The Construction Scheme of D-Iot Cloud Master Station

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Abstract. With the development of the Energy Internet, specific requirements are put forward for the Distribution Internet of Things technology. How to control the panoramic equipment and data through a horizontalization of all links and a secondary level of operation on the entire business cloud. And provide external platforms and applications. This article first proposes the architecture of the IoT cloud platform for distribution IoT, and discusses open cloud platform, Internet of Things access and equipment management, data storage and management technology, cloud edge collaboration, and other key technologies. Finally, it discusses application scenarios based on IoT technology, such as panoramic condition monitoring based on multi-dimensional information perception, tiered line loss hierarchical layered management, low voltage fault location. To provide technical support for the ubiquitous electric power Internet of Things in order to realize the interconnection of all things and human-computer interaction in all aspects of the power system, create a comprehensive status perception, efficient information processing, and convenient and flexible application.

1. Background
With the rapid development of China's social economy, the reform and opening up has gradually entered the deep-water area, and the energy production and consumption structure has also undergone profound changes [1]. State Grid Corporation has proposed a new strategic thinking of “three types and two networks”. The goal of building a world-class energy Internet enterprise is to create a modern enterprise with pivot, platform and sharing characteristics, and fully apply modern information technology such as mobile internet and artificial intelligence and advanced communication technology to realize the interconnection of all things and human-computer interaction in all aspects of the power system[2]. Creates a ubiquitous power Internet of Things with comprehensive state awareness, efficient information processing, and convenient and flexible application. [3]

The ubiquitous power Internet of Things will not only be an upgrade of the smart grid by the application of the Internet of Things technology, but also complement and develop with the smart grid to form a powerful value creation platform, which together constitute the third stream of energy flow, business flow and data flow[4]. The ubiquitous construction of the power Internet of Things will inevitably lead to a wider interconnection of energy-based energy, business innovation with energy services as the core, and energy consumption and new ecology with the concept of cooperation and win-win[5]. Distribution IoT is an important part of the ubiquitous power Internet of Things[6]. The cloud master station is the top-level part of the distribution of the Internet of Things (cloud, channel, edge and terminal) architecture, through the use of cloud computing, big data, artificial intelligence, etc. Advanced technology, realize the comprehensive cloudization under the Internet of Things architecture, and finally realize the functions of ubiquitous interconnection, open application, collaborative autonomy, and intelligent decision-making[7]. This paper proposes the design principles,
architecture, key technologies and application scenarios of the IoT-integrated distribution IoT cloud platform to provide technical support for the ubiquitous power IoT construction.

2. The architecture of D-IoT cloud master station

2.1. Software Architecture

![Software architecture diagram](image)

The platform software architecture is shown in Figure 1. The architecture is divided into three layers, including the IaaS layer, the PaaS layer, and the SaaS layer. The IaaS layer is the infrastructure service layer of the cloud platform, which consists of three parts: Calculation, Storage, Internet.

The PaaS layer is the platform service layer, and the PaaS layer is divided into four sub-parts: aPaaS, dPaaS, gPaaS, and application publishing center.

aPaaS is the application of PaaS, which refers to a common abstraction of the application of the primary station in the PaaS layer. It performs business functions with certain commonalities, such as alarm service, log service and permission service; gPaaS is a General PaaS that provides general-purpose, high-performance, highly reliable and flexible basic services such as micro-services, containers and IoT services to the SaaS application layer and aPaaS; dPaaS provides data management, data integration and data storage services for data service PaaS, providing data services for aPaaS and SaaS layer business applications, and is the model and data center of the Internet of Things cloud master station; the application publishing center is responsible for the review, release, removal, and statistics of applications.

The SaaS layer is a software service layer that provides service applications such as distribution network operation monitoring, active power supply services, and intelligent device inspection. Horizontally, the platform provides open sharing of horizontal links and comprehensively strengthens big data application innovation. For energy Internet services, enhance the ability of big data analysis and mining and value-added, realize the deep integration of big data and business activities, and open the platform-based capabilities to achieve interoperability between third-party systems/platforms and fully support the development of the industry.

