

Independent Communications Authority of South Africa

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2018/2019 Quarter 3:

Voice Quality of Service

Report -

Mpumalanga Province





Table of Contents

1.	Executive Summary	7
2.	Introduction	8
3.	Methodology	10
3.1.	Short & Long Call	10
3.2.	Equipment test setup and configuration	11
3.2.1.	System used	11
3.2.2.	Device Used	11
3.2.3.	Device Specification	11
3.3.	Route selection	12
3.4.	Measurement parameters and targets	12
3.4.1.	Targets	12
3.4.2.	Call Setup Success Ratio [%]	13
3.4.3.	Drop Call Ratio [%]	13
3.4.4.	Call Setup Time [s]	13
3.4.5.	Speech Quality (MOS)	13
4.	Results and Analysis	14
4.1.	Voice KPI Results	14
4.1.1.	Call Setup Success Ratio (CSSR) and Drop Call Ratio (DCR)	15
4.1.2.	Call Accessibility (Short call)	16
4.1.3.	Drop Call Ratio (Long call)	17
4.1.4.	Voice Call Setup Time (Short call)	18
4.1.5.	POLQA MOS (Long call)	19
4.1.6.	Radio Technology (Long call)	20
4.1.7.	CSFB (Short call)	21
4.1.8.	Roaming statistics (Long call)	22
5.	Conclusion	23
6.	Appendices	24
6.1.	Appendix 1: Detailed test results by Phase	24
6.2.	Appendix 2: Coverage maps	25
6.2.1.	Technology Maps	25
6.2.1.1.	Bethal	25
6.2.1.2.	eMalahleni	26
6.2.1.3.	Lydenburg	26





6.2.1.4.	Piet Retief	27
6.2.1.5.	Standerton	27
6.2.2.	Call Failures	28
6.2.2.1.	Bethal	28
6.2.2.2.	eMalahleni	28
6.2.2.3.	Lydenburg	29
6.2.2.4.	Piet Retief	29
6.2.2.5.	Standerton	30
6.2.3.	Roaming (Long call)	30
6.2.3.1.	Cell C	30
6.2.3.2.	Telkom	31





List of Abbreviations

CD	Call Duration
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
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





List of Figures

Figure 1. Mpumalanga Province Route Map	8
Figure 2. Call Window	10
Figure 3. CSSR KPI per Area	16
Figure 4. DCR KPI per Area	17
Figure 5. Call Setup Time [s] KPI Overall	18
Figure 6. Call Setup Time [s] KPI per area	18
Figure 7. Speech quality overall results	19
Figure 8. Speech Quality per Area	19
Figure 9. Radio technology	20
Figure 10. CSFB Overall stats	21
Figure 11. CSFB per Area	21
Figure 12. Overall Roaming percentages	22
Figure 13. Roaming percentages per Area	22
Figure 14. Bethal Technology Map	25
Figure 15. eMalahleni Technology Map	26
Figure 16. Lydenburg Technology Map	26
Figure 17. Piet Retief Technology Map	27
Figure 18. Standerton Technology Map	27
Figure 19. Bethal Call Failures	28
Figure 20. eMalahleni Call Failures	28
Figure 21. Lydenburg Call Failures	29
Figure 22. Piet Retief Call Failures	29
Figure 23. Standerton Call Failures	30
Figure 24. Cell C Roaming (Long Call)	30
Figure 25. Telkom Roaming (Long Call)	31





List of Tables

Table 1: Device Specification	11
Table 2: Test timelines for areas covered	12
Table 3: Distance and time driven per area	12
Table 4: Overall voice KPI results	14
Table 5: Summary of results per Area	15
Table 6: Short Call sample size per Area	16
Table 7: Long Call samples per Area	17
Table 8: Call Setup Success Rate (CSSR) per Area – Phase 1 & 2	24
Table 9: Drop Call Ratio (DCR) per Area – Phase 1 & 2	24





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 networks of mobile operators; Cell C, MTN, Telkom and Vodacom. The measurements were performed to monitor performance of mobile voice services offered by the operators in the Mpumalanga Province. The measurements were carried out in the period 30 October to 18 November 2018, 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. The sampled areas include eMalahleni, Lydenburg, Bethal, Standerton, and Piet Retief.

A vehicle equipped with Rohde and Schwarz Smart Benchmarker II measurement tool with 24 mobile phones was used to collect data in mobility conditions. The four Key Performance Indicators (KPIs) used to assess 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 achieved less than 98% CSSR values, thus failed to meet the Accessibility target. Vodacom, Cell C, and MTN did not meet the overall Drop Call Ratio target of less than 3%, only Telkom met the DCR target, thus achieving the Retainability target. All operators achieved Call Setup Time target of less than 20 seconds. Telkom is the only operator that failed to meet the target for Speech Quality.





