Abstract of project paper presented to the Senate of Infrastructure University Kuala Lumpur in partial fulfillment of the requirement for the degree of Master in Information Technology.

Comparative Study on TCP and Multi-homed SCTP Using Riverbed Simulator

By

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The use of the internet has increased significantly with the continued increase in wireless communication devices. Recently, there is a large number of research contribution focused on Stream Control Transmission Protocol (SCTP). Multi-homing is an important feature of SCTP which improves the communication performance by usage of multiple paths during association establishment, and it can bring significant improvements of throughput. In this thesis we compare the performance of SCTP and TCP traffic in the WLANs and we investigate the SCTP multi-homing to improve the communication performance in WLANs. We conducted some experiments to evaluate the performance of SCTP multi-homed host under various channel bit rates and mobility speeds. The results indicate that when the intensity of background traffic increases the SCTP multi-homed host with higher channel bit rate has better performance. In addition, the SCTP multi-homed host with using lower mobility speed has higher performance (throughput, delay and packet loss) (Q. Naith, 2014).

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APPROVAL

This project report was submitted to the Senate of Infrastructure University Kuala Lumpur (IUKL) and been accepted as partial fulfilment of the requirements for the award of Master of Information technology (MIT). The members of the Thesis Examination Committee were as follows:

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DECLARATION

I declare that this thesis is a presentation of my original research work. Wherever contributions of others involved, every effort putted is made to indicate this clearly, with due reference to the literature, and acknowledgement of collaborative research and discussion.

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NOMENCLATURE

BGP:	Border Gateway Protocol
CMT:	Charcot–Marie–Tooth disease
CTP:	Computer-to-plate
DFD:	Data Flow Diagram
EMAIL:	Electronic Mail
FCFS:	First Come First Serve
FTP:	File Transfer Protocol
GPRS:	General Packet Radio Service
HTTP:	Hypertext Transfer Protocol
IETF:	Internet Engineering Task Force
IGRP:	Interior Gateway Routing Protocol
IP:	Internet Protocol
IPv6:	Internet Protocol Version 6
ISP:	Internet Service Provider
IT:	Information Technology
LAN:	Local Area Network
LMDS:	Local Multipoint Distribution Service
LTE:	Long Term Evolution
MAC:	Medium Access Control
MC:	Mobile Client
MMDS:	Local Multipoint Distribution Service
MPLS:	Multiprotocol Label Switching
OSI:	Open Systems Interconnection
OSPF:	Open Shortest Path First
RIP:	Routing Information Protocol
SCTP:	Stream Control Transmission Protocol
TCP/IP:	Transmission Control Protocol /Internet Protocol
TCP:	Transmission Control Protocol
UDP/IP:	User Datagram Protocol/ Internet Protocolv
UDP:	User Datagram Protocol
VoIP:	Voice Over Internet Protocol

Wi-Fi:	Wireless Fidelity
WiMAX:	Worldwide Interoperability for Microwave Access
WLAN:	Wireless Local Area Network

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1

INTRODUCTION

1.1 Introduction

The communication services between the devices that connect one to another is provided by the Transport layer protocol through the internet. With the evolution of newfangled Telecommunication Wireless Networks, they have been able to develop the stable increase of the communication services over the IP Networks. This development depends on the presence of some of the protocols in the transport layer that help the network to transfer a huge set off data between the two end hosts. In general, the protocols in the transport layers play an important role of offering end to end data transport services to applications in the host. The transport layer services include: connection oriented data transport, reliability, ordered delivery and the overcrowding control as well (Q. Naith, 2014).

Stream Control Transmission Protocol (SCTP) is a new transport layer protocol developed with the goal of overcoming limitations of TCP. It has support for both multi-streaming and multi-homing, apart from other new features. However, additional overheads associated with extra supports may hinder the expected performance improvement. Here, we present a performance comparison of both the protocols through simulations (Kumar, Jacob, & Ananda, 2004). The most common protocols that used at the Open Systems Interconnection (OSI) transport layer are Transmission Control Protocols (TCP) and User Datagram Protocol (UDP). Both of the TCP and UDP are incomplete for some applications requirements such as transporting an unbroken stream of bytes. TCP is a network communication protocol that has been designed to send data over the internet, and also it is used to generate a connection between remote computers by transporting and ensuring the delivery of messages or date over supporting networks and the Internet.

