## DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

# Internet Of Things


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# IoT Architectural View

An architecture has the **following features**:

- The architecture serves as a reference in applications of IoT in **services and business processes**.

- A set of sensors which are **smart, capture the data, perform necessary** data element analysis and transformation as per device application framework and connect directly to a communication manager.

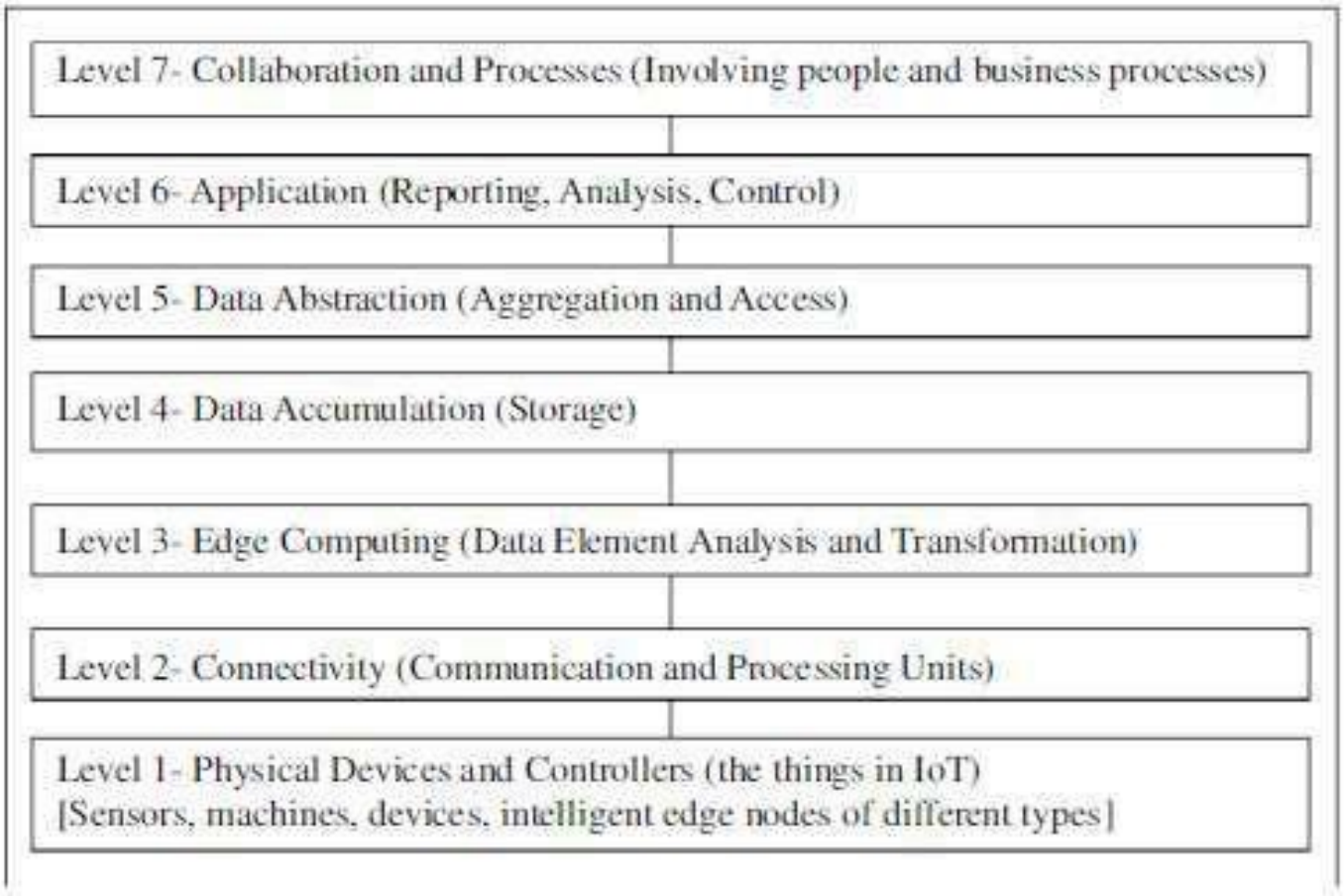
- A set of sensor circuits is connected to a gateway possessing separate **data capturing, gathering, computing and communication capabilities**. The gateway receives the data in one form at one end and sends it in another form to the other end.

