Proximus Optimization & Energy Savings

Version 1.0

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This is part of the GSMA case study series on Future Networks

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Executive Summary

As part of the Future Networks Programme, Network Economics workstream, a series of case studies have been developed, exploring areas where Operators can potentially reduce their Operational Expenditure (OpEx) through the application of innovative energy solutions. This case study focuses on the challenges and optimization of Mobile Cell Site Energy and OpEx costs while maintaining service coverage and capacity. Managing OpEx continues to be a key driver for any mobile operator and Proximus, the largest mobile operator in Belgium is no exception. A component of managing RAN OpEx in particular is reducing the energy consumption delivering a greener and more efficient network. Given the complexity and non-uniformity of networks today, manually optimizing the network is no longer an option. An automated customer-centric approach was needed

Proximus partnered with VIAVI Solutions, who provided their GEOoptimize solution which analyses subscriber-generated geolocated call trace data to make detailed recommendations for network configuration changes. A cluster of 42 3G cell sites was chosen across 3 RNCs. Design constraints were configured around parameters such as Power and Tilt at each cell site, as well as the key requirement that data services must not be degraded. After the optimization analysis was run, the recommendation was to increase power at 82 cells, adjust the E-Tilt on 4 cells and switch 8 cells off completely. The 8 cells recommended to be switched off represent just over 2.4% of the cluster. This design change ensured that packet switched services and KPIs were maintained, thereby preserving 3G data services while achieving OpEx reduction through energy saving.

The optimization algorithms utilized for this study work just as effectively across 3G and 4G for voice and data. A next step in the optimization of cell sites at Proximus would be to focus on a cluster specific to 4G and determine the Energy and OpEx savings in that domain.

The GSMA Network Economics model estimates that network optimisation solutions can deliver between a 2–3% saving in OpEx and a 2% CAPEX avoidance based on the case study parameters applied to a typical tier one operator. This would result in an OpEx intensity (OpEx/Revenue) reduction of between 0.3–0.5% and an estimated reduction of between 0.3-0.4% in CAPEX intensity (Capex/Revenue). Additional network optimisation case studies will be produced to help improve our modelling.

As networks evolve through 4.5G to 5G with more complexity, ultra-dense networks and intelligence at the edge, the need will be even greater to apply automated, customer-centric solutions to the challenges of OpEx and Energy consumption.

1 Introduction

Highly competitive mobile markets mean operators focus more on the customer experience which in turn is shifting attention from network-centric optimization to customer-centric. Margin pressure also means operators have to become more efficient with network management and operations processes to deal with the new economic reality of a changing digital ecosystem. The cost to deliver and manage services on the network vs. revenue return is being closely examined.

For example, Internet of Things (IoT) connectivity is needed for more devices in more places; however, since the revenue per device will be very low, an operator must be able to provide network service at an extremely low OpEx to support the IoT business case. The focus is shifting to reducing operating costs with a focus on automating "highly manual and time-consuming processes" and applying real-time intelligent analytics and machine learning to improve the visibility of the mobile network and service performance.

Manual approaches to optimization given the extreme non-uniformity of mobile networks is no longer an option. Automated, customer-centric methods are designed to not only address QoE but also the Operational and Energy Savings in the RAN. Given the RAN typically consumes up to 70% of the overall network energy budget, optimization delivers significant business benefits. Indeed, an automated approach to optimization with embedded machine learning can deliver real business benefits and improve QoE at the same time.

2 Market Overview

The Belgian mobile market is served by 3 operators: Proximus, Orange and Telenet (Base). Proximus (previously known as Belgacom Mobile) is the largest mobile operator. Founded in 1994 as a joint venture between Belgacom, Airtouch and later Vodafone, Proximus has a little over 45% of the market.

Proximus' ambition is to become a digital service provider, connecting everyone and everything so people live better and work smarter. Through our best-quality integrated fixed and mobile networks, we provide access anywhere and anytime to digital services and easy-to-use solutions, as well as to a broad offering of multimedia content. Proximus transforms technologies like the Internet of Things (IoT), Big Data, Cloud and Security into solutions with positive impact on people and society.

Proximus continues to grow its customer base despite intensifying competition. The total Mobile customer base stands at 6,025,000.

3 Business Imperative

Managing OpEx continues to be a key business driver for mobile operators. A component of this is addressing the energy costs in the RAN which is not only a major component of OpEx, reducing energy consumption delivers a greener network. Cell site optimization must meet QoE targets for the subscriber as well as the energy targets for the cell sites. In many cases these parameters are not mutually exclusive. If not managed appropriately, reducing RAN energy can have a negative impact on QoE. This is exactly why customer-centric automated algorithms are needed which can deal with the complexity of managing these often-opposing goals.

4 The Solution

Proximus partnered with VIAVI solutions on addressing the issues of OpEx and Energy Savings. While networks have become increasingly complex and dynamic, most optimization efforts are still primarily network-centric: a problem is located using network statistics and then adjustments are made to the network parameters to solve the problem. This network-centric approach of characterizing a problem using network statistics and then making macro site parameter adjustments no longer works when optimization is needed on a more granular level. This approach is also less effective when the intention is to change the configuration such that the performance is improved, rather than solve a specific problem.

Taking this a step further, most macro-based adjustments create and maintain a baseline for overall network performance, but do little to optimize performance for specific locations within the network at any given time. For example, workers based in an office might tend to use voice services during the morning but then leave their office during lunch hour and go outside. While outside, their usage might migrate away from voice to data services. This illustrates the changing nature of the services demanded from the network and where they need to be delivered.

An effective optimization would have to configure the network to deliver an acceptable user experience for this cohort of users, not just during the work hours and lunch break, but also during the commute time, evenings, and weekends. At each of these times the usage profile will be different and the locations will generally change. Taking automation to the limit sees the network able to adapt its configuration as the day progresses in response to the changes in the demands placed on it.

VIAVI (NASDAQ: VIAV) is a global provider of network test, monitoring, and assurance solutions to communications service providers, enterprises and their ecosystems, supported by a worldwide channel community including VIAVI Velocity Solution Partners. VIAVI delivers end-to-end visibility across physical, virtual and hybrid networks, enabling customers to optimize connectivity, quality of experience and profitability. VIAVI is also a leader in high performance thin film optical coatings, providing light management solutions to anti-counterfeiting, consumer electronics, automotive, defense and instrumentation markets.

4.1 VIAVI GEOoptimize solution

Proximus has evaluated VIAVI GEOoptimize solution for their OpEx reduction use case. This solution captures, geolocates and analyzes all call trace events and measurement reports from the RAN. It uses this subscriber generated intelligence together with sophisticated machine-learning optimization algorithms to create an optimal network cluster. This optimized design is created around the specific Proximus goals, and takes into account any network constraints around service KPIs to deliver OpEx and Energy Savings.

