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2020/2021 Quarter 3:

Voice Quality of Service

Report –

Mpumalanga Province

CONTENTS

List of Acronyms

CD	Call Duration
CS	Circuit Switch
CSFB	Circuit Switched FallBack
CSSR	Call Setup Success Ratio
DCR	Drop Call Ratio
GSM	Global System for Mobile Communications
GERAN	GSM EDGE Radio Access Network
IVR	Interactive Voice Response
LTE	Long Term Evolution
WCDMA	Wideband Code Division Multiple Access
MOC	Mobile Originating Call
KPI	Key Performance Indicator
UMTS	Universal Mobile Telecommunications System
UTRAN	UMTS Terrestrial Radio Access Network

EXECUTIVE SUMMARY

The Authority conducted Quality of Service (QoS) measurements on the networks of mobile operators; Cell C, MTN, Telkom and Vodacom. The measurements were performed to monitor performance of voice services offered by the mobile operators in the Mpumalanga Province. The measurements were carried out in the period 19 to 30 October 2020, covering a total distance of over 1700 km.

The purpose of performing QoS measurements was to monitor and analyse the quality of mobile voice service as experienced by the end user. The results were later benchmarked against the QoS standard set by the Authority. The measurements were conducted in areas and in circumstances where mobile voice service is likely to be accessed. The sampled areas include Boschfontein, Mbombela, Acornhoek, Bushbuckridge and Hazyview.

A vehicle equipped with Keysight Nemo Autonomous measurement tool including eight mobile phones were used to collect data in mobility conditions. The three Key Performance Indicators (KPIs) used to evaluate QoS are Retainability, Accessibility and Call Setup Time.

According to the End-User and Subscriber Service Charter Regulations of 2016, DCR should be less than 3% and CSSR should be greater than 98%. Call Setup Time must be less than 20 seconds.

All operators met the overall CSSR target of more than 98%, thus meeting the Accessibility target. MTN and Vodacom met the overall DCR target of less than 3% and thus meeting the Authority's Retainability target, while Cell C and Telkom failed to meet the DCR target. All operators met the target for Call Setup Time of less than 20 seconds.

1 INTRODUCTION

ICASA's mission is to ensure that all South Africans have access to a wide range of high-quality communication services at affordable prices[1]. The Authority ensures quality of service through its Quality of Service (QoS) monitoring activities. The Authority conducted QoS monitoring of the voice telephony service being offered by Cell C, MTN, Vodacom and Telkom within the Mpumalanga Province of South Africa.

Mpumalanga is the second-smallest province in South Africa after Gauteng, covering an area of 76 495 km² and has a population of 4 335 964 people. It is bordered by Swaziland and Mozambique to the east and Limpopo, Gauteng, Free State and KwaZulu-Natal within South Africa. Mbombela (previously Nelspruit) is the capital of the province and the administrative and business Centre of the Lowveld[2]. Other major cities and towns include eMalahleni, Standerton, eMkhondo, Malalane, Ermelo, Barberton and Sabie.

The QoS monitoring was conducted in the areas within Ehlanzeni District Municipality as shown in Figure 1. The selected areas are Boschfontein, Mbombela, Acornhoek, Bushbuckridge and Hazyview.

QoS is defined as the collective effect of service performance that determines the degree of satisfaction a user derives from a service. It provides an indication of what a customer experiences when using a mobile network. Call Accessibility, Call Setup Time and Call Retainability parameters are used to evaluate QoS.

[1] ICASA Strategic Plan 2016/17-2021

[2] http://www.localgovernment.co.za/provinces/view/6/mpumalanga

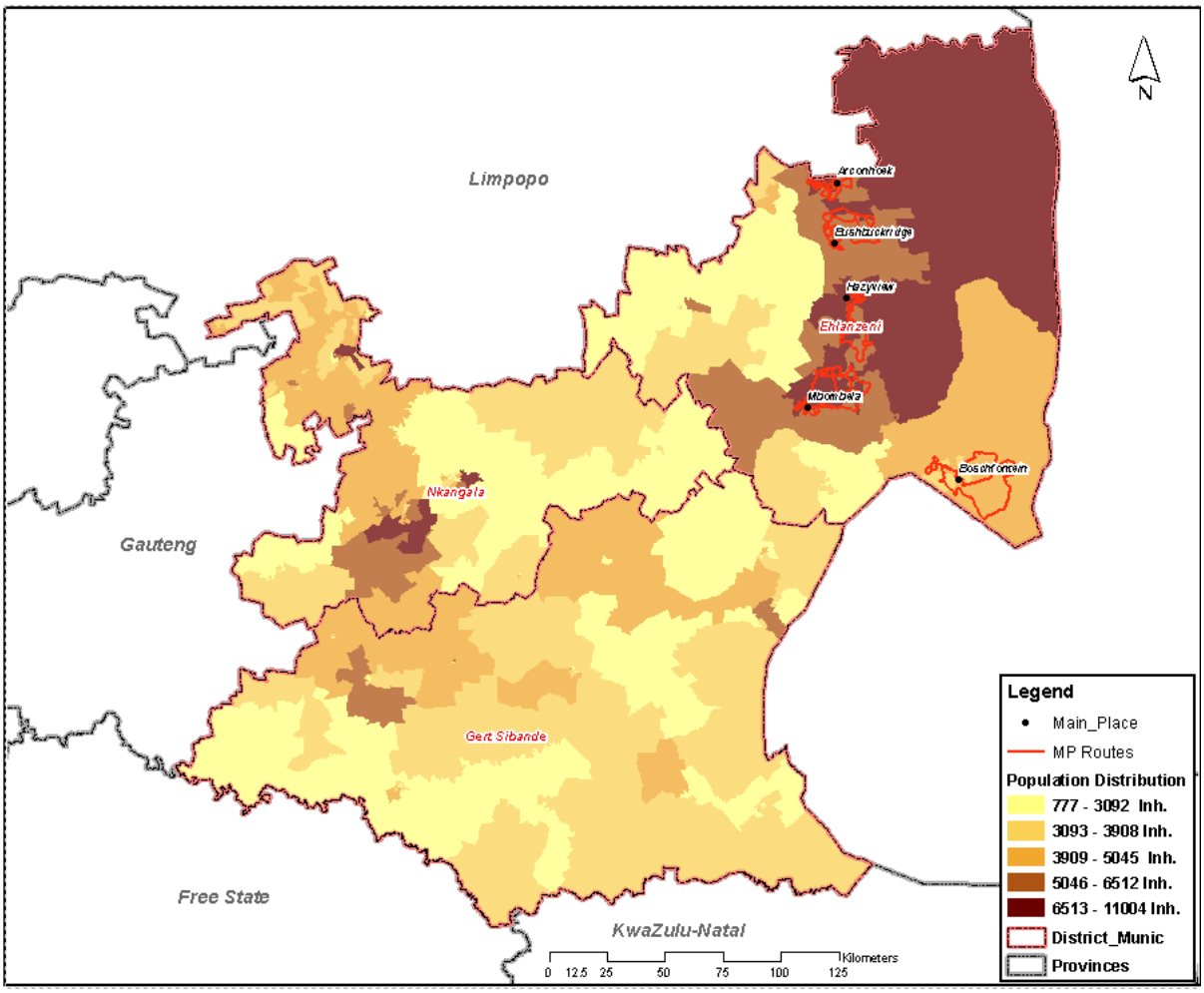


Figure 1: Mpumalanga Province Route Map

These QoS parameters for the measurements are described briefly below:

a) Call Accessibility is defined as a percentage and is a measure of the number of times a user is able to successfully establish a call as a percentage of the total calls attempted. It is measured using Call Setup Success Ratio (CSSR).
b) Call Setup Time is the time interval from the instant a user initiates a network connection request until a complete message indicating call disposition is received by the calling terminal. It is measured from the time a user presses the dial button until the user gets connected to the dialed party.
c) Retainability is defined as the ability for a call to stay connected through to a normal call tear-down process, without abnormally disconnecting from the cell site that caries the call. It is measured using Drop Call Ratio (DCR).

