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Mathematical Interpretation of High Length Wi-Fi Network System

*MD. Tahsin Ahmed, **Ashraful Islam, ***J. P. Clinton Corraya

Abstract:- Today's current sphere is always moving and searching for something new. Thinking back a few millennia ago, this was only possible thanks to science. Due to the internet, we are now able to complete tasks that were previously impossible, such as communicating with distant parties. [1] No matter where we are, we can now see them and speak to them with relative ease. To expand the reach of communication medium, the telecommunications industry was created. People can communicate swiftly with people nearby or far away. We are able to use the internet because the telecommunications industry has made it possible for us to do so. We use this internet medium in many different ways as a result of science. Similar to how the router and broadband line (Ethernet) systems work. [1] It will be our responsibility to provide internet access to everyone in the entire nation or world using the Wi-Fi router system. Because of this, anyone can access the internet whenever they want, no matter how far they are from the network. Network towers will be needed for our technology to completely cover the nation and create Wi-Fi systems like the routers we see today. [1]

Keywords:- *Telecommunication Sector, Cell Tower, Internet, Wi-Fi System.*

I. INTRODUCTION

Today's telecommunications industry is expanding its global networking efforts, and in order to do so, they are developing new systems. [2] like the 2G, 3G, and 4G networks. They have recently been focusing on the 5G Network system. The majority of nations have access to and are using the 5G network. For these reasons, the telecommunicationsindustry uses a lot of towers to cover the ground and connect individuals to the network. Our primary goal is to connect the area by building a shortage tower. [2] This essay demonstrates how to do so using this mathematical concept. The development of 5G wireless technology holds the potential to transform the telecom sector and alter how we live and work. [2] [3] This article examines how 5G will affect the telecom sector, which will have a significant impact on almost every part of our life. The advent of 5G will alter how you communicate. [3] It will have an impact on how we use our phones and tablets, as well as how your home entertainment system operates. Numerous new improvements that are not conceivable without 5G will be made possible by it. [4] The next generation of wireless communication, 5G, is undergoing a tremendous shift in the telecoms sector. The "G" - or generation - of wireless technology is one of the main forces behind the ongoing change and evolution of the telecom sector. Faster speeds, greater capacity, and new features that improve our quality of life and connectivity come with each successive generation. [4] [5]

II. THE 5G EFFECT ON TELECOM

- Broadband's current state, 5G, and its consequences.
- Budgets for telecom providers.
- The market environment and potential investment opportunities.

Faster speeds and increased capacity for activities like streaming video, downloading music, reading the web, and utilizing social media come with each successive generation. [5] And as we are all aware, nowadays, individuals use their smartphones for purposes other than merely making phone calls. The telecom sector needs to invest in 5G if it wants to remain competitive. This will not only provide them an advantage over their rivals, but it will also enable them to provide the most cutting-edge technologies to their clients.5G is significant because it has several benefits over other wireless technology generations. For starters, it boasts substantially faster speeds, allowing consumers to accomplish more with their devices. Additionally, it has decreased latency, which implies that using 5G-capable devices will result in less lag. Since 5G uses less energy than earlier generations, telecom companies can reduce their energy costs. Overall, 5G represents a significant advancement for the telecom sector. It provides greater reliability, lower latency, and higher speeds. All of which are necessary for the upcoming creation of new services and applications. [7]

III. DESCRIPTION OF CELL TOWER

A. What is cell tower?

Cellular networks have revolutionized communication by making wireless connectivity ubiquitous. At the very center of these networks are cell towers, which transmit and receive wireless signals as relay stations. [9] [10] Cell towers are the linchpin of a robust wireless communication infrastructure, allowing for seamless voice and data transmissions across vast geographical areas. [11]

Cell towers consist of a number of crucial components that collectively enable wireless communication. The key components consist of the antenna system, transceivers, basebandprocessing apparatus, power supply, and backhaul connections. Transmitting and receiving radio frequency (RF)

signals is the responsibility of antennas, while signal modulation and demodulation is handled by transceivers. Baseband processing equipment processes signals, manages network protocols, and enables mobile device connectivity. Power supply system's guarantee continuous operation, and backhaul connections connect the tower to the network core. [1] [11]

