Research on Energy Acquisition, Monitoring and Analysis Platform of Integrated Energy System Based on NB-IOT

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Abstract. His paper introduces the energy acquisition and monitoring analysis platform of the integrated energy system based on NB-IOT, the system platform realizes the collection, storage, statistics and monitoring analysis of comprehensive energy consumption information such as electricity / water / gas based on NB-IOT communication technology, and provides effective data support for the promotion and construction of comprehensive energy system.

Keywords: Integrated energy system, NB-IOT, Energy Information acquisition, Monitoring and analysis.

1. Introduction
Integrated energy system is the physical carrier of energy Internet. At present, when coordinating, cooperating and optimizing various energy supply and consumption systems as a whole, it lacks the support of various energy consumption information data (real-time data, demand data, energy efficiency data, etc.). It is necessary to form a set of comprehensive energy consumption measurement and collection scheme suitable for integrated energy system to provide effective data support for integrated energy system.

At present, the collection of energy consumption information data, such as electricity, water, gas and so on, is generally self-contained collection system, and often different energy sources adopt different communication measurement collection schemes, and the functions are mostly limited to simple data collection, which is inconvenient for unified management and analysis of energy consumption data.

In terms of communication scheme, there were various technical schemes used in energy metering before, from the early 485 to the later GPRS, ZigBee, carrier wave, small wireless, etc., and various energy sources such as electricity, water and gas were applied respectively. Due to various reasons, a suitable unified communication scheme was not formed, which brought inconvenience to management and construction.

NB-IoT is an innovative technology. It is a narrow-band Internet of Things technology based on cellular network defined by 3GPP. It supports massive connection, has deep coverage and low power consumption. By adopting NB-IoT communication technology scheme, it can realize the unification of energy communication acquisition schemes such as electricity, water and gas, improve management efficiency, and lay a good foundation for copying and collecting energy data of integrated energy system.
The research on the platform of energy collection, monitoring and analysis based on NB-IOT is to optimize the functional architecture of the platform of energy collection, monitoring and analysis of integrated energy system from the master station level by combining the characteristics of NB-IOT wireless communication technology. Combining data flow and business flow related to energy consumption information collection, storage and processing, developing master station layer module which can be used to collect energy consumption data of various energy meters and carry out monitoring and analysis, and providing support for establishing a complete comprehensive energy consumption information collection and monitoring and analysis platform.

2. Introduction of NB-IOT technology
As an innovative technology, NB-IoT is built on cellular networks, and has the characteristics of supporting massive connections, deep coverage and low power consumption. These inherent advantages make it very suitable for Internet of Things applications such as sensing, metering and monitoring. It is suitable for intelligent meter reading, intelligent parking, vehicle tracking, logistics monitoring, smart agriculture, forestry, animal husbandry and fishery, smart wear, smart home, smart community and so on. It has become an important branch of the Internet of Everything

Adopting NB-IoT has incomparable advantages. Firstly, the number of concurrent connections in a single base station (the number of chip accesses that a base station can accommodate) is significantly more than before. NB-IOT technology can make more efficient use of spectrum resources. Secondly, coverage is enhanced by more than 100 times. Many application scenarios of the Internet of Things are closed, which puts strict demands on its ability to detect the weakest network signals. NB-IoT is characterized by coverage sensitivity 20 decibels stronger than the traditional one, and coverage enhancement over 100 times. Finally, ultra-low power consumption. The power consumption is only 1/10 of 2G, and a 6000 mAh lithium battery can be used for more than 10 years, and there is room for further improvement in the future.

3. System structure
The system structure of the energy application system based on NB-IOT is shown in Figure 1

![System structure diagram](image)

**Figure. 1 Schematic diagram of system structure**

3.1. NB-IOT energy terminal
The NB-IOT electricity meter, water meter, gas meter, etc. that need to be connected are connected to the NB-IOT communication network through the built-in NB-IOT module and connected to the base station.

3.2. NB-IOT base station
It mainly undertakes the functions of NB-IOT terminal node access processing, and connects with IOT core network through S1-lite interface, and forwards non-access layer data to higher layer network cloud processing.
3.3. Core network
Undertake the function of interacting with the non-access layer of the terminal, and forward the data related to IOT services to the IOT intelligent management platform for processing.