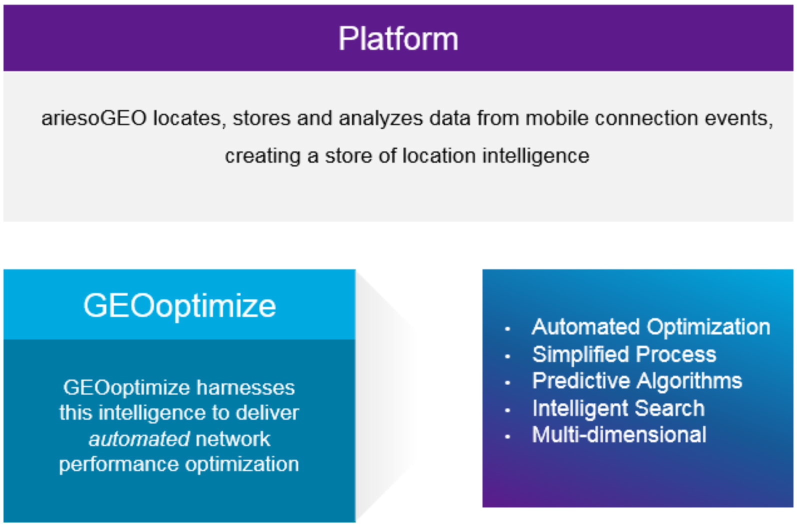


Figure 1 GEOoptimize overview

4.2 Process Overview

- Proximus provided their existing configuration and KPIs to VIAVI.
- The 3G call trace files were captured from their respective Huawei RNCs via Huawei trace servers.
- The ariesoGEO platform captures, locates and analyzes all events from the call trace files and this subscriber centric data is fed into the GEOoptimize server, where the algorithms run and generate the recommended changes to the network.
- Pre- and post-event KPI validation is performed, based on a full set of Huawei PM stats or by use of VIAVI's GEOperformance solution which is also deployed in Proximus for network optimisation and troubleshooting.
- Proximus implemented the recommended changes and performed post-change KPI analysis to confirm the outcome.

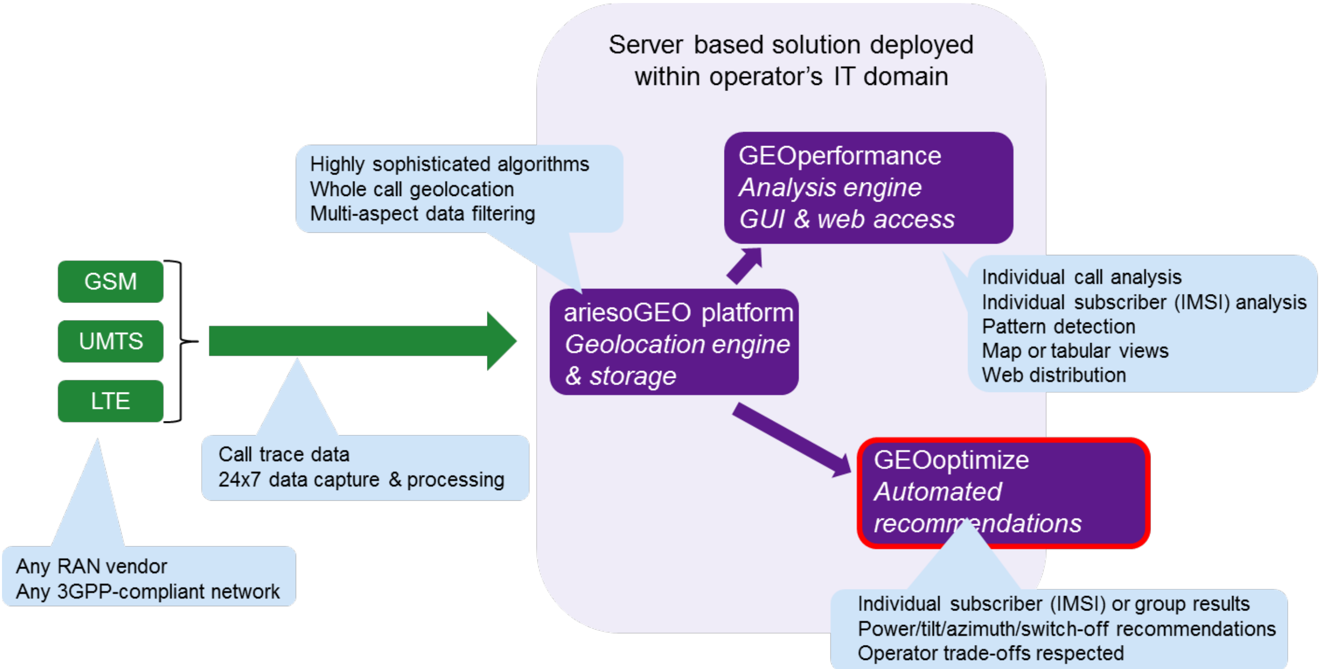


Figure 2 ariesoGEO solution architecture

5 Results and Benefits

Proximus requires an automated network optimization solution which uses a subscriber-centric view of the network to understand the experiences of subscribers in order to make a real step change in their network performance, in this case around OpEx reduction.

This section explains the approach taken and the results achieved.

5.1 The objective

The goal of this exercise is to identify the UMTS sectors that can be switched off to achieve OpEx savings while maintaining service availability at an acceptable level of experience for all subscribers.

In order to reach the expected optimization on target KPI results, the GEOoptimize solution will propose adjustments to the following target parameters to compensate for the effect of the cell/site switch-offs.

- *CPICH Power (dB)* (Considers the adjustment of Power levels assigned to the CPICH and other control channels of identified cells)
- *Electrical Tilt (°)* (Considers the adjustment of Electrical Tilt values for the antennas of identified cells)

The GEOoptimize 3G OpEx reduction evaluation will target the optimization of the following KPIs:

- Minimize
  - Number of Cells/Sites Switched On
- While limiting the (%) impact on
  - *ConnectedPsEcN0Coverage* (Proportion of devices connected using a packet data service measuring EcN0 above a user-specified quality threshold)
  - *ConnectedPsDurationSeconds* (Sum of time devices that were connected using packet data services spent communicating with the network)
  - *CS Average Ec/N0* (Average signal-to-noise on CPICH signals observed by devices connected using a circuit service)
  - *CS Ec/N0 Coverage* (Proportion of devices connected using a circuit service identified as having sufficient signal to noise levels received from the CPICH)
  - *CS Duration Seconds* (Sum of time devices that were connected using circuit services spent communicating with the network)

5.2 Project deliverables

As a result of this project, VIAVI delivered to Proximus:a ***design document*** that defines

- a ***list of cells/sites*** which can be switched off/removed from the network with limited impact on the KPIs (listed in section 5.1) that are acceptable to Proximus.

- a ***list of adjustments*** of target parameters for the neighbouring sites that will contribute to maintaining the subscribers' overall network perception (in excel format).

5.3 The cluster

The UMTS cluster '***Aalst***' has been optimized as part of the design and special consideration has been taken towards antenna design and shared antennas.

5.3.1 Cluster information

- Cluster name: Aalst
- Technology: UMTS
- Sites: 42
- Cells: 328
- RNCs: 3 RNCs covering the optimization area

NOTE: The Aalst cluster and surrounding area NodeBs are Huawei equipment.

