RADIO NETWORK PLANNING AND OPTMIZATION

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May, 2022

THIS STUDY IS DEDICATED TO OUR PARENTS AND BELOVED TEACHERS

DECLARATION

We hereby declare that this report has not been submitted to anywhere or any other institution for the purpose of acquiring a degree, diploma certificate or for publications.

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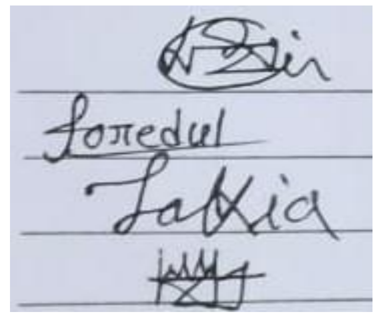

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In the name of Allah, the most gracious and merciful, we say Alhamdulillah. All credit goes to him. We thank him for providing us with the opportunity to successfully complete this thesis. We would also like to express our appreciation to Dr. Nafiz Imtiaz Bin Hamid, Assistant Professor (EEE) Islamic University of Technology (IUT). For his positive mentoring, as well as his efforts to assure the completion of our thesis. Our special thanks goes to our loving parents for guiding, supporting, and parenting us during our educational path.

ABSTRACT

With the passage of time, mobile communication is continuously evolving, and new technologies are being launched to help mobile users get the most out of their devices. Past technologies are being phased out in favor of new ones, and the need for new technologies is growing. Long-Term Evolution (LTE) will be the next big thing in mobile radio, and it was first introduced in 3GPP Release 8. It's the crucial stage toward 4th generation (4G) communication technologies, which will enhance mobile phone networks' capacity and speed. Only a few LTE radio planning projects have been developed with industrial attachment. However, due to commercial concerns, those works aren't readily distributed. For wireless communication technologies, radio network planning is a critical stage. As the LTE standardization process nears completion, it is imperative that LTE radio network planning guidelines be implemented. Initial planning for LTE, like other cellular technologies, is usually done at the discretion of individual businesses and vendors. They are unlikely to reveal their discoveries and advancements. This makes the work even more difficult. As a result, continuing with the perspective of LTE radio network planning is a well-chosen task and a popular topic in the current research arena. This paper presents a complete LTE radio network planning approach that focuses on nominal and detailed planning for future network installation in Dhaka, a heavily populated South Asian city.

CHAPTER 1 INTRODUCTION

The rapid rise of mobile communication and technology has made an excellent contribution to persistent computing environments, not only in terms of easing our daily lives but also in terms of making an important contribution to persistent computing environments. From the initial generation of cellular networks, which used analog communication, to the latest versions, such as LTE, LTE advanced, and WIMAX 802.16m, the technology has improved in terms of quality and accessibility. Apart from that, end user expectations have shifted from traditional mobile voice traffic to simple text communication, live streaming services, and internet access, all of which have a significant impact on traffic demand. All of these demands prompted the development of new system architectures and management systems to address challenges such as service quality, capacity, and coverage. As a result, the 3rd Generation Partnership Project (3GPP), which is now the world's primary specifications development body for mobile radio systems, has begun work on a new standard known as the Long-Term Evolution (LTE) (LTE). LTE is a fourth-generation mobile communications technology that is essentially an all-IP broadband Internet system with voice and other services built to ensure 3GPP's competitive advantage over competing cellular technologies. Unlike circuit-switched 3GPP technologies such as GSM and WCDMA, which presently serve over 85% of worldwide mobile users, LTE was meant to be a high data throughput, low latency system that mainly allows packet switched services [1].

For a wireless communication technology, radio network planning is a critical phase. As the LTE standardization process nears completion, it is imperative that efficient radio network planning guidelines for LTE be implemented. For the same reason, and because LTE radio network planning works in the same way as other cellular technologies, initial stage planning is usually done at the discretion of various industries and vendors. They are unlikely to reveal their discoveries and advancements. This makes the work even more difficult [2].

The ultimate goal of this work is to develop a complete radio access planning guideline for the city of Dhaka. With this aim in mind, a step-by-step strategy was used in this research, commencing with gathering preplanning information and progressing to coverage and capacity analyses. A link and operating system simulation, as well as a link budget, were required for this. All of these have been presented in this article. A brief discussion of radio network planning (RNP) approach was given before that [3].

1.1 STATEMENT OF PROBLEM

The radio network planning process of a cellular network follows a set of processes. These steps progress from simple analysis to computer-assisted mathematical computation, or from nominal planning to detail planning and finally optimization. Because the system to be implemented is a novel technology, the first phase in RAN planning, i.e. nominal planning, is a vital step because it provides the first rough estimate of coverage and capacity. Link budget calculations are used to estimate cell size, while speculative traffic and throughput calculations are used to estimate capacity in LTE nominal radio networks. Because of the flexibility of this stage, coverage estimation is usually done with a general modelling technique that does not take into account the real geographical information. As a result, the main issue with the results acquired is that they do not represent real values; nonetheless, in order to increase the accuracy of this RAN planning stage, the terrain model must be addressed in simple ways, so that the result may be improved while the procedure remains simple.

1.2 OBJECTIVES

The primary goal of this research is to investigate and describe the planning and optimization of nominal radio access networks in LTE. The goal of this project is to learn about alternative modeling methodologies, as well as input and output parameters, in LTE dimensioning. Furthermore, determining how appropriate the LTE would be for the form of geography found in Dhaka, as well as determining whether the results obtained will be of sufficient quality and cost-effectiveness to be implemented in the real world, and if they would be superior to existing services.

- Defining a "correct" or site-based mathematical model of LTE Radio Network planning for capacity and coverage estimate, which includes environmental data from the chosen deployment location to refine coverage estimation.
- Taking into account both theoretically simulations and Dhaka Map data from the deployment area, which was based on real data from Bangladesh Telecommunication Limited

1.3 SCOPE OF THE PROJECT

This projects is a case study that will address elements that are required for the proper RNP implementation in Dhaka cities.

- It should calculate capacity and coverage, as well as the process of putting stations in the study region.
- When planning, it is important to note the relationship between coverage and capacity from a technological standpoint.
- The quality of the Radio network planning in that location, as well as how efficient it is to create it in real time, must therefore be optimized.

CHAPTER 2 LITERATURE REVIEW

The LTE framework's fundamental goals are to develop a system capable of meeting high data rate needs, minimizing latency, and optimizing packet-domain traffic. The LTE system is designed to have a peak data throughput of 100 megabits per second in the DL and up to 50 megabits per second in the UL . Dimensioning is a component of the overall planning process, which also involves thorough network planning and optimization. The essential procedures for dimensioning a wireless cellular network are as follows:

- Data/Traffic Analysis that provides an estimate of the traffic that the system will carry.
- The word "coverage estimation" refers to the process of determining the coverage area of each base station.
- Capacity assessment Capacity planning is concerned with the network's ability to provide services to users at a desired level of quality.
- Transport dimensioning is concerned with the specification of interfaces between various network parts.

Dimensioning of LTE Capacity. Calculating the Budget for a Radio Link: Determining the link budget enables the coverage area and range of the cell to be determined, allowing idea of the amount of base stations required to cover the area in which the service will be offered. It is worth noting that the elements of the environment (dense urban, urban, suburban.) in which the network is built have an effect on the Link Budget results, as the signal will suffer propagation loss [4]. The knowledge of LTE resulted in the development and implementation of fourth generation radio technologies, generally referred to as 4G, in order to increase the capacity and data rate of existing 3G radio technologies. While a substantial amount of research has been conducted on capacity increase in WCDMA wireless radio networks, very little has been conducted on Long Term Evolution (LTE) [4] . Power regulation for utility maximization has been extensively explored in wireless networks and cellular telecommunication networks. There is a substantial amount of study on this subject, dating all the way back to the early articles [5]. The utilization of optimization techniques for ensuring optimal network performance is self-evident, both in terms of planning a network and/or radio resources and maximizing them during repair and control, provided that a decent trade between parameter estimate and reality can be found. Numerous technical features of UMTS networks, as well as certain practical considerations contains guidelines for driven optimization and tuning. [6] Discusses electricity control and capacity challenges. Discusses optimizing certain network features without regard for site selection.

CHAPTER 3 METHODOLOGY

We reviewed related literature of Radio Network Planning involving optimized 4G Parameters. The notion of LTE radio network planning is currently being researched, with many standardizations being used. As a conclusion, this project is totally depended on LTE texts, 3GPP standardization documents, numerous IEEE articles, journals, previous studies on the topic, and well-known simulations and NSN materials and tools. The project started with a general overview of LTE and radio network planning. During in the method of analyzing relevant papers, the statement of the problem had been clearly developed. On the process of reviewing related works knowledge we gained for generating simulation result we used atoll software version 3.3.

The following strategies were used to design the radio network planning and optimization:

3.1 SYSTEM DESIGN

- Outlining the process for coverage and capacity planning.
- The network requirements were identified and planned based on the best coverage and capacity analysis possible.
- Set the input parameters for the Dhaka digital map.

3.2 PREDICTION

- Perform several network coverage predictions.
- Comparing prediction results and adding base-stations where necessary.
- Perform calculation on prediction properties.

3.3 SIMULATIONS

- The simulation work flow for the RNPO tool was outline.
- The target area's coverage prediction simulation was run.
- The coverage and capacity of the network were simulated and evaluated.

3.4 RESULT AND INTERPRETATION

Coverage prediction findings, capacity evaluation, and optimization analysis were used to determine whether or not the goal of the network requirement was achieved.

CHAPTER 4 DATA ANALYSIS AND RESULT

4.1 RADIO NETWORK PLANNING

Dhaka is the capital of Bangladesh and it's the highly populated city in the South Asian region. With the best use of limited resources, efficient radio network planning is definitely a massive task. Coverage analysis, which includes link level simulation results, link budget preparation, and capacity analysis-system level simulation, was carried out in. Using Dhaka's associated pre-planning information:

According to the Cost-Hata propagation model, eNodeB has a coverage number of 53 and a capacity number of 50. Area: 1463.6 km2, inhabitants: 15 million (0.75 percent to be serviced), projected overbooking factor: 50. In this case, the percentage of layers required for coverage exceeds capacity, demonstrating that capabilities can be controlled well. The nominal and detailed broadcasting planning phases, which employ the Atoll radio planning tool, are used to test the intended capacity and coverage values.

There are several stages to radio network planning:

- The early stage entails gathering pre-planning data and beginning network dimensioning, which includes preparing a Link Budget, calculating coverage and capacity, and performing simulations.
- Nominal and detailed planning, including the selection and use of radio planning tools Tuning the propagation model, generating a thorough radio plan based on the criteria, matching network capacity to more specific traffic projections, Configuration planning, Site preparation, Site which was before and validation, and eNodeB variable trying to plan are all part of this step.
- Defining KPIs and Parameter Planning- utilizing eNodeB system parameters and counters, defining performance KPIs and target values based on vendor promises, verifying the KPIs and target values nominally using planning and dimensioning tools, and pre- and post-launch optimization [2].

Prior to radio planning, a thorough survey is undertaken to gather the relevant information. Various places have different densities of users. User profile in terms of data rate demand, usage rate, data traffic class of users, quality requirement, and tolerance for unexpected quality, payment capacity, and demographic trends, among other things. Building heights and locations, as well as greenery and highway overpasses. Clutter information (morphology) that describes the land cover at a specific area in general. Topography or elevations of the terrain. Absorption by rain and various forms of air pollution.

4.2 DIMENSIONING OF LTE NETWORK

The primary phase of network planning is dimensioning. It provides a first idea of the number of network elements as well as their capacity. The goal of dimensioning is to calculate the number of base stations required to provide a certain traffic load in a given area, as well as the specific service provided to cell edge customers. Dimensioning is a vital element of the overall planning process, which also includes extensive wireless cellular network planning and optimization. Planning is an iterative process that includes design, synthesis, and implementation [7]. The goal of this entire exercise is to develop a system for designing a wireless cellular network that fits the needs of the clients. Any wireless cellular network's requirements can be fulfilled by changing this procedure. This is a vital step in the network deployment process. The given findings are only valid for that set of input parameters because dimensioning is based on a set of input parameters. The area under consideration, estimated traffic, and required QoS are among these parameters. Dimensioning entails assessing network infrastructure requirements and calculating the number of sites required to service a given area while meeting coverage capacity requirements. For both access and core networks, this is done with the use of a dimensioning tool. In comparison to elaborate planning, dimensioning uses simpler models for representing actual conditions. Dimensioning takes less time with simpler models and procedures. When filled with the projected traffic profile and subscriber base, however, the dimensioning tool should be accurate enough to deliver results with an acceptable level of accuracy. Wireless cellular network dimensioning is directly tied to the network's quality and effectiveness, and can have a significant impact on its growth. The following are the basic steps in sizing a wireless cellular network:

- Data/Traffic Analysis.
- Coverage estimation.
- Capacity evaluation.
- Transport dimensioning.

Coverage Analysis: For a coverage-limited situation or an interference-limited scenario, coverage or cell range is determined. This is determined by factors such as fading margin, cell edge target throughput, average network load, and so on. Coverage estimation is used to identify which base station is necessary to provide coverage for the study region. Coverage estimation determines the area in which users can hear the base station (receivers). It specifies the largest region that a base station can cover.

Capacity Analysis: Capacity analysis comprises evaluating demand and available traffic while taking into account activity factor, Overbooking Factor (OBF), UL/DL frame ratio, and other factors. Capacity planning is concerned with the network's ability to provide high-quality services to its users.

4.3 ATOLL OVERVIEW

Atoll is a 64-bit multi-technology wireless network design and optimization tool that allows wireless operators from basic design through increased density and efficiency.

For both 3GPP (GSM/UMTS/LTE) and 3GPP2 (CDMA/LTE) technology streams, Atoll 3.3 provides integrated single RAN – multiple RAT network design capabilities. It gives operators and manufacturers a robust native 64-bit platform for creating and optimizing today's and tomorrows integrated multi-technology networks. Het Nets and tiny cells, for example, are supported by Atoll 3.3. Through flexible scripting and SOA-based techniques, Atoll's integration and automation features assist operators in automating planning and optimization activities. Atoll can be used in a variety of ways, from stand-alone to enterprise-wide server-based deployments. Atoll has become the industry standard for radio network planning and optimization, with over 6000 active licenses and 300+ customers in over 100 countries [8].

4.3.1 LTE IN ATOLL

Atoll was the market's first LTE network planning software when it launched in 2008. Atoll is utilized by a number of the world's largest LTE providers. Atoll 3.3 provides a complete framework for operators responsible for planning their migration to LTE and LTE-Advanced. It enables the planning and analysis of GSM/UMTS/LTE and CDMA2000/LTE integrated networks [5]. Atoll 3.3 contains unified multi-technology traffic models for GSM/UMTS/LTE (3GPP) and CDMA/LTE (3GPP2), Monte Carlo simulators, and an ACP (Automatic Cell Planning) module, as well as support for emerging technologies like as Het Nets and small cells.

4.3.2 ATOLL SIMULATIONS

Radio planning is currently being conducted utilizing a of Dhaka digital map. These maps depict the Dhaka airport, major roads, secondary roads, streets, trains, and waterways. The initial deployment of eNodeBs was intended to cover the entire city of Dhaka, with the number determined by the coverage and capacity analysis done in. Following installation of the eNodeBs, a coverage forecast was conducted to assist in justifying their placement. Each component of the Dhaka map was assigned its own traffic map. Automatic frequency and cell planning were undertaken before to each of these simulations. The detailed simulation result contains the following conditions: connected UL+DL, connected DL, connected UL, no service, scheduler saturation, and resource saturation.

4.4 DHAKA MAP

As a result, we employed the Atoll software for our research, and we imported the Dhaka map into our simulator at the start of the project. This is the Dhaka clutter classes' map, which we utilized for LTE 4G radio network planning without any transmitters or stations.

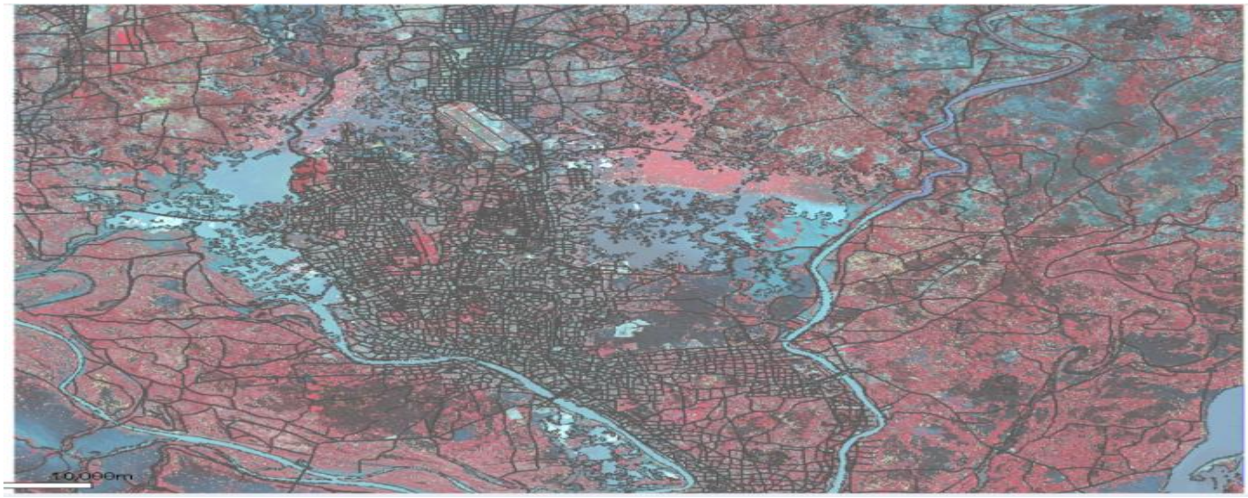


Figure 4. 1: Dhaka Map

Base stations seem to be radio receivers and transmitters that provide as the core of a local wireless network and can also provide as a gateway between a wired and wireless network. So start positioning the number of Antennas manually in the Dhaka clutter classes Map which shows us the site name also. We put here total 70 Station which name as site 1, site 2, and site 3 as well as up to site 70.

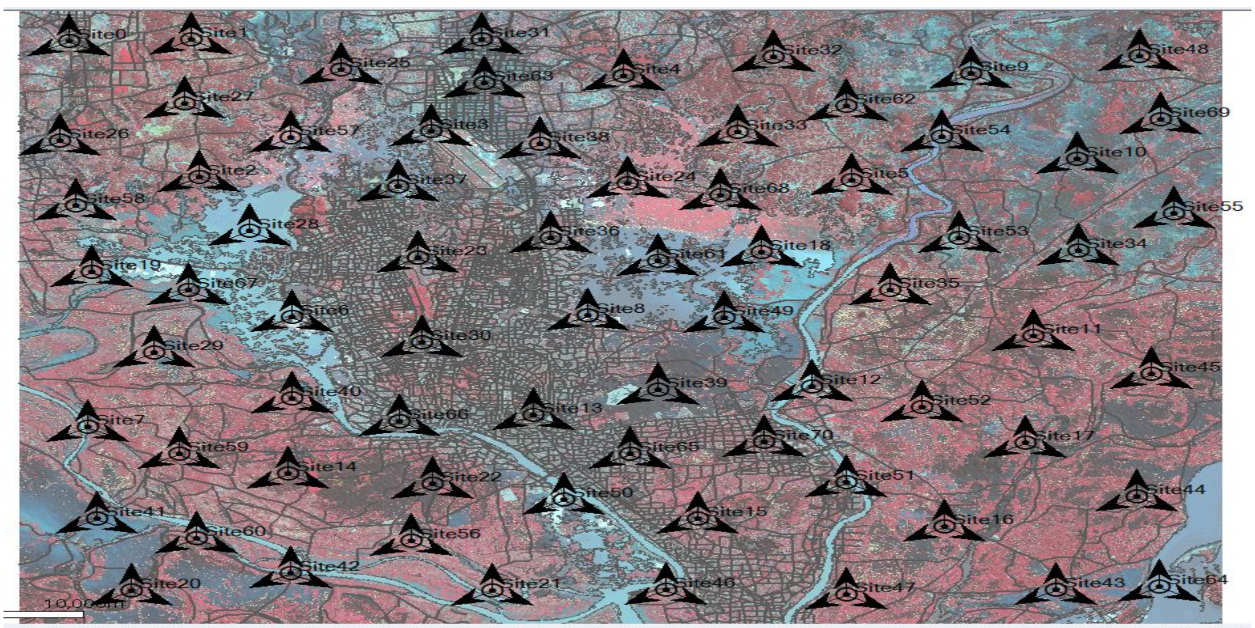


Figure 4. 2: Dhaka Map with Antennas

4.5 COVERAGE PREDICTION

Using the Atoll tools we will basically do the coverage prediction. Coverage predictions have been performed by: Coverage by Transmitter (DL), Coverage by Signal Level (DL), Overlapping Zones

(DL), Effective Signal Analysis (DL), Effective Signal Analysis (UL), Coverage by C/(I+N) Level (DL), Service Area Analysis (DL), Service Area Analysis (UL), Effective Service Area Analysis (DL+UL), Coverage by Throughput (DL), Coverage by Throughput (UL), Coverage by Quality Indicator (DL), Coverage by Quality Indicator (UL), Cell Identifier Collision Zones (DL).

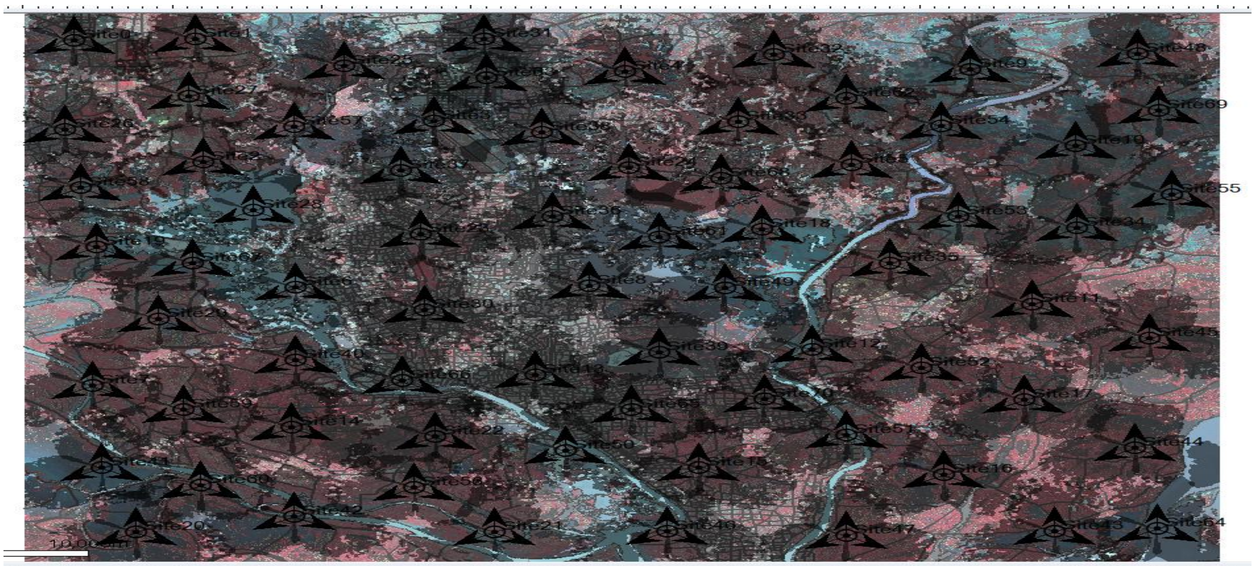


Figure 4. 3: Coverage by Transmitter (DL)

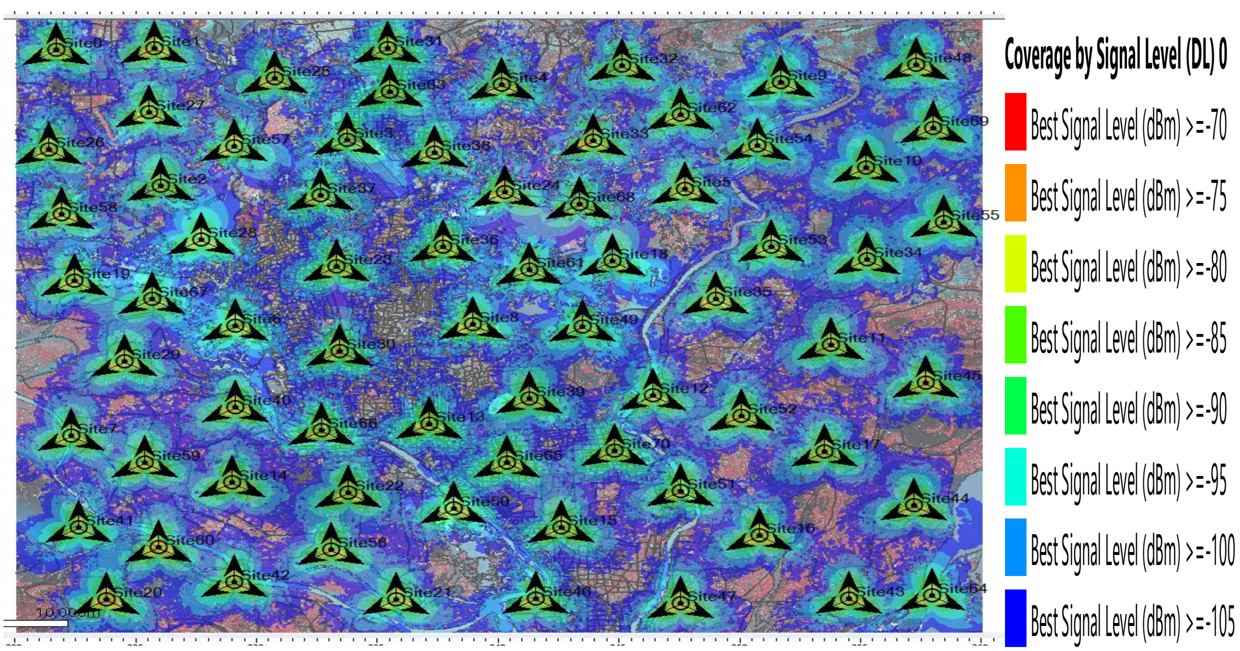


Figure 4. 4: Coverage by Signal Level (DL)

However, the strength of our cell phone signal is measured in decibels (dBm). A signal is sent out by a cell phone tower. The signal deteriorates or weakens as it travels away from the tower. Any obstructions in the route, like as buildings or trees, impact the signal. The signal is really strong when you are close to the tower. It has a lower dBm by the time it gets to your house. The signal strength of various networks ranges from roughly -30 dBm to -120 dBm, and the LOWER your decibels, the stronger your cell phone signal. Great signals are between -30 and -79 dBm, Good signals are between -80 and -89 dBm, and Average signals are between -90 and -99 dBm [9].

