

IPv6 Implementation fundamentals for ISPs

NANOG47 / ARIN XXIV
Dearborn, MI

Aaron Hughes, 6connect, Inc.

Unifying Internet Infrastructure

www.6connect.net

AGENDA

- Obtain an IPv6 allocation
- My first IPv6 packets
- Dual stacking the backbone
- OSPFv3 implementation (IS-IS if you want)
- IPv6 iBGP implementation
- IPv6 eBGP implementation
- IPv6 peering
- Extending dual stack from the backbone
- IPv6 for your customers

AUDIENCE

- Successful IPv6 implementation requires:
 - + ARIN
 - × Supporting policies
 - × Allocations / Assignments
 - × Decision influencers
 - + NANOG
 - × Designers / Architects
 - × Implementors
 - × Operators

REMEMBER YOUR ROLE!

- Attending and participating is not enough. We must influence our respective companies to make good decisions about future viability. This includes the decision to implement IPv6.
- Typically Strategy / Revenue generation / P&L / BisDev / Marketing / Customer demand drives product.
- IPv6 decisions based on survivability + costs \$'s
- Business justification -> another presentation.

IPV6 OBJECTIONS....

- Dispel the myths!
 - + Obtaining IPv6 space from my RIR is hard
 - + My transit providers don't support IPv6 yet
 - + No BGP multihoming
 - + Lack of general support
 - + IPv6 is hard to implement
 - + Existing infrastructure doesn't support IPv6
 - ✗ This one is harder to address, but better plan now!
 - ✗ Question of _when_ not _if_

OBTAINING AN ALLOCATION IS HARD!

- Lots of coverage on this topic..
- <https://www.arin.net/resources/templates/v6-isp.txt>
- Dear RIR,
- I am *planning* on assigning IPv6 space to 200 customers in the coming five years.
- Dear LIR,
- **[ARIN-20090507.2451] IPV6 REQUEST --APPROVED**

From: hostmaster@arin.net
Subject: **Re: [Ops] [ARIN-20090507.2451] IPV6 REQUEST --APPROVED**
Date: June 5, 2009 2:30:38 PM PDT
To: Aaron Hughes
Cc: ops@6connect.net

-----BEGIN PGP SIGNED MESSAGE-----

Hash: SHA1

Hello-

Your request for network addresses has been completed.

Below is the network which will be visible in ARIN's WHOIS tomorrow :

OrgName: 6connect, Inc.
OrgID: CONNE-81
Address: 1743 Park Ave.
Address: Suite 130
City: San Jose
StateProv: CA
PostalCode: 95126
Country: US

NetRange: 2607:FAE0:0000:0000:0000:0000:0000:0000 - 2607:FAE0:FFFF:FFFF:FFFF:FFFF:FFFF:FFFF
CIDR: 2607:FAE0:0000:0000:0000:0000:0000:0000/32
NetName: 6CONNECT-6-1
NetHandle: NET6-2607-FAE0-1
Parent: NET6-2600-1
NetType: Direct Allocation
Comment:
RegDate: 2009-06-05
Updated: 2009-06-05

OrgTechHandle: 6CONN-ARIN
OrgTechName: 6connect Operations
OrgTechPhone: +1-408-329-6901
OrgTechEmail: ops@6connect.net

WHERE ARE WE?



- Obtain an IPv6 allocation
 - My first IPv6 packets
 - Dual stacking the backbone
 - OSPFv3 implementation
 - IPv6 iBGP implementation
 - IPv6 eBGP implementation
 - IPv6 peering
 - Extending dual stack from the backbone
 - IPv6 for your customers

MY PROVIDER DOESN'T SUPPORT IPV6

- No need to cry, let's just route around them.



IPV6 TRANSIT IS FREE! (right now...)



Exchange Name	IP Address	Speed
AMS-IX	2001:7f8:1::a500:6939:1	10000
BigApe	2001:458:26:2::500	100
CoreSite - Any2 California	2001:504:13::1a	10000
DE-CIX	2001:7f8::1b1b:0:1	10000
Equinix Ashburn	2001:504:0:2::6939:1	10000
Equinix Chicago	2001:504:0:4::6939:1	10000
Equinix Dallas	2001:504:0:5::6939:1	10000
Equinix Hong Kong	2001:de8:7::6939:1	10000
Equinix Los Angeles	2001:504:0:3::6939:1	10000
Equinix Newark	2001:504:0:6::6939:1	10000
Equinix San Jose	2001:504:0:1::6939:2	20000
Equinix San Jose	2001:504:0:1::6939:1	20000
Equinix Tokyo	2001:de8:5::6939:1	10000
Equinix Zurich	2001:7f8:c:8235:194:42:48:80	10000
HKIX	2001:7fa:0:1::ca28:a19e	1000
KleyReX	2001:7f8:33::A100:6939:1	1000
LAIX	2001:504:a::a500:6939:1	1000
LINX Brocade LAN	2001:7f8:4:0::1b1b:1	10000

LONAP	2001:7f8:17::1b1b:1	1000
NetNod Stockholm	2001:7f8:d:fe::187	20000
NetNod Stockholm	2001:7f8:d:fb::187	20000
NetNod Stockholm	2001:7f8:d:ff::187	20000
NL-IX	2001:7f8:13::a500:6939:1	1000
NOTA	2001:478:124::176	10000
NYIIX	2001:504:1::a500:6939:1	10000
PAIX New York	2001:504:f:39	10000
PAIX Palo Alto	2001:504:d::10	10000
PaNAP	2001:860:0:6::6939:1	10000
SIX	2001:478:180::40	10000
SOL-IX	2001:7f8:21:10::101	1000
SOL-IX	2001:7f8:21:9::101	1000
STHIX	2001:7f8:3e::a500:0:6939:1	1000
Telx Atlanta	2001:478:132::75	10000
TorIX	2001:478:245:1::112	10000

30 IPv6 locations as of Sept 25th, 2009 10

Exchange Name	IP Address	Speed
AMS-IX	2001:7F8:1::A501:9151:1	10000
ChIX	2001:504:14::a501:9151:1	1000
CIIX (formerly LAAP)	2001:504:A::A501:9151:1	10000
CoreSite - Any2 California	2001:504:13:0:0:0:0:B	10000
DE-CIX	2001:7F8::4ACF:0:1	10000
Equinix Ashburn	2001:504:0:2:0:1:9151:1	20000
Equinix Chicago	2001:504:0:4:0:1:9151:1	10000
Equinix Dallas	2001:504:0:5:0:1:9151:1	10000
Equinix Los Angeles	2001:504:0:3:0:1:9151:1	10000
Equinix Newark	2001:504:0:6:0:1:9151:1	10000
Equinix San Jose	2001:504:0:1:0:1:9151:1	10000
LINX Brocade LAN	2001:7F8:4::4ACF:1	10000
LONAP	2001:7F8:17::4ACF:1	1000
MadIX	2607:F388:0:2200::3	1000
NOTA	2001:478:124::167	10000
NYIIX	2001:504:1::a501:9151:1	10000
PAIX Atlanta	2001:504:10::15	10000
PAIX New York	2001:504:F::9151:1	10000
PAIX Palo Alto	2001:504:D::9151:1	10000
PAIX Seattle	2001:504:12::25	10000
SIX	2001:504:16::4ACF	2000
Telx Atlanta	2001:478:132::12	10000
TorIX	2001:478:245:1::110	1000

Others??

23 IPv6 locations as of Sept 25th, 2009

WHERE TO START?

- Existing IX locations

- + IX provider,

- ✗ I am an existing customer at location X, Y, and Z.
 - ✗ My existing IPv4 addresses are X.X.X.X, X.X.X.X, etc.
 - ✗ What are my IPv6 addresses for those respective locations?

- You likely have already been assigned IPv6

PEERING INFORMATION LIST

- Make a list of all relevant peering information:
 - + \$My_Company info:
 - + <http://asXXXX.peeringdb.com/>
 - + AS: XXXX
 - + AS-SET: ALTDB AS-COMPANY
 - + Equinix Ashburn IPv4: 206.223.115.X
 - + Equinix Ashburn IPv6 : 2001:504:0:X:XXXX:1
 - + Equinix San Jose IPv4 : 206.223.116.X etc..
 - + Equinix San Jose IPv6 : 2001:504:0:1:0:X:XXXX:1
 - + PAIX Palo Alto IPv4 : 198.32.176.X
 - + PAIX Palo Alto IPv6 : 2001:504:D::XXXX
 - + Peering Contact : peering@domain.com
 - + NOC Contact : support@domain.com

UPDATE PEERINGDB

- Add your IPv6 records and check the v6 box.

Navigation Home Page Logout Your Records Peering Record User Account Search Records Networks Exchange Points Facilities Common Points Suggestions Comments New Exchange New Facility Help FAQ Statistics	Company Information Company Name <input type="text" value="Company Inc"/> Primary ASN / IRR Record <input type="text" value="8038"/> <input type="text" value="AS-6CONNECT"/> Also Known As (Aliases) <input type="text"/> Company Website URL <input type="text" value="http://www.6connect.net/"/> Approx Prefixes Announced <input type="text" value="500"/> Network Type <input type="text" value="ISP (Network Service Provider) / Backbone"/> Approx Traffic Levels <input type="text" value="5-10 Gbps"/> Approx Traffic Ratios <input type="text" value="Balanced"/> Geographic Scope <input type="text" value="North America"/> Looking Glass URL (http) <input type="text"/> Route Server URL (belsnet) <input type="text"/> Public Notes <input type="text"/> Private Notes <input type="text"/> Protocols Supported <input checked="" type="checkbox"/> Unicast IPv4 <input checked="" type="checkbox"/> Multicast <input checked="" type="checkbox"/> IPv6		Public Peering Locations <table border="1"> <thead> <tr> <th>Public Exchange Point</th> <th>ASN</th> <th>IP Address</th> <th>Mbit/sec</th> <th>Delete</th> </tr> </thead> <tbody> <tr> <td>CoreSite - Any2 Calif</td> <td>8038</td> <td>2001:504:13::</td> <td>1000</td> <td><input type="checkbox"/></td> </tr> <tr> <td>CoreSite - Any2 Calif</td> <td>8038</td> <td>206.223.143.</td> <td>1000</td> <td><input type="checkbox"/></td> </tr> <tr> <td>Equinix Ashburn</td> <td>8038</td> <td>2001:504:0:2::2</td> <td>1000</td> <td><input type="checkbox"/></td> </tr> <tr> <td>Equinix Ashburn</td> <td>8038</td> <td>206.223.115.</td> <td>1000</td> <td><input type="checkbox"/></td> </tr> <tr> <td>Equinix Los Angeles</td> <td>8038</td> <td>206.223.123.</td> <td>1000</td> <td><input type="checkbox"/></td> </tr> <tr> <td>Equinix Los Angeles</td> <td>8038</td> <td>2001:504:0:3::2</td> <td>1000</td> <td><input type="checkbox"/></td> </tr> <tr> <td>Equinix San Jose</td> <td>8038</td> <td>2001:504:0:1::2</td> <td>1000</td> <td><input type="checkbox"/></td> </tr> <tr> <td>Equinix San Jose</td> <td>8038</td> <td>206.223.116.</td> <td>1000</td> <td><input type="checkbox"/></td> </tr> <tr> <td>PAIX Palo Alto</td> <td>8038</td> <td>198.32.176.</td> <td>1000</td> <td><input type="checkbox"/></td> </tr> <tr> <td>PAIX Palo Alto</td> <td>8038</td> <td>2001:504:Dr::</td> <td>1000</td> <td><input type="checkbox"/></td> </tr> <tr> <td>SFMIX</td> <td>8038</td> <td>206.197.187.</td> <td>1000</td> <td><input type="checkbox"/></td> </tr> <tr> <td>Select Value</td> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table>	Public Exchange Point	ASN	IP Address	Mbit/sec	Delete	CoreSite - Any2 Calif	8038	2001:504:13::	1000	<input type="checkbox"/>	CoreSite - Any2 Calif	8038	206.223.143.	1000	<input type="checkbox"/>	Equinix Ashburn	8038	2001:504:0:2::2	1000	<input type="checkbox"/>	Equinix Ashburn	8038	206.223.115.	1000	<input type="checkbox"/>	Equinix Los Angeles	8038	206.223.123.	1000	<input type="checkbox"/>	Equinix Los Angeles	8038	2001:504:0:3::2	1000	<input type="checkbox"/>	Equinix San Jose	8038	2001:504:0:1::2	1000	<input type="checkbox"/>	Equinix San Jose	8038	206.223.116.	1000	<input type="checkbox"/>	PAIX Palo Alto	8038	198.32.176.	1000	<input type="checkbox"/>	PAIX Palo Alto	8038	2001:504:Dr::	1000	<input type="checkbox"/>	SFMIX	8038	206.197.187.	1000	<input type="checkbox"/>	Select Value				
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WHAT NEXT?

- We've a direct allocation
- We've IPv6 addresses for each of our IX locations
- We've made a list of info we will need to start
- We've updated peeringdb.com

DISCLAIMER

- Follow your own company change process!



CONFIGURING IPV6

- Locate existing IPv4 peering interfaces
- Enable IPv6 (Cisco)
- Configure the IPv6 address on the peering int
- Test

- First Cisco, then Juniper

CONFIGURING IPV6 CONT..

```
br01-1w-lax#conf t
Enter configuration commands, one per line. End with CNTL/Z.
br01-1w-lax(config)#ipv6 unicast-routing
br01-1w-lax(config)#^Z
```

- Enable IPv6 (Cisco)

```
br01-1w-lax#sh ip route 206.223.123.108
Routing entry for 206.223.123.0/25
  Known via "connected", distance 0, metric 0 (connected, via interface)
  Redistributing via ospf 23342, bgp 23342
  Advertised by ospf 23342 metric-type 1 subnets
  Routing Descriptor Blocks:
  * directly connected, via Vlan204
    Route metric is 0, traffic share count is 1
```

- Find the v4 int

```
!
interface Vlan204
 description [UL:PEERING:EQUINIX LAX] To EQX Peering
 ip address 206.223.123.108 255.255.255.128
 ip flow ingress
 ip flow egress
 load-interval 30
 no mop enabled
 no mop sysid
!
```

- Verify existing config

CONFIGURING IPV6 CONT..

```
br01-1w-lax#conf t
Enter configuration commands, one per line. End with CNTL/Z.
br01-1w-lax(config)#int vlan 204
br01-1w-lax(config-if)#ipv6 enable
br01-1w-lax(config-if)#ipv6 address 2001:504:0:3:0:2:3342:1/64
br01-1w-lax(config-if)#^Z

br01-1w-lax#ping 2001:504:0:3:0:2:3342:1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2001:504:0:3:0:2:3342:1, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 0/0/0 ms
br01-1w-lax#wr
Building configuration...
Compressed configuration from 60064 bytes to 21962 bytes
[OK]
```

- Configure

- Test

- We are passing IPv6 packets!

ZOOM IT A LITTLE

- Enabling IPv6 unicast on the router
 - + Cisco:
 - × 'ipv6 unicast-routing'
 - + Juniper
 - × enabled by default

INTERFACE CONFIG

■ Cisco

- + interface \$interface_name
- + ipv6 enable
- + ipv6 address 2001:1::1/64

■ Juniper

- + set interface \$interface_name unit \$unit family inet6 address 2001:1::1/64;

REACHING ACROSS THE INTERFACE

- Now that we have configured an interface and we know we can ping ourself, let's see if we can exchange some packets over IPv6 with the outside world.
- Finding other hosts in the subnet is no longer as simple as sending ICMP to the broadcast address. Instead IPv6 utilizes neighbor discovery.
- Let's take the easy way out and use peeringdb.

