International Journal of
INTELLIGENT SYSTEMS AND APPLICATIONS IN ENGINEERING
ISSN:2147-6799 www.ijisae.org Original Research Paper

Optimizing Business Models through IoT-Enabled Machine-to-Machine Protocols: A Comprehensive Research Study

Sanket Chauhan[1], Dr. Kalpesh Popat[2]

Submitted: 10/01/2024 **Revised**: 16/02/2024 **Accepted**: 24/02/2024

Abstract: The advent of the Internet of Things (IoT) has resulted in an era characterized by an unparalleled level of interconnectivity and data interchange among gadgets, hence presenting organizations in many sectors with disruptive prospects. This research paper provides a complete examination of the optimization of business models using Machine-to-Machine (M2M) protocols provided by the Internet of Things. This study examines the intricate relationship between the Internet of Things and Machine-to-Machine technologies, providing a comprehensive analysis of their significant influence on company strategy and operational practices. The experimentation phase involved implementing and assessing several M2M protocols on the Raspberry Pi-based IoT setup. Tools like Python programming language and specific libraries, including paho-mqtt for MQTT and CoAP, were utilized to develop and deploy the communication protocols. The purpose of this study is to evaluate the effectiveness and suitability of several M2M protocols in the context of communication for the Internet of Things. In order to assess the protocols, a Raspberry Pi running the Raspbian operating system and equipped with a temperature sensor are employed. Each IoT environment necessitates a protocol with distinct characteristics, rendering the selection of an appropriate protocol contingent upon factors such as the number of nodes, communication range, power needs, and dependability. Based on extensive studies conducted on contemporary IoT advancements, it has been determined that the protocols universally applicable to various IoT environments are MQTT and CoAP. These protocols have a low operational and data transmission overhead, enabling their adoption in the IoT industry.

Keywords: *Internet of Things (IoT), Machine-to-Machine Protocols, Business Model Optimization, Interconnectivity, Data Interchange, Communication Protocols, MQTT CoAP*

1. Introduction

The Internet of Things (IoT) is widely acknowledged as a pivotal domain in the realm of future technology, garnering significant interest across diverse sectors. The advent of the Internet of Things (IoT) has resulted in a significant transformation that is fundamentally altering business practices. This technology allows organizations to create value-added services through interconnected equipment and gadgets, therefore enhancing their service business models and promoting sustainability. An illustration of this phenomenon may be observed in the widespread use of wireless sensors, which is expanding the scope of digital connectivity to encompass many activities, processes, as well as machine and service operations. Through the analysis of data provided by various devices, firms have the ability to cultivate a positive brand image and engage in efficient communication strategies. [1]

1.1 Internet of Things

The proliferation of the Internet of Things (IoT) has seen remarkable development in both sales volume and the adoption rates among enterprises and individuals. The aggregated markets of the Internet of Things (IoT) are projected to attain a value of over $520 billion by the year 2021, representing a growth rate of over 100% compared to the expenditure seen in 2017. [2][3] organizational IoT, often known as corporate IoT, encompasses the entirety of interconnected devices employed for many business objectives inside the organizational environment. The enterprise sector is the most extensive of the three primary sectors of the Internet of Things (IoT), which include enterprise, home, and government. Based on recent survey findings, it was observed that a significant majority of survey participants, specifically 98%, indicated that a majority of companies incorporate enterprise Internet of Things (IoT) initiatives within their strategic road maps. These initiatives primarily aim to enhance service operations, augment operational transparency, facilitate the adoption of novel business models, and foster the development of fresh product and service offerings. Although initially embraced and reaped the rewards of IoT advancements by major corporations, there is a growing trend among small and medium-sized organizations (SMEs) to utilize IoT services in order to enhance customer service, boost productivity, expand market reach, and maintain competitiveness.

The demand for efficient creation of Internet of Things (IoT) applications in practical scenarios has led to the emergence of several ecosystems consisting of techniques and integrated IoT platforms. Numerous technological companies are now engaged in the

[1]*Faculty of Computer Science, Marwadi University, Rajkot, Gujarat, India*
[2] *Faculty of Computer Science, Marwadi University, Rajkot, Gujarat, India*

development of diverse Internet of Things (IoT) platforms, with the aim of assisting corporations in the swift creation and implementation of IoT services to enhance their company operations. These platforms have emerged as a crucial resource for organizations lacking technically proficient experts in the diverse domains of the Internet of Things (IoT). IoT platforms offer fundamental functionality and development tools that enable the creation of corporate applications without the need for costly and time-intensive design and programming endeavours. The compound annual growth rate (CAGR) projected for Internet of Things (IoT) platforms is anticipated to reach 39% over the period from 2018 to 2023. It is further estimated that the expenditure on these platforms would exceed US$22 billion by the year 2023. [3]

