A COMPARISON STUDY OF TCP PROTOCOL (RENO AND SACK) IN WLAN, LAN NETWORKS

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ABSTRACT

Todays, in order to compete with fast-growing companies, the demand for effective, efficient, and reliable access to data has rapidly increased, mainly by storing large amounts of information in computers that can manage this data electronically, rather than file cabinets and file mountains. Computer network technology is the glue that binds these elements together. Transport Control Protocol (TCP) is a connection-oriented protocol of the transport layer. This protocol supports some features such as reliability, flow control, and congestion control, TCP was designed to serve wired connection, thus it assumes that all the packets are lost in the network because of the congestion. While the wireless medium is more exposed to transmission errors and sudden changes. The main goal of this project is to evaluate various versions of TCP protocols in (LAN) and a (WLAN) networks. Simulation experiments are done using Simulation Network (NS2) programs for TCP Sack protocol and TCP Reno protocol for WLAN and LAN networks. In this project, the study performance metrics examined are network throughput, network congestion window (cwnd), and packet loss. Simulation experimental results have shown that the better TCP Reno has the better performance than TCP Sack in LAN network. Conversely, The TCP Sack showed better performances than TCP Reno in WLAN network.

ABSTRAK

Pada masa ini, dalam menangani persaingan antara syarikat-syarikat yang berkembang dengan cepat, permintaan-permintaan bagi akses yang berkesan, cekap dan boleh dipercayai kepada data secara tak langsung berkembang dengan cepat. Oleh itu, kaedah utama adalah dengan menyimpan kuantiti informasi yang besar dalam komputer yang mengendalikannya secara elektronik berbanding fail-fail kabinet dan sistem. Teknologi rangkaian komputer adalah strategi utama bagi penyatuan elemen-elemen. Protokol Kawalan Penghantaran (PKP) ialah protokol berasaskan sambungan pengangkutan. Protokol ini menyokong beberapa peranan seperti kebolehpercayaan, aliran pengawalan dan pengurusan kesesakan. PKP diwujudkan bagi menyambung sambungan berwayar yang mana rangkaian yang mempunyai kehilangan paket boleh mengakibatkan kesesakan. Dalam pada masa yang sama, persekitaran wayarles adalah cenderung untuk menghadapi kesilapan penghantaran dan perubahan secara tiba-tiba. Objektif utama bagi projek ini dijalankan adalah dengan menggunakan program rangkaian simulator (PRS) bagi protokol Sack PKP dan protokol Reno PKP untuk rangkain WLAN dan LAN. Dalam projek ini, petunjuk prestasi yang telah dikaji ialah rangkaian jalur lebar, cwnd dan kehilangan paket. Hasil simulasi menunjukkan Reno PKP mempunyai prestasi yang lebih baik berbanding Sack PKP terhadap LAN. Secara kontrasnya, Sack PKP menunjukkan prestasi yang lebih baik berbanding Reno PKP terhadap WLAN.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS AND ABBREVIATIONS

CRA	Constant Rate Assignment
CWND	Congestion Window
SACK	Selective Acknowledgement
TCP	Transport Control Protocol
LAN	Local Area Network
WAN	Wide Area Network
IETF	Internet Engineering Task Force
STCP	SACK TCP

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

This chapter will discuss the project background. In addition, problem statement, project objectives, scope of project, and the structure of the project report were introduced.

1.1 Background of Project

Nowadays a need for effective, efficient and reliable access to data has increased rapidly in order to compete with the fast-growing businesses, in the main time a huge amount of information is stored in computers which has the ability of managing this data electronically instead of file cabinets and mountains of papers. computer network technology, is a glue that links these elements together. However, the network allows the computer user's to send information and receive information from one to another person. Network technology is classified on the basis of two categories of LAN technologies that connect several computers that are relatively near to each other, usually in the same area. For example, a library terminal that displays information about a book will be connected through a local network. Wide Area Network (WAN) technology connects a small number of computers that can be separated by several kilometers. LAN is faster and more reliable than WAN, but progress in technology continues to blur the boundaries. Fiber-optic cables allow LAN technology to connect devices that are tens of kilometers away, while it is important to increase the reliability and speed of WAN [1].

Recently, the cost of implementing Ethernet technology has been relatively low, and the speed is relatively fast and has become a popular LAN technology. Two people, Bob Metcalf and DH Boggs, started creating Ethernet in 1972, and a specification based on this work appeared in IEEE 802.3 in 1980. Since then, Ethernet has become the most popular and widely used network technology in the world.

