Foundations of IoT

Internet of Things 1

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IoT Fundamentals

INTRODUCTION

The Internet of Things (IoT) is changing how people live by connecting everyday objects to the Internet, making life easier and more efficient. This unit covers what IoT is, its development over time, and how smart objects function to create these connected systems.

LEARNING OBJECTIVES

In this unit, you will:

> define the Internet of Things.

> describe the evolution of the Internet of Things.

> understand what the Internet of Things does.

> describe the Internet of Thing's impact on emerging technologies.

> define a smart object.

> classify smart objects and their usage.

> distinguish between the various types of sensors for smart objects.

> distinguish between the various types of actuators for smart objects.

LESSON 1

IoT Concepts

What Is the Internet of Things?

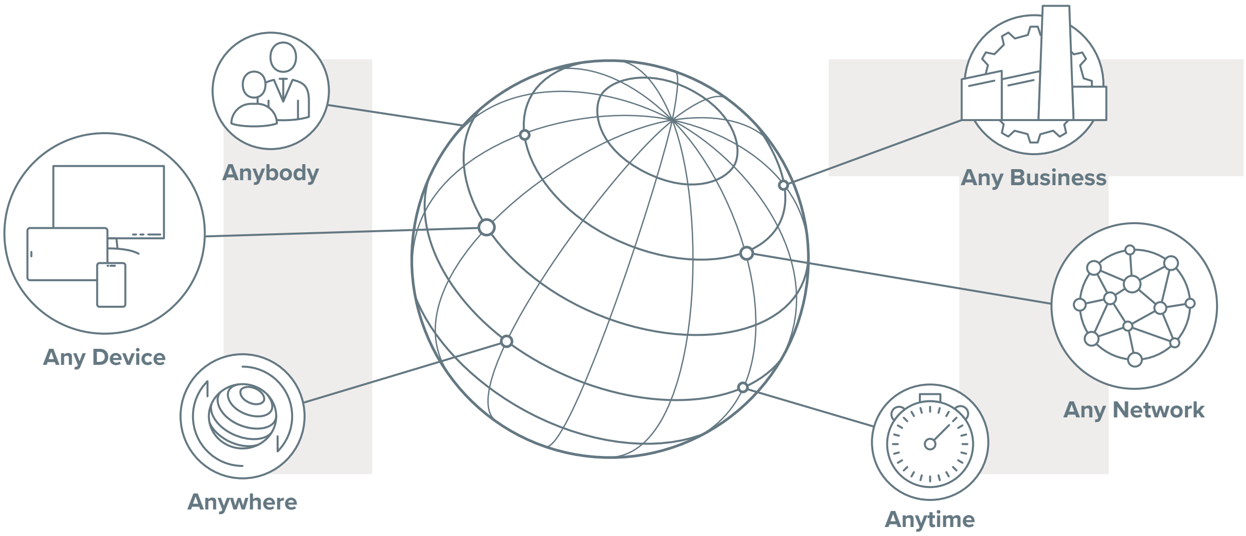
We currently live in a world where virtually anything imaginable can be online, communicate with other devices or people, and facilitate new services that improve our lives. The world is undergoing a significant technological transformation, from self-driving drones carrying food orders to wearable sensors monitoring our health. This progression is collectively known as the **Internet of Things (IoT)**.

The main objective of the IoT is to connect devices not already part of a computer network, whether private or public, like the Internet, so that they may share data and interact with people and other objects. The IoT is an evolution in technology that will enable devices to perceive and manage the physical environment by making objects autonomous and integrating them into an intelligent network.

Internet of Things (IoT)

A network of devices that are autonomously able to sense, monitor, or interact with the surrounding environment in addition to collecting and exchanging data.

The Internet of Things connects devices and people with services



When devices and equipment can detect their environment and be remotely controlled across a network, the physical world and computers can be tightly integrated. This integration permits productivity, automation, and cost reduction enhancements in almost every aspect of our lives. Today, the goal is to "connect the unconnected" and convert all objects to **IoT devices**, creating new applications on an intelligent network.

IoT Device

A physical object connected to a network that can gather and transmit data, be identified across that network, and communicate with other IoT devices or platforms.

Smart objects

Connected objects, or **smart objects**, are the objects that exchange data over a network. The interface with a user can be a simple one like a thermostat switch, a more complex one like that in a modern car, or an app with many features on a smartphone. However, there will also be many cases where the smart object does not have any "user interface", but instead has autonomous sensors and **actuators** interacting with their environment without human intervention. A sensor learns and measures its environment and an actuator can alter the physical world. Connected objects are divided into two categories: **digital-first** and **physical-first**. Digital-first objects are devices like smartphones, smartwatches, or home alarm systems that are necessarily designed to include digital/electronic interaction with the environment, while physical-first objects are everyday objects that require the addition of sensors or actuators to become smart objects. Refrigerators or lamps are physical-first objects as they do not use and exchange data unless we enhance them by adding specific sensors, microcontrollers, and antennas to connect them to the digital world of the Internet of Things.

Smartphone: Digital-first smart object

Thermostat: Physical-first smart object

The History of the Internet of Things

The idea of using sensors on physical objects and making them interact over a network is not new. In the 1980s, a group of university students tried remotely tracking the contents of a soda vending machine. Technology at that time was more limited, and the Internet was not available. As networks grew to become accessible to any computer in the world, and hardware companies advanced the miniaturization of chips, Central Processing Units (CPUs), and sensors, more technology applications were developed. The Internet and the World Wide Web (WWW) evolved out of the original ARPAnet (Advanced Research Projects Agency Network), established in 1969, into a significantly more sophisticated network based on the Internet Protocol (IP) and the Transmission Control Protocol (TCP). In April 1995, when the US government decommissioned the network backbone, an open framework for worldwide connectivity was built, and the Internet, as we know it today, was born. The unique IP address for each network device is the foundation of this connected world. Every device can connect to other devices using a unique code: smartphones, tablets, gaming consoles, cars, washing machines, lighting systems, front door locks, and credit card terminals. IP addresses are assigned to all IoT-connected devices. It may be a public IP address used to identify the device over the Internet or a private IP address used to locate a device on a local network. A router identifies these devices based on incoming requests and routes requests and data accordingly.

