5G technology in power systems

Anandhu Anilkumar
Department of Electronics and Communication Engineering St. Joseph's College of Engineering and Technology Palai, India ,anandhuanil3211@gmail.com

Anu Jyothy
Department of Electronics and Communication Engineering St. Joseph's College of Engineering and Technology Palai, India ,anujyothi@gmail.com

***Abstract*—5G Technology stands for fifth generation technology and it's been used in telephone companies since 2019. 5G technology is faster, has higher bandwidth and it improves existing quality of internet services. Theoretical peak speed of 5G technology is 20 Gbps , while that of 4G is only 1Gbps. 5G technology will have vast and flexible access architecture and enables faster data processing . It's been predicted that 5G technology will have more than 1.7 billion subscribers by 2025. Currently, power systems are being constantly updated and upgraded aiming high speed transmission which is related to the developments of power systems in communication field. As 5G technology develops, researches on developing 5G communication in power systems also increases. So, application of 5G technology in power systems is relevant and important. Security risks that 5G technology brings in power systems and technical solutions for power industry applications are also discussed in this paper.**

***Index Terms*—component, formatting, style, styling, insert**

I. Introduction

The State Grid Corporation of China (SGCC) has made a commitment in recent years to creating a top-tier energy Internet firm in order to hasten the development of the smart grid and improve the information and communication infrastructure. The number of IOT application terminals supporting the power grid production industry is rapidly increasing as a result of the ongoing development of power communication networks. Problems like the inability to sense data return in the process of power IOT construction data and transmission delay are gradually exposed as a result of the rapid development of distribution automation, distributed energy access, power consumption information collection, and other businesses, coupled with the stepped growth of communication demand of various kinds of power grid terminal customers. These problems make it difficult to meet the business and communication demands.

The SGCC suggested in March 2019 to use the power grid as the hub and completely use modern information technology and advanced communication technology in all parts of the power system to actualize human-computer interaction, data exchange, and interconnection of everything and to deliver value services for the entire industry, all market entities, and the government, connect power grid enterprises, power users, suppliers, power generation enterprises, and equipment. Wireless communication technology will be one of them. The industry has entered a new era of "Internet of Everything" with the rise of 5G mobile communication technology and its close integration with artificial intelligence, big data, and other contemporary information technologies. The performance characteristics of 5G communication technology include extremely low latency, extremely high network speed, super signal, extremely wide connection, etc. It is also more varied and all-encompassing than 3G and 4G communication technology. As a result, it will alter the way the communication industry operates and works, and it will offer technological assistance for the sector's enhancement of operational effectiveness and wise decision-making.

Low latency, high reliability, and widespread connectivity for the Internet of Things are some of the application scenarios for 5G communication technology that show great promise and commercial value in real-world applications like driverless cars, high-speed information resource downloads, remote surgery, and the Internet of vehicles. These scenarios are gradually ushering in an era of ultra-high speed communication. One such example of a network tailored to particular business needs is the 5G network slicing technology, which is the foundation of the 5G network. It can support the development of differentiated service level agreements (SLA), automatic on-demand construction, and mutual isolation. End-to-end network guarantee SLA, service isolation, network function customization, and automation are common aspects of 5G network slicing technology. It can not only offer network as a service (NaaS) and dynamically distribute network resources, but it can also apply information collecting and distribution automated slicing in accordance with various business scenarios. Different slicing can satisfy the technical index requirements of the respective situations if 5G network slicing (virtual private network) technology and the electric power communication network are thoroughly integrated. One of the top concerns of modern communication research is to build and address the bottlenecks of the power communication network and to figure out how to conduct in-depth study on the development of the 5G technology and the power communication network in the context of the smart grid and the power Internet of things.

II. 5G COMMUNICATION TECHNOLOGY

A. What is 5G technology?

The network structure of 5G communication consists of a core network, micro base stations, and macro base sta- tions. One of them, the macro base station, uses wireless communication to enable information transmission between various places and is connected to the main network through microwave or light. It is referred to be the ”central nervous system” of the communication system and has the character- istics of a large coverage area and high transmission power. The core network is in charge of linking data requests from various ports with the appropriate network, and it primarily regulates data transmission and system operation. A group of all-small base stations known as a ”micro base station” with limited coverage and weak transmission power is commonly known as the “peripheral nerve” of communication system.

Working of 5G Technology

Radio frequencies or the so called spectrum, are used by wireless communications systems to transmit data through air. 5G uses higher, less congested radio frequencies. This helps to transmit more data much more quickly.
The following are some of the most individual technologies that have combined to enable the speed and latency improvements of 5G.

