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# Industry 4.0 Implementation using 4G/LTE for Smart Food Processing Industry

**Vipul Khandare*[1], Dimple Agrawal[2]**
Silver Oak Collage of Engineering and Technology, Ahmedabad, Gujarat, India

## ABSTRACT

Day by day Internet User and Mobile User are Increase in Word Wide. Now a days in Telecommunication Long Term Evolution (LTE) as the fourth generation (4G) cellular system is capable of providing high data rates as well as support of high-speed mobility. Even though LTE promises a faster and more efficient mobile data Or Internet network Which Making various connectivity Communication. The Internet of Things (IoT) is a mechanism, which provides communication between human to machine and machine to machine. Moreover, IoT connectivity mechanism is possible only by it's different protocols. This paper work contains previous comparison results of IoT protocols. However, the key aspects of this paper is to implement the MQ Telemetry Transport (MQTT) protocol on open source platform in context with Industrial Environment, to get real Time data monitoring and controlling. In addition to that, real time data for industrial environmental information of different plants, such as temperature, pressure, humidity need to be monitor with mobile device and control rooms. Industry 4.0 is the smart factory model, in which, large amount of data environment) can be monitor and controlled with the use of 4G/LTE Wi-Fi, Internet of things (IoT), cloud computing (CC) and cyber physical

**Keywords:** Industry 4.0, LTE, 4G, IoT

## I. INTRODUCTION

Now a day in a smarter embedded world, have IoT (Internet of Things). IoT have lot of things for the embedded systems, and machine to machine (M2M) communication, and it has the potential to transform our world with the help of it. MQTT (Message Queue Telemetry Transport) is an IoT standard protocol. It is Client-Server, based publish/subscribe messaging transport protocol. It is light weight, open source, simple, and can be designed such way that, we can easily implement in embedded devices, and IoT based systems/applications. These characteristics make it ideal for use in many situations, including IoT based various applications, embedded systems, and communication in Machine to Machine (M2M) where a small code footprint is required and/or network bandwidth is at appreciate."

"Smart sensors are major aspect of IoT. Once you have real time data of various environments then actions can be taken easily based on that Wi-Fi based smart connected sensors. With the help of smart sensors, Wi-Fi module, MQTT protocol and IoT based various application, we are making system which used for monitoring sensors data like, Temperature, Humidity, Pressures, and Altitude of selected area where this system placed."

## II. RESULTS AND DISCUSSION

We are implementing the MQTT protocol to monitor the real time data of the industrial sensors. Sensors

provides temperature, pressure, altitude, humidity, fire alert, real-time and air quality detection and these sensors data will be publishing to the broker with the use of MQTT protocol with internet connection as well as local connected devices. Also, for monitoring the sensors data we are using android application for the mobile devices and for the computer we are using the MQTT Lens utility.

### A. AM2302 Sensor

The AM2302 sensor is for the humidity measurement. We are using this sensor for the monitoring the humidity inside industries. It is capacitive humidity sensing, which contains the compound has been calibrate digital signal output of humidity and temperature. It is small size, low power consumption, signal transmission distance up to 20 meters. Moreover, it's operating voltage range is 3.3V to 5.5V. Also, it's resolution is 0.1%RH, Accuracy at 25℃ is ±2%RH and measurement range is between0 to 99.9 %RH [1].

This sensor is also providing the temperature data because atmospheric temperature on the industry needs to be monitor continuously for the safety of the workers as well as for the sensitive component used outside the industry, though we are interested in the humidity as well as temperature because it's temperature range is between -40 to 80 ℃. Also, it's resolution in is 0.1 ℃ with 16bit [1].

### B. BMP180 Sensor

For temperature, pressure, and altitude we are using BMP180 sensor, it is the new digital barometric pressure sensor of Bosch Sensor Tec, with a very high performance. It consists of a piezoresistive sensor, an analog to digital converter and a control unit with E2PROM and a serial I2C interface. The E2PROM has stored 176 bit of individual calibration data. The pressure and temperature data has to be compensated by the calibration data of the E2PROM of the BMP180 [2].

