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## **Quality of Service Report:**

### **Mpumalanga Province**

### **2017/2018 Quarter 1**

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## **List of Acronyms**

ACSSR	Average Call Setup Success Ratio
ADCR	Average Drop Call Ratio
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 the 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 between 15 May 2017 and 9 June 2017. The total distance covered was over 2000 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 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 Kanyamazane, Mbombela, Ermelo, Secunda and KwaMhlanga.

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.

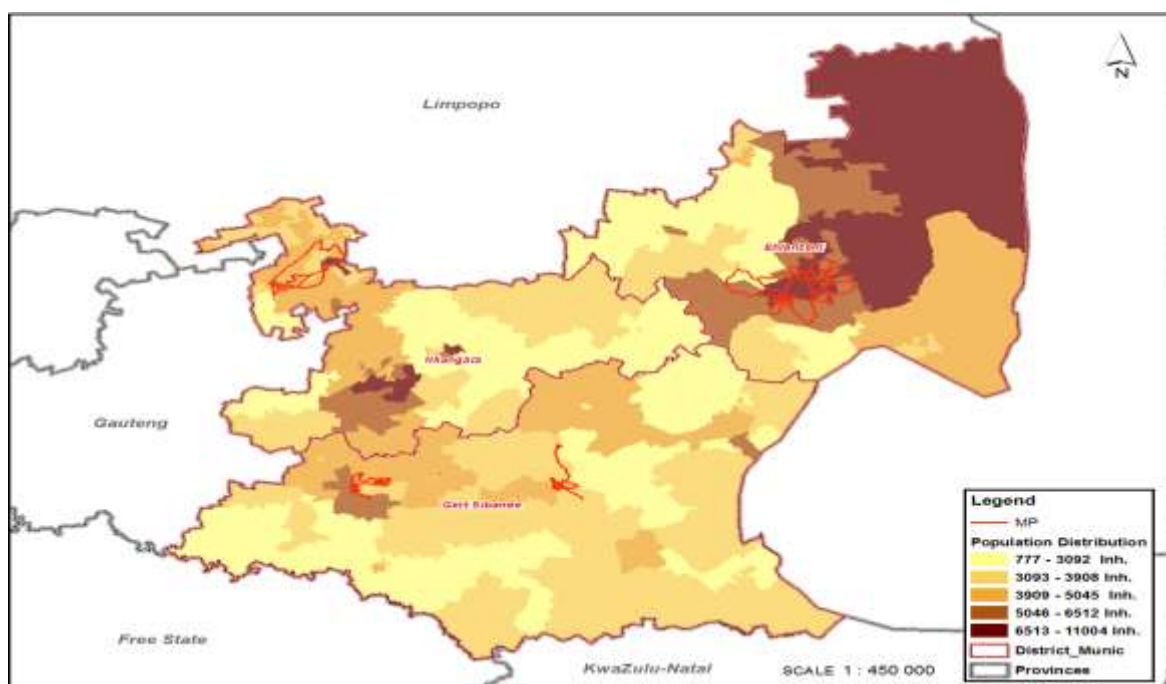
According to the End-User and Subscriber Service Charter regulations of 2016, DCR should be less than 3% and CSSR should be greater than 98%.

The results show that in terms of overall Call Setup Success Ratio, MTN and Telkom met the Accessibility target with a CSSR value of above 98%. Vodacom and Cell C failed to meet the Accessibility target as their overall CSSR values were below 98% target. In terms of overall Drop Call Ratio, Cell C is the only operator that did not meet the DCR target of less than 3%, while Vodacom, Cell C and 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 GSM voice telephony service offered by Cell-C, MTN, Vodacom and Telkom within Mpumalanga Province of South Africa.

Mpumalanga, the second-smallest province in South Africa after Gauteng, is located in the north-eastern part of the country, bordering Swaziland and Mozambique to the east. It also borders Limpopo, Gauteng, Free State and KwaZulu-Natal within South Africa. It covers an area of 76 495 km<sup>2</sup> and has a population of 4 335 964, making it the sixth most populous in the country. Mbombela (previously Nelspruit) is the capital of the province and the administrative and business centre of the Lowveld. Other major cities and towns include eMalahleni (previously Witbank), Standerton, eMkhondo (previously Piet Retief), Malalane, Ermelo, Barberton and Sabie<sup>2</sup>.



**Figure 1: Mpumalanga Province Route Map**

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

<sup>2</sup> <http://www.localgovernment.co.za/provinces/view/6/mpumalanga>

The QoS monitoring was conducted in the areas within Ehlanzeni District Municipality, Gert Sibande District and Nkangala District. The selected areas include Kanyamazane, Mbombela, Ermelo, Secunda and KwaMhlanga. 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 Rate (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 Rate (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 the selected routes and particular time of the day, which is 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 7.7.4 software and hardware, a Samsung Galaxy Note 4 (SM-N910F) mobile devices, a laptop computer and 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> Annexure B.2 of ETSI ETSI EG 202 057-3

## 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 the Table 1 below:

**Table 1: Selected routes and date**

Test Type	Municipality	Route Name	Dates
Accessibility and Retainability	Mbombela Local Municipality	Kanyamazane	15/05/2017
			5/06/2017
		Mbombela	16/05/2017
			6/06/2017
	Msukaligwa Local Municipality	Ermelo	17/05/2017
			7/06/2017
	Govan Mbeki Local Municipality	Secunda	18/05/2017
			8/06/2017
	Thembisile Local Municipality	KwaMhlanga	19/05/2017
			9/06/2017

## 2.3 Equipment test setup and configuration

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

**Table 2: Test plan and configurations**

Configuration	Explanation
Antennas	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 on an acceptable level. The coupling loss between two mobile handsets was a minimum of 40.5 dB <sup>4</sup> .
Band	The bands tested for voice services were GSM (900 and 1800 MHz) and WCDMA (900 and 2100 MHz).
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. Test drives 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 test was 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 behaviour<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>
Equipment used	The equipment used for testing was the TEMS Symphony 7.7.4 equipped with Samsung Galaxy Note 4 (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:

<sup>4</sup> Section 6.3 of ETSI TS 102 250-4 V.1.1.2 (2003-10)

<sup>5</sup> Section 4.8 of ETSI EG 202 057-3

<sup>6</sup> Section 4.2.1 of ETSI TS 102 250-5 V1.2.1 (2005-05)

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



	(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.
Test Number	The test calls were terminated on each operator's test platform or IVR system.
Network tested	Cell-C, MTN, Vodacom and Telkom.
SIM card	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.

