

The Whys and Hows of IPv6

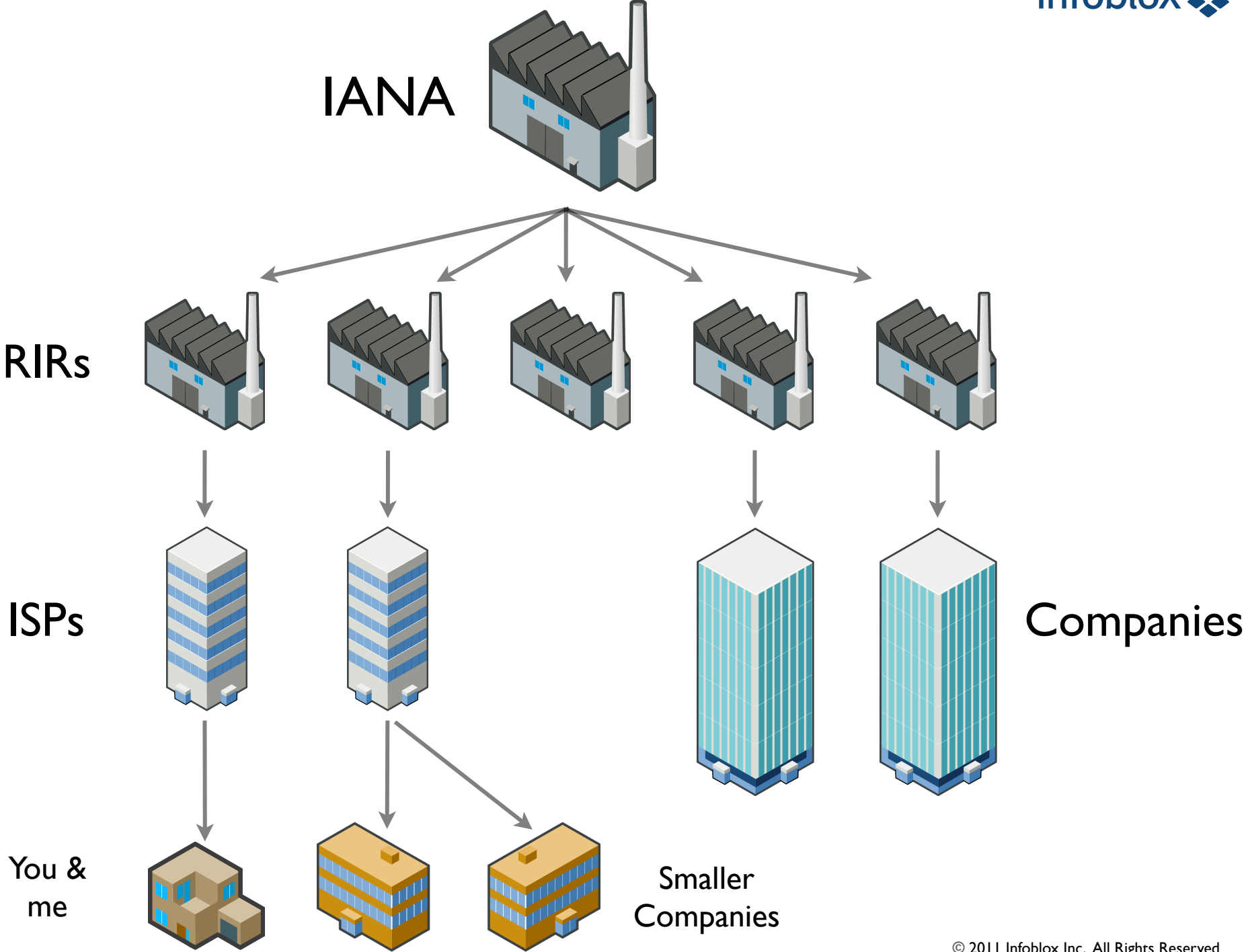
Cricket Liu, VP Architecture & Technology
Phoenix, April 27, 2012

Countries of Registrants



78 different countries and **5005** registrants

How Many Times Can We Run Out of IPv4 Addresses?