After sending a start sequence to initiate a pressure and/or temperature measurement and its conversion, the result value (pressure and/or temperature) can be read via the I2C interface. Therefore, calculating temperature in ℃ and pressure in hPa, the calibration data has been used [2]. These constants can be read out from the BMP180 E2PROM via the I2C interface by software initialization. The sampling rate can be increased up to 128 samples per second (standard mode) for dynamic measurement. It is low cost, very tiny sensor device, with three industrial environmental data parameters capture like, temperature range between -40 ºC to +85 ºC, pressure range between 300 to 1100 hPa, and give accurate altitude changes from reference height. It also operates in low power supply range 1.8 V to 3.6 V DC as per specification manual of this product [3].

### C. MQ-135 Sensor

MQ-135 is gas sensor. MQ-135 gas sensor applies SnO2 which has a lower conductivity in the clear air as a gas-sensing material [10]. In an atmosphere where there may be polluting gas, the conductivity of the gas sensor raises along with the concentration of the polluting gas increases. MQ-135 performs a good detection to smoke and other harmful gas, especially sensitive to ammonia, sulfide and benzene steam. Its ability to detect various harmful gas and lower cost make MQ-135 an ideal choice of different applications of gas detection. Moreover, MQ-135 is sensing gases like NH3, NOx, alcohol, Benzene, smoke, CO2 and many more [10]. For the safety and security purpose in the industry it needs to be placed and in real time scenarios it needs to be sensed so the worst can be prevented.

### D. SIM 7100E Module

SIM Com presents an ultra-compact and reliable wireless module SIM7100E which is based on Qualcomm MDM9215 multiple mode LTE platform. SIM7100E is a complete multi-band TDD-LTE/FDD-LTE/WCDMA/GSM/GNSS SMT type module designed with very powerful processors integrating application core Cortex A5(550MHz),three QDSP6 cores (Up to 500Mhz), allowing customer to benefit

from small dimensions and cost-effective product solutions. It has strong extension capability with rich interfaces including UART, USB2.0, SPI, I2C, Keypad, PCM, etc. With abundant application capabilities like TCP/UDP/FTP/FTPS/HTTP/HTTPS/SMTP/POP3 and MMS, the module provides much flexibility and ease of integration for customer's applications. [17]

| General features | |
|---|---|
| • Five-Band FDD-LTE B1/B3/B7/B8/B20 | • Supply voltage range: 3.4V~ 4.2V |
| • Dual-Band TDD-LTE B38/B40 | • Operation temperature: -40 to +85 |
| • Dual-Band UMTS/HSDPA/HSPA+ B1/B8 | • Dimension: 30 X 30X 2.9 mm |
| • Dual-Band GSM/GPRS/EDGE 900/1800 MHz | • Weight: 5.8g |
| • Control Via AT Commands | • GNSS:-GPS One Gen 8B; standalone; assisted, XTRA; |

### E. MQ Telemetry Transport (MQTT) Protocol

MQTT is the proposed protocol that we are using for making the Industry 4.0 as a reality. MQTT is the lightweight protocol. It is unlike the request response type protocol. Moreover, MQTT uses the broker as server and broker will provide between the sensor to remote devices to monitor the data with the use of the
Subscribe and publishing topic [8].

MQTT works with four major components. The foremost component of MQTT protocol is broker. Broker is same like a server but here broker will automatically allow to connect the different devices with the use of three different Quality of Services (QoS) [7].

In order to connect with the broker and getting the data second component come to picture. Second component of MQTT protocol is topic. Topics generally works as an identity of the information provided by the sensors as well as the devices which may get the information based on the same topics. Now to send the data and to receive the data MQTT protocol has another two terms named as Publish and Subscribe. Publish means, it sends the data to the broker and Subscribe means, it will get the data from the broker. In addition to that, publishing information on the topic (Topic like "Temp") will be send the information to the broker and at the subscriber side if the subscribing topic (Topic like "Temp") is same as the publishing topic then at subscribing side the information will be reached [6]. Unlike a traditional request response type protocol. MQTT is work with publish subscribe type protocol. Once the device needs to be connected to the broker device will send the Connect message to the broker, after that broker will send the Connect message to the device. Once the device is registered with the broker then it will get all the information regarding the topics on which it subscribed, also it can send the information to the same topics by publishing the information [8] [7] [6].

