3GPP TSG-RAN Meeting #88e **RP-2001001**
Online, June 29 – July 3, 2020 **Document for:** Approval

Way forward on NR Application Layer Throughput Performance Work in RAN4

Qualcomm, BT plc, Verizon, AT&T,
China Telecom, NTT Docomo, Orange,
CMCC, Vodafone, KDDI

Background - I

- In the past, there have been no tests defined that are widely used in the eco-system to verify application layer throughput except those contained in TR 37.901 for LTE and UMTS.
  - TR 37.901 only contains test cases and does not contain performance requirements.
  - This results in internal resources being used at the operators' side to come up with tests and performance requirements and it also increases the test burden on UE vendors since each operator has its own different sets of tests for the same purpose.
- To address this issue, RAN5 started an SI (RP-191590) on this topic for NR and sent an LS (R5-195422) to RAN4 asking it to be secondary responsible WG for this SI.
  - RAN4 was a secondary responsible WG for the RAN5 SI that resulted in the publication of TR 37.901.
- In RAN4#92, RAN4 discussed the issue based on the RAN5 LS
  - A Way forward R4-1910019 was presented to discuss this issue. The WF proposed to add RAN4 as secondary responsible WG to RAN5 SI. The WF also provided possible solutions on aligning simulation results and defining requirements.

Background - II

- WF R4-1910019 was noted due to the concern from some companies that this decision should be made in RAN plenary first. Therefore, RAN4 sent an LS reply to RAN5 in R4-1910562 and it was cc'd to TSG RAN, GCF CAG, PTCRB PVG, CTIA OTA WG and GTI.
- In the LS reply, below was mentioned:
  - Reply points out that plenary should decide whether RAN4 is to work on this issue and also says "RAN4 will study the feasibility of defining the physical layer throughput requirements with link adaptation in 38.101-4."
- Companies arguing that RAN4 work is not feasible should present concrete proof
  - RAN4 replied that it is feasible to work on this
- References: R4-1909961, R4-1908148, RP-191590, R5-195422, R4-1910019, R4-1910562.

Proposal

- RAN4 to be added as secondary responsible WG in the Study item by RAN5 for 5G NR Application Layer Data Throughput Performance.

- RAN4 to study the feasibility of defining link adaptation throughput requirements to assist RAN5 in defining the application layer throughput requirements.

RAN4 Scope

- Study the feasibility of defining requirements with link adaptation
  - Analyze in which scenarios absolute physical layer throughput requirement can be defined
    - Use currently defined RI test setup in 38.101-4 as baseline
    - Use the parameters suggested by RAN5 in R5-195422 as baseline
      - Other scenarios are not precluded if above parameters are not found feasible

Possible RAN4 work plan

- Initial Simulation Assumptions
  - Reuse test parameters used in existing Rank Indication test cases in 38.101-4 as much as possible.
  - Detailed initial simulation assumptions in Annex A.
- Alignment of results
  - Companies to present simulation results, multiple rounds of simulation might be needed
  - Refinement of simulation assumptions if needed
  - Some examples of alignment in Annex B.
- Conclusion
  - Tests to be declared feasible for the scenarios in which there is good alignment between results
  - Feasibility to be concluded if results from multiple companies are within +/- X % (e.g. 5%) of average LA throughput

Annex A: Initial Simulation Assumptions - I

Table A-1: Common NR Test Configuration

Configuration	Test Points to cover
NR Duplex Mode	FDD, TDD
NR Frequency Range	FR1, FR2
NR Channel Bandwidth/sub-carrier spacing[2]	10 MHz/15 kHz (FDD FR1) 40 MHz/30 kHz (TDD FR1) 100 MHz/120 kHz (TDD FR2)
NR Fading	TDLA30-5: FR1 TDLA30-35: FR2
SNR	FR1:20 dB; FR2: 16 dB
NR Antenna Config	ULA Low 2x2
Mapping of CQI index to Information Bit payload	As per TS 38.101-4 A.4-1 for FR2 and A.4-2 for FR1
TDD UL-DL Pattern	FR1.30-1 per TS 38.101-4 Annex A.1.2 for FR1 30 kHz SCS FR2.120-1 per TS 38.101-4 Annex A.1.3 for FR2 120 kHz SCS
Common test configuration parameters	As per TS 38.101-4 Table 8.1.2-1 for FR2 and TS 38.101-4 Table 6.1.2-1 for FR1
Maximum number of HARQ transmission	4
Number of HARQ processes	4 for FDD FR1 8 for TDD FR1 10 for TDD FR2

Annex A: Initial Simulation Assumptions - II

Table A-2: Test Parameters for FR1 FDD

Parameter		Unit	Value
ZP CSI-RS configuration	CSI-RS resource Type		Periodic
	Number of CSI-RS ports (X)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 5, (4,-)
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(9,-)
	CSI-RS periodicity and offset	slot	5/1
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Periodic
	Number of CSI-RS ports (X)		2
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 3 (6,-)
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(13,-)
	NZP CSI-RS-timeConfig periodicity and offset	slot	5/1
CSI-IM configuration	CSI-IM RE pattern		Pattern 0
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4,9)
	CSI-IM timeConfig periodicity and offset	slot	5/1
ReportConfigType			Aperiodic
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannelMeasurements			not configured
timeRestrictionForInterferenceMeasurements			not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	8
csi-ReportingBand			1111111
CSI-Report periodicity and offset		slot	5/1
Codebook configuration	Codebook Type		typeI-SinglePanel
	Codebook Mode		1
	(CodebookConfig-N1,CodebookConfig-N2)		N/A
	CodebookSubsetRestriction		010011 for following rank
	RI Restriction		N/A
Physical channel for CSI report			PUSCH
CQI/RI/PMI delay		ms	7
RI Configuration			Follow RI

