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# A COMPARISON STUDY OF WIFI 6 AND WIFI 5

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**ABSTRACT:-** India has the second largest population in the world. So every human being wants to connect up to date with the technology, hence more Bandwidth required to access their entertainment like video games, audio, text and calling. IEEE standard has introduced 802.11ax which is also called WiFi 6. The 802.11ax (WiFi6) supports four times higher network bandwidth and concurrently compared to 802.11ac (WiFi5). It provides many facilities like a network without a coverage hole, provides service with no waiting time, no packet loss during roaming, use in various sectors including digital calculation, digital airport, smart health care, smart government etc. WiFi6, the sixth generation of WiFi, incorporates a large number of key 5G technologies such as OFDMA, MU-MIMO and 1024 QAM and reduces network latency from 30ms to 20ms. The aim of this paper is to compare between Wifi 5 and WiFi 6.

**KEYWORDS:** IEEE 802.11, Networking, Communication, WLAN, OFDMA, MU- MIMO, QAM, WiFi, VR, AR.

## I. INTRODUCTION:

With the advancement of the mobile Internet era, wireless networks are useful in our daily work, learning, and life. Internet access is the basic necessity for us. Wi-Fi networks are widely Identified as infrastructure that is as Similarly essential as water and electricity. With Wi-Fi entering its 20th year, the benefits and business values of Wi-Fi are well known for enterprise. Wi-Fi technology will continue to grow to increase the Wi-Fi user experience by enhancing performance, capacity, and coverage.

Today, 70% of enterprises have implemented wireless offices, greatly improving their working efficiency. Through a Wi-Fi network, teachers and students can acquire online learning resources. Schools and colleges can also deliver the teaching content of students through Virtual Reality (VR) and Augmented Reality (AR), making teaching [1-4]

and learning more efficiently than ever. For example, In a stadium or large conference room or auditorium, it is unfeasible to employ a wired network that permits all users to access the internet but using wifi this is a feasible choice[5, 6].

In the coming future, the number of connected devices will reach 100 billion by 2025 so need a higher bandwidth, full coverage, long distance communication, low latency, high stability, fast speed etc. To support all these growing parameters, new connectivity technologies come up in the communication market. These include the WLAN, Wifi, 3G, 4G LTE, WiMax etc. All these technologies follow various standards on how to system communicate [7]. The main difference between these technologies is the broadband mobile devices are based on the Wifi with IEEE802.11 and the smartphone utilizes the 3G, 4G LTE technologies.[8].The IEEE802.11 is divided into the different categories like IEEE802.11a,b,g,n,ac and ax but in this paper, a comparative study of only two categories IEEE802.11ac and IEEE802.11ax. In short the new IEEE802.11ax standard will be called "Wi-fi 6" while the two previous Wi-Fi technology generation will be called "Wi-Fi 4 (IEEE802.11n) and Wi-Fi 5 (IEEE802.11ac) because this makes Wi-Fi names more user friendly [9, 10].

**Table.I Comparison between IEEE802.11 ac and ax**

| **802.11 Network PHY Standards** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **802.11 Protocol** | **Release date** | **Frequen cy (GHz)** | **Minimu m subcarri er bandwid th** | **No. of Valid subcarri er** | **Stream data rate Min- Max (Mbit/s)** | **Allowabl e MIMO Streams** | **Modulation Antenna Tech.** |
| 802.11 ac | Dec 2013 | 5 | 312.5 KHZ | 234 | 433 | 8 | 256-QAM |
| 802.11 ax | Sep2019 | 2.4 and 5 both | 78.5 KHZ | 980 | 600 | 10 | 1024-QAM |

**II. DETAILS OF IEEE802.11 AC AND AX STANDARDS**

A. IEEE802.11ac: 802.11ac technology means Wifi 5. It is the fifth generation in WiFi networking standards released in December 2013. this standard operating frequency is 5GHz and bandwidth of 20, 40, 80, 160MHz sectors. The stream rate ranges for these bandwidth sectors are 7.2-96.3 Mbps for 20MHz, 15-200Mbps for 40MHz, 32.5-433.3Mbps for 80MHz and 65-866.7Mbps for 160MHz. These standards show that the better performance and better coverage compared to older standards of Wifi. It is accessed on the OFDM technology[2] The 802.11ac devices support the MU-MIMO (4*4) in downlink. The 802.11ac standard utilizes a modulation technique 256 QAM. This technique allows a set of users or wireless terminals and more multiple input and multiple output to communicate with each other.In Wifi 5 it is difficult to employ within environments requiring multiple overlapping cells and contentious environment interference[6]

