Architecture of Internet of Things and its Key Technology Integration Based-on RFID

Minghui Zhang
Department of Information Technology and Business Management
Dalian Neusoft Institute of Information
Dalian,China
Email:zhangminghui@neusoft.edu.cn

Fuquan Sun, Xu Cheng
Department of Information Technology and Business Management
Dalian Neusoft Institute of Information
Dalian,China
Email:sunfuquan@neusoft.edu.cn

Abstract : In recent years, the IoT(Internet of Things)has been widespreadly concerned as a new technology architecture integrated by many information technologies. However, IoT is a complex system .If there is no intensive study from the system point of view , it will be very hard to understand the key technologies of IoT. In order to better study IoT and its technologies this paper proposes an extent six-layer architecture of IoT based on network hierarchical structure firstly. Then it discusses the key technologies involved in every layer of IoT ,such as RFID , WSN, Internet ,SOA, cloud computing and Web Service etc. According to this , an automatic recognition system is designed via integrating both RFID and WSN and a strategy is also brought forward to via integrating both RFID and Web Sevice. This result offers the feasibility of technology integration of IoT .

Keywords: IoT, RFID, WSN, Web Service, Technology Integration

I. INTRODUCTION

The term Internet of Things (IoT) was first used by Kevin Ashton in 1999. The concept of the Internet of Things has become popular through the Auto-ID Center [1]. Different definitions for the Internet of Things have appeared and the term is evolving as the technology and implementation of the ideas move forward. According general definition ,the IoT refers to all objects (things) in the world equipped with minuscule identifying devices such as RFID , sensors, smart objects et. are seamlessly integrated into the intelligent network by specific protocol where they can communicate each other.In IoT the Internet extends into our everyday lives through a wireless network of uniquely identifiable objects.

Recently IoT has become a new study field in IT and intense discus is conducting in many countries by spending much money. Different conclusion will be acquired from different study perspective. Firstly this paper analyses the IoT architecture and relevant critical technologies especially RFID .An extent architecture is built in. Finally based on this an automatic recognition model is designed by integrating both RFID and WSN. At the same time a strategy is also proposed by integrating both RFID and Web Service.

II. RFID AND THE ARCHITECTURE OF IOT

A. Introduction of RFID

One of the most important technology in the IoT is Radio-frequency identification (RFID). It is a technology that uses radio waves to transfer data from an electronic tag, called RFID tag or label, attached to an object, through a reader for the purpose of identifying and tracking the object. Normally, a RFID system consists of three parts: RFID tag, RFID reader and central computer system[2][3].

The RFID tag stores the objects information which is standard and with interoperability. And the tags are transferred to the central computer system via wireless network. Then the object can be recognized by the tag. Meanwhile, those tags are able to be exchanged and shared on the internet so as to manage the object transparently. In RFID system ,each physical object is accompanied by a rich ,globally accessible virtual object that contains both current and historical information on that objects's physical properties [4] .

Internet of things is a heterogeneous Network which includes heterogeneous access technology, heterogeneous data transmission network and heterogeneous terminal service. Its heterogeneity feature requires that all the key technologies must be integrated efficiently so that the various kind of information which are detected by RFID or other access equipments can be recognized and integrated and then used to application services.

B. The extent six-layer architecture model of IoT

The architecture model of internet of things is about its components and the relationship of them. There are different architecture models deduced from different angles which are interested by the researchers [5]. Currently, there is not a widely accepted architecture model in the world. The most representative ones are EPC Global from European and US and Ubiquitous ID(UID) from Japan[6].

There are three steps in the application flow of Internet of Things[7]. The first step is to identify the object. The identification equipment should be able to recognize the features of the objects and convert them to the electronical

978-0-7695-4811-1/12 $26.00 © 2012 IEEE
DOI 10.1109/ISCID.2012.81

signals which are fit for transportation. The second step is to transport the data into information center. The last step is intelligent processing. The three-layer structure of IoT is put forward by IOT Working Committee of China according to its practical demand in China as shown in Figure 1.

