Research on the Architecture and Key Technology of Internet of Things (IoT) Applied on Smart Grid

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Abstract

Advances in the areas of embedded systems, computing, and networking are leading to an infrastructure composed of millions of heterogeneous devices. These devices will not simply convey information but process it in transit, connect peer to peer, and form advanced collaborations. This "Internet of Things (IoT)" infrastructure will be strongly integrated with the environment. This paper focuses on researching on the architecture and key technology of Internet of Things. Moreover, the applications of Internet of Things are interpreted in this paper. Especially, the application of IoT in smart grid is emphasized. The work presented here proposes the principal characteristics for an effective integration of the Internet of Things in smart grid.

1. Introduction

The explosive growth of the requirement of the communication for information between machines raised concerns, such as, the optimization of the human environment, the management of urban security, the improvement of living quality, and the effective management of production, the "Internet of Things" (IoT) is in great demand. Our government has a high regard to the research and development of IoT, as we are moving towards the "Internet of Things" as depicted by[1], millions of devices will be interconnected, providing and consuming information available on the network and cooperate.

International Telecommunication Union (ITU) put forward "Internet of Things" in the report in 2005, but there is still not a generally accepted concept. The basic concept of IoT is: together with web services ,such as Radio Frequency Identification Devices (RFID), infrared sensor, Global Positioning System, laser scanner, a network of Internet-enabled objects connected with the Internet based on the conventional protocol, to exchange information and communicate, in order to achieve intelligent identify, locate, track, monitor and manage a network[2]. IoT evolves from the Internet and short-range communication network, Figure 1 describes the relationship between IoT and other existing networks.

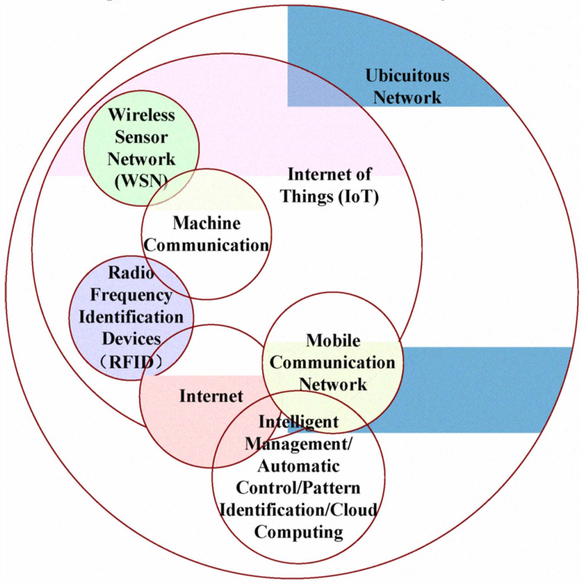

Figure 1. The relationship between IoT and other existing networks

Internet of Things has three important characteristics:

1. Comprehensive sense: using RFID, sensors, two-dimension code to collect information of objects anytime, anywhere.

2. Reliable transmission: accurate real-time delivering information of objects through meshing a variety of telecommunications networks and Internet.

3. Intelligent processing: using intelligent computing such as cloud computing and fuzzy identification to analyze and process vast amounts of data and information, for the purpose of implementation of intelligent control to objects.

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2. The architecture of Internet of Things

Internet of Things can be divided into 3 layers: perception layer, network layer, and application layer[3].

The perception layer consists of two-dimension code tag and code reader, RFID tag and reader, camera, GPS, all kinds of sensors, sensor network, M2M terminal, and sensor gateway, et al. The main function of Perception Layer is perception and identification of objects, and collecting and catching information.

The network layer consists of converged network formed by all kinds of communication network and internet. It has been widely accepted that this part be the maturest part. Besides, the IoT management center and information center are the parts of network layer. That is to say, the network layer not only has the ability of network operation, but also should improve the ability of information operation. The network layer is the infrastructure of IoT becoming universal service.

The application layer is the Internet of Things technology combined with industry expertise to achieve a broad set of intelligent application solutions. Through the application layer, Internet of Things of can achieve the depth of integration of information technology with the industry finally. It will have great effect on economic and social development. The key issue of the application layer is information sharing and information security.

Currently, there is not a widely accepted architecture of Internet of Things. The most representative structure of the Internet of Things is EPC Global "Internet of Things" supported by Europe and the United States, and the Japanese Ubiquitous ID (UID) IoT system.

