MEEAC: an Enhanced Scheme for Supporting QoS granularity by Multipath Explicit Endpoint Admission Control

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Abstract: **The international research community has been working for the last decade on designing solutions for the QoS in Internet. There has been a dramatic increase in the processing power of workstations and bandwidth of high speed networks. This has given rise to new real-time applications such as multimedia. These applications have traffic characteristics and performance requirements that are quite different from existing data-oriented applications. Supporting QoS in packet switching networks requires specialized infrastructure to be designed and developed. The Intserv framework aimed at providing per-flow QoS guarantees to individual application sessions. The scaling properties of the Diffserv architectural framework are achieved by marking each packet's header with one of the standardized codepoints. This paper proposes a new approach for improvement of EEAC-SV model, in order to supporting QoS granularity, by creating multiple paths in the network and selecting capability in source nodes. The simulation result shows the granularity of QoS in the proposed model is better than EEAC-SV model.**

Key words: QoS Granularity, Service classes, IntServ, DiffServ, EEAC-SV.

1. INTRODUCTION

The evolution towards next generation networks and rapid growth of Internet and real-time multimedia communications necessitate Quality of Service (QoS) provisioning mechanisms. As a result, QoS provisioning in networks becomes of high practical and research importance.

Different applications have different QoS requirements. As an example, video-on-demand (VoD) applications can tolerate and moderate end-to-end delay but require high throughput and very low error rate. In contrast, Internet telephony needs very low end-to-end latency but needs moderate throughput and a slightly higher error rate (than VoD) is acceptable [1]. The Internet, in the past has provided only best effort service with no predictable performance [6].

The QoS term has been used primarily in the networking community to define a set of network performance characteristics such as delay, jitter, bit error rate, packet loss, and more. With new multimedia services over packet networks such as the Internet, the concept of QoS involves not only the network but also the end systems. Currently, two service models have been proposed for end-to-end QoS provisioning in the Internet: Intserv [2] and Diffserv [3]. The former provides per-flow-based resource reservation and allocation, whereas the latter aggregates individual flows and provides only a number of services to the aggregated data flows.

The Intserv framework aimed at providing per-flow QoS guarantees to individual application sessions. It defined several new classes of services along with the existing best effort service. The main idea behind this framework is that applications should be able to choose a particular class based on their QoS requirements. The integrated services network provides a mechanism for applications to choose between multiple levels of delivery of its services. This network provides flow oriented service using soft connection oriented communication in conjunction with the existing best effort service. The complexity of the underlying heterogeneous network is hidden from application programmers.

The other IETF proposed framework, called Diffserv, could support a scalable form of QoS and could provide a variety of end-to-end services across multiple, separately administered domains. Trying to maintain per-flow QoS becomes a monumental task for large networks. Diffserv works at class level, where a class is an aggregate of many such flows.

Enforcement of the aggregate traffic contracts between Diffserv domains is a key for providing QoS. The admission control modules must ensure that new reservations do not exceed the aggregate traffic capacity. These features make it possible to provide end-to-end services using Diffserv architecture. Diffserv has no dynamic admission control. Therefore, the network managers must make sure that enough resources are available for the agreed service level agreements. Diffserv doesn't support per-flow QoS guarantees to achieve scalability. The QoS is supported over aggregates of many flows belonging to the same class. It becomes challenging to still maintain QoS, especially for voice and video, which need per-flow guarantees.

The remainder of this paper is organized as follows. In Section 2, the background of the work is investigated and also this section describes some related works. Section 3 describes the proposed scheme, Multi-Path Explicit Endpoint

Admission Control (MEEAC), and the simulation analysis is presented in section 4. Finally, the conclusion is drawn in Section 5.

2. Background and Related Works

The concept of controlling the admission of new calls is known as admission control [7]. If admission control is implemented in a network, there are basically two outcomes of new call request: It will either be accepted or rejected.

In order to implementing and supporting order of QoS, it must implements admission control mechanisms for Diffserv networks. Currently, there are two kinds of it: Static service level agreement and Dynamic admission control. Static control, however, is not practical for small time scales, such as seconds, but can be achieved for longer time scales, such as days or months. Dynamic admission control is not scalable, because requests must be processed per flow. Also, neither on these admission control methods, it cannot improve the granularity of QoS achieved in Diffserv networks.

