

Hitchhiker's Guide to Troubleshooting IPv6

cisco Live !

Nicole Wajer
Chief Stroopwafel Officer

Session ID: BRKENT-3340

Warmup to IPv6



Cisco Webex App

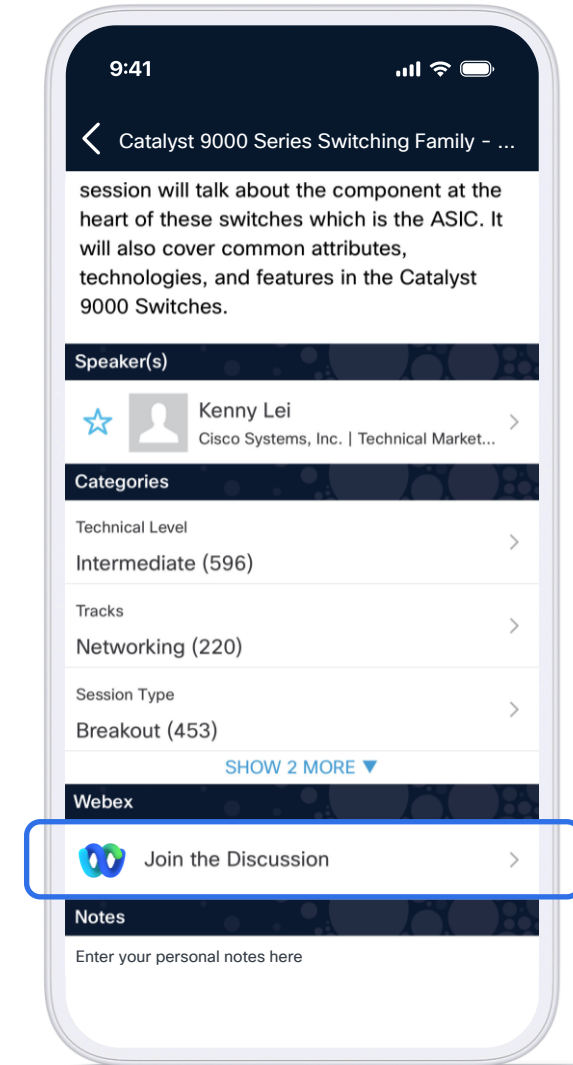
Questions?

Use Cisco Webex App to chat with the speaker after the session

How

- 1 Find this session in the Cisco Live Mobile App
- 2 Click “Join the Discussion”
- 3 Install the Webex App or go directly to the Webex space
- 4 Enter messages/questions in the Webex space

Webex spaces will be moderated by the speaker until 14 November 2025.



<https://ciscolive.ciscoevents.com/ciscolivebot/#BRKENT-3340>

Agenda

- 01 The beginning**
- 02 Config: Don't forget these**
- 03 RA's: Wireless**
- 04 Validate: Neighbor And Router Discovery**
- 05 War stories: NPv1 and NPv2**
- 06 Wireshark: Addressing Joy**

Nicole





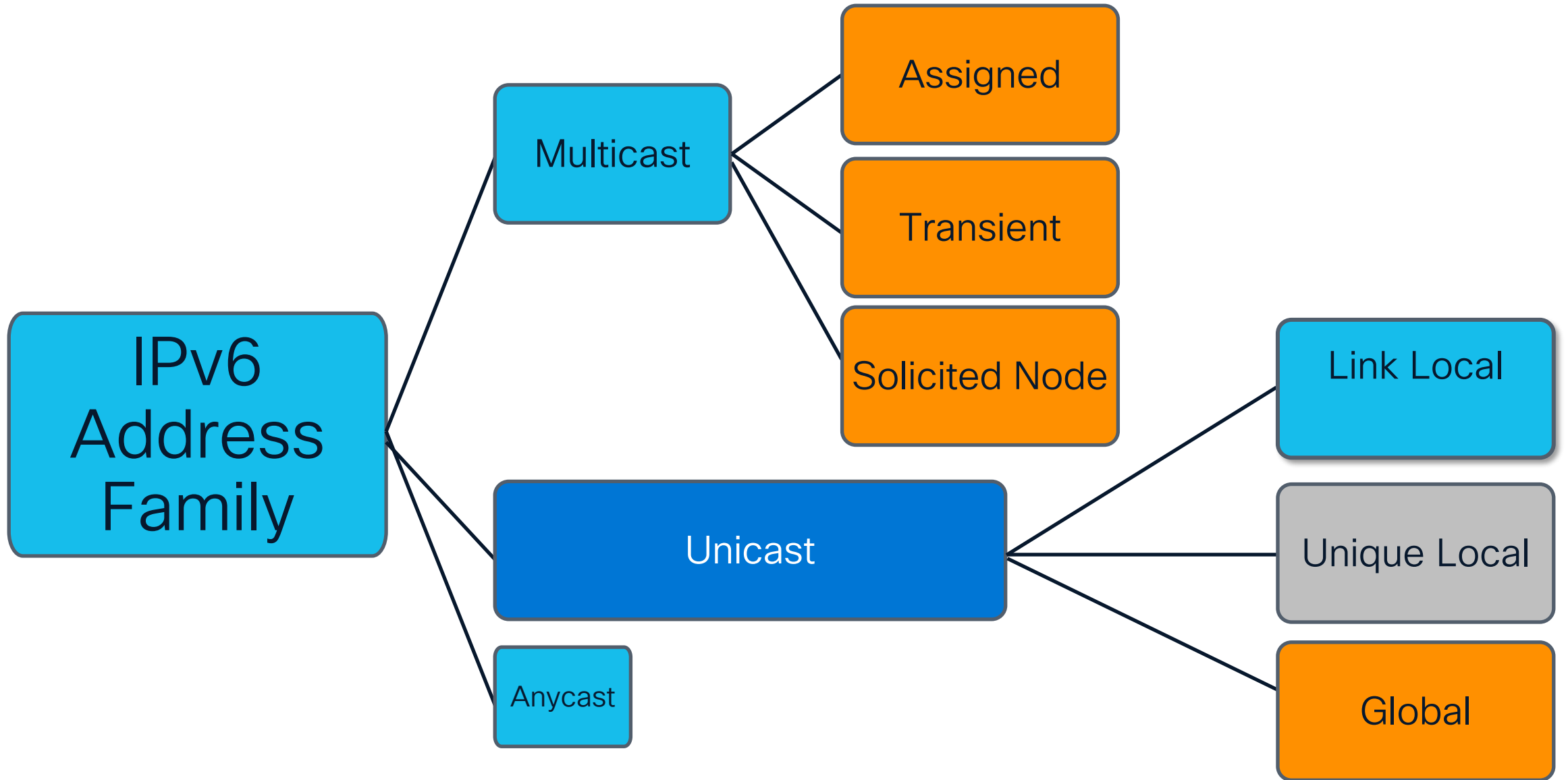
Don't Panic

The beginning RE-FRESH

The Address

2001:0db8:4646:0001:0000:0000:0000:1e2a

IPv6 Addressing



IPv6 Address rules (RFC 5952)

Lower case, suppress leading / compress consecutive zeros

2001:0db8:0046:a1d1:0000:0000:0000:0001

2001:db8:46:a1d1:0:0:0:1

2001:db8:46:a1d1::1

Prefix

Interface Id

2001 : 0db8 : 0046 : a1d1 : 0000 : 0000 : 0000 : 0001

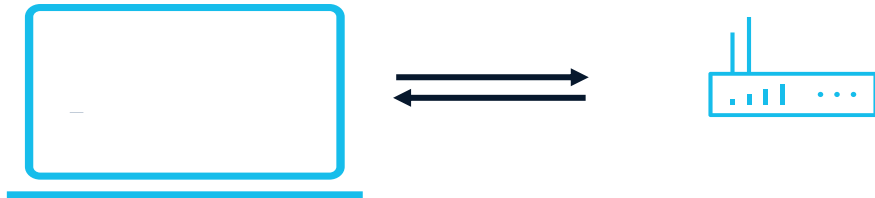


The diagram illustrates the components of the IPv6 address 2001:0db8:0046:a1d1:0000:0000:0000:0001. The address is split into eight 16-bit segments, each represented by a colored double-headed arrow below it. The first four segments (2001, 0db8, 0046, a1d1) are grouped under the 'Prefix' label. The last four segments (0000, 0000, 0000, 0001) are grouped under the 'Interface Id' label. The 'a1d1' segment is highlighted in pink, and the '0000' segments are highlighted in blue. The diagram demonstrates how leading zeros can be suppressed and how consecutive zeros can be compressed using a double colon (::).

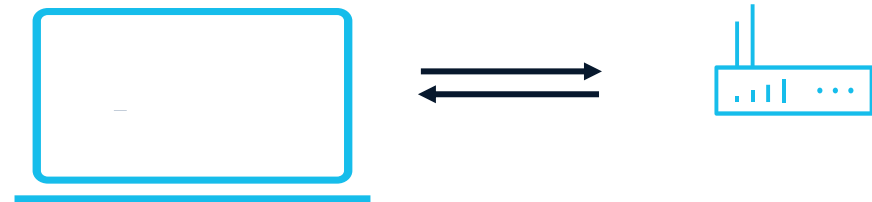
IPv6 interface ID Assignment

IPv6 way

Stateless Address Auto Configuration
SLAAC EUI64



SLAAC RFC 8981
Temporary Address Extensions for
Stateless Address Autoconfiguration
in IPv6 formerly Privacy Extensions



The Address

Link-Local address

Non routable exists on single layer 2 domain (fe80::/10)

fe80:0000:0000:0000:xxxx:xxxx:xxxx:xxxx

Unique Local Address

Routable within administrative domain (fc00::/7)

fc00:~::~:~::~:~::~:~::~:****:xxxx:xxxx:xxxx:xxxx

fd00:~::~:~::~:~::~:~::~:****:xxxx:xxxx:xxxx:xxxx

Global Address

Routable across the Internet (2000::/3)

Documentation Prefix 2001:0db8::/32 (July 2004) & 3fff::/20 (July 2024)

2000:****:****:****:xxxx:xxxx:xxxx:xxxx

3fff:****:****:****:xxxx:xxxx:xxxx:xxxx

Session Journey

1. Config

Don't forget these

2. RA's

Wireless

3. Validate

Neighbor And Router Discovery

4. War Stories

NPv1 and NPv2

5. Wireshark

Addressing Joy

Don't forget these



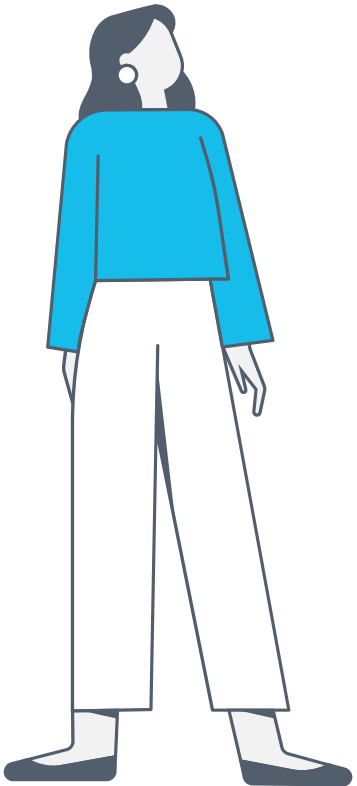
OSPFv2 vs OSPFv3

OSPFv2 == Legacy IP

OSPFv3 Support Both!



EIGRP IPv6 needs “no shutdown”



```
ipv6 router eigrp 1  
  router-id 192.0.2.1  
no shutdown
```

VRRPv3: default is VRRPv2 => no IPv6 support

```
R1#conf t
```

Enter configuration commands, one per line. End with CNTL/Z.

```
R1(config)#int e0/1
```

```
R1(config-if)# ipv6 address 2001:db8:cafe::1/64
```

```
R1(config-if)#vrrp 101 ?
```

authentication Authentication

description Group specific description

ip Enable Virtual Router Redundancy Protocol (VRRP) for IP

preempt Enable preemption of lower priority Master

priority Priority of this VRRP group

shutdown Disable VRRP Configuration

timers Set the VRRP timers

track Event Tracking

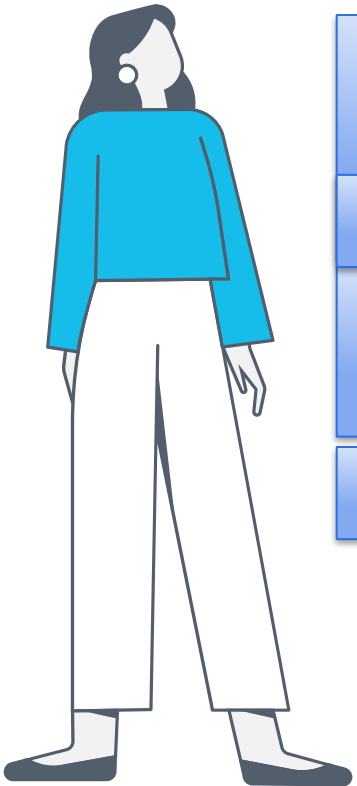
```
R1(config-if)#vrrp 101
```

VRRPv3: enabling it + successful configuration

```
fhrp version vrrp v3
```

```
interface Ethernet0/1  
no ip address  
ipv6 address 2001:db8:cafe::1/64  
vrrp 101 address-family ipv6  
address fe80::1 primary  
exit-vrrp  
!
```

