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AI Enabled-6G: Artificial Intelligence (AI) for Integration of 6G Wireless Communications

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Abstract

The research in wireless communication is rapidly shifting to the next generation mobile system, 6G. Fifth-generation mobile network standards are now in use. However, there are still some user criteria that are expected to be satisfied in the sixth-generation communication network. 6G is estimated to enable the unprecedented intelligence Internet of Things with extremely varied stimulating necessities. Currently, artificial intelligence (AI) is considered as a novel paradigm for the designing and optimizing intelligent 6G architectures, standards and functions. By 2030, all of the people would be using 6G. In this paper, we investigate 6G trends, requirements, challenges & potential solutions and how AI-enabled technique can integrate 6G communications. The analysis section provides the need and how AI-empowered technique efficiently and effectively enhances the performance of network. The 6G networks based on intelligent AI architecture used to understand automatic network adjustment, knowledge discovery, intelligent service provisioning, and smart resource management.

Keywords: Artificial Intelligence (AI), 6G, wireless communication, network performance, network optimization.

1. Introduction

Artificial intelligence in 6G communications will help meet the sophisticated communication needs of the data-centric, hyper connected paradigm that will connect consumers and objects in the future.. The

massive data generated by programs like YouTube or other streaming platforms, as well as the growing need for and widespread use of cellphones. It is now necessary to create a system that will have the ability to meet this need in order to handle the massive IP traffic and maintain control over it [1]. The goal of 6G communication in the future is to assist the creation of a pervasive intelligent mobile industry by providing incredibly high data speeds, incredibly low latency, and incredibly reliable. By 2030, 17.1 billion people will be using mobile broadband connection worldwide, predicts the International Telecommunication Union [2]. With full artificial intelligence, integration will be possible in 6G communication technology. Artificial intelligence will be crucial for 6G network's communication systems. This technology is also predicted to improve the "extended reality (ER) and augmented reality (AR)". The network system can be improved with the help of these technologies.
The user does not require any server, software or hardware setup; instead need a fast network connection. To create an authentic, informative ecosystem, cloud technology will be able to access any network connectivity and flexibility. The 6G network will be capable of handling vastly increased network systems with incredibly less latency, power consideration, and massive capacity [3]. The existing communication networking system is intelligently evolving with 6G communication. The many future applications of 6G in many fields, where 5G is the cornerstone for creating the future generation of communication technology, including smart transportation, the Internet of Things, and smart cities. 6G communication will definitely be an AI empowered model. The 6G communication necessities are great data rate, great working recurrence, high probability, minimum start to complete delay, high quality and frequency. 3D kinds of assistance will be offered in 6G with the aid of mounting innovation, for instance, artificial intelligence, block chain, and edge innovation [8]. The communication organization will receive a combined calculation, route, and detecting from 6G and it will address security, confidentiality, and protection of the massive data produced by billions of smart devices in the safety space. The main requirements for 6G communication are a 1000 km versatility range, a 300 m operating frequency, and a 1 Tbps data throughput [4]. The next section provides the 6G trends, requirements, challenges and solutions and AI enabled 6G for network communication.

2. 6G Trends and Requirements

The following are the essential requirements and trends of the sixth generation mobile networks.
High frequency bands: In order to support bandwidth-hungry services, NR is expected to use mm wave bands like 24GHz, 28GHz, and 37GHz. Future networks also call for higher spectrum technologies.
Scalability: The Internet of Everything (IoE) links billions of things, including high-end computers, sensors, actuators, smartphones, tablets, wearables, home appliances, cars, etc. A staggering amount of data is produced by such connected gadgets. Utilizing certain technologies, it is possible to uncover significant hidden knowledge from the data. As a result, algorithms and AI approaches are used to mine knowledge from data and analyse it. Prior to delivering the raw data, AI-enabled devices, such as user equipment (UE) and edge devices in the Internet of Everything, can analyse, summarise data, and find knowledge.
Great energy efficiency: Due to their intention to operate in higher frequency bands than previous generations, 6G devices require significantly more energy. As a result, power consumption and energy efficiency present a serious problem that must be taken into account. However, as new technologies are developed, we'll see a level of greater energy efficiency and even IoE devices without batteries.
3D Connectivity: In order to facilitate the integration of terrestrial and aerial service, the future network will be enlarged to 3D to include space, the seas, and the atmosphere. Numerous applications, such as climate monitoring, weather forecasting, and underwater monitoring, will be made possible by these networks.

