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RESEARCH ARTICLE

RESULT EVALUATION OF CONGESTION CONTROL BY DIFFERENTIATING NCL AND PR UPON THE ERT IN WIRELESS MESH NETWORKS USING TCP

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ABSTRACT

Communication congestion is one of the major issues of networks. Congestion degrades the performance of Transmission Control Protocol (TCP). To make run the network smoothly and efficiently several points should be kept in mind and the very important characteristic on which network performance is based is Congestion control techniques which play very important role. To control congestion and improve the performance of TCP, several methods are devised and some more needed. The total incoming traffic to a particular router or node go beyond the outgoing bandwidth means incoming packets traffic is more than the outgoing link. As result congestion occurs which degrades the performance of the network in the form of packet loss and also transmission delay occur. Hence TCP/IP uses the procedure of congestion control and avoidance to check the status of congestion. The previous techniques take into account by marking the packets which has to be dropped which are in the buffer. The conventional techniques rely on some kind of feedback by identifying status of the network and take appropriate action for. Therefore, the TCP congestion control technique can be handled and represented as a closed loop scheme which is based on feedback. By using control approach it has been exposed that although planned technique execute moderately, conventional control techniques similar to proportional control in the AQM controller can enhance the system responsiveness. In this paper a scheme is advised to control the congestion of TCP by differentiating Non-congestion loss and packet reordering upon the expirations of retransmission timeouts.

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INTRODUCTION

In today's world communication is changing very rapidly due to wide variety of device technologies available these days. Among them the most used is wireless networks use to their mobility support and portability. Wireless network is one of such network which supports various devices such as PDA's, mobiles, laptops, tablets etc. The devices are regularly communicating with each other for exchanging the information between them using a defined device supports. To support this communication at farthest locations, a large infrastructural investment needs to be applied for developing a supportive medium. Even if the distance is short, and without any line of sight objects the devices requires infrastructure. Among these infrastructure, routing devices are the most important ones whose work is to route the packets in desired directions.

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This routing is a decisive operation which depends on various factors. But some of network can use these infrastructural mediums such as router and switches. Among the various types of wireless network, WMN (Wireless Mesh Network) supports ad-hoc connectivity and can be used for small range communication. Wireless mesh networks usually provide a number of paths from a source to a destination, and by using such paths efficiently, we can gather together the available resources present in the network. To improve both capacity and reliability in such networks each node can be equipped with multiple radio interfaces using a set of orthogonal channels. This channel diversity improves the performance of a single-path, while at the same time increases the possibility to create multiple interference-free paths between the sender and the receiver. While any network performs reasonably well under less traffic it performs well, problems occurred when they are used extensively due to which certain challenges has to be suffered. The most notable and frequent problem that networks has to face is loss of data. It may happen due to a number of reasons. Network has to suffer from congestion which is one of the most common reason. Congestion mainly causes due to degradation in network performance when a network is heavily burdened with the data. This degradation in performance can be data loss, large delays when data transmission happens, which is often difficult to accept in the network. Because of this, controlling and get out of congestion is a critical problem in network management and design becomes severe challenge to control it.

A wireless ad hoc network is decentralized sort of wireless network. This network is ad hoc because it never rely on a pre-existing infrastructure access point in infrastructure wireless network or the routers. Each node in the network are actively participate in the network for forwarding the data to the other nodes and so the determination of which node will forward data is made dynamically which is based on the type of network connectivity. For the classical router, the ad hoc network uses the flooding for forwarding the data. Ad hoc network refers to a mode of operation of IEEE 802.11 wireless networks and also earliest wireless ad hoc networks were the "packet radio" networks (PRNETs). As for the mobile operation, ad hoc network are mainly peer-to-peer multi-hop mobile wireless networks, in this information packets are transmitted in a store-and-forward manner from a source to an arbitrary destination, by the use of intermediate nodes. Wireless networks can be classified based on the connectivity types of the various network elements, which are either Point to Point (PTP), Point to Multi-Point (PTM) or Multi-Point to Multi-Point (MPM) networks. Wireless ad hoc networks can be classified by their application:

- Wireless Mesh Networks (WMN)
- Wireless Sensor Networks (WSN)
- Mobile Ad-Hoc Networks (MANET)

Several loss differentiation algorithms have been projected to increase the functioning of TCP over wireless networks. On the other hand, these algorithms have no mechanism to spot and differentiate non-congestion losses from packet reordering in wireless mesh networks. TCPs incapability to make a distinction between non-congestion loss from packet reordering may causes needless retransmissions, which slow down the expansion of cwnd and also reduces the effectiveness of the receiving TCP. Consequently, it becomes an important concern for TCP to direct the TCP sender for activating the congestion control algorithms properly by distinguishing non-congestion losses from packet reordering as well to network congestion while the sender receives three dupacks.

TCP Congestion Control and Fairness

Primary aim of TCP to find and avoid network congestion. Next aim is to guarantee fairness among sender and receiver flows. TCP attain both these aim by responding to packet losses. Every packet loss is be concerned with as a congestion loss, and this congestion window is then being done halved. When Faster flows see more congestion losses, then it guarantees a certain form of fairness.

Packet Reordering

Packet reordering is a rather common event that poses negative effects on applications and protocols that require in-order data delivery. For TCP, the reordering of both data and acknowledgments affects performance (Breeson Francis *et al.,* 2012). Previous research has shown the possibility to mitigate reordering effects in a reactive and/or proactive manner

Transmission Control Protocol is the most popular connection oriented transport layer protocol used in the present internet and its congestion control algorithms are very necessary for the stability of the internet connection. TCP has severe performance problems when operated over WMNs (Sumedha *et al*., 2011). The principal problem of TCP lies in the congestion control mechanism. With TCP congestion control mechanism, multiple TCP connections can share network and link resources simultaneously. The quality of TCP connections degrades rapidly with the number of wireless hops in WMNs due to its incapability to differentiate non-congestion losses from congestion losses. Congestion control is an essential building block of data communication networks. With congestion control, end-hosts decide on how fast they can send packets to a destination over the network. An effective congestion control protocol enforces an efficient and fair sharing of the underlying network capacity among multiple competing applications. In this dissertation the congestion control problem in the context of wireless multi-hop networks is analyzed and its solution is developed in a novel way.