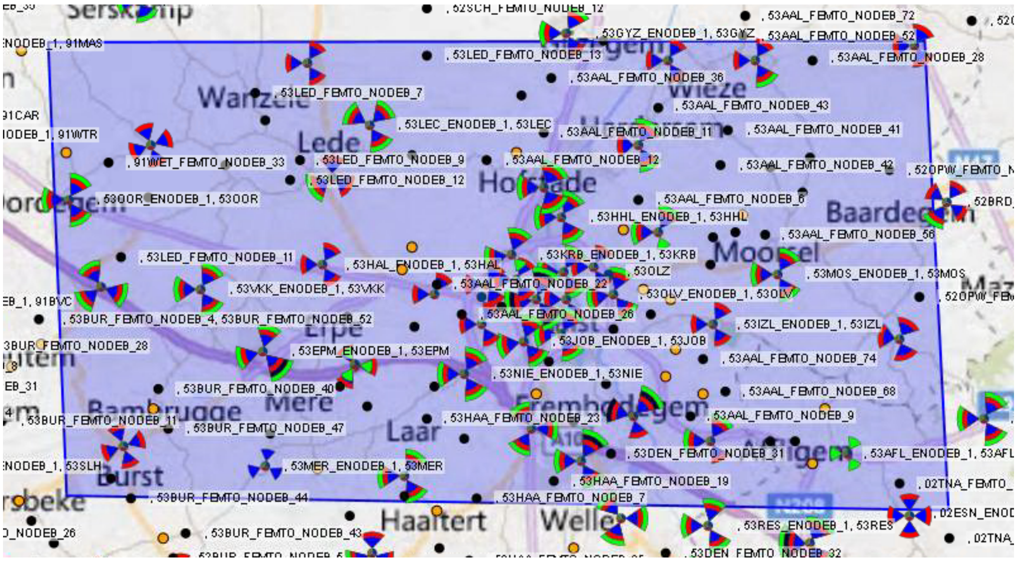


Figure 3 The Aalst cluster and surrounding sites

5.4 Design constraints

5.4.1 e-Tilt

- Electrical tilt limited to physical limits
- +- 3 degrees from current position

5.4.2 Shared antenna

- E-Tilts on antennas shared with the GSM band have not been allowed.
- Sectors having the same name are shared, for example 91BLA1U-91BLA1V-91BLA1W are on the same antenna

5.4.3 Power

- CPICH limited between 30 and 34

- Maximum allowed power for a complete sector = ((cell power U+ cell power V+ cell power W)+ cable loss)
- Concerning CPICH and Cell power: cell footprint per sector is the same (i.e. CPICH for U is the same as for V and W-layer).
- In Huawei networks, a capacity overhead of at least 7dB is needed (if CPICH=34dB then the minimum cell power = 41dB). Otherwise the cell cannot be activated in the network.

5.5 GEOoptimize design recommendations

A small number of different simulations were run to explore the potential number of sectors which could be switched off versus the predicted implications to performance in and around the cluster.

3 designs were discussed with increasing constraint levels to manage PS drops and blocks in the cluster.

The final proposal recommended the following parameter changes:

	Increase	Up	Off
Cells with CPICH change	82		
Cells with E-Tilt change		4	
Cells switch off			8

Table 1 Recommended changes in the parameter

5.5.1 CPICH Power (dB)

Considers the adjustment of Power levels assigned to the CPICH and other control channels of identified cells. The chart shows the number of cells for which a power change was recommended.

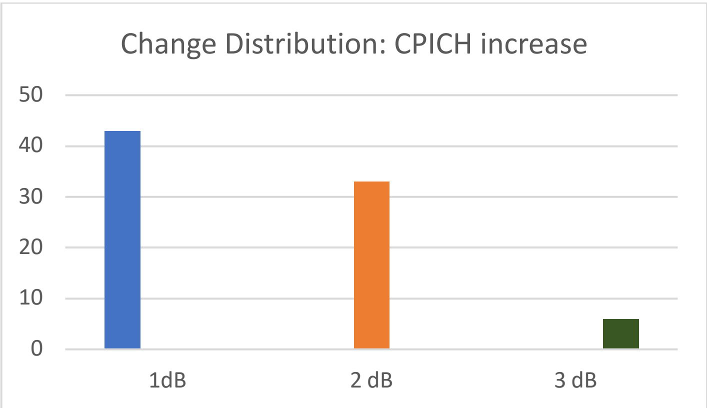


Figure 4 Distribution of changes in CPICH

5.5.2 Electrical Tilt (°)

Considers the adjustment of Electrical Tilt values for the antennas of identified cells. All Electrical Tilt changes are 2 degrees up-tilt

NOTE: Approximately 30% of the cells within the cluster have been changed by this proposed design. CPICH and Electrical Tilt changes were required to compensate the effect of the site switch-offs and maintain the key data service KPIs.

Sites with sectors proposed to be switched off are shown in the image along with surrounding sites with target parameter changes. The target parameters required to be adjusted to compensate the effect of the site switch-offs.

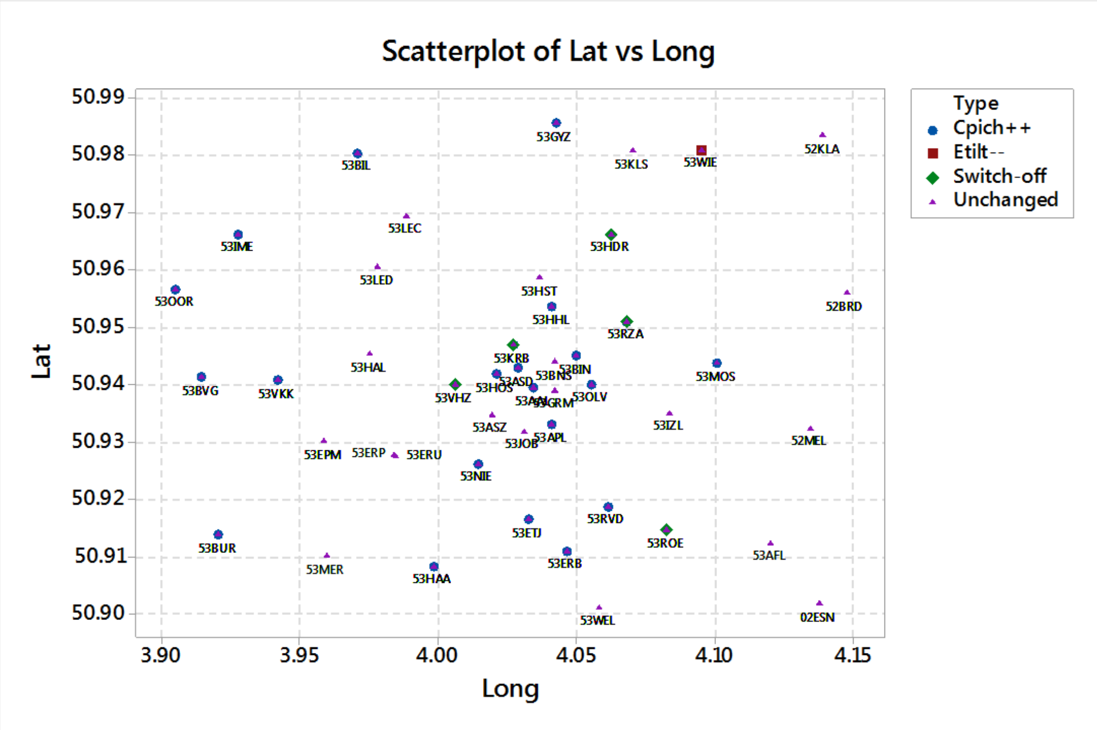


Figure 5 Scatterplot of Latitude vs. Longitude

The recommended cells switched off are shown in the table below:

Cell	Change	Label	Site
1000:38012	Cell Disable	53VHZ2V	53VHZ
1000:38011	Cell Disable	53VHZ2U	53VHZ
1000:10909	Cell Disable	53KRB2V	53KRB
1000:43831	Cell Disable	53RZA2U	53RZA
1000:14981	Cell Disable	53HDR3T	53HDR
1000:15690	Cell Disable	53ROE2T	53ROE
1000:43945	Cell Disable	53KRB2U	53KRB
1000:10926	Cell Disable	53RZA2V	53RZA

Table 2 List of cells recommended to be switched off

5.6 Aalst cluster KPIs

The impact on the key KPIs is summarised in the following table; please refer to later sections for a more detailed view.

