

IoT App Development



IoT Ecosystem

Different components of IoT

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IoT Ecosystem



It encompasses **all the components** needed to **collect**, **process**, and **analyse** data from IoT devices, enabling smart applications and services.

✓IoT Core

- **Sensors**, actuators, **microcontrollers**, internet **connectivity**, service platform including security

✓Cloud

- Provide **resources** to accept, accumulate, maintain, store, and analyse data

✓IoT Gateway

- It ensure bidirectional **communication** between IoT networks and other networks

✓Analytics

- It indulges in conversion and **analysis of data** which results in recommendations and future decision making

✓User Interface / Visualization

- Design sleek, visually appealing, interactive, and ease-of-use **graphical user interface** (GUI)

✓IoT Architectures

- **Graphical structure** of the designed IoT-based solutions and products
 - 3-layer architecture, IoT-WF, oneM2M, etc.

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✓ IoT Frameworks

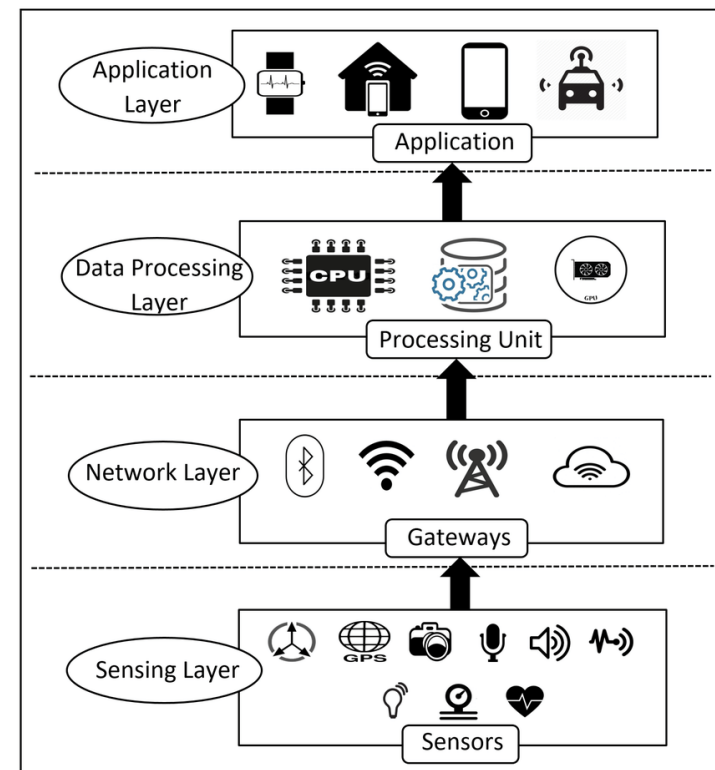
- Tools needed to design and implement IoT-based solutions and products
 - Microsoft Azure IoT,
 - Cisco Ultra IoT,
 - Amazon AWS IoT,
 - IBM Watson IoT,
 - etc.

IoT Network Architecture

- Network and its application should never be built without careful planning
- Architecture is how you design (i.e. [graphical structure](#)) your solution.

