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# DIFFERENT APPROACHES OF INTERNET OF THINGS (IOT) ARCHITECTURE

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**Abstract-** Internet of Things, a revolutionary technology that combines the internet and the telecommunication networks however it gives unique features. It allows representation of all physical objects towards the internet with proper identification, attributes and personalities. Internet of Things has gained more and more attention globally in the past recent years. But the architecture is still under review process. In this paper we discussed various approaches towards the architecture of IoT which is based on layers, services and applications. It is observed that the understanding of any technology becomes easier by categorizing its various aspects.

**Keywords –** Internet of Things (IoT), Architecture, Application

## 1. INTRODUCTION

The internet technology is widely used for decade for people-to-people communication. Many applications such as emailing, web pages and online games were designed for interactive communication. Internet can also be use in sensor networks as a bridge for communication between people and the physical world where all the environmental data can be sense by different sensors and transmit via internet. But these sensed physical data is isolated. The aim of Internet of Things (IoT) is to connect physical objects, sensors, actuators, and other technologies, to provide people-to-object and object-to-object communication [1].Internet of things (IoT) has created a significant impact to quite a few features of everyday life and also in the behaviour of the users. As it is suggested semantically, the "Internet of Things" means "a world-wide network of interconnected objects distinctively addressable based on standardized communication protocols" [1]. The things and objects around us - such as sensors, mobile phones, actuators, RFID tags can be enable and use for communication by using IoT technology [2].

## 2. BACKGROUND OF INTERNET OF THINGS

The theory of internet of thing was initiated by the Auto ID Labs of MIT in 1993 [3]. The intention of the Auto ID lab was to connect all the physical entities to the global network and to provide each entity a distinctive ID. The concept of approved by the report provided in World Summit on the Information Society (WSIS) organized in Tunisia in the year 2005 by the International Telecommunication Union (ITU) [4]. Since then IoT development is becoming the centre of attention of various research groups and scholars. It has been used as a catchphrase by numerous sources [5]. It provides a unique capability of monitoring and controlling any physical objects having any shape and size any where anytime and by any one via internet. According to a report presented [6] "by 2020 the IoT will help to drive 22 times as much data traffic as exist today". In terms of cost, performance, power consumption, availability, bandwidth, and other key attributes, the IoT will entail a much different variety of hardware, software and networking solutions. According to a survey [16], conducted by Zebra Technologies in June 2012 for various firms about the deployment of IoT.

