

## SharkFest '16

### Troubleshooting IPv6 with Wireshark

Tuesday June 14, 2016

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1

## IPv6 in Wireshark

- IPv6 – a bit more than basics
- Wireshark basics
- Wireshark color rules, display filters, columns, configuration profiles, and packet annotation
- IPv6 in Wireshark: hands-on labs

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# IPv6 in Wireshark

## IPv6: Trivia

- In modern day operating systems, is IPv6 an enabled protocol?
- Generally, will an IPv6 enabled interface have more than one IPv6 address assigned to it?

**YES!**

**YES!**

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## IPv6: Trivia

- How many IPv6 GUA addresses can a network interface have that are in the same network?
- How many IPv6 GUA addresses can a network interface have that are in different networks?

**Up to 4!**

**Almost infinite!**

- Can the IPv6 Link-Local address be the same address for all network interfaces in a host?

**YES!**

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# IPv6 in Wireshark

## IPv6: Trivia

- How does an IPv6 enabled host derive its default gateway? **Via the RA!**
- Does DHCPv6 have a configurable option to provide an IPv6 default gateway? **NO!**
- Does an IPv6 host use its LL or GUA address to communicate to its default gateway? **LL!**

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## IPv6: Trivia

- If an IPv6 enabled host has autoconfigured privacy extension addresses and a statically assigned address, which one gets used for off-net communications? **Temporary!**
- If attempting to communicate on-net using your GUA to another IPv6 host, will the communication be successful if the v6 router is not on-net? **NO!**

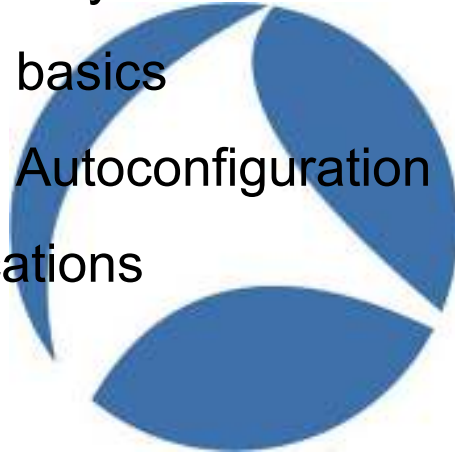
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# IPv6 in Wireshark

## IPv6 – a bit more than basics

- Quick IPv6 history
- IPv6 Address basics
- IPv6 Address Autoconfiguration
- IPv6 in applications



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## IPv6 Brief History

- Fall 1992 – IPv4 addresses will run out someday
- Oct 1993 – DHCP – RFC 1531 – easier IPv4 address management
- Dec 1993 – IPng – RFC 1550 – basic specification for next version IP
- May 1994 – NAT – RFC 1631 – temporary solution before IPng available
- Dec 1995 – RFC 1883 – Basic specifications of IPv6
- Feb 1996 – RFC 1918 – Private IPv4 addresses
- Dec 1998 – RFC 2460 – Full IPv6 defined
- May 2005 – RFC 3927 – APIPA (IPv4)

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# IPv6 in Wireshark

## Comparing IPv4 & IPv6 Addresses

- IPv4 addresses  $2^{32} = 4,294,967,296$
- IPv6 addresses  $2^{128} = 340,282,366,920,938,463,463,374,607,431,768,211,456$ 
  - which is 340 undecillion
    - 340 trillion trillion trillion
  - 79,228,162,514,264,337,593,543,950,336 times more v6 addresses than v4
- If IP addresses weighed one gram each:
  - IPv4 = half the Empire State Building
  - IPv6 = 56 billion earths

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## 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

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# IPv6 in Wireshark

## 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



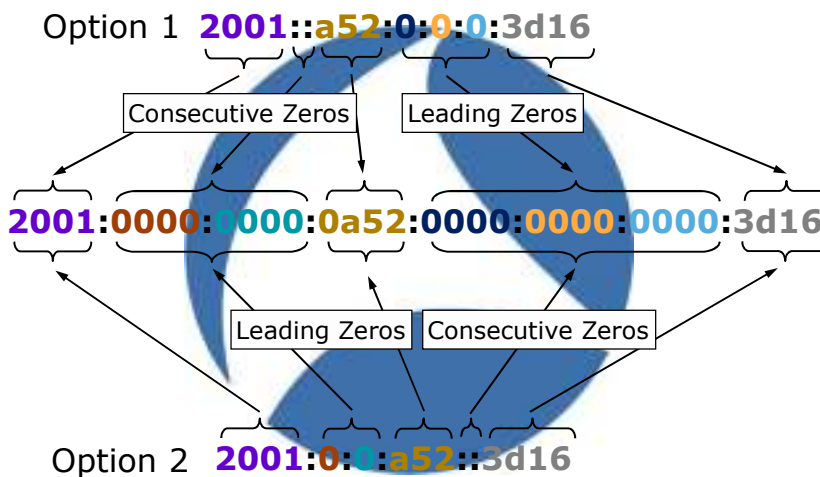
- A single /64 network yields **18 billion-billion** possible addresses