# IoT Architectural View Contind..

- The communication-management subsystem consists of **protocol handlers, message routers and message cache**.
- This management subsystem has functionalities for **device identity database, device identity management and access management**.
- Data routes from the gateway through the Internet and **data centre to the application server or enterprise server** which acquires that data.
- Organisation and analysis subsystems enable the services, business processes, enterprise integration and complex processes

# IoT Architectural View-Reference Model

**Architectures are based on reference models. A typical reference model developed by CISCO is given below:**

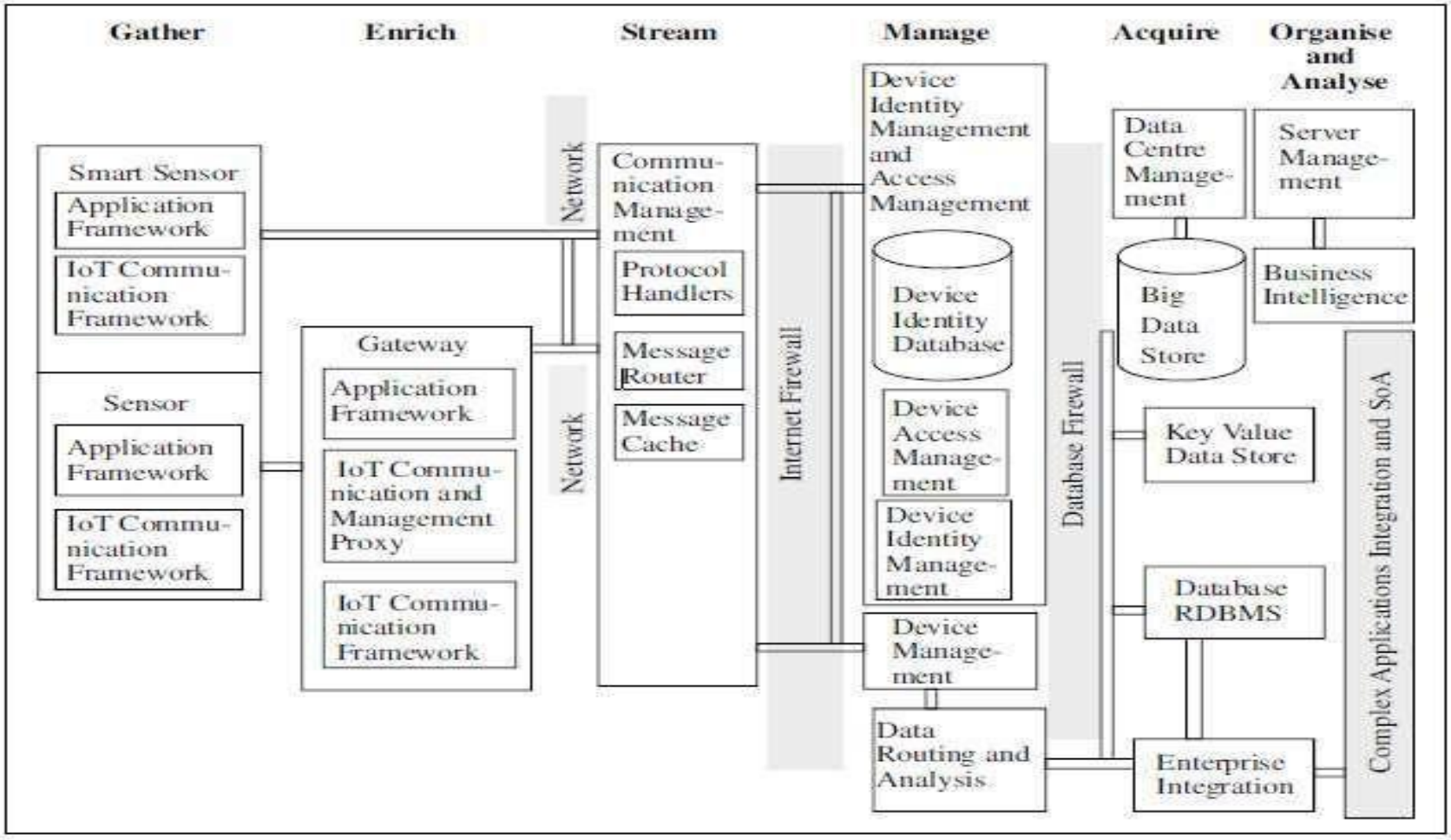



CISCO seven leveled reference model

# IoT Architectural View

**ARCHITECTURAL VIEW developed by Oracle based on the conceptual framework:**

Gather + Enrich + Stream + Manage + Acquire + Organise and Analyse
= Internet of Things with connectivity to data centre, enterprise or cloud server



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- Data routes from the gateway through the Internet and data centre to the application server or enterprise server which acquires that data.