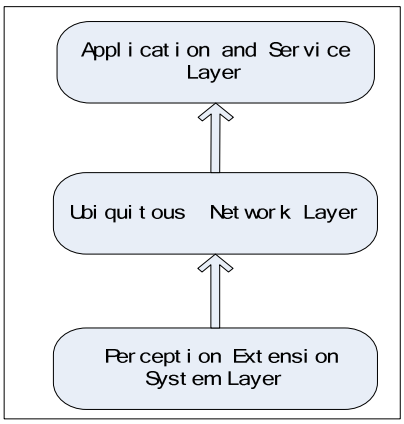

Figure 1 the basic three-layer architecture of IoT

Based on the working flow and three-layer architecture of IoT, this paper describes a new extent six-layer architecture from the point of technology. It is depicted in Figure 2.

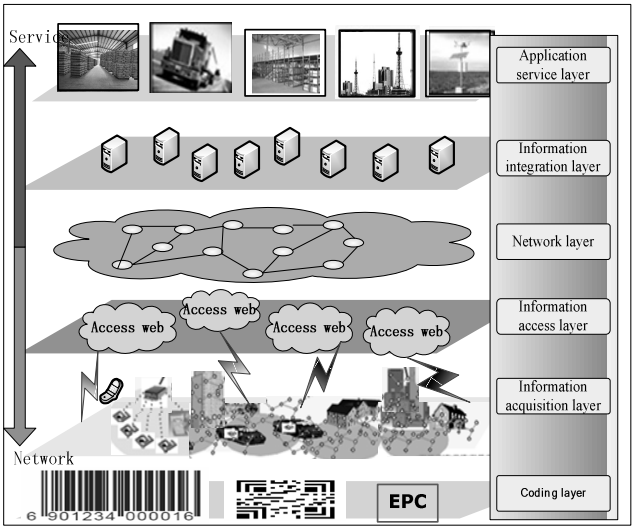

Figure 2 the extent six-layer architecture of IoT

It consists of six layers: coding layer, information acquisition layer, information access layer, network layer, information integration layer ,and application service layer. A brief description of each layer on this architecture follows:

- Coding layer: this layer is the base of the Internet of things. Coding is to issue an id number for each objects, then the objects can be recognized in whole cycle of the Internet of things.
- Information acquisition layer: this layer is to collect and identify the data of objects via various sensors, RFID, two-dimension code, camera, GPS and intelligent agents. This is the source of the IoT.
- Information access layer: this layer is to transmit the information which is obtained from Information collection layer to the network layer. The information transmission network can be mobile communication network(Such as, GSM, TD-SCDMA), WiMAX, WiFi and other communication equipments.
- Network layer: this layer is a network platform which is based on IPV6 and IPV4. Then it forms a large intelligent network which are able to utilize all the resources in the network.
- Information integration layer: this layer is to manage and control the massive and uncertain data in the network in real-time manner. Then the data is reorganized, filtered and integrated and then transformed into content service in the SOA. So it provides a good service interface to the application service layer.
- Application service layer: this layer integrates the service enablities and forms the application service for various industries.

Based on this , we can make an intensive study of IoT.

III. CRITICAL TECHNICAL INTEGRATION IN ACQUISITION LAYER BASED ON RFID

We have shown the extent architecture in the previous section .From this we can know IoT is an architecture of multi-technology combination and it is related to the following critical technologies :coding, information acquisition, protocol, network access , security, service and application, verification.(see Figure 3).

