



**Independent Communications Authority of South Africa**

350 Witch-Hazel Avenue, Eco Point Office Park  
Eco Park, Centurion.  
Private Bag X10, Highveld Park 0169  
Telephone number: (012) 568 3000/1

**2021/2022 Quarter 3:  
Voice Quality of Service  
Report  
Mpumalanga Province**

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## List of Abbreviations

CD	Call Duration
CSFB	Circuit Switched Fall Back
CRR	Call Retention Ratio
CSSR	Call Setup Success Ratio
CST	Call Setup Time
DCR	Drop Call Ratio
GSM	Global System for Mobile Communications
HD	High Definition
ICASA	Independent Communications Authority of South Africa
IVR	Interactive Voice Response
KPI	Key Performance Indicator
LTE	Long-Term Evolution
LTE-A	Long-Term Evolution Advanced
R&S	Rohde & Schwarz
MOC	Mobile Originating Call
MOS	Mean Opinion score
POLQA	Perceptual Objective Listening Quality Analysis
WCDMA	Wideband Code Division Multiple Access
VoLTE	Voice over Long-Term Evolution

## 1. Executive Summary

The Independent Communications Authority of South Africa (ICASA) appointed Metro Global Telecom Services (Pty)Ltd. (MetroTelworks) to conduct 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 mobile voice services offered by the operators in the Mpumalanga Province. The measurements were carried out between the in the period 6 October to 15 November 2021, covering a total distance of over 3242 kilometres.

The purpose of conducting 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. These areas include towns, townships, farm areas, rural areas, and economic activity nodes. The sampled areas within the Mpumalanga Province were Barberton, Belfast, Delmas, Matsulu and Siyabuswa.

A vehicle equipped with Rohde and Schwarz Smart Benchmark II testing system, and 12 mobile phones was used to collect data in mobility conditions. The four Key Performance Indicators (KPIs) used to assess QoS are Accessibility, Retainability, Call Setup Time and Speech Quality. The Drop Call Ratio (DCR) KPI is used to measure a user's ability to successfully complete a call and Call Setup Success Ratio (CSSR) KPI measures a user's ability to make a phone call.

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

The results show that in terms of overall Call Setup Success Ratio, all operators failed to meet the overall CSSR target of more than 98% and thus failed to meet the Authority's Accessibility target.

In terms of the overall Drop Call Ratio, all operators failed to meet the overall DCR target of less than 3%, thus failed to meet the Authority's Retainability target.

All operators met the Call Setup Time target of less than 20 seconds.

Cell C was the only operator that failed to achieve the Speech Quality Target of greater than 3.

## 2. Introduction

ICASA's mission is to regulate electronic communications, broadcasting, and postal services in the public interest. The Authority ensures the quality of service through its Quality of Service (QoS) monitoring activities. The Authority appointed Metro Global Telecom Services (Pty) Ltd. (MetroTelworks) to conduct drive testing in selected areas of the Mpumalanga Province. The test was focused on monitoring the cellular voice telephony service being offered by Cell C, MTN, Telkom and Vodacom within the Mpumalanga Province.

The QoS monitoring was conducted in areas that fall under the Ehlanzeni and Nkangala District Municipalities. The areas of interest that were selected within these municipalities were Barberton, Belfast, Delmas, Matsulu and Siyabuswa. The areas consist of major towns, townships, farm areas, rural areas, major road arteries, economic activity nodes and areas of previous complaints.

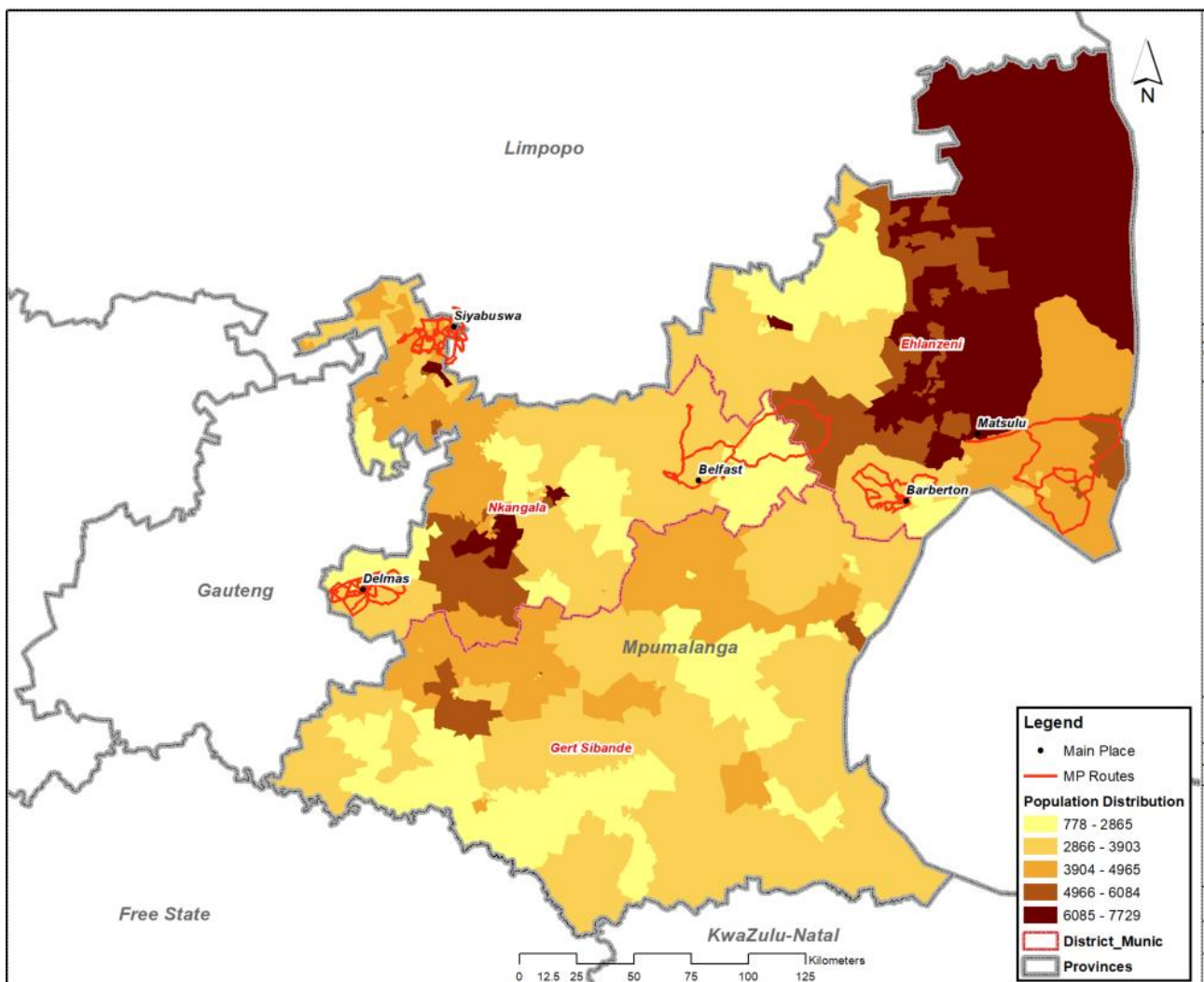


Figure 1. Mpumalanga Province Route Map with Population Distribution



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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 Call Accessibility, Call Setup Time, and Call Retainability and Speech Quality parameters.

- a) Call Accessibility is reported as a percentage and is a measure of the number of times a user can successfully establish a call as a ratio 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 mobile call 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 dialled 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 carries the call. It is measured using Drop Call Ratio (DCR).
- d) Speech Quality is the condition of conversational speech without noise and echo interference. It is measured using the Mean Opinion Score (MOS).

