ITS 332 Networking Lab

Wireshark

Dr Steven Gordon

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1 Overview

This lab will introduce you to an application for capturing traffic on networks. By "capturing", we mean record and view the details of every packet sent and received by the computer. The application is called *Wireshark*[1]. Packet capture applications are useful to inspect the details of the network operations being performed by your computer (and the network), thereby used to diagnose problems. We will use it in the remaining labs to understand how protocols work.

2 Background

The implementation of protocol layers in a network device (computer, router, switch, etc.) is done in a mix of hardware and software. Typically the Physical and Data Link layer are implemented in hardware, e.g. on an Ethernet LAN card. *Drivers* are special pieces of software that provide an interface from the operating system to a specific hardware device. That is, the Ethernet driver provides the functions for your operating system to receive Ethernet frames (and put them into memory) from your LAN card. The operating system normally implements the Network and Transport layers in software: that is, there is a software process that implements IP, as well as separate processes to implement UDP, TCP, ICMP and other transport layer protocols. Finally, each individual application (like web browsers, email clients, instant messaging clients) implement the Application layer protocols (such as HTTP and SMTP), as well as the user functionality and interface specific to that application. Figure 1 illustrates the layers and their implementation.

When a signal is received by your LAN card the signal is processed by the Physical and Data Link layers, and an Ethernet frame is passed to the operating system (via the Ethernet network driver). Normally the operating system will process the frame, sending it to the IP software process, which eventually sends the data to the transport layer protocol software process, which finally sends the data to your application.

In order to view all the frames received by your computer, we use special *packet capture* software, that allows all the Data Link layer frames sent from LAN card to operating system to be viewed by a normal application (in our case, Wireshark). The capturing of packets makes a copy of the exact packet receive by your computer—it does not modify the original packet. This allows us to analyse data received by the computer, in

