The bridge to possible

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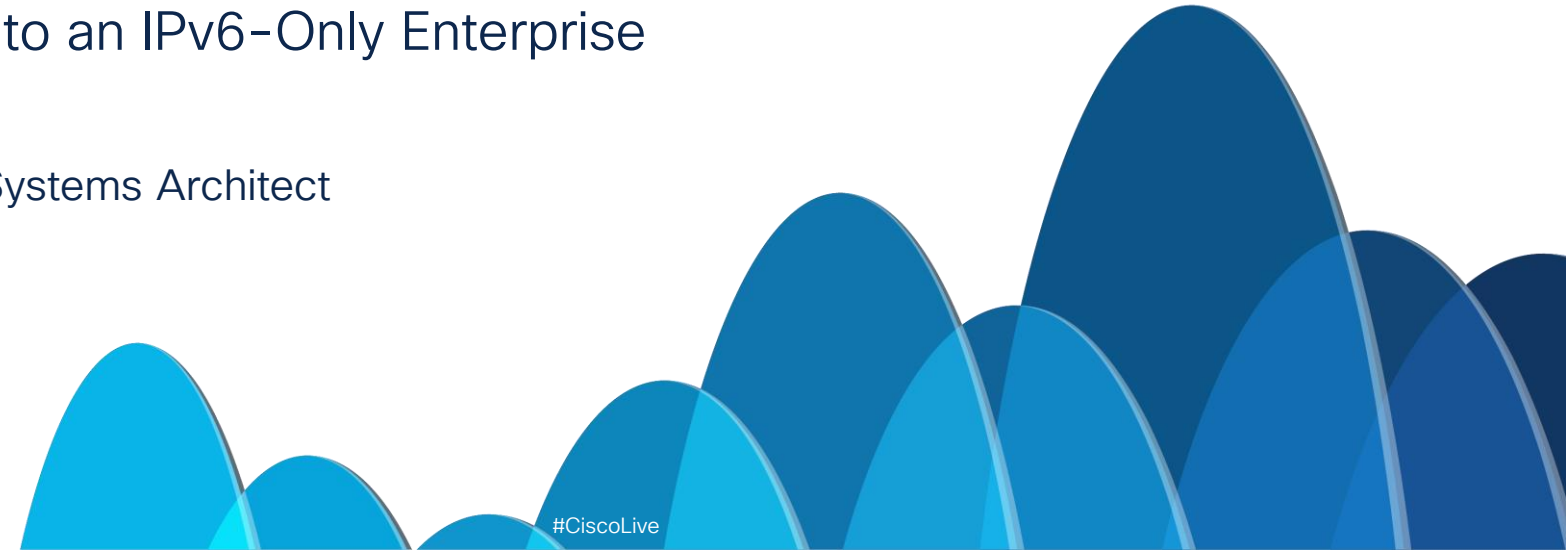
Goodbye Legacy,

the move to an IPv6-Only Enterprise

David Prall Systems Architect
@pralldc

BRKENT-2008



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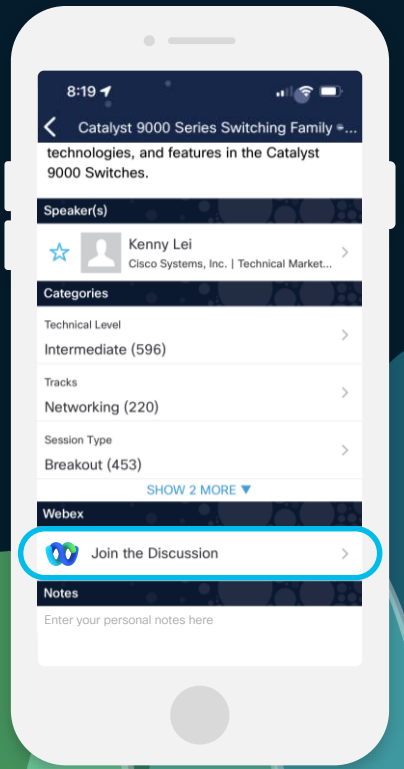
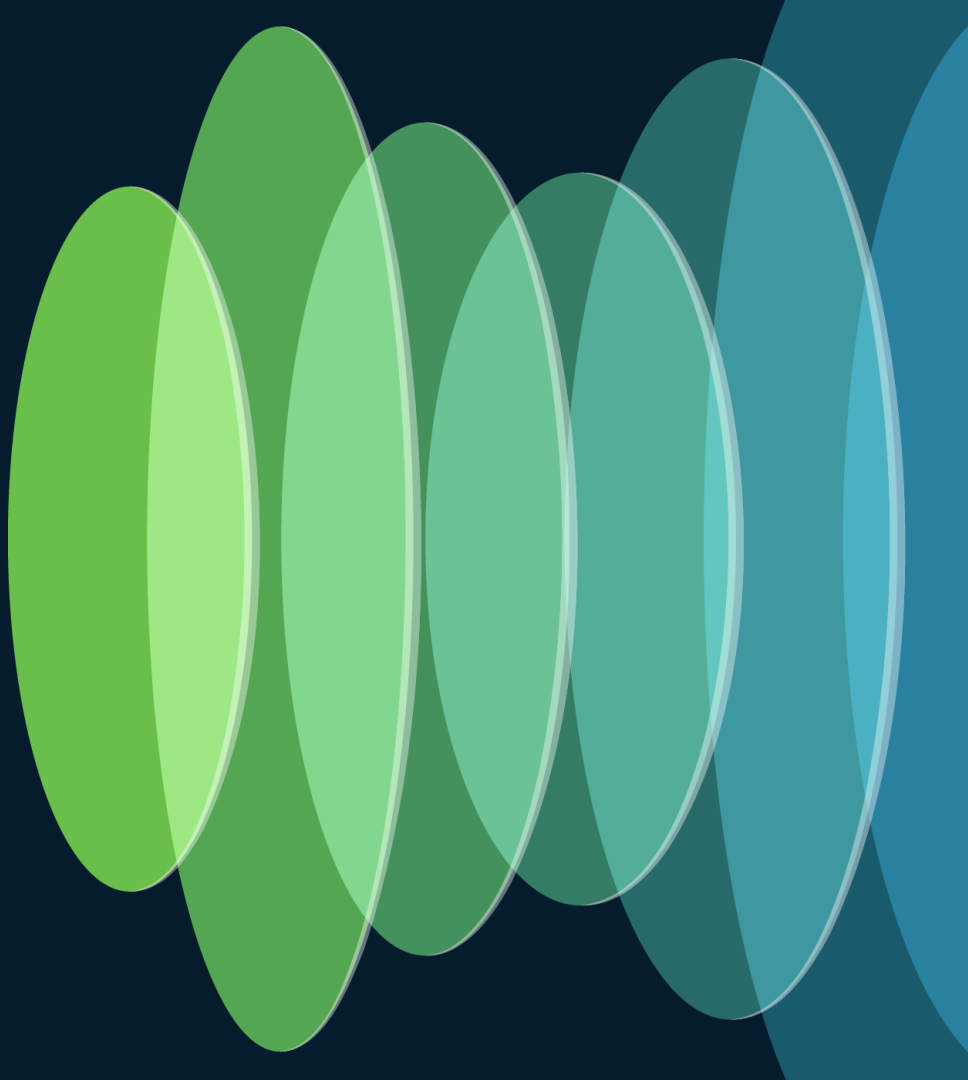


Agenda

- Introduction
- Our Dual Stacked Network
- IPv4 vs IPv6
- NAT64/DNS64
- IPv6-Only
- Conclusion
- Additional Learning

Introduction



Your speaker

- David Prall
- Solutions Engineer
- US Federal Area Defense
- dprall@cisco.com
- CCIE 6508 (R&S/SP/Security)
- 23 Years at Cisco
- Washington, DC
- Working with Dual-Stacked networks since September 2007

Abstract

- This session is for those who currently have IPv6 deployed in a dual-stack environment and are looking to transition from dual stack, to IPv6-mostly, and on to IPv6-only.
- Just as we've said goodbye to legacy protocols IPX/SPX, DECnet, AppleTalk, and others, it is now time to say goodbye to IPv4.
- We will focus on the move from dual-stacked IPv4 and IPv6 enterprise infrastructure to an IPv6-only infrastructure.
- What do we need to know before we make the move?
- What about IPv4-only enclaves?
- We will look at NetFlow as the picture of truth and NAT64/DNS64 as the transition gateway(s).

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Your IPv6 Journey

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Systems deployed in your Enterprise?

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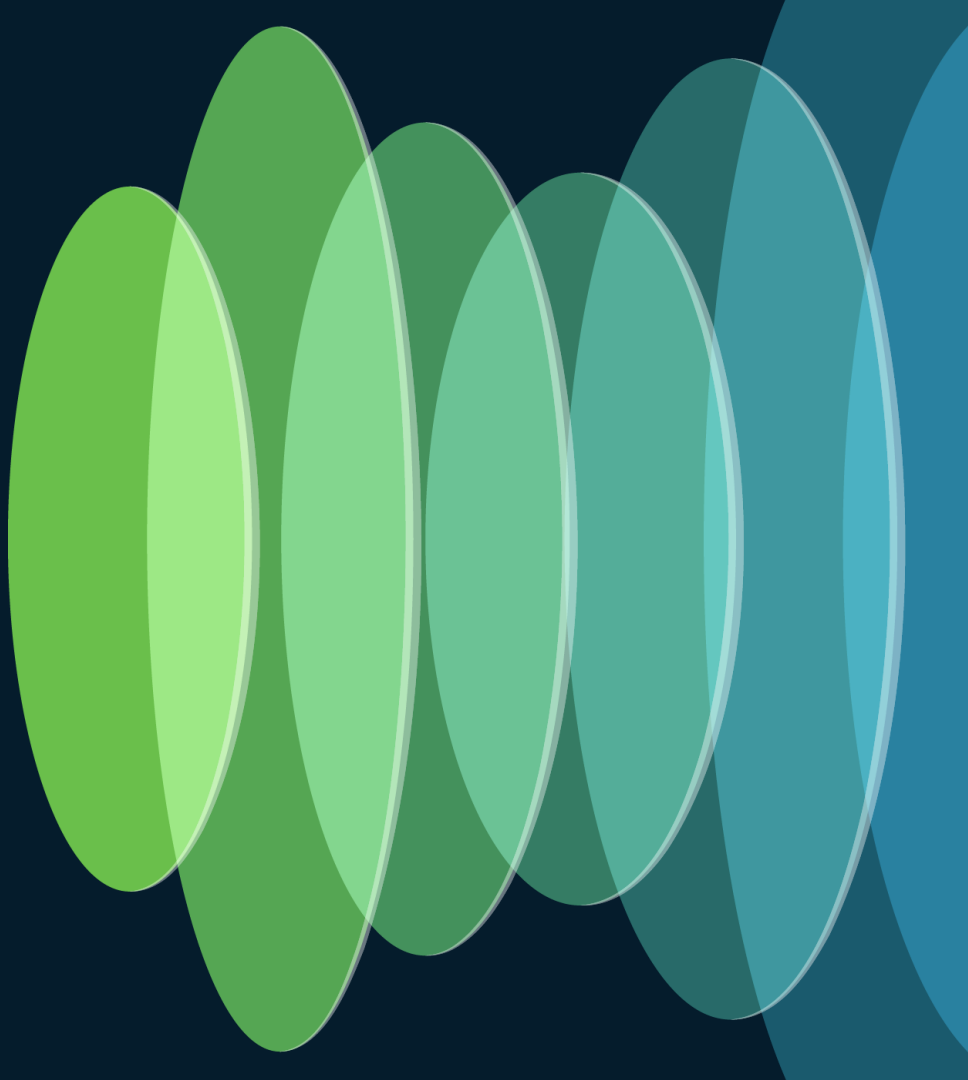
IPv6-Only is the Future

