Lab 2: Wireshark & Transport Layer

In this lab, you will use Wireshark to investigate TCP. Use the submission template document to supply your answers and screen shots (*Lab2_Submission_Template.docx*). When you finish the assignment name it *Lab2_lastname_firstname*.docx, replacing *lastname* and *firstname* with your name. You must upload your final assignment to D2L using the provided link by the due date and time posted in the assignments folder. There are some Wireshark capture files you will need to complete the assignment – they are available for download using the links provided.

PART 1: Analyzing TCP using Wireshark (20 points)

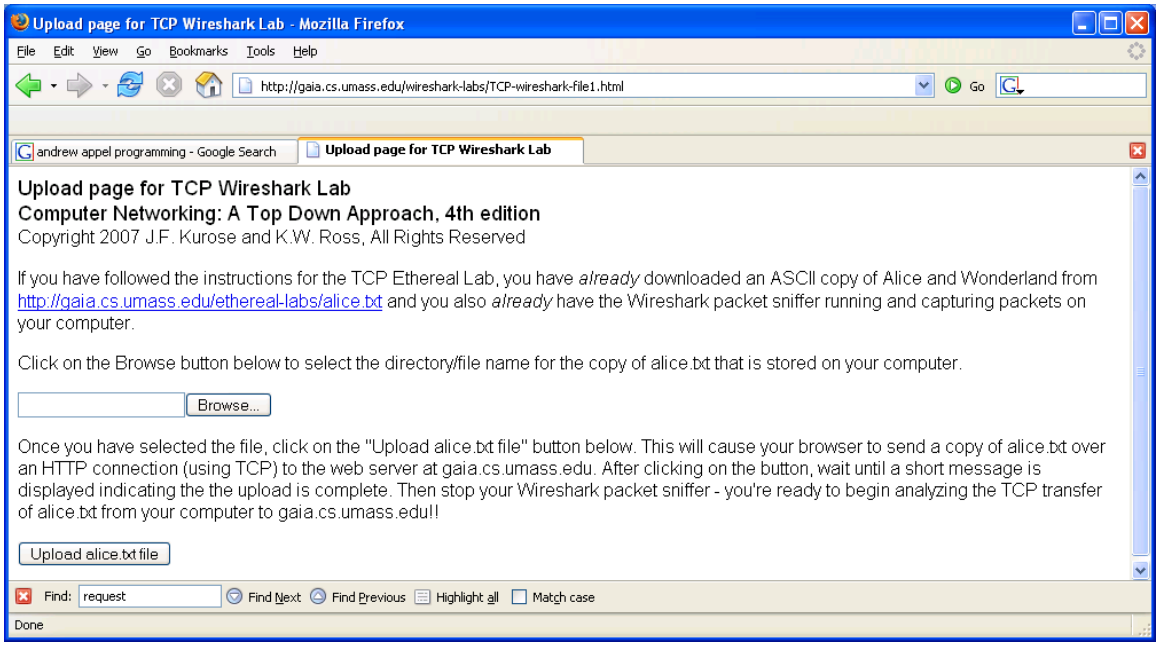
In this part, we'll investigate the behavior of the TCP protocol in detail. We'll do so by analyzing a trace of the TCP segments sent and received in transferring a 150KB file (containing the text of Lewis Carrol's *Alice's Adventures in Wonderland*) from your computer to a remote server. We'll study TCP's use of sequence and acknowledgement numbers for providing reliable data transfer; we'll see TCP's congestion control algorithm – slow start and congestion avoidance – in action; and we'll look at TCP's receiver-advertised flow control mechanism. We'll also briefly consider TCP connection setup and we'll investigate the performance (throughput and round-trip time) of the TCP connection between your computer and the server.

