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DAY 1

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Internet Of Things

Hands on Workshop

Like every other IoT workshop, I'll ask the same…

What is IoT?

- In the term, Internet of Things, “Thing” refers to any object. Eg: Table, fan, computer, phones, TV, AC, etc.
- **What about Sensors?** Anything and Everything that connects to the Internet is a part of IoT. An object may or may not have a sensor.
- **Need of Internet?** Connect every device with each other (inter-connect), to make a mesh of Connectivity among devices as well.
- In IoT, things need not be connected with cloud. They could form an IoT, even if it is running locally (LAN).

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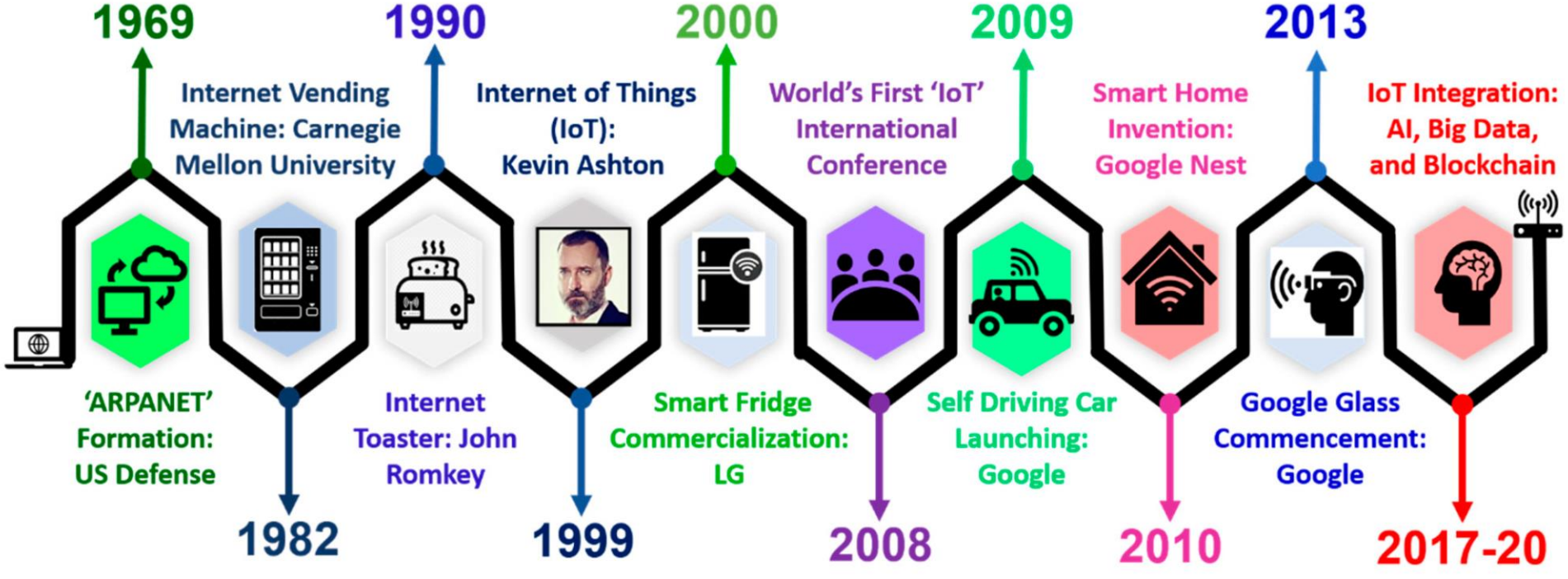

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- Introduction to IoT
  - IoT Concepts
  - Examples
  - Branches of IoT
  - Levels of IoT
- Communication Protocols
  - Types of IoT Protocols
  - IoT Communication Protocols
  - Serial Communication
- WebServer on ESP32
  - Create an ESP32 WebServer
  - Host images from ESP32 Memory (using SPIFFS)
- IoT Platforms
  - Use Blynk-cloud with API to control ESP32
  - Use thingspeak API to get data of ESP32
  - Introduction to Arduino IoT Cloud
- Store and Visualize Data
  - Store data in Google Sheet
  - Create a google chart with the data
- Create your Own IoT Service
  - Using Firebase to store data in JSON
  - Using self-developed REST API server - Data, chart
- Introduction to Toit
  - What is Toit?
  - Toit language - CLI
  - Control-Monitor everything with toit API
  - Over the Air Updates


