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Internet of Things: Beginning of New Era for Libraries

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ABSTRACT

Libraries have adopted information technology be that IT-enabled content development, content management tools, content access and delivery tools or long term presentation tools. Libraries are always in the fore front where the adoption and usage of new technologies are concerned. Internet of Things (IoT) is enabling objects to collect data and transfer the data over a network without human intervention by using internet, sensors, and RFID. It is being used in various fields and is still emerging. Various innovative solutions are created. This paper explores the concept of IoT, its historical background and its potential applications in libraries. Some of the challenges which will be faced by the library professional while implementing it are also discussed.

Keywords: Internet of Things, sensors, libraries, IoT use, theft prevention in libraries, IoT benefits

1. INTRODUCTION

Internet and smart phones have taken a vital role in everyone's life. One could have difficulty in recalling days when life was without phones. Starting from buzzing alarm in the morning to good night at the end of the day, they are helping in small and big chores. Smart phones have not only taken alarm clocks away from us but radio, camera, video camera, game stations and even desktops and laptops. Just imagine if one is on the road, and there is some oil/liquid spread or some accident or jam is there and he/she kilometers away, how wonderful it would be if the vehicle automatically senses it and signify on the car's display that there is some obstacle/danger ahead, and gives instructions to change the route and not only this, but also provides the direction for the new route. Here, non-living objects (obstacles) are communicating with other non-living objects (vehicle) and sharing information with each other for human usage. The day is not far when this would be part of human life. Embedded sensors, infrared, bluetooth, actuator nodes, WiFi, etc., are all technologies which enable and help for the possibilities to be actual. Here, a new term arises which is called Internet of Things (IoT). The IoT will allow an object (like car, refrigerator, watch, door, microwave oven, wardrobe, wearable devices, etc.,) to communicate with each other. how could libraries be not affected.

The IoT is not only capable to influence any of the tasks which would had been impossible automatically earlier, but may also have the potential to do it more efficiently, securely, be it any mundane task. So how could libraries be not affected. At present, libraries are struggling wuith many technology driven challenges, but IoT could certainly help overcome not only these but may give an important place in everyone's life.

2. INTERNET OF THINGS

As per Wikipedia¹ "Internet of Things is network of physical objects or things embedded with electronics, software, sensors, and network connectivity, enabling objects to

collect and exchange data. Objects can be sensed and controlled remotely across existing network infrastructure, creating opportunities for more direct integration between the physical world and computer-based systems, and resulting in improved efficiency, accuracy, and economic benefit"¹.

The IoT is an environment in which objects, animals or people are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. IoT has evolved from the convergence of wireless technologies, micro-electromechanical systems (MEMS) and the Internet².

It had been predicted that IoT is not a concept but it proves that internet will not only be for the people but with few added infrastructure and backed by miniaturization of the e-components, a new global network will come which will act as a platform for devices to communicate electronically around the world. The infrastructure and technology involved is sensors, processors, cloud computing, and wireless connectivity. These days, companies are embedding these technologies in consumer electronic items and hence giving intelligence and sensing capabilities to their products, with which they can sense, learn from, and interact with their environment.

Facebook, a social networking site has recently featured where nearby location of the people can be looked and tracked on for increasing social networking activities. This feature in one way or the other proves that slowly people are heading towards the IoT and adopting its applications. Atzori³ et al., in their paper has given wide applications of IoT in our human in various domains. They categorized futuristic IoT applications in following domains: Transportation and logistic domains; healthcare; smart environment (home, offices) domain; and personal and social domain. They also categorized them as short-medium term applications for each of them and their futuristic versions. Their applications domains can be extended further.

3. BACKGROUND

Kevin Ashton (one of the founder of the original Auto-ID Center) first coined the phrase IoT while working for the Procter and Gamble to improve supply chain management. He linked Radio-frequency identification (RFID) as a prerequisite to connect to the Internet. He found if all the objects and people in daily life were equipped with identifiers, then computers could easily manage and inventory them and apart from using RFID, barcodes, QR codes and digital watermarking can also be used for tagging the machines. In 2000, LG announce its first Internet connected Refrigerator. In November 2005, International Telecommunications Union (ITU) published its report on IoT and concludes it can create a plethora of innovative applications and services. It will serve to enhance quality of life and reduce inequalities and also will provide new revenue opportunities. The telecommunication industry will get an opportunity to capitalise on mobile and wireless communications to explore new frontiers. Fig 1 shows how the IoT evolved from the internet. Starting from the hands of scientists, engineers, and or technical persons, it passed from various phases, and is moving towards IoT⁴.

