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Troubleshooting IPv6 in Wireshark

Jeffrey L Carrell

Hewlett Packard Enterprise

Network Instructor

jeff.carrell@teachmeipv6.com

Twitter: @JeffCarrell_v6

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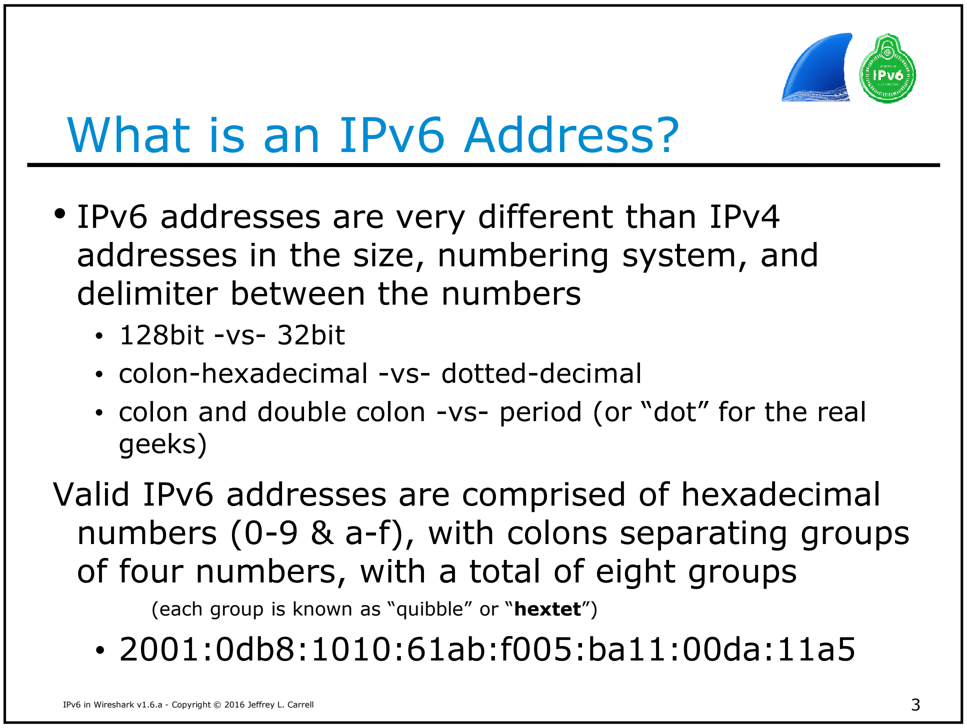
IPv6 in Wireshark

- IPv6 – a very quick review
- Wireshark basics
- Wireshark color rules, display filters, columns, configuration profiles, and packet annotation
- IPv6 in Wireshark: hands-on labs



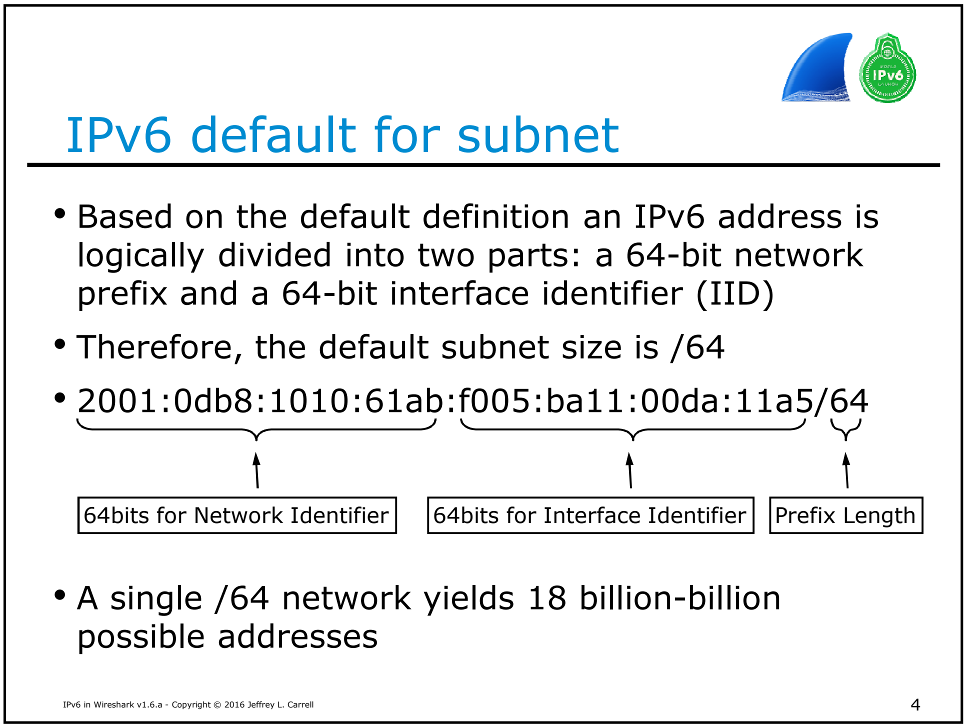
What is an IPv6 Address?

- IPv6 addresses are very different than IPv4 addresses in the size, numbering system, and delimiter between the numbers
  - 128bit -vs- 32bit
  - colon-hexadecimal -vs- dotted-decimal
  - colon and double colon -vs- period (or “dot” for the real geeks)

Valid IPv6 addresses are comprised of hexadecimal numbers (0-9 & a-f), with colons separating groups of four numbers, with a total of eight groups

(each group is known as “quibble” or “**hextet**”)

- 2001:0db8:1010:61ab:f005:ba11:00da:11a5



IPv6 default for subnet

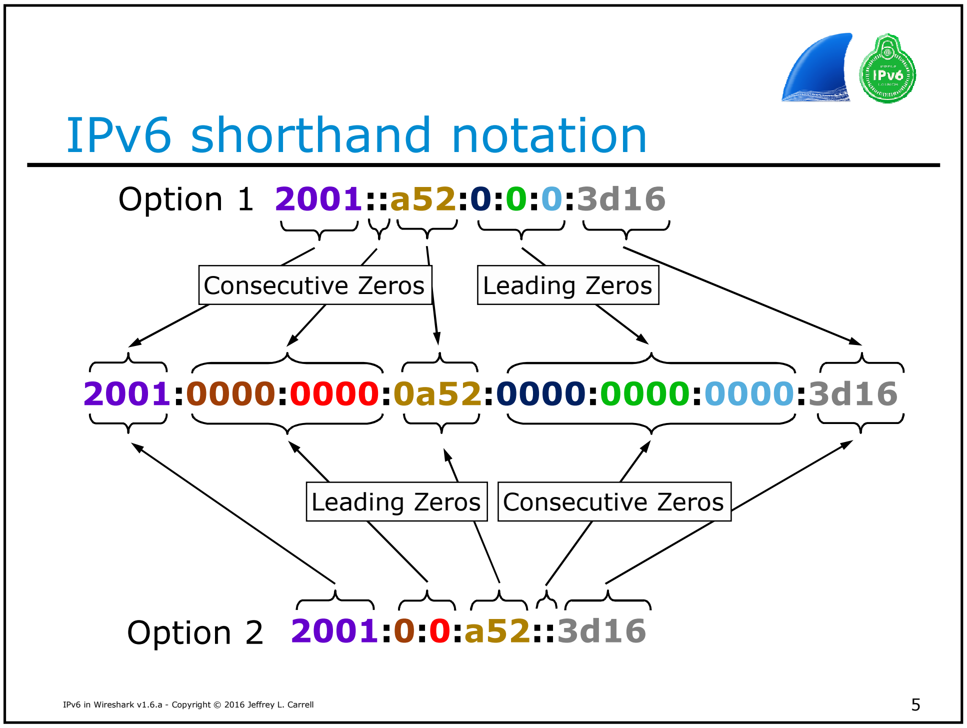
- Based on the default definition an IPv6 address is logically divided into two parts: a 64-bit network prefix and a 64-bit interface identifier (IID)
- Therefore, the default subnet size is /64
- 2001:0db8:1010:61ab:f005:ba11:00da:11a5/64

64bits for Network Identifier

64bits for Interface Identifier

Prefix Length

- A single /64 network yields 18 billion-billion possible addresses



IPv6 shorthand notation

Option 1 2001::a52:0:0:0:3d16

Consecutive Zeros

Leading Zeros

2001:0000:0000:0a52:0000:0000:0000:3d16

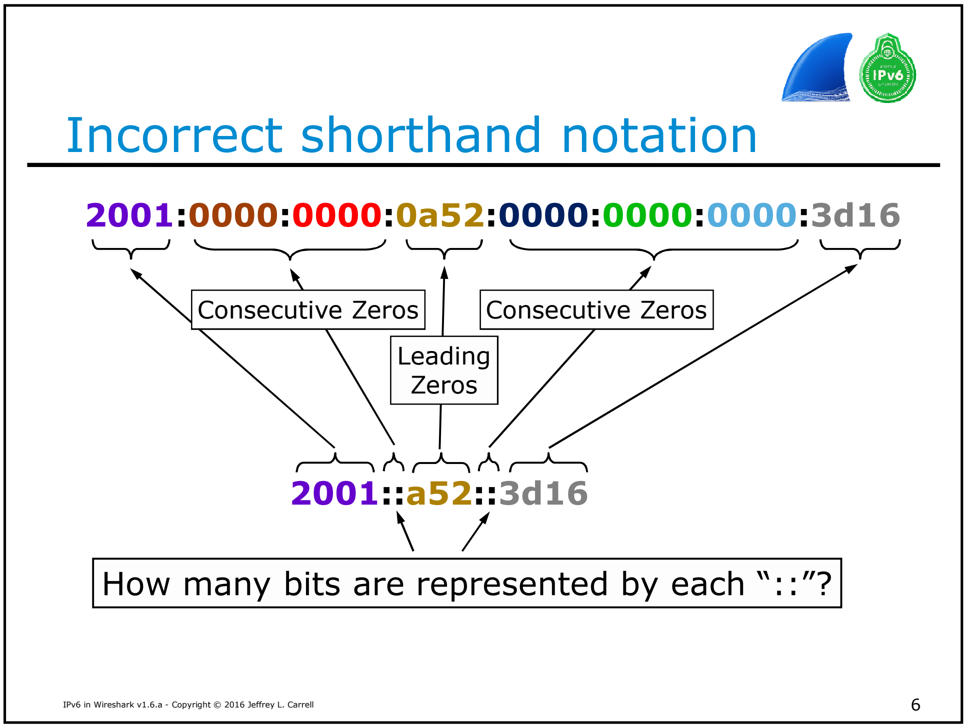
Leading Zeros

Consecutive Zeros

Option 2 2001:0:0:a52::3d16

IPv6 in Wireshark v1.6.a - Copyright © 2016 Jeffrey L. Carrell

5



Incorrect shorthand notation

2001:0000:0000:0a52:0000:0000:0000:3d16

Consecutive Zeros

Consecutive Zeros

Leading Zeros

2001::a52::3d16

How many bits are represented by each "::"?

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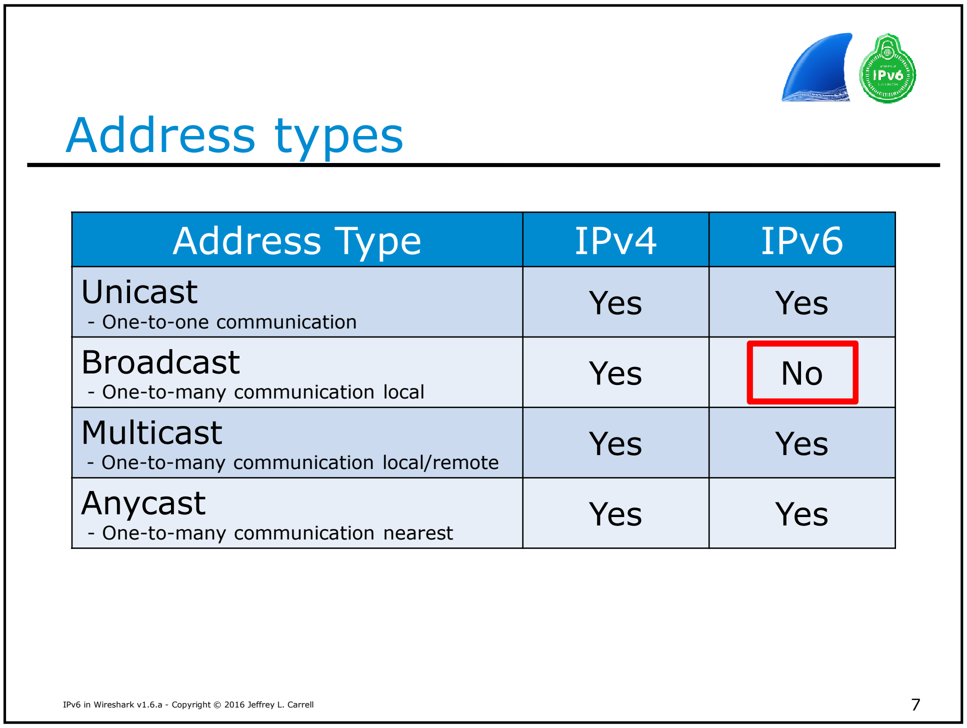
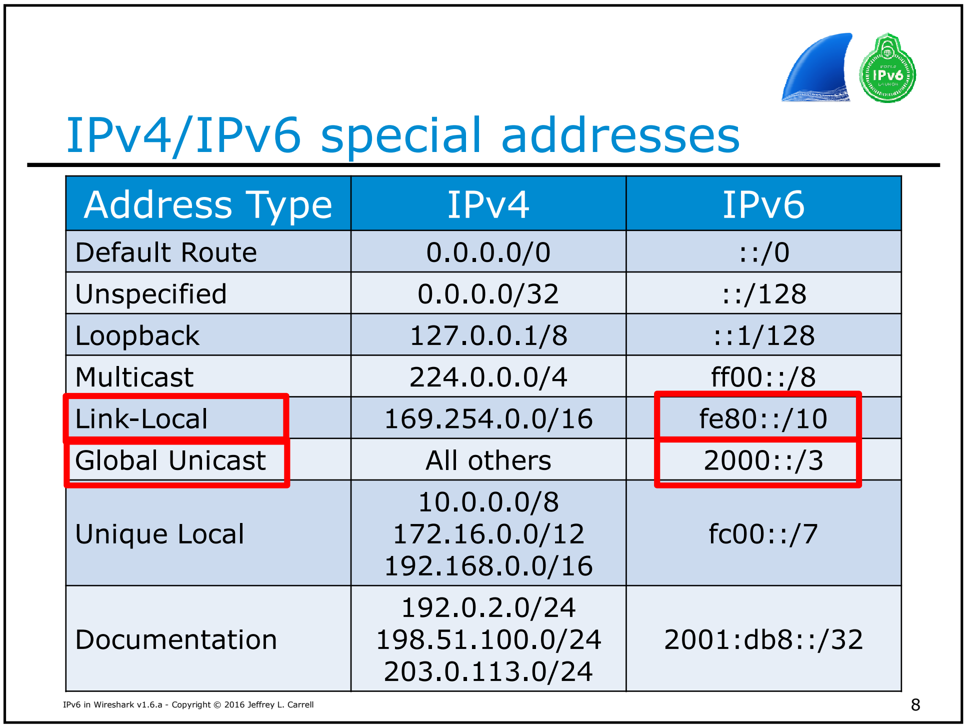
6



