IPv6 - What Do you Mean there isn't a Broadcast?

Fish Fishburne, CCIE #2639, CCDE#2009:14

BRKIPV-1616

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"

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4. Enter messages/questions in the Webex space

Webex spaces will be moderated
by the speaker until June 7, 2024.

IPv6 – My Journey as a Newbie to IPv6

IPv6 – My Journey as a Newbie to IPv6

CHECKLIST
- ✓ 128 bit address, 16-bit boundaries,
- ✓ hexadecimal, colons
- ✓ show ipv6 neighbor
- ✓ interface can have >1 IPv6 address
- ✓ ICMP important
- ✓ /64 for LANs
- ✓ 2001:DB8::/32 for documentations
- ✓ "no shut" for router EIGRP
- v3 for OSPF

No.	Source	Destination	Protocol	Length	Info
13	Cisco_0a:a2:80	~~Broadcast~~	ARP	64	Who has 10.10.10.2? Tell 1
14	Cisco_0a:b0:00	Cisco_0a:a2:80	ARP	64	10.10.10.2 is at c4:64:13:0

BACK TO SQUARE ONE

NDP

Solicited-Node Multicast

Link-Local Scope Multicast Addresses

4

IPv6 – My Journey as a Newbie to IPv6

- Part 1 of 7: Understanding IPv6: The Journey Begins

- Part 2 of 7: Understanding IPv6: Link-Local 'Magic'

- Part 3 of 7: Understanding IPv6: A Sniffer Full Of 3s

- Part 4 of 7: Understanding IPv6: What Is Solicited-Node Multicas...

- Part 5 of 7: Understanding IPv6: Prepping For Solicited-Node Multicast

- Part 6 of 7: Understanding IPv6: The Ping Before Solicited-Node Multicast

- Part 7 of 7: Understanding IPv6: Solicited-Node Multicast In Action

https://www.networkingwithfish.com/understanding-ipv6-7-part-series/
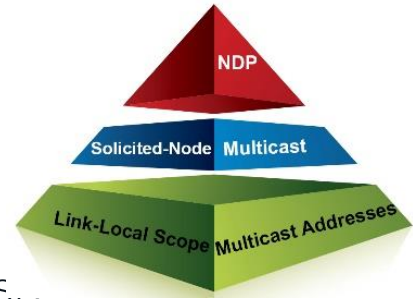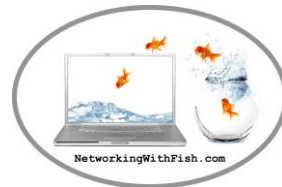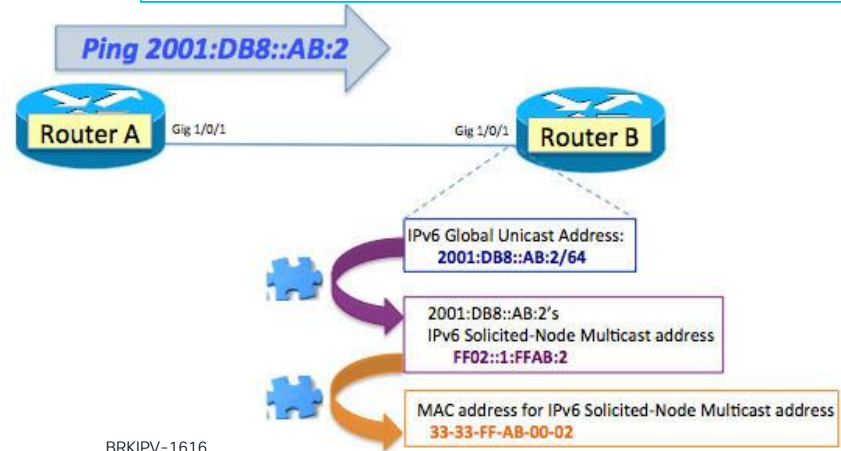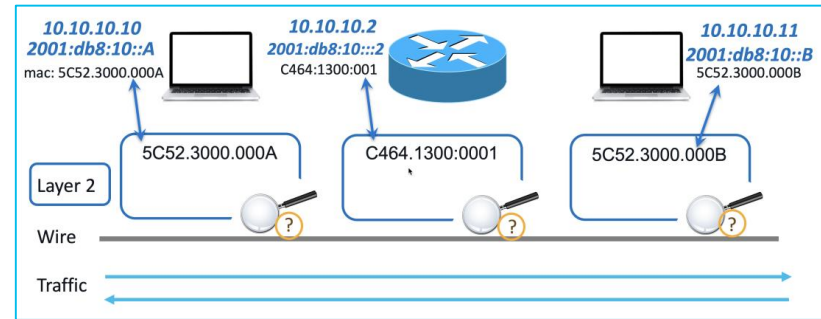
Agenda

- Setting the Stage: Picking Things Up off the Wire

  - Resolving The Destination MAC Address

  - Putting the Puzzle Pieces Together

- Show a Magic Trick
- Explain How the Magic Trick works
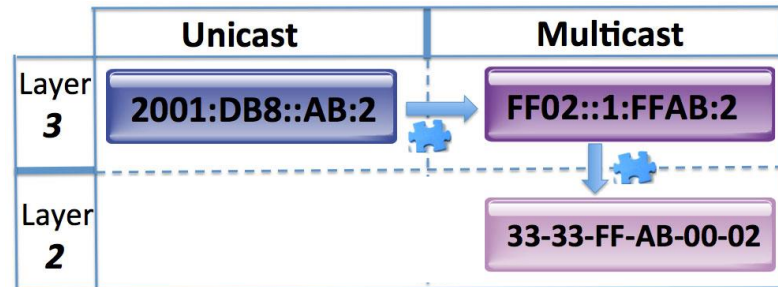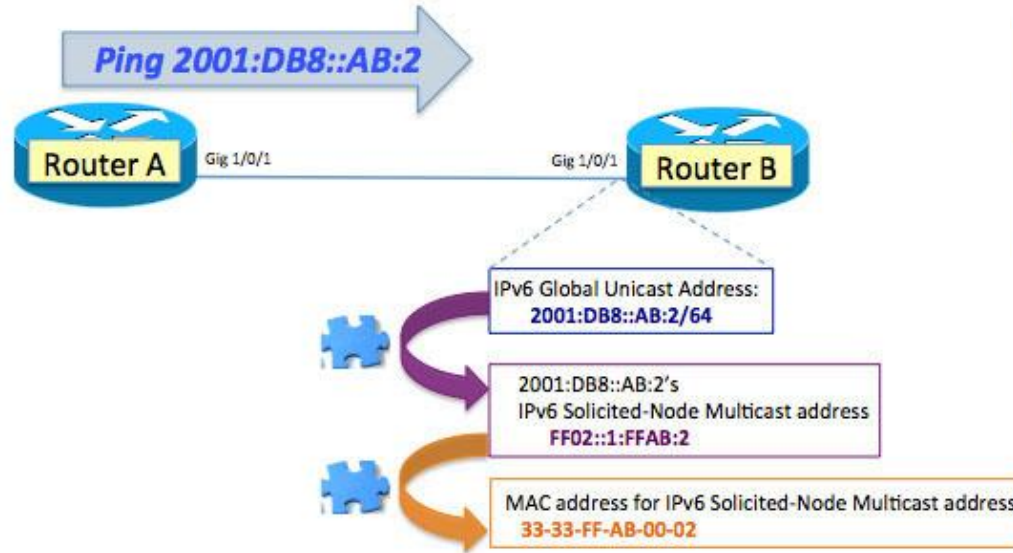
Quick Facts That Would Have Helped Me

1: It All Starts with Knowing the Address

→ you do NOT need to bother EVERYONE to get your neighbor's MAC address

Ping 2001:DB8::AB:2

Router A — Gig 1/0/1 — Gig 1/0/1 — Router B

IPv6 Global Unicast Address:
2001:DB8::AB:2/64

2001:DB8::AB:2's
IPv6 Solicited-Node Multicast address
FF02::1:FFAB:2

MAC address for IPv6 Solicited-Node Multicast address
33-33-FF-AB-00-02

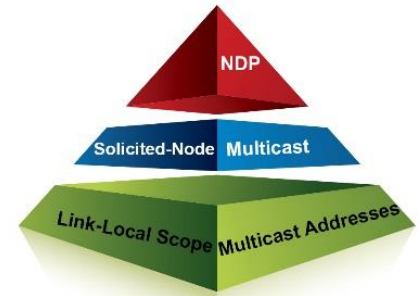|	Unicast	Multicast
Layer 3	2001:DB8::AB:2	FF02::1:FFAB:2
Layer 2		33-33-FF-AB-00-02

2: Extra IPv6 Address – Link Local

2 IPv6 Addresses:
- *FE80::1*
- *2001:DB8::AB:1*
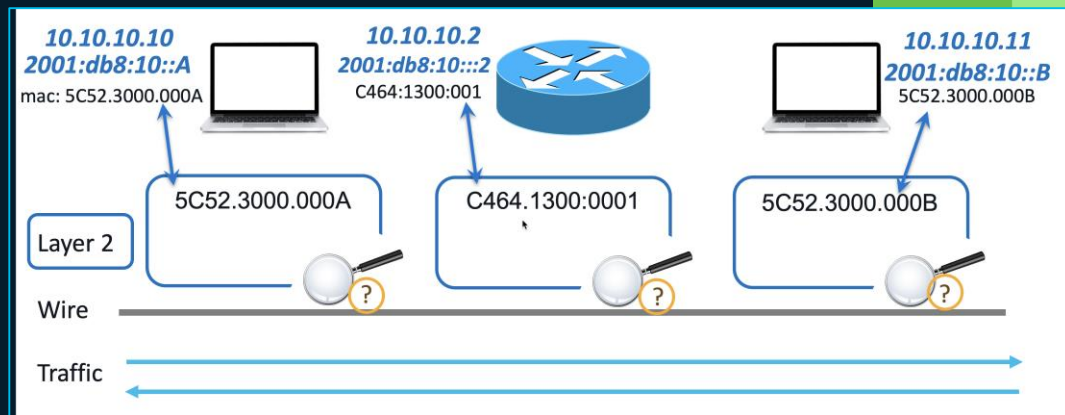
RouterA#sh ipv6 int gig1/0/1
GigabitEthernet1/0/1 is up, line protocol is up
  IPv6 is enabled, link-local address is FE80::1
  No Virtual link-local address(es):
  Global unicast address(es):
    2001:DB8::AB:1, subnet is 2001:DB8::/64

NDP

Solicited-Node Multicast

Link-Local Scope Multicast Addresses

3: IPv6 Addresses Can Look Funky

	IPv6 Layer 3 Address	Multicast	Unicast	Layer 2 Multicast MAC
FF02::5	✓	✓		
FE80::2237:6ff:fecf:67e4	✓		✓	
FE80::1	✓		✓	
2001:DB8::AB:2	✓		✓	
FF02::1:FFAB:2	✓	✓		
33:33:FF:AB:00:02				✓

