

# EMERGING TECHNOLOGY



**Sanjay Sharma**

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# EMERGING TECHNOLOGY

*for*

## ENGINEER'S

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**Sanjay Sharma**

B.E., M. Tech, and Ph.D.



**KHANNA PUBLISHERS®**

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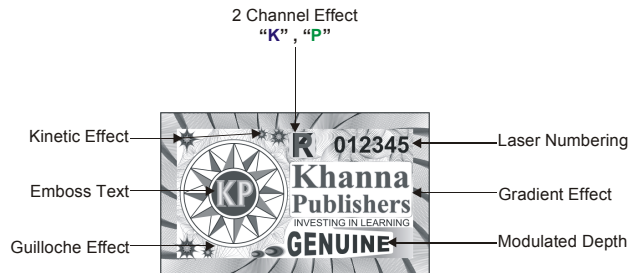
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## *Preface to the First Edition*

Emerging Technology for Engineer's is a vital subject for Engineering Graduates. Developments of latest and emerging technologies in Engineering during last few decades have increased the importance of this subject for the students of all streams of B. Tech First Year. Regardless of a student's ultimate area of specialization, knowledge of Emerging Technologies is no longer optional, it is essential to understand today's multidisciplinary applications.

This book is primarily intended to serve as a textbook in accordance with the syllabus of Emerging Technology for Engineering offered by AKTU, Lucknow, Uttar Pradesh, and also various Universities in India as well as abroad.

In the book, a significant effort has been made to find simple ways to explain theoretical aspects of Emerging Technology for Engineering. A strong emphasis has been given on presenting the text matter in a student-friendly manner. Neat and clear diagrams have been used for explanation of various concepts. In addition to this, every effort has been made to make the treatments simple and comprehensive. The whole text has been divided in five chapters:

Chapter 1: Introduces the Internet of Things

Chapter 2: Introduces the Cloud Computing

Chapter 3: Explains about Blockchain

Chapter 4: Explains the Digital Manufacturing: 3D Printing and Drones

Chapter 5: Introduces the Future Trends

The author hopes that the book will fulfill the need of interested readers and welcome any suggestions towards the improvement of the book.

March, 2022

— Dr. Sanjay Sharma

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# 1 UNIT

## Internet of Things

### 1.1. INTRODUCTION

The Internet of Things (IoT) is a term that refers to using the Internet to access and control everyday equipment and devices. In reality, the Internet of Things (IoT) is today at the centre of the Digital Transformation Revolution, which is transforming people's lives, automation, business, medical facilities, and enterprise. This shift has an impact on everything from how we maintain and operate our homes to the automation of procedures in almost every industry. The demand for Internet application development is currently very strong. As a result, the Internet of Things (IoT) is a major technology that allows us to create a variety of valuable internet applications. In recent years, IoT's adaptability has gained a lot of attention. So, having an IoT-based gadget has numerous advantages.

As a matter of fact, the Internet of Things (IoT) is the next big thing in the world. We all know that internet usage is growing at an exponential rate around the world. Because of this, the number of internet-connected devices will grow tremendously in the near future. With such quick growth taking place, the day will not be far away when we will be able to plan our dinner even before we go home.

### 1.2. WHAT EXACTLY IS THE INTERNET OF THINGS (IoT)?

**IoT (Internet of Things)\*** is a notion that refers to connections between physical equipment such as cars and home appliances, as well as other items incorporated in electronics such as sensors and software that allow these devices to connect, gather, and share data. As a result, we may simply define IoT (Internet of Things) *as everything in daily life that can be accessed or connected via the internet*. Therefore, the Internet of Things (IoT) is an excellent and intelligent approach for reducing human effort and providing easy access to physical items.

The Internet of Things (IoT) has enormous potential to improve people's lives on a daily basis. Everything becomes more efficient, productive, and advanced as a result of it.

As shown in Figure 1.1, the term "Things" in the Internet of Things (IoT) refers to anything and everything in daily life that may be accessible or connected over the Internet.

As a result, we can also define the Internet of Things (IoT) as a system of networked items, sometimes referred to as smart gadgets, that are connected via the Internet.

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\* There is a difference between the Internet of Things (IoT) and the Internet. Internet of Things (IoT) can create information about the connected objects, analyze it, and make decisions; in other words, one can tell that the Internet of Things is smarter than the Internet. Security cameras, sensors, vehicles, buildings, and software are examples of things that can exchange data among each other.

