Internet of Things: An approach for Advancement in Educational Institution

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***Abstract*—Internet of Things (IoT) is an emerging area of research in which different aspects are being studied and published. In this paper, a high level architecture of Internet of Things is discussed in which IoT is clubbed with two other emerging technologies, Cloud Computing and Big Data Analytics. Various challenges associated with IoT are discussed and the application of IoT in day to day life is discussed in the context of an educational institution.**

Keywords—Internet of Things (IoT); Cloud Storage; Analytical Engine; Smart Attendance; Smart Garbage Collection; Smart Environment Management; Smart Discipline Maintenance

INTRODUCTION

Internet of Things is a buzz word with lot of potential in taking the technology to a newer height. The term 'Internet of Things' was coined by Kevin Ashton in 1999[1]. It is a network of virtually everything that uses some embedded technology to communicate with each other. Cisco IBSG predicted that by 2020 approximately 50 million devices would be connected with total population of approximately 7.6 billion as shown in Figure 1[2]. When so many devices are connected, large amount of data would also be generated and so other emerging technologies are also required to be flourished for the success of IoT. These emerging technologies comprise of Cloud Computing and Big Data Analytics for

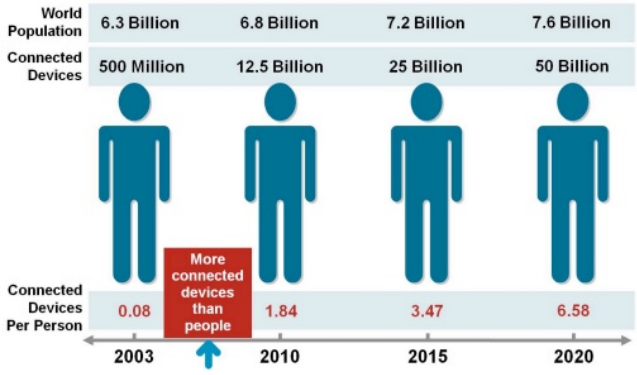

Figure 1. Devices connected to Internet

storing, handling and analyzing large amount of data generated by various things connected to internet. Internet of Things has applications in diverse areas across the world. Many applications are being developed, implemented and used across the world. In this paper, architecture of IoT is discussed in Section II along with the emerging technologies which, together with IoT, can offer lot more benefits to the user community. In Section III, challenges in IoT are discussed and in Section IV, an application of IoT is discussed for an educational institute. Finally concluding remarks are given in Section V.

I. ARCHITECTURE OF IOT

An IoT enabled environment requires services from other emerging technologies for providing required services so the architecture involves four layers as shown in Figure 2.

A. Layer 1: Things

Various IoT things which are connected to each other and transmitting data every second are in Layer 1. The IoT things must support Radio Frequency Identification (RFID), Wi-Fi, Zigbee, Near Field Communication (NFC) or other such technology which connects it to internet.

B. Layer 2: Network

This layer is the Network layer that represents the network of IoT enabled things which are capable of transmitting. Network involves communication devices which helps the things in communicating and channelizing the received data in right direction.

C. Layer 3: Cloud Storage

This layer includes Cloud Storage. The architecture of IoT enabled environment is incomplete without Cloud Storage as more and more things are getting connected to Internet and the data generated by these IoT enabled things are also increasing at a rapid pace. Cloud Storage which can be thought of an infinite storage capacity at service is a fantastic solution for storage of such huge data. Cloud Computing is a computing paradigm where large number of systems are connected forming a large pool of resources which can be rented out to people on pay per use basis. Various services are provided by Cloud Service Providers which include SaaS (Software as a Service), PaaS (Platform as a Service) and IaaS (Infrastructure as a Service). Sometimes Storage as a Service is also quoted separately otherwise it is thought of as a part of Infrastructure

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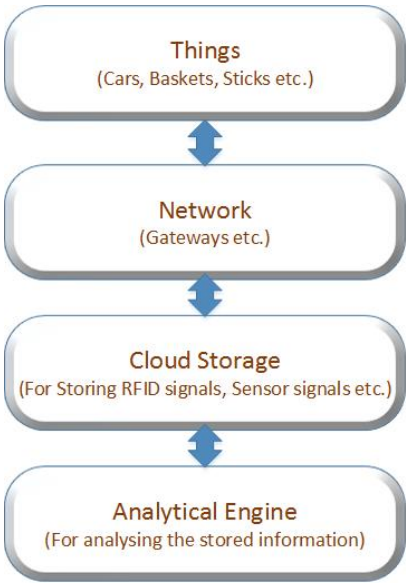

Figure 2. Four layered Architecture of IoT

as a Service[3]. Cloud Computing offers various benefits which are listed below:

- **Reduced Cost**: As the resources can be used by paying some amount, building the whole infrastructure for getting the work done is not required and hence huge investments can be avoided. Moreover the payment is to be made on pay-per-use basis.
- **Flexibility**: The flexibility of increasing or decreasing the demand for resources dynamically is a great advantage.
- **Global Accessibility**: As our data is on the cloud, it can be accessed from anywhere globally.
- **Infinite Pool of Resources**: If the demand for resources increases, user can always implement it by requesting more resources from cloud service provider. However, in a personally owned system, increase in demand means huge investments.

