ARIN XXII

San Antonio, Texas

A dive into IPv6 Implementation for ISPs - Is it that deep?

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Agenda:

- Who's here?
- Get an allocation
- My first IPv6 packets
- Dual stacking the infrastructure
- OSPFv3
- iBGP for IPv6
- eBGP for IPv6
- How to grow your IPv6 peering
- Dual stacking internally
- Getting to know IPv6 (especially operations)
- When to dual stack customers?
- How to dual stack customers

Reminder:

Your role as the DMR

- Operations
- Finance
- Organizational concerns
- Planning
- Design
- Architecture
- Allocations and assignments
- Company policy
- Operational policy

- Represent your entire company
- Separate personal opinions
- Contribute
- Share what you've learned

Get an allocation

- Lots of coverage on this topic. See NRPM and:

https://www.arin.net/resources/templates/v6-isp.txt

Dear RIR,

I am planning on assigning 200 customers IPv6 space in the coming five years.

Sincerely,
ISP/LIR

Dear ISP/LIR,

You are approved for a /32.

Sincerely,
RIR

OrgName: Unitedlayer, Inc.
OrgID: LAER
Address: 1019 Mission Street
City: San Francisco
StateProv: CA
PostalCode: 94103
Country: US

NetRange: 2607:F3A0:0000:0000:0000:0000:0000:0000 -
2607:F3A0:FFFF:FFFF:FFFF:FFFF:FFFF:FFFF
CIDR: 2607:F3A0:0000:0000:0000:0000:0000:0000/32
OriginAS: AS23342
NetName: NETBLK-UNITEDLAYER-V6-1
NetHandle: NET6-2607-F3A0-1
Parent: NET6-2600-1
NetType: Direct Allocation
NameServer: NS1.UNITEDLAYER.COM
NameServer: NS2.UNITEDLAYER.COM
Comment: noc@unitedlayer.com for all Network/Technical Issues.
RegDate: 2008-03-19
Updated: 2008-03-19

The most common objections for not dual-stacking:

- Transit providers don't accept my IPv6 announcement
- I cannot get a full IPv6 BGP table from my transit provider
- Lack of support in general
- No BGP multihoming
- Hard to implement

Let's dig into the myths!

Now what? I have my /32 but my transit providers won't route it!

IPv6 transit is FREE! (right now)
Transit over peering from a few networks.

HURRICANE ELECTRIC
INTERNET SERVICES

Exchange Name	IP Address
AMS-IX	195.69.145.150
AMS-IX	2001:7f8:1::a500:6939:1
Any2 LAX and SJC	2001:504:13::1a
Any2 LAX and SJC	206.223.143.122
BigApe	2001:458:26:2::500
DE-CIX	2001:7f8::1b1b:0:1
DE-CIX	80.81.192.172
Equinix Ashburn	2001:504:0:2::6939:1
Equinix Ashburn	206.223.115.37
Equinix Chicago	206.223.119.37
Equinix Chicago	2001:504:0:4::6939:1
Equinix Dallas	2001:504:0:5::6939:1
Equinix Dallas	206.223.118.37
Equinix Los Angeles	206.223.123.37
Equinix Los Angeles	2001:504:0:3::6939:1
Equinix San Jose	2001:504:0:1::6939:1
Equinix San Jose	206.223.116.37
HKIX	202.40.161.158
HKIX	2001:7fa:0:1::ca28:a19e
LAIIX	2001:504:a::a500:6939:1
LAIIX	198.32.146.50
LINX	195.66.224.21
LINX	2001:7f8:4:0::1b1b:1
LONAP	193.203.5.128
LONAP	2001:7f8:17::1b1b:1
NL-IX	193.239.116.14
NL-IX	2001:7f8:13::a500:6939:1
NOTA	198.32.124.176
NOTA	2001:478:124::176
NYCX	198.32.229.22
NYIIX	2001:504:1::a500:6939:1
NYIIX	198.32.160.61
PAIX New York	198.32.118.57
PAIX New York	2001:504:f::39
PAIX Palo Alto	2001:504:d::10
PAIX Palo Alto	198.32.176.20
PaNAP	62.35.254.111
PaNAP	2001:860:0:6::6939:1
SIX	198.32.180.40
SIX	2001:478:180::40
Telx Atlanta (formerly AtlantaIX)	198.32.132.75
Telx Atlanta (formerly AtlantaIX)	2001:478:132::75
TorIX	2001:478:245:1::112
TorIX	198.32.245.112

Others?

As of April 11, 2009

WV Fiber
a BroadbandONE company

Exchange Name	IP Address
AMS-IX	2001:7F8:1::A501:9151:1
AMS-IX	195.69.145.58
Any2 LAX and SJC	206.223.143.33
Any2 LAX and SJC	2001:504:13:0:0:0:0:B
Any2 Miami	Coming 2nd Quarter 2009
BigApe	198.32.238.14
BigApe	2001:0458:0026:2::700
ChIX	206.51.33.15
ChIX	2001:504:14::a501:9151:1
CIIX (formerly LAAP)	2001:504:A::A501:9151:1
CIIX (formerly LAAP)	198.32.146.59
DE-CIX	2001:7F8::4ACF:0:1
DE-CIX	80.81.192.220
Equinix Ashburn	2001:504:0:2:0:1:9151:1
Equinix Ashburn	206.223.115.47
Equinix Chicago	206.223.119.18
Equinix Chicago	2001:504:0:4:0:1:9151:1
Equinix Dallas	2001:504:0:5:0:1:9151:1
Equinix Dallas	206.223.118.120
Equinix Los Angeles	206.223.123.59
Equinix Los Angeles	2001:504:0:3:0:1:9151:1
Equinix Newark	2001:504:0:6:0:1:9151:1
Equinix Newark	206.223.131.33
Equinix Paris	Coming 1st Quarter 2009
Equinix San Jose	2001:504:0:1:0:1:9151:1
Equinix San Jose	206.223.116.18
LAIIX	See CIIX/LAAP IP
LINX	195.66.224.233
LINX	2001:7F8:4::4ACF:1
LONAP	2001:7F8:17::4ACF:1
LONAP	193.203.5.216
MadIX	144.92.233.237
MadIX	2607:F388:0:2200::3
NOTA	198.32.124.167
NOTA	2001:478:124::167
NYIIX	198.32.160.137
NYIIX	2001:504:1::a501:9151:1
PAIX Atlanta	2001:504:10::15
PAIX Atlanta	198.32.182.21
PAIX Dallas	Coming 2nd Quarter 2009!
PAIX New York	2001:504:F::9151:1
PAIX New York	198.32.118.68
PAIX Palo Alto	198.32.176.164
PAIX Palo Alto	2001:504:D::9151:1
PAIX Seattle	2001:504:12::25
PAIX Seattle	198.32.134.37
SIX	198.32.180.85
SIX	2001:0478:0180::85
Telx Atlanta (formerly AtlantaIX)	198.32.132.12
Telx Atlanta (formerly AtlantaIX)	2001:478:132::12
TorIX	2001:478:245:1::110
TorIX	198.32.245.110
VIX	First quarter 2009

Start by looking at where you currently peer over IPv4 and e-mail your sales or NOC contacts.

```
On Fri, Jul 25, 2008 at 10:10:18AM -0700, Equinix US NOC wrote:
> Hi Aaron,
>
> I found that there is an existing IPv6 entry for United Layer in LA
> Exchange, here is the info:
>
> 2001:504:0:3::2:3342:1/64
>
> Thanks,
> Parry Dhillon
> Equinix US NOC
>
> -----Original Message-----
> From: owner-noc@equinix.com [mailto:owner-noc@equinix.com] On Behalf Of
> Aaron Hughes
> Sent: Friday, July 25, 2008 7:30 AM
> To: Equinix US NOC
> Subject: Eqx LAX IPv6 address for peering
>
> Equinix NOC,
>
> Our v4 address is LAX is 206.223.123.108. We would like an v6 assignment
> for peering as well please.
>
> Cheers,
>
> Aaron
```

IX Provider,

- My IPv4 address is X.X.X.X
- I would like to know my IPv6 address.

Make a list of your peering points and addresses

```
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 : 206.223.123.108
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:D::1007
Any2 Los Angeles IPv4 : 206.223.143.17
Any2 Los Angeles IPv6 : 2001:504:13::30
SFMIX San Francisco : 206.197.187.3
Max-Prefixes-v4: 500
Max-Prefixes-v6: 20
Peering Contact: peering@unitedlayer.com
NOC Contact: support@unitedlayer.com
NOC Phone: +1-415-349-2100
```

Also happens to make a good signature as a peering coordinator.

Update peeringdb.com

Peering Network Record Maintenance

https://www.peeringdb.com/private/participant_maint.php

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Company Information

Company Name	UnitedLayer LLC
Primary ASN / IRR Record	23342 AS-UNITEDLAYER
Also Known As (Aliases)	UnitedLayer
Company Website URL	http://www.unitedlayer.com
Approx Prefixes Announced	500
Network Type	NSP (Network Service Provider) / Backbone
Approx Traffic Levels	5-10 Gbps
Approx Traffic Ratios	Balanced
Geographic Scope	North America
Looking Glass URL (http)	
Route Server URL (telnet)	
Public Notes	The ASN 6596 is being replaced by 23342 in PAIX-PAO.
Private Notes	
Protocols Supported	Unicast IPv4 ☑ Multicast ☑ IPv6 ☑

Peering Policy Information

Peering Policy URL	http://www.unitedlayer.com/peering.html
General Peering Policy	Open
Multiple Locations	Preferred
Ratio Requirements	No
Contract Requirements	Not Required

Update

Peering Contacts

Role	Contact Name	Telephone	E-Mail Address	Delete
Policy	Aaron Hughes	415-349-2128	peering@unitedlaye	☐
Ops.	Support	888 853-7733	support@unitedlaye	☐
Tech	Support	415-349-2102	network@unitedlaye	☐
Sales	Sales	888 853-7733	sales@unitedlayer.c	☐
Select				

Update

Public Peering Locations

Public Exchange Point	ASN	IP Address	Mbit/sec	Delete
Any2 LAX and SJC	23342	2001:504:13::30	1000	☐
Any2 LAX and SJC	23342	206.223.143.17	1000	☐
Equinix Ashburn	23342	2001:504:0:2::2:3342:1	1000	☐
Equinix Ashburn	23342	206.223.115.154	1000	☐
Equinix Los Angeles	23342	206.223.123.108	1000	☐
Equinix Los Angeles	23342	2001:504:0:3::2:3342:1	1000	☐
Equinix San Jose	23342	2001:504:0:1::2:3342:1	1000	☐
Equinix San Jose	23342	206.223.116.45	1000	☐
PAIX Palo Alto	23342	198.32.176.7	1000	☐
PAIX Palo Alto	23342	2001:504:D::1007	1000	☐
SFMIX	23342	206.197.187.3	1000	☐
Select Value				

Update

Private Peering Locations

Facility Name	ASN	SONET	Ethr	ATM	Delete
Equinix Ashburn (DC1-DC4)	23342	☐	☑	☐	☐
Equinix Los Angeles (LA1)	23342	☐	☑	☐	☐
Equinix San Jose (SV1)	23342	☑	☑	☐	☐
eXchange, 200 Paul	23342	☑	☑	☐	☐
One Wilshire Los Angeles	23342	☑	☑	☐	☐
PAIX Palo Alto	23342	☑	☑	☐	☐
The Main Exchange 365 Main San Francisco	23342	☐	☑	☐	☐
Select Value		☐	☐	☐	

Update

Follow your company change process!

Time for the hard part!

```
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 peering interface

```
!
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 configuration

Here it goes!

```
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

```
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 the IPv6 address

IPv6 packets are passing!

Let's look a little closer:

Enabling IPv6 on the router:

Cisco:

ipv6 unicast-routing

Juniper:

N/A

Configuring an IPv6 interface on a router:

Cisco:
interface $interfacename
ipv6 enable
ipv6 address 2001:1::1/64

Juniper:
set interface $interfacename unit $unit family inet6
address 2001:1::1/64

Now that we've configured an interface.

- We know we can ping ourselves
- How about the outside world?

Let's actually cross the interface.
There's no easy way to scan so let's look at the peeringdb

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Public Exchange Point Detailed View

Common Name	Equinix Los Angeles
Long Name	Equinix Los Angeles Exchange
City	Los Angeles
Country	US
Continental Region	North America
Media Type	Ethernet
Protocols Supported	Unicast IPv4 ☑ Multicast ☐ IPv6 ☐

Contact Information

Company Website	http://peering.equinix.com/
Traffic Statistics Website	
Technical E-Mail	support@equinix.com
Technical Phone	
Policy E-Mail	support@equinix.com
Policy Phone	

IP Address Blocks

Type	Address Block	Reverse DNS Scan
IPv4 Unicast	206.223.123.0/25	Link
IPv6 Unicast	2001:504:0:3::/64	Unsupported

Local Facilities

Facility Name	City	Country	Participant Count
Equinix El Segundo (LA3)	El Segundo	US	10
Equinix Los Angeles (LA1)	Los Angeles	US	77

List of Peers at this Exchange Point (Total: 63)

Peer Name	Local ASN	IP Address	IPs	Policy
Abovenet Communications Inc.	6461		1	Restrictive
Advanced Video Communications	46294	206.223.123.124	1	Open
Akamai Technologies	20940	206.223.123.102	1	Open
AT&T US - AS7132	7132	206.223.123.79	1	Selective
BandCon	26769	206.223.123.26	1	Selective
BitGravity, Inc.	40009	2001:504:0:3::4:9:1	2	Open
CENIC / CalREN	2152		1	Selective
Chunghwa Telecom	9505	206.223.123.51	1	Open
Cox Communications	22773	206.223.123.42	1	Selective
DALnet IRC Network	31800	206.223.123.88	1	Open
EarthLink	4355	206.223.123.32	1	Open
Equinix Corp Network	14609	206.223.123.126	1	Open
FAT Networks, LLC	14076	206.223.123.30	1	Open
Giganews	30094	206.223.123.114	1	Open
Global NAPS, GNAPS	1784	206.223.123.41	1	Open
Guam Cablevision, LLC.	3605	206.223.123.3	1	Open
Highwinds Network Group, Inc	12989	2001:504:0:3::1:2989:1	2	Selective
Hurricane Electric	6939	2001:504:0:3::6939:1	2	Open
Hypermedia Systems	30212	206.223.123.9	1	Open
ICANN	40528	2001:504:0:3:0:4:0528:1	2	Open
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
```

Same on JunOS...Time for the hard part!