In the vertical direction, the platform provides a cloud-integrated synergy mechanism with the plug-and-play system of the intelligent power distribution terminal, and shields the underlying network differences through the agent-linked agent and the IoT management center to realize the horizontalization of the whole link of objects and objects.
2.2. Data flow
The terminal/device sends data to the management information area distribution IoT cloud master station. The cloud master station provides generalized networking services, and the access equipment is open, supporting the access and management of multi-type, multi-protocol, multi-level mass terminals/devices, and realizing the access of the object. The multi-type refers to the access capability of the generalized networking service to provide multiple types of devices, and the device type can be extended to support the access of medium and low-voltage devices, improve the access capability of the primary station, and realize the access and management of massive equipment.

![Figure 2. Data Flow diagram.](image)

In addition, the cloud master station also has the data exchange capability with the production control area and the management information area business system. The data flow of cloud master station data collection is shown in Figure 2. ① The service data and management data of the Internet of Things terminal are sent to the master station application through the IoT component, as shown in the blue data stream; ② IEC standard terminal is sent to the master station service processing through the pre-collection, as shown in the data stream; ③ The information interaction service exchanges information with the I zone dispatching automation system and the distribution automation system through the physical isolation device; ④ Information interaction service through the enterprise service bus business system for information docking, including: PMS / GIS, EICS, MS and other systems.

3. The key technologies of D-IoT cloud master station

3.1. Open Cloud Platform
The cloud platform uses virtualized resource management technology to resourceize various physical resources of the computer; the micro-service technology is used to decompose a huge single program into a set of services; the container management and orchestration has automatic deployment, strong scalability, and strong agility. And the characteristics of resource optimization and configuration; enable the development and operation of the master station business with fast delivery, agile development and efficient operation and maintenance.
3.1.1. Cloud Platform Resource Deployment. Virtualization technology is the foundation of the cloud platform. By deploying virtualization software on the server, pooling hardware resources, centralized and policy-based management, transparently layering the underlying physical hardware, breaking the uncuttable barrier between physical structures, users can apply these resources in a better configuration, maximize the use of physical hardware, so that "one physical server can take on multiple servers" work. At the same time, based on the virtualization of the storage network, the hardware resources of the entire data center can be shared and flexibly allocated, and the business can be applied on demand, and can be used as needed.

3.1.2. Microservice Architecture. The micro-service improvement of the power distribution master station is improved from the single application of the primary station to the upper-level application service architecture based on the SOA architecture, to the current service componentization, development liberalization, decentralization and infrastructure. Automated microservices architecture. Based on the service transformation foundation of the SOA architecture, the micro-service improvement of the distribution network IoT cloud master station service can be quickly realized. The design purpose of the micro-service architecture is to effectively disassemble the electric master station application, realize agile development and deployment, and solve the problems of traditional single application coupling, inflexible deployment, and poor scalability. The microservice architecture is a distributed overall solution that includes service registration and discovery, service configuration, link monitoring, service gateway, load balancing, and service blowing.

3.1.3. Data Task Scheduling and Management. The data task scheduling requirement platform can select the optimal data application according to the data type generated by the micro service, thereby achieving the high efficiency and high-quality operation requirements of the micro service. According to the data type, the storage mode is selected, and the calculation mode is selected according to the storage mode, thereby saving memory, saving computing resources, and improving the access speed of the micro service.

3.2. Internet of Things Access and Equipment Management

IoT is the Internet connected with objects. It is an important part of the new generation of information technology and an important stage of development in the era of "informatization." There are two meanings: First, the core and foundation of the Internet of Things is still the Internet, which is an extended and expanded network based on the Internet. Second, its client extends and extends to any item and item for information exchange. And communication, that is, things. The Internet of Things is widely used in the convergence of networks through communication-aware technologies such as IntelliSense, Recognition, and Pervasive Computing.

