DEPARTMENT OF COMPUTER ENGINEERING,
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EC9520– DVANCED COMPUTER AND DATA NETWORKS
LABORATARY SESSION 2
Web Protocols using Wireshark

(Time duration 3 hours only)

1. **REGISTRATION NUMBER:**
2. **DATE:**
3. **OBJECTIVES:**
   - Learn about HTTP protocol.
   - Learn about SSL which is used by HTTPS
4. **APPARATUS:**
   - Windows Computer with Wireshark installed on it.
5. **REFERENCES:**
   This Lab session is based on supplementary labs of Computer Networking: A Top-Down Approach, 7th ed., J.F. Kurose and K.W. Ross
6. **LABORATORY TASKS:**

Note: 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

Part 1: HTTP

1. The HTTP CONDITIONAL GET/response interaction

Most web browsers perform object caching and thus perform a conditional GET when retrieving an HTTP object. Before performing the steps below, make sure your browser's cache is empty. (To do this under Firefox, select *Tools->Clear Recent History* and check the Cache box, or for Internet Explorer, select *Tools->Internet Options->Delete File;* these actions will remove cached files from your browser's cache.)

Now do the following:

- Start up your web browser, and make sure your browser's cache is cleared, as discussed above.
- Start up the Wireshark packet sniffer
- Enter the following URL into your browser
  http://gaia.cs.umass.edu/wireshark-labs/HTTP-wireshark-file2.html
  Your browser should display a very simple five-line HTML file.
- Quickly enter the same URL into your browser again (or simply select the refresh button on your browser)
- Stop Wireshark packet capture, and enter "http" in the display-filter-specification window, so that only captured HTTP messages will be displayed later in the packet-listing window.

Answer the following questions:

1. Inspect the contents of the first HTTP GET request from your browser to the server. Do you see an "IF-MODIFIED-SINCE" line in the HTTP GET?
2. Inspect the contents of the server response. Did the server explicitly return the contents of the file? How can you tell?

3. Now inspect the contents of the second HTTP GET request from your browser to the server. Do you see an "IF-MODIFIED-SINCE:" line in the HTTP GET? If so, what information follows the "IF-MODIFIED-SINCE:" header?
4. What is the HTTP status code and phrase returned from the server in response to this second HTTP GET? Did the server explicitly return the contents of the file? Explain.

2. Retrieving Long Documents

In our examples thus far, the documents retrieved have been simple and short HTML files. Let's next see what happens when we download a long HTML file. Do the following:

- Start up your web browser, and make sure your browser's cache is cleared, as discussed above.
- Start up the Wireshark packet sniffer
- Enter the following URL into your browser
  http://gaia.cs.umass.edu/wireshark-labs/HTTP-wireshark-file3.html
  Your browser should display the rather lengthy US Bill of Rights.
- Stop Wireshark packet capture, and enter "http || tcp" in the display-filter-specification window, so that only captured HTTP messages will be displayed.

In the packet-listing window, you should see your HTTP GET message, followed by a multiple-packet TCP response to your HTTP GET request. Recall that the HTTP response message consists of a status line, followed by header lines, followed by a blank line, followed by the entity body. In the case of our HTTP GET, the entity body in the response is the *entire* requested HTML file. In our case here, the HTML file is rather long, and at 4500 bytes is too large to fit in one TCP packet. The single HTTP response message is thus broken into several pieces by TCP, with each piece being contained within a separate TCP segment. In recent versions of Wireshark, Wireshark indicates each TCP segment as a separate packet, and the fact that the single HTTP response was fragmented across multiple TCP packets is indicated by the "TCP segment of a reassembled PDU" in the Info column of the Wireshark display. Earlier versions of Wireshark used the "Continuation" phrase to indicate that the entire content of an HTTP message was broken across multiple TCP segments. We stress here that there is no "Continuation" message in HTTP!

Answer the following questions:

5. How many HTTP GET request messages did your browser send? Which packet number in the trace contains the GET message for the Bill or Rights?
6. Which packet number in the trace contains the status code and phrase associated with the response to the HTTP GET request?
7. What is the status code and phrase in the response?
8. How many data-containing TCP segments were needed to carry the single HTTP response and the text of the Bill of Rights?

3. HTML Documents with Embedded Objects

Now that we've seen how Wireshark displays the captured packet traffic for large HTML files, we can look at what happens when your browser downloads a file with embedded objects, i.e., a file that includes other objects (in the example below, image files) that are stored on another server(s).