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## IPv6 shorthand notation



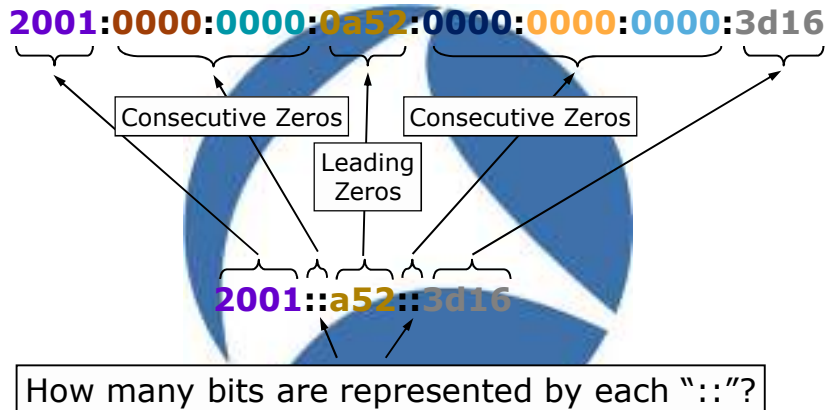
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# IPv6 in Wireshark

## Incorrect shorthand notation



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## Address types

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

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14



# IPv6 in Wireshark

## Address scopes

Address Scope	IPv4	IPv6
Link-Local - Not routable	Yes (is temp, APIPA)	Yes
Global Unicast - Routable to Internet	Aka public	Yes
Unique Local - Routable only within domain	RFC 1918 Aka private	RFC 4193

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15

## 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 (assigned from fd00::/8)
Documentation	192.0.2.0/24 198.51.100.0/24 203.0.113.0/24	2001:db8::/32

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# IPv6 in Wireshark

## IPv6 well known multicast addresses

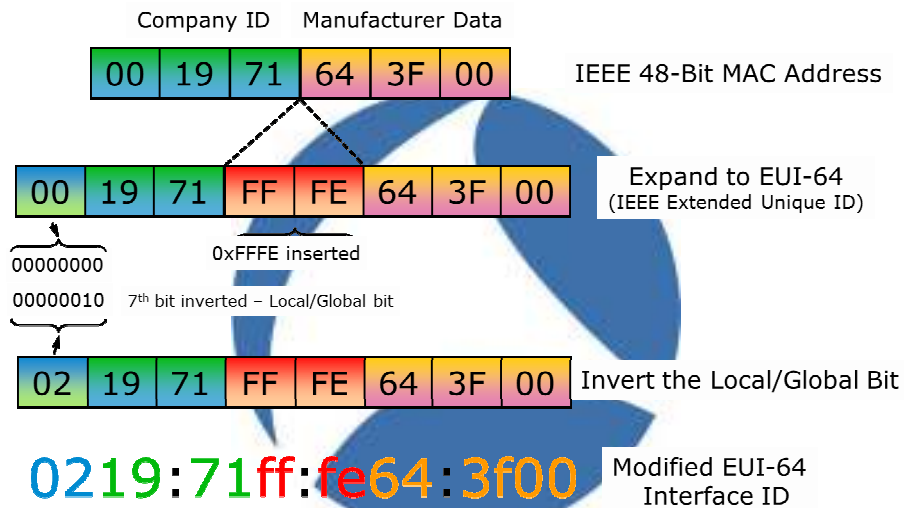
Address	Description	Scope
ff01::1	All nodes address	Interface-local
ff02::1	All nodes address	Link-local
ff01::2	All routers address	Interface-local
ff02::2	All routers address	Link-local
ff05::2	All routers address	Site-local
ff02::4	DVMRP routers	Link-local
ff02::5	OSPF drothers	Link-local
ff02::6	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

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## Interface ID from MAC address



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18

# IPv6 in Wireshark

## Interface ID from Random Number

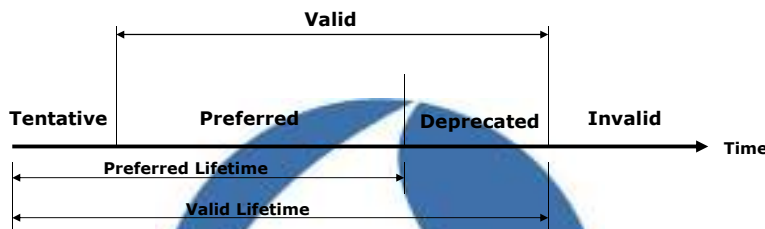
- RFC4941 - Privacy Extensions for Stateless Address Autoconfiguration in IPv6
- Initial IID is derived based on mathematical computation to create a “random 64bit number” and appended to prefix to create a GUA
- An additional but different 64bit number is computed, appended to prefix, and tagged “temporary” for a 2<sup>nd</sup> 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”

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19

## 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

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20

# IPv6 in Wireshark

## Comparing IPv4 & IPv6 Neighbor Discovery Protocols

IPv4	IPv6
ARP Request	Neighbor Solicitation
ARP Reply	Neighbor Advertisement
Router Solicitation	Router Solicitation
Router Advertisement	Router Advertisement
Gratuitous ARP	Duplicate Address Detection
ARP Cache	Neighbor Cache

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## 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 on
  - Learn link prefix addresses
  - Discover the on-link router
  - Discover on-link neighbors
  - Keep track of active neighbors

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# IPv6 in Wireshark

## 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)



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## 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)