### 3. Methodology

A minimum of 200 test samples per network operator were collected for each area tested over two phases of data collection. 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 particular time of the day, which may not be a true representation of the mobile service provider's overall network performance, however, it is considered statistically relevant.

Voice test set-up consisted of two test scenarios namely, short calls and long calls which are defined in this section. The short calls were used to measure Call Accessibility and Call Setup Time(s) whilst the long calls were used to measure Call Retainability and Speech Quality. The Long Call scenario required the use of two test mobiles per Operator i.e., call initiating side (A-side) and call receiving side (B-side). The Short Call scenario required the use of a single test mobile for each Operator making calls to the Operators IVR system. This set-up results in three mobile devices per operator bringing the total number of devices used for the test to twelve with three for each Mobile Operator. The Call Windows were set up as follows: Call duration + 30 seconds, (for the setup and release phases) + 30 seconds (for the minimum pause interval after call termination). The call duration for the long call was set at 120 seconds bringing the total call window size to 180 seconds with the short call duration set at 10 seconds resulting in a total call window of 70 seconds. The audio quality of speech samples was evaluated using the HD-voice capable and ITU standardized POLQA wideband algorithm with 10 samples being recorded during each call.

The devices were set to select the best available technology whilst the test SIMs in use were not activated for VoLTE services, although some operators may activate this setting via the air interface from time to time. With this setup, in areas where operators had LTE, they performed Circuit Switched Fall Back (CSFB) calls.

Voice testing was done in two phases with a measurement window gap of at least seven days in between both measurements.

### 3.1. Equipment test setup and configuration

#### 3.1.1. System used



The Test Equipment used was the Rohde & Schwarz SwissQual Benchmarker II platform with Sony XZ Premium smartphones installed inside the car using the R&S Phone Mount Walls. Four mobile devices were used for Short Call and eight mobile devices were used for Long Call. The mobile devices were configured to automatically select a mobile network and radio access technology.

technology.

#### 3.1.2. Device Description

The Sony Xperia XZ Premium Smartphone was selected as the measurement User Equipment (UE) for Voice Services. It supports the following technologies: GSM, HSPA, LTE and LTE-A.

#### 3.1.3. Short and Long Call Windows

Figure 2 shows the call windows for the long and short calls as highlighted in the methodology section.

##### Short Call:



##### Long Call:



Test Scenar..	Value
Short Call	Call Duration = 10s
	Call Setup timeout = 30s
	Call Window = 70s
Long Call	Call Duration = 120s
	Call Setup timeout = 30s
	Call Window = 180s
POLQA (WB)	

Figure 2. Call Window Duration

### 3.2. Route selection

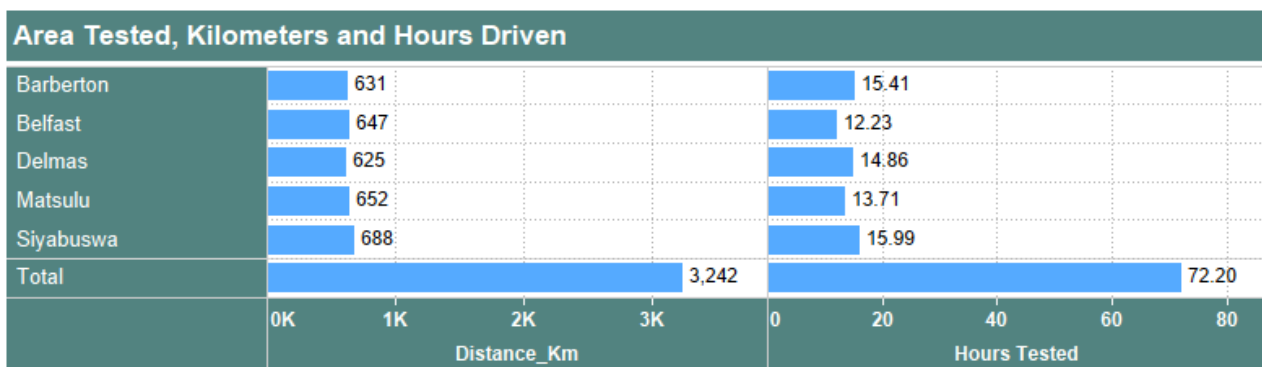
Measurement routes were selected so that they would reflect end user distribution at different geographical locations in areas where people live and use mobile phones - major towns, townships, farm areas, rural areas, major road arteries, economic activity nodes and areas of previous complaints. The selected five areas in which the QoS measurements were conducted are within Ehlanzeni and Nkangala District Municipalities as indicated in Table 1.

*Table 1. Test timeline for area covered*

Routes and Dates			
District	Area	Dates	Phase
Ehlanzeni/Nkangala	Delmas	26/10/2021	Phase1
		08/11/2021t	Phase 2
	Siyabuswa	27/10/2021 and 28/10/2021	Phase1
		09/11/2021 and 10/11/2021	Phase 2
	Belfast	29/10/2021	Phase1
		11/11/2021	Phase 2
	Matsulu	03/11/2021	Phase1
		12/11/2021	Phase 2
	Barberton	04/11/2021	Phase1
		15/11/2021	Phase 2

Table 2 shows the total distance covered in each area for both phases and active measurement duration.

*Table 2. Distance and time driven per area*



### 3.3. Measurement parameters and targets

#### 3.3.1. Parameters

##### 3.3.1.1. 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:

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

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

##### 3.3.1.2. 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, are dropped, or interrupted prior to the deliberate completion by the user. The formula to calculate DCR is shown below:

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

Where, D = number of dropped calls and S = number of successful calls established

##### 3.3.1.3. Call Setup Time [s]

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 dialled party.

##### 3.3.1.4. Speech Quality (MOS)

Speech quality on call basis is an indicator representing the end-to-end speech transmission quality of the mobile telephony service. This parameter computes the speech quality on the basis of completed calls. Measurement made use of the POLQA Algorithm which compares the reference signal received from the transmitting side against an equivalent sample on the receiving side.

#### 3.3.2. Targets

According to the End User and subscriber Service Charter Regulations of 2016, the following voice parameters' targets are defined as follows:

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

- Speech Quality – Average Speech Quality of MOS must be greater than 3.

## 4. 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: Barberton, Belfast, Delmas, Matsulu and Siyabuswa.

### 4.1. Accessibility, Retainability, Call Setup Time and Quality Measurements KPI Results per Area

Table 3 shows a summary of KPIs results per area. All operators failed to achieve the target for CSSR in three of the five tested areas (Barberton, Belfast and Matsulu). Vodacom was the only operator that achieved the CSSR target in Siyabuswa whilst both Vodacom and MTN met the target in Delmas.

Belfast was the only area where all operators achieved the DCR target. Cell C, Telkom and MTN failed to achieve the target in Barberton and Siyabuswa, Vodacom failed to achieve the DCR target only in Delmas. All the Operators met the Call Setup Time of less than 20 seconds in all the tested areas.

Cell C has poor Voice Quality in Barberton, Delmas and Matsulu. Vodacom, MTN and Telkom met the Voice Quality target of 3 in all the tested areas. Detailed results are provided in the Appendix 1 and Appendix 2.