IANA: EXHAUSTED 2/3/2011



APNIC: EXHAUSTED 4/15/2011



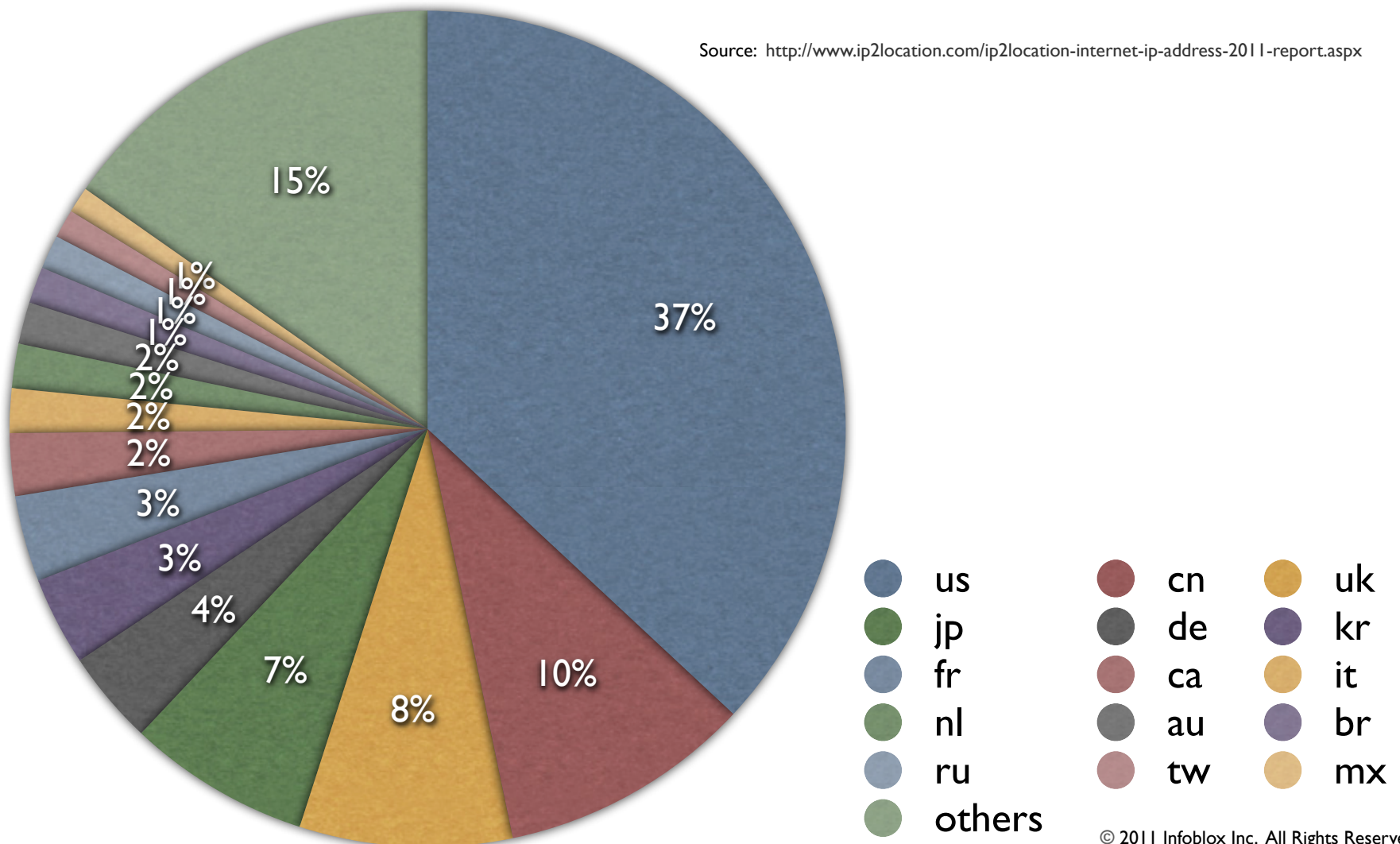
NEXT UP: RIPE?

(EST. 8/13/2012)



Where Did All Those IPv4 Addresses Go?

Source: <http://www.ip2location.com/ip2location-internet-ip-address-2011-report.aspx>



What's the One Thing Everyone Knows About IPv6?

- 128-bit addresses

But How Big Is That?

- 2^{128} addresses = 3.4×10^{38} addresses =
340 *undecillion* addresses

A satellite view of Earth showing the Middle East, Africa, and parts of Asia, with white text overlaid.

