A Recent Review on Application Layer Protocols for Internet of Things

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***Abstract*: The term Internet of Things (IoT) was introduced more than two decades. Also, so many researchers and research groups put their excellent effort, but it is not yet completely standardized. Nowadays, various IoT platforms were introduced for various applications. The new IoT platform uses technology, which partially satisfies the IoT requirements. The developer and research groups use the protocol to establish the communication from one physical device to another physical device. In this paper, we present the various application protocols in IoT. Finally, we provide the conclusion of the IoT application layer protocols.**

***Keywords*: Internet of Things, Application Protocol, Constrained Application Protocol.**

1. Introduction:

The IoT is an emerging technology, which provides various solutions in different domain. In 2020, the number of devices is expected to connect around 50 billion devices on the Internet [1-3]. The standard definition of IoT defined as "collection of inter-connected devices is connected to the Internet that able to communicate to other devices without human intervention. Nowadays, IoT can be used in numerous field such as smart farming, smart healthcare, smart home, smart building, smart logistics, smart connected cars, etc [4-6].

Fig.1 shows the general architecture of IoT. Generally, the IoT system consists of things, connectivity, storage and application. The things part contains various sensors and actuators namely, temperature, humidity, soil moisture, buzzer, burglar alarm, etc. the connectivity part contains the Wi-Fi, Bluetooth, cellular network, Zigbee and LoRa, etc. The storage part contains the local database or online cloud storage. The cloud computing is a technology, which provides the services on-demand basis. It provides the following services, namely Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS). The application layer provides the interface between storage layer and user. In application layer, we can use web application or mobile application to see the real-time sensor data [7,8].

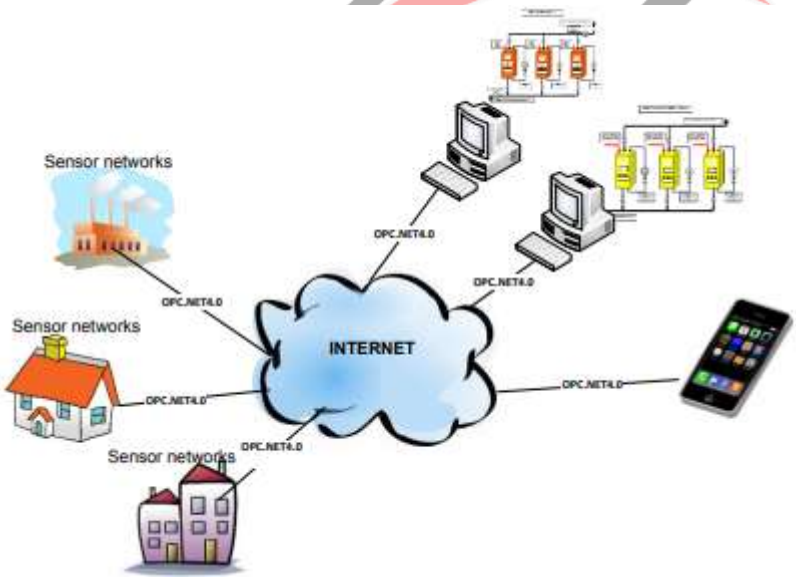

Fig. 1 General Architecture of IoT

Generally, the researchers were introduced as three-layered, four-layered, five-layered and seven-layered architecture. Fig. 2 depicts the three-layered architecture that consists of physical, network and application layer. The physical or sensing layer contains the sensor and actuators. Usually, the sensors sense the data and it transfers the data to the network layer. The network layer offers two types of communication, namely wired and wireless communication. The wired communication can use Ethernet for establishing the communication between the devices. The wireless communication can be used the wireless technologies like cellular, WiFi, etc. The application layer receives the data from the sensors and it will be displayed to the user.

Fig.3 depicts the four-layered architecture that consists of physical, network, service and application layer. The sensors and actuators are connected in the physical layer. The sensor values are transmitted to the local database or online cloud storage in the service layer through communication medium. We can write our own services in the services. Finally, the respective data can be viewed in the application layer.

Fig.4 depicts the five layered architecture that consists of physical layer, network layer, service layer, application and business layer. Actually, the five layered architecture is followed from the four layered architecture and additionally considered the business layer for improving the productivity and checks the accuracy [9]. Fig. 5 depicts the seven layered architecture that contains physical layer, connectivity layer, global infra structure, data ingestion, data analytics, application layer and people and process layer. In physical layer, variety of things is connected to the internet that is called the end point of IoT system. The connectivity layer establishes the connection between the devices. The global infrastructure deals the cloud infrastructure for storing and retrieving the sensor readings. The data ingestion is the entry level of data to form a big data in the IoT system. The data analytics is a process of represent the data in the form of statistics and visualization, etc. Application layer is responsible to display the sensor reading from the cloud storage. The people and process layer deals the automatic decision making among the IoT devices and also make the business model to verify whether the system is providing accurate reading or not? Also, analyze the strategies for improving the business growth [10-12].

