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Development of Ubiquitous Power Internet of Things and Research on Key Technologies

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Abstract: The Internet of Power Things is a key factor in the construction of the energy Internet, which is conducive to promoting the transformation of the country's energy structure, realizing the resiliency and security of the grid, and improving the level of refined services for all users. Although the ubiquitous power Internet of Things is still in its infancy, the development is not yet mature, and the research direction is relatively trivial, but it has become a decisive step in building the energy Internet. This article first briefly introduces the basic concepts and characteristics of the Internet of Things and the Ubiquitous Internet of Things, and then discusses in detail the architecture of the Ubiquitous Power Internet of Things, and summarizes the common application scenarios of the Ubiquitous Power Internet of Things, and finally summarizes the actual construction The key technical issues that need to be resolved in the process and the outlook for future development.

Keywords: Ubiquitous Power Internet of Things, Internet of Things , Energy Internet.

1. Introduction

In recent years, due to the abuse of oil, coal, and other non-environmental energy sources, the earth's pollution problem has become more and more serious. The large-scale integration of renewable energy represented by photovoltaics into the grid has created a huge threat to the security level of the grid [1]. At the same time, due to the undiscovered use of massive electric power big data, electric power researchers have not been able to fully realize its important value [2-3]. Therefore, the introduction of the Internet of Things technology in the power industry is particularly critical. Engineers can effectively use the Internet of Things technology to integrate the numerous information stored in the Internet of Things, thereby improving the security and stability of the power grid system, and greatly improving the level of power grid

informatization [4-5].

In order to realize the development of Internet of Things technology in the power field, various countries have achieved certain research results. Among them, our country focuses on the deep integration of IoT technology and smart grid. Therefore, in 2019, the State Grid proposed a new idea of building a ubiquitous power Internet of Things [6].

At present, some scholars at home and abroad have also carried out substantial explorations on the Internet of Power Things. Literature [7] deeply analyzed the application scenarios of 5G communication in the ubiquitous power Internet of Things. Literature [8] interprets the ubiquitous power Internet of Things from several levels: the overview of the Internet of Things, the characteristics of the ubiquitous power Internet of Things, the key technologies that support the ubiquitous power Internet of Things, and the typical application scenarios. Literature [9] established a data contextualized model based on cloud computing and data contextualization through data analysis and application frameworks, and proposed a three-dimensional maturity analysis method for industrial power users, which is evaluated from three aspects: load level, power consumption behavior and interaction User's electricity consumption characteristics. Literature [10] discusses the significance of the ubiquitous power Internet of Things based on the development process of the power system and the problems it faces, and proposes implementation strategies and possible problems. Literature [11] uses blockchain decentralization technology, combined with the characteristics of the power communication network, and proposes a distributed authentication scheme suitable for power Internet of Things. Literature [12] uses the aggregate computing power of multiple IoT devices by creating a local collaborative network for a subset of DNNs (vision-based applications). In this method, IoT devices work together to perform single batch reasoning in real time, while using several new model parallel methods that this article will introduce. Literature [13] proposed a workload distribution mechanism for the power supply and Internet of Things based on edge computing, thereby minimizing service delay. The above research results have made some preliminary explorations on the ubiquitous power Internet of Things, which is of great significance for its in-depth development. But at this stage, all research on the ubiquitous power Internet of Things is mostly focused on technical development and planning and design. When it comes to the future power grid operation model, there is still little content related to the IoT system architecture, and a relatively clear structural system is lacking, including deep consideration of future development positioning.

In view of the status quo and existing problems of the above problems, this article first expounds the basic concept of the Internet of Things, and extends the

connotation, characteristics and structural system of the Internet of Things. Then the typical application prospects of ubiquitous power Internet of Things are studied. At the end of the article, it analyzes the key technologies of ubiquitous power Internet of Things and looks forward to its future development direction.

2. Internet of Things and Ubiquitous Power Internet of Things

2.1 IoT concept

The concept of the Internet of Things was first proposed by Professor Kevin Ashton of MIT in a speech in Egypt for the first time. He innovatively imagined applying radio frequency identification (RFID) technology and other sensor technologies to everyday objects to construct an Internet of Things [14]. Its purpose is to connect everything with the Internet to realize intelligent identification and operation management. On November 8, 2005, the International Telecommunication Union promulgated the "ITU Internet Report 2005: Internet of Things" at the World Information Summit, and the concept of the Internet of Things was officially born [15].