- RFC 1883 – December 1995
  - Updated RFC 8200 (STD86) – July 2017
- US Government Memorandum M-21-07 Completing the Transition to Internet Protocol Version 6 (IPv6) – November 2020
  - September 2025 for 80% IPv6-only completion
  - US Government Memorandum M-05-22, Transition Planning for Internet Protocol Version 6 (IPv6) – August 2005
  - Transition to IPv6 – September 2010
- Germany (2030), China (2030), India (2022 DS), Brazil (2024 DS), The Netherlands (2024 DS), Czech Republic (2032), Vietnam (2024 DS), Botswana (2030), and others have released dates for IPv6-only completion

Our Dual Stacked Network



Our Dual Stacked Network

- IPv4 and IPv6 are both available
- Address Selection
- Happy Eyeballs RFC 8305 – Users are happy
- How did my Web Browser Connect
- SNMP
- NetFlow/IPFIX shows us what is being utilized
- IPv6 is Faster

IPv4 and IPv6 are both available for use

```
C:\>ipconfig
Windows IP Configuration

Ethernet adapter Ethernet0:

   Connection-specific DNS Suffix  . :
   IPv6 Address. . . . . . . . . . . : 2001:db8:8000:103::190
   Link-local IPv6 Address . . . . . : fe80::12a8:6d5:b492:dd26%12
   IPv4 Address. . . . . . . . . . . : 192.168.124.190
   Subnet Mask . . . . . . . . . . . : 255.255.255.192
   Default Gateway . . . . . . . . . : 2001:db8:8000:103::1
                                       fe80::272:78ff:fe55:15d%12
                                       192.168.124.129
```

```
$ ifconfig en0
en0: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
options=400<CHANNEL_IO>
ether 88:66:5a:4b:a2:38
inet6 fe80::c5:d6d9:3a53:5bb3%en0 prefixlen 64 secured scopeid 0x6
inet 192.168.141.108 netmask 0xfffffe00 broadcast 192.168.141.255
inet6 2001:db8:8000:140:58d:6787:27f2:9aab prefixlen 64 dynamic
nd6 options=201<PERFORMNUD,DAD>
media: autoselect
status: active
```

Address Selection

- RFC 6724 Default Address Selection for IPv6
  - RFC 6724bis current work in 6MAN
  - Address Selection Test https://rfc6724.vyncke.org/
- Globally Unique Addresses (GUA) are the only option
- Unique Local Addresses (ULA) are of limited use
  - Not the same as RFC1918
  - There is no NATv6 (?)
  - NPTv6 as defined changes only the prefix
  - As of RFC 6724 IPv4 is preferred over IPv6 ULA
    - Unless IPv6 ULA to IPv6 ULA

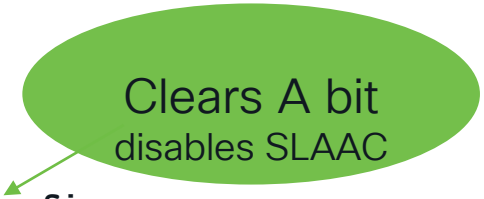
Happy Eyeballs RFC6555/8305

- On a dual-stacked system give IPv6 the edge but start an IPv4 session and see which is fastest.
- Before Happy Eyeballs dual-stacked systems would start an IPv6 session and if it didn't work after several attempts. Possibly fallback to IPv4.
- Typically, only needed today when a site is advertising an IPv6 AAAA but not functioning. Or when Cogent (AS174) and Hurricane Electric (AS6939) are involved.

Are you sure both are available?

- Android doesn't support DHCPv6

```
show running interface vlan 150
<snip>
 ipv6 nd prefix default 2592000 604800 no-autoconfig
 ipv6 nd managed-config-flag
 ipv6 dhcp relay destination 2001:DB8::547
<snip>
```

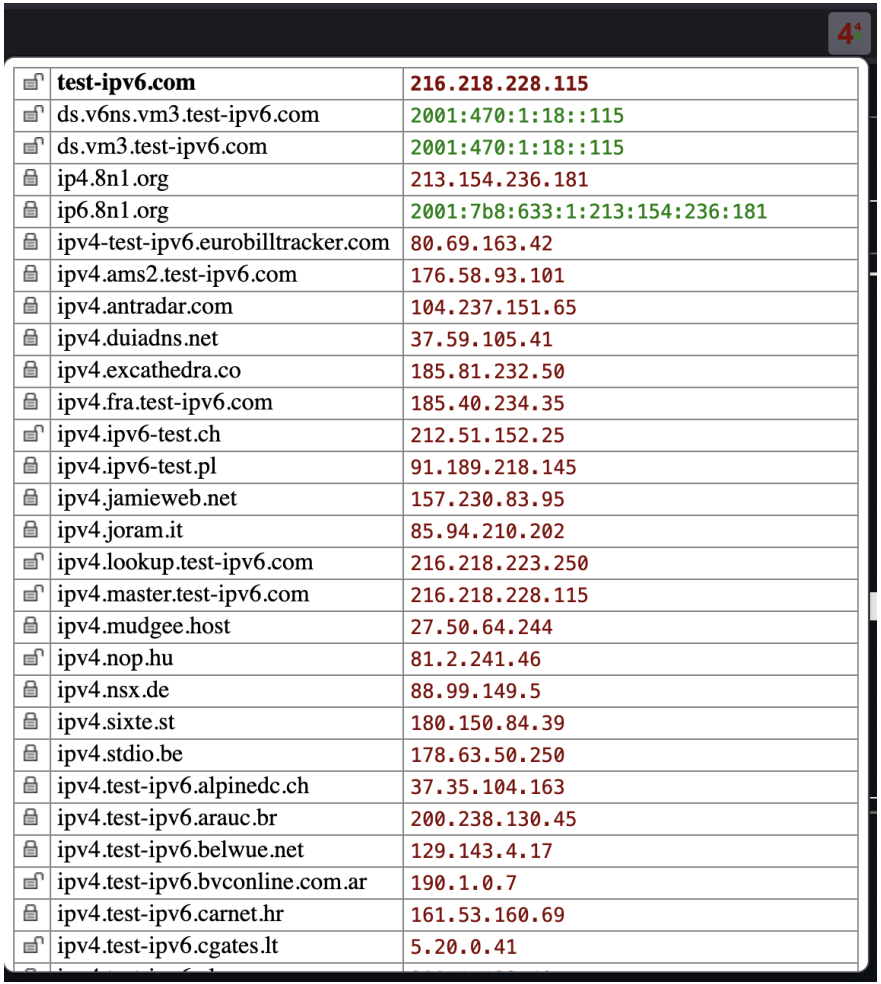


- For Android we must leave SLAAC enabled and provide DNS

```
config terminal
interface vlan 150
 no ipv6 nd prefix default
 ipv6 nd ra dns-search-list domain example.com
 ipv6 nd ra dns server 2001:DB8:53::111
 ipv6 nd ra dns server 2001:DB8:53::112
end
```

How did my Web Browser Connect?

- IPvFoo
  - Extension for Firefox and Chrome
  - Can be added to Edge enabling “Allow extensions from other stores.”



test-ipv6.com	**216.218.228.115**
ds.v6ns.vm3.test-ipv6.com	2001:470:1:18::115
ds.vm3.test-ipv6.com	2001:470:1:18::115
ip4.8n1.org	213.154.236.181
ip6.8n1.org	2001:7b8:633:1:213:154:236:181
ipv4-test-ipv6.eurobilltracker.com	80.69.163.42
ipv4.ams2.test-ipv6.com	176.58.93.101
ipv4.antradar.com	104.237.151.65
ipv4.duiadns.net	37.59.105.41
ipv4.excathedra.co	185.81.232.50
ipv4.fra.test-ipv6.com	185.40.234.35
ipv4.ipv6-test.ch	212.51.152.25
ipv4.ipv6-test.pl	91.189.218.145
ipv4.jamieweb.net	157.230.83.95
ipv4.joram.it	85.94.210.202
ipv4.lookup.test-ipv6.com	216.218.223.250
ipv4.master.test-ipv6.com	216.218.228.115
ipv4.mudgee.host	27.50.64.244
ipv4.nop.hu	81.2.241.46
ipv4.nsx.de	88.99.149.5
ipv4.sixte.st	180.150.84.39
ipv4.stdio.be	178.63.50.250
ipv4.test-ipv6.alpinedc.ch	37.35.104.163
ipv4.test-ipv6.arauc.br	200.238.130.45
ipv4.test-ipv6.belwue.net	129.143.4.17
ipv4.test-ipv6.bvconline.com.ar	190.1.0.7
ipv4.test-ipv6.carnet.hr	161.53.160.69
ipv4.test-ipv6.cgates.lt	5.20.0.41

