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A survey on Industrial Internet of Things for Mission Critical Things in Industry 4.0

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***Abstract*: This paper is based on the industrial standard 4.0 protocols utilized at each phase of mission basic application. Based on ping request-response, latency and throughput, comparison is made between their enhanced performance in industries like oil & gas, energy utility, telecommunication and many more. Also this paper illustrates the evolution of IoT (Internet of Things) from HTTP (Hyper Text Transfer Protocol) to lIoT (Industrial Internet of Things) for mission critical models. The proposed work deals with analysis of efficient protocol to handle dynamic inputs as per SCADA (Supervisory Control and Data Acquisition). The Trial consequences of stage 1 parameter is obtained and acknowledged through Message Queuing Telemetry Transport (MQTT) dealer and resultant checked through Wireshark.**

***Keywords*: IoT protocols, IIoT, Cyber Physical Space, MQTT, CoAP, Mission critical device modeling, Industry4.0, Literary survey.**

1. Introduction

World from the ascent of humankind to coding dialects and Artificial Intelligence, it has seen the development of zeros and ones, the Binary code. Imparting signals as "On/Off "were rather the fastest way to communicate, yet seems tedious for larger data and highly time consuming. From "state of definition" (Binary) towards "randomness of decisions" (fuzzy logic) based on environment and dynamic encounters of both human and machine can be categorised and performed by machine itself. Era of machine learning was an upgrade and training of machines to enormous data, algorithms and calculations.

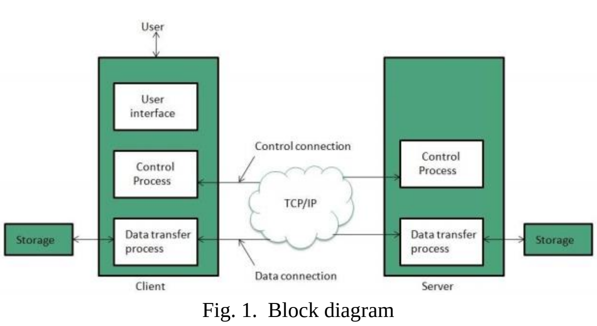

Fig. 1. Block diagram

Presently, Industry 4.0–the word hurled over the bench of German industrialists and research scholars has become eye of communication layer in Cyber Physical Space(CPS). The physical entity is now totally formed over cyber physical space by the machine, evaluated, verified, modified based on client requirement and re-done back to the physical entity (device-machine-device loop). This paper will work on CPS-IoT integration for mission critical things and its related papers.

2. Related Works

A. *Understanding of HTTP and standards before*

Due to strict IoT specific requirements, detailed characterization of the HTTP applications is required. In paper [8], a detailed analysis of throughput and latency for HTTP/1.1pipelining was evaluated by the impact that pipelining factor has on the latency. Based on these performance results, its analyzed whether this HTTP/1.1 model should be implemented in IoT systems with significant latency constraints.

B. *Internet of things challenges, comparison of protocols and methodology*

The MAC (Media Access Control) layer in combination with HTTP falls to be an important disadvantage of HTTP in IoT. Hence, standard architecture and application layers are analyzed in papers [8], [9] involving comparison between consumer and industrial IoT, architecture standardization (IEC)-5g, performance analysis, security and lightweight devices (ECC).

Discussions over CPS, Internet Technology and other embedded technology approved through SCADA were illustrated in paper [5].

Li Da Xu, Wu He, and Shancang Li in their survey: Internet of Things [16], brief over proposed usage of IOT in Industries.

But it involves complicated networks and their services management that was determined istedious. The IoT sequentially gets updated to Industry 4.0 for multi-level system devices.

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C. Industry 4.0, Inter-operability, design compatibility and framework

Machine to Machine (M2M) instruction fetch and execution is dealt by Industry 4.0. This involves lightweight protocols like Constrained Application Protocol (CoAP). The listed paper [9] discusses the security standards for long distance transmission, inter-water communication, different layers and stacks, medium access control ecosystem.

