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Study and Review on Advanced Application Layer Protocols in IoT

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Abstract— **Internet of Things is advance feature in Communication and information Technologies, providing facilities of global connectivity and management between the sensors, devices, users and information. A typical architecture of IoT consist of sensor nodes which collects the data, Gateway which processes the data and a cloud which stores the data. IoT the devices are resource constrained that is devices run on low power and they have less memory and processing power. Hence, the protocol stack used in IoT communication is consisting of protocols optimized for running on resource constrained devices. In this paper, dealing with the protocol used in the communication between IoT devices. Here, we analyze the advance application layer protocols used in IoT protocol stack and measure the performance. The one of the latest advance protocol introduced in IoT domain is HTTP2.0 which has enormous potential to be become as useful as other legacy protocols used by IoT developers. Hence, analyze the protocol and find out the suitability of this protocol in IoT domain as compared to other existing protocols.**

Keywords— **IoT, HTTP2.0 , MQTT, COAP, REST, Application Layer Protocols, Performance**

I.INTRODUCTION

The Internet of thing is network of everyday things. IoT is the inter-networking of physical devices, vehicles (also referred to as "connected devices" and "smart devices"), buildings, and other items embedded with electronics, software, sensors, actuators, and network connectivity which enable these objects to collect and exchange data. IoT refers to the networked interconnection of everyday objects which are often equipped with electronic circuits and sensors. In the IoT sense, these objects can refer to a wide variety of small devices embedded with electronics, software, sensors and network connectivity often integrated into larger systems. The application layer protocol available today are geared towards the M2M communication role, namely REST (Representational State Transfer), MQTT (Message Queuing Telemetry Transport), and CoAP (Constrained Application Protocol), XMPP(Extensible Messaging and Presence Protocol), AMQP(Advanced Message Queuing Protocol). IoT systems must be able to cope with potentially unreliable, intermittent, and low bandwidth connections for its access networks. IoT offer connectivity between devices,sensors, and services that use machine to machine communication and cover protocols in that use in IoT. A survey by the Eclipse IoT working group queried IoT developers about the protocols and technologies they are using and planning to use.

- MQTT 52 % developer
- CoAP 21 % developer
- HTTP1.1 61 % developer
- HTTP2.0 19 % developer

IoT architecture has not much clearly defined and have no agreement for protocol and standard. While developers employ existing technologies to build the IoT, research groups are working on adapting protocols to the IoT in order to optimize communications. IoT domain protocol stack is similar to the web domain except the protocols involved are optimized to run on the resource constrained devices. The major application layer protocols which are used in IoT domain are COAP, MQTT and REST Full (based on HTTP1.1). Lately, IETF has released more advanced HTTP/2 protocol in 2015 for web domain. From literature of HTTP2.0 it can be seen that this protocol is a good match for IoT for several reasons: Binary and Compact (9 byte header), Header Compression [RFC7541], More efficient formats, Support of RESTful model in major development frameworks. The feasibility study of HTTP2.0 protocol may lead to find out the suitability of this new protocol for IoT scenarios and may help in making it more popular amongst IoT developers.

In order to improve performance of protocols in IoT various protocol performance reconsidered IoT architecture the major devices used are sensor nodes, Gateway to aggregate the data and cloud to store the data. Different application layer protocols are

used to handle the communication between the gateways, the public Internet, and the final applications. These are the application that are used to not only update online servers with the latest end-device values but also to carry commands from applications to the end-device actuators. These Internet-specific IoT protocols have been developed to meet the requirements of devices with small amounts of memory, and networks with low bandwidth and high latency. The performance of the protocol is measure using various metrics like payload vs bandwidth consumption, round trip time, energy consumption and overhead. The feasibility study of HTTP2.0 protocol(against existing protocol) and find out header compression method of HTTP2.0 that may lead out the suitability of this new protocol for IoT scenarios and may help in making it more popular amongst IoT developers.

The rest of the paper is organized as follows: Section II provides an related work. Section III presents the proposed solution while section IV finallyconcludes the paper.

II. RELATED WORK

Mohamed et .al[1], proposed the A comparative study between different M2M protocols. Different M2M protocols used for M2M (Machine to Machine) communication and device management. The comparison is based on supported functions, network overhead, network reliability and security beside highlighting the different protocol architecture. communication based CoAP is providing very small network overhead beside laying on DTLS for security which is designed especially for constrained devices and provide the same security services as TLS. MQTT is based subscriber/publisher architecture and provide tiny network overhead. XMPP uses XML for data communication. This put overhead on the network for not supporting binary formats. Device management protocol OMA DM protocol is originally designed for smartphones which are not so limited in resources like M2M devices. The OMA published another standard for the LwM2M which is lighter than OMA DM. LwM2M works over CoAP and both provides a coupled protocol for both communication and Device management. Result include which protocol are efficient for M2M communication.