SNMP

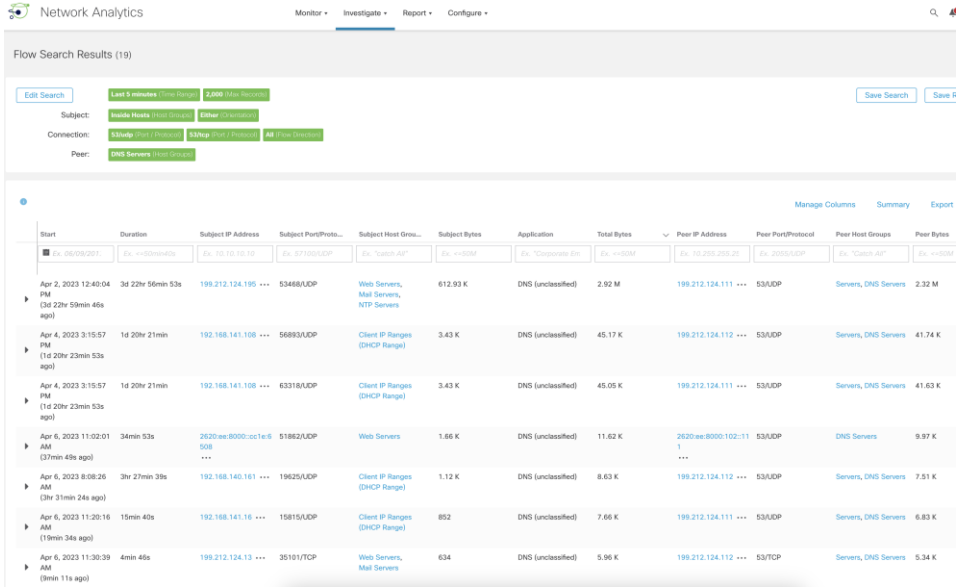
- SNMP is traditionally used to monitor Throughput on an Interface, %CPU, number of Routes.
- It can be used to specifically monitor IPv4 or IPv6

```
#snmpwalk .1.3.6.1.2.1.4.31.3.1
IP-MIB::ipIfStatsHCInOctets.ipv4.<ifindex>
.1.3.6.1.2.1.4.31.3.1.6.1.<ifindex>
IP-MIB::ipIfStatsHCInOctets.ipv6.<ifindex>
.1.3.6.1.2.1.4.31.3.1.6.2.<ifindex>
IP-MIB::ipIfStatsHCOutOctets.ipv4.<ifindex>
.1.3.6.1.2.1.4.31.3.1.33.1.<ifindex>
IP-MIB::ipIfStatsHCOutOctets.ipv6.<ifindex>
.1.3.6.1.2.1.4.31.3.1.33.2.<ifindex>
```

[SNMP Object Navigator]

NetFlow/IPFIX shows us what is being utilized

- NetFlow v9 / IPFIX (RFC 7011/STD 77) allows the network operator to see what is flowing on the network.
  - Secure Network Analytics / StealthWatch
  - DNA Center Assurance
  - Other Third Party
- What is using IPv4 still?
  - Internal or External?
- Why is it using IPv4 still?
  - Focus on Internal



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How are you monitoring IPv6 usage?

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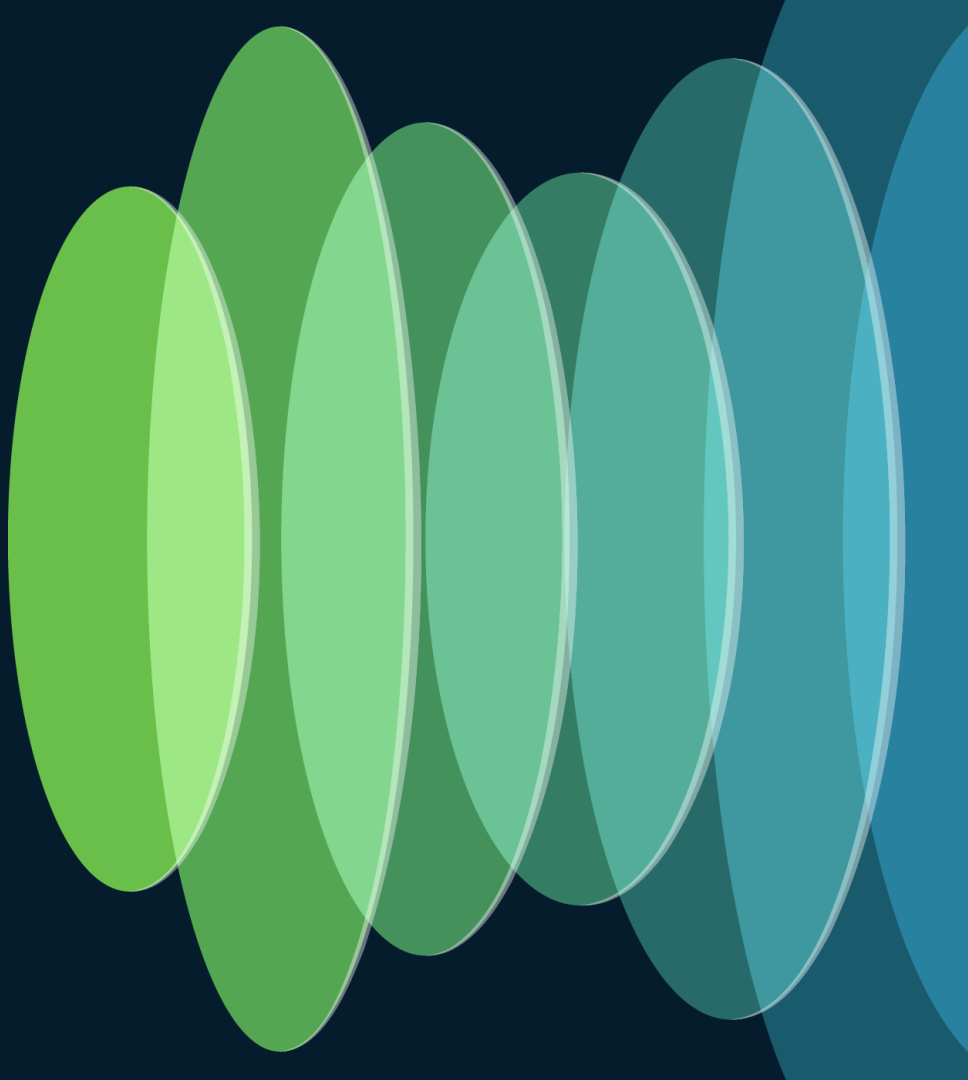
IPv6 is Faster?

- Google shows current latency impact for IPv6 from 0.00% in low deployment to -20ms / -0.09% in high deployment countries https://www.google.com/intl/en/ipv6/statistics.html#tab=per-country-ipv6-adoption
- Why is IPv6 Faster? I don't know. So let's look at some measurements.
- "We've observed that accessing Facebook can be 10-15 percent faster over IPv6. We believe other developers will see similar advantages from migrating." IPv6: It's time to get on board
- "Akamai's customer AbemaTV did a case study in 2019, which showed that IPv6 improved the throughput by 38% on average when compared with connections via IPv4." 10 Years Since World IPv6 Launch

NAT64/DNS64

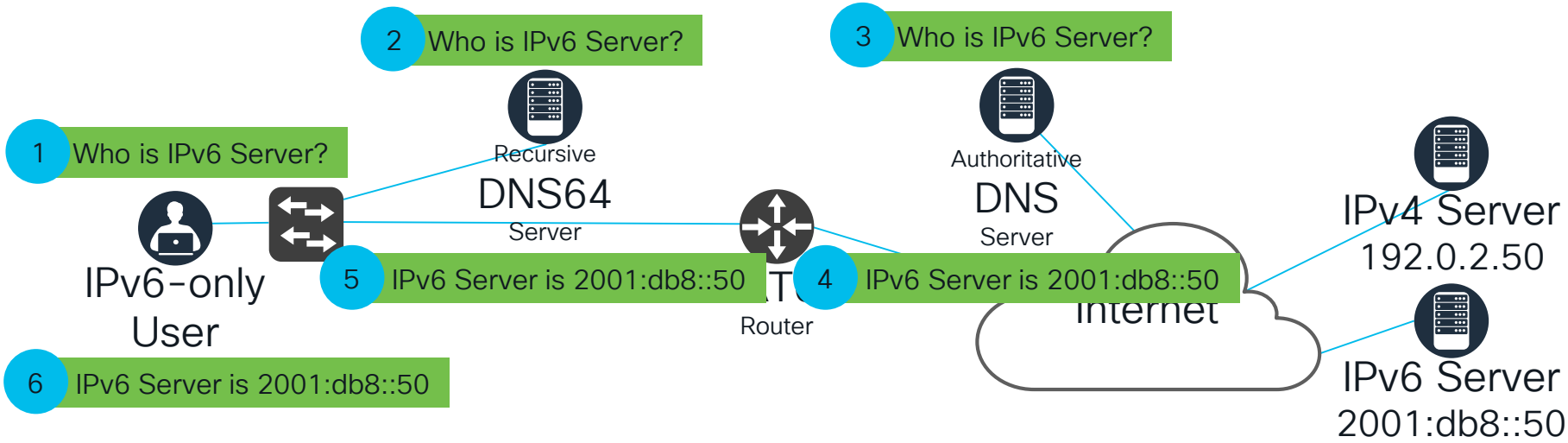


For Your Reference

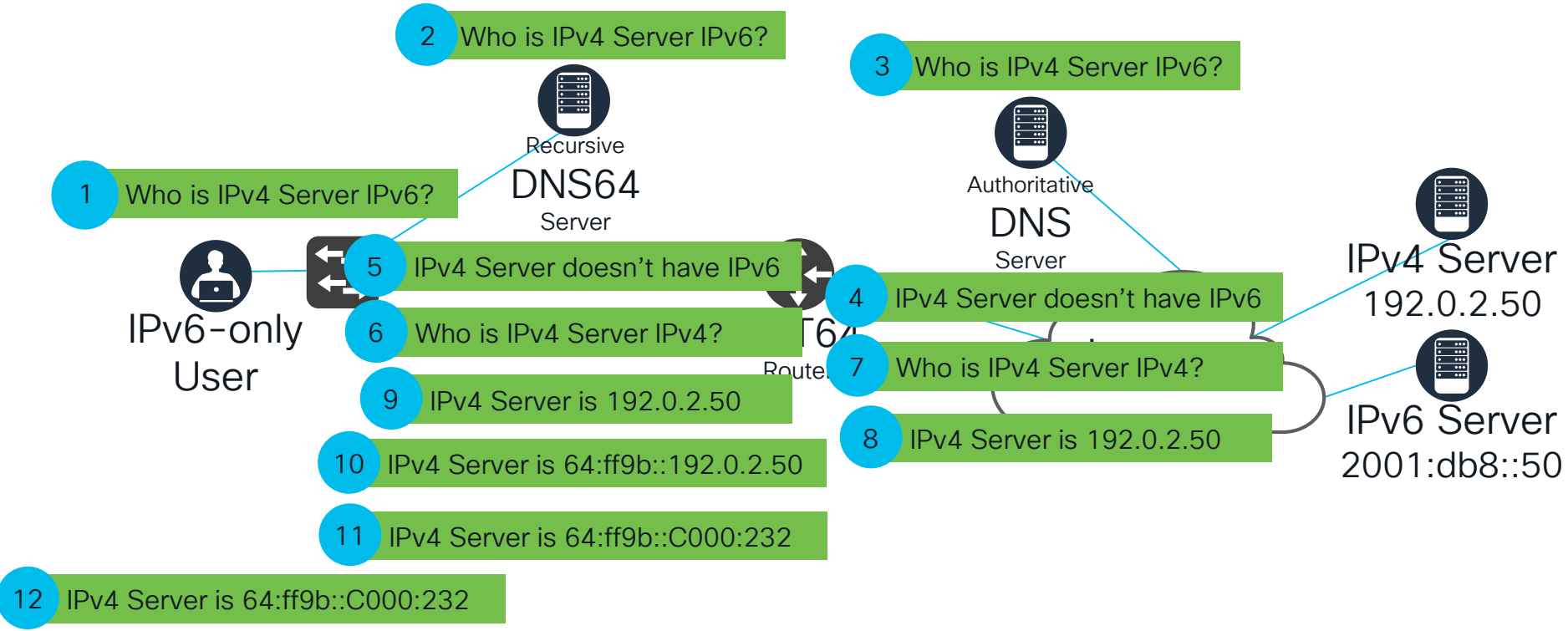
NAT64/DNS64

- RFC 6052 IPv6 Addressing of IPv4/IPv6 Translators
  - Well-Known Prefix for NAT64 – 64:ff9b::/96
- RFC 6144 Framework for IPv4/IPv6 Translation
- RFC 6145/7915 Stateless IP/ICMP Translation Algorithm
- RFC 6146 Stateful NAT64: Network Address and Protocol Translation from IPv6 Clients to IPv4 Servers
- RFC 6147 DNS64: DNS Extensions for Network Address Translation from IPv6 Clients to IPv4 Servers

