RSVP-aware Residential Gateway

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Abstract

Residential Gateway (RG) is a device that coordinates various home devices to communicate each other and links up the Internet. It plays an important role in home network, especially the applications in home network are evolving and growing quickly to demand required QoS (Quality of Service) for the delay-sensitive receivers. This paper presents a RSVP-aware RG that provides the RSVP library redirection mechanism (refer to QLR [8]) in RSVP-enable IntServ network, which makes legacy Internet applications RSVP-aware in the run-time. So it can guarantee the network bandwidth to meet the real-time multimedia demand in network congestion. The proposed mechanism is not necessary to design a completely new one or modified the original source codes with RSVP function. The RG is implemented on the Linux platform, features inexpensive, easily interoperability, maintainable from both software and hardware perspectives, and also easily upgradeable to meet market demands for new multimedia services.

Keywords: *Residential Gateway, RSVP, and QoS.*

I. Introduction

Today, the major obstacle to the 'digital networked house' is the access network; it is the well-known 'last mile problem'. This topic has been improved by the innovation in broadband access technology and the investment in access infrastructure such as copper enhancements (ADSL, SDSL, and VDSL), Fiber-To-The-Home (FTTH), and Wireless Local Loop (WLL) [5], but now the new barrier to the end-to-end broadband service provisioning is home network. For example, the bandwidth inside home can be over 400 Mbps (e.g. Home Audio/Video interoperability (HAVi) [6] is based on IEEE 1394), but that of the access network is generally below 512 kbps.

Currently the Internet offers the straightforward delivery service called "best effort". In this manner, data will be delivered as possible as the node it can, and the available bandwidth is contended by all nodes, therefore there is no commitment to bandwidth or latency for senders. However, the applications of network tend to diversification as the rising and flourishing development on the Internet, and more and more distributed multimedia applications like video-conference and Video-on-Demand have been developed; these applications are delay-sensitive that the best-effort delivery model is inadequate even under modest network loads. Therefore, it is necessary for the Internet to provide Quality of Service (QoS) according to different users and applications. For addressing the requirement, IETF (Internet Engorging Task Force) develops two types of QoS: Integrated Service (IntServ) [2] and Differentiated Service (DiffServ) [1]. IntServ reserves network resources for per-flow in accordance with requests from the end application. DiffServ provides a scalable scheme by defining different QoS-classes for packets and allocating resources on a per-class basis.

The current generation of RGs do not provide with the QoS mechanism [4], hence would not be able to meet the requirements of multimedia applications. This paper presents a RSVP-aware RG that provides the RSVP library redirection mechanism (refer to QLR [8]) in RSVP-enable IntServ network, which makes legacy Internet applications RSVP-aware in the run-time. So it can guarantee the network bandwidth to meet the real-time multimedia demand in network congestion. The proposed mechanism is not necessary to design a completely new one or modified the original source codes with RSVP function. The rest of this paper is organized as follows. Section II covers the proposed RG system architecture. Section III describes the proposed RSVP library redirection mechanism. Finally the conclusion and future works are presented in section IV.

II. RG System Architecture

The home network may transport data, audio/video, residential handling, and entertainment services;

hence it has to integrate the heterogeneous environments in the network. One potential solution is through a residential gateway, an electronic sub-system that provides interface and routing services and some management functionality to distribute and regulate the use of information services in the home. The residential gateway would interconnect the home network and the public access network, and provide the capability of remote control in order to reach the goal of intelligence home network; it resides between public network and home network, and is the "ingress" node for the home network, and provides the server capability in order to realize the ingress functions in Fig. 1.

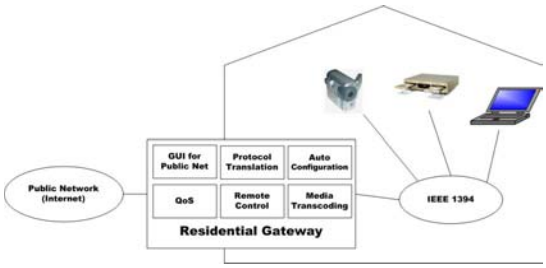

Figure 1. *The proposed residential gateway architecture.*

For the requirements and characteristics, RG has to take some topics into the considerations such as the dynamic access outside home, protocol translation/address translation between the IP and the (proprietary or non-IP) home devices network protocol, appropriate media translation function between the home network and the public network, the RSVP-QoS supporting for multimedia services to guarantee the network bandwidth to meet the real-time multimedia demand in network congestion., that is, the access point can be any kind of nodes e.g. PC, PDA, or mobile phone at anywhere to communicate with RG. For supporting RSVP protocol, the RG and all of the hosts in the client side must active the RSVP daemon to handle the all RSVP message events. The application and the RSVP daemon establish a Unix socket connection to exchange the information. Finally, RSVP daemon will determine when to deliver PATH and RESV message, and communicate with underlying layer for bandwidth reservation information to establish the QoS connection. By calling RSVP API, the Internet application can create, maintain and release QoS connection, and get the error information if happens to application for adjusting the parameter.