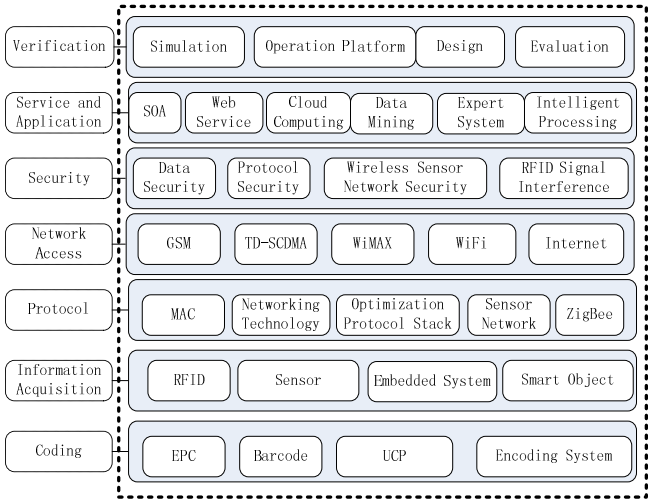

Figure 3. critical technologies in IoT

From the Fig2 we can see the information acquisition technologies in IoT mainly include RFID, sensor, embedded system and smart objects[8]. The sensing layer is the source of data as the main part of intelligent information acquisition in

internet of things. However, the information gathered by different devices is heterogeneous. In order to overcome this problem , many researchers are working towards an integration method among many technologies.

A. The Integration of RFID and Sensor Based on Zigbee

Wireless sensor networks behave as a digital skin, providing a virtual layer where the information about the physical world can be accessed by any computational system . ZigBee is a low-cost, low-power, wireless mesh network standard specification for a suite of high level communication protocols and applied in automatic control and monitoring very widely[9]. RFID is a technology that uses radio waves to transfer data between the reader and transponder bidirectionally by non-touching way. The sensor web based on Zigbee focus on the sensing indicator in some area, however RFID can identify the character and location of some sensing node very accurately[10]. If we can implement the integration both WSN and RFID, the IoT can gather and acquire real-time processing precisely. Considering this , an automatic recognition system is proposed and its architecture is depicted in Figure 4.

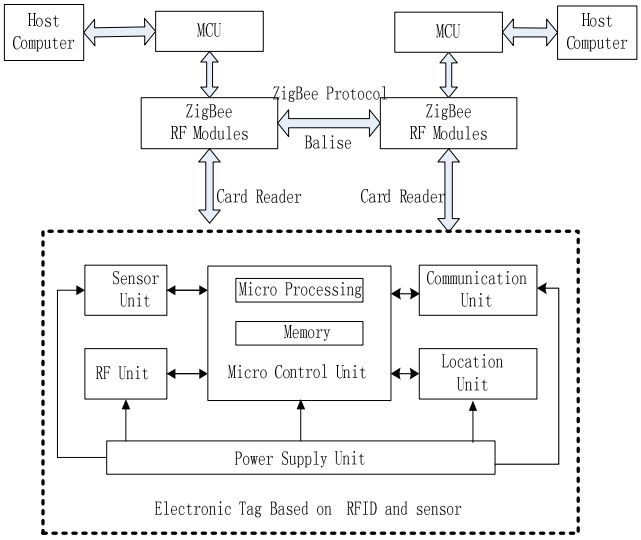

Figure 4 automatic recognition system based on Zigbee by integrating WSN and RFID

In this system ,we design the electronic tag via intergrationg the RFID and sensor .Then the card reader can acquire data from this tag and transport them into MCU through Zigbee protocol.

B. The Integration of RFID and Web Service

Data that is collected from information acquisition layer of IoT must be transported and processed ,then it can afford resources for application layer. In order to increase the visibility of objects with RFID tag we can create RFID web service with gateway and it can connect to outside service. Web services can also be used to implement an architecture according to service-oriented architecture (SOA) concepts, where the basic unit of communication is a message, rather than an operation [11] . The integration of RFID and Web Service can implement data collecting , interchange and sharing among heterogeneous webs. By RFID the business application system can know the information about attribute and flow direction of objects. Moreover these information can be transferred in deferent systems by Internet. Web Service can implement the real-time exchanging and sharing data that is located in different web nodes[12].

