ICASA

Limpopo Mobile Data Networks:
Quality of Service Report
2017/2018 Quarter 3

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- ICASA has a mandate to ensure that licensed ECN and ECNS operators and service providers **provide good quality of service** to end users of electronic communication services.

- ICASA's function is to **protect and promote** the interests of consumers with regards to the price, quality and variety of communication services.

- ICASA enforces or ensures Quality of Service (QoS) by set regulations such as **End-User subscriber service charter** of 2016 and ETSI standards such as **TS 102 250** series.

- ITU-T Rec. E. 800 defines QoS as the collective effect of service performance which determines the degree of satisfaction a user derives from a service.

- ATIO (Pty) Ltd was appointed by ICASA to conduct a mobile network end-user QoS benchmark campaign for data and video services in Limpopo Province.

- Measurements for benchmark were carried out during the period 30 October to 11 November 2017 (about 1400 kilometres of drive testing and static measurements were covered).

- Measurements were conducted in typical circumstances where mobile service usage is likely to occur (e.g. major towns, township, highways and major roads).

- Technologies covered: GSM, UMTS and LTE.

• Project objectives:

- To measure and analyse the current quality of video and data services offered by South Africa's mobile operators; Cell C, MTN, Telkom and Vodacom.

- Give a clear view of End-User perceived Quality of Service of mobile networks' performance in Limpopo.

- Benchmark the performance of the four mobile network operators against each other: Cell C, MTN, Telkom and Vodacom.
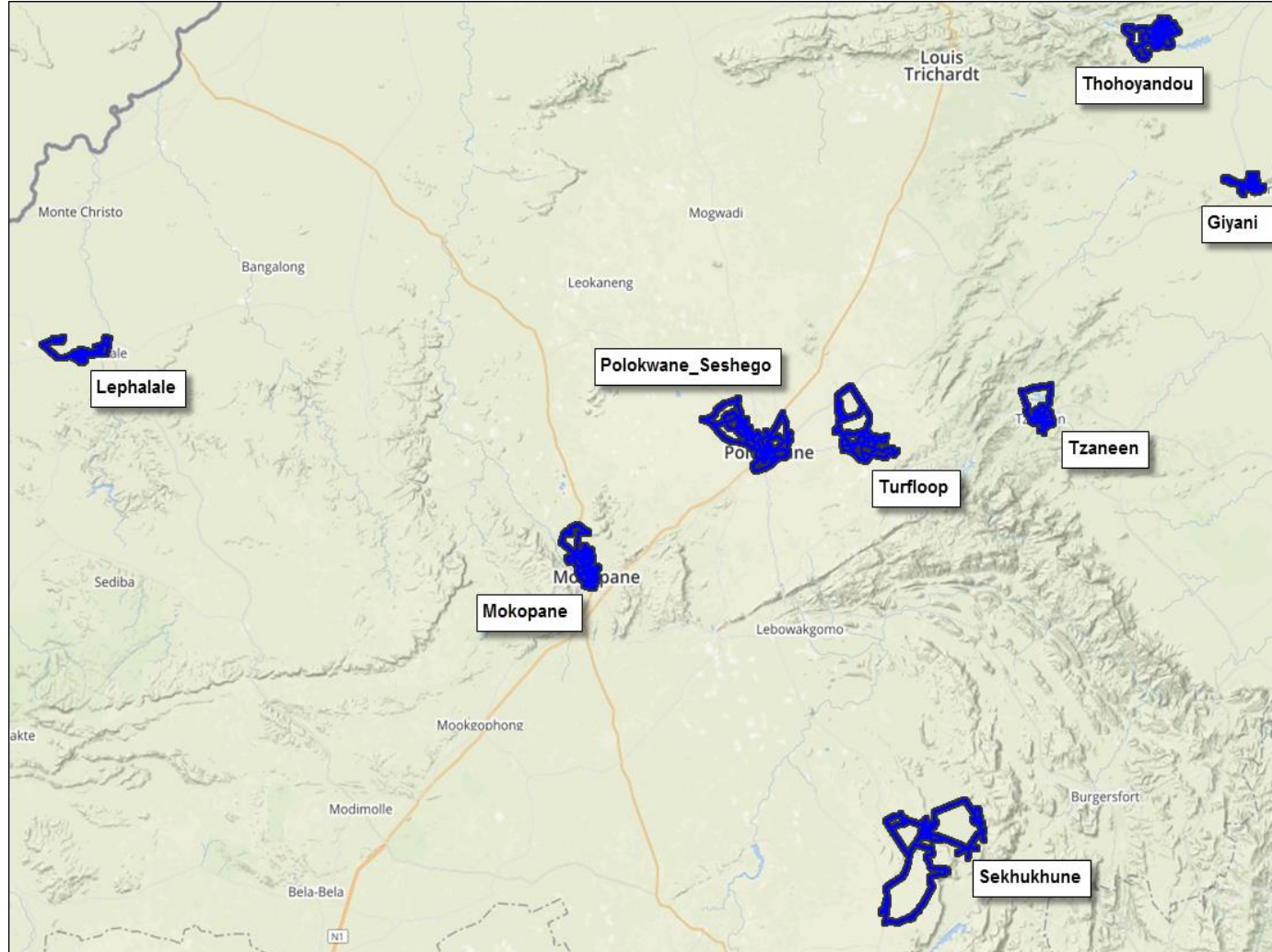
Figure 1: Maps for tested areas

Table 1: List of Areas and Static Points Tested

Areas Tested	Drive Tested Areas	Static Point
	Giyani	Masingita_Mall
	Lephalale	Waterburg_Municipal offices
	Mokopane	Mogalakwena Mine, The Crossing
	Thohoyandou	Thavhani Mall, University of Venda Block D
	Turfloop	University of Limpopo
	Tzaneen	Tzaneen Mall
	Polokwane_Seshego	Limpopo Mall, Mall of the North, Seshego SAPS Community Service Centre
	Sekhukhune	Jane Fures Plaza, Sekhukhune Nebo Traffic Department

