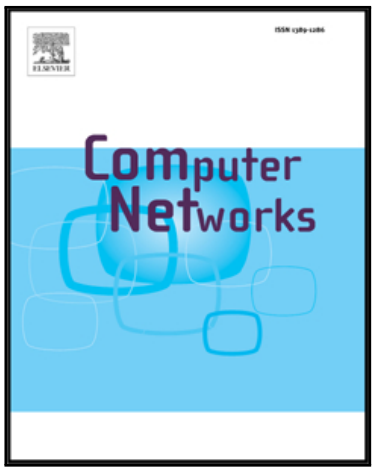

Quality of service in delay tolerant networks: A survey

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Quality of service in delay tolerant networks: A survey

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Abstract

Delay tolerant networks (DTNs) are characterized by the absence of the end-to-end path due to intermittent connectivity among the nodes. Such networks are potentially applicable in the challenging scenarios, e.g. interplanetary communication, post-disaster environment, where traditional communication infrastructure is partially or fully absent. Each application requires some quality of service (QoS) guarantees for the traffic flow. QoS support cannot be provided to a network without QoS provisioning. However, QoS provisioning in a DTN is more difficult task than traditional networks, because of its inherent characteristics. There exist various issues which affect QoS in DTNs. In this paper, we explore the issues that influence QoS in DTNs. Subsequently, we analyze the effects of the issues on the QoS in terms of delivery ratio, packet drop etc. We also review various QoS management solutions in DTNs. The schemes on the QoS issues are classified based on their underlying approaches and key features. The paper is concluded with a brief discussion on some of the open research issues regarding QoS in DTNs.

Keywords: Delay tolerant networks, Quality of service, QoS issues, QoS management solutions

1. Introduction

Delay tolerant networks (DTNs) [1] emerge as a possible solution for communications in various challenging environments like interplanetary communication in space, post-disaster scenario, rural communications etc. Unlike conventional wired or wireless networks (e.g. cellular networks), the communication link between any node pair is considered to be dynamic in DTNs. The reason behind this is the unpredictable movement of the nodes in the network. Hence, the DTN nodes contact with each other in an opportunistic manner [2]. Such opportunistic connectivity results in unstable network topology, long delay, and absence of the end-to-end path in DTNs.

Quality of service (QoS) generally indicates the level of network performance to the users. In other words, QoS refers to a certain performance level for a particular network service. It is a fact that a network needs to ensure some service guarantees during the transport of a traffic flow [3]. So, minimum required resources need to be available along the path from the source to the destination for achieving QoS guarantees in a network. QoS provisioning aims to improve the reliability of data delivery for heterogeneous traffic by efficient resource utilization in the network. Additionally, QoS provisioning helps to prioritize various types of network traffic based on their QoS requirements. For instance, real-time traffic is assigned higher priority than non real-time traffic, because consistent network service to the users is necessary during real-time traffic flow. If there is no QoS provisioning, all the traffic would have uniform priority in the network. In that case, users are likely to receive all the network service with the best-effort delivery that does not provide QoS support. Hence, QoS provisioning is an important task to support the transport of heterogeneous traffic in a manner that can be acceptable to their corresponding users in the network.

It may be noted that QoS provisioning is a more difficult task in wireless networks than wired networks [4]. Some of the important reasons are low bandwidth, high channel interference, fading, scarcity of new frequency spectrum in the wireless networks. Network infrastructure is another critical issue for QoS provisioning because it provides resources to a particular traffic for meeting its QoS requirement. Under the class of wireless ad-hoc networks, QoS provisioning is more challenging than cellular networks, since there are no fixed network infrastructures. In mobile ad-hoc networks (MANETs), node mobility makes the communication links unstable. Precisely, reliability and capacity of the links degrade with the mobility of the nodes in the network. These problems offer significant challenges in QoS provisioning. The situation is even more challenging in DTNs, where end-to-end path hardly exists because of low node density and high node mobility.

Importance of QoS provisioning in DTNs is explained in the following example. Fig. 1 shows hypothetical deployment of a DTN in the post-disaster scenario after the devastating floods across the state of "Uttarakhand" in India in 2013 [5]. In a post-disaster application scenario, availability of the network is the main QoS requirement. The figure shows, there are two relief camps and one control center. The relief camps get the update about the need of relief materials, through the volunteers/relief workers