Proposed Interoperable Reliable & Scalable Iot Architecture Implementing To Education Sector

Simmi Chawla[1] , Parul Tomar[2] , Sapna Gambhir[3]

[1]Research Scholar, Department of Computer Engineering JCBUST, YMCA, Faridabad, Haryana-121006 Simmichawla15@gmail.com
[2]Associate Professor, Department of Computer Engineering JCBUST, YMCA, Faridabad, Haryana-121006 ptomar_p@hotmail.com
[3]Associate Professor, Department of Computer Engineering JCBUST, YMCA, Faridabad, Haryana-121006 sapnagambhir@gmail.com

The Internet of Things (IoT) technology is ubiquitous, but increasingly complex and diverse. There are multiple vendors and suppliers are available, hence communication and coordination between heterogeneous devices is problematic due to lack of standardized interoperability. The systems were employed separate, proprietary protocols, not able to communicate each other smoothly. With the increased emphasis on information and communication technology in education sector there is a tremendous need for the integration of systems. Today, IoT is the biggest game-changer in the education industry. It allows cyberspace communications to happen between various objects, sensors, controllers and actuators, has revolutionized the education system entirely. An Interoperable scalable and reliable architecture based on MQTT is proposed for seamless communication on the top layer, an Application layer at the network stack. Due to heterogeneity in terms of data formats, protocol specifications and structure seamless integration is needed. In order to check the reliability, QoS, scalability and performance, interoperability testing is performed to monitor efficiency in this dynamic real-world environment.
The graphical interface supports configuring messages and provides an integration of faculty, staff, students, and parents via messaging system using MQTT protocol which offers lots of advantages to IoT ecosystem.

Keywords: IoT, Interoperability, seamless integration, MQTT, education.

Introduction:

The internet of Things (IoT) in education simply means to build smart solutions for educational environment as opportunities for IoT based applications are continue to expand. Today, various IoT devices are being used by universities, colleges and schools [1]. IoT applications offers smart and safe learning environment for the students but Student needs engaging and challenging learning experiences and teachers need advance tools to meet student needs. Interoperability is the major obstacle which is not easy to attain, indeed it requires standardization. The Australian National Schools Interoperability Program (NSIP) attempts to establish a 'industry backed standard used to link together data systems within the education sector'. The development of a 'standard' for interoperability is pushed as a basis for enabling school systems to interact and share data efficiently, securely and cost effectively, independent of the application and technological platform [3].

The Application layer is the highest layer in the IoT architecture which is responsible for data presentation, integration and formatting. Typically it is based upon HTTP protocol but due to large parsing overhead and heavyweight there is another popular protocol MQTT is used which is lightweight and used for M2M (machine to machine) communication. The major challenge comes in IoT to ensure effective communication

among different objects and establish a path to access all heterogeneous applications at the same platform or protocol.

For the improvement of access to instructional materials and learning resources, online performance evaluation, product & service integration in the educational environment, interoperability is necessary. [4]. Keeping these things in mind, this paper elaborates the followings:

- The need for the interconnection and integration of heterogeneous platforms in an educational scenario.
- An Interoperable reliable IoT architecture for seamless integration is proposed.
- Data comes from the different entities requires an integration at unique place for smooth communication.
- Interoperability testing is performed to measure latency, throughput and response time.

This paper is divided into the following sections. Section II describes related work done in context with interoperability. Interoperable reliable IoT architecture is proposed in section III and elaborated. Section IV presents integration and communication happens via MQTT reliable protocol. The results and discussion along with hardware set up are provided in Section V. In Section VI conclusion and future scope are discussed.

Section II

Related work

Interoperability is the major issue while talking about heterogeneity. It is an ability to interact between two different systems or two different applications all together. While going through an interoperability testing we ensure how the data is transferred from one application to another without prior information in a meaningful manner and further process to get accepted output. There are four types of interoperability in IoT are discussed [7] Device, syntactic, semantic and platform. IBM says whenever a device communicates there should be a one standard model for all the seven layers of protocol [6]. Interoperability is a multifaceted problem which is lies at different levels like Technical, language, syntax, semantic and organizational [8]. The first and most widely adopted open international standard for smooth and real-time data use and exchange is the School Interoperability Framework (SIF). It is a blue print for communicating heterogeneous software application together to interact and share data in K12 educational and administrative environment. In Figure – 2 shows different aspects of interoperability in education. The state of Educational interoperability varies at individual level, district level and state level. This will be helpful to reduce the workload of students and teachers [9].