Say this is all of IPv6
address space...

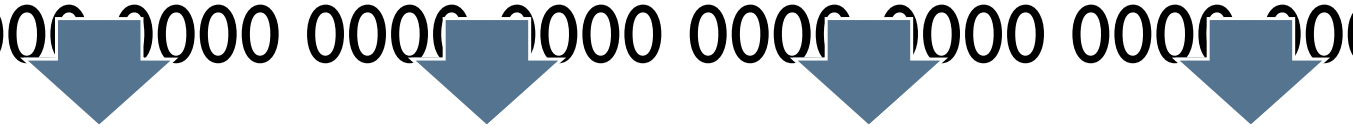
Then all of IPv4 address space is a little bigger than this...



How Do I Write an IPv6 Address?

```

0010 0000 0000 0001 0000 1101 1011 1000
1100 1010 1111 1110 0000 0000 0000 0001
0000 0000 0000 0000 0000 0000 0000 0000
0000 0000 0000 0000 0000 0000 0000 0000
    
```



2 0 0 1

How Do I Write an IPv6 Address?

2001:0db8:cafe:0001:0000:0000:0000:0001

2001:db8:cafe:1:0:0:0:1

2001:db8:cafe:1::1

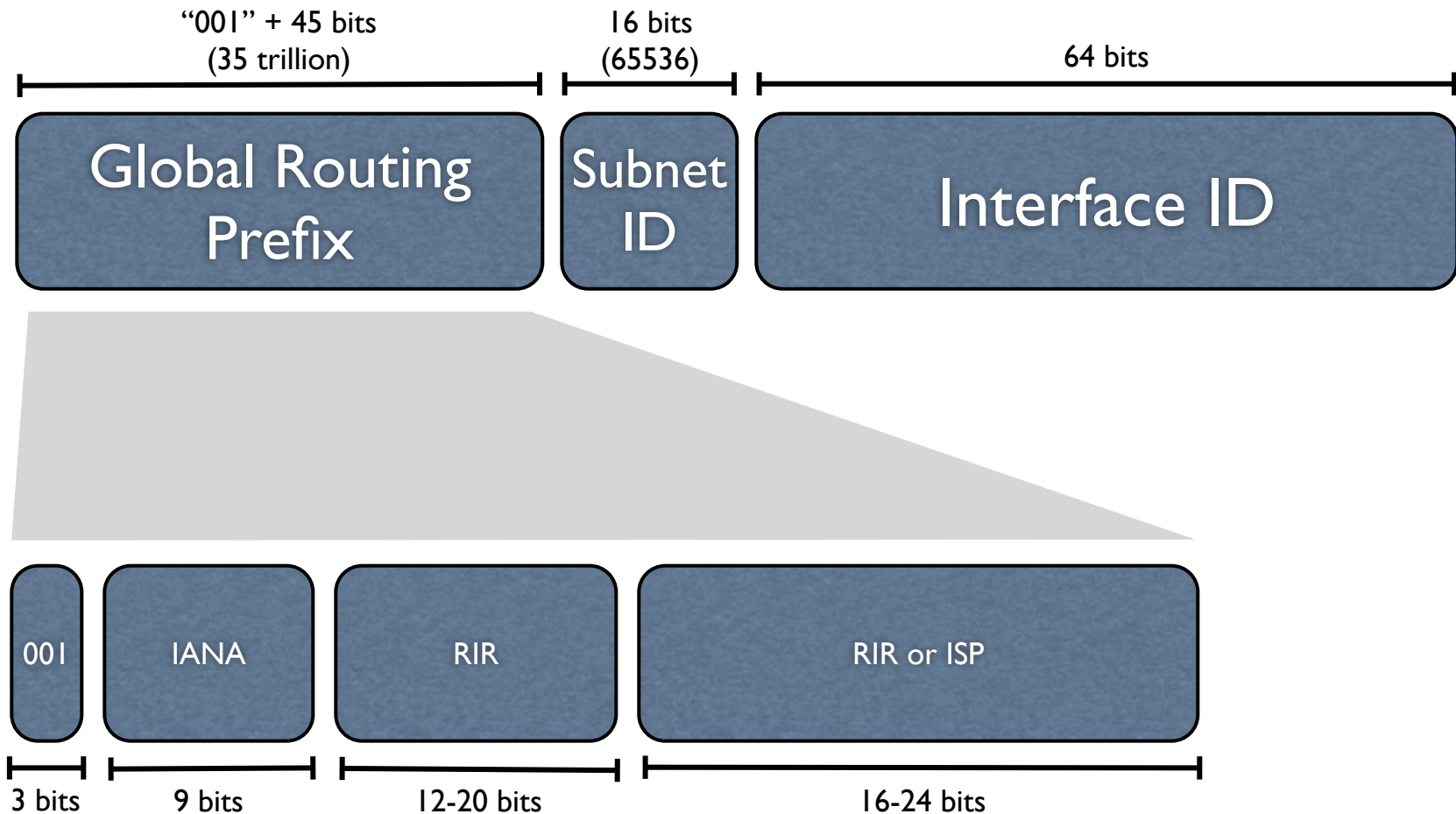
How Do I Write an IPv6 Network?

