IoT Levels and Deployment Templates

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IoT Levels and Deployment Templates

An IoT system comprises the following components:

1. Device – Identification, Remote Sensing, Actuating, Remote monitoring capabilities
2. Resource – Software Components on IoT devices for accessing, processing and storing sensor information or controlling actuators connected to the devices. Also include software component that enables network access for the devices
3. Controller Service – Sends data from the devices to the web services and receive commands from the application for controlling the devices
4. Database – Stores data generated by the devices
5. Web Service – Serves as a link between the IoT device, application, database and analysis component
6. Analysis Component – Analyse the data and generate the result
7. Application – Provides the interface that the users can use to control and monitor various aspects of IoT systems

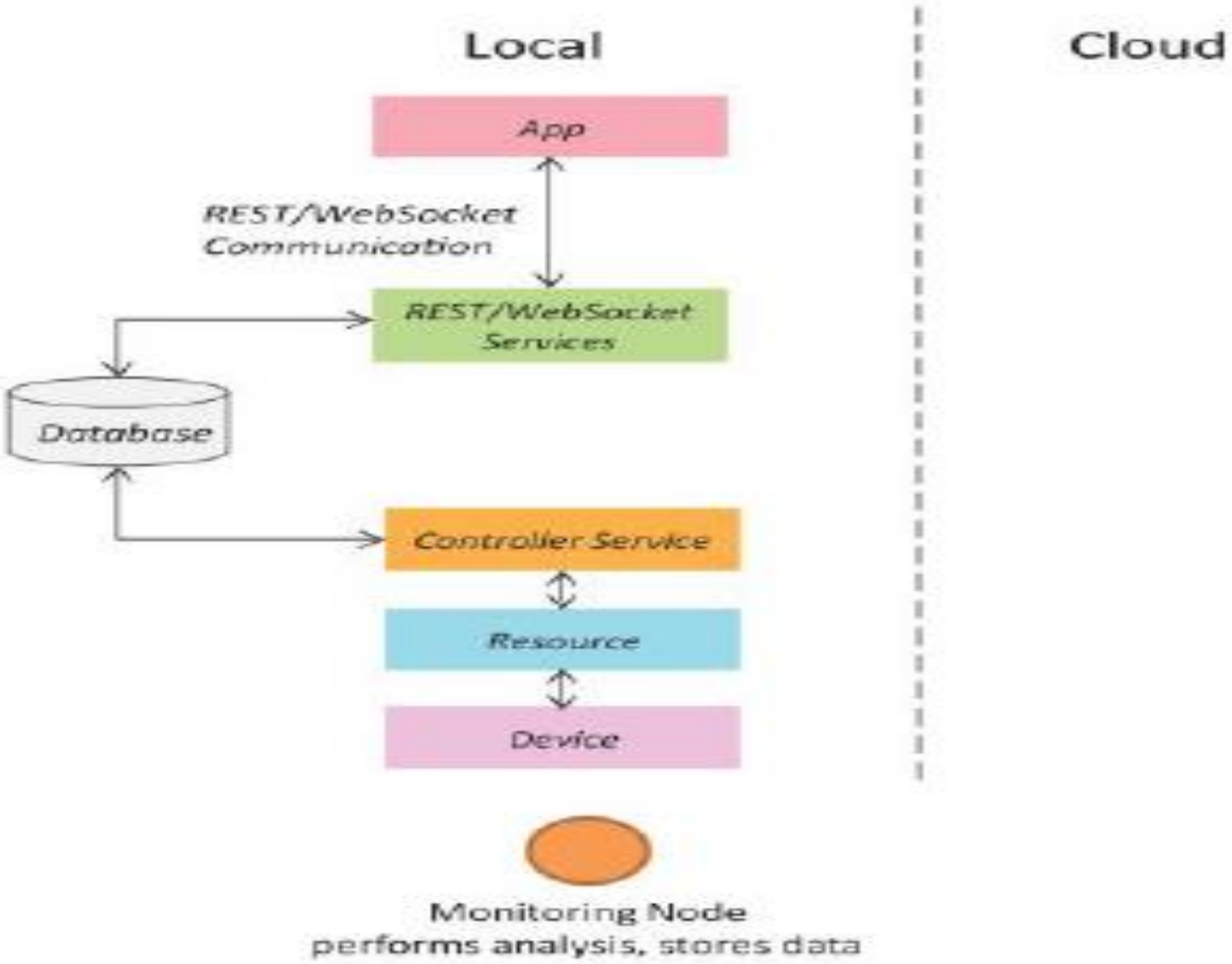
IoT Levels & Deployment Templates

- IoT Level 1
- IoT Level 2
- IoT Level 3
- IoT Level 4
- IoT Level 5
- IoT Level 6

IoT Level-1

- A level-1 IoT system has a **single node/device** that
  - Performs sensing and/or actuation
  - **Stores data**
  - Performs **analysis** and hosts the **application**
- Level-1 IoT systems are suitable for **modeling low cost and low-complexity solutions** where
  - **Data** involved is **not big**
  - Analysis requirements are **not computationally intensive**