3.4. NB-IOT intelligent management platform
IOT data obtained from various access networks are aggregated, and forwarded to corresponding application servers for processing according to different data application requirements. meanwhile, the instructions sent by the energy-using application servers are received and forwarded to energy-using terminals through the NB-IOT core network and the base station.

3.5. Energy utilization application server
Energy-using application server is the final convergence point of IoT energy-using data, which communicates and interacts with IOT intelligent management platform through HTTP/HTTPS, receives data sent by IOT platform, performs data analysis and business processing according to customer's application needs, and issues relevant instructions when necessary.

The adoption of NB-IOT wireless communication acquisition scheme simplifies the acquisition network architecture, reduces unnecessary networking nodes, reduces network failure points, and reduces construction and operation and maintenance costs compared with the previous scheme of intermediate acquisition equipment through collectors/concentrators. The NB-IOT wireless solution is more convenient to install and debug, which improves the scalability and compatibility of the system. Compared with the limited capacity of GPRS, it has the ability to support massive connections, and can reduce the risk of future expansion for more and more Internet of Things applications.

4. Overall system design
A comprehensive energy collection, monitoring and analysis platform based on NB-IOT is composed of system master station module, communication transmission network and field measurement and collection equipment. The network topology of the system is shown in Figure 2.

![Figure 2 Schematic diagram of system network topology](image)

On-site metering and acquisition equipment includes NB energy metering and monitoring terminals to realize energy consumption metering and related information collection.

Communication transmission network is based on the NB-IOT communication network, including the built-in NB-IOT module, NB-IOT base station, core network and IOT intelligent management platform of the terminal node mentioned in the previous section, which provides a safe and reliable data communication and interaction channel between the NB-IOT node and the system software.
platform. With the rapid development of NB-IOT, China's three major operators have completed the construction of NB-IoT network covering the whole country, which is a solid foundation for NB application.

The system master station module is the receiving and processing platform of NB-IOT energy acquisition equipment data information. The platform analyzes and stores the energy consumption data of various energy sources, carries out various statistical analysis according to the needs of business logic, obtains various energy consumption data and corresponding changes, and realizes the collection, monitoring and analysis of comprehensive energy consumption information.

5. Application and implementation of comprehensive energy collection, monitoring and analysis platform based on NB-IOT

The goal of building an integrated energy consumption collection, monitoring and analysis platform based on NB-IOT is to collect and monitor the energy consumption data of various energy sources by relying on the safe and reliable transmission channel provided by NB-IOT communication technology, thus providing effective data support for the integrated energy system. According to the construction goal of the system, the system application service architecture is designed as shown in Figure 3.

![Figure 3: Schematic diagram of system application service architecture design](image)

The system adopts B/S architecture, and Web browser is the most important application software of client. This mode unifies the client, concentrates the core part of the system function realization on the server, and simplifies the development, maintenance and use of the system; Only one browser needs to be installed on the client to exchange data with the system platform through Web services.

The system uses the software implementation scheme of function application layer, logic processing layer and data storage layer:

1. Function application layer: it includes the main functions such as metering equipment filing management, collection and alarm scheme configuration, calculation and statistics scheme setting, analysis and statistics report output and monitoring and analysis result output, etc. Customers perform business functions on the WEB business platform through the client browser;

2. Logic processing layer: it includes collection service, calculation service, alarm service, various data collection interfaces and standard data format, and realizes various business logic processing functions such as collection, calculation statistics, alarm and data interface.

3. Data storage layer: it includes the storage and reading of various data, such as measurement file data, measurement data collection and calculation statistics data.

Based on this hierarchical structure, our software platform is mainly divided into acquisition subsystem, computing subsystem, alarm subsystem, WEB service platform and interface subsystem. The interactive business flow among multiple subsystems is shown in Figure 4.
The main business process of the system: based on the NB-IOT communication network, the collection scheme, calculation scheme and alarm scheme are customized by the WEB service platform, and the collection subsystem sets the collection scheme according to the WEB service platform. The meter code data of the energy meter is collected through the communication interface, and then the calculation subsystem performs statistical calculation on the basis of collecting the original data according to the calculation and monitoring requirements of the WEB service platform, and the alarm service alarms and notifies events according to the alarm scheme of the WEB service platform. Then, the collected and calculated statistical data, event notification, etc. are presented on the WEB business platform. When interaction with external systems is needed, data communication or interaction is carried out according to the needs of practical applications.