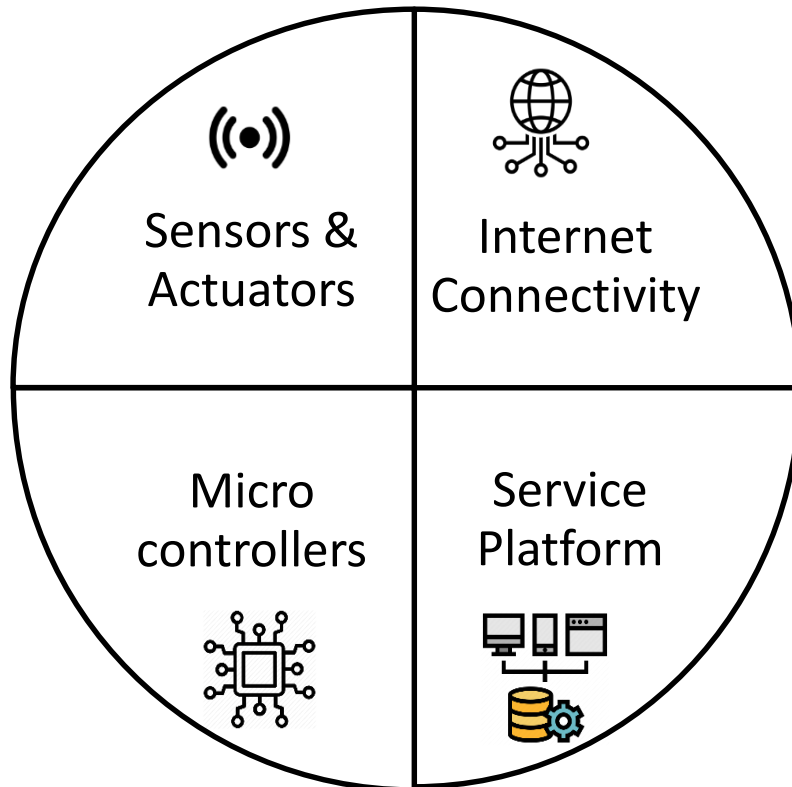
Very common 4-Layer Architecture for IoT

- IoT architecture refers to the framework that defines [how](#) different components of an IoT system [interact](#) to enable data collection, [transmission](#), [processing](#), and ultimately the [delivery](#) of services.



Source: Sikder *et al.*, "A Survey on Sensor-based Threats to Internet-of-Things (IoT) Devices and Applications" *IEEE Communications Surveys & Tutorials*, 23(2), pp. 1125 - 1159, 2021.

Core Components of IoT



- **Sensors** - to gather data and events
- **Actuators** – responsible for moving and controlling a mechanism or system
- **Microcontrollers** - automatically controls sensors and actuators; makes them smart
- **Internet connectivity** – responsible for **sharing information** and control command
- **Service Platform** – it enables the development, deployment, and management of services, efficiency, scalability, user experience and security

