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

KwaZulu-Natal 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 KwaZulu-Natal Province. The measurements were carried out in the period 5 to 22 October 2021, covering a total distance of over 3216 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 KwaZulu-Natal Province were Durban, Madundube, Mpumalanga, Senzokuhle and Umnini.

A vehicle equipped with Rohde and Schwarz Smart Benchmarker 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 achieved less than 98% CSSR, thus failed to meet the Accessibility target.

In terms of the overall Drop Call Ratio; MTN is the only operator that met the overall DCR target of less than 3%, Cell C, Telkom and Vodacom failed to meet the overall DCR target, thus failed to meet the Authority's Retainability target.

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

Cell C and Telkom failed to achieve the Speech Quality Target of greater than 3.

The overall voice performance for voice service was poor in most of tested areas of the KwaZulu-Natal Province.

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 KwaZulu-Natal Province. The test was focused on monitoring the cellular voice telephony service being offered by Cell C, MTN, Telkom and Vodacom within the KwaZulu-Natal Province.

The QoS monitoring was conducted in areas that fall under the eThekwini District Municipality. The areas of interest that were selected within this municipality were Durban, Madundube, Mpumalanga, Senzokuhle and Umnini. The areas consist of major towns, townships, farm areas, rural areas, major road arteries, economic activity nodes and areas of previous complaints.

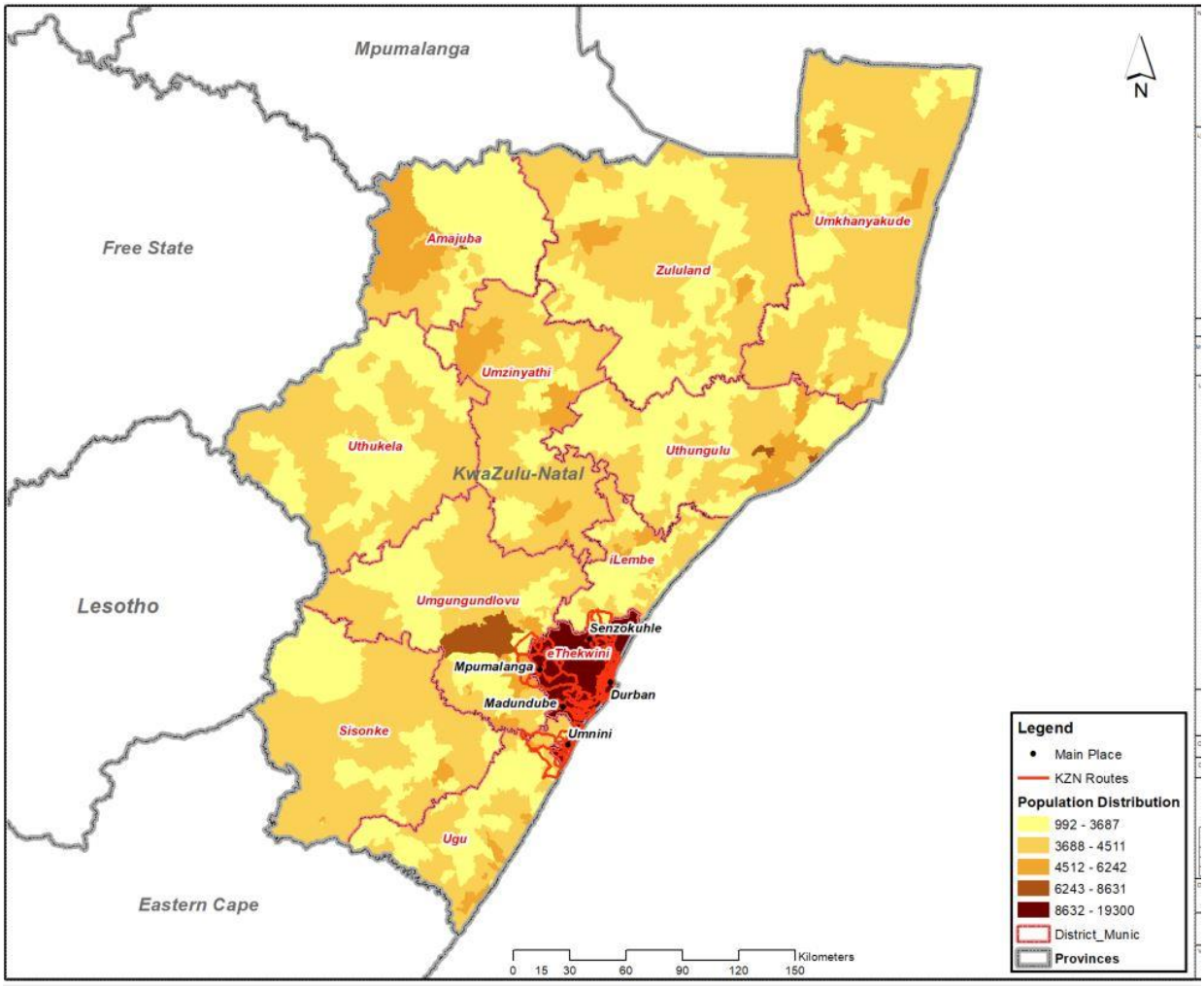


Figure 1. KwaZulu-Natal Province Route Map with Population Distribution

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 caries 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 (12), with three devices 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 the 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.

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.

