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Internal Assessment Test 1 – March 2024

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Sub: | Internet of Things | | | | Sub Code: | 18CS81 | Branch: ISE |
| Date: | 16/03/2024 | Duration: | 90 mins | Max Marks: 50 | Version/ Sem / Sec: | VIII/A,B,C | OBE |

Answer any FIVE FULL Questions

| | | MARKS | CO | RBT |
|---|---|---|---|---|
| 1. | Explain different types of sensors with examples. | [10] | CO2 | L2 |
| 2. | Explain the actuators with a neat diagram. | [10] | CO2 | L2 |
| 3. | Explain in detail about the IoT reference model published by IoTWF architecture. | [10] | CO1 | L2 |
| 4 (a) | Explain with a neat diagram the one M2M IoT Standardized Architecture. | [07] | CO1 | L2 |
| 4 (b) | What does IoT and Digitization mean? | [03] | CO1 | L1 |
| 5 (a) | Apply the concept of Data Aggregation in the hierarchy of smart objects. | [06] | CO2 | L3 |
| 5 (b) | Compare and contrast the differences between IT and OT networks with the various challenges. | [04] | CO1 | L1 |
| 6 (a) | Explain with a neat diagram the Simplified IoT architecture | [06] | CO1 | L2 |
| 6 (b) | Define IoT. Explain in detail about the Genesis of IoT. | [04] | CO1 | L2 |

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Internal Assessment Test 1 – March 2024

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## Scheme of Evaluation

## Internal Assessment Test 1 – March.2022

| **Sub:** | Internet of Things | | | | | | | **Code:** | 18CS81 |
|---|---|---|---|---|---|---|---|---|---|
| Date: | 16/04/2024 | Duration: | 90mins | Max Marks: | 50 | **Sem:** | VIII | **Branch:** | ISE |

**Note:** Answer Any Five Questions

| Question # | Description | Marks Distribution | Max Marks |
|---|---|---|---|
| 1 | • Different types of sensors with examples | 10M | 10 M |
| 2 | • Actuators with a neat diagram | 10 M | 10 M |
| 3 | • IoT reference model published by IoTWF | 10M | 10 M |
| 4 | • One M2M IoT Standardized Architecture<br>• IoT and Digitization | 7M<br>3M | 10 M |
| 5 | • Data Aggregation in the hierarchy of smart objects<br>• IT and OT networks with the various challenges. | 6M<br>4M | 10 M |
| 6 | • Simplified IoT architecture<br>• Definition of IoT.<br>• Genesis of IoT | 6M<br>2M<br>2M | 10 M |

**Internal Assessment Test 1 – March.2022**

| Sub: | Internet of Things | | | | | | | Code: | 18CS81 |
|---|---|---|---|---|---|---|---|---|---|
| Date: | 16/03/2024 | Duration: | 90mins | Max Marks: | 50 | Sem: | VIII | Branch: | ISE |

**Note:** Answer Any Five Questions

1. Different types of sensors with examples

Smart objects are any physical objects that contain embedded technology to sense and/or interact with their environment in a meaningful way by being interconnected and enabling communication among themselves or an external agent.

Some of the fundamental building blocks of IoT networks are

- Sensors
- Actuators
- Smart Objects

**Sensors:**

- A sensor does exactly as its name indicates: It senses.
- A sensor measures some physical quantity and converts that measurement reading into a digital representation.
- That digital representation is typically passed to another device for transformation into useful data that can be consumed by intelligent devices or humans.
- Sensors are not limited to human-like sensory data.
- They are able to provide an extremely wide spectrum of rich and diverse measurement data with far greater precision than human senses.
- Sensors provide superhuman sensory capabilities.
- Sensors can be readily embedded in any physical objects that are easily connected to the Internet by wired or wireless networks, they can interpret their environment and make intelligent decisions.

Sensors have been grouped into different categories

- **Active or passive:** Sensors can be categorized based on whether they produce an energy output and typically require an external power supply (active) or whether they simply receive energy and typically require no external power supply (passive).