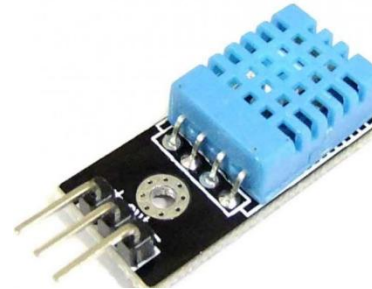
“Things” in IoT – Sensors



MQ135 - Air Quality Gas Sensor



Sound Detection Sensor



DHT11 - Temperature and Humidity Sensor



PIR Motion Detector Sensor



Pulse Sensor



LDR Light Sensor



Ultrasonic Distance Sensor



IR Sensor

“Things” in IoT – Actuators



4 Channel 5V Relay



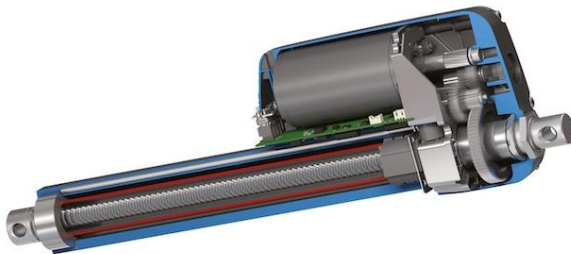
Servo Motor



DC Motor



Solenoid valve



Linear Actuators



LED



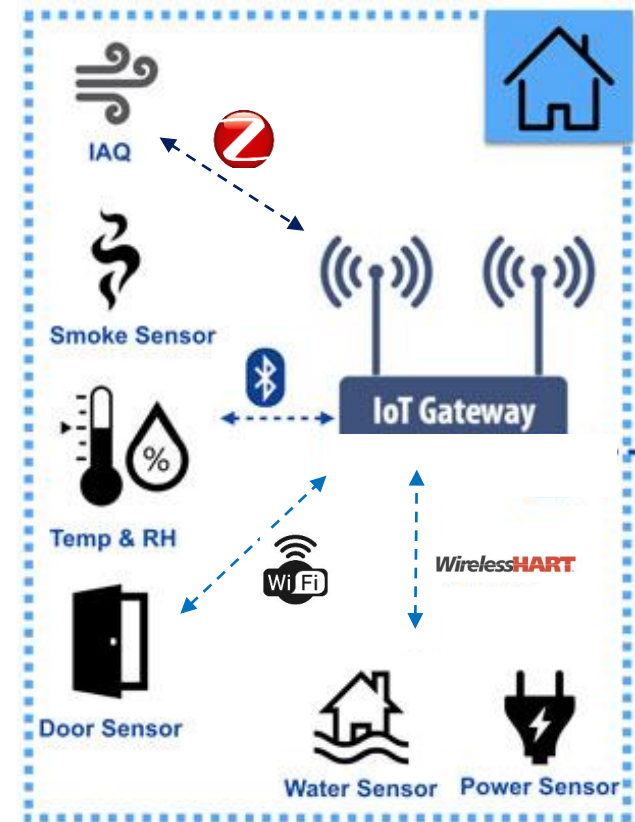
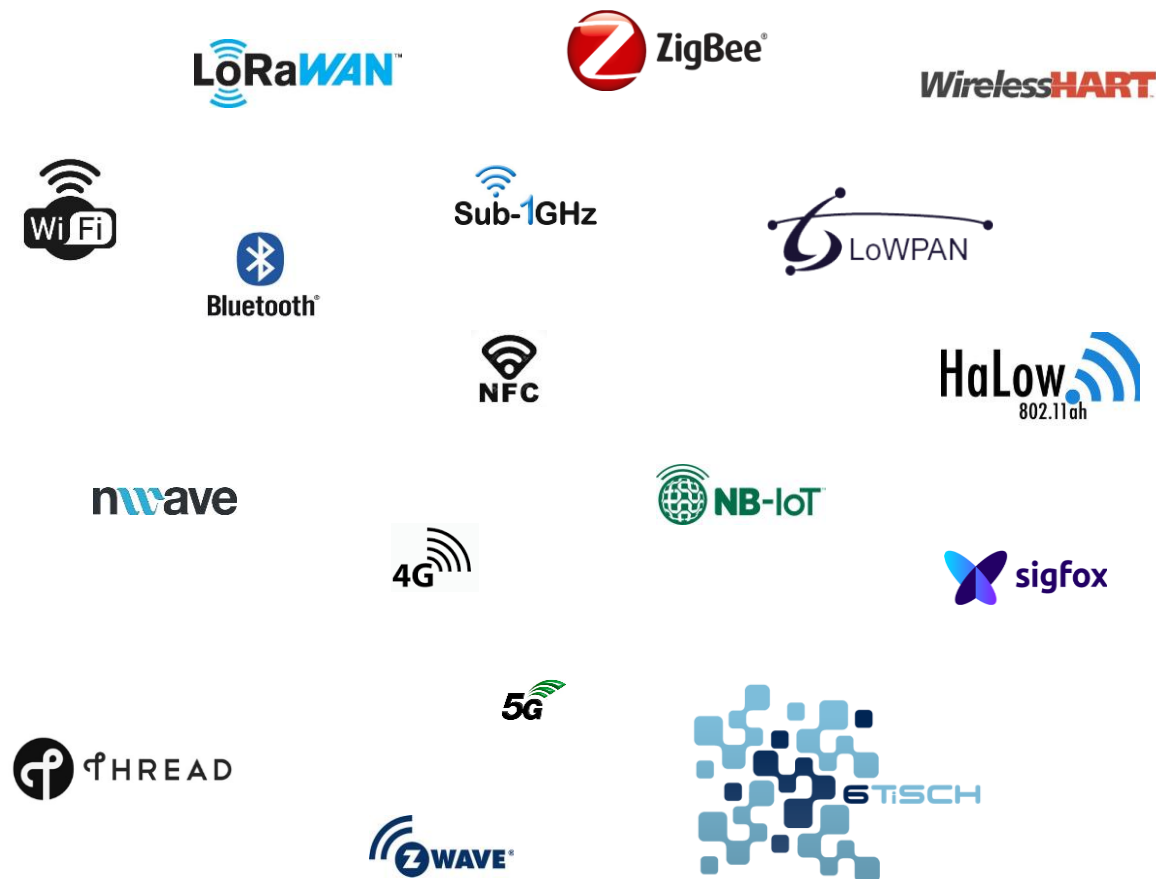
LCD Display

