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Research on Key Technology and Applications for Internet of Things

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Abstract

The Internet of Things (IOT) has been paid more and more attention by the academe, industry, and government all over the world. The concept of IOT and the architecture of IOT are discussed. The key technologies of IOT, including Radio Frequency Identification technology, Electronic Product Code technology, and ZigBee technology are analyzed. The framework of digital agriculture application based on IOT is proposed.

Keywords- Internet of Things, RFID, EPC, ZigBee, digital agriculture

1. Internet of Things and its architecture

1.1 Internet of Things

The idea of Internet of Things [1] that all the items were connected to Internet by sensor devices such as RFID (Radio Frequency Identification, RFID) in order to accomplish intelligent recognition and network management was first proposed by Auto-ID laboratory in MIT (Massachusetts Institute of Technology) in 1999. Its core support technology is a wireless sensor network and radio frequency identification technology.

The concept of Internet of things was addressed in *ITU Internet reports 2005: the Internet of things,* which was issued on the World Summit on the Information Society (WSIS) by the International

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Telecommunication Union (ITU) in Tunisia on November 17, 2005. It reports that everything can connect to each other at any place and in any time by radio frequency identification technology, wireless sensor networks technology, intelligent embedded technology, and nanotechnology.

Since there is no uniform definition of Internet of things, it can be defined as the following from a technical perspective. Internet of Things is the network which can achieve interconnection of all things anywhere, anytime with complete awareness, reliable transmission, accurate control, intelligent processing and other characteristics by the supportive technologies, such as micro-sensors, RFID, wireless sensor network technology, intelligent embedded technologies, Internet technologies, integrated intelligent processing technology, nanotechnology. Other definitions of things can be found in the literature [3].

1.2 Architecture of IoT

According to the recommendations of the International Telecommunication Union [4], the network architecture of IoT consists of the sensing layer, the access layer, the network layer, the middleware layer and application layers.

Sensing layer: the main features of this layer are to capture the interest information large-scaly by various types of sensors, identify intelligently, and share the captured information in the related units in the network.

The access layer: this layer's main function is to transfer information from the sensing layer to the network layer through existing mobile networks, wireless networks, wireless LANs, satellite networks and other infrastructure.

Network layer: this layer's main function is to integrate the information resources of the network into a large intelligence network with the Internet platform, and establish an efficient and reliable infrastructure platform for upper-class service management and large-scale industry applications.

The middleware layer: this layer's main function is to management and control network information real-time, as well as providing a good user interface for upper layer application. It includes various business support platform, management platform, information processing platform, and intelligent computing platform.

Application layer: this layer's main function is to integrate the function of the bottom system, and build the practical application of various industries, such as smart grids, smart logistics, intelligent transportation, precision agriculture, disaster monitoring and distance medical care.

2. Key Technology of IoT

2.1 RFID technology

RFID (Radio Frequency Identification, radio frequency identification) technology originated in the early 40 's, which was mainly used in machine recognition of enemy aircraft in air combat and friends. After several decades of development, it can be used for production management, safety, transportation, logistics management, and other areas.

RFID system uses radio frequency tags to bear information. To identify automatically, RFID tag and reader communicate by non-contact sensors, radio waves or microwaves. The most prominent feature of RFID technology is: non-contact reading and writing, distance from a few cm to dozens of meters, to recognize high speed moving objects, strong security, and can identify multiple targets simultaneously.

The key technologies of RFID includes high-adaptive wireless communication technology, high confidentiality; low power consumption, high reliability of RFID devices; small volume, high efficiency antenna technology; low-cost chip and reader.

2.2 Electronic Product Code

EPC (Electronic Product Code), which was developed by Auto-ID Center in Massachusetts Institute of Technology, can be used to construct a global intelligent network sharing information in real time by establishing a unique identifier for every single article, and then uses RFID, wireless communications technology through the Internet platform.

The complete system of EPC composes of EPC encoding, EPC tags, readers, EPC Savant, ONS server, PML, EPC-IS servers, and Internet.

