

IOT (Internet of things)

IOT = The Internet of things (IOT) is a network of physical (things) embedded with sensors, software and technology that connect and exchange data with other devices and systems over the internet.

Real life **example**:- A smart fridge can send a message to your phone when the milk is finished or even order groceries by itself.

* Microcontroller vs Microprocessor (MCU) (MPU)

Microcontroller	Microprocessor
1) Mini computer	1) Big computer
2) cheap	2) costly
3) slower than microprocessor	3) fast
4) Arduino, ESP32, RPi	4) Intel i5, i7, Ryzen 7, Ryzen 5
5) CPU + RAM + ROM + memory + I/O ports	5) only contains CPU
6) Not extendable, builtin	6) can extend memory
7) specific task	7) multitasking.

IOT VS IOH

IOT (Internet of things)

Network of physical devices connected to the internet

Devices - sensors, actuators, embedded systems

Tech used - WiFi, bluetooth, LoRa

Machine-to-machine (M2M)

ex. smart fridge, smart agriculture system, industrial robots

Automation and data exchange between machines

IOH (Internet of Human)

Network that connects humans directly to the internet

Smartphones, voice assist, smart wearables.

Voice, video, biometric sensors

Human-to-machine (H2M)

ex. voice calls, Zoom, Alexa, wearable fitness trackers

enhancing human connection and interaction.

Microcontroller

- Brands of microcontrollers.

1) **Arduino**:- A beginner-friendly microcontroller ideal for basic electronic and automation projects.

ex. Arduino UNO, R1, R4, Mega

Arduino UNO - widely used in hobby projects and educational settings.

2) **ESP32** - built in wifi and bluetooth, suitable for IoT applications.

ex. ESP32 WROOM, NodeMCU, AI Thinker
commonly used in smart home devices and wireless projects.

3) **Raspberry Pi** - A single-board computer that runs a full OS like Linux, ideal for complex tasks.

ex. Raspberry Pi 1, 2, 3, 4, 4+, 4B

Raspberry Pi 4 - used in robotics, media centers, and even desktops.

4) **Jetson Nano** - Designed by NVIDIA, it is used for AI and ML applications.

ex. Jetson Nano, Jetson Lite, Jetson Orin
used in computer vision and edge AI projects.

I2C - Inter-Integrated Circuit

- A serial communication protocol used to connect multiple devices using just 2 wires.

- **SDA** (Serial Data): carries the actual data.

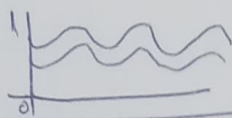
- **SCL** (Serial Clock): sends the clock signal to sync data transfer.

- Used for: LCDs, sensors

- Supports multiple devices on the same bus.

Sensor Vs Actuator

Sensor



- 1) Take input from the environment
- 2) Converts physical signals to electrical signals
- 3) example: Temperature sensor, LDR
- 4) provide analog or digital input to microcontroller
- 5) used for monitoring

Actuator

- 1) produces outputs to affect the environments.
- 2) Converts electrical signals to physical action
- 3) example: Motor, LED, Buzzer
- 4) Takes digital output from microcontroller
- 5) used for controlling

*UART- Universal Asynchronous Receiver Transmitter.

A serial communication protocol used for asynchronous data transfer.

- TX (transmit) → sends data.
- RX (Receive) → receive data.
- used for: communication betⁿ microcontrollers, computer
- GPS modules, Bluetooth
- no clock wire needed; devices must agree on baud rate.

