Application of 'Internet of Things' (IoT) Technology in Library Management & Services

Satish Kumar,
Information Scientist,
ARIES,
Nainital, UK

ABSTRACT

The Internet of Things (IoT) is a vision of connectivity for anything, at anytime and anywhere, which may have a dramatic impact on our daily lives similar to the Internet done in past 10-20 years. It is recognized as an extension of today's Internet to the real world of physical objects, which is often associated with such terms as "ambient intelligent," "ubiquitous network," and "cyber physical system." Its development depends on dynamic technical innovation in a number of important fields, ranging from fundamental microelectronic devices, sensor technologies to information and communication technologies (ICT).

The Internet of Things has been called by many names. The idea is that objects can be connected through the internet in new ways. This happens when a combination of web-enabled devices (computers, phones, handhelds) and technology that can communicate with those devices (sensors, RFID, 2D and 3D barcodes) allows information to be attached to an object. The information can stand on its own and be read by a device or it can trigger an action such as bringing up a web page, playing a video, reminding pick up book, or giving a message to customer.

This paper analyzes the key technology and working principle of IoT, its development in India and abroad, its application in the library development and management. The primary intent of this paper is to provide libraries an overview of IoT features and capabilities that can be used to develop online complex library solutions.

Keywords: *RFID Technology, Internet of Things (IOT), Electronic Tag, Sensor*

Introduction

The Internet of Things (IoT) is a web of objects with unique identifiers that can communicate with each other with or without the aid of a computer or internet. The communication is enabled through the sensors installed into the participating devices. Several technologies like wireless technologies, micro-electromechanical systems (MEMS) and the internet have contributed to the emergence of the IoT (Iyer, Ramakrishnan and Mishra, Radharaman, 2014). Internet of Things (IoT) is a fast growing, user friendly technology which allows everything to be connected together and also allows effective communication between the connected 'Things'. These 'Things' can include any object ranging from a small pen to a big car.

Currently, the applications of information technology have a great impact on all aspects of people's social life. The field of library also faces new challenges and opportunities for development. Especially in recent years, the Internet of Things rise quietly, which will absolutely bring about the next information technology revolution, just as the Internet was. Some experts assert that: ***once a micro sense is embedded in whatever objects such as watches, keys, trains, automobiles, buildings, the object can "talk" automatically***. With wireless

network technology, people can "talk" directly with objects, and objects can "communicate" with each other at any time.

This technology has expanded to such an extent that even living organisms are considered as the part of Internet of things. In IoT, intelligent devices such as Passive RFID Tag, Smart Dust etc., are connected together in a large network with unique accessibility. IoT exchanges data in a fraction of second and also it consumes less power. It makes the human life more comfortable and it helps to build a smarter world.

What Is Internet of Things (IOT)

Internet of things (IOT), known as the Internet of objects, refers to the networked interconnection of every object, which is composed of all kinds of information sensing devices, such as **Radio Frequency Identification** (**RFID**) devices, infrared sensors, global positioning systems, laser scanners and various other devices. When embedded with chips and sensors, these objects can "think", "feel", and "talk" with each other. Together with the infrastructure of the Internet and mobile networks, these objects can communicate with humans, and enable us to monitor and control them anytime anywhere and enjoy their intelligent service, making the idea of a "Smart Planet" a dream come true. It is described as ***a self-configuring wireless network of sensors whose purpose would be to interconnect all things.***

Evolution of Internet of Things (IOT)

Before 1990's communication happened between computers which were called as Electronic Data Transfer. These computers formed a network and it was further classified as Local Area network (LAN), Metropolitan Area Network (MAN) and Wide Area Network (WAN). This WAN was called as Internet where several computers around the world were able to communicate each other. Subsequently further improvements in networks allowed external peripheral devices to be connected to internet. In present we are giving instruction to devices instead IoT will make the devices to think and act according to our needs (Sarwesh, P.; Shet, N.S.V. and Chandrasekaran, K., 2014).

The concept of interconnecting all things is attributed to the former Auto-ID Center, founded in 1999, based at that time at the **Massachusetts Institute of Technology (MIT)**. Its original definition is very simple: ***connects all kinds of objects through***

radio frequency identification and other sensor equipment to the Internet, to achieve intelligent identification and management. In 2005, in **Tunis World Summit** on the Information Society (WSIS), the International Telecommunication Union (ITU) formally proposed the "Internet of Things".

