World IPv6 Day
Migrating to IPv6
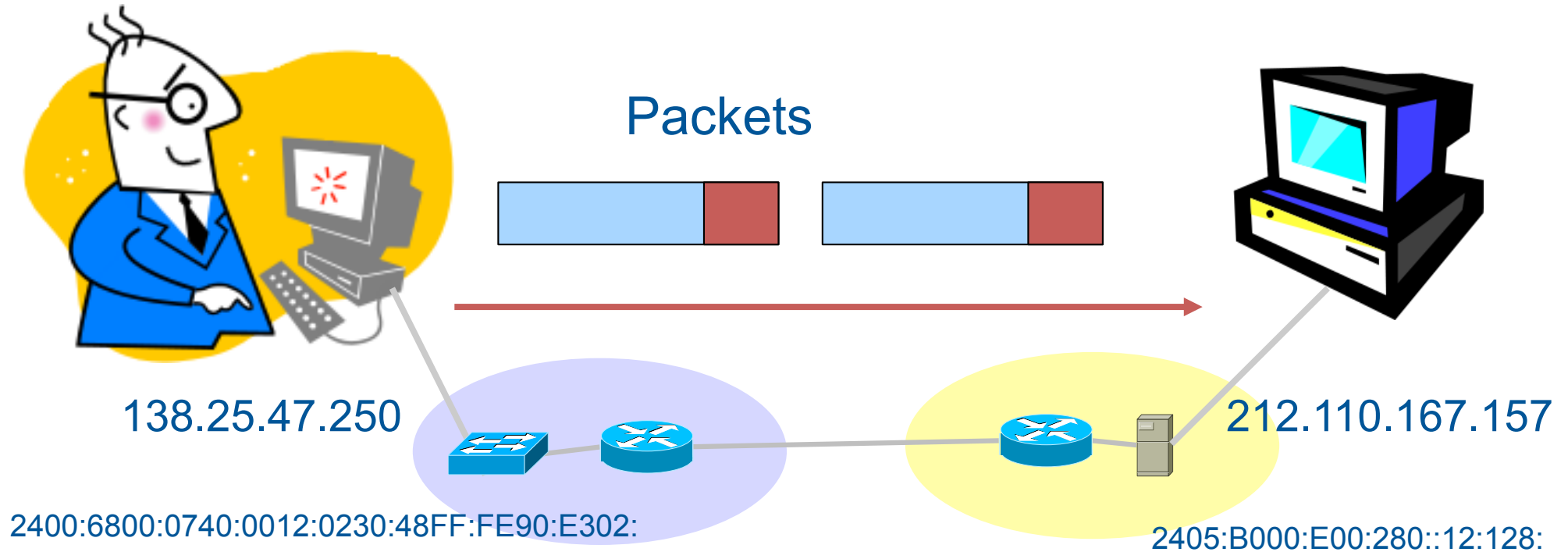## *making 6=4 and 4=6*

Narelle Clark

vice-president@isoc-au.org.au

Vice President, Internet Society of Australia

Member, Board of Trustees, ISOC

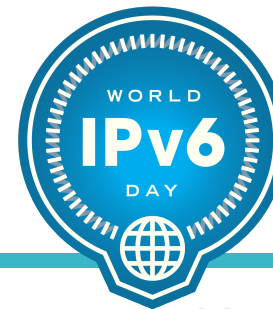*Telecommunications & Internet Practice, Pavonis Consulting*

IPv6 is simple, right?

Packets

138.25.47.250

2400:6800:0740:0012:0230:48FF:FE90:E302:

212.110.167.157

2405:B000:E00:280::12:128:

No direct interoperability between IPv4 and IPv6

The design of IPv4 forces any change to the basic protocol, such as the address, be done using a new protocol. Had IPv4 had a variable length address, IPv6 probably would not have become necessary.

What was World IPv6 Day?

For 24 hours on 8 June 2011 (00h00-23h59 UTC) Facebook, Google, Yahoo! and more than 1000 other websites turned on IPv6 access on their "front door"

Goals:

- Motivate Internet service providers, hardware makers, operating system vendors, Web companies and others to prepare their services for IPv6

- Understand what issues still need to be addressed to ensure a successful transition to IPv6 as IPv4 addresses run out.

While there have been similar notable efforts, World IPv6 Day was the first global, real-world "test-flight" of IPv6, and the largest ever.

Motivations for the World IPv6 Day Event

- Breaking the chicken-and-egg problem of IPv6 deployment – networks clearly see that content is getting there

- Improving IPv6 connectivity by understanding outstanding issues faced by a small percentage of users (but significant numbers for large content providers) – more fixes are in flight

- Providing a target date for already planned IPv6 rollouts – people definitely responded to having a date

- Spurring organizations to create a plan for rolling out IPv6 – being like Google, Facebook, and Yahoo! is important

- … - created customer demand for vendors, cdns, isps

- Catalyzing the kind of collaboration that the Internet has relied upon through its history – people noticed that the Internet industry came together to advance something that is important for the overall long term health of the Internet

Who turned up IPv6 on June 8?

www.google.com

www.facebook.com

www.youtube.com

www.yahoo.com

www.blogspot.com

www.yahoo.co.jp (#12)

www.bing.com (#21)

www.microsoft.com (#25)

www.bbc.co.uk (#38)

www.cnn.com (#48)

www.aol.com (#55)

Several local Australian hosting providers joined in

Netregistry (.gov.au supplier)