With the rapid development of power technology and Internet of Things technology in various countries around the world. The Internet of Things has gradually developed from the application of cutting-edge technology to the traditional industry-the electric power field, and this is also an inevitable trend in the electric energy field. The electric power system is by far the largest and most complex man-made system in the world. Among them, it involves two-way information transmission between many people, people and things, and things to achieve the two-way transmission and fusion of direct information between two objects. Interactive. The interaction between various electrical equipment in the power system, as well as between equipment and operators, combined with the Internet of Things technology, will surely form a more intelligent energy network. Therefore, the Internet of Things takes the power grid as the hub and leverages its platform advantages to create greater opportunities for the entire power industry, bring higher value to the power market, provide safer information protection for the power system, and improve system security and operation efficiency.

2.2 Definition of Ubiquitous Power Internet of Things

The ubiquitous power Internet of Things mainly refers to the information interconnection and interaction between any person and thing, person and person, and thing at any time [16]. The real-time communication between them is the most significant feature of the ubiquitous network. At the same time, the ubiquitous power Internet of Things is also an intelligent system based on modern advanced information technology, communication technology, and Internet of Things technology to realize the interconnection of everything in the power system. Interpreted from a conceptual

point of view, the proposal of this concept is the practical application of the ubiquitous Internet of Things in the power industry [17, 18]. Its essential effect is the sharing of information resources at the upper and lower levels, which in turn has the ability of intelligent identification and intelligent perception. Coordination and interaction between entities allows objects to perceive and control each other, thus forming a more intelligent power production and ecological system.

To understand the Internet of Things from a narrow perspective, it emphasizes a resource aggregation capability. If the traditional sensor network is taken into consideration, the relationship between the sensor network, the Internet of Things, and the Ubiquitous Power Internet of Things can be shown in Figure 1.

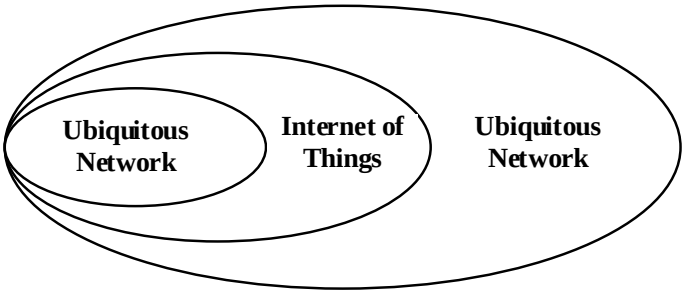

Fig. 1 Ubiquitous network, Internet of Things, and sensor network logical relationship structure

3. Ubiquitous power IoT system architecture and functions

As a specific application of the Internet of Things in the power industry, and a complex fusion of big data information, the ubiquitous Internet of Things has experienced the characteristics of whether energy, information, and services are interoperable. Another invisible network coexisting with the smart grid, its architecture includes the perception layer, network layer, platform layer, and application layer [20].

Perception layer: The perception layer is the neuron of the ubiquitous power Internet of Things. It is the information foundation of the network and the medium of information transmission. The key function is to realize all-round information collection for each device through various functional sensors. So as to control the operating status of the system in real time, evaluate the operating risks of the system, and achieve the effect of timely detection and resolution of potential safety hazards. In turn, it improves the user's energy use test and enhances the ability of the grid system to accept high-proportion distributed power sources and new loads.

Network layer: The function is mainly to provide a safe and reliable communication service quality between various types of devices in the ubiquitous power Internet of Things, between people, and between people and devices. As the transmission link in the system architecture, its communication methods are mainly mobile air network,

traditional Internet, short-range wireless transmission, etc. At present, with the continuous development of 5G technology, this method is also an emerging communication method in the ubiquitous power Internet of Things.

Platform layer: The main function is to carry the massive calculations generated during the operation of the power grid, and implement standardized storage and scheduling of operating data, source and load side data and many other information. It updates the data in the network layer in real time by building a data center and looking for platforms, thereby improving the efficient data processing and collaboration capabilities of each platform.

Application layer: The application layer is the hub of the entire power industry. Its function is mainly to support the intelligent operation of grid power to the grid business, as well as the integrated energy operation business, so as to integrate the grid, users, and platforms into a whole to realize users and Perceptual interaction of other energy systems.