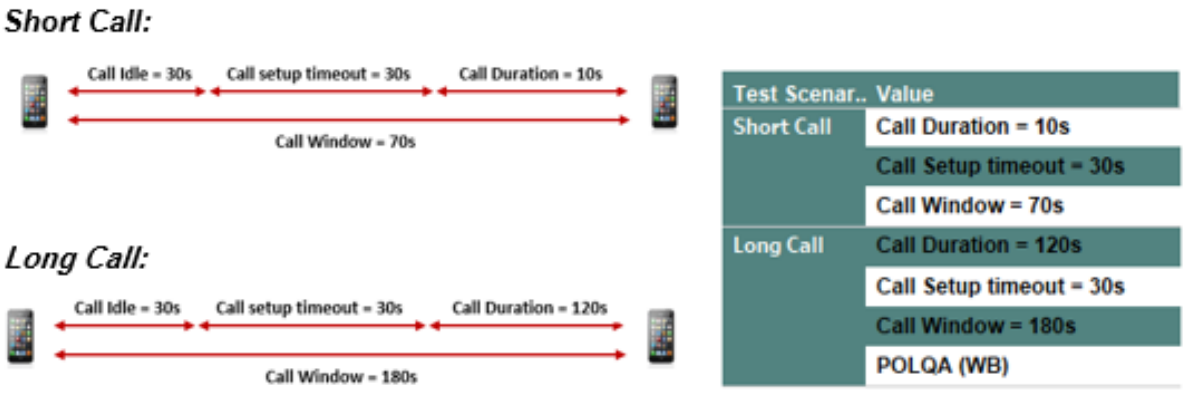


Figure 2. Call Window Duration

3.2. Route selection

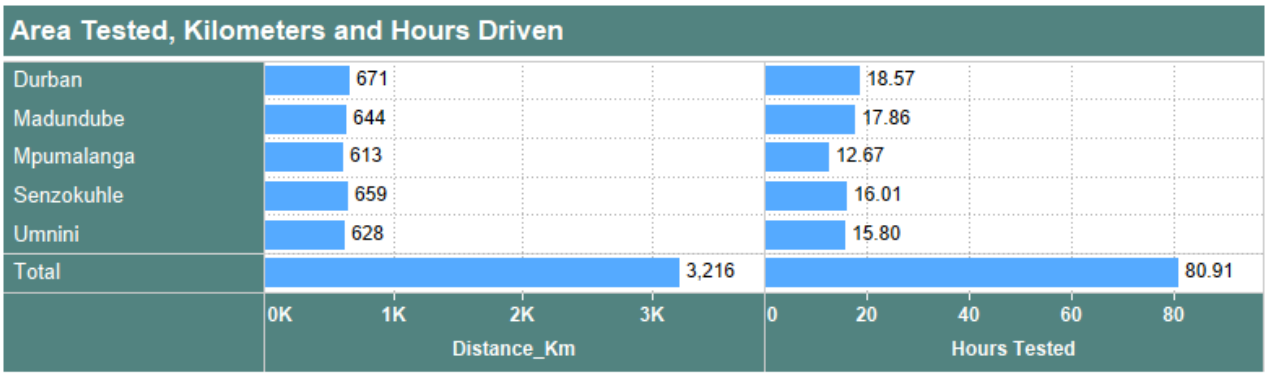
Measurement routes were selected so that they would reflect end user distribution at different geographical locations in areas where people live and use mobile phones - major towns, townships, farm areas, rural areas, major road arteries, economic activity nodes and areas of previous complaints. The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

Table 1. Test timeline for area covered

Routes and Dates			
District	**Area**	**Dates**	**Phase**
eThekwini	Durban	5/10/2021	Phase1
		14/10/2021	Phase 2
	Umnini	06/10/2021 and 07/10/2021	Phase1
		15/10/2021 and 18/10/2021	Phase 2
	Mpumalanga	8/10/2021	Phase1
		19/10/2021	Phase 2
	Madundube	11/10/2021 and 12/10/2021	Phase1
		20/10/2021 and 21/10/2021	Phase 2
	Senzokuhle	13/10/2021	Phase1
		22/10/2021	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:

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:

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%.

4. 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: Durban, Madundube, Mpumalanga, Senzokuhle and Umnini.

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

Table 3 shows a summary of KPI results per area. All operators failed to achieve the target for Accessibility in four of the five tested areas. Durban was an exception as Vodacom was the only operator that failed to achieve the target in this area. Retainability targets were achieved by all operators in Durban, however, most operators failed to achieve the target in the other tested areas. In addition to the Durban area, MTN was also able to achieve the Retainability target in Mpumalanga and Senzokuhle whilst Vodacom also achieved the target in Umnini. Cell C and Telkom have poor Voice Quality in all the tested areas. Vodacom have Voice quality below the target of 3 in only Umnini. Detailed results are provided in the Appendix 1 and Appendix 2.

Table 3. Summary of KPI Results per Area

		Durban	Madundube	Mpumalanga	Senzokuhle	Umnini
Call Setup Success Ratio - [%]	CellC	98.33%	87.05%	96.42%	94.51%	91.46%
	MTN	99.77%	91.10%	97.77%	97.63%	94.24%
	Telkom	99.24%	95.50%	96.32%	93.21%	90.76%
	Vodacom	97.47%	90.76%	90.38%	91.81%	90.58%
Drop Call Ratio [%]	CellC	2.06%	11.15%	5.41%	12.27%	8.99%
	MTN	0.59%	3.82%	1.33%	1.85%	5.19%
	Telkom	1.47%	3.95%	3.79%	7.52%	6.79%
	Vodacom	1.45%	4.81%	5.14%	7.97%	2.62%
Call Setup Time [s]	CellC	3.83	4.23	3.94	4.57	5.30
	MTN	4.55	4.95	3.22	4.91	4.92
	Telkom	3.71	3.97	3.79	4.13	4.12
	Vodacom	4.31	5.08	4.80	4.59	4.81
POLQA MOS	CellC	2.94	2.90	2.93	2.90	2.94
	MTN	3.57	3.44	3.43	3.45	3.41
	Telkom	2.98	2.89	2.93	2.88	2.88
	Vodacom	3.29	3.09	3.24	3.25	2.91

4.1.1. Call Accessibility (Short Call)

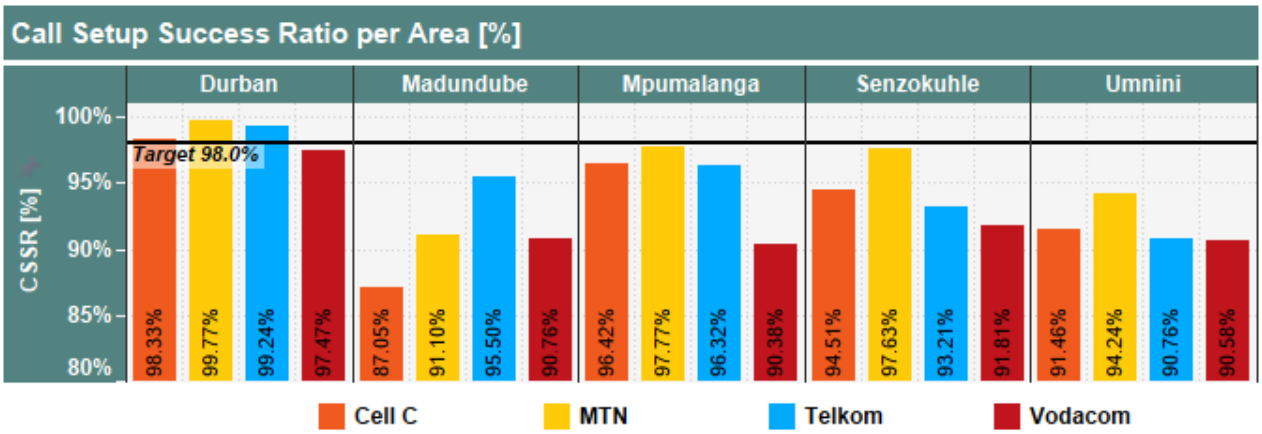


Figure 3. CSSR KPI per Area - Short Call

Figure 3 shows that none of the operators met the 98% CSSR target in four of the tested areas: Madundube, Mpumalanga, Senzokuhle and Umnini. In Durban, Vodacom was the only operator that failed to achieve the target.

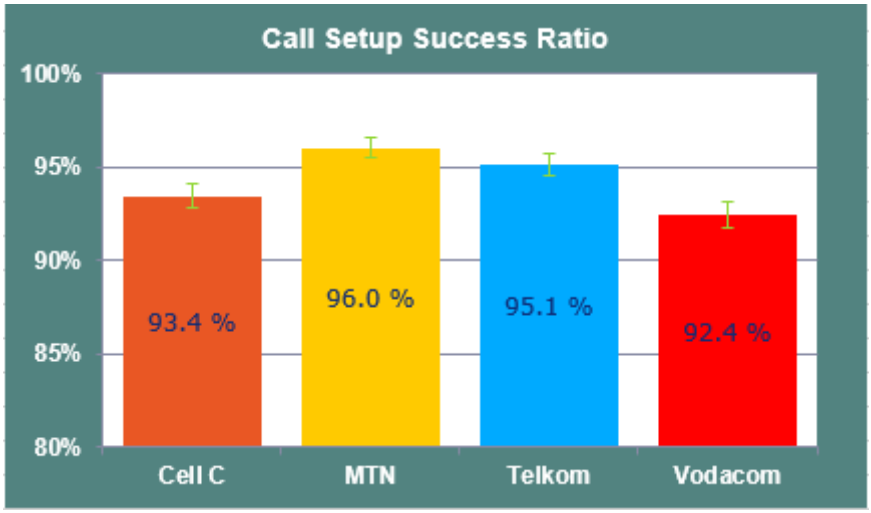


Figure 4. CSSR KPI Overall Results

Figure 4 shows all operators failed to achieve the overall CSSR target of 98%. MTN's Overall CSSR is the highest followed by Telkom, Cell C and Vodacom. There is statistical significance difference recorded between MTN and Vodacom, as well as MTN and Cell C. There is no statistical significance difference recorded between MTN and Telkom.

