



DIRECT DEFENSE

Introduction to Network Traffic Analysis

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BE INFORMED. BE STRATEGIC. BE SECURE.



Overview

- Part 1: The Basics
- Part 2: Tools
- Part 3: Common Protocols
- Part 4: Scapy
- Part 5: Analysis Tips
- Part 6: Practical Exercise



Part 1 – The Basics

Overview

Part 1 – The Basics

- OSI & TCP/IP Model Overview
- Hexadecimal Numbers
- Binary Numbers
- Ethernet Headers
- IP Headers
- TCP Headers
- UDP Headers
- ICMP Headers

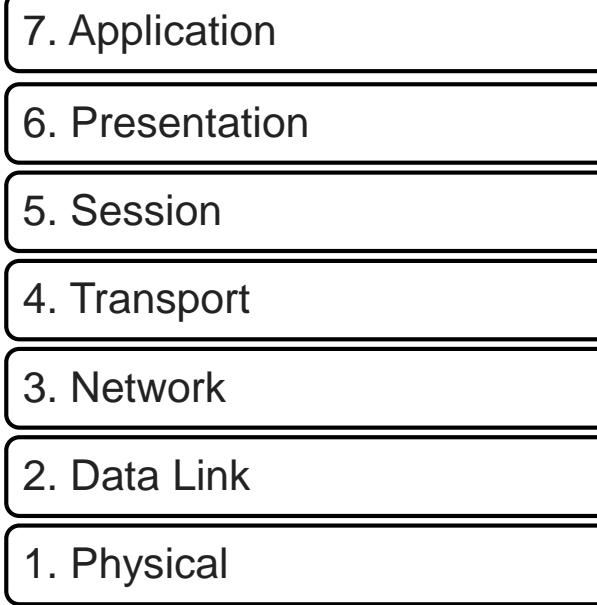


Why Bother with Packet Analysis?

- Faster than host-based forensics
- Investigate networking alerts
- Troubleshoot networking issues
- Tell if tools are working
- Reverse engineer protocols



The OSI Model



The TCP/IP Model

7. Application

6. Presentation

5. Session

4. Transport

3. Network

2. Data Link

1. Physical

4. Application

3. Transport

2. Internet

1. Network Access



Encapsulation

Example encapsulated HTTP request



Decimal in a New Light

8080

$10^3 | 10^2 | 10^1 | 10^0$

$$10^0 = 1$$

$$10^1 = 10$$

$$10^2 = 100$$

$$10^3 = 1000$$

$$10^4 = 10000$$



Hexadecimal Numbers

- Base 16 (normal counting is decimal, base 10)
- Decimal to Hex : Divide by powers of 16, ignore remainders
- Hex to Decimal : Multiply by powers of 16
- Prefixed by 0x



Counting in Hex

Decimal	Hex
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8

Decimal	Hex
9	9
10	A
11	B
12	C
13	D
14	E
15	F
16	10



Decimal to Hex Conversion

$$8080/4096 = 1.\text{xxxx}$$

$$8080 - (4096 * 1) = 3984$$

$$3984/256 = 15.\text{xxxx}$$

$$3984 - (15 * 256) = 144$$

$$144/16 = 9.0$$

$$16^0 = 1$$

$$16^1 = 16$$

$$16^2 = 256$$

$$16^3 = 4096$$

$$16^4 = 65536$$

1 F 9 0

$16^3 | 16^2 | 16^1 | 16^0$



Hex to Decimal Conversion

1 F 9 0

$16^3 | 16^2 | 16^1 | 16^0$

$$1(4096) + 15(256) + 9(16) + 0(1) = ?$$

$$4096+3840+144+0 = 8080$$

$$16^0 = 1$$

$$16^1 = 16$$

$$16^2 = 256$$

$$16^3 = 4096$$

$$16^4 = 65536$$



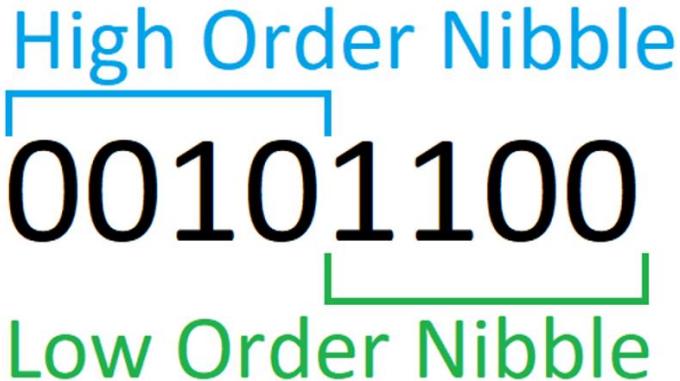
Binary Numbers

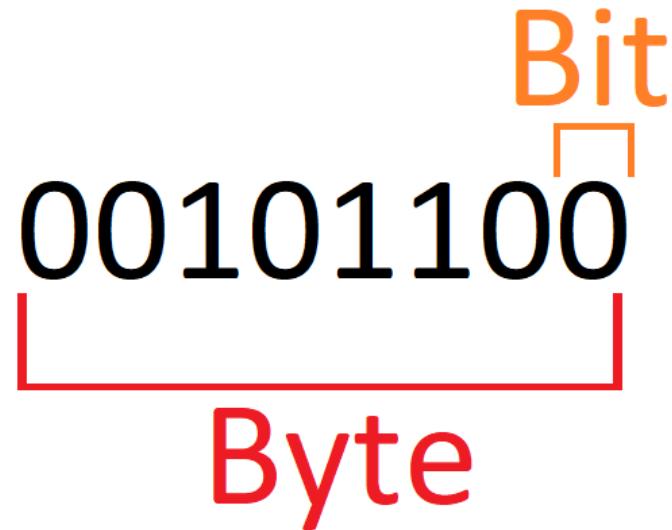
- Base 2
- Decimal to Binary : Divide by powers of 2, ignore remainders
- Binary to Decimal : Multiply by powers of 2
- Hex to Binary : Direct conversion of bytes to bits
- Binary to Hex : Direct conversion of bits to bytes



Bits, Bytes, and Nibbles

- A bit is a single binary number, 1 or 0
- A byte is 8 bits
- A nibble is 4 bits

High Order Nibble

00101100
Low Order Nibble

Bit

00101100
Byte



Counting in Binary

Decimal	Hex	Binary	Decimal	Hex	Binary
1	1	0001	9	9	1001
2	2	0010	10	A	1010
3	3	0011	11	B	1011
4	4	0100	12	C	1100
5	5	0101	13	D	1101
6	6	0110	14	E	1110
7	7	0111	15	F	1111
8	8	1000	16	10	00010000



Hex to Binary

1F90=

0001 1111 1001 0000

1 = 0001

F = 1111

9 = 1001

0 = 0000



Hex Bytes and Nibbles

- Nibble is a single hex digit
- Byte is two hex digits

Nibble
1F90
Byte



Words

- A word is 2 bytes (16 bits)
- A double-word is 4 bytes (32 bits)
- Often done in hex

Word
DEAD BEEF
Double Word



Knowledge Check

- Convert CAFE to decimal
- Convert 7A69 to binary
 - What is the high order nibble of the low order byte in binary?
 - What is the low order nibble of the high order byte in hex?



Knowledge Check - Answers

- Convert CAFE to decimal – C=12, A=10, F=15, E=14

$$12(16^3) + 10(16^2) + 15(16^1) + 14(16^0) =$$

$$12 \cdot 4096 + 10 \cdot 256 + 15 \cdot 16 + 14 = 51966$$

- Convert 7A69 to binary – 0111 1010 0110 1001

- What is the high order nibble of the low order byte in binary?

0110

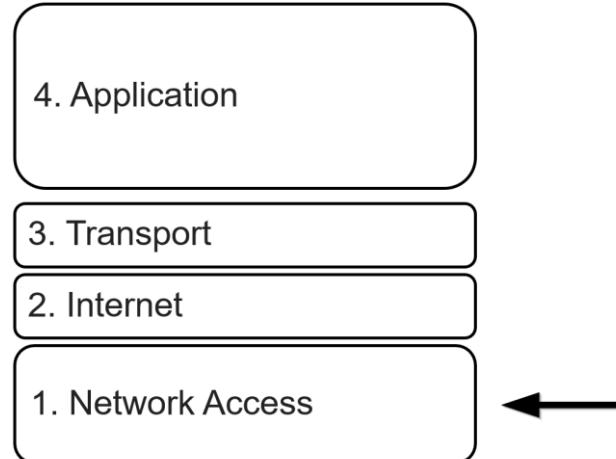
- What is the low order nibble of the high order byte in hex?

A

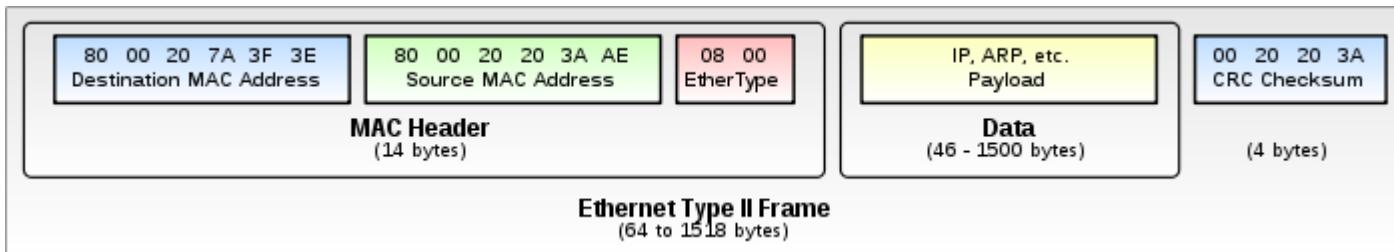


Network Access Layer

- Common protocols: Ethernet, Wireless, Bluetooth
- Ethernet & Wireless use Media Access Control (MAC) addresses
- Information does not “route”



Ethernet Headers – Network Access Layer



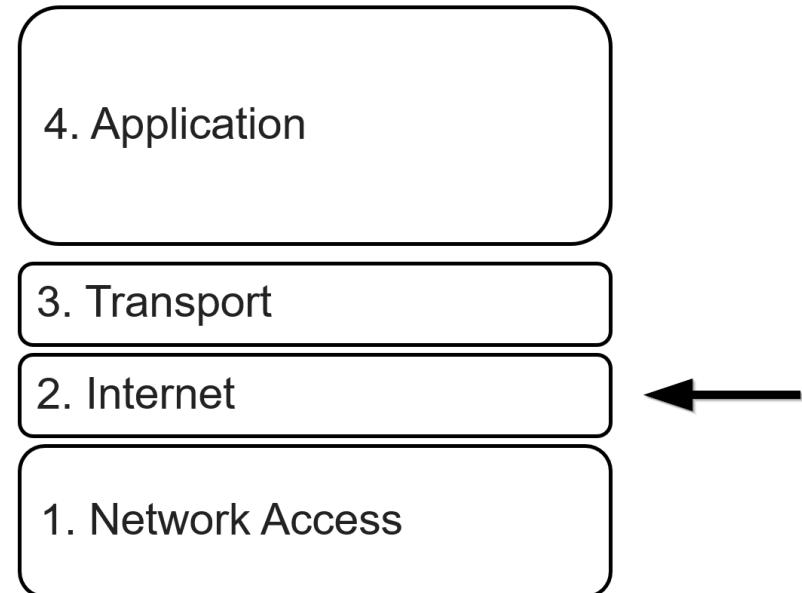
Source: https://en.wikipedia.org/wiki/Ethernet_frame

```
> Frame 56: 175 bytes on wire (1400 bits), 175 bytes captured (1400 bits)
└─ Ethernet II, Src: VMware_f0:0b:61 (00:0c:29:f0:0b:61), Dst: AsustekC_be:f7:98 (08:60:6e:be:f7:98)
    └─ Destination: AsustekC_be:f7:98 (08:60:6e:be:f7:98)
    └─ Source: VMware_f0:0b:61 (00:0c:29:f0:0b:61)
    └─ Type: IPv4 (0x0800)

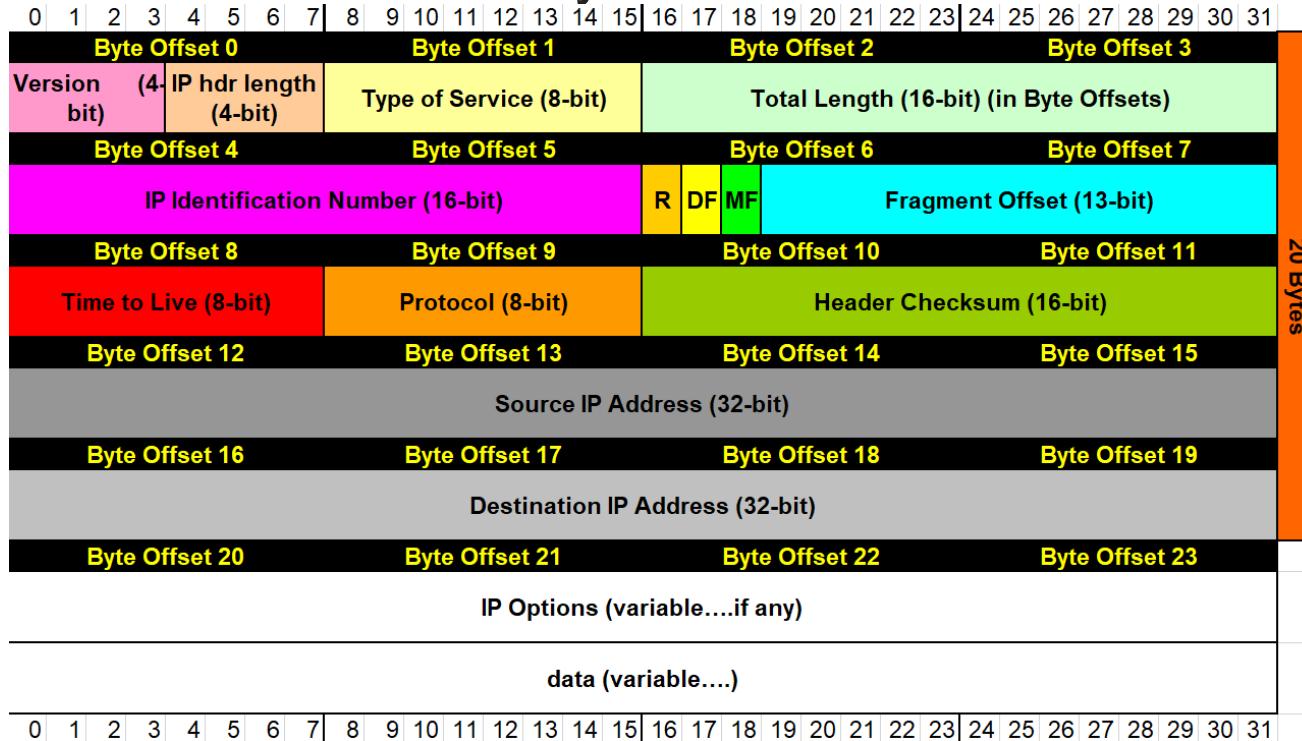
0000  08 60 6e be f7 98 00 0c 29 f0 0b 61 08 00 45 00 .`n..... )...a..E.
0010  00 a1 6e 5e 40 00 40 06 41 4b c0 a8 02 7a 36 98 ..n^@.@. AK...z6.
0020  90 f3 92 4c 00 50 71 0d f2 d6 52 61 85 9d 80 18 ...L.Pq. ...Ra....
0030  00 e5 8b 41 00 00 01 01 08 0a 01 5a 9c 93 44 5f ...A..... ...Z..D_
0040  16 d7 47 45 54 20 2f 66 34 39 30 61 33 35 61 63 ..GET /f 490a35ac
```

Internet Layer – IPv4

- Routes packets across the internet
- Uses 32-bit IP addresses
- ARP resolves MAC to IP
- Header length depends on options
 - Not that common
- Does not guarantee delivery



IPv4 Header – Internet Layer



http://wiki.gnghlug.org/twiki2/pub/Www/IpReference/Packet_Headers_Subnet_Breakdown.xls



IPv4 Fragmentation

- Naturally occurs
 - Packet size exceeds MTU (Maximum Transmission Unit)
- Sometimes orgs block it
- Foundation for many bypass techniques
- Observation point and target must decode the same way
- RFCs do not deal with edge cases



