



ICASA

Free State 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 Free State Province.
- Measurements for benchmark were carried out during during the period 13 to 24 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 Free State.
- Benchmark the performance of the four mobile network operators against each other: Cell C, MTN, Telkom and Vodacom.

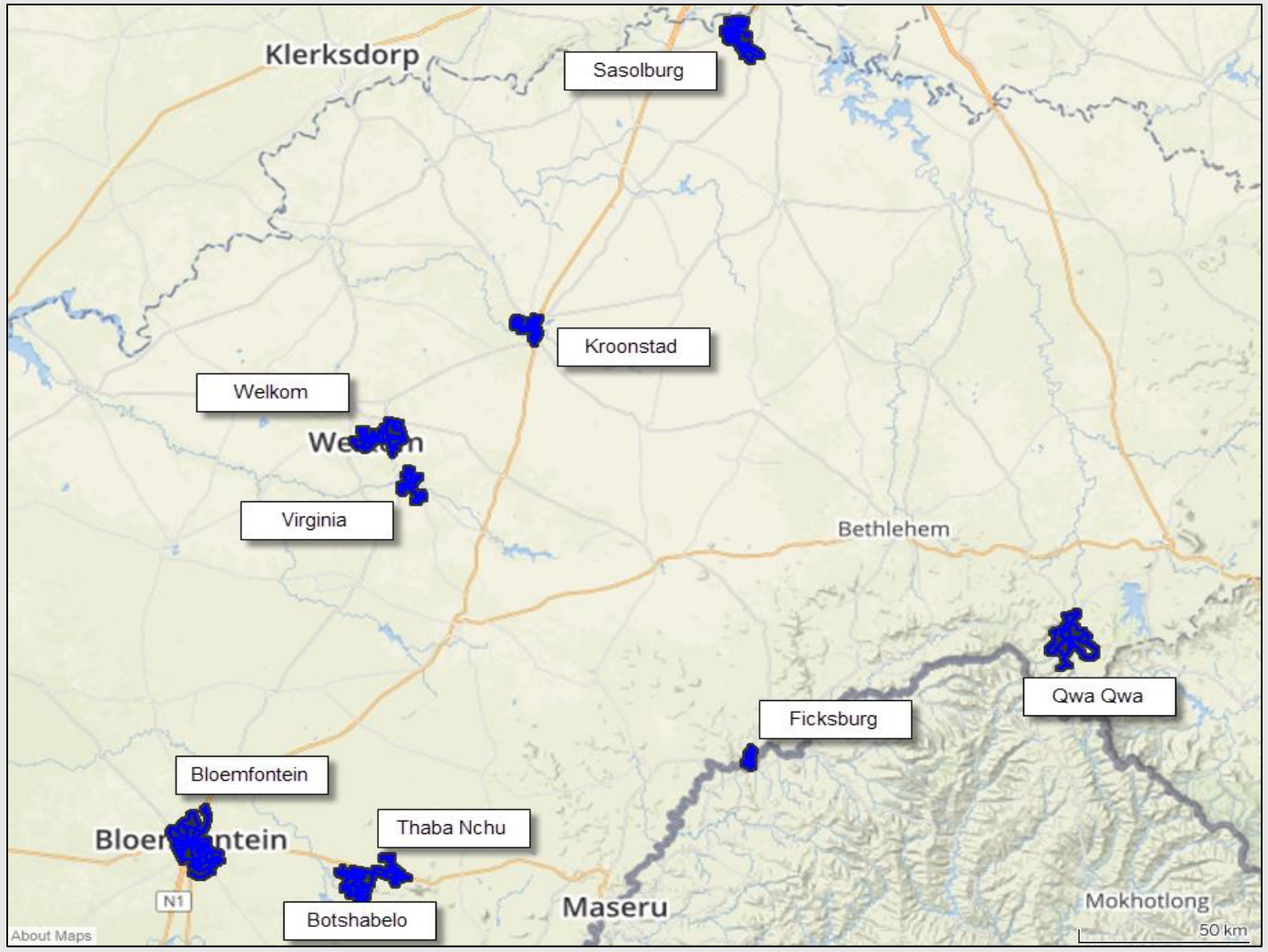


Figure 1: Maps for tested areas



Table 1: List of Areas and Static Points Tested

Areas Tested	Drive Tested Areas	Static Point
	Sasolburg	Zamdela Community Hall, Sasolburg Anchor Greek Marina, Sasolburg Midland
	Kroonstad	Kroonstad Taxi Rank
	Welkom	Goldfields Mall
	Bloemfontein	Bloemfontein Lemo Mall, Bloemfontein UFS
	Thaba-Nchu	Thaba-Nchu Shopping Complex
	Botshabelo	Botshabelo Park
	Ficksburg	Ficksburg Boarder Gates
	Qwa Qwa	Qwa Qwa Taxi Rank
	Virginia	N/A

Note: No static points were tested in Virginia.