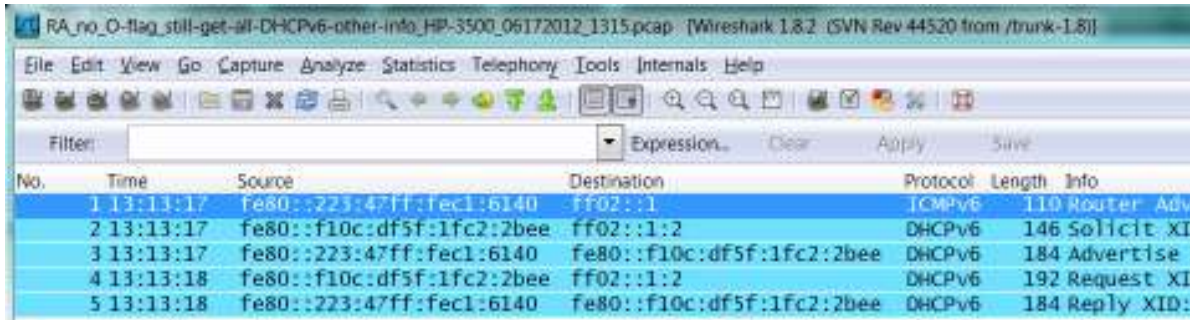
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# IPv6 in Wireshark

## IPv6 Stateful (DHCPv6) process



The image shows a Wireshark packet capture window with the title "RA\_no\_O-flag\_still-get-af-DHCPv6-other-info\_HP-3500\_06172012\_1315.pcap". The packet list pane shows five packets:

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 XI

- DHCPv6Solicit = DHCPDiscover (IPv4)
- DHCPv6Advertise = DHCPOffer (IPv4)
- DHCPv6Request = DHCPRequest (IPv4)
- DHCPv6Reply = DHCPAck (IPv4)

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25

## Wireshark

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



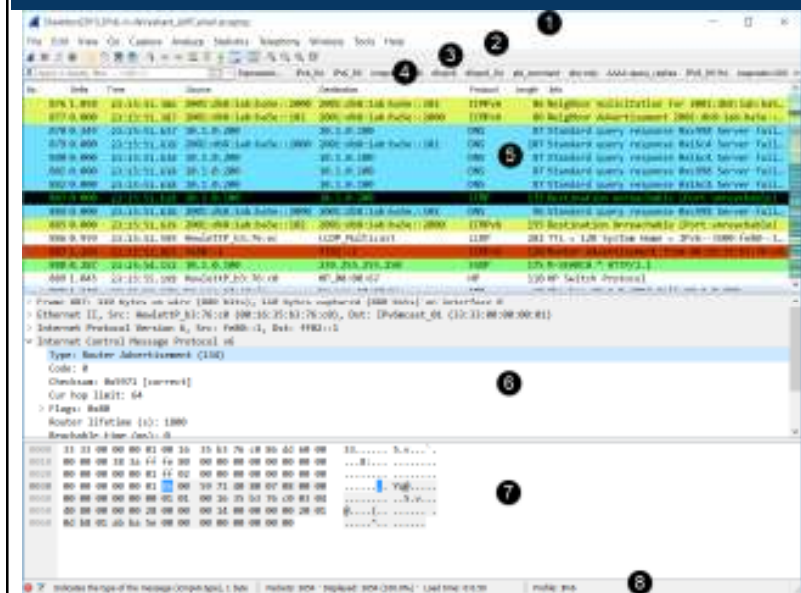
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26

# IPv6 in Wireshark

## Wireshark main view



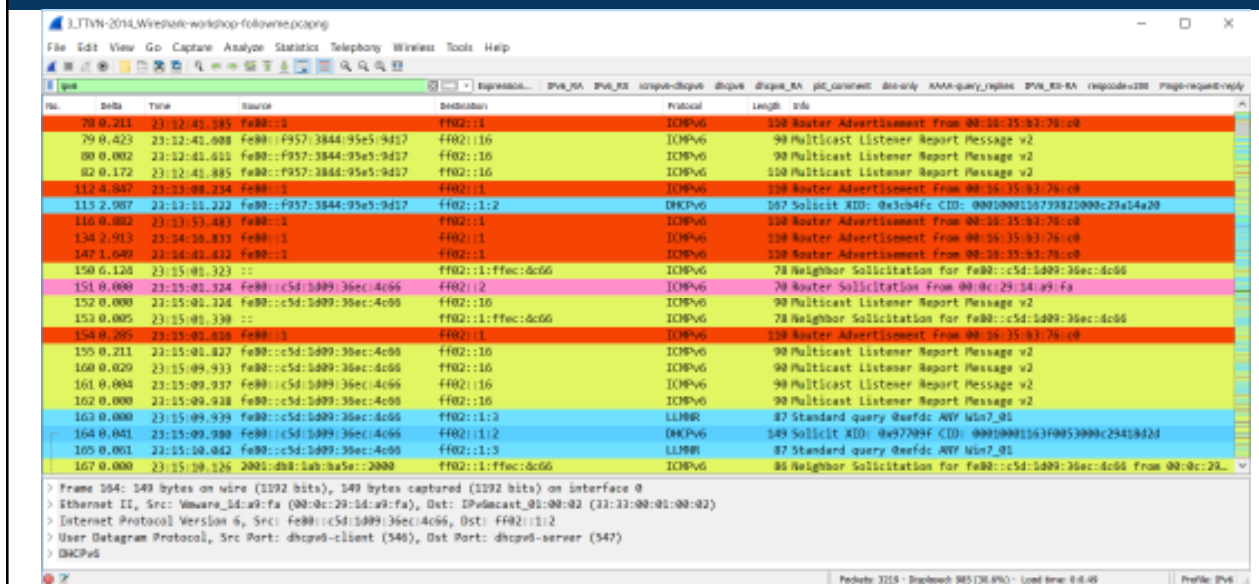
1. Title bar — trace file name or capture device name
2. Main menu — standard menu
3. Main toolbar — quick access
4. Display filter area — reduce the amount of traffic you see
5. Packet List pane — summary of each frame
6. Packet Details pane — dissected frames
7. Packet Bytes pane — hex and ASCII details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