IP routing process over the Internet

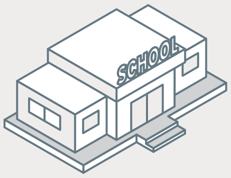
The noticeable reduction in size and enhancement in functionalities of electronic devices in recent years is evident to individuals who previously relied on desktop computers and now use smartphones. Although much smaller, the smartphone is faster, has more memory, and can easily connect to a wireless network using its own battery power. Additionally, it integrates several **sensors**: camera, microphone, Global Positioning System (GPS), magnetometer, accelerometer, gyroscope, proximity sensor, and ambient light sensor. Imagine a computer that has limited requirements in processing power, local data storage, and a few sensors. Today, a device can be so tiny that it can easily be embedded in other physical objects.

The Internet of Things era is commonly considered to have begun around 2008. Around this time, more devices became Internet-connected, and the Internet of Things became a reality. Kevin Ashton, a computer scientist, is credited with using the term "Internet of Things" for the first time in 1999 while working for a large multinational company. He used the term to describe a new concept involving tracking tags and computers with sensors connected to the Internet that can gather data to enhance the company's supply chain operations.

The evolution of the Internet of Things

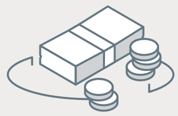
The evolution of the Internet went through four phases, which also defined the development of the Internet of Things.

Connectivity phase



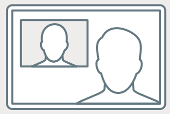
In the early years of the Internet, only organizations and schools had Internet connectivity. Internet connection was uncommon for the typical individual. During the connectivity phase, more and more individuals gained access to the Web.

Networked economy



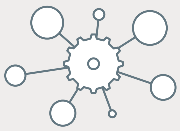
With the advancement of technology, connection speeds continued to increase, and connectivity was no longer the primary obstacle. This phase focused on maximizing efficiency and profit through networking.

Immersive experiences

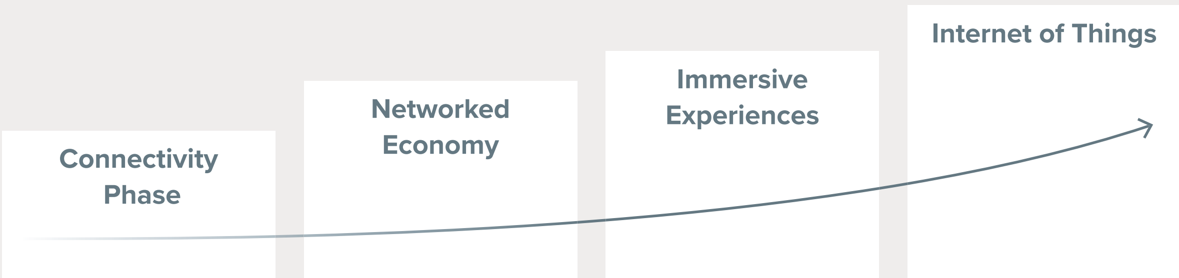


The era of immersive experiences is defined by the emergence of social media, collaboration, and widespread device availability. Human interactions have been digitized, and applications are gradually transitioning to cloud infrastructure.

Internet of Things



The final phase concerns the communication and transaction of data between almost every device connected to the Internet to provide solutions and experiences for various industries.

