

Packet Capture **Wireshark**

Fakrul Alam and Yoshinobu Matsuzaki

Why we need to capture packet & how it's related to security?

- Hosts send and receive packets to communicate with each others. When you have network related issues, sometimes it's necessary to **see the actual packets to troubleshoot.**
- And also it helps to **understand protocols and devices' behaviors**

tcpdump Definition

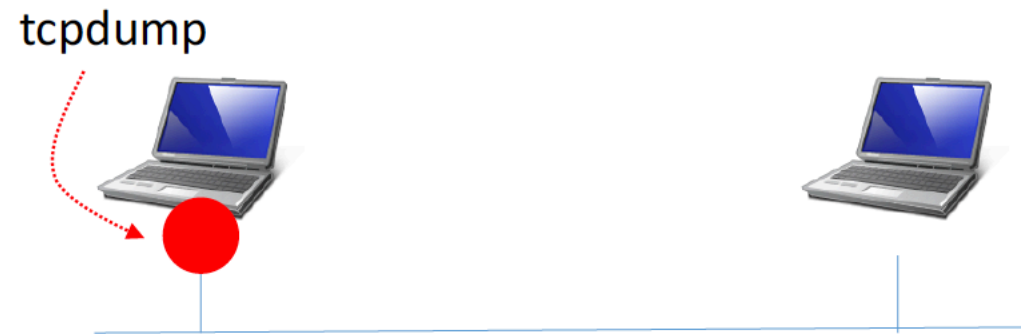
- tcpdump is a utility used to capture and analyze packets on network interfaces.
- Details about these packets can either be displayed to the screen or they can be saved to a file for later analysis.
- tcpdump utilizes the libpcap library for packet capturing.
- And there are variant of the software
 - Wireshark

What you can see

Packets arrived on your network interface

Packets to/from the host

Unicast, Multicast, Broadcast



You might not see others' communication

tcpdump command example

```
# tcpdump -nni eth0
# tcpdump -nni eth0 host 10.10.10.10
# tcpdump -nni eth0 dst host 10.10.10.10 and tcp
# tcpdump -nni eth0 src net 10.10.10.0/24 and tcp and portrange 1-1024
```

-nn = don't use DNS to resolve IPs and display port no

-i = interface to watch

dst = watch only traffic destined to a net, host or port

src = watch only traffic whose src is a net, host or port

net = specifies network

host = specifies host

port = specifies a port

proto = protocol ie tcp or udp

tcpdump command example

```
# tcpdump -nni eth0 -s0
```

```
# tcpdump -nni eth0 not port 22 -s0 -c 1000 -v
```

```
# tcpdump -nni eth0 not port 22 and dst host 10.10.10.10 and not src  
net 10.20.30.0/24
```

-s = packet length to be captured

-s0 = setting samples length to 0 means use the required length to catch whole packet

-c = number of packets

-v = print a more verbose description

tcpdump pcaps

```
# tcpdump -nni eth0 -w capture.pcap -vv -c 1000
```

```
# tcpdump -nni eth0 -r capture.pcap port 80
```

-w capture.pcap = save capture packet to capture.pcap

-vv = display number of packet captured

-r capture.pcap = read capture file

-c = number of packets

tcpdump Output

```
IP 199.59.148.139.443 > 192.168.1.8.54343: Flags [P.], seq 53:106,  
ack 1, win 67, options [nop,nop,TS val 854797891 ecr 376933204],  
length 53
```

```
IP 192.168.1.8.54343 > 199.59.148.139.443: Flags [.], ack 106, win  
4092, options [nop,nop,TS val 376934736 ecr 854797891], length 0
```

```
IP 199.59.148.139.443 > 192.168.1.8.54343: Flags [P.], seq 106:159,  
ack 1, win 67, options [nop,nop,TS val 854797891 ecr 376933204],  
length 53
```

```
IP 192.168.1.8.54343 > 199.59.148.139.443: Flags [.], ack 159, win  
4091, options [nop,nop,TS val 376934736 ecr 854797891], length 0
```


What is Wireshark?