REACHING ACROSS THE INTERFACE

Navigation	Public Exchange Point Detailed View				List of Peers at this Exchange Point (Total: 63)			
Home Page	Common Name	Equinix Los Angeles			Peer Name	Local ASN	IP Address	IPs Policy
Logout	Long Name	Equinix Los Angeles Exchange			AboveNet Communications Inc.	6461		1 Restrictive
	City	Los Angeles			Advanced Video Communications	46294	206.223.123.124	1 Open
Your Records	Country	US			Akamai Technologies	20940	206.223.123.102	1 Open
Peering Record	Continental Region	North America			AT&T US - AS7132	7132	206.223.123.79	1 Selective
User Account	Media Type	Ethernet			BandCon	26769	206.223.123.26	1 Selective
	Protocols Supported	Unicast IPv4 <input checked="" type="checkbox"/> Multicast <input type="checkbox"/> IPv6 <input type="checkbox"/>			BitGravity, Inc.	40009	2001:504:0:3::4:9:1	2 Open
Search Records	Contact Information				CEINIC / CalREN	2152		1 Selective
Networks	Company Website	http://peering.equinix.com/			Chunghwa Telecom	9505	206.223.123.51	1 Open
Exchange Points	Traffic Statistics Website				Cox Communications	22773	206.223.123.42	1 Selective
Facilities	Technical E-Mail	support@equinix.com			DALnet IRC Network	31800	206.223.123.88	1 Open
Common Points	Technical Phone				EarthLink	4355	206.223.123.32	1 Open
Suggestions	Policy E-Mail	support@equinix.com			Equinix Corp Network	14609	206.223.123.126	1 Open
Comments	Policy Phone				FAT Networks, LLC	14076	206.223.123.30	1 Open
New Exchange	IP Address Blocks				Giganews	30094	206.223.123.114	1 Open
New Facility	Type	Address Block	Reverse DNS Scan		Global NAPS, GNAPS	1784	206.223.123.41	1 Open
	IPv4 Unicast	206.223.123.0/25	Link		Guam Cablevision, LLC	3605	206.223.123.3	1 Open
	IPv6 Unicast	2001:504:0:3::/64	Unsupported		Highwinds Network Group, Inc	12989	2001:504:0:3::1:2989:1	2 Selective
Help	Local Facilities				Hurricane Electric	6939	2001:504:0:3::6939:1	2 Open
FAQ	Facility Name	City	Country	Participant Count	Hypermedia Systems	30212	206.223.123.9	1 Open
Statistics	Equinix El Segundo (LA3)	El Segundo	US	10	ICANN	40528	2001:504:0:3:0:4:0528:1	2 Open
	Equinix Los Angeles (LA1)	Los Angeles	US	77	imeem, inc.	36119	206.223.123.53	1 Selective
					Integra Telecom	7385	2001:504:0:3::7385:1	2 Open
					Internap	22212	206.223.123.29	1 Selective
					1 2 3 of 3 Next > Last >>			

```
br01-1w-lax#ping 2001:504:0:3::6939:1
```

```
Type escape sequence to abort.
```

```
Sending 5, 100-byte ICMP Echos to 2001:504:0:3::6939:1, timeout is 2 seconds:
```

```
!!!!
```

```
Success rate is 100 percent (5/5), round-trip min/avg/max = 0/2/4 ms
```


CONFIGURING IPV6 ON A JUNIPER

■ Find the IPv4 interface

```
syntax error, expecting <command>.  
aaronh@br01-eqx-ash> show route 206.223.115.154  
  
inet.0: 281580 destinations, 632286 routes (281580 active, 0 holddown, 0 hidden)  
+ = Active Route, - = Last Active, * = Both  
  
206.223.115.154/32 *[Local/0] 19w3d 08:10:51  
                Local via ge-1/3/0.3
```

■ Verify the config

```
aaronh@br01-eqx-ash> show configuration interfaces ge-1/3/0 unit 3  
description "[PEER:EQX:ASH] Equinix Peering Fabric";  
vlan-id 200;  
family inet {  
    filter {  
        input all;  
        output all;  
    }  
    address 206.223.115.154/24;  
}
```

■ Configure the IPv6 address

```
aaronh@br01-eqx-ash# set interfaces ge-1/3/0 unit 4 family inet6 address address 2001:504:0:2::2:3342:1/64;
```

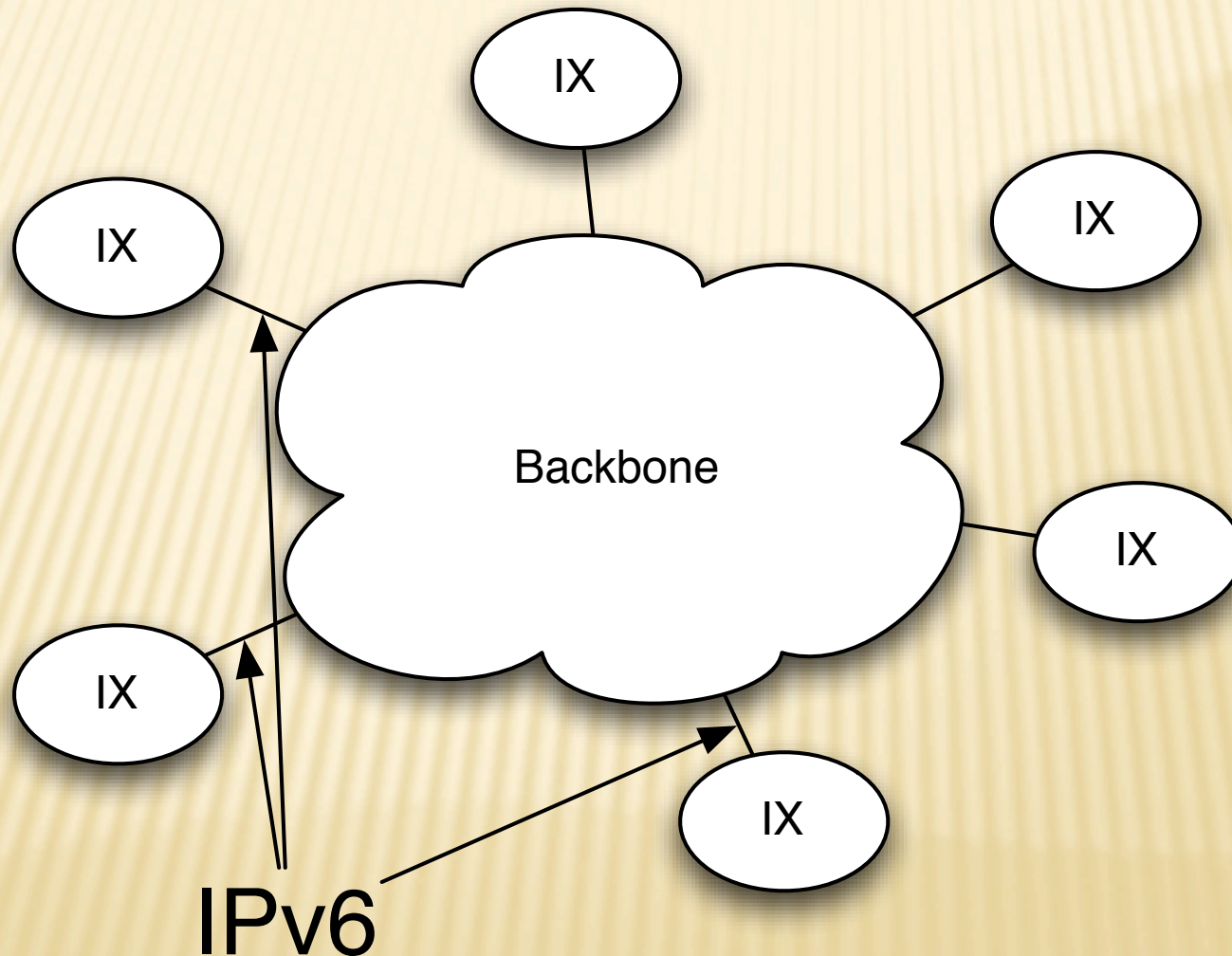
CONFIGURING ON A JUNIPER CONT.

```
aaronh@br01-eqx-ash> ping 2001:504:0:2::2:3342:1
PING6(56=40+8+8 bytes) 2001:504:0:2:0:2:3342:1 --> 2001:504:0:2:0:2:3342:1
16 bytes from 2001:504:0:2:0:2:3342:1, icmp_seq=0 hlim=64 time=0.265 ms
16 bytes from 2001:504:0:2:0:2:3342:1, icmp_seq=1 hlim=64 time=0.144 ms
16 bytes from 2001:504:0:2:0:2:3342:1, icmp_seq=2 hlim=64 time=0.161 ms
16 bytes from 2001:504:0:2:0:2:3342:1, icmp_seq=3 hlim=64 time=0.171 ms
16 bytes from 2001:504:0:2:0:2:3342:1, icmp_seq=4 hlim=64 time=0.173 ms
16 bytes from 2001:504:0:2:0:2:3342:1, icmp_seq=5 hlim=64 time=0.172 ms
16 bytes from 2001:504:0:2:0:2:3342:1, icmp_seq=6 hlim=64 time=0.156 ms
^C
--- 2001:504:0:2::2:3342:1 ping6 statistics ---
7 packets transmitted, 7 packets received, 0% packet loss
round-trip min/avg/max/std-dev = 0.144/0.177/0.265/0.037 ms
```

- IPv6 packets are passing!

WHERE ARE WE?

- IPv6 addresses are configured on the IX edges



WHERE ARE WE?

- ✓ Obtain an IPv6 allocation
- ✓ My first IPv6 packets
 - Dual stacking the backbone
 - OSPFv3 implementation
 - IPv6 iBGP implementation
 - IPv6 eBGP implementation
 - IPv6 peering
 - Extending dual stack from the backbone
 - IPv6 for your customers

IPV6 INTERNAL ASSIGNMENTS

- Keeping track of your peering interface address is one thing, however, keeping track of your internal assignments is an entirely different thing.
- If you have the resources to do so, write a tool to manage IPv6 DNS and assignments.
- If not?
 - + Spreadsheet?
 - + Database?
 - + DNS zone files?

ALLOCATION AND ASSIGNMENT TOOLS

- If you have the resources, write a tool

6connect

Welcome Aaron Hughes of 6connect, Inc.

1743 Park Ave.
Suite 130
San Jose, CA, US, 95126

View as:

Home Leads Opportunities Accounts Contacts Assets Support Monitoring Ticketing Cabinets Locations IP Logout

IPv4 - IPv6	Hosts	Is SWIPed	Is Aggregate	CustID	Description	Company Name	Action Filter:(Available Assigned) ARIN Report
2607:fae0:0:0::/64	2^64	0	0	1		6connect, Inc.	Description Reclaim whois viewSWIP sendSWIP
2607:fae0:0:1::/64	2^64	0	0	7		6connect Available	Assign
2607:fae0:0:2::/64	2^64	1	0	8		InfinIT Consulting	Description whois viewSWIP sendDESWIP
2607:fae0:0:3::/64	2^64	0	0	7		6connect Available	Assign
2607:fae0:0:4::/64	2^64	0	0	7		6connect Available	Assign
2607:fae0:0:5::/64	2^64	0	0	7		6connect Available	Assign
2607:fae0:0:6::/64	2^64	0	0	7		6connect Available	Assign
2607:fae0:0:7::/64	2^64	0	0	7		6connect Available	Assign
2607:fae0:0:8::/64	2^64	0	0	7		6connect Available	Assign
2607:fae0:0:9::/64	2^64	0	0	7		6connect Available	Assign
2607:fae0:0:a::/64	2^64	0	0	7		6connect Available	Assign
2607:fae0:0:b::/64	2^64	0	0	7		6connect Available	Assign
2607:fae0:0:c::/64	2^64	0	0	7		6connect Available	Assign
2607:fae0:0:d::/64	2^64	0	0	7		6connect Available	Assign
2607:fae0:0:e::/64	2^64	0	0	7		6connect Available	Assign
2607:fae0:0:f::/64	2^64	0	0	7		6connect Available	Assign
2607:fae0:0:10::/64	2^64	0	0	7		6connect Available	Assign
2607:fae0:0:1000::/64	2^64	0	0	7		6connect Available	Assign
2607:fae0:0:1001::/64	2^64	0	0	7		6connect Available	Assign
2607:fae0:0:1002::/64	2^64	0	0	7		6connect Available	Assign
2607:fae0:1:0::/48	2^48	0	0	7		6connect Available	Assign
2607:fae0:2:0::/48	2^48	1	0	8		InfinIT Consulting	Description whois viewSWIP sendDESWIP
2607:fae0:3:0::/48	2^48	0	0	7		6connect Available	Assign
2607:fae0:4:0::/48	2^48	0	0	7		6connect Available	Assign
2607:fae0:5:0::/48	2^48	0	0	7		6connect Available	Assign
2607:fae0:6:0::/48	2^48	0	0	7		6connect Available	Assign
2607:fae0:7:0::/48	2^48	0	0	7		6connect Available	Assign

Assigned Hosts: 3.68937696224E+19, Total Hosts: 3.68936851799E+20 Percentage used: 10.0000228881

[Generate next /48](#)

[Generate next /64 for Customer](#)

[Generate next /64 Give for Infrastructure](#)

- Tuesday, October 20, 2009

NUMBERING PLAN

```

/16  /32  /48  /64  /80  /96  /112
  v    v    v    v    v    v    v
2001:aaaa:bbbb:cccc:dddd:eeee:ffff:1111

```

Here is a little shortcut to hopefully help you subnet IPv6.

```

/16 /32 /48 /64 /80 /96 /112
 v  v  v  v  v  v  v
2001:aaaa:bbbb:cccc:dddd:eeee:ffff:1111

```

Prefix	/48 count	/56 count	Number of /64 Subnets	Number of Hosts
/64			1	18,446,744,073,709,551,616 (2^{64}) (quintillion)
/63			2	36,893,488,147,419,103,232
/62			4	73,786,976,294,838,206,464
/61			8	147,573,952,589,676,412,928
/60			16	295,147,905,179,352,825,856
/59			32	590,295,810,358,705,651,712
/58			64	1,180,591,620,717,411,303,424 (sextillion)
/57			128	2,361,183,241,434,822,606,848
/56		1	256	4,722,366,482,869,645,213,696 (2^{72})
/55		2	512	9,444,732,965,739,290,427,392
/54		4	1,024	18,889,465,931,478,580,854,784
/53		8	2,048	37,778,931,862,957,161,709,568
/52		16	4,096	75,557,863,725,914,323,419,136
/51		32	8,192	151,115,727,451,828,646,838,272
/50		64	16,384	302,231,454,903,657,293,676,544
/49		128	32,768	604,462,909,807,314,587,353,088
/48	1	256	65,536	1,208,925,819,614,629,174,706,176 (2^{80}) (septillion)

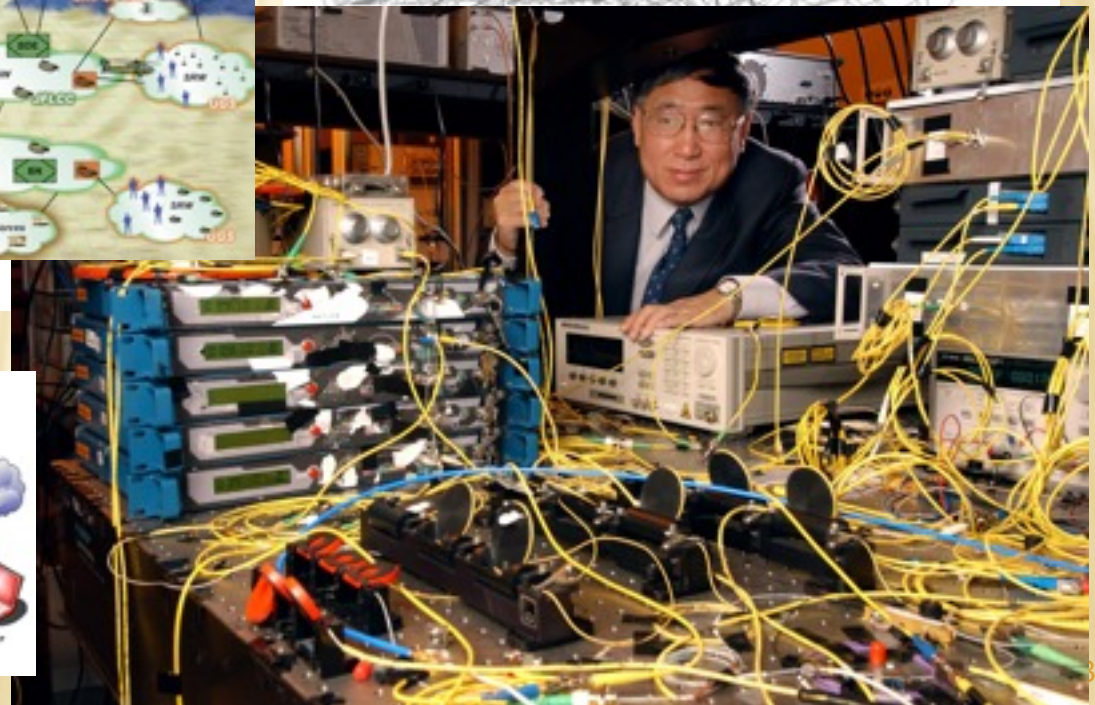
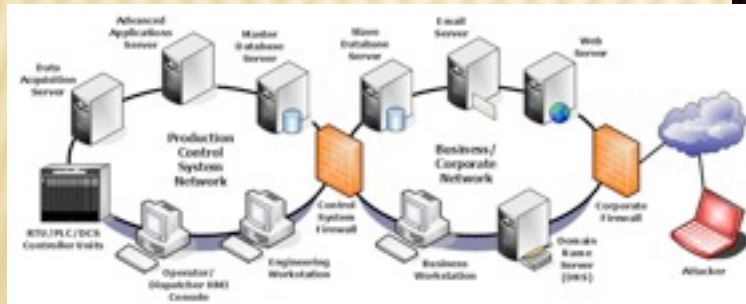
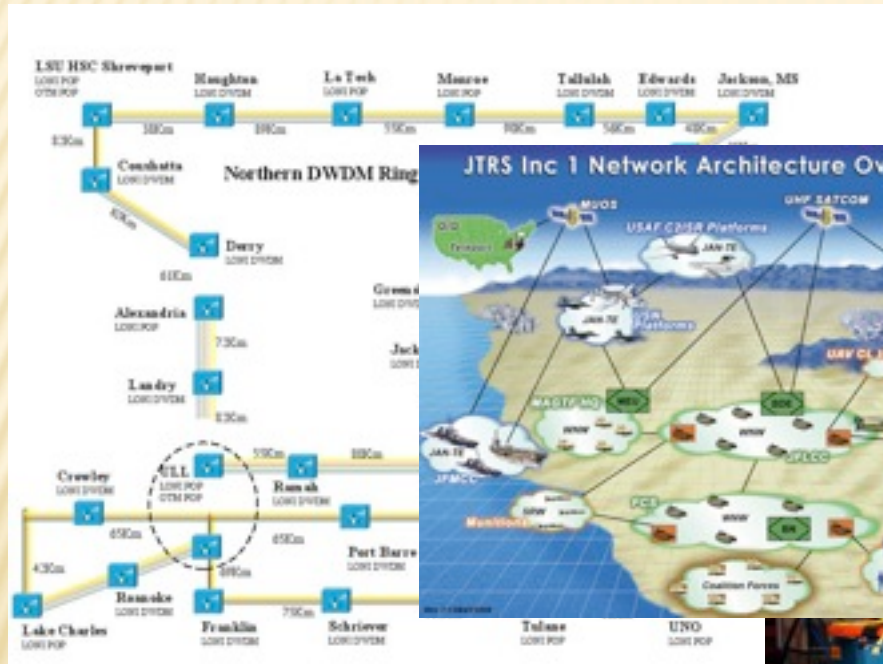
65,536 1,208,925,819,614,629,174,706,176 (2^{80}) (septillion)