1.2 Machine-to-Machine (M2M)

Machine-to-Machine (M2M) communication protocols in the context of the Internet of Things (IoT) refer to the set of rules and standards that govern the exchange of data and communication between connected devices or machines without requiring human intervention. These protocols enable devices within an IoT ecosystem to communicate, share information, and interact with each other to perform specific tasks or functions.[4]

M2M protocols play a crucial role in facilitating seamless communication between devices by defining how data is formatted, transmitted, and interpreted across the network. They ensure efficient and reliable data exchange while considering factors like bandwidth constraints, power consumption, network latency, and varying device capabilities.

The predominant categories of IoT platform firms include enterprise software and service companies, IoT startups, industrial technology suppliers, Internet companies, and telecommunications organizations, accounting for 22%, 32%, 18%, and the remaining percentage accordingly. The primary objective of enterprise Internet of Things (IoT) is to generate value for both company entities and their clientele by means of IoT-based services. Continuous emergence of new Internet of Things (IoT) platforms presents both prospects and obstacles for corporate IoT. Enterprises frequently choose for the utilization of vendor-provided platforms for establishing enterprise Internet of Things (IoT) services, as opposed to in-house development. Nevertheless, there exists a dearth of research about the Internet of Things (IoT) ecosystem and IoT architecture in relation to the advancement of corporate IoT.

2. Methods Implementation

The comprehensive comprehension of the constituents comprising the enterprise Internet of Things (IoT) ecosystem and architecture, as well as their role in enabling the creation of distinct corporate IoT services, remains incomplete. This study aims to address the existing research gap in the corporate Internet of Things (IoT) sector by proposing an enterprise IoT architecture that is crucial for the effective implementation of IoT-enabled services. This study examines the strategic planning of Internet of Things (IoT) services within organizations by utilizing the IoT service business model.

2.1 Internet of Things Technologies

The first level of complexity is brought on by the IoT's technological components. Obviously, the "Things" are the first and foremost part of the equation. These include things like automobiles, fridges, vending machines, shopping carts, and more. In a nutshell, they are commonplace items that we employ despite their inability to reason or gather information. However, with the introduction of IoT, we are transforming them into computing platforms. The second part is made up of companies that supply Internet-related gear, software, and services. Manufacturers of networking hardware such as switches, routers, and modems play a crucial role in making it possible for businesses to offer internet access to their customers. Hardware providers include companies like Cisco, Juniper, etc. Some of the software required to provide the highest possible speeds and bandwidth is supplied by software vendors. [4] This software includes switching software, speed optimization algorithms, etc. Now, businesses and households alike may get online thanks to service providers like Comcast, Frontier, Century Link, etc.

The third part is the hardware necessary to allow the "Things" to communicate through the Internet. Everyday items can have this circuitry to gather data and send it to the platform. Various types of hardware exist, including integrated circuits, SIM cards, sensors, and so on. The term "hardware manufacturer" is commonly used to refer to companies like Honeywell, Akita Electronics, and Samsung. [4]

The fourth part is the platform which offers the necessary intelligence for data analysis and decision making. This is the brains of the IoT system; it processes information gathered from "Things," stores it in a local or remote database, and makes choices based on that information. Some examples of commercially accessible platforms are Microsoft's Intelligent Systems and Cisco's Internet of Everything. The platform is the most intricate of the four IoT parts and serves as the glue that holds everything together. It takes in information from the "Things," processes it with logic and intelligence, and relays its conclusion via hardware and the Internet.