2 METHODOLOGY

A drive-test sampling methodology which provides a snapshot view of the mobile operator's quality of service was adopted. It provides a realistic picture of network performance from a user's point of view. The method adopted provides a snapshot of an operator's network performance on the selected routes and a particular time of the day.

Voice test set-up consisted of two categories which are short call (accessibility) and long call (retainability). The Call Window was set up as follows:

(i) Call duration + 30 seconds (for the setup and release phases) + 30 seconds (for the minimum pause interval).

(ii) The default call duration is 120 seconds for Long Call and thus results in 180 seconds call window. The call duration for Short Call is 10 seconds resulting in 70 seconds call window.

The devices were set to measure the best available technology and barred from making VoLTE calls, thus in the areas where operators had LTE they performed Circuit Switched Fall Back (CSFB) calls. CSFB allows terminal/mobile phones connected on LTE to use GERAN or UTRAN to connect to the CS domain mainly for voice calls.

2.1 Measurement Test Setup and Configuration

2.1.1 System/Equipment used

The drive test was carried out using a test kit comprising of four (4) Keysight Nemo Autonomous probes. Each probe has three Samsung Galaxy S8 (SM-G950F) mobile devices. The mobile devices were configured to automatically select a mobile network and radio access technology.

2.2 Route selection

Measurement routes were selected so that they would reflect end user distribution at different geographical locations in areas where people live and use mobile phones (e.g. urban, suburban, major towns, rural towns, township, farm areas, highways, tourism areas and major roads).

The selected five areas in which the QoS measurements were conducted are within the district municipalities as indicated in Table 1:

Table 1: Selected routes and dates

District	Route Name	Test Date
Ehlanzeni	Boschfontein	19/10/2020 26/10/2020
	Mbombela	20/10/2020 27/10/2020
	Acornhoek	21/10/2020 28/10/2020
	Bushbuckridge	22/10/2020 29/10/2020
	Hazyview	23/10/2020 30/10/2020

2.3 Equipment test setup and configuration

Table 2 shows the test plan and configurations of the drive-test equipment.

Table 2: Test plan and configurations

Configuration	Explanation
Antennas	Device Antennas were used as per SANS 1725-2[3]
Technologies	GSM, UMTS and LTE CSFB
Call Samples	A minimum of 120 test samples per network operator were collected except in the areas where services were limited on most part of the drive test route. Drive tests were planned to ensure, as far as practicable, that the results adequately reflect the QoS perceived by customers for the period under review. The drive tests were designed to be representative of the population relative to the traffic of the network.

[3] SABS Standard, SANS 1725-2:2019 End user related Quality of Service parameter definitions and measurements, Part 2: Mobile data services

	Measurements were scheduled to reflect accurately the traffic variations over the hours of a day, and user's behavior[4].
Call Type and Window Call	Long calls and short calls were used. Voice telephony was tested in the Mobile Originating Call (MOC) direction. The following call durations (CD) were used: • CD1: 10 seconds for call setup testing; • CD2: 120 seconds for typical tests, default call duration; Call Window: Call Duration + 30 seconds (for the setup and release phases) + 30 seconds (for the minimum pause interval). Thus, the default call duration for Long Call resulted in 180 seconds and 70 seconds for a Short Call[5].
Equipment	The equipment used for testing was the Keysight Nemo Autonomous probe with 3 x Samsung Galaxy S8 (SM-G950F) phones in each probe.
KPI[6]	The measurements focused on the following network parameters: (i) Drop Call Ratio (DCR) (ii) Call Setup Success Ratio (CSSR) (iii) Call Setup time (CST)
Log files	The log files for each test case were stored in different locations with different names. The log files were recorded per network operator. Nemo Analyzer was used to analyse the log files.
Mobile terminal used	The test calls were terminated on each operator's test platform or IVR system.
Network tested	Cell C, MTN, Vodacom and Telkom.
SIM cards	ICASA's Test SIM cards and SIM cards provided by each operator were used during the drive test.

[4] SABS Standard, SANS 1725-1:2016 End user related Quality of Service parameter definitions and measurements, Part 2: GSM voice services
[5] Ibid
[6] End User and Subscriber Service Charter Regulations of 2016

Vehicle used	A Ford Everest equipped with drive-test equipment was used. All the road traffic rules were observed during the drive test. The speed was maintained to an average of 60 km/h in town and built-up areas and an average of 100 km/h on highways.

2.4 Statistical significance

The purpose of statistical analysis is to present the statistical accuracy of reported KPIs. This means that one can be "relatively sure" that the results represent the reality (true population mean) and that they did not occur by chance. Statistical theory provides tools to assess the statistical significance of measurement observations with a given sample count and standard deviation. The 95% confidence level was used in calculating the statistical accuracy of the results.

2.5 Measurement parameters and targets

2.5.1 Targets

According to the End User and Subscriber Service Charter Regulations of 2016, the following targets have been set as the measurement parameters for the following services:

1. Call Setup Success Ratio – Average Call Setup Success Ratio must be greater than 98%;
2. Call Setup Time – Average Call Setup Time must take less than 20 seconds;
3. Drop Call Ratio – Average Drop Call Ratio must be less than 3%.[7]

2.5.1.1 Call Setup Success Ratio [%]

The Call Setup Success Ratio (CSSR) is the percentage of calls that are successfully set up as a percentage of the total call attempts.

The formula to calculate CSSR is shown below:

$$\text{CSSR} = \frac{Y}{X} \text{ x } 100\%$$

[7] https://www.icasa.org.za/uploads/files/39898_1-4_Icasa.pdf

Where, Y represents the calls that are call established successfully and X is the total number of call attempts.

2.5.1.2 Drop Call Ratio [%]

Drop Call Ratio (DCR) is the proportion of incoming and outgoing calls, which, once correctly established and therefore having been assigned a traffic channel, are dropped, or interrupted prior to the deliberate completion by the user.

The formula to calculate DCR is shown below:

$$DCR = \frac{D}{S} \times 100\%$$

Where, D represents number of dropped calls and S is the number of successful calls established.

2.5.1.3 Call Setup Time [s]

Call Setup Time refers to the time interval from the moment a user initiates a network connection request until a complete message indicating call disposition is received by the calling terminal. It is measured from the time a user presses the dial button until the user gets connected to the dialed party.

3 RESULTS AND ANALYSIS

This section provides a summary of the mobile operators' performance results based on the drive test route in the following test areas: Boschfontein, Mbombela, Acornhoek, Bushbuckridge and Hazyview.

