Research on New Technology of Power System Automation Based on Ubiquitous Internet of Things Technology

Qi Yuan
School of Electrical and Electronic Engineering, North China Electric Power University, Baoding 071003, Hebei, China
895197020@qq.com

Abstract. The ubiquitous power Internet of Things is a complex multi-network system consisting of a power system and a combination of intelligent terminal sensors, communication networks, artificial intelligence, and cloud platform technologies. The ubiquitous power Internet of Things realizes the real-time balance between energy production and consumption through power system equipment information interaction and character information interaction, and ensures the economic and safe operation of the power grid. The Internet of Things technology also promotes many new technologies that have developed many power system automation. The combination of ubiquitous IoT technology and power system will eventually build a multi-participating energy ecosystem and add more technical support for the development of power system construction.

1. Introduction
The ubiquitous power Internet of Things has many technical difficulties to be overcome in terms of data processing and analysis, information security, changes in business models, infrastructure construction, and high-tech research. However, with the support of national policies and the exploration of relevant industry experts, a preliminary set of information and communication theory systems supporting construction has been gradually formed.

2. The concept of ubiquitous power Internet of Things and power system automation
The ubiquitous power Internet of Things is a concrete manifestation of the ubiquitous Internet of Things in the power industry. Ubiquitous power Internet of Things through power users and their equipment, power grid enterprises and their equipment, power generation enterprises and their equipment, suppliers and their equipment, as well as the interconnection of people and things, to build a grid-based, real-time data sharing platform. Therefore, the ubiquitous power Internet of Things can be defined as: applying modern information technology and advanced communication technologies connecting people, machines and materials in all aspects of energy and power production and consumption online, carrying and running through the grid production and operation, Data flow and business flow of enterprise management and external customer service, realize a new generation information communication system with comprehensive awareness of power system status, efficient information processing, and convenient and flexible application [1].
Power system automation refers to the use of computer technology, communication technology to monitor the entire process of power production and transportation, to provide support for the stability of power system operation [2]. The workflow of power system automation is to install computers in the power control center area, install corresponding control equipment in nearby power plants and substations, radiate power plants and variable power stations, and then set up various power plants and transformer substations. The equipment, realize remote monitoring, based on this, establish a network system, which can timely grasp the actual operation of the power system, timely supervise and manage various faults, and provide support for the stability of the power system operation [3].

Figure 1. Development of the definition of power internet of things

3. Ubiquitous power Internet of things key technology

3.1. Intelligent terminal technology
At present, the power Internet of Things business terminals mainly include smart meters, power transmission and transformation monitoring devices, distribution automation devices, and dispatching automation measuring points[4]. The existing terminal standards are not uniform. It is necessary to establish a unified architecture system, standardize the development of standard intelligent terminals, and form unified access and management of service terminals: It is necessary to standardize the uplink interface protocol and data format of intelligent service terminals, and combine the precision and volume of smart chips. The characteristics of small and low power consumption promote the large-scale application of new business terminals and the upgrading and standardization of access terminals. It is necessary to speed up research on cross-professional data homology collection and multi-terminal function integration and cross-professional reuse to improve the online rate of business terminals [5].

3.2. Communication Network Optimization Technology
The communication network is an important basic support for the ubiquitous power Internet of Things network layer. Combined with the ubiquitous power IoT construction and application requirements, the number of cores, fiber coverage and network bandwidth of the backbone network is still insufficient. The selection and construction of wireless private network technology is relatively lagging, and it cannot adapt to the ubiquitous power Internet of Things.

3.2.1. Communication network architecture optimization and improvement. With the goal of "high reliability, comprehensive, diversified, broadband, and centralized", we will optimize and upgrade the
provincial transmission network, explore the development of OTN dual-plane construction, and enhance the inter-connectivity of provinces and cities. Improve the structure of the backbone fiber optic cable grid to solve the problem of the core of the backbone section without air cables. Carry out capacity expansion and transformation of the city's transmission network, strengthen the "PTN+SDH" network architecture, and build a regional transmission network with reasonable network structure, flexible network access, strong carrying capacity and sustainable development. The county transmission network upgrade will be carried out to solve the problem of low coverage and low bandwidth of the county transmission network, and meet the ever-increasing bandwidth demand of the ubiquitous ubiquitous access and power grid production control services of the ubiquitous power IoT terminal equipment.