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## Jeff's IPv6 Wireshark



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28



# IPv6 in Wireshark

## Coloring rules

No.	Delta	Time	Source	Destination	Protocol	Length	Info
441	0.058	23:15:51.386	2001:db8:lab:ba5e::2000	2001:db8:lab:ba5e::102	ICMPv6	86	Neighbor Solicitation for 2001:db8:1a
442	0.000	23:15:51.387	2001:db8:lab:ba5e::102	2001:db8:lab:ba5e::2000	ICMPv6	86	Neighbor Advertisement 2001:db8:1a
443	0.243	23:15:51.637	10.1.0.200	10.1.0.100	DNS	87	Standard query response 0xc993 Server
444	0.000	23:15:51.638	2001:db8:lab:ba5e::2000	2001:db8:lab:ba5e::102	DNS	107	Standard query response 0x16c4 Server
445	0.000	23:15:51.638	10.1.0.200	10.1.0.100	DNS	87	Standard query response 0xc993 Server
446	0.000	23:15:51.638	10.1.0.200	10.1.0.100	DNS	87	Standard query response 0xc993 Server
447	0.000	23:15:51.638	10.1.0.200	10.1.0.100	DNS	87	Standard query response 0x16c4 Server
448	0.000	23:15:51.638	10.1.0.200	10.1.0.200	ICMP	115	Destination unreachable (Port unreach
449	0.000	23:15:51.638	2001:db8:lab:ba5e::2000	2001:db8:lab:ba5e::102	DNS	96	Standard query response 0xc993 Server
450	0.000	23:15:51.639	2001:db8:lab:ba5e::102	2001:db8:lab:ba5e::2000	ICMPv6	155	Destination Unreachable (Port unreach
451	0.959	23:15:52.509	HewlettP_03:76:ec	LLDP Multicast	LLDP	282	TTL = 120 System Name = [Pv6--3500-fc
452	1.288	23:15:53.805	F802::1	F802::1	ICMPv6	118	Router Advertisement from 00:10:33:00
453	0.287	23:15:54.152	10.1.0.100	239.255.255.250	SSDP	175	R-SEARCH * HTTP/1.1
454	1.045	23:15:55.108	HewlettP_03:76:c0	HP_00:00:67	HP	110	HP Switch Protocol
455	1.130	23:15:56.320	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:lab:ba5e::102	2001:db8:lab: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

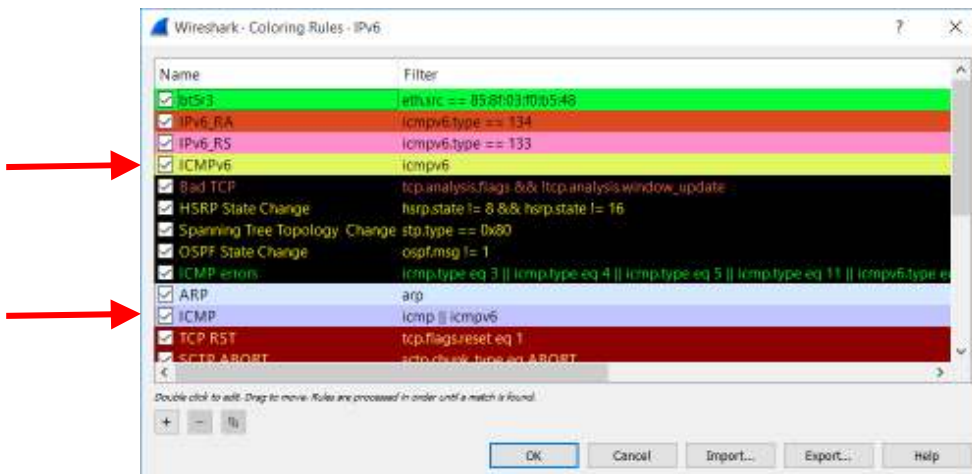
- Colors help you focus on specific address, protocols, events, and possibly find errors quickly

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29

## Color rule processing order



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

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30



# IPv6 in Wireshark

## Color rule creation

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## 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>

