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Analytic study on the structure and practical application of internet of things

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ABSTRACT

The introduction of Internet of Things (IOT) triggered a fever of IOT technology. Scholars are dedicating themselves in the research on relative technology of IOT so as to make contributions to the realization of an intelligent society. IOT technology has attracted great attentions from Chinese academic fields and news media. IOT related majors have been set up in universities so as to culture high-tech talents. Currently, problems still exist in IOT related concepts, principle analysis, designs for technology structure and IOT system model. Based on case study on IOT technology application, and see it from the perspective of the current study state, application and future development prospect, this paper introduces the key technology of IOT and its structure design. It also gives examples of its practical application. With the development and application of IOT, life could be more intelligent. For instance, city living environment will be more intelligent; real-time tracking dynamic information could be realized in logistics; congestions of large scale could be avoided with IOT application in traffic direction; timely medical assistance could be taken with the help of tele-medicine.

KEYWORDS

Internet of things technology (IOT technology); System network architecture (SNA); Radio Frequency Identification (RFID).

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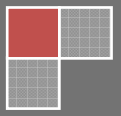

INTRODUCTION

IOT attracted widely attention in China in an unexpected speed after the concept came into being, and triggered a fever on IOT technology R&D. Since IOT is still in the initial stage both at home and abroad, no unified definition has been given on it. A lot of Controversies exist on IOT definition, and no definite standards have made on IOT standard system model. Besides, there is blindness in IOT technology research. The following aspects should be taken into consideration while we take further study and exploration on IOT. They are whether IOT technology and sensor network are the same concepts, the key technology of IOT, the key point to distinguish IOT technology from Internet, key element in model reorganization, and the significance of IOT development and application to developing countries.

IOT technology provides broad development space when traditional industries are facing limited improvement space or bottleneck. There is a large market demand for RFID and WSN (wireless sensor network), the major components of IOT technology. IOT technology also be applied in other fields, like logistics, intelligent transportation, military, intelligent home, tele-medicine and ETC (Electric Toll Collection). Real-time collection of field data could be realized through the application of wireless sensor nodes. In this way, we could monitor the condition of the forest so as to make quick response to emergency. Data collection devices, data process and data transmission are needed in the application, and people have to face many challenges during this process.

ANALYSIS OF IOT SYSTEM NETWORK ARCHITECTURE (SNA)

As the product of social development, IOT is both an opportunity and a Challenge for us. IOT is a large information system composed of many technologies and involving a great deal of industries in China. Currently, the universally recognized SNA of IOT is composed of perception layer, network layer and application layer.

Definition of IOT and key technologies of IOT

Internet of Things, namely IOT, was first put forward by Professor Kevin Ashton when he was doing research on RFID. It is a way to connect and communicate things around the world with the assistance of RFID, EPC standards and WSN communication technology[1]. As IOT technology developing, RFID is no longer the only technology that IOT technology depends on. IOT is now relying on a series of cutting edge collecting systems like RFID, WSN, GPS and laser scanning. With these systems, data of all kinds are collected and processed in real time. Then through telecommunication network and network, data will be sent to cloud computer for further process. Through the analysis and process of data, the front-end information acquisition will be controlled, or the backstage manager will be given information tips. Besides, with the advance of IOT technology, relative industries also been improved. TABLE 1 is the RFID demand data analysis in Chinese market. We could see from the table that RFID demand is expanding with the development of IOT technology.

TABLE 1 : Market demand scale of RFID in China in 2006-2013

Year	2006	2007	2008	2009	2010	2011	2012	2013
Real market scale（a hundred million）	42.7	53.1	61.7	75.1	88.2	97.8	113.7	140.9
Predicted market scale（a hundred million）	38.98	49.91	58.86	70.82	81.76	91.15	106.99	131.2
Relative error	0.087	0.060	0.046	0.057	0.073	0.068	0.059	0.064

IOT technology is not the simple combination of network and sensor technology; instead, it is the combination of many technologies. The perception layer of IOT includes RFID, WSN and so on; network layer includes the new generation of communication technologies like the Internet, telecommunication network LTE, etc; application layer includes new technology like cloud computing and data fusion.

RFID, also called electronic labeling, is an automatic identification technology which could realize contact-free information transmission by using coupling among radio frequency. RFID system has two main parts, reader and writer, electronic tag. Currently, most identification devices are used in logistics, drug regulation and ticket reorganization[2]. WSN, a self-organized network based on multi-hop, could sensor, collect and process data in a coordinated way. It is a new information collection technology of IOT technology that could realize dada quantifying and transmission. The current ZigBee protocol, a close and low-energy consumption two-way non-access technology, is applied in all kinds of remote monitoring. LTE, a technology based on the development of 3G technology, provides strong network technological support for the application of mobile internet. As the key technology in IOT technology, cloud computing can realize fast data process and transmission in the current information explosion era. It has a powerful data computing capacity and can realize data storage.

