A novel technique to enhance throughput and fairness over wireless mesh networks

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Introduction

Wireless Mesh Networks have gained a huge popularity for the last few years due to their advantages of self-organizing, rapid deployment, and easy maintenance. Wireless Mesh Networks (WMNs) are multi-hop networks classified into three categories: Infrastructure-less WMNs, infrastructure WMNs, and hybrid WMNs. Infrastructure-less WMNs consist of mesh clients which can communicate only with each other directly in an ad hoc manner. Infrastructure WMNs where a hierarchal architecture is existed consisted of a backbone of mesh routers and mesh clients, mesh clients access the wireless network through mesh routers only. Mesh routers, then, can serve as bridges to connect the wireless network to the internet. Finally, hybrid WMN is similar to infrastructure WMN; however, a mesh client can access the wireless networks through another mesh client [1].

Congestion control is a key issue in Wireless Mesh Networks. The issue of congestion has been identified in all kinds of computer networks as a result of heavy traffic load in networks where a lack of resources and unmanaged conditions are existed. Hence, congestion control purpose is to prevent or reduce any overloading or congestion may occur all over the network nodes and links. Provided that WMNs are multi-hop networks using radio channels as a medium to perform the communications among nodes, this makes the task of congestion control is more sophisticated [2].

Fairness is a major issue in wireless mesh networks. The throughput unfairness is a critical problem in wireless multi hop environments where the nearest nodes to the gateway get a higher chance to transmit and receive data, whereas the further nodes get less and less chance to transmit and receive. The unfairness in WMNs is due to mainly two layers mechanisms interacting over a wireless multi-hop network: MAC (IEEE802.11b, for instance) and transport (TCP) layers. Moreover, the contention on the wireless medium among different flows leads to a serious unfairness where the nearest to the gateway get more bandwidth while other flows which are a few hops away may starve [3]. Thus, solutions have been proposed in the literature to accommodate the unfairness issue. Those proposals can be classified according to their functionalities as: Mac layer [4], network layer [5], transport layer [6], or cross layer techniques [7]. Also, some of which is distributed while others are centralized.

In this research, a novel enhancement to [8] is proposed. This makes an end-to-end transport-layer technique that not only assures fairness in WMNs, but also improves the throughput for all the active flows that transmit simultaneously to the gateway which is in turn connected to the internet.

Design / Methodology / Approach

A literature review on different techniques for fairness issue in multi-hop wireless networks was carried out. Then a simulation platform NS2 used for implementing and modelling the proposed technique. Implementations of 3,5,7 chain flows with four different packet sizes (128, 256,512,1024)B have been done, and intensive analysis with LibreOffice Calc software to show the efficiency of the proposed technique.

Findings / Results

Aggregate throughput enhancement has been achieved with good fairness index (>0.9). For example, in a three flows chain topology (4 nodes) a throughput enhancement ratio ranges from 3.87% (packet size= 128B) to 3.50% (packet size= 1024B) with fairness index of (0.999). For a five flows chain topology (6 nodes) a ratio of 13.46% (packet size= 128B) to 13.62% (packet size= 1024B) with fairness index of (0.9345- 0.9128). As for a seven flows chain topology (8 nodes) a ratio of 24.30% (packet size= 128B) to 20.35% (packet size= 1024B) with fairness index of (0.9708- 0.9258).

Conclusion / Discussion

A practical enhancement to end-to-end transport-layer technique that aims to improve throughput and fairness in WMNs has been proposed. The analysis show promising results. The technique would be tested on different topologies and scenarios. Also, an answer to the question whether this technique would perform well in a mobile environment will be a future work.

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