3.1 Accessibility and Retainability Measurements

Table 3: Summary of Results

Route Name	Operator	CSSR (%)	DCR (%)	CST (ms)
Boschfontein	Cell C	98.56	3.76	6.92
	MTN-SA	99.36	1.56	4.70
	Telkom	96.36	7.09	5.53
	VodaCom-SA	99.52	3.11	3.92
Mbombela	Cell C	99.83	2.42	7.14
	MTN-SA	99.67	1.61	4.65
	Telkom	99.36	3.63	5.33
	VodaCom-SA	99.67	1.20	3.82
Acornhoek	Cell C	99.52	2.71	7.08
	MTN-SA	100.00	0.00	4.68
	Telkom	99.68	1.93	5.22
	VodaCom-SA	99.68	1.17	3.46
Bushbuckridge	Cell C	99.43	2.43	6.75
	MTN-SA	100.00	0.70	4.64
	Telkom	99.28	1.40	5.60
	VodaCom-SA	99.57	0.70	3.46
Hazyview	Cell C	99.18	4.38	7.15
	MTN-SA	99.67	0.81	4.80
	Telkom	99.01	4.90	5.57
	VodaCom-SA	100.00	0.40	3.34
Overall results for the above 5 areas	Cell C	99.31	3.06	7.01
	MTN-SA	99.75	0.93	4.69
	Telkom	98.74	3.72	5.45
	VodaCom-SA	99.69	1.31	3.60

Table 3 shows voice call measurement results in each route and as an overall for all areas for all the operators. Detailed results are presented in Appendix A.

3.1.1 Call Setup Success Ratio (CSSR)

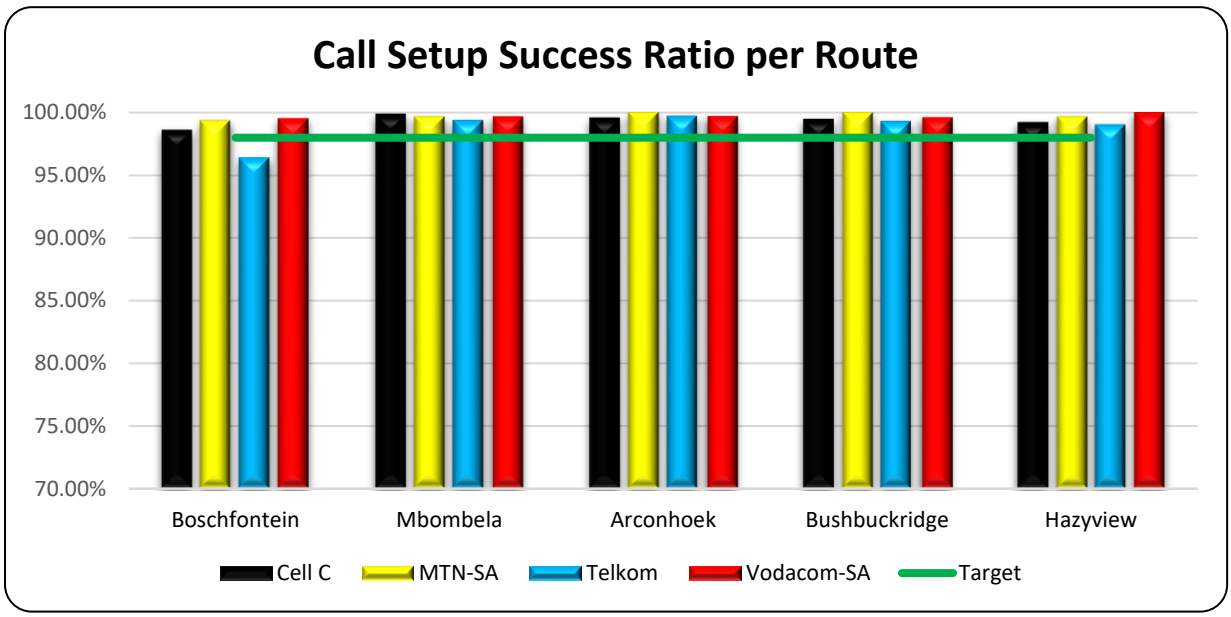


Figure 2: Call Setup Success Ratio (CSSR) per Route

Figure 2 shows that MTN, Vodacom and Cell C met the 98% CSSR target in all tested areas. Telkom failed to meet the target in Boschfontein.

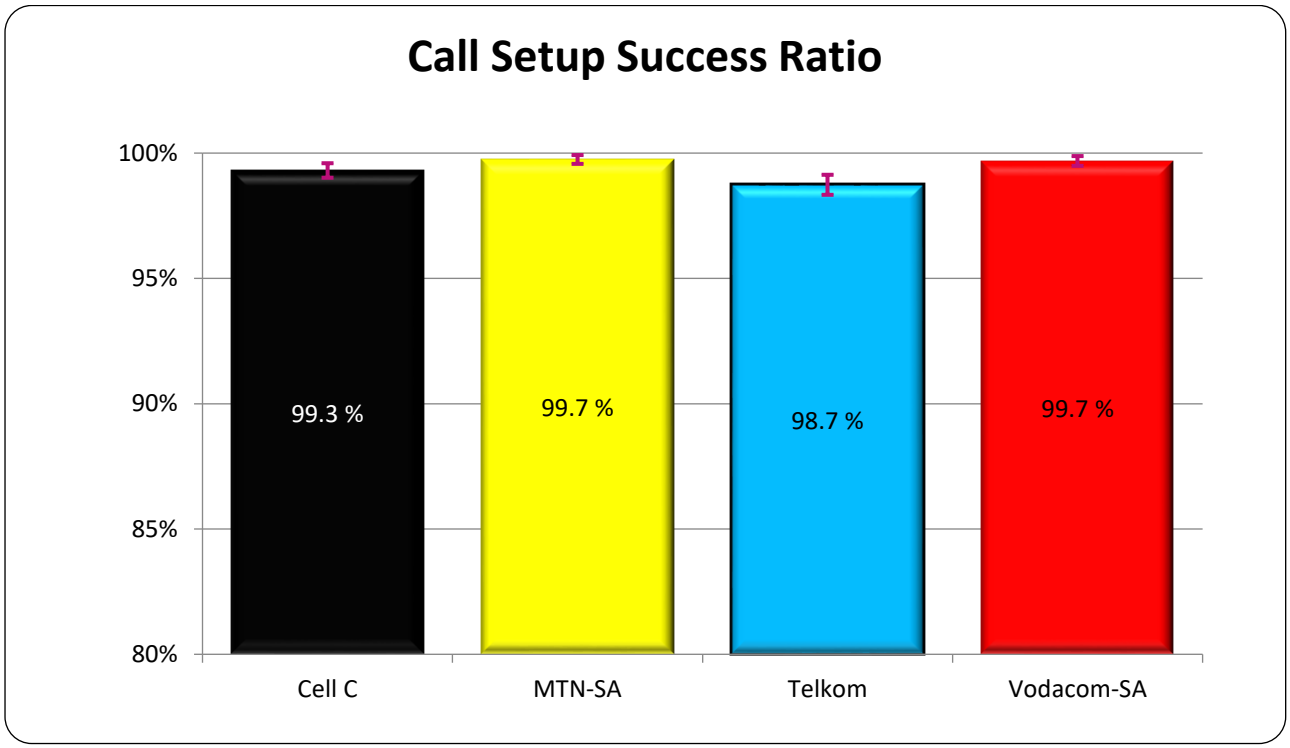


Figure 3: Overall Call Setup Success Ratio with Statistical Significance

Figure 3 shows that MTN and Vodacom overall CSSR values are the highest and on par, followed by Cell C and Telkom in descending order, respectively. All the operators performed well above 98% target. There is a no statistically significant difference recorded between Cell C, Vodacom and MTN, as well as between Telkom and Cell C. There is statistically significant difference between Telkom and Vodacom, as well as between Telkom and MTN.

