Internet Of Things: A Critical Survey On Various Layers, Technologies, Fields And Its Challenges

K.Sai Susheel, A.Seshagiri Rao

Abstract*: The substantial development in network technology is Internet of things which allows users to achieve deeper automation, analysis and integrate within system. It converts the real objects in to intelligent virtual objects with integration of things perception, Internet perception, semantic perception and utilizes emerging technology for sensing, networking, and robotics for communicate with same machines and with other machines. The machines consist of energy modules, power management modules, RF modules and sensing modules. It shares the information by using various technologies and applied in various applications. In this work contains a overview on architecture model of IoT, emerging communication technologies, future applications, market analysis in India and challenges by examining the present tendency and provide summary on related research work. At last, we gather detailed services to demonstrate how the various fields gathered in this paper suite together to bring desired IOT Services.

***Index Terms*: IOT, RFID module, cellular module, zigBee module, Sigfox module.**

I. INTRODUCTION

The Internet of Things (IOT) is one of the hottest IT buzzwords in the present world in various fields. Internet of Things is a system of ever growing network for connecting the physical devices to the internet that are possible to gather and exchange the data using embedded sensors, RF tags, actuators, Near Field Communication etc and it can provided

the unique identifiers (UID's) to the objects, animals and people without requiring any interaction between

the humans –to-humans , humans-to-computer. It can be used in the areas of embedded systems, cyber-physical systems, network technologies, computing technologies, data analytics, semantic inter-operability, operating platforms and security, and generic enablers. Now-a-days, it can be used in companies, factories, industrial manufactures, and in other places for various purposes to enable their requirements fastly and accurately to get the quality product to match the market demands and needs [1]. Commercial buildings and homes are using the system for converting in to smart homes for heating, venting and air conditioning (HVAC) for monitoring the energy in surroundings [2]. While using this system challenges are occurring and getting the security issues that are connected to concerning the network aspects. This survey gives the overall picture of the present status of IoT as follows.

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In section2, presenting the architecture of IOT. In section3, discuss about the emerging communication technologies. Section4 tells about the future applications. In section5 focused on market analysis of Internet of things in India. The topics such as challenges that can be discuss in section 7. Finally, conclude the summary of paper in section 8

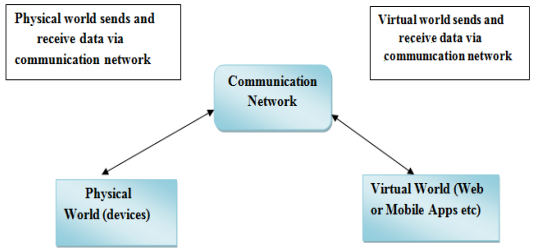

Fig 1. Internet of Things illustrated in Blocks

II. LAYERED ARCHITECTURE OF IOT:

In existing system, the communication protocols (TCP/IP) are used in internet for communication between the hosts. Although the IOT can connect to the numerous objects for creating transferring, processing, storage and traffic flow of data [3]. The architecture developed will meet the requirements of doing the work fastly in different domains [4]. Fig 2 shows the five layered architecture of IOT [1, 3, 4].

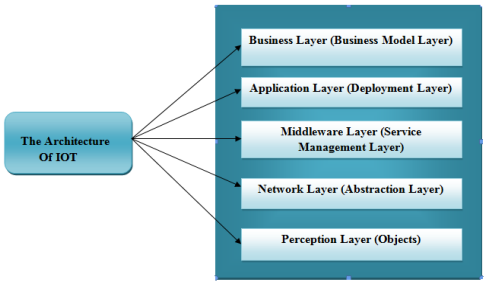

Fig 2. Architecture Model of IOT

1. Perception Layer: Also known as object layer [1], represents the components such as RFID, sensors, actuators which recognize the objects for collecting and processing the data and then transmit to the next layer [5]. Industrial devices to robotic camera systems, water level detectors, air quality sensors, accelerometers, heat rate monitors are the examples of this layer.

