IoT Protocols and communication modes

Lecture-2

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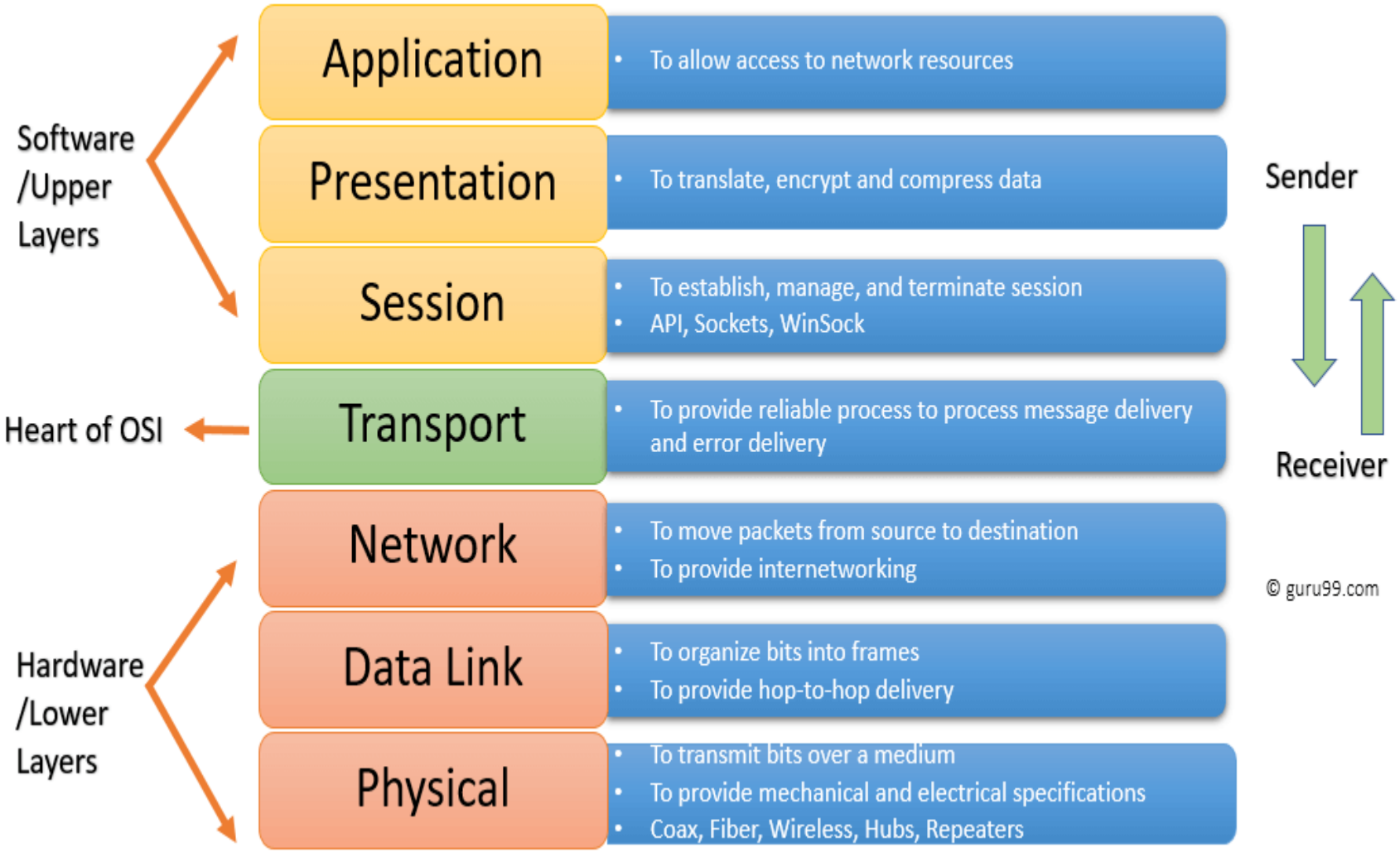
Contents

- IoT protocols
- Communication Modes
- IoT level

IoT Protocol

- IoT communication is based on a layered architecture that efficiently organizes data exchange across different protocols.
- Data exchange between devices goes through several layers from storage, to processing and to the user interface.
- Each layer is responsible for a specific task and communicates with the layers below and above it.

