

Internet of Thing

Chapter 4

IoT

The most important features of IoT include artificial intelligence, connectivity, sensors, active engagement, and small device use. A brief review of these features is given below

- **AI** – IoT essentially makes virtually anything “smart”, meaning it enhances every aspect of life with the power of data collection, artificial intelligence algorithms, and networks. This can mean something as simple as enhancing your refrigerator and cabinets to detect when milk and your favorite cereal run low, and to then place an order with your preferred grocer.
- **Connectivity** – New enabling technologies for networking and specifically IoT networking, mean networks are no longer exclusively tied to major providers. Networks can exist on a much smaller and cheaper scale while still being practical. IoT creates these small networks between its system devices.

IoT

- **Sensors** – IoT loses its distinction without sensors. They act as defining instruments that transform IoT from a standard passive network of devices into an active system capable of real-world integration.
- **Active Engagement** – Much of today's interaction with connected technology happens through passive engagement. IoT introduces a new paradigm for active content, product, or service engagement.

What is IoT?

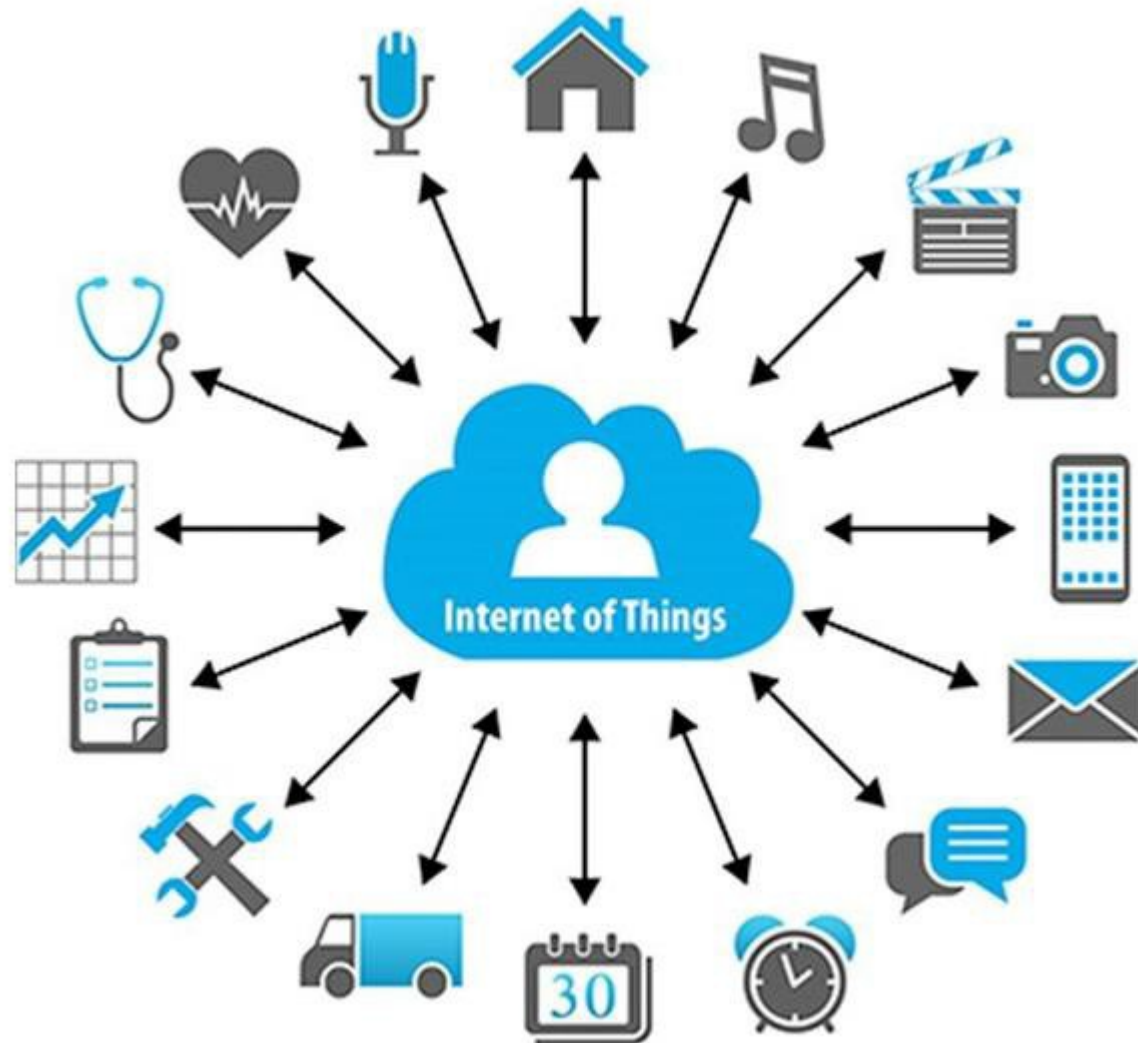
The description of the Internet of Things is related to different definitions used by several groups for promoting the particular concept in the whole world.

