3GPP TSG-RAN WG1#80bis **R1-151922**

Belgrade, Serbia, 20th - 24th April 2015

SOURCE: ERICSSON

TITLE: PERFORMANCE RESULTS AND DISCUSSION OF CAT.3 BASELINE

AGENDA ITEM: 7.2.5.1.2

DOCUMENT FOR: DISCUSSION AND DECISION

BACKGROUND

- In this contribution, we present Cat.3 baseline results for the 8x4,4x8 and 2x16 antenna configurations
  - Cat.3 configurations, tilts etc are according to excel sheet in email [85-05]

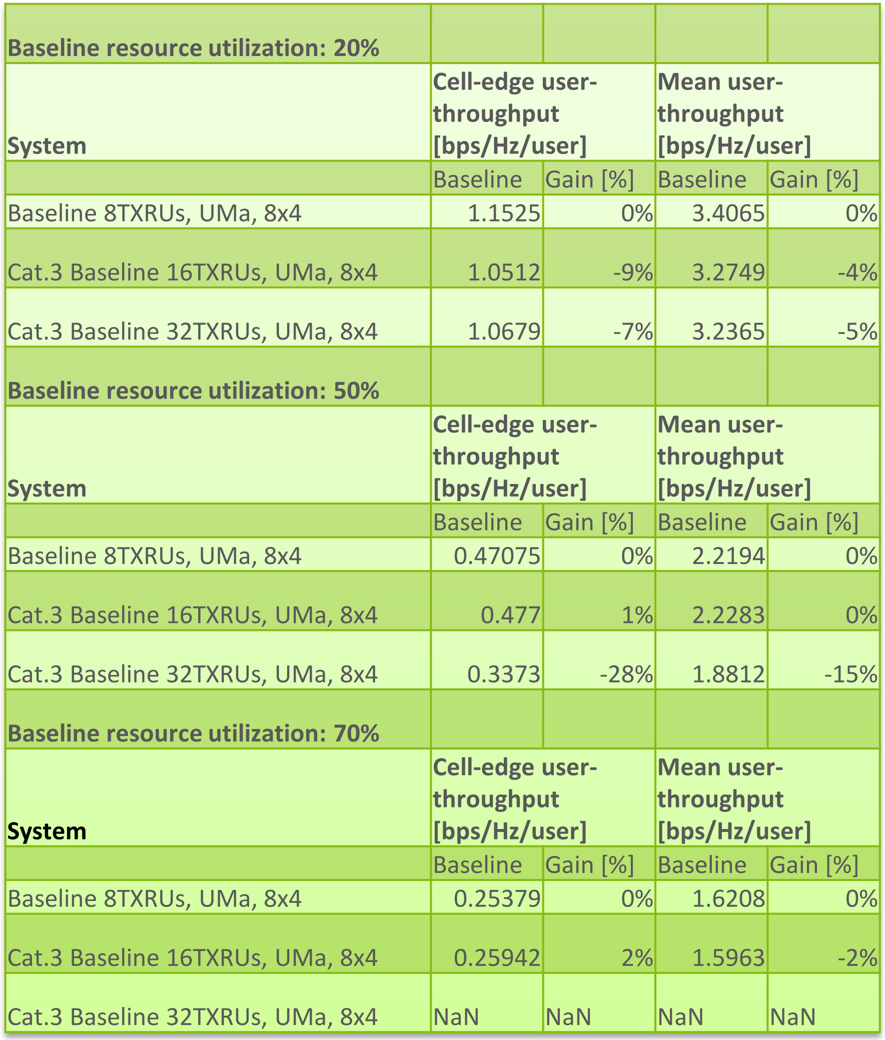
- Cat. 3: Two CSI processes per UE, one vertical with 2,4 or 8 TX ports (Rel.8/12/10 CB) and one horizontal with 8 antenna ports (Rel.10 CB). Rank is restricted to one for vertical process and normal rank feedback is used in horizontal process. eNB combines the two CQI reports.