## 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 setup 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> End-User and Subscriber Service Charter Regulations of 2016

### 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: Kanyamazane, Mbombela, Ermelo, Secunda and KwaMhlanga.

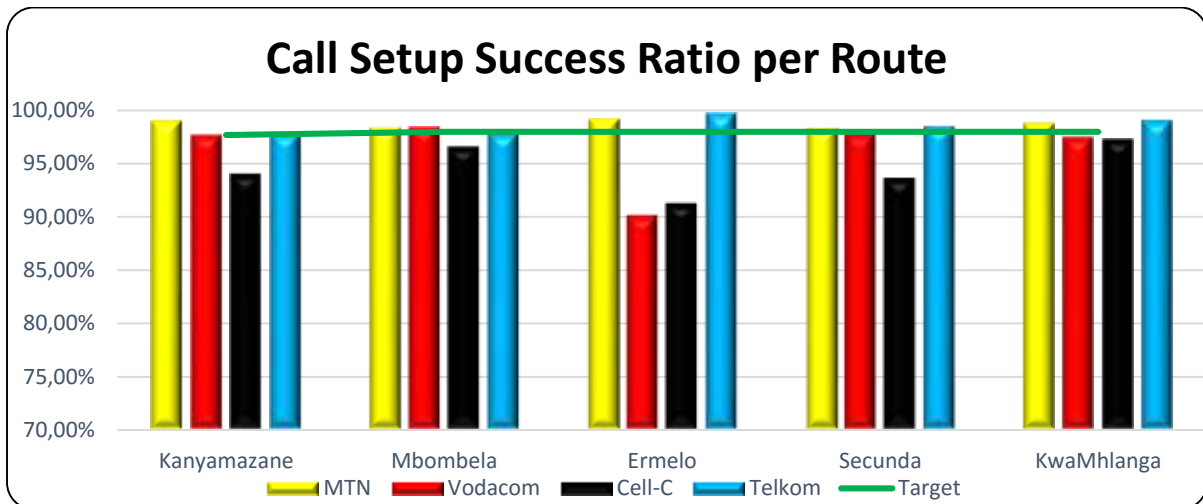
#### 3.1 Accessibility and Retainability measurements

**Table 3: Summary of results**

Route Name	Operator	CSSR (%)	DCR (%)
Kanyamazane	MTN	98.99%	5.29%
	Vodacom	97.62%	0.00%
	Cell C	93.99%	7.19%
	Telkom	97.76%	3.28%
Mbombela	MTN	98.29%	0.97%
	Vodacom	98,35%	4.30%
	Cell C	96.53%	9.45%
	Telkom	97.78%	2.88%
Ermelo	MTN	99.16%	0.36%
	Vodacom	90.11%	0.96%
	Cell C	91.22%	4.56%
	Telkom	99.69%	0.00%
Secunda	MTN	98.26%	0.76%
	Vodacom	97.74%	0.46%
	Cell C	93.57%	1.20%
	Telkom	98.41%	0.79%
KwaMhlanga	MTN	98.76%	0.96%
	Vodacom	97.44%	0.75%
	Cell C	97.26%	4.03%
	Telkom	99.01%	0.32%
Overall Results	MTN	98.68%	1.88%
	Vodacom	96.34%	1.34%
	Cell C	94.69%	5.61%
	Telkom	98.48%	1.62%

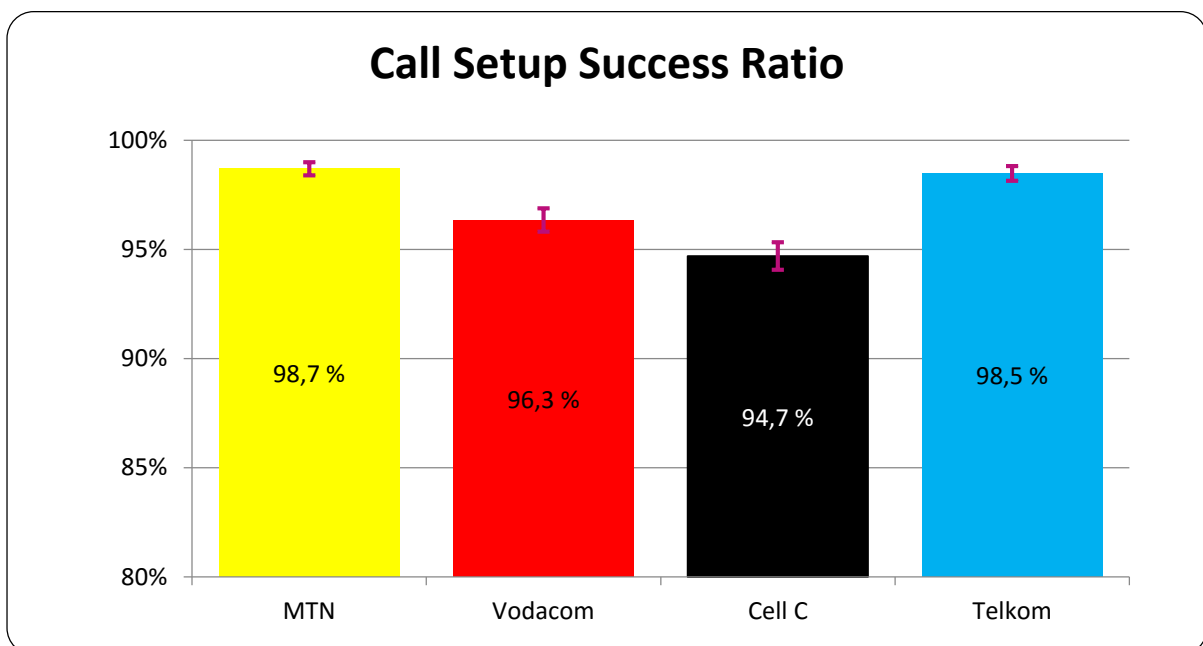
Table 3 above shows voice call measurement results in each route and the overall results for each operator. Additional KPIs are presented in the Appendix 6.