Limpopo Data Report

Table 2 : Test Case Cycle

Test Number	Test Type	Technology	
		4G Pref	**3G Pref**
		Measurement Cycle	
		PDP always on	
1	FTP FILE TRANSFER DOWNLOAD	FTP Get (15MB)	FTP Get (3MB)
		wait 15s	wait 15s
		PDP always on	
2	FTP FILE TRANSFER UPLOAD	FTP Put (5MB)	FTP Put (1MB)
		wait 15s	wait 15s
		PDP always on	
3	HTTP FILE TRANSFER DOWNLOAD	HTTP Get (5MB)	HTTP Get (3MB)
		wait 15s	wait 15s
		PDP always on	
4	HTTP FILE TRANSFER UPLOAD	HTTP Put (5MB)	HTTP Put (5MB)
		wait 15s	wait 15s
		PDP always on	
5	ICMP PING 32 BYTES	Ping (32 bytes)	Ping (32 bytes)
		wait 15s	wait 15s
		PDP always on	
6	YOUTUBE STREAMING	Video: YouTube 60sec	Video: YouTube 60sec
		wait 15s	wait 15s
		PDP always on	
7	STATIC WEB BROWSING	HTTP Browsing: Kepler	HTTP Browsing: Kepler
		wait 15s	wait 15s
		PDP always on	
7	LIVE WEB BROWSING	Gumtree, News24, MSN	Gumtree, News24, MSN
		wait 5s	wait 5s
		PDP always on	
8	PING	Ping (32 bytes) Google.com	Ping (32 bytes) Google.com
		wait 15s	wait 15s
		PDP always on	
9	STATIC WEB BROWSING	Ping (32 bytes) Google.com	Ping (32 bytes) Google.com
		wait 15s	wait 15s

Vehicle CONFIGURATION

Benchmarker 2

SERVER

Tower

TERACO (Independent Server)

Live Browsing Ping (Google Server)

Test Vehicle

4G Preferred CSM (20103130 - 00101318)

3G Preferred CSM (20103121)

Sony XZ (F8331)

Vodacom MTN Cell C Telkom

Samsung Galaxy S7 EDGE (SM-G935FD)