Do the following:

- Start up your web browser, and make sure your browser's cache is cleared, as discussed above.
- Start up the Wireshark packet sniffer
- Enter the following URL into your browser
  http://gaia.cs.umass.edu/wireshark-labs/HTTP-wireshark-file4.html
  Your browser should display a short HTML file with two images. These two images are referenced in the base HTML file. That is, the images themselves are not contained in the HTML; instead the URLs for the images are contained in the downloaded HTML file. Their publisher's logo is retrieved from the gaia.cs.umass.edu web site. The image of the cover for 5th edition of reference book is stored at the caite.cs.umass.edu server. (These are two different web servers inside cs.umass.edu).
- Stop Wireshark packet capture, and enter "http" in the display-filter-specification window, so that only captured HTTP messages will be displayed.

9. How many HTTP GET request messages did your browser send? To which Internet addresses were these GET requests sent?
10. Can you tell whether your browser downloaded the two images serially, or whether they were downloaded from the two web sites in parallel? Explain.

4. HTTP Authentication

Finally, let's try visiting a web site that is password-protected and examine the sequence of HTTP message exchanged for such a site. The URL http://gaia.cs.umass.edu/wireshark-labs/protected_pages/HTTP-wireshark-file5.html is password protected. The username is "wireshark-students" (without the quotes), and the password is "network" (again, without the quotes). So let's access this "secure" password-protected site. Do the following:

- Make sure your browser's cache is cleared, as discussed above, and close down your browser. Then, start up your browser
- Start up the Wireshark packet sniffer
- Enter the following URL into your browser http://gaia.cs.umass.edu/wireshark-labs/protected_pages/HTTP-wiresharkfile5.html Type the requested user name and password into the pop up box.
- Stop Wireshark packet capture, and enter "http" in the display-filter-specification window, so that only captured HTTP messages will be displayed later in the packet-listing window.

11. What is the server's response (status code and phrase) in response to the initial HTTP GET message from your browser?
12. When your browser's sends the HTTP GET message for the second time, what new field is included in the HTTP GET message?

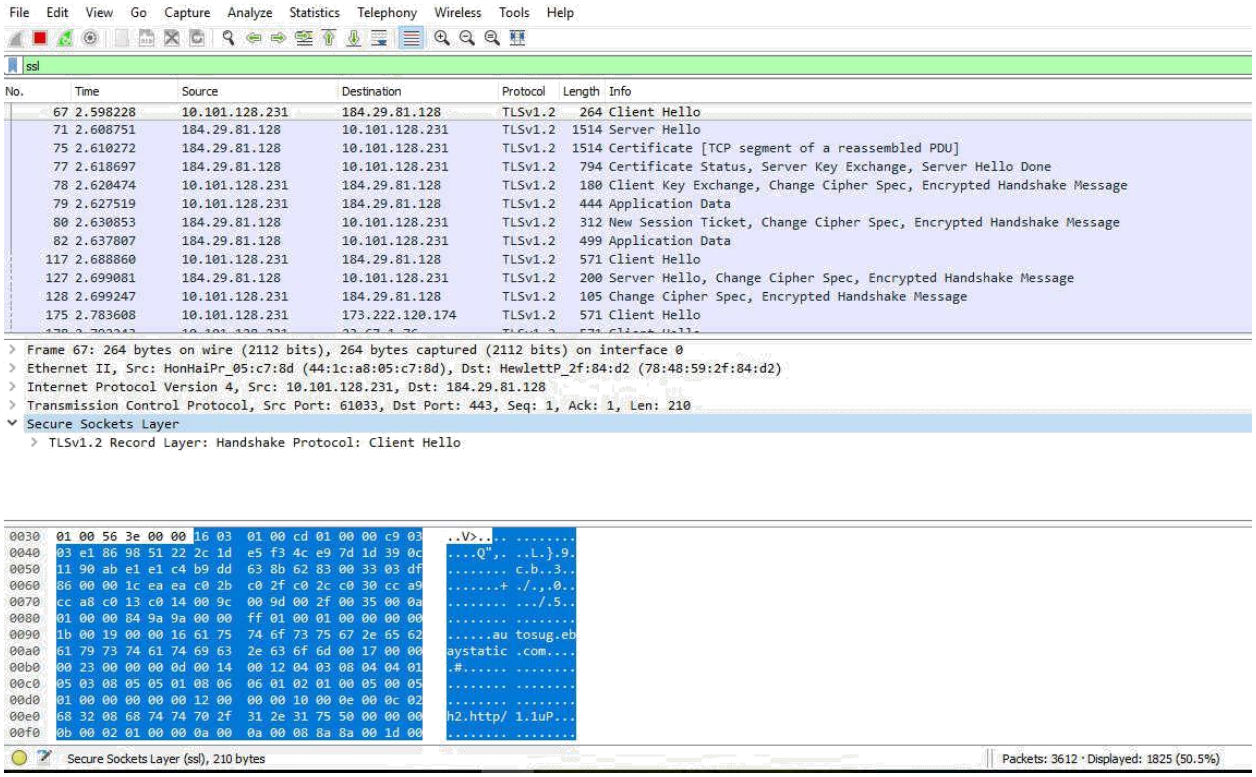
The username (wireshark-students) and password (network) that you entered are encoded in the string of characters (d2lyZXNoYXJrLXN0dWRlbnRzOm5ldHdvcms=) following the "Authorization: Basic" header in the client's HTTP GET message. While it may appear that your username and password are encrypted, they are simply encoded in a format known as Base64 format. The username and password are *not* encrypted! To see this, go to http://www.motobit.com/util/base64-decoder-encoder.asp and enter the base64-encoded string

