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Study on the MQTT protocol design for the application of the real-time HVAC System

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Abstract

In this paper, the existing domestic HVAC systems, devices TCP / IP does not support the most, thereby, not performed remote management, it is necessary to regularly field service, inefficiency and cost bring a burden. This is through a comparison of the IoT-based primary, real-time protocol of what has become a hot topic recently, to be able to control and real-time monitoring through the CCU device in the HVAC system. Compare for this Internet of Things device for real-time monitoring and control of the XMPP, CoAP, MQTT main real-time protocol is used on. Finally, flexibility, light weight, based on MQTT a two-way messaging protocols with reliable message delivery, implements the protocol on the real-time HVAC system in the cloud platform.

Keywords: *MQTT, HVAC, Cloud, Real-Time*

1. Introduction

Supply companies has increased to provide a TCP / IP-based HVAC system. The purpose of these systems is to provide a system such as cost reduction, reduction of energy consumption through decisions based on real-time data. Existing HVAC system is operated to build a server system for each administration site, thereby, it is impossible to individual management program is an integrated management It should be developed.[5] Accordingly, by constructing an integrated management system for mobile based cloud environment, it can reduce the cost, can be monitored and controlled on a mobile device, to provide management mobility and convenience. Further, in order to control and manage the information of the various HVAC system that is distributed across a plurality of scene in real time, only the existing HTTP protocol reduction of speed and reliability, such as reduction of the battery and Performance Polling used problems occur. Therefore, in this paper, to compare the IoT of protocol for real-time control.

Then, select the protocol suitable for implementation of event-based monitoring and intelligent control of a comparison protocols, provides real-time HVAC system design through the selected protocol.

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2. Related Research

2.1 CoAP(Constrained Application Protocol)

CoAP in CoRE (Constrained RESTful Environments) working group of the IETF, an international Internet Standards Organization (Internet Engineering Task Force), RESTful that has been developed for use in low power consumption, the sensor node with a low-capacity memory environment which is the base of the Web transfer protocol. Further, since it is designed to allow easy interfacing with HTTP for integration with the Web, it can be easily coupled with existing web services, satisfying the multicast support, requirements such as low overhead. [6]

These CoAP in order to asynchronous transfer with the UDP-based, for the transmission of reliable message, consists of four messages(Confirmable, Non-confirmable, Acknowledgement, Reset message), send messages to the interaction of the request / response of these messages.

The advantage of CoAP protocol, according to the use the UDP protocol, smaller overhead than the TCP, and that a small amount of data transferred in comparison to HTTP using ASCII header that uses the binary header, existing it is that it is possible to easily interlocked and Web services using the HTTP. On the other hand, there is a disadvantage that the overhead when using TLS for security is increased.

2.2 MQTT(Message Queuing Telemetry Transport)

MQTT (Message Queuing Telemetry Transport) is a messaging protocol that IBM and Arcom in 1999 has been developed for the purpose of use in a network with the memory space is a small device, low-bandwidth, long delay time. MQTT is, effective message sender in the pub / sub-based messaging protocol (publisher) to a large number of client connections, issued to the related topic, rather than to send a message to a specific recipient (subscriber) direct (publish), and the recipient (receiver) is to subscribe to the topic of interest (subscribe), is a method of receiving only the issue (publish) messages to the topic.

In other words, the client (publisher, subscriber) is connected to the server (broker), issued a message to the relevant topic (publish) or, is a method of (subscribe) subscription.[1,3,4,5,7]

MQTT is to minimize the resource occupation of a small transmission overhead (2-byte header) and can be implemented in a device with the following program 64kb. Compared with HTTPS, it has a better throughput, low battery consumption and network overhead.

The disadvantage of MQTT, if a message that does not support the transaction is transmitted once, there is no way to do roll back, expansion is difficult, in order to add new features, is necessary to newly change the protocol is there.