A cell tower's primary function is to provide network coverage and connect mobile devices to the cellular network. The extent of a tower's coverage area, commonly referred to as a cell or sector, can vary based on terrain, population density, and frequency allocation. Multiple cell towers are strategically positioned to form a network of overlapping coverage areas, allowing users to travel between cells without interruption. Cell towers optimize network efficiency and assure service quality by regulating signal strength, handoffs, and traffic allocation. [13]

There are numerous varieties of cell towers, with macrocells, microcells, picocells, and femtocells being the most common. Typically, towering structures with antennas, macrocell towers provide coverage for expansive areas. Microcells, picocells, and femtocells are designed for localized coverage in interior environments, densely populated areas, and specific building deployments. Population density, traffic demand, network capacity, and geographical considerations influence the placement of towers. [15]

The deployment and capabilities of cell towers have been significantly influenced by the development of wireless technologies. The transition from 2G to 3G, 4G, and 5G networks necessitated the installation of new towers and the improvement of extant infrastructure. Particularly, 5G networks rely on denser implementations of smaller cells to deliver higher data rates, lower latency, and enhanced network capacity. [1] [2] [15]

Cell towers are essential components of the wireless communication infrastructure because they allow for global connectivity and meet the ever-increasing demands that are placed on mobile networks. [9] [17] It is vital to have an understanding of the architecture, functioning, and deployment concerns of cell towerto maximize the performance of a network, ensure that there is no disruption in connectivity, and keep up with the changing requirements of wireless communication in the digital age.

B. Why do we use cell towers to broadcast Wi-Fi?

This research paper investigates the rationale behind transmitting Wi-Fi networks via cell towers. Despite the fact that cell towers are predominantly associated with cellular communication, utilizing their infrastructure for Wi-Fi deployment offers numerous advantages, including increased coverage, reduced costs, and simplified network management. [18] However, this strategy also presents interference, scalability, and compatibility issues. This paper investigates the benefits and drawbacks of using cell towers to broadcast Wi-Fi networks, casting light on the potential implications for wireless connectivity. Alternative methods for delivering Wi-Fi networks are being investigated due to the proliferation of wireless devices and the demand for ubiquitous connectivity. [18] Utilizing existing cell tower infrastructure is a promising method for extending Wi-Fi coverage and providing dependable connectivity to a larger number of users. This paper investigates the rationale behind using cell towers to broadcast Wi-Fi networks, emphasizing the benefits and drawbacks of this strategy. The Internet is a medium that allows for the dissemination of information. The entire globe at once. The internet has brought the world into our hands nowadays. We need to understand this because of the internet, which we are familiar with. Additionally, to using the many activities also use the internet. This website is the primary vehicle for achieving the pinnacle of contemporary society. [2] There are a few. Today's innovations and creative ideas are being daily growth was observed. The advent of the Internet a few years ago. We utilized it with the assistance of a wire we named Broadband (Ethernet) line. This form of media is still in use. However, Ethernet only allows one user to utilize a device at a time. However, many individuals will be able to utilize these items because router devices allow several users to use multiple devices simultaneously. [19] The main cause of development is that attempts are being made to introduce innovation as well as an increase in consumer demand brought on by the internet. There are urban and rural areas in every nation. Both urban and rural areas exist in Bangladesh. When we look at our country's metropolitan areas, we see that people have many opportunities there that rural folks do not. Rural residents are typically denied access to breakthrough technologies. The majority of individuals in our nation use Ethernet, or broadband line. Some people use the prepaid and postpaid systems that the corporation offers. However, many are now interested in using the internet via router systems because they wish to utilize multiple devices or multiple devices that are being used by several users at once. Figure illustrates how the Ethernet and router systems function. We create the phone to converse with those who are far away. [2] Then it was altered after the invention of the mobile phone. In order for people to communicate intelligently with persons who are far away or close by, the telecommunications industry must produce and provide signals. Network Tower was employed by the telecommunications industry to provide this signal to the user. Our system uses a controller to manage the server, which connects directly to the Wi-Fi Network Tower to generate the internet. [1] The main step begins once the internet is available for use. It connects to the tower and gives the user access to the internet. For security reasons, we will provide a system for logging in. Through the login process, users will connect their gadgets to the internet. Data will be kept in the system and under the controller's control. The majority of network tower types were employed in the telecommunications industry. [1]

