Future-Proofing 5G Networks: The Roleof Artificial Intelligence in Optimization

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Abstract*: 5G networks, which offer greater capacity for connected devices, reduced latency, and quicker data rates, are quickly taking shape and will be a big step forward for the telecom sector.This change is mostly due to artificial intelligence (AI), which is necessary for optimising processes, enhancing network efficiency, and ensuring sound resource management.With an emphasis on important topics like resource allocation, network slicing, self- optimizing networks (SON), energy efficiency, security improvements, and future directions, this review article methodically investigates the diverse contributions of AI to 5G networks. Due to AI's capacity to analyse enormous volumes of real-time data, networks are able to allocate resources dynamically, predict traffic patterns, and adjust to changing user behaviour. This results in lower latency and more effective bandwidth distribution, both of which are essential for applications like Internet of Things (IoT) services and high-definition streaming. AI-enabled network slicing automation also makes it possible to create and maintain virtual network segments that are customised to meet particular service needs and offer optimal performance for a range of use cases. Furthermore, AI's self-healing capabilities improve 5G networks' dependability. Networks can automatically identify and fix errors by using machine learning algorithms, which reduces service interruptions and improves user experience. Furthermore, by enabling automatic reactions to possible cyberthreats and real-time threat identification, AI significantly contributes to bolstering network security and protecting sensitive user data. Another important area where AI makes a major contribution is energy efficiency. Energy usage needs to be optimised because 5G networks are increasing the amount of energy consumed. Intelligent energy management, made possible by AI-driven analytics, lowers operating costs and the carbon footprint by enabling the dynamic modification of power levels andresource distribution in response to traffic demands in real time. Notwithstanding these benefits, the application of AI in 5G networks is beset by a number of difficulties, such as computational complexity, data handling privacy issues, and dependence on high-quality training data. Optimising AI's advantages for network management requires addressing these problems. Future developments are anticipated as a result of the combination of AI and next- generation networks, especially 6G, which will allow for completely autonomous and highly linked settings. This assessment establishes the groundwork for future research and development in AI-enhanced telecoms while highlighting the critical role AI plays in realizing 5G's full promise*

Keywords: 5G Networks, Artificial Intelligence (AI), Network Optimization, Latency Reduction, Self-Optimizing Networks (SON), Network Slicing, Autonomous Networks, Machine Learning, Resource Allocation, AI-Powered Automation, Energy Efficiency, Real-Time Data Analytics, Network Security, Predictive Maintenance, 6G Networks