OSI layer


Application
To allow access to network resources
Presentation
To translate, encrypt and compress data
Session
To establish, manage, and terminate session
API, Sockets, WinSock
Transport
To provide reliable process to process message delivery and error delivery
Network
To move packets from source to destination
To provide internetworking
Data Link
To organize bits into frames
To provide hop-to-hop delivery
Physical
To transmit bits over a medium
To provide mechanical and electrical specifications
Coax, Fiber, Wireless, Hubs, Repeaters
Software /Upper Layers
Heart of OSI
Hardware /Lower Layers
Sender
Receiver
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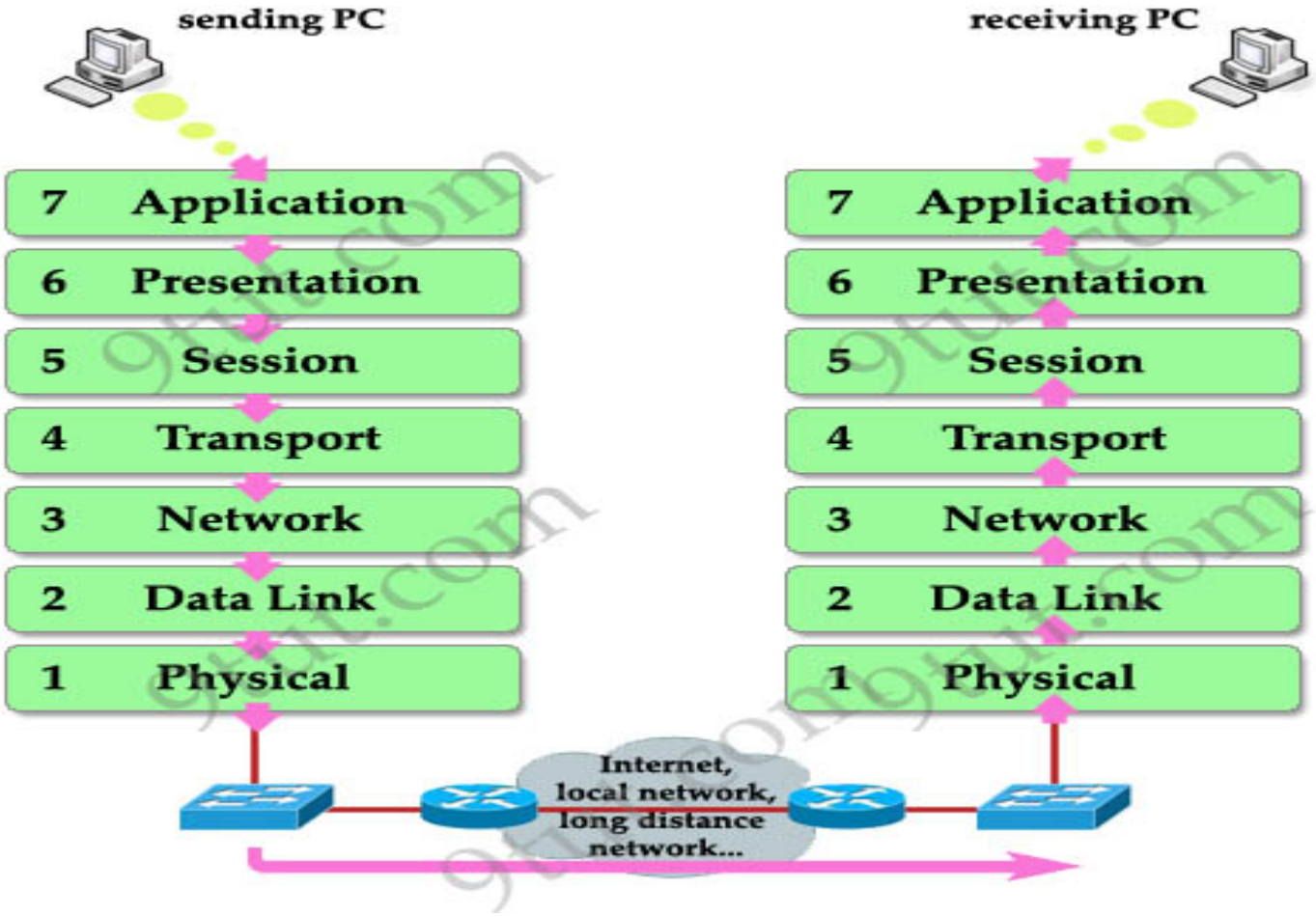
OSI layer..

- Mr. Cooper wants to send Ms. Palmer an email. Mr. Cooper composes his message in an email application on his laptop and then hits ‘send’. His email application will pass his email message over to the application layer, which will pick a protocol (SMTP) and pass the data along to the presentation layer.
- The presentation layer will then compress the data and then it will hit the session layer, which will initialize the communication session.
- The data will then hit the sender’s transportation layer where it will be segmented, then those segments will be broken up into packets at the network layer, which will be broken down even further into frames at the data link layer.
- The data link layer will then deliver those frames to the physical layer, which will convert the data into a bits tream of 1s and 0s and send it through a physical medium, such as a cable.

OSI layer..

- Once Ms. Palmer’s computer receives the bit stream through a physical medium (such as her wifi), the data will flow through the same series of layers on her device, but in the opposite order.
- First the physical layer will convert the bits tream from 1s and 0s into frames that get passed to the data link layer. The data link layer will then reassemble the frames into packets for the network layer. The network layer will then make segments out of the packets for the transport layer, which will reassemble the segments into one piece of data.
- The data will then flow into the receiver's session layer, which will pass the data along to the presentation layer and then end the communication session. The presentation layer will then remove the compression and pass the raw data up to the application layer. The application layer will then feed the human-readable data along to Ms. Palmer’s email software, which will allow her to read Mr. Cooper’s email on her laptop screen.

OSI layer..

