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Internet of Things(IoT): Applications and Challenges

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Abstract

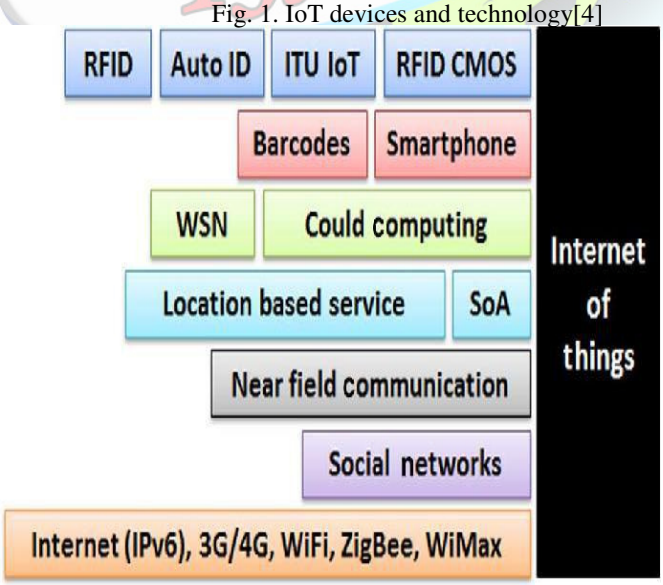
Internet of Things (IoT) is the collection of connected devices such as sensors and actuators communicating over the internet for generation and sharing of data. It is the next generation of internet so that physical world could get connected to the logical world. Now days, because of the popularity of smartphones, everyone is having access to the internet. Smart phones can be connected to devices over the internet and controlling can be done. Communicating devices became possible due to advent of wireless technologies like wireless sensing network that connects the sensors and actuators together for various applications. It looks very interesting, but in actual there are many challenges towards the development of IoT like security, heterogeneous devices, no defined standards, power consumption, size, amount of data generated, mobile computing architecture etc. In this paper we will discuss various application areas and challenges faced towards the development of IoT devices.

Keywords: IoT, RFID, GPS, tracking, QoS.

Introduction

Internet of things (IoT), it is nothing but the combination of network of various physical objects with electronics, software and network connectivity, which enables these physical objects to collect and exchange data between var ious sources to destinations[1].The Internet of Things (IoT) is a novel design which is rapidly gaining the importance in modern wireless communication systems. The basic or fundamental idea behind this concept is the pervasive presence around us of a variety of things or objects – such as Radio-Frequency Identification (RFID) tags, sensors, actuators, mobile telephones, etc. are able to interact with each other and cooperate with their neighbors to reach common goals[2]. As shown in the Fig. 2, the Internet of Things (IoT) is the network of devices featuring sensors and/or actuators as wellas internet connectivity, allowing them to both interact with the environment and exchange data over the internet. Some estimationpredicts that this network will grow to encompass 50 billion connected objects by 2020[3]. Every day new devices are adding up to the internet growing the count of connected devices. It is making the things smart so that physical world could get connected to the logical(Virtual) world. The applications of IoT is growing in various industries like manufacturing, agriculture, transportation, security and surveillance, food processing, environment monitoring, tracking systems etc.[4][14]. This review paper is focused upon the applications and major challenges faced in the development of IoT devices.

Fig. 1. IoT devices and technology[4]