# Technology Behind IOT

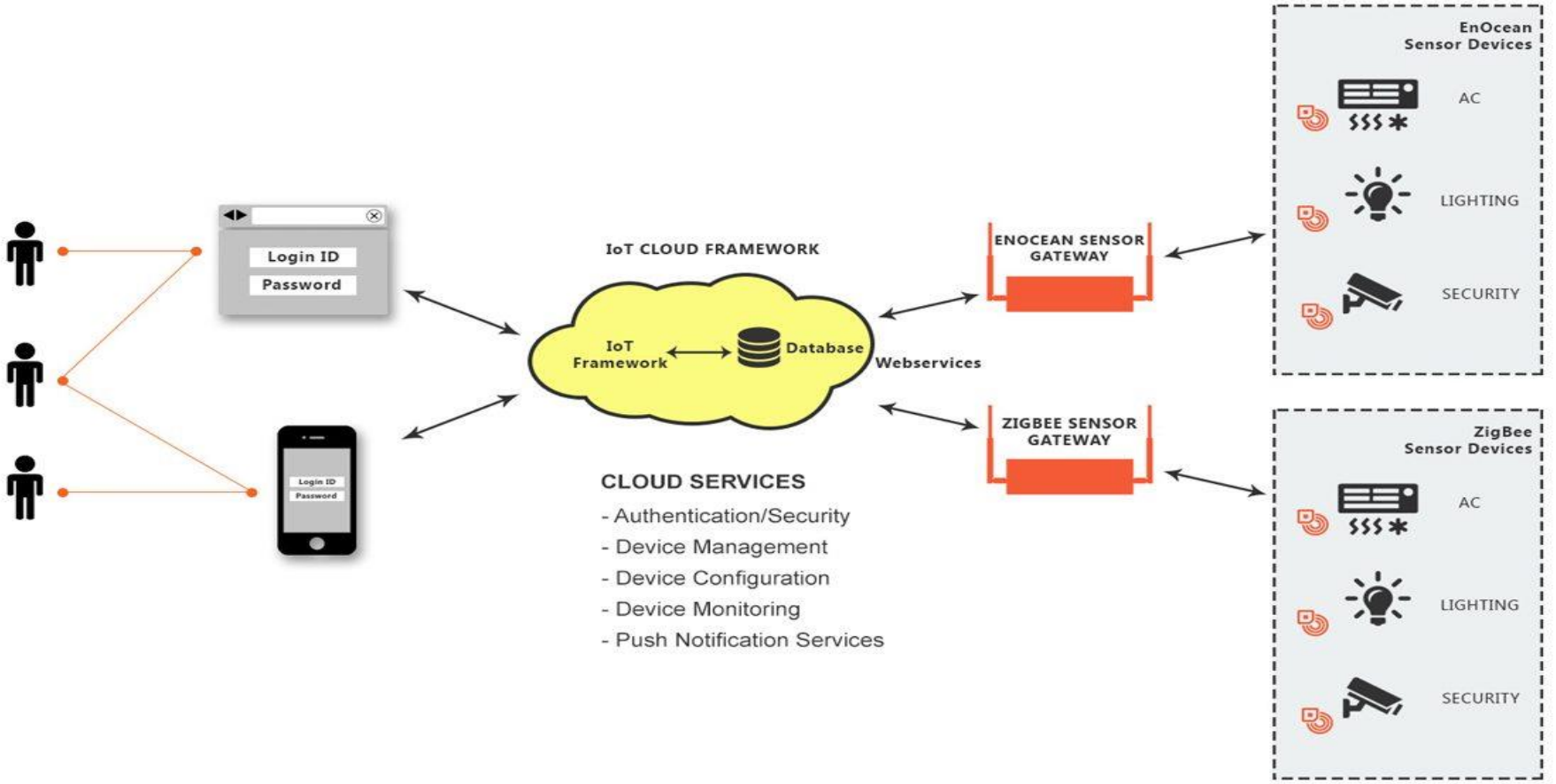
- Hardware – Arduino, Raspberry Pie, Intel Galileo, Intel Edison, ARM mBed…
- Integrated Development Environment (IDE) for developing device software, firmware, API (Application programming interface)
- Protocols – RPL, CoAP, RESTful HTTP, MQTT…
- Communication – Powerline Ethernet, RFID, NFC, Zigbee, Bluetooth, WiFi, WiMax, 2G/3G/4G…
- Network Backbone – IPv4, IPv6, UDP…
- Software – RIOT OS, Contiki OS, Thingsquare, Eclipse IOT …
- Internet cloud platforms – Sense, Nimbits, AWS IoT, TCS Cup, IBM BlueMix, CISCO IoT … They are costly, but very flexible for users. Dedicated servers are cost effective.
- Machine learning algorithm and software. Eg: GROK from Numenta Inc. using machine intelligence to analyse the streaming data from clouds and uncover anomalies.

