# CSG1105 Workshop Five

## 1 Introduction

This week we are going to explore aspects of TCP (Transmission Control Protocol) and Network Address Translation. These are all features of the Transport Layer. This layer is responsible for application multiplexing, segmentation of messages, reliable transfer and flow control.

## 2 Exercise: User Datagram Protocol

The User Datagram Protocol is for short messages that will fit within a 516 byte limit. It is also used for protocols that manage their own connections, not relying on TCP to do so. In this exercise, we will use **Wireshark** to capture some traffic and then examine some UDP datagrams.

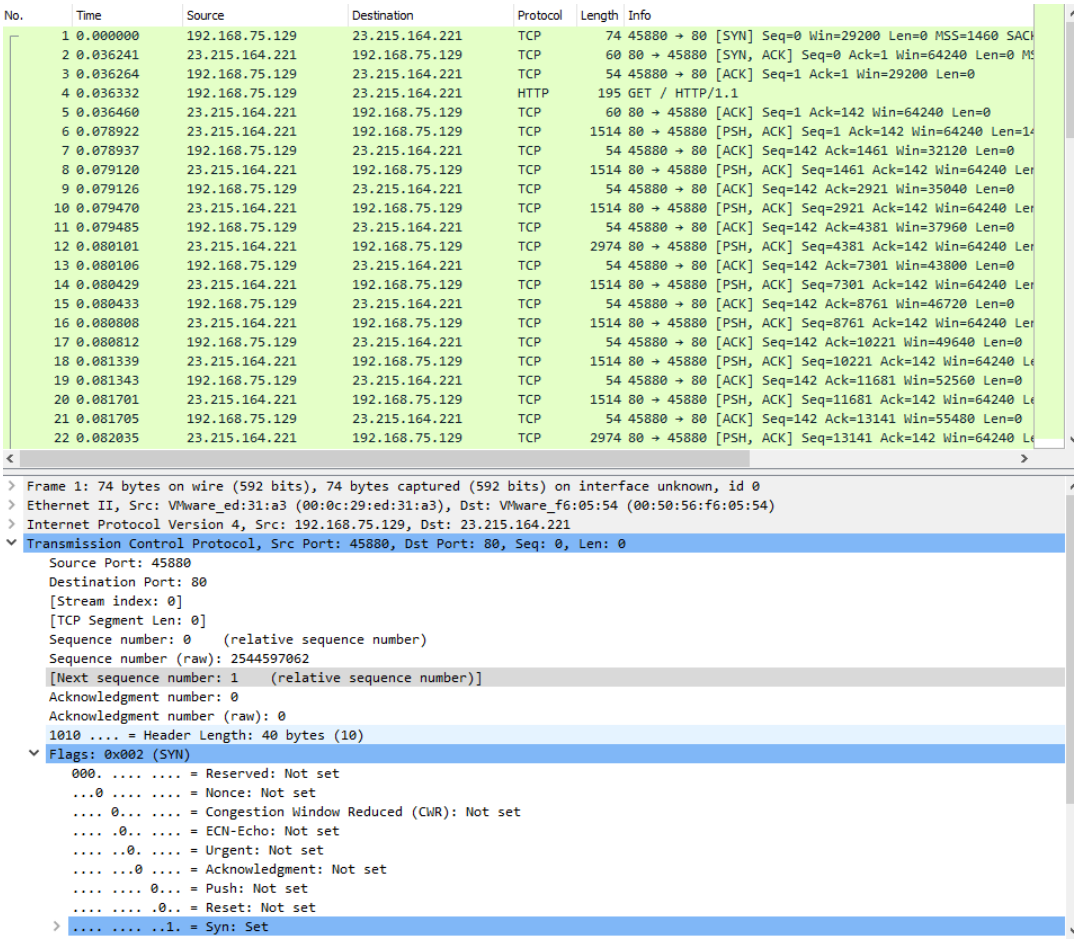
1. Start Wireshark capturing packets on your active network interface.
2. Use your browser to open a few websites
3. Stop the Wireshark capture
4. Enter "udp" into the **display filter** bar and click on the white with blue background arrow at the end of the bar to apply the filter
5. There will be many protocols displayed such as DNS and SNMP (simple network management protocol)
6. Select a **IPv4 DNS** entry. Wireshark will also show the DNS response. Note: This is **NOT** a connection, it is a query and a response sent and received in separate UDP datagrams.
7. Examine both the IP and UDP headers. The IP packet will contain the destination and source IP addresses. The UDP datagram will contain the destination and source **ports**. Recall that both of these are required to address a message to a server and for the server to reply to the client
8. Examine the DNS query and response, noting how much data was exchanged.