Only one time it required to connect to the broker and then it will automatically have connected with the broker when the connection get lost. It is possible because broker will continuously send the keep alive message check the device is connected or not. In addition to that once, the device may have disconnected for some time and then reconnected then again it will start to receive the data provided by the broker with QoS. We are using this protocol to our system to monitor the sensors data in real time scenario.

### F. COMPARISION OF MQTT, CoAP, AMQP, HTPP

For many years HTTP has been used as the reference
Communications protocol in this context. HTTP is a very wide spread protocol, and APIs for its use are available basically for every programming language. However, in the new era of internet technology there are various protocols has been introduced in last 5 to 6 years. Advance Message Queuing protocol (AMQP),

MQ Telemetry Transport protocol (MQTT), Constrained Application Protocol (CoAP) and many more.

Every single protocol is used for the particular application [12] [13]. Every system does not require a same protocol as we all used in the traditional way HTTP were used. Now a days Internet of Things protocol are used in many different application likes industrial application, medical application, military application, commercial communication application etc. So, based on the comparison of different protocols we have choose the MQTT protocol in context with the industry 4.0. We need to identify the requirements of the industry 4.0 and based on the requirements we have to find which protocol will be the best solution for our application. Moreover, we have made an analyses that industry 4.0 requires a continuous connection with the server in order to send the data in the real time scenario for that it does not required a large amount of bandwidth, power consumption of needs to be lesser means more energy efficient, at the loss of connection it needs to be connected automatic with the server, losing the connection and reconnects events needs to be FIFO (First Input First Out) because in the industrial environment if the real time data will be delayed or not shown at the connection re-established then the worst may happen and it damage the company revenue. Also, the system needs to be protected, data or the information provided by the system will be securely send to server and no external traffic affects to that system. AMQP will not be used for our system because connect and disconnect will change the information sequence from FIFO (First Input First Out) to LIFO (Last Input First Out). HTTP will not be used for the system because it is request response type protocol, also it consumes more bandwidth so more energy it requires so it is not used. CoAP will not be used for our system because packet loss rate under degraded network condition as well as implementation of CoAP is more complex due to its unavailability s open source [12] [13]. With the above mention requirements and comparison of the protocols, we found the MQTT protocol as the best solution for the industry 4.0 make a reality term.

### G. 4G/LTE

The fourth generation of wireless standards for cellular systems is 4G, the planned successor to the 3G standard. The ITU (International Telecommunications Union) has specified that the peak speed requirements for the 4G standard are to be 100Mbps for a mobile connection (such as in a car) and 1Gbps for stationary connections (such as sitting at a computer). 4G services that meet these requirements are not publically available yet (as of June 2011) but telecommunications providers are looking to upgrade their infrastructure to cater for 4G services in the not too distant future. The 4G service is set to offer a fast and secure all-IP, roaming mobile broadband solution to devices such as laptops with wireless 4G modems, 4G smartphone mobile phones and other 4G mobile devices that require internet access with speed intensive facilities being made available, including on-demand HD television, IP telephony, on-demand gaming and, of course, high speed internet access.

Currently marketed technologies such as LTE (Long Term Evolution) and Wi-MAX have been around for a few years and are being marketed as 4G whilst not meeting the requirements set by the ITU. It was recently announced that these services could continue to be marketed as 4G as they are precursors to the IMT-Advanced, 4G standard whilst also operating on the same basis of technology; however, these should really be considered as "Pre-4G" or "3.9G" as they technically do not offer the required data rates of (stationary) 1Gbps. The ITU has recognised two standards that are planned to meet the 4G IMT-Advanced requirements put forward by the two groups, 3GPP and IEEE. These are the LTE Advanced and Wireless MAN-Advanced (Wi MAX-Advanced) standards and will almost certainly abandon the old spread system technology found in

3G systems for OFDMA and other equalisation schemes, use MIMO technology, channel-dependant scheduling and dynamic channel allocation... all technologies that are being found on new, modern wireless networking equipment.