# Technology Behind IOT

- Server-end Technology
- Major Components of IoTSystem
- Development Tools and Open-source Framework for IoT Implementation
- APIs and Device Interfacing Components
- Platforms and Integration Tools

# Server end Technology

- Servers are critical components in IoT – eg: Application servers, enterprise servers, cloud servers, data centres…



# Major Components of IoT System

## 1) Physical Object with embedded software into a hardware

- **Sensors – Smart sensors – Sensor actuator pairs**
  - Temp, Pressure sensors, accelerometers, gyroscopes, GPS sensors, proximity sensors, Magnetic field sensors etc…
  - Can give analog o/p – temp, pressure sensors
  - Can give digital o/p – touch sensors, proximity sensors, metal and water detectors
- **Control Units**
  - Microcontrollers like Atmega, ARM Cortex …
  - Has processor, memory, hardware interfaces, firmwares, timers. Communication interfaces…
  - May contain application specific functional circuits like ADC, DAC, PWM etc…

## 2) Communication modules

- Softwares – device API's & device interface for communication (CoAP, LWM2M, IPv4, IPv6…)
- Consists of protocol handlers, message queue and cache. Device message queue handles data in first in-first out manner

# Major Components of IoT System

3) IOT Software

- **Middleware** (bridge b/w OS and end application on a network)
  - OpenIoT is an open sorce middleware – enables communication b/w sensor n/w and cloud base.
  - IoTSyS is anotherexample enabling smart communication b/w devices using protocols like IPv6, CoAP etc…
- **Operating System (** software for user interface )
  - *Raspbian* is a popular Raspberry Pi OS
  - RIOT is another example – supports ARM processors, Cortex, x86 PC's and TI MSP
  - AllJoyn is an open source OS by Qualcomm – available for Android, iOS, Windows, Linux
  - Spark is a distributed cloud based IoT OS
- **Firmware (**permanent software programmed into a read-only hardware memory)
  - Eg: Thingsquare Mist is an open source firmware

# Development Tools & Open Source rameworks for implementing IoT S/M

- Eclipse IoT – provides an open source implementation of various standards (MQTT CoAP, OMA-DM and OMA LWM2M) – Eclipse developed IoT programming language Lua
  - (Message Queuing Telemetry Transport, Constrained Application Protocol)

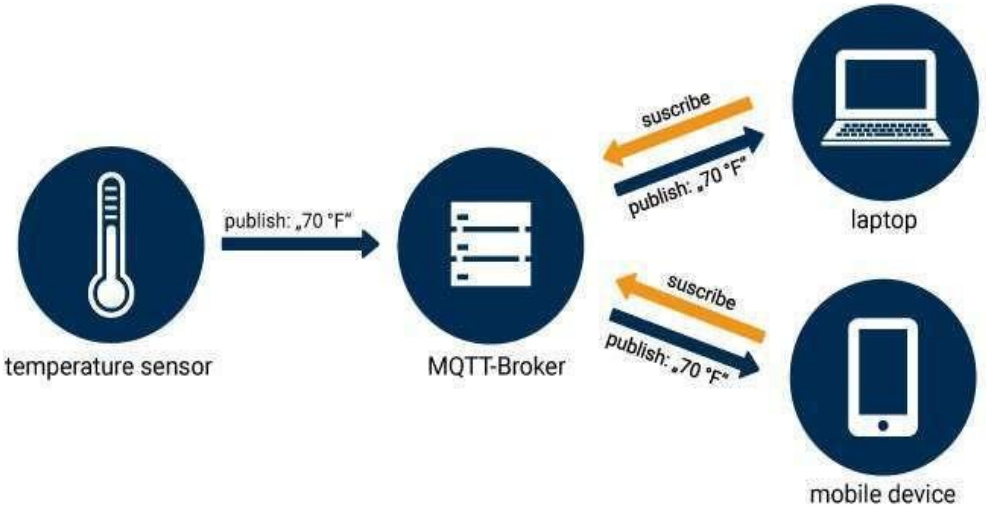
- Arduino development tools provide a set of software (including IDE) and Arduino programming language.

