

Intelligent Parking Cloud Services based on IoT using MQTT Protocol

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Abstract : *This paper presents the concept of vehicular cloud service network using IoT and Cloud together. Both these technologies (IoT and Cloud Computing) are able to solve real time problems faced by population. The tremendous growth of Internet of Thing(IoT) and Cloud Computing together have provided great solution to the increasing transportation issues. In this paper we propose, creating vehicular cloud service network using MQTT protocol. The main objective of this paper is to design a cloud vehicular service for parking purpose based on the basic communication principle of MQTT protocol. We propose an intelligent parking space services to make IoT more suitable for both small-sized and large-scale information retrieval by cloud. This paper briefs the most emerging paradigm of IoT in parking cloud services.*

Keywords— Internet of Things, Cloud computing Vehicular information network, MQTT.

I. Introduction

Internet of Thing(IoT) is a new era technology that connects different Things to a network[9]. Internet of Things is in early stage, as number of researches are going on with respective different areas. The integration of cloud and IoT technologies are bringing major revolution in different organizations[10]. Both these technologies have shown great significance in terms of healthcare, infrastructure, manufacturing, transportation etc. Now a days, vehicular information network technology have also gained much popularity in IoT. In vehicular information network, vehicles that act as nodes can communicate with their infrastructure through network[1][3]. Now a days, manufacturers are making so high-end technology vehicles. All those vehicles are heavily equipped with sensors and some communication devices so that vehicles can retrieve information. Retrieving and exchanging information with external environment are done over number of protocols like Tcp/Ip, Http, MQTT, COAP etc[2].

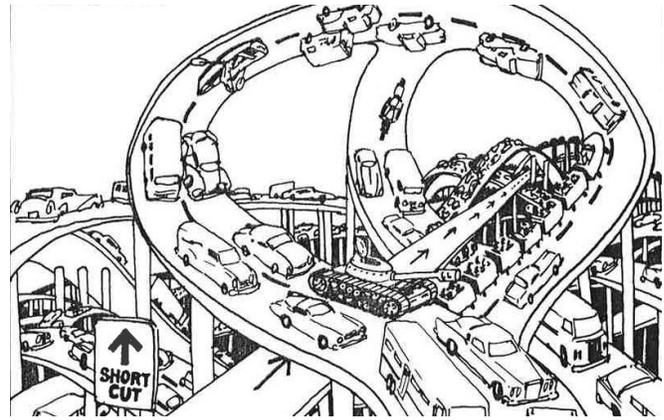


Fig:1.Traffic Congestion

The tremendous growth of Internet of Thing(IoT) and Cloud Computing together have provided great solution to the increasing transportation issues such as traffic problem, congestion problem, road accidents. Figure 1 shows clearly the traffic congestion problem. IoT has shown peculiar interest in transportation area. In transportation area IoT is in its early phase. Number of researchers have given theoretical solutions related transportation problems. Managing vehicle population in metro cities are very challenging task because day by day the population of vehicles are increasing as the population of people. Due to this increasing population living things and environment are suffering from number of problems such as, traffic congestion problem, road accidents, pollution and health problems(e.g. human beings are also facing psychological frustration)[1].To this end, we propose an intelligent parking system that helps in decreasing the problems facing due to increase in transportation. As due to increase in population the transportation related problem also increases. Thus its necessary to have an efficient and scalable parking system that should be able to solve real time problems facing due to vehicle population.

This paper demonstrates our contribution towards creating intelligent parking system in vehicular information network using MQTT protocol. The main objective of this paper is to design a cloud vehicular service for parking purpose based on the basic communication principle of MQTT protocol. We propose an intelligent parking space services to make IoT more suitable for both small-sized and large-scale information retrieval by cloud.

II. Related Work

a. Vehicular Information Network

Now a days number of vehicles are connected with internet. In development of vehicular network, wireless technology plays a vital role for communication purposes. The number of vehicles that are internet connected increases day by day and run more advanced applications to communicate with their infrastructure..