EPC system is composed of three parts: EPC encoding system, radio frequency identification system and information network system, including six areas. EPC "Internet of Things" Architecture consists of EPC code, EPC tags and readers, EPC middleware, ONS and EPCIS servers, et al. EPC global standard is divided into three levels: identification, capture, and exchange. As shown in Figure 2, they are in consensus with the entire structure of EPC Internet of things, respectively. EPC Internet of Things frame standard consists of hardware, software, data interfaces and the core services of EPC network. The aim is enhancing the logistics supply chain by using the EPC code [1].

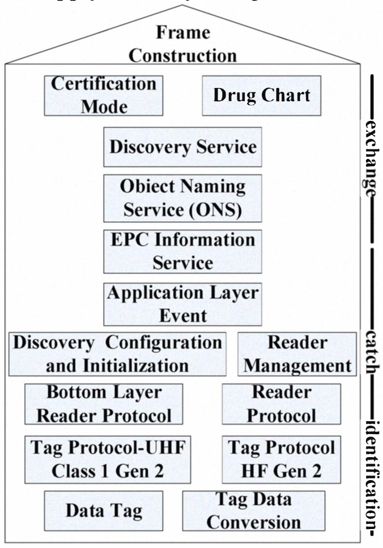

Figure 2. EPC global standard structure

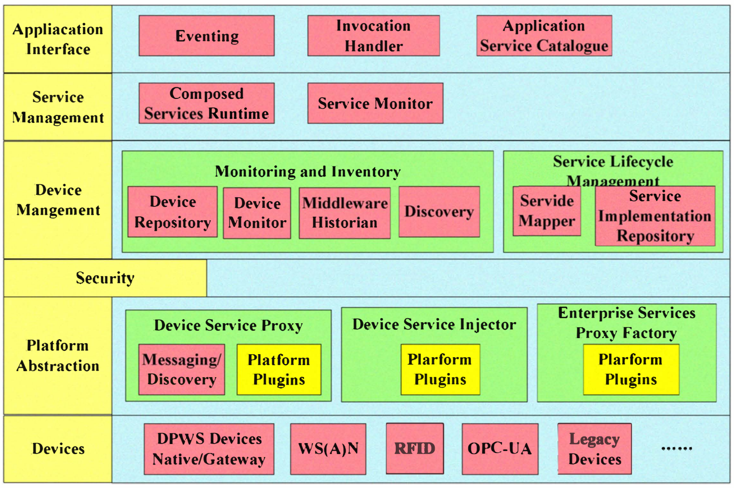

Figure 3. The integrated morphology of Internet of Things

The purpose of setting up UID center is to establish and popularize the needed basic technologies of automatic identification of "objects". Eventually, it can achieve the ideal environment of "ubiquitous computing". UID technology architecture is composed of the ubiquitous identifier (uCode), ubiquitous communications device, information system server, and uCode analysis servers. UID uses uCode as the identity of real world objects and places. UC reads electronic tags from uCode to obtain the status of these facilities, and control them. UC is similar to the PDA terminal. UID can be widely used in many industries, and link all relevant information to achieve "Internet of Things". Moreover, UID is an open architecture, and its specification is open to the public [4].

The structure of Internet of Things is shown as Figure 3. It collects the IoT capabilities effectively, service-oriented, using integrated real equipment of embedded software in accordance with IT systems standard [5].