Node/Device
Communication Protocol
Cloud/Local Server
DATABASE
User Interface
Data Analysis / ML models

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InterConnected Humans

Top Examples

- Inventory-tracking systems (workplace, logistics, import-export, etc)
- Machines in Manufacturing Factories
- Tags and sensors for security
- HealthCare system
- Appliance Control (home-automation, smart fridge, toaster, etc)
- Environmental data gathering (weather, air quality, etc)

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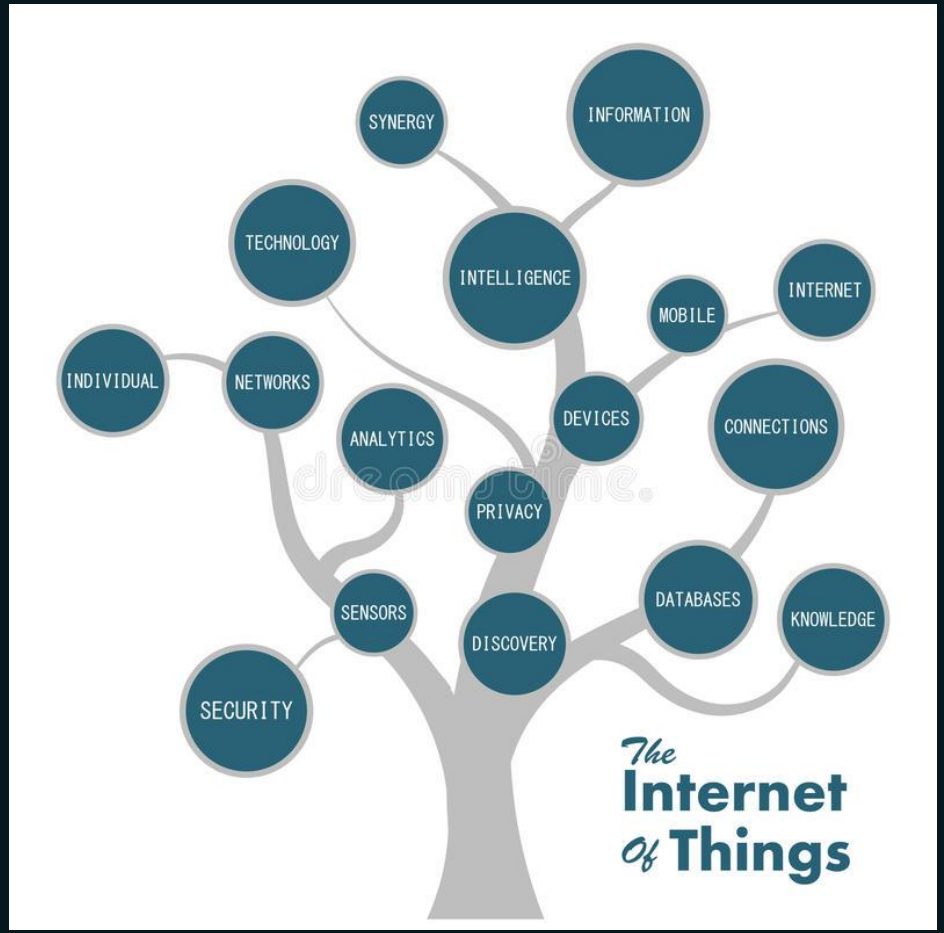


Branches of IoT

- **Data Centre**
- **Inventory Management**
- **Security**
- **Mobile Device (Portable/wearable)**
- **Asset and Fleet Management**
- **HealthCare**
- **Retail/Commercial Products**

Sections in IoT network

- **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 either implemented using HTTP and REST principles (REST service) or using WebSocket protocol (WebSocket service).