### 3.1.1 Call Setup Success Ratio (CSSR)



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

Figure 2 above shows that MTN met the 98% CSSR target in all the areas. Telkom failed to meet the target in Kanyamazane and Mbombela. Vodacom met the target in Mbombela and failed the target in other four areas. Cell C achieved less than 98% CSSR in all the target areas, thus it failed to reach the Accessibility target in all targeted areas.

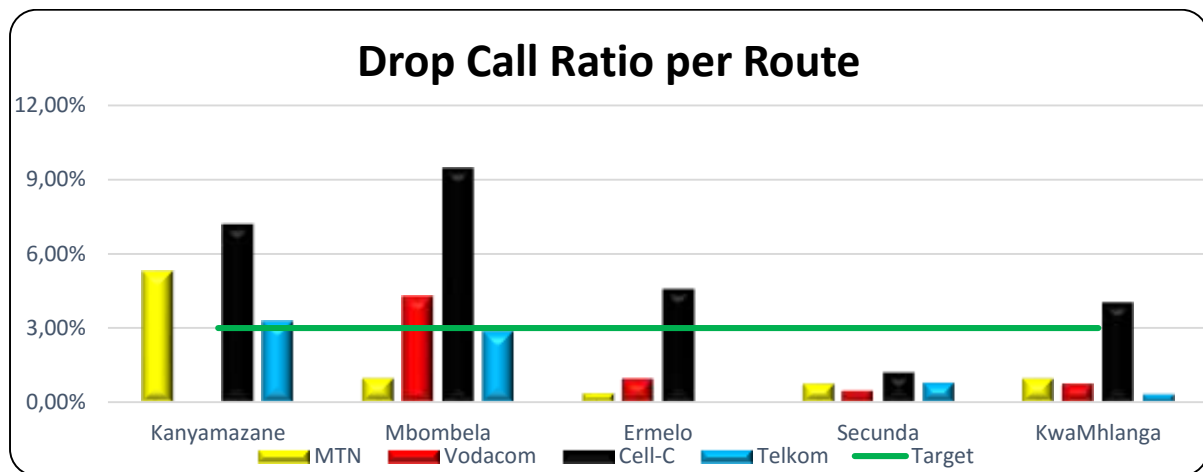


**Figure 3: Total Call Setup Success Ratio with Statistical Significance**

Figure 3 above shows that MTN’s CSSR is the highest, followed by Telkom, Vodacom and Cell C in their respective descending order. Cell C and Vodacom

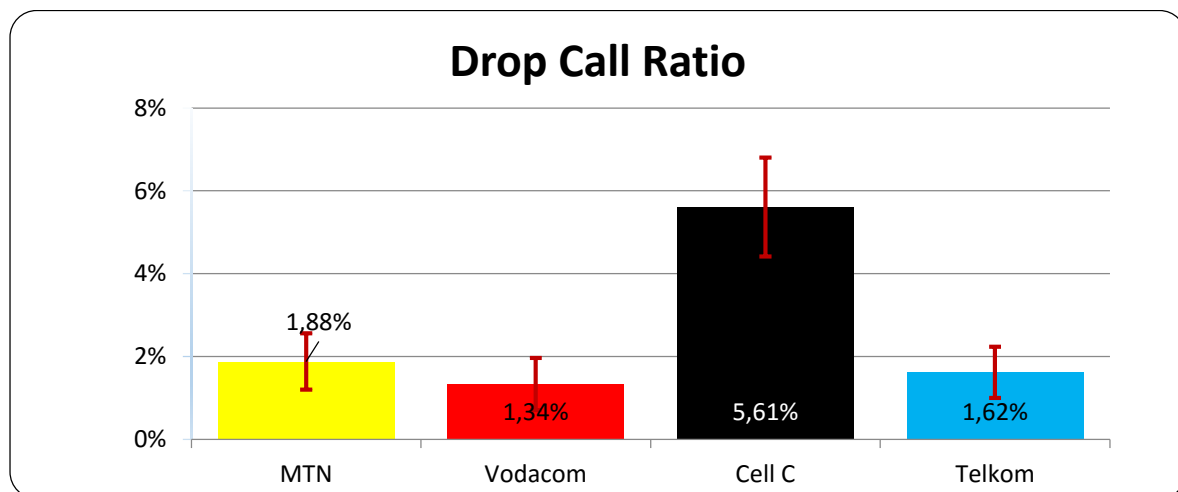
failed the CSSR target of above 98% as per "End-User and Subscribers Service charter regulations of 2016". There is no statistical significance difference between MTN and Telkom results. Cell C's results show statistical significance difference in relation to other operators' results. Vodacom's results also show statistical significance difference in relation to other operators' results.