3. Challenges And Potential Solutions

Despite the significance of AI in 6G systems, it has its own ethical, security, and privacy concerns. Additionally, AI can be used to launch clever attacks. The privacy, security, and ethical problems with AI are discussed in this section, along with some possible remedies.

3.1 Security Issues & Solutions in AI

Through AI-enabled features, 6G achieves connected intelligence, particularly with ML systems that are vulnerable to security risks. A ML system's learning phase is affected by poisoning attacks, which causes the model to learn incorrectly. Through AI-enabled features, 6G achieves connected intelligence, particularly with ML systems that are vulnerable to security risks. A ML system's learning phase is affected by poisoning attacks, which causes the model to learn incorrectly. AI systems can be made resilient by using potential defences like adversarial machine learning and moving target defence. The use of input validation and strong knowledge to defend against killing threats, adversarial training and defensive concentration to defend against evasion attacks, and asymmetric privacy and homomorphic encryption to defend against API-based attacks are additional defense tactics.

3.2 Privacy Issues & Solutions in AI

AI can quickly undermine privacy because of its capacity for large-scale data processing, as well as the speed of future computers and the technology requirements of future networks. Users no longer have control over how exterior systems will treat their data due to the large volume of user data that 6G requires to be acquired from billions of devices. A technical control for maintaining privacy is imposed by homomorphic encryption, which enables executing mathematical functions without first decrypting data [7,9].

4. AI- Enabled 6G Methodology

Edge computing and artificial intelligence will be used in 6G communication technology to bring the server from the cloud closer to the users. Technical advancement, possibility, difficulties and solutions of AI towards 6G is represented in table 1.

Table 1. Technical Advancement, Possibility, Difficulties and Solutions of AI towards 6G

Technical Advancement	Possibility as an Facilitating Technology	Existing Difficulties	Potential Solutions
Sensing of Data	Processing data obtained from a huge number of devices	The system might get overloaded while processing a lot of data, and constant data transmission reduces power efficiency	Improved energy efficiency with the use of AI at the sensor site for local inquiry
Sensing of Spectrum	Spectrum sensing and cognitive radios help users join networks regardless of their primary affiliation	Primary user may be impacted, and power usage may rise as a result of ongoing Spectrum scanning	AI-powered Cooperative Spectrum sensing can be utilized to efficiently use the frequency spectrum
Data Diversity	Connect devices with different sample rates, metrics, and data types	Various data types present challenges for data analysis	Data can be altered in feature space using AI for data analysis

4.1 Dynamic Specification

For the highly specialized user, a single network platform was customized. Without requiring any changes to the client data center network, clients can maintain their IP addresses and network topologies. Web services will increase dramatically as a result of hyper-specific network technologies. The spread of web services is being challenged. Our interactions with the web, our businesses, and one another have changed as a result of the concurrent surge in increase in data exchange.

4.2 Dynamic Capable

This method was originally referred to as "dynamic-channel" technology. It got its start as a reaction to substituting copper-based structure with faster data transfer techniques. Network protocols and network provisioning have seen some significant modifications as a result of the advancement of hyper capable network technology. The necessity to alleviate the 21st century network congestion is what motivates these advancements in the telecoms and Internet sector.

4.3 Dynamic Sensing

For wireless networks where the nodes are outfitted with numerous high-gain radio antennas, dynamic sensing is a new paradigm. With the available sensor technologies, the radio is intended for a single usage only. Thus, when compared to the human body, it consumes high power. Large-scale, multi-layered, highly complex, dynamic, and heterogeneous are only a few of the characteristics of 6G network development. Additionally, 6G networks must handle significant amounts of data produced by physical surroundings, sustain constant connectivity and ensure different QoS standards are met for the vast number of devices. As shown in Figure 1, the four main layers of the AI-enabled intelligent architecture for 6G networks are the intelligent sensing layer, the layer for data mining and analytics, the layer for intelligent control, and the layer for smart applications [5].