Working Principle and Key Technologies of Internet of Things (IOT)

"Internet of things" is based on network technology, in which **RFID** tag technology is the key Technology. RFID system generally consists of the following two components: **electronic tags and readers**. Electronic tags can be attached to objects to be identified while readers can read or read / write, which depends on the memory structure and technology. Main modules are integrated into a single chip, complete communication with readers. With embedded EEPROM, chip can store the identification codes or other data. EEPROM capacity changes from a few bits to tens of thousands bits. Just connecting the external antenna (and batteries), the chip can serve as a personal identification card or identification card of goods (G. Shen and X. Huang, 2011).

Working Method of RFID tag

In most RFID systems, the reader sends out *electromagnetic waves* within a region (which depends on the operating frequency and antenna size), while electronic tag has a LC series resonant circuit and its frequency is same with the transmitting frequency of the reader. When the electronic tag passes through the region, with the excitation of electromagnetic waves, LC resonant circuit resonates, so that the capacitor has been charged. On the other end of the capacitor, there is a single-direction electronic pump, which transmits this capacitor charge to another capacitor. When the accumulated charge reaches a certain value, this capacitor can be used as power supply voltage provided to other circuits, so electronic tag data can be transmitted or accept the reader data. When reader receives the RFID data, decoding and error checking are carried out to determine the validity of data, then, to transfer data wirelessly to a computer network.

The basic working principle of RFID technology is not complicated. When the tag enters the magnetic field, it begins to accept the RF signal emitted from readers, and send out the document information stored in the chip by the energy obtained from induced current. Reader reads the information and decodes, then sent to the relevant central data processing information systems.

Advantage of Electronic tags

Electronic tags have many advantages, such as non-contact, long working distance, being suitable for harsh environments, identifying moving targets, etc.

Application of Internet of Things (IOT)

Presently, nearly 100 organizations in more than 10 countries like Singapore, Australia, India, Netherlands and Malaysia have been using RFID technology in the library automated management system. **Singapore National Library (SNL)** is the first to implement the "**Radio Frequency Identification**" (RFID) system in the world. The library has a RFID tag on each book. In SNL, to borrow and return books are self-service system is followed.

In a Smart Library, for borrowing books, you only have to insert the ID card or library card into the reader, and then put the books you want to borrow on the scanner to scan. Returning a book in Smart Library is even simpler, just drop the book into the RFID embedded collector machine. Equipment will send the book automatically to the stack room. Similarly, with scanning device, staff can quickly know the type and location of the book to be sorted. Because each book has a label at the back cover, metal coil affixed to the label has stored basic information about the book, the scanner will send a weak radio wave coil, then the coil will give feedback to the scanner. In this way, information can be exchanged and identified instantly (G. Shen and X. Huang, 2011).

In China, a new library officially opened in July 2006 in Shenzhen is China's largest RFID project and the first to use full RFID equipment. The application of RFID technology in **Shenzhen Library** involves *three aspects*:

- the introduction of ***RFID technology*** and ***equipment***;
- ***innovative application in library operations***, such as digital library systems interfaces, compatibility and extending application;
- ***independent and innovative development of shelf labeling and document navigation***, which have been already put into application.

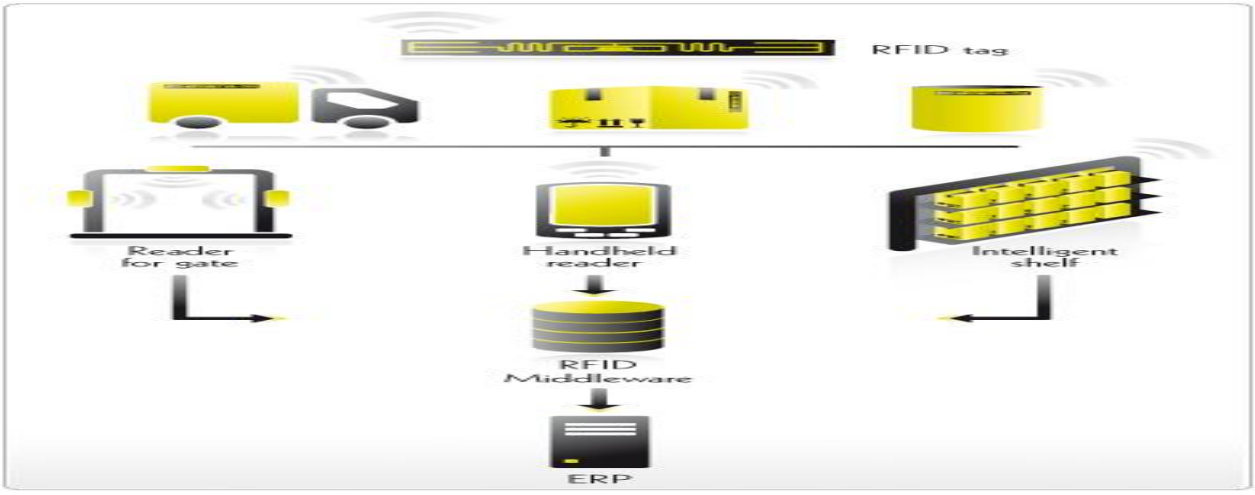
These applications and innovations can resolve the common problems in the library development and operations, showing a broad prospect for the popularity of RFID applications in libraries.