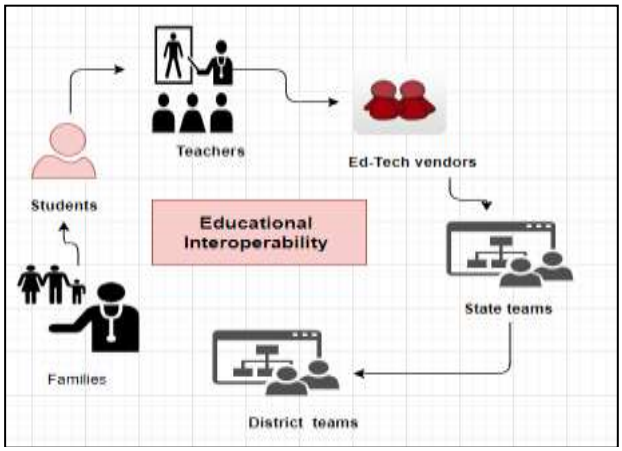


Figure-1: Aspects of Educational interoperability

Need for MQTT

In addition to achieve interoperability the main aim for the protocol that it should be lightweight, data agnostic, bandwidth efficient and simple to implement while contributing to Quality of service (QoS) data delivery. MQ Telemetry Transport (MQTT) protocol is first choice for sending high volume of sensor

messages to cloud and analytics platforms. It is based on Publish/Subscribe model. It is especially designed for those devices which will run on low power and low bandwidth. It transmits the messages in packets and one packet contains followings various fields:
1) Fixed header 2) variable header 3) Payload.

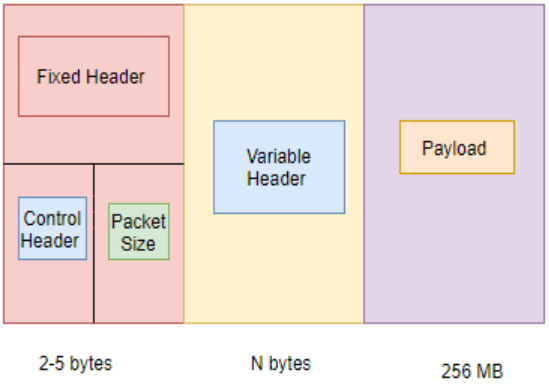


Figure-2: Packet format

Depending on the power of your CPU, it can link millions of devices. Its low system requirements and good compatibility with various applications that are connected to the Internet contribute to its popularity.

Section III

Proposed Architecture

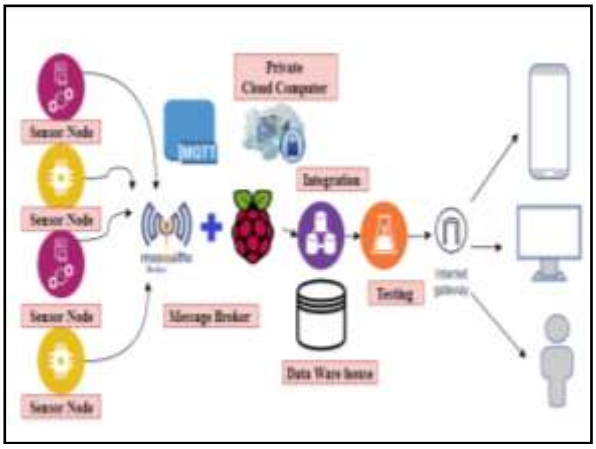


Figure-3: Interoperable architecture

In this proposed architecture various sensor nodes are publishing the data at the same time and message broker which acts as mediator for publishing and subscribing the messages. MQTT is a simple, 100 percent interoperable and adaptable protocol for exchanging IoT messages and data delivery. For the IoT developer, it is committed to creating a balance between data commutation happens via multiple platforms and hardware/network resources. Then mosquito is used which is the most scalable and popular open-source broker with a high performance that connects over 100Millons IoT devices in 1 cluster at 1ms latency. It handles and process millions of MQTT messages per second. Below IoT components are required for handling the whole process for seamless integration and further processing.

