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Quality of Service Report:

KwaZulu-Natal Province

2016/2017 Quarter 4

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List of Acronyms

| | |
|-------|---|
| 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 mobile operators; Cell C, MTN, Telkom, and Vodacom. The measurements were performed to monitor performance of voice services being offered by the operators in KwaZulu-Natal Province. The measurements were carried out in the period between 7 February 2017 and 9 March 2017. The total distance covered was over 2000 kilometers.

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 Myeki, Mfekayi, uMhlanga, Chatsworth, and Phoenix. uMhlanga and Phoenix were monitored in the financial year 2013/2014. One aim of the monitoring done now was to assess the level of improvement that the operators promised at the time.

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% over 6 months.

The results show that in terms of Average Call Setup Success Ratio, MTN is the only operator that met the Accessibility target with a CSSR of above 98%, and all operators' results were below the target of 98%. In terms of Average Drop Call Ratio, only Telkom 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.

The results for uMhlanga and Phoenix show that there was an improvement in terms of Retainability for the networks Vodacom, MTN and Cell C.

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. The Authority conducted QoS monitoring of the GSM voice telephony service being offered by Cell-C, MTN, Vodacom and Telkom within KwaZulu-Natal Province of South Africa.

Legend

- KZN
- Population Distribution
 - 777 - 3092 Inh.
 - 3093 - 3908 Inh.
 - 3909 - 5045 Inh.
 - 5046 - 6512 Inh.
 - 6513 - 11004 Inh.
- District_Munic
- Provinces

SCALE 1 : 600 000

¹ ICASA Strategic Plan 2016/17-2021

4 | Page

The QoS monitoring was conducted in the areas within uMkhanyakude District Municipality and eThekweni Metropolitan Municipality. The selected areas include Myeki, Mfekayi, uMhlanga, Chatsworth and Phoenix. 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 customer experience 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 call³. It is measured using Drop Call Ratio (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 Ratio (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 an external indicative snapshot of an operator's network performance from the user's point of view on the selected routes and time of the day. It is therefore 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 software, a Samsung Galaxy Note 4 (SM-N910F) mobile device, a laptop computer and a Probe Controller 1.9. The mobile devices were configured to automatically select cellular land-mobile network and radio access technology.

³ Annexure B.2 of 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 Table 1 below:

Table 1: Selected Routes and Date

| Test Type | District | Route Name | Dates |
|------------------------------------|--------------------------|------------|--------------------------------|
| Accessibility and Retainability | uMkhanyakude District | Myeki | 07/02/2017 08-09/03/2017 |
| | | Mfekayi | 08-09/02/2017 06-07/03/2017 |
| | eThekwini | uMhlanga | 09/02/2017 15/02/2017 |
| | | Chatsworth | 10/02/2017 13/02/2017 |
| | | Phoenix | 11/02/2017 14/02/2017 |
| | | | |

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 with a minimum distance between each other, reducing RF coupling to an acceptable level. The coupling loss between two mobile handsets was min 40.5 dB ⁴ . |
| Band | The bands tested 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 parts 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 the day, and user's behaviour.⁵</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">• CD1: 10 seconds for call setup testing;• CD2: 120 seconds for typical tests, default call duration; |

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

⁵ Section 4.8 of ETSI EG 202 057-3 V1.1.1 (2005-04)

| | |
|----------------------|--|
| | 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. ⁶ |
| Equipment | The equipment used for testing was the TEMS Symphony 7.7 equipped with Samsung Galaxy Note S4 (SM-N910F), PCTEL EXFlex Scanner and Dell Latitude with Probe Controller 1.9.2. |
| KPI ⁷ | The measurements focused on the following network parameters: (i) Dropped Call Ratio (DCR); (ii) Call Set-up Success Ratio (CSSR) |
| Log files | The log files for each test case were stored in a different location with different names. The log files were recorded per network operator. |
| Mobile terminal used | 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 | Toyota Hilux Double Cab 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 meaning 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

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

⁷ End-User and Subscriber Service Charter Regulations of 2016

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 a six (6) month period and Average Call Setup Success Ratio must be greater than 98% over a six (6) month 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.⁸

The formula to calculate DCR is shown below:

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

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.⁹

The formula to calculate CSSR is shown below:

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

where Y represents the calls that are established and X is the total call attempts.

⁸ End-User and Subscriber Service Charter Regulations of 2016

⁹ 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: Myeki, Mfekayi, Chatsworth, Phoenix and uMhlanga.

3.1 Accessibility and Retainability measurements

Table 3: Summary of Results

| Route Name | Operator | CSSR (%) | DCR (%) |
|------------------------------|----------|----------|---------|
| Myeki | MTN | 99.81% | 0.67% |
| | Vodacom | 97.72% | 1.27% |
| | Cell C | 92.60% | 5.80% |
| | Telkom | 95.38% | 10.82% |
| Mfekayi | MTN | 99.39% | 0.22% |
| | Vodacom | 94.07% | 1.41% |
| | Cell C | 94.08% | 0.64% |
| | Telkom | 99.13% | 18.38% |
| Chatsworth | MTN | 99.13% | 0.32% |
| | Vodacom | 81.90% | 5.23% |
| | Cell C | 97.84% | 2.63% |
| | Telkom | 96.45% | 3.20% |
| Phoenix | MTN | 99.49% | 0.36% |
| | Vodacom | 85.88% | 1.13% |
| | Cell C | 96.99% | 0.00% |
| | Telkom | 96.04% | 3.56% |
| uMhlanga | MTN | 99.12% | 0.00% |
| | Vodacom | 89.34% | 1.63% |
| | Cell C | 99.06% | 0.78% |
| | Telkom | 97.66% | 1.59% |
| Average for all areas | MTN | 99.39% | 0.31% |
| | Vodacom | 90.50% | 2.12% |
| | Cell C | 95.99% | 1.84% |
| | Telkom | 97.06% | 6.74% |

Table 3 above shows voice-call measurement results on each route and as an average for all areas for all the operators. Additional KPIs are presented in the Appendix 5.