As compared to these protocols, Stream Control Transport Protocol (SCTP) is a new developed protocol in the transport layer that helping in a similar role to the popular protocols such as TCP. It is standardized by IETF. SCTP provides some of the same service features of TCP such as: the sequence transport of messages with overcrowded control, and it is different from TCP by providing multi-homing and excrescent paths to increase flexibility and reliability. It was the first greeted protocol for the transportation of sending messages over cellular networks, but later it has appeared as a more generalized protocol of the transport layer (Thornber, 2005). SCTP has been developed for the transportation of telecommunication signaling over the IP layer. The SCTP works like the TCP with the extra characteristics fundamentals to transport signaling data that provides a reliable transmission and acknowledging when the information is reordered, and resending damaged information as necessary. SCTP provides a better communication between two end devices by supporting the multi-homing. Multi-homing is considered as the one of the feature key of the SCTP that provides a highly level of performance for the mobile host in the wireless environments (Q. Naith, 2014).

1.2 Comparison between TCP and SCTP

The TCP uses the very basic IP services to provide applications with an end-to-end and connection oriented packet transport mechanism that ensures the reliable and ordered delivery of data. TCP was designed for the wired network, and the main cause of the packet loss is the overcrowding in the wire. Each one of the TCP packet is connected with a sequence number, and only successfully received in order packets are transferred to the sender by the receiver, On the other side, packet loss or reception of out of order packets generates failures (Thornber, 2005).

The SCTP handles the transportations sequence of messages (in a group of bytes), rather than from sending an unbroken stream of bites as the TCP does in SCTP the sender sends a message in one operation, and the exact message is passed to the receiving application process in one operation. In contrast, TCP transporting stream of bytes reliably and in order. However, TCP does not allow the receiver to know the number of times that the sender application called on the TCP transport passing it groups of bytes to be sent out.

The sender side, TCP attaches more bytes to a queue of bytes which waiting to go out over the network, rather than to keep a queue of individual separate outbound messages which must be kept as such the multi-streaming refers to the ability of SCTP to transmit several independent streams of chunks in parallel, for example transmitting images of web page together with the web page text. TCP keeps byte order in the stream by including a sequence number with each segment. However, the SCTP on the other hand, assigns a sequence number of each messages that sent in a stream.

1.3 Overview

This chapter focuses mainly on introducing the whole research scope including the research background, motivation, objectives, research solution, research problems all conclude with a brief chapter summary.

1.4 Problem Statement

Nowadays, communication networks became one of the important technologies. It is also used between different societies, especially when the communication is between more than one devices through the IP network. When there is more than one device connected with each other over the IP network, there are many different layers employed for each of the devices such as: the physical layer, data link layer, network layer, transport layer, and the application layer. TCP is the most used protocol in transport layer. However, it is not enough to support the all network requirements such as the mobility. Thus, the SCTP has been developed to support the TCP

mobility. However, SCTP performance is not deeply evaluated, especially the SCTP Multi homed under different scenarios parameter such as the heavy traffic overloading while using different bit rate, and different mobility speeds as well.

1.5 Objectives

The objectives of this research are to:

i. To simulate both of the SCTP and TCP protocol by using the Riverbed
ii. To compare between the SCTP and TCP performance in term of the Packet Loss, End to End Delay and Throughput in the WLAN.
iii. To evaluate the impact of using various channel bit rates and mobility speeds on the SCTP and TCP performance of Packet Loss, End to End Delay and Throughput WLAN.

1.6 Scope

In this thesis the testing will be on the simulation not in real life experiment. The size of the environment is small, and the project evaluation is for the Wi-Fi only. The needed time for the delay over the handoff from the main path to an alternate path. The effective of end-to-end delay, and the packet loss and what makes it happen. The effective of end-to-end throughput heavy traffic overloading as well.