- Cut first /48 for infrastructure
- Cut a /64 off the top for loopbacks

[illegible]

ARCHITECTURE OF YOUR NETWORK

- Opportunity to change vs. keep the same as v4

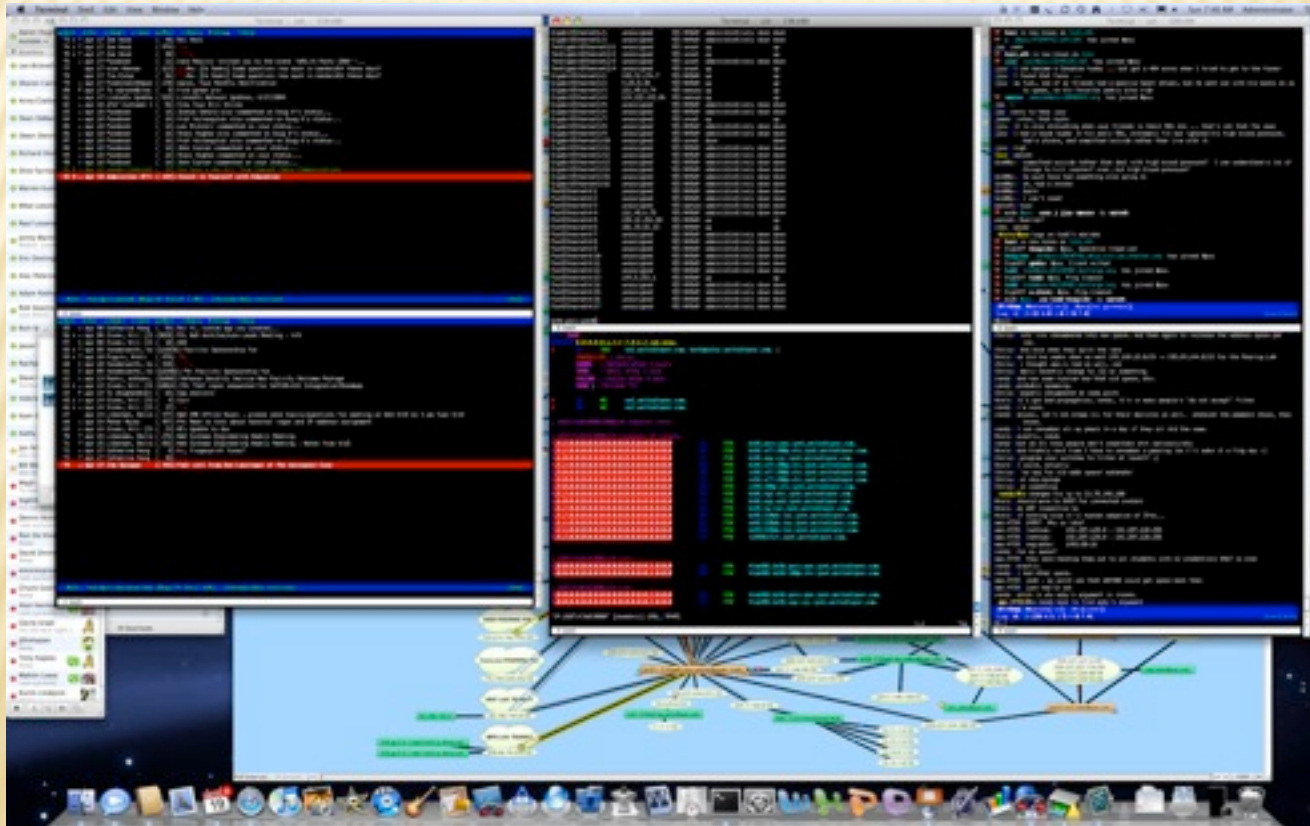


ARCHITECTURE CHOICES

- There are a ton of opinions about how to architect a network. For the purpose of this presentation, I've just picked one.
- Basic Network Architecture
 - + Loopbacks and connected infrastructure into OSPF
 - + iBGP full mesh sourced off loopbacks
 - + iBGP next-hop-self
 - + All connected except loopbacks into iBGP
 - + eBGP distribution via route-maps and communities

CONFIGURING YOUR BACKBONE

- Open your mail client, DNS zone editor and whatever application you use to access routers.



- ```

217 IN PTR cr02-365a-sfo.unitedlayer.com.
226 IN PTR cr01-365a-sfo.unitedlayer.com.
234 IN PTR br01-530w6-lax.unitedlayer.com.
247 IN PTR br01-paix-pao.unitedlayer.com.
251 IN PTR br01-530w6-lax.unitedlayer.com.
252 IN PTR br02-sf7-200p-sfo.unitedlayer.com.
253 IN PTR br01-1w-lax.unitedlayer.com.
254 IN PTR br01-sf9-200p-sfo.unitedlayer.com.

```

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# STARTING ROUTER

- Pick one router connected to an IX to start with.

```
ipv6 router ospf 23342
```

- Some versions of IOS require this.

```
!
interface Loopback0
description [UL:LOOPBACK]
ip address 209.237.224.247 255.255.255.255
ipv6 address 2607:F3A0::247/128
ipv6 enable
ipv6 ospf 23342 area 0
!
```

```
br01-paix-pao(config)#ipv6 ospf name-lookup
br01-paix-pao(config)#
```

```
interface Vlan903
description [UL:VLAN] ->br01-eqx-sjc-v903
mtu 9216
ip address 207.7.159.53 255.255.255.252
ip ospf cost 2
ipv6 address 2607:F3A0:0:2::1/64
ipv6 enable
ipv6 ospf 23342 area 0
!
```

- Enable IPv6 on the interface
- Add the IPv6 Address
- Enable IPv6 OSPF name-lookup
- Extend to edge interfaces facing backbone routers.

# EXTENDING IPV6 INTO YOUR CORE

- Rinse. Repeat.
- Extend from the outside in and watch as the OSPFv3 IPv6 sessions come up

```
br01-paix-pao#sh ip os ne
```

| Neighbor ID     | Pri | State   | Dead Time | Address       | Interface |
|-----------------|-----|---------|-----------|---------------|-----------|
| cr01-55sm-sjc.u | 1   | FULL/DR | 00:00:31  | 207.7.159.110 | Vlan905   |
| br01-eqx-sjc.un | 1   | FULL/DR | 00:00:34  | 207.7.159.54  | Vlan903   |
| br02-sf7-200p-s | 1   | FULL/DR | 00:00:39  | 207.7.129.74  | Vlan902   |

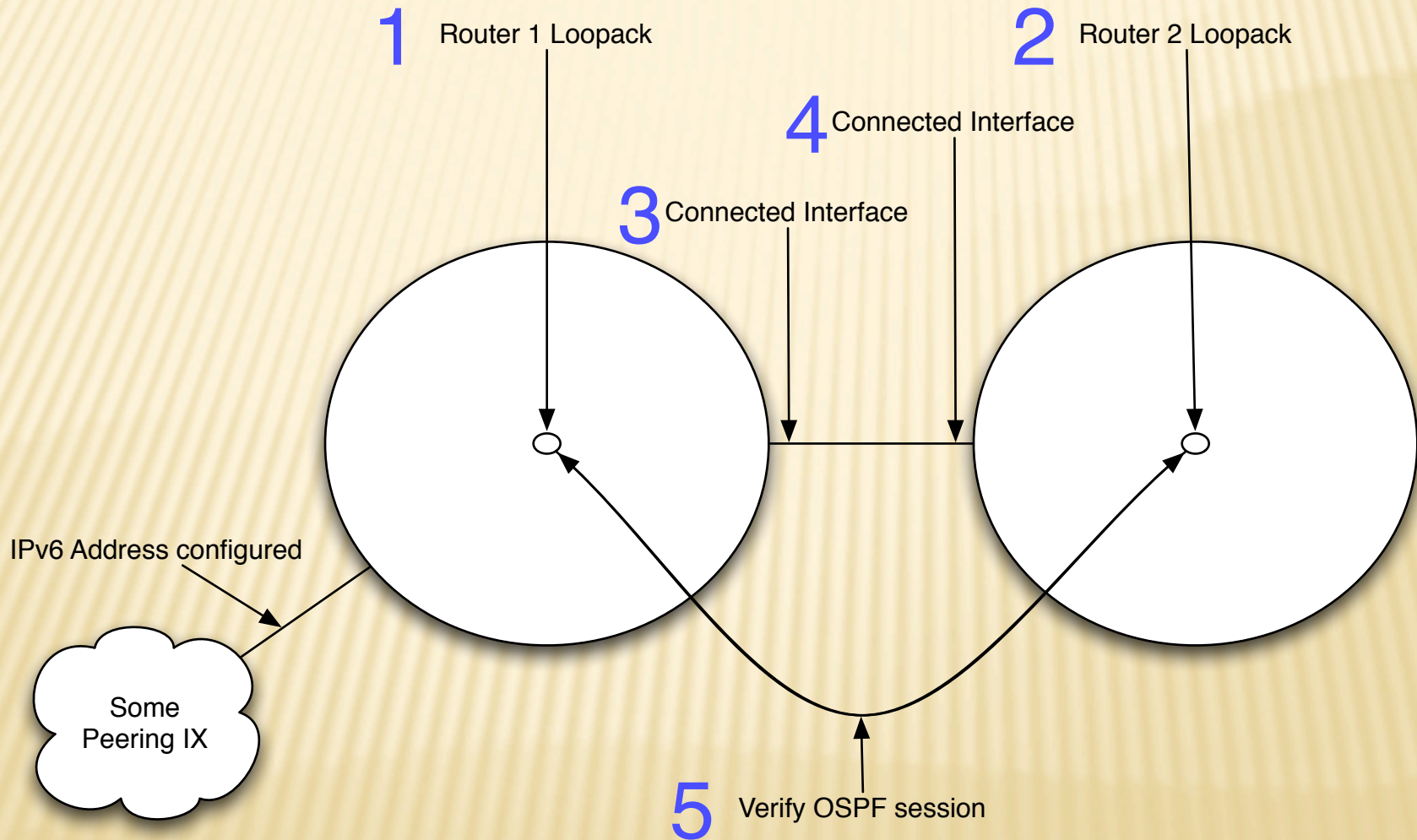
```
br01-paix-pao#sh ipv6 os ne
```

| Neighbor ID     | Pri | State   | Dead Time | Interface ID | Interface |
|-----------------|-----|---------|-----------|--------------|-----------|
| br01-eqx-sjc.un | 1   | FULL/DR | 00:00:31  | 85           | Vlan903   |
| br02-sf7-200p-s | 1   | FULL/DR | 00:00:36  | 79           | Vlan902   |

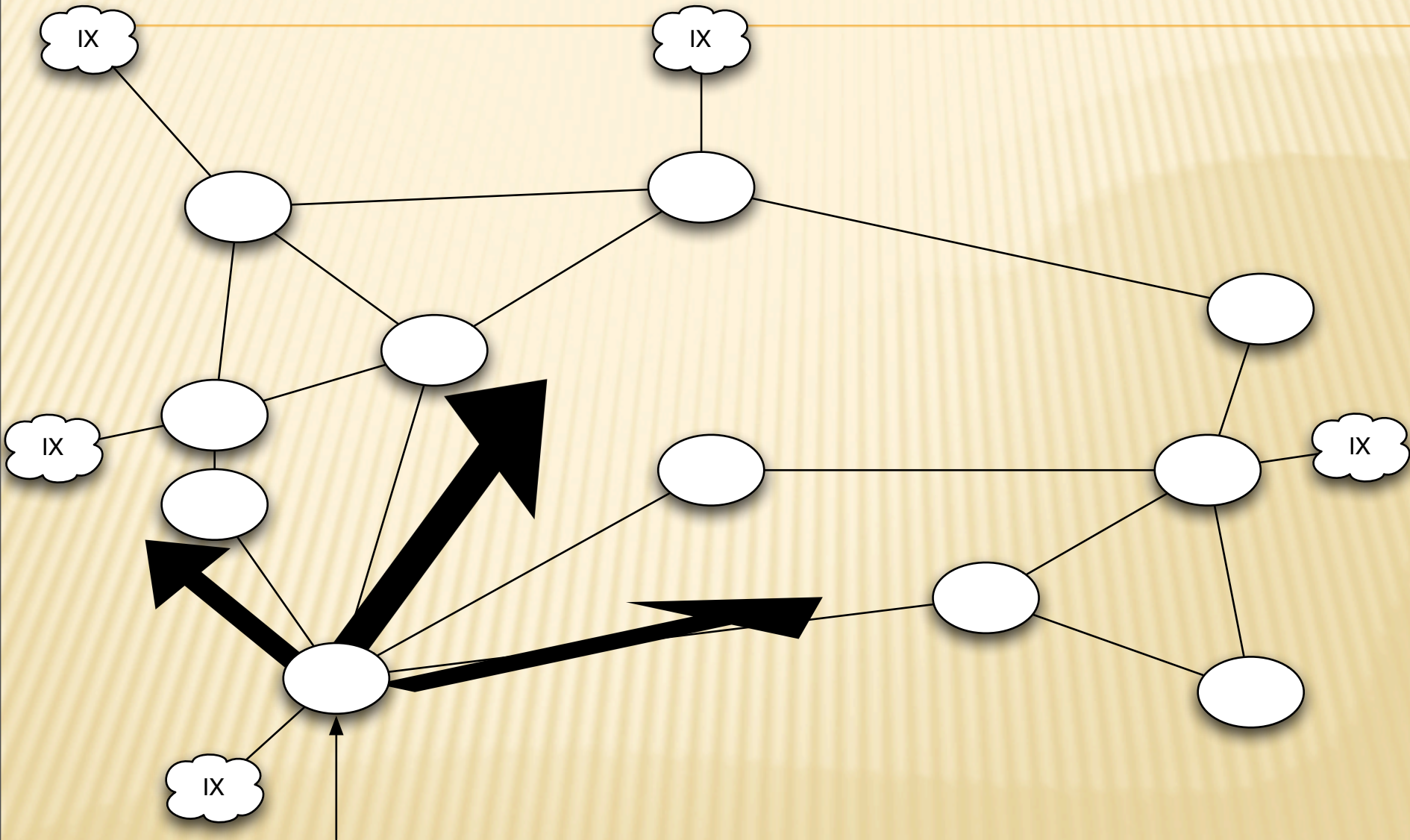
```
br01-paix-pao#
```



# EXTENDING IN FROM THE PEERING EDGE



# 10,000 FOOT VIEW



Pick a starting point  
Slowly work your way out across the connected links.

