ISSN (Online) 2394-2320

International Journal of Engineering Research in Computer Science and Engineering (IJERCSE)
Vol 5, Issue 5, May 2018

Development of IOT Gateway for Weather Monitoring

[1] Aniket S. Rokade, [2] Mahadev S. Patil
[1] Student, Department of Electronics and Telecommunication Rajarambapu Institute of Technology Sangli, India
[2] Professor, Department of Electronics and Telecommunication Rajarambapu Institute of Technology Sangli, India

***Abstract*— Internet of things is an emerging field in technology. The purpose of this project is to link the internet to the physical devices in the industry like sensors by the Gateway. Industrial IoT concept requires Gateway for secure monitoring of physical components. A microcontroller controls the sensors and transmits data through Gateway by GSM/GPRS module to the internet. The MQTT protocol is used as the Gateway. MQTT increases the security of data which gets the transfer from device to the internet. The result is a continuous sensor monitoring system which can be used to determine weather conditions.**

Keywords— Gateway, Industrial IoT, GPRS, MQTT.

I. INTRODUCTION

The fourth industrial revolution which was started in 2011 and which is defined by a collective term that is joining the internet technologies to industries creating a cyber-physical systems(CPS) surrounding. Later the CPS started to analyze physical processes depending on the sensor data. This tie-up between the internet and devices is termed as IoT and it is one of the most emerging fields of the 21st century. The weather monitoring is one of the important prospectuses of the society. Information regarding weather can be useful to decide various outcome on environmental changes and industry. With the emergence of the IOT it is seen that analyzing the physical constraints through sensors on the internet has become easy and less costly. Solar power station needs this statistical data of weather on regular basis to know the temperature, humidity and light changes in the surroundings. So, for this type of industrial concerns the concept of IIOT (Industrial Internet of Things) which is termed by General electronics in 2012. This includes a network of multiple devices connected by communications technologies that result in systems that can collect, monitor, analyze, exchange and deliver valuable new insights. These insights can be used for smarter, faster and safer business decision for industries. The ultimate goal is to create an IoT based platform for Weather monitoring. By using the gateway to calculate various factors such as Temperature, Pressure, Gas, Humidity. This information is sent to MQTT mosquito server. Sent information is displayed on a dashboard. Then the data is saved for further reference. This monitoring system can save lots of expenses on environmental damages, safety, human resource, goods and services. Thus, a useful system to implement.

II. LITERATURE SURVEY

Byungseok Kang, Daecheon Kim and Hyunseung Choo discussed the emerging of the gateways for the IoT. This paper illustrates the use of self-configuring gateway with real-time detection on the wireless network which can be useful for full automation. The use of integrated protocols for networking helps in storage and facilitates data flow securely. This transfer takes between devices and the cloud. That helps the gateways to communicate with control/sensors and customer. The mobile client connects with M2M (Machine to Machine) devices and endpoints are taken through IoT gateway. The architecture is capable of interacting with a non-smart device over AllJoyn framework. [1] Masoud Hemmatpour, Mohammad Ghazivakili, Bartolomeo Montrucchio and Maurizio Rebaudengo proposed a bridge between traditional industrial network and Internet of things. A gateway is designed to take advantages of many industrial solutions. Distributed industrial IoT gateway, called DIIG, is able to relay industrial network data to a centralized data-store. The real-time client-server programming model used by DIIG is based on S7 communication and Modbus TCP protocols. Also, the differences between PLC, SCADA as compare to IoT is explained. Performance analysis of gateway to achieving high-performance data transfer, good throughput and latency on IoT can be achieved. [3] Carles Gomez, Andrés Arcia-Moret, Jon Crowcroft explained the main IOT scenarios where TCP will be used. Describing the necessity from its historical reference to the future implementation and considering the role of TCP in IOT together, a

International Journal of Engineering Research in Computer Science and Engineering (IJERCSE)
Vol 5, Issue 5, May 2018

lightweight TCP implementation is necessary. TCP use in various IOT gateway protocols such as MQTT, CoAP, 6lowPan, AMQP is discussed. [5] Ala Al-Fuqaha, Mohsen Guizani, Mehdi Mohammadi, Mohammed Aledhari, Moussa Ayyash discussed protocols and application related to IOT. Study of protocols such as MQTT, CoAP, XMPP, DDS, AMQP. The advantages and disadvantages regarding these protocols and their usefulness in various environments [6] Ala Al-Fuqaha, Abdallah Khreishah, Mohsen Guizani, Ammar Rayes and Mehdi Mohammadi discussed the fragmentation process which is in between the use of protocols and the gateway. Current protocols lack the wide range of quality of service. Various performance test such as IP multitasking and traffic analytics techniques are conducted enhancing the MQTT protocol. [7] Lu Hou; Shaohang Zhao; Xiong Xiong; Kan Zheng; Periklis Chatzimisios; M. Shamim Hossain and Wei Xiang proposed a combination of HTTP and MQTT together for fast performance. This performance benefits the data transfer from physical devices to IOT cloud. For this, an architectural framework is defined in this paper [8]

III. PROPOSED SYSTEM

Fig1shows the overall block diagram of the project. In this at the start sensor data is sensed and read through various ADC pins present on microcontroller PIC32MX.

