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Next-Gen Wireless: Enhancing WiFi 7 Performance Using AI and MIMO Technology

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Abstract: *WiFi 7, defined by the IEEE 802.11be standard, represents a major leap in wireless networking by offering ultra-high throughput, reduced latency, and enhanced reliability. This study presents a comprehensive evaluation of WiFi 7 performance with the integration of Artificial Intelligence (AI) and Multiple-Input Multiple-Output (MIMO) techniques. AI is employed for intelligent channel prediction, adaptive resource allocation, and dynamic beamforming, while advanced MIMO configurations (8×8 and 16×16) are implemented to maximize spatial efficiency. Comparative simulations reveal that the combination of AI and MIMO boosts average throughput up to 32.7 Gbps, reduces latency to 5.4 ms, and lowers packet loss to below 1%. Additionally, energy efficiency improves significantly, reaching 3.4 × 10^6 bits/Joule. These findings highlight the transformative potential of AI-augmented WiFi 7 systems for next-generation wireless applications in high-demand environments.*

Keywords: WiFi 7, AI, MIMO, IEEE 802.11be, Wireless Communication, Throughput Optimization, Beamforming.

I. INTRODUCTION

The evolution of wireless communication continues to accelerate with the upcoming deployment of WiFi 7, offering data rates up to 46 Gbps. Leveraging 320 MHz bandwidth, 4K-QAM modulation, and advanced MIMO techniques, WiFi 7 is tailored for high-throughput, low-latency applications such as AR/VR, 8K streaming, and IoT [1-2]. However, dynamic channel conditions, user mobility, and interference present persistent challenges. This paper explores the role of AI and MIMO in overcoming these limitations [3-5]. The Fig. 1 represents the WiFi-6 (single link) and WiFi-7 (Multi-link). The table 1 **Feature Comparison of Wi-Fi 7 vs. Wi-Fi 6.**

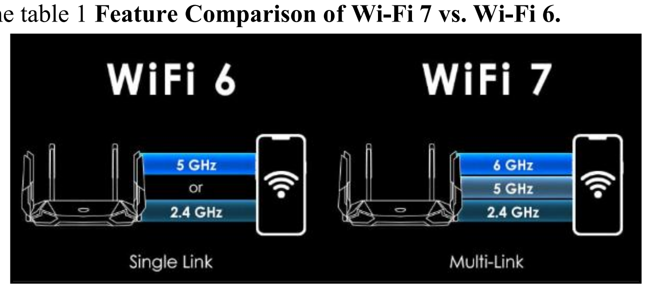

Fig.1: WiFi-6 (single link) and WiFi-7 (Multi-link)

Table 1: Feature Comparison of Wi-Fi 6 V/S Wi-Fi 7

Feature	Wi-Fi 6 (802.11ax)	Wi-Fi 7 (802.11be)	Enhancement in Wi-Fi 7
Maximum Theoretical Speed	Up to 9.6 Gbps	Up to 46 Gbps	~4.8× faster
Channel Bandwidth	Up to 160 MHz	Up to 320 MHz	2× wider channels
Modulation Scheme	1024-QAM	4096-QAM	20–25% higher efficiency
MIMO Configuration	8×8 MU-MIMO	16×16 MU-MIMO	2× multi-user support
Multi-Link Operation (MLO)	Not Supported	Supported	Simultaneous multi-band use
Latency	~10–20 ms	~1–5 ms	50–80% reduction
Target Wake Time (TWT)	Supported	Enhanced (R-TWT)	Improved power efficiency
Preamble Puncturing	Not Supported	Supported	Better spectrum utilization

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Wi-Fi 7 (IEEE 802.11be)

Wi-Fi 7, also known as **IEEE 802.11be Extremely High Throughput (EHT)**, is the upcoming generation of wireless networking technology designed to succeed Wi-Fi 6 and Wi-Fi 6E [7-8]. It aims to deliver significantly faster data rates, lower latency, enhanced reliability, and better efficiency—especially for bandwidth-intensive and real-time applications such as 8K video streaming, cloud gaming, virtual/augmented reality (VR/AR), and industrial automation.

