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Improvement in Wireless TCP Using Modified Loss Differentiation Algorithm

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Abstract: TCP was designed to perform on wired networks, where packet loss is mostly caused by congestion, as compared to wireless networks, where losses due to error in channel are more likely. Hence TCP respond to all kind of losses by invoking congestion control and avoidance schemes resulting in performance degradation. In this thesis, a modified Loss Discrimination Algorithm is proposed which identifies the actual cause of packet loss and accordingly adaptively decreases the congestion window size in case of congestion loss and maintains the congestion window size in the case of wireless loss. Loss Differentiation Algorithms (LDA) are used to identify the actual cause of the packet loss so as to improve the performance of the wireless Network. This algorithm analyse the behaviour of Packet Inter-Arrival Time, ROTT (Relative One way Trip Time) and gives an idea of the cause of packet loss to the TCP. Experimental results validate the ability of our proposed algorithm to successfully classify the cause of the packet loss, with low End-to-End Delay and high packet delivery ratio. The Throughput is also better than before.

Keywords: TCP, LDA,ROTT, Throughput.

INTRODUCTION

Wireless Networks are quickly becoming popular solution for connecting many different types of devices together. The protocols, developed within the last few years, are making it easier to develop a local area network since the need for wires has been removed - a device no longer has to be fixed to a single location by a wire. The device can be moved at any time, and new devices can be introduced to a network with ease. Wireless Ethernet local area networks (LANs) were introduced by a variety of manufacturers after the Federal Communications Commission (FCC) made the decision in 1985 to make unused bands of the wireless spectrum available for public use without the need for a license. While introductory wireless technologies were popular with customers, widespread adoption did not occur until the first wireless LAN standards were published by the Institute of electrical and Electronics Engineers (IEEE) in 1997.

The Transmission Control Protocol (TCP) is a core protocol of the Internet Protocol Suite. It originated in the initial network implementation in which it complemented the Internet Protocol (IP). Therefore, the entire suite is commonly referred to as TCP/IP. TCP provides reliable, ordered, and error-checked delivery of a stream of octets between applications running on hosts communicating over an IP network. TCP is the protocol that major Internet applications such as the World Wide Web, email, remote administration and file transfer rely on. Applications that do not require reliable data stream service may use the User Datagram Protocol (UDP), which provides a connectionless datagram service that emphasizes reduced latency over reliability.

TCP is a reliable stream delivery service that guarantees that all bytes received will be identical with bytes sent and in the correct order. Since packet transfer over many networks is not reliable, a technique known as positive acknowledgment with retransmission is used to guarantee reliability of packet transfers. This fundamental technique requires the receiver to respond with an acknowledgment message as it receives the data. The sender keeps a record of each packet it sends. The sender also maintains a timer from when the packet was sent, and retransmits a packet if the timer expires before the message has been acknowledged. The timer is needed in case a packet gets lost or corrupted.

Loss differentiation algorithms (LDA) are used to provide TCP with an estimate of the cause of packet losses, to improve performance over heterogeneous networks including wired and wireless links.

In our work, a modified Loss Discrimination Algorithm is proposed which identifies the actual cause of packet loss and accordingly adaptively decreases the congestion window size in case of congestion loss and maintains the congestion window size in the case of wireless loss.

II. Related Work

TCP is both complex and evolving transport protocol. The basic functionality of TCP is defined in [1] and was published in 1981. Since then, significant enhancements have been made and proposed. Host Requirements for Internet Hosts [2] clarifies a number of TCP protocol implementation requirements. Congestion occurs when the demand is greater than the available resources, such as bandwidths of links, buffer space and processing capacity at the intermediate nodes such as routers. Congestion control is concerned with allocating the resources in a network such that network can operate at an acceptable performance level when the demand exceeds the capacity of the network resources. Careful design is required to provide good service under heavy load. Otherwise, there can be a congestion collapse that is highly resource wasteful and causes undesirable state of operation.

Different types of congestion collapse are categorized in [Fall & Floyd, 1996]: classical congestion collapse, which occurs when the network is flooded with unnecessary retransmitted packets [Nagle, 1984] and was fixed with modern TCP retransmit timer and congestion control algorithm [Jacobson, 1988],fragmentation-based congestion collapse, which is given in [Kent & Mogul, 1987] and was fixed with Maximum Transfer Unit (MTU) discovery [3], and congestion collapse from undelivered packets, which occurs when networks overloaded with packets that are discarded before they reach the receiver [S. Floyd & Fall, 1999]

III General Features in TCP

1. It is Connection Oriented.
2. Reliability.
3. Segment Format
4. Data Flow.

S.V. Jansi Rani et al. [4] proposed a TCP in which it surpass the channel access Information to transport layer for improving the performance of TCP in heterogeneous environment. A snoop agent is deployed in the base station which is used to cache the unacknowledged packets in it and the channel status information obtained in the mac layer is sent to the transport layer and thus the Contention window value is adjusted.

Hari Balakrishnan et al. [5] has compared many schemes for improving the performance of the TCP and concluded that local reliability in link Layer Protocols provides better throughput as compare to techniques like loss recovery at sender and splitting the connection at the base station.