- Almost the same as in IPv4!
- Specify the bits in the network's prefix:
 - 2001:db8:cafe
- Add “::” for unspecified (local-part) bits:
 - 2001:db8:cafe::
- Add “/” and the number of bits in the prefix:
 - 2001:db8:cafe::/48

Types of IPv6 Addresses

Type	IPv6 Network/Address	IPv4 Equivalent
Unspecified Address	::/128	0.0.0.0
Loopback Address	::1/128	127.0.0.1
Unique Local Addresses	fc00::/7	RFC 1918 (e.g., 10/8)
Link-local Addresses	fe80::/10	169.254/16
Documentation	2001:db8::/32	192.0.2/24
Global Unicast	2000::/3	
Multicast	ff00::/8	224/4

Structure of IPv6 Global Unicast Addresses



How Do Clients Get IPv6 Addresses? Router Advertisements!

© www.vintagepaperads.com

Save \$30.00 on Sears Best Router.
Regular \$74.99. On Sale Now. Only \$44.99.

Now you can get Sears best router at a great low price. With this powerful 1-HP COMMERCIAL ROUTER and accessories such as listed below, you can decorate edges, do carving and make virtually every joint used in furniture building.

Its micro-adjust depth gauge allows you to adjust in 64ths of an inch up to 1 1/2 in. deep. It is double insulated. And the powerful ball-bearing motor generates a speed of 25,000 R.P.M.'s for a fast, smooth cutting action. No other router we offer is more powerful and it's on sale for only \$44.99. SALE BEGINS November 24, 1975 and ENDS December 13, 1975. At Sears, Roebuck and Co. retail stores. Similar savings in catalog.

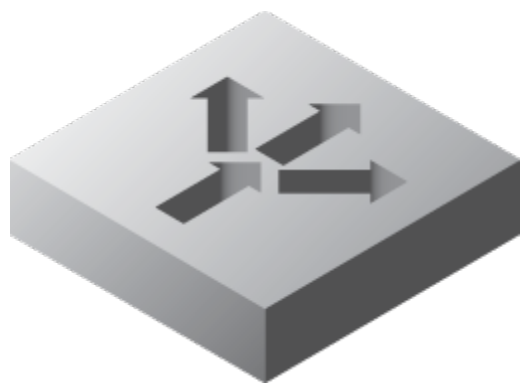
Save \$10.00 on this Craftsman 17-piece high speed Router Bit Set.
Regular \$49.99. Now only \$39.99.

Save \$4.00 on the Craftsman Router Table.
Regular \$14.99. Now only \$10.99.

Sears CRAFTSMAN
Tools that have earned the right to wear the name.

DECEMBER 1975 9

Actual IPv6 Router Advertisements



You're on
2001:db8:cafe:1::/64
A, M, O

Te A, M, O?

	Address Assignment		Option Assignment
A flag	SLAAC		RFC 5006/6106 (RDNSS/DNSSL)?
M flag	Stateful DHCPv6		Stateful DHCPv6
O flag	SLAAC		Stateless DHCPv6





Address Assignment Mechanisms

IPv6 Provisioning Mechanism	And What Sort of a Thing Is That?
Stateless Address Autoconfiguration (SLAAC)	Client derives IPv6 address from router-advertised prefix and self-generated suffix
Stateful DHCPv6	Like DHCP, but for IPv6
Stateless DHCPv6	Client uses SLAAC for IP address, DHCP for DNS, etc.
RFC 5006/6106 (RDNSS/DNSSL)	Client uses router advertisements for DNS, etc.