3.1.1 Call Setup Success Ratio (CSSR)

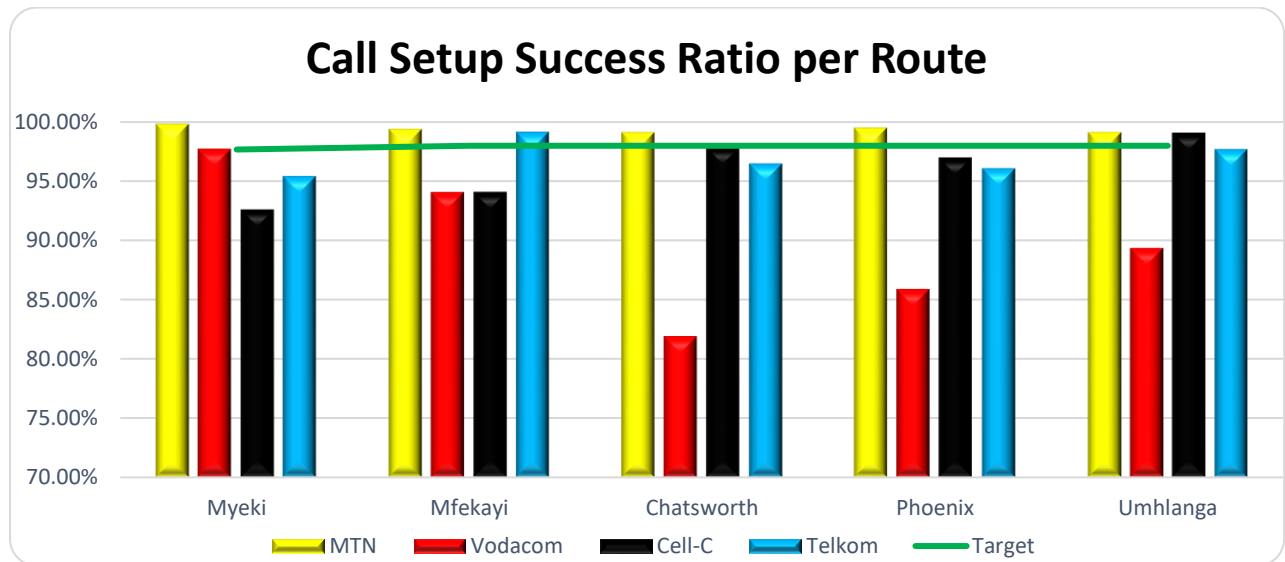


Figure 2: Call Setup Success Ratio (CSSR) per Route

Figure 2 above shows that MTN met the 98% CSSR target in all the target areas and Telkom met the target only in Mfekayi. Cell C met the target only in uMhlanga and Vodacom did not meet the target in all the target areas. The CSSR for Vodacom was less than 98% in all areas, thus the operator failed the Accessibility target in all the areas of interest. Vodacom's Accessibility was the lowest in Chatsworth which showed a CSSR of 81.9%.

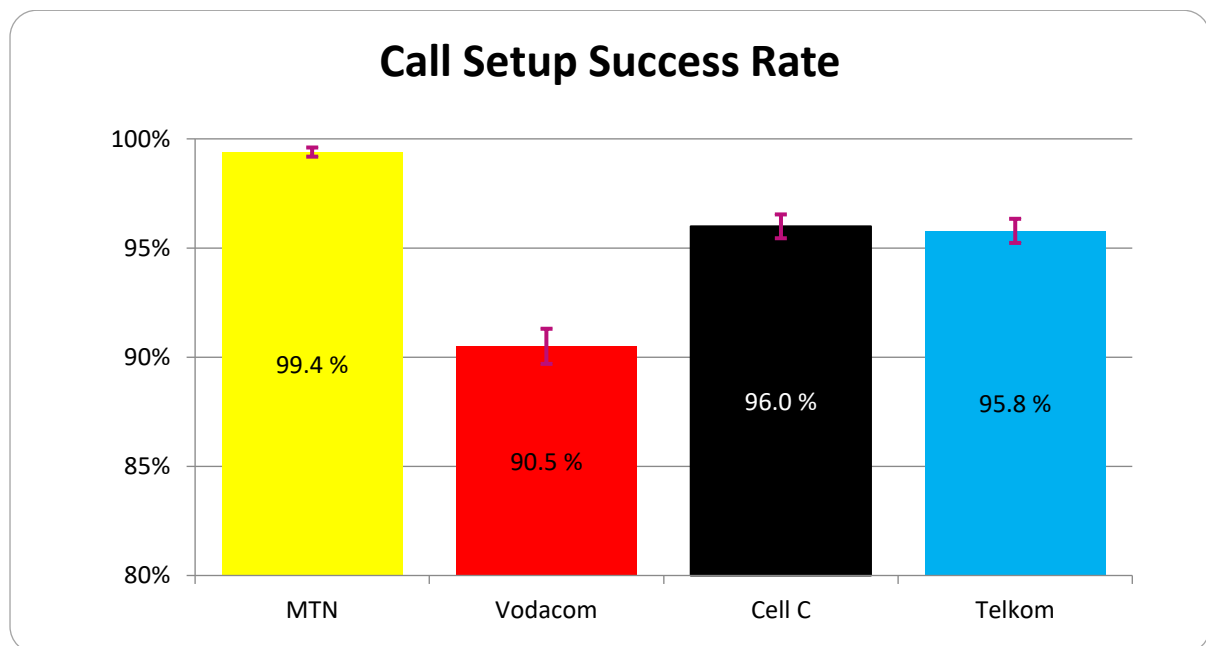


Figure 3: Overall Call Setup Success Ratio with Statistical Significance

Figure 3 above shows that MTN's total Provincial CSSR is the highest, followed by Cell C, Telkom and Vodacom in their respective descending order. MTN is the only operator that met the ICASA's CSSR target of above 98% as per "End-User and subscriber service charter regulations of 2016". There is no statistical significance difference between Cell C and Telkom results. MTN results show statistical significance difference in relation to other operators' results.

3.1.2 Drop Call Ratio (DCR)

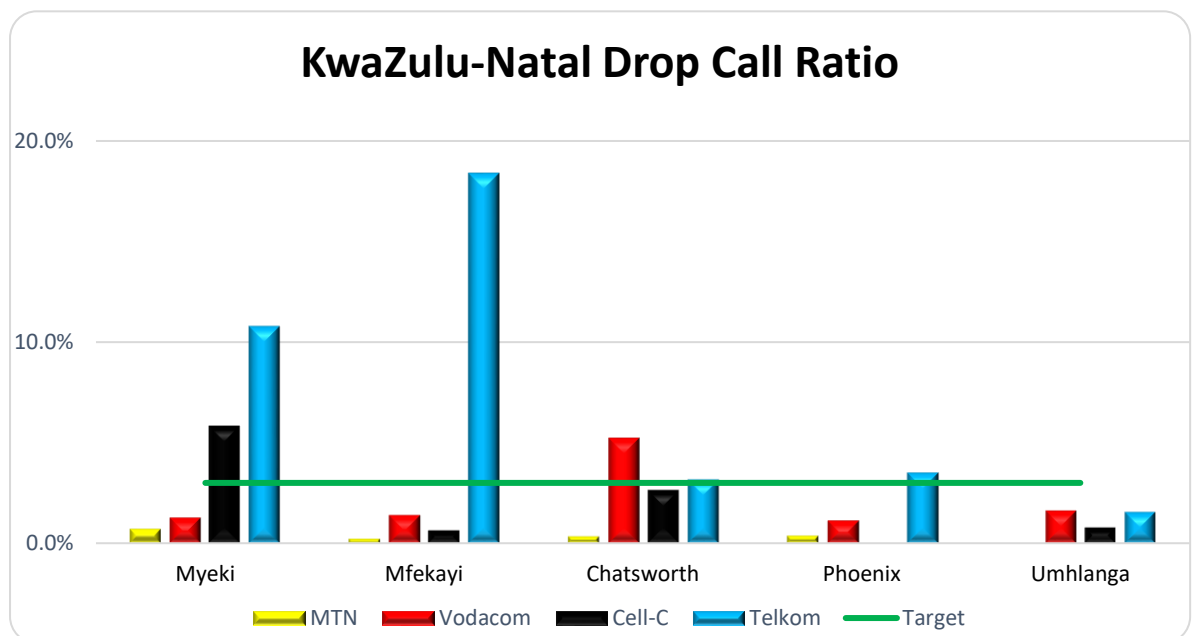


Figure 4: Drop Call Ratio (DCR) per Route

Figure 4 above shows that MTN met the below 3% DCR target in all the areas, and Vodacom failed the target only in Chatsworth. Cell C failed to meet the target in Myeki and Telkom failed to meet target in all the target areas except in uMhlanga. All the operators met the Retainability target in uMhlanga.