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Rooftop refers to a network tower that is installed on a roof, whereas green field refers to a network tower that is installed in an open space. The internet is currently used by the telecommunications industry. [1] They are utilizing the network towers for this. The work of internet service provider networks and mobile network towers is slightly different, but it is consistent with the work process. Recently, the 2G and 3G systems have been developed in our nation's telecom sector. They employed this for long-distance coverage. Systems, both 2G and 3G. For, this system is very beneficial improved communication. The 2G system has a long range. [1] Through this method, calling other live individuals is simple. In a far location from them. Wireless is the name of this procedure. Process of voice communication. Use of the 3G system UMTS. EDGE and UMT (Universal Mobile Telecom System). As a result, video call procedure, we can. Additionally, HSDPA (High Speed both HSUPA (High Speed Uplink Packet) and DL Packed Access and HSUPA (High Speed Uplink Packet Access). This method makes downloading simple. The LTE (Long Term Evolution) system is also employed here. [2] The network tower developed and offers the user this technique. Although not an easy process, it is a useful system for improved communication. They used it to connect users to the internet. The telecommunications industry also considers those individuals who cannot find a Wi-Fi infrastructure to connect their devices, therefore they purchase data packages. Users purchase data to utilize the internet, and they can do it with ease. Though it was first designed for residents of rural areas, the system is currently used by all users. [1]

IV. UTILIZING CELL TOWERS FOR WI-FI BROADCASTING OFFERS THESE BENEFITS

- Extended Coverage: Cell towers are strategically placed to provide coverage over a wide area for cellular communications. Utilizing these towers for Wi-Fi broadcasting expands coverage to areas where traditional Wi-Fi access points may not be practicable or affordable. [2] [3]

Table 1: Structure of Tower

Name	Height
Green Field	34m + Outdoor
Roof Top	32m + Outdoor
Roof Top/Green Field	29m/32m + Outdoor

- **Infrastructure Reuse:** Utilizing existing cell tower infrastructure reduces the need for additional infrastructure deployment, resulting in cost savings and faster network deployment. [1]
- **Simplified Network Management:** Cell towers are already equipped with robust administration and monitoring systems, allowing for simplified network management. Integrating Wi-Fi broadcasting into the existing tower infrastructure simplifies network administration and maintenance of separate systems. [21]
- **Seamless Handovers:** By leveraging cell tower infrastructure, Wi-Fi networks can seamlessly transfer connections between cellular and Wi-Fi networks, providing mobile devices with uninterrupted connectivity. [22]

V. DIFFICULTIES AND CONSIDERATIONS

- **Interference:** Coexistence challenges may arise when operating Wi-Fi networks and cellular networks on the same tower, potentially resulting in interference issues that can affect network performance. [3]

As the number of connected devices grows, the scalability of Wi-Fi networks deployed on cell towers becomes a crucial factor. For optimal performance, the tower's capacity and the number of simultaneous connections must be carefully managed. [5]

- **Compatibility and Standards:** For seamless integration and interoperability, it is essential to ensure compatibility between cellular and Wi-Fi technologies, such as by addressing differences in frequency bands and network protocols. [6]
- **Infrastructure Limitations:** For efficient Wi-Fi broadcasting, the power supply, backhaul capacity, and antenna configurations of the existing cell tower infrastructure may need to be addressed. [15]

Utilizing cell towers for broadcasting Wi-Fi networks offers various advantages, including extended coverage, cost savings, improved network management, and seamless handovers. However, difficulties relating to interference, scalability, compatibility, and infrastructure restrictions must be carefully addressed to ensure optimal performance and a seamless user experience. By identifying and overcoming these problems, using cell towers for Wi-Fi broadcasting can play a crucial role in expanding wireless access and fulfilling the growing demands of digital communication. [18]

VI. OPTIMIZING CELL TOWER SETUP FOR OPTIMAL WI-FI COVERAGE: STRATEGIES AND CONSIDERATIONS

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Establishing a cell tower to disseminate Wi-Fi networks necessitates the strategic configuration of multiple elements to ensure optimal coverage. This paper explores the essential considerations and strategies for installing a cell tower to

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maximize Wi-Fi coverage, including placement, antenna selection, transmission power management, and interference mitigation strategies.

