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# **2018/2019 Quarter 1: Voice Quality of Service Report – Free State Province**

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## **List of Abbreviations**

CD	Call Duration
CSSR	Call Setup Success Ratio
DCR	Drop Call Ratio
GSM	Global System for Mobile Communications
IVR	Interactive Voice Response
WCDMA	Wideband Code Division Multiple Access
MOC	Mobile Originating Call
KPI	Key Performance Indicator

## **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 being offered by the operators in the Free State Province. The measurements were carried out in the period of 7<sup>th</sup> to 18<sup>th</sup> May 2018. The total distance covered was over 2500 kilometres.

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 are 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. These areas include major towns, townships, farm areas, rural areas, major road arteries, economic activity nodes and areas of previous complaints. The sampled areas include Frankfort, Harrismith, Theunissen, Virginia and Bothaville.

A vehicle equipped with TEMS Symphony measurement tool was used to collect data by driving through areas of interest. The two Key Performance Indicators (KPIs) used to assess QoS are Retainability and Accessibility. The Drop Call Ratio (DCR) parameter is used to measure Retainability and Call Setup Success Ratio (CSSR) parameter measures Accessibility.

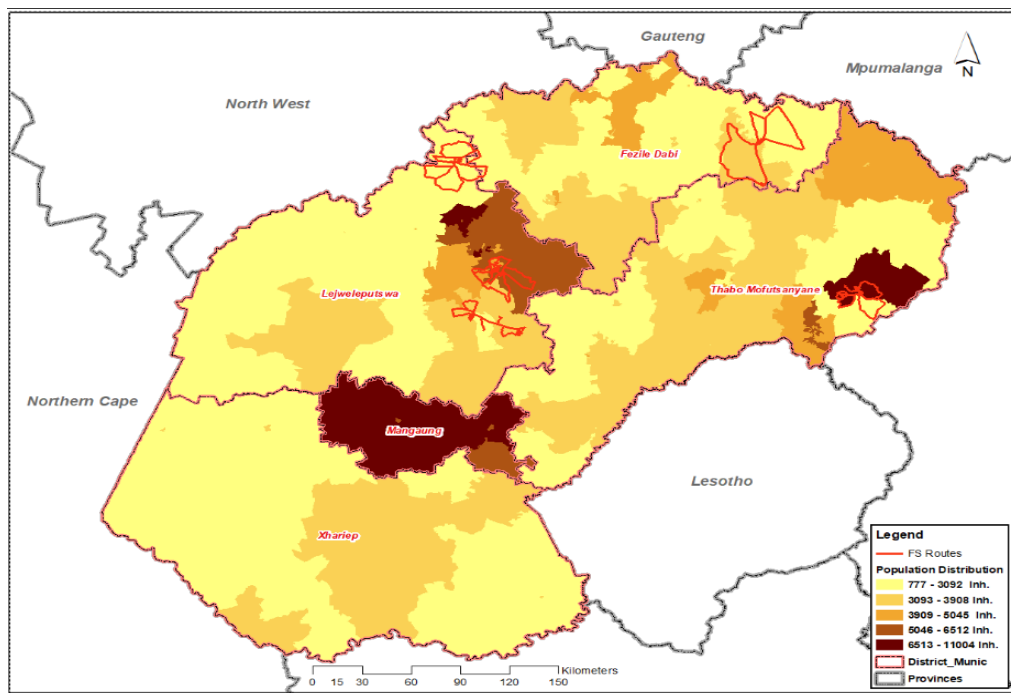
According to the End-User and Subscriber Service Charter regulations of 2016, DCR should be less than 3% and CSSR should be greater than 98%.

The results show that in terms of overall Call Setup Success Ratio, all operators achieved less than 98% CSSR values, thus failed to meet the Accessibility target. Vodacom, Cell C and Telkom did not meet the overall Drop Call Ratio target of less than 3%, only MTN met the DCR target, thus meeting the Retainability target.

# 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<sup>1</sup>. The Authority ensures the quality of service through its Quality of Service (QoS) monitoring activities. The Authority conducted QoS monitoring of the Cellular voice telephony service being offered by Cell C, MTN, Vodacom and Telkom within the Free State Province of South Africa.

The Free State is in the geographical centre of South Africa, bordered by the Northern Cape, Eastern Cape, North West, Mpumalanga, KwaZulu-Natal and Gauteng provinces, as well as Lesotho. The Free State is a rural province of farmlands, mountains, goldfields and widely dispersed towns. The third largest province in South Africa, with the second smallest population and the second lowest population density. It covers an area of 129 825 km<sup>2</sup> and has a population of 2 834 714 (5.1% of the national population). Its capital is Bloemfontein, which is South Africa’s judicial capital. Other important towns include Welkom, Kroonstad, Sasolburg and Bethlehem<sup>2</sup>.