2. Network Layer: Also known as abstraction layer or Transmission layer or Transport layer [1, 3, 4]. It converts the data from analog to digitized form by using data processing system. Network layer contains LAN, WAN, MAN, WI-FI, Bluetooth, 3G, 4G, etc for communicating and to

extend the capability of information performance and then transmit through a secure channel to the next layer [6].

3. Middleware layer: Also known as service management layer or processing layer [1, 4]. The responsibility of this layer is to handle the information for storing, extracting, analyzing and delivery of particular services automatically [4]. This layer is used for data mining, text mining, and service analytics.

4. Application layer: Also known as Deployment layer and determines the different types of applications. This layer provides the quality services to meet the user demands. It deploys the applications such as smart cities, smart buildings, industries automation, agriculture automation, smart healthcare etc [1, 7].

5. Business layer: Also known as business model layer. It manages the complete IOT system activities such as business, flowcharts, graphs, security etc and integrates into business process and enterprise systems [1, 7]. Furthermore, it compares the result of each stage with the expected result to extended services [1].

III. EMERGING COMMUNICATION TECHNOLOGIES:

This section discuss about the individual communication technologies are connected to gateway. A gateway is a physical device that serves as connection point between the cloud and controllers, sensors and intelligent devices. Communication technology can classified in to 1. Wide Range Network 2. Short Range Network in Fig.3[8].

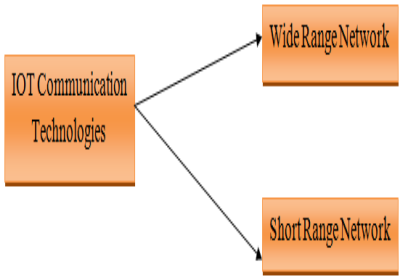

Fig 3. Types of Communication Technologies

A. Wide Range Network:

A.SigFox: SigFox is a lower power communication technology which is used to transmitted the data in sensors and M2M applications is much less than in voice or video call [8, 9]. It transports the small amount of data ranging up to 50 kilometers and uses Ultra Narrow band (UNB) technology. It handles the speed of data transfer from 10 to 1000 bits per second and run on small batteries [8] and saves a lot of power. In this world, smart cities are acquiring this communication technology. SigFox being used in smart waste management, fire-hydrant control, streetlight control, air-quality monitoring and real-time water level updates [9].

B.Cellular: This technology is used in applications that require operations over long distances can take the advantage of cellular communication such as GSM/3G/4G. It can provide reliable high speed connectivity to the internet for capable of sending high quantities of data and it needs cost, power consumption will be too high for many applications [8, 10]. It is suitable for sensor-based low bandwidth-data projects that will send low amount of data over the internet [10].

B. Short Range Network:

A. 6LoWPAN: It is the most commonly used in communication technologies and is an acronym of IPV6 over Low Power Personal Area Network [8, 11]. It is an adaption layer for IPV6 over IEEE802.15.4 links. This technology operates in the 2.4GHz frequency range with 250Kbps transfer rate [11]. This can be connected to another network with the IPV6 domain without maintaining the intermediate connections such as gateways, proxies. It is also low cost and low bandwidth power utilization and directly applied on the sensor nodes [8, 12].

B. ZigBee: It is an IEEE802.15.4 standard technology to suite high level communication for the purpose of wireless personal area network with limited and small size digital radios [13, 14]. This technology operates in the 2.4GHz frequency range with 250Kbps transfer rate and maximum no of nodes is 1024 with a range up to 200 meter. ZigBee used 128 bits AES encryption [11]. It includes low energy, cost, data rate, reliability, security and supports various topologies such as mesh, star etc to avoid hub devices and wi-fi connect to end points for the speed purpose [5, 15].

C. RFID: The acronym of RFID is Radio Frequency Identification and is a wireless communication technology for the purpose of transferring the data by using electro-magnetic radio waves to maintain and store in a tag connected to object for finding location and status [16, 17]. Two tags are used in RFID such as active and passive which uses high and low frequencies [8]. RFID tag range is from 16-64 Kbytes more than a barcode. It is used in many applications such as managing supply chains, tracking livestock, controlling building access, and automated checkout [18].