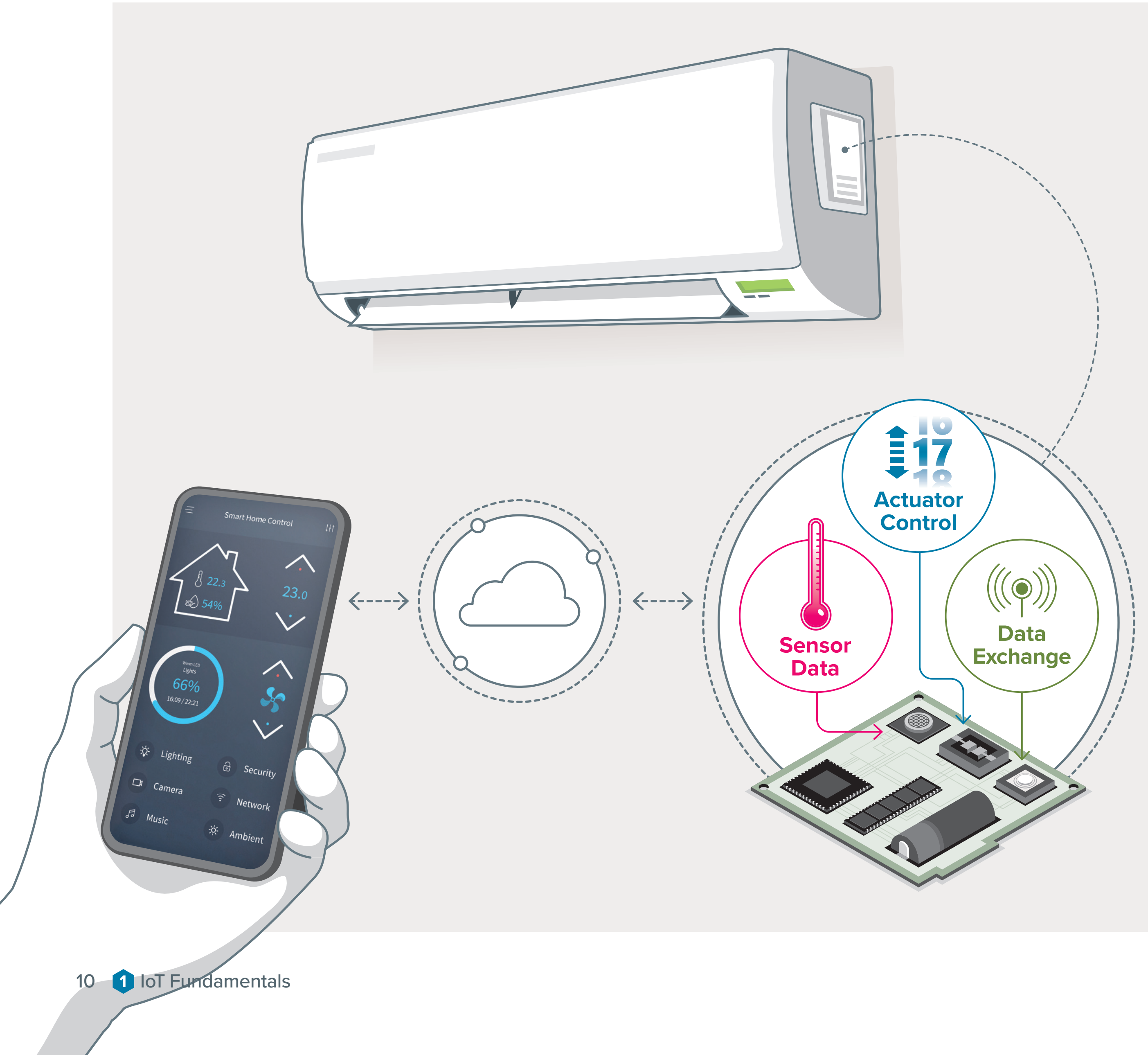


Industry 4.0

It is essential to recognize that the IoT is a collection of interconnected technologies and frameworks. Just like the Web connects computers and content, the IoT connects devices, data, and people. Moreover, as more technologies and systems interconnect, and data gathering accelerates, this interconnected world gains power and provides greater value. Emerging technologies, such as the IoT, Artificial Intelligence (AI), and robotics, are driving the digital transformation known as the Fourth Industrial Revolution or Industry 4.0.

What the Internet of Things Does

The IoT has led to technological breakthroughs and the creation of new types of products and services. This has been possible because the IoT enables the transmission of gathered data from a room in someone's home to a data center across the globe. The data can be processed along with other information in a central location, and an action can then be executed in the room via an actuator. For example, a thermostat senses the temperature and humidity in your room. The algorithm that processes these two values combines them with weather forecast data in your city and switches on the air conditioning system based on an AI algorithm that minimizes energy consumption. All this happens in real-time and without human intervention.



IoT applications are categorized into four main domains: **Consumer**, **Commercial**, **Industrial**, and **Infrastructure**.

Wearables or smart homes fall into the consumer IoT domain, commercial IoT is found in schools, offices, and retail stores, industrial IoT is the large-scale use of IoT devices in factories, farms, and transportation, and energy and water management comprise the infrastructure IoT domain.

Consumer

Commercial

Industrial

Infrastructure

As the IoT becomes an integral part of technology solutions, it is increasingly combining with other technologies like artificial intelligence and robotics, either using them to improve IoT applications or augmenting them with IoT-enabled objects. The result is that a collection of existing and emerging technologies is applied to solve old or new problems in the most efficient way. The table below shows applications of emerging technologies that are enhanced through IoT technologies.

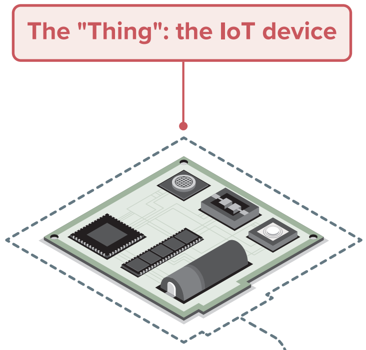
Applications enhanced through IoT

Application	Description
Automation	Machines and technologies that aid in automation can be found throughout history. The capacity to automate an activity frequently results in increased speed, efficiency, and safety and reduced cost. Today, automation is what enables intelligent homes, intelligent buildings, and intelligent factories. It includes lighting controls, smart speakers, security systems, intelligent home products, and robots.
Computer Vision	Sensors paired with AI algorithms enable computers to understand photos and videos, often better than humans can. Face recognition, helping drones and vehicles steer and avoid collisions, and improving machine learning models for assessing the accuracy of chemotherapy and other treatments through the analysis of photos and scans are all current applications of the technology. In industrial applications, this approach can increase the fault detection rate by 90% or more in various processes.
Natural Language Processing (NLP)	This field employs linguistics, computing, and Artificial Intelligence to understand and implement human language. Alexa, Siri, and Google Assistant are exemplary NLP user interfaces and voice interfaces are becoming increasingly prevalent on linked devices and equipment. This technology is also applied to chatbots and automated web services requiring typing or speaking. Nowadays, researchers are developing methods for systems to recognize emotions and intentions.