4.1.2. Drop Call Ratio (Long Call)

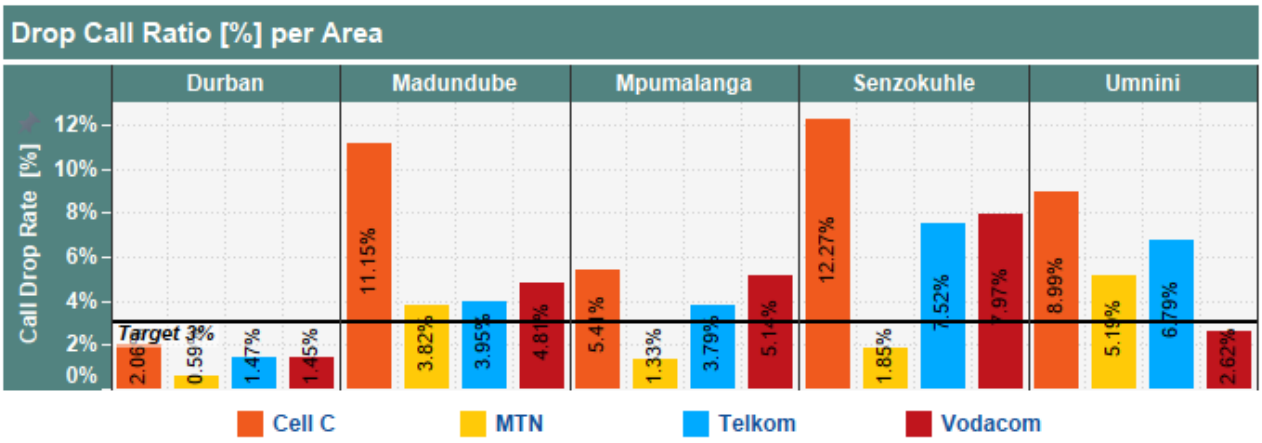


Figure 5. DCR KPI per Area Long Call

Figure 5 shows the DCR results per area for all the operators. All operators met the DCR target in Durban. All Operators failed to achieve the DCR target in Madundube. All operators except MTN failed to meet target in Mpumalanga and Senzokuhle. Vodacom was the only operator that met the target in Umnini.

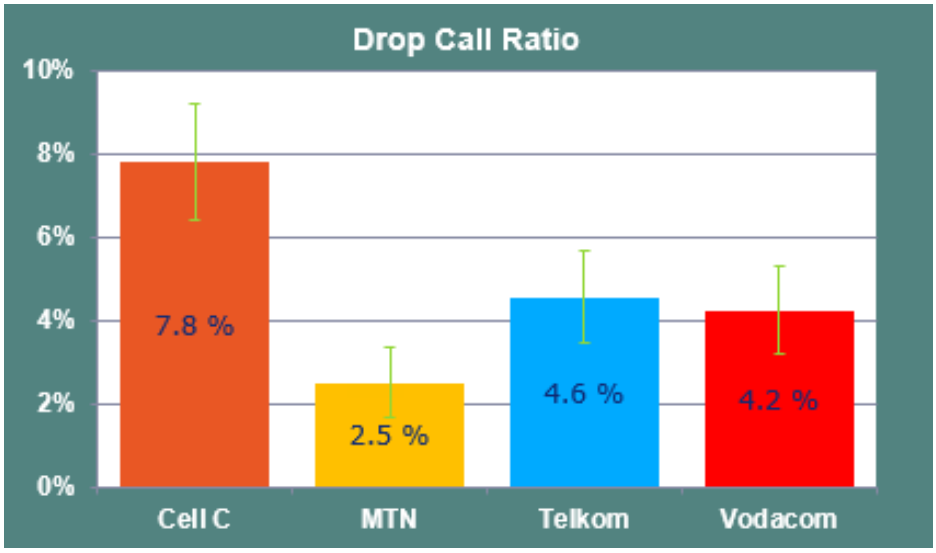


Figure 6. DCR KPI Overall Results

The Overall results on Figure 6 show that Cell C, Telkom and Vodacom failed to meet the overall DCR target of less than 3%, except MTN. MTN's Overall DCR is the lowest followed by Vodacom, Telkom and Cell C. There is no statistically significant difference recorded between MTN and Vodacom and between Vodacom and Telkom. There is statistical significance difference between

MTN and the other two operators: Cell C and Telkom. There is statistical significance difference between Vodacom and Cell C.

4.1.3. Call Setup Time (Short Call)

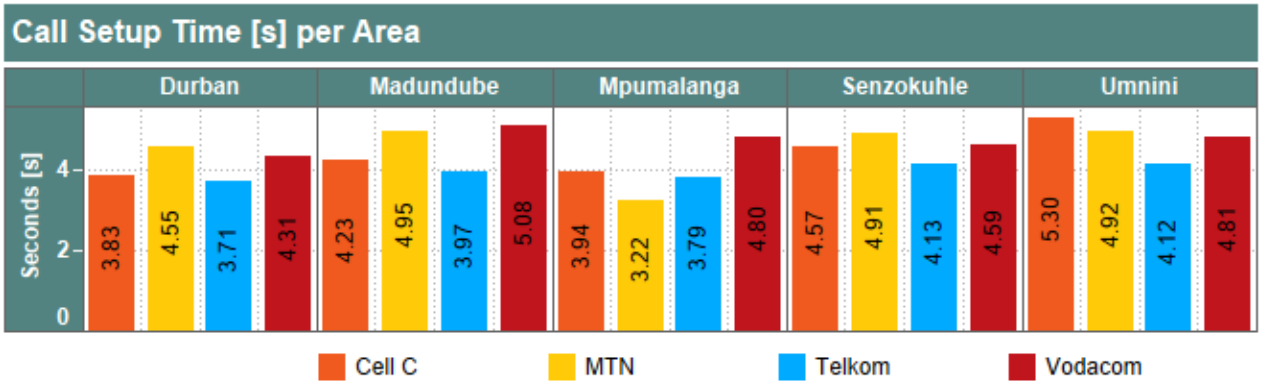


Figure 7. Call Setup Time[s] KPI per Area

Figure 7 shows that 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. Telkom had the lowest CST in four areas: Durban, Madundube, Senzokuhle and Umnini. MTN had the lowest CST in Mpumalanga.