D. Layer 4: Analytical Engine

This layer provides analytical capability. As the amount of data generated, increases, analyzing it also becomes time consuming. For small amount of data, traditional technique can work but for huge amount of data employing big data analytics can be of great help in reducing the turnaround time as well as response time which would be very crucial in real time applications specifically. Big Data refers to large amount of data which cannot be handled using traditional data processing applications. Various challenges are involved in Big Data which include capturing, storing and analyzing it. Big Data has 3 Vs associated with it: Volume, Variety and Velocity[4]. Veracity is also a characteristic of Big Data[5]. Big Data has very high volume of the order of Petabytes (2^{50} Bytes) moving towards Exabytes and Zettabytes. Variety is another characteristic of Big Data which means the data could be of different types or heterogeneous in nature. It could be having a definite structure or completely unstructured. Big Data arrives at high Velocity i.e. it is continuous data, streaming with high velocity. For analyzing data correctly for generating accurate results, the data needs to be accurate, so another characteristic of Big Data is Veracity. For analyzing big data traditional systems are not adequate so a new branch of Big Data Analytics has emerged, which examine big data in order to find out useful correlations, hidden patterns etc. Various techniques like data mining, machine learning are basis of Big Data Analytics. Big Data Analytics offer following benefits:

- **Better Decision Making**: Biggest benefit of Big Data is that large amount of data is available for analysis. As the amount of data for analysis increases so the accuracy of results and hence results in better decisions made on the basis of results obtained.
- **Cost Effective**: As Big Data involves distributed parallel processing using Hadoop/MapReduce framework, useful results can be obtained in short time. The cost of getting results is far less than the benefits got from the results obtained.

CHALLENGES IN IOT

IoT is facing lot of challenges for proper implementation and growth. As a device connects to internet, it is assigned an IP address. Most of the countries are relied on IPv4 which is a 32 bit address and is becoming obsolete day by day. As the number of devices, connected to internet, are increasing there is a need to shift to IPv6[6]. Other important challenges are standardization of enabled technologies, privacy & security. Each one is explained below:

- **IP addresses**: As IPv4 is becoming obsolete, companies are shifting to IPv6 which was designed by Internet Engineering Task Force (IETF) which is a 128 bit address represented as eight 16-bit blocks written in hexadecimal notation. IPv6 has various other features like simplified header, extensibility, mobility etc.

- **Standardization**: Numerous protocols and large number of APIs are used in Internet of Things which are not standardized. The reason could be infancy of IoT which can be taken care of once the technology carries momentum. In American

- **Privacy and Security**: These are important concerns in any network where transmission of data is involved. In an Internet of Things scenario, large amount of data related to things as well as human beings are involved which will be transmitted over internet. Securing the system from malwares and unauthorized access would be a primary concern. Securing the privacy of individual's data is also required to be taken care of primarily.

II. IoT Enabled Application For Educational Institution

Various research papers are published in literature proposing various use cases of Internet of Things like Waste Management in Smart City[7], providing health services[8] etc. An Educational Institute is a place where there is so much scope for IoT based advancements. In this section, an IoT enabled Application is discussed for an Educational Institution. The application includes four major modules:

- Smart Attendance Module.
- Smart Garbage Collection
- Smart Environment Management
- Smart Discipline Maintenance

A. Smart Attendance Module

In the traditional system, attendance of students is marked in the beginning of a lecture by concerned teacher either manually or in online fashion. In both the ways, the teacher is to call each student by name or roll number in the class and mark his presence or absence. In an IoT enabled attendance system as shown in Figure 3, following measures would be required:

- Students are to be properly tagged with RFID Tag Chips containing Electronic Code and Tag Antennas or NFC tags. With the help of these RFIDs, exact location of students can be tracked.
- A Server System that includes RFID reader Antennas and Application Software which will catch the captured data.

In the IoT enabled Attendance Module, the application software in the server system is fed with the time table of the department and students list for each class. Electronic Code associated with each student is also stored in the database. According to the time table, at the start of each lecture, the RFID reader will read the signals generated by RFID tag Antennas and after identifying the students on the basis of Electronic Code, presence or absence would be marked. If the concerned teachers desire to give flexibility of some time (say 5 minutes) to the students, modifications can be made in the software accordingly. For eg. in this case, the RFID reader will keep on reading the signals for five minutes and after the expiry of five minutes, attendance could be marked. This system has following advantages:

- Attendance will be marked on time.
- No human intervention is required.
- Saves time as teacher is not taking roll call personally.
- Even if teacher is on leave and students are coming, benefit of attendance could be given to students.

B. Smart Garbage Collection

The Garbage collection and management is done manually which can be automated using IoT enabled devices.