### 4G/LTE Application

- 4G Ultra high speed internet access - E-mail or general web browsing is available.
- 4G Data intensive interactive user services - Services such as online satellite mapping will load instantly.
- 4G Multiple User Video conferencing - subscribers can see as well as talk to more than one person.
- 4G Location-based services - a provider sends wide spread, real time weather or traffic conditions to the computer or phone, or allows the subscriber to find and view nearby businesses or friends whilst communicating with them.
- 4G Tele-medicine - a medical provider monitors or provides advice to the potentially isolated subscriber whilst also streaming to them related videos and guides.
- 4G HDTV - a provider redirects a high definition TV channel directly to the subscriber where it can be watched.
- 4G High Definition Video on demand - a provider sends a movie to the subscriber.
- 4G Video games on demand - a provider sends game data directly to the subscriber where they can play in real time.

### G. Proposed System and Figure

Aim of this research is to monitor the industrial sensors data in real time scenarios. Also it needs to be stable, very low cost, light weight, low power consumption. This system is used to monitor and control the industrial sensors data with the use of 4G/LTE module and implementing the MQTT protocol can get the data to the internet connected devices as well as local area connected devices. Here, given proposed monitoring system diagram.

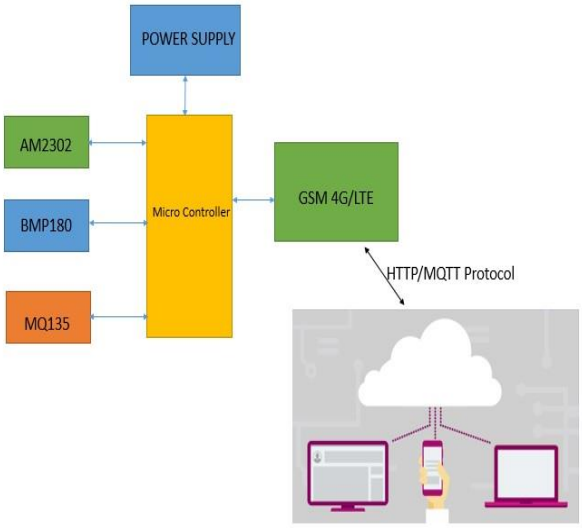


Figure 1 Proposed Monitoring System

As mention the component details in above section, we have used these sensors PT-100, AM2302, BMP180, and MQ-135. All the sensors have produced the output, which has been processed by the microcontroller. Microcontroller sent the data to the 4G/LTE module. Moreover, MQTT was implemented in the 4G/LTE
Module as shown in the below figure.

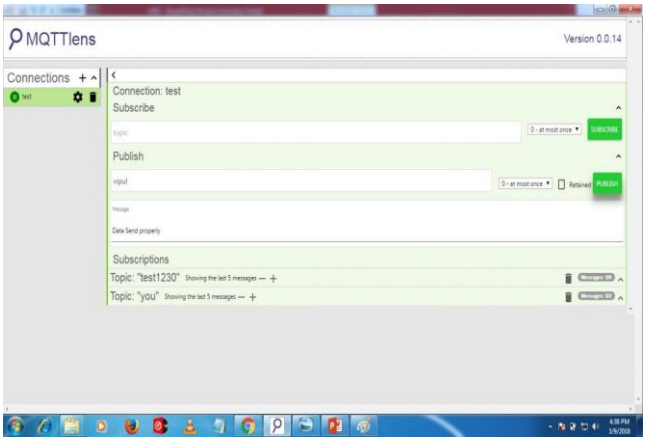


Figure 2 Creation of Topic in PC/Laptop

Here, we are using the open source broker provided by the eclipse corporation. Port number for the MQTT broker as per the security level is fixed 1883. In Figure 2 we Create Topic at PC/Laptop side and Publish the Data. Online mode will work when the

internet connection will available and sensors information needs to be monitor from anywhere on the earth with the use of mobile devices. In Figure 3 we Create Topic at mobile side and publish the Data.