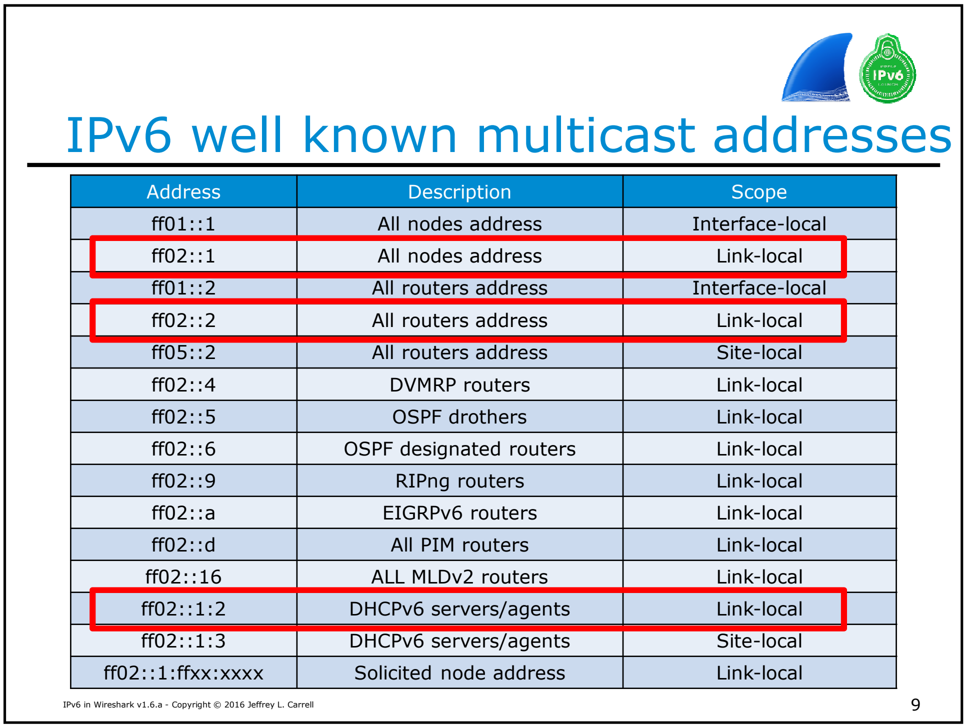
Address types

Address Type	IPv4	IPv6
Unicast - One-to-one communication	Yes	Yes
Broadcast - One-to-many communication local	Yes	No
Multicast - One-to-many communication local/remote	Yes	Yes
Anycast - One-to-many communication nearest	Yes	Yes



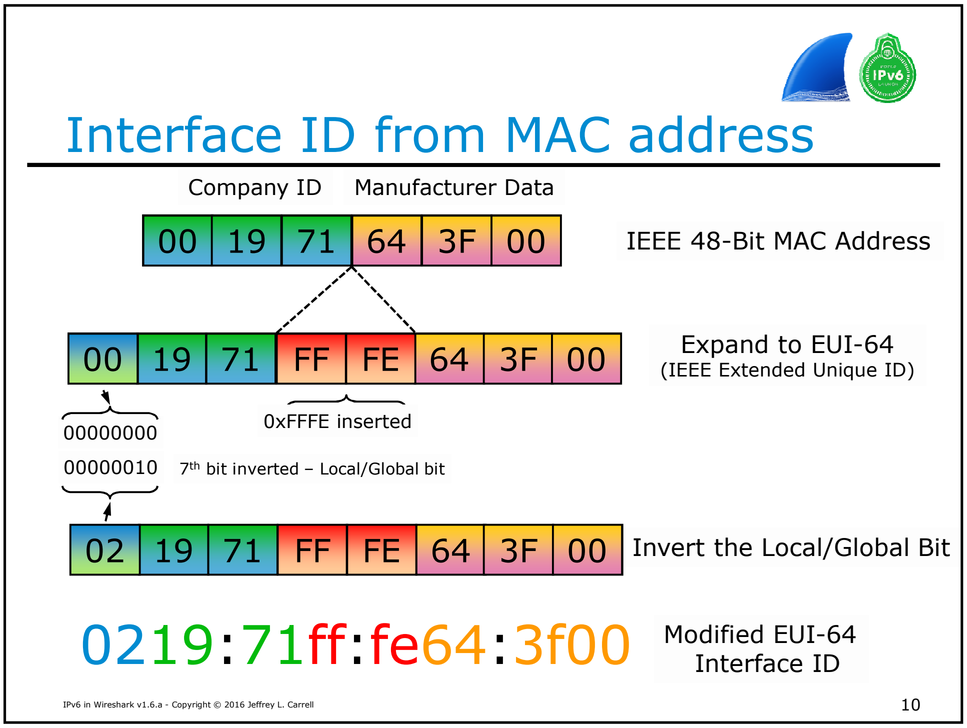
IPv4/IPv6 special addresses

Address Type	IPv4	IPv6
Default Route	0.0.0.0/0	::/0
Unspecified	0.0.0.0/32	::/128
Loopback	127.0.0.1/8	::1/128
Multicast	224.0.0.0/4	ff00::/8
Link-Local	169.254.0.0/16	fe80::/10
Global Unicast	All others	2000::/3
Unique Local	10.0.0.0/8 172.16.0.0/12 192.168.0.0/16	fc00::/7
Documentation	192.0.2.0/24 198.51.100.0/24 203.0.113.0/24	2001:db8::/32



IPv6 well known multicast addresses

Address	Description	Scope
ff01::1	All nodes address	Interface-local
ff02::1	All nodes address	Link-local
ff01::2	All routers address	Interface-local
ff02::2	All routers address	Link-local
ff05::2	All routers address	Site-local
ff02::4	DVMRP routers	Link-local
ff02::5	OSPF drothers	Link-local
ff02::6	OSPF designated routers	Link-local
ff02::9	RIPng routers	Link-local
ff02::a	EIGRPv6 routers	Link-local
ff02::d	All PIM routers	Link-local
ff02::16	ALL MLDv2 routers	Link-local
ff02::1:2	DHCPv6 servers/agents	Link-local
ff02::1:3	DHCPv6 servers/agents	Site-local
ff02::1:ffxx:xxxx	Solicited node address	Link-local



Interface ID from MAC address

Company ID Manufacturer Data

00 | 19 | 71 | 64 | 3F | 00 IEEE 48-Bit MAC Address

00 | 19 | 71 | FF | FE | 64 | 3F | 00 Expand to EUI-64 (IEEE Extended Unique ID)

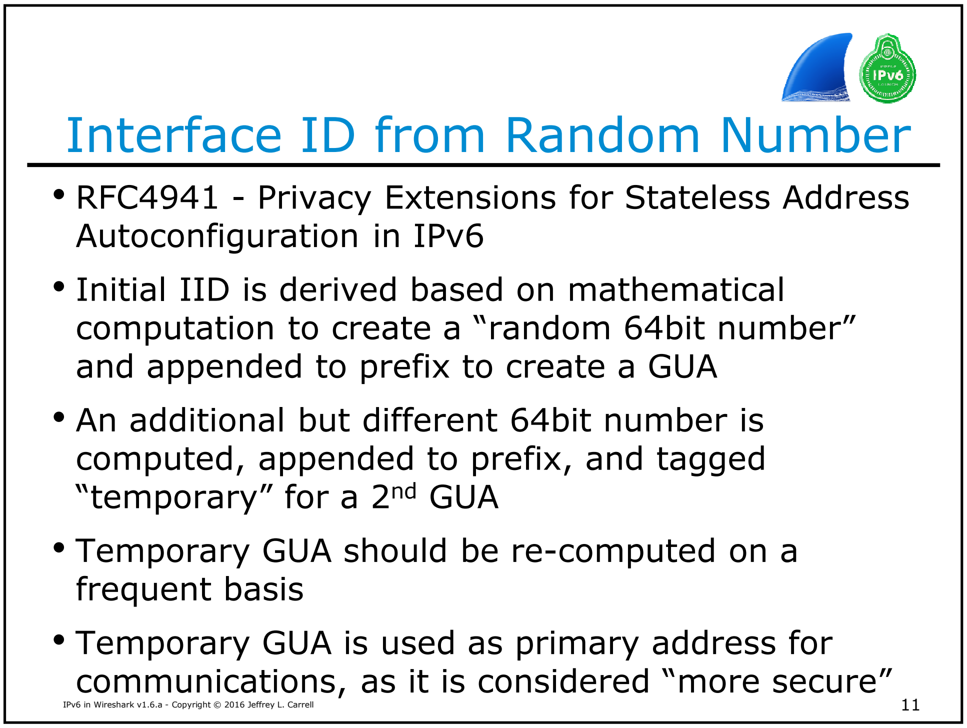
00000000

00000010 7th bit inverted – Local/Global bit

0xFFFE inserted

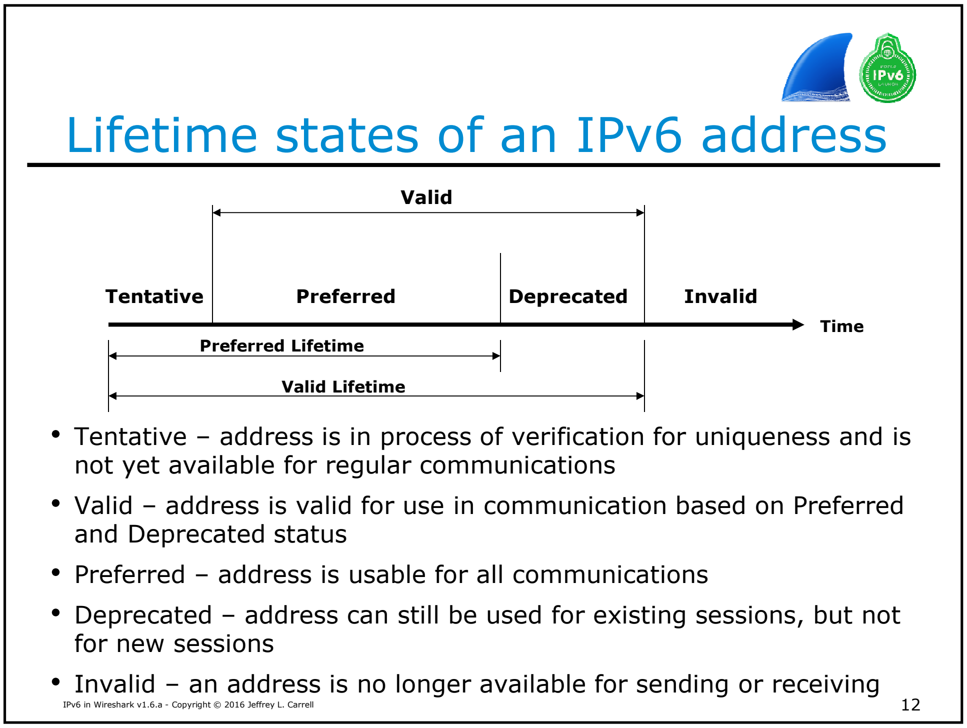
02 | 19 | 71 | FF | FE | 64 | 3F | 00 Invert the Local/Global Bit

0219:71ff:fe64:3f00 Modified EUI-64 Interface ID



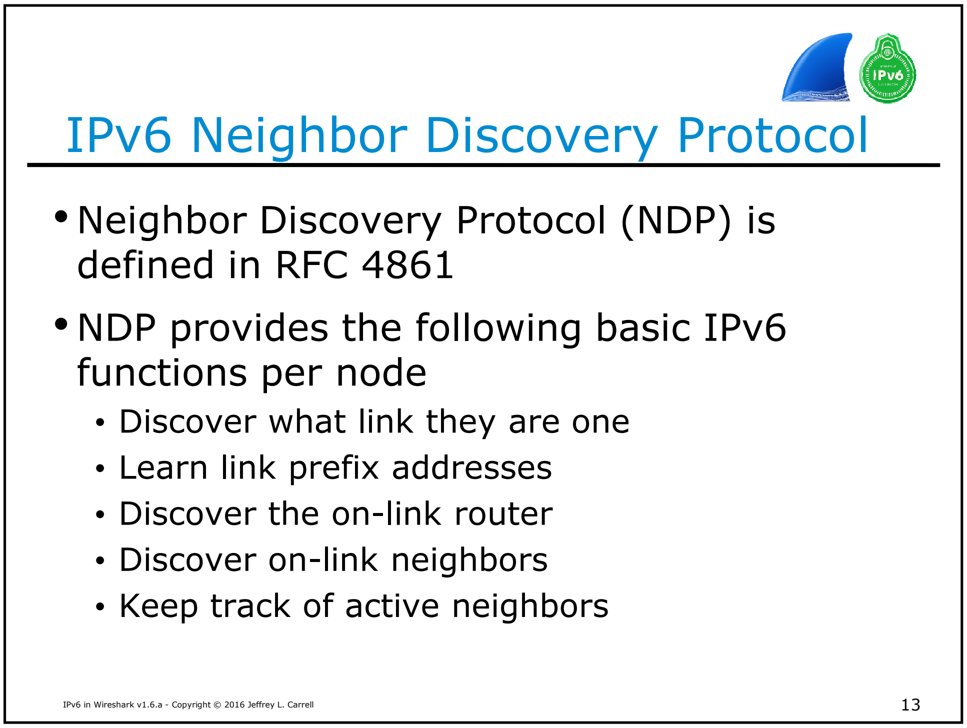
Interface ID from Random Number

- RFC4941 - Privacy Extensions for Stateless Address Autoconfiguration in IPv6
- Initial IID is derived based on mathematical computation to create a “random 64bit number” and appended to prefix to create a GUA
- An additional but different 64bit number is computed, appended to prefix, and tagged “temporary” for a 2nd GUA
- Temporary GUA should be re-computed on a frequent basis
- Temporary GUA is used as primary address for communications, as it is considered “more secure”



