

# Chapter 27

## Future Internet of Things (IOT) from Cloud Perspective: Aspects, Applications and Challenges



Nahid Sami, Tabish Mufti, Shahab Saquib Sohail, Jamshed Siddiqui,  
Deepak Kumar, and Neha

**Abstract** The technological development has changed the way we live. With the fast pace by which technology is advancing to an ultra-era of computerization, the perception and behavior of our daily life has also got a new direction. With early days of advancement when desktop computers had been perceived as a revolution, people started to rely upon digital transformation. But as the Internet has grown exponentially, desktop is considered as ‘gone are the days’. In the recent emergence of cloud services and Internet of Things (IoT), the various services and applications are applied without having any physical resources at one’s hand. Since, Internet of Things is proved to be very influencing and has become fastest growing technology which is very evident as it is reported that IoT Devices will cross 21 billion by 2025. IoT provides infrastructure for real time objects and also help in keeping track about these objects by connecting devices smartly so that they can share data and resources with other machines. IoT uses various types of sensors embedded in various devices which emit data. These sensors share data using IoT common platform. This chapter aimed at studying different aspects of IoT. With the help of the detail discussion carried out in the work, the researchers can get a clear insight of how IoT can be perceived in future; also what could be the possible ways of utilizing cloud resources in the application of IoT. The study is believed to be useful for the researchers especially seeking research dimension in the field of cloud computing and IoT.

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N. Sami · S. S. Sohail (✉) · Neha

Department of Computer Science and Engineering, School of Engineering Sciences  
and Technology, Jamia Hamdard, New Delhi, India

T. Mufti

Department of Computer Applications, Faculty of Computer Science and System Studies,  
Mewar University, Chittorgarh, Rajasthan, India

J. Siddiqui

Department of Computer Science, Aligarh Muslim University, Aligarh, India

D. Kumar

Amity Institute of Information Technology, Amity University, Noida, India

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## 27.1 Introduction

The extraordinary growth in the technological devices and the proliferation of Internet has made the things very different from what they were perceived few years back. The recent advancements in the technology has given birth to Internet of Things (IoT) and cloud computing. The various techniques have been suggested by the researchers to incorporate these two techniques together to make use of the features of the duo in a more effective way (Zhang et al. 2015; Munir et al. 2017; Rindos and Wang 2016). In the recent emergence of cloud services and Internet of Things (IoT), the various services and applications are applied without having any physical resources at one's hand. Since, Internet of Things is proved to be very influencing and has become fastest growing technology which is very evident as it is reported that IoT Devices will cross 21 billion by 2025 (Främling et al. 2014; Kobayashi et al. 2014). IoT provides infrastructure for real time objects and also help in keeping track about these objects by connecting devices smartly so that they can share data and resources with other machines. IoT uses various types of sensors embedded in various devices which emit data. These sensors share data using IoT common platform. These platforms collect data from various sources and then further analytics are performed on data and essential information is extracted before the result is concluded. Since, these resources is not easily available at every place, further, the cost is not affordable for all the research communities (Sohail et al. 2012). Hence, the cloud based services for IoT technologies would not only enhance the research performance but also it may reduce the cost and complexities in the implementation of several experiments. In future the devices can be implemented in smart farming, pulse oximeter, air pressure detection, smart eye and many more. It can also be used to figure DDoS (Distributed Denial of Service) attack by cyber criminals (Elkhatib et al. 2017; Abdelshkour 2015). These devices will be fueled with 5G network that will connect the 5G IoT devices directly with the network without using Wi-Fi router (Alam and Shakil 2013; Alam et al. 2013). But for using the smart devices, human need to be smarter as the rapid growth of these IoT devices give rise to privacy and security concern. These devices can be weaponized which in result may give adverse effect. This chapter aimed at studying different aspects of IoT. The chapter is organized as follows: the Sect. 27.2 deals with the background of the paper and illustrates how different sections are related. Section 27.3 gives the applications of the IoT from the perspectives of the cloud as reported in the literature, whereas Sect. 27.4 has a great insight of what IoT may look like in future. Finally the chapter is concluded in Sect. 27.5.

