Design and implementation of remote meter reading system based on cloud platform and NB IOT

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ABSTRACT

The smart electric energy meter is the core component of "smart grid", which plays an important role in the rapid and steady promotion of "smart grid". This paper proposes an energy meter reading method based on the cloud platform of the Internet of things and NB IOT (Narrow Band Internet of Things). The intelligent energy meter is connected to the Internet through NB IOT, and then establishes a connection with the cloud platform of the Internet of things. After the device is successfully connected, it can send data to the meter reading system in real time through the cloud platform. The corresponding meter reading system can also send meter reading instructions to the cloud platform in real time and forward them to the device which becomes two-way communication of data. In this way, the whole meter reading system can well solve the disadvantages of manual door-to-door meter reading and meet people's needs for intelligent and remote control of equipment operation.

Keywords: Smart electric energy, remote meter reading system, NB IOT, cloud computing

1. INTRODUCTION

The use of RS485 meter reading technology was mainly adopted in China. However, due to the disadvantages of RS485 bus meter reading, people had to consider reading meters through more stable and reliable technology, and the advantages of remote meter reading technology were particularly obvious.

The application of various IOT technologies makes meter reading technology develop and progress continuously[1]. The transmission distance of RS485 bus meter reading system can reach 1200 meters and the transmission speed is also fast. It is widely used in the industrial field. Compared with infrared meter reading, it has made a qualitative leap in reliability and stability. However, due to the complex wiring of RS485 bus, there will be many problems, such as excessive workload and difficult maintenance in the later stage; GPRS (General packet radio service) is a wireless packet switching technology based on GSM system, providing end-to-end, wide area wireless IP connection. Through GPRS meter reading system, it can realize the advantages of wide meter reading range, long transmission distance, high transmission rate and low cost, but there are still many disadvantages, because the capacity of GPRS base station is limited. When a large number of users access at the same time, there will be network congestion, the equipment can not upload data immediately, and the power consumption of GPRS module is high, which makes the equipment need to replace the battery frequently, which is undoubtedly another test for later maintenance[2].

The application of NB IOT technology to the remote meter reading system makes the whole system not only have all the advantages of GPRS meter reading, but also contain greater connection capacity. The NB IOT technology has the advantages of large connection, low power consumption The four characteristics of wide coverage and low cost can be said to be the only choice for network communication in IOT applications. The design of this system is based on NB IOT, which not only solves the problems faced by meter reading in the past, but also enables the equipment to go to the cloud through the docking with the cloud platform of the Internet of things.

2. SYSTEM ARCHITECTURE BASED ON IOT CLOUD PLATFORM

The IOT cloud platform undoubtedly provides us with a good implementation scheme. It centralizes all kinds of IOT devices, and provides unified equipment management, business development and security services for these IOT devices.

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Perception layer, network layer and application layer are the classic three-tier architecture in Internet of things. The frame composition is shown in Figure 1[3].

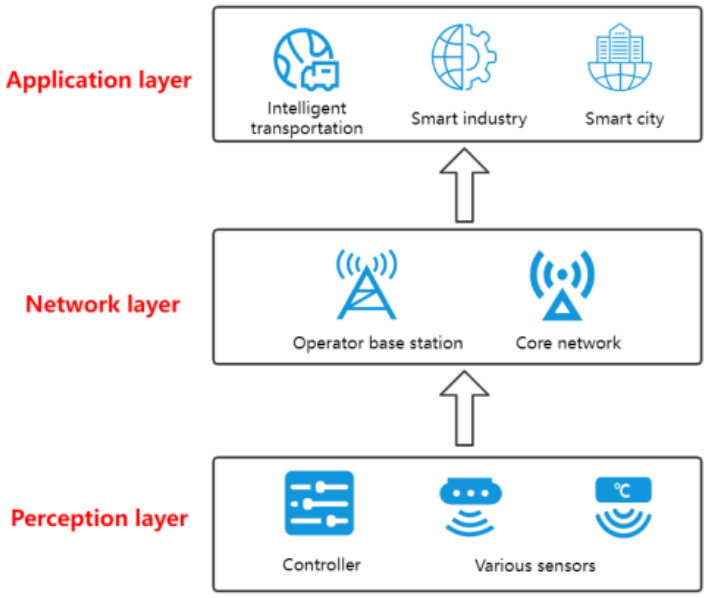

Figure 1. The three-layer architecture of internet of things.