### 3.1.2 Drop Call Ratio (DCR)



**Figure 4: Drop Call Ratio (DCR) per Route**

Figure 4 above shows that Cell C met the below 3% DCR target in Secunda but failed in other areas. MTN and Telkom failed to meet the target in Kanyamazane but met the target in other four areas, whereas Vodacom failed to meet the target in Mbombela but met the target in other areas. All operators met the Retainability target in Secunda.

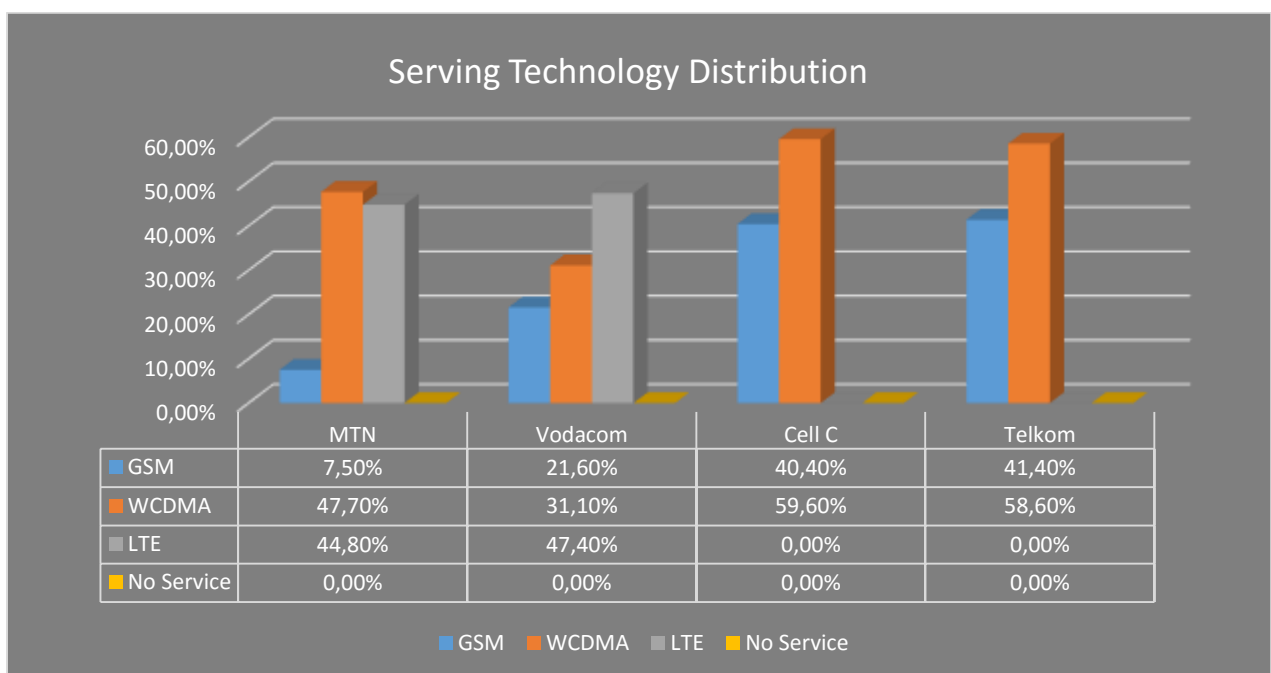


**Figure 5: Overall Drop Call Ratio with Statistical Significance**

Figure 5 shows that Vodacom’s DCR is the lowest followed by Telkom, MTN and Cell C in the respective ascending order. MTN, Telkom and Vodacom met the 3% DCR target, while Cell C did not meet the DCR target as the DCR value was above 3%. There was no statistical significant difference in results between MTN, Telkom and Vodacom. Cell C’s results show statistical significance difference in relation to other operators’ results. Cell C recorded the highest DCR of 5.61% and Vodacom was the lowest with 1.34%.

### 3.2 Analysis of the serving technology

Figure 6 below shows the statistical distribution of the serving technology during the drive test. The percentage represent the fraction of the sampling points, out of the total of the sampling points for all the routes, where the system was using a particular radio access technology. The serving technology distribution is based on the device used and the network parameter configuration which varies with the mobile operators. MTN and Vodacom serving technology distribution was mainly on LTE and WCDMA technologies, while Cell C and Telkom distribution was mostly on GSM and WCDMA technologies.



**Figure 6: Technology Distribution**

The maps in Appendix 6.3 shows the geographic areas where the preferred technology was selected by the mobile device.

#### **4 Responses to measurement results from operators.**

A draft report similar to section 1, 2, 3, 5 and 6 of this report, was provided to operators for their comments. Also provided were the log files with all measurement results. The information enables operators to critically review the Authority's measurements and to give comments on that, as well as a network improvement plan. The responses from the operators are summarised in Appendix 6.2.

#### **5 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, MTN and Telkom met the Accessibility target with a CSSR of above 98%, whereas Vodacom and Cell C failed to meet the Accessibility target with the CSSR values below 98% target. In terms of overall Drop Call Ratio, Cell C did not meet the DCR target of less than 3%; while Vodacom, Telkom and MTN met the DCR target thus meeting the Retainability target.