Beware the ACL “tightening”



```
ipv6 access-list ingress
```

```
permit tcp host 2001:db8::1 eq 80 any
```

```
permit icmp any any nd-ns ← implicit
```

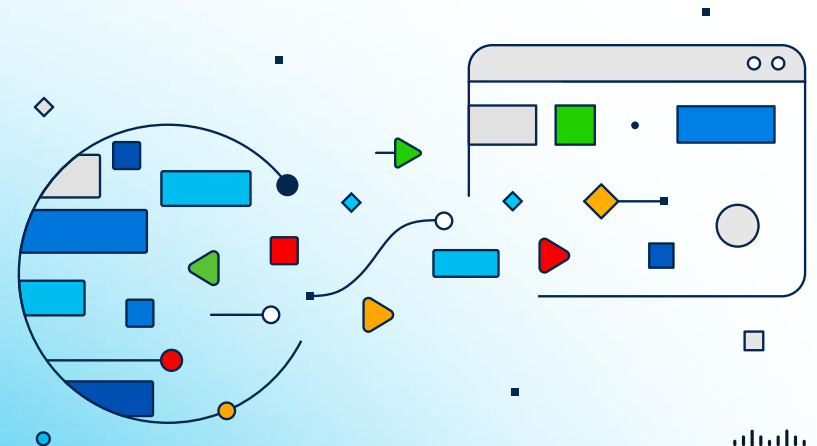
```
permit icmp any any nd-na
```

```
deny ipv6 any any ← implicit
```

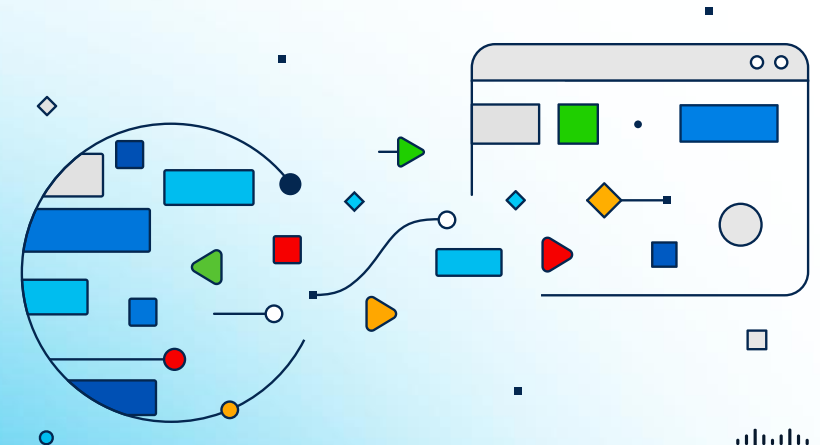
Remove IP Routing? – Live Dangerous

Remove IP Routing

- “no ip routing”



DO NOT DO THIS



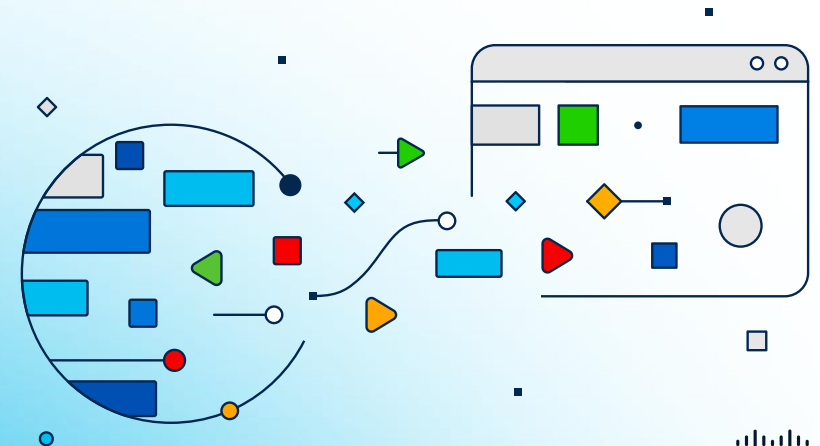
Remove IP Routing

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DO NOT DO THIS

BGP Can't be configured, current configuration removed



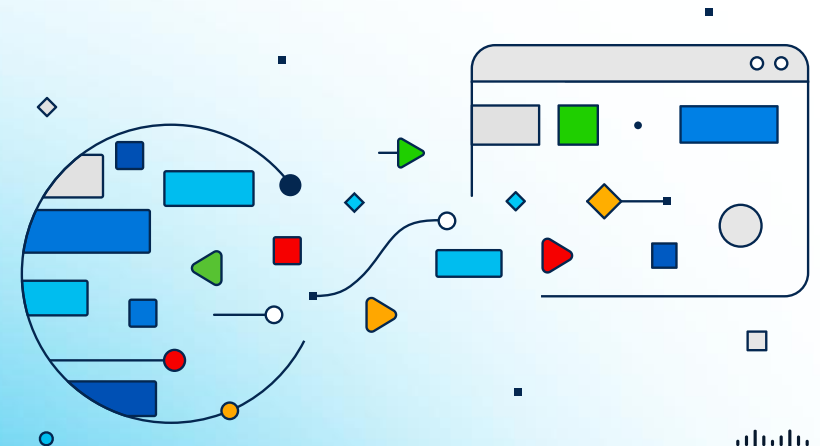
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BGP Can't be configured, current configuration removed
EIGRP goes down immediately



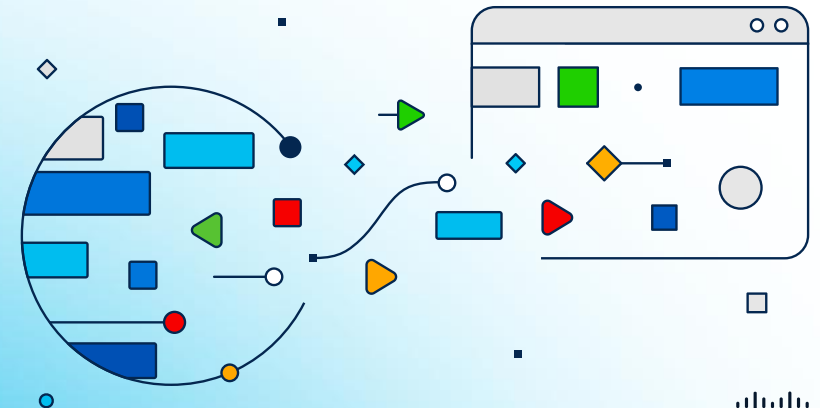
Remove IP Routing

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DO NOT DO THIS

BGP Can't be configured, current configuration removed
EIGRP goes down immediately
OSPFv3 goes down after dead time



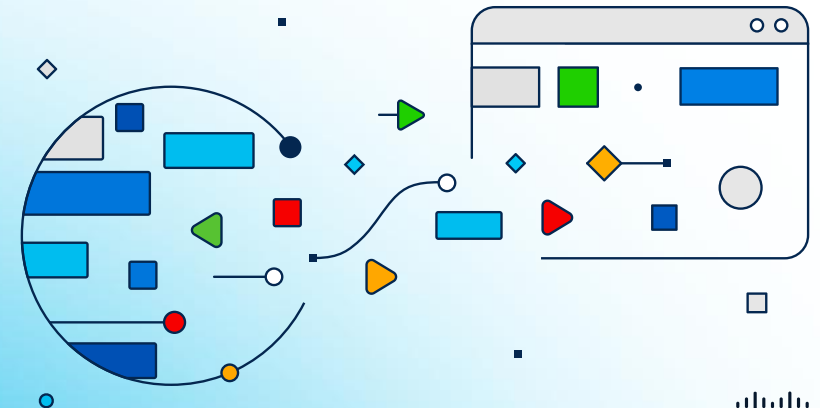
Remove IP Routing

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DO NOT DO THIS

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OSPFv3 goes down after dead time
RIPng goes down after holddown time



Remove IP Routing

- “no ip routing”



DO NOT DO THIS

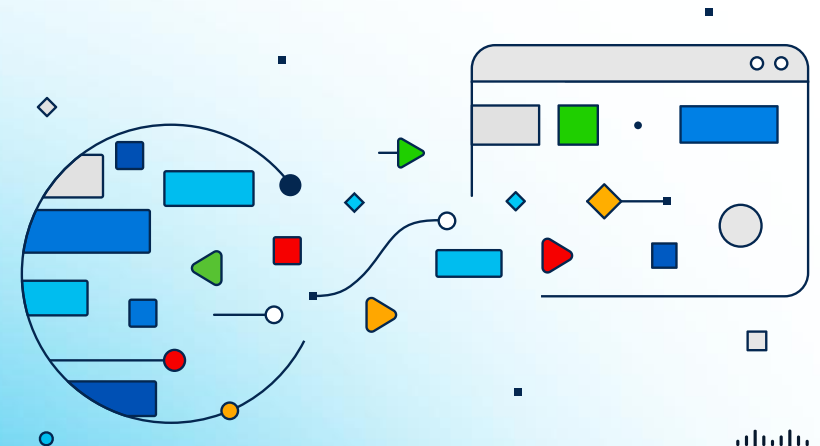
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EIGRP goes down immediately

