International Journal of Computer Applications (0975 – 8887)
Volume 11– No.1, December 2010

Performance Evaluation of Routing Protocol and Congestion Control Protocol in Wireless Multi-hop Networks

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ABSTRACT

Computer networks have long suffered from congestion. Congestion occurs when an increase in the offered load results in a decrease in the effective throughput of the network. The basic cause is that the short term packet arrival rate at some gateway exceeds its service rate. Existing congestion control schemes treat congestion as an individual problem and propose ad hoc solution that are dissatisfied. Wireless multi-hop networks have many potential applications, e.g., a small stand-alone network for group of mobile users (Mobile Ad Hoc Networks), a cost efficient sub-network to connect to the Internet (Wireless Mesh Networks), or a self-organized community network connecting houses together (Wireless Community Networks). We approach the problem from a different perspective: In this paper, we selected **WXCP, CALC, WCP, WCCP** congestion control protocols and conceptual study of **DSR, AOMDV** routing protocols for multi-hop networks. Subsequently we relax some of the assumptions and generalize the solution in terms of throughput and number of hops.

Keywords

Congestion control, routing protocol, Wireless multi-hop network

1. INTRODUCTION

A congestion control scheme which provides an efficient and fair sharing of the underlying network capacity among multiple competing applications is crucial to the efficiency, stability, and fairness of wireless multi-hop networks. Anderson. et.al. **[1]** show that the behavior of transport layer congestion control protocol has a significant impact on the stability of adaptive routing protocols in the Internet. An efficient congestion control protocol for wireless multi-hop networks should have the following properties:

1. Loss in packets is strongly correlated to congestion in wire-line networks. But they are not a reliable congestion signal in wireless networks, especially in wireless multi-hop networks, where non-congestion packet losses are caused not only by medium related errors, but also by frequent routing failures . An ideal congestion control protocol should be able to achieve high efficiency even with the presence of significant non congestion packet losses.

2.Congestion happens primarily on the wireless channel. Channel congestions are busty and spread out quickly. When the wireless link layer deploys adaptive bit-rate adaptation, the situation become even more challenging: the network throughput becomes very sensitive to the load over the network and the performance penalty of congestion collapse increases significantly. An efficient wireless congestion control protocol should be able to detect wireless channel congestions quickly and resolve them in their incipient stage before the network enters the congestion collapse loop.

2. RELATED WORKS

More recent work, for mobile ad-hoc wireless networks, is given as TCP-F**[2]**, TCP-ELFN**[3]**, TCP-Bus**[6]**, ATCP **[4]**, and EPLN/BEAD **[14]**, concentrates on improving TCP's throughput by freezing TCP's congestion control algorithm during link-failure induced losses, especially when route changes occur. Individual pieces of work differ in the manner in which these losses are identified and notified to the sender and in their details of freezing TCP. For example, TCP-ELFN**[6]** explicitly notifies the TCP sender of routing failure causing the sender to enter a standby mode. The sender re-enters the normal TCP mode on route restoration, identified using periodic probe messages.

3. PROTOCOLS CONSIDERED

In this section we have considered various class of protocol and studied their performance.

3.1 *Congestion control protocol overview*

XCP[8] is an explicit congestion control protocol originally developed for high band width delay product networks.XCP sender encapsulates the flow state information, e.g., RTT and CWND, into the data packet header; By conveying flow state information in the packet header between end-systems and routers. **WXCP[15]** Wireless explicit Congestion control Protocol extended from XCP routers which implement active queue management without maintaining per-flow information. WXCP gives the idea of explicit congestion control in the context of multi-hop wireless networks. In WXCP, the sender of a flow does not probe the available bandwidth along the path. Instead, the sender regulates the transmission rate of the flow based on the explicit rate feedback from the bottleneck routers. a number of TCP-level and link-layer techniques (e.g., TCP Vegas, TCP congestion control window clamping, and buffer resizing) to reduce contention in the wireless network are moderately effective in alleviating congestion and can improve the TCP performance over multi-hop paths. As a segment-based congestion control protocol, WXCP operates within the wireless network and enforce congestion control to all the flows in TCP over the wireless segment.