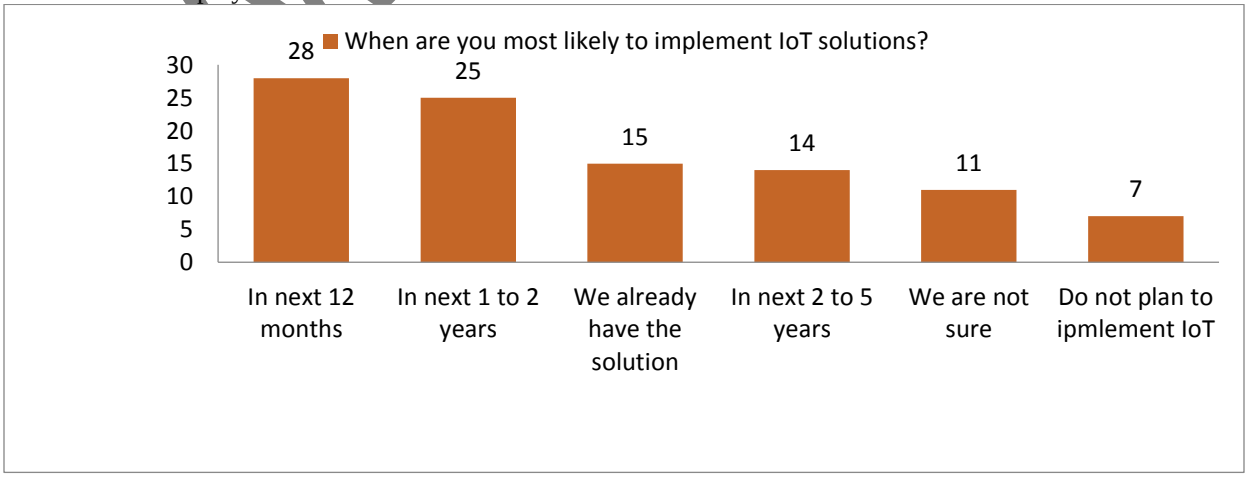


**Fig. 2.1 Percentage of Firms Planning to Deploy IoT [16]**

There is the survey showing the interest of organizational firms towards the Internet of Things. As the survey was conducted in 2012, no such huge output has seen lately. One of the prime reasons might be the lack of architectural approach of IoT. Several scholars, research groups, institutions and organizations is making their way in this direction and in the recent past a huge amount of research has been seen in the area of IoT and its architectures.

In this paper we are going to discuss generic approaches of architecture that can be useful of better understand the IoT. Firstly we discussed the layer based architecture, after that we talk about the service level and then the application. In the end a brief conclusion is presented.

## 3. GENERIC ARCHITECTURE OF IoT

### 3.1 Layer Based Architecture

Currently, there are two layered based IoT architectures which has been proposed, 3-Layered architecture and 5-Layered architecture.

#### 3.1.1 3-Layered Architecture

IoT 3 – layered architecture model which has been generally accepted consist of 3 layers known as Perception layer, Network Layer and the Application Layer.

##### 3.1.1.1 The Perception Layer

The Perception Layer performs like the 5 sensing organs of IoT whose primary function is to recognize the things and gathering information. RFID tags GPS, camera, sensors, sensor network and terminals. Its primary goal is to recognize the entity and information collection [7].

##### 3.1.1.2 The Network Layer

The network layer behaviour is just like a neural network and also refers as the mind of IoT. The primary goal of this layer involves transmission and processing of data. The network layer incorporate a convergence network of communication and internet system, network management centre, information centre and smart processing centre, etc [7]. The layer is use to transmit and process data received from the perception layer.

##### 3.1.1.3 The Application Layer

The application layer unites both IoT's social division and industrial requirements. The primary goal of this layer is to provide informative service consisting of three parts, IoT client side, data storage unit and data inquisition unit. The Application Layer is a junction of loT and industrial technologies which merged with the industrial requirements to understand the intellectualized industry, identical to person's public division of labour, ultimately form human society [7] [8].

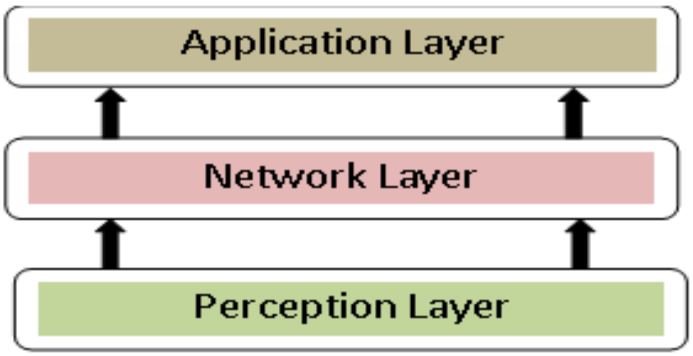


**Fig. 3.1 3-Layered Architecture [7]**

The 3-layered explains the detailed structure of IoT from the technical perspective which is acceptable in the early stage of development. Various Experts and Scholars believes that IoT is a cloud-castle vision approach due to lack of management and business methodology and therefore more focus need to be done for the better approach towards management and business models. As compared to Internet technology, IoT network can be controlled and managed and is very much similar to communication network. In order to study the correct IoT system, structure, the internet and communication network need to be analyse and combine the features of both networks to obtain a better and more reliable architecture of IoT.

### 3.1.2 5 – Layered Architecture

The IoT 3-Layer architecture which was proposed earlier lacks expected IoT development. Therefore, a much well-defined 5-layer architecture model is proposed. Experts believe that this architecture model would properly define all the aspects of the IoT. The architecture contains 5 layers known as Perception Layer, transport Layer, Processing Layer, Application and Business Layer as shown in the figure.