**Figure 1: Free State Province Route Map**

<sup>1</sup>ICASA Strategic Plan 2016/17-2021

<sup>2</sup><https://www.localgovernment.co.za/provinces/view/2/free-state>

The QoS monitoring was conducted in the areas within Fezile Dabi District Municipality, Thabo Mofutsanyane District Municipality, and Lejweleputswa District Municipality. The selected areas include Frankfort, Harrismith, Theunissen, Virginia and Bothaville. The areas consist of major towns, townships, farm areas, rural areas, major road arteries, economic activity nodes and areas of previous complaints.

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 and is evaluated in terms of Retainability and Accessibility parameters.

- a) 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 carries the call<sup>3</sup>. It is measured using Drop Call Ratio (DCR).
- b) Accessibility is defined as the percentage of the number of times a user is rejected due to the unavailability of system resources when attempting to place a call. It is measured using Call Setup Success Ratio (CSSR).

## **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 selected routes and particular time of the day. It is therefore not a true representation of the mobile service provider's overall network performance.

### **2.1 Drive-test equipment**

The drive test was carried out using a test kit comprised of TEMS Symphony 7.7 software and hardware, eight Samsung Galaxy Note 4 (SM-N910F) mobile devices, a laptop computer and a TEMS Probe Controller 1.9. The mobile devices were configured to automatically select mobile network and radio access technology.

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<sup>3</sup> SANS 1725-1:2016. End user related Quality of Service parameter definitions and measurements – Part 1: GSM voice

## 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 below:

**Table 1: Selected routes and dates**

Test Type	District	Route Name	Dates
Accessibility and Retainability	Fezile Dabi District Municipality	Frankfort	07/05/2018
			18/05/2018
	Thabo Mofutsanyane District Municipality	Harrismith	08/05/2018
			17/05/2018
	Lejweleputswa District Municipality	Theunissen	09/05/2018
			16/05/2018
10/05/2018			
Virginia	15/05/2018		
		11/05/2018	
Bothaville	14/05/2018		

## 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	<p>Tests were carried out from a moving vehicle with roof-mounted antennas. The antennas were arranged in a well-defined fixed way. A minimum distance between antennas is maintained to contain RF influence at an acceptable level. The coupling loss between two mobile handsets was a minimum of 40.5 dB<sup>4</sup>.</p>
Band	<p>The bands tested for voice were GSM (900 and 1800 MHz) and WCDMA (900 and 2100 MHz).</p> <p>The bands scanned were GSM (900 and 1800 MHz) and WCDMA 2100 MHz.</p>
Call Samples	<p>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.</p> <p>The drive tests were designed to be representative of the population relative to the traffic of the network. Measurements were scheduled to reflect accurately the traffic variations over the hours of a day, and user's behavior<sup>5</sup>.</p>
Call Type and Window Call	<p>Long calls and short calls were used.</p> <p>Voice telephony was tested in the Mobile Originating Call (MOC) direction. The following call durations were used:</p> <ul style="list-style-type: none"> <li>• CD1: 10 seconds for call setup testing;</li> <li>• CD2: 120 seconds for typical tests, default call duration;</li> </ul> <p>Call Window: Call Duration + 30 seconds, (for the setup and release phases) + 30 seconds (for the minimum pause. Interval), for the default call duration this results in 180 seconds<sup>6</sup>.</p>

<sup>4</sup> SANS 1725-1:2016. End user related Quality of Service parameter definitions and measurements – Part 1: GSM voice

<sup>5</sup> Ibid

<sup>6</sup> Ibid



Equipment	The equipment used for testing was the TEMS Symphony 7.7 equipped with Samsung Galaxy Note S4 (SM-N910F), PCTEL EXFlex Scanner and Dell Latitude with TEMS Probe Controller 1.9.2.
KPI <sup>7</sup>	The measurements focused on the following network parameters: (i) Dropped Call Ratio (DCR); (ii) Call Set-up Success Ratio (CSSR)
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.
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	Test SIM cards provided by each operator were used during the drive test.
Vehicle used	A Toyota Hilux Double Cab van 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 60km/h in town and built-up areas, and an average of 100km/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.

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<sup>7</sup> End-User and Subscriber Service Charter Regulations of 2016

## **2.5 Measurement parameters and targets**

### **2.5.1 Parameter targets**

The Average Drop Call Ratio should be less than 3% over 6 months' period and Average Call Setup Success Ratio must be greater than 98% over six months' period as per the "End-User and Subscriber Service Charter Regulations of 2016".

### **2.5.2 Drop-Call Ratio**

Dropped Call Ratio (DCR) is the proportion of incoming and outgoing calls, which, once correctly established and therefore having been assigned a traffic channel, is dropped or interrupted prior to the deliberate completion by the user<sup>8</sup>.