Background

At present mainly TCP works with two category of congestion: transient and persistent which works in this manner.

- *Transient congestion* works with a row of buffer at the router side. For the duration of congestion period the queue will get bigger and contain the excess packets while data tarnsferring. As soon as congestion phase finish, the buffered data is forwarded to the suitable output link.
- *Persistent congestion* is said to come about when the data overflows the buffer side. Even though transient congestion only presents a delay in data transmission, when persistent congestion outcome with data loss. These troubles are deal with two ways. Either the router find out the queue build up and notify the sources to slow down their sending rate.

Properties of a Congestion Control

There are several properties that which describes a congestion control mechanism. These properties can place into two categories:

➢Network controlling & Flow Managing Properties and
➢Ease of Deployment & Implementation Complexity

Some of the well known properties are given here which covers the most related aspects.

- Efficiency
- Fairness.
- Minimal Queuing Delay
- Average Flow Completion Times
- Negligible Loss Rate.
- Stability

- Resilience to End-User Misinformation
- Easy to Deploy
- Low Router Complexity

This Paper explores the middle ground between these two design points and presents the design and implementation of an efficient framework for congestion control. Growth in network dependencies raises the issues regarding the resource management and utilizations. It shows an increase in contention for the network resources. Thus this contention has affected the performance of WMNs. While any WMN performs reasonably well under light load, problems surface when they are used extensively. The most notable and common problem are faced with is loss of data. While loss of data occurs due to a variety of reasons, congestion in the WMN is the most common reason. Loosely speaking, congestion refers to the loss of performance when a WMN is heavily loaded. This loss of performance can be data loss, large delays in data transmission, which is often unacceptable. Due to this, controlling and avoiding congestion is a critical problem in WMN management and design. The importance of congestion control was practically realized and resulted in about a factor of thousand drops in throughput. Later, a congestion control algorithm was retrofitted in the Transmission Control Protocol (TCP), the most dominant transport protocol on the Internet today, to avoid this situation. Since then, TCP has served the Internet well. Yet, the TCP is now suffering from limited performance which in turn results in the need for new transport protocol designs which has become increasingly important.

Related Work

To improve the performance of TCP and congestion control, numbers of techniques are advised by authors. Some of them describes in this section (Pradeep Reddy, 2014). TCP NJ-Plus method is capable of detecting non-congestion losses from packet reordering and reacts accordingly. The key idea behind TCP NJ-Plus is, to set a dynamic delay threshold value by gathering information from the current status of the network when the sender receives three dupacks. TCP NJ-Plus has three mechanisms. a) Detection of non-congestion losses and packet reordering from network congestion. b) Detection of non-congestion losses from packet reordering and c) Congestion control mechanism of TCP NJ-Plus sender at the time of receiving three dupacks and timeout expiration.

The achievement of the network can partly be credited to the available congestion control algorithm in the Transmission Control Protocol (TCP) which has given tremendous results and improving TCP performance. On the other hand, growth in the range of the increased diversity, Bit-Error Rates and bandwidth delay products in applications has stressed TCP and the need for new transport protocol designs has become gradually more important. Although the earlier category of schemes are having performance limitations, and the latter one are hard to install which can introduce high per-packet overhead which leads to new security challenges. During the last few years different researchers had give vital solution. Among them some are covered here as the surveyed literature.
Improving the performance of TCP in wireless mesh network is the major working area among the researchers. In the paper (Pradeep *et al.,* 2014) this issue is considered for developing an optimal solution. Here the paper gives an improved congestion control mechanism for the TCP protocol in WMN. The paper deals with effective bandwidth management. The paper presents method named as Cross Layer Congestion Control (CLCC). The process is developed on the basis of the concept of cross layer optimization. The cross layer here uses the MAC layer and Transport layer. The complete approach is repetitively performed with decreased congestion window size. This reduction is performed by 25% each time after the process phase is initiated. Carrying on the further study it is proved that the packet loss is due to congestion in wireless mesh network (WMN). It happens due to high bit error rate which is caused by link, node breakdown and interference. It may also lead to some more packet loss also with very significant overhead may also be acquired. Thus this paper (AdebanjoAdekiigbe, 2011) a closer view is performed to the existing solutions. The work also conclude that many of these clustered solutions are found wanting in solving congestions problems in WMNs without modifications to their original forms. It will focus on the propensity of using Distributed Clustering Algorithm (DCA) as basis for developing an adaptive intra and inter cluster congestion control scheme for sustainable, effective and efficient congestion avoidance and control in WMNs.

After getting the deeper look at bandwidth impact on WMN there are some other factor which will also be considered. In the study it is found that wireless mesh network is having large variations in round trip time which depends on the changes in number off hops. In case of TCP the end to end throughput gets decreased very rapidly with the ever increasing number of hop counts for the network which have been the biggest problems of TCP have been seen over wireless mesh networks. In this paper (Ramratan Ahirwal, 2012), the intension is towards getting the complete congestion control using the technique of acknowledgement time intervals so as to determining for bandwidth estimation in TCP flow in the network. In the paper (Pradeep Reddy, 2014), an accurate measurement of the Available Bandwidth in a network is calculated and an enhanced congestion control mechanism for such paths in wireless mesh networks is proposed. The performance evaluation of the proposed model is simulated in NS-2 simulator and the results were compared with existing model. Universally its was driven by basic nature of TCP to drop packets during congestion occurrence. Now, if the notification of congestion occurrence is developed using ECN, it could be handled by the congestion window size (winsz) evaluation factor.