```
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
```

Find the v4 peering interface

```
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;
}
```

Verify configuration

Here it goes!

~~Enable IPv6~~

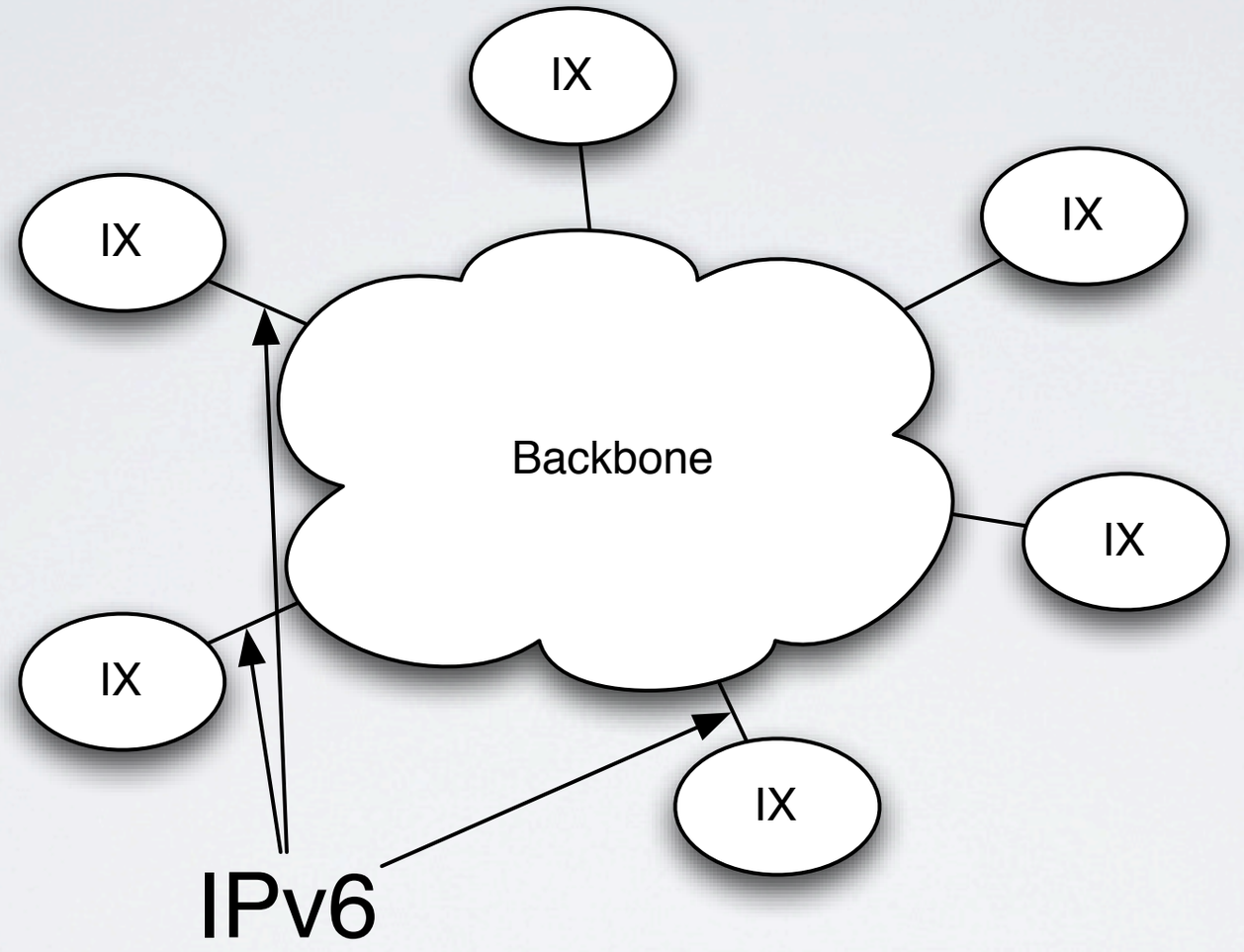
```
aaronh@br01-eqx-ash# set interfaces ge-1/3/0 unit 4 family inet6 address address 2001:504:0:2::2:3342:1/64;
```

Configure the IPv6 address

```
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?



Keeping track of your peering address is one thing but...

Chicken v. Egg
Do we write the tools now or get started?

- Spreadsheet?
- Database?
- DNS?
- Write a quick and dirty tool?

If you can do this quickly, just write one..

IPv4 - IPv6	Hosts	Is SWIPed	Is Aggregate	ULID	Description	Company Name	Action Filter:(Available Assigned) ARIN Report
2607:f3a0:0:0::/64	2^64	1	0	1000	Router Loopbacks	UnitedLayer, INF	Description whois viewSWIP sendDESWIP
2607:f3a0:0:1::/64	2^64	1	0	1000	Vlan902.br01-paix-pao - Vlan902.br02-200p-sfo	UnitedLayer, INF	Description whois viewSWIP sendDESWIP
2607:f3a0:0:2::/64	2^64	1	0	1000	Vlan903.br01-paix-pao - Vlan903.br01-eqx-sjc	UnitedLayer, INF	Description whois viewSWIP sendDESWIP
2607:f3a0:0:3::/64	2^64	1	0	1000	Vlan904.br01-200p-sfo - Vlan904.br01-eqx-sjc	UnitedLayer, INF	Description whois viewSWIP sendDESWIP
2607:f3a0:0:4::/64	2^64	1	0	1000	Vlan804.br02-200p-sfo - Vlan804.br01-200p-sfo	UnitedLayer, INF	Description whois viewSWIP sendDESWIP
2607:f3a0:0:5::/64	2^64	1	0	1000	Vlan518.br01-200p-sfo - Vlan518.cr01-200p-sfo	UnitedLayer, INF	Description whois viewSWIP sendDESWIP
2607:f3a0:0:6::/64	2^64	1	0	1000	Vlan529.br01-200p-sfo - Vlan529.cr02-200p-sfo	UnitedLayer, INF	Description whois viewSWIP sendDESWIP
2607:f3a0:0:7::/64	2^64	1	0	1000	Vlan807.cr01-200p-sfo - Vlan807.cr02-200p-sfo	UnitedLayer, INF	Description whois viewSWIP sendDESWIP
2607:f3a0:0:8::/64	2^64	1	0	1000	Vlan527.br02-200p-sfo - Vlan527.cr02-200p-sfo	UnitedLayer, INF	Description whois viewSWIP sendDESWIP
2607:f3a0:0:9::/64	2^64	1	0	1000	Vlan519.br02-200p-sfo - Vlan519.cr01-200p-sfo	UnitedLayer, INF	Description whois viewSWIP sendDESWIP
2607:f3a0:0:a::/64	2^64	1	0	1000	Gig2-13.br01-200p-sfo - Gig3-0.cr04-200p-sfo	UnitedLayer, INF	Description whois viewSWIP sendDESWIP
2607:f3a0:0:b::/64	2^64	0	0	1003		UnitedLayer Available	Assign
2607:f3a0:0:c::/64	2^64	1	0	1000	Vlan180.br02-200p-sfo - g0-1-0.br01-eqx-ash	UnitedLayer, INF	Description whois viewSWIP sendDESWIP
2607:f3a0:0:d::/64	2^64	1	0	1000	S0-2-0.br01-eqx-ash - S0-1-3.br01-1w-lax	UnitedLayer, INF	Description whois viewSWIP sendDESWIP
2607:f3a0:0:e::/64	2^64	1	0	1000	Vlan800.br01-200p-sfo - Vlan800.br01-1w-lax	UnitedLayer, INF	Description whois viewSWIP sendDESWIP
2607:f3a0:0:f::/64	2^64	1	0	1000	Vlan802.br02-200p-sfo - Vlan802.br01-1w-lax	UnitedLayer, INF	Description whois viewSWIP sendDESWIP
2607:f3a0:0:10::/64	2^64	1	0	1000	Vlan851.br01-530w6-lax - Vlan851.br01-1w-lax	UnitedLayer, INF	Description whois viewSWIP sendDESWIP
2607:f3a0:0:11::/64	2^64	1	0	1000	Vlan803.br01-200p-sfo - Gig0-1-0.br01-530w6-lax	UnitedLayer, INF	Description whois viewSWIP sendDESWIP
2607:f3a0:0:12::/64	2^64	1	0	1000	Vlan801.br02-200p-sfo - Gig0-1-0.br01-530w6-lax	UnitedLayer, INF	Description whois viewSWIP sendDESWIP
2607:f3a0:0:13::/64	2^64	1	0	1000	fe1-0.cr04-200p-sfo - ul-rb-router	UnitedLayer, INF	Description whois viewSWIP sendDESWIP
2607:f3a0:0:14::/64	2^64	1	0	1000	Vlan810.br01-200p-sfo - Vlan810.br01-1w-lax	UnitedLayer, INF	Description whois viewSWIP sendDESWIP
2607:f3a0:0:15::/64	2^64	1	0	1000	Vlan205.br01-1w-lax - Vlan205.ar02-1w-lax	UnitedLayer, INF	Description whois viewSWIP sendDESWIP
2607:f3a0:0:16::/64	2^64	1	0	1000	Vlan206.br01-1w-lax - Vlan206.ar03-530w6-lax	UnitedLayer, INF	Description whois viewSWIP sendDESWIP
2607:f3a0:0:17::/64	2^64	1	0	1000	Vlan213.br01-530w6-lax - Vlan213.ar02-530w6-lax	UnitedLayer, INF	Description whois viewSWIP sendDESWIP
2607:f3a0:0:18::/64	2^64	1	0	1000	Vlan215.br01-530w6-lax - Vlan215.ar03-530w6-lax	UnitedLayer, INF	Description whois viewSWIP sendDESWIP
2607:f3a0:0:19::/64	2^64	1	0	1000	fe6-9.cr01-200p-sfo - 2607:f3a0:0:19::2	UnitedLayer, INF	Description whois viewSWIP sendDESWIP
2607:f3a0:0:1a::/64	2^64	1	0	499		Aaron Hughes	Description whois viewSWIP sendDESWIP
2607:f3a0:0:1b::/64	2^64	1	0	498		Jet.net	Description whois viewSWIP sendDESWIP
2607:f3a0:0:1c::/64	2^64	0	0	1000		UnitedLayer, INF	Description Reclaim whois viewSWIP sendSWIP
2607:f3a0:0:1d::/64	2^64	0	0	1000		UnitedLayer, INF	Description Reclaim whois viewSWIP sendSWIP
2607:f3a0:0:1e::/64	2^64	0	0	1000		UnitedLayer, INF	Description Reclaim whois viewSWIP sendSWIP
2607:f3a0:0:1f::/64	2^64	0	0	1003		UnitedLayer Available	Assign
2607:f3a0:0:20::/64	2^64	0	0	1000	G1-6.ar03-530w6-lax.unitedlayer.com - G0-2.la4501rtr1.unitedlayer.com	UnitedLayer, INF	Description Reclaim whois viewSWIP sendSWIP
2607:f3a0:0:21::/64	2^64	0	0	1003		UnitedLayer Available	Assign
2607:f3a0:0:22::/64	2^64	0	0	1003		UnitedLayer Available	Assign
2607:f3a0:0:1000::/64	2^64	0	0	1000		UnitedLayer, INF	Description Reclaim whois viewSWIP sendSWIP
2607:f3a0:0:1001::/64	2^64	0	0	1000	Vlan13.cr01-200p-sfo	UnitedLayer, INF	Description Reclaim whois viewSWIP sendSWIP
2607:f3a0:0:1002::/64	2^64	0	0	1000	Vlan705.br01-200p-sfo	UnitedLayer, INF	Description Reclaim whois viewSWIP sendSWIP
2607:f3a0:0:1003::/64	2^64	0	0	1000	FA3-31.cr02-200p-sfo	UnitedLayer, INF	Description Reclaim whois viewSWIP sendSWIP
2607:f3a0:0:1004::/64	2^64	0	0	1000	FA3-45.cr01-200p-sfo	UnitedLayer, INF	Description Reclaim whois viewSWIP sendSWIP
2607:f3a0:0:1005::/64	2^64	0	0	1003		UnitedLayer Available	Assign
2607:f3a0:0:1006::/64	2^64	0	0	1000	Vlan15.br01-200p-sfo	UnitedLayer, INF	Description Reclaim whois viewSWIP sendSWIP
2607:f3a0:0:1007::/64	2^64	1	0	285	F6-19.cr01-sf7-200p-sfo	GoldStarModeling	Description whois viewSWIP sendDESWIP
2607:f3a0:0:1008::/64	2^64	0	0	1000	Vlan230.ar02-530w6-lax - 2607:f3a0:0:1008::2	UnitedLayer, INF	Description Reclaim whois viewSWIP sendSWIP
2607:f3a0:0:1009::/64	2^64	1	0	151		A Perfect Circle	Description whois viewSWIP sendDESWIP
2607:f3a0:0:100a::/64	2^64	0	0	33		rawbandwidth.com	Description Reclaim whois viewSWIP sendSWIP
2607:f3a0:0:100b::/64	2^64	0	0	1003		UnitedLayer Available	Assign
2607:f3a0:0:100c::/64	2^64	0	0	1003		UnitedLayer Available	Assign
2607:f3a0:a:0::/48	2^48	0	0	1003		UnitedLayer Available	Assign
2607:f3a0:b:0::/48	2^48	1	0	498		Jet.net	Description whois viewSWIP sendDESWIP
2607:f3a0:c:0::/48	2^48	0	0	33		rawbandwidth.com	Description Reclaim whois viewSWIP sendSWIP
2607:f3a0:beef:0::/48	2^48	1	0	499		Aaron Hughes	Description whois viewSWIP sendDESWIP