The formula to calculate DCR is shown below:

$$\text{DCR} = \text{D/S} * 100$$

where D represents the number of dropped calls and S is the number of successful call attempts

### **2.5.3 The 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<sup>9</sup>.

The formula to calculate CSSR is shown below:

$$\text{CSSR} = \text{Y/X} * 100$$

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

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<sup>8</sup> End-User and Subscriber Service Charter Regulations of 2016

<sup>9</sup> Ibid

### 3 RESULTS AND ANALYSIS

This section provides a summary of the mobile operator’s performance results based on the drive test route in the following test areas: Frankfort, Harrismith, Theunissen, Virginia and Bothaville.

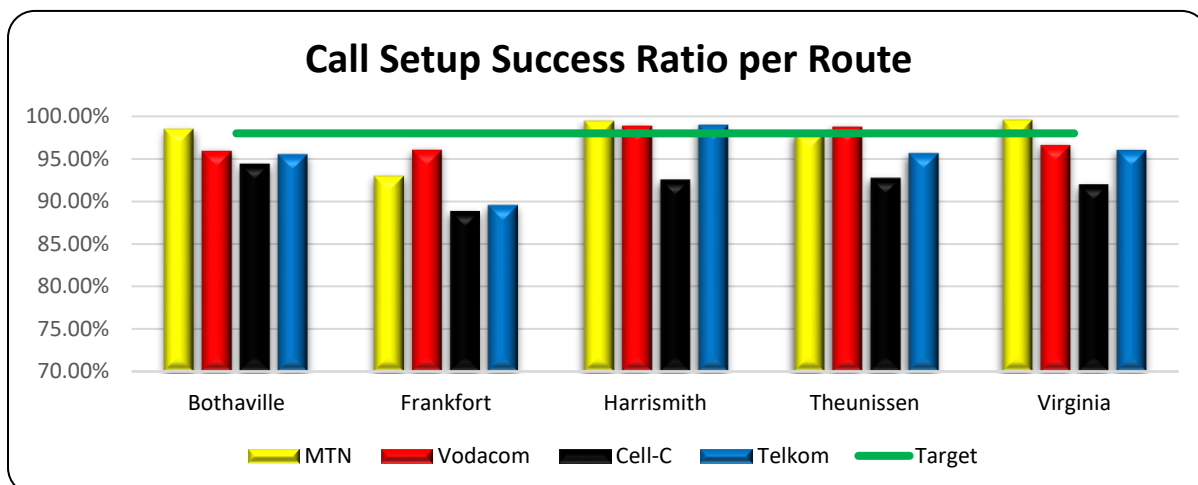
#### 3.1 Accessibility and Retainability measurements

**Table 3: Summary of results**

Route Name	Operator	CSSR (%)	DCR (%)
<b>Bothaville</b>	Telkom	95.49%	3.69%
	Cell C	94.30%	4.64%
	Vodacom	95.93%	1.71%
	MTN	98.46%	1.02%
<b>Frankfort</b>	Telkom	89.53%	9.45%
	Cell C	88.77%	5.67%
	Vodacom	96.05%	4.95%
	MTN	92.92%	5.11%
<b>Harrismith</b>	Telkom	98.89%	1.53%
	Cell C	92.47%	3.87%
	Vodacom	98.88%	1.83%
	MTN	99.39%	0.00%
<b>Theunissen</b>	Telkom	95.59%	1.98%
	Cell C	92.65%	3.96%
	Vodacom	98.77%	4.20%
	MTN	97.91%	1.05%
<b>Virginia</b>	Telkom	95.95%	1.15%
	Cell C	91.91%	2.92%
	Vodacom	96.60%	2.73%
	MTN	99.50%	1.00%
<b>Overall results for the above 5 areas</b>	Telkom	95.10%	3.64%
	Cell C	91.90%	4.24%
	Vodacom	97.31%	3.07%
	MTN	97.62%	1.68%

