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**Analyzing the Performance I-TCP and TCP with Explicit Lose Notification over
Wireless Links for the Purpose of Further Improvement**

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Abstract

Many researchers have been proposed different enhancements over wireless network for the Purpose of Further Improvement .in this research we do comparative study on the performance of the standard TCP over two other approaches meant for the advancement namely Indirect TCP (I-TCP) and TCP with Explicit Loss Notification (ELN-TCP).the main aim of this research is to improve the performance of TCP by providing analyzing approach for the I-TCP) and TCP with Explicit Loss Notification (ELN-TCP).

Keywords: I-TCP, TCP, WITH ELN , NS2.

Introduction

Tcp is a reliable protocol which build for wire network .the services provide by Tcp is needed on the wireless network part .the performance of Tcp suffers from the degradation when it used in wireless network because the packet loss occurrence which is common in wireless environment ,this happen because of the Tcp can not distinguish between packet lose during corruption in lossy wireless links and the congestion in the network .for that many enhancement was developed to over come this problem . In this research, we are focusing on the enhancement of TCP in wireless links. This focus is directed towards the need to allow TCP to distinguish between congestion in the network and packet corruption due to lossy wireless links.so we do comparative study on the performance of the I-TCP) and TCP with Explicit Loss Notification (ELN-TCP) and analysing the result to give out performance evaluation which help to improve the performance of the network

Problem Statements

TCP was meant to be developed for the wired network. However, since the emergence of wireless communication, the services provided by TCP are required for wireless environment as well. Yet this mechanism which was built for the wired network could not be optimized completely since wireless links differ in its own characteristics. It must also be noted that TCP performs poorly when corruption occur which is a common occurrence in wireless links. Due to this, some mechanism must be implemented in order to address the issues so that the performance of TCP can be optimized in wireless links as well. This

issue has become the main problem statement being used in this research. This study covers two TCP mechanisms which are the Indirect TCP and TCP with Explicit Loss Notification.

Significant of Research

The main significance of this research is to produce a performance evaluation of the Indirect TCP and TCP with Explicit Loss Notification for the purpose of further improvement of network throughput in wireless links. The findings of this research give out an idea of how each mechanism can be optimized in other specific wireless network environment.

Literature Review

Introduction

The standard TCP congestion control is incapable to distinguish if packet losses in the network are caused by congestion or bit-error on the channel (Ye Tian, Ka Xu & Ansari, 2005). This is a consequence of its designed which is meant for wired networks. Due to this issue, enhancement on TCP are proposed so that it would take into account the high probability of bit error to occur on a wireless channel so that different congestion control approach can be taken (Wenqing & Jamalipour, 2001).

Standard TCP

For the standard TCP version, when packet loss occur, TCP congestion control mechanism will take action by reducing the congestion window causing termination of TCP flow as it perceive the packet loss as a signal of congestion in the network.

(Padhye et al., 1998) analytically characterized throughput as a function of packet loss rate. It details not only the congestion avoidance phase but also considers the timeouts and the relative impact on throughput. A concise mathematical derivation of the throughput is also presented by (Padhye et al., 1998) which is presented in the equation below.

$$\text{Throughput} = \frac{\text{Number of bytes sent}}{\text{Duration of the transmission}}$$

The standard TCP mechanism uses 'slow start' method that temper the ongoing flow of connections in the network (Rung-Shiang et al., 2005). Figure 2.2 presents the TCP congestion control mechanism.

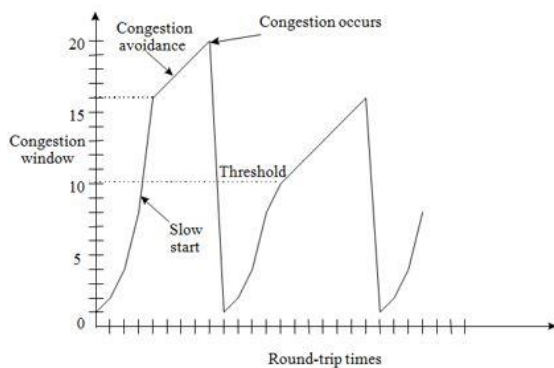


Figure (1) TCP Congestion Control Mechanism Indirect TCP

Indirect TCP is an enhance version of TCP for wireless links which is built based on the split approach (Bakre & Badrinath, 1997). Due to the slow end-to-end transmission over longer paths, TCP connections can be split at wireless gateways connected to both wired and wireless links. In this condition, when packets suffer corruption due to the wireless link, they can be retransmitted over the wireless part of the path only. Figure 2.3 shows the framework of Indirect TCP deployment in wireless network.

