

Chapter 4

Improving Throughput of Starved TCP Flow by Sidestepping Bottleneck Nodes Using Concurrent Transmission

Rajesh Verma
MNNIT, India

Arun Prakash
MNNIT, India

Rajeev Tripathi
MNNIT, India

Neeraj Tyagi
MNNIT, India

ABSTRACT

The TCP congestion control mechanism along with unfairness problem poses poor performance when IEEE 802.11 MAC protocol is used in multi-hop ad hoc networks because the traditional TCP has poor interaction with the IEEE 802.11 MAC protocol. Because of the greedy nature of TCP, starvation problem of TCP flows with longer paths is severe. In this paper, we first illustrate that the fairness, congestion control and medium contention are closely coupled issues and the spatial reuse of the channel can improve the performance of wireless ad hoc network. By using concurrent transmission protocol at the MAC layer, like CTMAC, in multi-hop networks we can achieve simultaneous transmissions within the interference regions. Further, we illustrate with extensive simulations in ns-2 that by scheduling multiple concurrent transmissions along the path links, the starvation problem due to greedy nature of TCP can be eliminated and ensuing higher flow throughput and lower end-to-end delay.

DOI: 10.4018/978-1-4666-0119-2.ch004

INTRODUCTION

The traditional transport layer protocol TCP behaves very unpredictably with degraded throughput in multi-hop wireless ad hoc networks, as it was designed to provide reliable end-to-end delivery of data packets over wired networks. In wireless scenarios, the main problem of TCP (Chen, Zhai, Wang & Fang, 2004; Fu, Meng & Lu, 2002) is the performance of congestion control mechanisms in case of losses which are not occurred due to network congestion. TCP is unable to distinguish between non-congestive losses (due to route failures because of mobility, random errors, contentions on the wireless channel and unfairness) and due to network congestion. So, TCP performs poorly in wireless ad hoc networks because it has to face new challenges due to several causes specific to these networks such as lossy channels, hidden and exposed nodes, path asymmetry, network partitions & route failures (in multi-hop environments) and power limitations.

When IEEE 802.11 MAC protocol is used in the multi-hop ad hoc networks, the traditional TCP congestion control mechanism encounters several new problems. In these networks, the medium contention is high which results in severe unfairness and starvation problems for TCP flows. The congestion control, fairness and medium contention are all related and closely coupled issues for TCP end-to-end throughput and the end-to-end delay. Several works have been done in the past related to greedy nature of TCP resulting in high level of congestion and thus degrading the performance of the wireless ad hoc networks. For example, Figure 1 shows a simple 9 static node chain topology with a single TCP flow from node 1 to node 9 with 1000 bytes payload, it is observed that the TCP traffic introduces a lot of collisions and therefore retransmissions of control (RTS/CTS) and Data packets at the MAC layer [3] and there are many TCP packets dropped at a rate of 0.83 to 3.63 packets/sec due to medium contentions without any queue overflow.

Again, TCP traffic is unstable in the wireless multi-hop scenario because the round trip time (RTT) oscillates in a larger range and so does the instantaneous throughput. These observations are due to the greedy nature of TCP and the strong dependencies between congestion and the medium contentions. The TCP increases the congestion window size till the first packet loss and when the transmission rate of the sender crosses the channel capacity, the subsequent incoming packets are accumulating at various nodes along the directed route. When all the neighboring nodes have packets in queue to transmit, they try for contending the channel and thus number of collisions increases and so is the channel contention delay, thereby slowing down the packet forwarding rate and frequent congestion occurs in the network. Thus congestion and the collision work jointly and continuous retransmission timeouts and delayed duplicate ACKs occurs giving poor end-to-end throughput and larger delays. Here in this simulation work, we will be using concurrent transmission MAC protocol (CTMAC), which was derived for single-hop independent multiple concurrent transmissions in MANETs for increasing the spatial reuse of the channel within the interfering regions in our proposed static ad hoc networks (SANETs) chain topology scenario because of its simple implementation and better results.

The rest of the paper is organized as follows: In section II, we discuss the related work on solutions to starvation problem and concurrent transmission protocols at the MAC layer level. We present a summary of IEEE 802.11 and working of a concurrent transmission protocol, CTMAC,

Figure 1. A 9-node topology with a single flow



12 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage:
www.igi-global.com/chapter/improving-throughput-starved-tcp-flow/62964

Related Content

Prioritization Schemes in Queuing Handoff and New Calls to Reduce Call Drops in Cellular Systems

Allam Mousa (2013). *Contemporary Challenges and Solutions for Mobile and Multimedia Technologies* (pp. 179-189).

www.irma-international.org/chapter/prioritization-schemes-queuing-handoff-new/70815

Multilingual SMS

M. Shirali-Shahreza (2007). *Encyclopedia of Mobile Computing and Commerce* (pp. 666-668).

www.irma-international.org/chapter/multilingual-sms/17153

Impact of Network Dynamics on the Performance of Distributed Physical Cell Identities Assignment Schemes

Ali Diaband Andreas Mitschele-Thiel (2016). *Self-Organized Mobile Communication Technologies and Techniques for Network Optimization* (pp. 1-34).

www.irma-international.org/chapter/impact-of-network-dynamics-on-the-performance-of-distributed-physical-cell-identities-assignment-schemes/151133

Chakuri-Bazaar: A Mobile Application for Illiterate and Semi-Literate People for Searching Employment

Muhammad Nazrul Islam, Md. Arman Ahmedand A.K.M. Najmul Islam (2020). *International Journal of Mobile Human Computer Interaction* (pp. 22-39).

www.irma-international.org/article/chakuri-bazaar-a-mobile-application-for-illiterate-and-semi-literate-people-for-searching-employment/258950

Affective Quality of Audio Feedback on Mobile Devices in Different Contexts

Julia Seebode, Robert Schleicherand Sebastian Möller (2014). *International Journal of Mobile Human Computer Interaction* (pp. 1-21).

www.irma-international.org/article/affective-quality-of-audio-feedback-on-mobile-devices-in-different-contexts/119516