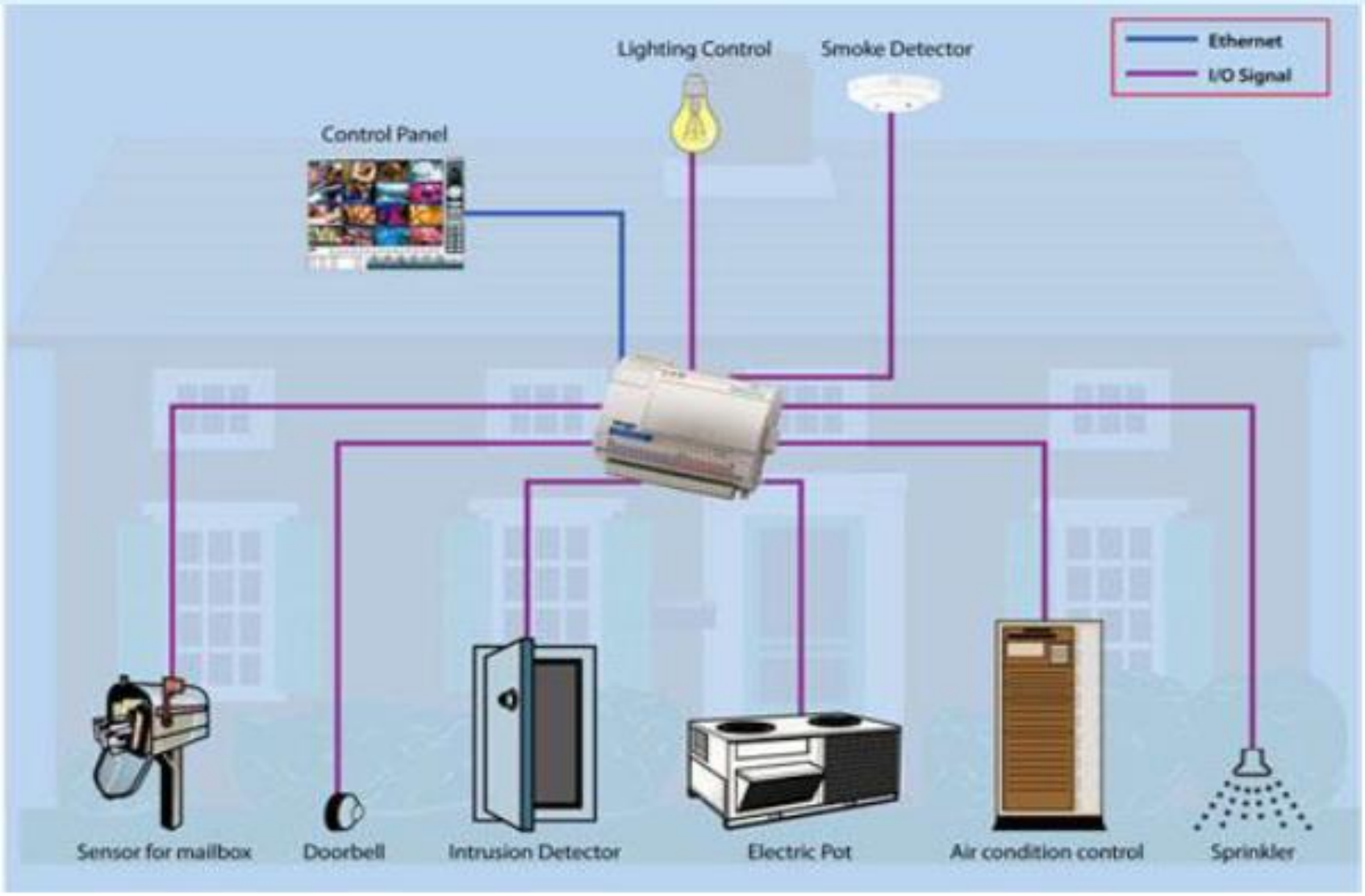
IoT Level-1


Local
Cloud
App
REST/WebSocket
Communication
REST/WebSocket
Services
Database
Controller Service
Resource
Device
Monitoring Node
performs analysis, stores data

IoT Level-1 Example – Home Automation

- The system consists of a **single node** that allows controlling the **lights** and **appliances** in home remotely
- **Electronic relay switch** is used to interface the devices
- Status information of each lights and appliances is maintained in a **local database**
- **Application** is deployed **locally**
- This level consists of **air conditioner, temperature sensor**, data collection and analysis and control & monitoring app
  - The data sensed in stored **locally**
  - The data analysis is done **locally**
  - Monitoring & Control is done using Mobile app or web app
  - The data generated in this level application is not huge
  - All the control actions are performed through internet
- **Example**
  - Room temperature is monitored using temperature sensor and data is stored/ analyzed locally.
  - Based on analysis made, control action is triggered using mobile app or it can just help in status monitoring.