Vodacom MTN Cell C Telkom

NQDI

Reporting
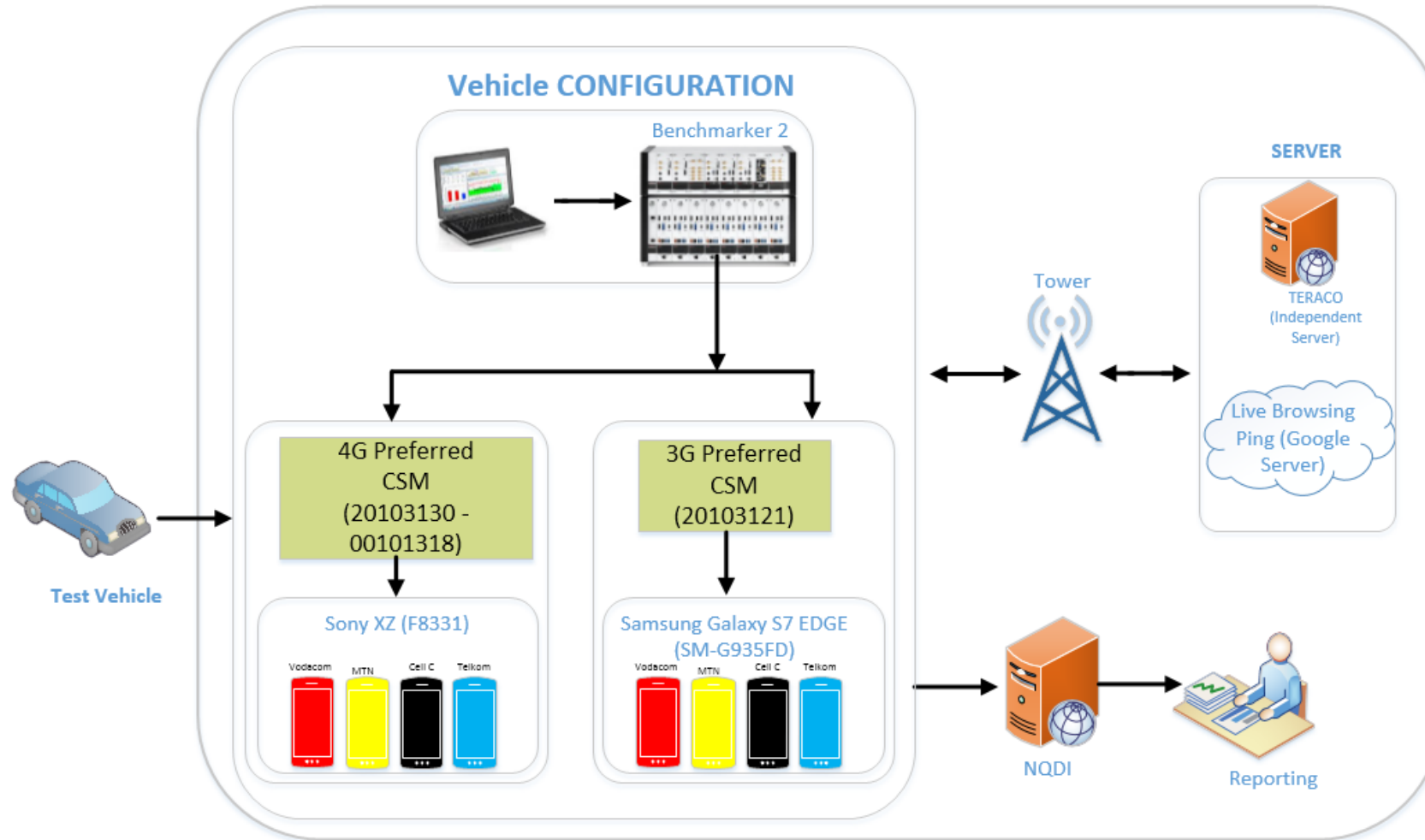
Figure 2: Equipment Setup

Table 3: Service Test Case Description

Test Case	Key Measurements	Test Description
32 byte ICMP Ping	Roundtrip time, or latency, in milliseconds	RTT (Round Trip Time) - is the time required for a packet to travel from a source to a destination and back. It measures the delay on a network at a given time. 1) a server hosted at Teraco (where all MNOs have direct peering access " **Independent Server**") 2) **www.google.com**.
FTP	File transfer throughput, in kbps Download and upload throughput speeds are measured	A reference file is downloaded from the test server to the users' device to measure download throughput speed, using the FTP 'get' command. A reference file is uploaded from the users' device to the test server to measure upload throughput speed, using the FTP 'put' command. Throughput speed is the rate at which data is transferred from the server to the user or vice versa and is measured in kbps.

HTTP	Web browsing session time (page loading) – measured for both HTTP and HTTPS protocols
	
	Download and upload throughput
		International and Local websites were also used to test HTTP and HTTPS performance from live websites with dynamic content with the following being selected;
		    o MSN.com – HTTPS Protocol
		    o News24.com – HTTPS Protocol
		    o Gumtree.co.za – HTTPS Protocol
		    o ETSI Kepler Reference Page
		<u>NB: For the dynamic websites the content can vary throughout the day and hence the values are to be used as an indication of possible performance:</u>

YouTube	YouTube Video Average Resolution ETSI YouTube Video Play Start Integrity - Video Stream Visual Quality (Avg over stream)	YouTube is the most popular video sharing service on the mobile internet platform and is therefore commonly used as the reference test by MNOs for video experience. Testing involves repeated downloading and playback of a known video clip. The clip selected was 47 seconds long and the script was set to allow up to 68 seconds for the playout to complete. 1. (*https://www.youtube.com/watch?v=uyPPAZUq66I*). 2. (*https://www.youtube.com/watch?v=uyPPAZUq66I*) – (6th - 11th November 2017). The YouTube test was aimed at measuring the following elements that make up the customer experience: 1. How long does a subscriber wait before a video starts playing on their device? 2. At what resolution was the Video clip delivered to the user. 3. What is the average perceived Video quality for the test

Mobile Test Summary Results

Table 4: 3G Preferred Mobile Drive Test Summary Results

		vodacom	MTN	CELL©	Telkom
FTP Throughput [kbps]	**Measure**				