* Arduino

ESP

RPi

programmable boards

embedded c

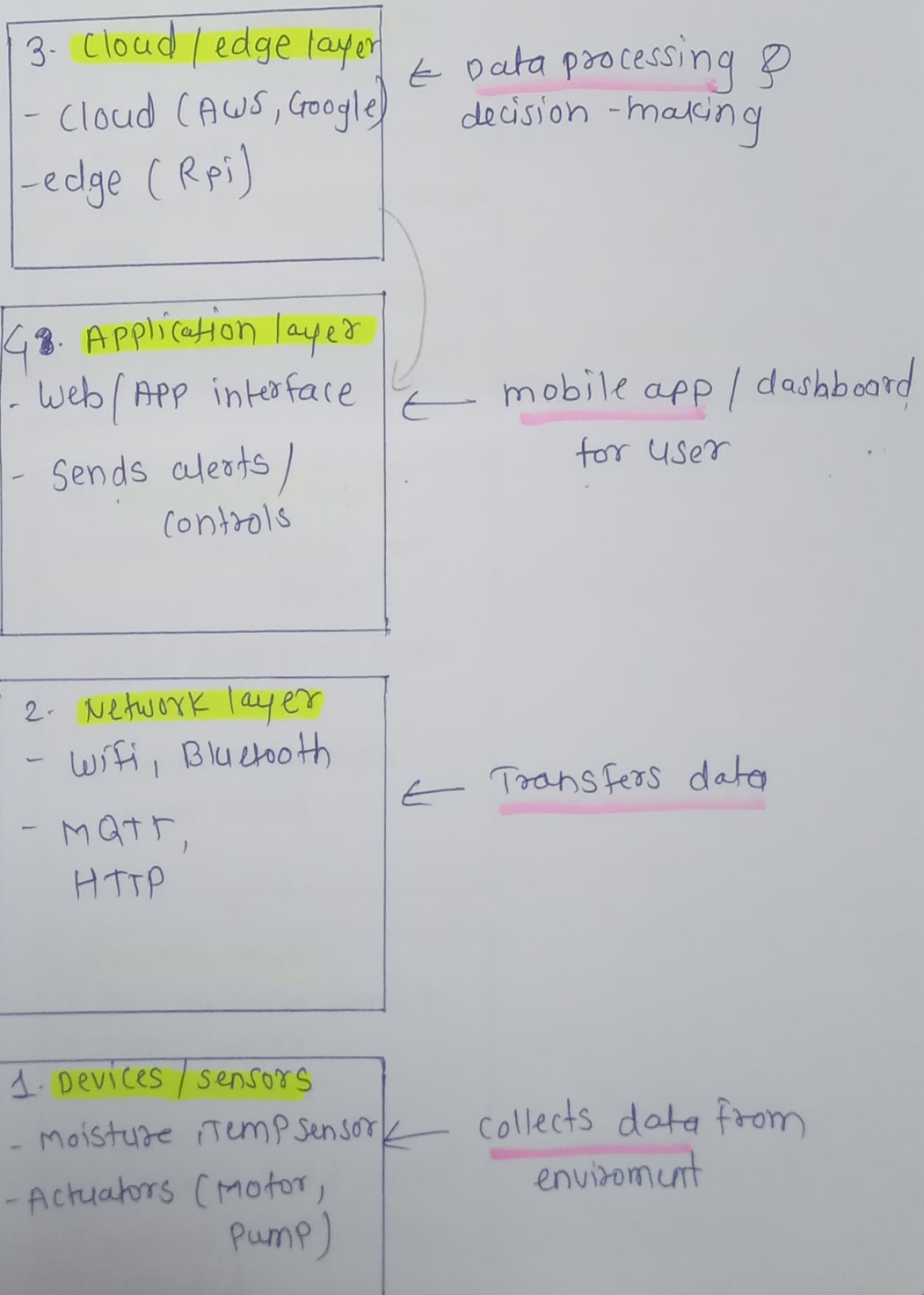
micropython

* GPIO - General purpose Input/output

- used to connect sensors / actuators
- can be set as input or output.