Sections in IoT network

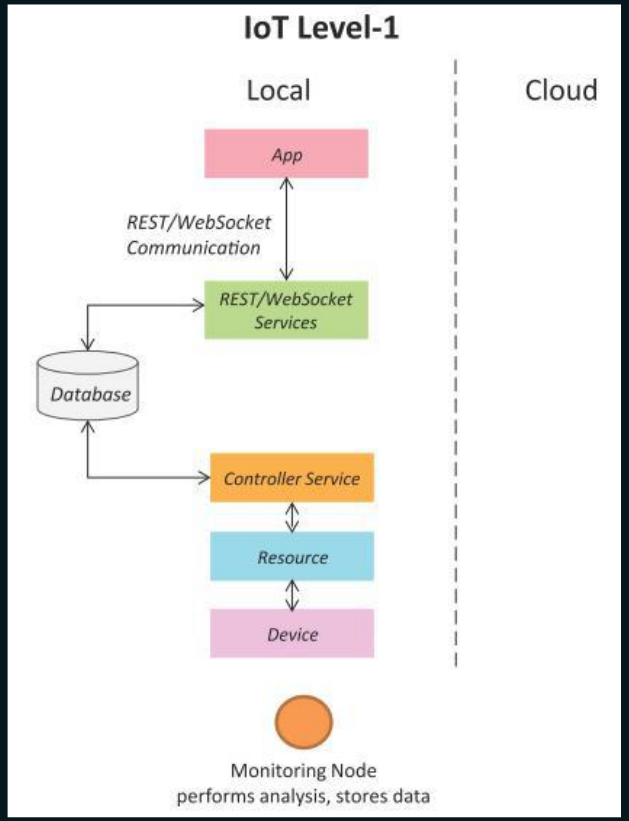
- **Analysis Component**: The Analysis Component is responsible for analyzing the IoT data and generate results in a form which are easy for the user to understand.

- **Application**: IoT applications provide an interface that the users can use to control and monitor various aspects of the IoT system. Applications also allow users to view the system status and view the processed data.


Node/Device
Communication Protocol
Cloud/Local Server
DATABASE
User Interface
Data Analysis / ML models

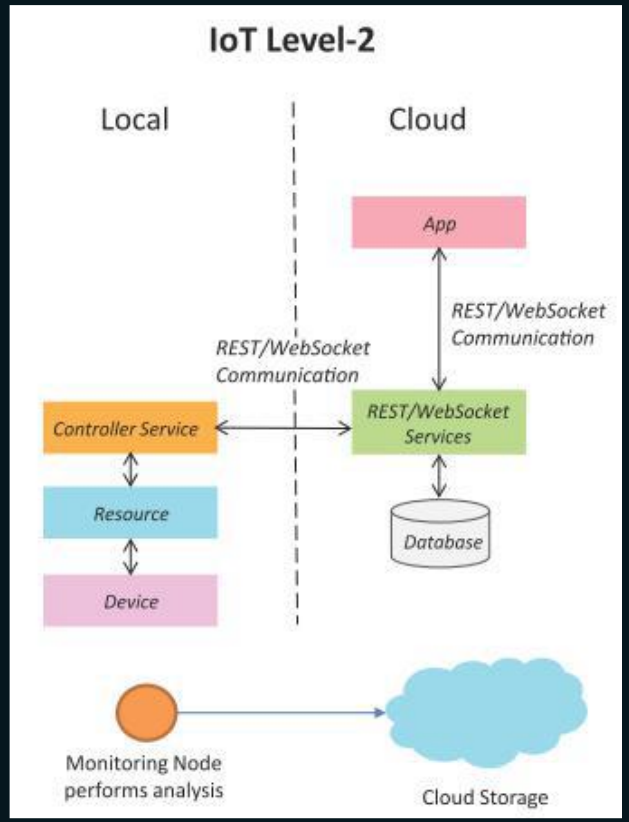
IoT Level 1

- A level-1 IoT system has a single node/device that performs sensing and/or actuation, stores data, performs analysis and hosts the application.
- Suitable for modelling low-cost and low-complexity solutions where the data involved is not big and the analysis requirements are not computationally intensive.