5.1. WEB service platform
The WEB service platform is the core subsystem of the system. The system platform sets various operating parameters, customizes operating rules and performs various business operations through the WEB service platform, including the functions of collecting data query and browsing, curve analysis, statistical report output and monitoring analysis result output.

The WEB service platform customizes the collection scheme of the collection subsystem, the calculation scheme of the calculation subsystem and the alarm scheme of the alarm subsystem, the interactive processing rules of the interface subsystem, and the relevant business data information of each subsystem can be presented on the WEB service platform.

5.2. Acquisition subsystem
The acquisition subsystem realizes the access support of communication protocol and communication channel, the acquisition and storage of various terminal/meter data, and the management and execution of various acquisition and control tasks; Realize online status monitoring of terminal/concentrator, monitoring of communication messages and monitoring and management of task execution.

The acquisition subsystem mainly interacts with the WEB service platform and communicates data with the communication interface. The acquisition subsystem collects data according to the acquisition scheme customized by the WEB service platform, and responds to the real-time data calling requirements of the WEB service platform and the calling message data; The acquisition subsystem maintains the connection with the communication interface. On the one hand, it analyzes and responds to the data reported by the communication interface; on the other hand, it issues the message...
instruction according to the task or real-time calling requirements to the communication interface, which is forwarded to the IOT management platform for execution.

5.3. **Computing subsystem**

The calculation subsystem carries out parameter loading, business change check and calculation log analysis, and realizes the calculation and statistics of various energy consumption data, abnormal energy consumption data analysis, loss data analysis, etc.

The computing subsystem mainly interacts with the WEB service platform. The WEB service platform customizes the computing scheme and computing service logic, and the computing subsystem performs statistical calculation of data according to the customized computing scheme and computing service logic of the WEB service platform, and the calculation results are stored in the database and output and presented on the WEB service platform. For the requirement of actual statistical data on the WEB service platform, the computing subsystem can also perform real-time calculation, and return the real-time calculation results to the WEB service platform for presentation.

5.4. **Alarm subsystem**

The alarm subsystem reads all kinds of alarm items generated by other subsystems, loads customized alarm schemes, and realizes timely processing and notification of alarm items.

The alarm subsystem interacts with other subsystems indirectly through the database. The WEB service platform customizes the alarm scheme, the collection subsystem stores the alarm items obtained in the collection process into the database, and the calculation subsystem stores the alarm items obtained by calculation and statistical analysis into the database. The alarm subsystem reads the alarm information in time and processes the alarm according to the alarm scheme rules.

5.5. **Interface subsystem**

The interface subsystem connects the data interaction between the system platform and other systems, and the communication interface realizes the data interaction between the IOT platform and the acquisition subsystem.

The communication interface of the interface subsystem serves as an interactive channel between the IOT platform and the acquisition subsystem. On the one hand, it analyzes the JSON reported data forwarded by the IOT callback and sends it to the acquisition subsystem; On the other hand, it receives command messages sent by acquisition subsystem, calls API interface functions provided by IOT platform, and forwards data to IOT platform. IOT platform calls plug-in to turn into data messages and send them to equipment. Message data responded by equipment is transferred to communication interactive interface via IOT platform, which is reported to acquisition subsystem by interface.

All subsystems cooperate with each other to realize interconnection and data exchange among subsystems in the comprehensive energy consumption collection, monitoring and analysis platform, so as to complete the overall coordination and cooperation of energy consumption information collection and processing business.

6. **System operation and test**

After the system design and development is completed, the interface of the Web business platform is shown in Figure 5.
Each interface of application subsystem is shown in Figure 6.
7. Conclusions

With the development of the internet of things technology, the advanced NB-IOT communication technology is used to unify the communication schemes for energy consumption collection, providing smooth, stable, safe and reliable communication channels. The software schemes at functional application layer, logic processing layer, data storage layer and other levels are used to realize the interactive operation of each subsystem, and a comprehensive energy consumption collection, monitoring and analysis platform is constructed, which can well realize the collection, monitoring and analysis of various energy consumption data and provide effective data support for the comprehensive energy system.
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