The Next Generation Wireless Network Protocol

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ABSTRACT

The second-largest population in the world is found in India. Thus, as everyone wants to stay connected to modern technology, more bandwidth is required to meet their requirements, like online gaming, songs, smart messaging, and call over IP protocol. The IEEE introduced WiFi-6 technology, referred to as 802.11ax. comparing to 802.11ac (WiFi5), 802.11ax (WiFi6) has four times the network bandwidth. It has various benefits, including a network with stable connection and sustained bandwidth, no halt, data delivery reliability while traveling, and application in a range of industries, including smart governance, smart health care, and digital calculation. WiFi6 is the sixth version of Wi-Fi, which maintains the network latency at 20ms and also provide the all benefit of fifth generation's tech. like 1024 QAM, OFDMA and MU-MIMO.

INTRODUCTION

The demand for WiFi-6 applications is rising as the 5G era approaches. WiFi-6 and WiFi-6E are the most current versions of WiFi technology, with considerable improvements in terms of speed, capacity, efficiency, and performance in high-density areas over their predecessors. WiFi-6, also referred to as IEEE 802.11ax protocol, is Wi-Fi technology's sixth iteration. It introduces numerous major technical edge properties over previous iterations, such as:

Higher data rates: WiFi-6 supports higher data rates compared to previous generations. It uses more advanced modulation techniques, such as 1024-QAM, which enables higher throughput and better efficiency.

Increased capacity: WiFi-6 divides a wireless network's carrier into several smaller channels using Orthogonal Frequency Division Multiple Access (OFDMA), which enables full duplex mode and more than one node can transmit messages simultaneously. This increases overall network capacity and efficiency, especially in congested areas.

Reduced latency: Target Wake Time (TWT) technology allows WiFi-6 devices to determine the frequency by which nodes can send and receive data by signaling and hence lowering delay and energy use.

Improved power efficiency: WiFi-6 nodes support the TWT properties that helps the nodes in a network to determine when to stop using battery and prevent other energy dissipation by simply entering into the sleep mode.

Enhanced performance in crowded areas: WiFi-6 includes features like BSS Coloring, which reduces interference in dense environments by distinguishing between neighboring networks, thereby improving performance.

WiFi-6E: WiFi-6E is an advancement over WiFi-6 which uses 6 GHz spectrum and inherits all the properties of WiFi-6 plus it has its own perks:

More available spectrum: The 6 GHz channel adds a considerable quantity of bandwidth for the user of WiFi and provides almost no congestion, higher channel capacity, and quicker transmission.

Wider channels: WiFi-6E supports wider channel bandwidths, such as 160 MHz, which enables even higher data rates.

Lower interference: Because the 6 GHz frequency range is not as busy, these systems have fewer disturbances with other devices using WiFi or not thus allowing the device to use internet at maximum performance rate with reliability

Support for new use cases: The increased frequency in the 6 GHz range enables fresh uses to make use cases requiring higher bandwidth and lower latency, such as virtual reality, or VR, mixed reality (AR), High resolution video streaming, and other resource-intensive applications. To fully benefit from WiFi-6E, both the Wi-Fi router or access point and the client devices (such as smartphones, laptops, and Connected gadgets) have to comply with the WiFi-6E standard and operate in the frequency range of 6 GHz. WiFi-6 and WiFi-6E provide considerable speed, capacity, and performance increases, making them appropriate for applications with a high number of nodes communicating or high-bandwidth requirements.

Thus, it is safe to say WiFi-6 and WiFi-6E comes with significant improvements in speed, capacity, efficiency, and performance, making them an irreplaceable standard in situations where nodes communicating to each other over WiFi are in huge. They provide faster and more reliable wireless connections, enhancing the overall user experience and enabling the use of advanced applications and services.