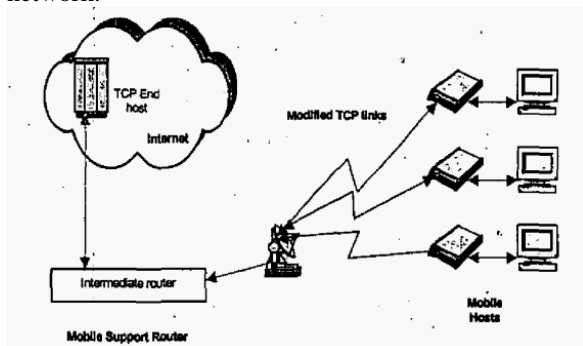


Figure (2): Deployment of Indirect TCP in wireless network (Saha et al., 2004)

TCP with Explicit Loss Notification

TCP with Explicit Loss Notification was proposed to perform by receiving additional information regarding the packet corruption at the wireless link by the MAC layer. This information will then be sent to the sender so that the sender can distinguish whether the packet loss occur due to the congestion in the network or because of the packet corruption (Buchholz, Ziegler & Van Do, 2005). This is a way used by TCP with Explicit Loss Notification to avoid unnecessary reduction of window size.

However there exists some prerequisite to apply this technique. The prerequisite includes requiring the sender must be identified with the sequence number of the corrupted packet so that the loss information can be retransmitted (Congying, Jianwei & Jianoing, 2006).

Network Simulator 2 (ns-2)

In order to carry out the simulation study, it must be pointed out that this research will be carried out using a simulator as the main tool for performance evaluation purposes. To date, there are many simulators either commercial or an open source initiatives available. Network Simulator (Version 2), widely known as ns-2, is a network simulator developed as part of the Virtual Internet TestBed project (VINT) in 1989.

It was a collaboration of many institutes including Information Science Institute, University of California (USC/ISI), University California Berkeley, the Palo Alto Research Center (XEROX PARC) and Lawrence Berkeley National Laboratory (LBNL). Simulation of ns-2 is a discrete event simulation tool that has proved useful for studying the dynamic nature of communication networks as mentioned in (Issariyakul & Hossain, 2009). Some of ns-2 features include:

- Simulation of wireless networks
- Traffic Source Behavior such as WWW, CBR, and VBR
- Multicasting
- Transport agents such as UDP and TCP
- Router queue management techniques such as DropTail, RED, and SFB
- Routing
- Network topology
- Packet flow
- Tracing packets on all links/specific links
- Applications such as Telnet, FTP, and Ping

Specify Performance Metrics

We are required to determine the important performance metric that can portray the performance of the network relatively. In this research, we are going

to focus on the throughput achieved in the network as the benchmark of the performance.

Process Output Data

After the simulation has been carried out for all of the TCP mechanism in wireless links, we are required to process the output data which is produced by NS-2. In this case, the output data provided by NS-2 is the trace file that has all the information about the simulation. This trace file however, is just a raw file contains raw information of row and columns.

Hence, in order to understand this file, we are required to process the trace file into understandable findings. In order to do this, we are going to use a programming script written either in AWK to extract the information from the trace file. A snapshot of an AWK script is shown in Figure 3.6.

```

{
  # Trace line format: normal
  if ($2 != "-t") {
    event = $1
    time = $2
    if (event == "+" || event == "-") node_id = $3
    if (event == "r" || event == "d") node_id = $4
    flow_id = $8
    pkt_id = $12
    pkt_size = $6
    flow_t = $5
    level = "AGT"
  }
  # Trace line format: new
}
    
```

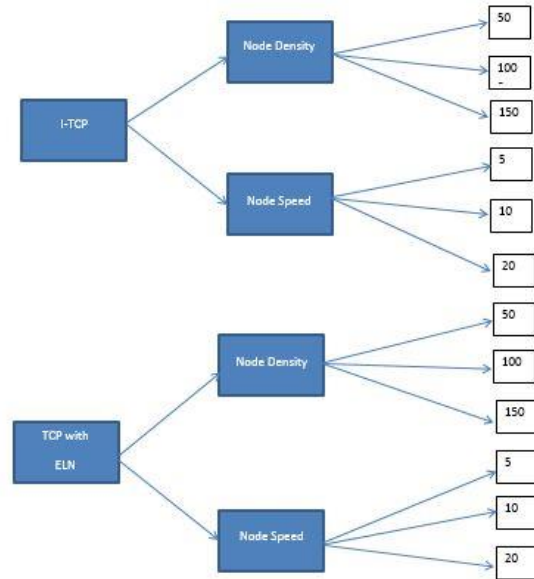
Figure 3.6 Snapshot of an AWK Script

Analyze and Interpret Results

once the results of each simulation are obtained, we are required to analyze and interpret the result accordingly. In this research, we are going to use a graphical tool to plot the graph of the results obtained.