OSPFv3 goes down after dead time

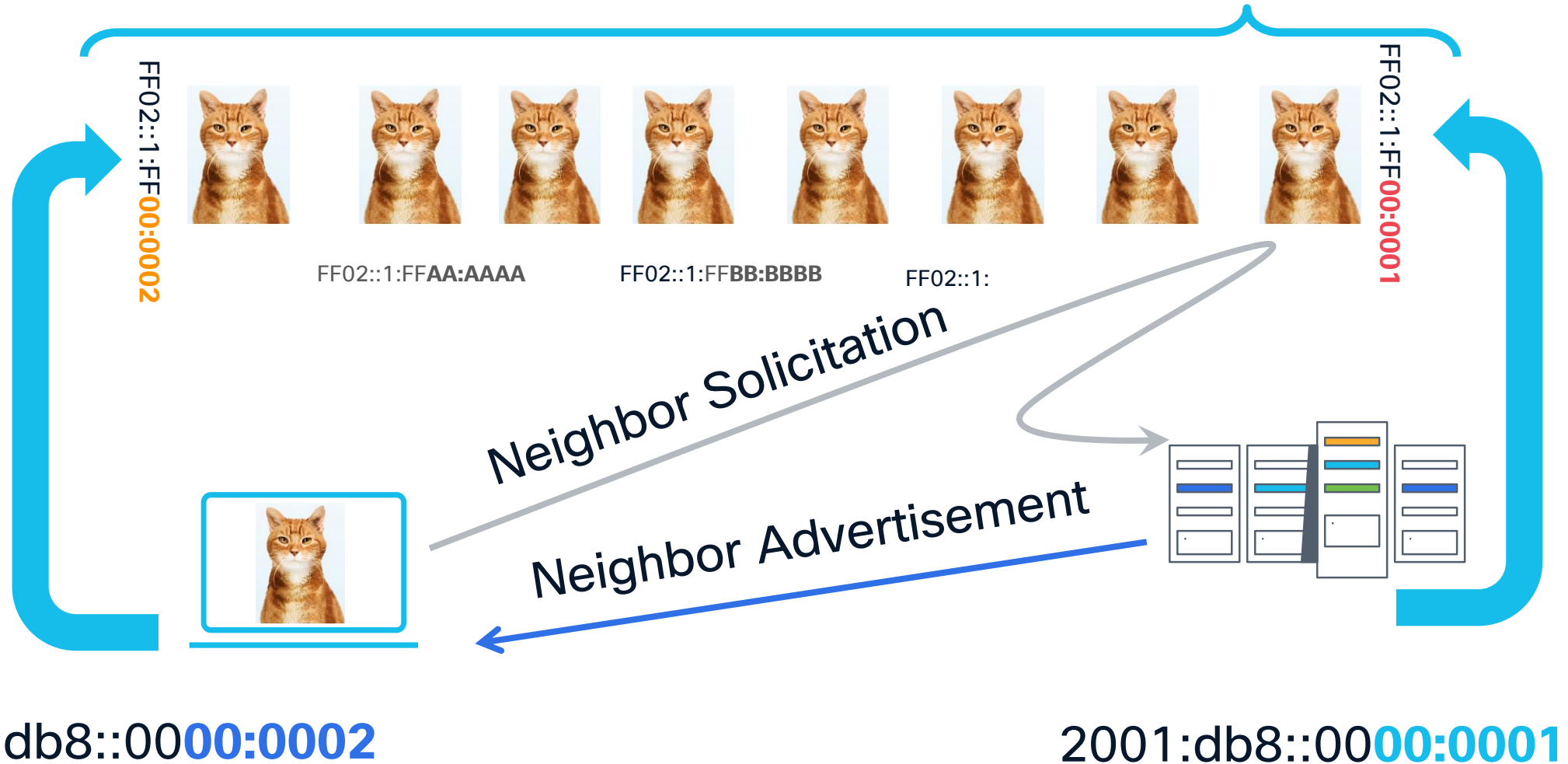
RIPng goes down after holddown time

ISIS could care less



Neighbor Discovery: Solicited Node Multicast

Solicited node multicast groups: FF02::1:FF00:0000 /104



Session Journey

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Wireless

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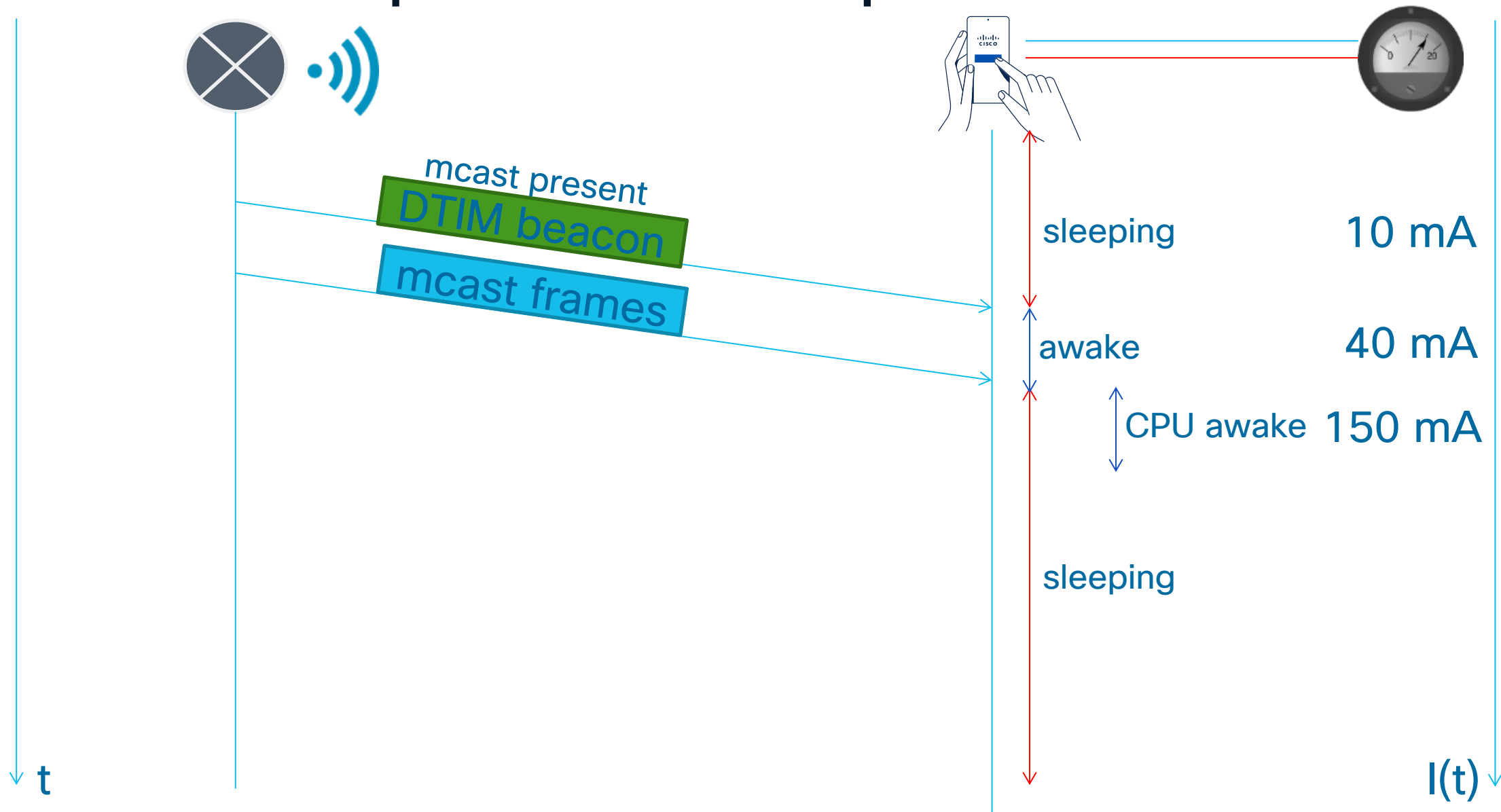
NPv1 and NPv2

5. Wireshark

Addressing Joy



Power Consumption On A Smartphone



Why Multicast Solicited RAs ?

RFC4861, 6.2.6. Processing Router Solicitations

In addition to sending periodic, unsolicited advertisements, a router sends advertisements in response to valid solicitations received on an advertising interface. A router **MAY** choose to unicast the response directly to the soliciting host's address (if the solicitation's source address is not the unspecified address), but the usual case is to multicast the response to the all-nodes group.

Tcpdump On A Host In A Large WiFi Network

```
22:15:25.308623 IP6 fe80::217:dfff:fe76:fc40 > ff02::1: ICMP6, router advertisement, length 64
22:15:25.309215 IP6 fe80::217:dfff:fe76:fc40 > 2a02:88fe:de30:501:5fe:13a0:afad:c700: ICMP6, neighbor
01:5fe:13a0:afad:c700, length 32
22:15:32.724207 IP6 fe80::217:dfff:fe76:fc40 > ff02::1: ICMP6, router advertisement, length 64
22:15:35.650625 IP6 fe80::217:dfff:fe76:fc40 > ff02::1: ICMP6, router advertisement, length 64
22:15:38.783752 IP6 fe80::217:dfff:fe76:fc40 > ff02::1:
22:15:42.437960 IP6 fe80::217:dfff:fe76:fc40 > ff02::1:
22:16:01.238144 IP6 fe80::217:dfff:fe76:fc40 > ff02::1:
22:16:15.442989 IP6 fe80::217:dfff:fe76:fc40 > ff02::1:
22:16:19.520928 IP6 fe80::217:dfff:fe76:fc40 > ff02::1:
22:16:23.903221 IP6 fe80::217:dfff:fe76:fc40 > ff02::1:
22:16:26.932310 IP6 fe80::217:dfff:fe76:fc40 > ff02::1:
22:16:29.961204 IP6 fe80::217:dfff:fe76:fc40 > ff02::1:
22:16:33.030970 IP6 fe80::217:dfff:fe76:fc40 > ff02::1:
22:18:26.253591 IP6 fe80::217:dfff:fe76:fc40 > ff02::1: ICMP6, router advertisement, length 64
22:18:27.485346 IP6 andrews-macbook-air.local > ff02::2: ICMP6, router solicitation, length 8
22:18:28.406047 IP6 andrews-macbook-air.local > ff02::2: ICMP6, router solicitation, length 8
22:18:29.344763 IP6 fe80::217:dfff:fe76:fc40 > ff02::1: ICMP6, router advertisement, length 64
22:18:29.357259 IP6 andrews-macbook-air.local > ff02::2: ICMP6, router solicitation, length 8
```

RA throttle

CISCO

MONITOR

WLANs

CONTROLLER

WIRELESS

SECURITY

Controller

General

Inventory

Interfaces

Interface Groups

Multicast

Internal DHCP Server

Mobility Management

Ports

NTP

CDP

IPv6

Neighbor Binding

RA Throttle Policy

RA Guard

mDNS

RA Throttle Policy > Edit

Enable RA Throttle Policy

☒

Throttle Period (10-86400 seconds)

Max Through (0-256)

No Limit ☐

Interval Option

Passthrough

Allow At-least (0-32)

Allow At-most (0-256)

No Limit ☐

Controller

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► **Internal DHCP Server**

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RA Throttle Policy > Edit

Enable RA Throttle Policy

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Throttle Period (10-86400 seconds)

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Interval Option

Passthrough

Allow At-least (0-32)

Allow At-most (0-256)

No Limit



Search Menu Items



Dashboard



Monitoring >



Configuration >



Administration >



Licensing



Troubleshooting

Walk Me Through >

Configuration > Services > RA Throttle Policy

+ Add

× Delete

	Policy Name	Target	Type	Range
☐	jims	-----	----	none
☐	nicole	-----	----	none

1 - 2 of 2 items

Add RA Throttle Policy

Name*

Policy Name

Throttle Period

600

Max Through

10

No limit ☐

Interval option

passthrough ▼

At Least Multicast RAs

1

At Most Multicast RAs

1

No limit ☐

× Close

✓ Add & Apply

Add RA Throttle Policy



Name*

Policy Name

Throttle Period

600

Max Through

10

No limit

☐

Interval option

passthrough ▼

At Least Multicast RAs

1

At Most Multicast RAs

1

No limit

☐

✕ Close

✓ Add & Apply

Session Journey

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4. War Stories

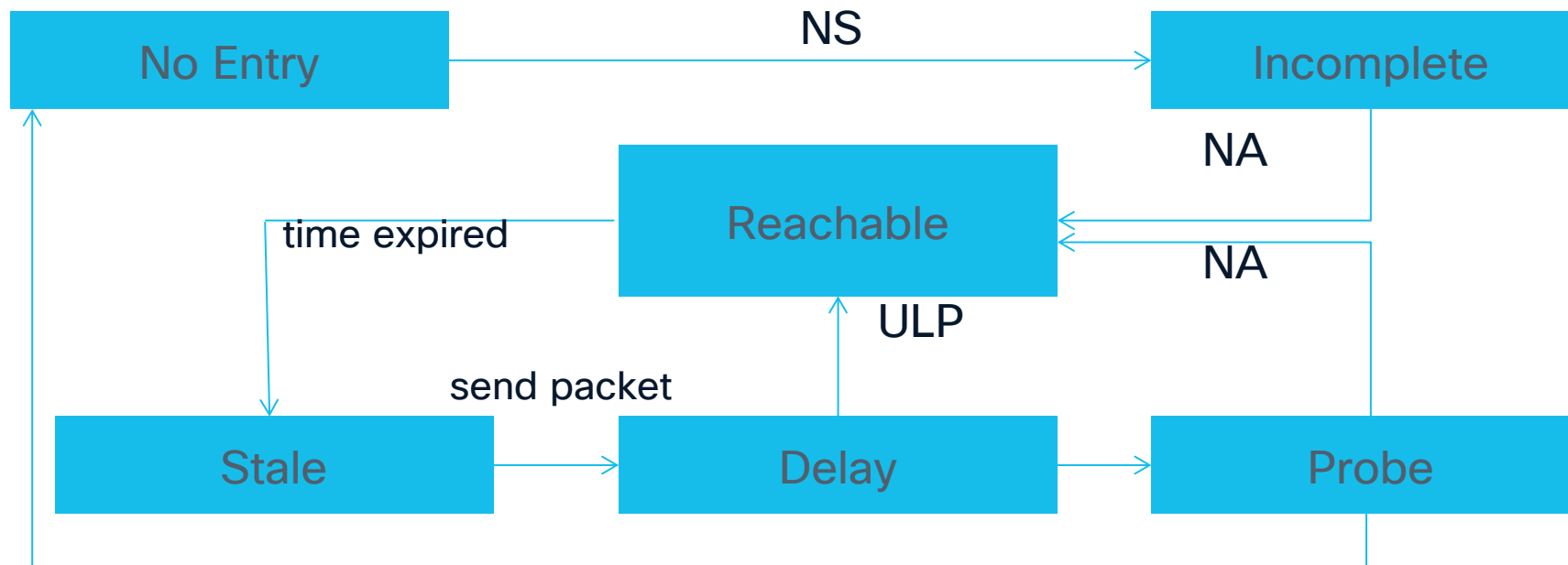
NPv1 and NPv2

5. Wireshark

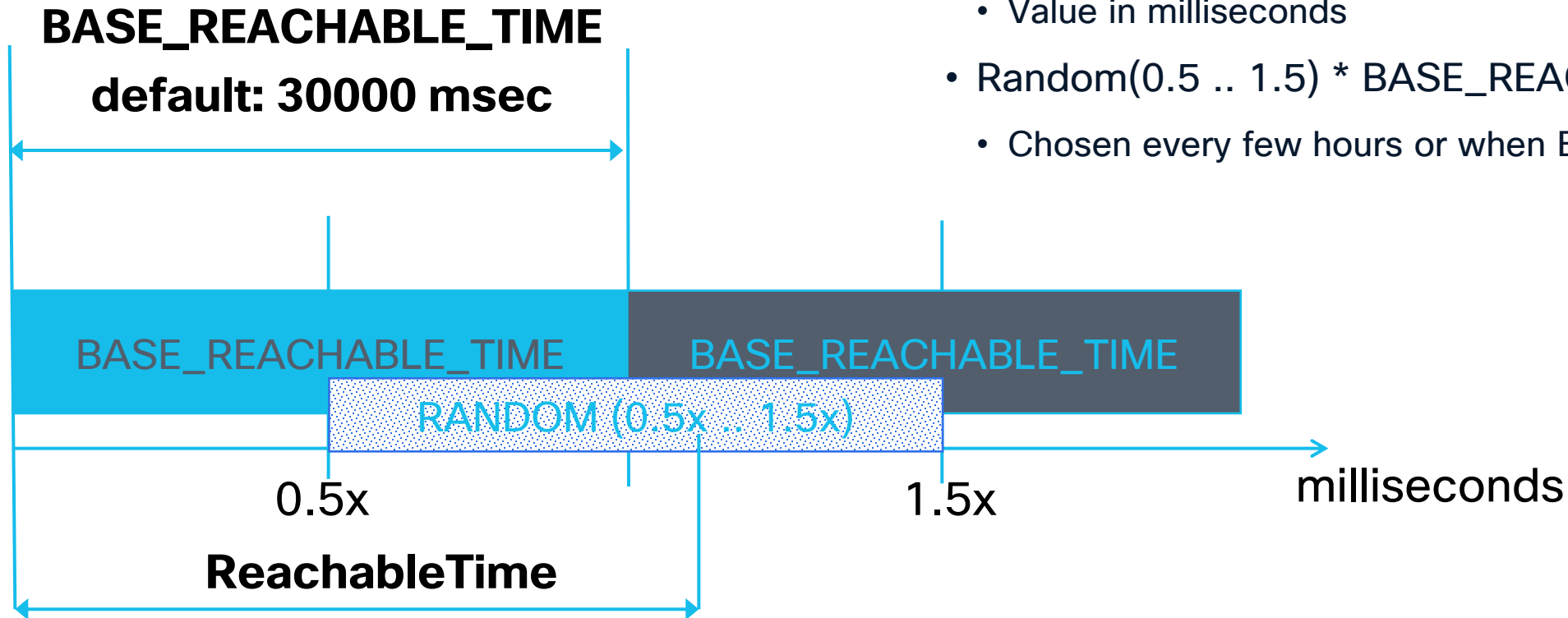
Addressing Joy

Neighbor Cache State Machine

- Incomplete – Pending address resolution, NS message outstanding
- Reachable – Recently used mapping, Can be refreshed by ULP
- Stale – Not currently communicating, waiting for next queued packet
- Delay – Using stale binding, awaiting (ULP) return traffic
- Probe – Sending Unicast NS to node (after Delay timer, 3x1 sec)



ReachableTime: How Long Is It ?