Setting the Stage: Picking Things Up off the Wire
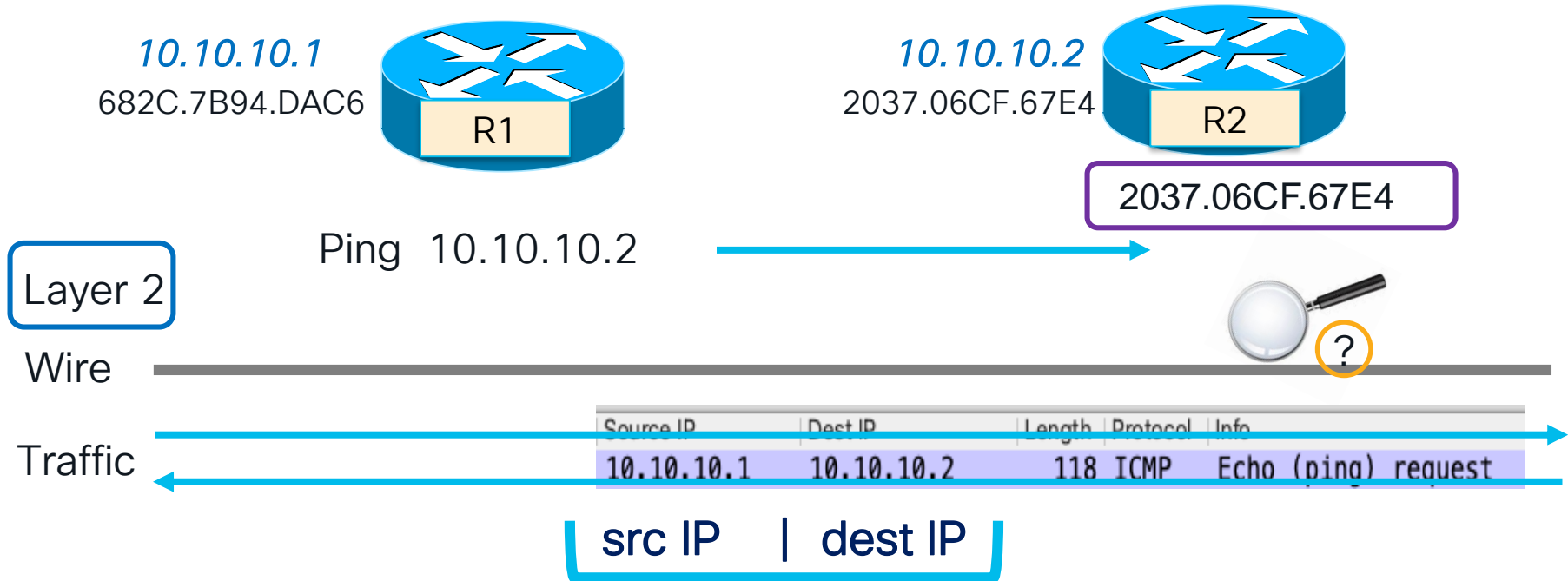
10.10.10.10
2001:db8:10::A
mac: 5C52.3000.000A

10.10.10.2
2001:db8:10:::2
C464.1300:001

10.10.10.11
2001:db8:10::B
5C52.3000.000B

5C52.3000.000A   C464.1300:0001   5C52.3000.000B

Layer 2

Wire

Traffic

Picking Things Up Off the Wire

10.10.10.1
682C.7B94.DAC6

R1

10.10.10.2
2037.06CF.67E4

R2

2037.06CF.67E4

Ping   10.10.10.2

Layer 2

Wire

?

Traffic

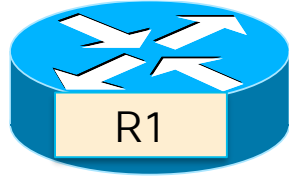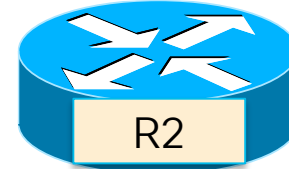| Source IP	Dest IP	Length	Protocol	Info
10.10.10.1	10.10.10.2	118	ICMP	Echo (ping) request

src IP | dest IP

Picking Things Up Off the Wire

10.10.10.1
682C.7B94.DAC6

R1

10.10.10.2
2037.06CF.67E4
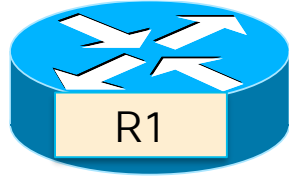
R2

2037.06CF.67E4

Ping   10.10.10.2

Layer 2

Wire

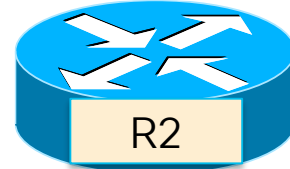| No.	Source MAC	Dest MAC	Source IP	Dest IP	Length	Protocol	Info
1	68:2c:7b:94:da:c6	20:37:06:cf:67:e4	10.10.10.1	10.10.10.2	118	ICMP	Echo (ping) request

src MAC | dest MAC   src IP | dest IP

Picking Things Up Off the Wire

2001:DB8::AB:1
682C.7B94.DAC6

R1

2001:DB8::AB:2
2037.06CF.67E4

R2

2037.06CF.67E4

Ping 2001:DB8::AB:2

Layer 2

Wire

No.	Source MAC	Dest MAC	Source IP	Dest IP	Length	Protocol	Info
1	68:2c:7b:94:da:c6	20:37:06:cf:67:e4	2001:db8::ab:1	2001:db8::ab:2	118	ICMPv6	Echo (ping) request

src MAC | dest MAC   src IP | dest IP

Dest MAC Address
"Discovery"

CISCO *Live!*
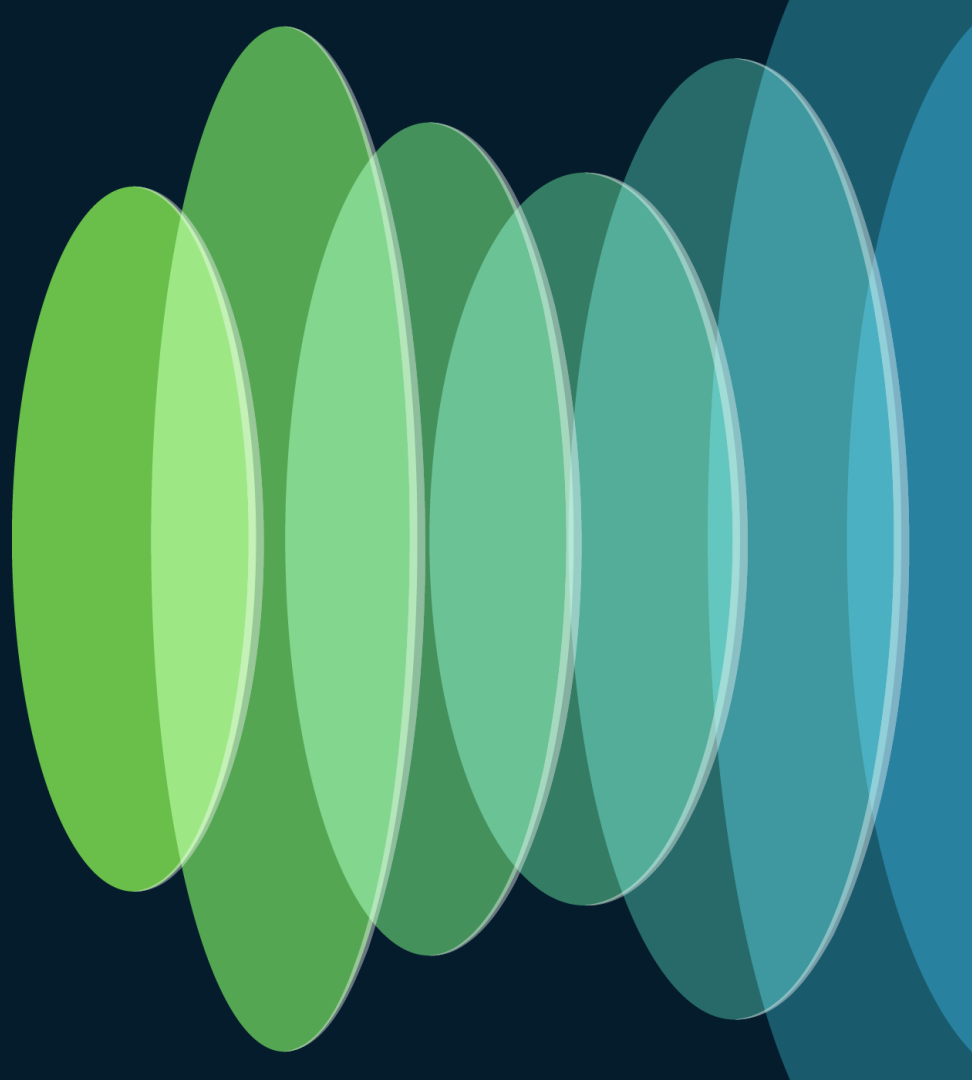
Asking Our Neighbors* on the Wire

10.10.10.1
682C.7B94.DAC6

R1
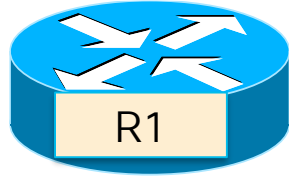
10.10.10.2
2037.06CF.67E4

R2

2037.06CF.67E4

FFFF.FFFF.FFFF

Layer 2

Wire

No.	Source MAC	Dest MAC	Source IP	Dest IP	Length	Protocol	Info
3	68:2c:7b:94:da:c6	20:37:06:cf:67:e4	10.10.10.1	10.10.10.2	118	ICMP	Echo (ping) request id=0x001b, seq=1/256,
4	20:37:06:cf:67:e4	68:2c:7b:94:da:c6	10.10.10.2	10.10.10.1	118	ICMP	Echo (ping) reply id=0x001b, seq=1/256,

Asking Our Neighbors* on the Wire

2001:DB8::AB:1

682C.7B94.DAC6

R1

2001:DB8::AB:2

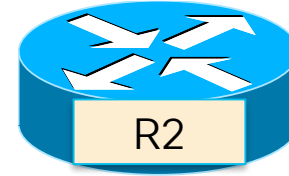2037.06CF.67E4

R2

2037.06CF.67E4

?????????????
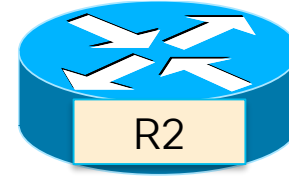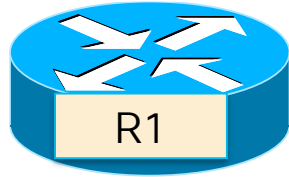
Layer 2

Wire

Source MAC	Dest MAC	Source IP	Dest IP	Length	Protocol	Info
68:2c:7b:94:da:c6	20:37:06:cf:67:e4	2001:db8::ab:1	2001:db8::ab:2	118	ICMPv6	Echo (ping) request id=0x0bf6, seq=0, hop limit=63 (reply in 4)
20:37:06:cf:67:e4	68:2c:7b:94:da:c6	2001:db8::ab:2	2001:db8::ab:1	118	ICMPv6	Echo (ping) reply id=0x0bf6, seq=0, hop limit=64 (request in 3)

RFC 1550 – IPng White Paper Solicitation

INFORMATIONAL

Network Working Group   S. Bradner
Request for Comments: 1550   Harv...
Category: Informational

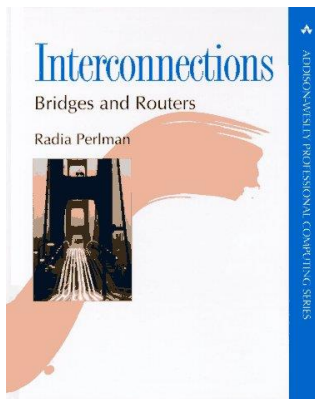...per Solicitation

...ction

The IP: next generation (IPng) area in the IETF is soliciting white
papers on topics related to the IPng requirements and selection
criteria.

