Internet of Things and libraries

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Internet has taken a giant leap forward from 'Internet of communication' to 'Internet of Things', making it possible to connect objects and transfer data with or without human intervention. This is likely to revolutionize the way we live. Like other service industries, it has a huge potential in betterment of library services. An attempt has been made to explain what is 'Internet of Things', the technology and its growth, examples from service industries and deliberate on it's possible impact on libraries and identify potential library areas where it can be implemented effectively.

Keywords: Internet of Things; libraries; RFID; beacons

Introduction

Today, Internet has occupied a distinctive position in various spheres of human life. Its growth is spearheaded by mobile devices, which have increasingly become part of modern living as everyone wishes to be connected to the Internet all the time. This has become possible owing to increasing availability of broadband Internet connection at a reduced cost, availability of more devices with Wi-Fi capabilities, technology affordability at lower cost and high penetration of smart phones. The technological developments have made it possible for us to access plethora of services such as finding information, shopping, booking tickets, navigating through maps and communication over email, social media and mobile apps. This all resulted in Internet for communication and accessing certain services over devices. But the next revolution, where in Internet, like mobile phones is going to occupy ubiquitous position in our lives as it starts connecting things in the physical world and this expected to have a big impact in the way we live.

It is called 'Internet of Things'(IoT), connecting any object, which may include everything from cell phones, coffee makers, cars, washing machines, air conditioners, lamps, wearable devices and almost anything else one can think of. The objects, using sensors and having networking capabilities would be able to communicate with each other, access Internet services and interact with the people. The objects or things in the Internet of things could be a person or an animal or a physical object such as car. A heart monitor implant installed in human body could be able to send messages to Doctors to define the state of health of a person to avoid any emergency hospitalization and a car having built in sensors in its tires could be able to alert the driver about low or high pressures to avoid any possible accidents.

This new paradigm is bound to impact business models, consumer experiences and everyday life. It is bringing in new opportunities, but also risks privacy and security of data, managing of which is going to be a challenge. However, the supporters of IoT argue that, when technology evolves, it brings in opportunities, threats and solutions. When Internet for communications happened, privacy was breached at certain areas, but technology over a period of time provided solutions to control such intrusions. Similarly, it is the technology, which might provide solutions to protect personal data by individuals themselves as IoT is different from web and concentrates more on individual behaviours and actions.

What is Internet of Things?

According to Techopedia[1] "The Internet of Things is a computing concept that describes a future where everyday physical objects will be connected to the Internet and be able to identify themselves to other devices". As per Whatis[2] "The Internet of Things is a scenario 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 Internet". In simple terms, Internet of things enables, any natural or man-made objects to communicate each other and transfer data using assigned IP address with or without human interventions.

As with any new thing, different people coined different names for IoT. Some of the names are smart devices, ubiquitous or pervasive computing devices, machine to machine communication and so on.

IoT history and growth

The concept of Internet of Things (IoT) was initially raised by Kevin Ashton in the early 2000s while working on a project for Proctor and Gamble to improve their supply chain management by linking RFID data to the Internet[3]. In January 2000 LG announced plans for first Internet connected refrigerator[4]. In 2005, International Telecommunications Union (ITU) took cognizance of the development and mentioned about 'Internet of things' in a published International Telecommunications Union report[5]. In 2008, IPSO alliance was formed to promote the use of Internet Protocol (IP) networked devices in energy, consumer, healthcare and industrial applications[6]. In 2012 IPv6 (Internet Protocol version 6) was launched[7], which made it possible to assign IP address to every atom on this earth without having any constraints, thus ensuring connectivity between and across millions of devices.

The growth forecast of Internet of Things is very high as number of objects connected to Internet is rising year after year. Even though the concept emerged in early 2000s, sudden surge of interest in IoT has happened owing to multiple factors viz., introduction of new version of Internet protocol i.e. IPv6, support of major network providers (Cisco, IBM, GE and Amazon) and decreasing connectivity costs. GE estimates that 'Industrial Internet' has the potential to add $10 to $15 trillion to global GDP in next 20 years[8]. Cisco's Internet Business Solutions Group (IBSG) predicts some 25 billion devices will be connected by 2015, and 50 billion by 2020[9]. According to BI Intelligence report it has been predicted that, by 2019, IoT will be the largest devices market in the world[10].

Technology

IoT uses a set of technologies to connect to objects. First is identification. Owing to billions of devices that will be connecting to the Internet, each one requires a unique identification. Next, devices need to sense, which is possible by putting sensors that measure various aspects of an object. Then object needs to have the ability to communicate, which could be Internet or other similar objects. Lastly, they require central server where data from all these objects will be collected for analysis and allow user to control[11].

