Design and Implementation of an IPv4/IPv6 Dual-Stack Automatic Service Discovery Mechanism for an Access Control System

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Abstract. With the development of the Internet network technologies, a vast number of things are connecting to the Internet. The available IPv4 addresses are used up almost. IPv6 and IPv4 will coexist for many years. Therefore, the Internet capabilities will be a significant issue. Moreover, we let the home monitoring system as a use case. This paper proposes an IPv4/IPv6 Dual-Stack Automatic Service Discovery Mechanism for an Access Control System. Our system architecture is divided into two parts: Door Access Controller Module and Door Access Control Server. The Door Access Control Server is implemented with an IPv4/IPv6 Dual-Stack network and Automatic Service Discovery on an Android-based IPTV Box. The functionalities of system configuration, access configuration and access monitoring are designed in the IPTV Box. Additionally, the Door Access Controller Module is designed by an embedded system. The modules of RFID reader and Camera can hot plug in anytime. In our implementation result, the IPv4/IPv6 Dual-Stack Automatic Service Discovery Mechanism works well. The test results of different service discovery methods with IPv4/IPv6 dual stack are presented in this paper. In the result, we can observe that the polling method is inefficiency. Especially with IPv6, it is unworkable due to the host ID space with 264 addresses. The performance of service discovery with multicast is a good solution in our system.

Keywords: IPv6, Dual Stack, Multicast, Service Discovery, Home Network, Internet of Things

1 Introduction

In recent years, the technology of communication and network is improved rapidly. The internet service is expanded anywhere in the world. The new term of IoT (Internet of Things) is proposed. Every object in our life and in our environment would be connected together and linked to the internet [1][2][3]. To the huge amount of objects, how to configure and manage efficiently is a significant issue.

With the development of the Internet network technologies, a vast number of things are connecting to the Internet. The available IPv4 addresses are used up almost. IPv6 and IPv4 will coexist for many years. Therefore, the Internet capabilities will be a significant issue. Moreover, we let the home monitoring system as a use case.

In this paper, the existing standard IPv6 network protocol, internet transition, routing schemes are applied to door access management and monitor APP into IPTV box. Moreover, the service discovery mechanism with IPv6 multicast is proposed. We build an access control monitoring system situation, then implement an access control system with IPv4/IPv6 dual-stack automatic service discovery and modularization. In our system, the IPTV box can discovery the door access control nodes in the home network automatically and quickly.

The remaining part of this paper is organized as follows. In Section 2, we introduce the background. In Section 3, the architectures of our system and modules are presented. Our experiment and evaluation is shown in Section 4. Finally, Section 5 concludes this paper.

2 Background

The IPv4 cannot support the requirements of huge IoT devices. The IPv6 is the alternative in the next generation of internet. However, to huge IoT nodes, how to provide an efficient service discovery mechanism for simple configuration and management is very significant[4].

The IPv6 provide unicast, multicast and anycast transmissions[5][6][7].

- The unicast transmission is to send data to a single network destination that is identified by a unique address.
- The multicast is a group communication. The group is identified by a group address. In the multicast domain, clients can join and leave the group anytime. When the source sends a packet to the group address. The participants in the group will received the same packet.
- Anycast is a network addressing and routing method. If the network destination is an anycast address, the packet will be delivered to the nearest node of the anycast address.

In a general case, the IPv6 prefix length of a LAN (Local Area Network) is 64. The maximum capacity is 2^{64} host addresses in this LAN. Using the pooling service discovery and scanning from host address 0 to 2^{64} is impossible. Additionally, the anycast is using in the inter network environment generally. Thus, multicast may be a good solution for service discovery.

In this paper, we design and Implement an IPv4/IPv6 dual-stack automatic service discovery mechanism for an access control system. The performance of service discovery with IPv4 unicast, IPv4 broadcast, IPv6 unicast and IPv6 multicast is shown below.

3 System Architecture

In order to respond to changing things in the Internet, IPv4 and IPv6 protocol is bound to coexist for a long time in the state, so this paper combined IPv4/IPv6 dual stack network, automatic service discovery feature to integrate RFID technology as identity identification, embedded system implementation by modular access control system. This chapter describes and explains the system architecture, function and operation of the process, the following discussion are divided into three parts:

- Part I: Introduction to support IPv4/IPv6 dual-stack architecture automatic service discovery and access control system of modular.
- Part II: Introduction to system architecture and operation of the access control process.
- Part III: The access control system architecture and operational processes of the server.

3.1 System Architecture

According to Figure 1, the system architecture divided into two parts: Door Access Controller Module and Door Access Control Server. We used embedded system board as Door Access Controller Module's control core, and external a Web Cam return image data to the Door Access Control Server. In Door Access Control Server is to use TV Box based on Android operating system. When Door Access Controller Module get IP address, user can use TV Box to do search Door Access Controller Module.

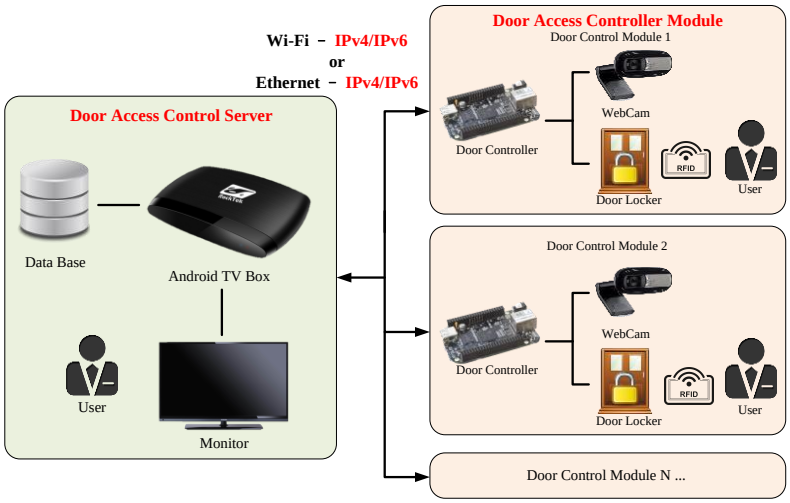


Fig 1. The system architecture.