Where were you in 1993?

Let's Go Back in Time (1990s)

CCIE

1992

1997
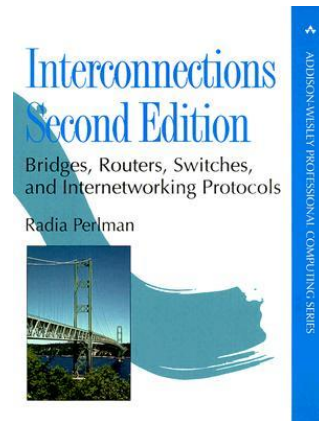
1999

IPX, AppleTalk, DECnet

IPX, AppleTalk, DECnet

RFC 1550 – IPng White Paper Solicitation

"In past discussions the following issues have been raised as relevant to the IPng selection process.

- Scaling
- Transition and deployment
- Security

- Configuration, administration and operation .
- Mobile hosts
- Flows and resource reservation

```
                                                    INFORMATIONAL

Network Working Group                                    S. Bradner
Request for Comments: 1550                       Harvard University
Category: Informational                                  A. Mankin
                                                               NRL
                                                     December 1993


           IP: Next Generation (IPng) White Paper Solicitation
```

RFC1550: Why I Feel it is So Important

Question: WHY bother EVERYONE to get your neighbor's MAC address

Generation" (IPng). RFC 1550 helped take me back in time to the issues that were at the forefront of people's minds and what the IPng protocol would need to address. I specifically liked one quote in section 5:

"Any or all of these issues may be addressed, as well as any other topic that the author feels is germane."

Asking Our Neighbors* on the Wire

2001:DB8::AB:1

682C.7B94.DAC6

R1

2001:DB8::AB:2

2037.06CF.67E4

R2

2037.06CF.67E4

?????????????

Layer 2

Wire

No.	Source MAC	Dest MAC	Source IP	Dest IP	Length	Protocol	Info
1							
2							
3	68:2c:7b:94:da:c6	20:37:06:cf:67:e4	2001:db8::ab:1	2001:db8::ab:2	118	ICMPv6	Echo (ping) request id=0x0bf6, seq=0, hop limit=63 (reply in 4)
4	20:37:06:cf:67:e4	68:2c:7b:94:da:c6	2001:db8::ab:2	2001:db8::ab:1	118	ICMPv6	Echo (ping) reply id=0x0bf6, seq=0, hop limit=64 (request in 3)

Alzatte la mano se vivetti en Italia

Picking Things Up Off the Wire

☐ Multicast MAC

2001:DB8::AB:1
682C.7B94.DAC6

R1

2001:DB8::AB:2
2037.06CF.67E4

R2

? ☐ *Unicast MAC*

? ☐ Broadcast MAC

Alzatte la mano se vivetti en Italia

Wire

Traffic

Picking Things Up Off the Wire

10.10.10.9

10.10.10.10

10.10.10.2
C464:130A:B000

10.10.10.3
C464:130A:B001

Join Multicast Group
239.1.1.1

← OSPF →

Layer 2

Wire

Traffic
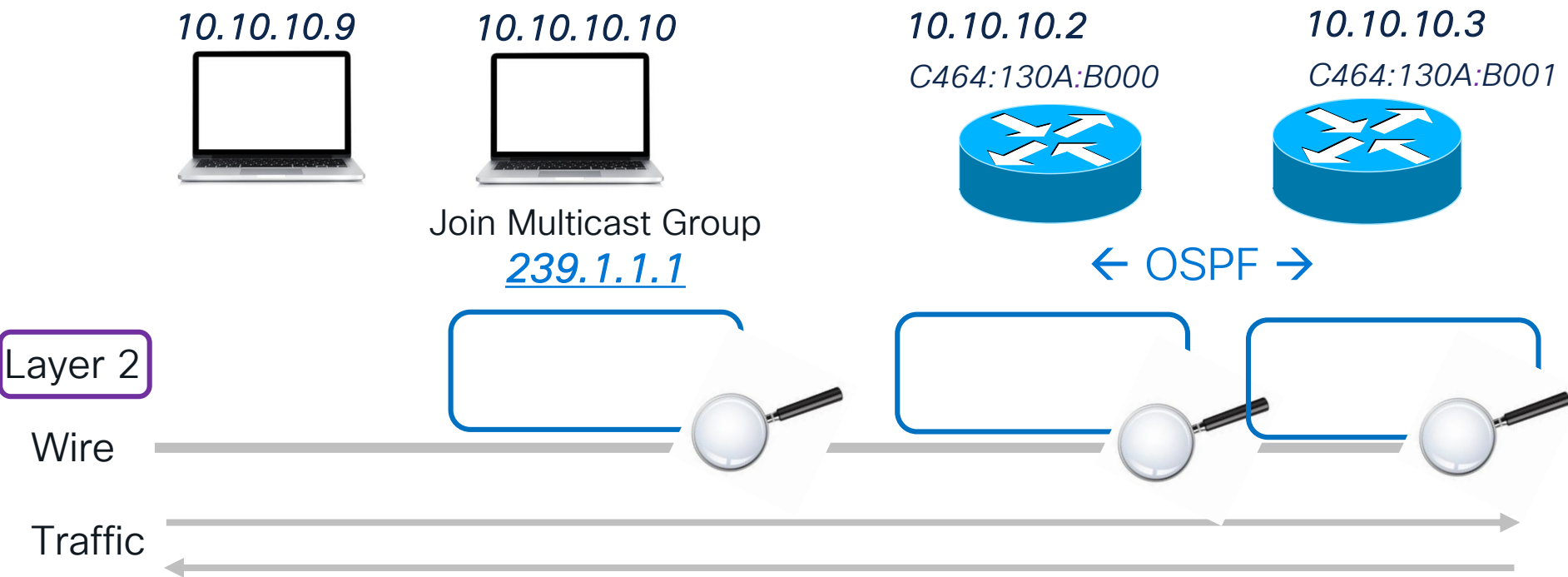
Picking Things Up Off the Wire

IP ADDRESS RANGE

224.0.0.0 → 239.255.255.255

MAC ADDRESS RANGE

01-00-5E-*00-00-00* → 01-00-5E-*7F-FF-FF*

RFC112:
"An IP host group address is mapped to an Ethernet multicast address by placing the low-order 23-bits of the IP address into the low-order 23 bits of the Ethernet multicast address 01-00-5E-00-00-00 (hex).
Because there are 28 significant bits in an IP host group address, more than one host group address may map to the same Ethernet multicast address."

Picking Things Up Off the Wire

❏ Multicast MAC

MAC ADDRESS RANGE

01-00-5E-*00-00-00* ➔ 01-00-5E-*7F-FF-FF*

239.1.1.1   **224.0.0.5**

Layer 2   ✓ 0100.5E01.0101   ✓ 0100.5E00.0005

Wire

Traffic

Picking Things Up Off the Wire

10.10.10.10

5C52.3000.000A
FFFF.FFFF.FFFF

☑ *Unicast MAC*
☑ Broadcast MAC
☑ Multicast MAC
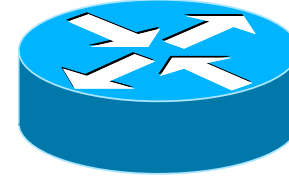
10.10.10.2

C464:130A:B000
FFFF.FFFF.FFFF

5C52.3000.000A
FFFF.FFFF.FFFF

0100.5E01.0101

C464.130A:B000
FFFF.FFFF.FFFF

0100.5E00.0005

Layer 2

Wire

Traffic

Picking Things Up Off the Wire – IPv6

*2001:**db8:10**::A*

5C52.3000.000A

5C52.3000.000A

*2001:**db8:10**:::2*

C464:1300:001

C464.1300:0001

Layer 2

Wire

Traffic
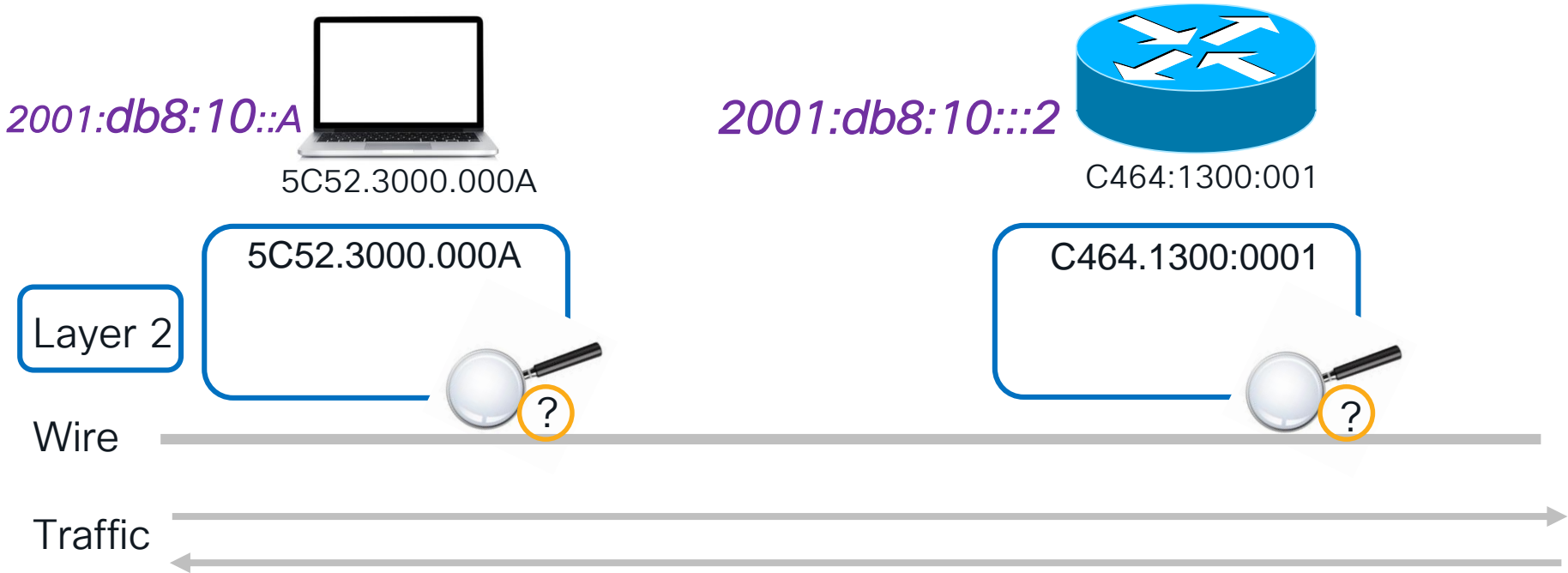
Resolving Destination MAC Address
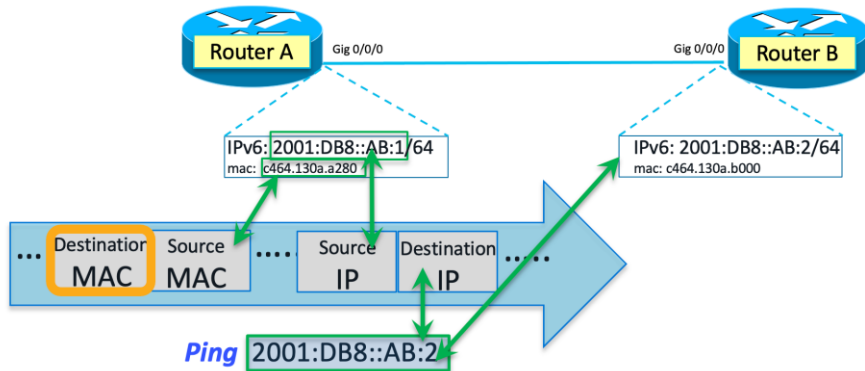
#1: It All Starts with Knowing the Address

