QoS Architecture for NGN

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***Abstract* — NGN (Next Generation Network) architecture is assumed as a next generation network where wired and wireless services are converged and quality of service is guaranteed. Though there have been several works on QoS provisioning mechanisms to improve quality of service in the current Internet, such as RSVP, DiffServ, because of the complexcity and scalabilty issues these mechanisms have not been deployed yet. In this paper, we propose a QoS mechanism to enhance end-to-end QoS though it is very simple but reasonable. The proposed mechanism uses controlling signal to reserve network resources from sending network to receiving network similarly to RSVP, then send data with QoS enabled flag similarly to DiffServ. In this paper we illustrate the proposed resource reservation mechanism with network topology and signaling.**

***Keywords* — NGN, scalable Internet QoS Architecture**

1. Introduction

Recently the demand on multimedia services especially such as VoIP, IPTV, Tele-conference has been greatly raised. But these kinds of services cannot be completely supported by the current Internet environment without any consideration on the Internet quality of service (Quality of Service: QoS) such as transmission delay and delay jitter etc.

Of course there have been a lot of researches about Internet QoS for past several years. Among them, IntServ[2], DiffServ[3], RSVP[4] are the representative researches to guarantee Internet QoS. However these mechanisms are not fully used in actual Internet environment because of several crucial problems, such as scalability and the way of reservation.

In this paper, we propose a very light Internet infrastructure by simplifying the internal resource reservation scheme and it also can provide end-to-end QoS between a source to a destination. The proposed method uses an out-of-band signaling for resources reservation and handles simple queue mechanism for data delivery. The most remarkable features of the proposed mechanism are that each router can minimize the state information used for resource reservation so that scalability can be provided. Secondly, it is a sender-based soft state resources reservation so that data delivery path is identical to reserved path without any additional information management required. Finally it provides a fully end-to-end resource reservation mechanism.

In the section 2, some related studies of this proposed structure are presented as a background of this proposal and pointed out what is the problem in current Internet QoS. In the section 3, the outline of proposed structure is described. In the Section 4 and 5 we present QoS signaling and the details about a QoS data delivery scheme. The final section concludes the proposed scheme and shows some further study left.

2. Related Study

IntServ is one of a most representative standard model of an Internet QoS infrastructure for the current Internet environment where only best-effort service can be provided. Especially resource reservation signaling, admission control and a packet scheduling mechanism is defined here. As one of signaling mechanisms for resource reservation, RSVP has been proposed.

The most featured characteristic of RSVP is that it can guarantee per flow end-to-end QoS through receiver-based soft-state approach. In the RSVP, a sender advertises the characteristics of data flow to send by way of the periodic PATH message, and the receiver reserves the resources using RESV message according to the flow specification advertised by PATH message. With this RESV message, RSVP routers can renew resources reservation state. To release the reserved resources from source to destination, a receiver can send TEAR message to the source, or do nothing. If a periodic RESV message does not appear within a specific timeout period, an RSVP router can release the reserved resources for the receiver. Also multiple hosts can share network resources with others to have more efficient network resource utilization.

Traditionally, an L3 router simply switches ingress packets to its egress interfaces by lookup routing table. But in the RSVP, each router should mange the per-flow state information containing IP addresses and port numbers from source to destination. This causes RSVP router to be overburden, to provide scalability.

To solve this problem, a DiffServ mechanism is proposed. In this mechanism, every packet holds PHB(Per Hop

Behavior)[6] information according to the CoS(Class of Service) previously defined, and a DiffServ router only forwards packets according to PHB set. Marking PHB bits can be done by source or edge router of a DS network. If DiffServ packet passes between two DS network, a PHB bit can be adjusted by the policies of the two. As the largest merit of a DiffServ mechanism, it can solve the scalability problem shown in IntServ by diminishing the size of information a router should manage.

However a DiffServ cannot provide end-to-end QoS services to users, but only differentiated CoS(Class of Service) services where network resource competition happens. But under heavily competed situation, a packet having better PHB also can be suffered likewise the packet having worse PHB.

3. An Overview of Proposed QoS Structure

In this section, an overview of proposed QoS structure is presented. Basically, a proposed structure consists of 4 parts, source/destination hosts, QoS handlers, ingress/egress edge routers and a series of core routers as shown in Figure 1.

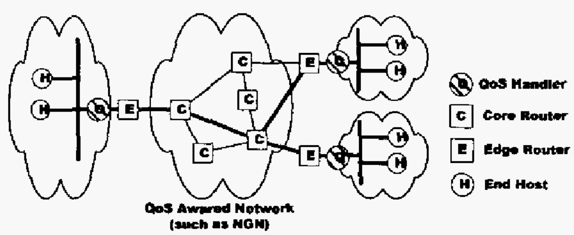

Figure 1 Proposed Internet QoS Structure

There two major parts of the proposed structure are shown in figure2, which are signaling and data delivery modules.