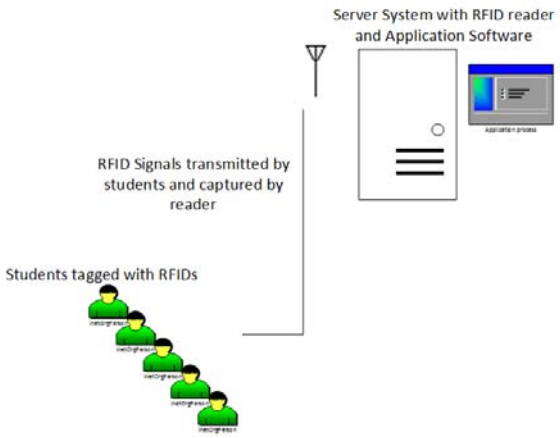

Figure 3. IoT enabled Attendance System

As in Smart Attendance Module, two important components are required for Smart Garbage Collection: RFID enabled bins and a Server with RFID reader antennas and Application Software. The bins tagged with RFID devices can send required signals to the server regarding the status of the bin. Based on the status of the bin, server can issue commands or warnings for the garbage collector. Suppose the garbage bin is crossing the limit of volume of garbage it can store, so it is time to inform garbage collector to empty the bin. Some other types of information can also be transmitted which can instigate the cleaning or repair of the bins. An abstract architecture is shown in Figure 4. This module will ensure cleanliness in the institute in an automated way and it saves human efforts.

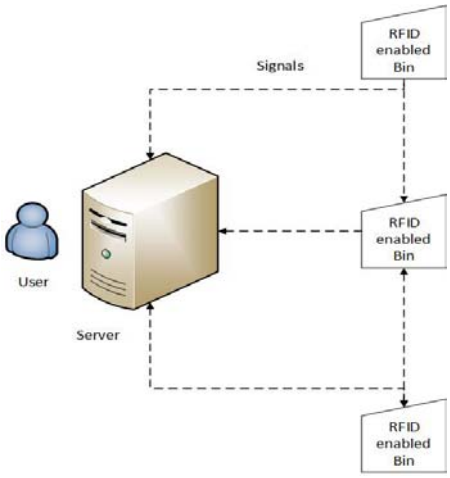

Figure 4. IoT enabled Garbage Collection

C. Smart Environment Management

Environmental factors play very important role in the growth of an educational institution. Two environmental aspects are taken care of in this module.

- Lightning in the classrooms and laboratories.
- Temperature in the classrooms and laboratories.

RFID tags with sensor capabilities can be installed in rooms and classrooms which can periodically sense the intensity of light and temperature and send the sensed information to server which can issue commands to smart lights, fans, heaters and Air Conditioners accordingly as shown in Figure 5. Such environment will check any kind of disturbance which could be caused due to poor environmental conditions in the rooms and laboratories.

D. Smart Discipline Management

As students and teachers can be duly tagged with RFID tags, it is very easy to find location of a tag holder. Some of the points which can be brought into notice in automated way include the following:

- Teacher not present in the class.
- Students accumulating in a particular area of the institute which is not meant for accumulation.
- Noise level in a classroom or laboratory crossing a pre-specified limit.

On finding any such situation in the department, announcements can be made for teachers or students to take measures accordingly.

III. CONCLUSION

IoT is an emerging technology which is carrying momentum at high pace. It is carrying little slow in India but it is going to affect us all in coming future.

As more and more systems connect to IoT, large amount of data generates which can be handled with the use of other emerging technologies like Cloud Computing and Big Data Analytics. Because of the properties of these two emerging technologies, IoT can provide more benefits in terms of reduced turnaround time and increased throughput. An IoT enabled Educational Institution can provide much better services in an automated way. Many such IoT enabled applications can be developed and deployed for making our society better.

REFERENCES

[1] S. Sarma, D. L. Brock, and K. Ashton, "The networked physical world," Auto-ID Center White Paper MIT-AUTOID-WH-001, 2000.

[2] D. Evans, "The internet of things: How the next evolution of the internet is changing everything. cisco," 2015.

[3] P. Mell and T. Grance, "The nist definition of cloud computing," 2011.

[4] D. Laney, "3d data management: Controlling data volume, velocity and variety," META Group Research Note, vol. 6, p. 70, 2001.

[5] M. R. Trifu, M. L. Ivan et al., "Big data: present and future," Database Systems Journal, vol. 5, no. 1, pp. 32–41, 2014.

[6] J. Czyz, M. Allman, J. Zhang, S. Iekel-Johnson, E. Osterweil and M. Bailey, "Measuring ipv6 adoption," ACM SIGCOMM Computer Communication Review, vol. 44, no. 4, pp. 87-98, 2015

[7] T. Anagnostopoulos, K. Kolomvatsos, C. Anagnostopoulos, A. Zaslavsky, and S. Hadjiefthymiades, "Assessing dynamic models for high priority waste collection in smart cities," Journal of Systems and Software, vol. 110, pp. 178–192, 2015.

[8] C. O. Fernandes, C. J. P. de Lucena, C. A. P. de Lucena, and B. A. de Azevedo, "Enabling a smart and distributed communication infrastructure in healthcare," in Innovation in Medicine and Healthcare 2015. Springer, 2016, pp. 435–446.