However, many of the problems that are complex for Ethernet are common to many network technologies, so solving these problems can be the basis for improving the understanding of the network. As the computer networks developed, Ethernet standards began to incorporate new technologies. As stated in the IEEE 802.3 standard, local Ethernet networks typically use a coaxial cable or a twisted pair of special quality [2]. Figure 1.1 shows a simple Ethernet connection using various devices connected to the bus.

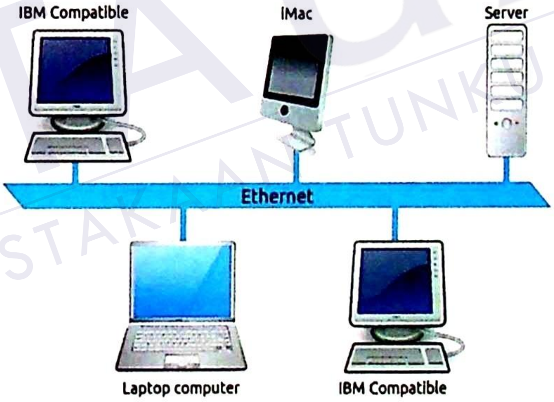

Figure 1.1: Simple Ethernet (LAN) system connection [1].

10BASE-T is the most widely used type of Ethernet system. From the name you can find out that the data transfer rate reaches 10 Mbit / s. In this type of device, it is connected to the cable and uses multiple carrier-assisted access for competition. Access using Collision Detection Protocol (CSMA / CD). At the same time, the 100BASE-T type is Fast Ethernet, which provides a transmission speed of up to 100 megabits per second for LAN and workstation systems supporting 10BASE-T cards.

Another type of Ethernet is called Gigabit Ethernet, which provides a higher level of basic support at a speed of 1000 megabits per second (1 gigabit or 1 billion bits per second).

Finally, 10 Gigabit Ethernet supports up to 10 billion bits per second. There is a limit on the size of Ethernet. This is due to the length and size of the total cable. Electrical signals move very fast along the cable, but they are weakened by movement, and electrical interference from nearby devices, such as fluorescent lamps, can interact with the signal.

For the opposite end of the device, it is recommended to use a shorter network cable, since the signal reception is clean. This sets the distance limit for the maximum separation between the two Ethernet devices. [2].

On the other hand, the wireless local area network (WLAN) considers flexible messaging systems as the development and replacement of wired LANs in buildings or complexes. Electromagnetic waves are a means of transactions. WLAN transmits and receives information over the air, which minimizes the need for wired connections. Thus, the WLAN combines the data transfer capabilities with the mobility of users and implements the mobile LAN through a simplified configuration. Figure 1.2 shows a simple connection structure for establishing WLAN between devices via a wireless router, but in a typical WLAN configuration, the transmitter / receiver device (called the access point) uses standard Ethernet from a fixed location. Connect to a wired network cable. The access point receives, buffers, and transmits data between at least the WLAN and the wired network infrastructure. The access point has the ability to link a small group of users and can operate in a range of less than one hundred to several hundred feet. An access point (or an antenna connected to an access point) is usually set high, but it can be installed in any practical place, if there is necessary radio coverage. [2]

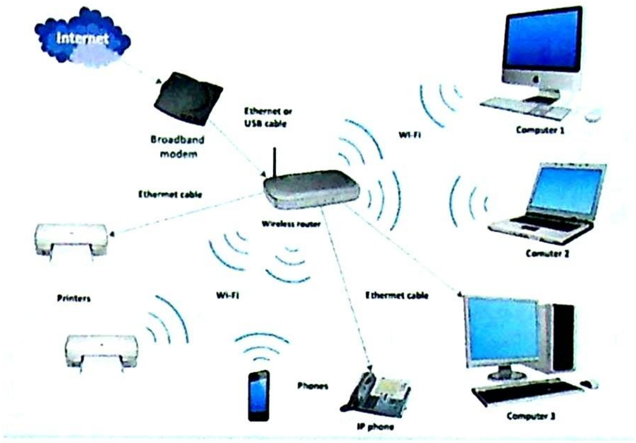

Figure 1.2 : Simple Wireless (WLAN) system connection [2].

