Chapter 2
Transmission Control Protocol for Mobile Ad Hoc Network

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ABSTRACT

The Transmission Control Protocol (TCP) is a reliable protocol of transport layer which delivers data over unreliable networks. It was designed in the context of wired networks. Due to popularity of wireless communication it is made to extend TCP protocol to wireless environments where wired and wireless network can work smoothly. Although TCP work in wireless and wired-cum-wireless network, the performance is not up to the mark. In literature lot of protocols has been proposed to adopt TCP in wireless mobile ad hoc network. In this, we present an overall view on this issue and detailed discussion of the major factors involved. In addition, we survey the main proposals which aim at adapting TCP to mobile and static Ad hoc environments. Specifically, we show how TCP can be affected by mobility and its interaction with routing protocol in static and dynamic wireless ad hoc network.

1. INTRODUCTION

In military domain the wireless communication happens through point-to-point radio links. Wireless network can be categorized into wired-cum-wireless networks, that is wireless network at the periphery of wired network and totally wireless networks also called the mobile ad hoc networks. In case of the wired-cum-wireless network, the wired networks provide a high-speed backbone and the wireless LAN is attached at the periphery of the wired network. The wireless network area is divided into smaller regions called cells. A fixed base station provides an interface between the wired and wireless part of the network and controls each cell. The Mobile Hosts (MH) can move freely from one cell to another. Any call originating from one wireless network to another wireless network, passes through the wired backbone. In case of mobile ad hoc networks there are no fixed base stations. Each MH movement is independent of the movement of other hosts and it can enter or leave the system at any time. There is no fixed backbone and the MHs cooperate to deliver the messages from one MH to another.

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Ad Hoc Networks are complex distributed systems that consist of wireless mobile or static nodes that can freely and dynamically self-organize. In this way they form arbitrary, and temporary “Ad hoc” networks topologies, allowing devices to seamlessly interconnect in areas with no pre-existing infrastructure. MANETs are self-configuring infrastructure-less networks that adapt dynamically to changing environments. In contrast to cellphone technology, MANETs are able to support multi-hop wireless communication over a shared medium. However, the capacity and performance of MANETs are much lower, compared to cellphone networks, and informing future users and service developers on the limitations as well as the advantages of this technology is essential for proliferation of the MANET technology. While MANET technology is very suitable for tactical communication, many IP-based protocols are not directly usable in MANETs. These protocols were developed in a strictly wire-based network domain, where attributes like interference and packet loss are less dominant and better controlled than in wireless multi-hop networks. For instance, queue loss is the sole contributor to packet loss, while medium-based bit errors are but non-existent. In MANETs, the Bit Error Rate (BER) is much higher than in wired networks (several orders of magnitude). Protocols that anticipate the cause of packet loss to be caused by queue drop-tail may make the wrong assumption in MANETs, reacting badly in this situation.

2. TCP OVERVIEW

TCP (Transmission Control Protocol) (Postel, 1981) was designed to provide reliable end-to-end delivery of data over unreliable networks. The Transmission Control Protocol (TCP) has become an essential protocol for Internet communication due to most of the internet traffic carries by TCP. It provides important function like rate control, flow control and traffic congestion without which the Internet is useless. However, TCP makes several assumptions about the network. It assumes the packet loss is the only reason of network congestion, and not transmission errors. It also assumes that the Round Trip Time (RTT) is relatively constant (little jitter) and that rerouting happens very quickly. This assumption is limited to wired network.

Since bit error rates are very low in wired networks, nearly all TCP versions nowadays assume that packets losses are due to congestion. Consequently, when a packet is detected to be lost, either by timeout or by multiple duplicated ACKs, TCP slows down the sending rate by adjusting its congestion window. Although this assumption is reasonable for wired networks, it is questionable for wireless networks especially MANETs. All those causes that are not related to congestion can result in unnecessary congestion control, which will degrade the TCP performance. In wireless networks packet loss may be due to high bit error rate, mobility, path asymmetry, multi hop communication and interference by neighbor nodes where losses are not related to congestion. So TCP cannot adapt to this environment. In last few decades many researchers have been tried to enhance and optimize the performance of TCP over wireless networks. These improvements include infrastructure based WLANs(Balakrishnan, 1997; Bakre, 1997; Balakrishnan, 1995) mobile cellular networking environments(Brown, 1997; Balakrishnan, 1995) and satellite networks(Hinderson, 1999; Durst, 1996). In fact TCP has variants of protocols: Tahoe, Reno, Newreno, Sack1 and Vegas. All these protocols were proposed to improve their congestion control techniques and perform differently in Ad hoc networks(Xu, 2002). However, all these versions suffer from the same problem of inability to distinguish packet losses due to congestion or due to the specific features of Ad hoc networks. These proposals are not directly useful for the employment of TCP in MANETs. However, there has become more interest during the last decade in improving TCP for communication