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

2018/2019 Quarter 3:

Voice Quality of Service

Report –

KwaZulu-Natal Province

Table of Contents

List of Abbreviations

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

List of Figures

List of Tables

1. Executive Summary

The Independent Communications Authority of South Africa (ICASA) contracted ATIO Corporation (Pty) Ltd to conduct Quality of Service (QoS) measurements on the mobile network 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 conducted during the period between 21st of November 2018 to the 9th of January 2019, covering a total distance of over 3000 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 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.

A vehicle equipped with Rohde and Schwarz Smart Benchmarker II measurement tool including 24 mobile phones was used to collect data in mobility conditions. The four Key Performance Indicators (KPIs) used to evaluate QoS are Retainability, Accessibility, 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, DCR should be less than 3% and CSSR should be greater than 98%. Call Setup Time must be less than 20 seconds and the score for Speech Quality must be greater than 3.

The results show that in terms of overall Call Setup Success Ratio, all operators scored less than 98% CSSR values, thus failed to meet the Accessibility target.

All operators failed to meet overall Drop Call Ratio target of less or equal to 3% as per authority's target.

MTN and Vodacom are the only operators that met the target for Speech Quality in the overall results.

All operator met the achieved Call Setup Time target.

2. Introduction

ICASA's mission is to ensure that all South Africans have access to a wide range of high-quality communication services at affordable prices[1]. The Authority ensures the quality of service through its Quality of Service (QoS) monitoring activities. In order to monitor the QoS, ICASA contracted ATIO Corporation (Pty) Ltd 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 MTN, Vodacom, Cell C and Telkom within the KwaZulu-Natal Province of South Africa.

The QoS monitoring was conducted in the following areas within the District Municipalities; Amajuba, uMzinyathi, Zululand, uThungulu and uMkhanyakude. The selected areas include Newcastle, Msinga, Ulundi, Ohlelo and Hlabisa. The areas consist of major towns, townships, farm areas, rural areas, major road arteries, economic activity nodes and areas of previous complaints. Figure 1 depicts the routes which were driven in the KwaZulu-Natal Province.

Figure 1. KwaZulu-Natal Province Route Map

---

[1] **ICASA Strategic Plan 2016/17-2021**

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. These parameters are described briefly below:

a) Call Accessibility is defined as a percentage and is a measure of the number of times a user is able to successfully establish a call as a percentage of the total calls attempted. It is measured using Call Setup Success Ratio (CSSR).

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

3. Methodology

A minimum of 120 test samples per network operator were collected. A drive test sampling methodology which provides a snapshot view of the mobile operator's quality of service was adopted. It provides a realistic picture of network performance from a user's point of view. The method adopted provides a snapshot of an operator's network performance on the selected routes and a particular time of the day.

Voice test setup consisted of two categories which are short call (accessibility) and long call (retainability) and each category required two items of end-user equipment (UE) i.e. call initiating side (A-side) and call receiving side (B-side). This setup results in four UEs per operator resulting in sixteen UEs for four operators in one drive test vehicle. The Call Window was set up as follows: Call duration + 30 seconds (for the setup and release phases) + 30 seconds (for the minimum pause interval). The default call duration was set at 120 seconds for Long Call and results in 180 seconds call window and call duration for Short Call was set at 10 seconds resulting in 70 seconds call window. The audio quality of speech samples was evaluated using the HD-voice capable and ITU standardized POLQA wideband algorithm.

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

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

3.1. Short & Long Call
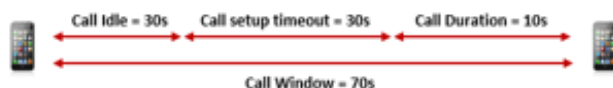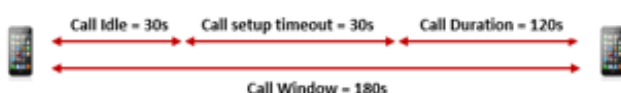
Figure 2. Call Window

Figures 2 depicts the call window for both Short Call and Long Calls scenarios together with call stages.

3.2. Equipment test setup and configuration

3.2.1. System used

The Test Equipment utilised was the R&S SwissQual Benchmarker II platform with Sony XZ Premium smartphones installed inside the car using the R&S Phone Mount Walls.
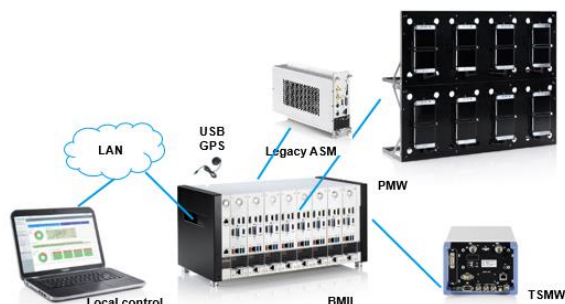
3.2.2. Device Used

The Sony XZ Premium Smartphone was selected as the measurement UE for Voice and Data Services. It uses the Qualcomm Snapdragon 835 chipset and supports the following technologies; GSM, WCDMA, LTE & LTE-A.

3.2.3. Device Specification

Table 1 depicts device specification:

Table 1: Device Specification

Technology	Info
Data:	LTE-A Pro Cat 16 (1000/150 Mbit/s), HSDPA+ (4G) 42.2 Mbit/s, HSUPA 5.76 Mbit/s, UMTS
GSM:	850, 900, 1800, 1900 MHz
UMTS:	800, 850, 900, 1700/2100, 1900, 2100 MHz
LTE (FDD):	Bands 1, 2, 3, 4, 5, 7, 8, 12, 13, 17, 19, 20, 26, 28, 29, 32
LTE (TDD):	Bands 38, 39, 40, 41
Processor:	Octa-core, 2450 MHz, Kryo 280 and ARM Cortex-A53, 64-bit
System chip:	Qualcomm Snapdragon 835 MSM8998
Qualipoc version:	18.0.0.63

3.3. Route selection

The areas and routes that were tested are shown in Table 2 including the dates driven. The distance travelled, and active measurements time are shown in Table 3:

Table 2: Test timelines for areas covered

Routes and Dates			
District	**Area**	**Date**	**Test Type**
Amajuba	Newcastle	2018/11/21	Phase 1
		2018/11/22	Phase 1
		2018/12/02	Phase 2
uMzinyathi	Msinga	2018/12/10	Phase 1
		2018/12/03	Phase 2
Zululand	Ulundi	2018/11/28	Phase 1
		2018/11/29	Phase 1
		2018/12/05	Phase 2
		2018/12/06	Phase 2
		2019/01/08	Phase 2
uThungulu	Ohlelo	2018/11/26	Phase 1
		2018/12/04	Phase 2
		2019/01/09	Phase 2
uMkhanyakude	Hlabisa	2018/12/09	Phase 1
		2018/12/06	Phase 2

Table 3: Area Tested, Kilometers and Hours Driven per area
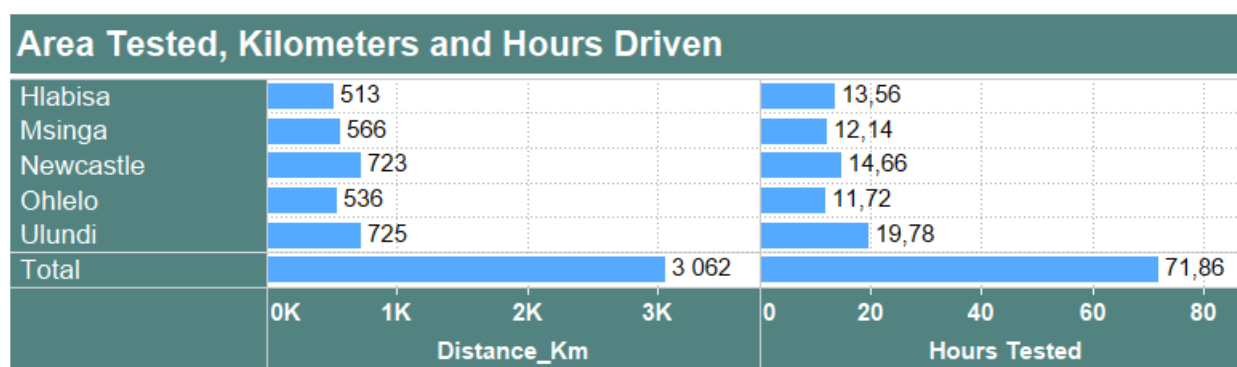
3.4. Measurement parameters and targets

3.4.1. Targets

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

1. Call Setup Success Ratio – Average Call Setup Success Ratio must be greater than 98%
2. Call Setup Time Ratio – Average Call Setup Time must take 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.[2]

3.4.2. 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:

$$CSSR = Y/X *100$$

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

3.4.3. 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:

$$DCR= D/S*100$$

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

3.4.4. Call Setup Time [s]

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

3.4.5. Speech Quality (MOS)

---

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

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. Measurements made use of the POLQA Algorithm which compares the reference signal received from the transmitting side against an equivalent sample on the receiving side.

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: Hlabisa, Msinga, Newcastle, Ohlelo and Ulundi.

4.1. Voice KPI Results

Table 4: Overall voice KPI results

		MTN	Vodacom	Cell C	Telkom
Short Call	Call Attempt	3459	3433	3256	3377
	Call Failed	140	300	196	443
	Successfull Attempts	3319	3133	3060	2934
	Call Dropped	8	0	0	5
	Call Complete	3311	3133	3060	2929
	Call Setup Success Rate [%]	95,95	91,26	93,98	86,88
	Call Setup Time [s]	5,08	5,37	5,05	7,95
Long Call	Call Attempt	1582	1685	1604	1761
	Call Failed	135	270	189	351
	Successfull Attempts	1447	1415	1415	1410
	Call Dropped	84	68	122	73
	Call Complete	1363	1347	1293	1337
	Call Drop Rate [%]	5,81%	4,81%	8,62%	5,18%
	POLQA MOS	3,52	3,46	2,96	2,71

Table 4 shows overall voice measurement results for both Short and Long Calls scenarios. CSSR and Call Setup Time were measured in Short Call scenario. The DCR and POLQA MOS KPI's were measured in Long Call scenario. Results which are coloured in red indicate that the operator did not meet the target set by the Authority. Appendix 1 shows operator results per route per phase tested.