IPv4 Fragmentation

- Fragments are in IP header, bytes 6 and 7
- DF – Don't Fragment
- MF – More Fragments
- Multiply fragment offset by 8, 13 bits cannot represent full packet length
- MF bit set when more fragments follow (not in last frag or unfragmented packets)



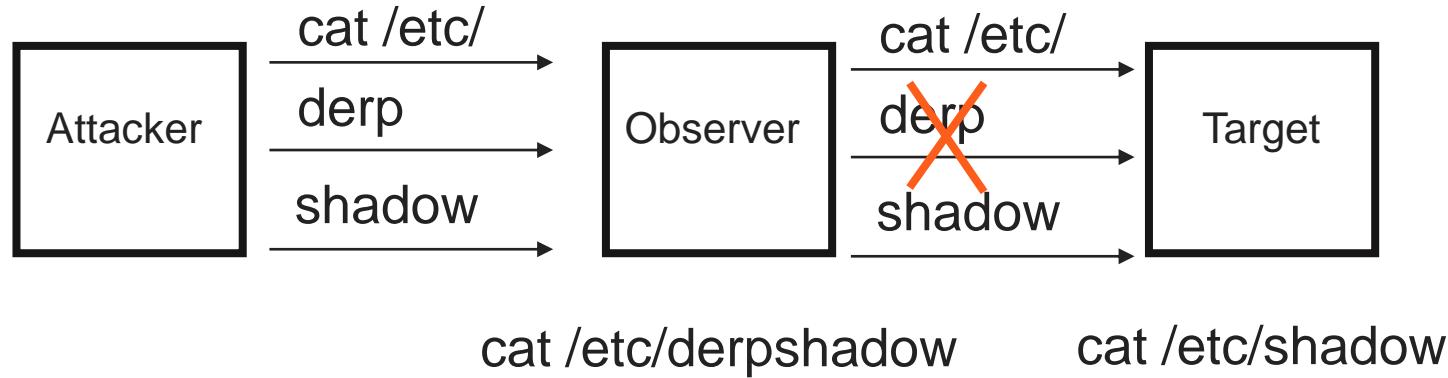
IPv4 Fragmentation – Example (icmpfrag.pcap)

- Payload per packet size = MTU-(IP header length)
- Only first packet in the train has the transport protocol header
- MTU of 1500 (Ethernet)
- 20 byte IP header
- 1480 payload bytes per packet
- Packet 1 Offset : 0
- Packet 2 Offset : $1480/8$ decimal = B9 hex
- Packet 3 Offset : $2960/8$ decimal = 172 hex



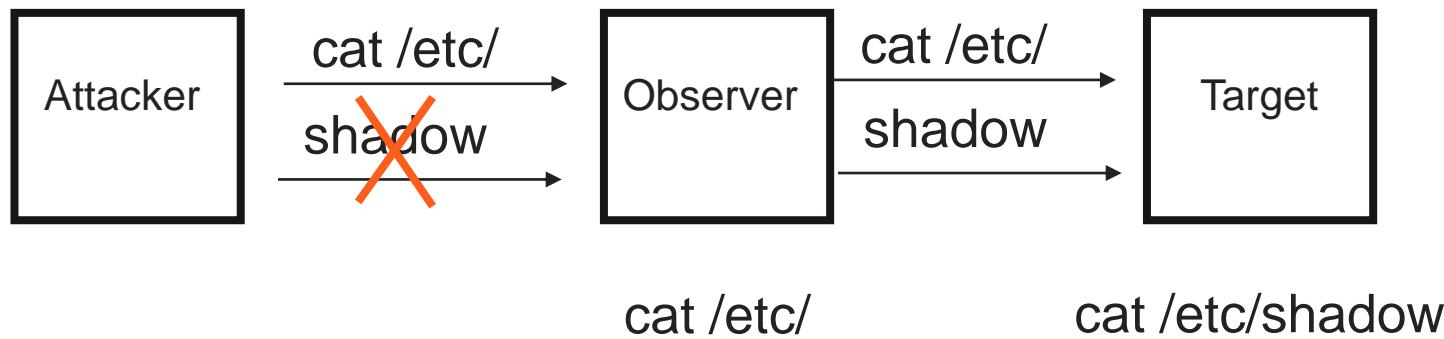
IPv4 Fragmentation - Insertion

- Observation system accepts data the target does not



IPv4 Fragmentation - Evasion

- Observation system rejects data the target does not



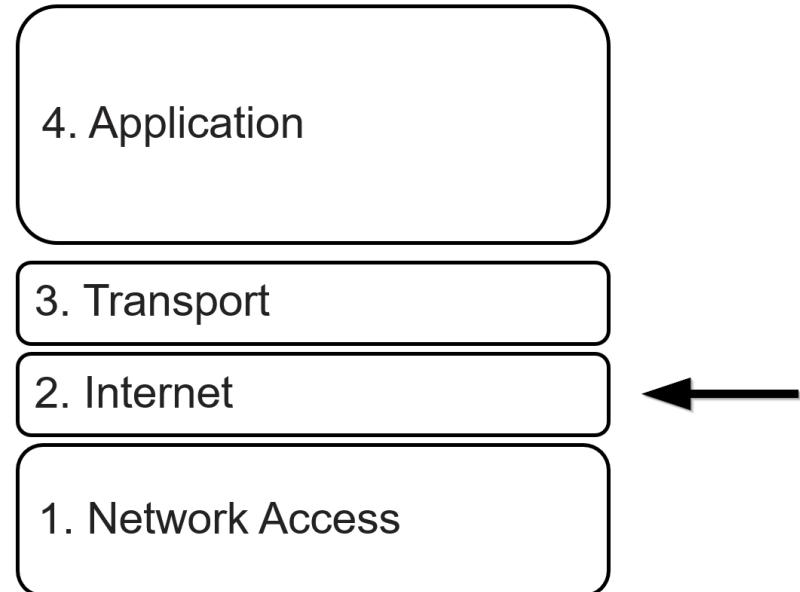
Traceroute

- Find list of hops between hosts
- Relies on ICMP Time Exceeded in Transit messages
- Can use ANY layer 4 protocol
- Send packets with variable TTL values
- Each hop decrements TTL by 1, discarding router sends ICMP
- Windows uses ICMP echo requests
- Linux uses UDP 33434 to UDP 33534

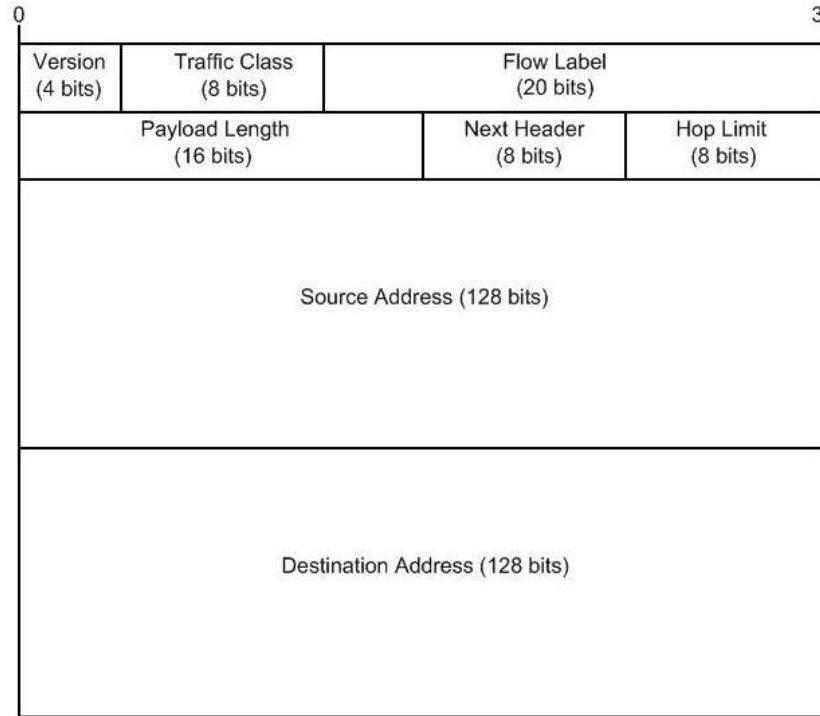


Internet Layer – IPv6

- Same purpose as IPv4
- Uses 128-bit IP addresses
- Neighbor Solicitation resolves MAC to IP
- Does not guarantee delivery



IPv6 Header – Internet Layer

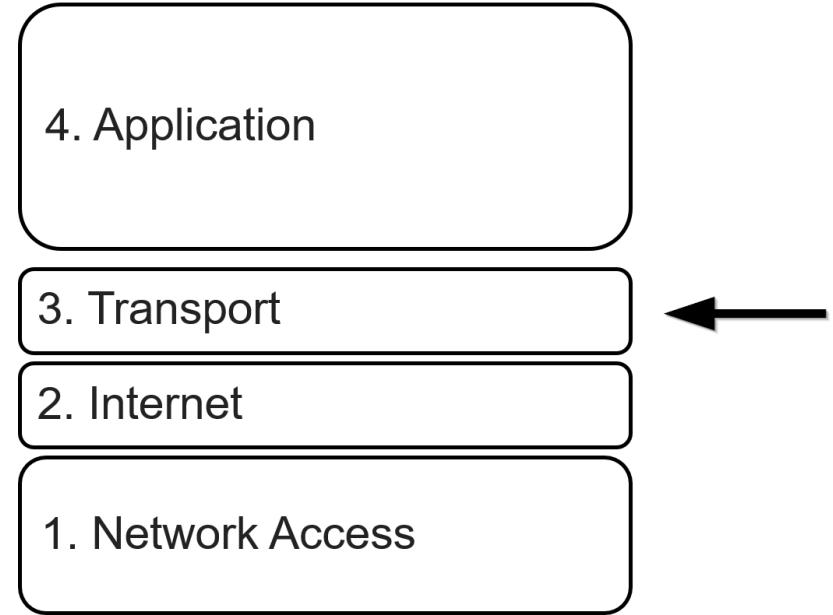


<https://www.cisco.com/c/en/us/about/security-center/countermeasures-ipv6-type-0.html>

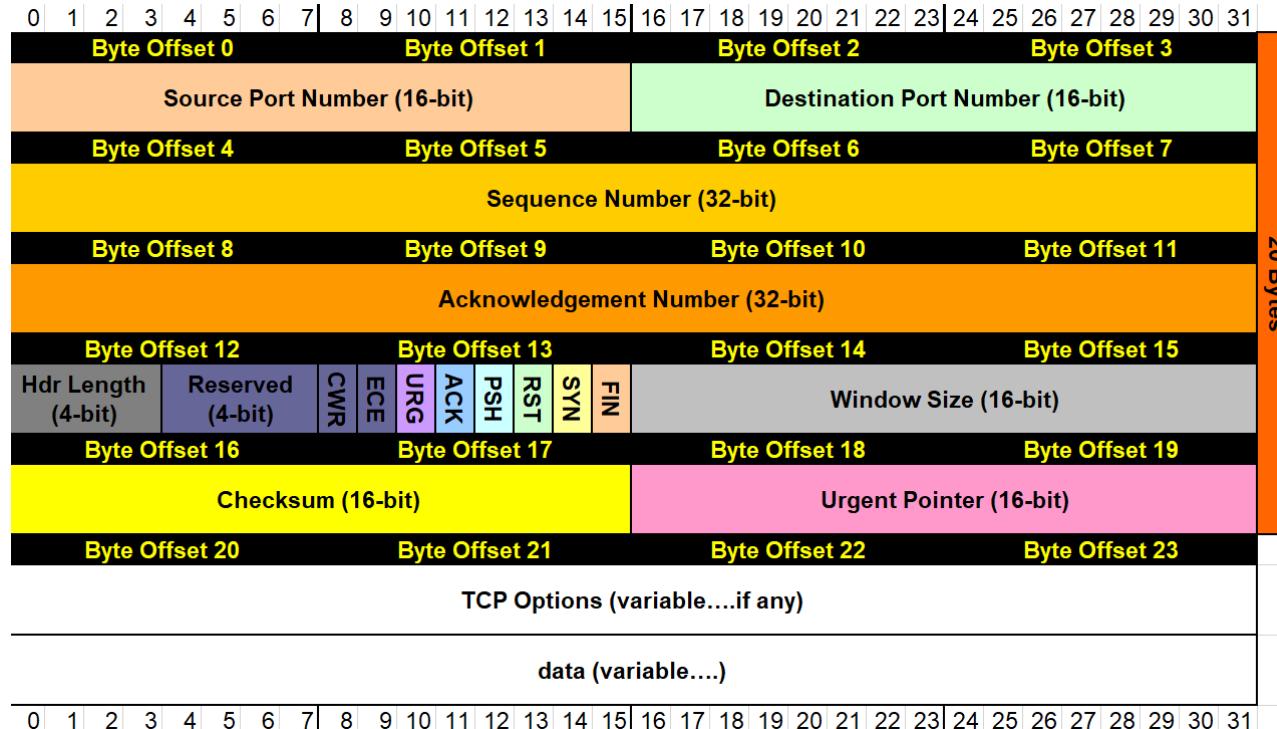


Transport Layer - TCP

- Transmission Control Protocol
- Ensures packet delivery
- Most common transport layer protocol
- Communication status controlled with TCP flags



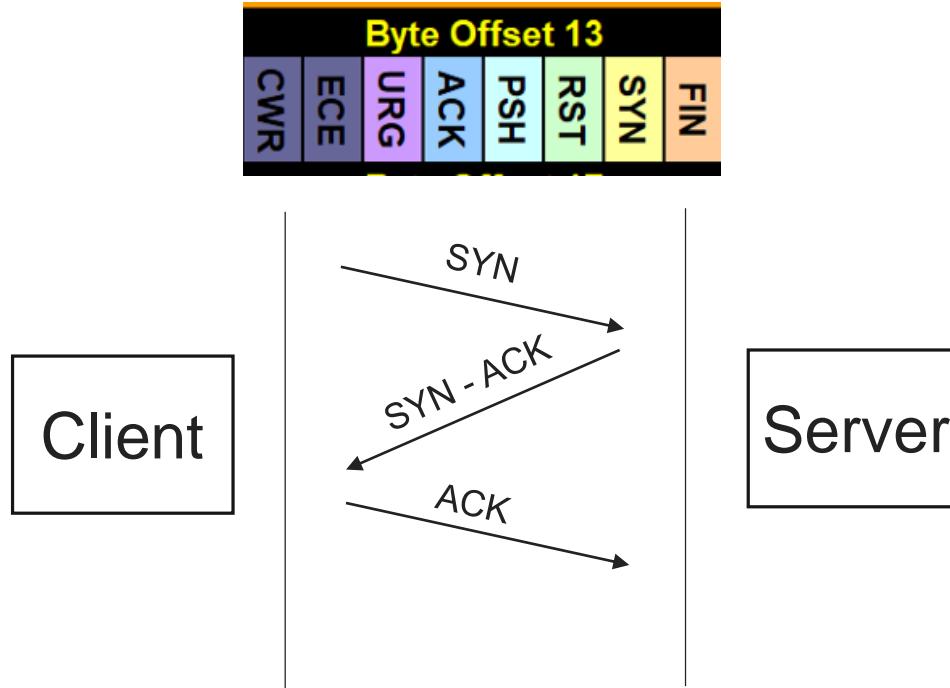
TCP Header



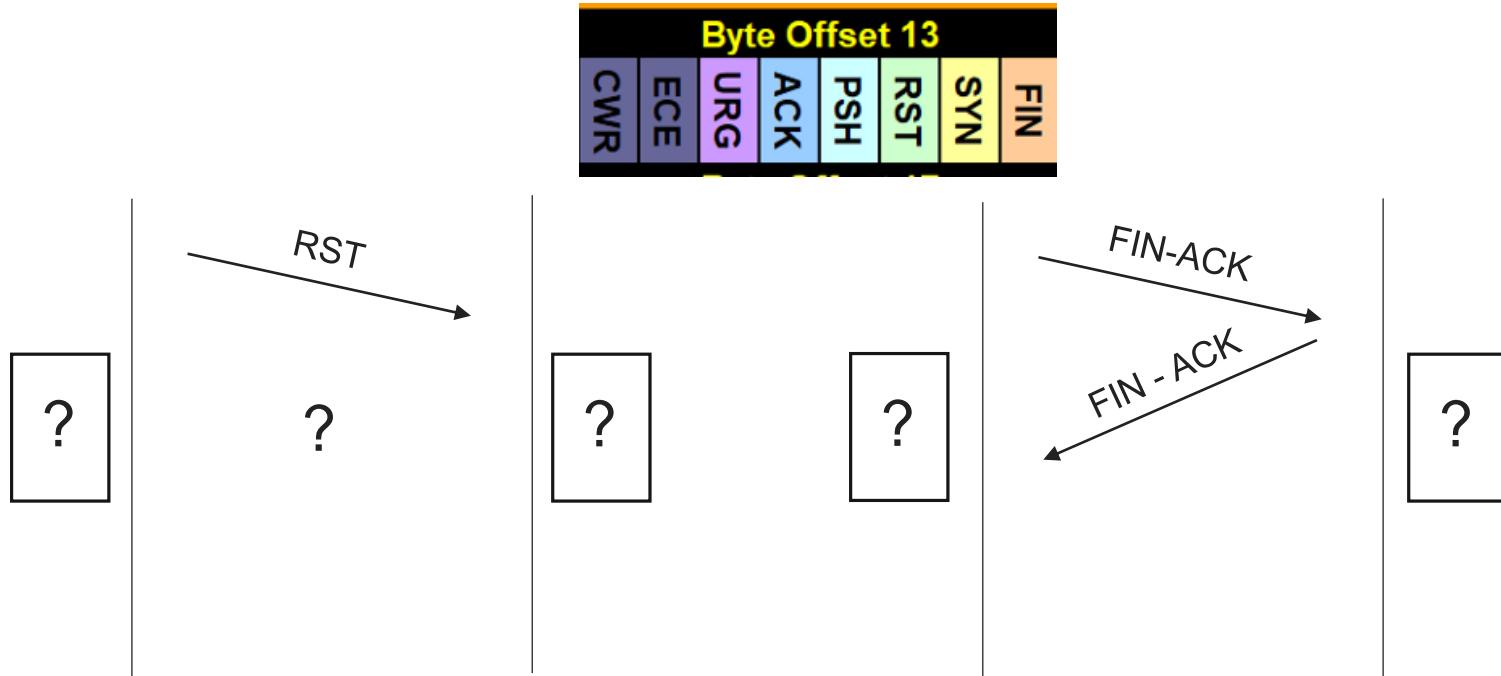
http://wiki.gnghlug.org/twiki2/pub/Www/IpReference/Packet_Headers_Subnet_Breakdown.xls