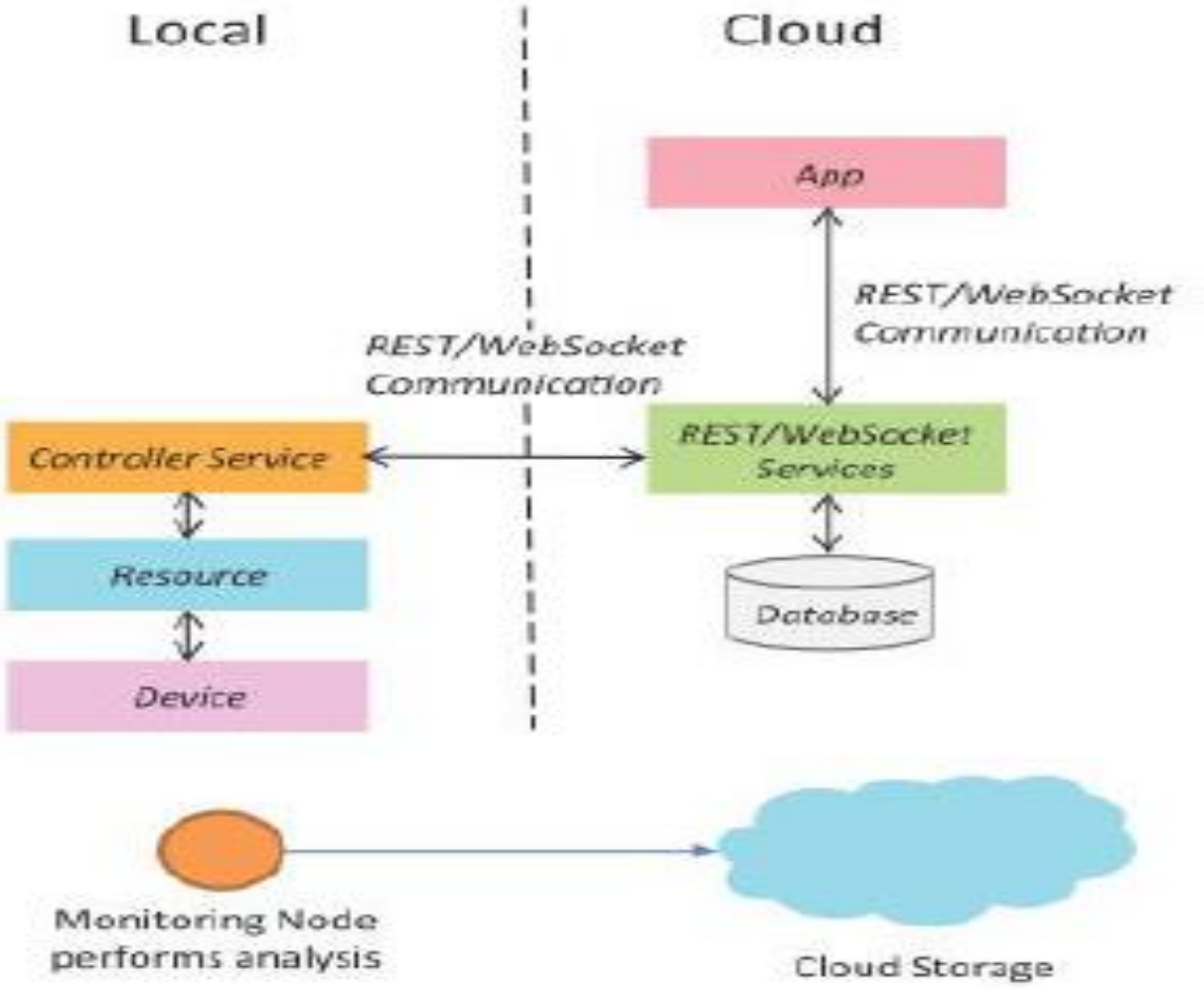
IoT Level-1 Example – Home Automation



IoT Level-2

- A level-2 IoT system has a **single node** that performs sensing and/or actuation and **local analysis**
- **Data is stored in the cloud** and **application** is usually **cloud-based**
- Level-2 IoT systems are suitable for solutions where
  - **the data involved is big**
  - the primary **analysis** requirement is **not computationally intensive** and **can be done locally itself.**