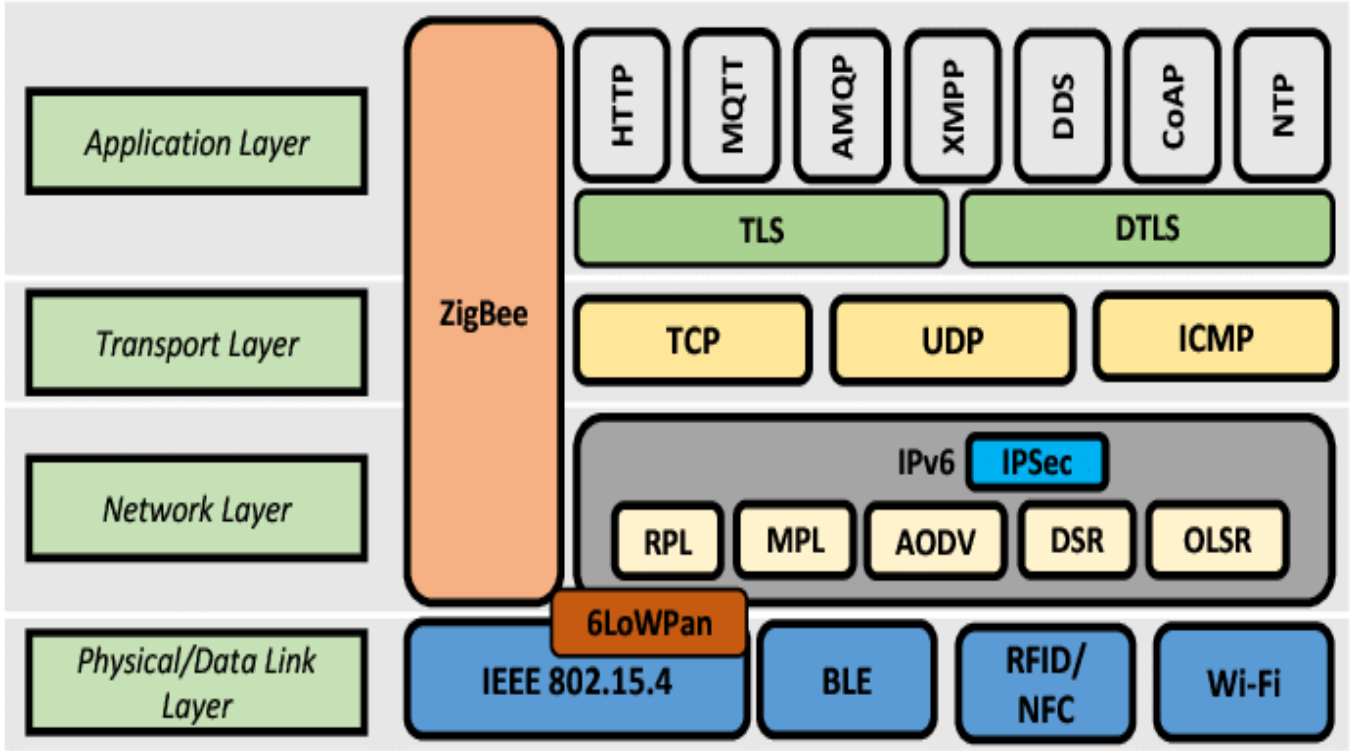

sending PC
receiving PC
7 Application
6 Presentation
5 Session
4 Transport
3 Network
2 Data Link
1 Physical
7 Application
6 Presentation
5 Session
4 Transport
3 Network
2 Data Link
1 Physical
Internet, local network, long distance network...

IoT protocols layers

- **Physical layer:** this layer includes the physical equipment involved in the data transfer, such as the cables and switches.
- it converts into a bit stream, which is a string of 1s and 0s. The lowest layer physically connects devices and transmits the bits via cable or mobile communications.
- **Wi-Fi Bluetooth ZigBee LTE LoRaWAN**

- **Data link layer:** the data link layer facilitates data transfer between two devices on the *same* network.
- The data link layer takes packets from the network layer and breaks them into smaller pieces called frames.
- responsible for flow control and error control in intra-network communication
- **Ethernet, PPP (Point-to-Point Protocol), IEEE 802.15.4**

IoT protocol layers



IoT protocols layers..

- **Network layer**
- The network layer is responsible for facilitating data transfer between two different networks.
- The network layer breaks up segments from the transport layer into smaller units, called packets, on the sender's device, and reassembling these packets on the receiving device.
- The network layer also finds the best physical path for the data to reach its destination; this is known as routing.
- **IP, RPL, 6LowPAN**

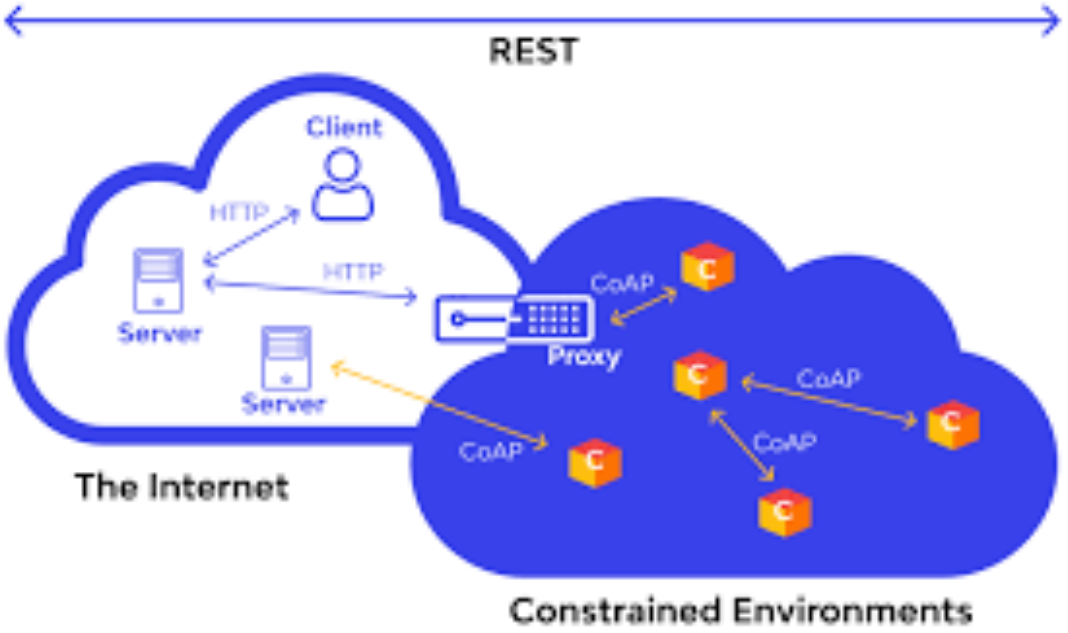
IoT protocols layers..

- **Transport layer:** This layer controls the transmission of data between end-to-end communication between the two devices ensuring reliable and orderly transmissions of data packets. **TCP, UDP**
- The **application layer** provides network services directly to end-user applications. It defines protocols for specific data exchange and communication needs. **HTTP, CoAP, MQTT, AMQP** etc

https://www.cloudflare.com/learning/ddos/glossary/open-systems-interconnection-model-osi/

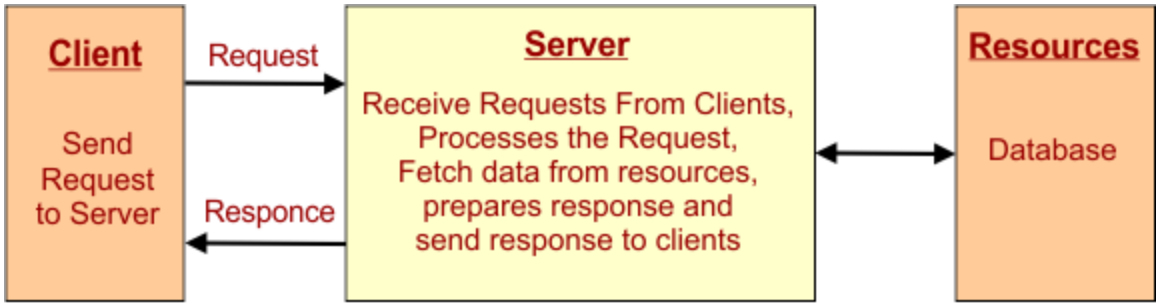
Communication Models in IoT

- **Request & Response Model**
- **Publisher-Subscriber Model**
- **Push-Pull Model**
- **Exclusive Pair**