1.7 Methodology

Simulation software should be utilized to access and measure the performance of routing protocol. In this project Riverbed tool will be used. The simulation software gives results which will be used to evaluate the routing protocols performances.

The different of the performances for the routing protocols will be compared, and techniques to improve the behavior of those protocols it will be simulated to determine how effective it will be. The following Figure 1-1 shows the methodology of the network development lifecycle.

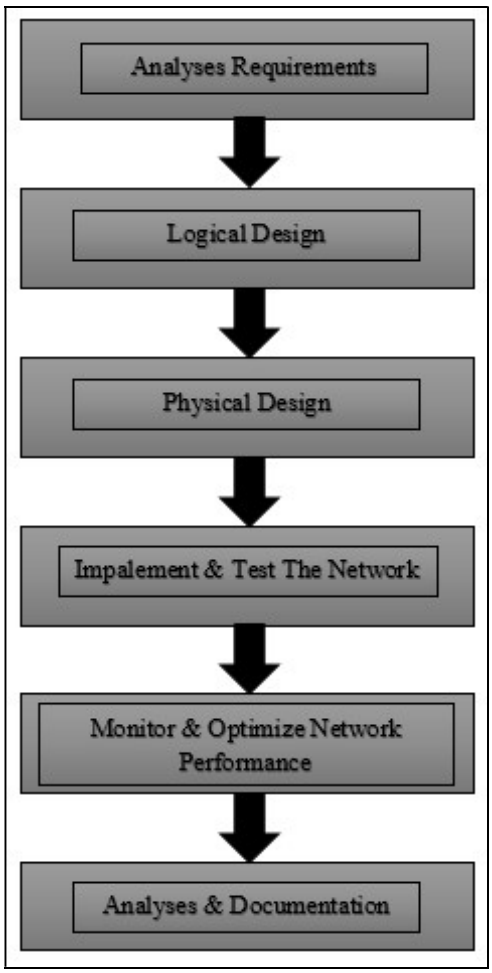

Figure 1-1: The Methodology Flow Chart

1.7.1 Analyses Requirements

To design the scope. Great base of use case, establish technical standard, and generate performance specification.

1.7.2 Logical Design

To design the logical topology of the new system. System layer tending on: naming, enchanting and steering convention.

1.7.3 Physical Design

The specification for technologies and product of physical design to realize the; selected logical design, which starts during logical design, and it must be completed during this step.

1.7.4 Impalement and Test the Network

At this point; when the design has been endorsed, the execution will begin, and the re-enactment will be worked by outline determination.

1.7.5 Monitor and Optimize Network Performance

This step monitors the result of the performance, and the parameter analyser will be chosen it to check what is the wrong, and starts to work to optimize the evaluated and analysed performance to compare and give suggestions to the best of the routing protocols.

1.7.6 Analyses and Documentation

This step is all about the documenting analysis, and it is actually the assignment of inspecting the physical item that kept the goal to gain the realization about the work that digitized, and to choose what is the reason and the eventual fate in the task involved in section 1.6 (System requirement).

1.8 System Requirements

i. Software:

   a) Riverbed is popular simulation written by American IT Company that used to study the performance of the protocols in the network field.
   b) Windows 10 home.

ii. Hardware:

   a) Personal Laptop.
   b) Processor (intel corei7).
   c) 64bit Operation System.
   d) Hard disk capacity is one Tera.

iii. Documentation tools:

   a) Microsoft Office.

1.9 Thesis Overview

The current thesis is organized as follows:

Chapter 1, Introduction.

Chapter 2, Elaborates on the literature review which covers

Chapter 3, Outlines the methodology.

Chapter 4, Implementation.

Chapter 5, Results and discussion chapter.

Chapter 6, Conclusions, presents the conclusions drawn from all the work and future direction which this work can take towards.