The system architecture of ITO

The perception layer realizes the collection of information through smart cards, electronic tags, sensor nodes and identifiers[3]; the network layer realizes information transmission through wireless network, mobile network and internet; the

main functions of application layers are information data analysis and process, the realization of intelligent application and service, and making intelligent to play its full role. Compared with internet technology, IOT enjoys something that the internet does not, like data information collection, intelligent tracking of electronic tags, the state of the object sensor real-time acquired and dynamic image caught by surveillance camera. Figure 1 shows the basic system architecture of IOT.

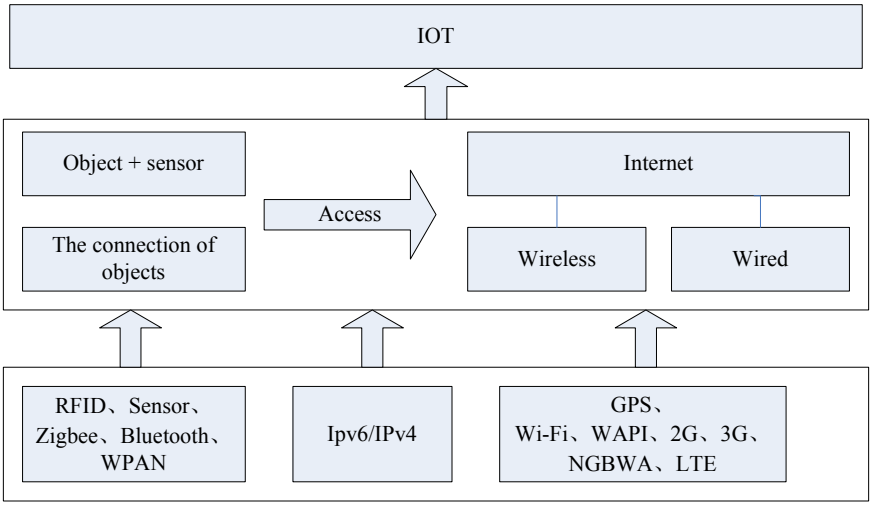

Figure 1 : Analytic chart of IOT basic system architecture

As much IOT system architectures being published, researchers also put forward IOT system architecture of reference value, such as World Wide Web (WWW) system architecture. It is mainly of an application-oriented IOT system architecture, a network structure of user-centric, with which simple real information transmission and acquisition will be realized by insetting WWW technology into the system.

The independent architecture[4] of IOT is mainly introduced to adapt to Heterogeneous Network. Independent technology is the core of autonomous network. Network communication could be guaranteed changeable as independent pieces realizing end-to-end and intermediate nodes to nodes data transmission. As shown in Figure 2, independent system architecture of IOT consists of management plane, control plane, data plane and knowledge plane. Management is to coordinate and manage the exchange between data and control, and realize the capacity of independent communication of IOT; the function of control plane is to send data through data plane, and this could optimize data throughput of data plane and guarantee the reliability of data[5]; data plane is responsible for data transmission; knowledge plane provides a complete view result of the whole network system architecture, thus to guide the operation process of the adaption of control plane.

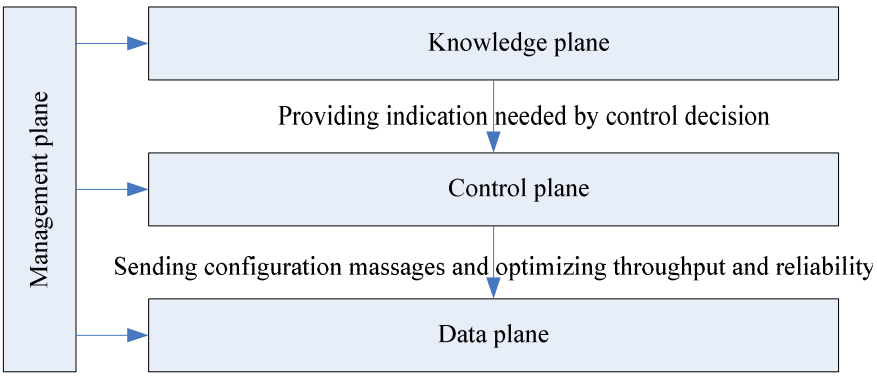

Figure 2 : Independent system architecture of IOT

THE ANALYSIS OF IOT TECHNOLOGY APPLICATION

IOT technology has been widely applied in production practice, such as in intelligent transportation, smart home, smart grid, environment protection, production and life, public safety, care for the elderly and intelligent fire fighting. The prospect of IOT is amazing, for instance, through remote control, products connected by the internet at your home can be remotely controlled, such as remote control cooking; washing machine will tell the user the requirement of water temperature for different clothes. Of course, we still need more time to realize this. The current application range is limited, and I will give an introduction to the real application cases.