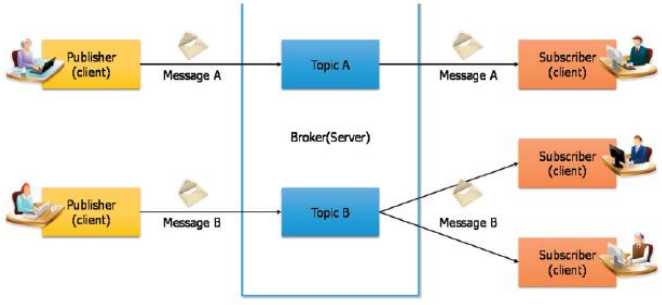

Figure 1. MQTT Publish/Subscribe messaging

2.3 XMPP(eXtensible Messaging and Presence Protocol)

XMPP is a communication protocol for instant messenger based on XML (Extensible Markup Language) that Jabber open source community has developed in 1999. A plurality of expandable messages in real time between the networks, have been developed for the purpose of the network availability (presence) exchange.

It is aimed to make relatively exchange structured data in small portions (XML stanza) among the plurality of network objects.

Generally, XMPP, the client plurality of servers are connected - this is by using a server model, the client to access the network, means that it is necessary to connect to the server. In other words, the client can after being connected with the server, exchanging other objects and XML stanza on the network.[9]

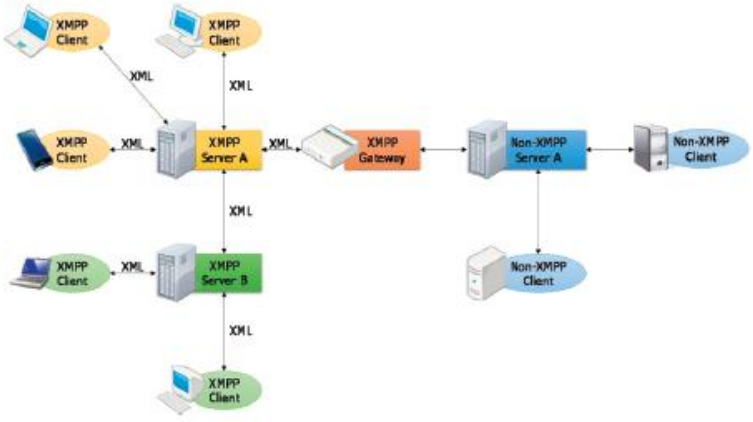

Figure 2. XMPP Structure

XMPP is an open standard, because it is based to XML, it is easy expansion. It is possible to start the only XMPP server at your anyone that does not require a central server. Not only between XMPP server, there is an advantage that it can communicate with other protocols through XMPP gateway.

On the other hand, by using the TCP protocol, it has the disadvantage that overhead for XML-based text is that there is large.

2.4 Comparison of the protocol

When standardized by oneM2M the International Organization for Standardization of Internet of Things are compared for the three of the major IoT protocol in progress, which is shown in the following Table.

Table 1. Comparison of the protocols

	CoAP	MQTT	XMPP
purpose	Limited circumstances	Remote message transmission	IM(Instant Messaging) Presence information
Architecture	Web services-oriented	Publish/subscribe model	XML-based distributed client / server
Protocol	UDP	TCP	TCP
Applications		Facebook Messenger	Google Talk AIM, MS Messenger
security	DTLS	SSL	SASL, TLS

3. Design of MQTT protocol-based, real-time HVAC system

MQTT-based real-time HVAC system is based on the open source-based cloud platform, it is configured in the cloud applications and Web services that control / management / monitoring by integrating the CCU (Central Control Unit).