Section IV

How Communication happens

The communication happens among different sensor nodes in the form of publish and subscribe messages.

In the first step, install broker and while communicating
Below command will be used to connect broker:

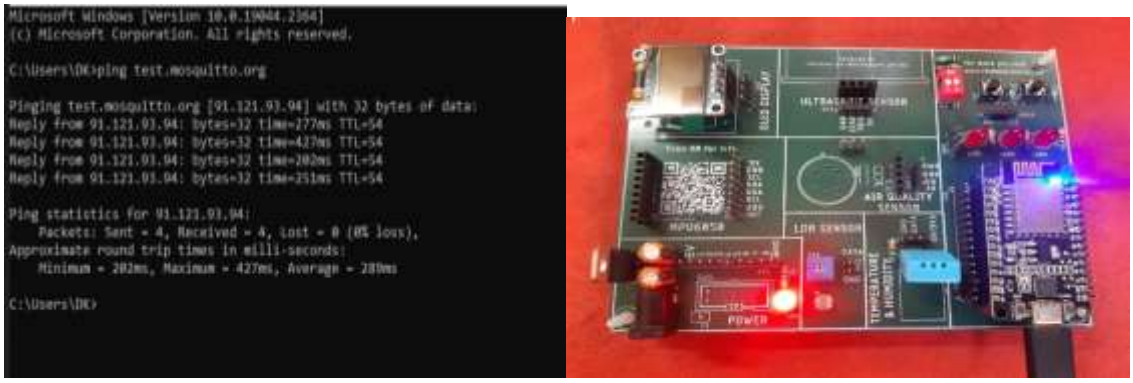


Figure-6: Hardware Set Up

Figure-4: connecting with mosquito broker

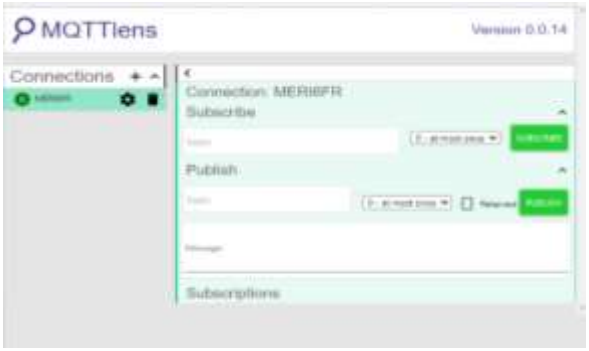


Figure-5: MQTT client

In the second step, here connection is established via MQTT lens, now we can publish and subscribe the massages. Afterwards source code is written at Arduino IDE that will be uploaded at NodeMCU board as shown in the image below:

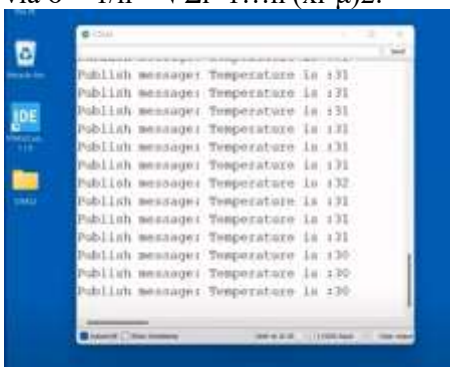
Figure-5: Source code

Section V

Result & discussion

Figure-7: Mobile interface

Figure-8 shows the output where heterogonous devices are communicating with each other smoothly, while testing the broker it is found that 1800 samplers were communicating together without intervention. Figure-9 shows to improve performance Interoperability testing is performed and received Throughput = 8003.557/minutes, Response time (33 ms), no. of samples 1800. Hence standard deviation (σ) is measured via $\sigma = 1/n * \sqrt{\Sigma i=1\ldots n (xi-\mu)2}$.