## 6 Appendixes

### 6.1 Appendix A: Drive Test Results KPI's

**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 (%)
Kanyamazane	MTN	223	7	3.14%	155	13	8.39%	378	20	5.29%
	Vodacom	135	0	0.00%	164	0	0.00%	299	0	0.00%
	Cell C	185	15	8.11%	149	9	6.04%	334	24	7.19%
	Telkom	213	6	2.82%	153	6	3.92%	366	12	3.28%
Mbombela	MTN	202	1	0.50%	106	2	1.89%	308	3	0.97%
	Vodacom	140	7	5.00%	139	5	3.60%	279	12	4.30%
	Cell C	161	18	11.18%	167	13	7.78%	328	31	9.45%
	Telkom	191	8	4.19%	191	3	1.57%	382	11	2.88%
Ermelo	MTN	144	1	0.69%	135	0	0.00%	279	1	0.36%
	Vodacom	86	2	2.33%	123	0	0.00%	209	2	0.96%
	Cell C	127	5	3.94%	114	6	5.26%	241	11	4.56%
	Telkom	139	0	0.00%	150	0	0.00%	289	0	0.00%
Secunda	MTN	131	0	0.00%	133	2	1.50%	264	2	0.76%
	Vodacom	83	0	0.00%	134	1	0.75%	217	1	0.46%
	Cell C	125	2	1.60%	125	1	0.80%	250	3	1.20%
	Telkom	134	1	0.75%	120	1	0.83%	254	2	0.79%
KwaMhlanga	MTN	159	0	0.00%	154	3	1.95%	313	3	0.96%
	Vodacom	107	1	0.93%	159	1	0.63%	266	2	0.75%
	Cell C	126	8	6.35%	147	3	2.04%	273	11	4.03%
	Telkom	153	0	0.00%	159	1	0.63%	312	1	0.32%



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

Route Name	Operator	PHASE 1				PHASE 2				TOTAL				
		Call Attempt	Call Setup	User Busy	CSSR (%)	Call Attempt	Call Setup	User Busy	CSSR (%)	Call Attempt	Call Setup	Call Established	User Busy	CSSR (%)
Kanyamazane	MTN	785	774	0	98.60%	498	496	0	99.60%	1283	1270	475	0	98.99%
	Vodacom	601	587	0	97.67%	450	439	0	97.56%	1051	1026	423	0	97.62%
	Cell C	464	423	5	92.16%	489	468	0	95.71%	953	891	435	5	93.99%
	Telkom	715	694	6	97.88%	502	483	7	97.58%	1217	1177	411	13	97.76%
Mbombela	MTN	678	669	0	98.67%	726	711	0	97.93%	1404	1380	746	0	98.29%
	Vodacom	558	543	2	97.66%	476	470	2	99.16%	1034	1013	330	4	98.35%
	Cell C	514	486	2	94.92%	642	628	0	97.82%	1156	1114	311	2	96.53%
	Telkom	575	557	5	97.72%	559	545	2	97.85%	1134	1102	621	7	97.78%
Ermelo	MTN	477	475	0	99.58%	475	469	0	98.74%	952	944	1180	0	99.16%
	Vodacom	397	390	1	98.48%	505	421	1	83.53%	902	811	975	2	90.11%
	Cell C	384	352	7	93.37%	482	427	5	89.52%	866	779	849	12	91.22%
	Telkom	468	466	0	99.57%	497	496	0	99.80%	965	962	1178	0	99.69%
Secunda	MTN	382	379	0	99.21%	478	466	0	97.49%	860	845	1552	0	98.26%
	Vodacom	413	410	1	99.51%	474	455	1	96.19%	887	865	1223	2	97.74%
	Cell C	453	432	0	95.36%	465	427	0	91.83%	918	859	978	0	93.57%
	Telkom	449	440	1	98.21%	438	429	3	98.62%	887	869	1055	4	98.41%
KwaMhlanga	MTN	551	539	1	98.00%	498	496	0	99.60%	1049	1035	1314	1	98.76%
	Vodacom	430	422	1	98.37%	435	417	3	96.53%	865	839	983	4	97.44%
	Cell C	482	462	3	96.45%	507	495	2	98.02%	989	957	976	5	97.26%
	Telkom	517	509	2	98.83%	498	494	0	99.20%	1015	1003	1005	2	99.01%

## **6.2 Appendix B: Summary of operator's responses**

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

### **6.2.1 Vodacom**

Vodacom submitted that it has reviewed the Authority report and shared the following remedial action to address poor coverage and quality of service in the areas:

- Mbombela route – Two new sites in acquisition phase to address poor coverage.
- Ermelo route - Currently busy with cluster optimisation to improve general coverage in the area and address missing neighbors.
- Secunda route – New planned site in acquisition phase to address poor coverage, and further investigation will be conducted to improve the poor call setup results.
- KwaMhlanga - New planned site to address poor coverage, and further investigation will be conducted to improve the poor call setup results.

### **6.2.2 MTN**

MTN submitted that it has reviewed the Authority's draft report and noted that out of five areas measured it only fails CSSR in Kanyamazane. The remedial action to improve quality of service, but not limited to Kanyamazane area include:

- Five new sites which are currently in Kanyamazane 2017/18 site build plans.
- Seven additional sites have been planned for in the area where the Authority did the drive tests and are expected to be live by year end.
- Network optimisation has been completed in areas where the failures were not related to lack of coverage. Furthermore E-tilt and power optimisation were completed to improve coverage over the short term.

### **6.2.3 Cell C**

Cell C highlighted the lack of its own continuous coverage in some of the areas tested. In some areas Cell C relies on national roaming arrangements with

Vodacom's network. In summary, the poor performance was attributed by the following:

- The dropped calls and call setup failures due to low signal levels and insufficient transmission capacity, respectively.
- Lack of seamless roaming/handover between Cell C and Vodacom network. Cell C relies on its national roaming arrangement with Vodacom in some of the areas specified in the Authority's report. Roaming provides coverage where Cell C's own network does not have coverage.

Despite roaming arrangements, there are projects planned for the future to have new base-station sites and to have capacity and transmission routes improved and optimised in the low-performing areas. Cell C's plans and remedies in the low performance areas include:

- New sites which are planned to be rolled out in the next 3 years.
- Plan to implement seamless roaming in the future.
- Continuous optimisation and capacity initiatives to improve network quality and coverage.