- Wireshark is a network packet/protocol analyzer.
 - A network packet analyzer will try to capture network packets and tries to display that packet data as detailed as possible.
- Wireshark is perhaps one of the best open source packet analyzers available today for **UNIX** and **Windows**.

Wireshark

- Yet another packet capturing and analysis software
- GUI
- It can handle the tcpdump file format (pcap)
- You can analyze packets which is captured on a remote server using tcpdump

About Wireshark

- Formerly known as “Ethereal”
 - Author, Gerald Combs quit Network Integration Services
 - Free
- <https://www.wireshark.org/>

Packages for Windows and MacOS are available

Most UNIX system has own package of Wireshark

- Requirement on windows
 - Need to install winpcap
 - Latest wireshark installer contains winpcap, don't worry
 - (On Windows Vista) Need Administrator Privilege to capture

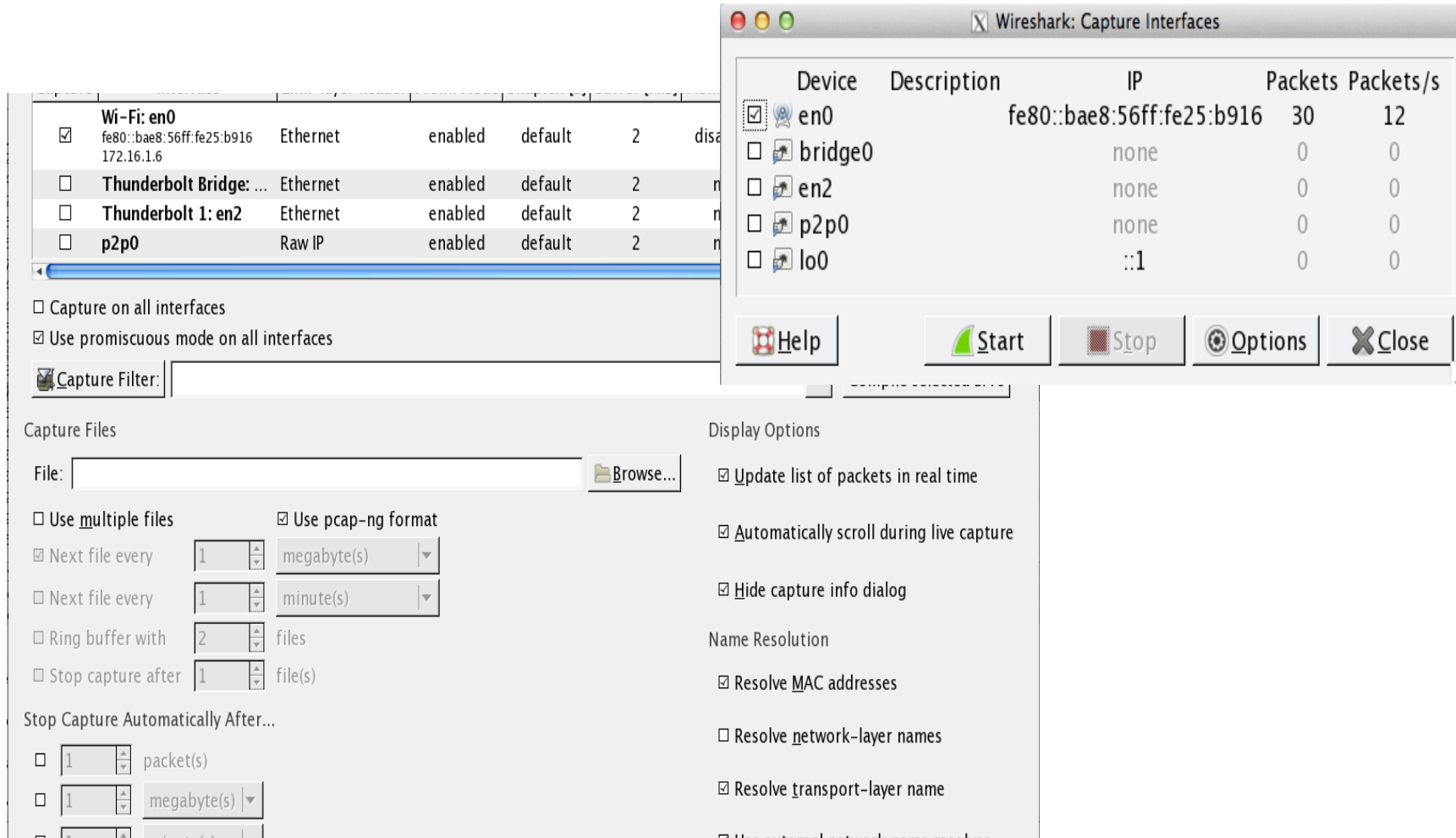
Why Wireshark

- network administrators use it to **troubleshoot network problems**
- network security engineers use it to **examine security problems**
- developers use it to **debug protocol implementations**
- people use it to **learn network protocol** internals
- Wireshark isn't an intrusion detection system.
- Wireshark will not manipulate things on the network, it will only "measure" things from it.

How to Install

- Very straight forward
- Just double-click and follow the instructions.

Capture



Dashboard

File Edit View Go Capture Analyze Statistics Telephony Tools Internals Help

Filter: Expression... Clear Apply Save

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	173.194.38.136	172.16.1.6	TLSv1.2	119	Application Data