Application	Description
Machine Learning	This technology, a subfield of AI, interprets and predicts future outcomes for various scenarios using mathematical models trained on training data. Machine Learning helps globally distributed systems within the Internet of Things complete tasks without explicit programming. It is particularly beneficial for monitoring, forecasting, and telemetry applications.
Edge AI	Increasing numbers of digital devices are capable of performing local processing. Edge AI allows data processing to be carried out on the device itself or on a local server (at the "edge" of the network), rather than in a centralized data center. This architecture enables devices to run faster, more intelligently, and with less energy. It drastically alters the operation of autonomous devices and extends the battery life of sensors by years.
Advanced Analytics	Because data is frequently dispersed, the IoT alters how analytic procedures are carried out. This implies that software must be able to assemble and interpret the appropriate data. Manufacturing, healthcare, transportation, financial services, energy, telecommunications, and home automation are among the industries that benefit from IoT-centered analytics.
Robotics	Autonomous machines, such as drones, mobile robots, and autonomous vehicles, are improving rapidly due to onboard artificial intelligence and powerful sensor technology. A new concept has been introduced: the Internet of Robotic Technologies (IoRT), which refers to systems that observe events around them, calculate the data onboard and via the cloud, and then use this information to act in the real world.
Augmented Reality (AR)	AR's strength lies in its capacity to integrate, modify, and augment the virtual and actual worlds. In the consumer market, AR smartphone apps are used to improve images, digitally try on clothing, and play games. Various glasses and goggles aid in various jobs, from training to engineering. Text and graphics are generated by a rendering engine that receives the appropriate data from the IoT and delivers it to a device.
Virtual Reality (VR)	Immersive and intuitive, 3D computer-generated VR simulations require an IoT infrastructure. Today's videoconferencing systems, for instance, are transforming into VR places where individuals from all over the world can join a meeting, participate in a webinar, or attend a virtual conference through a 2D screen such as a laptop or smartphone or dedicated headgear. VR enables the assembly of elements from various physical locations to form a single virtual world.
Blockchain	The distributed ledger technology, which was first developed for digital currency, plays a crucial role in the Internet of Things. It can monitor and authenticate data as it traverses devices, databases, and microservices. Thus, it can aid with automation and detect infractions such as tampering. This is particularly beneficial in a highly decentralized IoT context, where data continually passes through organizations, servers, and systems.

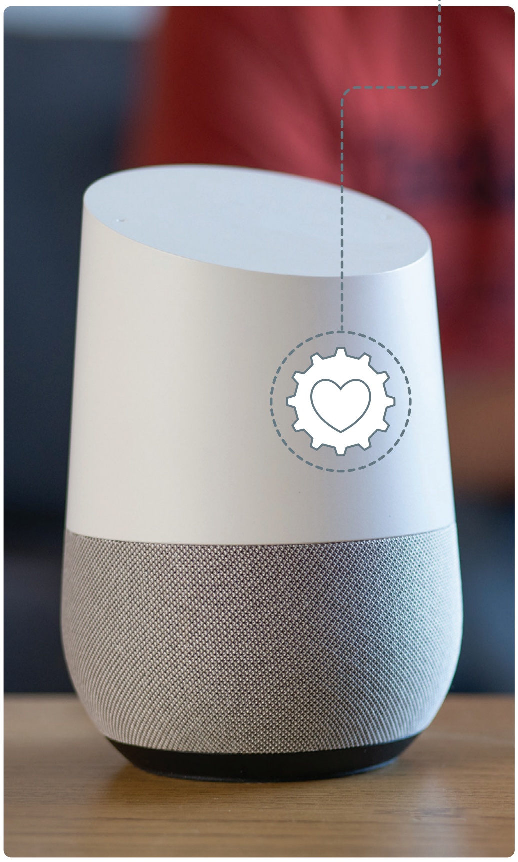
The Components of an IoT Application

An IoT application consists of hardware, software, and infrastructure components. Some of them are essential, and others depend on the type of application. The key component is the "thing", the IoT device that interacts with its environment in different ways. The IoT device may have sensors or actuators, but it must have a microcontroller with its power supply, memory, and a network connection module that exchanges data through a network. Some IoT devices may have screens or buttons for user interaction, and others are completely hidden from sight. Connectivity is critical and is usually accomplished through the Internet via specialized IoT gateways and optimized network protocols. This enables the IoT device to connect to local or centralized computing devices, the IoT cloud.



Servers for IoT applications can be simple computers or cloud servers in large data centers, even in other countries. The server handles data storage and processing to decide if commands for specific actions will be sent back to the IoT device. Data analytics are generated to provide useful insights on the use of the IoT application, especially when thousands or, in some cases, even millions of devices are involved. You will explore all the components of an IoT application in detail in the next lessons.

Examples of IoT devices around us
Smart TV
Smart earbuds
Smart home controller (like Alexa)
Mesh WiFi system
Smart thermostat with room sensors
Fitness or health tracker
Smart air conditioner
Lighting system with smart switches and intelligent lamps
Smart power plug
Air quality monitor
Electricity consumption monitor
Internet-connected refrigerator
Home security system with smart doorbell camera



EXERCISES

1 Choose the correct answer.

1. Which of the following is true about IoT?

A. The IoT is a network of interconnected devices that communicate with each other.

B. The IoT includes devices that are not connected to the Internet.

C. Smart objects work exclusively without human input.

D. Data from IoT sensors cannot be used for VR applications.

2. Which of the following is an example of a smart object?

A. Garage door that can be controlled remotely.

B. A traditional light bulb.

C. A car that requires manual navigation.

D. A bookshelf.

3. How are IoT and AI related?

A. IoT and AI research has advanced simultaneously to develop common applications.

B. IoT cannot work with AI applications.

C. IoT focuses solely on collecting data, while AI cannot interact with this data.

D. AI does not require IoT data for decision-making.

2 Describe the main characteristics of the Internet of Things that separates it from other emerging technologies.

3 Name the most critical technological advancement in recent history that made the IoT possible.

4 Explain which of the four phases of the Internet do you think was the most disruptive technologically and economically.

