A new Information publishing system Based on Internet of things

Li Zhu ¹,²,³,a and Guoguang Ma ⁴,b

¹ Hubei Collaborative Innovation Center for High-efficient Utilization of Solar Energy, Hubei University of Technology, Wuhan, 430068, P. R. China;
² Hubei Key Laboratory for High-efficiency Utilization of Solar Energy and Operation Control of Energy Storage System, Hubei University of technology Wuhan, 430068, P. R. China
³ Hubei Power Grid Intelligent Control and Equipment Engineering Technology Research Center, Wuhan, 430068, P. R. China
⁴ Shenzhou rent screen (Xiamen) network technology Company Limited

a julianabiding@126.com, b maguoguang@x-link.com.cn

Abstract. A new information publishing system based on Internet of things is proposed, which is composed of four level hierarchical structure, including the screen identification layer, the network transport layer, the service management layer and the publishing application layer. In the architecture, the screen identification layer has realized the internet of screens in which geographically dispersed independent screens are connected to the internet by the customized set-top boxes. The service management layer uses MQTT protocol to implement a lightweight broker-based publish/subscribe messaging mechanism in constrained environments such as internet of things to solve the bandwidth bottleneck. Meanwhile the cloud-based storage technique is used to storage and manage the promptly increasing multimedia publishing information. The paper has designed and realized a prototype SzIoScreen, and give some related test results.

1 Introduction

With the popularity of various kinds of display devices such as plasma displays and LED displays, information releasing by screens increasingly be widely used in a variety of scenarios, public service, government agency, education sector, medical system, finance industry, hotel service, exhibition hall, for example. It can not only provide timely, interesting, comprehensive, high-quality and efficient information services, but also greatly improves a new culture and a beautiful environment, which is the development trend of the building industry in the future [1].

The existing information publishing system can send the text, sound, graphics, images, animation, video and other multimedia information to the terminal display equipment by the servers through public or private networks. It realizes the remote centralized management and updating at any time for the released information. The audience could receive the freshest information in first time. This kind publishing system widely used in all walks of life [2]-[5]. There are two main types of using forms for the player terminal screens. One is the screens bought directly by enterprises, departments or individuals. These screens have different prices, and some of them even are expensive. The information issue range is very limited and the information transmission efficiency is relatively low.
because of the fixed screens’ position. The published content is usually monotonous and repeated, and the actual utilization rate of the screens is not high. The other is the screens chosen freely and rent from the owners [6]. This mode greatly reduces the releasing cost, which is the main method of information distribution now. But there are still many problems.

Firstly, the publishers are usually the government organizations or the large-scale enterprises. It has nothing to do with the masses. The published information is less interesting, less attractive and less interaction. Secondly, the widespread of the information is also limited unless the geographically dispersed screens are used. Thirdly, there are a mountain of repetitive operations related to screen renting and information management because the multiple chosen screens always have different owners or belong to different platforms. The more screens, the more work. At last, there is no unified platform for that the screen renters are independent each other and management systems are standalone.

In this paper, a new multimedia information publishing system based on Internet of things are proposed to solve the industry issues mentioned above. A unified platform is realized to manage screens and release information by connecting geographically dispersed independent screens to the internet and adopting the IOT technique [7], MQTT technique [8] and cloud computing [9].

2 The new Information publishing system Architecture

The information publishing system architecture is composed of four level hierarchical structure, including the screen identification layer, the network transport layer, the service management layer and the publishing application layer, as shown in Figure 1. In the screen identification layer, the internet of screens has realized in which geographically dispersed independent screens are connected to the internet by the customized set-top boxes. The service management layer uses MQTT protocol to implement a lightweight broker-based publish/subscribe messaging mechanism in constrained environments such as internet of things to solve the bandwidth bottleneck. The cloud-based storage technique is also used to storage and manage the promptly increasing multimedia information.

In this system, mobile terminal (MT) or fixed terminal (FT) access server cluster system in service management layer by the client software provided by the publishing application layer. The service management layer is responsible for dispatching and managing different kinds of servers, thus providing various services to the publishing application layer. The network transport layer provides high-speed data access to the system. The screens will be identified by separate addresses, managed and connected to the network in the screen identification layer.

2.1 The publishing application layer

The publishing application layer is related closely to the specific applications of the information
release system. Its main functions include: define the adoptive network protocols and methods, and realize the corresponding client software. With the rapid development of broadband wireless access technology and intelligent mobile terminal technology, mobile internet come into being and the mobile phone becomes the largest internet terminal.