HISTORY

In compliance with a 1985 American Telecommunications Committee order, portions of the Ghz channels were made accessible to unlicensed wireless usage. Since these use identical 2.4 gigahertz ranges like equipment such as microwaves, those ranges of frequencies remain subject to disturbance. Wave LAN, the forerunner to 802.11, originated in the Netherlands in 1991 by "NCR Corporation" & AT&T Limited intended implementation in the payment process systems. the NCR's "Vic Hayes and Bell Labs' Bruce Tuch" addressed the Society of Engineers (IEEE) about creating a code of conduct. Over eleven years, Vic Hayes was chairman of IEEE 802.11, and both men were involved in the creation of the early IEEE 802.11b and IEEE 802.11a norms. During the year 1992, a team of scientists of the Commonwealth Scientific and Industrial Research Organization or CSIRO in the Radio Physics Division, under the direction of Dr. John O'Sullivan, produced a working trial platform for a network that used wireless technology. Others nevertheless, think that this is an example of trademark fishing. When the 802.11 protocol was first introduced in 1997, it allowed connection speeds of up to 2 Mbit/s. In 1999, 802.11b was added to enable for 11 Mbit/s connection speeds. In 1999, the Wi-Fi Alliance was formed as a trade organization to handle the WiFi trademark rights, whose major role is to sell devices runs in the developed standard

WIRELESS FIDELITY SIXTH GENERATIONS' BASIC SCHEMA

The structure of WiFi-6 can be divided into different components that work together to provide enhanced wireless connectivity. Let's explore the key elements of WiFi-6:

OFDMA: It is a key component of WiFi-6 which allows the more effective spectrum usage. It splits the available frequency spectrum into Resource Units (RUs), which are sub division of the bandwidth. Each RU can be assigned to a certain device or utilized for a specific purpose. This enables numerous devices to broadcast data concurrently inside a single channel, dramatically improving network capacity and decreasing latency. Previously, whenever a STA communicated information, a large number of small management and control frames would occupy the whole channel, in variable message size. This is comparable to a huge bus with only one passenger on board. This is completely implausible. This technique breaks an electromagnetic wave over many sub-channels in the spectrum space to form resource units (RUs). Because just user data is transferred over RUs and doesn't use the full channel, many The Service Transfer Agents can transmit data at the same time during every single interval. The Service Transfer Agents are now no longer necessary to wait in the queue hence, increasing productivity while decreasing queue time. In 20 MHz Ghz, wifi-5 contains fifty-two(52) information transporting mini sub bands, whereas wifi-6 contains two hundred thirty four(234) mini sub bands. An Access Point assigns RUs based on downlink packets and user priorities while employing downlink OFDMA. In uplink OFDMA, an access point detects The Service Transfer Agents of assets which may be allocated using frames that are timely triggered.

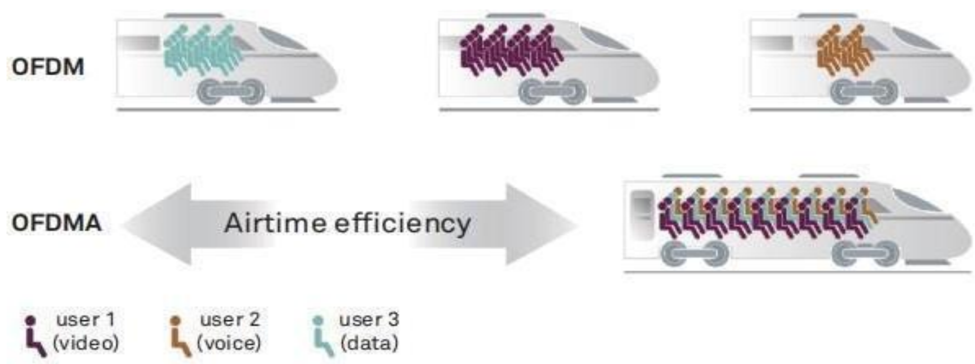

Figure 1. OFDMA Flow [4]