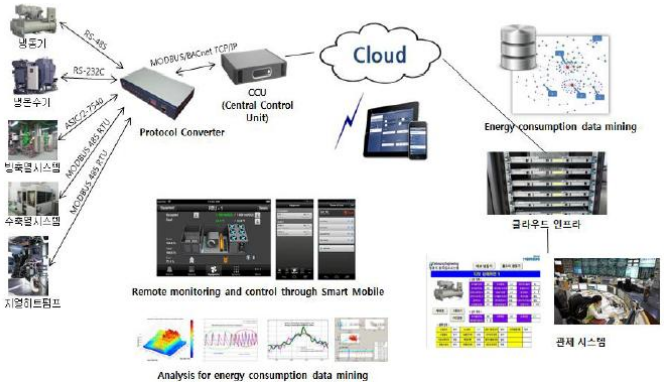

Figure 3. System Configuration Diagram

Figure 3 shows an entire configuration diagram of a real-time HVAC system, and Protocol Converter that will convert the interface of the air conditioning apparatus that uses a different protocol from each other in the TCP / IP, controlling the air conditioner through this / it is composed of applications and Web services that CCU and (Central Control Unit) can be a remote control / monitoring of the cloud platform-based HVAC systems that can be monitored

3.1 The configuration of the Push Service

The control and monitoring of the cloud server, between the CCU and the database, CCU and MQTT server, proceed Push service based on MQTT protocol part related to the user of the connection, using the HTTP protocol there. MQTT server, stored in the database the information generated from the CCU in real

time, which is to be transferred to the Web server, to monitor the state of the equipment to the user.

The following figure shows the Push process on the CCU and the cloud server

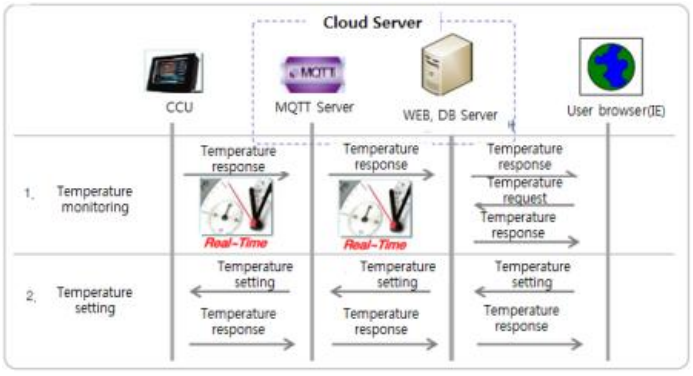

Figure 4. Push Process example

3.2 Design of MQTT protocol

The protocol defined on the system defined by the three Monitoring, Request / Set and Event, defined for each type are shown in the following Table 2

Table 2. Protocol type and define

Type	Define
Monitoring	Data collection of real-time, which is collected in the CCU
Request/Set	Setting the change request and control value for the user
Event	When an alarm occurs, that is, setting of the operation when an event occurs

3.2.1 Monitoring type

The control point data is transmitted from the CCU to the MQTT in real time, transmission period is defined from the CCU. Figure 5 displays the contents of the Monitoring

Data	Define
JOB	Processing division(MONITOR)
SITE	Return the Site ID
CCU_ID	Return the CCU ID
CCU_IP	Return the CCU IP
DEVICE	Return the Device ID
TIME	Return the Time Info
Monitoring Point	Return the Monitoring Point ID and Value

Figure 5. Monitoring type

3.2.2 Request/Set type

Request / Set, the subject of the event is the MQTT server, check the connection status of a device connected to a specific CPU, the user confirmation request of state value of specific equipment (output), users of specific equipment four can be classified to load state value change request (input) the device information to the cloud server. Figure 6 is a Request / Set, shows the contents for confirming the connection status of a device connected to a specific CPU. Figure 7 is a Request / Set, the user indicates the contents of the confirmation request the status value of the particular device (output). Figure 8 is a Request / Set, the user indicates the contents of the confirmation request the status value of the particular device (input). Figure 8 illustrates the contents for stacking device information on the Request / Set in the cloud server.