3.2 Access Controller of Module

Access control architecture is using the Beagle Bone Black core of embedded system development platform, combined with RFID identification devices, door locks, Web Cam and internal Data Base of the composition. Access Controller with IPv4/IPv6 dual stack mechanism, when obtained automatically assigned by the router down after IPv4 or IPv6 addresses will be automatically added to Multicast Group waiting to receive a message, the internal Data Base will be used to store the user can enter the door white list , so users can use RFID sensor card authenticating operation when the recognition result is determined in line with the user identity, the door will open, and vice versa kept locked state, the user can also be an arbitrary access control server whitelist for each modular access control operation of content to add, modify and remove. Web Cam detect whether the device when the device is detected, the user can watch the real-time monitoring of access control on the server screen.

3.3 Access Control of Server

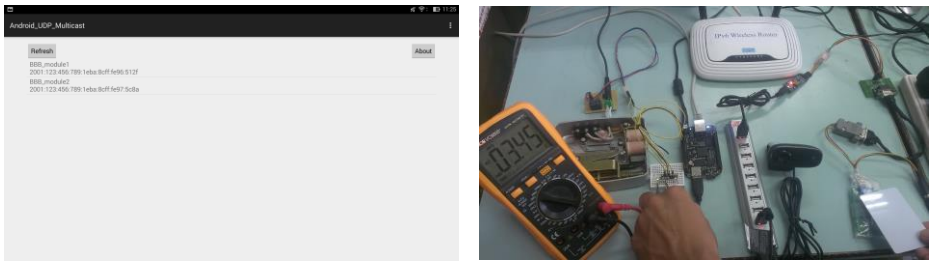
The TV Box is running Android operating system. The built-in SQLite Data Base and our designed access control App are performed. Functions are as follows:

- Access Controller Search: Search by Multicast all the modular access control within the LAN, and establish a connection.
- User list management: the user lists all modular controllers synchronize access to the inside of the SQLite Data Base, and allows users to modify data on users.
- Graphical user interface: To make the operation more humane, to reduce the cognitive burden on the user, it provides simple graphical user interface, so that you can use to easily carry out various operations management.
- Webcam Watch: Using real-time video streaming technology, to obtain images of the Web Cam on a modular access control, so that users can be viewed directly on the server in the control of access.

4 Experiment and Evaluation

In the system situation experiment, user can use Door Access Control Server to search Door Access Controller Module showed in Fig. 2 (a). Fig.2 (b) is showed that user can use been registered in the list of RFID card, then successfully controlled door locker.

In this paper, we use IPv4/IPv6 service discovery applied to our access control system. According to Fig.3, we use Multicast, Broadcast and Polling three ways to do the comparison test. Broadcast will lead to unnecessary loss of network bandwidth, and Polling will let response time too long. Therefor Multicast is our best choice.



(a) (b)

Fig. 2 The experiment of access control system.

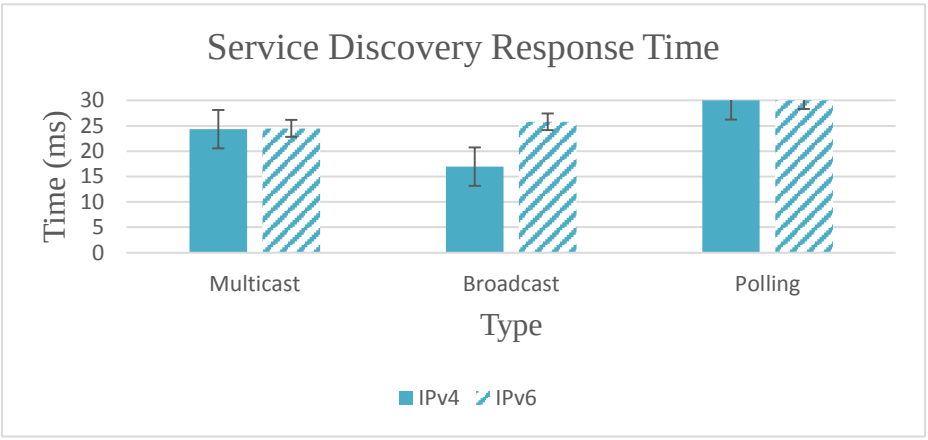


Fig. 3 The response time of service discovery.

5 Conclusion

The paper proposes an IPv4/IPv6 dual-stack automatic service discovery mechanism for an access control system. The service discovery mechanism is based on IPv4/IPv6 multicast. In the IPv4/IPv6 Dual-Stack network, the devices obtain both of IPv4 and IPv6 address. The system architecture is divided into two parts: Door Access Controller Module and Door Access Control Server. Users can use Door Access Control Server to search Door Access Controller Module, and use RFID card to identify the users to control the door locker. In the implementation results, the system works well, and the IPv4/IPv6 multicast is a good solution for service discover mechanism. In the future, the service discovery mechanism would be applied to more different situation.

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