[1] Previously it was called *Ethereal*

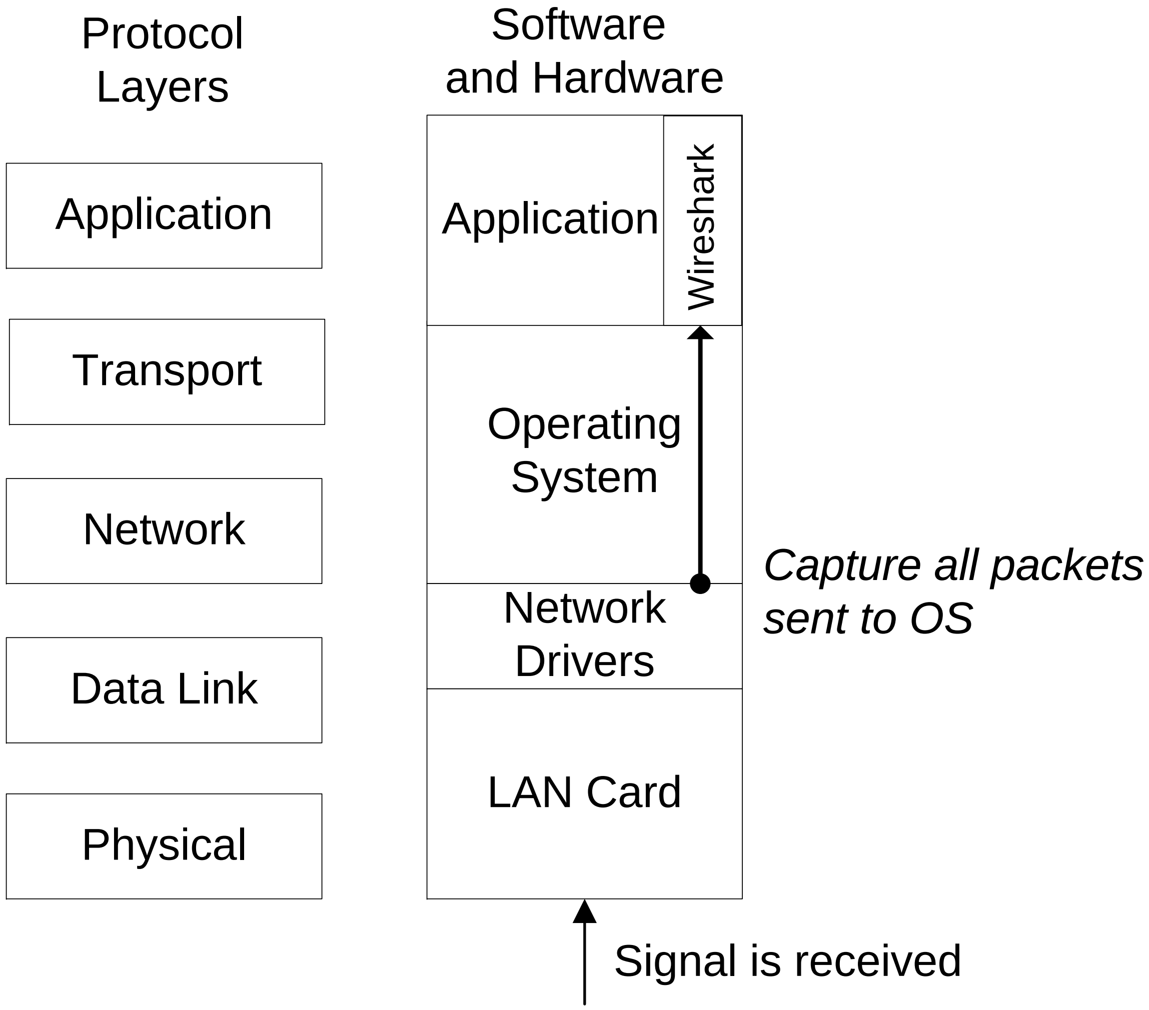


Figure 1: Capturing packets in the Operating System

order to perform various network management tasks (such as diagnose problems, measure performance, identify security leaks).

3 Wireshark

3.1 Starting Wireshark

To start Wireshark, go to the menu: *Applications→Internet* and select *Wireshark (as root)*. (It is important you select *Wireshark (as root)* instead of just *Wireshark* because you will then have the privileges to capture all traffic).

If the menu item is not available, then possibly Wireshark is not installed. Let the Lab Instructor know if this is the case - the instructor will explain how to install Wireshark.

3.2 Capturing Traffic

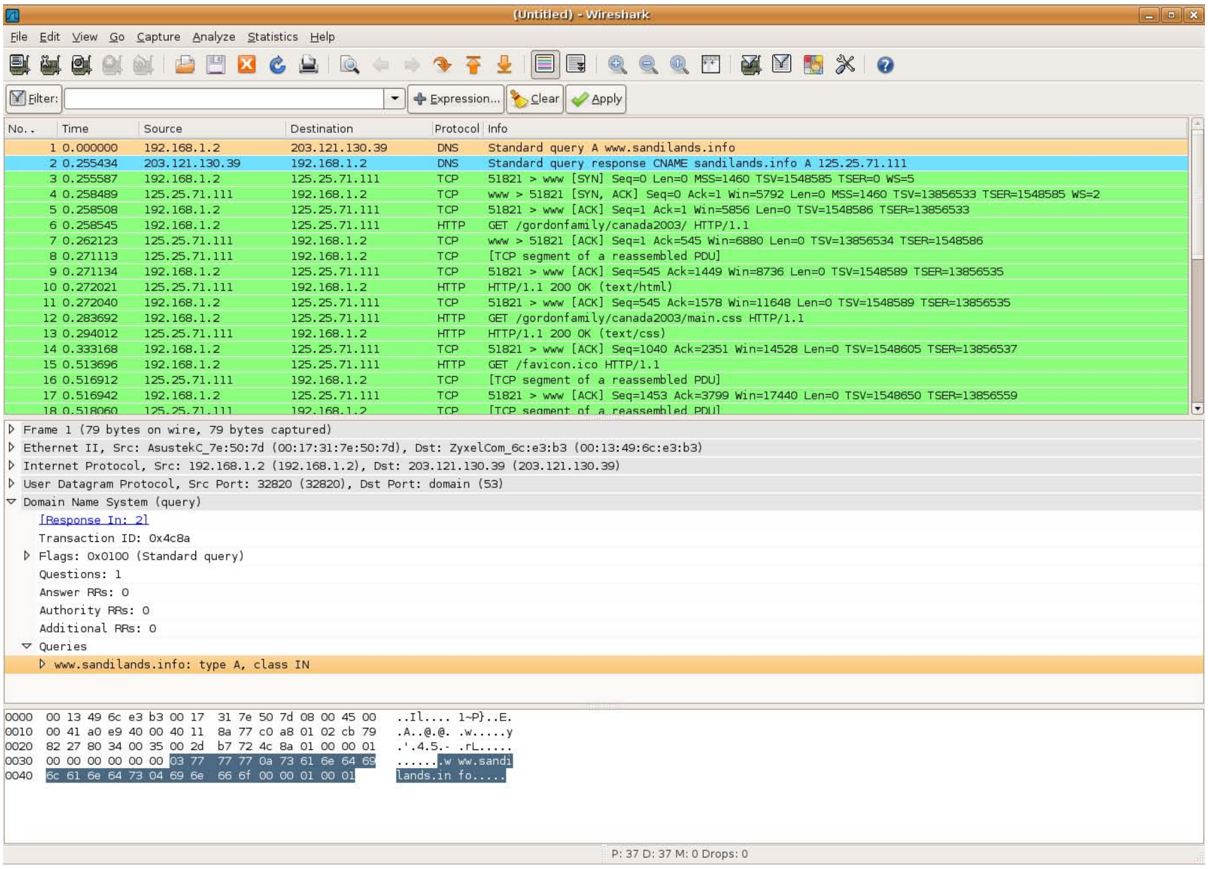
The first thing to do in order to capture traffic is to select the interface to capture on. Remember your computer has several interfaces: two Ethernet interfaces and a loopback interface. Go to the *Capture→Interfaces...* menu item in Wireshark and select your interface. You want an Ethernet interface (e.g. `eth2` or `eth3`) - the one that is currently connected to the network. Select the interface and press *Start*. This will start capturing traffic. You will see a window displayed that counts the different types of packets captured. Press the *Stop* button to end the packet capture.