The application of IOT technology in logistics

Logistics refers to the dynamic procedure of transporting goods from their initial supply location to the receiver. With the development of society, links of logistics has been expanded; it contains supply, procurement, production, package, sell and transport. Figure 3 is the cost proportions of different links. Traditional delivery method now can no longer meet the need of fast development with the increase of logistics products. Both the sender and receiver hope to realize real-time information tracking so as to guarantee the safety of products during transportation.

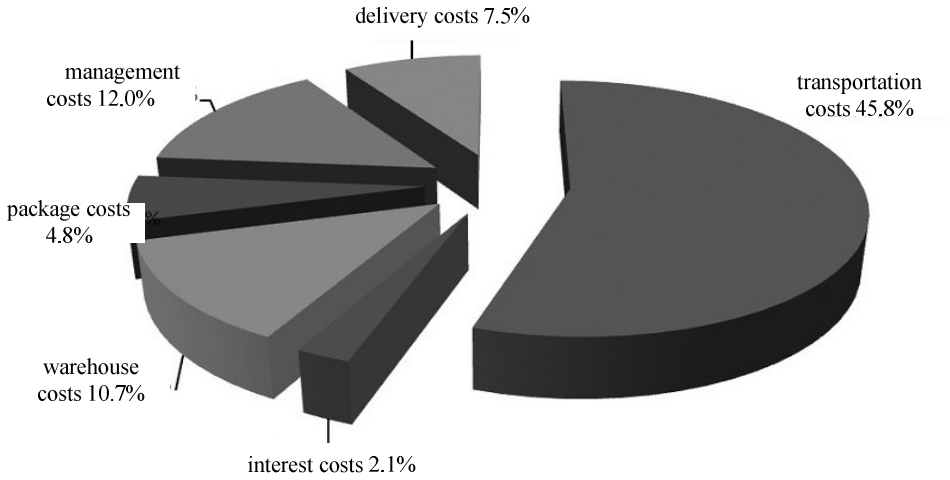

Figure 3 :Proportions of different links in logistics

IOT technology has radically altered logistics industry, and it has also changed our habits and customs. Logistic informatization in China has been attached great importance. IOT hot technologies that have been vigorously developed by NDRC (National Development and Reform Commission) and MIIT (the Ministry of Industry and Information Technology), such as RFID, GPS and intelligent robot, have been widely promoted in logistics. RFID technology is the most prevalently use IOT technology. Figure 4 tells us the application of IOT sensing technologies of all kinds in the first half of the year 2011. We can see from it that nearly 50% cases of logistics informatization applied RFID technology, which was used in sensor location, procedure tracking, information collecting and items sorting and selecting; nearly 40% of the user applied GPS/GIS technology to locate, track, monitor and manage vehicles and products during transportation and delivery. Video recognizing technology, sensor technology and other IOT technologies were applied in the remaining cases.

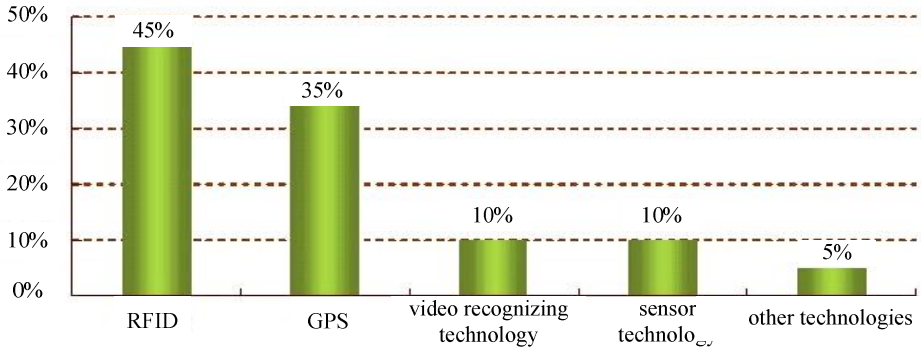

Figure 4 : Application of IOT sensing technologies in logistics in China in the first half of 2011

IOT technology based intelligent logistics has four functions, quality control, item selecting, real-time tracking on item information and intelligent inventory management[6]. Quality control, which is mostly used in production link, could transport raw materials and parts to production line timely and accurately; commonly applied in selling, item selecting could allocate a great number of items in accordance with different categories the items belong to. TABLE 2 is the logistics quality diagram of major cities. Real-time tracking is commonly applied in the transportation of products. Users of order information of the product can check the status and location of the product transported so as to guarantee that the product will not lost or be stolen during transportation. Intelligent inventory management is mainly used in warehouse management. With this technology, inventory information can be easily acquired, thus providing managers with data analysis so as to replenish goods, or increase the quantity of selling[7].

