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RESEARCH ARTICLE

RF Planning And Optimization Of 5G On The City Campus (MUST) of Mirpur, Pakistan

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Abstract

As we know, the world is rapidly moving towards 5G and B5G technology to achieve high data rates, massive communication capacity, connectivity, and low latency. 5G offers a latency of less than 1 ms and extremely high data volume compared to previous technologies. The main challenge is the complex nature of 5G network deployment, especially at high frequencies (3–300 GHz) on a university campus with varied building structures. In this paper, we will discuss a scenario for deploying 5G at the Mirpur University of Science and Technology (MUST) in Mirpur, Pakistan so that telecom operators and vendors who wish to deploy a 5G network on the campus in the future can draw on our research findings. This article aims to optimize RF planning for enhanced network performance using Altair WinProp for modeling and MATLAB for visualization. RF planning on campus is conducted to propose equipment for 5G deployment, considering environmental impact, socio-economic perspective, spectral efficiency, electrical effectiveness, and latency in the user project. This helps to identify key base station locations, analyzes path loss and field strength, and shows how high-frequency millimeter waves interact with real-world structures.

Keywords: 5G, RF, optimization, Pakistan, MUST.

1 Introduction

In addition to a general uptick in the number of mobile broadband subscriptions worldwide, an increase in the average amount of mobile data consumed by each mobile broadband subscription is the primary driver of the continuous expansion of mobile data traffic. Streaming and sharing of ever-higher-definition video, along with a plethora of newly emerging immersive video content, have been major contributors to the latter phenomenon (e.g., augmented reality). Between 2019 and 2025, mobile data traffic is expected to quadruple, reaching 160 exabytes (EB) in each month worldwide (projected with an additional 53 EB in each month wireless access traffic) [1–5]. Mobile operators are upgrading their networks to meet the growing demands of new services and stay ahead of the competition as a result of predictions of mobile

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data traffic.

The current norm for network operators is to maintain backward compatibility with previous generations of technology while simultaneously expanding their footprints for long-term evolution (LTE) networks of the fourth generation (4G) (pre-4G). The LTE-Advanced and LTE-Advanced Pro standards are being implemented by network operators to maximize the return on their LTE infrastructure investments[6–8]. Both the scalability of capacity and the adaptability to use cellular connectivity for different kinds of vertical services will benefit from these enhancements. These LTE upgrades include narrowband cellular connectivity for the Internet of Things (IoT) devices and infrastructure-less proximity services for vehicle-to-everything and public safety use cases [9].

Fifth-generation (5G) network technologies are already being assertively trialed and spun out by mobile operators, equipment vendors, and other industry patrons to support the evolving connectivity demands of upcoming years [10]. This is even though LTE network growth is still happening globally. The need for networks that are scalable for both anticipated and unplanned circumstances is further emphasized by the rapid or unexpected variations in mobile traffic trends (as was recently discovered by changes in traffic patterns generated by COVID-19 measures [11]. To this end, 5G is proposed as a unified connectivity fabric that not only supports the ever-increasing volume of data traffic but also opens the door to numerous new applications in the vertical market [12].

This is because 5G was conceived from the start to facilitate the connection of a vast swath of Internet of Things devices, enable improved mobile broadband services, and support mission-critical communications with stringent reliability and latency criteria [13]. A 5G new radio (NR) air interface with flexible numerology and enhanced capacity through efficient spectral efficiency (via higher-order modulation, massive multiple-input multiple-output (MIMO), etc.) and operation in new high bands (involving pioneer millimeter wave) has been developed in response to the resulting varied system requirements. The intentional re-purposing of the spectrum and greater network densification are two further ways in which 5G might increase network capacity [14]. Adding new cell sites, mainly tiny cell sites, to complement existing macro cellular networks is the final step in the network densification process. This phenomenon is commonly measured in terms of site density (sites per km^2) or inter-site distance.