3\_TTVN-2014\_Wireshark-workshop-followme.pcapng

File Edit View Go Capture Analyze Statistics Telephony Wireless Tools

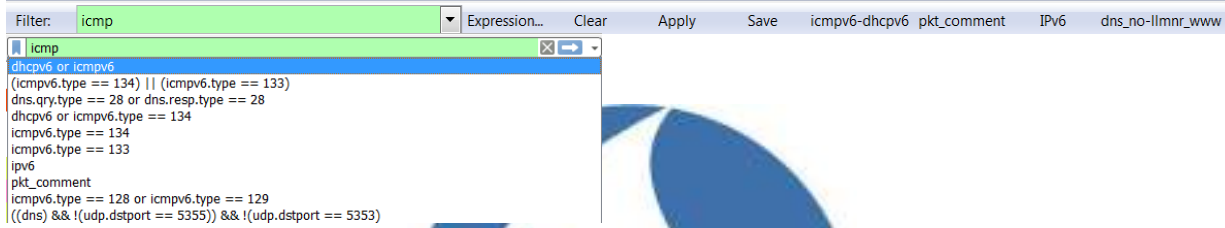
icmpv6 or dhcpv6

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# IPv6 in Wireshark

## Display filters – option 1



- 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

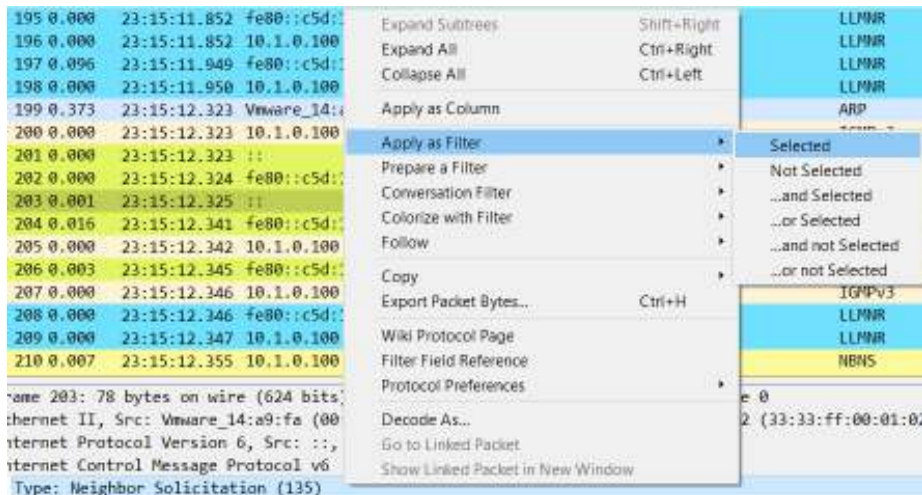
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33

## Display filters – option 2

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



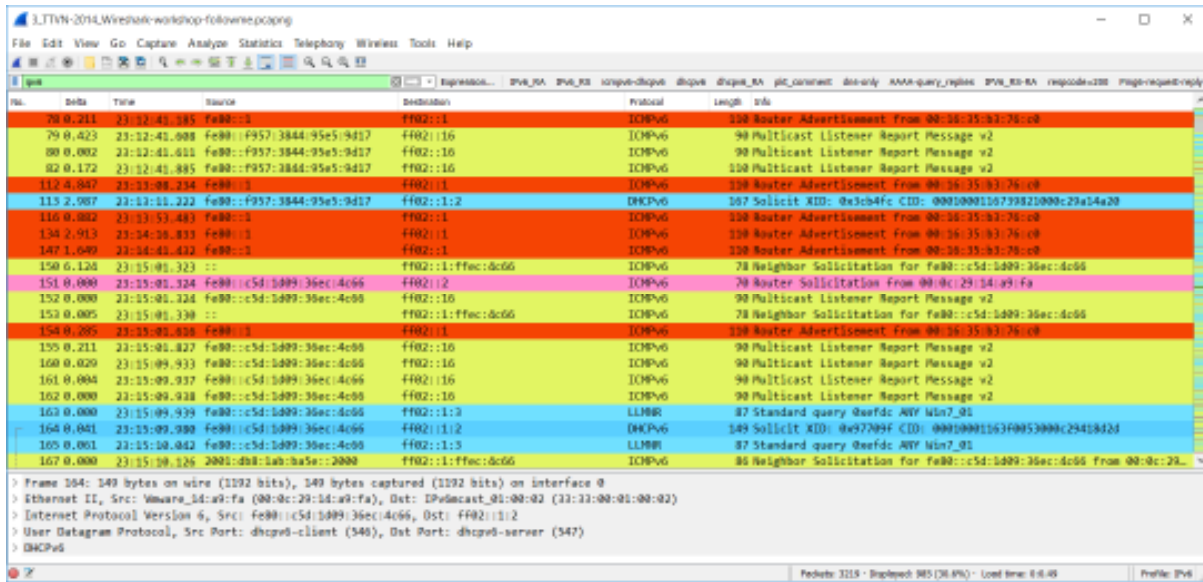
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34