All in all, the Internet of Things (IoT) may also be termed as a platform that allows common things to become smarter, processing to become intelligent, and communication to become more informed. So, it has established a controlled link between the digital and physical worlds.

**There were only two types of communication before the Internet of Things:** human-to-human and human-to-devices, but the Internet of Things (IoT) made it feasible to establish communication between Machines-to-Machines without any human interference or contact. It allows you to connect to the cloud and manage and collect data.

Now-a days, the Internet of Things (IoT) is widely employed in a variety of businesses. It enables them to work more efficiently, provide better service to customers, improve decision-making, and increase the value of the company.

**Key Point :** The Internet of Things is essentially a fairly basic notion; it entails linking all of the physical places and things in the world to the internet.

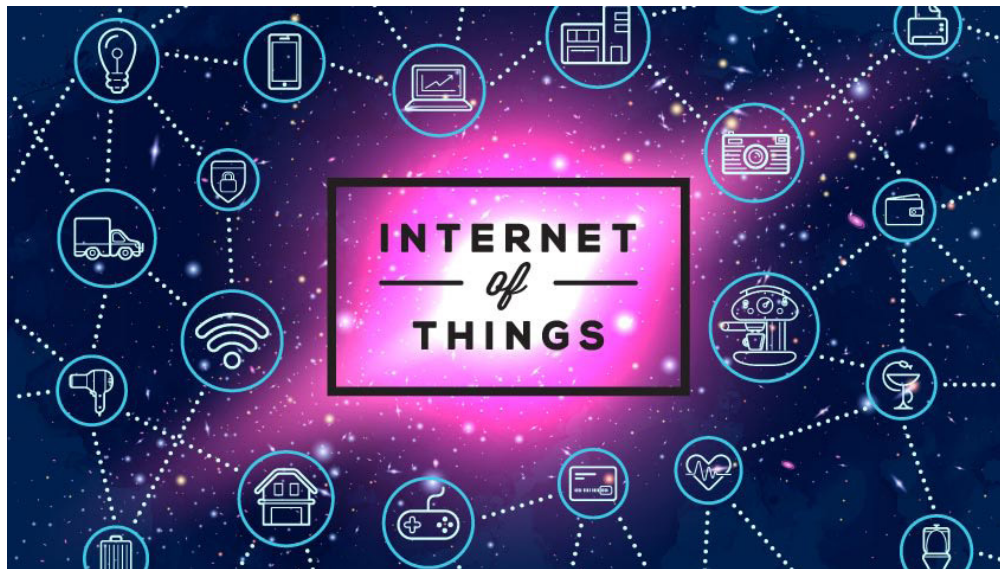


Fig. 1.1. Brief Idea of Internet of Things (IoT)

### 1.2.1. Detailed Aspects of the Internet of Things (IoT)

We all know that now-a-days, internet is an essential aspect in our lives. Assume you're reading a book on the internet. It could be a PC, a smartphone, or a tablet, but whatever gadget you're using is almost certainly connected to the Internet. An internet connection is a fantastic thing; it allows us to take advantage of a variety of features that were before unattainable. Consider your phone prior to it becoming a smartphone if you're old enough. Sure, you could call and text, but today you can read any book, view any movie, and listen to any song on your smart phone.

Here, the point is that connecting things to the internet provides several incredible advantages. All of us have experienced these advantages with our smartphones\*, computers, and tablets, but the same can be said for anything else. As a result, the Internet of Things (IoT)

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\* Smartphones do play a large role in the IoT because many IoT devices can be controlled through an app on a smartphone.

is a relatively straightforward concept: it entails linking all physical places and things on the planet to the internet.

Therefore, the Internet of Things (IoT) essentially makes use of smart technology to connect things at any time and in any location for any purpose. Kevin Ashton, one of the founders of MIT's Auto-ID Center, coined the phrase "Internet of Things" in 1999.

Figure 1.2 shows the detailed aspects of Internet of Things (IoT); how things are connected in IoT. As shown in figure 1.2, IoT is a notion that refers to connections between physical devices such as automobiles, home appliances, and other items incorporated in electronics such as sensors and software that enable these devices to connect, gather, and share data. Any device can be connected to an Internet switch under the Internet of Things (IoT) concept. Coffee makers, cell phones, lamps, washing machines, wearable devices, and anything else that comes to mind are all possible examples of these devices\*.