## 3 Exercise: TCP Connections

This exercise and the next will be completed in Wireshark using packet capture files already generated. You will need to download from Blackboard two packet capture files: `NAT_Linux_inside.pcapng` and `NAT_Windows_outside.pcapng`. The Linux PC is inside a NAT gateway using local addresses, the Windows PC is on a network outside the NAT

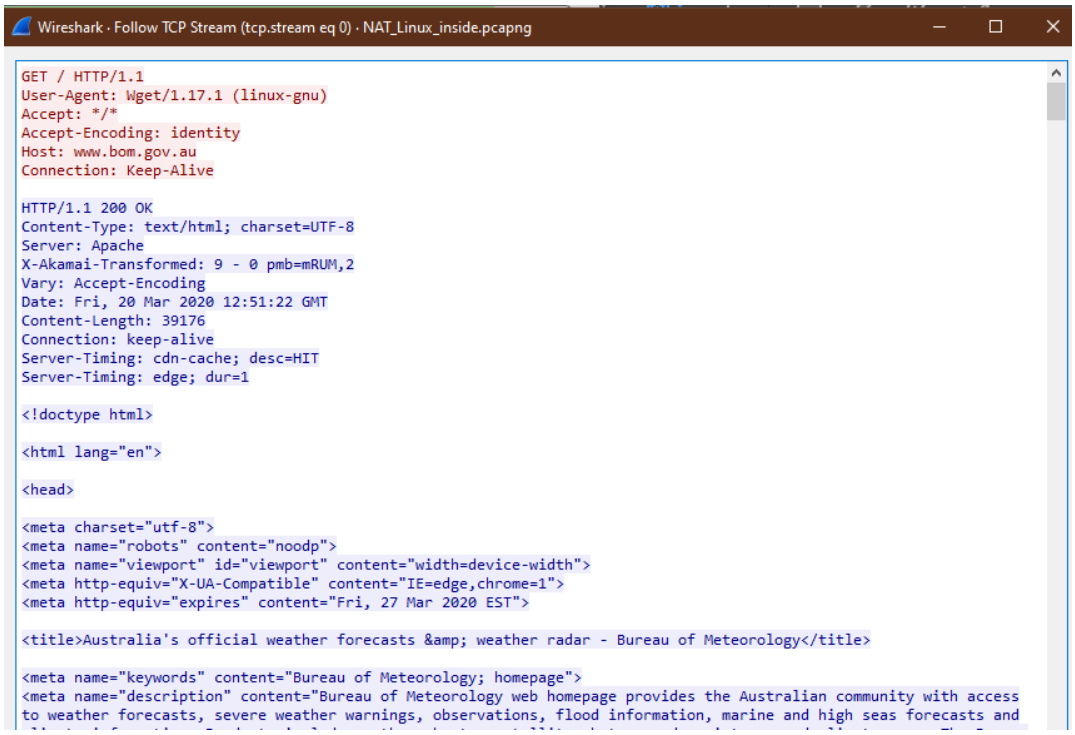
gateway using a different network. (In reality, there is antother NAT gateway between the Windows PC and the Internet.)

1. Run Wireshark, but don't select the active network connection.
2. Use the file menu to load NAT_Linux_inside.pcapng.
3. It will display a set of frames captured using **tcpdump** on Linux. This may be configured to produce a Wireshark compatible frame capture file.




4. Examine the first three segments in the TCP connection. Make sure to expand the flags section.
5. Note the use of the source and destination ports (45880 and 80). The destination port, 80, is the location of a Web Server listening for connections
6. The first segment is from the client to the server and will have the 'SYN' flag set (1) and a **relative** sequence number of zero (the actual sequence number is randomly assigned to assist in the prevention of session hijacking)
7. The second segment is from the server to the client and will have both the 'SYN' and 'ACK' flags set. The server will set a sequence number randomly (again with a relative value of zero) and acknowledge the SYN with an Acknowledgement of 1 (next expected sequence number)
8. The third segment is from the client to the server and has the 'ACK' flag set, a sequence number of 1 and acknowledges the next expected sequence number of 1 from the server.

9. These three segments are the **Three Way Handshake** that establishes a TCP connection.
10. Now that the TCP connection is established, the fourth segment is a HTTP get request from the client to the server
11. Frame number six is the beginning of the transfer of a web page from the server to the client. There is a jump in sequence numbers as some irrelevant frames have been filtered from the capture. Trace a number of frames and see the use of sequence numbers in both directions
12. With frame six selected, from the **analyze** menu, select **Follow TCP stream**. You will see a window pop up with the contents of the web page retrieved.




13. Close the pop up window and scroll to the end of the capture
14. Examine Segments 44 -> 47. This show the closing of a TCP connection. Segment 44 acknowledges the previous segment but also sets the **FIN** flag. The following two segments perform an Acknowledgement then a 'FIN' from the server end.
15. A final 'ACK' closes the connection.