## 27.2 Background

### 27.2.1 Understanding IoT

In our daily life we have often come across modern and digitally equipped infrastructure where we find real objects which are connected to the internet. These real objects are electronic products that span over varieties of electronic gadgets, modern systems, intelligent sensors or smart devices. When these systems are connected to Internet, they are usually referred as “IoT-enabled” devices (Kim et al. 2015; Singh et al. 2015). The simple inference of the term IoT enabled is that the device is connected to the internet. These IoT enabled products can communicate data and able to be operated remotely which gives sense of an automated system. The exponential growth in the field of IoT can be understood by the truth that it has grown the attraction of the market and almost in all sectors of daily life it has received huge investments recently (Ahuja and Deval 2018; De Cremer et al. 2017; Karimi and Atkinson 2013; Sohail et al. 2014; Fleisch 2010). Figure 27.1 shows the details of IoT expenses in different sectors (<https://www.zdnet.com/article/what-is-the-internet-of-things-everything-you-need-to-know-about-the-iot-right-now/>; <https://www.pocket-lint.com/apps/news/126559-internet-of-things-explained-your-complete-guide-to-understanding-iot>).

### 27.2.2 IoT and Its Relation with Cloud

The Internet of Things facilitates the users to use the connected devices for their use with the modern and updated equipped technology. Below in Fig. 27.2, we have shown a diagrammatic representation of how the different cloud based ToT services can be provided to users for better facilities (Yassine et al. 2019; Sohail et al. 2018a; Cui 2016).

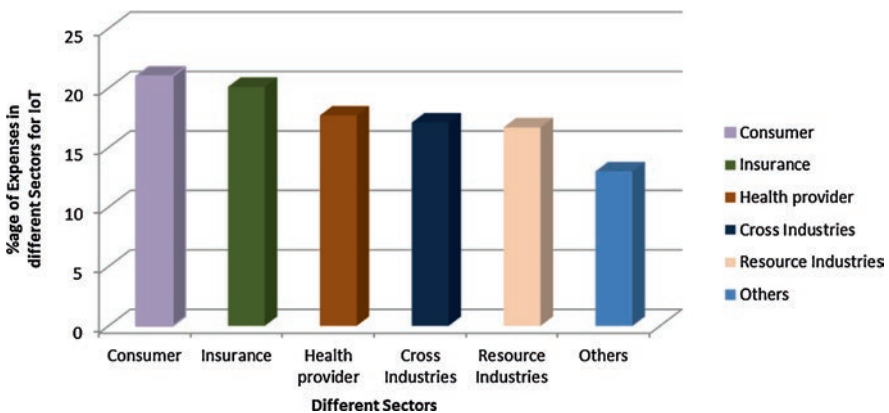
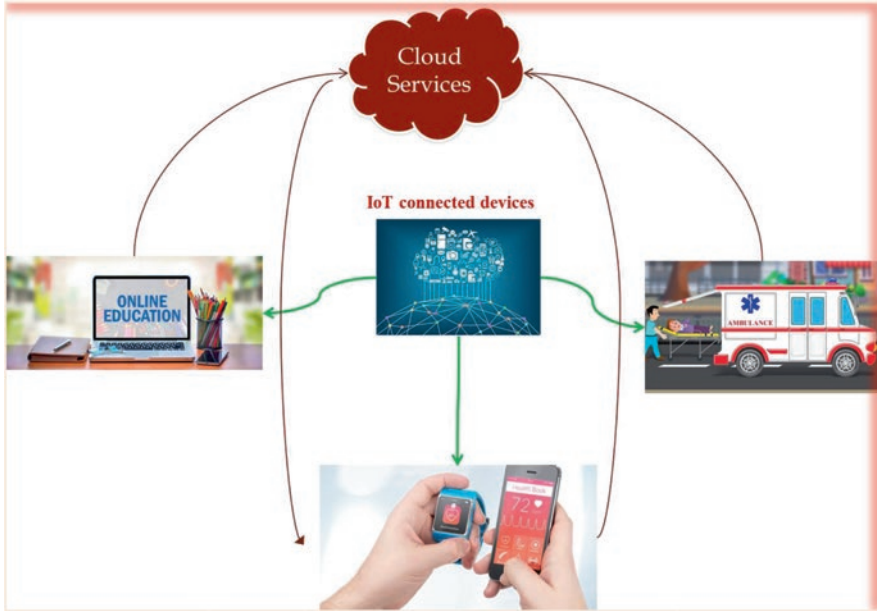