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 prices¹. 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 Mpumalanga Province. The test was focused on monitoring the cellular voice telephony service being offered by MTN, Vodacom, Cell C, and Telkom within the Mpumalanga Province of South Africa.

The QoS monitoring was conducted in the following areas within the District Municipalities; Enhlanzeni, Gert Sibande and Nkangala. The selected areas include eMalahleni, Lydenburg, Bethal, Standerton, and Piet Retief. 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 drive tested in the Mpumalanga Province.



Figure 1. Mpumalanga 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, Call Retainability and Speech Quality parameters.

- 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 except in the areas where services were limited on most part of the drive test route. 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 the 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.

Voice test set-up consisted of two categories which are Short Call (Accessibility) and Long Call (Retainability), and each category required two end-user equipment (UE) i.e. call initiating side (A-side) and call receiving side (B-side). This set-up results in four UEs per operator and 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 (Perceptual Objective Listening Quality Analysis) POLQA wideband algorithm.

The devices were set to measure the best available technology and barred from making VoLTE calls, thus in areas where operators had LTE the UEs performed Circuit Switched Fall Back (CSFB) calls.

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

3.1. Short & Long Call

Sho	ort Call:			
1	Call Idle = 30s Call setup timeout = 30s Call Duration = 10s		Test Scenar.	Value
	Call Window = 70s		Short Call	Call Duration = 10s
				Call Setup timeout = 30s
				Call Window = 70s
10	na Call:		Long Call	Call Duration = 120s
207				Call Setup timeout = 30s
-	Call Idle = 30s Call setup timeout = 30s Call Duration = 120s			Call Window = 180s
ст.,	Call Window - 180s			POLQA (WB)

Figure 2. Call Window





3.2. Equipment test setup and configuration

3.2.1. System used

The Test Equipment used 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. The distance travelled, and active measurements time are shown in Table 3:

Table 2:	Test	timelines	for areas	s covered
ruoro L.	1001		ioi uiouc	0010104

Routes and Dates								
District	Area	Date	Test Type					
Ehlanzeni	Lydenburg	2018/11/01	Phase 1					
		2018/11/13	Phase 2					
		2018/11/14	Phase 2					
Gert Sibande	Bethal	2018/11/05	Phase 1					
		2018/11/16	Phase 2					
		2018/11/17	Phase 2					
	Piet Retief	2018/11/03	Phase 1					
		2018/11/15	Phase 2					
	Standerton	2018/11/07	Phase 1					
		2018/11/08	Phase 1					
		2018/11/18	Phase 2					
Nkangala	eMalahleni	2018/10/30	Phase 1					
		2018/11/09	Phase 2					

Table 3: Distance and time driven per area

Kilometers & Hours Driven										
Bethal		630					13,87			
eMalahleni		634					16,44	4		
Lydenburg		500					13,04			
Piet Retief		666					15,57			
Standerton		616					13,51			
Total				3 04	8					72,43
	0K	1K	2K	3 K	1	0	20	40	60	80
	Distance_Km				Hours Tested					

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 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, is 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 call established

3.4.4. 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.

3.4.5. 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.

² https://www.icasa.org.za/uploads/files/39898_1-4_lcasa.pdf





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: eMalahleni, Lydenburg, Standerton, Bethal, and Piet Retief.

4.1. Voice KPI Results

Table 4: Overall voice KPI results

		MTN	Vodacom	Cell C	Telkom
	Call Attempt	3608	3692	3590	3590
	Call Failed	99	159	125	281
Call	Successfull Attempts	3509	3533	3465	3309
hort	Call Dropped	10	0	0	1
s	Call Complete	3499	3533	3465	3308
	Call Setup Success Rate	97.26	95.69	96.52	92.17
	Call Setup Time [s]	4.27	4.25	4.84	7.15
Long Call	Call Attempt	1485	1510	1467	1546
	Call Failed	72	113	89	168
	Successfull Attempts	1413	1397	1378	1378
	Call Dropped	45	44	44	41
	Call Complete	1368	1353	1334	1337
	Drop Call Ratio [%]	3.18%	3.15%	3.19%	2.98%
	POLQA MOS	3.71	3.63	3.08	2.74

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.

From the Table 4 above, it can be seen that all operators failed to achieve the Call Setup Success Ratio target as per regulations. All operators were, however, able to achieve the Call Setup Time target. Telkom was the only operator that met the Drop Call Ratio target, however, it was the only operator that failed to achieve the Speech Quality score of above 3.





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

Table 5 shows voice call measurement results in each route for each operator. Lydenburg and Piet Retief were the areas where the operators experienced poor performance with none of the operators achieving the target in any of these areas.