- Kinoma Software platform. Kinoma connect is a free app for Android and iOS.

# MQTT

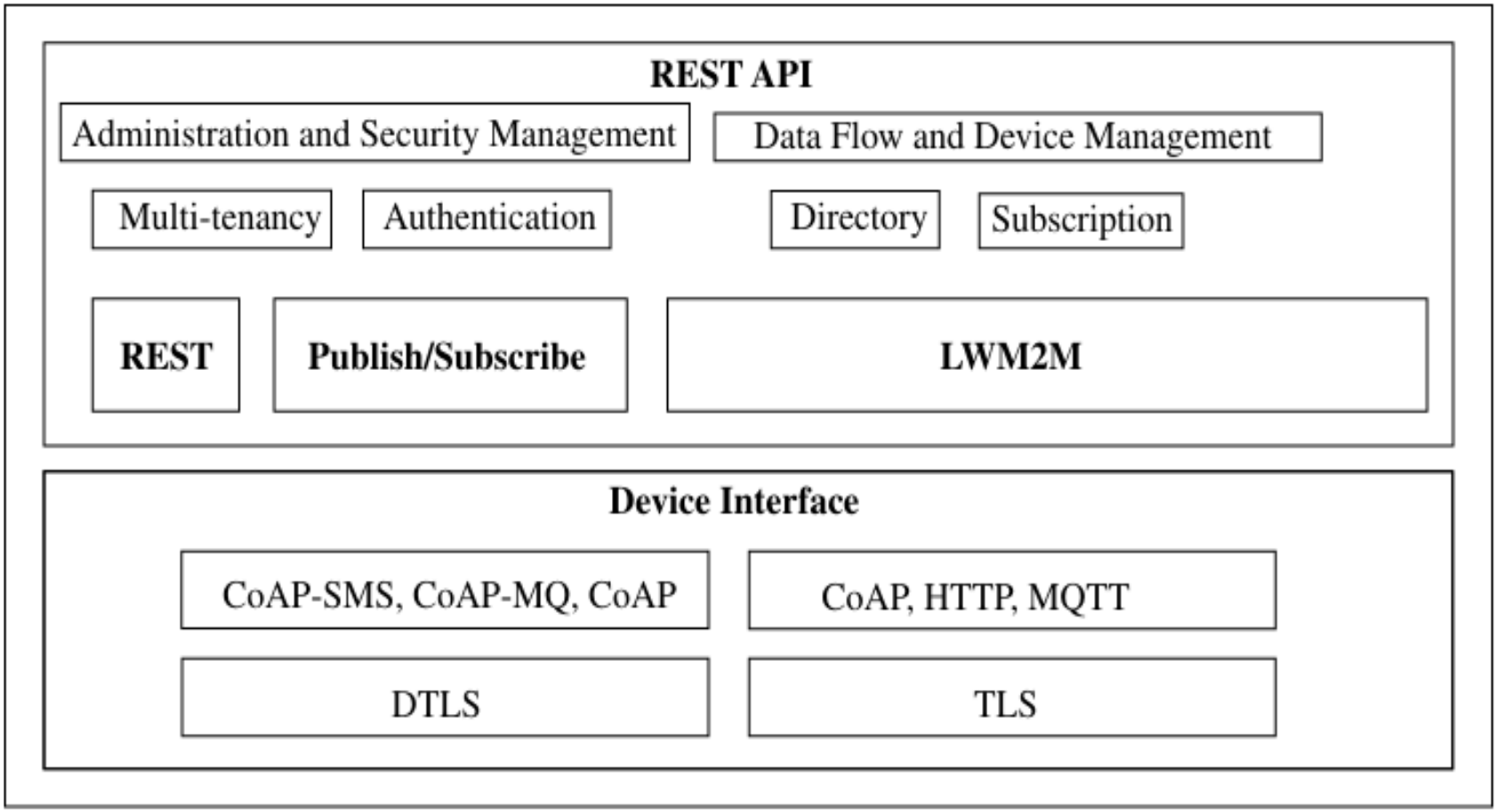
## MQTT

With **Message Queuing Telemetry Transport,** data is sent from a large number of machines to a single destination – the cloud – where the data can be analyzed, interpreted and forwarded. The cloud hosts an **MQTT broker** – an intermediary between