Table 4 shows that all operators failed to achieve the Call Setup Success Ratio target. All operators were, however, able to achieve the Call Setup Time target. All operators failed to achieve the Drop Call Ratio target. It can also be seen that only MTN and Vodacom achieved the speech quality target of above 3.

4.1.1.Call Setup Success Ratio (CSSR) and Drop Call Ratio (DCR)

Table 5 shows voice call measurement results for each route per operator. All operators have poor performance in Hlabisa, Msinga and Ohlelo , none of the operators achieved the CSSR and DCR targets in these areas.

Table 5: Summary of results per Area

		Hlabisa	Msinga	Newcastle	Ohlelo	Ulundi
Call Setup Success Rate - [%]	**MTN**	96,98%	89,16%	98,47%	91,94%	99,20%
	Vodacom	94,17%	78,61%	96,54%	84,93%	95,56%
	Cell C	93,39%	88,50%	97,13%	90,00%	97,67%
	Telkom	94,19%	78,33%	94,00%	86,59%	81,10%
Drop Call Ratio [%]	**MTN**	8,80%	7,52%	8,01%	5,98%	0,77%
	Vodacom	8,19%	6,33%	1,37%	9,33%	1,32%
	Cell C	5,73%	13,90%	4,11%	15,06%	6,36%
	Telkom	4,95%	5,31%	5,15%	4,93%	5,43%
Call Setup Time [s]	**MTN**	4,87	5,25	4,56	6,08	4,95
	Vodacom	4,95	5,62	4,61	7,68	4,86
	Cell C	4,95	6,00	4,51	5,81	4,58
	Telkom	7,35	8,61	7,09	9,19	7,98
POLQA MOS	**MTN**	3,49	3,50	3,64	3,37	3,54
	Vodacom	3,43	3,15	3,70	3,23	3,61
	Cell C	3,00	2,88	3,04	2,88	2,98
	Telkom	2,59	2,58	2,93	2,63	2,76

4.1.2. Call Accessibility (Short call)

Table 6 shows number of samples collected per area for Short Call scenario.

Table 6: Short Call sample size per Area

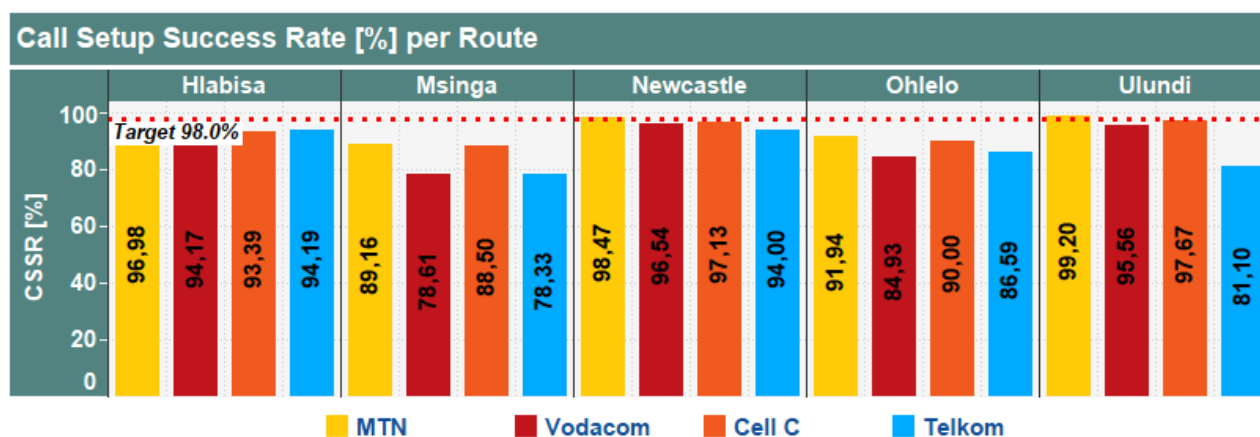|		Hlabisa	Msinga	Newcastle	Ohlelo	Ulundi
Call Attempt	**MTN**	662	498	720	583	996
	Vodacom	652	505	722	564	990
	Cell C	635	487	696	580	858
	Telkom	654	466	700	589	968
Call Failed	**MTN**	20	54	11	47	8
	Vodacom	38	108	25	85	44
	Cell C	42	56	20	58	20
	Telkom	38	101	42	79	183
Call Dropped	**MTN**	2	0	6	0	0
	Vodacom	0	0	0	0	0
	Cell C	0	0	0	0	0
	Telkom	4	1	0	0	0
Call Complete	**MTN**	640	444	703	536	988
	Vodacom	614	397	697	479	946
	Cell C	593	431	676	522	838
	Telkom	612	364	658	510	785

Figure 3. CSSR KPI per Area

Figure 3 shows MTN met 98% CSSR target in Newcastle and Ulundi, but failed to meet the target in Hlabisa, Msinga and Ohlelo. All other operators (Vodacom, Cell C and Telkom) failed to meet CSSR target in all tested areas.

4.1.3.Drop Call Ratio (Long call)

Table 7 shows number of samples collected per area for Long call scenario.

Table 7: Long Call samples per Area

|		Hlabisa	Msinga	Newcastle	Ohlelo	Ulundi
Call Attempt	MTN	301	301	326	261	393
	Vodacom	325	343	320	281	416
	Cell C	307	336	309	296	356
	Telkom	312	335	333	265	516
Call Failed	MTN	17	75	14	27	2
	Vodacom	44	106	28	56	36
	Cell C	28	77	17	57	10
	Telkom	29	90	42	42	148
Call Dropped	MTN	25	17	25	14	3
	Vodacom	23	15	4	21	5
	Cell C	16	36	12	36	22
	Telkom	14	13	15	11	20
Call Complete	MTN	259	209	287	220	388
	Vodacom	258	222	288	204	375
	Cell C	263	223	280	203	324
	Telkom	269	232	276	212	348
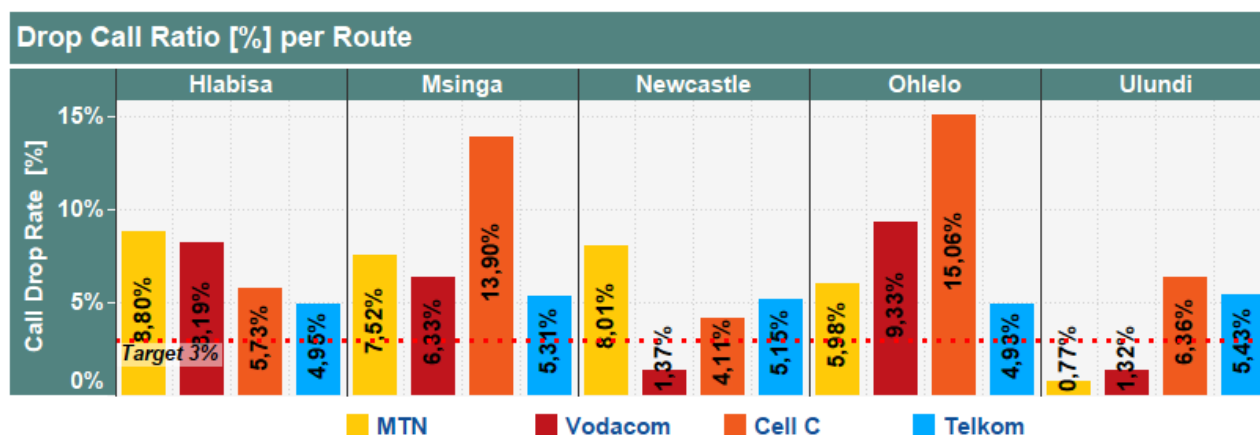
Figure 4. DCR KPI per Area

Figure 4 shows Vodacom met DCR KPI target in Newcastle and Ulundi whilst MTN achieved the target only in Ulundi. Cell C and Telkom failed to meet the target on all the routes tested.

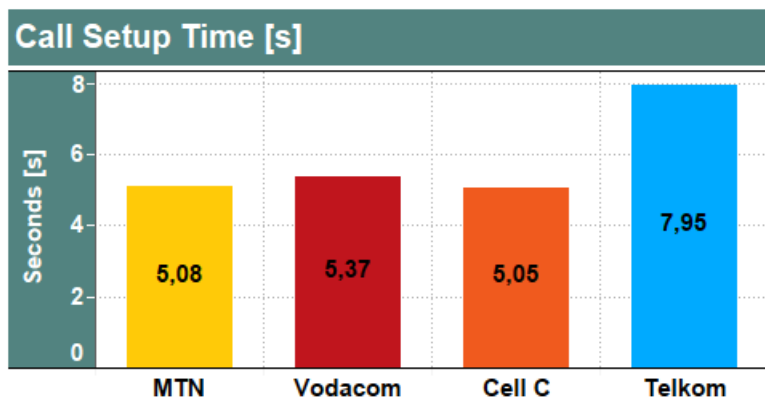## 4.1.4. Voice Call Setup Time (Short call)

Call Setup Time [s]