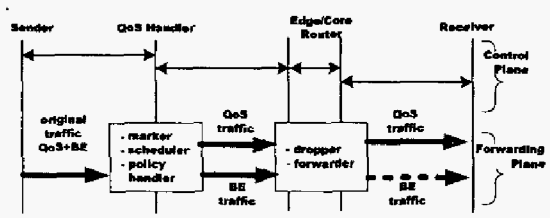

Figure 2 Signaling & Data Transmission Module

In this scenario, a data must be classified into two classes, i.e. a QoS-enabled and QoS-disabled class, and the classified packet is transmitted from source to destination by data delivery module.

Role of an edge router takes charge of transmitting packets from a sending host to a core router by resources reservation acceptance control. Resource reservation procedure is done by an out-of-band signaling and data forwarding from end host is delivered according to the QoS bit setting in the packet header telling QoS-enabled or not. In the case of QoS-disabled packet, an edge router transmits the packets with best effort.

On the contrary, for the QoS-enabled packets, additional traffic monitoring is done by an edge router. If an end host conforms to the bandwidth which he made a reservation for, a packet is delivered to a core router. If not, the corresponding packets are set up as QoS-disabled.

A queue mechanism of this proposal is different from that of RSVP or Diff-Serv. Router resources are divided into a multiple class in case of RSVP or DiffServ[1], there are only two classes which are In-Service and an Out-Service class in this proposal.

An In-Service bandwidth is used for a delivery of QoS-enabled packets, the another is used for the delivery of not that kind of packets. Resource request for the In-Service bandwidth can be done by OOB signaling but not for the Out-Service. If the In-Service bandwidth is not fully reserved, the left portion can be used for the delivery of Out-Service packets for better utilization.

Figure 3 shows the elements which an edge router is composed of. An edge router is managing QoS reservation state about each flow, and monitors whether the incoming flow from a sending host violates the contract. If a violated *QoS-enabled* packet is found, it converts the *QoS-enabled* bit into *QoS-disabled.*

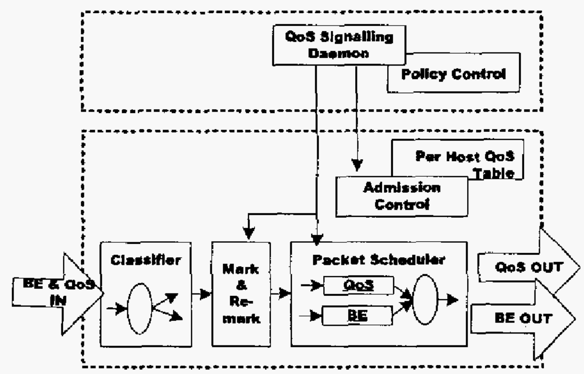

Figure 3. Insides of QoS Handler

It is composed of a series of core router from an edge router to a receiving side edge router. Resources reservation signaling of this part consists of a hop-by-hop way. The details of a QoS signaling between end hosts are presented in the following paragraph. And the reserved path between end nodes is identical to a path obtained by a routing table.

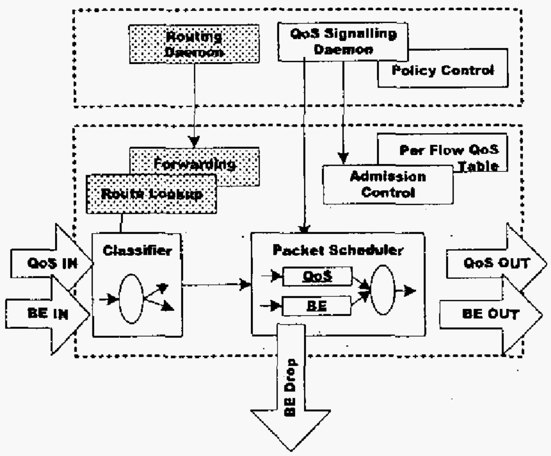

Figure 4. Insides of Proposed Router

If an error arises during the resources reservation, an error message is delivered with reverse-course, and the resources reservation is canceled. Only after a successful resources reservation QoS-enabled packets are transmitted according to the queue from source to destination made by the reservation. Each router manages only two queues like figure 4. An IS(In-Service) queue is a queue for QoS service to be provided, and an OS(Out-Service) queue is a queue to transmit an best effort service packet. As a result a router can manage only a little state according to managing only two queues per each interface.

4. Signaling

Among other router resources generally a bandwidth is the largest consideration object. In a mechanism proposed to an object making a reservation for is the sender that delivers QoS data, and an object carrying out resources reservation is achieved in routers between a sender and receivers. Resources reservation signaling consists of a hop-by-hop way from a sender to a receiver like looking in figure 5.