machines and other machines and/or people. And this is an important distinction, as the machines do not communicate directly with each other, but through the broker.




Mosquitto is an MQTT broker and part of the Eclipse Foundation and is a project of iot.eclipse.org

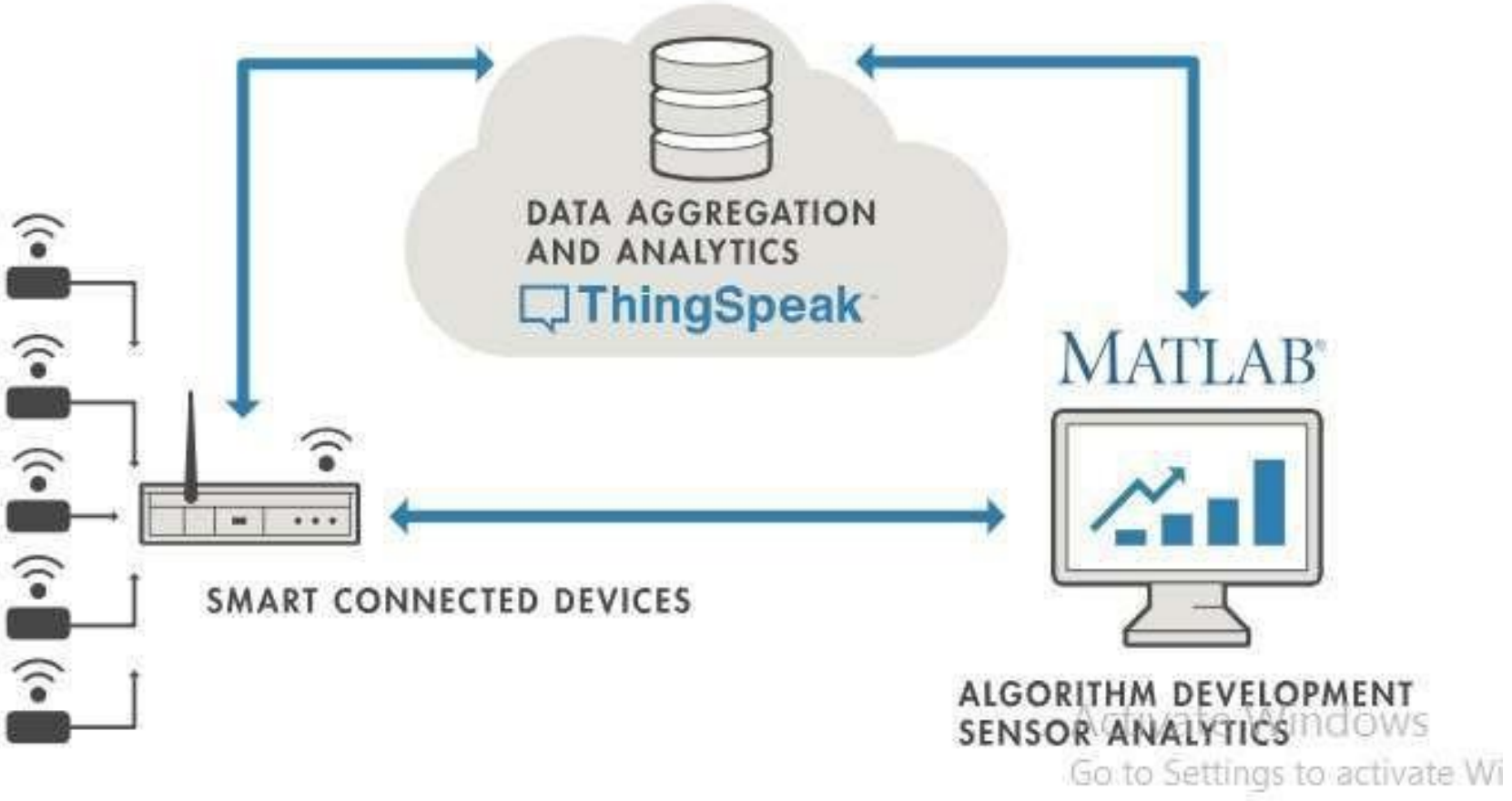
# Application program Interface (API) & Device Interfacing components