3.1.2 Drop Call Ratio (DCR)

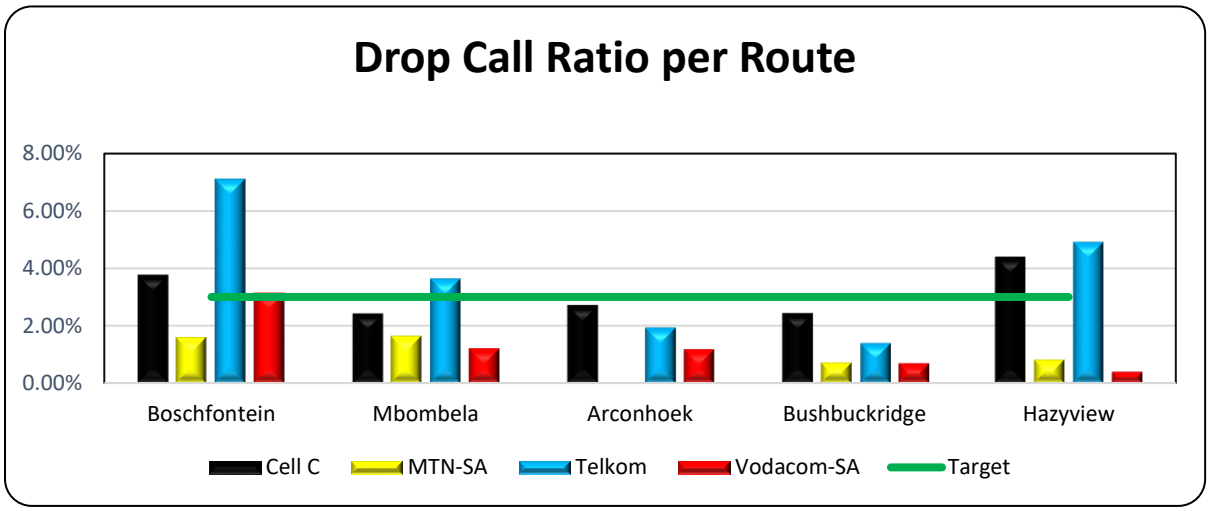


Figure 4: Drop Call Ratio (DCR) per Route

Figure 4 shows that MTN met the 3% DCR target in all tested areas. Telkom met the DCR target in Acornhoek and Bushbuckridge but failed to meet the target in Boschfontein, Mbombela and Hazyview. Vodacom met the DCR target in four areas (Mbombela, Acornhoek, Bushbuckridge and Hazyview) but failed to meet the target in Boschfontein. Cell C met the target in three areas (Mbombela, Acornhoek, Bushbuckridge) but failed to meet target in Boschfontein and Hazyview.

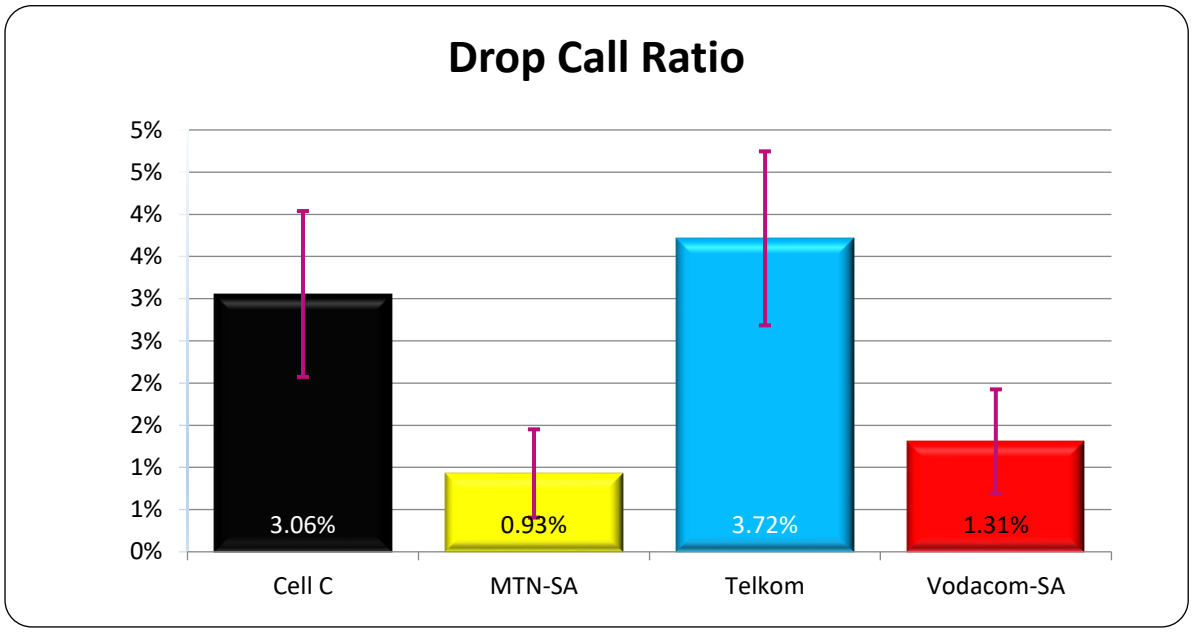


Figure 5: Total Drop Call Ratio with Statistical Significance

Figure 5 shows that MTN overall DCR is the lowest followed by Vodacom, Cell C and Telkom in an ascending order, respectively. MTN and Vodacom met the 3% overall DCR target, but Cell C and Telkom failed to meet the target. There is a no statistically significant difference recorded between Cell C and Telkom, as well as between MTN and Vodacom. There is statistically significant difference between Cell C and MTN, as well as between Cell C and Telkom. There is statistically significant difference between Telkom and Vodacom, as well as Telkom and MTN.

