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A Recent Survey on Enabling Technologies for Internet of Things

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Abstract **- As a new technology, the IoT has a significant impact on how we live our daily lives. Day-by-Day, the number of Internet connected devices are rapidly increased due to the smart human life and optimizing the resources, etc. In this survey, we discuss the introduction about Internet technologies. Later on, we will go over in detail the different wireless communication enabling technologies, both short and long range, that are available. Finally, we present the conclusion about IoT enabling technologies.**

Keywords- Enabling Technologies, Internet of Things, Wireless Communication , IoT Applications.

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I. INTRODUCTION

The IoT is one of the newest research disciplines in modern technology, and it is drawing increasing interest from both the industrial and academic groups. According to [1-3], the IoT is a collection of physical objects that are linked to one another over the Internet. In this case, the physical devices are capable of communicating with one another without the assistance of a person. Kevin Ashton coined the concept IoT in 1999, and it has been in use ever since. Globally connected devices are shown in Figure 1 [4, 5]. As human society advances, the number of Internet-connected gadgets grows year after year. The total number of devices is connected approximately 33 billion devices in year 2020. Approximately 73 billion devices are expected to connect by 2025 [6-8].

Every day, more and more devices are connected to the internet. So, the wireless connectivity is most important to exchange the data between the things. Short-range communication such as Wi-Fi, LTE, Bluetooth, and Zigbee are used by the overwhelming majority of Internet of Things (IoT) applications. Especially, the long range wireless technology is needed for outdoor applications like unmanned aerial vehicles and environmental monitoring. There are few long range communication technologies are available to monitor the outdoor activities. The long range communication technologies are Sigfox and LoRa (Long range wireless Communication). The LoRa network is well suited for devices with low data rates and power consumption in the network. The best application of LoRa is smart cities. It is quite similar to the traditional cellular network.

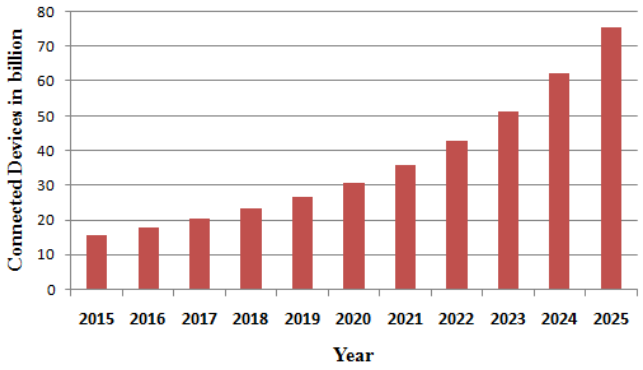

FIG.1 NUMBER OF DEVICES IS CONNECTED TO THE INTERNET IN WORLD WIDE

II. IOT ENABLING TECHNOLOGIES

In future, billions of devices are expected to connect in Internet. So, we need appropriate wireless technologies to transfer the data from one thing to another. The communication technologies are categorized into two types. One of these technologies is short-range communication. The second kind of technology is long-distance communication. Bluetooth, Zigbee, and Wi-Fi are examples of short-range communication. The long range communication are LTE, 5G and LPWAN, etc [9-14].

A. Short range Technologies

It establishes the connection between small areas. The brief discussion of short range communication technologies are discussed below.

The information gathered by IoT devices must be aggregated, processed, and analyzed locally and over a greater distance to access the cloud. Information gathered via wireless-enabled sensors may be small, and, except for Wi-Fi, all short-range IoT connectivity options incorporate a variety of networking capabilities. Mesh networking is best suited for devices that communicate without data passing through a router or gateway hub.

Short-range solutions are required as follows:

a) IoT devices that communicate with each other over a network, preferably mesh
b) The ability to support a large number of networked IoT devices
c) Enabling IoT devices to operate on coin cell batteries for years
d) Robust security
e) The lowest possible complexity and hardware costs
f) Internet Protocol Version 6 (IPv6)

There are several classic technologies working on IoT platform to provide communication through different mediums on a shortest distance. Classic connectivity protocols are working under various factors like range, distance and sources. In short range of communication over IoT, there are 6 methods had developed by standard protocols to perform this.