RF Analysis	Ec/No	RSCP	Comment
RF CDF	Same	Same	See charts and details in results
RF Histogram	Same	Same	See charts and details in results
	Before	**After**	**Comment**
Pilot Pollution	47576	47467	See chart and details in results
Performance KPIs	**CS**	**PS**	**Comment**
RRC Success Rate	99.980% → 99.981%	99.864% → 99.843%	See charts and details in performance KPIs results
RAB Success Rate	99.988% → 99.986%	99.797% → 99.986%	
Drop Call Rate	0.059% → 0.061%	0.612% → 0.629%	
RTWP	-105.115 dBm	-105.088 dBm	
Traffic KPIs	**Before**	**After**	**Comment**
DL Traffic Volume	1.86E+12	1.81E+12	See details in Traffic KPIs slide
UL Traffic Volume	3.44E+11	3.39E+11	
Erlang	45039	47420	
Mobility KPIs	**Before**	**After**	**Comment**
SHO SR	99.954%	99.954%	See details in Mobility KPIs slide
IRAT SR	98.881%	98.869%	

Table 3 RF Analysis and changes in KPIs

5.7 Design implementation

VIAVI and Proximus cooperated in the implementation of the proposed adjustments and in the benchmarking of the results.

Proximus implemented in the network the adjustments defined by VIAVI for a period of one week; during this time, the cluster under analysis was monitored by Proximus and VIAVI to ensure stability.

VIAVI and Proximus checked and benchmarked the results, generating a report to compare the KPIs before-and-after the application of the proposed adjustments and demonstrating the improvement achieved by the use of GEOoptimize.

5.8 Implementation results:

5.8.1 General considerations

- Before change: 2nd to 8th of October
- After change: 9th to 15th of October

- Data source: VIAVI

5.8.2 3G RF KPIs – EcNo

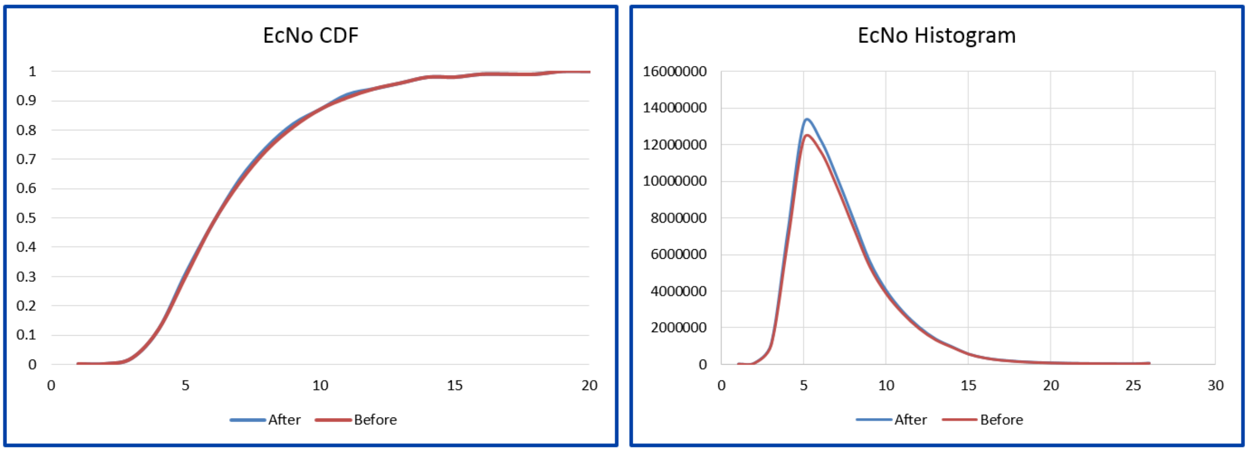


Figure 6 Changes in EcNo performance

EcNo has the same distribution before and after the implementation of the recommendations. The 8 spot areas where the cells were switched off have better RF values individually, but do not significantly affect the overall outcome across a full 328 cell cluster.

5.8.3 3G RF KPIs – RSCP

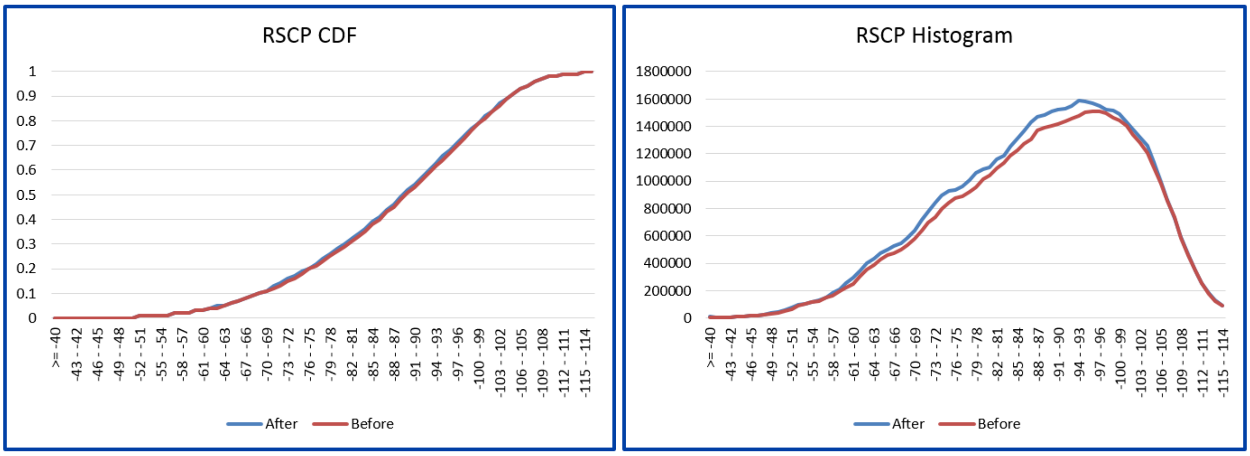


Figure 7 Changes in RSCP performance

RSCP has the same distribution before and after the implementation of the recommendations. The 8 spot areas where the cells were switched off have better RF values individually, but do not significantly affect the overall outcome across a full 328 cell cluster.