# MANAGING ASSIGNMENTS WITH DNS ZONE

- First /48 for all internal infrastructure
  - + Alternatively you can get a direct allocation for this.
- First /64 of the /48 for router loopbacks
- Second /64 is for your first connected interface



# CUT, PASTE, INCREMENT

```
; 2607:f3a0:0:0001/64 Link
1.0.1.0.0.0 IN PTR Vlan982.br01-paix-pao.ipv6.unitedlayer.com.
2.0.1.0.0.0 IN PTR Vlan982.br02-200p-sfo.ipv6.unitedlayer.com.

; 2607:f3a0:0:0002/64 Link
1.0.2.0.0.0 IN PTR Vlan983.br01-paix-pao.ipv6.unitedlayer.com.
2.0.2.0.0.0 IN PTR Vlan983.br01-exq-sjc.ipv6.unitedlayer.com.

; 2607:f3a0:0:0003/64 Link
1.0.3.0.0.0 IN PTR Vlan984.br01-200p-sfo.ipv6.unitedlayer.com.
2.0.3.0.0.0 IN PTR Vlan984.br01-exq-sjc.ipv6.unitedlayer.com.

; 2607:f3a0:0:0004/64 Link
1.0.4.0.0.0 IN PTR Vlan884.br02-200p-sfo.ipv6.unitedlayer.com.
2.0.4.0.0.0 IN PTR Vlan884.br01-200p-sfo.ipv6.unitedlayer.com.

; 2607:f3a0:0:0005/64 Link
1.0.5.0.0.0 IN PTR Vlan518.br01-200p-sfo.ipv6.unitedlayer.com.
2.0.5.0.0.0 IN PTR Vlan518.cr01-200p-sfo.ipv6.unitedlayer.com.

; 2607:f3a0:0:0006/64 Link
1.0.6.0.0.0 IN PTR Vlan529.br01-200p-sfo.ipv6.unitedlayer.com.
2.0.6.0.0.0 IN PTR Vlan529.cr02-200p-sfo.ipv6.unitedlayer.com.

; 2607:f3a0:0:0007/64 Link
1.0.7.0.0.0 IN PTR Vlan887.cr01-200p-sfo.ipv6.unitedlayer.com.
2.0.7.0.0.0 IN PTR Vlan887.cr02-200p-sfo.ipv6.unitedlayer.com.
```

# WHAT COMES AFTER 9?

[illegible]



# CONFIGURE THE BACKBONE

- Time passes.. /64s and /128s in OSPF

```

#PVE-rolling-guests.sh /tmp/roam/roam.sh
[PVE-Rolling-Table - Default - 1024 entries
Codes: C - Corrected, L - Local, S - Static, U - Per-user Static table
B = 1024, R = 1024, I = 1024 L1, L2 = 1024 L2
1A - 1025 references, 1B - 1025 memory
C - DIFF Defrag, O1 - DIFF Integ, O2 - DIFF ext 1, O3 - DIFF ext 2
O4 - DIFF ext 3, O5 - DIFF ext 4, O6 - DIFF ext 5
0 268T/F34d:126/126 [10A/1]
via FE80::126/126/F34C:0000, Vlan062
0 268T/F34d:127/126 [10A/1]
via FE80::126/126/F34C:0000, Vlan062
0 268T/F34d:128/126 [10A/2]
via FE80::128/126/F34C:0000, Vlan062
0 268T/F34d:129/126 [10A/2]
via FE80::129/126/F34C:0000, Vlan062
0 268T/F34d:130/126 [10A/2]
via FE80::130/126/F34C:0000, Vlan062
0 268T/F34d:131/126 [10A/2]
via FE80::131/126/F34C:0000, Vlan062
0 268T/F34d:132/126 [10A/2]
via FE80::132/126/F34C:0000, Vlan062
0 268T/F34d:133/126 [10A/2]
via FE80::133/126/F34C:0000, Vlan062
0 268T/F34d:134/126 [10A/2]
via FE80::134/126/F34C:0000, Vlan062
0 268T/F34d:135/126 [10A/2]
via FE80::135/126/F34C:0000, Vlan062
0 268T/F34d:136/126 [10A/2]
via FE80::136/126/F34C:0000, Vlan062
0 268T/F34d:137/126 [10A/2]
via FE80::137/126/F34C:0000, Vlan062
0 268T/F34d:138/126 [10A/2]
via FE80::138/126/F34C:0000, Vlan062
0 268T/F34d:139/126 [10A/2]
via FE80::139/126/F34C:0000, Vlan062
0 268T/F34d:140/126 [10A/2]
via FE80::140/126/F34C:0000, Vlan062
0 268T/F34d:141/126 [10A/2]
via FE80::141/126/F34C:0000, Vlan062
0 268T/F34d:142/126 [10A/2]
via FE80::142/126/F34C:0000, Vlan062
0 268T/F34d:143/126 [10A/2]
via FE80::143/126/F34C:0000, Vlan062
0 268T/F34d:144/126 [10A/2]
via FE80::144/126/F34C:0000, Vlan062
0 268T/F34d:145/126 [10A/2]
via FE80::145/126/F34C:0000, Vlan062
0 268T/F34d:146/126 [10A/2]
via FE80::146/126/F34C:0000, Vlan062
0 268T/F34d:147/126 [10A/2]
via FE80::147/126/F34C:0000, Vlan062
0 268T/F34d:148/126 [10A/2]
via FE80::148/126/F34C:0000, Vlan062
0 268T/F34d:149/126 [10A/2]
via FE80::149/126/F34C:0000, Vlan062
0 268T/F34d:150/126 [10A/2]
via FE80::150/126/F34C:0000, Vlan062
0 268T/F34d:151/126 [10A/2]
via FE80::151/126/F34C:0000, Vlan062
0 268T/F34d:152/126 [10A/2]
via FE80::152/126/F34C:0000, Vlan062
0 268T/F34d:153/126 [10A/2]
via FE80::153/126/F34C:0000, Vlan062
0 268T/F34d:154/126 [10A/2]
via FE80::154/126/F34C:0000, Vlan062
0 268T/F34d:155/126 [10A/2]
via FE80::155/126/F34C:0000, Vlan062
0 268T/F34d:156/126 [10A/2]
via FE80::156/126/F34C:0000, Vlan062
0 268T/F34d:157/126 [10A/2]
via FE80::157/126/F34C:0000, Vlan062
0 268T/F34d:158/126 [10A/2]
via FE80::158/126/F34C:0000, Vlan062
0 268T/F34d:159/126 [10A/2]
via FE80::159/126/F34C:0000, Vlan062
0 268T/F34d:160/126 [10A/2]
via FE80::160/126/F34C:0000, Vlan062
0 268T/F34d:161/126 [10A/2]
via FE80::161/126/F34C:0000, Vlan062
0 268T/F34d:162/126 [10A/2]
via FE80::162/126/F34C:0000, Vlan062
0 268T/F34d:163/126 [10A/2]
via FE80::163/126/F34C:0000, Vlan062
0 268T/F34d:164/126 [10A/2]
via FE80::164/126/F34C:0000, Vlan062
0 268T/F34d:165/126 [10A/2]
via FE80::165/126/F34C:0000, Vlan062
0 268T/F34d:166/126 [10A/2]
via FE80::166/126/F34C:0000, Vlan062
0 268T/F34d:167/126 [10A/2]
via FE80::167/126/F34C:0000, Vlan062
0 268T/F34d:168/126 [10A/2]
via FE80::168/126/F34C:0000, Vlan062
0 268T/F34d:169/126 [10A/2]
via FE80::169/126/F34C:0000, Vlan062
0 268T/F34d:170/126 [10A/2]
via FE80::170/126/F34C:0000, Vlan062
0 268T/F34d:171/126 [10A/2]
via FE80::171/126/F34C:0000, Vlan062
0 268T/F34d:172/126 [10A/2]
via FE80::172/126/F34C:0000, Vlan062
0 268T/F34d:173/126 [10A/2]
via FE80::173/126/F34C:0000, Vlan062
0 268T/F34d:174/126 [10A/2]
via FE80::174/126/F34C:0000, Vlan062
0 268T/F34d:175/126 [10A/2]
via FE80::175/126/F34C:0000, Vlan062
0 268T/F34d:176/126 [10A/2]
via FE80::176/126/F34C:0000, Vlan062
0 268T/F34d:177/126 [10A/2]
via FE80::177/126/F34C:0000, Vlan062
0 268T/F34d:178/126 [10A/2]
via FE80::178/126/F34C:0000, Vlan062
0 268T/F34d:179/126 [10A/2]
via FE80::179/126/F34C:0000, Vlan062
0 268T/F34d:180/126 [10A/2]
via FE80::180/126/F34C:0000, Vlan062
0 268T/F34d:181/126 [10A/2]
via FE80::181/126/F34C:0000, Vlan062
0 268T/F34d:182/126 [10A/2]
via FE80::182/126/F34C:0000, Vlan062
0 268T/F34d:183/126 [10A/2]
via FE80::183/126/F34C:0000, Vlan062
0 268T/F34d:184/126 [10A/2]
via FE80::184/126/F34C:0000, Vlan062
0 268T/F34d:185/126 [10A/2]
via FE80::185/126/F34C:0000, Vlan062
0 268T/F34d:186/126 [10A/2]
via FE80::186/126/F34C:0000, Vlan062
0 268T/F34d:187/126 [10A/2]
via FE80::187/126/F34C:0000, Vlan062
0 268T/F34d:188/126 [10A/2]
via FE80::188/126/F34C:0000, Vlan062
0 268T/F34d:189/126 [10A/2]
via FE80::189/126/F34C:0000, Vlan062
0 268T/F34d:190/126 [10A/2]
via FE80::190/126/F34C:0000, Vlan062
0 268T/F34d:191/126 [10A/2]
via FE80::191/126/F34C:0000, Vlan062
0 268T/F34d:192/126 [10A/2]
via FE80::192/126/F34C:0000, Vlan062
0 268T/F34d:193/126 [10A/2]
via FE80::193/126/F34C:0000, Vlan062
0 268T/F34d:194/126 [10A/2]
via FE80::194/126/F34C:0000, Vlan062
0 268T/F34d:195/126 [10A/2]
via FE80::195/126/F34C:0000, Vlan062
0 268T/F34d:196/126 [10A/2]
via FE80::196/126/F34C:0000, Vlan062
0 268T/F34d:197/126 [10A/2]
via FE80::197/126/F34C:0000, Vlan062
0 268T/F34d:198/126 [10A/2]
via FE80::198/12
```

```

0 2607:F3A0:0:3::/64 [110/3]
 via FE80::219:7FF:FE31:B000, Vlan902
0 2607:F3A0:0:4::/64 [110/2]
 via FE80::219:7FF:FE31:B000, Vlan902
0 2607:F3A0:0:5::/64 [110/3]
 via FE80::219:7FF:FE31:B000, Vlan902
0 2607:F3A0:0:6::/64 [110/3]

```

```
br01-paix-pao#sh ipv6 route ospf
IPv6 Routing Table - Default - 1834 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user Static route
 B - BGP, R - RIP, I1 - ISIS L1, I2 - ISIS L2
 IA - ISIS interarea, IS - ISIS summary
 O - OSPF Intra, OI - OSPF Inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
 ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
0 2607:F3A0::66/128 [110/91]
 via FE80::219:7FF:FE31:B000, Vlan902
0 2607:F3A0::67/128 [110/1]
 via FE80::21A:30FF:FE28:15C0, Vlan903
0 2607:F3A0::92/128 [110/2]
```



# WHERE ARE WE?

- ✓ Obtain an IPv6 allocation
- ✓ My first IPv6 packets
- ✓ Dual stacking the backbone
- ✓ OSPFv3 implementation
  - IPv6 iBGP implementation
  - IPv6 eBGP implementation
  - IPv6 peering
  - Extending dual stack from the backbone
  - IPv6 for your customers

# WHERE ARE WE CONT.

- IPv6 configured on all exchange interfaces
- IPv6 configured on all loopback interfaces
- IPv6 configured on all connected interfaces between backbone routers.
- OSPFv3 configured on Loopbacks (/128s)
- OSPFv3 configured on connected (/64s)
- What's next?
  - + I want to access the rest of the IPv6 world
  - + Next we configure iBGP

# IPV6 PEER PEER-GROUP

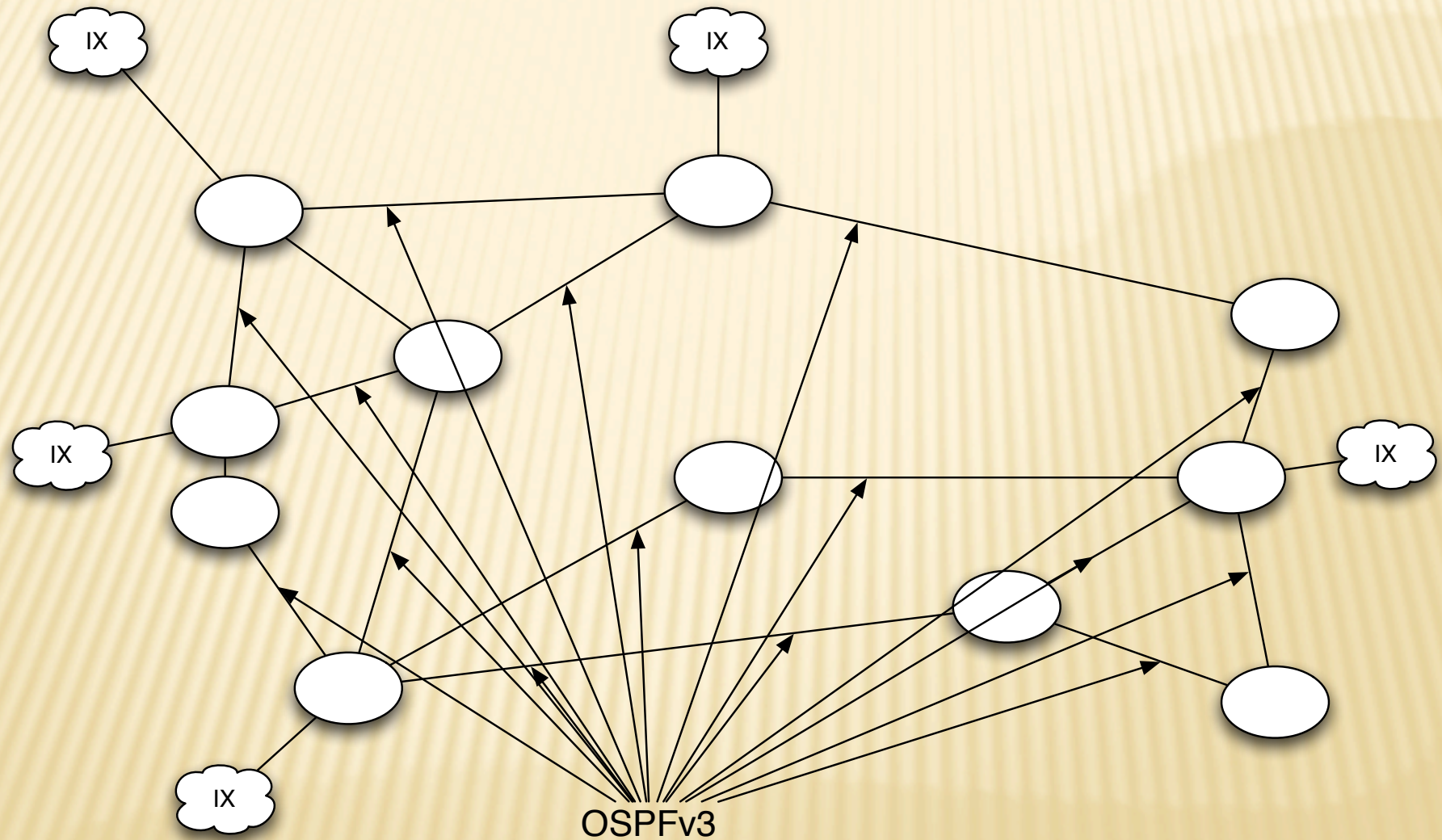
- Peer group for an IPv6 peer:
  - + neighbor PEERS-v6 peer-group
  - + neighbor PEERS-v6 soft-reconfiguration inbound
  - + neighbor PEERS-v6 prefix-list Sanity-v6 in
  - + neighbor PEERS-v6 prefix-list Sanity-v6 out
  - + neighbor PEERS-v6 route-map PEER-IN-v6 in
  - + neighbor PEERS-v6 route-map PEER-OUT-v6 out



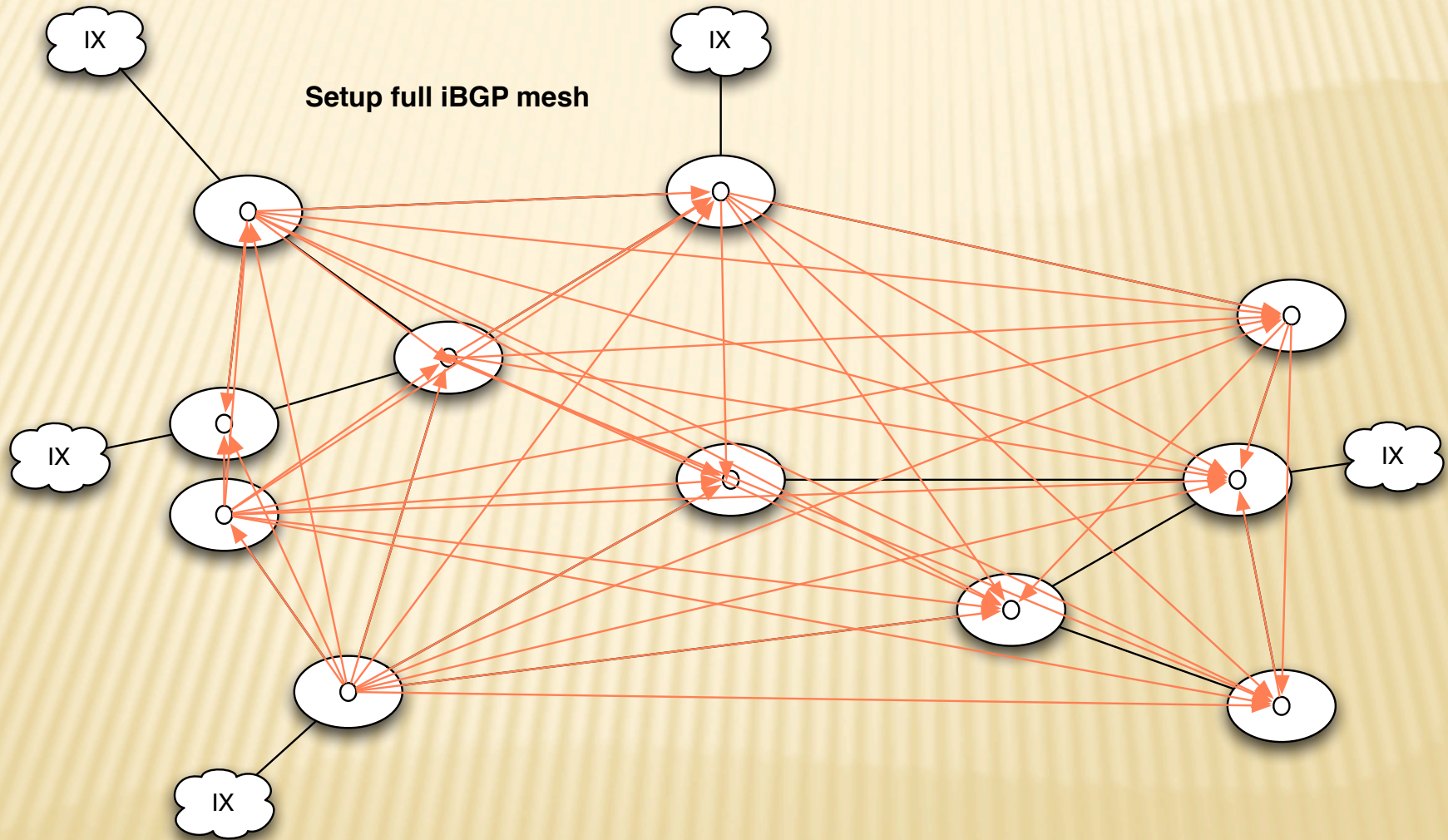
# IPV6 IBGP PEER-GROUP

- Peer group for an IPv6 core router:
  - + neighbor CORE-v6 peer-group
  - + neighbor CORE-v6 remote-as XXXX < your ASN
  - + neighbor CORE-v6 soft-reconfiguration inbound
  - + neighbor CORE-v6 update-source Loopback0
  - + neighbor CORE-v6 send-community
  - + neighbor CORE-v6 next-hop-self