To meet the needs of different occasions, the application client is divided into MT and FT. According to different operating systems, the terminals are divided into Android versions, Apple versions, Microsoft versions, and Linux versions. Among them, MT APP is the most important access mode to our information publishing system. Users can use MT APP to issue multimedia information easily at any time and in any place, even at the moving route.

All kinds of the terminals have the same functions, searching for the suitable screens, publishing the relevant information, querying and managing historical information, etc. This system is widely applied to every fields in the modern society, such as education, entertainment, display, military, advertising and public service.

2.2 The service management layer

The service management layer is a core layer in our multimedia information publishing system based on Internet of things. It is a server cluster system, including application server, MQTT server, database server, cloud storage server, big data server, etc. These servers are mainly used for: (1) system scheduling and control; (2) user information management, authorization and audit; (3) publishing information storage and transmit; (4) big data analysis and decision making.

The application server provides the website services for the users and converts commands from the users into command that can be interpreted and executed by MQTT Client. Database server stores user information, controlling information, etc. The MQTT server realizes the transmission and forwarding of all kinds of messages that control the screen terminal, which solves the bottleneck problem of the network service bandwidth. The cloud storage server is used to store and manage vast amounts of multimedia data to solve the explosive growth problem of publishing information.

MQ Telemetry Transport (MQTT) is a lightweight broker-based publish/subscribe messaging protocol. It is designed to be simple, open, lightweight and easy to implement. It generates a small transport overhead but minimized protocol exchanges to reduce network traffic. At present, MQTT is increasingly becoming an important component of the IOT protocol. In our system, MQTT Server is deployed on the MQTT server. MQTT Client is deployed in the application server and the terminal screens. MQTT Server filters and transmits the control and query instructions from the application server to the terminal screen.

Cloud Storage [10] is a new model of data storage, which has been a new direction to be developed based on cloud computing. It stores files in logical storage pools which work together through utility software by cluster technology, network techniques and distributed computation. Cloud Storage has significant advantages such as automation, intelligence, high-efficiency, high-reliability, scalability and low cost. It provides data storage and business access to the internet applications. The publisher can upload and release information at anytime, anywhere, any network- connecting devices by the cloud storage server integrated in our publishing system.

2.3 The network transport layer

The network transport layer is a high-speed network interface connecting user terminals, server clusters, and terminal screens. According to the user demand, it can choose suitable network, such as special IP network, virtual private network, Internet, mobile communication network, dedicated wireless communication network, LAN, or heterogeneous network. For example, mobile communication network can be used to transmit information between mobile users and application servers; LAN can be used between the servers, and so on.

2.4 The screen identification layer

In order to realize our information publishing system based on the Internet of things, one of the most critical challenges is how to connect all kinds of screens to the Internet. Existing screens are divided into two categories. One is the screens with operating system, such as Internet TV, IPAD,
mobile phone, media advertising machine, etc. The other is the screens without operating system, such as LCD monitors, LED screens, and liquid crystal Mosaic TV walls, etc. The former can be directly connected to network using customized software and identified by the information publishing system. The latter has to be connected to the internet by the customized set-top box for that it is only display device.

The customized set-top box is actually a micro system. It can help the ordinary display becoming a intelligent networking item with some processing capability. The upgraded terminal screens can connect to the internet, play the information and display pictures by customized software. MQTT Client is also configurated in the micro system and perform the control and query instructions from MQTT Server forwarded by the application Server.

3 The transaction processing flow

In our information release system of the Internet of things, the control link of the service requests and the transmission link of the file are separated. In the control link, the application server receives the service request from the user, and then forwards the request to the MQTT server. MQTT server processes the request message and transmit to the terminal screen, which reduces the overhead transmission bandwidth of the network. In the file transmission link, when the corresponding control command is completed, the user directly uploads the multimedia files to the cloud storage system. The terminal screen also directly downloads the multimedia files from the cloud storage system so as to solve the storage and management of the growing huge amounts of multimedia datum.

The transaction processing flow about that the terminal screen access and play the multimedia file from the cloud storage system on the user's demand is as follows: ①The publishers make service requests to the application server through the MT APP or FT; ②After the requests are passed by system administrator, the application server forwards the service requests to MQTT server via MQTT Client; ③The MQTT server packages user requests into smaller messages by some filtering rules to the screen terminal; ④The terminal screen sends data access requests to the cloud storage server according to the list of playlists; ⑤The cloud storage server verifies the validity of the playlists and establishes the transmission connection. ⑥The terminal screen obtains the true multimedia files from the cloud storage server. Meantime it completes the broadcast and display of the published information.