D. NFC: The acronym of NFC is Near Field Communication is standardized limited range of wireless communication technology on the basis of RFID through which the electronic objects are interacted with other objects by exchanging the data over a small distance [19, 7]. The frequency range of NIFC is 13.56 MHz and has 424 Kbps maximum data transfer rate [7, 20]. Two tags are used in NFC such as active and passive one which uses two objects to generate magnetic field and other which uses the two objects, one is to generate field and other is for transferring of data [7]. This can be used in various applications such as NFC Ticketing, NFC Mobile Payment System, NFC Setup, NFC Vendors and Manufactures [20].

E. Bluetooth Low Energy: It formerly named as Bluetooth smart is a wireless personal area network technology based on wireless sensors designed and enhanced by Bluetooth special Interest Group (BSIG) [21, 22]. The distance range of BLE is >100 and has 125 Kbps maximum data transfer rate [21]. BLE can be used to exchange the data by initializing the connection is of two types such as Master role, Slave role. The device will have master role when changing the state initiating to the state connection and device will have slave role when entering the state connection from the state advertising [22]. This can be used in many applications such as mesh

profiles, health care profiles, sports and fitness profiles, internet connectivity, generic sensors, HID connectivity etc [21].

IV. IOT USED IN VARIOUS DOMAINS:

Smart Industry: IOT can be used in smart industry to monitor industrial applications automatically and produce alerts by taking decisions smartly and control the devices using IOT. It is used the sensors, RFID, BLE, WSN's etc to sensing the objects in the industries and produce minimal involvement of the people to create, monitor, interchange, analyze and consume the data [23, 24]. IOT used in industry for performing to control the quality, goods tracking automatically and to increase the GDP rate [25].

Smart Healthcare: While using the IOT in smart healthcare it can't stop the diseases of humans at a time and at least by using the technology make healthy life easily in terms of accessibility. It is used to empower the patients to give healthy life by connecting to the devices [25]. It collects the data of blood pressure, body temperature, ECG, and oxygen condition of patient by connecting the devices to the mobile apps .It provides storage capability of electronic devices and transfers the data to the particular medical doctor [26].

Smart Farming: IOT can be used in smart farming to monitor the environmental conditions, water usage to the crop, quality of soil, to increase the crop nutrients and production and send information to the farmer by using the smart devices such as sensors [27]. To educate the farmers for implementing this technology in proper places [28]. It gives the corrective measure to the farmer about the production and prevent the crop from fungus, insects.

Smart Eye: IOT can be used in smart eye for developing the eye tracking system that can control the appliances, electric wheelchair, to study the human behavior and communicate with the relative for sending the message to the mobile [29]. This system connected with sensors and gives the accessibility right to the eye. Eye tracking system is used in automotive industry, research and science, market surveys, computer games, industrial applications etc [30].

Smart Cities: IOT can be used to change the cities in to smart for connecting to all systems such as urban security surveillance, water supply monitoring, manage the environmental conditions etc with the help of public administration, people in every aspects [31, 32]. To extend the transport to the public, monitor the vehicles, parking places, check the trembling and material quality of various buildings to bring useful to the users and by the internet in every area to get the data from the various places under particular communication technologies [32, 33].

Smart Air Detection: IOT can be used in smart air detection can be classified in to two types such as direct and indirect air detection for the purpose of monitoring of air pressure in tier. In indirect air detection the sensors can fix in to the tier and send the information to your car system and activate the indicator light. The other indirect air detector works with antilock braking system and if the air is low it can run on different rotation speed than the other wheels [34].