The Integrated Services (Intserv) architecture provides a means for the delivery of end-to-end QoS to applications over heterogeneous networks. To support this end-to-end model, the Intserv architecture must be supported over a wide variety of different types of network elements. In this context, a network that supports Differentiated Services (Diffserv) may be viewed as a network element in the total end-to-end path.

In [4], the end-to-end quantitative QoS is provided by applying the end-to-end Intserv model, across a network containing one or more Diffserv regions. The Diffserv regions may, but are not required to, participate in end-to-end RSVP signaling for the purpose of optimizing resource allocation and supporting admission control.

From the perspective of Intserv, Diffserv regions of the network are treated as virtual links connecting Intserv capable routers or hosts. Within the Diffserv regions of the network routers implement specific PHBs (aggregate traffic control). The total amount of traffic that is admitted into the Diffserv region that will receive a certain PHB may be limited by policing at the edge. However, this model cannot improve the granularity of QoS proposed in Diffserv networks. Also, mapping method of end-to-end flow QoS requirements from Intserv to the Diffserv will be new challenge.

EEAC (Explicit Endpoint Admission Control) schemes have been extensively studied in the literature to address the scalability issue of the dynamic admission control in the Diffserv networks. Generally, there are two parties involved in EEAC with the Diffserv network: user side and network side. The basic functionality of the network side is to provide differentiated services to users. The end user will carry out the task of admission control with or without the help of the Diffserv network. There are two phases of Endpoint Admission Control: probing phase and data transfer phase. In the probing phase, the host would map the QoS requirements to a network service and start a probing process to obtain information about its performance. Then the host determines whether or not to admit the flow into the network. If the flow is admitted, the data transfer phase starts (see Fig. 1). Since the core node does not need to make admission control decision for each individual flow, the scalability feature of the Diffserv model can be maintained in EEAC schemes [6].

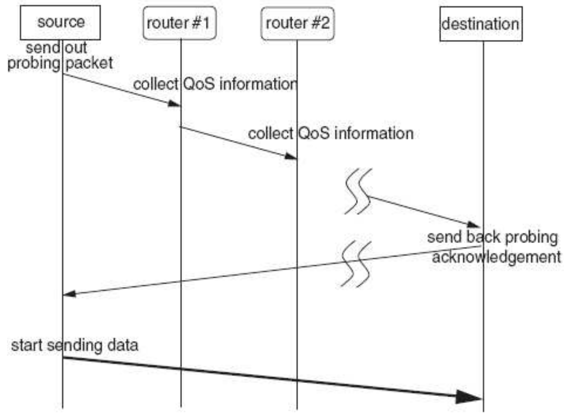

Figure 1. Successful EEAC Procedure

To reduce the probing overhead and enhance the probing accuracy, the performance measurement can be conducted by each router and conveyed to the end hosts by marking or dropping the probing packet. The end host will start sending data only when the probing packet is neither dropped nor marked. Since the measurement is performed on the aggregated traffic, the result should be more accurate compared to the measurement obtained through the individual probing flows, and it is not necessary to send a large sequence of probing packets to the network. Although classified as an EEAC scheme, it should be noted that in this type of EEAC schemes, the admission decision is actually made by the router through the marking or dropping of probing packets, rather than by the end hosts. Therefore, the admission decision may not be customized according to the user requirements. All these schemes assume that the data flow will use the same service along the data path, and therefore, they cannot be applied conveniently to indicate the performance of each service at each router along the data path, but only the end-to-end performance of a specific service.

Current EEAC schemes also bring up the problem of resource abuse. Some users with loose QoS requirements may abuse network resources by choosing the services that are supposed to provide stringent QoS, and therefore users that really require stringent QoS bounds may not get satisfactory QoS. The resource abuse problem may be partially solved by the integration of pricing and admission control. Actually provisioning of different services with different pricing is one of the objectives for the deployment of Diffserv model. In the literature, user benefit optimization models that introduce pricing schemes into the network service provisioning have been studied to enhance the user benefits from the network services. For applications with adaptive QoS requirements, i.e., applications that can adjust their QoS requirements according to the network congestion, pricing schemes can be used to provide incentives to users to adjust their data rate so that network service congestion can be avoided and users can maximize their benefits. The results presented in demonstrate that changing service price according to network congestion enhances both the network performance and the perceived user benefit compared to the flat-rate pricing.