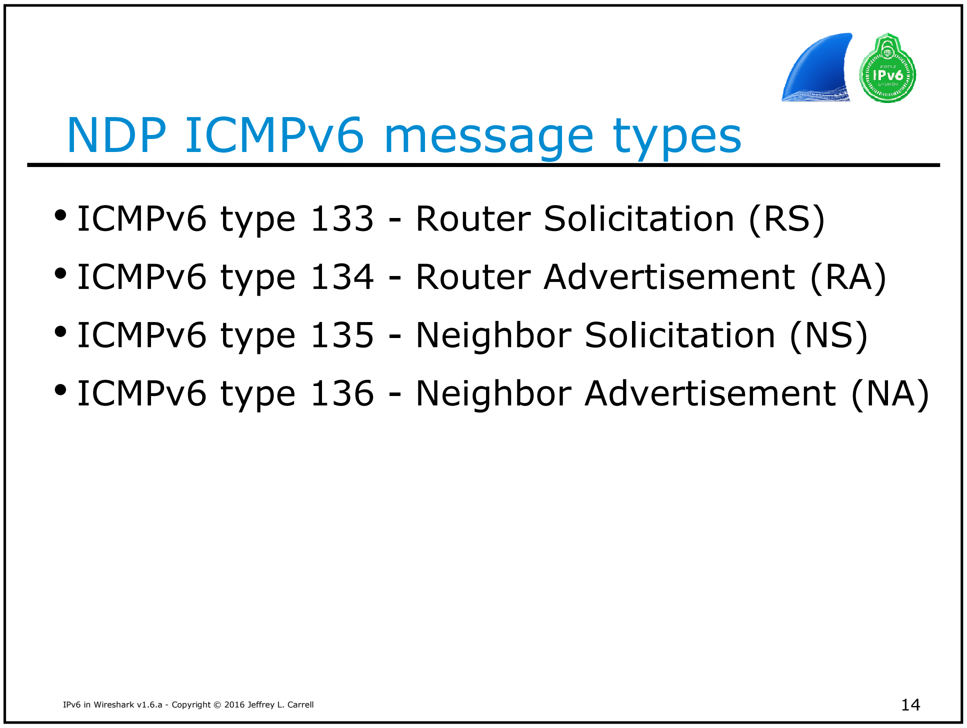
Lifetime states of an IPv6 address

- Tentative – address is in process of verification for uniqueness and is not yet available for regular communications
- Valid – address is valid for use in communication based on Preferred and Deprecated status
- Preferred – address is usable for all communications
- Deprecated – address can still be used for existing sessions, but not for new sessions
- Invalid – an address is no longer available for sending or receiving



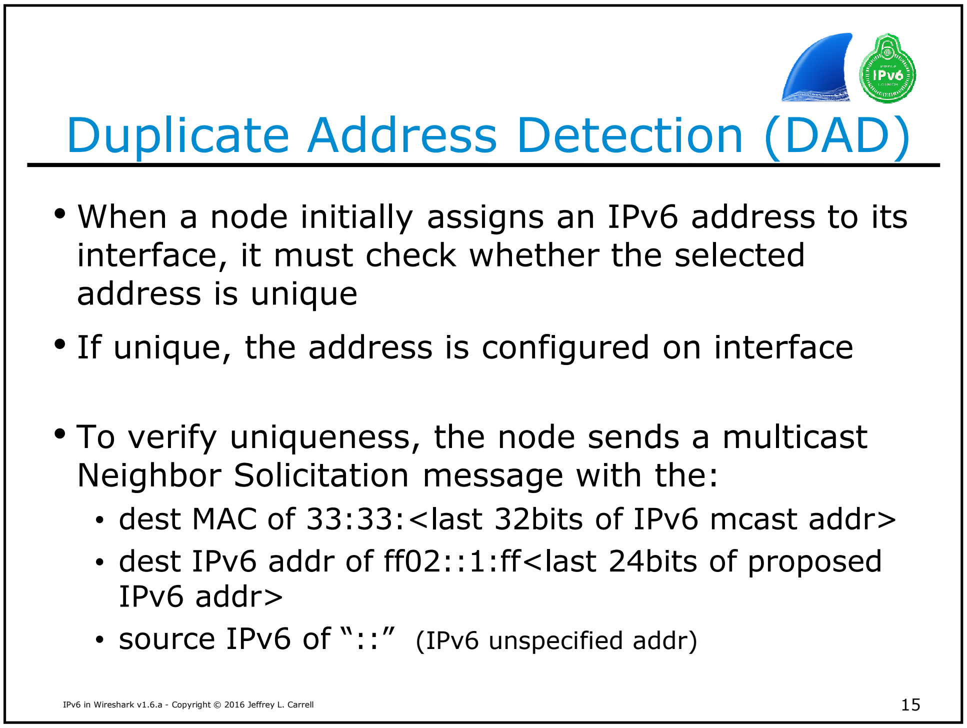
IPv6 Neighbor Discovery Protocol

- Neighbor Discovery Protocol (NDP) is defined in RFC 4861
- NDP provides the following basic IPv6 functions per node
  - Discover what link they are one
  - Learn link prefix addresses
  - Discover the on-link router
  - Discover on-link neighbors
  - Keep track of active neighbors



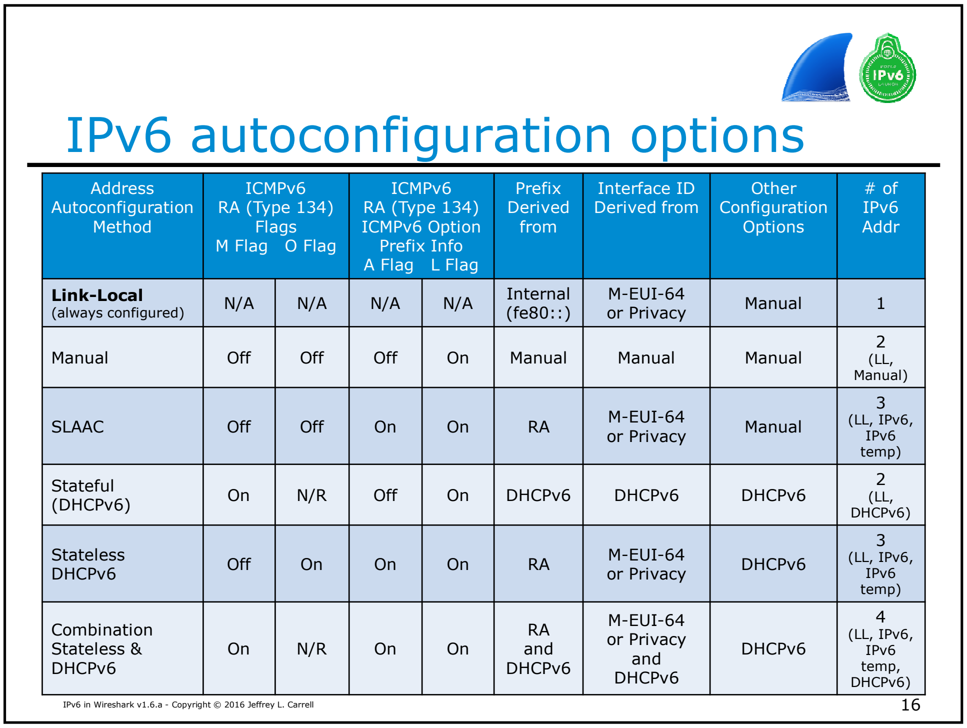
NDP ICMPv6 message types

- ICMPv6 type 133 - Router Solicitation (RS)
- ICMPv6 type 134 - Router Advertisement (RA)
- ICMPv6 type 135 - Neighbor Solicitation (NS)
- ICMPv6 type 136 - Neighbor Advertisement (NA)



Duplicate Address Detection (DAD)

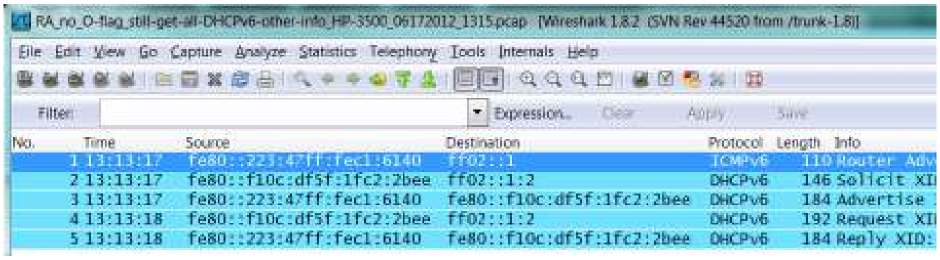
- When a node initially assigns an IPv6 address to its interface, it must check whether the selected address is unique
- If unique, the address is configured on interface
- To verify uniqueness, the node sends a multicast Neighbor Solicitation message with the:
  - dest MAC of 33:33:<last 32bits of IPv6 mcast addr>
  - dest IPv6 addr of ff02::1:ff<last 24bits of proposed IPv6 addr>
  - source IPv6 of "::" (IPv6 unspecified addr)



IPv6 autoconfiguration options

Address Autoconfiguration Method	ICMPv6 RA (Type 134) Flags		ICMPv6 RA (Type 134) ICMPv6 Option Prefix Info		Prefix Derived from	Interface ID Derived from	Other Configuration Options	# of IPv6 Addr
	M Flag	O Flag	A Flag	L Flag				
Link-Local (always configured)	N/A	N/A	N/A	N/A	Internal (fe80::)	M-EUI-64 or Privacy	Manual	1
Manual	Off	Off	Off	On	Manual	Manual	Manual	2 (LL, Manual)
SLAAC	Off	Off	On	On	RA	M-EUI-64 or Privacy	Manual	3 (LL, IPv6, IPv6 temp)
Stateful (DHCPv6)	On	N/R	Off	On	DHCPv6	DHCPv6	DHCPv6	2 (LL, DHCPv6)
Stateless DHCPv6	Off	On	On	On	RA	M-EUI-64 or Privacy	DHCPv6	3 (LL, IPv6, IPv6 temp)
Combination Stateless & DHCPv6	On	N/R	On	On	RA and DHCPv6	M-EUI-64 or Privacy and DHCPv6	DHCPv6	4 (LL, IPv6, IPv6 temp, DHCPv6)

IPv6 Stateful (DHCPv6) process


RA_no_O-flag_still-get-all-DHCPv6-other-info_HP-3500_06172012_1315.pcap [Wireshark 1.8.2 (SVN Rev 44520 from /trunk-1.8)]
File Edit View Go Capture Analyze Statistics Telephony Tools Internals Help
Filter:
Expression... Clear Apply Save

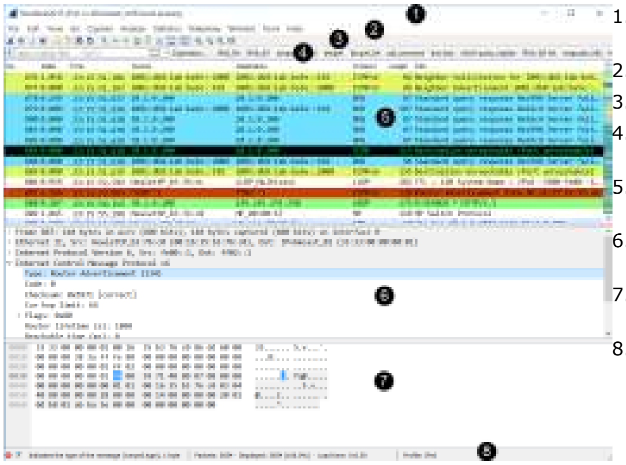
```
No.   Time      Source                       Destination                  Protocol  Length  Info
    1 13:13:17  fe80::223:47ff:fec1:6140     ff02::1                      ICMPv6      110 Router Adv
    2 13:13:17  fe80::f10c:df5f:1fc2:2bee    ff02::1:2                    DHCPv6      146 Solicit XI
    3 13:13:17  fe80::223:47ff:fec1:6140     fe80::f10c:df5f:1fc2:2bee    DHCPv6      184 Advertise 
    4 13:13:18  fe80::f10c:df5f:1fc2:2bee    ff02::1:2                    DHCPv6      192 Request XI
    5 13:13:18  fe80::223:47ff:fec1:6140     fe80::f10c:df5f:1fc2:2bee    DHCPv6      184 Reply XID:
```

- DHCPv6**S**olicit = DHCP**D**iscover (IPv4)
- DHCPv6**A**dvertise = DHCP**O**ffer (IPv4)
- DHCPv6**R**equest = DHCP**R**equest (IPv4)
- DHCPv6**R**eply = DHCP**A**ck (IPv4)

Wireshark

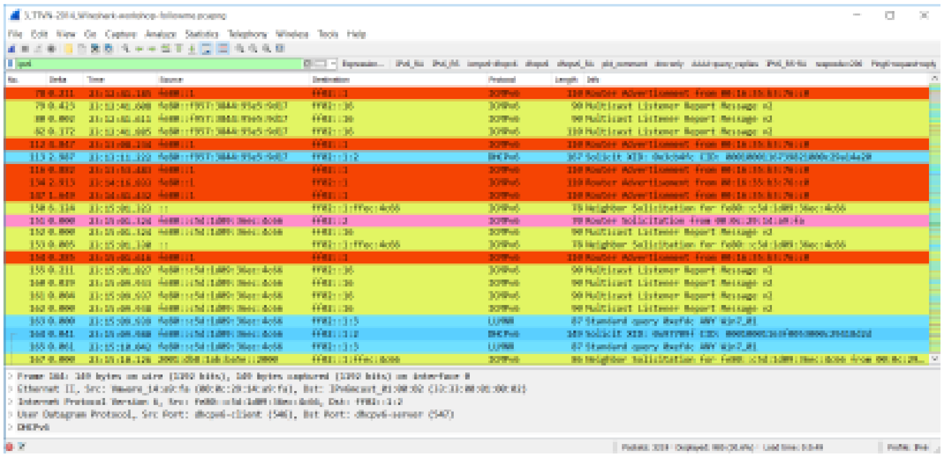
- Wireshark basics
- Wireshark
  - color rules
  - display filters
  - columns
  - configuration profiles
  - packet annotation
- Wireshark labs!!!