Request & Response Mode

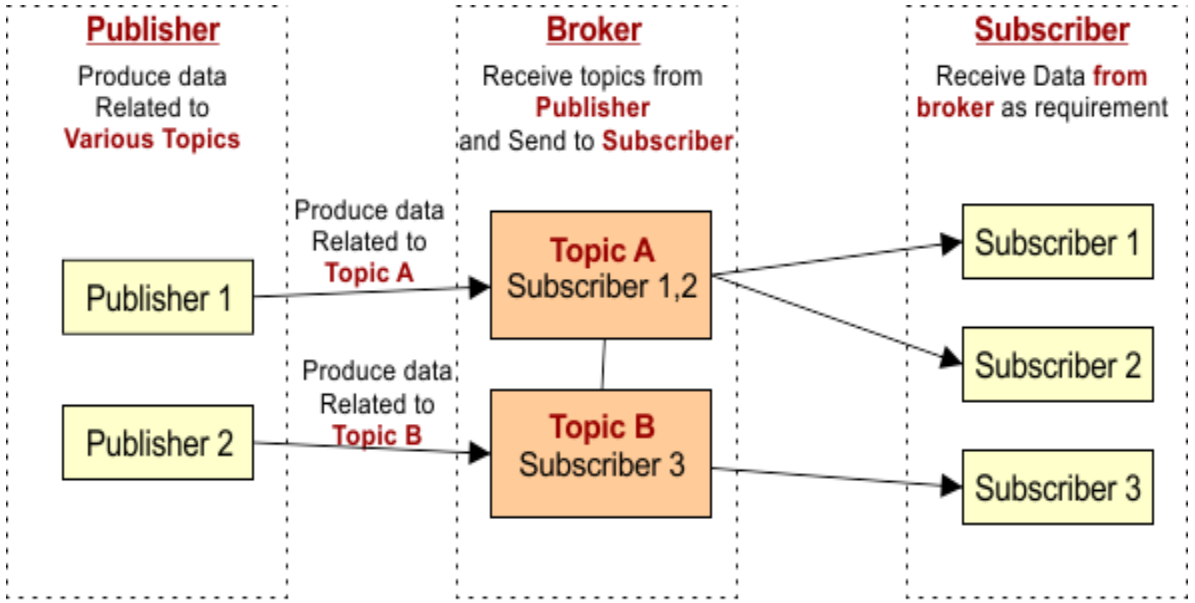
- In IoT, the **client device** sends a request to the server.
- The request may be an upload or transfer of data. The Server responds to the request.
- The **server** may be remote or local and can handle the requests of multiple clients.
- The server receives the request, processes (decides) the response to that request, and fetches the data from resources (i.e., database).



Request-Response Communication Model

Publisher-Subscriber Model

- **Publisher:** It transfers data to the broker. Publishers don't know about consumers.
- **Broker:** It accepts publisher data and sends it to the appropriate subscriber.
- **Subscriber:** It consumes the topics that the broker manages.

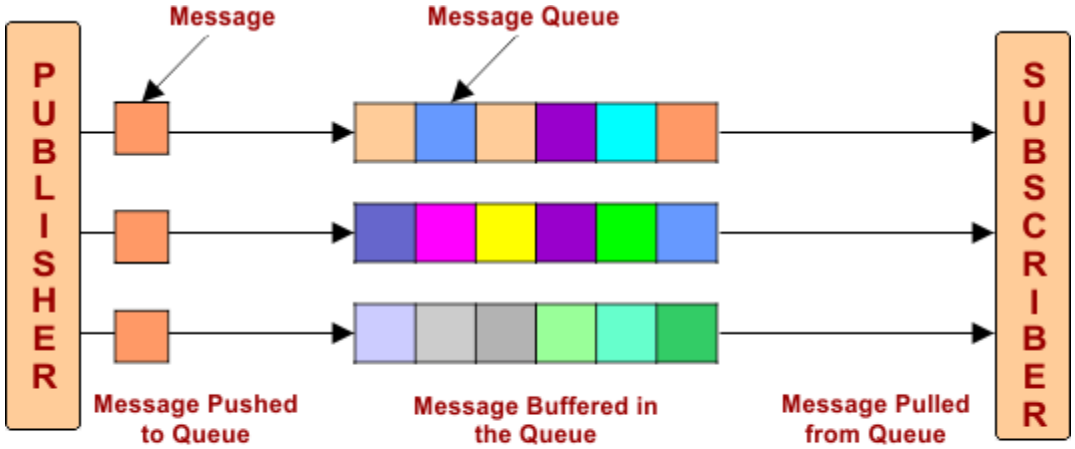


https://cstaleem.com/iot-communication-models

Publish/Subscriber Model

Push-Pull Model

- Push-pull involves a direct, often one-to-one, connection between sender and receiver, with either the sender pushing data or the receiver pulling data.
- **Publisher**: It pushes the data into Message Queue
- **Message Queue**: it is a buffer that stores data pushed by a publisher
- **Subscriber**: It pulls data from the message queue.



Push-Pull Model

Exclusive Pair

- It is a bi-directional.
- In an exclusive pair, the client establishes a connection with the server by sending a request, and this connection remains open until the client sends a request to close the connection.