#### **6.2.4 Telkom**

Telkom was pleased with the Authority's draft report and highlighted the following in its response:

- The problem of the lack of 900 MHz frequency band, which is a crucial requirement for the cost-effective deployment of national coverage specifically in rural areas.
- Within Mpumalanga test area, about 73% of tests were made on MTN's network on which Telkom is roaming and 27% on Telkom's own network. However, Telkom met the DCR target of less than 3% in four areas, but failed in one area namely Kanyamazane. Telkom met the CSSR (Call Setup Success Ratio) target of 98% in three of the five tested areas.

Although the ICASA drive testing only gives a snapshot of network performance on the specific day and time and not a true representation of the overall network performance, Telkom takes the results as input to further improve the quality of

its networks in these areas. Telkom's plans and remedies in the low-performance areas are as follows:

- In Kanyamazane and Mbombela areas, Telkom has 96 sites in total of which 76% are in planning phase.
- Continuous engagement with the roaming partner regarding network improvements in the areas where Telkom subscribers roam on MTN's network.

## 6.3 Appendix C: Coverage maps

### 6.3.1 Scanner measurements

#### 6.3.1.1 Vodacom

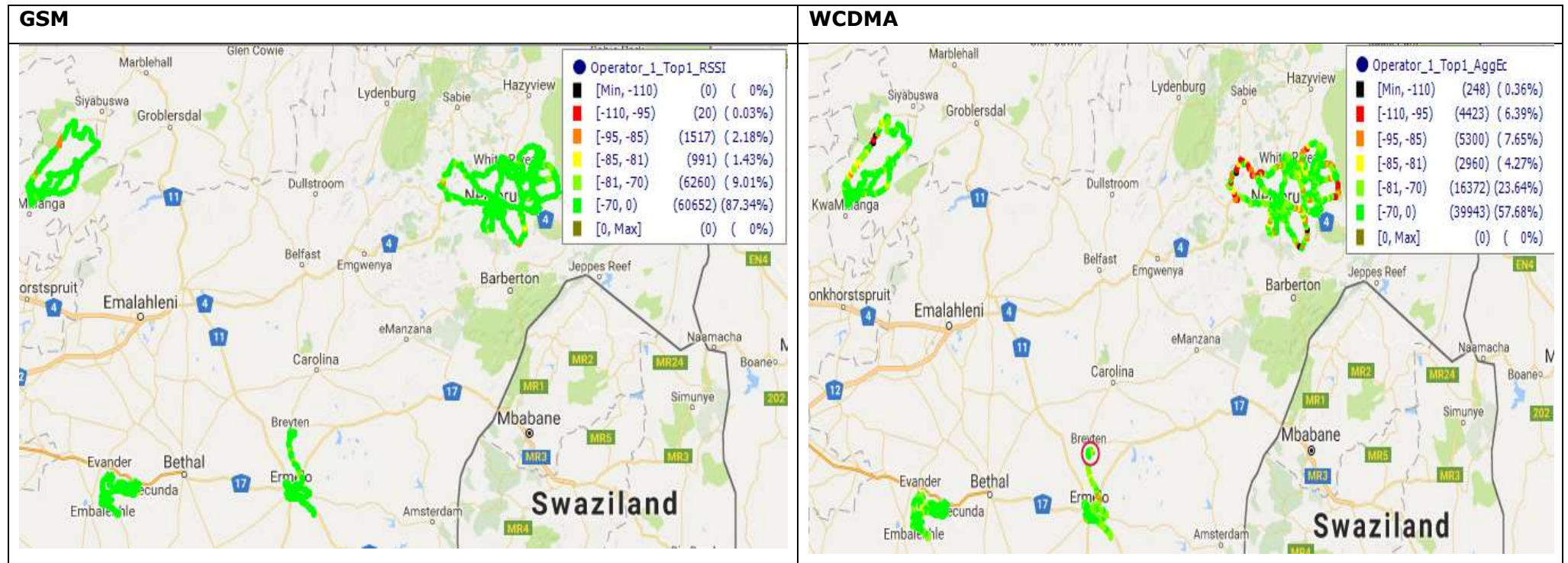


