International Journal of Future Generation Communication and Networking
Vol. 13, No. 4, (2020), pp. 4397–4404

A Taxonomy of Various Building Blocks of Internet of Things

Abhishek Raghuvanshi[1]
Department of Computer Science & Engineering
Mahakal Institute of Technology
Ujjain, India

Dr. Umesh Kumar Singh[2]
Director
Institute of Computer Science, Vikram University
Ujjain, India

Dr. Prashant Panse[3]
Associate Professor, Department of IT, Medi-Caps University, Indore

Monika Saxena[4]
Banasthali Vidyapith, Jaipur, Rajasthan 304022

Abstract:

IoT is affecting each and every aspect of human life, since it is a woven combination of traditional system, sensors, cloud, mobile applications, web applications and control systems. IoT is a network of objects, where each object has unique identification as well as communication capabilities. This paper has described a conceptual framework of IoT. This framework is a woven combination of sensors, cloud platform, cloud servers and mobile applications. This paper also discusses IoT communication technologies and other basic building blocks of Internet of Things. The basic building blocks of IoT are: sensors, control units, communication technologies and software. This paper provides taxonomy of different building blocks of IoT.

Keywords: *Internet of Things, WSN, RFID, Sensors, IoT Building Blocks*

1. Introduction:

Industrial revolution occurred before 200 years prior, to expand the efficiency, which prompts quicken the economy. When mechanical forces replaced human and creature muscle power. Internet came into existence in 1950, which relies upon networking and communication so as to expand the efficiency and supported worldwide economy obviously superior to mechanical upset. The next revolution that will drive another string to build the productivity is Internet of Things (IoT).

"A world where physical objects are seamlessly integrated into the information network and where the physical objects can become active participants in the business process". [1].

During the most recent decade, IoT moved toward our lives quietly and slowly, the advances in remote correspondence, implanted frameworks, and the vitality productive radio advances were the basic strides to

ISSN: 2233-7857 IJFGCN
Copyright ⓒ2020 SERSC

empower little minuscule gadgets to respond and screen their encompassing and shape another systems administration worldview ready to follow up on physical items. IoT vision empowers the third measurement space by associating (Anything) to the previously existing two measurements the (wherever) and (whenever) which will make more applications and administrations that change the manner in which we bargain condition, wellbeing, monetary and our public activities [2].

But with ever increasing number of heterogeneous devices in IoT network and the amount of data being handelled, there are certain issues which are needed to be resolved such as security, privacy, and identification[3][4][5][6].

This paper presents evolution and introduction to internet of things. A conceptual framework of IoT is also discussed; this conceptual framework contains basic elements involved in IoT infrastructure. Basic building blocks of IoT like- sensors, development boards, and various communication technologies are also elaborated in detail.

2. Conceptual Framework of Internet of Things:

The conceptual framework of Internet of Things is shown below in figure 1. The major elements of conceptual framework of IoT are: Sensors, IoT platform, Cloud server and mobile applications.

Fig.1. Conceptual Framework of IoT

Sensors are a lot of diodes equipped for detecting natural physical boundaries, for example, temperature, pressure .Sensors are responsible for acquisition of data. They can be configured to collect data continuously. Sensors are capable of capturing humidity, temperature, motion and many more. IoT platform is a middleware. IoT platform is a bridge between IoT devices and the cloud server. It is responsible for the transmission between IoT devices and cloud server. Many quality IoT platforms are available now a day's such as- Microsoft Azure IoT and AWA IoT. Actual data is stored in cloud server. In cloud, data analytics applications are applied and relevant data is shared with stakeholders using mobile applications.

3. Basic Building Blocks of Internet of Things

This section presents a brief review of various basic building blocks of Internet of Things. IoT needs technologies for sensing data, identification of devices, IP addressing of such huge number of IoT devices, and for establishing communication among different heterogeneous devices. These technologies are building blocks of IoT ecosystem.

The basic building blocks of IoT are: sensors, control units, communication technologies and software. Let us explain each one in brief.