3. Multi-Path Explicit Endpoint Admission Control (MEEAC)

This section proposes the MEEAC-SV architecture that enhances the QoS granularity by creating new PATHs in the networks, that end point hosts can select these paths. This on demand path model uses in order to create new paths in the network and its task is updating bandwidth for flows virtually, and also holding used bandwidth in the flows based on boundary routers and service classes. In the congestion situation, new paths will prepare in the network based on threshold parameter defined for the service class.

Although in the EEAC-SV model, by enabling flows to select deferent services in the routers, that causes increase the quality of service granularity, but by creating new paths in the networks and using potentially free resource in the other paths, we can find better QoS granularity in the network. In this situation network hosts can get information of deferent services in the other paths, and choose the efficient path in order to send its flows on that path.

The architecture of proposed model in this paper has two sides (network, user) and two phases, same as EEAC-SV's architecture. The first phase contains searching, admission controlling and virtual bandwidth reservation. Data sending will be done in the second phase.

First, in the user stage, the host sends request messages to the destination host and waits to receive the corresponding admissions. When the admission messages had received before the predefined time, end to end operation can be done in the deferent paths based on the messages information. After determining the end to end operation of paths, the path that meets the minimum requirement of QoS will be selected as efficient one. So, the reserve message that contains flow identification, service vector related to the path, path identification, destination host and bandwidth usage of flow, will be send to the boundary router. This method used in order to registering the amount of spent bandwidth for the flows [8].

Then On Demand Path (ODP) could create new path based on this information. Searching and admission packet may lose in the path. Destination may avoid response to the source request message. In this situation, the protocol benefits timers, after timer expiration, and source host retry to send message again after expansion of distribution delay time. In the Network side, when the searching packet reach to the boundary router of the network, the router, after specifying the outgoing routers, gets the path or paths of the outgoing routers. So, boundary router, creates searching packet based on the number of created path on ODP, and then sends it on all paths and collects the status of service classes on them.

In the data sending stage, the proposed method uses service model of EEAC-SV, and it implemented by using selected service vector based on the information embedded in the searching message in the deferent paths. End hosts add service vector and path pattern to the data packet. Intermediate routers in the selected path, will use the service vector in order to serving the data packet. Fig. 2 demonstrates the stages of MEEAC model.

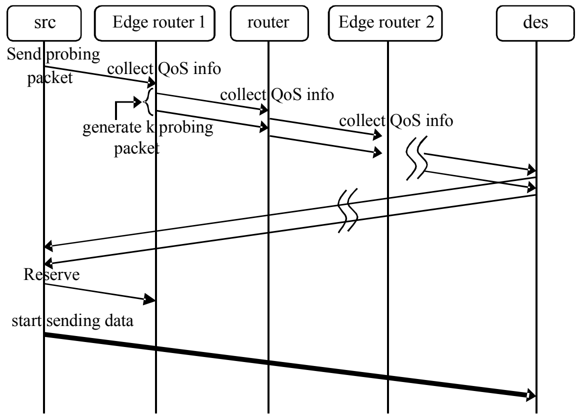

Figure 2. Accepted request in MEEAC

IP networks are stateless and data sending will be done by hop by hop method. So, to selecting path in the MEEAC model, it needs to add a field with name path_pattern in the packets. Its length in bit is equal by needed bits number for showing the router ports multiple to the number of routers. Result values in this pattern identify the ID of output port in the middleware routers. When the packed received in the router, it looks up the output interface in the forwarding table based on longest prefix matching algorithms.

4. Simulation Analyses

Simulation experiments were performed using ns-2 simulator to compare MEEAC model with method of InServ over DiffServ [4]. Fig. 3 shows the topology of network that used in the simulation. Network links capacity is R=9.0Mbps. In the network, flows are classified and corresponding packets get services based on specified class. All packets of one class get services by using FIFO method. Scheduling policy between deferent services is WFQ [5]. In each router, three types of services are implemented (EF, AF and BF) and weight of each one is 0.25, 0.25 and 0.5.