Hosting companies added IPv6 Addresses to thousands of domains

www.netregistry.net

www.host.md (@4500 - permanent)

www.task.com.br (@7000 – left on)

www.df.eu (@700,000)

www.strato.de (@4,000,000 – left on)

… others with 1000s and 10000s of thousands

Documenting Success

Improved connectivity

- Large websites have their finger on the pulse of this important aspect of June 8

Participating sites

- Documented through an IPv6 reachability dashboard
  - http://www.worldipv6day.org/participants-dashboard/index.html
- Longer term goal is permanently turning up IPv6: some of that happened June 8; some will happen as a result of the activities on the day, but later; some will need more time
- Roughly 2/3rds of the participating sites who contacted us remained on

Traffic increased and remained higher

- Ripe Labs measured impact on IPv6 traffic
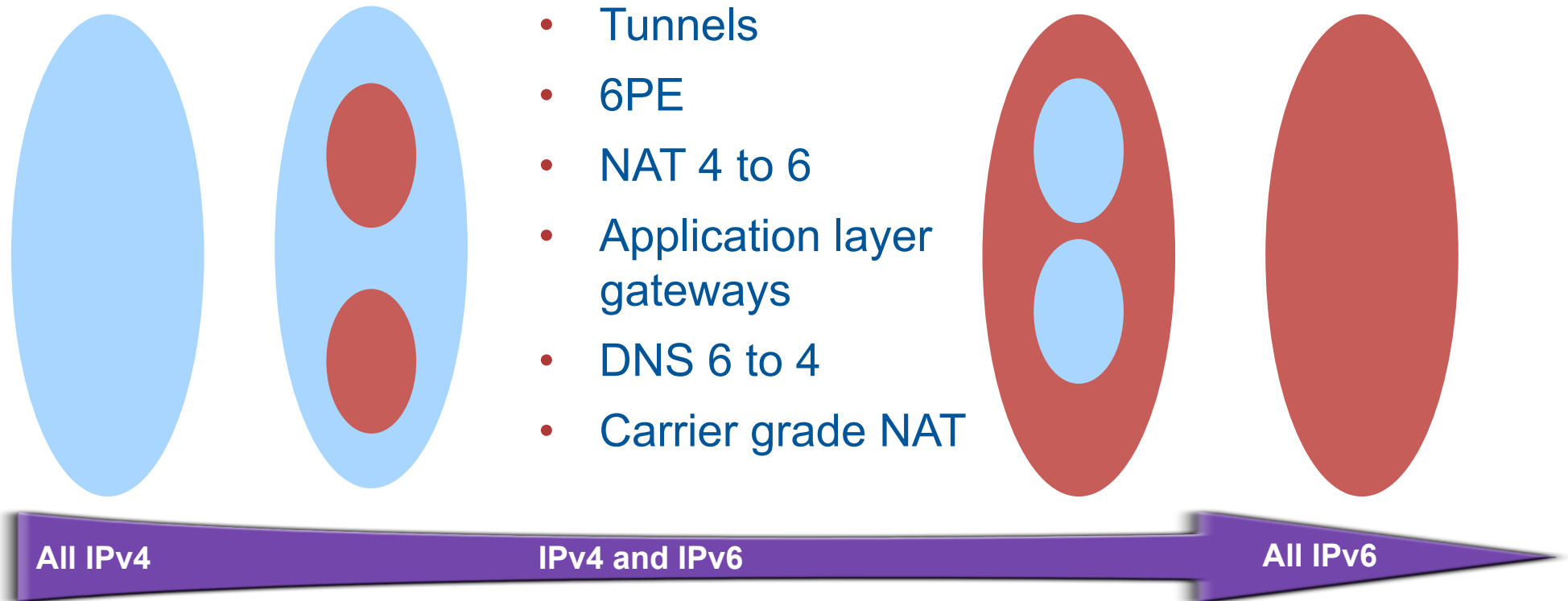 - http://labs.ripe.net/Members/emileaben/measuring-world-ipv6-day-long-term-effects
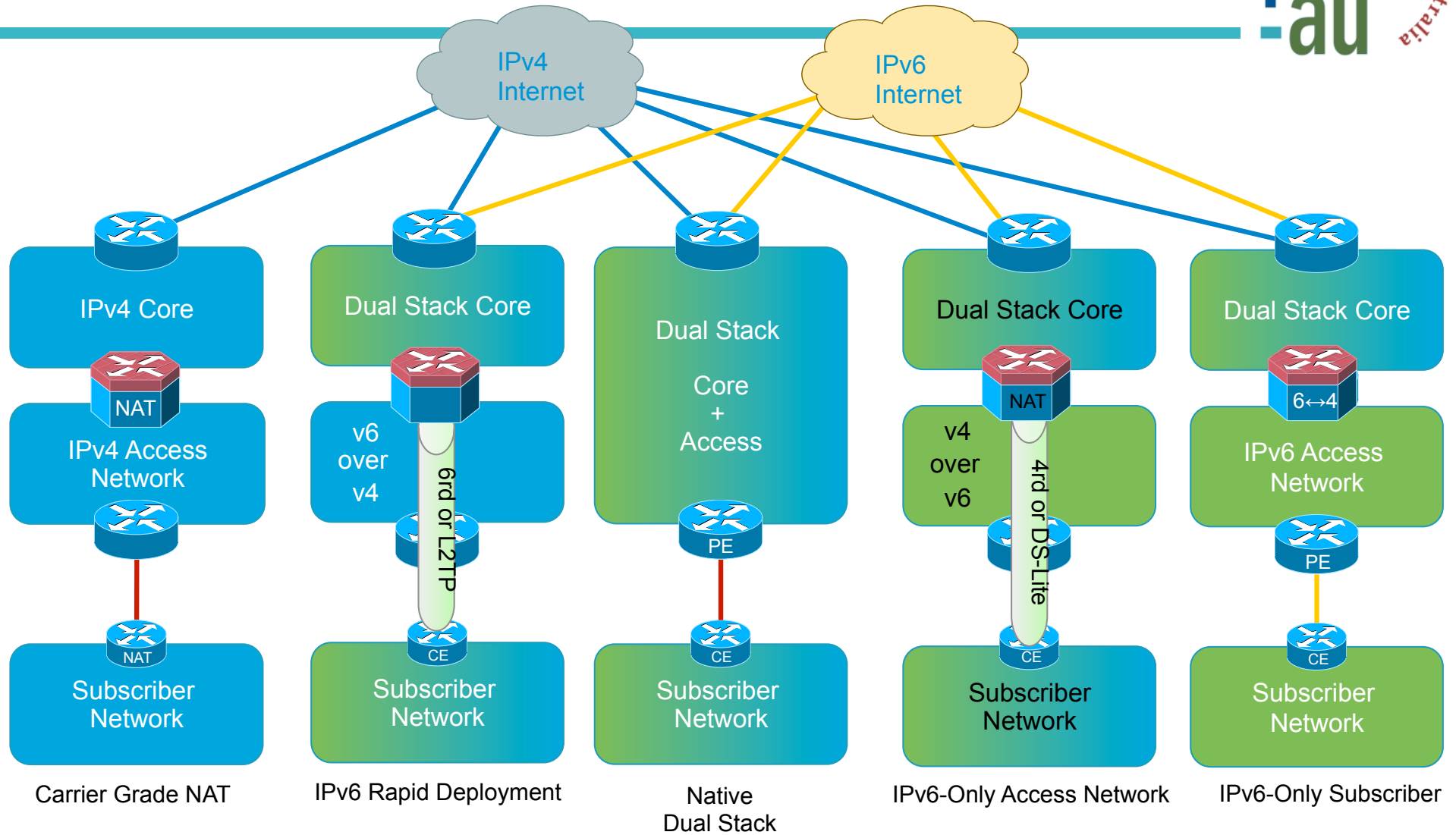
Broad observations