*Table 3. Summary of KPI Results per Area*

		Barberton	Belfast	Delmas	Matsulu	Siyabuswa
Call Setup Success Ratio - [%]	Cell C	76.42%	87.69%	96.49%	89.17%	50.77%
	MTN	82.07%	92.53%	98.67%	92.47%	58.82%
	Telkom	86.65%	88.15%	96.40%	94.23%	97.08%
	Vodacom	92.68%	96.44%	98.96%	96.49%	98.50%
Drop Call Ratio [%]	Cell C	6.83%	1.03%	2.33%	1.44%	10.74%
	MTN	6.58%	2.50%	1.14%	1.95%	10.08%
	Telkom	7.23%	2.49%	3.80%	4.20%	3.55%
	Vodacom	1.94%	1.84%	8.12%	1.61%	1.40%
Call Setup Time [s]	Cell C	4.69	4.66	4.96	5.01	5.67
	MTN	4.20	3.62	4.44	4.82	5.72
	Telkom	4.16	3.97	4.39	4.09	3.96
	Vodacom	3.51	3.57	3.81	3.05	3.07
POLQA MOS	Cell C	2.94	3.11	2.92	2.90	2.53
	MTN	3.36	3.61	3.44	3.37	2.88
	Telkom	3.19	3.13	3.30	3.38	3.14
	Vodacom	3.40	3.51	3.51	3.55	3.49

### 4.1.1. Call Accessibility (Short Call)

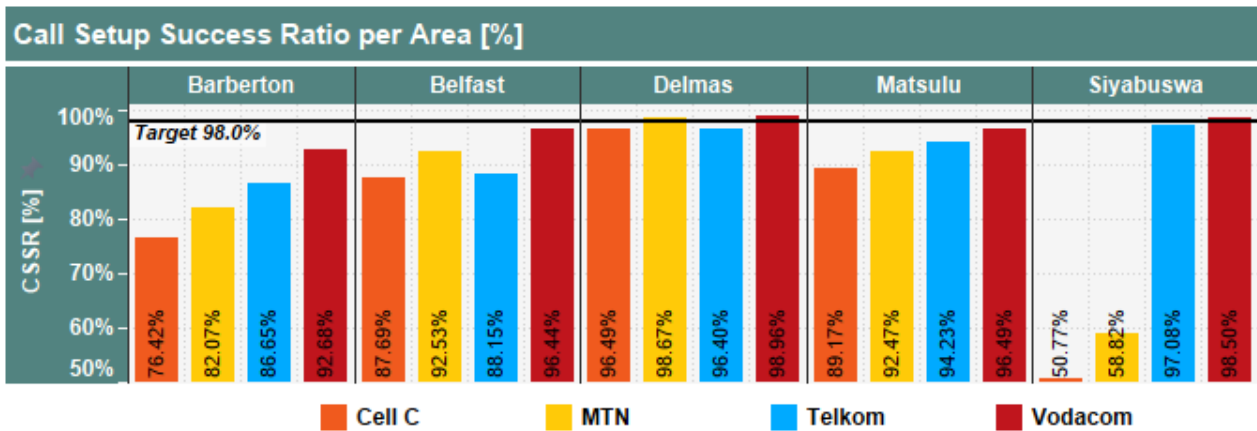


Figure 3. CSSR KPI per Area - Short Call

Figure 3 shows that none of the operators met the 98% CSSR target in three areas: Barberton, Belfast and Matsulu. In Siyabuswa, Vodacom was the only operator that achieved the target. In Delmas, Vodacom and MTN were the only operators that met the CSSR target.

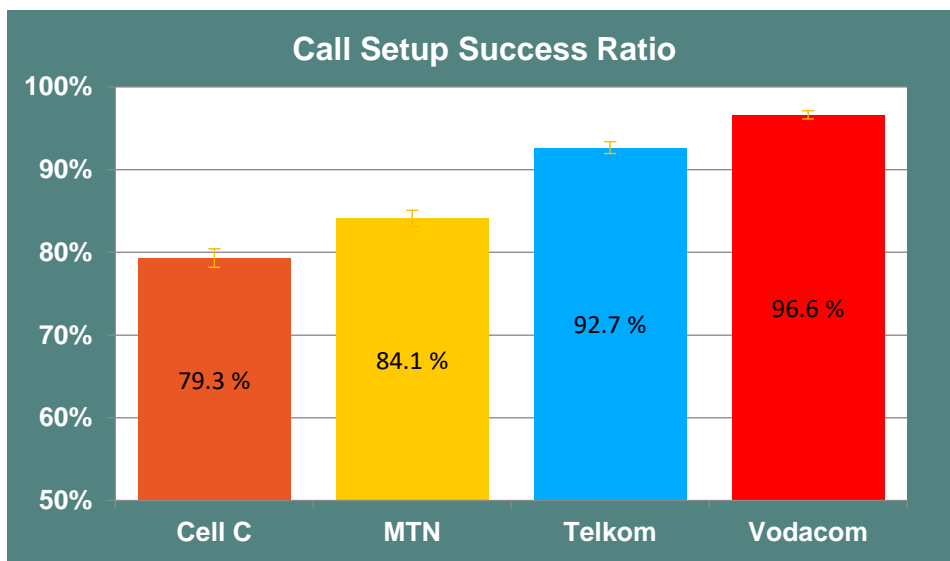


Figure 4. CSSR KPI Overall Results

Figure 4 shows all operators failed to achieve the overall CSSR target of 98%. Vodacom’s overall CSSR is the highest followed by Telkom, MTN and Cell C in a descending order. There is statistical significance difference recorded between MTN and Vodacom, MTN and Telkom as well as MTN and Cell C.

### 4.1.2. Drop Call Ratio (Long Call)

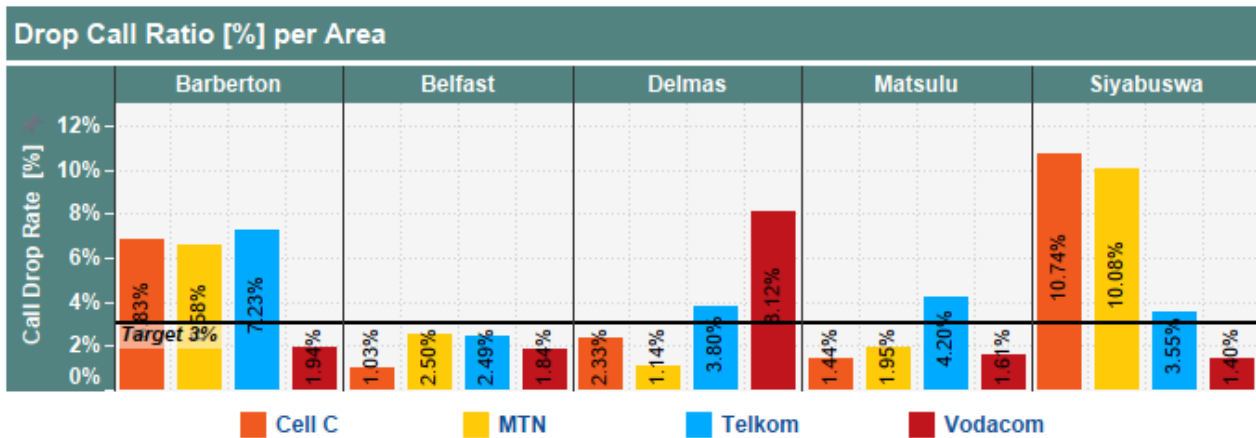


Figure 5. DCR KPI per Area Long Call

Figure 5 shows the DCR results per area for all the operators. All operators met the DCR target in Belfast, thus achieved the 3% DCR target in that area. All operators except Vodacom failed to meet the target in Barberton and Siyabuswa. Telkom was the only operator that failed to meet the DCR target in Matsulu. Telkom and Vodacom were the two operators that failed to meet the DCR target in Delmas.