To provide 4G services, network densification has become crucial, with densities of 10–30 sites per square kilometer (km^2) becoming the norm, especially in urban areas [15],[17],[25]. Given that 5G networks will be using higher spectrum bands and will need to sustain traffic levels that are two to three orders of magnitude higher than those of LTE, the need for tiny cells will become even more critical. Experts agree that in some urban and indoor contexts, 5G will drive hyper-dense deployments with a site denseness of more than 150 sites/km^2 [16].

The steady introduction of 5G has led to a more diverse mobile network. Now, it's multi-layered, with distinct cell types operating in different frequency bands (low and mid bands utilized by all RATs, and 5G high bands), and based on a wide variety of radio access technologies (4G and 5G, alongside pre-4G technologies). To offer new vertically-driven use cases and improved user experiences that exploit 5G performance increases, operators need to keep their networks diverse so that they can continue to provide services for traditional user equipment (UE) categories. This study will focus on the mobile radio communication system's radio frequency (RF) planning and optimization.

Radio frequency (RF) planning is the method used to provide sufficient coverage and capacity for the required services. Transmitter and receiver frequencies and locations are determined during RF planning. Our studies center on enhancing the process of RF planning and optimization for 5G networks. Soon, it will be used to facilitate the roll-out of a 5G network over the MUST campus. The internet is ubiquitous in today's society and plays a role in nearly every facet of daily life. The division's employees rely heavily on the Internet for both internal and external communication and collaboration. When it is fully implemented, the fifth generation of the worldwide system for mobile communication (5G) network will completely revolutionize the mobile communications industry.

With 5G technology, consumers will be able to take advantage of higher data transfer speeds, faster response times (lower latency), more dependability, very large network capacities, greater availability, and a more standardized user experience. High performance and efficiency not only help connect new industries but also lead to better user experiences. The fundamental goal of our project is to improve traffic capacity and performance via spectral efficiency and system coverage optimization. Raising spectral efficiency is the means through which this goal will be met. To put out a proposal for the installation of 5G hardware at the Mirpur University of Science and Technology in Mirpur, Pakistan city campus. This project requires investigation into the following factors, both financially and environmentally: Examining how building height affects signal quality during transmission.

The 3-300GHz range covers frequencies essential for 5G communication especially millimeter waves (25 GHz and Above) which are crucial for high bandwidth application. These frequencies ensure high data rates but suffer from path loss which necessitates densely spaced base stations. if lower frequencies such sub-6GHz are used, the signal would propagate further with low path loss but with reduced space and lower bandwidth. while the higher bandwidth allows more data rate but it degrades especially in NLOS (Non-Line of Sight) scenarios. That is why network densification is significant in millimeter wave frequencies and this work focuses on optimizing that deployment.

2 Background Study

Utilizing millimeter wave (mm-waves) frequency bands is a significant development for achieving more bandwidth. This is done so that fifth-generation communication networks can transfer more data at once (5G). Several issues arise when radio signals are carried at millimeter wave frequencies. These include propagation loss, time delay, fading, and scattering losses. Improving performance in a wireless network requires adjusting the propagation parameters for that network specifically [19]. The 5G standard is still very much under development, but the 3rd Generation Partnership Project (3GPP) [20] is expected to provide the first standard specification for the 5G network by the end of 2020. With the help of 5G, we will be able to vastly improve the present generation's mobile communication networks. Some examples of these important factors are the ideas of speed, latency, bandwidth, and energy usage [21].

A critical element of 5G technology lies in its architectural design, which aims to ensure seamless compatibility with pre-existing systems and protocols. This encompasses key technologies such as massive Multiple Input Multiple Output (MIMO), the Internet of Things (IoT), Cognitive Radio, and Heterogeneous Networks (HetNets). Notably, in November 2016, the Radio Spectrum Policy Group (RSPG) established a strategic roadmap for 5G by adopting and publishing its inaugural "Opinion on spectrum-related considerations for next-generation wireless networks (5G)." Future wireless systems' spectrum needs were spelled out in this report. The ICS telecom nG program and Winprop are usually recognized as the most effective of the many software planning tools developed by large organizations.