Access Technologies in IoT



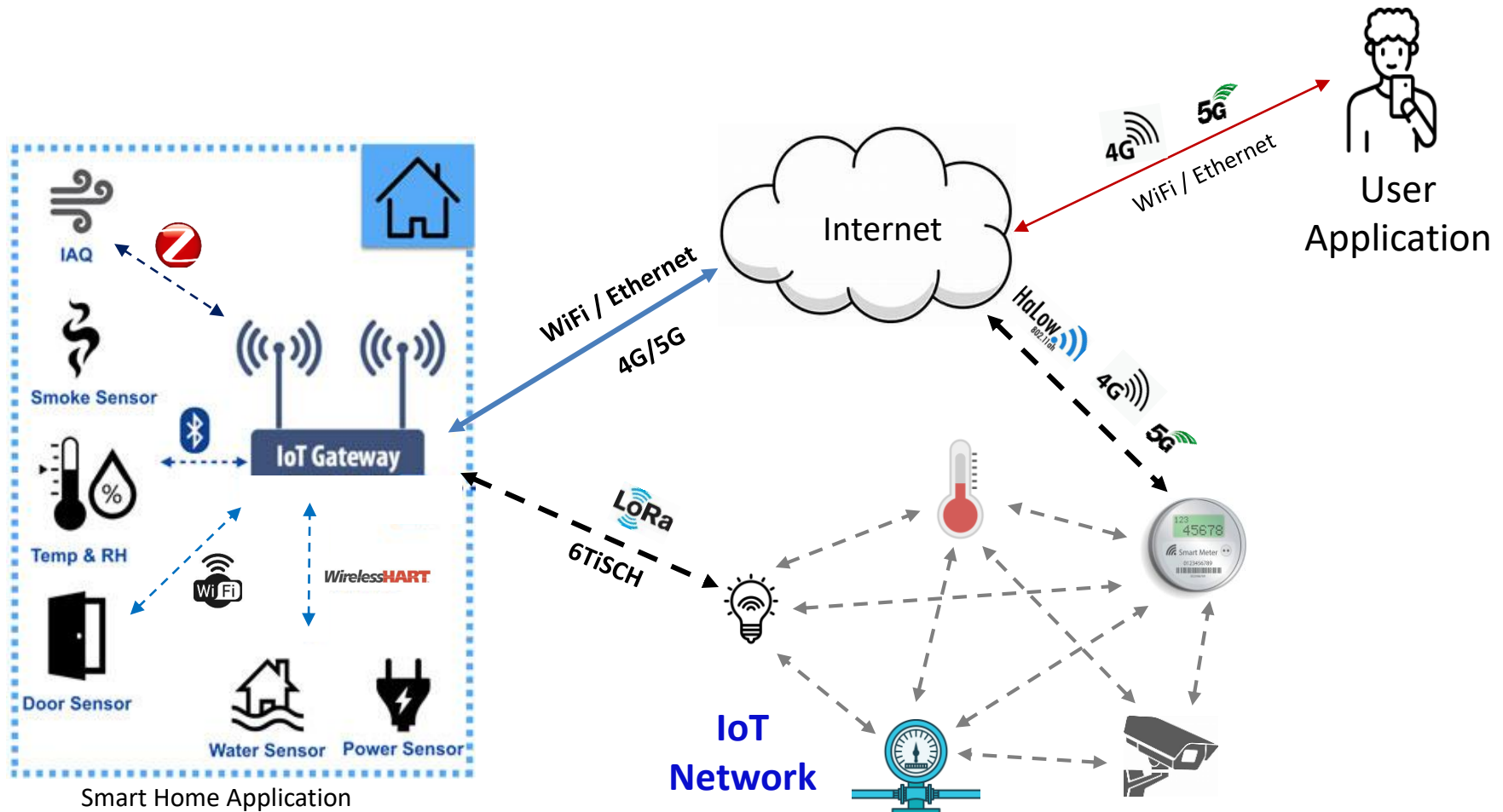
- Basic attributes to classify different Access Technologies:
 - Range
 - ✓ Short Range
 - ✓ Medium Range
 - ✓ Long Range
 - Frequency bands
 - ✓ Licensed
 - ✓ Unlicensed (i.e. ISM)
 - Topology
 - ✓ Mesh
 - ✓ Star
 - ✓ Tree
 - Power consumptions
 - ✓ Low
 - ✓ High
 - Constrained devices
 - ✓ Low Resources
 - ✓ Average Resources
 - ✓ High Resources
 - Constrained networks
 - ✓ Low-Power Networks
 - ✓ General (high-power) Networks