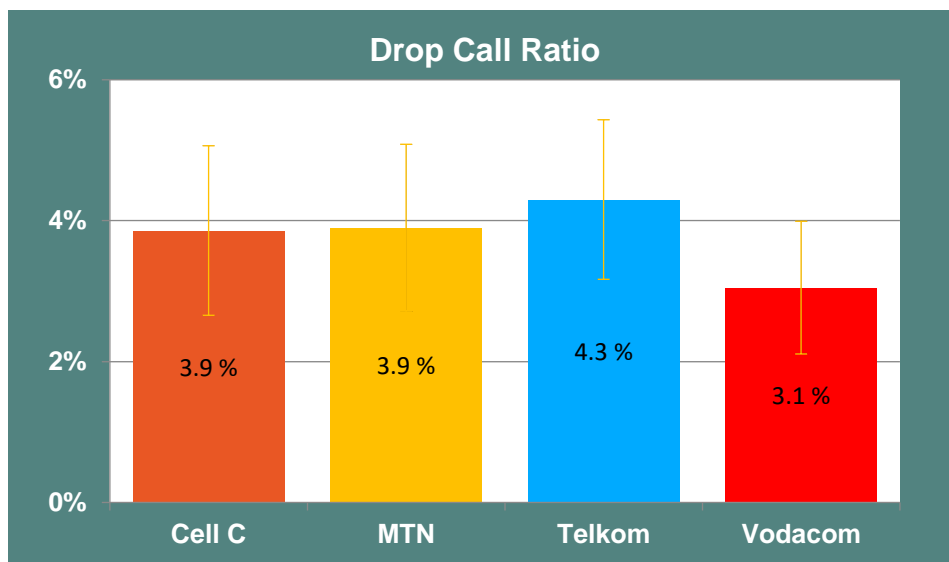


Figure 6. DCR KPI Overall Results

The overall results on Figure 6 show that all operators failed to meet the DCR KPI target of less than 3%, thus failed to meet the Authority’s Retainability target. Vodacom’s overall DCR is the lowest followed by MTN, Cell C and Telkom. There is no statistically significant difference recorded between MTN and Vodacom, MTN and Telkom as well as MTN and Cell C.



### 4.1.3. Call Setup Time (Short Call)

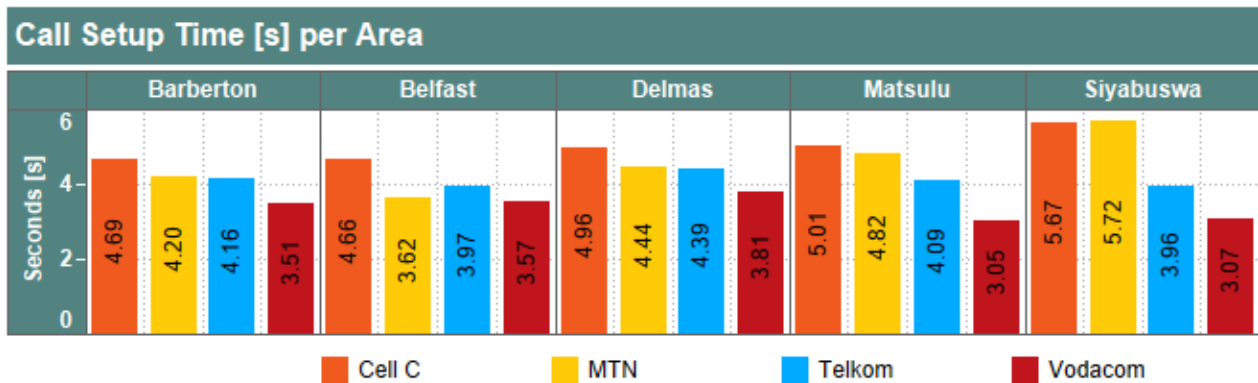


Figure 7. Call Setup Time[s] KPI per Area

Figure 7 shows all operators met the Call Setup Time target of less than 20 seconds in all the tested areas as per the End-User and Subscribers Service Charter Regulations of 2016. Vodacom had the lowest CST in all the five tested areas: Barberton, Belfast, Delmas, Matsulu and Siyabuswa.

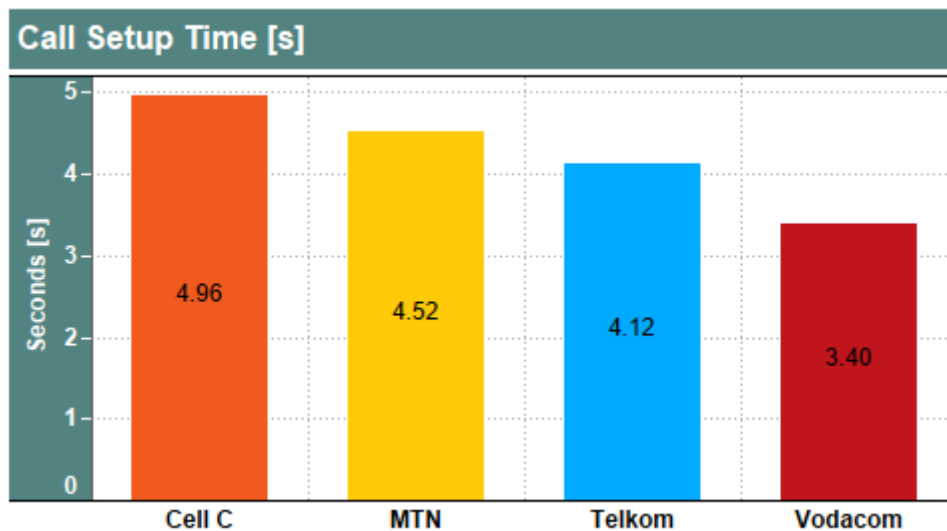


Figure 8. Call Setup Time[s] KPI Overall Results

Figure 8 shows the overall Call Setup Time results. Vodacom had the lowest overall Call Setup Time followed by Telkom, MTN and Cell C.

#### 4.1.4. POLQA MOS (Long Call)

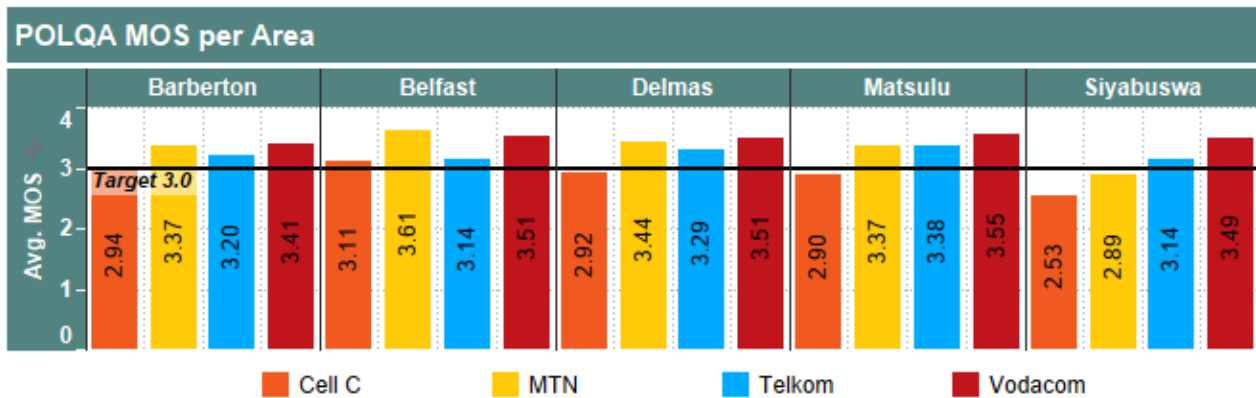


Figure 9. Speech Quality per Area

Figure 9 depicts speech quality results per tested area. Vodacom, MTN and Telkom achieved an average POLQA MOS of at least 3, thus meeting the required speech quality target in Barberton, Belfast, Delmas, Matsulu. Cell C failed to meet the target for speech quality in four of the five tested areas: Barberton, Delmas, Matsulu and Siyabuswa. MTN failed to meet speech quality target only in Siyabuswa.