1.10 Conclusion

This chapter has explained a brief of the project introduction. The topics that have been covered in this section are: introduction, problem statement, objectives, project scope and the methodology. So a given description of the performance matric for real time application which will be tested for the protocols end to end delay, throughput, packet loss and the needed time for the delay over the handoff from the main path to an alternate path.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In order to have a clear understanding about the research topic, this chapter will state the relevant researches and theory, also it will cover the applied on the simulation tool (Riverbed). The purpose behind this chapter is to present some of the research that has been previously accomplished and that is related to our research study. The research gathered within this chapter will be beneficial in the subsequent chapters, and will be used as a foundation for this thesis study. In the last few years, the SCTP multi-homing has be considered one of the most significant methods for the purpose of achieving seamless mobility in wireless network environments. Several research and studies have been done to evaluate the performance of SCTP multi-homed host for mobility and handover mechanism in wired and wireless networks.

2.2 Overview of Literature Review

The overview of this chapter is to study and review some other major topics from different areas in this project. It is going to be achieved out by carrying some researches through different transport layer protocols. While carrying out this literature review it will us to get more knowledge about the transport layer protocols, and it will help us to study more about the routing protocols. Thus, our knowledge will be enhanced. This chapter presents some of the previous related works that relevant to the understanding of the problem. In order to gather information, thesis and encyclopedia that used in this process to develop this project. The following Figure 2-1 will explain about this chapter.

2.3 Hierarchical Literature Review Map Drawing for Chapter 2

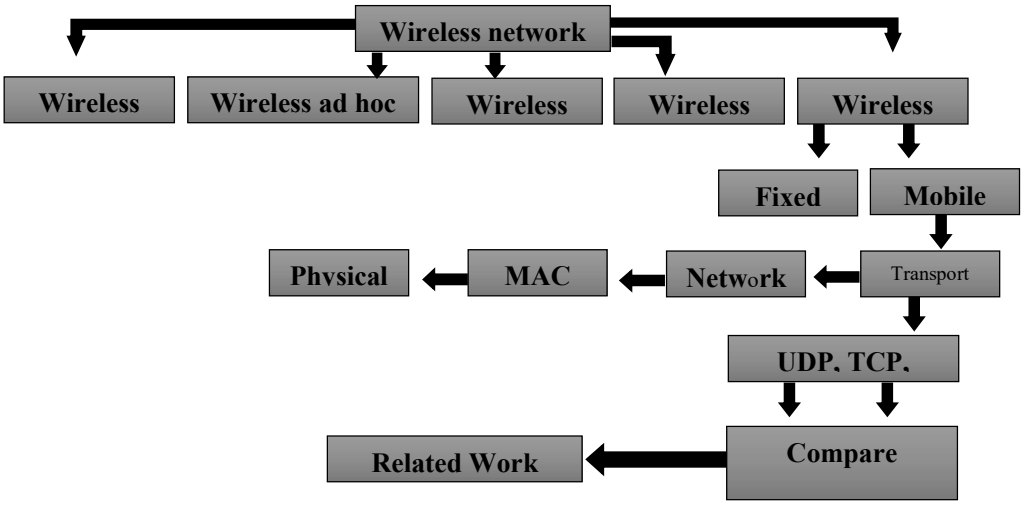

Figure 2-1: Hierarchical Literature Review Map

2.4 Wireless LAN

Wireless Local Area Network (WLAN) is a connection between two or more of devices over a short distance by using the microwave radio signal instead of using the basic network cables. WLAN will never rely on the cabled Ethernet connections. It only can be an extension to a current cabled network or an alternative to it. IEEE 802.11 supports three basic topologies for WLANs: the Independent Basic Service Set (IBSS), the Basic Service Set (BSS), and the Extended Service Set (ESS). All three configurations are supported by the MAC layer implementation.

The 802.11 standard defines two modes: ad hoc/IBSS and infrastructure mode. Logically, an ad-hoc configuration is analogous to a peer-to-peer office network in which no single node is required to function as a server. IBSS WLANs include a

number of nodes or wireless stations that communicate directly with one another on an ad-hoc, peer-to-peer basis, building a full-mesh or partial-mesh topology. Generally, ad-hoc implementations cover a limited area and aren't connected to any larger network. Using infrastructure mode, the wireless network consists of at least one access point connected to the wired network infrastructure and a set of wireless end stations. An Extended Service Set (ESS) is a set of two or more BSSs forming a single sub network. ESS configurations consist of multiple BSS cells that can be linked by either wired or wireless backbones. IEEE 802.11 supports ESS configurations in which multiple cells use the same channel, and use different channels to boost aggregate throughput (Nedeltchev, 1991).