Each and every object in IoT acts as a smart object and has to carry a unique identification. So, IPv6 (Internet Protocol version 6) has acted as a backbone to the IoT. In 2012, IPv6 was launched. IPv6 uses a 128-bit address and theoretically will allow 2^{128} , i.e. approximately 3.4×10^{38} addresses. Approximately 12.1 billion Internet-connected devices were in use in April 2014, and analysts presume that this figure is expected to zoom to above 50 billion by 2020. About 100 things currently connect to the Internet every second, and the number is expected to reach 250 per second by 2020. Eventually, the

IoT will encompass about 99 percent of all objects, which currently totals approximately 1.5 trillion things⁵.

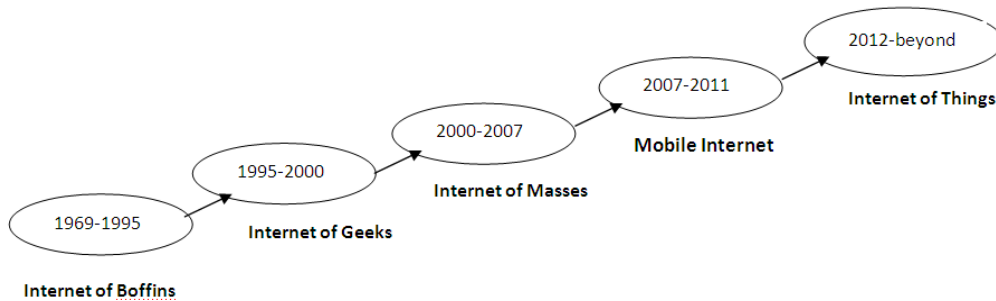


Figure 1. Evolution of Internet of Things from internet.

4. TECHNICAL PERSPECTIVE

Technically, the IoT works at three levels for its three basic functionalities. It includes: (a) Identification; (b) Sensing; and (c) Communication

The identification at first level is carried out through a ‘transponder’ available on the identifiable object. This is more or less like an RFID tags most commonly used on the books in libraries. It is an electronic chip carrying coil and a microwave antenna. The next level in the architecture is ‘Sensing’. The sensor reads the transmitted data which is the low power radio signal. The last level is the communication. It talks to the deliverable and act as an interface for the mobile to mobile communication. These three levels constitute the basic work carried out in the IoT. Lot of other technologies are also involved in the IoT. Another important component is a software layer between the technology and the application layer which is a middleware.

Internet of Things: Libraries Perspective

As library is a complex organization which has embedded constituents linked together and a large no. of interactions take place be it with man to man or man to machine, machine to man, and with IoT object with object interaction has a great possibility. Libraries can have some futuristic applications. These applications are probable, but with supporting technologies associated with IoT these can to put in action. Some of the potential applications for libraries are:

- **Inventory Control**

Apart from books, journals, magazines, various other library sources such as microfiche, video, audio, etc., can also be controlled by applying sensors on them. With IoT, the movements of each item can be tracked. Though RFID already serves bit of the same purpose for books, but with IoT since internet is involved, so it provides all the real time data on mobile of the librarian/manager and hence better inventory control is possible and ultimately the library personnel require to do less work for stock verification.

- **Theft Management**

With tags on each item of the library inventory (scanners, printers, hard disk, CDs, etc.), a kind of tracking can be made all-time. To prevent theft the library gate can be enabled with high-end sensors and transponders, which apart from signaling the authorities on their mobiles or by loud alarm, can also block the theft with taking the automatic prompt action like shutting the door, etc.

Another application can be that it lets the library staff remotely see camera views of their homes, send a warning when something isn't right and they can approach the emergency service people to take action.

- **Circulation Desk**

Circulation desk in libraries involves activities such as issue and return of books and other library material, maintain records, creation and updation of library cards, overdue, reminders, etc. RFID technology helped to ease out some of these activities like issue and return. But with IoT, online connectivity can be provided through mobile apps to the users, which can automate rest of the circulation jobs such as records' maintenance, creation and updation of library cards, overdue, reminder. With IoT, the users need not stand in the queues on circulation desk, can check for the books overdue on his/her mobile. Also if someone has demanded any book which is already issued, when the book is returned then with IoT an automated message will be received by the demanding user. In case of ebooks, the required book will be issued automatically. So IoT will help not only save efforts of the staff but also will save the time of the users.

Also if someone comes at circulation desk then without any library manpower present at the circulation desk, the sensors at the desk can sense a library user who requires assistance. The computers at the desk can provide options for his/her preferences/needs and take action accordingly.

- **User Identification**

The sensors at the library gate can do face recognition of all visitors and will match the face with the available databases and then the gate will allow only the authorized users to enter. Otherwise an electronic message will be sent to the librarian in charge who can be any where and at anytime. The librarian incharge can take action from distance whether to open the door for the unknown face or not.

- **Reservation of Books**

One potential use of the IoT can be that the patron can search the desired book from the OPAC of the library available on internet through his smart phone and reserve the book through smart phone. Then the desired book, available in the shelf of the library, which is enabled with sensors through network can show its presence through a beep or may start flashing light. This way the book itself will identify its location. Then there won't be any need to physically search the book on the shelves of the library. Then the librarian can easily identify the required books and then can issue them to the patrons. This way the IoT will help in saving the manpower and time of both the librarians and the users.