# IBGP OVER OSPFV3

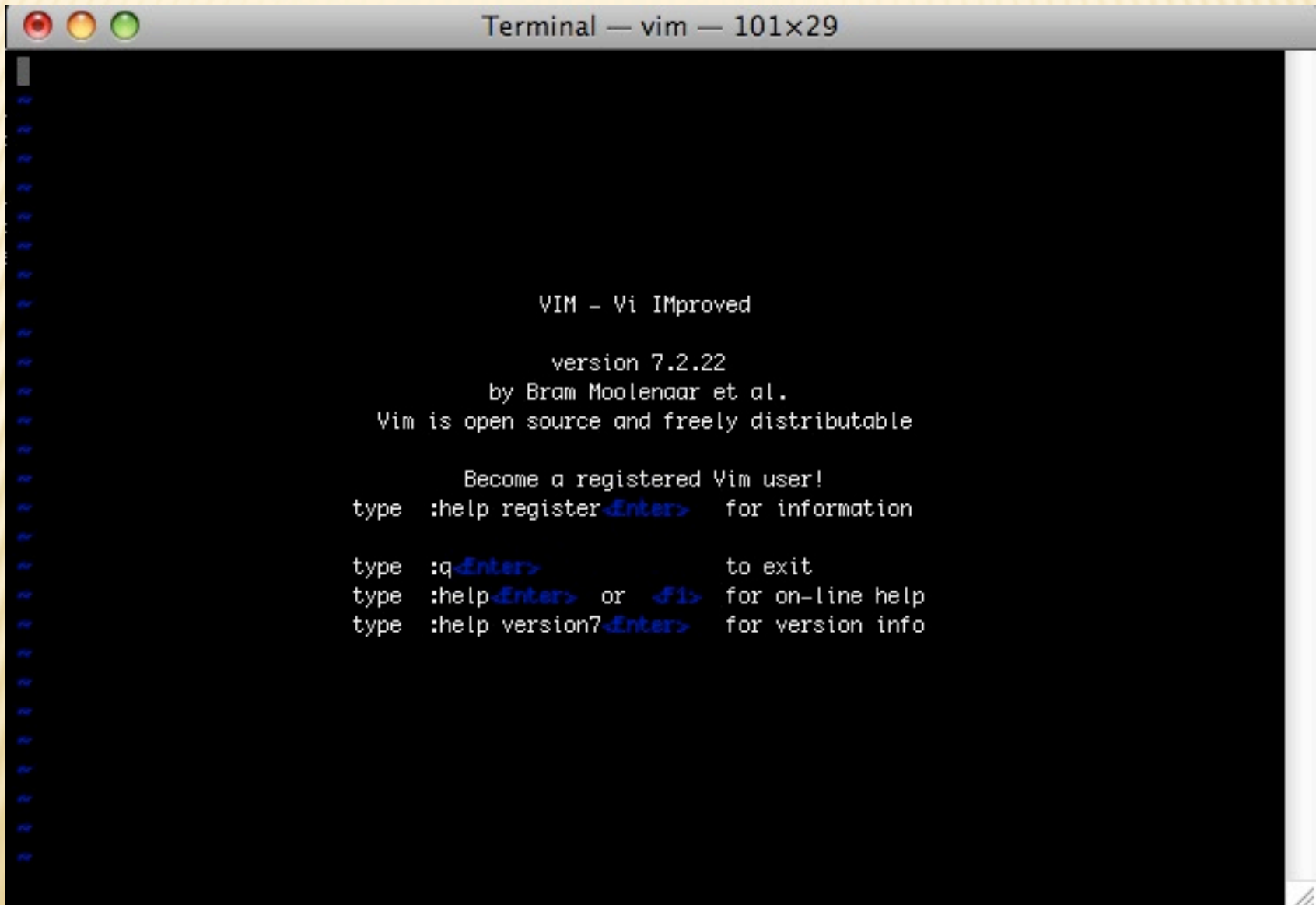


# IBGP SOURCES OFF LOOPBACKS





# OPEN AN EDITOR FOR COMMON CONFIGS



```
Terminal — vim — 101x29

VIM - Vi IMproved

version 7.2.22
by Bram Moolenaar et al.
Vim is open source and freely distributable

Become a registered Vim user!
type :help register<Enter> for information

type :q<Enter> to exit
type :help<Enter> or <F1> for on-line help
type :help version7<Enter> for version info
```

# IBGP CONFIGURATION

- Remember iBGP is going to handle connected interfaces (except loopbacks)
- We use a route-map to do this:
  - + route-map redist-connected-v6 deny 10
    - × match interface Loopback0
  - + route-map redist-connected-v6 permit 20
    - × match ipv6 address matchall
    - × set community 6:1

# BASIC IPV6 BGP CONFIG

- + router bgp XXXX <- your ASN
- + address-family ipv6
- + network 2607:ffff::/32 <- Your block
- + neighbor CORE-v6 peer-group
- + neighbor CORE-v6 remote-as XXXX < your ASN
- + neighbor CORE-v6 soft-reconfiguration inbound
- + neighbor CORE-v6 update-source Loopback0
- + neighbor CORE-v6 send-community
- + neighbor CORE-v6 next-hop-self
- + redistribute connected route-map redist-connected-v6
- + no synchronization



# MAKE A LIST OF ROUTER LOOPBACKS

- 2607:ffff:66
- 2607:ffff:67
- 2607:ffff:92
- 2607:ffff:95
- 2607:ffff:247
- 2607:ffff:251
- 2607:ffff:252
- 2607:ffff:253
- 2607:ffff:254

# BUILD NEIGHBOR CONFIG

- Convert to internal neighbor statements
  - + neighbor 2607:ffff:66 peer-group CORE-v6
  - + neighbor 2607:ffff:67 peer-group CORE-v6
  - + neighbor 2607:ffff:92 peer-group CORE-v6
  - + neighbor 2607:ffff:95 peer-group CORE-v6
  - + neighbor 2607:ffff:251 peer-group CORE-v6
  - + neighbor 2607:ffff:252 peer-group CORE-v6
  - + neighbor 2607:ffff:253 peer-group CORE-v6
  - + neighbor 2607:ffff:254 peer-group CORE-v6

# CONFIG FILE TO PUSH

```
config t
!
route-map redist-connected-v6 deny 10
 match interface Loopback0
!
route-map redist-connected-v6 permit 20
 match ipv6 address matchall
 set community 6:1
!
router bgp 23342
 address-family ipv6
 network 2607:F3A0::/32
 !
 neighbor ul-inet-core-v6 peer-group
 neighbor ul-inet-core-v6 remote-as 23342
 neighbor ul-inet-core-v6 update-source Loopback0
 neighbor ul-inet-core-v6 send-community
 neighbor ul-inet-core-v6 next-hop-set
 neighbor ul-inet-core-v6 soft-reconfiguration inbound
 !
 neighbor 2607:F3A0::66 peer-group ul-inet-core-v6
 neighbor 2607:F3A0::67 peer-group ul-inet-core-v6
 neighbor 2607:F3A0::92 peer-group ul-inet-core-v6
 neighbor 2607:F3A0::95 peer-group ul-inet-core-v6
 neighbor 2607:F3A0::251 peer-group ul-inet-core-v6
 neighbor 2607:F3A0::251 peer-group ul-inet-core-v6
 neighbor 2607:F3A0::252 peer-group ul-inet-core-v6
 neighbor 2607:F3A0::253 peer-group ul-inet-core-v6
 neighbor 2607:F3A0::254 peer-group ul-inet-core-v6
 !
 redistribute connected route-map redist-connected-v6
 no synchronization
 !
 !
```



# PUSHING THE CONFIG FILE

- At this point we can either push the config file as is or wait until we have the peering peer-group defined as well.
- For the sake of simplicity, let's push this now
- Push using ssh, telnet, rancid, etc.
- NOTE: Remove the neighbor statement to yourself for each of the routers.

# IBGP SESSIONS COME UP

- At this point you will only see the connected exchange interfaces in the table.

```
br01-paix-pao#sh bgp ipv6 u s | in 23342
BGP router identifier 209.237.224.247, local AS number 23342
2607:F3A0::66 4 23342 2185152 2767004 4441680 0 0 1w2d 27
2607:F3A0::67 4 23342 2396394 2435359 4441680 0 0 25w5d 1527
2607:F3A0::92 4 23342 464884 2432269 4441680 0 0 1w2d 7
2607:F3A0::95 4 23342 464903 2432195 4441680 0 0 1w2d 6
2607:F3A0::251 4 23342 779495 2433652 4441680 0 0 1w2d 11
2607:F3A0::252 4 23342 464920 2432188 4441680 0 0 1w2d 11
2607:F3A0::253 4 23342 2330334 2405038 4441680 0 0 1w2d 1651
2607:F3A0::254 4 23342 464960 2433266 4441680 0 0 1w2d 12
br01-paix-pao#
```

# WHERE ARE WE?

- ✓ Obtain an IPv6 allocation
- ✓ My first IPv6 packets
- ✓ Dual stacking the backbone
- ✓ OSPFv3 implementation
- ✓ IPv6 iBGP implementation
  - IPv6 eBGP implementation
  - IPv6 peering
  - Extending dual stack from the backbone
  - IPv6 for your customers



# WHERE ARE WE CONT.

- IPv6 configured on all exchange interfaces
- IPv6 configured on all loopback interfaces
- IPv6 configured on all connected interfaces between backbone routers.
- OSPFv3 configured on Loopbacks (/128s)
- OSPFv3 configured on connected (/64s)
- All inter-AS routers are exchanging IPv6 BGP routes
- OSPFv3 is managing iBGP routing based on next-hop (Loopback0s)

# CONFIGURING PEERS

- We've done all this work, and still can't reach the outside world!
  - + We need a peering peer-group and a peer!
  - + neighbor PEERS-v6 peer-group
  - + neighbor PEERS-v6 soft-reconfiguration inbound
  - + neighbor PEERS-v6 prefix-list Sanity-v6 in
  - + neighbor PEERS-v6 prefix-list Sanity-v6 out
  - + neighbor PEERS-v6 route-map PEER-IN-v6 in
  - + neighbor PEERS-v6 route-map PEER-OUT-v6 out

# CONFIGURING PEERS BASIC SANITY

- Basic sanity prefix-list
  - + ipv6 prefix-list Sanity-v6
    - ✗ seq 5 permit ::/0 ge 16 le 48
    - ✗ seq 10 deny ::/0 le 128
- Don't redistribute peering points connected
  - + ipv6 prefix-list PEERINGPOINTS
    - ✗ seq 5 permit 2001:504:0:1::/64
    - ✗ seq 10 permit 2001:504:D:1::/64
    - ✗ seq 15 permit 2001:504:13:1::/64
    - ✗ seq 20 permit 2001:504:0:3::/64
    - ✗ seq 25 permit 2001:504:0:2::/64
    - ✗ seq 30 etc....



# CONFIGURE PEERS CONT.

- Create a list of your ASNs IPv6 prefix(es)
  - + ipv6 prefix-list MINE seq 5 permit 2607:ffff::/32
- Create a route-map to apply outbound
  - + route-map PEER-OUT-v6 deny 5
    - × match ipv6 address prefix-list PEERINGPOINTS
  - + route-map PEER-OUT-v6 permit 10
    - × match community ALL-CUSTOMERS
  - + route-map PEER-OUT-v6 permit 20
    - × match ipv6 address prefix-list MINE

# CONFIGURE PEERS CONT.

- Create a route-map to apply inbound
  - + route-map PEER-IN-v6 permit 10
    - ✗ match ip address prefix-list Sanity-v6
    - ✗ set local-preference 400
    - ✗ set community 8038:117    Use the same community for peers

# TURN UP A PEER!

- Send e-mail to [peering@he.net](mailto:peering@he.net)
  - + HE Peering,
  - + I have completed the dual-stack of my backbone and am ready to turn up IPv6 peering. I would greatly appreciate turning up sessions with you at our common locations. Also, I would appreciate the full IPv6 BGP table.
  - + Cheers,
  - + Aaron
- Remember to attach your peering info file



# TURN UP A PEER! CONT.

```
Terminal — ssh — 124x84

From: Aaron Hughes <aaron@unitedlayer.com>
To: peering@he.net
Cc: peering@unitedlayer.com
Bcc:
Subject: 6909 HE / 23342 UnitedLayer IPv6 peering
Reply-To:

HE Peering,

I am have completed the dual-stack of my backbone and am ready to turn up IPv6 peering. I would greatly appreciate turning up sessions with you at all of our common locations. Also, I would appreciate a full IPv6 table.

UL Information:
http://as23342.peeringdb.com/
AS: 23342
AS-SET: ALTDB AS-UNITEDLAYER
Equinix Ashburn IPv4 : 206.223.115.154
Equinix Ashburn IPv6 : 2001:504:0:2:0:2:3342:1
Equinix San Jose IPv4 : 206.223.116.45
Equinix San Jose IPv6 : 2001:504:0:1:0:2:3342:1
Equinix Los Angeles IPv4 : 206.223.123.100
Equinix Los Angeles IPv6 : 2001:504:0:3:0:2:3342:1
PAIX Palo Alto IPv4 : 198.32.176.7
PAIX Palo Alto IPv6 : 2001:504:0::1007
Any2 Los Angeles IPv4 : 206.223.143.17
Any2 Los Angeles IPv6 : 2001:504:13::30
SFPIX San Francisco : 206.197.107.3
Max-Prefixes-v4: 500
Max-Prefixes-v6: 20
Peering Contact: peering@unitedlayer.com
NOC Contact: support@unitedlayer.com
NOC Phone: +1-415-349-2100
No ad5 requirement.

—

Aaron Hughes
Facility Security Officer
+1-415-349-2120
aaron@unitedlayer.com
http://www.unitedlayer.com/
—
—
—
```

# TURN UP A PEER! CONT.

- Receive reply with 'sessions have been configured'

```

From: Rob Risher <peer@the.net>
Subject: [6835236] Re: IPv6 Transit request for additional locations - AS 2342 (United Layer)
To: martin@the.net
Cc: aaron@unitedlayer.com
Reply-To: peer@the.net
Date: Tue, 22 Jul 2009 15:39:04 -0700
Subject: RE: Tickets
Message-Id: <156766344.29120@the.net>

```

Hi Aaron, I have setup sessions to the following addresses:

```

Equinix SJC: 2001:504:0:2::1342::1
Equinix ADR: 2001:504:0:2::1342::1

```

If you would like to have any more configured please let us know. Our information is below, if you could drop us a line when you bring them live that would be great. Thanks!