1. Capturing a bulk TCP transfer from your computer to a remote server

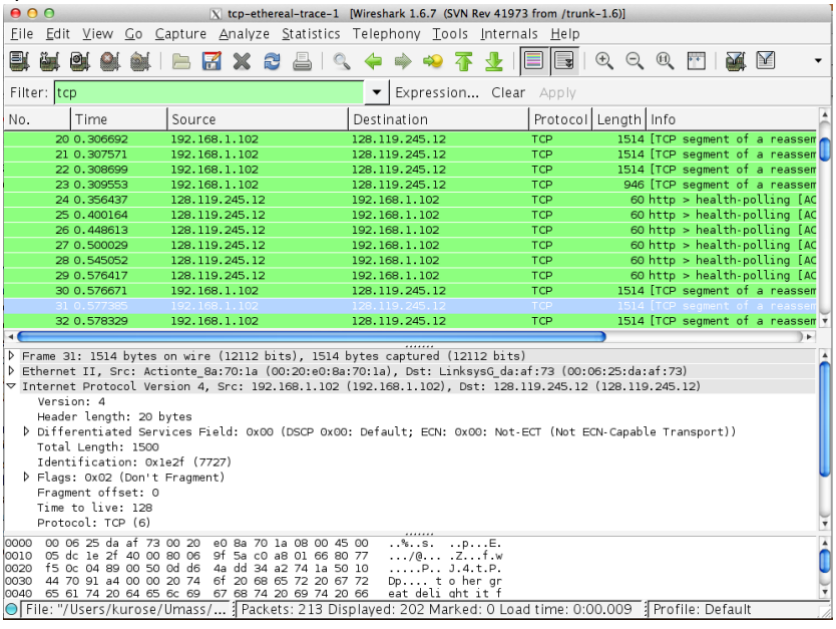
Before beginning our exploration of TCP, we'll need to use Wireshark to obtain a packet trace of the TCP transfer of a file from your computer to a remote server. You'll do so by accessing a Web page that will allow you to enter the name of a file stored on your computer (which contains the ASCII text of *Alice in Wonderland*), and then transfer the file to a Web server using the HTTP POST method (see section 2.2.3 in the text). We're using the POST method rather than the GET method as we'd like to transfer a large amount of data *from* your computer to another computer. Of course, we'll be running Wireshark during this time to obtain the trace of the TCP segments sent and received from your computer.

Do the following:

- Start up your web browser. Go the http://gaia.cs.umass.edu/wireshark-labs/alice.txt and retrieve an ASCII copy of *Alice in Wonderland.* Save this file somewhere on your computer.
- Next go to http://gaia.cs.umass.edu/wireshark-labs/TCP-wireshark-file1.html.
- You should see a screen that looks like:



- Use the *Browse* button in this form to enter the name of the file (full path name) on your computer containing *Alice in Wonderland* (or do so manually). Don't yet press the "*Upload alice.txt file*" button.
- Now start up Wireshark and begin packet capture *(Capture->Start)* and then press *OK* on the Wireshark Packet Capture Options screen (we'll not need to select any options here).
- Returning to your browser, press the "*Upload alice.txt file*" button to upload the file to the gaia.cs.umass.edu server. Once the file has been uploaded, a short congratulations message will be displayed in your browser window.
- Stop Wireshark packet capture. Your Wireshark window should look similar to the window shown below (But it may not be exactly the same because of your local network and host conditions).



If you are unable to run Wireshark on a live network connection, you can download a packet trace file that was captured while following the steps above[1]. You may well find it valuable to download this trace even if you've captured your own trace and use it, as well as your own trace, when you explore the questions below.

2. A first look at the captured trace

Before analyzing the behavior of the TCP connection in detail, let's take a high level view of the trace.

First, filter the packets displayed in the Wireshark window by entering "tcp" (lowercase, no quotes, and don't forget to press return after entering!) into the display filter specification window towards the top of the Wireshark window.

What you should see is series of TCP and HTTP messages between your computer and gaia.cs.umass.edu. You should see the initial three-way handshake containing a SYN message. You should see an HTTP POST message. Depending on the version of Wireshark you are using, you might see a series of "HTTP Continuation" messages being sent from your computer to gaia.cs.umass.edu. Recall from our discussion in the earlier HTTP Wireshark lab, that is no such thing as an HTTP Continuation message – this is Wireshark's way of indicating that there are multiple TCP segments being used to carry a single HTTP message. In more recent versions of Wireshark, you'll see "[TCP segment of a reassembled PDU]" in the Info column of the Wireshark display to indicate that this TCP segment contained data that belonged to an upper layer protocol message (in our case here, HTTP). You should also see TCP ACK segments being returned from gaia.cs.umass.edu to your computer.

Answer the following questions, by opening the Wireshark captured packet file *tcp-ethereal-trace-1* in http://gaia.cs.umass.edu/wireshark-labs/wireshark-traces.zip (that is download the trace and open that trace in Wireshark; see footnote 2). Whenever possible, when answering a question you should hand in a printout of the packet(s) within the trace that you used to answer the question asked. Annotate the printout[2] to explain your answer. To print a packet, use *File->Print*, choose *Selected packet only*, choose *Packet summary line,* and select the minimum amount of packet detail that you need to answer the question.

1. What is the IP address and TCP port number used by the client computer (source) that is transferring the file to gaia.cs.umass.edu? To answer this question, it's probably easiest to select an HTTP message and explore the details of the TCP packet used to carry this HTTP message, using the "details of the selected packet header window" (refer to Figure 2 in the "Getting Started with Wireshark" Lab if you're uncertain about the Wireshark windows.

