FUNDAMENTAL THEORY OF IOT AND APPLICATIONS

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Abstract

The main aim of the present paper is how to the things are operating with internet, the importance of cloud computing in the Internet of Things and advantages and disadvantages of Internet of Things. In present days we are using number of applications through internet of things. Hence we have to know about the IoT.

Internet of Things is connecting between people and people through electronic devices. The electronic devices are communicated by using set of rules i.e. protocols. By using IoT, the information shared from one person to another person or many persons at a time. Its best management is emerging as a significant contest [1].

Introduction

Internet of Things (IoT) is a recent communication, in which a network connects things to the internet for communicating through the sensing devices with suitable protocols and exchange data among each other by using wireless sensor networks. Internet of Things (IoT) is the combination of physical elements and virtual elements. Physical elements are sensors, actuators, computing systems, etc., and virtual elements are cloud services, specific protocols such as - UDP, IPV6, IETF6LOWPAN and application user interface-UART, SPI, I2C, CAN etc. [2]

Using IoT the device is connected to the internet and all the information is shared with other objects without human intervention. In IoT the objects acquire the information using sensor and the data is processed using wireless communication and the data are collected using Cloud technology.

1.1. Layers of IoT

The layers of IoT can be grouped into three categories: IoT n Points, Gateways, Cloud.

IoT n Points

The Internet of Things (IoT) is a system of interrelated computing devices, mechanical and digital instruments, substances, birds or people are provided with single identifiers and ability to allocate the data over a network lacking human-to-human or human-to-system interaction.

Internet of Things is a network of physical devices such as combination of hardware and software, sensing devices and connectivity of network, to gather and conversation of information. IoT brands daily objects smart by allowing them to share the data and automate tasks, without needful any physical intervention.

IoT is a potential tool towards the target of self-organized, decision making, and automation in the agriculture farming. IoT includes Precision agriculture [5], automated irrigation scheduling, and optimization of plant growth, farm land monitoring and greenhouse monitoring and farming production process management in crops [6].

Gateways

A gateway is a co-operating device over the internet and connects two networks using protocols. It acts as a gate in between networks. It may be a router, firewall, server or another devices permit traffic to movement inside and outside of the network.

A gateway is a hardware instrument that performances as a gate in the middle of dual networks. It may be a router, firewall, server or another device that supports traffic to flow inside and outside of the network. Gateway look after the nodes in the interior network, it also a node itself. Gateways are mainly two types:

- Unidirectional gateways and
- ✓ Bidirectional gateways.

Unidirectional gateways permit alerts to flow in only one direction. Bidirectional gateways can be considered as synchronization tools. It can refer warnings to different targets.

Cloud

Cloud computing is an application-based software. It stores data on remote areas also, which can be accessed through the internet. The cloud computing works can be distributed into front-end and back-end.

Front-end is talk about to as the client-side of the application. The front-end languages are HTML, CSS, and JavaScript. The back-end which is mainly the server-side of the application and back-end languages such as Java, Ruby, Python, PHP and etc.

1.2. Elements of IoT

In IoT, two types of elements are there such as Physical elements and Virtual Elements

1. Physical Elements

Sensors

The ability to detect changes in the physical states of things is essential for recording changes in the environment. Sensors assemble data from their environment, generating data and raising alertness about context. Wireless sensor technology play a energetic role in bridging the gap between the physical and computer-generated worlds and empowering things to answer to changes in their physical environment.

Actuators

An actuator is it is a device that bases motion and it can cause linear or rotary motion. An IoT device is made up of a physical object like thing, controller or processor like brain sensing devices, actuators and internet. An actuator is a device component, it changes or the device. They are linear or rotatory actuators, can move particular angular.

Types of Actuators

- ✓ Linear Actuators
- ✓ Rotary Actuators
- ✓ Hydraulic Actuators
- ✓ Pneumatic Actuators
- ✓ Electric Actuators
- ✓ Thermal and Magnetic Actuators
- ✓ Mechanical Actuators
- ✓ Supercoiled Polymer Actuators

Computing Systems

Computing is procedure of processer technology to complete particular task. It may include the design and development firmware systems for a broad range of purposes often constructing, handling and dealing any generous of data to aid in the detection of scientific studies, making bright systems and creating and using various media for entertainment and communication.