TCP Conversations - Beginning



TCP Conversations - Ending



TCP - Tracking Conversations

- Socket (Source – Destination combination)
- Sequence Number
 - Client and server have different sequence numbers
- Acknowledgement Number
 - Acknowledge last sequence # + payload length
- Wireshark tracks this well



TCP - Tracking Conversations

- C-S – Syn – SEQ 0x82acd14d ACK 0x00000000, no payload
- S-C – Syn-Ack – SEQ 0x9696fd7e ACK 0x82acd14e, no payload
- C-S – Ack – SEQ 0x82acd14e ACK 0x9696fd7f, no payload
- C-S – Ack – SEQ 0x82acd14e ACK 0x9696fd7f, 306 byte payload
- S-C – Ack – SEQ 0x9696fd7f ACK 0x82acd280, no payload
- S-C – Ack – SEQ 0x9696fd7f ACK 0x82acd280, 1261 byte payload
- C-S – Ack – SEQ 0x82acd280 ACK 0x9697026c, 286 byte payload
- S-C – Ack – SEQ 0x9697026c ACK 0x82acd39e, 1460 byte payload



TCP - Retransmission

- Blocked connections usually reset or dropped
- Dropped packets look “lost” to host
- Hosts retry at progressively larger intervals



TCP - Retransmission

```
20:51:22.704756 IP 192.168.2.175.53840 > 172.217.0.4.6667: Flags [S], seq 2001742320,  
[mss 1460,sackOK,TS val 2567562150 ecr 0,nop,wscale 10], length 0  
20:51:23.725627 IP 192.168.2.175.53840 > 172.217.0.4.6667: Flags [S], seq 2001742320,  
[mss 1460,sackOK,TS val 2567563176 ecr 0,nop,wscale 10], length 0  
20:51:25.741171 IP 192.168.2.175.53840 > 172.217.0.4.6667: Flags [S], seq 2001742320,  
[mss 1460,sackOK,TS val 2567565201 ecr 0,nop,wscale 10], length 0  
20:51:29.869389 IP 192.168.2.175.53840 > 172.217.0.4.6667: Flags [S], seq 2001742320,  
[mss 1460,sackOK,TS val 2567569352 ecr 0,nop,wscale 10], length 0  
20:51:38.061189 IP 192.168.2.175.53840 > 172.217.0.4.6667: Flags [S], seq 2001742320,  
[mss 1460,sackOK,TS val 2567577594 ecr 0,nop,wscale 10], length 0  
20:51:54.189403 IP 192.168.2.175.53840 > 172.217.0.4.6667: Flags [S], seq 2001742320,  
[mss 1460,sackOK,TS val 2567593827 ecr 0,nop,wscale 10], length 0  
20:52:27.879042 IP 192.168.2.175.53840 > 172.217.0.4.6667: Flags [S], seq 2001742320,  
[mss 1460,sackOK,TS val 2567627335 ecr 0,nop,wscale 10], length 0
```



TCP – “Normal” Behavior

- SYN to an open port causes SYN-ACK response

Info
7510 → 8888 [SYN] Seq=0
8888 → 7510 [SYN, ACK]

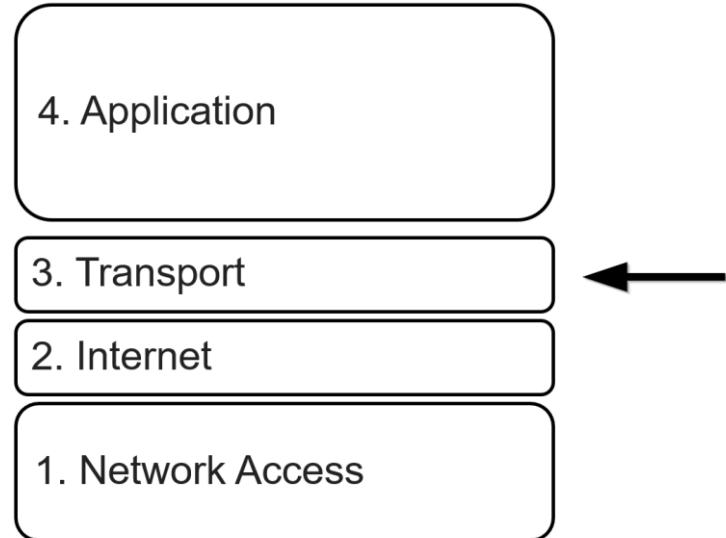
- SYN to a closed port causes a RST

Info
47468 → 691 [SYN] Seq=0
691 → 47468 [RST, ACK]

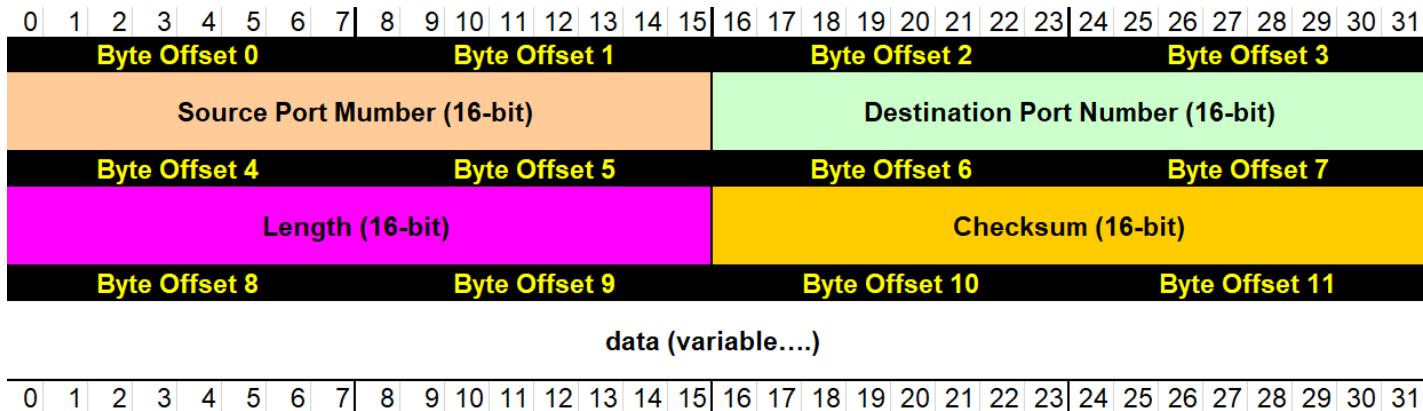


Transport Layer - UDP

- User Datagram Protocol
- Unreliable delivery
- Faster than TCP
- Packet loss handled at the application layer
- Suitable for streaming (VOIP, video, etc)
- DNS and tftp commonly use UDP
- QUIC uses UDP



UDP Header

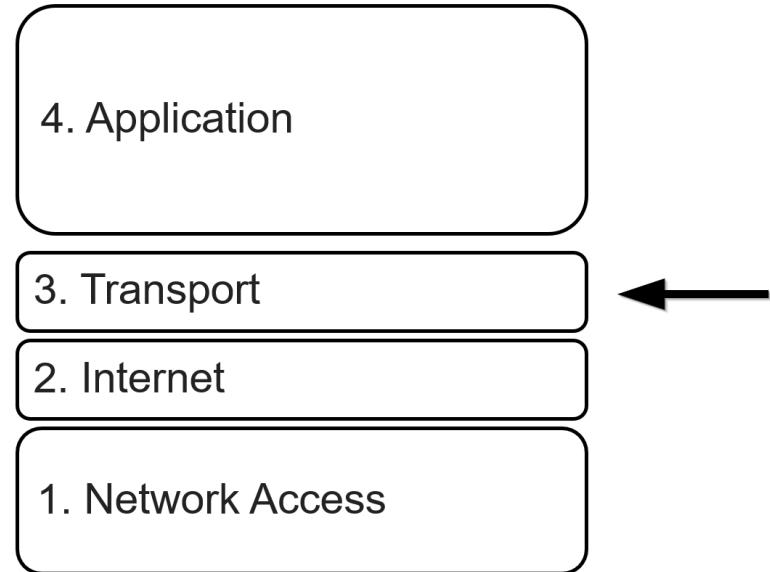


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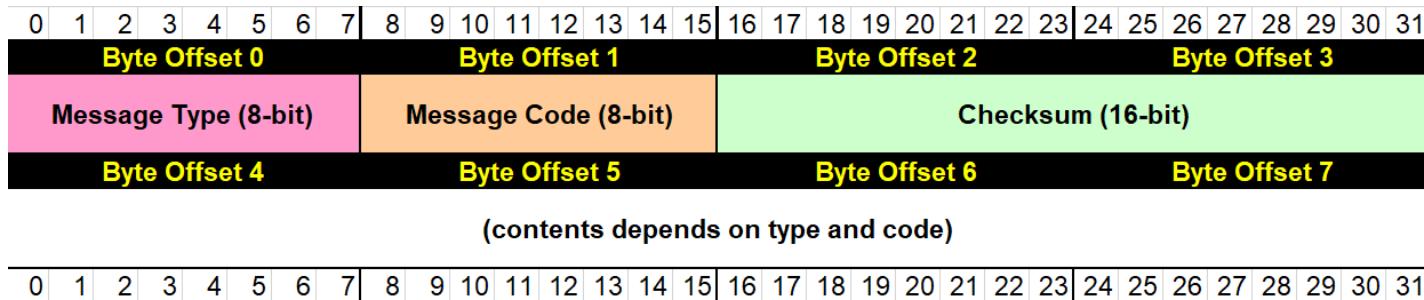


Transport Layer - ICMP

- Internet Control Message Protocol
- Administrative communication
- Ping, unreachable messages, router advertisement, redirection, etc.
- Often result from a stimulus
 - Ping response
 - Port unreachable



ICMP Header



http://wiki.gnrlug.org/twiki2/pub/Www/IpReference/Packet_Headers_Subnet_Breakdown.xls



ICMP Header

TYPE	CODE	Description	TYPE	CODE	Description
0	0	Echo Reply	4	0	Source quench
3	0	Network Unreachable	5	0	Redirect for network
3	1	Host Unreachable	5	1	Redirect for host
3	2	Protocol Unreachable	5	2	Redirect for TOS and network
3	3	Port Unreachable	5	3	Redirect for TOS and host
3	4	Fragmentation needed but no frag. bit set	8	0	Echo request
3	5	Source routing failed	9	0	Router advertisement
3	6	Destination network unknown	10	0	Route solicitation
3	7	Destination host unknown	11	0	TTL equals 0 during transit
3	8	Source host isolated (obsolete)	11	1	TTL equals 0 during reassembly
3	9	Destination network administratively prohibited	12	0	IP header bad (catchall error)
3	10	Destination host administratively prohibited	12	1	Required options missing
3	11	Network unreachable for TOS	13	0	Timestamp request (obsolete)
3	12	Host unreachable for TOS	14		Timestamp reply (obsolete)
3	13	Communication administratively prohibited by filtering	15	0	Information request (obsolete)
3	14	Host precedence violation	16	0	Information reply (obsolete)
3 44	15	Precedence cutoff in effect	17	0	Address mask request
			18	0	Address mask reply

ICMP Anomalous Traffic

- Response with no stimulus
 - ICMP echo responses with no request
 - Different numbers of ICMP echo requests and responses
- Nonstandard payloads
 - Windows echo request
abcdefghijklmnoprstuvwxyzabcdefghi
 - Linux echo request !"#\$%&'()*+,-./01234567



ICMP Tunnel

82	2018-02-03...	192.1...	192.16...	ICMP	70	Echo (ping) reply	id=0xc622, seq=0/0, ttl=64 (request in 81)
83	2018-02-03...	192.1...	192.16...	ICMP	102	Echo (ping) reply	id=0xc622, seq=0/0, ttl=64
84	2018-02-03...	192.1...	192.16...	ICMP	1094	Echo (ping) request	id=0xc622, seq=1/256, ttl=64 (reply in 85)
85	2018-02-03...	192.1...	192.16...	ICMP	1094	Echo (ping) reply	id=0xc622, seq=1/256, ttl=64 (request in 84)
86	2018-			ICMP	360	Echo (ping) request	id=0xc622, seq=2/512, ttl=64 (reply in 87)
87	2018-			ICMP	360	Echo (ping) reply	id=0xc622, seq=2/512, ttl=64 (request in 86)
88	2018-			ICMP	70	Echo (ping) reply	id=0xc622, seq=3/512, ttl=64 (request in 88)
89	2018-02-03...	192.1...	192.16...	ICMP	1094	Echo (ping) reply	id=0xc622, seq=4/512, ttl=64 (request in 89)
90	2018-02-03...	192.1...	192.16...	ICMP	126	Echo (ping) reply	id=0xc622, seq=5/512, ttl=64 (request in 90)
91	2018-02-03...	192.1...	192.16...	ICMP	150	Echo (ping) request	id=0xc622, seq=6/512, ttl=64 (request in 91)
92	2018-02-03...	192.1...	192.16...	ICMP	150	Echo (ping) reply	id=0xc622, seq=7/512, ttl=64 (request in 92)
93	2018-02-03...	192.1...	192.16...	ICMP	382	Echo (ping) reply	id=0xc622, seq=8/512, ttl=64 (request in 93)
94	2018-02-03...	192.1...	192.16...	ICMP	138	Echo (ping) request	id=0xc622, seq=9/512, ttl=64 (request in 94)
95	2018-02-03...	192.1...	192.16...	ICMP	138	Echo (ping) reply	id=0xc622, seq=10/512, ttl=64 (request in 95)

Odd lengths

Multiple
replies per
request



Transport Layer – ICMPv6

- Internet Control Message Protocol
- Same purpose as ICMPv4
- Additional responsibility – Neighbor Discovery Protocol

ICMPv6 packet

Bit offset	0–7	8–15	16–31
0	Type	Code	Checksum
32	Message body		



Knowledge Check

- What ICMP type and code indicate a ping response?
- What two bytes start most IPv4 packets?
- What ICMP type might indicate a traceroute?
- What are the steps to the TCP 3-way handshake?
- What are the two common methods of terminating a TCP connection?