- For the 2x16 array
  - with 16 TXRUs, a 2x2 TXRU to subarray mapping is used with horizontal weights [1 1] and vertical tilts 122º (UMa) and 130º (UMi).
  - with 32 TXRUs, horizontal subarray mapping is used with weights [1 1].

8X4 UMA

- For 16 TXRU, Cat. 3 Baseline is worse than Phase 1 at low load

- For 32 TXRU, Cat.3 baseline is worse than Phase 1 for all evaluated load points

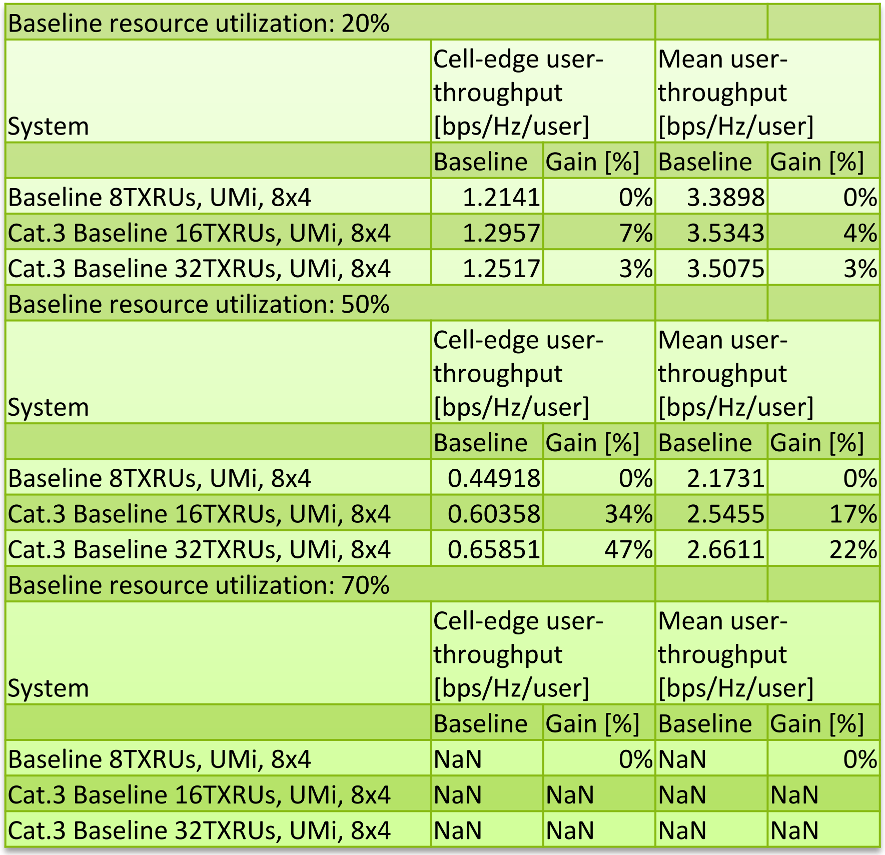


Baseline resource utilization: 20%				
System	**Cell-edge user-throughput [bps/Hz/user]**		**Mean user-throughput [bps/Hz/user]**	
	Baseline	Gain [%]	Baseline	Gain [%]
Baseline 8TXRUs, UMa, 8x4	1.1525	0%	3.4065	0%
Cat.3 Baseline 16TXRUs, UMa, 8x4	1.0512	-9%	3.2749	-4%
Cat.3 Baseline 32TXRUs, UMa, 8x4	1.0679	-7%	3.2365	-5%
Baseline resource utilization: 50%				
System	**Cell-edge user-throughput [bps/Hz/user]**		**Mean user-throughput [bps/Hz/user]**	
	Baseline	Gain [%]	Baseline	Gain [%]
Baseline 8TXRUs, UMa, 8x4	0.47075	0%	2.2194	0%
Cat.3 Baseline 16TXRUs, UMa, 8x4	0.477	1%	2.2283	0%
Cat.3 Baseline 32TXRUs, UMa, 8x4	0.3373	-28%	1.8812	-15%
Baseline resource utilization: 70%				
System	**Cell-edge user-throughput [bps/Hz/user]**		**Mean user-throughput [bps/Hz/user]**	
	Baseline	Gain [%]	Baseline	Gain [%]
Baseline 8TXRUs, UMa, 8x4	0.25379	0%	1.6208	0%
Cat.3 Baseline 16TXRUs, UMa, 8x4	0.25942	2%	1.5963	-2%
Cat.3 Baseline 32TXRUs, UMa, 8x4	NaN	NaN	NaN	NaN

