Design of IP Sharing Device for Multimedia Streaming using UDP Datagram Switching Mechanism

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Abstract—In this paper, we propose a mechanism to support switching of multimedia services toward one display equipment among others connected to IP sharing device especially in home network. For this, we developed a client agent mounted on display equipment for recognizing of user’s information, a switching agent mounted on IP sharing device, which is related to IPTables management in the device, and embedded board with NAT(Network Address Translation) function. A user can be provided a seamless multimedia service with his information without other signaling procedure between multimedia streaming server and IP sharing device.

Keywords—seamless multimedia service, mobility, handover, IPTV

I. INTRODUCTION

In future network, home networking is one of the most critical issues, and user’s demand on multimedia service has being increased in home network. Moreover, users want to be provided seamless multimedia services after moving to other display equipment in NATed(Network Address Translated) environment of home networking.

There have been researches related to these issues. One thing deals with location-based architecture for service portability[1]. Another is for agent-based user mobility support mechanism in RFID networking environment[2]. However, these mechanisms are not suitable for the NATed environment. And these take a long time to switch multimedia service traffic. Moreover, Multimedia service which is based on the user datagram protocol (UDP), like other Internet applications, cannot avoid the NAT traversal problem[3].[4]. Also, the details regarding binding tables were not considered on previous researches.

Therefore, we propose the UDP datagram switching mechanism which is suitable for NATed environment using IP sharing device and the IPTables management which is the UDP hole punching technique to avoid NAT traversal problem. And we developed software and embedded board for switching of multimedia service on IP sharing device. Moreover, our mechanism considered binding table details.

This paper is organized as follows. In section II, we describe about the related works. The proposed mechanism is explained in section III. In section IV, we implement software and embedded board which includes NAT function for operating the proposed mechanism. The performance analysis of the proposed mechanism is shown in section V. Finally, conclusion is given in section VI.

II. RELATED WORKS

A. IPTV SERVICE based on UDP datagram

IPTV is a digital television service which is delivered using IP over a network infrastructure. IPTV service market will grow significantly, due to a variety of services provided. For example, basic TV video, premium video, VoIP, DVR, VOD, DVR, HDTV, and etc[8]. IPTV service contents, especially real-time service such as live TV, are transported to user by using UDP. STB is located in a NATed environment, like other Internet applications, it cannot avoid the NAT traversal problem. Due to this, the service continuity of IPTV service can’t be guaranteed.

B. NAT Traversal Problem

A NAT allows several terminals to share a single public IP address. Private IP addresses are assigned to hosts behind NATs. A NAT maintains port and address translation information, which means that communication between terminals and the public Internet nodes pass through the NAT [3]-[7].

A NAT allows the inside session formation. But, NAT blocks session from outside as a fire-wall, so it has problem which makes difficult communication between outside and inside [3]. To solve this problem, many kinds of mechanisms are studied such as STUN, ALG, UDP Hole Punching, and etc. [7].

Simple traversal of UDP through NATs (STUN) is a protocol which is able to detect kinds of NAT like Symmetric

NAT, Cone NAT and information of mapping [3]. However, STUN needs additional server in public network and has to add a STUN-client to terminal.

An application layer gateway (ALG) extends the functionality of a NAT for specific protocols [7]. However, ALG supports only the application layer protocols that are specifically implemented and may fail when encryption is used.

UDP Hole Punching is well known to mechanism to solve the NAT traversal problem. UDP hole punching enables two clients to set up a direct peer-to-peer UDP session with the help of a well-known rendezvous server, even if the clients are both behind NATs [6].

Moreover, since the UDP transport protocol provides NATs with no reliable, application-independent way to determine the lifetime of a session crossing the NAT, most NATs simply associate an idle timer with UDP translations, closing the hole if no traffic has used it for some time period. There is unfortunately no standard value for this timer. If the application needs to keep an idle UDP session after establishing the session via hole punching, the application must send periodic keep-alive packets to ensure that the relevant translation state in the NATs is continuously [6].

However, this mechanism has a problem that a well-known rendezvous server is needed in public network.

III. PROPOSED MECHANISM

A. UDP datagram switching mechanism

Proposed mechanism supports rapid switching of multimedia service using signaling procedures between display equipment and IP sharing device without signaling with MSS.

Figure 1. Network configuration to support switching of multimedia service based on IP sharing device

Figure 1 shows the wire/wireless network configuration for providing switching of multimedia service on IP sharing device. And the compositional element is as follows.