The basic set of technologies associated to enable IoT to happen, include RFID (Radio Frequency Identification Device), wireless communication devices (such as Beacons), sensors, energy harvesting technologies, cloud computing and advanced Internet protocol (IPv6). RFID helps to identify and track the data of things, sensors collect and process data to detect the changes in the physical status of objects, energy harvesting technologies help in low energy consumption of associated technologies such as Bluetooth, the collected data is stored on the cloud for further processing and wireless communication enable connection and interaction between objects to take further course of action. These smart technologies helps in enhancing the power of network and enable smallest objects with a capacity to connect and interact. Smart phones would act as the main connecting link between objects and humans in interacting and conveying the messages.

These underlying technologies mentioned above enable any of the physical objects connect to Internet and to each other. In some cases, there may be a central hub, which helps in connecting each of the objects. Finally, the cloud services which help in collection and processing of data to enable humans to find out what is happening and take action using mobile apps.[12]

Examples from service industry

Today, we are seeing innumerable examples of IoT applications in different types of industries viz., manufacturing, health-sector, home appliances, insurance, logistics etc. In case of service industry, IoT is applied in order to monitor consumer's activities, which brings in far reaching implications in a way the business is undertaken and risks are reduced. It is likely to play a bigger role in two broader areas of information and analysis and automation and control. For example it is possible to track movement of products and monitor interaction between these products, have better awareness of real time events and sensor driven analytics. In industries, one can improve

processes by monitoring at micro level at various process stages, optimize resource consumption of utilities based on real time costs and real time sensing of unpredictable conditions and instantaneous responses e.g. automatic brakes, driverless vehicles etc.

Take the example of insurance industry, at present, most of the general insurance companies issue insurance for cars irrespective of how the car is driven. In case of accidents or theft, it does not give much scope for the companies to assess the exact reasons, except depending on physical verification of facts or hearings from owner / third party/investigating agencies, which is often considered as second order data. The IoT can give first order data in real times on many of the risks by creating a feedback control processes to substantially reduce losses[13]. The vehicle telematics introduced in some of the smart cars and adopted by a few insurance companies has enabled auto insurance companies to assess the drivers' behaviour and accordingly fix the rate of premium based on the risk factors. The same type of implications can be seen in other types of insurance policies, not depending completely on historical information, thus giving a chance for better risk management. IoT will ultimately enable industry to minimize loss and introduce safety techniques in each and every type of insurance they sell to the public.

In case of healthcare, IoT has given birth to remote patient care and monitoring thus helping in reduction of health costs and better treatment for patients. From the smart devices attached to human bodies, doctors would be able to monitor the state of health of patients and can avoid emergency hospitalizations by having early interventions. The convergence of IoT and healthcare bring in rich dividends by giving real time information about patients' health and greater understanding of their behaviour, which are key factors in treating chronic illnesses[14]. The devices that are connected to humans, to the Internet and to each other help doctors in broadening patient care and can bring in potential benefits such as scaled expertise, ongoing monitoring and hospital prevention[15]. For example, with the help of IoT, a person having heart disease can be better monitored by doctors by receiving constant reports on the status of health, effect of medication and able to know early signals of any distress, so that emergencies can be avoided.

Impact on libraries

Even though IoT is still in its infancy, it has a huge potential for libraries. Libraries will be able to add more value addition to their services and offer rich library experience for patrons. IoT is all about connecting objects each other online as they are uniquely identifiable. Librarians are already familiar with this in libraries owing to the use of RFID, which does the similar thing of interacting with machines, tags and updates library management system with entries of books issued to a user, but in case of IOT, only the difference is, it is the Internet interacting with a thing or object such as book. Libraries have books, journals, CDs/DVDs, theses and many more physical objects and IoT can be a blessing in disguise to overcome some of the perennial library problems such as misplacement of objects and their usage. It can even help in strengthening the ties between the books and readers thereby realizing Dr S.R. Ranganathan's 2nd law of library science "Every Reader his or her Book." Since most of the patrons in present days have smart phones, using a mobile app, libraries can enable them to access and use library resources through virtual library card. It has the great potential for libraries to market their services.

Some of the potential areas for implementation of IoT in libraries include the following:

Access to library and its resources

Libraries, using a mobile app, may provide a virtual library card to its members, which will enable members to gain access to library and use its resources. When a user accesses the library catalogue to locate the required resource/s, the library app stored on his or her mobile, will provide a map of the library guiding user to the location of resource/s. It can also provide additional information about a resource by connecting to a site such as Amazon, so that user has detailed information about a resource, before he/she borrows it.