*Results are compared at the same offered load

8X4 UMI

- For 16 and 32 TXRU, Cat.3 Baseline is better than Phase 1

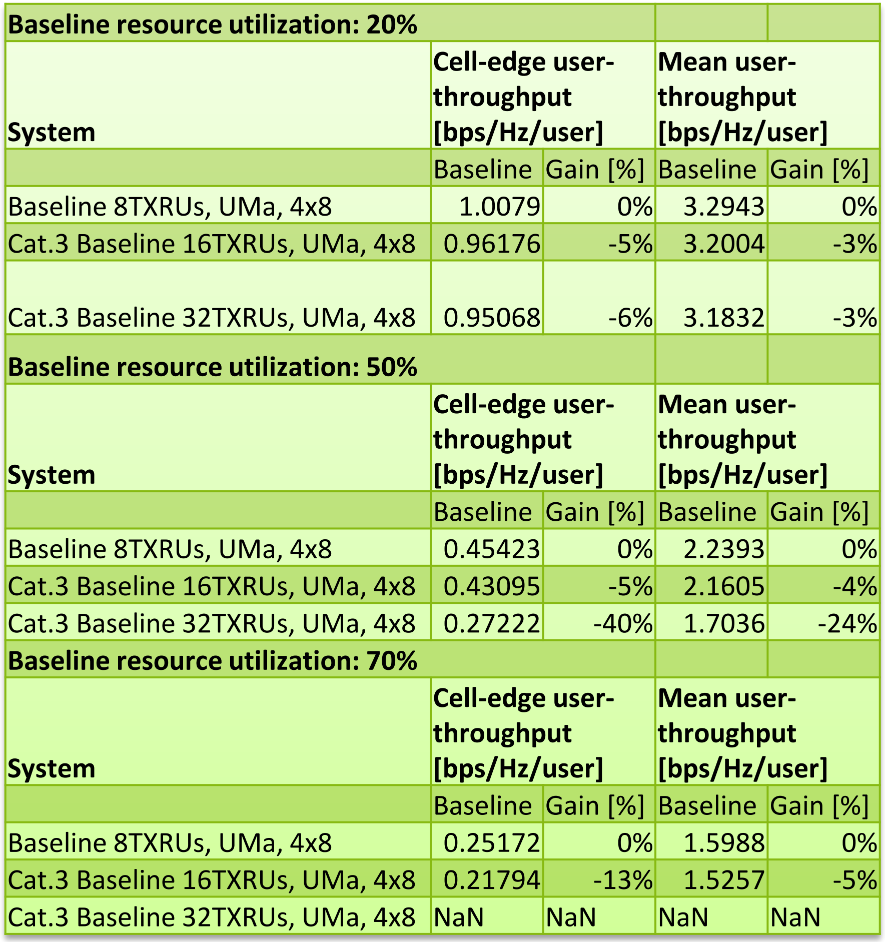


Baseline resource utilization: 20%				
System	Cell-edge user-throughput [bps/Hz/user]		Mean user-throughput [bps/Hz/user]	
	Baseline	Gain [%]	Baseline	Gain [%]
Baseline 8TXRUs, UMi, 8x4	1.2141	0%	3.3898	0%
Cat.3 Baseline 16TXRUs, UMi, 8x4	1.2957	7%	3.5343	4%
Cat.3 Baseline 32TXRUs, UMi, 8x4	1.2517	3%	3.5075	3%
Baseline resource utilization: 50%				
System	Cell-edge user-throughput [bps/Hz/user]		Mean user-throughput [bps/Hz/user]	
	Baseline	Gain [%]	Baseline	Gain [%]
Baseline 8TXRUs, UMi, 8x4	0.44918	0%	2.1731	0%
Cat.3 Baseline 16TXRUs, UMi, 8x4	0.60358	34%	2.5455	17%
Cat.3 Baseline 32TXRUs, UMi, 8x4	0.65851	47%	2.6611	22%
Baseline resource utilization: 70%				
System	Cell-edge user-throughput [bps/Hz/user]		Mean user-throughput [bps/Hz/user]	
	Baseline	Gain [%]	Baseline	Gain [%]
Baseline 8TXRUs, UMi, 8x4	NaN	0%	NaN	0%
Cat.3 Baseline 16TXRUs, UMi, 8x4	NaN	NaN	NaN	NaN
Cat.3 Baseline 32TXRUs, UMi, 8x4	NaN	NaN	NaN	NaN

*Results are compared at the same offered load

4X8 UMA

- For 16 and 32 TXRU, Cat.3 is worse than Phase 1



Baseline resource utilization: 20%				
System	**Cell-edge user-throughput [bps/Hz/user]**		**Mean user-throughput [bps/Hz/user]**	
	Baseline	Gain [%]	Baseline	Gain [%]
Baseline 8TXRUs, UMa, 4x8	1.0079	0%	3.2943	0%
Cat.3 Baseline 16TXRUs, UMa, 4x8	0.96176	-5%	3.2004	-3%
Cat.3 Baseline 32TXRUs, UMa, 4x8	0.95068	-6%	3.1832	-3%
Baseline resource utilization: 50%				
System	**Cell-edge user-throughput [bps/Hz/user]**		**Mean user-throughput [bps/Hz/user]**	