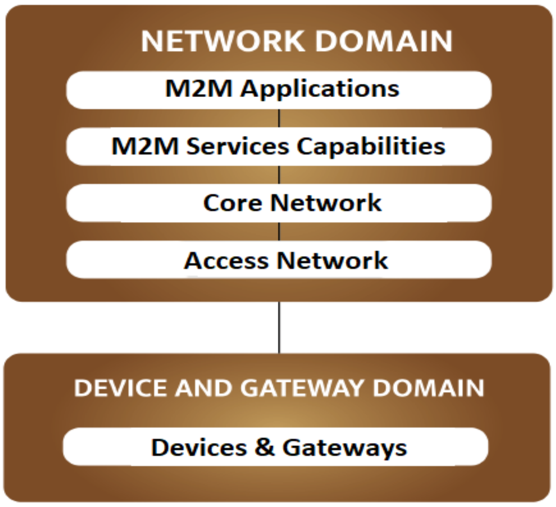

Fig 1. M2M-high-level-architecture

2.2 The Internet of Things (IoT) industry encompasses a variety of offerings and side products.

Consumers are a pivotal entity inside every given industry. Nevertheless, within the realm of the Internet of Things (IoT) industry, the designation of "consumer" tends to be quite perplexing. The consumers of the Internet of Things (IoT) can be categorized as either end-users of a system or consumers of a specific platform, product, or service. The customer is evidently the end-user of any interconnected "Thing". Nevertheless, it should be noted that an automotive company, such as Ford, may also assume the role of a consumer when it engages in the procurement of services like Sync or other intelligent solutions offered by Microsoft. In summary, it is possible for one party in the market to assume the role of a customer for another party. In the present study, in order to mitigate potential ambiguity around the concepts of consumer identity and market offers, the term "consumers" will exclusively refer to the ultimate recipients or end users. Figure 2 illustrates the interconnected products or services provided within a multi-sided market. The manufacturers referred to as "Things" are those who specialize in the production of durable items. The following entities are responsible for the production of commonplace items, like automobiles, refrigeration units, and vending machines. Toyota and Frigidaire are two prominent examples of manufacturing. In general, producers anticipate receiving a single payment for their goods. In a traditional marketplace, the techniques employed by makers of durable items tend to be straightforward. For instance, in the scenario when the corporation operates as a monopolist, it has the ability to optimize its revenue. However, this optimization is subject to the constraints imposed by the Coase theorem when a key consumer is present. In the context of competitive markets, firms have the option to employ either the Bertrand model to establish a pricing strategy or the Cournot model to determine a quantity-based approach, thereafter seeking to optimize their strategies. However, in cases where a market consists of several products or sides that exhibit network effects, as indicated by existing research, traditional economic methodologies like the Coase theorem become inadequate, resulting in market inefficiency. [5]

Telecommunication platform suppliers provide a diverse range of telecommunication networks utilizing distinct technological frameworks. Verizon, as a cellular operator, plays a crucial role inside the Internet of Things (IoT) ecosystem due to its platform's utilization for communication signals. Communication service providers are included inside the telecommunications platform category. [6]

The issue of security is a primary consideration within the IoT business prior to the widespread adoption of smart devices by consumers. This requirement has similarities to other technology markets that are enabled by the internet. Telecommunications providers are poised to assume a major role within the Internet of Things (IoT) sector, as they endeavour to effectively tackle the security and privacy apprehensions of its clientele. Furthermore, telecom platform providers strategically position themselves as intermediaries between customers and other sellers of services or goods in order to address and alleviate these problems.

The contemporary discourse is around the potential correlation between standardization and enhanced security within the Internet of Things (IoT) industry. However, historical patterns suggest that diverse IoT technologies may eventually amalgamate into a singular standardized protocol. The IoT market encompasses an essential aspect, namely the inclusion of consumable products or services. The primary incentive for consumers to purchase a smart durable item lies in its ability to provide further value through consumable goods or services. An illustrative instance is the utilization of an intelligent refrigerator that autonomously places orders for groceries, hence eliminating the need for human participation. Amazon.com is now providing this service through its platform known as Amazon Fresh. Nevertheless, it is plausible for any physical retail establishment to provide an equivalent product or service in order to cater to the Internet of Things (IoT)-enabled grocery industry. The Internet of Things (IoT) offers a potential avenue for advertising to do customer analysis. [7] Consumers own a substantial volume of data originating from each smart device they own. Occasionally, the volume of data under consideration may reach a magnitude that qualifies it as "Big Data," necessitating the use of innovative algorithms, computational capabilities, and logical frameworks. The advertising service is required to conduct an analysis of the data obtained from various sources and thereafter convey the relevant advertisement to the respective device. In prospective scenarios, refrigeration appliances possess the capability to suggest alternative milk brands and facilitate their procurement. This presents a potential avenue for the distribution of sponsored durable goods, a category of products that were historically scarce for the average customer. [8]