By using multiple channels the aggregate capacity of wireless mesh networks can be increased. Multiple network interface cards (NICs) are being embedded on the stationary wireless routers. Each network interface card NIC is allocated with a separate frequency channel. This paper, works on the Joint Optimal Channel Assignment and Congestion Control (JOCAC) as a decentralized utility maximization problem. This JOCAC is having a fix and limited constraints which arise due to the interference of the adjacent neighboring transmissions for further progress. The paper [14] devise congestion control problem and it will focus on restless multi-armed bandit problem, which is very renowned decision problem in the literature. Multi-Armed Bandit (MAB) is one of the popular investigated stochastic problems which is being found in decision theory. Multi-Armed Bandit is a category of sequential resource allocation problems, so it efficiently make use of diversified applications such as sensor management , queuing systems, control theory, etc. For comparative evaluation NS-2 simulations are used along with a real test bed experiment with a wire line TCP variant and a wireless TCP protocol is performed. Here the complete formulate is applied for the congestion control problem and map it to a variant of the decision problem, which is used as MABCC. Compared to the majority of earlier job which constructs on simulations, the paper [15] implements a Linux prototype of the suggested approach and evaluates its achievability in an actual 20-node mesh test bed.

Experiments show that the suggested approach, which is denoted as Mesh Adaptive Pacing (MAP), it can be gain up to 150% more good_put than TCP New_Reno and significantly improves fairness between competing flows. Comparative performance study showed that, depending on the current link quality, MAP achieves up to 150% more good_put than TCP New_Reno. The Congestion Coherence enhancement we have proposed in the paper split the end-to-end job of congestion control in this local operations of multi path routing and wireless retransmission. Here we suppose that the Explicit Congestion Notification (ECN) is being employed in the whole network [16]. Besides this, ECN has been approved as an Internet official protocol standard in RFC 3168 and is advised to be broadly set up as a router technique. While a router's queue length exceeds a threshold, the incoming packet is marked as Congestion Experienced. In this Simulation outcomes had shown that Congestion Coherence significantly trim down spurious retransmissions, timeouts, unnecessary decreasing of congestion window, and consequently endow with better improvement than existing wireless TCP enhancements.

Problem Identifaction

Transmission Control Protocol is the most popular connection oriented transport layer protocol used in the present internet and its congestion control algorithms are very necessary for the stability of the internet connection. TCP has severe performance problems when operated over WMNs [3]. After studying the various articles related with congestion control the work found that improving the current scenario of TCP performance the non congestion loss and packet reordering plays a vital role. It works by counting the acknowledgement and assembling information which sets a dynamic delays threshold value by present values of the network. The principal problem of TCP lies in the congestion control mechanism. With TCP congestion control mechanism, multiple TCP connections can share network and link resources simultaneously. The quality of TCP connections degrades rapidly with the number of wireless hops in WMNs due to its incapability to differentiate non-congestion losses from congestion losses. In this work the congestion control problem in the context of wireless multi-hop networks is analyzed and its solution is developed in a novel way.

The proposed goals are:

To detect in congestion control in TCP in the presence of neighbour nodes for each node within its reachable radio transmission, using ns-2 network simulator. This is achieved by using NCL and PR differentiation.

- To inform the upper layer, routing protocol when a transmission was not successful, and if a neighboring node is in the transmission range of each other.
- To compare the achieved results with previous values, performing simulations in several (static and mobility) scenarios, and for different type of traffic.
- The work also provides the identification of the usable configuration methods, built-in functions and limitations of hardware communication platform, which can influence the opportunity of the congestion control

An efficient congestion control protocol that achieves both an optimal throughput and a fair sharing of the network bandwidth is crucial to the efficiency and stability of multi-hop wireless networks. In this paper we claim that:

"*A channel-aware congestion control protocol that explicitly incorporates the wireless channel information is able to adapt to the wireless network dynamics quickly. As a result, this protocol is able to effectively eliminate the congestion collapse within the wireless channel and significantly improve the efficiency, stability, and fairness of multi-hop wireless networks*."

Proposed Solution

To conquer the throughput degradation of TCP in multihop wireless mesh networks, we modified the fast retransmit and recovery algorithms of TCP. The key idea of our algorithm is to calculate the outstanding packets and set the value of slow start threshold (ssthresh) based on half of the difference between maximum data packets sent and the last acknowledgment received at the TCP sender. We used this difference for minimizing the frequent retransmission timeouts caused by retransmission loss. The algorithm starts operating by setting the connection between the mobile nodes. It must have the fixed or static node counts and the source and destination must be identified previously before the communication. Initially all the packets counter for successful and dropped packets are set to zero values. The source node transmits the route discovery packets to all its neighbors. All the intermediate nodes verify their destination id and if the destination id is not matched then the packet is further forwarded to their neighbour.

Once the destination node receives this message then it replies back with some of the information and the destination id. The reply message also holds the hop count information along with other route details. At the source node the different replies are measured for the shortest route from where the communication had to be performed. Once the connection is established then the data packets are sent to the same respective routes to the destination. The destination node then replies with the acknowledgement packet to the source. Here the reliable communication protocol TCP is used. It is based on the packet conservation phenomenon which restricts the packets injection in the network if the capacity of the band is exceeded or the network is already congested. It waits for some packets to be taken out off the network. TCP implements this principle by using the acknowledgements to clock outgoing packets because an acknowledgement means that a packet was taken off the wire by the receiver. During this transmission congestion monitoring scheme verifies the total counter values of successful packets transmitted and the number of packets dropped. First the total dropped packets are measured using the counter values. Later on the packet dropped calculated against the congestion process only. For calculating the packet dropped due to congestion thee reply acknowledgement is checked whether it was received or not along with the expiration time values. If the acknowledgement is null and the expiration time is zero then it is considered to be dropped due to congestion. Rests of the packets are considered as drop occurs without congestion. In this way the difference is measured and the congestion statics are measured. From this detail the packets which are dropped due to congestion are retransmitted or any other decided action can be taken out. Congestion control reasons are not calculated here because it is assumed that the congestion has occurred in the network and then the dropped packets are categorized accordingly. Once the values are measured then the congestion can be avoided.