- LPWAN
- Bluetooth
- Wi-Fi
- Zigbee
- RFID
- Cellular

i. LPWAN

It is a communication technique that works over a short distance between two points in order to send data between devices. The application areas are occupancy detection, environmental monitoring, asset tracking, etc. Generally, the LPWAN can exchange the small amount of data i.e., low data rate. Hence, it is not required high bandwidth on the operating environment. Day-by-day, the use of LPWAN is growing significantly. In addition, the availability of LPWAN is projected to cover 100% of the total population.

ii. Bluetooth

Bluetooth is a protocol which is used to transfer data to a shorter range with very fast and effectively. Though distance is low, speed data transmission is possible between the nodes. In recent years, the BLE is enabled in electronic devices like smartphones which is used to exchange the data to the cloud. Furthermore, it is also using in fitness, medical devices and smart home devices.

iii. Wi-Fi

Wi-Fi is an abbreviation for wireless fidelity. It was invented by Wi-Fi Alliance. The personal computer, smart phones, smart speakers, drones, etc. It provides the extra coverage than Bluetooth technologies. It is not suitable for large scale networks with battery operated network devices. It is more suitable for smart home, security surveillance based applications. Wi-Fi 6 is the new generation of Wi-Fi, which provides extra bandwidth to increase the through while exchange the data.

iv. Zigbee

ZigBee is a wireless technology, which supports low memory, slow processing and low cost networking protocol for remote monitoring as well as automation applications. IEEE and ZigBee alliance jointly introduced the protocol stack. The physical, the data connection, the network, and the application layer are all subdivided into these four categories. Topologies supported by the MAC and physical layers include star, cluster, and mesh. The routing protocol ensures the energy consumption, throughput and low latency. The important feature of ZigBee is data redundancy in the mesh networks.

v. RFID

RFID consists of one or many readers and so many tags. Tag has separate unique identification number that we can the tag in our objects. Usually, the tags use the radio frequency electromagnetic signal. The RFID reader reads the tag's electronic data. The primary goal of RFID is to provide real-time monitoring of physical items in the environment. The RFID tag contains one small microchip that combined with antenna. The signal from the reader is received by the tag antenna and sent back to the reader. Hitachi has produced a very tiny tag.

vi. Cellular

This reliable broad band communication is used to transfer data between short rang devices using cellular mobile networks. It can connected with IoT devices for sending voice and video streaming applications. It is mainly used to tracking of devices and other mediums through cellular network protocols the entire data has sent to different places with in a short range. In-car entertainment as well as fleet monitoring and telematics services may be supported by the ubiquitous and high-bandwidth cellular connection.

The following Figure 1 denotes the ranges and bandwidth of all short communication technologies

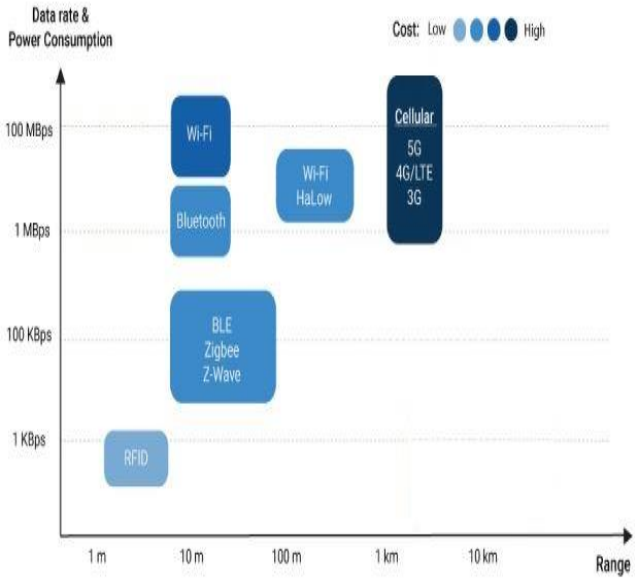

FIG.1 SHORT RANGE COMMUNICATION TECHNOLOGIES

The major connectivity solutions available today are shown in Table 1. Wi-Fi, in existence longer than other short-range technologies, is fundamentally different. It was never intended to deal with tiny, power-stripping devices like IoT sensors, as the goal was to provide high-speed data and replace wired networks. Wi-Fi is power hungry and depends on fairly expensive components. However, its throughput ensures its appeal as an adjunct to connect low-power solutions, such as video surveillance to the Internet. Several short-range wireless technologies are compared in Table 1.