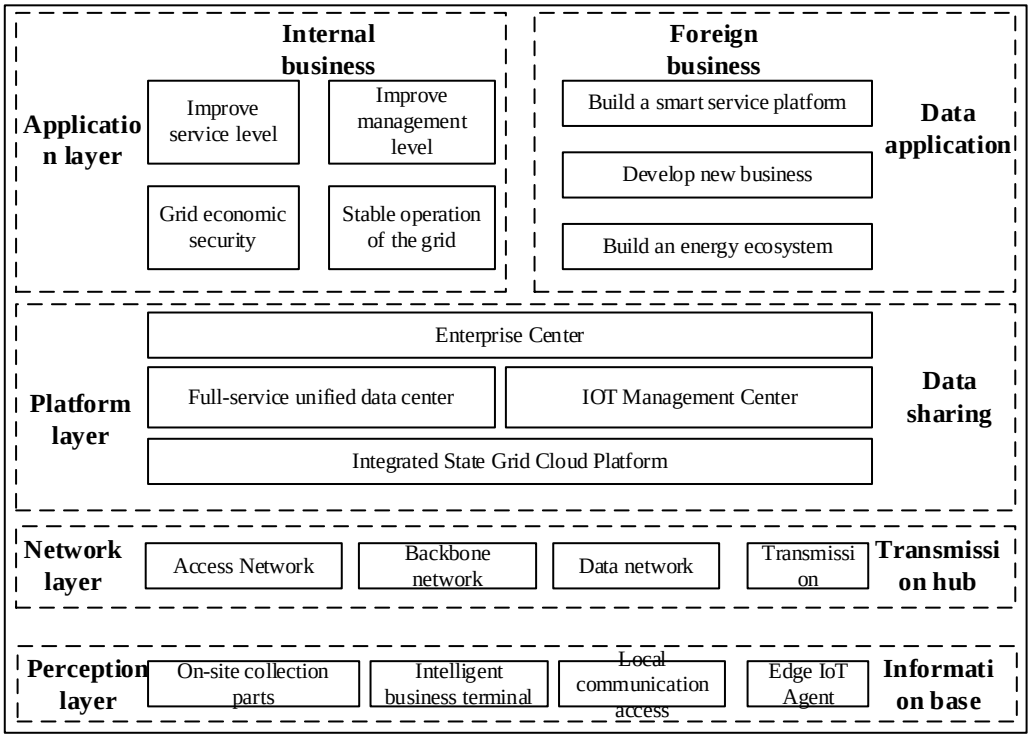

Fig. 2 Ubiquitous power Internet of Things overall architecture

There is a standard system in Ubiquitous Power Internet of Things, which is a data platform access standard, as shown in Table 1. The perception layer "send-send-change-use" each connected device generates a large amount of data. These data sources are different, the data types are different, and the lengths are different. This creates barriers between the data, and it is difficult to use them in a unified manner. Data platform standards can improve data quality and realize real-time sharing.

Table 1 Integrated data standard for ubiquitous power Internet of Things

General specification	Interface	Communication and information exchange	Service support	Collaborative information processing	Net management	Information security
The term	Physical interface	Physical layer	Information description	Support services and interfaces	Network planning	Safety technology
Demand analysis	Data interface	MAC layer	Information storage	Reference model		Safety management
Reference architecture		Networking	Middle interface			Safety Evaluation

