



Wi-Fi 7: The Next Frontier in Wireless Connectivity

Dr.A.Shaji George¹, A.S.Hovan George², Dr.T.Baskar³

^{1,2}Independent Researcher, Chennai, Tamil Nadu, India.

³Professor, Department of Physics, Shree Sathyam College of Engineering and Technology, Sankari Taluk, Salem District, Tamil Nadu, India.

Abstract – Wi-Fi 7 (802.11be) is poised to revolutionize the world of wireless connectivity by offering significant improvements in data rates, latency, and efficiency. As the next-generation wireless standard, it aims to address the ever-growing demand for faster and more reliable connections in both consumer and industrial applications. This survey paper delves into the key features of Wi-Fi 7, its potential impact on various sectors, and the current progress in its development and adoption. In addition, we examine the contributions of major industry players such as Apple, Intel, Qualcomm, Broadcom, and MediaTek in advancing and integrating Wi-Fi 7 technology. One of the most notable features of Wi-Fi 7 is its increased peak data rate, which is expected to be up to 40 Gbps, a significant leap from the Wi-Fi 6E's maximum data rate of 9.6 Gbps. This boost in speed is made possible by leveraging advanced modulation schemes, wider channel bandwidths, and enhanced multi-user multiple-input and multiple-output (MU-MIMO) capabilities. As a result, Wi-Fi 7 is set to deliver faster and more reliable connections for data-intensive applications such as high-resolution video streaming, augmented reality (AR), virtual reality (VR), and cloud-based services. Another key feature of Wi-Fi 7 is Multi-Link Operation (MLO), which allows devices to simultaneously connect and transmit data over multiple frequency bands or channels. This innovative approach significantly reduces latency, providing a seamless and high-quality user experience, particularly in time-sensitive applications like online gaming and real-time communication. Wi-Fi 7 also introduces Restricted Target Wake Time (RTWT), a technology that improves network efficiency by enabling routers to reserve bandwidth for specific types of data traffic. This feature ensures that critical data streams receive high priority, resulting in lower latency and better performance for mission-critical applications. Beyond its technical features, Wi-Fi 7 will have a profound impact on various industries. For instance, the automotive sector can benefit from faster and more reliable connections for vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication. Additionally, Wi-Fi 7's low latency can provide significant improvements for AR/VR experiences, industrial automation, and robotics, enabling more efficient and safer operations in these fields. As Wi-Fi 7 continues to progress towards its final specification, major industry players are actively involved in its development and integration. Apple, for example, is expected to adopt Wi-Fi 7 in its future products and is reportedly working on in-house network connectivity solutions. Meanwhile, Intel, Qualcomm, Broadcom, and MediaTek are all contributing to Wi-Fi 7's development and plan to introduce support for the new standard in their products. In conclusion, Wi-Fi 7 promises to usher in a new era of wireless connectivity by offering significant improvements in data rates, latency, and efficiency. Its wide-ranging impact on consumer and industrial applications underscores the importance of this emerging technology. As the standard continues to evolve, the collaborative efforts of major industry players will be crucial in ensuring the successful advancement and integration of Wi-Fi 7 technology into the market.



Keywords: Wi-Fi 7, Wireless technology, Data rates, Low latency, Network efficiency, Router infrastructure, Apple, IoT, Smart cities, Telemedicine.

1. INTRODUCTION

As the world becomes increasingly connected, the demand for faster, more reliable wireless connectivity continues to grow. This constant evolution of wireless technology has led to the development of Wi-Fi 7 (802.11be), the next-generation standard for wireless communication. The importance of Wi-Fi 7 lies in its potential to address the challenges posed by the ever-increasing number of connected devices and the growing need for high-speed data transmission in various applications. The purpose of this survey paper is to provide an in-depth overview of Wi-Fi 7, its key features, potential impact on consumer and industrial applications, and the role of major industry players in its development and adoption. Wi-Fi 7 builds upon the advancements made by its predecessor, Wi-Fi 6E, which introduced enhanced capacity, efficiency, and performance in the 6 GHz frequency band. However, Wi-Fi 7 takes wireless connectivity to a whole new level by further improving data rates, latency, and network efficiency. These improvements are essential to support the increasing number of devices connected to the internet, as well as to enable new applications and services that demand real-time responsiveness and high data throughput.

Some of the key features of Wi-Fi 7 include a peak data rate of up to 40 Gbps, Multi-Link Operation (MLO), and Restricted Target Wake Time (RTWT). These features work together to provide a seamless and high-quality user experience for a wide range of applications, such as high-resolution video streaming, augmented reality (AR), virtual reality (VR), cloud-based services, and mission-critical applications. The potential impact of Wi-Fi 7 on consumer and industrial applications is immense. For instance, in the automotive industry, Wi-Fi 7 can enable faster and more reliable vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication, leading to improved road safety and traffic management. In the realm of AR/VR, Wi-Fi 7's low latency and high data rates can provide more immersive experiences, enabling more realistic simulations for gaming, training, and education. Moreover, in industrial settings, Wi-Fi 7 can support advanced automation and robotics, leading to increased efficiency and productivity.