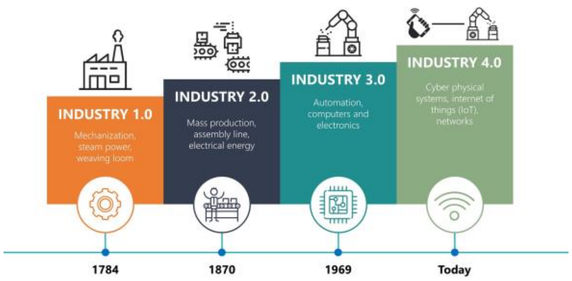

Fig. 2. Industry 1.0 to Industry 4.0

Evaluations of Protocols like XMPP (Extensible Messaging and Presence Protocol); MQTT; CoAP; RESTFUL; DSS (Decision Support System); AMQP (Advanced Message Queuing Protocol); Web Socket were performed in paper [14].

Reem Abdul Rahman, Babar Shah details over security standards in their paper [13] and lists out the redefined HTTP to enable data layer security through CoAP. Application of CoAP for class 1 and 2 machines serves a limitation.

Important constraints like Power consumption, performance, reliability, predictability and efficiency were major highlights of paper [12]. Throwing light on MQTT-reliability, operating layers' table and data distribution system to power, grid communication devices. Though the paper holds scope for 5g, its compatibility cannot be matched during consequent updates.

Industrial Internet of Things hierarchy, models of IIOT and its functionality stands as design pattern [6]. This paper's scope relies on heterogeneous model implementations.

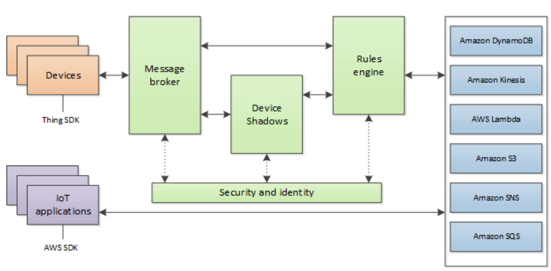

Fig. 3. Framework

The paper [4] on inter-operability illustrates heterogeneous approach on exchange of data between devices, networks, protocols, physical connectors that works on platform even after upgrade. All protocols do not overlap functions and stays different for different devices and their upgrades. This holds as the paper's limitation.

Organizing huge database by efficient resource management and intelligent broker is the main aspect of paper [3]. Segregation of data into Meta modules enables the intelligent broker to index and prioritize the request and acknowledgement. Paper [3] can be implemented over interactive and real-time updates can be done in MQTT communication.

D. Mission critical approach of industrial internet of things

Challenge of MODBUS/TCP reliability and wired embedded design of recent trend is sorted through paper [2]. Its opportunity may holds good for one to many client-subscriber paradigms.

Utilization of short packets for low latency communications is altered by finite block length coding. By Using actuator and eaves-antenna dropper, the authors of paper[1] attain low latency. Here short packets provide high quality data. The antenna dropper instead of crypto technology for physical security layer is considered. Research may follow relaying nodes addition, inclusion of more antenna droppers, aiming over Wi-Fi security stacking ways to minimize block-length code. Paper [1] limitation consists of,

- addition of nodes can cause more error
- more users or more Signal to Noise Ratio (SNR), the total concept will collapse
- much of a theoretical approach

Considering Mission Critical approach design models are discussed in paper [10]. This is followed with the communication technology for industry 4.0 [11] where it illustrates about Production Performance Management Protocol (PPMP), Reference Architecture Model Industry (RAMI) model.

3. Proposed Work

The Wi-Fi interestingly with the Zigbee has higher data transfer capacity and bolsters IP based exchanging.

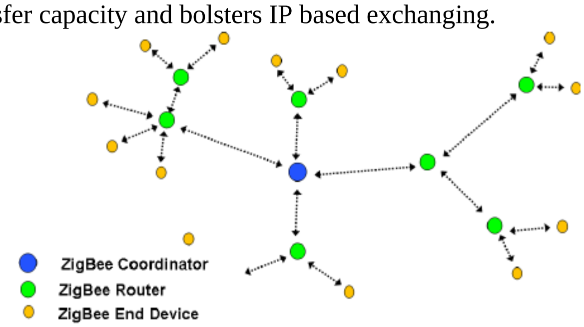

Fig. 4. Zigbee

The Industrial IoT conventions like Wireless HART, MQTT, COAP, and REST can be actualized effectively with our Wi-Fi Network. In Industries particularly for the mission critical applications emerge a requirement for the quicker control and speedier observing, which cannot be provided by the different remote advances like ZIGBEE, Bluetooth and so forth.