Free State Data Report



Free State Data Report



Table 2 : Test Case Cycle

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

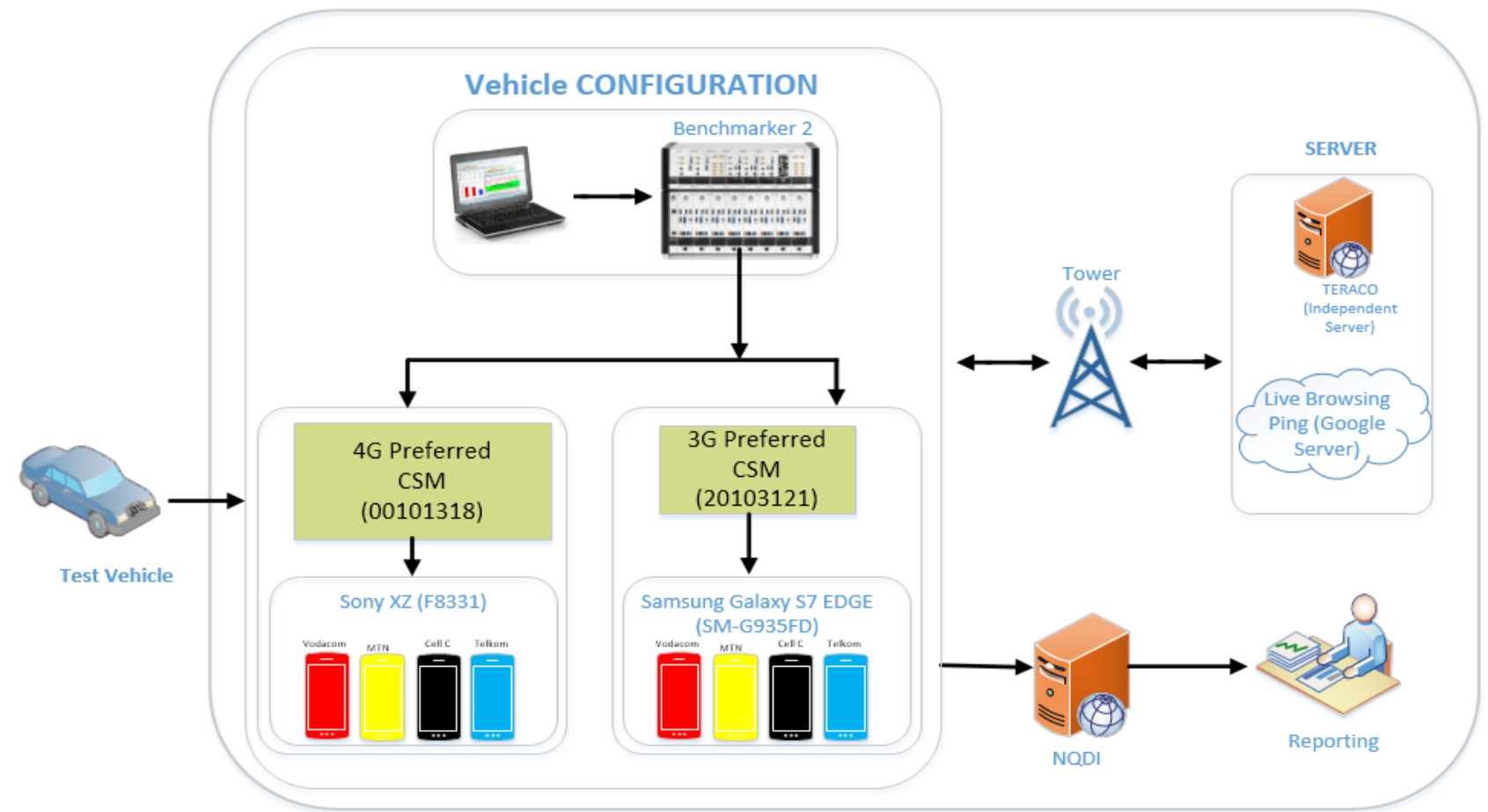


Figure 2: Equipment Setup



Table 3: Service Test Case Description

Test Case	Key Measurements	Test Description
32 byte ICMP Ping	Roundtrip time, or latency, in milliseconds	<p>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.</p> <p>1) a server hosted at Teraco (where all MNOs have direct peering access “ Independent Server”)</p> <p>2) www.google.com.</p>
FTP	<p>File transfer throughput, in kbps</p> <p>Download and upload throughput speeds are measured</p>	<p>A reference file is downloaded from the test server to the users’ device to measure download throughput speed, using the FTP ‘get’ command.</p> <p>A reference file is uploaded from the users’ device to the test server to measure upload throughput speed, using the FTP ‘put’ command.</p> <p>Throughput speed is the rate at which data is transferred from the server to the user or vice versa and is measured in kbps.</p>
HTTP	<p>Web browsing session time (page loading) – measured for both HTTP and HTTPS protocols</p> <p>Download and upload throughput</p>	<p>International and Local websites were also used to test HTTP and HTTPS performance from live websites with dynamic content with the following being selected;</p> <ul style="list-style-type: none"> ○ MSN.com – HTTPS Protocol ○ News24.com – HTTPS Protocol ○ Gumtree.co.za – HTTPS Protocol ○ ETSI Kepler Reference Page <p>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:</p>
YouTube	<p>YouTube Video Average Resolution</p> <p>ETSI YouTube Video Play Start</p> <p>Integrity - Video Stream Visual Quality (Avg over stream)</p>	<p>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.</p> <p>The clip selected was 47 seconds long and the script was set to allow up to 68 seconds for the playout to complete.</p> <p>https://www.youtube.com/watch?v=uyPPAZUq66I.</p> <p>The YouTube test was aimed at measuring the following elements that make up the customer experience:</p> <ol style="list-style-type: none"> 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