Transmission Control Protocol (TCP) is a connection-oriented protocol for the transport layer. The protocol supports functions such as reliability, flow control and congestion management. TCP is designed for wired connections, so it assumes that all packet loss on the network is the cause of the overload. At the same time, wireless environments are more susceptible to transmission errors and sudden changes. Because of the high error rate and the ability to connect wirelessly, TCP reacts to packet loss, as in a wired environment. It discards the size of the transfer window and initiates congestion management or failure mechanisms before retransmission of the packet, such as slow start and reset of its transmission timer. This leads to a reduction in the use of the bandwidth of the communication channel, which can degrade performance in the form of low bandwidth [3].

1.2 Problem Statement

Transmission Control Protocol (TCP) is a connection-oriented protocol for the transport layer. The protocol supports features such as reliability, flow control, and congestion control. TCP is designed for wired connections, so it assumes that all packet loss in the network is a cause of congestion. At the same time, wireless media is more susceptible to transmission errors and sudden changes. TCP has various versions, so select the better type from TPC according to the network environment (LAN/WLAN) is a problem because each type of protocol TPC shows a different performance depending on the environment in which it operates. Furthermore, choosing a specified TCP protocol with various performance metrics before used in LAN/WLAN increases the challenge to achieve optimum performance for the network. Hence, this project provides a performance evaluation of different versions from TCP protocol for WLAN and LAN networks.

1.3 Objectives of the Project

The objectives of this project are:

- To identify different versions from TCP protocol.
- To evaluate the performance of these protocols for LAN and WLAN networks using a set of performance metrics through experiment simulations.
- To do a comparison analysis of these protocols for LAN and WLAN networks.

1.4 Scope of Project

The scopes of this project are:

- Study the TCP Sack and TCP Reno protocols for WLAN and LAN networks.
- The evaluation of the TCP Sack and TCP Reno protocols for WLAN and LAN networks using a set of performance metrics, including throughput, congestion window (cwnd), and packet loss.
- The network simulation (NS-2.34) program used to study and analysis the different versions from TCP protocol for LAN and WLAN networks.

1.5 Thesis Outline

This project is a documentary to deliver the generated idea, the concepts applied, the activities done, and finally, the project result produced. This project consists of five chapters.

- Chapter 1 will discuss the background of the research. In addition, the problem statements, objectives of project, scope of study and thesis structures outline are presented.
- Chapter 2 contains a literature review, discussing the WLAN and LAN networks, the TCP protocol along with its variants protocols Sack and Reno model. In addition, the simulation programs that will be used in the methodology.
- Chapter 3 will discuss the methodology scenario that will be used in this project with the software and hardware required for do the simulation.
- Chapter 4 contains a result of twelve simulation scenarios these results include through output of each case, status of packet loss and congestion window statues as well.
- Chapter 5 will involve discussion and conclusion of comparing the two TCP variants and will suggest further recommendation to enhance accuracy of results and simulation.

CHAPTER 2

LITERATURE REVIEW

This chapter provides background information on the research topic, and it begins a review of the previous work as compared to variants type of protocol options, moving forward to review previous work and what factors might affect the protocol in term of through output, cwnd and packet loss in both wired and wireless media. In addition, this method was reviewed, compared and discussed. Finally, the conclusions of the comments are presented and summarized.

2.1 TCP Variants: Reno & SACK

Of course, the purpose of all types of TCP options is certainly the same, because it was invented to improve TCP efficiency and maximum throughput, but the difference between these options is how they work. Many types of TCP variants were created many years ago [4] because of the inefficiencies and limitations of the TCP protocol bandwidth at that time. Some TCP options are listed below: TCP Reno, TCP New Ren, TCP SACK and TCP TAHOE.

2.2 TCP Reno

TCP RENO retains the basic principles of Tahoe, such as slow start and coarse-grained retransmission timers. However, this improves some of its intelligence, so that packets are lost faster, and the pipe is not reset each time the packet is lost. Whenever a segment is accepted, Reno needs an instant acknowledgment of the data. The logic of this is that whenever a duplicate data is received, if the next segment of the expected sequence is delayed in the network, and the segment does not correspond to the order, or if the packet is erroneous, its duplicate confirmation can be received. It's lost [5].