- According to the Internet Architecture Board's (IAB) definition, **IoT is the networking of smart objects**, meaning a huge number of devices intelligently communicating in the presence of internet protocol that cannot be directly operated by human beings but exist as components in buildings, vehicles or the environment.
- According to the Internet Engineering Task Force (IETF) organization's definition, IoT **is the networking of smart objects in which smart objects have some constraints such as limited** bandwidth, power, and processing accessibility for achieving interoperability among smart objects.

What is IoT?

- According to the IEEE Communications category magazine's definition, **IoT is a framework of all things that have a representation in the presence of the internet** in such a way that new applications and services enable the interaction in the physical and virtual world in the form of Machine-to-Machine (M2M) communication in the cloud.
- According to the Oxford dictionary's definition, **IoT is the interaction of everyday object's computing devices** through the Internet that enables the sending and receiving of useful data.
- The term Internet of Things (IoT) according to the 2020 conceptual framework is expressed through a simple formula such as:
 - **IoT= Services+ Data+ Networks + Sensors**

IoT Domain



History of IoT

- The Internet of Things has not been around for very long. However, there have been visions of machines communicating with one another since the early 1800s.
- The Internet, itself a significant component of the IoT, started out as part of **DARPA (Defense Advanced Research Projects Agency)** in 1962 and evolved into ARPANET in 1969.
- **Global Positioning Satellites (GPS)** became a reality in early 1993, with the Department of Defense providing a stable, highly functional system of 24 satellites. This was quickly followed by privately owned, commercial satellites being placed in orbit.
- One additional and important component in developing a functional IoT was **IPV6's remarkably intelligent decision to increase address space.**
- The Internet of Things, as a concept, **wasn't officially named until 1999**. One of the first examples of an Internet of Things is from the early 1980s and was a Coca Cola machine, located at the Carnegie Mellon University.
- By the year 2013, the Internet of Things had evolved into a system using multiple technologies, ranging from the Internet to wireless communication and from micro-electromechanical systems (MEMS) to embedded systems.

IoT – Advantages

- **Improved Customer Engagement** – Current analytics suffer from blind-spots and significant flaws in accuracy; and as noted, engagement remains passive. IoT completely transforms this to achieve richer and more effective engagement with audiences.
- **Technology Optimization** – The same technologies and data which improve the customer experience also improve device use, and aid in more potent improvements to technology. IoT unlocks a world of critical functional and field data.
- **Reduced Waste** – IoT makes areas of improvement clear. Current analytics give us superficial insight, but IoT provides real-world information leading to the more effective management of resources.
- **Enhanced Data Collection** – Modern data collection suffers from its limitations and its design for passive use. IoT breaks it out of those spaces and places it exactly where humans really want to go to analyze our world. It allows an accurate picture of everything.

IoT - Disadvantages

- As the number of connected devices increases and more information is shared between devices, the potential that a **hacker** could steal confidential information also increases.
- If there's a **bug** in the system, it's likely that every connected device will become **corrupted**.
- Since there's **no international standard of compatibility for IoT**, it's difficult for devices from different manufacturers to communicate with each other.
- **Enterprises may eventually have to deal with massive numbers** maybe even millions of IoT devices and collecting and managing the data from all those devices will be challenging.

Challenges of IoT

Security – IoT creates an ecosystem of constantly connected devices communicating over networks. The system offers little control despite any security measures. This leaves users exposed to various kinds of attackers.

Privacy – The sophistication of IoT provides substantial personal data in extreme detail without the user's active participation.

Complexity – Some find IoT systems complicated in terms of design, deployment, and maintenance given their use of multiple technologies and a large set of new enabling technologies.