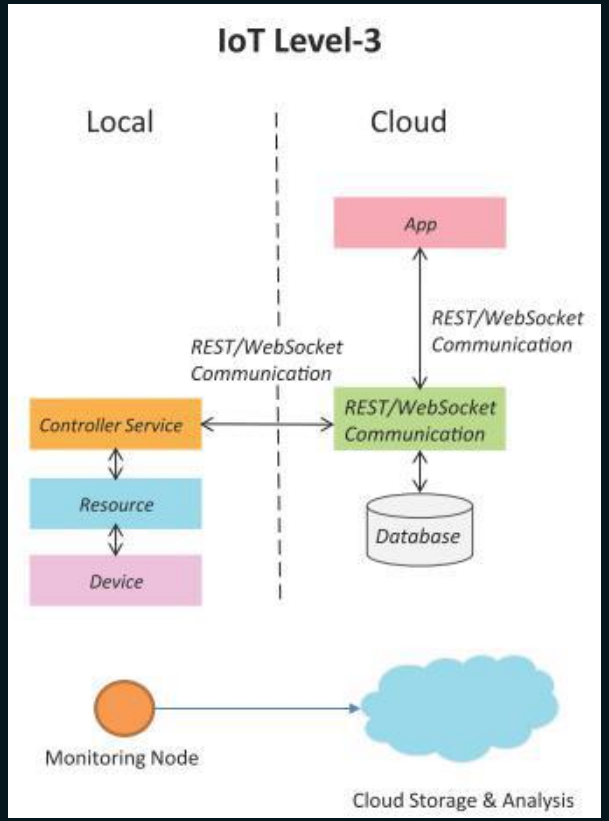
IoT Level 2

- 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 cloudbased.
- Suitable for solutions where the data involved is big, however, the primary analysis requirement is not computationally intensive and can be done locally itself.



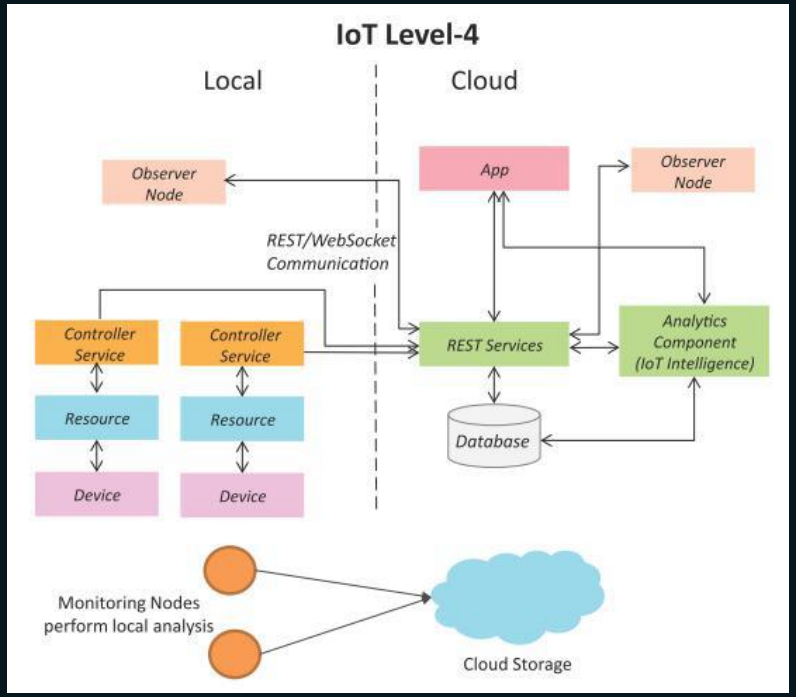
IoT Level 3

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



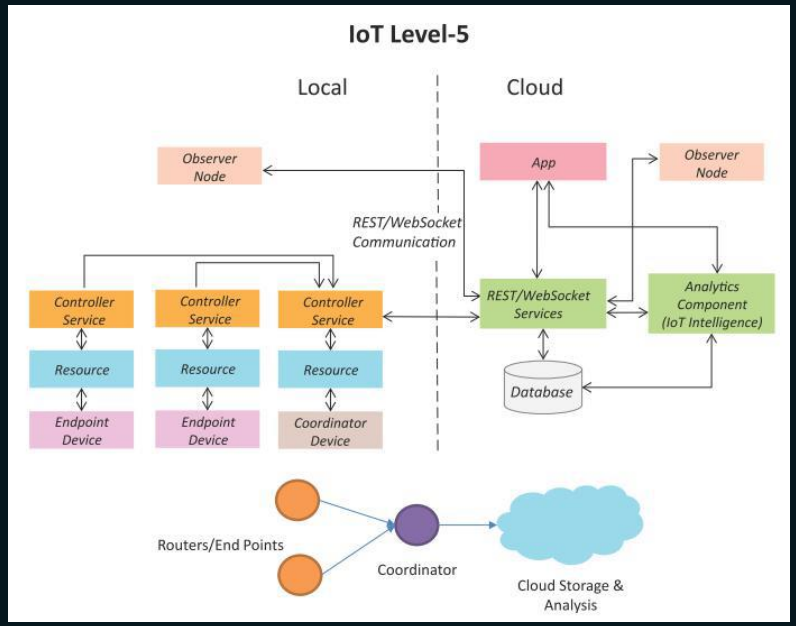
IoT Level 4

- 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 cloudbased 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, the data involved is big and the analysis requirements are computationally intensive.