#### 3.1.2.1 The Perception Layer

The only goal of the Perception Layer is to recognize the physical attributes of objects (for instance, temperature, movement, geographical position and so on.) by a variety of sensors (for instances barcode, infrared sensors, RFID), and digitized the information which is well suited for network transmission [7]. Sensors use in this layer performs like "Network Element" in establishing Telecommunication Management Network. The vital techniques in this layer are sensing technology, barcode, GPS, RFID technology (along with labels and literacy) etc [7].

#### 3.1.2.2 The Transport Layer

This layer is responsible for transmitting information received from the Perception Layer to the processing unit. It can be a wireless network, wired network or even the enterprise Local Area Network (LAN) [7]. The most important techniques in this layer consist of Wifi, FTTx, Bluetooth, Zigbee, 3G, infrared technology etc. [7][8]. The core protocol apply in this layer is IPv6 (Internet Protocol v6) that can be utilize for addressing.

#### 3.1.2.3 The Processing Layer

All the data transmit from the transport layer is further store, process and analyse in the processing layer. In this layer the major techniques are consist of database management, cloud computing, smart processing, ubiquitous computing and so on Cloud computing and ubiquitous computing is the major technologies in this layer [7] [8]. Experts believe that the potential development and research of Internet of Things can be done in this layer.

#### 3.1.2.4 The Application Layer

The responsibility of the Application Layer depends on the data processed at the Processing Layer and to develop diverse applications of the IoT. This includes smart transportation, logistics administration, uniqueness authentication, location based service (LBS) and safety etc [7]. This layer offer applications for every kind of industrial usage and also to promote the IoT development to a larger scale development.

#### 3.1.2.5 The Business Layer

The business layer performs the managing task that includes management of applications and business model. The Business Layer not only manages the release and charging of a variety of applications but also the research on business and profit model [7].

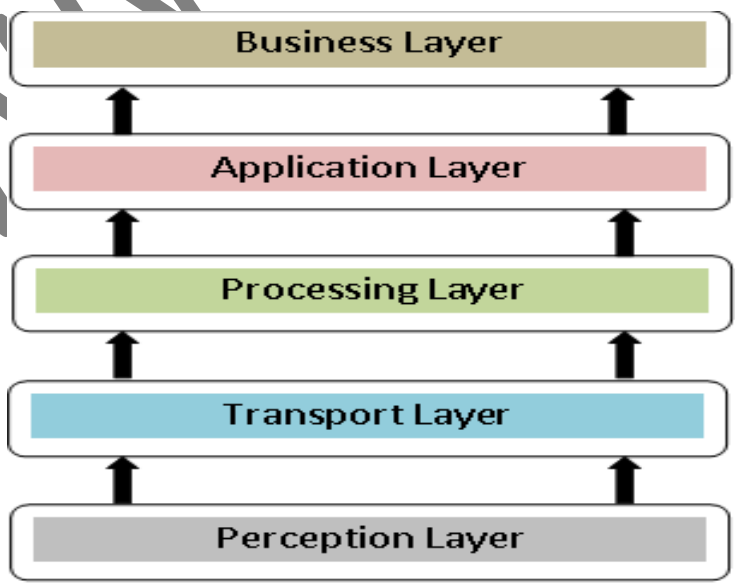


**Fig. 3.2 5-Layered Architecture [7] [8]**

Based on this approach, the IoT cannot be helpful without the research of a long term development on Business model. The business layer is also responsible about the user's privacy and all research associated to the IOT applications [8].

### 3.2 Service Oriented Architecture

Service means to offer a distinct and standardized interface which provides every functionality and processes need to interact with a physical entity. The service oriented architecture of IoT is comprised of two parts firstly as Communication Based Services and secondly as Management Based Services.