Altair Winprop [26, 27] is best suited for propagation modelling in both urban and rural surroundings. It allows ray tracing, diffraction, scattering simulation which are essential in understanding signal of milometer wave frequencies. It also help to model building penetration loss and NLOS conditions as well. Winprop is intuitively selected because of its capability in handling high frequency millimeter waves. the flexibility in 3D modelling of complex campus environments like MUST campus is essential in our analysis. The process of creating, simulating, and analyzing cutting-edge technology in intricate settings is greatly improved by its use. Multiple services, such as voice and data, are required to handle a wide range of environments that may be found on a given day [22].

5G deployment can be achieved using the existing harmonized mobile frequency bands in Asia, particularly those below 1 GHz, which are essential for ensuring widespread 5G coverage [28] across all regions. The 26 GHz band (24.25-27.5 GHz) is poised to be the leading frequency above 24 GHz in Asia, offering ultra-high capacity to support innovative new services and enabling new business models and sectors of the economy to benefit from 5G [29]. Research indicates that the fifth-generation network architecture typically consists of three interconnected layers or rings. Each of the recursive circuits relies on its own special carrier frequency. Macro-cells, which operate at a carrier frequency of 700MHz during light traffic, microcells, which operate at a carrier frequency of 3.6GHz during moderate traffic, and Pico cell(s), which operate at a carrier frequency of 26GHz during heavy traffic [30], make up the outer, middle, and inner rings, respectively.

The 700 MHz bands can be utilized to offer coverage over a wide region, whereas the 3.6 GHz frequency can be used to provide high capacity and coverage when employed in macro cells and small cells. The 26 GHz spectrum is anticipated to be used in high-traffic areas like airports and train stations as well as in busy public spaces like arenas and shopping malls. Due to its limitations, the 26 GHz frequency will not be used to establish widespread coverage [23]. The 700 MHz band is an important spectrum resource that supports current DTT services. It is anticipated that mobile service providers will be granted access in the latter part of 2019. The 700 MHz band is a strong contender for improving 5G mobile coverage due to its technical qualities [24]. In a radio mobile communications system, radio frequency planning is the procedure through which frequencies, antenna placements, and other wireless communications system parameters are allocated. The procedure's objective is to supply sufficient capacity and coverage for the necessary services.

When planning for radio frequency (RF), capacity and coverage are two of the most important factors to consider. The coverage area is the area that can receive a strong enough radio frequency signal from the system. The capacity of a system is defined as its ability to serve a given load. Inevitably, either capacity or coverage will need to be reduced to meet granular demands for both service quality and throughput. The radio frequency planning procedure described here includes the following four stages:

- Finding out how many sites will be needed for a given RF communication is the first step in the RF planning process, which involves calculating a budget.
- The second stage of RF planning relies on a comprehensive propagation model, which provides a more accurate assessment of the coverage of the sites than the first stage of numerical propagation model.
- Step three of an RF plan entails fine-tuning and optimizing the plan, which is crucial when deciding where to put the system or what kind of service contract to get.
- Continuous optimization is the fourth step of RF planning, and it's used to account for changes in the environment and the need for new services.

The Primary Challenge of 5G deployment, especially at high frequencies is managing signal degradation due to environmental factors like buildings, vegetation, and terrain. These issues are heightened on a university campus due to the mix of open spaces and dense structures. The goal of this article is to optimize RF planning using ALtair Winprop to

Figure 1. Aerial view of MUST Campus.

model 5G propagation on MUST campus. It includes analysis of field strength, path loss, and network performance at millimeter-wave frequencies (above 24 GHz) to identify optimal locations for base stations and antennas. Our work provides a case study for telecom operators deploying 5G in university settings. Unlike generalized urban deployments, our analysis considers the unique mix of obstacles and layouts found on campuses, helping operators refine their planning approaches for similar environments.