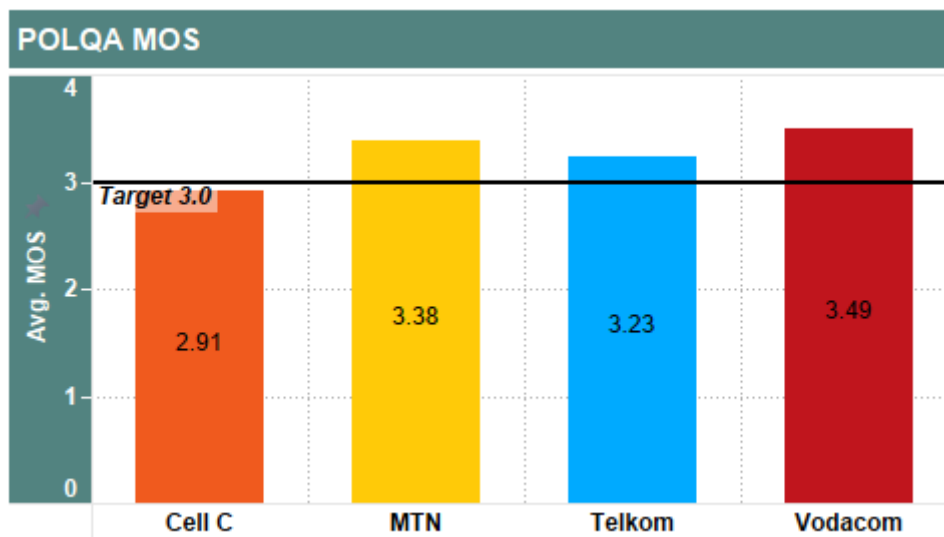


Figure 10. Speech Quality Overall Results

Figure 10 shows the overall Voice Quality scores for each operator. Vodacom achieved the best Overall Speech Quality followed by MTN, Telkom and Cell C. Cell C is the only operator that failed to meet the required overall speech quality target score of 3.

## 4.2. Radio Technology

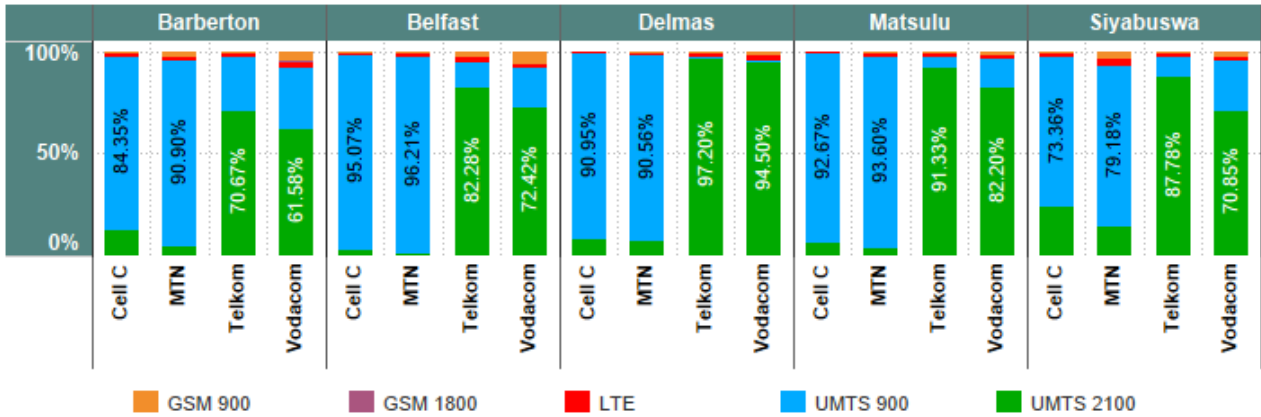


Figure 11. Serving Radio Technology per Area

Figure 11 shows the distribution of the serving radio technology per area. MTN and Cell C showed significant presence of UMS 900 for all area. Telkom and Vodacom showed significant presence of UMS 2100.

Figure 12 shows the distribution of the overall serving technology during the drive test. All operators' serving technology was mainly on UMS. Telkom and Vodacom showed presence of most samples on UMS 2100. MTN have the highest UMS 900 presence followed by Cell C, Vodacom, and Telkom in a descending order.

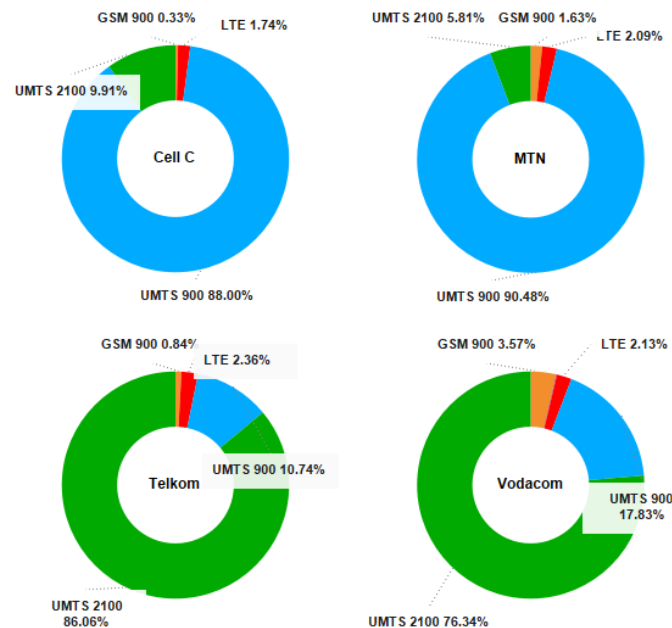


Figure 12. Serving Radio Technology Overall Results

### 4.3. CSFB

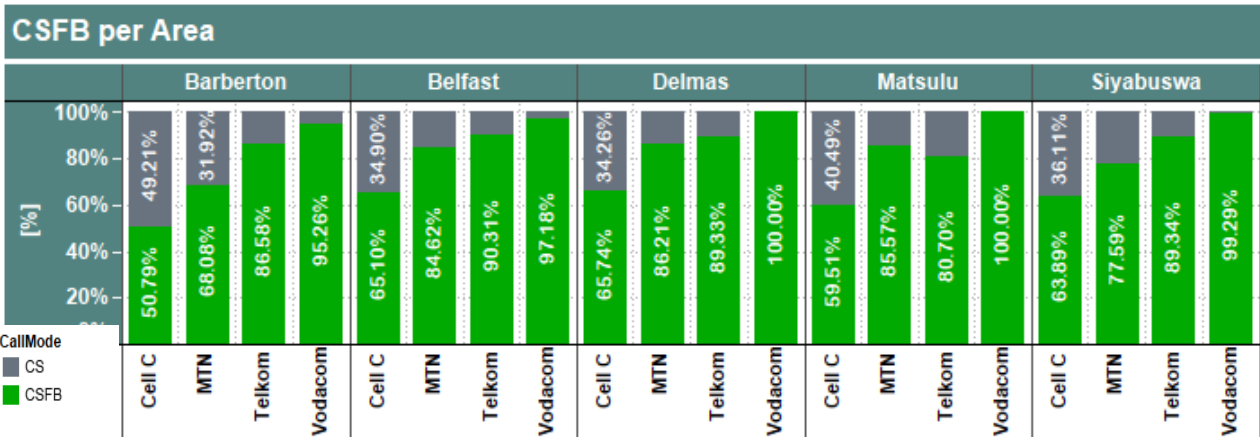


Figure 13. CSFB per Area

Figure 13 shows the breakdown of CS/CSFB calls per Route. Vodacom, Telkom and MTN have most CSFB samples in all the areas. This is an indication that the three operators have significant LTE coverage in all the tested areas.