5 Search the Internet for an example of an IoT application that utilizes Computer Vision and NLP and describe it.

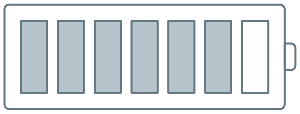
LESSON 2

IoT Devices

What Is a "Thing"?

Smart objects

Things or smart objects are the building blocks of the IoT. They are small and low-cost computers that interact with the physical environment around them by gathering data from sensors and providing real-time interactions via actuators. Sensors and actuators transform everyday objects into smart objects that are able to get information from and interact with the environment in a meaningful way. The real power of smart objects in an IoT solution comes from their being networked together rather than being isolated as standalone devices.



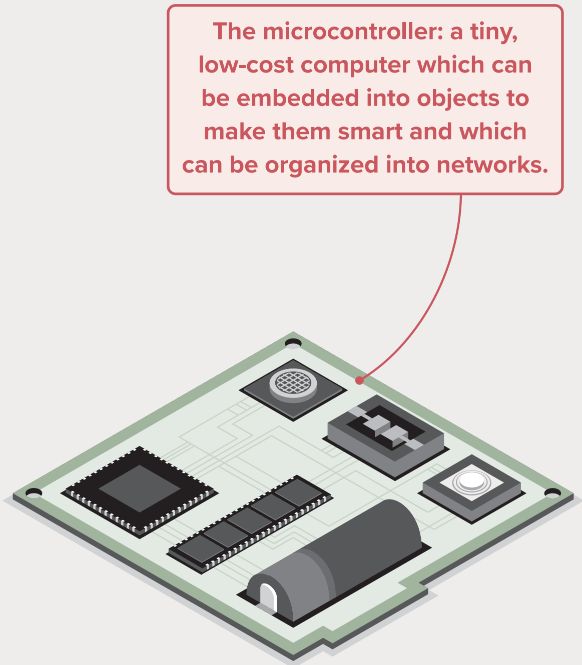
Smart objects are powered by a power source like the electrical grid or a battery or are self-powered through solar or wind energy. Their power consumption is so low that sometimes a smart object can run for months or years on batteries. There is even a new generation of smart objects for the human body that can be powered by the electrical current of the body.

Every smart object has a communication device that sends the data collected from the sensors and receives the necessary instructions for the actuators. The communication device connects the smart object to the cloud.

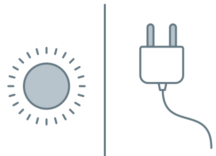
Smart objects also contain a processing unit in the form of a microcontroller which coordinates the sensors, the actuators, and the communication device.

The microcontrollers used in development or for teaching purposes, such as Arduino or Raspberry Pi, are very small computers.

Actual IoT applications use substantially smaller microcontrollers, sometimes as small as 2 × 2 millimeters in size. One example is "smart dust," which is a wireless network of computing and sensing platforms that are no bigger than a grain of sand and can work on their own. Smart dust can sense things like light, temperature, sound, and the presence of toxins or vibration and can record and send that information wirelessly to larger computer systems.

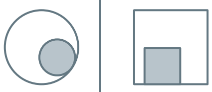


Classifying smart objects



Self-powered or power-connected

The object may carry its own energy source, a battery or solar panel, or it may be powered continuously by an external source. Self-powered objects can be very mobile, but batteries restrict the object's usage period and affect data collection frequency and data transmission range.

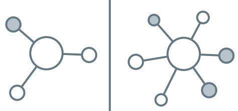


Mobile or static

A smart object may be mobile or it may have to always remain in the same place. An object can be mobile if it is attached to a larger moving object.

Low or high reporting frequency

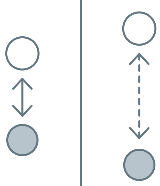
The parameters that are monitored by the smart object may be reported more or less frequently. A rust sensor on a bridge may report monthly values. A motion sensor in a car may report acceleration values hundreds of times per second. Higher reporting frequencies result in greater energy consumption, which may impose limitations on the power source.



Simple or rich data

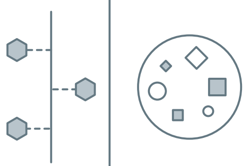
This classification is based on the amount of data collected and exchanged during each report cycle. A humidity sensor in a field can record a simple daily index value, whereas an engine sensor may record hundreds of parameters, such as temperature, pressure, gas velocity, and compression speed. Data transfer rate is determined based on two factors: data classification (simple or complex), and data transmission rate (low to high). Throughput is a combined metric.

A medium-throughput object may transmit simple data at a relatively high rate (in which case the flow structure is observed to be continuous) or rich data at a relatively low rate (in which case the flow structure is noted to be incontinuous).



Report range

The distance between the smart object and the data collector defines the report range. For a fitness band sending data to your phone, for instance, the report range is up to a few meters. In contrast, a moisture sensor embedded in a road's asphalt surface may need to communicate with an antenna located hundreds of meters or even kilometers away.



Object density per cell

This classification is based on the amount of smart objects with similar communication needs connected to the same IoT gateway. An oil pipeline may utilize one single sensor every few miles. In contrast, astronomy telescopes use hundreds or even thousands of mirrors over a small area, each equipped with multiple gyroscopes and gravity and vibration sensors.