B. IEEE802.11ax: 802.11ax technology means Wifi 6. Wi-Fi 6 is Important for changing the way we support applications on today's Wi-Fi networks. Its deployment allows a new and improved user satisfaction in dense deployment scenarios compared to that of earlier Wi-Fi generations. Wifi 6 focuses more on increasing the challenge of user experience. It is the main technology in the Wifi market in the next five years which will bring the following changes to improve the user satisfaction[1, 3]

- Ultra-high bandwidth: 9.6 Gbit/s (theoretical)
- 4-times of 11ac on network access capacity, allowing for more STAs to access the network simultaneously
- Power consumption of terminals reduced by more than 30%.
- It has low power consumption.

The IEEE 802.11ax standard involves a number of features, including orthogonal frequency division multiple access (OFDMA), multi-user multiple-input multiple- output (MU-MIMO), target wake time (TWT) and BSS coloring.

OFDMA: OFDMA is defined as orthogonal frequency division multiple Access (OFDMA) and was first applied to communication technologies. In the earlier OFDM technology was used but in Wifi 6 OFDMA technology is adopted to improve the spectrum utilization. In the previous version, when each STA sends data (regardless of the size of the data packet), the whole channel is occupied by a large number of small- sized management frames and control frames. This is like a big bus carrying only one passenger. This is very unfeasible. The OFDMA technology divides a radio channel into multiple subcarriers in the frequency domain to form resource units (RUs). User data is only carried on the RUs and does not occupy the whole channel, so that implementing simultaneous transmission of data from multiple STAs during each time segment. STAs no longer need to wait in queues. This technology improves the efficiency and reduces the queuing delay. In the 802.11ac 52 data carrying sub carriers in a 20 MHz RF channel, while 802.11ax has 234. Wi-Fi 6 supports OFDMA in both downlink and uplink directions. In downlink OFDMA, an AP determines the allocation of RUs based on the downlink packets and priorities of users. In uplink OFDMA, an AP observes STAs of the resources that can be allocated through trigger frames.