FTP Throughput [kbps]		Measure			
FTP Download	(Avg) - Higher is better	7 660	7 457	3 339	5 041
	(MAX) - Higher is better	22 260	13 272	12 217	12 103
FTP Upload	(Avg) - Higher is better	1 606	2 159	1 101	1 835
	(MAX) - Higher is better	3 951	3 527	3 411	3 428
HTTP Throughput [kbps]		Measure			
HTTP Download	(Avg) - Higher is better	7 391	7 792	3 505	4 641
	(MAX) - Higher is better	19 261	20 903	14 317	11 392
HTTP Upload	(Avg) - Higher is better	1 718	2 197	1 071	1 960
	(MAX) - Higher is better	3 978	3 876	3 861	3 526
Web-Page Download [s]		Web Page			
HTTP Browser	Kepler - lower is better	4,43	3,04	7,13	3,89
	Kepler Mobile - lower is better	2,36	1,97	4,92	2,41
	MSN - lower is better	10,19	5,67	8,95	5,05
	News24 - lower is better	24,94	15,68	27,95	17,81
HTTPs Browser	Gumtree - lower is better	15,65	9,30	17,21	11,09
YouTube					
Visual Stream Quality (Avg over stream) - higher is better		3.79	3.84	3.71	3.78
Video Average Resolution [p] - higher is better		1 003	1 001	887	894
Video Play Start [s] - lower is better		2.73	2.34	3.70	3.00
Ping Average [ms]					
Independent Server - lower is better		967	764	902	755
Google - lower is better		806	683	448	632

3G Preferred

Out of 18 KPIs, MTN leads in 10 KPIs, followed by Vodacom with 5 KPIs, Telkom with 2 KPIs and Cell C with 1 KPI.

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



4G Preferred Mobile Drive Test Summary Results



Table 5: 4G Preferred Mobile Drive Test Summary Results



4G Preferred

FTP Throughput [kbps]		Measure			
FTP Download	(Avg) - Higher is better	29 872	21 138	2 291	19 025
	(MAX) - Higher is better	73 427	66 475	14 720	68 524
FTP Upload	(Avg) - Higher is better	12 970	11 608	960	8 681
	(MAX) - Higher is better	23 276	22 820	2 438	18 700
HTTP Throughput [kbps]		Measure			
HTTP Download	(Avg) - Higher is better	26 216	21 208	2 127	16 824
	(MAX) - Higher is better	82 279	80 600	9 584	52 009
HTTP Upload	(Avg) - Higher is better	12 616	11 513	899	8 946
	(MAX) - Higher is better	22 582	22 016	2 149	18 896
Web-Page Download [s]		Web Page			
HTTP Browser	Kepler - lower is better	1,30	1,71	7,46	2,15
	Kepler Mobile - lower is better	0,88	1,04	4,45	1,47
	MSN - lower is better	3,91	4,63	7,69	2,66
	News24 - lower is better	11,96	12,59	26,31	10,86
HTTPs Browser	Gumtree - lower is better	10,55	7,55	13,50	8,01
YouTube					
Visual Stream Quality (Avg over stream) - higher is better		4.08	4.07	3.67	4.01
Video Average Resolution [p] - higher is better		1 077	1 067	875	1 055
Video Play Start [s] - lower is better		1.32	1.23	3.99	1.30
Ping Average [ms]					
Independent Server - lower is better		80	106	850	128
Google - lower is better		89	118	507	127

Out of 18 KPIs, Vodacom leads in 14 KPIs, followed by MTN and Telkom with 2 KPIs respectively.

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 and the highest peaks in all FTP KPIs as well as the peak for HTTP upload.
- MTN achieved the highest averages in all HTTP KPIs and the highest peak for HTTP download.

4G Summary

- Vodacom achieved the highest in all 8 KPIs.



Web browsing Results Summary

3G Summary

- MTN leads in 4 KPIs out of 5 the KPIs, followed by Telkom with 1 KPI out of the 5 KPIs.

4G Summary

- Both Vodacom and Telkom are joined leaders with 2 KPIs out of the 5 KPIs each.

Video Streaming Results Summary

3G Summary

- MTN leads in 2 KPIs out of the 3 KPIs, followed by Vodacom which leads in 1 KPI out of the 3 KPIs.