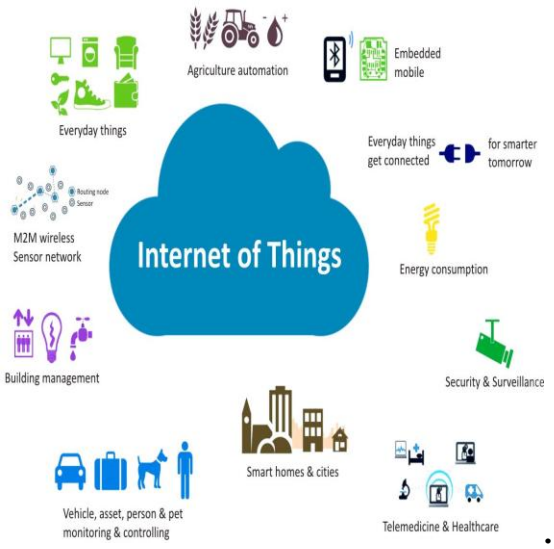

Fig 4: IOT Used in Various Domains

Market Analysis in India: India's IOT market is increasing in a next few years. According to 6wresearch, the Indian IOT market to grow at a CAGR of 28.2 percent in the year 2018-2022 [35]. 31.3 % of the responders expect IOT to increase in health care, 20.5% of the responder except IOT to increase the traffic management and 24.7% of the responder except IOT to reduce the air pollution and 14.5% of responders except to improve the government services to get the better life [36]. In India increasing the investment research and development to expand the product in IOT in various fields. Increased adoption of 4G/5G modules for tele-communications in IOT [37]. By 2050, Indian population is expected to reach 1.7 billion making most populated country in the world [38]. In India in future by 2050, enablers like rational pricing, rapid prototyping, cost reductions, increasing economics of scale, adoption of smart measures and more competitive supply chain are expected to make DRE penetration high in the integrated grid [39]. Eric Schmidt, the former CEO of Google, said a few years ago "Just think what will happen when India's entrepreneurial innovators can create great global companies without leaving their country.

V. RESULTS:

1. Security: Security is the essential pillar in the network and is the most important challenge for the IOT. Increasing the number of connected devices to increases the security challenges, which can expose user data to break-in by moving data flow ineffectively protected in some cases people's health and safety can be put at risk. For many end-users, they will finally need to acknowledge the cost vs. security agreement connected with mass-scale implementation of IoT devices.

2. Privacy: The IOT create challenges such that privacy issues are existed in present days. It is prevalent in customer devices, such that tracking the objects by using the mobiles and cars. Voice recognition are being combined that can listen to communicate and transmit the data to a cloud service providers for processing, which will connect to middle

party. The collection of data displays the legal and managerial threat facing privacy law. Data colection process with global scope that cross social and enriching borders. The strategies will need to be developed to esteem individual privacy choices across a broad spectrum of expectations, while still forward innovation in new technologies and its benefits.

3. Keeping IOT Hardware Updated: Data Integrity is a probable challenge in the industries who uses IOT. Data is coming from various sources; it's tough to separate useful, actionable information from irrelevant chatter. Sensors are embedded in many various devices, including power monitors, current champs, and more, and it's difficult to synchronize the data flow between all this hardware without the help of a professional team.

4. Cloud Attacks: The large amount of data will execute on IOT and can be stored in the cloud. The cloud service providers will the main targets in the cloud attack. Cyber-security is still under developed to the potential scale of the threat. The world budgetary forum analysis that cloud service provider could cause $120 billion of budgetary damage. The annual economic rate for cyber crime is now excepted is $l trillion and also approximately $300 billion from natural disasters.

VI. CONCLUSION

Internet of things is very useful to human life that can perform the task fast and smart automatically by using the intelligent virtual objects. By using this technology the user can get quality and accurate data to improve the efficiency. In this paper, discussed about the architecture model of iot with different layers to know how the data can be transferred from one layer to another layer, Here, to explained about the various devices in emerging technologies, applications of iot that can explain how the iot can be used in various fields, in the analysis section to explained about the market analysis of iot in various fields in India by 2050 and explained about the research challenges that can occur in IOT.

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