#### 3.2.1 Communication Base Service

The communication based service describes about the communication system and interfacing schemes develop to various technologies involved in an IoT system. It offers a universal interface to other IoT services. It gives a plain interface to instantiate and to control the high level information flow. Specifically it begins with the top most OSI/ISO model layer. It handles data representation, point to point path information, network management, addressing & naming issues and machine specific attributes. Every communication based service must require some authentication and security features which can be impose by using assorted encryption techniques at each and every OSI layer [5]. The Quality of Service (QOS) can be provided by using different queue management schemes such as structured queue and unstructured queue.

#### 3.2.2 Management Based Services

The management phase of service based architecture of IoT system further divided into four areas; Cost Reduction, Attending unexpected usage issues, Fault Handling and Flexibility.

#### 3.2.2.1 Cost Reduction

For the cost control of overall systems of IoT, it is built for the higher number of users. "A way for the designer to deal with the requirements of multiple groups of users is to abstract from the differences in [the] requirements and [to] parameterize the design" [Pras 1995]. After establishing the system, these factors will be initialized by the Management Functionality Group [5].

#### 3.2.2.2 Attending Unexpected Events

The management functionality group offers numerous approaches for the improvement of any unanticipated circumstances including link failure or overloading of queues. For the adaptation of new circumstances, it is mandatory for the management functionality group to have a detailed know how of the system state.

#### 3.2.2.3 Fault Handling

Fault handling deals with the irregularity and unforeseen behavior of the system. It can be seen in the complex IoT systems or in such systems where the devices do not endow their behavioral model in IoT systems [5]. To tackle these unseen scenarios, the countermeasures are,

- Forecast of possible failures
- Reveal of existing failures
- Drop down of the effects of failures
- Repair and fixation

The top three countermeasures can be accomplish by a comparison between the present behaviors of the system with the previous behavior of the system.

#### 3.2.2.4 Flexibility

Flexibility is based on the utilization of system by the users. The utilization is variable and hence, the designing of up-to-the-minute and a fresh system is not possible. System itself must have some flexibility. The management functionality group of the IoT system will be able to react to changes in the user requirement [5]. It can occur at the boot up, commissioning or at run time too.

### 3.3 Application Based IOT

IoT gives a variety of applications in every walk of human lives that can be beneficial in many ways. It provides the utilizations from home to industries, from individuals to communities and from health care to transportation

systems. It gives you the tendency to use the scarce resources with an optimal way. There are various applications of IoT.