The implementation of RG is shown as in Fig. 2, which interconnects the Internet and the home network, the IEEE 1394 AV network. The IEEE 1394 system uses the isochronous mode to transfer A/V data. These implementations of RG are based on the Linux platform. Linux is developed under the GNU General Public license and its source code is freely available to everyone. This, along with its good stability and real time capabilities makes this OS a good candidate in developing low cost RG. Dynamically loading code, as it is needed is attractive as it keeps the load of the RG at a minimum and makes it easy to update different modules from a remote server, without rebuilding the kernel and rebooting the RG.

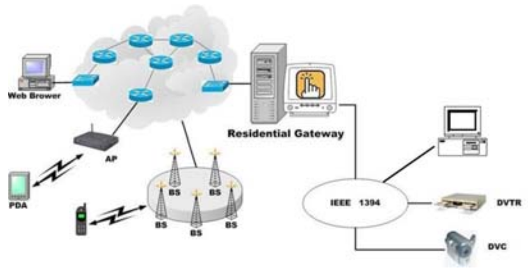

Figure 2. *Implementation of the residential gateway.*

III. RSVP Library Redirection Mechanism

IntServ uses the Resource ReSerVation Protocol (RSVP) [3] and it's API (RAPI). The RSVP library redirection mechanism (refer to QLR [8]) using RAPI to communicate RSVP daemon, and then RSVP daemon sends RSVP messages to every device along data flow. In the receiver, an independent agent waits for PATH messages from sender. It extracts QoS parameters from PATH message, and send RESV message back with the same parameters. The sender firstly delivers the QoS request, then the receiver determines to follow sender's or adjust the parameter depends on the receiver network environment. The RSVP Agent of receiver uses RAPI to create a RSVP session and register a callback function. When RSVP daemon in receiver receives a PATH message, it triggers a RAPI_PATH_EVENT event. Then the callback function is called to parse the PATH messages in order to get QoS parameters, such as token rate, bucket depth, etc. Finally, the RSVP Agent sends RESV messages back. The time to setup RSVP flow with two hosts between two routers is measured. It spends 0.015-0.05 second, so it makes dynamic QoS possible when the negotiation period is larger 1 second.

The following details the RSVP library redirection mechanism how to design and operate. As shown in Fig.3, the application creates the RSVP connection by calling RAPI [7]. It completes by negotiation among RAPI, RSVPD and applications. RAPI communicates both interfaces as follows:

- Application calling interface: The application delivers the parameters via RSVP protocol to achieve the goal of bandwidth reservation. RSVP API is the interface for Internet application calls the RSVP protocol. It consists of many functions and forms to a library.

- Communicate RSVP daemon interface: They can exchange information by RSVP API creating a UNIX-domain socket connection between the application and the RSVP daemon.

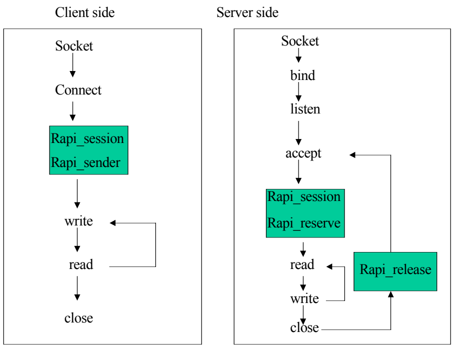

Figure 3. *RSVP-aware application.*

The RSVP library redirection mechanism, which provides QoS library redirection, is a software technology. The goal is to provide a middleware interface to RSVP-unaware Internet application in order to add RSVP traffic information in run-time. It makes legacy Internet applications RSVP-aware to deliver QoS data flow in the run-time. We adopt library redirection method [8], so no need to design a completely new one or modified the original source codes with RSVP function. The library redirection mechanism is using environment variable setup to call the shared library first to perform specific commission for specific demand, then callback to perform system library. This way can help user to enhance system feature flexibly. We integrate the RSVP API and library redirection mechanism to make Internet applications RSVP-aware as shown in the Fig.4.