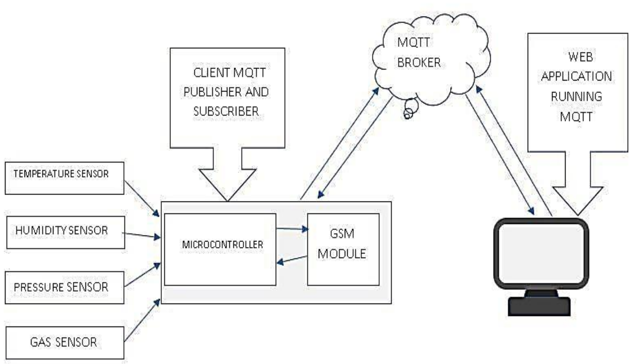


Fig.1.Proposed Block Diagram

Signal conditioning is done in order to match the calculations required for ADC conversions. Signal conditioning block converts an analog signal to specified voltage or current, this output will be used by ADC in the microcontroller to match that required voltage to start sampling. The sampling by sample and hold circuit gives a step output that can be converted into a digital signal. This digital signal is utilized by the microcontroller for programming and controlling the sensor. After the ADC conversion, MQTT client code is applied for gateway conversions. The MQTT stands for Message Queuing Telemetry Transport. A TCP/IP connection is established between the PIC controller and the MQTT broker TCP address. This creates a gateway connection between the sensors and the web server. The GSM/GPRS module acts as the wireless medium of transfer. AT commands are used to utilize the MQTT client and send the packets through GPRS internet service. For coding, the software's like MPLAB X ide is used. Before coding PIC32MX its datasheet should be thoroughly studied. Embedded C programming is used to work on MPLAB with the specific instruction set that varies from the microcontroller to microcontroller. MQTT client version should be embedded C compatible. Good use of memory on the microcontroller for each sensor increases the chances of accuracy and throughput of the Gateway. Purposed system is divided into two sections Sensing unit and MQTT Gateway Implementation.

A. SENSING UNIT

1.Controller:

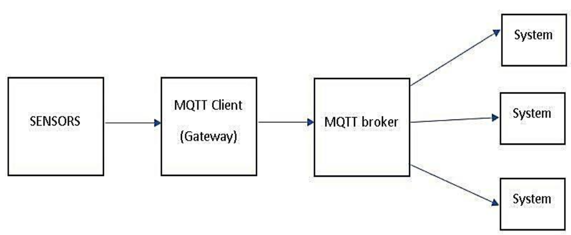
The microcontroller used here is PIC32. It controls the sensors and calculates the output. The MQTT client-side programming is done through the controller. GSM module is connected to the microcontroller for using the MQTT broker connection by GPRS. TCP connection is established through GPRS and the message is sent to the broker. [10]

2. Sensors:

In the block diagram, basic sensors that can be used in any industrial environment are selected. The Temperature sensor, Humidity sensor, Gas sensor and Pressure sensor. These all sensors are commonly used in various industries for weather monitoring. It will be easy to know the operating environment of the industry from a remote location. Due to this caution can be taken for any unusual change in recorded sensor data. [4]

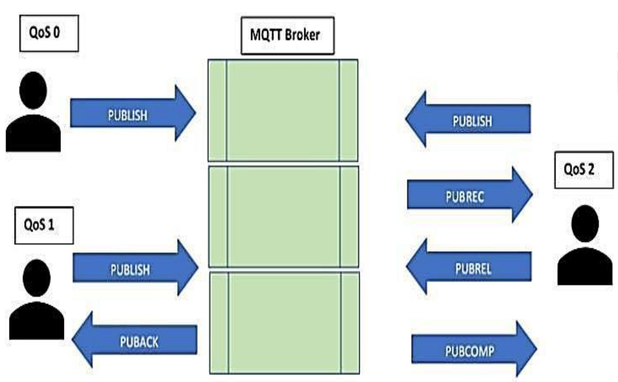
B. MQTT GATEWAY IMPLEMENTATION

Fig..2 Illustrates the MQTT gateway protocol. This is the software part where the sensor data from the controller is applied to MQTT client program and MQTT packet transfer program. As MQTT only transfers hexadecimal values the ASCII terms should be transferred or converted to hexadecimal values. The MQTT broker converts this hexadecimal value back to ASCII by this we can acquire the required data which we sent from the microcontroller. The MQTT use publish and subscribe method for transmission of packets. MQTT Client publishes the packet on MQTT broker. Various systems subscribe the service allotted by MQTT client on MQTT broker. This makes multiple engagements of systems from different handling protocols to subscribe to a common protocol by means of MQTT, thus acting as a gateway.