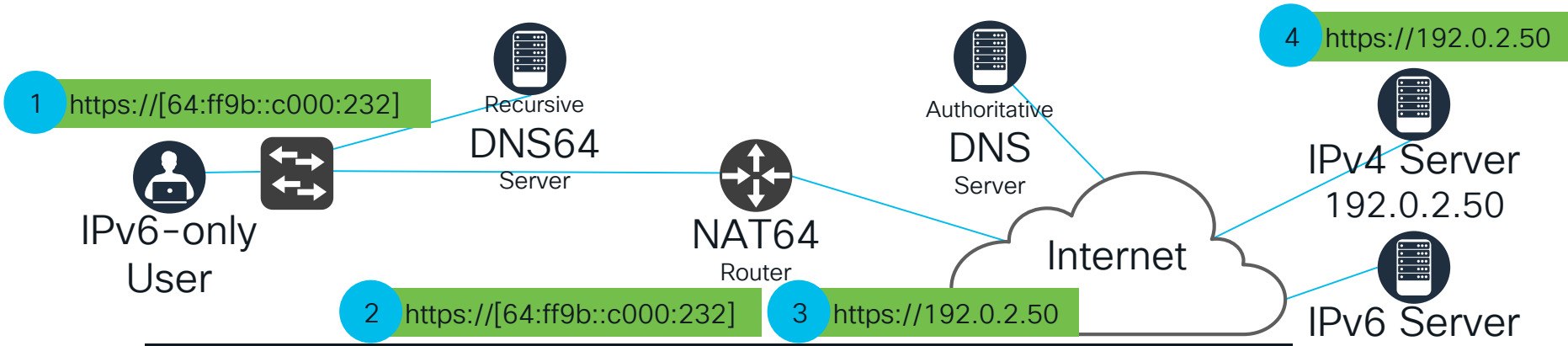
IPv6 AAAA DNS Request



IPv6 AAAA DNS64 Request



NAT64 Traffic Flow




```
cat8k-nat64#sh nat64 translations

Proto  Original IPv4          Translated IPv4
       Translated IPv6        Original IPv6
------------------------------------------------------------------------------
-

tcp    192.0.2.50:443         [64:ff9b::c000:232]:443
       192.0.2.252:52362      [2001:db8:8000:150::2]:52362
```

IOS-XE Router Configuration

IPv6-Only Network to IPv4 Internet

IP NAT and NAT64 cannot be together

- When using Well-Known Prefix 64:ff9b::/96
  - Can utilize public DNS64 servers

```
interface GigabitEthernet1
 ip address 192.168.67.2 255.255.255.0
 nat64 enable
interface GigabitEthernet2
 no ip address
 nat64 enable
 ipv6 address 2001:DB8:8000:666::5/64
ipv6 access-list nat64-acl
 sequence 10 permit ipv6 2001:DB8::/32 any
nat64 v4 pool nat64-pool 192.0.2.252 192.0.2.252
nat64 v6v4 list nat64-acl pool nat64-pool overload
```

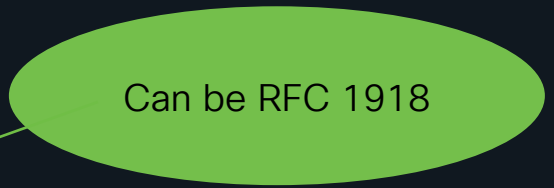
Must be Public per RFC 6052

IOS-XE Router Configuration

IPv6-only Network to IPv4 Network

- Let's use a Global Unicast Address (GUA) Prefix
  - Must utilize own DNS64 server

```
interface GigabitEthernet1
 ip address 192.168.67.2 255.255.255.0
 nat64 enable
interface GigabitEthernet2
 no ip address
 nat64 enable
 ipv6 address 2001:DB8:8000:666::5/64
ipv6 access-list nat64-acl
 sequence 10 permit ipv6 2001:DB8::/32 any
nat64 prefix stateful 2001:DB8:FFFF::/96
nat64 v4 pool nat64-pool 192.168.255.254 192.168.255.254
nat64 v6v4 list nat64-acl pool nat64-pool overload
```



IOS-XE Router Configuration

IPv4 Internet to IPv6-Only Server

While this is possible, this would typically be handled by a server load balancer or reverse proxy.

```
interface GigabitEthernet1
 ip address 192.168.67.2 255.255.255.0
 nat64 enable
interface GigabitEthernet2
 no ip address
 nat64 enable
 ipv6 address 2001:DB8:8000:666::5/64
nat64 v6v4 static 2001:DB8:8000:150::10 192.0.2.10
```

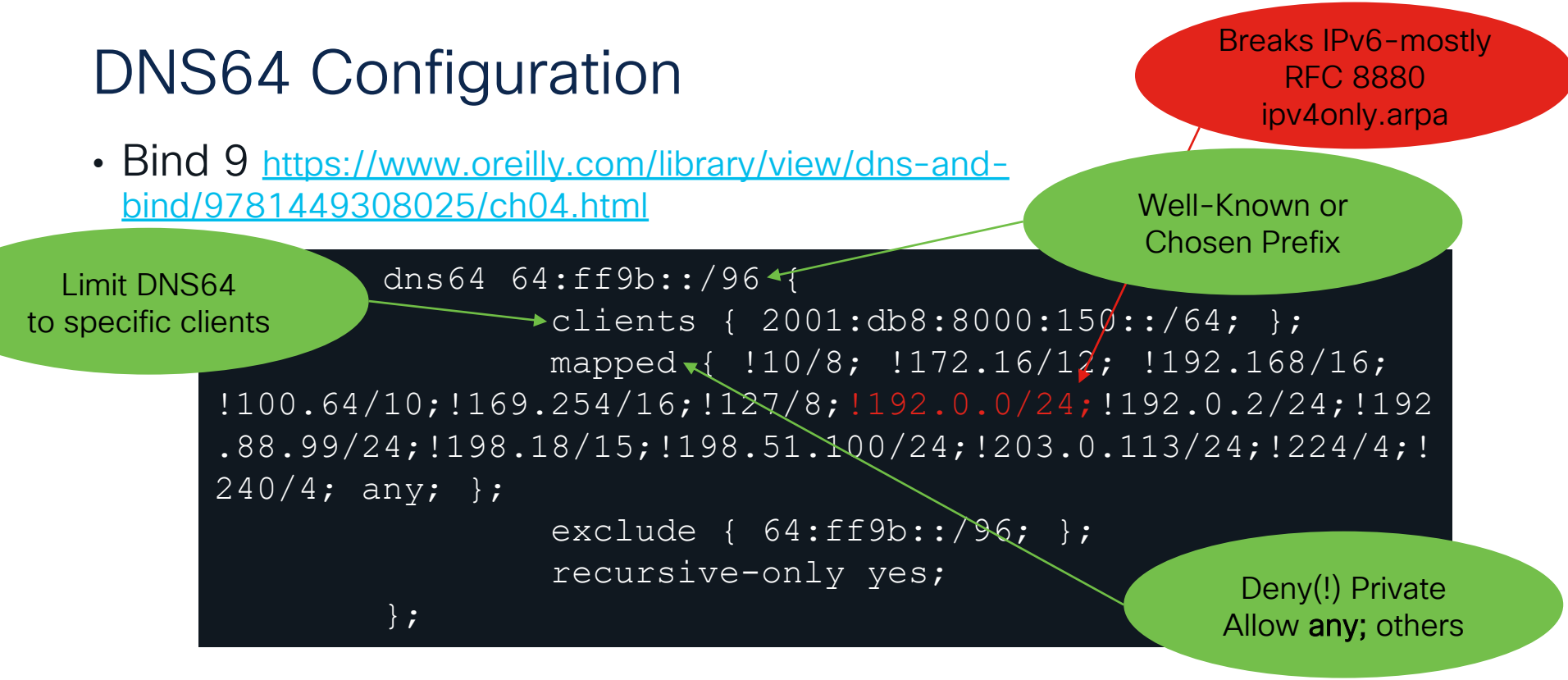
For Your Reference

Public Recursive DNS64 Servers

- https://gist.github.com/mutin-sa/5dcbd35ee436eb629db7872581093bc5
- Google Public DNS64
  https://developers.google.com/speed/public-dns/docs/dns64
  - 2001:4860:4860::6464
  - 2001:4860:4860::64
- Cloudflare DNS64
  - 2606:4700:4700::64
  - 2606:4700:4700::6400