Figure 5. Call Setup Time [s] KPI Overall

Figure 5 shows the overall results for Call Setup Time. Cell C had the lowest overall Call Setup Time, followed by MTN, Vodacom and Telkom in ascending order.
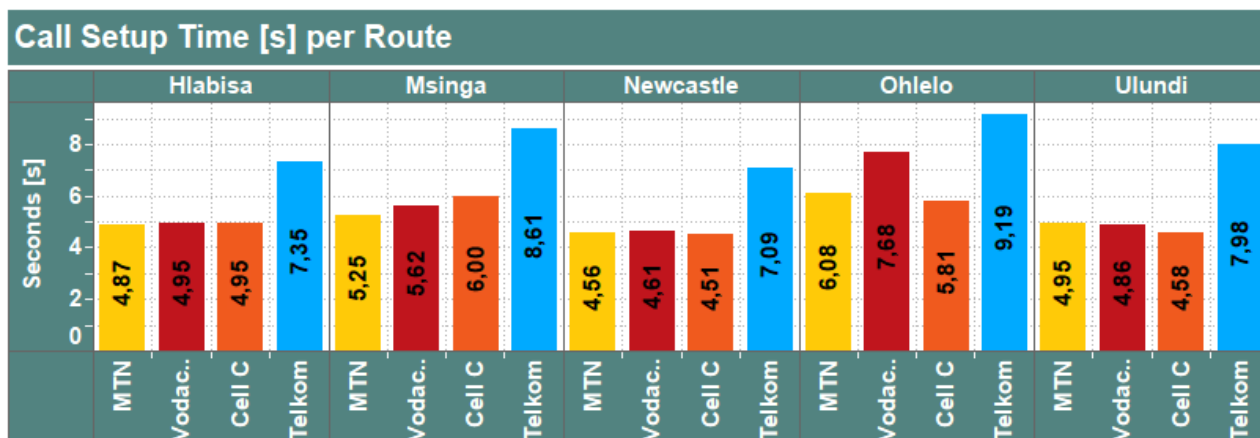

Figure 6. Call Setup Time [s] KPI per area

Figure 6 shows all operators met the Call Setup Time target of less than 20 seconds as per the End-User and Subscribers Service Charter Regulations of 2016.
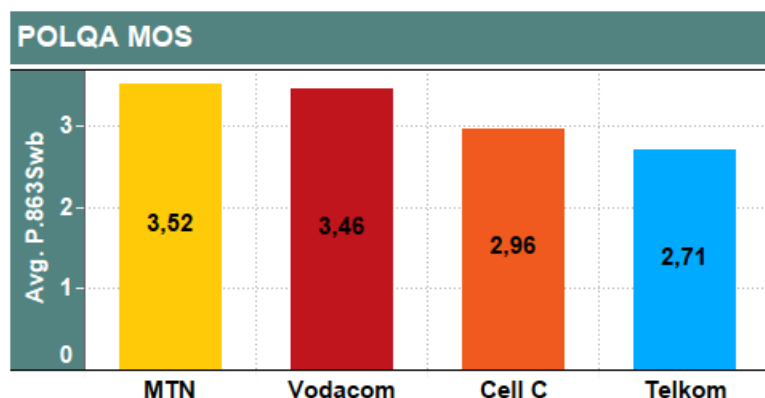
4.1.5. POLQA MOS (Long call)

Figure 7. Speech quality overall results

Figure 7 shows MTN achieved best Speech Quality followed by Vodacom, Cell C and Telkom in the descending order.
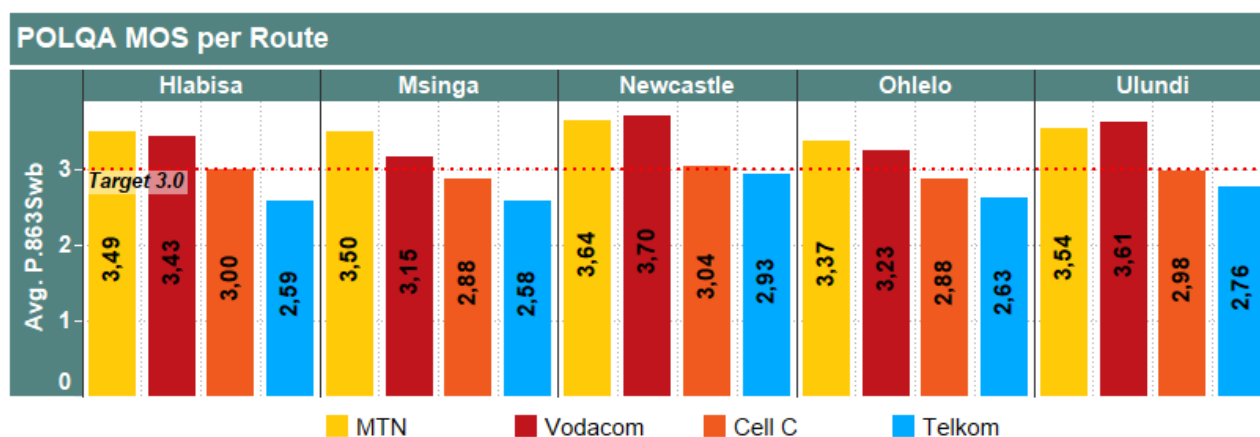

Figure 8. Speech Quality per Area

Figure 8 depicts speech quality results per tested area. MTN and Vodacom achieved an average MOS of over 3 in all the tested areas thus meeting the Authority's target. Cell C achieved the speech quality target in Hlabisa and Newcastle only. Telkom failed to meet the target for Speech Quality in all tested areas.

4.1.6. Radio Technology (Long call)
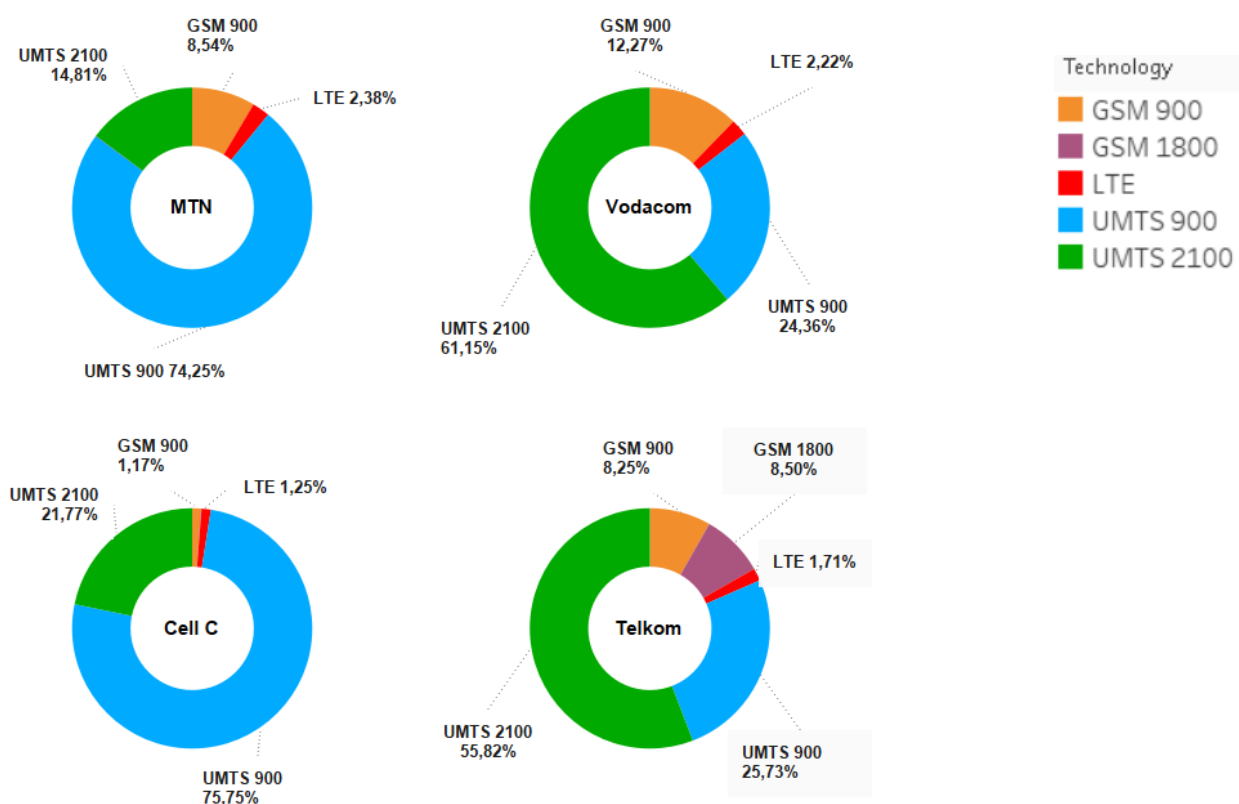
Figure 9 Radio technology

Figure 9 shows the distribution of the serving technology during the drive test. The serving technology distribution is based on the device used and the network parameter configuration which varies with the mobile operators. All operators' serving technology was mainly on UMTS technology.
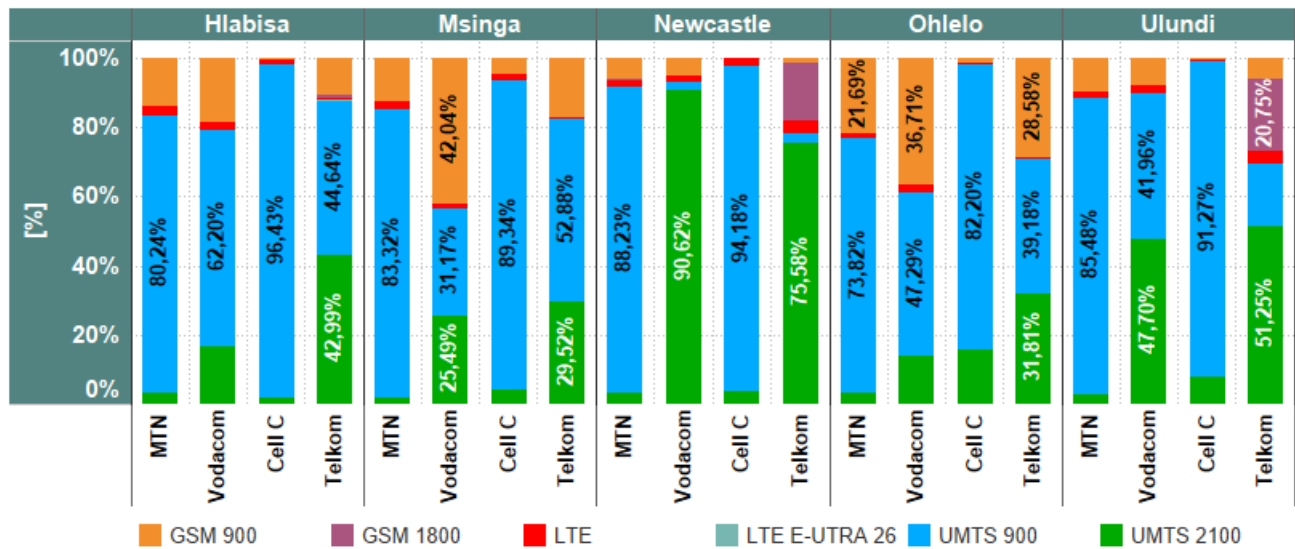
Figure 10 Radio technology per Area

Figure 10 shows the distribution of the serving technology during the drive test per Area.