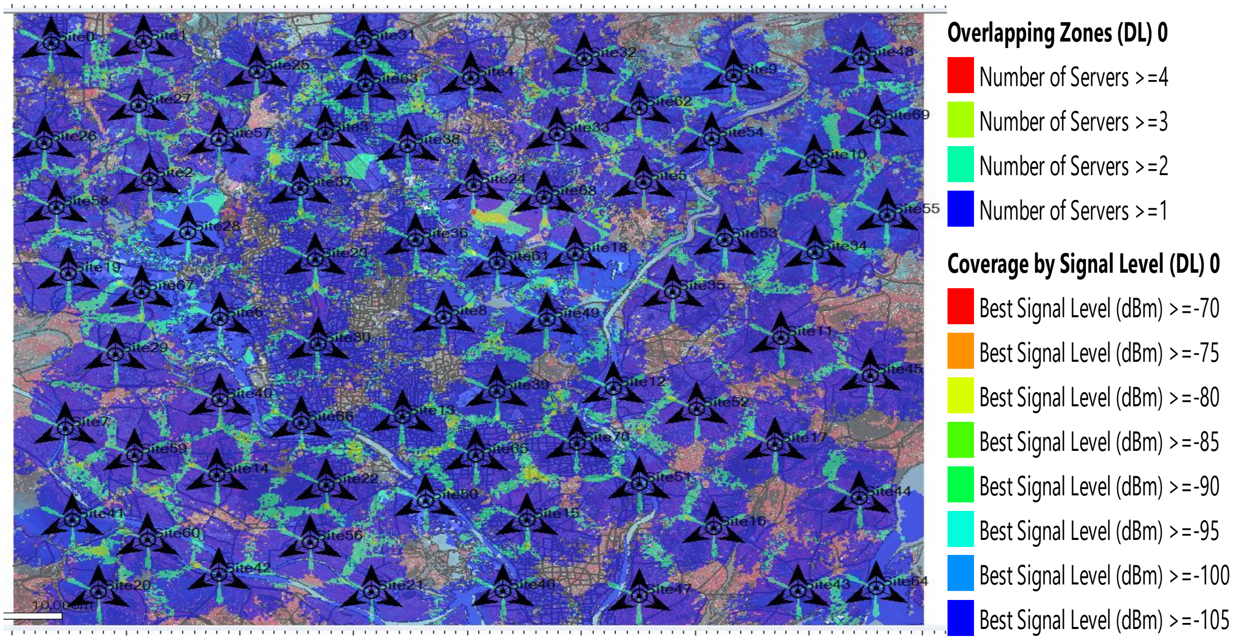


Figure 4. 5: Overlapping Zones (DL)

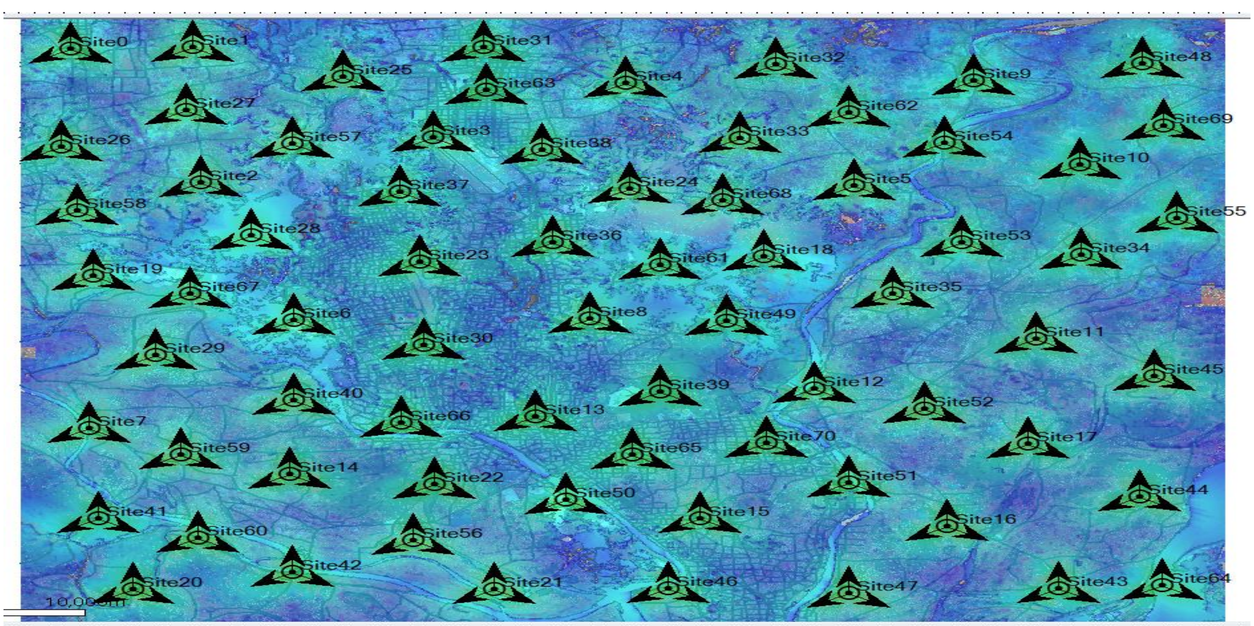


Figure 4. 6: Effective Signal Analysis (DL)

RSRP is Reference Signal Received Power. It is the power of the LTE Reference Signals spread over the full bandwidth and narrowband. A cellular phone or another LTE-equipped device would display signal strength in RSRP, Its typical range is around -44dbm (good) to -140dbm (bad).

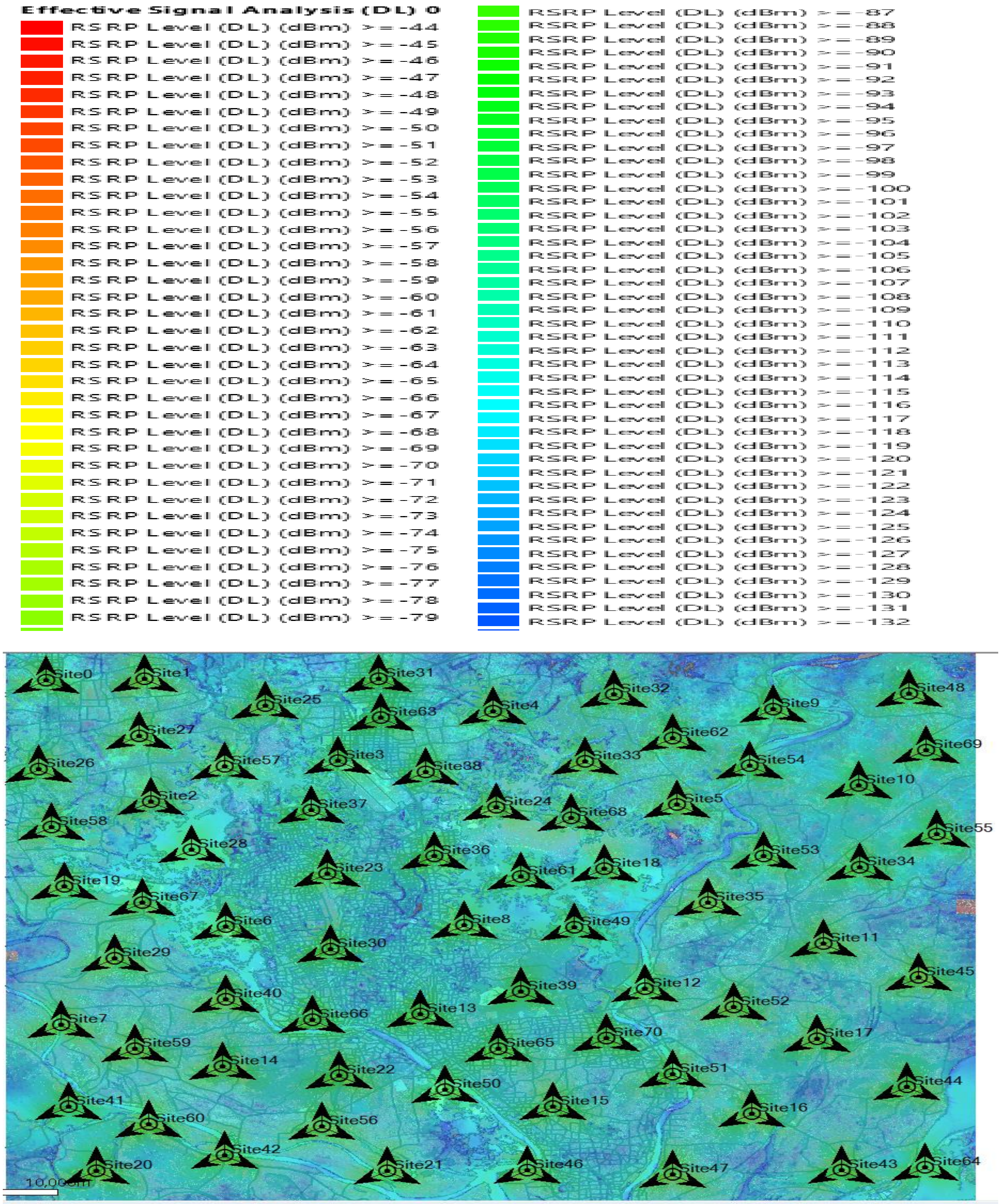


Figure 4. 7: Effective Signal Analysis (UL)

The purpose of this analysis is to the show the effectiveness of the signal for the uplink and the downlink. We chose the entire Dhaka map and placed 70 sites on it, then used prediction to calculate the effective signal. The signal level near the site is high, and as the distance from the site increases, the signal level decreases. Figure 4.3.6 shows how we analyzed the signal to see if it is effective or not. On the map, we manually select and place the antennas.

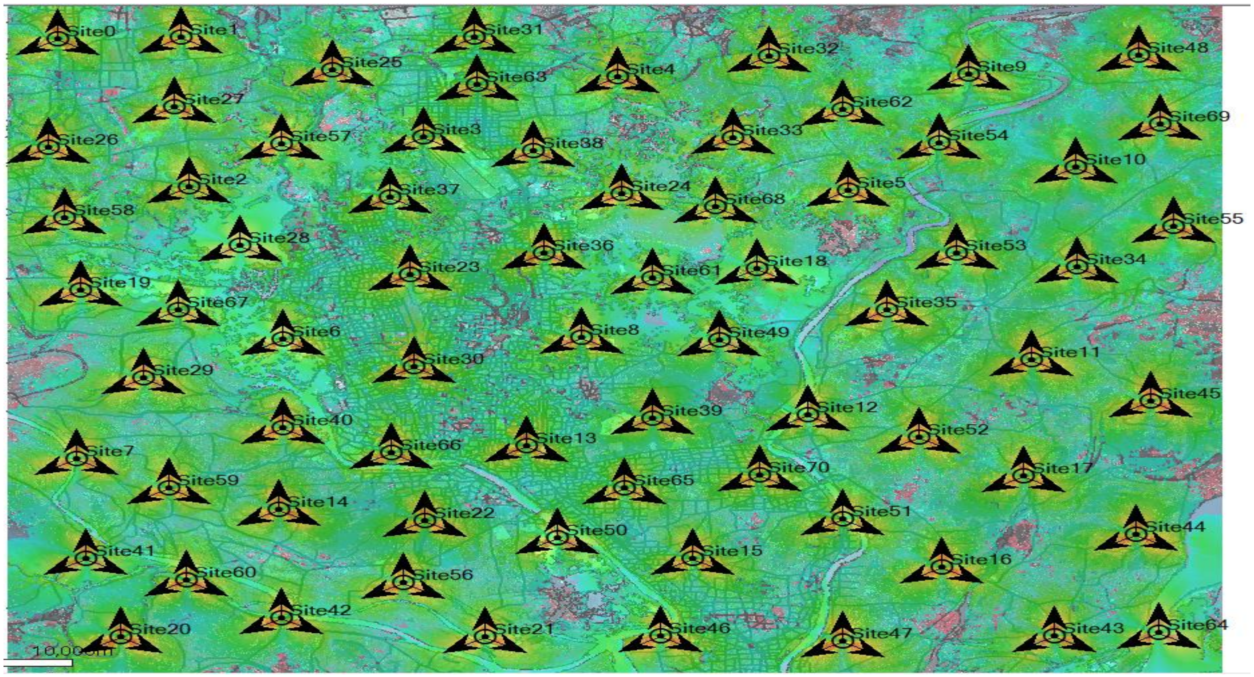


Figure 4. 8: Coverage by C/(I+N) Level (DL)

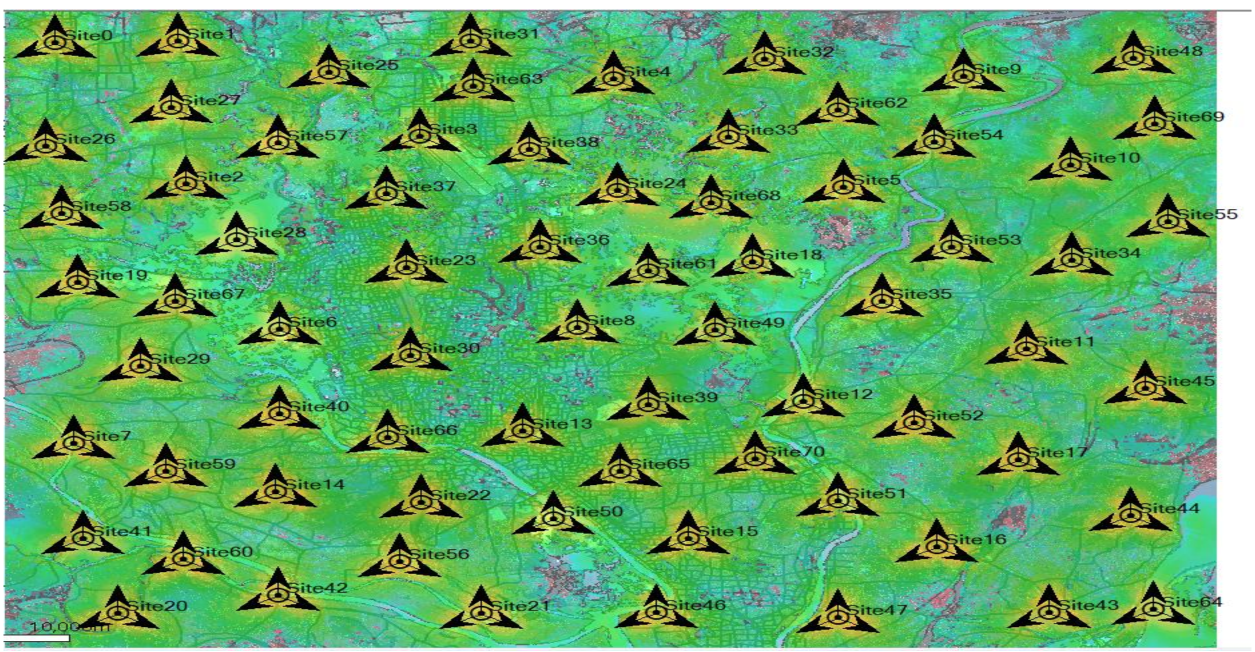


Figure 4. 9: Coverage by C/(I+N) Level (UL)

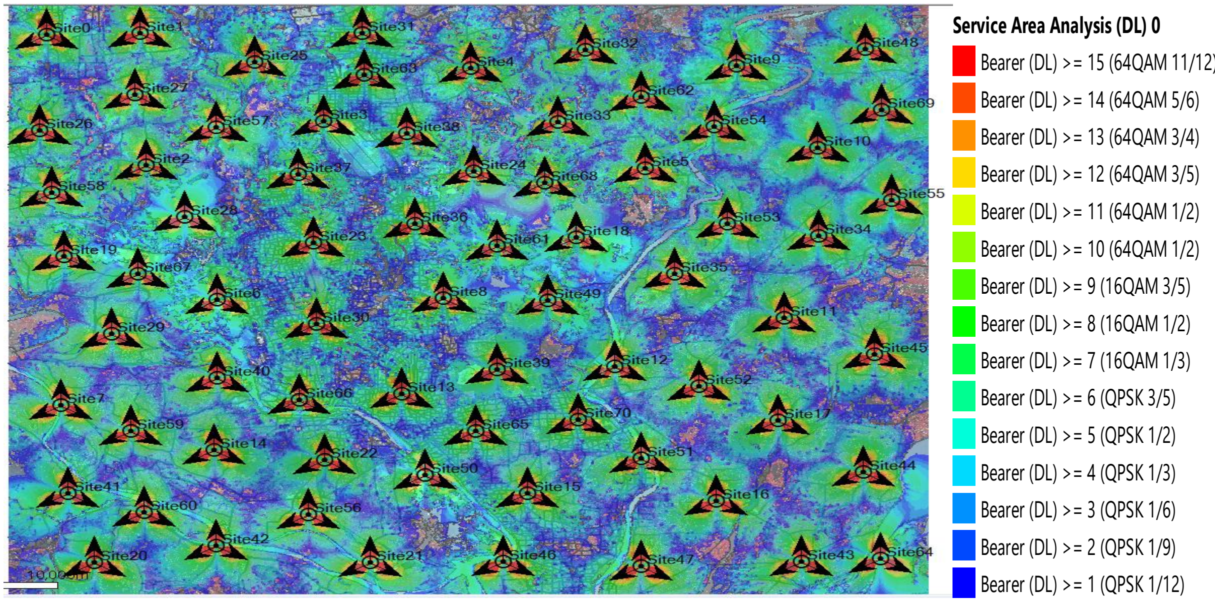


Figure 4. 10: Service Area Analysis (DL)

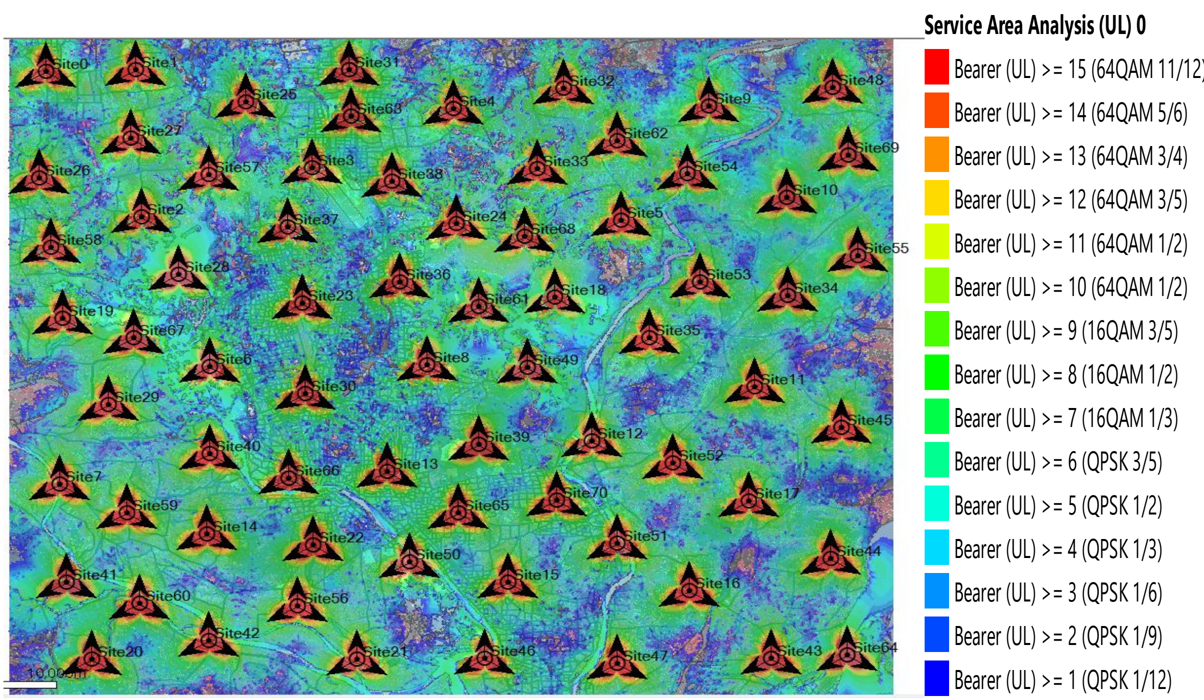


Figure 4. 11: Service Area Analysis (UL)

An analysis of the service area is carried out to determine how much area will be covered by the Antennas. What level of signal quality will be received by the consumer?

