# IoT

IoT is a network of physical objects or "things" embedded with electronics, software, sensors and network connectivity, which enables these objects to collect and exchange data.

## Challenges of IoT (SSS

Scalability → Power supply
Discovery
Technological Standardization
Interaction and short range communication
Fault Tolerance (wireless communication)
~~Software~~ complexity

## Critisms and controversies of IoT (PASS + SAD)

Privacy
security
Social control
Design
Environmental Impact
Autonomy and control

## Applications

→ Home automation
→ Media → Smart city
→ Manfacturing
→ Medical & health care
→ Transportation

## How IoT works

1. Sensors : Collect live data from environment
2. ~~Data~~ connectivity : Connected to cloud using various mediums of communications. Bluetooth, Wifi, LoRa LAN
3. Data Processing
4. User Interface

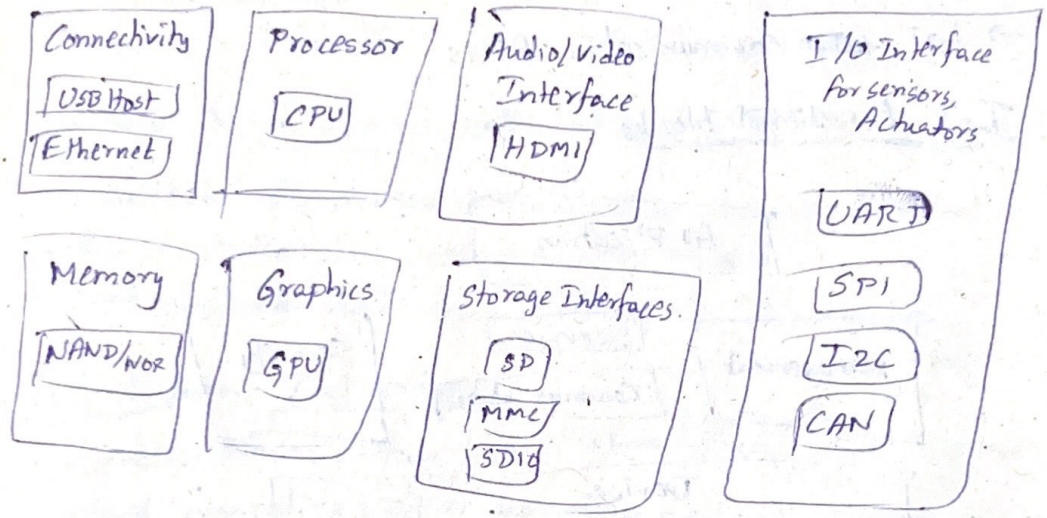
## Characteristics of IoT

Unique Identity
Dynamic Nature
Self-Adopting
Self configuring
Heterogeneity
Scalability
Safety

