



# IPv4/IPv6 Transition: Status and Recommendations



**Fred Baker**

**Cisco Fellow**

**Chair, IETF IPv6 Operations Working Group**

# Before I start...

## Let me tell you my historical position on IPv6

- 1996-2001, Chair of IETF
  - “Long term, we need more IP addresses”
  - Saw value in the Nimrod Architecture
    - Connections between Transport Endpoints, portable between network layer locators
    - Separation between EID (names of endpoints) and Locator (locations in the network)
  - Observed temporary value of IPv4 CIDR and NAT
    - I see dangers as well
  - “The jury is still out on IPv6”*
- 2002-2003, Industry commentator
  - Observed various bodies deciding to make IPv6 work
  - Still need a long term solution
  - Decided to do the same
- 2004-present, v6ops Chair
  - Working to make IPv6 meet the requirements I consider important
  - Supporting general deployment*

# Why IPv6?

- Fundamentally two points:

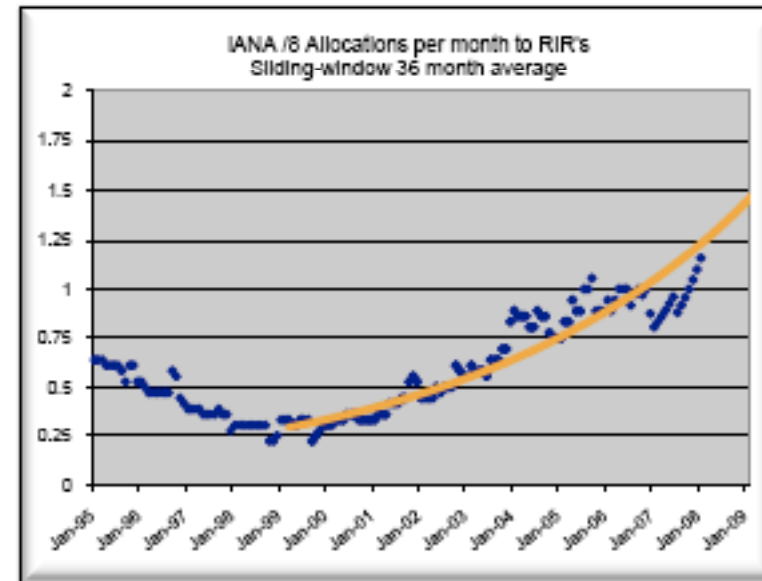
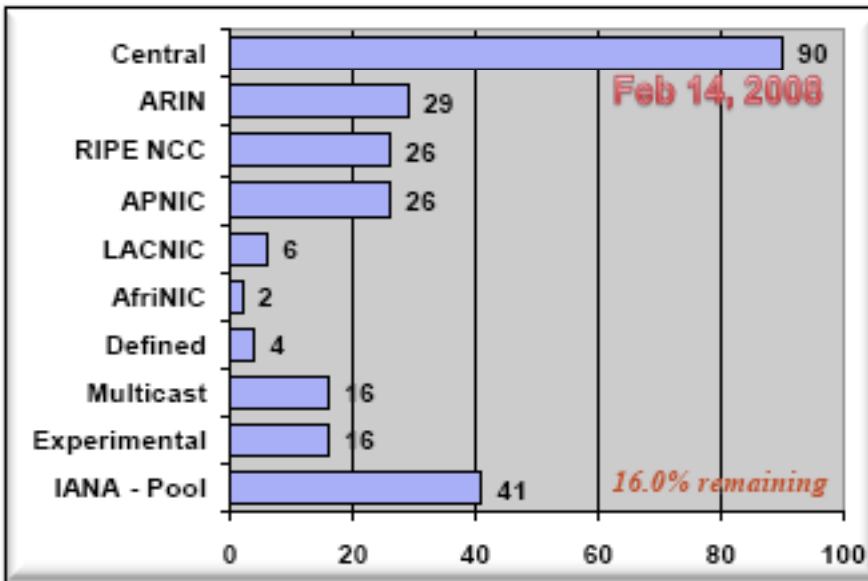
- It solves the present need for more addresses without the complexities becoming necessary in IPv4

- It gives us room to work on remaining issues, including but not limited to a rational Id/Locator split and improvement of routing

- The reason for more addresses:

- Let's talk a little about economics and geography

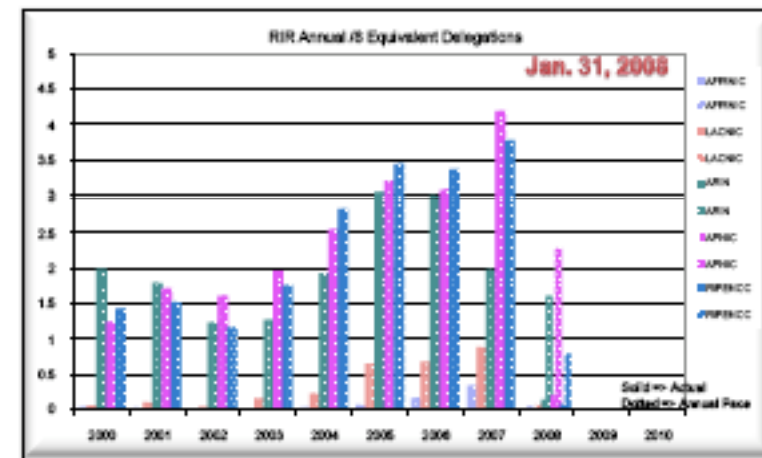
# IANA IPv4 Allocations by /8



- Consumption is accelerating despite increasingly intense conservation efforts.

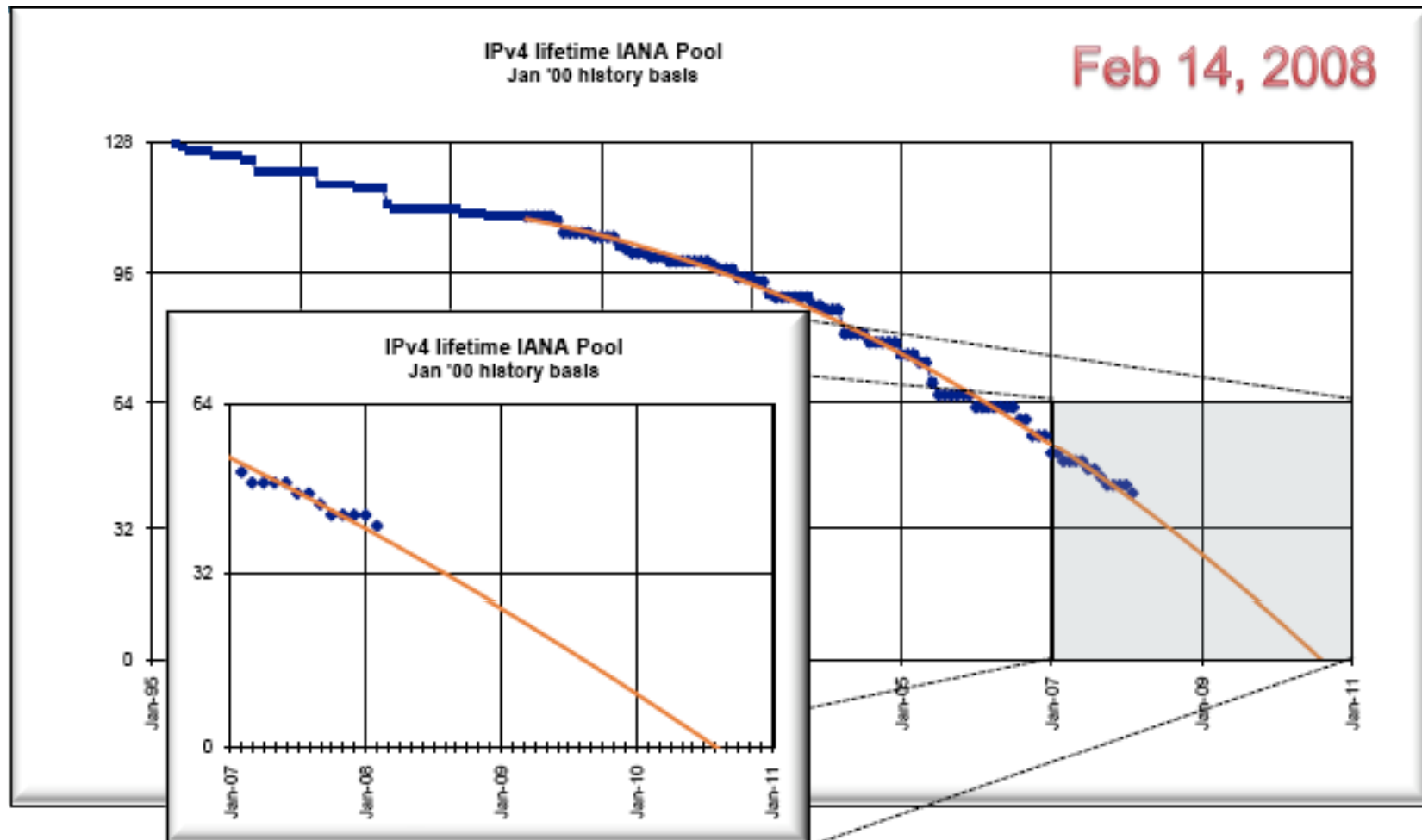
- **Growth is occurring in all regions**

While growth as seen in the routing system is strongest in Asia, the allocation growth is strongest in Europe.



