5G-encode

Test Bed Monitoring

Testbed property type	Specific Property Metric Title	Baseline	Measurement (4G)	Measurement (5G)	Target 1 (4G)	Target 2 (5G)
Use Case 1 - AR/VR Remote Training	0	0	0	0	Phase 1	Phase 2
Network Performance	Camera to Server Bandwidth	20Mbps video stream to the server	2.2Mbps - 6 users supported on VR	~3.0Mbps per user/device - at least 5 users on VR headset and 3 on mobile devices (across 4 sessions, totalling over 20 users)	1 - 10 mbps (4G LTE)	10-100 mbps (5G)
Network Performance	Server to Users Bandwidth (total cell Tput)	20Mbps 360 video stream to reach each user	9.9 Mbps - 6 users supported on VR	16.1Mbps average with 31Mbps peak - at least 5 users on VR headset and 3 on mobile devices (across 4 sessions, totalling over 20 users)	>= 4mps (6 user clients on LTE)	>= 20mpbs per user (12 user clients on 5G)
Network Performance	Server to Users Bandwidth (each user Tput)	20Mbps 360 video stream to reach each user	NA from latest test	3.22Mbps average	>= 4mps (6 user clients on LTE)	>= 20mpbs per user (12 user clients on 5G)
Network Performance	Latency Tolerance	200ms	Range: 4 to 18 mean milliseconds	3.15 milliseconds	200ms	<50ms
Network Performance	Jitter Tolerance	200ms	1.5 to 5.984ms	2.05 milliseconds	100ms	50ms
Network Performance	Packet Loss Tolerance	<1%	140 packet drop rate	0.0012	<1%	<1%
Network Performance	Packet drop - Downlink	See Description	4, 500 packet drop rate	0.0012	>2%	>2%
Network Performance	Packet drop - Uplink	See Description	260, 000 packet drop rate	0	>2%	>2%
Use Case 2 - Asset Tracking - Active tracking of time sensitive assets and asset conditions and maintaining pedigree and traceability	0	0	0	0	Phase 1	Phase 2
Network Performance	Number of Active users (SIMS)	1 SIM per LTE device. 1 RFID reader sat behind it leveraging NAT config.	See Column K & L for comments	4 LTE CPEs + 1 5G CPE (4 Siemens devices, 1 Robustel device) 1 RFID reader sat behind each device leveraging NAT config.	1 Active user to generate some network traffic for this return. It was not possible to capture network traffic on this round of use case testing as the tools were not available at the time.	-> 3 active users
Network Performance	Traffic per SIM (which is one per modem)	None of these metrics readily available on systems installed on site.	See Column L for more info	NCC Capabilities: 450Mbps down 57Mbps up as max values MAX Peak Traffic Up 5000 - 24000 Kb (data from Zeetta)	Peak Traffic GTP-U Octets Received DL = 380kb Peak Traffic GTP-U Octets Received UL = 80kb	Peak Traffic GTP-U Octets Received DL = 380kb Peak Traffic GTP-U Octets Received UL = 80kb
Network Performance	Packet loss	Minimal Inconsistent packet loss identified at all locations on 4G network - 300 ping test done with results below: -W1 Freezer: sent= 300 received= 299 lost= 1 (0%loss) -W1 Acclimatisation rack: sent= 300 received= 300 lost= 0 (0% loss) --W1 AFP: sent= 300 received= 300 lost= 0 (0%loss) -W1 PCMM: sent= 300 received= 300 lost= 0 (0%loss) -W2 CIVC: sent= 300 received= 300 lost= 0 (0%loss)	See column L for more info	300 ping test done for 5G with results below: -W1 Acclimatisation rack: sent = 300 received = 300 lost = 0 (0%loss) -WI Acclimatisation rack on 4G: sent = 300 received = 300 lost = 0 (0% loss) Similar results, however more consistent and reliable measurements for 5G (variation of packet loss for 4G between 0 to 11% packet loss, while 5G records consistent 0% packet loss)	0% loss GTP U downlink Packet lost rate is consistent with initial network commissioning results. Air interface PDCP SDU lost rate does peak on one cell as per the graphs below. We do have issue with interference from machinery in and around this cell.	0% Loss

