Implementation of Software Defined Networks in Internet of Things

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Abstract

Internet of Things (IoT) is one most promising technology to bring changes in our daily life, which making our life simpler and comfortable. The aim of the internet of things is to integrate both physical and digital worlds in one single ecosystem with efficiency, scalability, adaptability, flexibility, reliability etc. So, the Internet of Things is referred to as the Future of the Internet. Thus, IoT works on "ANY" paradigm. The internet of things also associated with the number of technologies like Big Data, Cloud Computing, Software Defined Network, Artificial Intelligence and so on. But the internet of things used Software Defined Networking for restructuring the current network infrastructure which increase the efficiency of the network. SDN help to reduces the complexity of the network management. Companies like Google and Amazon are become a main hub of this revolutionary of the concept because the Software-Defined Networks provide the facility of programmability, adjustable and dynamically reconfiguration of the networking devices

Keywords: - IoT, IIoT, SDN, AI, M2M, API

1. Introduction

In Digital world, Technology and Innovation go hand to hand. The Computer Science and Applications field is related to technology, in which every day has a lot of innovation and updating in the existing technologies. At present, the internet has great significance in the life of a human being. If we are imaging our life without the internet, it becomes tough to manage our daily routines. So that many researchers have performed a lot of researches work in this field. Now in these days, most trending and currently demanding area of technology is the Internet of Things.

Internet of Things (IoT) is one of the best technologies which make our daily life more straightforward and comfortable. Thus, the Internet of Things is the next biggest boom in the networking field because it connects daily used objects to the internet, with or without a human. At present, there is no universal definition of the internet of things [1]. The meaning of the internet of things is varying according to researcher view. Sensors and actuators are embedded with in the physical devices to convert these devices into smart devices. These smart devices generated a huge amount of data and communicate this data over a communication medium.

1.1. Basic Components of the Internet of Things are: -

- ❖ Sensors
- ❖ Connectivity
- ❖ People and Processes

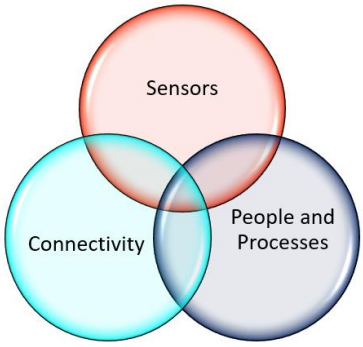


Figure 1: Basic component of IoT

1.2. Essential Characteristics of the IoT: -

Some essential characteristics of the Internet of Things are given below: -

1. **Interconnected:** To provide interconnection facilitates between people to device and device to device.
2. **Smart Sensing:** IoT devices must have smart sensing capabilities.
3. **Save Energy:** IoT devices have motion detectors to senses movement for energy saving.
4. **Intelligence:** IoT devices must have intelligent interfaces to connect other devices efficiently.

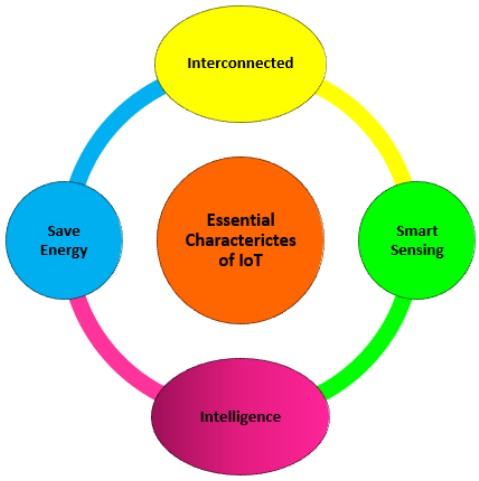


Figure 2: Essential Characteristics of the IoT

Thus, IoT provides a dynamic global network infrastructure with self-configuration capabilities. So IoT works on "ANY" paradigm, i.e., anyone, anything, anyplace, anywhere, anytime connected to each other and provides any services [2].

