On Ensuring End-to-End Quality of Service in Inter-Domain Environment

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Abstract. Internet use is in permanent evolution, Internet traffic has become more and more diversified, and each type of traffic has its own Quality of Service (QoS) requirements. Different problems appear with this diversity. One of the main problems is the difficulty in ensuring QoS for traffics that cross multiple domains or Autonomous Systems (ASs). We propose in this paper a new method which ensures the end to end QoS requirements over multiple ASs. This method keeps the same values of QoS parameters required by the traffic, even during its passage across several ASs. This paper explains the problem of end-to-end QoS and gives a detailed description of our new approach.

Keywords: Inter-domain routing, QoS.

1 Introduction

Early, before the appearance of different types of traffic, which requires more bandwidth, less delay, and other necessary parametres, Internet traffic didn't have any quality of service constraints. However, today network traffics are very diverse, and each type of traffic has its own QoS requirements. Ensuring QoS has become an additional task for the network. Various models have been implemented to ensure QoS in intra-domain case. Nevertheless, in the inter-domain case the problem is not resolved yet.

Objective of this paper is to propose a new method that ensures the end-to-end QoS constraints for traffic services across multiple domains. Services involved in our approach include real time services such as voice and video telephony and conference, as well as services that require high capacity interconnections like links between scientific sites or cloud services, which are provided by different domains.

This paper is organized as follows. Section 2 gives related works and discusses the inter-domain problem. Next in section 3, we describe our approach that ensures end-to-end QoS over multiple domains, and finally, in section 4, we conclude this paper and give future works.

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2 Inter-Domain Problem and Related Works

Several solutions and technologies have been proposed and implemented to provide QoS within the same domain (AS), such as IntServ (Integrated Services) [1] model, DiffServ (Differentiated Services) [2] model or even MPLS [3].

However, a serious problem is posed when the traffic crosses another domain (AS). This problem is due to the fact that QoS constraints, required by the client and which the operator undertakes to provide (usually specified in the Service Level Agreement, SLA), are defined in the classes of service. While the definition of the classes of service is assured by the domain administrator, they are consequently specific to each domain, and are valid only within this domain. In this case, in the transition to another domain the QoS constraints offered to the traffic will not be the same as in the source domain, therefore the QoS required by the client at the beginning will not be provided from the end-to-end until its destination.

A various studies and several solutions have been proposed to ensure the quality of service (QoS) in inter-domain; each solution suggests a specific approach to treat the subject. All solutions proposed in the different works [4][5][6][7][8] treat the end-to-end inter-domain QoS problem by focusing on one of the two following aspects:

1. Paths computation: by proposing new algorithms,
2. Management functions: by proposing a new model based on new procedures and methods or on existing technologies (e.g. MPLS).

However, these inter-domain solutions do not provide to clients traffic the same required QoS as in its source domain. In this context, we introduce this paper which presents a solution that offer to clients traffic the same QoS constraints even in passing to another domain.

3 Proposed Solution Description

3.1 Approach Definition

To ensure continuity of QoS constraints offered to the client even after the transition to other domains, we introduce a new method that provides a new mechanism for inter-domain traffic treatment.

The basic idea in our approach is to designate in each domain a server responsible for the management of the different classes of service, named the **Class Manager** (CM). On this server we define a table, named **Class Table** (CT) that contains all information concerning the different classes defined in this domain (such as bandwidth, loss rate, delay, etc.).

Once the CM of each domain filled its CT, it sends it to a neighbouring domain. In this way, each CM has all the information about its neighbours classes of services, and then, upon receiving a packet from the neighbouring domain, the router in the current domain can classify it in a class that has the