## Hurricane Electric Peering Information :

Contact Address:  
Hurricane Electric  
700 Mission Ct  
Fremont, CA 94539

WCC:  
Phone: 510-506-4100  
Fax: 510-506-4155  
Email: [net@the.net](mailto:net@the.net) / [peer@the.net](mailto:peer@the.net)

RA Information:  
ASN: AS6809  
AS-Name: AS-HURRICANE

## Exchange Point Connections:

| Net            | Status | Speed  | IPv4             | IPv6                       |
|----------------|--------|--------|------------------|----------------------------|
| EQUINIX-ADR    | UP     | 10GigE | 206.223.119.37   | 2001:504:0:2::1342::1      |
| EQUINIX-CHI    | UP     | 10GigE | 206.223.119.37   | 2001:504:0:4::1342::1      |
| EQUINIX-DAL    | UP     | 10GigE | 206.223.119.37   | 2001:504:0:5::1342::1      |
| EQUINIX-LAX    | UP     | 10GigE | 206.223.123.37   | 2001:504:0:3::1342::1      |
| EQUINIX-SJC    | UP     | 10GigE | 206.223.119.37   | 2001:504:0:1::1342::1      |
| LIAD           | UP     | 10GigE | 193.160.224.21   | 2001:778:1:0:1::1342::1    |
| LIADP          | UP     | GigE   | 193.160.224.21   | 2001:778:1:0:1::1342::1    |
| AMS-IX         | UP     | 10GigE | 195.169.1.45-150 | 2001:778:1:1:0:000:0000::1 |
| NL-IX          | UP     | GigE   | 193.239.116.14   | 2001:778:1:1:0:000:0000::1 |
| PAIX Palo Alto | UP     | 10GigE | 190.32.176.20    | 2001:504:0:1:0:000:0000::1 |
| PAIX New York  | UP     | 10GigE | 190.32.118.57    | 2001:504:0:1:0:000:0000::1 |
| NYIX           | UP     | 10GigE | 190.32.160.64    | 2001:504:1:1:0:000:0000::1 |
| LAIX           | UP     | GigE   | 190.32.146.50    | 2001:504:0:0:0:000:0000::1 |
| NYIX           | UP     | GigE   | 190.32.229.22    | 2001:504:0:0:0:000:0000::1 |
| EDGEPE         | UP     | 1000T  |                  | 2001:478:25:12::500        |
| SIK            | UP     | 10GigE | 190.32.180.40    | 2001:478:1:0:0:0:0:0       |
| Paradip        | UP     | 10GigE | 62.36.254.111    | 2001:060:0:0:0:0:0:0       |
| DE-CIX         | UP     | 10GigE | 90.80.192.172    | 2001:778:1:0:0:0:0:0       |
| MITA           | UP     | 10GigE | 190.32.124.176   | 2001:478:1:24::176         |
| Any2-LAX       | UP     | 10GigE | 206.223.143.122  | 2001:504:1:3:0:0:0:0:14    |

# TURN UP A PEER! CONT.

- Now we configure our side of the session:
  - + router bgp XXXX
  - + address-family ipv6
  - + neighbor 2001:504:D::10 remote-as 6939
  - + neighbor 2001:504:D::10 peer-group PEERS-v6
  - + neighbor 2001:504:D::10 description HE
  
- Router log should show:
  - + %BGP-5-ADJCHANGE: neighbor 2001:504:D::10 Up



# TEST THE SESSION

- Make sure things look good:
  - + br01-paix-pao#sh bgp ipv6 u s | in 2001:504:D::10
  - + 2001:504:D::10 4 6939 446117 168688 4449635 0 0 2m 1793
- Session is up and we see 1793 prefixes!
  - + br01-paix-pao#sh bgp ipv6 u ne 2001:504:D::10 ad
  - + BGP table version is 4449635, local router ID is 209.237.224.247 Status codes: s suppressed, d damped, h history, \* valid, > best, i - internal, r RIB-failure, S Stale
  - + Origin codes: i - IGP, e - EGP, ? - incomplete
  - + Network    Next Hop Metric LocPrf Weight Path
  - + \*> 2607:F3A0::/32 :: 0 32768 i
  - + Total number of prefixes 1
- I'm advertising my /32!

# TEST REACHABILITY

## ■ Now we can finally reach the outside world!

■ traceroute ipv6 arin.net. Translating "arin.net."...domain server (209.237.230.11) [OK]

Type escape sequence to abort. Tracing the route to arin.net (2001:500:4:13::80)

```
1 paix.ipv6.he.net (2001:504:D::10) 4 msec 0 msec 0 msec
2 10gigabitethernet2-4.core1.ash1.he.net (2001:470:0:35::2) [AS 6939] 76 msec 76 msec 72 msec
3 equi6ix-ash.arin.net (2001:504:0:2:0:1:745:1) 76 msec 76 msec 76 msec
4 2001:500:4:10::12 [AS 10745] 76 msec 76 msec 76 msec
5 2001:500:4:11::2 [AS 10745] 80 msec 88 msec 80 msec
6 * * *
```

traceroute ipv6 ripe.net. Translating "ripe.net."...domain server (209.237.230.11) [OK]

Type escape sequence to abort. Tracing the route to ripe.net (2001:610:240:11::C100:1319)

```
1 paix.ipv6.he.net (2001:504:D::10) 0 msec 4 msec 0 msec
2 10gigabitethernet4-1.core1.sjc2.he.net (2001:470:0:32::1) [AS 6939] 0 msec 0 msec 0 msec
3 10gigabitethernet1-3.core1.nyc4.he.net (2001:470:0:33::2) [AS 6939] 80 msec 80 msec 96 msec
4 10gigabitethernet1-2.core1.lon1.he.net (2001:470:0:3E::2) [AS 6939] 156 msec 148 msec 148 ms
5 10gigabitethernet1-1.core1.ams1.he.net (2001:470:0:3F::2) [AS 6939] 156 msec 156 msec 156 ms
6 gw.ipv6.amsix.nikrtr.ripe.net (2001:7F8:1::A500:3333:1) [AS 1200] 156 msec 156 msec 160 msec
7 gw.ipv6.transit.nsrp.ripe.net (2001:610:240:101::1) [AS 3333] 156 msec 156 msec 156 msec
8 ripe.net (2001:610:240:11::C100:1319) [AS 3333] 156 msec 156 msec 160 msec
```

# SETUP FIRST PEER CONT.

- Setup the others sessions and look at the table

```

tr01-paix-pao#sh bgp ipv6 u
BGP table version is 4449688, local router ID is 209.237.224.247
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
 r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

 Network Next Hop Metric LocPrf Weight Path
* 2001::/32 2001:504:::4C 400 0 12909 24785 12573 ?
*>
* i 2001:504:::10 1 400 0 6939 i
* i 2687:F3A8::67 1 400 0 6939 i
* i 2687:F3A8::253 1 400 0 6939 i
*> 2001:200::/32 2001:504:::10 400 0 6939 2500 i
* i 2687:F3A8::67 0 400 0 6939 2500 i
* i 2687:F3A8::253 0 400 0 6939 2500 i
*> 2001:200:136::/48
* i 2001:504:::10 400 0 6939 2516 7668 9367 i
* i 2687:F3A8::67 0 400 0 6939 2516 7668 9367 i
* i 2687:F3A8::253 0 400 0 6939 2516 7668 9367 i
* i2001:200:600::/48
* i 2687:F3A8::67 0 400 0 6939 2516 7667 i
*>
* i 2001:504:::10 400 0 6939 2516 7667 i
* i 2687:F3A8::253 0 400 0 6939 2516 7667 i
* i2001:200:900::/48
* i 2687:F3A8::67 0 400 0 6939 2516 7668 i
*>
* i 2001:504:::10 400 0 6939 2516 7668 i
* i 2687:F3A8::253 0 400 0 6939 2516 7668 i
* 2001:200:A000::/35
* i 2001:504:::10 400 0 6939 3257 2497 4690 i
*> i 2687:F3A8::67 0 400 0 19151 2497 4690 i
*> 2001:200:C000::/35
* i 2001:504:::10 400 0 6939 2500 23634 i
* i 2687:F3A8::67 0 400 0 6939 2500 23634 i
* i 2687:F3A8::253 0 400 0 6939 2500 23634 i
*> 2001:200:E000::/35
* i 2001:504:::10 400 0 6939 4635 7668 i
* i 2687:F3A8::67 0 400 0 6939 4635 7668 i
* i 2687:F3A8::253 0 400 0 6939 4635 7668 i
* i2001:200::/32 2687:F3A8::67 0 400 0 6939 23911 9000 30035 7610 i
*>
* i 2001:504:::10 400 0 6939 23911 9000 30035 7610 i
* i 2687:F3A8::253 0 400 0 6939 23911 9000 30035 7610 i
* i2001:218::/32 2687:F3A8::67 0 400 0 19151 2914 i
*>
* i 2001:504:::10 400 0 6939 2914 i
* i 2687:F3A8::253 0 400 0 6939 2914 i
*> 2001:220::/35 2001:504:::10 400 0 6939 2500 7668 9270 i
* i 2687:F3A8::253 0 400 0 6939 2500 7668 9270 i
* i 2687:F3A8::67 0 400 0 6939 2500 7668 9270 i
*> 2001:220:2000::/35
* i 2001:504:::10 400 0 6939 4635 23911 7668 9270 38128 i
* i 2687:F3A8::253 0 400 0 6939 4635 23911 7668 9270 38128 i
* i 2687:F3A8::67 0 400 0 6939 4635 23911 7668 9270 38128 i

```



# WHERE ARE WE?

- ✓ Obtain an IPv6 allocation
- ✓ My first IPv6 packets
- ✓ Dual stacking the backbone
- ✓ OSPFv3 implementation
- ✓ IPv6 iBGP implementation
- ✓ IPv6 eBGP implementation
- ✓ IPv6 peering
  - Extending dual stack from the backbone
  - IPv6 for your customers

# ATTACHING A HOST TO THE V6 NETWORK

- Now that we have a functioning IPv6 network, let's get a host on-line to play with.
  - + Something non-production?
  - + A small segment of the office?
  - + A development environment?
  - + Your desktop or laptop?
- Keep in mind that you are not yet monitoring or supporting your IPv6 network.

# NETWORK CONFIG FOR FIRST HOST

- Find the interface on the network the host is connected to via IPv4. In this case we have chosen ns0 as our dev box:

```
br02-sf7-200p-sfo#sh ip route ns0
Routing entry for 209.237.230.32/28
 Known via "connected", distance 0, metric 0 (connected, via interface)
 Redistributing via ospf 23342
 Advertised by ospf 23342 metric-type 1 subnets
 Routing Descriptor Blocks:
 * directly connected, via Vlan705
 Route metric is 0, traffic share count is 1
```



# NETWORK CONFIG FOR FIRST HOST

- Look at the existing v4 config

```
interface Vlan705
description [UL:VLAN] Dev nameservers
ip address 209.237.230.44 255.255.255.240
no ip redirects
no ip proxy-arp
!
```

## NETWORK CONFIG FOR FIRST HOST

- Grab the next /64 from your DNS zone file:

```

; START OF CUSTOMERS

; 2607:f3a0:0:1001/64 Link
1.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.1.0.0.1 IN PTR Vlan13.cr01-200p-sfo.ipv6.unitedlayer.com.
2.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.1.0.0.1 IN PTR Vlan13.cr02-200p-sfo.ipv6.unitedlayer.com.
3.6.4.e.0.2.e.f.f.f.f.3.2.1.2.0.1.0.0.1 IN PTR chayote.hn.ipv6.unitedlayer.com.
a.2.b.4.f.e.e.f.f.f.f.5.c.5.1.2.0.1.0.0.1 IN PTR clove.hn.ipv6.unitedlayer.com.
0.5.2.5.6.5.e.f.f.f.f.8.4.0.3.2.0.1.0.0.1 IN PTR ns1.ipv6.unitedlayer.com.
2.9.8.3.3.4.e.f.f.f.f.8.4.0.3.2.0.1.0.0.1 IN PTR ns2.ipv6.unitedlayer.com.

; 2607:f3a0:0:1002/64 Link
1.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.2.0.0.1 IN PTR Vlan705.br01-200p-sfo.ipv6.unitedlayer.com.
2.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.2.0.0.1 IN PTR Vlan705.br02-200p-sfo.ipv6.unitedlayer.com.
a.e.9.5.2.4.e.f.f.f.f.8.4.0.3.2.0.2.0.0.1 IN PTR ns0.ipv6.unitedlayer.com.

```

- In this case I just added 1000. We can worry about regional aggregation later.

# NETWORK CONFIG FOR THE FIRST HOST

- Add the IPv6 config to the interface of the router

```
config t
int vl705
ipv6 enable
ipv6 address 2607:F3A0:0:1002::2/64
```

- Wait a few seconds..

```
eth0 Link encap:Ethernet HWaddr 00:30:48:42:59:EA
 inet addr:209.237.230.37 Bcast:209.237.230.47 Mask:255.255.255.240
 inet6 addr: 2607:f3a0:0:1002:230:48ff:fe42:59ea/64 Scope:Global
 inet6 addr: fe80::230:48ff:fe42:59ea/64 Scope:Link
 UP BROADCAST RUNNING MULTICAST MTU:1500 Metric:1
 RX packets:69869405 errors:0 dropped:0 overruns:0 frame:0
 TX packets:63543470 errors:1160015 dropped:0 overruns:0 carrier:1160015
 collisions:1379164 txqueuelen:100
 RX bytes:936819857 (893.4 MiB) TX bytes:1187390989 (1.1 GiB)
 Base address:0xa000 Memory:ec000000-ec020000
```

- Poof!



# NETWORK CONFIG FOR FIRST HOST

## ■ A little testing...

```
root@ns0:/home/aaronh> ping6 bind.com
PING bind.com(trace.ipv6.bind.com) 56 data bytes
64 bytes from trace.ipv6.bind.com: icmp_seq=1 ttl=61 time=46.7 ms
64 bytes from trace.ipv6.bind.com: icmp_seq=2 ttl=61 time=44.9 ms
64 bytes from trace.ipv6.bind.com: icmp_seq=3 ttl=61 time=45.8 ms
64 bytes from trace.ipv6.bind.com: icmp_seq=4 ttl=61 time=40.0 ms
64 bytes from trace.ipv6.bind.com: icmp_seq=5 ttl=61 time=43.0 ms
64 bytes from trace.ipv6.bind.com: icmp_seq=6 ttl=61 time=46.9 ms
64 bytes from trace.ipv6.bind.com: icmp_seq=7 ttl=61 time=43.6 ms

--- bind.com ping statistics ---
7 packets transmitted, 7 received, 0% packet loss, time 9416ms
rtt min/avg/max/mdev = 40.092/44.482/46.971/2.274 ms
root@ns0:/home/aaronh> ping6 ripe.net
PING ripe.net(aquila.ripe.net) 56 data bytes
64 bytes from aquila.ripe.net: icmp_seq=1 ttl=56 time=151 ms
64 bytes from aquila.ripe.net: icmp_seq=2 ttl=56 time=151 ms
64 bytes from aquila.ripe.net: icmp_seq=3 ttl=56 time=151 ms

--- ripe.net ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2001ms
rtt min/avg/max/mdev = 151.486/151.610/151.700/0.330 ms
root@ns0:/home/aaronh> traceroute6 arin.net
traceroute to arin.net (2001:500:4:13::81) from 2607:f3a0:0:1002:230:48ff:fe42:59ea, 30 hops max, 16 byte packets
 1 Vlan705.br02-200p-sfo.ipv6.unitedlayer.com (2607:f3a0:0:1002::2) 1.64 ms 0.31 ms 0.444 ms
 2 g0-1-0.br01-eqx-ash.ipv6.unitedlayer.com (2607:f3a0:0:c::2) 70.646 ms 70.597 ms 70.554 ms
 3 equi6ix-ash.arin.net (2001:504:0:2:0:1:745:1) 71.954 ms 71.704 ms 71.91 ms
 4 2001:500:4:10::12 (2001:500:4:10::12) 72.392 ms 72.363 ms 72.683 ms
 5 2001:500:4:11::2 (2001:500:4:11::2) 75.807 ms 75.738 ms 75.55 ms
 6 *
```

# NETWORK CONFIG FOR FIRST HOST

- From the routers perspective:

```
br02-sf7-200p-sfo#ping 2607:F3A0:0:1002:230:48FF:FE42:59EA

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2607:F3A0:0:1002:230:48FF:FE42:59EA, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 0/1/8 ms
br02-sf7-200p-sfo#sh ipv6 neighbors | in V1705
2607:F3A0:0:1002:230:48FF:FE42:59EA 0 0030.4842.59ea REACH V1705
FE80::230:48FF:FE42:59EA 1 0030.4842.59ea STALE V1705
br02-sf7-200p-sfo#
```

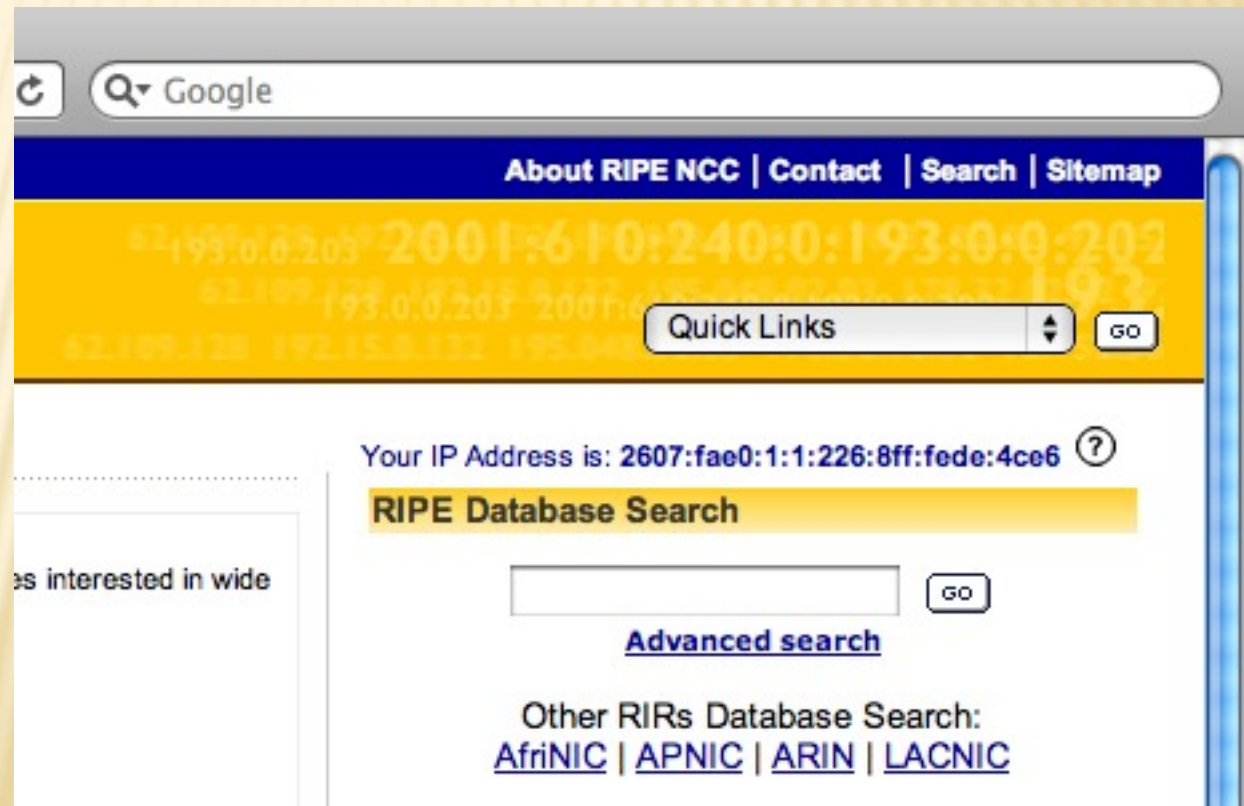
- This will be the first connected IPv6 prefix:

```
br02-sf7-200p-sfo#sh bgp ipv6 u 2607:F3A0:0:1002::/64
BGP routing table entry for 2607:F3A0:0:1002::/64, version 1236
Paths: (2 available, best #1, table Global-IPv6-Table)
 Advertised to update-groups:
 2
 Local
 :: from 0.0.0.0 (209.237.224.252)
 Origin incomplete, metric 0, localpref 100, weight 32768, valid, sourced, best
 Community: 6:1
 Local, (received & used)
 2607:F3A0::254 (metric 1) from 2607:F3A0::254 (209.237.224.254)
 Origin incomplete, metric 0, localpref 100, valid, internal
 Community: 6:1
br02-sf7-200p-sfo#
```



# TESTING THE HOST

- If you have a web-browser on this machine, try <http://ripe.net/> Look at the top right corner.