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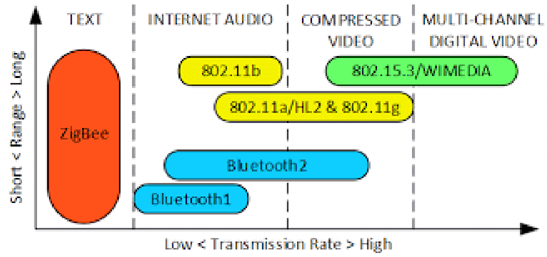


Fig. 5.

Through the NB-IOT and 4G which possess long run and higher transfer speed cannot be considered for these applications as they are exclusively network/ISP supplier-based advances. So, we propose an examination for the different Wi-Fi based IIoT protocols for the mission critical applications in Industry 4.0 standard. An appropriate convention that fulfills the requirement for the control and monitoring of its implementation in real time.

Advantages:

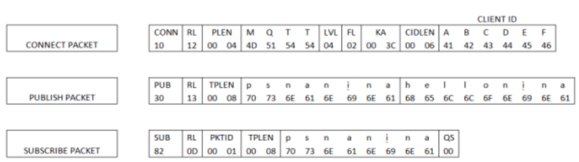
- Faster control and Monitoring
- Inter-operability
- Scalable and can be extended
- Secure and encrypted

The protocolof Wi-Fi mesh networks for real-time applications is analysed. It involves comparison of available internet protocols by their ping response, data length, latency and throughput. An efficient protocol is to be identified for mission critical application. An industrial real-time model is built, and resultant efficient protocol is to be applied, tested and verified.

Heavy data transfer is routed with low latency and high security. Disadvantages of Wired system in industry can be totally converted to the standards of Industry 4.0 in real time.

4. Result

As per phase 1, one of the protocols was analyzed and the result is noted for further analysis. The internet protocol considered was MQTT which is one of the most effective, one to many systems with publish-subscribe paradigm. The detailed MQTT working is studied through papers [2], [12] and was tested using chrome MQTT open source broker.



Sample MQTT packets are explained in case of mosqitto MQTT broker. Google chrome MQTT server enables the task easier and researcher friendly with inbuilt packet updates.

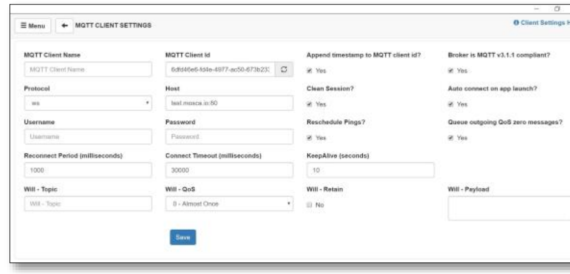


Fig. 6. Default page of MQTT broker for client setup

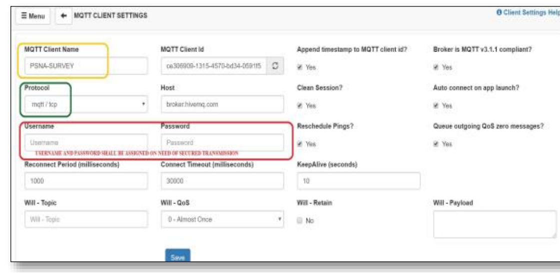


Fig. 7. Protocol selection-MQTT

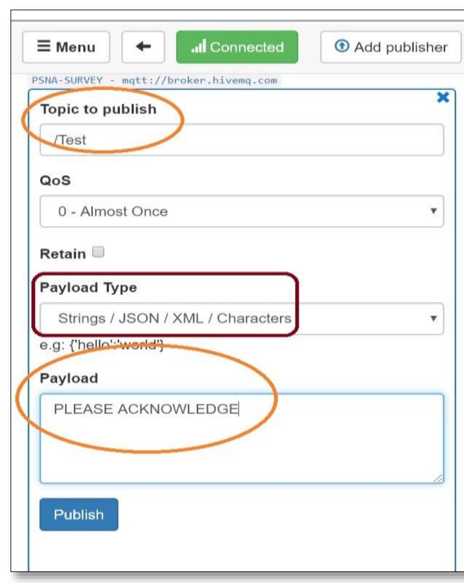


Fig. 8. MQTT Publisher, i) topic, ii) Payload type, iii) Payload (data)