		Bethal	eMalahleni	Lydenburg	Piet Retief	Standerton
Call Setup Success	MTN	98.77%	100.00%	96.61%	92.43%	98.25%
Nute - [70]	Vodacom	99.29%	99.18%	94.58%	87.37%	98.13%
	Cell C	98.22%	99.88%	95.87%	90.85%	97.58%
	Telkom	95.01%	97.50%	86.28%	84.82%	96.78%
Drop Call Ratio [%]	MTN	1.84%	3.55%	4.21%	4.72%	1.52%
	Vodacom	1.10%	0.60%	4.00%	8.80%	2.23%
	Cell C	5.64%	0.30%	4.00%	3.24%	3.46%
	Telkom	0.75%	1.81%	6.27%	3.59%	2.70%
Call Setup Time [s]	MTN	4.51	3.39	4.27	4.76	4.58
	Vodacom	4.15	3.96	4.13	4.98	4.11
	Cell C	5.13	3.64	4.59	5.51	5.71
	Telkom	6.95	7.29	6.77	7.06	7.61
POLQA MOS	MTN	3.68	3.73	3.73	3.72	3.66
	Vodacom	3.69	3.70	3.66	3.33	3.69
	Cell C	3.13	3.07	3.09	3.06	3.06
	Telkom	2.66	2.88	2.81	2.65	2.65

Table 5: Summary of results per Area





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

		Bethal	eMalahleni	Lydenburg	Piet Retief	Standerton	
Call Attempt	MTN	648	839	709	727	685	
	Vodacom	709	849	664	776	694	
	Cell C	675	849	703	743	620	
	Telkom	682	840	685	731	652	
	MTN	8	0	24	55	12	
Call Failed	Vodacom	5	7	36	98	13	
Call Failed	Cell C	12	1	29	68	15	
	Telkom	34	21	94	111	21	
	MTN	1	4	2	3	0	
Call Droppod	Vodacom	0	0	0	0	0	
Call Dropped	Cell C	0	0	0	0	0	
	Telkom	0	0	0	1	0	
Call Complete	MTN	639	835	683	669	673	
	Vodacom	704	842	628	678	681	
	Cell C	663	848	674	675	605	
	Telkom	648	819	591	619	631	



Figure 3. CSSR KPI per Area

Figure 3 shows that MTN and Vodacom met 98% CSSR target in Bethal, eMalahleni, and Standerton. Cell C met the target in Bethal and eMalahleni, whilst Telkom did not meet the CSSR target in any of the tested areas. All operators failed to meet CSSR target in Piet Retief and Lydenburg.





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

		Bethal	eMalahleni	Lydenburg	Piet Retief	Standerton	
Call Attempt	MTN	279	341	294	301	270	
	Vodacom	273	333	304	324	276	
Call Attempt	Cell C	278	332	298	288	271	
	Telkom	285	346	343	291	281	
	MTN	7	3	9	47	6	
Call Failed	Vodacom	1	2	29	74	7	
Call Failed	Cell C	12	2	23	41	11	
	Telkom	19	15	72	40	22	
Call Deserved	MTN	5	12	12	12	4	
	Vodacom	3	2	11	22	6	
Call Dropped	Cell C	15	1	11	8	9	
	Telkom	2	6	17	9	7	
0.11.0	MTN	267	326	273	242	260	
	Vodacom	269	329	264	228	263	
-Can complete	Cell C	251	329	264	239	251	
	Telkom	264	325	254	242	252	



Figure 4. DCR KPI per Area

Figure 4 shows that MTN met DCR KPI target only in Bethal and Standerton. Vodacom met the target in Bethal, eMalahleni as well as in Standerton. Cell C only met the target in eMalahleni and failed the target in the other four tested areas. Telkom only met the target in the following areas: Bethal, eMalahleni and Standerton. All operators failed to meet the DCR target in Lydenburg and Piet Retief.





4.1.4. Voice Call Setup Time (Short call)



Figure 5. Call Setup Time [s] KPI Overall

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



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. Telkom failed to meet ICASA's target of a score of 3 for speech quality.





Figure 8 depicts speech quality results per tested area. MTN, Vodacom and Cell C achieved an average Mean Opinion Score (MOS) of over 3 in all the tested areas thus meeting the Authority's target. Telkom failed to meet the target for speech quality in all tested areas.





4.1.6. Radio Technology (Long call)

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.









4.1.7. CSFB (Short call)



Figure 10. CSFB Overall stats

Figure 10 shows percentage of calls that were attempted on traditional networks as well as the ones initiated on LTE network and fell back to UMTS/ GSM.



Figure 11. CSFB per Area

Figure 11 shows the breakdown of CS/ CSFB calls per Route. Telkom is seen with no CSFB samples in Bethal, Piet Retief and Standerton. This is also an indication that the operator does not have LTE coverage in the areas.