2	0.000098000	172.16.1.6	173.194.38.136	TCP	54	49419 > https [ACK] Seq=1 Ack=66 Win=16379 Len=0
3	0.000801000	173.194.38.136	172.16.1.6	TLSv1.2	99	Application Data
4	0.000805000	173.194.38.136	172.16.1.6	TCP	54	https > 49419 [FIN, ACK] Seq=111 Ack=1 Win=661 Len=0
5	0.000890000	172.16.1.6	173.194.38.136	TCP	54	49419 > https [ACK] Seq=1 Ack=111 Win=16381 Len=0
6	0.000891000	172.16.1.6	173.194.38.136	TCP	54	49419 > https [ACK] Seq=1 Ack=112 Win=16381 Len=0
7	0.001069000	172.16.1.6	173.194.38.136	TCP	54	49419 > https [FIN, ACK] Seq=1 Ack=112 Win=16384 Len=0
8	0.085171000	173.194.38.136	172.16.1.6	TCP	54	https > 49419 [ACK] Seq=112 Ack=2 Win=661 Len=0
9	0.094660000	172.16.1.6	173.194.117.105	TLSv1.2	867	Application Data
10	0.094797000	172.16.1.6	173.194.117.105	TCP	1484	[TCP segment of a reassembled PDU]
11	0.094814000	172.16.1.6	173.194.117.105	TLSv1.2	853	Application Data
12	0.177621000	173.194.117.105	172.16.1.6	TCP	66	https > 49424 [ACK] Seq=1 Ack=802 Win=661 Len=0 TSval=3785855858 TSecr=765825879
13	0.178644000	173.194.117.105	172.16.1.6	TCP	66	https > 49424 [ACK] Seq=1 Ack=2220 Win=661 Len=0 TSval=3785855860 TSecr=765825879
14	0.179049000	173.194.117.105	172.16.1.6	TCP	66	https > 49424 [ACK] Seq=1 Ack=3007 Win=661 Len=0 TSval=3785855860 TSecr=765825879
15	0.204537000	172.16.1.3	172.16.1.255	BJNP	58	Scanner Command: Unknown code (2)
16	0.205484000	172.16.1.3	224.0.0.1	BJNP	58	Scanner Command: Unknown code (2)
17	0.370673000	173.194.117.105	172.16.1.6	TLSv1.2	123	Application Data
18	0.370771000	172.16.1.6	173.194.117.105	TCP	66	49424 > https [ACK] Seq=3007 Ack=58 Win=8188 Len=0 TSval=765826153 TSecr=378585605
19	0.370988000	173.194.117.105	172.16.1.6	TLSv1.2	196	Application Data