FTP Download	(Avg) - Higher is better	6 138	7 505	2 867	6 116
	(MAX) - Higher is better	22 615	16 586	13 380	17 372
FTP Upload	(Avg) - Higher is better	2 012	1 823	1 054	1 541
	(MAX) - Higher is better	4 304	3 842	3 607	3 655
HTTP Throughput [kbps]	**Measure**				
HTTP Download	(Avg) - Higher is better	6 123	8 188	2 847	5 541
	(MAX) - Higher is better	23 745	21 246	13 468	14 975
HTTP Upload	(Avg) - Higher is better	2 220	1 826	1 165	1 646
	(MAX) - Higher is better	4 343	3 729	3 120	4 115
Web-Page Download [s]	**Web Page**				
HTTP Browser	Kepler - lower is better	4,60	3,52	13,94	4,74
	Kepler Mobile - lower is better	2,19	2,03	7,59	2,77
	MSN - lower is better	13,52	5,72	12,49	5,91
	News24 - lower is better	25,04	13,29	27,67	16,45
HTTPs Browser	Gumtree - lower is better	23,60	9,89	23,47	12,31
YouTube					
Visual Stream Quality (Avg over stream) - higher is better		3.72	3.77	3.78	3.73
Video Average Resolution [p] - higher is better		953	988	987	937
Video Play Start [s] - lower is better		3.55	2.20	3.33	3.12
Ping Average [ms]					
Independent Server - lower is better		883	855	798	807
Google - lower is better		723	860	559	737

Out of the 18 KPIs, MTN leads in 9 KPIs, followed by Vodacom with 6 KPIs and Cell C with 3 KPIs.

N.B. The best results are shown in white text on a green background.

Table 5: 4G Preferred Mobile Drive Test Summary Results

		vodacom	MTN	CELL C	Telkom
FTP Throughput [kbps]	**Measure**				
FTP Download	(Avg) - Higher is better	21 012	16 492	7 006	17 698
	(MAX) - Higher is better	79 726	59 454	43 689	67 384
FTP Upload	(Avg) - Higher is better	10 657	9 358	3 863	9 626
	(MAX) - Higher is better	22 430	23 033	20 993	19 160
HTTP Throughput [kbps]	**Measure**				
HTTP Download	(Avg) - Higher is better	19 345	17 071	6 914	16 022
	(MAX) - Higher is better	64 831	63 524	29 854	48 371
HTTP Upload	(Avg) - Higher is better	10 252	9 398	3 651	9 937
	(MAX) - Higher is better	22 295	22 940	20 885	19 441
Web-Page Download [s]	**Web Page**				
HTTP Browser	Kepler - lower is better	1,43	1,84	8,42	2,36
	Kepler Mobile - lower is better	0,90	1,16	4,93	1,11
	MSN - lower is better	5,74	5,15	5,89	2,37
	News24 - lower is better	18,80	11,09	16,91	9,38
HTTPs Browser	Gumtree - lower is better	15,92	7,79	13,63	7,71
YouTube					
Visual Stream Quality (Avg over stream) - higher is better		3.97	3.98	3.90	3.97
Video Average Resolution [p] - higher is better		1 060	1 049	1 013	1 063
Video Play Start [s] - lower is better		1.89	1.49	2.58	1.35
Ping Average [ms]					
Independent Server - lower is better		83	180	342	121
Google - lower is better		92	183	290	148

(Left margin label: 4G Preferred)

Out of 18 KPIs, Vodacom leads in 10 KPIs, followed by Telkom with 5 KPIs out and MTN in 3 KPIs.