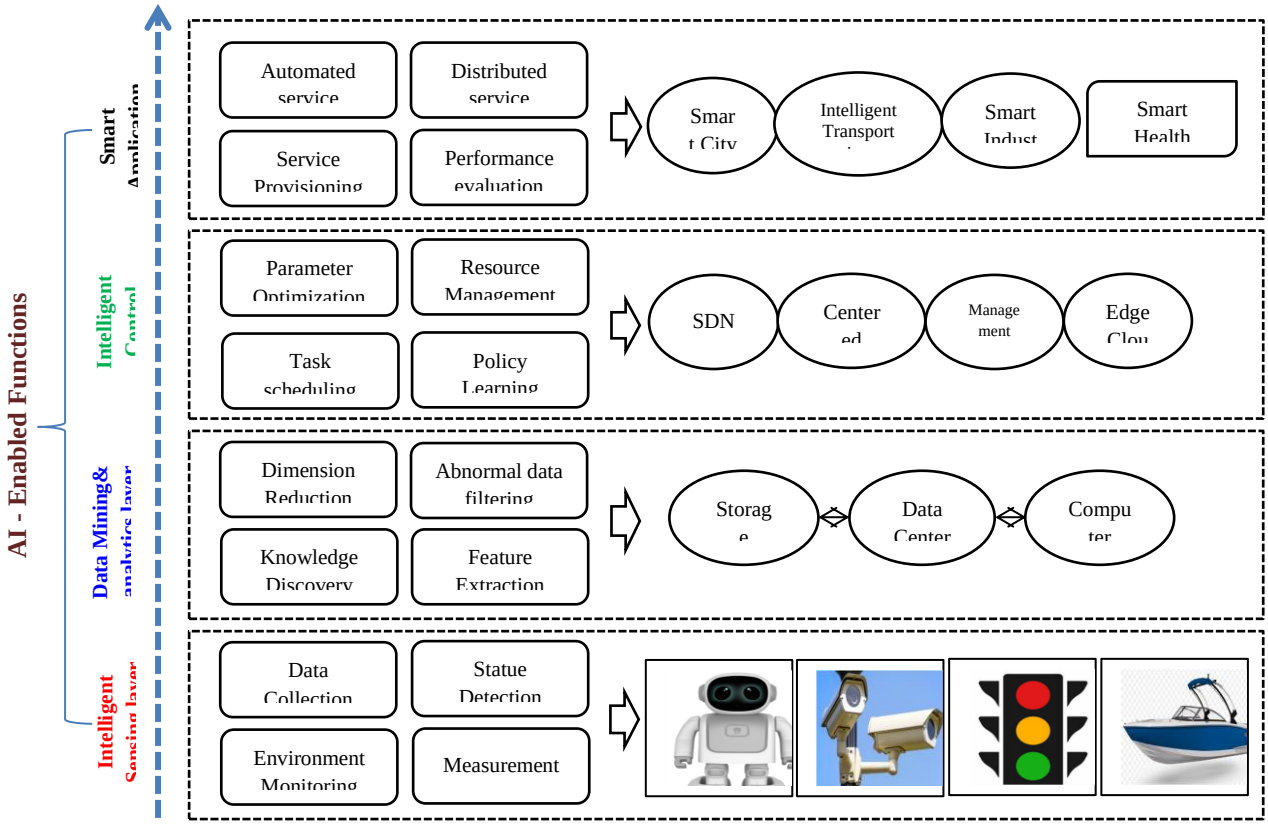

Figure 1. AI-Enabled 6G Network Architecture

4.4 Intelligent Sensing Layer

Sensing and finding is the most basic works in 6G networks, where the data from physical settings is typically sensed and detected by 6G networks using large equipment like cameras, smartphones, sensors, vehicles and drones. AI-enabled sensing and detecting, which primarily includes radio-frequency recognition, environment monitoring, spectrum sensing, detection of interference & intrusion, other functions, are capable of immediately engaging with the actual environment to collect vast amounts of dynamic, varied, and scalable data.