[1] Download the zip file http://gaia.cs.umass.edu/wireshark-labs/wireshark-traces.zip and extract the file tcp-ethereal-trace-1. The traces in this zip file were collected by Wireshark running on one of the author's computers, while performing the steps indicated in the Wireshark lab. Once you have downloaded the trace, you can load it into Wireshark and view the trace using the *File* pull down menu, choosing *Open*, and then selecting the tcp-ethereal-trace-1 trace file.

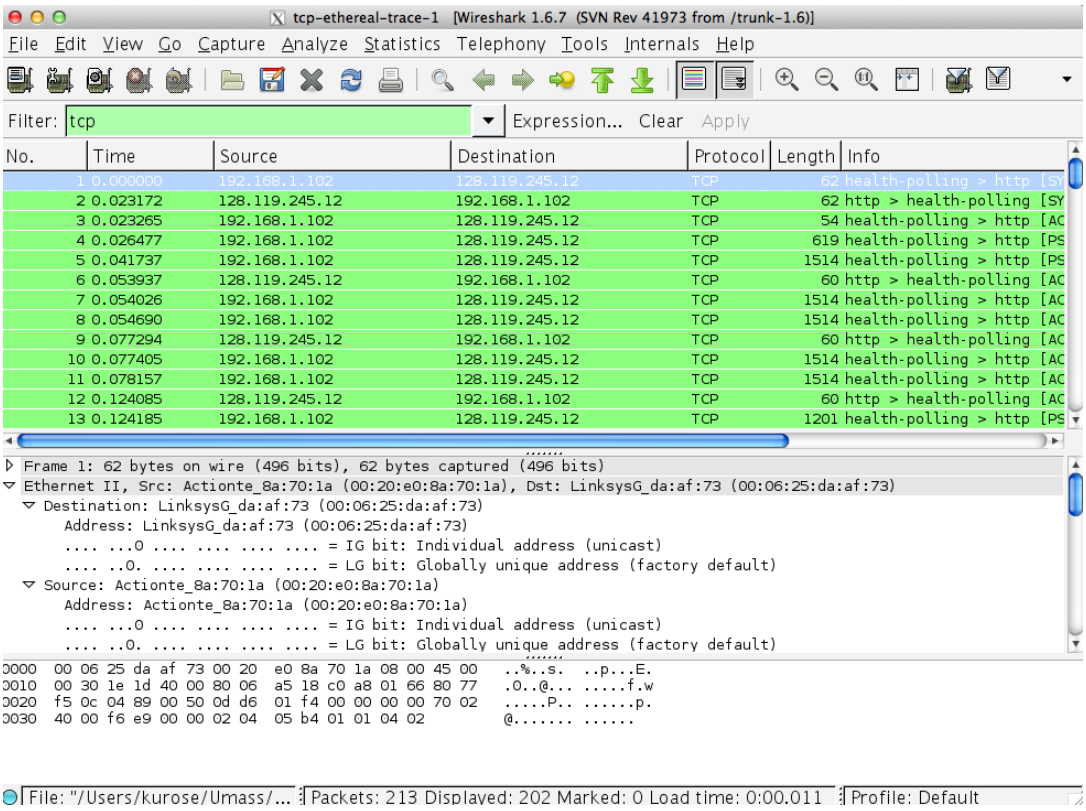
[2] What do we mean by "annotate"? If you hand in a paper copy, please highlight where in the printout you've found the answer and add some text (preferably with a colored pen) noting what you found in what you 've highlight. If you hand in an electronic copy, it would be great if you could also highlight and annotate.

2. What is the IP address of gaia.cs.umass.edu? On what port number is it sending and receiving TCP segments for this connection?

Now, if you successfully created your own trace for the Alice.txt upload, answer the following question:

3. What is the IP address and TCP port number used by your client computer (source) to transfer the file to gaia.cs.umass.edu?

Since this lab is about TCP rather than HTTP, let's change Wireshark's "listing of captured packets" window so that it shows information about the TCP segments containing the HTTP messages, rather than about the HTTP messages. To have Wireshark do this, select *Analyze->Enabled Protocols.* Then uncheck the HTTP box and select *OK*. You should now see a Wireshark window that looks like:



This is what we're looking for - a series of TCP segments sent between your computer and gaia.cs.umass.edu. We will use the packet trace that you have captured (and/or the packet trace *tcp-ethereal-trace-1* in http://gaia.cs.umass.edu/wireshark-labs/wireshark-traces.zip; see earlier footnote) to study TCP behavior in the rest of this lab.