Algorithm

```
Algo CongControl (N, S, D)                // N is Number of
Nodes, S is Source and D is Destination
{
 Initialize c1=0,c2=0,c3=0;                    // Counter specify
drop packets
 //Route discovery is initiated using routing protocol
 S->Send (Route Request);      // Source send route request to
its neighbors
 D->Reply (Route Reply);
 // after route discovery source starts data packets transmission
S->Send (Data packets, D);
D->Reply (Ack, S);
// during the data transmission congestion monitoring scheme
apply. First total drop packets determined.
  If(S->Reply (Ack, S)==NULL)
  {
  c1++;
  Display (Packet dropped)
  }
// determine drop packets due to congestion

  If(S->Reply (Ack, S)==NULL && ExpirTime==0)
  {
   c2++;
   Display (Packets drop due congestion)
  }
  Else
     If(S->Reply (Ack, S)==NULL)
     {
     c3++;
     Display (Non congestion packets drop )
     }
}
```

- Create network environment considering certain number of nodes. Also configure routing and mac protocol to simulate environment.
- Generate TCP traffic to consider specific source and destination.
- To extract whole packets which are dropped during the transmission
- Find and separate dropped packets due to congestion and retransmission ordering from the record of whole dropped packets.
- After this, find packet loss rate basis on the packet expiration transmission timeouts.
- Finally filters actual packet loss by differentiating all of this and try to reduce them and improve performance of TCP.

Simulation Analysis

To implement the desired system first a network is created using nodes and the above defined configurations required to simulate. System contents are the mobile nodes and they are free to perform communication with each other. Every time when Route discovery starts RREQ packets are sent and received by the nodes of the network to their neighbor nodes. First time node sends a RREQ packets to its neighbor node when the node sends a RREP packet to the node sending RREQ packet then first session is created. To prepare simulation for desired network utility the following given network setup is provided.

Table 1. Network Setup

No of nodes	40
Radio-propagation/Ad-Hoc	Propagation/Two Ray Ground
Antenna model	Antenna/Omni Antenna
Communication protocol	TCP
Simulation dimension	750 X 550
Initial energy in Joules	1000
Simulation time	50 seconds
Traffic	TCP
Channel type	Channel/Wireless Channel

Using TCL script the network scenario is created then Simulation is executed. And by using AWK file RREQ packets send, received is captured and also used for the remaining energy of the nodes. When the simulation starts then trace file and nam file generated. fig shown below is the scenario of the Wireless mobile ad-hoc network with six nodes

Result Evaluation

We implemented the above proposed solution and tried to do experiemental analysis. We figure out some graphical comparisions as explainedbelow:

Application Areas

- This Military Operations
- Electric meters
- Broadband home networking.
- Community and neighborhood networking.
- Enterprise networking.
- Metropolitan area networks.
- Transportation systems
- Building automation
- Health and medical systems.
- Security surveillance systems