Types of Computing Environments

- Personal Computing Environment
- Time Sharing Computing Environment
- Client Server Computing Environment
- Distributed Computing Environment
- Cloud Computing Environment
- Cluster Computing Environment

Communication Interface

An electronic circuit, usually designed to a specific standard, which enables one machine to telecommunicate with another machine.

2. Virtual Element

Cloud services

Cloud computing defines to read or edit and store over the wireless network. This Cloud technology delivers the security, monitoring and maintaining the data. It is mainly used for an efficient use of resources and price saving. It has high flexibility, ease of access and device liberation. The cloud platform connects devices, apps, services and everything. IoT Protocols

- Infrastructure (ex: 6LowPAN, IPv4/IPv6, RPL)
- Identification (ex: EPC, uCode, IPv6, URIs)
- Comms / Transport (ex: Wifi, Bluetooth, LPWAN)
- Discovery (ex: Physical Web, mDNS, DNS-SD)
- Data Protocols (ex: MQTT, CoAP, AMQP, Websocket, Node)
- Device Management (ex: TR-069, OMA-DM)
- Semantic (ex: JSON-LD, Web Thing Model)

Application User Interface

The user interface (UI) is the point at which human users interact with a computer, website or application. The aim of effective UI is to make easy experience and intuitive, requiring minimum effort part of the users to receive maximum wanted outcome.

User Interface is created in layers of interaction that appeal to the human senses like sight, touch, auditory and etc., They include both input devices like keyboard, mouse, trackpad, microphone, touch screen, fingerprint scanner, e-pen and camera and output devices like monitors, speakers and printers. Devices that interact with different senses are called multimedia user interfaces. For example, everyday UI uses a combination of tactile input like keyboard and mouse and a visual and auditory output like monitor and speakers.

Other types of user interfaces can include:

- Graphical user interface: An User Interface input like key board with a visual User Interface output like monitor.
- Form-based user interface: Used to write data into a program or application by offering a limited selection of choices like a settings menu on a device is form-based.
- Menu-driven user interface: An User Interface uses a list of choices to direct in a program. Automatic Teller Machines use menu-driven User Interface.
- Touch user interface: User Interface through haptics or touch such as smartphones, tablets and any device that operates using a touch screen use haptic input.
- Voice user interface: Interactions in the middle of humans and machines using hearing instructions.
- Internet of Everything which brings together people, process, data and things to make networked connections more relevant and valuable than ever before by turning information into action [7].

2. Block Diagram of an IoT Device

The Block diagram of an IoT Device as shown in figure 1. It consists of many blocks such as

- 1. Cyber CONNECTIVITY
- **2.** CPU
- 3. Physical AUDIO/VIDEO Interface
- 4. Physical Interface to Sensors
- 5. Memory
- 6. GPU
- 7. Storage



Figure1: Generic Block diagram of an IoT Devices

1. Cyber Connectivity

Cyber security is defending the computers, servers, mobile devices, electronic instruments, networks and data from cruel attacks. It's also called as information technology electronic information security.

Cyber security raises to the establishment of new technologies, procedures, performs planned to networks, devices, agendas and data from attack, damage or unofficial access.

2. CPU

The computer's central processing unit (CPU) is the quota of a computer that retrieves and executes instructions. The CPU is essentially the brain of a computer aided design system. It consists of an arithmetic and logic unit (ALU), a control unit (CU) and various registers. The CPU is normally referred to as the processor.

A central processing unit (CPU) also called processor is the electronic circuit. It execute the instructions consist of a computer program. The CPU implements different operations such as arithmetic, logic, controlling and input or output (I/O) operations specified by the instructions in the program.

3. Physical AUDIO/VIDEO Interface

High-Definition Multimedia Interface (HDMI) is a proprietary audio/video interface for transmitting uncompressed video data and compressed or uncompressed digital audio data from an HDMI-compliant source device such as a display controller to compatible computer monitor, video projector and digital television.

4. Physical Interface to Sensors

The internet of things is dominated by protocols like LoRaWAN and 5G, what sort of sensors we might need for a smart building, how might. IoT make a project more efficient etc. When physical interface to sensors comes down to picking, there are a little more things to consider, notably, sensor interfaces. Barely the most glamourous part of an IoT network, they are nonetheless a vital part. We could have the fastest communication protocol in the world and the latest in minute accuracy sensing technology.