N.B. The best results are shown in white text on a green background.

Throughput Results Summary

3G Preferred
– Vodacom achieved the highest FTP peak download throughput as well as the highest peak for HTTP peak download.
– MTN achieved the highest FTP average download and HTTP average download.
– Vodacom achieved the highest FTP and HTTP average.
– Vodacom achieved the highest FTP and HTTP peak.

4G Summary
– Vodacom achieved the highest FTP and HTTP average for both download and upload.
– Vodacom achieved the highest FTP and HTTP peak for both download and upload.
– MTN achieved the highest FTP peak upload and HTTP peak upload.

Web browsing Results Summary

3G Summary

- MTN leads in all KPIs.

4G Summary

- Telkom leads with 3 KPIs out of the 5 KPIs, followed by Vodacom which leads with 2 KPIs out of the 5 KPIs.

Video Streaming Results Summary

3G Summary

- MTN leads in 2 KPIs out of the 3 KPIs, with Vodacom leading in the remaining 1.

4G Summary

- Telkom leads in 2 KPIs out of 3 KPIs, with Vodacom leading in the remaining 1.

Stationery Test Summary Results

Table 6: 3G Preferred Stationary Test Summary Results

		vodacom	MTN	CELL C	Telkom
FTP Throughput [kbps]	**Measure**				
FTP Download	(Avg) - Higher is better	8 755	7 839	2 176	6 339
	(MAX) - Higher is better	23 704	18 176	10 092	17 930
FTP Upload	(Avg) - Higher is better	2 135	1 976	984	1 375
	(MAX) - Higher is better	3 953	3 941	2 750	2 956
HTTP Throughput [kbps]	**Measure**				
HTTP Download	(Avg) - Higher is better	8 097	8 854	2 226	6 431
	(MAX) - Higher is better	22 006	18 681	9 439	14 642
HTTP Upload	(Avg) - Higher is better	2 377	2 149	1 022	1 406
	(MAX) - Higher is better	4 245	4 044	2 977	3 806
Web-Page Download [s]	**Web Page**				
HTTP Browser	Kepler - lower is better	2,86	2,78	13,68	3,64
	Kepler Mobile - lower is better	1,33	1,72	7,78	2,09
	MSN - lower is better	17,27	6,26	13,01	6,28
	News24 - lower is better	27,25	14,19	36,14	15,03
HTTPs Browser	Gumtree - lower is better	28,96	11,51	24,79	11,06
YouTube					
Visual Stream Quality (Avg over stream) - higher is better		3.76	3.76	3.82	3.78
Video Average Resolution [p] - higher is better		979	991	998	937
Video Play Start [s] - lower is better		3.13	2.07	3.47	2.86
Ping Average [ms]					
Independent Server - lower is better		885	911	780	857
Google - lower is better		706	883	587	774

3G Preferred

Out of 18 KPIs, Vodacom leads in 8 KPIs, followed by MTN with 5 KPIs, Cell C with 4 KPIs and Telkom with 1 KPI.

N.B. The best results are shown in white text on a green background.

4G Preferred Stationary Drive Test Summary Results

Table 7: 4G Preferred Stationary Test Summary Results

		Vodacom	MTN	CELL©	Telkom
FTP Throughput [kbps]	**Measure**				
FTP Download	(Avg) - Higher is better	27 127	16 582	5 933	21 491
	(MAX) - Higher is better	61 568	41 347	26 571	72 562
FTP Upload	(Avg) - Higher is better	12 156	10 410	3 484	10 647
	(MAX) - Higher is better	21 141	21 209	18 411	19 005
HTTP Throughput [kbps]	**Measure**				
HTTP Download	(Avg) - Higher is better	21 753	15 709	6 403	17 365
	(MAX) - Higher is better	49 995	42 283	30 392	49 669
HTTP Upload	(Avg) - Higher is better	12 164	10 358	3 651	10 512
	(MAX) - Higher is better	21 525	21 100	18 845	19 251
Web-Page Download [s]	**Web Page**				
HTTP Browser	Kepler - lower is better	1,52	1,55	4,36	2,40
	Kepler Mobile - lower is better	0,81	1,02	3,90	1,01
	MSN - lower is better	9,23	5,89	5,19	2,09
	News24 - lower is better	27,60	14,84	17,13	10,21
HTTPs Browser	Gumtree - lower is better	21,02	9,29	11,85	7,17
YouTube					
Visual Stream Quality (Avg over stream) - higher is better		3.99	3.92	3.96	3.98
Video Average Resolution [p] - higher is better		1 066	1 019	1 022	1 056
Video Play Start [s] - lower is better		2.02	1.66	2.07	1.33
Ping Average [ms]					
Independent Server - lower is better		64	265	283	176
Google - lower is better		93	250	270	171

4G Preferred

Out of 18 KPIs, Vodacom leads in 12, Telkom leads in 5 and MTN leads in 1.

N.B. The best results are shown in white text on a green background.