**Important Point:** So, the Internet of Things (IoT) is changing our way of life, from how we react to how we act. Smart air conditioners, smart autos that provide the shortest route, and smartwatches that measure our daily activities are just a few examples.

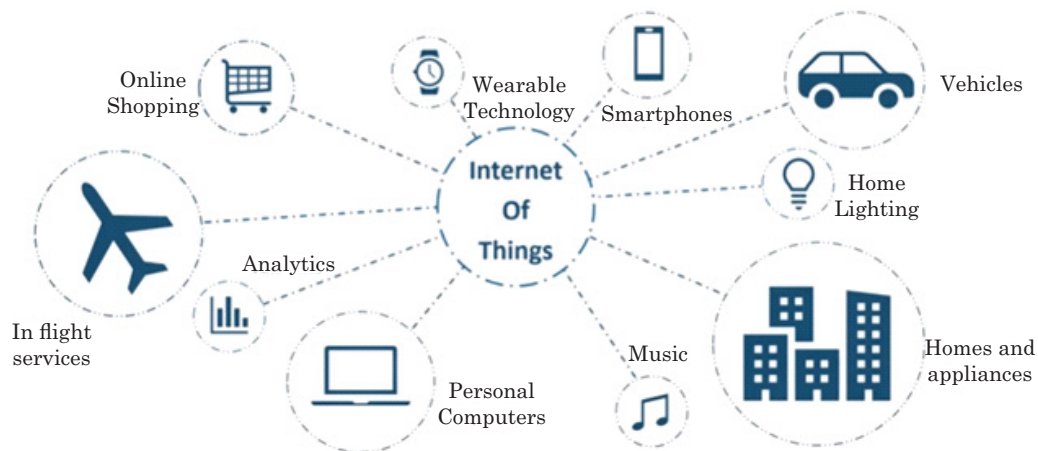


Fig. 1.2. The Detailed Aspects of Internet of Things (IoT)

### 1.2.2. How Does Actually IoT Work?

#### Explanation of IoT Based Upon a Practical Example

Let us consider a smart gadget such as a traffic camera. The camera can monitor the streets for traffic congestion, accidents, and weather conditions and send this information to a central hub. This gateway also takes data from other types of cameras and sends it to a city-wide traffic monitoring system.

Now, let us again consider, for example, that the City Authority needs to rebuild a certain road. On the way to a national highway, this could cause traffic gridlock. This information is forwarded to the city's traffic monitoring system. Now, because the traffic system we are using here, is a smart traffic system, it uses smart technology to swiftly learn and forecast traffic patterns. As a result, the smart system can analyze the situation, estimate its impact, and send the information to neighboring cities with smart systems that connect to the same roadway.

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\*As the number of real-time applications (devices) that need smart connections among each other is increased, the Internet of Things (IoT) challenges will also increase.

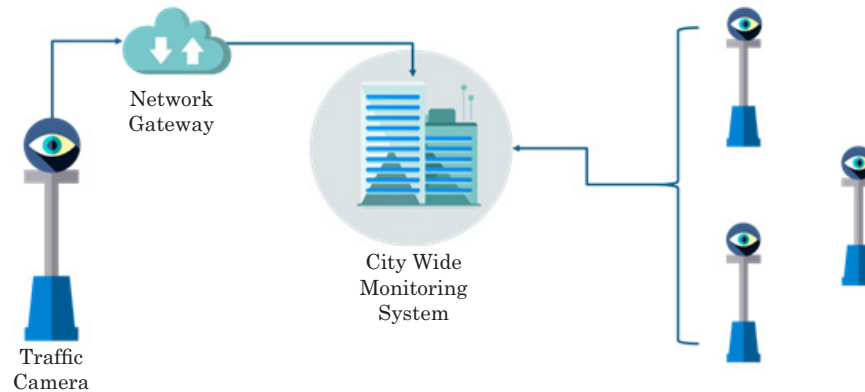


Fig. 1.3. A Basic Smart Traffic System

Therefore, to avoid bottlenecks, the Traffic Management System may evaluate data and generate routes around the project. Drivers might also receive live directions from the system via smart devices and radio channels. Meanwhile, public schools and employers in close proximity to the project may be asked to adapt their timetables.