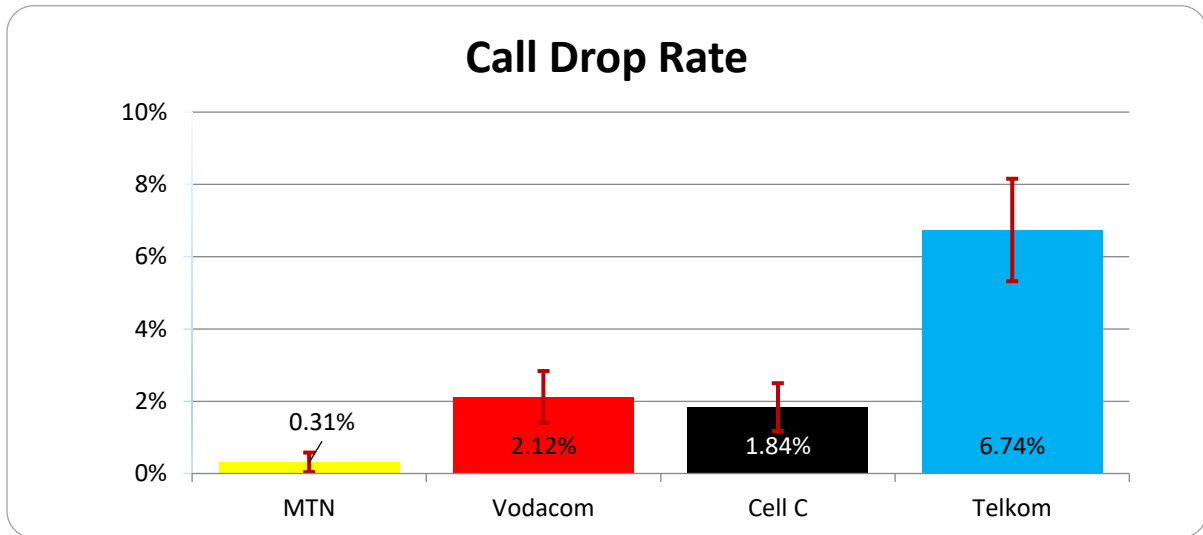


Figure 5: Total Call Drop Ratio with Statistical Significance

Figure 5 above shows that MTN's total Provincial DCR is the lowest followed by Cell C, Vodacom and Telkom in the respective descending order. MTN, Cell C, and Vodacom met ICASA's 3% DCR target, while Telkom did not meet the DCR target as the DCR value was above 3%. There was statistical significant difference recorded between MTN results and all the results of other operators. There was no statistical significant difference between Cell C and Vodacom results. There is statistical significant difference between MTN and Vodacom results. Telkom recorded the highest DCR of 6.74% and MTN was the lowest with 0.31%.

3.1.3 Analysis of the serving technology

Figure 6 below shows the statistical distribution of the serving technology during the drive test. The serving technology distribution were based on the device used and the network parameter configuration which varies with the mobile operators. MTN, Cell C and Telkom serving technology distribution was mainly on WCDMA while Vodacom distribution was even with GSM and LTE, with WCDMA as a dominant technology.

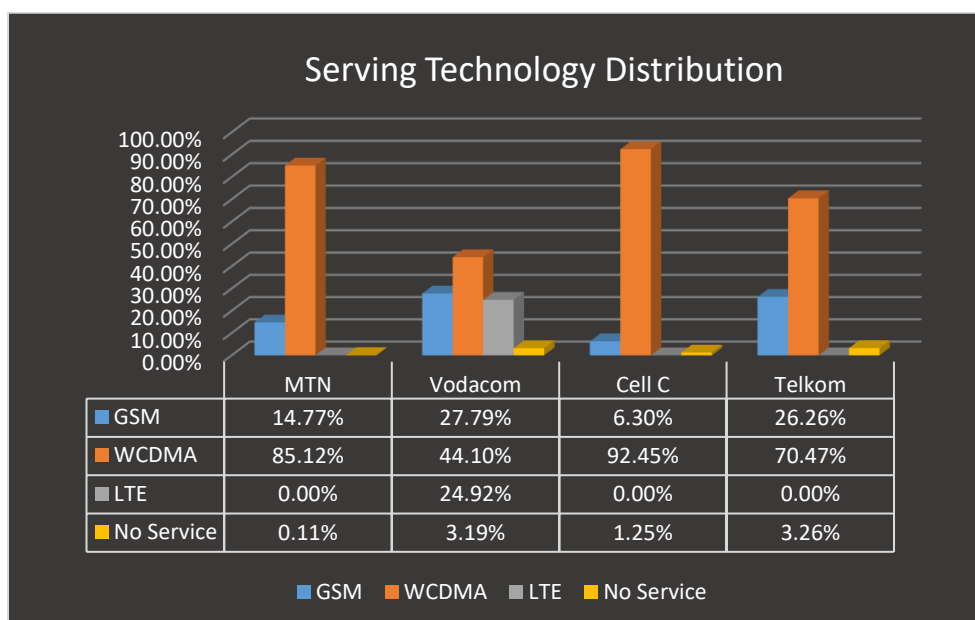


Figure 6: Technology Distribution

3.1.4 Comparison of current results to results of 2013/14

uMhlanga and Phoenix were monitored in the financial year 2013/2014. One aim of the monitoring done now was to assess the level of improvement that the operators promised at the time. The results show that there was an improvement in terms of Retainability by all operators. There was also improvement in Accessibility for the networks of MTN and Cell C. The target for Accessibility was 95% in 2013/2014, whereas it was 98% for the current measurements. This was because the regulation applied in 2013/2014 was revised, and the revised regulation became effective on 1 April 2016. Table 4 below summarise the previous and current results.

Table 4: Comparison with previous results

| | Accessibility | | | Retainability | | |
|---------|--|---------|----------|--|---------|----------|
| | 2013/14 | 2016/17 | | 2013/14 | 2016/17 | |
| | Durban North (Phoenix, uMhlanga and Verulam) | Phoenix | uMhlanga | Durban North (Phoenix, uMhlanga and Verulam) | Phoenix | uMhlanga |
| Vodacom | 96.85% | 85.88% | 89.34% | 3.88% | 1.13% | 1.63% |
| MTN | 97.48% | 99.49% | 99.12% | 3.23% | 0.36% | 0.00% |

| | | | | | | |
|--------|--------|--------|--------|--------|-------|-------|
| Cell C | 96.10% | 96.99% | 99.06% | 12.50% | 0.00% | 0.78% |
| Telkom | - | 96.04% | 97.66% | - | 3.56% | 1.59% |

4 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-user's quality of service and operators' network performance varies significantly on a per-location basis.

As we benchmark the operators, the results show that in terms of Average Call Setup Success Ratio, MTN is the only operator that met the Accessibility target with a CSSR of above 98%. All other operators' results were below the target of 98%. In terms of Average Drop Call Ratio, only Telkom 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.

There are roaming agreements amongst the network operators (e.g. Telkom on MTN) which are not on blanket approach and may differ from area to area. It should also be noted that the performance of roaming operator (roamer) will not necessarily be identical to the operator offering service as it is subjected to the Service Level Agreement in the roaming agreement.

Operators have taken note of the results obtained by the Authority. They have undertaken to further investigate and improve their networks in the area of concern. Two areas (Phoenix and Umhlanga), which were covered during the financial year 2013/2014, show the effort made by the mobile operators. . The results show that there was an improvement in terms of Retainability by all operators. There was also improvement in Accessibility for the networks of MTN and Cell C.