Packet 19: 196 bytes on wire (1576 bits), 79 bytes captured (632 bits) on interface 0

Ethernet II, Src: Apple_25:b9:16 (b8:e8:56:25:b9:16), Dst: Netgear_a5:25:96 (c0:3f:0e:a5:25:96)

Internet Protocol Version 4, Src: 172.16.1.6 (172.16.1.6), Dst: 66.195.95.174 (66.195.95.174)

Version: 4

Header Length: 20 bytes

Differentiated Services Field: 0x10 (DSCP 0x04: Unknown DSCP; ECN: 0x00: Not-ECT (Not ECN-Capable Transport))

Total Length: 58

Identification: 0x33b8 (13240)

Flags: 0x02 (Don't Fragment)

Fragment offset: 0

Time to live: 64

Protocol: TCP (6)

0000	e0 3f 0e a5 25 96 b8 e8 56 25 b9 16 08 00 45 10	...	...
0010	00 3a 33 b8 40 00 40 06 b7 6e ac 10 01 06 42 c3	...	...
0020	5f ae c1 27 00 17 47 46 90 1f 8c 0e 0c 7c 80 18	...	...
0030	20 00 9d 70 00 00 01 01 08 0a 2d a5 d2 59 74 36	...	...
0040	71 03 72 76 69 65 77 73	...	...

Menu

Filter

Capture Data

Raw Data

Filters

- Capture filter
 - Capture Traffic that match capture filter rule
 - save disk space
 - prevent packet loss
- Display filter
- Tweak appearance

Apply Filters

- `ip.addr == 10.0.0.1` [Sets a filter for any packet with 10.0.0.1, as either the source or dest]
- `ip.addr==10.0.0.1 && ip.addr==10.0.0.2` [sets a conversation filter between the two defined IP addresses]
- `http or dns` [sets a filter to display all http and dns]
- `tcp.port==4000` [sets a filter for any TCP packet with 4000 as a source or dest port]
- `tcp.flags.reset==1` [displays all TCP resets]
- `http.request` [displays all HTTP GET requests]
- `tcp contains rviews` [displays all TCP packets that contain the word 'reviews'. Excellent when searching on a specific string or user ID]
- `!(arp or icmp or dns)` [masks out arp, icmp, dns, or whatever other protocols may be background noise. Allowing you to focus on the traffic of interest]

Follow TCP Stream

The image shows the Wireshark network protocol analyzer interface. The main packet list pane displays a series of captured packets. Packet 118, at time 16.275298000, is selected. A right-click context menu is open over this packet, with the 'Follow TCP Stream' option highlighted in blue. Other menu options include 'Mark Packet (toggle)', 'Ignore Packet (toggle)', 'Set Time Reference (toggle)', 'Time Shift...', 'Packet Comment...', 'Manually Resolve Address', 'Apply as Filter', 'Prepare a Filter', 'Conversation Filter', 'Colorize Conversation', 'SCTP', 'Copy', 'Protocol Preferences', 'Decode As...', 'Print...', and 'Show Packet in New Window'. The packet details pane below shows the structure of packet 118: Ethernet II, Internet Protocol Version 4, Transmission Control Protocol, and Telnet. The packet bytes pane at the bottom shows the raw hex and ASCII data.