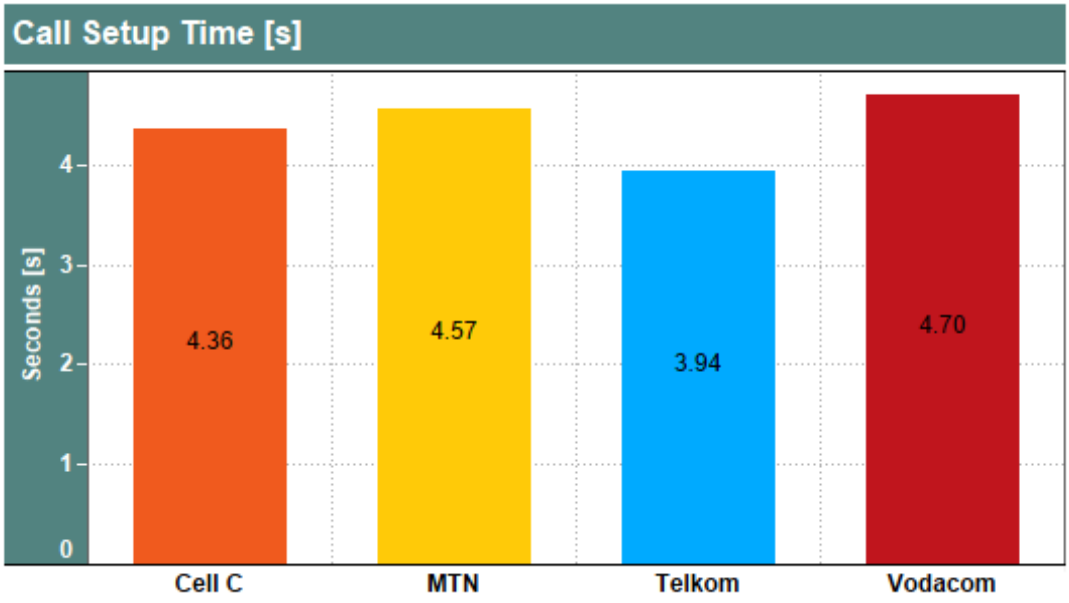


Figure 8. Call Setup Time[s] KPI Overall Results

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

4.1.4. POLQA MOS (Long Call)

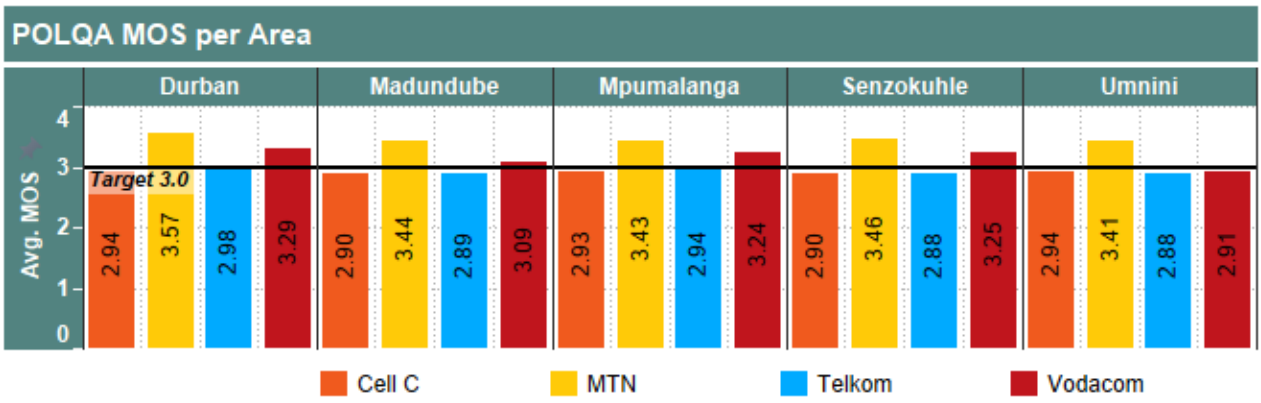


Figure 9. Speech Quality per Area

Figure 9 depicts the Speech Quality results per tested area. MTN and Vodacom are the only operators that achieved an average POLQA MOS of at least 3, thus meeting the required Speech Quality target in all the tested areas except in Umnini where Vodacom was below 3. Cell C and Telkom failed to meet the Speech Quality target in all five tested areas.

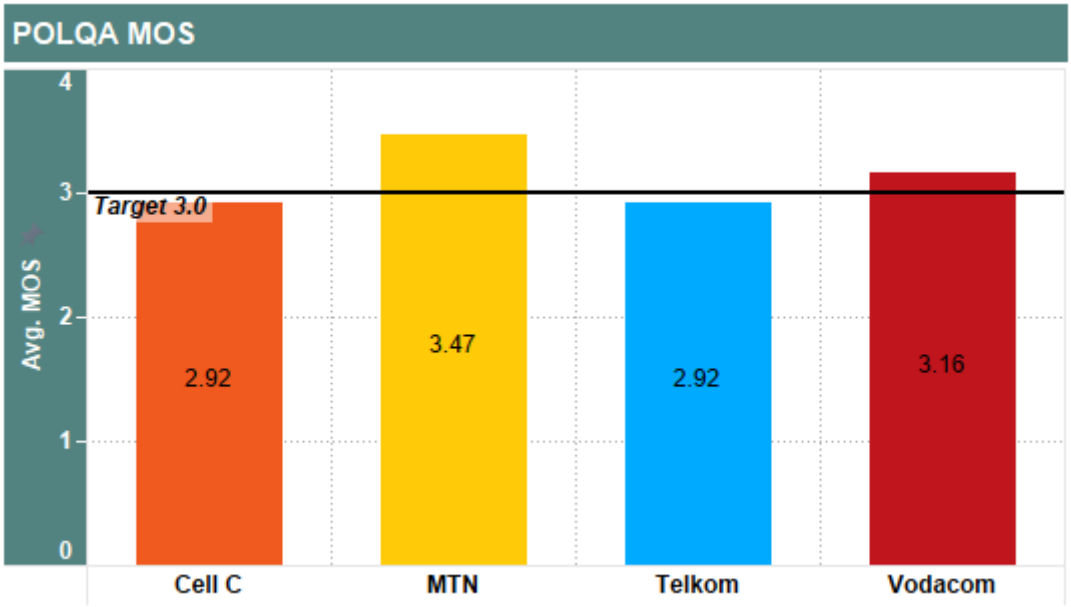


Figure 10. Speech Quality Overall Results

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

4.2. Radio Technology

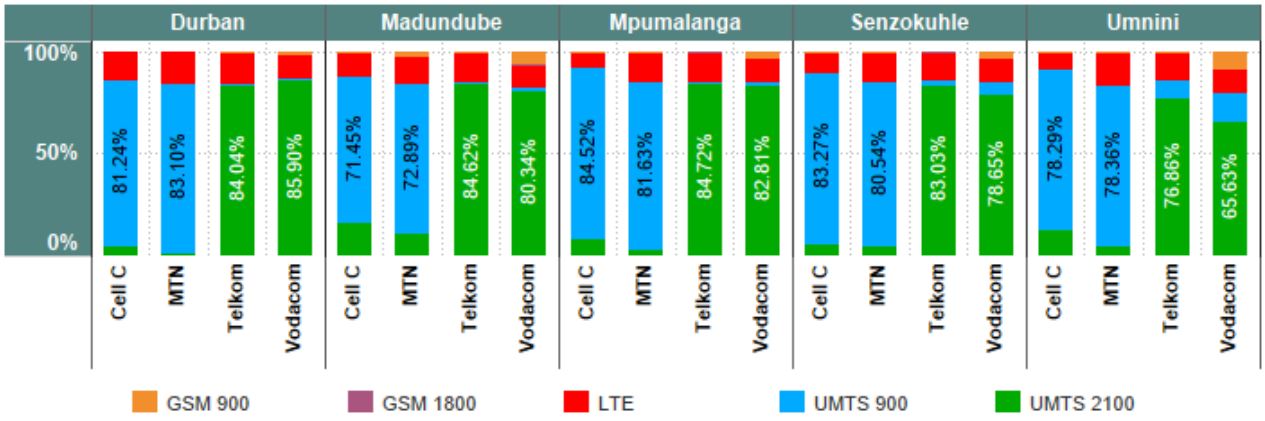


Figure 11. Serving Radio Technology per Area

Figure 11 shows the distribution of the serving radio technology per area. MTN and Cell C showed significant presence of UMTS 900 for all areas.