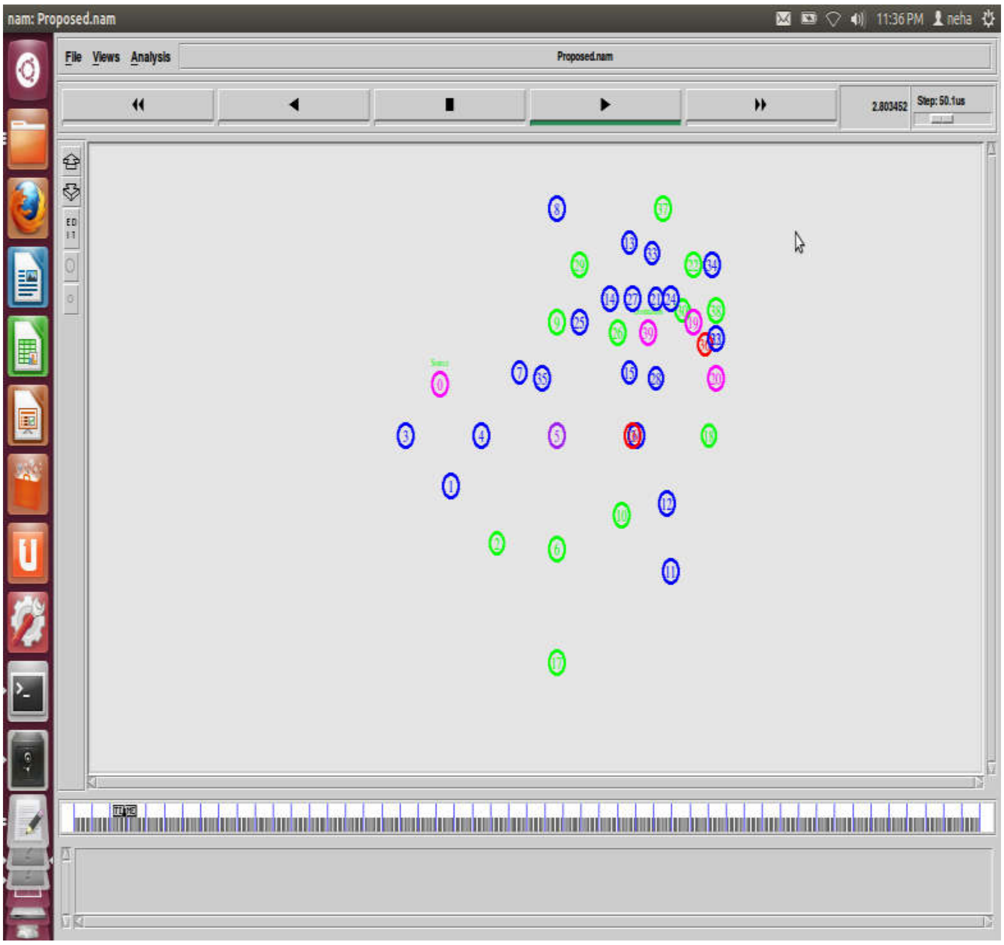

Fig. 1.0. Nam file of the network simulation

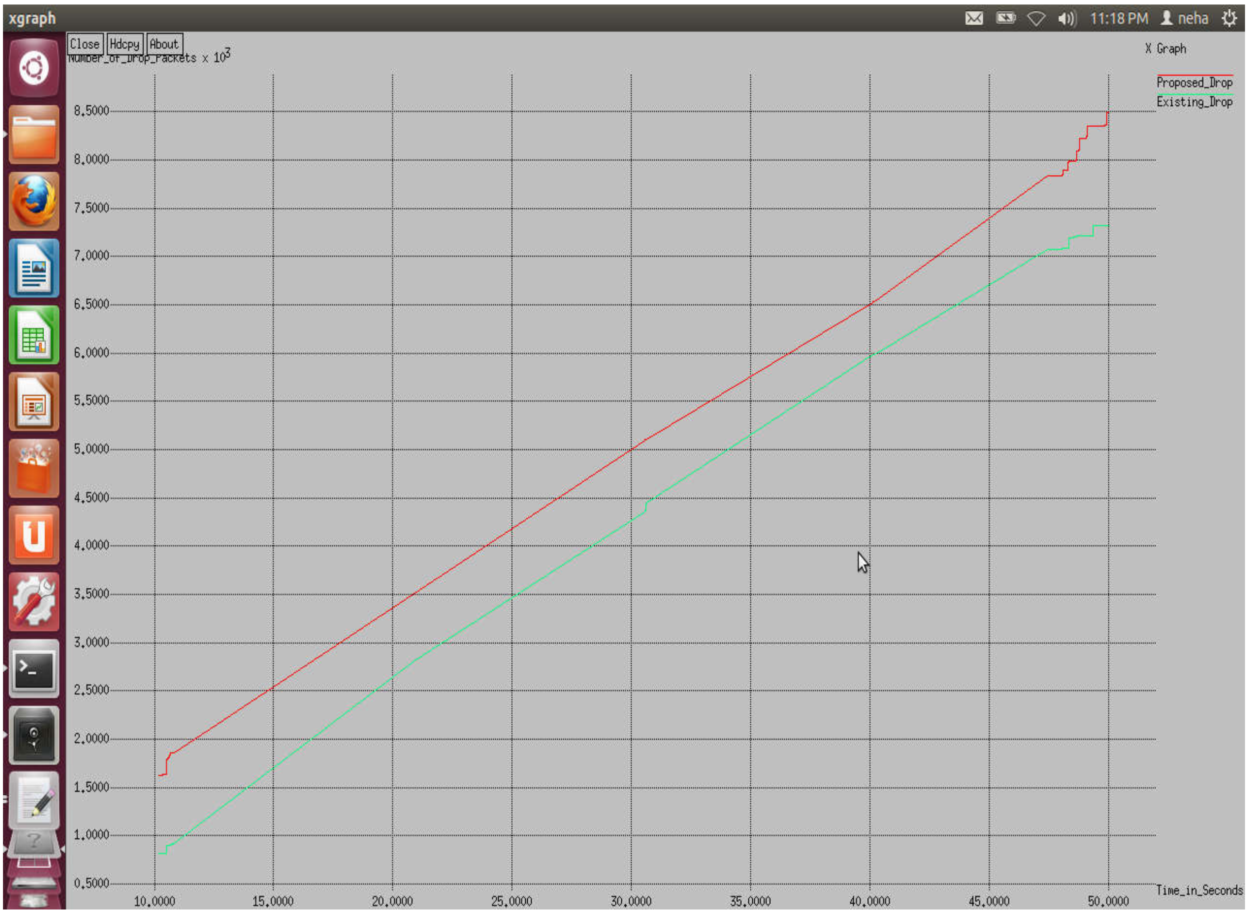

Fig 1.1 Comparison graph of Drop between Proposed and Existing Using Xgraph

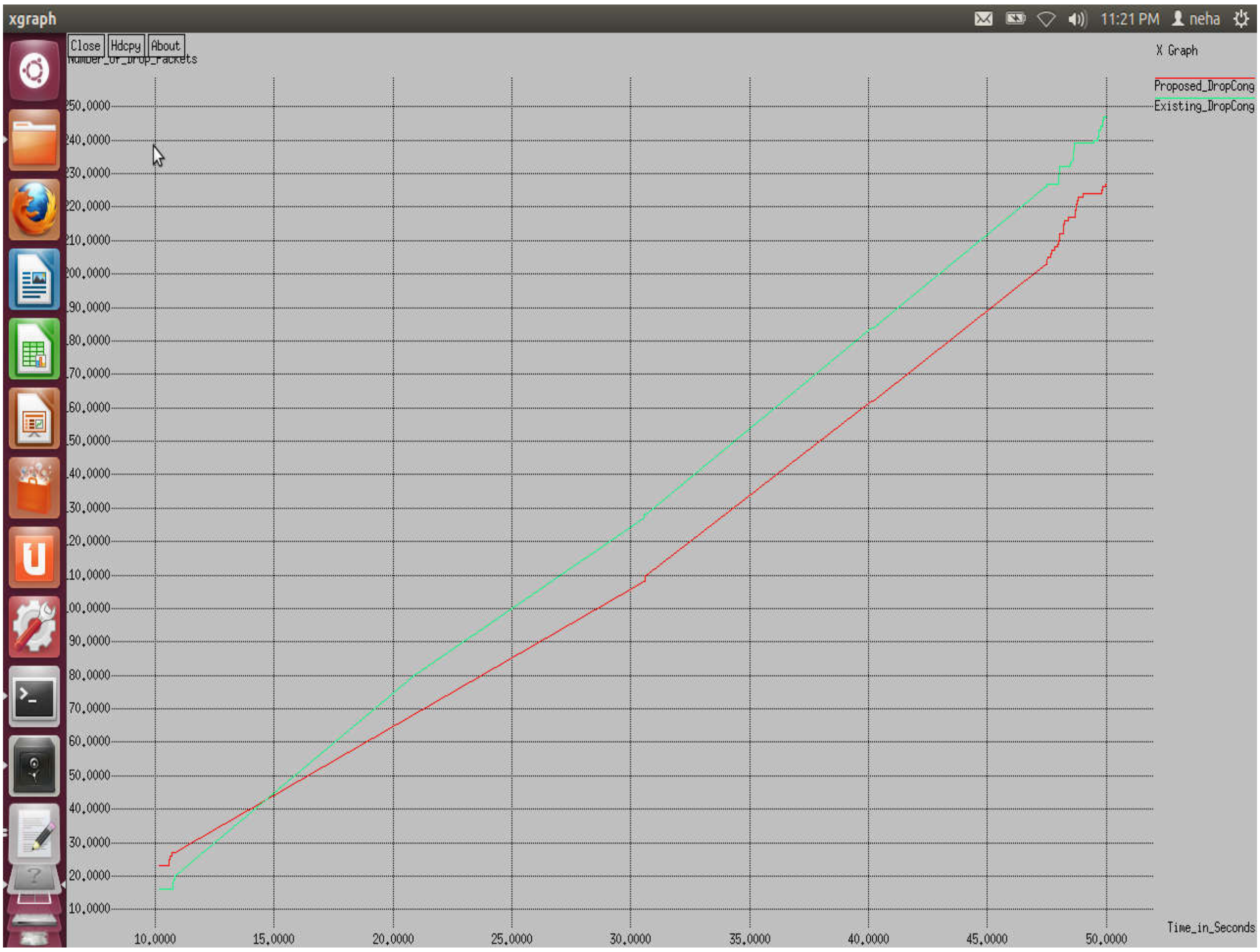