# IPv6 in Wireshark

## Using Wireshark to view IPv6 pkts

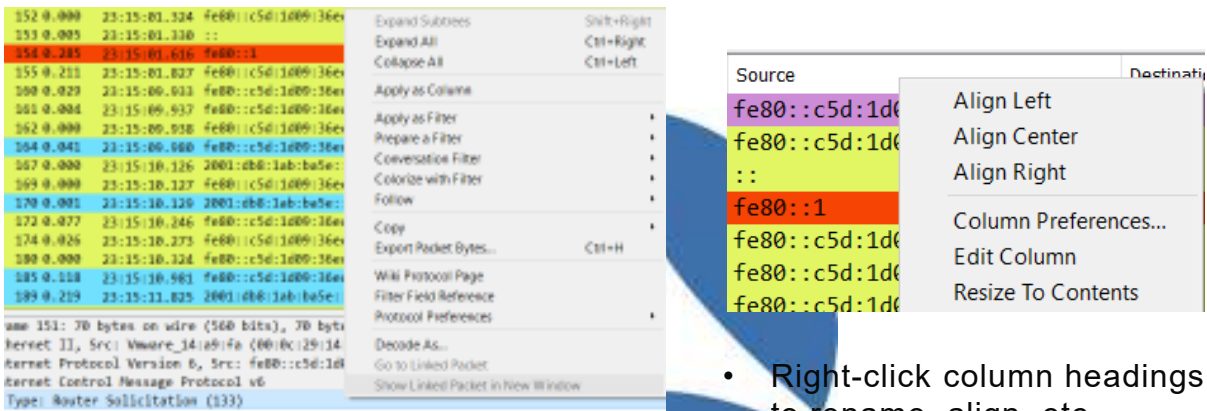


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35

## Columns



- In the Packet Details view, right-click on a specific field to Apply as Column

- Right-click column headings to rename, align, etc

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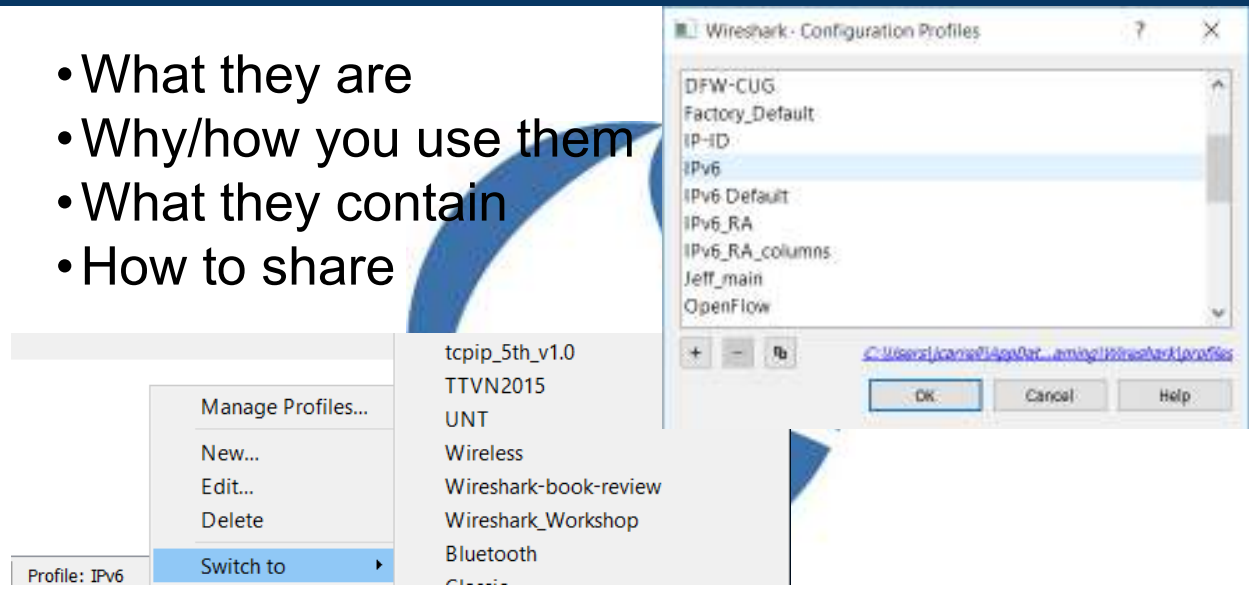
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36

# IPv6 in Wireshark

## Configuration profiles

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

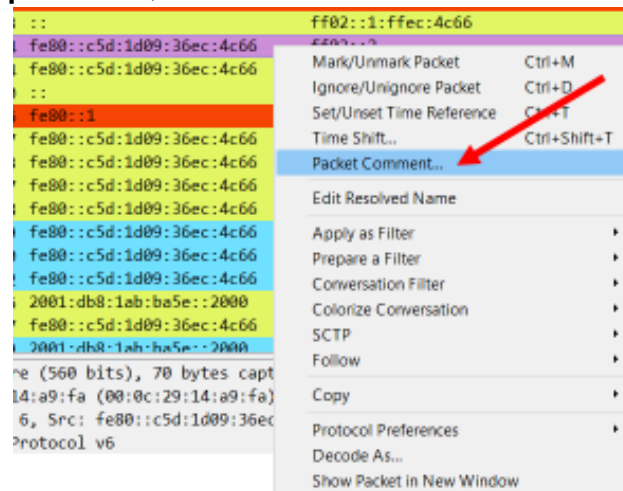


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37

## Packet annotation

- Right click packet, select Packet Comment



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38

# IPv6 in Wireshark

## Packet annotation

No.	Time	Source	Destination	Protocol	Length	Info
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	ff02::16	ICMPv6	90 Multicast Listener Report Message v2
153	0.005	23:15:01.330	::	ff02::1	ICMPv6	78 Neighbor Solicitation
154	0.285	23:15:01.616	fe80::11	ff02::1	ICMPv6	110 Router Advertisement
155	0.211	23:15:01.827	fe80::c5d:1d09:36ec:4c66	ff02::16	ICMPv6	90 Multicast Listener Report Message v2
160	0.029	23:15:09.933	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	23:15:09.939	fe80::c5d:1d09:36ec:4c66	ff02::16	ICMPv6	87 Standard query 0xef0
164	0.001	23:15:09.980	fe80::c5d:1d09:36ec:4c66	ff02::2	ICMPv6	149 Solicit XID: 0x97709f