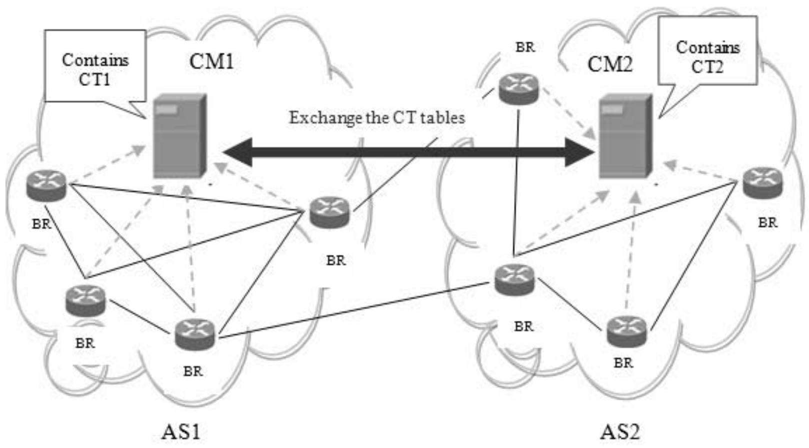

Fig. 1. Mechanism of the proposed Solution

same characteristics as the source class. In this manner, the client flow retains the same QoS constraints throughout its path to the destination, and receives the same treatment from end-to-end. The diagram in the figure [1] resumes this mechanism.

3.2 CT Table Structure

The class table is structured according the following fields:

1. AS number: to identify domain associated with the class.
2. Class number: to identify the class of service.
3. Bandwidth: to indicate the percentage of bandwidth allocated to the class.
4. Priority: to specify the priority level of the class.
5. Queue-limit: to specify the maximum number of packets that the queue can hold for this class.
6. Random-detect: to indicate whether the algorithm WRED is enabled on that class.

We note that, to ensure a certain correspondence between the CT tables of the different domains, we define in the CT table only class parameters common between various router's constructors, which are basic parameters used by the different constructors to characterize a class of service. However, the CT table fields can be adapted later to parameters used by the router's constructor implemented in the network. The parameters used in the CT table must be specified in the agreement established between the domains as we will explain later in this paper.

3.3 Sending Information from Routers to CM Sever

As we have already mentioned, routers receive the customer traffic and class it by applying mechanisms of adopted QoS intra-domain model. Information concerning parameters relatives to every class defined on a router is in the router configuration file. The border router sends this file to the CM server. Once received, the CM server executes a script to retrieve information concerning classes of service, and to place them in a file named CT, this file represents the class table which is responsible of storing information concerning all classes of service defined in the domain. However, sending the entire border routers configuration file to the CM server presents a serious security risk, this point will be discussed in future work.

3.4 Exchanging Tables between CM Servers

The communication between the CM servers of all domains uses the TCP protocol. Information exchanged between CM servers is included in TCP streams. So, before sending its CT table, each CM server establish a TCP session with the one holding in the neighbouring domain. Once the session TCP is established, the first message exchanged between both CM servers is the identification message, which allows each CM server to become identified by its neighbour, by sending its IP address and AS number. After the identification, CM servers exchange their CT tables by sending a set of messages to announce their classes of services, called Announcement Messages. Every message contains various parameters values relatives to every class defined in the domain.

When the CM server receives the message transporting the informations from its neighbour, it stores them in its CT table. In this way, when the CM server receives the totality of messages, it will have all information concerning all classes defined in the neighbouring domain.

The last type of message is the Update Message, which is sent by a CM server when there is an addition or modification of a class of service defined in its domain. The update message has the same structure as the announcement message.

3.5 Broadcasting CT Tables

Once a CM server receives its neighbour CT table, it diffuses it to the routers of its domain. Hence, all domain routers will possess all information about class of service defined in the neighbouring domain, and can use this information to create and configure classes of service which will have same values of QoS parameters.

According to these classes of service, the receiving router will classify packets comming from the neighbouring domain to be forwarded in the current domain with the same QoS constraints.

3.6 Agreements between Domains

The proposed solution is mainly based on agreements established between domains. Indeed, the information exchanged between domains in CT tables is very important and very sensitive, and the domain administrators have to negotiate and establish an agreement that will manage relations between domains. The agreement also defines how the tables exchange will be charged.

4 Conclusion and Future Work

Different problems appear with the evolution of Internet. One of the main problems aims the inter-domain routing with a guaranteed quality of service (QoS). Today, the Internet traffic is diversified, and each type of traffic has its own requirements. In this paper, we proposed a new mechanism which could ensure end-to-end QoS over multiple AS. We described it and we gave details of its operations and its components.

Our mechanism keeps the same QoS required and our objective is achieved. However, we can't confirm its performances before a study is done. So, our future work will focus on the performance evaluation of the new solution in order to show its advantages and limitations.

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