Spot the IPv6 Address!

```
% ifconfig
lo0: flags=8049<UP,LOOPBACK,RUNNING,MULTICAST> mtu 16384
  options=3<RXCSUM, TXCSUM>
  inet6 fe80::1%lo0 prefixlen 64 scopeid 0x1
  inet 127.0.0.1 netmask 0xff000000
  inet6 ::1 prefixlen 128
en0: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
  options=27<RXCSUM, TXCSUM, VLAN_MTU, TSO4>
  ether 00:23:df:a9:98:14
  inet6 fe80::223:dfff:fea9:9814%en0 prefixlen 64 scopeid 0x4
  inet6 2001:db8:1f05:1a2f:223:dfff:fea9:9814 prefixlen 64 autoconf
  inet6 2001:db8:1f05:1a2f:e1d1:33a6:981f:de48 prefixlen 64 autoconf temporary
  inet6 2001:db8:1f05:1a2f::64 prefixlen 64
  inet 192.168.0.244 netmask 0xffffffff00 broadcast 192.168.0.255
  media: autoselect (100baseTX <full-duplex,flow-control>)
  status: active
en1: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
  ether 00:23:6c:97:bc:bf
  inet6 fe80::223:6cff:fe97:bcbf%en1 prefixlen 64 scopeid 0x5
  inet6 2001:db8:1f05:1a2f:223:6cff:fe97:bcbf prefixlen 64 autoconf
  inet6 2001:db8:1f05:1a2f:dc3a:80d7:5ea:f0c5 prefixlen 64 autoconf temporary
  inet6 2001:db8:1f05:1a2f::6b prefixlen 64
  inet 192.168.0.236 netmask 0xffffffff00 broadcast 192.168.0.255
  media: autoselect
  status: active
```

default

foo.example Zone    

Records

Quick Filter | Filter On | [Show Filter](#)  [Toggle flat view](#)

Go to

Name	Type
<input type="checkbox"/>	SOA Record
<input type="checkbox"/>	DNSKEY Record
<input type="checkbox"/>	DNSKEY Record
<input type="checkbox"/>	NS Record
<input type="checkbox"/>	NS Record
<input type="checkbox"/>	DNSKEY Record
<input type="checkbox"/>	NSEC Record
<input type="checkbox"/>	RRSIG Record
<input type="checkbox"/>	RRSIG Record
<input type="checkbox"/>	RRSIG Record
<input type="checkbox"/>	RRSIG Record
<input type="checkbox"/>	RRSIG Record
<input type="checkbox"/>	RRSIG Record
<input type="checkbox"/>	RRSIG Record
<input checked="" type="checkbox"/>	charm Host
<input type="checkbox"/>	charm NSEC Record
<input type="checkbox"/>	charm RRSIG Record
<input type="checkbox"/>	charm RRSIG Record
<input type="checkbox"/>	charm RRSIG Record

Company 1 > default > charm.foo.example (Host Record)

Basic

General

TTL

Aliases

IPv4 Discovered Data

Extensible Attributes

Permissions

IPv4 Address	Priority
<input type="checkbox"/> 192.168.0.244	<input type="checkbox"/>
<input type="checkbox"/> 192.168.0.236	<input type="checkbox"/>

IPv6 Addresses

IPv6 Address	DUID	DHCP
<input type="checkbox"/> 2001:db8:1f05:1a2:		<input type="checkbox"/>
<input type="checkbox"/> 2001:db8:1f05:1a2:		<input type="checkbox"/>
<input type="checkbox"/> 2001:db8:1f05:1a2:		<input type="checkbox"/>
<input type="checkbox"/> 2001:470:1f05:1a2:		<input type="checkbox"/>

Comment

Disabled

DNS and IPv6: Forward Mapping

`www.infoblox.com. IN AAAA 2001:1868:ad01:1::33`

Supporting IPv4 and IPv6 (or Why World IPv6 Day?)