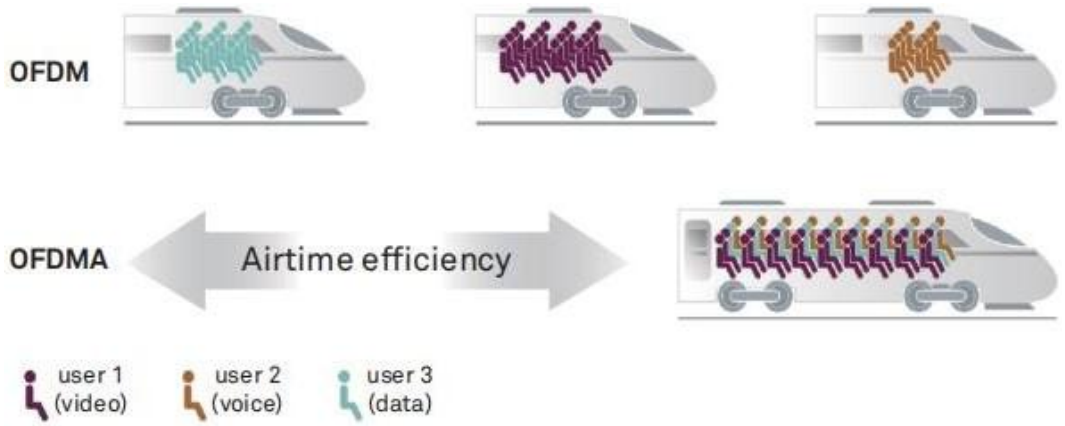


**Figure 1: OFDMA Channel Mode**

MU-MIMO: MU-MIMO which stands for multi user multiple input multiple output. It was created to support the technology and environment where multiple users are trying to connect a wireless network at the same time.This technology allows the multiple user to access router functions without any interference. The 802.11ac Wave 2 is downlink MU-MIMO. APs can send data packets to multiple STAs that support MU-MIMO at the same time, In the previous version, the APs can communicate with only one STA at a time but in Wi-Fi 6 take over this technology and is capable to send data to eight STAs at the same time. Additionally, WiFi 6 supports uplink MU-MIMO and allows for simultaneous uplink transmission of a maximum of eight 1x1 STAs.
OFDMA and MU-MIMO are the two most essential technologies of Wifi 6 they allow the multiple simultaneous function transmission in the frequency space and physical space respectively. These two factor advantages greatly improve the overall network performance and speed and to optimize the user satisfaction [7-10]

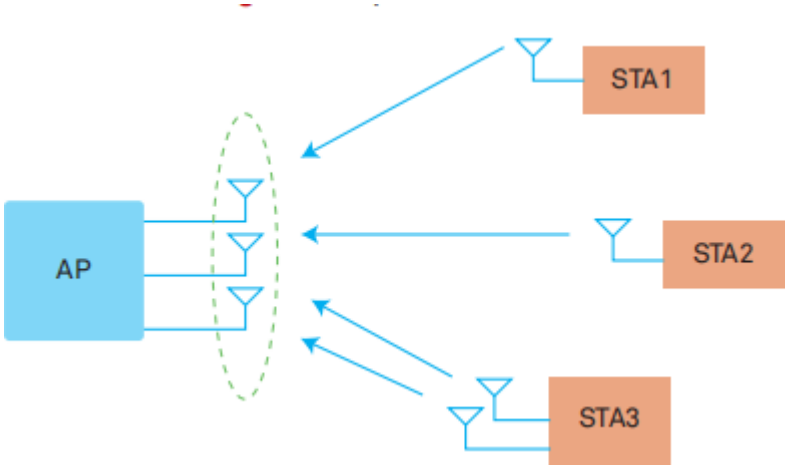


**Figure 2: MU-MIMO coworking mode**

TWT: Another unique feature of the Wifi6 is Target Wake Time (TWT). It is a method to allow an AP to observe the activity in the Wifi network, in order to minimize the conflict between the stations (STAs) and to reduce the required amount of time.The TWT function also increases the sleep time of devices and saves power battery life. For example, if multiple smart home devices are connected to the Wi-Fi network in your home, the AP can set up a wake-up protocol with each device individual. In this manner, the devices enter the working mode only after receiving the wakeup messages, and stay in a sleep mode during other times and another example is one of the devices within range of a Wi-Fi 6 AP may be an IoT proximity sensor that does not require continuous radio contact with the network. The TWT feature can be used to periodically activate the IoT sensor. In working this way, the TWT function can improve network efficiency and conserve battery life in portable/mobile devices. In this technology multiple devices can be woken at the same time to implement simultaneous connection for multiple services such as video, voice and data services [8]

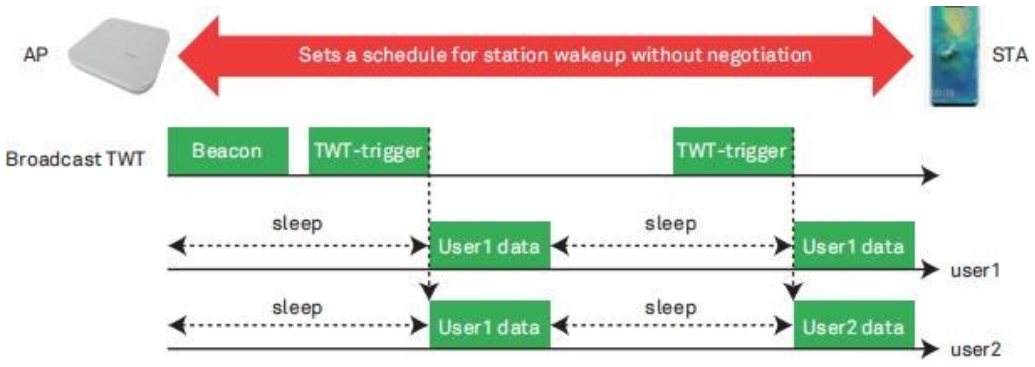


**Figure 3: Broadcast TWT operation**

Spatial Reuse (BSS Colouring): The BSS stands for Basic Service Set. This technology is mainly used to avoid the interference between the multiple users because at the same time multiple devices are connected to each other. This technology is especially used in dense medium.The shortage of frequency resources has been a challenge to Wi-Fi deployment, especially in high-density stadiums. When multiple APs are deployed, they can detect the frames of all other APs on the same channel. Even the most powerful frequency modulation algorithm