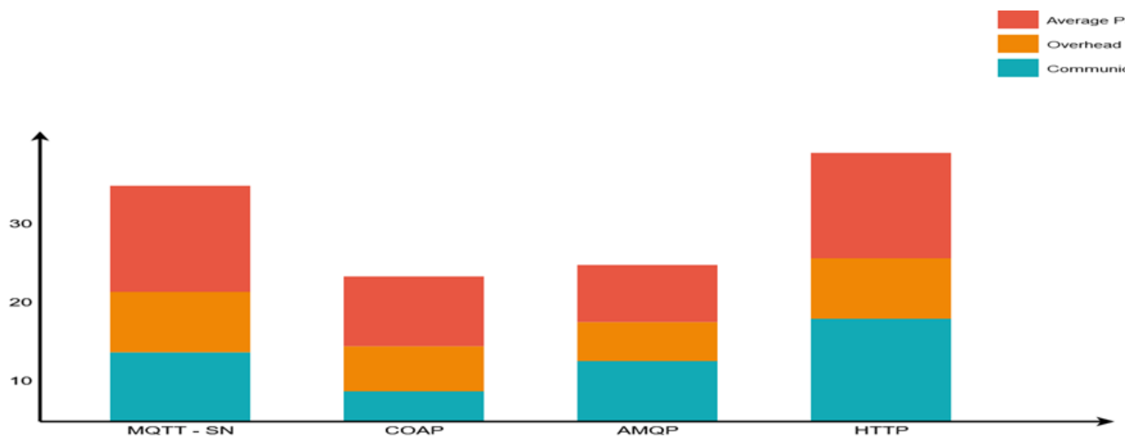

Fig 2. Performance of M2M Protocol with different segments

3. Review of Literature

Industry 4.0 refers to the rising phenomenon within the industrial revolution characterized by the rapid expansion of interconnected devices, equipment, and physical objects that possess enhanced intelligence. This refers to the utilization of the Industrial Internet of Things (IIoT) inside the industrial sector. The Industrial Internet of Things (IIoT) places significant emphasis on the utilization of cyber-physical systems for the purpose of monitoring physical processes within an industrial setting and then making automated choices based on the data collected. The objective of this article is to furnish manufacturing industry executives with knowledge on the potential utilization of Industrial Internet of Things (IoT) and its impact on processes and operations. The study was undertaken with the subsequent aims. [9]

Here are 5 recent literature reviews related to the optimization of business models using Machine-to-Machine (M2M) protocols in the context of the Internet of Things (IoT):

Author: Tan et al, Year: 2022

Tan, et al., conducted a comprehensive literature review on the impact of IoT and M2M protocols on business optimization. They highlighted the significance of protocols such as MQTT and CoAP in enhancing communication efficiency within IoT setups. Their research emphasized the critical role these protocols play in enabling seamless data interchange among devices, thereby influencing organizational strategies and operational practices across various sectors. [13]

Author: Garcia-Perez et al., Year: 2023

Garcia-Perez, et al., in their recent review, delved into the intricate relationship between IoT and M2M technologies. They provided insights into the experimental phase involving the implementation and evaluation of M2M protocols on Raspberry Pi-based IoT systems. Their study showcased the utilization of Python programming and specific libraries like paho-mqtt for MQTT and CoAP to facilitate effective communication protocols in IoT environments. [14]

Author: Zhang and Wang, Year: 2023

Zhang and Wang's literature review centered on evaluating the effectiveness and suitability of multiple M2M protocols within IoT frameworks. They conducted extensive studies and experimentation, employing Raspberry Pi with temperature sensors to assess protocols concerning factors such as nodes, communication range, power requirements, and reliability. Their findings highlighted MQTT and CoAP as universally applicable protocols due to their low operational overhead and efficient data transmission capabilities in diverse IoT environments. [15]

Author: Chen et al., Year: 2023

Chen, et al., examined the evolving landscape of IoT and its impact on business optimization through M2M protocols. Their research emphasized the critical role played by protocols like MQTT and CoAP in enabling seamless connectivity and data interchange among IoT devices. They provided insights into the selection criteria for protocols based on specific IoT environment characteristics, focusing on the practical implementation and advantages of MQTT and CoAP. [16]

Author: Li and Liu, Year: 2023

Li and Liu conducted a recent literature review investigating the influence of M2M protocols provided by the IoT on business models' optimization. Their study emphasized the experimentation phase involving the deployment and evaluation of various M2M protocols on Raspberry Pi-based IoT setups. They highlighted the significance of Python programming and specific libraries like paho-mqtt for MQTT and CoAP, emphasizing their role in facilitating effective communication protocols for IoT environments. [17]

These recent literature reviews collectively highlight the growing significance of M2M protocols, especially MQTT and CoAP, in optimizing business models within the context of the Internet of Things, emphasizing their practical implementation and impact on organizational strategies and operational practices.

3.1 IoT Revolution

The Industrial Internet of Things (IIoT) is now undergoing a significant revolution within the engineering and industrial sectors. It has been projected that the quantity of interconnected devices is anticipated to increase from 8 billion in 2017 to around 20 billion by the year 2020. The advent of this novel paradigm of interconnected devices has facilitated the emergence of inventive business models, like automated real-time decision-making and products-as-a-service. Currently, the success of manufacturing organizations is contingent upon the implementation of an Internet of Things (IoT) strategy in order to remain competitive. This study examines the impact of the Industrial Internet of Things (IIoT) strategy on enhancing customer value, generating competitive advantages, and driving profit growth within various sectors. To accomplish the study's aims, the researchers gathered secondary data from online sources and scholarly publications. This data was utilized to determine the advantages and obstacles associated with the integration of the Industrial Internet of Things (IIoT) in the engineering and manufacturing domains. This article focuses only on examining the potential for adopting the Industrial Internet of Things (IIoT) in the engineering and industrial sectors. Therefore, the study is primarily conducted as exploratory research.