Josiane Nzouonta, Neeraj Rajgure authors stated that the vehicular information network is an ecosystem of sensed data collection by sensors[8]. The collected data usually include traffic pattern, pollution traces in environment and health care data so as to monitor and analyse driver's physical status. Authors present a class of routing protocol called RBVT for real time traffic vehicular information.

b. Cloud Computing

Authors Rong Yu, Guangdong proposed different approaches to design a vehicular cloud, a roadside cloud, and a central cloud[3]. In automotive domain cloud computing is playing a vital role which is considered to reform the vehicular software and services provided by them. The delivery of services to the end consumer is the main function of cloud computing. In cloud paradigm, wireless sensor network is considered to be fully responsible for sensing data around them. Since Internet of Things are having limited storage and processing power while cloud is considered to offer large storage and processing capabilities than Internet of Things. That is why integration of Internet of Things with Cloud computing is necessary to solve real time problems[10].

c. Internet of Things

Authors Ala Al-Fuqaha, Mohsen Guizani stated the concept of "Internet of Thing" is to change the world to look ubiquitous form[2]. IoT is a fast emerging technology that truly changes the view of internet by providing ip addresses to the physical objects connecting with each other into network[9]. This emerging technology is expected to solve the number of problems related to the transportation area. Now a days manufacturers are manufacturing so high end technology vehicles, those vehicles have powerful sensing capability to sense the data around them. This sensing capability is provided by the sensors (Internet of Thing) connected to the vehicles. Due to this capability IoT technology proves to track the vehicle's current location, monitor driver's movement etc. Authors Wu He, Gongjun Yan stated that the integration of cloud with IoT proves to be unique solution provider for solving real time problems of transportation[1]. Its due to IoTCloud technology, the intelligent parking system concept is possible to develop/deploy in real time to monitor and avoid road congestion ,traffic problem and maintain pollution level. But authors failed in proving scalability, performance and quality of service.

d. Overview of MQTT

Authors Ala Al-Fuqaha, Mohsen Guizani, Mehdi Mohammadi stated the definition of Message Queue Telemetry Transport protocol(MQTT) that is based on Client Server architecture[2]. This messaging protocol is introduced by an IBM developer Andy Stanford-Clark in 1993 and was internationally standardized in 2013. Embedded devices and networks are connected with application through MQTT. MQTT provides communication facilities among connected embedded devices and application. Using MQTT, data packets can follow three routing mechanisms (one-to-one, one-to-many,many-to-many).MQTT follow the publish/subscribe pattern for communication where publisher publishes the topic and subscriber subscribes the topic. Fig. 2 clearly depicts the architecture of MQTT having three main components, Subscriber, Publisher, Broker. All three components have their independent work mechanism. Both Subscriber and Publisher are MQTT clients where Subscriber would be registered by an interested device and subscribes to topics

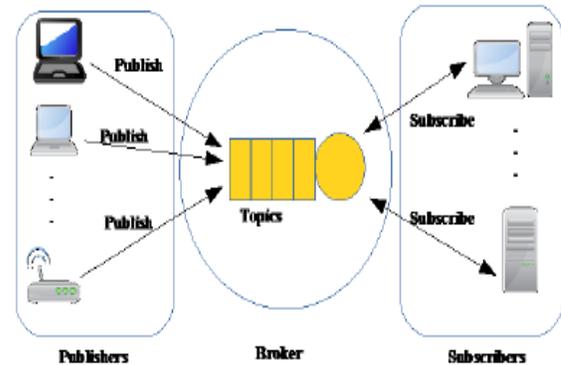


Fig. 2 MQTT Architecture.

through Broker which acts as a server. The publisher client acts as a data generator that publishes the interested information to subscriber through Broker. For Internet of Things and M2M, MQTT protocol proves itself an ideal messaging protocol for communication.

III. Existing System

[Wu He, Gongjun Yan] proposed intelligent parking cloud service. They have given a modular software architecture approach in theoretical terms where they stated that each vehicle is equipped with transceiver that is Bluetooth or infrared devices and a processor also for computational purposes[1]. They have designed a parking lot using infrared devices or WIFI network. The disadvantage of this existing system is, it works on the normal Https protocol that is based on request and response process. The existing algorithm (Http over Secure Socket Layer) and mechanisms are not able to meet all the requirements (Scalability, Performance, Quality of Service) at the same time. This system proves failure to be scalable to handle number of vehicles at a time and it consumes lot of battery power. There is also time latency problem while delivering response to end client. So this existing system needs

to improve the communication reliability. Thus it is very important to enhance the existing system by using MQTT protocol approach facing psychological frustration). In this paper we are proposing intelligent parking cloud service using MQTT protocol. This system will automatically help in controlling the traffic congestion problem.