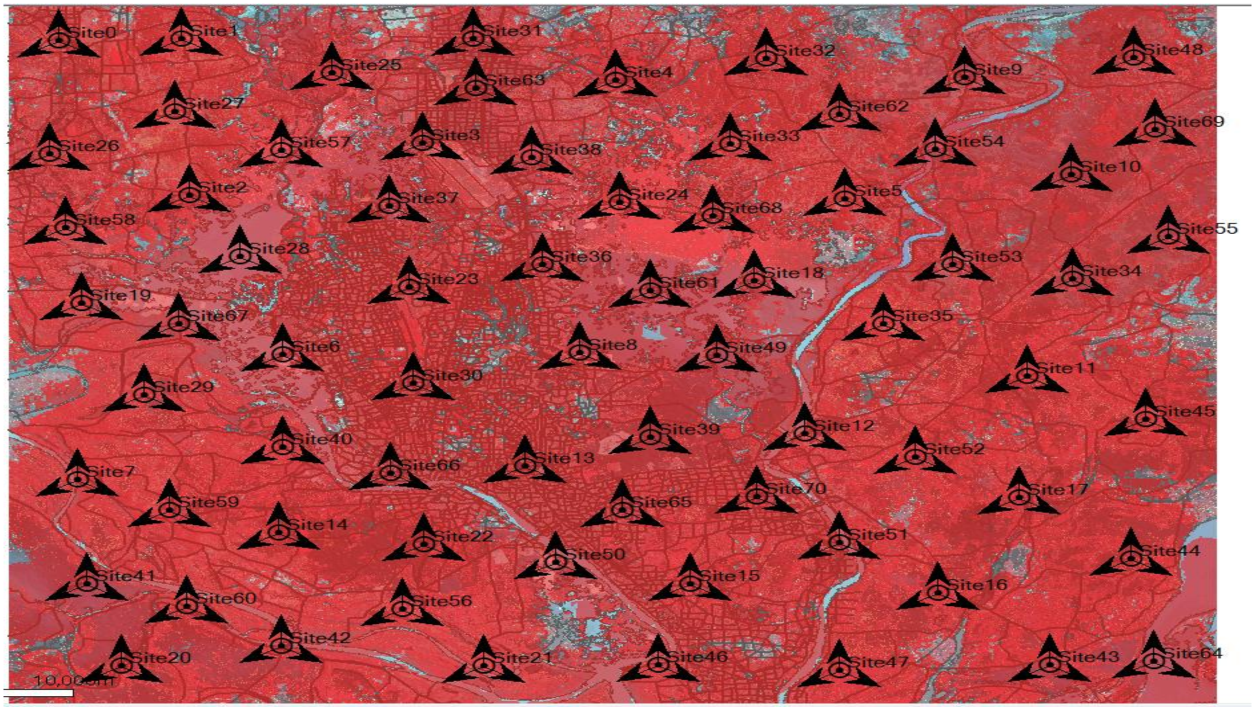


Figure 4. 12: Effective Service Area Analysis (DL+UL)

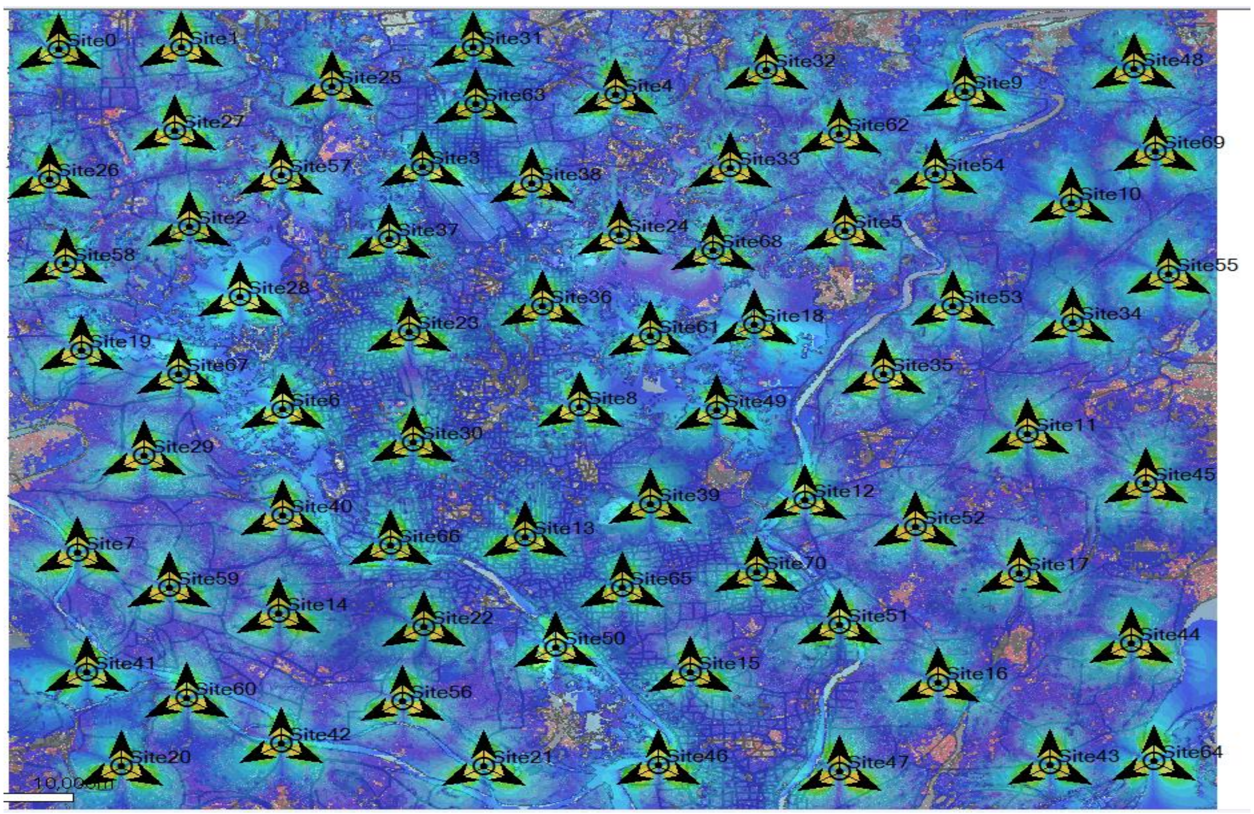


Figure 4. 13: Coverage by Throughput (DL)

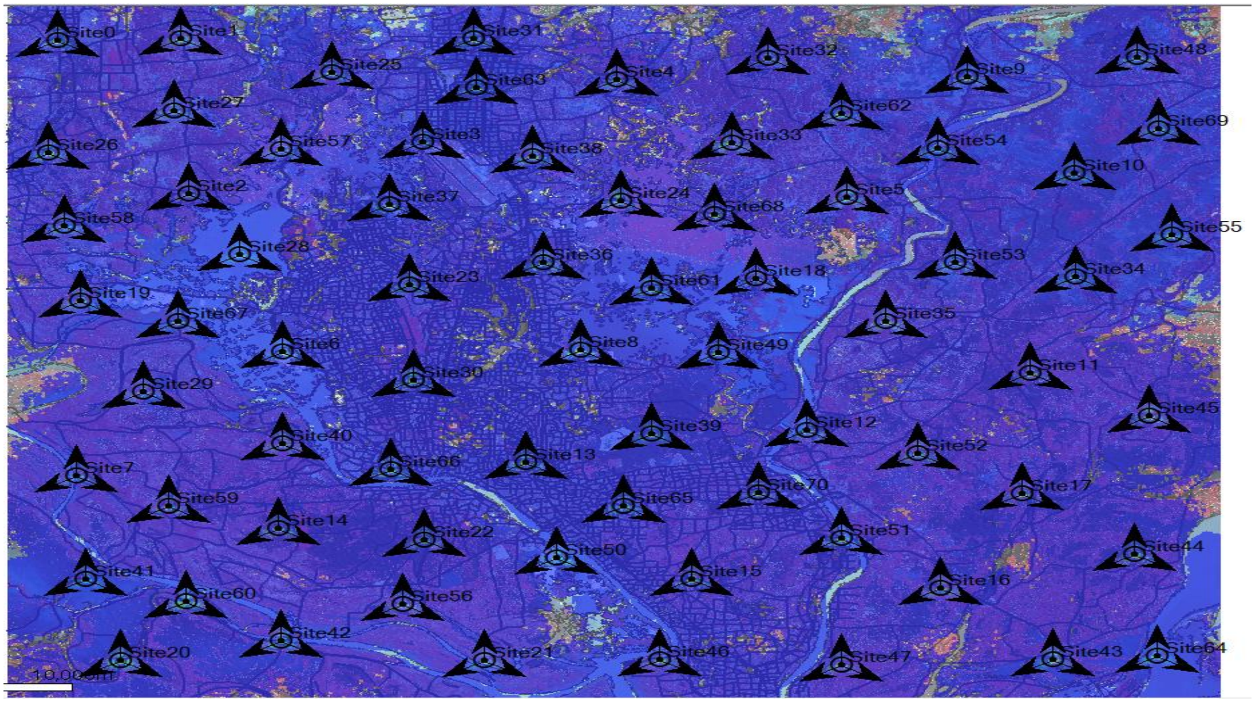


Figure 4.5 1: Coverage by Throughput (UL)

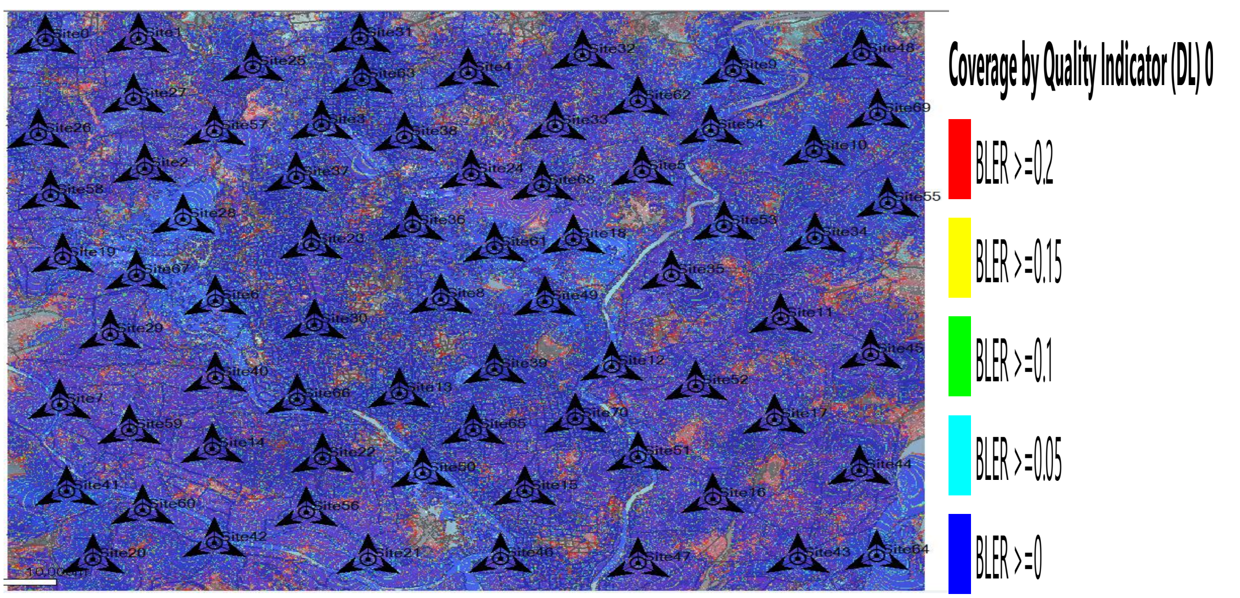


Figure 4. 14: Coverage by Quality Indicator (DL)

Block error rate (BLER) is a quantitative measure of how well audio is retained in a compact disc (CD) over a period of time. It is used to measure the error rate at the time of extracting data frames from a CD or the in-sync or out-of-sync indication during radio link monitoring (RLM). Normal BLER is 2% for an in-sync condition and 10% for an out-of-sync condition. The BLER is the ratio of total erroneous blocks to that of total number of blocks received in a digital circuit [10].

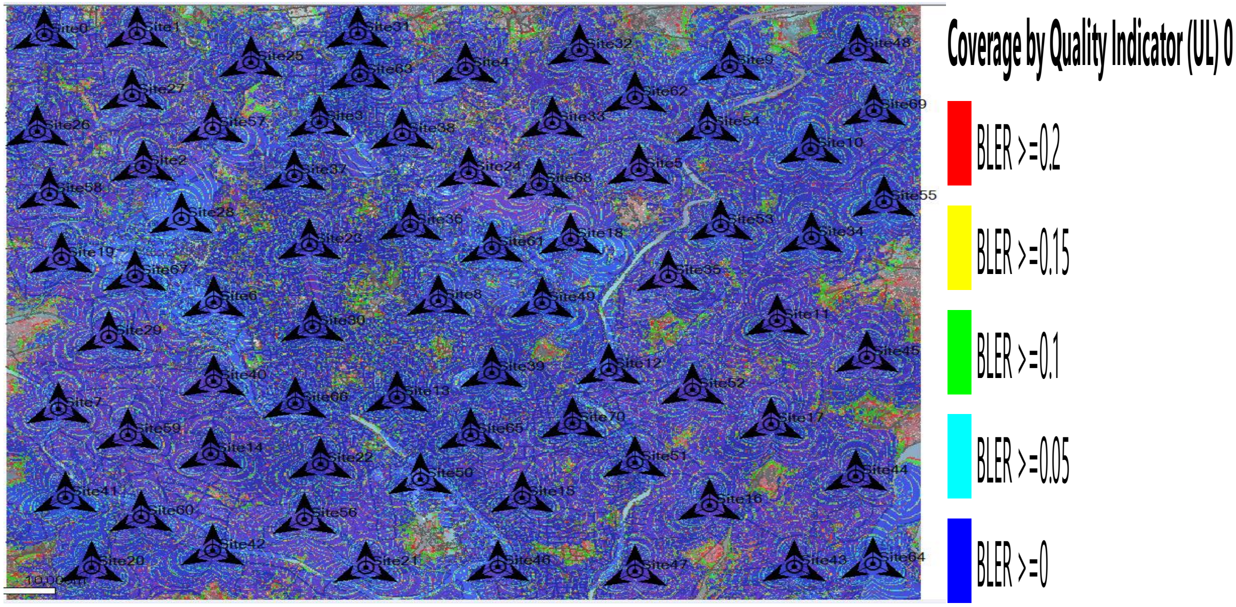


Figure 4. 15: Coverage by Quality Indicator (UL)

Coverage by Quality Indicator (DL) 0: As illustrated in Figure 4.3. 15, the signal quality is effectively good throughout the target area. This was accomplished through the subsequent addition of base stations performance of several coverage prediction.

4.5.1 PERFORMANCE ANALYSIS OF THE PLANNED NETWORK

Here we put our pointer at X: 240626 and Y: 2641919 which is cover through the site 4, site 24, site 33 and site 38. This pointer is like a consumer. That means which consumer are stayed within this area they will get signal from all those site. To analyze the cell edge throughput scenario and all other uplink and downlink parameters, the point analysis tool of Atoll site 2_ (0) was chosen from the Dhaka map, along with a receiver. As shown the results of the point analysis were as follows: The link budget scenario for another site 33_1 (0) from the point analysis tool is the same as the one shown in Table 1. This one almost matches the link budget prepared and other values obtained using link and system simulators.

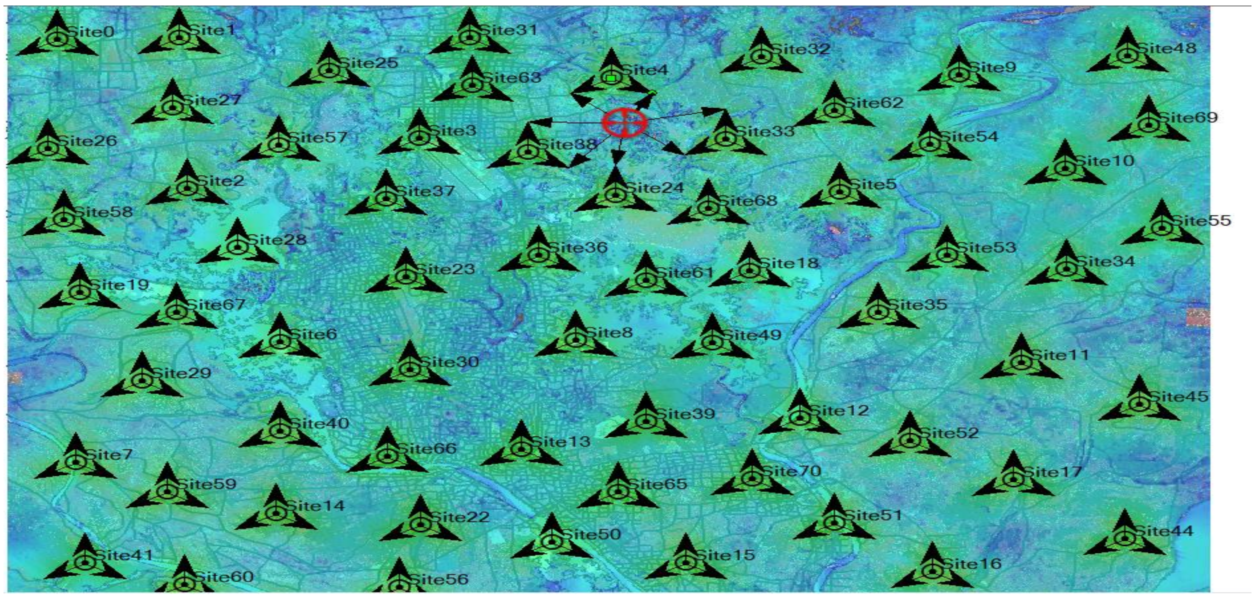


Figure 4. 16: Using pointer

There are many types of propagation model. But in our measurements we use the propagation model is Cost-Hata type. That's why the profile graph give us the propagation type is Cost- Hata. The profile graph gives cost-hata -106.6dBm.

Figure 4. 17: Profile Graph

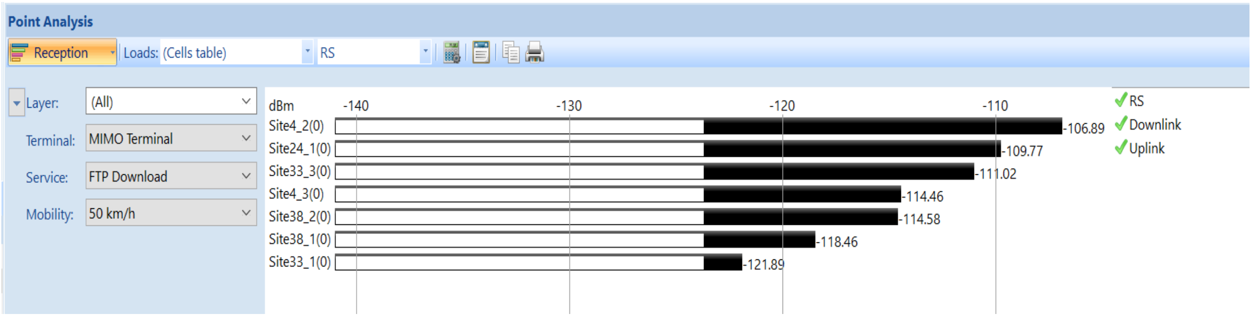


Figure 4. 18: Reception Graph

Here, the graph shows that the consumer who are stayed in between site 4, site 24, site 33 and site 38 at that such position he will get good radio signal, downlink and uplink signal. That's why in the graphs radio signal, downlink and uplink signal shows the green mark.

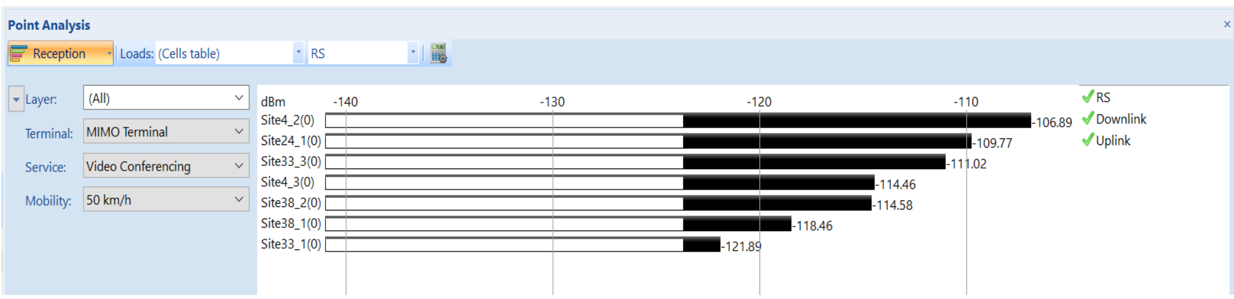


Figure 4. 19: Reception Graph for Video Conferencing

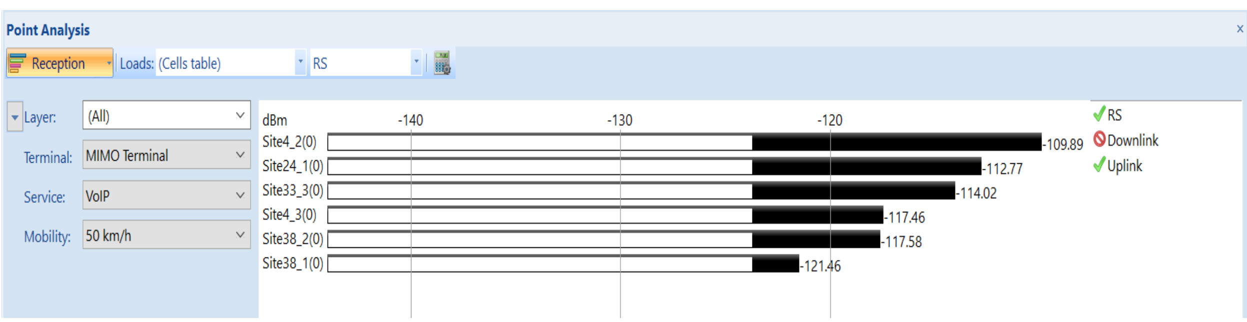


Figure 4. 20: Reception Graph for VoIP

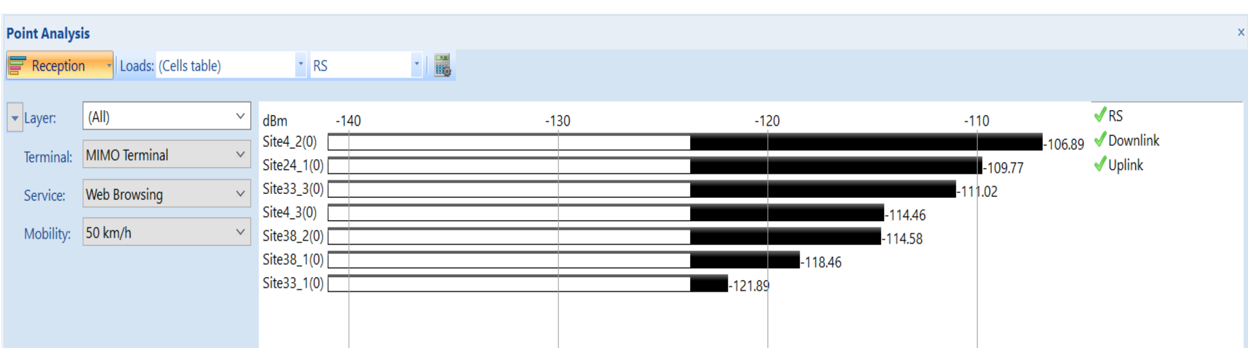


Figure 4. 21: Reception Graph for Web Browsing

The above Figure 4.19; 4.20; 4.21 are the reception graph. Figure 4.19 Reception Graph for Video Conferencing; Figure 4.20 Reception Graph for VoIP; Figure 4.21 Reception Graph for Web Browsing. For Video conferencing and Web Browsing the radio signal, downlink and uplink signal are getting properly. But for VoIP the downlink signal is not available.

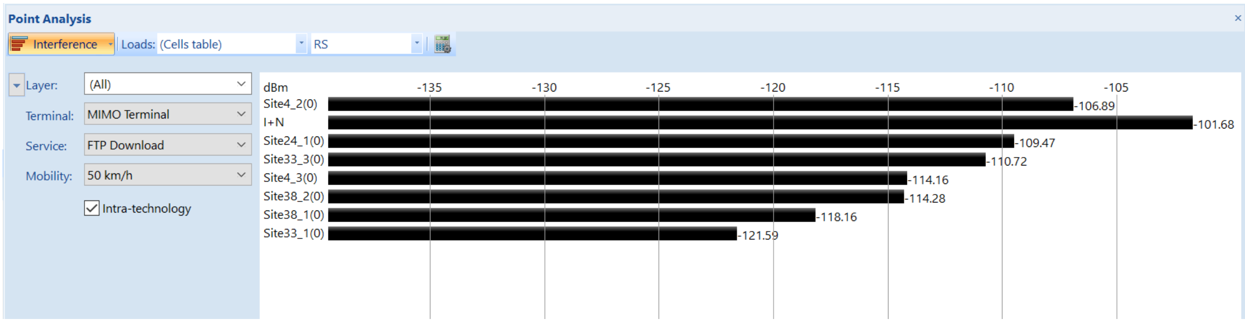


Figure 4. 22: Interference Graph

Point Analysis

Details · Loads: Dhaka Secondry Road

Layer: (All) · Terminal: Mobile Terminal · Service: FTP Download · Mobility: 50 km/h · Show interferers only

x:240,626 y:2,641,919 z:15 Clutter:74 (Code74)

Cell	Distance (m)	Physical Cell ID	ICIC Zone	Diversity Mode (DL)	Path Loss (DL) (dB)	Received RS Power (dBm)	RS C/(I+N) (DL) (dB)	RSRP (DL) (dBm)	Received PDCCH Power (dBm)	Received PDCCH EPRE (dBm)	Received PDSCH Power (dBm)	Received PDSCH EPRE (dBm)	Received SS Power (dBm)	Received SS EPRE (dBm)	Received PBCH Power (dBm)	Received PBCH EPRE (dBm)
Site4_2(0)	***2,361***	***0***	***Cell cent***		***159.19***	***-106.27***	***-4.59***	***-126.27***	***-98.87***	***-118.87***	***-98.71***	***-118.71***	***-107.7***	***-127.7***	***-107.7***	***-127.7***
Site24_1(0)	3,701	0			162.69	-109.77		-129.77	-102.37	-122.37	-102.21	-122.21	-111.2	-131.2	-111.2	-131.2
Site33_3(0)	3,386	0			163.94	-111.02		-131.02	-103.62	-123.62	-103.46	-123.46	-112.45	-132.45	-112.45	-132.45
Site4_3(0)	2,361	0			167.38	-114.46		-134.46	-107.05	-127.05	-106.89	-126.89	-115.88	-135.88	-115.88	-135.88
Site38_2(0)	3,562	0			167.5	-114.58		-134.58	-107.18	-127.18	-107.02	-127.02	-116.01	-136.01	-116.01	-136.01
Site38_1(0)	3,562	0			171.38	-118.46		-138.46	-111.05	-131.05	-110.89	-130.89	-119.88	-139.88	-119.88	-139.88
Site33_1(0)	3,386	0			174.81	-121.89		-141.89	-114.49	-134.49	-114.33	-134.33	-123.32	-143.32	-123.32	-143.32

Table 4. 1: Details of Point Analysis

The Table above shows the Link budget and performance results Obtained from the Chosen sites and receivers using point analysis tool. It can be seen that Site 4-2(0) has the lowest path loss of **159.19dB** and the distance of **2,361m** and the Receive ss power is **-108.32.** The bellow table gives the total idea about the total performance about the planned point analysis area. From which site the consumer will get the better signals for which purpose. From the table we can get the clear idea that The Site4_2(0) provide the better signals than the others. The second one is Site24_1(0), the 3rd one is Site33_3(0) and so on.