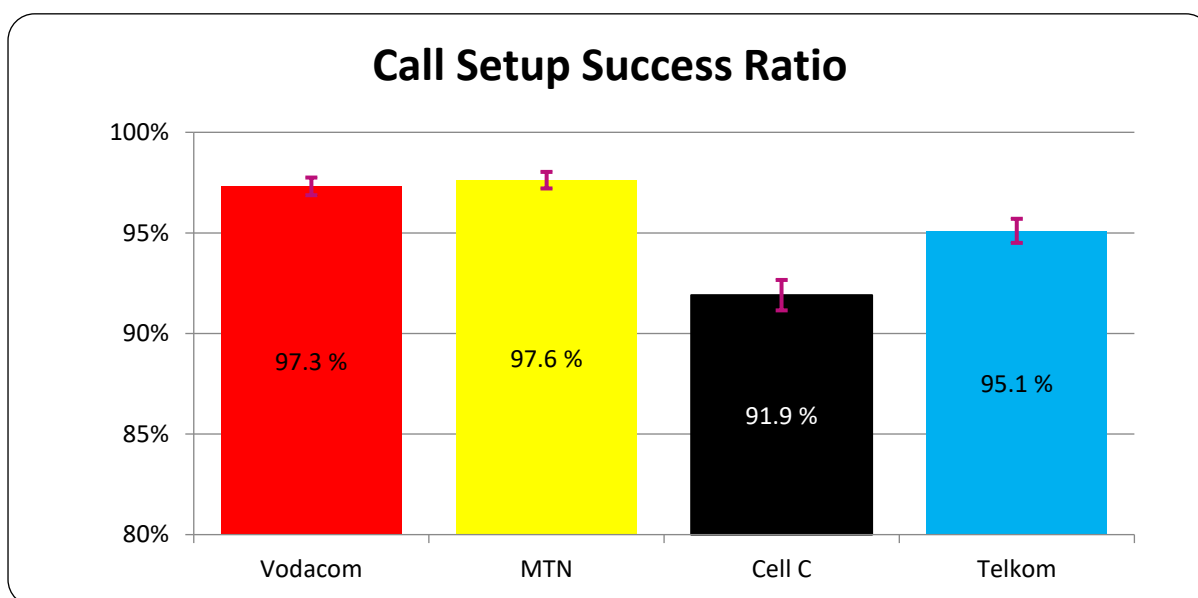
Table 3 shows voice call measurement results in each route and as an overall for all areas for all the operators. Detailed results are presented in the Appendix 6.

### 3.1.1 Call Setup Success Ratio (CSSR)



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

Figure 2 shows that MTN met the 98% CSSR target in Bothaville, Harrismith and Virginia. Vodacom met the CSSR target in Harrismith and Theunissen. Telkom only met the target in Harrismith. Cell C achieved less than 98% CSSR in all five measured areas, Telkom achieved less than 98% CSSR in four area, Vodacom in three areas and MTN in two areas. All operators failed to meet the CSSR target in Frankfort.

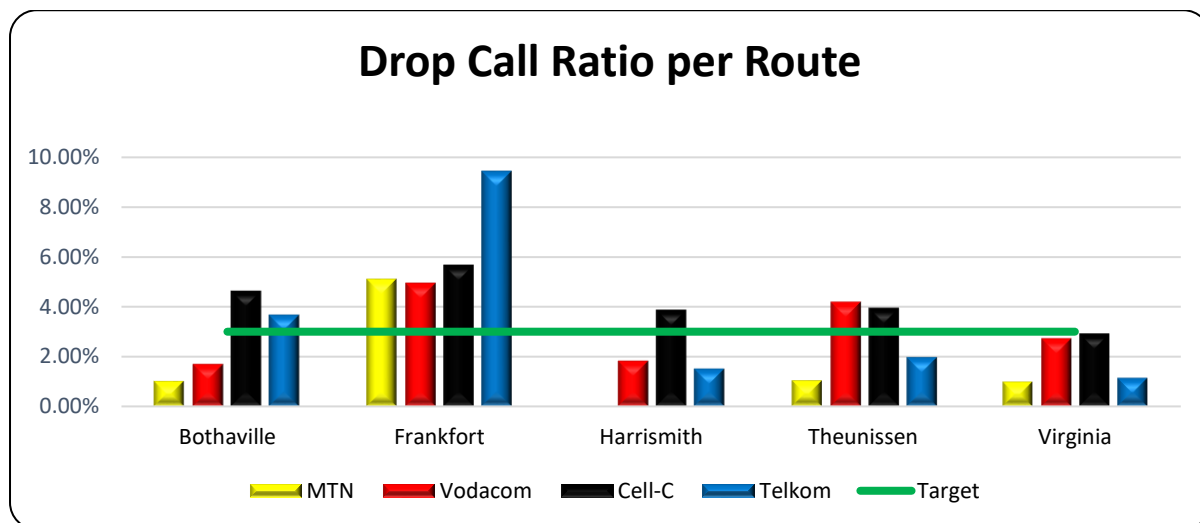


**Figure 3: Overall Call Setup Success Ratio with Statistical Significance**

Figure 3 shows that MTN’s CSSR is the highest, followed by Vodacom, Telkom and Cell C in their respective descending order. None of the operators met ICASA’s CSSR target of above 98% as per “End-User and Subscribers Service charter regulations of 2016”. MTN's results show no statistically significant difference in