(1) EPC encoding: EPC encoding is a string of four field composed of a number, followed by the EPC header, EPC Manager, object classification, a serial number. The code length includes 64 bits, 96-bit and 256-bit, which can assign a unique number to all the world's goods. It was managed by EPCglobal institutions and states subsection management. EPC encoding structure can be found in the literature [5].

(2) EPC tags: EPC is the only information stored in the EPC tags. EPC tags can be divided into read-only labels and read/write tags depending on how to read and write.

(3) Reader: is used for reading or writing of EPC labels information.

(4) EPC Savant: its main task is to deliver and manage the EPC information come from the reader.

(5) ONS server: ONS (Object Name Service) servers resolute based on EPC encoding and user's requests, to determine which the related information is stored in the EPC-IS.

(6) PML: PML (Physical Markup Language), which develops from the Extensible Markup Language (XML), adopts a common, standard syntax to describe natural objects.

(7) EPC-IS: EPC-IS (EPC Information Service) storages and provides various products information corresponding to the EPC code. This information is generally stored in PML format, can also be stored in the database.

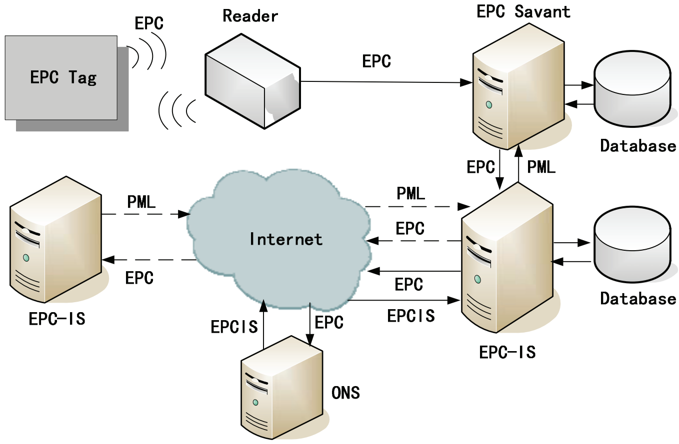

Figure 1. The architecture of EPC network

The mechanisms of the EPC system as shown in Figure 1: the reader reads EPC information in EPC tags by means of non-contact, and then sends to EPC Savant. After a series of complex processing, Savant try to look for the EPC product information in the local EPC-IS, if Savant finds the information, it obtains and sends the information to the EPC Savant directly; if not, the local EPC-IS will send query request used EPC codes as a keyword to the ONS servers on the Internet. When ONS server returns the IP address of the remote EPC-IS, local EPC-IS send query request to the remote EPC-IS and get the product information, and then send it to the EPC Savant, writing it in local PML cache [6]. EPC Savant is at the core position during the entire process.

The Key technology of EPC Savant:

(1) Data filtering: identification of redundant data and filter; incomplete filtering of EPC data.

(2) Data aggregation: EPC information can be aggregated quickly and reliably before transmitting, which can be found in literature [7].

(3) Information transfer: transmit information secure and real-time, with high priority, error recovery mechanisms.

2.3 ZigBee

ZigBee is a short-range, low-rate wireless network technology, and its physical layer and MAC layer protocol are almost the same as IEEE802.15.4. ZigBee Alliance, which was founded in August 2001, has enhanced the IEEE802.15.4; including the definition of the secure network layer and API are standardized so that it can support multiple architectures as well as providing high reliability wireless communication.

ZigBee is widely used in home automation, digital agriculture, industrial controls, and medical monitoring. The characteristic of ZigBee Wireless Sensor Network are shown in table 2.

Table 1. The characteristic of ZigBee Wireless Sensor Network

Features	Description
Shorter delay	15ms—30ms
Low rate	1kB/S—250kB/S
Large capacity	Can support up to 255 devices
Multi-band	2.4GHz、868MHz and 915MHz
Security	Provides data integrity checking, and a AES-128 encryption algorithm
Low power consumption	Two ordinary route 5th battery can be used 6 months to 2 years (standby mode)

Key technology of ZigBee networks includes the following three main areas.