Flexibility – Many are concerned about the flexibility of an IoT system to integrate easily with another. They worry about finding themselves with several conflicting or locking systems.

Compliance – IoT, like any other technology in the realm of business, must comply with regulations. Its complexity makes the issue of compliance seem incredibly challenging when many consider standard software compliance a battle.

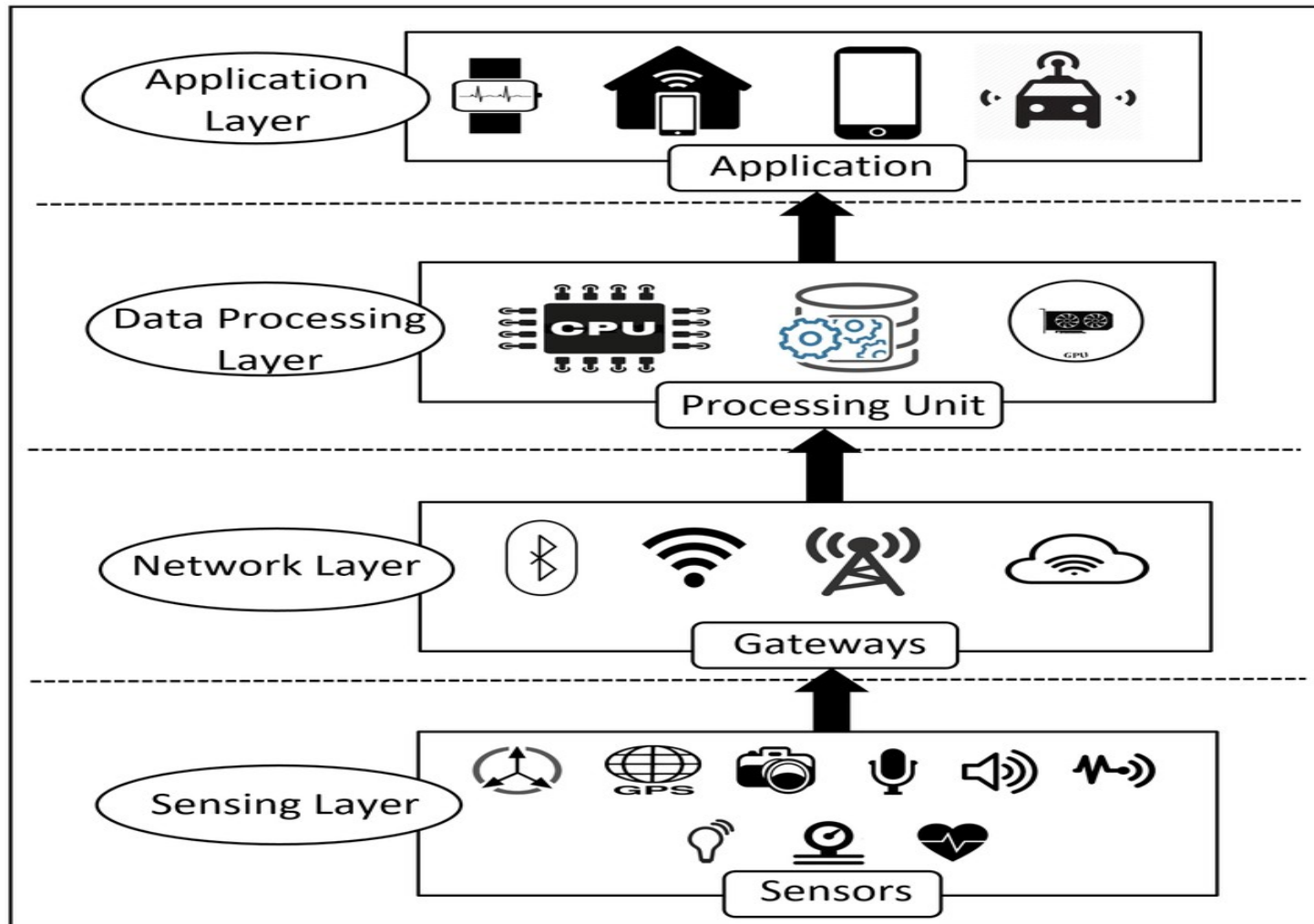
How does it work?

An IoT ecosystem consists of web-enabled smart devices that use embedded processors, sensors and communication hardware to collect, send and act on data they acquire from their environments.