Fig. 27.1 IoT expenses in different sectors

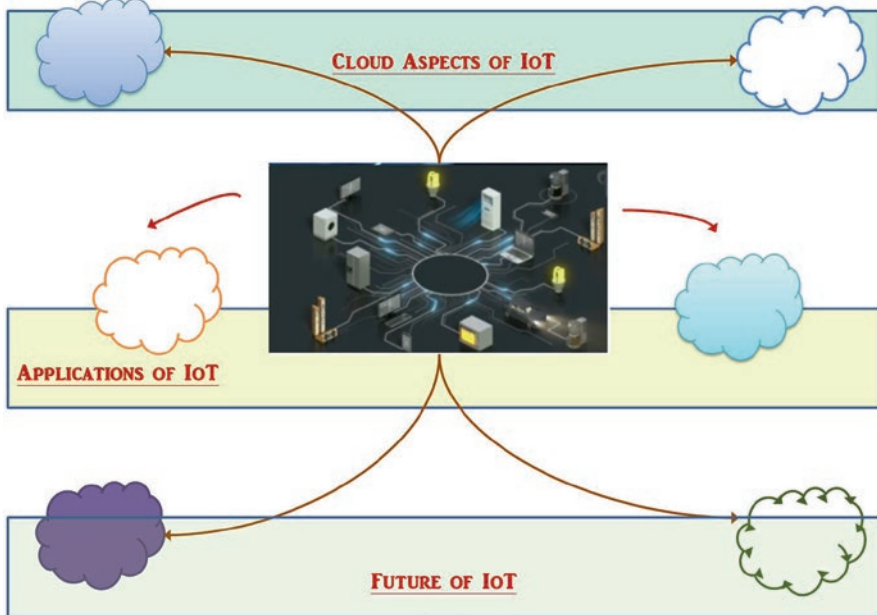


**Fig. 27.2** IoT services at cloud

In this chapter we have tried to simplify the futuristic opportunities of IoT and highlights the advantages of the cloud computing and IoT when combined together. The chapter presents cloud aspects of IoT, applications of IoT and their cloud importance, and future IoT. These contents are provided in the Fig. 27.3 below for the readers.

### 27.3 Application of IoT

The emergence of IoT has introduced new technologies and has successfully explored several areas of research. On a keen observation of several online trends, we have come to know three trends of online social media behaviors i.e. the Google search, the twitter and the LinkedIn feeds, an approximate score of 100 percent will be achieved as per a study conducted wherein the other applications using IoT ranked with a correspondingly relative percentage to the highest score. IoT offers many applications, uses and solutions but the major solutions directly related to our day to day life as well as economic usage of resources are enumerated below (Kodali et al. 2016; Alam et al. 2012; Gram-Hanssen and Darby 2018; Ashton 2009).



**Fig. 27.3** The different aspects of IoT from cloud perspectives which have been discussed in the chapter.

### 27.3.1 Smart Home

Creating a smart home what does it mean, 100 years ago smart was able to turn lights on-off with the switch on the wall (Ashton 2009; Wijaya et al. 2014). The term smart means we can take control of your home with smart phones, tablets or another digital devices. By making things smart the things able to do work them self without you have to do anything at all like the lights turn on – off when the sun goes up and down or the lights turn on automatically when you arrive home or you turn on car through smart phone while having breakfast in the morning for better to save time (Alam et al. 2012; Gram-Hanssen and Darby 2018) According to the same study, approx. 60,000 people look for the term “smart home” every month which is quite believable because the IoT analytics company database preserves a database of 256 companies and startups for smart homes. The funding received to the startups for smart homes is above \$ 2.5bn which includes multinationals like Haier, Philips and startups like Nest, AlertMe etc. (Främling et al. 2014; Sohail et al. 2012)With increase in need of innovation IoT provides the way to easily operate smart devices from a single touch. Allen Pan’s Home Automation System used string of musical notes for the functions done (Mardacany 2014; Fig. 27.4).