Exclusive Pair Model

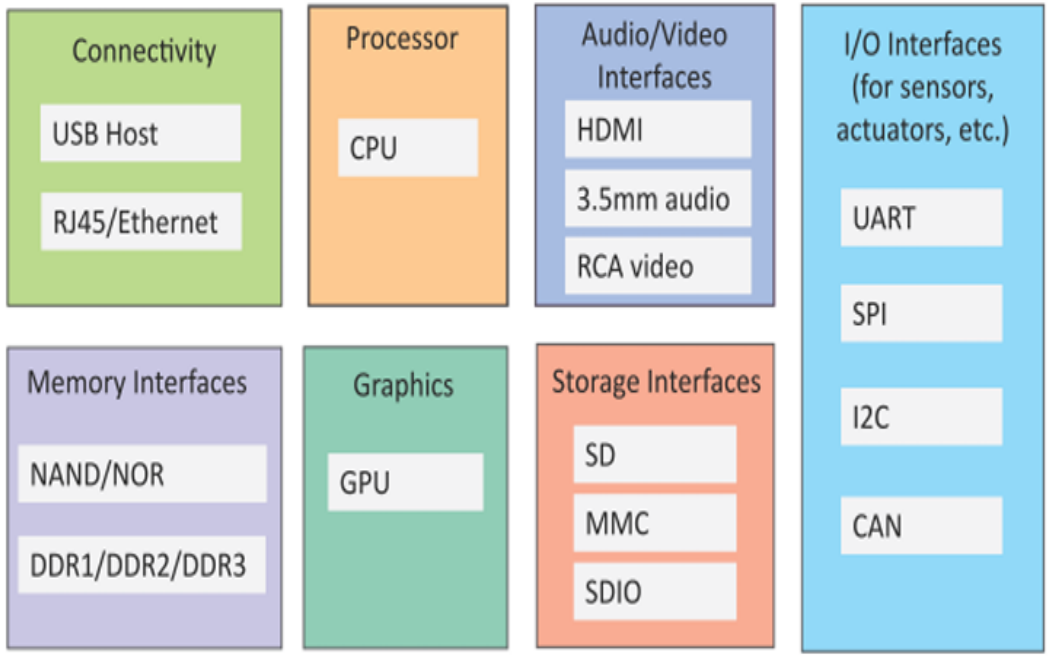
IoT Ecosystem

- An IoT ecosystem is a network of interconnected devices, objects, and even people that all work together to collect, share, and act on data. It's like a giant web of things, all communicating with each other to achieve a common goal.
- **Devices:** These are the smart gadgets that we typically associated with IoT, like thermostats, fitness trackers, and even industrial machines.
- **Sensors:** These are the eyes and ears of the devices, picking up things like temperature, motion, or air quality.
- **Networks:** This is how all the devices communicate with each other and send their data to the cloud. It can be through WiFi, cellular networks, or other methods.
- **Cloud Platforms:** This is the big data storage center. The data collected by the devices is sent here to be analyzed and used.
- **Applications:** These programs allow users to interact with the data and control their devices. This could be anything from a phone app to a complex industrial control system.

IoT System Design : IoT Levels and Deployment

An IoT system comprises the following components :

Devic e : An IoT device allows identification, remote sensing, actuating and remote monitoring capabilities.



Source: Book website: http://www.internet-of-things-book.com

IoT system ..

- Resources : Resources are software components on the IoT device for accessing, processing and storing sensor information, or for controlling actuators connected to the device.

- Controller Service : Controller service is a native service that runs on the device and interacts with the web services. Controller service sends data from the device to the web service and receives commands from the application (via web services) for controlling the device

IoT system..

- Database : Database can be either local or in the cloud and stores the data generated by the IoT device. Web Service : Web services serve as a link between the IoT device, application, database and analysis components.
- Web service can be implemented using HTTP and REST principles (REST service) or using the WebSocket protocol (WebSocket service)

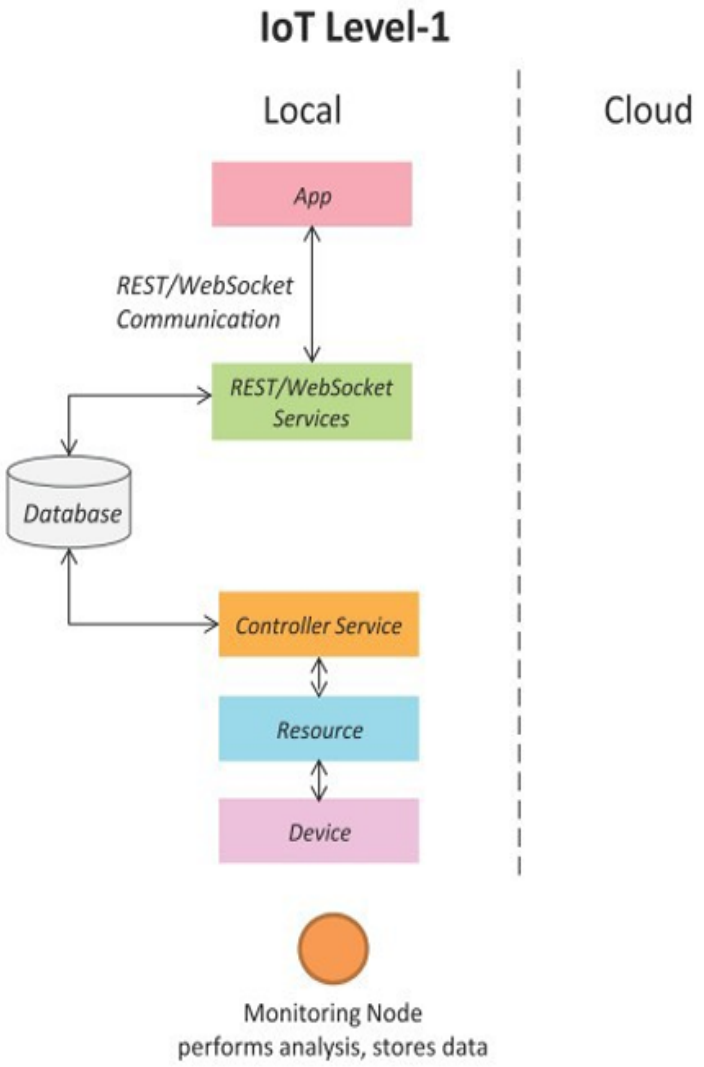
IoT Level - 1

IoT Level - 1 has a **single node** that performs sensing and/or actuation and hosts applications.