4.5 Data Mining and Analytics Layer

In order to perform semantic derivation and knowledge discovery, this layer's primary responsibility is to handle and evaluate the enormous amounts of raw data produced by the enormous number of devices used in 6G networks. Data mining and analytics can be used in 6G networks to solve the problems of processing the enormous amount of data as well as to analyze the collected data in the direction of knowledge acquisition. The enormous amounts of data gathered from physical environments could be complex, nonlinear, or high dimensional. By converting high dimensional data into a low dimensional subspace via AI-based data mining, 6G networks can significantly reduce model complexity, computing time, and storage requirements. In order to find relevant information and create valuable knowledge, data analytics is in charge of carefully evaluating the gathered data. In 6G networks, a huge amount of data are gathered from the real world, the internet, and social media, all of which offer important details and interesting features.

4.6 Intelligent Control Layer

The core functions of the intelligent control layer are learning, optimization, and decision-making. By utilising the relevant information from lower layers, this layer enables massive agents to intelligently learn, optimise, and select the most appropriate actions with dual functions to support a variety of social network services. By implementing AI methods in 6G networks, where every agent is outfitted with an artificial brain to automatically learn to make results on its own, this function is made possible. The key feature of 6G networks is intelligence; when AI and 6G networks are combined, they can acquire to accomplish Self-organizing, self-configuring, self-optimizing, and self-healing, ultimately raising the practicality threshold. For instance, PM-MIMO will be used in 6G systems to handle thousands of transceiver antennas with mmWave or THz broadcasts. Making decisions is a crucial cognitive job that enables large-scale agents to intelligently reason, plan, and select the best options in order to satisfy the demands for high-quality service.

4.7 Smart Application Layer

This layer's primary duties include providing application-specific services to people in accordance with their diverse needs and assessing the provided services before providing feedback on the analysis result to the intelligence process. In order to achieve network self-organization, all smart device, terminal, and infrastructure operations in 6G networks are also succeeded by the smart application layer using AI approaches. This layer's evaluation of service performance involves a number of aspects and variables, including QoS, QoE, the quality of the data that was collected, and the quality of the knowledge that was learnt.

5. Results & Discussion

5.1 Enhance the network performance

A high Quality of Services and client-driven communications with AI-enabled services are defined by the Quality of Experiences (QoE). Holographic communications, AR, virtual reality, and material internet will achieve quality of experience (QoE), which demands a high information rate with remarkably low inertness [10]. In order to give users a higher QoE, AI must combine with 6G

communication. Only when 6G can fulfil all of its promises will a high QoE be attained. By ensuring high quality experiences, 6G will assist the educational sector in sustaining high quality service experiences. With the introduction of 6G communication technology, the 6G network has the potential to revolutionize the communication industry and enable us to gather all of our necessities in one location. The Internet of Everything is a broad concept that aims to provide Internet of Things setups an advantage [6].

Table 2. 6G Performance Indicators

Performance Indicators	**6G**
Peak transmission rate	100 Gb / s ~ 1 *Tb / s*
User experience rate	*30 ~ 50 Gb / s*
Time delay	*0.1 ~ 1 ms*
Reliability	10^{-9}
Flow density	100 ~ 1000 *Tbps / km*^{2}
Positioning precision	0.1 ~ 1 m
Connection density	10 ~ 100 million / *km*^{3}
Network Efficiency	200 *bit /s*
Mobility	*1000 km /h*
Spectrum bandwidth	*200 ~ 500 bps / Hz*
Base station computing power	*1000 Tops*
Coverage	Global
Security	Endogenous Security
Information	Extremely High

Table 2 represents the performance indicators of 6G network. An overview of applying artificial intelligence towards 6G is represented in figure 2.