# A QUICK SLAAC NOTE

- It is important to note that all hosts setup for autoconfig (default on all UNIX OS's and any other current OS) will receive an IPv6 address if they are connected to the same subnet. This means if your dev box is on the same subnet as production boxes, they too will autoconfig via SLAAC and receive a public IPv6 address.

# TIME TO ADD NAMESERVICE

## ■ Add DNS

### + Reverse:

× a.e.9.5.2.4.e.f.f.f.8.4.0.3.2.0.2.0.1 IN PTR ns0.ipv6

### + Forward:

× ns0 IN A 209.237.230.37

× ns0 IN AAAA 2607:f3a0:0:1002:230:48ff:fe42:59ea

### + rndc reload and test!

# ADDING DNS CONT.

- Our first host on IPv6!

```
br02-sf7-200p-sfo#ping ns0

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 2607:F3A0:0:1002:230:48FF:FE42:59EA, timeout is 2 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 0/1/8 ms
br02-sf7-200p-sfo#
```



# SECURITY NOTE

- This machine is now globally accessible on the IPv6 Internet with no filters in place. It is listening on all ports daemons are running on.
- Everything connected to this VLAN or interface with autoconf enabled has an IPv6 address.
- Use `show ipv6 neighbors` to view configured hosts.
- If you have a security policy implemented for IPv4 you will need to implement the IPv6 version of that at this time.

# WHAT'S NEXT? MORE PEERING!

[Reset](#) [118 sessions on this page](#) | [Peers only](#) | [Customers only](#) | [Upstream only](#) | [Show Down Sessions](#) | [IPv6 Only](#) | [IPv4](#)

| ASN                  | Company Name                      | Location                    | IP Address           | AS-SET                            | Router        |                       |               |
|----------------------|-----------------------------------|-----------------------------|----------------------|-----------------------------------|---------------|-----------------------|---------------|
| <a href="#">42</a>   | Packet Clearing House             | <a href="#">PAIX PAQ</a>    | 2001:504:d::35       | <a href="#">AS-PCH</a>            | br01-paix-pao | 001:504:0:2::7385:1   | br01-eqx-ash  |
| <a href="#">42</a>   | Packet Clearing House             | <a href="#">Equinix ASH</a> | 2001:504:0:2::42:1   | <a href="#">AS-PCH</a>            | br01-eqx-ash  | 001:504:0:1::7385:1   | br01-eqx-sjc  |
| <a href="#">293</a>  | Energy Sciences Network           | <a href="#">Equinix SJC</a> | 2001:504:0:1::293:1  | <a href="#">AS-ESNET</a>          | br01-eqx-sjc  | 001:504:D::1D         | br01-paix-pao |
| <a href="#">293</a>  | Energy Sciences Network           | <a href="#">PAIX PAQ</a>    | 2001:504:d::a        | <a href="#">AS-ESNET</a>          | br01-paix-pao | 001:504:d::32         | br01-paix-pao |
| <a href="#">293</a>  | Energy Sciences Network           | <a href="#">Equinix ASH</a> | 2001:504:0:2::293:1  | <a href="#">AS-ESNET</a>          | br01-eqx-ash  | 001:504:13::1e        | br01-lw-lax   |
| <a href="#">558</a>  | Net2EZ                            | <a href="#">ANY2 LAX</a>    | 2001:504:13::48      | <a href="#">AS-NET2EZ</a>         | br01-lw-lax   | 001:504:D::B1         | br01-paix-pao |
| <a href="#">1280</a> | Internet Systems Consortium, Inc. | <a href="#">Equinix SJC</a> | 2001:504:0:1::1280:1 |                                   | br01-eqx-sjc  | 001:504:13::23        | br01-lw-lax   |
| <a href="#">1280</a> | Internet Systems Consortium, Inc. | <a href="#">PAIX PAQ</a>    | 2001:504:D::12       |                                   | br01-paix-pao | 001:504:0:2::7784:1   | br01-eqx-ash  |
| <a href="#">1280</a> | Internet Systems Consortium, Inc. | <a href="#">PAIX PAQ</a>    | 2001:504:D::1        |                                   | br01-paix-pao | 001:504:0:2::8001:1   | br01-eqx-ash  |
| <a href="#">2516</a> | KDDI                              | <a href="#">PAIX PAQ</a>    | 2001:504:D::D        |                                   | br01-paix-pao | 607:F3A0:0:1A::2      | br02-200p-sfo |
| <a href="#">3043</a> | Internet Operating Services LLC   | <a href="#">ANY2 LAX</a>    | 2001:504:13::26      |                                   | br01-lw-lax   | 001:504:13::46        | br01-lw-lax   |
| <a href="#">3043</a> | Internet Operating Services LLC   | <a href="#">Equinix ASH</a> | 2001:504:0:2::3043:1 |                                   | br01-eqx-ash  | 001:504:13::61        | br01-lw-lax   |
| <a href="#">3320</a> | Deutsche Telekom                  | <a href="#">Equinix ASH</a> | 2001:504:0:2::3320:1 | <a href="#">AS3320-AS-DTAG-V6</a> | br01-eqx-ash  | 001:504:13::2A        | br01-lw-lax   |
| <a href="#">3320</a> | Deutsche Telekom                  | <a href="#">PAIX PAQ</a>    | 2001:504:D::39       | <a href="#">AS3320-AS-DTAG-V6</a> | br01-paix-pao | 001:504:13::29        | br01-lw-lax   |
| <a href="#">3856</a> | Packet Clearing House             | <a href="#">Equinix ASH</a> | 2001:504:0:2::3856:1 | <a href="#">AS-PCH</a>            | br01-eqx-ash  | 001:504:0:1::8121:1   | br01-eqx-sjc  |
| <a href="#">3856</a> | Packet Clearing House             | <a href="#">PAIX PAQ</a>    | 2001:504:d::f9       | <a href="#">AS-PCH</a>            | br01-paix-pao | 001:504:0:2::8121:1   | br01-eqx-ash  |
| <a href="#">4323</a> | TWTelecom                         | <a href="#">Equinix ASH</a> | 2001:504:0:2::4323:1 |                                   | br01-eqx-ash  | 001:504:D::57         | br01-paix-pao |
| <a href="#">4323</a> | TWTelecom                         | <a href="#">Equinix LAX</a> | 2001:504:0:3::4323:1 |                                   | br01-lw-lax   | 001:504:0:2::8218:1   | br01-eqx-ash  |
| <a href="#">4323</a> | TWTelecom                         | <a href="#">Equinix SJC</a> | 2001:504:0:1::4323:1 |                                   | br01-eqx-sjc  | 001:504:d::5f         | br01-paix-pao |
| <a href="#">4589</a> | Easynet                           | <a href="#">Equinix ASH</a> | 2001:504:0:2::4589:1 | <a href="#">AS-EASYNET</a>        | br01-eqx-ash  | 001:504:d::60         | br01-paix-pao |
| <a href="#">4589</a> | Easynet                           | <a href="#">ANY2 LAX</a>    | 2001:504:13::1d      | <a href="#">AS-EASYNET</a>        | br01-lw-lax   | 001:504:0:2::8781:1   | br01-eqx-ash  |
| <a href="#">4589</a> | Easynet                           | <a href="#">Equinix SJC</a> | 2001:504:0:1::4589:1 | <a href="#">AS-EASYNET</a>        | br01-eqx-sjc  | 001:504:0:2::8881:1   | br01-eqx-ash  |
| <a href="#">4589</a> | Easynet                           | <a href="#">PAIX PAQ</a>    | 2001:504:d::4a       | <a href="#">AS-EASYNET</a>        | br01-paix-pao | 001:504:13::39        | br01-lw-lax   |
| <a href="#">4648</a> | Telecom New Zealand               | <a href="#">PAIX PAQ</a>    | 2001:504:d::61       |                                   | br01-paix-pao | 001:504:0:2::9002:1   | br01-eqx-ash  |
| <a href="#">4648</a> | Telecom New Zealand               | <a href="#">Equinix LAX</a> | 2001:504:0:3::4648:1 |                                   | br01-lw-lax   | 001:504:D::AE         | br01-paix-pao |
| <a href="#">4657</a> | StarHub SiX                       | <a href="#">PAIX PAQ</a>    | 2001:504:d::2c       |                                   | br01-paix-pao | 001:504:13::33        | br01-lw-lax   |
| <a href="#">4739</a> | Intermode Systems                 | <a href="#">Equinix LAX</a> | 2001:504:0:3::4739:1 |                                   | br01-lw-lax   | 001:504:13::40        | br01-lw-lax   |
| <a href="#">4739</a> | Intermode Systems                 | <a href="#">Equinix SJC</a> | 2001:504:0:1::4739:1 |                                   | br01-eqx-sjc  | 001:504:d::30         | br01-paix-pao |
| <a href="#">4739</a> | Intermode Systems                 | <a href="#">PAIX PAQ</a>    | 2001:504:d::4f       |                                   | br01-paix-pao | 001:504::2:0:1:310:1  | br01-eqx-ash  |
| <a href="#">4739</a> | Intermode Systems                 | <a href="#">ANY2 LAX</a>    | 2001:504:13::13      |                                   | br01-lw-lax   | 001:504::1:0:1:310:1  | br01-eqx-sjc  |
| <a href="#">4826</a> | Vocus Communications              | <a href="#">Equinix SJC</a> | 2001:504:0:1::4826:1 |                                   | br01-eqx-sjc  | 001:504:0:1:0:1:310:1 | br01-eqx-sjc  |
| <a href="#">4826</a> | Vocus Communications              | <a href="#">PAIX PAQ</a>    | 2001:504:d::86       |                                   | br01-paix-pao | 001:504:2:0:1:745:1   | br01-eqx-ash  |
| <a href="#">4826</a> | Vocus Communications              | <a href="#">ANY2 LAX</a>    | 2001:504:13::3B      |                                   | br01-lw-lax   | 001:504:13::1f        | br01-lw-lax   |
| <a href="#">6939</a> | Hurricane Electric, Inc.          | <a href="#">ANY2 LAX</a>    | 2001:504:13::1A      |                                   | br01-lw-lax   | 001:504:2:0:1:1666:1  | br01-eqx-ash  |
| <a href="#">6939</a> | Hurricane Electric, Inc.          | <a href="#">Equinix SJC</a> | 2001:504:0:1::6939:1 |                                   | br01-eqx-sjc  | 001:504:13::65        | br01-lw-lax   |
| <a href="#">6939</a> | Hurricane Electric, Inc.          | <a href="#">PAIX PAQ</a>    | 2001:504:D::10       |                                   | br01-paix-pao | 001:504:2:0:1:2989:1  | br01-eqx-ash  |



# MORE PEERING!

```
br01-paix-pao>sh bgp ipv4 u s
BGP router identifier 209.237.224.247, local AS number 23342
BGP table version is 8756433, main routing table version 8756433
2131 network entries using 300471 bytes of memory
9838 path entries using 747688 bytes of memory
201507/1627 BGP path/bestpath attribute entries using 28222180 bytes of memory
19 BGP rrinfo entries using 456 bytes of memory
93144 BGP AS-PATH entries using 2444746 bytes of memory
7280 BGP community entries using 573030 bytes of memory
10 BGP extended community entries using 1370 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 32209941 total bytes of memory
2255 received paths for inbound soft reconfiguration
BGP activity 5188551/4888696 prefixes, 254129137/252934605 paths, scan interval 60 secs
```

| Neighbor       | V | AS    | MsgRcvd | MsgSent | TblVer  | InQ | OutQ | Up/Down | State/PfxRcd |
|----------------|---|-------|---------|---------|---------|-----|------|---------|--------------|
| 2001:504:0::1  | 4 | 1200  | 399077  | 394839  | 8756433 | 0   | 0    | 6w6d    | 18           |
| 2001:504:0::A  | 4 | 293   | 575769  | 542651  | 8756433 | 0   | 0    | 11w4d   | 3            |
| 2001:504:0::D  | 4 | 2516  | 333532  | 330018  | 8756433 | 0   | 0    | 4w1d    | 21           |
| 2001:504:0::10 | 4 | 6939  | 3364618 | 394918  | 8756433 | 0   | 0    | 20w0d   | 1985         |
| 2001:504:0::12 | 4 | 1200  | 236227  | 221549  | 0       | 0   | 0    | 28w1d   | Active       |
| 2001:504:0::10 | 4 | 7385  | 332415  | 366299  | 8756433 | 0   | 0    | 15w3d   | 4            |
| 2001:504:0::1F | 4 | 15169 | 820665  | 776323  | 8756433 | 0   | 0    | 19w1d   | 13           |
| 2001:504:0::2C | 4 | 4657  | 130779  | 129939  | 8756433 | 0   | 0    | 3w5d    | 1            |
| 2001:504:0::2E | 4 | 38061 | 168730  | 130140  | 8756433 | 0   | 0    | 6w0d    | 0            |
| 2001:504:0::30 | 4 | 9924  | 0       | 0       | 0       | 0   | 0    | never   | Active       |
| 2001:504:0::32 | 4 | 7473  | 819559  | 776594  | 8756433 | 0   | 0    | 26w0d   | 17           |
| 2001:504:0::35 | 4 | 42    | 77171   | 76621   | 8756433 | 0   | 0    | 7w4d    | 15           |
| 2001:504:0::38 | 4 | 33517 | 0       | 0       | 0       | 0   | 0    | never   | Active       |
| 2001:504:0::39 | 4 | 3320  | 332778  | 330434  | 8756433 | 0   | 0    | 11w4d   | 4            |
| 2001:504:0::4A | 4 | 4509  | 370406  | 365502  | 8756433 | 0   | 0    | 3w5d    | 11           |
| 2001:504:0::4C | 4 | 12909 | 384346  | 336225  | 8756433 | 0   | 0    | 3d16h   | 37           |
| 2001:504:0::55 | 4 | 32354 | 397626  | 394915  | 8756433 | 0   | 0    | 26w0d   | 1            |
| 2001:504:0::57 | 4 | 8121  | 4771007 | 4658258 | 8756433 | 0   | 0    | 26w0d   | 1            |
| 2001:504:0::5B | 4 | 64597 | 363767  | 1021363 | 8756433 | 0   | 0    | 11w4d   | 0            |
| 2001:504:0::5F | 4 | 8218  | 847623  | 776592  | 8756433 | 0   | 0    | 26w0d   | 22           |
| 2001:504:0::60 | 4 | 8781  | 200300  | 278229  | 8756433 | 0   | 0    | 1w4d    | 1            |
| 2001:504:0::61 | 4 | 4648  | 560906  | 524339  | 8756433 | 0   | 0    | 26w0d   | 2            |
| 2001:504:0::70 | 4 | 18508 | 438049  | 1309564 | 8756433 | 0   | 0    | 3d23h   | 2            |
| 2001:504:0::86 | 4 | 4826  | 217672  | 195710  | 8756433 | 0   | 0    | 3w5d    | 26           |
| 2001:504:0::AE | 4 | 9264  | 797740  | 711140  | 8756433 | 0   | 0    | 26w0d   | 20           |
| 2001:504:0::B1 | 4 | 7575  | 826209  | 776592  | 8756433 | 0   | 0    | 26w0d   | 20           |
| 2001:504:0::C1 | 4 | 26415 | 348411  | 346074  | 8756433 | 0   | 0    | 6d22h   | 1            |
| 2001:504:0::F9 | 4 | 3856  | 81003   | 96343   | 8756433 | 0   | 0    | 4w2d    | 0            |
| 2607:F3A0::66  | 4 | 23342 | 2997638 | 4784819 | 8756433 | 0   | 0    | 5w3d    | 1797         |
| 2607:F3A0::67  | 4 | 23342 | 3528416 | 4347757 | 8756433 | 0   | 0    | 11w4d   | 1677         |
| 2607:F3A0::92  | 4 | 23342 | 694447  | 4345015 | 8756433 | 0   | 0    | 19w3d   | 6            |
| 2607:F3A0::95  | 4 | 23342 | 694335  | 4344947 | 8756433 | 0   | 0    | 19w3d   | 7            |
| 2607:F3A0::251 | 4 | 23342 | 1102036 | 4346399 | 8756433 | 0   | 0    | 19w3d   | 13           |
| 2607:F3A0::252 | 4 | 23342 | 694373  | 4344932 | 8756433 | 0   | 0    | 19w3d   | 9            |
| 2607:F3A0::253 | 4 | 23342 | 3448942 | 4318983 | 8756433 | 0   | 0    | 19w3d   | 1833         |
| 2607:F3A0::254 | 4 | 23342 | 694395  | 4346011 | 8756433 | 0   | 0    | 19w3d   | 12           |

```
br01-paix-pao>
```

```
20521 BGP AS-PATH entries using 567350 bytes of memory
1176 BGP community entries using 48370 bytes of memory
0 BGP extended community entries using 1346 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
BGP using 6534297 total bytes of memory
4163 received paths for inbound soft reconfiguration
BGP activity 1124032/1047355 prefixes, 6632409/6524326 paths, scan interval 60 secs
```