5.8.4 3G RF KPI – Pilot pollution

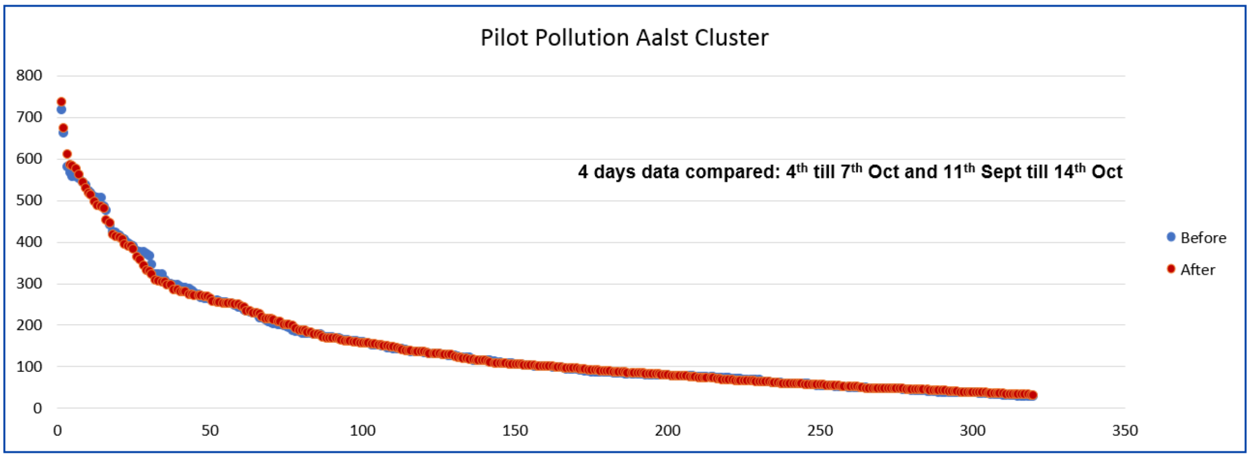
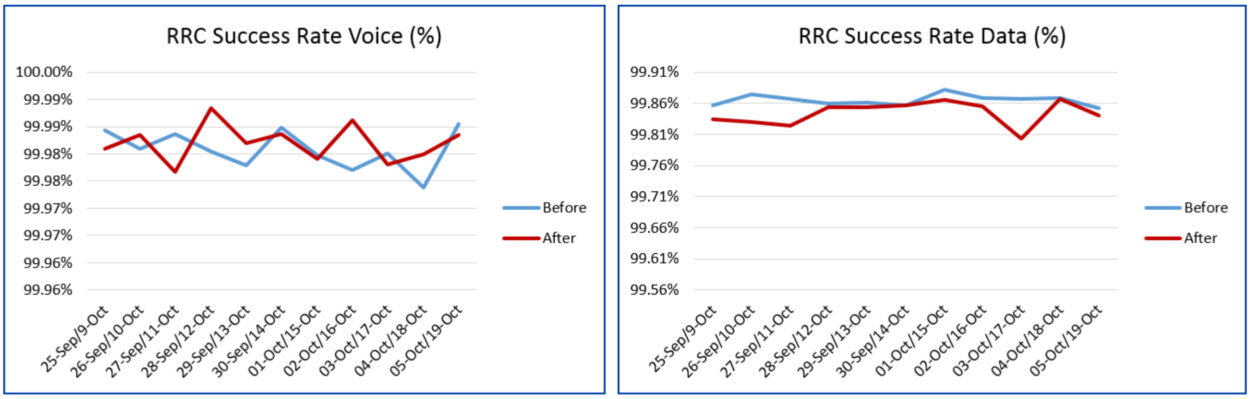


Figure 8 Changes in Pilot Pollution

Pilot pollution almost remains the same after the implementation of several CPICH increases and Electrical Up-tilts.

In the above chart, all 320 cells pilot pollution results are included from Aalst cluster.

5.8.5 3G Performance KPIs – RRC Success Rate



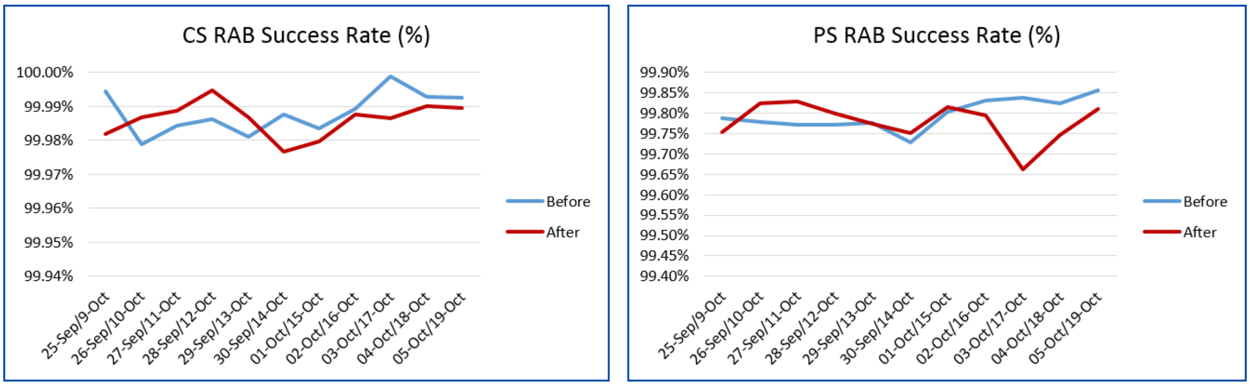
	Before	After
Weekly average	99.980%	99.981%

	Before	After
Weekly average	99.864%	99.843%

Figure 9 Changes in RRC Success Rate (Voice & Data)

RRC Success rate for CS and PS remained same with around the same amount of CS and PS attempts.

5.8.6 3G Performance KPIs – RAB Success Rate



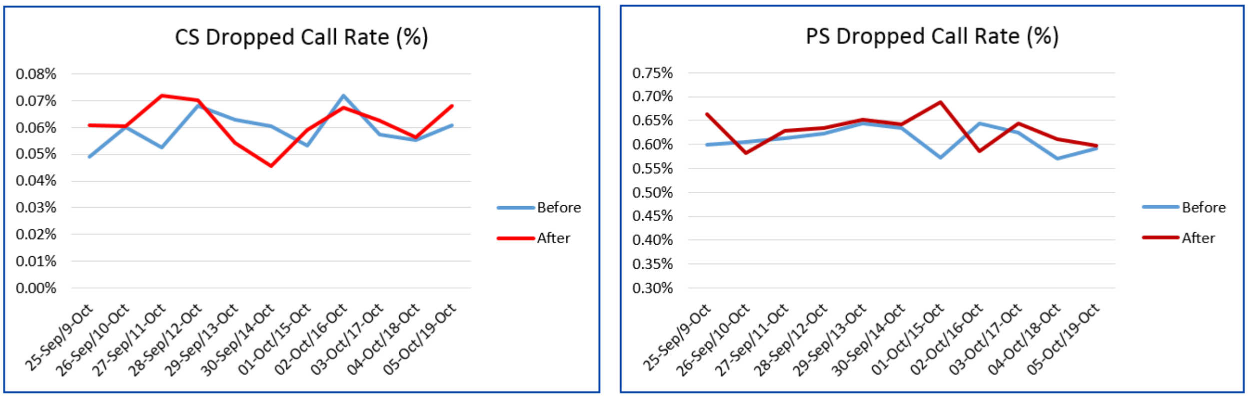
	Before	After
Average	99.988%	99.986%

	Before	After
Average	99.797%	99.778%

Figure 10 Changes in RAB Success Rate

RAB Success rate for CS and PS remained the same with around the same amount of CS and PS attempts.

5.8.7 3G Performance KPIs – Dropped Call Rate



	Before	After
Average	0.059%	0.061%

	Before	After
Average	0.612%	0.629%

Figure 11 Changes in Dropped Call Rate

Dropped call rate for CS and PS remained the same with around the same amount of CS and PS attempts.