- **BASE_REACHABLE_TIME**
 - Sent in RA or taken from default
 - Value in milliseconds
- $\text{Random}(0.5 \dots 1.5) * \text{BASE_REACHABLE_TIME}$
 - Chosen every few hours or when BASE... changes

Session Journey

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Addressing Joy

The NP logic

War Stories... The Nicole Syndrome ☺



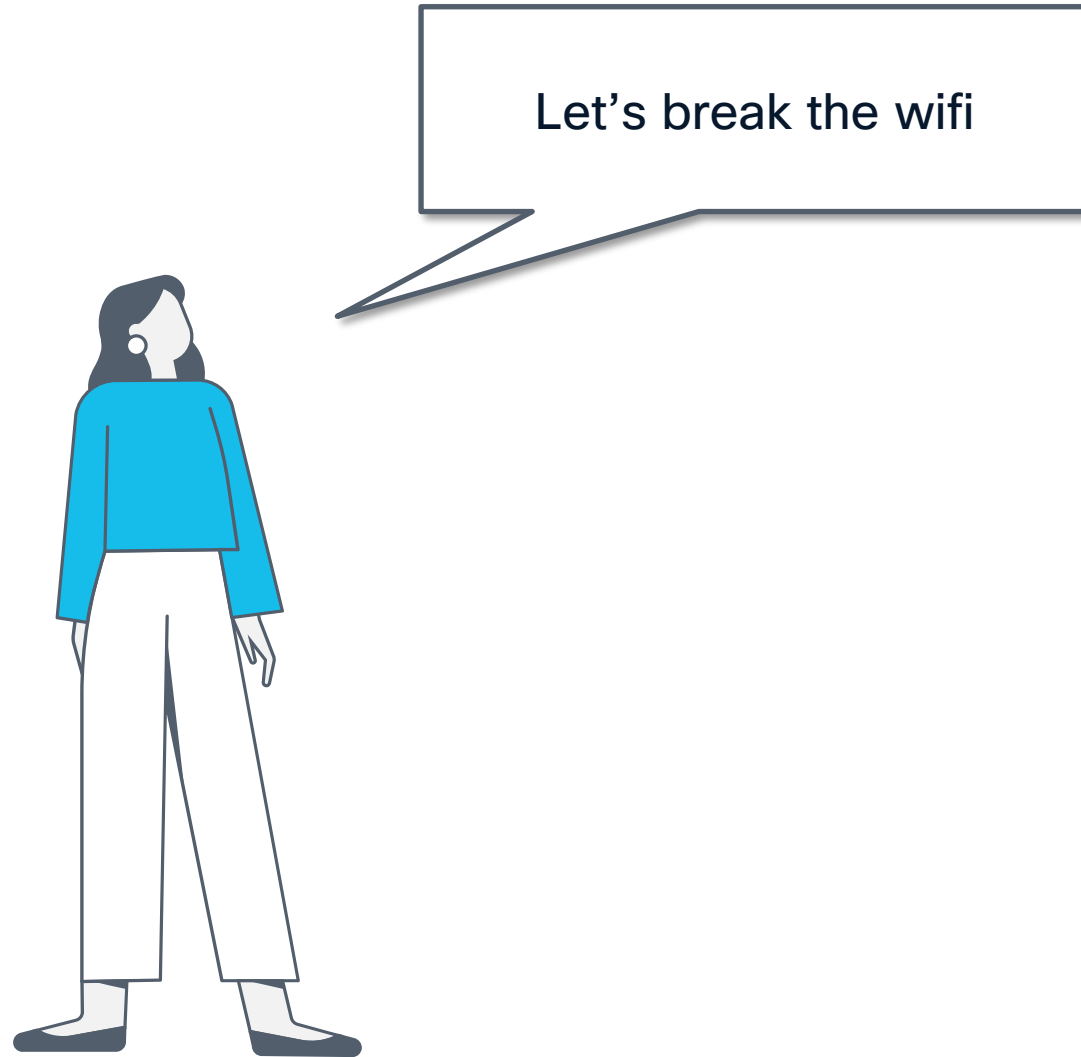
Smart Device



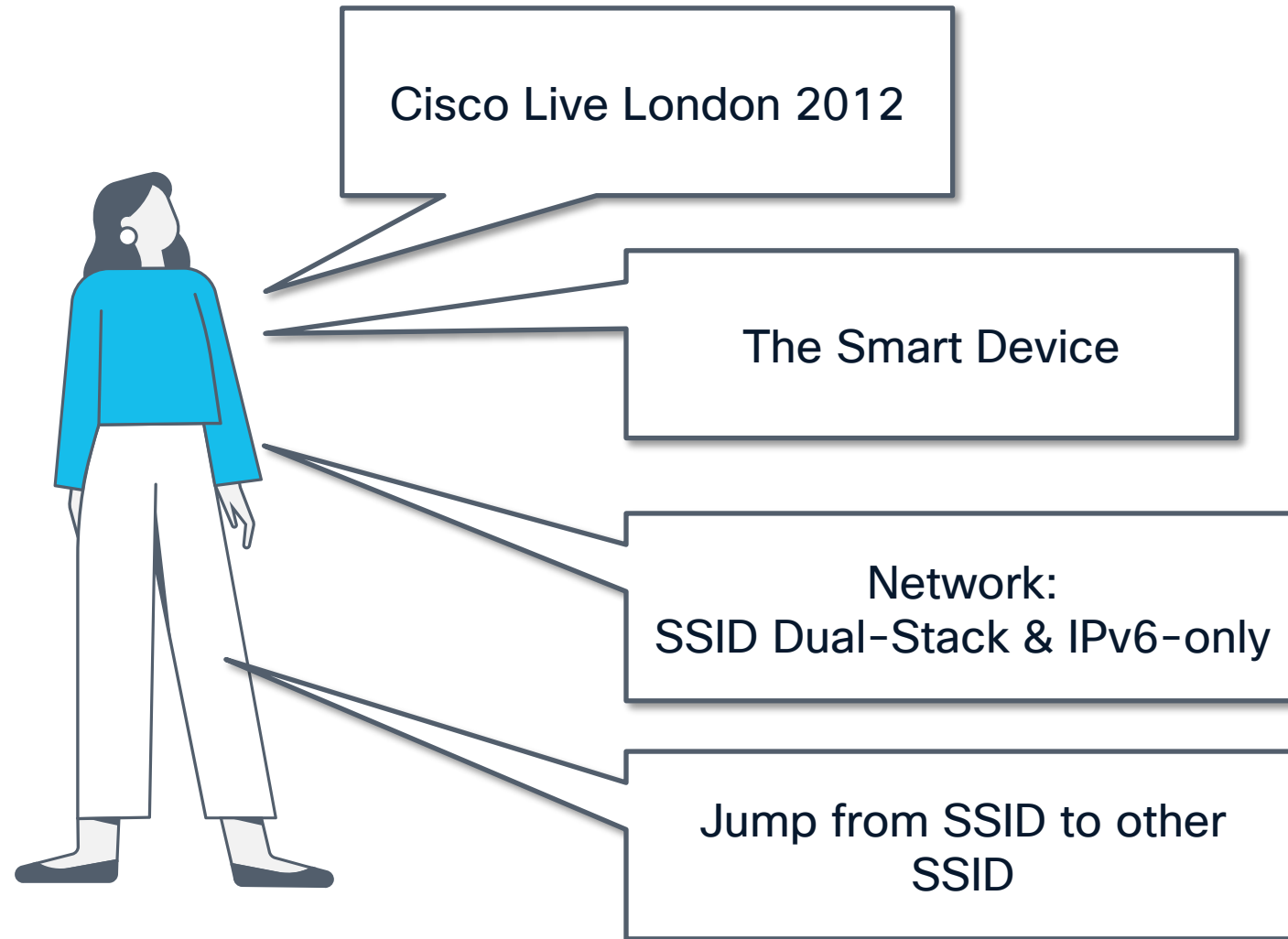
NPv1

Nicole Problem-V1

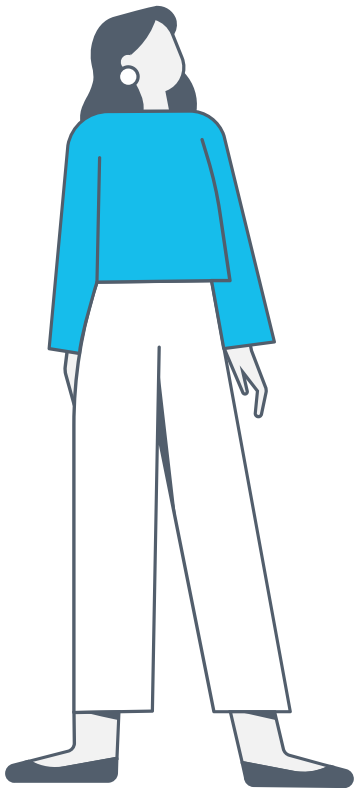
NPv1 – the max of MAC on interface no GUA



NPv1 – What did Nicole do?



NPv1 – What happened to my GUA?



CISCO

MONITOR WLANs CONTROLLER WIRELESS SECURITY MANAGEMENT

Monitor

Summary

▶ Access Points

▶ Cisco CleanAir

▶ Statistics

▶ CDP

▶ Rogues

Clients

Multicast

Clients > Detail

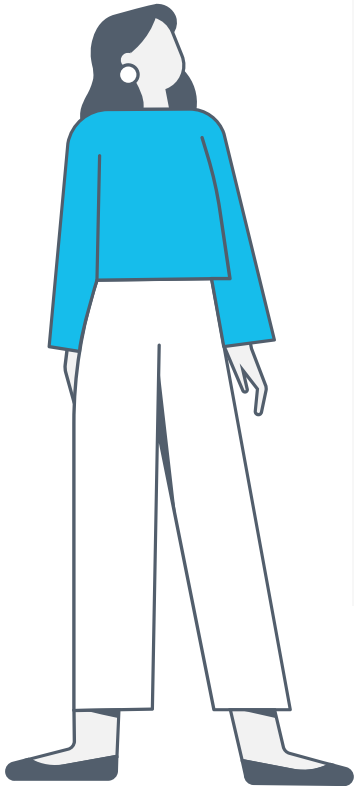
Client Properties

MAC Address	f8:1e:df:e3:0a:76
IPv4 Address	192.168.20.30
IPv6 Address	2001:db8:0:20:518:e245:bbf8:f935, 2001:db8:0:20:fa1e:dfff:fee3:a76, fe80::fa1e:dfff:fee3:a76,

Jumping SSID's



NPv1 – What happened to my GUA?