- **Invasive or non-invasive:** Sensors can be categorized based on whether a sensor is part of the environment it is measuring (invasive) or external to it (non-invasive).

- **Contact or no-contact:** Sensors can be categorized based on whether they require physical contact with what they are measuring (contact) or not (no-contact).

- **Absolute or relative:** Sensors can be categorized based on whether they measure on an absolute scale (absolute) or based on a difference with a fixed or variable reference value (relative).

- **Area of application:** Sensors can be categorized based on the specific industry or vertical where they are being used.

- **How sensors measure:** Sensors can be categorized based on the physical mechanism used to measure sensory input (for example, thermoelectric, electrochemical, piezoresistive, optic, electric, fluid mechanic, photoelastic).
- **What sensors measure:** Sensors can be categorized based on their applications or what physical variables they measure.
  The physical phenomenon a sensor is measuring is shown in Table-2.1

| Sensor Types | Description | Examples |
|---|---|---|
| Position | A position sensor measures the position of an object; the position measurement can be either in absolute terms (absolute position sensor) or in relative terms (displacement sensor). Position sensors can be linear, angular, or multi-axis. | Potentiometer, inclinometer, proximity sensor |
| Occupancy and motion | Occupancy sensors detect the presence of people and animals in a surveillance area, while motion sensors detect movement of people and objects. The difference between the two is that occupancy sensors generate a signal even when a person is stationary, whereas motion sensors do not. | Electric eye, radar |
| Velocity and acceleration | Velocity (speed of motion) sensors may be linear or angular, indicating how fast an object moves along a straight line or how fast it rotates. Acceleration sensors measure changes in velocity. | Accelerometer, gyroscope |
| Force | Force sensors detect whether a physical force is applied and whether the magnitude of force is beyond a threshold. | Force gauge, viscometer, tactile sensor (touch sensor) |
| Pressure | Pressure sensors are related to force sensors, measuring force applied by liquids or gases. Pressure is measured in terms of force per unit area. | Barometer, Bourdon gauge, piezometer |
| Flow | Flow sensors detect the rate of fluid flow. They measure the volume (mass flow) or rate (flow velocity) of fluid that has passed through a system in a given period of time. | Anemometer, mass flow sensor, water meter |

- A fascinating use case to highlight the power of sensors and IoT is in the area of precision agriculture (sometimes referred to as smart farming), which uses a variety of technical advances to improve the efficiency, sustainability, and profitability of traditional farming practices.
- This includes the use of GPS and satellite aerial imagery for determining field viability; robots for high-precision planting, harvesting, irrigation, and so on; and real-time analytics and artificial intelligence to predict optimal crop yield, weather impacts, and soil quality.
  Different types of sensors in a smart phone is shown in figure 2.1


**Figure 2.1: Sensors in a smart phone**

2. Actuators with a neat diagram

**Actuators:**

- Actuators are natural complements to sensors.
- Figure 2.2 demonstrates the symmetry and complementary nature of these two types of devices.
- Sensors are designed to sense and measure practically any measurable variable in the physical world.
- They convert their measurements (typically analog) into electric signals or digital representations that can be consumed by an intelligent agent (a device or a human).
- Actuators, on the others hand, receive some type of control signal (commonly an electric signal or digital command) that triggers a physical effect, usually some type of motion, force, and so on.

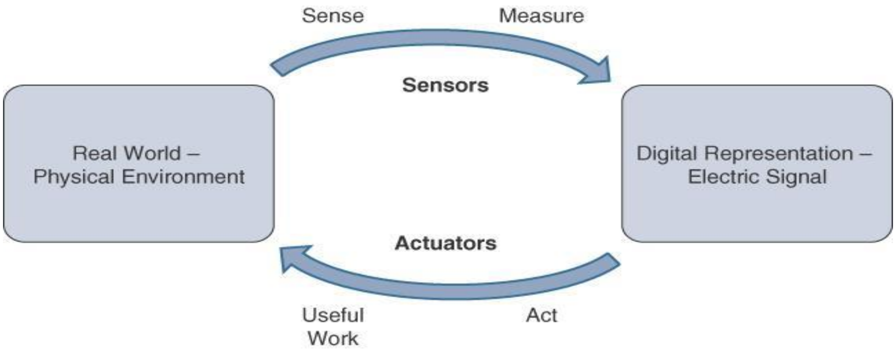



**Figure 2.2 : How Sensors and Actuators Interact with the Physical World**

Much like sensors, actuators also vary greatly in function, size, design, and so on. Some common ways that they can be classified include the following:

- **Type of motion:** Actuators can be classified based on the type of motion they produce (for example, linear, rotary, one/two/three-axes).
- **Power:** Actuators can be classified based on their power output (for example, high power, low power, micro power)
- **Binary or continuous:** Actuators can be classified based on the number of stable-state outputs.
- **Area of application:** Actuators can be classified based on the specific industry or vertical where they are used.

- **Type of energy:** Actuators can be classified based on their energy type.

Different types of Actuators are presented in Table -2.2

| Type | Examples |
|---|---|
| Mechanical actuators | Lever, screw jack, hand crank |
| Electrical actuators | Thyristor, biopolar transistor, diode |
| Electromechanical actuators | AC motor, DC motor, step motor |
| Electromagnetic actuators | Electromagnet, linear solenoid |
| Hydraulic and pneumatic actuators | Hydraulic cylinder, pneumatic cylinder, piston, pressure control valves, air motors |
| Smart material actuators (includes thermal and magnetic actuators) | Shape memory alloy (SMA), ion exchange fluid, magnetorestrictive material, bimetallic strip, piezoelectric bimorph |
| Micro- and nanoactuators | Electrostatic motor, microvalve, comb drive |

**Table -2.2: Actuator Classification by Energy Type**

*Micro-Electro-Mechanical Systems (MEMS)*

- Micro-electro-mechanical systems (MEMS referred to as micro-machines, can integrate and combine electric and mechanical elements, such as sensors and actuators, on a very small (millimeter or less) scale.
- The combination of tiny size, low cost, and the ability to mass produce makes MEMS an attractive option for a huge number of IoT applications.
  **Ex:** Inkjet printers use micropump MEMS. Smart phones also use MEMS technologies for things like accelerometers and gyroscopes

3. IoT reference model published by IoTWF

Layer 1: Physical Devices and Controllers Layer

- This layer is home to the “things” in the Internet of Things, including the various endpoint devices and sensors that send and receive information.
- The primary function is generating data

Layer 2: Connectivity Layer

- The primary function of this IoT layer is the reliable and timely transmission of data.

Layer 3: Edge Computing Layer

- Here emphasis is on data reduction and converting information that is ready for storage and processing by higher layers.

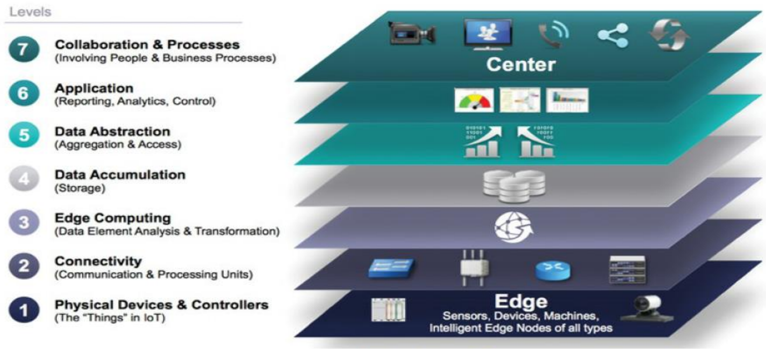



**Figure 2-2** IoT Reference Model Published by the IoT World Forum

4. a. One M2M IoT Standardized Architecture b. Genesis of IoT

- It was created with a goal of accelerating Machine to machine applications & devices.
- It expanded to include IoT.
- One M2M was launched with a goal to promote efficient M2M communication systems and IoT.
- OneM2M Goal: create a common services layer.
- Its framework focuses on IoT services , applications, and platforms.
- It divides IoT functions into 3 major domains.
- It supports wide range of IoT technologies.