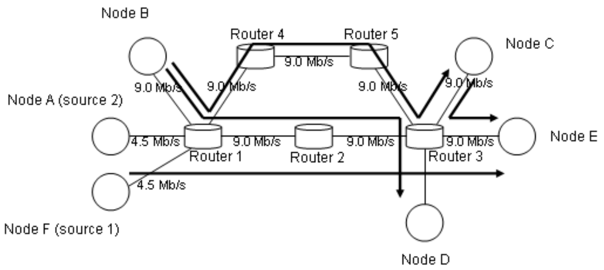

Figure 3. Considered Network Topology for Simulation

In the simulation, on-off traffic source with average rate 12.8kbps and maximum rate 25.6 kbps, used to modeling of flows. Packet length is 500 bytes and time length for state on and off is 0.1s. Maximum traffic rate in nodes A and F is 4.5Mbps. We assume two types of acceptable delay in flows for the simulation. Type 1 with delay<=500ms and type 2 with delay<=750ms.

The cross traffic is summarized in Table 1 and it makes the load of corresponding services at each node unbalanced.

Table 1. Summary of bandwidth occupied by the cross traffic

Source	Destination	Class 0 BW	Class 1 BW	Class 2 BW
Node B	**Node D**	15%	5%	20%
Node C	**Node E**	5%	15%	30%
Node B	**Node C**	70%	70%	70%

As shown in Fig. 4, the probability of request rejection in model MEEAC is less than EEAC-SV. This achievement is because of creation of new path and also more aggregated traffic. Also it is worth to mention that the behavior of both model are almost similar and both of them have the maximum Request Rejection at same time.

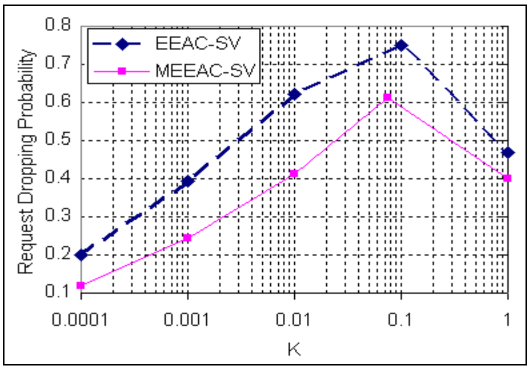

Figure 4. Request Rejection Probability

Packet Dropping Probability is presented in Fig. 5.

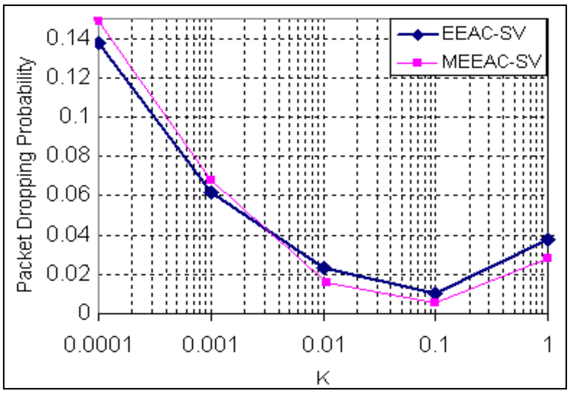

Figure 5. Packet Dropping Probability

Fig. 6 demonstrates the average end to end latency. As shown in the picture, when the request load increases the amount of incoming flows are going up and finally it causes to longer end to end delay.

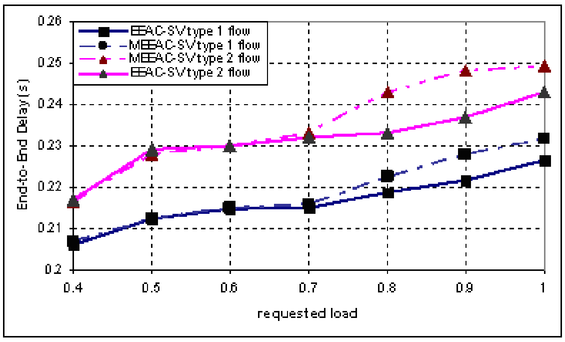

Figure 6. Average End to End Latency

In Fig. 7 the request drop ratio is presented and Fig. 8 compares the average cost per packet under different types of service vectors.

