# Unit 1

# Introduction of IOT

# Introduction of IoT

- Internet of things is a concept which enables communication between internetworking devices and Applications, whereby physical objects or ‘things’ communicate through the internet.
- The concept of IoT began with things classified as identity communication devices.
- Radio frequency identification device (RFID) is an example of an identity communication device.
- Things are tagged to these devices for their identification in future and can be tracked , controlled and monitored using remote computers connected through the internet.
- For example GPS–based tracking, controlling and monitoring of devices , machine-to-machine communication(M2M) communication , connected cars ; communication between wearable and personal devices and industry 4.0.
- The IoT concept has made smart cities a reality and is also expected to make self-driving cars functional very soon.

# Definition

- The ***internet*** is a vast global network of connected servers , computers , tablets and mobiles that is governed by standard protocols for connected systems. It enables sending , receiving and communication of information, connectivity with remote servers, cloud and analytics platforms.

- ***Thing*** is a word used to refer to a physical object , an action or idea, a situation or activity.

- ***Internet of things*** means a network of physical things (objects) sending , receiving or communicating information using the internet or other communication technologies and network just as the computers, tablets and mobile do, and thus enabling the monitoring, coordinating or controlling process across the internet or another data network.

- ***Internet of things*** is the network of physical objects or ‘things’ embedded with electronics, software , sensors and connectivity to enable it to achieve greater value and service by exchanging data with the manufacturer , operators and/or other connected devices. Each thing is uniquely identifiable through its embedded computing system but is able to interoperate within the existing internet infrastructure.