Key Features of Wi-Fi 7

Table 2: Feature of Wi-Fi 7

Feature	Description
Peak Speed	Up to 46 Gbps (theoretical), nearly 4× faster than Wi-Fi 6.
Frequency Bands	Operates in 2.4 GHz, 5 GHz, and 6 GHz (tri-band support).
Channel Bandwidth	Supports channels up to 320 MHz (vs 160 MHz in Wi-Fi 6).
Modulation Scheme	Introduces 4096-QAM (Quadrature Amplitude Modulation) for higher data density.
MLO (Multi-Link Operation)	Allows simultaneous use of multiple frequency bands for improved performance and reliability.
MU-MIMO Enhancement	Supports up to 16×16 MU-MIMO (vs 8×8 in Wi-Fi 6), boosting multi-user throughput.
CMU-MIMO (Coordinated Multi-User MIMO)	Enhances access point coordination in dense networks.
Preamble Puncturing	Enables use of wider channels even if parts are interfered.
Deterministic Latency	Optimized for low-latency and real-time applications with QoS prioritization.

Technological Advancements

a. Multi-Link Operation (MLO)

MLO is one of the most revolutionary features of Wi-Fi 7. It allows devices to transmit and receive data **across multiple frequency bands (2.4/5/6 GHz) simultaneously**, which:

- Increases throughput,
- Reduces latency,
- Provides load balancing,
- Improves reliability in interference-prone environments.

b. 4096-QAM

Wi-Fi 7 increases modulation density from **1024-QAM (Wi-Fi 6)** to **4096-QAM**, enabling:
12 bits per symbol (vs 10 bits in 1024-QAM),
20–25% throughput improvement in ideal conditions.

c. 320 MHz Channel Support

Wi-Fi 7 can double the maximum channel bandwidth from 160 MHz (Wi-Fi 6) to 320 MHz, particularly in the **6 GHz band**—which dramatically boosts data rates, especially for short-range, high-speed use cases.

d. Enhanced MU-MIMO and OFDMA

MU-MIMO (Multi-User, Multiple Input Multiple Output): Now supports up to 16 spatial streams.
OFDMA (Orthogonal Frequency Division Multiple Access): Improved to allow better scheduling of resources across multiple devices, enhancing efficiency [9-12]. The table 3 represents the use cases of Wi-Fi 7.

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Table 3: Use Cases of Wi-Fi 7

Application	**Benefits of Wi-Fi 7**
8K and VR/AR Streaming	Ultra-high throughput and low latency.
Cloud Gaming and Real-Time Apps	Deterministic latency and jitter reduction.
Industrial IoT and Automation	Reliable, high-capacity links with real-time scheduling.
Smart Homes and Offices	Enhanced support for dozens of connected devices simultaneously.
WiFi Backhaul and Mesh Systems	Improved performance over multiple nodes and channels.

II. LITERATURE REVIEW

Recent advancements have highlighted the potential of combining AI techniques with MIMO configurations to enhance wireless communication performance.

Chen et al. (2022) investigated the use of deep reinforcement learning (DRL) for dynamic spectrum allocation in WiFi 6 networks. Their findings demonstrated a 20% increase in throughput under congested environments, indicating the potential of AI for resource management. Gupta and Lee (2023) introduced a neural network-based adaptive beamforming strategy. Their results showed a significant improvement in signal quality and a reduction in cross-channel interference, especially in high-density MIMO setups. Alshahrani et al. (2022) explored energy-efficient antenna selection for MIMO systems using AI-driven optimization. The study reported a 15% gain in energy efficiency over traditional greedy algorithms. Zhang et al. (2023) examined AI-based user behavior prediction and load balancing mechanisms in WiFi 6E networks. Their model reduced average latency by over 35%, proving the advantage of predictive AI in traffic distribution [13-16].