In the configured network, the IP sharing device is connected to MSS and display equipment is connected to this IP sharing device.

IP sharing device includes NAT function, networking function, authentication function, binding table managing function and switching agent function. This includes two binding tables. One is the authentication binding table to manage user’s authentication information. Another is the session binding table to manage the user’s location information and service information.

Display equipment includes user recognition function and signaling function. Here, the user recognition function is activated when a user presses the keyboard. An additional function of MSS is not required. Display equipment is laptop computer and desktop computer in configured network.

The detail procedure of the multimedia service switching system is as shown in Figure 2 and Figure 3. Proposed mechanism can be divided into two cases. One is the case that user is positioned in display equipment#1 to receive multimedia service traffic from the MSS. The other is the case that user is positioned in display equipment#2 to receive seamless multimedia service traffic from the MSS after movement.

Figure 2 presents the initial request procedure of multimedia service transmission when a user joins in NATed environment at the first.
delivery message from display equipment #1.

If there is the preregistered user’s authentication information, the switching agent creates the new session binding table entry which includes user’s ID, display equipment’s L2 ID, display equipment’s L3 ID and service information. And if there is no information, the proposed mechanism does not operate.

This means that if there is the session binding table entry related user’s ID, the authentication operation was completed. Therefore, authentication operation does not need any more.

IP sharing device translates source’s(src’s) L3 ID which includes the signaling message into IP sharing device’s L3 ID after receiving the signaling message which requests the multimedia service transmission.

MSS sends the reply message to IP sharing device. IP sharing device sends the reply to display equipment #1 after translating destination’s(dst’s) L3 ID which includes the reply into display equipment’s L3 ID. Destination’s L3 ID included in multimedia service traffic received from MSS is translated into display equipment’s L3 ID and translated traffic is sent to display equipment.

As the result of procedure mentioned above, a user can receive the multimedia service traffic.

Figure 3 shows the request procedure of multimedia service transmission when a user joins NATed environment after moving to display equipment #2. Before illustrating the detail procedure, we assume that session binding table already includes entry about user’s ID.

When a user presses the keyboard, display equipment #2 recognizes user movement and gets user’s ID information which is preregistered in display equipment.

IP sharing device sends Ack signaling message to display equipment #2. And this sends notification of user’s movement signaling message to display equipment #1 to stop display.

After signaling messages, multimedia service traffic from MSS to display equipment is delivered via the IP sharing(NAT) device. At this time, switching agent mounted on the IP sharing device translates L3 ID which included in packet from MSS into NATed L3 ID. And translated packets are forwarded to display equipment.

As the result of procedure mentioned above, when a user moves to other display equipment in the NATed environment, he can be provided the multimedia service as soon as possible by this procedure.

B. Management mechanism of two binding tables

We used two binding tables to manage the authentication information and the session information.

<table>
<thead>
<tr>
<th>Table 1. Format of authentication binding table</th>
</tr>
</thead>
<tbody>
<tr>
<td>No.</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>……</td>
</tr>
</tbody>
</table>

Table 1 presents the format of authentication binding table to store the authentication information of a user who joins home network. Here, user’s authentication information is preregistered by administrator.

<table>
<thead>
<tr>
<th>Table 2. Format of session binding table</th>
</tr>
</thead>
<tbody>
<tr>
<td>No.</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>……</td>
</tr>
</tbody>
</table>

Table 2 shows the format of session binding table to store user’s location, session and service information.

Two binding tables which mentioned above include time column. This is the maintenance time of binding table entries.
Figure 4 shows the operation to maintain binding table entries.

When switching agent starts, authentication binding table is created. And when user authentication successfully completes, session binding table is created. Entries of two binding table managed by binding table managing function. And the flow chart presents the operation of respective entry.

When client agent is down or user terminates the client agent unusually, error is occurred in switching agent. To prevent this problem, switching agent need to confirm the validation of client agent.

For this, switching agent sends the confirmation message to client agent periodically. And client agent sends the ack message after receiving the confirmation message from the switching agent. Here, periodic time is one second.

If there is no ack message which received from the client agent during the maintenance time, switching agent delete the binding table entry. If there is ack message, switching agent changes the maintenance time into initial value.

Our proposed mechanism for multimedia service switching operates very stable and dynamic by using flow mentioned above.

C. IPtables management to avoid NAT traversal problem

In the IP sharing(NAT) device, translation of destination’s L3 ID which is included in multimedia service packets(UDP) using IPtables needs to avoid NAT traversal problem for multimedia service switching.