Table -1: Wi-Fi standards from Wi-Fi 0 to Wi-Fi 7, including their theoretical peak speed and invited year:

Wi-Fi Standard	Theoretical Peak Speed (Gbps)	Invited Year
Wi-Fi 0	11 Mbps	1997
Wi-Fi 1	54 Mbps	1999
Wi-Fi 2	6.93 Mbps	2003
Wi-Fi 3	10.9 Mbps	2006
Wi-Fi 4	300 Mbps	2009
Wi-Fi 5	6.9 Gbps	2014
Wi-Fi 6	9.6 Gbps	2019
Wi-Fi 7	46 Gbps	2023



As the development and adoption of Wi-Fi 7 progress, the contributions of major industry players such as Apple, Intel, Qualcomm, Broadcom, and MediaTek are crucial. These companies are actively involved in shaping the Wi-Fi 7 standard and are working on introducing support for the new technology in their products. Their collective efforts will play a significant role in ensuring the successful integration of Wi-Fi 7 into the market. Finally, Wi-Fi 7 represents a significant milestone in the evolution of wireless connectivity, offering unparalleled improvements in data rates, latency, and efficiency. Its potential impact on a wide range of consumer and industrial applications highlights the importance of this emerging technology. This survey paper aims to provide a comprehensive understanding of Wi-Fi 7, its key features, and the role of industry players in its development and adoption. As the world moves towards a more connected future, Wi-Fi 7 will undoubtedly play a crucial role in shaping the way we communicate, work, and live.

2. WI-FI 7: A TECHNICAL OVERVIEW

Wi-Fi 7 (802.11be) represents a significant step forward in wireless communication technology, offering remarkable improvements in data rates, latency, and network efficiency. This section delves into the technical aspects of Wi-Fi 7, discussing its peak data rate, Multi-Link Operation (MLO), Restricted Target Wake Time (RTWT), and frequency bands.

2.1. Peak Data Rate

One of the most remarkable features of Wi-Fi 7 is its increased peak data rate, which is expected to reach up to 40 Gbps. This is a substantial improvement compared to the maximum data rate of 9.6 Gbps offered by Wi-Fi 6E, the previous wireless standard. This leap in data rates is achieved through a combination of advanced modulation schemes, wider channel bandwidths, and enhanced Multi-User Multiple-Input and Multiple-Output (MU-MIMO) capabilities.

Wi-Fi 7 employs 4096-QAM (Quadrature Amplitude Modulation), a modulation scheme that allows for the transmission of more data per symbol, compared to the 1024-QAM used in Wi-Fi 6E. Additionally, Wi-Fi 7 supports channel bandwidths up to 320 MHz, double the 160 MHz bandwidth available in Wi-Fi 6E. This wider bandwidth enables higher data throughput, resulting in faster and more reliable connections.

Furthermore, Wi-Fi 7 enhances MU-MIMO capabilities by supporting up to 16 simultaneous streams, allowing routers to communicate with multiple devices concurrently. This improvement leads to increased network capacity and reduced latency, crucial for data-intensive applications and services.

2.2. Multi-Link Operation (MLO)

Multi-Link Operation (MLO) is a groundbreaking technology introduced in Wi-Fi 7 that enables devices to simultaneously connect and transmit data over multiple frequency bands or channels. This feature allows Wi-Fi 7 devices to maintain multiple connections at the same time, effectively distributing data traffic and reducing overall latency.

MLO is particularly beneficial for time-sensitive applications, such as online gaming and real-time communication, where low latency is crucial for a seamless user experience. By leveraging MLO, Wi-Fi 7 can substantially reduce latency and network congestion, ensuring optimal performance even in environments with a high density of connected devices.

2.3. Restricted Target Wake Time (RTWT)



Restricted Target Wake Time (RTWT) is another innovative feature of Wi-Fi 7 that aims to improve network efficiency. RTWT allows routers to reserve bandwidth for specific types of data traffic, ensuring that critical data streams receive high priority and are transmitted with lower latency.

RTWT works by allowing devices to negotiate specific wake time intervals with the router, during which they can transmit or receive data. These intervals can be restricted to certain types of data or applications, preventing network congestion and ensuring optimal performance for mission-critical applications.

This feature is particularly advantageous in settings where real-time communication or critical data transmission is essential, such as industrial automation, healthcare, and financial services. By utilizing RTWT, Wi-Fi 7 can deliver better performance and increased reliability for applications that demand high levels of network efficiency.

2.4. Frequency Bands

Wi-Fi 7 is designed to operate across multiple frequency bands, including the 2.4 GHz, 5 GHz, and 6 GHz bands. The availability of multiple frequency bands allows Wi-Fi 7 devices to take advantage of the unique characteristics of each band, such as the higher capacity and reduced interference offered by the 6 GHz band, and the longer range and better penetration provided by the 2.4 GHz band.

The inclusion of the 6 GHz band in Wi-Fi 7 is particularly significant, as it offers up to 1.2 GHz of additional spectrum for Wi-Fi use. This expanded spectrum enables Wi-Fi 7 devices to support more channels and wider channel bandwidths, leading to increased capacity, reduced latency, and improved network efficiency.

By supporting multiple frequency bands, Wi-Fi 7 can adapt to different network environments, balancing the need for high data rates, low latency, and extended range. This flexibility ensures that Wi-Fi 7 can deliver an optimal wireless experience for a wide variety of applications and use cases.