A Universal Serial Bus is maybe the most universal example of a sensor interface in regular lifecycle, it plugs in to so many devices and unifies communications in ways that wouldn't otherwise be possible with proprietary interfaces. Generally, in the IoT a sensor interface is a bridge between a device and any involved sensor. The information gathered by the sensor device and outputs it to the attached device like a water level sensor passing data to a radio transmitter. Different interface options vary in complexity. Correspondent interface might use current parameter to carry the information,

whereas SDI-12 be sure of on microprocessors to modernise information. We will cover a few different types of sensor interface in Internet of Things.

5. Memory

Memory mentions to the processes that are used to obtain, collection, recollect and retrieve information. There are three major processes involved in memory: encoding, storage, and retrieval. Mortal memory includes the capability to both preserve and make progress information.

Memory is the personal record of past experiences. It is the brain's ability to store information to use later. There are two types of memory: short-term and long-term memory, or known as working memory and reference memory.

6. Graphical Processing Unit (GPU)

Graphical Processing Unit is one of the specific processor. It is designed to accelerate graphics representation. It can process different type of data at the same time and it is used in machine learning, video editing and gaming applications. The block diagram of Graphical Processing Unit as shown in figure 2 and it consists of

- ✓ Connectivity
- ✓ Communication Interface
- ✓ Network Protocol Stack
- ✓ Device



Figure 2: Block diagram of GPU

The Graphical Processing Unit have of many devices, these are connected with wireless **Connectivity**

The ability to connect or communicate with another device or instrument. The Network connectivity is the processing of connect to the different parts of the network through access points such as routers and gateways.

Different types of Connectivity

- Dial-up Connection.
- > Integrated Services Digital Network.
- > Digital Subscriber Line.
- > Cable TV Internet connections.
- > Satellite Internet connections.
- > Wireless Internet Connections.

Communication Interface

In Communication Interface, some functional characteristics such as code conversions, set of rules and some physical characteristics such as electrical, mechanical and optical characteristics. Types of Communication Interface

1. Recommended Standard (RS)-232

2. Recommended Standard (RS)-485

Network Protocol Stack

Set of rules or instructions is called Protocol. Protocol Stack is two types such as IoT and TCP/IP as shown in table1. In future internet of things, every object or network node must have an IP address and use IP protocol. IPv6 will perform the key role by providing IP addresses to all the smart objects [8].

	IETF IoT Protocol Stack	TCP/IP Protocol Stack
Application Layer	IETF COAP	HTTP,FTP,DNS,SSH,SMTP,NTP
Transport Layer	UDP	TCP,UDP
Network Layer	IPV6,IETF,RPL	IPV4,IPV6
Adaption Layer	IETF 6LOWPAN	NETWORK ACCESS
MAC Layer	IEEE 802.15.4 MAC	NETWORK ACCESS
Physical Layer	IETF 802.15.4	NETWORK ACCESS

Table 1: Network Protocol Stack between IETF IoT and TCP/IP Protocol Stack Device

One thing made or adapted for a particular task, specially a piece of mechanical or electronic equipment. An electronic instrument controlled by the processor, including desktop and laptop computers, smartphones and tablets. It usually refers to a general-purpose **d**evice that can accept software for many purposes in contrast with a dedicated unit of equipment such as a network switch or router.

Applications of IoT: Now a days, The IoT includes everything in the world such as online payments, online classes, online examinations, telemedicine, etc.



Figure 3: Different applications of IoT

O Automative

In this, many industries are used automatic machines by using controlling and monitoring through smart phones or tablets [3,4].

- ✓ Light & temperature control
- ✓ Energy optimization
- ✓ Predictive maintenance

- ✓ Connected appliances.
- ✓ Access control
- O Environmental Monitoring
- \checkmark Temperature measurement and control
- ✓ Humidity measurement
- **O** Medical & Health care systems
- \checkmark Remote monitoring
- ✓ Ambulance telemetry
- ✓ Drug tracking
- ✓ Hospital asset tracking
- ✓ Access control
- ✓ Predictive maintenance

O Transportation

- ✓ Amazon
- ✓ Flipcart
- ✓ Zomato
- ✓ Swiggy
- ✓ Uber

O On line payments

- ✓ Phone pay
- ✓ Google pay
- ✓ Net Banking

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