MONITOR

WLANs

CONTROLLER

WIRELESS

SECURITY

MANAGEMENT

Monitor

Summary

▶ Access Points

▶ Cisco CleanAir

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Clients

Multicast

Clients > Detail

Client Properties

MAC Address	f8:1e:df:e3:0a:76
IPv4 Address	192.168.20.30
IPv6 Address	<div>fe80::fa1e:dfff:fee3:a76,</div>

WE ARE CHECKING





Solution – flush the neighbor cache



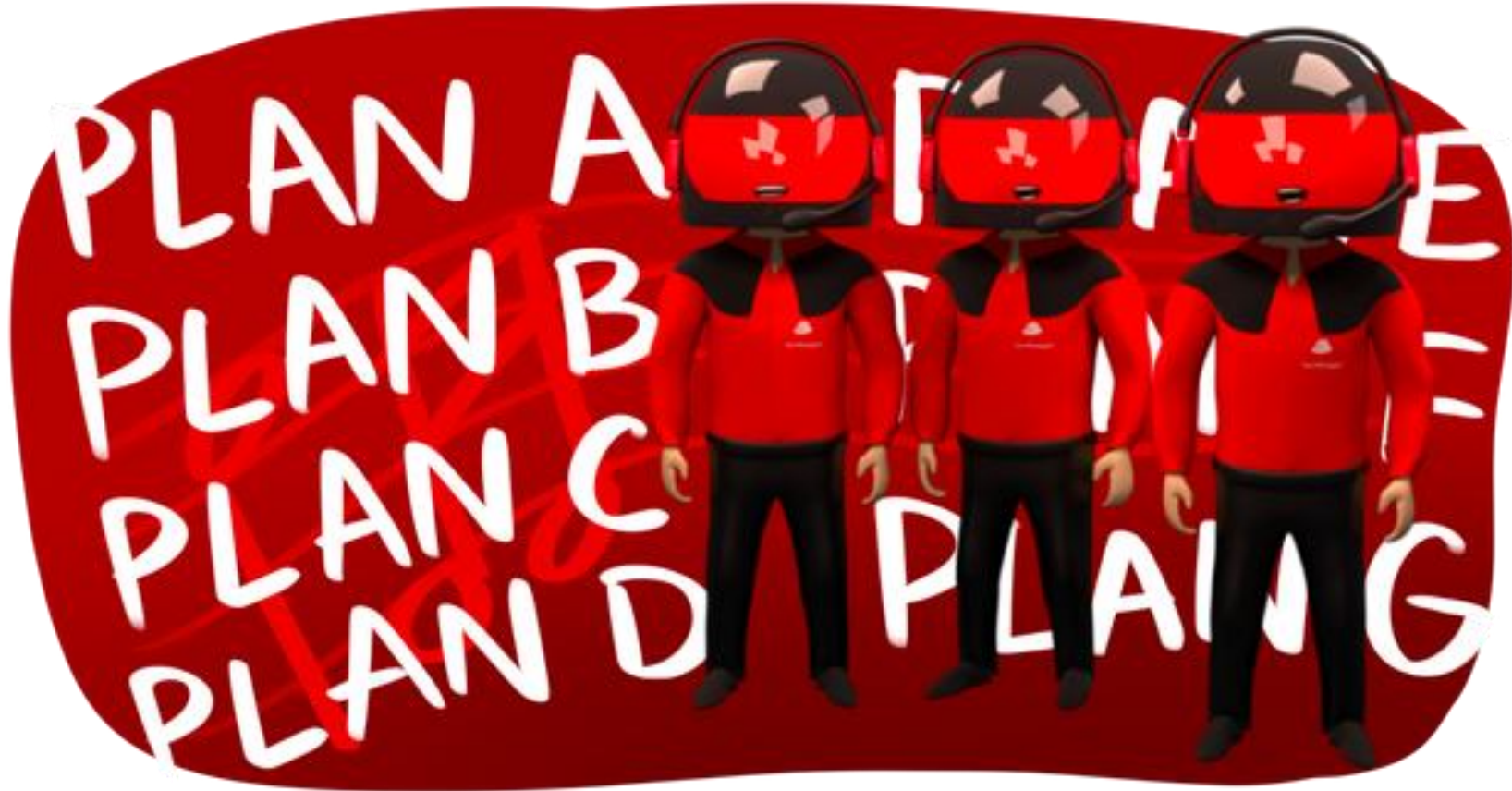
Nicole Problem-V2

NPv2 – Windows machines Public and Cisco Secure client

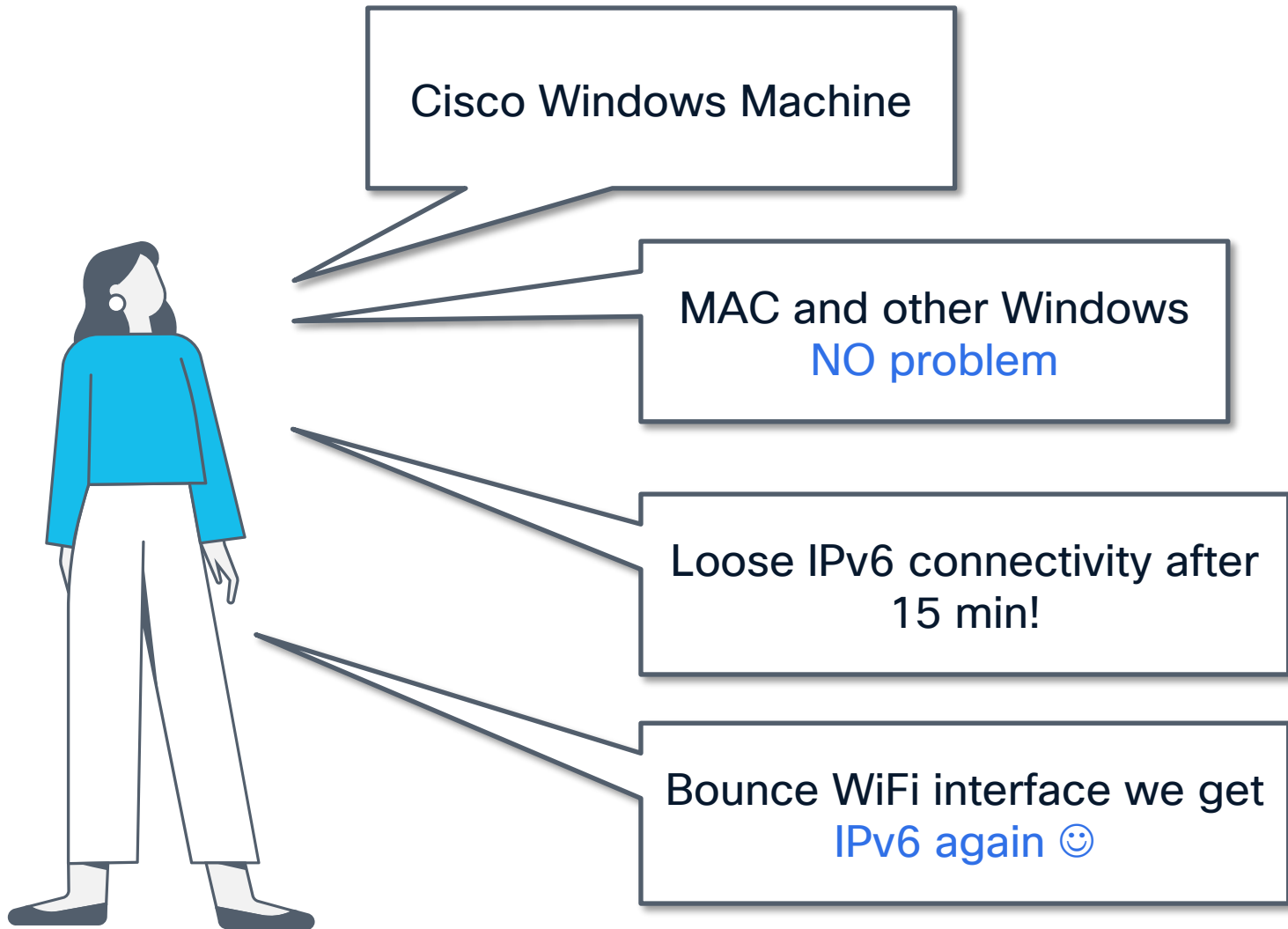
Why do I lose my IPv6?

IPv
Foo

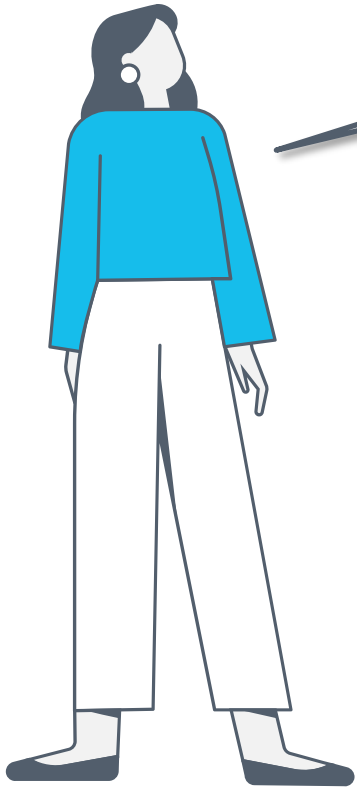
  		
	www.youtube.com	142.250.124.91
	accounts.youtube.com	142.250.195.142



NPv2 - Troubleshooting



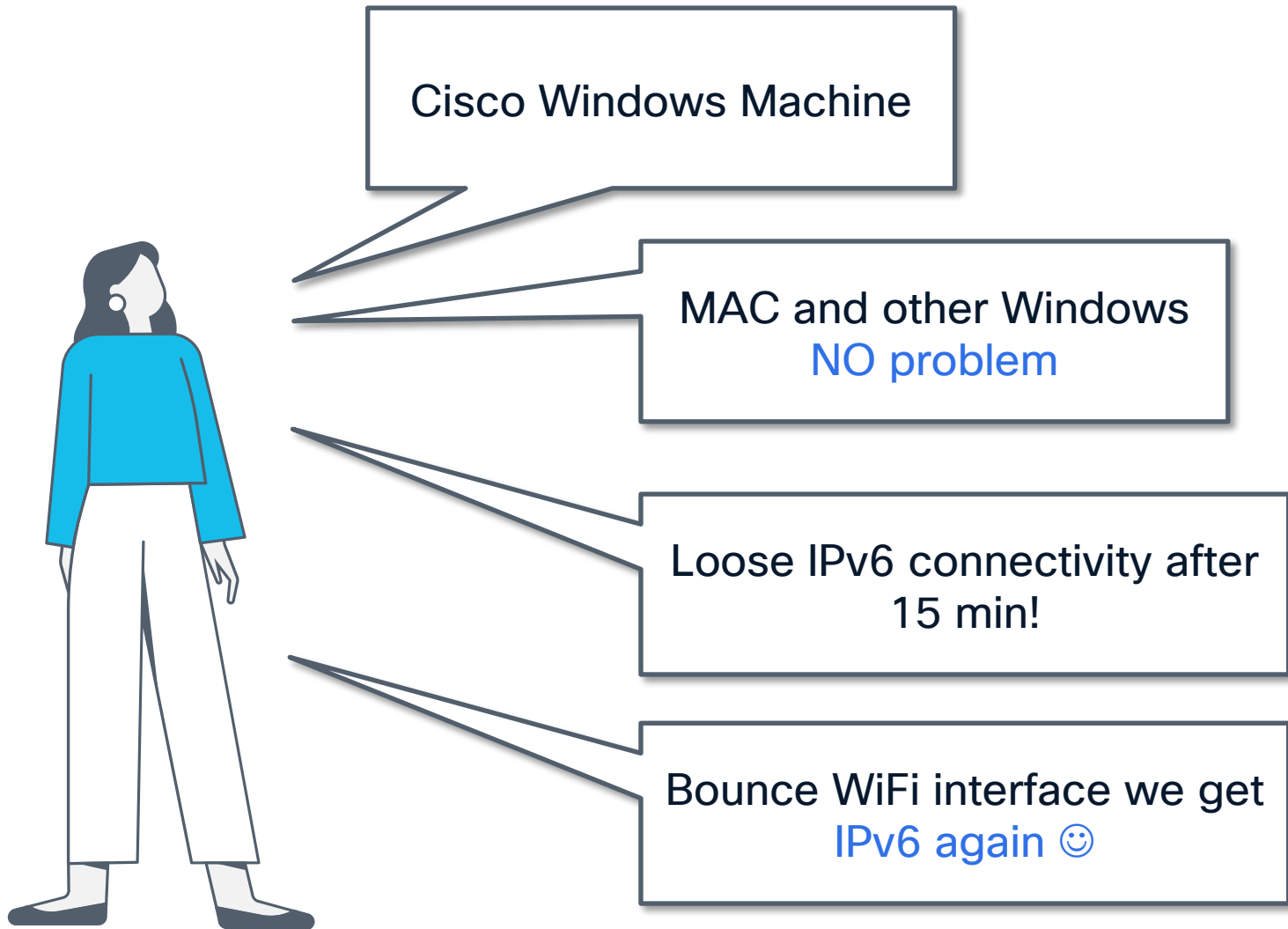
NPv2 - Troubleshooting



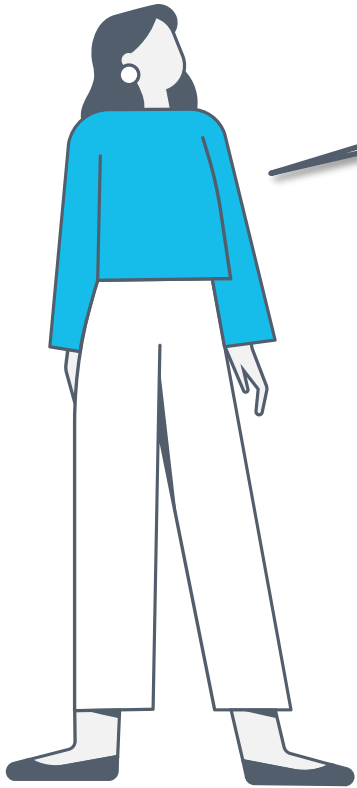
Loose IPv6 connectivity after
15 min!

Remember Neighbor cache state machine!

NPv2 - Troubleshooting



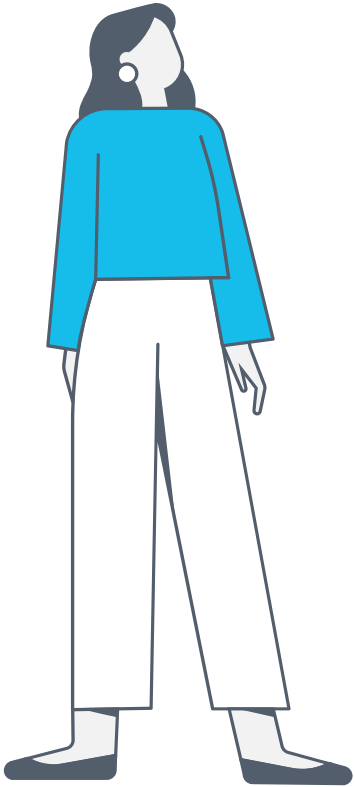
NPv2 - Troubleshooting



Bounce WiFi interface we get
IPv6 again 😊

**This means a new RS is send out and RA is
received by the host**

NPv2 – Troubleshooting – So what are we NOT getting?