Access Technologies in IoT

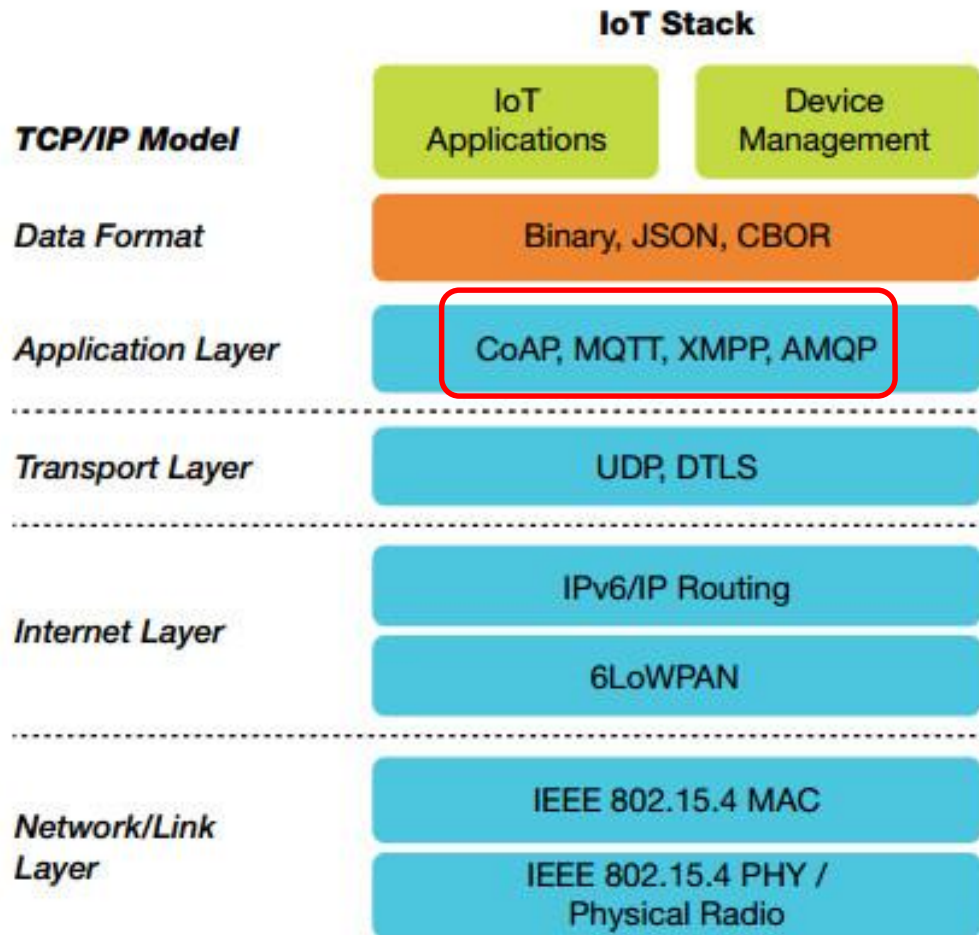


Smart Home

Use of Internet

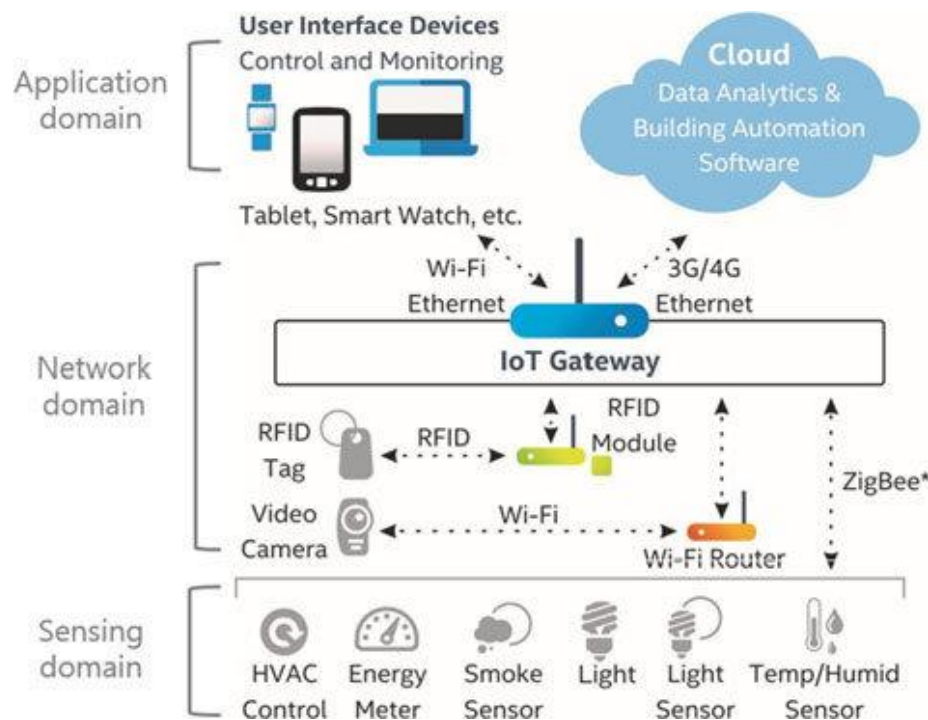


Application Layer



IoT Gateway

- It is a **physical device or software program** that serves as the connection point between the two different types of networks

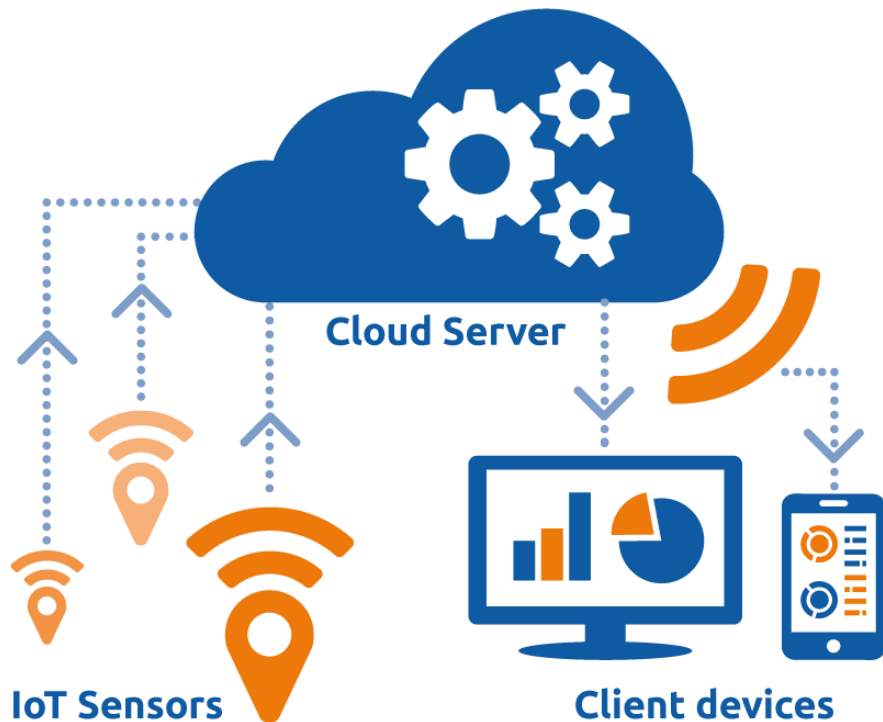


Gateway

- Provides bidirectional **communication**
 - Between IoT protocols and other networks
 - e.g. Zigbee <--> Ethernet
- Sometimes programmed to execute some **processing** operations
 - Edge computing
- It is necessary to maintain **security** to a certain extent
 - Can shield the entire IoT systems from any cyberattack

Source: B. Kang, D. Kim, H. Choo, "Internet of Everything: A Large-Scale Autonomic IoT Gateway", IEEE Transactions on Multi-scale Computing Systems, vol. 3, no. 3, 2017, pp. 206-214.