MU-MIMO: It stands for "*Multi-User Multiple Input Multiple Output*". This acts as a critical element of WiFi-6 that is an enhancement over previous Wi-Fi iterations. This method enables numerous devices to interact with the access point (AP) at the same time by utilizing multiple antennas. It is supported in WiFi-6 for communication either upload or download., allowing for more efficient communication with many devices and improved overall network performance. This is intended to manage the environment and services in which multiple devices are attempting to connect on a WiFi connection around the exact same time. This technique allows several users to access router functions without interruption. When a Service Transfer Aagent supports MU-MIMO, an AP can deliver data packets to many The Service Transfer Agents around the exact same time. An AP could only provide data to one STA at a time in Wi-Fi 5, however WiFi-6 can cover eight The Service Transfer Agents at the exact same time. WiFi-6 also supports uplink MU-MIMO, allowing up to eight 1x1 STAs to be sent at the same time. [7 - 10]

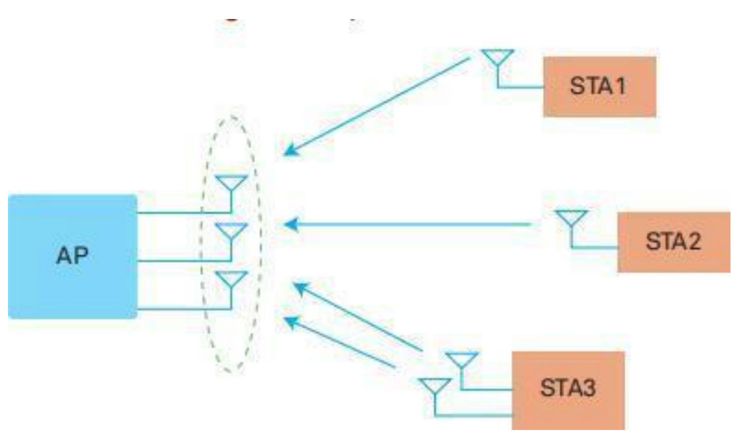

Figure 2. Co-working of MU-MIMO

TWT: TWT stands for "target wake time". This property allows devices connected using WiFi-6 to consume less energy. It enables equipment to send or receive data in an ordered and systematic manner. By synchronizing communication schedules between the AP and devices, TWT reduces unnecessary device wake-ups, resulting in power savings and improved battery life for connected devicesThis technology that allows an AP to monitor Wi-Fi network usage with the goal to reduce disagreements with other units (STAs) thus reduce the processing time. TWT extends equipment rest periods thus conserves the battery's life. For instance, when you connect many intelligent home gadgets to your house's WiFi network, the AP may create a get up connection for every gadget independently. As a result of this, gadgets go into active state upon obtaining awakening calls, while they stay in state of sleep during every other moment. Another instance is the reality that one of the gadgets inside the WiFi-6 AP's coverage might be an IoT proximity gauge who requires no continual electromagnetic interaction with the internet. With TWT functionality, an Internet of Things probe could be engaged on frequent intervals. Through functioning in this way, its feature may improve the lifespan of batteries for portable/mobile gadgets as well as boost network performance. The method allows the contemporaneous connectivity of many services, such as audio, data, and video services, across various gadgets. [8]

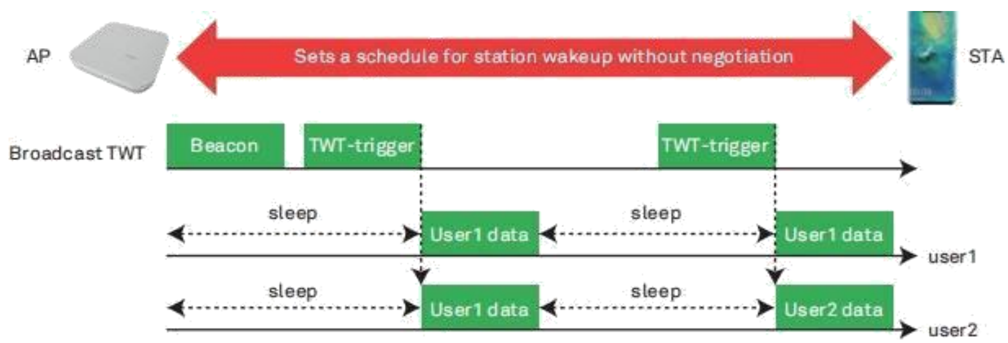

Figure 3. Broadcast Operation of TWT

BSS Coloring: BSS Coloring is a mechanism that helps alleviate congestion and interference in environments with multiple overlapping Wi-Fi networks. Each network is assigned a unique "color" that is embedded in the Wi-Fi frames. Devices can then differentiate between frames from their own network and frames from neighboring networks, reducing interference and improving overall network performance.