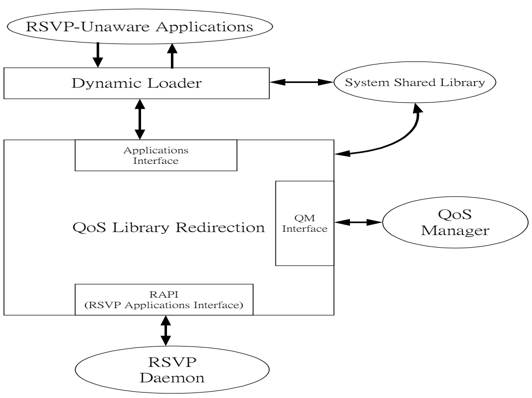

Figure 4. *The RSVP library redirection model.*

Firstly we develop our own share library, called RSVP share library, including RSVP API. Through setup user environment variable, the RSVP library redirection mechanism will redirect the function to our own share library first, perform the RSVP share library processing, then callback to perform system library, last go back to user application, and continue the next command. So RSVP share library must be able to call the system shared library instead of application does. In this way will add RSVP-aware function code during application processing, setup bandwidth parameters via QoS manager interface of QoS library redirection. It provides three interfaces, to the application layer, the RSVP layer, and the QoS manager layer as follows for information exchange and QoS parameters setup.

- The application layer interface: The RSVP library redirection must know which application is working on, so this interface provides application recognition and calls the system shared library instead of application does.
- The RSVP layer interface: The RSVP library redirection must collect application-related information after application recognition, and deliver these information to the RSVP layer interface for parameter setup of .the RAPI.
- The QoS manager layer interface: This interface will setup the size of bandwidth reservation, that is token-bucket parameter such as r (token bucket rate), b (bucket depth), p (peak rate) and so on [3] in the IntServ network.

IV. Conclusion and Future Works

This paper presents a RSVP-aware RG that provides the RSVP library redirection mechanism in RSVP-enable IntServ network, which makes legacy Internet applications RSVP-aware in the run-time. So it can guarantee the network bandwidth to meet the real-time multimedia demand in network congestion. Through the RSVP library redirection mechanism, RAPI communicate the Internet application and RSVP daemon to setup QoS parameter for the reservation of the required network bandwidth. Under the development is on the Linux platform, the RG offers a solution that meets the key goals of a cost-effective, low-maintenance, upgradeable multimedia gateway.

Today the in-home networking exists more than 50 candidate technologies, working groups and standard specifications, divides into new wires (such as IEEE 1394, Ethernet, USB), no new wires (such as ApBus, X-10, CEBus, Lonworks, PLC), and wireless (such as IEEE 802.11, Bluetooth, IrDA, and HomeRF) [5]. Next step the proposed RG will add X-10 system, Bluetooth, and so on. At that time the packets containing A/V data could deteriorate the quality of sound or image if there is time delay during the transmission of the packets, but the home device control traffic sometimes is very important, e.g. fire alarm or gas alarm may cause serious damages if the control packets are not processed in time. How to make the minimize delay, quickly transfer different traffic packet and delay analysis in RG is the key issue.

Reference

[1] S. Blake et al., "An Architecture for Differentiated Services," IETF RFC 2475, Dec. 1998.

[2] R. Braden et al., "Integrated Services in the Internet Architecture: An overview," IETF RFC 1633, June 1994.

[3] R. Braden et al., "Resource Reservation Protocol (RSVP) version 1 Functional Specification," IETF RFC 2205, September 1997.

[4] Takeshi Saito, Ichiro Tomoda, Yoshiaki Takabatake, Junko Ami and Keiichi Teramoto, "Home gateway architecture and its implementation," IEEE Transactions on Consumer Electronics, Vol. 46, No.4, pp.1161-1166, November 2000.

[5] Th. Zahariadis, K. Pramataris and N. Zervos, "A comparison of competing broadband in-home technologies," Electronics & communication engineering journal, pp.133-142, August 2002.

[6] http://www.havi.org/

[7] R. Braden and D. Hoffman, "RAPI-An RSVP Application Programming Interface version 5", Internet Draft, August 11, 1998.

[8] 魏全佑, 苗育本, 謝錫堃 , 邱基峰, 黃文祥, 2000, " 採透通方式達成具有RSVP能力UNIX FTP ", Proc. 5th on Computer & Communication Technology 2000, pp. 2B-1 ~ 2B-6.