The perception layer is the key part of information collection, which can be popularly understood as watt hour meter terminal in this paper. The electric energy meter terminal mainly contains three boards, a display board, a control board and an electric quantity acquisition board. The data acquisition terminal is divided into two parts, one is Hall sensor, the other is acquisition chip. The hall sensor is used to collect the current signal and input it to the acquisition chip. The acquisition chip r8209d collects the voltage and current signals in one channel, and calculates the electric energy data to supply the control motherboard and display board to complete the display.

The network layer can realize the communication transmission and data interaction of devices, which exists between the perception layer and the application layer. It is mainly composed of various wide area networks provided by operators. In this paper, it refers to NB IOT. In addition, there are 4G, GPRS and other mobile communication networks.

The application layer is the final implementation of IOT applications. According to the specific needs of different services, the application is developed and provided to users in the form of software application or PC browser. The corresponding is the remote meter reading system in this paper.

However, the IOT application architecture in this paper can be subdivided into four layers: perception layer, network layer, platform layer and application layer, as shown in Figure 2. Here, the IOT cloud platform is not classified as the network layer or application layer, but as a separate layer architecture, because the IOT cloud platform plays a very important role in the whole Internet of things system architecture. Firstly, it centralizes the management of terminal devices. At the same time, it can also be connected to the perception layer downward through IOT communication devices, and can also be connected to the application layer upward, accept the data uploaded by the perception layer and the instructions issued by the application layer, and can provide a variety of interfaces for application development.

3. TECHNICAL ANALYSIS OF NB IOT

In various practical applications of IOT technology, the communication status of the network is the support of the whole IOT application. With the development and progress of society, IOT applications use more wireless communication methods. NB IOT technology have become the best choice for many IOT applications.

We analyze the network architecture of NB IOT based on the idea of analyzing the system architecture of the Internet of things. The whole NB IOT network architecture can be divided into five parts: NB IOT terminal, wireless network side, core network, IOT cloud platform and specific IOT applications, as shown in Figure 3 below.

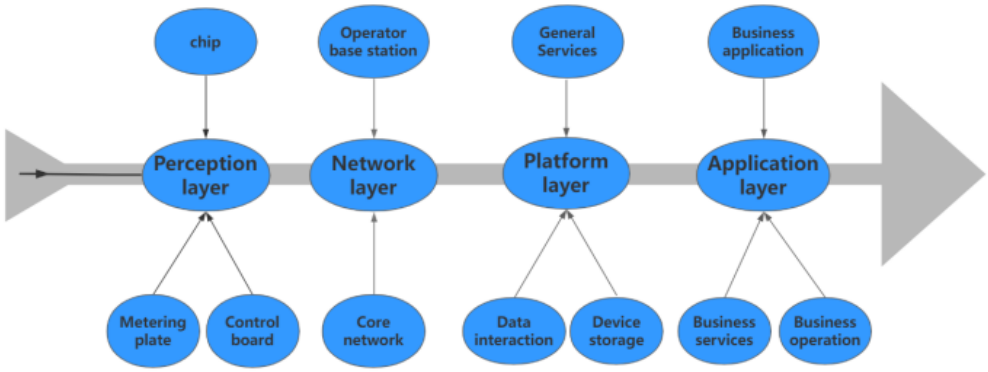

Figure 2. The internet of things architecture based on cloud platform.

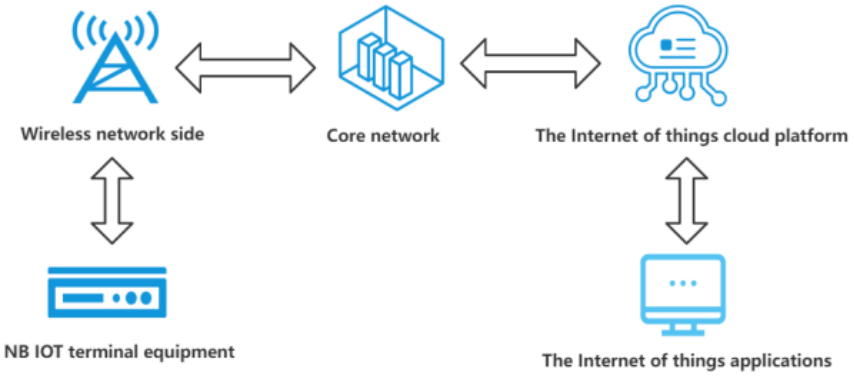

Figure 3. The NB IOT network architecture.