www.infoblox.com. IN A 205.234.19.21

www.infoblox.com. IN AAAA 2001:1868:ad01:1::33

IPv6 Subdomains

www.infoblox.com. IN A 205.234.19.21

www.**ipv6**.infoblox.com. IN AAAA 2001:1868:ad01:1::33

IPAM Home

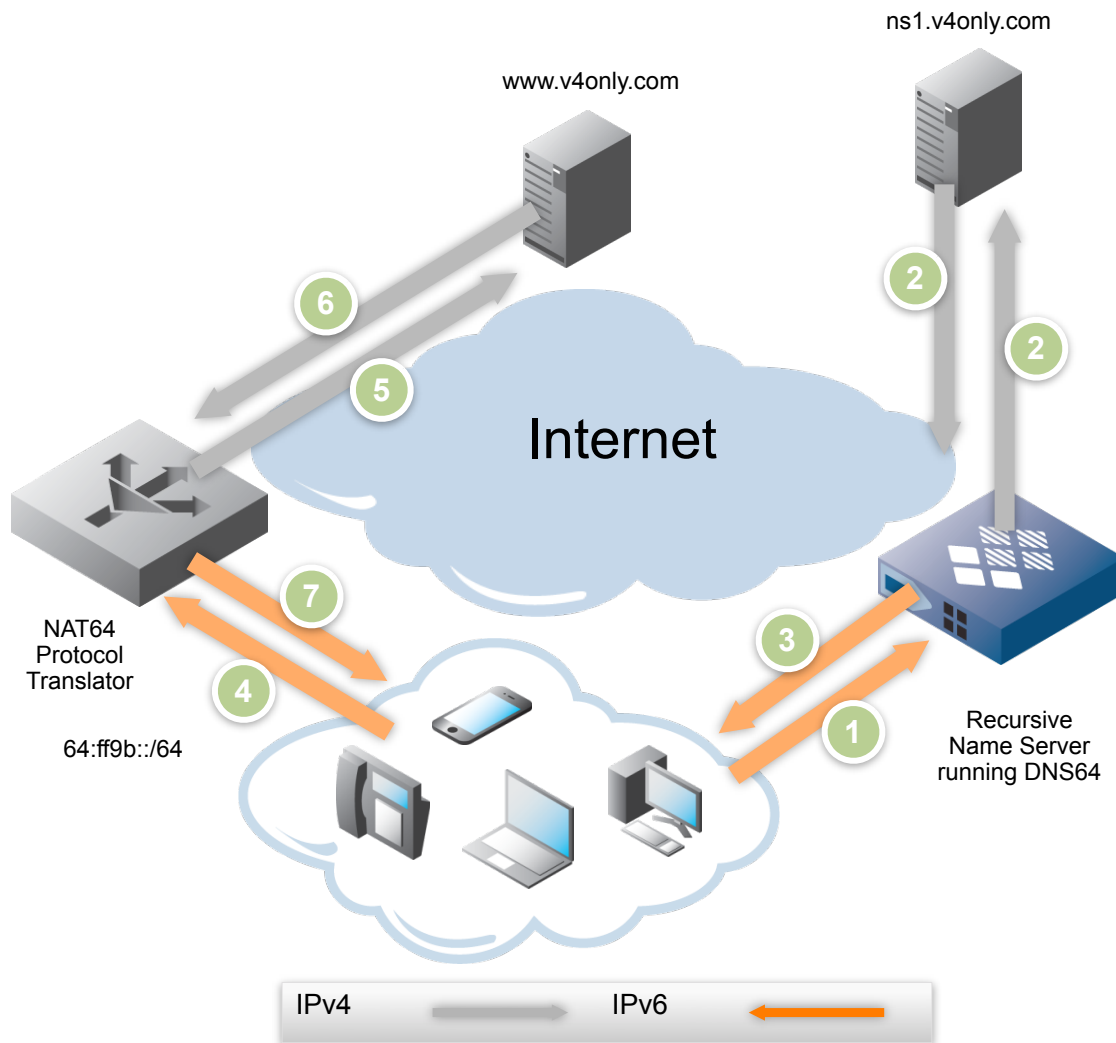
2001:db8::/32 IPv6Network [Go to DHCP View](#)

Quick Filter Off Filter On [Show Filter](#)

Go to

<input type="checkbox"/>	IP Address ^	Name	DUID	Status	Type	Usage	Lease State	Comment
<input type="checkbox"/>	2001:db8:1f05:1a2f::64	charm.foo.example		USED	Host	DNS		
<input type="checkbox"/>	2001:db8:1f05:1a2f:223:dfff:fea9:9814	charm.foo.example		USED	Host	DNS		
<input type="checkbox"/>	2001:db8:1f05:1a2f:e1d1:33a6:981f:de48	charm.foo.example		USED	Host	DNS		

How Does an IPv6-only Client Talk to an IPv4-only Server?