Fig. 27.4 Smart home

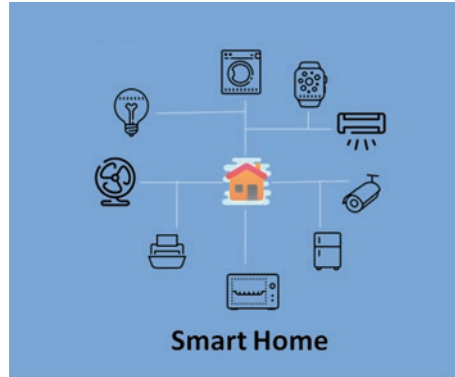
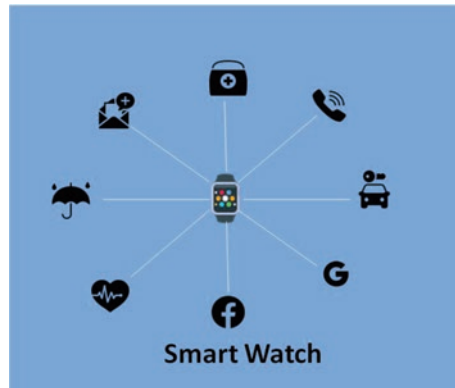


Fig. 27.5 Smart watch



### 27.3.2 Wearables Technologies

Another hot topic of IoT searches is Accessories like smart watches, trainers, smart bracelets and the like. Although Apple’s smart watches led the race in 2015. However since then, plethora of other devices has gained customer’s attention like the Sony Smart B trainer, Myo control LookSee bracelet. The startup by the name of Jawbone has received a record funding of more than half a million dollars in IoT wearables market. Wearable technology has a variety of applications being incorporated into navigation systems, quick trackers and healthcare (Repko and DeBroux 2012). In 2004, fashion design label invention called Hugshirt won the grand prize at the Cyber Art Festival in Bilbao, Spain. Fitbit released its first wearable around 2009 they basically works on active tracking (Fig. 27.5).



Fig. 27.6 Smart city

### 27.3.3 *Smart City*

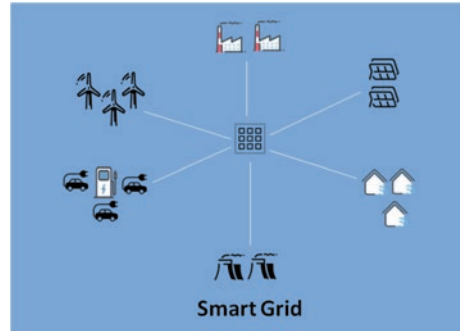
In today's overpopulated metropolitans, citizens can only dream of cities which provide solutions to the day to day challenges they face in their lives (Abdelshkour 2015). Smart city is one such term which has gained popularity over the internet because of smart solutions to traffic woes, reduced noise and environmental pollutions and safety promise of such smart cities which are very few in the world but definitely possible due to the given level of technology and science (Ejaz and Anpalagan 2019). IoT is drastically used by the engineers and government for solving the issues faced globally for the better water management, (Ahuja and Deval 2018) increasing urban density, clean drinking water, analyzing air quality and often complex factors of town planning specifically to aid the problems facing by them. Palo Alto, San Francisco, is the first smart city which used new approach for traffic management (Gassmann et al. 2019; Fig. 27.6).

### 27.3.4 *Smart Grids*

A conceptualized Smart Grid of future resolves to use the supply and demand of electricity based on usage and consumption patterns in order to increase the efficiency, reliability and economics of electricity. Every month approx 40,000



**Fig. 27.7** Smart grids



searches on Google highlight the popularity of this concept. However because of the lack of technical and conceptual knowledge reduces the number of tweets on this topic. With more than half of the world population using IoT for making the cities ready for tomorrow’s needs so that they can explore new opportunities, solutions and mechanisms to digitalized by creating a smart grid (Khatiwada 2018; Tsiatsis et al. 2019; Wang et al. 2010; Nogueira and Carnaz 2019; Fig. 27.7).