# All five RIRs...

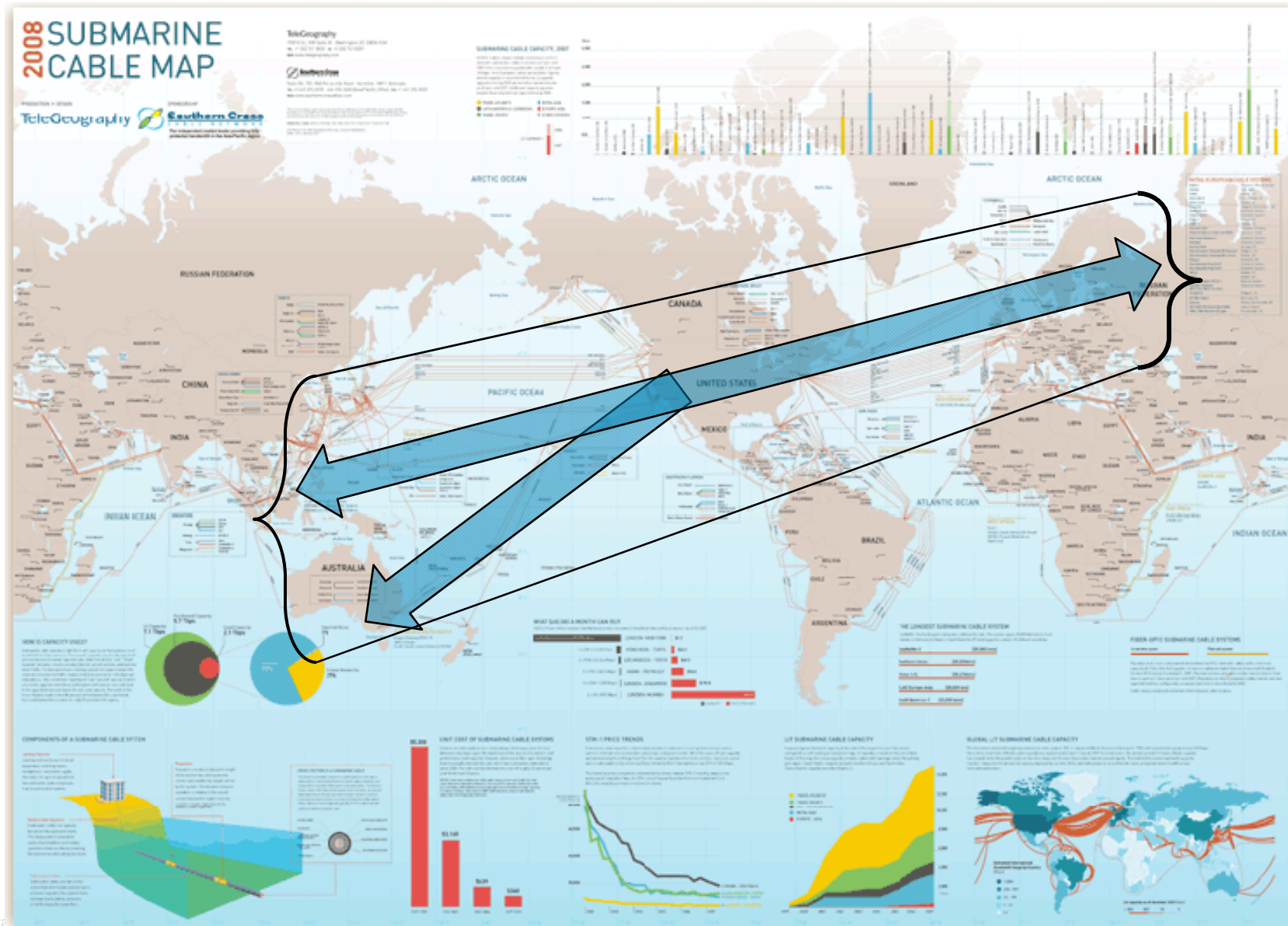
- Recommending IPv6 operational deployment due to pending exhaustion of the IPv4 address space