Millimeter waves: The majority of 5G networks will operate on frequencies between 30 and 300 GHz. Compared to the lower-frequency transmissions now utilised by 4G LTE, which are typically below 1 GHz, or Wi-Fi, which peaks out at 6 GHz, this high-frequency band can carry far more information per unit of time. Traditionally, millimeter-wave technology has been expensive and challenging to implement. These challenges have been overcome by technological advancements, which is part of what has made 5G viable today.

Small Cells: Millimeter wave transmission has the disadvantage that it is more susceptible to interference when it passes through physical objects than Wi-Fi or 4G signals. To get around this, the 5G networks will be powered by considerably smaller base stations dispersed throughout cities at a distance of roughly 250 metres apart, producing cells of service that are equally smaller. This will replace the massive cellular-antenna masts we’ve grown to accept as part of the landscape.

Massive MIMO: Despite being significantly smaller than their 4G predecessors, 5G base stations contain a huge number of antennas. These antennas have multiple inputs and multiple outputs (MIMO), which enables them to manage numerous two-way conversations over a single data flow. This allows 5G networks to support more than 20 times as many conversations as 4G networks.

Network slicing: The physical network of a carrier is divided into a number of virtual networks using network slicing, and each network is tailored to a different set of service needs. Realize software defined networking (SDN) and network function virtualization (NFV) (SDN). In order to accommodate various scenarios, this can be segmented into various networks based on latency, bandwidth, security, and reliability.

III. ELECTRICAL POWER SYSTEMS

A. What are power systems?

An electrical power grid is a network of connected devices that transports electricity from a generator to its end users. It is occasionally referred to as an electrical power system. A power grid is made up of power plants, transmission lines, and distribution networks. The placement of power plants is determined by the viability of the site, the location of the dam, or the best spot for renewable energy sources. As a result, they are frequently found far from populous areas. This is highly useful since moving electrical power over greater distances is far more cost-effective than moving any other fuel. Additionally, a hydroelectric facility must be situated in accordance with the location of a suitable dam, or a wind power plant may be situated offshore to capture additional wind energy. As a result, in order to transfer the generated electricity to populated areas, a long distance transmission infrastructure is required. And to deliver the power to each consumer at the proper voltages, a distribution system is required.

1V. APPLICATIONS OF 5G TECHNOLOGY IN POWER SYSTEMS

A. Applied to Distribution Networks

The component of the power system known as the distri- bution system is responsible for distributing electricity for local use. A distribution system is typically the electrical network that runs from the substation that is supplied by the transmission system to the consumer metres.
An automatic controller must evaluate the current flowing through a circuit at both ends in order to provide differential protection in distribution networks. Due to the fact that electric currents move at the speed of light, differential protection calls for incredibly small delay times. In order to provide differen- tial protection in the 4G era, optical fibres had to be employed because 4G networks can have delays of up to hundreds of milliseconds. The promotion and use of differential protection are, however, severely constrained by the time, expense, and proneness to damage associated with large-scale deployment of optical fibres. The best solution is to provide differential protection using 5G.
Through the use of 5G communication technology, neighbour- ing component information may be swiftly gathered in order to provide differential protection, reduce failure duration, and boost power supply dependability.

B. Applied to Precise Load Control

One of the primary objectives of a power system is flexible response. To accomplish timely response to power fluctuations, correct load control must be carried out, with a focus on the issues of insufficient rotating reserve, blocking of cascade faults, and power flow overrun of key channels.

While the reliability of using optical fibre communication to deliver accurate load control services is high, the expense of installing, operating, and maintaining optical fibre is also significant. The deployment of 5G communication technology can lower costs, satisfy the demands of business communication and security, and carry accurate load control services.

The interruptible load of enormous distributed power consumers is carefully managed by 5G, in accordance with DC power loss, to allow for interaction between the grid and power sources/loads as well as instantaneous balance of power supply and demand.