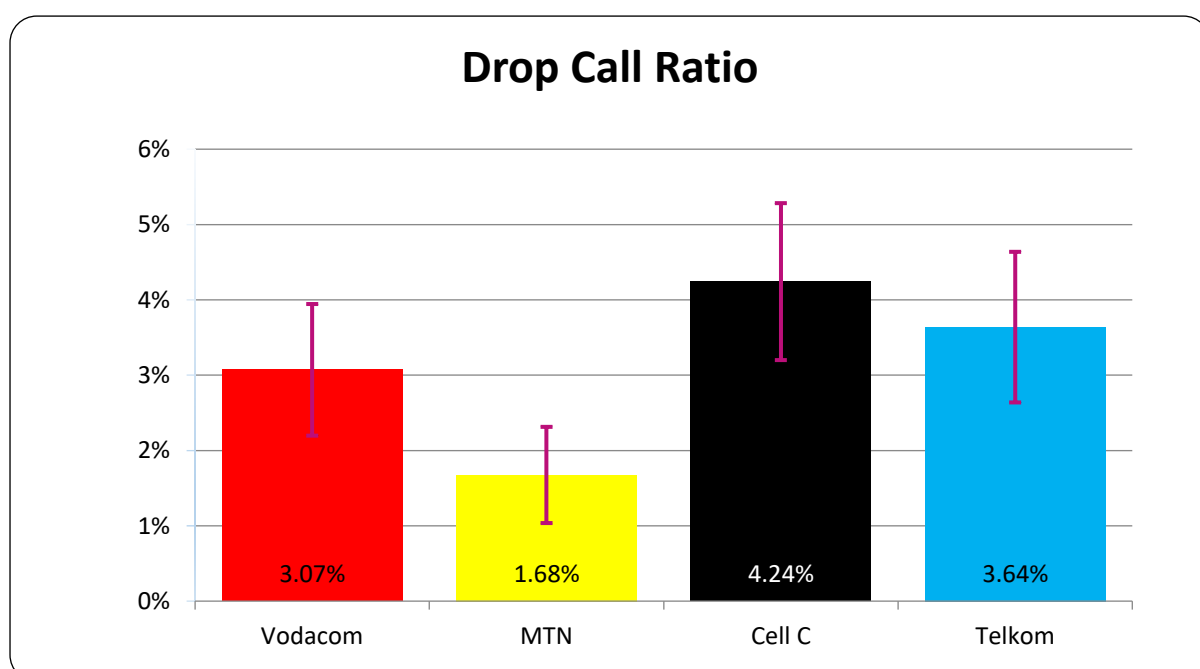
relation to Vodacom results. There is statistically significance between Vodacom and Cell C results, between Vodacom and Telkom results, between MTN and Cell C results, between MTN and Telkom results as well as between Cell C and Telkom.

### 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 except in Frankfort. Vodacom met the target in Bothaville, Harrismith and Virginia but failed in Frankfort and Theunissen. Telkom met the target in Harrismith, Theunissen and Virginia but failed in Bothaville and Frankfort. Cell C only met the target in Virginia and failed to meet the target in all other tested areas. All operators failed to meet the DCR target in Frankfort.