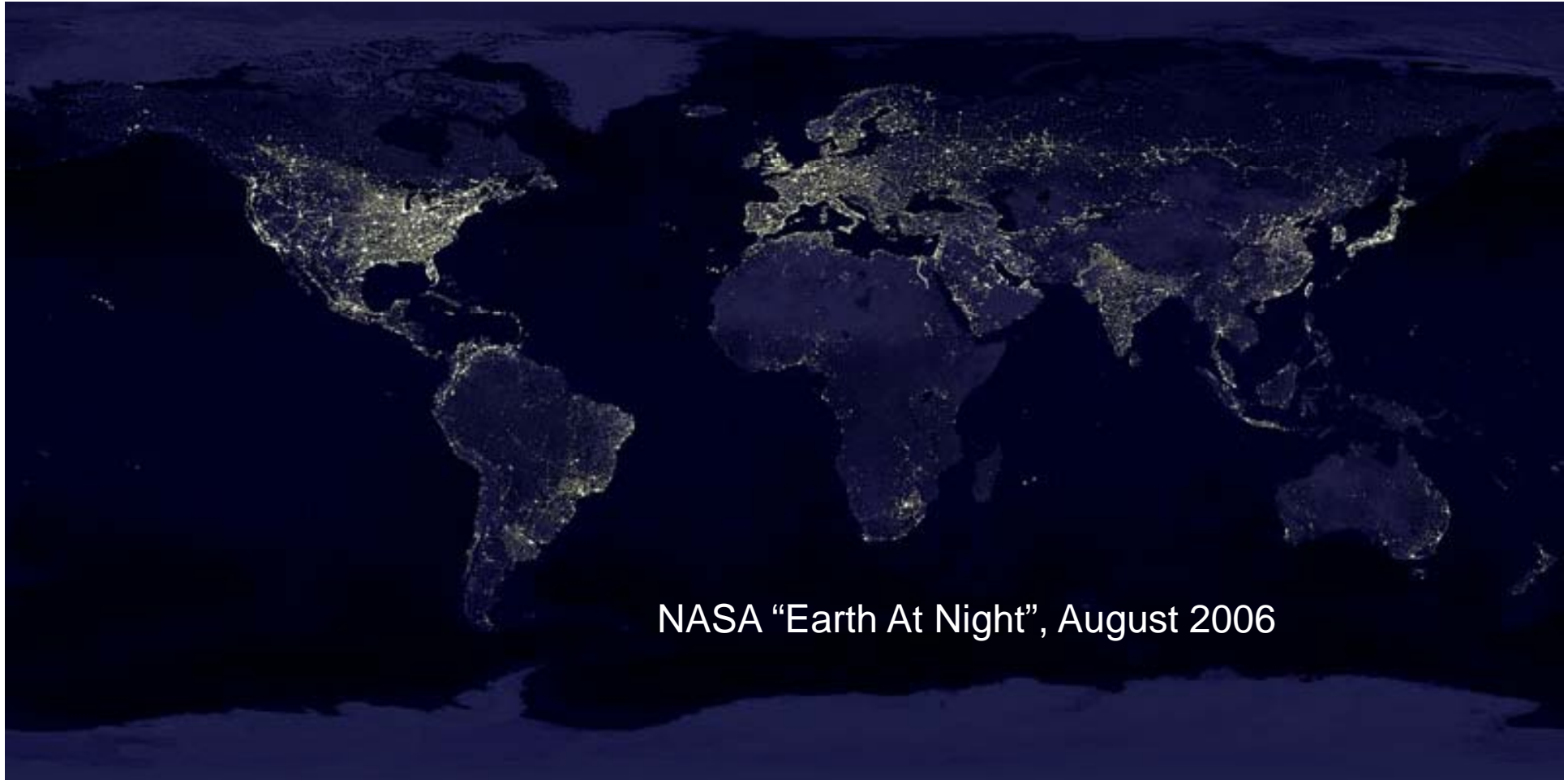
# Where is the broadband Internet today?