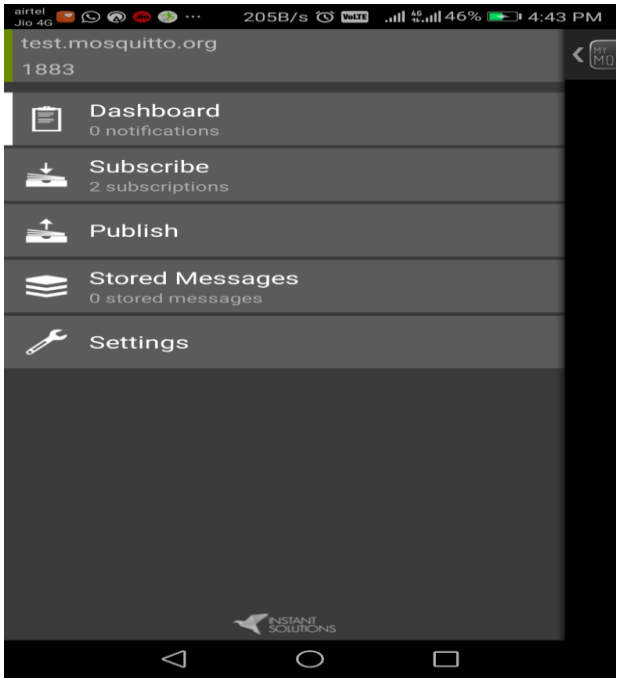


Figure 3 Creation of Topic in mobile

In Figure 4 4G Module are Activated and Establish the Connection
Between Sensors to Microcontroller and 4G Module.

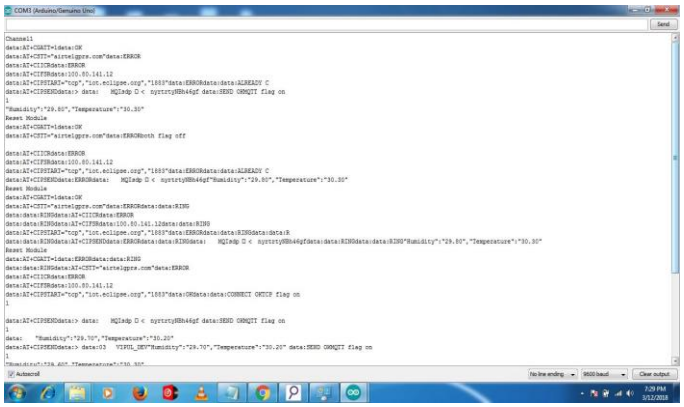

Figure 4 Device Connection

## H. EXPERIMENT RESULT

In Figure 5 Temperature and humanity data are Receive in PC/Laptop. Here we show the Topic name is same .

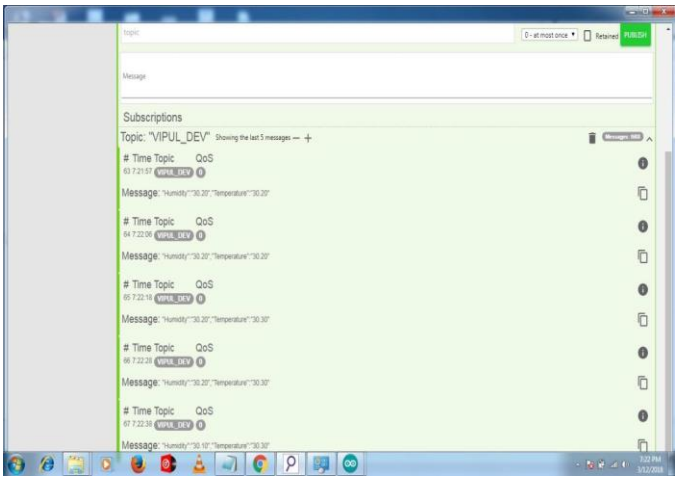


Figure 5 Data Receive in PC/Laptop

In Figure 6 Temperature and humanity data are Receive in Mobile.


Figure 6 Data Receive in Mobile

## III. CONCLUSION

With this paper, we have shown, the industrial sensors Information monitoring system, which is low cost, low power and real time based. Industry 4.0 is

the term associated with the Internet of Things and with the help of MQTT protocol we have provided the real time data monitoring for the smart production as well as industrial safety purpose. As a part of future work, we have found that the proposed system which we had shown in this paper is we can control sensors at remote Distance. In future mesh node network implementation will help to cover every corner of the industry. Moreover, from the security point of view we will allot the SSL certificate based machine to machine communication so that no one outside of the industry will subscribe to the sensors topics.

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