- No large scale breakage

- For 24 hours some people (some websites/content owners and some end users) could ignore things being a bit off

- DDOS fears did not pan out

- Difficult for some in financial sector to join in

- Mismatch between local efforts and head office

- V6 Islands to be addressed – "Happy Eyeballs" needs work

- Work remains to be done

Transition mechanisms

- Dual stack
- Tunnels
- 6PE
- NAT 4 to 6
- Application layer gateways
- DNS 6 to 4
- Carrier grade NAT

All IPv4　　　　　　　　　**IPv4 and IPv6**　　　　　　　　　**All IPv6**

IP network transitional technologies

IPv4 Internet

IPv6 Internet

IPv4 Core

NAT

IPv4 Access Network

NAT

Subscriber Network

Carrier Grade NAT

Dual Stack Core

v6 over v4

6rd or L2TP

CE

Subscriber Network

IPv6 Rapid Deployment

Dual Stack

Core + Access

PE

Subscriber Network

Native Dual Stack

Dual Stack Core

NAT

v4 over v6

4rd or DS-Lite

CE

Subscriber Network

IPv6-Only Access Network

Dual Stack Core

6↔4

IPv6 Access Network

PE

CE

Subscriber Network

IPv6-Only Subscriber

Tunneling and translation are mostly unavoidable...

End game is to dual stack IPv4 and IPv6

- Difficult as some older hardware elements do not support IPv6
- Memory, performance considerations

IPv6 tunnelling methods – 6rd, ISATAP, 6PE

- End devices require clients therefore requires client management. Also breaks inline systems such as DPI, FW, IPS, etc.