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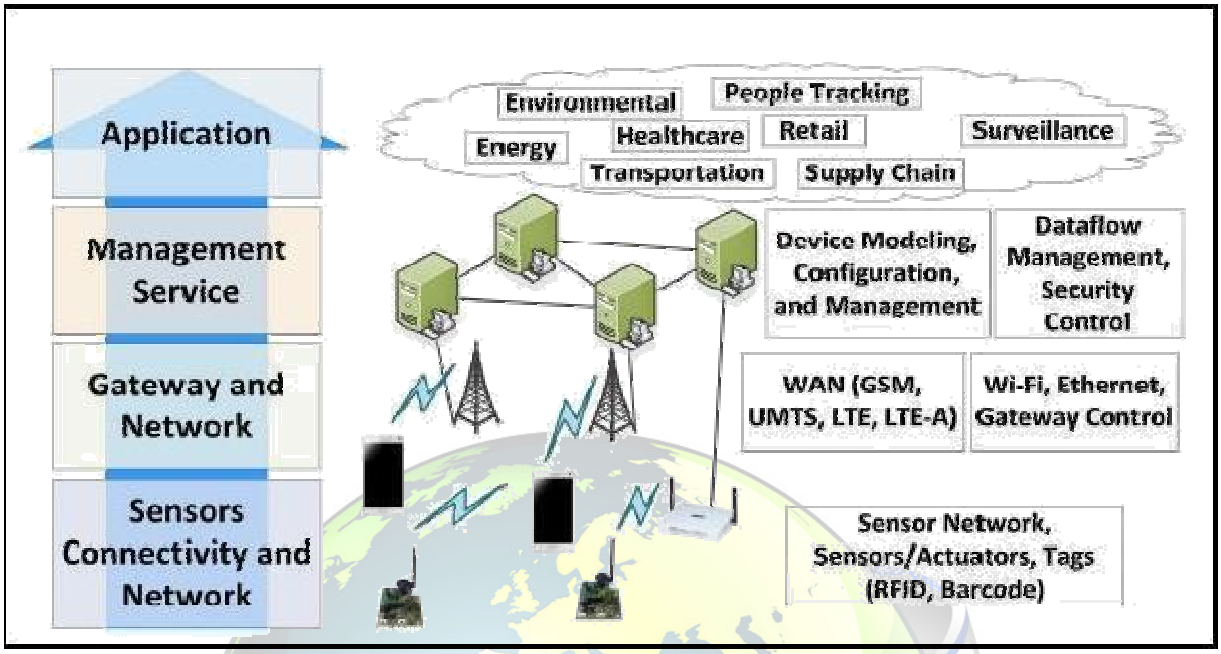

Fig. 2. Layered architecture of IoT[5

Applications

IoT have found it's applications in various areas starting from healthcare, manufacturing, transportation, tracking systems, logistics management, home automation, security[15] etc. some of them are explained below.

1. **Healthcare:**In health care IoT can be great help, be it recording the data about the patient, reminding the patient to take medicine, diagnostics report generation, pulse rate detection, blood sugar level detection in blood. IoT device can collect and transmit the health related data to the diagnostics center or the doctor so that corrective measures can be taken before hand[4][13]. It will save the time for the patient. Now days we can see some wearable gadgets like Fitbit, smart watch, that keeps on monitoring the persons physical activity and keeps on providing the details on its own display or to the smartphone that have an application installed to interface the device. It becomes the personal fitnessmonitor that can remind you about your physical activity. One can set the target also.

2. **Transportation and Logistics:**When you go to the shopping mall, select some goods and reach the billing counter, the person just uses some barcode scanner to get the item details like price, item code, item name, discount available etc. within a fraction of second and it gets printed on the bill too. Objects are generally fitted RFID[12], Barcodes, sensors that can provide the location, destination, sender information etc. with a little amount of time[4]. Even RFID have found its application at toll plaza, Metro station, turnstile gating and so many other places to make it convenient and time saving process.

3. **Tracking:**Cars, Busses, Trains can have some GPS device embedded in to it[8-9]. That GPS device gets connected over the internet and one can track the location, speed, millage, fuel consumed, miles covered, by the vehicle. Now a days you can book a taxi(Uber, Ola) online using your smartphone and can track that when it will reach to pick you. This all have become possible due to connected devices only.

4. **Environment Monitoring:**With the development of various kind of sensors like, smoke sensors, radioactivity sensors, gas sensors etc., it have become possible to design a sensor network that can capture and exchange data so that if some environmental conditions are changing at some place, alarm could be raised and corrective actions can be taken to control the situation. Some examples related to the same are

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detecting the conditions for avalanche in snow hit high altitude areas like Siachen, gas or water leak detection in mining, radio activity detection in nuclear reactor etc.

5. **Surveillance:** Unmanned aerial vehicles popularly called as Drone are gaining a lot popularity now days. A drone is a connected device that receives commands from ground and sends the pictures or video stream to base station. It is used to monitor the ground activity from air. Drones were used by US military during Afghanistan operation to locate or destroy the militant camps.

6. **Home Automation:** IoT plays a great role to control the consumer appliances and security systems installed at home. Various devices are connected over a local network at home, generally a Wi-Fi router, that further connects the network to the internet[1][10]. The owner have some kind of application installed in his connected device like smartphone or laptop by that he/she can control the devices like AC, TV, CCTV cameras, Lights, geyser etc.