Throughput Results Summary

3G Summary

- Vodacom achieved the highest FTP average download.

- MTN achieved the highest HTTP average download.

- Vodacom achieved highest FTP and HTTP average upload.

4G Summary

- Vodacom achieved the highest FTP and HTTP average download.

- Vodacom achieved the highest peak upload.

Web browsing Results Summary

3G preferred

– MTN leads with 3 out of the 5 KPIs.

– Both Vodacom and Telkom lead in 1 KPI out of 5 KPIs.

4G Summary

– Out of 5 KPIs, Telkom leads with 3 KPIs and Vodacom leads with 2 KPIs.

Video Streaming Results Summary

3G Summary

– Cell C leads in 2 out of the 3 KPIs and MTN leads in 1 KPI.

4G Summary

– Vodacom leads in 2 out of the 3 KPIs and Telkom leads in 1 KPI.
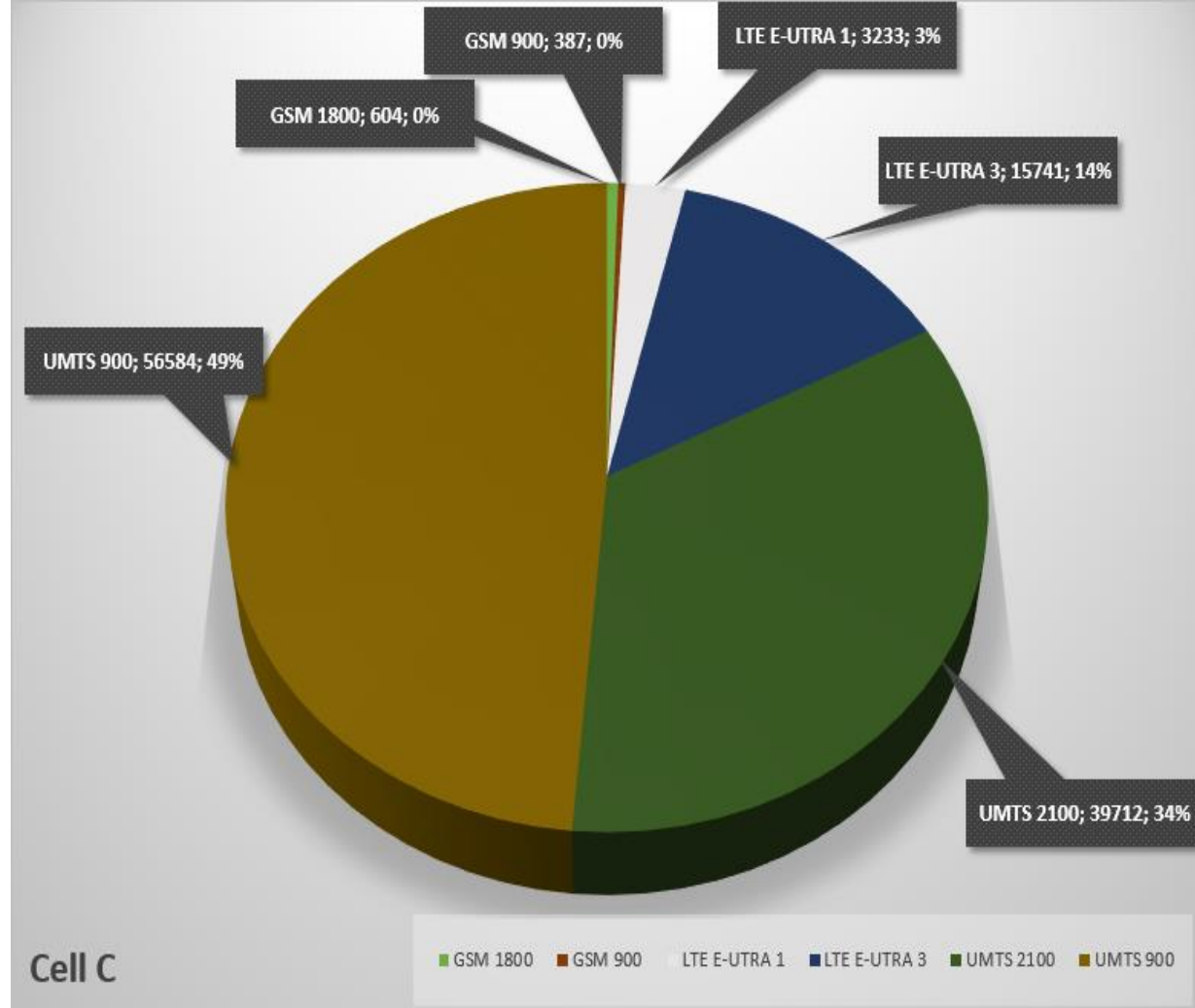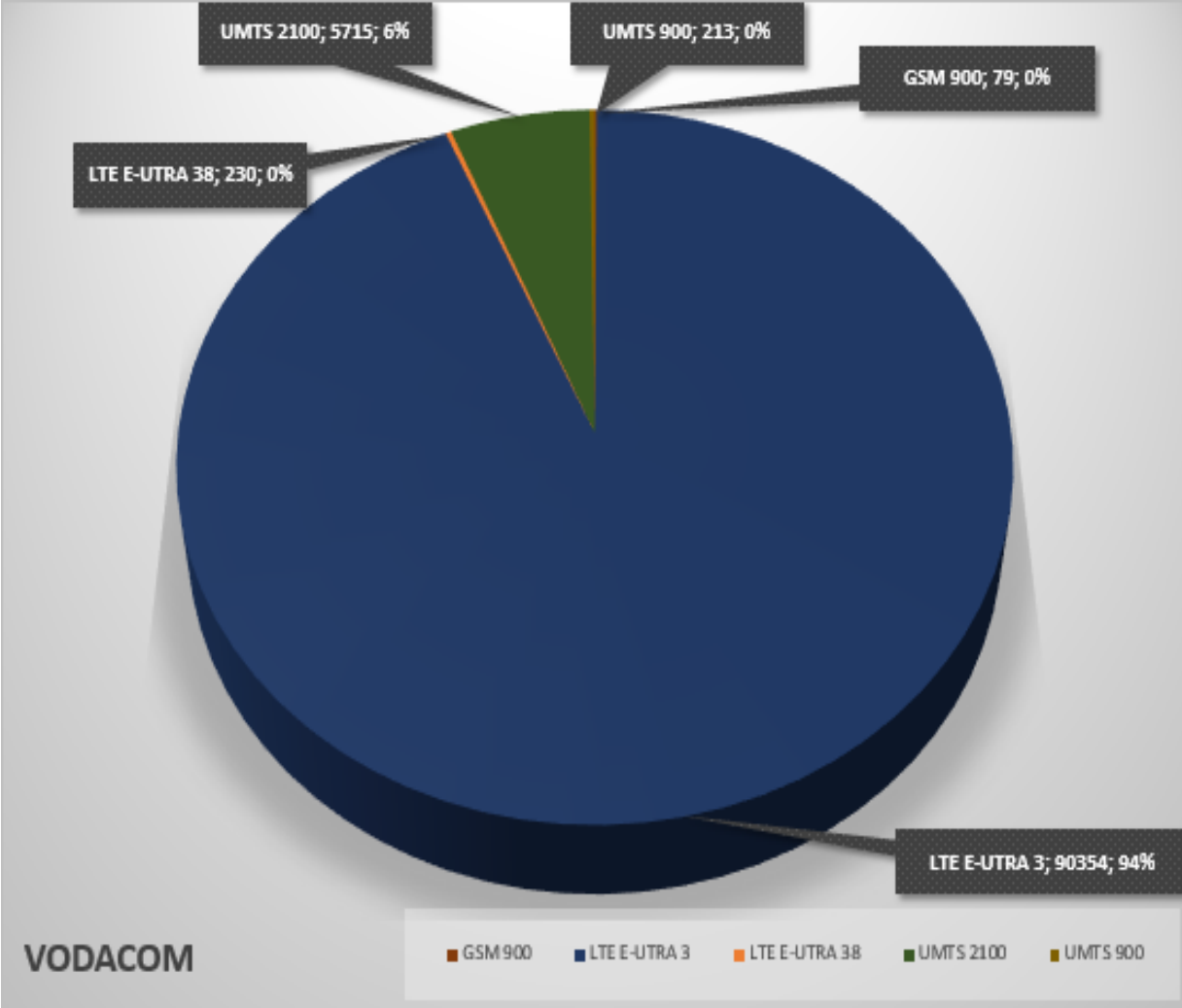
LTE Technology Distribution