In TCP Reno, when it receives a packet, it creates a fast ACK. These ACK prompts help the TCP sender with a reasonable transfer status. At any time, the data packet is lost or deferred in the system, or the beneficiary receives an unscheduled data packet that generates a fast ACK.

When the sender collects duplicate ACKs, the sender understands that if only one or two duplicates of the ACK are received, the packet is delayed in the system. It has a short time for a new ACK. If the TCP receiver generates at least three ACK replicas, then the sender will explain that the data packet was lost in the system, and there is no time, he will resend the packet [6], the TCP Reno algorithm looks like this:

```
if (cwnd<ssthresh)
cwnd = cwnd + 1 # slow start
else if (cwnd>= ssthresh)
cwnd = cwnd + 1/cwnd# congestion avoidance
if (duplicate ACK) (Rate 64000)
if (duplicate ACK = = (1 || 2))
 cwnd = ssthresh #packet delayed/ out-of-packet received
 ssthresh = cwnd/2
else (duplicate ACK > 2)
cwnd = cwnd + Number (ACK) # packet loss due to congestion
 ssthresh = cwnd/2
```

Figure 2.1 shows the Reno works with CRA of 2500 bps. Amid the entire recreation time, it gets timeouts twice (because it has twice during a slow start). Also, at whatever point it experiences copy ACKS (packet loss), it recuperates proficiently and gives sensible execution.

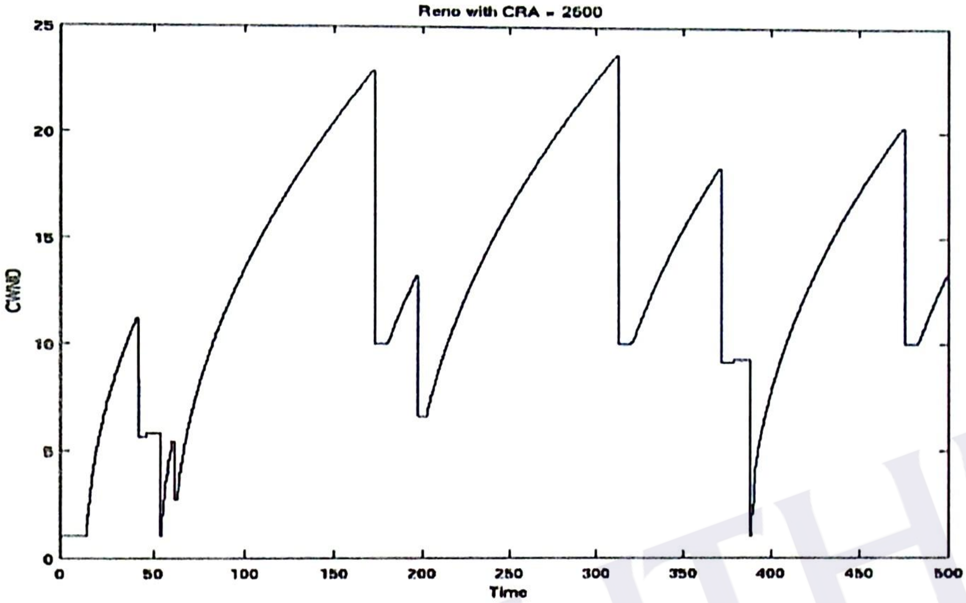

Figure 2.1: Reno with CRA= 2500 [7]

2.3 TCP SACK

ACK is the extension of TCP Reno. It looks at the slow start phase of Reno and the fast retransmission mechanisms. However, the coarse-grained timeout scheme is also used if its algorithm does not recognize packet loss [7].

The SACK calculation changes, the behaviour of the receiver, and sends the SACK parameter. In the SACK, the receiving party sends a specific ACK acknowledgment when collecting the information. Each ACK contains a SACK segment that describes the confirmed segment. These works show the sender, who effectively achieved his goals and which parts are still unusual in the system. The SACK Sender can use these squares to calculate the number of significant packets in the system. The evaluation of meaningful information is placed in a variable, called a "pipeline", which remains unchanged during the fast recovery phase. This component is not present in the fast recovery of TCP Reno [7].