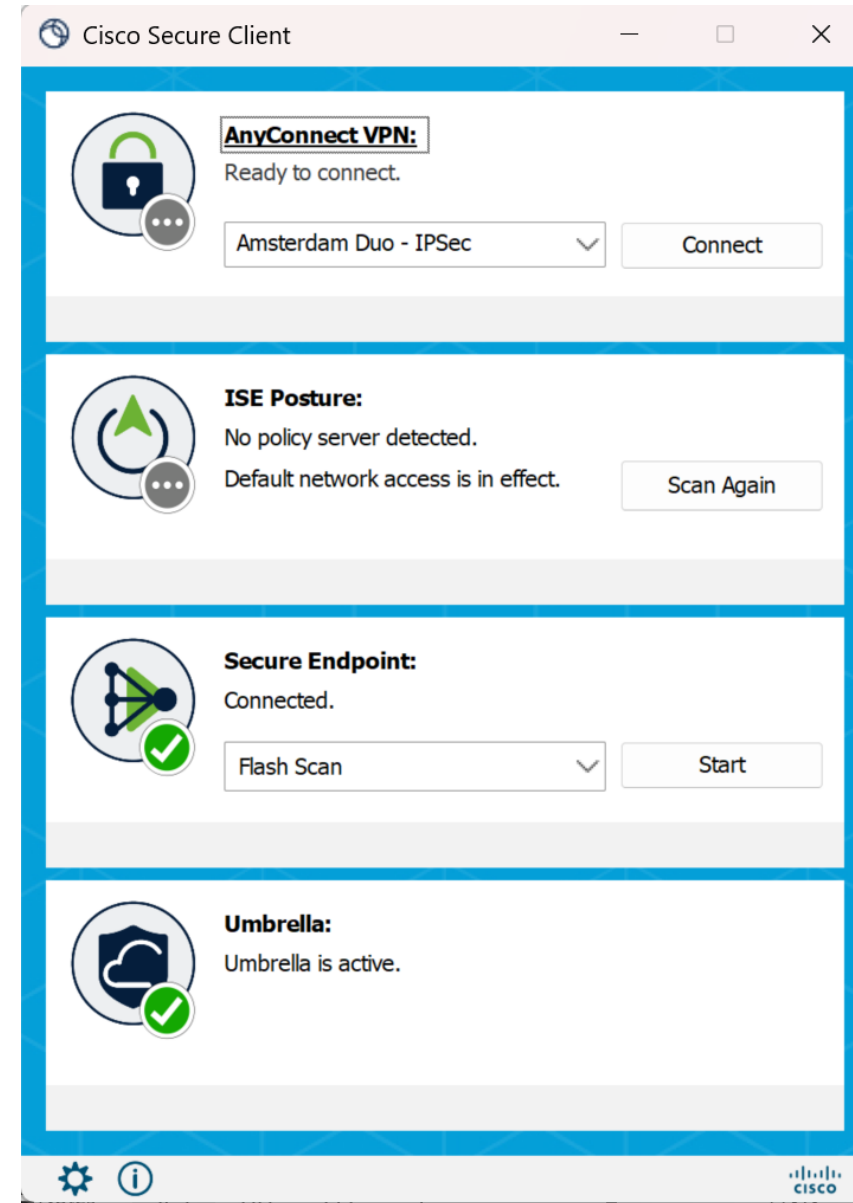


**Unsolicited RA from the Router
is not arriving to the host!**

Solution – Bug fixed in Cisco Secure Client



No RA's



Session Journey

1.Config

Don't forget these

2. RA's

Wireless

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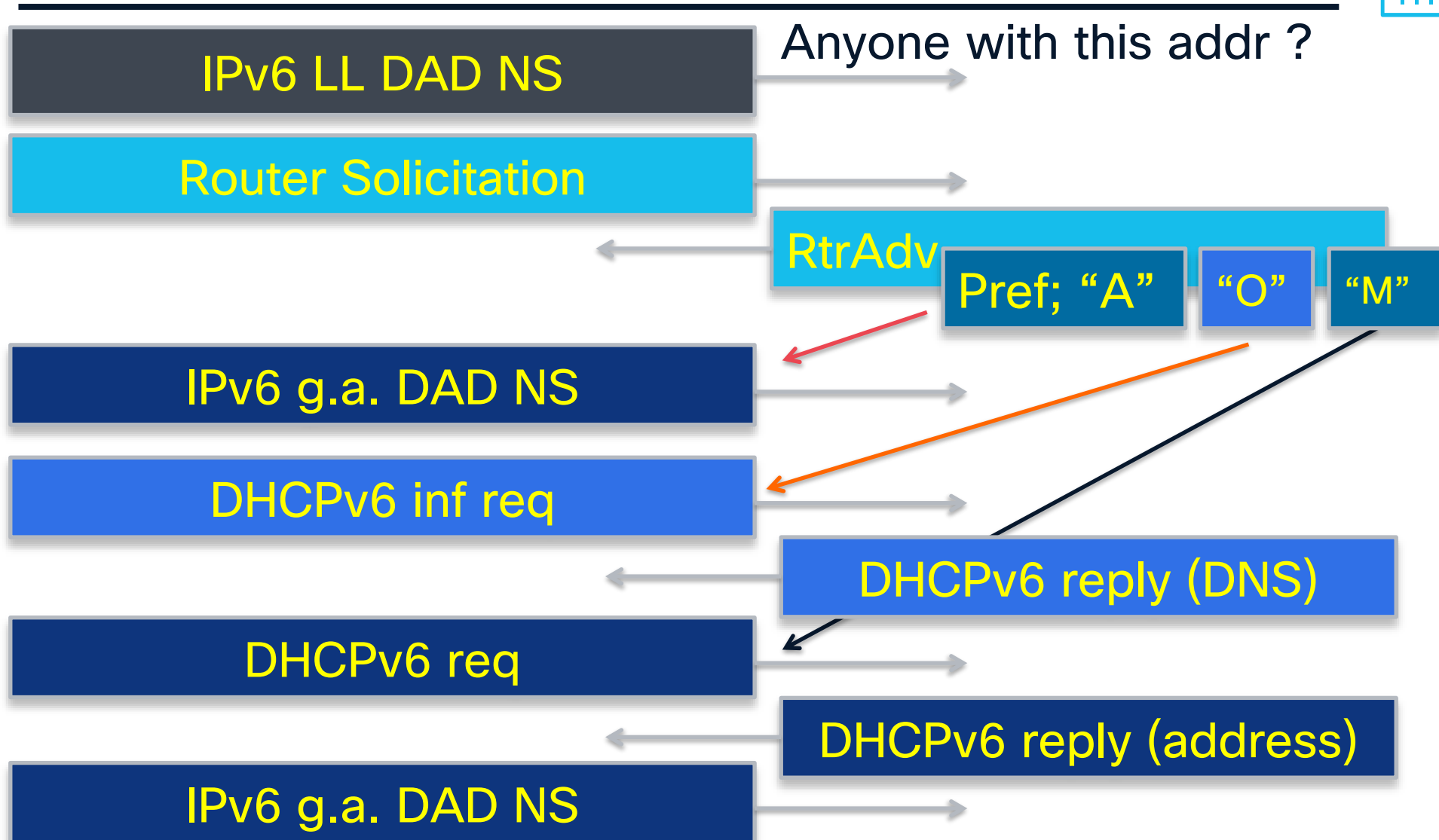
NPv1 and NPv2

5. Wireshark

Addressing Joy

Host Attachment

IPv6 Host Attachment Procedure





Host Attachment In The Wild Wireshark “Sniffer” Time!

Wireshark packet capture analysis of IPv6 traffic on the Wi-Fi interface en0. The capture shows several ICMPv6 Router Solicitation and Router Advertisement messages, DHCPv6 Confirm and Reply messages, and a TCP SYN packet. The selected packet is an ICMPv6 Router Solicitation (No. 7).

No.	Time	Source	Destination	Protocol	Length	Info
7	0.007437	fe80::f65c:89ff:feb4:8c3	ff02::2	ICMPv6	62	Router Solicitation
12	0.016085	fe80::a2f3:c1ff:feff:4992	fe80::f65c:89ff:feb4:8c3	ICMPv6	230	Router Advertisement from a0:f3:c1:ff:49:92
39	0.191713	fe80::f65c:89ff:feb4:8c3	ff02::1:2	DHCPv6	142	Confirm XID: 0x8bbf90 CID: 000100011e9645d9f45c89b408c3...
40	0.193907	fe80::a2f3:c1ff:feff:4992	fe80::f65c:89ff:feb4:8c3	DHCPv6	163	Reply XID: 0x8bbf90 CID: 000100011e9645d9f45c89b408c3
60	0.526502	::	ff02::1:ffb4:8c3	ICMPv6	78	Neighbor Solicitation for fd33:af04:eb8d:0:f65c:89ff:fe...
105	0.568780	2001:470:1f15:289:9500:7c17:9c09:ce79	2a00:1450:4013:c00::6c	TCP	98	63086 → 993 [SYN] Seq=0 Win=65535 Len=0 MSS=1220 WS=32 ...
109	0.571217	fe80::f65c:89ff:feb4:8c3	ff02::1:2	DHCPv6	114	Solicit XID: 0x936496 CID: 000100011e9645d9f45c89b408c3

Frame 7: 62 bytes on wire (496 bits), 62 bytes captured (496 bits) on interface 0
Ethernet II, Src: Apple_b4:08:c3 (f4:5c:89:b4:08:c3), Dst: IPv6mcast_02 (33:33:00:00:00:02)
Internet Protocol Version 6, Src: fe80::f65c:89ff:feb4:8c3, Dst: ff02::2
Internet Control Message Protocol v6
Type: Router Solicitation (133)
Code: 0
Checksum: 0xf562 [correct]
Reserved: 00000000

Wireshark packet capture showing IPv6 traffic. The interface is 'Wi-Fi: en0'. The filter is 'ipv6'. The packet list shows several ICMPv6 and DHCPv6 packets. The selected packet is number 39, a DHCPv6 Confirm message.

No.	Time	Source	Destination	Protocol	Length	Info
7	0.007437	fe80::f65c:89ff:feb4:8c3	ff02::2	ICMPv6	62	Router Solicitation
12	0.016085	fe80::a2f3:c1ff:feff:4992	fe80::f65c:89ff:feb4:8c3	ICMPv6	230	Router Advertisement from a0:f3:c1:ff:49:92
39	0.191713	fe80::f65c:89ff:feb4:8c3	ff02::1:2	DHCPv6	142	Confirm XID: 0x8bbf90 CID: 000100011e9645d9f45c89b408c3...
40	0.193907	fe80::a2f3:c1ff:feff:4992	fe80::f65c:89ff:feb4:8c3	DHCPv6	163	Reply XID: 0x8bbf90 CID: 000100011e9645d9f45c89b408c3
60	0.526502	::	ff02::1:ff4:8c3	ICMPv6	78	Neighbor Solicitation for fd33:af04:eb8d:0:f65c:89ff:fe...
105	0.568780	2001:470:1f15:289:9500:7c17:9c09:ce79	2a00:1450:4013:c00::6c	TCP	98	63086 → 993 [SYN] Seq=0 Win=65535 Len=0 MSS=1220 WS=32 ...
109	0.571217	fe80::f65c:89ff:feb4:8c3	ff02::1:2	DHCPv6	114	Solicit XID: 0x936496 CID: 000100011e9645d9f45c89b408c3

```

▶ User Datagram Protocol, Src Port: 546 (546), Dst Port: 546 (546)
▼ DHCPv6
    Message type: Confirm (4)
    Transaction ID: 0x8bbf90
    ▶ Client Identifier
    ▶ Option Request
    ▶ Elapsed time
    ▼ Identity Association for Non-temporary Address
        Option: Identity Association for Non-temporary Address
        Length: 40
        Value: 0000000000000000000000000000000050018fd33af04eb8d
        IAID: 00000000
        T1: 0
        T2: 0
        ▼ IA Address
            Option: IA Address (5)
            Length: 24
            Value: fd33af04eb8d0000000000000000000007cd0000000000
            IPv6 address: fd33:af04:eb8d::7cd
            Preferred lifetime: 0
            Valid lifetime: 0

```

```

▼ Identity Association for Non-temporary Address
  Option: Identity Association for Non-temporary Address (3)
  Length: 40
  Value: 0000000000000000000000000000000050018fd33af04eb8d0000...
  IAID: 00000000
  T1: 0
  T2: 0
▼ IA Address
  Option: IA Address (5)
  Length: 24
  Value: fd33af04eb8d000000000000000000007cd00000000000000000
  IPv6 address: fd33:af04:eb8d::7cd
  Preferred lifetime: 0
  Valid lifetime: 0

```

Wi-Fi: en0

ipv6

No.	Time	Source	Destination	Protocol	Length	Info
7	0.007437	fe80::f65c:89ff:feb4:8c3	ff02::2	ICMPv6	62	Router Solicitation
12	0.016085	fe80::a2f3:c1ff:feff:4992	fe80::f65c:89ff:feb4:8c3	ICMPv6	230	Router Advertisement from a0:f3:c1:ff:49:92
39	0.191713	fe80::f65c:89ff:feb4:8c3	ff02::1:2	DHCPv6	142	Confirm XID: 0x8bbf90 CID: 000100011e9645d9f45c89b408c3...
40	0.193907	fe80::a2f3:c1ff:feff:4992	fe80::f65c:89ff:feb4:8c3	DHCPv6	163	Reply XID: 0x8bbf90 CID: 000100011e9645d9f45c89b408c3
60	0.526502	::	ff02::1:ff4:8c3	ICMPv6	78	Neighbor Solicitation for fd33:af04:eb8d:0:f65c:89ff:fe...
105	0.568780	2001:470:1f15:289:9500:7c17:9c09:ce79	2a00:1450:4013:c00::6c	TCP	98	63086 → 993 [SYN] Seq=0 Win=65535 Len=0 MSS=1220 WS=32 ...
109	0.571217	fe80::f65c:89ff:feb4:8c3	ff02::1:2	DHCPv6	114	Solicit XID: 0x936496 CID: 000100011e9645d9f45c89b408c3