*1024-QAM***:** WiFi-6 features 1024- higher-order Quadrature Amplitude Modulation which can be seen as a state of the art, sophisticated encoding method. When contrasted to prior WiFi norms, it makes it possible for more efficient data encoding and better throughput. With this higher modulation strategy, WiFi-6 devices may reach larger data rates, increasing total network performance as well as bandwidth.

Channel Utilization and Spectrum Efficiency: WiFi-6 incorporates various mechanisms to enhance spectrum efficiency and reduce interference. These include improved channel access methods, more efficient use of available channels, and better management of transmission collisions. These enhancements result in higher network throughput and improved performance, particularly in high-density environments.

By combining these features, WiFi-6 (802.11ax) Better transfer speeds, larger bandwidth on networks, fewer delays, improved energy economy, plus greater efficiency within congested locations include the benefits of this technology. The new features allow WiFi-6 to meet the expanding needs for contemporary mobile connectivity while also supporting an array of software as well as gadgets.

How WiFi-6 Uses OFDMA?

WiFi-6 employs OFDMA to support following additional benefits:

Frequency Division: OFDMA divides the available frequency spectrum in Resource Units (RUs) which are small sub-ranges of bandwidth. These RUs can vary in size depending on the specific implementation, typically ranging from 26 sub-carriers to 242 sub-carriers.

Allocation of Resource Units: In WiFi-6, the access point (AP) allocates different RUs to different devices within a given channel. Each RU can be allocated to a specific device, a group of devices, or a specific purpose. This allocation is managed by the AP using advanced scheduling algorithms.

Simultaneous Data Transmission: With OFDMA, multiple devices can transmit data simultaneously within the same channel by utilizing their assigned RUs. Each device can use its allocated RU to send or receive data independently of other devices. This parallel transmission capability increases the network's capacity and efficiency, allowing more devices to communicate simultaneously.

Dynamic RU Allocation: The AP dynamically adjusts the RU allocation based on the real-time communication needs of connected devices. It can allocate more RUs to devices that require higher bandwidth or prioritize specific devices or applications. This dynamic allocation helps optimize resource utilization and maximize network performance.

Efficient Handling of Small Data Frames: OFDMA in WiFi-6 also addresses the issue of small data frames. Traditional Wi-Fi norms, such as WiFi-5, often experience inefficiency when handling small packets, leading to increased overhead. With OFDMA, WiFi-6 can group several small data frames from different devices together in a single RU, reducing overhead and improving overall efficiency.

Support for Uplink OFDMA: The advantages of OFDMA are extended to upstream broadcasts via WiFi-6. Upstream transmission was formerly limited to SU-MIMO (Single User Multiple Input Multiple Output) / SU-SISO (Single User Single Input Single Output) methods. Multiple devices can transmit data to the AP at the same time using WiFi-6's uplink OFDMA, increasing capacity and decreasing latency.

By employing OFDMA, WiFi-6 enables more efficient utilization of the frequency spectrum, supports simultaneous transmissions from multiple devices, improves network capacity, and enhances overall performance. These enhancements make WiFi-6 particularly well-suited for high-density environments with numerous connected devices and diverse traffic requirements.

DIFFERENCE BETWEEN WIRELESS FIDELITY VERSION 5 AND 6

IEEE Standards (Physical)-802.11							
Protocol	**Release Date**	**Bandwidth (GHz)**	**Minimum Sub-Carrier Bandwidth**	**No. of Valid Sub-Carrier**	**Data Rate In Mbps**	**Accessible MIMO Band**	**Regulation Delivery Technique**
802.11 ac	Dec 2013	5	312.5 KHz	234	433	8	256-QAM
802.11 ax	Sep 2019	2.4&5	78.5 KHz	980	600	10	1024-QAM