5 Appendixes

5.1 Appendix A: Drive Test Results KPI's

Table 5: 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 (%) |
| Myeki | MTN | 146 | 2 | 1.37% | 154 | 0 | 0.00% | 300 | 2 | 0.67% |
| | Vodacom | 165 | 3 | 1.82% | 149 | 1 | 0.67% | 314 | 4 | 1.27% |
| | Cell C | 146 | 6 | 4.11% | 130 | 10 | 7.69% | 276 | 16 | 5.80% |
| | Telkom | 111 | 12 | 10.81% | 120 | 13 | 10.83% | 231 | 25 | 10.82% |
| Mfekayi | MTN | 289 | 1 | 0.35% | 178 | 0 | 0.00% | 467 | 1 | 0.21% |
| | Vodacom | 250 | 4 | 1.60% | 177 | 2 | 1.13% | 427 | 6 | 1.41% |
| | Cell C | 294 | 1 | 0.34% | 175 | 2 | 1.14% | 469 | 3 | 0.64% |
| | Telkom | 95 | 18 | 18.95% | 90 | 16 | 17.78% | 185 | 34 | 18.38% |
| Chatsworth | MTN | 163 | 0 | 0.00% | 148 | 1 | 0.68% | 311 | 1 | 0.32% |
| | Vodacom | 153 | 15 | 9.80% | 153 | 1 | 0.65% | 306 | 16 | 5.23% |
| | Cell C | 156 | 4 | 2.56% | 148 | 4 | 2.70% | 304 | 8 | 2.63% |
| | Telkom | 155 | 6 | 3.87% | 126 | 3 | 2.38% | 281 | 9 | 3.20% |
| Phoenix | MTN | 139 | 1 | 0.72% | 142 | 0 | 0.00% | 281 | 1 | 0.36% |
| | Vodacom | 128 | 1 | 0.78% | 137 | 2 | 1.46% | 265 | 3 | 1.13% |
| | Cell C | 138 | 0 | 0.00% | 136 | 0 | 0.00% | 274 | 0 | 0.00% |
| | Telkom | 127 | 7 | 5.51% | 126 | 2 | 1.59% | 253 | 9 | 3.56% |
| uMhlanga | MTN | 128 | 0 | 0.00% | 132 | 0 | 0.00% | 260 | 0 | 0.00% |
| | Vodacom | 122 | 3 | 2.46% | 123 | 1 | 0.81% | 245 | 4 | 1.63% |
| | Cell C | 126 | 1 | 0.79% | 130 | 1 | 0.77% | 256 | 2 | 0.78% |
| | Telkom | 126 | 1 | 0.79% | 126 | 3 | 2.38% | 252 | 4 | 1.59% |

Table 5: Call Setup Success Ratio (CSSR) per route

| Route Name | Operator | PHASE 1 | | | PHASE 1 | | | TOTAL | | |
|------------|----------|--------------|------------|----------|--------------|------------|----------|--------------|------------|----------|
| | | Call Attempt | Call Setup | CSSR (%) | Call Attempt | Call Setup | CSSR (%) | Call Attempt | Call Setup | CSSR (%) |
| Myeki | MTN | 615 | 614 | 99.84% | 428 | 427 | 99.77% | 1043 | 1041 | 99.81% |
| | Vodacom | 635 | 612 | 96.53% | 417 | 415 | 99.52% | 1052 | 1027 | 97.72% |
| | Cell C | 506 | 471 | 93.27% | 346 | 317 | 91.62% | 852 | 788 | 92.60% |
| | Telkom | 563 | 555 | 99.11% | 356 | 313 | 89.43% | 919 | 868 | 95.38% |
| Mfekayi | MTN | 902 | 895 | 99.22% | 415 | 414 | 99.76% | 1317 | 1309 | 99.39% |
| | Vodacom | 1030 | 947 | 91.94% | 421 | 418 | 99.29% | 1451 | 1365 | 94.07% |
| | Cell C | 965 | 914 | 95.21% | 359 | 326 | 91.06% | 1324 | 1240 | 94.08% |
| | Telkom | 874 | 864 | 99.20% | 396 | 392 | 98.99% | 1270 | 1256 | 99.13% |
| Chatsworth | MTN | 502 | 497 | 99.20% | 529 | 523 | 99.05% | 1031 | 1020 | 99.13% |
| | Vodacom | 468 | 393 | 84.52% | 458 | 358 | 79.20% | 926 | 751 | 81.90% |
| | Cell C | 522 | 509 | 97.51% | 498 | 488 | 98.19% | 1020 | 997 | 97.84% |
| | Telkom | 536 | 508 | 94.95% | 507 | 497 | 98.03% | 1043 | 1005 | 96.45% |
| Phoenix | MTN | 485 | 482 | 99.38% | 494 | 492 | 99.60% | 979 | 974 | 99.49% |
| | Vodacom | 430 | 383 | 90.33% | 437 | 347 | 81.46% | 867 | 730 | 85.88% |
| | Cell C | 462 | 451 | 97.62% | 469 | 452 | 96.38% | 931 | 903 | 96.99% |
| | Telkom | 467 | 446 | 95.50% | 467 | 451 | 96.57% | 934 | 897 | 96.04% |
| uMhlanga | MTN | 454 | 449 | 98.90% | 459 | 456 | 99.35% | 913 | 905 | 99.12% |
| | Vodacom | 419 | 381 | 91.15% | 417 | 365 | 87.53% | 836 | 746 | 89.34% |
| | Cell C | 418 | 414 | 99.04% | 429 | 425 | 99.07% | 847 | 839 | 99.06% |
| | Telkom | 422 | 408 | 96.91% | 433 | 426 | 98.38% | 855 | 834 | 97.66% |