▶ Frame 40: 163 bytes on wire (1304 bits), 163 bytes captured (1304 bits) on interface 0

▶ Ethernet II, Src: Tp-LinkT_ff:49:92 (a0:f3:c1:ff:49:92), Dst: Apple_b4:08:c3 (f4:5c:89:b4:08:c3)

▼ Internet Protocol Version 6, Src: fe80::a2f3:c1ff:feff:4992, Dst: fe80::f65c:89ff:feb4:8c3

0110 = Version: 6

▶ 0000 0000 = Traffic class: 0x00 (DSCP: CS0, ECN: Not-ECT)

.... 0000 0000 0000 0000 = Flowlabel: 0x00000000

Payload length: 109

Next header: UDP (17)

Hop limit: 64

Source: fe80::a2f3:c1ff:feff:4992

[Source SA MAC: Tp-LinkT_ff:49:92 (a0:f3:c1:ff:49:92)]

Destination: fe80::f65c:89ff:feb4:8c3

[Destination SA MAC: Apple_b4:08:c3 (f4:5c:89:b4:08:c3)]

[Source GeoIP: Unknown]

[Destination GeoIP: Unknown]

▶ User Datagram Protocol, Src Port: 547 (547), Dst Port: 546 (546)

▼ DHCPv6

Message type: Reply (7)

Transaction ID: 0x8bbf90

▼ Server Identifier

Option: Server Identifier (2)

Length: 10

Value: 00030001a0f3c1ff4992

DUID: 00030001a0f3c1ff4992

DUID Type: link-layer address (3)

Hardware type: Ethernet (1)

Link-layer address: a0:f3:c1:ff:49:92

wireshark_pcapng_en0_20160519182107_NGSxSR

Packets: 1385 · Displayed: 309 (22.3%) · Dropped: 0 (0.0%) Profile: Default

ipv6		
No.	Time	Source
105	0.568780	2001:47...
109	0.571217	fe80::f...
113	0.574190	fe80::a...
116	0.591664	2001:47...
129	0.654411	fe80::f...
130	0.687292	::
139	0.716622	::

▶ Frame 109: 114 bytes on wire
 ▶ Ethernet II, Src: Apple_b4:0
 ▶ Internet Protocol Version 6,
 ▶ User Datagram Protocol, Src
 ▼ DHCPv6

Message type: Solicit (1)
 Transaction ID: 0x936496
 ▶ Client Identifier
 ▶ Option Request
 ▼ Elapsed time

Option: Elapsed time (8)
 Length: 2
 Value: 0000
 Elapsed time: 0 ms

▼ Identity Association for Non-temporary Address
 Option: Identity Association for Non-temporary Address (3)
 Length: 12
 Value: 00000000000000000000000000000000
 IAID: 00000000
 T1: 0
 T2: 0

Internet Protocol Version 6: Protocol

DHCPv6	
Message type: Solicit (1)	
Transaction ID: 0x936496	
▶ Client Identifier	
▶ Option Request	
▼ Elapsed time	
Option: Elapsed time (8)	
Length: 2	
Value: 0000	
Elapsed time: 0 ms	
▼ Identity Association for Non-temporary Address	
Option: Identity Association for Non-temporary Address (3)	
Length: 12	
Value: 00000000000000000000000000000000	
IAID: 00000000	
T1: 0	
T2: 0	

Packets: 1385 · Displayed: 309 (22.3%) · Dropped: 0 (0.0%) Profile: Default

Wi-Fi: en0

ipv6

No.	Time	Source
105	0.568780	2001:470:1f15:289:9500:7c17:9c09:
109	0.571217	fe80::f65c:89ff:feb4:8c3
113	0.574190	fe80::a2f3:c1ff:feff:4992
116	0.591664	2001:470:1f15:289:9500:7c17:9c09:
129	0.654411	fe80::f65c:89ff:feb4:8c3
130	0.687292	::
139	0.716622	::

▶ Ethernet II, Src: Tp-LinkT_ff:49:92 (a0:f3:c1:ff:49:92), Dst: 01:00:0c:00:00:00

▶ Internet Protocol Version 6, Src: fe80::a2f3:c1ff:feff:4992, Dst: ::

▶ User Datagram Protocol, Src Port: 547 (547), Dst Port: 547 (547)

▼ DHCPv6

Message type: Advertise (2)
Transaction ID: 0x936496

- ▶ Server Identifier
- ▶ Client Identifier
- ▶ SOL_MAX_RT
- ▶ DNS recursive name server
- ▶ Domain Search List
- ▶ Reconfigure Accept

▼ Identity Association for Non-temporary Address

Option: Identity Association for Non-temporary Address (3)
Length: 40
Value: 0000000000000546000000870000050018fd33af04eb8d0000...
IAID: 00000000
T1: 21600
T2: 34560

▼ IA Address

Option: IA Address (5)
Length: 24
Value: fd33af04eb8d0000000000000000000007cdffffffffffffffff
IPv6 address: fd33:af04:eb8d::7cd
Preferred lifetime: infinity
Preferred lifetime: infinity

IPv6 address (dhcpv6.iaaddr.ip), 16 bytes

Message type: Advertise (2)
Transaction ID: 0x936496

- ▶ Server Identifier
- ▶ Client Identifier
- ▶ SOL_MAX_RT
- ▶ DNS recursive name server
- ▶ Domain Search List
- ▶ Reconfigure Accept

▼ Identity Association for Non-temporary Address

Option: Identity Association for Non-temporary Address (3)
Length: 40
Value: 0000000000000546000000870000050018fd33af04eb8d0000...
IAID: 00000000
T1: 21600
T2: 34560

▼ IA Address

Option: IA Address (5)
Length: 24
Value: fd33af04eb8d0000000000000000000007cdffffffffffffffff
IPv6 address: fd33:af04:eb8d::7cd
Preferred lifetime: infinity
Preferred lifetime: infinity

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📁 ipv6

No.	T
113	0
116	0
129	0.654411
130	0.687292
139	0.716622
140	0.716674
141	0.728485

ff02::1:ffb4:8c3

ff02::1:ffb4:8c3

ff02::1:ffb7:f1d5

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Expression...

+

11e9645d9f45c89b408...

n=0 MSS=1220 WS=32 ...

No.	Time	Source	Destination	Protocol	Length	Info
129	0.654411	fe80::f65c:89ff:feb4:8c3	ff02::fb	MDNS	287	Standard query 0x0000 PTR _airport._tcp.local, "QU" que...
130	0.687292	::	ff02::1:ffb4:8c3	ICMPv6	78	Neighbor Solicitation for fe80::f65c:89ff:feb4:8c3
139	0.716622	::	ff02::1:ffb4:8c3	ICMPv6	78	Neighbor Solicitation for 2001:470:1f15:289:f65c:89ff:f...
140	0.716674	::	ff02::1:ffb7:f1d5	ICMPv6	78	Neighbor Solicitation for fd33:af04:eb8d:0:644c:4383:c5...
141	0.728485	fe80::f65c:89ff:feb4:8c3	ff02::1:ffb4:8c3	ICMPv6	86	Multicast Listener Report

▶ Frame 130: 78 bytes on wire (624 bits), 78 bytes captured (624 bits) on interface 0

▶ Ethernet II, Src: Apple_b4:08:c3 (f4:5c:89:b4:08:c3), Dst: IPv6mcast_ff:b4:08:c3 (33:33:ff:b4:08:c3)

▼ Internet Protocol Version 6, Src: ::, Dst: ff02::1:ffb4:8c3

0110 = Version: 6

▶ 0000 0000 = Traffic class: 0x00 (DSCP: CS0, ECN: Not-ECT)

.... 0000 0000 0000 0000 = Flowlabel: 0x00000000

Payload length: 24

Next header: ICMPv6 (58)

Hop limit: 255

Source: ::

Destination: ff02::1:ffb4:8c3

[Source GeoIP: Unknown]

[Destination GeoIP: Unknown]

▼ Internet Control Message Protocol v6

Type: Neighbor Solicitation (135)

Code: 0

Checksum: 0xeadb [correct]

Reserved: 00000000

Target Address: fe80::f65c:89ff:feb4:8c3

78 Neighbor Solicitation for fe80::f65c:89ff:feb4:8c3

78 Neighbor Solicitation for 2001:470:1f15:289:f65c:89ff:f...

78 Neighbor Solicitation for fd33:af04:eb8d:0:644c:4383:c5...

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wireshark_pcapng_en0_20160519182107_NGSxSR

Packets: 1385 · Displayed: 309 (22.3%) · Dropped: 0 (0.0%)

Profile: Default

ipv6
Expression...

No.	Time	Source	Destination	Protocol	Length	Info
141	0.728485	fe80::f65c:89ff:feb4:8c3	ff02::1:ffb4:8c3	ICMPv6	86	Multicast Listener Report
142	0.728486	fe80::f65c:89ff:feb4:8c3	ff02::2:ff64:38e7	ICMPv6	86	Multicast Listener Report
143	0.728546	fe80::f65c:89ff:feb4:8c3	ff02::1:ff09:ce79	ICMPv6	86	Multicast Listener Report
144	0.728546	fe80::f65c:89ff:feb4:8c3	ff02::1:ffb7:f1d5	ICMPv6	86	Multicast Listener Report
145	0.728547	fe80::f65c:89ff:feb4:8c3	ff02::fb	ICMPv6	86	Multicast Listener Done
146	0.728547	fe80::f65c:89ff:feb4:8c3	ff02::fb	ICMPv6	86	Multicast Listener Report
147	0.728547	fe80::f65c:89ff:feb4:8c3	ff02::fb	ICMPv6	86	Multicast Listener Done

▶ Frame 144: 86 bytes on wire (688 bits), 86 bytes captured (688 bits) on interface 0

▶ Ethernet II, Src: Apple_b4:08:c3 (f4:5c:89:b4:08:c3), Dst: IPv6mcast_ff:b7:f1:d5 (33:33:ff:b7:f1:d5)

▼ Internet Protocol Version 6, Src: fe80::f65c:89ff:feb4:8c3, Dst: ff02::1:ffb7:f1d5

0110 = Version: 6

▶ 0000 0000 = Traffic class: 0x00 (DSCP: CS0, ECN: Not-ECT)

..... 0000 0000 0000 0000 = Flowlabel: 0x00000000

Payload length: 32

Next header: IPv6 Hop-by-Hop Option (0)

Hop limit: 1

Source: fe80::f65c:89ff:feb4:8c3

[Source SA MAC: Apple_b4:08:c3 (f4:5c:89:b4:08:c3)]

Destination: ff02::1:ffb7:f1d5

[Source GeoIP: Unknown]

[Destination GeoIP: Unknown]

▼ Hop-by-Hop Options

Next Header: ICMPv6 (58)

Length: 0 (8 bytes)

▶ IPv6 Option (PadN)

▶ IPv6 Option (Router Alert)

▼ Internet Control Message Protocol v6

Type: Multicast Listener Report (131)

Code: 0

Checksum: 0x1534 [correct]

Maximum Response Delay [ms]: 0

Reserved: 0000

Multicast Address: ff02::1:ffb7:f1d5

wireshark_pcapng_en0_20160519182107_NGSxSR
Packets: 1385 · Displayed: 309 (22.3%) · Dropped: 0 (0.0%)
Profile: Default

Wi-Fi: en0

ipv6

No.	Time	Source	Destination	Protocol	Length	Info
141	0.000000	ff02::1:ffb4:8c3	ff02::1:ffb7:f1d5	ICMPv6	86	Multicast Listener Report
142	0.000000	ff02::2:ff64:38e7	ff02::1:ffb7:f1d5	ICMPv6	86	Multicast Listener Report
143	0.000000	ff02::1:ff09:ce79	ff02::1:ffb7:f1d5	ICMPv6	86	Multicast Listener Report
144	0.000000	ff02::1:ffb7:f1d5	ff02::1:ffb7:f1d5	ICMPv6	86	Multicast Listener Report
145	0.000000	ff02::fb	ff02::fb	ICMPv6	86	Multicast Listener Done
146	0.000000	ff02::fb	ff02::fb	ICMPv6	86	Multicast Listener Report
147	0.000000	ff02::fb	ff02::fb	ICMPv6	86	Multicast Listener Done

Frame 144 on interface Wi-Fi (en0):

Ethernet II, Src: Apple (08:00:00:0e:14:01), Dst: Multicast (01:00:5e:00:00:01)

Internet Protocol Version 6, Src: fe80::f65c:89ff:feb4:8c3, Dst: ff02::1:ffb7:f1d5

Internet Control Message Protocol v6

Type: Multicast Listener Report (131)

Code: 0

Checksum: 0x1534 [correct]

Maximum Response Delay [ms]: 0

Reserved: 0000

Multicast Address: ff02::1:ffb7:f1d5

Payload length: 32

Next header: IPv6 Hop-by-Hop Option (0)