- **Fire Detection and Prevention**

Suppose there is fire in the library and there is no one to notice it. The fire detection devices may alarm and sensors in the library with the associated networks will automatically send the message to the Fire Department. And not only this but the concerned person of the library (say Fire Officer) who could be available any where and is responsible for taking action can also receive a message. This way IoT will help in taking action automatically at early stage and prevent further damages.

- **Mobile Reference**

Since IoT allows each and every activity of the library to be connected to the internet. So, with just a single app on mobile, one can refer the library without even physically being present there.

- **Tracking movement of Resources and Inventory**

With IoT, users can be categorized based on the criteria for accessing library resources. As some libraries offer different accessing rights to faculties, students, staff, regular and non-regular students, etc. Suppose in case a book/magazine is wrongly issued to a non-authorized user. With IoT, the tracking is possible on mobile of the librarian that where the library resource is physically present (inside or outside) the library.

Many times the library items are sent outside the library for repair, etc. With IoT, it is possible to track the location of the inventory outside the library.

- **Assistive Technology**

Today smart phone are also providing the features such as text to speech, touch navigation, hands free operations, especially for the person with disabilities. IoT adopts this feature of the mobile phones and provides services to such library users. With IoT such persons can request the required resource (say book, which will have tag) with speech and once they want the resource physically, they can find directions to that book in the library by voice communication in the mobile.

- **Virtual Library and Book Tracking**

IoT through the mobile apps will allow its users to not only have the virtual tour of the library on their mobile devices, but also keep and track the availability of the book on the respective shelves or check the other resource availability despite the location wherever they are.

5. CHALLENGES AND ISSUES

With evolvement of new technology many new avenues open which help us in various tasks. But technology brings new challenges and issues. These issues could be what it is, how to use, what are the drawbacks, how to improve upon, etc. But, the urge to accept the technology provides its solutions too. Similarly, some of the probable challenges and issues that may arise with adoption of IoT for libraries could be:

- **Privacy and Security**

For availing best of the IoT, the users may have to keep the mobile data always enabled. This enabling may track its location, as well as may intrigue its privacy by having access control on device as well as contents available on phone such as photographs, documents, etc. Hence the privacy of individuals may get compromised.

- **Accuracy in Understanding**

It is very essential that the IoT is highly accurate and the system understands the semantics clearly. It needs a clear understanding of the requirement of the user without any ambiguity; otherwise the whole system can fail.

- **Transactions**

These days people largely depend on mobile transactions. One can sync his/her credit/debit card with Google wallet (for android) or Apple's Passbook (IOS) and can simply buy things simply by peaking phone in front of a sensor at checkout. Same way the transactions for overdue charges, payment for services of library can be done.

- **Hacking**

As with IoT, mobile apps can have full control on the data and personal information of the users, so it can track and hack the sensitive information and make it available for the unauthorized use.

- **Expenditure**

IoT involves tagging the items of the inventory of the library, so this may involve added expenditure on the library budget. Other expenditures involved are: sensors, actuators, communication devices, internet connectivity, etc. These may need huge investment. Also maintenance of the involved technology has to be all time requirement. This issue could be another challenge for the IoT.

- **System Development**

The development of IoT applications for the libraries is at a very nascent stage. The libraries have to understand and identify where and how the IoT can be used. Different applications will require different inputs from the librarians and staff. To create a highly reliable and accurate system it is important that all the requirements are given in a highly accurate manner and deep involvement of the librarian and staff is necessary.

- **User Training**

Though not much of the information literacy may be required for smooth running of the IoT in libraries, still the basic training has to be provided to the staff for IoT's better implementation. The library staff may not be comfortable to use it in the beginning, so apart from convincing him/her demonstration tools needs to be created to automate the assistance to the users.

- **Existence of Physical Library**

Libraries are already facing problems like less footfall, large use of ebooks, cut in budget, changed management views, etc. So with this present scenarios, IoT may come as another problem which may generate fear in the librarian to adopt it. The fear that IoT may further aggravate already present challenges may restrict library professionals to vouch for it. So, IoT has to face already available challenges and also have to come as a solution and not as another problem to the libraries existence.

6. CONCLUSIONS

The library professionals are always at the forefront in adopting the new technologies. They are very smart and active in implementing and getting benefits of the technology for their work. Some such technologies are: library automation software, library management tools, digitisation technology, tools for search and access, preservation tools, internet, social media, mobile applications, sms, e-mails, etc. The Library professionals don't leave any stone unturned to use the technology and serve their patrons.

Now the IoT has emerged and definitely there are applications of it for the libraries some probable have been mentioned in this article. IoT will help the libraries and their users in a big way. Even though there are certain issues which need to be addressed but surely with time as the technology has emerged, the solutions will also come out. Library professionals have to think ahead of time which they definitely are.

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