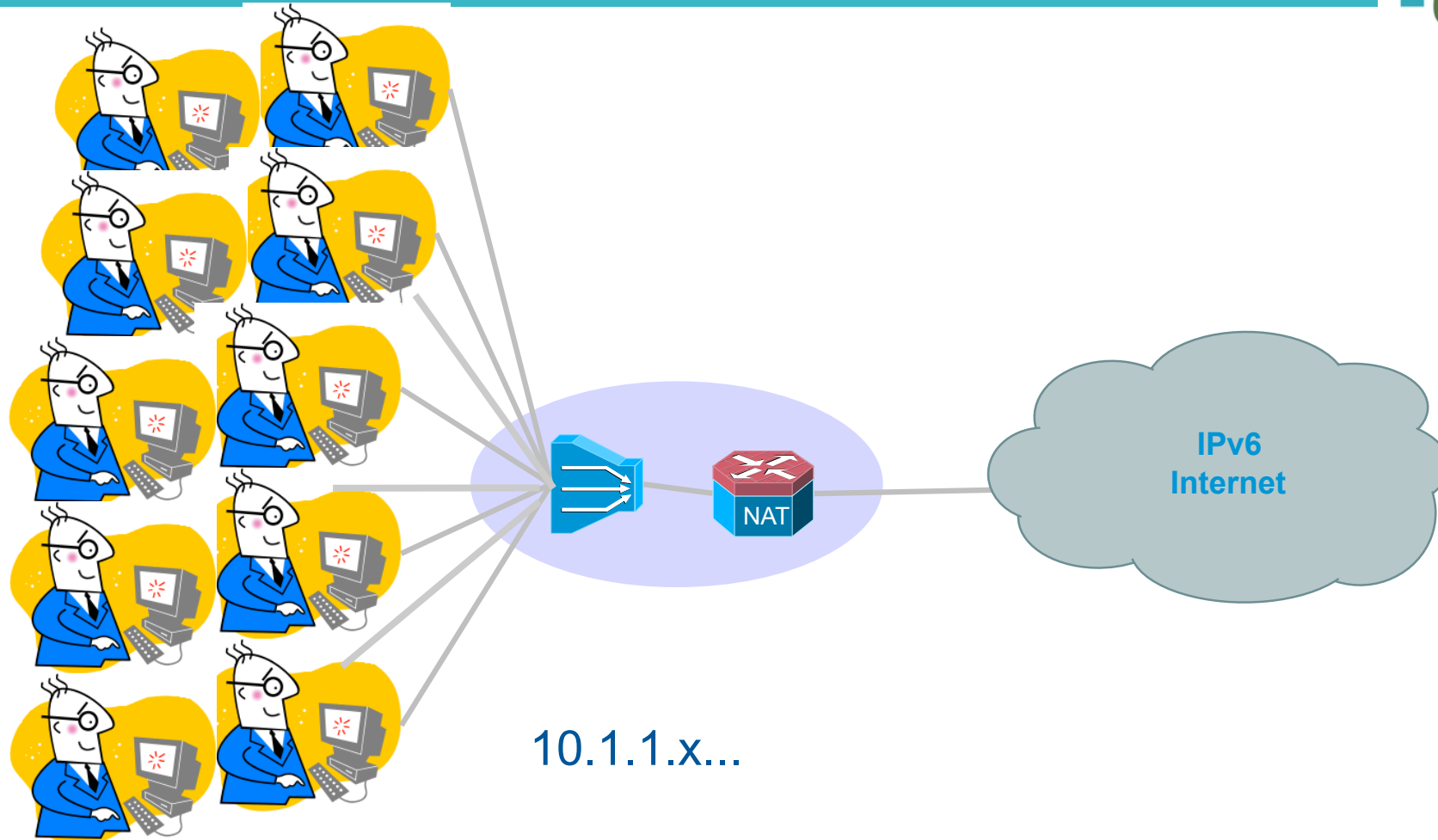## IPv6 Translation Methods – SIIT, NAT-PT, NAT64, DNS64

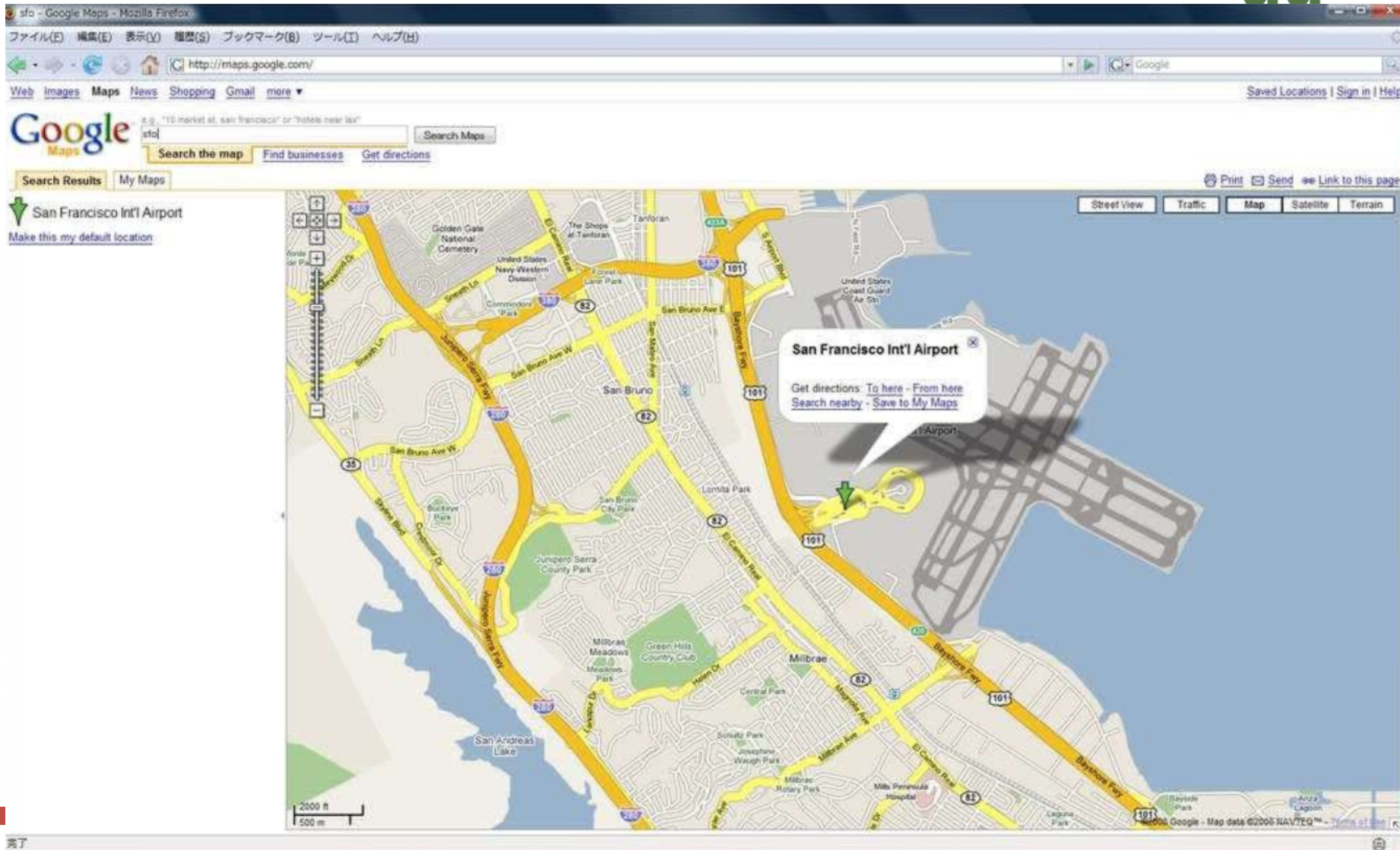- Simplest method as it can be applied at the network edge

