COPS-Based Dynamic QoS Support for SIP Applications in DSL Networks

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Abstract. In this paper, several dynamic QoS solutions including Direct DiffServ, Admission-based Direct DiffServ, Indirect DiffServ, and Hybrid DiffServ are proposed to support largely emerging SIP-based P2P(Peer-to-Peer) and ASP(Application Service Provider) multimedia applications in DSL networks, most widely deployed as broadband access networks. The proposed solutions are designed to be based on standard COPS protocol which is simple and service-independent.

1 Introduction

SIP-based multimedia applications can be serviced in P2P(Peer to Peer) environment, where each end user is responsible for the QoS provisioned, as well as in ASP(Application Service Provider) environment, where the ASP is responsible for the QoS. Dynamic QoS for a SIP multimedia application needs to be supported in an appropriate way according to the corresponding service environment of the application. Currently most QoS-enabled access networks are developed based on the DiffServ IP QoS architecture because of the complexity problem of the other IntServ QoS architecture[1,2,3]. In this paper, several dynamic QoS solutions including Direct DiffServ, Admission-based Direct DiffServ, Indirect DiffServ, and Hybrid DiffServ, are proposed to support largely emerging SIP-based multimedia applications in DSL networks. How to apply each proposed dynamic QoS solution to the corresponding service and network environment is also discussed in this paper.

2 Proposed Solutions: Direct DiffServ, Admission-Based Direct DiffServ, Indirect DiffServ, and Hybrid DiffServ

1) Direct DiffServ solution for dynamic QoS support enables end-user entities of a SIP multimedia application to directly access the corresponding IP QoS required for the application's dynamic QoS. In the Direct DiffServ solution, UAC(User Agent Client) and UAS(User Agent Server) firstly collect the identification information and QoS attribute values for each media stream of a multimedia application through SDP

Y.-T. Kim and M. Takano (Eds.): APNOMS 2006, LNCS 4238, pp. 554 – 557, 2006.

offer and SDP answer exchange procedure embedded within SIP session establishment[4,5], and perform DiffServ classification based on the collected QoS data. The DiffServ classification is an environment-specific matter. (a) of Fig.1 shows an example scenario of Direct DiffServ dynamic QoS solution for a simple SIP multimedia application which does not include QoS preconditions.

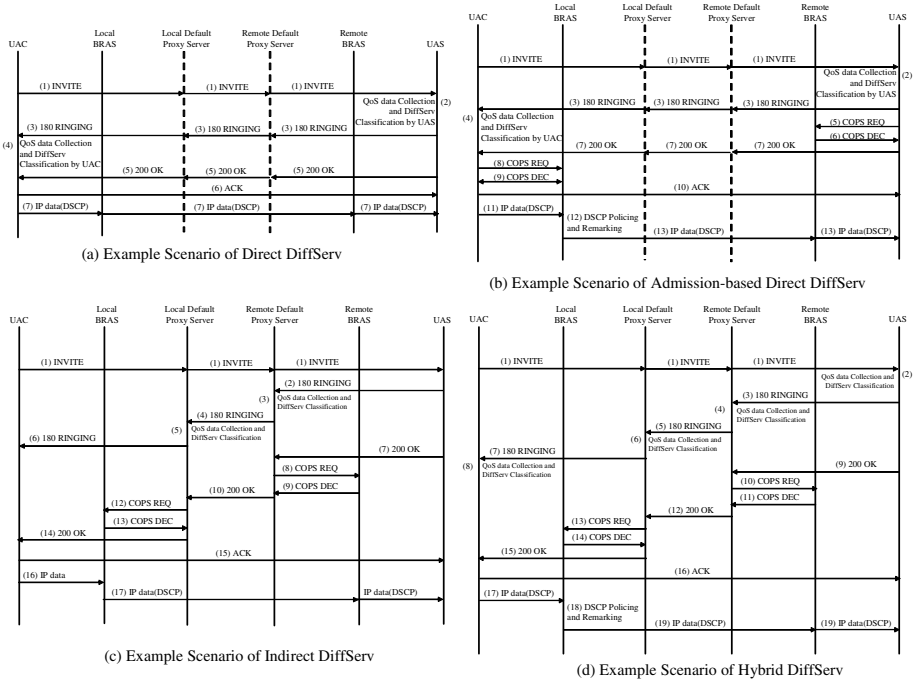

Fig. 1. Example scenarios of Direct DiffServ, Admission-based Direct DiffServ, Indirect DiffServ, and Hybrid DiffServ

Since Direct DiffServ does not require any additional signaling to support dynamic QoS, it is very simple. But it does not provide any mechanisms to do admission control for IP QoS and policing service of the admitted IP QoS to protect authorized users from non-authorized users. This means that it is difficult to apply Direct DiffServ solution to the most broadband access environments where QoS policing is necessarily required to filter non-authorized QoS packets. We believe that Direct DiffServ solution will be useful to support P2P SIP multimedia applications, in which end systems are fully responsible for QoS support, in enterprise network environments where end users who are sending QoS packets can be trusted.