Wireshark main view

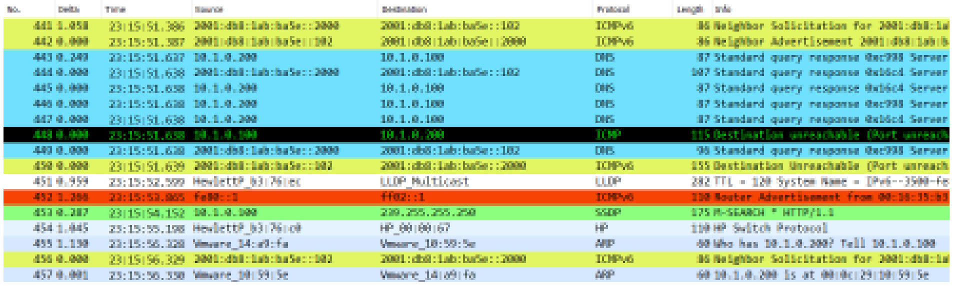


1. Title bar — trace file name or capture device name
2. Main menu — standard menu
3. Main toolbar — quick access
4. Display filter area — reduce the amount of traffic you see
5. Packet List pane — summary of each frame
6. Packet Details pane — dissected frames
7. Packet Bytes pane — hex and ASCII details
8. Status Bar — access to the Expert, annotations, file location, packet counts, and profiles

Jeff’s IPv6 Wireshark



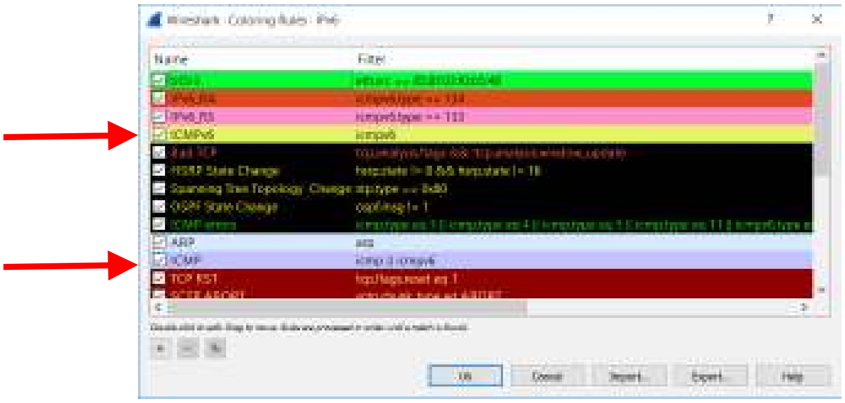
Coloring rules



```
No.  Delta  Time          Source                     Destination                Protocol  Length Info
441 1.058   23:15:51.386  2001:db8:1ab:ba5e::2000   2001:db8:1ab:ba5e::102     ICMPv6     86 Neighbor Solicitation for 2001:db8:1a
442 0.000   23:15:51.387  2001:db8:1ab:ba5e::102    2001:db8:1ab:ba5e::2000    ICMPv6     86 Neighbor Advertisement 2001:db8:1ab:b
443 0.249   23:15:51.637  10.1.0.200                10.1.0.100                 DNS        87 Standard query response 0xc998 Server
444 0.000   23:15:51.638  2001:db8:1ab:ba5e::2000   2001:db8:1ab:ba5e::102     DNS       107 Standard query response 0x16cd Server
445 0.000   23:15:51.638  10.1.0.200                10.1.0.100                 DNS        87 Standard query response 0x16c4 Server
446 0.000   23:15:51.638  10.1.0.200                10.1.0.100                 DNS        87 Standard query response 0xc998 Server
447 0.000   23:15:51.638  10.1.0.200                10.1.0.100                 DNS        87 Standard query response 0x16cd Server
448 0.000   23:15:51.638  10.1.0.100                10.1.0.200                 ICMP      115 Destination unreachable (Port unreach
449 0.000   23:15:51.638  2001:db8:1ab:ba5e::2000   2001:db8:1ab:ba5e::102     DNS        98 Standard query response 0xc998 Server
450 0.000   23:15:51.639  2001:db8:1ab:ba5e::102    2001:db8:1ab:ba5e::2000    ICMPv6    155 Destination Unreachable (Port unreach
451 0.959   23:15:52.599  HewlettP_b3:76:ec         LLDP_Multicast             LLDP      282 TTL = 120 System Name = IPv6--3500-fe
452 1.288   23:15:53.885  fe80::1                   ff02::1                    ICMPv6    120 Router Advertisement from 00:18:35:b3
453 0.287   23:15:54.152  10.1.0.100                239.255.255.250            SSDP      175 M-SEARCH * HTTP/1.1
454 1.045   23:15:55.198  HewlettP_b3:76:c0         HP_00:00:67                HP        110 HP Switch Protocol
455 1.130   23:15:56.328  Vmware_14:a9:fa           Vmware_10:59:5e            ARP        60 Who has 10.1.0.200? Tell 10.1.0.100
456 0.000   23:15:56.329  2001:db8:1ab:ba5e::102    2001:db8:1ab:ba5e::2000    ICMPv6     86 Neighbor Solicitation for 2001:db8:1a
457 0.001   23:15:56.330  Vmware_10:59:5e           Vmware_14:a9:fa            ARP        60 10.1.0.200 is at 00:0c:29:10:59:5e
```

- Colors help you focus on specific address, protocols, events, and possibly find errors quickly

Color rule processing order



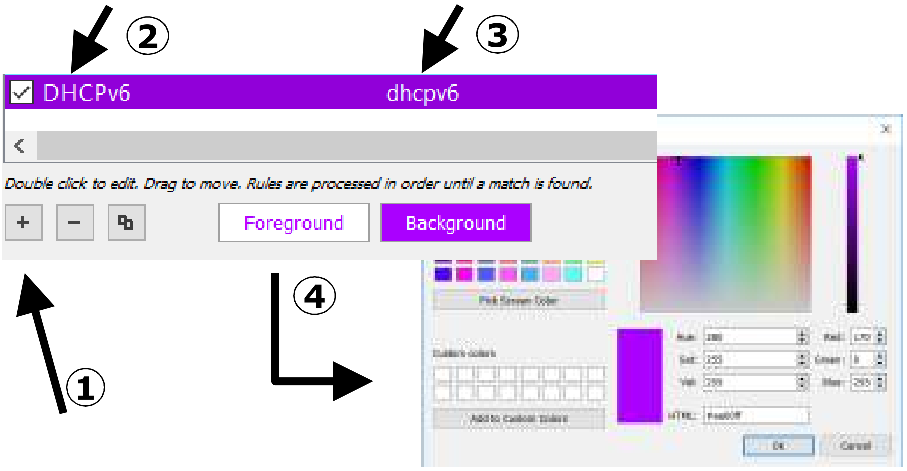
Wireshark · Coloring Rules · IPv6

Name	Filter
☑ [illegible]	eth.src == [illegible]
☑ IPv6_RA	icmpv6.type == 134
☑ IPv6_RS	icmpv6.type == 133
☑ ICMPv6	icmpv6
☑ Bad TCP	tcp.analysis.flags && !tcp.analysis.window_update
☑ HSRP State Change	hsrp.state != 8 && hsrp.state != 16
☑ Spanning Tree Topology Change	stp.type == 0x80
☑ OSPF State Change	ospf.msg != 1
☑ ICMP errors	icmp.type eq 3 || icmp.type eq 4 || icmp.type eq 5 || icmp.type eq 11 || icmpv6.type e
☑ ARP	arp
☑ ICMP	icmp || icmpv6
☑ TCP RST	tcp.flags.reset eq 1
☑ SCTP ABORT	sctp.chunk_type eq ABORT

Double click to edit. Drag to move. Rules are processed in order until a match is found.

- Color rules read like a router ACL or firewall rule
  - First color rule that matches wins

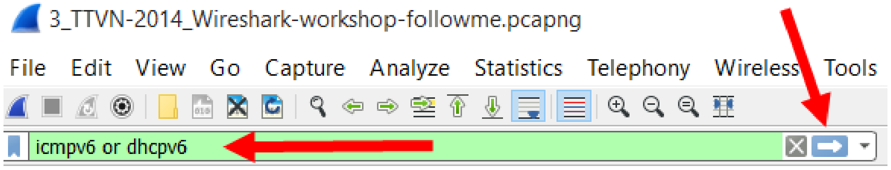
Color rule creation



Double click to edit. Drag to move. Rules are processed in order until a match is found.

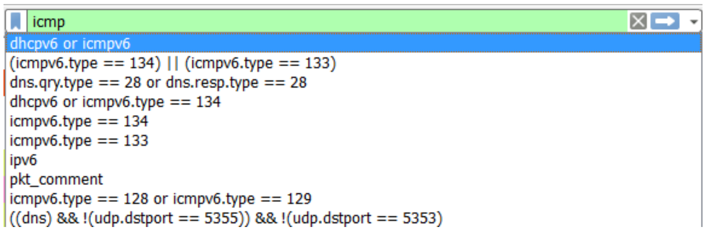
Using Wireshark to view IPv6 pkts

- IPv6 display filter families
  - ipv6
  - icmpv6
  - dhcpv6
- IPv6 related display filters:
  - http://www.wireshark.org/docs/dfref/i/ipv6.html



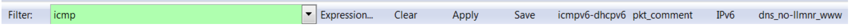
icmpv6 or dhcpv6

Display filters – option 1



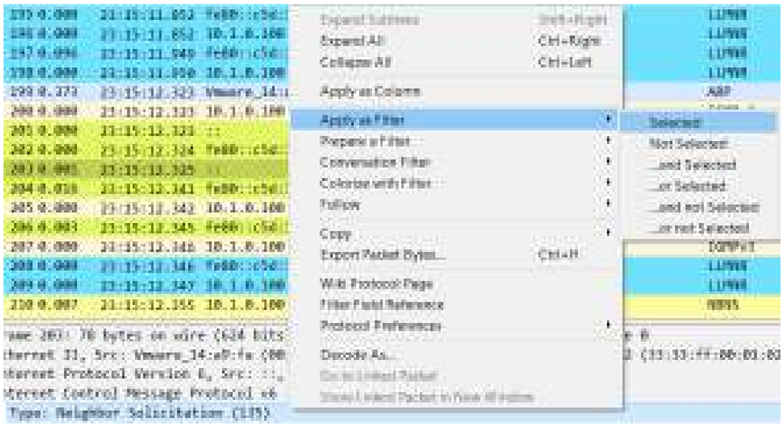
```
icmp
dhcpv6 or icmpv6
(icmpv6.type == 134) || (icmpv6.type == 133)
dns.qry.type == 28 or dns.resp.type == 28
dhcpv6 or icmpv6.type == 134
icmpv6.type == 134
icmpv6.type == 133
ipv6
pkt_comment
icmpv6.type == 128 or icmpv6.type == 129
((dns) && !(udp.dstport == 5355)) && !(udp.dstport == 5353)
```

- The Filter bar will change colors as you type to signify correct syntax for the filter
  - Green – syntax is correct
  - Red – syntax is incorrect
  - Yellow – syntax is suspect
- The Filter dropdown will show last 10 filters used
- You can save Filter definitions for frequent use



Filter: icmp

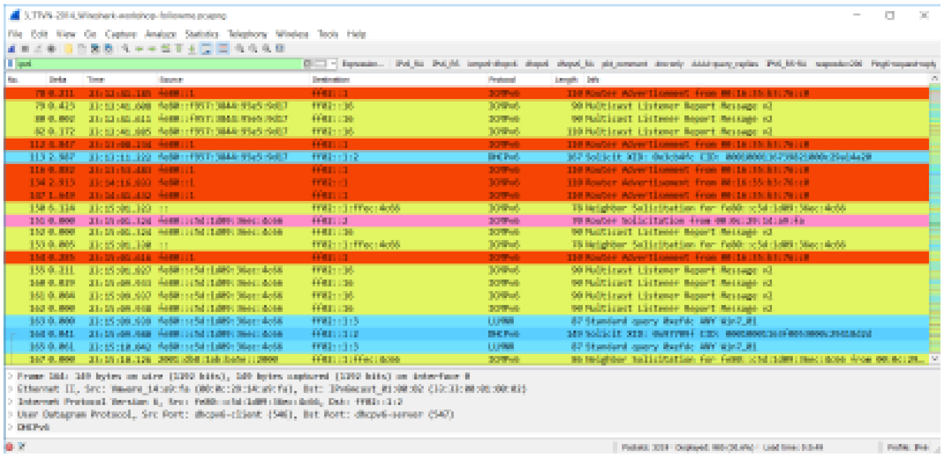
Display filters – option 2



```
rame 203: 78 bytes on wire (624 bits
thernet II, Src: Vmware_14:a0:fa (00
nternet Protocol Version 6, Src: ::,
nternet Control Message Protocol v6
Type: Neighbor Solicitation (135)
```