IV. Proposed System

In this paper, we propose an intelligent parking cloud services which will overcome the drawbacks of an existing system. Fig. 8 is the architecture of proposed system. The architecture of proposed system depends upon the microcontroller board design .It consists of an arduino board, an ethernet shield and IR sensor.

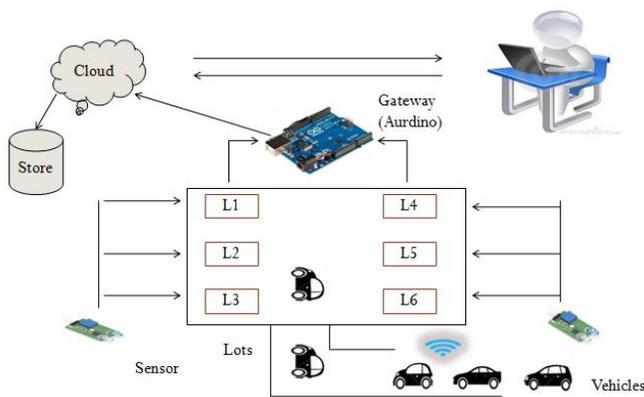


Fig. 8 Proposed Architecture

A. Arduino Board:-



Fig. 9 Arduino Board

Fig. 9 is the image of Arduino Board that earlier was designed by arduino company. It is a hardware device which is used for the interaction purposes with other objects like sensors and controls the things around us.

B. Ethernet Shield:-



Fig. 10 Ethernet connected with Arduino Board

Fig. 10 is the image of Ethernet shield connected with Arduino device. The Ethernet shield has pin layout structure that intact and allow other devices to be stacked on its top. Due to this it will allow arduino to connect to the internet. Ethernet shield is connected with system(Laptop) by using Ethernet cable(RJ-45).

In proposed system, parking lots are fitted with IR sensors. When vehicle enters the parking space area, the user will park its vehicle in that parking lot which was reserved /booked by him/her earlier through the system. Then the sensor senses the vehicle and update data to the cloud through the connected gateway(Arduino) that the space is occupied by some vehicle. There will be the end user who uses the remote parking service available on cloud. User will also monitor which parking lot is available or which one is vacant.

1. Comparison Analysis

Packet Size:-

The size of data packets in Http is up to 2Kb is more than the MQTT which is having packet size up to 2bytes. We have captured the MQTT and Http data packets using Wireshark tool, to analyse the packet size difference between MQTT and Http.

• Using MQTT protocol:-

We have connected MQTT client to Eclipse server where MQTT broker is installed (MQTT lens).

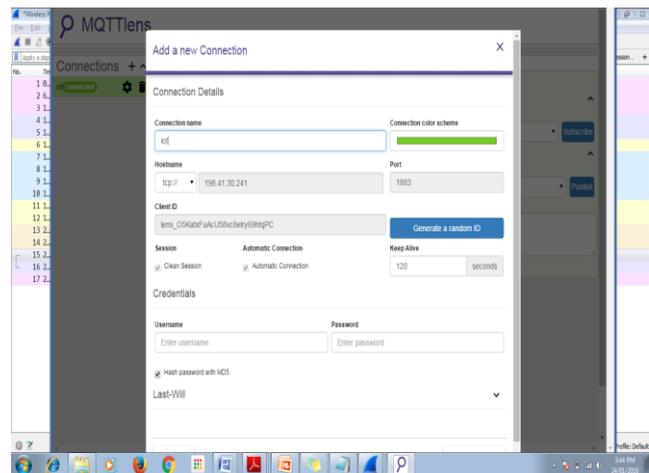


Fig. 3 MQTT Client Connection.