The devices do most of the work without human intervention, although people can interact with the devices. For instance, to set them up, give them instructions or access

the data. The connectivity, networking and communication protocols used with these web-enabled devices largely depend on the specific IoT applications deployed.

Architecture of IoT



Architecture of IoT

1. **Sensing Layer** - The main purpose of the sensing layer is to identify any phenomena in the devices' peripheral and obtain data from the real world. This layer consists of several sensors. Using multiple sensors for applications is one of the primary features of IoT devices. Sensors in IoT devices are usually integrated through sensor hubs.

Example , Motion sensor , Water Level Sensor.

2. **Network Layer** - The network layer acts as a communication channel to transfer data, collected in the sensing layer, to other connected devices. In IoT devices, the network layer is implemented by using diverse communication technologies (e.g., Wi-Fi, Bluetooth, Zigbee, Z-Wave, LoRa, cellular network, etc.) to allow data flow between other devices within the same network.

3. **Data Processing Layer** - The data processing layer consists of the main data processing unit of IoT devices. The data processing layer takes data collected in the sensing layer and analyses the data to make decisions based on the result. In some IoT devices (e.g., smartwatch, smart home hub, etc.), the data processing layer also saves the result of the previous analysis to improve the user experience. This layer may share the result of data processing with other connected devices via the network layer.

4. **Application Layer** - The application layer implements and presents the results of the data processing layer to accomplish disparate applications of IoT devices. The application layer is a user-centric layer that executes various tasks for the users. There exist diverse IoT applications, which include smart transportation, smart home, personal care, healthcare, etc.

Devices and Networks

Connected devices are part of a scenario in which every device talks to other related devices in an environment to automate home and industrial tasks, and to communicate usable sensor data to users, businesses and other interested parties. IoT devices are meant to work in concert for people at home, in industry or in the enterprise. As such, the devices can be categorized into three main groups: consumer, enterprise and industrial.

Consumer connected devices include smart TVs, smart speakers, toys, **wearable**, and smart appliances. smart meters, commercial security systems and smart city technologies such as those used to monitor traffic and weather conditions are examples of industrial and enterprise IoT devices.

Devices and Networks

IoT network typically includes a number of devices with constrained resources (power, processing, memory, among others) and some of those devices may be massively deployed over large areas like smart cities, industrial plants, whereas others may be deployed in hard-to-reach areas like pipelines hazardous zones, or even in hostile environments like war zones.

Therefore, the efficient management of IoT networks requires considering both the constraints of low power IoT devices and the deployment complexity of the underlying communication infrastructure.

IoT Tools and Platforms

There are many vendors in the industrial IoT platform marketplace, offering remarkably similar capabilities and methods of deployment. These IoT Platform Solutions are based on the Internet of Things and cloud technology. They can be used in areas of smart home, city, enterprise, home automation, healthcare or automotive, just to name a few.

IoT Platform	Key features
KAA https://www.kaaproject.org/demo	• Manage an unlimited number of connected devices • Set up cross-device interoperability • Perform real-time device monitoring • Perform remote device provisioning and configuration • Collect and analyze sensor data • Analyze user behavior and deliver targeted notifications • Create cloud services for smart products

IoT Tools and Platforms

IoT Platform	Key features
SiteWhere https://sitewhere.io/en/	Run any number of IoT applications on a single SiteWhere instance • Spring delivers the core configuration framework • Add devices through self-registration • Integrates with third-party integration frameworks such as Mule any point • Default database storage is MongoDB • Eclipse Californium for CoAP messaging • InfluxDB for event data storage • Grafana to visualize SiteWhere data
ThingSpeak https://thingspeak.com/login?skipSSOCheck=true	• Collect data in private channels • Share data with public channels • MATLAB analytics and visualizations • Alerts • Event scheduling • App integrations • Worldwide community
DeviceHive https://devicehive.com/	• Directly integrate with Alexa • Visualization dashboard of your choice • It supports Big data solutions such as ElasticSearch, Apache Spark, Cassandra and Kafka for real-time and batch processing. • Connect any device • It comes with Apache Spark and Spark Streaming support. • Supports libraries written in various programming languages, including Android and iOS libraries • It allows running batch analytics and machine learning on top of your device data

Applications of IoT

The versatile nature of IoT makes it an attractive option for so many businesses, organizations, and government branches, that it doesn't make sense to ignore it. Here's a sample of various industries, and how IoT can be best applied.

