QoS Provisioning for Multimedia Applications on MANeTs by Adapting MPLS

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ABSTRACT

Multimedia applications require certain QoS guarantees to be met in order to function properly. QoS requirements for multimedia transmission include bandwidth guarantees and temporal guarantees (delay and jitter). Existing routing protocols on MANeTs are not adequate enough to deal with these necessities imposed by multimedia traffic. In this article, an adaptation of MPLS is proposed for MANeTs. MPLS and MLDP together are employed in MANeTs to provide QoS and traffic engineering for real time multimedia traffic. These protocols are implemented and tested in the OMNeT++ network simulator. This article describes in detail the design and implementation of MPLS and MLDP.

Keywords: MANeT; MPLS; Multimedia traffic; QoS

INTRODUCTION

Mobile ad hoc networks (MANeTs) have been around for some time now. However, research in this area is still a hot topic. By default, MANeTs are complex in nature. In MANeTs nodes are in continuous movement, wireless medium is used for communication purposes, and moreover, there are no routers or central servers involved. All these attributes make MANeTs an intricate entity to deal with. Research in this field is still going on and there are many aspects of MANeTs which are yet to be dealt with.

Enabling multimedia communications over MANeTs is an interesting and a difficult proposition (Doyle, Kokaram, & O’Mahony, 2001). The very idea of multimedia transmission demands bounded delays, jitter, and other quality of service (QoS) guarantees. Given the highly dynamic nature of MANeTs, such tight bounds required by real time multimedia communications are very challenging.
applications remain a challenging issue (Yeh, Mouftah, & Hassanein, 2002).

A robust routing protocol is needed in order to cater for the transmission of multimedia traffic over MANeTs. Such a protocol should not only be able to discover the path to a destination in a MANeT, but also maintain this path under varying typology and more importantly this path should “always” guarantee the QoS requirements put forward by the multimedia traffic. Added to these conditions, the protocol should be easily configurable such that it can provide different routes for different traffic from the same source to the same destination (traffic engineering).

Currently, there does not exist any standard for a routing protocol over MANeTs that provides QoS and traffic engineering (TE) for multimedia traffic. Research in this topic is still in the immature stages. Many problems remain to be solved before any such standard can be devised.

In this article, we propose a protocol: mobile multiprotocol label switching (M²PLS) that can provide QoS guarantees and traffic engineering to multimedia traffic in small- to medium-sized MANeTs with limited movement. The essence of this protocol is mainly based on the concept of multiprotocol label switching (MPLS). MPLS was adapted such that it could take into account (a) the dynamic nature of the nodes involved; (b) no involvement of routers; and (c) the fact that wireless medium is used for interaction purposes. There are two main protocols proposed in this article. M²PLS runs in each mobile host. It is the layer that goes in the OSI stack in every mobile node between the data link layer and the network layer. It deals with sending and receiving data between the nodes once a path has been established. The second protocol is the signaling protocol, which is responsible for establishing the path between the nodes such that it meets the QoS guarantees put forward by the multimedia traffic. It also deals with maintaining this path under node movement and constructing a new path once an old path has broken due to node movement or node disappearance (the node could be out of range or it could have gone down to limited battery life). The effectiveness of these protocols is validated through simulation over OMNeT++ network simulator (Varga, 2003). The results of the experiments were quite promising and depict that the quality of multimedia traffic is maintained even when the nodes are in movement and path breakage is occurring frequently. However, the decrease in terms of jitter and delay and the increase in terms of throughput for multimedia traffic come at the cost of signaling overhead. Signaling packets are exchanged to establish and maintain QoS guaranteed paths.

The rest of the article is organized as follows. The next section gives a brief review of related work, followed by a section discussing the main issues involved in the design of a QoS provisioning routing protocol. Then, the next section discusses the design and implementation of our proposed protocols. An evaluation and analysis of the proposed protocols is presented after that. In the last section, we present the conclusion and direction for future work.

RELATED WORK
Most of the existing ad hoc routing protocols such as the dynamic source routing protocol (DSR), ad hoc on demand distance vector protocol (AODV), and temporally ordered routing protocol (TORA) establish and maintain routes on a best-effort basis (Perkins, 2001; Perkins & Royer, 1998; Park & Corson, 1997). While this might be sufficient for a certain class of MANeT applications, it is not adequate for the support of more demanding applications such as multimedia audio and video. Such applications require the network to provide guarantees on the QoS.

QoS as characterized in RFC 2386 is defined as a set of service requirements that need to be met by the network while transporting a packet stream from a source to its destination (Crawley, Nair, Rajagopalan, & Sandick, 1998). Network needs are governed by the service requirements of the end user applications. The network is expected to ensure a set of quantifiable prespecified QoS attributes to the users.
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