Figure 7: Mpumalanga Province - Vodacom GSM and WCDMA Signal Levels

#### 6.3.1.2 MTN

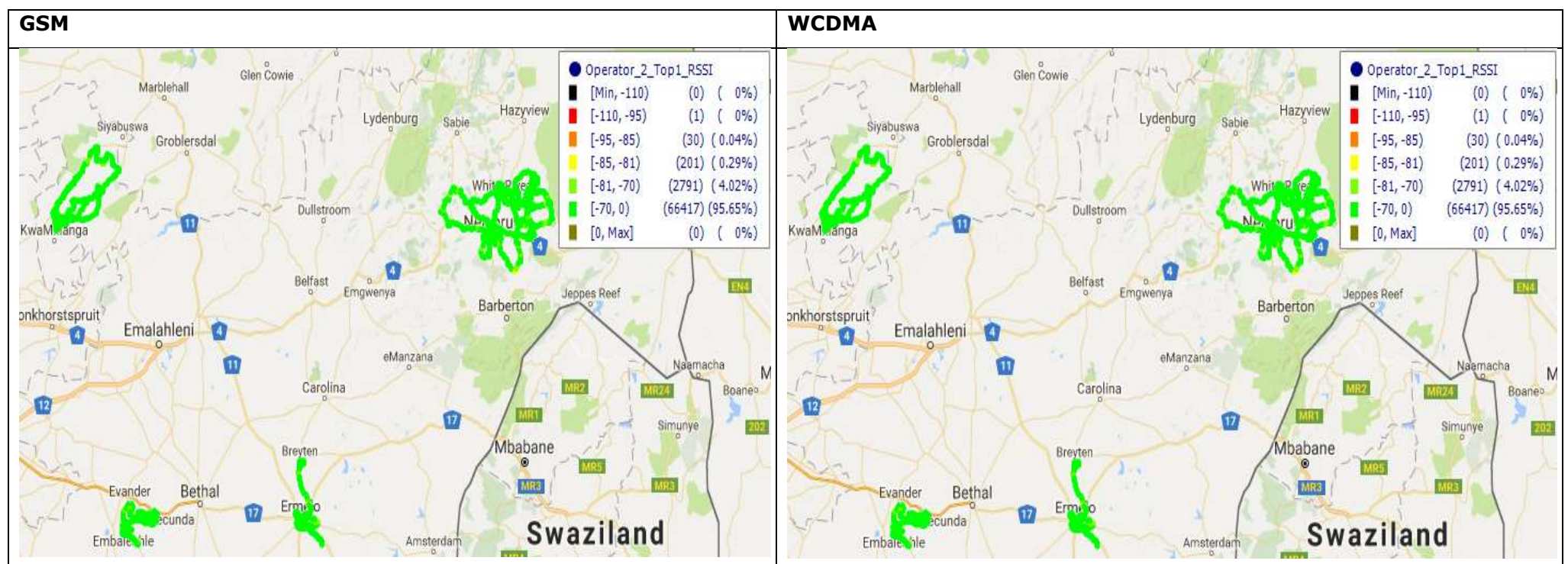


Figure 8: Mpumalanga Province - MTN GSM and WCDMA Signal Levels

#### 6.3.1.3 Cell C

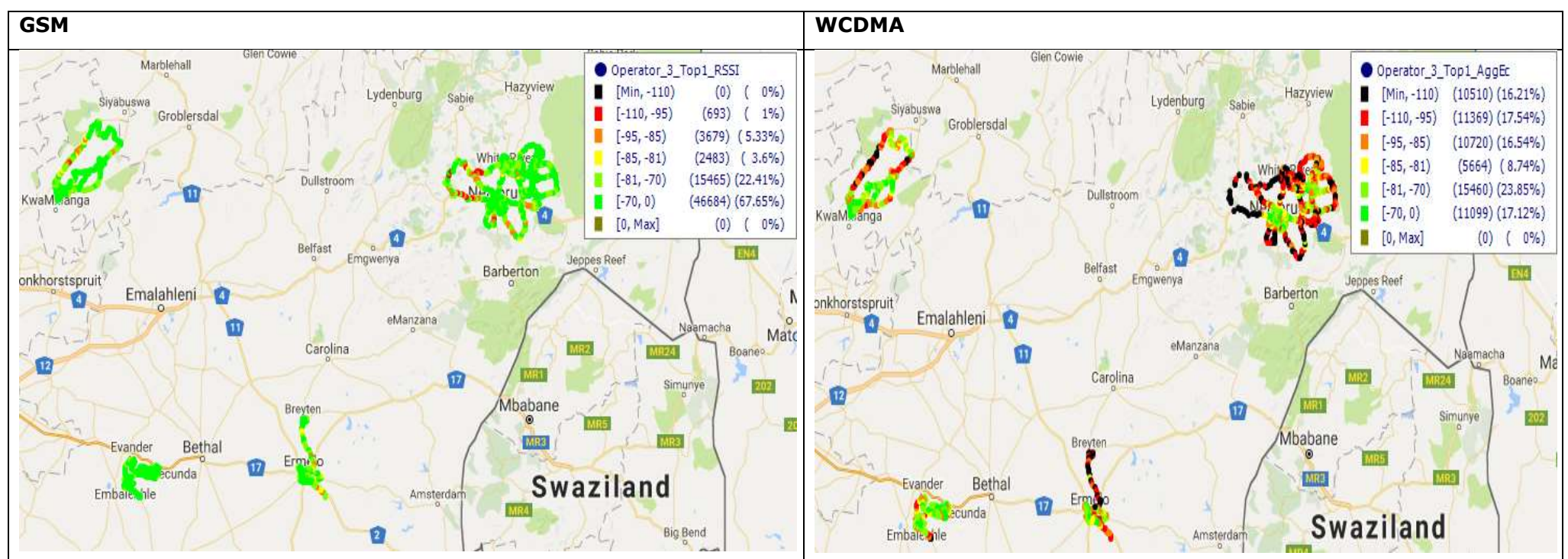


Figure 9: Mpumalanga Province - Cell C GSM and WCDMA Signal Levels

6.3.1.4 Telkom

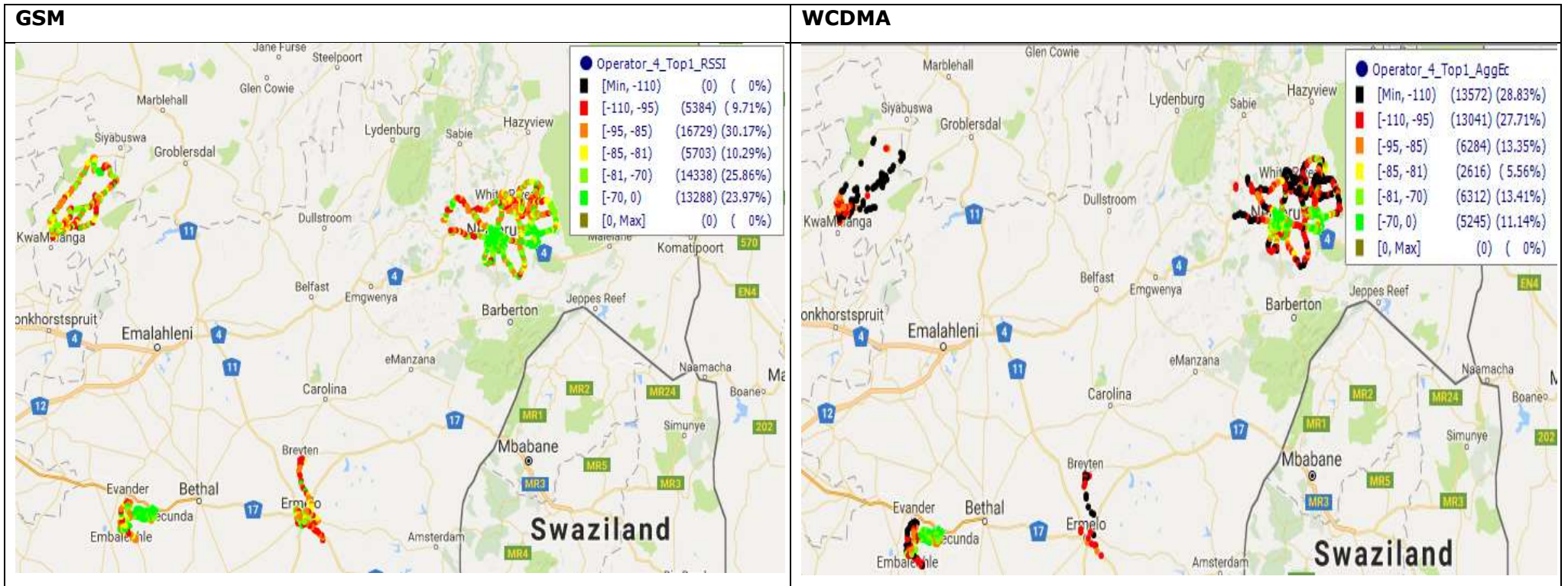


Figure 10: Mpumalanga Province - Telkom GSM and WCDMA Signal Levels

6.3.2 Serving technology details

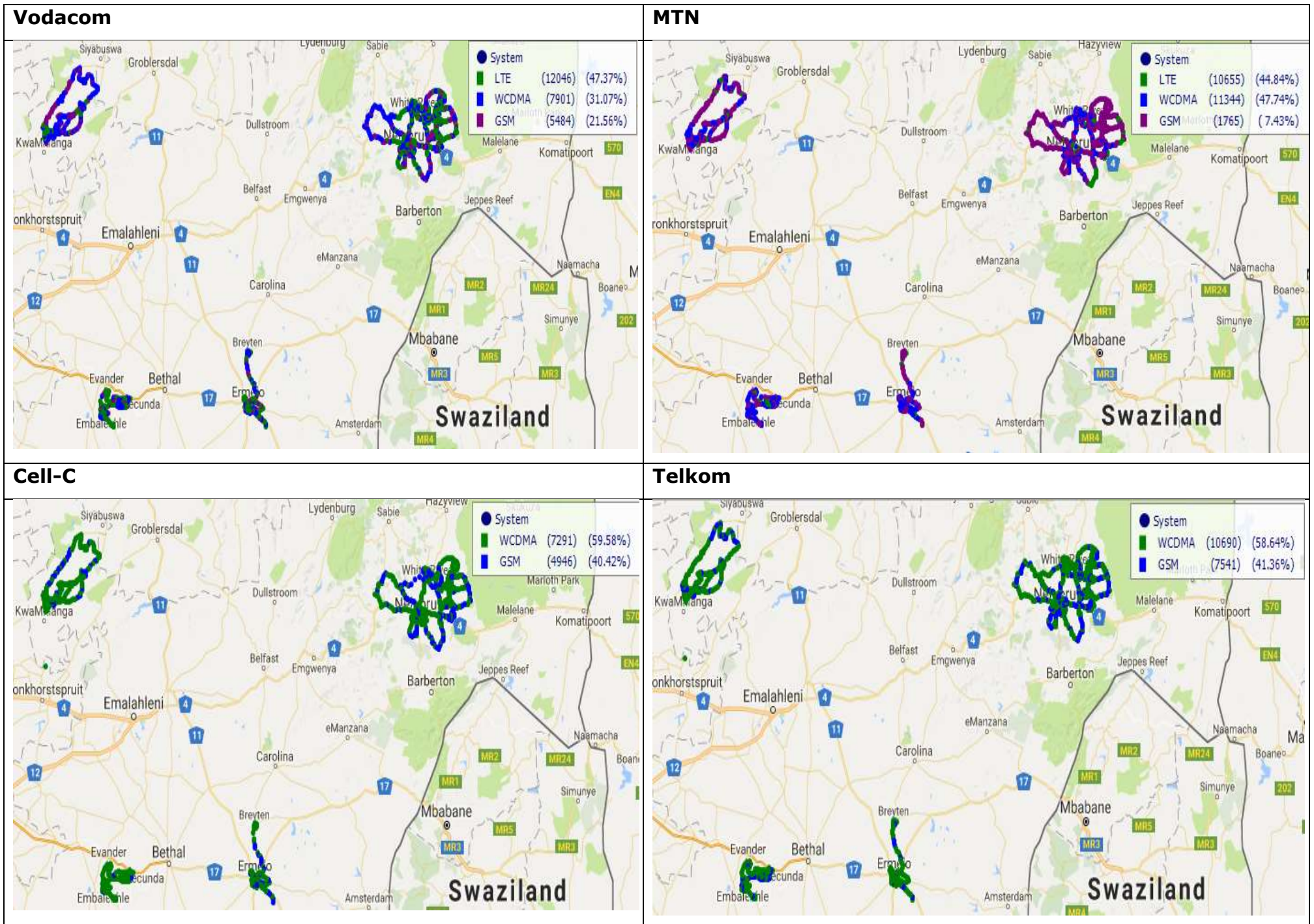


Figure 11: Mpumalanga Province Serving Technology Plots