Table 1. IEEE 802.11 ac (WiFi 5) vs. IEEE802.11 ax (WiFi-6)

***IEEE802.11ac*:** WiFi 5 relies on 802.11ac architecture. The standard is the 5th installment in WiFi communication norms, which were introduced on December of 2013. Its 5GHz operating band has been separated into areas with 20, forty, eighty, and 160 MHz, respectively. These guidelines outperform previous WiFi norms in terms of both performance and availability. This is possible to attain this employing OFDM method [9]. The IEEE 802.11ac equipment support MU-MIMO (4*4) in the downstream. The IEEE

802.11ac standard employs the QAM encoding technique which uses 256 bits. With the help of this method, a group of users, wireless terminals, and other devices with many inputs and outputs can communicate with one another. It is challenging to use Wi-Fi 5 in settings that call for several overlapping cells with disputed ambient interference. [10]

IEEE802.11ax: WiFi-6 is a product of 802.11ax technology. WiFi-6 will revolutionize the experience of end user who wants constant healthy stream of network data without any disturbance than its previous iterations. its implementation enables a new and increased level of user satisfaction in dense deployment settings. WiFi-6 is more concerned with upping the user experience's difficulty. The following modifications will be made to the Wi-Fi market during the next five years in order to increase customer satisfaction [10, 12]. Highest possible bandwidth: 9.6 Gbit/s. More STAs may access the network simultaneously thanks to a 4-times improvement over 11ac in network access capacity. This also results in a more than 30% reduction in terminal power consumption. It uses a small amount of power.

Key Points	**WiFi 5**	**WiFi-6**
Channels	20,40,80+80,160 MHz	20,40,80+80,160 MHz
Connection Mode	OFDM	OFDMA
Speed of Connectivity	Low	High
Entry Control Point	Four	Eight
Receivers	MU-MIMO (4*4)	MU-MIMO (8*8)
Noise	More	Less
Battery Drainage	More	Less
Extra Property	N/A	TWT, BSS Coloring

Table 2. IEEE802.11 ac (Wi-Fi 5) vs. IEEE802.11 ax (WiFi-6)- Additional Features [14]

WIFI-6 VS WIFI-6E

	WiFi-6	**WiFi-6E**
Data Rate	1.146 Gbps	1.788 Gbps
Bandwidth	2.4 & 5 GHz	2.4, 5 & 6 GHz
Possible Band in Highest(160MHz) Range	1	8
Mesh Tech.	Yes	Yes

Table 3. WiFi-6 vs WiFi-6E [10,13]

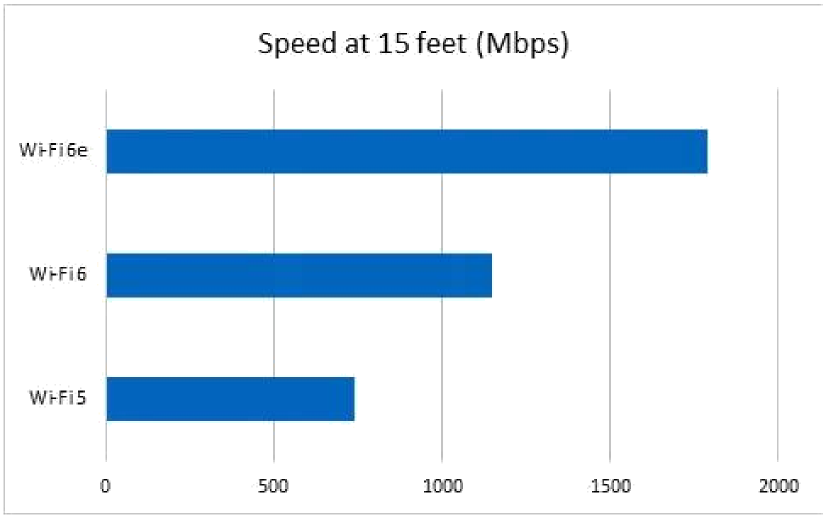

Figure 4. Speed of WiFi Technologies

CONCLUSION

This chapter discusses how IEEE802.11ax boosts functionality and reliability over IEEE802.11ac. The recently released IEEE 802.11ax norms went live in September 2019 as well as seeks to achieve Gbps speed along with data flow rates. Commercial WiFi evolved become a basis for digital change as well as increased output and efficiency throughout a broad range of different sectors. A nice Wi-Fi network may considerably boost user satisfaction and corporate operational efficiency while also enabling more digital and intelligent services. If you have not already done so, we have to setup or switch into the current version of WiFi version as quickly as possible to be able to meet the needs of electronic service enhancement.