**Figure 2.** Application of Power Internet of Things in Power System Technology

3.2.2. Research on wireless communication network technology. As the development direction of next-generation mobile communication technology, 5G is an important evolution direction of wireless access. It is necessary to speed up the introduction of software-defined networks and edge computing technologies, and study the application of 5G technologies to meet the faster terminal access rate, lower service transmission delay and more terminal connection capacity requirements. In terms of large bandwidth, it meets the needs of scenarios such as dispatching, transportation inspection, marketing, construction and other grid service upgrades, high-definition video communication, wearable intelligent inspection, etc.; low latency, meeting distribution automation, "three remote" and other low time Extending the business needs of the grid; in terms of wide connectivity, it meets the needs of ubiquitous, diversified, intelligent, and large-scale access to mass terminal equipment.
3.3. **Big Data Analysis**

Ubiquitous power IoT construction needs to speed up the construction of energy big data analysis platform, using data mining, data modeling, simulation, data correlation analysis and other technologies to promote the deep application of big data in the energy field, improve the integration of big data technology, business integration and data fusion capabilities, effectively assisting government decision-making and promoting coordinated development of the industry. With the vigorous promotion of the energy Internet, energy management will be based on the energy Internet, supported by electric energy, and integrate a variety of distributed energy sources such as cold, heat, electricity and hot water to build a "source-network-load" interactive regional type. The demand for energy internet is urgent. The construction of energy big data analysis platform can promote data sharing and integration, realize energy coordinated control and comprehensive energy efficiency management, and promote collaborative innovation and development of the energy industry.

4. **Power system automation technology**

4.1. **FACTS technology**

In the development of modern society, all walks of life put forward more stringent requirements on the stability of power system operation. In the application process of power transmission and distribution technology, in order to ensure the stability of voltage and current, improve the limitations of traditional transmission capacity, establish a new type of transmission system has made the flexible AC transmission system come into being. The core content of this system is the inverter and the parallel capacitor. The three-phase AC output of the device and the grid voltage are synchronized, which can be effectively adjusted and controlled. The operation of the voltage to achieve the stability of the voltage operation. In addition, flexible AC transmission system devices have a wide range of adjustable, fast response, inertia problems during the operation of mechanical equipment, and can eliminate noise during mechanical rotation and operation. Among them, the essence of the ASVC device is a solid-state device that can control the transient state of the network, which makes its controllability improved.
4.2. Intelligent Control Technology
In the development process of power system automation, intelligent control technology has been effectively applied, which has the significance of the times. In the traditional power system control process, the relevant technicians need to deeply analyze the linear control and transfer function control problems, and apply the intelligent control technology to the power system. However, the development of intelligent control technology is relatively weak, and the intelligent control theory has gradually become the theoretical guidance content of the automatic operation of power systems at this stage.

4.3. DFACTS technology
DFACTS technology refers to the flexible communication after the application of the power distribution system. The application of this technology is based on the power supply requirements of the distribution network. The new theoretical viewpoints are based on the quality of the power supply system. The problem is solved by applying this system to introduce a new type of power electronic controller during the operation of commercial users and distribution networks.

5. Ubiquitous power Internet of Things is applied in power systems

5.1. Using data to lay down the service foundation
Building a ubiquitous power Internet of Things requires first fully exploiting the data in the power system. Collect data on various aspects such as substation, transmission line, and electricity consumption information, and use the information communication theory of the energy Internet to combine the communication principle and graph theory to normalize, reduce, and reconstruct the data. It lays a solid foundation for the optimal operation and coordinated planning of the power system.

The main method of data collection is to widely arrange the fully compatible sensing devices in all aspects of the power system to sense, measure and monitor the operating conditions of the key power equipment, thus providing great data support for the management of power grid companies' power equipment. And convenient.

With the advent of the 5G era, the communication speed of the network will be faster and more stable, real-time, high-speed, two-way transmission of data can be realized. After the addition of 4G/5G network, edge computing technology will make data processing more convenient, resource
sharing more rapid, and network construction more comprehensive. At the same time, the multi-level power communication network covering the ground power satellite, the establishment of the wireless private network, and the formation of the backbone network will further meet the network information interaction requirements and realize the ubiquitous connection. In addition, edge computing will complement the cloud computing to further improve the speed and accuracy of the analysis and processing data, allowing users and the grid and users and users to interact in real time.