5.8.8 3G Performance KPI – RTWP

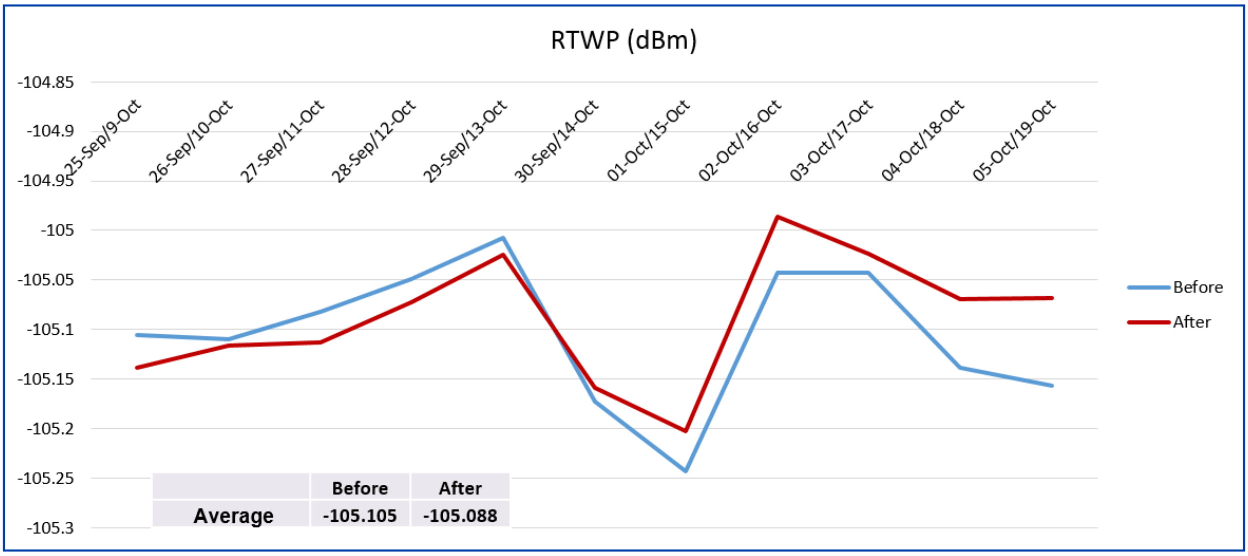
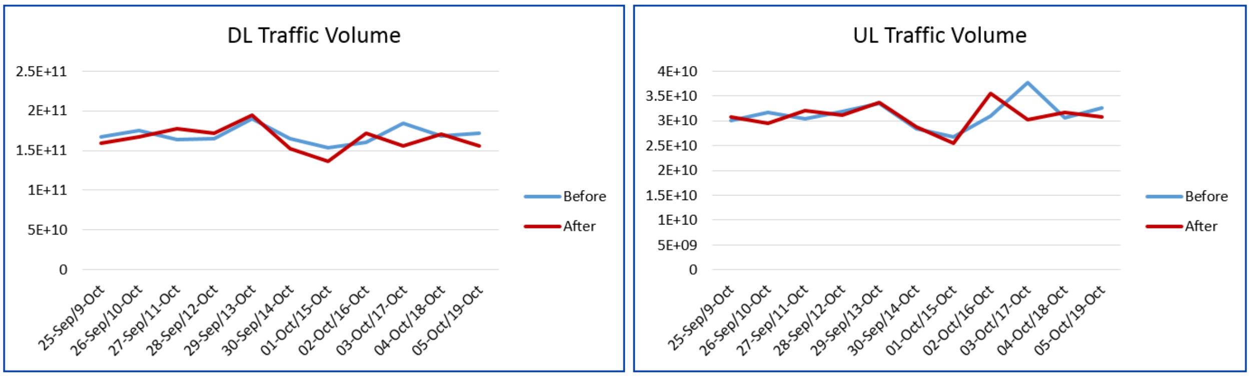


Figure 12 Changes in RTWP

The uplink interference has not degraded as can be seen from the received total wideband power (RTWP) remaining the same

5.8.9 3G Traffic KPIs – Traffic volume

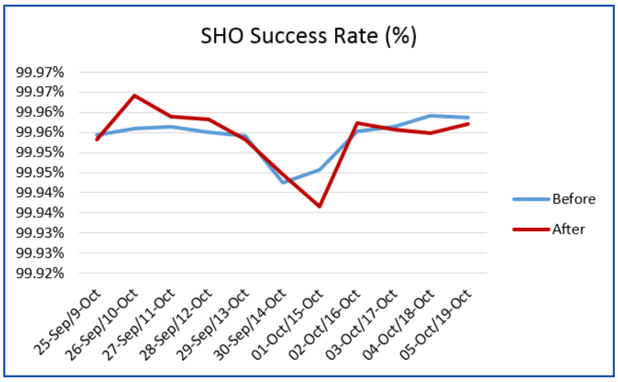


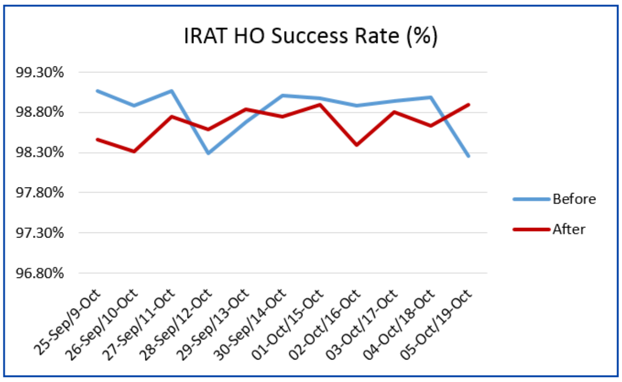
	Before	After
Weekly average	1.86E+12	1.81E+12

	Before	After
Weekly average	3.44E+11	3.39E+11

Figure 13 Changes in Traffic Volume (DL and UL)

5.8.10 3G Mobility KPIs – SHO and IRAT





	Before	After
Weekly average	99.954%	99.954%

	Before	After
Weekly average	98.881%	98.869%

Figure 14 Changes in SHO and IRAT HO

SHO and IRAT for CS and PS remained same with around the same amount of CS and PS attempts.

6 Challenges

To reduce OpEx and power consumption, Proximus built some processes internally to analyze case by case, cell by cell what the impact would be to shutdown cell at site x. This is a very workload intensive, time consuming exercise. Given the complexity of today's mobile networks (several technologies, multiple layers) and the fact that performance degradation is not allowed, the need for an automated process became very high.

The challenges encountered can be divided into two main targets.

- **GreenICT**
  - Reducing power consumption by deactivating Cells.
    - Area Performance should stay the same
    - No loss of traffic.
- **OpEx Saving**
  - Demolish sites
    - Do we have sites that could be removed -> Save on rent.
    - Area Performance should stay the same
    - No loss of traffic
  - Very expensive Sites with low return on investment.
    - What if we remove the site?
      - Impact on Area?
    - After area optimization what is the estimated impact on the area?

With SON solutions, several greenICT feature are already available and used. However, it is possible to go even more aggressive without loss of performance for the customer.

7 Lessons Learned

One of the lessons learned from the OpEx reduction exercise is to run the GEOoptimize analysis again after the recommended cells have been switched off. This is to see if with the implemented changes, further carriers can be switched off.

This comes from the sector analysis where only 2 carriers (53KRB2U, 53KRB2V) were switched off and the 3rd carrier (53KRB2T) was kept as remaining in the sector.