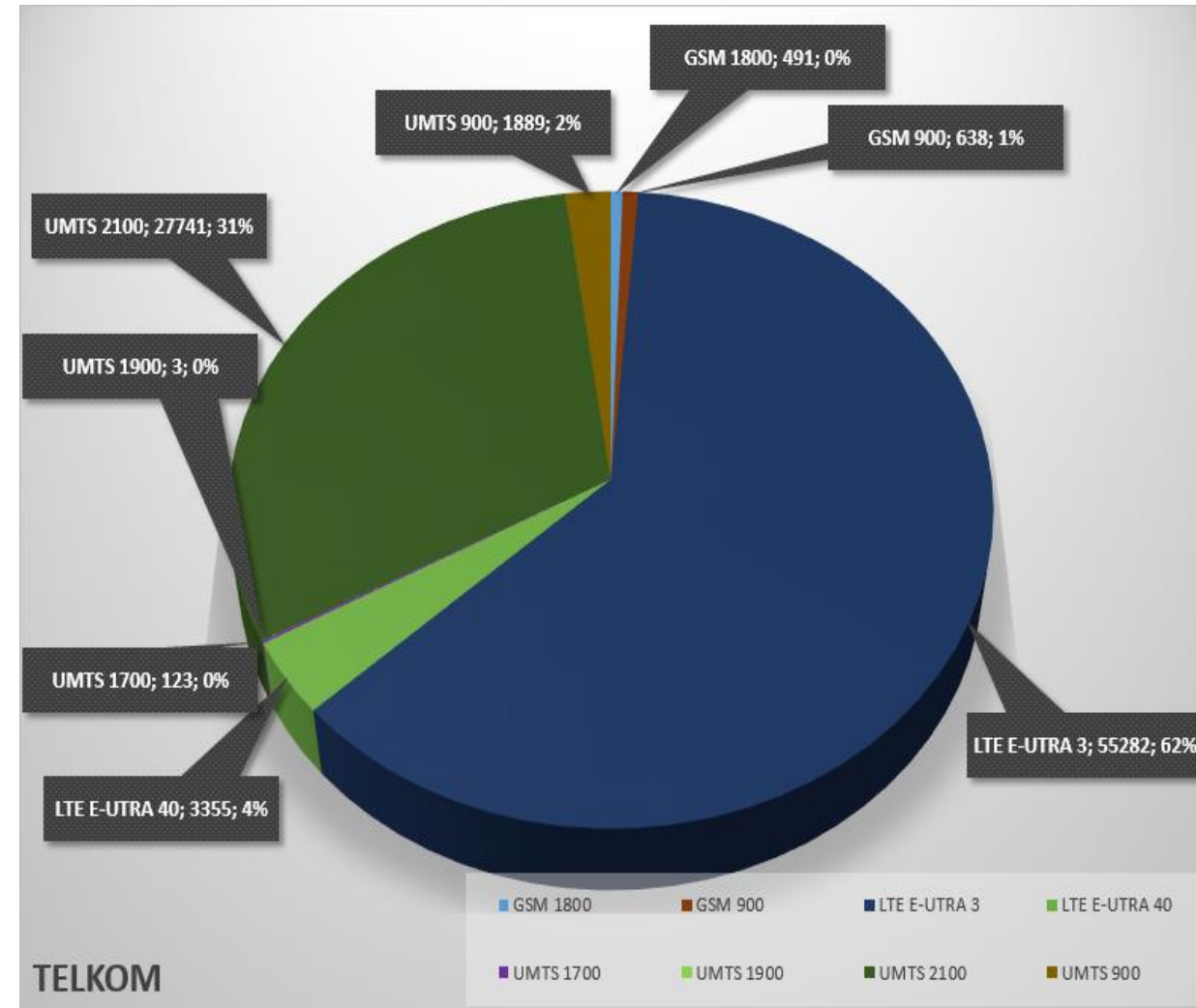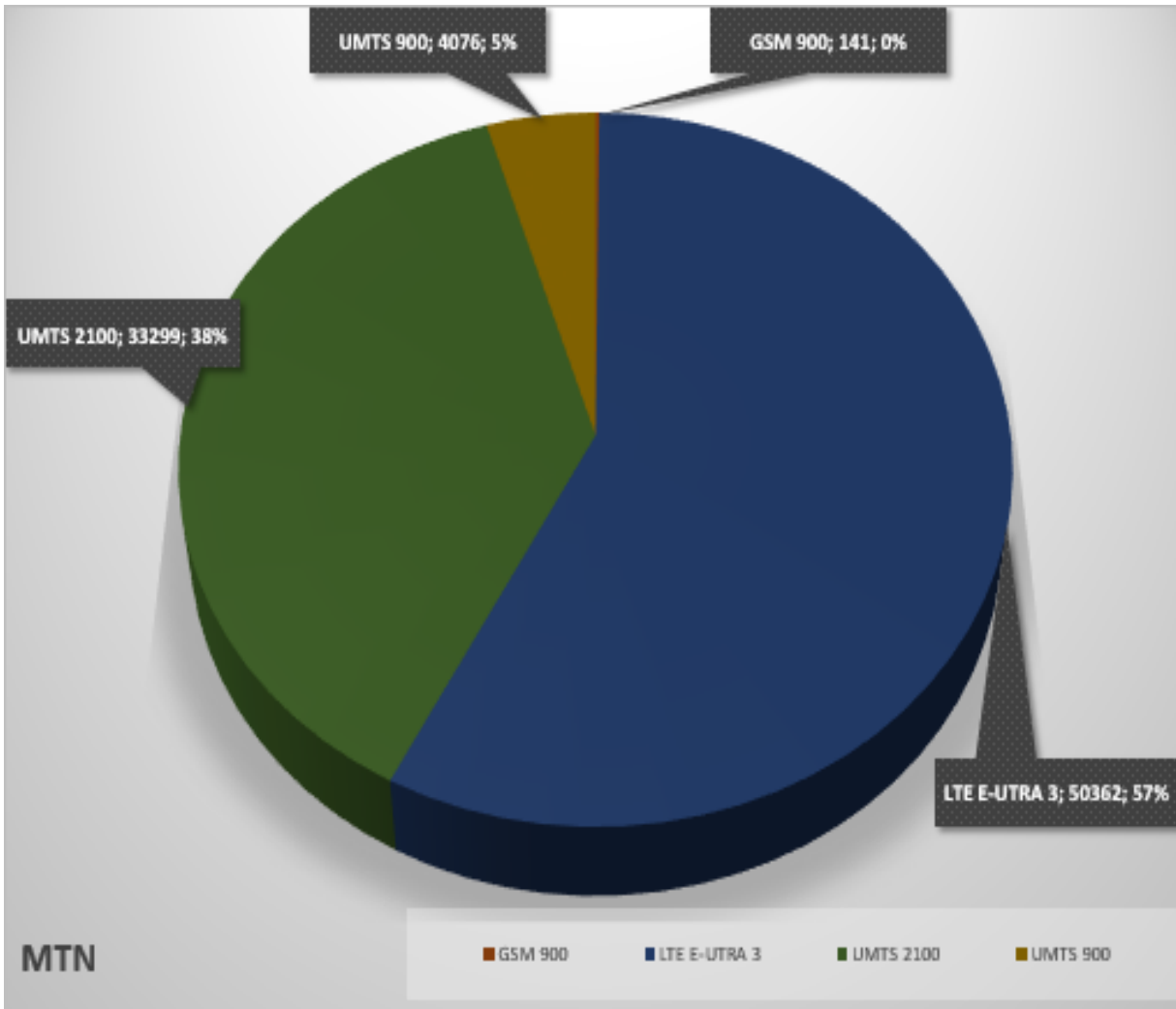**Figure 3: Vodacom and Cell C LTE Coverage stats**