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

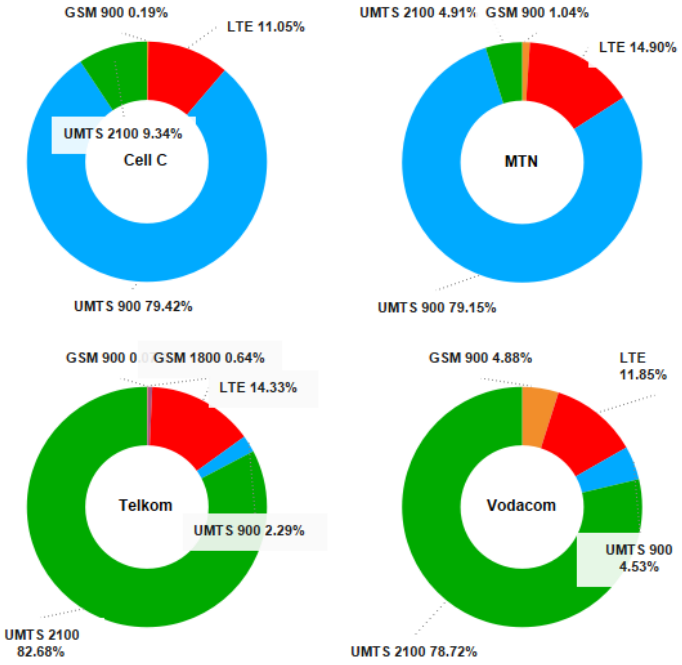


Figure 12. Serving Radio Technology Overall Results

4.3. CSFB

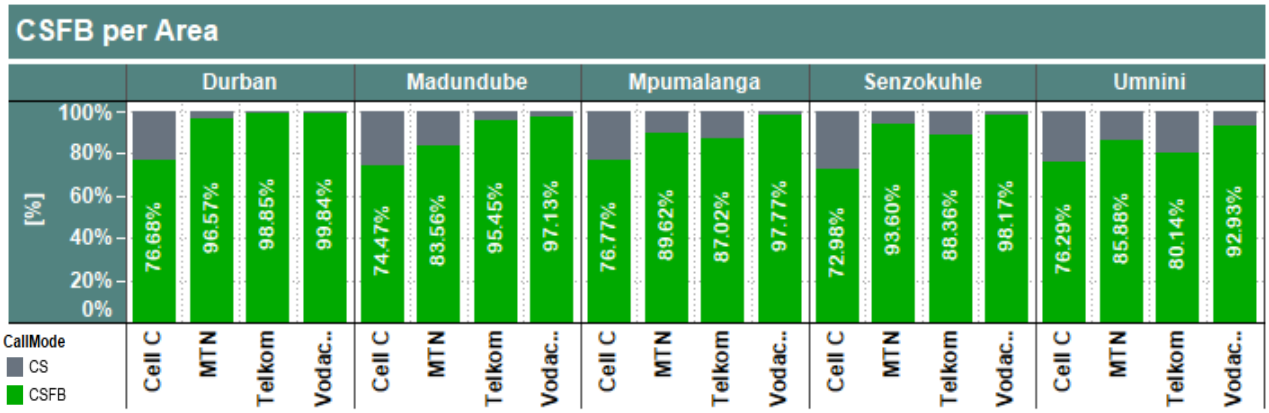


Figure 13. CSFB per Area

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

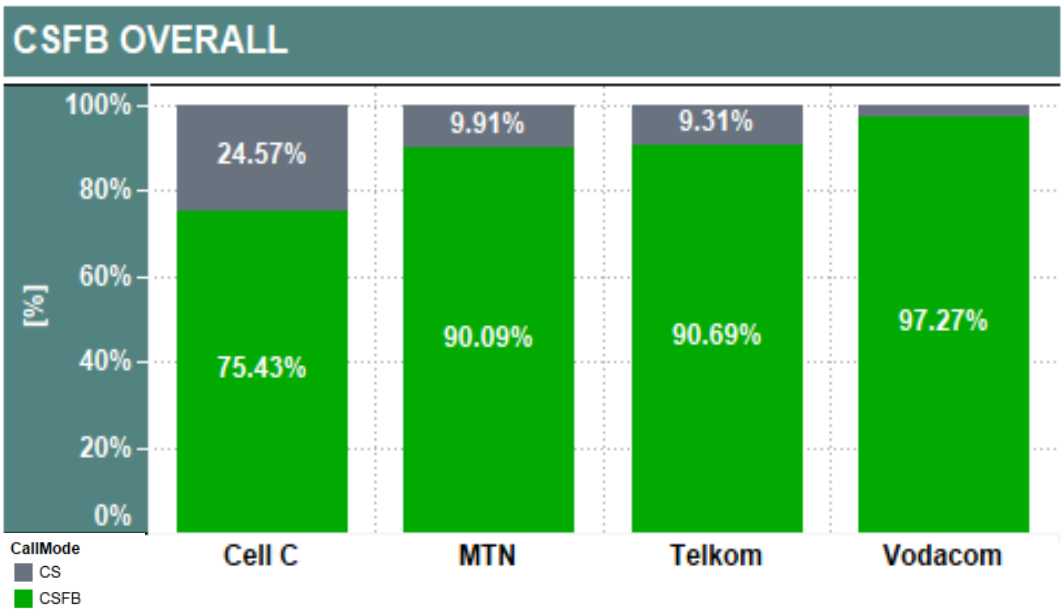


Figure 14. CSFB Overall Results

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.

4.4. Comparison of current results to previous results

Durban North/KwaMashu was previously monitored in the financial year 2013/2014. The aim of conducting the recent QoS measurements in these areas was to assess the level of improvement that the operators promised in the previous financial year.

Table 4 results indicates that all operators show improvement in terms of Accessibility, regardless of Vodacom failing to meet the target for 2021/2022. In terms of Retainability; all operators show a significant improvement.

It must be noted that the target for Accessibility was 95% in 2013/2014, this is before the revision of *End-User and Subscriber Service Charter Regulations of 2016* which became effective on 1 April 2016. Table 4 summarises the previous and current results. Telkom was not yet included in the measurements during the financial year 2013/14.