Cell 53KRB2U had a small footprint 300 m by 100 m only, as can be seen clearly below. GEOoptimize recommended this cell to be switched off based on low traffic and small footprint.

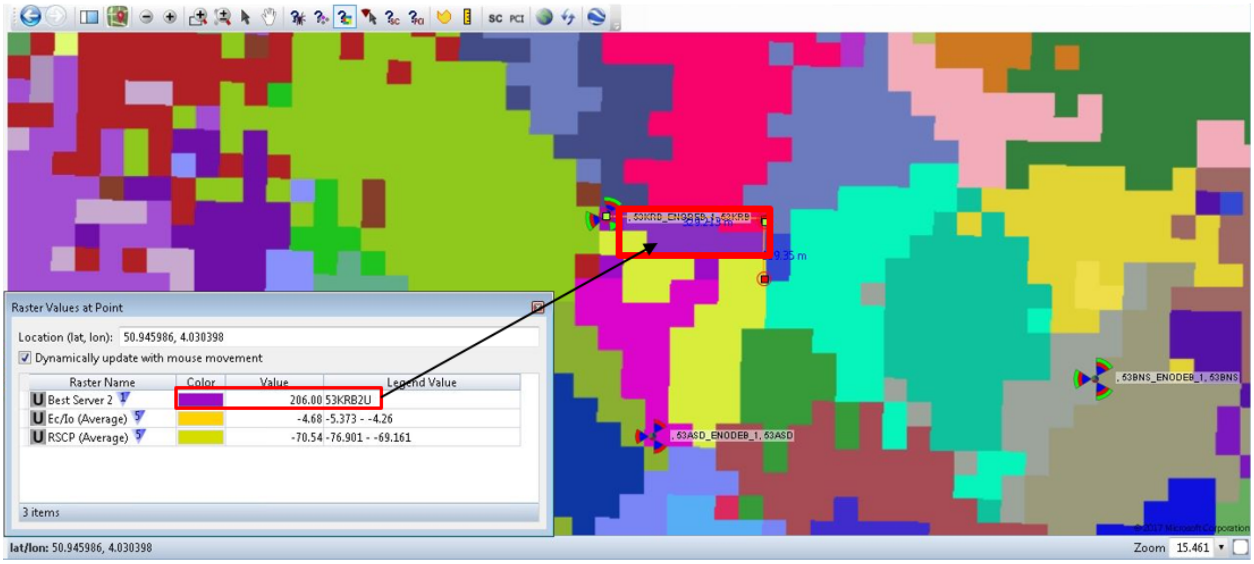


Figure 15 Recommendation for Cell 53KRB2U

Cell 53KRB2V only represent a best cell in 2 bins. The bins are highlighted below. GEOoptimize recommended this cell to be switched off based on low traffic and small footprint.

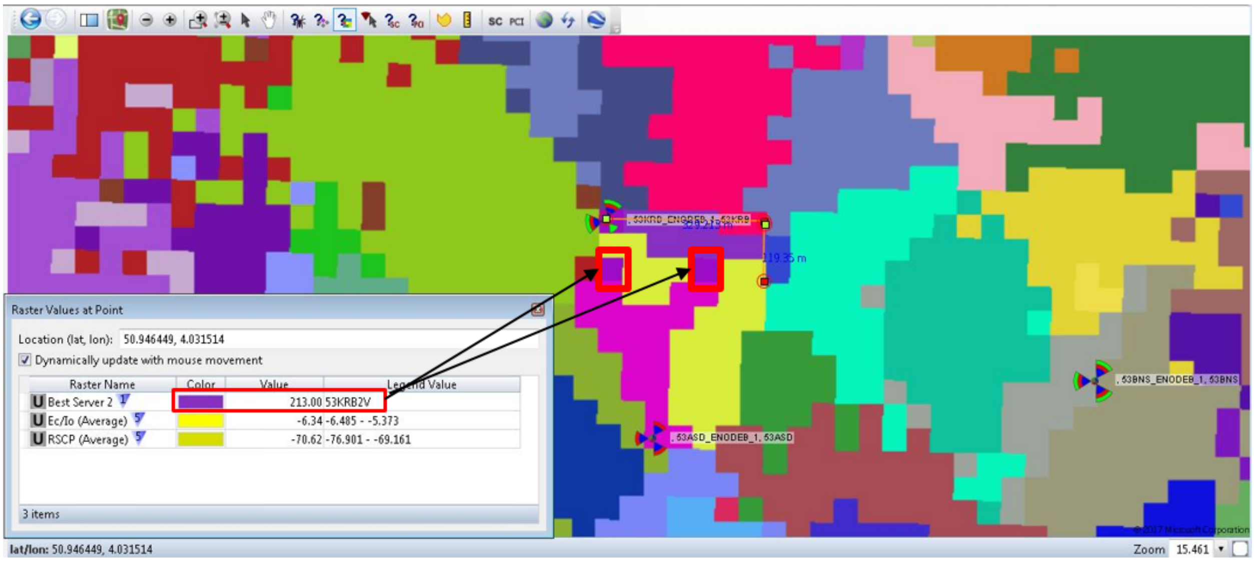


Figure 16 Recommendation for Cell 53KRB2V

Cell 53KRB2T is best cell in 2 bins near to the site location, and a bit away from the site 1.3 km in 1 bin. Bins are highlighted below. GEOoptimize did not recommend to switch of this cell in the plan, and remained on.

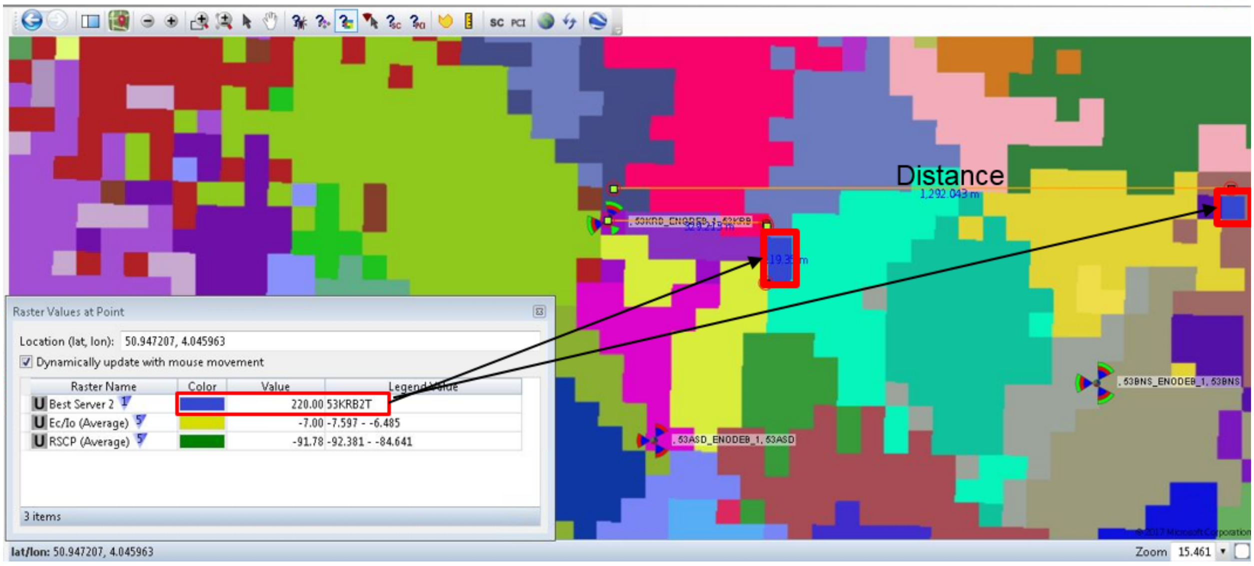


Figure 17 Recommendation for Cell 53KRB2T

The 3rd carrier (53KRB2T) in these 2 sectors had a slightly bigger and scattered footprint before, compared with the other 2 carriers which were picked up by GEOoptimize in the first round.