IoT Level-2

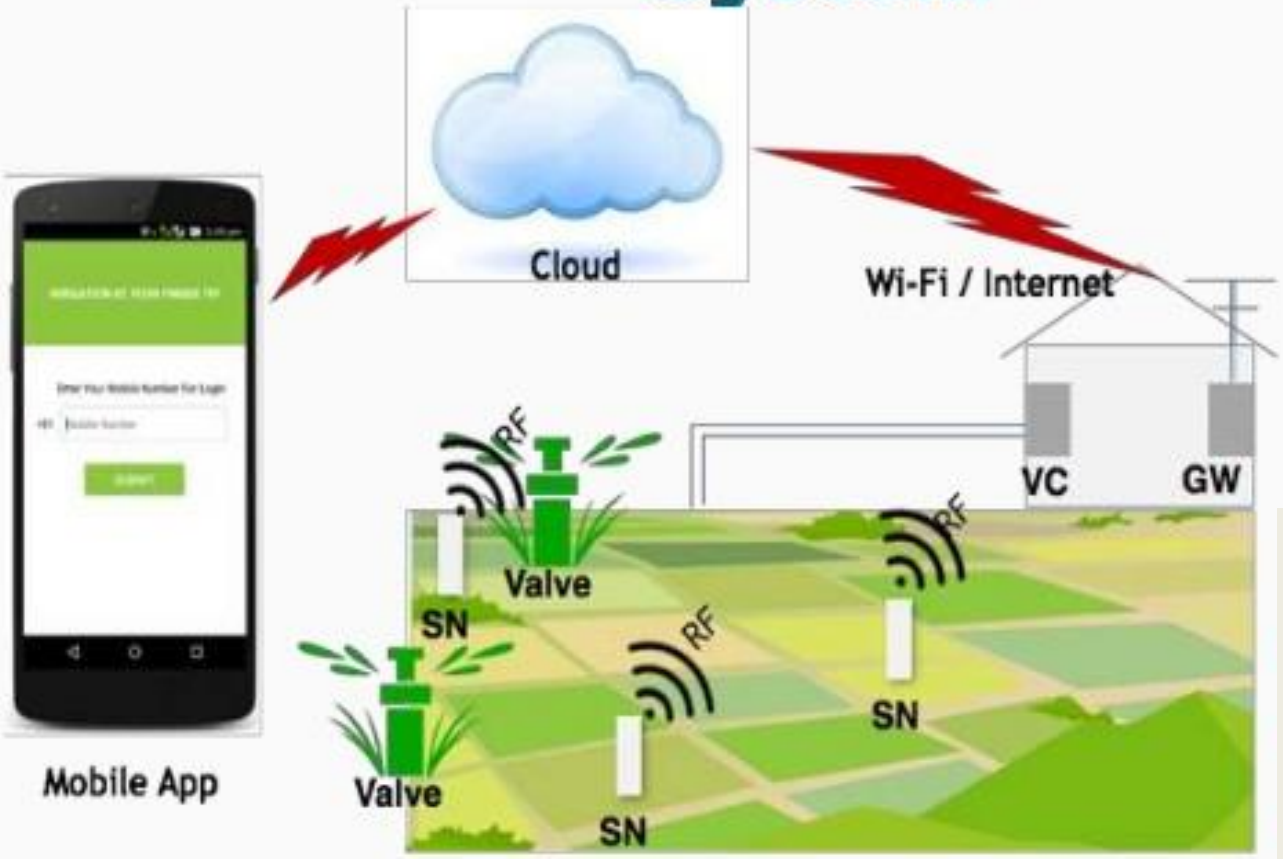

Local
Cloud
App
REST/WebSocket
Communication
REST/WebSocket
Communication
Controller Service
REST/WebSocket
Services
Resource
Database
Device
Monitoring Node
performs analysis
Cloud Storage

IoT Level-2

- It consists of air conditioner, temperature sensor, Big data (Bigger than level -1, data analysis done here) , cloud and control & monitoring app
- Level-2 is complex compare to level-1
- Rate of sensing is faster compare to level-1
- Level- 2 has voluminous size of data → cloud storage is used
- Data analysis is carried out locally
- Cloud is used for only storage purpose
- Based on data analysis, control action is triggered using web app or mobile app
- **Examples:** Agriculture applications, room freshening solutions based on odour sensors etc.

IoT – Level 2 Example
Smart Irrigation

IOT based Smart Irrigation System

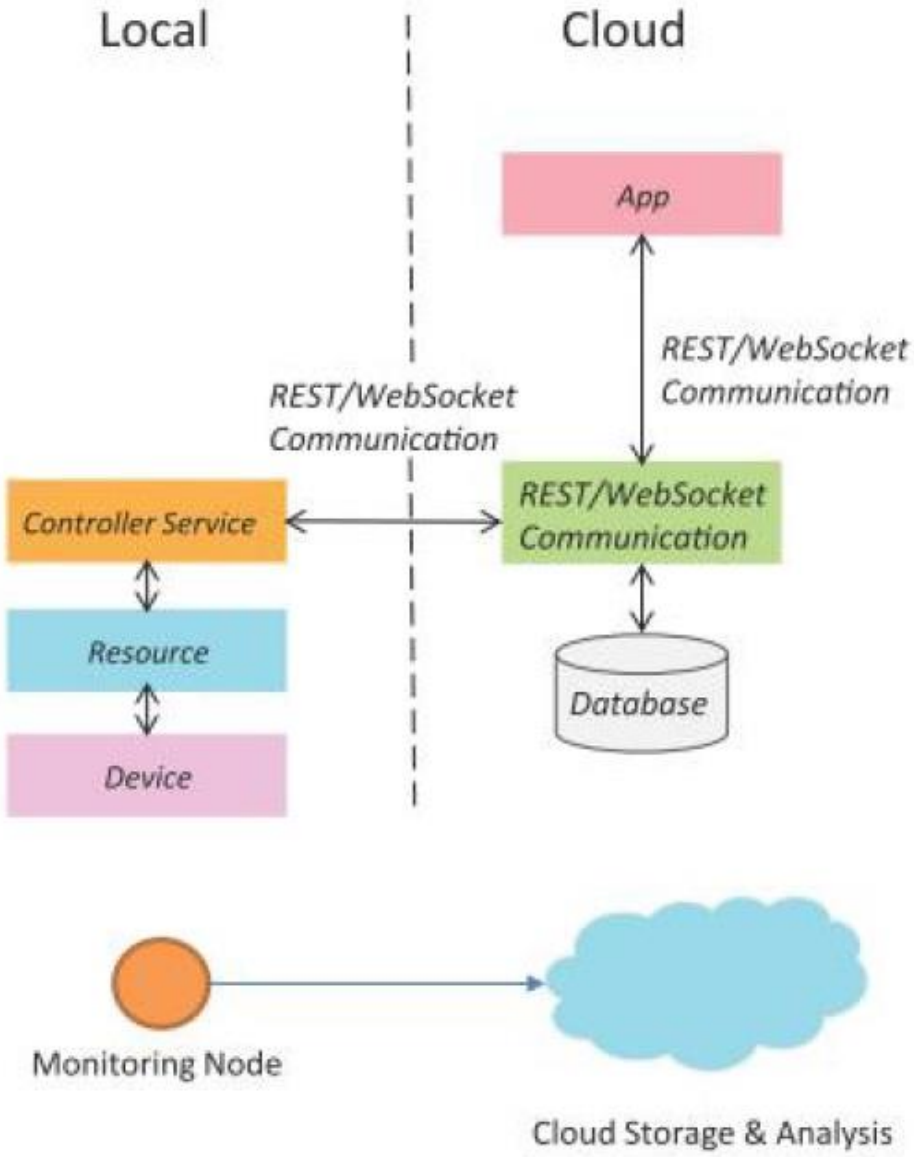


SN: Sensor Node; GW: Gateway; VC: Valve Controller; RF: Radio Frequency

Level 3

- A level-3 IoT system has a **single node**
- Data is **stored** and **analyzed** in the **cloud** and application is cloud based
- Level-3 IoT systems are suitable for solutions where
  - **Data** involved is **big** and
  - Analysis requirements are **computationally intensive**