By analyzing the coverage prediction results for the eNodeB placement in relation to it is clear that the intended network provides adequate coverage. Again, post-simulation analysis of the traffic map reveals that subscribers mostly remain connected at both uplink (UL) and downlink (DL), which is a very favorable indicator for the planned network. Performance study using the point analysis tool reaffirms the proposed network's effectiveness.

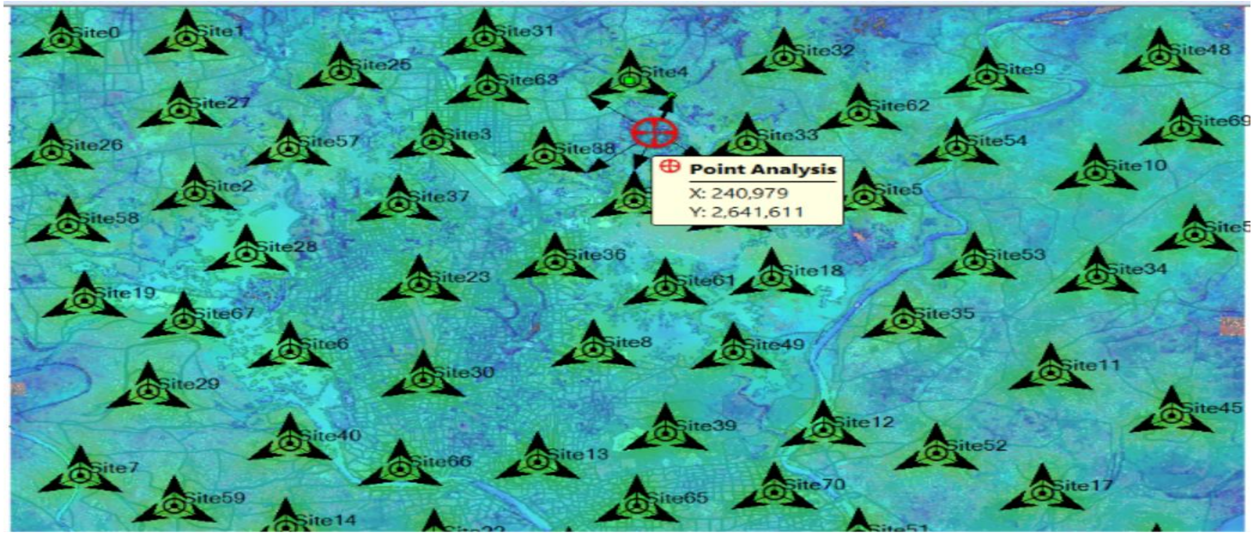


Figure 4. 23: Changing Pointer Position

Now, Here we put our pointer at X: 240,979 and Y: 2,641,611 before which was at X: 240626 and Y: 2641919. It's also cover through the site 4, site 24, site 33 and site 38.

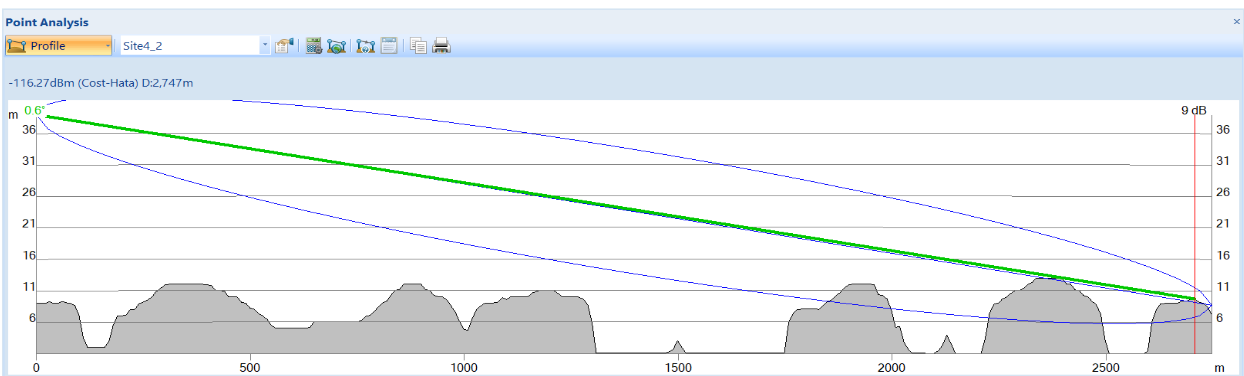


Figure 4. 24: Profile Graph

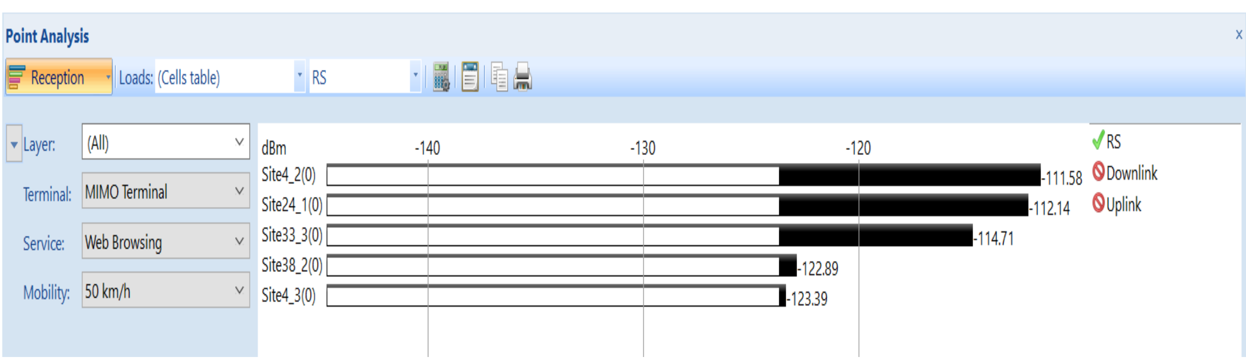


Figure 4. 25: Reception Graph

Figure 4.25 shows that the consumer will not get the downlink and uplink signal. But the radio signal is available.

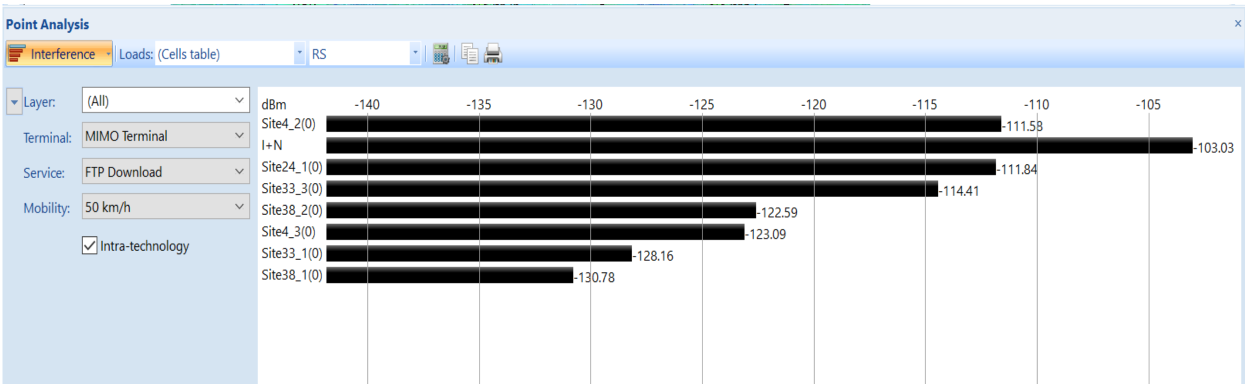


Figure 4. 26: Interference Graph

4.6 CAPACITY PLANNING

The capacity planning is under the simulation result. Capacity analysis entails determining demand and availability traffic while accounting for activity factor, overbooking factor, UL/DL frame ratio, and other variables. Capacity planning is focused on ensuring that the network can deliver high-quality services to the customer. Dhaka traffic simulation properties shown in figure4.27; 4.28; 4.29; 4.30; Dhaka main road, Airport, Street, Secondary Road and Simulation result shown in table 4.3.2; 4.3.3; 4.3.4; 4.3.5; 4.3.6; 4.3.7; 4.3.8;.

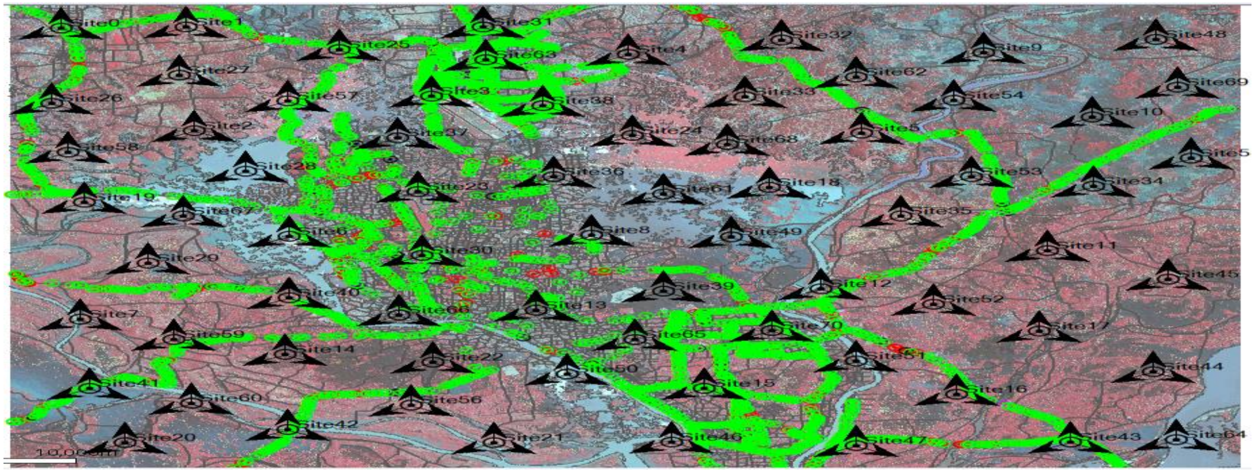


Figure 4. 27: Dhaka Main Road

The bellow table shows the indicator color circle. There are nine indicator circles**.** Each of the color circles contains some value and also some legend. The greenish-colored circle value is **Connected DL+UL** and the legend is **Connected DL+UL.** The red-colored circle value is for "**No Coverage** and **No Services"** and the legend is for "**No Coverage** and **No Services."**

So Figure 4.27 Dhaka Main Road simulation, which covers the area covered by the antenna that is showing the green color. But which areas are not getting covered through the antennas that show the red circle color? Despite the fact that we use more antennas, they cover the majority of the area. That’s why it shows the greenish.

Display

Display type: Discrete values

Field: Connection Status

		Value	Legend
1	⦿	Connected DL+UL	Connected DL+UL
2	⦿	Connected DL	Connected DL
3	⦿	Connected UL	Connected UL
4	⦿	Inactive	Inactive
5	⦿	No Coverage	No Coverage
6	⦿	No Service	No Service
7	⦿	Scheduler Saturation	Scheduler Saturation
8	⦿	Resource Saturation	Resource Saturation
9	⦿	Backhaul Saturation	Backhaul Saturation

	Total number of users trying to connect			**Total number of connected users**		
	Users: 3,940	Active:	Downlink: 2,810	Users: 3,431 (87.1%)	Active:	Downlink: 2,476
			Uplink: 691			Uplink: 591
			Downlink + Uplink: 308			Downlink + Uplink: 254
		Inactive: 131			Inactive: 110	
FTP Download	Users: 2,038	Active	Downlink: 1,819	Users: 1,792 (87.9%)	Active	Downlink: 1,592
			Uplink: 208			Uplink: 189
			Downlink + Uplink: 11			Downlink + Uplink: 11
		Inactive: 0			Inactive: 0	
Video Conferencing	Users: 95	Active	Downlink: 22	Users: 80 (84.2%)	Active	Downlink: 18
			Uplink: 33			Uplink: 28
			Downlink + Uplink: 21			Downlink + Uplink: 17
		Inactive: 19			Inactive: 17	
VoIP	Users: 734	Active	Downlink: 149	Users: 614 (83.7%)	Active	Downlink: 127
			Uplink: 198			Uplink: 169
			Downlink + Uplink: 275			Downlink + Uplink: 225
		Inactive: 112			Inactive: 93	
Web Browsing	Users: 1,073	Active	Downlink: 820	Users: 945 (88.1%)	Active	Downlink: 739
			Uplink: 252			Uplink: 205
			Downlink + Uplink: 1			Downlink + Uplink: 1
		Inactive:0			Inactive: 0	

Table 4. 2: Dhaka Main Road simulation Result

This is the result of a traffic simulation on Dhaka's main road. The number of people seeking to connect to this Dhaka main road and the number of users who have already connected are all listed in the table below. It is necessary to determine how many are active and how many are dormant. All of the following are indicated: FTP download, video conferencing, VoIP, and web browsing. Thus, according to the simulation outcome data table, 88.1 percent of people successfully connect to the network while web browsing. Following that, 87.9% of consumers successfully connect to the network in order to download FTP files.

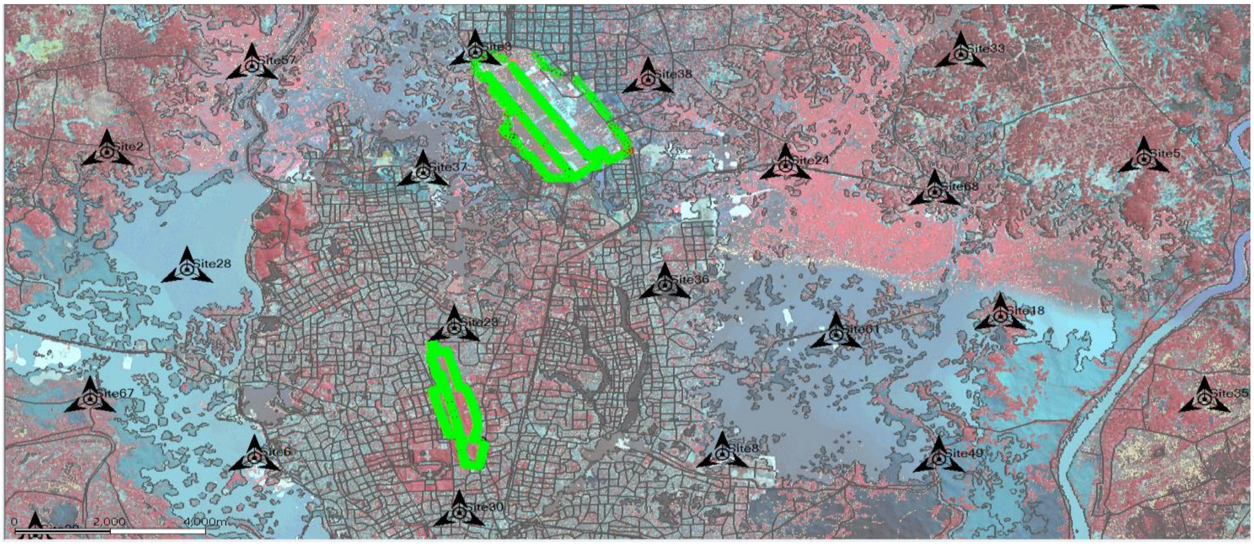


Figure 4. 28: Dhaka Airport Simulation

Site	Connection Success Rate (%)	Connection Success Rate FTP Download (%)	Connection Success Rate Video Conferencing (%)	Connection Success Rate VoIP (%)	Connection Success Rate Web Browsing (%)
Site23	93.23	94.57	100	93.88	90.32
Site3	92.05	93.75	85.71	82.46	95.74
Site30	95.6	97.84	100	94	92.31
Site36	100			100	
Site37	80	80		100	66.67
Site38	93.9	96.04	75	92.31	92.45

Table 4. 3: Dhaka Airport Site Average Success%

The bellow table is the outcome of a traffic simulation at Dhaka International Airport. The number of customers seeking to connect to this Dhaka Airport, as well as the number of consumers who have actually connected, are all displayed in this table data. For the following purposes: FTP download, video conferencing, VoIP, and online surfing, how many are active and how many are dormant is important to understand. As a result, according to the simulation outcome data table, 95.4 percent of persons are effectively connected to the network when downloading files over FTP. In order to browse the internet efficiently, 92.8 percent of users establish a successful network connection

	Total number of users trying to connect			**Total number of connected users**		
	Users: 990	Active:	Downlink: 672	Users: 926	Active:	Downlink: 635
			Uplink: 201			Uplink: 186
			Downlink + Uplink: 78			Downlink + Uplink: 70
		Inactive: 39			Inactive: 35	
FTP Download	Users: 481	Active	Downlink: 414	Users: 459 (95.4%)	Active	Downlink: 393
			Uplink: 64			Uplink: 63
			Downlink + Uplink: 3			Downlink + Uplink: 3
		Inactive: 0			Inactive: 0	
Video Conferencing	Users: 21	Active	Downlink: 6	Users: 19 (90.5%)	Active	Downlink: 6
			Uplink: 9			Uplink: 7
			Downlink + Uplink: 2			Downlink + Uplink: 2
		Inactive: 4			Inactive: 4	
VoIP	Users: 198	Active	Downlink: 43	Users: 179 (90.4%)	Active	Downlink: 39
			Uplink: 47			Uplink: 44
			Downlink + Uplink: 73			Downlink + Uplink: 65
		Inactive: 35			Inactive: 31	
Web Browsing	Users: 290	Active	Downlink: 209	Users: 269 (92.8%)	Active	Downlink: 197
			Uplink: 81			Uplink: 72
			Downlink + Uplink: 0			Downlink + Uplink: 0
		Inactive: 0			Inactive: 0	

Table 4. 4: Dhaka Airport Simulation Result

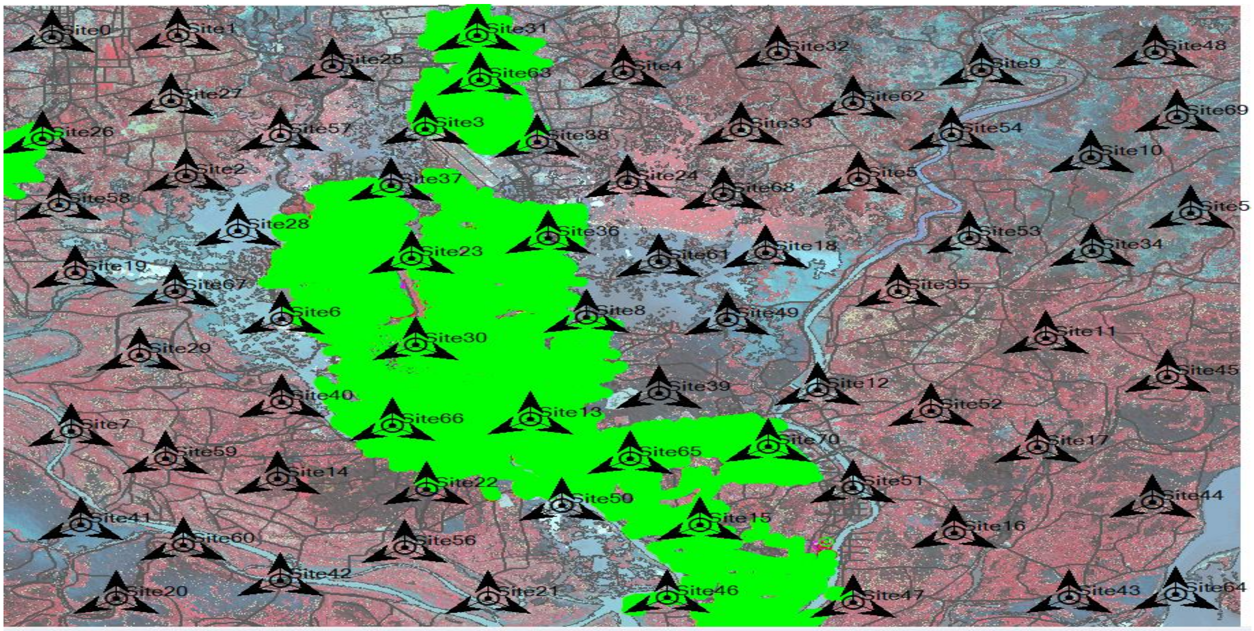


Figure 4. 29: Dhaka Street Simulation

People ran a traffic simulation on Dhaka Street to see how it would work. In this table, you can see how many people are trying to connect to this Dhaka Street and how many people are already connected to this Dhaka Street. How many people are using them for FTP downloads, video conferencing, VoIP, and web browsing, and how many aren't using them at all. So, the data table from the simulation shows that 91.7 percent of people are able to connect to the network when they download files through FTP. After that, 80.9 percent of people are able to connect to the VoIP network.

	Total number of users trying to connect			Total number of connected users		
	Users: 122,868	Active:	Downlink: 88,008	Users: 83,924 (68.3%)	Active:	Downlink: 57,082
			Uplink: 21,380			Uplink: 16,095
			Downlink + Uplink: 9,186			Downlink + Uplink: 7,024
		Inactive: 4,294			Inactive: 3,723	
FTP Download	Users: 63,505	Active	Downlink: 55,951	Users: 58,257 (91.7%)	Active	Downlink: 51,349
			Uplink: 7,274			Uplink: 6,653
			Downlink + Uplink: 280			Downlink + Uplink: 255
		Inactive: 0			Inactive: 0	
Video Conferencing	Users: 2,784	Active	Downlink: 665	Users: 1,951 (70.1%)	Active	Downlink: 404
			Uplink: 700			Uplink: 502
			Downlink + Uplink: 710			Downlink + Uplink: 383
		Inactive: 709			Inactive: 662	
VoIP	Users: 22,173	Active	Downlink: 5,261	Users: 17,935 (80.9%)	Active	Downlink: 4,137
			Uplink: 5,255			Uplink: 4,357
			Downlink + Uplink: 8,072			Downlink + Uplink: 6,380
		Inactive: 3,585			Inactive: 3,061	
Web Browsing	Users: 34,406	Active	Downlink: 26,131	Users: 5,781 (16.8%)	Active	Downlink: 1,192
			Uplink: 8,151			Uplink: 4,583
			Downlink + Uplink: 124			Downlink + Uplink: 6
		Inactive:0			Inactive: 0	

Table 4. 5: Dhaka Street Simulation Result

Site	Peak RLC Cumulated Throughput (DL) (kbps)	Peak RLC Cumulated Throughput (UL) (kbps)	Connection Success Rate (%)	Connection Success Rate FTP Download (%)	Connection Success Rate Video Conferencing (%)	Connection Success Rate VoIP (%)	Connection Success Rate Web Browsing (%)
Site12	1,920.30	1,194.61	75.22	87.04	87.5	74.42	55.22
Site13	11,257	17,671.10	63.97	92.2	46.85	75.64	5.85
Site14	186.7	32	71.42	75		0	100
Site15	11,524.40	24,487.40	66.02	91.69	59.49	77.5	10.94
Site2	2,046.82	253.17	70.14	64.52	100	66.67	77.78
Site22	6,556.07	7,930.34	73.45	95.01	93.65	88	20.47
Site23	10,645.10	17,530.80	66.99	87.99	77.78	81.56	16.98
Site24	2,873.62	1,530.17	91.7	92.78	87.5	86.49	93.65
Site25	1,752	245.93	88.09	86.36	100	85.71	90
Site26	25,752	16,237.40	81.6	98.17	96.97	96.68	42.23
Site28	4,780.73	4,692.69	65.04	85.96	89.74	73.02	16.38
Site3	17,370.80	20,264.50	77.36	97.1	92.71	96.12	24.25
Site30	9,580.62	16,966.50	64.5	84.68	73.08	73.4	21.54
Site31	20,797.90	39,023.60	77.72	99.26	90.95	97.13	24.59
Site36	13,099.10	21,261	70.87	92.68	77.12	87.74	20.66
Site37	10,350.30	10,457.10	63.19	89.96	51.08	79.67	4.36
Site38	8,126.09	20,358.20	75.67	96.05	90.91	93.96	26.04
Site39	6,641.55	9,911.32	66.58	86.07	83.08	73.62	22.36
Site4	2,884.74	120.4	88	79.31	100	100	100
Site40	5,625.42	3,394.06	73.18	90.25	86.67	77.54	41.55
Site46	27,336.20	14,325.10	57.04	84.38	40.3	55.08	10.55
Site47	5,693.93	7,365.64	50.22	78.57	34.29	44.86	3.81
Site49	1,355.18	236.33	76.31	83.33	100	57.14	66.67
Site50	9,602.21	13,857.70	71.37	93.48	93.88	88.42	22.87
Site51	4,026.96	1,137.30	77.23	88.06	87.5	69.05	63.1

Table 4. 6: Dhaka Street Site Average Success%

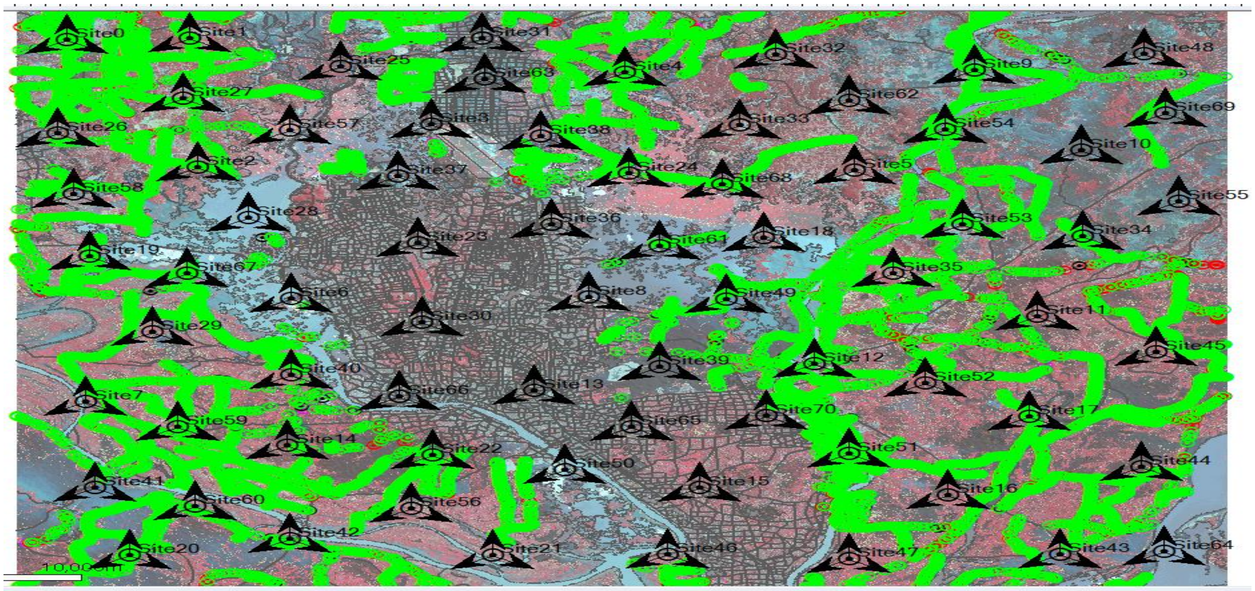


Figure 4. 30: Dhaka Secondary Road Simulation

The number of consumers attempting to connect to this Dhaka secondary road, as well as the number of consumers who have actually connected, are all reflected in the statistics in this table. For the following purposes: FTP download, video conferencing, VoIP, and web surfing, how many are active and how many are dormant is important to know. As a result, according to the simulation outcome data table, 79.3 percent of persons are effectively connected to the network when completing FTP downloads when using the Internet. Then, 76.7 percent of users are able to successfully connect to the network in order to conduct web browsing.