Fig 1.2. Comparison graph of Drop Congestion between Proposed and Existing Using Xgraph

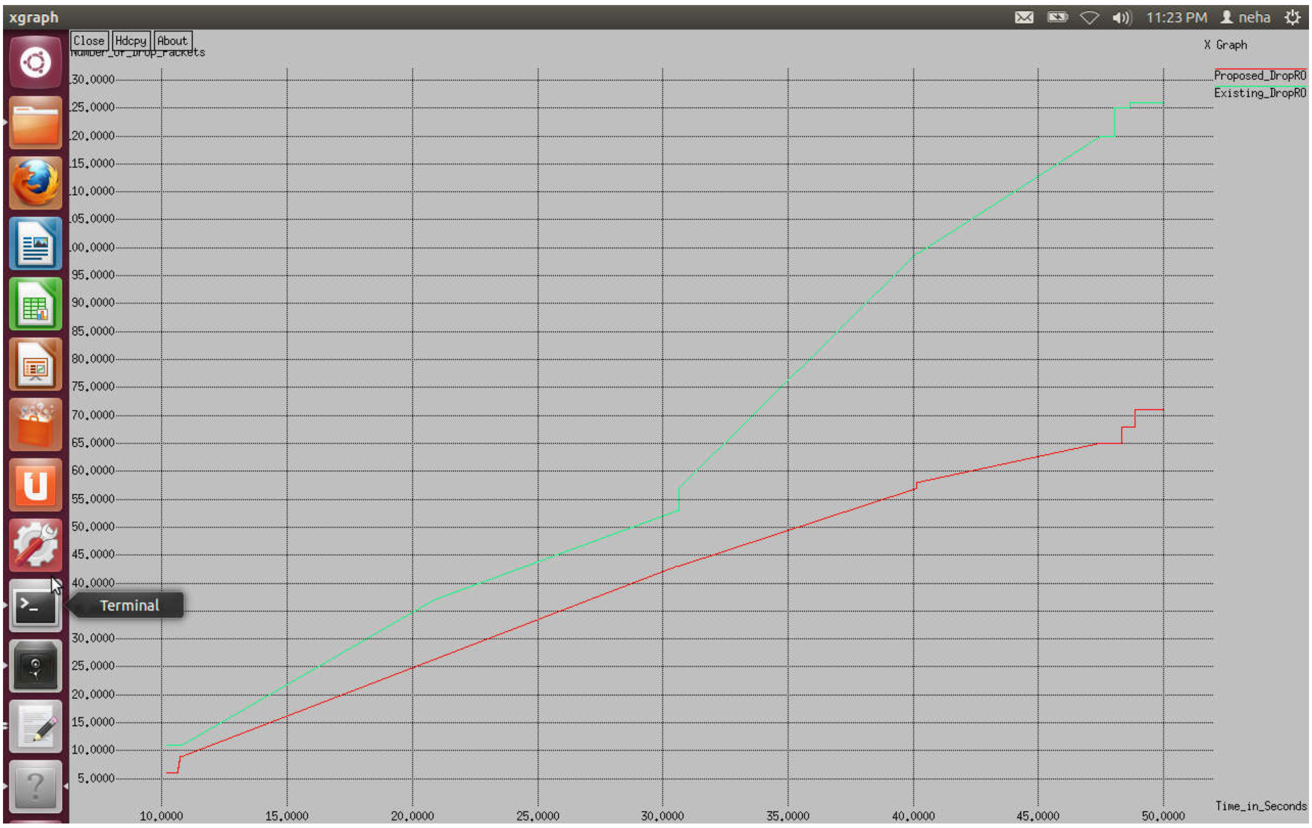

Fig 1.3. Comparison graph of Drop Retransmission Ordering between Proposed and Existing Using Xgraph