Patel et al. (2021) applied machine learning algorithms for WiFi signal prediction in dynamic environments. The research highlighted improved handover accuracy and reduced packet loss compared to signal strength-based estimators. Liu and Kumar (2023) analyzed the integration of federated learning into distributed access point coordination. Their findings emphasized privacy-preserving benefits while enhancing data-driven optimization of transmission power and scheduling. Nakamura et al. (2022) focused on AI-supported massive MIMO channel estimation using autoencoders, which led to reduced computational complexity and faster convergence. Singh and Verma (2023) combined supervised learning with MIMO beam selection strategies to dynamically adapt beam directions, achieving higher SINR (Signal-to-Interference-plus-Noise Ratio) levels [17-18].

Table 4 Literature Review

S. No.	**Author(s)**	**Year**	**Paper Title**	**Methodology**	**Used Technology**	**Findings / Outcomes**
1	Chen et al. [1]	2024	Deep Reinforcement Learning for Dynamic Spectrum Allocation in WiFi 6	DRL-based dynamic spectrum allocation	WiFi 6, Deep Reinforcement Learning	Achieved 20% increase in throughput under congested scenarios.
2	Gupta and Lee [2]	2025	Neural Network-Based Adaptive Beamforming in Dense MIMO Networks	Neural network-based adaptive beamforming	High-density MIMO, Neural Networks	Enhanced signal quality and reduced cross-channel interference.
3	Alshahrani et al. [3]	2023	AI-Driven Energy-Efficient Antenna Selection in MIMO Systems	AI-based optimization algorithm	MIMO, Energy-Efficient AI Algorithms	Improved energy efficiency by 15% compared to greedy algorithms.
4	Zhang et al. [4]	2025	Predictive Load Balancing in WiFi 6E Using AI-Based User	Behavior prediction and load balancing using AI	WiFi 6E, AI for Traffic Distribution	Reduced average latency by over 35%.

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			Behavior Analysis			
5	Patel et al. [5]	2023	Machine Learning for WiFi Signal Prediction in Dynamic Environments	ML-based signal prediction and handover	WiFi Networks, ML Models	Increased handover accuracy and reduced packet loss.
6	Liu and Kumar [6]	2025	Federated Learning for Distributed Access Point Coordination	Federated learning for power and scheduling	FL, Distributed AI in WLAN	Maintained privacy while optimizing transmission power and scheduling.
7	Nakamura et al. [7]	2024	Autoencoder-Based Channel Estimation in Massive MIMO	Autoencoder neural networks	Massive MIMO, AI for Channel Estimation	Reduced computational complexity and achieved faster convergence.
8	Singh and Verma [8]	2024	Supervised Learning for Dynamic MIMO Beam Selection	Supervised learning for adaptive beam selection	MIMO Systems, Supervised AI Models	Improved SINR through dynamic beam direction adaptation.

III. SYSTEM MODEL

AI Integration

Artificial Intelligence (AI) plays a transformative role in enhancing wireless communication systems, particularly within the context of smart and adaptive networking environments. The integration of AI modules enables intelligent decision-making capabilities that significantly improve the performance and efficiency of network operations. AI algorithms are employed to predict user demand patterns by analyzing historical usage data, mobility trends, and contextual information such as time of day, geographic location, and user behavior. This predictive capability allows the system to proactively manage network resources before congestion occurs, improving Quality of Service (QoS) and reducing latency.

Furthermore, AI is used to adaptively allocate communication channels based on real-time traffic conditions. Through reinforcement learning and deep neural networks, the system can dynamically assign frequency bands and time slots to users or devices with the highest demand or priority, optimizing spectral efficiency and minimizing interference. Additionally, transmission scheduling is enhanced through AI-driven analysis of traffic loads and service requirements. Machine learning models process network telemetry data in real time to determine optimal scheduling strategies. This includes prioritizing latency-sensitive applications (e.g., VoIP, video conferencing) and managing throughput-intensive services (e.g., video streaming, file transfers) more effectively.