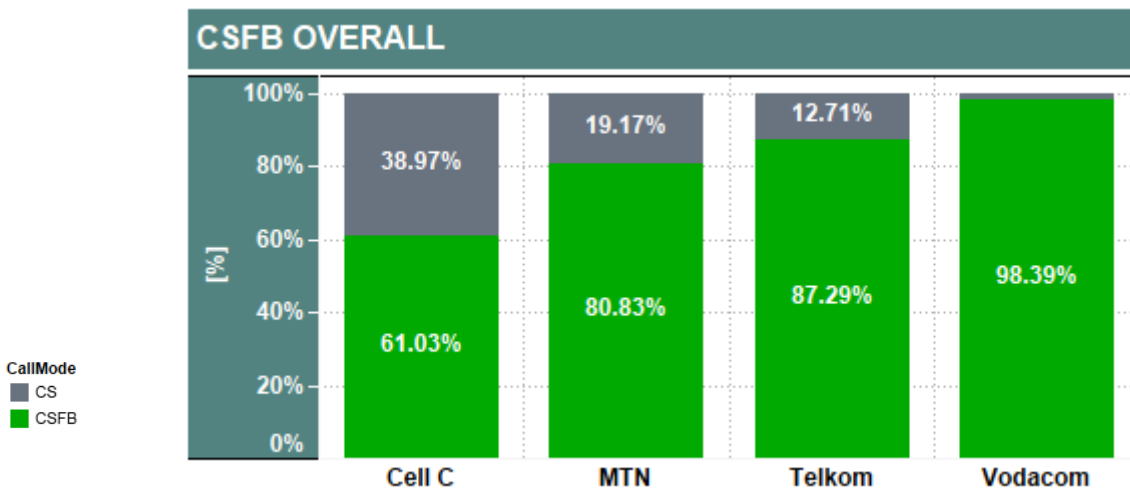


Figure 14. CSFB Overall Results

Figure 14 shows percentage of calls that were attempted on traditional networks as well as the ones initiated on LTE network and made CS fall back to UMTS/ GSM. Vodacom is seen with the most CSFB samples in overall results.

## 5. Conclusion

This section provides the summary and key findings of the measurements. The 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-user's Quality of Service and Operators' network performance varies significantly per area tested. Below are the highlights:

- **Worst Performing Area:** All the operators failed to meet the CSSR target in Barberton, Belfast and Matsulu. All operators, except Vodacom, failed to meet the DCR target in Barberton and Siyabuswa.
- **Call Setup Success Ratio (CSSR):** The results show that in terms of overall Call Setup Success Ratio, all operators achieved less than 98% CSSR, thus failing to meet the Accessibility target.
- **Drop Call Ratio (DCR):** All operators failed to meet the overall Drop Call Ratio of less than 3%, thus failed to meet the Retainability target, thus failed to meet the Retainability target.
- **Speech Quality (MOS):** All operators, excluding Cell C, met the speech quality target of a score of 3.
- **Call Setup Time (CST):** All operators achieved the CST target of less than 20 seconds as per the End-User and Subscribers Service Charter Regulation of 2016.

## 6. Appendices

### 6.1. Appendix 1: Mobile operators' feedback on the report

#### 6.1.1. Vodacom

Vodacom provided feedback and network improvement plans that are in place for areas which performed poorly. The plans were provided as follows:

- Delmas: The area experienced poor coverage as a result of poor signal quality and coverage gaps. There are seven (7) sites which are ready to build which are aimed at improving coverage in the drive test area. Furthermore, frequency optimisation which include centre frequency change for L900 and GSM900 spectrum re-farming will be implemented.
- Siyabuswa: The area experienced high unavailability due to on-going load shedding as well as some of the sites not having back up power. The solution to improve poor performance include Radio frequency optimisation to improve interference and Backup batteries as part of the on-going Back Up power installation project.
- Barberton: The main cause of failures is due to coverage gaps as well as poor quality. The remedial action includes planned new sites to address coverage gaps, tilt adjustments and Resolve configuration issues for UMTS capability.
- Belfast: The area experienced handover failures due to coverage gaps. RF optimisation has been performed and re-trialled to ensure improvement in performance.

#### 6.1.2. MTN

Vodacom provided feedback and network improvement plans that are in place for areas which performed poorly. The plans were provided as follows:

- Delmas: MTN has identified one location where a new site will be built to ensure that coverage is improved in the area. Most of the failures were due to site availability issues at the time when the Authority was conducting drive tests and these issues have been resolved.
- Siyabuswa: MTN has indicated that Eskom outages remains a serious challenge on the availability of the sites. All the issues on the sites were later resolved.
- Belfast: Low call accessibility experienced were mainly due to availability issues on five sites when the drive tests were conducted. These issues were later resolved to improve call accessibility in the area. On another two sites, antenna optimisation methods will be implemented immediately to improve coverage.

- Matsulu: Low CSSR were mainly due to operational site availability issues on three sites. MTN has also identified two locations where new coverage sites will be built from the 2023 financial year. On another two sites, antenna optimisation methods will be implemented immediately to improve coverage.
- Barberton: Most failures were due to poor coverage. MTN will build new sites in two locations from the 2023 financial year to improve coverage in the area. Also, two more sites will be sectorised to address coverage patches that resulted in poor call accessibility in the area.

### 6.1.3. Cell C

Cell C in its response indicated that it notes the findings of the Authority and will continue to engage with its national roaming service provider to improve coverage in areas identified with poor performance. The plans to address poor performance were provided as follows:

- Delmas, Siyabuswa, Barberton, Belfast, and Matsulu: Most of the failures were due to terrain/low signal coverage, poor availability due to Eskom loadshedding and mobile device trying to connect to prohibited network operator. The solution includes new site activation in Barberton area, and investigation with the roaming service provider in the areas where Cell C do not have its own coverage.

### 6.1.4. Telkom

Telkom's response to the report indicated that it views the Authority's test results as very significant and uses them as additional input to further improve the quality of the mobile network. Furthermore, Telkom indicated that they will be engaging with the roaming partners to resolve issues and improve customer experience.

- Delmas: Most failures were due to poor coverage caused by flapping sites that were affected by Eskom power failures and the sites do not have backup batteries due to theft. The installation of back-up power will commence in the new financial year. Failures that occurred on our roaming partner's network were due to poor coverage. Telkom Mobile to continue to engage with roaming partner to improve/resolve these issues to improve customer experience in the affected areas.
- Siyabuswa: Failures that occurs on the roaming partner's network on the outskirts of Siyabuswa were caused by signal quality, which will be addressed with the roaming partner to improve customer experience in the affected areas.
- Belfast: Most of the failures in Belfast were due to poor coverage and these failures will be resolved by planning sites in the affected area.

- 
- Matsulu: Most of the failures occurred on the roaming partner's network on the outskirts. Telkom will engage with the roaming partner to improve/resolve these issues to improve customer experience in the area.
  - Barberton: Most of the failures were on the roaming partner's network on the outskirts. Telkom will engage with the roaming partner to improve/resolve these issues to improve customer experience in the area.