Knowledge Check

- What ICMP type and code indicate a ping response?
 - Type 0, code 0
- What two bytes start most IPv4 packets?
 - 0x4500
- What ICMP type might indicate a traceroute?
 - Type 11
- What are the sets of flags in a normal TCP 3-way handshake?
 - SYN, SYN-ACK, ACK
- What are the two common methods of terminating a TCP connection?
 - FIN, RST



Part 2 – Tools

Overview

Part 2 – Tools

- TCPDump
- Wireshark
- TShark
- ngrep
- GNU Tools



TCPDump

- Packet sniffing application
- *nix, windump on Windows
- Little interpretation past transport layer
- Fastest sniffer available
- Uses Berkeley Packet Filters (BPF)



TCPDump Common Options

- nn : Do not resolve host names or ports
- i : Capture interface
- w : write packets to a file
- r : read capture file
- A : Dump ASCII
- x : Dump hex
- X : Dump hex and ASCII
- v[vvvv] : increase verbosity



TCPDump

Time	Source IP	Source Port	TCP Flags	Payload Length	Destination IP	Destination Port	TCP Options
21:35:32.553653	IP 192.168.2.79.47699 > 192.168.2.235.4444:		Flags [S] seq 3348367871, win 16384, options [mss 1460,nop,nop,sackOK,nop,wscale 3,nop,nop,TS val 1287161824 ecr 0], length 0				
21:35:32.610283	IP 192.168.2.79.42358 > 192.168.2.234.4444:		Flags [S], seq 2198709766, win 16384, options [mss 1460,nop,nop,sackOK,nop,wscale 3,nop,nop,TS val 2235206617 ecr 0], length 0				
21:35:32.715093	IP 192.168.2.75.4444 > 192.168.2.79.8889:		Flags [R.], seq 0, ack 305633690 1, win 0, length 0				
21:35:32.960183	IP 192.168.2.200.4444 > 192.168.2.79.48185:		Flags [R.], seq 0, ack 3895182 559, win 0, length 0				
21:35:33.257014	IP 192.168.2.235.4444 > 192.168.2.79.47699:		Flags [R.], seq 0, ack 3348367 872, win 0, length 0				



TCPDump Verbose Output

```
21:51:04.312150 IP (tos 0x0, ttl 47, id 52284, offset 0, flags [DF], proto UDP (17), length 76)
    173.71.68.101.123 > 192.168.2.175.51305: [udp sum ok] NTPv4, length 48
        Server, Leap indicator: (0), Stratum 1 (primary reference), poll 3 (8s), precision -19
        Root Delay: 0.000000, Root dispersion: 0.050003, Reference-ID: PPS^@
        Reference Timestamp: 3726528663.424345441 (2018/02/01 21:51:03)
        Originator Timestamp: 3726528664.061811511 (2018/02/01 21:51:04)
        Receive Timestamp: 3726528664.819150386 (2018/02/01 21:51:04)
        Transmit Timestamp: 3726528664.819465378 (2018/02/01 21:51:04)
        Originator - Receive Timestamp: +0.757338874
        Originator - Transmit Timestamp: +0.757653867
```



Berkeley Packet Filters

- Widely used in networking tools
- Limit traffic TCPDump accepts
- Allows targeted captures
- Filter existing captures



Berkeley Packet Filters

- host *host* : capture traffic from a specific host
- src host *host* : specific source host
- dst host *host* : specific destination host
- ip src host *host* : IP packets from specific source host
- Port *port* : Packets to or from a specific transport-layer port
- ether *ehost* : packets from a specific MAC
- net *subnet* : packets to or form a specific subnet



Berkeley Packet Filters

- ip[0] = 0x45 : IPv4 packets, header length 20
- tcp[2:2] = 443 : TCP packets destination port 443
- tcp : capture all TCP packets
- udp : capture all UDP packets
- tcp && src host *host* : TCP packets from a specific host
- tcp || src host *host* : Any TCP packet or packet from a specific host



TCP Flags (Byte 13)

- Byte 13 in the TCP header contains control flags
- Help manage the TCP conversation

SYN Packet Flags							
CWR	ECE	URG	ACK	PSH	RST	SYN	FIN
0	0	0	0	0	0	1	0



Berkeley Packet Filters

- $\text{tcp}[13] = 0x02$: SYN packets
- $\text{tcp}[13] = 0x04$: RST packets
- $\text{tcp}[\text{tcpflags}] = \text{tcp-syn}$: also SYN packets
- How can you capture packets without the SYN flag set?



Bit Masking

- Logical AND (&)
 - Both statements must be true
- Logical OR (|)
 - Either statement is true

	False	True
False	False	False
True	False	True

	False	True
False	False	True
True	True	True



Berkeley Packet Filters

- Packets with the SYN flag set
- $\text{tcp}[13] \& 0x02 == 0x02$

SYN Packet Flags							
CWR	ECE	URG	ACK	PSH	RST	SYN	FIN
0	0	0	0	0	0	1	0
0	0	0	0	0	0	1	0

SYN-ACK Packet Flags							
CWR	ECE	URG	ACK	PSH	RST	SYN	FIN
0	0	0	1	0	0	1	0
0	0	0	0	0	0	0	0

SYN-FIN Packet Flags							
CWR	ECE	URG	ACK	PSH	RST	SYN	FIN
0	0	0	0	0	0	1	1
0	0	0	0	0	0	1	0

XMAS Packet Flags							
CWR	ECE	URG	ACK	PSH	RST	SYN	FIN
1	1	1	1	1	1	1	1
0	0	0	0	0	0	1	0



Berkeley Packet Filters

- Packets **without** the SYN flag set
- $\text{tcp}[13] \& 0x02 \neq 0x02$
- $\text{tcp}[13] \& 0x02 = 0$

RST Packet Flags							
CWR	ECE	URG	ACK	PSH	RST	SYN	FIN
0	0	0	0	0	1	0	0
0	0	0	0	0	0	1	0

FIN-ACK Packet Flags							
CWR	ECE	URG	ACK	PSH	RST	SYN	FIN
0	0	0	1	0	0	0	1
0	0	0	0	0	0	1	0



Knowledge Check

- Find SYN-ACK packets
- Find packets with a source port of 80
- Find packets with all TCP flags set
- Find all UDP packets with a destination port of 123
- Find all type 3 code 3 ICMP packets



Knowledge Check Answers

- Find SYN-ACK packets
 - `tcp[13]=0x12`
- Find packets with a source port of 80
 - `src port 80`
 - `udp[0:2]=80 || tcp[0:2]=80`
- Find packets with all TCP flags set
 - `tcp[13]=0xff`
- Find all UDP packets with a destination port of 123
 - `udp[2:2]=123`
 - `udp && dst port 123`
- Find all type 3 code 3 ICMP packets
 - `icmp[0]=3 && icmp[1]=3`



Wireshark

- Not as confusing as TCPDump
- Graphical interface to view packets
- Robust application layer support
- More powerful filters
- Slow.
- Can be misleading
- Almost unusable > 1GB packet captures
- Can have remote code execution vulnerabilities



Wireshark – Time Display

The screenshot shows the Wireshark application window. The menu bar at the top includes View, Go, Capture, Analyze, Statistics, Telephony, Wireless, Tools, and Help. The View menu is currently open, displaying various display filter options. The 'Time Display Format' option is highlighted with a blue selection bar. A submenu for 'Time Display Format' is open, listing nine different time display formats, each with a keyboard shortcut. The submenu items are:

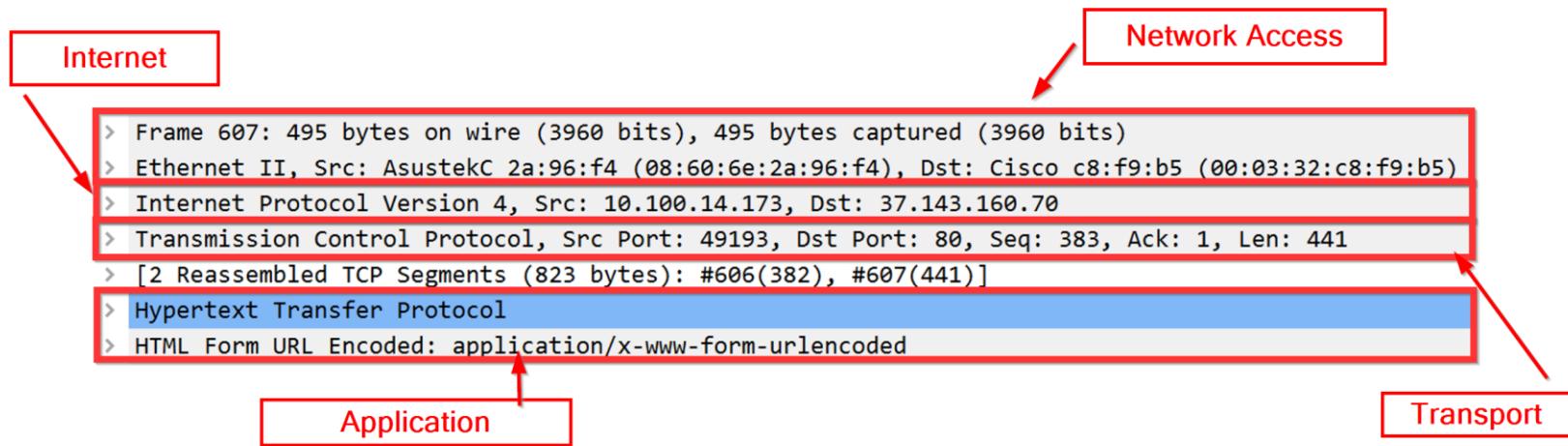
- Date and Time of Day (1970-01-01 01:02:03.123456) Ctrl+Alt+1
- Year, Day of Year, and Time of Day (1970/001 01:02:03.123456)
- Time of Day (01:02:03.123456)
- Seconds Since 1970-01-01
- Seconds Since Beginning of Capture
- Seconds Since Previous Captured Packet
- Seconds Since Previous Displayed Packet
- UTC Date and Time of Day (1970-01-01 01:02:03.123456)
- UTC Year, Day of Year, and Time of Day (1970/001 01:02:03.123456)
- UTC Time of Day (01:02:03.123456) Ctrl+Alt+8

Below the 'Time Display Format' submenu, other options in the View menu include Main Toolbar, Filter Toolbar, Wireless Toolbar, Status Bar, Full Screen (F11), and three display list options: Packet List, Packet Details, and Packet Bytes.

Destination	Protocol	Channel
.253	208.80.154.225	HTTP
.253	208.80.154.240	HTTP



Wireshark



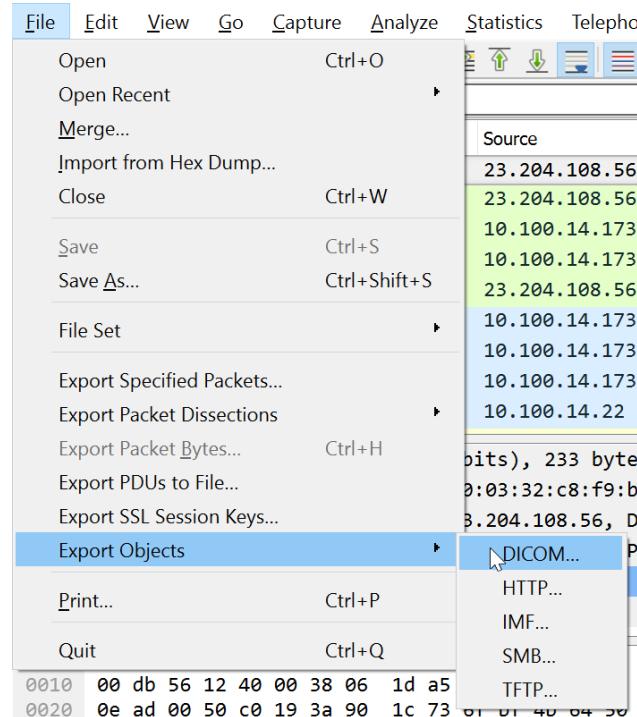
Wireshark Statistics

Ethernet · 5	IPv4 · 20	IPv6	TCP · 65	UDP · 46						
Address	Port	Packets	Bytes	Tx Packets	Tx Bytes	Rx Packets	Rx Bytes	Latitude	Longitude	
37.143.160.70	80	12	1668	5	431	7	1237	—	—	
47.89.250.83	80	12	3325	5	2070	7	1255	—	—	
83.255.177.54	80	12	2302	5	1065	7	1237	—	—	
5.56.73.146	80	11	2536	5	1359	6	1177	—	—	
41.110.200.194	80	11	2402	5	1225	6	1177	—	—	
46.29.1.191	80	11	2339	5	1162	6	1177	—	—	
81.12.175.59	80	11	1608	5	431	6	1177	—	—	
84.224.160.159	80	11	1608	5	431	6	1177	—	—	
109.96.148.33	80	11	1608	5	431	6	1177	—	—	
195.228.41.2	80	11	1608	5	431	6	1177	—	—	
23.204.108.56	80	10	858	5	461	5	397	—	—	
2.185.239.164	80	3	194	0	0	3	194	—	—	
10.100.14.22	88	201	62 k	94	30 k	107	32 k	—	—	
10.100.14.22	135	30	3720	12	1672	18	2048	—	—	
10.100.14.22	389	79	25 k	35	11 k	44	14 k	—	—	
10.100.14.22	445	104	24 k	49	8012	55	16 k	—	—	



Wireshark Exports

- Dump files from pcaps
- File | Export Objects
- Limited protocol support
 - HTTP
 - SMB
 - DICOM
 - IMF
 - TFTP



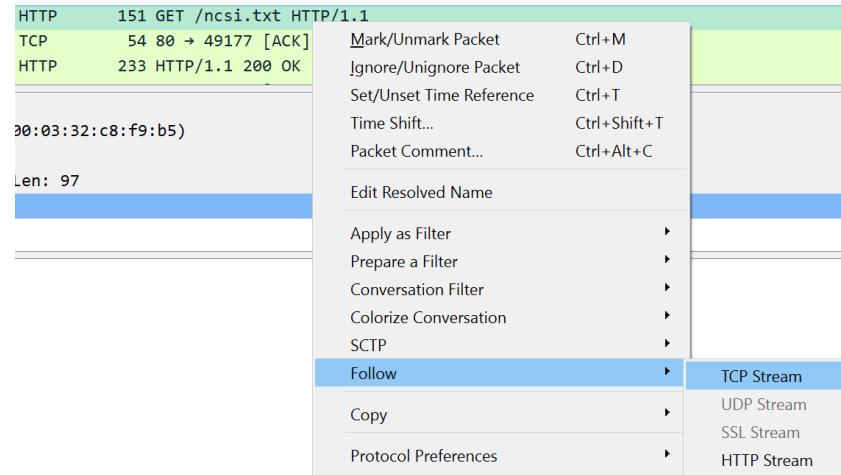
Export Objects

Packet	Hostname	Content Type	Size	Filename
315	www.msftncsi.com	text/plain	14 bytes	ncsi.txt
607	zepter.com	application/x-www-form-urlencoded	441 bytes	index.php
622	zepter.com	application/x-www-form-urlencoded	441 bytes	index.php
633	zepter.com	application/x-www-form-urlencoded	441 bytes	index.php
635	zepter.com	text/html	903 bytes	index.php
643	zepter.com	application/x-www-form-urlencoded	441 bytes	index.php
654	zepter.com	application/x-www-form-urlencoded	441 bytes	index.php
665	zepter.com	application/x-www-form-urlencoded	441 bytes	index.php
668	zepter.com	text/html	706 bytes	index.php
677	zepter.com	application/x-www-form-urlencoded	441 bytes	index.php
687	zepter.com	application/x-www-form-urlencoded	441 bytes	index.php
700	zepter.com	application/x-www-form-urlencoded	441 bytes	index.php
702	zepter.com	text/html	769 bytes	index.php
712	carfax.com	application/x-www-form-urlencoded	453 bytes	index.php
716	carfax.com	text/html	692 bytes	index.php
718	carfax.com	text/html	692 bytes	index.php