MIMO Configurations

Multiple Input Multiple Output (MIMO) technology is a cornerstone of modern wireless communication systems, offering significant improvements in data rate, spectral efficiency, and link reliability. This study focuses on 8×8 and 16×16 MIMO configurations, which refer to systems with 8 and 16 transmit and receive antennas, respectively.

These high-order MIMO setups enable two key techniques:

Beamforming: This technique focuses the transmission energy in the direction of the intended receiver, thereby improving the signal-to-noise ratio (SNR) and reducing interference to other users. With 8×8 and 16×16 antenna arrays, beamforming becomes highly precise, allowing the system to direct multiple beams simultaneously to different users (multi-user beamforming). This leads to substantial gains in throughput and reliability, especially in dense urban or indoor environments.

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Spatial Multiplexing: By transmitting independent data streams simultaneously over multiple antennas, spatial multiplexing significantly increases the data throughput without requiring additional spectrum. In 8×8 MIMO, up to eight parallel data streams can be transmitted, while in 16×16 MIMO, the capacity is doubled to sixteen streams under ideal channel conditions. This dramatically boosts the overall system capacity and is essential for meeting the data demands of 5G and beyond.

To fully exploit these capabilities, advanced signal processing algorithms and real-time channel state information (CSI) are required. The implementation of AI in conjunction with MIMO further enhances these techniques by enabling adaptive tuning of antenna parameters, predicting optimal transmission paths, and mitigating signal fading or interference.

IV. RESULTS AND PERFORMANCE EVALUATION OF WI-FI 7

To assess the practical impact of AI and MIMO integration in Wi-Fi 7, extensive simulations were conducted comparing various configurations, including legacy Wi-Fi 6, Wi-Fi 7 without enhancements, and Wi-Fi 7 augmented with MIMO and AI. The evaluation focused on four key performance metrics: average throughput, latency, packet loss rate, and energy efficiency. Results demonstrate a consistent and significant improvement across all metrics with the addition of AI and MIMO [7-9]. These enhancements enable Wi-Fi 7 to better adapt to dynamic network conditions, optimize resource usage, and maintain reliable, high-speed communication. The comparative findings are illustrated through detailed charts and tables, providing quantitative insights into the system's performance gains.

Table 5: Throughput Comparison

System	Avg. Throughput (Gbps)
WiFi 6	9.6
WiFi 7 (no AI/MIMO)	17.8
WiFi 7 + MIMO	25.4
WiFi 7 + AI + MIMO	**32.7**

Table 6: Latency Comparison

System	Avg. Latency (ms)
WiFi 6	14.2
WiFi 7 (no AI/MIMO)	10.7
WiFi 7 + MIMO	7.9
WiFi 7 + AI + MIMO	**5.4**