Dinesh Thangavel et.al[2], proposed the performance evaluation of MQTT and CoAP via a Common Middleware. They have design and implemented common middleware interface that supports protocols MQTT and CoAP. One way for wireless sensor networks to transfer data from a gateway to clients is the publish-subscribe architecture. For the performance of MQTT and CoAP are most commonly use protocols for gateway-to-backend data transport. Performance of protocol is based on various network condition. Two protocol are CoAP and MQTT proposed for gateway to server communication and developed common middleware has some features 1] extensible support for existing and various gateway to server transport protocol. 2] common API that provide common programming interface access functionalities of underlying protocols. 3] Adaptive that middleware can decide on the protocol employ on constraints. Performance of protocol are measure in term of delay and total data transfer per message(byes). Total data transfer per message is indicator of badwidth used by protocol. Delay is difference between time when file is received and time when file is published. Experimental result shows MQTT has lower delay for lower packet loss than CoAP and higher delay for higher packet loss than CoAP. When message size is small and loss rate is less than or equal 25% then CoAP generate minimum traffic than MQTT.

Upendra et.al[3], proposed the empirical study of application layer protocols for IoT. The application layer protocols used are key drivers of internet traffic. Appropriately chosen protocols can reduce network traffic, improve reliability. They have measured the performance of three application layer protocols, Constrained Application Protocol (CoAP), Message Queuing Telemetry Transport (MQTT) and REST (Representational State Transport). Performance is measured experimentally and taken in terms of bandwidth consumed and time taken. Two different networks are used: cellular 4G and High-speed broadband connection. Results show that CoAP is best performer in term of time and bandwidth for small payloads and performance decreases when payload size increases. MQTT takes large time for smallest payload. Bandwidth consumption remain same for both broadband and 4G network. Time required for upload and dowanload is changes for 4G and broaaband network and4G network takes least and double time sometimes 5 times more than broadband network.

Vasileios Karagiannis et.al[4], proposed a Survey on Application Layer Protocols for the Internet of Things. The Representational State Transfer (REST) is not really a protocol but an architectural style. It was first introduced by Roy Fielding in 2000, and it is being widely used ever since. REST uses the HTTP methods GET, POST, PUT, and DELETE to provide a resource-oriented messaging system where all actions can be performed simply by using the synchronous request/response HTTP commands.

I.Hedi et.al[5], proposed IoT network protocols comparison for the purpose of IoT constrained networks. MQTT is a many-to-many communication protocol for exchanging messages between multiple clients. CoAP network is primarily a one-to-one protocol for transferring state information between client and server. CoAP runs over UDP which means that communication overhead is significantly reduced. If constrained communication and battery consumption is not an issue, RESTful services can be

easily implemented and interact with the Internet using the worldwide HTTP. Finally, proposed system involves implementing MQTT, CoAP and REST protocols in a lab environment and obtain an experimental comparison among them.

S. Loreto et.al [6], proposed H2oT: HTTP/2 for the Internet of Things. Various goals and optimization aspect related to HTTP2 are defined. HTTP2 provides various features that support for IoT domain such as Binary and Compact(9 byte header), Header compression[RFC7541], Traversal past firewalls/middle boxes via TLS over port443, Support of RESTful model in major development frameworks. HTTP/2 has settings that can improve its performance for IoT applications by reducing bandwidth, codespace, and RAM requirements. For Constrained and Internet scenarios, it is assumed that HTTP/2 runs over TLS.

R. Peon et.al [7], proposed HPACK: Header Compression for HTTP/2. HPACK is header compressor, a format use in efficiently represent HTTP headers in the HTTP/2.0. Format defined various header trades that are used in header compression. Experimental result shows header compression and decompression mechanisms.

Robby Simpson et.al [8], proposed HTTP/2 and the Internet of Things. HTTP/2 also encourages each client/server pair to use a single TCP connection. Individual requests and their responses are sent in streams over this connection. HTTP2.0 provides features such as binary message framing, server push mechanism, header size negotiation, windowing.

Yassein et.al [9], proposed Application Layer Protocols for the Internet of Things: A survey. IoT involves interaction between multiple devices, things and objects. Interaction opens different directions of enhancement and development in many fields, such as architecture, dependencies, communications, protocols, security, applications and big data. The internet of thing builds effective communication between devices and build sustained bond among different types of applications. Choosing protocols for application and environment since constraint communication environment that run on low power RESTfull services are efficient for that constraint network , MQTT protocol are good choice for large volume of payload. Analysed a protocol performance are best in specific scenarios and bad in another scenarios.