ISSN: 2233-7857 IJFGCN
Copyright ⓒ2020 SERSC

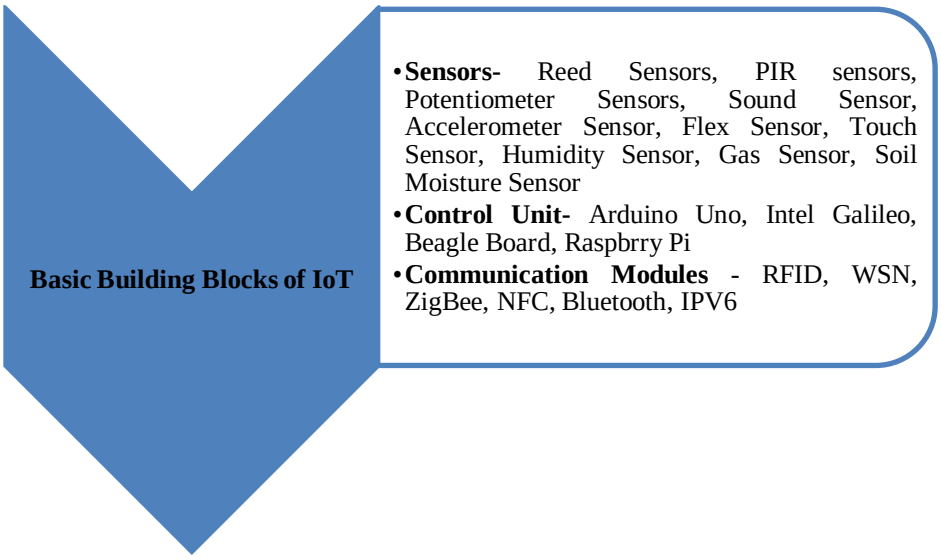

Fig.2. Taxonomy of Basic Building Blocks of IOT

In above diagram, taxonomy of basic building blocks of internet of things is available. It depicts all the basic components discussed in this section.

3.1 Sensors

Sensors are an array lot of diodes capable for detecting natural physical conditions, for example, temperature, pressure, and so on [7]. Sensor and actuator are valuable devices in the mechanical autonomy and other control frameworks in industry. Sensors are utilized to figure temperature, grating, moistness, acceleration, GPS signals, and magnetic field. Two sorts of sensors are reliant on the kind of input they provide for the control unit and are subsequently called analog and digital sensors. Analog sensors incorporate a thermistor, a weight counter, a Hall sensor, and so on. The digital sensors incorporate a touch sensor, metal sensor, rotator encoder, encompassing light sensor, etc.

The most commonly used sensors are as follows:

- **Reed Sensor (Digital)**
- **PIR Sensor**
- **Potentiometer Sensor**
- **Sound Sensor**.
- **Accelerometer Sensor GY-61 with ADXL335 Chip (Analog)**
- **Flex Sensor**
- **Digital Capacitive Touch Sensor**
- **DHT11/DHT22 Humidity Sensor**
- **MQ2 Gas Sensor**
- **YL-69 Soil Moisture Sensor**

3.2 Control Unit

ISSN: 2233-7857 IJFGCN
Copyright ⓒ2020 SERSC

As a control unit, a Microcontroller Unit (MCU) is used. The chip or core in a VLSI or SoC is basically a small scale controller. A MCU consists of a cpu, a memory and a few other devices that are combined. In addition, an MCU includes and interferes with firmware, clocks and useful IO modules.

The most commonly used development boards are as follows:

Arduino Uno: This board [8] uses MCU ATMega 32u4 that has Arduino uphold and moreover consolidates Wi-Fi, Ethernet, USB port, Micro-SD card space and three reset gets in the module. The board can similarly get together with Atheros AR9331 to run Linux.

Raspberry Pi Wireless Inventors Kit (RasWIK): This engages Raspberry Pi Wi-Fi related devices [9]. But a cost should be paid by the customer for the hardware, the sum of the code is in the open source. A customer can think about another idea or use one of the 29 particular undertakings whose documentation goes with the contraption. It can in like manner be used to make IoT devices financially.

3.3 Communication Module

In a model, the physical cum information interface layer is comprised of a neighborhood or an individual zone arrange. A neighborhood system of M2M or IoT gadgets utilizes either wired correspondence innovation or remote correspondence innovation. The significant correspondence innovations are as per the following:

- **Radio Frequency Identification**

Radio Frequency Identification (RFID) is one of the key empowering agents of IoT. Interfacing and speaking with little items require an interestingly recognized framework and constant following, a RFID gadget or once in a while called RFID tag. It is a little microchip joined with a receiving wire intended to be utilized for distinguishing and following items. Information put away in RFID tag are perused by the RFID reader without the need of being in view [10][11].

RFID gadgets are set to be monitored and their development observed. The article may be a kit or it appears to be a novice, and there are several implementations in subsequent innovations. Most IoT use of RFID devices exists in companies where it can be used to track packages, stock control and monitor, chain executives flexibly, and log in deals.

- **Near Field Communication:**

NFC [12] is also an important communication module in internet of things. NFC is a mechanism which allows two nearby devices to communicate with each other by sending or receiving messages.