Figure 4: MTN and Telkom LTE Coverage stats

Operators' Feedback

- The report was shared with all four mobile operators for comments and remedial actions.
- The mobile operators raised the following issues:
  - Lack of South African National Standard (SANS 1725-2) which would have been the ideal reference for mobile QoS measurements which is currently under development by relevant technical committee of South African Bureau of Standards (SABS).
  - Authority did not agree with the licensees on the KPIs to be measured prior to measurements campaign.
  - Operators face challenges with longer site acquisition processes, it takes them approximately 2 years or more to bring up a new site.
  - Given a low penetration of smart devices and extensive use of 2G based point of sale devices in the Province, operators are restricted in the amount of spectrum available for refarming from 2G to be used in the deployment of LTE.

- Cell C noted that even though they had relatively good coverage and quality for both LTE and 3G.

    – Acknowledges that it performed inadequately during the Authority's test drive as some of the areas had limited LTE coverage.

    – The testing period corresponds to the time when the network experienced problems, thus resulting in low performance for Key Performance Indicators.

    – It has since started with network optimisation was to resolve these challenges.

Cell C Remedial Actions

Area Name	Remedial Action
Giyani	▪ Deploy DC-HSPA+ on U900 during Q1 2018.
Lephalale	▪ LTE Deployment during Q4 2018 ▪ 1800 MHz and 2100 MHz capacity upgrade during Q2 2018
Mokopane	▪ 1800 MHz and 2100 MHz capacity upgrade during Q2 2018
Thohoyandou	▪ Deploy DC-HSPA+ on U900 during Q1 2018.
Turfloop	▪ Deployed LTE-A planned during Q4 2017
Tzaneen	▪ Deploy DC-HSPA+ on U900 during Q1 2018.
Polokwane and Seshego	▪ Deployed LTE-A and DC-HSPA+ by end of Q4 2017
Sekhukhune	▪ Deploy DC-HSPA+ on U900 during Q1 2018.

- Although MTN did not contest the results following concern were raised:
  - The ping tests were carried out while the test device was in FACH state as opposed to the DCH state. MTN is of the view that the state the device is in has impact on the RTTT measured, hence the latency experienced by the user while downloading and playing games.
  - Given the low penetration of smart devices and extensive use of 2G based point of sale devices in Limpopo and Free State provinces., MTN is significantly restricted in the amount of spectrum available for refarming from 2G to be used in the deployment of LTE.
  - MTN is of the view that the data performance would be significantly improved when ICASA makes new and suitable spectrum available to the licensees.
- MTN was content with significant improvements in its mobile data performance as reflected in the report compared to that in the previous(Gauteng) report issued by ICASA.

- MTN remedial actions include plans to make improvements on its data network, particularly on the LTE network. The envisaged improvements include new site builds, upgrades to the existing sites and further spectrum refarming.

- Telkom gave the following concerns on the Authority's draft report:

  - Test phone latched onto LTE for most of the time [71.0%] during drive test.

  - In Lephalale Telkom roams 100% on MTN;

  - In the outskirts of some areas (e.g. Tzaneen and Sekhukhune), Telkom also roamed on MTN (UMTS) due to limited coverage in these areas.

- Telkom note the following on the report:

  – Telkom scored above 10 Mbps average download throughput in seven regions out of the eight tested.

  – Overall results – In some test cases Telkom performed similar to its competitors or better in some KPIs i.e. Web Browsing and accessing YouTube. The average download throughput are above 10 Mbps for 4G preferred.

- Telkom provided the following remedial action:

  - 3 planned sites in the Lephalale area that are expected to be on air in approximately 6 months depending on approval.

  - In the outskirts of some areas (e.g. Tzaneen and Sekhukhune), Telkom also roamed on MTN (UMTS) due to limited coverage in these areas. An additional 7 sites are planned for these areas, which are expected to be on air in approximately 9 months.

  - Telkom will continue to depend on MTN to provide service to its customers in Lephalale and outskirts of Sekhukhune until Telkom has deployed a network in these areas.

  - More than 40 sites have already been planned for Limpopo area that will improve LTE, UMTS and GSM coverage and user perceived throughput.

- Vodacom noted the following:

  - Vodacom noted that it performed better relative to other operators when it comes to 4G technology but lacked on 3G.

  - High 2G traffic and low high end device penetration continues to halt the possibility to introduce new technologies as a result of limited spectrum. We continue to leverage on ongoing project i.e. deep rural coverage to provide solutions within hard to reach rural communities in Limpopo province.

  - Vodacom performance exceeds the minimum requirements for customer experience however due to high UMTS2100 load and spectrum re-farming challenges to introduce UMTS900, Vodacom comes 2nd on 3G throughput.

Vodacom Remedial Actions

Area Name	Remedial Action
Giyani	- U900 Re-farming by June 2018 - LTE bandwidth capacity upgrade by June 2018 5 sites will be commissioned by end June 2018
Lephalale	- U900 deployed in Nov 2017 - Radio frequency capacity upgrade completed in Nov 2017
Mokopane	- Radio Frequency capacity for 3G in Mokopane CBD was increased in Nov 2017 3G sites in the nearest townships will also be optimised and are planned to go live by end June 2018
Thohoyandou	- Two 3G sites are under construction and scheduled to be live by end April 2018. - Additional sites are also planned and awaiting approvals.
Turfloop	- Radio frequency capacity on existing sites was increased Jan 2018 3G upgrade is pending on three planned sites which are to go live by end June 2018.
Tzaneen	Eleven sites are planned to improve coverage and capacity to improve customer experience.
Polokwane and Seshego	Radio frequency capacity was increased in January 2018
Sekhukhune	- Frequency refarming is delayed to preserve customer experience for high volume 2G subscribers in the region. - Nine 3G sites are planned to increase capacity and close coverage gaps.

- Vodacom had ~95% LTE coverage on the route driven.

- MTN had ~58% LTE coverage on the route driven.

- Telkom had ~66% LTE coverage on the route driven.

- Cell C had ~18% LTE coverage on the route driven.

- The results shows that Vodacom will give better end-user experience for 3G preferred stationery testing and also for 4G preferred subscribers for both mobile and stationery testing.

- MTN will give better end-user experience to 3G Preferred subscribers in mobile conditions.

- It is evident from the results that MTN and Vodacom customers are getting better download and upload throughputs than Telkom and Cell C customers.