4G Summary

- Vodacom leads in 2 KPIs out of the 3 KPIs, followed by MTN which leads in 1 KPI out of the 3 KPIs.



Stationary Test Summary Results



Table 6: 3G Preferred Stationary Test Summary Results

FTP Throughput [kbps]		Measure			
FTP Download	(Avg) - Higher is better	9 366	8 994	3 855	7 630
	(MAX) - Higher is better	24 389	13 542	9 810	15 640
FTP Upload	(Avg) - Higher is better	1 659	2 191	1 056	2 067
	(MAX) - Higher is better	4 113	4 428	1 683	3 436
HTTP Throughput [kbps]		Measure			
HTTP Download	(Avg) - Higher is better	9 868	9 897	3 992	6 767
	(MAX) - Higher is better	24 500	15 338	9 970	13 696
HTTP Upload	(Avg) - Higher is better	1 806	2 430	1 171	2 184
	(MAX) - Higher is better	3 606	3 635	1 883	3 826
Web-Page Download [s]		Web Page			
HTTP Browser	Kepler - lower is better	3,32	2,79	5,69	3,41
	Kepler Mobile - lower is better	3,22	1,84	3,63	2,12
	MSN - lower is better	9,30	5,00	8,45	4,48
	News24 - lower is better	20,99	12,10	20,50	13,38
HTTPs Browser	Gumtree - lower is better	16,72	8,80	16,89	10,28
YouTube					
Visual Stream Quality (Avg over stream) - higher is better		3.79	3.84	3.78	3.87
Video Average Resolution [p] - higher is better		1 014	1 065	977	977
Video Play Start [s] - lower is better		1.90	1.81	2.71	2.06
Ping Average [ms]					
Independent Server - lower is better		875	702	860	719
Google - lower is better		857	741	400	594

Out of 18 KPIs, MTN leads in 11 KPIs, followed by Vodacom and Telkom with 3 KPIs respectively.

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

FTP Throughput [kbps]		Measure			
FTP Download	(Avg) - Higher is better	36 323	21 562	4 352	28 588
	(MAX) - Higher is better	72 852	51 623	17 877	52 256
FTP Upload	(Avg) - Higher is better	14 110	10 742	1 264	11 931
	(MAX) - Higher is better	23 263	21 351	2 720	18 851
HTTP Throughput [kbps]		Measure			
HTTP Download	(Avg) - Higher is better	34 376	22 977	3 759	24 826
	(MAX) - Higher is better	64 592	56 568	14 424	44 410
HTTP Upload	(Avg) - Higher is better	13 825	10 990	1 109	11 794
	(MAX) - Higher is better	21 898	21 696	2 265	18 388
Web-Page Download [s]		Web Page			
HTTP Browser	Kepler - lower is better	1,44	1,78	4,21	1,46
	Kepler Mobile - lower is better	1,01	0,98	3,51	0,98
	MSN - lower is better	4,25	4,54	6,44	2,38
	News24 - lower is better	12,26	10,38	20,47	10,56
HTTPs Browser	Gumtree - lower is better	11,78	7,34	10,96	6,74
YouTube					
Visual Stream Quality (Avg over stream) - higher is better		4.07	4.08	3.96	4.07
Video Average Resolution [p] - higher is better		1 065	1 069	1 001	1 076
Video Play Start [s] - lower is better		1.53	1.28	2.53	0.93
Ping Average [ms]					
Independent Server - lower is better		126	112	698	80
Google - lower is better		99	119	431	80

4G Preferred

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

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



Throughput

3G Summary

- Vodacom achieved the highest FTP average download and the highest peak for FTP and HTTP downloads.
- MTN achieved the highest and HTTP average download plus the highest average for both FTP and HTTP upload.
- Telkom achieved the highest peak for the HTTP upload.

4G Summary

- Vodacom achieved the highest in all 8 KPIs.



Web browsing

3G Summary

- MTN leads in 4 KPIs out of the 5 KPIs, followed by Telkom with 1 KPI.

4G Summary

- Both MTN and Telkom lead in 2 KPIs out of the 5 KPIs, followed by Vodacom with 1 KPI.

Video Streaming

3G Summary

- MTN leads in 2 KPIs out of the 3 KPIs, followed by Telkom with 1 KPI.