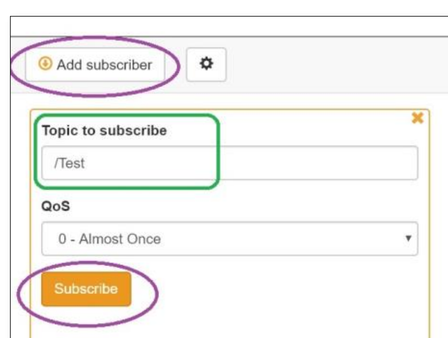


Fig. 9. Subscriber

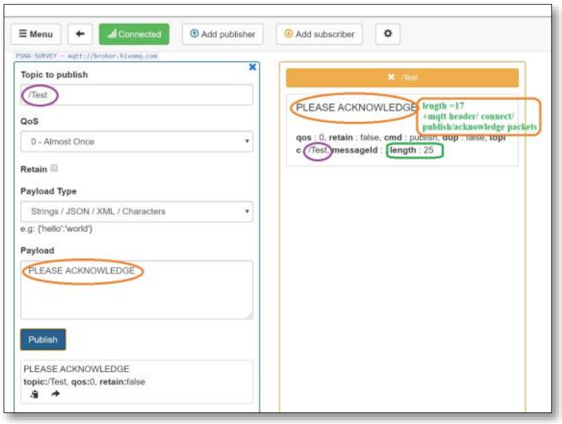


Fig. 10. Test connect-publish-acknowledgement

Now that, the whole process of MQTT communication is done, we must determine the Wi-Fi ping request and response by estimating i) actual data length of this MQTT connection ii) ping timing response. Wireshark, an open source platform, is used for determination of the same.

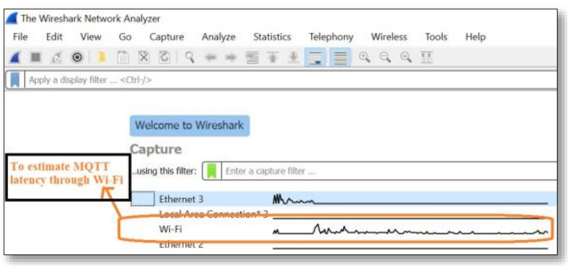


Fig. 11. Wireshark reading

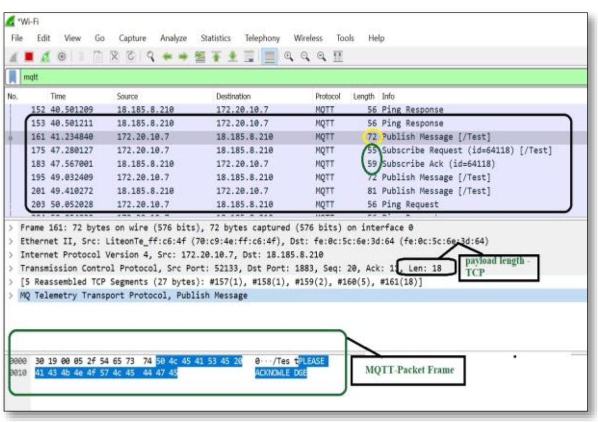


Fig. 12. MQTT frame formats for data

Thus, latency of MQTT shall be calculated from the derived framework.

5. Conclusion

The objective of this paper is to determine efficient protocol theoretically and to study the same in real-time. Proposed work shall comprise the analysis of the prevailing protocols and the optimal internet protocol shall be estimated and implemented for mission critical applications in Industry 4.0. Model of $I^{4.0}$would be built and testing shall be completed.

As aimed, the survey covers the available protocols of Industry 4.0 is keenly analyzed and studied in real-time. Test execution of one among the protocol is also illustrated in detail.

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