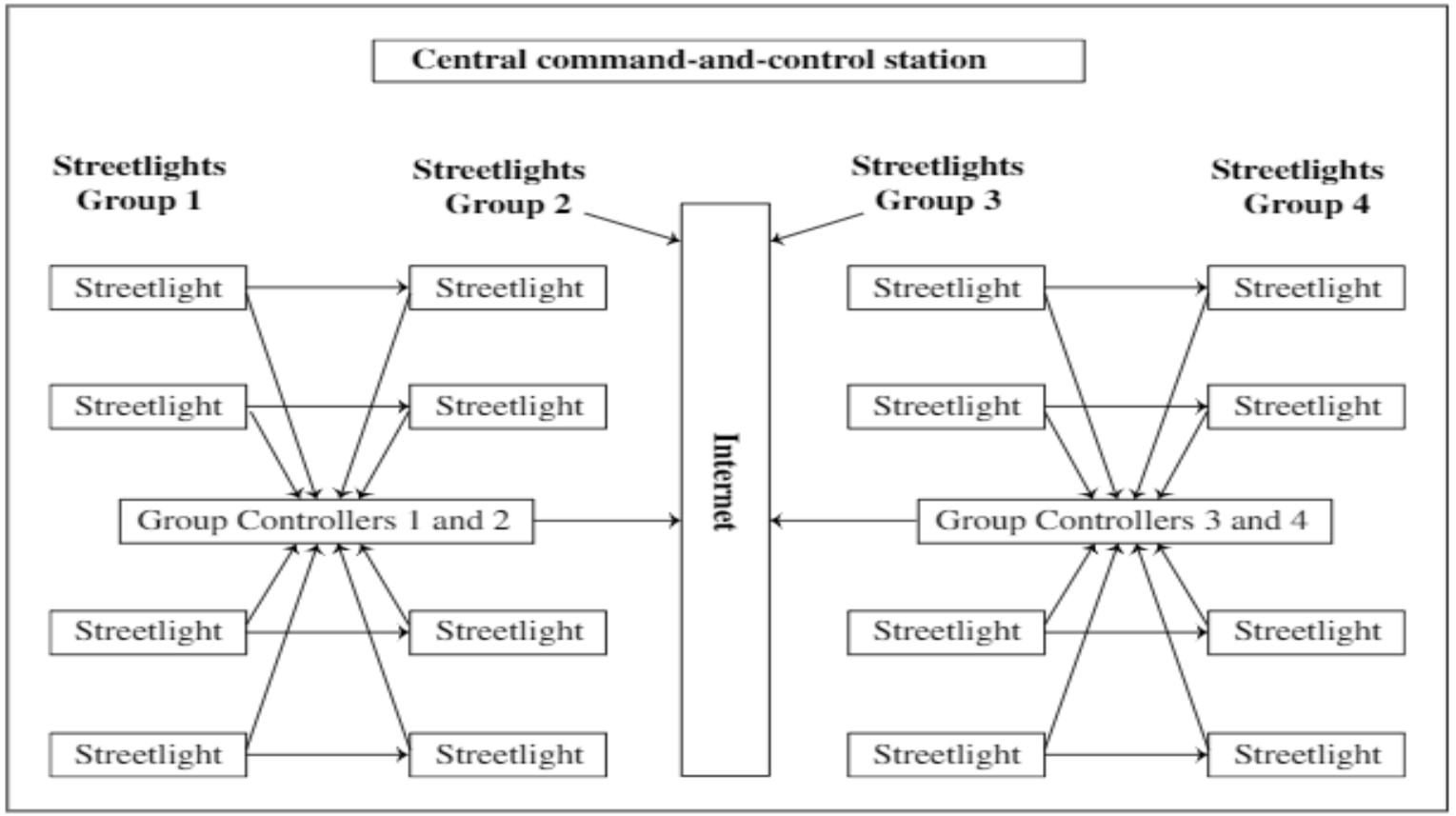
# IoT vision

- Internet of things is a vision where things (wearable watches , alarm clocks , home devices , surrounding objects) become ‘smart’ and function like living entities by sensing , computing and communicating through embedded devices which interact with remote objects( servers, clouds, applications, services and processes) or persons through the internet or near-field communication(NFC) etc..

- Through computing , an umbrella can be made to function like a living entity. By installing a tiny embedded device , which interacts with a web based weather service and the devices owner through the internet the following communication can take place.

- The umbrella, embedded with a circuit for the purpose of computing and communication connects to the internet. A website regularly publishes the weather report. The umbrella receives these reports each morning, , analyses the data and issues reminders to the owner at intermittent intervals around his/her office-going time.

# IoT concept for streetlights in city



# Smart and hyperconnected Devices

- Hyperconnectivity means use of multiple systems and devices to remain constantly connected to social networks and streams of information.
- Smart devices are devices with computing and communication capabilities that can constantly connect to networks.

# Smart and hyperconnected Devices

- General framework for IoT using smart and hyperconnected devices, edge computing and applications.