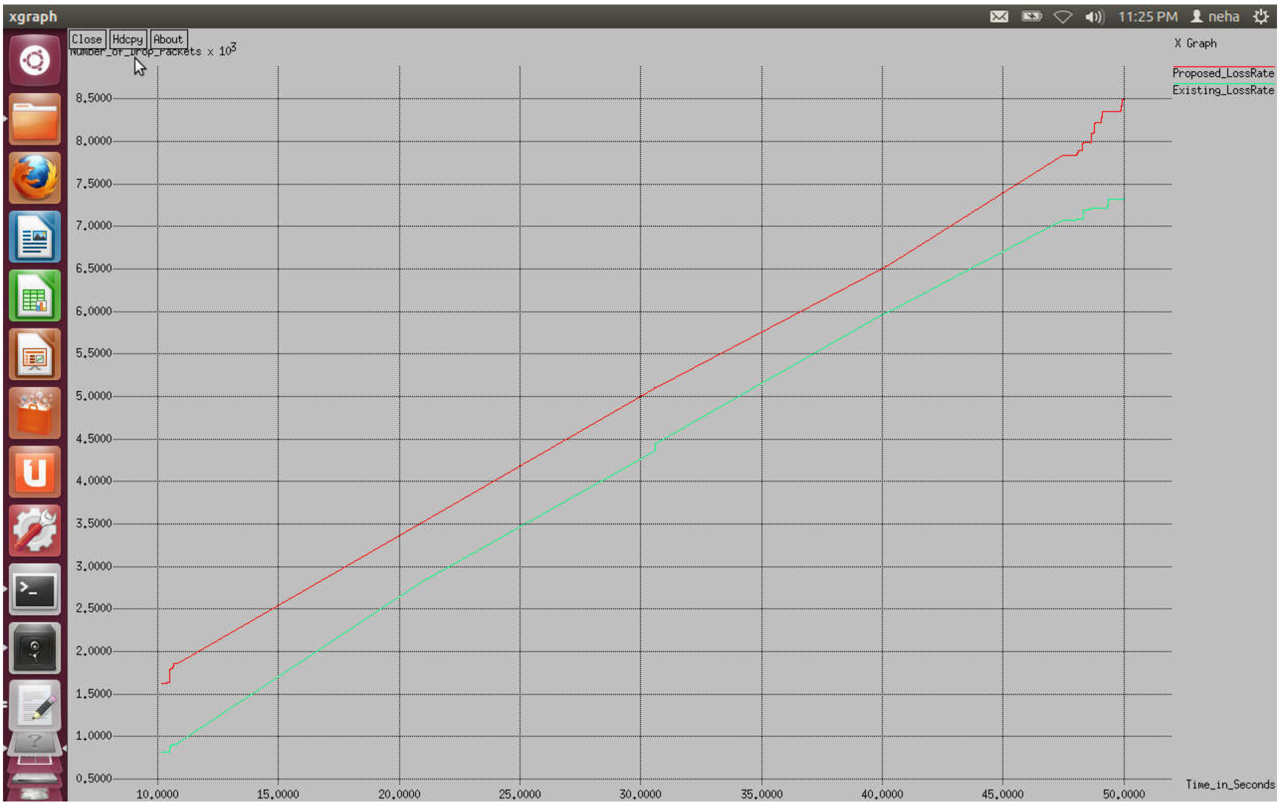

Fig 1.4 Comparison graph of Loss Rate between Proposed and Existing Using Xgraph

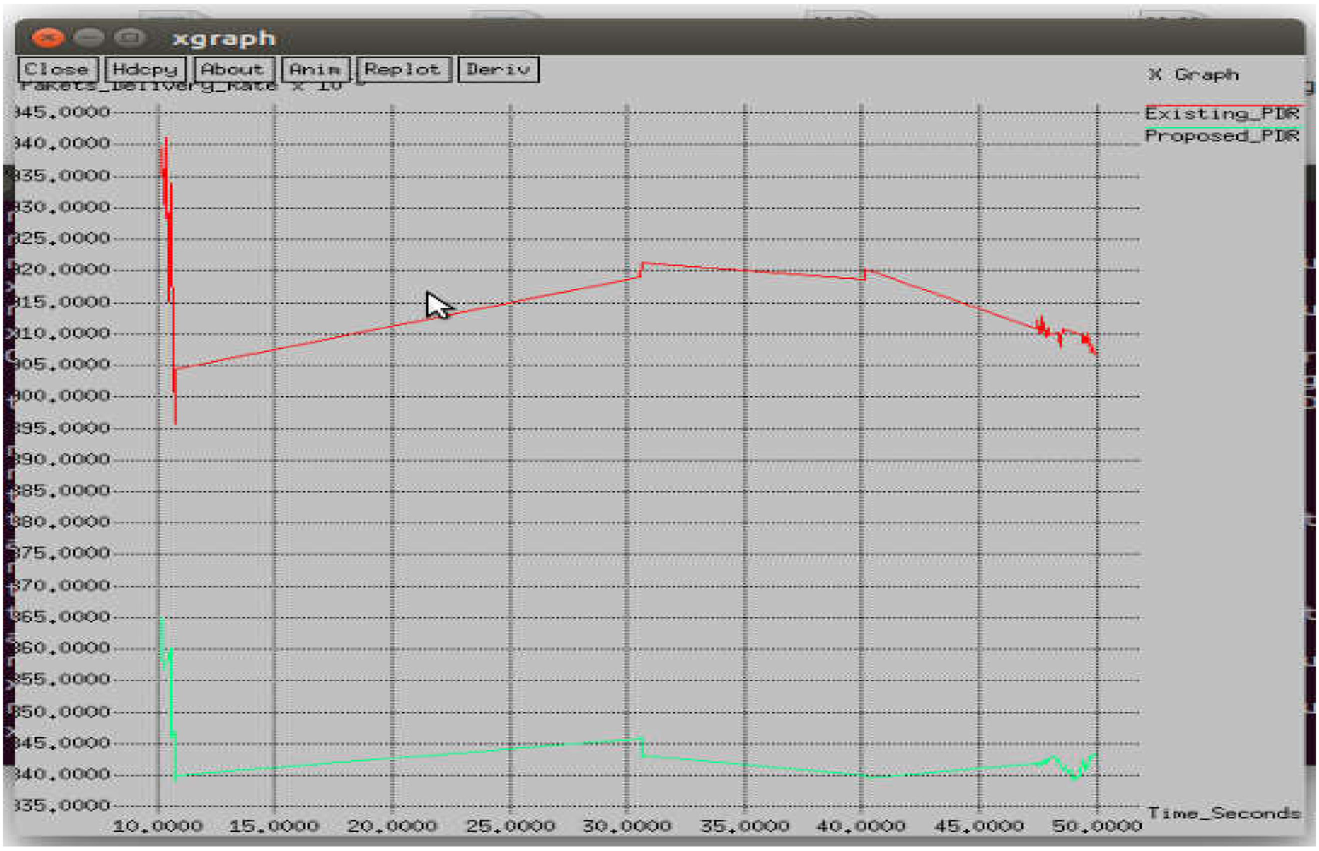

Fig 1.5. Comparison graph of PDR between Proposed and Existing Using Xgraph

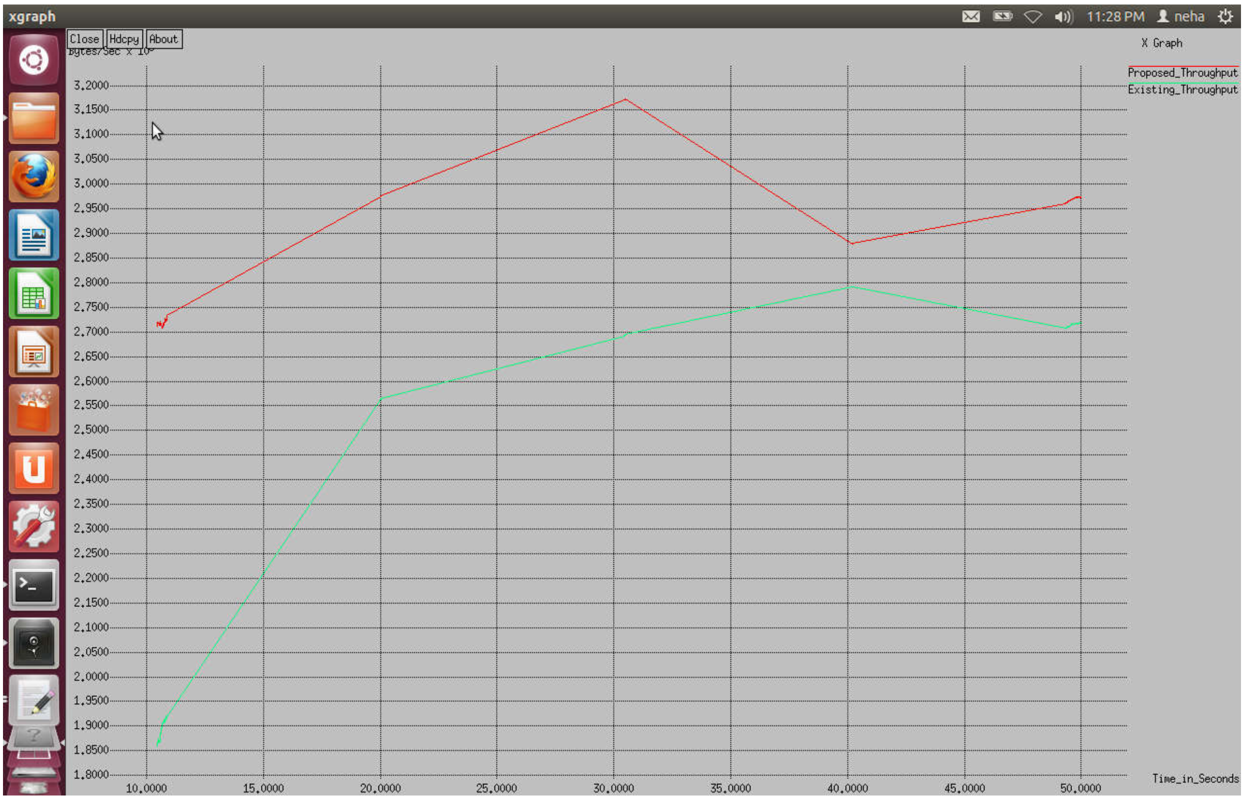

Fig.1.6. Comparison graph of throughput between Proposed and Existing Using Xgraph

Conclusion

Controlling congestion and improve TCP performance, we studied several approaches are devised to differentiate non-congestion loss from congestion loss and packet reordering. Proposed approach will also try to resolve congestion problem of TCP traffic. It offers to monitoring and differentiating non-congestion loss based on the expiration of retransmission timeouts of packets. Additionally, approach enhances the performance of TCP and control the congestion. The previous techniques take into account by marking the packets which has to be dropped which are in the buffer. The conventional techniques rely on some kind of feedback by identifying status of the network and take appropriate action for. Therefore, the TCP congestion control technique can be handled and represented as a closed loop scheme which is based on feedback. To make run the network smoothly and efficiently several points should be kept in mind and the very important characteristic on which network performance is based is Congestion control techniques which play very important role. The total incoming traffic to a particular router or node go beyond the outgoing bandwidth means incoming packets traffic is more than the outgoing link. As result congestion occurs which degrades the performance of the network in the form of packet loss and also transmission delay occur. Hence TCP/IP uses the procedure of congestion control and avoidance to check the status of congestion. The proposed TCP based congestion control algorithms maintain the network connectivity along with traffic divergence for improving the previous approaches which further improves the network performance. These algorithms not only outperform existing approaches in terms of energy efficiency, network capacity, and several other performance metrics, but also provide certain performance guarantees such as the degree bound of optimality.

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