IV LDA Scheme

In the scheme we include all the parameters from both of the base schemes[6] i.e. the new scheme classifies a packet loss based on the number of losses, *n*, the difference *d*=rotti - rottmean and Tmin. Now a loss is classified as wireless if among the following conditions is true:

$(n = 1$ AND $d < -$ rottdev;

OR

$n = 2$ AND $d < -$ 0.5rottdev

OR

$n = 3$ AND $d < 0$

OR

$n = 4$ AND $d < 0.5$ rottdev)

AND

$(n+1)\text{Tmin} \leq \text{Ti} < (n+2)\ \text{Tmin}$

The significance of including all the parameters is to classify more strictly a packet loss as wireless loss in which there is no need of reducing the transmission rate. Since misinterpreting congestion loss as wireless loss is more severe than misinterpreting a wireless loss as congestion loss.

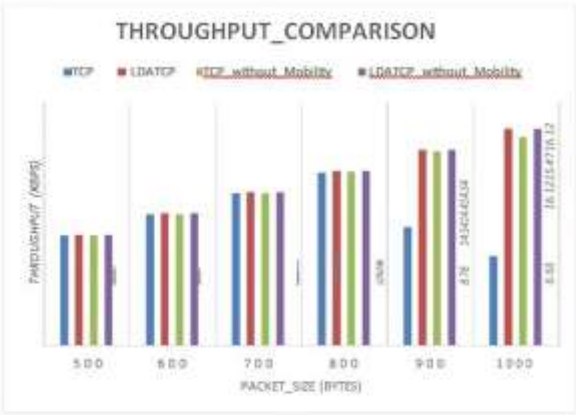
V EXPERIMENTAL SETUP

We use a simulation model based on NS-2 version 2.34 to investigate the performance of the proposed approach. We installed NS-2 on red hat operating system. We have introduced tcp-ldatcp.cc and tcp-ldatcp.h in the standard installation folder of NS-2 to compare the performance of the standard TCP and the LDATCP.

Specifically, in our simulation, the channel capacity of mobile hosts is set to the same value: 2 Mbps. We assume all nodes have the same transmission range of 250 meters. In the simulation, mobile nodes are varied from 21 to 50 nodes and nodes move in 2400 meter X 700 meter region. It moves in the direction of the destination in a speed uniformly chosen between the minimal speed and the maximal speed. After it reaches its destination, the node stays there for a pause time and then moves again. In our simulation, the minimal speed is 25 m/s, and the maximal speed is 50 m/s. We have used Constant Bit Rate (CBR) traffic as the background traffic. The interval time for data transmission is 0.1 second. The size of all data packets is varied from 500 bytes to 1000 bytes to analyse the performance. The simulation time is set to 20 s.

Fig. Network Scenario with 21 nodes

Network scenario created for evaluating TCP and LDATCP is shown in fig. 5.1 and fig. 5.2, where fig. 5.1 is a snapshot of the scenario having 21 wireless nodes, of which node 0 is the source node from where the CBR traffic is generated after every .1s and node 21 is the destiny node. Node 21 is a mobile node which moves towards source node. After 2s of simulation, it starts moving with a speed of 50m/s and there after it moves with a speed of 25m/s.



(a)

(b)

Based on the results shown in figure (a), we analysed that the TCP and LDATCP have same throughput margins under the packet size 500 to 600 bytes, during mobility and without mobility. And when we increased the packet size from 700 to 1000 bytes we analysed that, there is a little throughput margin for TCP during mobility and without mobility whereas the throughput margins remained same for LDATCP during mobility and without mobility and is better than the margins of TCP.

Based on the results shown in figure (b), we analysed that there is high end-to-end delay under the packet size 700 to 900 bytes using TCP during mobility whereas it is quite low for LDATCP during mobility and without mobility. We can say that LDATCP is consistent since the end-to-end delay remained almost same during mobility and without mobility.

VI CONCLUSION AND FUTURE SCOPE

I Conclusion:

A TCP model was developed after modifying the TCP Reno algorithm to avoid unnecessary reduction of congestion window in case of wireless loss. The model implements its TCP fast retransmit mechanism and expresses the steady state congestion window, when loss due to congestion is detected. It analyses the Packet Inter-Arrival Time and ROTT. In the new model, there is an improvement in the end-to-end delay, also the packet delivery ratio is better than before. This speeds up the sending and the receiving process and increases the bandwidth utilisation over the networks with heavy packet losses, such as wireless networks.

The transmission control protocol (TCP) is one of the most extensively used transport layer protocol over internet. Wireless technology is doing great and is widely in use over internet. The proposed scheme significantly improves performances of wireless TCP by correctly identifying the cause of packet loss. It firstly identifies the actual cause of packet loss and invokes standard congestion control scheme in case of congestion loss otherwise maintains the congestion window size and enters into fast recovery mode, which results in better performance of the wireless TCP.

The proposed model was implemented in NS-2 for a wireless network and its performance was compared with that of TCP NewReno. Simulation results showed that the proposed model reduced the TCP end-to-end delay and improved the TCP performance compared to that of TCP NewReno.

II Future Work:

Even though we have illustrated the effectiveness of our algorithms, these algorithms could be further improved. Optimizing the TCP performance to react to a packet loss other than congestion remains an open research problem. In future, the researcher can analyse the performance of proposed modified TCP over existing wireless technology such as Wi-Fi, WiMAX.

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