Use of Cloud

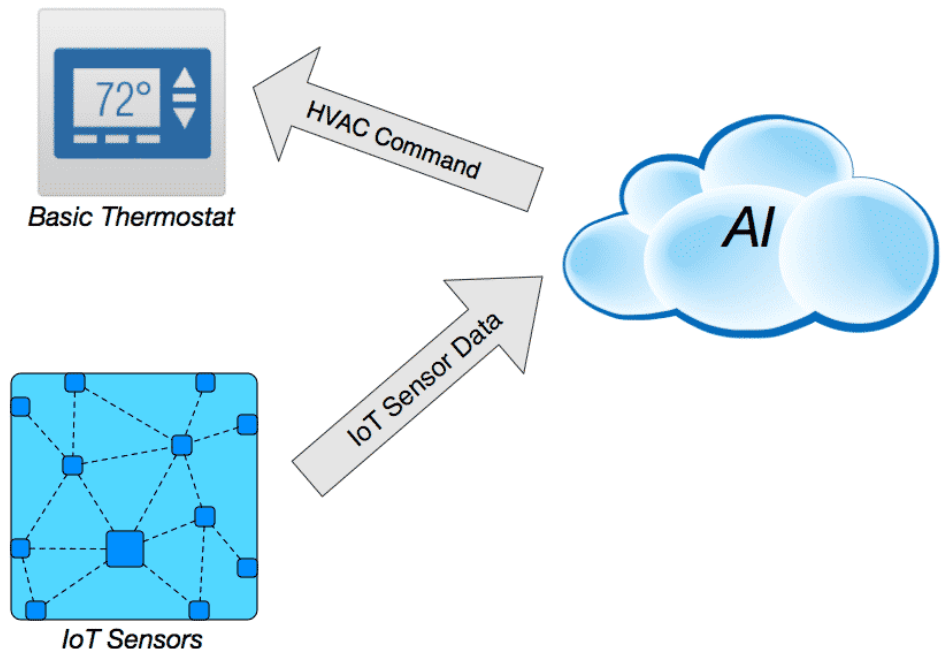


- IoT generates **vast amount of Big Data**; this in turn puts a huge strain on Internet Infrastructure.
- **Cloud can facilitate** to
 - Provide different **services**
 - **Store** huge amount of data
 - **Process** the data efficiently
- **Benefits of Cloud Platform in IoT**
 - Network Scalability
 - Data Mobility
 - Time to market
 - Security
 - Cost-effectiveness

- AI focuses on **putting human intelligence in machine**
- It gives the ability to a machine/program to **think and learn by itself**

Use of AI in IoT:

- **Smart Home**
 - Automated HVAC control
- **Industrial IoT**
 - Predictive maintenance
 - Optimized supply chain
- **Farming**
 - Smart farming
 - Interruption warning
- **Self-driving Car**
 - Mimic human driving on road
- **Health**
 - Auto-diagnosing any disease
 - Assistive healthcare

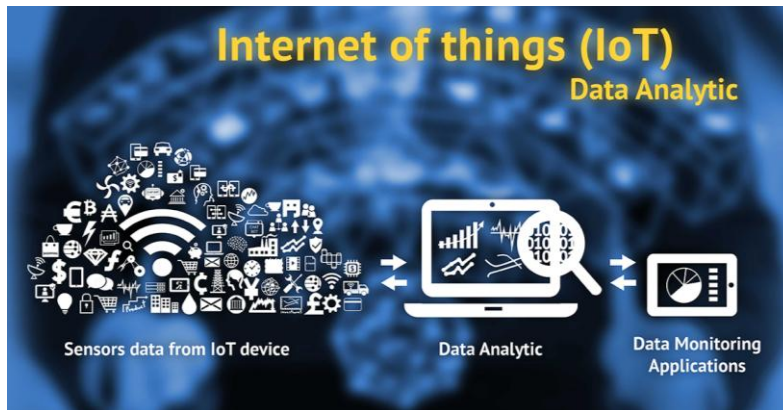


Data Analytics in IoT

- ❖ The **business value of IoT** is not just in the ability to **connect devices**, but it comes from **understanding the data** these devices create.

