Introduction to Internet of Things - IOT

The Internet of Things (IoT) refers to a network of interconnected physical objects such as devices, machines, vehicles, or people embedded with sensors, software, and unique identifiers that enable them to collect, exchange, and process data over a network without requiring direct human-to-human or human-to-computer interaction.

IOT Ecosystem

Sensors collect data and send it via the network to edge or cloud systems where the data is processed and analyzed. Results are delivered to users through apps or used to automatically drive actuators and systems.

Components of IoT System

IoT systems are built on four essential components that work together to enable seamless connectivity and intelligent decision-making:

1. Devices & Sensors

- Physical objects embedded with sensors or actuators that collect data from the environment (e.g., temperature, motion, gas, light).
- Sensors convert physical signals into digital data for further analysis.

2. Connectivity: Networks such as Wi-Fi, Bluetooth, Zigbee, LoRaWAN, or 5G that transmit data between devices, gateways, and cloud platforms.

3. Data Processing

- Edge devices, gateways, or cloud platforms process and analyze collected data, often using AI or big data technologies.
- This step transforms raw data into meaningful insights.

4. User Interface (UI)

- Applications, dashboards, or mobile apps through which users interact with IoT systems.

- Interfaces can also trigger actuators to perform automated actions.

Note: *Modern IoT systems also rely on low-power embedded systems, ensuring devices consume minimal energy while maintaining high performance.*

Different types of Sensors

- **Temperature Sensors:** Measure heat or temperature changes in the environment or objects.
- **Image Sensors**: Capture visual data for cameras and computer vision applications.
- **Gyro Sensors (Gyroscope):** Detect angular velocity and orientation of objects.
- **Obstacle Sensors:** Identify the presence of obstacles to avoid collisions.
- **RF Sensors**: Use radio frequency signals for detection, tracking, and communication.
- **IR Sensors (Infrared):** Detect heat signatures or motion using infrared light.
- **MQ-02/05 Gas Sensors:** Sense the presence and concentration of gases like CO, methane, or smoke.
- **LDR Sensor (Light Dependent Resistor):** Measure light intensity and brightness levels.
- **Ultrasonic Distance Sensor**: Calculate distance by using ultrasonic sound waves.

IoT Enablers

IoT enablers are the key technologies and tools that make the Internet of Things work. They provide the foundation for devices to connect, collect data, process information, and deliver meaningful outcomes.

- **RFID & NFC:** Used for automatic identification and tracking of objects through radio waves or short-range communication.

- **Sensor Technologies:** Devices that measure environmental factors such as motion, temperature, gas, or light and convert them into digital signals.
- **Low-Power Embedded Systems:** Specialized hardware designed to consume minimal energy while delivering reliable performance, ensuring longer device life.
- **Smart Networks & Protocols**: Communication methods like MQTT, CoAP, Zigbee, and 5G that enable fast, efficient, and reliable data transfer.
- **Cloud & Big Data**: Platforms that store, manage, and analyze massive volumes of IoT data to generate insights.
- **Edge/Fog Computing:** Local data processing near the devices, reducing latency, improving speed, and saving bandwidth.

Working of IoT Devices

- **Collect and Transmit Data :** For this purpose sensors are widely used they are used as per requirements in different application areas.
- **Actuate device based on triggers produced by sensors or processing devices:** If certain conditions are satisfied or according to user's requirements if certain trigger is activated then which action to perform that is shown by Actuator devices.
- **Receive Information:** From network devices, users or devices can take certain information also for their analysis and processing purposes.
- **Communication Assistance:** Communication assistance is the phenomenon of communication between 2 networks or communication between 2 or more IoT devices of same or different networks. This can be achieved by different communication protocols like: MQTT, Constrained Application Protocol, ZigBee, FTP, HTTP etc.

IOT

Characteristics of IoT

- **Always Connected** : IoT devices love to stay connected, but to save energy they sometimes take small naps (sleep mode) and wake up only when needed.
- **Good at Teamwork:** They can talk to all kinds of other devices big or small, old or new without complaining about differences in hardware or software.
- Adaptive in Nature: Like a quick learner, an IoT device can adjust itself when situations change for example, a smart light getting brighter when the room gets dark.
- **Quietly Smart:** They don't just collect data; they process it to give meaningful insights like a fitness tracker telling you not just how many steps you walked, but how healthy your activity level is.
- **Scalable:** Whether you add one device or thousands, IoT systems are designed to grow without losing efficiency.
- **Energy Conscious:** They know how to save battery, turning off when not in use and waking up only when needed, just like an energy-efficient roommate.

Modern Applications

- Smart Grids and energy saving
- Smart cities
- Smart homes/Home automation
- Healthcare
- Earthquake detection
- Radiation detection/hazardous gas detection
- Smartphone detection

History of IOT

- 1982: Vending Machine: First IoT concept; reported inventory status remotely.
- 1990: Toaster: First internet-connected appliance; remote control of devices.

- 1999:IoT Term Coined: Kevin Ashton introduced "Internet of Things."
- 2000: LG Smart Fridge: Remote monitoring of fridge contents; IoT in daily life.
- 2004: Smart Watch: Wearables with fitness tracking & notifications.
- 2007: iPhone: Smartphones became IoT hubs via apps and connectivity.
- 2009: Cars: IoT enabled diagnostics , performance monitoring.
- 2011: Smart TV: Internet enabled entertainment & apps.
- 2013: Google Lens: Object recognition linking physical world to digital info.
- 2014: Amazon Echo: Voice controlled smart home via Alexa.
- 2015: Tesla Autopilot: Semiautonomous driving with IoT sensors/software.

Advantages of IoT

- Improved efficiency and automation of tasks.
- Increased convenience and accessibility of information.
- Better monitoring and control of devices and systems.

Disadvantages of IoT

- Potential for hacking and data breaches.
- Collection and misuse of personal data.
- Significant initial investment required.