4.1.7.CSFB (Short call)
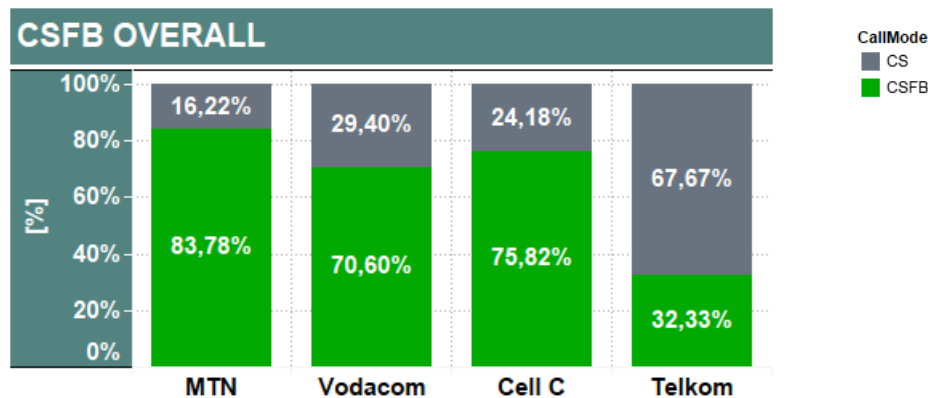
Figure 11. CSFB Overall stats

Figure 11 shows percentage of calls that were attempted on traditional networks (CS Calls) as well as the ones initiated on LTE network and fell back to UMTS/ GSM (CSFB Calls).
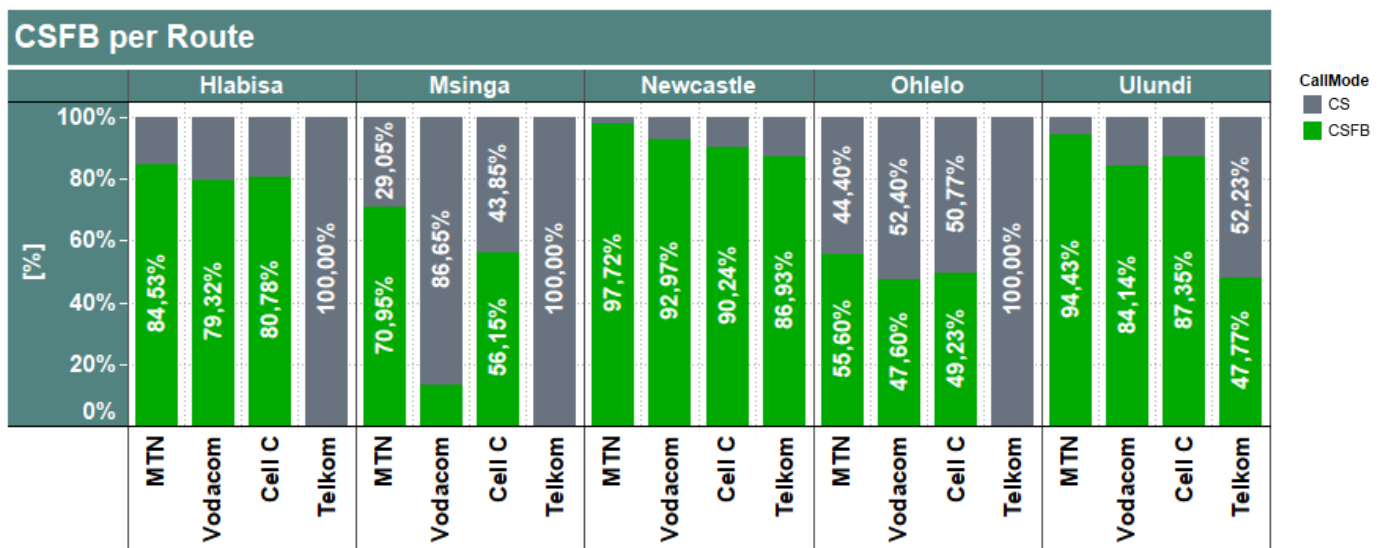
Figure 12. CSFB per Area

Figure 12 shows the breakdown of CS/ CSFB calls per Route. Telkom is seen with no CSFB samples in Hlabisa, Msinga and Ohlelo. This indicates that the operator does not have LTE coverage in these areas.

4.1.8.Roaming statistics (Long call)
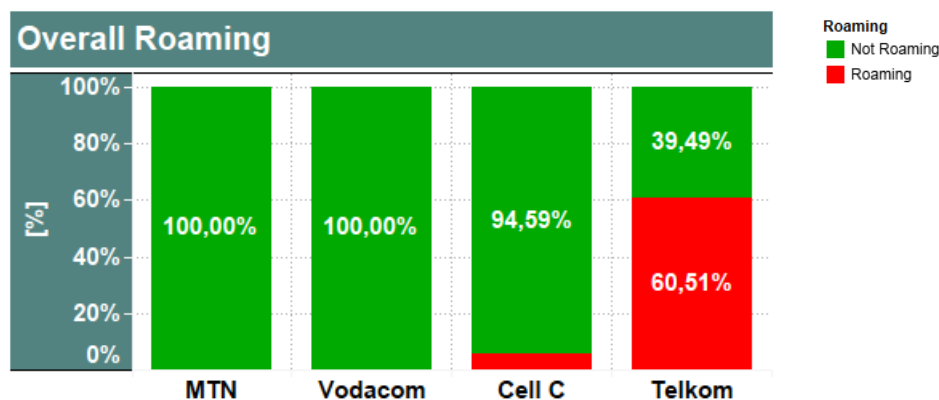
Figure 13. Overall Roaming percentages

Figure 13 shows overall roaming samples for each operator. Cell C and Telkom are seen with roaming samples, with Telkom having the highest percentage of roaming.

Figure 14. Roaming percentages per Area

Figure 14 shows Roaming per Operator per Route. Telkom is seen with the high percentage of roaming in Msinga, Ohlelo and Hlabisa; these are the areas with poor to no coverage.

5. Conclusion

This section provides the summary and key findings of all measurements. The results illustrate a snapshot of the mobile network performance and customer experience within the measured time and location context.
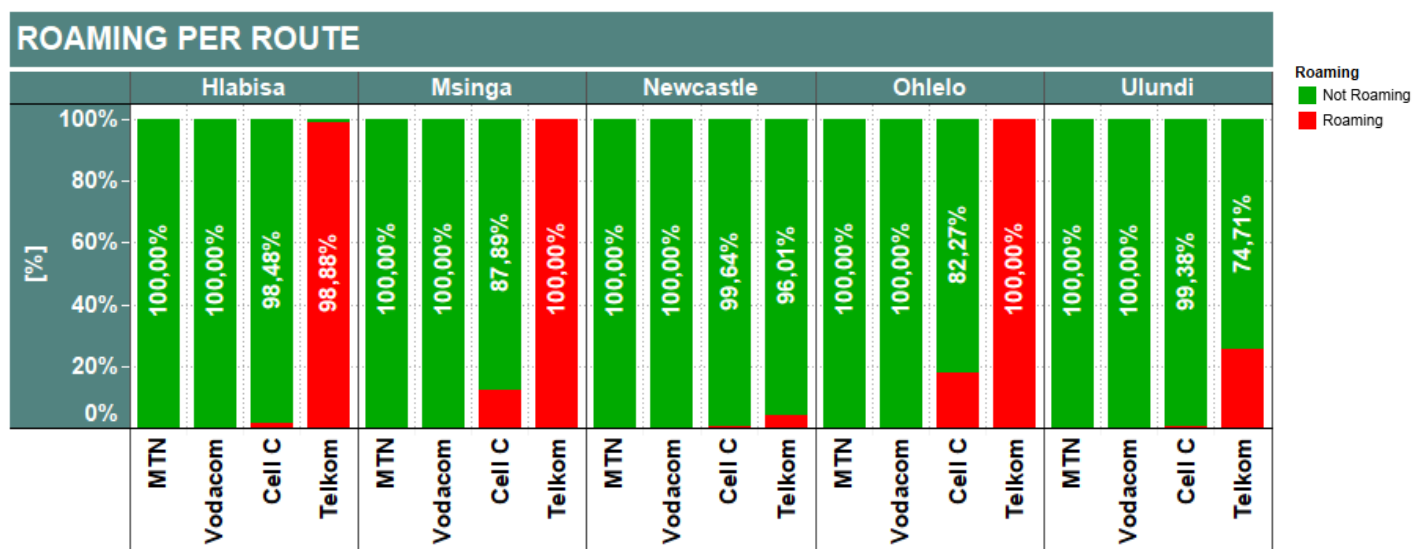
The results indicate that the end-user's quality of service and operators' network performance varies significantly per area tested.