3 Proposed Work

For this purpose, we have used Winprop software and its two main components called ProMan & Wallman. WinProp is a complete set of tools in the domain of wireless propagation and radio network planning. With applications ranging from satellite to terrestrial, from rural via urban to indoor radio links, WinProp's innovative wave propagation models combine accuracy with short computation time. For RF planning we need a specific area where we can install all possible things and can study the strength of the RF signal. For that purpose, we choose the city campus of MUST Mirpur, Pakistan, as shown in Figure 1. The two-dimensional view of the university campus from the Google map is shown in Figure 2.

The MUST campus covers an area of approximately 200000 square meters with a combination of low rise and high rise buildings. The Campus building ranges from one to seven stories in height and the campus have open green spaces as well as densely built up areas. the terrain of the campus is overall flat but it have some vegetation and water bodies that can lead to scattering and signal attenuation, which are included in 3D model. These Factors are important for RF propagation modeling as height , layout and

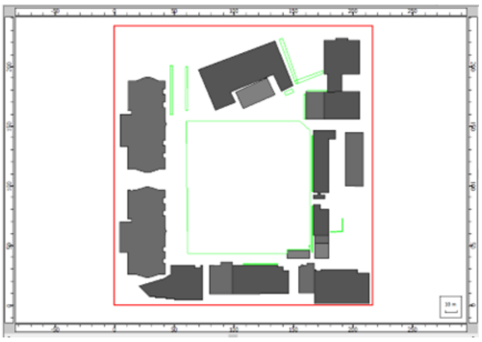

Figure 2. 2D View.

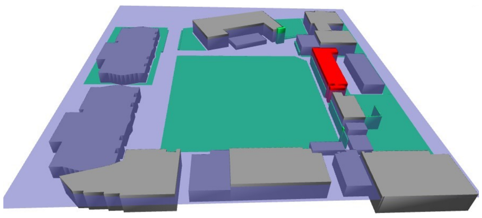

Figure 3. 3D view of Campus.

material of building directly impact the line-of-sight and path loss.

First, we surveyed the campus manually and found the width and length of the whole campus which is 215*245=52,675 m/sq. Now we had to find the length and width of all blocks on the campus. There are 10 buildings on the whole campus. After the survey, we created 2D and 3D scenarios of all buildings on the campus. After the creation of 3D buildings, as depicted in Figure 3, we created the vegetation for the plain area and named it as vegetation area.

The green color in the Figure 4 is the vegetation area. After the creation of 3D buildings and vegetation areas, we need to scale all objects (buildings and vegetation). In scaling, we gave length, width, and height to all objects in meters. We have given 12 m maximum height to buildings.

When scaling is done the next step is to install antennas, there are two types of antennas one is omni-directional, and the other is a directional antenna. A directional antenna is further divided into sectors, like a 2-sector and a 3-sector antenna. For this purpose, we have used two 2-sector antenna having site 1 (site 1 antenna 1 azimuth 145 degrees, site 1 antenna 2 azimuth 45 degrees), as shown in Figure 5. Following is the picture of the antenna having site 1.

One Limitation is the approximation of building material in 3D modeling, which might affect the accuracy of penetration and signal reflection predictions. we can assume all walls concrete but

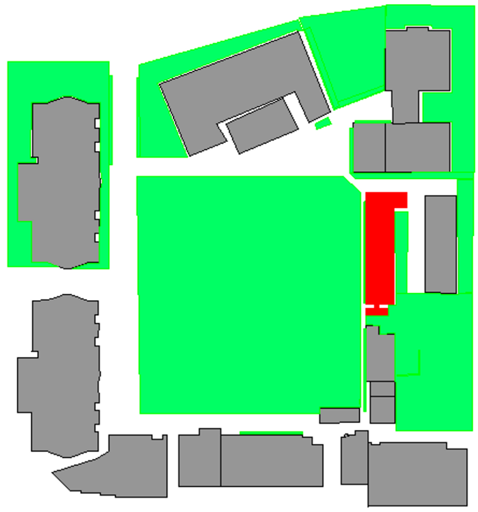

Figure 4. The creation of vegetation.