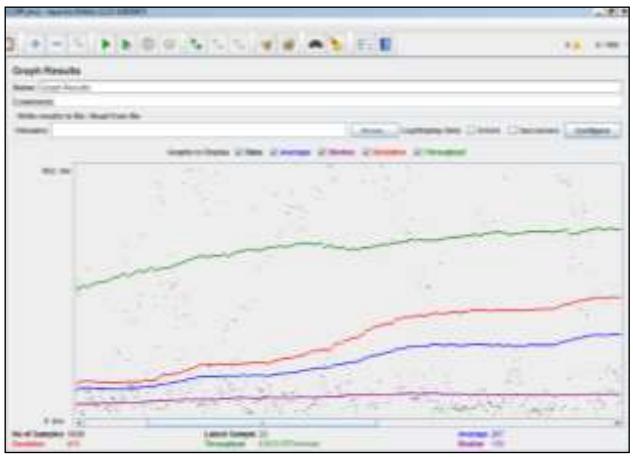


Figure-8: Publish messages

Figure-9 Interoperability Testing

Conclusion & future scope

Internet of Things, a promising new Internet protocol that aims to link all existing and future devices and users. To enable these sensor devices to act independently by communicating, exchanging data, and making choices, the IoT incorporates artificial intelligence. To put it briefly, the Internet of Things is the shift from

human-to-human communication to communication between humans and devices. to serve as a model for cross-platform implement educational application protocols; these protocols are essentially a series of stages that allow for communication across various forms of education technology. Each educational system will join forces with others in a federation of systems. To increase the architecture's dependability, availability, and scalability, we want to provide a structured data communication between them that is both safe and encrypted. an up-to-date survey of the infrastructure, tools, protocols, and software that make up the IoT ecosystem. Specifically, the reference layers of the most common architectures in the Internet of Things have been detailed. IEEE 802.15.4, LoWPANs, and Sigfox No-IoT, MQTT are some of the most popular and widely used supporting technologies and protocols. Although the worldwide market for the Internet of Things (IoT) is expanding at an incredible pace, statistics, statistical analysis, and market forecast analysis are not required to fully comprehend this growth. The top layer of the network stack, the application layer, is planned to have an interoperable, scalable, and reliable design based on MQTT. A smooth integration is required due to the variety in data formats, protocol standards, and structure. The graphical user interface allows for message configuration and facilitates integration of teachers, staff, students, and parents through a messaging system based on the MQTT protocol, which has several benefits for the IoT ecosystem. Right in front of our eyes, the Internet of Things and other emerging technologies like smart homes, cities, businesses, and meters are becoming more and more significant. It is practically impossible to imagine what may result from growing the IoT. The programmatic approaches chosen by manufacturers in the global market to ensure maximum compatibility across all linked devices will have a significant impact on the level of interoperability and integration, as well as the consideration given to problems of safety.

References

[1]Behailu Negash, Tomi Westerlund, Hannu Tenhunen,Towards an interoperable Internet of Things through a web of virtual things at the Fog layer,Future Generation Computer Systems,Volume 91,2019,Pages 96-107,ISSN-016739X,https://doi.org/10.1016/j.future.2018.07.053.

[2]Adel-Basset, M., Manogaran, G., Mohamed, M., & Rushdy, E. (2018). Internet of things in smart education environment: Supportive framework in the decision-making process. Concurrency and Computation: Practice and Experience, e4515. doi:10.1002/cpe.4515

[3]https://data-smart-schools.net/2019/08/01/what-is-data-interoperability-and-why-is-it-important-in-education/

[4] https://www.nsip.edu.au/interoperability-in-education

[5] Amaxilatis, D., Akrivopoulos, O., Mylonas, G. and Chatzigiannakis, I., 2017. An IoT-based solution for monitoring a fleet of educational buildings focusing on energy efficiency. Sensors, 17(10), p.2296.

[6]https://brinkshome.com/smartcenter/how-do-iot-devices-communicate

[7] Noura, M., Atiquzzaman, M. & Gaedke, M. Interoperability in Internet of Things: Taxonomies and Open Challenges. Mobile Netw Appl 24, 796–809 (2019). https://doi.org/10.1007/s11036-018-1089-9

[9] Maremi, K., Herselman, M., & Botha, A. (2020). school interoperability frame work, Interoperability maturity models for consideration when using School Management Systems (SMS) in South Africa: A scoping review.

[10]https://www.gettingsmart.com/2019/02/the-state-of-educational-interoperability-in-2019-and-beyond/