- NB IOT terminal equipment: in this system, it refers to the intelligent electric energy meter. The NB module on the intelligent electric energy meter can be connected to the nearby operator base station, and then carry out the interactive transmission of data through the NB module[4].
- Wireless network side: the interface device for mobile equipment to access the Internet, which is also a form of radio station. It refers to the radio transceiver station that transmits information with the mobile phone terminal through the mobile communication switching center in a certain radio coverage area. In this system, it refers to the operator base station, which is the basis for the connection between intelligent watt hour meter and communication network.
- Core network: it is responsible for transmitting the relevant data of NB IOT terminal equipment to the IOT cloud platform, which is a key part of connecting to the specific IOT cloud platform.
- The IOT cloud platform: centralized processing of data sent by NB IOT terminal, unified management of terminal equipment through the cloud platform, and mutual communication with other servers through the cloud platform to realize remote control of equipment and data sending and receiving. In this system, it refers to the human cloud IOT platform.
- The IOT application: the final implementation of the whole system can be in the form of host computer, software application and browser website. It is the final collection place of terminal data, which can be analyzed and processed according to different services. In this system, it refers to the remote meter reading system at the PC end[5].

4. OVERALL ARCHITECTURE DESIGN OF REMOTE METER READING SYSTEM

According to the system architecture based on the IOT cloud platform and the analysis of NB IOT, this paper designs a remote meter reading system based on the IOT cloud platform and NB IOT.

4.1 Device connected to IOT cloud platform

According to the business requirements of the remote meter reading system, and based on the IOT cloud platform and NB IOT technology, the overall design of the remote meter reading system is carried out. The successful connection of equipment to the cloud platform is the cornerstone of the normal operation of the remote meter reading system[6]. The general process is shown in Figure 4.

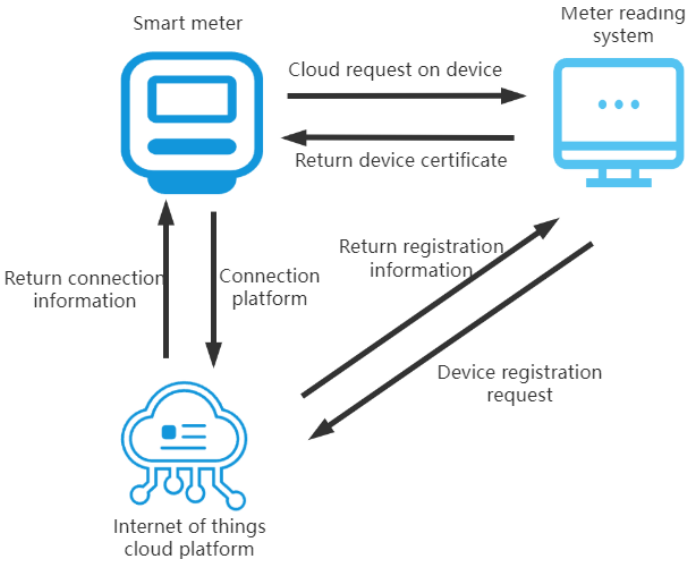

Figure 4. The process of devices connected to the cloud platform of the Internet of things.

The premise for a device to successfully go to the cloud is to hold the device certificate of the IOT cloud platform. Through the device certificate to connect with the IOT platform, the device certificate issued by IOT cloud platform in two ways can be obtained in two ways[7]:

(1) Burning the equipment certificate on the equipment

The scheme is that after the equipment manufacturer obtains the equipment certificate issued by the IOT platform, the certificate is burned to the equipment on the production line. After the device is powered on to the Internet of things, use the certificate to connect to the cloud platform of the Internet of things. This scheme requires equipment manufacturers to transform their production lines so that the production lines have the ability to burn certificates.

(2) Obtaining the certificate from the cloud platform.

The scheme is to automatically obtain the IP address after the equipment is powered on and connected to the cloud server of the equipment manufacturer to obtain the certificate. During production, equipment manufacturers do not need to burn equipment certificates for such equipment. After the device is powered on and connected to the Internet of things, the device certificate issued by the IOT cloud platform is obtained from the manufacturer's cloud server, and then connected to the IOT cloud platform.

This paper is based on scheme 2 to realize the device connection to cloud platform. Using this scheme, you can not design the certificate burning process on the production line and speed up the mass production of equipment. After the device is powered on and connected to the Internet each time, it will send a request to the meter reading system to connect the device to the cloud platform. The request carries the device number. The meter reading system will first register a corresponding image device on the cloud platform of the Internet of things according to the device number. After successful registration, it will obtain the device certificate returned by the platform, and then return the corresponding device certificate to the device. After the device obtains the device certificate, you can successfully access the cloud platform of the Internet of things through the device certificate. Finally, the device will save the corresponding device certificate locally to ensure that you can directly establish a connection with the platform later.

