

IoT Technology: A Literature Review

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Abstract— IoT or Internet of Things is a new revolutionary technology for consumers and industries for better utilization of resources. This technology offers communication between two or more devices (or things) without or with minimal human interaction. Developments of various technologies like internet, wireless connectivity, sensors, big data, etc. have enabled IoT technology to work in the current environment. This paper will provide an insightful review of IoT technology, definitions, key enablers, and its various applications.

Keywords: Sensors, Internet of Things, IoT, Consumer IoT, Industrial IoT, Automation

I. INTRODUCTION

The “Internet of Things” technology is the fastest growing technology and its gaining popularity in both consumers sector as well as in the industrial sector. IoT consists of two main elements viz. the internet and things. Internet could be public or private and may be based on wired or wireless communication. Things are mainly objects, like- sensors, or any other device which can collect environment information and can use communication protocols to send this information on the network. The basic idea of this technology is to use as many sensors as possible from our nearby environment to achieve a common goal. These sensors could be Radio Frequency Identification (RFID) tags, heart rate monitors, vehicle telemetric, Closed circuit television cameras, mobile phones, etc. This technology is affecting the everyday life of users, whether it is home automation or it is real-time health monitoring, it offers a quality experience. For industries, IoT technology opened new doors to improve productions by incorporating sensors with machines. Impact of IoT technology can be felt by its place in the list of most 6 disruptive civil technologies, a list prepared by the U.S. national intelligence council [1]. According to “Forbes”, worldwide spent on IoT technology will reach USD 1.2 trillion in 2022 while “Ericsson” is expecting total cellular IoT connections would reach 3.5 billion in 2023 [2]. Smart fitness bands, health monitors, driverless cars, Amazon Alexa, biometric attendance, etc. are some examples of IoT technology.

II. DEFINITION

Though IoT is the latest trending technology, still it does not have any universal definition. There are many groups, researchers and organizations are available, those have defined it. According to IEEE, IoT is “A network of items- each embedded with sensors- which are connected to the Internet” [3]. According to ITU, IoT is a type of network which is available anywhere, anytime by anything and anyone [4]. OASIS describes IoT as “system, where the internet is connected to the physical world via ubiquitous sensors.” [5].

III. ARCHITECTURE

IoT technology is a broad concept, there is no unique architecture is available, but the general concept is the same in every architectural model. Some of popular IoT architecture models are discussed here.

A. Concept

Generally, IoT technology is a group of sensors, communication method and cloud-based services like AI, Big data, etc.

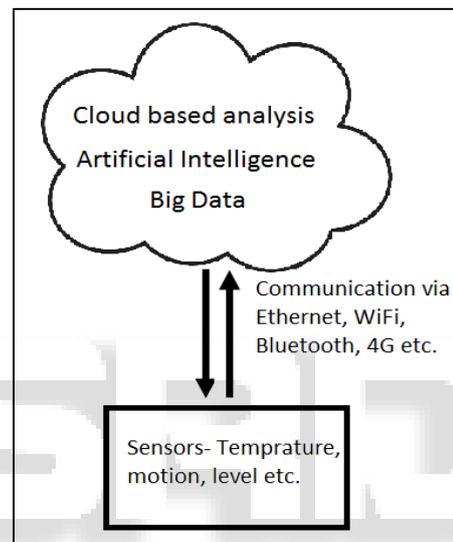


Fig. 1: General IoT concept

B. ITU architectural model of IoT

ITU reference model consists of 4 layers with security and management capabilities [6] –

- 1) Application layer – This layer provides supports for IoT applications.
- 2) Service and application support layer – This layer provides support like data handling, storage, processing, etc. to IoT applications
- 3) Network layer – This layer provides transportation service for IoT devices and applications.
- 4) Device layer – It includes capabilities like communication with networks with or without gateways, sleeping, and wakeup capabilities for devices, etc.
- 5) Management capabilities – These capabilities includes fault management, remote device activation/deactivation, network management, traffic management etc.
- 6) Security capabilities – These capabilities includes authorization, authentication, data privacy, data integrity, etc.