3.1.3 Call Setup Time (CST)

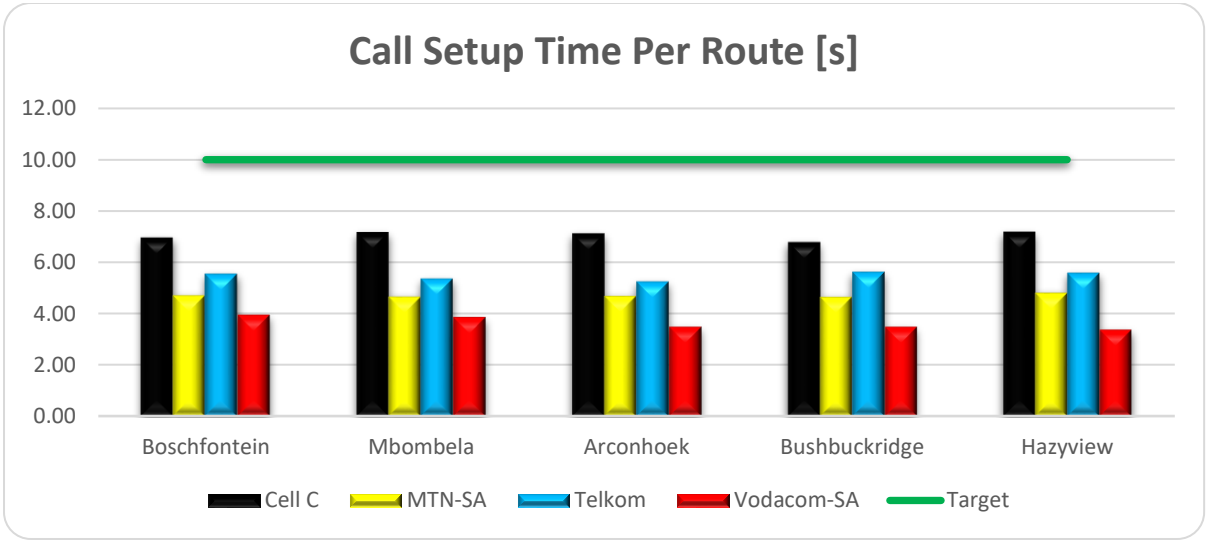


Figure 6: Call Setup Time [s] per area

Figure 6 shows that all operators met the call setup time of 20 seconds target in all tested areas.

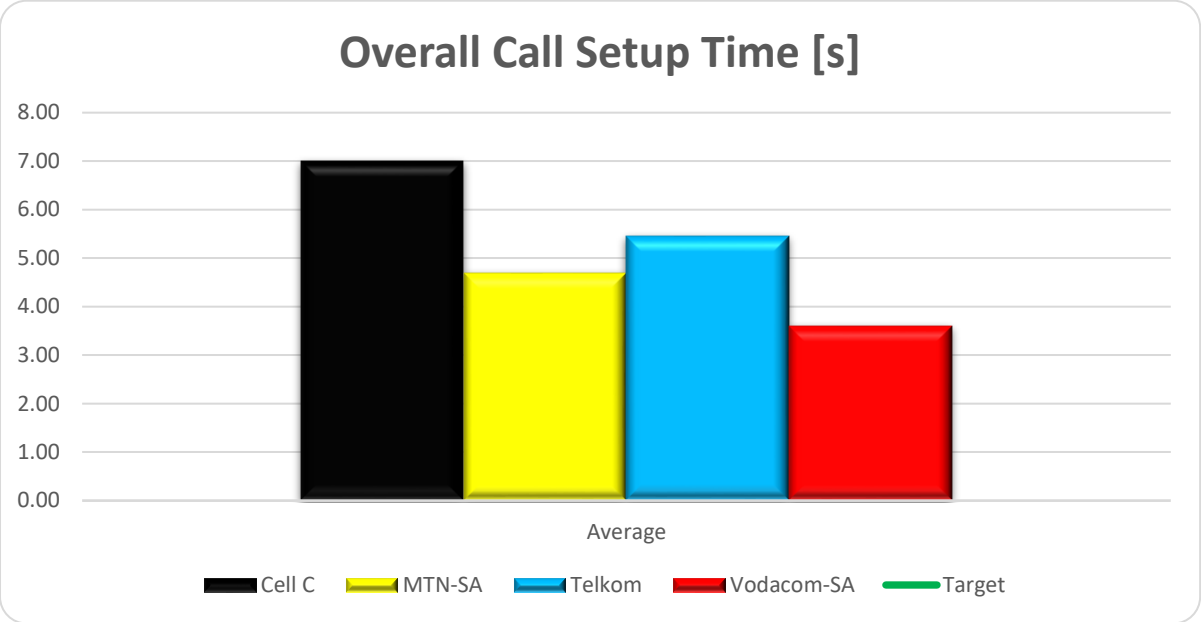


Figure 7: Call Setup Time [s] overall results

Figure 7 shows that the overall results for Call Setup Time. Vodacom has the lowest overall Call Setup Time, followed by MTN, Telkom and Cell C in ascending order.

3.2 Analysis of the serving technology

The serving technology distribution were based on the devices used and the network parameter configuration which varies with the mobile operators. The percentage distribution represents the fraction sampling points, out of the total of sampling points for all results, where the system was on a radio access technology. Figure 8 below shows the statistical distribution of the serving technology during the drive test. All four operators serving technology distribution were mainly on LTE for more than 50% of the time. MTN has the highest LTE presence followed by Telkom, Vodacom and Cell C in a descending order.

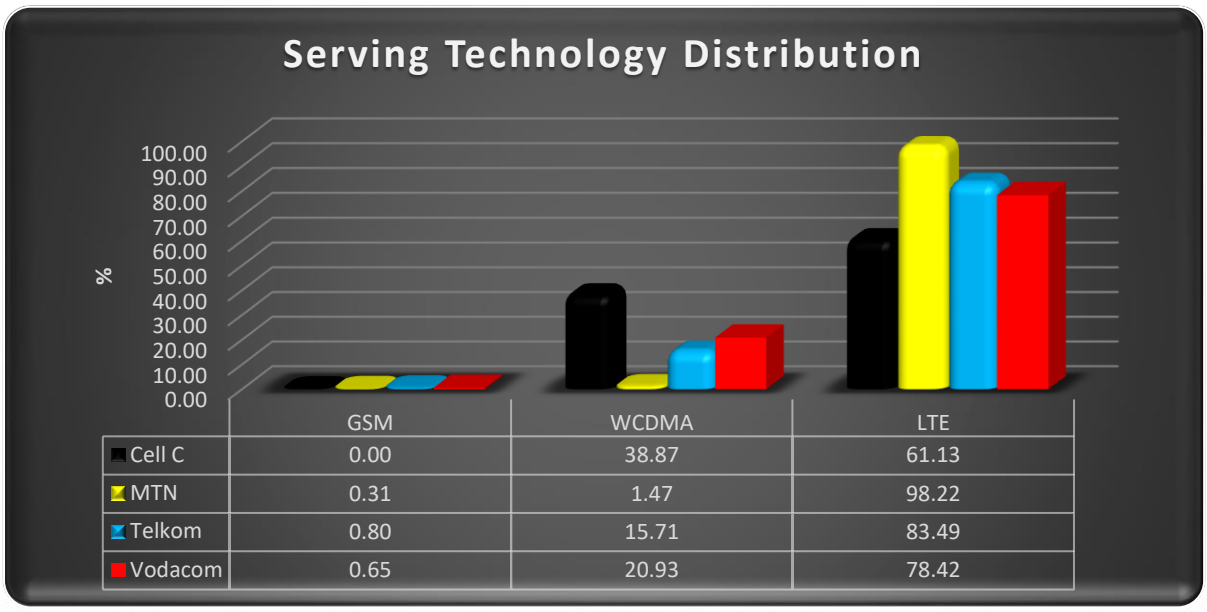


Figure 8: Technology Distribution

The maps in Appendix B show the geographic areas where the radio access technology was selected by the mobile device.