	Baseline	Gain [%]	Baseline	Gain [%]
Baseline 8TXRUs, UMa, 4x8	0.45423	0%	2.2393	0%
Cat.3 Baseline 16TXRUs, UMa, 4x8	0.43095	-5%	2.1605	-4%
Cat.3 Baseline 32TXRUs, UMa, 4x8	0.27222	-40%	1.7036	-24%
Baseline resource utilization: 70%				
System	**Cell-edge user-throughput [bps/Hz/user]**		**Mean user-throughput [bps/Hz/user]**	
	Baseline	Gain [%]	Baseline	Gain [%]
Baseline 8TXRUs, UMa, 4x8	0.25172	0%	1.5988	0%
Cat.3 Baseline 16TXRUs, UMa, 4x8	0.21794	-13%	1.5257	-5%
Cat.3 Baseline 32TXRUs, UMa, 4x8	NaN	NaN	NaN	NaN

*Results are compared at the same offered load

4X8 UMI

- For 16 and 32 TXRU, Cat.3 is worse than Phase 1.

Baseline resource utilization: 20%				
System	**Cell-edge user-throughput [bps/Hz/user]**		**Mean user-throughput [bps/Hz/user]**	
	Baseline	Gain [%]	Baseline	Gain [%]
Baseline 8TXRUs, UMi, 4x8	1.1977	0%	3.4233	0%
Cat.3 Baseline 16TXRUs, UMi, 4x8	1.079	-10%	3.2857	-4%
Cat.3 Baseline 32TXRUs, UMi, 4x8	0.96132	-20%	3.1868	-7%
Baseline resource utilization: 50%				
System	**Cell-edge user-throughput [bps/Hz/user]**		**Mean user-throughput [bps/Hz/user]**	
	Baseline	Gain [%]	Baseline	Gain [%]
Baseline 8TXRUs, UMi, 4x8	0.45099	0%	2.295	0%
Cat.3 Baseline 16TXRUs, UMi, 4x8	0.3975	-12%	2.149	-6%
Cat.3 Baseline 32TXRUs, UMi, 4x8	0.34254	-24%	1.99	-13%
Baseline resource utilization: 70%				
System	**Cell-edge user-throughput [bps/Hz/user]**		**Mean user-throughput [bps/Hz/user]**	
	Baseline	Gain [%]	Baseline	Gain [%]
Baseline 8TXRUs, UMi, 4x8	0.23588	0%	1.6079	0%
Cat.3 Baseline 16TXRUs, UMi, 4x8	0.17657	-25%	1.3803	-14%
Cat.3 Baseline 32TXRUs, UMi, 4x8	NaN	NaN	NaN	NaN