Proposed Work

The simulation carried out using the I- TCP and TCP WITH ELN. The scenarios include three different values for node density with I-TCP and TCP-WITH ELN respectively, in addition to the three different values for the speed of travelling nodes for TCP-WITH ELN respectively. Hence, in total, there will be 12 .scenarios that will be simulated. The organization of the simulated scenarios is presented in the Figure below. The performance of the two will be compared and analyzed.



Performance of I- TCP and TCP-WITH ELN

At the First time , we run the simulation with the two approach (the I- TCP and with TCP-ELN) to verification their performance when they apply with different number of nodes .at this phase we have set the speed of the travelling nodes to a constant which is 10m/s. On the other hand, we have set the number of nodes to be 30, 50 and 100 respectively for each simulation .

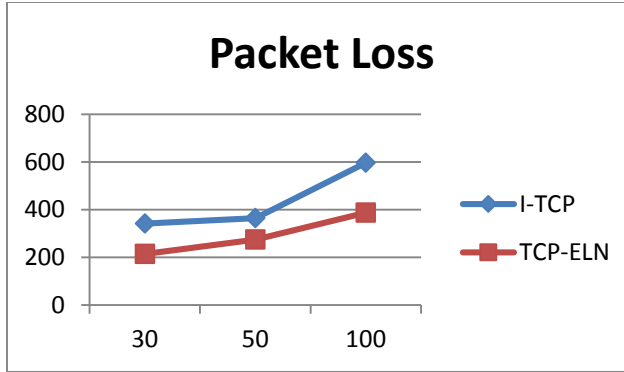
Second, we run the simulations with the two approach (the I- TCP and with TCP-ELN) to verification their performance when the speed of the travelling nodes in the network is varied. In this phase. we have set the number of nodes to a constant which is 100 nodes. On the other hand, we have set the speed of the travelling nodes to 5 m/s, 10 m/s and 20 m/s respectively for each simulation.

The performance evaluation of the I- TCP AND TCP WITH-ELFN will be evaluated using three different performances metric which are packet loss, average end-to-end delay and throughput.

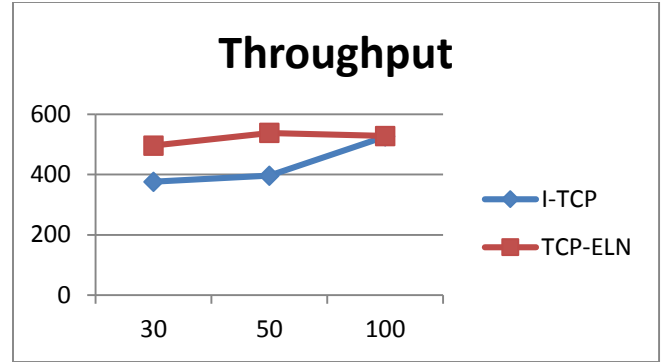
Discuss the Result

Packet Loss (node density)

Figure (1)below show that TCP WITH ELN produce better performance than I-TCP base on the less packet losses with three different node density which are (30,50,100) nodes .Also we note that packet loss increasing when the number of nodes increasing at both TCP mechanisms which show that TCP WITH ELN is preferable in any network.



Figure(1) show packet loss with different node density



Figure(3) show throughput with different node density

End to end delay (node density)

Figure (2)below which show the comparison between I-TCP and TCP WITH ELN in term of end to end delay ,we see that TCP WITH ELN is much lower than I-TCP depend on node density ,but when the number of node increasing (100 nodes)both TCP mechanisms will be little different . so the TCP WITH ELN is better perform than I-TCP in the Average End to End Delay.