Annex A: Initial Simulation Assumptions -III

Table A-3: Test Parameters for FR1 TDD

Parameter		Unit	Value
ZP CSI-RS configuration	CSI-RS resource Type		Periodic
	Number of CSI-RS ports (X)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 5, (4,-)
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(9,-)
	CSI-RS periodicity and offset	slot	10/1
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Periodic
	Number of CSI-RS ports (X)		2
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 3 (6,-)
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(13,-)
	NZP CSI-RS-timeConfig periodicity and offset	slot	10/1
CSI-IM configuration	CSI-IM RE pattern		Pattern 0
	CSI-IM Resource Mapping (k_{CSI-IM},l_{CSI-IM})		(4,9)
	CSI-IM timeConfig periodicity and offset	slot	10/1
ReportConfigType			Aperiodic
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannelMeasurements			not configured
timeRestrictionForInterferenceMeasurements			not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	16
csi-ReportingBand			1111111
CSI-Report periodicity and offset		slot	10/1
Codebook configuration	Codebook Type		typeI-SinglePanel
	Codebook Mode		1
	(CodebookConfig-N1,CodebookConfig-N2)		N/A
	CodebookSubsetRestriction		010011 for following rank
	RI Restriction		N/A
Physical channel for CSI report			PUSCH
CQI/RI/PMI delay		ms	6.5
RI Configuration			Follow RI

Annex A: Initial Simulation Assumptions -IV

Table A-4: Test Parameters for FR2 TDD

Parameter		Unit	Parameter
ZP CSI-RS configuration	CSI-RS resource Type		Aperiodic
	Number of CSI-RS ports (X)		4
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 4, (8,-)
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(13,-)
	CSI-RS interval and offset	slot	8/1
NZP CSI-RS for CSI acquisition	CSI-RS resource Type		Aperiodic
	Number of CSI-RS ports (X)		2
	CDM Type		FD-CDM2
	Density (ρ)		1
	First subcarrier index in the PRB used for CSI-RS (k_0, k_1)		Row 3 (6,-)
	First OFDM symbol in the PRB used for CSI-RS (l_0, l_1)		(13,-)
	NZP CSI-RS-timeConfig interval and offset	slot	8/1
CSI-IM configuration	CSI-IM RE pattern		Pattern 1
	CSI-IM Resource Mapping ($k_{CSI\text{-}IM}$,$l_{CSI\text{-}IM}$)		(8,13)
	CSI-IM timeConfig interval and offset	slot	8/1
ReportConfigType			Aperiodic
reportQuantity			cri-RI-PMI-CQI
timeRestrictionForChannelMeasurements			not configured
timeRestrictionForInterferenceMeasurements			not configured
cqi-FormatIndicator			Wideband
pmi-FormatIndicator			Wideband
Sub-band Size		RB	8
csi-ReportingBand			111111111
CSI-Report interval and offset		slot	10/1
aperiodicTriggeringOffset			0
Codebook configuration	Codebook Type		typeI-SinglePanel
	Codebook Mode		1
	(CodebookConfig-N1,CodebookConfig-N2)		N/A
	CodebookSubsetRestriction		010011 for following rank
	RI Restriction		N/A
Physical channel for CSI report			PUSCH
CQI/RI/PMI delay		ms	1.375
RI Configuration			follow RI

Annex B: Alignment of Results - I

- We look at how throughput results for PMI reporting tests in Rel-15 align from different companies to justify whether alignment is possible for this SI
  - PMI reporting tests have fixed MCS and Rank
  - As SNRs chosen for this SI are already in Rank2 operating regime, it is justifiable to look at PMI reporting results which have fixed Rank.
  - CQI reporting is supposed to operate in 90% of peak throughput regime, so we look at throughputs around 90% of peak throughput
- In next 3 slides, we provide some examples where companies' throughput numbers are quite aligned. So, it is possible to have aligned throughput results with Link Adaptation.

Annex B: Alignment of Results - II

- From R4-1903382, throughputs in bits/s with following PMI for 4x2 FR1 FDD:

SNR (dB)	Company A	Company B	Company C	Span/ Average
2	8112525.00	8355760.00	8291101.50	2.95%
4	8748300.00	8842778.00	8860101.35	1.27%
6	8972175.00	8996890.00	9002496.14	0.34%
8	9011925.00	9026388.00	9026943.79	0.17%
10	9030000.00	9029398.00	9028165.67	0.02%

Annex B: Alignment of Results - III

- From R4-1903383, throughputs in bits/s with following PMI for 4x2 FR1 TDD:

SNR (dB)	Company A	Company B	Company C	Span / Average
2	24953357.14	25279752.14	26123509.17	4.60%
4	27466189.29	27829611.39	27789855.21	1.31%
6	28155121.43	28254997.75	28208368.91	0.35%
8	28262400.00	28277127.67	28262400.00	0.05%

Annex B: Alignment of Results - IV

- From R4-1903384, throughputs in bits/s with following PMI for 2x2 FR2 TDD:

SNR (dB)	Company A	Company B	Company C	Span / Average
4	33234072.48	32901655.15	35866371.89	8.72%
6	41468476.00	41994476.22	40863824.74	2.73%
8	42314800.00	42353403.36	42254839.84	0.23%
10	42314800.00	42353403.36	42314800.00	0.09%