	Total number of users trying to connect			Total number of connected users		
	Users: 19,209	Active:	Downlink: 13,828	Users: 14,815 (77.1%)	Active:	Downlink: 10,837
			Uplink: 3,339			Uplink: 2,504
			Downlink + Uplink: 1,367			Downlink + Uplink: 976
		Inactive: 675			Inactive: 498	
FTP Download	Users: 9,974	Active	Downlink: 8,823	Users: 7,906 (79.3%)	Active	Downlink: 6,991
			Uplink: 1,119			Uplink: 890
			Downlink + Uplink: 32			Downlink + Uplink: 25
		Inactive: 0			Inactive: 0	
Video Conferencing	Users: 429	Active	Downlink: 112	Users: 315 (73.4%)	Active	Downlink: 82
			Uplink: 111			Uplink: 74
			Downlink + Uplink: 85			Downlink + Uplink: 64
		Inactive: 121			Inactive: 95	
VoIP	Users: 3,439	Active	Downlink: 824	Users: 2,476 (72%)	Active	Downlink: 599
			Uplink: 835			Uplink: 606
			Downlink + Uplink: 1,226			Downlink + Uplink: 868
		Inactive: 554			Inactive: 403	
Web Browsing	Users: 5,367	Active	Downlink: 4,069	Users: 4,118 (76.7%)	Active	Downlink: 3,165
			Uplink: 1,274			Uplink: 934
			Downlink + Uplink: 24			Downlink + Uplink: 19
		Inactive:0			Inactive: 0	

Table 4. 7: Dhaka Secondary Road Simulation Result

Site	Peak RLC Cumulated Throughput (DL) (kbps)	Peak RLC Cumulated Throughput (UL) (kbps)	Connection Success Rate (%)	Connection Success Rate FTP Download (%)	Connection Success Rate Video Conferencing (%)	Connection Success Rate VoIP (%)	Connection Success Rate Web Browsing (%)
Site0	24,307.1	5,631.78	89	94.75	100	80.77	82.46
Site1	25,340.5	3,195.86	89.63	87.82	92.86	88.75	93.75
Site10	4,721.44	242.76	89.23	86.11	100	92.86	91.67
Site11	9,593.91	645.33	78.76	81.16	50	76.92	77.55
Site12	26,529.6	2,930.04	93.96	94.69	100	91.3	93.75
Site13	27.41	0	100	100			
Site14	19,265.4	1,740.22	91.54	94.44	77.78	83.02	93.59
Site16	17,563.1	1,942.23	85.75	88.13	80	77.42	86
Site17	15,352	2,098.73	85.26	87.8	90	81.33	83.06
Site18	3,505.21	357.97	87.09	85.71	100	75	95.24
Site19	28,664.2	1,926.15	92.62	95.15	100	91.18	89
Site2	22,293.7	1,765.01	93.07	93.24	100	88.46	95.18
Site20	19,192.8	3,363	84.07	86.22	100	80.26	81.29
Site21	17,058.1	931.55	59.55	65.95	40	50	54.63
Site22	22,592.6	1,272.89	94.41	94.79	100	85.71	98.11
Site24	21,074.7	1,301.03	92.38	95.58	80	82.98	95.56
Site25	12,851	1,482.72	81.84	86.03	76.92	80.36	75.76
Site26	8,579.19	2,830.73	77.35	86.36	80	66.34	66.9

Site27	17,975.6	2,471.83	88.33	90.24	63.64	89.39	86.78
Site28	1,076.5	61.36	88.88	90		100	75
Site29	21,273.8	2,460.54	94.02	95.85	87.5	85.48	95.9
Site3	9,563.21	659.41	88.18	90.77	100	80.95	87.5
Site30	0	12.2	100			100	
Site31	13,992.9	1,213.61	77.83	81.77	58.33	65.38	81.42
Site32	13,113.7	1,370.66	73.77	75.52	62.5	63.93	77.91
Site33	7,345.71	530.44	78.51	83.64	100	78.26	70
Site34	29,451.1	1,487.58	78.17	81.12	50	78.72	73.21
Site35	19,220.9	2,698.54	87.65	89.67	100	80.88	87.2
Site36	2,787.18	75.42	75	83.33		55.56	71.43
Site37	2,200.9	280	86.04	95.24		80	75
Site38	20,707.4	1,534.49	92.73	92.56	100	85.37	96.77
Site39	4,029.53	481.78	85.91	93.1	33.33	80	87.5
Site4	20,722	2,805.68	76.62	82.58	76.92	68.27	70.39
Site40	17,554.4	2,017.87	96.35	95.52	100	96.49	97.3
Site41	11,755.3	912.54	95.45	95.45	75	91.67	100
Site42	22,205.3	1,928.6	69.64	68.64	60	72.88	70.37
Site43	21,374.2	1,515.31	87.85	88.96	80	77.27	92.65
Site44	19,777.6	1,686.3	79.87	81.2	64.29	77.22	80.6
Site45	15,001.6	3,060.83	80.91	85.8	82.35	67.94	80.66

Site46	15,832.4	1,282.96	73.38	71.88	100	76.92	72.73
Site47	16,220.5	1,787.54	70.19	74.68	50	64.36	67.72
Site48	4,669.75	423.71	93.05	93.94		93.33	91.67
Site49	26,542.8	1,090.4	93.98	93.62	100	92.59	94.74
Site5	9,686.34	671.64	88.42	89.06	50	85.71	93.75
Site50	6,906.78	847.45	96.77	97.78	100	94.44	96.3
Site51	30,672.2	4,865.1	95.72	95.3	100	95.8	96.32
Site52	13,990	1,496.14	88.61	89.63	100	87.8	86.36
Site53	26,006.6	1,748.44	92	94.81	75	93.22	87.01
Site54	32,902.2	2,087.42	91.55	91.59		93.33	90.41
Site55	1,885.39	140.2	68.42	75	100	33.33	66.67
Site56	14,918.7	621.04	89.7	91.55	100	77.78	94.44
Site57	10,124.6	546.52	89.81	98.18	100	76.19	83.33
Site58	26,618.8	2,349.55	94.32	97.14	100	90.74	90.72
Site59	21,904.6	2,786.15	94.32	96.04	81.82	92.94	93.33
Site6	4,547.43	231.38	91.93	93.33	100	87.5	91.3
Site60	19,533.7	2,326.02	93.87	94.12	100	88.46	96.3
Site61	8,437.03	350.7	98.27	96.43	100	100	100
Site62	407.79	0	53.84	42.86		100	60
Site63	7,430.95	462.54	80.59	84	0	75	80
Site64	8,069.74	488.35	85.58	86.44	100	81.25	84.38

Site66	1,635.08	106.65	87.5	87.5		80	100
Site67	19,584.1	1,411.61	96.61	97.46	100	90.32	98.11
Site68	18,302.6	849.3	95.31	98.46	100	80.77	100
Site69	20,777.6	861.16	100	100		100	100
Site7	23,231.8	1,698.64	96.55	97.81	100	93.18	95.83
Site70	13,471.7	1,330.38	93.83	94.26	80	94.44	93.75
Site8	1,598.54	104.82	84.61	91.67		60	88.89
Site9	18,177.9	3,389.88	85.2	87.5	61.54	72.34	90.97

Table 4. 8: Dhaka Secondary Road Site Average Success %

CHAPTER 5 OPTIMIZATION

Using the atoll software program version 3.3, the optimization was carried out completely automatically. This program has numerous features that assist us in achieving our desired results. The atoll is equipped with budgeting and optimization capabilities. Due to the fact that some of these features are set as default, and we attempted to input our own figures, the results were less than satisfactory and did not correspond to some actual current costs when compared to the number of equipment and other resources used throughout the project, we did not include budgeting. The tool also has the advantage of optimizing automatically, which means that it can give you with information on how many antennas will be required to be installed in that particular region, as well as the percentage of the work completed that has been optimized. In this approach, we targeted the Dhaka airport and optimized the area around it, and we were successful in providing 95 percent successive coverage of the entire area. It was determined that the reference signal received power (RSRP) and the reference signal received quality (RSRQ) were used in the calculation (RSRQ). If you look closely at the graph, you will notice that it has varied colors representing different signal strengths in different areas ranging from -70db to -105db. Listed below are the outcomes of the optimization process that we provided for you to review.

5.1 INPUT CRITERIA

For modern LTE networks, RSRP and RSRQ are important signal level and quality indicators. When a mobile moves from cell to cell in a cellular network and performs cell selection/reselection and handover, it must measure the signal strength/quality of neighboring cells. A UE in an LTE network measures two parameters on the reference signal: RSRP (Reference Signal Received Power) and RSRQ (Reference Signal Received Quality). Reference Signal Received Quality or with abbreviated version RSRQ is quality of the received signal. Here the “received signal” is reference signal (RSRP)

In the optimization input criteria we use the number of iterations is 100 and the resolution is 50m. Our objectives for RSRP the used technology layer is 2110FDD (E-UTRA Band 1) the bandwidth is -105 dBm and the target of coverage area is 90%. And for the RSRQ bandwidth is -15 dBm and the target of coverage area is 85%.

Input criteria	
Number of iterations	100
Resolution	50m
Total number of pixels in computation area	514020
Calculation setting	Default
Low quality improvement changes	Default
Optimisation on zone	Computation (default)+Computation (default)
Maximum number of active sites:	None
Optimisation with Objectives:	
Objective: LTE RSRP	
Used technology layers	2110 FDD (E-UTRA Band 1)
Used quality	LTE[RSRP]
Rules	*2110 FDD (E-UTRA Band 1)* RSRP ≥ -105 dBm
Target	Area coverage >= 90%
Objective: LTE RSRQ	
Used technology layers	2110 FDD (E-UTRA Band 1)
Used quality	LTE[RSRQ]
Rules	*2110 FDD (E-UTRA Band 1)* RSRQ ≥ -15 dB
Target	Area coverage >= 85%
Context	
Date	2022-04-16 01:48:13
IID	33020169
ATL Project	LTE (70NEW)All DOne

Table 5. 1: Input Criteria

5.2 STATISTICS

The table shows that objectives for LTE RSRP coverage area of 90% is failed to achieve but the objectives for LTE RSRQ coverage area for 85% is achieved. The improvement for LTE RSRQ is 1.18%.

Duration of optimisation: 4 min 8.85 s

Objective *LTE RSRP* (Coverage >= 90.0%)	Evaluation Zone
Initial	7.25%
Final	8.48%
Improvement	***1.23%***
Objective	**FAILED**

Objective *LTE RSRQ* (Coverage >= 85.0%)	Evaluation Zone
Initial	84.29%
Final	85.47%
Improvement	***1.18%***
Objective	**ACHIEVED**

Site Selection and Reconfiguration Statistics

Reconfiguration	**Antenna**	**Elec. Tilt**	**Azimuth**	**Mech. Tilt**	**Antenna Height**	**Power**
	0	0	19	81	0	0

<< Hide Change Statistics

Detailed Zone Results

Objective: LTE RSRP		
Zone	*Initial*	*Final*
Computation (default)	7.25%	8.48%
Objective: LTE RSRQ		
Zone	*Initial*	*Final*
Computation (default)	84.29%	85.47%

Table 5. 2: Statistics

5.3 DIFFERENT SECTORS

The various sectors output the results of our inputs such as site selection, total power, antenna layout, and azimuth. Then, following optimization, we obtain this result, which is identical to the initial and final values. There are several signaling colors available there, such as green for reconfiguration, grey for TX addition, and pink for TX removal. The altering parameters are listed in the table below.

General | Statistics | Sectors | Graph | Quality | Change Details | Commit

Cell/Tx Name	Use			Antenna Pattern		Azimuth		Mechanical Tilt		LTE RSRP (%)		LTE RSRQ (%)	
	An	Azi	MTil	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
Site0_1(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	0	0	0	3	22.85	27.50	97.49	95.29
Site0_2(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	120	140	0	3	6.84	9.06	90.92	94.05
Site0_3(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	240	240	0	4	9.54	17.59	92.03	93.67
Site10_1(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	0	0	0	0	6.66	6.34	97.47	96.17
Site10_2(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	120	120	0	3	8.05	10.20	99.83	99.75
Site10_3(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	240	240	0	0	6.50	6.49	97.63	98.00
Site11_1(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	0	0	0	3	5.13	7.38	90.66	91.54
Site11_2(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	120	120	0	4	5.42	8.44	94.10	94.42
Site11_3(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	240	240	0	3	4.62	6.79	92.31	91.52
Site12_1(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	0	0	0	3	4.28	6.93	87.26	87.68
Site12_2(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	120	120	0	3	8.20	10.45	96.67	95.88
Site12_3(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	240	240	0	3	7.63	11.24	76.49	76.55
Site13_1(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	0	0	0	0	5.77	5.81	66.19	66.21
Site13_2(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	120	120	0	3	9.44	12.55	85.97	84.62
Site13_3(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	240	240	0	0	7.27	7.70	65.25	67.23
Site14_1(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	0	0	0	0	9.14	9.20	99.08	99.02
Site14_2(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	120	120	0	0	6.59	6.59	95.03	95.00
Site14_3(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	240	240	0	0	8.44	8.44	96.11	96.11
Site15_1(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	0	0	0	3	7.77	10.65	77.47	77.16
Site15_2(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	120	120	0	3	3.94	6.93	62.18	65.87
Site15_3(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	240	240	0	3	7.34	11.33	66.31	72.44
Site16_1(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	0	0	0	0	6.60	6.60	91.12	92.91
Site16_2(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	120	120	0	0	5.24	5.43	81.11	82.57
Site16_3(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	240	240	0	3	5.52	7.40	87.97	92.01
Site17_1(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	0	0	0	3	5.36	7.74	91.00	89.42
Site17_2(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	120	120	0	3	4.20	7.27	92.59	93.01
Site17_3(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	240	240	0	3	4.75	7.31	87.68	89.35
Site18_1(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	0	0	0	3	5.24	8.98	91.64	91.14
Site18_2(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	120	120	0	4	3.97	6.36	88.95	88.32
Site18_3(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	240	240	0	4	6.30	12.71	94.45	95.44
Site19_1(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	0	0	0	0	9.46	9.09	92.94	92.57
Site19_2(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	120	120	0	0	9.88	10.79	99.45	99.67
Site19_3(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	240	220	0	0	6.09	5.73	75.86	83.74
Site1_1(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	0	0	0	3	25.00	34.48	99.25	97.52
Site1_2(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	120	120	0	0	6.11	6.23	78.90	78.79
Site1_3(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	240	240	0	0	10.80	9.57	93.68	93.16
Site20_1(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	0	0	0	0	10.79	11.69	95.98	98.12
Site20_2(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	120	120	0	0	13.44	13.08	98.39	98.19
Site20_3(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	240	260	0	0	8.23	7.24	72.70	80.31
Site21_1(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	0	20	0	0	5.98	5.46	77.71	82.89
Site21_2(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	120	100	0	0	7.08	6.76	80.05	88.04
Site21_3(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	240	240	0	0	7.97	7.76	91.85	92.15
Site22_1(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	0	0	0	0	9.51	10.09	82.08	83.13
Site22_2(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	120	100	0	0	7.11	6.98	76.98	78.95
Site22_3(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	240	240	0	0	8.59	8.68	97.33	97.57
Site23_1(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	0	0	0	0	7.21	6.92	77.52	75.40
Site23_2(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	120	120	0	0	6.31	6.46	61.78	62.82
Site23_3(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	240	240	0	0	5.59	5.54	69.86	69.81
Site24_1(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	0	0	0	0	7.15	7.21	79.24	79.26
Site24_2(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	120	120	0	3	10.54	14.26	93.48	96.40
Site24_3(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	240	240	0	0	8.53	8.59	84.60	84.41
Site25_1(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	0	0	0	0	5.63	5.66	83.47	83.33
Site25_2(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	120	120	0	3	7.29	10.76	78.59	83.33
Site25_3(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	240	240	0	0	7.06	7.20	87.52	88.39
Site26_1(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	0	0	0	3	6.58	9.52	84.61	87.75
Site26_2(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	120	120	0	0	8.41	8.56	88.67	89.27
Site26_3(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	240	240	0	0	22.26	22.68	97.50	97.47
Site27_1(0)	✓	✓	✓	65deg 18dBi	65deg 18dBi	0	0	0	0	10.20	10.35	98.53	98.69

Legend: Reconfiguration | TX Added | TX Removed

Table 5. 3: Different sectors Output

5.4 OBJECTIVE ACHIEVEMENT GRAPH

Our objectives was to obtain coverage the area of 90% for RSRP and 85 % for RSRQ. But we fail to obtain that. The bellow Figure 5.1 is showing that;

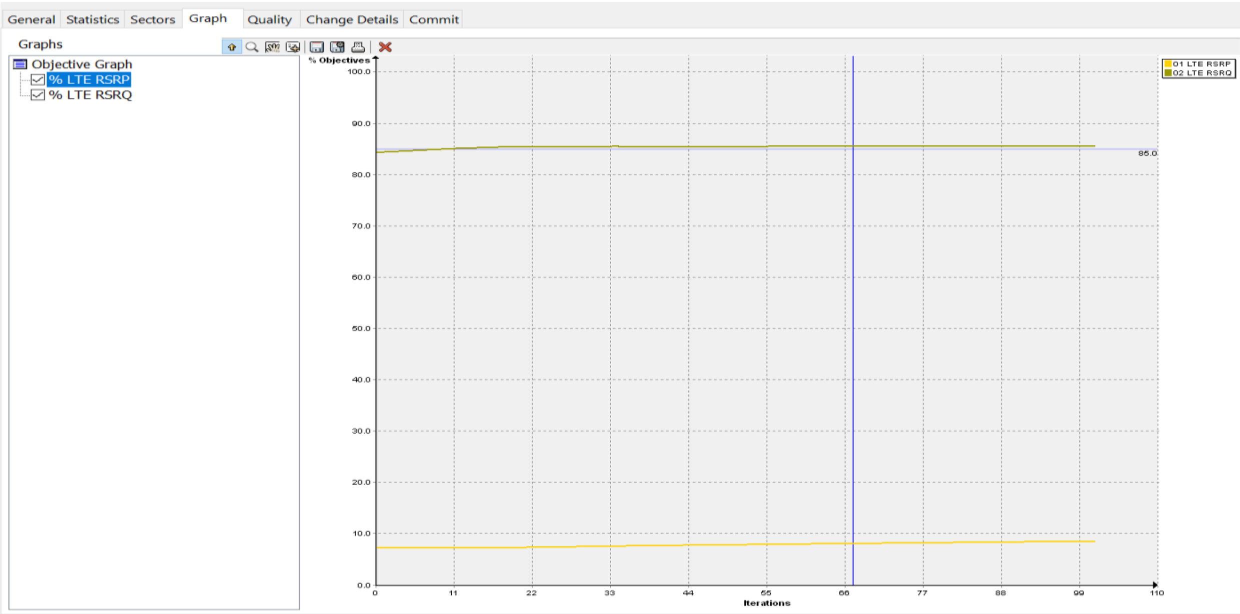


Figure 5. 1: Objective Achievement Graph

5.5 QUALITY OF SIGNAL LEVEL

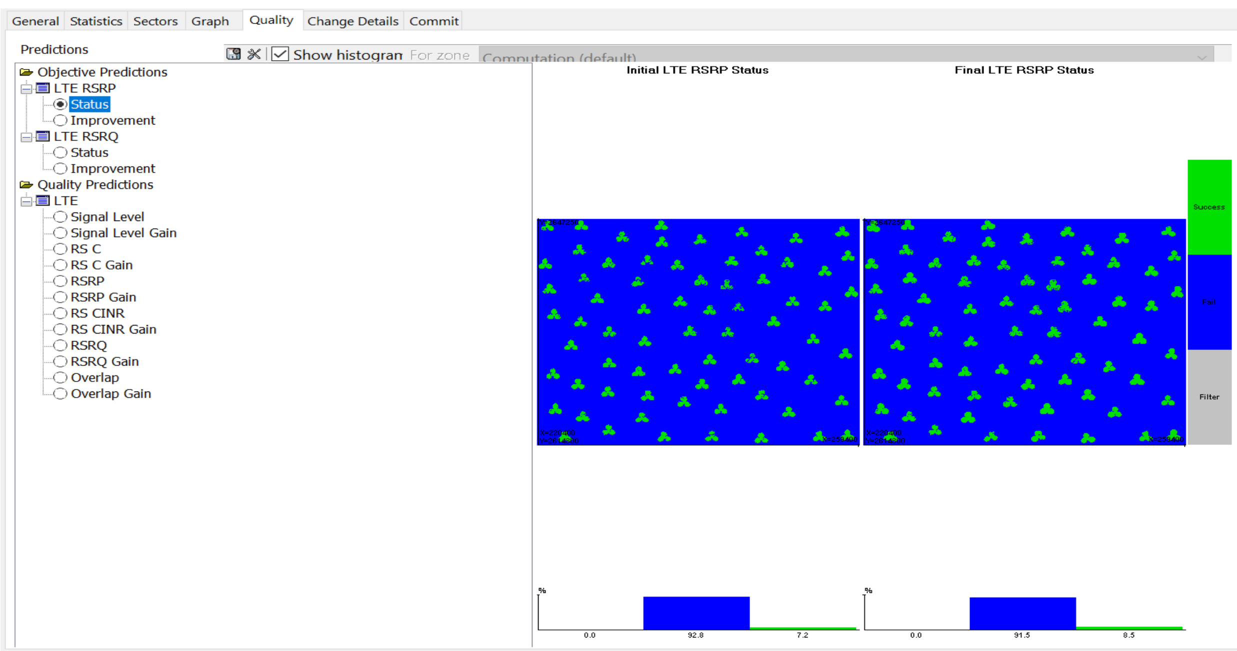


Figure 5. 2: Quality of Signal Level of RSRP (Status)