IoT Level-3


Local
Cloud
App
REST/WebSocket
Communication
REST/WebSocket
Communication
Controller Service
REST/WebSocket
Communication
Resource
Database
Device
Monitoring Node
Cloud Storage & Analysis

Level 3 Example – Tracking Package Handling

- The system consists of a **single node** (**package**)
- That monitors the **vibration levels** for a package being sipped.
- The device in this system uses **accelerometer** and **gyroscope** sensors for monitoring vibration levels.
- The **controller system** sends the sensor data to the cloud using web sockets.
- The **data stored** in the cloud and **visualized** using cloud based application.
- The **analysis components** in the cloud can **trigger alerts** if the vibration levels greater than the threshold.

IoT – Level 3 Example: Tracking Package Handling

Sensors used

Accelrometer

sense movement or vibrations

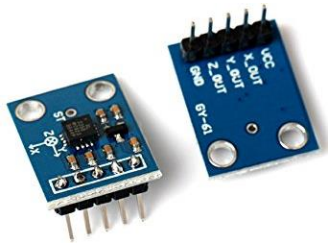
Gyroscope

Gives orientation info

Websocket service is used because sensor data can be sent in real time.

Accelerometer Sensor

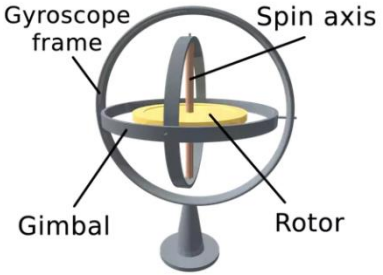
- Accelerometers are electromechanical devices that measure **acceleration**, the **rate of change in velocity of an object**. In other words, it's devices used to respond to any **vibrations** associated with movement.
- Uses:
  - **Compass/Map applications** on your smartphone devices (iPhones, Andriod, etc.) through axis based sensing
  - **Tilt sensing**; iPhone uses an accelerometer to sense whether the phone is being held in portrait or landscape mode
  - **Earthquake detection**
  - **Fall sensing**
  - **Medical devices** such as artificial body parts
  - **Fitness trackers/wearables**
  - **Games/applications t**hat require motion sensing (Wii, Kinect, etc.)



- Note: Accelerometers are most **commonly used** to detect position, velocity, vibration, and to determine orientation.