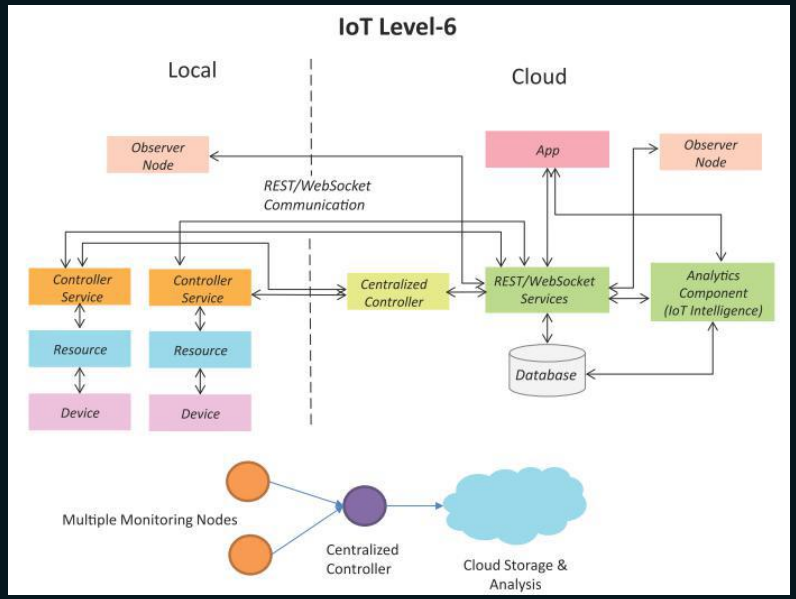
IoT Level 5

- 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 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 analyses 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.



Type of IoT Protocol

IoT Network

IoT Data

IoT Networks

1. Wifi

- **Standard -** Based on IEEE 802.11n
- **Frequencies -** 2.4 GHz and 5 GHz bands
- **Range- Approx. - 50 -** 100 meters
- **Data Rates -** 600 Mbps maximum, the most common is 150-200 Mbps.

IoT Networks

2. Bluetooth

- **Standard** - Bluetooth 4.2 core specification
- **Frequencies** - 2.4 GHz (ISM)
- **Range- Approx.** - 10meter - 50 meters
- **Data Rates** - 1MBps(Smart/BLE)

IoT Networks

3. Zigbee

- **Standard** - Zigbee 3.0 based on IEEE802.15.4
- **Frequencies** - 2.4 GHz (ISM)
- **Range- Approx.** - 10 - 100 meters
- **Data Rates** - 250KBps

IoT Networks

4. Cellular

- **Standard** - GSM/GPRS/EDGE(2G), UMTS/HSPA(3G), LTE(4G)
- **Frequencies** - 900/1800/1900/2100MHz
- **Range- Approx.** - 35km max for GSM, 200 km max for HSPA
- **Data Rates** - 35 – 170 KBps

IoT Networks

5. LoRa

- **Standard- LoRa WAN**
- **Frequencies**- Various
- **Range- Approx. –** 2.5km (Urban) and 15km (SubUrban)
- **Data Rates -** 0.3 – 50 KBps

IoT Networks

6. SigFox

- **Standard - SigFox**
- **Frequencies** - 900 MHz
- **Range- Approx. – 3 - 10**km (Urban) and 30 - 50km (SubUrban)
- **Data Rates** - 10 – 1000 Bps

IoT Data Protocols

1. **REST API-** Application programming interface (API or web API) that conforms to the constraints of REST architectural style and allows for interaction with RESTful web services.

2. **WebSocket-** A computer communications protocol, providing full-duplex communication channels over a single TCP connection.

3. **MQTT-** MQTT is a lightweight, publish-subscribe network protocol that transports messages between devices. The protocol usually runs over TCP/IP, however, any network protocol that provides ordered, lossless, bi-directional connections can support MQTT.

4. **Others -** CoAP, AMQP, XMPP are some of the popular IoT data protocols.

Device Communication

1. **Serial Communication** - Uses one or two transmission lines to send and receive data, and that data is continuously sent and received one bit at a time.