No.	Time	Source	Destination	Protocol	Length	Info
111	14.339156000	172.16.1.3	224.0.0.1	BJNP	58	Scanner Command: Unknown code (2)
112	15.352153000	172.16.1.6	202.4.97.11	SIP	767	Request: PUBLISH sip:09611033085@202.4.97.11;transport=UDP |
113	15.352381000	172.16.1.6	82.129.27.63	CLASSIC-S	70	Message: Binding Request
114	15.352412000	172.16.1.6	202.4.97.11	SIP	996	Request: REGISTER sip:202.4.97.11;transport=UDP |
115	15.352436000	172.16.1.6	202.4.97.11	UDP	46	Source port: 52696 Destination port: sip
116	15.359213000	202.4.97.11	172.16.1.6	SIP	573	Status: 200 OK (1 bindings) |
117	15.773121000	82.129.27.63	172.16.1.6	CLASSIC-S	130	Message: Binding Response
118	16.275298000	172.16.1.6	66.195.95.174	TELNET	72	Frame 118: 72 bytes on wire (576 bits), 72 bytes captured (576 bits) on interface 0
119	16.806218000	66.195.95.174	172.16.1.6	TELNET	72	Ethernet II, Src: Apple_25:b9:16 (b8:e8:56:25:b9:16), Dst: Netgear_a5:25:96 (c0:3f:0e:a5:25:96)
120	16.806322000	172.16.1.6	66.195.95.174	TCP	60	Internet Protocol Version 4, Src: 172.16.1.6 (172.16.1.6), Dst: 66.195.95.174 (66.195.95.174)
121	17.112570000	172.16.1.6	66.195.95.174	TELNET	72	Transmission Control Protocol, Src Port: 49447 (49447), Dst Port: telnet (23), Seq: 273, Win: 0, Len: 0
122	17.616299000	66.195.95.174	172.16.1.6	TELNET	72	Telnet
123	17.616389000	172.16.1.6	66.195.95.174	TCP	60	Ethernet II, Src: Apple_25:b9:16 (b8:e8:56:25:b9:16), Dst: Netgear_a5:25:96 (c0:3f:0e:a5:25:96)
124	18.025688000	66.195.95.174	172.16.1.6	TELNET	72	Internet Protocol Version 4, Src: 172.16.1.6 (172.16.1.6), Dst: 66.195.95.174 (66.195.95.174)
125	18.025773000	172.16.1.6	66.195.95.174	TCP	60	Transmission Control Protocol, Src Port: 49447 (49447), Dst Port: telnet (23), Seq: 273, Win: 0, Len: 0
126	19.709711000	172.16.1.6	66.195.95.174	TELNET	72	Telnet
127	19.711165000	173.194.38.150	172.16.1.6	TLSv1.2	100	Ethernet II, Src: Apple_25:b9:16 (b8:e8:56:25:b9:16), Dst: Netgear_a5:25:96 (c0:3f:0e:a5:25:96)
128	19.711240000	172.16.1.6	173.194.38.150	TCP	60	Internet Protocol Version 4, Src: 172.16.1.6 (172.16.1.6), Dst: 173.194.38.150 (173.194.38.150)
129	20.278535000	66.195.95.174	172.16.1.6	TCP	60	Transmission Control Protocol, Src Port: 49447 (49447), Dst Port: telnet (23), Seq: 273, Win: 0, Len: 0

Frame 118: 72 bytes on wire (576 bits), 72 bytes captured (576 bits) on interface 0

Ethernet II, Src: Apple_25:b9:16 (b8:e8:56:25:b9:16), Dst: Netgear_a5:25:96 (c0:3f:0e:a5:25:96)

Internet Protocol Version 4, Src: 172.16.1.6 (172.16.1.6), Dst: 66.195.95.174 (66.195.95.174)

Transmission Control Protocol, Src Port: 49447 (49447), Dst Port: telnet (23), Seq: 273, Win: 0, Len: 0