## 4 Network Address Translation

1. Use Wireshark to open the second capture file
2. Use the file menu to load NAT_Windows_outside.pcapng
3. This file was captured on Windows outside a NAT gateway
4. Arrange the two Wireshark windows side-by-side
5. Compare the contents of the first few frames in both windows

6. First, the Linux inside capture

| | | | | | |
|---|---|---|---|---|---|
| 1 | 0.000000 | 192.168.75.129 | 23.215.164.221 | TCP | 74 45880 → 80 [SYN] Seq=0 Win=29200 |
| 2 | 0.036241 | 23.215.164.221 | 192.168.75.129 | TCP | 60 80 → 45880 [SYN, ACK] Seq=0 Ack=1 |
| 3 | 0.036264 | 192.168.75.129 | 23.215.164.221 | TCP | 54 45880 → 80 [ACK] Seq=1 Ack=1 Win= |
| 4 | 0.036332 | 192.168.75.129 | 23.215.164.221 | HTTP | 195 GET / HTTP/1.1 |
| 5 | 0.036460 | 23.215.164.221 | 192.168.75.129 | TCP | 60 80 → 45880 [ACK] Seq=1 Ack=142 Wi |
| 6 | 0.078922 | 23.215.164.221 | 192.168.75.129 | TCP | 1514 80 → 45880 [PSH, ACK] Seq=1 Ack=1 |
| 7 | 0.078937 | 192.168.75.129 | 23.215.164.221 | TCP | 54 45880 → 80 [ACK] Seq=142 Ack=1461 |
| 8 | 0.079120 | 23.215.164.221 | 192.168.75.129 | TCP | 1514 80 → 45880 [PSH, ACK] Seq=1461 Ac |
| 9 | 0.079126 | 192.168.75.129 | 23.215.164.221 | TCP | 54 45880 → 80 [ACK] Seq=142 Ack=2921 |
| 10 | 0.079470 | 23.215.164.221 | 192.168.75.129 | TCP | 1514 80 → 45880 [PSH, ACK] Seq=2921 Ac |
| 11 | 0.079485 | 192.168.75.129 | 23.215.164.221 | TCP | 54 45880 → 80 [ACK] Seq=142 Ack=4381 |
| 12 | 0.080101 | 23.215.164.221 | 192.168.75.129 | TCP | 2974 80 → 45880 [PSH, ACK] Seq=4381 Ac |

7. Next the Windows outside capture

| | | | | | |
|---|---|---|---|---|---|
| 1 | 0.000000 | 192.168.0.254 | 23.215.164.221 | TCP | 66 23936 → 80 [SYN] Seq=0 Win=64240 L |
| 2 | 0.035856 | 23.215.164.221 | 192.168.0.254 | TCP | 66 80 → 23936 [SYN, ACK] Seq=0 Ack=1 |
| 3 | 0.035922 | 192.168.0.254 | 23.215.164.221 | TCP | 54 23936 → 80 [ACK] Seq=1 Ack=1 Win=1 |
| 4 | 0.036216 | 192.168.0.254 | 23.215.164.221 | HTTP | 195 GET / HTTP/1.1 |
| 5 | 0.073133 | 23.215.164.221 | 192.168.0.254 | TCP | 60 80 → 23936 [ACK] Seq=1 Ack=142 Win |
| 6 | 0.078326 | 23.215.164.221 | 192.168.0.254 | TCP | 1514 80 → 23936 [ACK] Seq=1 Ack=142 Win |
| 7 | 0.078802 | 23.215.164.221 | 192.168.0.254 | TCP | 1514 80 → 23936 [ACK] Seq=1461 Ack=142 |
| 8 | 0.078855 | 192.168.0.254 | 23.215.164.221 | TCP | 54 23936 → 80 [ACK] Seq=142 Ack=2921 |
| 9 | 0.079183 | 23.215.164.221 | 192.168.0.254 | TCP | 1514 80 → 23936 [ACK] Seq=2921 Ack=142 |
| 10 | 0.079787 | 23.215.164.221 | 192.168.0.254 | TCP | 1514 80 → 23936 [ACK] Seq=4381 Ack=142 |
| 11 | 0.079788 | 23.215.164.221 | 192.168.0.254 | TCP | 1514 80 → 23936 [ACK] Seq=5841 Ack=142 |
| 12 | 0.079814 | 192.168.0.254 | 23.215.164.221 | TCP | 54 23936 → 80 [ACK] Seq=142 Ack=7301 |

8. Examine the IP addresses and port numbers expand the IP and TCP headers
9. The inside IP is **192.168.75.129** and the the inside port is **45880**
10. The outside IP is **192.168.0.254** and the outside port is **23936**. (Yes, this is a **Private IP address**, there's another NAT gateway out to the Internet. The Linux capture was performed in a VM with the hypervisor (Vmware) providing the NAT gateway. If you wanted to repeat the entire exercise yourself, install Wireshark on Ubuntu in a VM and perform simultaneous captures on the host OS as well as on Linux )
11. Examine segments and packets pairwise between the two captures. You will see that other than the re-written IPs and port numbers, the contents are identical and the end user would be unaware that NAT was in action.
12. The TCP sequence numbers are identical (although the TCP window size changes across the NAT gateway)
13. To confirm this, use Analyse->Follow TCP Stream in both Wireshark windows. Compare and you will see identical HTTP streams (including the User_Agent field identifying Wget as the client)

## 5 Summary

We have looked at a simple UDP datagram where the message is in a single packet and no setup is required. We have also looked at the establishment, operation and closing of a TCP connection to send a single HTML page. There is considerable overhead to establish a TCP connection, but it provides reliability and flow control for the connection. Lastly, we looked at the same TCP connection on either side of a NAT gateway and have seen that the contents of the connection are unaltered, only the IP and port numbers are rewritten.