### 27.3.5 *Industrial Internet*

Unlike the consumer oriented IoT concepts, an upcoming industrial IoT concept that has been on a rage on internet both on Google and twitter as well as LinkedIn feeds is “Industrial Internet”. Market research companies like Garter, Cisco etc. see Industrial internet as a potential promise but due to its lack of popularity among the masses it lags behind other consumer related IoT solutions. However, Industrial Internet gets the biggest word on twitter with approximately 1700 tweets per month. By connecting the machines, turbines, tools and devices in industries to a central Internet connection which has the capacity to collect, store and utilize data in instances of unplanned downtimes or system failures. This will not only boost as well as stabilize the production cycle but also ensures regulated growth and improvisation. The products quality is one of the major factor for a higher return on investment, by using IoT one can re-innovate product for better performance to create a table turning point in both cost and customer experience. In just 1-year internet connected devices reaches from 5 million to billions. Business Insider Intelligence estimates that 24 billion IoT devices increases over 300 billion as they grow over time (Pantano and Timmermans 2014; Fig. 27.8).



Fig. 27.8 Industrial IoT

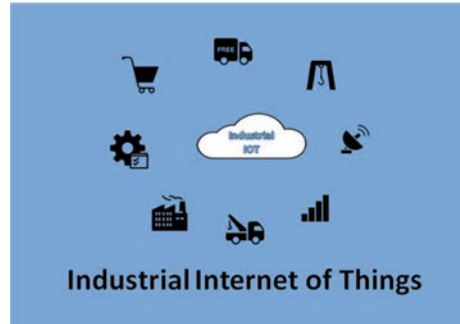
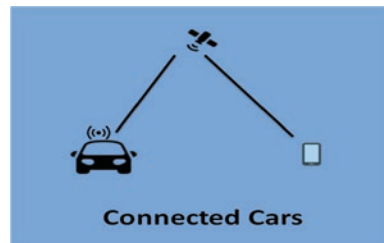


Fig. 27.9 Smart cars



### 27.3.6 Connected Car

Most of the innovative and ambitious automakers and some brave startups are working rigorously on the concept of Connected Cars. Apart from the auto giants like Ford and BMW, the techno giants like Apple, Google and Microsoft have announced the platforms for connected cars. Since the development cycle takes anything between 2 and 5 years, there is not much buzz yet in the masses yet. Still this concept occupies some margin on the internet especially Google (Kodali et al. 2016; Repko and DeBroux 2012; Kanchana 2018). Connected Car technology includes a network of antennas, sensors and embedded software's inside the car to enable it to deal with our complex world. It enables an automobile to use a mass of information it has gathered overtime to make consistent and accurate decisions and manage speed. This set of data and its IoT management will be crucial especially when the human lose all control on the steering and brakes to the autonomous controls of the smart car. Connected cars innovated in the way so that they can reach the peak to solve the current needs as the engineers working on it to made them self-authenticating and analyzing the problems while driving as they can easily analyze the defects on the way like pit holes, reasons of blockage etc. The first automobile invented by Carl Benz which patent his "vehicle powered by a gas engine" (Nogueira and Carnaz 2019; Fig. 27.9).

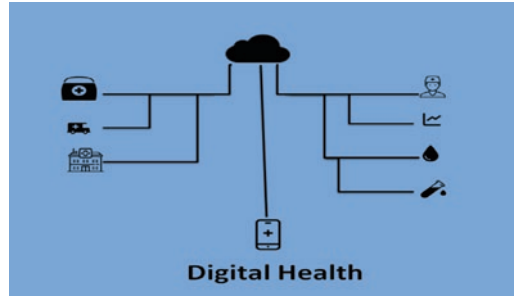


Fig. 27.10 Digital health

### 27.3.7 *Connected Health (Digital Health/Tele Health/Tele Medicine)*

The notion of Connected Health Care System and Smart Medical devices stands massive potential still remain the sleeping giants of the IoT (Jayaram 2017). Not just for the industry sector but also for the national well-being this concept should get push from the government and hopefully the few startups working in this area receive some push. By increasing the connectivity between the doctors and their patients, IoT may boost the relationship and satisfaction into the industry. IoT has brought new tools in the health industry ranging from fitness sensors to robotic surgery equipments. Thus it is a great way offer pocket friendly solutions in health-care. It basically uses leftover data, controlled environments for medical advices. IoT basically works in the way to makes something important into something essential as they creates systems rather than just equipments (Bhavani Shanker and Shanmugam 2016; Fig. 27.10).