5.2 Appendix B: Coverage Maps

5.2.1 Scanner Measurements

5.2.1.1 Vodacom

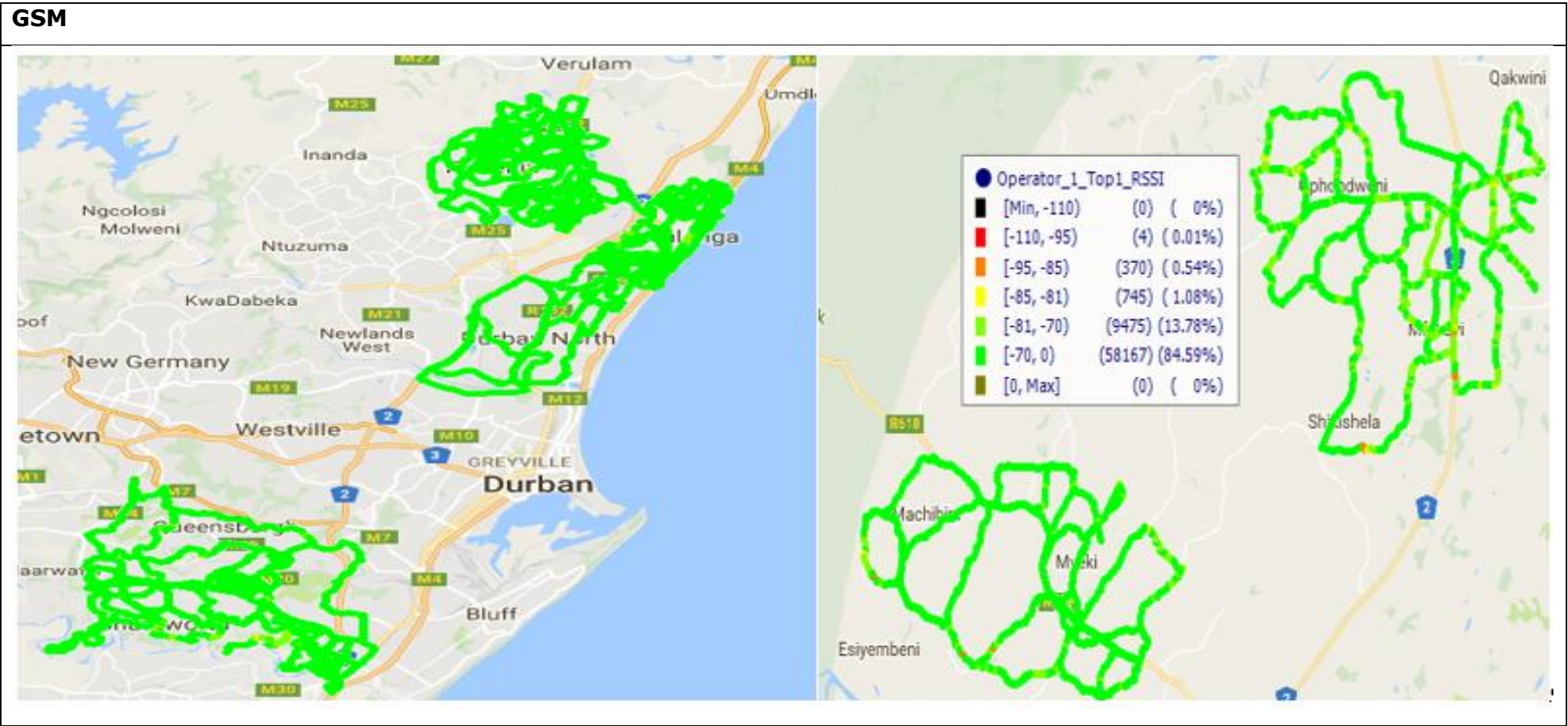


Figure 7: KwaZulu-Natal Province - Vodacom GSM Signal Levels

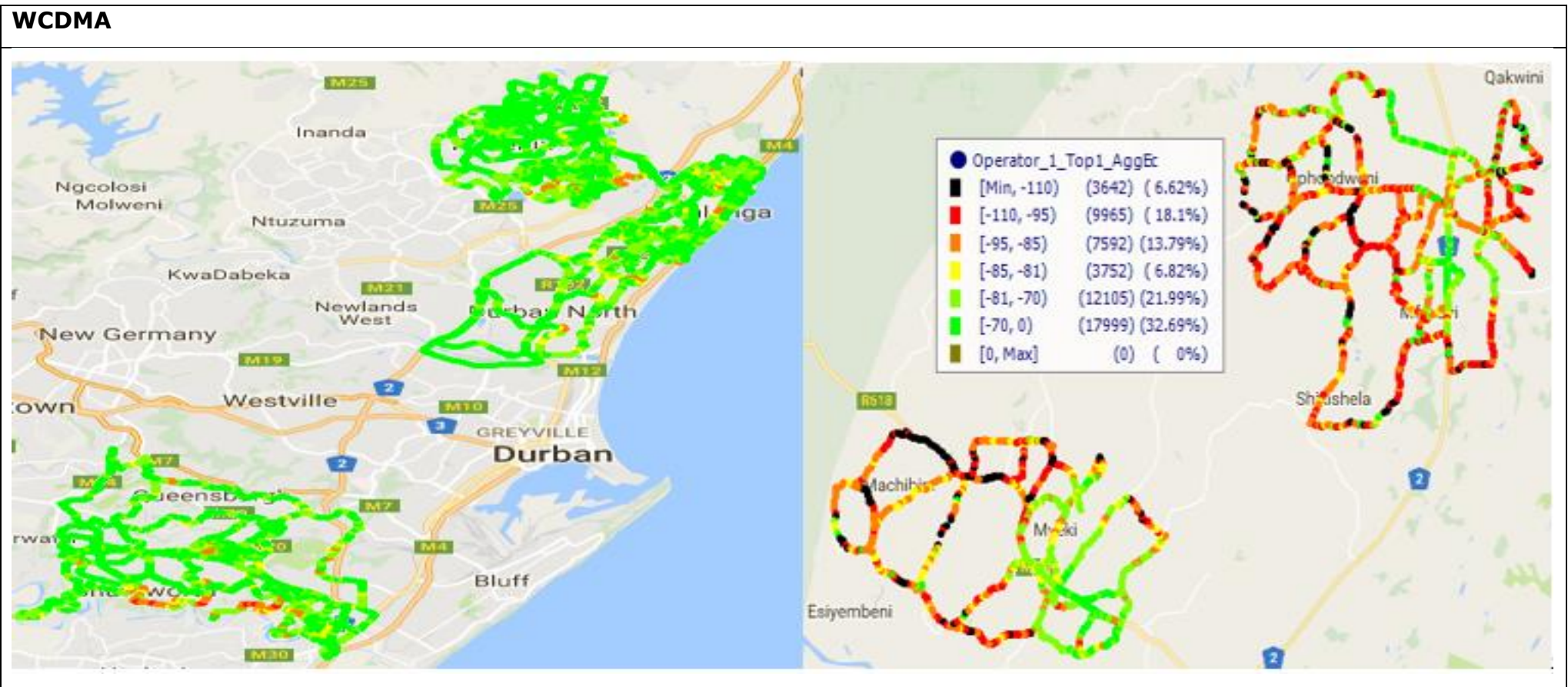


Figure 8: KwaZulu-Natal Province - Vodacom WCDMA Signal Levels