Table 4 Comparison of previous results

		Accessibility (%)				Retainability (%)			
Route	**Financial Year**	**Cell C**	**MTN**	**Telkom**	**Vodacom**	**Cell C**	**MTN**	**Telkom**	**Vodacom**
Durban North /KwaMashu	13/14	96,07	94,46	-	96,29	12,67	3,60	-	4,00
Durban	21/22	98,33	99,77	99,24	97,47	2,06	0,59	1,47	1,45

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 targets for most KPIs in **Madundube and Umnini.**
- **Best Performing Area: Durban** is the area where the operators achieved most of the targets. Cell C and Telkom failed to achieve the MOS target, whilst Vodacom is the only operator that failed to achieve the CSSR target.
- **Call Setup Success Ratio (CSSR)**: All the operators failed to meet CSSR target in **all the tested areas,** except Durban**.** Overall results show that all the operators failed to achieve 98% CSSR target, thus failing to meet the Accessibility target.
- **Call Setup Time (CST)**: All operators achieved the CST target as per the End-User and Subscribers Service Charter Regulation of 2016.
- **Drop Call Ratio (DCR)**: All the operators except MTN, failed to meet the overall Drop Call Ratio target of 3%, thus failing to meet the Retainability target.
- **Speech Quality (MOS)**: MTN and Vodacom achieved the overall Speech Quality target of a score of more than 3, while Cell C and Telkom failed to meet the target for Speech Quality.

In terms of the Accessibility results for each specific route; none of the operators met the 98% CSSR target in four of the tested areas: Madundube, Mpumalanga, Senzokuhle and Umnini. Vodacom failed to achieve the target in all tested areas.

In terms of the Retainability results for each specific route; all operators met the DCR target in Durban but failed to achieve the DCR target in Madundube. All operators except MTN failed to meet target in Mpumalanga and Senzokuhle. Vodacom was the only operator that met the target in Umnini

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 as amended.

MTN achieved an average MOS of at least 3 in all the tested areas, thus, meeting the Speech Quality target. Vodacom achieved an average MOS of at least 3 in four tested areas but failed in Umnini. Cell C and Telkom failed to meet the target for Speech Quality in all tested areas.

The overall voice performance for voice service was poor in most tested areas of the KwaZulu-Natal Province.

6. Appendices

6.1. Appendix 1: 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.

6.1.1 Vodacom

Vodacom provided feedback and network improvement plans that are in place for areas which performed poorly. Vodacom says their Network Key Performance Indicators were checked for the period which measurements were conducted in the region and confirms poor sites availability mainly due to Eskom load shedding causing sites outages, leading poor coverage and high congestion in the areas serviced.

It is also mentioned that call setups were initiated on 3G technology but completed on GSM where they got disconnected, regardless of the adequate 2G RF conditions during the time of failure.

The solutions proposed in order to address the challenges are as follows:

a) A project that involves site hardening and backup power installation will be implemented in 2022 Financial Year.
b) A network audit was conducted for the sites that serves the area. All Radio Frequency (RF) faults that were picked up will be resolved with cluster optimisation which will be completed in April 2022.
c) Inter Radio Access Technology (IRAT) audits will be done to ensure that there are no incorrect configurations causing the use equipment to drop calls during handovers.

6.1.2 MTN

MTN acknowledged the Authority's report and provided remedial actions in the following areas:

- Umnini – The poor call accessibility and call retainability are due to coverage holes. Electrical down tilts will be implemented on the identified sites to improve coverage which will eventually improve the CSSR and DCR. MTN indicated that they will plan and build new sites in the 2023 financial year to resolve most call accessibility and retainability issues.
- Mpumalanga – MTN indicated that it has fair amount of coverage sites and blocked calls were experienced due to uneven terrain in the area. MTN indicated that they will immediately implement electrical down tilts on two sites to improve coverage. Furthermore, MTN has

identified two new locations where new coverage sites will be built from the financial year 2023 to address the coverage issues in the areas.

- Madundube – The dropped calls and blocked calls experienced during the Authority's drive testing in the area are mainly due to poor coverage. MTN indicated that they have identified two new locations where sites will be built from the 2023 financial year to address coverage issues in the area. Down tilts will be implemented immediately on existing sites to improve coverage.
- Senzokuhle – Most dropped calls and blocked calls experienced in the area were due to site availability at the time when the Authority was conducting measurements. MTN has identified few sites where antenna optmisation methods will be implemented immediately to improve the quality.

6.1.3 Cell C

Cell C indicated that their response includes the highlights of the report taking into account the network coverage of Cell C and MTN under the commercial national roaming agreement. Cell C also stated that they will engage with their Roaming Partner, with regards to providing 3G and 4G coverage in the tested areas. Furthermore, Cell C mentioned that:

- majority of failed and dropped calls are in areas where there is poor coverage which will be further analyzed and implement the solutions with the national roaming service provider.
- Setup Failures (short call): There is an on-going investigation by Cell C to see why mobile is blocked from accessing the network.
- the challenges of mobile roaming on a prohibited network operator to be investigated.
- high drops on CSFB to be investigated.
- the drop call to be investigated in the areas where good coverage was experienced.

6.1.4 Telkom

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

Furthermore, Telkom indicated that:

- Most of the on-net failures were caused by coverage and quality issues on UMTS and GSM technology and will be resolved through parameter optimization. Failures which occurred on

the roaming partner's network were due to poor coverage, thus, the operator will continue engaging with their roaming partners to resolve issues and improve customer experience.

- two hundred and thirty-four (234) sites were down due to various reasons and thirty-four (34) of these sites were affected by vandalism.

There are eight (8) sites at different stages of rollout within the tested areas. One hundred and eleven (111) sites are in site acquisition phase (thirty-eight in Durban, twenty-three in Mpumalanga, seventeen in Senzokuhle, fourteen in Umnini and nineteen in Madundube) and expected to be in service by the second quarter of 2022/2023 financial year, depending on the landlord's approvals. There are sixty-eight (68) sites on a re-planning phase (thirty-two in Durban, twelve in Mpumalanga, ten in Senzokuhle, eight in Umnini and six in Madundube).

6.2. Appendix 1: Detailed Test results per Phase

Table 5. CSSR and Call Setup Time Phase 1 and Phase 2

		Durban		Madundube		Mpumalanga		Senzokuhle		Umnini		Grand Total
		Phase 1	Phase 2	Phase 1	Phase 2	Phase 1	Phase 2	Phase 1	Phase 2	Phase 1	Phase 2	
Call Attempt	CellC	661	653	645	614	442	452	560	569	600	524	5720
	MTN	663	653	650	619	445	452	565	572	603	525	5747
	Telkom	662	654	649	617	444	452	565	569	603	523	5738
	Vodacom	662	643	648	618	444	450	564	571	602	523	5725
Call Failed	CellC	11	11	92	71	20	12	31	31	41	55	375
	MTN	1	2	72	41	14	6	13	14	22	43	228
	Telkom	4	6	39	18	26	7	26	51	48	56	281
	Vodacom	19	14	49	68	44	42	42	51	59	47	435
Call Setup Success Ratio [%]	CellC	98.34%	98.32%	85.74%	88.44%	95.48%	97.35%	94.46%	94.55%	93.17%	89.50%	93.44%
	MTN	99.85%	99.69%	88.92%	93.38%	96.85%	98.67%	97.70%	97.55%	96.35%	91.81%	96.03%
	Telkom	99.40%	99.08%	93.99%	97.08%	94.14%	98.45%	95.40%	91.04%	92.04%	89.29%	95.10%
	Vodacom	97.13%	97.82%	92.44%	89.00%	90.09%	90.67%	92.55%	91.07%	90.20%	91.01%	92.40%
Call Setup Time [s]	CellC	3.78	3.88	4.21	4.24	4.00	3.88	4.59	4.56	5.32	5.27	4.37
	MTN	4.51	4.60	4.85	5.05	3.25	3.18	4.83	5.00	4.89	4.96	4.51
	Telkom	3.65	3.78	4.01	3.92	3.80	3.77	4.02	4.26	4.10	4.14	3.94
	Vodacom	4.31	4.32	4.91	5.26	4.93	4.69	4.45	4.73	4.94	4.66	4.72