Middleware is computer software that connects software components or people and their applications. The software consists of a set of services that allows multiple processes running on one or more machines to interact. This technology evolved to provide for interoperability in support of the move to coherent distributed architectures, which are most often used to support and simplify complex distributed applications. It includes web servers, application servers, and similar tools that support application development and delivery. It has become a hot topic in the field of IoT[13][14].

This paper forms a Message — Oriented Middleware （MOM）via the integration of the RFID and Web services technologies in the information integration layer of IoT . Its processing flow is depicted in Figure 5. RFID defines the data interface and describes the massive data with the help of XML(eXtensible Markup Language) and PML(Physical Markup Language), and then transmits these data as message from one program to another one in asynchronous manner. RFID Middleware is able to transmit information and provides the security, wrong data recovery, data translation, data buffering, data casting, and network resources location services as well.

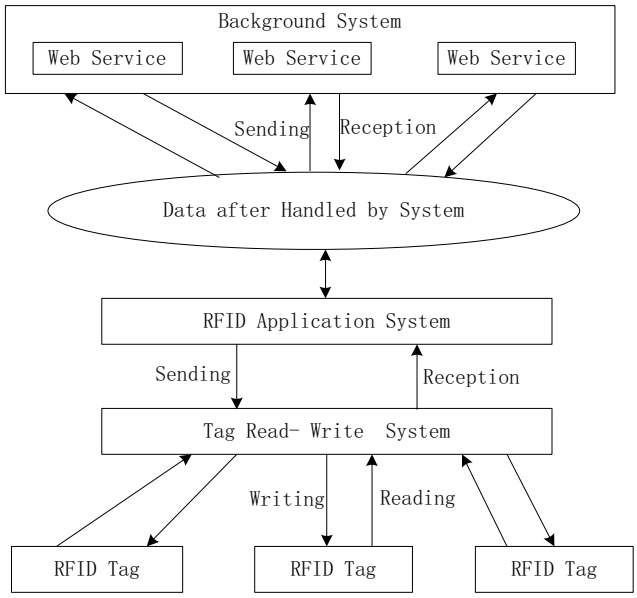

Figure 5 the flow of processing in IoT based on RFID and Web Service

C. *Research on integration among other technologies.*

IoT is an architecture of multi-technology combination. Recently there are many researches on the integration of IoT critical technologies. In Reference [15] a integration between WSN and Computer Network model has been built and in Reference [16] a integration method between RFID and smart objects is also proposed. In Reference [17] an Integrated frame is also put forward from the following four aspect: reader, active Tag , RFID Tag and systematic hierarchy.

Nevertheless, the actual results on this particular field are insufficient .There is a long way to run in the future.

IV. CONCLUSIONS AND FUTURE WORK

It is clear that the multi-technology combination is necessary in IoT. After discussing the both RFID and the architecture in the course of this paper, we give the automatic recognition system based on Zigbee by integrating WSN and RFID. In addition , a flow of processing in IoT based on RFID and Web Service is given based on RFID and Web Service. The proposed IoT architectural model introduces a more generic IoT architecture by integrating both the RFID and WSN and Web Service infrastructures. The RFID, despite its simplicity and scalability, is inevitably restricted by the dichotomy of RFID tags and RFID readers.

Based on our study results , we feel that RFID-based personal object and friend tracking are promising, basic services for the IoT that our system can quickly been achieved. However one key problem we must overcome is finding techniques that improve or compensate for low tag-read rates. It is suggested that IoT projects in the long run should focus on the research and development of the infrastructure systems and technologies of IoT. It will mainly focus on 1) evaluating the proposed infrastructure in terms of scalability, adaptability and performance maximization, 2) extending the social scope of the proposed architecture by studying the human-object interaction, especially in social network environments.3) Information security and the leak of management in RFID integration.