Assigned Hosts: 7.56317351447E+20, Total Hosts: 8.85444841438E+20 HD Ratio: 0.854166534212

Generate next /48

Generate next /64 for Customer

Generate next /64 Glue for Infrastructure

If not, a DNS zone file works well:

```
$TTL 3600
$ORIGIN 0.0.0.0.0.0.a.3.f.7.0.6.2.ip6.arpa.
@       IN      SOA     ns1.unitedlayer.com. hostmaster.unitedlayer.com. (
        2009011301 ; Serial
        10800   ; Refresh after 3 hours
        3600    ; Retry after 1 hour
        691200  ; Expire after 8 days
        3600 ) ; Minimum TTL

@       IN      NS      ns1.unitedlayer.com.
@       IN      NS      ns2.unitedlayer.com.

; 2607:f3a0:0000:0000/48 Internal infra
```

```
; 2607:f3a0:0:0000/64 Loopbacks of routers
7.4.2.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0  IN  PTR  br01-paix-poo.ipv6.unitedlayer.com.
2.5.2.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0  IN  PTR  br02-sf7-200p-sfo.ipv6.unitedlayer.com.
7.6.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0  IN  PTR  br01-eqx-sjc.ipv6.unitedlayer.com.
4.5.2.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0  IN  PTR  br01-sf9-200p-sfo.ipv6.unitedlayer.com.
2.9.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0  IN  PTR  cr01-sf7-200p-sfo.ipv6.unitedlayer.com.
5.9.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0  IN  PTR  cr02-sf7-200p-sfo.ipv6.unitedlayer.com.
3.9.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0  IN  PTR  cr04-200p-sfo.ipv6.unitedlayer.com.
0.5.2.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0  IN  PTR  br01-eqx-chi.ipv6.unitedlayer.com.
6.6.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0  IN  PTR  br01-eqx-ash.ipv6.unitedlayer.com.
3.5.2.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0  IN  PTR  br01-1w-lax.ipv6.unitedlayer.com.
1.5.2.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0  IN  PTR  br01-530w6-lax.ipv6.unitedlayer.com.
2.1.1.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0  IN  PTR  cr02-530w6-lax.ipv6.unitedlayer.com.
7.2.1.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0  IN  PTR  cr03-530w6-lax.ipv6.unitedlayer.com.
8.4.2.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0  IN  PTR  lo4501rtr1.ipv6.unitedlayer.com.
```

```
217     IN      PTR     cr02-365m-sfo.unitedlayer.com.
226     IN      PTR     cr01-365m-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.
```

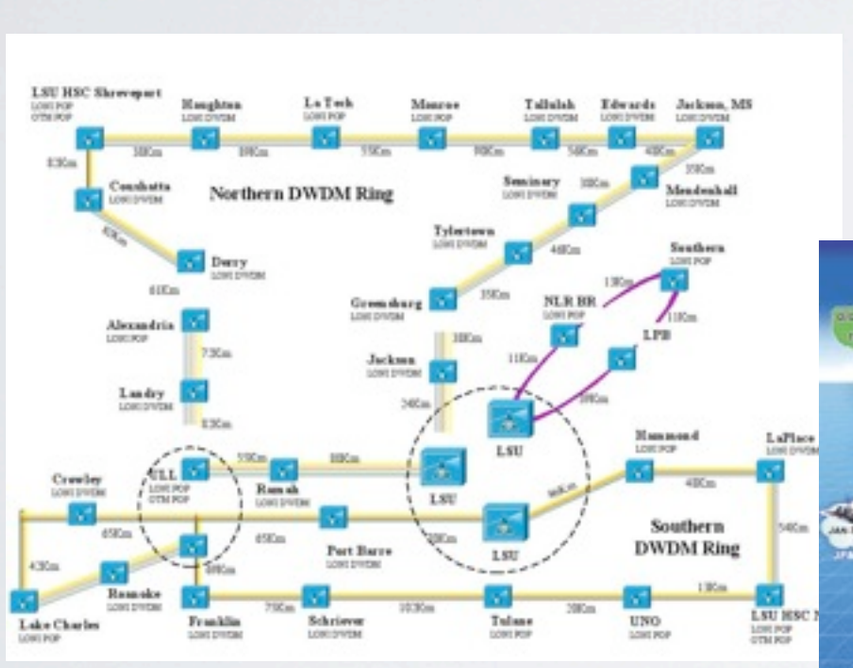
Easy v4 -> v6 Loopback

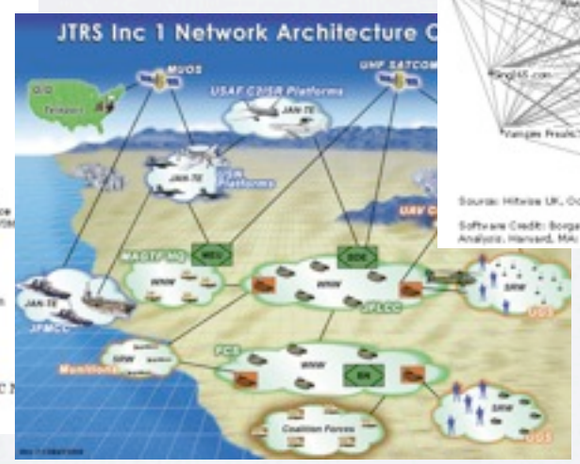
```
; 2607:f3a0:0:0000/64 Loopbacks of routers
7.4.2.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0     IN      PTR     br01-paix-pao.ipv6.unitedlayer.com.
2.5.2.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0     IN      PTR     br02-sf7-200p-sfo.ipv6.unitedlayer.com.
7.6.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0     IN      PTR     br01-eqx-sjc.ipv6.unitedlayer.com.
4.5.2.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0     IN      PTR     br01-sf9-200p-sfo.ipv6.unitedlayer.com.
2.9.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0     IN      PTR     cr01-sf7-200p-sfo.ipv6.unitedlayer.com.
5.9.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0     IN      PTR     cr02-sf7-200p-sfo.ipv6.unitedlayer.com.
3.9.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0     IN      PTR     cr04-200p-sfo.ipv6.unitedlayer.com.
0.5.2.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0     IN      PTR     br01-eqx-chi.ipv6.unitedlayer.com.
6.6.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0     IN      PTR     br01-eqx-ash.ipv6.unitedlayer.com.
3.5.2.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0     IN      PTR     br01-1w-lax.ipv6.unitedlayer.com.
1.5.2.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0     IN      PTR     br01-530w6-lax.ipv6.unitedlayer.com.
2.1.1.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0     IN      PTR     ar02-530w6-lax.ipv6.unitedlayer.com.
7.2.1.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0     IN      PTR     ar03-530w6-lax.ipv6.unitedlayer.com.
8.4.2.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0     IN      PTR     lo4501rtr1.ipv6.unitedlayer.com.
```

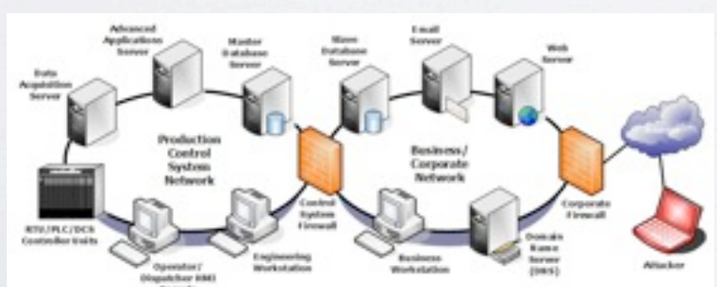
LOTS of opinions on this, this is mine.

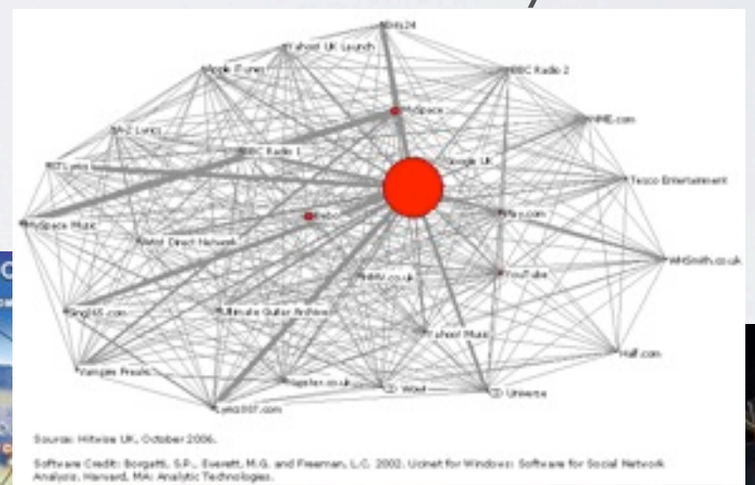
Basic Network Architecture

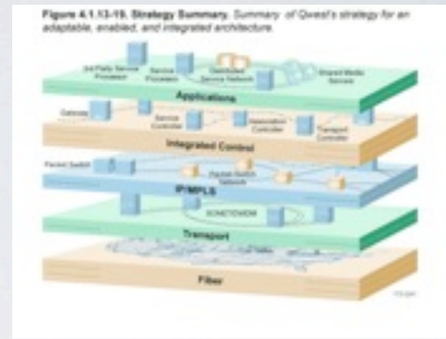
- Loopbacks and infrastructure into OSPF
- All iBGP next-hop-self
- All other "connected" into iBGP
- eBGP filters based on community.