DNS64 Configuration

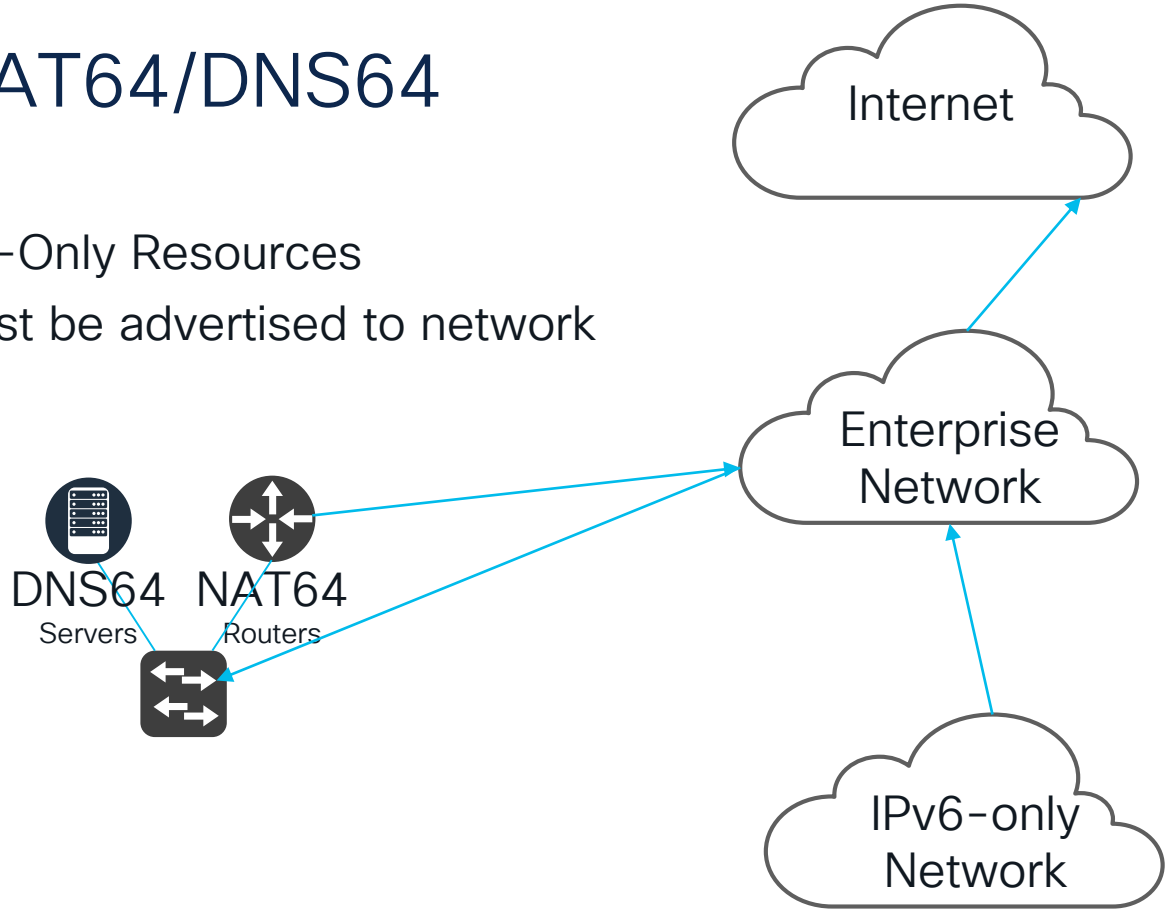
- Bind 9 https://www.oreilly.com/library/view/dns-and-bind/9781449308025/ch04.html



- Infoblox https://docs.infoblox.com/space/nios86/36704017/About+DNS64
- Unbound https://github.com/NLnetLabs/unbound/blob/master/doc/README.DNS64

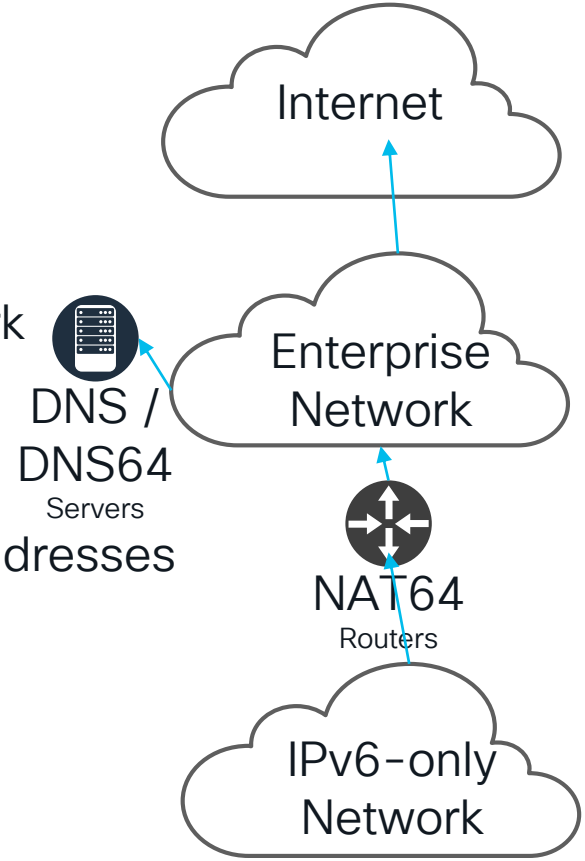
Placement NAT64/DNS64

- Service Block
  - Placed near IPv4-Only Resources
  - NAT64 prefix must be advertised to network



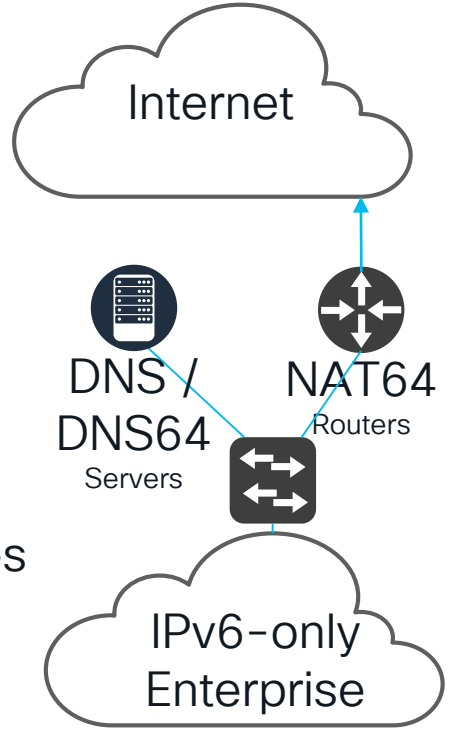
Placement NAT64/DNS64

- Service Block
  - Placed near IPv4-Only Resources
  - NAT64 prefix must be advertised to network
- Integrated
  - NAT64 placed near IPv6-only Users
  - DNS64 can be limited to specific source addresses
  - NAT64 prefix resides with default

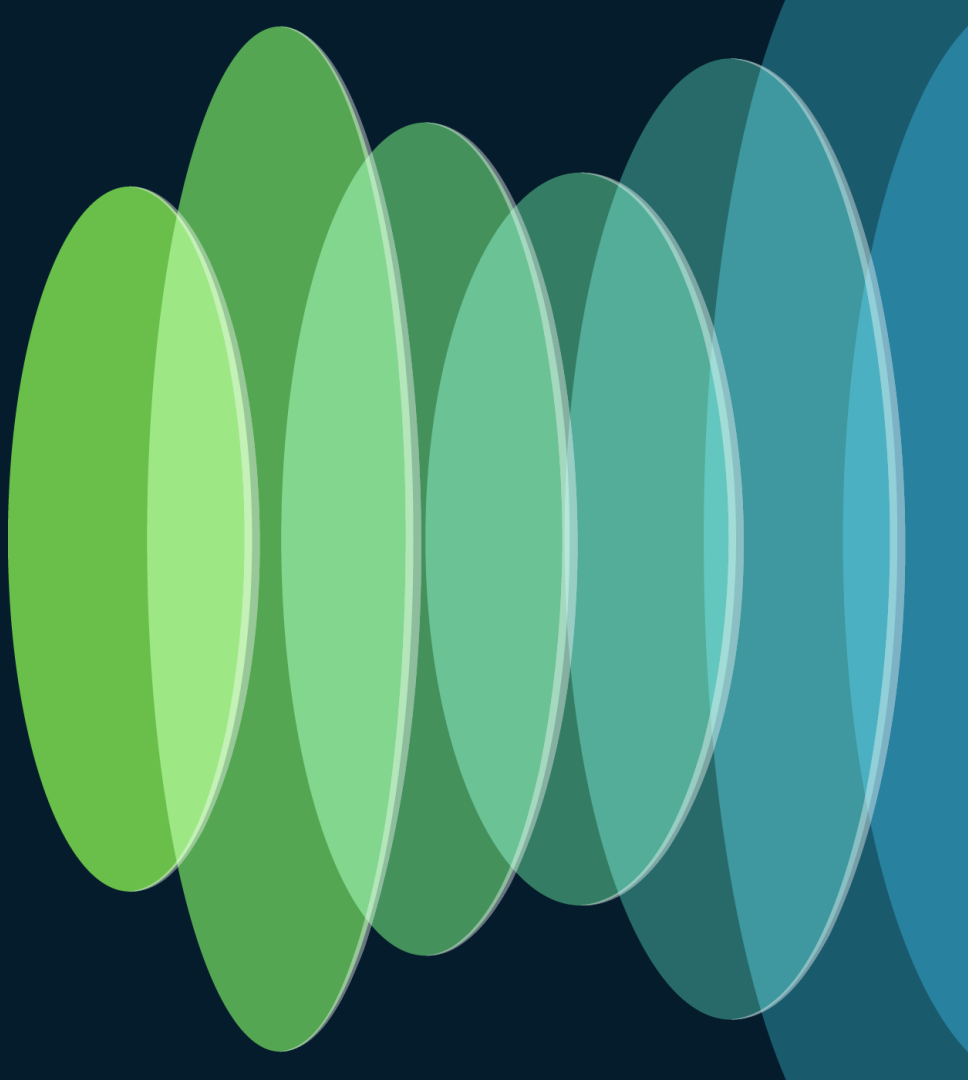


Placement NAT64/DNS64

- Service Block
  - Placed near IPv4-Only Resources
  - NAT64 prefix must be advertised to network
- Integrated
  - NAT64 placed near IPv6-only Users
  - DNS64 can be limited to specific source addresses
  - NAT64 prefix resides with default
- Edge
  - IPv6 is fully functional internally for **everything(?)**
  - IPv6-only Users can reach internal IPv6-only and Dual Stack Resources
  - Only required for external/Internet sites that haven't Dual Stacked



IPv6-Only



IPv6-Only

- Where do we start?
- Do I need to disable IPv4 in OS?
- IPv6-Mostly
- Stop IPv4 on the Network
- How did my Web Browser Connect
- NetFlow shows us what is being utilized
- Network Equipment

Where do we start?

- Outside In
  - Network Engineers
  - Help Desk
  - Select user VLAN’s
    - VLAN by VLAN
    - Site by Site
  - Data Center
  - Network Infrastructure

Do I need to disable IPv4 in OS?

No support for IPv4 Literals

- On an IPv6-only VLAN

```
C:\>ipconfig
Windows IP Configuration

Ethernet adapter Ethernet0:

   Connection-specific DNS Suffix  . :
   IPv6 Address. . . . . . . . . . . : 2001:db8:8000:150::2
   Link-local IPv6 Address . . . . . : fe80::9c73:7c11:8a59:3f3d%13
   Autoconfiguration IPv4 Address. . : 169.254.42.133
   Subnet Mask . . . . . . . . . . . : 255.255.0.0
   Default Gateway . . . . . . . . . : 2001:db8:8000:150::1
                                       fe80::272:78ff:fe55:17d%13
```

- What happens while travelling?