Fig. 1.4. Showing Importance of Smart Traffic System in Managing Traffic across the city due to rebuilding of a road

This results in a network of self-contained systems that take advantage of real-time control. This is just one example of Internet of Things (IoT) applications.

Now, based upon above example, we can define IoT in another way as follows:

**IoT Definition Based Upon Above Example:** *So, the Internet of Things (IoT) is essentially a platform that connects embedded objects to the internet so that they may gather and exchange data with one another. It allows devices to communicate, collaborate, and learn from one another in the same way that humans do.*

### 1.2.3. What are the Requirements for an IoT Application to Run

As a matter of fact, the hardware device, software, device unique identification or IP (Internet Protocol) address, Internet connectivity, and a cloud platform are the very minimum for an IoT application to run.

Sensors or integrated chips are commonly used in device hardware. These are low-cost devices featuring a variety of CPUs, operating systems, and memory. For data collecting, these are installed in various sites such as buildings, factories, and cities, as well as inside animals.

The IP address is the device's most crucial feature. This one-of-a-kind identification lets you know which device is delivering or receiving data. Communications or Internet connectivity allows the device to communicate with each other.

**Important Point:** Because the volume of data collected each month exceeds 100 exabytes, a cloud infrastructure with low-cost storage is required. Finally, cloud applications or data analytics tools are critical for turning data into action that has a significant influence on your company.

**Key Note:** Because of the convergence of many technologies, real-time analytics, machine learning, commodity sensors, and embedded systems, the Internet of Things (IoT) has evolved. Embedded systems, wireless sensor networks, control systems, automation, and other fields all help to make the Internet of Things (IoT) a reality. IoT is a cutting-edge automation and analytics system that uses artificial intelligence, sensors, networking, electrical, cloud messaging, and other technologies to create comprehensive product or service systems. IoT has established a system with more transparency, control, and performance.

#### 1.2.4. The Importance of the Internet of Things (IoT)

As it is obvious that IoT has emerged as one of the most important technologies of the twenty-first century in recent years. Everyday goods such as kitchen appliances, vehicles, thermostats, and baby monitors can now be connected to the internet via sensors implanted in gadgets, allowing for seamless communication between people, processes, and things.

The internet of things uses low-cost computing, the cloud, big data, analytics, and mobile technologies to help people live and work smarter and gain complete control over their lives. Things collect and share data with minimal human intervention using low-cost computing, the cloud, big data, analytics, and mobile technologies. Digital systems record, monitor, and adapt each interaction between connected things in this hyper connected world, allowing the physical and digital worlds to work together.

#### Do You Know?

IoT makes once 'dumb' devices 'smarter' by giving them the ability to send data over the internet, allowing the device to communicate with people and other IoT-enabled Things.

In addition, IoT gives organizations a real-time view of how their systems work, providing insights into equipment performance to supply chain and logistics.

By allowing businesses to automate processes, the Internet of Things lowers labor expenses. It enhances service delivery, lowering the cost of manufacturing and delivering items while also increasing customer transparency.

The Internet of Things is gaining traction in a variety of areas, including banking, healthcare, retail, manufacturing, and more.

**Key Point:** IoT is one of our most important technologies, and it will continue to grow as more businesses grasp the value of linked devices in keeping them competitive.

### 1.2.5. Salient Features of Internet of Things (IoT)

There are certain salient features or characteristics\* of Internet of Things (IoT) as under:

**Connectivity:** Connectivity refers to the establishment of a secure link between all IoT devices and the IoT platform, which could be a server or the cloud. After the IoT devices have been connected, high-speed messaging between the devices and the cloud is required to provide reliable, secure, and bi-directional communication.

**Analyzing:** After connecting all of the important pieces, it's time to analyze the data collected in real time and apply it to develop efficient business intelligence. If we have a strong understanding of the data gathered from all of these sources, we refer to our system as smart.

**Integrating:** The Internet of Things (IoT) is integrating diverse concepts/latest technologies to improve the user experience.

**Artificial Intelligence:** The Internet of Things (IoT) uses data to make things smarter and improve people's lives. As an example, if a coffee machine's beans are about to run out, the coffee machine will place an order with the retailer for the coffee beans of your choice.