“Data Analytics + IoT => Smart Business Solutions”

- **IoT analytics** is the **application of data analysis tools and procedures** to realize value from the huge volumes of data generated by connected IoT devices



Challenges:

- ✓ Huge **Volume**
- ✓ Real-time data **flow**
- ✓ **Variety** of data types
 - e.g. XML, video, SMS
- ✓ Unstructured data
- ✓ **Variable** data model and meaning / **value**

Securing IoT

- Both the IoT **manufacturers** and their **customers** didn't care about the security !

Unauthorized access to IoT devices



Source: <https://www.theguardian.com/technology/2016/oct/26/ddos-attack-dyn-mirai-botnet>

Major cyber attack disrupts internet service across Europe and US;
October 26, 2016

Unauthorized access to IoT network



Source: <http://metropolitan.fi/entry/ddos-attack-halts-heating-in-finland-amidst-winter>

DDoS attack halts heating in Finland amidst winter;
November 7, 2016

User Interface

- Information made available to the end-users
- Users can actively **check and act in** for their IOT system



Important Characteristics:

- ✓ Sleek design
- ✓ Visually appealing
- ✓ Interactive UI
- ✓ Ease-of-use
- ✓ Handy

Source: <https://www.daikin.com/about/design/2017/05/entry-15>

IoT Platform

- Consider **an example** of a transport & warehouse company
 - Tracking, configuring, and managing the sensors placed at various locations of warehouses, vehicles, and other supply chain entities are essential.



It is an extremely complex task and challenging for IoT app developer.



Solution: Cloud-hosted IoT Platforms

- IoT Platform offers automated solutions with minimal human interaction for
 - device discovery,
 - managing connectivity and configuration,
 - software patch updates,
 - data management for millions of devices,
 - dashboard for data visualization
- IoT Platform mainly provide middleware and infrastructure that enables end-user to interact with smart objects seamlessly.
- Normally IoT Platforms are offered by generic cloud providers such as Amazon, Google, Microsoft, etc.

Main Features of IoT Platforms



- **Device Control and Management**

- ✓ Primary goal is to **manage the life cycle of the devices** securely and reliably from the cloud platform.
- ✓ **Features like** registration, identification, modeling, offloading tasks, remote administration, management, troubleshooting, diagnostics, and software patch updating of devices along with authentication.

- **Network Management**

- ✓ **It is the fundamental feature** of the IoT platform
- ✓ It provides a **secure and persistent connectivity** between IoT devices and the cloud platform.
- ✓ It includes the **interoperate communication protocol** such as REST API, HTTP, MQTT, and CoAP.
- ✓ The **network layer** is an enabler for the data acquisition, remote management and control of devices by **maintaining reliability, security, and trustworthiness**.
- ✓ It also provides **multi-network connections**.

Main Features of IoT Platforms



- **Data Analysis and Routing**

- ✓ It focuses on architectural components for handling data-related operations such as storage, executing, controlling, delivering, routing, and enhancing the value of information using AI/ML/DL.
- ✓ IoT data management has transitioned from traditional relational data management to heterogeneous and distributed real-time data processing

- **Data Visualization, Alerts, and Notifications**

- ✓ It helps to create customizable dashboards and renders the IoT data in real-time to the end user
- ✓ It helps decision-makers to explore the insights easily using visualization dashboard.
- ✓ Alert and notifications feature provides an opportunity to inform the end user or other entities to alert and send notifications through email or messaging platform.

Lessons Learned



- What is IoT Ecosystem

- Different components of IoT
 - i. IoT Architecture
 - ii. IoT Core
 - Sensors & Actuators
 - IoT Access Technologies
 - Use of Internet
 - iii. IoT Gateway
 - iv. Use of Cloud in IoT
 - v. AI for IoT
 - vi. Data Analytics in IoT
 - vii. Security in IoT
 - viii. User Interface for IoT
 - ix. IoT Framework/Platform

Thanks!