## 6.2. Appendix 2: Detailed Test results per Phase

Table 4. CSSR and Call Setup Time Phase 1 and Phase 2

		Barberton		Belfast		Delmas		Matsulu		Siyabuswa		Grand Total
		Phase 1	Phase 2	Phase 1	Phase 2	Phase 1	Phase 2	Phase 1	Phase 2	Phase 1	Phase 2	
Call Attempt	Cell C	545	545	427	442	494	559	487	464	546	563	5072
	MTN	546	547	428	442	495	560	488	481	563	571	5121
	Telkom	542	544	427	442	495	560	488	482	561	570	5111
	Vodacom	546	547	428	442	495	559	488	482	562	571	5120
Call Failed	Cell C	107	150	16	91	17	20	36	67	180	366	1050
	MTN	87	109	10	55	9	5	23	50	144	323	815
	Telkom	66	79	54	49	32	6	28	28	22	11	375
	Vodacom	41	39	13	18	3	8	19	15	4	13	173
Call Setup Success Ratio [%]	Cell C	80.37%	72.48%	96.25%	79.41%	96.56%	96.42%	92.61%	85.56%	67.03%	34.99%	79.30%
	MTN	84.07%	80.07%	97.66%	87.56%	98.18%	99.11%	95.29%	89.60%	74.42%	43.43%	84.09%
	Telkom	87.82%	85.48%	87.35%	88.91%	93.54%	98.93%	94.26%	94.19%	96.08%	98.07%	92.66%
	Vodacom	92.49%	92.87%	96.96%	95.93%	99.39%	98.57%	96.11%	96.89%	99.29%	97.72%	96.62%
Call Setup Time [s]	Cell C	4.72	4.66	4.71	4.60	5.03	4.89	4.75	5.30	5.72	5.57	4.96
	MTN	4.29	4.10	3.78	3.46	4.43	4.45	4.34	5.33	5.78	5.62	4.52
	Telkom	4.19	4.13	4.02	3.92	4.60	4.22	4.12	4.07	4.04	3.89	4.12
	Vodacom	3.59	3.43	3.48	3.65	3.76	3.86	3.05	3.06	3.05	3.09	3.40

Table 5. (DCR) and POLQA MOS Phase 1 and Phase2

		Barberton		Belfast		Delmas		Matsulu		Siyabuswa		Grand Total
		Phase 1	Phase 2	Phase 1	Phase 2	Phase 1	Phase 2	Phase 1	Phase 2	Phase 1	Phase 2	
Call Completed	Cell C	108	83	104	88	118	133	116	89	66	42	947
	MTN	112	101	104	91	121	140	117	84	75	41	986
	Telkom	111	120	92	104	112	141	117	111	137	135	1180
	Vodacom	121	132	105	108	114	135	124	121	140	141	1241
Call Dropped	Cell C	4	10	1	1	1	5	2	1	4	9	38
	MTN	9	6	2	3	1	2	3	1	8	5	40
	Telkom	11	7	3	2	6	4	5	5	4	6	53
	Vodacom	3	2	2	2	13	9	0	4	3	1	39
Drop Call Ratio [%]	Cell C	3.57%	10.75%	0.95%	1.12%	0.84%	3.62%	1.69%	1.11%	5.71%	17.65%	3.86%
	MTN	7.44%	5.61%	1.89%	3.19%	0.82%	1.41%	2.50%	1.18%	9.64%	10.87%	3.90%
	Telkom	9.02%	5.51%	3.16%	1.89%	5.08%	2.76%	4.10%	4.31%	2.84%	4.26%	4.30%
	Vodacom	2.42%	1.49%	1.87%	1.82%	10.24%	6.25%	0.00%	3.20%	2.10%	0.70%	3.05%
POLQA MOS	Cell C	2.93	2.94	3.10	3.12	2.89	2.96	2.97	2.82	2.64	2.35	2.91
	MTN	3.35	3.38	3.62	3.60	3.39	3.49	3.46	3.24	2.99	2.71	3.38
	Telkom	3.25	3.15	3.09	3.18	3.24	3.34	3.41	3.35	3.16	3.13	3.23
	Vodacom	3.43	3.38	3.52	3.51	3.53	3.49	3.58	3.53	3.51	3.47	3.49