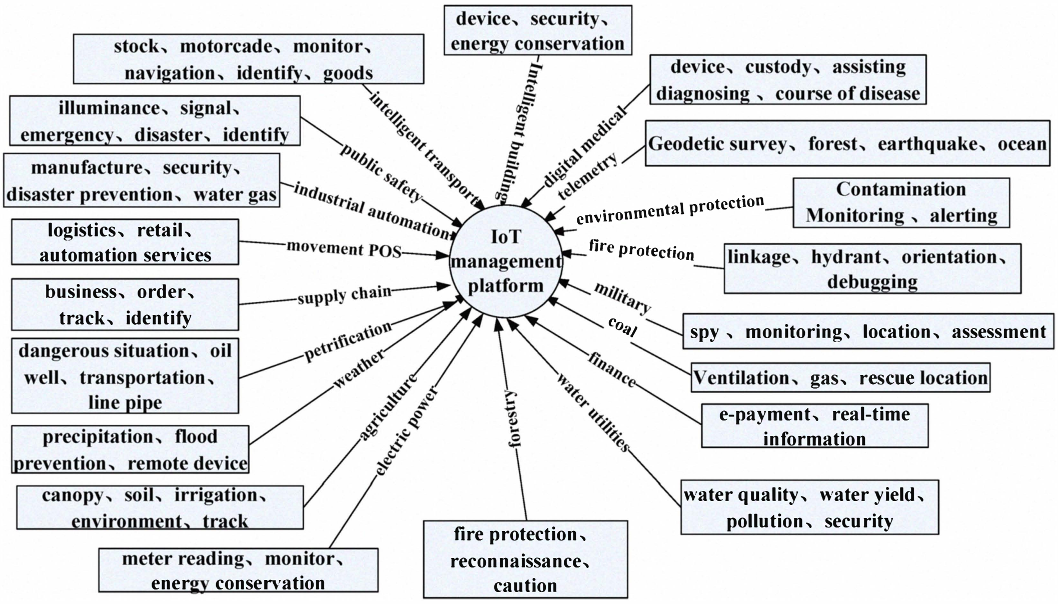

Figure 4. The full view of the application scenarios of Internet of Things

3. The key technology of Internet of Things

IoT can be brought about through the interaction and perfect of the technology of signal detecting, short-range communication, long haul transmission, intelligent analysis of massive dump and management. There are four key applied technology of IoT in ITU report: RFID, sensor technologies, smart technologies and nanotechnology.

3.1. RFID

RFID uses electromagnetic induction or electromagnetic propagation for the purpose of non-contact automatic identification of objects or human. In wireless condition, the affiliated EEPROM in the electronic label can be written and read by the professional read-write equipment. RFID has the feature against reproduction, combined encryption, and securer data on ticket, document, certificate, and items, for the purpose of anti-counterfeiting.

3.2. Sensor network

Wireless sensor networks provide a new platform to sense the world, process the data. It is widely applied in lots of fields, such as military defense, industry control, agriculture control, city management, biomedicine, rushing to deal with an emergency, rescue, remote control to danger zone, manufacture, et al. Wireless sensor networks are consists of a large number of nodes which can be capable of communicating, computing and cooperation in adhoc model.

3.3. Smart technology

Smart technologies are the methods employed to achieve certain purpose by using a priori knowledge. Objects which get intelligent after the implantation of smart technologies, can communicate with users actively or passively. Content and direction of major research includes: artificial intelligence theory, advanced human - machine interaction technologies and systems, intelligent control technology and systems, intelligent signal processing.

3.4. Nanotechnology

Nanotechnology - the study of these tiny particles - is being used to improve products across a number of industries, including medicine, energy and transportation. The use of nanotechnology means that objects which interact and connect with each other can be the smaller ones.

4. The application of Internet of Things

On the background of fusion of industrialization and information, Internet of things will be a more realistic breakthrough for industry information. Once Internet of things begins to be popularized massively, many more intelligent sensors need to be installed. The number will greatly exceed the current mobile phone number.

4.1. The general application of IoT

According to the characteristics of own Internet of Things, following categories of services should be provided:

1. Networking service: goods identification, communication and positioning
2. Informational service: information collection, storage and query
3. Operation service: Remote configuration, monitoring, operations and control
4. Security service: user management, access control, event alarm, intrusion detection, attack prevention
5. Management service: Fault diagnosis, performance optimization, system upgrades, billing management services.

General type of service of IoT listed above, which could extend on the basis of application requirements of IoT in diverse areas. Figure 4 shows the future context of IoT use.

4.2. The application of IoT in smart grid

Smart grid can solve the problem on energy alternative and compatible use, which integrate system data on the basis of building open system and shared information model to optimize the operation and management of the grid. The principal characteristics of smart grid include self-healing, mutual operation and participation of the users, perfect electricity quality, distributed generations and demand response, sophisticated market and effective asset management. Sensor technology in IoT forms interactive real-time network connection between the users, corporation and power equipment to make data reading real-time, high-speed and two-way, which improve the overall efficiency of the integrated power grid. Detection terminal, in charge of acquisition parameter of the sensors, transmit data to the supervisory computer through telecommunications networks[6]. The computer stores data to database or fixed disk, where power monitoring network users can find current grid information, including operation of power equipment, power quality, the situation of power supply and demand, and metering information (including fault alarm and alarm device interference).

5. Conclusion

This paper focuses on researching on the architecture and key technology of Internet of Things. Moreover, the applications of Internet of Things are interpreted in this paper. Especially, the application of IoT in smart grid is emphasized.

6. References

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