During a fast recovery, the SACK sender determines the pipeline estimate. It sends information only when the score of the pipe is less than cwnd. When the TCP sender sends a packet, the score for the channel is incremented by one. In any case, when the sender receives confirmation from the recipient, he subtracts 1 from the pipeline estimate. Along these lines, the sender sends most of the important information in such a way that several packets in the RTT can be resent. When most of the relevant data is resent, the TCP sender receives the recovery ACK from the receiver (communicates most of the special information) and exits the fast recovery phase. The complexity of TCP SACK prevents its frequent use [7]. So far, scientists have not been able to improve receivers that can use selective confirmation of SACK. However, the CRA provides good overall performance for the SACK 2500 bit / s. Figure 2.2 looks very good, proving that SACK is very efficient in terms of performance and provides more bandwidth. He does not receive any timeout, because he never enters the slow start phase [7].

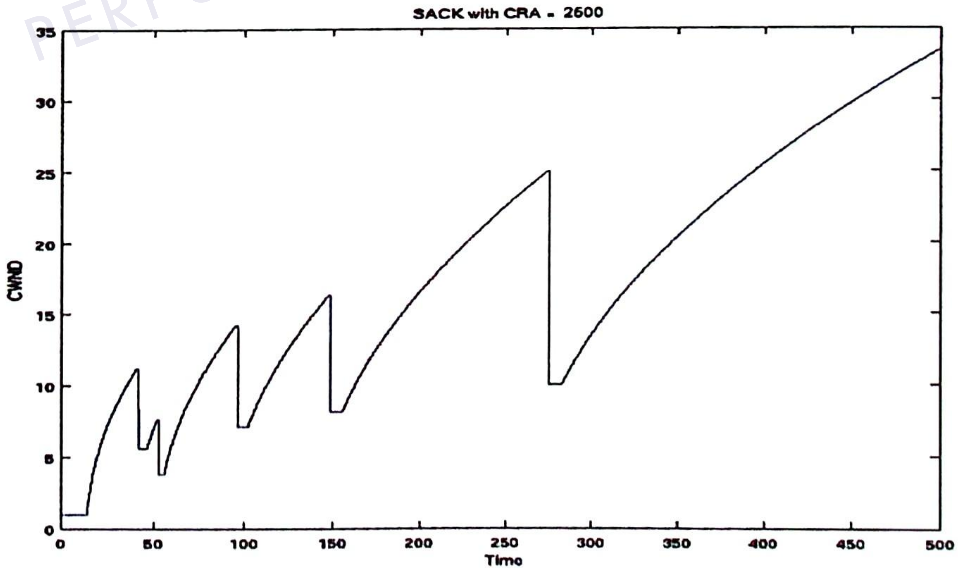

Figure 2.2: SACK with CRA =2500 [7].

2.4 Related works

A study by [8] shows comparative analysis of four different TCP versions (TCP SACK, TCP Reno, TCP New Reno and TCP Tahoe), the analysis was accomplished using simulation, in order to validate the efficiency of TCP SACK as a connection-oriented, Streaming, the most reliable end-to-end data transfer protocol and other protocols. NS software was used to measure all the parameters required for a study of comparative analysis of four different TCP variants in this finding, as it covers a wide area of simulation such as applications, protocols, network elements and traffic models, the reason that was justified for using such software was because of NS possesses a huge library covering several networks and protocols. It also provides the capabilities of wired and wireless media. NS offer many functionalities in wired media such as transport layer protocols, traffic services and traffic generators. However, this finding evaluates the performances of TCP variants verses constant rate from 2500bps and 4500bps, the results were focused on TCP throughput and the congestion window (cwnd) was plotted and recorded alongside regular intervals. Moreover, the behavior of all versions was obtained and observed by using the simulation graph, the outcomes show (TCP Sack) to be effective in term of wireless, heterogeneous networks. In this discovery, TCP SACK proved the final performance of other TCP options for different situations with a CRA of at least 2500 bps. On the other hand, TCP Reno supports good performance. If it is not equal to SACK, it is considered slightly smaller, but Reno has a higher packet transfer rate. This study also shows reasonable bandwidth. Simulate Tahoe to exercise moderate behavior and reasonably consider its limitations on operational algorithms [8], we can observe that SACK is the best alternative of other variants, but it has a drawback of difficulty in implementation, whereas TCP Reno is reasonable in performance and implementation.

Another conclusion [9] was to examine the advantages of selective repetition in TCP and selective acknowledgment (SACK), a comparison of Tahoe and Reno with two modified versions of Reno . The first type is New-Reno TCP, which is a modified TCP type without SACK. When several information packets are lost from the data window, some performance problems with Reno TCP can be avoided. The second is SACK TCP, which is a conservative extension of Reno TCP, proposed by the Internet Engineering Task Force (IETF) for modification using the SACK option.