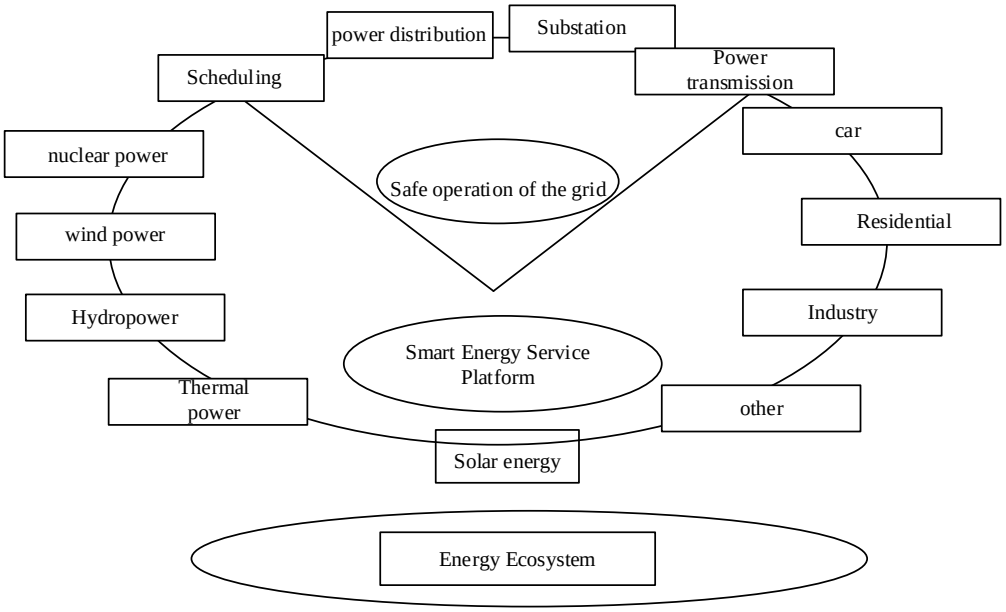

Fig. 3 Application architecture of ubiquitous power Internet of Things

4. Typical applications of ubiquitous power Internet of Things

The multi-scenario "transmission and transmission" part of the ubiquitous network-electrical Internet of Things technology has already been applied, such as the use of physical ID in power grid asset evaluation, and some have not yet been implemented and need to be continuously promoted and applied [21]. The promotion and application of the overall architecture of the Ubiquitous Power Internet of Things will strongly promote the research and development of smart chips and smart power sensors, integrate the design of communication networks, establish an Internet of Things management platform, and finally formulate several national and industry standards to guide Ubiquitous Power The construction of the Internet of Things. Therefore, it is necessary to conduct in-depth research on the integration of ubiquitous Internet of Things and power systems and typical application scenarios. The application of the ubiquitous power Internet of Things is divided into five parts:

ensuring the safe and economic operation of the power grid, creating a smart energy integrated service platform and opening up the power market, building an energy ecosystem, improving the efficiency of new energy utilization, and establishing data sharing services, as shown in Figure 2. Show.

4.1 Build a comprehensive energy ecological chain

Based on the close relationship between comprehensive energy production, transportation, and users, summarize and formulate corresponding standards to meet the needs of the entire industry, integrate, deepen the mutual dependence of the upstream and downstream industrial chains, reconstruct the external ecological structure, and promote the industry's pincer growth. The industrial ecosystem of the ubiquitous Internet of Things [22]. Its ecological topology is shown in Figure 4.

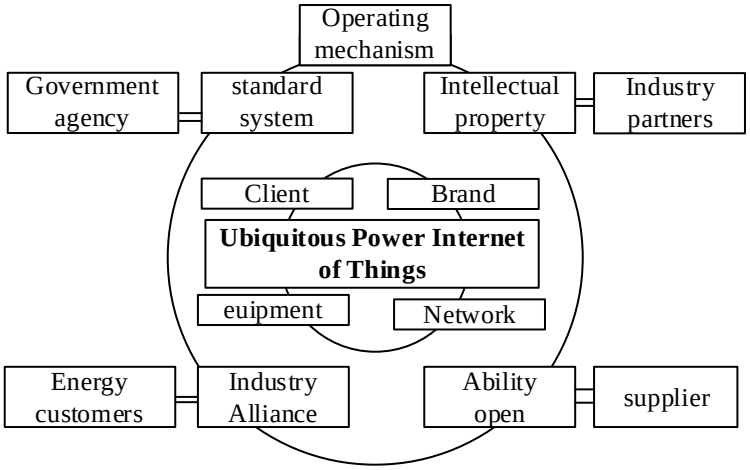

Fig. 4 Ecological topology

4.2 Improve penetration and consumption of new energy

The technology of ubiquitous power Internet of Things provides a convenient way for in-depth, real-time monitoring of clean energy. Using this technology, user-side usage can be used to participate in frequency modulation, reducing the impact of new energy grid connection. Based on the discussion of collected data, realize the dispatch and control of clean energy such as photovoltaic, wind energy, biogas, etc., reduce unnecessary consumption of these clean energy, improve the self-consumption ability of new energy, and promote the green and intelligent world energy structure.

4.3 Improve the level of safe and economic operation of power grid

As far as the current development status is concerned, power grids in various countries have a series of problems such as unbalanced energy distribution, incomplete structural system, and poor network adjustment capabilities. However, the successful development of ubiquitous Internet of Things technology can effectively and quickly solve these intractable diseases. Through research on wind power, solar power, and IoT technology as a platform, a solid and reliable control system is established. Use

smart sensor equipment to achieve joint output, data transmission, data analysis, and improve the application of smart power grids. Of course, engineers can establish an intelligent power distribution management system to realize automatic power grid detection, troubleshooting, and effective execution of optimized operation. As a result, reduce staff redundancy and improve work efficiency.