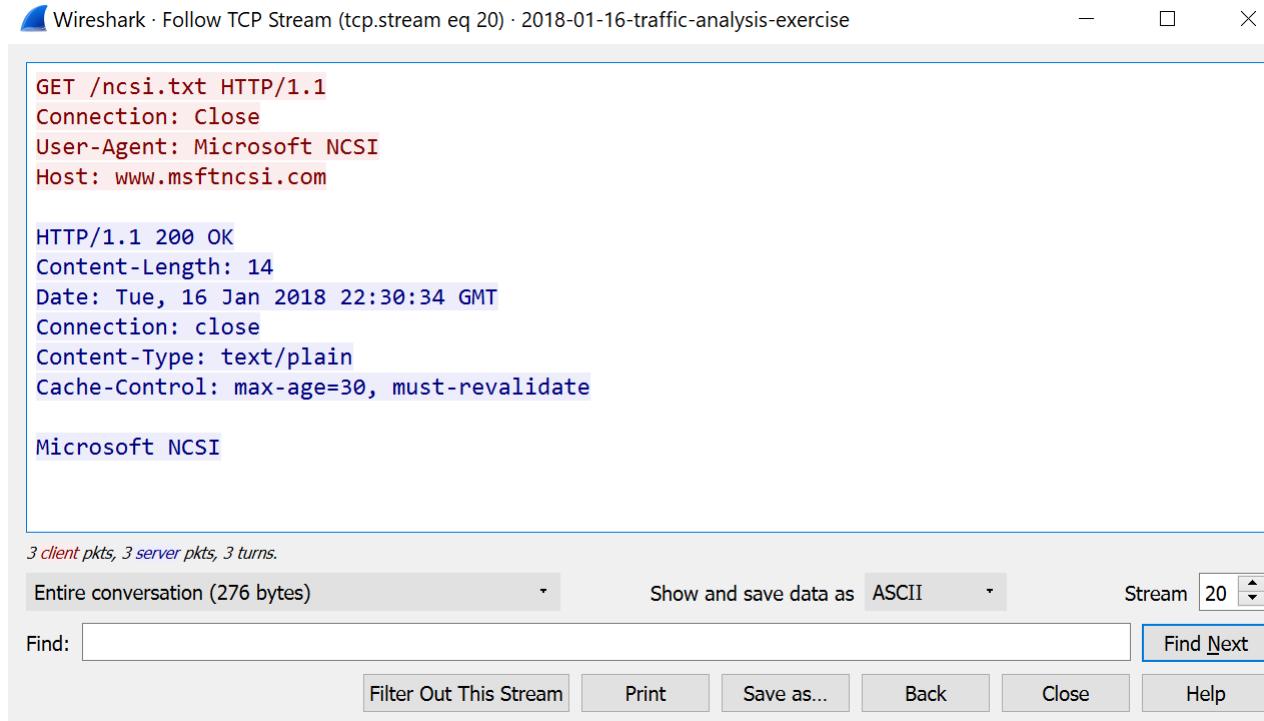


Wireshark Follow TCP Streams

- Limits displayed packets to a specific set
- Can use to export alternate protocols



Followed TCP Stream - HTTP



Wireshark · Follow TCP Stream (tcp.stream eq 20) · 2018-01-16-traffic-analysis-exercise

```
GET /ncsi.txt HTTP/1.1
Connection: Close
User-Agent: Microsoft NCSI
Host: www.msftncsi.com

HTTP/1.1 200 OK
Content-Length: 14
Date: Tue, 16 Jan 2018 22:30:34 GMT
Connection: close
Content-Type: text/plain
Cache-Control: max-age=30, must-revalidate

Microsoft NCSI

3 client pkts, 3 server pkts, 3 turns.
```

Entire conversation (276 bytes) Show and save data as ASCII Stream 20 ▾

Find: Find Next

Filter Out This Stream Print Save as... Back Close Help



Followed TCP Stream - SMB



Wireshark Filters

- Capture Filters
 - Use BPF to limit traffic collected
- Display Filters - SLOW
 - Wireshark-specific language
 - Limit traffic displayed
 - Does not alter capture file
 - Intellisense



Wireshark Display Filters

- Equality & comparison
 - Numeric : ==, !=, <, <>, >, <=, >=
 - String : eq, ne, lt, gt, le, ge
 - contains
 - matches
- Logical operators
 - &&, ||, !
 - and, or, not
- Parenthetical notation
 - Use parenthesis to group logic statements



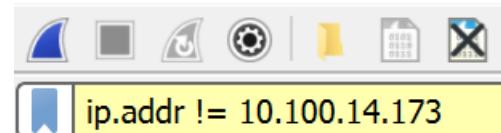
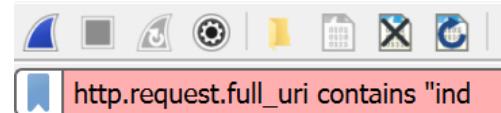
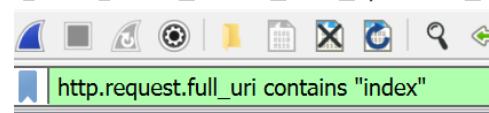
Common Wireshark Display Filters

- `ip.addr == host`
- `ip.src == host`
- `http.request.full_uri contains "string"`
- `ip.addr == host && (dns || http.request.full_uri || ssl.handshake.certificate)`
- `tcp.port == port`
- `!(ip.addr == host)`



Display Filters Interface

- Working filter
- Broken filter
- Insane filter



TShark

- Command line interface to Wireshark
- Supports display filters
- Far faster
- Supports file exports (recent versions)
- Parse with text-based tools
- Slower than tcpdump, but more functional



TShark Command Line Switches

- r : read pcap file
- nn : do not resolve ports and hosts
- Y : display filter
- T : format output
- e : specify fields
- w : write packets to file
- export-objects : export objects of specified protocol to specified directory



TShark Command Line Switches

```
rangercha@kali:/tmp$ tshark -r 2018-01-16-traffic-analysis-exercise.pcap -nn -Y "dns" -T fields -e "dns.qry.name"
_ldap._tcp.dc._msdcs.marsmart.com
_ldap._tcp.dc._msdcs.marsmart.com
_ldap._tcp.dc._msdcs.marsmart.com
_ldap._tcp.dc._msdcs.marsmart.com
marsmart-dc.marsmart.com
marsmart-dc.marsmart.com
marsmart-dc.marsmart.com
marsmart-dc.marsmart.com
_ldap._tcp.Default-First-Site-Name._sites.marsmart.com
_ldap._tcp.Default-First-Site-Name._sites.marsmart.com
isatap.marsmart.com
isatap.marsmart.com
_ldap._tcp.Default-First-Site-Name._sites.Marsmart-DC.marsmart.com
_ldap._tcp.Default-First-Site-Name._sites.Marsmart-DC.marsmart.com
```



TShark Command Line Switches

```
rangercha@kali:/tmp$ tshark -r 2018-01-16-traffic-analysis-exercise.pcap -nn --export-objects http,export  
1 0.000000 10.100.14.173 > 10.100.14.22 DNS 93 Standard query 0x5475 SRV _ldap._tcp.ac._msdc.marsmart.com A 10.100.14.22
```

```
rangercha@kali:/tmp$ ls export/  
'index(10).php'  'index(12).php'  'index(14).php'  'index(2).php'  'index(4).php'  'index(6).php'  'index(8).php'  index.php  
'index(11).php'  'index(13).php'  'index(1).php'   'index(3).php'  'index(5).php'  'index(7).php'  'index(9).php'  ncsi.txt  
rangercha@kali:/tmp$
```



TShark Output Fields

- Separate multiple fields into separate -e arguments
 - tshark -r filename.pcap -T fields -e 'http.request.full_uri' -e 'http.referer' -Y 'tcp.port==80'
- I would not call it complete...
 - Some fields are blank for no reason
- List of all possible fields
 - <https://www.wireshark.org/docs/deref/>
 - icmp.data
 - http.request.full_uri
 - http.referer



Ngrep

- Find packets matching a regex
- grep, but for packets
- Why not use grep?
 - Need to know the packet information
- Command line switches
 - ql : suppress hash marks, read from file



Ngrep

```
rangercha@kali:/tmp$ ngrep -qI 2018-01-16-traffic-analysis-exercise.pcap 'in.ex'
input: 2018-01-16-traffic-analysis-exercise.pcap
filter: ((ip || ip6) || (vlan && (ip || ip6)))
match: in.ex

T 10.100.14.173:49193 -> 37.143.160.70:80 [AP] #606
POST /l5yhus/index.php HTTP/1.1..Cache-Control: no-cache..Connection: Keep-Alive..Pr
t: zepter.com..User-Agent: Mozilla/4.0 (compatible; MSIE 7.0; Windows NT 6.1; WO
W64; R 3.0.30729; Media Center PC 6.0; .NET4.0C; .NET4.0E)..Content-Length: 441....
```



Text Parsing

- Find, massage, and present text
- One of the best skills to have
- Not just for packet analysis
- Linux-based tools
 - Also have windows versions



Output Redirection

- stdin, stdout, stderr
- | : direct stdout to stdin
- > : direct stdout to file
- >> : direct stdout append to file
- < : direct file to stdin
- 2>&1 : direct stderr to stdout



Cut

- Splits input into columns
- Outputs selected columns
- Bad for reordering
- Splits on arbitrary characters
- Beware of repeating characters
- Switches
 - f *field_number* : select specified fields
 - d '*delimiter*' : use specified delimiter to split



Cut

```
rangercha@kali:/tmp$ tshark -r 2018-01-16-traffic-analysis-exercise.pcap -nn --export-objects http,export -Y 'http' 2>&1 | cut -f 7 -d ' '
```

10.100.14.173
23.204.108.56
37.143.160.70
10.100.14.173
195.228.41.2
10.100.14.173
5.6.73.146
→
61 12 175 59

Why does this happen?

Cut command



Translate - tr

- Replaces single character
- tr 'a' 'b' : replace a with b
- tr -s '' : squeeze repeating characters
- tr -d '..' : delete character
- Very handy before cut



Tr with Cut

```
rangercha@kali:/tmp$ tshark -r 2018-01-16-traffic-analysis-exercise.pcap -nn --export-objects http,export -Y 'http' 2>&1 | tr -s ' ' | cut -f4 -d' '
10.100.14.173
23.204.108.56
10.100.14.173
37.143.160.70
10.100.14.173
195.228.41.2
10.100.14.173
5.56.73.146
10.100.14.173
81.12.175.59
10.100.14.173
109.96.148.33
10.100.14.173
```



Cut Multiple Columns

```
rangercha@kali:/tmp$ sudo tcpdump -nn -r 2018-01-16-traffic-analysis-exercise.pcap | tr -s ' ' | cut -f5,7-8,10- -d' '
reading from file 2018-01-16-traffic-analysis-exercise.pcap, link-type EN10MB (Ethernet)
10.100.14.22.53: SRV? _ldap._tcp.dc._msdcs.marsmart.com.
10.100.14.173.61280: 1/0/1 SRV 0 100 (111)
10.100.14.22.53: SRV? _ldap._tcp.dc._msdcs.marsmart.com.
10.100.14.173.61280: 1/0/1 SRV 0 100 (111)
10.100.14.22.53: A? marsmart-dc.marsmart.com.
10.100.14.22.53: A? marsmart-dc.marsmart.com.
10.100.14.173.49554: 1/0/0 A (58)
10.100.14.173.49554: 1/0/0 A (58)
10.100.14.22.389: length 170
10.100.14.22.389: length 170
```

`cut -f5,7-8,10- -d' '`

cut columns 5, 7 through 8, 10, and all columns after 10, delimited by space



Sort

- Orders text
- Alphabetical or numeric
 - n : numeric sort
- Can reverse sort
 - r : reverse sort
- Needed for aggregation



Output Chain

- | tr -s ' ' | cut -f5 -d' ' | cut -f5 -d'.' | tr -d ':' | sort
- Squeeze spaces
- Get column 5, space delimited
- Get column 5, period delimited
- Delete the : character
- Sort output



Unique - uniq

- Aggregates repeating lines
- Can provide a count with -c
- Sort first



Get Top 10 Destination Ports

```
rangercha@kali:/tmp$ sudo tcpdump -nn -r 2018-01-16-traffic-analysis-exercise.pcap  
| tr -s ' ' | cut -f5 -d' ' | cut -f5 -d'.' | tr -d ':' | sort | uniq -c | sort -  
rn | head  
reading from file 2018-01-16-traffic-analysis-exercise.pcap, link-type EN10MB (Eth  
ernet)  
 107 88  
   83  
   71 80  
   55 445  
   47 389  
   36 137  
   27 49155  
   23 53  
   21 5355  
   20 49158
```



Head & Tail

- `head -n number`
 - Get top *number* rows (default 10)
- `tail -n number`
 - Get last *number* rows (default 10)



Get Top 10 Destination Ports – New Connections

```
rangercha@kali:/tmp$ sudo tcpdump -nn -r 2018-01-16-traffic-analysis-exercise.pcap  
'tcp[13] = 0x02 '| tr -s ' ' | cut -f5 -d' ' | cut -f5 -d'.' | tr -d ':' | sort |  
uniq -c | sort -rn | head  
reading from file 2018-01-16-traffic-analysis-exercise.pcap, link-type EN10MB (Ethernet)  
21 88  
14 80  
5 389  
4 445  
2 49155  
2 135  
1 49158
```

—



Word / Line Count

- wc
- wc -l
 - Count lines
- Answer “how many ports” and “how many hosts” questions



Decoding

- `xxd`
 - Decode ASCII to hex and hex to ASCII
 - `xxd -r -p`
 - Hex to ASCII
- `Base64`
 - Encode/decode base64 encoded content
 - Decode: `base64 -d`
 - Encode: `base64 -e`



Practical Exercise - Fragmentation

- frags.pcap
 - Why might only 1 host have responded to the ICMP echo request?
- frags2.pcap
 - What was the server's response code?
 - What URL was probably requested?



Practical Exercise - Scanning

- nmap.pcap
 - Which host was performing scanning?
 - Which host was the scan target?
 - How many TCP ports were scanned?
 - How many UDP ports were scanned?
 - Which TCP ports were open?
 - What may have caused the scan behavior after 12:04:10?



Practical Exercise – Fragmentation Answers

- frags.pcap
 - Why might only 1 host have responded to the ICMP echo request?
 - Fragmented ICMP blocked by Google, but not by local router
- frags2.pcap
 - What was the server's response code?
 - 301
 - What URL was probably requested?
 - www.google.com



Practical Exercise – Scanning Answers

- nmap.pcap
 - Which host was performing scanning?
 - 192.168.2.175
 - `tcpdump -r nmap.pcap -nn 'tcp[13]=0x02' | cut -f3 -d ' ' | cut -f1-4 -d '.' | sort | uniq -c | sort -n`

```
reading from file nmap.pcap, link-type EN10MB (Ethernet)
      1 192.168.2.45
      3 192.168.2.75
     18 192.168.2.98
  4537 192.168.2.175
```



Practical Exercise – Scanning Answers

- nmap.pcap
 - Which host was the scan target?
 - 192.168.2.75
 - `tcpdump -r nmap.pcap -nn 'tcp[13]=0x02' | cut -f5 -d' ' | cut -f1-4 -d '.' | sort | uniq -c | sort -n`

```
reading from file nmap.pcap, link-type EN10MB (Ethernet)
 1 65.55.44.109
 4 192.168.2.45
 16 192.168.3.249
 4538 192.168.2.75
```



Practical Exercise – Scanning Answers

- nmap.pcap
 - How many TCP ports were scanned?
 - 1000
 - `sudo tcpdump -r nmap.pcap -nn 'tcp[13]=0x02 && src host 192.168.2.175 && dst host 192.168.2.75' | cut -f 5 -d' ' | cut -f5 -d'.| cut -f1 -d':' | sort | uniq | wc -l`
 - How many UDP ports were scanned?
 - 30
 - `sudo tcpdump -r nmap.pcap -nn 'udp && src host 192.168.2.175 && dst host 192.168.2.75' | cut -f 5 -d' ' | cut -f5 -d'.| cut -f1 -d':' | sort | uniq | wc -l`



Practical Exercise – Scanning Answers

- nmap.pcap

- Which TCP ports were open?