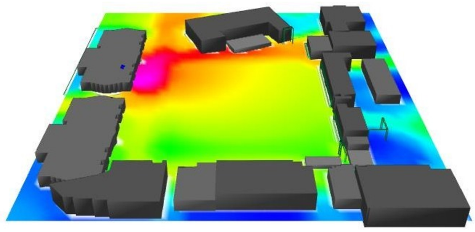

Figure 5. 3D view with Antenna.

metal or glass window and door surfaces would reflect the signal in different way. Another limitation is the static environments. as in real scenario moving obstacles like people or car could impact reliability or signal strength especially in NLOS (Non-Line of Sight) conditions.

4 Result and Discussion

This section briefly describes RF planning and its result in the deployment of 5G network technologies.The detail of antenna parameters used for detailed in Table 1.

In Figure 6, color dots represent the value of field strength according to the color bar. Red color represents the highest value of field strength and blue color represents the lowest value of field strength or

Table 1. List of parameters for scenario 1.

Parameter	Antenna 1	Antenna 2
Height (m)	13	13
Azimuth (degree)	45	145
Down Tilt (m)	15	15
Transmit Power (dBm)	10	10
Frequency (GHz)	28	28
Position (m)	40	115

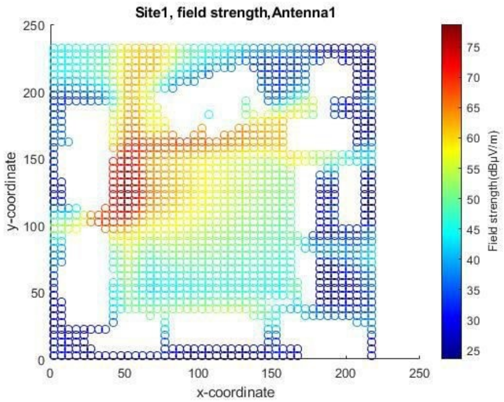

Figure 6. Field strength of site 1, Antenna 1.

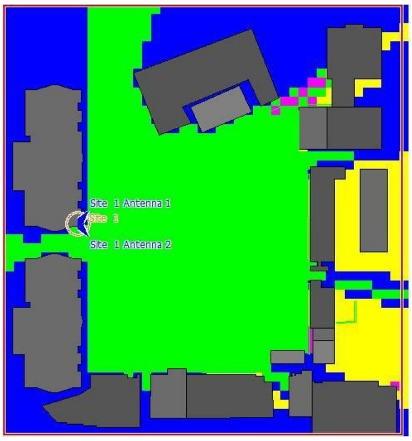

Figure 7. Line of Sight (LOS).

no field strength. As antenna1 is at an angle of 145 so along this antenna direction the value of field strength is stronger than in the other direction.

The green area in Figure 7 represents the line of sight (LOS), and the blue and yellow color represents the non-LOS of antennas. and it will remain the same for all the scenarios because the position of antennas does not change in other scenarios.

Fewer obstacles in the LOS condition lead to better signal strength and lower path loss, whereas in NLOS, owing to reflections, diffraction, and scattering, signal degradation occurs significantly at millimeter-wave frequencies. The path loss exponent in Figure 8, owing to higher attenuation at millimeter-wave frequencies, is higher for sub-6GHz deployments. Figure 8 represents the large-scale fading the red line describes the fitting of received power (dBm) with distance. The blue triangles represent the quadrants regarding the position of the antenna. When the distance from the transmitter antenna increases quadrants increase and can be seen in the form of a grid of quadrants and received power decreases. The path loss exponent for antenna1 is equal to -3.2dB and can be calculated by finding the slope of the fit, shown in Figure 8.