# Platforms and Integration Tools

- ThingSpeak – open data platform with an open API that can collect real time data, geological data, process it and visualize. Supports Arduino, Raspberry Pi, MATLAB data analytics…
- Nimbits – Cloud Platform
- IoT Toolkit
- SiteWhere

# Example



# Sources of IoT



## Popular Development Boards

- All development boards need an IDE (Integrated development Environment) for developing device software, firmware and API (Application programming interface)


### Arduino Yun

- uses ATmega32u4 and includes WiFi, Ethernet, USB, Micro SD

### Microduino

- small board compatible with Arduino – can be stacked with other boards.

### Intel Galileo

- Arduino certified development boards based on Intel x86 architecture – features Intel SOC X1000

# Sources of IoT

## Intel Edison

- It's a compute module – enables creation of smart IoT wearable and computing devices
- Has device internetworking and device to cloud communication

## Beagle Board

- Has very low power consumption
- Has a card like computer and can run Android and Linux


## Raspberry Pi Wireless Inventors Kit (RasWIK)

- Enables Raspberry Pi WiFi connected devices

# Sources of IoT:
# RFID - Radio-frequency Identification

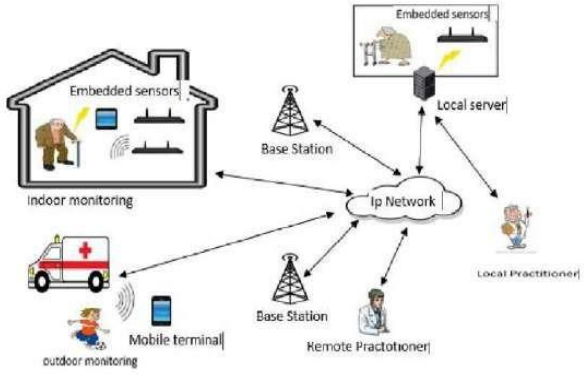


Technology whereby digital data encoded in **RFID** tags or smart are captured by a reader via radio waves

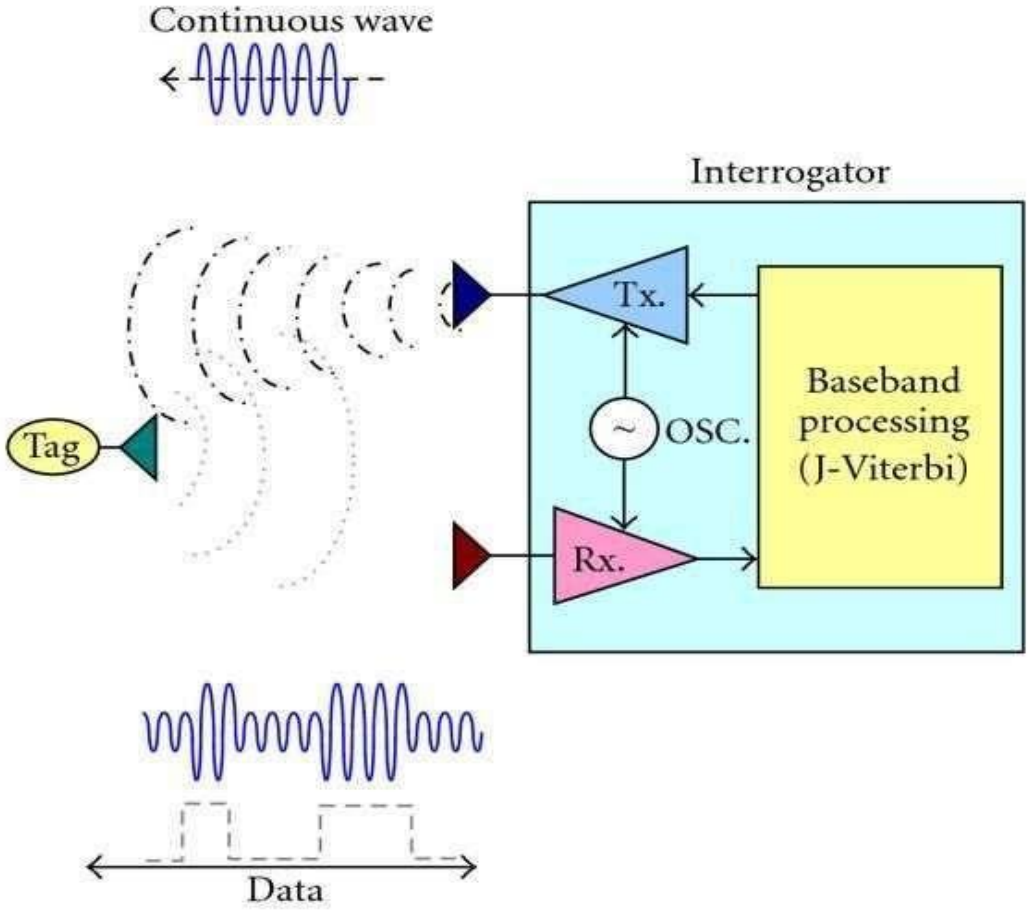
- Enables tracking and inventory control
- Identification in supply chains
- Access to buildings
- Road toll management
- Secured place entry
- RFID based temperature sensors
- New applications – factory design, anti counterfeiting in payments, quality management…