This article uses an congestion control algorithm in the implementation of the SACK TCP simulation and is proved, but the results show that if there is no selective confirmation, the TCP implementation is forced to retransmit no more than one discarded packet during the round-trip time or retransmit the packet. Perhaps it was successfully delivered. This article discusses the limitations of the lack of selective TCP performance checks [9]. Therefore, from this study, we conclude that adding a selective confirmation to TCP will open the door for the future development of TCP options.

Another study is to compare the impact of quality of service delays and packet loss on bandwidth, which is achieved through SCTP and TCP Reno as the transmission protocol. The simulation software helps this task to be a simulator (ns -2), especially in wired environments. The NS2.30 network simulator is used for all the work, because it contains the built-in capabilities of analog SCTP [10]. It is believed that some configurations can calculate the effect of packet loss and delay, for example:

- STCP is designed to use only one thread. Because it uses only one connection between the source and the target
- The payload for both IP protocols is set to 1480 bytes.
- The STCP is configured to send data in order.

- Sack decided to be required for SCTP, so TCP uses Sack

The results show that both SCTP and TCP Reno demonstrate almost the same behavior in terms of single-threaded and competitive traffic delays, while SCTP achieves a higher throughput than TCP when it causes a different probability of network loss [10]. Fig. 2.3 shows the behavior of the overload window when deleting multiple packages in one window. Therefore, based on this discovery, we can see that the simulation is performed on a local network that is not a WLAN, so the result is limited to wired networks, and higher bandwidth also results in higher latency. Moreover, in terms of packet loss, SCTP shows a higher throughput than TCP.

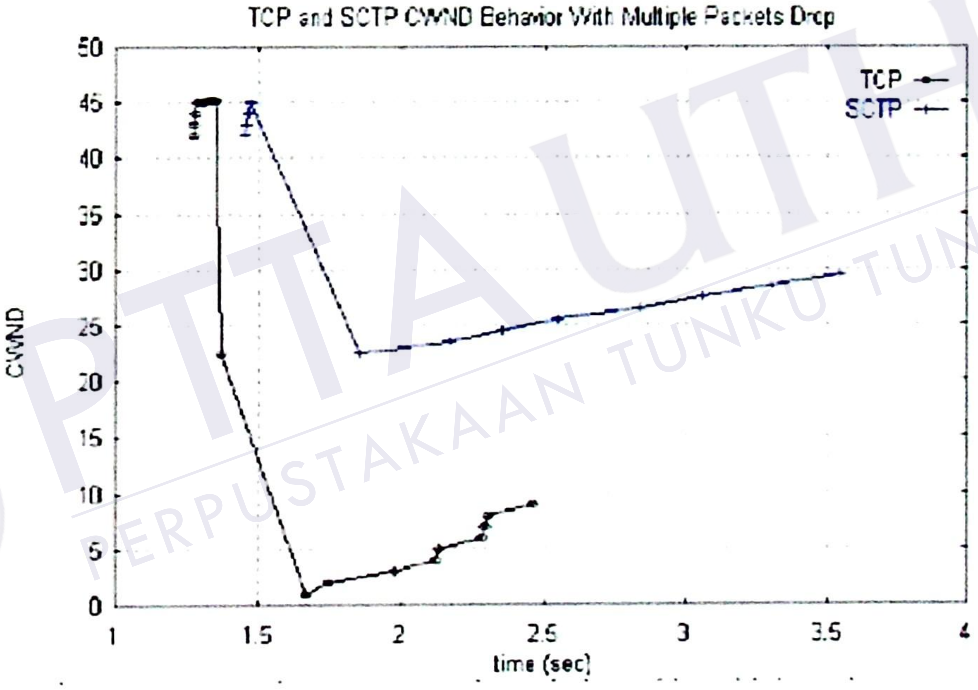

Figure 2.3: TCP and STCP congestion window with multiple packet drops [10].

A study conducted in late 1996 [11] showed compression of some schemes aimed at improving TCP performance in such networks. Since these schemes are defined as three types of end-to-end protocols, in this type the sender knows the wireless connection, the second type is the link-layer protocol that provides local reliability, and the latter is the connection splitting protocol, the base station the whole connection

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