5.2.1.2 MTN

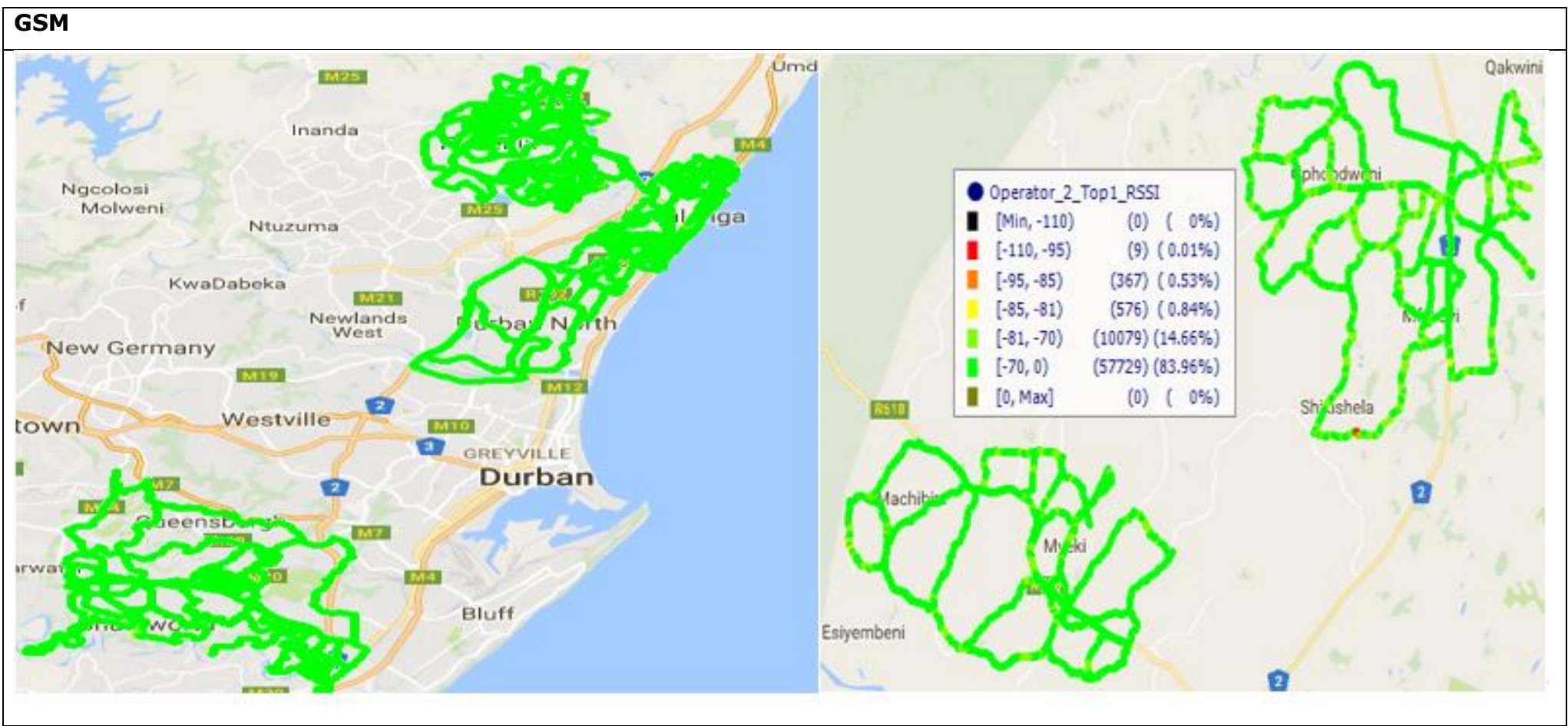


Figure 9: KwaZulu-Natal Province - MTN GSM Signal Levels

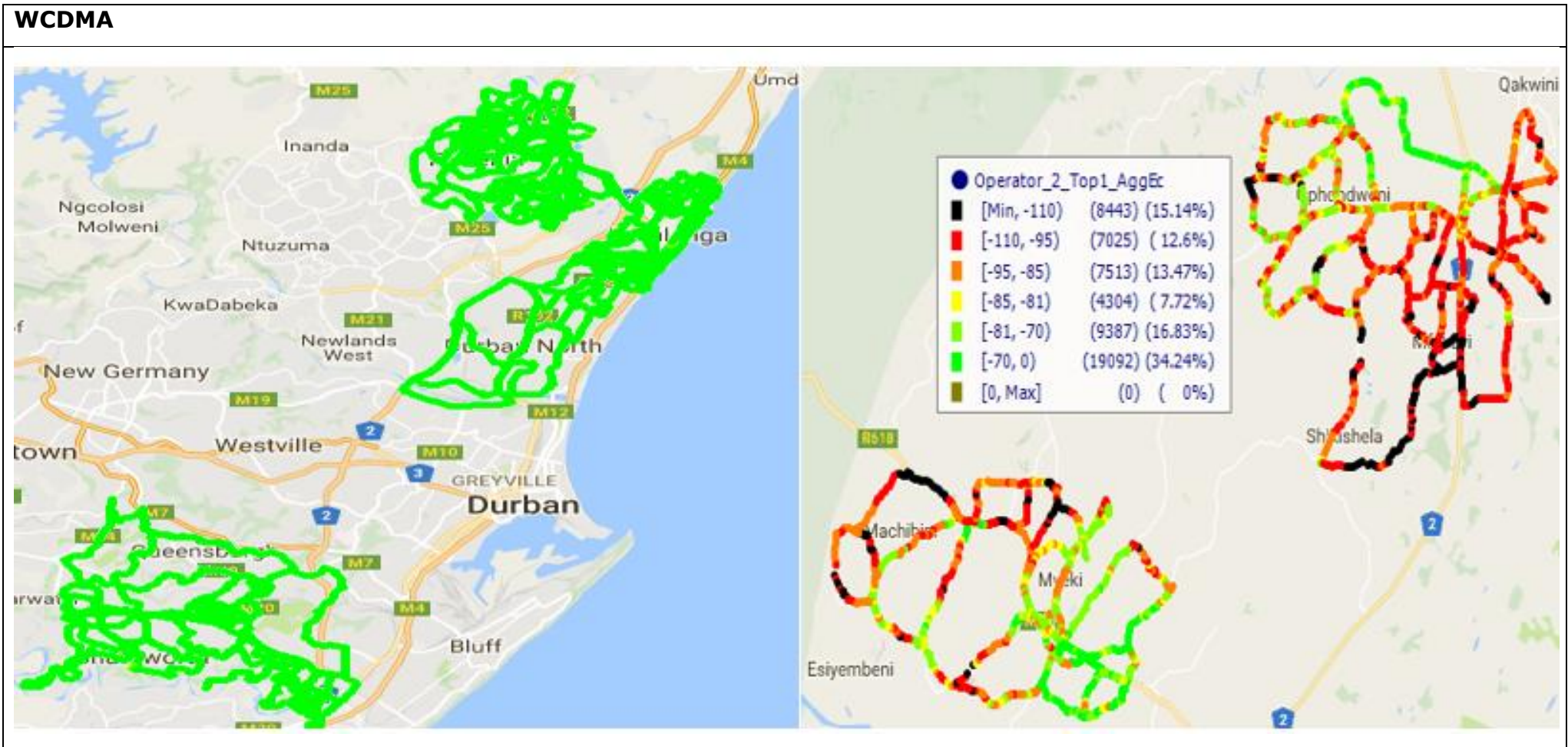


Figure 10: KwaZulu-Natal Province - MTN WCDMA Signal Levels

5.2.1.3 Cell-C

GSM

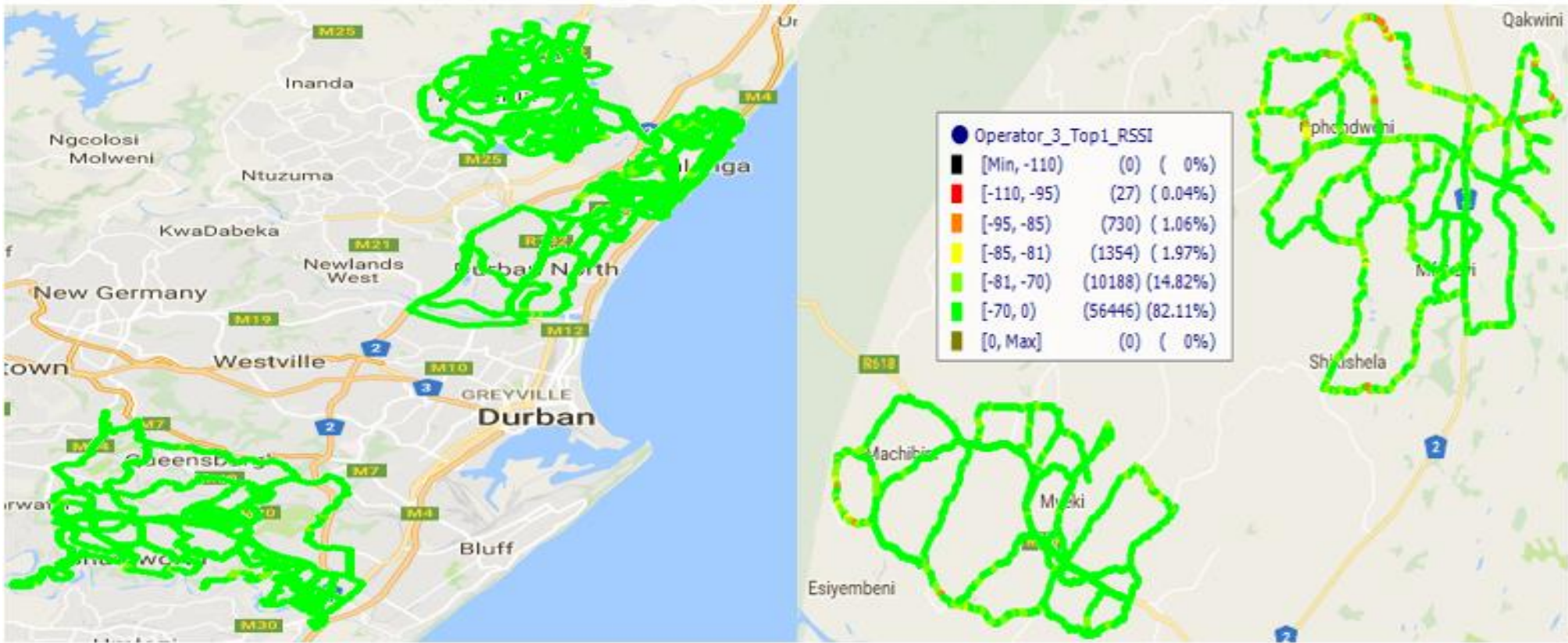