IPv6-Mostly

For Your Reference

- draft-link-v6ops-6mops IPv6-Mostly Networks: Deployment and Operations Considerations
- RFC 6877 464XLAT: Combination of Stateful and Stateless Translation
  - Host translation of IPv4 to IPv6
- RFC 7050 / 8880 Special Use Domain Name 'ipv4only.arpa'
  - Learn NAT64 prefix via DNS64 query for ipv4only.arpa
  - Can host authoritative DNS zone for ipv4only.arpa with AAAA record to relieve load on IANA DNS servers.
- RFC 8781 Discovering PREF64 in Router Advertisements
  - Use Router Advertisement (RA) to advertise NAT64 prefix
- RFC 8925 IPv6-Only Preferred Option for DHCPv4
  - DHCP Option 108 signal to clients to utilize IPv6-only if possible

Hosts require support for 8880 or 8781, and 8925 to function

Do I need to disable IPv4 in OS?
RFC 6877 - 464XLAT Support and RFC 8925 - DHCP Option 108

- On an IPv6-mostly VLAN (Mac OS X)

```
$ ifconfig en0
en0: flags=88e3<UP,BROADCAST,SMART,RUNNING,NOARP,SIMPLEX,MULTICAST> mtu 1500
options=400<CHANNEL_IO>
ether 88:66:5a:56:d4:df
inet6 fe80::ccd:72d8:8979:ab49%en0 prefixlen 64 secured scopeid 0x6
inet6 2001:db8:8000:150:ca:5788:879f:170b prefixlen 64 autoconf secured
inet6 2001:db8:8000:150:e934:6cd8:39be:6eaf prefixlen 64 autoconf temporary
inet 192.0.0.2 netmask 0xffffffff broadcast 192.0.0.2
inet6 2001:db8:8000:150:1061:3d95:4cc4:563b prefixlen 64 clat46
nat64 prefix 64:ff9b:: prefixlen 96
nd6 options=201<PERFORMNUD,DAD>
media: autoselect
status: active
```

- Windows 11 Plans to Expand CLAT Support
  - https://techcommunity.microsoft.com/t5/networking-blog/windows-11-plans-to-expand-clat-support/ba-p/4078173

Do I need to disable IPv4 in OS?
RFC 6877 - 464XLAT Support and RFC 8925 - DHCP Option 108

- On an IPv6-mostly VLAN (Mac OS X)

```
$ ifconfig en0
en0: flags=88e3<UP,BROADCAST,SMART,RUNNING,NOARP,SIMPLEX,MULTICAST> mtu 1500
options=400<CHANNEL_IO>
ether 88:66:5a:56:d4:df
inet6 fe80::ccd:72d8:8979:ab49%en0 prefixlen 64 secured scopeid 0x6
inet6 2001:db8:8000:150:ca:5788:879f:170b prefixlen 64 autoconf secured
inet6 2001:db8:8000:150:e934:6cd8:39be:6eaf prefixlen 64 autoconf temporary
inet 192.0.0.2 netmask 0xffffffff broadcast 192.0.0.2
inet6 2001:db8:8000:150:1061:3d95:4cc4:563b prefixlen 64 clat46
nat64 prefix 64:ff9b:: prefixlen 96
nd6 options=201<PERFORMNUD,DAD>
media: autoselect
status: active
```

Dependent on SLAAC

Do I need to disable IPv4 in OS?
RFC 6877 - 464XLAT Support and RFC 8925 - DHCP Option 108

- On an IPv6-mostly VLAN (Mac OS X)

```
$ ifconfig en0
en0: flags=88e3<UP,BROADCAST,SMART,RUNNING,NOARP,SIMPLEX,MULTICAST> mtu 1500
options=400<CHANNEL_IO>
ether 88:66:5a:56:d4:df
inet6 fe80::ccd:72d8:8979:ab49%en0 prefixlen 64 secured scopeid 0x6
inet6 2001:db8:8000:150:ca:5788:879f:170b prefixlen 64 autoconf secured
inet6 2001:db8:8000:150:e934:6cd8:39be:6eaf prefixlen 64 autoconf temporary
inet 192.0.0.2 netmask 0xffffffff broadcast 192.0.0.2
inet6 2001:db8:8000:150:1061:3d95:4cc4:563b prefixlen 64 clat46
nat64 prefix 64:ff9b:: prefixlen 96
nd6 options=201<PE
media: autosele
status: active
```

RFC 8781
ipv6 nd ra nat64-prefix

RFC 7050/8880
DNS64 ipv4only.arpa

Do I need to disable IPv4 in OS?
RFC 6877 - 464XLAT Support and RFC 8925 - DHCP Option 108

- On an IPv6-mostly VLAN (Mac OS X)

```
$ ifconfig en0
en0: flags=88e3<UP,BROADCAST,SMART,RUNNING,NOARP,SIMPLEX,MULTICAST> mtu 1500
options=400<CHANNEL_IO>
ether 88:66:5a:56:d4:df
inet6 fe80::ccd:72d8:8979:ab49%en0 prefixlen 64 secured
inet6 2001:db8:8000:150:ca:5788:879f:170b prefixlen 6
inet6 2001:db8:8000:150:e934:6cd8:39be:6eaf prefixlen 64
inet 192.0.0.2 netmask 0xffffffff broadcast 192.0.0.2
inet6 2001:db8:8000:150:1061:3d95:4cc4:563b prefixlen 64 clat46
nat64 prefix 64:ff9b:: prefixlen 96
nd6 options=201<PERFORMNUD,DAD>
media: autoselect
status: active
```

RFC 8925
DHCPv4 Option 108

```
ip dhcp pool <name>
 network <ip address> <subnet mask>
 default-router <default gateway>
 option 108 hex 0000.0000
```

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- On an IPv6-mostly VLAN (Mac OS X)

Support for IPv4 Literals

```
$ ifconfig en0
en0: flags=88e3<UP,BROADCAST,SMART,RUNNING,NOARP,SIMPLEX,MULTICAST> mtu 1500
options=400<CHANNEL_IO>
ether 88:66:5a:56:d4:df
inet6 fe80::ccd:72d8:8979:ab49%en0 prefixlen 64 secured scopeid 0x6
inet6 2001:db8:8000:150:ca:5788:879f:170b prefixlen 64 autoconf secured
inet6 2001:db8:8000:150:e934:6cd8:39be:6eaf prefixlen 64 autoconf temporary
inet 192.0.0.2 netmask 0xffffffff broadcast 192.0.0.2
inet6 2001:db8:8000:150:1061:3d95:4cc4:563b prefixlen 64 clat46
nat64 prefix 64:ff9b:: prefixlen 96
nd6 options=201<PERFORMNUD,DAD>
media: autoselect
status: active
```

Hosts require 8880 or 8781, and 8925 to function

```
$ ping -c 1 208.67.220.220
PING 208.67.220.220 (208.67.220.220): 56 data bytes
64 bytes from 208.67.220.220: icmp_seq=0 ttl=53 time=21.625 ms

--- 208.67.220.220 ping statistics ---
1 packets transmitted, 1 packets received, 0.0% packet loss
```

Stop IPv4 at Layer 2

- VLAN Map, example for limited address space

```
vlan access-map vlan-map-ipv4-link-local 10
 match ip address ipv4-link-local-deny
 action forward
vlan access-map vlan-map-ipv4-link-local 20
 match ip address ipv4-link-local-permit
 action drop
vlan filter vlan-map-ipv4-link-local vlan-list 150
ip access-list extended ipv4-link-local-deny
 10 deny   ip 169.254.0.0 0.0.255.255 any
 20 permit ip any any
ip access-list extended ipv4-link-local-permit
 10 permit ip 169.254.0.0 0.0.255.255 any
```

Stop IPv4 at Layer 3

- Unicast Reverse Path Forwarding

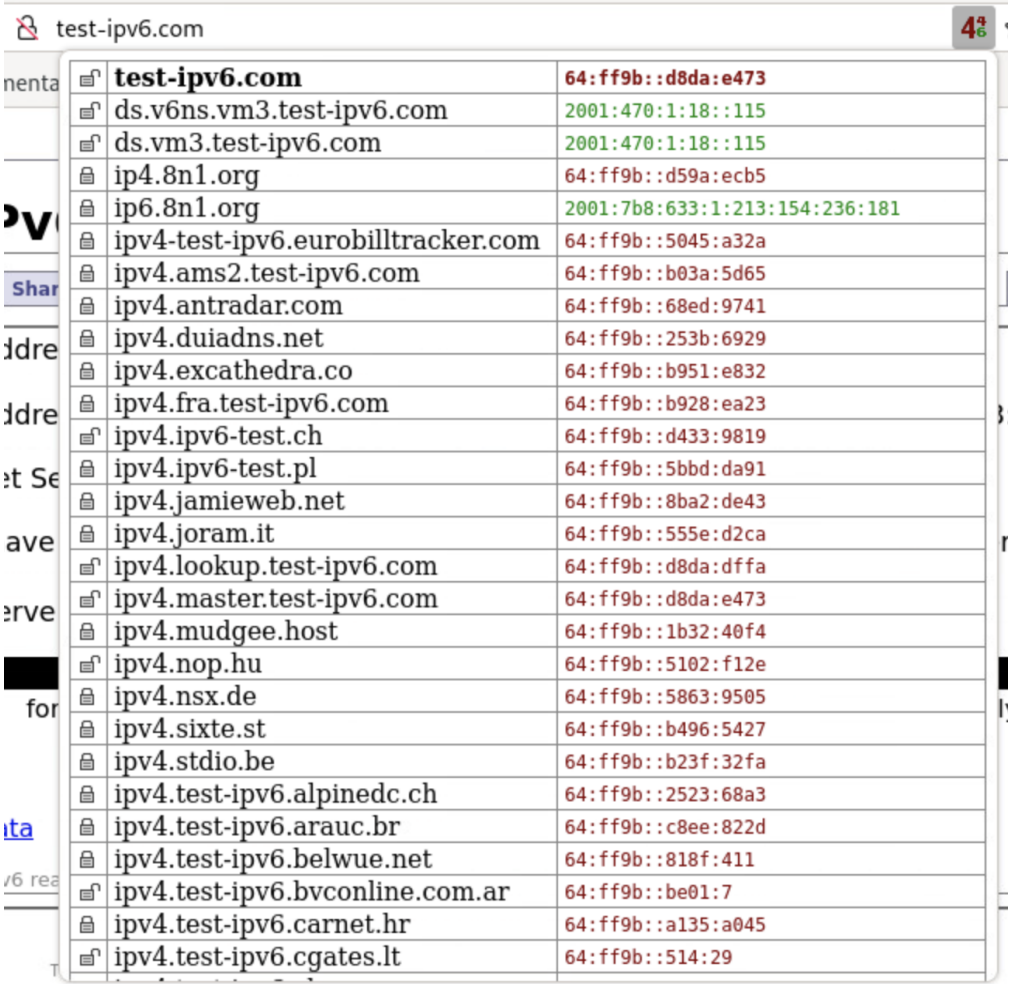
```
interface Vlan150
 no ip address
 ip verify unicast source reachable-via rx
```

- Access List

```
interface Vlan150
 no ip address
 ip access-group no-ipv4 in
 ip access-group no-ipv4 out
ip access-list extended no-ipv4
 10 deny ip any any
```