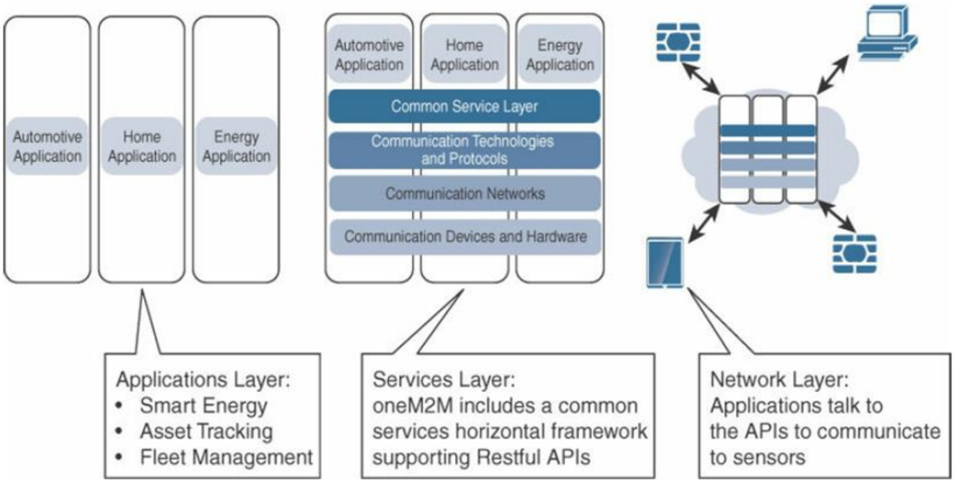



**Figure 2-1** The Main Elements of the oneM2M IoT Architecture

4 b. IoT and Digitization

***IoT*** is focused on connecting "things" to Internet.

**Example:** Wi-Fi location tracking in shopping mall

| | |
|---|---|
| "things" | Wi-Fi devices |
| Operation | Tracking consumer locationto understand how much time they spend in different parts of a mall or store through their smart phone. |
| Advantages | Changing locations of product displays and advertising, shops, rent to charge and security positions. |

***Digitization*** is the conversion of information into a digital format. It is focused on connecting "things" with its data and business result.

**Example:** Digitization of Photography

| | |
|---|---|
| "things" | Digital camera |
| Advantages | No need retailer to develop film and better capturing of images. |

**Example:** Digitization of Taxi services

| | |
|---|---|
| "things" | Taxi Driver device, Rider mobile |
| Advantages | Mobile app identifies cab, driver and fare. The rider pays fare through app. |

In the context of IoT, digitization brings together things, data, and business process to make networked connections more relevant and valuable.

**Example**: "Nest" home automation
The sensors determine desired climate settings and other smart objects, such as smoke alarms, video cameras, and other third-party devices. The devices and their functions are managed and controlled together and could provide the holistic experience.

Smart objects and increased connectivity drive digitization, and thus many companies, countries, and governments are embracing this growing trend.

5a. Data Aggregation in the hierarchy of smart objects

Wireless sensor networks are made up of wirelessly connected smart objects, which are sometimes referred to as *motes*. The following are some of the most significant limitations of the smart objects in WSNs:

- Limited processing power
- Limited memory
- Lossy communication
- Limited transmission speeds
- Limited power

These limitations greatly influence how WSNs are designed, deployed, and utilized. Figure 2.3 below shows an example of such a data aggregation function in a WSN where temperature readings from a logical grouping of temperature sensors are aggregated as an average temperature reading.