### 27.3.8 *Smart Retail*

Smart Retail or Proximity Advertising is slowly gaining popularity but the search trend still seems to be low as per a study only 430 feeds are coming on LinkedIn for this upcoming trend. Most of the real life and online retail giants as well as startups are already using some applications of IoT to improve their Store operations, Purchase momentum and theft control, inventory management and enhanced consumer experience (Sohail et al. 2017). Through IoT Physical retailers can beat the threats faced by the online retailing and regain the losing consumer base back to store. Such smart in store applications will also save the time and increases the efficiency of the consumer too (Sheela et al. 2019). It is an adverse need of smart retail in this competitive world to survive in the market. As Paytm is going to bring a first-of-its-kind cloud –based store to empowers the smart retail t increase profitability with ease (SR 2015; Fig. 27.11).

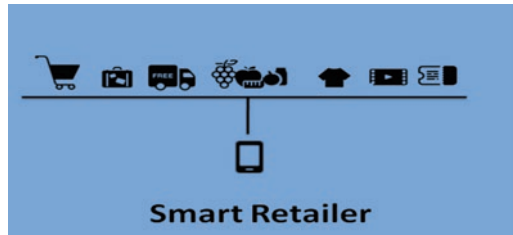


Fig. 27.11 Smart retailer



Fig. 27.12 Smart supply chain management

### 27.3.9 *Smart Supply Chain*

The supply chain has already induced the solutions like tracking of supplies and exchanging inventory information before and during delivery line since many years. This area will also require smarter logic but so far its popularity is confined and supply chain seems to be happy with the current achievements. With the help of IoT enabled systems, embedded sensors in the Factory could send and receive data based on arrange of parameters like pressure, temperature and utilization of machines while processing workflow information, equipment change settings and optimum performance. Industries need an intelligent supply chain for being responsive and flexible working. Tech Mahindra used a cloud based solution which provides end- to- end information visibility (WijerathnaYapa 2019; Fig. 27.12).

### 27.3.10 *Smart Farming*

Smart Farming can be a smart idea for agrarian economies and agricultural- export countries (Ahuja and Deval 2018; Gram-Hanssen and Darby 2018; SR 2015). The IoT is often overlooked when it comes to this category unlike the rapid adoptions at the industrial and consumer goods segment. Although it has the potential to revolu-



**Fig. 27.13** Smart farming

tionize the way farming is done from maintaining the Livestock information to the agricultural cycles and other farming operations can be drastically supported (SR 2015; Mufti et al. 2019). As an emerging concept that defines managing farms using modern technologies like IoT to increase the quantity with quality. Statistics estimate the grows at world population to reach nearly 10 billion by the year 2050. Smart greenhouse is the need for future feed (Fig. 27.13).

### **27.3.11 Smart Factories**

Smart factory is a flexible system which is a broad concepts consist the functioning of a factory to self-adapt, optimize and learn from the new conditions to produce more effectively in real-time conditions, IoT helps the plants, factories to transform to use new ideas to prevent the losses and expand the profitability. Schneider, which entered India in 1963, now has 24 manufacturing facilities provides over employment for 20,000 people. Although with smart solutions Panasonic aims to be the one stop solution for all welding, SMT and digital marketing needs (WijerathnaYapa 2019; Gubbi et al. 2013; <https://us.norton.com/internetsecurity-iot-5-predictions-for-the-future-of-iot.html>; Mufti et al. 2019). The Indian Institute of Science(IISC) is building India's first smart factory in Bengaluru. Due to rise of IoT in manufacturing industries Indian companies are being competitive to each other for achieving the tag of smart factory (Fig. 27.14).

### **27.3.12 Smart Food Industry**

With IoT food industries are smarting up as they are using it for processing, tracking and quality check of food. The precise quantity of nutrients can be listed within a second and the freshness of food can be stored for a longer period of time. Different

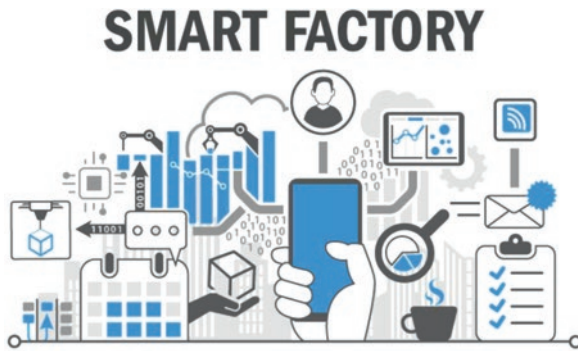


Fig. 27.14 Smart factory

kinds of sensors are used to monitor essential production state, temperature and so on (Gram-Hanssen and Darby 2018). The Indian food industry is worth US\$13.56 billion & is growing at 17%. The food services sector touched upto US\$24.77 billion by 2015. The first of series of India-wide smart food culinary symposia was organized by chefs from major dining chains and food representatives in Bangalore (Abdelshkour 2015; Wang et al. 2010).