# Physical design of IoT

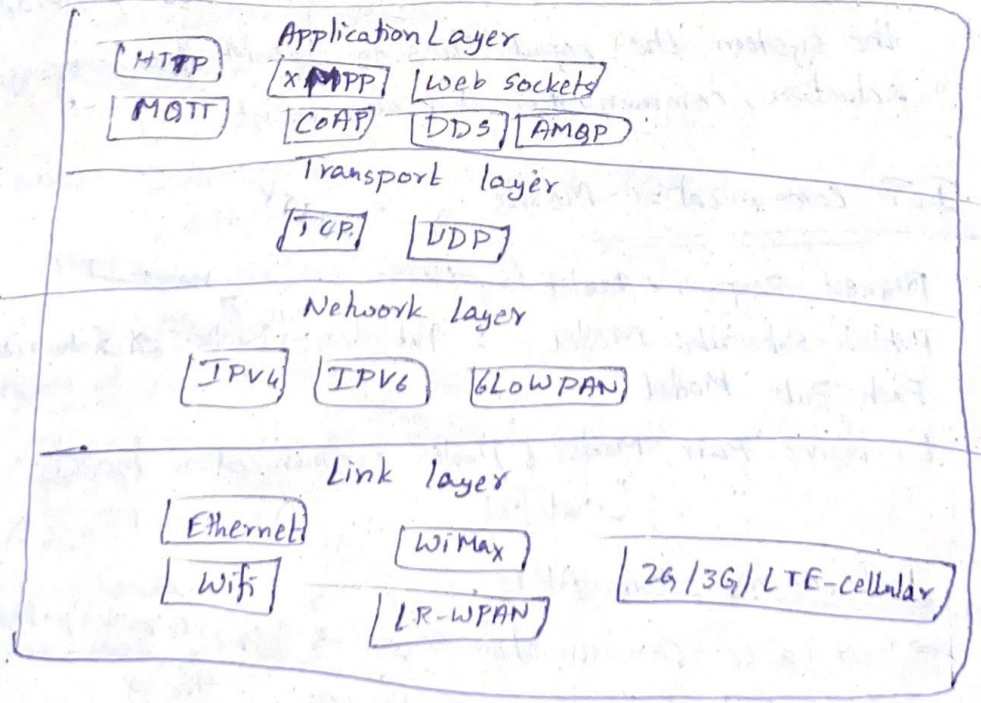
- IoT Devices
- IoT Protocols

## Block diagram of IoT devices




## IoT Protocols

Helps to establish connection b/w IoT Device and Cloud based server over Internet

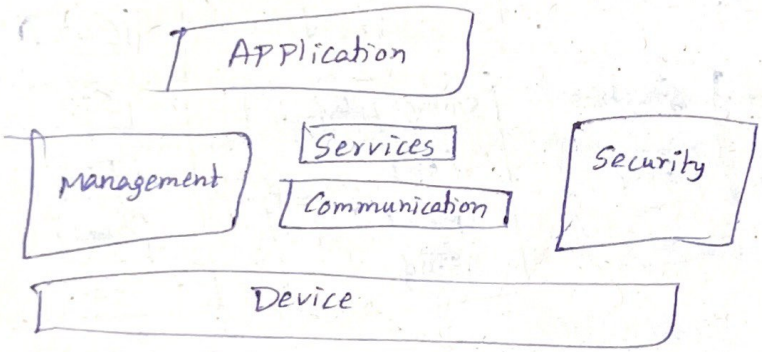


## Logical design of IoT

Abstract representation of entities & processes without going into low-level specifics of the implementation

→ IoT Functional Blocks
→ IoT communication Models
→ IoT ~~APIs~~ communication APIs

### IoT Functional blocks




Comprises of no. of functional blocks that provide the system the capabilities for identification, sensing, actuation, communication & management.

### IoT Communication Models

Request-Response Model (stateless) → HTTP
Publish-Subscribe Model : Publishers ⇄ Brokers ⇄ Subscribers (Manage topics)
Push-Pull Model
Exclusive Pair Model : Bidirectional, Duplex communication model (stateful)

### IoT Communication APIs

→ Rest Based Communication APIs → Req, Res Model, → Design → Web API to web services → Popular
→ WebSocket based communication APIs.

↓ Design
~~It provides~~ web api's to web services. (It uses request-response communication model)

## Rest based Communication API constraints

- Client-server
- Stateless
- Cacheable
- Layered system
- Uniform Interface
- Code on demand

## Web Socket based communication APIs

- Bidirectional, full duplex communication b/w cli & serv.
- follow exclusive pair communication model.
- Most suitable IoT comm. APIs for IoT system.

## IoT Enabling Technologies

- Wireless sensor Network : Distributed Devices with sensors used to monitor environmental & physical cond-
- Cloud computing : Deliver applications & services over internet.
- Big Data Analytics
- Communication Protocols
- Embedded systems

→ WSN = Indoor Air Quality Monitoring System
Weather MS
Soil Moisture MS
Health MS

## Types of Cloud Computing Services

IaaS - Infrastructure as a Service
PaaS - Platform
SaaS - software

→ Clients can use storage to install and manage OS and any applications Ex: web hosting, Microsoft Azure.
→ Client can install, build & modify applications
Ex: App cloud, Google App engine
→ Client can access and use software at remote location using web browser - Ex: Google docs

## Big Data Analytics

amount of data ↗ Types of data ↘ speed of data processing

Collection of data whose volume, velocity and variety is too large and difficult to store, manage, process and analyze using traditional databases.