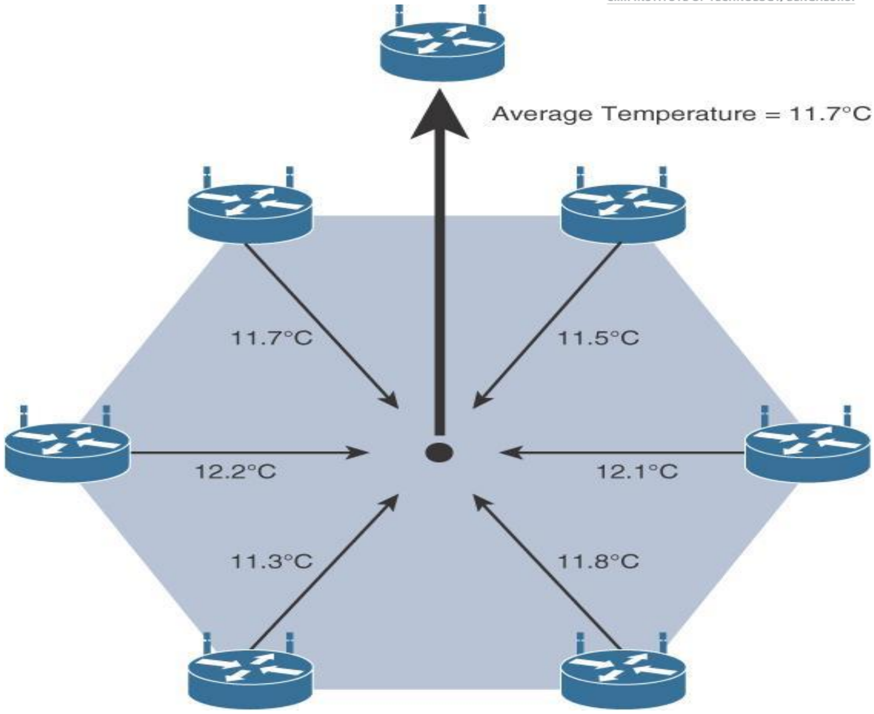



**Figure 2.3 Data Aggregation in Wireless Sensor Networks**

These data aggregation techniques are helpful in reducing the amount of overall traffic (and energy) in WSNs with very large numbers of deployed smart objects. Wirelessly connected smart objects generally have one of the following two communication patterns:

- **Event-driven:** Transmission of sensory information is triggered only when a smart object detects a particular event or predetermined threshold.
- **Periodic:** Transmission of sensory information occurs only at periodic intervals.

**Communication Protocols for Wireless Sensor Networks:**

- Any communication protocol must be able to scale to a large number of nodes.
- Likewise, when selecting a communication protocol, you must carefully take into account the requirements of the specific application.
- Also consider any trade-offs the communication protocol offers between power consumption, maximum transmission speed, range, tolerance for packet loss, topology optimization, security, and so on.
- Sensors often produce large amounts of sensing and measurement data that needs to be processed.
- This data can be processed locally by the nodes of a WSN or across zero or more hierarchical levels in IoT networks.
- IoT is one of those rare technologies that impacts all verticals and industries, which means standardization of communication protocols is a complicated task, requiring protocol definition across multiple layers of the stack, as well as a great deal of coordination across multiple standards development organizations.

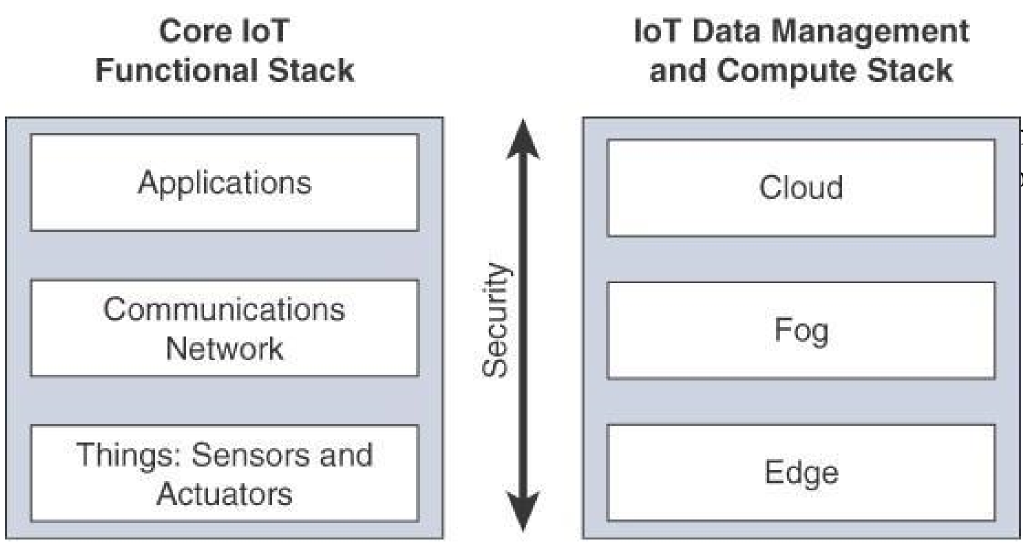
5b. Differences between IT and OT networks and their various challenges