![Figure 5. Application of Power Internet of Things in Smart Grid Automation](image)

After building a data service and data transmission platform, new services can be derived from the effective use of data, such as renting and selling data. The financial industry, scientific research institutions, and universities have huge demand for the raw data of the power industry. Under the ubiquitous system of power Internet of Things, data will not become a barrier to the development of the industry, and can achieve rapid development of related industries. The ubiquitous improvement of the power Internet of Things.

5.2. **Building an economic and safe grid**
Combining the high-speed development of machine learning methods and acquired data, the new energy-load real-time monitoring and power prediction system is developed, and a power dispatching system based on thermal power and nuclear power units is established. Combined with real-time data collection and equipment status automatic diagnosis technology of the power equipment in operation, the actual operation status of the equipment can be sensed, and the maintenance strategy can be formulated to improve the reliability level of the equipment, thereby improving the reliability of the power supply. The intelligent distribution management system (IDMS) is established in combination with the human-computer interaction of the ubiquitous material link to realize the online operation of the field operation link, and reduce the redundancy of personnel through electronic identity and electronic work tickets, thereby improving the internal working efficiency of the national network.

The ubiquitous power Internet of Things is a space-time interactive network involving many sources such as source, network, Dutch, storage, and people. Therefore, it is necessary to achieve multi-objective optimization of energy resources, both to meet supply and demand requirements, but
also to consider cost, price, Efficiency and other issues. In the context of ubiquitous power Internet of Things, through the perception of data, we can analyze the characteristics and interconnections of ubiquitous IoT nodes, and use optimization models to solve resource optimization problems to meet the diverse needs of users and services.

In addition to being safe and economical in terms of operational planning, there has also been a dramatic change in communication with customers. Ubiquitous power Internet will build a smart energy service platform for the power grid, improve efficiency within the enterprise, realize online registration, online management, automatic inspection, etc.; realize real-time information recording in distribution, improve transparency and security; change traditional business models will introduce new policies, which will expand the scope of services and provide online basic power supply services, financial services, and big data management for energy companies, industrial areas, and private users, including government, power grid, users, and financial institutions.

5.3. Promoting the absorption of new energy
The generation, consumption and transmission of energy are all due to the progress of society. In recent years, a large number of distributed power sources have been connected to the power grid, but due to the intermittent, volatility and randomness of wind and solar energy resources, the safety of the power grid is made. Stable operation faces enormous challenges, and it also causes a lot of abandoned winds. The ubiquitous construction and development of the power Internet of Things has opened up new ideas for the safe and stable operation of the power grid and the promotion of new energy consumption. Using artificial intelligence technology to predict short-term power generation for new energy sources, reducing the difficulty of scheduling; information exchange between heterogeneous energy sources, giving full play to the complementary advantages of energy, improving the flexibility of power systems, and stabilizing the uncertainty of wind power and photovoltaic power generation, Effectively solve the problem of abandoning wind and abandoning light, realizing the optimal utilization of resources; dynamically reconstructing the distribution network through data interaction, achieving the optimization goal of minimum abandonment of wind and light; guiding the user's electricity consumption through power market means, achieving peak clipping The goal of filling the valley; through the addition of energy storage devices, based on the data sharing platform, the source network storage and storage synergy optimization, to play the timeliness of energy storage devices, reduce the pressure of grid consumption.

![Figure 6. New Technology Application of Power Internet of Things in Power System](image-url)
6. Research direction of power system automation under ubiquitous Internet of Things technology

6.1. Ensuring the safe operation direction of the power grid
The ubiquitous construction and development of power Internet of Things can effectively solve the problems of imbalanced power distribution, unreasonable power grid structure and poor regulation capability in China at this stage. On the one hand, using advanced means such as data sharing and big data analysis, relying on the intelligent analysis and decision-making system for transportation inspection, it promotes high data and intelligentization of power grid operation and maintenance, real-time monitoring of power grid equipment, active early warning, intelligent inspection, optimization control and high efficiency. Management. On the other hand, real-time monitoring of wind energy, solar energy and load, establishing a unified power and energy control system to improve grid flexibility and regulation. In addition, the ubiquitous power IoT physical ID deepening application can realize the whole process of grid equipment planning, design, procurement, construction and operation, and the upstream and downstream information integration, improve the lean management level, and ensure the safe and economic operation of the power grid.