Table 6. (DCR) and POLQA MOS Phase 1 and Phase2

		Durban		Madundube		Mpumalanga		Senzokuhle		Umnini		Grand Total
		Phase 1	Phase 2	Phase 1	Phase 2	Phase 1	Phase 2	Phase 1	Phase 2	Phase 1	Phase 2	
Call Completed	CellC	168	165	121	126	103	107	123	120	132	111	1276
	MTN	169	170	142	135	110	112	135	131	143	113	1360
	Telkom	169	166	145	147	100	103	131	115	133	114	1323
	Vodacom	168	165	121	126	103	107	123	120	132	111	1276
Call Dropped	CellC	4	3	16	15	4	8	16	18	9	15	108
	MTN	1	1	6	5	1	2	2	3	5	9	35
	Telkom	2	3	8	4	3	5	5	15	11	7	63
	Vodacom	5	0	2	12	5	6	14	8	2	5	59
Drop Call Ratio [%]	CellC	2.33%	1.79%	11.68%	10.64%	3.74%	6.96%	11.51%	13.04%	6.38%	11.90%	7.80%
	MTN	0.59%	0.58%	4.05%	3.57%	0.90%	1.75%	1.46%	2.24%	3.38%	7.38%	2.51%
	Telkom	1.17%	1.78%	5.23%	2.65%	2.91%	4.63%	3.68%	11.54%	7.64%	5.79%	4.55%
	Vodacom	2.91%	0.00%	1.34%	8.45%	4.72%	5.56%	10.14%	5.80%	1.39%	4.07%	4.24%
POLQA MOS	CellC	2.95	2.93	2.93	2.88	2.93	2.93	2.90	2.89	2.95	2.92	2.92
	MTN	3.57	3.56	3.45	3.43	3.43	3.44	3.47	3.45	3.42	3.41	3.47
	Telkom	2.99	2.98	2.88	2.90	2.93	2.95	2.92	2.84	2.89	2.86	2.92
	Vodacom	3.24	3.34	3.12	3.05	3.17	3.30	3.29	3.22	2.87	2.96	3.16

