JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

A REVIEW PAPER ON RECENT TRENDS IN WIRELESS NETWORK

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ABSTRACT

This abstract shed light on the present tendencies that will influence wireless networks in 2024. Wireless networks are undergoing major changes due to the expansion of Internet of Things (IoT) devices, 5G improvements, and the progression towards 6G technology. This study examines how major advancements in software-defined networking (SDN), edge computing integration, and AI-driven network optimisation may affect wireless communication in the future. In addition, it looks at issues including spectrum shortage, security flaws, and sustainability issues, and it makes suggestions for future research directions and possible remedies. This abstract provides a thorough overview of the state-of-the-art in wireless networking by analysing the most recent advancements and industry initiatives, pointing academics and practitioners in the direction of significant contributions in this rapidly evolving subject.

KEYWORDS

Network, AI, Wireless, WIFI, ML, IOT,5G, Interference Management.

I.INTRODUCTION

The landscape of wi-fi networks has undergone outstanding evolution over the years, fuelled by way of relentless innovation and the ever-developing call for connectivity. As we navigate thru 2024, the trajectory of wireless networking keeps to shape the manner we talk, collaborate, and engage with the sector round us. This magazine pursuits to provide a comprehensive review of the present-day developments, developments, and demanding situations in the realm of wireless networks inside the contemporary year.

In this period of fast technological advancement, wi-fi networks have transcended mere convenience to come to be vital components of our everyday lives, powering the entirety from smart homes and cities to self-reliant cars and immersive virtual experiences. The proliferation of net of factors (IoT) devices, the appearance of 5G generation, and the emergence of facet computing are reshaping the dynamics of wireless connectivity, supplying each remarkable opportunities and complicated challenges.

With the deployment of 5G networks gaining momentum globally, we witness a paradigm shift in wireless communique, promising extremely-rapid speeds, lower latency, and big connectivity. but, along these advancements come urgent troubles together with community protection, spectrum allocation, and infrastructure readiness, underscoring the need for robust frameworks and collaborative efforts to make certain the seamless integration of 5G into our interconnected world.

II. WIRELESS NETWORK AND ITS TYPES

2.1.5 G Deployment and Impact

The deployment of 5G technology promises faster data speeds, lower latency, and increased connectivity. Its impact spans various sectors including healthcare, transportation, manufacturing, and entertainment. It enables advancements in IoT, autonomous vehicles, remote surgery, and immersive experiences. However, concerns regarding privacy, cybersecurity, and potential health effects have also been raised and are subjects of ongoing research and debate.

2.2. Edge Computing and Wireless Networks

Edge computing involves processing data closer to its source, reducing latency and bandwidth usage by handling tasks locally rather than transmitting everything to a centralized data centre. Wireless networks play a crucial role in enabling edge computing by providing connectivity to devices and sensors at the edge of the network. This combination allows for real-time data analysis, faster response times, and more efficient use of network resources. It's especially beneficial for applications like IoT, autonomous vehicles, and augmented reality where low latency and high reliability are essential.

2.3. IoT and Wireless Connectivity

IoT (Internet of Things) relies heavily on wireless connectivity to enable communication between devices, sensors, and systems. Wireless technologies such as Wi-Fi, Bluetooth, Zigbee, LoRa, and cellular networks provide the infrastructure for IoT devices to connect and exchange data. This connectivity allows for remote monitoring, control, and automation across various industries and applications, including smart homes, smart cities, industrial automation, agriculture, healthcare, and transportation. The versatility and scalability of wireless connectivity make it a key enabler for the widespread adoption of IoT solutions.

III. FEATURES OF AI AND MACHINE LEARNING IN WSN

Artificial Intelligence (AI) and Machine Learning (ML) play significant roles in enhancing the efficiency, performance, and security of wireless networks. Here are several applications of AI and ML in this domain.

3.1.RESOURCE MANAGEMENT

AI and ML algorithms can optimize resource allocation in wireless networks, dynamically adjusting parameters such as bandwidth allocation, power control, and spectrum management to improve network capacity and performance.

3.2.INTERFERENCE MANAGEMENT

ML techniques can mitigate interference in wireless networks by identifying patterns and predicting interference sources, allowing for better channel allocation and interference avoidance strategies.