Telnet

0000 c0 3f 0e a5 25 96 b8 e8 56 25 b9 16 08 00 45 10 .?..%...V%...E.
0010 00 3a 33 b8 40 00 40 06 b7 6e ac 10 01 06 42 c3 .:3.@.@.n...B.
0020 5f ae c1 27 00 17 47 46 90 1f 8c 0e 0c 7c 80 18 _...GF.....|..
0030 20 00 9d 70 00 00 01 01 08 0a 2d a5 d2 59 74 36 .p.....Yt6
0040 71 03 72 76 69 65 77 73 q.rviews

Follow TCP Stream

- Build TCP Stream
 - Select TCP Packet -> Follow TCP Stream



```
Stream Content
168.215.52.9.Chicago, IL
..168.215.52.32.Dallas, TX
..168.215.52.192.Denver, CO
..168.215.53.186.Los Angeles, CA
..168.215.52.197.Oakland, CA
..168.215.52.203.Seattle, WA

This route-server should not be used to measure network performance.
High CPU utilization on this device causes unreliable results from
ping and traceroute.

For questions about this route-server, email: support@twtelecom.net

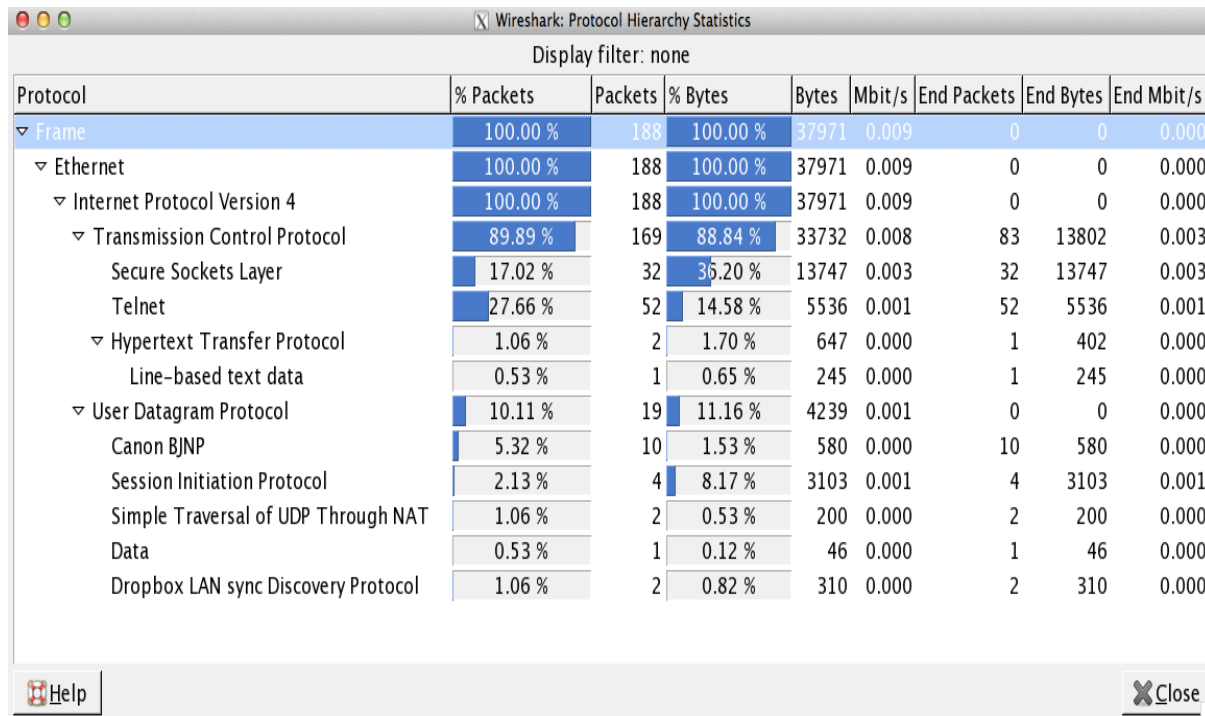
Login with username 'rviews' and password 'rviews123'

***** route-server.twtelecom.net *****

.
route-server (tty1)
.
.
Password:rviews123
.
Login incorrect
login: rviewsrviews
.
Password:rviews123
.
--- JUNOS 8.3R4.3 built 2008-02-24 20:35:04 UTC
```