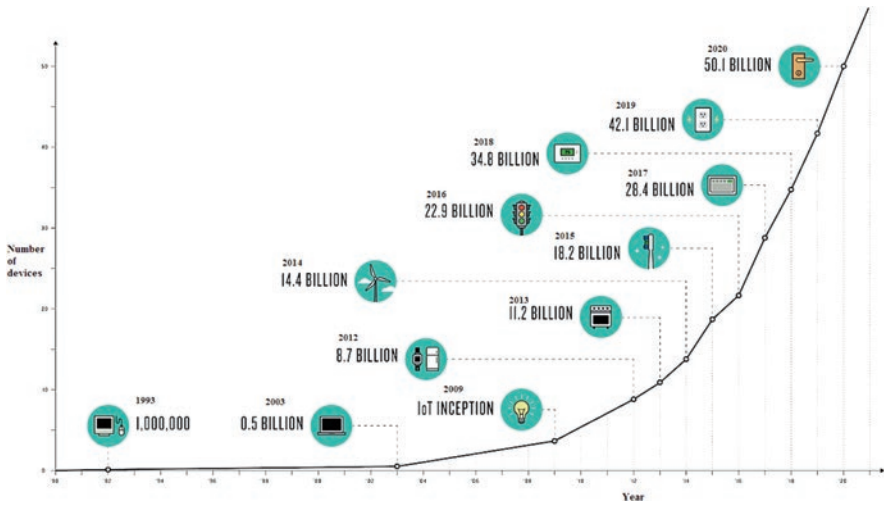
## 27.4 Future of IoT

IoT is gathering enormous popularity all around the world for its huge demand in the field of technology. In IoT objects are present around us in one or another form. This new technology will give rise to Wireless Sensor Network (WSN) for its implementation (Gubbi et al. 2013). As the devices need to be connected ubiquitously for its smart functioning which will eventually increase its demand and usage? looking at its existing demand and potential, we can conclude that it has a great future ahead.

Looking at the present scenario of IoT, we wonder what the future technology is going to provide us. Going through an intense research led us say that the devices will make use technology in the most efficient way.

The above Fig. 27.15 shows the rapid growth of IoT devices over years in different sectors. The future seems to be more smart and ubiquitous with the emerging technology. Some of the futuristic predictions made about IoT includes (<https://us.norton.com/internetsecurity-iot-5-predictions-for-the-future-of-iot.html>).

- It has been roughly calculated that by 2025 IoT devices will cross 50 billion. The estimation made by the analytics of IoT shows that in 2016 4.7 billion devices were connected through the internet which may increase to 11.6 billion by 2021 and so on.



**Fig. 27.15** Growth of IoT devices over years

- The advancement in technology will led to smart city development. The usage of IoT is not limited to people. Now a day companies and cities are adopting the smart technologies very frequently to save more money as well as time (Mufti et al. 2019). This will result in automated city which can be remotely managed and the data will be collected through IoT devices using various technologies.
- The increasing demand of IoT will give rise to artificial intelligence as the smart devices will collect data and that will be stored at cloud. Machine learning will help the system to understand things without using programming concept (Wang et al. 2016). Systems are designed such that data is given priority as it is received which later on make the machine smarter by giving preferences and work on the basis of need of the system.
- More intelligent and secure routers need to be used in case the IoT devices are installed in private places as they are not highly secure. While manufacturing IoT devices the focus is more upon their efficiency and less upon security. Routers need to be secure enough to prevent the connected devices at entry level. So, the manufacturers should look after the different technologies to enhance the security of the system.
- IoT growth will be boosted with the use of 5G network. The 5G(fifth generation) network will enhance the speed as well as efficiency in terms of connecting more smart devices simultaneously. This will also give rise to recent products based on the demand of costumer.
- Security and privacy will also become the area to be concerned about with the arrival of new 5G technology. The devices will be connected within the network through routers which will directly affect them with several attacks. The data will be stored on cloud and make easier for the attackers to aim them.