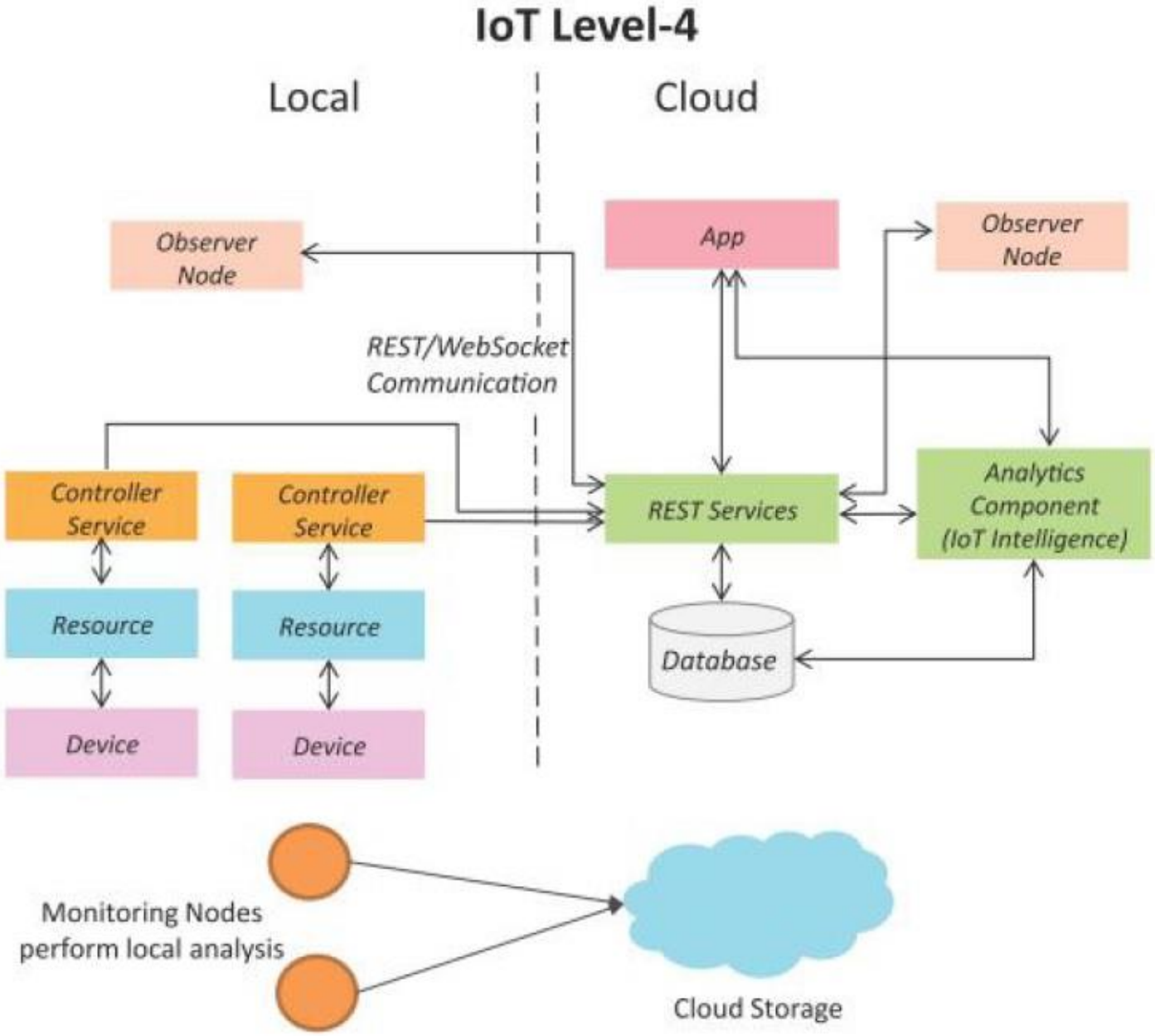
Gyroscope Sensor

- Gyroscope is a device used for measuring **rotational changes** or maintaining orientation
- It's based on the principle of **preserving angular momentum**.
- A typical gyroscope contains a **rotor** that's suspended inside three rings called the **gimbals**.
- It works through the **precession effect**, allowing gyroscopes to defy gravity when the **spin-axis** is rotated
- This means that instead of falling over from the force of gravity, it automatically adjusts itself sideways
- Uses:
  - **Aircrafts**
  - **Space stations**
  - **Stability in vehicles**; motorcycles, ships
  - **Inertial guidance systems**
  - Consumer electronics through MEMS gyroscopes (Most mid-range to higher-end **Andriod phones**)



Level 4

- A level-4 IoT system has **multiple nodes** that perform **local analysis**
- **Data** is stored in the **cloud** and application is **cloud-based**
- Level-4 contains **local** and **cloud** based **observer nodes** which can subscribe to and receive information collected in the cloud from IoT devices
- Level-4 IoT systems are suitable for solutions where
  - **Multiple nodes** are required
  - **Data** involved is **big** and
  - **Analysis** requirements are **computationally intensive**


IoT Level-4
Local
Cloud
Observer Node
App
Observer Node
REST/WebSocket Communication
Controller Service
Controller Service
REST Services
Analytics Component (IoT Intelligence)
Resource
Resource
Database
Device
Device
Monitoring Nodes perform local analysis
Cloud Storage

Level 4 Example – Noise Monitoring

- The system consists of **multiple nodes** placed in different locations.
- Nodes are equipped with **sound sensor**.
- Nodes are **independent** of each other.

- Each node runs its own **controller service** that **sends the data to the cloud.**
- The **data** is stored in **cloud database**.
- The **analysis** of data collected from a number of nodes is done in the **cloud**.
- A **cloud based application** is used for visualizing the aggregated data.