Hop limit: 1

Source: fe80::f65c:89ff:feb4:8c3

[Source SA MAC: Apple_b4:08:c3 (f4:5c:89:b4:08:c3)]

Destination: ff02::1:ffb7:f1d5

[Source GeoIP: Unknown]

[Destination GeoIP: Unknown]

Hop-by-Hop Options

Next Header: ICMPv6 (58)

Length: 0 (8 bytes)

IPv6 Option (PadN)

IPv6 Option (Router Alert)

Internet Control Message Protocol v6

Type: Multicast Listener Report (131)

Code: 0

Checksum: 0x1534 [correct]

Maximum Response Delay [ms]: 0

Reserved: 0000

Multicast Address: ff02::1:ffb7:f1d5

wireshark_pcapng_en0_20160519182107_NGSxSR

Packets: 1385 · Displayed: 309 (22.3%) · Dropped: 0 (0.0%)

Profile: Default

Wi-Fi: en0

ipv6

No.	Time	Source	Destination	Protocol	Length	Info
162	0.822814	fe80::a2f3:c1ff:fe				
163	0.823768	fe80::a2f3:c1ff:fe				
176	0.866847	::				
463	1.577676	fe80::f65c:89ff:fe				
464	1.579741	fe80::a2f3:c1ff:fe				
475	1.639431	fe80::a2f3:c1ff:fe				
476	1.639507	fe80::f65c:89ff:fe				

▶ Frame 463: 156 bytes on wire (1248 bits)

▶ Ethernet II, Src: Apple_b4:08:c3 (f4:5c:00:b4:08:c3), Dst: fe80::a2f3:c1ff:fe80::a2f3:c1ff:fe

▶ Internet Protocol Version 6, Src: fe80::a2f3:c1ff:fe80::a2f3:c1ff:fe, Dst: fe80::f65c:89ff:fe80::f65c:89ff:fe

▶ User Datagram Protocol, Src Port: 546, Dst Port: 546

▼ DHCPv6

Message type: Request (3)
Transaction ID: 0x0be2c2

▶ Client Identifier

▶ Option Request

▶ Elapsed time

▶ Server Identifier

▼ Identity Association for Non-temporary Address

Option: Identity Association for Non-temporary Address (3)
Length: 40
Value: 0000000000000000000000000000000050018fd33af04eb8d0000...
IAID: 00000000
T1: 0
T2: 0

▼ IA Address

Option: IA Address (5)
Length: 24
Value: fd33af04eb8d0000000000000000000007cd00000000000000000
IPv6 address: fd33:af04:eb8d::7cd
Preferred lifetime: 0
Valid lifetime: 0

9500:7c17:9...
5c89b408c3 ...
:89b408c3 IA...
9500:7c17:9...
00:7c17:9c09...

wireshark_pcapng_en0_20160519182107_NGSxSR

Profile: Default

wireshark_pcapng_en0_20160519182107_NGSxSR

ault

No.	Time	Source
162	0.822814	fe80::a2f3:c1ff:feff:4992
163	0.823768	fe80::a2f3:c1ff:feff:4992
176	0.866847	::
463	1.577676	fe80::f65c:89ff:feb4:8c3
464	1.579741	fe80::a2f3:c1ff:feff:4992
475	1.639431	fe80::a2f3:c1ff:feff:4992
476	1.639507	fe80::f65c:89ff:feb4:8c3

▶ Internet Protocol Version 6, Src: fe80::a2f3:c1ff:feff:4992, Dst: fe80::f65c:89ff:feb4:8c3
 ▶ User Datagram Protocol, Src Port: 547 (547), Dst Port: 547
 ▼ DHCPv6

Message type: Reply (7)
 Transaction ID: 0x0be2c2

▶ Server Identifier
 ▶ Client Identifier
 ▶ SOL_MAX_RT
 ▶ DNS recursive name server
 ▶ Domain Search List
 ▶ Reconfigure Accept
 ▶ Authentication

▼ Identity Association for Non-temporary Address

Option: Identity Association for Non-temporary Address (3)
 Length: 40
 Value: 000000000000054600000870000050018fd33af04eb8d0000...
 IAID: 00000000
 T1: 21600
 T2: 34560

▼ IA Address

Option: IA Address (5)
 Length: 24
 Value: fd33af04eb8d0000000000000000000007cdfffffffffffffffff
 IPv6 address: fd33:af04:eb8d::7cd
 Preferred lifetime: infinity
 Preferred lifetime: infinity

Message type: Reply (7)
 Transaction ID: 0x0be2c2

▶ Server Identifier
 ▶ Client Identifier
 ▶ SOL_MAX_RT
 ▶ DNS recursive name server
 ▶ Domain Search List
 ▶ Reconfigure Accept
 ▶ Authentication

▼ Identity Association for Non-temporary Address

Option: Identity Association for Non-temporary Address (3)
 Length: 40
 Value: 000000000000054600000870000050018fd33af04eb8d0000...
 IAID: 00000000
 T1: 21600
 T2: 34560

▼ IA Address

Option: IA Address (5)
 Length: 24
 Value: fd33af04eb8d0000000000000000000007cdfffffffffffffffff
 IPv6 address: fd33:af04:eb8d::7cd
 Preferred lifetime: infinity
 Preferred lifetime: infinity

Wi-Fi: en0

ipv6

No.	Time	Source	Destination	Protocol	Length	Info
463	1.577676	fe80::f65c:89ff:feb4:8c3	ff02::1:2	DHCPv6	156	Request XID: 0xbe2c2 CID: 000100011e9645d9f45c89b408c3 ...
464	1.579741	fe80::a2f3:c1ff:feff:4992	fe80::f65c:89ff:feb4:8c3	DHCPv6	215	Reply XID: 0xbe2c2 CID: 000100011e9645d9f45c89b408c3 IA...
475	1.639431	fe80::a2f3:c1ff:feff:4992	ff02::1:ff09:ce79	ICMPv6	86	Neighbor Solicitation for 2001:470:1f15:289:9500:7c17:9...
476	1.639507	fe80::f65c:89ff:feb4:8c3	fe80::a2f3:c1ff:feff:4992	ICMPv6	86	Neighbor Advertisement 2001:470:1f15:289:9500:7c17:9c09...
479	1.640398	2a00:1450:4013:c00::6c	2001:470:1f15:289:9500:7c17:9c09:ce79	TCP	94	993 → 63086 [SYN, ACK] Seq=0 Ack=1 Win=43520 Len=0 MSS=...
480	1.640400	2a00:1450:4013:c00::6c	2001:470:1f15:289:9500:7c17:9c09:ce79	TCP	94	993 → 63087 [SYN, ACK] Seq=0 Ack=1 Win=43520 Len=0 MSS=...
481	1.640449	2001:470:1f15:289:9500:7c17:9c09:ce79	2a00:1450:4013:c00::6c	TCP	74	63086 → 993 [RST] Seq=1 Win=0 Len=0

▶ Frame 475: 86 bytes on wire (688 bits), 86 bytes captured (688 bits) on interface 0

▶ Ethernet II, Src: Tp-LinkT_ff:49:92 (a0:f3:c1:ff:49:92), Dst: IPv6mcast_ff:09:ce:79 (33:33:ff:09:ce:79)

▶ Internet Protocol Version 6, Src: fe80::a2f3:c1ff:feff:4992, Dst: ff02::1:ff09:ce79

▼ Internet Control Message Protocol v6

- Type: Neighbor Solicitation (135)
- Code: 0
- Checksum: 0x90e5
- Reserved: 00000000
- Target Address: 2001:470:1f15:289:9500:7c17:9c09:ce79
- ▼ ICMPv6 Option (Source link-layer address : a0:f3:c1:ff:49:92)
- Type: Source link-layer address (1)
- Length: 1 (8 bytes)
- Link-layer address: Tp-LinkT_ff:49:92 (a0:f3:c1:ff:49:92)

wireshark_pcapng_en0_20160519182107_NGSxSR

Packets: 1385 · Displayed: 309 (22.3%) · Dropped: 0 (0.0%)

Profile: Default

Wi-Fi: en0

ipv6

No.	Time	Source	Destination	Protocol	Length	Info
463	1.577676	fe80::f65c:89ff:feb4:8c3	ff02::1:2	DHCPv6	156	Request XID: 0xbe2c2 CID: 000100011e9645d9f45c89b408c3 ...
464	1.579741	fe80::a2f3:c1ff:feff:4992	fe80::f65c:89ff:feb4:8c3	DHCPv6	215	Reply XID: 0xbe2c2 CID: 000100011e9645d9f45c89b408c3 IA...
475	1.639431	fe80::a2f3:c1ff:feff:4992	ff02::1:ff09:ce79	ICMPv6	86	Neighbor Solicitation for 2001:470:1f15:289:9500:7c17:9...
476	1.639507	fe80::f65c:89ff:feb4:8c3	fe80::a2f3:c1ff:feff:4992	ICMPv6	86	Neighbor Advertisement 2001:470:1f15:289:9500:7c17:9c09...
479	1.640398	2a00:1450:4013:c00::6c	2001:470:1f15:289:9500:7c17:9c09:ce79	TCP	94	993 → 63086 [SYN, ACK] Seq=0 Ack=1 Win=43520 Len=0 MSS=...
480	1.640400	2a00:1450:4013:c00::6c	2001:470:1f15:289:9500:7c17:9c09:ce79	TCP	94	993 → 63087 [SYN, ACK] Seq=0 Ack=1 Win=43520 Len=0 MSS=...
481	1.640449	2001:470:1f15:289:9500:7c17:9c09:ce79	2a00:1450:4013:c00::6c	TCP	74	63086 → 993 [RST] Seq=1 Win=0 Len=0

▶ Frame 476: 86 bytes on wire (688 bits), 86 bytes captured (688 bits) on interface 0

▶ Ethernet II, Src: Apple_b4:08:c3 (f4:5c:89:b4:08:c3), Dst: Tp-LinkT_ff:49:92 (a0:f3:c1:ff:49:92)

▶ Internet Protocol Version 6, Src: fe80::f65c:89ff:feb4:8c3, Dst: fe80::a2f3:c1ff:feff:4992

▼ Internet Control Message Protocol v6

- Type: Neighbor Advertisement (136)
- Code: 0
- Checksum: 0
- ▶ Flags: 0x40
- Target Address
- ▼ ICMPv6 Option (Target link-layer address : f4:5c:89:b4:08:c3)
- Type: Target link-layer address (2)
- Length: 1 (8 bytes)
- Link-layer address: Apple_b4:08:c3 (f4:5c:89:b4:08:c3)

wireshark_pcapng_en0_20160519182107_NGSxSR

Packets: 1385 · Displayed: 309 (22.3%) · Dropped: 0 (0.0%) Profile: Default

Host State Post-Attachment

```
ayourtch — -bash — 101x26
[AYOURTCH-M-D1HB:~ ayourtch$ ifconfig en0
en0: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
    ether f4:5c:89:b4:08:c3
    inet6 fe80::f65c:89ff:feb4:8c3%en0 prefixlen 64 scopeid 0x4
    inet 192.168.1.235 netmask 0xffffffff00 broadcast 192.168.1.255
    inet6 2001:470:1f15:289:f65c:89ff:feb4:8c3 prefixlen 64 autoconf
    inet6 2001:470:1f15:289:9500:7c17:9c09:ce79 prefixlen 64 autoconf temporary
    inet6 fd33:af04:eb8d::f65c:89ff:feb4:8c3 prefixlen 64 autoconf
    inet6 fd33:af04:eb8d::644c:4383:c5b7:f1d5 prefixlen 64 autoconf temporary
    inet6 fd33:af04:eb8d::7cd prefixlen 64 dynamic
    nd6 options=1<PERFORMNUD>
    media: autoselect
    status: active
```

```
inet6 fe80::f65c:89ff:feb4:8c3%en0 prefixlen 64 scopeid 0x4
inet 192.168.1.235 netmask 0xffffffff00 broadcast 192.168.1.255
inet6 2001:470:1f15:289:f65c:89ff:feb4:8c3 prefixlen 64 autoconf
inet6 2001:470:1f15:289:9500:7c17:9c09:ce79 prefixlen 64 autoconf temporary
inet6 fd33:af04:eb8d::f65c:89ff:feb4:8c3 prefixlen 64 autoconf
inet6 fd33:af04:eb8d::644c:4383:c5b7:f1d5 prefixlen 64 autoconf temporary
inet6 fd33:af04:eb8d::7cd prefixlen 64 dynamic
```

M-, O-, A- flags: (Too) Many To Choose From?



For Your
Reference

Host State	Input	Behavior
Host has not acquired any addresses	No RA	Some OS perform DHCPv6, some do not
Host has not acquired any addresses	RA with M=0, O=1	Some OS acquire info only if A=1
Host has acquired DHCPv6 addresses (M=1, A=0)	RA with M=0	Some OS release DHCPv6 addresses immediately, some not
Host has acquired SLAAC-only addresses (A=1, M=0)	RA with M=1	Some OS acquire DHCPv6 address immediately, some not

<https://tools.ietf.org/html/draft-ietf-v6ops-dhcpv6-slaac-problem>

Quiz time!







**"IPv6 is Internet broccoli.
Good for us in the long run but no
immediate sugar rush from
deploying it now"**

Shameless self promotion of my own quotes – Nicole Wajer





[EXT] Everything you always wanted to know about IPv6 but were a...

63 people • Cisco's Internet Highway of IPv6

<https://eurl.io/#Pw7m5J7S->



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