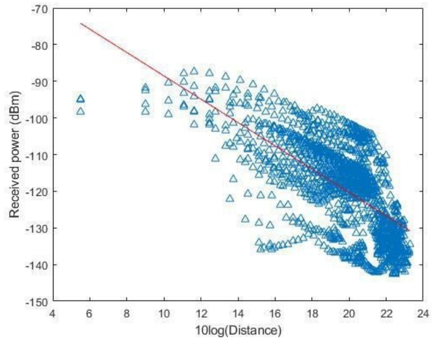

Figure 8. Large scale fading of site 1, antenna 1.

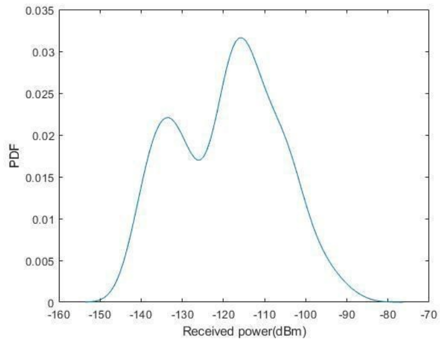

Figure 9. Small scale fading of site 1, antenna 1.

The small-scale fading is normalized to one and the graph between the probability density function (pdf) and received power (dBm) is shown in Figure 9. The highest peak of the graph represents the mean value of received power and it is between -110dBm to 120dBm. As antenna2 is at the angle of 45 so along this antenna direction the value of field strength is stronger than in the other direction. The field strength of antenna 2 is shown in Figure 10.

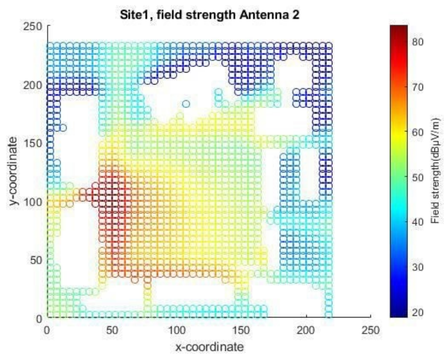

Figure 10. Field strength of site 1, antenna 2.

The large-scale fading of the red line describes the fitting of received power (dBm) with distance as shown in Figure 11. The path loss exponent for antenna 2 is equal to -4.7dB and can be calculated by finding the sloop of the fit.

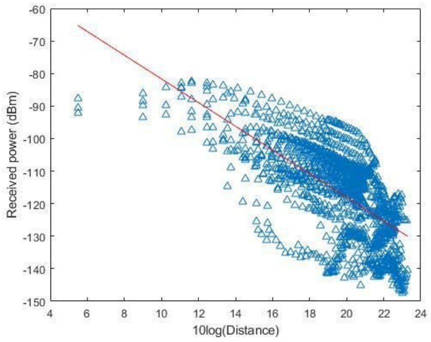

Figure 11. Large scale fading of site 1, antenna 2.

The normalized small-scale fading is shown in Figure 12. The mean value of received power is indicated by the highest peak of the graph which is between -105dBm to -115dBm.

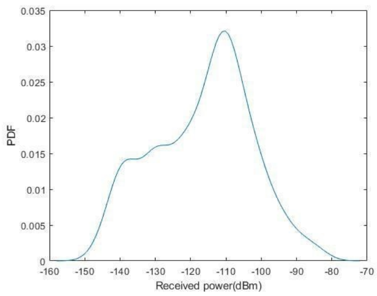

Figure 12. Small scale fading of site 1, antenna 2.