Data cleansing
Data munging
Data Processing
Data visualisation

## Communication Protocols

Allows to exchange data over networks.
Functions:
→ Sequence control
→ Flow control
→ Retransmission of lost packets

## Embedded Systems

Computer hardware having software embedded in it
Either independent or part of large system.

Robots, Digital cameras, DVD, MP3 players, Microwave

Key Components
→ Microprocessor/ Micro controller
→ Memory
→ Storage
→ I/o units
→ Networking units (Ethernet, wifi adaptors)

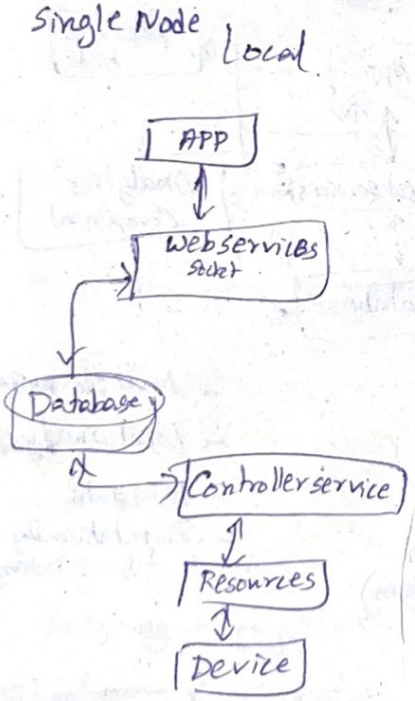
# IoT levels & Deployment

Components in IoT system

Device
Resources
Controller service
Database
Web service
Analysis component
Application

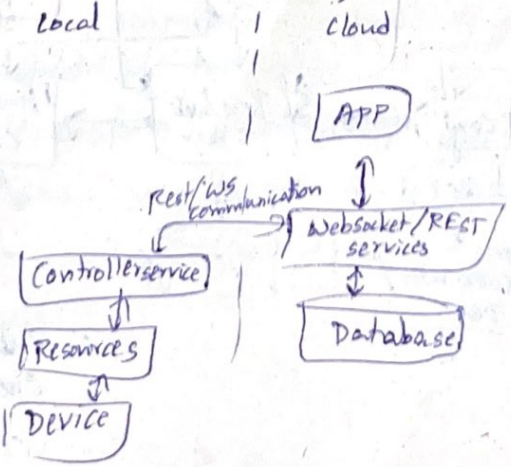
## IoT Level-1 (Home Automation System)

Single Node



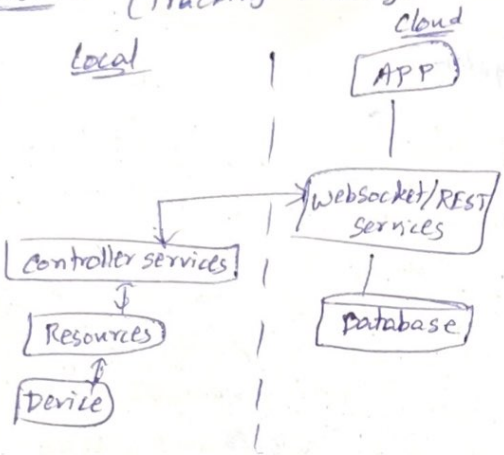

- Small data
- Low-cost
- Low complexity
- Not computationally intensive
- Local analysis.
- Single Node

