Green Communication in 6G

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Abstract: Green communication networking is a part of sustainable development. It aims to reduce energy consumption and serve the network to a vast number of servers cost-effectively. Green communication integrates artificial intelligence to solve complex mathematical problems for enhancing energy efficiency, flexibility, security, and quality of life services. One of the most remarkable characteristics of today's telecoms sector is wireless communication, used for more than a century. Infrared, radio frequency, satellite, and other electromagnetic waves are used in wireless communication technologies to send data over the air. More data is necessary for the 6G experience. More data is necessary and more excellent ambient sensing and awareness. Sensing systems in automated cars, for example, are exceedingly complicated and rely on cellular networks. Mobile and wireless networks, such as 6G, can use green communication to balance resource usage and conserve energy. In this study, 6G for green communication has been discussed to justify the necessity of 6G.

1. Introduction

Green communication, such as information sharing, spectrum/energy awareness, route adaptation, and data caching, allows mobile and wireless networks such as 5G or 6G to balance resource consumption and save energy. The wireless networking system, one of the critical concerns that need immediate attention from the scientific community, is energy limits [1]. The amount of data transferred is fast increasing, and wireless communications are widely utilized. Still, network design regulations have primarily overlooked using an energy-efficient network design method to reduce CO2 emissions [2]. Green Communications is the name given to this method. Significant energy savings in mobile networks may be predicted by establishing and standardizing energy efficiency criteria and integrating energy-aware flexible radios and networks. Therefore, this study aims to present the applications and overall approach of green communication in the context of a 6th generation network.

Green communication and networking are excellent initiatives for sustainable development and the whole economic chain. The objective of green communication technology is to recommend. Green communication is aimed to be 'energy efficient' by describing the ratio of delivered data and consumption of total energy [3-7]. Considering the traffic demand, it is difficult to ensure how green communication can 'Send More Information bits with Less Energy' (SMILE). In order to materialize the goal of SMILE, a network-based framework is being proposed is 'Mobility Enhanced Edge Intelligence.' There are four areas of scope for the implementation of green communication stated below [8].

2. Green Communication in 6G

Area 1: Green Internet and Service Provisioning:

Manmade climate change is the cause of global warming, so the world is encouraging the Information and Communication Technology (ICT) industries to reduce energy consumption [9-10].

Routing Algorithm and Internet Architecture: 6G will use artificial intelligence as an essential part with the proficiency of configuring heterogeneous network-related problems. Machine learning can efficiently solve complex mathematical problems [11]. A novel 6G network is required to overcome the challenges such as the massive distribution of wireless networking technology, cause effectiveness, and evaluate network functions based on their fluctuating nature [12].

6G Wireless Systems: 6G uses artificial intelligence to enhance the heterogeneous wireless network. A couple of complex mathematical problems such as mathematical optimization problems, match theory, game theory, and brute force algorithms need to be solved through the help of machine learning to improve the wireless network. Moreover, 6G architecture should be capable of technical challenges such as reliability, supervision, and evaluating virtual network function for the undetermined nature [13-16].

Area 2: Green Communication and Wireless Network Generation:

Due to the gradual rate of excessive energy consumption in massive traffic, it has become challenging to serve the community. So, the wireless communication network has become available in-home and enterprise environments. The greenhouse effect and energy crisis are

prominent obstacles to developing wireless communication networks. So, the green communication network has drawn the attention of the industries because green communication is energy efficient. Energy efficiency and energy harvesting techniques have been initiated for enabling technical and economic progress through GCN. Green Communication networks prioritize energy efficiency by materializing significant technological trends. The researchers are aimed to lower the carbon footprint in green communication networks. For example, a manageable and successful green communication keeps a device in an intelligent sleeping mood through artificial intelligence. Artificial intelligence will help us designate the situation, and a particular intelligence machine will fill standard gaps. In 6G networking, the auto-tuning modem plays a significant role. For the first time, 6G implemented standard cellular using machine learning. Moreover, tactile internet, skills, and autonomous vehicles are innovative inventions of the 6G network [16].

Area 3: Green Internet of Things & Energy-harvesting Communications

Energy Harvesting and Management: There are significant challenges in initiating the energy efficiency of communication machinery. The energy-efficient communication technology is well organized in 6G because of the short distance. Symbiotic Radio (SR) proposed solving energy problems that combine backscatter with dynamic transmissions. Ambient backscatter devices are examples that use ambient RF signals to transfer without the permission of an active RF transmitter. RF transmitters made possible communication without using a battery [17-20].