In many places people have started implementing the smart things/devices in real-time applications such as RFID tracking, **smart dust** implementation in battle field, smart health care system, smart irrigation system for agriculture and smart grid for power consumption management, wildlife monitoring by multimedia sensor networks and some sensors implemented under the ground, sea, forest and bank of rivers to prevent the world from natural disasters like tsunami, earthquake, forest fire, flood etc.

Advantages of IoT in the Library Management

Library management is an important aspect of IOT technology. Although most libraries have adopted bar code recognition, computer networks, computer software and other modern management and technology, there are still many problems for the library staff. ***For example,*** self-service borrowing and returning books, quick inventory, organize books disordered and other issues are still not well resolved, hindering the library to further improve its management and service level. The above problems

can be solved by applying the IOT technology in library management (Ning, H. and Zhang, Y., 2008).



1. **Self-help borrowing / returning books**. By using self-service subsystem of RFID technology, people no longer need to open the title page and scan the button bar of each book, can borrow / return more books, complete the process automatically, simplifying borrowing / returning procedure, will greatly improve working efficiency. Because RFID self-service machine can work 24 hours with no staff, this technology will greatly enhance the library services and book circulation efficiency.
2. The **formation of the reader circle**. Books, shelves and borrowing information can be stored in the electronic tag, which will integrate RFID technology into existing central library systems. Tag cannot be easily damaged and has dirt-resistance, will not affect the efficiency of borrowing and returning books. Also, according to the storage capacity of electronic tags, electronic tags can also store other information, such as previous borrower information, review of books, and other similar books to help readers assess the book and can set up a book "Readers Circle", for more reference information.
3. **Quick Book Search**. There are mobile search and fixed search. ***Mobile search*** is to input the search information of multiple books into the handheld RFID terminal to find the related information. ***Fixed search*** is to search for books by RFID readers, the computer and wireless LAN connections. With the use of RFID wireless location technology, you can quickly find the specific location of books in the library, thus avoiding "***wrong frame***" — books can be retrieved, but cannot be found.
4. **To complete long-distance**, rapid, bulk and accurate inventory of books. At the same time, IOT can improve inventory efficiency, reduce the workload caused by the handling books, achieve graphical user interface management, data download, pre-alarm function, fully showing the great advantages of the RFID technology.
5. **To check book theft**. Book theft can be checked automatically with the help of detecting software installed on the computer. Its hardware includes RFID circuits, sound and light alarm, and security door type antenna. It can have functions as long-distance recognition (generally up to 2 meters), quick recognition, sound and light alarm, zero false report.
6. The use of RFID technology enables activation of **second-generation ID card as library card** to use library services at any time, without worrying about whether they carry reader cards or not

and is more convenient, safer, more reliable and easier to manage.

Key IT Challenges with Internet of Things Implementation in Library

IoT based library applications have some important characteristics:

- Very high event data rates – high number of transactions per day in a library
- Huge volume of continuous data – huge collection of library
- Need for continuous monitoring
- Minimal latency
- High level of complexity in finding meaning in the data
- Immediate response in case of an alert situation.

IoT applications and traditional applications in library (e.g. native web based applications) are significantly different in many ways. Technological and architectural implications of these differences are profound. It will bring big opportunities and even bigger challenges such as:

- Processing large number of documents procured at a high speed need a matching infrastructure.
- Since the number of connected devices might increase drastically, the architecture need to be scalable.
- Library applications has to have integration capabilities with different types of devices and systems.
- Considering the high volume of data, need to ensure the data quality.
- High network bandwidth in library is required to read all the raw data generated by millions of connected devices.
- No uniform standards for data generated from devices which may result in data silos and can prevent widespread adoption.
- There could be potential security implications since the connected devices can be vulnerable to hacking and hence need a secure identity management and authentication to be implemented.
- Defining the data retention, archival and purging could be a challenging task for the massive amount of data that get generated from devices (Iyer, Ramakrishnan and Mishra, Radharaman, 2014).

