dB)	-9.3	-15.26	-17.50	-2.51	-8.91	-11.24	-9.00	Representative value (dB)	-7.30	-7.57	-3.53	-4.52	-3.93	-3.45

- Network deployment and coexistence impacts

Option	SSB/CORESET# 0 configuration	Common PDSCH transmission, e.g., SIB1, OSI, RAR	Early indication	SSB presence	BWP operation	New timing requirements	Scheduling impacts
BW3		√	√				
PR3		√	√				
PR1							
BW1	√	√	√	√	√		
PT1			√			√	√
PT2						√	√

Views on potential solutions for Rel-18 RedCap



■ Comparison between different potential solutions

Option	Cost saving gain	Coverage impact	Performance degradation	Latency	Network deployment and coexistence impact	Spec impact
BW3	Medium	Minimum, SIB1	High, SIB1	-	Low	Low
PR3	Medium, 1% less than BW3	Minimum, SIB1	High, SIB1	-	Low	Low
PR1	Low	No	No	-	No	Minimum
BW1	High	Minimum, PDCCH/SIB1	High, PBCH/PDCCH/SIB1	-	High	High
PT1	Low	No	No	High	Medium	Medium
PT2	Low	No	No	High	Medium	Medium

■ Xiaomi's view:

■ Analysis

- Option BW3 has comparable cost gain to BW1 with relatively low spec impact
- Option BW3 provides ~1% more cost saving gain than Option PR3, with almost the same spec impact
- PT1 and/or PT2 has limited cost saving gain with non-negligible latency and spec impact

➔ Option BW3 is supported for Rel-18 RedCap

Views on potential solutions for Rel-18 RedCap



■ Support of long eDRX >10.24s cycle

- SA2 has sent an LS to RAN2 and RAN3 to ask them to take the following information into consideration and provide their views on the following aspects[1]:
 - 1) NG-RAN providing UE unreachability information to CN for MT data/signalling handling when UE is not reachable in RRC_INACTIVE state.
 - 2) NG-RAN can handle a new NG_AP message to trigger RAN paging when UE is in RRC-INACTIVE.
 - 3) Including the UE context retrieval with data forwarding handling between NG-RAN nodes via CN.
 - 4) NG-RAN buffering capabilities of MT data for the duration of the eDRX cycle.
 - 5) NG-RAN's ability to perform UE context release procedure towards the AMF and locally releases the UE to RRC-IDLE when receiving DL NAS message and the UE is not reachable for a time period longer than 10.28s.
 - 6) Alternative to 5): NG-RANs ability to only provide an indication to AMF when receiving DL NAS message and the UE is not reachable for a time period longer than 10.28s. The UE remains in RRC_INACTIVE.
- Xiaomi's view:
 - Take eDRX >10.24s cycle as an objective for Rel-18 RedCap WI

Views on Rel-18 RedCap WI scope



- ◆ Proposal: Adopt the following objectives for Rel-18 RedCap WI.
 - Power saving/energy efficiency enhancements [RAN2, RAN3, RAN4]
 - Enhanced eDRX in RRC_INACTIVE (>10.24s)
 - *Note that this objective requires SA2, CT1 involvement*
 - Complexity/cost reduction
 - Support for 5MHz BB bandwidth only for PDSCH (for both unicast and broadcast) and PUSCH with 20MHz RF bandwidth for UL and DL in FR1
 - The other physical channels and signals are still allowed to use a BWP up to the 20MHz maximum UE RF+BB bandwidth

Reference



[1] R2-2206967, “LS On FS_REDCAP_Ph2 option feasibility”, 3GPP TSG RAN WG2#119-e, 17th - 29th August, 2022



THANK YOU