**Sensing:** In IoT technologies, sensor devices detect and measure changes in the environment and report on their state. The Internet of Things (IoT) transforms inert networks into active networks. It may be noted that there could be no functional or real IoT environment without sensors.

**Active Engagement:** The Internet of Things (IoT) allows connected technology, products, and services to engage in active communication with one another.

**Endpoint Management:** It is critical to have endpoint management for any IoT systems; otherwise, the system will fail completely. As an example, if a coffee machine purchases coffee beans when the timer runs out, but what happens if it orders the beans from a store while we are not at home for a few days, the IoT system will fail. As a result, endpoint management is of utmost importance.

### 1.2.6. IoT Benefits

In the commercial sector, the Internet of Things offers a number of advantages in day-to-day living. The following are some of its benefits or advantages:

**Efficient Resource Consumption:** By understanding the functionality and operation of each device, we can improve resource utilization and better monitor natural resources.

**Reduce Human Effort:** Because IoT devices interact and communicate with one another and perform a variety of tasks for us, they reduce human effort.

**Save Time:** Because it decreases the amount of human labor required, it saves time. The primary factor that can be saved by using an IoT platform is time.

**Increased Security:** If we have a system in which all of these elements are connected, we can make it more secure and efficient.

### 1.2.7. IoT Drawbacks

The Internet of Things brings with it a slew of advantages, but it also brings with it a slew of problems. The following are some of the IoT challenges:

#### Do You Know?

The basic premise and goal of IoT is to "connect the unconnected." This means that objects that are not currently joined to a computer network, namely the Internet, will be connected so that they can communicate and interact with people and other objects.

\*The smart home is one of the main applications that use the Internet of things infrastructure to connect several sensors. The sensors can sense and collect surrounding information that is used to fully control different home systems such as lighting and security

**Security:** Because IoT systems are networked and communicate via networks, security is a concern. Despite any security measures, the system provides limited control and can be used to launch numerous types of network assaults.

**Privacy:** Even if the user does not actively participate, the IoT system gives extensive personal data in great detail.

**Difficulty:** Creating, building, managing, and enabling a major technology to IoT system is difficult.

### 1.3. A BRIEF INCEPTION HISTORY OF THE INTERNET OF THINGS (IoT)

As discussed earlier, the Internet of Things (IoT) is the next step in the growth of the internet related technologies. Physical devices can now be brought into the digital sphere thanks to advancements in various latest technologies. Despite the growing popularity of IoT, many individuals are unaware of its capabilities. The Internet of Things is a relatively new breakthrough, yet the notion dates back to the early 1980s.

As a matter of fact, a Coca-Cola vending machine was connected to the internet by computer science graduate students at Carnegie Mellon University in 1982. The programmers created an application that checked the drink's availability and temperature.



Fig. 1.5.

Further, in 1999, the Internet of Things was acknowledged as a unique technology. After that IoT was taken into consideration to be applied in wireless communications, embedded systems, and micro-electromechanical systems for the next few years as the technology's applicability grew.

Basically, the Internet of Things (IoT) can be thought of as a massive network of interconnected gadgets. Data is collected and shared between internet-connected devices. In current times, many businesses are investing in Internet of Things (IoT) technologies. IoT-based solutions offer effective monitoring and control of linked devices as well as the automation of daily operations. As a result, task performance is becoming more and more efficient and convenient.

## 1.4. WHAT TECHNOLOGIES HAVE MADE THE INTERNET OF THINGS POSSIBLE?

The following technologies have been critical in putting the Internet of Things into practice:

1. **Cloud Computing:** The device's sensors collect a large amount of data. As a result, a significant amount of space is required to not only process but also store this data, which is where Cloud computing comes in. Cloud computing offers the ability to process large amounts of data fast and without errors. One example of an IoT solution that provides data security is identity management systems. The cloud has the advantage of being more scalable and efficient.

2. **Sensors:** Sensors\* are the most important component of IoT since they collect and gather data from devices before broadcasting it to an IoT cloud platform to be processed. Sensors, like microprocessors, utilize lithographic processes to facilitate inter-device communication. As a result of the low cost and high reliability of sensors, IoT technology is becoming more accessible to more manufacturers.