*Results are compared at the same offered load

2X16 UMA

- For 16 and 32 TXRU, Cat.3 is worse than Phase 1.

Baseline resource utilization: 20%				
System	**Cell-edge user-throughput [bps/Hz/user]**		**Mean user-throughput [bps/Hz/user]**	
	Baseline	Gain [%]	Baseline	Gain [%]
Baseline 8TXRUs, UMa, 2x16	0.98876	0%	3.1581	0%
Cat.3 Baseline 16TXRUs, UMa, 2x16	0.92341	-7%	3.0787	-3%
Cat.3 Baseline 32TXRUs, UMa, 2x16	0.96174	-3%	3.1883	1%
Baseline resource utilization: 50%				
System	**Cell-edge user-throughput [bps/Hz/user]**		**Mean user-throughput [bps/Hz/user]**	
	Baseline	Gain [%]	Baseline	Gain [%]
Baseline 8TXRUs, UMa, 2x16	0.40723	0%	2.0484	0%
Cat.3 Baseline 16TXRUs, UMa, 2x16	0.36732	-10%	2.032	-1%
Cat.3 Baseline 32TXRUs, UMa, 2x16	0.3214	-21%	1.8495	-10%
Baseline resource utilization: 70%				
System	**Cell-edge user-throughput [bps/Hz/user]**		**Mean user-throughput [bps/Hz/user]**	
	Baseline	Gain [%]	Baseline	Gain [%]
Baseline 8TXRUs, UMa, 2x16	0.21423	0%	1.5007	0%
Cat.3 Baseline 16TXRUs, UMa, 2x16	0.2067	-4%	1.4202	-5%
Cat.3 Baseline 32TXRUs, UMa, 2x16	NaN	NaN	NaN	NaN

*Results are compared at the same offered load

2X16 UMI

- For 16 TXRU, Cat.3 is worse than Phase 1.

- For 32 TXRU, Cat.3 is a better baseline than Phase 1 at low load, but not at medium to high load.

Baseline resource utilization: 20%				
System	**Cell-edge user-throughput [bps/Hz/user]**		**Mean user-throughput [bps/Hz/user]**	
	Baseline	Gain [%]	Baseline	Gain [%]
Baseline 8TXRUs, UMi, 2x16	1.0152	0%	3.2926	0%
Cat.3 Baseline 16TXRUs, UMi, 2x16	0.98125	-3%	3.1966	-3%
Cat.3 Baseline 32TXRUs, UMi, 2x16	1.1774	16%	3.47	5%
Baseline resource utilization: 50%				
System	**Cell-edge user-throughput [bps/Hz/user]**		**Mean user-throughput [bps/Hz/user]**	
	Baseline	Gain [%]	Baseline	Gain [%]
Baseline 8TXRUs, UMi, 2x16	0.41074	0%	2.1141	0%
Cat.3 Baseline 16TXRUs, UMi, 2x16	0.35411	-14%	2.0401	-4%
Cat.3 Baseline 32TXRUs, UMi, 2x16	0.37926	-8%	2.0371	-4%
Baseline resource utilization: 70%				
System	**Cell-edge user-throughput [bps/Hz/user]**		**Mean user-throughput [bps/Hz/user]**	
	Baseline	Gain [%]	Baseline	Gain [%]
Baseline 8TXRUs, UMi, 2x16	0.1896	0%	1.5047	0%
Cat.3 Baseline 16TXRUs, UMi, 2x16	0.18032	-5%	1.4585	-3%
Cat.3 Baseline 32TXRUs, UMi, 2x16	NaN	NaN	NaN	NaN