- In the Packet Details view, right-click on a specific field to build a filter

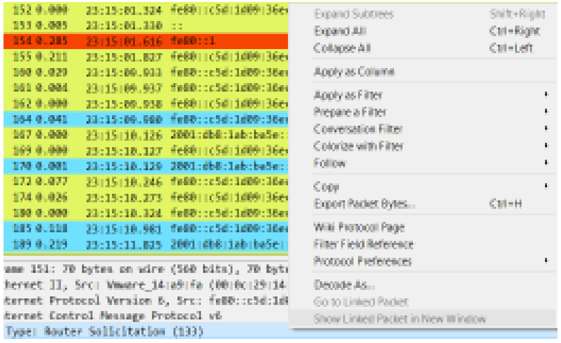
Using Wireshark to view IPv6 pkts



```
No.  Delta  Time          Source                      Destination         Protocol  Length Info
 78  0.211  23:13:02.185  fe80::1                     ff02::1             ICMPv6    118 Router Advertisement from 00:18:15:61:76:18
 79  0.415  23:13:02.600  fe80::f957:3844:95e5:9d07   ff02::16            ICMPv6     90 Multicast Listener Report Message v2
 80  0.002  23:13:02.611  fe80::f957:3844:95e5:9d07   ff02::16            ICMPv6     90 Multicast Listener Report Message v2
 82  0.372  23:13:02.985  fe80::f957:3844:95e5:9d07   ff02::16            ICMPv6    110 Multicast Listener Report Message v2
112  0.847  23:13:08.250  fe80::1                     ff02::1             ICMPv6    118 Router Advertisement from 00:18:15:61:76:18
113  2.987  23:13:11.322  fe80::f957:3844:95e5:9d07   ff02::1:2           DHCPv6    167 Solicit XID: [illegible] CID: [illegible]
116  0.882  23:13:53.483  fe80::1                     ff02::1             ICMPv6    118 Router Advertisement from 00:18:15:61:76:18
134  2.915  23:14:16.650  fe80::1                     ff02::1             ICMPv6    118 Router Advertisement from 00:18:15:61:76:18
147  1.049  23:14:01.432  fe80::1                     ff02::1             ICMPv6    118 Router Advertisement from 00:18:15:61:76:18
150  6.334  23:15:01.122  ::                          ff02::1:ffec:4c66   ICMPv6     78 Neighbor Solicitation for fe80::c5d:1d09:36ec:4c66
151  0.000  23:15:01.128  fe80::c5d:1d09:36ec:4c66    ff02::2             ICMPv6     70 Router Solicitation from 00:0c:29:14:a9:fa
152  0.000  23:15:01.128  fe80::c5d:1d09:36ec:4c66    ff02::16            ICMPv6     90 Multicast Listener Report Message v2
153  0.005  23:15:01.130  ::                          ff02::1:ffec:4c66   ICMPv6     78 Neighbor Solicitation for fe80::c5d:1d09:36ec:4c66
154  0.285  23:15:01.616  fe80::1                     ff02::1             ICMPv6    118 Router Advertisement from 00:18:15:61:76:18
155  0.211  23:15:01.827  fe80::c5d:1d09:36ec:4c66    ff02::16            ICMPv6     90 Multicast Listener Report Message v2
160  0.029  23:15:09.911  fe80::c5d:1d09:36ec:4c66    ff02::16            ICMPv6     90 Multicast Listener Report Message v2
161  0.004  23:15:09.937  fe80::c5d:1d09:36ec:4c66    ff02::16            ICMPv6     90 Multicast Listener Report Message v2
162  0.000  23:15:09.938  fe80::c5d:1d09:36ec:4c66    ff02::16            ICMPv6     90 Multicast Listener Report Message v2
163  0.000  23:15:09.938  fe80::c5d:1d09:36ec:4c66    ff02::1:3           LLMNR      87 Standard query [illegible] ANY Win7_01
164  0.041  23:15:09.980  fe80::c5d:1d09:36ec:4c66    ff02::1:2           DHCPv6    149 Solicit XID: [illegible] CID: [illegible]
165  0.061  23:15:10.042  fe80::c5d:1d09:36ec:4c66    ff02::1:3           LLMNR      87 Standard query [illegible] ANY Win7_01
167  0.000  23:15:10.126  2001:db8:1ab:ba5e::2000     ff02::1:ffec:4c66   ICMPv6     86 Neighbor Solicitation for fe80::c5d:1d09:36ec:4c66 from 00:0c:29...
```

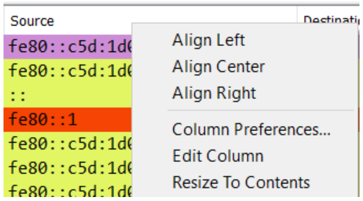
```
> Frame 164: 149 bytes on wire (1192 bits), 149 bytes captured (1192 bits) on interface 0
> Ethernet II, Src: Vmware_14:a9:fa (00:0c:29:14:a9:fa), Dst: IPv6mcast_01:00:02 (33:33:00:01:00:02)
> Internet Protocol Version 6, Src: fe80::c5d:1d09:36ec:4c66, Dst: ff02::1:2
> User Datagram Protocol, Src Port: dhcpv6-client (546), Dst Port: dhcpv6-server (547)
> DHCPv6
```

Columns



```
152 0.000   23:15:01.324 fe80::c5d:1d09:36e
153 0.005   23:15:01.330 ::
154 0.285   23:15:01.616 fe80::1
155 0.211   23:15:01.827 fe80::c5d:1d09:36e
160 0.029   23:15:09.911 fe80::c5d:1d09:36e
161 0.004   23:15:09.937 fe80::c5d:1d09:36e
162 0.000   23:15:09.938 fe80::c5d:1d09:36e
164 0.041   23:15:09.980 fe80::c5d:1d09:36e
167 0.000   23:15:10.126 2001:db8:1ab:ba5e:
169 0.000   23:15:10.127 fe80::c5d:1d09:36e
170 0.001   23:15:10.128 2001:db8:1ab:ba5e:
172 0.077   23:15:10.246 fe80::c5d:1d09:36e
174 0.026   23:15:10.273 fe80::c5d:1d09:36e
180 0.000   23:15:10.324 fe80::c5d:1d09:36e
185 0.118   23:15:10.981 fe80::c5d:1d09:36e
189 0.219   23:15:11.825 2001:db8:1ab:ba5e:

ame 151: 70 bytes on wire (560 bits), 70 byt
hernet II, Src: Vmware_14:a9:fa (00:0c:29:14
ternet Protocol Version 6, Src: fe80::c5d:1d
ternet Control Message Protocol v6
Type: Router Solicitation (133)
```

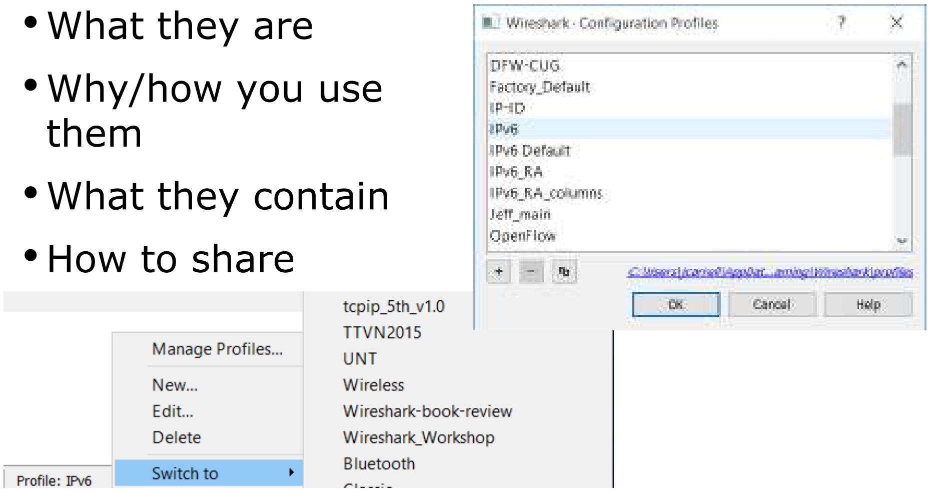


```
Source            Destinati
fe80::c5d:1d0
fe80::c5d:1d0
::
fe80::1
fe80::c5d:1d0
fe80::c5d:1d0
fe80::c5d:1d0
```

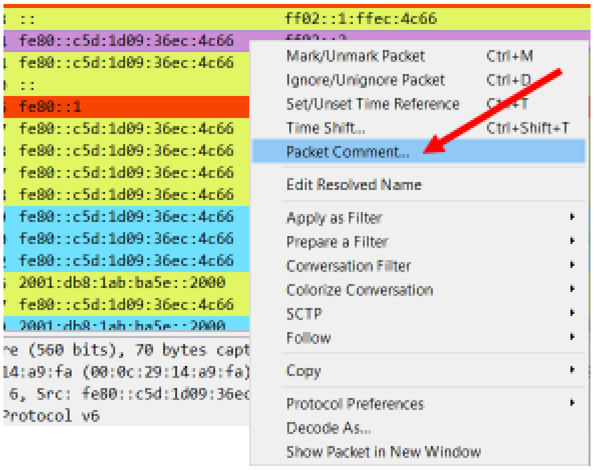
- In the Packet Details view, right-click on a specific field to Apply as Column
- Right-click column headings to rename, align, etc

Configuration profiles

- What they are
- Why/how you use them
- What they contain
- How to share



Packet annotation

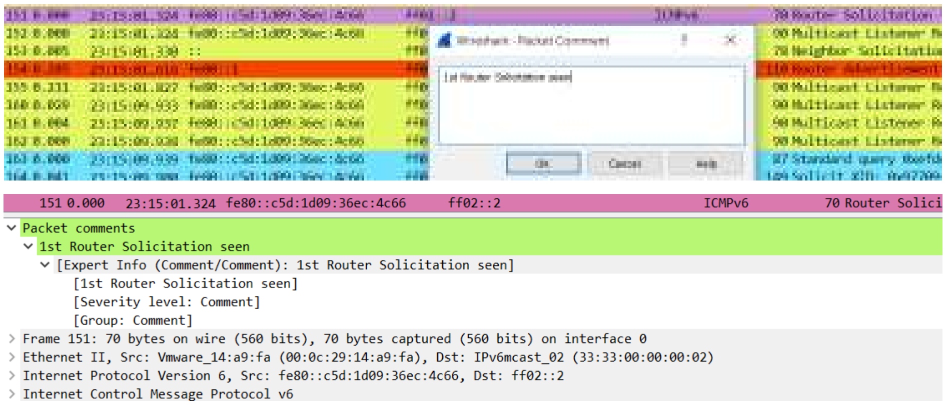


```
::                                  ff02::1:ffec:4c66
fe80::c5d:1d09:36ec:4c66            ff02::2
fe80::c5d:1d09:36ec:4c66
::
fe80::1
fe80::c5d:1d09:36ec:4c66
fe80::c5d:1d09:36ec:4c66
fe80::c5d:1d09:36ec:4c66
fe80::c5d:1d09:36ec:4c66
fe80::c5d:1d09:36ec:4c66
fe80::c5d:1d09:36ec:4c66
fe80::c5d:1d09:36ec:4c66
2001:db8:1ab:ba5e::2000
fe80::c5d:1d09:36ec:4c66
2001:db8:1ab:ba5e::2000
e (560 bits), 70 bytes capt
14:a9:fa (00:0c:29:14:a9:fa)
6, Src: fe80::c5d:1d09:36ec
Protocol v6
```

- Right click packet, select Packet Comment

Troubleshooting IPv6 with Wireshark

Packet annotation



```
151 0.000  23:15:01.324 fe80::c5d:1d09:36ec:4c66   ff02::2   ICMPv6   70 Router Solicitation
152 0.000  23:15:01.324 fe80::c5d:1d09:36ec:4c66   ff0               90 Multicast Listener R
153 0.005  23:15:01.330 ::                         ff0               78 Neighbor Solicitation
154 0.285  23:15:01.616 fe80::1                    ff0              110 Router Advertisement
155 0.311  23:15:01.927 fe80::c5d:1d09:36ec:4c66   ff0               90 Multicast Listener R
160 0.059  23:15:09.933 fe80::c5d:1d09:36ec:4c66   ff0               90 Multicast Listener R
161 0.004  23:15:09.937 fe80::c5d:1d09:36ec:4c66   ff0               90 Multicast Listener R
162 0.000  23:15:09.938 fe80::c5d:1d09:36ec:4c66   ff0               90 Multicast Listener R
163 0.000  23:15:09.939 fe80::c5d:1d09:36ec:4c66   ff0               87 Standard query 0xefd
164 0.001  [illegible]                                              109 Solicit XID: 0x97709

151 0.000  23:15:01.324 fe80::c5d:1d09:36ec:4c66   ff02::2   ICMPv6   70 Router Solici
```

```
∨ Packet comments
  ∨ 1st Router Solicitation seen
    ∨ [Expert Info (Comment/Comment): 1st Router Solicitation seen]
        [1st Router Solicitation seen]
        [Severity level: Comment]
        [Group: Comment]
> Frame 151: 70 bytes on wire (560 bits), 70 bytes captured (560 bits) on interface 0
> Ethernet II, Src: Vmware_14:a9:fa (00:0c:29:14:a9:fa), Dst: IPv6mcast_02 (33:33:00:00:00:02)
> Internet Protocol Version 6, Src: fe80::c5d:1d09:36ec:4c66, Dst: ff02::2
> Internet Control Message Protocol v6
```

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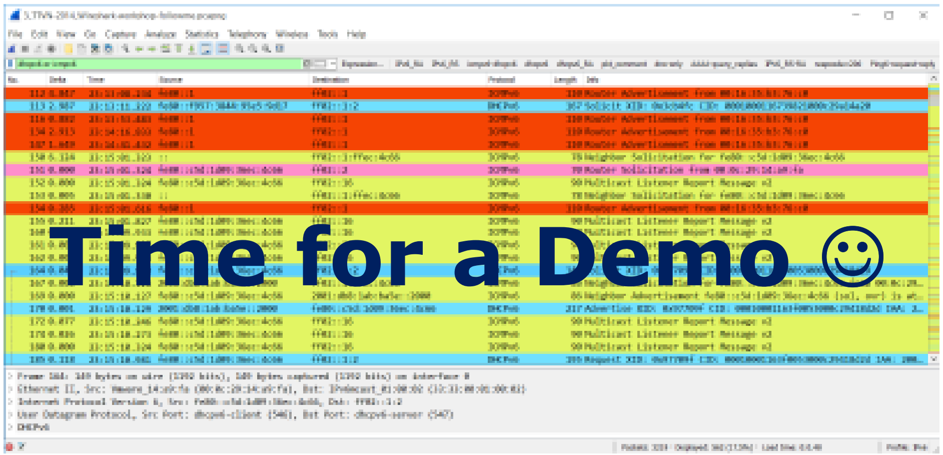
31