- 1025,1026,1027,1031,1032,1034,135,
139,2869,3306,445,5357

- sudo tcpdump -r nmap.pcap -nn
'tcp[13]=0x12 && dst host
192.168.2.175 && src host
192.168.2.75'| cut -f 3 -d' '| cut -f5 -d'.'|
cut -f1 -d':' | sort | uniq

```
reading from file nmap.pcap
1025
1026
1027
1031
1032
1034
135
139
2869
3306
445
5357
```



Practical Exercise – Scanning Answers

- nmap.pcap
 - What may have caused the scan behavior after 12:04:10?
 - Firewall enabled that does not reset connections

```
56710 → 445 [SYN] Seq=0 Win=29200
33664 → 111 [SYN] Seq=0 Win=29200
56884 → 256 [SYN] Seq=0 Win=29200
33784 → 443 [SYN] Seq=0 Win=29200
33602 → 22 [SYN] Seq=0 Win=29200 L
42012 → 53 [SYN] Seq=0 Win=29200 L
36270 → 113 [SYN] Seq=0 Win=29200
34480 → 23 [SYN] Seq=0 Win=29200 L
52224 → 587 [SYN] Seq=0 Win=29200
51006 → 8080 [SYN] Seq=0 Win=29200
51008 → 8080 [SYN] Seq=0 Win=29200
52230 → 587 [SYN] Seq=0 Win=29200
```

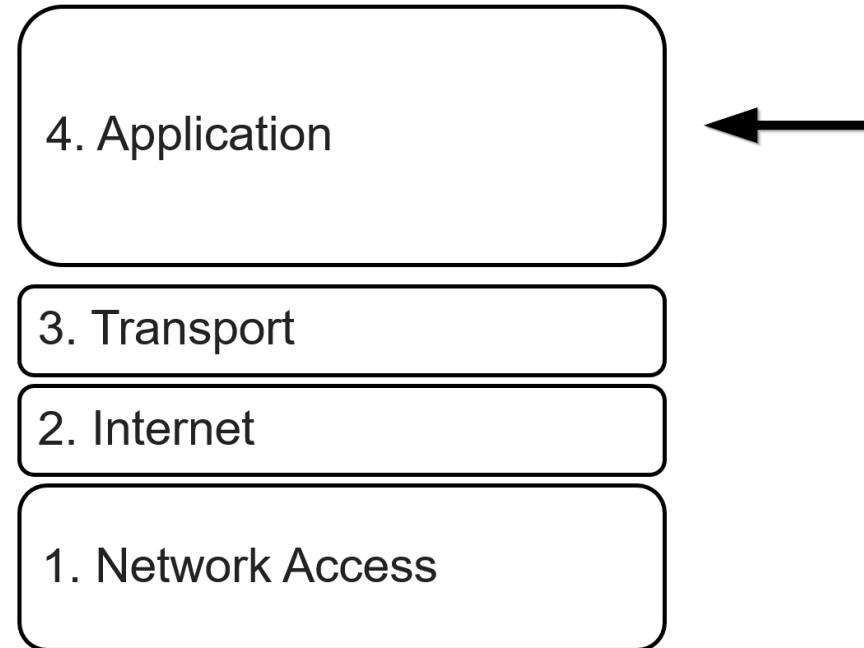


Part 3 – Common Protocols

Overview

Part 3 – Common Protocols

- HTTP
- SSL
- ARP (not app layer)
- DNS
- FTP



HTTP

- Extremely common
- Source of most infections
- Often permitted through firewalls
- Use 2015-08-31-traffic-analysis-exercise.pcap
for examples (from malware-traffic-analysis.net)



HTTP Request

URI Path

Referer

User Agent

Host Name

Wireshark · Follow HTTP Stream (tcp.stream eq 34) · 2015-08-31-traffic-analysis-exercise

```
GET / HTTP/1.1
Accept: text/html, application/xhtml+xml, */*
Referer: http://www.google.com/url?
sa=t&rct=j&q=&esrc=s&source=web&cd=2&ved=0CFIQFjABahUKEwjEyKvJ8tPHAhXKfJIKHe_hBUG&url=http
%3A%2F%2Fwww.bluproducts.com
%2F&ei=bpXkVcTZNMr5yQTvw5fABA&usg=AFQjCNFwAKScdYLAWSdw_9GoT-1hz1U8A
Accept-Language: en-US
User-Agent: Mozilla/5.0 (Windows NT 6.1; Trident/7.0; rv:11.0) like Gecko
Accept-Encoding: gzip, deflate
Host: www.bluproducts.com
DNT: 1
Connection: Keep-Alive
```



HTTP Response

```
HTTP/1.1 301 Moved Permanently
Location: http://www.google.com/
Content-Type: text/html; charset=UTF-8
Date: Mon, 31 Aug 2015 17:56:48 GMT
Expires: Wed, 30 Sep 2015 17:56:48 GMT
Cache-Control: public, max-age=2592000
Server: gws
Content-Length: 219
X-XSS-Protection: 1; mode=block
X-Frame-Options: SAMEORIGIN

<HTML><HEAD><meta http-equiv="content-type" content="text/html; charset=utf-8">
<TITLE>301 Moved</TITLE></HEAD><BODY>
<H1>301 Moved</H1>
The document has moved
<A HREF="http://www.google.com/">here</A>.
</BODY></HTML>
```



Important HTTP Response Headers

- “Referer”
 - Tells which page caused the current request
 - May be blank if referred from HTTP to HTTPS
- Location
 - 30X responses send user to “Location” header value
- Content-Type
 - Tells how to interpret server response



HTTP Redirection

- Only certain ways to load content
 - 30X response code
 - iframe
 - script
 - meta refresh
- <http://ranger-cha.blogspot.com/2015/02/following-trail-http-referer-header.html>



HTTP Forensics

- Starting from an alert...

```
08/31-17:58:18.615707  [**] [1:2021338:10] ET CURRENT_EVENTS Possible Evil Redirecto
Trojan was detected] [Priority: 1] {TCP} 64.20.39.203:80 -> 192.168.137.239:49259
08/31-17:58:18.958675  [**] [1:2025105:2] ET INFO DNS Query for Suspicious .ga Domai
] {UDP} 192.168.137.239:64920 -> 192.168.137.1:53
08/31-17:58:31.536056  [**] [1:2020716:2] ET POLICY Possible External IP Lookup ipin
tion] [Priority: 1] {TCP} 192.168.137.239:49286 -> 54.164.11.220:80
08/31-17:58:33.321082  [**] [1:2022284:3] ET TROJAN AlphaCrypt CnC Beacon 5 [**] [C1
CP} 192.168.137.239:49287 -> 72.55.148.19:80
08/31-17:58:34.271246  [**] [1:2021724:5] ET TROJAN Alphacrypt/TeslaCrypt Ransomware
as detected] [Priority: 1] {TCP} 72.55.148.19:80 -> 192.168.137.239:49287
08/31-17:59:15.095598  [**] [1:2022284:3] ET TROJAN AlphaCrypt CnC Beacon 5 [**] [C1
CP} 192.168.137.239:49288 -> 72.55.148.19:80
```



HTTP Forensics

- Use source port

tcp.port == 49259						
No.	Time	Source	Destination	Protocol	Length	Info
	7639 2015-08-31 ...	192.168.137.239	64.20.39.203	TCP	66	49259 → 80 [SYN] S
	7643 2015-08-31 ...	64.20.39.203	192.168.137.239	TCP	66	80 → 49259 [SYN, A]
	7644 2015-08-31 ...	192.168.137.239	64.20.39.203	TCP	60	49259 → 80 [ACK] S
→	7645 2015-08-31 ...	192.168.137.239	64.20.39.203	HTTP	381	GET / HTTP/1.1
	7651 2015-08-31 ...	64.20.39.203	192.168.137.239	TCP	54	80 → 49259 [ACK] S
	7654 2015-08-31 ...	64.20.39.203	192.168.137.239	TCP	1421	80 → 49259 [ACK] S
	7655 2015-08-31 ...	192.168.137.239	64.20.39.203	TCP	60	49259 → 80 [ACK] S
	7656 2015-08-31 ...	64.20.39.203	192.168.137.239	TCP	1421	80 → 49259 [ACK] S
	7657 2015-08-31 ...	64.20.39.203	192.168.137.239	TCP	1421	80 → 49259 [ACK] S



HTTP Forensics

-Follow TCP stream

```
GET / HTTP/1.1
Accept: text/html, application/xhtml+xml, /*/*
Referer: http://channels.feiddigest.com/domain?d=vitaminsthatrock.com
Accept-Language: en-US
User-Agent: Mozilla/5.0 (Windows NT 6.1; Trident/7.0; rv:11.0) like Gecko
Accept-Encoding: gzip, deflate
DNT: 1
Connection: Keep-Alive
Host: vitaminsthatrock.com
```



HTTP Forensics

- Find iframe

```
class="slzjmlkllun"><iframe src="http://vclphjybj.ioxbpjgtqvwfzmwhn.ga:13390/giant/1171219/host-dare-creature-valley-pour-tunnel-sense-season-thumb-soft" width="250" height="250"></iframe></div>
<div id="page">

<div id="header" role="banner">
    <div id="headerimg">
        <h1><a href="http://vitaminsinthatrock.com/">VitaminsThatRock.
```

1 client pkt, 1 server pkt, 1 turn.

Entire conversation (70 kB)

Show and save data as A

Find: iframe



HTTP Forensics

```
GET /giant/1171219/host-dare-creature-valley-pour-tunnel-sense-season-thumb-soft HTTP/1.1
Accept: text/html, application/xhtml+xml, /*
Referer: http://vitaminsthatrock.com/
Accept-Language: en-US
User-Agent: Mozilla/5.0 (Windows NT 6.1; Trident/7.0; rv:11.0) like Gecko
Accept-Encoding: gzip, deflate
Host: vclphjybj.ioxbpjgtqvqfzmwhn.ga:13390
DNT: 1
Connection: Keep-Alive
```

```
<param value= always name= allowScriptAccess />
<embed name="qvuhndngs" width="167" pluginspage="http://www.macromedia.com/go/
getflashplayer" allowScriptAccess="sameDomain" height="799" type="application/x-shockwave-
flash" quality="high" src="/defense/eGxyaGM" play="true" loop="false" align="middle"/>
</object>

</body>
```



HTTP Forensics

```
</html>GET /defense/eGxyaGM HTTP/1.1
Accept: /*
Accept-Language: en-US
Referer: http://vclphjybj.ioxbpjgtqvwfzmwhn.ga:13390/giant/1171219/host-dare-creature-
valley-nour-tunnel-sense-season-thumb-soft
x-flash-version: 18,0,0,203
Accept-Encoding: gzip, deflate
User-Agent: Mozilla/5.0 (Windows NT 6.1; Trident/7.0; rv:11.0) like Gecko
Host: vclphjybj.ioxbpjgtqvwfzmwhn.ga:13390
DNT: 1
Connection: Keep-Alive
```



HTTP Forensics

- After finding the exploit, work backwards from the alert



HTTP Forensics

```
GET /external/http%3A%2F%2Fvitaminsthatrock.com HTTP/1.1
Accept: text/html, application/xhtml+xml, /*
Referer: http://channels.feeddigest.com/domain?d=vitaminsthatrock.com
Accept-Language: en-US
User-Agent: Mozilla/5.0 (Windows NT 6.1; Trident/7.0; rv:11.0) like Gecko
Accept-Encoding: gzip, deflate
Host: channels.feeddigest.com
DNT: 1
Connection: Keep-Alive
Cookie: _ga=GA1.2.734754304.1441043872; _gat=1; _ym_visorc_31433973=w

HTTP/1.1 302 Found
Server: nginx/1.8.0
Date: Mon, 31 Aug 2015 17:58:15 GMT
Content-Type: text/html; charset=utf-8
Transfer-Encoding: chunked
Connection: keep-alive
Location: http://vitaminsthatrock.com
```



HTTP Forensics

- What happened?
 - User went to google
 - Clicked on a link
 - web.feeddigest.com
 - 302 redirect to vitaminsthatrock.com
 - iframe to
vclphjybj.ioxbpjgtqvwfzmwhn.ga:13390
 - Loaded flash exploit



HTTP Forensics

- Why bother?
 - Effective blocks
 - Supply malware analysis teams
 - Effective threat intelligence
 - Build statistics
 - Notify compromised sites



SSL

- Becoming more common
- Uses public key infrastructure (PKI)
- Encrypts other protocols (often HTTP)
- Can authenticate the client, but not common
- Often permitted through firewalls
- `ssl_pcap_example.pcap`



SSL Connection Steps

- TCP handshake
- Client hello (supported protocols & cipher suites)
- Server cert & key exchange (selected protocol & cipher suite)
- Client session key & change cipher spec



SSL Handshake in Wireshark

tcp.stream eq 0							Expression...	+
No.	Time	Source	Destination	Protocol	Length	Info		
1	2018-02-03...	::1	::1	TCP	94	55022 → 443 [SYN] Seq=0 Win=43690 Len=0 MSS=65476 SACK_PERM...		
2	2018-02-03...	::1	::1	TCP	94	443 → 55022 [SYN, ACK] Seq=0 Ack=1 Win=43690 Len=0 MSS=6547...		
3	2018-02-03...	::1	::1	TCP	86	55022 → 443 [ACK] Seq=1 Ack=1 Win=44032 Len=0 TSval=6681155...		
13	2018-02-03...	::1	::1	TLSv1.2	283	Client Hello		
14	2018-02-03...	::1	::1	TCP	86	443 → 55022 [ACK] Seq=1 Ack=198 Win=45056 Len=0 TSval=66811...		
21	2018-02-03...	::1	::1	TLSv1.2	1190	Server Hello, Certificate, Server Key Exchange, Server Hell...		
22	2018-02-03...	::1	::1	TCP	86	55022 → 443 [ACK] Seq=198 Ack=1105 Win=46080 Len=0 TSval=66...		
25	2018-02-03...	::1	::1	TLSv1.2	179	Client Key Exchange, Change Cipher Spec, Encrypted Handshak...		
28	2018-02-03...	::1	::1	TLSv1.2	360	New Session Ticket, Change Cipher Spec, Encrypted Handshake...		
37	2018-02-03...	::1	::1	TCP	86	55022 → 443 [RST, ACK] Seq=291 Ack=1379 Win=48128 Len=0 TSv...		



SSL – What do we know?

- Client supported protocols and cipher suites
 - Client public key if used
- Server selected protocol and cipher suite
- Server public certificate
 - May have site name in cert



SSL Decryption

- Need to decrypt the session key
- Does not work with Diffie-Hellman key exchange
- Client encryption info is ephemeral
 - Can enable SSL key logging in browser
- Server private key can decrypt



SSL Decryption

No.	Time	Source	Destination	Protocol	Length	Info
1	2018-02-03...	::1	::1	TCP	94	55022 → 443 [SYN] Seq=0 Win=43690 Len=0 MSS=65476 SACK
2	2018-02-03...	::1	::1	TCP	94	443 → 55022 [SYN, ACK] Seq=0 Ack=1 Win=43690 Len=0 MSS
3	2018-02-03...	::1	::1	TCP	86	55022 → 443 [ACK] Seq=1 Ack=1 Win=44032 Len=0 TSval=66
13	2018-02-03...	::1	::1	TLSv1.2	283	Client Hello
14	2018-02-03...	::1	::1	TCP	86	443 → 55022 [AC]
21	2018-02-03...	::1	::1	TLSv1.2	1190	Server Hello, C
22	2018-02-03...	::1	::1	TCP	86	55022 → 443 [AC]
25	2018-02-03...	::1	::1	TLSv1.2	179	Client Key Exch
28	2018-02-03...	::1	::1	TLSv1.2	360	New Session Tic
37	2018-02-03...	::1	::1	TCP	86	55022 → 443 [RS]

> Frame 13: 283 bytes on wire (2264 bits), 283 bytes captured (2264 bits)
> Ethernet II, Src: 00:00:00_00:00:00 (00:00:00:00:00:00), Dst: 00:
> Internet Pr Open Secure Sockets Layer preferences...
> Transmission
< Secure Sockets Layer RSA keys list... RSA keys list...
 ▼ TLSv1.2
 Content Reassemble SSL records spanning multiple TCP segments
 Version Reassemble SSL Application Data spanning multiple SSL records
 Length Message Authentication Code (MAC), ignore "mac failed"
 ▼ Handshake
 Pre-Shared-Key: ...
 (Pre)-Master-Secret log filename...
 Disable SSL...



SSL Decryption

The screenshot shows a NetworkMiner interface with a list of network packets. Packet 70 is selected, showing details for an HTTP request to '/meterpreter' over port 443. A context menu is open over this packet, listing options like 'Mark/Unmark Packet', 'Ignore/Unignore Packet', and 'Edit Resolved Name'. Below the menu, a submenu for 'Hypertext Transfer Protocol' is displayed, with 'SSL Stream' highlighted. The main list continues with other TCP and TLS packets.