4.1.8. Roaming statistics (Long call)



Figure 12. Overall Roaming percentages

Figure 12 shows overall roaming samples for each operator. Cell C and Telkom are seen with some roaming samples with Telkom having the highest percentage of roaming.



Figure 13. Roaming percentages per Area

Figure 13 shows roaming status per operator in the specific rou. Telkom is seen with 100% roaming in Bethal, Piet Retief and Standerton.





5. Conclusion

This section provides 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.

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

MTN, Vodacom and Cell C failed to meet overall Drop Call Ratio target except for Telkom that achieved overall target of 2.98%. Telkom is the only operator that failed to meet the target for Speech Quality.

All operator achieved 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

		Bethal		eMalahleni		Lydenburg		Piet Retief		Standerton		Total
		Phase 1	Phase 2	Phase 1	Phase 2	Phase 1	Phase 2	Phase 1	Phase 2	Phase 1	Phase 2	TOtal
Call Attempt	MTN	358	290	395	444	354	355	341	386	374	311	3608
	Vodacom	373	336	391	458	357	307	381	395	379	315	3692
	Cell C	348	327	394	455	351	352	351	392	325	295	3590
	Telkom	359	323	388	452	336	349	375	356	342	310	3590
Call Setup	MTN	352	288	395	444	341	344	311	361	367	306	3509
	Vodacom	369	335	388	454	338	290	330	348	372	309	3533
	Cell C	342	321	393	455	332	342	311	364	314	291	3465
	Telkom	335	313	381	438	296	295	337	283	328	303	3309
Call Setup Success Rate [%]	MTN	98.32%	99.31%	100.00%	100.00%	96.33%	96.90%	91.20%	93.52%	98.13%	98.39%	97.26%
	Vodacom	98.93%	99.70%	99.23%	99.13%	94.68%	94.46%	86.61%	88.10%	98.15%	98.10%	95.69%
	Cell C	98.28%	98.17%	99.75%	100.00%	94.59%	97.16%	88.60%	92.86%	96.62%	98.64%	96.52%
	Telkom	93.31%	96.90%	98.20%	96.90%	88.10%	84.53%	89.87%	79.49%	95.91%	97.74%	92.17%

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

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

		Bethal		eMalahleni		Lydenburg		Piet Retief		Standerton		Total
		Phase 1	Phase 2	Phase 1	Phase 2	Phase 1	Phase 2	Phase 1	Phase 2	Phase 1	Phase 2	Total
Call Complete	MTN	139	128	148	178	137	136	102	140	142	118	1 368
	Vodacom	140	129	150	179	132	132	98	130	143	120	1 353
	Cell C	130	121	151	178	130	134	105	134	138	113	1 334
	Telkom	137	127	148	177	127	127	104	138	141	111	1 337
Call Dropped	MTN	1	4	11	1	3	9	3	9	2	2	45
	Vodacom	2	1	1	1	7	4	8	14	4	2	44
	Cell C	8	7	0	1	6	5	2	6	7	2	44
	Telkom	2	0	5	1	9	8	5	4	3	4	41
Drop Call Ratio [%]	MTN	0.71%	3.03%	6.92%	0.56%	2.14%	6.21%	2.86%	6.04%	1.39%	1.67%	3.18%
	Vodacom	1.41%	0.77%	0.66%	0.56%	5.04%	2.94%	7.55%	9.72%	2.72%	1.64%	3.15%
	Cell C	5.80%	5.47%	0.00%	0.56%	4.41%	3.60%	1.87%	4.29%	4.83%	1.74%	3.19%
	Telkom	1.44%	0.00%	3.27%	0.56%	6.62%	5.93%	4.59%	2.82%	2.08%	3.48%	2.98%





6.2. Appendix 2: Coverage maps

6.2.1. Technology Maps

6.2.1.1. Bethal



Figure 14. Bethal Technology Map





6.2.1.2. eMalahleni



Figure 15. eMalahleni Technology Map

6.2.1.3. Lydenburg



Figure 16. Lydenburg Technology Map





6.2.1.4. Piet Retief



Figure 17. Piet Retief Technology Map

6.2.1.5. Standerton



Figure 18. Standerton Technology Map





6.2.2. Call Failures

6.2.2.1. Bethal



Figure 19. Bethal Call Failures

6.2.2.2. eMalahleni



Figure 20. eMalahleni Call Failures





6.2.2.3. Lydenburg



Figure 21. Lydenburg Call Failures

6.2.2.4. Piet Retief



Figure 22. Piet Retief Call Failures





6.2.2.5. Standerton



Figure 23. Standerton Call Failures

6.2.3. Roaming (Long call)

6.2.3.1. Cell C



Figure 24. Cell C Roaming (Long Call)





6.2.3.2. Telkom



Figure 25. Telkom Roaming (Long Call)