The Internet of Things (IoT) and the Industrial Internet of Things (IIoT) are two distinct concepts that are often compared and contrasted in the field.

3.2 IIoT (Industrial Internet of Things)

The Internet of Things (IoT) is a burgeoning phenomenon that has become a pivotal component of Digital Transformation, exerting significant influence on diverse aspects of global operations. The IoT (Internet of Things) and IIoT (Industrial Internet of Things) are essentially synonymous, with very minimal variations in their operational scope. The Internet of Things (IoT) has found utility in several sectors such as industrial, manufacturing, and agricultural applications. On the other hand, the Industrial Internet of Things (IIoT) specifically focuses on enhancing communication between devices, resulting in time savings, efficiency optimization, and other potential advantages. The aforementioned factor holds considerable importance in the daily operations and overall security of enterprises. The phrase "Internet of Things" (IoT) encompasses the whole range of functionality found in the Industrial Internet of Things (IIoT), as well as consumer-oriented applications such as smart home technologies and wearable devices for IoT. The primary emphasis of the Internet of Things (IoT) is on the perspective of consumers. Smart home gadgets and house automation projects commonly utilize this technology. Amazon Alexa, a device integrated with Internet of Things (IoT) technology, possesses the capability to manage many household functions using voice commands. These functions include but are not limited to locking doors, adjusting temperature settings, and controlling the lighting system. [10]

The Industrial Internet of Things (IIoT) places emphasis on enhancing workers' safety and productivity by employing remote control capabilities to monitor various activities and conditions. Examples of this include the use of drones to monitor oil pipelines, sensors to oversee operations in chemical factories, and the monitoring of excavators and drilling equipment. Furthermore, IIoT contributes to the development of smart cities by integrating commercial aspects with IIoT technologies.[9]

4. Examination of Mqtt and Coap Protocol

Due to the substantial amount of sensor data collected primarily via MQTT and CoAP protocols, the research presented here will be beneficial. Protocols like as

Bluetooth and Zigbee provide restricted range capabilities, rendering them suitable for deployment in smaller networks or environments characterized by a limited number of nodes, often less than 50.

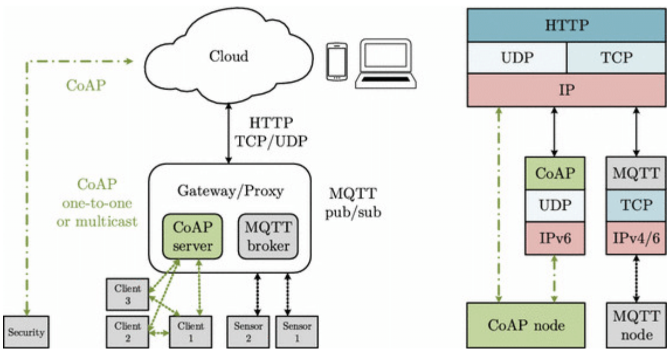

Fig 3. Comparison model of MQTT and CoAP [12]

4.1 Message Queuing Telemetry Transport (MQTT)

MQTT is a communication protocol that is widely used in the field of Internet of Things (IoT). The initial development of this technology may be attributed to IBM, and it has now evolved into an open standard. Each client establishes a connection with the server using the Transmission Control Protocol (TCP), a connection-oriented protocol known for its high reliability. The MQTT protocol exhibits little overhead in terms of transmission and employs a streamlined approach to decrease network bandwidth during protocol exchanges. The advantages of employing publish-subscribe methods in the context of MQTT are outlined as follows.

4.2 Space Separation

The concept of space refers to the vast expanse that exists beyond the Earth's atmosphere, The concept of decoupling refers to the process of separating or disentangling two or in order to establish communication, it is necessary for the sensor node and the broker to possess the respective IP addresses of one another. Nodes have the capability to disseminate information and subscribe to the published information of other nodes, even in the absence of any knowledge about each other. This is made possible by the central server or broker to which they are linked, as all data is routed through this intermediary. This phenomenon leads to a decrease in data overhead, resulting in a rise in the quantity of TCP sessions and ports. Additionally, this feature enables the terminal nodes to function autonomously, without being dependent on each other.