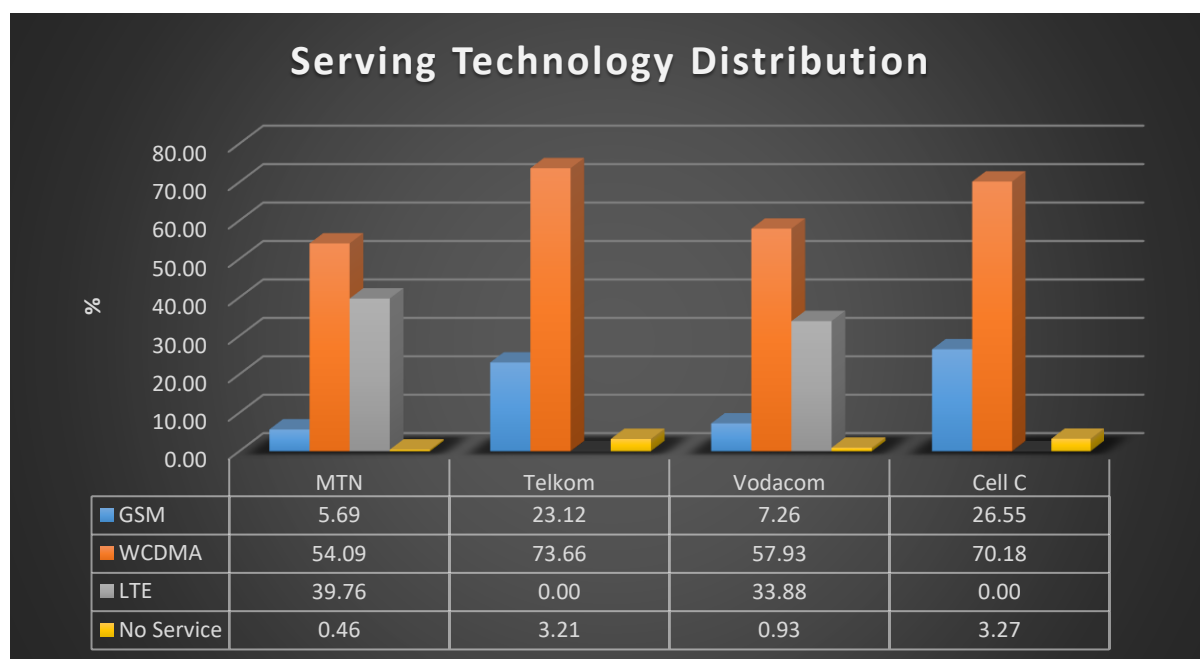


**Figure 5: Total Drop Call Ratio with Statistical Significance**

Figure 5 shows that MTN’s DCR is the lowest followed by Vodacom, Telkom and Cell C in the respective ascending order. MTN met ICASA’s 3% DCR target, while Vodacom, Cell C and Telkom did not meet the DCR target. There was no statistically significant difference in results between Vodacom’s results and all other operators. MTN’s results show a statistically significant difference in relation to Cell C and Telkom results. Cell C’s results also show no statistically significant difference in relation to Telkom’s results. The highest recorded DCR was Cell C with 4.24% and MTN was the lowest with 1.68%.

### 3.2 Analysis of the serving technology

Figure 6 shows the statistical distribution of the serving technology during the drive test. The serving technology distribution were based on the device used and the network parameter configuration which varies with the mobile operators. All operators’ serving technology distribution was mainly on WCDMA technology, Vodacom and MTN had significant distribution on LTE technology.



**Figure 6: Technology Distribution**

The maps in Appendix 6.3.1 show the geographic areas where the radio access technology was selected by the mobile device.

## **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 varies significantly on per location basis.

As we benchmark the operators, the results show that in terms of overall Call Setup Success Ratio, all operators achieved less than 98% CSSR values, thus failed to meet the Accessibility target. Vodacom, Cell C and Telkom did not meet the overall Drop Call Ratio target of less than 3%, only MTN met the DCR target, thus meeting the Retainability target.

## 5 APPENDICES

### 5.1 Appendix A: Detailed test results

Table 4: Drop call ratio (DCR) per Route

Route Name	Operator	Phase 1			Phase 2			Total		
		Call Established	Call Dropped	DCR (%)	Call Established	Call Dropped	DCR (%)	Call Established	Call Dropped	DCR (%)
Bothaville	Telkom	150	9	6.00%	148	2	1.35%	298	11	3.69%
	Cell C	153	4	2.61%	149	10	6.71%	302	14	4.64%
	Vodacom	149	2	1.34%	144	3	2.08%	293	5	1.71%
	MTN	156	1	0.64%	138	2	1.45%	294	3	1.02%
Frankfort	Telkom	145	11	7.59%	130	15	11.54%	275	26	9.45%
	Cell C	176	8	4.55%	124	9	7.26%	300	17	5.67%
	Vodacom	186	10	5.38%	137	6	4.38%	323	16	4.95%
	MTN	188	9	4.79%	145	8	5.52%	333	17	5.11%
Harrismith	Telkom	130	2	1.54%	132	2	1.52%	262	4	1.53%
	Cell C	149	3	2.01%	135	8	5.93%	284	11	3.87%
	Vodacom	184	4	2.17%	143	2	1.40%	327	6	1.83%
	MTN	194	0	0.00%	145	0	0.00%	339	0	0.00%
Theunissen	Telkom	128	2	1.56%	124	3	2.42%	252	5	1.98%
	Cell C	159	7	4.40%	119	4	3.36%	278	11	3.96%
	Vodacom	125	4	3.20%	137	7	5.11%	262	11	4.20%
	MTN	167	3	1.80%	119	0	0.00%	286	3	1.05%
Virginia	Telkom	131	1	0.76%	129	2	1.55%	260	3	1.15%
	Cell C	139	2	1.44%	135	6	4.44%	274	8	2.92%
	Vodacom	151	6	3.97%	142	2	1.41%	293	8	2.73%
	MTN	156	3	1.92%	144	0	0.00%	300	3	1.00%