The main components of a smart object

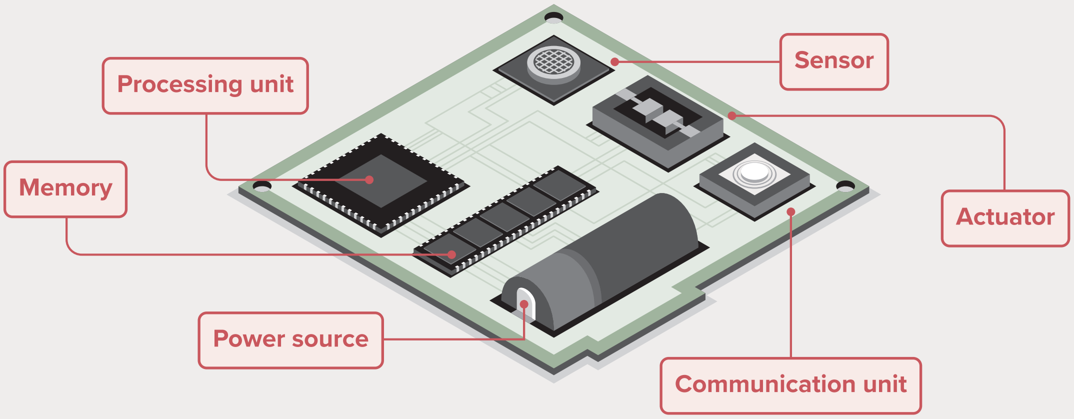
A smart object is a device with at least the four components listed below. The smart object may have just one sensor or one actuator, more than one sensor or more than one actuator, or a combination of sensors and actuators, depending on the IoT application.

Processing unit

A smart object contains a processing unit for gathering data, processing and analyzing information received by the sensor(s), coordinating control signals to the actuator, and operating a variety of systems, including communication and power systems. Depending on the processing requirements of a given application, the type of processing unit employed can vary significantly. Microcontrollers are the most prevalent due to their compact size, versatility, programming ease, low power consumption, and low cost.

Sensors and actuators

A smart object is able to interact with the physical world via its sensors and actuators. As discussed in the preceding sections, a sensor learns and measures its environment, but an actuator can alter the physical world. It is not necessary for a smart object to incorporate both sensors and actuators. Depending on the application, a smart object may contain one or more sensors and/or actuators.



Communication unit

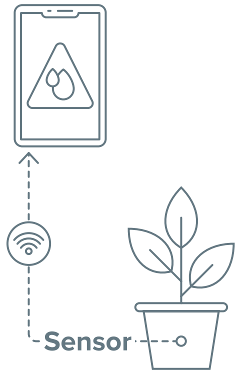
The communication unit is responsible for linking a smart item to other smart objects and the outside world (via the network). Smart object communication devices can be either wired or wireless. In IoT networks, smart items are interconnected wirelessly for a variety of reasons, including cost, limited infrastructure availability, and ease of implementation. There are numerous communication protocols for smart items.

Power source

Smart objects have components that require a power source. Interestingly, the communication unit of a smart item typically consumes the greatest amount of energy. As with the other three elements of smart objects, the power needs vary substantially between applications. Smart objects typically have limited power, are deployed for an extended period of time, and are difficult to access.

This combination necessitates power efficiency, prudent power management, sleep modes, ultra-low power consumption hardware, etc., especially when the smart object relies on battery power. For long-term installations when smart items are, for all intents and purposes, unavailable, scavenging sources are typically used to provide power.

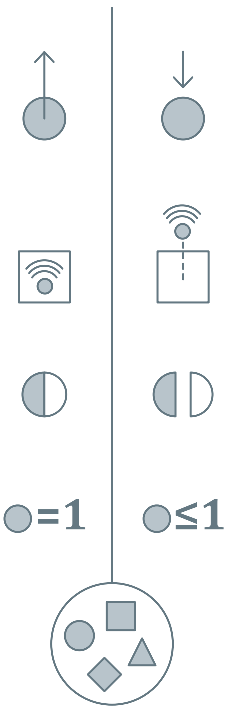
Sensors



A sensor does exactly what its name indicates: it senses. More specifically, a sensor measures a physical quantity, converts that measurement into data, and passes it on to be used by smart devices or humans. Sensors are not limited to gathering human-like sensory data. They provide a wide spectrum of measurement data with greater precision than human senses. Sensors can be embedded in any physical object and connected to the Internet by wired or wireless networks.

A modern car has an impressive collection of sensors that provide an immense amount of data that can be consumed by smart systems as well as shared with other vehicles on the road. The driver can check and control everything in the car with sensors of all types, like water and oil temperature, location, tire pressure, and velocity, which provide relevant data to improve safety and vehicle maintenance.

Classifying sensors



Active or passive

Sensors can be classified according to whether they need an external power source. Active sensors must use energy in order to detect changes in the environment (for example, an IR proximity sensor), while passive sensors can detect change without using energy (for example, a gyroscope).

Invasive or non-invasive

Sensors can be a part of the environment they are measuring (invasive) or external component (non-invasive).

Contact or no-contact

Sensors may require physical contact with the object being measured (contact) or not (no-contact).

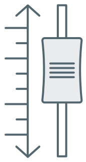
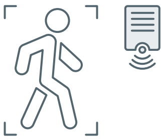
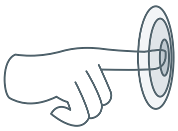
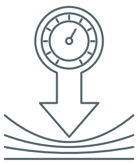
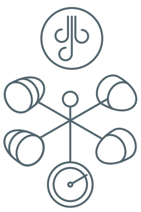
Absolute or relative

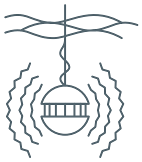
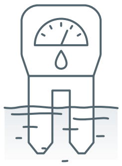
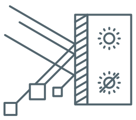
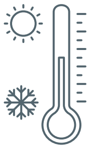
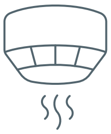
Sensors can gather data on an absolute scale or relative to a reference value.

Area of application

Sensors can be categorized according to the specific industry in which they are utilized.