cannot solve the co-channel interference issue. To increase overall system performance and utilization of spectrum resources in a dense

deployment environment, Wi-Fi 6 establishes a spatial reuse technique, that is, BSS coloring. This technique adds a 6-bit identifier to a frame to distinguish the BSS of different APs on the same channel. This method allows the frequency spectrum by a number or "color code" which is included within the network physical-layer (PHY) header that is communicated between each device and its AP. This process is possible in Wifi 6.BSS coloring indicates when a channel is unavailable, two or more devices are coded by the same color. It also provides information to manage multiple devices and users in congested areas by adjusting clear-channel-assessment (CCA) parameters, including dynamic range and power control.

**Table. II Comparison between IEEE802.11 ac and ax with additional features**

| Parameter | WiFi-5 (802.11ac) | Wifi -6 (802.11 ax) |
|---|---|---|
| Bandwidth (Channels) | 20,40,80+80,160 MHz | 20,40,80+80,160 MHz |
| Access | OFDM | OFDMA |
| Connection Speed | Less | 40% higher |
| Maximum user/AP | 4 | 8 |
| Antennas | MU-MIMO (4*4) | MU-MIMO (8*8) |
| Interference | High | low |
| Power Consumption | High | Low |
| Core technologies | Downlink | Uplink and downlink |
| Feature | Not applicable | TWT, BSS colouring |

**III. MISCONCEPTION ABOUT WIFI 6**

1. Wifi 6 and 802.11ax are two different standards**:** The new name reflects the technical progress following the upgrade of the Wifi standards.

**Table. III Difference between WiFi alliance and IEEE**

| Wifi Alliance | IEEE |
|---|---|
| Wifi -4 | 802.11n |
| Wifi -5 | 802.11ac |
| Wifi -6 | 802.11ax |
| Wifi-7 | ? |

2. Aps deployed on the live network can be upgraded through software to support Wifi 6: Wifi 5 and Wifi 6 are the two different generations. Wifi 6 has introduced more than 75 latest functions, which can be only supported by Wifi

chipset. Therefore, the new features of Wifi 6 can only be implemented after AP hardware is replaced.

3. Wifi 6 will be of little value in the 5G era: Wifi 6 and 5G technologies complement each other and it is used for different scenarios and applications. These two technologies will coexist and be mutually beneficial.

4. Deploying a Wifi 6 network directly can solve user experience issues in high density scenerio: To obtain the optimal user experience, a professional site survey and network planning through a software based network algorithm is required. Aps may improve the user experience.

## IV. CONCLUSION

This paper describes how IEEE802.11ax builds up the quality and performance when compared with IEEE802.11ac standard. IEEE 802.11ax standard is the new technology released september 2019 to obtain throughput and high data stream rate in the range of Gigabit per second. Enterprise Wi-Fi has become an infrastructure that supports digital evolution and increases production and work efficiency of varying industries. A convenient Wi-Fi network can greatly upgrade enterprise operation efficiency and user satisfaction, and support more digital and intelligent services of organization. Therefore, if you have not established a Wi-Fi network. you cannot meet the requirements of your digital service development you are advised to deploy or upgrade to the latest WiFi as soon as possible, with the following factors considered:

Trends of wireless networks in the future: There are three typical trends in the development and evolution of full wireless networks in the future:

(1) Users' requirements on wireless networks are shifted from coverage-based connections to high broadband experience (highly reliable signals, video-class capacity, and millisecond-level latency).

(2) Multiple IoT applications and Wi-Fi networks are installed together, sites on different networks are converged, capacities are collaboratively planned, and interference between networks is avoided.

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