This chapter demonstrates that the potential outcomes of fifth-generation technology in addition with WiFi-6 have to be considered for the larger picture of the way that earlier versions of mobile as well as WiFi systems contributed to the expansion of mobile wireless communication along with what could mean in the years ahead. With ever increasing demand of new connection, this is expected that electronic transmission is going to grow quickly and alongside an increasing share of gadgets relying on wireless communication as their primary means of connection. As the COVID-19 pandemic of 2019-2021 has demonstrated, increased digital connectivity is critical to facilitating distant work, education, and social participation during the worldwide catastrophe. However, as a result of the pandemic's changed social and work patterns, new tendencies may arise. These innovations could have a bearing regarding the geographical as well as chronological utilization of a wireless internet access connection, in addition to the associated profitability associated with every innovation. The customer requirements for internet are going to be greatly influenced by the ongoing willingness to watch increasing amounts of better resolution streaming material, although business needs is reflected by the increased use of cloud-based systems and services [21].

REFERENCES

[1]. F. A. Abid, F. Faydhe al-Azzawi, K. Y. Kamal and M. S. Ibrahim, "5G and 6G WiFi Transceiver Comparison in Multi Modulation Schemes Performance with MATLAB Simulink," 2023 Third International Conference on Advances in Electrical, Computing, Communication and Sustainable Technologies (ICAECT), Bhilai, India, 2023, pp. 1-7, doi: 10.1109/ICAECT57570.2023.10117736.

[2]. I. -F. Chen, X. -J. Chen and C. -M. Peng, "Advanting Throughput Antenna Structure for 4×4 MIMO WiFi 6 Mini PC Applications," 2020 IEEE International Symposium on Antennas and Propagation and North American Radio Science Meeting, Montreal, QC, Canada, 2020, pp. 1419-1420, doi: 10.1109/IEEECONF35879.2020.9329527.

[3]. B. Yang, H. Huang, B. Feng and L. Deng, "An Omnidirectional Antenna with Wide Bandwidth and High Gain for WiFi-5 and WiFi-6 Applications," 2020 IEEE 3rd International Conference on Electronic Information and Communication Technology (ICEICT), Shenzhen, China, 2020, pp. 714-716, doi: 10.1109/ICEICT51264.2020.9334314.

[4]. Hall, J. W., Thacker, S., Ives, M. C., Cao, Y., Chaudry, M., Blainey, S. P., & Oughton, E. J. (2016a). Strategic analysis of the future of national infrastructure. Proceedings of the Institution of Civil Engineers - Civil Engineering, 1–9. https://doi.org/10.1680/jcien.16.00018

[5]. Hall, J. W., Tran, M., Hickford, A. J., & Nicholls, R. J. (2016). The future of national infrastructure: A system-of-systems approach. Cambridge University Press.

[6]. Huang, J., Wang, C.-X., Feng, R., Sun, J., Zhang, W., & Yang, Y. (2017). Multi-frequency mmWave massive MIMO channel measurements and characterization for 5G wireless communication systems. IEEE Journal on Selected Areas in Communications, 35, 1591–1605. https://doi.org/10.1109/JSAC.2017.2699381

[7]. Intel. (2020). Comparing 5G vs. WiFi-6 accessed 12.27.20 https://www.intel.com/content/www/us/en/wireless-network/5g-technology/5g-vs-wifi.html

[8]. D Pandey, V Pandey, “”Requirement Engineering: An Approach to Quality Software Development, Journal of Global Research in Computer Science Vol. 3, Issue 9, pp. 31-33, 2012.