→ you do NOT need to bother EVERYONE to get your neighbor's MAC address
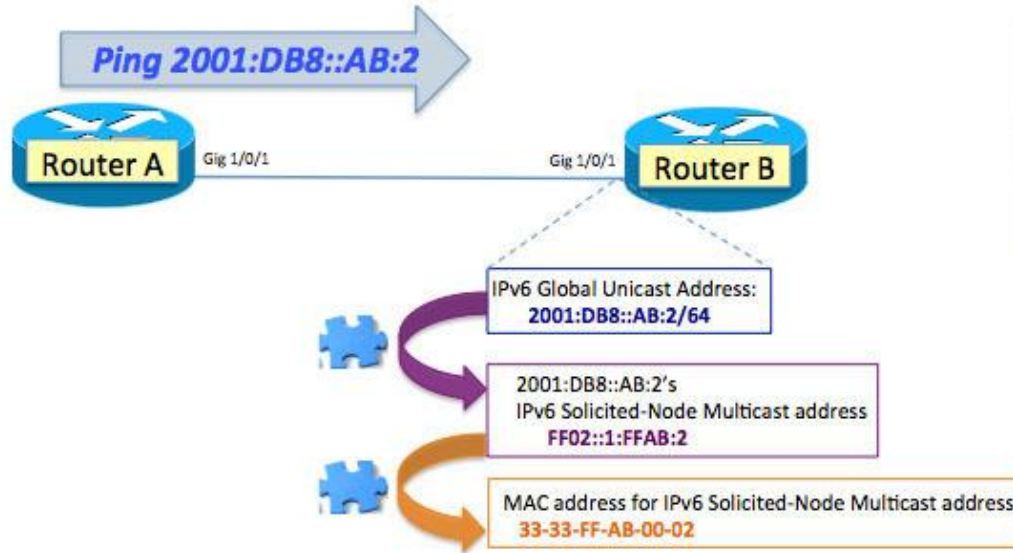
Resolving the Destination MAC Address
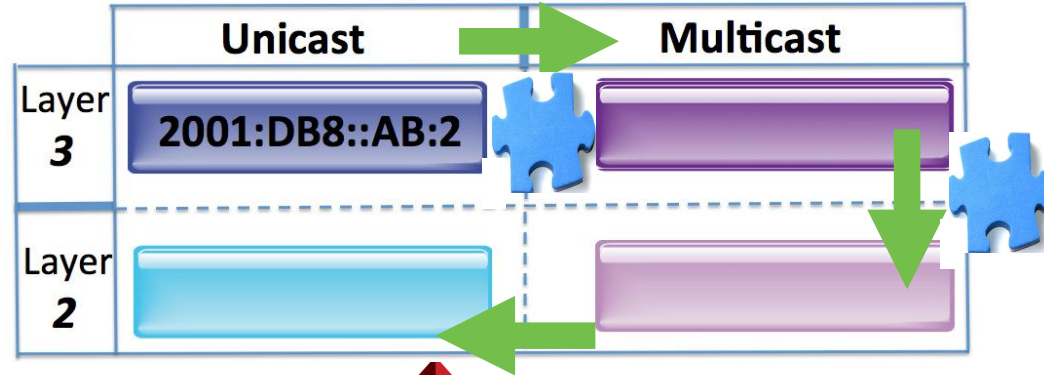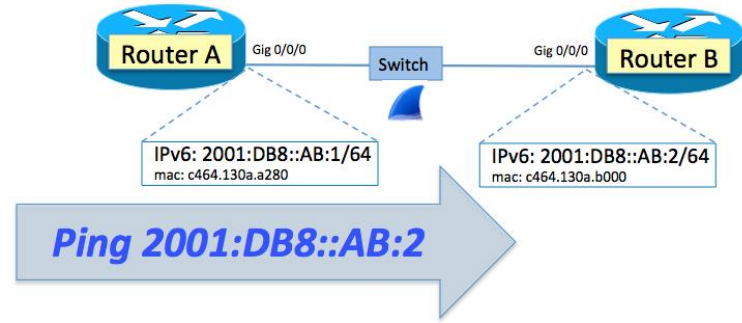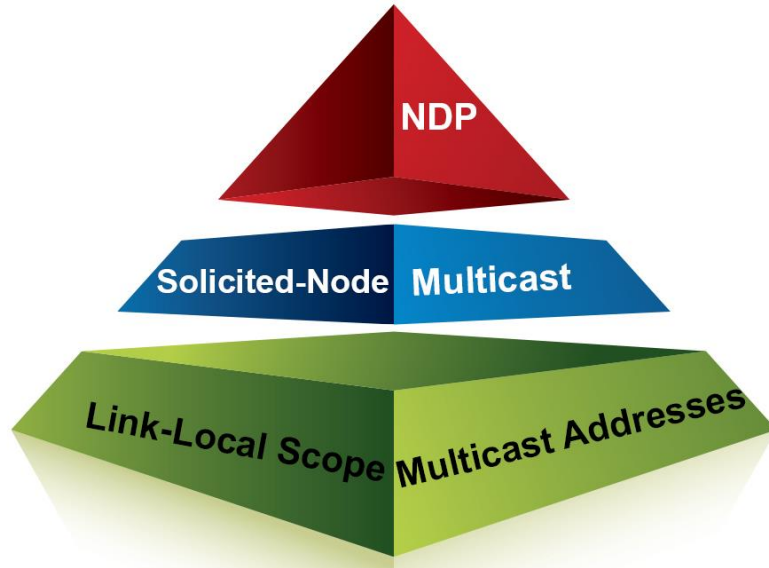
Solicited-Node Multicast

Snippets from RFC4291 section 2.7

- *A node is required to compute and join (on the appropriate interface) the associated solicited-node multicast addresses for all unicast and anycast addresses that have been configured for the node's interfaces (manually or automatically).*

- A Solicited-Node multicast address
  - is formed by taking the low-order 24 bits of an address (unicast or anycast) and
  - appending those bits to the prefix FF02:0:0:0:0:1:FF00::/104
  - resulting in a multicast address in the range FF02:0:0:0:0:1:FF00:0000 to FF02:0:0:0:0:1:FFFF:FFFF

Solicited-Node Multicast

Snippets from RFC4291 section 2.7**

> Low-order 24 bits of an address (unicast or anycast) and append those bits to the prefix FF02:0:0:0:0:1:FF00::/104

- *IPv6 address 4037::01:800:200E:8C6C ***
  - *MUST listen for the multicast address FF02::1:FF0E:8C6C.*

- *IPv6 address 2001:DB8::AB:2*
  - *MUST listen for the multicast address FF02::1:FFAB:0002*

Resolving the Destination MAC Address
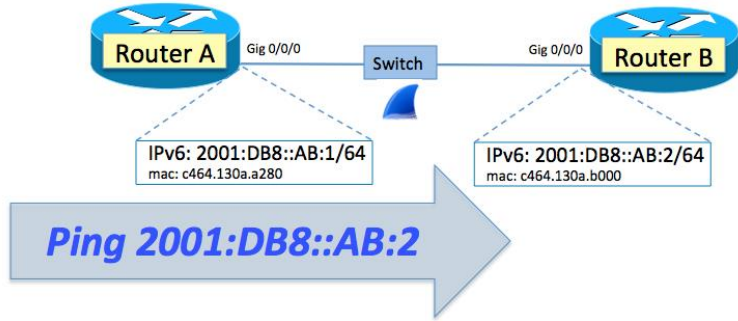
Ping 2001:DB8::AB:2

- A node is required to compute and join the associated solicited–node multicast address for all unicast addresses
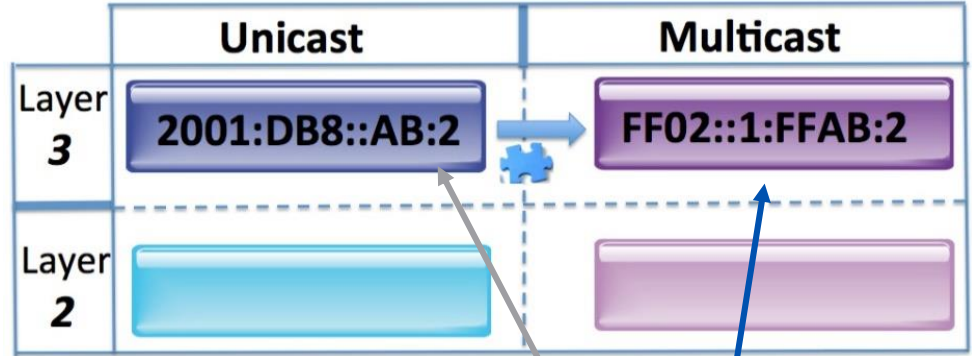
IPv6 Unicast Address: *2001:DB8::AB:2*

=   ***2001:DB8:0:0:0:0:00AB:0002***

Compute Associated solicited–node multicast:

FF02:0:0:0:0:1:FF***AB***:0002

Resolving the Destination MAC Address

Ping 2001:DB8::AB:2

Layer 3   Router A   Gig 1/0/1   Gig 1/0/1   Router B

Layer 2

IPv6 Global Unicast Address:
2001:DB8::AB:2/64

2001:DB8::AB:2's
Solicited-Node Multicast
FF02::1:FFAB:2

IPv6 Unicast Address: *2001:DB8::AB:2*

=   *2001:DB8:...AB:0002*

Compute As...

FF02:0:...