7. **Agriculture:** Environmental factors play a critical role in agriculture. Moisture level, temperature, soil information collection are some of basic things need to be considered. Real time data collection is done for these parametersand processed by the server so the farmer could be assisted to take corrective measures that help to increase yield[99]. Biosensors can be used to check the quality of the food.

Challenges

1. **Low resources in terms of computational power and energy:** IoT devices are very small and handy, most of the time part of larger system, fitted in to some remote location, battery operated. Because of this kindof uses, IoT devices contains bare minimum set of resources like microcontroller, amount of RAM, ROM, transmitter and receiver. So it limits its functionality like data transmission range etc. So IoT are mostly used in near field communication or in a cluster so they need some sort of network backbone.

2. **Attractive target to hackers:** The devices in IoT are exchanging the data over the internet and that too wirelessly and it has become the attractive target for the hackers to attack and manipulate the data[6]. What if somebody hacks into the driverless car's network and changes the destination or route? We can use some encryption and decryption mechanism so that hackers not be able to detect the data, but this will demand more resources in terms of processing power, memory and electric power.
3. **Lack of standards and common platform:** One of the biggest challenge that is being faced by IoT is lack of standards[11], i.e. there are no set of rules defined that how the different devices will generate and understand the data, communication protocols, different kind of architectures by different developers. One of the common example for the same is some of the devices are compatible with Android platform and some with iOS only, like the Bluetooth connectivity in iPhone. There are various organizations who working on it like European Standards Organization, IETF, ETSI, IETF etc[7].
4. **Data generation and management:** IoT devices keep on generating huge amounts of data. The problem is to identify that what data is required and what is to be discarded[6]. The generated data will be a raw stream of sensor data. Noisy data can also captured by the sensor. A camera installed for face detection will be capturing the real life images. Now it have to make the decision that only the image data that contains face have to be captured and sent, not all the images of every moment have to captured. Some data mining techniques have to be applied to generate the knowledge base. If the device keeps on sending all collected data than it will consume more bandwidth as well as power for transmission.
5. **Connectivity:** Every day a lot of IoT devices are coming up. Many of them are sharing the network space. It is becoming a problem to share the network bandwidth among the connected devices and maintaining the QoS. The performance of network may go down because the devices have to transfer and receive the data over the network[4]. Scalability or on demand access is one of the solution to the problem so that in the event of more devices demanding access to the network, network could be scaled up to increase the bandwidth.

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Table 1.Characteristics and standards related to IoT Devices

Standard	Objective	Status	Range(m)	Data Rate(Kbps)
EPCglobal	Integration of RFID technology into the electronic product code (EPC) framework which allows for sharing of information related to products	Advanced	<1	100
GRIFS	European Coordinated Action aimed at defining RFID standards supporting the transition from localized RFID applications to the Internet of Things	Ongoing	<1	100
M2M	Definition of cost-effective solutions for machine-to-machine (M2M) communications, which should allow the related market to take off	Ongoing		
6LoWPAN	Integration of low-power IEEE 802.15.4 devices into IPv6 networks	Ongoing	10-100	100
ROLL	Definition of routing protocols for heterogeneous low-power and lossy networks	Ongoing		
Wireless Hart	Definition of protocols for self-organizing, self-healing and mesh architectures over IEEE 802.15.4 devices	Advanced	10-100	100
ZigBee	Enabling reliable, cost-effective, low-power, wirelessly networked, monitoring and control products	Advanced	10-100	100

Conclusion

With the advancement in mobile computing architectures, development of sensors and actuators, the devices are becoming cheaper, small in size and affordable. People are using more gadgets. The difference between the physical world and the virtual world is narrowing down. Industry is moving towards automation from switching off the AC from a remote location to surveillance and security using drones. The world moving towards the development of driverless cars. It all has become possible with the use of connected devices. The new areas of application from personal healthcare to space missions are getting added up. Challenges in the form of data security, privacy protection, scaling, connectivity, huge data collection, lack of standards need to resolve. Research is going on to solve the problems; still a lot needs to be done. In this review paper some of the application areas and challenges faced towards the development of IoT devices are discussed. People have started accepting IoT as an important part of their life, moving towards the automation . Both researchers and industry are working towards addressing the key issues being faced.

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