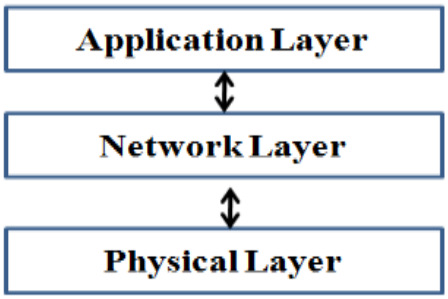

Fig. 2 Three Layered Architecture

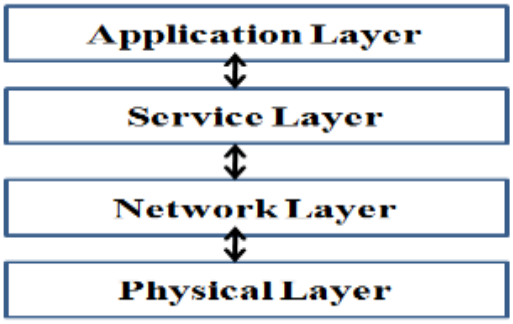

Fig. 3 Four Layered Architecture

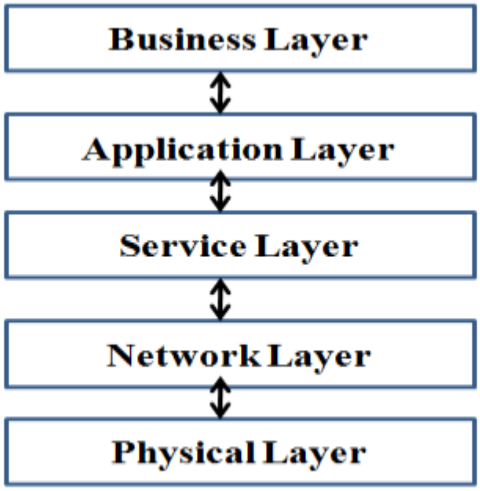

Fig.3 Five Layered Architecture

Fig. 4 Seven Layered Architecture

The routing is a process of forwarding the data from the source to the destination node. In IoT, the routing process is classified into three types, namely protocol operation, network organization and route discovery. The network structure is based on how the nodes are deployed and how the nodes are interconnected in the network. The protocol operation is based on routing characteristics like communication, delivery methods, computational capacity, etc. The route discovery is a process of maintaining the route information from source to the destination. Again, it is categorized into three types, namely proactive, reactive and hybrid routing protocols. IPv6 routing protocol for low power and lossy networks (RPL) is a routing protocol, which is standardized by the Internet Engineering Task Force (IETF) [12,13]. The rest of the paper is discussed about various IoT application layer protocols. Finally, section 3 presents the conclusion of the paper.

2. IoT Application Layer Protocols

This section discusses various application layer protocols in IoT. In most of the IoT application uses the application layer in the form of the web application. Moreover, it uses TCP or UDP protocol in the transport layer. In the application layer, the important protocols are constrained application protocol (CoAP), message telemetry transport (MQTT), advanced message queuing protocol (AMQP), extensible messaging and presence protocol (XMPP), data distribution service (DDS) [14].

2.1. CoAP

CoAP stands for constrained application protocol, which can be used for highly resource-constrained devices. It is an alternative solution for hypertext markup language (HTTP). It has a request and response model for providing the services among the IoT devices. CoAP is a prominent application protocol, especially for IoT [15]. The important features are the following.

i. CoAP protocol run over the UDP.
ii. It has four bytes header, which provides the reliable data delivery.
iii. It supports 4 messages, namely confirmable, non-confirmable, Acknowledgement and reset.

2.2. MQTT

MQTT is one of the application layer protocols, which was developed by IBM in 1999. It supports publish/ subscribe architecture, which is similar to client/ server architecture. The advantage of MQTT is simplicity and lightweight protocol. It supports a wide range of IoT applications. Also, it provides TLS/SSL security in the transport layer [16].

2.3. AMQP

The AMQP protocol is suitable for the financial industry. Also, it provides the TLS/SSL security in the transport layer. It's run over the TCP protocol. It follows the publish/subscribe architecture for transferring the message from one device to other devices [17].

2.4. XMPP

XMPP is suitable for chatting applications, which was standardized by IETF. It has publish/ Subscribe architecture and also follows the request/response model for providing reliable communication among the IoT devices. But it is not suitable for M2M communication-based applications [18-50].

2.5. DDS

DDS is one of the application layer protocol, which was developed by the object management group (OMG). It is especially suitable for M2M communication. It has two layers, namely data-centric publish/ subscribe and data local reconstruction sub-layers[51-93].

3. Conclusion

The term Internet of Things (IoT) was introduced more than two decades. Also, so many researchers and research groups put their excellent effort, but it is not yet completely standardized. Nowadays, various IoT platforms were introduced for various applications. The recent IoT platform uses technology, which partially satisfies the IoT requirements. The developer and research groups use the protocol to establish the communication from one physical device to another physical device. In this paper, we presented the various layered architecture, routing protocols. Finally, we discussed different popular application protocols in IoT.

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