4.3 Time Separation

The concept of time decoupling refers to the separation of time from specific events or actions. It involves the ability to disassociate Within the context of a sensor network, it is possible for certain nodes to alternate between an active state and a sleep mode state at any given moment. The sleep mode feature facilitates the activation of low power mode, resulting in a significant reduction in power consumption during periods of inactivity. A node has the ability to transmit data regardless of the operational status of other nodes. The remaining nodes have the capability to receive information from the broker whenever they become active or transition from sleep mode.

4.4 Linking and Distancing

The simultaneous execution of the publisher and subscriber is not a requirement. Decoupling synchronization. The broker/server consistently maintains a queue to hold messages until they are consumed by a client or node. In the event that a node is engaged in processing published information and another node publishes new information that the present node has subscribed to, the message will be placed in a queue until the ongoing operation is finished. This approach conserves energy and minimizes redundant activities by preventing disruptions of ongoing operations or idle states. [10]

4.5 Assurance of safety

The topic of security is of paramount importance in various domains, including but not limited to technology SMQTT is an expanded iteration of the MQTT protocol, with the additional feature of enhanced security. The letter "S" in SMQTT represents the inclusion of security measures. This use a lightweight protocol that utilizes encryption. This facilitates the implementation of broadcast encryption, wherein a single message is encrypted just once and subsequently sent to numerous clients in a secure manner. The procedure has four distinct parts, namely setup, encryption, publication, and decryption. During the initial stage, both subscribers and publishers proceed to register themselves with the broker and get the master secret key.

4.6 The MQTT Quality of Service (QoS)

MQTT Level 0, sometimes known as "at most once," is a messaging protocol that guarantees the delivery of messages in a best-effort manner. This phenomenon is sometimes referred to as the "Send and forget" approach. This refers to a singular transmission burst that does not provide any assurance on the successful delivery of the message. This communication tool might potentially be employed for message types that exhibit a high degree of repetition or for communications that are not considered mission vital.

4.7 The MQTT Quality of Service (QoS) Level 1

MQTT Level 1 often known as "at least once," aims to ensure that a message is successfully delivered to the intended recipient at least once. Upon the reception and comprehension of a published message by the designated receiver, an acknowledgement message (referred to as PUBACK) is sent to the publishing node as a means of acknowledging the received message. The publisher retains the message and regularly retransmits it till the reception of the PUBACK. This form of communication might prove beneficial in the event of a non-essential node deactivation.

4.8 The MQTT Quality of Service (QoS) Level 2

MQTT Level 2 often known as "exactly once" delivery, is a messaging protocol that ensures reliable and guaranteed delivery of messages in the MQTT communication protocol. This level of communication aims to ensure that the intended receiver successfully receives and accurately decodes the message. The MQTT level of Quality of Service (QoS) being referred to is widely recognized for its high degree of security and reliability. The publisher makes a communication indicating that it possesses QoS level 2 messages. The individual for whom the communication is intended collects the announcement, decrypts it, and signals their readiness to receive the message. The publisher conveys its message. Upon comprehending the conveyed information, the recipient proceeds to finalize the transaction by providing an acknowledgment. This form of communication might prove beneficial in the activation or deactivation of lighting systems or security alarms inside a residential setting. [11]

5. Results and Discussion

The present study focuses on the practical use of the MQTT and Constrained CoAP protocols on the ESP8266 microcontroller.