3.1 Comparison of current results to previous results

Bushbuckridge and Acornhoek were previously monitored in the financial year 2015/2016 as one complete route. Mbombela was previously monitored in the financial year 2017/18. The aim of conducting the recent QoS measurements in the area was to assess the level of improvement that the operators promised in the previous financial years. The results in Table 4 shows that there is performance improvement from all operators in Bushbuckridge, an improvement by all operators in terms of Retainability and Accessibility. In Mbombela, all operators show a significant improvement in terms of Accessibility; Cell C and Vodacom show significant improvement in terms of Retainability. Telkom did not improve from previous Mbombela Retainability results. Telkom was not yet included in the measurements during the financial year 2015/16.

It must be noted that the target for Accessibility was 95% in 2015/2016, this is before the revision of *End-User and Subscriber Service Charter Regulations of 2016* which became effective on 1 April 2016. Table 4 below summarises the previous and current results.

Table 4: Comparison with previous results

Route	Financial Year	Accessibility (%)				Retainability (%)			
		Cell C	MTN	Telkom	Vodacom	Cell C	MTN	Telkom	Vodacom
Bushbuckridge (includes Acornhoek)	2015/16	92.91	92.49	-	97.06	6.00	3.96	-	1.16
Bushbuckridge	2020/21	99.43	100.00	99.28	99.57	2.43	0.70	1.40	0.70
Acornhoek	2020/21	99.52	100.00	99.68	99.68	2.71	0.00	1.93	1.17
Mbombela	2017/18	96.53	98.28	97.78	98.35	9.45	0.97	2.88	4.30
	2020/21	99.83	99.67	99.36	99.67	2.42	1.61	3.63	1.20

4 CONCLUSION

This section provides the summary and key findings of all measurements. The obtained results illustrate a snapshot of the mobile network performance and customer experience within the measured time and location context.

The results indicate that the end users' Quality of Service and operators' network performance is relatively good in the Mpumalanga province.

Bushbuckridge and Mbombela were monitored in the previous monitoring exercises.

After benchmarking the operators, the results show that in terms of overall Call Setup Success Ratio; all operators (Telkom, MTN, Cell C and Vodacom) met the target of 98%, thus meeting the Accessibility target. In terms of overall Drop Call Ratio, Cell C and Telkom failed to meet the DCR target of less than 3%. In terms of overall Call Setup Time all four mobile operators met the target.

The results in Table 4 show that there is a continuous improvement on network performance in Bushbuckridge and Mbombela since the last measurements in the 2015/16 and 2017/18 financial years, with the exception of Telkom retainability results in Mbombela. The good performance could be attributed due to the following factors:

- High investment in infrastructure, and
- Roaming arrangements between operators.

5 APPENDICES

5.1 Appendix A: Drive Test Results KPI's

Table 5: Drop Call Ratio (DCR) per Route

		Phase 1			Phase 2			Total		
Route Name	Operator	Call Established	Call Dropped	DCR (%)	Call Established	Call Dropped	DCR (%)	Call Established	Call Dropped	DCR (%)
Boschfontein	Cell C	-	-	-	133	5	3.76	431	5	3.76
	MTN-SA	122	4	3.28	134	0	0.00	256	4	1.56
	Telkom	122	11	9.02	132	7	5.30	254	18	7.09
	VodaCom-SA	122	6	4.92	135	2	1.48	257	8	3.11
Mbombela	Cell C	121	1	0.83	127	5	3.94	248	6	2.42
	MTN-SA	123	3	2.44	126	1	0.79	249	4	1.61
	Telkom	123	6	4.88	125	3	2.40	248	9	3.63
	VodaCom-SA	122	1	0.82	127	2	1.57	249	3	1.20
Acornhoek	Cell C	131	3	2.29	127	4	3.15	258	7	2.71
	MTN-SA	130	0	0.00	125	0	0.00	255	0	0.00
	Telkom	133	4	3.01	126	1	0.79	259	5	1.93
	VodaCom-SA	130	1	0.77	126	2	1.59	256	3	1.17
Bushbuckridge	Cell C	146	2	1.37	142	5	3.52	288	7	2.43
	MTN-SA	142	1	0.70	142	1	0.70	284	2	0.70
	Telkom	144	1	0.69	142	3	2.11	286	4	1.40
	VodaCom-SA	145	2	1.38	142	0	0.00	287	2	0.70
Hazyview	Cell C	128	9	7.03	123	2	1.63	251	11	4.38
	MTN-SA	126	2	1.59	122	0	0.00	248	2	0.81
	Telkom	124	9	7.26	121	3	2.48	245	12	4.90
	VodaCom-SA	127	0	0.00	124	1	0.81	251	1	0.40
Overall results for the above 5 areas	Cell C							1476	36	3.06
	MTN-SA							1292	12	0.93
	Telkom							1292	48	3.72
	VodaCom-SA							1300	17	1.31

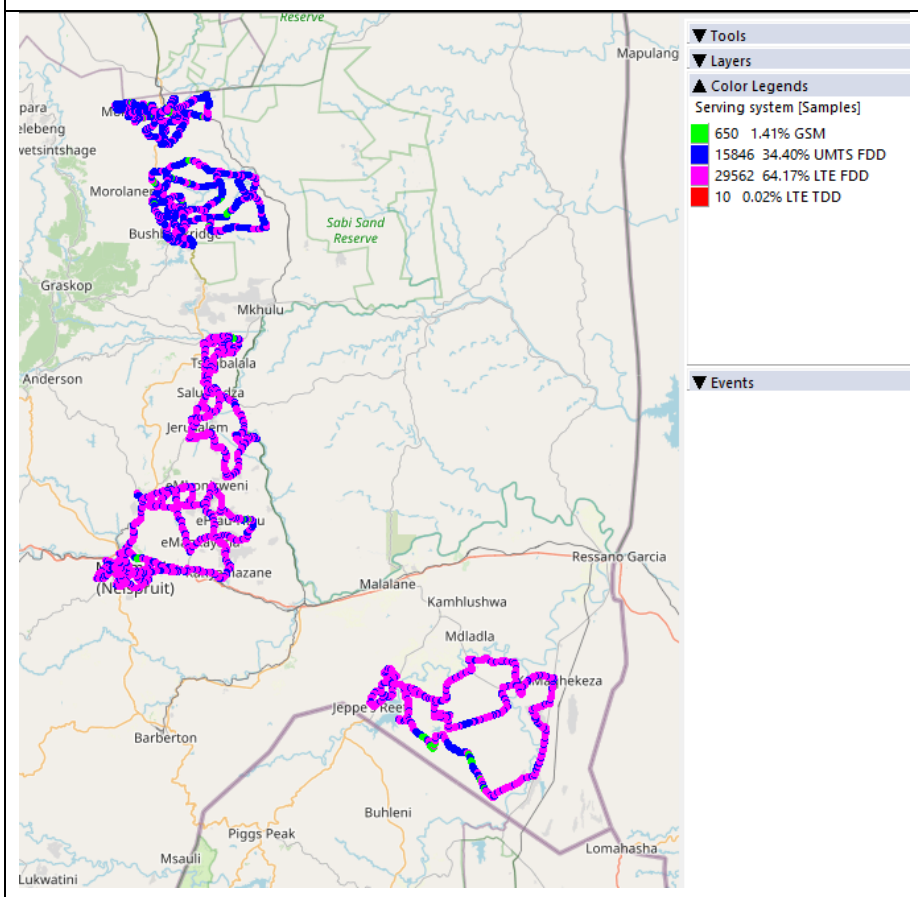
Table 6: Call Setup Success Ratio (CSSR) per Route