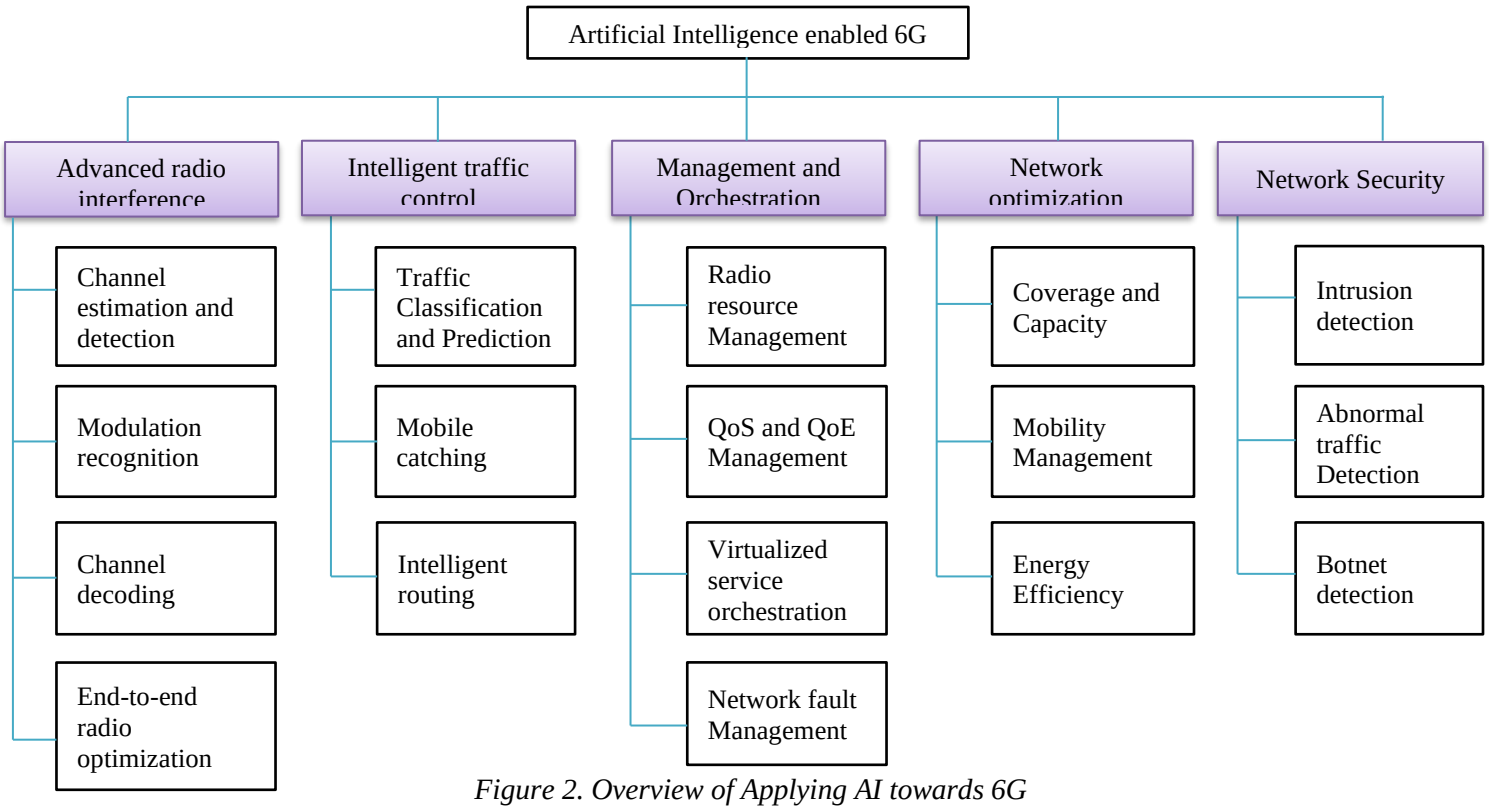

Figure 2. Overview of Applying AI towards 6G

Figure 3 shows the need to integrate 6G network communication. The current 5G technology is lag to balance the mobile data traffic. Artificial intelligence empowered 6G will be expected to balance this data traffic efficiently.