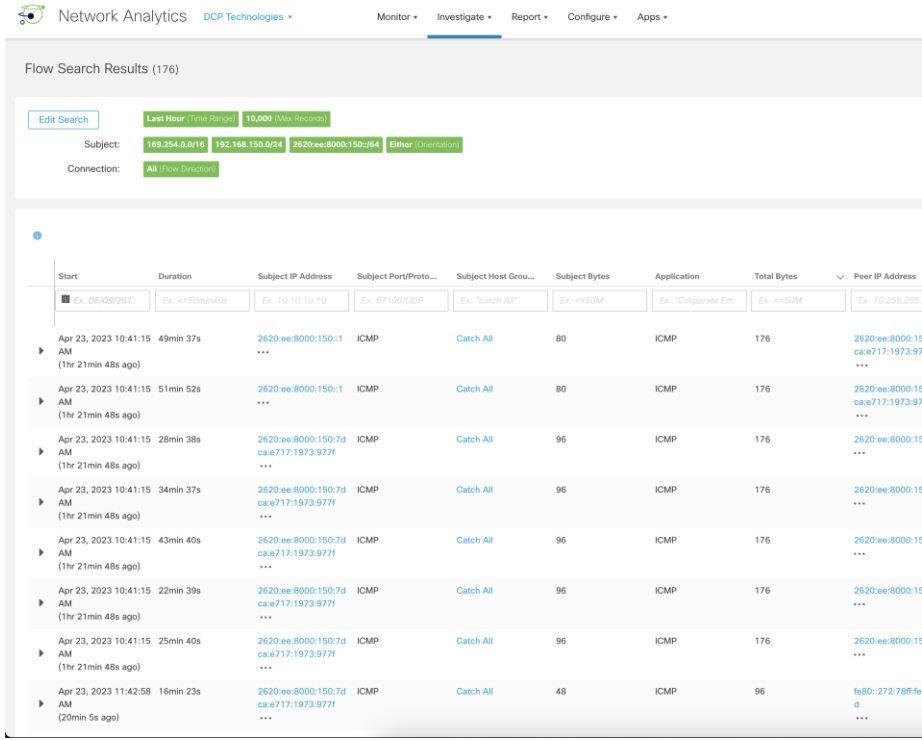
How did my Web Browser Connect?

- IPvFoo
  - Extension for Firefox and Chrome
  - Can be added to Edge enabling
    “Allow extensions from other stores.”
  - By using the Well-Known Prefix, we still know what is only IPv4



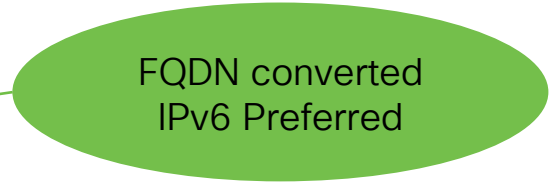
NetFlow v9 / IPFIX shows us what is being utilized

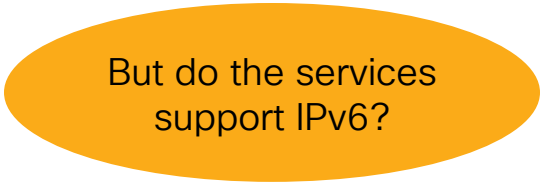
- Why do we still see IPv4?
  - Flow monitor on L2 interfaces happens before L3 processing.
  - 169.254.0.0/16 link-local IPv4
    - UPnP/SSDP 239.255.255.250:UDP/1900
    - Multicast DNS 224.0.0.251:UDP/5353
  - Static Configuration?
- IPv6 is all that is active!



Network Equipment

- Services converted to IPv6? All services support IPv6?
  - NTP - `ntp peer ipv6 time.example.com`
  - NetFlow
    - `flow exporter FLOWEXPORTER`
      `destination 2001:DB8::2055`
  - Logging - `logging host fqdn ipv6 syslog.example.com`
  - DNS - `ip name-server 2001:DB8:53::111 2001:DB8:53::112`





Network Equipment

- Services converted to IPv6? All services support IPv6?
  - SNMP
    - `snmp-server group <v3-group-name> v3 [auth|noauth|priv] access ipv6 <ipv6-acl> <ipv4-std-acl>`
      `snmp-server community private RW ipv6 <ipv6-acl> <ipv4-std-acl>`
      `snmp-server community public RO ipv6 <ipv6-acl> <ipv4-std-acl>`
      `snmp-server host 192.0.2.162 <snip>`
  - VTY Access-Lists
    - `line vty 0 4`
      `ipv6 access-class <ipv6-acl> in`
      `access-class <ipv4-std-acl> in`
  - Authentication
    - `tacacs server TACACS`
      `address fqdn tacacs.example.com`
    - `radius server RADIUS`
      `address fqdn radius.example.com`

Adding IPv6 requires restating IPv4

FQDN converted IPv4 Preferred

But do the services support IPv6?

Routing Protocols

- Router ID's are 32-bit values
- Commonly represented as 4 dotted octets
- Cisco Routers by default utilize an interface IPv4 address
- IPv6-only must manually configure router-id
  - Majority will not work without
- DO NOT be surprised with the first router reload

Routing Protocols

- BGP

  `%BGP-4-NORTRID: BGP could not pick a router-id. Please configure manually.`

  - `bgp router-id x.x.x.x`
- OSPFv3

  `%OSPFv3-4-NORTRID: Process OSPFv3-<area>-IPv6 could not pick a router-id, please configure manually`

  - `router-id x.x.x.x`
- EIGRP
  - NOTHING
  - `eigrp router-id x.x.x.x`
- RIPng and ISIS could care less

Remove IP Routing

- `no ip routing`

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

```
%BGP-5-ADJCHANGE: neighbor 2001:DB8::2 Down Unknown path error
%BGP_SESSION-5-ADJCHANGE: neighbor 2001:DB8::2 IPv6 Unicast topology
base removed from session  Unknown path error
```

  - EIGRP goes down after hold time
    - Both Numbered and Named

```
%DUAL-5-NBRCHANGE: EIGRP-IPv6 1: Neighbor FE80::5054:FF:FE1B:C299
(GigabitEthernet1) is down: holding time expired
```

  - OSPFv3 goes down after dead time

```
%OSPFv3-5-ADJCHG: Process 1, Nbr 192.168.0.1 on GigabitEthernet1 from
FULL to DOWN, Neighbor Down: Dead timer expired
```

  - RIPng goes down after holddown time
  - ISIS could care less

Wireless Controller

IPv6 Control Plane

- DHCPv6 Option 52 to assign CAPWAP Access Controller
  - IOS

```
ipv6 dhcp pool [name]
 capwap-ac address [ipv6-address]
```

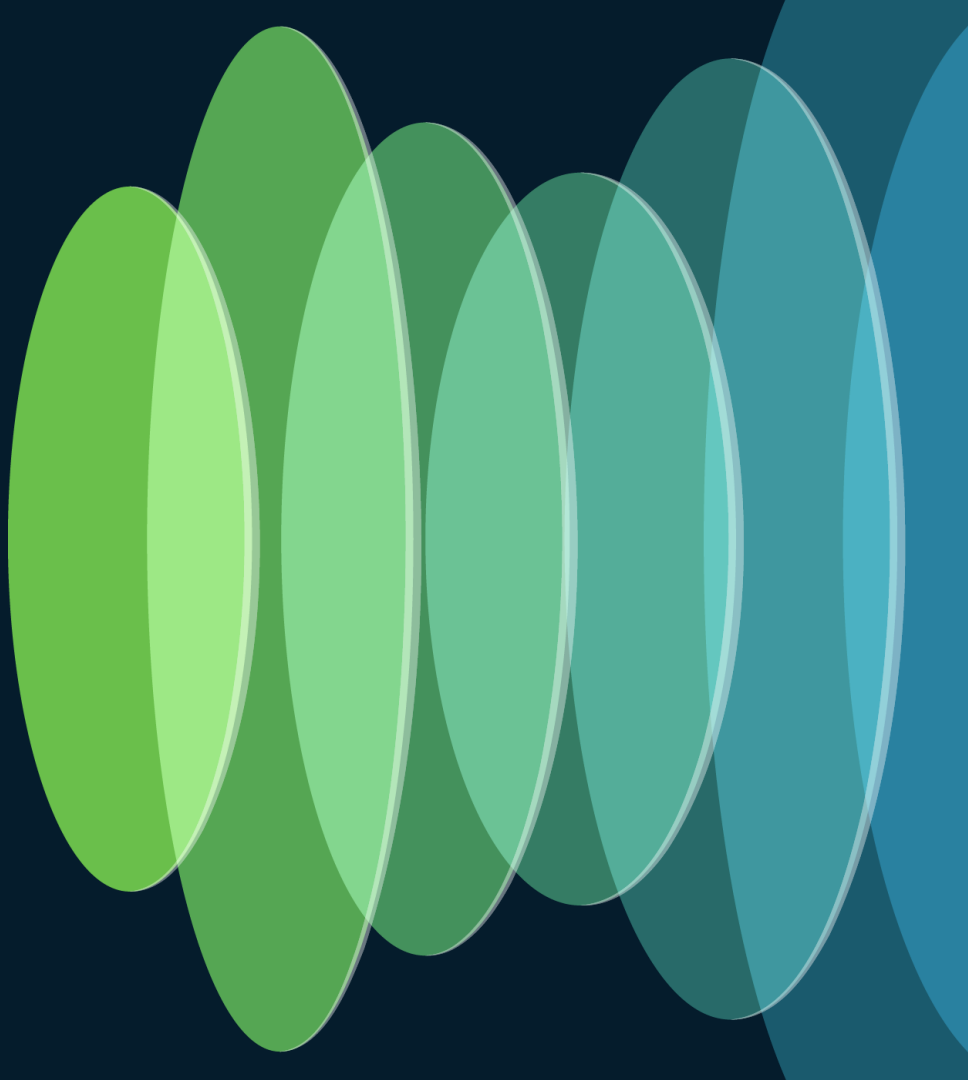
  - Windows
    - Scope Options > Configure Options > 052 capwap-ac-v6

Wireless Controller

IPv6 Data Plane

- “IPv4 DHCP Required” can’t be utilized for IPv6-only and IPv6-mostly SSID’s
  - Configuration > Tags & Profiles > Policy
    - Select Profile > Advanced > IPv4 DHCP Required
- “IP Theft or IP Reuse” with older MacOS leaking of 192.0.0.2 in IPv6-mostly deployment.
  - Configuration > Security > Wireless Protection Policy
    - Client Exclusion Policies > IP Theft or IP Reuse