		PHASE 1					PHASE 2					TOTAL				
Route Name	**Operator**	**Call Attempt**	**Call Setup**	**Call Attempt Failure**	**CSSR (%)**	**Call Setup Time [s]**	**Call Attempt**	**Call Setup**	**Call Attempt Failure**	**CSSR (%)**	**Call Setup Time [s]**	**Call Attempt**	**Call Setup**	**Call Attempt Failure**	**CSSR (%)**	**Average Call Setup Time [s]**
Boschfontein	Cell C	296	293	3	98.99	6.56	328	322	6	98.17	7.29	624	615	9	98.56	6.92
	MTN-SA	299	297	2	99.33	4.66	330	328	2	99.39	4.74	629	625	4	99.36	4.70
	Telkom	286	275	11	96.15	5.41	319	308	11	96.55	5.64	605	583	22	96.36	5.53
	VodaCom-SA	291	288	3	98.97	4.11	328	328	0	100.00	3.72	619	616	3	99.52	3.92
Mbombela	Cell C	295	295	0	100.00	7.23	309	308	1	99.68	7.04	604	603	1	99.83	7.14
	MTN-SA	299	297	2	99.33	4.62	311	311	0	100.00	4.68	610	608	2	99.67	4.65
	Telkom	167	167	0	100.00	4.98	301	298	3	99.00	5.69	468	465	3	99.36	5.33
	VodaCom-SA	297	297	0	100.00	3.95	310	308	2	99.35	3.70	607	605	2	99.67	3.82
Acornhoek	Cell C	321	319	2	99.38	7.10	307	306	1	99.67	7.06	628	625	3	99.52	7.08
	MTN-SA	313	313	0	100.00	4.69	309	309	0	100.00	4.66	622	622	0	100.00	4.68
	Telkom	324	324	0	100.00	5.29	308	306	2	99.35	5.15	632	630	2	99.68	5.22
	VodaCom-SA	325	324	1	99.69	3.50	306	305	1	99.67	3.41	631	629	2	99.68	3.46
Bushbuckridge	Cell C	360	357	3	99.17	6.75	346	345	1	99.71	6.75	706	702	4	99.43	6.75
	MTN-SA	345	345	0	100.00	4.61	345	345	0	100.00	4.66	690	690	0	100.00	4.64
	Telkom	359	356	3	99.16	5.29	336	334	2	99.40	5.92	695	690	5	99.28	5.60
	VodaCom-SA	354	353	1	99.72	3.36	349	347	2	99.43	3.55	703	700	3	99.57	3.46
Hazyview	Cell C	308	303	5	98.38	6.98	299	299	0	100.00	7.32	607	602	5	99.18	7.15
	MTN-SA	303	301	2	99.34	4.67	295	295	0	100.00	4.93	598	596	2	99.67	4.80
	Telkom	304	303	1	99.67	5.82	300	295	5	98.33	5.32	604	598	6	99.01	5.57
	VodaCom-SA	317	317	0	100.00	3.33	306	306	0	100.00	3.35	623	623	0	100.00	3.34
Overall results for the above 5 areas	Cell C											**3169**	**3147**	**22**	**99.31**	**7.01**
	MTN-SA											**3149**	**3141**	**8**	**99.75**	**4.69**
	Telkom											**3004**	**2966**	**38**	**98.74**	**5.45**
	VodaCom-SA											**3183**	**3173**	**10**	**99.69**	**3.6**