Then we have captured the MQTT packet using wire shark. Fig. 4 clearly shows the data packets sent through the MQTT protocol.

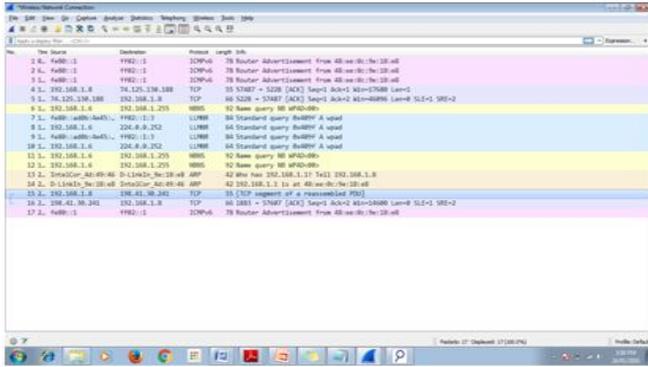


Fig. 4 Packet Size.

• Using Http Protocol:

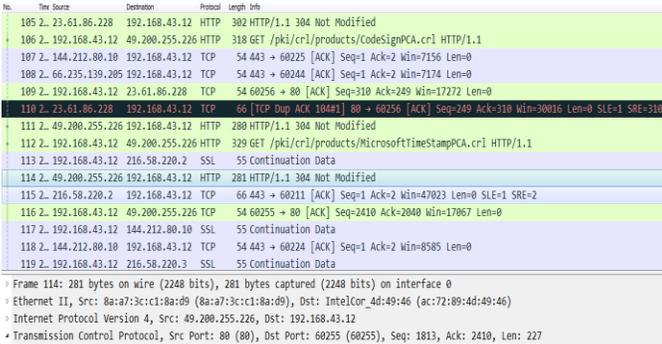


Fig. 5. Packet Size

Fig. 5 clearly shows the packet size through the Http protocol. From the above two packet size figures, its clear that Http packet size is more than the MQTT packet size.

2. Power Consumption:-

While using Http, battery used for creating and maintaining a connection is more than the MQTT protocol. Fig. 6 shows the graphical representation of power consumption while using WIFI network.

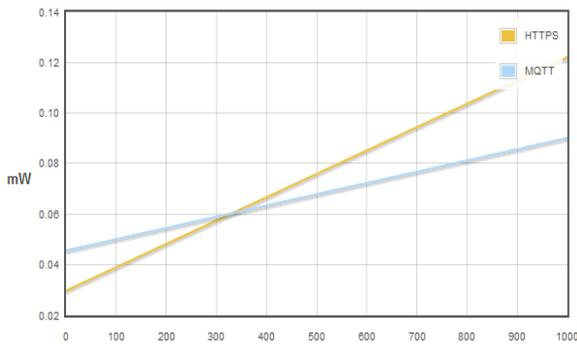


Fig. 6 Power Consumption.

3. Time Latency:-

Fig. 7 shows the time latency between Http and MQTT protocol. The time delay in fetching or receiving the data is slightly more in Http than MQTT. It is due to the reason of large packet size of Http takes time delay to fetch or receive the data.

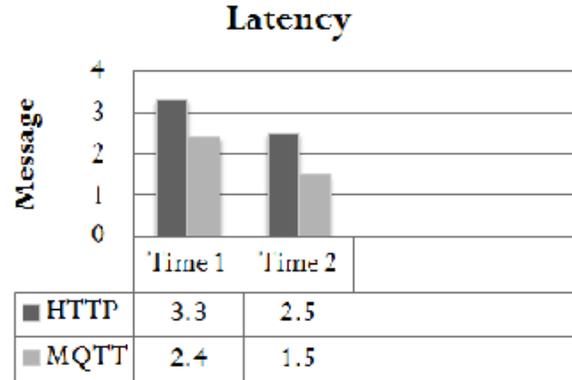


Fig. 7 Time Latency.