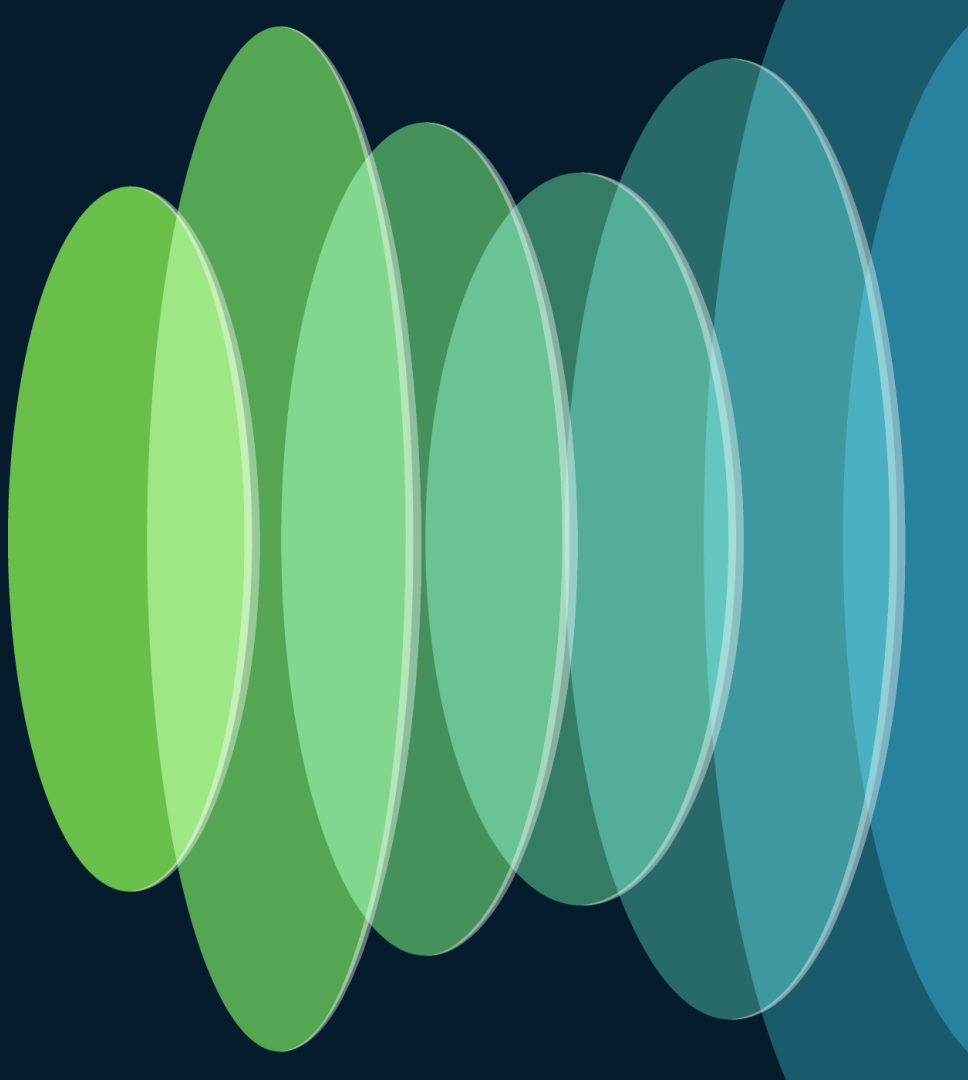
Conclusion



Get to it, IPv6 is almost 30

- NetFlow v9 / IPFIX for visibility
- IPng Working Group proposed Oct 1994
  - https://datatracker.ietf.org/wg/ipngwg/history
- RFC 1883 – December 1995
  - Updated RFC 8200 (STD 86) – Jul 2017
- IOS 12.2(2)T 1st IPv6 Release – Feb 2001
  - IPv6 Prototype – 1996 / IPv6 Public EFT – 1999
- IPv6-only is ready for deployment
  - If your applications are ready!
  - RFC 6586 – Experiences from an IPv6-only Network – Apr 2012
  - Cogent & Hurricane Electric both reachable directly

Additional Learning



Further Reading

- Validated Solution: IPv6 Integration with Cisco SD-Access, SD-WAN, and Firepower
  - http://cs.co/ipv6cvpsda
  - BRKIPV6-2015 – new IPv6 Campus CVP
- An IPv6 Campus of the Future
  - https://blogs.cisco.com/networking/an-ipv6-campus-of-the-future
- RFC 6586 - Experiences from an IPv6-only Network
- RFC 7381 - Enterprise IPv6 Deployment Guidelines

Cisco Live US IPv6 Learning Map

Sunday–2nd

TECXAR-2000 9AM
Integrating IPv6 Services with SD-WAN

TECIPV-2000 9AM
IPv6 in the Host and in the Local Network

TECIPV-2001 2PM
IPv6 Beyond the Local Network

TECMPL-2119 2PM
SRv6 Tech Update: Use Cases and Operations

Monday–3rd

BRKIPV-2191 8:30AM
IPv6:: It's Happening!

BRKENT-2109 10:30AM
Let's Deploy IPv6 Now

BRKMPL-2203 10:30AM
Introduction to SRv6 uSID Technology

BRKENS-2834 11:00AM
IPv6-Enabled Wireless (Wi-Fi) Access: Design and Deployment Strategies

BRKIPV-1616 1PM
IPv6 – What Do You Mean There Isn't a Broadcast?

BRKENT-3002 1PM
IPv6 Security in the Local Area with First Hop Security

IBOENT-2811 2:30PM
Everything You Wanted to Know about IPv6 but Were Afraid to Ask

Tuesday–4th

IBOIPV-1000 10:30AM
U.S. Government Mandate Driving to 50% IPv6-Only and beyond in 2024

BRKENT-3340 1PM
The Hitchhiker's Guide to Troubleshooting IPv6

BRKENT-2008 2:30PM
Goodbye Legacy, the Move to an IPv6-Only Enterprise

BRKIPV-2418 3PM
Deploying IPv6 Routing Protocols: Specifics and Considerations

Wednesday–5th

CTF-1001 10:15AM
IPv6: The Internet's best kept secret!

IBOIPV-1428 2:30PM
IPv6 Unleashed: Cisco Meraki Cutting-Edge Design Session

Thursday–6th

BRKIPV-2015 8:00AM
Integrating Cisco Campus, SD-WAN and Firepower in IPv6 Enterprise Networks

BRKSEC-2044 9:30AM
Secure Operations for an IPv6 Network

IBOIPV-2000 1PM
Sharing Experience on IPv6 Deployments

Walk in Labs

LABIPV-1639 IPv6 Foundations: A Dive into Basic Networking Concepts
LABIPV-2640 IPv6 Deep Dive: Beyond Basics to Brilliance
LABMPL-1201 SRv6 Basics
LABSP-2129 SRv6 Micro-Segment Basics
LABSP-3393 Implementing Segment Routing v6 (SRv6) Transport on NCS 55xx/5xx and Cisco 8000: Advanced

Instructor-led Labs

LTRENT-2016 Learning IPv6 in the Enterprise for Fun and (Fake) Profit: A Hands-On Lab
LTRSPG-2212 SRv6 and Cloud-Native: A Platform for Network Service Innovation
LTRSPG-2006 Explore the Power of SRv6: Unleashing the Potential of Next-Generation Networking

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- Attend the interactive education with DevNet, Capture the Flag, and Walk-in Labs
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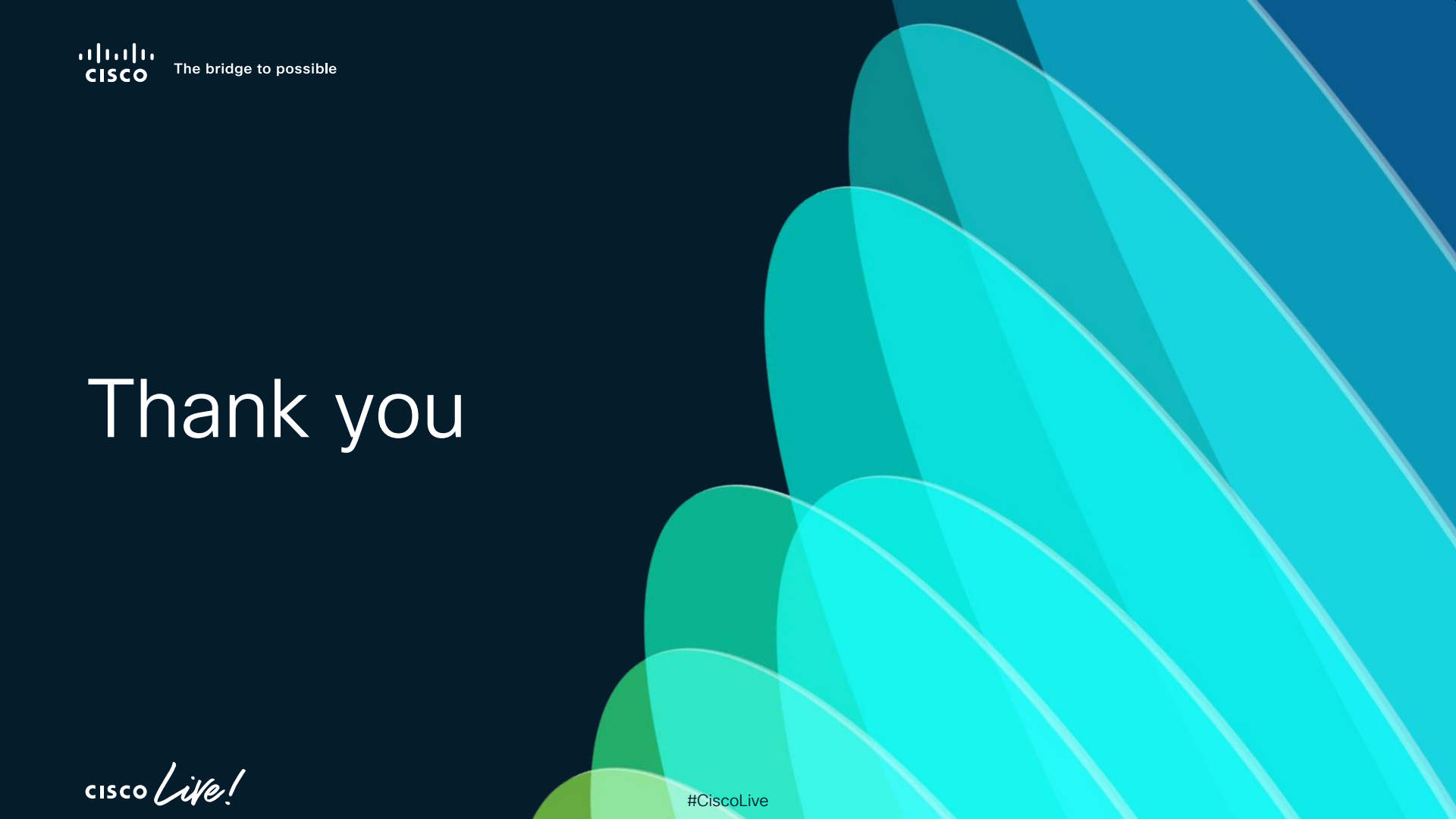
Contact me at: dprall@cisco.com


The bridge to possible
Thank you
cisco Live!
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