Sensor types with examples

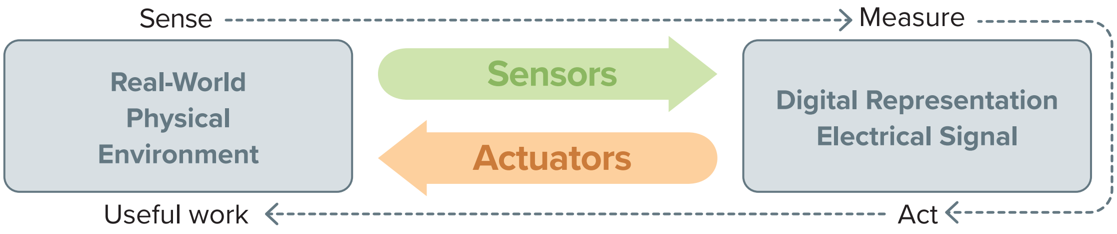
Sensor type	Description	Examples
 Position	A position sensor measures the position of an object; the measurement can be in absolute or relative terms. There are three types of position sensors: linear, angular, and multi-axis.	Potentiometer, inclinometer, and proximity sensor
 Occupancy and motion	In a surveillance area, occupancy sensors detect the presence of people and animals, while motion sensors detect the movement of people and objects. In contrast to motion sensors, occupancy sensors generate a signal even when a person is inactive.	Electric eye, and radar
 Velocity and acceleration	Velocity sensors may be linear or angular, indicating how quickly an object moves in a straight line or how quickly it rotates. Acceleration sensors measure velocity changes.	Accelerometer, and gyroscope
 Force	Force sensors determine if a physical force is applied.	Force gauge, viscometer, and touch sensor
 Pressure	Similar to force sensors, pressure sensors measure the force exerted by liquids or gases.	Barometer, and piezometer
 Flow	Flow sensors detect the fluid flow rate.	Anemometer, mass flow sensor, and water meter

Sensor type	Description	Examples
 Acoustic	Acoustic sensors measure sound levels in the environment.	Microphone, geophone, and hydrophone
 Humidity	Humidity sensors measure the amount of humidity in the air or in a mass.	Hygrometer, humidity sensor, and soil moisture sensor
 Light	Light sensors are capable of detecting the presence of light.	Infrared sensor, photodetector, and flame detector
 Radiation	Radiation sensors detect environmental radiation.	Geiger-Müller counter, and neutron detector
 Temperature	Temperature sensors quantify the amount of heat or cold within a system. Contact temperature sensors must be in physical contact with the target object. Non-contact temperature sensors measure temperature from a distance.	Thermometer, calorimeter, and temperature gauge
 Chemical	Chemical sensors determine the chemical concentration within a system.	Breathalyzer, and smoke detector
 Biosensor	Biosensors can detect biological properties in living organisms.	Blood glucose biosensor, pulse oximetry, and electrocardiograph

Actuators

Actuators are the complement of sensors

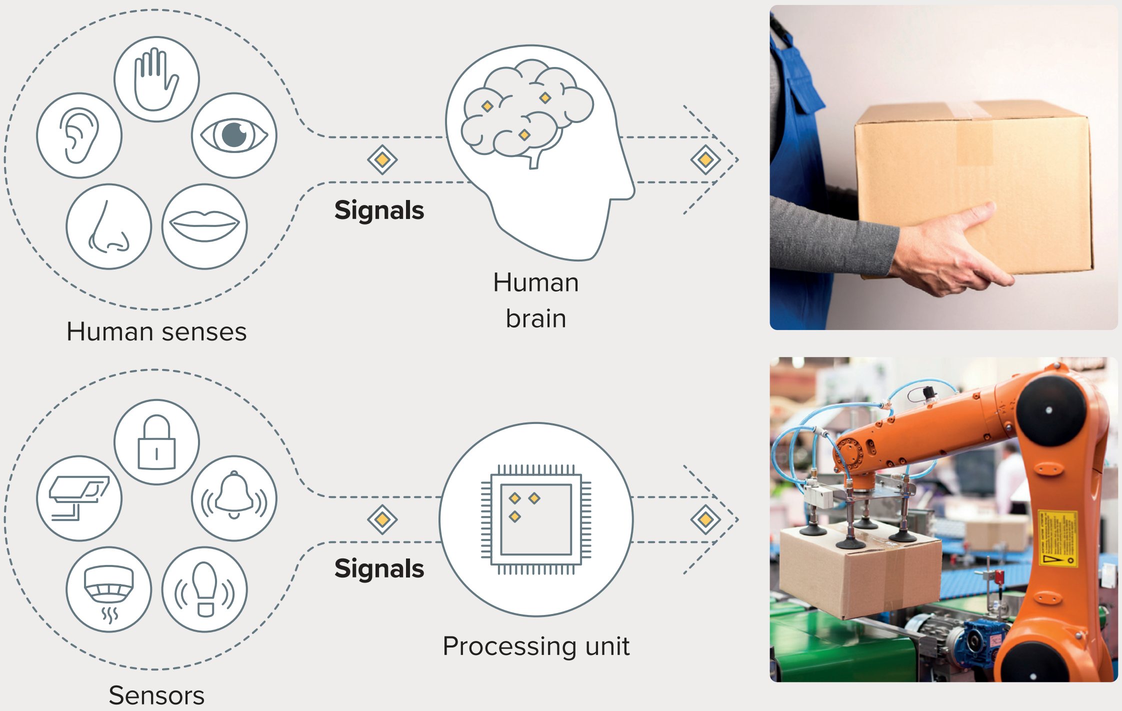
Actuators receive a control signal, most commonly an electrical signal or digital command, that triggers a physical effect in the system.



Human analogy

Humans use their five senses to sense and measure their environment. The sensory organs convert this information into electrical pulses that the nervous system sends to the brain for processing. Likewise, IoT sensors are devices that sense and measure the physical world and send their measurements as electrical signals to a microprocessor or microcontroller for additional processing.