| Neighbor                | V | AS    | MsgRcvd | MsgSent | TblVer | InQ | OutQ | Up/Down  | State/PfxRcd |
|-------------------------|---|-------|---------|---------|--------|-----|------|----------|--------------|
| 2001:504:0:2::42::1     | 4 | 42    | 77190   | 77171   | 622503 | 0   | 0    | 7w4d     | 15           |
| 2001:504:0:2::293::1    | 4 | 293   | 240320  | 232735  | 622503 | 0   | 0    | 1w4d     | 3            |
| 2001:504:0:2::2641::1   | 4 | 26415 | 100292  | 100295  | 622503 | 0   | 0    | 7w3d     | 3            |
| 2001:504:0:2::3043::1   | 4 | 3043  | 93244   | 93647   | 622503 | 0   | 0    | 1w4d     | 1            |
| 2001:504:0:2::3320::1   | 4 | 3320  | 113573  | 113593  | 0      | 0   | 0    | 2001h    | Active       |
| 2001:504:0:2::3856::1   | 4 | 3856  | 77004   | 77020   | 622503 | 0   | 0    | 7w3d     | 0            |
| 2001:504:0:2::4323::1   | 4 | 4323  | 241897  | 232910  | 622503 | 0   | 0    | 11w3d    | 12           |
| 2001:504:0:2::4589::1   | 4 | 4589  | 117140  | 116492  | 622503 | 0   | 0    | 2w2d     | 11           |
| 2001:504:0:2::6939::1   | 4 | 6939  | 3504280 | 115950  | 622503 | 0   | 0    | 3w2d     | 1984         |
| 2001:504:0:2::7385::1   | 4 | 7385  | 104480  | 115947  | 622503 | 0   | 0    | 11w3d    | 4            |
| 2001:504:0:2::7704::1   | 4 | 7704  | 241359  | 231859  | 622503 | 0   | 0    | 11w3d    | 1            |
| 2001:504:0:2::8005::1   | 4 | 8005  | 231622  | 231846  | 622503 | 0   | 0    | 20:16:43 | 3            |
| 2001:504:0:2::8121::1   | 4 | 8121  | 115993  | 115947  | 622503 | 0   | 0    | 11w3d    | 1            |
| 2001:504:0:2::8218::1   | 4 | 8218  | 244207  | 232900  | 622503 | 0   | 0    | 11w3d    | 22           |
| 2001:504:0:2::8701::1   | 4 | 8701  | 0       | 0       | 0      | 0   | 0    | never    | Active       |
| 2001:504:0:2::8801::1   | 4 | 8801  | 233144  | 116472  | 622503 | 0   | 0    | 11w3d    | 12           |
| 2001:504:0:2::9002::1   | 4 | 9002  | 240596  | 231851  | 622503 | 0   | 0    | 9w6d     | 26           |
| 2001:504:0:2:0:1:310:1  | 4 | 10310 | 242563  | 231700  | 622503 | 0   | 0    | 7w0d     | 1            |
| 2001:504:0:2:0:1:745:1  | 4 | 10745 | 115266  | 115301  | 622503 | 0   | 0    | 1d16h    | 2            |
| 2001:504:0:2:0:1:1666:1 | 4 | 11666 | 115061  | 115964  | 622503 | 0   | 0    | 7w4d     | 1            |
| 2001:504:0:2:0:1:2909:1 | 4 | 12909 | 132116  | 116465  | 622503 | 0   | 0    | 3d18h    | 37           |
| 2001:504:0:2:0:1:5169:1 | 4 | 15169 | 238925  | 231860  | 622503 | 0   | 0    | 11w3d    | 11           |
| 2001:504:0:2:0:1:9800:1 | 4 | 19800 | 0       | 0       | 0      | 0   | 0    | never    | Active       |
| 2001:504:0:2:0:1:9151:1 | 4 | 19151 | 332187  | 116409  | 622503 | 0   | 0    | 5w3d     | 1811         |
| 2001:504:0:2:0:2:940:1  | 4 | 20940 | 0       | 0       | 0      | 0   | 0    | never    | Active       |



# MORE PEERING

- It's IPv6 peering so today:
  - + Policies are more flexible
  - + Almost all networks have an open IPv6 peering policy
  - + Others will want to peer with you
  - + E-mail everyone regardless of IPv4 peering policy
  - + Watch the IX lists for new IPv6 peers
  
- Today, every bit moved over IPv6 is FREE!

# WHERE ARE WE?

- ✓ Obtain an IPv6 allocation
- ✓ My first IPv6 packets
- ✓ Dual stacking the backbone
- ✓ OSPFv3 implementation
- ✓ IPv6 iBGP implementation
- ✓ IPv6 eBGP implementation
- ✓ IPv6 peering
- ✓ Extending dual stack from the backbone
  - IPv6 for your customers

# TURN UP YOUR FIRST CUSTOMER

---

- I have a customer picked, what now?
- You guessed it, back to router configs!



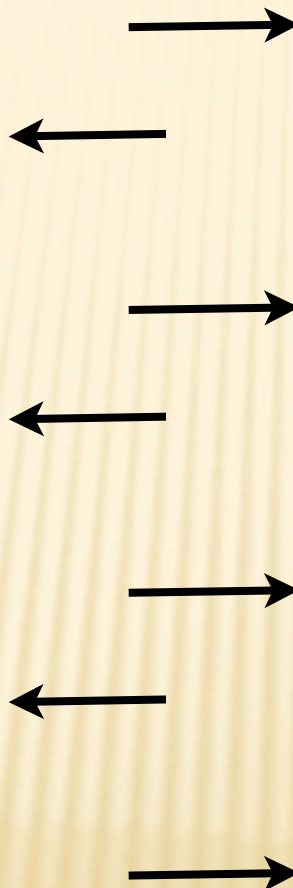
# V4->V6 ROUTE-MAPS

```
!
route-map Customer-In permit 10
description Prepend_CU1
match ip address prefix-list Sanity
match community prependCU1
set local-preference 500
set as-path prepend last-as 1
set community 23342:418
!
route-map Customer-In permit 20
description Prepend_CU2
match ip address prefix-list Sanity
match community prependCU2
set local-preference 500
set as-path prepend last-as 2
set community 23342:418
!
route-map Customer-In permit 30
description Prepend_CU3
match ip address prefix-list Sanity
match community prependCU3
set local-preference 500
set as-path prepend last-as 3
set community 23342:418
!
```

```
!
route-map Customer-In permit 40
description Prepend_UL1
match ip address prefix-list Sanity
match community prependUL1
set local-preference 500
set as-path prepend 23342
set community 23342:418
!
route-map Customer-In permit 50
description Prepend_UL2
match ip address prefix-list Sanity
match community prependUL2
set local-preference 500
set as-path prepend 23342 23342
set community 23342:418
!
route-map Customer-In permit 60
description Prepend_UL3
match ip address prefix-list Sanity
match community prependUL3
set local-preference 500
set as-path prepend 23342 23342 23342
set community 23342:418
!
route-map Customer-In permit 70
description No prepending
match ip address prefix-list Sanity
set local-preference 500
set community 23342:418
!
```

# V4 -> V6 ROUTE-MAPS


```
!
route-map Customer-In-v6 permit 10
description Prepend_CU1
match ip address prefix-list Sanity-v6
match community prependCU1
set local-preference 500
set as-path prepend last-as 1
set community 23342:418
!
route-map Customer-In-v6 permit 20
description Prepend_CU2
match ip address prefix-list Sanity-v6
match community prependCU2
set local-preference 500
set as-path prepend last-as 2
set community 23342:418
!
route-map Customer-In-v6 permit 30
description Prepend_CU3
match ip address prefix-list Sanity-v6
match community prependCU3
set local-preference 500
set as-path prepend last-as 3
set community 23342:418
!
```




```
!
route-map Customer-In-v6 permit 40
description Prepend_UL1
match ip address prefix-list Sanity-v6
match community prependUL1
set local-preference 500
set as-path prepend 23342
set community 23342:418
!
route-map Customer-In-v6 permit 50
description Prepend_UL2
match ip address prefix-list Sanity-v6
match community prependUL2
set local-preference 500
set as-path prepend 23342 23342
set community 23342:418
!
route-map Customer-In-v6 permit 60
description Prepend_UL3
match ip address prefix-list Sanity-v6
match community prependUL3
set local-preference 500
set as-path prepend 23342 23342 23342
set community 23342:418
!
route-map Customer-In-v6 permit 70
description No prepending
match ip address prefix-list Sanity-v6
set local-preference 500
set community 23342:418
!
```



# V4 -> V6 ROUTE-MAPS



```
!
route-map Customer-Out deny 10
 match community BLACKHOLE no-export
!
route-map Customer-Out permit 20
 match ip address prefix-list UL
 set community none
!
route-map Customer-Out permit 30
 match community ALL-CUSTOMERS ALL-PEERS ALL-TRANSIT
!
```



```
!
route-map Customer-Out-v6 deny 10
 description ->BGP->Match Blackhole
 match community BLACKHOLE NO-EXPORT
!
route-map Customer-Out-v6 permit 30
 match community ALL-CUSTOMERS ALL-PEERS ALL-TRANSIT
!
route-map Customer-Out-v6 permit 40
 match ipv6 address prefix-list UL
!
```



# V4 -> V6 PEER-GROUPS

```
neighbor CUSTOMERFULL peer-group
neighbor CUSTOMERFULL version 4
neighbor CUSTOMERFULL activate
neighbor CUSTOMERFULL send-community
neighbor CUSTOMERFULL soft-reconfiguration inbound
neighbor CUSTOMERFULL route-map Customer-In in
neighbor CUSTOMERFULL route-map Customer-Out out
neighbor CUSTOMERFULL maximum-prefix 2000
```

```
neighbor CUSTOMERFULLv6 peer-group
neighbor CUSTOMERFULLv6 activate
neighbor CUSTOMERFULLv6 activate
neighbor CUSTOMERFULLv6 send-community
neighbor CUSTOMERFULLv6 soft-reconfiguration inbound
neighbor CUSTOMERFULLv6 route-map Customer-In-v6 in
neighbor CUSTOMERFULLv6 route-map Customer-Out-v6 out
neighbor CUSTOMERFULLv6 maximum-prefix 100
```

# IPV6 CUSTOMER TURN UP

## IPv4:

```
conf t
router bgp XXXXX
neighbor x.x.x.x remote-as 8038
neighbor x.x.x.x description Customer-Bind
neighbor x.x.x.x peer-group CUSTOMERFULL
```

## IPv6:

```
conf t
router bgp XXXXX
neighbor 2607:F3A0:0:1F remote-as 8038
neighbor 2607:F3A0:0:1F description Customer-Bind
neighbor 2607:F3A0:0:1F peer-group CUSTOMERFULLv6
```



```

br01-1w-lax#sh bgp ipv6 u s | be 1F::2
2607:F3A0:0:1F::2
 4 8038 119098 325951 11423932 0 0 1w5d 2
br01-1w-lax#sh bgp ipv6 u ne 2607:F3A0:0:1F::2 route
BGP table version is 11424013, local router ID is 209.237.224.253
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
 r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

 Network Next Hop Metric LocPrf Weight Path
*> 2607:F3A0:BEEF::/48
 2607:F3A0:0:1F::2
 0 500 0 8038 i
*> 2607:FAE0::/32 2607:F3A0:0:1F::2
 0 500 0 8038 i

Total number of prefixes 2
br01-1w-lax#sh bgp ipv6 u 2607:F3A0:BEEF::/48
BGP routing table entry for 2607:F3A0:BEEF::/48, version 11065134
Paths: (4 available, best #3, table Default)
 Advertised to update-groups:
 1 2 3 4
6939 8038
 2001:504:13::1A (FE80::212:F2FF:FE97:5901) from 2001:504:13::1A (216.218.252.178)
 Origin IGP, localpref 400, valid, external
 Community: 23342:117
6939 8038, (received-only)
 2001:504:13::1A (FE80::212:F2FF:FE97:5901) from 2001:504:13::1A (216.218.252.178)
 Origin IGP, localpref 100, valid, external
8038
 2607:F3A0:0:1F::2 (FE80::203:E3FF:FE03:1F1) from 2607:F3A0:0:1F::2 (207.7.159.26)
 Origin IGP, metric 0, localpref 500, valid, external, best
 Community: 23342:418
8038, (received-only)
 2607:F3A0:0:1F::2 (FE80::203:E3FF:FE03:1F1) from 2607:F3A0:0:1F::2 (207.7.159.26)
 Origin IGP, metric 0, localpref 100, valid, external
br01-1w-lax#

```



# IPV6 CUSTOMER TURN UP CONT

What are we advertising?

```
br01-1w-lax#
br01-1w-lax#sh bgp ipv6 u ne 2607:F3A0:0:1F::2 ad
BGP table version is 11424103, local router ID is 209.237.224.253
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
 r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

 Network Next Hop Metric LocPrf Weight Path
*> 2001::/32 2001:504:13::1A 1 400 0 6939 i
*> 2001:200::/32 2001:504:13::1A 400 0 6939 2500 i
*> 2001:200:A000::/35
 2001:504:13::1A 400 0 6939 2497 4690 i
*> 2001:200:C000::/35
 2001:504:13::1A 400 0 6939 2500 23634 i
*> 2001:200:E000::/35
 2001:504:13::1A 400 0 6939 4635 7660 i
*> 2001:218::/32 2001:504:13::1A 400 0 6939 2914 i
*> 2001:220::/35 2001:504:13::1A 400 0 6939 2500 7660 9270 i
*> 2001:220:806::/48
 2001:504:13::1A 400 0 6939 4635 23911 24489 9270 9687 i
*> 2001:220:2000::/35
 2001:504:0:3:0:1:9151:1
 0 400 0 19151 9304 4635 17579 7660 9270 38128 i
*> 2001:220:4000::/34
 2001:504:0:3:0:1:9151:1
 0 400 0 19151 9304 4635 17579 7660 9270 38128 i
*> 2001:220:8000::/33
 2001:504:0:3:0:1:9151:1
 0 400 0 19151 9304 4635 17579 7660 9270 38128 i
*> 2001:238:700::/41
 2001:504:13::1A 400 0 6939 3549 9505 i
*> 2001:240::/32 2001:504:13::1A 400 0 6939 2497 i
*> 2001:250::/32 2001:504:13::1A 400 0 6939 23911 4538 i
*> 2001:250:204::/48
```

# OTHER WAYS TO DUAL STACK CUSTOMERS

- Connected interface
  - + Colo customers
  - + Metro E
- Static routes
  - + no BGP
  - + Connected /64 + Static /64 -> /48
  - + Add route-map for redist static

# WHERE ARE WE?

- ✓ Obtain an IPv6 allocation
- ✓ My first IPv6 packets
- ✓ Dual stacking the backbone
- ✓ OSPFv3 implementation
- ✓ IPv6 iBGP implementation
- ✓ IPv6 eBGP implementation
- ✓ IPv6 peering
- ✓ Extending dual stack from the backbone
- ✓ IPv6 for your customers



# NEXT STEPS

---

- Address your security policy
- Get your operations staff to use IPv6
- Dual stack your NOC
- Get IPv6 objects in monitoring
- Dual stack your offices
- Start updating tools
- Work with all departments on education
- Get a test customer up and running
- Make a longer term plan from here..

# CONCLUSION

---

- Obtaining IPv6 space is easy
- IPv6 BGP multihoming works
- IPv6 generally well supported on routers
- Transit providers are not needed to implement IPv6
- Lots of IPv6 peers out there to connect with
- Dual stacking the backbone will not impact your edges until you are ready
- Implementation is not hard
- Config mostly intuitive and same as IPv4

# QUESTIONS?

---

- Get IPv6 implemented today!