Figure 11: KwaZulu-Natal Province - Cell C GSM Signal Levels

WCDMA

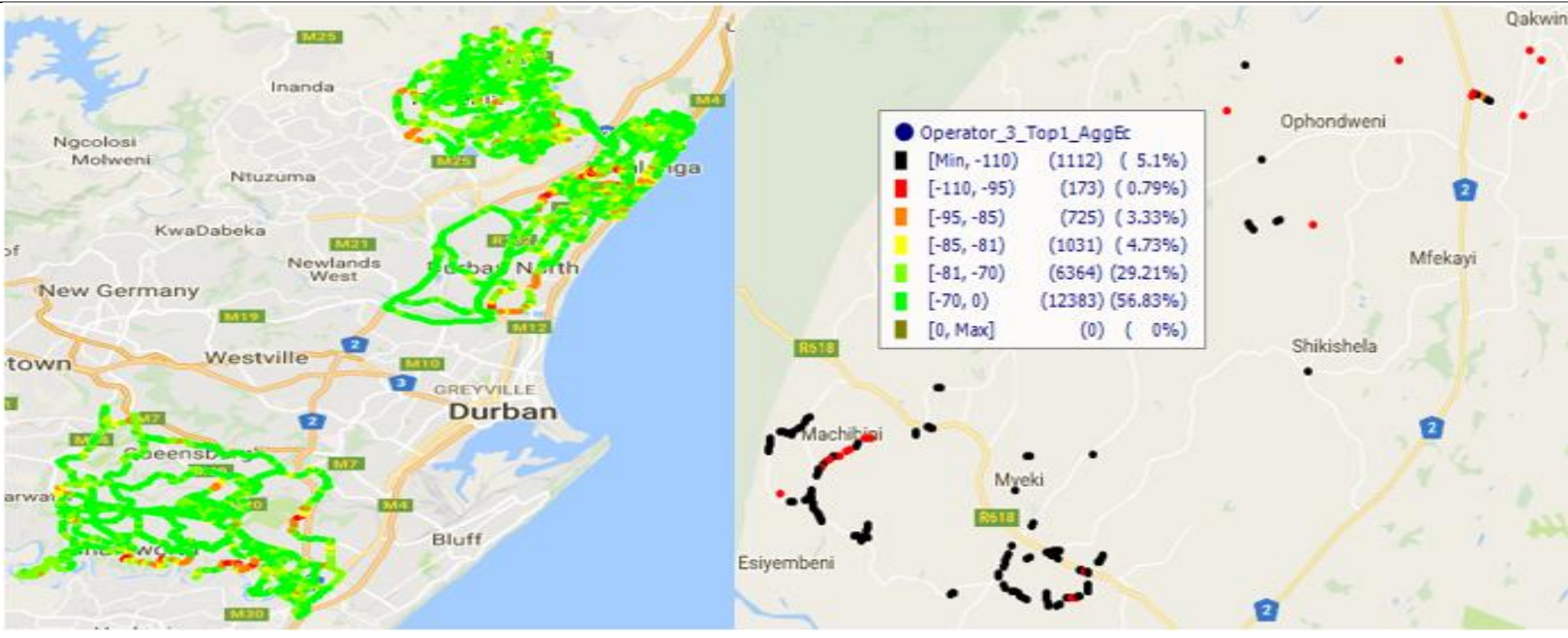


Figure 12: KwaZulu-Natal Province – Cell C WCDMA Signal Levels

5.2.1.4 Telkom

GSM

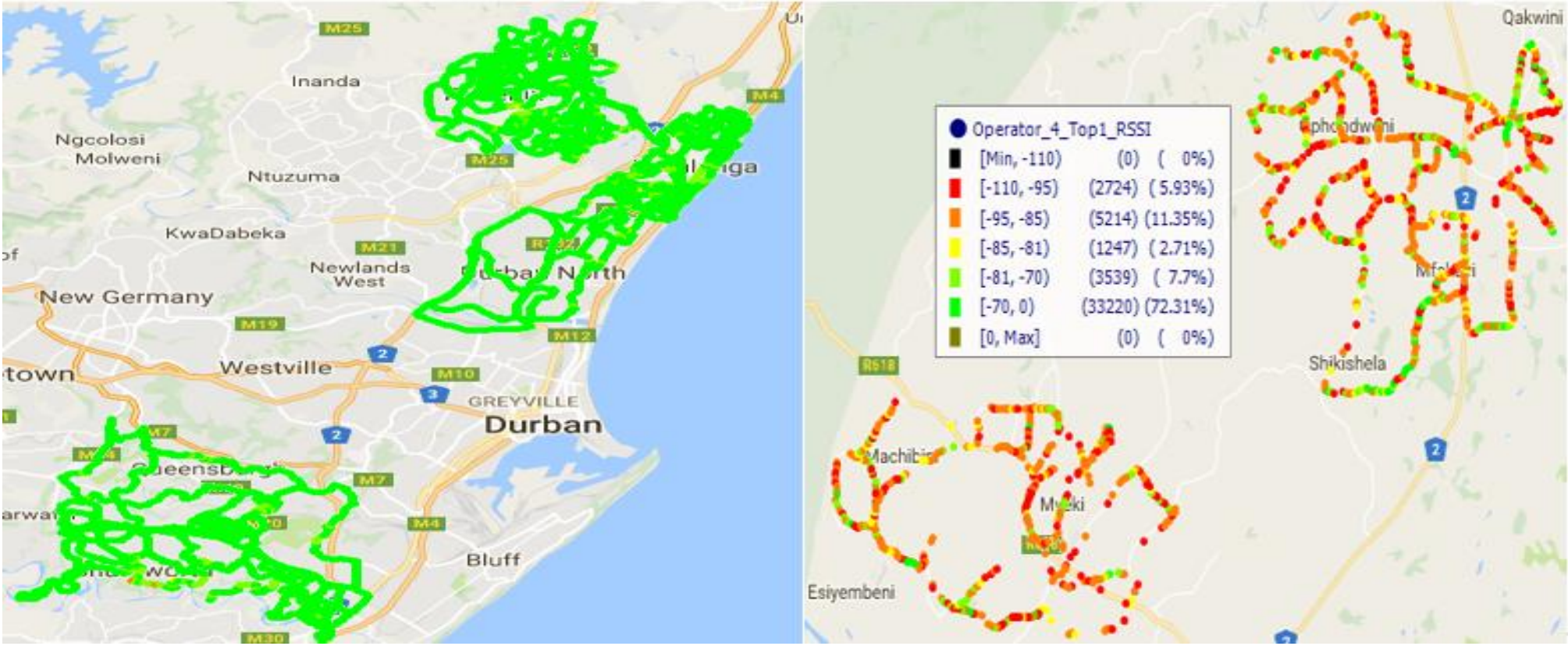


Figure 13: KwaZulu-Natal Province - Telkom GSM Signal Levels