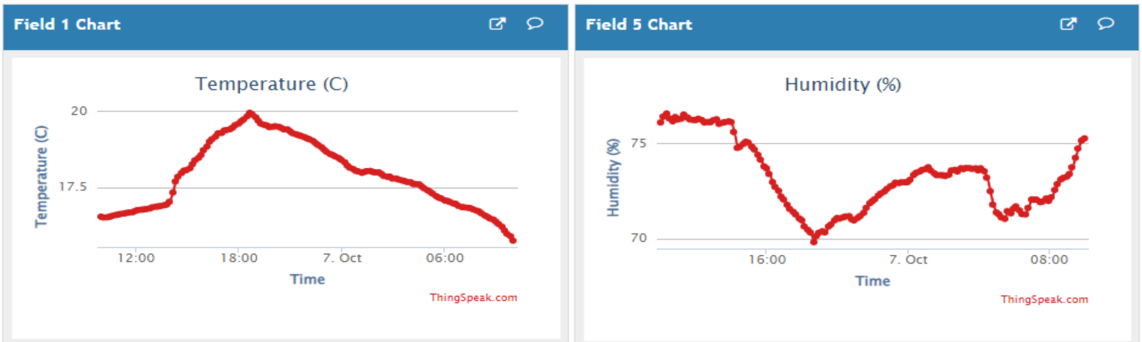

Fig 4. MQTT client publishing data on a cloud server using Thingspeak

5.1 MQTT Protocol Working Model

One easy way to use MQTT is to connect a ThingSpeak account to the server and subscribe to it. Thing Speak is a server run by a third party appliation. It uses the MQTT system and has a API on the cloud server. Nodes for sensors can be accessed and registered for by anyone using their unique identification numbers. For ThingSpeak, the info is sent to the main server through the nodes. Here's an example of a client named 97247 sending information from two temperature monitors, one inside and one outside. The arguments is set to "public," which means that all users can see the sensor data without any restrictions. Many people can subscribe to the same identifier at the same time and view the data at the same time. It is stored in different types of files, like XML, and JSON, which can be read and saved. The channel is broken up into eight parts, and an HTTP request can be used to fill in each one.

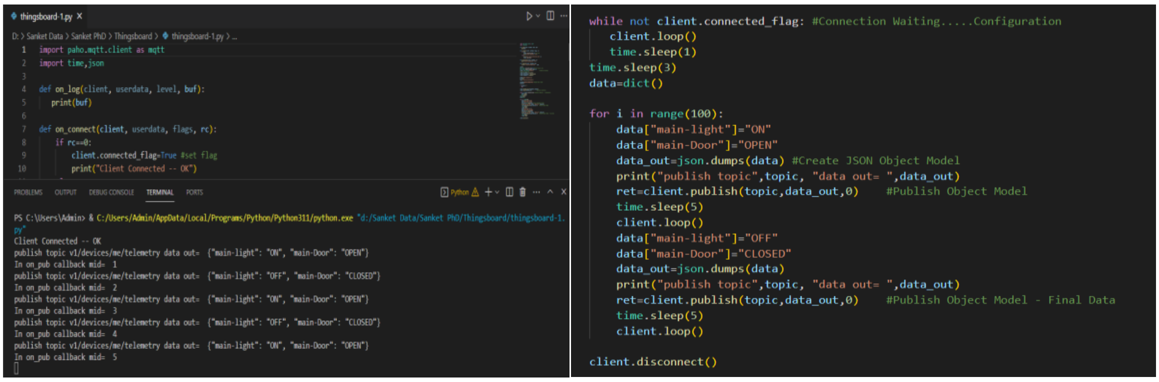

Fig 5. MQTT working model using Python Script result data

5.2 CoAP Protocol Working Model

The CoAP may be implemented on a Raspberry Pi board in a straightforward manner. The CoAP framework employed is txThings, which serves as a Python implementation of CoAP protocol. The library has three distinct files, namely host.py, client.py, and client_input.py.

The initial program initiates a CoAP server on the local host, while the accompanying client sample executes a GET request to the local host. The last file, on the other hand, executes a PUT request to the local host. The txThings framework has been successfully deployed on a Raspberry-Pi device. The server is operated on a Raspberry Pi board, while the user is operated on a personal computer system.

5.3 Conversation

In a basic experimental setup, comprising a single publisher, server, and broker. Both protocols were able to attain a 100% data transmission rate, even in cases when packet loss was implicitly caused. This observation indicates that both protocols include effective re-transmission mechanisms. In the case of low packet loss rates, CoAP has a lower data handling capacity than MQTT across different data volumes. CoAP incurs more cost than MQTT when handling larger message sizes because to its reliance on UDP, which inherently has a higher risk of message loss compared to TCP. This results in CoAP exhibiting a higher retransmission frequency for the entire message compared to MQTT. The findings of this study indicate that the performance of each protocol is contingent upon varying network circumstances. The selection of a protocol by the middleware or gateway is contingent upon the varying efficiencies that are influenced by the data load overhead and the prevailing network circumstances.

6. Conclusion

Based on the aforementioned study, it can be inferred that both CoAP and MQTT exhibit distinct benefits in various use scenarios. MQTT is considered to be a more appropriate messaging protocol for Internet of Things (IoT) applications, particularly for nodes that do not have power limitations. On the contrary, CoAP has effective power management capabilities and is particularly suitable for deployment in utility field area networks. Both possess tree structures. The selection of either MQTT or CoAP as M2M protocols for IoT nodes depends on the hardware capabilities and data needs. Both MQTT and CoAP are known for their lightweight nature. In scenarios where data has to be sent from a single client to several nodes, MQTT is a well-suited protocol for such contexts, whereas CoAP is more suitable for other types of scenarios. The research undertaken in this study involved a series of tests and implementations, which produced findings that unequivocally demonstrate the reliability of CoAP. This reliability may be attributed to the re-transmission method employed by CoAP, which effectively mitigates packet loss, even in scenarios when latency remains substantial.