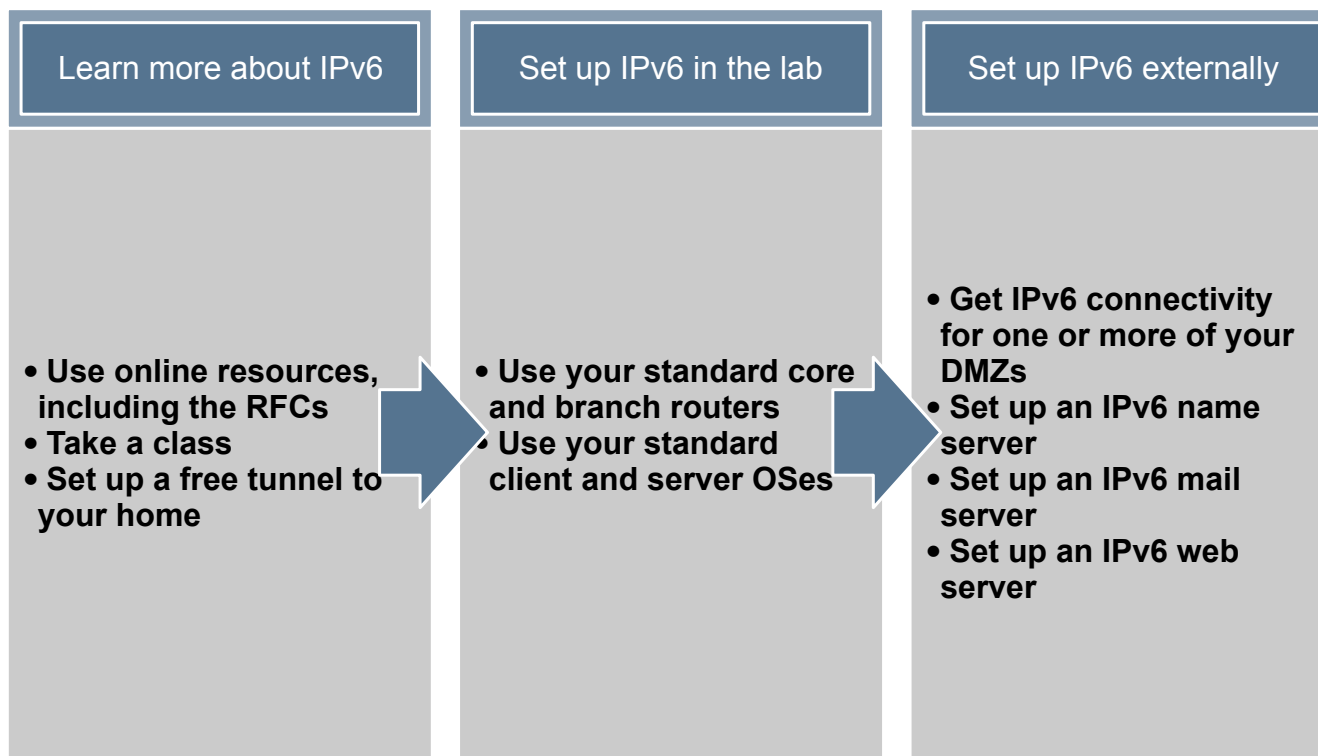


- 1 Client queries local recursive name server for `www.v4only.com/AAAA`.
- 2 Recursive name server queries name server for `v4only.com` zone and gets no AAAA records. Recursor then queries for A records and gets one.
- 3 Recursive name server embeds the IPv4 address in an IPv6 address by appending it to a /96 prefix. Recursor returns synthesized AAAA record to client.
- 4 Client sends packet to synthesized IPv6 address, which is routed to the NAT64 protocol translator.
- 5 NAT64 device translates packet to destination IPv4 address.
- 6 IPv4-only web server returns response over IPv4 to NAT64 protocol translator.
- 7 NAT64 protocol translator converts the packet to IPv6 to return to the originating client.