Large Scale NAT

- Already deployed in many networks, some applications need ALG. Beware of ever increasing session counts on the NAT devices.
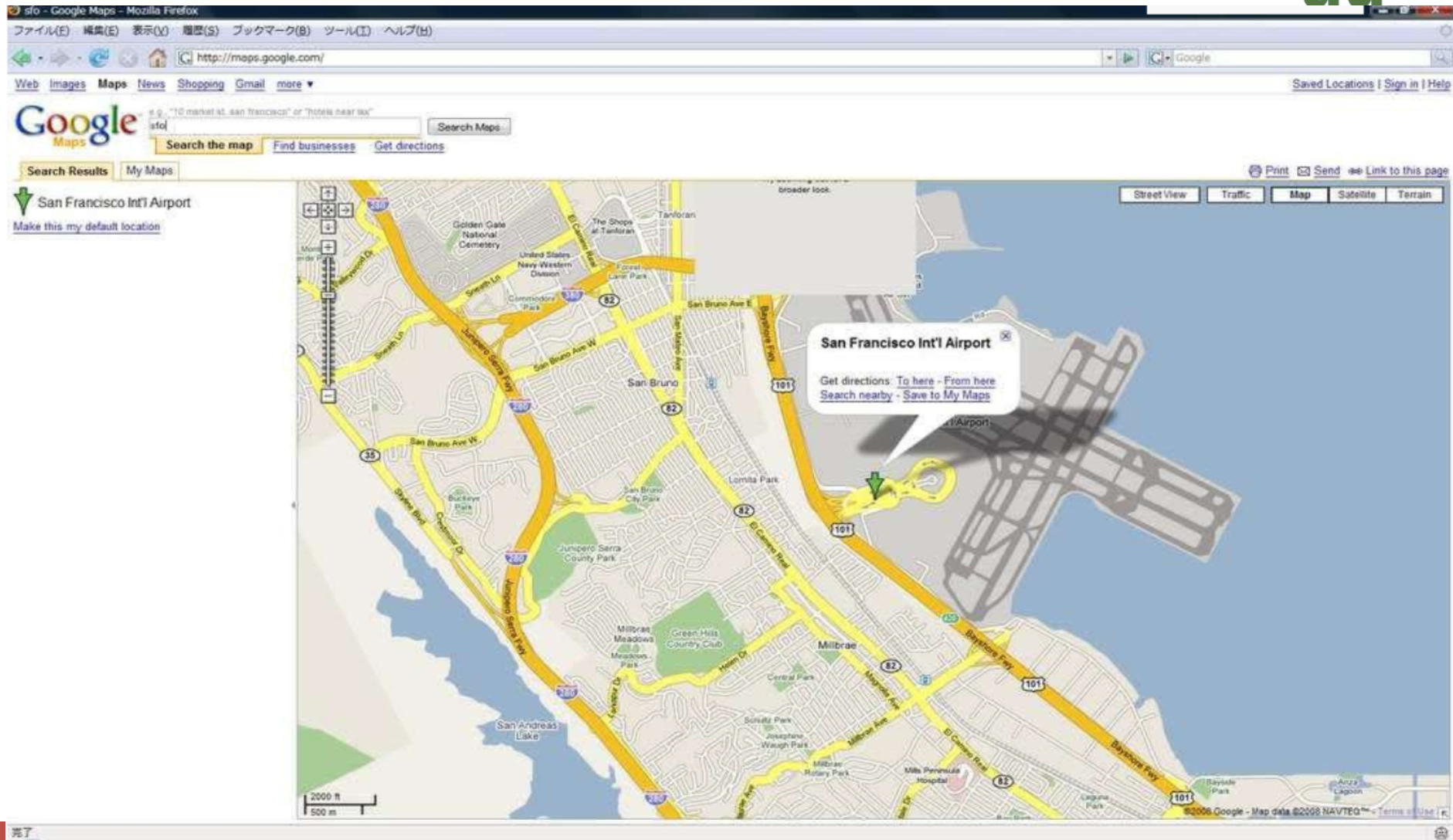
NAT44 → NAT64 → Dual Stack → NAT46

Why bother, let's just NAT!

10.1.1.x...

IPv6 Internet

Some caution about NAT... 30 sessions

Source: Shin Miyakawa, NTT 2008

Some caution about NAT... 20 sessions

Migrating to IPv6

Source: Shin Miyakawa, NTT 2008

Some caution about NAT... 15 sessions

Migrating to IPv6

Source: Shin Miyakawa, NTT 2008

Some caution about NAT... 10 sessions

Migrating to IPv6

Source: Shin Miyakawa, NTT 2008

Some caution about NAT... 5 sessions

Source: Shin Miyakawa, NTT 2008

Secure Encryption

….and now do this
   munging v4 addresses to v6
   addresses inside the HTML…
   without breaking SSL certificates
   and encrypted payloads

Yes, NATs really ARE evil!