## IoT Level-2 (Smart Irrigation)



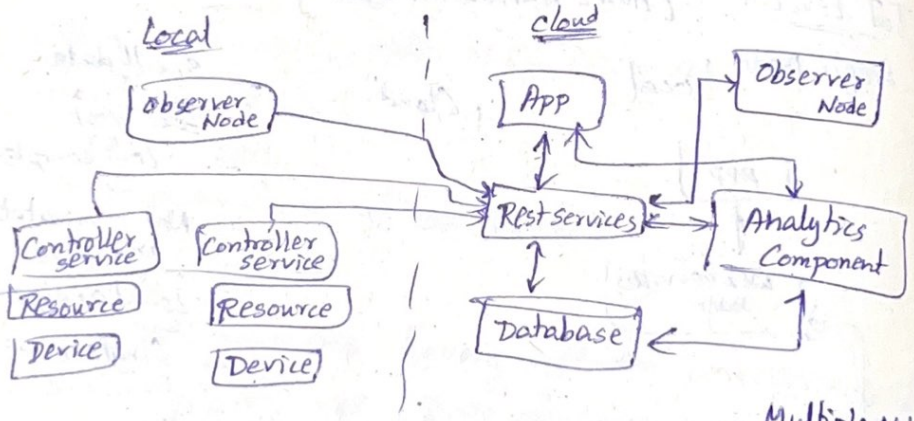

- Data stored in cloud
- big data
- Not computationally intensive
- Local analysis
- Single Node.

Level-3 (Tracking Package Handling.



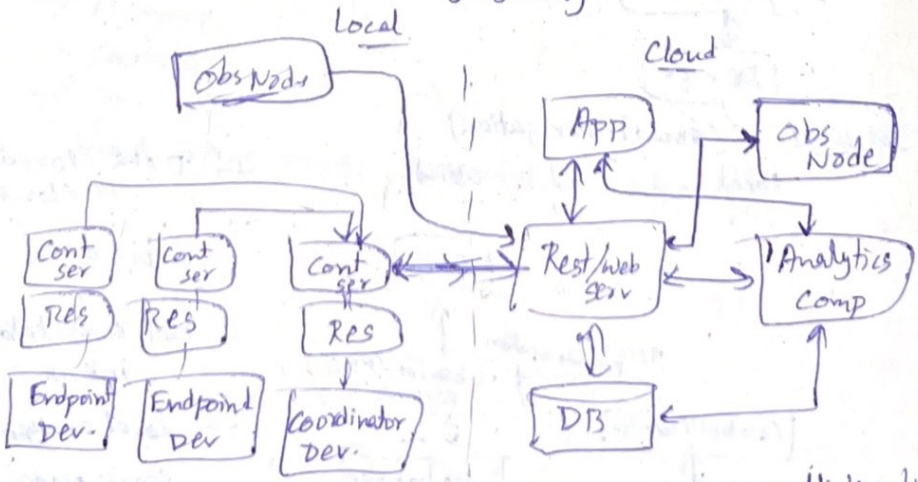

- single node
- Cloud analysis
- Computationally intensive
- Big Data

Level-4 (Noise Monitoring)