4G Summary

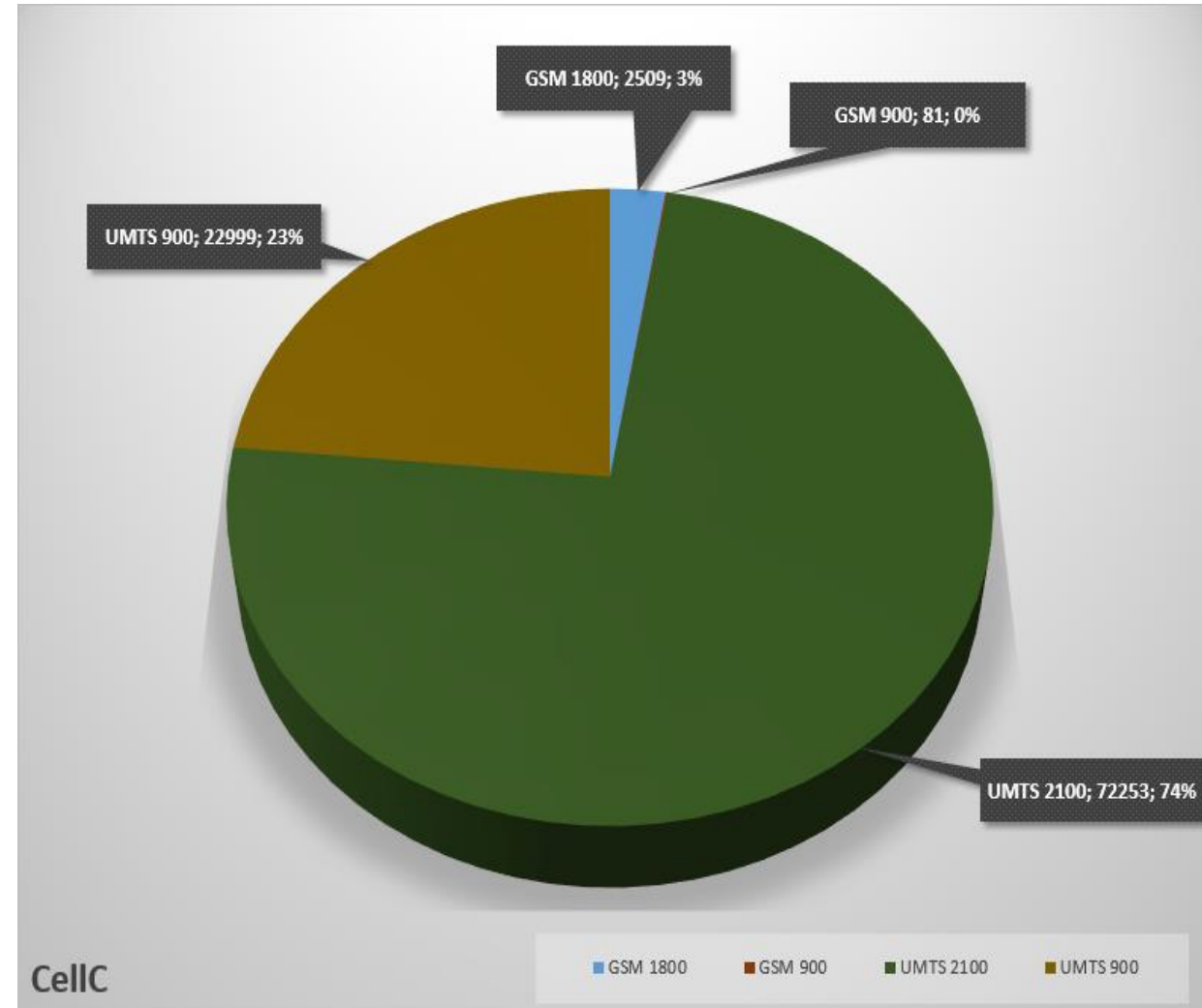
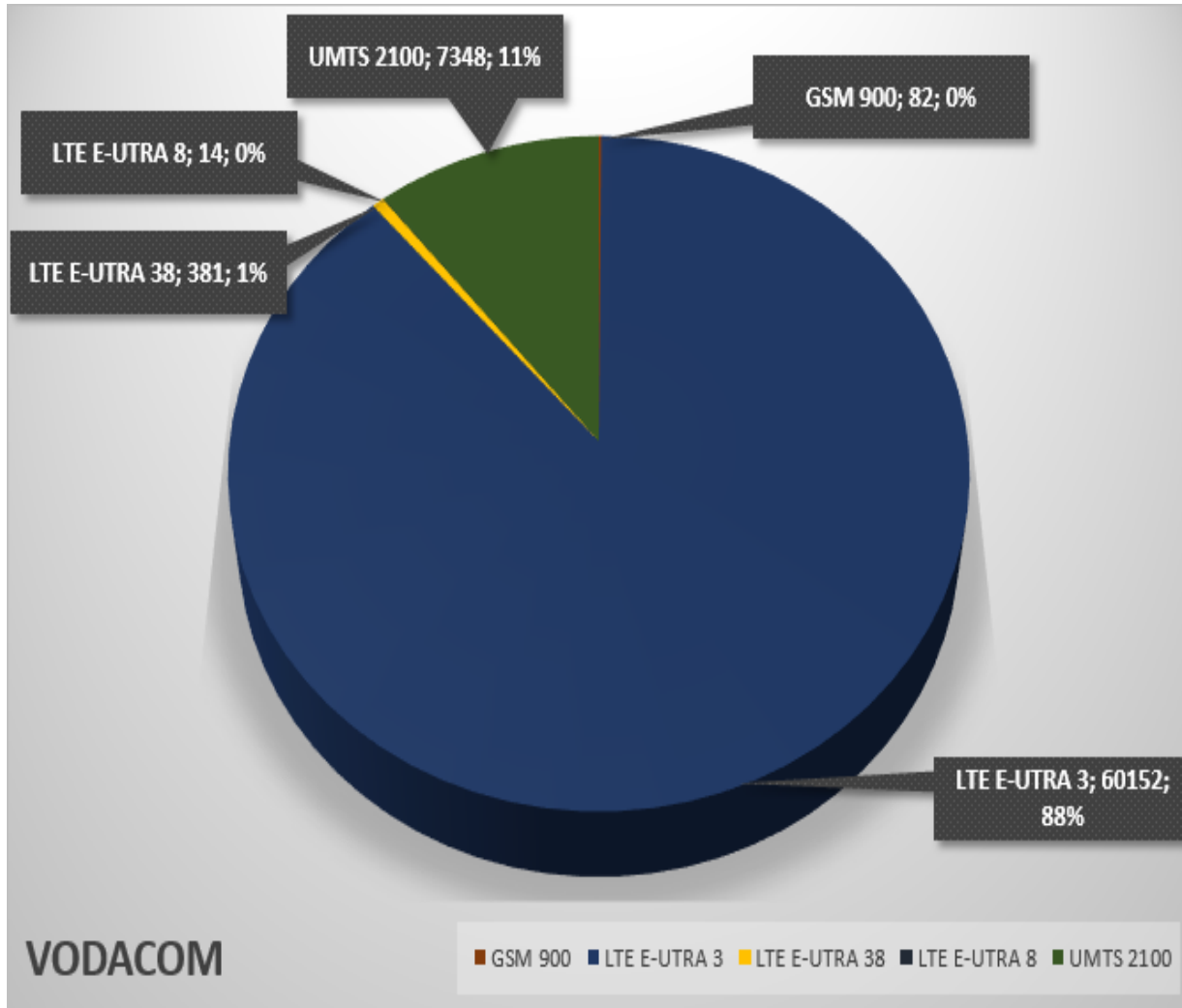
- Telkom leads in 2 KPIs, followed by MTN with 1 KPI out of the 3 KPIs.