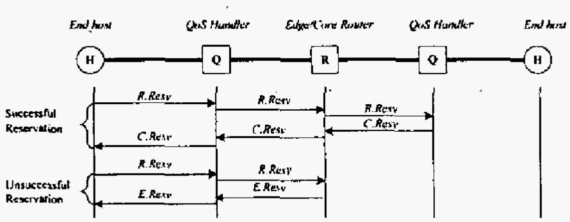

Figure 5. Resource Reservation Signaling

As mentioned above with figure 1, there are two kinds of routers between a sender and receivers. The router which bordered on an end host is called an edge router. This router does an admission control for the resource reservation and monitoring on the ingress packets from its network.

The series of routers between edge routers are defined as core routers. A core router does not perform admission control , a policy control nor packet monitoring. A core router makes a resource reservation according to resource availability and forwards the incoming QoS data properly.

The most important information that core routers must manage are how much the resources are used and how much the resources are available. Figure 6 shows the modified routing table holding the necessary information.

The sending host which reserves resources needs to send resources reservation request message periodically. An edge router requests to a core router according to this message only after the admission control is accepted.

Similar to RSVP, a soft-state management is needed. Resource reservation can be renewed by periodic resources request message. And if there is no a explicit cancellation request, a reserved resources information can be flushed as the routing table is renewed. However, this state management is performed only in an edge router, but not in a core router.

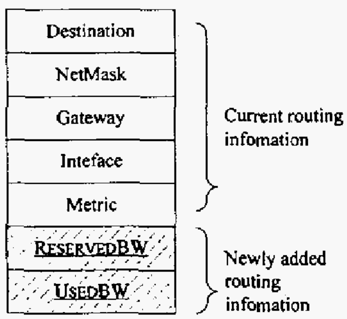

Figure 6. Modified Routing Table

5. Data Delivery

A sender can send QoS data to the receiver only after it made a reservation successfully through a OOB signaling. A QoS packet is marked as a QoS-enabled and delivered to the receiver following the pre-reserved QoS channel.

After successful reservation, a sending host must monitor the quantity of sending QoS packets. Because it can collect all the information about traffics it generates, not only per-flow but also per-host, and resources it has reserved for an interface. A sending host must performs traffic monitoring not to violate the reservation conformation.

As well as sending host, a QoS handler monitors the traffic to make a decision whether the packet conforms the contract or not. If a packets violates the contract for the reservation, an edge changes the corresponding QoS-enabled packet into QoS-disabled packet, then treats as QoS- disabled.

Traffic passing an In-Service(IS) queue ensures guaranteed service, and the traffic passing an Out-Service(OS) queue provides only best-effort service, therefore passing OS queue packets can be sluffered from loss or delay when a router became congested.

If we consider the traffic generated from the source is divided in to two streams, one for guaranteed service which is conforming to the contract and the other is its best-effort services and can be presented as in equation (1).

$$f_{out}(t) = r_{out}(t) + b_{out}(t) \qquad (1)$$

This stream is appeared in the ingress point of QoS Handler as presented in equation (2). The r_{ij} presents that the reserved stream from node i to node j, while b_{ij} presents that the best effort stream from node i to node j.

$$f_{ingress}(t) = \sum_{i=1}^{N} r_{ij}(t) + \sum_{i=1}^{N} b_{ij}(t) \qquad (2)$$

This stream is appeared in the egress point of QoS Handler as presented in equation (3). The r'_{ij} presents that the reserved stream from node i to node j, while b'_{ij} presents that the best effort stream from node i to node j.

$$f_{egress}(t) = \sum_{i=1}^{N} r'_{ij}(t) + \sum_{i=1}^{N} b'_{ij}(t) + \sum_{i=1}^{N} d_{ij}(t) \qquad (3)$$

The d_{ij} presents the amount of packet drop caused by resource insufficiency and is equalt to the difference between the input and output amount of stream.

$$\sum_{i=1}^{N} d_{ij}(t) = \sum_{i=1}^{N} r_{ij}(t) - \sum_{i=1}^{N} r'_{ij}(t) + \sum_{i=1}^{N} b_{ij}(t) - \sum_{i=1}^{N} b'_{ij}(t) \qquad (4)$$

The main role of the proposed architecture is to make the packet drop rate to zero by conforming to the contract.

6. Conclusion and Further Study

Internet quality of service offer plan is the very important matter to be considered so that a multimedia service can be provided in Internet. Showing that the global Internet QoS mechanism has not been proposed yet, although Internet QoS related study had been carried out for past several years, Internet QoS is not an easy work.

Therefore we propose a noble Internet QoS guarantee scheme that can be easily applied to the current Internet from the merits and demerits of the past study results. I.e, by using a set of procedure, a sending host can reserve a guaranteed QoS path identical to router path. An one bit QoS data is passed by the reserved path.

A sending host must coordinate traffic in order to conform to reservation resources, if a contract was broken, a penalty about these packets is granted by a QoS handler to degrade into non-QoS data.

As a result, the core router is always ensured data to correspond to resources reserved for. Only structure about a QoS guarantee mechanism was proposed at present, simulation performance validation and a prototype implementation will be continued.

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