3. TCP Basics

Answer the following questions for the TCP segments and provide screen shots as necessary:

4. What is the sequence number of the TCP SYN segment that is used to initiate the TCP connection between the client computer and gaia.cs.umass.edu? What is it in the segment that identifies the segment as a SYN segment?
5. What is the sequence number of the SYNACK segment sent by gaia.cs.umass.edu to the client computer in reply to the SYN? What is the value of the Acknowledgement field in the SYNACK segment? How did gaia.cs.umass.edu determine that value? What is it in the segment that identifies the segment as a SYNACK segment?
6. What is the sequence number of the TCP segment containing the HTTP POST command? Note that in order to find the POST command, you'll need to dig into the packet content field at the bottom of the Wireshark window, looking for a segment with a "POST" within its DATA field.
7. Consider the TCP segment containing the HTTP POST as the first segment in the TCP connection. What are the sequence numbers of the first six segments in the TCP connection (including the segment containing the HTTP POST)? At what time was each segment sent? When was the ACK for each segment received? What is the length of each of the first six TCP segments?[3]
8. What is the minimum amount of available buffer space advertised at the received for the entire trace? Does the lack of receiver buffer space ever throttle the sender?
9. Are there any retransmitted segments in the trace file? What did you check for (in the trace) in order to answer this question?
10. How much data does the receiver typically acknowledge in an ACK? Can you identify cases where the receiver is ACKing every other received segment?

Part 2: TCP Connection Establishment and Teardown (18 points)

The goal of this assignment is to observe the 3-way handshake to initiate a TCP connection, the use of TCP in data transfer, and the ending of a TCP connection.

1. Open the **TCP.pcap** file in Wireshark.
2. What is the purpose of the first three frames? **(1 point)**

   _____

   Packet 1: (2 POINTS)

[3] The TCP segments in the tcp-ethereal-trace-1 trace file are all less than 1460 bytes. This is because the computer on which the trace was gathered has an Ethernet card that limits the length of the maximum IP packet to 1500 bytes (40 bytes of TCP/IP header data and 1460 bytes of TCP payload). This 1500 byte value is the standard maximum length allowed by Ethernet. If your trace indicates a TCP length greater than 1500 bytes, and your computer is using an Ethernet connection, then Wireshark is reporting the wrong TCP segment length; it will likely also show only one large TCP segment rather than multiple smaller segments. Your computer is indeed probably sending multiple smaller segments, as indicated by the ACKs it receives. This inconsistency in reported segment lengths is due to the interaction between the Ethernet driver and the Wireshark software. We recommend that if you have this inconsistency, that you perform this lab using the provided trace file.

a. What is the purpose of this packet?

_____

b. What is the source port number? _____

c. What is the destination port number? _____

d. What is the sequence number? _____

e. What is the acknowledgement number? _____

f. Which flags are set? Why?

_____

_____

g. How many more bytes of data can the source computer accept (find window size)?

_____

Packet 2: (2 POINTS)

a. What is the purpose of this packet?

_____

b. What is the source port number? _____

c. What is the destination port number? _____

d. What is the sequence number? Why? _____

e. What is the acknowledgement number? Why? _____

f. Which flags are set? Why?

_____

_____

g. How many more bytes of data can the destination computer accept?

_____

Packet 3: (2 POINTS)

a. What is the purpose of this packet?

_____

b. What is the sequence number? Why? _____

c. What is the acknowledgement number? Why? _____

d. Which flags are set? Why?

_____

_____

e. How many more bytes of data can the source computer accept?

_____

3. What is the purpose of frames 4 to 37? _____

(1 points)

Why is the sequence number the same for all of the odd frames from 5 – 35 (frames from 192.168.1.2 →174.143.213.184)? **(1 point)**

_____

The length of the even frames 18 is 1514 bytes, but what is the size of the payload in the TCP segment? How did you determine this? **(2 points)** _____

What is the purpose of Frame 36? **(1 point)** _____

4. Answer the following questions about frames 38-40.

Packet #38 (2 POINTS)

a. What is the purpose of this packet?

_____

b. What is the source port number? _____

c. What is the destination port number? _____

d. What is the sequence number? _____

e. What is the acknowledgement number? _____

f. Which flags are set? Why?

_____

_____

Packet #39 (2 POINTS)

a. What is the purpose of this packet?

_____

b. What is the sequence number? Why? _____

c. What is the acknowledgement number? Why? _____

d. Which flags are set? Why?

_____

_____

Packet #40 (2 POINTS)

a. What is the purpose of this packet?

   _____

b. What is the sequence number? Why? _____

c. What is the acknowledgement number? Why? _____

d. Which flags are set? Why?

   _____

   _____