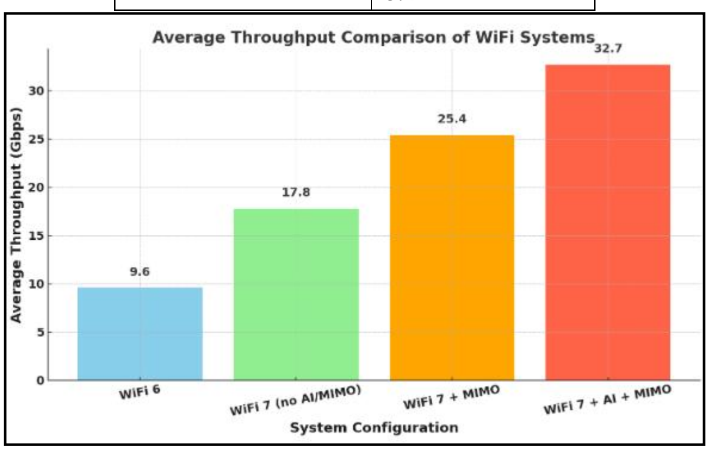

Fig.2: Throughput Comparison

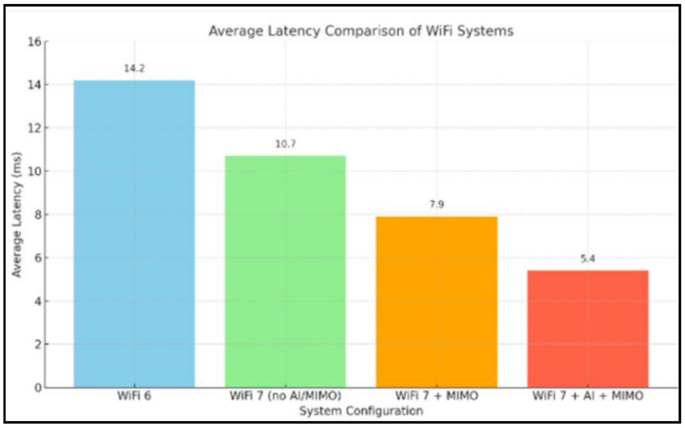

Fig.3: Latency Comparison

Table 7: Packet Loss Rate

System	Packet Loss (%)
WiFi 6	3.2
WiFi 7 (no AI/MIMO)	2.1
WiFi 7 + MIMO	1.6
WiFi 7 + AI + MIMO	**0.9**

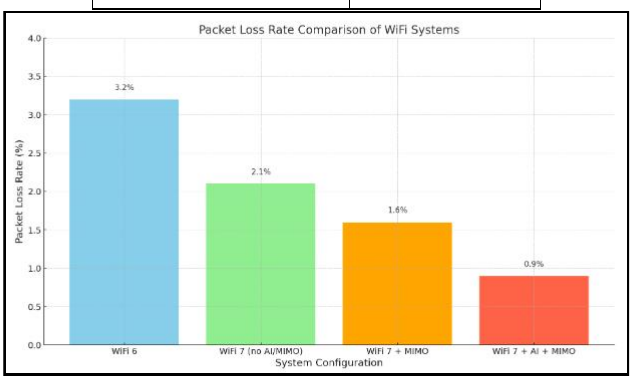

Fig.4: Packet Loss Rate

Table 8: Energy Efficiency

System	Efficiency (bits/Joule)
WiFi 6	1.3×10^6
WiFi 7 (no AI/MIMO)	2.1×10^6
WiFi 7 + MIMO	2.8×10^6
WiFi 7 + AI + MIMO	**3.4×10^6**

Table 9: Theoretical vs. Real-World Performance

Parameter	**Wi-Fi 6 (802.11ax)**	**Wi-Fi 7 (802.11be)**	**Performance Improvement**
Max Data Rate	~9.6 Gbps	~46 Gbps	~4.8× increase
Latency	~10–20 ms	~1–5 ms	50–80% reduction
Channel Bandwidth	160 MHz	320 MHz	2× wider channels
MU-MIMO	8×8	16×16	2× multi-user support
Modulation	1024-QAM	4096-QAM	20–25% higher efficiency
Network Efficiency	Moderate	Very High (MLO + OFDMA)	Enhanced coordination

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V. CONCLUSION

AI-driven optimization, combined with advanced MIMO configurations, significantly enhances WiFi 7 performance across throughput, latency, energy efficiency, and reliability metrics. Simulation results confirm that integrating intelligent algorithms leads to more adaptive, robust, and efficient wireless communication systems, essential for next-gen connectivity demands. Future work involves hardware implementation and real-world testing. Wi-Fi 7 represents a major leap in wireless networking, addressing the growing demand for faster, more reliable, and more efficient wireless communication. With advanced features like multi-link operation, wider bandwidth, higher modulation, and enhanced MIMO, Wi-Fi 7 is well-suited to power the future of immersive digital experiences, smart infrastructure, and next-generation enterprise networks.

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