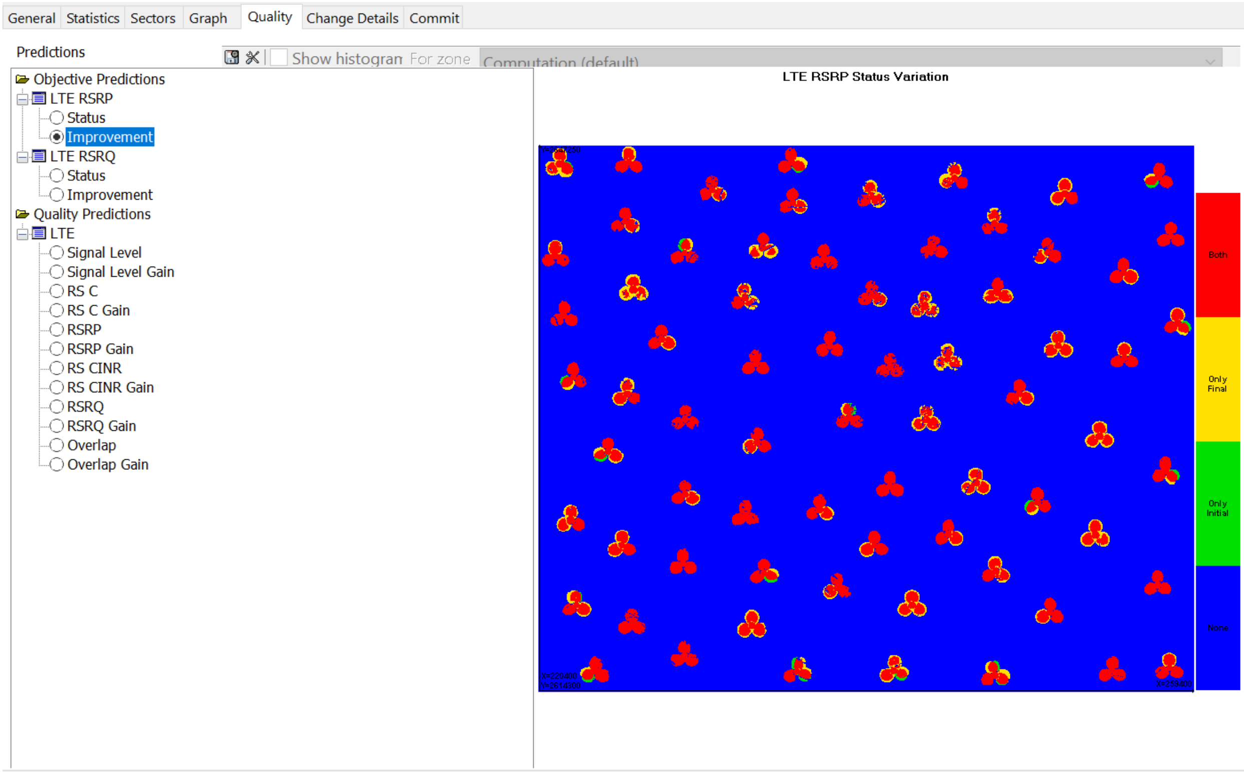


Figure 5. 3: Quality of Signal Level of RSRP (Improvement)

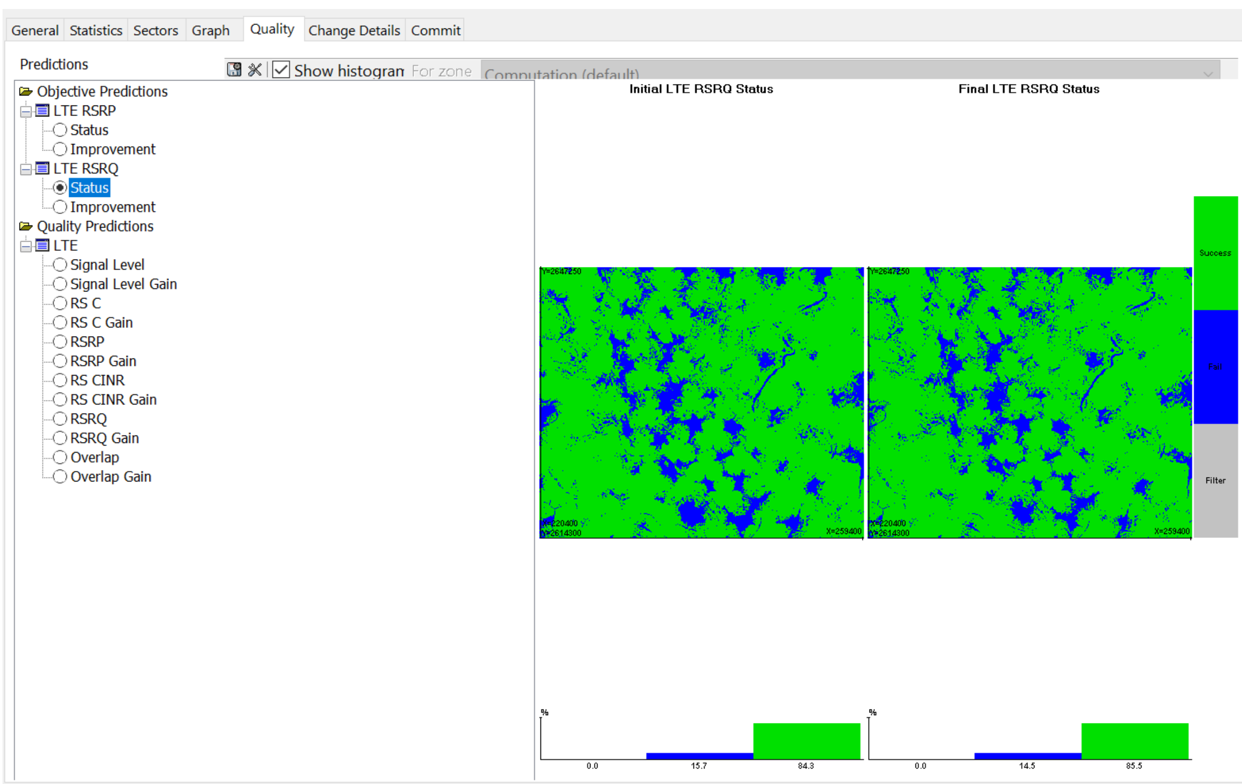


Figure 5. 4: Quality of Signal Level of RSRQ (status)

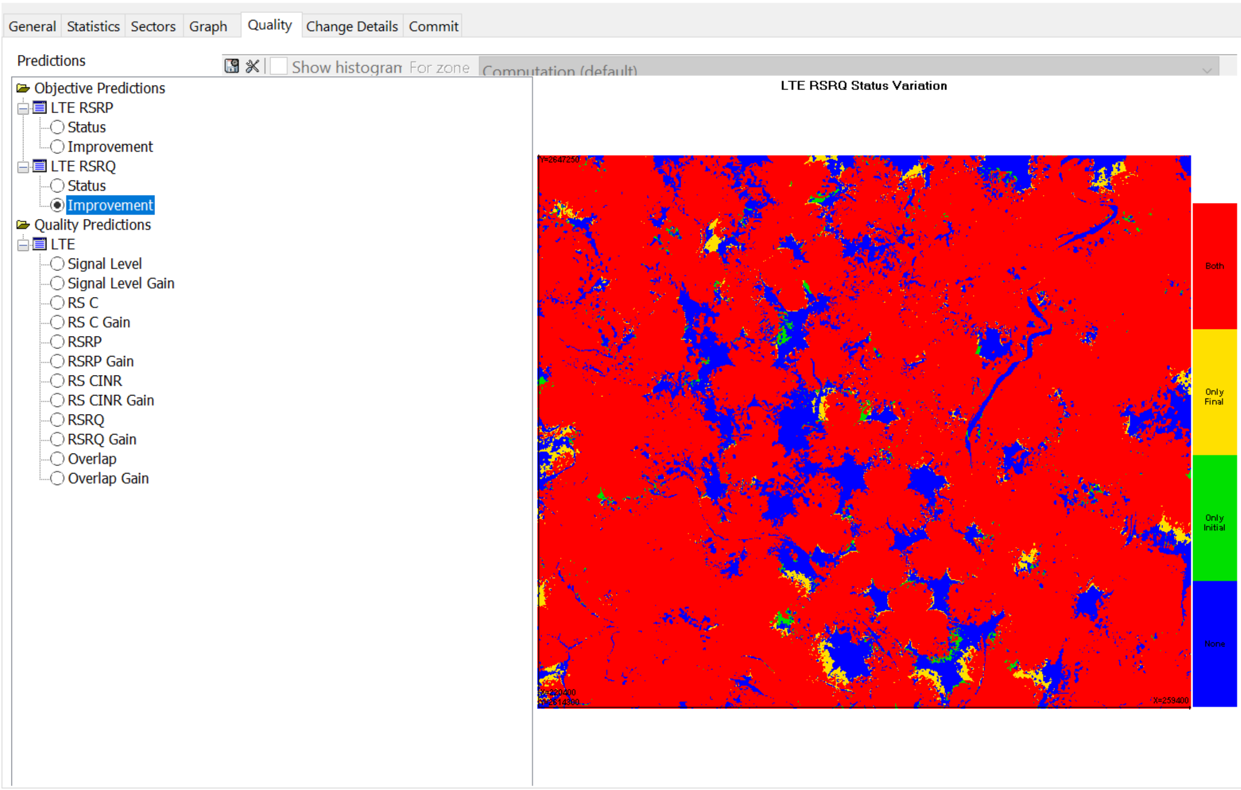


Figure 5. 5: Quality of Signal Level of RSRQ (Improvement)