3. **IPv6:** IPv6 is a more advanced version of the principal communication protocol that allows computers and devices on the Internet to be identified and located. It boosts performance, improves packet handling efficiency, and boosts security.

IPv6 is important for following three reasons:

- (a) Security: Supports more secure name resolution and provides end-to-end encryption.
- (b) Scalability
- (c) Connectivity

4. **Machine Learning and Analytics:** With machine learning as the technology of the century, organizations can access massive volumes of data saved in the cloud to obtain insights faster and more efficiently. The advent of these linked technologies continues to push the IoT's frontiers, and the data generated by IoT feeds these technologies as well.

5. **Conversational Artificial Intelligence:** Neural networks have added natural-language processing (NLP) to IoT devices like Alexa, Cortana, and Siri, making them more appealing, inexpensive, and practical for home use.

### Do You Know?

In our daily lives, IoT provides a personalized experience from the home to the office to the organizations we frequently do business with. This improves our overall satisfaction, enhances productivity, and improves our health and safety. For example, IoT can help us customize our office space to optimize our work.

## 1.5. DETAILED APPLICATIONS OF THE INTERNET OF THINGS (IoT)

IoT applications have the potential to add enormous value to our lives. The Internet of Things, with its newer wireless networks, superior sensors, and breakthrough processing capabilities, could be the next frontier in the quest for a piece of the pie. IoT applications are projected to provide connectivity and intelligence to billions of ordinary things.

The Internet of Things (IoT) is the key to the industrial revolution's next phase. Physical devices can now be brought into the digital realm thanks to technological advancements.

The Internet of Things (IoT) is the concept of fusing the "real world" with the "digital world," allowing individuals to be in constant communication and engagement with other people or items.

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\* IoT devices contain sensors and mini-computer processors that act on the data collected by the sensors via machine learning. Essentially, IoT devices are mini computers, connected to the Internet, and are vulnerable to malware and hacking.

The Internet of Things allows items to be activated and managed remotely over an existing network infrastructure, allowing for greater convergence between the physical and computer worlds.

The power of internet connectivity has gone beyond smartphones and computers, and IoT is no longer science fiction. From smartwatches to self-driving cars, the internet is now being employed in all smart gadgets that are designed to tackle real-world problems.

As technology advances in the coming years, the number of IoT applications will increase. IoT will most likely be combined with Artificial Intelligence in the near future to provide smart solutions.