d2lyZXNoYXJrLXN0dWRlbnRz and decode. *Voila!* You have translated from Base64 encoding to ASCII encoding, and thus should see your username! To view the password, enter the remainder of the string Om5ldHdvcms= and press decode. Since anyone can download a tool like Wireshark and sniff packets (not just their own) passing by their network adaptor, and anyone can translate from Base64 to ASCII (you just did it!), it should be clear to you that simple passwords on WWW sites are not secure unless additional measures are taken.

Part 2: SSL

1. Capturing packets in an SSL session

The first step is to capture the packets in an SSL session. To do this, you should go to your favorite e-commerce site and begin the process of purchasing an item (but terminating before making the actual purchase!). After capturing the packets with Wireshark, you should set the filter so that it displays only the Ethernet frames that contain SSL records sent from and received by your host. (An SSL record is the same thing as an SSL message.) You should obtain something like Figure 2.



2. A look at the captured trace

Your Wireshark GUI should be displaying only the Ethernet frames that have SSL records. It is important to keep in mind that an Ethernet frame may contain one or more SSL records. (This is very different from HTTP, for which each frame contains either one complete HTTP message or a portion of a HTTP message.) Also, an SSL record may not completely fit into an Ethernet frame, in which case multiple frames will be needed to carry the record. Whenever possible, when answering a question below, you should hand in a printout of the packet(s) within the trace that you used to answer the question asked. Annotate the printout to explain your answer.

1. For each of the first 8 Ethernet frames, specify the source of the frame (client or server), determine the number of SSL records that are included in the frame, and

list the SSL record types that are included in the frame. Draw a timing diagram between client and server, with one arrow for each SSL record.

2. Each of the SSL records begins with the same three fields (with possibly different values). One of these fields is "content type" and has length of one byte. List all three fields and their lengths.

Client Hello Record:

3. Expand the Client Hello record. (If your trace contains multiple Client Hello records, expand the frame that contains the first one.) What is the value of the content type?
4. Does the Client Hello record contain a nonce (also known as a "challenge")? If so, what is the value of the challenge in hexadecimal notation?
5. Does the Client Hello record advertise the cyber suites it supports? If so, in the first listed suite, what are the public-key algorithm, the symmetric-key algorithm, and the hash algorithm?

Server Hello Record:

6. Locate the Server Hello SSL record. Does this record specify a chosen cipher suite? What are the algorithms in the chosen cipher suite?
7. Does this record include a nonce? If so, how long is it? What is the purpose of the client and server nonces in SSL?
8. Does this record include a session ID? What is the purpose of the session ID?
9. Does this record contain a certificate, or is the certificate included in a separate record. Does the certificate fit into a single Ethernet frame?

Client Key Exchange Record:

10. Locate the client key exchange record. Does this record contain a pre-master secret? What is this secret used for? Is the secret encrypted? If so, how? How long is the encrypted secret?

Change Cipher Spec Record (sent by client) and Encrypted Handshake Record:

11. What is the purpose of the Change Cipher Spec record? How many bytes is the record in your trace?
12. In the encrypted handshake record, what is being encrypted? How?
13. Does the server also send a change cipher record and an encrypted handshake record to the client? How are those records different from those sent by the client?

Application Data

14. How is the application data being encrypted? Do the records containing application data include a MAC? Does Wireshark distinguish between the encrypted application data and the MAC?
15. Comment on and explain anything else that you found interesting in the trace.