Lastly, Wi-Fi 7 represents a major leap forward in wireless technology, offering significant improvements in peak data rates, latency, and network efficiency through features such as MLO, RTWT, and multi-band support. These advancements make Wi-Fi 7 a highly capable and flexible wireless standard, well-suited to support the growing demand for high-speed, reliable connectivity in various consumer and industrial applications.

3. KEY APPLICATIONS AND BENEFITS

Wi-Fi 7's advancements in data rates, latency, and network efficiency have far-reaching implications for various applications across consumer and industrial sectors. This section explores the key applications and benefits of Wi-Fi 7, including AR/VR, high-resolution video streaming, automotive industry, cloud computing, gaming, video applications, mission-critical, and industrial applications.

3.1 Augmented Reality/Virtual Reality (AR/VR)

Wi-Fi 7's high data rates and low latency can have a transformative impact on AR/VR experiences and applications. Seamless streaming of high-quality 3D content and the ability to process and transmit data in real-time are crucial for creating immersive AR/VR experiences. Wi-Fi 7's advanced capabilities can significantly enhance the realism and responsiveness of AR/VR applications, unlocking new possibilities in gaming, entertainment, education, training, and telepresence.

3.2 High-Resolution Video Streaming



The growing demand for 4K and 8K video streaming requires robust and high-speed wireless connections. Wi-Fi 7's peak data rate of up to 40 Gbps and enhanced MU-MIMO capabilities make it well-suited to support high-resolution video streaming, ensuring smooth playback without buffering or quality degradation. By providing reliable and high-quality streaming experiences, Wi-Fi 7 can foster the widespread adoption of 4K and 8K video content in home entertainment and professional applications.

3.3 Automotive Industry

Wi-Fi 7 has the potential to revolutionize the automotive industry by enabling faster and more reliable vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication. The low-latency and high-capacity features of Wi-Fi 7 can support real-time data exchange between connected vehicles, traffic management systems, and roadside infrastructure. These capabilities can contribute to improved road safety, efficient traffic flow, and the development of advanced driver assistance systems (ADAS) and autonomous vehicles.

3.4 Cloud Computing, Gaming, and Video Applications

The advancements in Wi-Fi 7 can lead to substantial improvements in cloud computing, gaming, and video applications. For cloud computing, Wi-Fi 7's high data rates and low latency can enable faster and more efficient data processing and transfer between devices and cloud servers. This can boost the performance of various cloud-based services, such as data analytics, storage, and software as a service (SaaS).

In gaming, Wi-Fi 7 can provide a more responsive and seamless experience by reducing latency and supporting high-resolution graphics. This can enhance the quality of online multiplayer games, cloud gaming, and game streaming services. Moreover, the increased network capacity of Wi-Fi 7 can support the simultaneous streaming of multiple video applications, such as video conferencing, surveillance, and content creation, without compromising on quality or performance.

3.5 Mission-Critical and Industrial Applications

Wi-Fi 7's advanced features make it well-suited to support mission-critical and industrial applications, where reliable and real-time data transmission is essential. In healthcare, Wi-Fi 7 can enable the seamless transmission of medical data and support remote patient monitoring, telemedicine, and robotic surgery. In financial services, Wi-Fi 7 can facilitate secure and high-speed data exchange, ensuring timely and efficient transactions.

In industrial settings, Wi-Fi 7 can support advanced automation, robotics, and real-time monitoring of equipment and processes. The low latency and high network capacity of Wi-Fi 7 can facilitate the integration of Internet of Things (IoT) devices, enabling smart factories and Industry 4.0 initiatives. Additionally, Wi-Fi 7 can support mission-critical applications in public safety, transportation, and energy management, where real-time communication and data exchange are crucial for efficient and safe operations.

In summary, Wi-Fi 7's exceptional data rates, latency, and network efficiency can unlock new possibilities and enhance the performance of various applications across consumer and industrial sectors. By supporting a wide range of use cases, from AR/VR experiences and high-resolution video streaming to mission-critical and industrial applications, Wi-Fi 7 can play a pivotal role in shaping the future of wireless connectivity and transforming the way we live, work, and communicate.

What are the benefits of Wi-Fi 7 over previous versions?