IOT Architecture

IOT architecture defines how IOT systems are structured to collect, process and use data efficiently



"Smart Agriculture" - IOT Architecture

4. Application layer

- Farmer's mobile app
- Web dashboard showing farm status
- view soil moisture, temp



3. cloud / edge layer

- AWS, Azure cloud
- Raspberry Pi
- stores & analyzes sensor data
- decides when to turn on water pump



2. Network layer

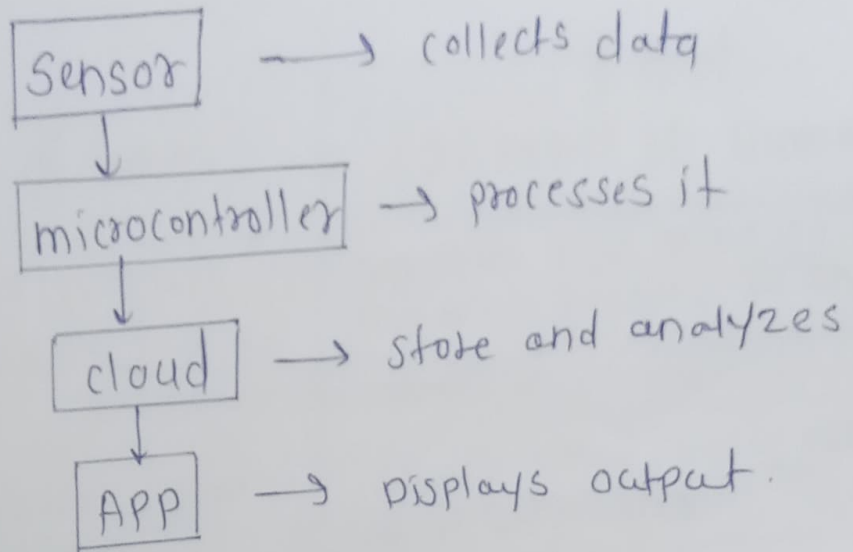
- LoRa (long range, low power)
- sends data from farm to cloud
- receives commands from cloud



1. Sensors layer

- Soil moisture sensor
- Temp sensor
- Light sensor
- Water pump
- monitors field condition
- waters plants when needed

Data flow in IoT



IOT Use Cases

1. Smart city

- smart lighting, traffic monitoring, waste management

2. Smart Home

- voice assistants, smart TVs, door locks

3. Smart Healthcare

- patient monitoring, medicine tracking

4. ADAS (Advanced Driver Assistance system)

- smart mirrors, proximity sensors

5. Remote monitoring

Data logging via cloud (ESP32 → bluetooth → APP)

Automation

(predefined step)

Automation is a To Run predefined step in order to replace manual process & execute tasks without human intervention.

ex. - Smart lights turning ON when someone enters a room.

- Smart locks automatically securing doors when you leave home.

benefits:-

- Save energy and time
- Reduces human effort
- Increases accuracy and safety

Type of Automation:-

1- Home Automation

- control lighting, heating, cooling and security using IoT

- example: smart thermostats, Alexa - controlled light

2- Industrial Automation

- use IoT sensors and machines in factories for production and monitoring

example: predictive maintenance.

3- Agricultural Automation

IoT in farming for irrigation, soil monitoring.

ex. smart irrigation system.

• Predictive maintenance.

Predictive maintenance uses IoT sensor (vibration, temp, pressure) to monitor machine and predict failures before they happen.

Sensors collect data → Data analyzed in real time →

System predict when a machine will fail → maintenance is done only when needed.

ex. car companies use IoT to alert drivers when part need servicing

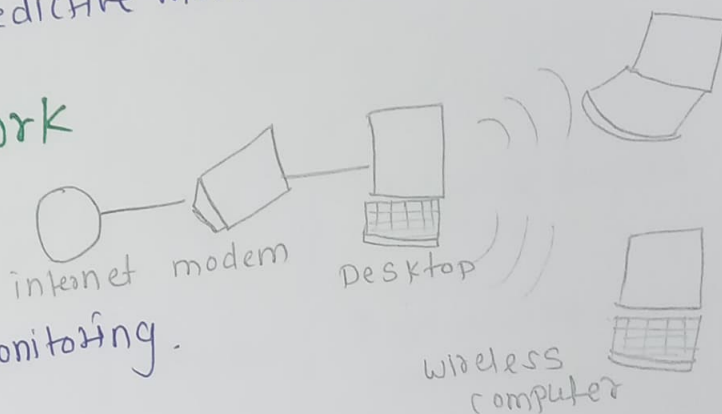
IOT Applications

1. Home Automation :- smart thermostats, lights and locks controlled via apps improve comfort, security and energy saving.
2. Smart cities :- Traffic sensors, smart streetlights, save energy and improve services.
3. Healthcare :- wearable (fitbit, Apple watch)
4. Agriculture :- smart irrigation and precision farming optimize water use, reduce costs and increases productivity
5. Industrial IoT :- predictive maintenance, smart factories,