Area 4: Green Computing & Artificial Intelligence:

Green communication is aimed to lowering the use of fossil fuels to mitigate energy consumption in information technology. In recent years the volume of network infrastructure and the number of stations has increased. In a consequence, the energy serving cost has become expensive [21]. Green communication is initiated to enhance the quality of service, security, flexibility, intelligence, and energy efficiency in a cost-effective manner. Artificial intelligence [22], specifically machine learning techniques and deep learning method, help to overcome challenges of energy efficiency in green communication [23].

3. Enabling Technologies

The following sections look into the emerging technologies as 6G network enablers. In 5G networks, several of the technologies have already been researched or discussed. They are not commercially viable for 5G networks due to technological restrictions or market boundaries. Breakthroughs in 6G can occur at various layers, including the physical layer (PHY), network architecture, communication protocols, network intelligence, and so on. This section focuses on 6G evolutionary technologies. To build 6G networks, evolutionary solutions try to employ existing or already adopted technologies (e.g., MIMO). Revolutionary solutions provide 6G by utilizing novel technology (THz communications). In other aspects, when compared to 5G networks, the revolutionary technologies would radically modify various layers of cellular networks (e.g., the PHY layer). It is worth noting that many features of breakthrough technologies are still being researched scientifically [24].

3.1. Non-Terrestrial Technologies

Current mobile networks based on traditional terrestrial technologies have overcome the hurdles of offering comprehensive wireless coverage to rural areas, lack of accessibility, or vulnerability to natural and human-caused calamities. To overcome these obstacles, 6G networks will combine terrestrial and non-terrestrial technologies, such as UAV-assisted wireless communications and satellite connectivity, to provide comprehensive coverage or ample capacity connectivity [25].

3.2. Energy Harvesting

Energy harvesting technologies have been integrated into 5G to meet stringent energy constraints in a cost-effective and long-term manner. These techniques can create electrical power from external sources to power network equipment, such as routers. These techniques can create electrical power for network device energy supply from outside sources. Massive MIMO systems can achieve substantially improved performance or enhance their energy economy by utilizing LIS technology, as LIS elements do not require any continuous power source to transmit information [26].

3.3. AI and 6G

Artificial intelligence (AI) is perhaps the most prominent and recently suggested enabling technology for the 6G network. AI has been applied in 5G to a limited extent, particularly machine learning (ML) methods, including deep learning (DL) as well as reinforcement learning (RL). Furthermore, 6G will ultimately conceptualize AI for various purposes (e.g., intelligent thinking, decision making, or design and optimization of architecture, operations, and protocols). The 6G network is planned to enable ubiquitous AI services from the core to the end devices. Moreover, there are already significant issues with 5G energy harvesting technologies, including coexistence with communication protocols and efficiency loss during the conversion of captured signals to electricity. In light of the 6G network's anticipated massive scale and the fact that any long-term development in communications networks and systems should pay close care to consumption of energy, 6G would require to effectively energy development and harvest techniques and efficient energy communication mechanisms.

Furthermore, its projected that in the 6G future massive networking of battery less and low-power smart devices would enable IoT. Nonetheless, discovery a visible solution to extend the battery life of devices is a vital problem. For tackling these issues, two possible solutions have found much consideration: 1) enhancement of the efficiency of the energy for low-power gadgets, and 2) energy harvesting mechanisms, wireless information and power transfers (WIPT). Developing 6G supporting technologies such as Terahertz (THz) communications or smart surfaces provides numerous options for the 6G network to attain energy personality and self-sustainability. For WIPT applications,

the THz frequency band, for example, is more efficient than lower frequency bands because of its higher directionality [27].

4. Limitations

The wireless network's range is limited, posing problems for many users. Moreover, installing a wireless network can be difficult for people unfamiliar with computers. Because the wireless network is highly susceptible to interference, weather and radiation can cause it to fail. In addition, installing a wireless network is prohibitively expensive. Furthermore, the wireless network only has a limited amount of bandwidth.

Consequently, these are the limitations of wireless connections [28]. Besides, the limitations of a 5g wireless connection are: Waves frequencies could only a short distance travel due to 5G has a limited range connectivity. Add to this the problem of 5G spectrums is usually disturbed by physical impairments, comprising towers, walls, trees, or building. The 5G developing expenditures for upgrade to current or infrastructure would be important as well. These would be added by combined to the continuous maintenances cost which always needed to preserve high-speed data rate, and clients would possibly tolerate the impact of these substantial issues. Whereas 5G may deliver proper connectivity to urban regions, those living in rural areas may not necessarily benefit from the connections. When it comes to 5G-enabled cellular devices, it appears that the batteries are not capable of lasting a long time. However, the download speeds of 5G technology are extremely fast, reaching up to 1.9Gbps in some circumstances [29].