Index	Date	Source IP	Destination IP	Protocol	Description
67	2018-02-03...	::1	::1	TCP	86 55174 → 443 [ACK] Seq=198 Ack=792 W
68	2018-02-03...	::1	::1	TLSv1.2	428 Client Key Exchange, Change Cipher
69	2018-02-03...	::1	::1	TLSv1.2	384 New Session Ticket, Change Cipher S
70	2018-02-03...	::1	::1	HTTP	603 GET /meterpreter HTTP/1.1
71	2018-02-03...	::1	::1	TLSv1.2	23
72	2018-02-03...	::1	::1	TLSv1.2	23
73	2018-02-03...	::1	::1	TCP	
74	2018-02-03...	::1	::1	TLSv1.2	65
75	2018-02-03...	::1	::1	TLSv1.2	15
76	2018-02-03...	::1	::1	TCP	
77	2018-02-03...	::1	::1	TLSv1.2	65
78	2018-02-03...	::1	::1	TLSv1.2	62

> Frame 70: 603 bytes on wire (4824 bits), 603 b
> Ethernet II, Src: 00:00:00_00:00:00 (00:00:00:
> Internet Protocol Version 6, Src: ::1, Dst: ::
> Transmission Control Protocol, Src Port: 55174
> Secure Sockets Layer
> Hypertext Transfer Protocol

- TCP Stream
- UDP Stream
- SSL Stream**
- HTTP Stream

Follow ▾

- Copy ▾
- Protocol Preferences ▾
- Decode As...
- Show Packet in New Window



Address Resolution Protocol (ARP)

- Resolve MAC address to IP address
- Stays within broadcast domain
- Request and response packets
- No security
 - Allows MitM



Address Resolution Protocol (ARP) Format

Hardware Type (Word)	Protocol Type (Word)	Hardware Size (Byte)	Protocol Size (Byte)	Opcode (Word)	Sender MAC (6 Bytes)	Sender IP (4 Bytes)	Target MAC (6 Bytes)	Target IP (4 Bytes)
----------------------	----------------------	----------------------	----------------------	---------------	----------------------	---------------------	----------------------	---------------------

▼ Address Resolution Protocol (request)

Hardware type: Ethernet (1)

Protocol type: IPv4 (0x0800)

Hardware size: 6

Protocol size: 4

Opcode: request (1)

Sender MAC address: Apple_a4:3b:c4 (6c:94:f8:a4:3b:c4)

Sender IP address: 192.168.2.158

Target MAC address: 00:00:00_00:00:00 (00:00:00:00:00:00)

Target IP address: 192.168.2.1



Address Resolution Protocol (ARP)

24	2018-02-03...	Vmware_28:20:8c	Broadcast	ARP	42 Who has 192.168.2.244? Tell 192.168.2.175
25	2018-02-03...	Vmware_28:20:8c	Broadcast	ARP	42 Who has 192.168.2.243? Tell 192.168.2.175
26	2018-02-03...	Vmware_28:20:8c	Broadcast	ARP	42 Who has 192.168.2.242? Tell 192.168.2.175
27	2018-02-03...	Vmware_28:20:8c	Broadcast	ARP	42 Who has 192.168.2.241? Tell 192.168.2.175
28	2018-02-03...	Vmware_28:20:8c	Broadcast	ARP	42 Who has 192.168.2.229? Tell 192.168.2.175
29	2018-02-03...	Vmware_28:20:8c	Broadcast	ARP	42 Who has 192.168.2.36? Tell 192.168.2.175
30	2018-02-03...	Vmware_28:20:8c	Raspberr_72:a5:28	ARP	60 192.168.2.45 is at 00:0c:29:28:20:8c
31	2018-02-03...	Vmware_28:20:8c	Raspberr_72:a5:28	ARP	60 192.168.2.60 is at 00:0c:29:28:20:8c
32	2018-02-03...	Vmware_28:20:8c	Raspberr_72:a5:28	ARP	60 192.168.2.60 is at 00:0c:29:28:20:8c
33	2018-02-03...	Vmware_28:20:8c	Raspberr_72:a5:28	ARP	60 192.168.2.60 is at 00:0c:29:28:20:8c
34	2018-02-03...	Vmware_28:20:8c	Raspberr_72:a5:28	ARP	60 192.168.2.75 is at 00:0c:29:28:20:8c
35	2018-02-03...	Vmware_28:20:8c	Raspberr_72:a5:28	ARP	60 192.168.2.79 is at 00:0c:29:28:20:8c
36	2018-02-03...	Vmware_28:20:8c	Raspberr_72:a5:28	ARP	60 192.168.2.110 is at 00:0c:29:28:20:8c

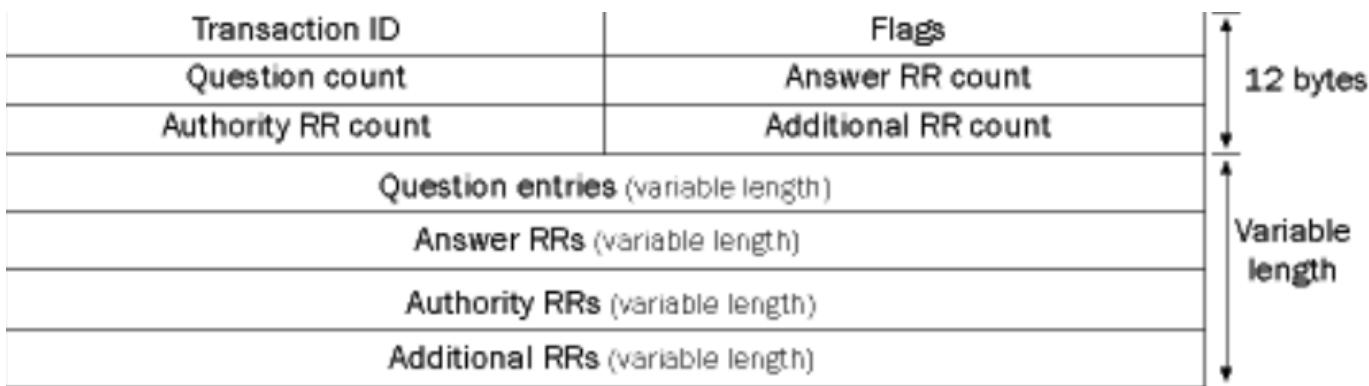


Domain Name Service (DNS)

- Resolves host names to IP addresses
- Often occurs before malicious traffic
- Also used for data exfiltration
- Usually UDP 53
 - Can be TCP 53



DNS Query Header



<https://technet.microsoft.com/en-us/library/bb962025.aspx>



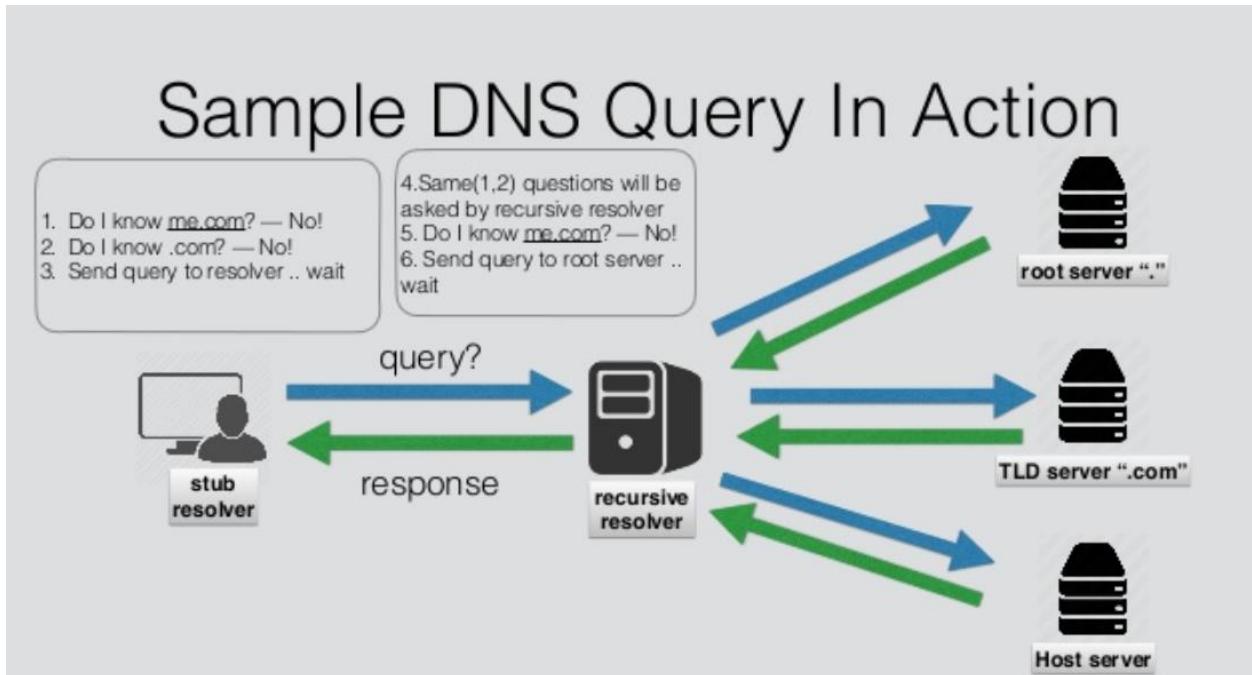
DNS Response Header

RR name (variable length)
Record type – 16 bits
Record class – 16 bits
TTL RR – 32-bits
Resource data length – 16 bits
Resource data – variable length

<https://technet.microsoft.com/en-us/library/bb962025.aspx>



DNS Recursion



DNS Odd Behavior

Time	Source	Destination	Protocol	Length	Info
524 2015-11-30...	52.2...	10.42...	DNS	156	Standard query response 0xe3d3 TXT cmd.sg1.atnascorp.com TXT
571 2015-11-30...	10.42...	52.2.2...	DNS	131	Standard query 0xe3d4 TXT cmd.sg1.atnascorp.com
573 2015-11-30...	52.2...	10.42...	DNS	188	Standard query response 0xe3d4 TXT cmd.sg1.atnascorp.com TXT
574 2015-11-30...	10.42...	52.2.2...	DNS	170	Standard query response 0x1337 TXT reply.sg1.atnascorp.com TXT
575 2015-11-30...	10.42...	52.2.2...	DNS	190	Standard query response 0x1337 TXT reply.sg1.atnascorp.com TXT
576 2015-11-30...	10.42...	52.2.2...	DNS	218	Standard query response 0x1337 TXT reply.sg1.atnascorp.com TXT
577 2015-11-30...	10.42...	52.2.2...	DNS	194	Standard query response 0x1337 TXT reply.sg1.atnascorp.com TXT
578 2015-11-30...	10.42...	52.2.2...	DNS	222	Standard query response 0x1337 TXT reply.sg1.atnascorp.com TXT
579 2015-11-30...	10.42...	52.2.2...	DNS	230	Standard query response 0x1337 TXT reply.sg1.atnascorp.com TXT
580 2015-11-30...	10.42...	52.2.2...	DNS	206	Standard query response 0x1337 TXT reply.sg1.atnascorp.com TXT
581 2015-11-30...	10.42...	52.2.2...	DNS	198	Standard query response 0x1337 TXT reply.sg1.atnascorp.com TXT
582 2015-11-30...	10.42...	52.2.2...	DNS	250	Standard query response 0x1337 TXT reply.sg1.atnascorp.com TXT
583 2015-11-30...	10.42...	52.2.2...	DNS	226	Standard query response 0x1337 TXT reply.sg1.atnascorp.com TXT
584 2015-11-30...	10.42...	52.2.2...	DNS	242	Standard query response 0x1337 TXT reply.sg1.atnascorp.com TXT
585 2015-11-30...	10.42...	52.2.2...	DNS	198	Standard query response 0x1337 TXT reply.sg1.atnascorp.com TXT
586 2015-11-30...	10.42...	52.2.2...	DNS	218	Standard query response 0x1337 TXT reply.sg1.atnascorp.com TXT



File Transfer Protocol

- Plaintext protocol for transferring files
- May be wrapped in SSL (FTPS)
- Not to be confused with SFTP (SSH file transfer)
- USER command to send username
- PASS command to send password
- Two types of FTP, active and passive

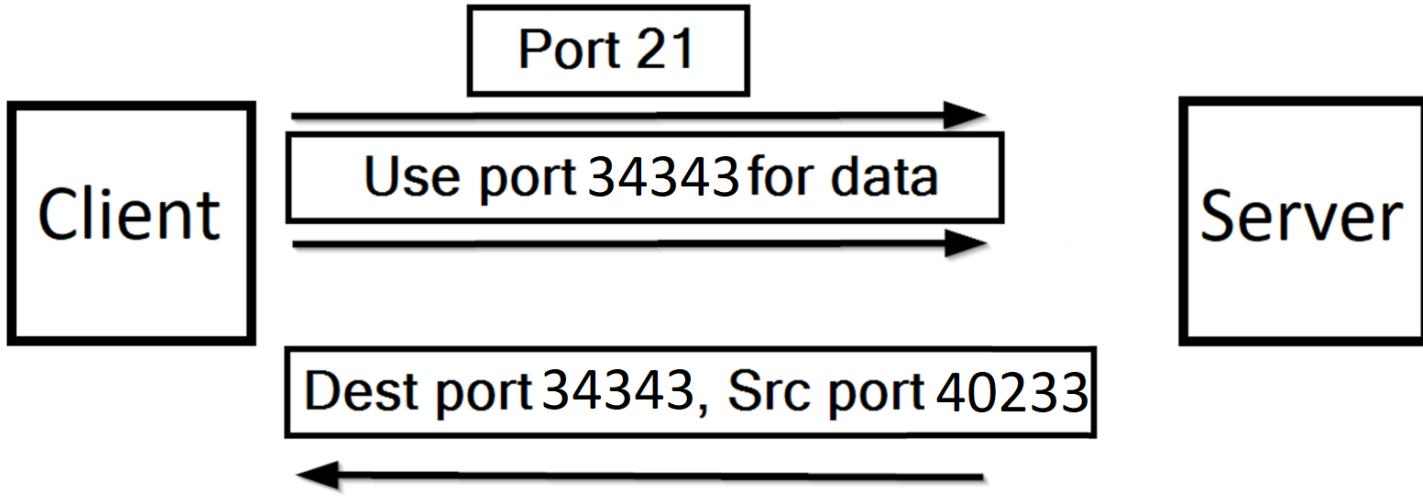


Active Mode FTP

- Client connects to server on port 21 (command channel)
- **Client gives server an ephemeral port for data (data channel)**
- **Server connects back to client on data channel (ephemeral source and destination)**



Active Mode FTP

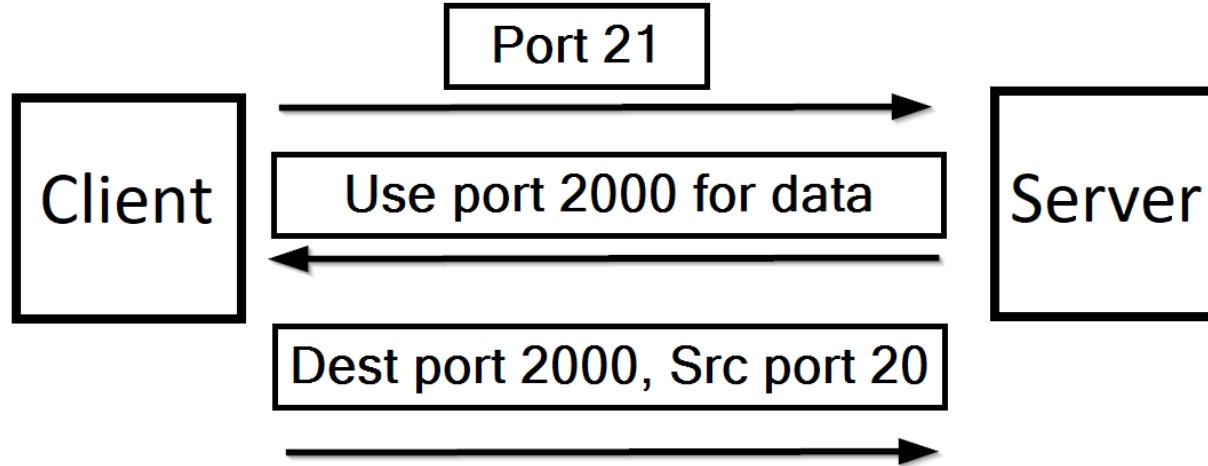


Passive Mode FTP

- Client connects to server on port 21 (command channel)
- **Server gives client** an ephemeral port for data (data channel)
- **Client connects to server** on data channel (source port 20)



Passive Mode FTP



Part 4 – Scapy

Scapy

- Python packet crafting library
- Written by Philippe Biondi
- Slow, but simple
 - Not great for broad scanning
- Helpful for simulating odd behavior
- Allows complex sequences of packets