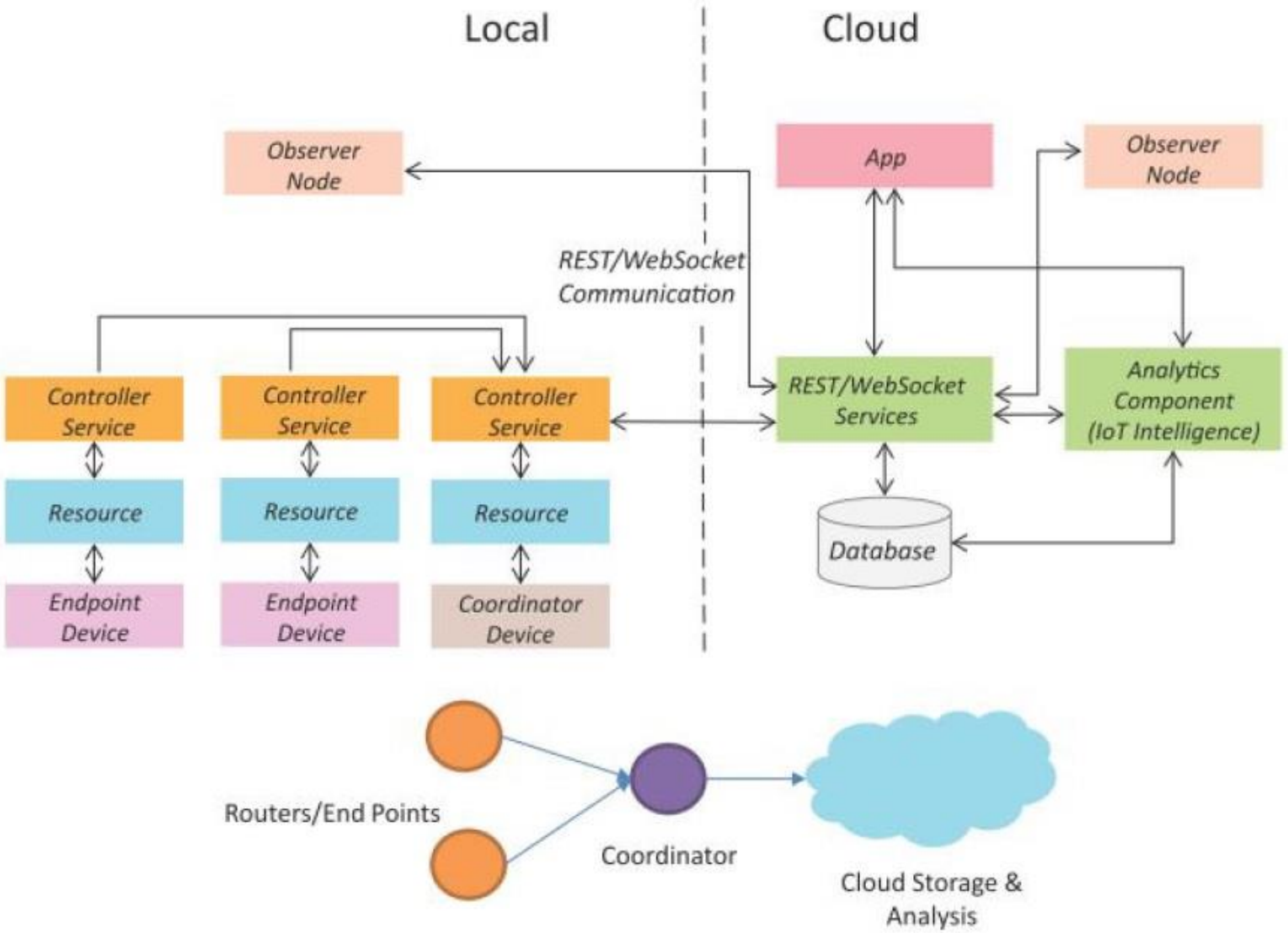
IoT – Level 4 Example: Noise Monitoring

Sound Sensors are used

Level 5

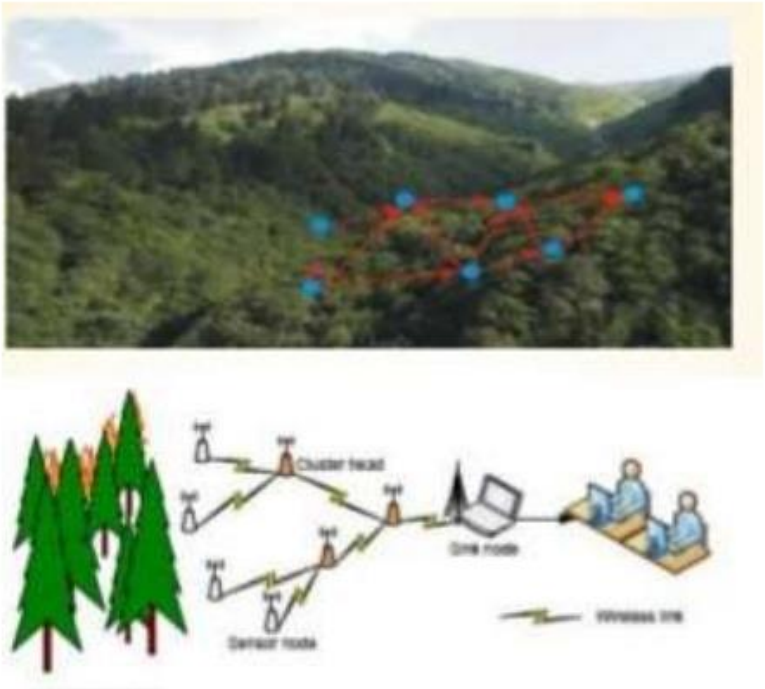
- A level-5 IoT system has **multiple end nodes** and **one coordinator node**
- The **end nodes** that perform **sensing** and/or **actuation**
- **Coordinator node** collects data from the end nodes and sends to the cloud
- **Data** is stored and **analyzed** in the **cloud** and **application** is **cloud-based**
- Level-5 IoT systems are suitable for solutions
  - based on **wireless sensor networks**, in which the data involved is big and the analysis requirements are computationally intensive.

IoT Level-5


Local
Cloud
Observer Node
App
Observer Node
REST/WebSocket Communication
Controller Service
Controller Service
Controller Service
REST/WebSocket Services
Analytics Component (IoT Intelligence)
Resource
Resource
Resource
Database
Endpoint Device
Endpoint Device
Coordinator Device
Routers/End Points
Coordinator
Cloud Storage & Analysis