The major factor that has extended the lifetime of V4 has been Network Address Translation technology

And this the single largest architectural problem in today's Internet:

– NATs destroy persistent identity
– NATs create a client / server world.
– NATs require proxies and middleware
– NATs produce complex application-specific solutions
– NATs lock us all back into service-specific network platforms.
– NATs cannot drive a ubiquitous agile Internet spanning a plethora of chatty devices

ISP comments in IETF and RIRs

We have seen a 180 degree change in ISP viewpoints in NANOG, RIPE, APNIC, and the IETF

Oct 26, 2007: The Day the Routers Died "I guess we'll have to look at IPv6"

August 2008: CTO of major ISP "we have to switch to IPv6 by 2012, but we're worried about content"

2009: CERNET, Comcast, and Free standardizing tools for IPv6 deployment

2009, 2010: Google IPv6 Implementor's Conferences

IETF meetings in 2010: "We are deploying, and these are our problems"

IETF-79 (November 2010, Beijing)

Numerous ISPs making impassioned pleas for support in their transition plans

Example: China Telecom, "IPv6-only within two years" with IPv4 overlay

Example: Telstra, "Dual Stack, planning to use Carrier Grade NAT for IPv4"

Example: numerous DSL networks using 6rd like Free.fr is

IETF-80 (March 2011, Prague)

IETF choosing to obsolete 6to4 (RFCs 3056/3068) as "in the way"

ISPs matter-of-factly talking about IPv6 deployment experience

IETF IPv6ops (July 2011, Quebec):

ARIN to be asked to allocate an IPv4 block for "transition use"
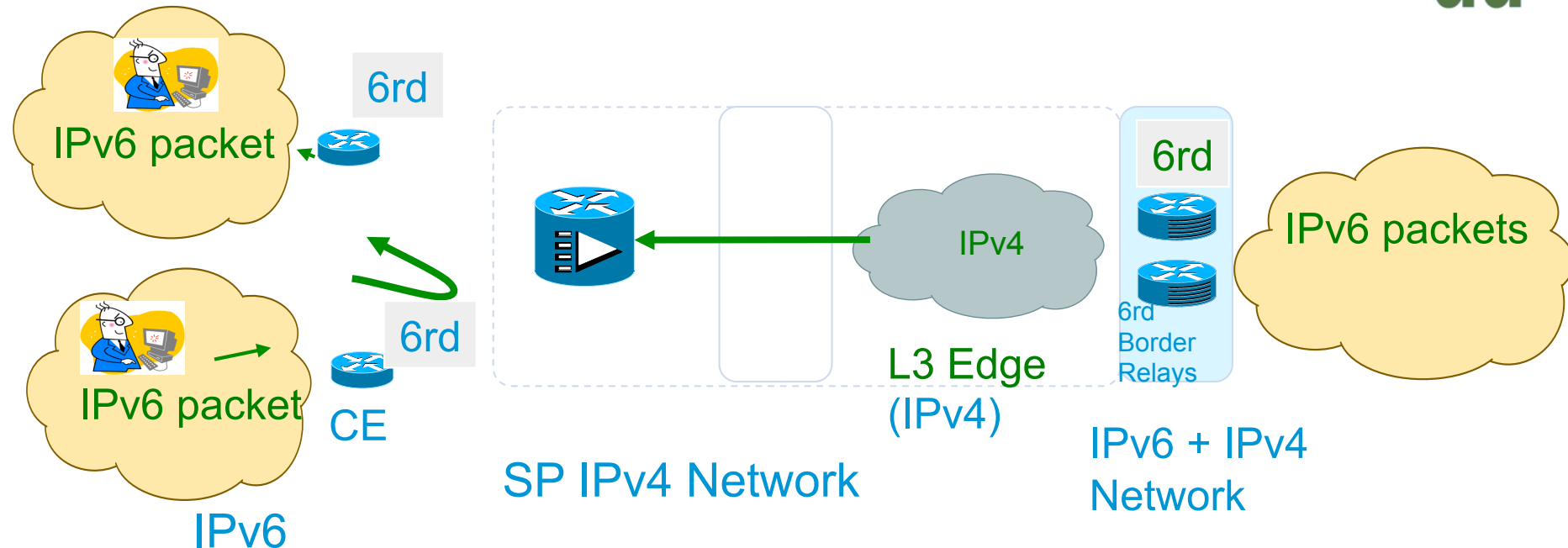
RIR community:

IANA announced IPv4 run-out 31 January 2011

APNIC announced IPv4 run-out 15 April 2011
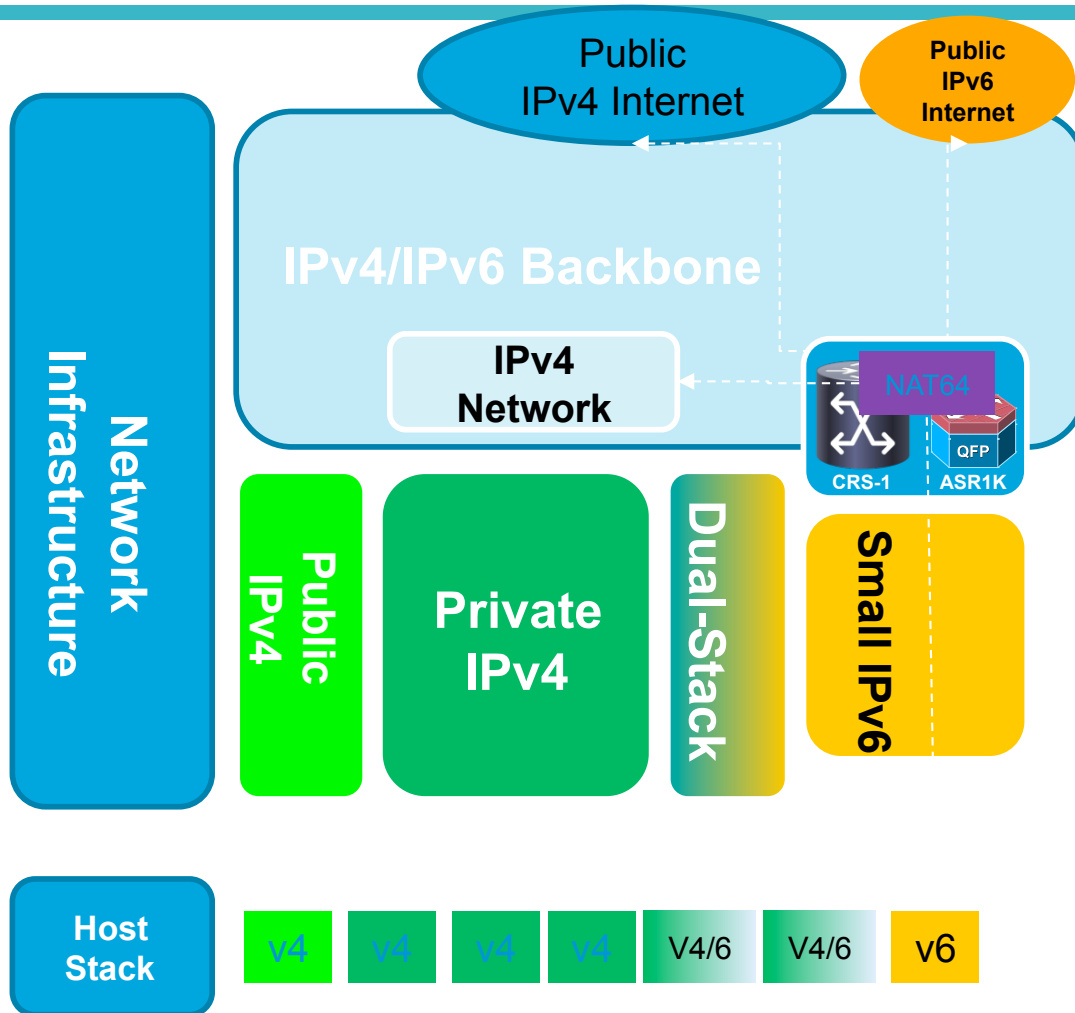
RIPE expected to run out autumn 2011

ARIN likely early 2012.

6rd: Dynamic IPv6/IPv4 tunneling

- IPv6 service in the home is essentially identical to native IPv6 service
- IPv6 Packets follow IPv4 routing
- 6rd Border Relay traversed only when exiting or entering a 6rd domain
- 6rd Border Relays are fully stateless, no limit on "number of subscribers" supported
- Border Relays may be placed in multiple locations, addressed via anycast.

IPv6 Transition Solutions 2011: NAT64

Public IPv4 Internet

Public IPv6 Internet

IPv4/IPv6 Backbone

IPv4 Network

NAT64

CRS-1   ASR1K   QFP

Network Infrastructure

Public IPv4

Private IPv4

Dual-Stack

Small IPv6

Host Stack

v4 v4 v4 v4 V4/6 V4/6 v6

2011   2012   2013   2014   2015

- Deploy "small" controlled IPv6 network with known hosts

- Stateless NAT64
  · Employs 1:1 mapping
  · Enables bi-directional session setups

- Stateful NAT64
  · N:1 mapping (IPv4 address sharing)
  · ideal for large Mobile IPv6 to public IPv4 Internet

- Advantages to operator is head-start on IPv6 adoption & services/application deployment

Preparation for IPv6 transition

Process of deployment:

1. **Audit application and network hardware and software for IPv6 compatibility**
2. Determine configurations
3. Deploy piecemeal through network