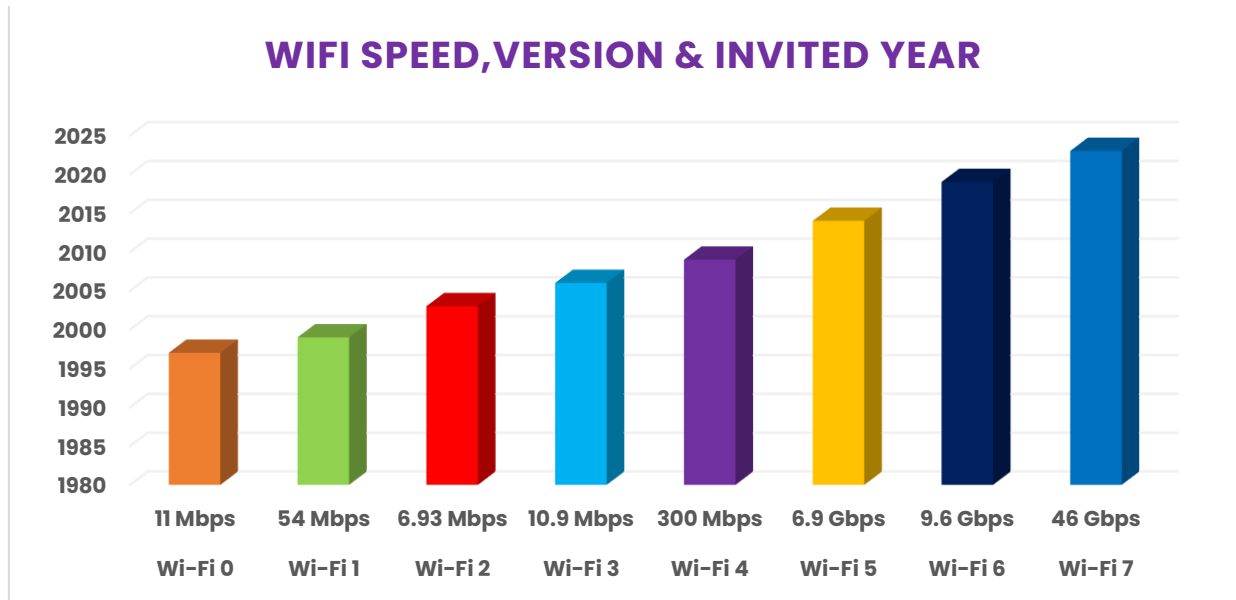


Fig -1: WiFi Speed, Version & Invited Year

Wi-Fi 7 offers several key advancements over previous Wi-Fi standards, providing numerous benefits to users and devices:

- Higher data rates:** Wi-Fi 7 is expected to deliver maximum data rates of up to 40 Gbps, significantly improving the speed of wireless connections. This enables faster downloads, smoother video streaming, and more responsive online gaming experiences.
- Lower latency:** Wi-Fi 7 is designed to reduce latency to as low as 1 millisecond, making it ideal for real-time applications such as virtual reality (VR), augmented reality (AR), and remote control of robots or drones.
- Improved network efficiency:** Enhanced multi-user capabilities, better spectrum management, and advanced modulation schemes allow Wi-Fi 7 networks to support more devices simultaneously and provide better performance in congested environments.
- Increased range and coverage:** Wi-Fi 7's improved beamforming and other signal enhancement techniques will enable better signal penetration and coverage, even in challenging environments with multiple obstacles and interference sources.
- Better support for IoT and smart home devices:** The improved network efficiency and multi-user capabilities of Wi-Fi 7 will be crucial in supporting the growing number of connected devices in smart homes and IoT applications, enabling better communication and coordination between devices for enhanced automation and control.

These advancements make Wi-Fi 7 a transformative step forward in wireless connectivity, offering users and connected devices a more seamless, responsive, and efficient wireless experience.



4. THE STATE OF WI-FI 7 SPECIFICATION AND ADOPTION

Wi-Fi 7 (802.11be) is poised to revolutionize wireless communication with its remarkable improvements in data rates, latency, and network efficiency. This section provides an overview of the current state of Wi-Fi 7 specification completion, router availability and pricing, and device integration.

4.1. Specification Completion

As of September 2021, the Wi-Fi 7 specification was still under development by the IEEE 802.11 Working Group. The IEEE 802.11be Task Group has been actively working on drafting and refining the Wi-Fi 7 standard to ensure it meets the performance requirements and addresses the challenges of next-generation wireless communication. Although the timeline for the completion of the Wi-Fi 7 specification is subject to change, it is expected to be finalized by late 2023 or early 2024. Following the completion of the specification, Wi-Fi Alliance certification for Wi-Fi 7 devices is likely to commence, paving the way for widespread adoption.

4.2. Router Availability and Pricing

The availability of Wi-Fi 7 routers will depend on the finalization of the Wi-Fi 7 specification and the subsequent Wi-Fi Alliance certification process. Given the expected timeline for specification completion, it is likely that the first Wi-Fi 7 routers will hit the market sometime in 2024. The initial pricing for Wi-Fi 7 routers may be on the higher side, owing to the advanced features and capabilities they offer. However, as with previous Wi-Fi standards, it is expected that the prices will gradually decrease over time as Wi-Fi 7 becomes more prevalent and economies of scale come into play.

4.3. Integration into Devices

The integration of Wi-Fi 7 into devices is expected to follow a similar trajectory as the router availability, with the first Wi-Fi 7-capable devices likely to be released in 2024. This timeline is contingent on the finalization of the Wi-Fi 7 specification and the commencement of Wi-Fi Alliance certification. As with previous Wi-Fi standards, it is anticipated that flagship smartphones, tablets, and laptops from major manufacturers will be among the first to support Wi-Fi 7.

Apple, being one of the leading technology companies, is expected to incorporate Wi-Fi 7 into its products soon after the standard is finalized and certified. While it is difficult to predict the exact timeline for Wi-Fi 7 integration into Apple devices, it is reasonable to expect that the company's flagship products, such as the iPhone, iPad, and MacBook, will support Wi-Fi 7 within a year or two of the standard's completion and certification. In conclusion, Wi-Fi 7 is set to usher in a new era of wireless connectivity, offering significant improvements in data rates, latency, and network efficiency. The Wi-Fi 7 specification is expected to be completed by late 2023 or early 2024, with the first Wi-Fi 7 routers and devices likely to become available shortly thereafter. As the Wi-Fi 7 standard gains traction and the technology becomes more prevalent, it is anticipated that a wide range of devices, including smartphones, tablets, laptops, and IoT devices, will support Wi-Fi 7, enabling users to take full advantage of the enhanced capabilities offered by this groundbreaking technology.