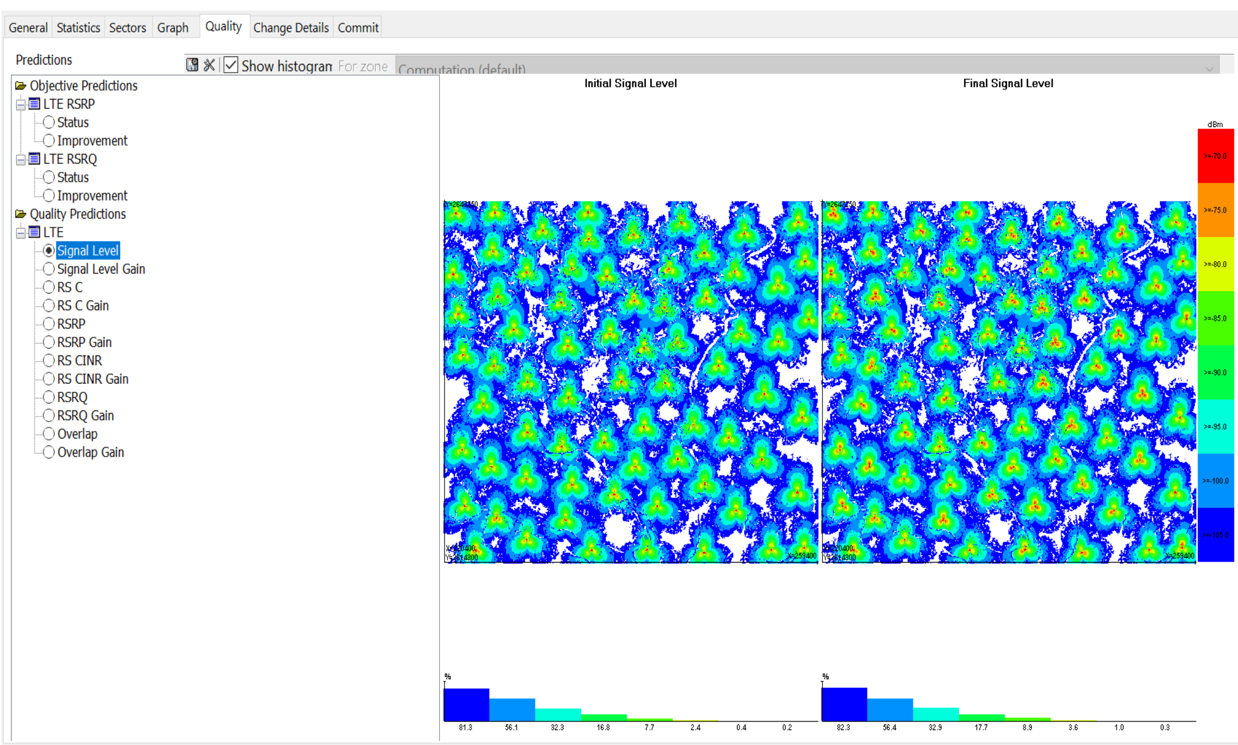


Figure 5. 6: LTE Signal Level

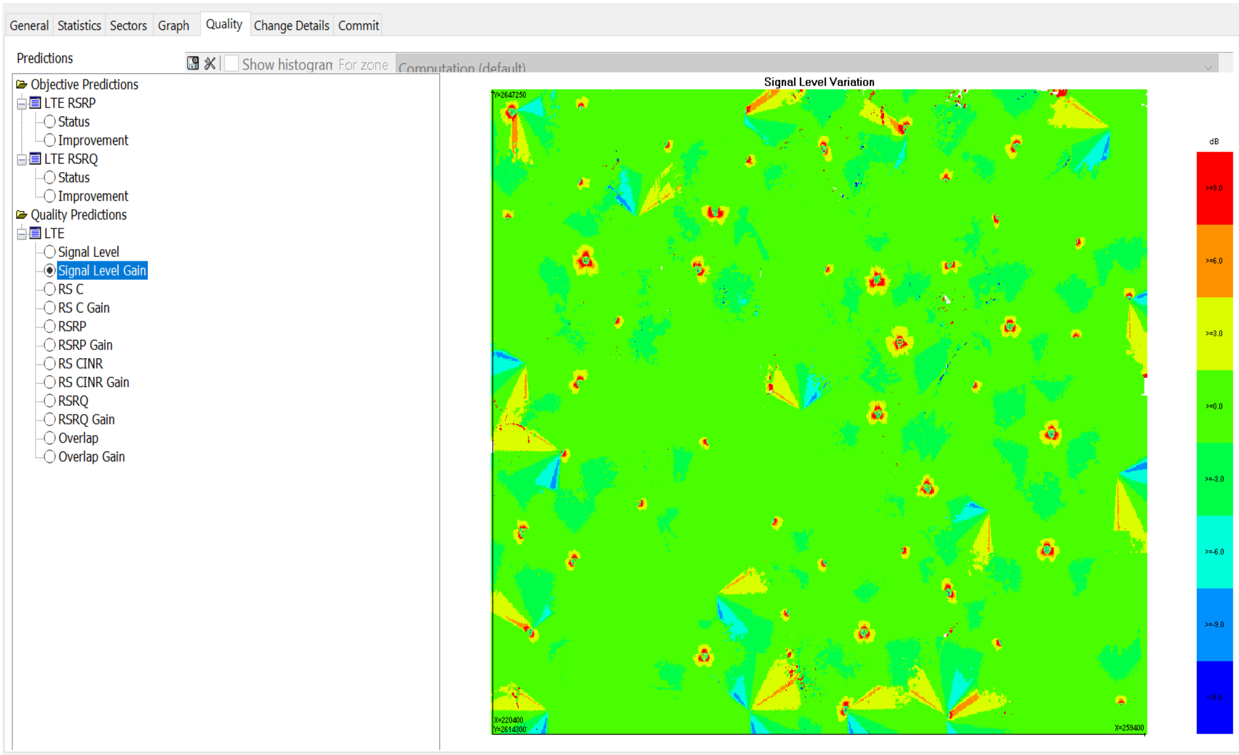


Figure 5. 7: LTE Signal Level Gain

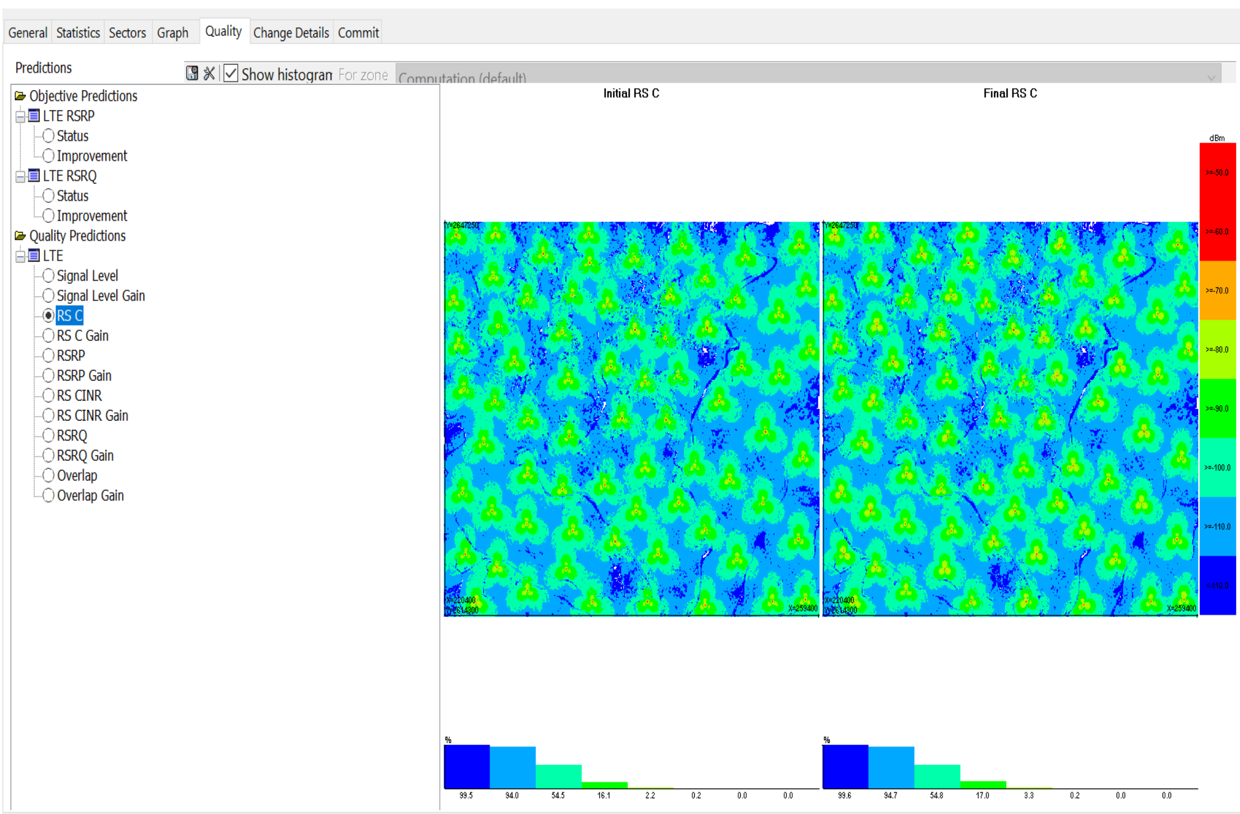


Figure 5. 8: LTE RS C

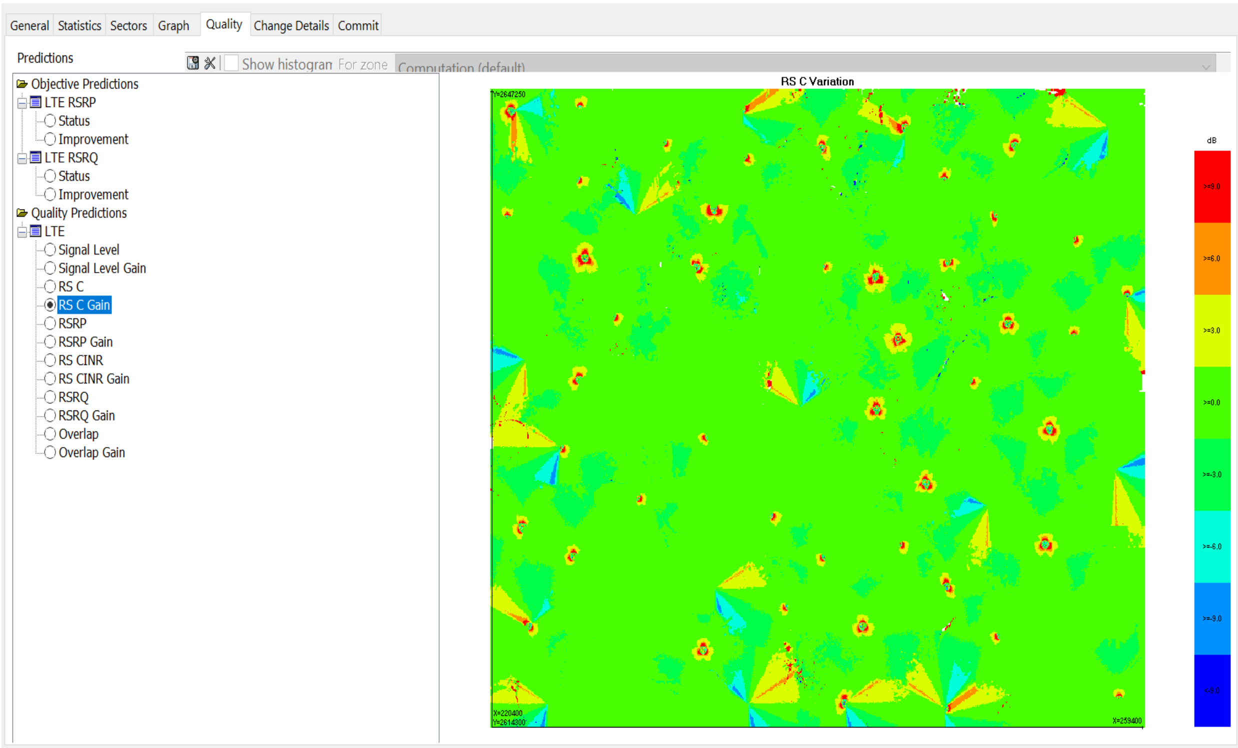


Figure 5. 9: LTE RS C Gain

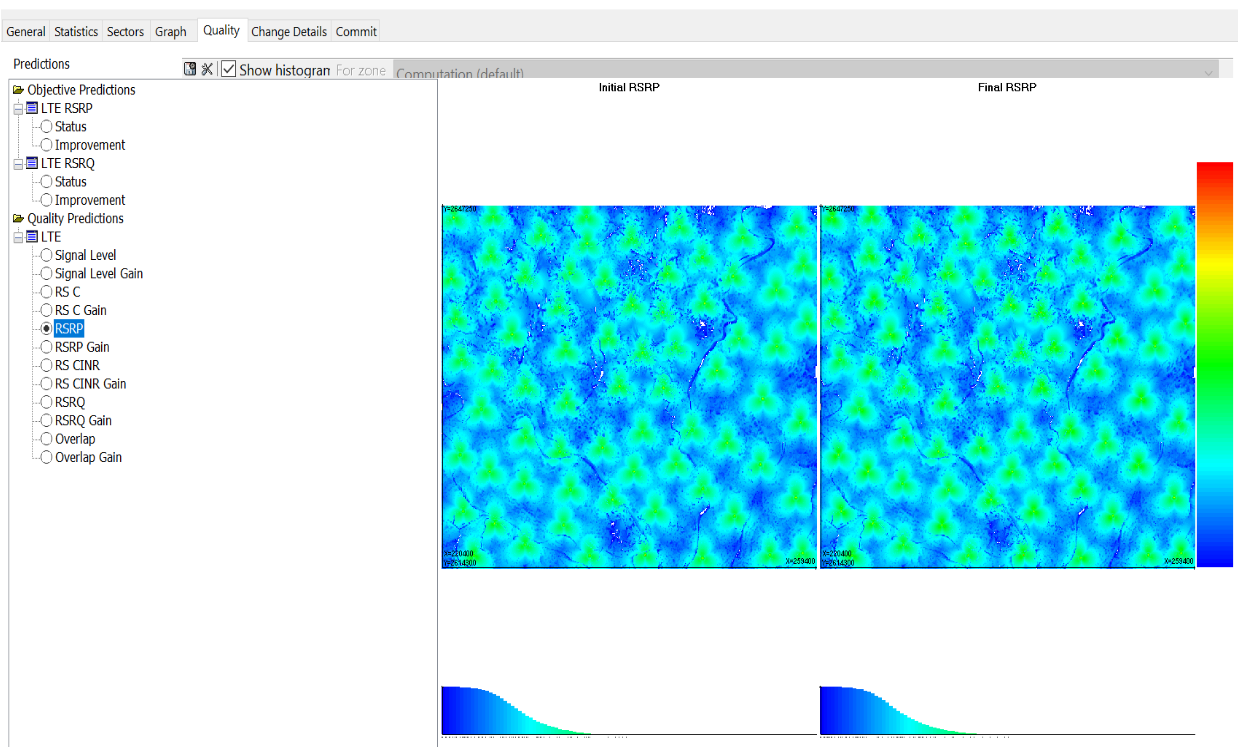


Figure 5. 10: LTE RSRP

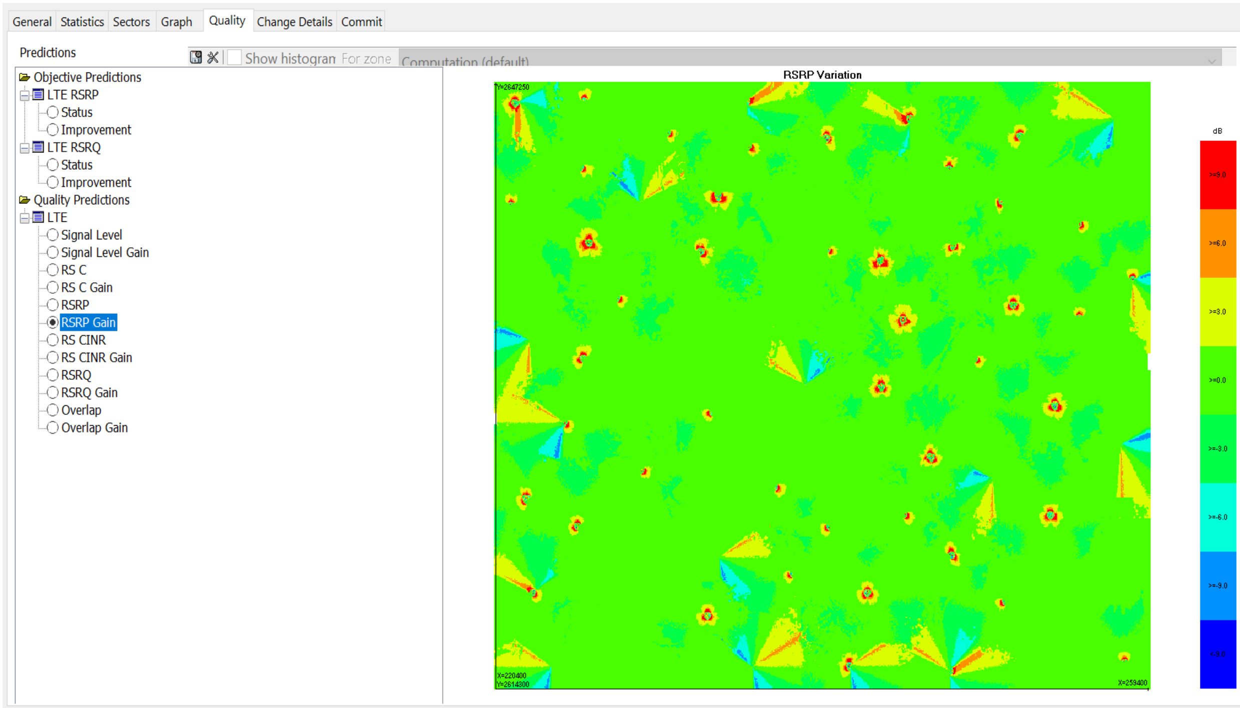


Figure 5. 11: LTE RSRP Gain

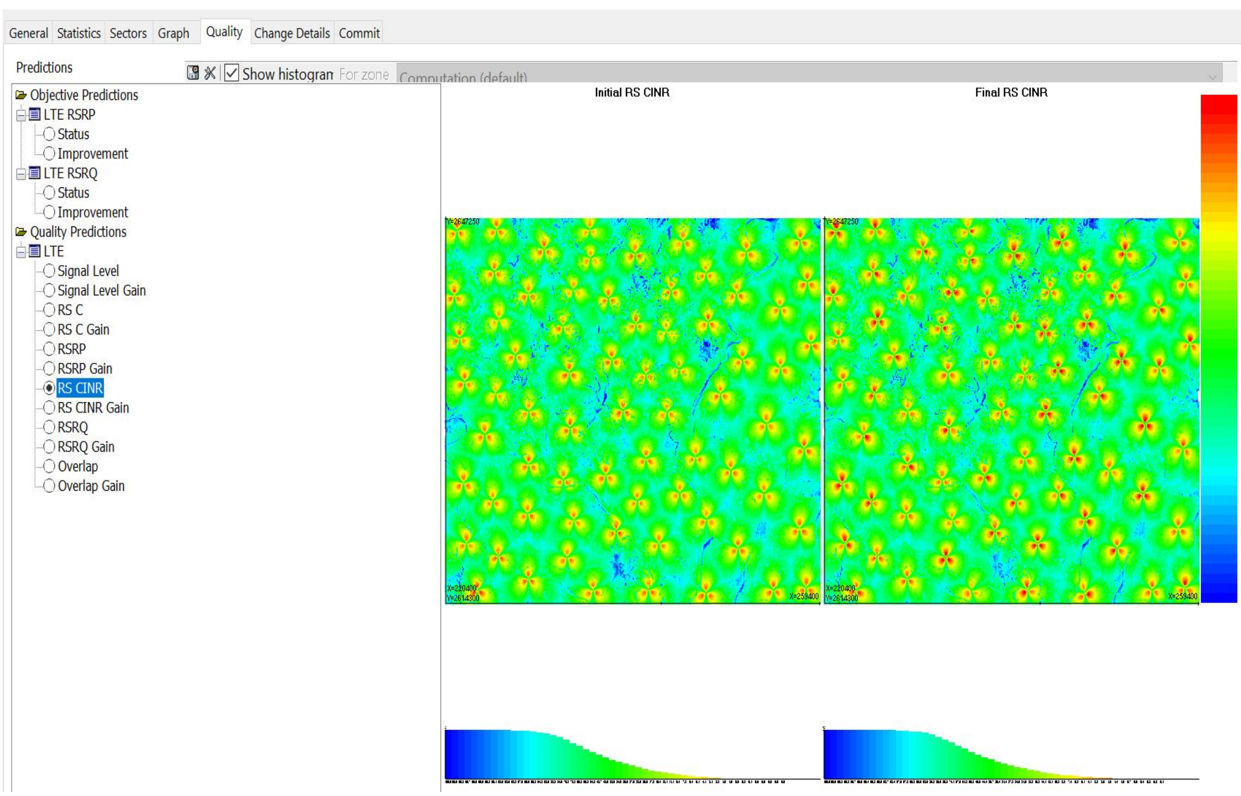


Figure 5. 12: RS CINR

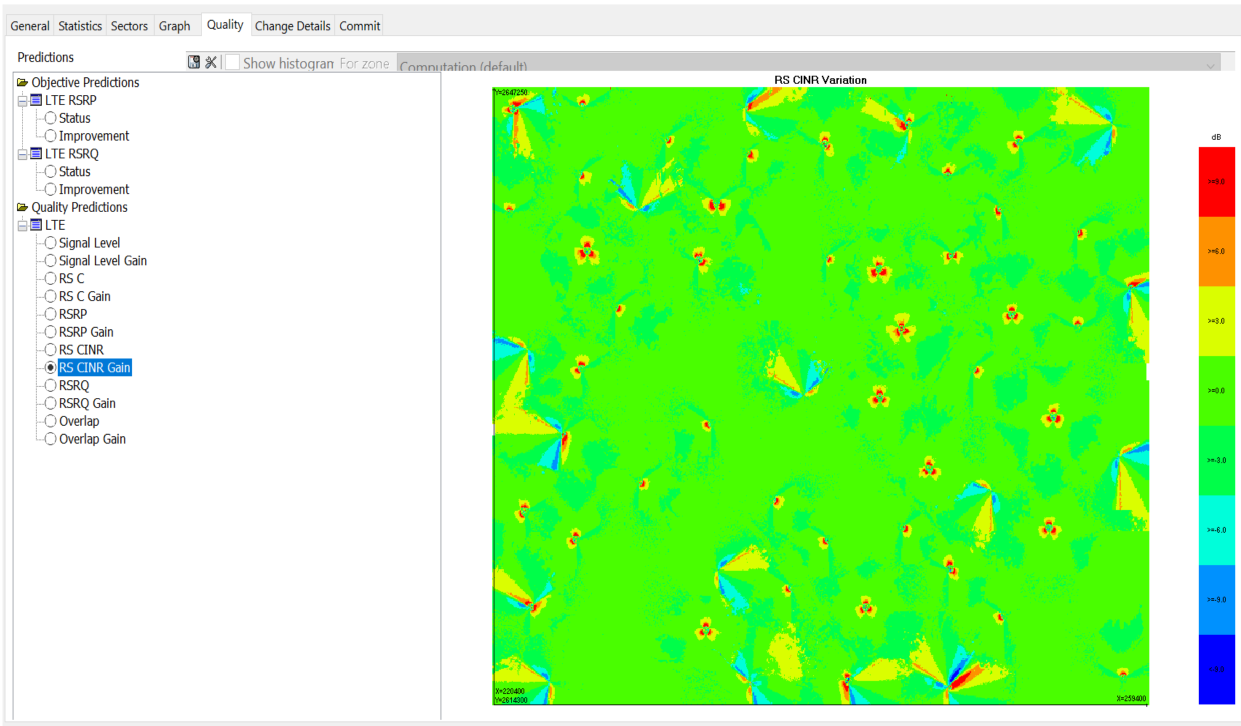


Figure 5. 13: RS CINR Gain

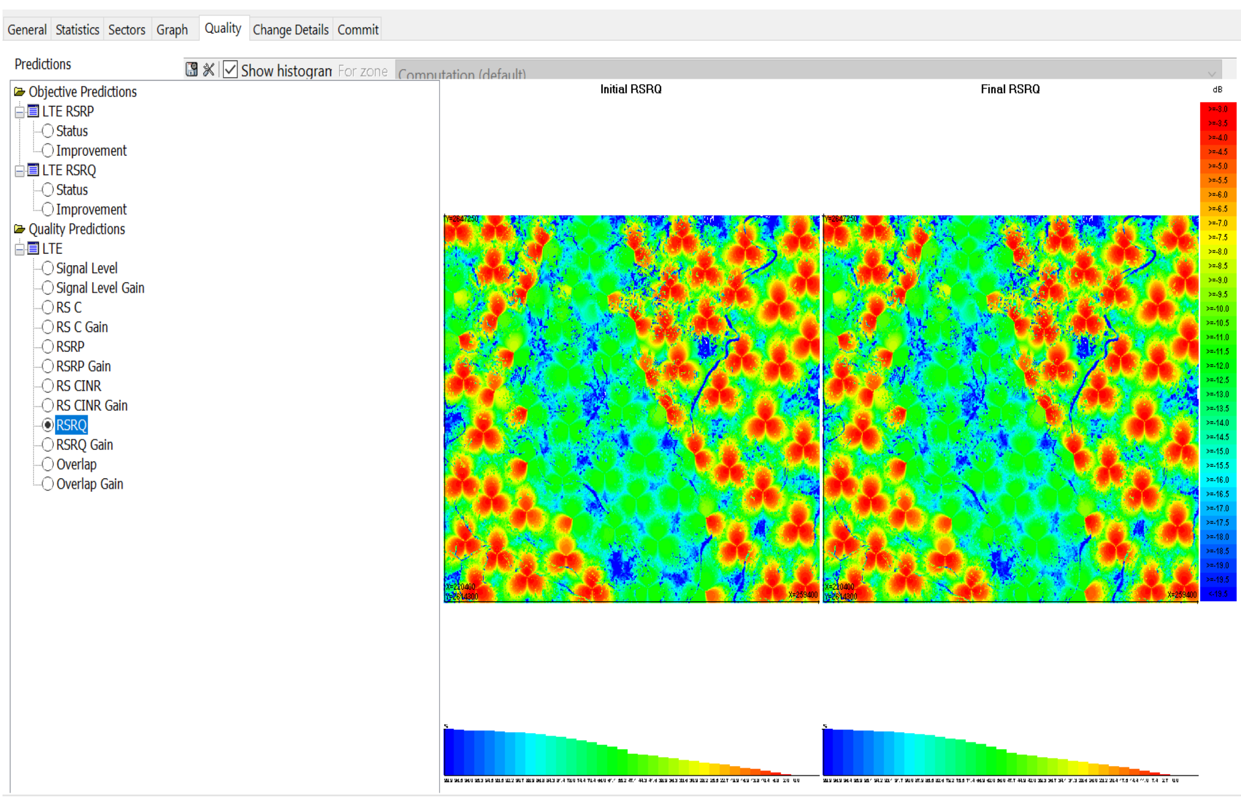


Figure 5. 14: RSRQ

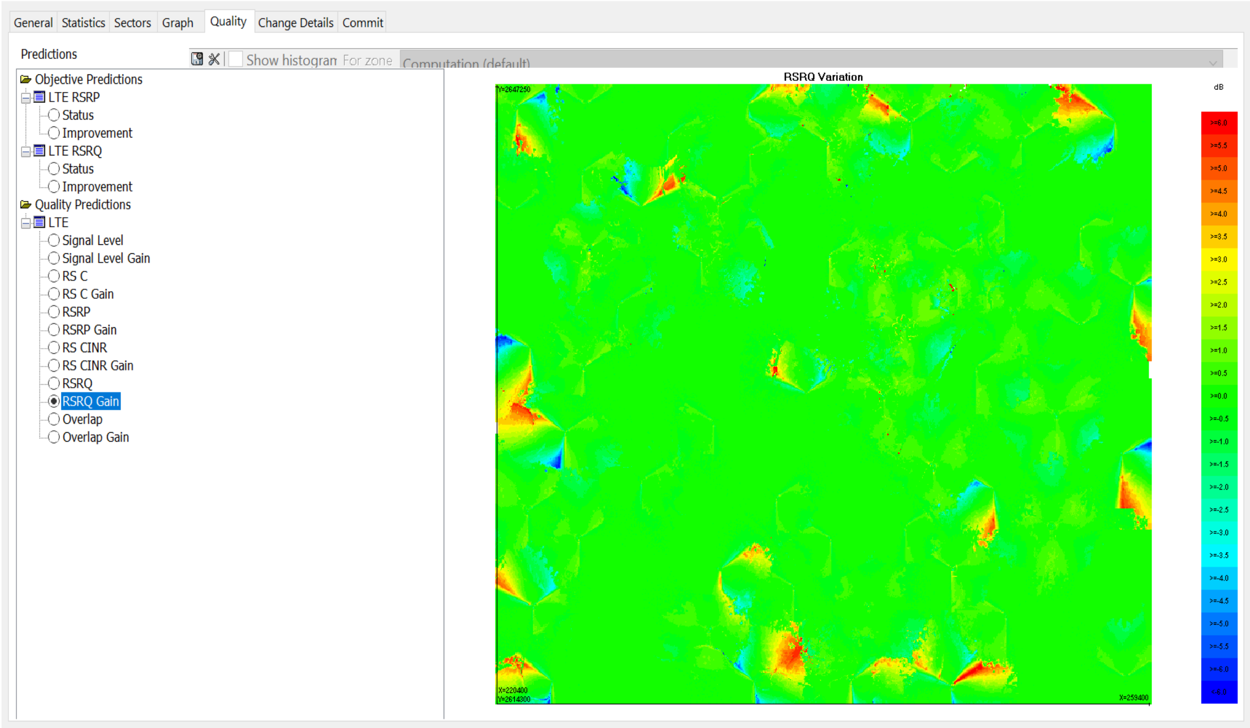


Figure 5. 15: RSRQ Gain

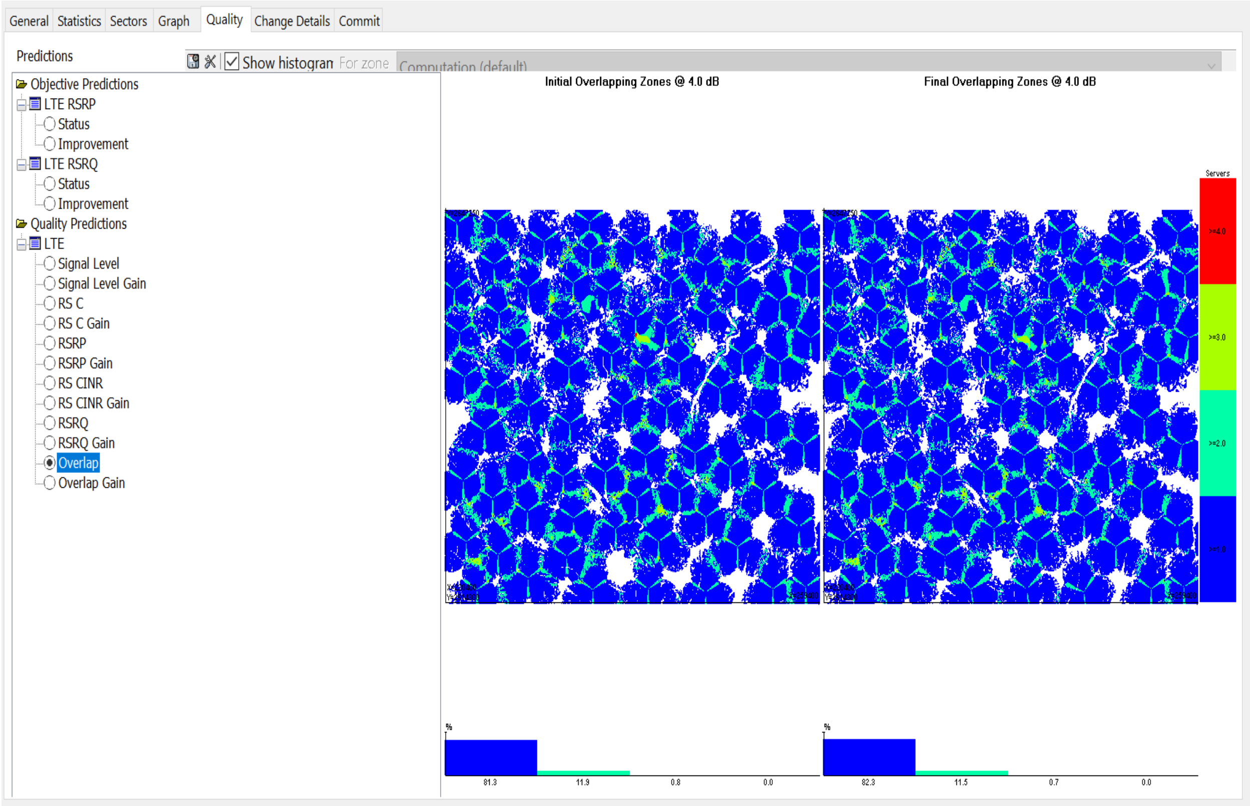


Figure 5. 16: Overlap

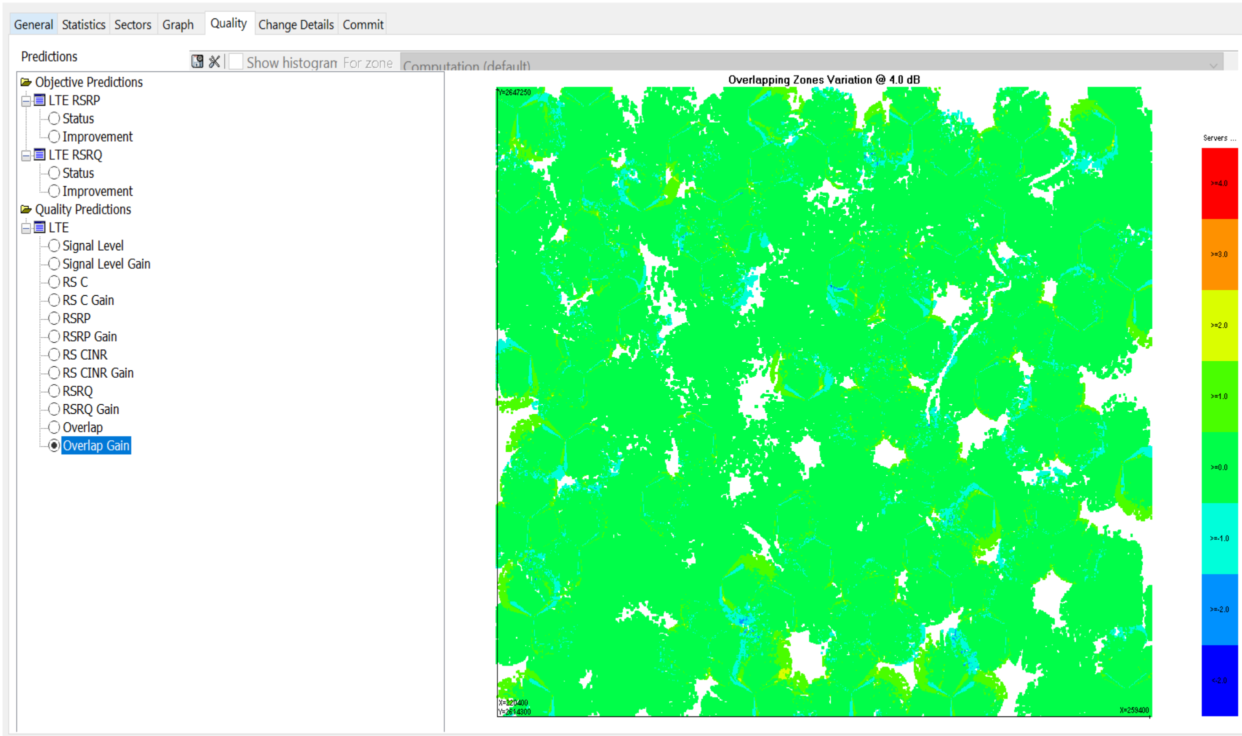
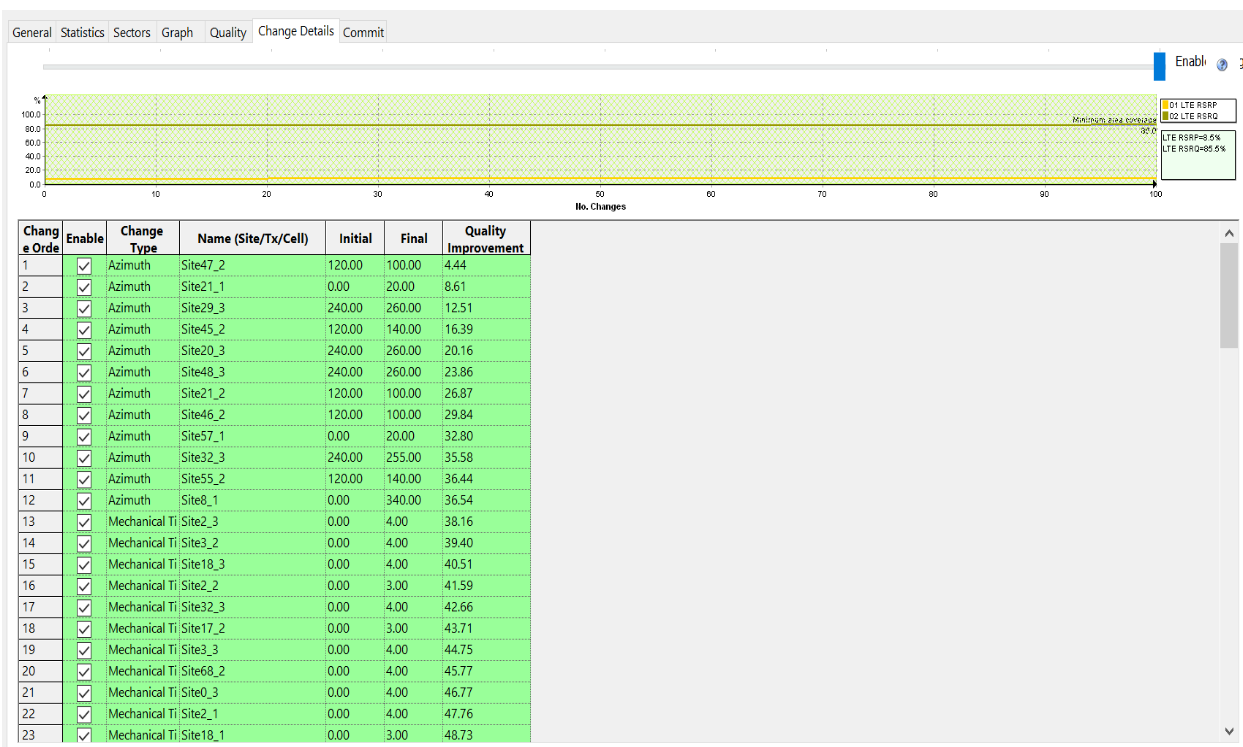


Figure 5. 17: Overlap gain



Change Order	Enable	Change Type	Name (Site/Tx/Cell)	Initial	Final	Quality Improvement
1	☑	Azimuth	Site47_2	120.00	100.00	4.44
2	☑	Azimuth	Site21_1	0.00	20.00	8.61
3	☑	Azimuth	Site29_3	240.00	260.00	12.51
4	☑	Azimuth	Site45_2	120.00	140.00	16.39
5	☑	Azimuth	Site20_3	240.00	260.00	20.16
6	☑	Azimuth	Site48_3	240.00	260.00	23.86
7	☑	Azimuth	Site21_2	120.00	100.00	26.87
8	☑	Azimuth	Site46_2	120.00	100.00	29.84
9	☑	Azimuth	Site57_1	0.00	20.00	32.80
10	☑	Azimuth	Site32_3	240.00	255.00	35.58
11	☑	Azimuth	Site55_2	120.00	140.00	36.44
12	☑	Azimuth	Site8_1	0.00	340.00	36.54
13	☑	Mechanical Ti	Site2_3	0.00	4.00	38.16
14	☑	Mechanical Ti	Site3_2	0.00	4.00	39.40
15	☑	Mechanical Ti	Site18_3	0.00	4.00	40.51
16	☑	Mechanical Ti	Site2_2	0.00	3.00	41.59
17	☑	Mechanical Ti	Site32_3	0.00	4.00	42.66
18	☑	Mechanical Ti	Site17_2	0.00	3.00	43.71
19	☑	Mechanical Ti	Site3_3	0.00	4.00	44.75
20	☑	Mechanical Ti	Site68_2	0.00	4.00	45.77
21	☑	Mechanical Ti	Site0_3	0.00	4.00	46.77
22	☑	Mechanical Ti	Site2_1	0.00	4.00	47.76
23	☑	Mechanical Ti	Site18_1	0.00	3.00	48.73