- **Bluetooth BR/EDR and Bluetooth Low Energy:**

Bluetooth is also a well known communication protocol, which allows wireless communication between the devices [13]. It allows a very fast exchange of data and messages between sending and receiving stations.

- **ZigBee:**

Zigbee uses IEEE 802.15.4 standard to provide wireless communication facility to connecting devices. [13].

- **Wireless Sensor Networks**

ISSN: 2233-7857 IJFGCN
Copyright ⓒ2020 SERSC

WSNs have advanced altogether over the most recent couple of years; the fundamental component of a WSN is the sensor nodes [13]. These sensor hubs are implanted in things to detect the data from the things‟ encompassing, for example, natural conditions, movement and so forth as needs be founded on this data legitimate move can be made, henceforth sensor hubs can make thing mindful of their environmental factors. For instance, cooler can illuminate if food things are required, savvy lights report the status of lights (on/off), keen locks report whether entryways are bolted or not and so forth sensors make things alive and mindful of their environmental factors.

- **Internet Protocol Version 6 (IPV6)**

The number of IOT devices is growing exponentially. The current IPV4 tending to has 32-piece address group which can bolster 4.3 billion special IP addresses. Be that as it may, addresses are generally used accordingly can't suit the normal billions of IoT gadgets [14]. IPV6 was created to grows the quantity of accessible IP addresses with considerably more tending to space it utilizes 128 bits address design which are sufficient to distinguish each item should have been a piece of the IoT condition [15]. Likewise, we can allocate an IPv6 address to all the things remembered for the system. Every gadget ought to have a remarkable IP address.

4. Internet of Things Architecture:

Although many architectures have been proposed for Internet of Things. The 3-layer architecture [16][17], service-oriented architecture [18] and 5-layer architecture [19]. This section contains a brief introduction to different architectures of Internet of things.

4.1 Five-Layer Architecture:

Five-layer architecture for Internet of Things is shown below in figure 3:

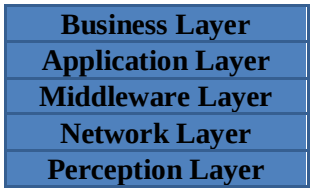

Fig.3 Five- Layer Architecture of IOT

- **The Perception Layer**

The perception layer is the first layer. Basically this layer manages the recognizing things, gathering information from the things. It incorporates RFID labels, QR code, and different kinds of sensors, camera, terminals, and remote sensor organize 2-D scanner tag marks and readers. Principle capacity of this layer is to recognize the items remarkably and gather the data.

- **The Network Layer**

The network layer is also known as the transmission layer. This layer receives the information from the perception layer and transmits that information safely to the IOT devices. This layer handles various networking devices such as router, hub and switch.

- **The Middleware layer**

The middleware layer lies between the application layer and the network layer. It implements information handling and process filtering. Every gadget interfaces and speaks with just those different gadgets which

ISSN: 2233-7857 IJFGCN
Copyright ⓒ2020 SERSC

actualize a similar assistance type. This layer is additionally liable for administration the board and has a connect to the database. It gets the data from the Network layer and store in the database.

- **The Application Layer**

The application layer lies between middleware layer and business layer. Application layer delivers application related services to the users. There may be many applications in this layer, including: smart health, smart home, smart city, smart car, smart farming, smart logistics, smart transportation etc.

- **The Business Layer**

This layer is responsible for the management of whole IoT system. It collects results from different applications available at application layer and represents that result in form of graphs, tables and charts.

4.2 Service Oriented Architecture:

Service oriented architecture consists of four layers [18]. It is shown below in figure 4.

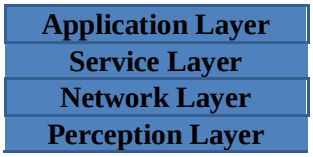

Fig.4. Service Oriented Architecture

These four layers are: perception layer, network layer, service layer and application layer. The service layer provides different services required by different applications at application layer. Perception layer gathers data by using sensors, cameras and RFID. Data acquisition performed by perception layer is most crucial as all other layers deals with this data to get the desired output from IoT applications. Networking layer is responsible for the routing of data. It handles various networking and congestion control issues. Application layer provides user-related application services. A number of applications may be available in this layer, including: smart health, intelligent home, smart city, intelligent car, intelligent agriculture, smart logistics and smart transportation.

4.3 Three-Layer Architecture

The three-layer architecture consists of three layers [16][17]. It is shown below in figure 5.

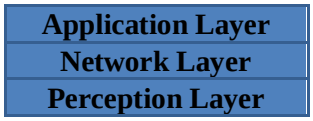

Fig.5. Three Layer Architecture

These three layers are: The perception layer, the network layer and the application layer. Five-layer architecture and the service oriented architecture are built on top of the three layer architecture.