5. INDUSTRY PLAYERS AND THEIR CONTRIBUTIONS

The development and integration of Wi-Fi 7 technology involve the collaborative efforts of several major industry players, including Apple, Intel, Qualcomm, Broadcom, and MediaTek. This section examines the roles and contributions of these companies in advancing Wi-Fi 7 technology and their plans for incorporating Wi-Fi 7 support in their products.



5.1 Apple's Adoption and In-House Development

As a leading technology company, Apple has a history of embracing new Wi-Fi standards and incorporating them into its products relatively quickly. The company is expected to adopt Wi-Fi 7 in its flagship devices, such as the iPhone, iPad, and MacBook, within a year or two of the standard's completion and certification. This rapid adoption will likely contribute to the widespread acceptance and integration of Wi-Fi 7 technology.

In addition to adopting Wi-Fi 7 for its devices, Apple has been investing in the development of in-house network connectivity solutions. In recent years, the company has acquired several smaller firms specializing in wireless technology, such as Xnor.ai and Silk Labs, to bolster its expertise in this area. While the exact nature of Apple's in-house developments remains undisclosed, it is possible that the company is working on custom Wi-Fi 7 solutions to further enhance the performance and efficiency of its products.

5.2 Intel, Qualcomm, Broadcom, and MediaTek's Wi-Fi 7 Support

Several other industry players, including Intel, Qualcomm, Broadcom, and MediaTek, play crucial roles in the development and integration of Wi-Fi 7 technology. These companies design and manufacture wireless chips and networking solutions that power a wide range of devices, from smartphones and laptops to IoT devices and routers.

- **Intel:** As a leading provider of wireless chips for laptops and other computing devices, Intel is expected to support Wi-Fi 7 in its upcoming products. The company has a history of adopting new Wi-Fi standards and incorporating them into its product lineup. Intel will likely contribute to the development of Wi-Fi 7 technology by refining its chip designs to take advantage of the enhanced capabilities offered by the new standard, ensuring that its products continue to deliver optimal performance and efficiency.
- **Qualcomm:** Qualcomm is a major player in the wireless chip market, particularly for smartphones and other mobile devices. The company has been actively involved in the development of Wi-Fi 7 technology and has showcased its prototypes at industry events. Qualcomm is expected to be among the first to introduce Wi-Fi 7 support in its products, enabling device manufacturers to integrate the new standard into their offerings. This will be vital in driving the adoption of Wi-Fi 7 across the industry.
- **Broadcom:** Broadcom is another important contributor to the Wi-Fi 7 ecosystem. The company designs and produces networking chips and solutions for a wide range of devices, including routers, switches, and access points. Broadcom's participation in the development of Wi-Fi 7 technology will help ensure that its products are optimized to take full advantage of the new standard's capabilities. This, in turn, will enable device manufacturers and network operators to provide better performance and coverage for Wi-Fi 7 networks.
- **MediaTek:** As a prominent designer of wireless chips for smartphones, tablets, and other devices, MediaTek's support for Wi-Fi 7 is essential for the widespread adoption of the new standard. The company is expected to introduce Wi-Fi 7 support in its upcoming product lineup, allowing device manufacturers to integrate the technology into their offerings. MediaTek's involvement in Wi-Fi 7 development will help drive innovation and ensure that a wide range of devices can benefit from the enhanced capabilities offered by the standard.



In conclusion, the successful development and integration of Wi-Fi 7 technology depend on the collective efforts of major industry players, such as Apple, Intel, Qualcomm, Broadcom, and MediaTek. These companies play crucial roles in advancing Wi-Fi 7 technology and incorporating it into their products, ensuring that consumers and businesses can take full advantage of the groundbreaking capabilities offered by the new standard. As these industry players continue to innovate and refine their offerings, Wi-Fi 7 is poised to revolutionize wireless connectivity and transform the way we live, work, and communicate.

6. THE TRANSITION FROM WI-FI 6E TO WI-FI 7

The transition from Wi-Fi 6E to Wi-Fi 7 is expected to be a significant shift in wireless technology, offering enhanced data rates, lower latency, and improved network efficiency. This section discusses the challenges and strategies surrounding the transition from Wi-Fi 6E to Wi-Fi 7, including Apple's transition strategy and the development of router infrastructure.

6.1. Apple's Transition Strategy

Apple is known for its proactive approach to adopting new wireless standards, and it is expected to follow a similar strategy in transitioning from Wi-Fi 6E to Wi-Fi 7. The company's approach will likely involve the following elements:

- Early adoption:** Apple is expected to integrate Wi-Fi 7 into its flagship products, such as the iPhone, iPad, and MacBook, within a year or two of the standard's completion and certification. This early adoption will help drive demand for Wi-Fi 7-enabled devices and encourage other manufacturers to support the new standard.
- Seamless compatibility:** Ensuring that Wi-Fi 7-enabled devices are backward compatible with Wi-Fi 6E and older Wi-Fi standards is crucial for a smooth transition. Apple will likely prioritize maintaining compatibility with existing Wi-Fi networks to ensure that users can continue to connect to available Wi-Fi hotspots as the Wi-Fi 7 infrastructure develops.
- Comprehensive ecosystem integration:** Apple's strength lies in its tightly integrated ecosystem of hardware, software, and services. The company will likely focus on optimizing its entire ecosystem for Wi-Fi 7, including updating its operating systems, software applications, and services to take full advantage of the enhanced capabilities offered by the new standard.
- Marketing and education:** Apple's marketing efforts will likely emphasize the benefits of Wi-Fi 7 in terms of speed, latency, and network efficiency. The company may also provide resources and guidance to help users understand the advantages of Wi-Fi 7 and how to make the most of the new technology.