After the other two carriers (53KRB2U, 53KRB2V) were switched off in the sector, the analysis in the VIAVI ariesoGEO solution showed the 3rd carrier (53KRB2T) footprint decreased into similar size, like the picked-up cells.

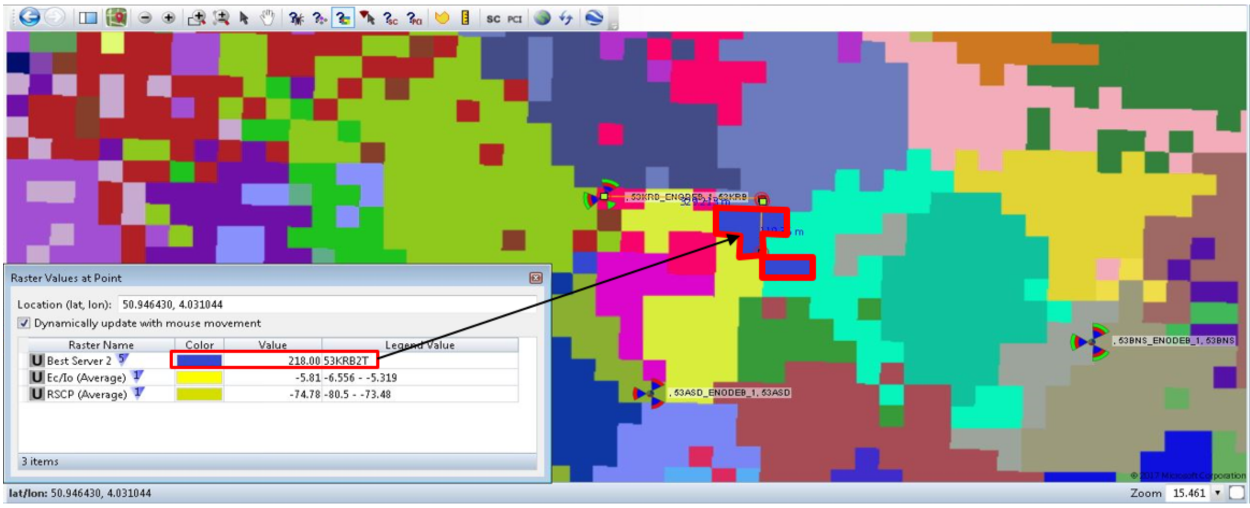


Figure 18 Changes in performance of cell 53KRB2T

After switching these two cells off, the neighbor cells provided coverage with good RF values.

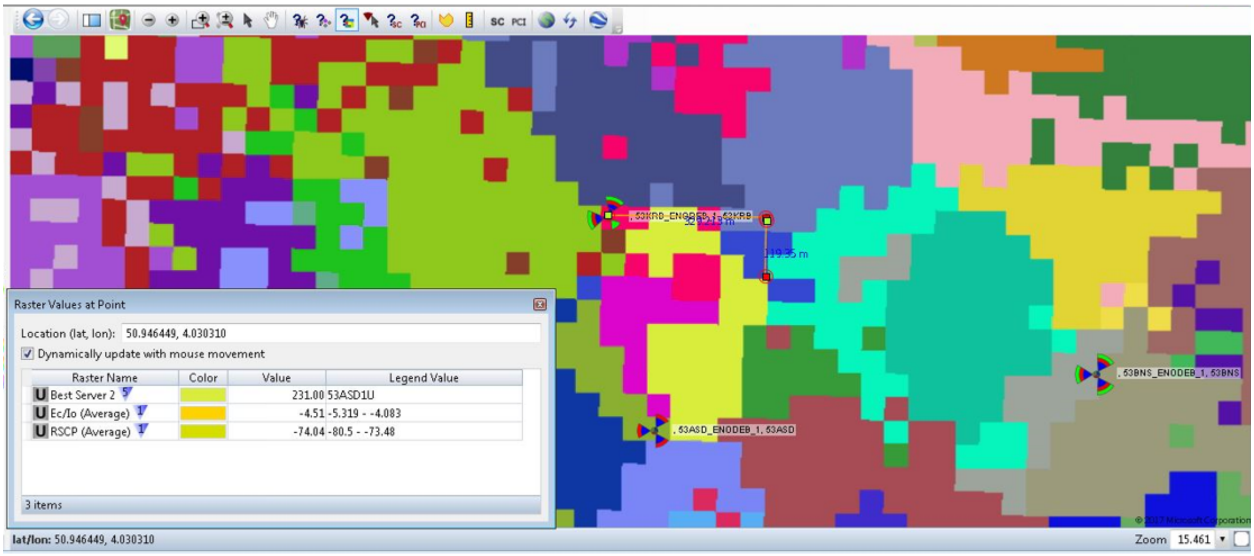


Figure 19 Changes in performance of the neighbor cells

8 Summary

Proximus partnered with VIAVI Solutions, who provided their GEOoptimize solution which analyses subscriber-generated geolocated call trace data to make detailed recommendations for network configuration changes. After taking into account Proximus's design constraints and certain KPIs that they were not willing to degrade, GEOoptimize recommended that 82 cells out of 328 should increase power, 4 cells should adjust their E-Tilt, and 8 cells should be switched off completely. This was achieved while maintaining Proximus's key KPIs at or close enough to their existing values, thereby preserving 3G data services while achieving OpEx reduction through energy saving. The optimization algorithms utilized for this study are field proven to be equally effective across 3G and 4G for voice and data.

Following inputs and indicative energy cost reduction assumptions from a case study involving VIAVI and Proximus, the GSMA Network Economics model estimated potential savings in

OpEx and CAPEX for typical operators across four different segments[1]. The model estimates an OpEx saving of between 2 – 3% associated with an energy optimization of 25% for both macro and micro sites during 'less loaded' periods (a 6 hour period where traffic loading requirement are at their lowest throughout one day, typically between 12am-6am)[2]; and also from the reduced number of base stations following closures of sites - from identifying non-required mast sites. These saving are estimated to result in an OpEx intensity (OpEx/Revenue) reduction of between 0.3 – 0.5%[3]. For CAPEX, our model predicts an avoidance of 2% from the build avoidance on sites following closures – based on the assumption that operators will streamline their number of sites given a stronger focus on running energy efficient base stations. This resulted in a predicted 0.3-0.4% reduction in CAPEX intensity (Capex/Revenue).[4]

1 - In the NE Model, operators' cost structure are profiled by operating regions, based on market maturity and population density (Developed/Developing; Urban/Rural). Country and operator profiling below:

2 – Assumptions and inputs received from Viavi/Proximus CS. Savings calculated as 'new OpEx' following network transformation minus baseline OPEX.

3 & 4 – Network Economics Model table can be found at

(https://infocentre2.gsma.com/gp/pr/FNW/NE/WorkingDocuments/Network%20Economics/Proximus%20Optimization%20and%20Energy%20Savings_FINAL.pdf)