5 Conclusion

In this paper, We demonstrated the deploying 5G network at millimeter wave frequencies (3-300GHz) on Mirpur University of science and technology (MUST) campus require detailed planning because of high path loss particularly in NLOS scenarios. the simulation using Altair WinProp gave detailed insight of field strength, path loss, and coverage challenges in the campus by emphasizing dense base station deployment that ensure network stability. This work gave practical approach to 5G network planing in university campuses and serve as reference for dense urban like environments. Results from graphs show that the distance from the transmitter to the receiver increases as received power decreases and path loss increases. It also concluded that by increasing the antenna's height Field strength dwindles. The slope of the path loss exponent decreases when distance and received power increase. Our project is a combination of both LOS and N-LOS, so the path loss exponent value at any two points is less than 4 (IEEE standard). By optimizing the location of base station and signal propagation at high frequencies, telecom operators can make more informed decision about network reliability and infrastructure investment. This work have can further be utilized in an dynamic world environment, beam forming and MIMO (Multiple Input Multiple Output) technologies.

Data Availability Statement

Data will be made available on request.

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Conflicts of Interest

The authors declare no conflicts of interest.

Ethical Approval and Consent to Participate

Not applicable.

References

[1] Osseiran, A., Boccardi, F., Braun, V., Kusume, K., Marsch, P., Maternia, M., ... & Fallgren, M. (2014). Scenarios for 5G mobile and wireless communications: the vision of the METIS project. *IEEE communications magazine*, 52(5), 26-35. [CrossRef]

[2] Dahlman, E., Mildh, G., Parkvall, S., Peisa, J., Sachs, J., & Selén, Y. (2014). 5G radio access. *Ericsson review*, 6(1). [CrossRef]

[3] Liang, Q., Durrani, T. S., Liang, J., & Wang, X. (2016). Enabling Technologies for 5G Mobile Systems. *Mob. Inf. Syst.*, 2016, 1945783-1. [CrossRef]

[4] Akyildiz, I. F., Nie, S., Lin, S. C., & Chandrasekaran, M. (2016). 5G roadmap: 10 key enabling technologies. *Computer Networks*, 106, 17-48. [CrossRef]

[5] Osseiran, A., Monserrat, J. F., & Marsch, P. (Eds.). (2016). *5G mobile and wireless communications technology*. Cambridge University Press.

[6] Elkashlan, M., Duong, T. Q., & Chen, H. H. (2014). Millimeter-wave communications for 5G: fundamentals: Part I [Guest Editorial]. *IEEE Communications Magazine*, 52(9), 52-54. [CrossRef]

[7] Sun, S., Rappaport, T. S., Thomas, T. A., Ghosh, A., Nguyen, H. C., Kovacs, I. Z., ... & Partyka, A. (2016). Investigation of prediction accuracy, sensitivity, and parameter stability of large-scale propagation path loss models for 5G wireless communications. *IEEE transactions on vehicular technology*, 65(5), 2843-2860. [CrossRef]

[8] Stefanovic, M., Panic, S. R., de Souza, R. A., & Reig, J. (2017). Recent advances in RF propagation modeling

for 5G systems. *International Journal of Antennas and Propagation* , 2017(4701208), 1-5. [CrossRef]

[9] Khawaja, W., Guvenc, I., Matolak, D. W., Fiebig, U. C., & Schneckenburger, N. (2019). A survey of air-to-ground propagation channel modeling for unmanned aerial vehicles. *IEEE Communications Surveys & Tutorials*, 21(3), 2361-2391. [CrossRef]

[10] Mushtaq, B., & Khalid, S. (2023). Design of miniaturized single and dual-band bandpass filters using diamond-shaped coupled line resonator for next-generation wireless systems. International Journal of Microwave and Wireless Technologies, 15(3), 375-383. [CrossRef]

[11] Dahlman, E., Parkvall, S., & Skold, J. (2016). *4G, LTE-Advanced Pro and the Road to 5G*. Academic Press.

[12] Mushtaq, B., Khalid, S., & Rehman, M. A. (2022). Design of a compact novel stub loaded pentaband bandpass filter for next generation wireless RF front ends. *IEEE Access*, 10, 109919-109924. [CrossRef]

[13] 5G Americas. (2017, November). *5G services and use cases* (White paper). 5G Americas.