TABLE1

COMPARISON OF DIFFERENT SHORT-RANGE WIRELESS TECHNOLOGIES

	Bluetooth 5	**Wi-FI**	**6LowPAN**	**Z-Wave**	**Zigbee**
Standard	802.15.1	802.11 a, b, g, n, ac	802.15.4	802.15.4	802.15.4
Maximum coverage range (m)	200	40	10	100	100
Mess Support	Yes	Yes	Yes	Yes	Yes
IPv6 Support	Yes	Yes	Yes	Yes	Yes
Maximum data rate	2 Mbps	2.4 and 5 GHZ	565-915 MHZ 2.4 GHZ	100kbps	60kpbs

B. Long range Wireless Technologies

Long range IoT communication is on the basis of Low Power Wide Area Network (LPWAN). In LPWAN, the devices are low power, small memory and low processing ability. In that, the sensors are connected wirelessly in the gateway. The gateway is connected with Internet. The long range communication technologies are developed to fulfill the requirement of LPWAN devices [15-17].

i. *Cellular wireless/LTE*

The device can connect directly to the internet without gateway in cellular networks. For this, the devices need SIM card to exchange the data in cloud. With help of network service provider, the data will be send to the receiver. The development of cellular network is to increase the data transmission rate. Long-term evolution (LTE) is a relatively new communication technology that has the potential to enhance data transfer speeds by roughly 3.9 Gbps.

ii. SigFox

SigFox supports long range communication technologies, which covers 30 to 50km in rural areas and 3 to 10 km in city sides. It uses BPSK modulation and also used the ultra narrowband. In reality, the SigFox system is made up of end devices and a base station. The data is generated by the end devices, which then send it to the base station. The SigFox base station is connected with Internet. It has own cloud infrastructure and all the data will be stored in it. SigFox based infrastructure is under construction. The French based companies decided to use this technologies nearly 10 to 50 cities within 6 months.In this technology, threre is no SIM card. but we have to pay money on the basis of number of messages sent by the person or devices.The SigFox uses the Atmel's family microcontroller. To improve the processing ability, the ATA8520 is conneted to all the microcontroller, which is present in the end device.

iii. LoRa

In the wireless communication world, LoRa is an acronym that stands for long range wireless technology, which is quite similar to SigFox. it maximum supports nearly 15 km. it is highly expensive when compared to all the wireless communication technologies. The LoRa Alliance was introduced the technology in year 2015. It is made up of LoRa end devices, a network server, a gateway, and an application server, among other things. The LoRa end devices generate the data and it will be send to the LoRa gateway. The gateway is connected with network server. The network server stores all the sensor data. Withhelp of application either web application or mobile application, user can control or monitor the devices. The key features of LoRa is long range, low power, secure, enabled the geolocation, mobility and high capacity. The applications of LoRa technologies are smart city, air pollution monitoring, Fire detection, Fleet monitoring, Industrial monitoring, etc.

Table-2 shows the various recent long range wireless technologies.

TABLE2

VARIOUS RECENT LONG RANGE WIRELESS TECHNOLOGIES

Attribute	**LTE**	**SigFox**	**LoRa**
Range	1km-10km	3km-50km	2km-20km
Power consumption	Medium	Low	Low
Module cost	$8-$20	Below $5	$8-$15
Throughput	Up to 1 Mbps	Up to 100 bps	10kbps-50 kbps
Ongoing cost	Recurring	Recurring	One-time
Topology	Star	Star	Star

III. CONCLUSION

The IoT is one of the new innovations that allows us to live our human life better. Day-by-day, the number of Internet-connected devices is increasingly growing due to smart human life and resource optimisation, etc. In this survey, we discussed the introduction about Internet technologies. Later, we elaborately discussed the various short-range and long-range wireless communication enabling technologies.

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