	Unicast	Multicast
Layer 3	2001:DB8::AB:2	FF02::1:FFAB:2
Layer 2		
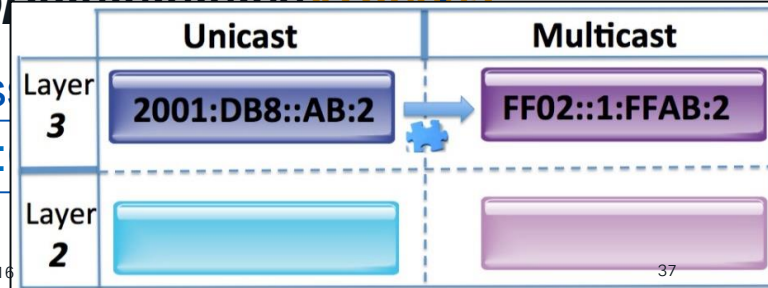
Solicited-Node Multicast

FF02::1:FFAB:2 is the Solicited-Node Multicast Address for 2001:DB8::AB:2

	IPv6 Layer 3 Address	Multicast	Link Local
FF02::1:FFAB:2	✓	✓	✓

Ping 2001:DB8::AB:2

Router A — Gig 1/0/1 ———— Gig 1/0/1 — Router B

IPv6 Global Unicast Address:
2001:DB8::AB:2/64

2001:DB8::AB:2's
Solicited-Node Multicast
FF02::1:FFAB:2
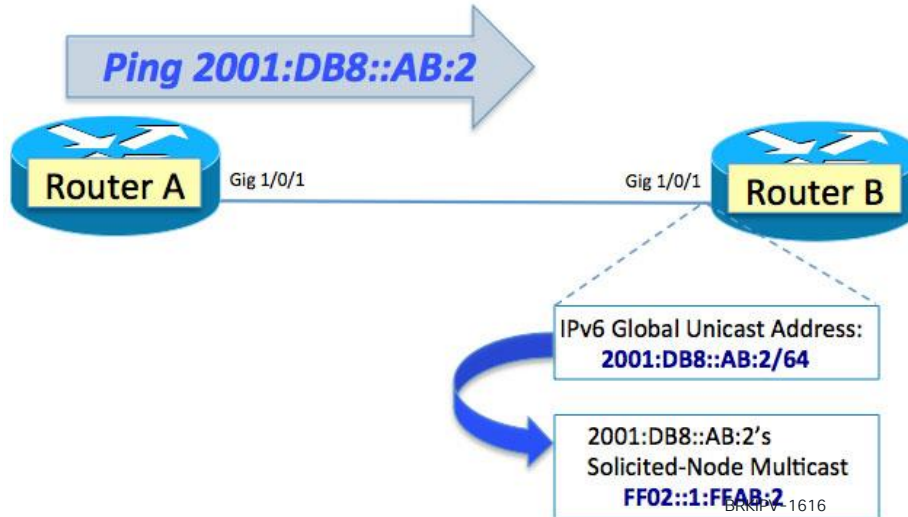
Resolving the Destination MAC Address

IPv6 Multicast MAC address range

33-33-00-00-00-00 through
33-33-FF-FF-FF-FF

"The low 32 bits an Ethernet address for IPv6 multicast traffic are the low 32 bits of the multicast IPv6 address used.

For example, IPv6 multicast traffic using the address *ff02::d* uses the MAC address *33-33-00-00-00-0D,* and traffic to *ff05::1:3* goes to the MAC address *33-33-00-01-00-03.*"

– https://en.wikipedia.org/wiki/Multicast_address

Picking Things Up Off the Wire

❑ **Multicast MAC**

IPv6 Multicast MAC ADDRESS RANGE

33-33-00-00-00-00 through
33-33-FF-FF-FF-FF

FF02::1:FFAB:2

Layer 2   ✓   *33-33-FF-AB-00-02*

	Unicast	Multicast
Layer 3	2001:DB8::AB:2	FF02::1:FFAB:2
Layer 2		33-33-FF-AB-00-02

Wire

Traffic
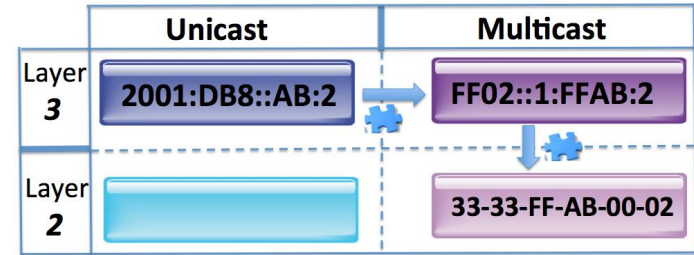
Resolving the Destination MAC Address

	Unicast	Multicast
Layer 3	2001:DB8::AB:2	FF02::1:FFAB:2
Layer 2		33-33-FF-AB-00-02

Ping 2001:DB8::AB:2

Router A — Gig 1/0/1 —————— Gig 1/0/1 — Router B

IPv6 Global Unicast Address:
2001:DB8::AB:2/64

2001:DB8::AB:2's
IPv6 Solicited-Node Multicast address
FF02::1:FFAB:2
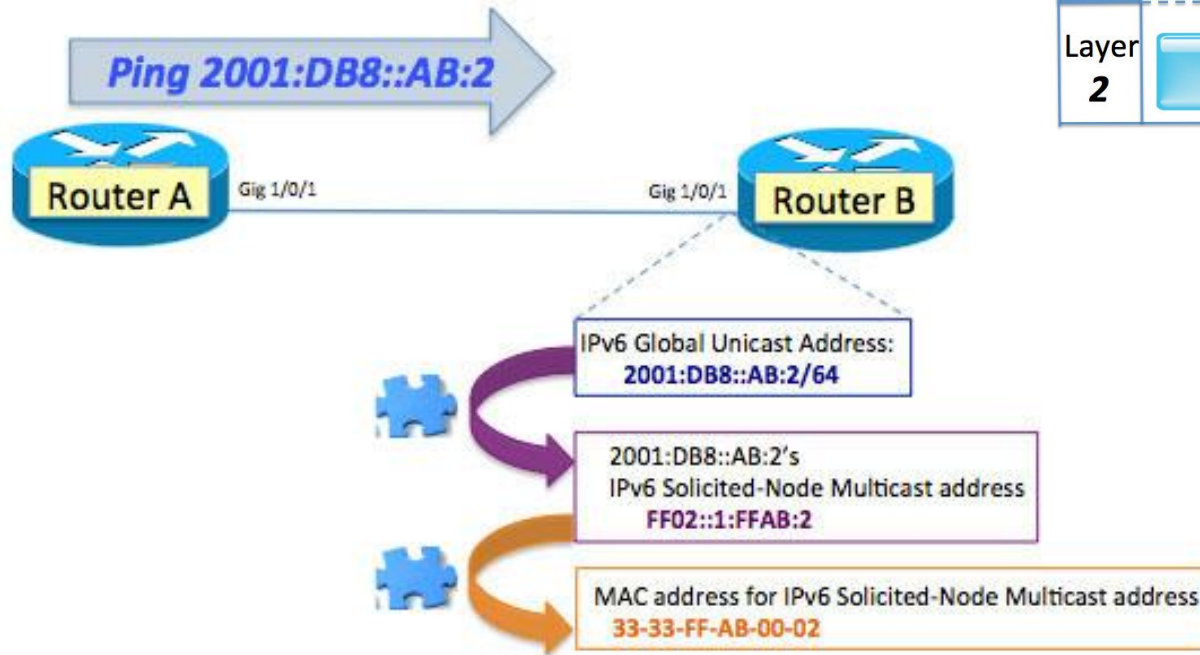
MAC address for IPv6 Solicited-Node Multicast address
33-33-FF-AB-00-02

Putting the Puzzles Pieces Together

The Final Piece

	Unicast	Multicast
Layer 3	2001:DB8::AB:2	FF02::1:FFAB:2
Layer 2		33-33-FF-AB-00-02

NDP

Solicited-Node Multicast

Link-Local Scope Multicast Addresses

NDP
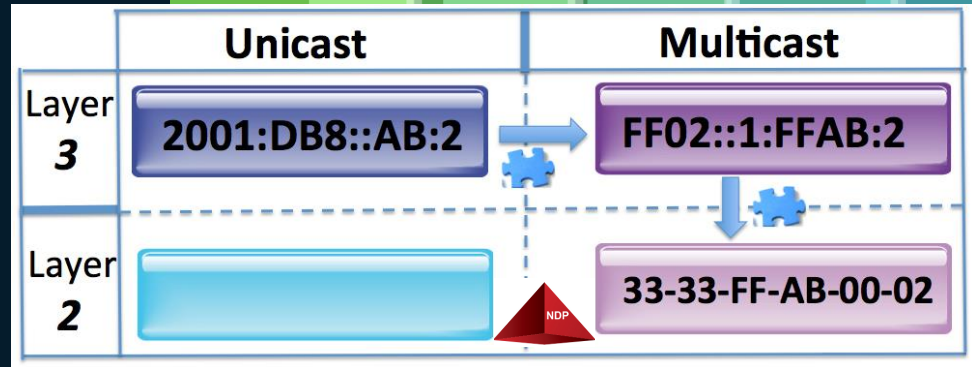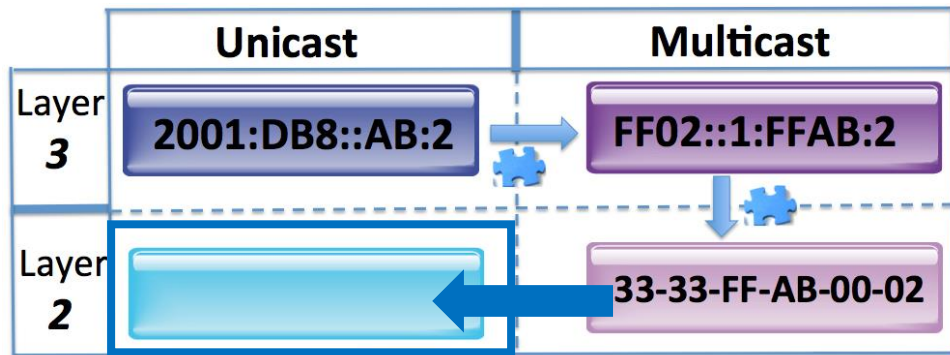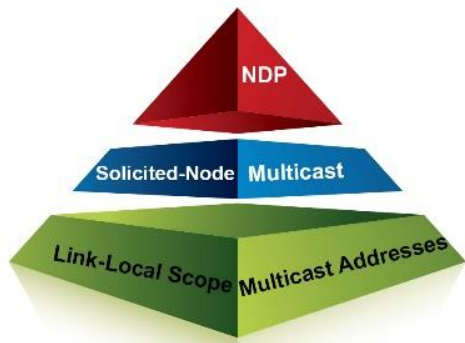
The Final Piece

IPv6 Unicast 2001:db8::AB:2

Solicited Node Multicast: FF02::1:FFAB:2

C464:130a:b000
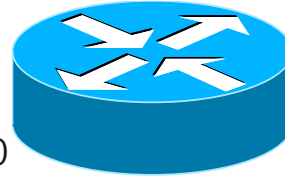
C464.1300:0001

3333.FFAB.0002

Layer 2

	Unicast	Multicast
Layer 3	2001:DB8::AB:2	FF02::1:FFAB:2
Layer 2	c464.130a.b0:00	33-33-FF-AB-00-02
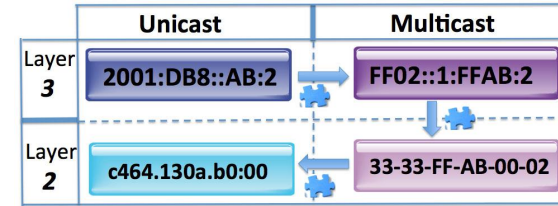
Wire

No.	Source	Destination	Protocol	Length	Info
5	2001:db8::ab:1	ff02::1:ffab:2	ICMPv6	90	Neighbor Solicitation for 2001:db8::ab:2 from c464.130a.a280
6	2001:db8::ab:2	2001:db8::ab:1	ICMPv6	90	Neighbor Advertisement 2001:db8::ab:2 (sol, ovr) is at c464.130a.b000
7	2001:db8::ab:1	2001:db8::ab:2	ICMPv6	118	Echo (ping) request id=0x24ff, seq=0, hop limit=64 (reply in 8)
8	2001:db8::ab:2	2001:db8::ab:1	ICMPv6	118	Echo (ping) reply id=0x24ff, seq=0, hop limit=64 (request in 7)
9	2001:db8::ab:1	2001:db8::ab:2	ICMPv6	118	Echo (ping) request id=0x24ff, seq=1, hop limit=64 (reply in 10)
10	2001:db8::ab:2	2001:db8::ab:1	ICMPv6	118	Echo (ping) id=0x24ff, seq=1, hop limit=64 (request in 9)