Data is stored at the node.

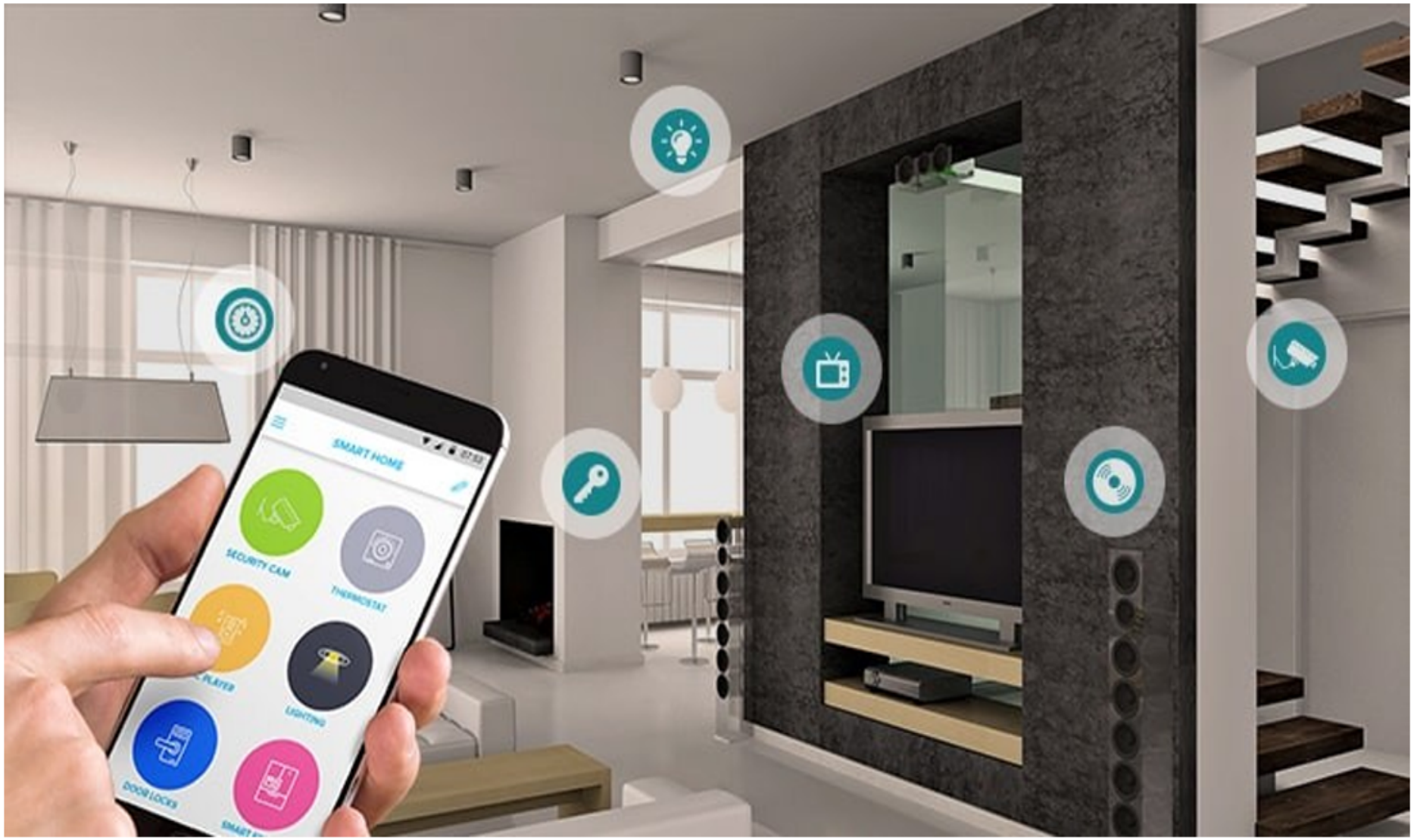
Application runs at the node

They are suitable for modelling low cost solutions where **data is not big and analysis requirements are not computationally intensive**



Source: Book website: http://www.internet-of-things-book.com

oT Level - 1 : Smart Home



Sensors used : Light, Temperature, Motion, Camera

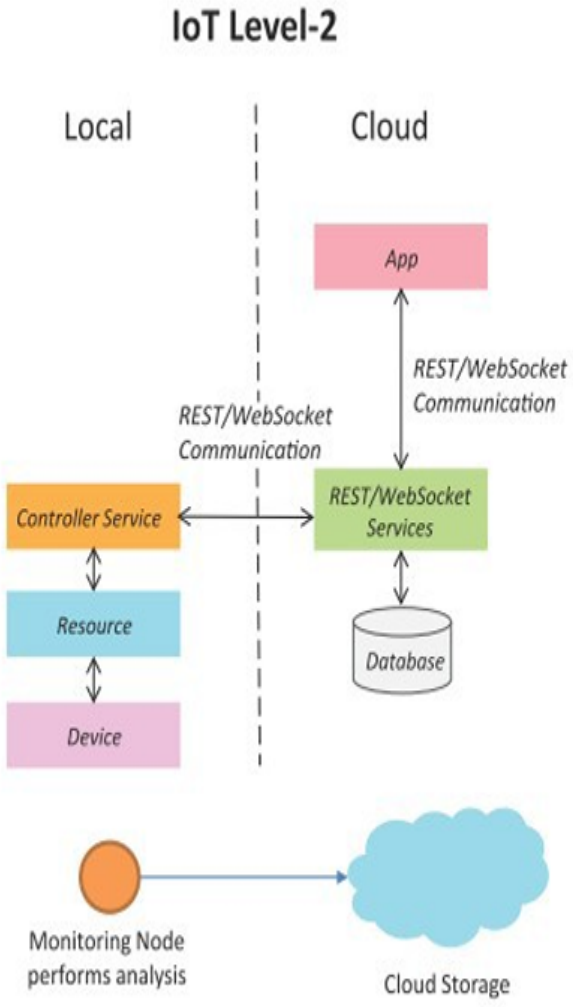
Source: Internet

IoT Level - 2

IoT Level - 2 has a single node that performs sensing and/or actuation and local analysis.