*Results are compared at the same offered load

OBSERVATION:

- Cat.3 baseline shows poor performance in many of the evaluated cases
  - The Phase 1 baseline (using 8 TXRU) provides approximately equal or better performance
  - Some exceptions exist where Cat.3 shows benefit

APPENDIX:
SIMULATION PARAMETERS

Carrier frequency	2 GHz
Bandwidth	10 MHz
Scenarios	3D UMi 200m ISD, 3D UMa 500m ISD
Cell layout	19 sites, 3 sectors per site
Wrapping	Radio distance based
UE receiver	MMSE-IRC
CSI periodicity	5 ms
CSI delay	5 ms
CSI mode	Aperiodic mode 3-2
Outer loop LA	Yes, 10% BLER target
eNB Tx power	41 dBm UMi, 46dBm UMa
Traffic model	Non-full buffer, 500 kB packet size
UE speed	3 km/h
UE noise figure	9dB
Scheduling	Proportional fair in time and frequency
CRS interference	Not modeled. Overhead accounted for 2 CRS ports.
DMRS overhead	2 antenna ports
CSI-RS	Overhead accounted for ; channel estimation error modeled
Codebook	Rel.10 8Tx
HARQ	Max 5 retransmissions
Antenna spacing	0.8 lambda in vertical, 0.5 lambda in horizontal
Handover margin	3 dB

APPENDIX

- In the appendix we provide absolute throughput numbers and offered loads at a fixed RU for each baseline case.

8X4 UMA

		Phase 1 8TXRU	Cat. 3	Cat. 3
	TXRUs	8	16	32
20% baseline RU	**cell-edge user throughput (bits/s/Hz/user)**	1.1525	1.0879	1.1112
	Normalized user-throughput (bits/s/Hz/user)	3.4065	3.3322	3.3057
	Offered traffic (bits/s/Hz/cell)	0.6917	0.6472	0.6538
50% baseline RU	**cell-edge user throughput (bits/s/Hz/user)**	0.4707	0.48279	0.44344
	Normalized user-throughput (bits/s/Hz/user)	2.2194	2.2422	2.1709
	Offered traffic (bits/s/Hz/cell)	1.2692	1.2634	1.1470
70% baseline RU	**cell-edge user throughput (bits/s/Hz/user)**	0.2538	0.26648	0.24305
	Normalized user-throughput (bits/s/Hz/user)	1.6208	1.6292	1.5472
	Offered traffic (bits/s/Hz/cell)	1.5736	1.5623	1.4004

8X4 UMI

		Phase 1 8TXRU	Cat. 3	Cat. 3
	TXRUs	8	16	32
20% baseline RU	**cell-edge user throughput (bits/s/Hz/user)**	1.2141	1.2474	1.2219
	Normalized user-throughput (bits/s/Hz/user)	3.3898	3.4682	3.4637
	Offered traffic (bits/s/Hz/cell)	0.6775	0.7086	0.7045
50% baseline RU	**cell-edge user throughput (bits/s/Hz/user)**	0.4492	0.47665	0.52695
	Normalized user-throughput (bits/s/Hz/user)	2.1731	2.2753	2.3689
	Offered traffic (bits/s/Hz/cell)	1.1732	1.2889	1.3174
70% baseline RU	**cell-edge user throughput (bits/s/Hz/user)**	NaN	0.25384	0.27577
	Normalized user-throughput (bits/s/Hz/user)	NaN	1.605	1.6732
	Offered traffic (bits/s/Hz/cell)	NaN	1.5510	1.6205