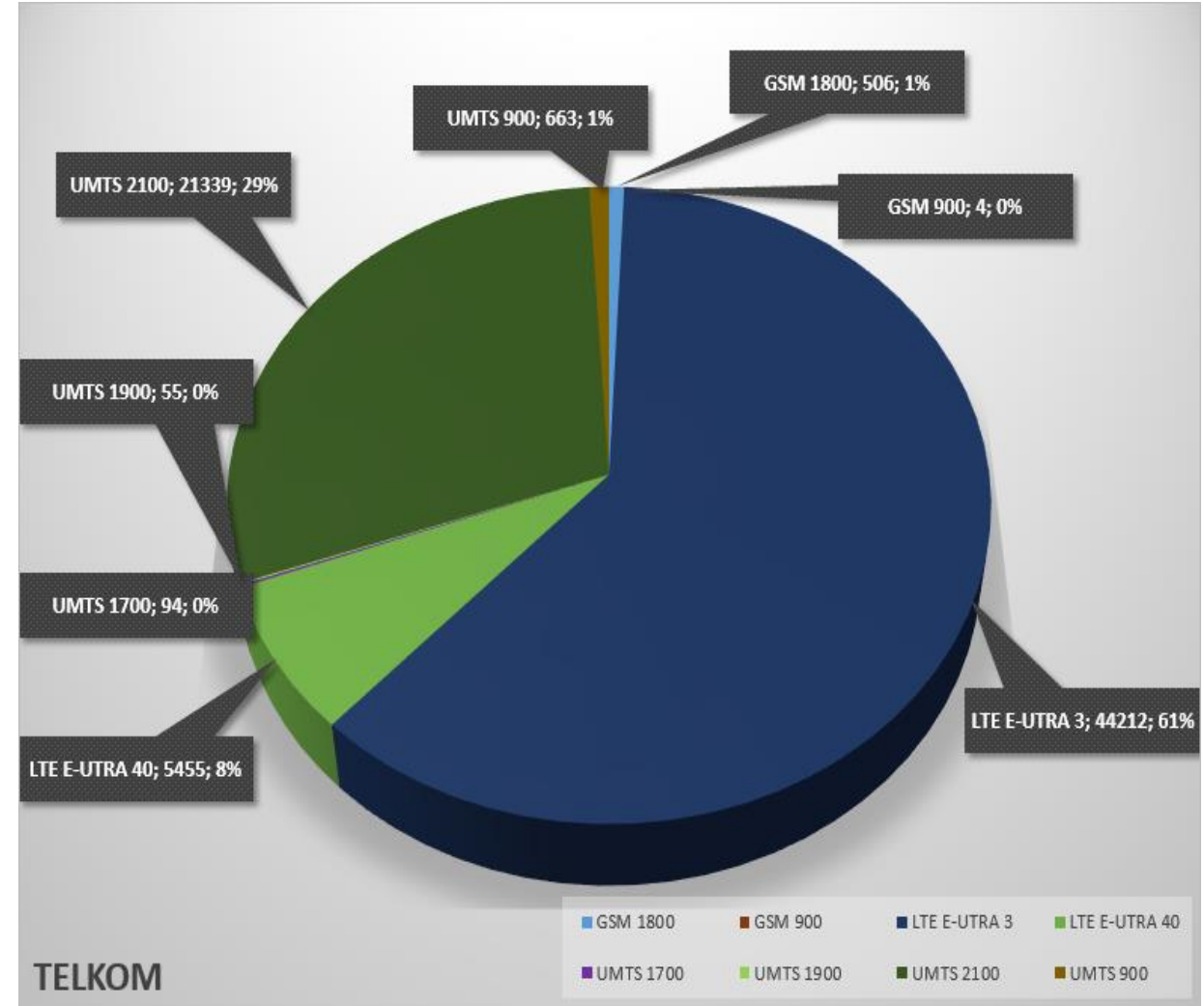
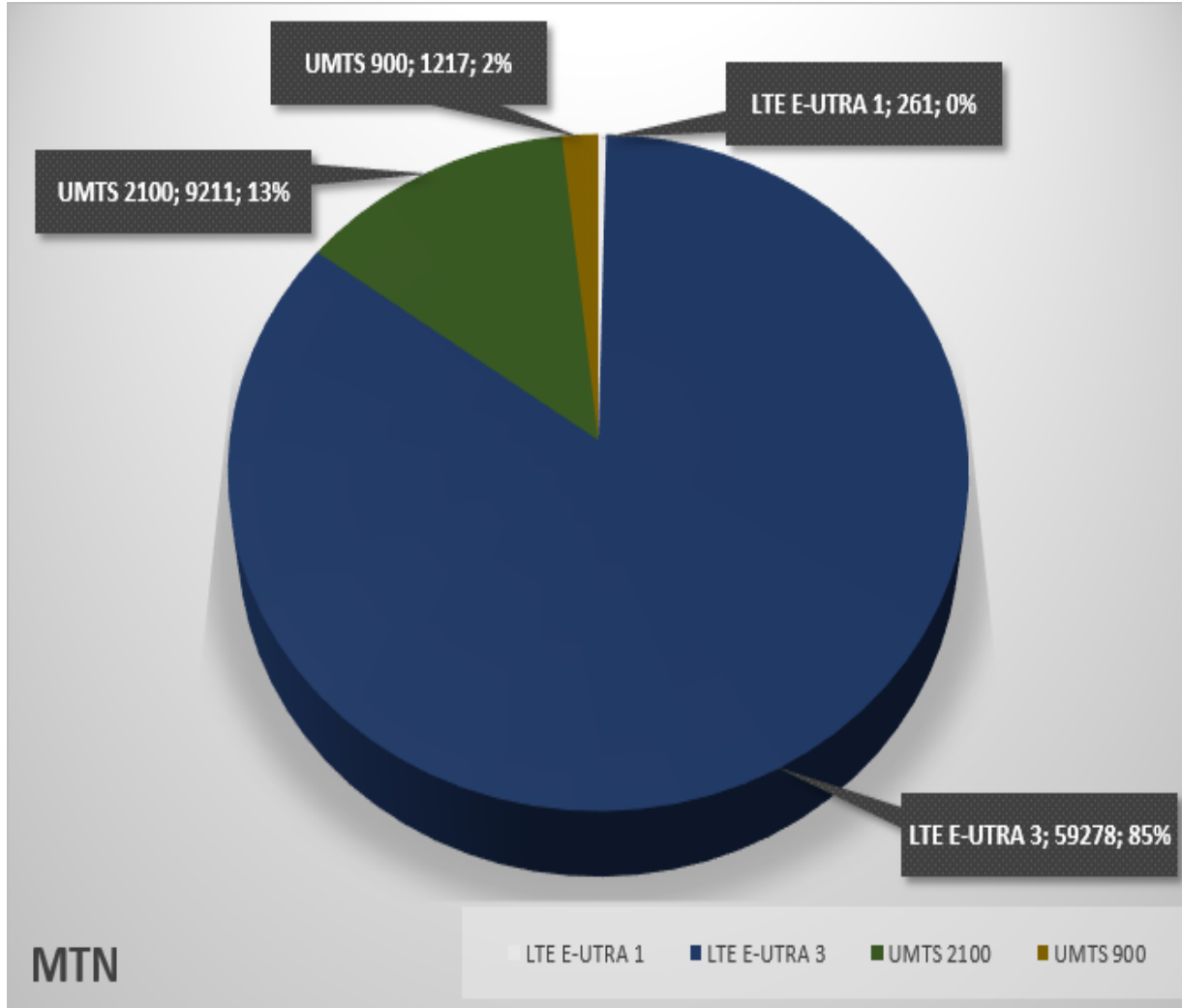