3.3 Viewing Captured Traffic

After a packet capture has finished, the main Wireshark window shows the captured packets. The window is split into three sections:

1. The top section (packet list) showing the list of capture packets. Each packet has the following information:
   - Packet number (with respect to the total number of packets captured)
   - Time the packet is captured, assuming the time the first packet captured is time 0.0
   - The source and destination IP addresses of the packet
   - The highest layer protocol associated with the packet
   - Summary information about the information carried by the packet
2. The middle section (packet details) showing detailed information about the packet selected in the top section. This is separated based on the layers of the packet.
3. The bottom section (packet bytes) showing the hexadecimal and ascii representations of the packet data.

When selecting the first packet (in the top section), and then selecting the Domain Name System (in the middle section), the details of the packet are shown as below. It tells us that a DNS query request for `www.sandilands.info` has been sent from `192.168.1.2` to `203.121.130.39`. Other details of the packet (such as UDP, IP and Ethernet options) can be seen as well.



No.	Time	Source	Destination	Protocol	Info
1	0.000000	192.168.1.2	203.121.130.39	DNS	Standard query A www.sandilands.info
2	0.255434	203.121.130.39	192.168.1.2	DNS	Standard query response CNAME sandilands.info A 125.25.71.111
3	0.255587	192.168.1.2	125.25.71.111	TCP	51821 > www [SYN] Seq=0 Len=0 MSS=1460 TSV=1548585 TSER=0 WS=5
4	0.258489	125.25.71.111	192.168.1.2	TCP	www > 51821 [SYN, ACK] Seq=0 Ack=1 Win=5792 Len=0 MSS=1460 TSV=13856533 TSER=1548585 WS=2
5	0.258508	192.168.1.2	125.25.71.111	TCP	51821 > www [ACK] Seq=1 Ack=1 Win=5856 Len=0 TSV=1548586 TSER=13856533
6	0.258545	192.168.1.2	125.25.71.111	HTTP	GET /gordonfamily/canada2003/ HTTP/1.1
7	0.262123	125.25.71.111	192.168.1.2	TCP	www > 51821 [ACK] Seq=1 Ack=545 Win=6880 Len=0 TSV=13856534 TSER=1548586
8	0.271113	125.25.71.111	192.168.1.2	TCP	[TCP segment of a reassembled PDU]
9	0.271134	192.168.1.2	125.25.71.111	TCP	51821 > www [ACK] Seq=545 Ack=1449 Win=8736 Len=0 TSV=1548589 TSER=13856535
10	0.272021	125.25.71.111	192.168.1.2	HTTP	HTTP/1.1 200 OK (text/html)
11	0.272040	192.168.1.2	125.25.71.111	TCP	51821 > www [ACK] Seq=545 Ack=1578 Win=11648 Len=0 TSV=1548589 TSER=13856535
12	0.283692	192.168.1.2	125.25.71.111	HTTP	GET /gordonfamily/canada2003/main.css HTTP/1.1
13	0.294012	125.25.71.111	192.168.1.2	HTTP	HTTP/1.1 200 OK (text/css)
14	0.333168	192.168.1.2	125.25.71.111	TCP	51821 > www [ACK] Seq=1040 Ack=2351 Win=14528 Len=0 TSV=1548605 TSER=13856537
15	0.513696	192.168.1.2	125.25.71.111	HTTP	GET /favicon.ico HTTP/1.1
16	0.516912	125.25.71.111	192.168.1.2	TCP	[TCP segment of a reassembled PDU]
17	0.516942	192.168.1.2	125.25.71.111	TCP	51821 > www [ACK] Seq=1453 Ack=3799 Win=17440 Len=0 TSV=1548650 TSER=13856559
18	0.518060	125.25.71.111	192.168.1.2	TCP	[TCP segment of a reassembled PDU]

```
▷ Frame 1 (79 bytes on wire, 79 bytes captured)
▷ Ethernet II, Src: AsustekC_7e:50:7d (00:17:31:7e:50:7d), Dst: ZyxelCom_6c:e3:b3 (00:13:49:6c:e3:b3)
▷ Internet Protocol, Src: 192.168.1.2 (192.168.1.2), Dst: 203.121.130.39 (203.121.130.39)
▷ User Datagram Protocol, Src Port: 32820 (32820), Dst Port: domain (53)
▽ Domain Name System (query)
    [Response In: 2]
    Transaction ID: 0x4c8a
  ▷ Flags: 0x0100 (Standard query)
    Questions: 1
    Answer RRs: 0
    Authority RRs: 0
    Additional RRs: 0
  ▽ Queries
    ▷ www.sandilands.info: type A, class IN
```

```
0000  00 13 49 6c e3 b3 00 17  31 7e 50 7d 08 00 45 00   ..Il.... 1~P}..E.
0010  00 41 a0 e9 40 00 40 11  8a 77 c0 a8 01 02 cb 79   .A..@.@. .w.....y
0020  82 27 80 34 00 35 00 2d  b7 72 4c 8a 01 00 00 01   .'.4.5.- .rL.....
0030  00 00 00 00 00 00 03 77  77 77 0a 73 61 6e 64 69   .......w ww.sandi
0040  6c 61 6e 64 73 04 69 6e  66 6f 00 00 01 00 01      lands.in fo.....
```