• Type of IOT Network

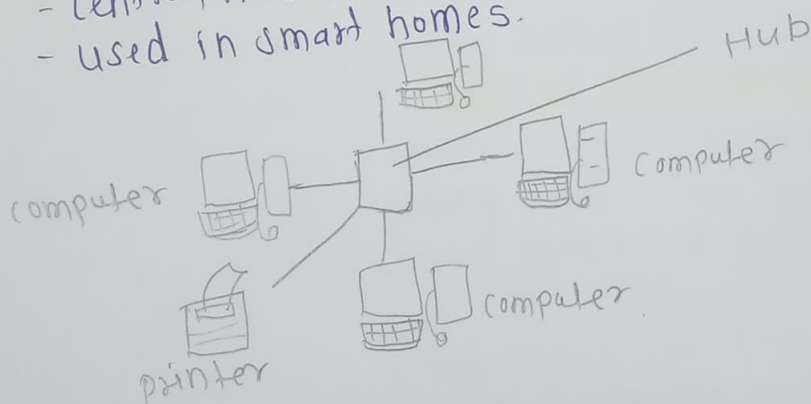
1) Ad-hoc Network

- Temporary
- no central hub.
- used in disaster monitoring.



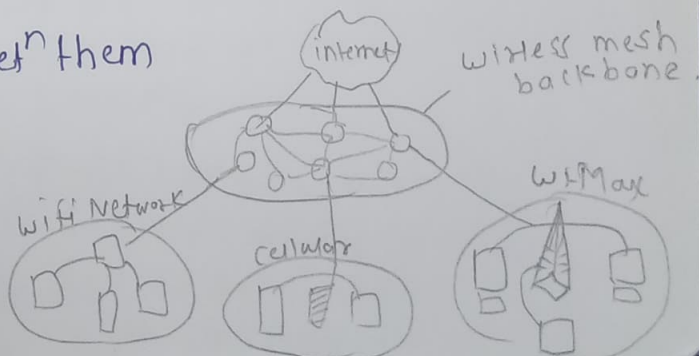
2) star Network

- central hub connects all devices.
- used in smart homes.



3) mesh network

- interconnect; data can hop betⁿ them
- used in smart cities.



IOT Network.

In the IOT, devices need to talk to each other or to each other or to a central system like a cloud or server. For this they need network - the roads on which the data travels.

Type	Range	speed	Power use	example use case
<u>PAN</u> (Personal Area Network)	Few meter	Low	very low	Smartwatches, fitness trackers.
<u>LAN</u> (Local Area Network)	upto 100m	medium	medium	smart homes, factories.
<u>WAN</u> (wide Area Network)	many km	medium/high	high	city-wide sensors, vehicles.
<u>LPWAN</u> (Low Power WAN)	2-15 km	Low	very low	Agriculture, remote monitoring.

communication protocols

communication protocols define how the data is transferred between IOT devices. rule of conversation betn machines

1. Zigbee - A low-power, short-range protocol used in smart lighting and home automation.
ex: Philips Hue smart bulbs use Zigbee for wireless control.
2. LoRa (long range) - A long-range, low-power protocol used in precision agriculture and remote monitoring.
ex: smart irrigation systems use LoRa to send soil moisture data from fields to farmers.
3. Bluetooth Low energy (BLE) - A short range, energy efficient protocol used in fitness trackers and wearables.
ex: Fitbit and Apple Watch use BLE to sync health data with smartphone