6.2. Promoting clean energy consumption direction
At present, the application rate of renewable energy in China is relatively low, and clean energy such as wind energy and solar energy has not been widely and efficiently applied. Due to the intermittent nature of wind power generation, some regions have abandoned wind and abandoned electricity due to the lack of FM camera sets and insufficient flexibility of the power grid. Through the construction of virtual power plant intelligent management and control platform, the ubiquitous power Internet of Things optimizes the interconnection and interoperability of distributed energy and power dispatching systems and power trading platforms through the calculation, analysis and storage of distributed clean energy data and power load information to achieve regional coordination. Control, increase or decrease the load as needed, reduce the impact of distributed energy grid-connected, thus effectively promoting widespread and safe consumption of clean energy.

![Smart grid power system investment development statistics](image)

**Figure 7.** Smart grid power system investment development statistics

6.3. Promoting the direction of integrated energy services
The ubiquitous power Internet of Things creates a "user-centric" integrated energy service platform, providing a broad communication platform between grid companies and users. The integrated energy service platform provides energy Internet user services around energy efficiency management, demand response and power trading. It expands the new energy consumption model, meets the diversified energy needs of users, and guides users to actively participate in the comprehensive energy service experience and promote comprehensive energy new energy. Modes, new systems, and new formats are popularized.
6.4. Data value-added service direction
Data promotes industry integration. Power big data can be widely used in different industrial and commercial industries such as cold, heat and gas; using the characteristics of power data, industries such as hot and cold gas can adjust and optimize production activities, develop personalized production processes, user service processes, and promote electricity. Industry cooperation to achieve better social services and higher corporate profits. Data derivative new business. Big data and high-quality data can be applied to Internet finance and other fields. The ubiquitous power Internet of Things can expand the business of Internet financial traffic entry based on its huge user base and accumulated user data. Data rental. The financial industry, universities, scientific research institutions, etc. have huge demand for power raw data or processing data. Under the protection of its powerful network security, the ubiquitous power Internet of Things does not need to use data as an industry barrier. Through data rental and sales, it can realize the rapid development of related industries and promote the continuous improvement of the ubiquitous power Internet of Things.

![Figure 8. Comparison between Internet of Things technology and traditional power automation technology](image)

7. Conclusion
The ubiquitous power Internet of Things is an important guarantee to support the high-quality development of China's energy Internet, and is a major turning point for the transformation of power grid companies from traditional grid companies to integrated energy service providers. The ubiquitous power Internet of Things construction has a long way to go, and it needs to break through a number of key technologies and key tasks such as intelligent terminals, communication network optimization, and big data analysis. The ubiquitous construction of the power Internet of Things will play a positive and far-reaching role in ensuring the safe operation of the power grid, promoting the clean energy consumption, and promoting comprehensive energy services, laying a solid foundation for the global energy Internet construction.

References
[1] Yang Dongsheng, Wang Daohao, Zhou Bowen, et al. Key technologies and application prospects of ubiquitous power Internet of Things. Power Generation Technology, 3, 6, 2017, pp.126-129.
[2] Fu Zhixin, Li Yiyi, Yuan Yue. Discussion on Key Technologies of Ubiquitous Power Internet of Things. Electric Power Construction, 9, 12, 2016, pp.221-223.
[3] Jiang Xiuchen, Liu Yadong, Fu Xiaofei, and so on. Power transmission and distribution equipment ubiquitous power IoT construction ideas and development trends. High voltage technology, 10, 12, 2018, pp.231-246.
[4] Li Chaohuai. Technical Measures to Prevent Settlement of Adjacent Buildings in Dewatering Construction of Deep Foundation Pit. Fujian Architecture, 9, 2017, pp.160-162.

[5] Li Tao, Qu Junwei, Zhou Yanjun. Influence of Dewatering of Deep Foundation Pit on Settlement of Surrounding Buildings. Journal of Beijing Polytechnic University, 7, 2016, pp.336-338.