[14] 3rd Generation Partnership Project (3GPP). (2020, March). *Service requirements for the 5G system; Stage 1* (3GPP TS 22.261, version 17.2.0). 3GPP.

[15] Zaidi, A., Athley, F., Medbo, J., Gustavsson, U., Durisi, G., & Chen, X. (2018). *5G Physical Layer: principles, models and technology components*. Academic Press.

[16] Small Cell Forum. (2017, February). *Hyperdense HetNets: Definition, drivers and barriers* (Technical Report). Small Cell Forum.

[17] Mirjalili, S. M. (2019, October 10). *Fifth-Generation (5G) of Wireless Data Networks*. Concordia University.

[18] Mushtaq, B., AbdulRehman, M., Khalid, S., & Alhaisoni, M. (2023). Design of Tri-band Bandpass filter using Modified X-shaped structure for IoT Based wireless Applications. *IEEE Embedded Systems Letters*. [CrossRef]

[19] Liu, G., & Jiang, D. (2016). 5G: Vision and requirements for mobile communication system towards year 2020. *Chinese Journal of Engineering*, 2016(1), 5974586. [CrossRef]

[20] Mushtaq, B., Rehman, M. A., Hussain, A., & Abbass, M. J. (2023, March). A highly selective dual bandpass filter using couple line resonator for modern wireless communication systems. In *2023 4th International Conference on Computing, Mathematics and Engineering Technologies (iCoMET)* (pp. 1-5). IEEE. [CrossRef]

[21] Morgado, A., Huq, K. M. S., Mumtaz, S., & Rodriguez, J. (2018). A survey of 5G technologies: regulatory, standardization and industrial perspectives. *Digital Communications and Networks*, 4(2), 87-97. [CrossRef]

[22] *Making 5G NR a reality – Leading the technology inventions for a unified, more capable 5G air interface.* (2016, December).

[23] Khawaja, W., Ozdemir, O., Erden, F., Ozturk, E., & Guvenc, I. (2020). Multiple ray received power modelling for mmWave indoor and outdoor scenarios. *IET Microwaves, Antennas & Propagation*, 14(14), 1825-1836. [CrossRef]

[24] Difference between different generations of GSM.(n.d.). Retrieved from http://netnformations.com/q/diff/generations.html.

[25] Al-Saman, A., Cheffena, M., Elijah, O., Al-Gumaei, Y. A., Abdul Rahim, S. K., & Al-Hadhrami, T. (2021). Survey of millimeter-wave propagation measurements and models in indoor environments. *Electronics*, 10(14), 1653. [CrossRef]

[26] Guijarro, V. F., Vega-Sánchez, J. D., Paredes, M. P., Arévalo, F. G., & Osorio, D. M. (2024). Comparative Evaluation of Radio Network Planning for Different 5G-NR Channel Models on Urban Macro Environments in Quito City. *IEEE Access*. [CrossRef]

[27] AGAFARI, Y. T. (2020). 5G NETWORK PLANNING AND OPTIMIZATION FOR FUTURE DEPLOYMENT. [CrossRef]

[28] Martinez, E. J. (2022). Mobility Solutions for 5G New Radio over Low-Earth Orbit Satellite Networks. *Aalborg Universitetsforlag*. [CrossRef]

[29] Zeman, K. (2019). *MODELLING OF M M WAVE PROPAGATION CHANNEL FOR OFF-BODY COMMUNICATION SCENARIOS* (Doctoral dissertation, BRNO UNIVERSITY OF TECHNOLOGY). [CrossRef]

[30] Wang, R. (2024). *Dynamic EM Ray Tracing for Complex Outdoor and Indoor Environments With Multiple Receivers* (Doctoral dissertation, University of Maryland, College Park). [CrossRef]

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