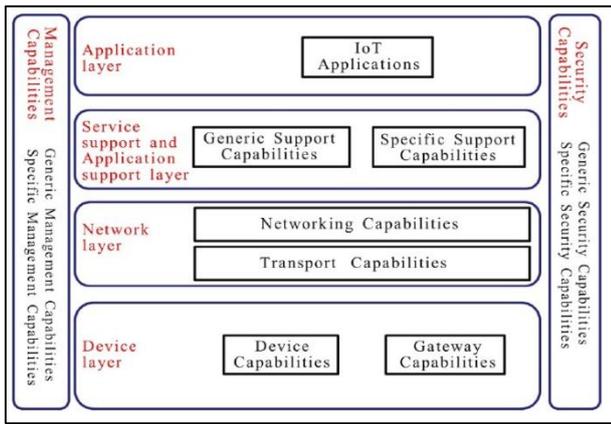


Fig. 2: ITU architecture of IoT, Source – [6]

C. IEEE P2413 architectural model of IoT

IEEE’s project workgroup P2413 has proposed IoT architecture as a 3 layered architecture, which includes application layer, sensing layer, and networking-data communication layer [3].

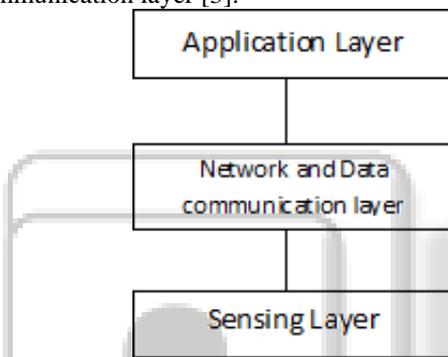


Fig. 3: IEEE-P2413 architecture of IoT, Redrawn from [3]

D. oneM2M Architectural Model of IoT

oneM2M model of IoT is also 3 layered architecture, it includes application layer, common service layer, and network service layer [3].

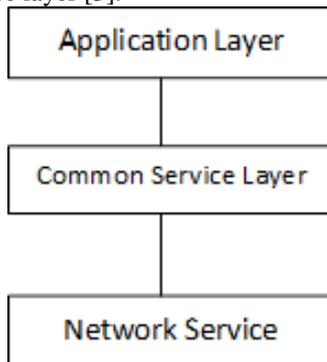


Fig. 4: oneM2M architecture of IoT, Redrawn from [3]

IV. KEY ENABLERS

IoT is not a single technology; it is a group of several existing intelligent technologies. Some of the important technologies are discussed here, those enabled IoT technology to come into existence.

A. IP (Internet Protocol)

This network protocol was developed in the 1970s. A first remarkable version of IP was IPv4, but as day by day networked devices like sensors, CCTV, smartphones, etc. are increasing, availability of unique IP addresses for each device reduced drastically. To overcome this problem, IPv6 was introduced, which can provide 2¹²⁸ unique addresses. In IoT technology, every sensor or devices can be assigned a unique IP address, based on the requirement. With the help of these addresses, devices or sensors can communicate to the central server. Communication between sensors or sensor and central server can be via wired or wireless mode.

B. Wi-Fi

It is a networking technology that allows high-speed wireless communication between networking devices and can penetrate walls. This technology was invented by Vic Hayes. It is based on IEEE 802.11 standards which came into existence in 1997. It normally uses two bands 2.4 and 5 GHz [7] and generally accepted as a high-speed default connectivity option for IoT devices. It is more vulnerable for attack than any wired network. There are many versions of 802.11 launched each with greater speed and range than to its precursor. This technology is quite popular and included in normally all smartphones, smart tv, smartwatch, etc. those are coming in the market nowadays.

C. RFID (Radio-Frequency Identification)

RFID is a wireless method to identify any object with an RFID tag. This system has mainly three components viz. antenna, transponder, and transceiver. Transponder with antenna is known as RFID tag, while the transceiver is a reader, which sends signals to the transponder to activate it. Once activated, the RFID tag can communicate with the RFID receiver. Mainly two types of RFID tags are available active tags and passive tags [8]. Active tags have their own power source while passive doesn’t. Active tags are bigger than passive tags due to the battery source. A most general example of RFID tags can be found in shopping malls, where these can be found attached to clothes, grocery items, etc.