2. **SPI Communication** - Devices are in a master-slave relationship. The master is the controlling device (usually a microcontroller), while the slave (usually a sensor, display, or memory chip) takes instruction from the master.

3. **I2C Communication** - I2C combines the best features of SPI and UARTs. You can connect multiple slaves to a single master (like SPI) and you can have multiple masters controlling single, or multiple slaves.

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What is ESP32?

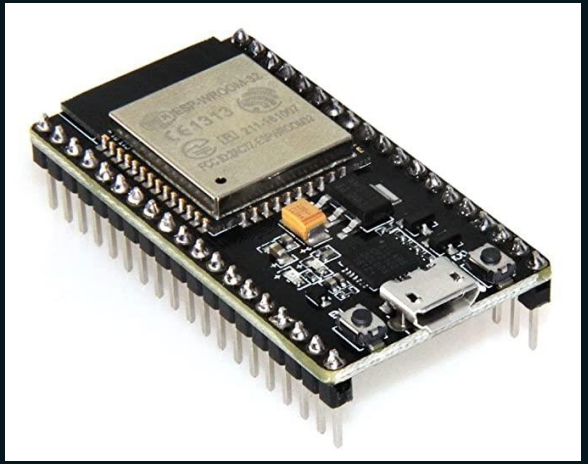
Espressif - 32

ESP32 is a system on a chip that integrates the following features:

- Wi-Fi (2.4 GHz band)
- Bluetooth
- Dual high performance Xtensa® 32-bit LX6 CPU cores
- Ultra Low Power co-processor
- Multiple peripherals

ESP32 provides a robust, highly integrated platform, which helps meet the continuous demands for efficient power usage, compact design, security, high performance, and reliability.

ESP32 vs ESP32 Dev Board



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Access all Code (Web Server on ESP32)

shorturl.at/hlLV7

IoT Platforms

- Blynk IoT
- ThingSpeak API
- Arduino IoT Cloud

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Access all Code (IoT Platforms)

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Arduino IoT Cloud

Arduino IoT Cloud is an application that helps makers build connected objects in a quick, easy and secure way. You can connect multiple devices to each other and allow them to exchange real-time data. You can also monitor them from anywhere using a simple user interface.

Arduino has taken a step forward to keep IoT as simple and reachable as possible. Initially, IoT Cloud was available only to the Arduino Boards, but now, it even provides Web Sketches for other third-party boards like ESP8266 / 32, LoRaWAN as well.

Arduino IoT Cloud

ARDUINO

IoT CLOUD

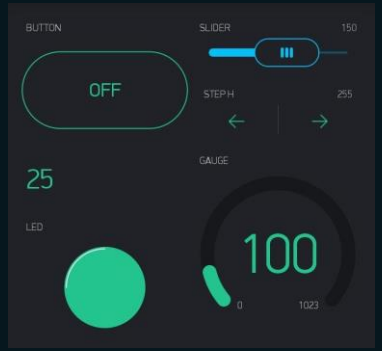
https://docs.arduino.cc/cloud/iot-cloud/tutorials/esp-32-cloud

TASK (1/5)

Create a Flow Diagram of an IoT Network, in a Forest

- Add necessary devices and sensors required, to be used in the Wildlife of Forest.
- Concern on Climate Monitor (fire, moisture, rain, etc), Wild Animal movement, etc.
- Mention the IoT Level used, with an explanation on the flow. State reasons for each block.
- Make sure any device/sensor MUST not link directly to any Animal or Organism.
- Scores based upon Creativity and Uniqueness.
- Use Pen-Paper/Photoshop/FlowChartBuilder/Anything. No restrictions on that.

TASK (2/5)



Blynk_HomeAutomation_Verifier.html

Use the Blynk App and create a Basic Home Automation Control. Follow the Configuration :

- V0 – Button
- V1 – Slider (0 - 1023) – Show Value
- V2 – Step H (0 - 1023) – Show Value – icon(+/-)
- V3 – Value Display (0 – 255)
- V4 – Gauge (0 - 1023) - ºC
- V5 – LED

Copy the Auth Token of the Project and Paste it on the WebPage and click Enter.

Send a screenshot of the Blynk App with the Configuration working.

Submission Link

https://forms.gle/CG7B44EAnnkKXZZ48

Thank You

Reach me in the below Socials:

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Hackster - hackster.io/akshayansinha

Instagram - instagram.com/akshayansinha/

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Meet you on 2nd November.