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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## Wireshark demo #1 – watch me

No.	Time	Source	Destination	Protocol	Length	Info
112	0.007	23:15:01.234	fe80::1	ff02::1	ICMPv6	110 Router Advertisement from 00:16:35:83:76:c0
113	2.507	23:15:11.222	fe80::f957:3844:95e5:9d17	ff02::1:2	ICMPv6	107 Solicit XID: 0x3c94fc CID: 0001000116739821000:2915420
116	0.002	23:15:11.483	fe80::1	ff02::1	ICMPv6	110 Router Advertisement from 00:16:35:83:76:c0
134	2.913	23:14:16.433	fe80::1	ff02::1	ICMPv6	110 Router Advertisement from 00:16:35:83:76:c0
147	1.600	23:14:41.432	fe80::1	ff02::1	ICMPv6	110 Router Advertisement from 00:16:35:83:76:c0
150	0.124	23:15:01.323	::	ff02::1:ffec:4c66	ICMPv6	78 Neighbor Solicitation for fe80::c5d:1d09:36ec:4c66
151	0.000	23:15:01.324	fe80::c5d:1d09:36ec:4c66	ff02::2	ICMPv6	70 Router Solicitation from 00:0c:29:14:a9:fa
152	0.000	23:15:01.324	fe80::c5d:1d09:36ec:4c66	ff02::16	ICMPv6	90 Multicast Listener Report Message v2
153	0.005	23:15:01.330	::	ff02::1:ffec:4c66	ICMPv6	78 Neighbor Solicitation for fe80::c5d:1d09:36ec:4c66
154	0.285	23:15:01.616	fe80::11	ff02::1	ICMPv6	110 Router Advertisement from 00:16:35:83:76:c0
155	0.211	23:15:01.827	fe80::c5d:1d09:36ec:4c66	ff02::16	ICMPv6	90 Multicast Listener Report Message v2
160	0.029	23:15:09.933	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
164	0.001	23:15:09.980	fe80::c5d:1d09:36ec:4c66	ff02::2	ICMPv6	149 Solicit XID: 0x97709f CID: 0001000116739821000:2915420
167	0.000	23:15:09.126	0011:0000:0000:0000:0000:0000:0000:0000	ff02::1	ICMPv6	110 Router Advertisement from 00:0c:29:14:a9:fa
169	0.000	23:15:10.127	0011:0000:0000:0000:0000:0000:0000:0000	ff02::1	ICMPv6	110 Router Advertisement from 00:0c:29:14:a9:fa
170	0.001	23:15:10.129	2001:db8:1ab:ba5e::2000	fe80::c5d:1d09:36ec:4c66	ICMPv6	217 Advertise XID: 0x97709f CID: 0001000116739821000:2915420 IAA: 2
172	0.077	23:15:10.246	fe80::c5d:1d09:36ec:4c66	ff02::16	ICMPv6	90 Multicast Listener Report Message v2
174	0.026	23:15:10.273	fe80::c5d:1d09:36ec:4c66	ff02::16	ICMPv6	90 Multicast Listener Report Message v2
180	0.000	23:15:10.324	fe80::c5d:1d09:36ec:4c66	ff02::16	ICMPv6	90 Multicast Listener Report Message v2
185	0.110	23:15:10.981	fe80::c5d:1d09:36ec:4c66	ff02::1:2	ICMPv6	105 Request XID: 0x97709f CID: 0001000116739821000:2915420 IAA: 200

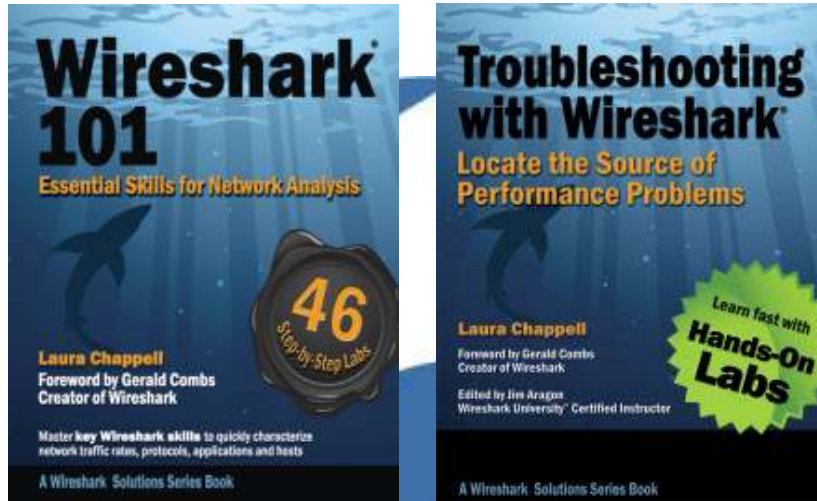
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# IPv6 in Wireshark