Use “Statistics”

- What protocol is used in your network
 - Statistics -> Protocol Hierarchy



Wireshark: Protocol Hierarchy Statistics

Display filter: none

Protocol	% Packets	Packets	% Bytes	Bytes	Mbit/s	End Packets	End Bytes	End Mbit/s
▼ Frame	100.00 %	188	100.00 %	37971	0.009	0	0	0.000
▼ Ethernet	100.00 %	188	100.00 %	37971	0.009	0	0	0.000
▼ Internet Protocol Version 4	100.00 %	188	100.00 %	37971	0.009	0	0	0.000
▼ Transmission Control Protocol	89.89 %	169	88.84 %	33732	0.008	83	13802	0.003
Secure Sockets Layer	17.02 %	32	36.20 %	13747	0.003	32	13747	0.003
Telnet	27.66 %	52	14.58 %	5536	0.001	52	5536	0.001
▼ Hypertext Transfer Protocol	1.06 %	2	1.70 %	647	0.000	1	402	0.000
Line-based text data	0.53 %	1	0.65 %	245	0.000	1	245	0.000
▼ User Datagram Protocol	10.11 %	19	11.16 %	4239	0.001	0	0	0.000
Canon BJNP	5.32 %	10	1.53 %	580	0.000	10	580	0.000
Session Initiation Protocol	2.13 %	4	8.17 %	3103	0.001	4	3103	0.001
Simple Traversal of UDP Through NAT	1.06 %	2	0.53 %	200	0.000	2	200	0.000
Data	0.53 %	1	0.12 %	46	0.000	1	46	0.000
Dropbox LAN sync Discovery Protocol	1.06 %	2	0.82 %	310	0.000	2	310	0.000

Help Close

Use “Statistics”

- Which host most chatty
 - Statistics -> Conversations

Conversations: Wi-Fi: en0

Ethernet: 3 | Fibre Channel | FDDI | IPv4: 14 | IPv6 | IPX | JXTA | NCP | RSVP | SCTP | TCP: 8 | Token Ring | UDP: 14 | USB | WLAN

IPv4 Conversations

Address A	Address B	Packets	Bytes	Packets A→B	Bytes A→B	Packets A←B	Bytes A←B	Rel Start	Duration	bps A→B	bps A←B
172.16.1.6	173.194.38.136	8	542	4	216	4	326	0.000000000	0.0852	20288.60	306.0
172.16.1.6	173.194.117.105	36	12 105	18	10 215	18	1 890	0.094660000	10.2695	7957.54	14.0
172.16.1.3	172.16.1.255	5	290	5	290	0	0	0.204537000	28.2675	82.07	
172.16.1.3	224.0.0.1	5	290	5	290	0	0	0.205484000	28.2675	82.07	
172.16.1.6	173.194.38.150	23	8 733	12	6 654	11	2 079	2.100977000	17.6103	3022.78	9.0
66.195.95.174	172.16.1.6	84	7 668	37	4 230	47	3 438	3.777726000	29.8142	1135.03	9.0
172.16.1.6	202.4.97.11	5	3 149	4	2 576	1	573	6.708171000	8.6510	2382.14	
108.160.162.108	172.16.1.6	4	779	2	311	2	468	7.035072000	0.3396	7327.32	110.0
108.160.166.139	172.16.1.6	4	301	2	169	2	132	10.037002000	0.0010	1290076.34	10076.0
82.129.27.63	172.16.1.6	2	200	1	130	1	70	15.352381000	0.4207	N/A	
172.16.1.6	199.16.156.48	2	170	1	66	1	104	20.688040000	0.0001	N/A	
69.171.235.16	172.16.1.6	8	3 434	4	1 234	4	2 200	25.400490000	1.7128	5763.56	102.0
172.16.1.6	255.255.255.255	1	155	1	155	0	0	25.726302000	0.0000	N/A	
172.16.1.6	172.16.1.255	1	155	1	155	0	0	25.726700000	0.0000	N/A	

☒ Name resolution ☐ Limit to display filter

Help Copy

Follow Stream Graph A→B Graph B→A Close

Need CLI?