The Magic Trick

The Magic Trick


```
int gig1/0/1
ipv6 enable
ipv6 ospf 6 area 0.0.0.0
```

Router A   Gig 1/0/1   Gig 1/0/1   Router B

OOB Mgt
14.14.14.101

OOB Mgt
14.14.14.102

mac: 2037.06cf.67e4   mac: 580a.20eb.91e4
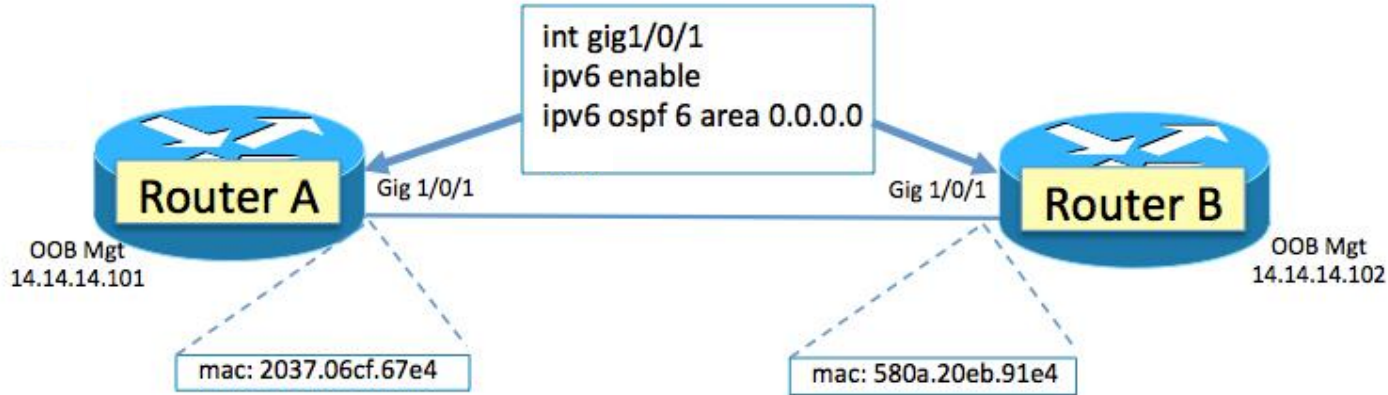
```
RouterA#sh ipv6 ospf neighbor

        OSPFv3 Router with ID (14.14.14.101) (Process ID 6)

Neighbor ID        Pri    State      Dead Time   Interface ID   Interface
14.14.14.102        1    FULL/DR    00:00:38    63             Gig1/0/1
```

RFC1550: Why I Feel it is So Important

Question: WHY use a precious global IP address on a point to point link?

Generation" (IPng). RFC 1550 helped take me back in time to the issues that were at the forefront of people's minds and what the IPng protocol would need to address. I specifically liked one quote in section 5:

> "Any or all of these issues may be addressed, as well as any other topic that the author feels is germane."

How The Magic Trick Works

Router A — Router B

How the Magic Trick Works


```
int gig1/0/1
ipv6 enable
ipv6 ospf 6 area 0.0.0.0
```

Router A — Gig 1/0/1 — Gig 1/0/1 — Router B

OOB Mgt 14.14.14.101

OOB Mgt 14.14.14.102

mac: 2037.06cf.67e4

mac: 580a.20eb.91e4

Source IPs

Destination IPs

FF02::5

FF02::5

FE80::2237:6ff:fecf:67e4

FE80::5a0a:20ff:feeb:91e4

```
12 fe80::5a0a:20ff:feeb:91e4   ff02::5                       OSPF   Hello Packet
15 fe80::2237:6ff:fecf:67e4    ff02::5                       OSPF   Hello Packet
18 fe80::5a0a:20ff:feeb:91e4   fe80::2237:6ff:fecf:67e4      OSPF   Hello Packet
19 fe80::2237:6ff:fecf:67e4    fe80::5a0a:20ff:feeb:91e4     OSPF   Hello Packet
33 fe80::5a0a:20ff:feeb:91e4   ff02::5                       OSPF   Hello Packet
   fe80::2237:6ff:fecf:67e4    ff02::5                       OSPF   Hello Packet
39 fe80::5a0a:20ff:feeb:91e4   ff02::5                       OSPF   Hello Packet
40 fe80::2237:6ff:fecf:67e4    ff02::5                       OSPF   Hello Packet
43 fe80::5a0a:20ff:feeb:91e4   ff02::5                       OSPF   Hello Packet
44 fe80::2237:6ff:fecf:67e4    ff02::5                       OSPF   Hello Packet
49 fe80::5a0a:20ff:feeb:91e4   ff02::5                       OSPF   Hello Packet
50 fe80::2237:6ff:fecf:67e4    ff02::5                       OSPF   Hello Packet
51 fe80::5a0a:20ff:feeb:91e4   fe80::2237:6ff:fecf:67e4      OSPF   DB Description
   fe80::2237:6ff:fecf:67e4    fe80::5a0a:20ff:feeb:91e4     OSPF   DB Description
   fe80::2237:6ff:fecf:67e4    fe80::5a0a:20ff:feeb:91e4     OSPF   DB Description
56 fe80::5a0a:20ff:feeb:91e4   fe80::2237:6ff:fecf:67e4      OSPF   DB Description
57 fe80::2237:6ff:fecf:67e4    fe80::5a0a:20ff:feeb:91e4     OSPF   DB Description
58 fe80::5a0a:20ff:feeb:91e4   fe80::2237:6ff:fecf:67e4      OSPF   DB Description
59 fe80::2237:6ff:fecf:67e4    fe80::5a0a:20ff:feeb:91e4     OSPF   LS Request
```

FF02::5

FE80::2237:6ff:fecf:67e4

FE80::5a0a:20ff:feeb:91e4

How the Magic Trick Works
FF02::5

Exists in IPv4 & IPv6

IPv4	
	Description
	(…ved)
224.0.0.2	All …
224.0.0.3	Unassigned
224.0.0.4	DVMRP Routers
224.0.0.5	OSPFIGP OSPFIGP All Routers
224.0.0.6	OSPFIGP OSPFIGP Designated Routers
224.0.0.7	ST Routers
224.0.0.8	ST Hosts
224.0.0.9	RIP2 Routers
224.0.0.10	IGRP Routers
224.0.0.11	Mobile-Agents
224.0.0.12	DHCP Server / Relay Agent
224.0.0.13	All PIM Routers
224.0.0.14	RSVP-ENCAPSULATION

```
33 fe80::5a0a:20ff:feeb:91e4   ff02::5       OSPF    Hello Packet
34 fe80::2237:6ff:fecf:67e4    ff02::5       OSPF    Hello Packet
39 fe80::5a0a:20ff:feeb:91e4   ff02::5       OSPF    Hello Packet
40 fe80::2237:6ff:fecf:67e4    ff02::5       OSPF    Hello Packet
43 fe80::5a0a:20ff:feeb:91e4   ff02::5       OSPF    Hello Packet
44 fe80::2237:6ff:fecf:67e4    ff02::5       OSPF    Hello Packet
49 fe80::5a0a:20ff:feeb:91e4   ff02::5       OSPF    Hello Packet
```
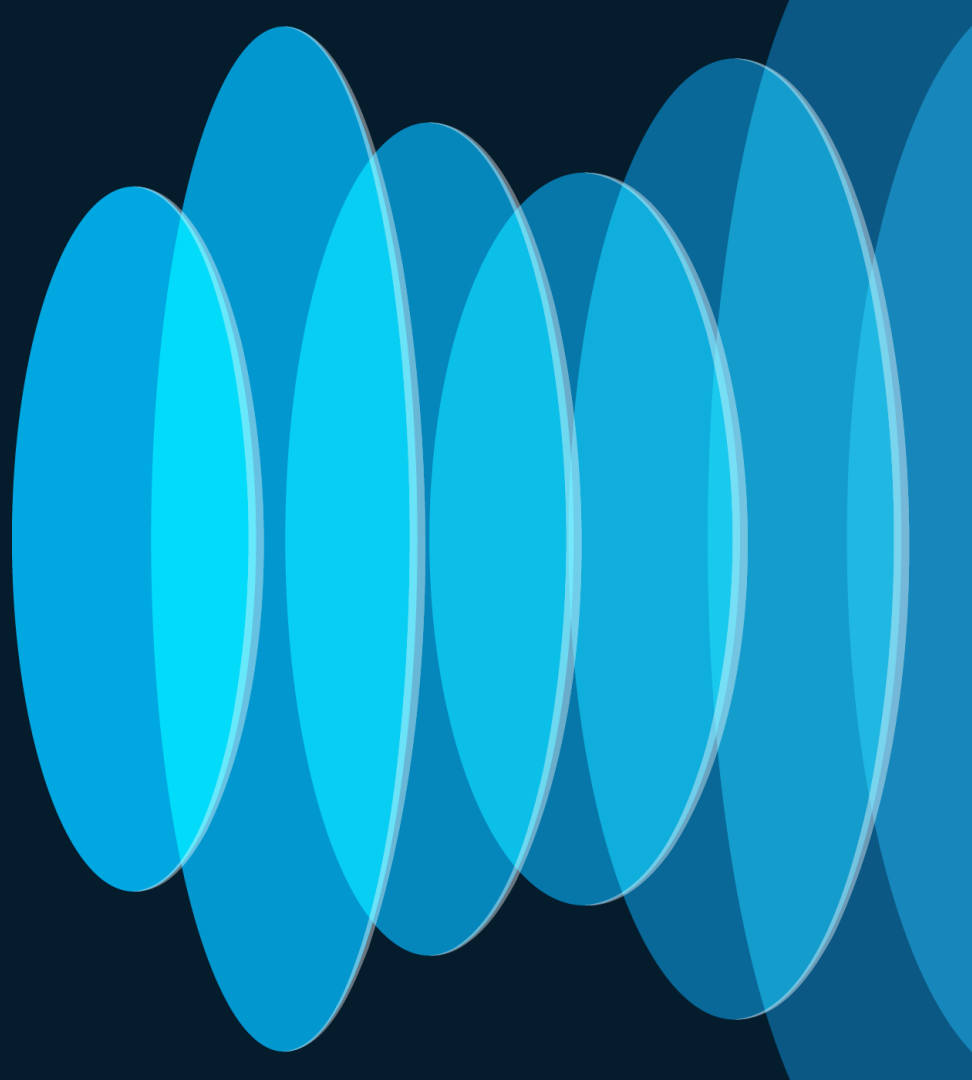
FF02::5

How the Magic Trick Works

IPv6	
Address(s)	**Description**
FF02:0:0:0:0:0:0:1	All Nodes Address
FF02:0:0:0:0:0:0:2	All Routers Address
FF02:0:0:0:0:0:0:3	Unassigned
FF02:0:0:0:0:0:0:4	DVMRP Routers
FF02:0:0:0:0:0:0:5	OSPFIGP
FF02:0:0:0:0:0:0:6	OSPFIGP Designated Routers
FF02:0:0:0:0:0:0:7	ST Routers
FF02:0:0:0:0:0:0:8	ST Hosts
FF02:0:0:0:0:0:0:9	RIP Routers
FF02:0:0:0:0:0:0:A	EIGRP Routers
FF02:0:0:0:0:0:0:B	Mobile-Agents
FF02:0:0:0:0:0:0:C	SSDP
FF02:0:0:0:0:0:0:D	All PIM Routers
FF02:0:0:0:0:0:0:E	RSVP-ENCAPSULATION