D. Cloud Computing

Cloud computing provides on-demand computing to users as a service. It can provide platforms, infrastructure, and software as a service [9]. Since sensors have a lack of memory and processing power, cloud computing is used to analyze data, which is received from large numbers of sensors. Cloud computing also supports artificial intelligence for decision making, thus it can reduce human intervention. Cloud computing has many advantages like scalability, faster decision making, faster implementation, easy and global access with proper security.

E. AI (Artificial Intelligence)

AI is intelligence similar to human or animals, which can be shown by machines. AI can work with different kind of sensors to optimize resources; it can predict situations and can alert users before they occur so the user can take actions to avoid that kind of situation. Health monitors can detect sugar level, heartbeat, blood pressure, etc. and by using AI, these systems can alert a person before any unwanted situation

occurs. Same can be applied in industries for predictive maintenance of equipment. This technology also used in speed recognition, problem-solving, planning, etc.

V. KEY APPLICATIONS

IoT technology is now being used in almost every sector. IoT devices and their uses are increasing every day. Some general applications of IoT technology have been discussed here.

A. Industries

Industries are a major consumer IoT technology. It can be in industries for process control, quality control, etc. Sensors can be used to sense level, temperature, humidity, movement, weight, etc. Control valves use actuators control the flow of any line. DCS, SCADA, PLC are some IoT based technologies; those are used by industries for control operations. Sensors can help in predictive maintenance. Robotic technology can be used, to work in a hazardous environment. Robots can perform jobs that may require intense work or those are time-consuming.

B. Home Automation

Home automation or smart homes are homes with smart technology which generally includes auto lightening, auto heating, monitoring of appliances, surveillance cameras with recording, motion detectors, theft alarm, fire alarm, auto call, auto door lock-unlock, door opening/closing mechanism, access control, automation of entertainment system, etc. These homes normally use AI to implement smart technologies. Smart homes can change the home environment based on the user's mood, they can also cut electricity if any fire or smoke detected. They can detect fire, smoke, intrusion, and can inform the resident or local authority as per the setting of the system.

C. Smart Cities

Smart cities use smart technologies for better management of transportation, education, power, sewage, water, safety, security and traffic control of the city. Smart cities use IoT sensors to collect data from the city for analysis and implementation. A smart city is generally based on four major pillars- physical, institutional, social and economic infrastructure [10]. Smart cities may have their own power generation through solar or wind energy. They may have installed telematics for vehicles. They use ICT technologies in the education field for better education, which includes the use of the Internet, interactive lectures, projectors, etc.

D. Healthcare

IoT devices have been deployed in the healthcare sector widely. Whether it is a smart fitness band or it is a pacemaker, IoT shows its significant uses in all smart healthcare products. Using IoT technology in fitness band one can observe real-time heart rate, calorie intake, calorie burn, sleeping pattern, etc. Some types of smart devices can be implanted in the human body for better evaluation and prognosis.

E. Agriculture

Use of IoT technology in agriculture field can improve production. IoT sensors can monitor pH, CO₂ levels, nutrients, moisture, and fertilizer content of the soil. AI and

IoT integration in farming can use weather forecast with other data to provide optimal support to farmers, so farmers can take a particular action on time. IoT technology can be used to monitor livestock also. GPS and RFID can track livestock location. Sensors like temperature, humidity, etc. can sense the environment and based on data, cloud computing or edge computing can suggest a better environment for livestock.

VI. CONCLUSION

IoT technology is still in its growing phase and will get its place in every sector in the near future. This technology is a group of many existing technologies and now being used in consumer as well as in the industrial sector. Day by day size of sensors and devices is becoming smaller, so these can be used in every environment. This technology is being used for enhancing life quality experience as well as for improving the production of companies. Though this technology is in demand, still it faces some challenges including security, compatibility, privacy, etc. those needs to be rectified. This paper tries to give some insight into this technology including definitions, architecture, and applications after reviewing various research papers and online database.

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