4 The prototype and Test results

In this paper, a prototype system SzIoScreen for self-service information publishing system is designed. The performance of the server cluster system in it is preliminarily tested. The test environment is as follows: three servers are considered respectively as application server, MQTT server, and database server. They all have dual-core CPU, 4GB memory, CentOS 7.2 operating system. Application programs and MQTT Client are installed and configured on the application server. Mqtt-broker is installed and configured on the MQTT server. Mysql-community-server is installed and configured on the database server. Otherwise there are five user computers for making application requests, P4 3.0G CPU、2 GB memory、Windows7 operating system.

| Number of connection s | CPU utilization (%) | memory occupancy (M) | average delay of pushing all messages (s) | pushing success rate (%) |
|------------------------|--------------------|----------------------|------------------------------------------|-------------------------|
| 5000                   | 8.35               | 16                   | 6.8                                      | 100                     |
| 10000                  | 12.29              | 23                   | 11.4                                     | 100                     |
| 20000                  | 22.01              | 47                   | 26.7                                     | 100                     |
| 30000                  | 30.17              | 72                   | 41.3                                     | 100                     |
| 40000                  | 38.52              | 96                   | 67.5                                     | 100                     |
| 50000                  | 42.91              | 119                  | 108.1                                    | 100                     |
The performance parameters of the MQTT server are included under different load conditions which gradually increased, such as memory occupancy, CPU utilization, average delay of pushing messages, pushing success rate, etc. A large scale users simulated on user computers initiate connection requests to the application server. Every user computer can mostly simulates 10000 users, and five user computers can simultaneously participating in the test. The test results are shown in Table 1.

Table 1 depicts that, all the pushing success rate reached 100%. Single MQTT server is enough to support 50000 connections. The memory occupancy and CPU utilization are all in the acceptable range, which shows the MQTT server has a certain compressive ability and robustness. Furthermore the average delay of pushing all messages can be accepted. In addition, the files which will be played on the terminal screen will be normally downloaded from the cloud storage server.

5 Conclusion

In this paper, a new information publishing system is proposed, which is composed of four level hierarchical structure. The geographically dispersed independent screens are connected to the internet by the customized set-top boxes. MQTT protocol is adopted to implement a lightweight broker-based publish/subscribe messaging mechanism to solve the bandwidth bottleneck. Meanwhile the cloud-based storage technique is used to storage and manage the promptly increasing multimedia publishing information. Our system provides a good solution to the development of large information release system in the future. It is also an important application field on Internet of things.

Acknowledgement

In this paper, the research was sponsored by the National Natural Science Foundation of China (61471162, 61501178); Science and Technology Research Program of Hubei Provincial Department of Education (Q20171401); Open Foundation of Hubei Collaborative Innovation Center for High-efficient Utilization of Solar Energy (HBSKFMS2014032); Program of International science and technology cooperation (2015DFA10940)

References

[1] Chenggang Liu, Cong Zhao. The latest development trend of Multimedia information publishing system [J]. Intelligent Building. 2015, 12(184):39-40.
[2] Tianyue Qiu, Xu Chen, Chao Ma, Tao Yuan, Linyi Li. An android based on information collection and dissemination system of agriculture internet of things [J]. Acta agriculturae Shanghai. 2014, 30(2):6-9.
[3] Xiaolin Liu, Yixin Hua, Xiaopeng Zhang. The design and realization of boundary information release system [J]. Bulletin of Surveying and Mapping. 2012, (2):77-78.
[4] Jieke Zhang. Design and Implementation of Information Distribution System Based on Internet of Vehicles [D]. South China University of technology. 2014.
[5] Xiaoxiao Zhang, Chongchang Wang. The construction of transaction information release system based on WebGIS for house property [J]. Science of Surveying and Mapping. 2017, 3(42):169-173.
[6] Du Li, Zhang Jianjun. Design of Information Distribution System Based on Wireless LED Screen [J]. Journal of Beijing Polytechnic College. 2012, 2(11):39-42.
[7] Kevin Ashton. That “internet of things” thing [J]. RFID Journal. 2009, (22):97-114.
[8] International Business Machines Corporation (IBM) Eurotech. MQTT V3.1 Protocol Specification. IBM developerWorks China. 2010-12-06.
[9] Brian Hayes. Cloud computing [J]. Communications of the Acm. 2008, 51(7):9-11.
[10] Lei Li, Dagang Li, Zhiliang Su, Lianwen Jin, Ganbo Huang. Performance Analysis and Framework Optimization of Open Source Cloud Storage System [J]. China Communications. 2016, 6:110-122.