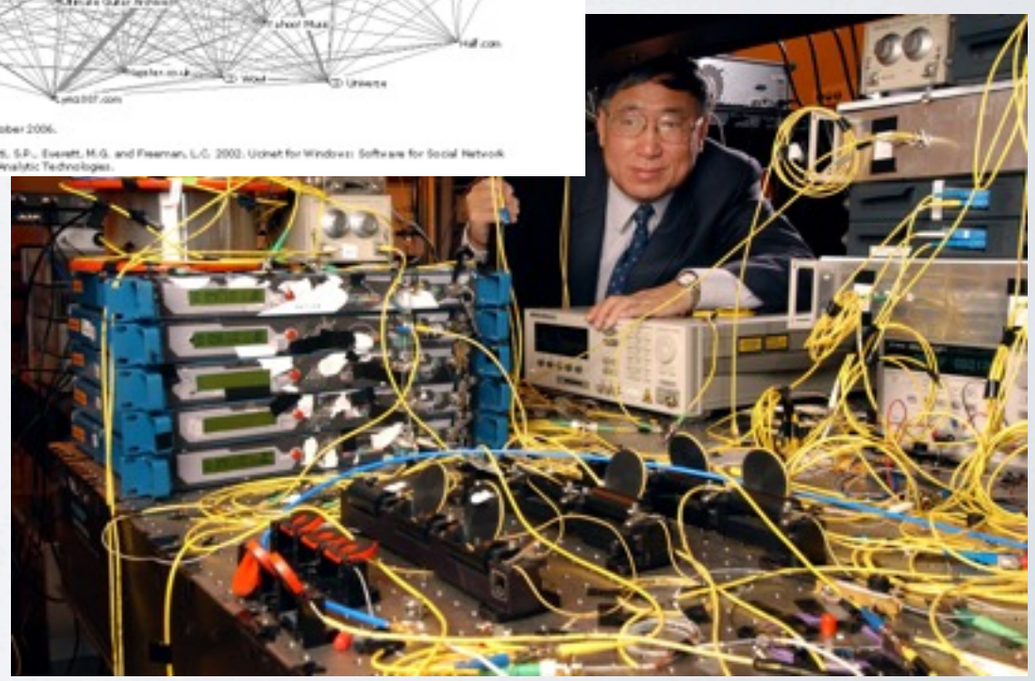




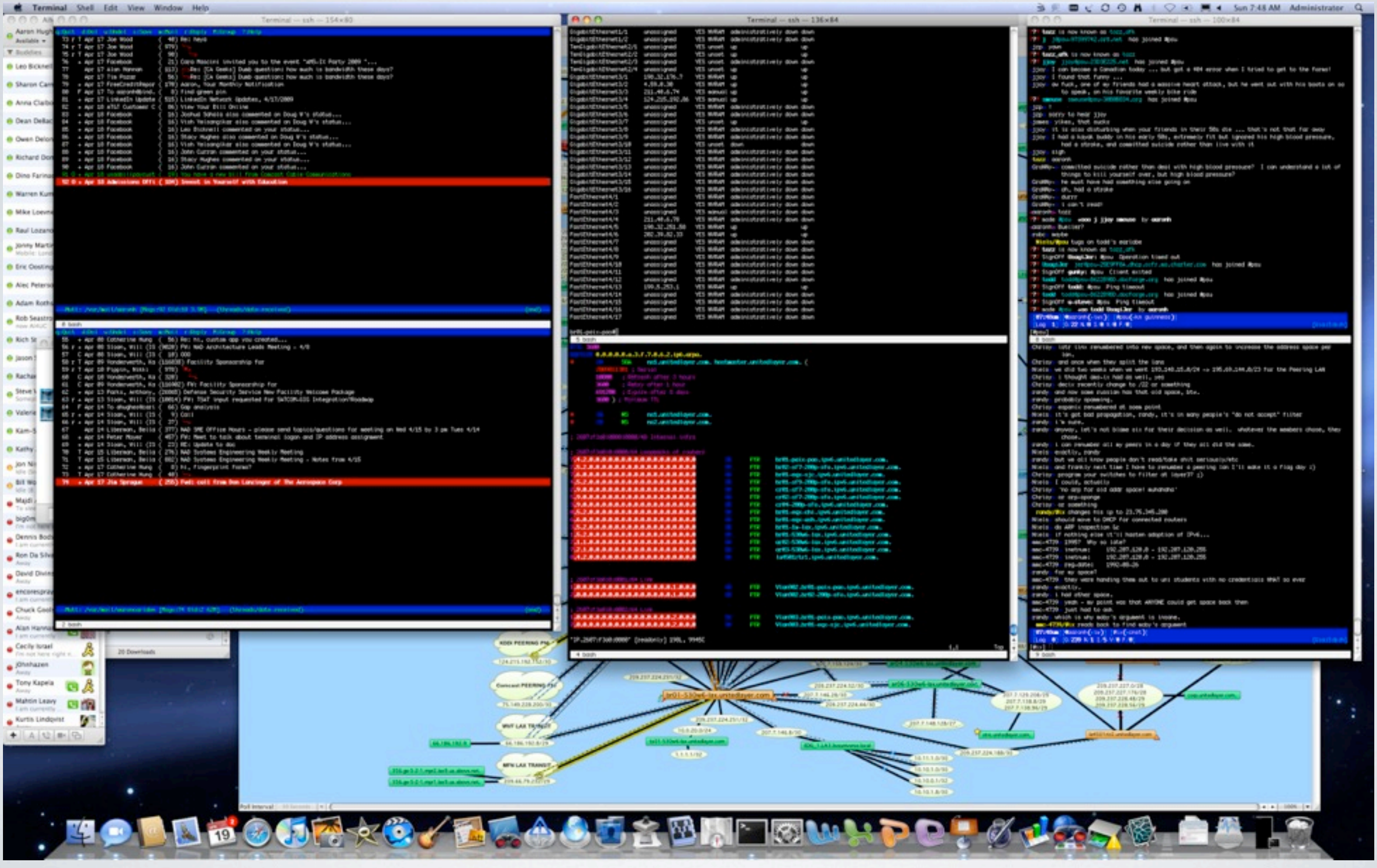








Open your mail, DNS zone, access to routers etc..



Back to this... Let's get started.

```
217     IN      PTR     cr02-365m-sfo.unitedlayer.com.
226     IN      PTR     cr01-365m-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.
```

Easy v4 -> v6 Loopback

```
; 2607:f3a0:0:0000/64 Loopbacks of routers
7.4.2.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0     IN      PTR     br01-paix-pao.ipv6.unitedlayer.com.
2.5.2.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0     IN      PTR     br02-sf7-200p-sfo.ipv6.unitedlayer.com.
7.6.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0     IN      PTR     br01-eqx-sjc.ipv6.unitedlayer.com.
4.5.2.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0     IN      PTR     br01-sf9-200p-sfo.ipv6.unitedlayer.com.
2.9.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0     IN      PTR     cr01-sf7-200p-sfo.ipv6.unitedlayer.com.
5.9.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0     IN      PTR     cr02-sf7-200p-sfo.ipv6.unitedlayer.com.
3.9.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0     IN      PTR     cr04-200p-sfo.ipv6.unitedlayer.com.
0.5.2.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0     IN      PTR     br01-eqx-chi.ipv6.unitedlayer.com.
6.6.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0     IN      PTR     br01-eqx-ash.ipv6.unitedlayer.com.
3.5.2.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0     IN      PTR     br01-1w-lax.ipv6.unitedlayer.com.
1.5.2.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0     IN      PTR     br01-530w6-lax.ipv6.unitedlayer.com.
2.1.1.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0     IN      PTR     ar02-530w6-lax.ipv6.unitedlayer.com.
7.2.1.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0     IN      PTR     ar03-530w6-lax.ipv6.unitedlayer.com.
8.4.2.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0     IN      PTR     lo4501rtr1.ipv6.unitedlayer.com.
```

Pick ONE peering router to start

```
ipv6 router ospf 23342
```

Sometimes you have to type 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
!
```

Most versions, this does it automatically

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

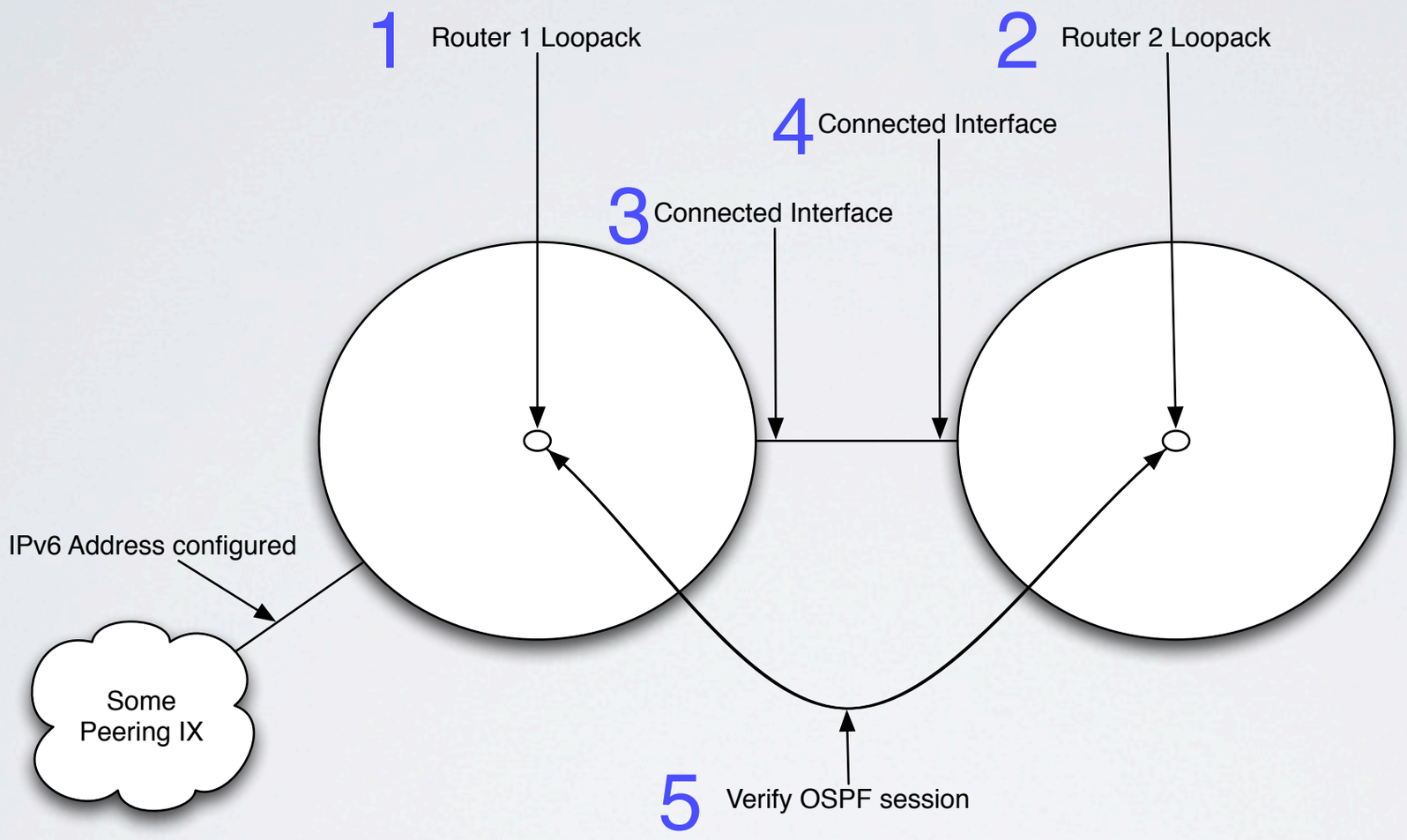
Personal preference

```
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
!
```

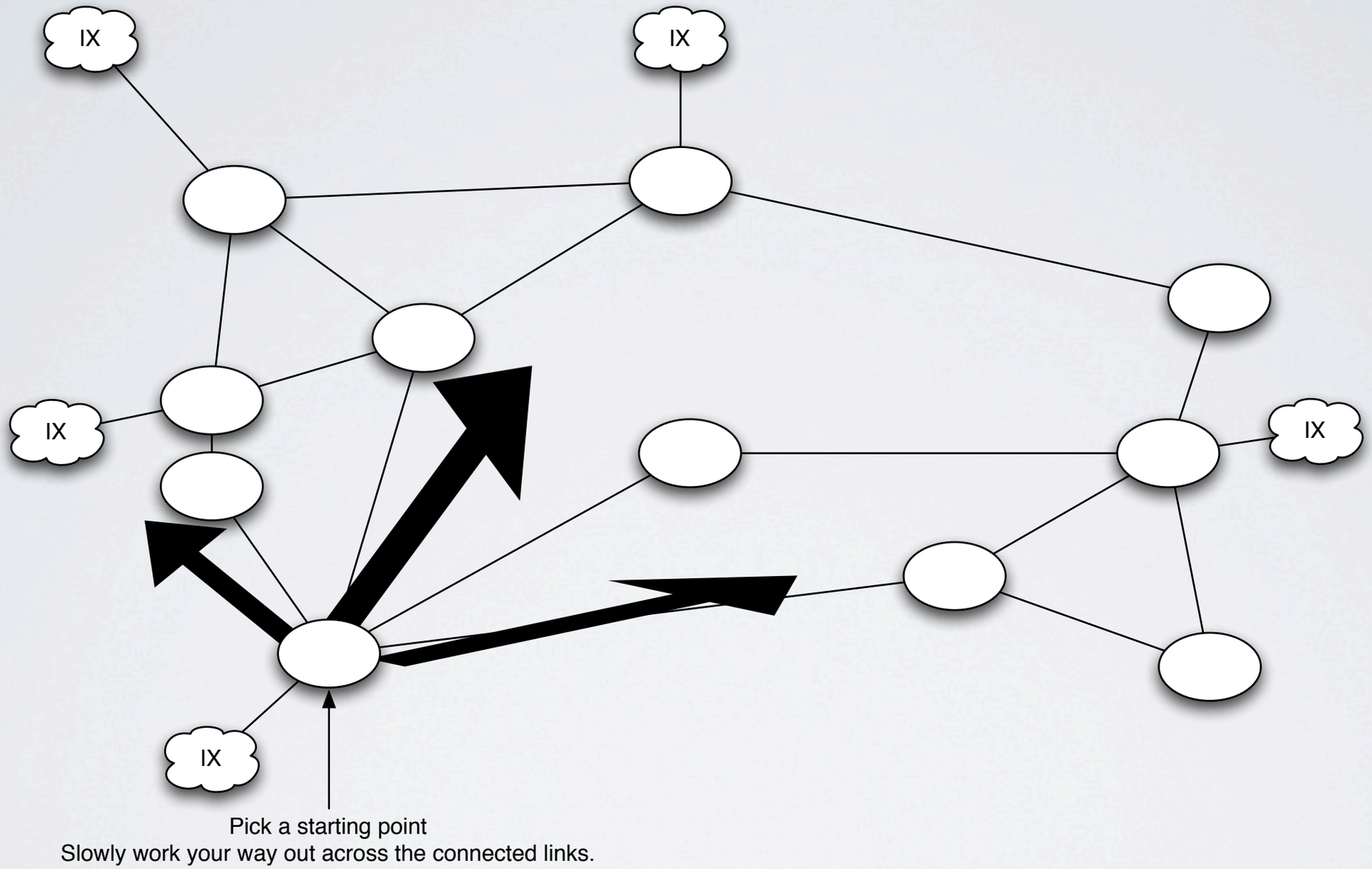
Rinse repeat

```
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#
```

Basic idea:


1
Router 1 Loopack
2
Router 2 Loopack
4
Connected Interface
3
Connected Interface
IPv6 Address configured
Some
Peering IX
5
Verify OSPF session

Slightly bigger picture



Back to Numbering plan / DNS / Tool:

- First /48 for all internal infrastructure
- First /64 for all loopbacks in the network
- Second /64 is your first connected interface!

```
; 2607:f3a0:0:0001/64 Link
1.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.1.0.0.0     IN      PTR     Vlan902.br01-paix-pao.ipv6.unitedlayer.com.
2.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.1.0.0.0     IN      PTR     Vlan902.br02-200p-sfo.ipv6.unitedlayer.com.