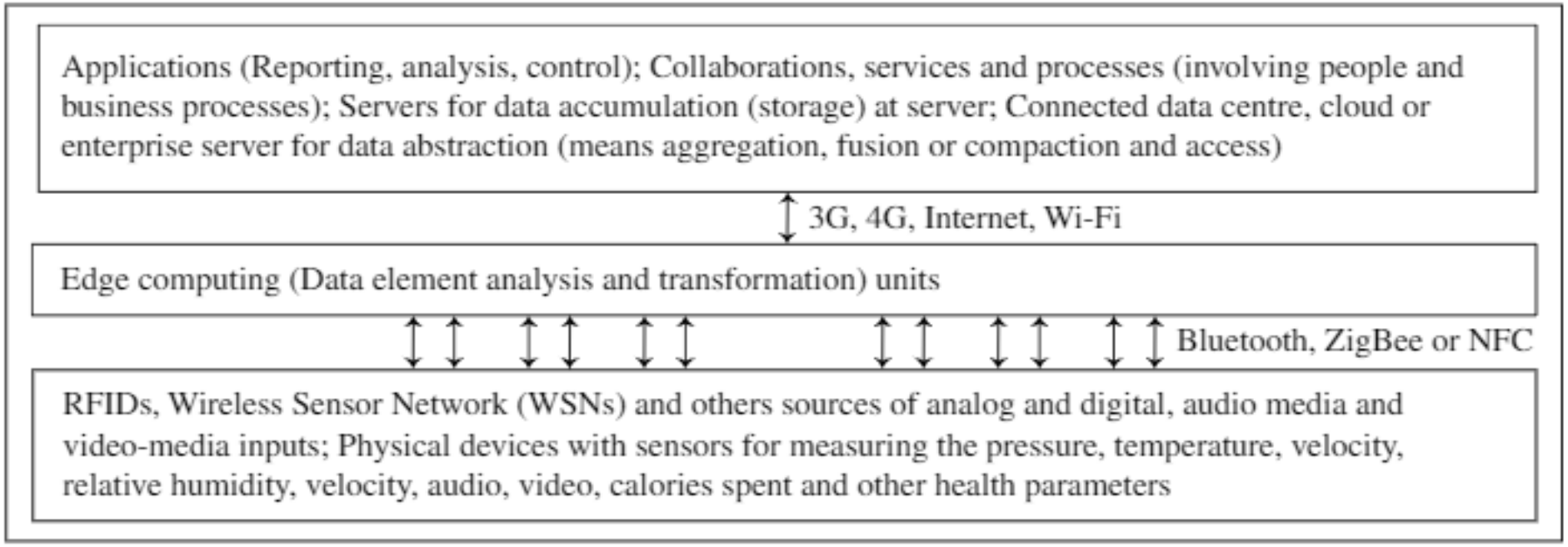



**Figure 1.2** A general framework for IoT using smart and hyperconnected devices, edge computing and applications

# IoT conceptual Framework

- Simple conceptual framework of IoT

**Physical Object + Controller, Sensor and Actuators + Internet = Internet of Things**
**… 1.1**

Equation 1.1 conceptually describes the Internet of umbrellas as consisting of an umbrella, a controller, sensor and actuators, and the Internet for connectivity to a web service and a mobile service provider.

- **Gather + Enrich + Stream + Manage + Acquire + Organise and Analyse = Internet of Things with connectivity to data centre, enterprise or cloud server** **… 1.2**

# IoT conceptual Framework

Equation 1.2 is an IoT conceptual framework for the enterprise processes and services, based on a suggested IoT architecture given by Oracle (Figure 1.5 in Section 1.3). The steps are as as follows:

1. At level 1 data of the devices (things) using sensors or the things gather the pre data from the internet.
2. A sensor connected to a gateway, functions as a smart sensor (smart sensor refers to a sensor with computing and communication capacity). The data then enriches at level 2, for example, by transcoding at the gateway. Transcoding means coding or decoding before data transfer between two entities.
3. A communication management subsystem sends or receives data streams at level 3.
4. Device management, identity management and access management subsystems receive the device's data at level 4.
5. A data store or database acquires the data at level 5.
6. Data routed from the devices and things organises and analyses at level 6. For example, data is analysed for collecting business intelligence in business processes.

# IoT conceptual Framework

- IoT conceptual Framework for complex system

**Gather + Consolidate + Connect + Collect + Assemble + Manage and Analyse**
**= Internet of Things with connectivity to cloud services** ... 1.3

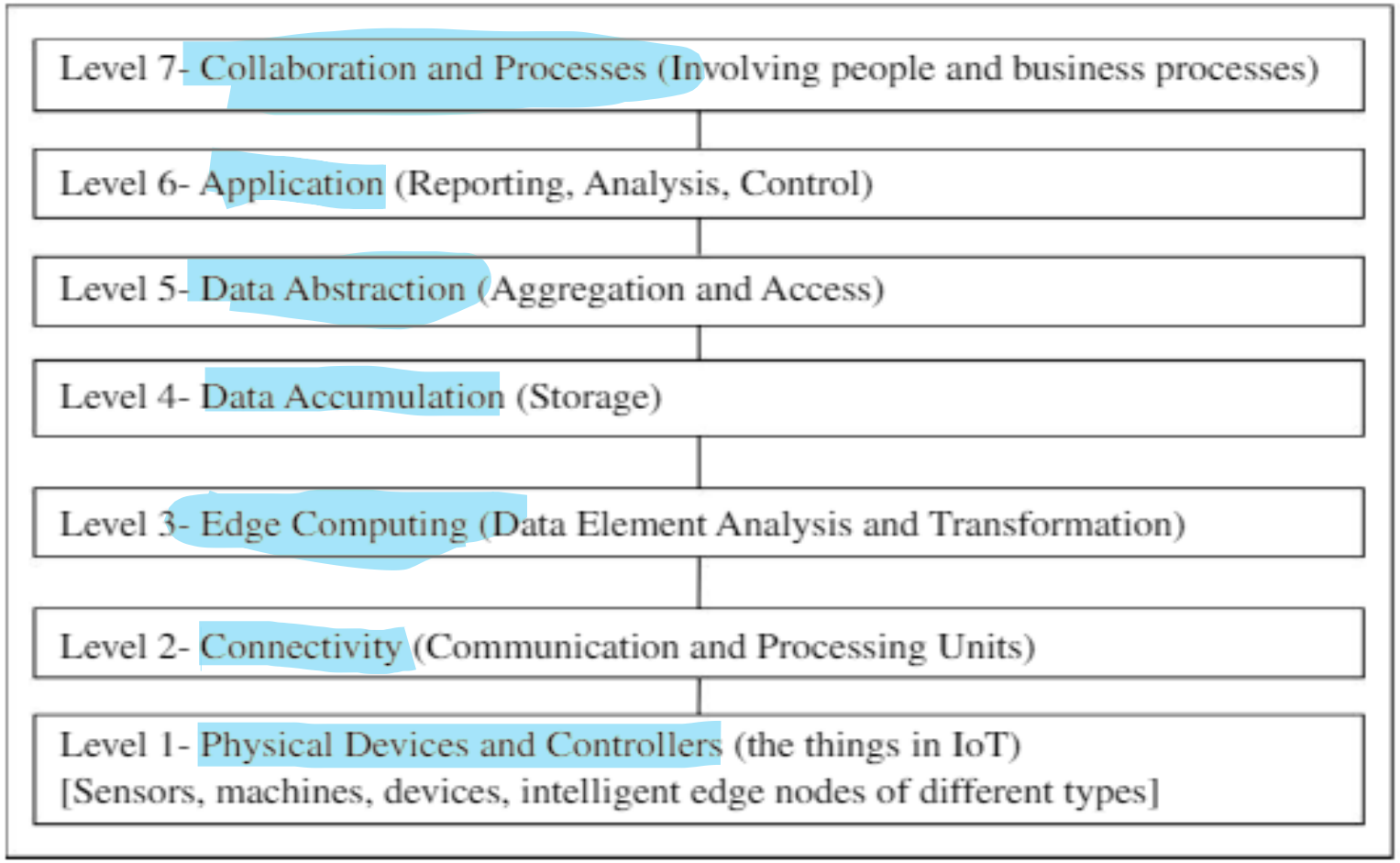
Equation 1.3 represents a complex conceptual framework for IoT using cloud-platform-based processes and services. The steps are as follows:

1. Levels 1 and 2 consist of a sensor network to gather and consolidate the data. First level gathers the data of the things (devices) using sensors circuits. The sensor connects to a gateway. Data then consolidates at the second level, for example, transformation at the gateway at level 2.
2. The gateway at level 2 communicates the data streams between levels 2 and 3. The system uses a communication-management subsystem at level 3.
3. An information service consists of connect, collect, assemble and manage subsystems at levels 3 and 4. The services render from level 4.
4. Real time series analysis, data analytics and intelligence subsystems are also at levels 4 and 5. A cloud infrastructure, a data store or database acquires the data at level 5.

# IoT Architecture

- An IoT system has multiple levels (equations 1.1 to 1.3). These levels are also known as tiers.
- A model enables conceptualisation of a framework.
- A reference model can be used to depict building blocks, successive interactions and integration.

# CISCO Reference model




CISCO seven leveled reference model

**Figure 1.4** An IoT reference model suggested by CISCO that gives a conceptual framework for a general IoT system

# Features of Architecture

- The architecture **serves as a reference** in application 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..
- 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.

# Technology behind IoT

- Hardware ( Arduino , Raspberry Pi, Intel Galileo, Intel Edison, ARM mBed, Bosch XDK110, Beagle Bone Black and Wireless Soc)
- Integrated Development Environment (IDE) for developing device software, firmware and APIs
- Protocols [RPL, CoAP , RESTful , HTTP, MQTT,XMPP)
- Communication ( Powerline Ethernet, RFID , NFC , 6LowPAN , UWB , ZigBee , Bluetooth , Wifi , WiMax , 2G/3G/4G)
- Network backbone (IPv4,IPv6,UDP and 6LowPAN)
- Software(RIOT OS,Contiki OS, Thingsquare Mist firmware, Eclipse IoT)
- Internetwork Cloud Platforms/Data Centre (sense, ThingWorx, Nimbits,Xively, openHAB , AWS IoT ,IBM BlueMix,CISCO IoT,IOx and Fog, EvryThng,Azure,TCS CUP)
- Machine learning algorithms and software.

# Server-end technology

- IoT servers are application servers, enterprise servers, cloud servers, data centres and databases.
- **Software components:**

1) Online platforms
2) Devices identification, identity management and their access management.
3) Data accruing, aggregation, integration, organizing and analyzing
4) Use of web applications, services and business processes.

# Major components of IoT system

1) **Physical object** with embedded software into a hardware

2) **Hardware** consisting of a micro-controller, firmware,sensors, control unit,actuators and communication module.

3) **Communication module** : software consisting of device APIs and device interface for communication over the network and communication circuit/port(s), and middleware for creating communication stacks using 6LowPAN(IPv6 over Low-power wireless Personal Area Network),CoAP(Constrained Application Protocol), LWM2M(Light weight mobile to mobile) ,IPv4,IPv6 and other protocols.

4) **Software** for actions on messages, information and commands which the device receive and then output to the actuators, which enable actions such as glowing LEDs, robotic hand movement etc..