Table 2-1: The WLAN Standard

Standard type	Advantages	Disadvantages
802.11a	-Fast data transfer rate (up to 54Mbps) -Supports more simultaneous connections Less sensitivity to interference	-Short range (60-100feet) -Less able to break through physical partitions
802.11b	-Better in break through physical partitions - Bigger range (70-150feet) - The Hardware is cheaper	- Slow data transfer rates (up to 11Mbps) -Doesn't support the simultaneous connections -Very sensitive to the interference
802.11g	- Faster data transfer rates (up to 54Mbps) - Better range from 802.11b (65-120feet)	-High sensitivity to interference

2.5 Fixed WLAN

Is a part of the WLAN, and it is an operation of the wireless devices or system that used to connect two fixed locations with each other, such as building to building to enable the data communication between them. Fixed WLAN has two types:

i. Local Multipoint Distribution System (LMDS)
ii. Multichannel Multipoint Distribution Service (MMDS)

Some of the most important assets of fixed wireless:

i. Subscribers can be added or moved without adjusting any of the infrastructure.
ii. The subscribers in the remote areas can be brought into the network without any need of stringing new cables.
iii. Broad bandwidth is possible, because there are no cables to let in any reactance into the connection.
iv. Whenever the number of subscribers increases, the price of the connection per subscriber will be decreased down.

There could be great opportunities for private and public sectors to join together to build a robust and affordable broadband infrastructure for rural and remote communities. Hence, we need to embrace the full opportunities of fixed wireless broadband and mobile broadband technology convergence in rural and remote area Optic fibre technology though expensive has been proven to deliver the best bandwidth for broadband service delivery (Tiwari, Lane, & Alam, 2015).

2.6 Mobile WLAN

The mobile network can be explained as a service of a telecommunications that has a wireless voice and a data communication for the mobile users. The service of the mobile wireless provided to users or customers who might be in temporary locations, such as offices, restaurants and shops. Mobile wireless services work through set or group of devise that include portable modems, mobile phones and some technologies such as WiMAX, GPRS, and LTE (Parmar & Lohia, 2016).

2.7 Transmission Control Protocol (TCP)

TCP is a network communication protocol that have been designed to send the data over the Internet. It is an OSI transport protocol, and is used to the remote connection between the remote computers. It also ensures that the message will be delivered and supported over the network and the internet (Balakrishnan & Katz, 1998). TCP is a part of the Internet protocol suite, and it very used in the network communication from others, and it can be called as TCP/IP as well. It also ensures that the end to end date delivery is between the distinct nodes. The TCP works in a collaboration with the Internet Protocol that defines the logical location of the remote node, while the TCP transports and ensures that the data will be delivered to the correct destination.

The TCP always greats a connection between the booth source and the destination node before transmitting the data packets to keep it alive until the communication is active, then it breaks the large data packets into small packets and ensures that the data integrity will be intact when it is grouped at the destination node. TCP has two types of controls congestion, and congestion controller has a feature of preventing the congestion before it happens, or remove it, after it has happened. Thus, congestion can be divided into two categories as showed in Figure 2-2:

i. Open-Loop Congestion Control (preventing)
   In the open-loop congestion control, the policies have been applied to prevent the congestion before it happens. So, by applying these mechanisms, the congestion control is being handled by either the source or the destination.
ii. Closed-Loop Congestion Control (removing)
   Closed-loop congestion control mechanisms try to relieve or forbid the congestion after it happens.

Normally the sender window size is specified by the available buffer space in the receiver window. The sender's window size is being specified by both of the receiver and also the congestion in the network. The sender has two pieces of information: the receiver-advertised window size and the congestion window size. The actual size of the window is the minimum of these two. In the TCP/IP model, the transport layer

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