WCDMA

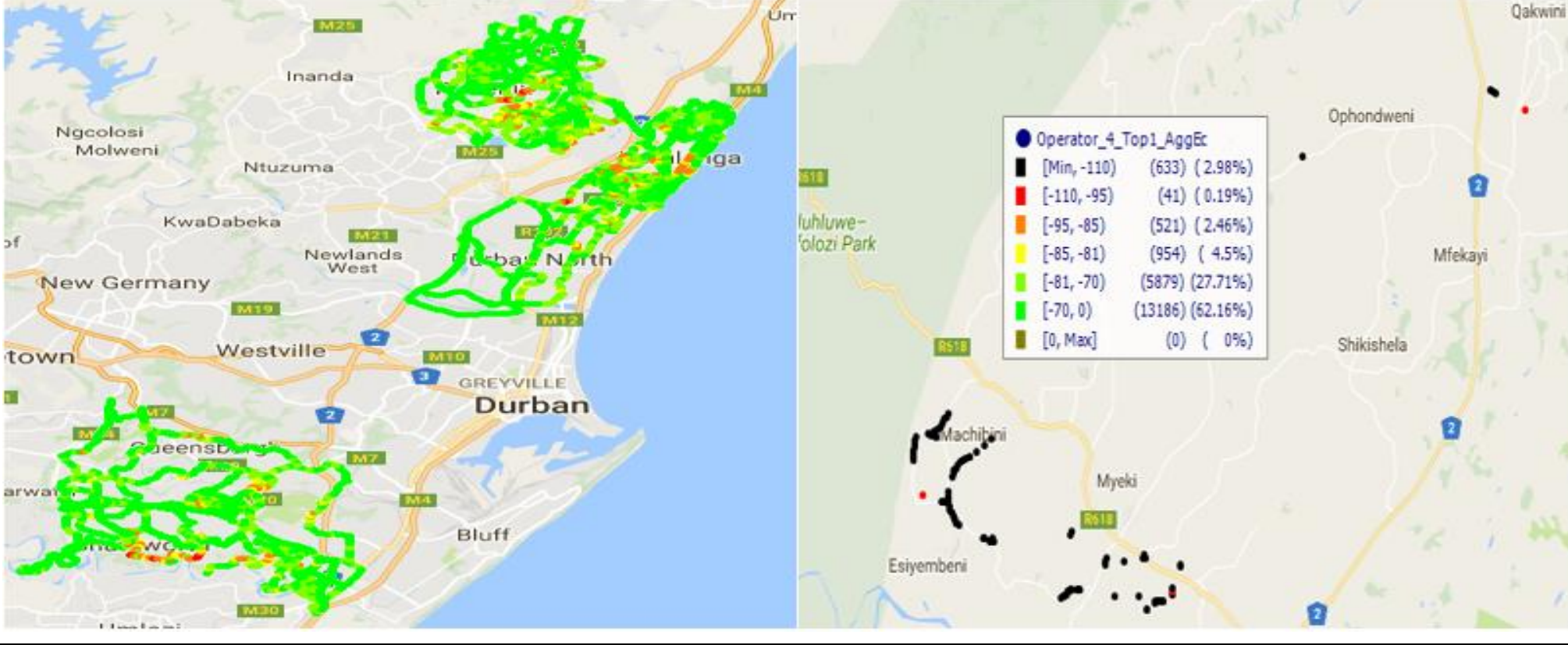


Figure 14: KwaZulu-Natal Province - Telkom WCDMA Signal Levels

5.2.2 Serving Technology Details

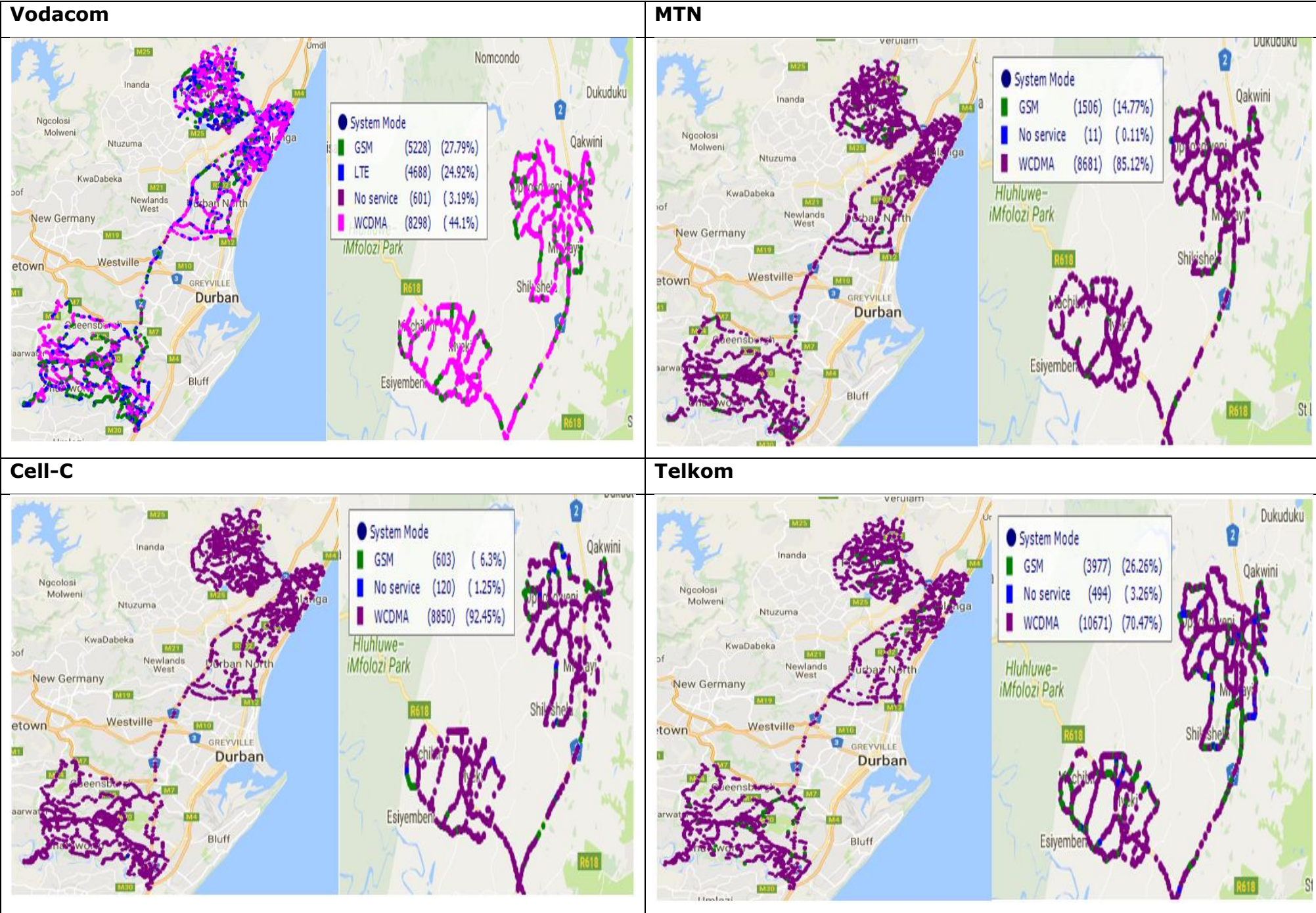


Figure 15: KwaZulu-Natal Province Serving Technology Plots