**Table 5: Call Setup Success Ratio (CSSR) per Route**

		PHASE 1				PHASE 2				TOTAL			
Route Name	Operator	Call Attempt	Call Setup	User Busy	CSSR (%)	Call Attempt	Call Setup	User Busy	CSSR (%)	Call Attempt	Call Setup	User Busy	CSSR (%)
Bothaville	Telkom	528	505	0	95.64%	494	470	1	95.33%	1022	975	1	95.49%
	Cell C	496	474	2	95.95%	490	453	1	92.64%	986	927	3	94.30%
	Vodacom	573	554	0	96.68%	556	529	0	95.14%	1129	1083	0	95.93%
	MTN	550	542	0	98.55%	552	542	1	98.37%	1102	1084	1	98.46%
Frankfort	Telkom	604	506	3	84.19%	433	418	2	96.98%	1037	924	5	89.53%
	Cell C	674	611	0	90.65%	475	409	0	86.11%	1149	1020	0	88.77%
	Vodacom	415	405	0	97.59%	471	446	0	94.69%	886	851	0	96.05%
	MTN	628	561	2	89.62%	463	450	1	97.40%	1091	1011	3	92.92%
Harrismith	Telkom	609	603	0	99.01%	472	466	0	98.73%	1081	1069	0	98.89%
	Cell C	561	521	0	92.87%	461	424	0	91.97%	1022	945	0	92.47%
	Vodacom	658	649	0	98.63%	507	503	0	99.21%	1165	1152	0	98.88%
	MTN	658	654	0	99.39%	497	494	0	99.40%	1155	1148	0	99.39%
Theunissen	Telkom	509	485	2	95.66%	378	360	1	95.49%	887	845	3	95.59%
	Cell C	463	438	0	94.60%	421	381	0	90.50%	884	819	0	92.65%
	Vodacom	580	572	0	98.62%	478	473	0	98.95%	1058	1045	0	98.77%
	MTN	454	445	0	98.02%	457	447	0	97.81%	911	892	0	97.91%
Virginia	Telkom	494	471	1	95.54%	471	454	0	96.39%	965	925	1	95.95%
	Cell C	484	451	0	93.18%	469	424	1	90.60%	953	875	1	91.91%
	Vodacom	461	439	1	95.43%	510	498	0	97.65%	971	937	1	96.60%
	MTN	499	497	0	99.60%	500	497	0	99.40%	999	994	0	99.50%

## **5.2 Appendix B: Summary of operators' feedback**

A summary of the response received from operators is provided below.

### **5.2.1 Cell C**

Cell C highlighted the lack of its own network coverage in some of the areas tested. In order to provide Cell C subscriber with good quality of service, Cell C relies on its national commercial roaming agreement with Vodacom in addition to its own network coverage.

Cell C's plans and remedies to improve the low performance areas include the following:

- Cell C has project plans for the future to have site roll-out, capacity and transmission routes improved and optimised in the low performing areas.
- Cell C has further entered into a national commercial roaming agreement with MTN. This agreement includes seamless handover which was absent in the Vodacom agreement.
- Frankfort route – Cell C experienced intermittent transmission fault on the network serving the area during the measurements, this fault was cleared.

### **5.2.2 MTN**

MTN limited their response to two areas (Theunissen and Frankfort) where they did not meet the targets.

- Frankfort route – With the limited scope of the network, MTN has adjusted antenna tilts to improve the coverage and optimised neighbouring cell as an interim solution to improve customer experience. MTN have planned new sites to improve coverage in the area.
- Theunissen route – During phase 1 measurements, some of the sites were down and thus caused calls to block and drop. MTN is in the process of optimising sites in the area. There is also a plan to build new sites around poor coverage areas.

### **5.2.3 Telkom**

Telkom gave the following response to the Authority's draft report:

- Telkom views the test results as very significant and uses them as additional input to further improve the quality of the mobile network.
- Telkom depends mostly on its roaming partner (MTN) for coverage.

- To mitigate coverage problems in all tested areas, Telkom has additional 14 sites planned. The plan is to have these sites on air later this year.
- Virginia and Harrismith routes – Plans to build seven (7) sites before the end of 2018/19 financial year.
- Bothaville – Telkom has no sites in the area and planned to build sites to build 3 sites which are projected to be on air by October 2018.
- Frankfort route – Plans to build 3 sites, site planning is still on the initial site survey phase.

Telkom reiterates that the lack of access to lower frequency spectrum has negative influence on their ability to provide quality network coverage within targeted areas. Telkom will continue to engage with its roaming partner regarding service improvements in the affected area.

#### **5.2.4 Vodacom**

Vodacom provide feedback and network improvement plans that are in place for the areas that were identified to be negatively affecting customer experience by the Authority's QoS monitoring; and shared the following remedial actions:

- Frankfort route – Plans to build six (6) sites in this area to resolve coverage gaps and problems in the area. The estimated implementation of these sites is between one and two years (2020).
- Harrismith route – Plans to build eight (8) sites in this area to resolve coverage gaps and problems in the area; one of the sites came on air on the 30<sup>th</sup> May 2018. The remaining new sites are waiting for budget allocation. The estimated implementation of these sites is between two and three years (2021).
- Virginia route – Plans to build seven (7) sites in this area to resolve coverage gaps and problems in the area; some of the new sites are expected to be live between July and September 2018. Full area optimisation will be done once these sites come on air.
- Theunissen route – Plans to build seven (7) sites in this area to resolve coverage gaps and problems in the area; three (3) new sites to be on air by September 2018. Full area optimisation will be done once these sites come on air.