Fig,.2. MQTT Gateway implementation Block Diagram

MQTT increases the overall efficiency of the devices by using QoS (Quality of Service). This gives a guarantee of packet transmission on the network. It has three types QoS 0, QoS 1, QoS 2. [9]



1)QoS 0:

It sends the message at most once. The message is not acknowledged in this by the receiver. Storing and resending of the message is not possible for a sender.

II)QoS 1:

It sends the message at least once. The message is acknowledged in this by the receiver. If the acknowledgment is not received by the sender then it continuously sends duplicate flag until it receives an acknowledgment. Moderate overhead is present in this process.

III)QoS 2:

It sends message exactly once. The message is acknowledged in this by the receiver. This service is used when we require fixing delivery of the message. This technique has more overhead. MQTT uses TLS (Transport Layer Security) encryption which is not present in normal HTTP. Hence data can be sent securely over the network. The MQTT has short message header and packet size of 2bytes. As compared to MQTT the HTTP has lengthy header and message. So, by this, it is proved that this messaging technique is easy, more secure, efficient and less data consuming. [2]

IV. RESULTS

The result section includes the graphical representation of sensor readings on website and simulation of the sensor in accordance with the microcontroller. Fig..4 Shows the simulation in PROTEUS software arranging sensors with their signal conditioning elements is done. With the ADC outputs of connected sensors on LCD display. This virtual simulation of the sensor output is done in this process.

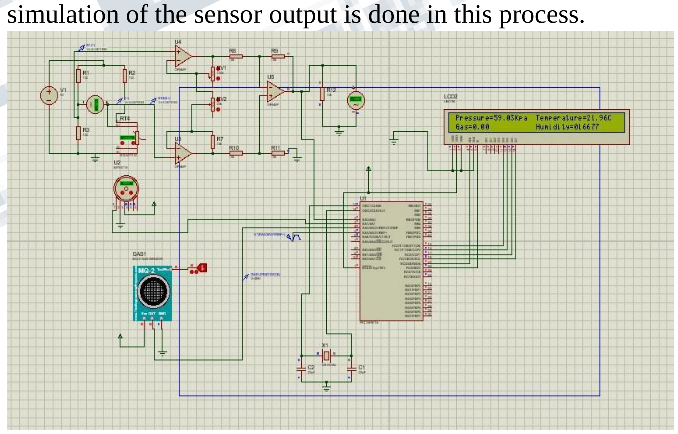


Fig.4. Simulation of project on Proteus

Table.1 and Fig.5gives the reference to the website based digital output for sensor readings. The readings are taken from 7:20 am to 10:05 am in the morning at Bavdhan, Pune. The readings show an increase in temperature and reduce humidity as time goes on. Also, the pressure decreases and reaches a common atmospheric value of 101.305kPa. Gases like CO2 and CH4 starts to increase in between 9 am onwards. These readings are stored on the server. Allowing us to download all past readings in the form of Excel sheet or PDF format.

TABLE I SENSOR TESTING ON WEB SERVER

ISSN (Online) 2394-2320

International Journal of Engineering Research in Computer Science and Engineering (IJERCSE)
Vol 5, Issue 5, May 2018

sensor readings

Time	Temprature	Humidity	Gas	Pressure
2018-03-14 10:04:33	31	25	8	102
2018-03-14 09:57:22	29	25	9	102
2018-03-14 09:30:04	28	26	7	102
2018-03-14 08:45:56	27	28	2	103
2018-03-14 08:45:54	27	28	2	103
2018-03-14 07:54:34	26	28	4	104
2018-03-14 07:52:39	25	29	3	105
2018-03-14 07:41:58	25	29	3	105
2018-03-14 07:39:33	24	33	6	107
2018-03-14 07:34:07	24	30	5	107
2018-03-14 07:25:42	24	33	6	107

This result is displayed on the adafruit.io website by means of mosquito server. On this website, we can apply triggers for the sensor readings. This function gives safety when the readings increase or decrease from the threshold level. If such situation arises an email or SMS is send to the subscriber.