Data is stored in the cloud and application is cloud based

They are suitable for modelling where **data is big** However, **analysis requirements are not computationally intensive** and can be done locally



Source: Book website: http://www.internet-of-things-book.com

IoT Level - 2 : Smart Irrigation

Sensors used : Temperature, Humidity, Pressure

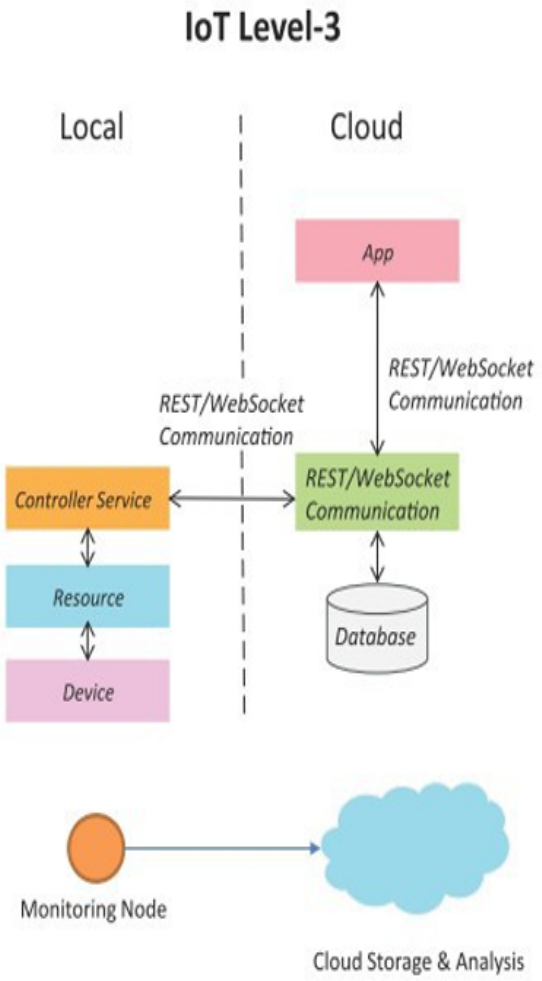
Source: Internet

IoT Level - 3

IoT Level - 3 has a single node that performs sensing and/or actuation and local analysis.

Data is stored in the cloud and application is cloud based

They are suitable for modelling where **data is big** However, **analysis requirements are computationally intensive**



Source: Book website: http://www.internet-of-things-book.com

IoT Level - 3 : Tracking Package Delivery

Sensors used : Gyroscope and Accelerometer

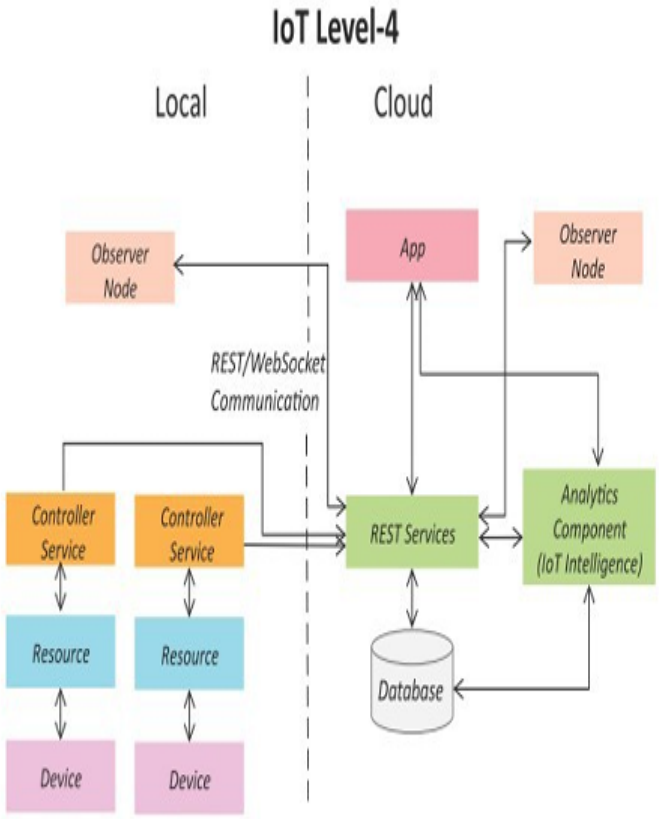
IoT Level - 4

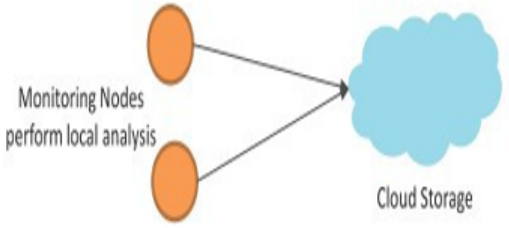
IoT Level - 4 has a **multiple nodes** that performs local analysis

Data is stored in the cloud and application is cloud based.