M. Belshe et.al[10], proposed Hypertext Transfer Protocol Version 2 (HTTP/2). Detailed features of HTTP2 are described such as HTTP request/response, server push mechanism, frame format, stream and multiplexing, header compression and decompression. Header compression is stateful. One compression context and one decompression context are used for the entire connection. A decoding error in a header block MUST be treated as a connection error. A "stream" is an independent, bidirectional sequence of frames exchanged between the client and server within an HTTP/2connection.

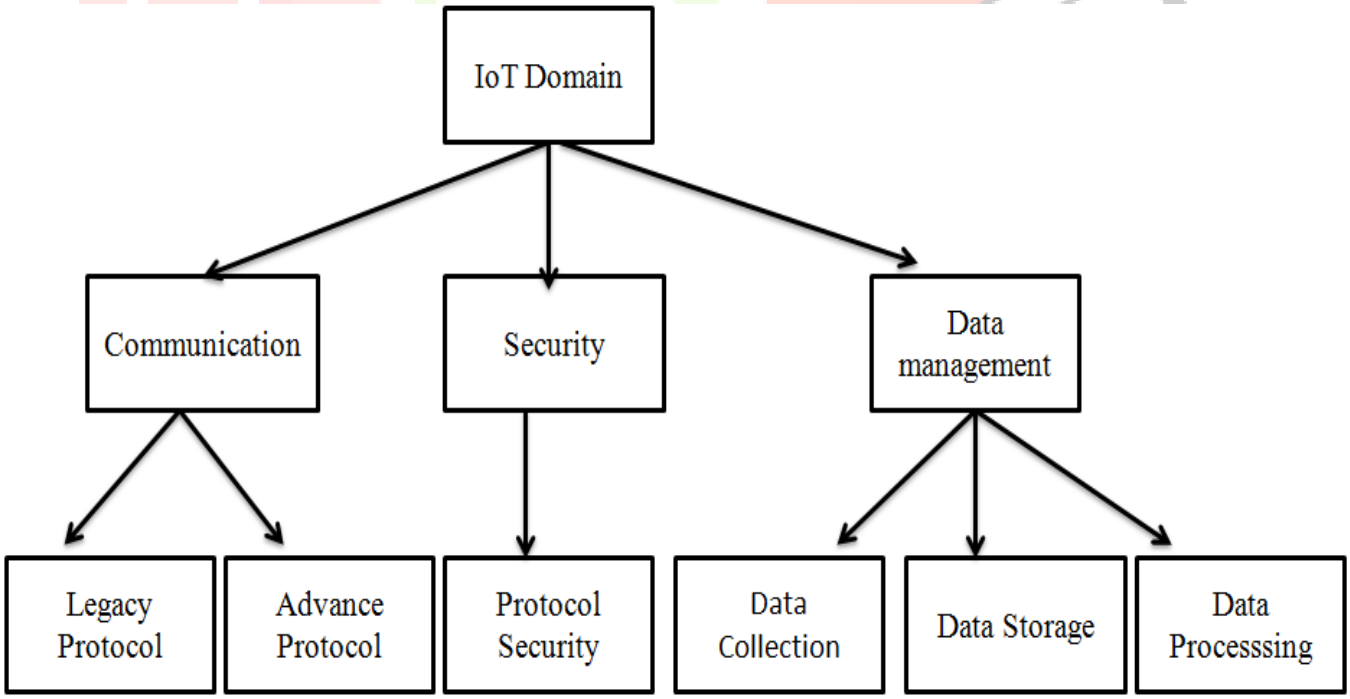

Fig: Structure of Literature survey

III.PROPOSED SOLUTION

IoT protocols are developed to meet the requirement of devices which as small memory, low network bandwidth and high latency. Typical IoT architecture consist of Sensor nodes, Gateway and Cloud. Data is collected from node. Nodes are sensors, Infrared and Bluetooth. Collected data is then aggregated at gateway. Gateway is then process the data and transfer data to the cloud. This data is then further accessed by various client. For example, in case of room temperature monitoring application in IoT, various nodes i.e. temperature sensors are installed in the various parts of the room. These nodes are connected to one common gateway. Typically, gateway is small scaled device e.g. raspberry pie or it may be a ATMEGA microcontroller. Gateway then aggregates the data and passes it on to the cloud where it gets stored. Anyone who wants to find out the temperature can connect to the cloud and see the temperature.

The majorly used devices in the IoT are node, gateway and cloud. Based the different type of communication taking place in IoT there are two types of the IoT architecture viz. constrained network scenario and Internet scenario.