; 2607:f3a0:0:0002/64 Link
1.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.2.0.0.0     IN      PTR     Vlan903.br01-paix-pao.ipv6.unitedlayer.com.
2.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.2.0.0.0     IN      PTR     Vlan903.br01-eqx-sjc.ipv6.unitedlayer.com.

; 2607:f3a0:0:0003/64 Link
1.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.3.0.0.0     IN      PTR     Vlan904.br01-200p-sfo.ipv6.unitedlayer.com.
2.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.3.0.0.0     IN      PTR     Vlan904.br01-eqx-sjc.ipv6.unitedlayer.com.

; 2607:f3a0:0:0004/64 Link
1.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.4.0.0.0     IN      PTR     Vlan804.br02-200p-sfo.ipv6.unitedlayer.com.
2.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.4.0.0.0     IN      PTR     Vlan804.br01-200p-sfo.ipv6.unitedlayer.com.

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

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

; 2607:f3a0:0:0007/64 Link
1.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.7.0.0.0     IN      PTR     Vlan807.cr01-200p-sfo.ipv6.unitedlayer.com.
2.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.7.0.0.0     IN      PTR     Vlan807.cr02-200p-sfo.ipv6.unitedlayer.com.
```

Copy, Paste, Increment, Name

Remember how to count?
What comes after 9?

```
; 2607:f3a0:0:0009/64 Link
1.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.9.0.0.0     IN      PTR     Vlan519.br02-200p-sfo.ipv6.unitedlayer.com.
2.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.9.0.0.0     IN      PTR     Vlan519.cr01-200p-sfo.ipv6.unitedlayer.com.

; 2607:f3a0:0:000a/64 Link
1.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.a.0.0.0     IN      PTR     Gig2-13.br01-200p-sfo.ipv6.unitedlayer.com.
2.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.a.0.0.0     IN      PTR     Gig3-0.cr04-200p-sfo.ipv6.unitedlayer.com.

; 2607:f3a0:0:000b/64 Link
1.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.b.0.0.0     IN      PTR     Pos2-2.cr04-200p-sfo.ipv6.unitedlayer.com.
2.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.b.0.0.0     IN      PTR     S0-3-0.br01-eqx-chi.ipv6.unitedlayer.com.

; 2607:f3a0:0:000c/64 Link
1.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.c.0.0.0     IN      PTR     Vlan180.br02-200p-sfo.ipv6.unitedlayer.com.
2.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.c.0.0.0     IN      PTR     g0-1-0.br01-eqx-ash.ipv6.unitedlayer.com.

; 2607:f3a0:0:000d/64 Link
1.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.d.0.0.0     IN      PTR     S0-2-0.br01-eqx-ash.ipv6.unitedlayer.com.
2.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.d.0.0.0     IN      PTR     S0-1-3.br01-1w-lax.ipv6.unitedlayer.com.

; 2607:f3a0:0:000e/64 Link
1.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.e.0.0.0     IN      PTR     Vlan800.br01-200p-sfo.ipv6.unitedlayer.com.
2.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.e.0.0.0     IN      PTR     Vlan800.br01-1w-lax.ipv6.unitedlayer.com.

; 2607:f3a0:0:000f/64 Link
1.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.f.0.0.0     IN      PTR     Vlan802.br02-200p-sfo.ipv6.unitedlayer.com.
2.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.f.0.0.0     IN      PTR     Vlan802.br01-1w-lax.ipv6.unitedlayer.com.

; 2607:f3a0:0:0010/64 Link
1.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.1.0.0.0     IN      PTR     Vlan851.br01-530w6-lax.ipv6.unitedlayer.com.
2.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.1.0.0.0     IN      PTR     Vlan851.br01-1w-lax.ipv6.unitedlayer.com.

; 2607:f3a0:0:0011/64 Link
1.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.1.1.0.0     IN      PTR     Vlan803.br01-200p-sfo.ipv6.unitedlayer.com.
2.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.1.1.0.0     IN      PTR     Gig0-1-0.br01-530w6-lax.ipv6.unitedlayer.com.
```

Time passes.. Sometimes a lot..
(depends on the number of interfaces)

```
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
O   2607:F3A0::66/128 [110/91]
     via FE80::219:7FF:FE31:B000, Vlan902
O   2607:F3A0::67/128 [110/1]
     via FE80::21A:30FF:FE28:15C0, Vlan903
O   2607:F3A0::92/128 [110/2]
     via FE80::219:7FF:FE31:B000, Vlan902
O   2607:F3A0::95/128 [110/2]
     via FE80::219:7FF:FE31:B000, Vlan902
O   2607:F3A0::112/128 [110/3]
     via FE80::219:7FF:FE31:B000, Vlan902
O   2607:F3A0::127/128 [110/3]
     via FE80::219:7FF:FE31:B000, Vlan902
O   2607:F3A0::251/128 [110/2]
     via FE80::219:7FF:FE31:B000, Vlan902
O   2607:F3A0::252/128 [110/1]
     via FE80::219:7FF:FE31:B000, Vlan902
O   2607:F3A0::253/128 [110/2]
     via FE80::219:7FF:FE31:B000, Vlan902
O   2607:F3A0::254/128 [110/2]
     via FE80::219:7FF:FE31:B000, Vlan902
O   2607:F3A0:0:3::/64 [110/3]
     via FE80::219:7FF:FE31:B000, Vlan902
O   2607:F3A0:0:4::/64 [110/2]
     via FE80::219:7FF:FE31:B000, Vlan902
O   2607:F3A0:0:5::/64 [110/3]
     via FE80::219:7FF:FE31:B000, Vlan902
O   2607:F3A0:0:6::/64 [110/3]
     via FE80::219:7FF:FE31:B000, Vlan902
O   2607:F3A0:0:7::/64 [110/3]
     via FE80::219:7FF:FE31:B000, Vlan902
O   2607:F3A0:0:8::/64 [110/2]
     via FE80::219:7FF:FE31:B000, Vlan902
O   2607:F3A0:0:9::/64 [110/2]
     via FE80::219:7FF:FE31:B000, Vlan902
O   2607:F3A0:0:C::/64 [110/91]
     via FE80::219:7FF:FE31:B000, Vlan902
O   2607:F3A0:0:E::/64 [110/3]
     via FE80::219:7FF:FE31:B000, Vlan902
O   2607:F3A0:0:F::/64 [110/2]
     via FE80::219:7FF:FE31:B000, Vlan902
O   2607:F3A0:0:10::/64 [110/3]
     via FE80::219:7FF:FE31:B000, Vlan902
O   2607:F3A0:0:11::/64 [110/3]
     via FE80::219:7FF:FE31:B000, Vlan902
O   2607:F3A0:0:12::/64 [110/2]
     via FE80::219:7FF:FE31:B000, Vlan902
O   2607:F3A0:0:14::/64 [110/3]
     via FE80::219:7FF:FE31:B000, Vlan902
O   2607:F3A0:0:15::/64 [110/3]
     via FE80::219:7FF:FE31:B000, Vlan902
O   2607:F3A0:0:16::/64 [110/3]
     via FE80::219:7FF:FE31:B000, Vlan902
O   2607:F3A0:0:17::/64 [110/3]
     via FE80::219:7FF:FE31:B000, Vlan902
O   2607:F3A0:0:18::/64 [110/3]
     via FE80::219:7FF:FE31:B000, Vlan902
O   2607:F3A0:0:1C::/64 [110/92]
     via FE80::219:7FF:FE31:B000, Vlan902
O   2607:F3A0:0:1D::/64 [110/3]
     via FE80::219:7FF:FE31:B000, Vlan902
O   2607:F3A0:0:1E::/64 [110/4]
     via FE80::219:7FF:FE31:B000, Vlan902
br01-paix-pao#
```