Figure 3: "ANY" paradigm in IoT

Therefore, the Internet of Things provide a new dimension in which any time, any place is connecting to anyone in this digital world.

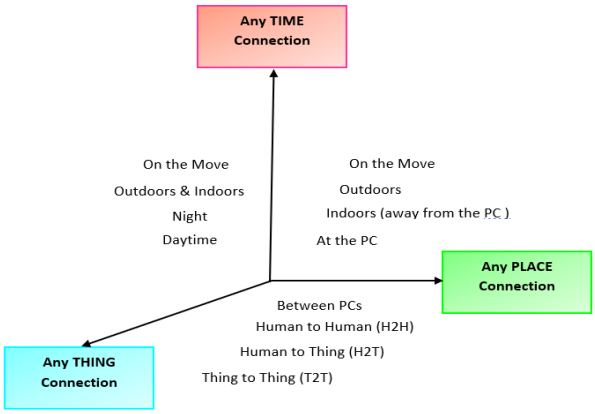


Figure 4: New Dimension of IoT

The internet of things provides a lot of convenience in our life, we just need to understand the architecture of the internet of things which is divided into three layers, the names of these layers are: -

1. **Perception Layer:** Perception Layer is the lowest layer in the IoT architecture, which is related to physical IoT sensors and actuators, how they performed measurements (like temperature and humanity etc.) and corresponding different functionalities.
2. **Transportation Layer:** Transportation Layer which mainly concerns how to transmit the information which is received from perception layer to particular network using various communications technologies like 3G/4G, Wi-Fi, RFID, Bluetooth, ZigBee, NFC, etc. It is also called the middle layer.
3. **Application Layer:** Application Layer is the topmost or upper layer in the IoT architecture, which provides various services to a user according to their requirements. The importance of this layer in IoT is that it provides smart and high-quality services to the customers.

The Life Cycle of Internet of Things has mainly followed four steps are: -

1. **Collection:** The data generated at various IOT devices are collected using sensors.
2. **Communication:** Data will be communicated to some destination through networks.
3. **Analysis:** After analysis of the data, required information is generated.
4. **Action:** Based on the information proper action will be taken.

1.3. Emerging Technologies in IoT/ IoT and its associated Technologies:

Large number of technologies associated with the internet of things are: -

Cloud Computing: Cloud computing technology comes with a new model to provide any where any time access to the services of cloud. This model is based on parallel computing and grid computing models used previously.

Fog Computing: Fog Computing is a term coined by the CISCO. It acts as intermediate layer between cloud and devices which help to problems faced by the IoT devices during the data processing.

Artificial Intelligence: Artificial Intelligence becomes an essential part of the technology industry because it is branch of computer science that is mainly concerned with automation of intelligent behavior that aims to create intelligent machines. Machine learning is also an essential part of AI, which provides systems to capability of automatically learn and improve from experience without explicitly programmed.

M2M: M2M is refers to communications and interactions between machines and devices. M2M is a team introduced by telecommunication services providers which emphasis on machines interactions via one or more communication networks.

SDN: The Internet of Things restructuring the current/traditional network infrastructure whose name is Software-Defined Networks (SDN). The SDN is a very important technology which offer lot of potential uses in the field of internet of things, because it increases the efficiency of the network significantly.

1.4. Applications of Internet of Things (IoT)

Internet of Things enables us to a lot of improvements in applications of various fields such as healthcare, smart cities, manufacturing, smart grids, smart homes, transport, etc [1,2]. In these applications, IoT gets 100% popularity in Smart homes application.

Smart Grid: Electric energy has a vital role in the industry economic development. Smart grid technology work behind the electricity distribution line, which provide optimization of electricity production line into the account of user demand throughout the electricity distribution line.

Smart Healthcare: Smart Healthcare plays a significant role in the health care applications. Physiological status of a patient can be monitored through the IOT devices and the information can be transmitted to the physician in real time.