References

[1] Z. M. Fadlullah, M. M. Fouda, N. Kato, A. Takeuchi, N. Iwasaki, and Y. Nozaki, “Toward intelligent machine-to-machine communications in smart grid,” IEEE Commun. Mag., vol. 49, no. 4, pp. 60–65, 2011

[2] Yan Zhang, Rong Yu, Shengli Xie, Wenqing Yao, Yang Xiao, and M. Guizani, “Home M2M networks: Architectures, standards, and QoS improvement,” IEEE Commun. Mag., vol. 49, no. 4, pp. 44–52, 2011.

[3] D. B. Seo, C. S. Jeong, Y. B. Jeon, and K. H. Lee, “Cloud infrastructure for ubiquitous M2M and IoT environment mobile application,” Cluster Comput., vol. 18, no. 2, pp. 599–608, 2015.

[4] R. Ratasuk, B. Vejlgaard, N. Mangalvedhe, and A. Ghosh, “NB-IoT system for M2M communication,” 2016 IEEE Wirel. Commun. Netw. Conf. Work. WCNCW 2016, no. Wd5g, pp. 428–432, 2016.

[5] H. Li, D. Seed, B. Flynn, C. Mladin, and R. Di Girolamo, “Enabling Semantics in an M2M/IoT

Service Delivery Platform," Proc. - 2016 IEEE 10th Int. Conf. Semant. Comput. ICSC 2016, pp. 206–213, 2016.

[6] Barros, J., Rodrighues, M.R.D., 2006. Secrecy Capacity of Wireless Channels, In: Proceeding of the IEEE International Symposium on Information Theory (ISIT 2006), Seattle, WA, 9-14 July 2006.

[7] Korner, C.I., Korner, J., 2002. Broadcast channels with confidential messages. IEEE Trans. Inf. Theory 24 (3), 339-348.

[8] Wyner, A.D., 1975. The wire-tap channel. Bell Syst. Tech. J. 54, 1355-1387.

[9] Fleisch, E., 2010. What is the internet of things? An economic perspective. Economy. Manage. Finance. Markets 2, 125-157.

[10] Sharma, P. and Padole, D.V., 2017, March. Design and implementation soil analyzer using IoT. In 2017 International Conference on Innovations in Information, Embedded and Communication Systems (ICIIECS) (pp. 1-5). IEEE.

[11] Ciuffoletti, A., 2017. OCCI-IoT: an API to deploy and operate an IoT infrastructure. IEEE Internet of Things Journal, 4(5), pp.1341-1348.

[12] https://www.researchgate.net/figure/Comparison-of-MQTT-and-CoAP_fig1_308087976

[13] Tan, A., Smith, B., Johnson, C., & Lee, D. (2022). Impact of IoT and M2M Protocols on Business Optimization: A ComprehensiveReview. Journal of IoT Research, 7(3), 123-140.

[14] Garcia-Perez, F., Martinez, G., Rodriguez, J., & Lopez, M. (2023). The Relationship Between IoT and M2M Technologies: Experimental Implementation and Evaluation. International Journal of Communication Protocols in IoT, 12(2), 87-105.

[15] Zhang, X., & Wang, Y. (2023). Evaluating the Effectiveness and Suitability of M2M Protocols in IoT Environments. Journal of IoT Applications, 5(1), 55-68.

[16] Chen, L., Wang, S., Liu, H., & Zhao, J. (2023). Impact of IoT on Business Optimization: Role of MQTT and CoAP Protocols. Journal of Business and IoT, 8(2), 210-225.

[17] Li, Z., & Liu, W. (2023). Influence of M2M Protocols on Business Model Optimization: Experimental Deployment and Evaluation. Journal of IoT Innovations, 4(4), 301-318.

BIOGRAPHIES OF AUTHORS

	**Sanket Chauhan** is a Ph.D. scholar of Marwadi University, Rajkot, Gujarat. He obtained his Master's degree in Computer Application at CHARUSAT University, Changa. Currently he is doing research on IoT and M2M protocol and till date total three research and survey articles have been submitted in International Journal. He is currently a Technical Trainer / Corporate Trainer / Developer. He has taken 250+ seminars/webinars and workshops on iOS Application Development, Python, IoT, and Digital Marketing across Gujarat colleges and universities. He is a member of the Computer Society of India. Right now, He is an Apple Authorized Trainer.
	**Dr. Kalpesh A Popat** is currently working as Associate Professor at Marwadi University, Rajkot, Gujarat. He obtained his Master's degree in Computer Application from IGNOU in 2003. He is a member of the Computer Society of India. He has published 30+ Paper in International Journal. His research area is mobile computing.