[9]. IEEE 802.11, https://en.wikipedia.org/wiki/IEEE_802.11, accessed August 22, 2015.

[10]. IEEE802.11ac: The Next Evolution of Wi-Fi Standards, A Qualcomm publication, May,2012 Accessed August 22, 2015.

[11]. Ramia Babiker Mohammed Abdelrahman, Amin Babiker A. Mustafa, Ashraf A. Osman- A Comparison between IEEE 802.11a, b, g, n and ac Standards, IOSR Journal of Computer Engineering (IOSR-JCE), Ver. III (Sep. – Oct. 2015), PP 26-29

[12]. E. Perahia and R. Stacey, ―Next Generation Wireless LANs: Throughput, Robustness, and Reliability in 802.11n‖, Cambridge University Press, Cambridge, UK, 2008.

[13]. Jungnickel, V., Manolakis, K., Zirwas, W., Panzner, B., Braun, V., Lossow, M., Sternad, M., Apelfro¨jd, R., & Svensson, T. (2014). The role of small cells, coordinated multipoint, and massive MIMO in 5G. IEEE Communications Magazine, 52, 44–51.

[14]. Katsaros, K., & Dianati, M. (2017). A conceptual 5G vehicular networking architecture. In W. Xiang, K. Zheng, X. Shen, &) Sherman (Eds.), 5G mobile communications (pp. 595–623). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-34208-5_22.

[15]. Khorov, E., Kiryanov, A., Lyakhov, A., & Bianchi, G. (2019). A tutorial on IEEE 802.11ax high efficiency WLANs. IEEE Communications Surveys Tutorials, 21, 197–216. https://doi.org/10.1109/COMST.2018.2871099

[16]. Knieps, G., & Stocker, V. (Eds.). (2019). The future of the internet: Innovation, integration and sustainability (1 edition). Nomos Verlag.

[17]. Lehr, W., & McKnight, L. W. (2003). Wireless internet access: 3G vs. WiFi? Telecommunications policy. Compeitition in Wireless: Spectrum, Service and Technology Wars, 27, 351–370. https://doi.org/10.1016/S0308-5961(03)00004-1

[18]. Increasing Safety and Robustness in Traffic Controlling Circumstances Using WSN" **IJCRT**, Vol. 6 | Issue 1, Jan 2018, ISSN 2320-2882, pp. 16-21.

[19]. A Review on various Security Issues and Challenges in VANET", " **IJCRT,** Vol. 6 | Issue 1, Feb 2018, ISSN 2320-2882, pp. 396-40.

[20]. Dr. Prakash Kumar, International Journal of Computer Science and Mobile Computing, Vol.6 Issue.12, December- 2017 | ISSN 2320–088X, pp. 157-163.

[21]. Dr. Prakash Kumar, International Journal of Creative Research Thoughts , Volume 6, Issue 2 April 2018 SSN: 2320-2882, pp. 428-434.

[22]. Dr. Prakash Kumar, Security Issues in Vehicular network" in **JESMT** Vol. 2 | Issue 1, 2012, ISSN 2231- 1521.

[23]. "Survey on Tools & Technologies used in Semantic web and IOT" **IJCRT,** Vol. 6 | Issue 2, June 2018, ISSN2320-2882,pp. 302-306.

[24]. "A Novel Software development life Cycle Model for Developing Software Project", **IJCRT,** Vol. 6 | Issue 2, April 2018, ISSN 2320-2882,pp. 428-434.

[25]. "Security Aspects in Social Networking Model "**IJCRT,** UGC Approved, Vol.6| Issue 1, Jan 2018, ISSN 2320-2882.

[26]. "Cloud Database Services improve using load balancing Technique" in **JETIR** Vol.8| Issue 1, 2021, ISSN 2349-5162,pp.822-826

[27]. Impact of the Internet Shutdown in Ranchi, Jharkhand: A Survey. Volume 9 Issue 7 July, 2022, JETIR, ISSN: 2349-5612.

[28]. A review on the Risk and its Counter Measures in Cloud Environment. Volume 9 Issue 8, August 2022, JETIR, ISSN: 2349-5612.