```
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
O   2607:F3A0::66/128 [110/91]
     via FE80::219:7FF:FE31:B000, Vlan902
O   2607:F3A0::67/128 [110/1]
     via FE80::21A:30FF:FE28:15C0, Vlan903
O   2607:F3A0::92/128 [110/2]
```

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

/128s and /64s visible!

Where are we?

- IPv6 configured on exchange interfaces
- IPv6 configured on all router loopbacks
- IPv6 configured on all router to router connected interfaces

- IPv6 OSPFv3 configured
  - All Loopbacks /128s in OSPF
  - All connected /64s in OSPF

Time for a little planning....

Our next desire:
- Access the rest of the world
- iBGP setup

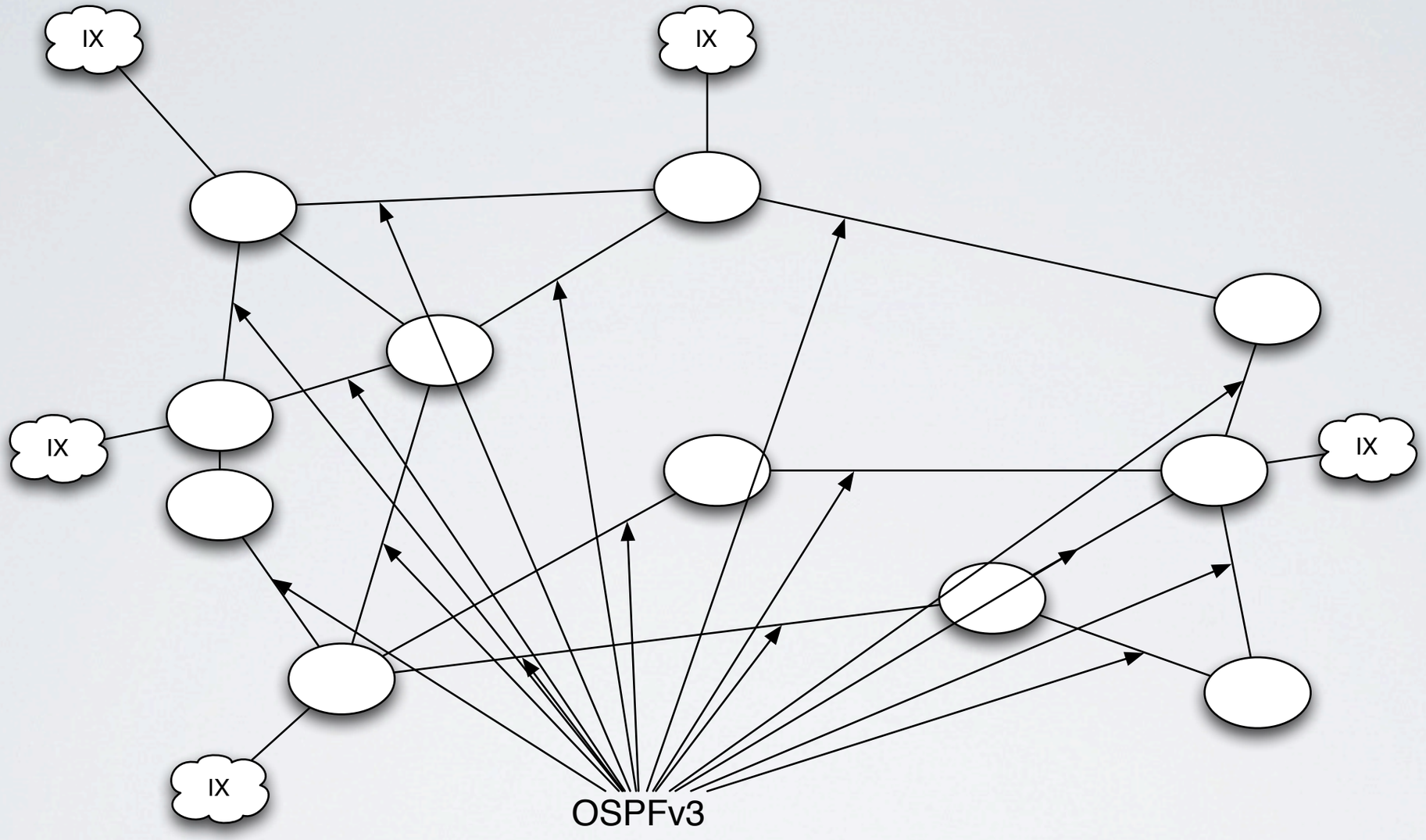
Planning for a v6 Peer:

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

Planning for a v6 iBGP session:

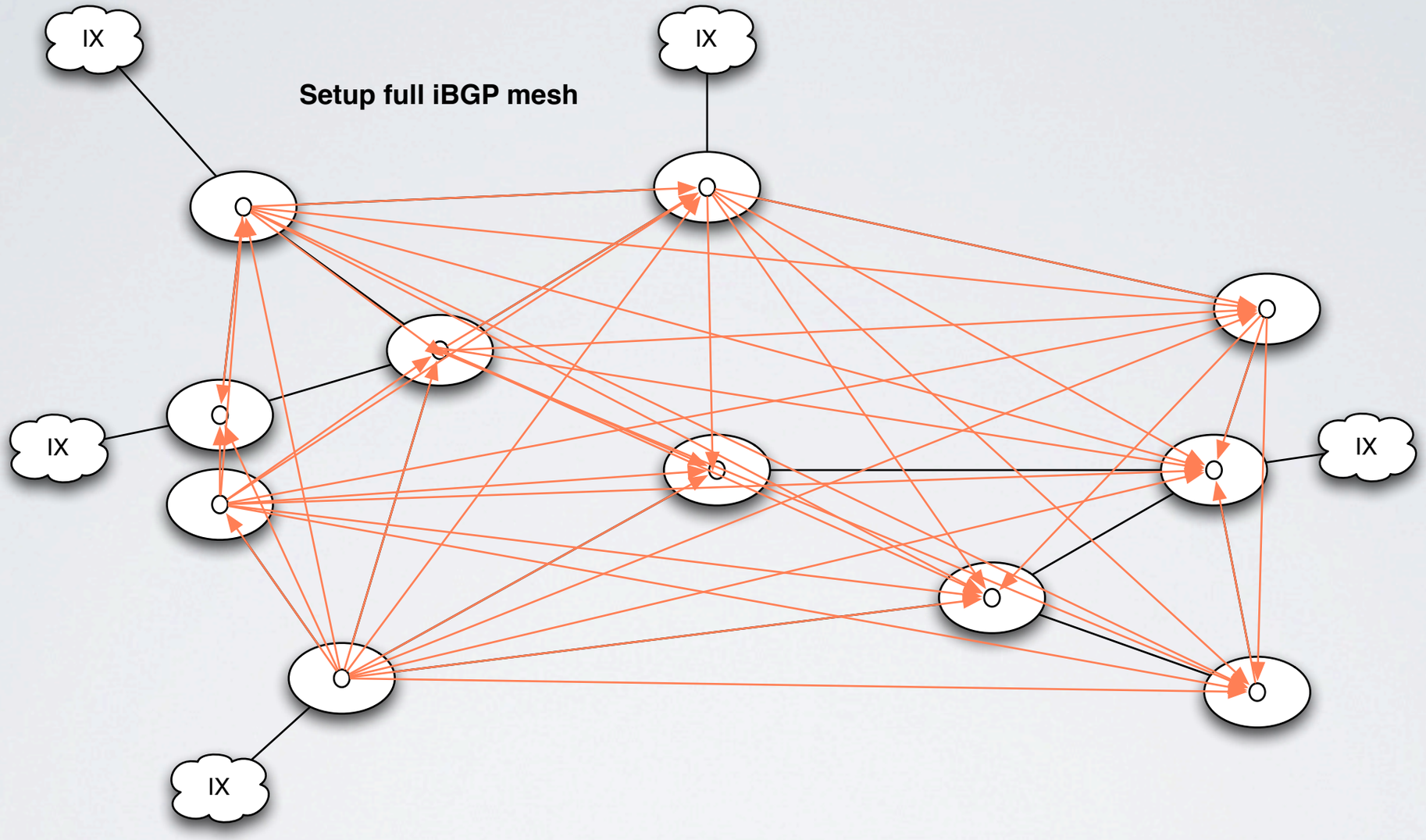
neighbor ul-inet-core-v6 peer-group
neighbor ul-inet-core-v6 remote-as 23342
neighbor ul-inet-core-v6 update-source Loopback0
neighbor ul-inet-core-v6 send-community
neighbor ul-inet-core-v6 next-hop-self
neighbor ul-inet-core-v6 soft-reconfiguration inbound

Let's start with our iBGP setup

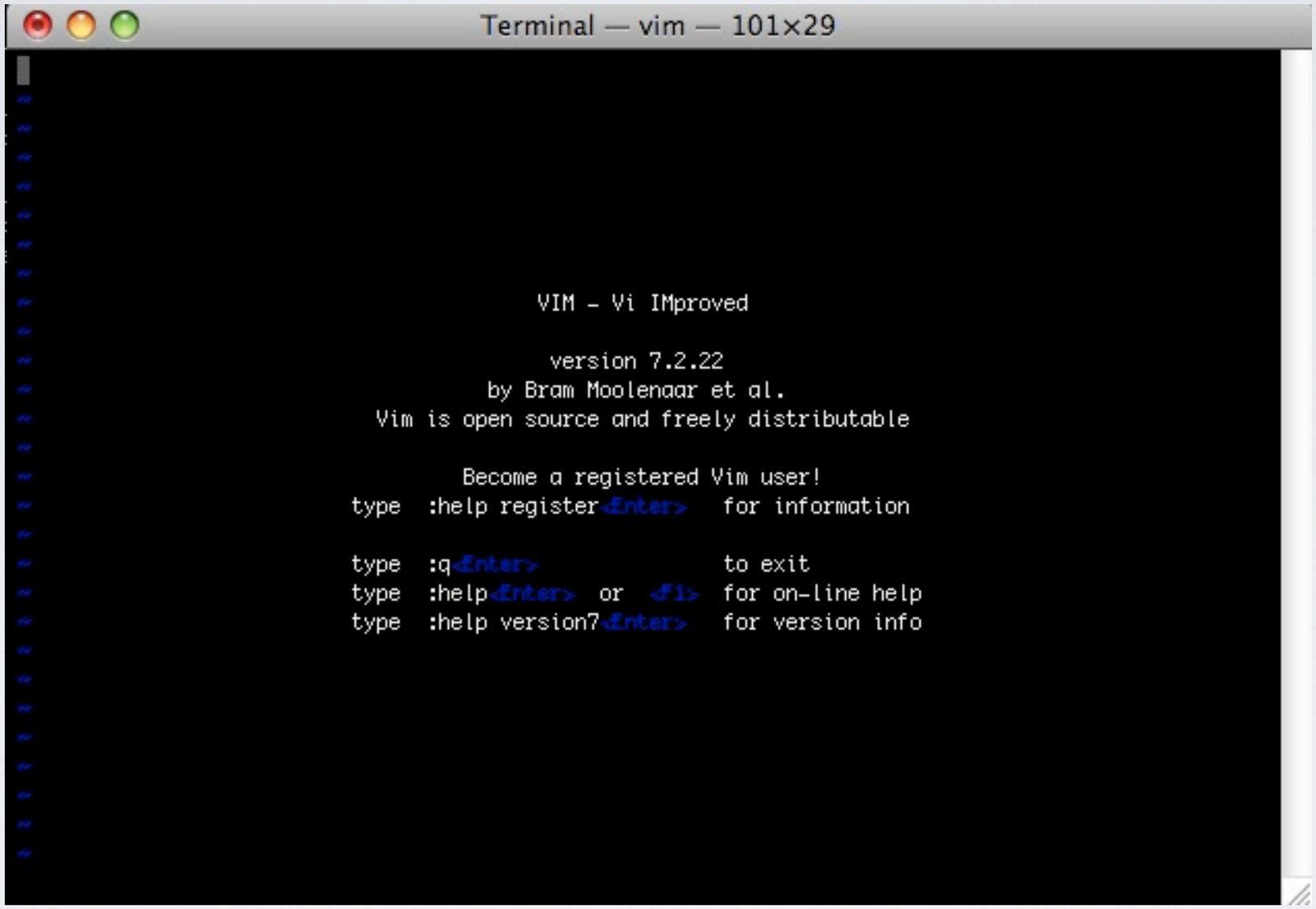


OSPFv3 will tell iBGP how to get to/from loopbacks

Setup full iBGP mesh



Open an editor and save your common config: (this will make your config easier)



Remember iBGP is going to handle connected interfaces (with the exception of loopbacks)

No Loopbacks

Yes all other connected

Set a community

We need a route-map:

```
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
```

Build our basic iBGP router config file:

```
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-self
neighbor ul-inet-core-v6 soft-reconfiguration inbound
redistribute connected route-map redist-connected-v6
no synchronization
```

There are other ways to do this but lets assume you will only have one /32 for the moment.

Make a list of your core routers IPv6 loopback address:

2607:F3A0::66
2607:F3A0::67
2607:F3A0::92
2607:F3A0::95
2607:F3A0::247
2607:F3A0::251
2607:F3A0::252
2607:F3A0::253
2607:F3A0::254

Convert this to internal neighbor statements:

```
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
```

At this point the config you are building looks like this:

```
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-sel
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
!
```

We can go ahead and push this out or wait until we have the peering peer-group defined as well.

(for the sake of simplicity let's do it now)

Push this up to all routers:
- ssh / telnet / rancid / whatever

```
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-sel
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
!
```

Note: Remove the session to yourself

BGP sessions will come up:

```
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#
```

You will only see the connected exchange interfaces in the table

Where are we?

- IPv6 configured on exchange interfaces
- IPv6 configured on all router loopbacks
- IPv6 configured on all router to router connected interfaces

- IPv6 OSPFv3 configured
  - All Loopbacks /128s in OSPF
  - All connected /64s between routers in OSPF

- IPv6 iBGP configured
  - All inter AS routers are exchanging IPv6 BGP routes
  - OSPFv3 is managing iBGP routing based on next-hop

We've done all this work and still can't reach the outside world!

Peering peer-group:

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

Basic Sanity

Don't allow a prefix smaller than a /48 to be advertised to or from you:

```
ipv6 prefix-list Sanity-v6
   seq 5 permit ::/0 ge 16 le 48
   seq 10 deny ::/0 le 128
```

Don't redistribute peering points!

```
ipv6 prefix-list PEERINGPOINTS: 5 entries
   seq 5 permit 2001:504:0:1::/64
   seq 10 permit 2001:504:D::/64
   seq 15 permit 2001:504:13::/64
   seq 20 permit 2001:504:0:3::/64
   seq 25 permit 2001:504:0:2::/64
etc.....
```

Create a list of your AS's v6 prefix(es)

```
ipv6 prefix-list UL seq 5 permit 2607:F3A0::/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 UL
```

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 23342:117
!
```

Use the same community as you do other peers

Turn up our first peer!

Terminal — ssh — 124×84

```
From: Aaron Hughes <aaron@unitedlayer.com>
To: peering@he.net
Cc: peering@unitedlayer.com
Bcc:
Subject: 6939 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 : 206.223.123.108
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:D::1007
Any2 Los Angeles IPv4 : 206.223.143.17
Any2 Los Angeles IPv6 : 2001:504:13::30
SFMIX San Francisco : 206.197.187.3
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 md5 requirement.

--

Aaron Hughes
Facility Security Officer
+1-415-349-2128
aaron@unitedlayer.com
http://www.unitedlayer.com/
~
~
~
~
```

```
--Mutt: =Peering [Msgs:696 Old:168 5.7M]--(threads/date-received)--------------(1%)--
From: Rob Mosher <peering@he.net>
Subject: [#1035331] Re: IPv6 Transit request for additional locations - AS 23342 (United Layer)
To: martin@he.net
Cc: aaron@unitedlayer.com
Reply-To: peering@he.net
Date: Tue, 22 Jul 2008 15:39:04 -0700
X-Mailer: HE-Tickets
Message-Id: <1216766344.29133@ops.he.net>

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

Equinix SJC: 2001:504:0:1:0:2:3342:1
Equinix ASH: 2001:504:0:2:0:2:3342:1

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
     760 Mission Ct
     Fremont, CA 94538

NOC:
     Phone:          510-580-4100
     Fax:            510-580-4151
     Email:          noc@he.net / peering@he.net

RA Information:
     ASN:            AS6939
     AS-MACRO:       AS-HURRICANE

Exchange Point Connections:

NAP             Status  Speed   IPv4           IPv6
--------------- ------- ------- -------------- ------------------------
EQUINIX-ASH     UP      10GigE  206.223.115.37  2001:504:0:2::6939:1
EQUINIX-CHI     UP      10GigE  206.223.119.37  2001:504:0:4::6939:1
EQUINIX-DAL     UP      10GigE  206.223.118.37  2001:504:0:5::6939:1
EQUINIX-LAX     UP      10GigE  206.223.123.37  2001:504:0:3::6939:1
EQUINIX-SJC     UP      10GigE  206.223.116.37  2001:504:0:1::6939:1
LINX            UP      10GigE  195.66.224.21   2001:7f8:4:0::1b1b:1
LoNAP           UP      GigE    193.203.5.128   2001:7f8:17::1b1b:1
AMS-IX          UP      10GigE  195.69.145.150  2001:7f8:1::a500:6939:1
NL-IX           UP      GigE    193.239.116.14  2001:7f8:13::a500:6939:1
PAIX Palo Alto  UP      10GigE  198.32.176.20   2001:504:d::10
PAIX New York   UP      10GigE  198.32.118.57   2001:504:f::39
NYIIX           UP      10GigE  198.32.160.61   2001:504:1::a500:6939:1
LAIIX           UP      GigE    198.32.146.50   2001:504:a::a500:6939:1
NYCX            UP      GigE    198.32.229.22
BIGEAPE         UP      100BT                   2001:458:26:2::500
SIX             UP      10GigE  198.32.180.40   2001:478:180::40
PaNAP           UP      10GigE  62.35.254.111   2001:860:0:6::6939:1
DE-CIX          UP      10GigE  80.81.192.172   2001:7f8::1b1b:0:1
NOTA            UP      10GigE  198.32.124.176  2001:478:124::176
Any2-LAX        UP      10GigE  206.223.143.122 2001:504:13:0:0:0:0:1A
```

Time to configure our side of the sessions:

```
router bgp 23342
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
```

```
%BGP-5-ADJCHANGE: neighbor 2001:504:D::10 Up
```

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 3w3d         1674
```

Sessions up and we see 1674 prefixes from them

```
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

Now we can really reach the outside world!