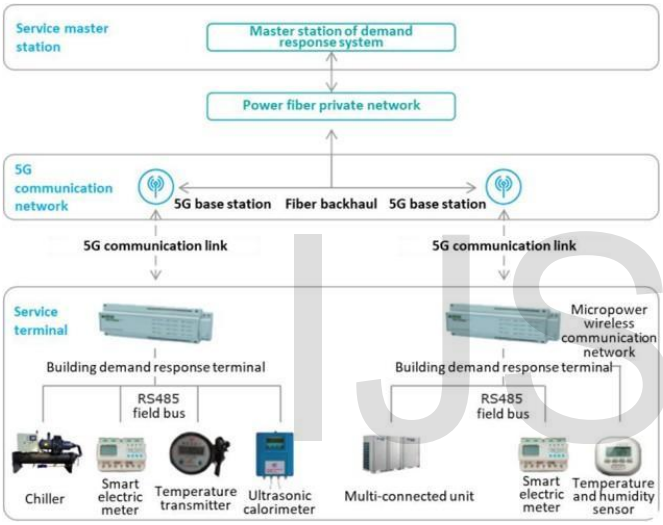

Fig. 1. Application scenarios for 5G-based precision load control services

C. Distributed Power Control

Laying optical cables to access the power communication private network is typically required for large-scale distributed energy, although doing so will raise the cost and complicate deployment. Basic data is gathered over wireless public networks for small-scale distributed energy sources in order to realise ”just monitoring but not regulating,” which restricts the regulation and control of power grid businesses. Multiple power sources can be connected to the grid via 5G technology, enabling users to both consume and produce electricity. The distribution network side’s power flow mode is more complicated and requires unified control.

D. Transmission Line Inspection

Transmission lines have many flaws, including exceeding the air distance restriction, corroding metal fittings, wire breakage, and insulator string dropping, among others. The department responsible for power operation and maintenance must frequently inspect transmission cables each year. Manual inspection techniques are mostly used in traditional circuit inspection. The efficiency of transmission lines will decrease as a result of higher inspection costs, which are predicted to be impacted by the terrain environment and poor weather. But when gathering data about a line, using helicopters, drones, or other cutting-edge technology can not only effectively reduce the impact of the environment and terrain on line inspection work but also increase the accuracy of the inspection work. In contrast to the large-broadband 5G communication technology, 4G network data transmission has a poor data collecting impact and is susceptible to the lag defect. Therefore, adopting 5G technology for collection operations allows for direct data transmission from the terminal to the terminal and real-time monitoring of the transmission lines’ operational status on the display platform. Operation and maintenance staff do the necessary maintenance tasks to offer reliable data support and to substantially boost the effectiveness of line inspection.

E. Emergency Communication

When an emergency occurs during the functioning of a power system, it is important to quickly gather site information and create customised remedies. However, due to the unpredictable nature of an emergency’s location, it is impossible to get pertinent information quickly using conventional communication techniques. As a result, maintenance staff must study a significant quantity of data and travel to the fault site to address the issue. Numerous IoT sensors in the power system can transfer data information to the data centre in a timely manner thanks to 5G technology, and the data centre can quickly analyse data information with the aid of 5G technology in order to suggest solutions to issues. Additionally, by installing automated maintenance equipment failure problems of processing, the use of 5G technology will also be able to control the uav to fault location. Additionally, while performing maintenance work, the background staff can be realised with the aid of 5G technology to all kinds of real- time control of operation and maintenance equipment using rapid communication way to complete the problem handling.

V. CONCLUSION

The use of the IoT could strengthen the economic operation efficiency of the power grid, create new business value, and break through traditional Juxian thinking as the power communication network develops from power line carrier to optical fibre to various wireless communication systems. The advancement of the Power Internet of Things is guaranteed by the use of 5G communication network technologies. It is an important piece of technology for power network connectivity and has transformed how most people produce and live. The usage of 5G communication network technology in the future development process still requires further research efforts in accordance with the actual needs. The technical perspective of 5G offer distinct network service capabilities for various power grid enterprises, while opening up new possibilities for the development of smart grids. Expediting the adoption of 5G in the power sector is critical for implementing the national 5G and technology Internet

strategy, supporting the development of a new power system with energy as its main component, and help in the establishment of an international market-leading energy Internet enterprise.

REFERENCES

Zhang, Qiang, Ling He, Huiting Yang, Yue Li, Xuewei Duan, and Weiwei Jiang. ”5G key technology and deep application in power system.” In 2022 IEEE 10th Joint International Information Technology and Artificial Intelligence Conference (ITAIC), vol. 10, pp. 863-867. IEEE, 2022.

Guo, Xuerang. ”The impact of 5G communication technology on electrical power systems.” In 2022 IEEE 6th Information Technology and Mechatronics Engineering Conference (ITOEC), vol. 6, pp. 1786- 1789. IEEE, 2022.

Sun, Xin, Fei Zhang, ChunYang Wang, and Bin Lv. ”Application of 5G Mobile Communication Technology in Specific Environment of Power System.” In 2021 International Wireless Communications and Mobile Computing (IWCMC), pp. 648-651. IEEE, 2021.

Zou, Zhenwan, Tao Chen, Jia Chen, Yingsa Hou, and Ruxia Yang. ”Research on network security risk and security countermeasures of 5g technology in power system application.” In 2021 IEEE 5th Advanced Information Technology, Electronic and Automation Control Conference (IAEAC), vol. 5, pp. 102-105. IEEE, 202