Based on the information received from the senses, the brain sends signals to direct motor function and movement, and the nervous system carries that information to the appropriate part of the muscular system. Correspondingly, a processor can send an electrical signal to an actuator that converts the signal into physical action and has a measurable impact on its environment. This interaction between sensors, actuators, and processors and the similar functionality in biological systems is the basis for the fields of robotics and biometrics.



Classifying actuators

Type of motion

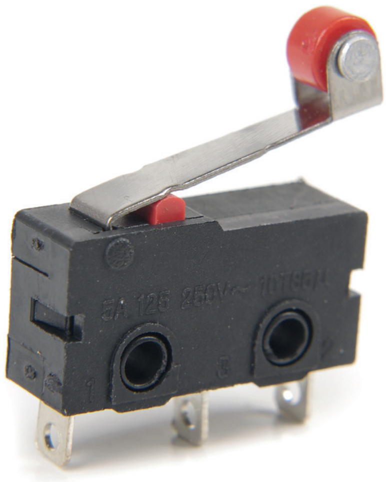
Actuators can be classified according to the type of motion they produce.

Examples: Linear, rotary, and one/two/three-axes

Force output

Actuators can be categorized according to the force exerted.

Examples: High power, low power, and micro power



Output type

Actuators can be classified according to the number of stable-state outputs.

Examples: Binary, and continuous

Area of application

Actuators can be categorized according to the specific industry in which they are used.

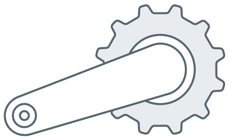
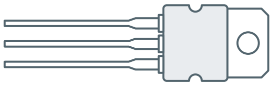
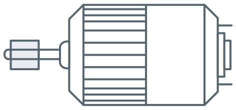
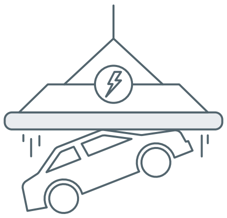
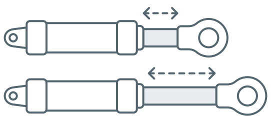
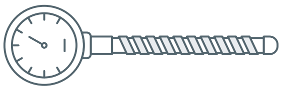
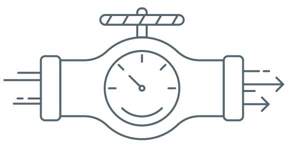
Examples: Manufacturing, automotive, and medicine

Type of energy

Actuators can be categorized based on the type of energy they utilize.

Examples: Electrical, chemical, and kinetic

Actuator types with examples

Actuator type	Examples
 Mechanical actuator	Lever, screw jack, and hand crank
 Electrical actuator	Thyristor, bipolar transistor, and diode
 Electromechanical actuator	AC motor, DC motor, and step motor
 Electromagnetic actuator	Electromagnet, and linear solenoid
 Hydraulic and pneumatic actuator	Hydraulic cylinder, pneumatic cylinder, piston, and pressure control valve
 Thermal and magnetic actuators	Magnetorestrictive material, bimetallic strip, and piezoelectric bimorph
 Microactuators and nanoactuators	Electrostatic motor, microvalve, and comb drive

EXERCISES

1 Choose the correct answer:

1. Smart objects are:

A. Powered exclusively by renewable energy sources.

B. Devices that need no external services to function.

C. Complex electronic devices that require large amounts of processing power.

D. Devices that are simple and do not require processing power.

2. What does the processing unit do in an IoT system?

A. Sends collected sensor data to external services on the Internet.

B. Detects the presence of objects in the environment.

C. Powers the smart object.

D. Generates renewable energy for the system.

3. Which statement about actuators is correct?

A. Actuators can only take discrete data as input.

B. Actuators take input directly from sensors without the need for external data services.

C. Actuators are responsible for thermal readings in an environment.

D. Actuators do not interact with sensors at all.

2 Describe the main components of a smart object.

3 List some types of applications that require self-powered sensors and others that require power-connected sensors.

4 Different IoT applications require different types of smart objects. List the features that help us to categorize smart objects.

5 Select three sensor types that are important for measuring the environment and describe their use.

6 Explain briefly which actuator types require more complex data to accomplish their required tasks, and why.

PROJECT

IoT Integration for Daily Devices

The Internet of Things is expanding to cover most aspects of our personal and professional lives. When integrated into an IoT application, common devices become smart objects that produce and consume IoT data.

1. Choose a common electronic device you use daily and create a proposal for an IoT application that begins with this device. This device sends and receives data from the IoT system to create forecasts and optimize its effectiveness.

2. Create a PowerPoint presentation that describes your proposal and how it could scale to more devices of the same type or in conjunction with other types of smart objects.

1

IoT Fundamentals

WRAP UP

THIS UNIT COVERED HOW TO:

> define the IoT and describe its history.
> distinguish the various uses of IoT applications.
> understand how the IoT enhances emerging technologies.
> describe smart objects and their uses.
> classify the sensors and actuators that exist in smart objects.

KEY TERMS

- Actuator
- Digital-First
- Internet of Things (IoT)
- IoT Device
- Physical-First
- Sensor
- Smart Object
- Thing

Foundations of IoT

Internet of Things 1

Connect the world, control the future

Have you ever imagined a world where your home, car, and devices all work together seamlessly? What if you could be at the forefront of this revolution, learning how everyday objects become smart devices that transform our lives?

Foundations of IoT: The Internet of Things 1 introduces you to the core concepts of IoT, from understanding connected devices to building real-world applications. Explore how to create projects like smart home systems and plant watering systems using Arduino, and discover how IoT platforms integrate devices into larger networks.

By the end, you'll not only understand the Internet of Things but also have the skills to design IoT applications and create practical solutions that connect the world in smarter ways.

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