Opportunities for Addressing Technical Challenges of the Internet of Things

a) **To address the challenges of the IoT architectures**:

✓ View the things as a service is a big challenge due to performance and cost limitations.

✓ Automated things composition for the IoT applications.

✓ Domain control for the IoT applications.

✓ Cross-domain interoperation and cooperation.

b) **To address the challenges of the network technology**:

✓ The IoT integration of heterogeneous networks, and system seamless wired or wireless access to various types of networks to cater to various users' communication requirement.

✓ Device automatic selection of local networks, and adaptation to local communication environments.

✓ Multiple virtual addresses allocating to devices or objects in the physical world in things to things communication for identification and localization.

✓ Optimization of devices management, including mobility, network types, communication priority, network handover, and improving the quality and efficiency of the wireless communication system.

c) **To address the challenges of the discovery and search engine technologies**:

- ✓ A description language to describe the Things in the IoT. The language must be standardized, scalable, and flexible to vary kinds of things in different implement environments, such as tags, sensors, back-end servers.
- ✓ P2P based discovery and search engine mechanisms and algorithms that take into consideration the issues of sensors (tags) roaming, real-time requirement, privacy protection, massive data,
- ✓ Cross-domain interoperation and different semantics and laws of governance.

d) **To address the challenges of the security and privacy technologies**:

- ✓ Light weight ciphers and protocols for sensors (including tags) authentication. In these ciphers and protocols, the performance, energy and cost will be tough in designing, manufacturing and deploying.
- ✓ Apervasive, efficient, scalable and robust security service based on cloud computing to support the IoT application. The service should provide the key management, ciphers and protocols evaluation, identity management, and audit.
- ✓ Trade of performance, energy and cost with the developing the IoT technologies and application requirement.
- ✓ Privacy preservation and anonymity mechanism.
- ✓ The behaviour specification of active sensors (including tags).
- ✓ Domain- and event-based policy-driven security management.
- ✓ Quantified the security level for the application, and provide customized security features.
- ✓ Standardization.

e) **To address the challenges of the applications**:

- ✓ Discovery of killer applications.
- ✓ Integration with the current IT systems. (Butters, A., 2008).

Development of IoT in India

Internet of Things is of strategically significance, India has by now ranked ahead of the world in ICT development. No matter in terms of policies, technologies or the industrial chain, India's development of the Internet of Things is provided with an outstanding advantage and has hard-won development opportunities.

The research and development of the network has been booming in India since the last decade after the government decided to promote the promising industry, along with industries such as new energy, new materials and information networks. Now with this new Government, the Internet of Things enjoys a prosperous development. India is speeding up on development of "Internet of Things", making it a new engine for economic growth and an opportunity to catch up with the developed countries; it will lead the development of global economic growth and become the chasing hot of various capitals.

Internet of things will bring thousands of billion of chain size for India, its application will cover dozens of industries, such as logistics, transportation, agriculture, manufacture, healthcare, security, smart home, tourism, military, and etc. In next five years, the technologies will be commonly used in smart grid, smart home, digital city, smart healthcare and vehicle sensors etc. (Srinivasan, S. and Vanithamani, R.., 2013).

Conclusion

In the world of urbanization, time and efficiency are matter of priority. RFID (Radio Frequency Identification) is emerging technology which improve standard of living. Library is the key place of knowledge. The requirements of books and creations or publishing are increased every day. The volumes of library books increased as per need but the management is big issue nowadays. In some libraries RFID is used for automation but it is not implemented with alert system. "Internet of Things"

is a number of technologies and research disciplines that enable the Internet to reach out into the real world of physical objects. Technologies like RFID short-range wireless communications, real-time localization and sensor networks are now becoming increasingly common, bringing the Internet of Things into library use. They foreshadow an exciting future that closely interlinks the physical world and cyberspace - a development that is not only relevant to researchers and librarians, but to corporations and individuals alike.

The IoT is developing very quickly, and we introduce the technical view to the IoT which includes the architecture models, network and communication technologies, discovery and search engine technologies, security and privacy technologies, applications and technical challenges. With the supports of governments and companies in the world, the technologies of the IoT are developing faster than in the past. However these technical challenges also call the researchers, developers and officers to contribute to these on-going efforts to resolve them.

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