V. Mathematical Model

Let S be “Parking” model such that

$$S = \{v, t, \mu, \lambda\}$$

Where

- v=Number of vehicles
- t= Time frame
- μ=Death/Vacant rate
- λ=Birth/occupy rate

$$\{X(t); t > 0\}$$

Where X(t)=number of slots occupied in time ‘t’

Occupied slot at time ‘t’ is:

$$X(t+h) = i+1 | X(t) = i = \lambda h$$

Above equation states that number of vehicles occupied space at time will be i+1, as vehicles get incremented by i, for all i= 0,1,..... and λ gives the birth or occupy slot rate of vehicles.

Vacant slot is:

$$X(t+h) = i-1 | X(t) = i = \mu h$$

Above equation states that number of vehicles vacate their parking space at time will be i-1, as vehicles get decremented by i, for all i= 0,1,..... and μ gives the death or vacant slot rate of vehicles.

Results

We have worked on the analysis part of the project. We have clearly differentiated the differences between the protocols (Http and MQTT) using wireshark tool. We have practically analysed that MQTT protocol is superior than Http protocol.

• Outcome of System

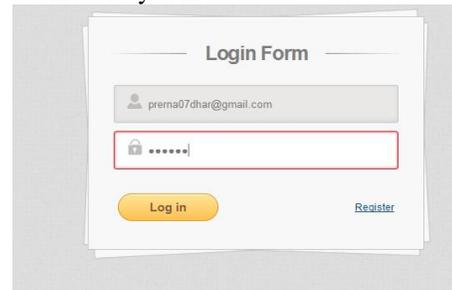


Fig:8 Login Page

Fig. 8 is login form, we first login to the system. After login our system will connect to the AWS (Amazon) server.

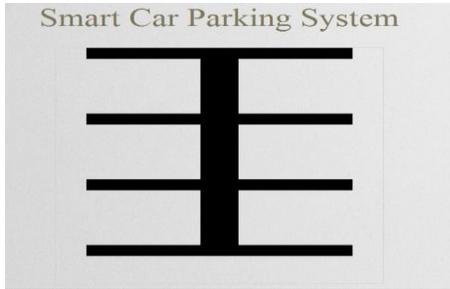


Fig. 9 Parking System

Fig. 9 is parking system that will get uploaded after connecting with cloud server.

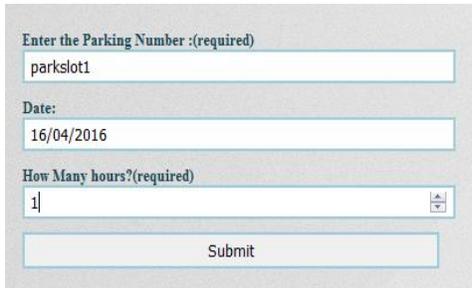


Fig. 10 Publish console

Fig. 10 is publish console where client will enter the available parking slot with required date and time(for how many hours..).

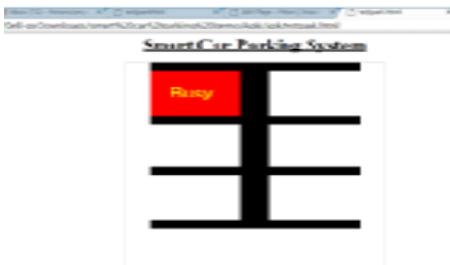


Fig. 11 Occupy Slot

Above Fig.11 appears after reserving slot i.e parkslot1.Parkslot will appear in red color showing text as "Busy".

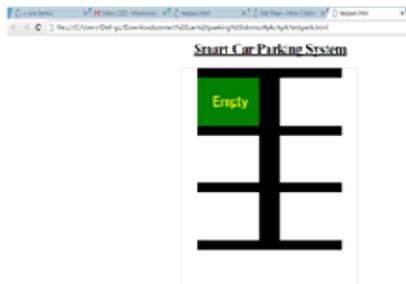


Fig. 11 Vacate slot

When client vacate that reserved slot, system will make that slot to appear in green color showing text as "Empty".

Conclusion

The conclusion of the proposed system is that this system is so intelligent that helps in avoiding the increasing traffic issues in the heavy parking areas like shopping malls and other hectic areas like road side unit. Due to this it will ultimately or slowly help in reducing traffic problems, road congestion and also save the fuel of vehicles and thus reduce the rate of pollution in environment.

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