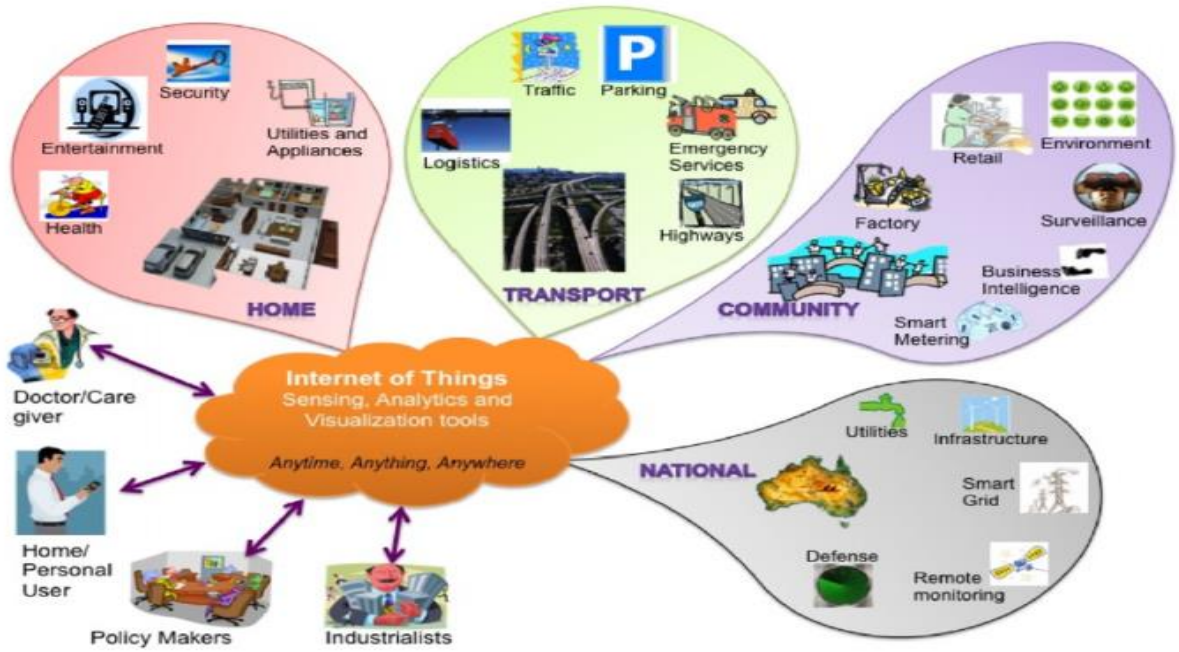


**Fig. 3.3 The End Users & Application Areas [10]**

### 3.3.1 Enterprise

We usually talk about to the networks of objects contained by a running environment as a venture based utility. The collection of information by these networks is utilized simply by the proprietor [11]. Wireless sensors are always been an essential component of any enterprise in order to enhance the security, provision of automation, temperature control etc. All these sensors are IoT based for the enterprise maintenance. Smart Environment IoT is one of the most important application areas of IoT.

### 3.3.2 Personal and Home

IoT applications provide an extensive environment especially in the field of healthcare which has been neglected for past two decades. This can de done by using body are sensors and use of IoT network at the backend to upload the desired information to the servers. Smartphone devices can be applicable for communication in conjunction with numerous interfaces such as Bluetooth for interfacing sensors measuring physiological parameters [10]. Similarly, various healthcare parameters can be measured using several applications that are now intensively available in Google Android, Apple iOS and Windows phone operating system. Yet the information needs to be centralized in the cloud network so that physician can access the same information from anywhere. An addition of the personal BAN (Body Area Network) is building a house monitoring system for aged care, which permits the healthcare professionals to observe patient's condition while the elderly personals remain in their homes thus cutting down the hospitalization expenses through early involvement and cure [10].IoT applications can also be helpful in controlling several home appliances such as computers, television, telephones and so forth that permit improved home and energy management. In this way many consumers would concerned about the revolution of internet of things. In the same manner as internet revolutionized in earlier. Even though this gives a common structure by utilizing cloud for information access and an improved security model would be desirable for this to be totally realized. [10]

### 3.3.3 Utilities

Smart Metering and Water network monitoring are some of the vital applications of IoT that is focused on service optimization. Many electrical supply companies are providing smart meters facility for the observation of their utilities and well-organized resource management. This setup is usually deployed by a large group of companies on

area and nationwide. The core network for this setup can be operated through cellular network or by satellite system [10] [11]. Well-organized energy utilization can be accomplished by constantly monitoring the electrical ends used by homes, industries, business organizations and utilizing this information to change the techniques of energy consumption. Thus it can improve the quality of service by load balancing. Similarly the quality of assurance of drinking water can be deal with the utilization of Io. Sensors deployed to on various locations to evaluate the significant water parameters for better drinking water quality supply [10] [11]. This can eventually avoid the pollution level that can occur through chemical factories outlets, sewages or storm water drains in the drinking water.

### 3.3.4 Smart Grid

IoT can be applicable for smart grid systems. It is capable of improving the level of information and automation of manufacturing progressions of the power system [9]. The data would be gathered by the entire sensor nodes and transmitted to the sink node. As the sink node having the data gathering units, data processing and management unit, communication unit and a power supply unit therefore you be able to computerize the arrangement of the data, choose suitable pre rectification schemes, functionality of the lines and equipment for centralized categorization and information fusion [9]. Consequently it will minimize the forwarding load of the sink node. Though the sink node has the limited energy and processing ability, the data gathering in the primary sensor node and should be send out to the smart grid ICT systematic processing platform in order to control and manage of fine-grained, identification and rectifying the crashes eventually.