Wireshark demo #1 – watch me


File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help

Time for a Demo ☺

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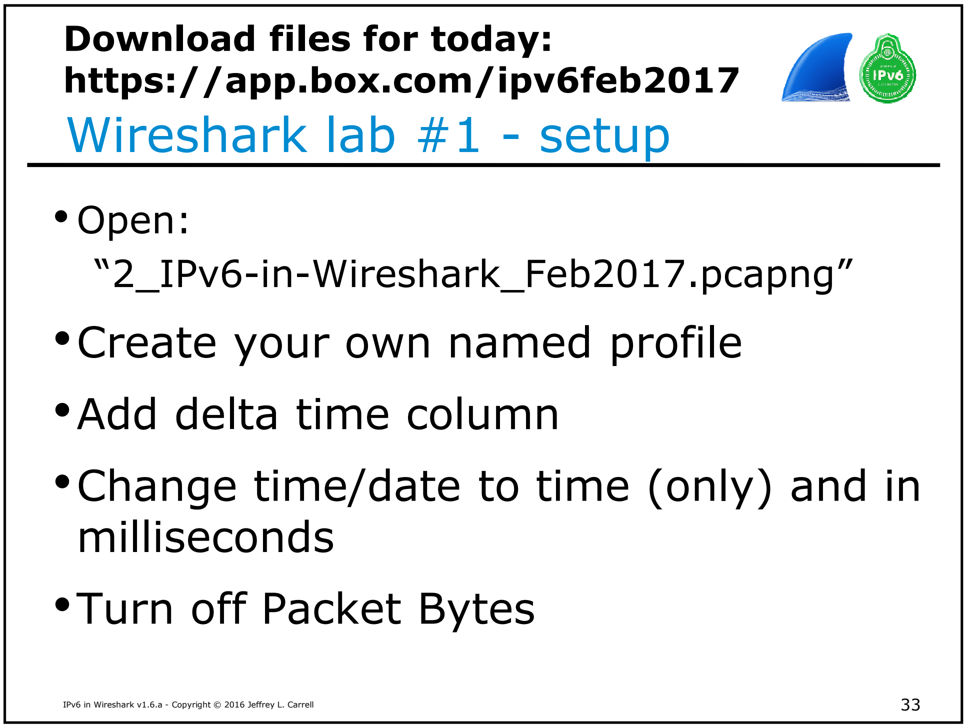
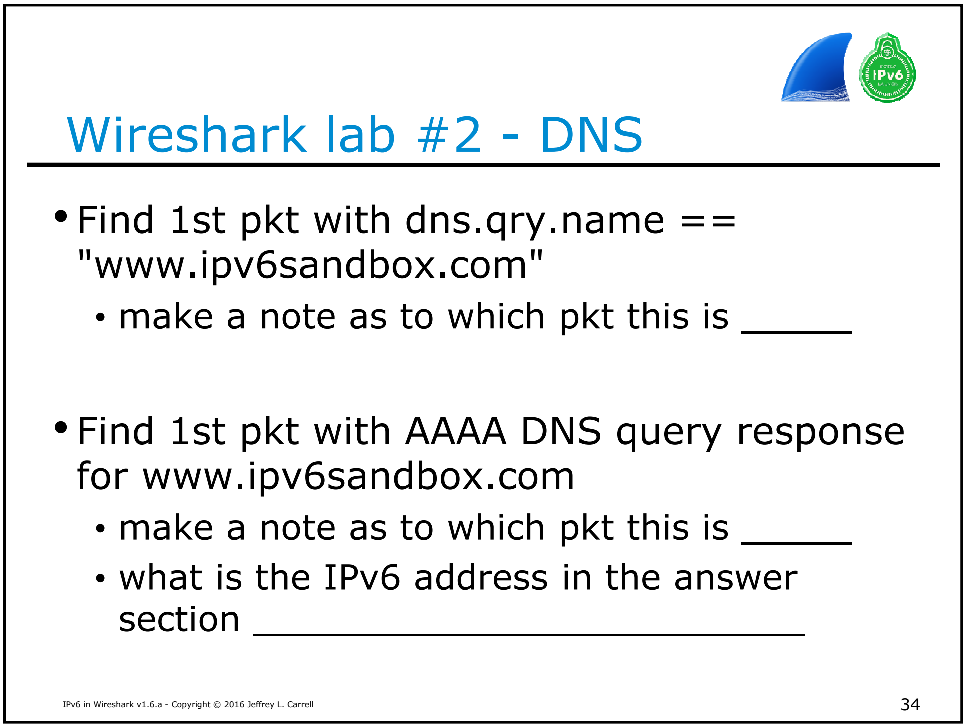
32



Download files for today:
https://app.box.com/ipv6feb2017

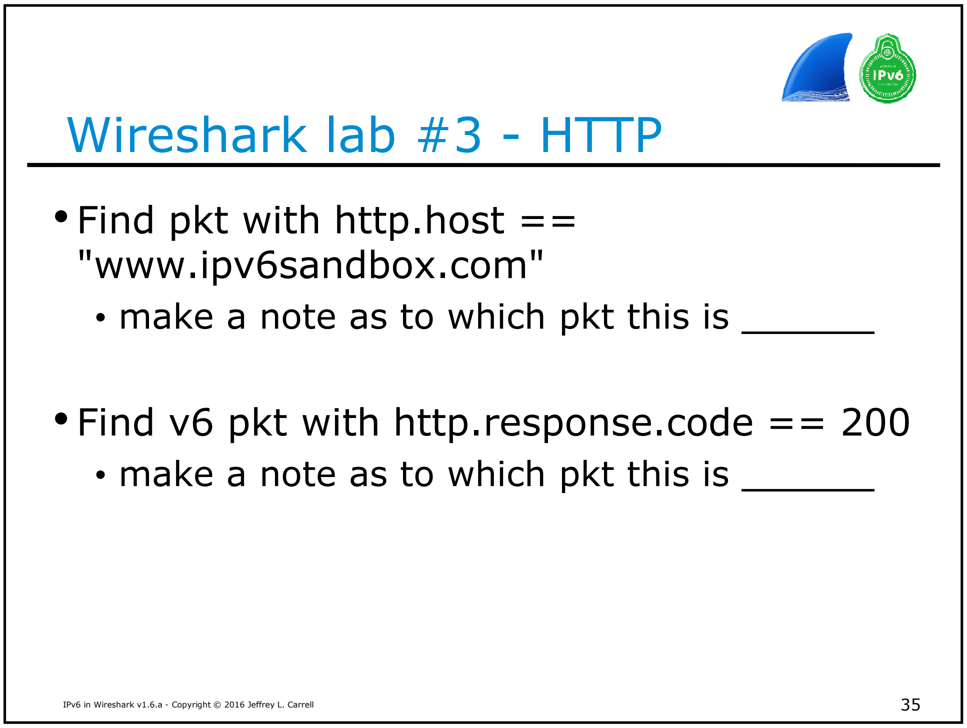
Wireshark lab #1 - setup

- Open:
  "2_IPv6-in-Wireshark_Feb2017.pcapng"
- Create your own named profile
- Add delta time column
- Change time/date to time (only) and in milliseconds
- Turn off Packet Bytes



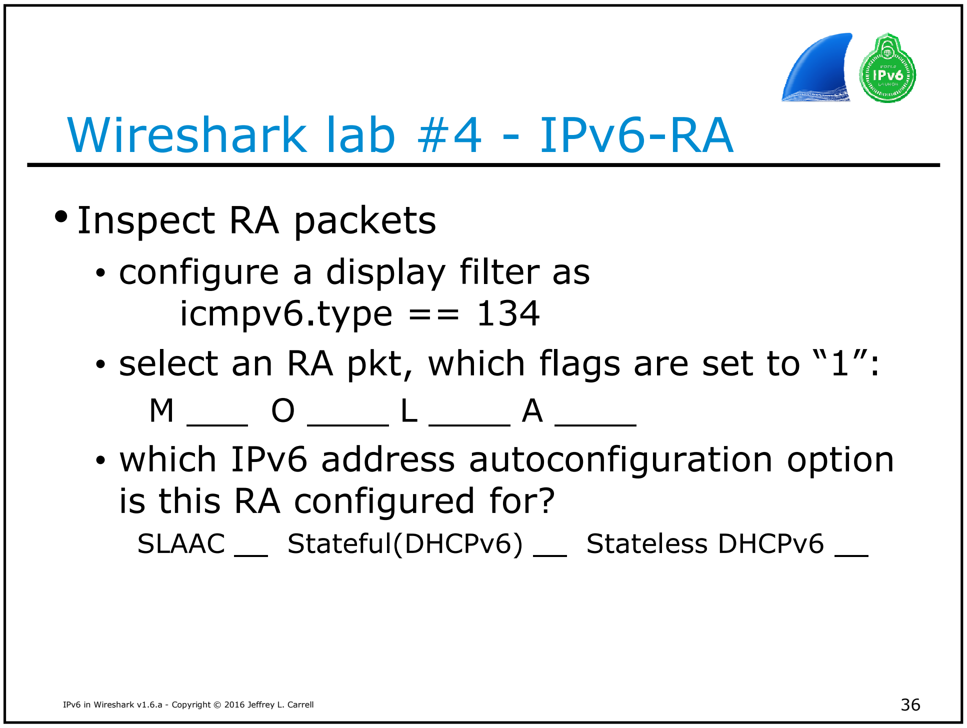
Wireshark lab #2 - DNS

- Find 1st pkt with dns.qry.name == "www.ipv6sandbox.com"
  - make a note as to which pkt this is ______
- Find 1st pkt with AAAA DNS query response for www.ipv6sandbox.com
  - make a note as to which pkt this is ______
  - what is the IPv6 address in the answer section ______________________________



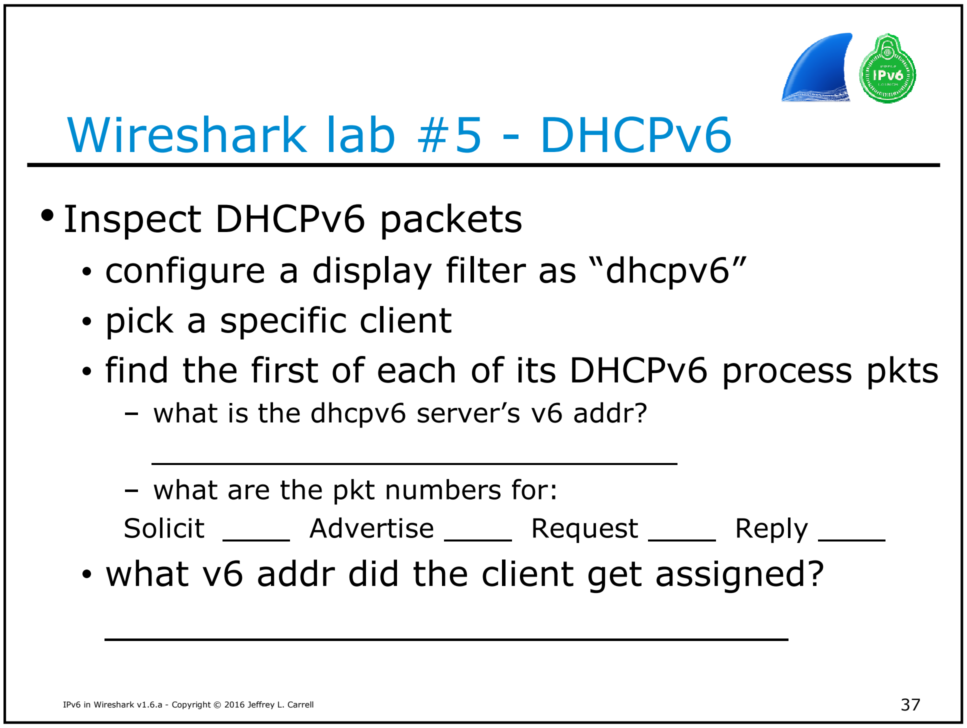
Wireshark lab #3 - HTTP

- Find pkt with http.host == "www.ipv6sandbox.com"
  - make a note as to which pkt this is _______
- Find v6 pkt with http.response.code == 200
  - make a note as to which pkt this is _______



Wireshark lab #4 - IPv6-RA

- Inspect RA packets
  - configure a display filter as
    icmpv6.type == 134
  - select an RA pkt, which flags are set to "1":
    M ____ O _____ L _____ A _____
  - which IPv6 address autoconfiguration option is this RA configured for?
    SLAAC __ Stateful(DHCPv6) __ Stateless DHCPv6 __



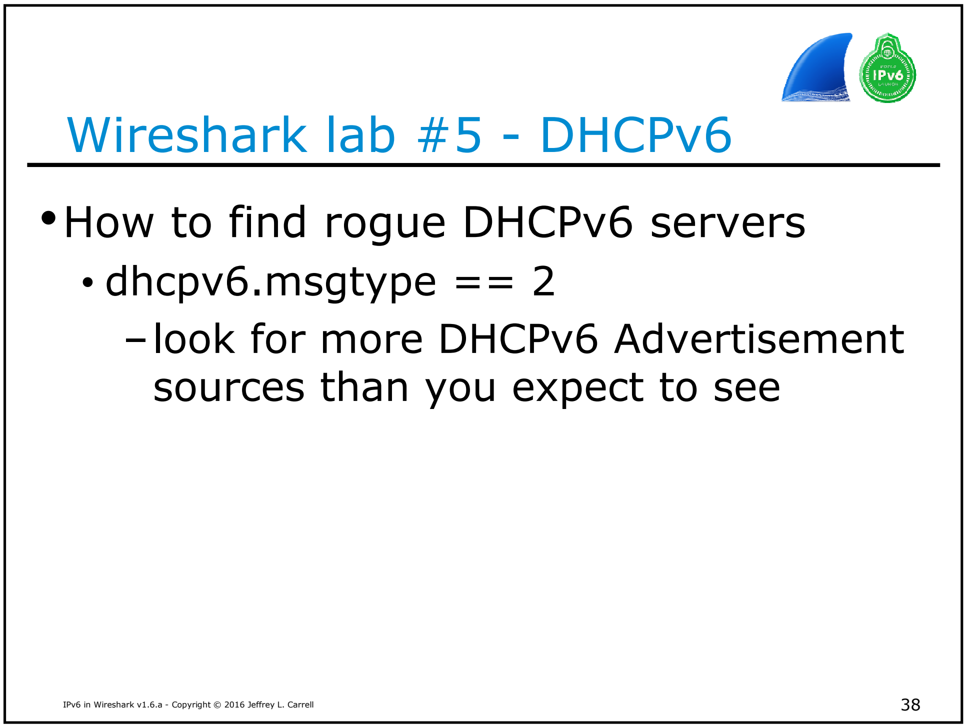
Wireshark lab #5 - DHCPv6

- Inspect DHCPv6 packets
  - configure a display filter as “dhcpv6”
  - pick a specific client
  - find the first of each of its DHCPv6 process pkts
    - what is the dhcpv6 server’s v6 addr?