Table 5. 4: Change Details

As was seen above, we tried to do the optimization considering the whole Dhaka city map with 70 antennas but were unable to achieve our goal of target coverage area of 90% for the RSRP. So for the optimization using the automatic cell planning tool of Atoll thus we decided to choose only a specific zone or area, the Dhaka airport, to see if we could achieve an area coverage of 85-95 percent as shown in the figure below .As we adjust the parameter setting and run the optimization we succeeded in achieving 95 percent area coverage for both the RSRP and the RSRQ as shown below

5.6 OPTIMIZATION FOR DHAKA AIRPORT

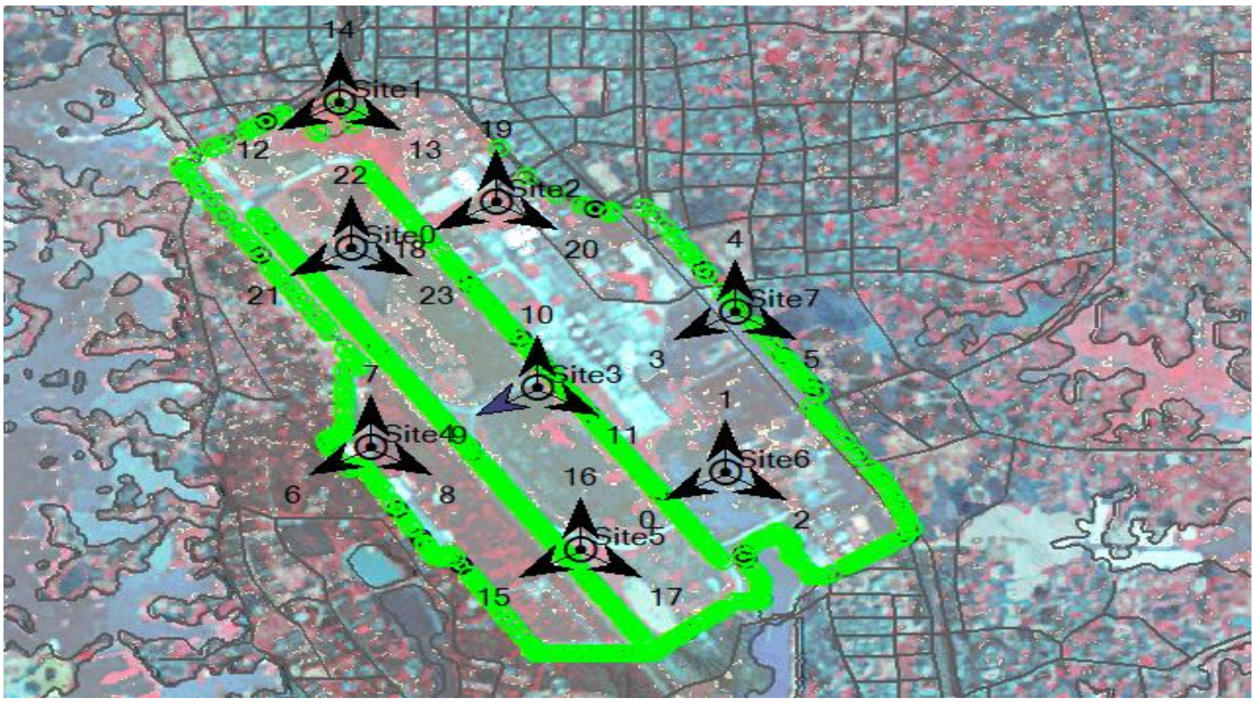


Figure 5. 18: Dhaka Airport Simulation

As seen on the map of Dhaka digital map above, the area was covered by eight antennas. The results of the optimization are depicted in the diagram below. Before adjusting some of the parameter settings, the initial RSRP status shows the map as blue (Fail), indicating that the percentage of coverage was not achieved. The desired target of 95% was met thanks to some manipulation of the initial parameter settings, as evidenced by the map (green) on the final RSRP status, indicating that the goal was met.

In the same vein, the result obtained from the optimization results of the Reference signal receive quality RSRQ is shown below. The 95-percent area coverage of the received signal's (RSRQ) quality was achieved. As discussed above with the maps, the figures are self-explanatory as seen in Figure 4.20; 4.21; 4.22; 4.23.

Resolution	50m
Total number of pixels in computation area	2608
Calculation setting	High precision
Low quality improvement changes	Default
Optimisation on zone	Computation+Focus
Maximum number of active sites:	None
Optimisation with Objectives:	
Objective: LTE RSRP	
Used technology layers	2110 FDD (E-UTRA Band 1)
Used quality	LTE[RSRP]
Rules	*2110 FDD (E-UTRA Band 1)* RSRP ≥ -105 dBm
Target	Area coverage >= 95%
Objective: LTE RSRQ	
Used technology layers	2110 FDD (E-UTRA Band 1)
Used quality	LTE[RSRQ]
Rules	*2110 FDD (E-UTRA Band 1)* RSRQ ≥ -15 dB
Target	Area coverage >= 95%

Table 5. 5: Input Criteria

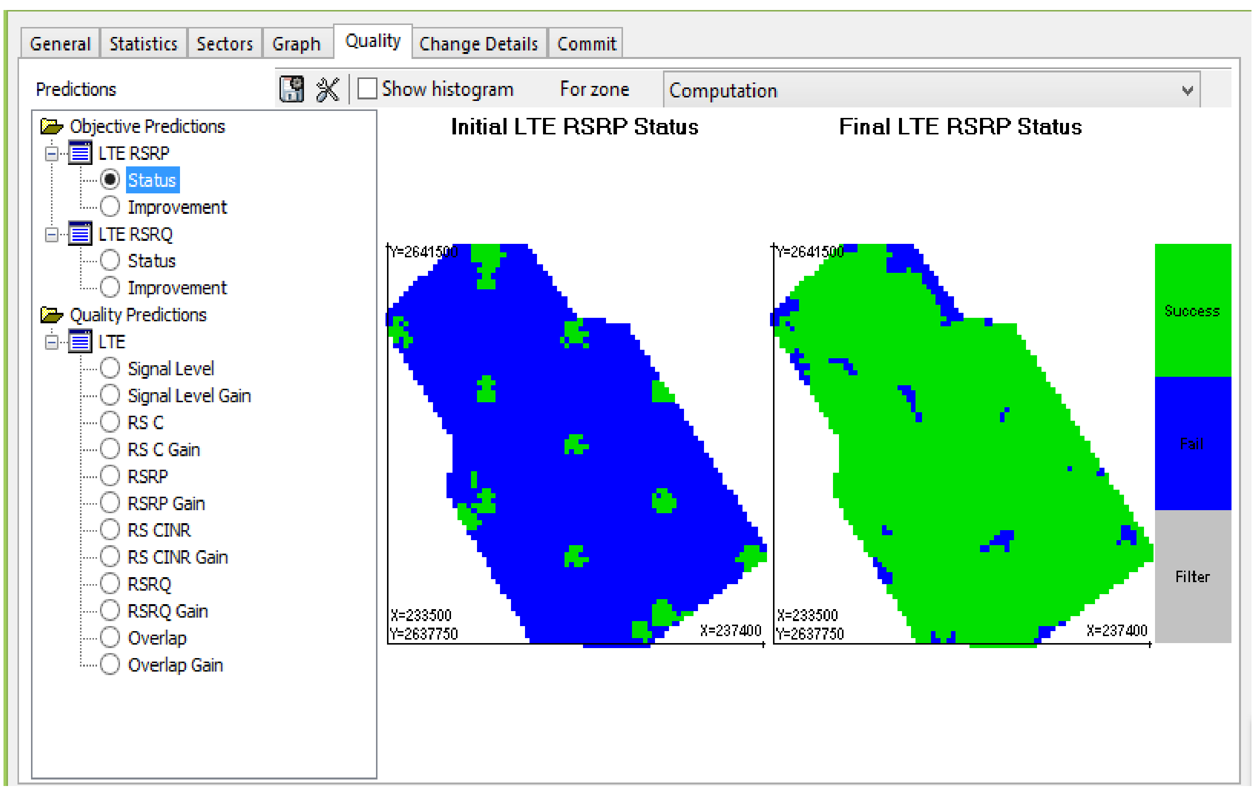


Figure 5. 19: Quality of Dhaka Airport LTE RSRP (Status)

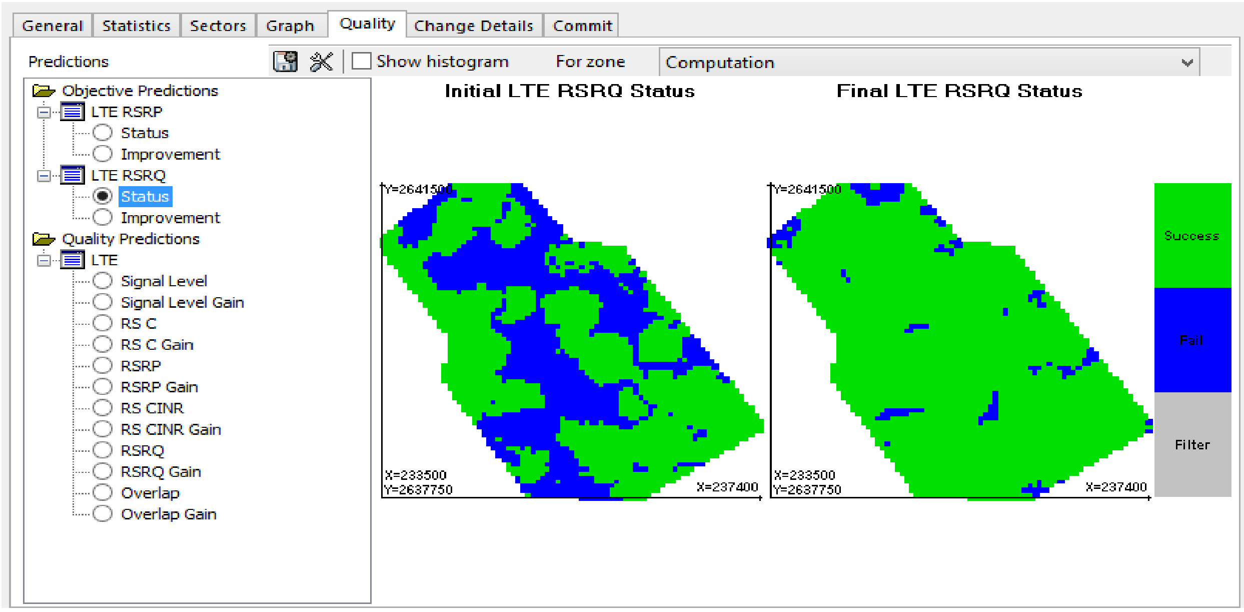


Figure 5. 20: Quality of Dhaka Airport LTE RSRQ (Status)

Figure 5.20; 5.21 shows the initial and final RSRP and RSRQ status. There are three indicating colors, such as the green color, which means success, blue means fail, and grey means filter. So the initial LTE RSRP status for most of the area is blue, but the final LTE RSRP status is green. Because the initial coverage area was so small, but our objective was to cover 95% of the area. Though we achieved our objectives, the area is green, which means success.

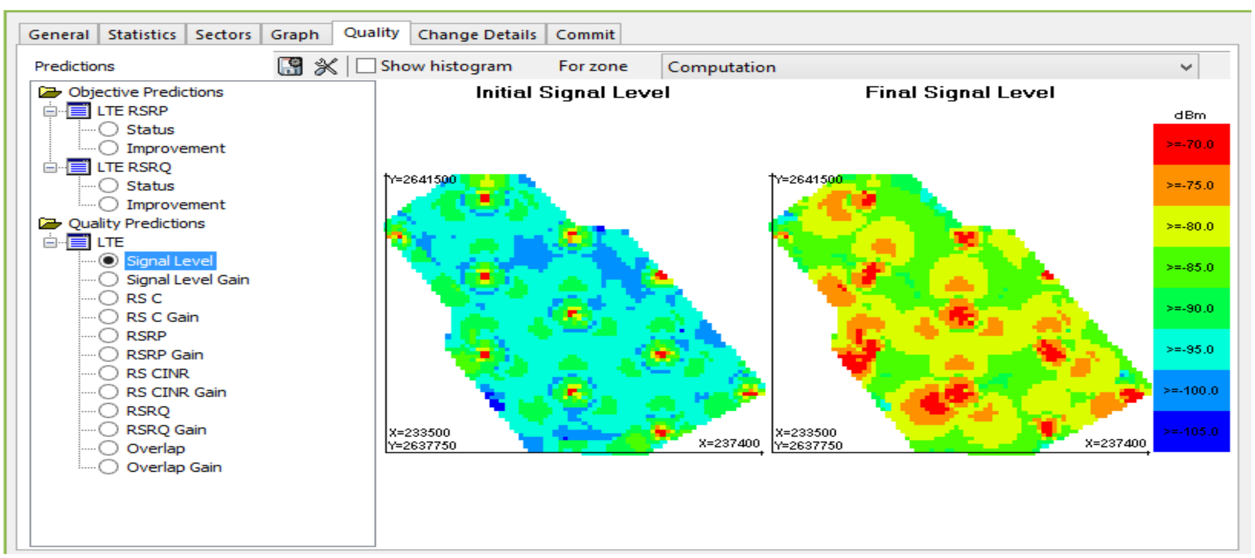


Figure 5. 21: Quality of LTE Signal Level

This Figure 5.22 depicts the quality of the signal level at the Dhaka International Airport, as well as the intensity of the signal level in a number of different places across the map.

General | Statistics | Sectors | Graph | Quality | Change Details | Commit

Cell/Tx Name	Use						Total Power (dBm)		Antenna Pattern		Azimuth	
	Pow	Ant.	Azi.	MTilt	Heigh	Sele	Initial	Final	Initial	Final	Initial	Final
Site11_1(0)	✓	✓	✓	✓		✓	43.00	58.00	65deg 18dBi 0Tilt 2	65deg 18dBi 0Tilt 2	0	0
Site11_2(0)	✓	✓	✓	✓		✓	43.00	58.00	65deg 18dBi 0Tilt 2	65deg 18dBi 0Tilt 2	120	120
Site11_3(0)	✓	✓	✓	✓		✓	43.00	58.00	65deg 18dBi 0Tilt 2	65deg 18dBi 0Tilt 2	240	240
Site12_1(0)	✓	✓	✓	✓		✓	43.00	43.00	65deg 18dBi 0Tilt 2	65deg 18dBi 0Tilt 2	0	0
Site12_2(0)	✓	✓	✓	✓		✓	43.00	58.00	65deg 18dBi 0Tilt 2	65deg 18dBi 0Tilt 2	120	120
Site12_3(0)	✓	✓	✓	✓		✓	43.00	43.00	65deg 18dBi 0Tilt 2	65deg 18dBi 0Tilt 2	240	240
Site13_1(0)	✓	✓	✓	✓		✓	43.00	56.00	65deg 18dBi 0Tilt 2	65deg 18dBi 0Tilt 2	0	0
Site13_2(0)	✓	✓	✓	✓		✓	43.00	43.00	65deg 18dBi 0Tilt 2	65deg 18dBi 0Tilt 2	120	120
Site13_3(0)	✓	✓	✓	✓		✓	43.00	43.00	65deg 18dBi 0Tilt 2	65deg 18dBi 0Tilt 2	240	240
Site14_1(0)	✓	✓	✓	✓		✓	43.00	58.00	65deg 18dBi 0Tilt 2	65deg 18dBi 0Tilt 2	0	0
Site14_2(0)	✓	✓	✓	✓		✓	43.00	58.00	65deg 18dBi 0Tilt 2	65deg 18dBi 0Tilt 2	120	120
Site14_3(0)	✓	✓	✓	✓		✓	43.00	43.00	65deg 18dBi 0Tilt 2	65deg 18dBi 0Tilt 2	240	240
Site15_1(0)		✓	✓	✓			43.00	43.00	65deg 18dBi 0Tilt 2	65deg 18dBi 0Tilt 2	0	0
Site15_2(0)		✓	✓	✓			43.00	43.00	65deg 18dBi 0Tilt 2	65deg 18dBi 0Tilt 2	120	120
Site15_3(0)		✓	✓	✓			43.00	43.00	65deg 18dBi 0Tilt 2	65deg 18dBi 0Tilt 2	240	240
Site16_1(0)	✓	✓	✓	✓		✓	43.00	43.00	65deg 18dBi 0Tilt 2	65deg 18dBi 0Tilt 2	0	0
Site16_2(0)	✓	✓	✓	✓		✓	43.00	43.00	65deg 18dBi 0Tilt 2	65deg 18dBi 0Tilt 2	120	120
Site16_3(0)	✓	✓	✓	✓		✓	43.00	58.00	65deg 18dBi 0Tilt 2	65deg 18dBi 0Tilt 2	240	240
Site5_1(0)	✓	✓	✓	✓		✓	43.00	43.00	65deg 18dBi 0Tilt 2	65deg 18dBi 0Tilt 2	0	0
Site5_2(0)	✓	✓	✓	✓		✓	43.00	43.00	65deg 18dBi 0Tilt 2	65deg 18dBi 0Tilt 2	120	120
Site5_3(0)	✓	✓	✓	✓		✓	43.00	43.00	65deg 18dBi 0Tilt 2	65deg 18dBi 0Tilt 2	240	240
Site6_1(0)	✓	✓	✓	✓		✓	43.00	58.00	65deg 18dBi 0Tilt 2	65deg 18dBi 0Tilt 2	0	0
Site6_2(0)	✓	✓	✓	✓		✓	43.00	43.00	65deg 18dBi 0Tilt 2	65deg 18dBi 0Tilt 2	120	120

Legend: Reconfiguration | TX Added | TX Removed

Table 5. 6: Different sectors output table including (cell, total power, antenna pattern, and azimuth)

This Table 7.4.4 shows what we have given input like this (selecting site, total power, antenna pattern, and azimuth). Then, after optimization, we get this result. This shows the initial and final values.

General | Statistics | Sectors | Graph | Quality | Change Details | Commit

Cell/Tx Name	Antenna Height (m)		Sector Selection		LTE RSRP (%)		LTE RSRQ (%)	
	Initial	Final	Initial	Final	Initial	Final	Initial	Final
Site11_1(0)	30.00	30.00	✓	✓	2.66	97.43	60.11	98.53
Site11_2(0)	30.00	30.00	✓	✓	3.76	97.00	99.25	100.00
Site11_3(0)	30.00	30.00	✓	✓	3.20	99.00	5.60	97.00
Site12_1(0)	30.00	30.00	✓	✓	26.09	57.14	30.43	28.57
Site12_2(0)	30.00	30.00	✓	✓	5.50	98.56	58.72	94.24
Site12_3(0)	30.00	30.00	✓	✓	9.84	100.00	37.70	50.00
Site13_1(0)	30.00	30.00	✓	✓	5.22	96.53	99.25	100.00
Site13_2(0)	30.00	30.00	✓	✓	43.48	83.33	73.91	83.33
Site13_3(0)	30.00	30.00	✓	✓	18.89	77.78	62.22	22.22
Site14_1(0)	30.00	30.00	✓	✓	3.43	99.55	54.86	90.05
Site14_2(0)	30.00	30.00	✓	✓	4.29	98.08	95.09	99.52
Site14_3(0)	30.00	30.00	✓	✓	3.94	100.00	41.73	100.00
Site15_1(0)	30.00	30.00	✓	✓	12.50	0.00	62.50	0.00
Site15_2(0)	30.00	30.00	✓	✓	15.79	100.00	63.16	100.00
Site15_3(0)	30.00	30.00	✓	✓	7.59	100.00	11.39	50.00
Site16_1(0)	30.00	30.00	✓	✓	12.24	60.00	89.80	100.00
Site16_2(0)	30.00	30.00	✓	✓	100.00	100.00	100.00	50.00
Site16_3(0)	30.00	30.00	✓	✓	11.76	92.71	100.00	97.92
Site5_1(0)	30.00	30.00	✓	✓	15.00	33.33	47.50	33.33
Site5_2(0)	30.00	30.00	✓	✓	5.15	75.00	52.58	100.00
Site5_3(0)	30.00	30.00	✓	✓	80.00	100.00	100.00	100.00
Site6_1(0)	30.00	30.00	✓	✓	6.62	95.98	100.00	100.00
Site6_2(0)	30.00	30.00	✓	✓	3.13	100.00	56.88	100.00

Legend: Reconfiguration | TX Added | TX Removed

Table 5. 7: Different sectors output table including (cell, antenna height, lte rsrp%, lte rsrq%)

This Table **7.4.5** shows what we have given input like this (selecting site, antenna height, LTE RSRP%, LTE RSRQ %), then after optimization, we get this result. This shows the initial and final values.

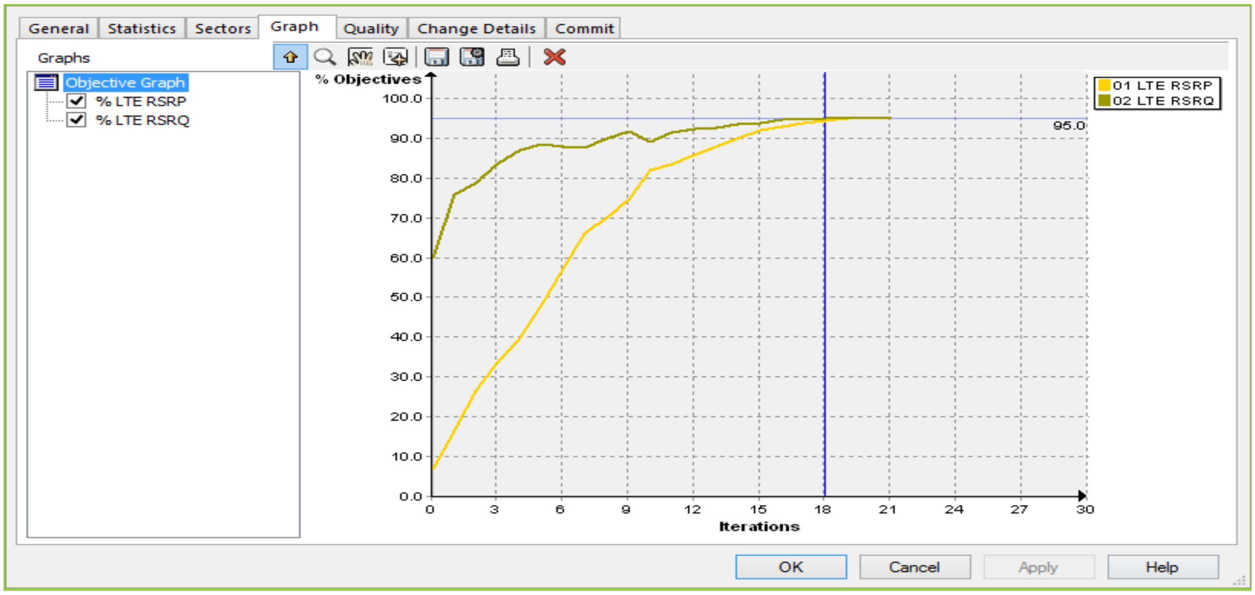


Figure 5. 22: Objectives Achieved by Graph

The figure below depicts the total achievement of the calculated area or zone's reference signal received power (RSRP) and reference signal received quality (RSRQ).

Duration of optimisation: 9.19 s

Objective *LTE RSRP* (Coverage >= 95.0%)

	Evaluation Zone
Initial	5.79%
Final	95.44%
Improvement	***89.65%***
Objective	**ACHIEVED**

Objective *LTE RSRQ* (Coverage >= 95.0%)

	Evaluation Zone
Initial	86.66%
Final	95.63%
Improvement	***8.97%***
Objective	**ACHIEVED**

Table 5. 8: Objective achieved by coverage area

With a 95% focus and predicted computation, the objective is to calculate the reference signal received power (RSRP) and reference signal received quality (RSRQ) of a desired area or zone, as seen in the figure below.

Detailed Zone Results

Objective: LTE RSRP		
Zone	*Initial*	*Final*
Focus	6.74%	95.29%
Computation	6.77%	95.16%
Objective: LTE RSRQ		
Zone	*Initial*	*Final*
Focus	59.76%	95.14%
Computation	59.83%	95.13%

Table 5. 9: Detailed zone result

This is 7.4.8 table. The objective is to calculate the reference signal received power (RSRP) and reference signal received quality (RSRQ) of a desired area or zone and expect to generate a result of 95% focus and computation.

CONCLUSION

The study's ultimate goals are to introduce relevant LTE technologies, define basic models for signal propagation planning, and predict coverage and regarding network count. The guidelines presented may aid in the creation of various radio network planning tools (RNP). The coverage and capacity study results were employed in the nominal and detailed radio planning stages by Atoll, which used the Dhaka digital map as input. On a digitized map of Dhaka, Atoll simulations involving both coverage projections and traffic simulations were done in detail. The point analysis tool was used to evaluate performance once more. For early network implementation, only a small number of customers are taken into account for calculating coverage and capacity. As a result, future capacity expansion remains a challenge. However, for the heavily populated South Asian city of Dhaka, it can still be regarded a conventional radio planning platform.

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