Intelligent Transportation System: Next generation of transportation system is represented by Intelligent Transportation System (ITS). The embedded systems through various communication technologies develop vehicular networks of people, road and vehicles are connected together to reduce the accident and other problems due to large traffic volumes on the roads.

Smart Cities: Today, smart cities consider as one of the most important application of the IoT to significantly improve the living standard. To create a smart city, sensors are used to collect data from various sources and the data will be used to avoid different types of incidents.

Manufacturing: The Internet of Things can also be used to make automate process of manufacturing and control of the production chain in industries. New technologies such as Machine to Machine (M2M), Wireless Sensor Network (WSN), automatization technologies as well as Big Data are used in Industrial internet of Things (IIoT), which create an intelligent industrial ecosystem.

Education: In education field, the IoT also developed several innovative applications that can improve the quality of education, to make learning more agile, offer communication channels for global students and assist disability pupils and many more. The modern technologies like IoT also deliver an interactive learning experience.

Smart Homes: IoT gets 100% popularity in Smart homes applications, because it reduces cost and conserve energy. IoT enables house equipment's more intelligent, remote controllable and interconnected through various apps.

Smart Billing and Payment System: The IoT sensors are used to tally the purchases in a customer's cart and sending the data to a cloud- base billing and payment system. There is no need to customer to stand and wait in the queue for checkout and billing. Customers can pay the bill through a payment apps on their smartphones.

2. Challenges of IoT

In perception layer has a lot of risk factor involve as compare transportation layer due to hardware limitations and technology heterogeneity but transportation layer has faced major limitation regarding lack of standard wireless data transfer technology [3,4]. Finally, the application layer has involved the variable level of risk which is depending on specific application use. So, the Internet of Things has faced or suffers a lot of challenges are: -

1. **Resource Limitations:** IoT devices has limited memory, low computation capabilities, and high battery consumption.
2. **Mobility:** In IoT devices have sensors and actuators which embedded human bodies which are generally mobile, i.e., move from one place to other.
3. **Heterogeneity:** When communication between different networks over internet use different protocols, technologies, and standards.
4. **Scalability:** As the number of IoT devices are connected over the internet must have a better internet connection, bandwidth, etc.
5. **Code Management:** Reprogramming in code is difficult when the location of the device is updated.
6. **Data Storage:** Due to limited memory it is difficult to store huge amount of data.
7. **Interoperability:** Various companies use different platforms and frameworks therefore integration of devices is not easy.

To resolve these challenges in IoT by using Software Defined Networking which supports real-time specification and increases network performance and efficiency by the implementation of flow-table. Thus, SDN help to reduce the complexity of the management.

Because the Internet has created a digital society in which everyone wants to connect to know what is happening in this digital world. So that many researchers have performed a lot of researches work in this field.

When the network users rapidly change the demand of the network resources then Software-Defined Networks (SDN) is quickly satisfy their needs as so as possible. Thus, we can say that network innovations provide a position to the SDN as the forthcoming of networking. The Software-Defined Networks provide a novel paradigm architecture to achieve new innovation in the networking field by decoupled the control plane from the data plane. The Software-Defined Networks provide the facility of programmability, adjustable and dynamically reconfiguration of the networking devices. Thus, SDN offer the flexibility, centralized view control, decrease the complexity as well as decrease in the cost of the network systems.