Wireless Sensor Networks (WSN) - A n/w in which, wirelessly and has capabilities of computation for da and analysis, communication & networking.

- Sensors can be networked by wireless technology
- Analog/digial
- Can acquire data from remote locations
- Uses RF transceiver
- Temp, pressure, metal proximity etc…

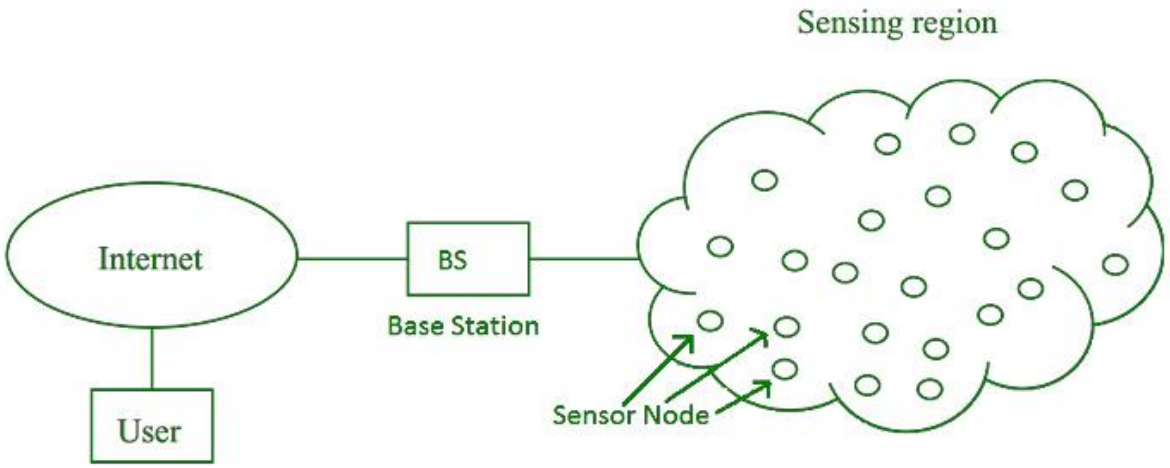


# Sources of IoT: RFID - Radio-frequency Identification



# Sources of IoT: Wireless Sensor Networks

- Sensors can be networked using **wireless technology** and can cooperatively monitor physical or environmental conditions.
- Sensors acquire data from remote locations, which may not be easily accessible. Each wireless sensor also has communication abilities for which it **uses a radio-frequency transceiver.**
- Each node either has an analog sensor with signal conditioner circuit or a digital sensor.
- Sensing can be done to monitor temperature, **light intensity, presence of darkness, metal proximity, traffic, physical**, chemical and biological data etc




Thank You