CALC[15] a Channel-Aware Link-layer Congestion Control protocol congestion control protocol, It is a link-layer hop-by-hop congestion control protocol for wireless multi hop networks. CALC is built on top of commodity 802.11 hardware with no need to modify the MAC protocol. It sits between the network layer and the link layer and enforces congestion control for all the traffics within the wireless network. CALC enforces congestion control by buffer management at intermediate wireless routers and incorporates in-network hop-by-hop flow control to facilitate the per host buffer management. Hop-by-hop flow control allows CALC to respond more quickly to congestion caused by dynamic channel conditions or traffic changes on nearby links.

WCP[13] Wireless Control Protocol is an AIMD-based rate-control protocol, which recognizes that wireless congestion is a neighborhood phenomenon, not a node-local one, and appropriately reacts to such congestion.

WCCP[12] wireless congestion control protocol, *efficiently and fairly support the transport service in multi* hop ad hoc networks. In this protocol, each forwarding node along a traffic flow exercises the inter-node and intra-node fair resource allocation and determines the MAC layer feedback accordingly. The end-to-end feedback, which is ultimately determined by the bottleneck node along the flow, is carried back to the source to control its sending rate.

3.2 *Protocol for Multi-Hop Wireless Ad Hoc Networks*

Kitae Nahm.et.al**. [4]** IEEE 802.11 wireless local area networks (WLANs) technologies are being considered as potential turnkey solutions for constructing infrastructures of wireless mesh networks (WMNs). Facts states that, performances at the transport layer, in transmission Control Protocol (TCP), have not been doing satisfactorily for connections passing through multiple hops using 802.11 technologies. Data throughput usually drops significantly when a connection has to go through more than three wireless hops. According to **[7]** Deployed into multi-hop wireless networks, and high throughput data rate should be achievable for multi-hop TCP connections. TCP transport protocols can perform poorly because of complex interference among neighboring nodes. In particular, TCP does not explicitly account for the fact that congestion in a mesh network is a neighborhood phenomenon.

DSR[9] The *Dynamic Source Routing* protocol (DSR) is a simple and efficient routing protocol designed specifically for use in multi-hop wireless ad hoc networks of mobile nodes. DSR allows the network to be completely self-organizing and self-configuring, without the need for any existing network

infrastructure or administration. The protocol is composed of the two mechanisms of *Route Discovery* and *Route Maintenance*, which work together to allow nodes to discover and maintain *source routes* to arbitrary destinations in the ad hoc network.

AODV[5] Adhoc On Demand Distance Vector Routing AODV a novel algorithm for the operation of such adhoc networks. Each Mobile Host operates as a specialized router and routes are obtained as needed i.e. on demand with little or no reliance on periodic advertisements. AODV uses symmetric links between neighboring nodes. It does not attempt to follow paths between nodes when one of the nodes cannot hear the other. AODV uses a broadcast route discovery mechanism as is also used in the Dynamic Source Routing DSR algorithm. Instead of source routing however, AODV relies on dynamically establishing route table entries at intermediate nodes. This difference pays off in networks with many nodes where a larger overhead is incurred by carrying source routes in each data packet.

Later on AODV was extended by Mahesh K. Marihas.et.al and new protocol was suggested as AOMDV[11] (Adhoc On Demand Multiple Distance Vector).It is able to achieve a remarkable improvement in the end-to-end delay and is able to reduce routing overheads.

4. METHODOLOGY

We have evaluated these protocols in the simulator Qualnet.

5. COMPARISION RESULTS

WCCP Vs. TCP According to Fig.1 WCCP is better than TCP in terms of delay, channel utilization, and fairness, and throughput. As the number of hops increases WCCP shows better performance.