6.2. Router Infrastructure and Availability

The development of Wi-Fi 7 router infrastructure is crucial for the widespread adoption of the new standard. However, several challenges must be addressed to ensure a smooth transition:

- Upgrading existing infrastructure:** Many existing routers and access points will need to be replaced or upgraded to support Wi-Fi 7. Network operators, businesses, and consumers will need to invest in new hardware, which may initially be more expensive due to the advanced features and capabilities offered by Wi-Fi 7.



2. **Ensuring compatibility:** As Wi-Fi 7-enabled devices enter the market, it is essential to maintain compatibility with Wi-Fi 6E and older Wi-Fi standards. This will require Wi-Fi 7 routers and access points to support multiple Wi-Fi standards simultaneously, which may introduce complexity and increase costs.
3. **Spectrum allocation and management:** Wi-Fi 7 is expected to utilize additional frequency bands to achieve higher data rates and lower latency. Efficient spectrum management will be essential to ensure that Wi-Fi 7 networks can coexist with other wireless technologies and services without causing interference.
4. **Security and privacy:** As Wi-Fi 7 networks become more widespread, it will be crucial to address potential security and privacy concerns. This will require the development and implementation of robust security protocols and best practices to protect users and their data.
5. **Public awareness and adoption:** Encouraging widespread adoption of Wi-Fi 7 will require efforts to educate consumers, businesses, and network operators about the benefits of the new standard. This may involve marketing campaigns, public demonstrations, and educational resources to showcase the advantages of Wi-Fi 7 and how to make the most of the technology.

In conclusion, the transition from Wi-Fi 6E to Wi-Fi 7 presents numerous challenges and opportunities for industry players, network operators, and consumers alike. Companies like Apple will play a crucial role in driving the adoption of Wi-Fi 7 by incorporating the new standard into their products and promoting its benefits. Developing a robust Wi-Fi 7 router infrastructure and addressing the challenges associated with compatibility, spectrum management, security, and public awareness will be key to ensuring a smooth transition and unlocking the full potential of Wi-Fi 7 technology.

7. CONCLUSION AND FUTURE OUTLOOK

This survey paper has explored the development and integration of Wi-Fi 7 technology, examining its key features, potential applications, and the roles and contributions of major industry players in advancing this new wireless standard. As a revolutionary step forward in wireless connectivity, Wi-Fi 7 promises to deliver unparalleled speed, latency, and network efficiency, transforming the way we live, work, and communicate.

In summary, Wi-Fi 7 technology offers several key advancements over previous Wi-Fi standards:

1. **Higher data rates:** With maximum data rates of up to 40 Gbps, Wi-Fi 7 promises to dramatically improve the speed of wireless connections, enabling faster downloads, smoother video streaming, and more responsive online gaming.
2. **Lower latency:** Wi-Fi 7 is designed to reduce latency to as low as 1 millisecond, making it ideal for real-time applications like virtual reality, augmented reality, and remote control of robots or drones.
3. **Improved network efficiency:** Enhanced multi-user capabilities, better spectrum management, and advanced modulation schemes help Wi-Fi 7 networks support more devices simultaneously and provide better performance in congested environments.
4. **Increased range and coverage:** Wi-Fi 7's improved beamforming and other techniques will allow for better signal penetration and coverage, even in challenging environments with multiple obstacles and interference sources.

The widespread adoption of Wi-Fi 7 technology has the potential to impact various industries significantly:



1. **Consumer electronics:** Devices such as smartphones, tablets, laptops, and smart TVs will benefit from the faster data rates and lower latency offered by Wi-Fi 7, providing users with a seamless and responsive experience.
2. **IoT and smart home:** The improved network efficiency of Wi-Fi 7 will be crucial in supporting the growing number of connected devices in smart homes, enabling better communication and coordination between devices for enhanced automation and control.
3. **Enterprise and industrial applications:** Wi-Fi 7's advanced features can facilitate more reliable and efficient communication within businesses and industrial environments, supporting real-time data transmission, remote monitoring, and control of equipment.
4. **Telemedicine and remote education:** Wi-Fi 7's low latency and high data rates can enable real-time video consultations and remote learning experiences, opening up new possibilities for healthcare and education.
5. **Transportation and smart cities:** Wi-Fi 7 can play a significant role in the development of smart cities and connected transportation systems, facilitating real-time communication between vehicles, traffic infrastructure, and urban services.