(1) Hardware platforms: to design low power consumption, small size, low cost wireless sensor node; to develop high micro-kernel, modules, energy-efficient embedded operating systems.

(2) Network communication protocol: The key technology in physical layer is to be behavioral characteristics and accumulation of experience of low power communication data when the environment changes frequently. The key technology in MAC layer is to develop channel allocation and scheduling mechanism for avoiding conflict; to build the dormancy mechanism of energy conservation node. The key technology in network layer is to build and control the efficient and stable network topology, to establish the self-organization information transmission paths with adaptive network coverage; low power consumption. The key technology in application layer is to detect and classify the network object, to track multiple mobile targets, to schedule dynamic task and allocate resource.

(3) Information processing technology: it includes query optimization and processing, information integration, inner-network processing, data compression, distributed storage and signal processing.

3. The Key Technologies of IoT in Digital Agriculture

Internet technology will be widely used in digital agriculture, Smart grids, smart home, intelligent transportation, smart logistics, disaster monitoring, distance medical care, and other fields. The key technologies and application framework of digital agricultural are addressed in the next sector.

3.1 Production processes

As field information is obtained primarily through manual measuring experience or judgment in traditional agriculture, it takes lots of labor power and the data accuracy is low. To exploit agricultural resources reasonably, reduce production costs, improve the ecological environment, improve the agricultural products, the atmospheric, soil, and other information can be collected real time and accurately for scientific predictions, precise control, scientific cultivation by using wireless sensor networks technology, which is shown in the left of Figure 2. Firstly, the information, such as air temperature, humidity, wind, precipitation, soil moisture, conductivity and pH values are collected by various types of sensors. Secondly, the information is transmitted to the gateway by ZigBee. Finally, the gateway controls the switch unit to water, fertilize, ventilate and control temperature automatically with the support of the application servers.

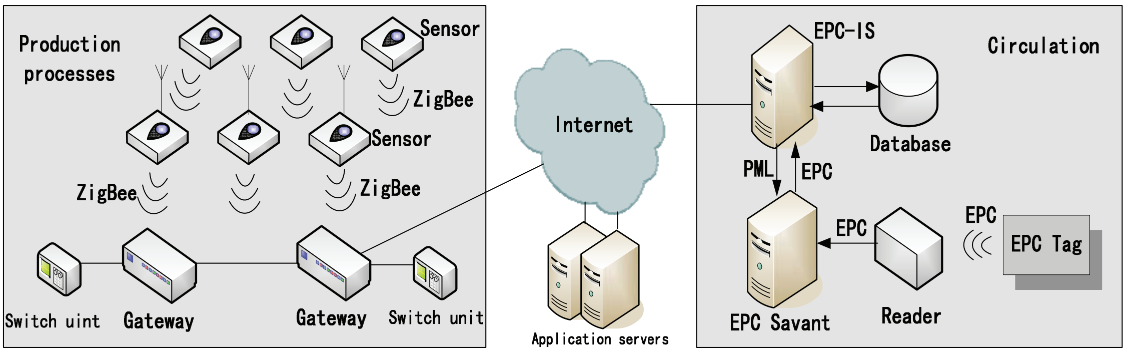

Figure 2. The framework of digital agriculture application based on IOT

3.2 Circulation

As lack of effective regulation, there are many defects in the field of agricultural products circulation in our country currently, such as security incidents, inferior products posing well-known brands. Using EPC technology can solve those problems efficiently, just as shown in the right of Figure 2. Firstly, the label is embedded to agricultural products in the production process. Secondly, the EPC reader is installed at the required position, such as mall, market, and warehouse. With the support of various application servers, food security sector can regulate production, process, wholesale and retail, consumer can track products of sources, produced commercial, quality, period, and quarantine.

4. Conclusions

IoT will undoubtedly be an information revolution following computers and Internet. United States has identified smarter planet as a key strategy for a new round of international competition, also "Sense China" ambitious strategic goals have been made in China. The key technology of IoT will be widely used in digital agriculture, smart grids, smart home, intelligent transportation, smart logistics, disaster monitoring, distance medical care and other fields. The key technologies and application framework of digital agricultural are addressed in this article.

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