Collection management

The library collection having RFID tags on each of the items enables their virtual representation, which can be identified using computers and RFID readers. Through integration of RFID tags in to member cards, circulation of items and fine collection can be streamlined. The IoT will be able to tell users about overdue books and how much fine they owe to the library, to enable them return the overdue books and pay the fine online without needing to stand in a queue in the library circulation desk[16]. Smart digital shelves may be able to promote the content based on patrons borrowing records and search history on the

Internet. IoT will also help in better inventory management (stock verification) as it will be easy to locate misplaced books.

Information literacy

Information literacy or orientation is offered to new patrons to educate them about a library, its resources and services. IoT may help libraries in providing self guided virtual tour of the library. Libraries having setup beacons like wireless devices at various sections of the library, when users visit the particular section, their mobile phone will play a video or audio explaining more about that section and how one can get maximum benefit out of it. It may even able to provide enriched experience of special collections such as manuscripts by providing digital format of it on their mobile phones as physical access to such resources is restricted[17].

Recommendation service

IoT can use patron's data to suggest tailored recommendations, using real time data, based on the history of their borrowings. When a researcher searching a database for resources on topic of his or her research, it will be possible to suggest other resources, which would be of interest to them. Even when a user, while visiting library next time or is he or she is close to the library, IoT would be able to inform the user about new arrivals in his or her area of work or about availability of borrowed book, which he or she was looking for during his/her earlier visit.

Location based services

IoT would help libraries in providing location based services. If a user having created his favourite list in library catalogue using his or her account from home or office, walking in to the library with IoT enabled mobile device, would be able to get directions for stacks, where favourite books have been shelved and also would be able to help him or her to know interesting titles available on the topic and status of checked out books. It may also enable libraries to provide status of availability of reading rooms, discussion rooms, printers, scanners, computers etc, by displaying the peak and non peak hours of their usage on library website or users can check it using their library mobile app[18].

Appliances management

IoT may help libraries and their users in better management of available appliances thus saving the energy costs. Even though some of such things are in place in some libraries, but it may extend the control not only to library staff but also to users. Imagine, a user walking into library, using a cubicle or reading table using their IoT enabled mobile phones would be able to control the lighting, air conditioning, Wi-Fi etc.

Some library and museum examples

In November 2014, Orlando Public Library implemented Bluubeam technology to send location triggered information to patrons. Patrons using the library app will get alert about library offers and events. For example, if the user is searching for a cookbook, they also receive library's cuisine corner program having local chef demos.

Neue Galerie in New York and Boston Atheneuam worked with a technology company called Spotzer to provide enriched information about work of an art. Once a museum visitor downloads the app, it tracks the person movements to art and learns the person's preference and provides personalized experience as he/she moves to other art.

More than 30 libraries in USA have signed up Bluubeam technology for implementation. One library is using this technology to push alert of new movies released that day. Another library has advertised free computer workshops and book sales. Another technology company Capira has 100 library clients. Two of their libraries sends user reminder about overdue books and items available for pick up as soon as they enter the library[19].

Future of IoT in libraries

The future of IoT in libraries seems to be robust looking in to the developments in this sector. IoT once fully evolved, may bring in sea change in a way how libraries function and provide services to their patrons. It may turn library buildings in to smart buildings, wherein patron can interact with various things in the library and get virtually all kinds of information using devices having communication capabilities.

Over the years, apart from the possible areas of implementation mentioned above, IoT may enter deeper into various areas of libraries and may be able to give statistics on usage of library resources, map indicating areas of library most used, satisfaction level of users' experience and when students get frustrated with library resources and resort back to Google[20].

Libraries need to take into consideration various issues before jumping into the bandwagon of IoT. First is privacy and security of patron's data as there is a possibility of sharing this data with third parties, which may lead to hacking. Secondly, cost of investment in IoT technologies in terms of money, manpower and time. Thirdly, staff training and finally the most important thing is decline in the use of physical library[21]. Libraries by taking their patrons into confidence, informing them about privacy and security of data and providing the required training and infrastructure would be able to implement IoT to enrich their services and patron's library experiences.

Conclusion

IOT has a great potential for libraries. If implemented in the desired lines, may bring in desired results and make value addition to library resources and services. It is still in evolving stage and it makes sense for librarians to learn about this new technology and wait until the technology is more widely accepted, adopted and available for better implementation in libraries. At the same time, it would be also interesting to learn from early adopters and devise better ways to maximize the benefit of IoT adoption in libraries. Libraries are prone for change and it has been witnessed over a period of history, hence IoT would be the next big thing after Internet, which is going to bring in plethora of changes to the library arena particularly the way library connects and communicates with its patrons.

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