4X8 UMA

		Phase 1 8TXRU	Cat. 3	Cat. 3
	TXRUs	8	16	32
20% baseline RU	**cell-edge user throughput (bits/s/Hz/user)**	1.0079	0.97093	0.95594
	Normalized user-throughput (bits/s/Hz/user)	3.2943	3.2195	3.1897
	Offered traffic (bits/s/Hz/cell)	0.6172	0.6023	0.6141
50% baseline RU	**cell-edge user throughput (bits/s/Hz/user)**	0.4542	0.45855	0.40688
	Normalized user-throughput (bits/s/Hz/user)	2.2393	2.2249	2.1106
	Offered traffic (bits/s/Hz/cell)	1.2082	1.1633	1.0692
70% baseline RU	**cell-edge user throughput (bits/s/Hz/user)**	0.2517	0.23374	0.21023
	Normalized user-throughput (bits/s/Hz/user)	1.5988	1.5899	1.4845
	Offered traffic (bits/s/Hz/cell)	1.4646	1.4433	1.2835

4X8 UMI

		Phase 1 8TXRU	Cat. 3	Cat. 3
	TXRUs	8	16	32
20% baseline RU	**cell-edge user throughput (bits/s/Hz/user)**	1.1977	1.1237	1.0339
	Normalized user-throughput (bits/s/Hz/user)	3.4233	3.3404	3.2911
	Offered traffic (bits/s/Hz/cell)	0.6896	0.6643	0.6258
50% baseline RU	**cell-edge user throughput (bits/s/Hz/user)**	0.4510	0.43624	0.43166
	Normalized user-throughput (bits/s/Hz/user)	2.2950	2.2245	2.2271
	Offered traffic (bits/s/Hz/cell)	1.2318	1.1872	1.1423
70% baseline RU	**cell-edge user throughput (bits/s/Hz/user)**	0.2359	0.22263	NaN
	Normalized user-throughput (bits/s/Hz/user)	1.6079	1.6105	NaN
	Offered traffic (bits/s/Hz/cell)	1.4812	1.4158	NaN

2X16 UMA

		Phase 1 8TXRU	Cat. 3	Cat. 3
	TXRUs	8	16	32
20% baseline RU	**cell-edge user throughput (bits/s/Hz/user)**	0.9888	0.94153	0.95462
	Normalized user-throughput (bits/s/Hz/user)	3.1581	3.1092	3.1785
	Offered traffic (bits/s/Hz/cell)	0.5921	0.5778	0.5955
50% baseline RU	**cell-edge user throughput (bits/s/Hz/user)**	0.4072	0.37169	0.38729
	Normalized user-throughput (bits/s/Hz/user)	2.0484	2.0427	2.0295
	Offered traffic (bits/s/Hz/cell)	1.0462	1.0418	0.9916
70% baseline RU	**cell-edge user throughput (bits/s/Hz/user)**	0.2142	0.21962	0.19839
	Normalized user-throughput (bits/s/Hz/user)	1.5007	1.473	1.4334
	Offered traffic (bits/s/Hz/cell)	1.2707	1.2499	1.1663

2X16 UMI

		Phase 1 8TXRU	Cat. 3	Cat. 3
	TXRUs	8	16	32
20% baseline RU	**cell-edge user throughput (bits/s/Hz/user)**	1.0152	0.99831	1.0883
	Normalized user-throughput (bits/s/Hz/user)	3.2926	3.2212	3.3679
	Offered traffic (bits/s/Hz/cell)	0.6158	0.6045	0.6559
50% baseline RU	**cell-edge user throughput (bits/s/Hz/user)**	0.4107	0.39185	0.43323
	Normalized user-throughput (bits/s/Hz/user)	2.1141	2.1313	2.1698
	Offered traffic (bits/s/Hz/cell)	1.0928	1.0640	1.0617
70% baseline RU	**cell-edge user throughput (bits/s/Hz/user)**	0.1896	0.19329	NaN
	Normalized user-throughput (bits/s/Hz/user)	1.5047	1.5192	NaN
	Offered traffic (bits/s/Hz/cell)	1.2988	1.2786	NaN

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