2) Admission-based Direct DiffServ solution adds some signaling mechanism between end-users and NSP to the Direct DiffServ solution. Through the signaling, NSP can do admission control of IP QoS requests from end-users, and provide policing service of the admitted IP QoS based on the authorization information given at the signaling phase. (b) of Fig.1 shows an example scenario of Admission-based Direct

DiffServ solution to support dynamic QoS for simple SIP multimedia applications. Since UA is performing the role of QoS PEP(Policy Enforcement Point) and BRAS(Broadband Remote Access Server) of QoS-enabled DSL networks is acting as QoS PDP(Policy Decision Point), in the Admission-based Direct DiffServ, the standard PEP-PDP COPS(Common Open Policy Service) protocol [6] can be used for the QoS signaling between UA and BRAS. The PIB(Policy Information Base) defined as a named object for the UA-BRAS COPS protocol will convey identification information, QoS attribute values, and DiffServ classification information for each media stream of a multimedia application. Though the UA-BRAS COPS signaling protocol makes Admission-based Direct DiffServ solution more complex than Direct DiffServ solution, it can provide policing service of the admitted QoS for authorized users to protect from non-authorized users. Therefore, this solution will be very useful to support P2P SIP multimedia applications in most broadband access networks where QoS policing is necessarily required.

3) In Indirect DiffServ solution, some QoS proxy servers of a multimedia application will be responsible for supporting dynamic QoS on behalf of the end-user entities of the application. SIP default(inbound/outbound) proxy servers will become QoS proxy servers in QoS-enabled DSL access networks. COPS protocol can be also used for the QoS signaling between default proxy server and BRAS, same as in the UA-BRAS signaling of Admission-based Direct DiffSrev solution. (c) of Fig. 1 shows example scenario of Indirect DiffServ solution to support dynamic QoS for simple SIP multimedia applications. Default proxy servers, taking the role of QoS proxy servers, collect identification information and QoS attribute values for each media stream and determine DiffServ class, by capturing SDP offer and answer exchanged between UAC and UAS via INVITE and 180 RINGING messages. When the remote default proxy server receives 200 OK message indicating successful QoS negotiation from UAS, it delivers the identification information and QoS attribute values to its remote BRAS and requests IP QoS admission, by sending COPS REQ message. Remote BRAS admits the IP QoS request by sending COPS DEC message, after checking the configuration profile for the ASP and its resource allocation status. Admitted remote default proxy server sends 200 OK response to local default proxy server. Local default proxy server, after receiving 200 OK message, performs similar IP QoS admission procedure with its local BRAS by using COPS protocol, and delivers the 200 OK message to UAC, if successfully admitted. And then, BRAS will be ready to perform packet classification and DSCP marking for media stream incoming from the user, and aggregate queuing and prioritization.

In the Indirect DiffServ solution, BRAS is injection point of IP QoS and end-user systems are not involved in the IP QoS enforcement. This means that Indirect DiffServ can be easily deployed in the legacy QoS-unaware end-system environments. On the other hand, Indirect DiffServ solution can be supported only in ASP environments where there are QoS proxy servers and COPS signaling is supported between QoS proxy server and BRAS. Moreover, Indirect DiffServ has a significant disadvantage that there is no ways to support IP QoS in the access network ahead of BRAS because end-systems are not involved in the QoS support. Consequently Indirect DiffServ solution will be very useful to support dynamic QoS for ASP SIP multimedia applications in legacy broadband access networks where most end-systems are QoS-unaware.

4) Hybrid DiffServ solution is an integrated solution of Direct DiffServ and Indirect DiffServ solutions. Whereas end-systems of Indirect DiffServ solution are not involved in any activities to support IP QoS, Hybrid DiffServ solution additionally allows end-systems to directly perform IP QoS enforcement activities such as DSCP marking, based on the identification information, QoS attribute values, and DiffServ classification information for each media stream collected during QoS negotiation procedure. This will solve the problem of Indirect DiffServ solution that IP QoS is not supported in access network ahead of BRAS. (d) Fig. 1 shows an example scenario of Hybrid Diff-Serv solution to support dynamic QoS of simple SIP multimedia applications.

3 Concluding Remarks

In this paper, we proposed four different dynamic QoS solutions based on DiffServ. Direct DiffServ solution is useful to support P2P SIP multimedia applications in enterprise network environments where end users can be trusted. Admission-based Direct DiffServ can be easily applied to support P2P SIP multimedia applications in most broadband access networks where QoS policing is necessarily required. Indirect DiffServ solution will be effective in supporting dynamic QoS for ASP SIP multimedia applications in legacy broadband access networks where most end-systems are QoS-unaware, since end-user systems are not involved in the IP QoS enforcement. Hybrid DiffServ solves the problem of Indirect DiffServ solution that IP QoS is not supported in access network ahead of BRAS by additionally allowing end-systems to directly perform IP QoS enforcement activities such as DSCP marking.

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