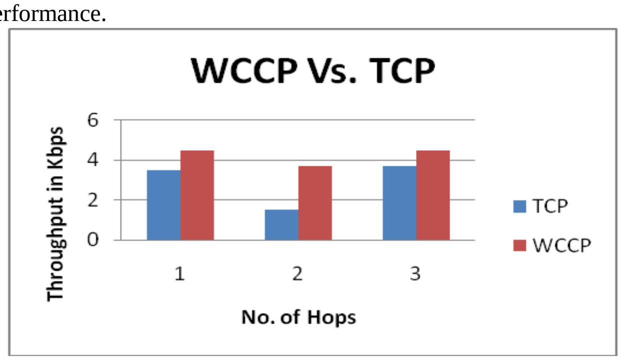

Fig1 : WCCP Vs. TCP Throughput

WCP Vs. TCP According to Fig. 2 WCP achieves near optimal throughput for all the topologies. It is extremely easy to implement. As the number of hops increases WCP and TCP shows nearly the same result.

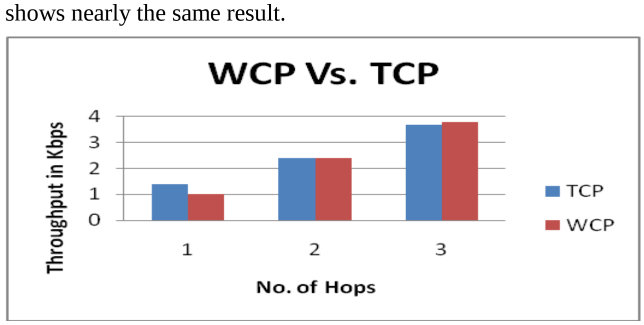

Fig. 2 WCP Vs. TCP

WXCP Vs. TCP Fig. 3 shows that as the number of hops increases WXCP significantly outperforms TCP congestion control in terms of efficiency and fairness in dynamic wireless environment.

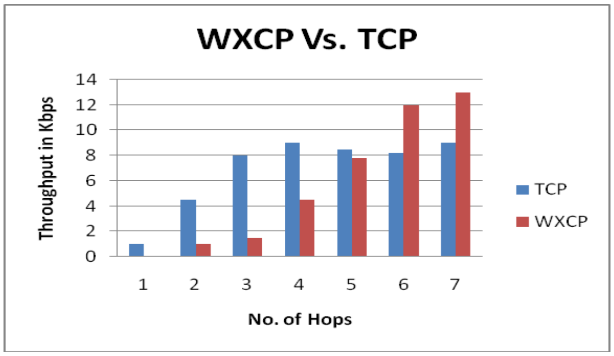

Fig. 3 Throughput of WXCP Vs. TCP

CALC Vs. TCP Fig. 4 shows that as the number of hops increases CALC shows better performance

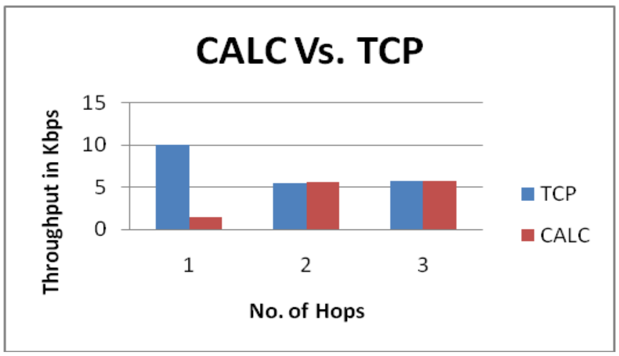

Fig. 4 Throughput of CALC Vs. TCP

6. CONCLUSION

There is an interesting interaction between congestion control protocols and adaptive routing protocols in wireless multi-hop networks and it has been shown by Kitae Nahm et. al. [10] that the behavior of TCP has a significant impact on the performance of on-demand routing protocols e.g., DSR[2] and AODV[5]. Although performing well in single-hop paths, link-layer bit-rate adaptation becomes very inefficient for TCP flows as the length of the path increases. Poor interaction between TCP and bit-rate adaptation contributes to the inefficiency. When TCP grows its congestion window excessively and overloads the network, aggressive link-layer local error recovery may over-react and reduce the transmission bit rate, hence hiding the congestion from TCP. Eventually these steps lead to reduced throughput in the wireless networks.

7. FUTURE WORK

In the future, it will be interesting to further investigate the performance of channel-aware congestion control protocols, Wireless explicit Congestion control Protocol with dynamic routing .Comparision of adhoch protocols will be done in future.

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