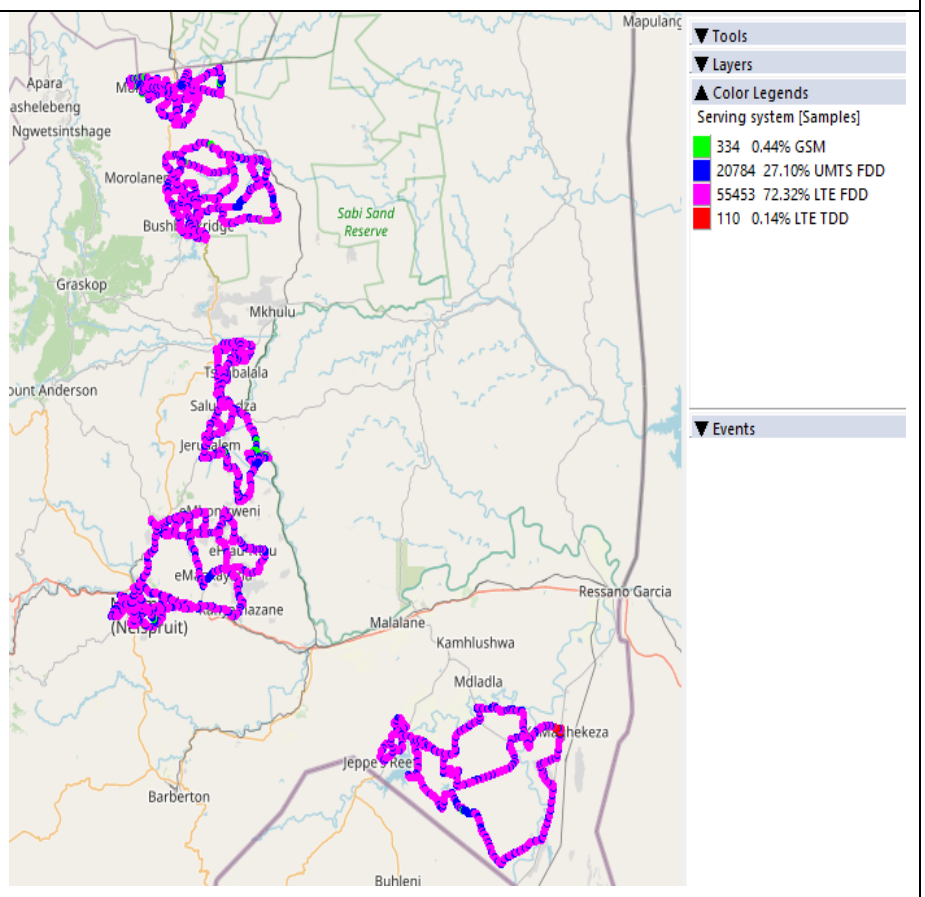
5.2 Appendix B: Coverage Maps

5.2.1 Serving Technology Details

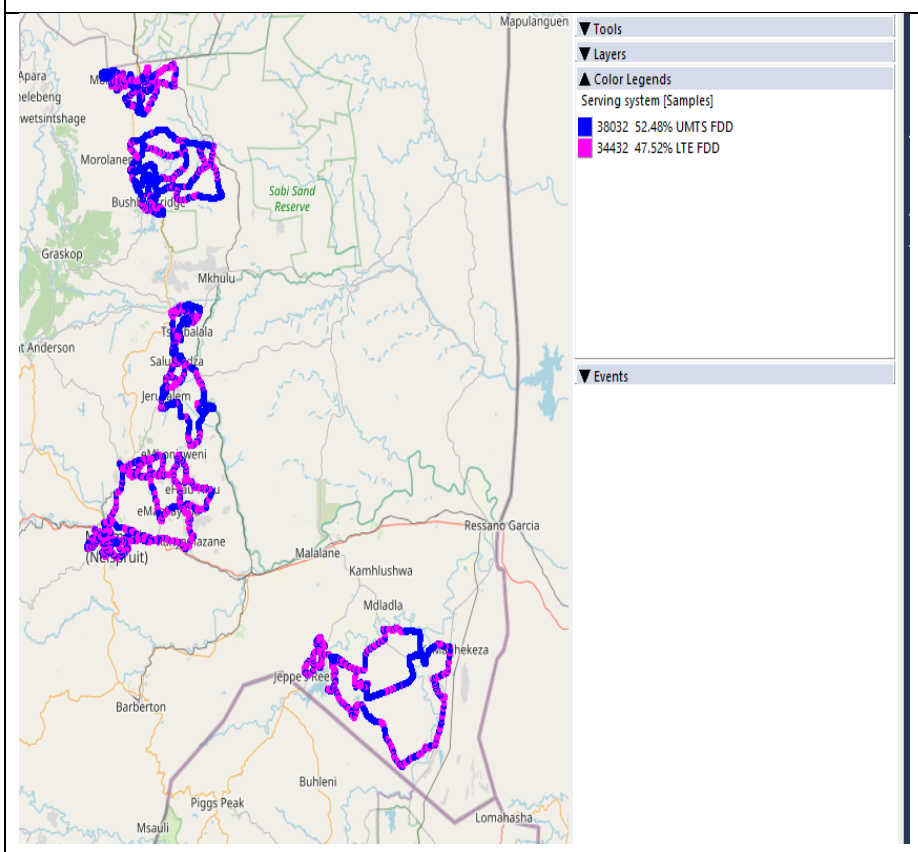
Vodacom



MTN



Cell-C



Telkom

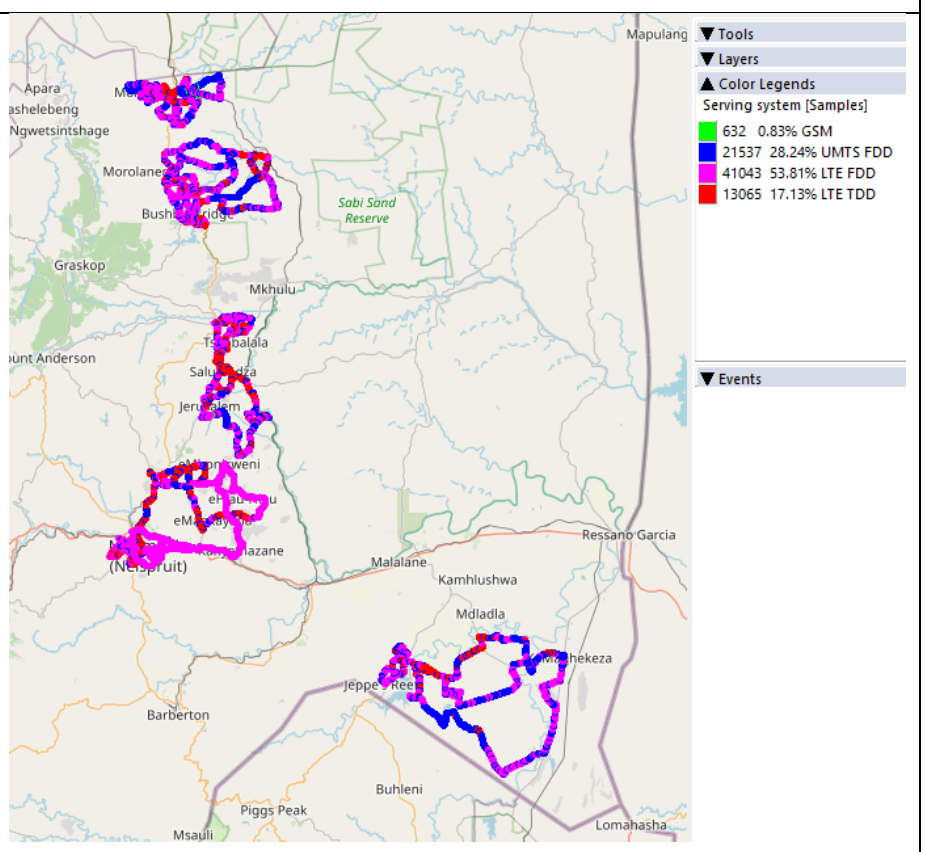


Figure 9: Mpumalanga Province Serving Technology Plot

5.3 Appendix C: Mobile operators' feedback on the report

A detailed report was shared with the mobile operators in order for them to share their plans and remedial actions to address issues of poor performance. The improvement plans and remedial actions are provided below.

5.3.1 Vodacom

Vodacom provided feedback and network improvement plans that are in place for all areas; including areas where performance was good.

- Boschfontein – Radio Frequency (RF) optimisation and parameter adjustment were completed in December 2020. Two new sites are planned in the area for September 2021 and March 2022.
- Mbombela - Radio Frequency optimisation and parameter adjustment were completed in December 2020.
- Acornhoek – A new site is planned in the area for March 2022.
- Bushbuckridge – A new site is planned in the area for March 2022. Radio Frequency optimisation was completed in December 2020.

5.3.2 MTN

MTN has indicated that it will remain committed to the improvement of the network quality even in areas where performance was good, thereby improving the end user mobile voice service experience.

- Boschfontein and Mbombela – MTN plans to build a new site in each area to ensure that the quality of voice service in the area is improved significantly.
- Mbombela - A new site is planned to ensure improved service in the area.
- Bushbuckridge - An additional sector will be added on a site which covers the area where dropped calls were experienced during the drive test, to improve coverage.
- Hazyview – To improve the overall network quality of service in the area, MTN plans to build a new site.

5.3.3 Cell C

Cell C in its response indicated that it notes the findings of the Authority and is continually improving coverage by engaging their roaming partners on the future corrective measures.

Cell C shared the following plan and remedy to improve the low performance areas:

- Bushbuckridge – There is relatively poor coverage and Cell C will work on the business plan to improve coverage in the next financial year.

5.3.4 Telkom

Telkom's response to the report indicated that it views the Authority test results as very significant and use them as additional input to further improve the quality of the mobile network.

Furthermore, Telkom indicated that they will be engaging with their roaming partners to resolve issues and improve customer experience.

- Boschfontein – Several CSSR failures occurred due to location update failures, poor coverage and RF quality related failures. Telkom will engage with its roaming partner to improved/resolve these issues to improve customer experience. DCR failures in Boschfontein were caused by limited network coverage on the outskirts.
- Mbombela – DCR failures were due to poor RF levels as well as overshooting site. Optimisation and downward tilting of antenna will be carried out to remove overshooting sites to resolve these failures. Vandalized sites in the area will also be addressed.
- Hazyview – DCR failures were mostly due to poor RF quality on the UMTS2100 network and poor coverage. Poor coverage will be mitigated by building more sites and by restoring the two site that were down.

Low-band upgrades are in various stages of execution to improve the coverage footprint in Hazyview, Mbombela, Boschfontein and Bushbuckridge. Telkom plans to build twenty-nine (29) sites; more than two (2) of these sites are expected to be in-service before the end of the 2020/2021 financial year.