3. Software-Defined Networks (SDN)

Software-Defined Networks provide a novel paradigm to achieve new innovation in the networking field by decouple the control plane from the data plane. The SDN provide capability to the enterprises and the service providers, with a motive to improve the control of the network, so that they can do fast response to the changing business needs [5]. The Software-Defined Networks provide the facility of programmability, adjustable and dynamically reconfiguration of the networking devices. Thus, SDN offer the flexibility, centralized view control, decrease the complexity as well as decrease in the cost of the network systems [6]. The novel network paradigm of SDN is more flexible than the traditional network. At present many well-reputed companies such as Google, Telekom, Verizon, Microsoft, Cisco, HP, IBM, Samsung etc. adopted and support it. The Software-Defined Networks (SDN), has mainly consists of three planes (layers) are:

- **Data Plane**

In data plane mainly consist of forwarding devices such as routers, switches which are connected to each other. These forwarding devices act as the simpler forwarding elements due to the decoupling between the control and data plane. The behaviour of forwarding devices is dictated by the controller. The data plane or Infrastructure layer has responsibilities for the data forwarding as well as monitoring information and gathering statistics.

- **Control Plane**

The control plane act as the "Network Brain", because it provides a logically global view of the entire network. The controller has capability to configure or reconfigure the forwarding devices by customizing their policies in the dynamic manner. Thus, it is most crucial part of the SDN paradigm. The control plane act as an intermediate between the application plane and the data plane.

- **Application Plane**

In the application plane, various networking applications are implemented which control the logic of entire network. A controller is used to run these applications. The communication between the application and control plane is possible through the northbound APIs, which request the network state and also provide facility to manipulate the services.

3.1. Difference between Traditional Network and Software Defined Network

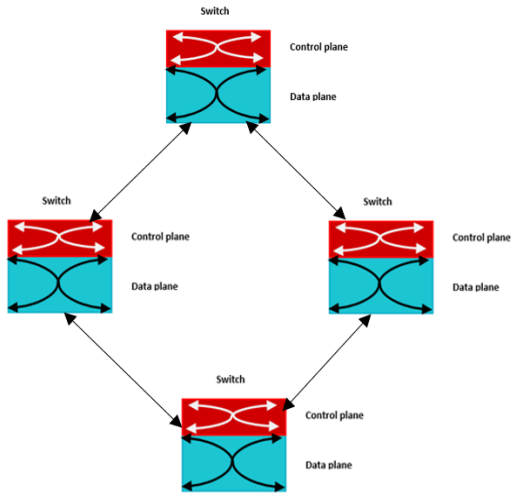
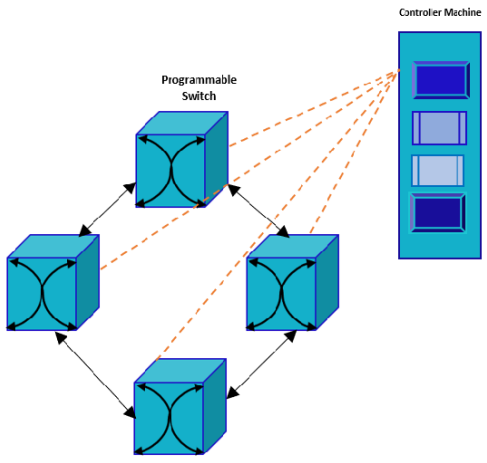
Traditional Networks	Software- Defined Networks (SDN)
Hardware-based networks.	Software-based networks.
Vertically integration exist between the functional components.	Splitting the vertically integration between the functional components.
Traditional networks maintain routing table in every switch.	SDN maintain flow table at every switch.
Does not provide centralized control.	Centralized control provided by the controller.
	

Figure1: Traditional Networks versus Software-Defined Networks

Conclusion

Internet of Things is referred to as the future of the internet to integrate both physical and digital worlds in one single ecosystem with efficiency, scalability, adaptability, flexibility, etc. IoT provides intelligent collaboration with devices anytime and anywhere. So IoT makes our life easy and secure to sharing information between interconnected devices. Thus, IoT is easily adopted by users. But the Internet of Things has suffered those challenges can be resolve by using Software Defined Networking which increases network performance and efficiency as compares traditional network. Thus, SDN help to reduce the complexity of the management and also SDN offer the flexibility, centralized view control, decrease the complexity as well as decrease in the cost of the network systems.

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