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

br01-paix-pao#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 msec
  5 10gigabitethernet1-1.core1.ams1.he.net (2001:470:0:3F::2) [AS 6939] 156 msec 156 msec 156 msec
  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
```

Set up the rest of the sessions and have a look at the table

```
br01-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:D::4C                   400      0 12989 24785 12573 ?
*>                  2001:504:D::10            1      400      0 6939 i
* i                  2607:F3A0::67             1      400      0 6939 i
* i                  2607:F3A0::253            1      400      0 6939 i
*> 2001:200::/32    2001:504:D::10                   400      0 6939 2500 i
* i                  2607:F3A0::67             0      400      0 6939 2500 i
* i                  2607:F3A0::253            0      400      0 6939 2500 i
*> 2001:200:136::/48
                    2001:504:D::10                   400      0 6939 2516 7660 9367 i
* i                  2607:F3A0::67             0      400      0 6939 2516 7660 9367 i
* i                  2607:F3A0::253            0      400      0 6939 2516 7660 9367 i
* i2001:200:600::/40
                    2607:F3A0::67             0      400      0 6939 2516 7667 i
*>                  2001:504:D::10                   400      0 6939 2516 7667 i
* i                  2607:F3A0::253            0      400      0 6939 2516 7667 i
* i2001:200:900::/40
                    2607:F3A0::67             0      400      0 6939 2516 7660 i
*>                  2001:504:D::10                   400      0 6939 2516 7660 i
* i                  2607:F3A0::253            0      400      0 6939 2516 7660 i
*  2001:200:A000::/35
                    2001:504:D::10                   400      0 6939 3257 2497 4690 i
*>i                 2607:F3A0::67             0      400      0 19151 2497 4690 i
*> 2001:200:C000::/35
                    2001:504:D::10                   400      0 6939 2500 23634 i
* i                  2607:F3A0::67             0      400      0 6939 2500 23634 i
* i                  2607:F3A0::253            0      400      0 6939 2500 23634 i
*> 2001:200:E000::/35
                    2001:504:D::10                   400      0 6939 4635 7660 i
* i                  2607:F3A0::67             0      400      0 6939 4635 7660 i
* i                  2607:F3A0::253            0      400      0 6939 4635 7660 i
* i2001:208::/32    2607:F3A0::67             0      400      0 6939 23911 9800 38035 7610 i
*>                  2001:504:D::10                   400      0 6939 23911 9800 38035 7610 i
* i                  2607:F3A0::253            0      400      0 6939 23911 9800 38035 7610 i
* i2001:218::/32    2607:F3A0::67             0      400      0 19151 2914 i
*>                  2001:504:D::10                   400      0 6939 2914 i
* i                  2607:F3A0::253            0      400      0 6939 2914 i
*> 2001:220::/35    2001:504:D::10                   400      0 6939 2500 7660 9270 i
* i                  2607:F3A0::253            0      400      0 6939 2500 7660 9270 i
* i                  2607:F3A0::67             0      400      0 6939 2500 7660 9270 i
*> 2001:220:2000::/35
                    2001:504:D::10                   400      0 6939 4635 23911 7660 9270 38128 i
* i                  2607:F3A0::253            0      400      0 6939 4635 23911 7660 9270 38128 i
* i                  2607:F3A0::67             0      400      0 6939 4635 23911 7660 9270 38128 i
```

Get your first machine online

What to start with?
- Something non-production
- A small segment of the office
- A dev machine
- Your laptop
- etc.

In this case, ns0.unitedlayer.com

From v4 to dual stack

Find the v4 interface:

```
br02-sf7-200p-sfo#sh ip route ns0.unitedlayer.com.
Translating "ns0.unitedlayer.com."...domain server (209.237.230.11) [OK]

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

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

```
interface Vlan705
 description [UL:VLAN] Dev nameservers
 ip address 209.237.230.44 255.255.255.240
 no ip redirects
 no ip proxy-arp
 ip ospf cost 150
!
```

Grab the next /64 from your DNS zone file:

```
; START OF CUSTOMERS

; 2607:f3a0:0:1001/64 Link
1.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.1.0.0.1     IN      PTR     Vlan13.cr01-200p-sfo.ipv6.unitedlayer.com.
2.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.1.0.0.1     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.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.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.8.4.0.3.2.0.1.0.0.1           IN      PTR     ns2.ipv6.unitedlayer.com.

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

; 2607:f3a0:0:1003/64 Link Staff VLAN
1.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.3.0.0.1     IN      PTR     FA3-31.cr02-200p-sfo.ipv6.unitedlayer.com.
```

I just added 1000..You can plan for regions later

Add the IPv6 config to the interface:

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

Wait a few seconds and poof!

```
root@ns0:/var/named/zones/reverse> ifconfig -a
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:52827359 errors:0 dropped:0 overruns:0 frame:0
          TX packets:47263399 errors:377873 dropped:0 overruns:0 carrier:377873
          collisions:547959 txqueuelen:100
          RX bytes:3020008353 (2.8 GiB)  TX bytes:3130577634 (2.9 GiB)
          Base address:0xa000 Memory:ec000000-ec020000
```

```
root@ns0:/var/named/zones/reverse> ping6 bind.com
PING bind.com(trace.ipv6.bind.com) 56 data bytes
64 bytes from trace.ipv6.bind.com: icmp_seq=1 ttl=62 time=42.2 ms
64 bytes from trace.ipv6.bind.com: icmp_seq=2 ttl=62 time=45.4 ms
64 bytes from trace.ipv6.bind.com: icmp_seq=3 ttl=62 time=39.0 ms
64 bytes from trace.ipv6.bind.com: icmp_seq=4 ttl=62 time=40.6 ms
64 bytes from trace.ipv6.bind.com: icmp_seq=5 ttl=62 time=36.6 ms
64 bytes from trace.ipv6.bind.com: icmp_seq=6 ttl=62 time=42.2 ms

--- bind.com ping statistics ---
6 packets transmitted, 6 received, 0% packet loss, time 5006ms
rtt min/avg/max/mdev = 36.668/41.046/45.464/2.776 ms
root@ns0:/var/named/zones/reverse>
```

From the routers perspective:

```
br02-sf7-200p-sfo#sh ipv6 neighbors  | in Vl705
2607:F3A0:0:1002:230:48FF:FE42:59EA         0 0030.4842.59ea  REACH Vl705
FE80::230:48FF:FE42:59EA                    1 0030.4842.59ea  STALE Vl705
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 = 0/0/0 ms
br02-sf7-200p-sfo#
```

This will be the first IPv6 connect interface in iBGP

```
br02-sf7-200p-sfo#sh bgp ipv6 u 2607:F3A0:0:1002::/64
BGP routing table entry for 2607:F3A0:0:1002::/64, version 180
Paths: (2 available, best #2, table Global-IPv6-Table)
  Advertised to update-groups:
     1          2
  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
  Local
    :: from 0.0.0.0 (209.237.224.252)
      Origin incomplete, metric 0, localpref 100, weight 32768, valid, sourced, best
      Community: 6:1
br02-sf7-200p-sfo#
```

Add DNS:

Reverse:
a.e.9.5.2.4.e.f.f.f.8.4.0.3.2.0.2.0.0.0.1 IN PTR ns0.ipv6.unitedlayer.com.

Forward:
ns0 IN A 209.237.230.37
ns0 IN AAAA 2607:f3a0:0:1002:230:48ff:fe42:59ea

rndc reload and test:

```
root@ns0:/var/named/zones/reverse> host 2607:f3a0:0:1002:230:48ff:fe42:59ea
a.e.9.5.2.4.e.f.f.f.8.4.0.3.2.0.2.0.0.0.1.0.0.0.0.0.a.3.f.7.0.6.2.ip6.arpa domain name pointer ns0.ipv6.unitedlayer.com.
root@ns0:/var/named/zones/reverse>
root@ns0:/var/named/zones/reverse> host ns0.unitedlayer.com
ns0.unitedlayer.com has address 209.237.230.37
ns0.unitedlayer.com has IPv6 address 2607:f3a0:0:1002:230:48ff:fe42:59ea
root@ns0:/var/named/zones/reverse>
```

Our first host on IPv6!

```
root@ns0:/var/named/zones/reverse> ping6 ns0.unitedlayer.com
PING ns0.unitedlayer.com(ns0.ipv6.unitedlayer.com) 56 data bytes
64 bytes from ns0.ipv6.unitedlayer.com: icmp_seq=1 ttl=64 time=0.035 ms
64 bytes from ns0.ipv6.unitedlayer.com: icmp_seq=2 ttl=64 time=0.035 ms
64 bytes from ns0.ipv6.unitedlayer.com: icmp_seq=3 ttl=64 time=0.033 ms
64 bytes from ns0.ipv6.unitedlayer.com: icmp_seq=4 ttl=64 time=0.039 ms

--- ns0.unitedlayer.com ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3000ms
rtt min/avg/max/mdev = 0.033/0.035/0.039/0.006 ms
root@ns0:/var/named/zones/reverse>
```

Security note:

- This machine is now globally accessible on the IPv6 Internet with no filters in place.
- Listening on the same ports as IPv4 (mostly)
- Everything connected to this VLAN or Interface with SLAAC / auto-conf enabled has an IPv6 address.
- The show ipv6 neighbors will make this visible

- If you have a security policy for IPv4 you will need to implement the IPv6 version of that. (iptables -> ip6tables, ipfw -> ip6fw, router v4 ACLs -> router v6 ACLs).
- It's all about the same, but now you need to be aware of the additional stack.

We are now officially a dual-stacked network!

What's next?

- More peering
- More peering
- More peering

Reset **99** 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
293	Energy Sciences Network	Equinix SJC	2001:504:0:1::293:1	AS-ESNET	br01-eqx-sjc
293	Energy Sciences Network	PAIX PAO	2001:504:d::a	AS-ESNET	br01-paix-pao
293	Energy Sciences Network	Equinix ASH	2001:504:0:2::293:1	AS-ESNET	br01-eqx-ash
558	Net2EZ	ANY2 LAX	2001:504:13::48	AS-NET2EZ	br01-1w-lax
1280	Internet Systems Consortium, Inc.	Equinix SJC	2001:504:0:1::1280:1		br01-eqx-sjc
1280	Internet Systems Consortium, Inc.	PAIX PAO	2001:504:D::12		br01-paix-pao
1280	Internet Systems Consort	8881	Versatel Global Network	Equinix ASH	2001:504:0:2::8881:1	AS-VT-TRANSIT	br01-eqx-ash
2516	KDDI	9002	RETN	ANY2 LAX	2001:504:13::39	AS-RETN	br01-1w-lax
3320	Deutsche Telekom	9002	RETN	Equinix ASH	2001:504:0:2::9002:1	AS-RETN	br01-eqx-ash
3320	Deutsche Telekom	9264	ASNET	PAIX PAO	2001:504:D::AE		br01-paix-pao
4323	TWTelecom	9304	Hutchison Global Communications	ANY2 LAX	2001:504:13::33		br01-1w-lax
4323	TWTelecom	9497	Digitel Philippines	ANY2 LAX	2001:504:13::40		br01-1w-lax
4323	TWTelecom	9924	Taiwan Fixed Network	PAIX PAO	2001:504:d::30		br01-paix-pao
4589	Easynet	10310	Yahoo!	Equinix ASH	2001:504::2:0:1:310:1	AS-YAHOO	br01-eqx-ash
4589	Easynet	10310	Yahoo!	Equinix SJC	2001:504::1:0:1:310:1	AS-YAHOO	br01-eqx-sjc
4589	Easynet	10310	Yahoo!	Equinix SJC	2001:504:0:1:0:1:310:1	AS-YAHOO	br01-eqx-sjc
4589	Easynet	10848	Tellurian Networks, Inc.	ANY2 LAX	2001:504:13::1f	AS-TELLURIAN	br01-1w-lax
4648	Telecom New Zealand	11666	Nexicom Inc.	Equinix ASH	2001:504:0:2:0:1:1666:1		br01-eqx-ash
4648	Telecom New Zealand	11666	Nexicom Inc.	ANY2 LAX	2001:504:13::65		br01-1w-lax
4739	Internode Systems	12989	Highwinds Network Group, Inc	Equinix ASH	2001:504::2:0:1:2989:1	AS-HIGHWINDS	br01-eqx-ash
4739	Internode Systems	12989	Highwinds Network Group, Inc	Equinix LAX	2001:504::3:0:1:2989:1	AS-HIGHWINDS	br01-1w-lax
4826	Vocus Communications	12989	Highwinds Network Group, Inc	PAIX PAO	2001:504:d::4c	AS-HIGHWINDS	br01-paix-pao
4826	Vocus Communications	13030	Init Seven	ANY2 LAX	2001:504:13::37		br01-1w-lax
4826	Vocus Communications	14589	Digital West Networks, Inc.	Equinix SJC	2001:504::1:0:1:4589:1		br01-eqx-sjc
6762	Telecom Italia Sparkle	14589	Digital West Networks, Inc.	ANY2 LAX	2001:504:13::7		br01-1w-lax
6939	Hurricane Electric, Inc.	15169	Google Inc.	PAIX PAO	2001:504:D::1F		br01-paix-pao
6939	Hurricane Electric, Inc.	15169	Google Inc.	Equinix SJC	2001:504::1:0:1:5169:1		br01-eqx-sjc
6939	Hurricane Electric, Inc.	15169	Google Inc.	Equinix ASH	2001:504::2:0:1:5169:1		br01-eqx-ash
6939	Hurricane Electric, Inc.	15169	Google Inc.	ANY2 LAX	2001:504:13::54		br01-1w-lax
6939	Hurricane Electric, Inc.	18508	Force10 Networks	PAIX PAO	2001:504:D::7D		br01-paix-pao
7385	Integra Telecom, Inc.	19151	WV FIBER LLC	Equinix LAX	2001:504::3:0:1:9151:1	AS-WVFIBER	br01-1w-lax
7385	Integra Telecom, Inc.	19151	WV FIBER LLC	Equinix SJC	2001:504::1:0:1:9151:1	AS-WVFIBER	br01-eqx-sjc
7385	Integra Telecom, Inc.	19151	WV FIBER LLC	Equinix ASH	2001:504::2:0:1:9151:1	AS-WVFIBER	br01-eqx-ash
7385	Integra Telecom, Inc.	19740	Sudjam, LLC	ANY2 LAX	2001:504:13::3a		br01-1w-lax
7385	Integra Telecom, Inc.	20144	ICANN	Equinix LAX	2001:504:0:3:0:2:0144:1		br01-1w-lax
7473	Singapore Telecommuni	25795	ARP Networks, Inc.	ANY2 LAX	2001:504:13::6C		br01-1w-lax
7473	Singapore Telecommuni	26415	VeriSign	PAIX PAO	2001:504:D::C1	AS-GTLD	br01-paix-pao
7575	AARNet	26415	VeriSign	Equinix ASH	2001:504:0:2::2641:1	AS-GTLD	br01-eqx-ash
7575	AARNet	26773	Datavo	ANY2 LAX	2001:504:13::16		br01-1w-lax
7784	Atlantech Online, Inc.	27321	Internet Systems Consortium, Inc.	ANY2 LAX	2001:504:13::35		br01-1w-lax
8001	Net Access	29748	Carpathia Hosting	Equinix ASH	2001:504:0:2:0:2:9748:2	AS-CARPATHIA	br01-eqx-ash
8038	Bind	30071	OCCAID	Equinix SJC	2001:504::1:0:3:71:1		br01-eqx-sjc
8092	Ygnition Networks	30071	OCCAID	Equinix ASH	2001:504::2:0:3:71:1		br01-eqx-ash
8121	Layer42 Networks	32354	UNWIRED	PAIX PAO	2001:504:D::55		br01-paix-pao
8121	Layer42 Networks	33419	Tribal Fusion Inc.	Equinix ASH	2001:504:0:2:0:3:3419:1		br01-eqx-ash
8121	Layer42 Networks	34763	TIML Radio	ANY2 LAX	2001:504:13::5	AS-VIRGINRADIO	br01-1w-lax
8121	Layer42 Networks	36351	SoftLayer Technologies, Inc	Equinix ASH	2001:504::2:0:3:6351:1	RS-SOFTLAYER	br01-eqx-ash
8121	Layer42 Networks	40009	BitGravity	Equinix ASH	2001:504::2:0:4:9:1		br01-eqx-ash
8218	NeoTelecoms SAS	40009	BitGravity	Equinix SJC	2001:504::1:0:4:9:1		br01-eqx-sjc
8218	NeoTelecoms SAS	40009	BitGravity	Equinix LAX	2001:504::3:0:4:9:1		br01-1w-lax
8781	QTel	40528	ICANN	Equinix LAX	2001:504::3:0:4:528:1		br01-1w-lax
8781	QTel	46135	Gangus Internet Services, LLC	ANY2 LAX	2001:504:13::4B		br01-1w-lax
		64597	Renesys	PAIX PAO	2001:504:d::5b		br01-paix-pao
		64597	Renesys	ANY2 LAX	2001:504:13::5a		br01-1w-lax