The operators have poor performance in Hlabisa, Msinga and Ohlelo, none of the operators achieved the CSSR and DCR targets in these areas.

As we benchmark the operators, the results show that in terms of overall Call Setup Success Ratio, all operators scored less than 98% CSSR values, thus failed to meet the Accessibility target.

All operators failed to meet overall Drop Call Ratio target of less than 3%.

MTN and Vodacom are the only operators that met the target for Speech Quality in the overall results.

All operator met the Call Setup Time target according to the End-User and Subscribers Service Charter Regulation of 2016.

6. Appendices

6.1. Appendix 1: Detailed test results by Phase

Table 8: Call Setup Success Rate (CSSR) per Area – Phase 1 & 2

| | | Hlabisa | | Msinga | | Newcastle | | Ohlelo | | Ulundi | | Total |
		Phase 1	Phase 2	Phase 1	Phase 2	Phase 1	Phase 2	Phase 1	Phase 2	Phase 1	Phase 2	
Call Attempt	**MTN**	376	286	172	326	357	363	278	305	483	513	3459
	Vodacom	373	279	180	325	361	361	264	300	488	502	3433
	Cell C	361	274	167	320	342	354	274	306	349	509	3256
	Telkom	376	278	171	295	354	346	279	310	472	496	3377
Call Setup	**MTN**	367	275	167	277	354	355	253	283	481	507	3319
	Vodacom	352	262	151	246	348	349	232	247	465	481	3133
	Cell C	341	252	147	284	335	341	250	272	344	494	3060
	Telkom	351	265	153	212	331	327	238	272	369	416	2934
Call Setup Success Rate [%]	**MTN**	97,61%	96,15%	97,09%	84,97%	99,16%	97,80%	91,01%	92,79%	99,59%	98,83%	95,95%
	Vodacom	94,37%	93,91%	83,89%	75,69%	96,40%	96,68%	87,88%	82,33%	95,29%	95,82%	91,26%
	Cell C	94,46%	91,97%	88,02%	88,75%	97,95%	96,33%	91,24%	88,89%	98,57%	97,05%	93,98%
	Telkom	93,35%	95,32%	89,47%	71,86%	93,50%	94,51%	85,30%	87,74%	78,18%	83,87%	86,88%

Table 9: Drop Call Ratio (DCR) per Area – Phase 1 & 2

		Hlabisa		Msinga		Newcastle		Ohlelo		Ulundi		Total
		Phase 1	Phase 2	Phase 1	Phase 2	Phase 1	Phase 2	Phase 1	Phase 2	Phase 1	Phase 2	
Call Complete	MTN	139	120	119	90	152	135	103	117	197	191	1 363
	Vodacom	137	121	121	101	154	134	98	106	187	188	1 347
	Cell C	139	124	108	115	145	135	97	106	133	191	1 293
	Telkom	145	124	120	112	141	135	97	115	174	174	1 337
Call Dropped	MTN	15	10	11	6	12	13	7	7	0	3	84
	Vodacom	15	8	6	9	2	2	7	14	2	3	68
	Cell C	7	9	20	16	6	6	16	20	12	10	122
	Telkom	5	9	7	6	8	7	4	7	11	9	73
Drop Call Ratio [%]	MTN	9,74%	7,69%	8,46%	6,25%	7,32%	8,78%	6,36%	5,65%	0,00%	1,55%	5,81%
	Vodacom	9,87%	6,20%	4,72%	8,18%	1,28%	1,47%	6,67%	11,67%	1,06%	1,57%	4,81%
	Cell C	4,79%	6,77%	15,63%	12,21%	3,97%	4,26%	14,16%	15,87%	8,28%	4,98%	8,62%
	Telkom	3,33%	6,77%	5,51%	5,08%	5,37%	4,93%	3,96%	5,74%	5,95%	4,92%	5,18%

6.2. Appendix 2: Coverage maps

6.2.1. Technology Maps

6.2.1.1.   Hlabisa
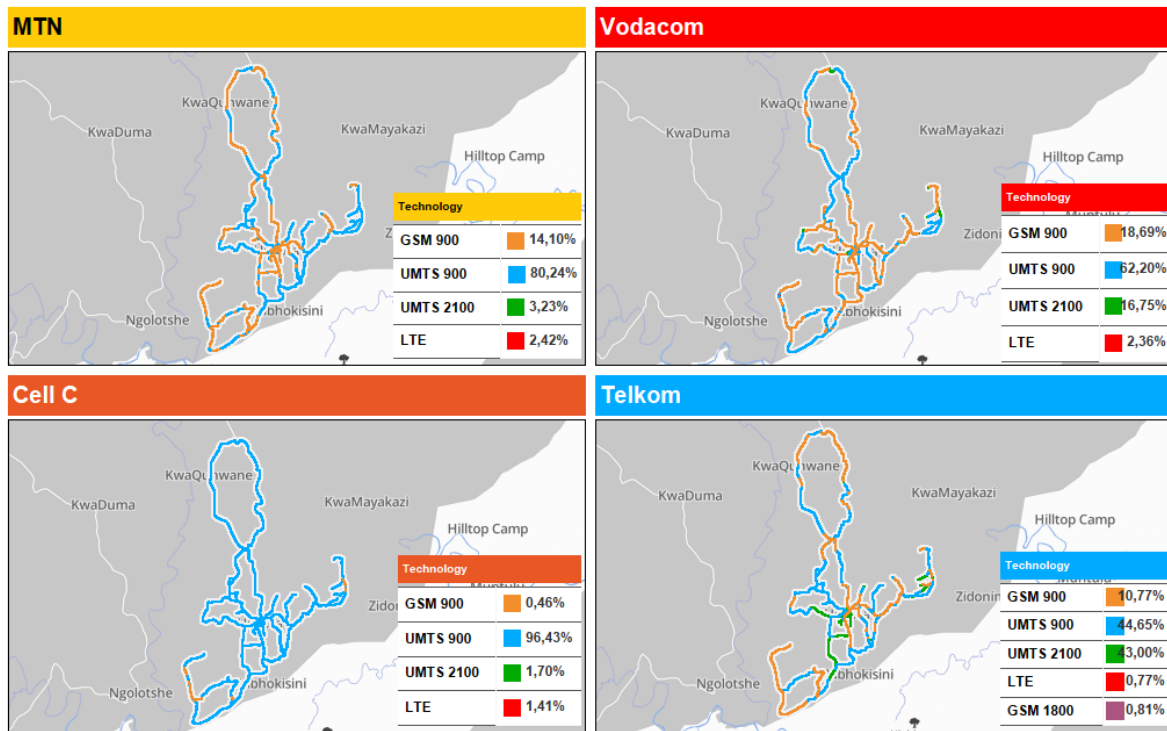
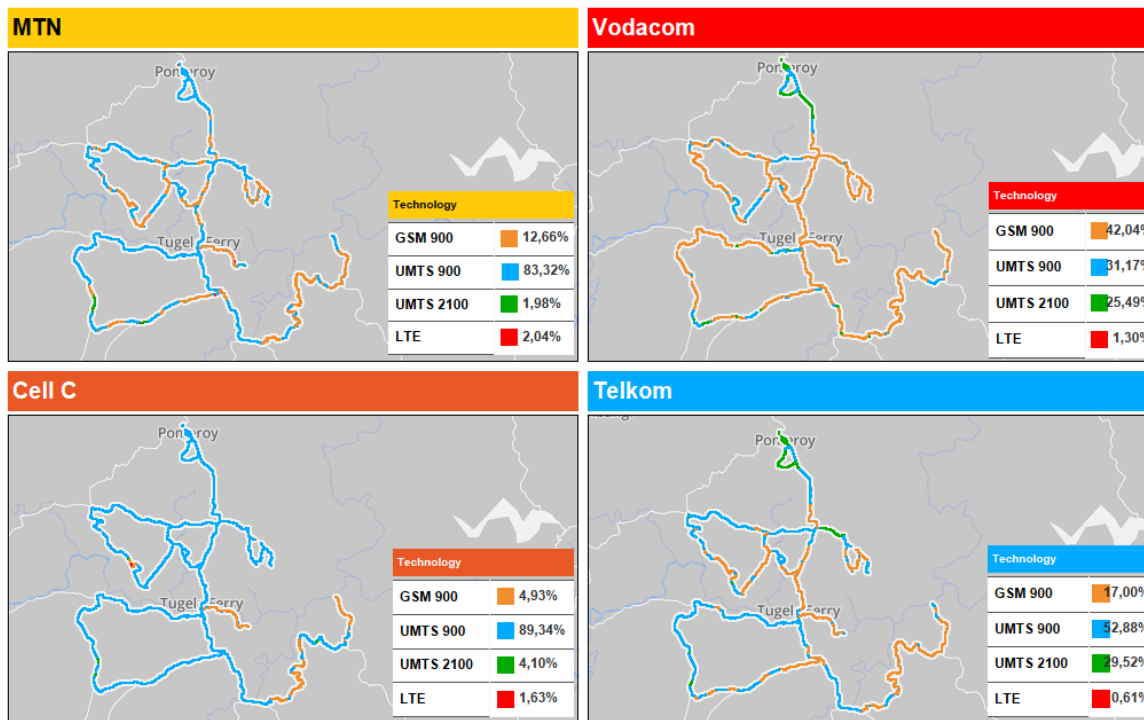
Figure 15. Hlabisa Technology Map