3.3.PREDICTIVE MAINTENANCE

AI-driven predictive maintenance models can analyse network data to forecast potential equipment failures or performance degradation, enabling proactive maintenance and minimizing downtime.

3.4.SECURITY

AI and ML algorithms can enhance security in wireless networks by detecting anomalies, identifying malicious activities, and mitigating cyber threats in real-time, such as intrusion detection, malware detection, and anomaly detection.

3.5.DYNAMIC SPECTRUM ACCESS

Cognitive radio systems powered by AI can intelligently select unused spectrum bands, optimize channel selection, and adapt transmission parameters based on environmental conditions to improve spectrum utilization and minimize interference.

3.6.BEAMFORMING AND MIMO OPTIMIZATION

ML techniques can optimize beamforming and Multiple Input Multiple Output (MIMO) configurations in wireless communication systems, maximizing signal strength and throughput while minimizing interference and power consumption.

3.7.QUALITY OF SERVICE (QOS) OPTIMIZATION

AI algorithms can predict network congestion, identify traffic patterns, and prioritize traffic based on QoS requirements to ensure a consistent and reliable user experience.

3.8.HANDOVER AND MOBILITY MANAGEMENT

ML models can predict user mobility patterns and optimize handover decisions between different access points or cells in heterogeneous wireless networks, reducing handover latency and improving network efficiency.

3.9.ENERGY EFFICIENCY

AI and ML techniques can optimize energy consumption in wireless devices and infrastructure by intelligently managing power states, scheduling transmissions, and optimizing network protocols to prolong battery life and reduce environmental impact.

Overall, AI and ML technologies have the potential to revolutionize wireless networks by enabling autonomous, adaptive, and intelligent network management, leading to improved performance, reliability, and security.

IV.Wireless Network Virtualization

Wireless network virtualization is the process of abstracting and decoupling wireless network resources, such as radio spectrum, access points, and network functions, from the underlying hardware infrastructure. This allows multiple virtualized wireless networks to coexist and operate independently on shared physical infrastructure. Here are some key aspects of wireless network virtualization

4.1.RESOURCE POOLING

Virtualization enables the pooling and sharing of wireless resources, such as spectrum, bandwidth, and processing power, among multiple virtual networks. This efficient utilization of resources improves network capacity and flexibility.

4.2.ISOLATION

Virtualization provides isolation between different virtual networks, ensuring that they operate independently and do not interfere with each other. This isolation is essential for maintaining security, privacy, and performance guarantees for each virtual network.

4.3.DYNAMIC RESOURCE ALLOCATION

Virtualized wireless networks can dynamically allocate resources based on changing demand, traffic patterns, and quality-of-service requirements. This dynamic resource allocation improves network efficiency and adaptability.

4.4.NETWORK SLICING

Wireless network virtualization enables network slicing, where a physical infrastructure is partitioned into multiple logical network slices, each tailored to specific use cases, applications, or tenants. Network slicing allows for the creation of customized, end-to-end virtual networks with unique configurations and characteristics.

4.5.SERVICE CUSTOMIZATION

Virtualization enables service providers to offer customized wireless networking services tailored to the diverse needs of different users, applications, and industries. Service customization improves service differentiation, flexibility, and monetization opportunities.

4.6.SCALABILITY

Virtualization enhances the scalability of wireless networks by abstracting underlying hardware resources and enabling dynamic provisioning of virtual resources. This scalability allows for the efficient support of growing numbers of users, devices, and applications.

4.7.ORCHESTRATION AND MANAGEMENT

Virtualized wireless networks require robust orchestration and management systems to automate the provisioning, configuration, monitoring, and optimization of virtual resources and network slices. Orchestration and management platforms streamline network operations and reduce complexity.

4.8.NETWORK FUNCTION VIRTUALIZATION (NFV)

NFV is a key enabler of wireless network virtualization, allowing network functions, such as routing, switching, security, and optimization, to be implemented in software and deployed as virtualized network functions (VNFs) on commodity hardware. NFV enhances flexibility, scalability, and cost-effectiveness.