Scapy

- Define each layer of a packet
- Ping localhost
 - testpacket = IP(dst="127.0.0.1")/ICMP()
- Connect to Bing on port 80 TCP
 - testpacket =
IP(dst="www.bing.com")/TCP(dport=80)/*GET /
HTTP/1.1\r\n\rn"
 - Not going to work great
 - Data on SYN
 - Networking stack will reset the connection



Scapy – useful commands

-ls(): list all object members

```
>>> ls(IP)
version      : BitField (4 bits)                      = (4)
ihl         : BitField (4 bits)                      = (None)
tos          : XByteField                           = (0)
len          : ShortField                          = (None)
id           : ShortField                          = (1)
flags        : FlagsField (3 bits)                   = (0)
frag         : BitField (13 bits)                  = (0)
ttl          : ByteField                           = (64)
proto        : ByteEnumField                     = (0)
chksum       : XShortField                        = (None)
src          : SourceIPField (Emph)                = (None)
dst          : DestIPField (Emph)                 = (None)
options      : PacketListField                   = ([])
```



Scapy – useful commands

-object.summary: list non-default field values

```
>>> testpacket.summary  
<bound method IP.summary of <IP frag=0 proto=tcp  
dst=Net('www.bing.com') |<TCP dport=http |<Raw  
load='GET / HTTP/1.1\n\n' |>>>
```



Scapy – useful commands

- Resp, noresp = sr(testpacket)
 - Send packet, match responses. Store responses in resp, unanswered packets in noresp
- sr1(testpacket)
 - Send packet, match single response
- send(testpacket)
 - Send packet, do not look for responses



Scapy – notes

- Native networking stack may get confused
 - Diagnose with tcpdump
 - Use iptables to prevent it
 - `iptables --save >> iptables_original`
 - `iptables -A OUTPUT -p tcp --tcp-flags RST RST -j DROP`
 - Fix using `iptables --restore iptables_original` or `iptables --flush`
- Run Scapy as root



Part 5 – Analysis Tips

Common External Ports

- Good egress filtering should block most external traffic
- Permitted traffic should go through an intermediary
 - TCP:80 (HTTP)
 - TCP:443 (SSL)
 - UDP:123 (NTP)
 - Should be blocked
 - UDP:53 (DNS)



Common Internal TCP Ports

- 22 (SSH)
- 445 (SMB)
- 88 (Kerberos)
- 135 (DCE/RPC)
- 389 (LDAP)
- 636 (LDAPS)
- 993 (IMAPS)



Common Internal TCP Ports

- 80 (HTTP)
- 443 (HTTPS)
- 8080 (Alternate HTTP)
- 8443 (Alternate HTTPS)
- Ephemeral ports (RPC)



Common Internal UDP Ports

- 53 (DNS)
- 5355(LLMNR)
- 123(NTP)
- 514(SYSLOG)



Alerts

- Many sources
 - Intrusion Detection System
 - Intrusion Prevention System
 - Web Application Firewall
- Signatures are not always great
- Places to start
 - Use the source port



Continued Analysis

- Work forward for post infection
 - Find binary files for analysis
 - Identify command and control traffic
- Work backward to find the origin
 - Often starts with legitimate sites



Useful Techniques

- Wireshark display filters
 - dns || http.request.full_uri || ssl.handshake.certificate
- Find “odd” URLs
 - Long alphanumeric strings that are not words
 - Directed outside of domain
 - Use “referer” to work backwards
 - Find redirection call in calling page (URL string)



Automated Tools

- Virustotal.com
 - Binaries or pcaps
- Sandboxes
 - <https://zeltser.com/automated-malware-analysis/>



More Training

- <https://malware.dontneedcoffee.com/>
- <https://contagiodump.blogspot.com/>
- <https://www.malware-traffic-analysis.net/>
- <https://www.root-me.org/>



Part 6 – Practical Exercise

ch2.pcap
(from root-me.org)

-Find the FTP password



ch3.pcap
(from root-me.org)

-Find the twitter password



2015-03-24-traffic-analysis-exercise.pcap
(from malware-traffic-analysis.net)

- IP address of the infected host
- Which server is probably legitimate, but compromised?
- What redirection techniques does this exploit kit use?
- What malware was used?



sansholidayhack2013.pcap (from the SANS holiday hack challenge, 2013)

- What are the MACs and IPs of the machines that ARP cache poison? Is it successful?
- What are the IPs of the systems that were port scanning?
- What systems and protocols did the scan discover?
- What account was used in an attack over the SMB protocol?



packet_intro.pcap

- What are the max and minimum SSL/TLS versions supported by 192.168.2.122?
- Find the 7 flags



Part 7 – Practical Exercise Answers

ch2.pcap

- Find the FTP password
 - ngrep for PASS

```
rangercha@kali:~/mnt/hgfs/vmshared/training/packet_intro_long$ ngrep -qI ch2.pcap 'PASS'  
input: ch2.pcap  
filter: ((ip || ip6) || (vlan && (ip || ip6)))  
match: PASS  
  
T 10.20.144.150:35974 -> 10.20.144.151:21 [AP] #11  
PASS cdts3500..
```



ch3.pcap

- Find the twitter password
- `ngrep -ql ch3.pcap 'Authorization: Basic' | tr ':' '\n' | grep 'Basic' | cut -f3 -d' ' | cut -f1 -d'.' | base64 -d`

```
rangercha㉿kali:/mnt/hgfs/vmshared/training/packet_intro_long$ ngrep -qI ch  
3.pcap 'Authorization: Basic' | tr ':' '\n' | grep 'Basic' | cut -f3 -d' '  
| cut -f1 -d'.' | base64 -d  
usertest:passwordrangercha㉿kali:/mnt/hgfs/vmshared/training/packet_intro_l  
ong$ █
```



2015-03-24-traffic-analysis-exercise.pcap

- IP address of the infected host
 - 192.168.122.200
- Which server is probably legitimate, but compromised?
 - forums.pelicanparts.com
- What redirection techniques does this exploit kit use?
 - Script tag injection
- What types of exploits were served?
 - Adobe Reader, Flash, Java, Silverlight



sansholidayhack2013.pcap

- What are the MACs and IPs of the machines that ARP cache poison? Is it successful?
 - 00:0c:29:f7:f4:9a - 10.21.22.253 - successful
 - 10.25.22.252 - unsuccessful
- What are the IPs of the systems that were port scanning?
 - 10.25.22.252, 10.21.22.253, 10.25.22.253
 - `tcpdump -nn -r sansholidayhack2013.pcap 'tcp[13]=0x02' | cut -f3,5 -d' ' | tr ' ' '.' | cut -f1-4,6-10 -d'.' | sort | uniq -c | sort -rn`
 - `tcpdump -nn -r sansholidayhack2013.pcap 'tcp[13]=0x14' | cut -f5 -d' ' | cut -f1-4 -d'.' | sort | uniq -c | sort -n`



sansholidayhack2013.pcap

- What systems and protocols did the scans discover?
 - `tcpdump -nn -r sansholidayhack2013.pcap 'tcp[13]=0x12 && (dst host 10.25.22.252 || dst host 10.21.22.253 || dst host 10.25.22.253)' | cut -f3 -d' ' | sort | uniq`



sansholidayhack2013.pcap

10.16.11.5.110	10.25.22.22.80	165.254.158.56.80	208.80.154.234.80
10.21.22.22.502	10.25.22.23.80	173.194.43.47.443	208.80.154.240.80
10.21.22.23.502	10.25.22.250.80	192.190.173.45.80	216.22.25.175.80
10.21.22.24.502	10.25.22.30.80	192.204.3.75.80	54.230.49.239.80
10.21.22.253.1225	10.25.22.58.4444	199.7.57.72.80	63.245.217.36.80
10.2.2.2.8081	10.25.22.58.445	208.80.154.224.80	69.16.175.10.80
72.167.239.239.80	74.125.226.239.443	82.103.140.42.443	74.125.226.228.80



sansholidayhack2013.pcap

72.21.195.198.443	74.125.226.242.443	10.25.22.22.44818
72.21.203.211.80	74.125.226.251.80	165.254.138.136.80
72.21.214.3.443	74.125.22.82.80	208.80.154.225.80
72.21.215.52.80	81.169.180.37.443	69.195.141.178.443
74.125.226.199.443	81.169.180.37.80	82.103.134.102.80



sansholidayhack2013.pcap

- What account was used in an attack over the SMB protocol?
 - ernie



packet_intro.pcap

- What are the max and minimum SSL/TLS versions supported by 192.168.2.122?
 - Max: TLS 1.2
 - Min: TLS 1.0



packet_intro.pcap

No.	Date	Source	Destination	Protocol	Length
111	2016-05-29 ...	192.168.2.122	216.58.193.132	TLSv1.2	583
116	2016-05-29 ...	216.58.193.132	192.168.2.122	TLSv1.2	2
118	2016-05-29 ...	192.168.2.122	216.58.193.132	TLSv1.2	1

> Frame 111: 583 bytes on wire (4664 bits), 583 bytes captured (4664 bits)
> Ethernet II, Src: Vmware_f0:0b:61 (00:0c:29:f0:0b:61), Dst: AsustekC_be:1
> Internet Protocol Version 4, Src: 192.168.2.122, Dst: 216.58.193.132
> Transmission Control Protocol, Src Port: 40702, Dst Port: 443, Seq: 1, Ack: 1
▼ Secure Sockets Layer
 ▼ TLSv1.2 Record Layer: Handshake Protocol: Client Hello
 Content Type: Handshake (22)
 Version: TLS 1.0 (0x0301)
 Length: 512
 ▼ Handshake Protocol: Client Hello
 Handshake Type: Client Hello (1)
 Length: 500
 Version: TLS 1.2 (0x0303)
 Random: F2d5a94c15a18e1e4845f09e01c9a2353710b639e7ef06b4...
 Session ID Length: 32
 Session ID: dae500cd74df5dc6c9a4351d72b82efd997499260631196...



packet_intro.pcap

-Flag 1

- http.request.full_uri contains “flag”

http.request.full_uri contains flag			
Frame	Time	Source	Dest
56	2016-05-29 22:14:30.517459	192.168.2.122	54

```
Frame 56: 175 bytes on wire (1400 bits), 175 bytes captured (1400 bits)
Ethernet II, Src: Vmware_f0:0b:61 (00:0c:29:f0:0b:61), Dst: AsustekC_be:f7:98
Internet Protocol Version 4, Src: 192.168.2.122, Dst: 54.152.144.243
Transmission Control Protocol, Src Port: 37452, Dst Port: 80, Seq: 1, Ack: 1,
Hypertext Transfer Protocol
> GET /f490a35ac6f7ee0e686a7e2179524bf2 HTTP/1.1\r\n
Host: www.flag1.com\r\n
User-Agent: curl/7.47.0\r\n
Accept: */*\r\n
\r\n
[Full request URI: http://www.flag1.com/f490a35ac6f7ee0e686a7e2179524bf2]
```



packet_intro.pcap

-Flag 2

-ngrep -qI packet_intro.pcap 'flag2'

```
root@kali:/mnt/hgfs/vmshared/training/packet_intro_long# ngrep -qI packet_intro.pcap
'flag2'
input: packet_intro.pcap
filter: ((ip || ip6) || (vlan && (ip || ip6)))
match: flag2

T 192.168.2.122:57196 -> 66.235.120.113:80 [AP] #2344
    GET / HTTP/1.1..Host: askjeevs.com..User-Agent: flag2:82d5927b53538c2da5c4e5eadba2bf2a..Accept: */*.....
root@kali:/mnt/hgfs/vmshared/training/packet_intro_long#
```



packet_intro.pcap

-Flag 3

```
-ngrep -qI packet_intro.pcap 'flag3'
```

```
root@kali:/mnt/hgfs/vmshared/training/packet_intro_long# ngrep -qI packet_intro.pcap
'flag3'
input: packet_intro.pcap
filter: ((ip || ip6) || (vlan && (ip || ip6)))
match: flag3

U 192.168.2.122:60663 -> 8.8.8.8:53 #4750
.V..... b768e1e8075fd6c1b7c11c84536dd467.flag3.com.....
U 8.8.8.8:53 -> 192.168.2.122:60663 #4757
.V..... b768e1e8075fd6c1b7c11c84536dd467.flag3.com.....?dns1.re
gistrar-servers.com,..hostmaster.Mx..0.....:
```



packet_intro.pcap

- Flag 4
 - echo "flag" | base64
 - ngrep -ql packet_intro.pcap 'ZmxhZ'
 - ngrep -ql packet_intro.pcap 'ZmxhZ' | grep 'ZmxhZ' | tr -s '' | cut -f3 -d' ' | cut -f2- -d'=' | base64 -d



packet_intro.pcap

```
rangercha@kali:/mnt/hgfs/vmshared/training/packet_intro_long$ echo "flag" | base64  
ZmxhZwo=  
rangercha@kali:/mnt/hgfs/vmshared/training/packet_intro_long$ ngrep -qI packet_intro.pcap 'ZmxhZ'  
input: packet_intro.pcap  
filter: ((ip || ip6) || (vlan && (ip || ip6)))  
match: ZmxhZ  
  
T 192.168.2.122:56154 -> 174.36.107.130:80 [AP] #5040  
GET /?a=ZmxhZzQ6MDIxMDFkZDNmNwYxZjA0NGRiYjM1YTUzMDUyMjQx0Tc== HTTP/1.1..Host: supersketch.com..User-Agent: curl/7.47.  
0..Accept: */*....  
  
rangercha@kali:/mnt/hgfs/vmshared/training/packet_intro_long$ ngrep -qI packet_intro.pcap 'ZmxhZ' |  
grep 'ZmxhZ' | tr -s ' ' | cut -f3 -d' ' | cut -f2- -d'=' | base64 -d  
flag4:02101dd3f5f1f044dbb35a5305224197base64: invalid input  
rangercha@kali:/mnt/hgfs/vmshared/training/packet_intro_long$
```



packet_intro.pcap

- Flag 5
 - echo "flag5" | xxd -ps
 - ngrep -ql packet_intro.pcap '666c616735'
 - printf
"666c6167353a643638666337323164613331
6565663932663565373939616466643534653
139" | xxd -r -p



packet_intro.pcap

```
rangercha@kali:/mnt/hgfs/vmshared/training/packet_intro_long$ echo "flag5" | xxd -ps  
666c6167350a  
rangercha@kali:/mnt/hgfs/vmshared/training/packet_intro_long$ ngrep -qI packet_intro.pcap '666c616735'  
input: packet_intro.pcap  
filter: ((ip || ip6) || (vlan && (ip || ip6)))  
match: 666c616735  
  
T 192.168.2.122:51588 -> 204.79.197.200:80 [AP] #5712  
GET /search=666c6167353a6436386663373231646133316565663932663565373939616466643534653139 HTTP/1  
.1..Host: bing.com..User-Agent: curl/7.47.0..Accept: */*....  
  
T 204.79.197.200:80 -> 192.168.2.122:51588 [AP] #5728  
HTTP/1.1 301 Moved Permanently..Location: http://www.bing.com/search=666c6167353a64363866633732  
31646133316565663932663565373939616466643534653139..Server: Microsoft-IIS/8.5..X-MSEdge-Ref: Re  
f A: FE730BDA1B4241D7AC872F3CE666680F Ref B: 36FB7548E3AF536AF11F30FF82345B4A Ref C: Sun May 29  
19:15:33 2016 PST..Date: Mon, 30 May 2016 02:15:32 GMT..Content-Length: 0....  
rangercha@kali:/mnt/hgfs/vmshared/training/packet_intro_long$ printf "666c6167353a643638666337323164  
6133316565663932663565373939616466643534653139" | xxd -r -p
```



packet_intro.pcap

- Flag 6
 - tshark -r packet_intro.pcap -T fields -e icmp.type -Y 'icmp' | xargs printf '%0x' | xxd -r -p



packet_intro.pcap



packet_intro.pcap

- Flag 7
 - tcpdump -r packet_intro.pcap -nnA 'icmp' | grep '\.\.' | cut -f4 -d'-' | grep -v '@\.\.\.\.\.\.z' | tr -d '\n'



packet_intro.pcap

```
rangercha@kali:/mnt/hgfs/vmshared/training/packet_intro_long$ sudo tcpdump  
-r packet_intro.pcap -nnA 'icmp' | grep '\.\.' | cut -f4 -d '-' | grep  
-v '@\.\.\.\.\.\.z' | tr -d '\n'  
[sudo] password for rangercha:  
reading from file packet_intro.pcap, link-type EN10MB (Ethernet)  
flag7:02ae9641b7052bfa4124dc41943cf36c rangercha@kali:/mnt/hgfs/vmshared/tr
```





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