4.4 Build a smart energy service platform

As a platform for the power grid, smart energy services provide a friendly interactive platform for the majority of people [23]. Business planning and stimulus policies can amicably increase the enthusiasm of users to participate in electricity. Use peak and frequency modulation to compensate the electricity price on the user side. Through this platform, traditional enterprises, new energy enterprises, smart cities, parks, etc. are all connected to the scope of services. Reuse electric vehicles, photovoltaics, and terminal technologies to provide a series of new services to achieve the perfect construction of the energy ecosystem. Therefore, building a smart energy service platform is of great significance.

4.5 Build a comprehensive energy ecological chain

Data sharing function, which is a data model based on the ubiquitous power Internet of Things. It can realize the unification of data interface and transmission standards and achieve customized service level. Through the analysis of a large number of power equipment in the power grid and the data generated in the Internet of Things, it also conducts comprehensive monitoring of its operation level. Not only meets the precise requirements of electricity sales and load, but also supports new energy dispatch. Based on the big data used by users, macroeconomic forecasts and analysis of industry indexes can be realized. The realization of this function provides enterprises, grid companies, and governments with accurate and efficient decision-making suggestions.

5. Prospects for key technologies of ubiquitous power Internet of Things Conclusion

The ubiquitous power Internet of Things is evolved from the smart grid. Its core is to build a distributed management intelligent system network, which mainly includes intelligent self-adaptive judgment and self-adaptive adjustment to achieve the effect of safe grid connection of multiple new energy sources, essential energy flow and compatible expansion. The essence of the Ubiquitous Power Internet of Things is quite different. Its essence is based on the massive amount of power information, efficient information processing technology, and the 4-layer system architecture of the Ubiquitous Power Internet of Things, which includes 4 key factors, namely, the power data collection terminal Intelligent, secure transmission of power data, analysis, storage, management of power data, and comprehensive utilization of power

information.

In summary, in the future development of the power industry, the criticality of data is as important as the acquisition of energy. Nowadays, the power Internet of Things in all countries in the world is still in its infancy. The introduction of ubiquitous Internet of Things technology into the traditional distribution network still lacks effective experience. Here, this article specifically sorts out the issues that need to be studied in-depth in the application of ubiquitous power Internet of Things at this time, and provide references for further in-depth research.

(1) As far as the perception layer is concerned, the power distribution system is still lacking in the ability and scope of detecting the underlying equipment. This fatal problem greatly restricts the degree of fine control of the power distribution system. Therefore, there is an urgent need to increase the monitoring range of the underlying equipment and the breadth of communication coverage. This defect can be achieved by continuously optimizing and upgrading the underlying sensors and improving the hardware detection level of the deployment of IoT terminals.

(2) In the network layer, high-speed communication between system energy data and user data is still a technical gateway and security risk in communication technology. If this problem is not solved, it will be difficult to realize the real-time and effectiveness of the ubiquitous Internet of Things. In the future, when the Internet of Things is introduced into the power distribution system, it is necessary to consider the seamless connection of the communication system and the issue of information security.

(3) For the platform layer, the ubiquitous power Internet of Things contains a large number of system data with different characteristics in the network, including internal operation data of the power grid and user energy consumption data. These data have issues such as updates, type differences, and data volume differences. In the future, the construction of the ubiquitous power Internet of Things platform layer must consider the issues of unified storage, induction, and management. For the solution of this problem, data analysis methods such as storage strategy and big data design can be used to improve the big data management level of the power system.

(4) For the last application layer, the application of the real ubiquitous power Internet of Things has not yet been implemented. In this context, how to apply different types of data to various advanced application scenarios still needs further research. Through the research of data mining and edge computing technology, the development of the power grid towards materialization, informatization and direction is promoted. In addition, and most importantly, the current information gap between the power system and other energy systems still exists, such as energy interconnection optimization, multi-energy multi-platform transactions, and other new industries are still in the stage of theoretical demonstration. In short, the construction of the

ubiquitous power Internet of Things requires the extensive participation of all walks of life and joint efforts in public relations technical problems, so as to promote the upgrading of the energy industry.

6. Conclusion

The core of the ubiquitous power Internet of Things is the power system. It not only combines intelligent terminal sensors and communication networks, but also artificial intelligence and cloud platform technology to form a complex multi-stream system. The ubiquitous power Internet of Things uses power equipment information interaction and character information interaction to achieve a dynamic balance of energy consumption and make the power grid operate safely and stably. As a new field and new concept, to a certain extent, it has also promoted the opening of the electricity market, realizing a quick response to the balance of supply and demand, and implementing a clearer and clearer assessment of the power grid. With the continuous development of integrated energy, as the core product of the third energy revolution era, the ubiquitous power Internet of Things is bound to be the main development direction of the future energy industry.

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