### 6.3. Appendix 3: Technology Maps

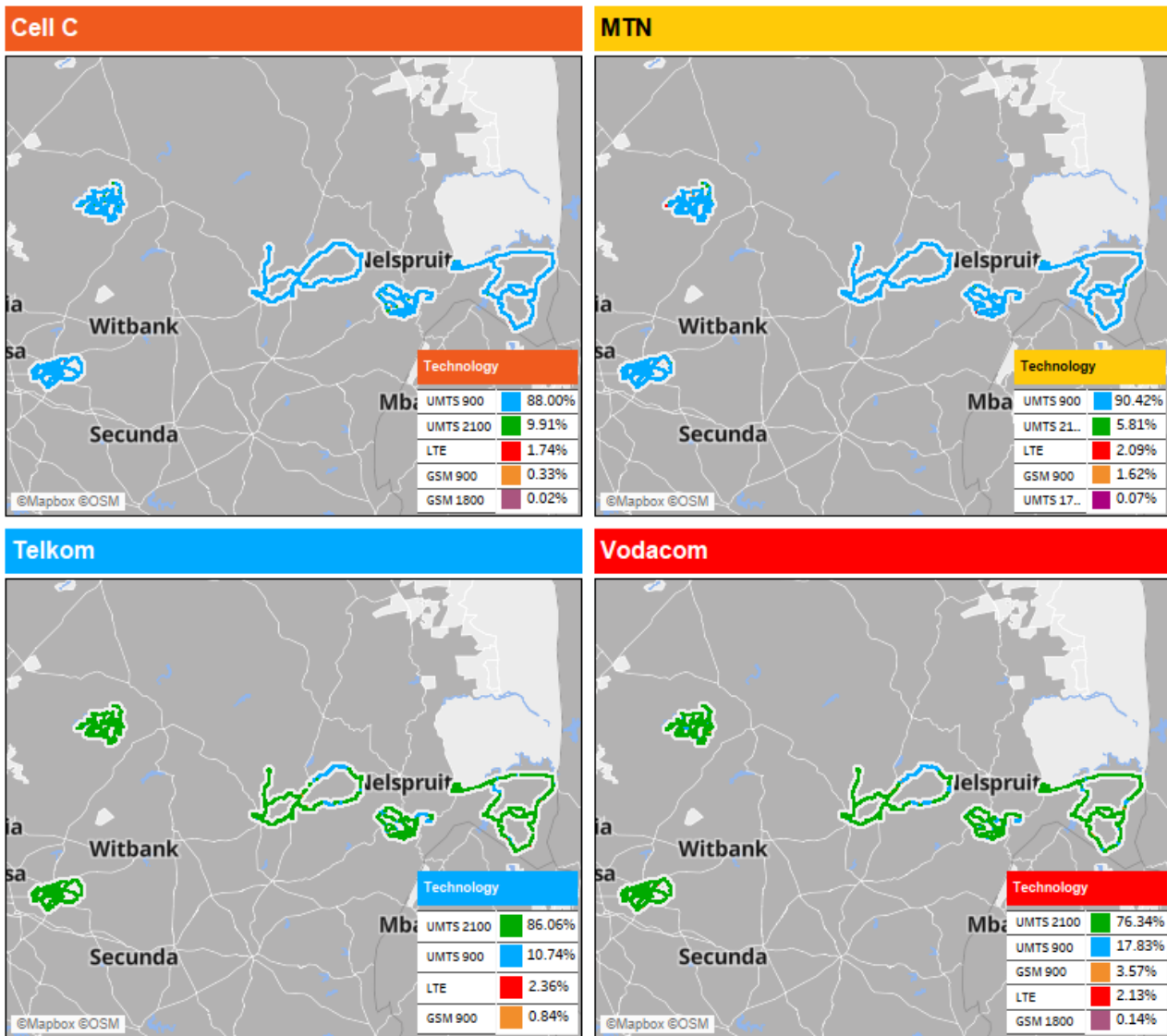


Figure 15. Radio Technology Maps

## 6.4. Appendix 4: UMTS Coverage Maps

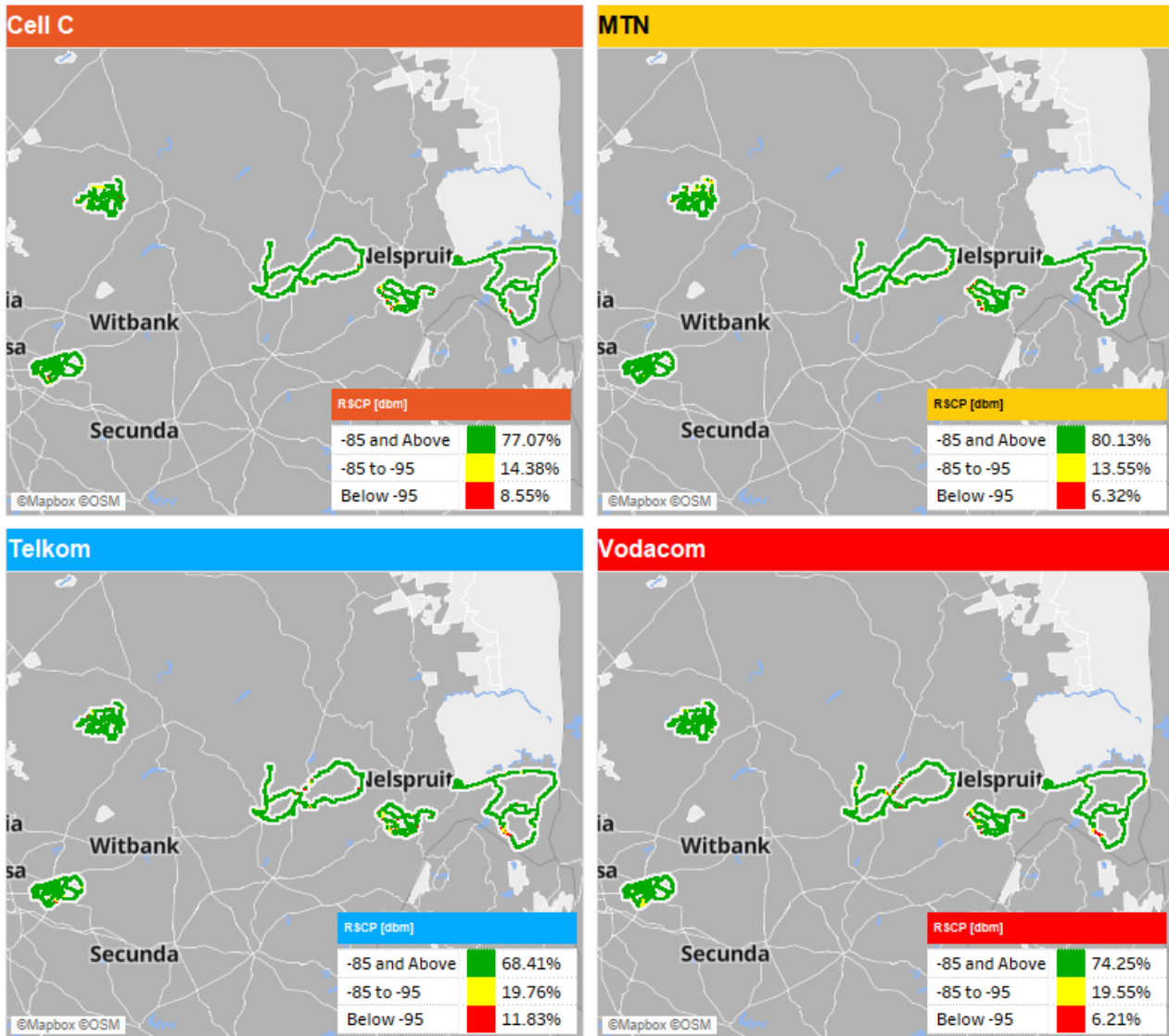


Figure 16. UMTS Coverage Maps

## 6.5. Appendix 5 UMTS Quality Map

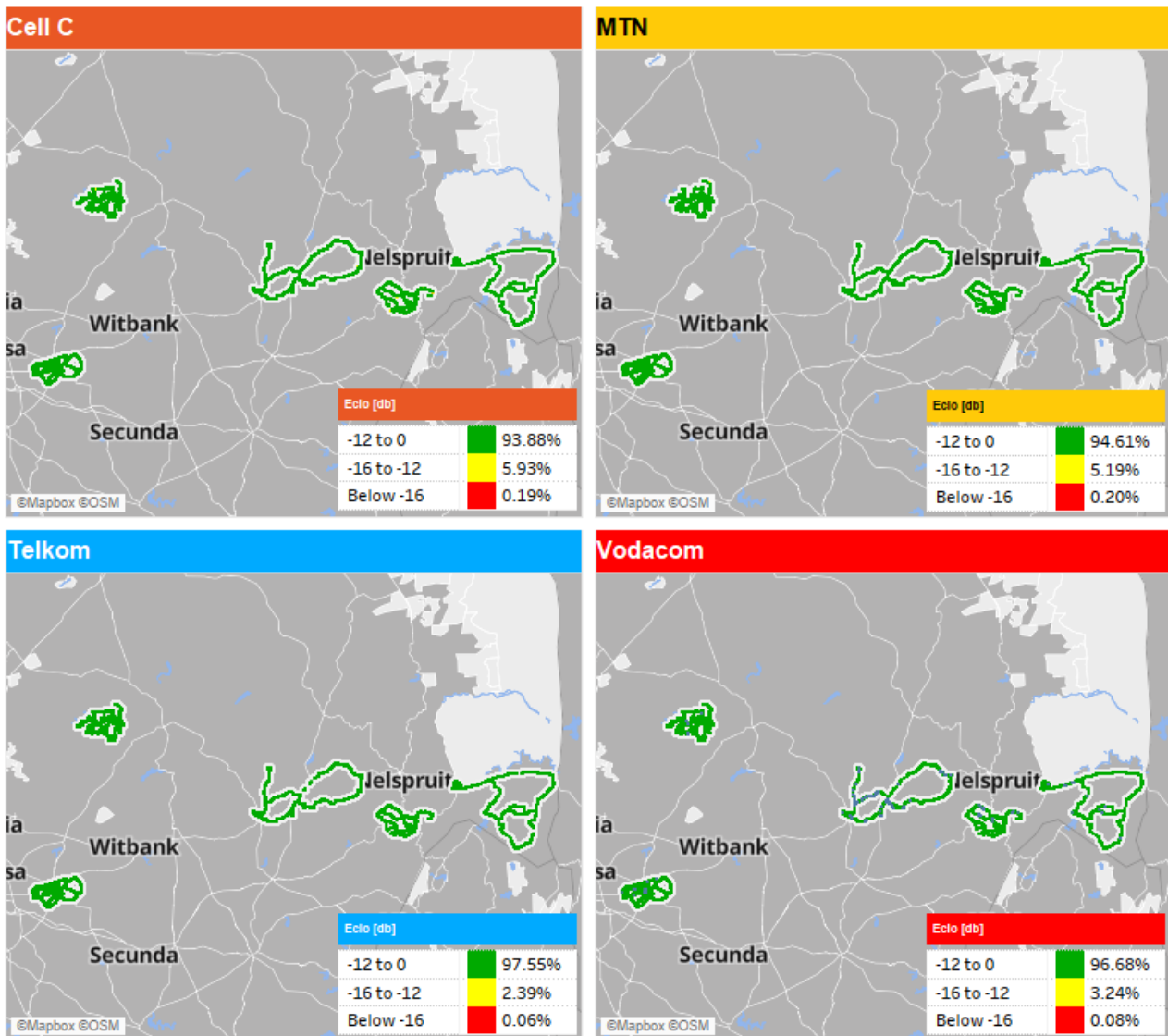


Figure 17. UMTS Quality Maps