ACKNOWLEDGMENT

This paper is supported by DaLian High-tech Zones Program for Science and Technology Innovation Project, Project Number: 20113006. At the same time, thanks to the project of and Technology Department of Liaoning Province of China: Research of a Service Scheduling Mechanism Oriented Outsourcing Enterprise Cloud Platform , Project Number: 201204796 , and it gives us financial and data support for the research.

REFERENCES

[1] ITU Strategy and Policy Unit(SPU) . ITU Intemet Reports 2005 : The Intemet of Things[R] . Geneva : International Telecommunication Union(ITU) , 2005

[2] T. Kriplean et al., Physical Access Control for Captured RFID Data, IEEE Pervasive Computing, VOL. 6, No. 4, 2007

[3] Zhang Handong , Zhu Lin . RFID Technology and Structure of Internet of Things. COMPUTER TECHNOLOGY AND DEVELOPMENT.VOL.21, No. 5.2011.5

[4] Evan W,Leilani B ,Garret C,Kayla G,Kyle R,et al.Building the Internet of Things Using RFID.The RFID ecosystem experience.IEEE Internet Computing,2009,13

[5] Shen Subin, MAO Yanqin, Fan Qu,Zong Ping, HuangWei.The ConceptModel and Architecture of the Internet of Things. Journal o f Nanjing University of Posts and Telecommunications (Natural Science). VOL. 30, No. 4,2010

[6] Shen Subin,Fan Quli ,Zong Ping,Mao Yanqin ,Huang Wei.Study on the Architecture and Associated Technologies for Internet of Things. Journal of Nanjing University of Posts and Telecommunicatio ns(Natura l Sc i ence) ,VOL. 29 No. 6,Dec 2009.

[7] Patrik S, Stamatis K, Dominique G, et al. SOA-based Integration of the Internet of Things in Enterprise Services[C]//Proc. of the 2009 IEEE International Conference on Web Services. Los Angeles, USA: IEEE Press, 2009.

[8] LIU Qiang,CUI Li,CHEN Hai-ming.Key Technologies and Applications of Internet of Things.Compute Science,VOL.37,NO.6,June 2010.

[9] Ding Long-gang. Based on RFID,Wi-Fi,Bluetooth,ZigBee of things of electromagnetic compatibility and interference coordination.Internet of Things Technology.2011.1,59-61

[10] NIE Tao , LU Yang , ZHANG Peng , YUAN Xu—hong , SU Yi. Analysis for collaborative mechanism of RFID & WSN in Internet of things. Application Research of Computers.2011.6

[11] YANG Bin, ZHANG Wei-dong, ZHANG Li-xin, ZHANG Li-jun, SHI Peng .Internet of Things Application Fundamental Framework Based on SOA. Computer Engineer.VOL .36 ,No.17 ,Sep 2010

[12] FREDERI X I . Internet of Things and radio frequency identificationin caretaking , facts and privacy challenge.The 1st International Conference on Wireless Commun cation, Vehicular Technology , In f or mati on Theory and Aerospace & Electronic Systems Technology . 2009: 319- 323 .

[13] Wang Baoyun .Review on internet of things. JOUNAL OF ELLECTRONIC MEASUREMENT AND INSTRUMENT. VOL 23 ,No.12, Dec 2009.

[14] http://en.wikipedia.org/wiki/Middleware.2011.10

[15] Liu Hai , BOLIC M , NAYAKAND A , et . Taxonomy and challenges of the integration of RFID and wireless sensor networks[J] . IEEE Network , 2008 , 22(6) : 26—35 .

[16] Wu Zuoshun.Network Model for Convergence of WSN and Computer Network. Computer Science.2010.2

[17] Evangelos A. Kosmatos, Nikolaos D. Tselikas, Anthony C. Boucouvalas , Integrating RFIDs and Smart Objects into a Unified Internet of Things Architecture,Science Research. 2011, 1