### 27.4.1 IoT Network in Future

This part explains a deep understanding about the IoT network in coming future. The given figure below describes different components in the network and how they are interconnected. The working of each component is explained further. The below architecture uses the concept of SDN(Software Defined Network) which is a prominent architecture in network (Reitblatt et al. 2013). It supervises the network control directly rather than using the forwarding concept (Sohail et al. 2018b). The working of SDN is done through different layers mostly infrastructure/physical, control/middle and the application layer (Kobayashi et al. 2014; Nunes et al. 2014; McKeown et al. 2008) (Kumar and Mufti 2017; Fig. 27.16).

- All the network devices required within is connected at the infrastructure layer which includes the routers, switching equipment etc.
- At the control layer the different mechanism works regarding providing essential protocols required for the network. Open flow plays a vital role here by providing the specification required for the network devices and controllers within the network.
- Application layer is basically concerned with the data regarding statistics, state, and the topology of the network.

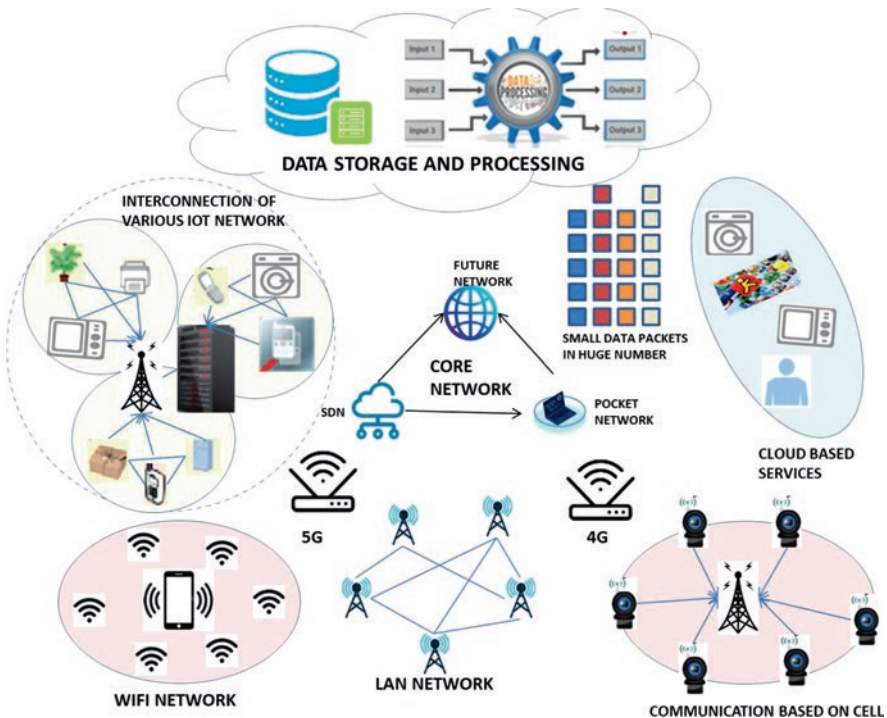


Fig. 27.16 Future IoT network



The use of SDN makes the working of devices smoother. And the use of open flow protocol provides the controller and network devices to communicate with each other (Wang et al. 2016; Patil et al. 2012). It helps in multiple packets simultaneously within the network and improves the quality of service being provided (Ishimori et al. 2013). And the fastest growing 5G technology in the future provides a high speed communication within the architecture (Patil et al. 2012). The IoT provides association such that everything can be tracked individually and easily. The most important right in such network is the privacy of an individual. It provides a trustable environment which should not have any negative impact over society. Technology should be standardized for better performance by reducing barriers (Coetzee and Eksteen 2011).

## 27.5 Conclusion

We intend to present a prospective idea of how IoT can influence our daily life and how the cloud computing can enhance the IoT services in future. The idea is explained and demonstrated using proper diagrams and explanations. The main contribution in the chapter is its inclusion of those unimaginable areas where the researcher may focus which in turn shall prove a milestone for the research community.

Further, there are the area where a lot of exploration is required which is yet to be answered. Hence, the study tries to reveal those areas and would be very helpful for the new researcher to explore the field of research in the related domain.

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