6.2.1.2.   Msinga

MTN

Technology	
GSM 900	12,66%
UMTS 900	83,32%
UMTS 2100	1,98%
LTE	2,04%

Vodacom

Technology	
GSM 900	42,04%
UMTS 900	31,17%
UMTS 2100	25,49%
LTE	1,30%

Cell C

Technology	
GSM 900	4,93%
UMTS 900	89,34%
UMTS 2100	4,10%
LTE	1,63%

Telkom

Technology	
GSM 900	17,00%
UMTS 900	52,88%
UMTS 2100	29,52%
LTE	0,61%

Figure 16. Msinga Technology Map

6.2.1.3.   Newcastle

MTN

Technology	
GSM 900	6,08%
UMTS 900	88,23%
UMTS 2100	3,17%
LTE	2,48%
GSM 1800	0,04%

Vodacom

Technology	
GSM 900	5,20%
UMTS 900	2,16%
UMTS 2100	90,62%
LTE	2,02%

Cell C

Technology	
UMTS 900	94,18%
UMTS 2100	3,64%
LTE	2,18%

Telkom

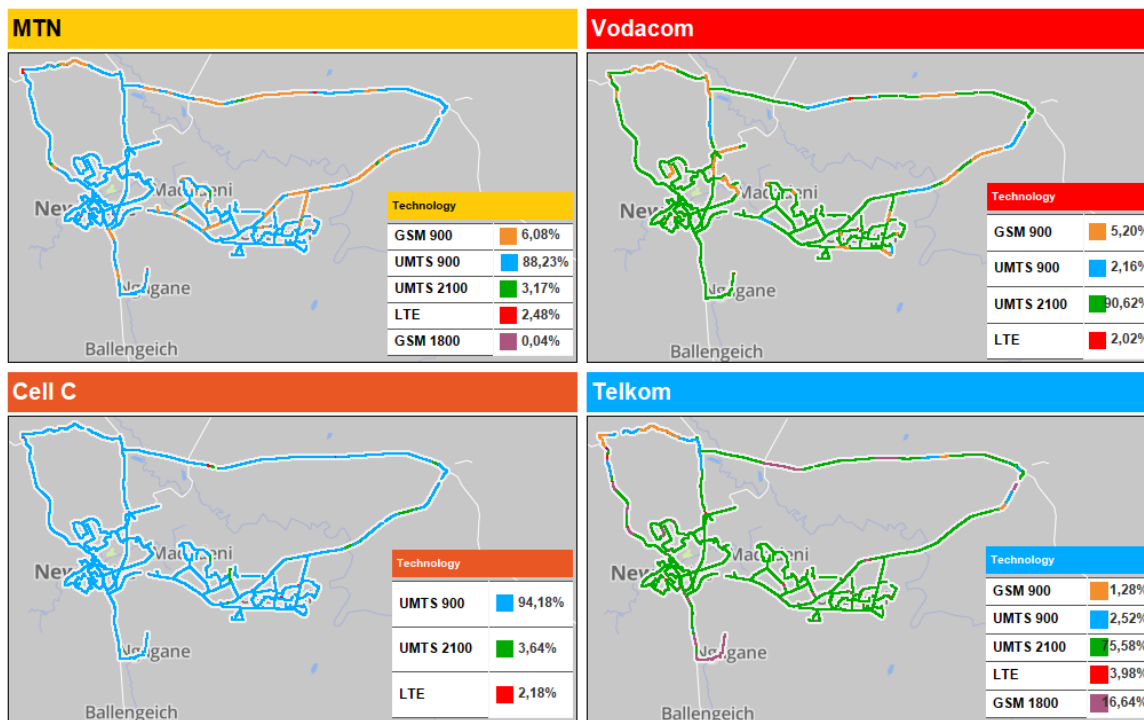| Technology	
GSM 900	1,28%
UMTS 900	2,52%
UMTS 2100	75,58%
LTE	3,98%
GSM 1800	16,64%

Figure 17. Newcastle Technology Map
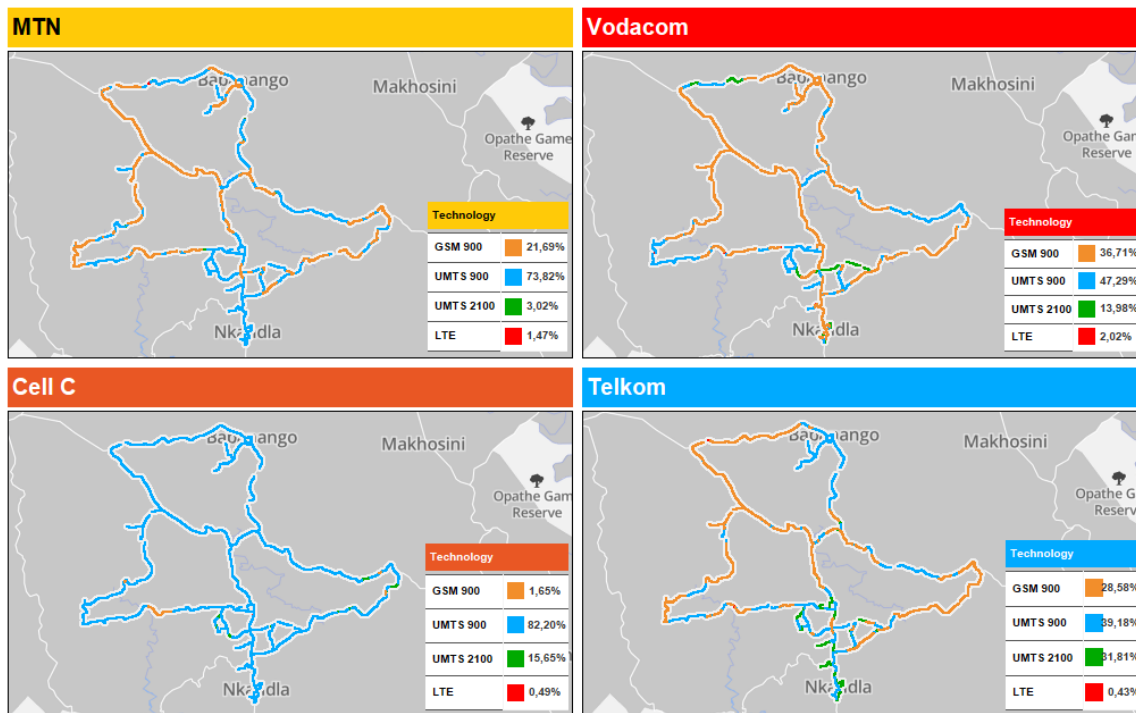
6.2.1.4. Ohlelo

Figure 18. Ohlelo Technology Map
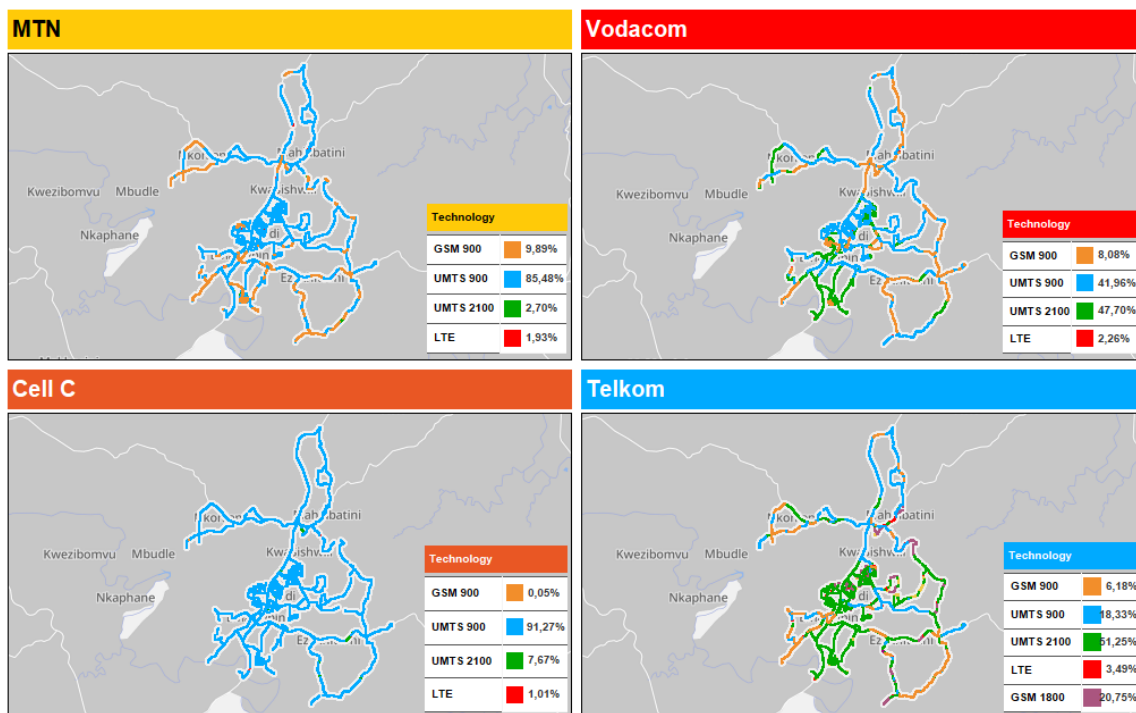
6.2.1.5. Ulundi