Most IP sharing devices hold an idle timer for a UDP session and block the hole for the given period. Due to the reasons mentioned above, NAT traversal problem is occurred.

There are several mechanisms for solving NAT traversal problem in existing research. Among the mechanisms, we used UDP hole punching mechanism for solving NAT traversal problem.

Our mechanism is very simple method without additional server, application or user handling. The mechanism only has two steps for modifying the UDP hole timeout value.

Firstly, a location of UDP hole timeout value is searched in IP sharing device. Secondly, the UDP hole timeout value is modified to zero.

Modifying this value to zero means that UDP hole timer do not work. As the result of method mentioned above, IP sharing device can solve a NAT traversal problem.

IV. IMPLEMENTATION

Figure 5 shows the developed embedded board with NAT function. Here, IP sharing device is the developed embedded board.

Table 3 presents main features about developed embedded board with NAT function.

Developed embedded board includes port mirroring function, JTAG Debugging function, UART console function and IGMP snooping function apart from main features.

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Developed embedded board includes port mirroring function, JTAG Debugging function, UART console function and IGMP snooping function apart from main features.
Switching agent included in our software operates on this embedded board which is based on Arm 922T CPU and Linux platform.

V. PERFORMANCE ANALYSIS

In figure 7, the IP sharing device is connected to MSS by wire which located out of NATed environment. And two display equipment and monitoring equipment are connected to this IP sharing device by wireless.

IP configuration of figure 7 is as follows.
MSS’s L3 ID is configured with “210.125.147.232”, “192.168.1.55” is L3 ID which is configured at display equipment #1. And L3 ID of Display equipment #2 is “192.168.1.66”

The situation that a user moves from display equipment #1 to display equipment #2 is possible by pushing the keyboard of display equipment #2. When user’s movement is recognized, signaling message for multimedia service switching is occurred.

We used WIRESHARK, network packets analyzing tool, to capture packets which are transmitted and received service between IP sharing device and display equipment on monitoring equipment.

Also, in order to get multimedia service switching time, we used I/O filtering graph of WIRESHARK.

Figure 8 shows the traffic change which follows in user movement between one display equipment and another one.

In this graph, graph1 is flow between MSS and display equipment #1, and graph2 is flow between MSS and display equipment #2.

Packet filtering rules applying to analyze captured packets are as follows.
Graph1’s filtering rule is “ip.src == 210.125.147.232 && ip.dst == 192.168.1.55”
Graph2’s filtering rule is “ip.src == 210.125.147.232 && ip.dst == 192.168.1.66”

The switching time which occurred from process of multimedia service switching can be calculated by analyzing the packets which got from demonstration environment.

Figure 8. The flow of multimedia service traffic

The switching time is the time interval between time sending signaling message after user’s movement and time sending multimedia service packets after establishment of signaling process.

Table 5. Multimedia service switching time

<table>
<thead>
<tr>
<th>Movement</th>
<th>Signaling starting time(ms)</th>
<th>Service starting time(ms)</th>
<th>Service switching time(ms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>11587</td>
<td>111678</td>
<td>91</td>
</tr>
<tr>
<td>2</td>
<td>18239</td>
<td>18341</td>
<td>102</td>
</tr>
<tr>
<td>3</td>
<td>24905</td>
<td>24997</td>
<td>92</td>
</tr>
<tr>
<td>……</td>
<td>……</td>
<td>……</td>
<td>……</td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td></td>
<td>98</td>
</tr>
</tbody>
</table>

Table 5 presents switching time occurred from process of multimedia service switching according to user’s movement. We measured about 350 times to calculate the average multimedia switching time. As shown in table 5, measured multimedia service switching time is averagely 98ms. From this measured result, we confirmed that proposed mechanism can be used in NATed environment of home network.

VI. CONCLUSION

In this paper, we proposed the UDP datagram switching mechanism and the method of IPtables management to support multimedia service switching in NATed environment of home network.

To support proposed mechanism, we developed software package(client agent and switching agent) and embedded board. And to measure this performance, we built test environment and used WIRESHARK tool.

From this measured result, we confirmed the more fast switching time than previous researches. And this mechanism stably operates for long time.
As a result, we show the possibility that our proposed mechanism can be used in NATed environment of home network.

For further works, we plan to study the switching schemes which are required to support global multimedia service switching when a user moves from one NATed environment to another one.

VII. ACKNOWLEDGMENT

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VIII. REFERENCES