### 3.3.5 Healthcare & Patient Monitoring

Indeed, there are numerous applications that IoT provides in every walk of life just of the betterment human being. Though healthcare and patient monitoring is one of the most important areas where IoT becomes pivotal. There are different elements that can communicate to build a network for monitoring the patients' abnormality. Patients having disease such as diabetic, hypertension, cardiac or respiratory disorder needs special and immediate care as compare to the other patients. They may need the doctor, ambulance or any other medical help with in emergency conditions. Therefore, the newer technology must focus on such devices to revolutionize and facilitate the patients having adverse conditions and ease the medical and healthcare profession by initiating tele-monitoring service in the Internet of Things. By the induction of tele-monitoring, medical experts can analyze the patient's condition by monitoring them while remaining at their workplaces [12]. A single step in this direction would save so many lives.

**Table-3.1 Application Domain of Smart Environment [10]**

| | Smart Home/ Office | Smart City | Smart Transportation | Smart Retail | Smart agriculture/forest | Smart Water |
|---|---|---|---|---|---|---|
| Network Size | Small | Average | Large | Small | Medium/Large | Large |
| Capacity | Very Few Users | Many User | Many Users | Few Users | Few Users, landowners, policy maker | Few Users, government |
| Energy | Rechargeable Battery | Rechargeable battery, Energy Harvesting | Rechargeable battery, Energy Harvesting | Rechargeable batteries | Energy harvesting | Energy harvesting |
| Internet Connectivity | Wifi, 3G,4G LTE Backbone | Wifi,3G,4G LTE Backbone | Wifi, Satellite Communication | Wifi, 3G, 4G LTE Backbone | Wifi, satellite communication | Satellite communication , microwave links |
| Data Management | Local Server | Shared Server | Share Server | Local Server | Local Server, Share Server | Shared Server |
| IoT Technologies | Radio Frequency IDentifiers, Wireless Sensor Networks | Radio Frequency IDentifiers, Wireless Sensor Networks | Radio Frequency IDentifiers, Wireless Sensor Networks, Single Sensor | Radio Frequency IDentifiers, Wireless Sensor Networks | Wireless Sensor Network | Single Sensor |
| Bandwidth | Low | High | Moderate | Low | Moderate | Moderate |

### 3.3.6 Eatables and Beverages Safety

While talking about the health, one should be agreed to the fact that most of the health issues begin with the usages of expired or adulterated food and beverages. Contamination in the food and beverages such as adding water in the milk or mixing small stones in the beans can is really common in Pakistan and India. Also food contamination, sooner or later, wind up in losing the trust of the consumers since they avoid such products just to stay away from the side effects it could generate hence all these things can become the cause of economic fall of the country. IoT can bring the things online and it would help in monitoring of food and beverages item easily [13].

### 3.3.7 Transportation

Internet of things can be useful in intelligent transportation. For that purpose, RFID tags would be needed to install at the traffic circle in the city. The tags can collect the quantity of traffic automatically and sent the information to the central transportation management zone. It can help the traffic management zone to switch the traffic signal in accordance to the traffic length. By doing this, they can avoid long traffic jams in the city as well as can avoid the extra fuel consumption occur due to long waiting in the queue. It can also help the police to track down the stolen vehicles [14].

### 3.3.8 New, Media and Entertainment

IoT can be useful in gathering the news with the help of ad-hoc networks [15]. It is foreseen that someday people can send queries to the IoT in order to spot the multimedia enabled devices located in the near vicinity of the event occurring of their interest and gather news, financial updates and can remain up-to-date with the sports and entertainment world. As there are numerous applications several organizations are taking interest in IoT.

## CONCLUSION

At the beginning of the development of IoT, most research groups are aiming to connect technologies yet the architecture of IoT is under consideration. This paper discusses various approaches of architecture of IoT. It provided the layer based approach, service based approach and application based IoT. Every approach has its own dimensions. By reviewing all 3 modes, we hope that it facilitates the scholars to better understand the Internet of Things.

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