Data	Define	Data	Define
Request/Set Type(1)		Request/Set Type(2)	
JOB	Processing division(CONNECT)	JOB	Processing division(GET)
CCU	Return the CCU ID	CCU	Return the CCU ID
DEVICE	Device Name	DEVICE	Return the Device ID
TYPE	Equipment Type Name	MODE	Operating mode of the Equipment
STATUS	Current status of the machine	STATUS	Current status of the machine
ALARM_CODE	Equipment by the alarm code	TIME	Data transfer time
POSITION	Equipment Location	Monitoring Point	Return the Monitoring Point ID and Value
CONNECT	Connection Status		
TIME	Data transfer time		

Data	Define	Data	Define
Request/Set Type(3)		Request/Set Type(4)	
JOB	Processing division(SET)	JOB	Processing division(INIT)
CCU	Return the CCU ID	CCU	CCU ID for the device
DEVICE	Return the Device ID	DEVICE	Device ID
MODE	Operating mode of the Equipment	NAME	Device NAME
STATUS	Current status of the machine	TYPE	Equipment Type Name
TIME	Data transfer time	TIME	Data transfer time
Monitoring Point	Return the Monitoring Point ID and Value		

Figure 6. Request/Set type

3.2.3 Event type

Subject of the Event is, CCU is the real-time delivery when an alarm occurs from CCU to MQTT server, when the device fluctuation matters occur, CCU and the time of device variation matters occurred (change), CCU and the time of device variation matters occurred (Delete) to four the division can be. Figure 7 shows the contents to be transmitted from the alarm when CCU in the Event to MQTT. The following Figure 7 shows the contents to be transmitted at varying matter generation device on the Event from (newly added) CCU to MQTT. Figure 7 illustrates the contents for sending CCU as when device fluctuation matters generated in the Event of (modified) CCU to MQTT. Figure 7 shows the contents of the order to send CCU and when the device fluctuation matters occurred in Event from (Delete) CCU to MQTT

Data	Define	Data	Define
Event Type(1)		Event Type(2)	
JOB	Processing division(ALARM)	JOB	Processing division(INSERT)
SITE	Return the Site ID	CCU	Return the CCU ID
CCU	Return the CCU ID	ITEM	Add CCU, Device item
DEVICE	Return the Device ID	DEVICE	Add Device ID
TIME	Data transfer time	NAME	Add Device Name
ALARM_CODE	Equipment by the alarm code	TYPE	Add Equipment Type Name
ALARM_SET	Alarm Reset	POSITION	Equipment Location
		TIME	Data transfer time

Data	Define	Data	Define
Event Type(3)		Event Type(4)	
JOB	Processing division(UPDATE)	JOB	Processing division(DELETE)
CCU	Return the CCU ID	CCU	CCU ID for the device
ITEM	Add CCU, Device item	ITEM	Delete CCU, Device(Equipment)
ID	Update CCU, Device item	VALUE	Delete CCU, Device ID
NAME	Update CCU, Device Name	TIME	Data transfer time
IP_TYPE	Update IP, Equipment		
POSITION	Equipment Location		
TIME	Data transfer time		

Figure 7. Event type

4. Implementation of MQTT-based, real-time HVAC control system

A Environment for operation of the system LINUX (Linux Server Ubuntu12.04), PostgreSQL9.1.14, in the broker server for application of the MQTT protocol mosquitto version1.3.5, for WebSocket and Web Application operation to implement the Event function We went the development and operation in Tomcat7 Server environment.

System developed in this paper utilizes the Html5, JavaScript, CSS in order to be able to use in different environments, to design a user's screen, was developed. Thus, in addition to the Web browser, without the need to install other programs, when you enter the address in the Web browser, and can be connected to the system.

The following Figure 8 on connections on the built system, the field after the initial screen and login, shows such as screen of the device.

Figure 8. Implementation System UI example

5. Conclusion

In this paper, we propose a MQTT-based real-time HVAC control protocol design for the collection and real-time control of data between the CCU and the cloud server in the HVAC system of mobile cloud environment. The proposed system has the scalability issues that must modify the new protocol in order to add a message once when the transfer period, there is no way to roll back the new features.

It is planning to propose a protocol that takes into account the scalability, such as additional future of transaction function.

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