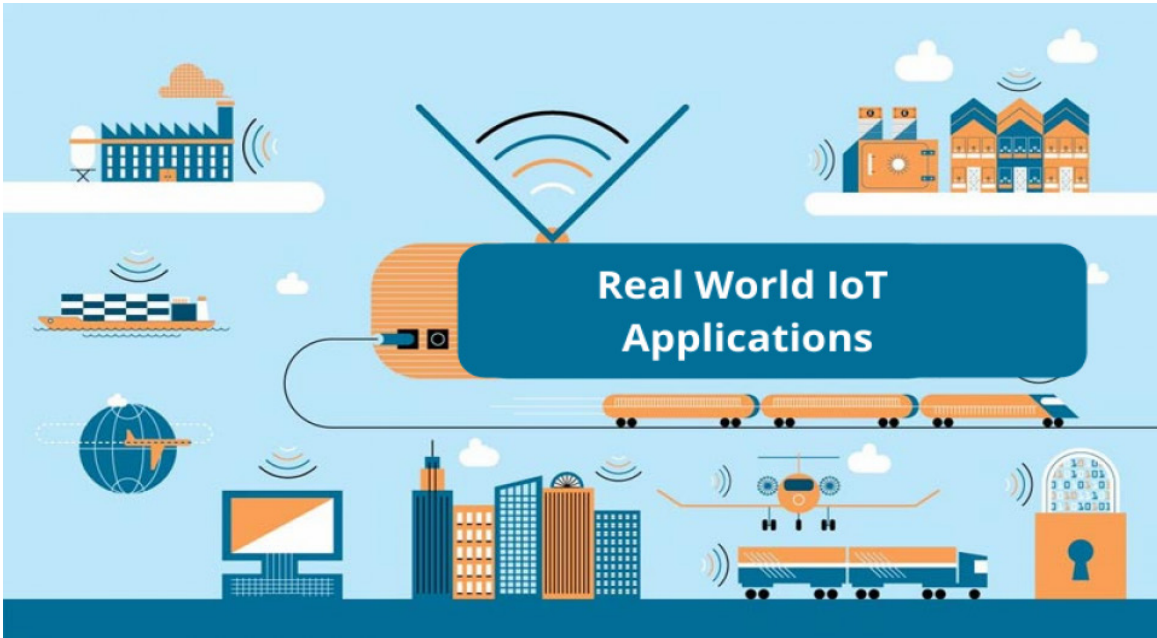


Fig. 1.6. Illustration of IoT applications

Now, let us discuss potential applications of Internet of Things (IoT) in various fields, one by one:

### 1. The Smart City: City of the Future.

Smart City, also known as “City of the Future,” is a concept that categorizes technology as being responsible for improving urban infrastructure to make cities more efficient, affordable, and enjoyable to live in. The notion of a “Smart City” addresses planning and public administration in an innovative and sustainable approach by automating services. Government services, transportation and traffic management, energy, health care, water, creative urban agriculture, and waste management are among the industries that have been building smart cities.

#### Do You Know?

IoT pushes us towards our imagined future of medicine which exploits a highly integrated network of sophisticated medical devices. Today, IoT can dramatically enhance medical research, devices, care, and emergency care. The integration of all elements provides more accuracy, more attention to detail, faster reactions to events, and constant improvement while reducing the typical overhead of medical research and organizations.



Fig. 1.7. The Smart City: City of the Future

The intelligent management of urban waste delivers helpful information to the public, encouraging a more convenient and ecologically friendly method of rubbish collection.

**2. Houses with Smart Technology\*.** Smart houses are the most common of these applications. The goal of a smart house is to be able to regulate household appliances like lights, faucet water flow, and home security and safety. The homeowners can control and monitor these actions from their smart devices (smartphones, tablets, laptops). Consider the case: You've already left the house and forgotten to turn off a water faucet. You can simply turn your phone off. You can control all of your home devices from a single spot in a smart home. An IoT-enabled security camera can also be used to prevent thefts and robberies.

#### Do You Know?

The connected 'smart home' is a good example of IoT in action. Internet-enabled thermostats, doorbells, smoke detectors and security alarms create a connected hub where data is shared between physical devices and users can remotely control the 'things in that hub' i.e., adjusting temperature settings, unlocking doors, etc, via a mobile app or website.



Fig. 1.8. Houses with Smart Technology

\* Internet of Things (IoT) makes our world as possible as connected together. Now a days we almost have internet infrastructure wherever and we can use it whenever. Embedded computing devices would be exposed to internet influence. Common instances for embedded computing devices are MP3 players, MRI, traffic lights, microwave ovens, washing machines and dish washers, GPS, even heart monitoring implants or biochip and etc.

# EMERGING TECHNOLOGY

## About the Book:

**Emerging Technology for Engineering** is a vital subject for Engineering graduates. Developments of the latest and emerging technologies in Engineering during the last few decades have increased the importance of this subject for the students of all streams of B.Tech first year. Regardless of a student's ultimate area of specialization, knowledge of Emerging Technologies is no longer optional, it is essential to understand today's multidisciplinary applications. This book is primarily intended to serve as a textbook in accordance with the syllabus of **Emerging Technology for Engineering** offered by AKTU, Lucknow, Uttar Pradesh, and also various Universities in India as well as abroad. In the book, a significant effort has been made to find simple ways to explain theoretical aspects of **Emerging Technology for Engineering**. A strong emphasis has been given to presenting the text matter in a student-friendly manner. Neat and clear diagrams have been used for the explanation of various concepts. In addition to this, every effort has been made to make the treatments simple and comprehensive.

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**Dr. Sanjay Sharma** is **B.E., M.Tech,** and **Ph.D.** He has a total of **26 years** of teaching and research experience. He has more than **50 publications** in Journals and International Conferences of repute. He has authored several best seller books like **Mobile Computing, Data Communication, and Computer Networks, Communication Systems,** and others. His current research interests are in the field of **Computational Intelligence and Signal Processing.** He has been a reviewer of various journals and conferences of repute. He is a member of **IEEE** and a member of **IEEE Communication Society,** Life Member of IETE, Institution of Engineers, and other Professional Societies.



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