RFC4291, Section 2.4

```
2.4.   Address Type Identification

   The type of an IPv6 address is identified by the high-order bits of
   the address, as follows:

      Address type         Binary prefix       IPv6 notation   Section
      ------------         -------------       -------------   -------
      Unspecified          00...0  (128 bits)  ::/128          2.5.2
      Loopback             00...1  (128 bits)  ::1/128         2.5.3
      Multicast            11111111            FF00::/8        2.7
      Link-Local unicast   1111111010          FE80::/10       2.5.6
      Global Unicast       (everything else)
```

How the Magic Trick Works

"Link Local" Multicast Exists in IPv4 & IPv6

IPv6			IPv4	
Address(s)	**Description**		**Address(es)**	**Description**
			224.0.0.0	Base Address (Reserved)
FF02:0:0:0:0:0:0:1	All Nodes Address		224.0.0.1	All Systems on this Subnet
FF02:0:0:0:0:0:0:2	All Routers Address		224.0.0.2	All Routers on this Subnet
FF02:0:0:0:0:0:0:3	Unassigned		224.0.0.3	Unassigned
FF02:0:0:0:0:0:0:4	DVMRP Routers		224.0.0.4	DVMRP Routers
FF02:0:0:0:0:0:0:5	OSPFIGP		224.0.0.5	OSPFIGP OSPFIGP All Routers
FF02:0:0:0:0:0:0:6	OSPFIGP Designated Routers		224.0.0.6	OSPFIGP OSPFIGP Designated Routers
FF02:0:0:0:0:0:0:7	ST Routers		224.0.0.7	ST Routers
FF02:0:0:0:0:0:0:8	ST Hosts		224.0.0.8	ST Hosts
FF02:0:0:0:0:0:0:9	RIP Routers		224.0.0.9	RIP2 Routers
FF02:0:0:0:0:0:0:A	EIGRP Routers		224.0.0.10	IGRP Routers
FF02:0:0:0:0:0:0:B	Mobile-Agents		224.0.0.11	Mobile-Agents
FF02:0:0:0:0:0:0:C	SSDP		224.0.0.12	DHCP Server / Relay Agent
FF02:0:0:0:0:0:0:D	All PIM Routers		224.0.0.13	All PIM Routers
FF02:0:0:0:0:0:0:E	RSVP-ENCAPSULATION		224.0.0.14	RSVP-ENCAPSULATION

- Multicast

- Local: They are local to the wire they are on.

- Common interest:
  If a router wants to participate in EIGRP, it already knows the local multicast address (IPv4/IPv6) to start to listen to and the corresponding MAC address.

- Join:
  "Join" just by just deciding to listen to a local multicast address and then, by extension, to the corresponding MAC address for that multicast IP address.

Link-Local Scope Multicast Address

IPv6 Multicast MAC address range

33-33-00-00-00-00 through
33-33-FF-FF-FF-FF

Multicast IPv6 Address	Ethernet Address	Description
FF02:0:0:0:0:0:0:5		OSPFIGP All Routers
FF02:0:0:0:0:0:0:6		OSPFIGP Designated Routers
FF02:0:0:0:0:0:0:9		RIP2 Routers
FF02:0:0:0:0:0:0:A		EIGRP Routers

Dest IP	Dest MAC
fe80::2	
ff02::6	
ff02::5	
fe80::2	
ff02::6	
ff02::5	

"The low 32 bits of an Ethernet address for IPv6 multicast traffic are the low 32 bits of the multicast IPv6 address used.
For example, IPv6 multicast traffic using the address *ff02::d* uses the MAC address *33-33-00-00-00-0D,* and traffic to *ff05::1:3* goes to the MAC address *33-33-00-01-00-03*."

– https://en.wikipedia.org/wiki/Multicast_address

Picking Things Up Off the Wire

IPv6 Unicast 2001:db8:10:::2

IPv6 Multicast: FF02::5

C464:1300:001

☑ *Unicast MAC*

☑ Multicast MAC

Layer 2

C464.1300:0001

3333.0000.0005

Wire

Traffic
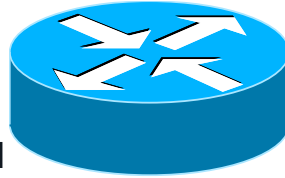
Multicast IPv6 Address	Ethernet Address	Description
FF02:0:0:0:0:0:0:5	33:33:00:00:00:05	OSPFIGP All Routers
FF02:0:0:0:0:0:0:6	33:33:00:00:00:06	OSPFIGP Designated Routers
FF02:0:0:0:0:0:0:9	33:33:00:00:00:09	RIP2 Routers
FF02:0:0:0:0:0:0:A	33:33:00:00:00:0A	EIGRP Routers

Link-Local **Multicast**

	IPv6 Layer 3 Address	Multicast	Layer 2 Multicast MAC	Local Link
FF02::5	✓	✓		✓
33:33:00:00:00:05			✓	✓

FE80::2237:6ff:fecf:67e4

FE80::5a0a:20ff:feeb:91e4

Router A   Router B

How the Magic Trick Works

```
int gig1/0/1
ipv6 enable
ipv6 ospf 6 area 0.0.0.0
```

Router A   **Router B**

Gig 1/0/1   Gig 1/0/1

OOB Mgt   OOB Mgt
14.14.14.101   14.14.14.102

FE80::2237:6ff:fecf:67e4   *FE80::5a0a:20ff:feeb:91e4*

mac: 2037.06cf.67e4   mac: 580a.20eb.91e4

50	fe80::2237:6ff:fecf:67e4	ff02::5	OSPF	Hello Packet
51	fe80::5a0a:20ff:feeb:91e4	fe80::2237:6ff:fecf:67e4	OSPF	DB Description
52	fe80::2237:6ff:fecf:67e4	fe80::5a0a:20ff:feeb:91e4	OSPF	DB Description
55	fe80::2237:6ff:fecf:67e4	fe80::5a0a:20ff:feeb:91e4	OSPF	DB Description
56	fe80::5a0a:20ff:feeb:91e4	fe80::2237:6ff:fecf:67e4	OSPF	DB Description
57	fe80::2237:6ff:fecf:67e4	fe80::5a0a:20ff:feeb:91e4	OSPF	DB Description
58	fe80::5a0a:20ff:feeb:91e4	fe80::2237:6ff:fecf:67e4	OSPF	DB Description
59	fe80::2237:6ff:fecf:67e4	fe80::5a0a:20ff:feeb:91e4	OSPF	LS Request

How the Magic Trick Works

FE80::

Router A

Router B

mac: **20**37.06cf.67e4
IPv6 Link-Local:
FE80::**22**37:06FF:FE**CF:67E4**

mac: **58**0a.20eb.91e4
IPv6 Link-Local:
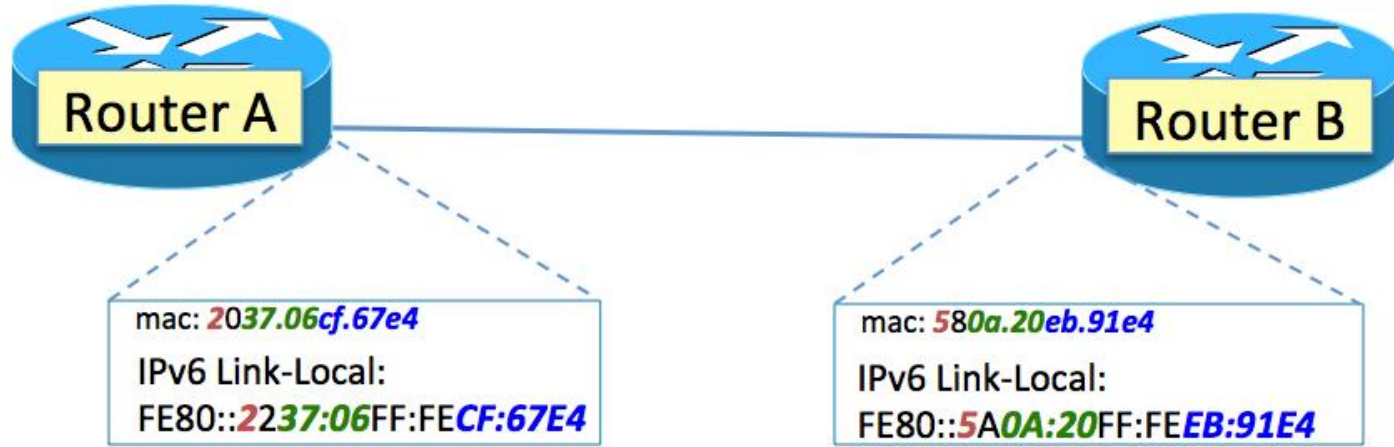FE80::**5A0A:20**FF:FE**EB:91E4**

51	fe80::5a0a:20ff:feeb:91e4	fe80::2237:6ff:fecf:67e4	OSPF	DB Description
52	fe80::2237:6ff:fecf:67e4	fe80::5a0a:20ff:feeb:91e4	OSPF	DB Description
55	fe80::2237:6ff:fecf:67e4	fe80::5a0a:20ff:feeb:91e4	OSPF	DB Description
56	fe80::5a0a:20ff:feeb:91e4	fe80::2237:6ff:fecf:67e4	OSPF	DB Description
57	fe80::2237:6ff:fecf:67e4	fe80::5a0a:20ff:feeb:91e4	OSPF	DB Description
58	fe80::5a0a:20ff:feeb:91e4	fe80::2237:6ff:fecf:67e4	OSPF	DB Description
59	fe80::2237:6ff:fecf:67e4	fe80::5a0a:20ff:feeb:91e4	OSPF	LS Request

How the Magic Trick Works

FE80::

FE80::2237:6ff:fecf:67e4

FE80::5a0a:20ff:feeb:91e4

→

FE80::

"Link-Local" Unicast

RFC4291, Section 2.4

2.4. Address Type Identification

The type of an IPv6 address is identified by the high-order bits of
the address, as follows:

Address type	Binary prefix	IPv6 notation	Section
Unspecified	00...0 (128 bits)	::/128	2.5.2
Loopback	00...1 (128 bits)	::1/128	2.5.3
Multicast	11111111	FF00::/8	2.7
Link-Local unicast	1111111010	FE80::/10	2.5.6
Global Unicast	(everything else)		

How the Magic Trick Works

FE80::

A host is __REQUIRED__ to have
a link-local address for each interface

RFC4291, Section 2.4

FE80::2237:6ff:fecf:67e4

FE80::5a0a:20ff:feeb:91e4

2.8. A Node's Required Addresses

A host is required to recognize the following addresses as
identifying itself:

o Its required Link-Local address for each interface.