| Criterion | Industrial OT Network | Enterprise IT Network |
|---|---|---|
| Operational focus | Keep the business operating 24x7 | Manage the computers, data, and employee communication system in a secure way |
| Priorities | 1. Availability<br>2. Integrity<br>3. Security | 1. Security<br>2. Integrity<br>3. Availability |
| Types of data | Monitoring, control, and supervisory data | Voice, video, transactional, and bulk data |
| Security | Controlled physical access to devices | Devices and users authenticated to the network |
| Implication of failure | OT network disruption directly impacts business | Can be business impacting, depending on industry, but workarounds may be possible |
| Network upgrades (software or hardware) | Only during operational maintenance windows | Often requires an outage window when workers are not onsite; impact can be mitigated |
| Security vulnerability | Low: OT networks are isolated and often use proprietary protocols | High: continual patching of hosts is required, and the network is connected to Internet and requires vigilant protection |

*Source*: Maciej Kranz, *IT Is from Venus, OT Is from Mars*, blogs.cisco.com/digital/it-is-from-venus-ot-is-from-mars, July 14, 2015.

**Table 1-3** *Comparing Operational Technology (OT) and Information Technology (IT)*

6a. Simplified IoT architecture




nted by Kevin Ashton.
out senses—they only
knowledge. Butin the

**Figure 2-6** *Simplified IoT Architecture*

Nearly every published IoT model includes core layers including "things," a communications network, and applications. However, unlike other models, the framework presented here separates the core IoT and data management into parallel and aligned stacks, allowing you to carefully examine the functions of both the network and the applications at each stage of a complex IoT system. This separation gives you better visibility into the functions of each layer.

The presentation of the Core IoT Functional Stack in three layers is meant to simplify your understanding of the IoT architecture into its most foundational building blocks. Of course, such a simple architecture needs to be expanded on. The network communications layer of the IoT stack itself involves a significant amount of detail and incorporates a vast array of technologies. Consider for a moment the heterogeneity of IoT sensors and the many different ways that exist to connect them to a network. The network communications layer needs to consolidate these together, offer gateway and backhaul technologies, and ultimately bring the data back to a central location for analysis and processing.

Unlike with most IT networks, the applications and analytics layer of IoT doesn't necessarily exist only in the data center or in the cloud. Due to the unique challenges and requirements of IoT, it is often necessary to deploy applications and data management throughout the architecture in a tiered approach, allowing data collection, analytics, and intelligent controls at multiple points in the IoT system. In the model presented in this book, data management is aligned with each of the three layers of the Core IoT Functional Stack.

The three data management layers are the edge layer (data management within the sensors themselves), the fog layer (data management in the gateways and transit network), and the cloud layer (data management in the cloud or central data center).