Benefits Realization

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Network Performance	Packet Delay	Latency varied between stations - 300 ping test done with results below: -W1 Freezer: min= 22ms max= 117ms average= 71ms -W1 Acclimatisation rack: min= 23ms max= 116ms average= 70ms -W1 AFP: min= 22ms max= 120ms average= 70ms -W1 PCMM: min= 23ms max= 115ms average= 68ms -W2 CIVC min= 21ms max= 117ms average= 71 ms	See columns L & M for more info	300 ping test done for 5G with results below: - W1 Acclimatisation rack: min = 11 max = 45 average = 25 -W1 Acclimatisation rack on 4G: min= 22ms max= 117ms average= 71ms An improvement of 65% is seen in latency. Improved end user experience - reliable 5G connection and fast location update of asset in Plataine TPO. Interference effects in the area have been avoided as the 5G connection moves the frequency bandwidth higher in the spectrum, away from the interference region (1.8 - 2 GHz where the 4G also acts).	10mS or less on average across the cells	<100ms
Network Performance	Block Error Rate - DL	TCP segment statistic data available when SSH into the 4G router but unsure how to measure BLER.	See Column L for more info	Desired value 2% - No metrics available in current 5G system	Range 5 - 15%	0.02
Network Performance	Block Error Rate - DL	TCP segment statistic data available when SSH into the 4G router but unsure how to measure BLER.	See Column L for more info	Desired value 2% - No metrics available in current 5G system	Range 2-5 %	0.02
Use Case 3 - LRI	0	0	0	0	Phase 1	Phase 2
Network Capacity	Idle to Transmit time	dedicated communication resource	See Column L for more info	0	<500ms	<200ms
Network Capacity	Transmit Time	dedicated communication resource	See Column L for more info	0	<100ms	<50ms
Network Capacity	Latency	dedicated communication resource	81ms (avg)	33ms (avg)	<100ms	<50ms
Network Capacity	Reliability	dedicated communication resource	1	0.857	>99.99%	>99.99%
Network Capacity	Packet Loss	dedicated communication resource	0	0	0	0
Use Case 4 - APC	0	0	0	0	Phase 1	Phase 2
Network Capacity	Latency	dedicated communication resource	Over 19 pings -Max = 1372ms -Mean = 155ms	Over 100 pings - Max = 164ms - Min = 11ms - Mean = 19ms	<100ms	<50ms
Network Capacity	Uplink Throughput	dedicated communication resource	Limited scope - this is for Phase 2.	Maximum observed throughput = 18Mbps Data rate = 2.25MBps	Limited scope - this is for Phase 2.	900 - 1000 Mbps (down link), not relevant for this use case 60-65MBps (Up link)
Network Capacity	Uplink Radio Capacity	dedicated communication resource	Limited scope - this is for Phase 2.	UL - ~70% DL ~2-5%	Limited scope - this is for Phase 2.	(unsure what target value should be - metric added in as deemed important data for these type of applications)
General	0	0	0	0	Phase 1	Phase 2
Network Performance	Ability to support all use case requirements with single RAN system	Network not used.	See Column L for more info	0	Limited scope - this is for Phase 2.	Use case metrics above all supported simultaneously by single network - no impact of use case 1 (high bandwidth) on use case 2/3 operations.

Benefits Realization

Test Bed Monitoring

Testbed property type	Specific Property Metric Title	Baseline	Measurement (4G)	Measurement (5G)	Target 1 (4G)	Target 2 (5G)
Toshiba - Ultra Low Latency	0	0	0	0	Phase 1	Phase 2
Network Performance	Latency	Network not used.	See Column L for more info	0	20-30ms (4.5G)	<10ms (5G)
0	0	0	0	0	0	0
Note: The NCC 5G testbed is brand new; therefore, rather than improving the same technology KPIs, the project will perform comparative studies between existing technologies, i.e. Wi-Fi, potentially 4G/LTE Advanced and 5G.	0	0	0	0	0	0