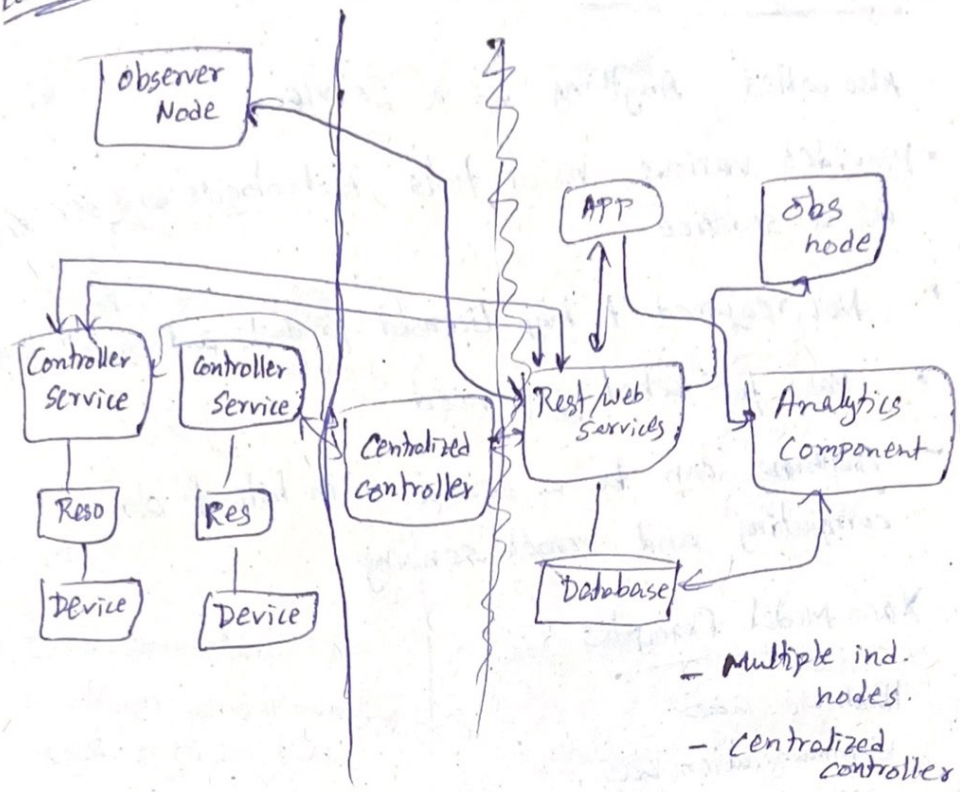

- Multiple Nodes
- Local analysis
- Big data
- Computationally intensive

Level-5 (~~Weather Monitoring System~~ Forest fire detection)




- Multiple end nodes
- One coordinator node
- Cloud analysis
- Bid data
- Computationally intensive.

Level-6 (Weather monitoring system)




- Multiple ind. nodes.
- Centralized controller
- Data stored in cloud.
- Cloud based analysis.

## IoT issues & challenges

- Interoperability
- Security
- Privacy
- Legality & Rights
- Economy & Development.

## Benefits of IoT Paas

- Provide a common infrastructure to obtain value from industrial topologies
- Enable uniform communication, security, analytics and management layers for heterogeneous IoT topologies
- Provide simplier and more agile models for building IoT solutions.

## Everything as a Service

- Also called Anything as a Service.
- Provides various no.of tools, technologies and services as a service.
- Not required to buy licensed products and install them.
- Pay for what you need.
- Anything can be a service with help of cloud computing and remote sensing.

### Xaas Model Examples

Hardware aas
Communication aas
Desktop aas
Security aas
Healthcare aas
Transport aas

### Advantages

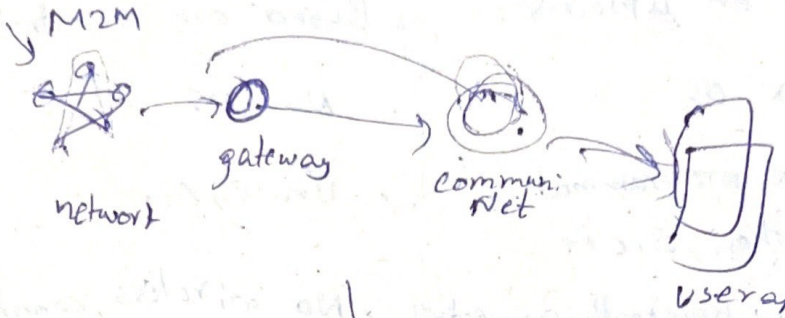
- Cost saving
- Scalability
- Accessibility
- Faster Implementation
- Quick Modification
- Better security
- Boost Innovation
- Flexibility

### Disadvantages

Internet Breakage
slowdown
Difficult in Troubleshoot
Change brings Problem

# IoT Data Processing Requirements

Capture → Interoperate → Analyse → Act




| M2M | IOT |
|---|---|
| • Direct connections b/w machines communicating with one another. | • Over the air communication Indirect through centralized controller |
| • Mainly used for automation | • Used for automation remote maintenance & control. |
| • Less scalable | • More scalable |
| • Uses either internet or no internet. | • Uses internet & cellular networks. |
| • Small scale projects | • Large scale projects. |
| • Not supported by open API | • Supported by open API |
| • Limited devices in scope. | • Large devices in scope |
| • Remote monitoring | • Smart city smart agriculture. |
| • Old protocols. | • Internet protocols are used |

| Raspberry | Arduino |
| --- | --- |
| • Single board computer | • Development circuit board |
| • Based on μprocessor | • Based on μcontroller |
| • Linux OS | • No OS |
| • Can be programmed in Python, C, C++ | • In C, C++ |
| • Wifi, Bluetooth connectivity on board | • No wireless connectivity |
| • Closed source | • Open source h/w, s/w (h/w: hardware) |