Local and cloud based **observer nodes** which can subscribe to and receive information collected in the cloud

They are suitable where multiple nodes are Required, **data is big and analysis requirements are computationally intensive**





Source: Book website: http://www.internet-of-things-book.com

IoT Level – 4 : Noise Monitoring System

Sensors used : Sound Sensors

IoT Level - 5

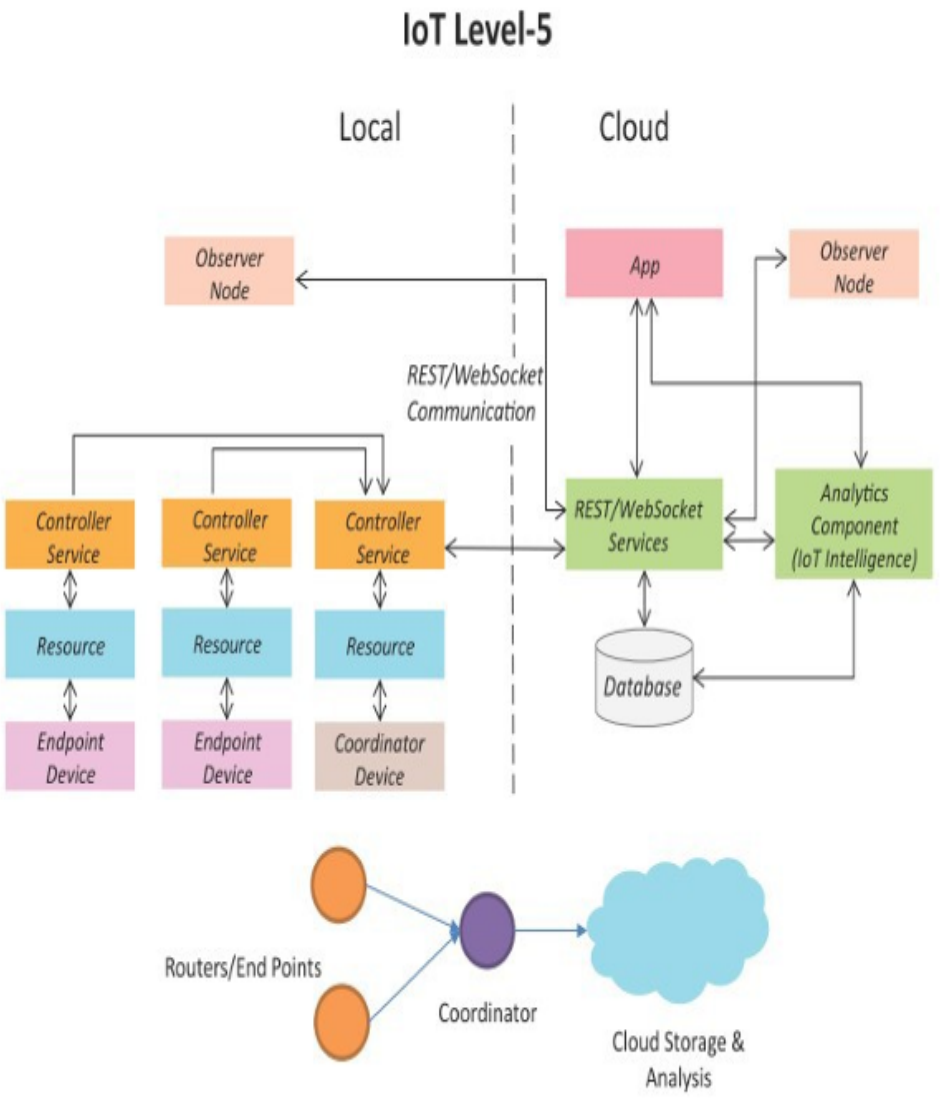
IoT Level - 5 has a **multiple end nodes** and one **co-ordinator node**

End node performs sensing and actuation

Collector node collects data from end nodes and send it to the cloud

Data is stored in the cloud and application is cloud based.

Level 5 IoT systems are suitable for solutions based on wireless sensor network in which **data is big and analysis requirements are computationally intensive**



Source: Book website: http://www.internet-of-things-book.com

IoT Level – 5 : Forest Fire Detection System

- Sensors used : temperature, smoke, weather, slope of earth, wind speed, speed of fire, flame length

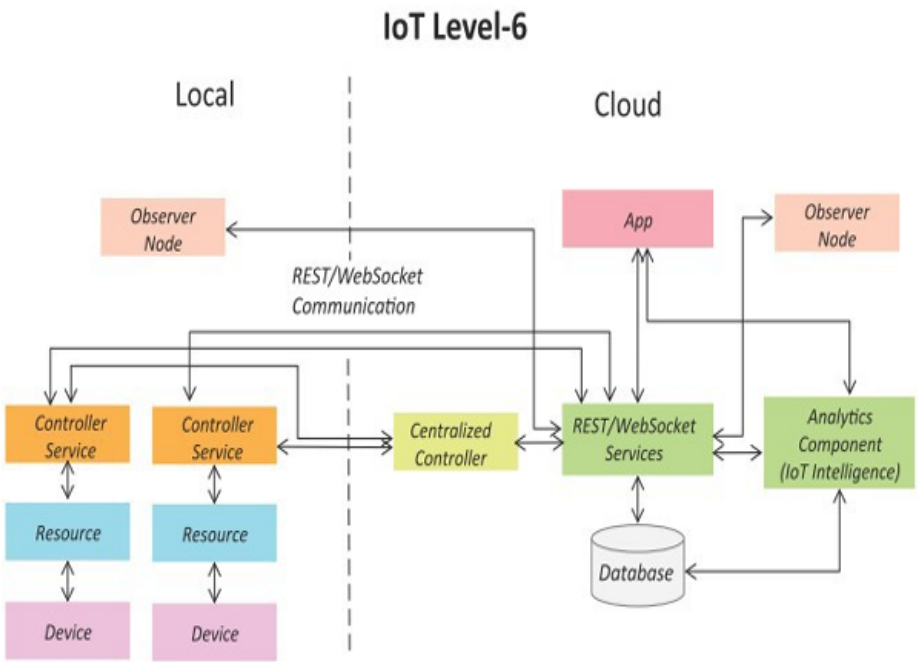
IoT Level - 6

IoT Level - 6 has a multiple independent end Nodes that perform sensing and / or actuation and send data to the cloud.

Data is stored in the cloud and application is cloud based.

The analytics component analyses data and stores it in the cloud database

The results are visualized with the cloud based application. **The centralized controller is aware of the status of all end nodes and sends cor commands to the nodes**



Source: Book website: http://www.internet-of-things-book.com

https://technophileholmes.hashnode.dev/internet-of-things-iot-levels

IoT Level – 6 : Weather Monitoring Station

- Sensors used : wind speed direction, solar radiation, temperature, relative humidity, precipitation, snow depth, barometric pressure,soil moisture

Thank you