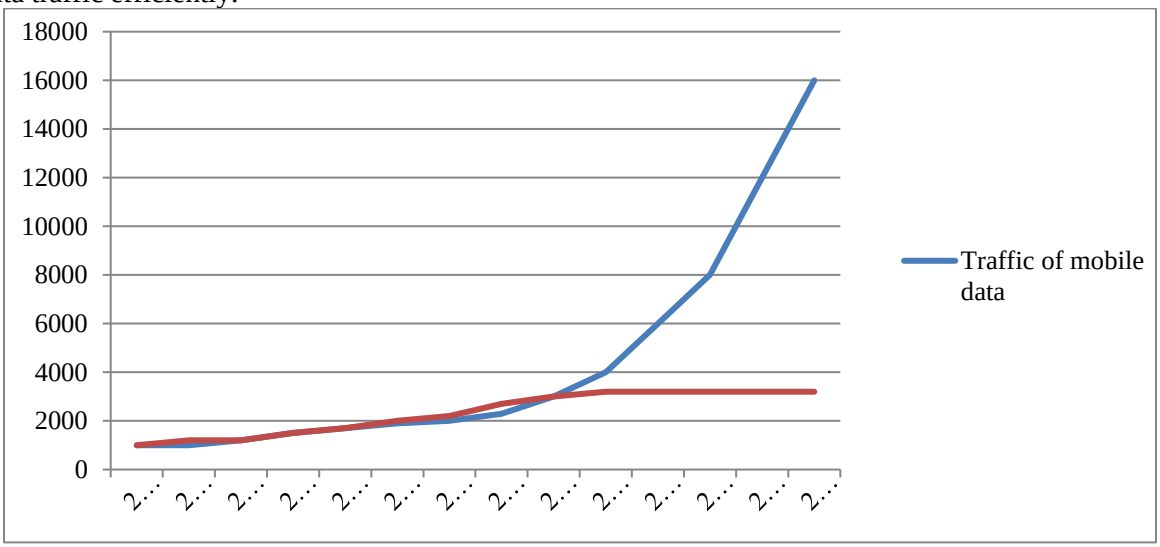

Figure 3. 6G Traffic: Expected Need

Figure 4 represents the 6G future developments using artificial intelligence techniques. Using the AI techniques in 6G, the network performance will become increased.

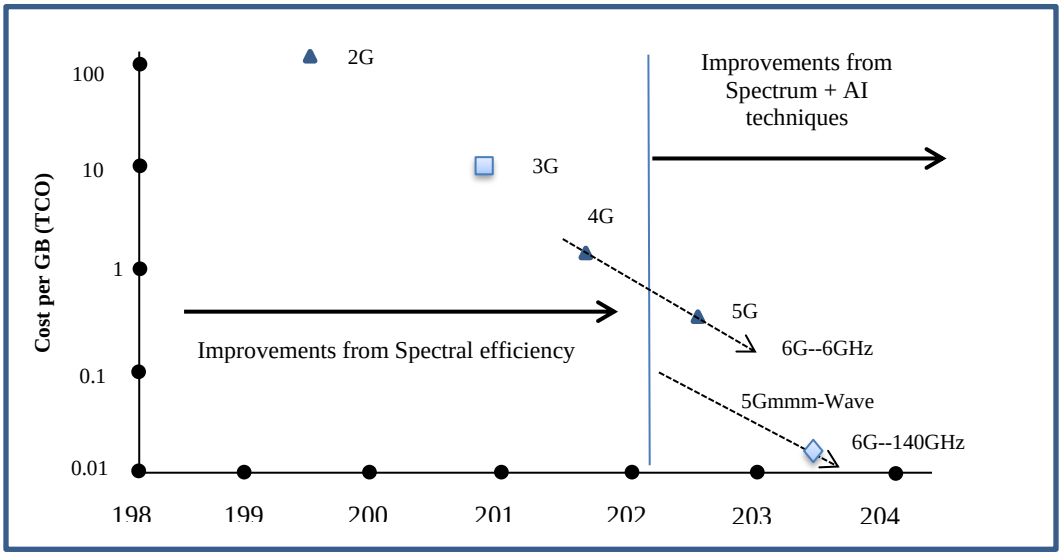

Figure 4. Future 6G Network Optimization through AI

The mobile network service providers consider framing up 6G as a “critical network”. With the aid of artificial intelligence, 6G will provide critical services towards end customers. To achieve the future communication needs with security, a highly-intelligent domain (6G) is used that requires artificial intelligence. AI enabled 6G will become more effective and consistent to the end user. In digital communication technology, combined artificial intelligence and 6G communication networks will form a new era.

6.Conclusion

Using cutting-edge radio technologies and novel paradigms, the 6G system is intended to serve a wide range of new applications. To accomplish the challenging objective of the 6G system, numerous technical challenges still need to be resolved. In 6G networks, AI is anticipated to have a significant impact. In the near future, 6G communications will be a necessity for the majority of people, and it will be combined with AI to create an intelligent communication system.

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