

# Broadband Multimedia Networks

## Lab 4 – TCP Variants

### I. INTRODUCTION

In this lab, you will:

- Explore the characteristics of three TCP Congestion Control (CC) algorithms in FreeBSD: NewReno, CUBIC, and Vegas. See the man pages for 'mod\_cc', 'cc\_cubic', 'cc\_newreno' and 'cc\_vegas' (<http://www.freebsd.org/cgi/man.cgi>).
- Learn how to use Wireshark or similar packet trace analysis software and interpret output from statistical logging tools.
- Learn how to use data analysis and graphing tools. Some commonly used software: Microsoft Excel, OpenOffice Calc, Matlab, Scilab, Python, R.

### II. LAB METHODOLOGY

This lab focuses on developing an understanding of various TCP congestion control algorithms. A dataset containing the trace files collected from testbed experiments is provided. You would not need to run any experiments. However, you will need to:

- Think about what the selected experiment scenarios represent.
- Interpret the output of SIFTR (Statistical Information For TCP Research) log entries.
- Use data analysis and graphing software to plot the specified TCP metrics.
- Interpret the packet capture (PCAP) output with Wireshark or other similar packet analysis software to identify the TCP options set in the headers.

#### A. Experiment scenarios

- 1) The dataset contains SIFTR log files and PCAP files for the following scenarios:

Scenario	Bandwidth	Path RTT	TCP CC algorithms
A	5 Mbps	100 ms	NewReno, CUBIC, Vegas
B	512 Kbps	40 ms	
C	5 Mbps	40 ms	

- 2) There is only **one** traffic flow in each direction: TCP data flow from sender to the receiver, TCP ACK flow from the receiver to the sender. The IP address and port information of the sender and receiver are as follows:

- Sender: 172.16.11.67, random port
- Receiver: 172.16.10.65, Port 5000

#### B. Experiment analysis with SIFTR

The SIFTR man page states:

"SIFTR is a kernel module that logs a range of statistics on active TCP connections to a log file. It provides the ability to make fine-grained measurements of TCP connection state, aimed at system administrators, developers and researchers."

A log entry is generated for every TCP segment seen. To understand the format of SIFTR log entries see: 'man siftr' (<http://www.freebsd.org/cgi/man.cgi?query=siftr>). TCP metrics of interests are:

- Congestion Window (*cwnd*)
- Sending Window (*swnd*)
- Receiving Window (*rwnd*)
- Socket send buffer occupancy
- Socket receive buffer occupancy
- TCP RTT estimates

You are required to graph a subset of **TCP metrics vs time**, as specified below:

TCP Metrics vs time	Scenario	TCP CC algorithms	Remarks	Number of graphs
<i>cwnd</i> & send buffer occupancy	A	NewReno, CUBIC, Vegas	Overlay <i>cwnd</i> and send buffer occupancy plots on the same graph. Repeat for all CCs.	3
Smoothed RTT	B, C		Overlay smoothed RTT plots for the same CC in Scenarios B and C. Repeat for all CCs.	3
<i>cwnd</i>	A, C		Overlay <i>cwnd</i> plots for the same CC in Scenarios B and C. Repeat for all CCs.	3

### C. Packet capture analysis

Use Wireshark or other similar packet analysis software to identify the TCP options negotiated at the start of the data transfer. You will need to discuss the options in your report.

### III. GENERAL QUESTIONS

- 1) What is meant by the term ‘TCP congestion control’? Provide descriptions of the basic characteristics of the CCs explored in this lab (NewReno, CUBIC and Vegas). In addition, provide three other examples of CC algorithms that are used on the Internet today and write a short description of how they operate.
- 2) What is the default TCP congestion control method used in the following operating systems?
  - The latest version of FreeBSD
  - The latest version of MacOSX
  - The latest version of the Linux kernel
  - Windows XP, 7, 10
- 3) What are TCP options? Where and when are they transmitted? Provide short descriptions of what two of them do.

### IV. LAB-BASED QUESTIONS

- 1) Calculate the Bandwidth Delay Product (BDP) for Scenarios A, B and C.
- 2) Perform data analysis as described in Section II-B. Explain and discuss what you see in your results. Some questions to consider:
  - a) What do Scenarios A, B and C represent? *Hint*: Think in terms of BDP.
  - b) How are socket send buffer occupancy and *cwnd* values relate to each other? *Hint*: Have a look at results from Scenario A.
  - c) How do you obtain the Smoothed RTT estimates? *Hint*: HZ=1000 & TCP\_RTT\_SCALE=32
  - d) How do Smoothed RTT estimates vary with the bandwidth? *Hint*: Compare results from Scenarios B and C.

- e) How does path RTT affect *cwnd* growth? *Hint*: Compare results from Scenarios A and C.
- 3) What **TCP options** were negotiated between the peers in each Scenario?  
*Hint*: Have a look at the PCAP trace files.

## V. ASSESSMENT

### A. Submission guidelines

- Your response to this lab shall be a two-column research report of no more than **10 pages**, including figures, appendices and/or annexes, using the required template's font, font size and column height/width.
- The required template is provided on Canvas in Rich Text, OpenOffice and  $\LaTeX$  formats. Not using the templates will result in the loss of marks.
- Pay close attention to the points raised at: <http://caia.swin.edu.au/reports/howto.html>
- The lab is worth **5%** of your final mark.
- Answer all of the questions in Sections **III** and **IV**. To receive full marks, answers should consist of a concise description of steps taken, summary of relevant reasoning and a concise explanation of your findings.
- Where applicable, assumptions used to answer questions must be stated. Single line or purely numerical answers to any question will not receive full marks.

### B. Submission process

You **MUST** submit your report as a **PDF file** to Canvas. The name of your file **MUST** be of the form: `broadband-lab4-XXXXXXX.pdf` where XXXXXXX is your student ID number. There is no need to provide raw data in your submission – just the lab report.

**Note #1:** You will be marked on quality not quantity. Simply meeting the page/word limit does not guarantee any particular grade.

**Note #2:** You must refer to external sources of information to support factual claims you make. Un-cited claims will result in a loss of marks. Re-using chunks of text from external sources will be considered plagiarism if not properly credited (e.g. You can use quotation marks and/or italics to make clear what text you are quoting, and provide references to the quote's source in footnotes or at the end of the paper.) Properly credited content from external sources will be considered as supporting material only, and will not contribute to your grade for the assignment. Focus on writing your insights and contributions in your own words. Remember, we know how to use Google too.

**Deadline:** Refer to Swinburne Canvas (<https://swinburne.instructure.com/>).