The expected timeline for widespread Wi-Fi 7 adoption will likely involve the following milestones:

1. **Standard completion and certification:** The Wi-Fi 7 standard is expected to be completed and certified by the Wi-Fi Alliance in the 2024–2025 timeframe.
2. **Early adoption by industry players:** Major technology companies like Apple, Intel, Qualcomm, Broadcom, and MediaTek will likely begin incorporating Wi-Fi 7 support into their products within a year or two of the standard's completion, driving demand for Wi-Fi 7-enabled devices and encouraging other manufacturers to support the new standard.
3. **Development of router infrastructure:** As Wi-Fi 7-enabled devices enter the market, network operators, businesses, and consumers will need to invest in new router infrastructure to support the enhanced capabilities of Wi-Fi 7. This process may take several years, as existing routers and access points are replaced or upgraded.
4. **Widespread adoption and integration:** As Wi-Fi 7 router infrastructure expands and more devices support the new standard, Wi-Fi 7 will gradually become the dominant wireless technology, providing users with the full benefits of its enhanced speed, latency, and network efficiency.

In conclusion, Wi-Fi 7 technology has the potential to revolutionize wireless connectivity, offering unprecedented speed, latency, and network efficiency. The successful development and integration of Wi-Fi 7 will depend on the collaborative efforts of major industry players, network operators, and regulatory bodies. As Wi-Fi 7 technology matures and becomes more widely adopted, it promises to transform a wide range of industries and applications, enhancing our daily lives and shaping the future of wireless communication.

REFERENCES

- [1] T. (2023, June 16). Challenges and Opportunities in the Intelligent Transportation System Market – The Creators. Challenges and Opportunities in the Intelligent Transportation System Market – the Creators. <https://thecreators.com/challenges-and-opportunities-in-the-intelligent-transportation-system-market/>



- [2] Dr.A.Shaji George, A.S.Hovan George, Aakifa Shahul, & Dr.T.Baskar. (2023). AI-Driven Breakthroughs in Healthcare: Google Health's Advances and the Future of Medical AI. *Partners Universal International Innovation Journal (PUIIJ)*, 01(03), 256-267. <https://doi.org/10.5281/zenodo.8085221>
- [3] Frąckiewicz, M. (2023, June 4). V2X Communications: A New Era of Cooperation Between Vehicles and Infrastructure. *TS2 SPACE*. <https://ts2.space/en/v2x-communications-a-new-era-of-cooperation-between-vehicles-and-infrastructure/>
- [4] Dr.A.Shaji George, A.S.Hovan George, & A.S.Gabrio Martin. (2023). ChatGPT and the Future of Work: A Comprehensive Analysis of AI's Impact on Jobs and Employment. *Partners Universal International Innovation Journal (PUIIJ)*, 01(03), 154-186. <https://doi.org/10.5281/zenodo.8076921>
- [5] Ajulu, S. (2023, February 17). The Future of Wireless Communication: 6G Network and WiFi 7 Technology | Stephen Ajulu. *The Future of Wireless Communication: 6G Network and WiFi 7 Technology* | Stephen Ajulu · Entrepreneur, Writer, Designer & Creator. <https://stephenajulu.com/blog/the-future-of-wireless-communication-6g-network-and-wifi-7-technology/>
- [6] Singh, S. (2023, July 25). 5G: Empowering the Future of Wireless Connectivity - The Corporate Women. *The Corporate Women*. <https://thecorporatewomen.com/technology/5g/>
- [7] Dr.A.Shaji George, & A.S.Hovan George. (2023). Telemedicine: A New Way to Provide Healthcare. *Partners Universal International Innovation Journal (PUIIJ)*, 01(03), 98-129. <https://doi.org/10.5281/zenodo.8075850>
- [8] Today, T. T. (2023, April 18). revolutionizing-connectivity-the-power-of-wireless-communication. *Tech Trends Today*. <https://techtrendstoday.com/revolutionizing-connectivity-the-power-of-wireless-communication/>
- [9] A.Shaji George, S.Sagayarajan, Yazeed AlMatroudi, & A.S.Hovan George. (2023). IF/THEN Democracy: Exploring the World of Decentralized Autonomous Organizations (DAOs). *Partners Universal International Research Journal (PUIRJ)* ISSN: 2583-5602, 02(02), 241-274. <https://doi.org/10.5281/zenodo.8051072>
- [10] Rebecca Lee Armstrong, K. P., Parrish, K., & Armstrong, R. L. (2023, August 1). How Important Is My Wireless Router to My Internet Speed? *HighSpeedInternet.com*. <https://www.highspeedinternet.com/resources/how-important-is-my-wireless-router-to-my-internet-speed>
- [11] Dr.A.Shaji George, A.S.Hovan George, & Dr.T.Baskar. (2023). SD-WAN Security Threats, Bandwidth Issues, SLA, and Flaws: An In-Depth Analysis of FTTH, 4G, 5G, and Broadband Technologies. *Partners Universal International Innovation Journal (PUIIJ)*, 01(03), 1-37. <https://doi.org/10.5281/zenodo.8057014>
- [12] Wi-Fi 7 Explained: A Solid Upgrade from 6E | Dong Knows Tech. (2023, July 21). *Dong Knows Tech*. <https://dongknows.com/wi-fi-7-explained/>
- [13] Dr.A.Shaji George, A.S.Hovan George, & Dr.T.Baskar. (2023). Unshackled by Servers: Embracing the Serverless Revolution in Modern Computing. *Partners Universal International Research Journal (PUIRJ)* ISSN: 2583-5602, 02(02), 229-240. <https://doi.org/10.5281/zenodo.8051052>
- [14] J. (2022, January 27). Wi-Fi 7: What Is It, and How Fast Will It Be? *Wi-Fi 7: What Is It, and How Fast Will It Be?* <https://www.howtogeek.com/782023/what-is-wi-fi-7/>
- [15] Wi-Fi 7: What is it and why is it so important for cities? (n.d.). *Wi-Fi 7: What Is It and Why Is It so Important for Cities?* <https://tomorrow.city/a/what-is-wifi-7>
- [16] Dr.A.Shaji George, & A.S.Hovan George. (2023). The Cobot Chronicles: Evaluating the Emergence, Evolution, and Impact of Collaborative Robots in Next-Generation Manufacturing. *Partners Universal International Research Journal (PUIRJ)* ISSN: 2583-5602, 02(02), 89-116. <https://doi.org/10.5281/zenodo.8021406>
- [17] What Wi-Fi 7 Can Do For Your Network - Home Network Community. (2022, November 3). *What Wi-Fi 7 Can Do for Your Network - Home Network Community*. <https://community.tp-link.com/en/home/stories/detail/501872>
- [18] Dr.A.Shaji George, A.S.Hovan George, & A.S.Gabrio Martin. (2023). Quantum-Centric Supercomputing: Ambitious Plan to Solve the World's Biggest Problems. *Partners Universal International Research Journal (PUIRJ)* ISSN: 2583-5602, 02(02), 68-88. <https://doi.org/10.5281/zenodo.8020371>
- [19] WiFi 7: A Patenting Surge and Advancements in Next-Gen Wireless Connectivity - Global IP, Innovation, Technology Support & Market Research Consulting firm. (n.d.). *Global IP, Innovation, Technology Support & Market Research Consulting Firm*. <https://www.researchwire.in/resources/wifi-7-a-patenting-surge-and-advancements-in-next-gen-wireless-connectivity/>