- **Agriculture** - For indoor planting, IoT makes monitoring and management of micro-climate conditions a reality, which in turn increases production. For outside planting, devices using IoT technology can sense soil moisture and nutrients, in conjunction with weather data, better control smart irrigation and fertilizer systems. If the sprinkler systems dispense water only when needed, for example, this prevents wasting a precious resource.
- **Consumer Use** - For private citizens, IoT devices in the form of wearables and smart homes make life easier. Wearables cover accessories such as Fitbit, smartphones, Apple watches, health monitors, to name a few. These devices improve entertainment, network connectivity, health, and fitness. Smart homes take care of things like activating environmental controls so that your house is at peak comfort when you come home.

Applications of IoT

- **Healthcare** - First and foremost, wearable IoT devices let hospitals monitor their patients' health at home, thereby reducing hospital stays while still providing up to the minute real-time information that could save lives. In hospitals, smart beds keep the staff informed as to the availability, thereby cutting wait time for free space. Putting IoT sensors on critical equipment means fewer breakdowns and increased reliability, which can mean the difference between life and death. Elderly care becomes significantly more comfortable with IoT. In addition to the above-mentioned real-time home monitoring, sensors can also determine if a patient has fallen or is suffering a heart attack.
- **Insurance** - Even the insurance industry can benefit from the IoT revolution. Insurance companies can offer their policyholders discounts for IoT wearables such as Fitbit. By employing fitness tracking, the insurer can offer customized policies and encourage healthier habits, which in the long run benefits everyone, insurer, and customer alike.

IoT Based Smart Home

Smart Home initiative allows subscribers to remotely manage and monitor different home devices from anywhere via smartphones or over the web with no physical distance limitations.

- **Remote Control Appliances:** Switching on and off remotely appliances to avoid accidents and save energy.
- **Weather:** Displays outdoor weather conditions such as humidity, temperature, pressure, wind speed and rain levels with the ability to transmit data over long distances.
- **Smart Home Appliances:** Refrigerators with LCD screen telling what's inside, food that's about to expire, ingredients you need to buy and with all the information available on a smartphone app. Washing machines allowing you to monitor the laundry remotely, and. The kitchen ranges with the interface to a Smartphone app allowing remotely adjustable temperature control and monitoring the oven's self-cleaning feature.
- **Safety Monitoring:** cameras, and home alarm systems making people feel safe in their daily life at home.
- **Intrusion Detection Systems:** Detection of window and door openings and violations to prevent intruders.
- **Energy and Water Use:** Energy and water supply consumption monitoring to obtain advice on how to save cost and resources, & many more.

IoT Based Smart City

In cities, the development of smart grids, data analytics, and autonomous vehicles will provide an intelligent platform to deliver innovations in energy management, traffic management, and security, sharing the benefits of this technology throughout society.

- **Structural Health:** Monitoring of vibrations and material conditions in buildings, bridges and historical monuments.
- **Lightning:** intelligent and weather adaptive lighting in street lights.
- **Safety:** Digital video monitoring, fire control management, public announcement systems.
- **Transportation:** Smart Roads and Intelligent High-ways with warning messages and diversions according to climate conditions and unexpected events like accidents or traffic jams.
- **Smart Parking:** Real-time monitoring of parking spaces available in the city making residents able to identify and reserve the closest available spaces,
- **Waste Management:** Detection of rubbish levels in containers to optimize the trash collection routes. Garbage cans and recycle bins with RFID tags allow the sanitation staff to see when garbage has been put out.

IoT Based Smart Farming

- **Green Houses:** Control micro-climate conditions to maximize the production of fruits and vegetables and its quality.
- **Compost:** Control of humidity and temperature levels in alfalfa, hay, straw, etc. to prevent fungus and other microbial contaminants.
- **Animal Farming/Tracking:** Location and identification of animals grazing in open pastures or location in big stables, Study of ventilation and air quality in farms and detection of harmful gases from excrements.
- **Offspring Care:** Control of growing conditions of the offspring in animal farms to ensure its survival and health.
- **Field Monitoring:** Reducing spoilage and crop waste with better monitoring, accurate ongoing data obtaining, and management of the agriculture fields, including better control of fertilizing, electricity and watering.