4.2 Two-way communication between equipment and system

After the device is successfully connected to the platform, the meter reading system can conduct two-way communication with it through the IOT cloud platform. The communication between the meter reading system and the IOT cloud platform is based on the AMQP (Advanced Message Queuing Protocol) server, and the communication between the Internet of things cloud platform and the device is based on the MQTT (Message Queuing Telemetry Transport) server[8]. Whether MQTT or AMQP, the message flow is basically based on the publish subscribe model, which is implemented by relying on topic, so we need to create topics. Above, we explained the general process of cloud on devices. The premise of cloud on devices is to successfully register on the IOT cloud platform. In fact, the platform will create a corresponding topic for the device at the same time of successful registration, and the topic here is applied to the message communication among devices, IOT cloud platform and meter reading system. The process is roughly shown in Figure 5.

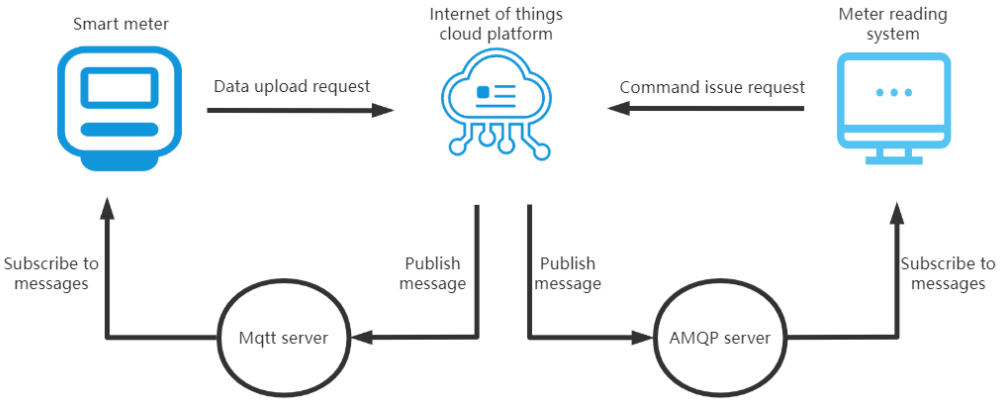

Figure 5. The message communication process.

According to the above figure, we can see that the whole two-way communication process can be divided into two parts: device to IOT cloud platform to meter reading system and meter reading system to IOT cloud platform to device, in which IOT cloud platform is the hub[9]. The meter reading system first sends the request issued by the instruction to the cloud platform of the Internet of things. In addition to the specific instruction, the request also needs to carry a specific topic. After the platform receives the request, it analyzes the request content. First, it verifies the accuracy of the request. After the verification is passed, it sends the message content in the request to the topic specified by the MQTT server. The device side subscribes to the topic as an MQTT client. As long as there is a message on the topic, it will be consumed. When consuming, it will be analyzed according to the communication protocol agreed between the device and the meter reading system; After the device side parses the instructions, it will respond accordingly and send a data upload request to the IOT cloud platform. In addition to specific instructions, the request also needs to carry a specific topic. After receiving the request, the platform parses the request content. First, it verifies the accuracy of the request. After passing the verification, it sends the message content in the request to the topic specified by the AMQP server. The meter reading system subscribes to the topic as an AMQP client. As long as there is a message on the topic, it will be consumed. During consumption, it will be parsed according to the communication protocol agreed between the device and the meter reading system. At the same time, the parsed data will be saved in the database for subsequent business operations[10].

4.3 Relevant tests of the system

The cloud platform of the Internet of things provides log services for each registered device. The log service provides functions such as data query and analysis, consumption and delivery in a one-stop manner. The performance test of the whole meter reading system is based on the equipment log service. The system is tested according to the information in the log service, the test results are shown in Table 1.

Table 1. The system performance table.

Stability	The equipment and system can be 100% connected without disconnection.
Reliability	The equipment and system can ensure the data integrity and error free interaction without packet loss.
Low latency	When the network is good, a complete communication process takes about 1 second; In case of network delay, a complete communication process takes about 5 seconds.

5. CONCLUSION

In this paper, the traditional meter reading mode is upgraded in all aspects from the actual meter reading business requirements. Based on the network architecture of the Internet of things and the cloud platform as the hub, the intelligent meter reading business of intelligent electric energy meter is realized. From single household to the whole meter, from manual to automatic, the whole remote meter reading system well meets the business requirements.

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