How the Magic Trick Works

A host is *required* to *have and recognize* its *link local unicast* address

int gig1/0/1
ipv6 enable
ipv6 ospf 6 area 0.0.0.0

Router A

Gig 1/0/1

OOB Mgt
14.14.14.101

mac: 2037.06cf.67e4

FE80::2237:6ff:fecf:67e4

Router B

Gig 1/0/1

OOB Mgt
14.14.14.102

mac: 580a.20eb.91e4

FE80::5a0a:20ff:feeb:91e4
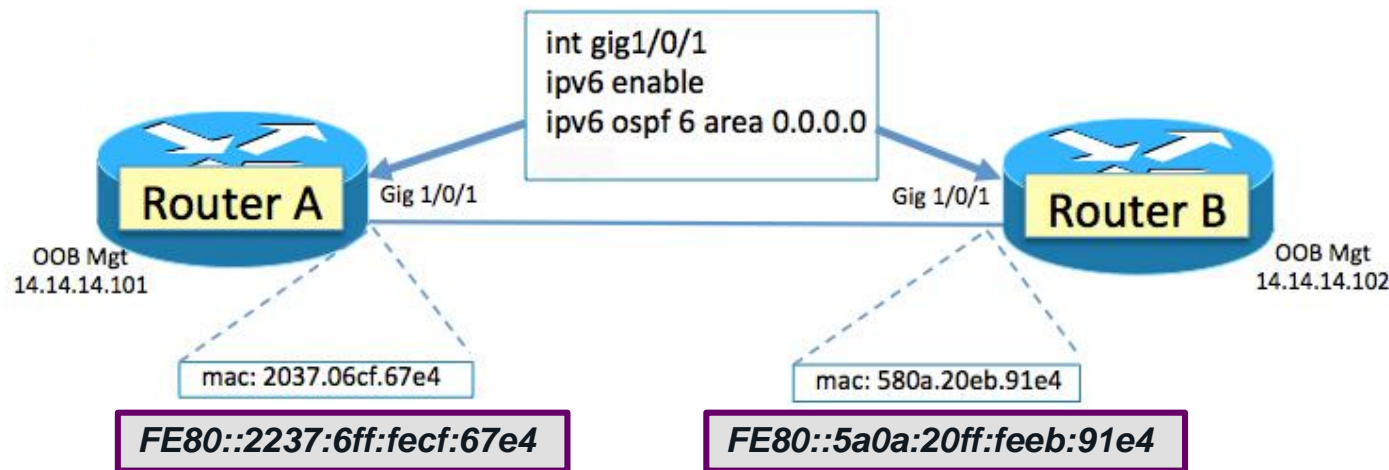
Link-Local __Unicast__ Address

	IPv6 Layer 3 Address	Multicast	Unicast	Local Link
FE80::5a0a:20ff:feeb:91e4	✓		✓	✓
FE80::2237:6ff:fecf:67e4	✓		✓	✓

How the Magic Trick Works

✓ *FF02::5*

✓ *FE80::*

```
int gig1/0/1
ipv6 enable
ipv6 ospf 6 area 0.0.0.0
```

Router A — Gig 1/0/1 ... Gig 1/0/1 — Router B

OOB Mgt
14.14.14.101

OOB Mgt
14.14.14.102

mac: 2037.06cf.67e4

mac: 580a.20eb.91e4
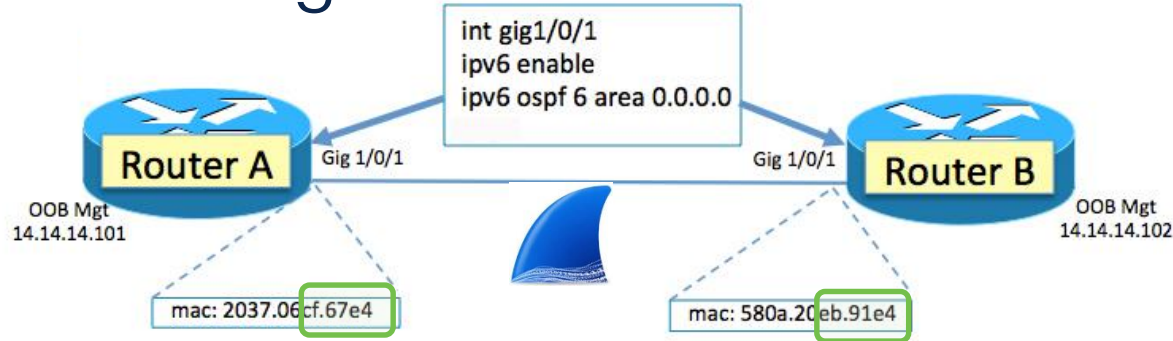
Source IPs   *Destination IPs*

```
12 fe80::5a0a:20ff:feeb:91e4   ff02::5            OSPF   Hello Packet
15 fe80::2237:6ff:fecf:67e4    ff02::5            OSPF   Hello Packet
18 fe80::5a0a:20ff:feeb:91e4   fe80::2237:6ff:fecf:67e4   OSPF   Hello Packet
19 fe80::2237:6ff:fecf:67e4    fe80::5a0a:20ff:feeb:91e4  OSPF   Hello Packet
33 fe80::5a0a:20ff:feeb:91e4   ff02::5            OSPF   Hello Packet
   fecf:67e4                   ff02::5            OSPF   Hello Packet
   fe80::5a0a:20ff:feeb:91e4   ff02::5            OSPF   Hello Packet
40 fe80::2237:6ff:fecf:67e4    ff02::5            OSPF   Hello Packet
43 fe80::5a0a:20ff:feeb:91e4   ff02::5            OSPF   Hello Packet
44 fe80::2237:6ff:fecf:67e4    ff02::5            OSPF   Hello Packet
49 fe80::5a0a:20ff:feeb:91e4   ff02::5            OSPF   Hello Packet
50 fe80::2237:6ff:fecf:67e4    ff02::5            OSPF   Hello Packet
51 fe80::5a0a:20ff:feeb:91e4   fe80::2237:6ff:fecf:67e4   OSPF   DB Description
   fecf:67e4                   fe80::5a0a:20ff:feeb:91e4  OSPF   DB Description
   fecf:67e4                   fe80::5a0a:20ff:feeb:91e4  OSPF   DB Description
56 fe80::5a0a:20ff:feeb:91e4   fe80::2237:6ff:fecf:67e4   OSPF   DB Description
57 fe80::2237:6ff:fecf:67e4    fe80::5a0a:20ff:feeb:91e4  OSPF   DB Description
58 fe80::5a0a:20ff:feeb:91e4   fe80::2237:6ff:fecf:67e4   OSPF   DB Description
59 fe80::2237:6ff:fecf:67e4    fe80::5a0a:20ff:feeb:91e4  OSPF   LS Request
```
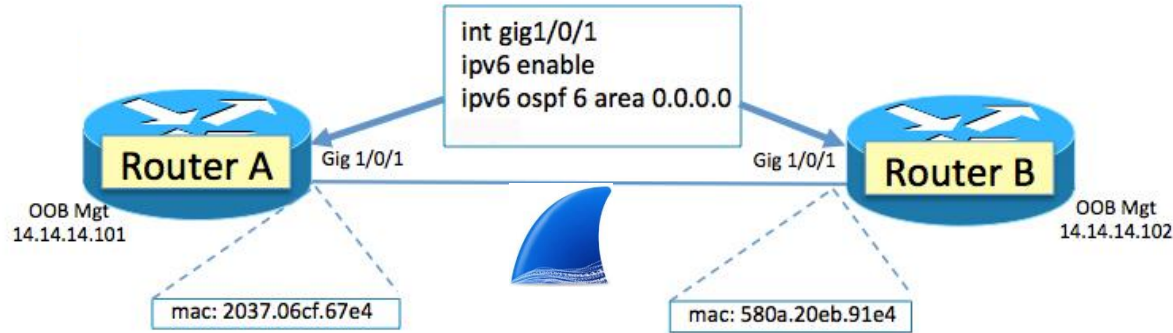
FF02::5

FF02::5

FF02::5

FE80::2237:6ff:fecf:67e4

FE80::5a0a:20ff:feeb:91e4

FE80::2237:6ff:fecf:67e4

FE80::5a0a:20ff:feeb:91e4

Link Local Addresss

int gig1/0/1
ipv6 enable
ipv6 ospf 6 area 0.0.0.0

Router A   Gig 1/0/1   Gig 1/0/1   Router B

OOB Mgt   OOB Mgt
14.14.14.101   14.14.14.102

mac: 2037.06cf.67e4   mac: 580a.20eb.91e4

Source IPs   *Destination IPs*

| No.	^	Source IP	Dest IP	Protocol	Info
1		fe80::ab:1	ff02::5	OSPF	Hello Packet
2		fe80::ab:1	ff02::5	OSPF	Hello Packet
4		fe80::ab:1	ff02::5	OSPF	Hello Packet
5		fe80::ab:2	ff02::5	OSPF	Hello Packet
8		fe80::ab:1	fe80::ab:2	OSPF	Hello Packet
11		fe80::ab:1	ff02::5	OSPF	Hello Packet
12		fe80::ab:2	fe80::ab:1	OSPF	DB Description
13		fe80::ab:1	fe80::ab:2	OSPF	DB Description
14		fe80::ab:2	fe80::ab:1	OSPF	DB Description
15		fe80::ab:1	fe80::ab:2	OSPF	DB Description
16		fe80::ab:1	fe80::ab:2	OSPF	LS Request

Continue YOUR IPv6 Journey
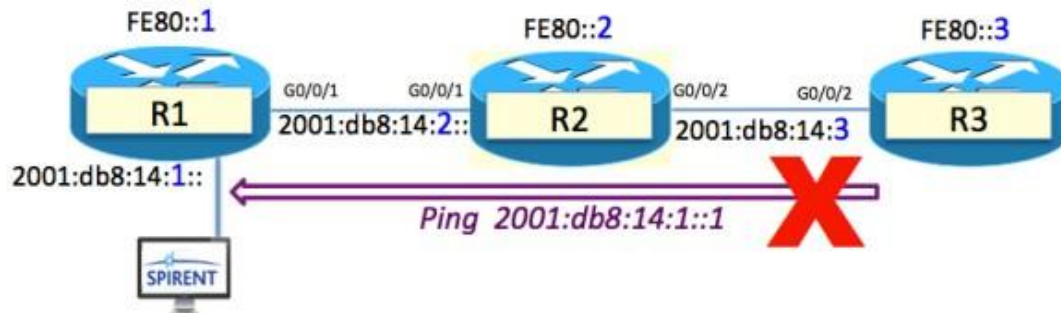
7-part IPv6 Blog Series

- Part 1 of 7: Understanding IPv6: The Journey Begins

- Part 2 of 7: Understanding IPv6: Link-Local 'Magic'

- Part 3 of 7: Understanding IPv6: A Sniffer Full Of 3s

- Part 4 of 7: Understanding IPv6: What Is Solicited-Node Multicast

- Part 5 of 7: Understanding IPv6: Prepping For Solicited-Node Multicast

- Part 6 of 7: Understanding IPv6: The Ping Before Solicited-Node Multicast

- Part 7 of 7: Understanding IPv6: Solicited-Node Multicast In Action

https://www.networkingwithfish.com/understanding-ipv6-7-part-series/
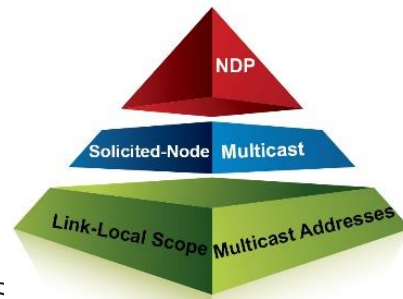
2 Part IPv6 Networking Detection Fun

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