Figure 2: Main window of Wireshark

3.4 Analysis and Statistics

Wireshark has many in-built statistics that allow you to analyse the captured packets. This is very useful, especially if you have many packets captured (1000's to millions). You should explore (that is, view them and try to understand what they show) the following from the *Statistics* menu:

- Summary
- Protocol Hierarchy
- Conversations
- Flow Graph
- HTTP
- Packet Length
- TCP Stream Graph

3.5 Filters

The example used above was for a small trace of less than 100 packets captured over 10 seconds. When capturing over a long time period (and hence thousands or hundreds of thousands of packets), it is often desirable to investigate a selected portion of the packets (for example, packets between certain pairs of hosts, or using a particular protocol). Hence filters can be applied during the packet capture (such that only packets that meet the specified criteria are captured - called *capture filters*) or after the capture (such that analysis is only performed on packets that meet the specified criteria - called *display filters*). There is no reason for you to use capture filters, instead you can use display filters.

Display filters are used mainly to view certain types of packets. They make analyzing the data easier. One place you can enter a display filter is just above the top (packet list) section. You can either type in the filter and press Apply or create the filter using the Expression command. Some example filters include:

The following filter can be used to display only packets that have source or destination IP address of `10.10.1.171`

```
ip.addr==10.10.1.171
```

The next filter can be used to display only packets that have IP address of `10.10.1.127` and do not have a TCP port address of 8080.

```
ip.addr==10.10.1.127 && !tcp.port==8080
```

The next filter displays only ICMP packets.

```
icmp
```

The next filter displays only packets exchanged with a web server (assuming the web server is using port 80).

```
tcp.port==80
```

Further details of the display filter language and where it can be applied can be found in the Wireshark manual.

4 Tasks

For all of the following tasks, make sure you have no applications running generating traffic on the network. That is, exit any instant messaging applications and close all web browsers that are not needed for the task.

For each task you should draw a diagram illustrating the exchange of packets observed in Wireshark, as well as answer the questions. As an example, a packet exchange should be illustrated as in Figure 3. A packet (including headers) should illustrate the headers at the Data Link layer and above (Network, Transport etc.). As an example, a packet should be illustrated as in Figure 4.