VII. METHODS FOR OPTIMAL CELL TOWER INSTALLATION

It is essential to identify the optimal location for the cell tower. Population density, geographic terrain, and building structures must be taken into account to ensure broad coverage and minimize obstacles that may impede signal propagation.

- **Choice of Antenna:** Choosing the proper form of antenna is crucial for attaining the desired coverage pattern. Omni-directional antennas radiate signals in all directions, whereas directional antennas direct the signal in a specific direction. The selection depends on variables such as coverage area, desired range, and potential sources of interference. [1]
- **Transmission Power Management:** To achieve a balance between coverage and interference, it is essential to adjust the transmission power of the cell tower. Optimizing power levels helps prevent unnecessary signal overspill and reduces the likelihood of interfering with adjacent networks.
- **Interference Mitigation:** Interference from other Wi-Fi networks, electrical devices, or physical structures can reduce network coverage. Techniques such as channel selection, frequency planning, and interference-avoidance mechanisms such as beamforming can be used to reduce interference and improve Wi-Fi coverage.

To achieve optimal coverage when transmitting Wi-Fi networks through a cell tower, [1] meticulous planning and implementation are required. Crucial aspects of the setup procedure include optimizing tower positioning, selecting suitable antennas, managing transmission power, and mitigating interference. By employing effective strategies and taking into account these key factors, operators can construct cell towers that provide optimal Wi-Fi coverage, thereby meeting the wireless connectivity demands of the present day.

VIII. METHODS FOR OPTIMAL CELL TOWER INSTALLATION

Typically, a few kilometers around the tower, a cell tower can help provide wireless internet service within a constrained geographic area. Many cell towers would need to be strategically placed to cover as much ground as possible in order to offer service for a full nation. The height of the tower, the frequency of the signal, the transmit strength of the antenna, the topography, and nearby obstructions are just a few of the variables that affect a cell tower's coverage area. As a result, a single cell tower may effectively cover an area of about 700 square kilometers. Many cell towers would need to be strategically placed to cover as much ground as possible in order to offer service for a full nation.

IX. FORMULA

To estimate the coverage area of a cell tower, we can use the following formula:

Coverage Area = π × (Distance)^2

Where π is the mathematical constant pi (approximately 3.14), and distance is the maximum distance from the tower at which the signal strength is still sufficient for reliable communication. Let's assume that a cell tower has a transmit power of 40 watts and is equipped with a directional antenna with a gain of 18 dBi (decibels relative to isotropic). The tower is also located on a high point, such as a hill or a tall building, giving it an effective height of 50 meters above ground level. Using a radio propagation model, we can estimate that the maximum distance from the tower at which the signal strength is still sufficient for reliable communication is approximately 15 kilometers. Plugging this value into the formula above, we get:

Coverage Area = 3.14 × (15 km) ^2 = 706.5 square kilometers

Also, to offer seamless coverage over greater areas, wireless operators frequently employ a network of connected cell towers. This is referred to as a cellular network, and it enables wireless devices to change towers as they move from one place to another while keeping an ongoing internet connection.

X. CONCLUSION

We have mostly focused on our papers, which provide internet access throughout the world via Wi-Fi network tower systems, and we have created limitation network towers for the region to provide indemnity. Our primary focal split is this. We divided the work in order to achieve our job goal and complete our mission. We started by tackling the limitation area. Following that, we worked on city before moving on to diverge. However, our mission or objective is to expand the user base while providing internet to all nations. Additionally, we discussed network tower fetch and the Wi-Fi network tower system to determine which tower is most effective at providing internet access. Because the internet and people are both essential to our world, if this system succeeds, employment growth will also increase. Each job requires access to the internet. People will always use the internet if it is created. For this reason, we also want strong power plants that continuously supply electricity. This approach is quite effective for better communication and professional development, although more research is needed on this topic. [1]

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