3GPP TSG RAN Meeting #93-e
Electronic Meeting, September 13 - 17, 2021

RP-211795

Agenda Item: 9.0.2

Source: Samsung

Title: On RedCap enhancement in Rel-18

Document for: Discussion and Decision

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R17 RedCap

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- **Target bitrate of each use cases:**
  - Wearable: 5-50Mbps in DL and 2-5Mbps in UL
  - Industrial wireless sensors: <2Mbps UL heavy
  - Video surveillance: 2-4Mbps and 7.5-25Mbps
- **Cost reduction features:**
  - 1 or 2 Rx
  - 20MHz/100MHz bandwidth for FR1/FR2
  - Modulation order relax
  - FDD, TDD, HD-FDD
- **Cost saving:**
  - 60%~70% cost reduction of the reference UE for FR 1
  - 50% cost reduction of the reference UE for FR 2
- **Peak date rate (FR1):**
  - ~80Mbps for FDD; 50/20Mbps for DL/UL TDD

Single Rx + 64QAM	Peak Data Rate [Mbps]	
	DL	UL
FDD	~82	~88
TDD (DDDDDDDSUU) where S = 6-DL : 4-Guard : 4-UL	~61	~20
TDD (DDDSUDDSUU) where S = 10-DL : 2-Guard : 2-UL	~52	~29

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Lower bit rate for eRedCap

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- **Motivation**:
  - Compatible to LTE Cat 1bis (10Mbps), aiming to achieve lower cost
- **Observations:**
  - Rel-17 RedCap can support low bit rate without any changes. No clear additional cases for lower bit rate. Industrial wireless sensors had been **covered by Rel-17** use case
  - **Additional cost saving is not promising**, but the impact to network and specification **are large**
  - Fragmentation of the market will **increase the actual cost** of chipset and also **increase the OPEX**

	Smaller BW	Restrict TBS/allocated # of RB	Relaxed processing time
Description	Smaller BW, e.g., 5MHz BW	Restrict the max TBS and/or allocated number of RB for PDSCH/PUSCH	Relax PDCCH/PDSCH/PUSCH/CSI processing time
Cost saving	Only additional **3%** of cost saving of the reference UE (Details are in Appendix)	Additional **2%** cost saving of the reference UE	Additional **1%** cost saving of the reference UE
Impact	• DL coverage e.g., 6dB. impact on common channels, e.g., common PDCCH repetition • Potential new SSB design or with 30kHz SCS for n77/78/79 • Coexistence with non-redcap UEs and R17 Redcap UEs	• Resource allocations • Coexistence with non-redcap UEs and R17 Redcap UEs	• Separated handling from RACH, or handled all UE types as the UE with relaxed processing time until obtained UE capability. (Not accepted by R17) • Coexistence with non-redcap UEs and R17 Redcap UEs

- **Proposal:**
  - No support of further cost/complexity reduction for R18 RedCap

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Power consumption reduction

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- **Motivation:**
  - Power consumption is important for Redcap UEs, as well as for eMBB/URLLC UEs
- **Observations:**
  - Low power WUS is applicable to all types of UEs
    - Further study is needed including at least tradeoff between power saving gain and coverage loss
  - Rel-17 power saving is discussion on paging enhancement with (FFS) PDCCH based or sequence based WUS
  - Enhanced DRX in RRC_INACTIVE (>10.24s) is still under discussion in R17 RedCap
  - Energy harvesting is premature for WI or even with a SI phase
    - There is no clear requirements, use cases and study on the impact to wireless network

- **Proposals:**
  - Support enhanced eDRX in RRC_INACTIVE (>10.24s) if not completed in R17 RedCap
  - Discuss low power WUS separately as a general feature for all type of UEs
  - Do not consider energy harvested from the environment in R18 RedCap

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Efficiency improvement

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- **Motivation**:
  - Some network capacity and spectral efficiency degradations were observed in R17 SI phase due to reduced number of antenna and relaxed modulation order
  - Massive connections of RedCap UEs are expected in near future
- **Observations:**
  - PDCCH blocking is observed due to reduced number of Rx branches and reduced bandwidth
  - CSI enhancement can provide scheduling gain
  - Frequency hopping in wider bandwidth can provide scheduling and diversity gain
  - Fast BWP switching and separated initial BWP(s) can provide better scheduling flexibility

- **Proposals:**
  - Specify the following techniques to increase network capacity:
    - Fast BWP switching
    - Frequency hopping enhancement in a wider BWP
    - CSI enhancement
    - PDCCH overhead reduction (e.g. multi TB/UE scheduling)
    - Multiple seperated initial BWPs

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Coverage recovery

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- **Motivation and observations**:
  - PDCCH CSS and Msg4 need some coverage recovery for FR 1 DL PSD 24dBm/MHz and FR2

- **Proposals:**
  - Support DL coverage recovery for at least for broadcast PDCCH and Msg4

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Summary

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- **Proposed objectives for R18 RedCap:**
  - Specify the following techniques to increase network capacity:
    - Fast BWP switching
    - Frequency hopping enhancement in a wider BWP
    - CSI enhancement
    - PDCCH overhead reduction (e.g. multi TB/UE scheduling)
    - Multiple separated initial BWPs
  - Support enhanced eDRX in RRC_INACTIVE (>10.24s) *(if not completed in R17)*
  - Support DL coverage recovery for at least for broadcast PDCCH and Msg4

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THANK YOU

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Appendix: Cost analysis

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Reduced UE bandwidth (20 MHz instead of 100 MHz)	Reference	20MHz	5MHz	20MHz combined with other features*	20MHz with restricted TBS combined with other features*	5MHz combined with other features*
RF: Power amplifier	25.0%	24.1%	24.0%	24.0%	24.0%	24.0%
RF: Filters	10.0%	10.0%	10.0%	4.3%	4.3%	4.3%
RF: Transceiver (including LNAs, mixer, and local oscillator)	45.0%	43.7%	43.0%	22.0%	22.0%	22.0%
RF: Duplexer / Switch	20.0%	20.0%	20.0%	17.8%	17.8%	17.8%
RF: Total	**100.0%**	**97.7%**	**97%**	**68%**	**68%**	**68%**
BB: ADC / DAC	10.0%	2.8%	0.5%	1.1%	1.1%	0.15%
BB: FFT/IFFT	4.0%	1.1%	0.2%	0.6%	0.6%	0.1%
BB: Post-FFT data buffering	10.0%	2.3%	0.5%	0.9%	0.9%	0.3%
BB: Receiver processing block	24.0%	9.1%	7.0%	4.2%	3.5%	3.5%
BB: LDPC decoding	10.0%	3.8%	1.0%	1.1%	0.5%	0.5%
BB: HARQ buffer	14.0%	4.2%	1.4%	1.3%	0.7%	0.7%
BB: DL control processing & decoder	5.0%	4.5%	4.5%	4.4%	4.4%	4.4%
BB: Synchronization / cell search block	9.0%	9.0%	9.0%	4.5%	4.5%	4.5%
BB: UL processing block	5.0%	3.4%	2.0%	3.4%	2.0%	2.0%
BB: MIMO specific processing blocks	9.0%	8.2%	7.0%	3.7%	3.5%	3.5%
BB: Total	**100.0%**	**48.4%**	**33%**	**25%**	**22%**	**19.7%**
RF+BB: Total (with RF:BB cost split 40:60)	**100.0%**	**68.1%**	**59%**	**42%**	**40%**	**39%**

* Other features: Single Rx branch, relaxed modulation order

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