LTE Technology Distribution



Vodacom and CellC LTE Coverage on Routes Driven







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 not agreeing 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.
- In order to provide a Cell C subscriber with good quality of service for 2G and 3G, Cell C relies on its national roaming arrangement with Vodacom in some areas specified in the report in addition to Cell C’s network coverage.
- Notwithstanding the roaming arrangement, Cell C has project plans for the future to have its own site roll-out, capacity and transmission routes improved and optimised in the low coverage areas. Cell C has plans to build new sites. Lastly,
- Frequent optimisation and capacity initiatives are taking place in the regions as well to complement the existing coverage.

Cell C Remedial Actions



Area Name	Remedial Actions
Bloemfontein	<ul style="list-style-type: none"> ▪ LTE sites were rolled out in December 2017 ▪ Additional new sites will be rolled out by March 2018 ▪ Transmission capacity upgrade planned for the first half of 2018.
Botshabelo	<ul style="list-style-type: none"> ▪ Plans to rollout LTE in the second half of 2018 ▪ Transmission capacity upgrades were done after ICASA's drive test.
Ficksburg	<ul style="list-style-type: none"> ▪ Transmission capacity upgrades planned for Q4 2018 ▪ Area is near the border between Lesotho and South Africa which requires low coverage due to minimise radio frequency spillage into Lesotho
Kroonstad	<ul style="list-style-type: none"> ▪ Plans to rollout LTE in the second half of 2018 ▪ Additional new sites during 2018 FY ▪ Transmission capacity upgrades done in Feb 2018
QwaQwa	<ul style="list-style-type: none"> ▪ Transmission capacity upgrades were done after ICASA's drive test. ▪ Address power reliability to improve site availability ▪ Plans to rollout LTE in the year 2019
Virginia	<ul style="list-style-type: none"> ▪ Plans to rollout LTE in the year 2019 ▪ Transmission capacity are planned for first half of 2018 ▪ Plan to address capacity and coverage gaps
Welkom	<ul style="list-style-type: none"> ▪ LTE roll-out is planned for 2019 ▪ Additional new sites during 2018 FY
Thaba Nchu	<ul style="list-style-type: none"> ▪ Planned LTE rollout during second half of 2018 ▪ Transmission capacity upgrades were done after ICASA's drive test.



- 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



- 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 has noted the following:
 - 95% of the areas driven, the test phone was latched onto Telkom’s network. Telkom acknowledges that overall network coverage technology during the mobile 4G Preferred mode test scenario was 73.36% and 26.64% in legacy system.
 - In Ficksburg Telkom roams on MTN (3G only) and has plans to provide own coverage.
- Overall performance 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 is above 15 Mbps for 4G preferred. Telkom’s internal benchmark testing indicates an increase in average throughput over time due to ongoing network improvements.



- Telkom remedial actions include:
 - 3 sites already planned for Ficksburg area which are expected to be on air within 12 months.
 - ongoing network improvements.



Area Name	Available Technology during Measurements	Remedial Actions
Bloemfontein	2G, 3G and LTE	<ul style="list-style-type: none"> Additional LTE sites and 3G sites are planned to go live at the end of March 2018 Transmission network capacity to be increased by end March 2018 Planned RF optimisation to be completed by March 2018
Botshabelo and Thaba Nchu	2G, 3G and LTE	<ul style="list-style-type: none"> Planned LTE optimisation to give better coverage by end of April 2018 six additional LTE sites are planned and 10 sites will be upgraded to 3G Six additional sites are planned
Ficksburg	2G, 3G and LTE	<ul style="list-style-type: none"> No radio frequency optimisation will be conducted as to reduce spillage into Lesotho
Kroonstad	2G, 3G and LTE	<ul style="list-style-type: none"> 3G and LTE RF optimization to reduce interference by April 2018 New Sites planned to close coverage gaps LTE upgrade on 3 sites without LTE
QwaQwa	2G, 3G and LTE	<ul style="list-style-type: none"> Transmission network capacity to be increased by end March 2018 33 LTE upgrades by end of March 2019 3G and LTE RF optimization by March 2018 10 new additional sites planned
Virginia	2G, 3G and LTE	<ul style="list-style-type: none"> RF optimization to improve coverage gaps by April 2018 New Sites planned to close coverage gaps
Welkom	2G, 3G and LTE	<ul style="list-style-type: none"> RF optimization to be done to improve coverage March 2018 New Sites planned to close coverage gaps Add LTE on a site without LTE by March 2018



- Vodacom had ~85% of LTE coverage and MTN had ~80% LTE coverage on the route driven.
- Telkom had ~60% LTE coverage on the route.
- There was no LTE coverage for Cell C in the areas covered.
- The results shows that Vodacom will give better end-user experience on LTE for mobile and stationery testing.
- MTN will give better end-user experience on 3G in both mobile and stationery .
- It is evident from the results that MTN and Vodacom customers are getting better download and upload throughputs than Telkom and Cell C customers.