Figure 19. Ulundi Technology Map

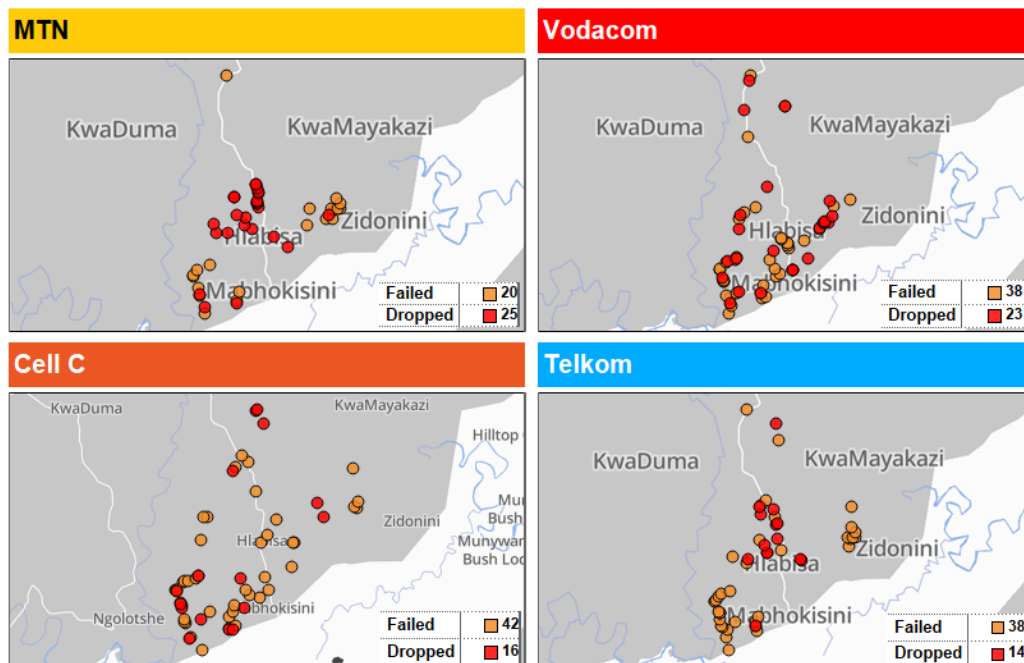## 6.2.2. Call Failures

6.2.2.1.   Hlabisa

Figure 20. Hlabisa Call Failures

6.2.2.2.   Msinga

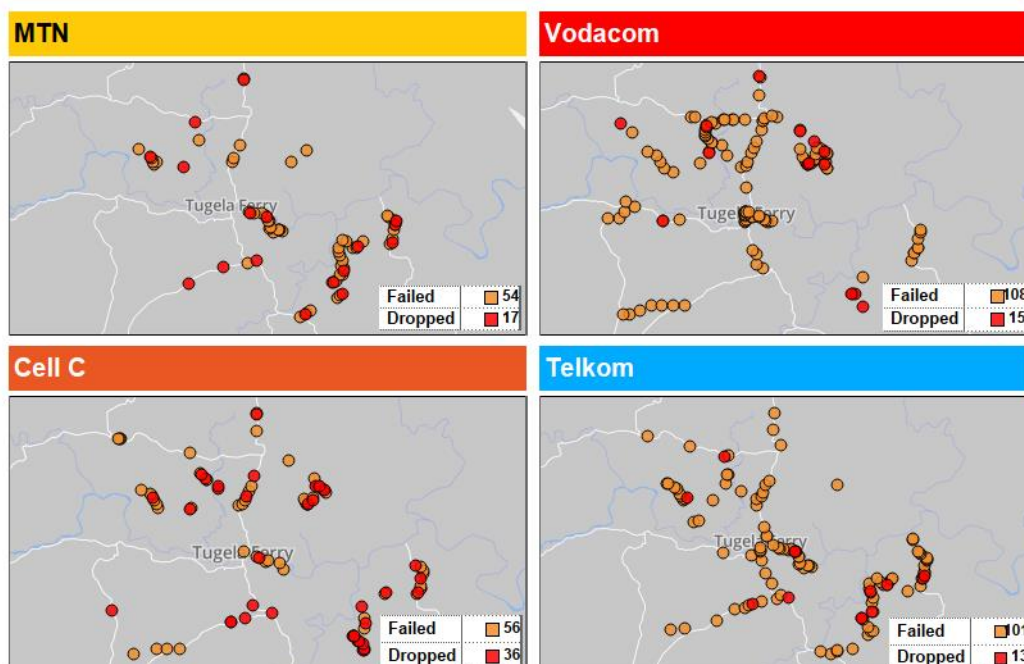*Figure 21. Msinga Call Failures*
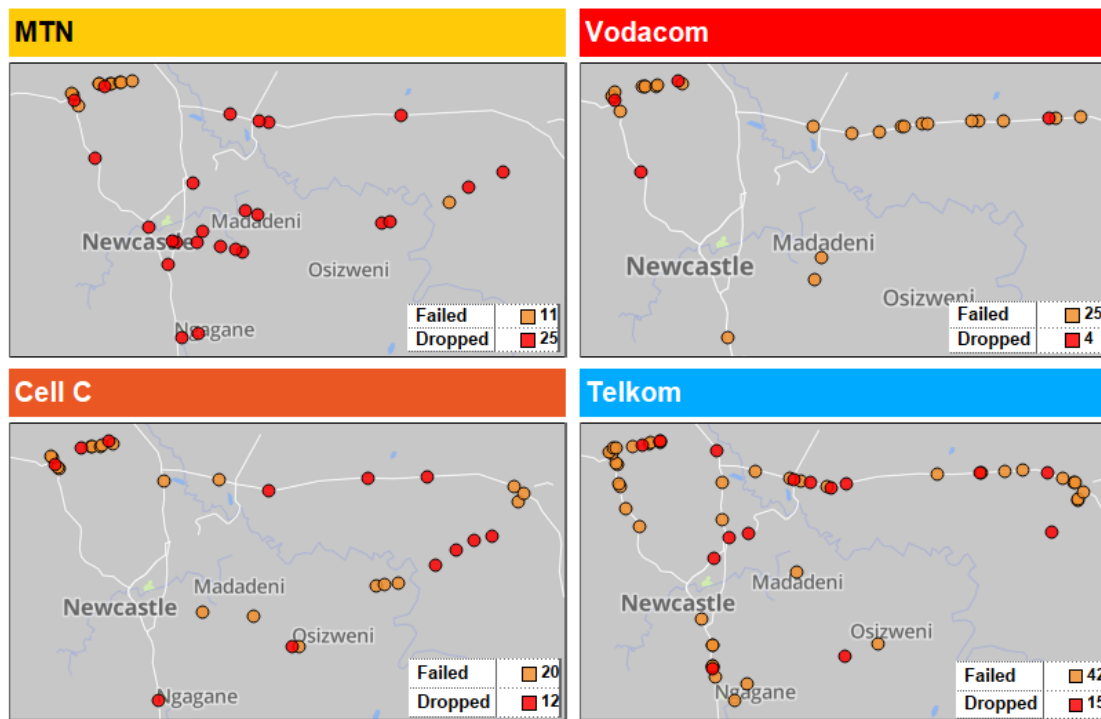
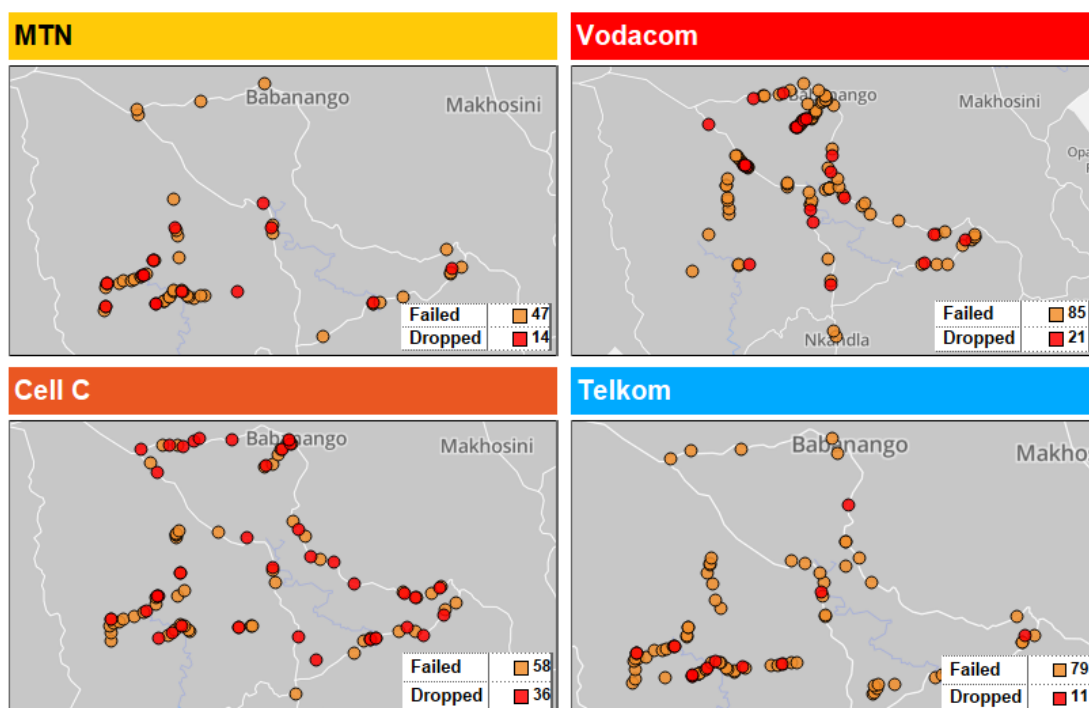## 6.2.2.3.   Newcastle