IoT – Level 5 Example: Forest Fire Detection

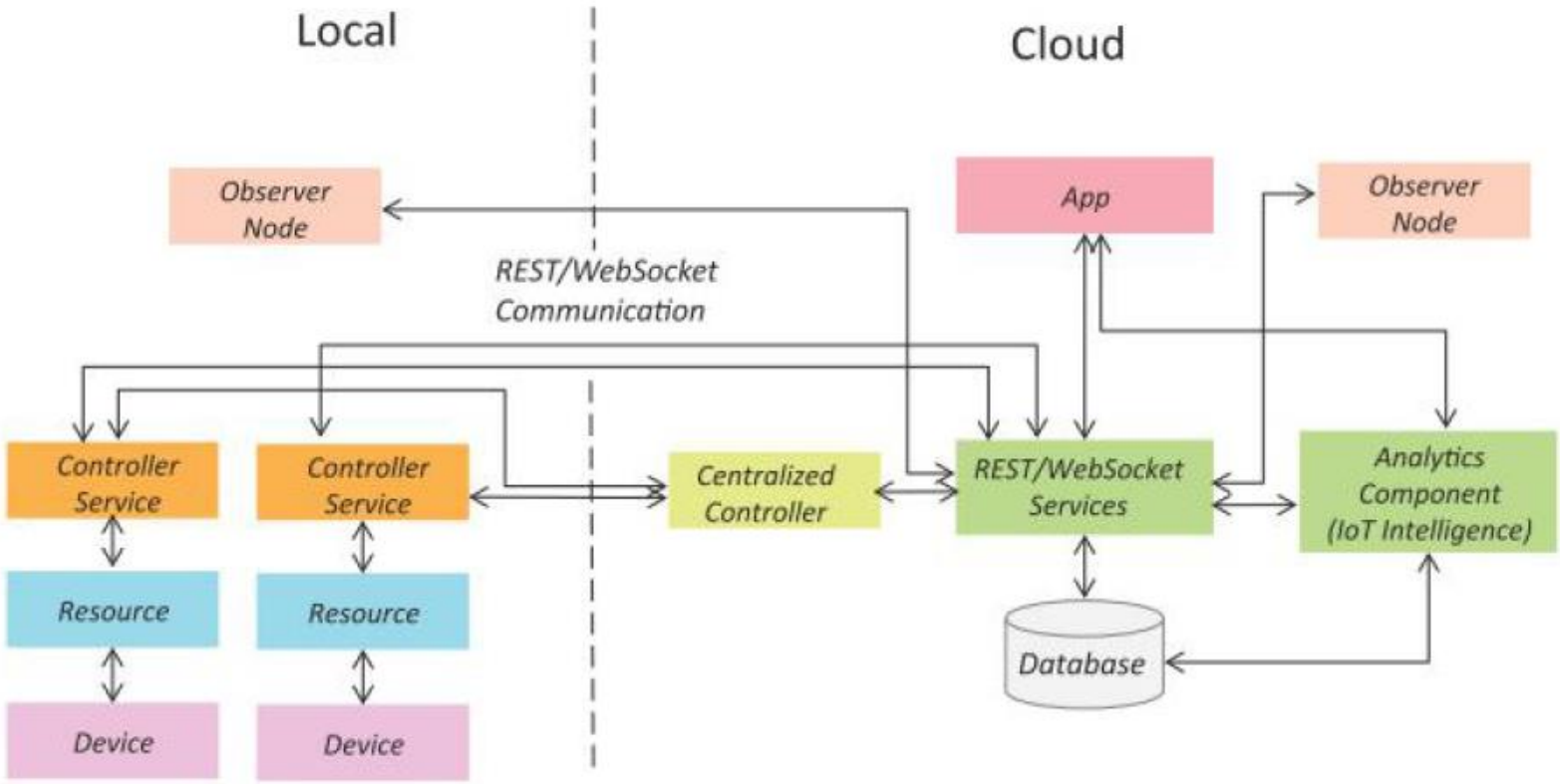
Detect forest fire in early stages to take action while the fire is still controllable.
Sensors measure the temperature, smoke, weather, slope of the earth, wind speed, speed of fire spread, flame length

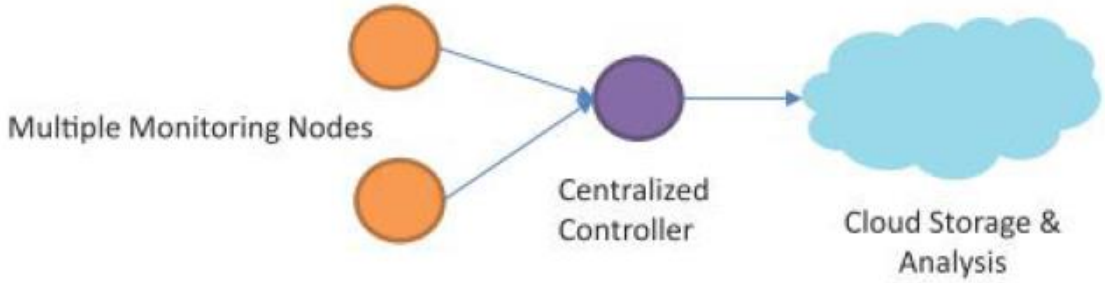


Level 6

- A level-6 IoT system has **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** analyzes the data and stores the results in the **cloud database**
- The results are **visualized** with the **cloud-based Application**
- The **centralized controller** is aware of the **status of all the end nodes** and **sends control commands to the nodes**

IoT Level-6


Local
Cloud
Observer Node
REST/WebSocket Communication
App
Observer Node
Controller Service
Controller Service
Centralized Controller
REST/WebSocket Services
Analytics Component (IoT Intelligence)
Resource
Resource
Database
Device
Device


Multiple Monitoring Nodes
Centralized Controller
Cloud Storage & Analysis

Level 6 Example – Weather Monitoring System

- The system consists of **multiple nodes** placed in different locations for monitoring **temperature**, **humidity** and **pressure** in an area
- The end nodes are equipped with various sensors,
  - **Temperature**
  - **Pressure**
  - **Humidity**
- The end nodes send the data to the cloud in real time using **websockets**
- The **data stored** in **cloud database**
- The **analysis of data** is done in the **cloud** to aggregate the data and make predictions
- **Cloud based application** is used for visualizing the data

IoT – Level 6 Example: Weather Monitoring System

Sensors used

- Wind speed and direction
- Solar radiation
- Temperature (air, water, soil)
- Relative humidity
- Precipitation
- Snow depth
- Barometric pressure
- Soil moisture