- If you stick to character based interface, try tshark.exe
- C:\program files\wireshark\tshark.exe

Tcpdump & Wireshark

- `tcpdump -i <interface> -s 65535 -w <some-file>`
 - `-s <snaplen>`: amount of bytes captures for each packet
 - `-w <some-file>`: write the raw packets to a file

Exercise

- Install Wireshark into your PC
- Or, you can use VM (tcpdump)

\$ ssh workshop@10.0.0.x

Note: x is your group#

Note: password is iij/2497

- Run wireshark and Capture inbound/outbound traffic
- Download capture files from <https://github.com/randyqx/apricot-sec2019>
 - 2-2-2.WiresharkExerciseData.zip

Exercise 1: Good Old Telnet

- File
 - telnet.pcap
- Question
 - Reconstruct the telnet session.
- Q1: Who logged into 192.168.0.1
 - Username _____, Password _____ .
- Q2: After logged in what did the user do?
 - Tip
 - telnet traffic is not secure

Exercise 2: Massive TCP SYN

- File
 - massivesyn1.pcap and massivesyn2.pcap
- Question
 - Point the difference between them.
- Q1: massivesyn1.pcap is a _____ attempt.
- Q2: massivesyn2.pcap is a _____ attempt.
- Tip
 - Pay attention to Src IP

Exercise 3: Chatty Employees

- File
 - chat.dmp
- Question
- Q1: What kind of protocol is used? _____
- Q2: This is a conversation between _____@hotmail.com and [@hotmail.com](#)
- Q3: What do they say about you(sysadmin)?
- Tip
 - Your chat can be monitored by network admin.

Exercise 4: Suspicious FTP activity

- File
 - [ftp1.pcap](#)
- Question
 - Q1: 10.121.70.151 is FTP _____ .
 - Q2: 10.234.125.254 is FTP _____ .
 - Q3: FTP Err Code 530 means _____ .
 - Q4: 10.234.125.254 attempt _____.
- Tip
 - How many login error occur within a minute?

Exercise 5: Unidentified Traffic

- File
 - Foobar.pcap
- Question
 - Q1: see what's going on with wireshark gui
 - Statistics -> Conversation List -> TCP (*)
 - Q2: Which application use TCP/6346? Check the web.

Exercise 6: Covert channel

- File
 - covertinfo.pcap
- Question
 - Take a closer look! This is not a typical ICMP Echo/Reply...
 - Q1: What kind of tool do they use? Check the web.
 - Q2: Name other application which tunnel user traffic.

Exercise 7: Analyze Malware

- File
 - malware.pcap
- Questions:
 - Q1: Find the bad HTTP traffic
 - Q2: Is there any malware in the HTTP traffic?
 - Q3: Upload one sample malware to <https://www.virustotal.com/>
 - Does all antivirus detect the malware?
- Tips
 - Filter with **http contains "in DOS mode"**
 - Export all the files

Exercise 8: SIP

- File
 - sip_chat.pcap
- Questions:
 - Q1: Can we listen to SIP voice?
 - Q2: How!!

Exercise 9: Your telnet

- Capture your telnet session to VM
 - PuTTY can telnet
 - Host Name: 10.0.0.x
 - Select Telnet
- Login: workshop
- Password: iij/2497
- Look at the captured data

Exercise 10: Your ssh

- Capture your ssh session to VM
 - \$ ssh [workshop@10.0.0.x](#)
 - password is iij/2497 (or key-based authentication)
- Look at the captured data