## Resources

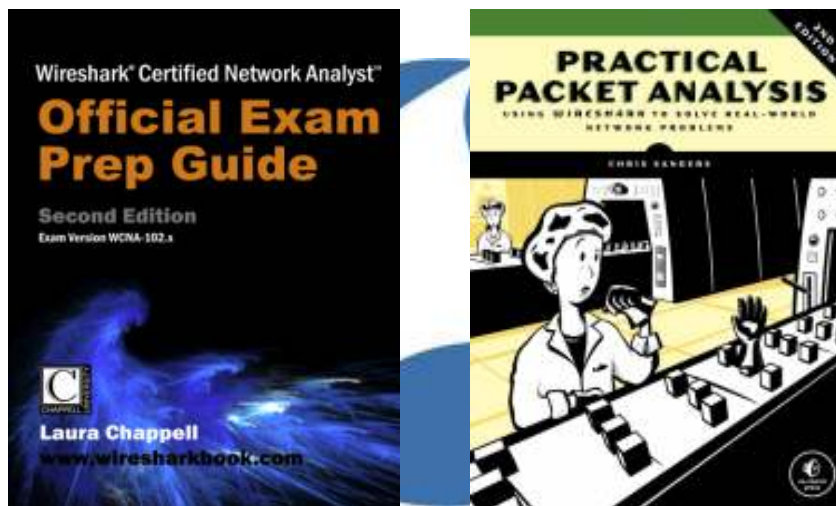


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43

## Resources



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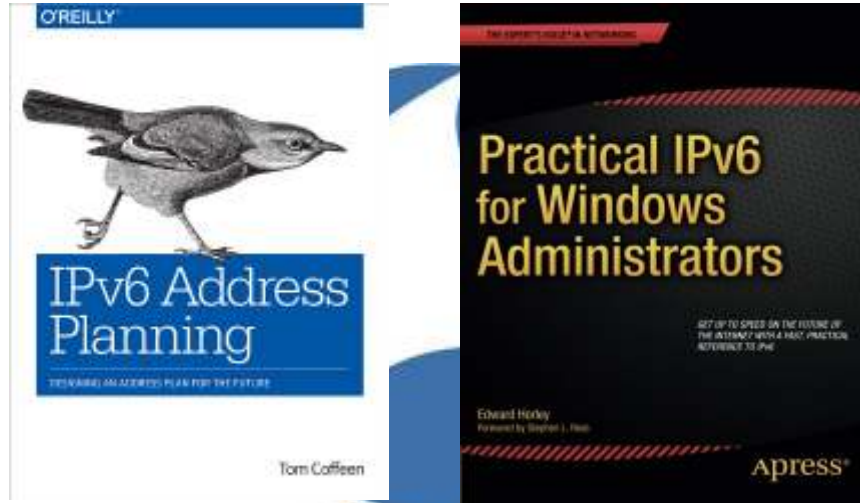
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44



# IPv6 in Wireshark

## Resources

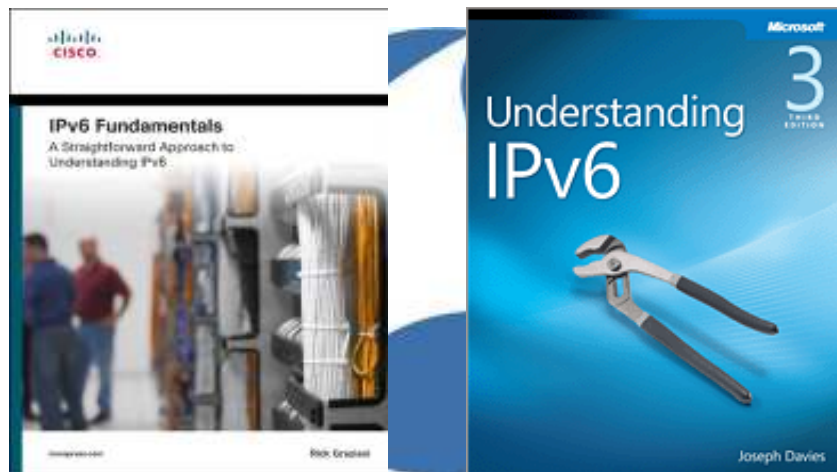


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45

## Resources



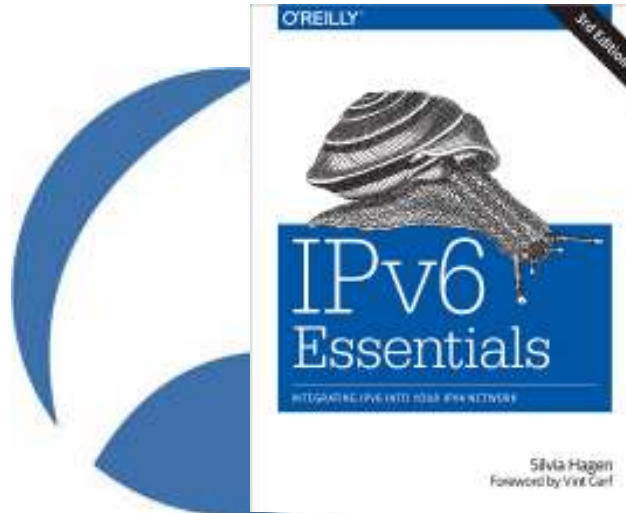
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47

## Thank You for Attending!

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48