Figure 3. Internet of Things access architecture diagram.
As shown in Figure 3, the object association agent is introduced at the terminal layer to implement cloud edge collaboration and unified access of a mass terminal; At the platform level, through the construction of the IoT management center and the capability opening center, users, services and terminals are opened to realize open resources sharing. The open distribution IoT platform supports MQTT, CoAP, RTSP, HTTPS and IEC standard protocols; supports terminal plug and play; provides SDK to build an open ecosystem; adapts to mainstream IoT access such as NARI and Huawei Module.

### 3.3. Data Storage and Management Technology

In order to effectively cope with the complex and diverse data processing requirements in the IoT environment, it is necessary to apply features to different data, and store and manage data from multiple perspectives, multiple levels, and multiple dimensions. Data storage and management technology refers to the classification, encoding, storage, retrieval and maintenance of IoT data through certain means. It is the central issue of data processing. The functions of data management are based on different data storage methods, and on this basis, data access services and related interface functions are provided.

![Data storage type](image)

As shown in Figure 4, the relational database mainly stores: model data, management data and statistical data; Distributed column storage database mainly stores: historical data, alarm data and log data; Distributed file storage main storage: graphic files, document data and offline backup.

### 3.4. Cloud Edge Collaboration

Cloud-side collaboration, following the 28th principle, 80% is analysed on the side, 20% is analysed and processed in the cloud master station, and the abnormal results of the edge analysis are sent to the cloud master station in real time. Regularly synchronize all data on the side to the cloud master through the replication channel through non-real-time synchronization. The edge provides a web publishing service that can query and collect local data. The service channel uses a short connection, and the management channel is kept alive by a heartbeat.

Based on the Internet of Things architecture, the Internet of Things protocol, and the IoT information model, the business function software definition method is adopted, and the functions of rapid release and flexible function iteration are used to improve the computing capability of the edge layer. The master station service sinks to the edge layer and is distributed. Edge computing, business in-situ analysis and decision-making, business cloud side collaborative interaction.

### 4. D-IoT cloud application scenario

The construction and application of distribution Internet of Things with the “cloud, channel, edge and terminal” top-level architecture as the main line. The cloud master station uses the Internet of Things technology to enhance the sensing capability of the medium and low voltage distribution network, and
realize holographic sensing and panoramic monitoring. Deeply integrate software definition with data
science and artificial intelligence technology to form an industrial chain including software-defined
master station, software-defined network, and software-defined terminal. Through soft and hard
decoupling, it can realize rapid iteration of business and break the original closed and isolated. And
solidified management mode to build a new, flat, flexible and efficient business system.

4.1. Panoramic condition monitoring based on multi-dimensional information perception
Combining the Internet of Things technology, we will carry out the application research of intelligent
equipment such as intelligent distribution terminal, smart meter, intelligent manhole cover and robot to
improve the state awareness and state control ability of the distribution network. Based on smart
covers, intelligent monitoring devices, robots, intelligent distribution terminals and other intelligent
devices, holographic sensing and panoramic monitoring of transmission lines, substations, cable wells,
substations and low-voltage distribution networks are realized.

4.2. Tiered line loss hierarchical layered management
The intelligent distribution terminal and the metering level low-voltage sensor are used to realize the
time-dependent statistics, daily statistics and monthly statistics of the power supply, supply and output,
line loss and line loss rate of each node according to the line topology, when the line loss rate exceeds
the theoretical maximum value. Or an abnormal alarm is issued.

4.3. Low voltage fault location
The TTU identifies faults based on known low-voltage network topology information and data of
monitoring equipment at all levels, locates faulty segments, reports the results to the primary station,
pushes the alarms, and visualizes them in the zone map.

5. Evolution route
The distribution network of the Internet of Things (IoT) cloud platform is connected to the whole
process of the main equipment of the electric power equipment, and runs on the cloud of the whole
service to realize the control of the panoramic equipment and data, and provides the “platform +
application” mode to realize the full chain business of energy and power. Services, leading the
development direction of the future energy Internet field.

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