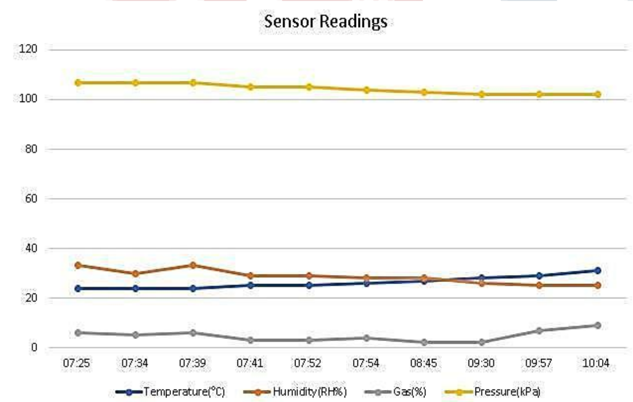


Fig.5.Sensor Readings

Fig.6 shows the change in latency for the topic. Each topic represents a sensor. The variation of sensing by the sensor in accordance with the time gives the latency. In below figure the latency variation is present between the time range of 14 seconds to 20 seconds. A constant latency over time increases the throughput of the system.

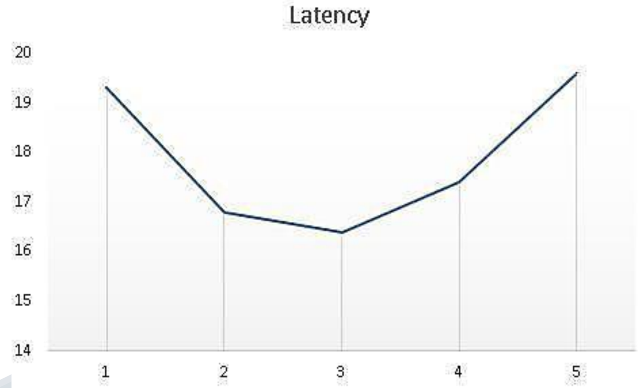


Fig.6.Variation of Latency with respect to Topic

V. CONCLUSIONS

The IOT gateway protocol applied in this paper is MQTT which acts as the bridge between the recent paradigm of the Internet of things and classical industrial network. Weather monitoring using MQTT protocol is used to generate the real-time sensing values with less maintenance. This protocol increases the overall accuracy of the system with less delay which is an important requirement for weather monitoring system. A comparison between HTTP and MQTT is done in order to check the benefits by using this protocol. Representation of the sensing values is done in interactive charts. Weather information in these charts is stored in My SQL database.

REFERENCES

[1] Byungseok Kang, Daecheon Kim, Hyunseung Choo, "Internet of Everything a Large-Scale Autonomic IoT Gateway," IEEE Transactions on Multi-Scale Computing Systems, vol. 3, no. 3, pp. 206 – 214, 2017.

[2] Michael W. Condry, Catherine Blackadar Nelson, "Using Smart Edge IoT Devices for Safer, Rapid Response with Industry IoT Control Operations," IEEE Journals & Magazines, vol. 104, no. 5, pp. 938 – 946, 2016.

[3] Masoud Hemmatpour, Mohammad Ghazivakili, Bartolomeo Montrucchio, Maurizio Rebaudengo, "DIIG: A Distributed Industrial IoT Gateway," IEEE 41st Annual Computer Software and Applications Conference, vol. 01, pp. 755 – 759, 2017.

[4] Kun Wang, Yihui Wang, Yanfei Sun, Song Guo, Jinsong Wu, "Green Industrial Internet of Things Architecture: An Energy-Efficient Perspective," IEEE

Communications Magazine, vol. 54, no.12, pp. 48 – 54, 2016.

[5] Carles Gomez, Andrés Arcia-Moret, Jon Crowcroft, "TCP in the Internet of Things: From Ostracism to Prominence," IEEE Internet Computing, vol. 22, no. 1, pp. 29 - 41,2018.

[6] Ala Al-Fuqaha, Mohsen Guizani, Mehdi Mohammadi, Mohammed Aledhari, Moussa Ayyash,"Internet of Things: A Survey on Enabling Technologies, Protocols, and Applications," IEEE Communications Surveys & Tutorials, vol.17, no. 4, pp. 2347 - 2376,2015.

[7] Ala Al-Fuqaha; Abdallah Khreishah; Mohsen Guizani; Ammar Rayes; Mehdi Mohammadi,"Toward better horizontal integration among IoT services," IEEE Communications Magazine, vol. 53, no. 9, pp. 72 - 79,2015.

[8] Lu Hou; Shaohang Zhao; Xiong Xiong; Kan Zheng; Periklis Chatzimisios; M. Shamim Hossain; Wei Xiang, "Internet of Things Cloud: Architecture and Implementation," IEEE Communications Magazine, vol. 54, no.12, pp. 32 - 39,2016.

[9] MQTT http://docs.oasisopen.or g/mqtt/mqtt/v3.1.1 /csprd02 /mqtt-v3.1.1-csprd02.doc :Version 3.1.1.

[10] S. Pooja; D. V. Uday; U. B. Nagesh; Shamitha Gurunath Talekar, “Application of MQTT protocol for real time weather monitoring and precision farming,” International Conference on Electrical, Electronics, Communication, Computer, and Optimization Techniques (ICEECCOT), pp.1 – 6,2017.