6.3. Appendix 2 Technology Maps

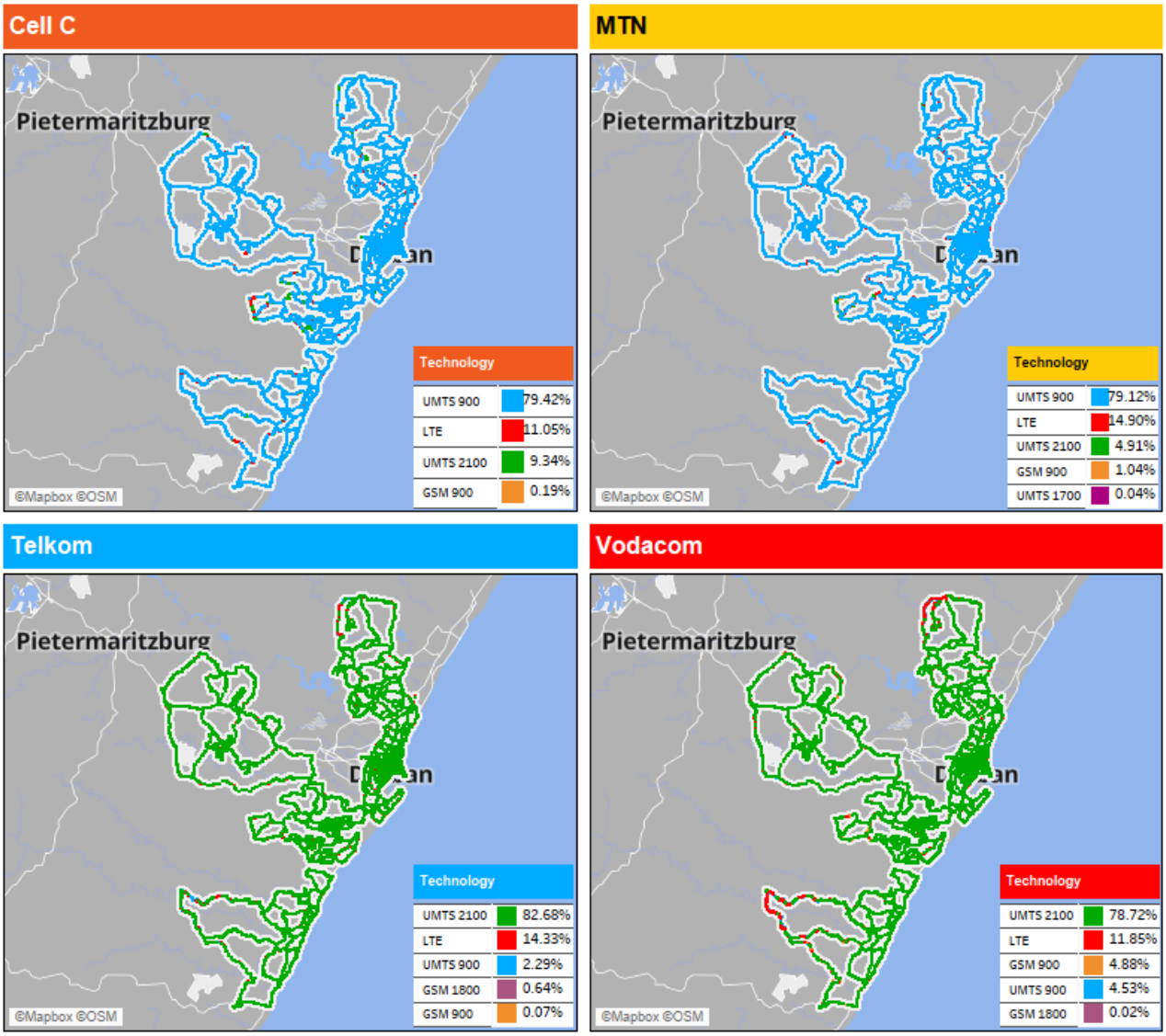


Figure 15. Radio Technology Maps

6.4. Appendix 3 UMTS Coverage Maps

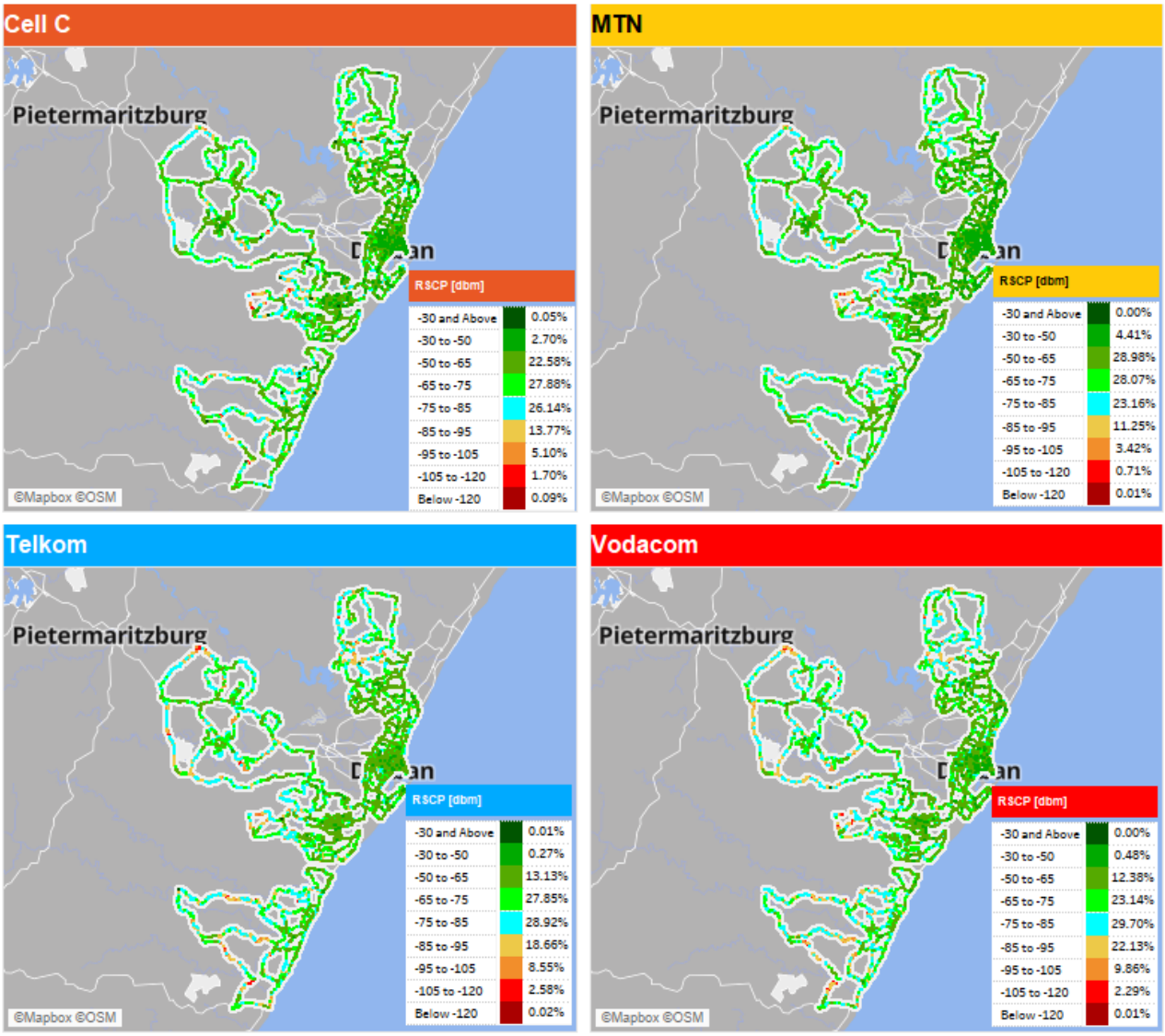


Figure 16. UMTS Coverage Maps

6.5. Appendix 4 UMTS Quality Map

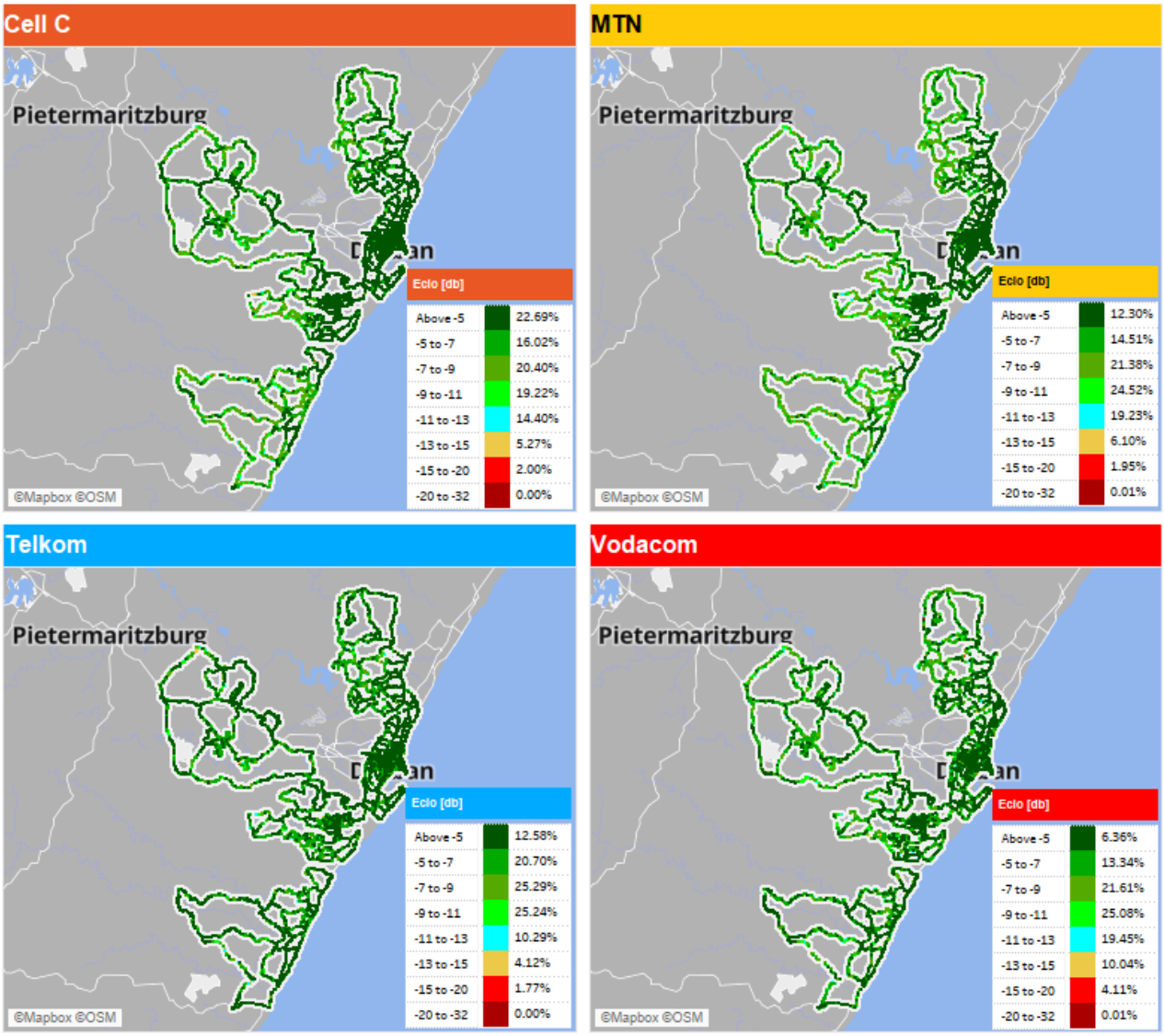


Figure 17. UMTS Quality Maps