Nevertheless, upload speeds rarely exceed 100Mbps, so they are not quite as impressive as they seem. Most towns oppose the construction of new cellphone towers or the extension of existing cell phone towers because they are perceived to detract from an area's general appearance and feel [7]. Therefore, we hope that these can be the limitation of the 6g network. However, 6g may have its limitations. So, the limitation of 6g is:

From the realm of possibility to the realm of certainty, because of the unique characteristics of Internet Protocol, the services supplied by mobile internet in the past were plagued with uncertainties and instabilities. These services can readily please subscribers in the 4G era. Even so, slight networks packet loss and delay have no effect on a client's capacity for watching movies or online shopping. Additionally, 6G and 5G networks with IoT would grow to all businesses, comprising IoE (Internet of everything), guaranteeing good reliability and low latencies. Because of This slicing of the network, Multi-access Edges Computing (MEC), and all other factors have been comprised in 5G to offer services level agreement (SLA) guaranteed end-to-end services network. It is likely that the 5G networks services reliabilities would be enhanced in the next generation era, consenting to numerous situations respond across varied businesses [29-31].

4.1. Openness and customization

Additional to all that, the sharing and openness was the main essence behind the Internet idea, which assistances to widely grow. The mobile communications and networks ecosystem, to some extent restrict its progress by developing unique technologies. The 5G mobile network would inspire the IT and CT integration to discover more new services and applications to allow all industries types to contribute to the transformation toward digital [32-33]. The customization and openness abilities will growth in the next mobile generation, with more interfaces for API that support agile and flexible businesses for customers to qualify and fulfil the deploying requirement of tailored customized and networks services [34].

4.2. Network of Artificial Intelligence

AI (Artificial Intelligence) is now being used in various fields, including picture recognition, speech recognition, automatic translation, and so on. For one thing, as network services evolve, higher network latency, reliability, and user experience criteria are required. Furthermore, the more intricate the network, the more difficult it is to maintain and improve network KPIs through standard operations [35-37]. To address these issues, network operators and equipment vendors are attempting to integrate artificial intelligence (AI) into the network to promote network automation and intelligent transformation. To maximize the usefulness of an AI engine, however, enormous data and processing resources are required. As a result, future artificial intelligence networks in the 5G and 6G periods will require AI and network interaction [38].

4.3. Full coverage

Today, yet over two billion of people globally still cannot access the Internet. These due to optical fiber (OF) cables and BSs deployment high cost over wide geographical locations with high cost of network failure maintenance in isolated and remote areas. In the next mobile infrastructure generation, the earth-space combination network is needed to achieve the gool of worldwide full coverage [39]. Base station should be deployed on top of stratospheric stages and A low earth orbits (LEOs) satellites to integrate the earth-space networks that can reach remote areas and support them by Internet for digital dividend. In general, these solutions examine the potential of various new applications [40].

4.4. Transformation to a low-carbon economy

Promoting low-carbon transformation is a global goal and essential in the ICT industry. In light of the dramatic increase in network throughput and escalating resource consumption, operators must build low-carbon and energy-saving networks as a necessary measure of lowering OPEX and responsible social behavior. The intelligent network with end-to-end AI and perceptive capability will assist operators in achieving their energy-saving goals in the future [41].

4.5. Flexibility, redundancy, and the ability to self-heal

5G/6G technology is the solid foundation for supporting digital manufacturing, operation, and administration, which requires a higher quality of network dependability and stability due to the numerous uses of 5G/6G in all industries. Every job in the telecom business

should focus on building a flexible, redundant, and self-healing network that can provide stable network services even if the network fails [42]. It can be said that 6g is related to green communication because Green Communication works with energy efficiency. So, there is a possibility of a relationship between 6g and green communication.

5. Conclusion

The demand for green communication is growing in tandem with the evolution of communication and technology. Green communication improves energy efficiency while lowering CO2 emissions. CO2 is a severe environmental hazard. We have already talked about why 6G networks are necessary. As a result, 6G research should be done to meet the goals by 2030. Then, we discussed 6G for green communication and justified why 6G is necessary. In addition, important energy efficiency, uses, application, and possible critical enabling technologies for 6G networks have been described. Cost, spectral efficiency, and bandwidth limitations remain unsolved research problems. In this work, various green communication approaches are discussed. It has been concluded that 6G will boost network performance and integrate many technologies.

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