Quality of Service for Multimedia and Real-Time Services

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ABSTRACT

New web technologies have encouraged the deployment of various network applications that are rich with multimedia and real-time services. These services demand stringent requirements that are defined through Quality of Service (QoS) parameters such as delay, jitter, loss, etc. To guarantee the delivery of these services QoS routing algorithms that deal with multiple metrics are needed. Unfortunately, QoS routing with multiple metrics is considered an NP-complete problem that cannot be solved by a simple algorithm. This paper proposes three source-based QoS routing algorithms that find the optimal path from the service provider to the user that best satisfies the QoS requirements for a particular service. The three algorithms use the same filtering technique to prune all the paths that do not meet the requirements which solves the complexity of NP-complete problem. Next, each of the three algorithms integrates a different Multiple Criteria Decision Making method to select one of the paths that have resulted from the route filtering technique. The three decision making methods used are the Analytic Hierarchy Process (AHP), Multi-Attribute Utility Theory (MAUT), and Kepner-Tregoe KT. Results show that the algorithms find a path using multiple constraints with a high ability to handle multimedia and real-time applications.

Keywords: Kepner-Tregoe, Multi-Attribute Utility Theory, Multi Metric Routing, Multiple Criteria Decision Making, Quality of Service

INTRODUCTION

Multimedia and real-time applications are being highly deployed in the Internet world. These applications need Quality of Service (QoS) to assure user satisfaction. The internet sends multimedia through the network as a sequence of IP packets and does not take into account the service characteristics for each type of application being transmitted. This means that the internet does not provide any quality assurance. Since diverse applications have different network requirements, these requirements should be provided to the network in order to achieve the desired QoS. These requirements are defined

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through one or more QoS parameters such as bandwidth, delay and jitter (delay variation).

There are three problems that the algorithms proposed aim to solve. The first problem is that there is a variety of diverse multimedia and real-time applications deployed throughout the Internet, where each application has its own QoS requirements to ensure customer satisfaction that differ form the other applications; for example, video conferencing needs higher bandwidth requirements than Voice over Internet Protocol (VoIP) call (Szigeti & Hattingh, 2004). Therefore, the path selected to deliver a certain application to the end user will depend directly on the QoS requirements of the requested service. This problem is solved by creating different service profiles for each type of application where each service profile contains a list of constraints and all necessary information to deliver the service to the client.

The second problem, is that multimedia and real-time applications cannot be delivered using the traditional routing algorithms, where only a single metric is considered; for example ‘distance’ in Dijkstra’s shortest path algorithm (Dijkstra, 1959; Cormen, 2001). Consequently, multimedia and real-time applications are usually associated with multiple constraints such as delay, jitter, loss rate, bandwidth, etc. where QoS routing is applied (Guo et al., 2009; Xueshun et al., 2009). Unfortunately, routing with multiple constraints has been proven to be an NP-complete problem (Wang & Crowcroft, 1996; Mottazpour & Khadivi, 2009), where the routing problem cannot be solved to find the exact solution in a real time scale. This problem is solved by decreasing the number of paths that the algorithm has to search which in return decreases the complexity problem; this is done by pruning all the links that do not meet any of the metric requirements for a particular service in the search process. Thus, a feasible solution can be found by combining more than one type of metric with any other types of metrics (additive, concave, or multiplicative) (Wang & Crowcroft, 1996; Mottazpour & Khadivi, 2009).

The third problem is selecting the best path that satisfies multiple metrics that have resulted from the filtering technique, where comparing these paths together on more than one metric can be complicated and needs special methods to make the right selection. In this paper, Multiple Criteria Decision Making methods have been used for selecting the optimal path for service delivery.

According to the problems stated above and the solutions proposed the paper aims to develop and implement a QoS routing algorithm that finds the best path from the source node to the destination node that satisfies the QoS requirements for the requested service. This can be achieved by filtering out all the paths that violate the QoS constraints for a particular service. Another aim is to implement multiple criteria decision making methods into the routing process to assist the algorithm choose the best path.

RELATED WORK

Routing can be classified into three types, unicast, multicast and broadcast. Broadcast routing is not a problem because the packets are sent to all receivers, so there is no need to find an optimal path. The routing problem has two major problems, the unicast routing problem and the multicast routing problem. This paper focuses on the unicast routing problem, where the unicast routing problem is to find the best feasible path from the source node to the destination node that satisfies a set of QoS constraints. Unicast routing algorithms can be further divided to single metric, dual-metrics or multiple metrics routing. As this paper aims to provide QoS routing it is necessary to use multiple metrics.

There are many attempts to solve the unicast routing problem with regards to multiple constraints (Leng et al., 2009; Esfahani & Analoui, 2008; Lee et al., 2009) but only a few papers have considered implementing multiple criteria decision making methods to solve this
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