4.9.SOFTWARE-DEFINED NETWORKING (SDN)

SDN complements wireless network virtualization by providing centralized control and programmability of network resources. SDN enables dynamic network configuration, traffic engineering, and policy enforcement, facilitating efficient resource utilization and network optimization.

V. FEATURES OF 5G AND INDUSTRY4.0

5G technology plays a pivotal role in enabling and accelerating the implementation of Industry 4.0, also known as the Fourth Industrial Revolution. Here's how 5G contributes to the advancement of Industry 4.0:

5.1.MASSIVE IOT CONNECTIVITY

5G networks support a massive number of Internet of Things (IoT) devices and sensors, allowing industries to deploy large-scale IoT solutions for monitoring, tracking, and optimizing various processes and assets. This enables the creation of smart factories and supply chains with interconnected and intelligent systems.

5.2.ULTRA-RELIABLE LOW-LATENCY COMMUNICATION (URLLC)

URLLC capabilities of 5G ensure reliable and low-latency communication, which is critical for mission-critical applications in industrial automation, robotics, and autonomous systems. URLLC enables precise control, synchronization, and coordination of industrial processes, improving safety and productivity.

5.3.NETWORK SLICING

5G network slicing enables the creation of dedicated virtual networks optimized for specific industrial use cases, such as smart manufacturing, remote monitoring, and predictive maintenance. Network slicing allows industries to tailor network performance, security, and reliability according to their requirements, ensuring optimal support for diverse applications and services.

5.4. EDGE COMPUTING

5G networks leverage edge computing capabilities to process data closer to the source, reducing latency and bandwidth usage. Edge computing enables real-time data analysis, decision-making, and control at the edge of the network, empowering industries to implement distributed and localized intelligence in their operations.

5.5. AUGMENTED REALITY (AR) AND VIRTUAL REALITY (VR)

5G's high-speed and low-latency connectivity enable seamless deployment of AR and VR technologies in industrial settings. AR and VR applications enhance

VI. Wireless Network Standards and Regulations

Wireless network standards and regulations vary depending on the region and the specific application. However, there are several key standards and regulatory bodies that influence wireless communications globally:

6.1. 3GPP STANDARDS

The 3rd Generation Partnership Project (3GPP) develops standards for mobile telecommunications, including:

- Long-Term Evolution (LTE): A standard for high-speed wireless communication commonly used for 4G networks.

- 5G New Radio (NR): Defines standards for 5G wireless communication, offering faster speeds, lower latency, and greater capacity compared to previous generations.

6.2.REGULATORY BODIES

Federal Communications Commission (FCC): The FCC is the regulatory authority for communications in the United States. It sets rules and regulations for spectrum allocation, licensing, and interference mitigation. European Telecommunications Standards Institute (ETSI): ETSI develops standards for telecommunications in Europe and contributes to global standards development. International Telecommunication Union (ITU): The ITU is a United Nations agency responsible for coordinating global telecommunications standards and spectrum allocation.

6.3.SPECTRUM REGULATION

Wireless communication relies on radio frequency spectrum, which is regulated by governments and international bodies to prevent interference and ensure efficient use. Spectrum regulation includes licensing requirements, spectrum allocation, and spectrum sharing arrangements.

6.4.SECURITY REGULATIONS

Regulatory bodies often establish security requirements and protocols to protect wireless networks from unauthorized access, interception, and cyber threats. These regulations may include encryption standards, authentication protocols, and compliance requirements for network operators.

Overall, wireless network standards and regulations play a crucial role in ensuring interoperability, reliability, security, and compliance in wireless communications systems. Compliance with these standards and regulations is essential for the deployment and operation of wireless networks worldwide.

VII.CONCLUSION

In conclusion, the evolution of wi-fi networks in 2024 displays a dynamic landscape pushed via technological improvements. The widespread adoption of 5G era has substantially improved connectivity, permitted quicker records switch and decreased latency. the integration of synthetic intelligence and the internet of things (IoT) has similarly optimized community management and person experiences. As we pass ahead, the continuous innovation in wireless communique is poised to revolutionize diverse industries, from healthcare to smart towns. but challenges which include security and privacy issues necessitate ongoing research and development.

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