- [20] T. (2023, July 19). Unraveling the Latest Wi-Fi Standards: Exploring Wi-Fi 6E and Wi-Fi 7. TECHDesign Blog. <https://blog.techdesign.com/unraveling-the-latest-wi-fi-standards-exploring-wi-fi-6e-and-wi-fi-7/>
- [21] Dr.A. Shaji George, Dr.T. Baskar, A.S. Hovan George, Digvijay Pandey, & A.S.Gabrio Martin. (2022). A Review of 6G: Towards The Future, Partners Universal International Research Journal (PUIRJ) ISSN: 2583-5602, 01(04), 1–12. <https://doi.org/10.5281/zenodo.7419694>
- [22] What is Latency? - Everything you need to know - AWS. (n.d.). Amazon Web Services, Inc. <https://aws.amazon.com/what-is/latency/>
- [23] Dr. A. SHAJI GEORGE, & A.S.HOVAN GEORGE. (2020). A Review of Wi-Fi 6 : The Revolution of 6th Generation Wi-Fi Technology. Research Inventy: International Journal of Engineering and Science, 10(09), 56–65. <https://doi.org/10.5281/zenodo.7024625>
- [24] KL, A. (2022, November 18). What is Wi-Fi 7 (Wi-Fi 802.11be)? What Are the New Features of Wi-Fi 7? The Sec Master. <https://theseccmaster.com/what-is-wi-fi-7-wi-fi-802-11be-what-are-the-new-features-of-wi-fi-7/>
- [25] Wi-Fi 7 Explained: A Solid Upgrade from 6E | Dong Knows Tech. (2023, July 21). Dong Knows Tech. <https://dongknows.com/wi-fi-7-explained/>
- [26] Smith, A. (2023, February 2). Revolutionizing Network Communication With Time-Sensitive Protocols. Forbesonly. <https://forbesonly.com/revolutionizing-network-communication-with-time-sensitive-protocols/>
- [27] The Unwavering Importance of WiFi in the 5G Era. (n.d.). The Unwavering Importance of WiFi in the 5G Era. <https://www.avsystem.com/blog/wifi-advantages-over-5g/>
- [28] Weinberg, N. (n.d.). What is Wi-Fi 7, and will it replace wired Ethernet? Network World. <https://www.networkworld.com/article/3666691/what-is-wi-fi-7-and-will-it-replace-wired-ethernet.html>
- [29] Beagle, R. (2023, June 8). Wi-Fi 7: The Next Generation of Wireless Connectivity - Today's Technology News And Resources. Today's Technology News and Resources. <https://blog.rentacomputer.com/2023/06/08/wi-fi-7-the-next-generation-of-wireless-connectivity/>
- [30] Team, M. M. (2023, May 23). What is WiFi 7? Here's What You Need to Know | MATE. Mate. <https://www.letsbemates.com.au/mate/what-is-wifi-7/>
- [31] Dr. A.SHAJI GEORGE, & A.S.HOVAN GEORGE. (2022). Potential Risk: Hosting Cloud Services Outside the Country. International Journal of Advanced Research in Computer and Communication Engineering, 11(4), 5–11. <https://doi.org/10.5281/zenodo.6548114>
- [32] WiFi 7: A Patenting Surge and Advancements in Next-Gen Wireless Connectivity - Global IP, Innovation, Technology Support & Market Research Consulting firm. (n.d.). Global IP, Innovation, Technology Support & Market Research Consulting Firm. <https://www.researchwire.in/resources/wifi-7-a-patenting-surge-and-advancements-in-next-gen-wireless-connectivity/>