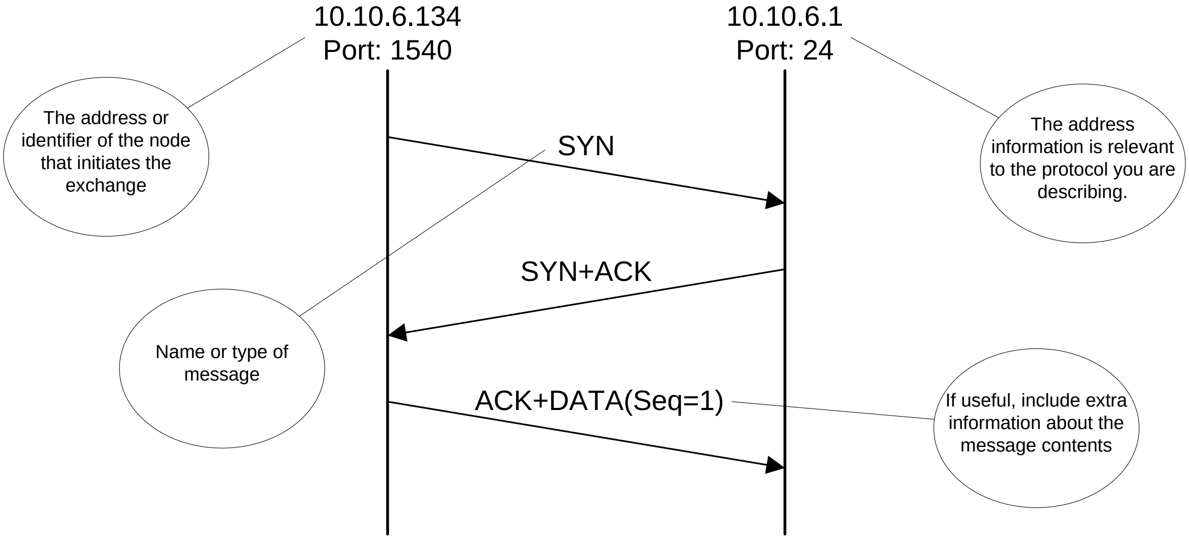

10.10.6.134
Port: 1540
10.10.6.1
Port: 24
The address or identifier of the node that initiates the exchange
SYN
The address information is relevant to the protocol you are describing.
SYN+ACK
Name or type of message
ACK+DATA(Seq=1)
If useful, include extra information about the message contents

Figure 3: Example illustrating an exchange of packets

IEEE 802.3	IP	TCP	HTTP	Data

Figure 4: Example illustrating a packet

4.1 Ping

Task 1. *Capture traffic of a ping from your computer to another computer on the network. Limit the ping to send only 3 requests. Draw the exchange of packets.*

Task 2. *What is the default interval between ping requests?*

Task 3. *Draw a ping request packet.*

Task 4. *What does the first byte in the ICMP header indicate? What are the possible values for the first byte in the ping messages you captured, and what do they indicate?*

Task 5. *What is the default amount of data sent in the ICMP packet? Do you think the results of ping will change if the data size was larger? If so, how (explain your answer)?*

Task 6. *What is the interval between each ping request and ping reply as recorded by Wireshark? How does this compare to the results shown by ping? If there is a difference, explain a possible reason.*

4.2 Web Access

Before performing the following tasks, make sure you delete all cached information in your browser (in Firefox, go to *Tools→Clear Private Data*).

Task 7. *Capture the traffic when you access* `http://ict.siit.tu.ac.th/~sgordon/its332/`*. Draw the exchange of packets.*

Task 8. *Explain what you see from the packet capture.*

Task 9. *View the Flow Graph for the exchange of packets (make sure you select* TCP Flow, *not* General Flow*). Check whether your diagram from Task 12 is correct.*

Task 10. *Record the following details: port number used by your web browser; size TCP data sent to web server; size of TCP data sent from web server to browser; the window advertised by the web server when sending the HTML page to the browser.*

Task 11. *Use the* Follow TCP Stream *analysis method to view the details of the HTTP request and response. Try to identify what the options in the HTTP request and response are used for.*

Task 12. *Now click on the link to* contact details. *Draw the exchange of packets and explain what you see from the capture.*

4.3 Web File Download

Again, your web browser is used (so clear the cache), but this time to download a binary file: the PDF handout for the lab Facilities (you can find it on the Handouts page for ITS332).

Task 13. *Capture the traffic when you access the Facilities PDF handout. You do not have to draw the exchange of packets.*

Task 14. *View the* Protocol Hierarchy *statistics. What is the TCP throughput (Mb/s) measured? What is the total number of bytes transferred? What is the size of the large binary file? What is the efficiency of the data file download?*

Task 15. *View the* Packet Length *statistics. What are the ranges of the two most common packet lengths? What do you think these two ranges represent (that is, what type of packets)?*

Task 16. *What is the most common size of data sent in a TCP segment? Give a reason why the segment may be limited to this size.*

A Notes

Record any additional notes from this lab here (e.g. important points made by the instructor, summary of things you learned, mistakes you made). You should use this in future labs, as well as in preparation for assessment items like exams.