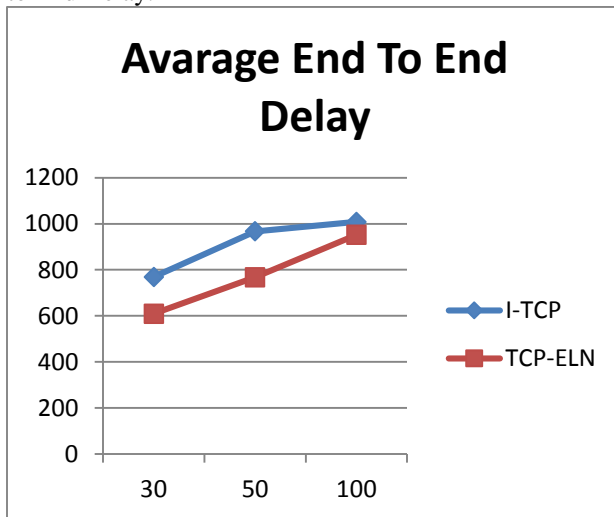


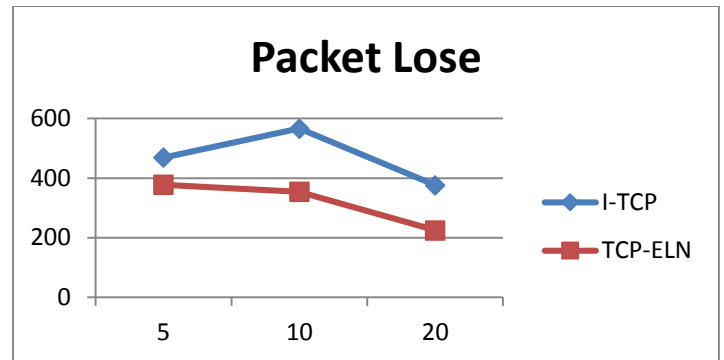
Figure (2) show average end to end delay with different node density

Throughput (node density)

Figure (3)below presents the performance comparison of the I- TCP and TCP WITH ELN in term of throughput with different number of nodes. When the nodes are set to 30 and 50, throughput for TCP WITH ELN is much higher than the I- TCP. However, when the number of nodes is 100, TCP WITH ELN and I-TCP performance are equal .so TCP WITH ELN is better than I- TCP.

Packet loss (speed)

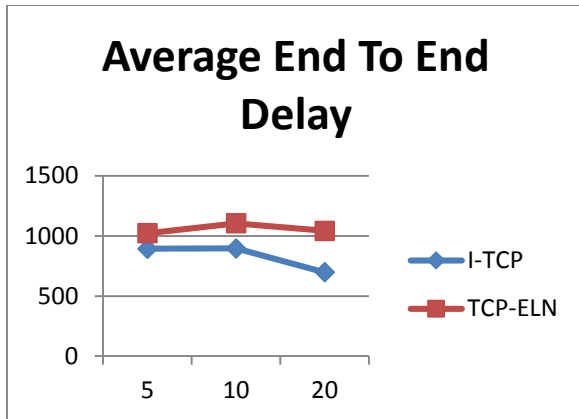
Figure (4)below show the comparison between performance of I-TCP and TCP WITH ELN in term of packet loss with different travelling speed of nodes . it present clear picture that TCP WITH ELN perform better than I-TCP .



Figure(4) show packet loss with different node speed

End to end delay (node speed)

Figure(5) below show the comparison between performance of I-TCP and TCP WITH ELN in term of Average end to end delay with different travelling speed of nodes . it present clear picture that I-TCP perform better than TCP WITH ELN by produce less delay .even when the speed 20m delay with TCP WITH ELN will decrease .



Figure(5) show average end to end delay with different node speed

Throughput (node speed)

Figure (6) below presents the performance of the I- TCP and TCP WITH ELN in terms of throughput with different nodes speed. From the figure we can deduced that TCP WITH ELN is perform better than I-TCP and when speed is 5m it look like little different .

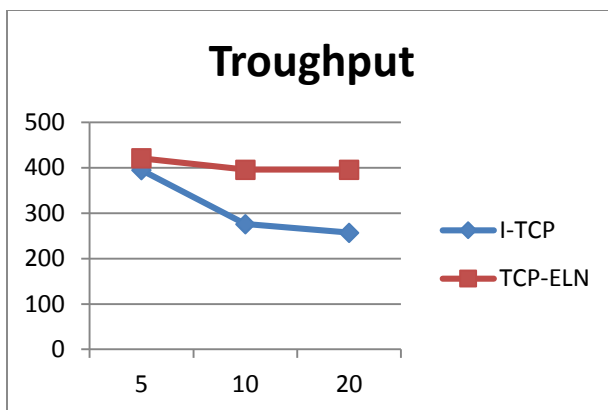


Figure (6) show troughput with different node speed

Conclusion

In this research our main focus is to evaluate the performance of Indirect TCP and TCP with Explicit Loss Notification. These TCP versions are being tested in a wireless environment which requires certain specification to be met before the TCP congestion control mechanism can be optimized. This research also have been directed towards the achievable throughput of each mechanism in order to evaluate their performance accordingly.so the result show that TCP WITH ELN mechanism outperform I-TCP mechanism with different node density and different node speed in term of loss packet ,end to end delay and throughput .which mean that use TCP

WITH ELN is preferable to use in any network than I-TCP .

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