Might use 6rd, translation, or other technologies to deal with issues

1. Eventually network is dual stack

Process of IPv4 turndown

1. Determine that IPv4 utilization no longer make **business sense**
2. Remove A records from DNS

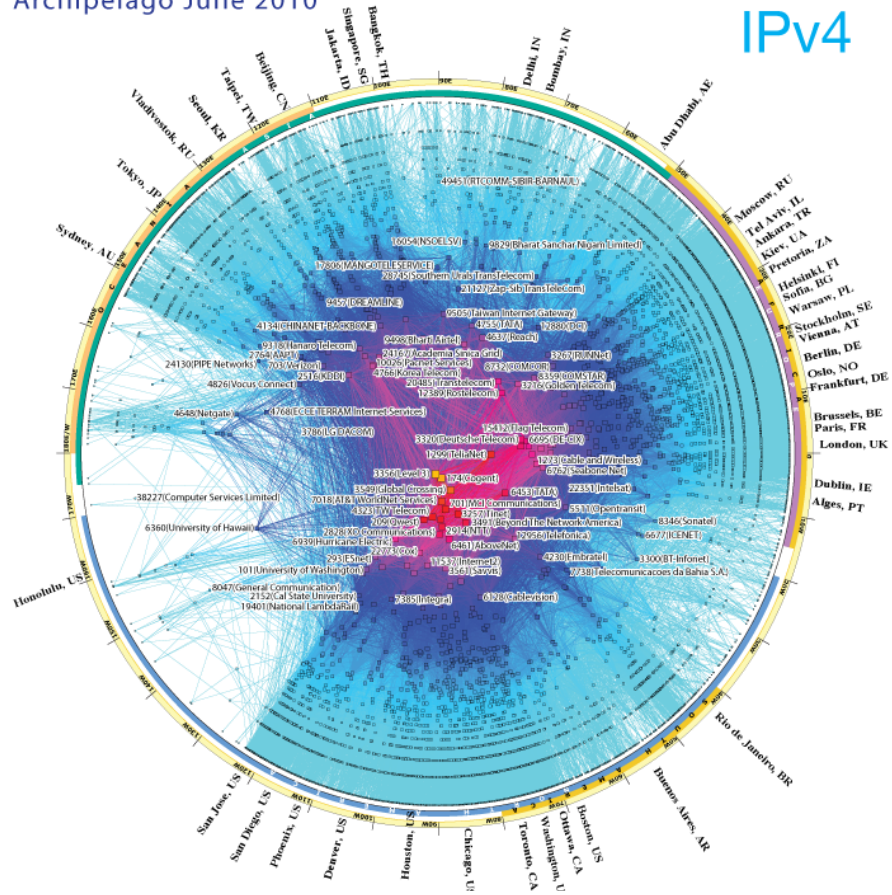*You will discover quickly if someone still needs them*

1. Remove DHCP from network
2. Remove IPv4 routing from network
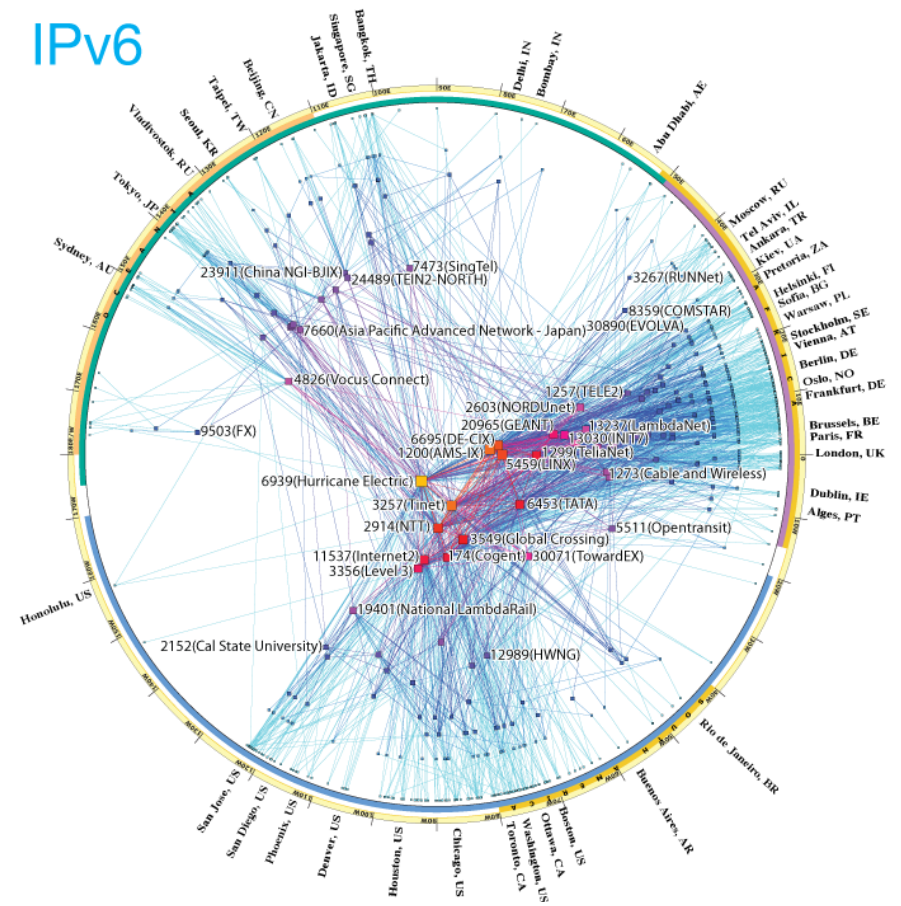3. Hosts and applications will take care of themselves

CAIDA's IPv4 & IPv6 AS Core
AS-level INTERNET GRAPH
Archipelago June 2010

IPv4

IPv6

Australian IPv6 Summit 2011

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Learning From Experience

Melbourne, 17-19 October 2011
Welcome, IPv4 user ... let us bring you up to date!

A vast new IPv6 world awaits - but which path will get you there?
Luckily, pioneers have already forged ahead to find a home on the (address) range.
They've hacked through the RFC undergrowth, dual-stacked the hostile servers,
and even transitioned the mighty DNS...
And they're here to tell you how they did it: the pitfalls, the
breakthroughs, and the successes of moving to IPv6.

Come along to Australia's premier IPv6 event, with two days of
presentations **plus TWO optional IPv6 Workshops.**

Internet Protocol Version 6 provides simpler networking, enhanced security,
and almost unlimited addresses for today's expanding mobile Internet.
In 2011, learn from the experience of IPv6 pioneers!

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2005: Global IPv6 Preparation

http://www.ipv6.org.au/summit

16/09/11

EARLYBIRD Registration closes TODAY!

Prepare Now – IPv6 Week 2012!

Thank you

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