Vodacom further highlighted the following challenges which makes it difficult to invest in the areas and poses high operational expenditure costs:

*a) Lack of infrastructure*

- > Access roads are too expensive to build at most of the planned sites.
- > It is expensive to bring Eskom power close to area of interest where Vodacom wants to build sites.
- > High vandalism in the area poses a security challenge on existing sites.

*b) Municipality under administration*

- > The municipality owes Eskom billions of rands thus, Vodacom is facing challenges on existing infrastructure with lot of power cuts which increase operational costs.



### 5.3 Appendix C: Coverage maps

#### 5.3.1 Serving technology maps

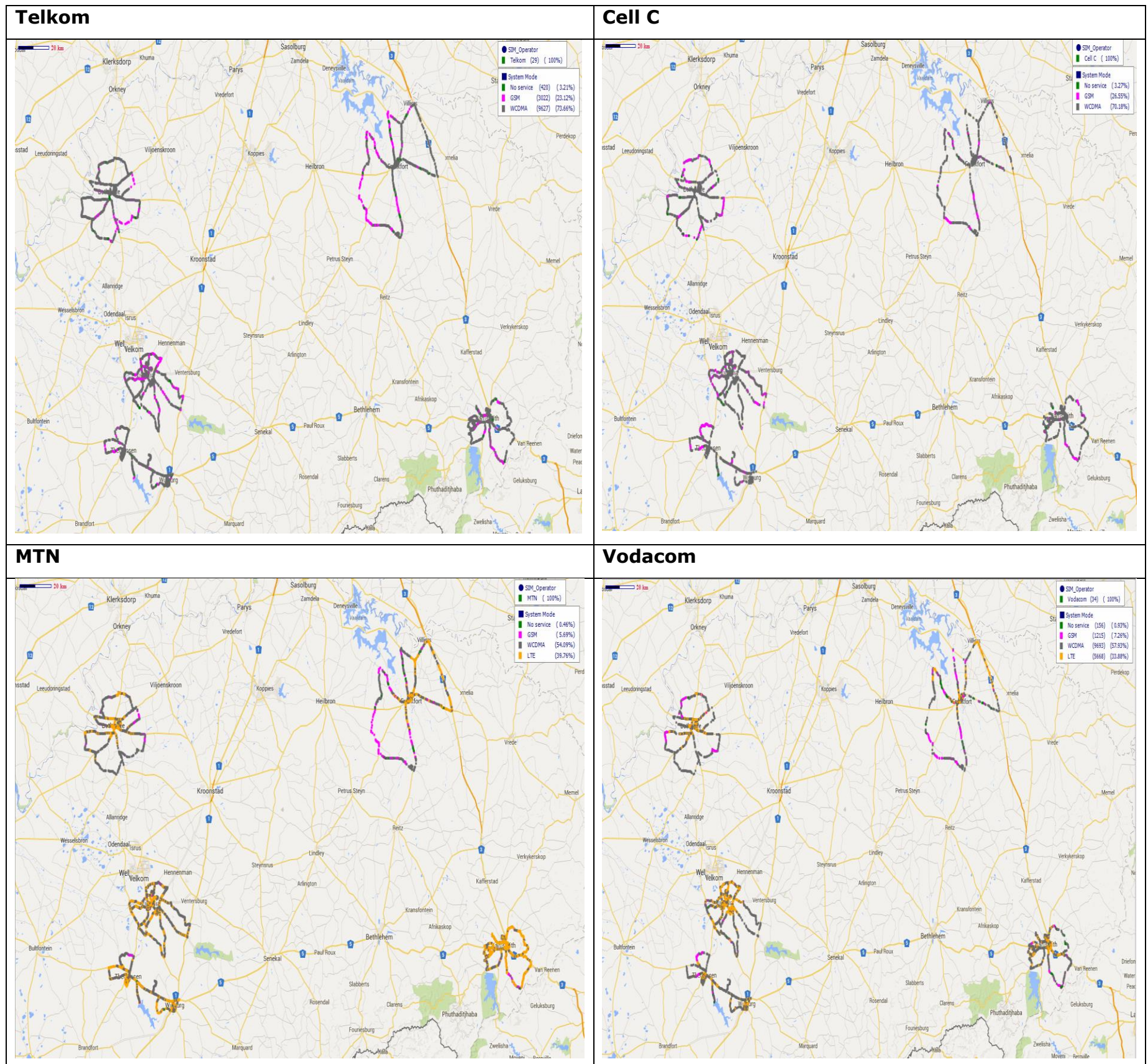


Figure 7: Free State Province Serving Technology Plot