In all three architectures, three layers are common. These layers are perception layer, network layer and application layer. 3-layer architecture is basic architecture of IoT. Service oriented architecture and 5 layer architectures are built on basic 3 layer architecture. Service oriented has a service layer to support different applications at service layer. Five layer architectures are best among three architectures available, as it has business layer. This layer is capable of collecting data from different applications, performing collaborations and also capable of representing results.

ISSN: 2233-7857 IJFGCN
Copyright ⓒ2020 SERSC

5. Conclusion

IoT is flourishing in all fields related to human life. It is affecting each and every individual in the world. Application of IoT in fields like- healthcare, smart cities, smart roads, smart agriculture, smart traffic management, smart waste management is resulting in improved quality of life. IoT is also resulting in reducing operational cost, live tracking and monitoring, optimum use of human resources, increased revenue and also saving life. In this paper, a conceptual framework is also presented in paper to describe basic components of a IoT ecosystem. Major building blocks of IoT are also presented so that we can understand which basic building blocks are needed to create an IoT healthcare network.

References:

[1] Raghuvanshi, A., & Singh, U. (2020). Internet of Things for smart cities- security issues and challenges. *Materials Today: Proceedings*. doi: 10.1016/j.matpr.2020.10.849
[2] Ammar, Mahmoud, Giovanni Russello, and Bruno Crispo. "Internet of Things: A survey on the security of IoT frameworks." Journal of Information Security and Applications38 (2018): 8-27.
[3] Saxena, Monika & Jha, C. (2016). Heterogeneous Big Smart data in Perspective of Smart Cities Development, International Journal of Computer Science Engineering (IJCSE), 5(3),137-141.
[4] Saxena, Monika & Jha, C. (2018). Analytics of IoT Streaming Data using Modified New Pattern Mining Algorithm. International Journal on Future Revolution in Computer Science & Communication Engineering. 4(1), 265-270
[5] Saxena M. (2020). Novel framework and service model for internet of things in context of smart cities. International research journal of modernization in engineering technology & Science. 2(9), 1730-1735.
[6] Suyash Kumar Singh, Sanjiv Tokekar, Abhishek Raghuvanshi and Umesh Kumar Singh. Java and IoT (Internet of Things): Automating the Industrial Economy. International Journal of Computer Applications 175(1):9-13, October 2017.
[7] Badamasi, Yusuf Abdullahi. "The working principle of an Arduino." 2014 11th International Conference on Electronics, Computer and Computation (ICECCO). IEEE, 2014.
[8] Pi, Raspberry. "Raspberry Pi Model B." (2015).
[9] Finkenzeller, Klaus. RFID handbook: fundamentals and applications in contactless smart cards, radio frequency identification and near-field communication. John Wiley & Sons, 2010.
[10] Juels, Ari. "RFID security and privacy: A research survey." IEEE journal on selected areas in communications 24.2 (2006): 381-394.
[11] Song, Boyeon, and Chris J. Mitchell. "Scalable RFID pseudonym protocol." Network and System Security, 2009. NSS'09. Third International Conference on. IEEE, 2009.
[12]. Kamal, Raj. Internet of Things. McGraw-Hill Education, 2017.
[13] Ma, Jianguo. "Internet-of-Things: Technology evolution and challenges." Microwave Symposium (IMS), 2014 IEEE MTT-S International. IEEE, 2014.
[14] Agrawal, Shashank, and Dario Vieira. "A survey on Internet of Things." Abakós 1.2 (2013): 78-95.
[15] Van Kranenburg, Rob, et al. "The internet of things." Proc. of the First Berlin Symposium on Internet and Society. 2011.
[16] Yang, Zhihong, et al. "Study and application on the architecture and key technologies for IOT." *Multimedia Technology (ICMT), 2011 International Conference on*. IEEE, 2011.
[17] Wu, Miao, et al. "Research on the architecture of Internet of Things." *Advanced Computer Theory and Engineering (ICACTE), 2010 3rd International Conference on*. Vol. 5. IEEE, 2010.
[18] Lin, Jie, et al. "A survey on internet of things: Architecture, enabling technologies, security and privacy, and applications." *IEEE Internet of Things Journal* 4.5 (2017): 1125-1142.

ISSN: 2233-7857 IJFGCN
Copyright ⓒ2020 SERSC

[19] Khan, Rafiullah, et al. "Future internet: the internet of things architecture, possible applications and key challenges." *Frontiers of Information Technology (FIT), 2012 10th International Conference on*. IEEE, 2012.

ISSN: 2233-7857 IJFGCN
Copyright ⓒ2020 SERSC