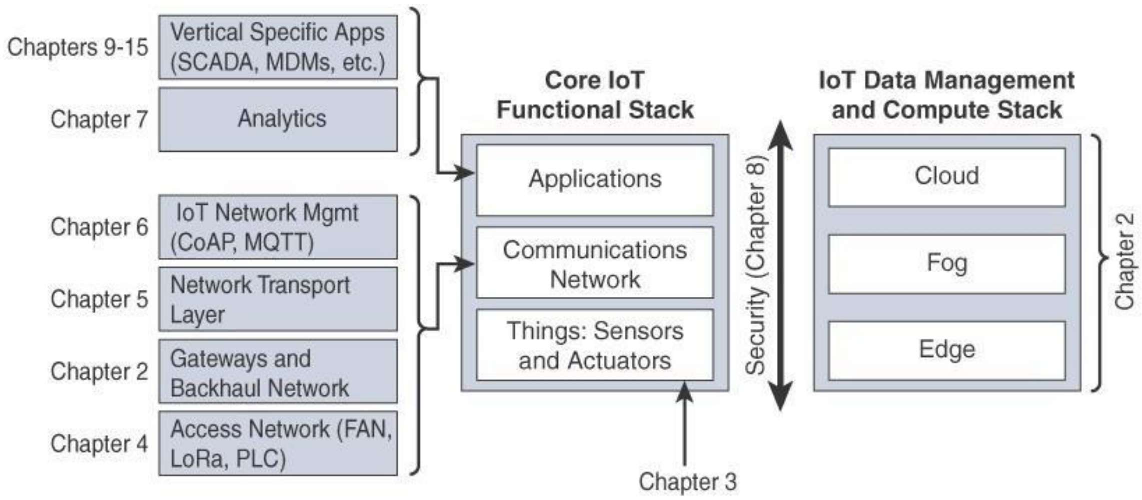



**Figure 2-7** *Expanded View of the Simplified IoT Architecture*

The communications layer is broken down into four separate sub-layers: the access network, gateways and backhaul, IP transport, and operations and management sub-layers.

The applications layer of IoT networks is quite different from the application layer of a typical enterprise network. Instead of simply using business applications, IoT often involves a strong big data analytics component. One message that is stressed throughout this book is that IoT is not just about the control of IoT devices but, rather, the useful insights gained from the data generated by those devices. Thus, the applications layer typically has both analytics and industry-specific IoT control system components.

6b. IoT. Genesis of IoT.

A world where everything is online and communicating to other things and people to enhance people's lives like self-driving drones and sensors for monitoring your health, is collectively known as the ***Internet of Things*** (IoT).

Basic goal of IoT : "connect the unconnected."
This means that objects not currently joined to the Internet will be connected so that they can communicate and interact with people and other objects.

The evolution of the Internet can be categorized into four phases:

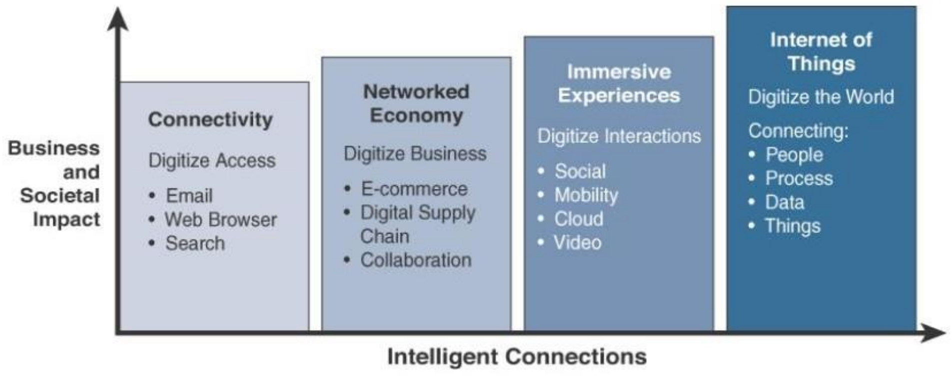



**Figure 1-1** *Evolutionary Phases of the Internet*

| | Internet Phases | Definition |
|---|---|---|
| 1. | Connectivity ( Digitize access ) | • Connect people using email, web services… • Search and access the information |
| 2. | Networked Economy( Digitize business ) | • Enable e-commerce and supply-chain enhancements • Collaborative engagement to increase efficiency |
| 3. | Immersive Experiences( Digitize interactions ) | • Extend Internet using social media while always beingconnected through mobility. • Most applications are cloud-based. |
| 4. | Internet of Things ( Digitize the world ) | • Connect objects and machines in real world. • Enable connecting the unconnected. |