      ____
    - what are the pkt numbers for:

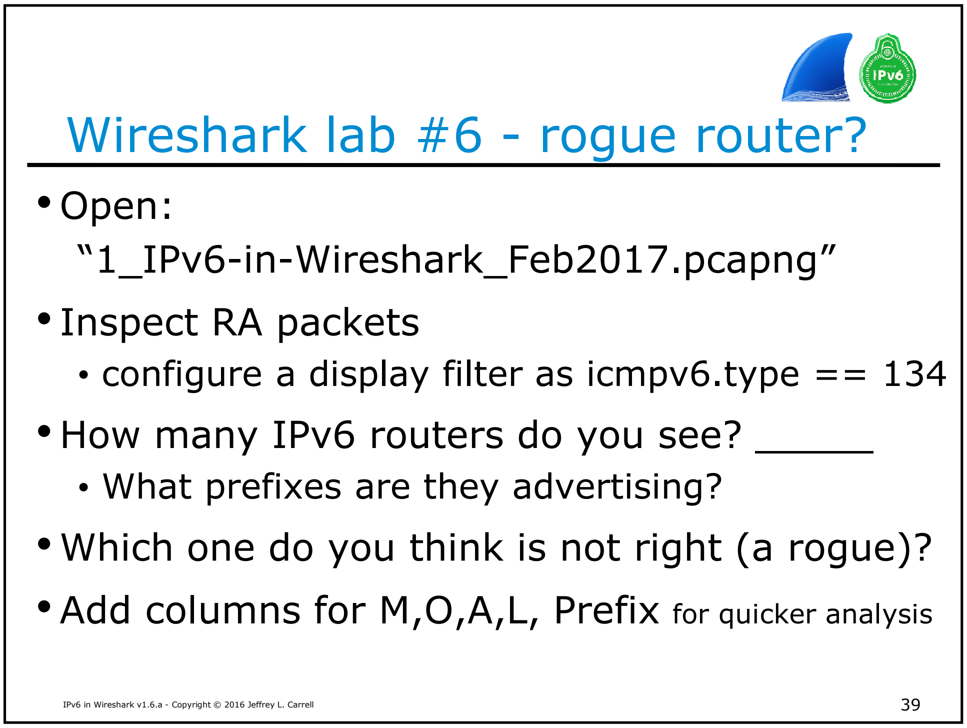
      Solicit _____ Advertise _____ Request _____ Reply _____
  - what v6 addr did the client get assigned?

    ____



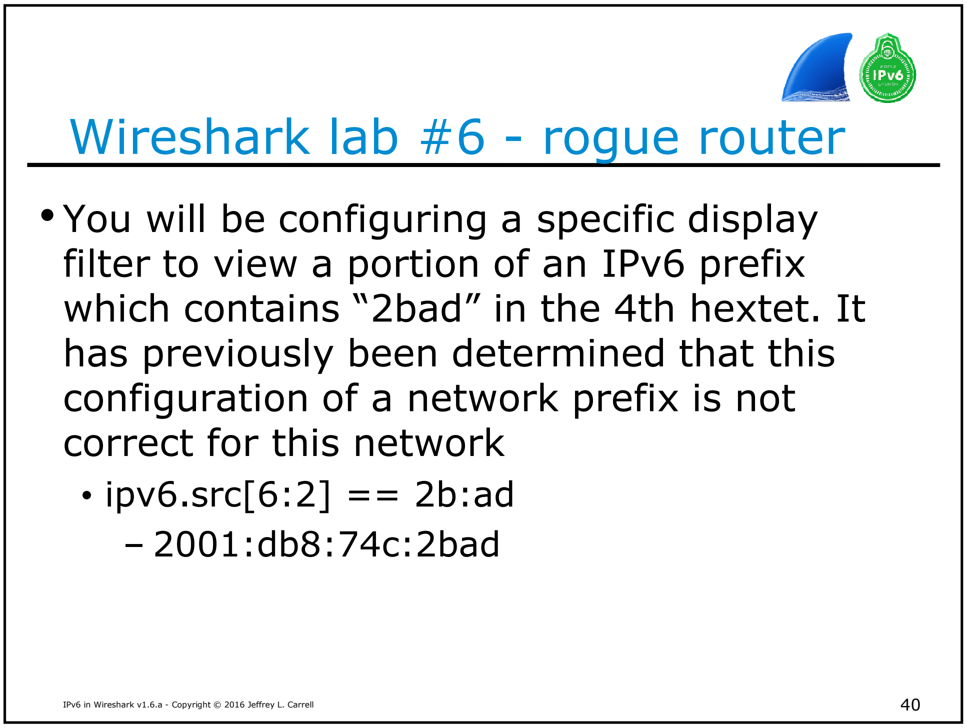
Wireshark lab #5 - DHCPv6

- How to find rogue DHCPv6 servers
  - dhcpv6.msgtype == 2
    - look for more DHCPv6 Advertisement sources than you expect to see



Wireshark lab #6 - rogue router?

- Open:
  "1_IPv6-in-Wireshark_Feb2017.pcapng"
- Inspect RA packets
  - configure a display filter as icmpv6.type == 134
- How many IPv6 routers do you see? ______
  - What prefixes are they advertising?
- Which one do you think is not right (a rogue)?
- Add columns for M,O,A,L, Prefix for quicker analysis



Wireshark lab #6 - rogue router

- You will be configuring a specific display filter to view a portion of an IPv6 prefix which contains "2bad" in the 4th hextet. It has previously been determined that this configuration of a network prefix is not correct for this network
  - ipv6.src[6:2] == 2b:ad
    - 2001:db8:74c:2bad

Wireshark lab #6 - bad prefix

- In pkt 1915, the client attempts to ping a valid IPv6 address for google.com.
  - How did it know that was the correct address?
  - Did the DNS reply back to the client on IPv6?

- What is happening, why does it look like it is working – kinda????

Wireshark lab #7 – did you see that

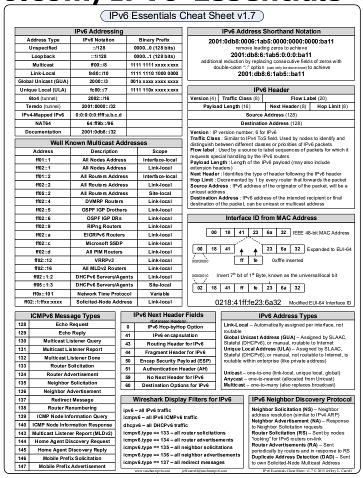
- Look for all clients sending AAAA query. Scroll through the list and view both IPv4 and IPv6 clients making and replying to these queries. Specifically view if any IPv6 clients are making AAAA queries
  - dns.qry.type == 28
    - Do you see something interesting, if so, what was it? ____________________

Wireshark lab #8 – lots of prefixes

- Now using pkt 1911, configure display filter on source MAC address
- View all the different IPv4 and IPv6 address associated with this MAC address
- How many different IPv6 address are associated with this Mac address? _____
  - Why is this occurring?

IPv6 Essentials Cheat Sheet

http://teachmeipv6.com/IPv6-Essentials-Cheat-Sheet.pdf



IPv6 Essentials Cheat Sheet v1.7

IPv6 Addressing

Address Type	IPv6 Notation	Binary Prefix
Unspecified	::/128	0000...0 (128 bits)
Loopback	::1/128	0000...1 (128 bits)
Multicast	ff00::/8	1111 1111 xxxx xxxx
Link-Local	fe80::/10	1111 1110 1000 0000
Global Unicast (GUA)	2000::/3	001x xxxx xxxx xxxx
Unique Local (ULA)	fc00::/7	1111 110x xxxx xxxx
6to4 (tunnel)	2002::/16	
Teredo (tunnel)	2001:0000::/32	
IPv4-Mapped IPv6	0:0:0:0:0:ffff:a.b.c.d	
NAT64	64:ff9b::/96	
Documentation	2001:0db8::/32	

Well Known Multicast Addresses

Address	Description	Scope
ff01::1	All Nodes Address	Interface-local
ff02::1	All Nodes Address	Link-local
ff01::2	All Routers Address	Interface-local
ff02::2	All Routers Address	Link-local
ff05::2	All Routers Address	Site-local
ff02::4	DVMRP Routers	Link-local
ff02::5	OSPF IGP Drothers	Link-local
ff02::6	OSPF IGP DRs	Link-local
ff02::9	RIPng Routers	Link-local
ff02::a	EIGRPv6 Routers	Link-local
ff02::c	Microsoft SSDP	Link-local
ff02::d	All PIM Routers	Link-local
ff02::12	VRRPv3	Link-local
ff02::16	All MLDv2 Routers	Link-local
ff02::1:2	DHCPv6 Servers/Agents	Link-local
ff05::1:3	DHCPv6 Servers/Agents	Site-local
ff0x::101	Network Time Protocol	Variable
ff02::1:ffxx:xxxx	Solicited-Node Address	Link-local

IPv6 Address Shorthand Notation

2001:0db8:0006:1ab5:0000:0000:0000:ba11
remove leading zeros to achieve
2001:db8:6:1ab5:0:0:0:ba11
additional reduction by replacing consecutive fields of zeros with double-colon "::" option (can only be done once) to achieve
2001:db8:6:1ab5::ba11

IPv6 Header

Version (4)	Traffic Class (8)	Flow Label (20)	
Payload Length (16)		Next Header (8)	Hop Limit (8)
Source Address (128)			
Destination Address (128)			

Version : IP version number, 6 for IPv6
Traffic Class : Similar to IPv4 ToS field. Used by nodes to identify and distinguish between different classes or priorities of IPv6 packets
Flow label : Used by a source to label sequences of packets for which it requests special handling by the IPv6 routers
Payload Length : Length of the IPv6 payload (may also include extension headers)
Next Header : Identifies the type of header following the IPv6 header
Hop Limit : Decremented by 1 by every router that forwards the packet
Source Address : IPv6 address of the originator of the packet, will be a unicast address
Destination Address : IPv6 address of the intended recipient or final destination of the packet, can be unicast or mulficast address

Interface ID from MAC Address

00 18 41 23 6a 32 IEEE 48-bit MAC Address
00 18 41 23 6a 32 Expanded to EUI-64
00000000
ff fe 0xfffe inserted
00000010 Invert 7th bit of 1st Byte, known as the universal/local bit
02 18 41 ff fe 23 6a 32
0218:41ff:fe23:6a32 Modified EUI-64 Interface ID

ICMPv6 Message Types

128	Echo Request
129	Echo Reply
130	Multicast Listener Query
131	Multicast Listener Report
132	Multicast Listener Done
133	Router Solicitation
134	Router Advertisement
135	Neighbor Solicitation
136	Neighbor Advertisement
137	Redirect Message
138	Router Renumbering
139	ICMP Node Information Query
140	ICMP Node Information Response
143	Multicast Listener Report (MLDv2)
144	Home Agent Discovery Request
145	Home Agent Discovery Reply
146	Mobile Prefix Solicitation
147	Mobile Prefix Advertisement

IPv6 Next Header Fields
(Extension Headers)

0	IPv6 Hop-byHop Option
41	IPv6 encapsulation
43	Routing Header for IPv6
44	Fragment Header for IPv6
50	Encap Security Payload (ESP)
51	Authentication Header (AH)
59	No Next Header for IPv6
60	Destination Options for IPv6

IPv6 Address Types

Link-Local – Automatically assigned per interface, not routable
Global Unicast Address (GUA) – Assigned by SLAAC, Stateful (DHCPv6), or manual, routable to Internet
Unique Local Address (ULA) – Assigned by SLAAC, Stateful (DHCPv6), or manual, not routable to Internet, is routable within enterprise (like private address)

Unicast – one-to-one (link-local, unique local, global)
Anycast – one-to-nearest (allocated from Unicast)
Multicast – one-to-many (also replaces broadcast)