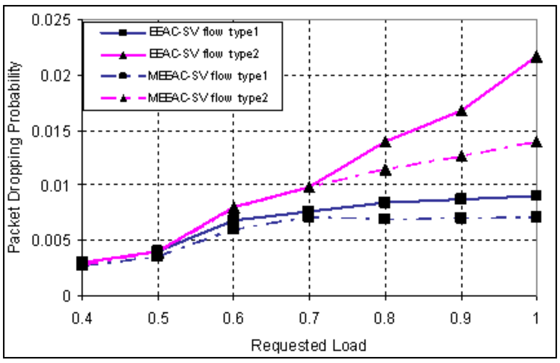

Figure 7. Request drop ratio with different requested load

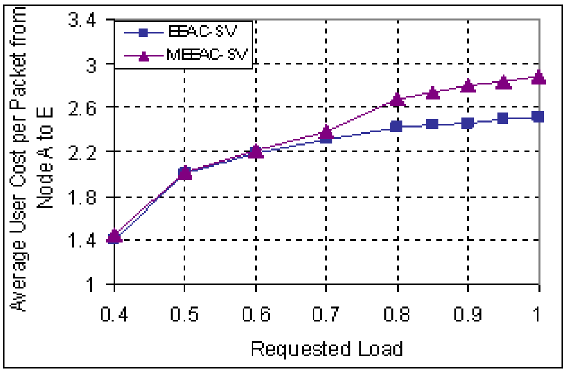

Figure 8. Average cost per packet with different requested load

In Fig 9 and 10 the MEEAC model has been compared with IDSRA (IntServ over DiffServ with static resource allocation) and IDDRA (IntServ over DiffServ with dynamic resource allocation) architectures [9, 10].

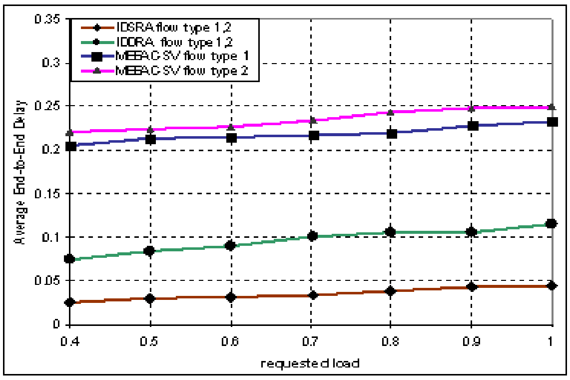

Figure 9. End to End Delay in Different Architecture

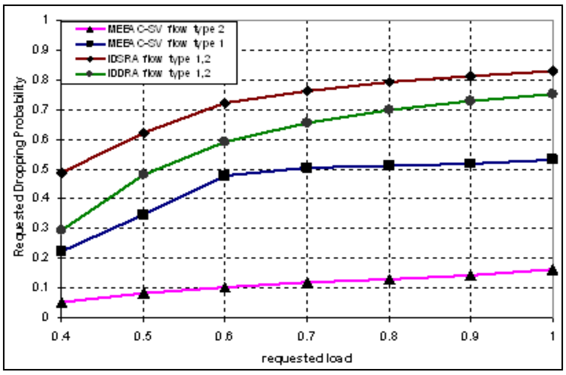

Figure 10. Request drop ratio in Different Architecture

5. CONCLUSION

In this paper, a new service paradigm has been proposed which decouples the end-to-end QoS provisioning from the service establishment at each core routers via a new framework of Multi-Path Explicit Endpoint Admission Control (MEEAC). The aim of this new scheme of service paradigm is to enhance the QoS granularity in Diffserv networks. Unlike conventional EEAC schemes, the proposed MEEAC scheme requires the explicit support of the endpoint admission control, which should provide corresponding performance information to the end hosts. By performing MEEAC during the data transfer, the end hosts can obtain better QoS granularity compared with EEAC-SV.

It is demonstrated through the discussion and simulation results, presented in this article, that the new scheme of the user optimization model implemented through the framework of MEEAC, can provide the finest end-to-end QoS granularity and users can achieve the most net benefit from the network services as compared to other schemes.

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