TABLE 2 : Total logistics mass of major cities

Ranking	Port	Accumulated since the beginning of the year (ten thousand tons)	This month, june, (ten thousand tons)	Accumulated mass is (%) of the corresponding period of last year
1	Suzhou	10121	1704	116.4
2	Nantong	7016	1220	113.7
3	Nanjing	5748	980	106.2
4	Jiangyin	4267	750	119.5
5	Zhenjiang	4196	700	111.4
6	Jiaxing	3783	613	—
7	Wuhan	2761	530	105.6
8	Wuhu	2724	470	128.1
9	Yueyang	2663	753	150.6
10	Hangzhou	2547	421	96.0

The application of IOT technology in intelligent transportation

Transportation means a lot to the development of a city. It is the expectation of both government and people to have a smooth traffic. For without real-time image of road traffic and parking information, Traffic congestion and lack of parking space are the headaches of many cities in China. In the event of holidays or rush hours, the traffic will be entirely crippled, thus leading to increasing pressure, resources wasting and environment pollution. Figure 5 is the market scale of intelligent transportation in recent years.

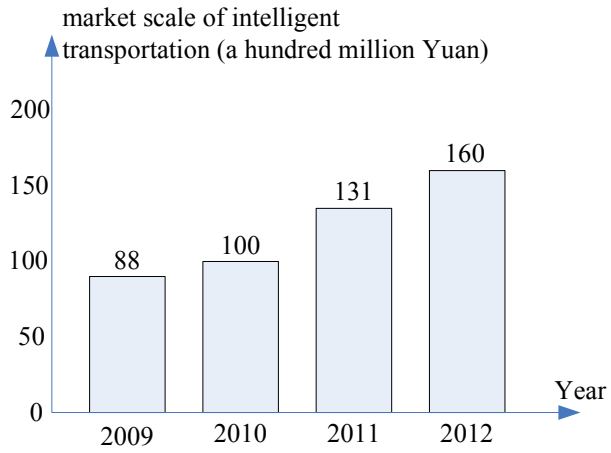

Figure 5 : Market scale of intelligent transportation in recent years

Intelligent transportation is integrated intelligent transportation management system, with which vehicles could acquire real-time traffic volume of each section of road. People could make optimized choice of the road in accordance with real conditions so as to avoid two extreme conditions (one road has an excessive traffic while the other is smooth)[8]. Besides, bus drivers could also adjust according to road condition so as to guarantee timely ride. Intelligent toll collection system could be realized in parking lot, and fast and accurate location on vacant spaces could be done. It is time-saving and could avoid gasoline wasting. TABLE 3 is the emission reduction proportion of automobiles in Beijing.

TABLE 3 : Emission reduction proportion of automobiles in beijing

Pollutants	HC	CO	NO_x
Proportion of Reduction	15%	11.5%	4%

The application of IOT technology in agriculture

China is a large agricultural country. Agriculture is the national basic industry that could determine whether we could maintain lasting political stability. However the current agriculture technology is weak in China and the output is relatively low, thus wasting resources to some extent. To change this situation, some experts have already applied IOT technology into agriculture production, and intelligent production and management in agriculture have been realized. IOT

technology could intelligently control of agriculture products cultivation and the safety of agriculture and sideline products. Wireless sensor nodes could be applied to realize real-time capture of crop growth, temperature, humidity, light and nutrition in farmland, thus reminding planters to deal with different situation so as to guarantee the health growth of agriculture products.

With various kinds of sensor nodes, IOT could realize crop data collection from different aspects. By installing surveillance camera on the spot, crop growth real-time control can be realized[9]. Automatic irrigation system and lighting system could be controlled by mobile phone. With information collected from the spot, we could provide scientific basis for comprehensive development of agriculture, thus realize automatic and intelligent management so as to improve crop growth both qualitatively and quantitively.

CONCLUSIONS

As one of the high-tech industries of the 21st century, IOT technology has brought opportunities to all walks of life. It also influent our daily life by making life more convenient, transportation more smooth and medical cares more timely. However, more technical personal of relevant specialties are needed so as to break technical barriers as IOT technology developing. Currently, the lack of unified standard system is the shortcoming of the development of IOT technology. With technologies like sensor, RFID and GPS, IOT technology realizes real-time control on objects by data collecting, processing and controlling. In this way, connection and communication among objects and intelligent society could be finally realized. Based on the existing research theories, this paper analyzes the system architecture of IOT, application cases of IOT, structure model of IOT application and functional operation that can not be realized by existing technologies. People from all works of life should make more efforts to overcome technical difficulties and promote the development of IOT technology.

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