A Solution to Improve TCP Performance over IEEE 802.11 Multi-Hop Ad Hoc networks

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1. Introduccion

Wireless networks are being in focus of many researchers as its importance increase with the worldwide deployment of Wireless Local Area Networks. The WLAN technology IEEE 802.11 helps the users to access Internet at any moment and at any time to get any information, but the big problem is the terrible performance degradation in wireless environments when using TCP standard.

The transmission control protocol (TCP) is a reliable, stream-oriented transport layer protocol, which was designed for use over fixed low-error networks like the Internet. Route failures and disruptions as well as mobility of the work stations or servers are very infrequent since the network is fixed. Therefore, packet loss, which is detected by TCP as a timeout, can be reliably interpreted as a symptom of congestion in the network. In response, TCP invokes congestion control mechanisms. Because TCP was designed for wired networks in wireless environments TCP does not distinguish between congestion and packet loss due to transmission errors, random errors and/or mobility. This inability of TCP results in performance degradation in Mobile Ad Hoc networks

According to IEEE 802.11 Standard, 1999 edition, an Ad hoc Network is a network composed solely of stations within mutual communication range of each other via the wireless medium. A mobile ad hoc network becomes a multi-hop ad hoc network when it needs to send a message using three or more node routers between a node transmitter and a node receiver, extending the communication range of the network.

2. Related works

In 2000, Dongyun Kim e, Toh C.-K and Yanghee Choi [Kim 2000] proposed a new mechanism that improves TCP performance in a wireless ad hoc network, called TCP-BUS, where each node can buffer packets during a route disconnection and reestablishment. They deployed the Associatively Based Routing (ABR) as the underlying routing protocol based on source-initiated on demand protocol. ABR advocates for stable and long-lived routes. It is important to note that the use of an appropriated wireless routing protocol increase the throughput performance because in their performance testes TCP-BUS was better than other TCPs.

In 2001 Chengzhou Li and Symeon Papavassiliou [Li 2001] presented their proposal named Link signal strength Agent (LSSA). The LSSA resides between the TCP and IP layers, in a position similar to the Internet control Message Protocol (ICMP) in the Internet. When receiving the signal strength indication (in wireless mobile ad hoc networks, each Mobile Host emits a beacon signal that is used to identify itself and notify its neighbors about its existence) from lower layers, LSSA encapsulates it into a link signal strength Indication (LSSI) message, and sends it to the TCP Source and destination. By analyzing this information, the TCP source is able to monitor the state of current TCP connections (e.g. good (strong) condition, bad (weak) condition or down). According to the link, condition TCP source may freeze its congestion window, invoke congestion avoidance or request new route reconstruction. Each node can detect the strength of a signal coming from all its neighbors.

Other interesting proposal was presented by Jian Liu and Suresh Singh [Liu 2001] called ATCP (TCP for Mobile Ad Hoc Networks), their solution is to implement a thin layer between IP and TCP that ensures correct TCP behavior while maintaining high throughput. ATCP maintains End-to-End TCP semantics, it is transparent which means that nodes with and without ATCP can normally set up TCP connections, ATCP does not interfere with TCP's congestion control behavior when there is network congestion.

3. Problems of TCP performance over 802.11 Multi-hop ad hoc networks

Dong Sun et al. [Sun 2001] shows that TCP Reno and other versions over mobile *ad-hoc* networks, when mobility increase the Goodput (the ratio between the amount of data arrived at the destination and the amount of data generated by the TCP source) and throughput (only the packets that the sender has received the ACKs are counted in the throughput) decrease and the delay and transfer time increase probing that new solutions to improve TCP over wireless are required.

Also Shugong Xu et al [Xu 2000] and Hai Jian et al [Jian 2001] studied the performance of the *de facto* standard TCP Reno in mobile ad hoc networks showing performance degradation due to multi-hops and mobility respectively. Jian Liu et al [Liu 2001] realized that, if we run transmission control protocol (TCP) over wireless ad-hoc networks, the throughput of the connection is extremely poor because TCP treats lost or delayed acknowledgments as congestion.

In addition Gavin Holland et al [Holland 2002] noticed that "half duplex" transmission implemented in IEEE 802.11 brings low performance in wireless links when we have multi-hop networks here all the results were based on a network configuration consisting of TCP-Reno over IP on an IEEE 802.11 wireless network, with routing provided by the Dynamic Source Routing (DSR) protocol. The same degradation of performance throughout was observed in [Toh 2002] while using associatively-based routing (ABR) protocol, in a real test-bed with four nodes (laptops) and three hops.

S. G. Xu et al [Xu 2002] found three problems instability, unfairness and incompatibility in TCP Reno in a multi-hop ad hoc network.

Besides these problems other important aspects must be considered: Energy efficiency, dynamic network topology at different speeds, limited bandwidth, obstacles in the environment, etc.

4. Our Proposal

In order to fulfill with our goal of improve the performance of TCP, we have to choose some appropriate metrics for our experiments as seen in the following table:

Metric	Unit	Description
Throughput	Bit/s.	The amount of data moved successfully from one place to another in a given time period.
Delay	msec.	Time used by the network for transmit a packet End to End.
Jitter	msec.	Variation of delay
Network size	Node	Measured in the number of nodes
Network connectivity	Node	The average number of neighbors of a node
Lost packet Rate	%	Lost packets in relation with the total sent packets
Error Rate	%	N° transmissions with error in comparison with total transmission
Speed (mobility)	Meter/s	Speed of the nodes in the Ad Hoc Networks
Bandwidth (capacity)	Bit/sec	Amount of data that can be sent through a network connection.

Because the TCP Performance in the wireless environment is also affected by the performance of the routing protocol of the network layer, we selected to work with the Dynamic Source Routing Protocol (DSR) and the Ad hoc On Demand Distance Vector Routing protocol (AODV) because they are widely deployed, are implemented in the simulators we are going to use (NS-2, GloMoSim, NCTUns1.0), several scientific papers show they area better than other Routing Protocols as the Temporally-Ordered Routing Algorithm (TORA), or the Destination-Sequenced Distance-Vector Routing protocol (DSDV) and some actual proposals used them for upgrade or make variations creating new ones. After making our own tests finally we will decide if DSR or AODV will be our default routing protocol

Our Simulation test-bed of Mobile Multi-hop Ad Hoc will be a Chain Topology of “n” nodes where n = 3,4, … 10,000, because it represents a basic Multi-hop Ad hoc Network. We are actually trying to augment the performance of TCP by:

a. Changing TCP inner variables: Round Trip Time (RTT), Retransmission time out (RTO), Congestion Windows (CWND), etc.
b. Modify one or more TCP wireless solutions presented in the related works, in order to create a new one with better Performance characteristics of its predecessors.
c. If it is necessary in order to get better throughput we plan to make some Modifications to the Routing Protocol.

We will implement our proposal in the network simulator NS-2 and will be validated with other simulators as GloMoSim and NSTUns 1.0

5. Conclusion

In our proposal we plan to inherit the best characteristics to improve performance of previous well known TCPs As well as include our insights fruit of the simulations in NS-2 and the analysis and comparison of the simulated results.

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