- Node to Node - A constrained node engages in direct communication with another constrained node.
- Node to Gateway - A constrained node and a gateway node engage in direct communication. A gateway node is directly on both a constrained network (e.g., a lowpan) and on a non-constrained network (a normal network using mainstream stack implementations, typically connected to the Internet).
- Gateway to Cloud - A gateway node (see above) engages in communication with unconstrained networks, typically a cloud service on the Internet.
- Node to Cloud - node on a constrained network engages in direct communcation with unconstrained networks, typically a cloud service on the Internet.

Architecture

In proposed system, the actual data collected from nodes is passed to the gateway. Here the data generated is very high in volume as sensor nodes senses the data periodically and is sent to the gateway. On gateway the data is aggregated and is converted to the proper format for sending it to the cloud for storage. The data is sent to the cloud where it is stored. As the data transferred on the network is between constrained devices the protocol used here are optimized for minimum usage of the resources. The application layer protocol in IoT are designed specifically run on the resources constrained devices. These protocols are COAP, MQTT and HTTP1.2. The advance protocol which is introduced in the IoT domain in the HTTP2.0 protocol. The performance of the protocol varies based on the various factors but to limit the scope this project deals with the bandwidth consumed by the protocol against the payload it is transferring. Thus the performance is calculated based on the payload vs bandwidth result. This is specific factor is being used because these two factors viz. bandwidth consumption against payload is most commonly responsible for the protocol in IoT domain.

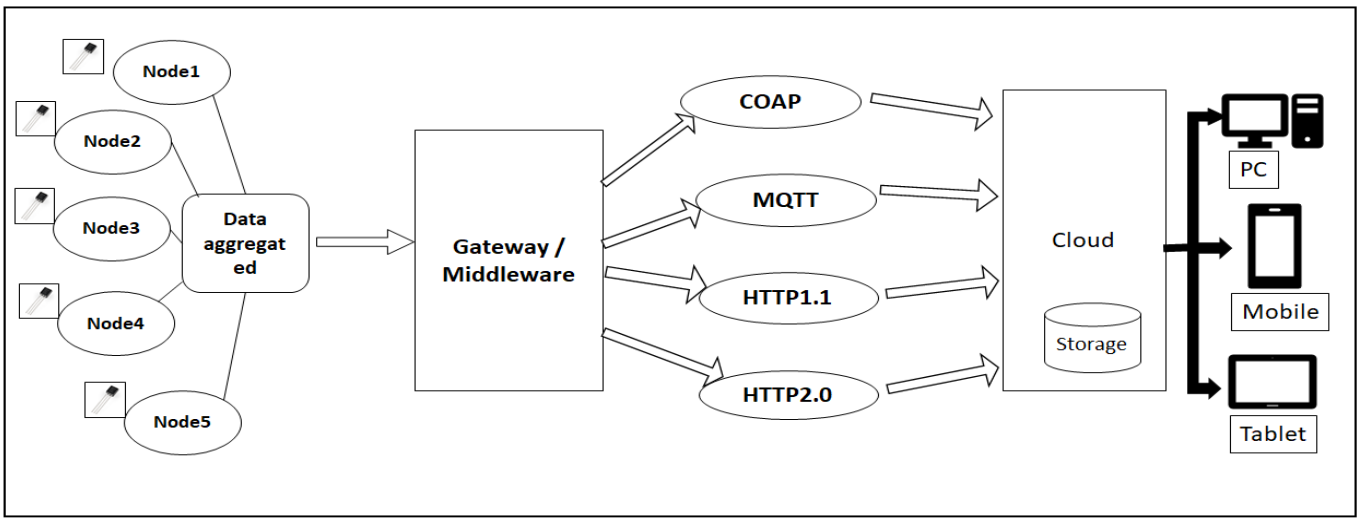

Fig: IoT architecture

IV.CONCLUSION

The Internet of Things seems to have evolved largely with the advent of new technologies in the communication area, but still finding the suitable application layer protocol remains the challenge for IoT developers. Currently developers are majorly preferring to most commonly used protocols i.e. MQTT, CoAP , REST protocols. The newly available advance protocol in IoT application layer i.e. HTT2.0 is still not much popular amongst IoT developers. Looking at the new features added in HTTP/2 makes it prominent replacement for existing protocols. Some of the such features are –binary, fully multiplexed, header compression, server push mechanism. In proposed system performance is evaluated for advance protocol HTTP2.0 against the existing protocols viz. MQTT, CoAP and REST. Performance of protocol is calculated based on the parameters payload against bandwidth. Round trip time and bandwidth consumption are considered for performance measurement. Header compressor HPACK introduced in HTTP2.0 protocol helps to remove redundant header fields, limits vulnerability to known security attack ,and has a bounded memory requirement for constrained network. The biggest challenge faced by IoT developer for using HTTP/2 is the implementation support in the programming language but with the advent of programming languages HTTP/2 will be supported by almost all programming languages.

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