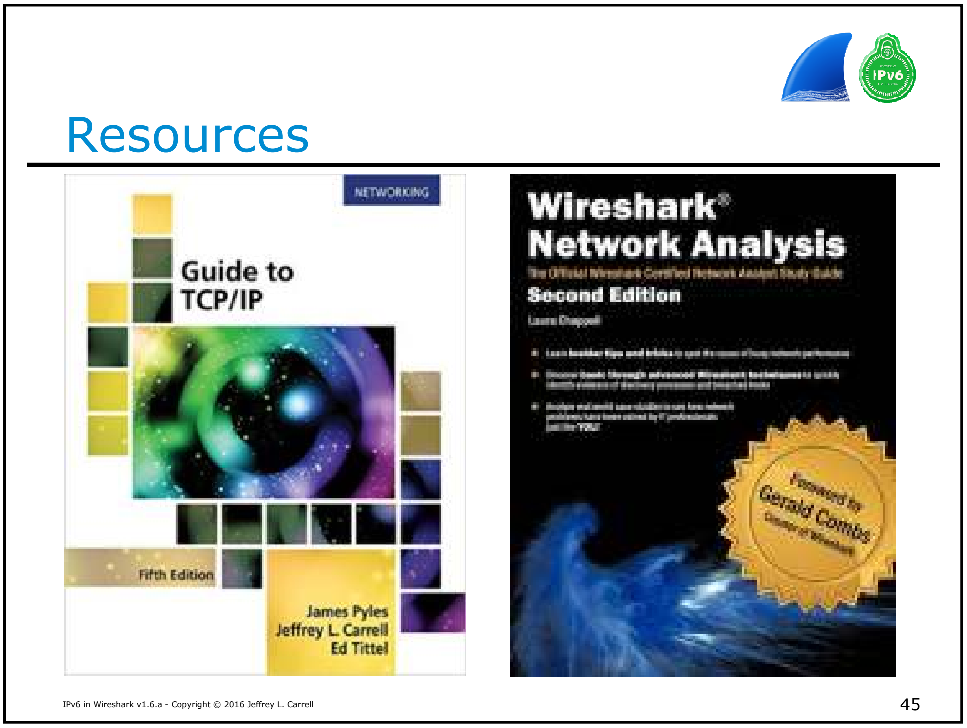
Wireshark Display Filters for IPv6

ipv6 – all IPv6 traffic
icmpv6 – all IPv6 ICMPv6 traffic
dhcpv6 – all DHCPv6 traffic
icmpv6.type == 133 – all router solicitations
icmpv6.type == 134 – all router advertisements
icmpv6.type == 135 – all neighbor solicitations
icmpv6.type == 136 – all neighbor advertisements
icmpv6.type == 137 – all redirect messages

IPv6 Neighbor Discovery Protocol

Neighbor Solicitation (NS) – Neighbor address resolution (similar to IPv4 ARP)
Neighbor Advertisement (NA) – Response to Neighbor Solicitation requests
Router Solicitation (RS) – Sent by nodes "looking" for IPv6 routers on-link
Router Advertisements (RA) – Sent periodically by routers and in response to RS
Duplicate Address Detection (DAD) – Sent to own Solicited-Node Multicast Address

www.teachmeipv6.com jeff.carrell@teachmeipv6.com IPv6 Essentials Cheat Sheet v1.7 © 2015 Jeffrey L. Carrell



Resources

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Resources

Wireshark® 101
Essential Skills for Network Analysis
46 Step-by-Step Labs
Laura Chappell
Foreword by Gerald Combs
Creator of Wireshark
Master key Wireshark skills to quickly characterize network traffic rates, protocols, applications and hosts
A Wireshark Solutions Series Book
Troubleshooting with Wireshark®
Locate the Source of Performance Problems
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Foreword by Gerald Combs
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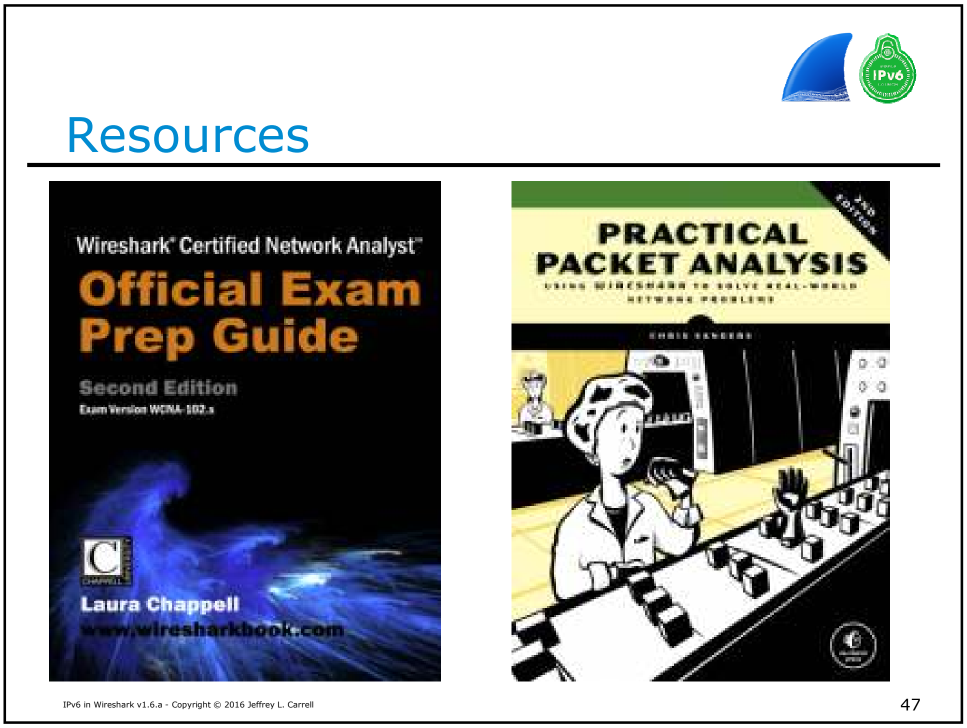

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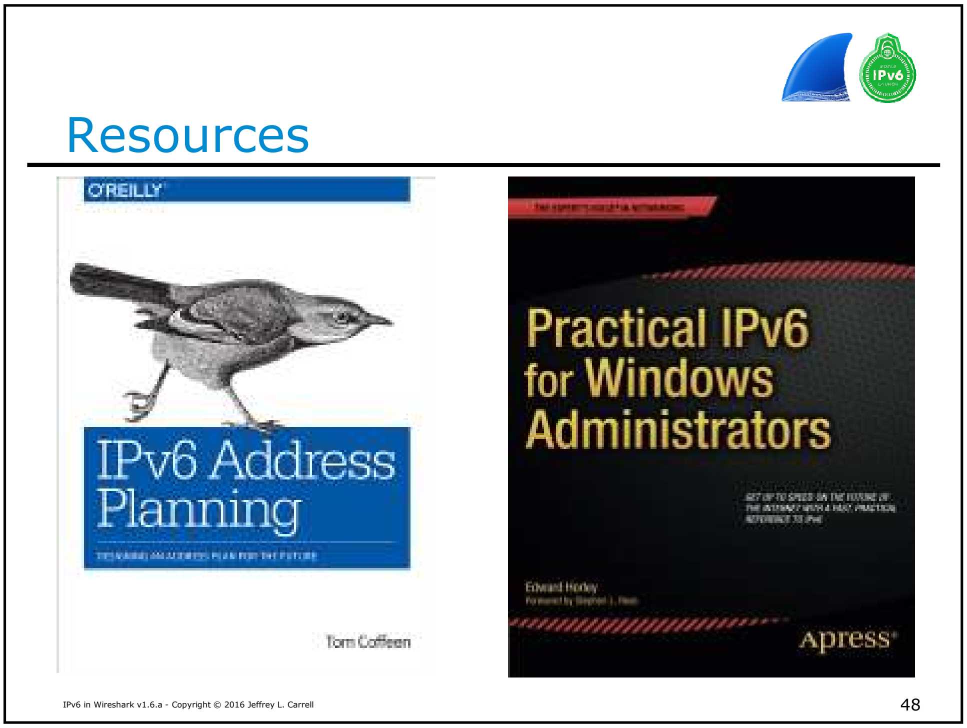

Resources

O'REILLY
IPv6 Address Planning
DESIGNING AN ADDRESS PLAN FOR THE FUTURE
Tom Coffeen
Practical IPv6 for Windows Administrators
Edward Horley
Apress®

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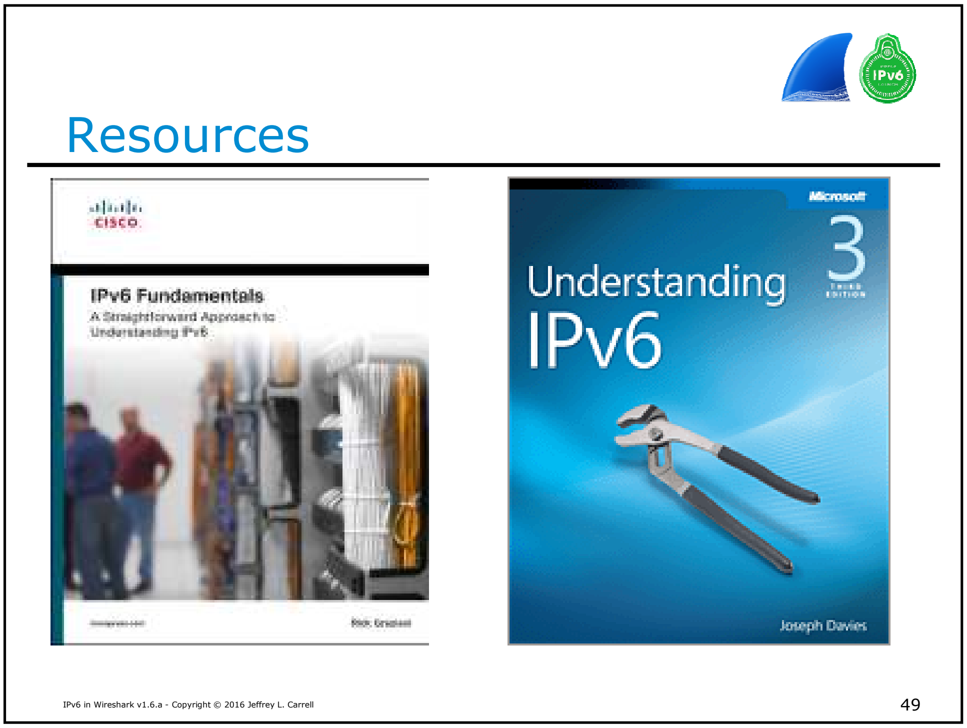

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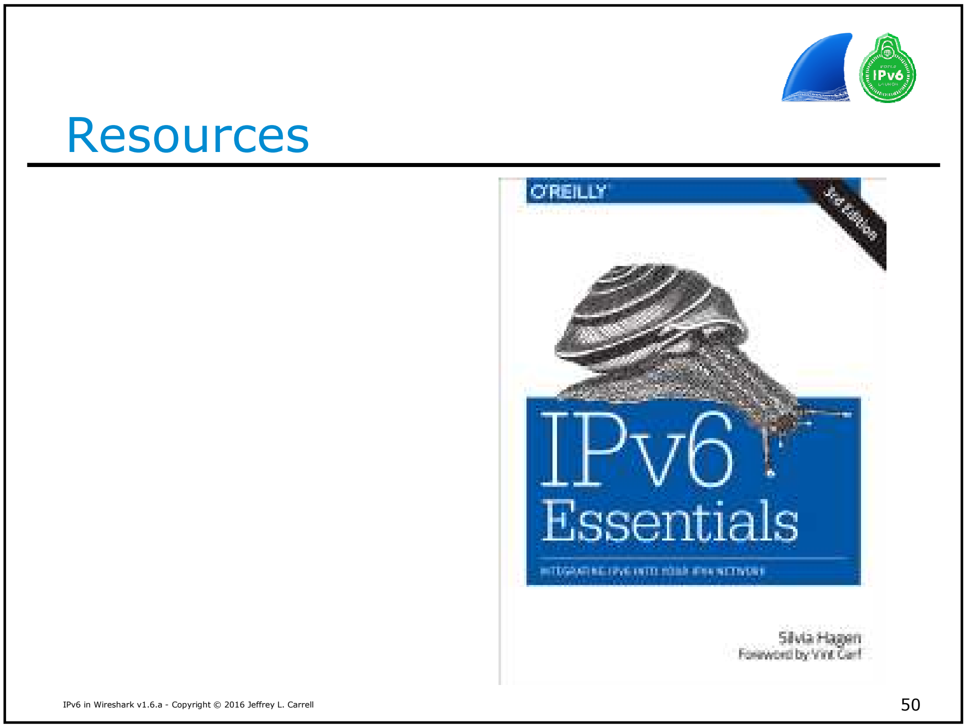
49



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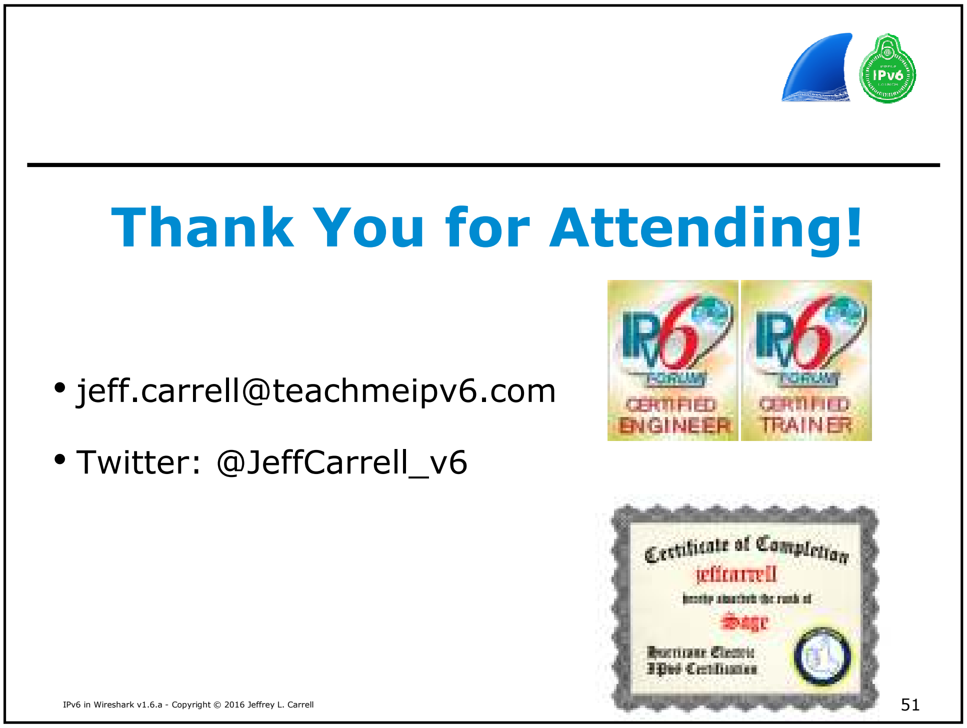
50



Thank You for Attending!

- jeff.carrell@teachmeipv6.com
- Twitter: @JeffCarrell_v6

Certificate of Completion
jeffcarrell
hereby awarded the rank of
Sage
Hurricane Electric
IPv6 Certification

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51