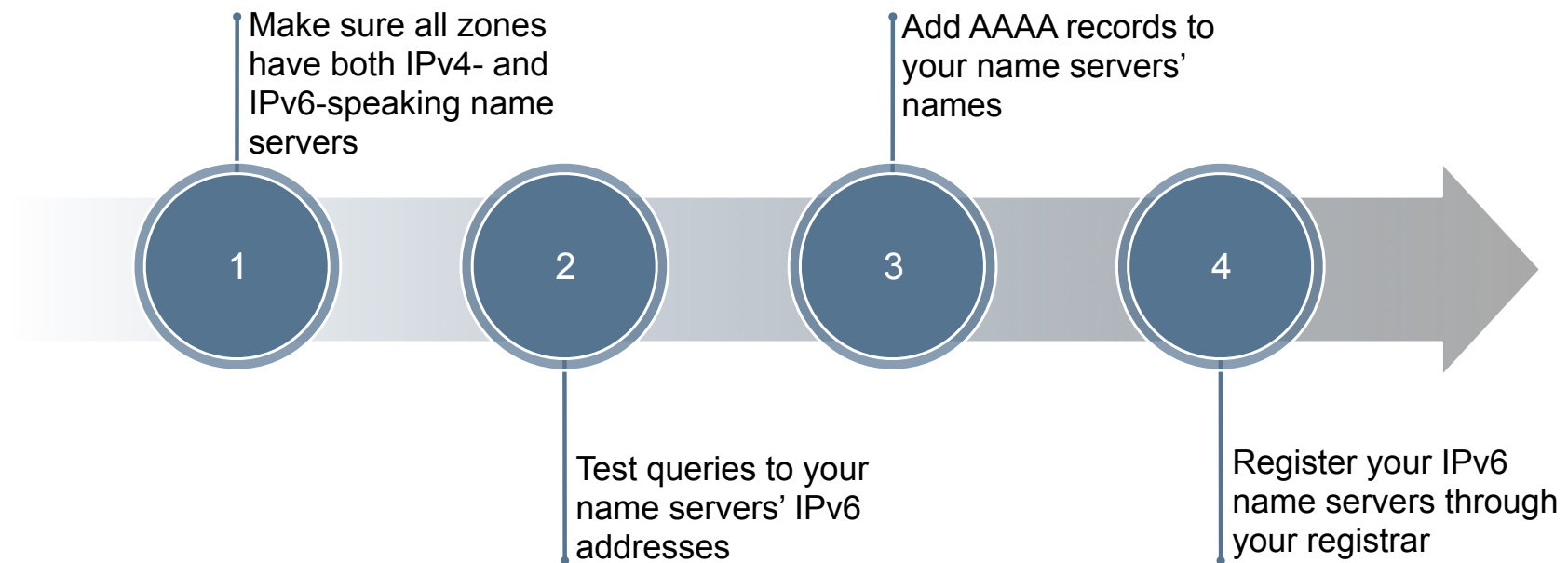
How's This Going to Play Out?

- Asian ISPs and wireless carriers begin expanding using IPv6
 - Using transition technologies like NAT64/DNS64 to provide access to IPv4 resources
- European ISPs and wireless carriers begin expanding using IPv6
- The balance gradually shifts toward IPv6
- Services offered over IPv6 avoid bottlenecks and provide a better experience to customers with IPv6-only connectivity

How Do I Begin?



Running Name Servers Over IPv6



Internet Arithmetic

family emergency
+
natural disaster
=
career in DNS

Knock
knock

References

- Infoblox's IPv6 Resource Center: <http://www.infoblox.com/en/resources/ipv6-resource-center.html>
- Geoff Huston's IPv4 Address Report: <http://www.potaroo.net/tools/ipv4/>
- Frank Capra's "It's a Wonderful Life": <http://www.imdb.com/title/tt0038650/>
- IP2Location Internet IP Address 2011 Report: <http://www.ip2location.com/ip2location-internet-ip-address-2011-report.aspx>
- ICANN blog: <http://blog.icann.org/2007/06/ipv6-the-ipod-and-the-earth/>
- Hurricane Electric's Tunnel Broker Service: <http://tunnelbroker.net/>

Q & A