Figure 22. Newcastle Call Failures

6.2.2.4.   Ohlelo

Figure 23. Ohlelo Call Failures
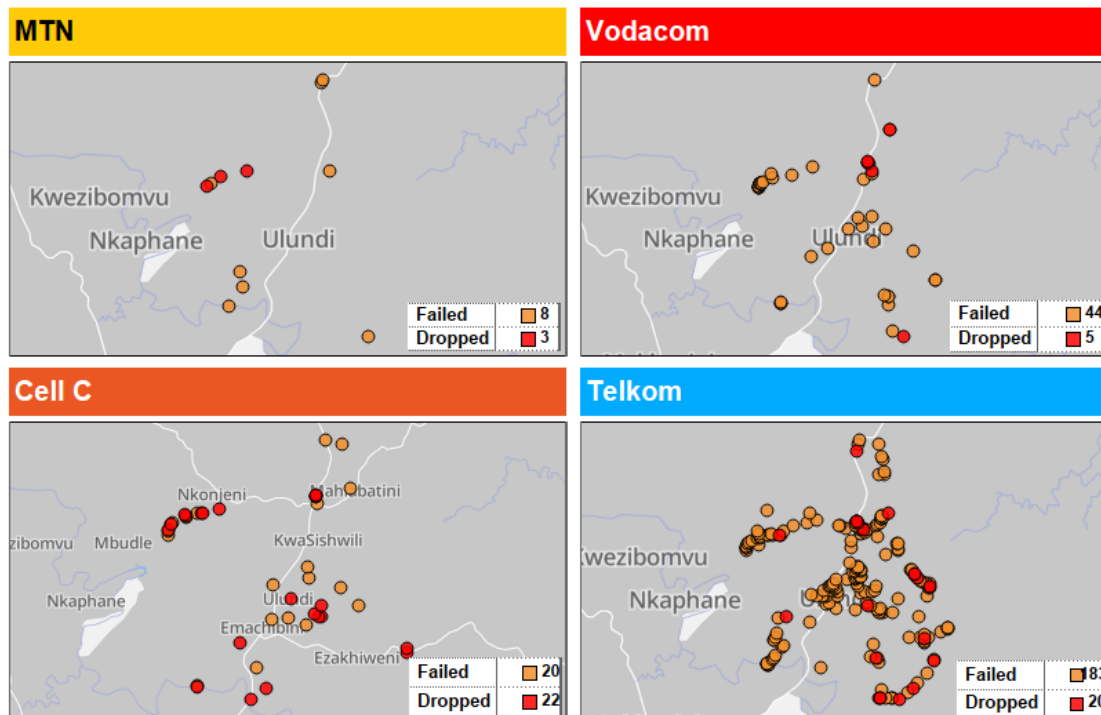
6.2.2.5. Ulundi

Figure 24. Ulundi Call Failures

6.2.3.Roaming (Long call)

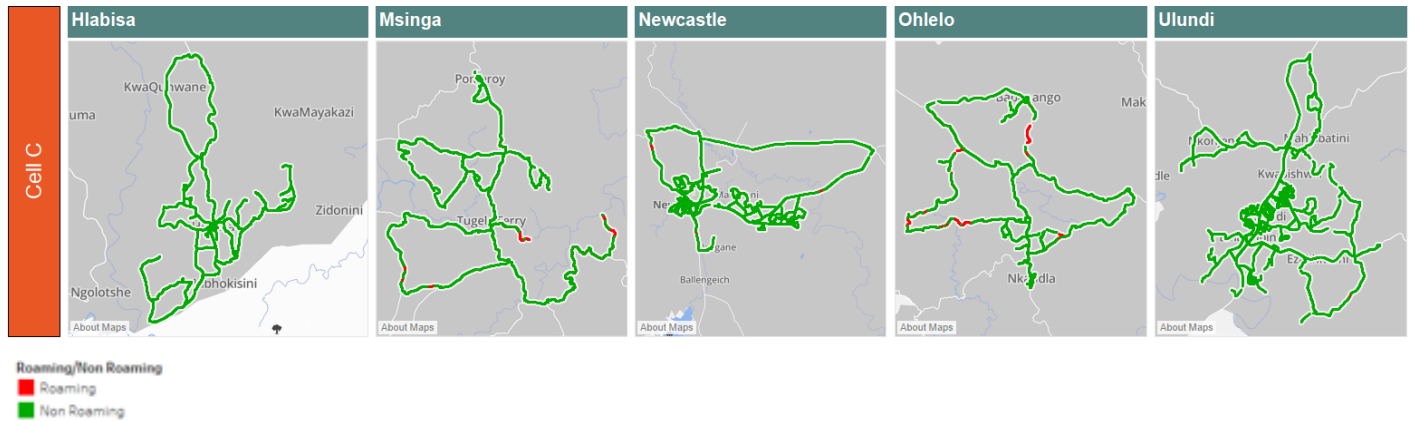### 6.2.3.1. Cell C

Figure 25. Cell C Roaming (Long Call)
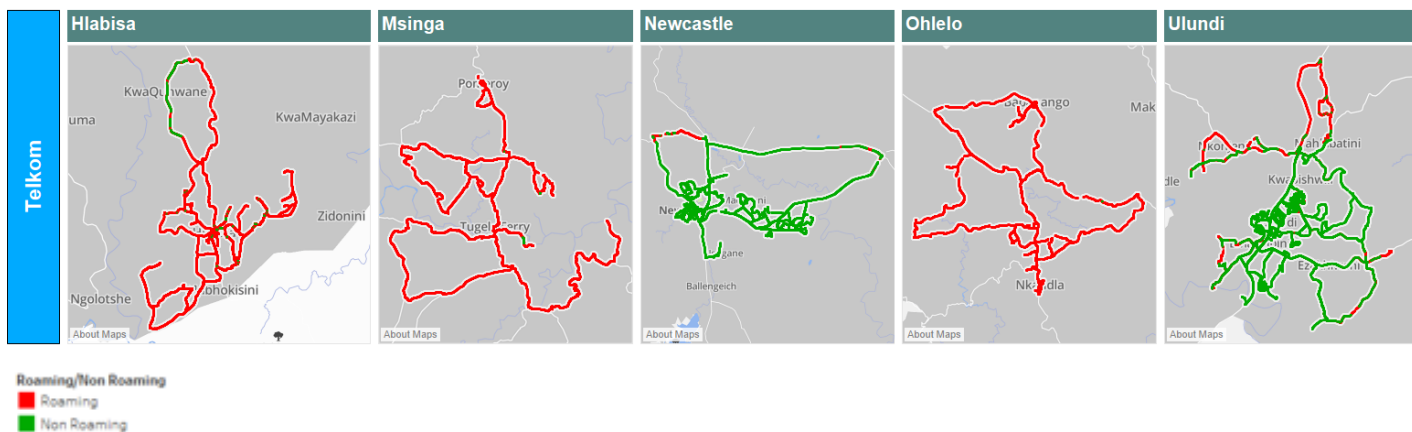
6.2.3.2. Telkom

Figure 26. Telkom Roaming (Long Call)

6.3. Appendix 3: Mobile operators' feedback on the report

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

6.3.1. Vodacom

Vodacom provided 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 report and shared the following plans and remedial actions:

- Hlabisa route – Performance was affected by poor sites availability as a result of theft and vandalism. Batteries will be replaced as well as site security improvement will be investigated. New site is also planned and will be built by end of September 2020.
- Msinga and Ulundi route – Performance was affected by poor sites availability as a result of theft and vandalism. Batteries will be replaced as well as site security improvement will be investigated.
- Newcastle route – Poor performance was due to poor coverage and new site was activated in January 2019, to improve network performance.
- Ohlelo route – Poor coverage and quality gaps were identified. Two new sites are planned in the area to be completed by September 2020 and radio frequency (RF) optimisation projects have been implemented. 60% of the failures have already been resolved by the solutions that have been implemented.

6.3.2. MTN

MTN provided 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 plans and remedial actions:

- Hlabisa route – Nine (9) new sites are planned in the area to address weak coverage. A further re-drive and network optimisation will be conducted.

- Msinga route – Ten (10) new sites are planned in the area to address poor coverage and performance. Furthermore, network optimisation will be conducted to improve performance.
- Newcastle route – Eight (8) new sites are planned in the area to address poor coverage and performance. Furthermore, network optimisation will be conducted to improve performance.
- Ohlelo route – Ten (10) new sites are planned in the area to address poor coverage and performance. Furthermore, redrive and network optimisation will be conducted to improve performance.
- Ulundi route –Five (5) new sites are planned in the area to address poor coverage and performance. Furthermore, redrive and network optimisation will be conducted to improve performance.

6.3.3.Cell C

Cell C attributes poor performance, to tests currently underway to update system parameters in order to accommodate MTN national roaming arrangement. Low performance is also due to low coverage. However, Cell C's plans and remedies to improve the low performance areas include the following:
- Hlabisa route – Poor performance was due to lack of network capacity and the issue will be addressed through network capacity upgrade.
- Ulundi and Newcastle route - Poor performance was due to poor coverage and the issue will be addressed through building new sites and upgrade of the existing sites.
- Msinga and Ohlelo route - Poor performance was due to poor coverage and the issue will be addressed through planned network expansions.
- Ulundi route - Poor performance was due to poor coverage and the issue will be addressed through building new sites and upgrade of the existing sites.

Furthermore, there was a major network optimisation project which took place during the month of November 2018 to December 2018. Power failures (load shedding) was also the contributor to poor performance. A total of 113 sites are being upgraded in the above areas.

6.3.4. Telkom

Telkom views the test results as very significant and uses them as additional input to further improve the quality of the mobile network. Most call failures on the Telkom network were due to inadequate network coverage. This is being addressed by building additional sites in the tested areas to provide a more contiguous network coverage. Telkom's deployment plan within these areas are set out below:

- Hlabisa route – a total of 11 sites are planned to be built.
- Msinga route – a total of 15 sites are planned to be built.
- Newcastle route – a total of 91 sites are planned to be built.
- Ohlelo route – a total of 26 sites are planned to be built.
- Ulundi route – a total of 16 sites are planned to be built.

In addition to building additional sites, other initiative to improve network and service quality is underway including LTE Carrier Aggregation, refarming of 2100 MHz spectrum for LTE, UMTS R99 parameter optimization, 256QAM modulation, etc.

Furthermore, Telkom has recently signed a new national roaming agreement with Vodacom, which is being implemented. Advantages of the new roaming agreement includes roaming on 4G/LTE and seamless call handover between networks. This will significantly improve Telkom's overall network voice and data quality, especially in areas where it has limited or no network coverage.