More peering!

```
br01-paix-pao#sh bgp ipv6 u s
BGP router identifier 209.237.224.247, local AS number 23342
BGP table version is 4450218, main routing table version 4450218
1827 network entries using 257607 bytes of memory
6929 path entries using 526604 bytes of memory
204097/1394 BGP path/bestpath attribute entries using 28573580 bytes of memory
19 BGP rrinfo entries using 456 bytes of memory
91289 BGP AS-PATH entries using 2402218 bytes of memory
6619 BGP community entries using 570878 bytes of memory
8 BGP extended community entries using 1322 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 32332665 total bytes of memory
1849 received paths for inbound soft reconfiguration
BGP activity 3445397/3161065 prefixes, 163422520/162228135 paths, scan interval 60 se

Neighbor        V    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
2001:504:D::1   4  1280  170594  168780  4450218    0    0 3w3d           17
2001:504:D::A   4   293  105089   98987  4450218    0    0 3w3d            2
2001:504:D::D   4  2516  106134  105207  4450218    0    0 3w3d           20
2001:504:D::10  4  6939  446270  168766  4450218    0    0 3w3d         1674
2001:504:D::12  4  1280  236227  221549        0    0    0 5w4d     Active
2001:504:D::1D  4  7385  127187  140145  4450218    0    0 3w3d            3
2001:504:D::1F  4 15169  350761  331598  4450218    0    0 2w4d            7
2001:504:D::30  4  9924       0       0        0    0    0 never    Active
2001:504:D::32  4  7473  344683  331863  4450218    0    0 3w3d            8
2001:504:D::35  4    42       0       0        0    0    0 never    Active
2001:504:D::39  4  3320  105560  104825  4450218    0    0 3w3d            3
2001:504:D::46  4  6762    5668    5610        0    0    0 3w0d     Active
2001:504:D::4A  4  4589  140974  139354  4450218    0    0 3w1d           10
2001:504:D::4C  4 12989  125827  110104  4450218    0    0 3w3d           28
2001:504:D::55  4 32354  169915  168766  4450218    0    0 3w3d            1
2001:504:D::57  4  8121 2038599 1990472  4450218    0    0 3w3d            1
2001:504:D::5B  4 64597  136944  291657  4450218    0    0 3w3d            0
2001:504:D::5F  4  8218  363978  331861  4450218    0    0 3w3d           18
2001:504:D::60  4  8781   52464   52079  4450218    0    0 3w3d            1
2001:504:D::61  4  4648   85175   79608  4450218    0    0 3w3d            1
2001:504:D::7D  4 18508  215836  577182  4450218    0    0 3w3d            1
2001:504:D::86  4  4826       0       0        0    0    0 never    Active
2001:504:D::AE  4  9264  318174  266409  4450218    0    0 3w3d           19
2001:504:D::B1  4  7575  352901  331861  4450218    0    0 3w3d            6
2001:504:D::C1  4 26415  128453  127570  4450218    0    0 3w3d            3
2607:F3A0::66   4 23342 2189488 2772994  4450218    0    0 1w3d           27
2607:F3A0::67   4 23342 2401640 2439881  4450218    0    0 26w0d        1527
2607:F3A0::92   4 23342  466606 2436791  4450218    0    0 1w3d            7
2607:F3A0::95   4 23342  466625 2436717  4450218    0    0 1w3d            6
2607:F3A0::251  4 23342  782021 2438174  4450218    0    0 1w3d           11
2607:F3A0::252  4 23342  466642 2436710  4450218    0    0 1w3d           11
2607:F3A0::253  4 23342 2335729 2409560  4450218    0    0 1w3d         1652
2607:F3A0::254  4 23342  466682 2437788  4450218    0    0 1w3d           12
Bell in window 1
```

```
br01-eqx-sjc>sh bgp ipv6 u s
BGP router identifier 209.237.224.67, local AS number 23342
BGP table version is 4352038, main routing table version 4352038
1827 network entries using 257607 bytes of memory
9721 path entries using 738796 bytes of memory
124044/1402 BGP path/bestpath attribute entries using 17366160 bytes of memory
19 BGP rrinfo entries using 456 bytes of memory
63060 BGP AS-PATH entries using 1645448 bytes of memory
966 BGP community entries using 33942 bytes of memory
8 BGP extended community entries using 1322 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 20043731 total bytes of memory
3273 received paths for inbound soft reconfiguration
BGP activity 4449310/4166162 prefixes, 225520829/224806830 paths, scan interval 60 secs

Neighbor        V    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
2001:504:0:1::293:1
                4   293  105035   98919  4352032    0    0 2w5d            2
2001:504:0:1::1280:1
                4  1280  170545  168782  4352032    0    0 16w6d          17
2001:504:0:1::4323:1
                4  4323  296957  275578  4352032    0    0 13w6d           8
2001:504:0:1::4589:1
                4  4589  141794  140144  4352032    0    0 13w6d          10
2001:504:0:1::4739:1
                4  4739  141145  140143  4352032    0    0 10w0d           2
2001:504:0:1::4826:1
                4  4826  157330  138444  4352032    0    0 13w5d          16
2001:504:0:1::6939:1
                4  6939  444941  168792  4352032    0    0 4w4d         1674
2001:504:0:1::7385:1
                4  7385  153261  168782  4352032    0    0 16w6d           3
2001:504:0:1::8121:1
                4  8121  169934  168782  4352032    0    0 16w6d           1
2001:504:0:1:0:1:310:1
                4 10310  353812  329167  4352032    0    0 4w5d            2
2001:504:0:1:0:1:4589:1
                4 14589  232054  216696  4352032    0    0 11w0d           1
2001:504:0:1:0:1:5169:1
                4 15169  282088  275577  4352032    0    0 8w4d            7
2001:504:0:1:0:1:9151:1
                4 19151  230543   96583  4352032    0    0 9w4d         1483
2001:504:0:1:0:3:71:1
                4 30071       0       0        0    0    0 never    Active
2001:504:0:1:0:4:9:1
                4 40009  169871  168778  4352032    0    0 2w5d            0
2607:F3A0::66   4 23342 2369646 2925552  4352038    0    0 1w3d           27
2607:F3A0::92   4 23342  561172 2500706  4352038    0    0 1w3d            7
2607:F3A0::95   4 23342  561174 2500604  4352038    0    0 1w3d            6
2607:F3A0::247  4 23342 2621027 2529032  4352038    0    0 26w0d        1497
2607:F3A0::251  4 23342  904642 2521278  4352038    0    0 1w3d           11
2607:F3A0::252  4 23342  561203 2500608  4352038    0    0 1w3d           11
2607:F3A0::253  4 23342 2518882 2566562  4352038    0    0 1w3d         1649
2607:F3A0::254  4 23342  561284 2501783  4352038    0    0 1w3d           12
br01-eqx-sjc>
```

It's IPv6 peering which means...

- Policies are more flexible
- Almost all networks have open IPv6 policies
- Others will want to peer with you
- E-mail everyone
- Watch the lists for new IPv6 peers
- **Right now, every bit moved to v6 is free!**

BTW: If your CTO asks you, that's your answer.

What now?

- Address your security policy
- Get your operators using v6
- Dual stack your NOC
- Dual stack your offices
- Start updating tools
- Work with operations, marketings, sales, etc.
- Get a test customer..
  - You likely already have a customer who wants IPv6.
  - Make notes of the things that need updates as you implement the test customer.
  - Make a plan from there...

I've got the test customer, what now?

Back to router configs...

```
!
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 23342:417
!
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 23342:417
!
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 23342:417
!
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 23342:417
!
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 23342:417
!
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 23342:417
!
route-map Customer-In permit 70
 description No prepending
 match ip address prefix-list Sanity
 set local-preference 500
 set community 23342:417
!
```

Customer IN

Again 4->6

```
!
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
!
```

Just a little more...

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

4->6

```
!
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
!
```

```
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 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
```

Turn up the customer BGP session:

```
2607:F3A0:0:1A::2
               4  8038   15939   32050    40368    0    0 1w2d           1
br02-sf7-200p-sfo#sh bgp ipv6 u ne 2607:F3A0:0:1A::2 route
BGP table version is 40368, local router ID is 209.237.224.252
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

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

Total number of prefixes 1
Bell in window 1
```

```
br02-sf7-200p-sfo#sh bgp ipv6 u 2607:F3A0:BEEF::/48
BGP routing table entry for 2607:F3A0:BEEF::/48, version 9359
Paths: (2 available, best #1, table Global-IPv6-Table)
  Advertised to update-groups:
     2
  8038
    2607:F3A0:0:1A::2 from 2607:F3A0:0:1A::2 (207.7.140.2)
      Origin IGP, metric 0, localpref 500, valid, external, best
      Community: 23342:418
  8038, (received-only)
    2607:F3A0:0:1A::2 from 2607:F3A0:0:1A::2 (207.7.140.2)
      Origin IGP, metric 0, localpref 100, valid, external
br02-sf7-200p-sfo#
```

Now if we look at what we are advertising

```
br01-paix-pao#sh bgp ipv6 u ne 2001:504:D::1  ad
BGP table version is 4450565, 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
*>i2607:F3A0:BEEF::/48
                    2607:F3A0::252           0    500      0 8038 i

Total number of prefixes 2
br01-paix-pao#
```

Technically a violation of policy.. but.. we can multi-home too

```
br01-paix-pao#sh bgp ipv6 u 2607:F3A0:BEEF::/48
BGP routing table entry for 2607:F3A0:BEEF::/48, version 4399920
Paths: (3 available, best #3, table Default)
  Advertised to update-groups:
     2          4
  6939 8038
    2001:504:D::10 (FE80::20C:DBFF:FEFE:FD00) from 2001:504:D::10 (216.218.252.165)
      Origin IGP, localpref 400, valid, external
      Community: 23342:117
  6939 8038, (received-only)
    2001:504:D::10 (FE80::20C:DBFF:FEFE:FD00) from 2001:504:D::10 (216.218.252.165)
      Origin IGP, localpref 100, valid, external
  8038, (received & used)
    2607:F3A0::252 (metric 1) from 2607:F3A0::252 (209.237.224.252)
      Origin IGP, metric 0, localpref 500, valid, internal, best
      Community: 23342:418
br01-paix-pao#
```

Other ways to dual stack a customer:

- Dual stack a connected interface
- Static route
  - You'll need to add a redistribute static
    - and of course another route-map

Conclusion

- Dual stacking is not hard to set up
- Transit providers do not need to accept your route.
- Support won't get better until you help define issues
- Customers will always find a way to get what they want.
    - Multi-homing for starters.

Get started with IPv6 today!

QUESTIONS?