## The Europe/America/East Asia/ANZ fiber corridor

Map copyright 2008 TeleGeography



# Power, and by extension money, throughout the world



NASA "Earth At Night", August 2006

# IP Addresses throughout the world today





# IETF discussions on transition plans



# Changing conversations

- Used to be:
  - “Do we need IPv6? Why worry about it?”
  - “But the US isn’t deploying!”
- Now I hear:
  - “Why is my ping time longer?” ...
  - ... “Because you get different routing with IPv6”
  - ... “Actually, mine is shorter.”
- ISP perspectives
  - “What’s the point?” and “Where’s the money?” has shifted to quiet deployment in trial networks and some backbones

# The goal...

- I'm not sure everyone is working on the same goals.
- In general, the goal is “extend the life of the Internet”

For some, that means “*retain simplicity* by extending addressing to more prefixes and more machines”

For others, that means “*retain the infrastructure* I am familiar with and have invested heavily in”

Some stop with “having turned IPv6 on, be happy”

- To me, the goal is:

***Extend the life of the Internet with maximized application options and minimized long term operational and capital cost***

- That implies:

Deploy IPv6 for more addresses

IPv4/IPv6 coexistence is required for a turn-up period

At some point, IPv4 is no longer needed

At that point, *turn IPv4 off*

# RFC 4213: IETF's basic transition recommendation

## “Turn it on in your existing IPv4 network”

- What does that mean?

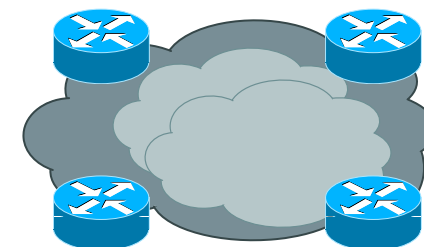
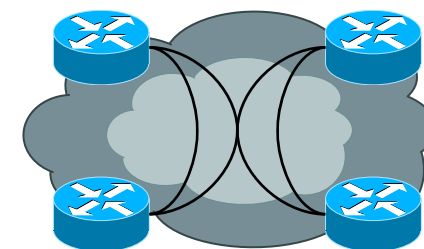
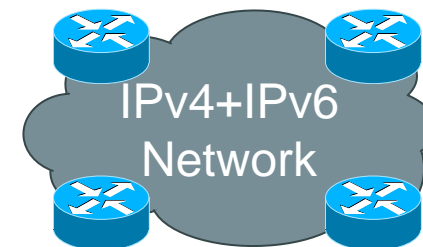
  - Could mean “enable IPv6 on all interfaces”

  - Could mean “enable IPv6 on all edge interfaces and tunnel as needed”

  - Could mean “enable IPv6 on edge interfaces and deploy a separate interior network”

- Key point:

  - Anyone outside your network, and any computer in your network, should have both IPv4+IPv6 connectivity



# When to deploy IPv6?

## RFC 5211: John Curran's Internet Transition Plan

- 2009
  - Preparation Phase:
    - ISPs deploy a parallel IPv4+IPv6 service
    - ISPs and end users enable IPv6 access to their various servers
    - Fred suggests: raise price of IPv4-only and offer IPv4+IPv6 at present service price given installation of an IPv4+IPv6 CPE.
- 2010
  - Transition phase
    - As users turn up IPv6, raise price of IPv4-only and IPv4+IPv6, and introduce lower price IPv6-only service
- 2012 or later
  - Post-Transition Phase
    - Turn down IPv4 when economics warrant

# Is there another way forward?

To facilitate deployment or to delay it, various ISPs are looking at approaches to translation and tunneling

- NAT-PT

  - RFC 2766: Suggest NATs between IPv4 and IPv4+IPv6

  - RFC 4966: Deprecate - assert it is not a long term solution

- IPv4/IPv6 Coexistence and Transition: Requirements

  - <http://tools.ietf.org/html/draft-bagnulo-v6ops-6man-nat64-pb-statement>

- Carrier Grade Network Address Translator

  - <http://tools.ietf.org/html/draft-nishitani-cgn>

- Locator/ID Separation Protocol (LISP)

  - <http://tools.ietf.org/html/draft-farinacci-lisp>

- Prefix-specific and Stateless Address Mapping

  - <http://tools.ietf.org/html/draft-xli-behave-ivi>

  - <http://tools.ietf.org/html/draft-baker-behave-ivi>

*A few of many proposals*

# IPv4/IPv6 Coexistence and Transition: Requirements

<http://tools.ietf.org/html/draft-ietf-v6ops-6man-nat64-pb-statement>

- Joint project to specify NAT-PT replacement
  - Leadership from IESG (Jari Arkko)
  - v6ops - IPv6 Operations
  - behave – NAT specifications working group
- Objective:
  - Facilitate adoption/integration of IPv6 technology in IPv4 networks
- Status:
  - v6ops discussion says that current document is too detailed
  - behave rat-holed in recent meeting
  - Interim meeting proposed to sort specifications out

# Carrier Grade Network Address Translator

<http://tools.ietf.org/html/draft-nishitani-cgn>

- Simple notion:

If the use of NAT in the home extended IPv4 lifetime 15 years, how long can ISP use of NAT extend IPv4 lifetime?

- DNS issue

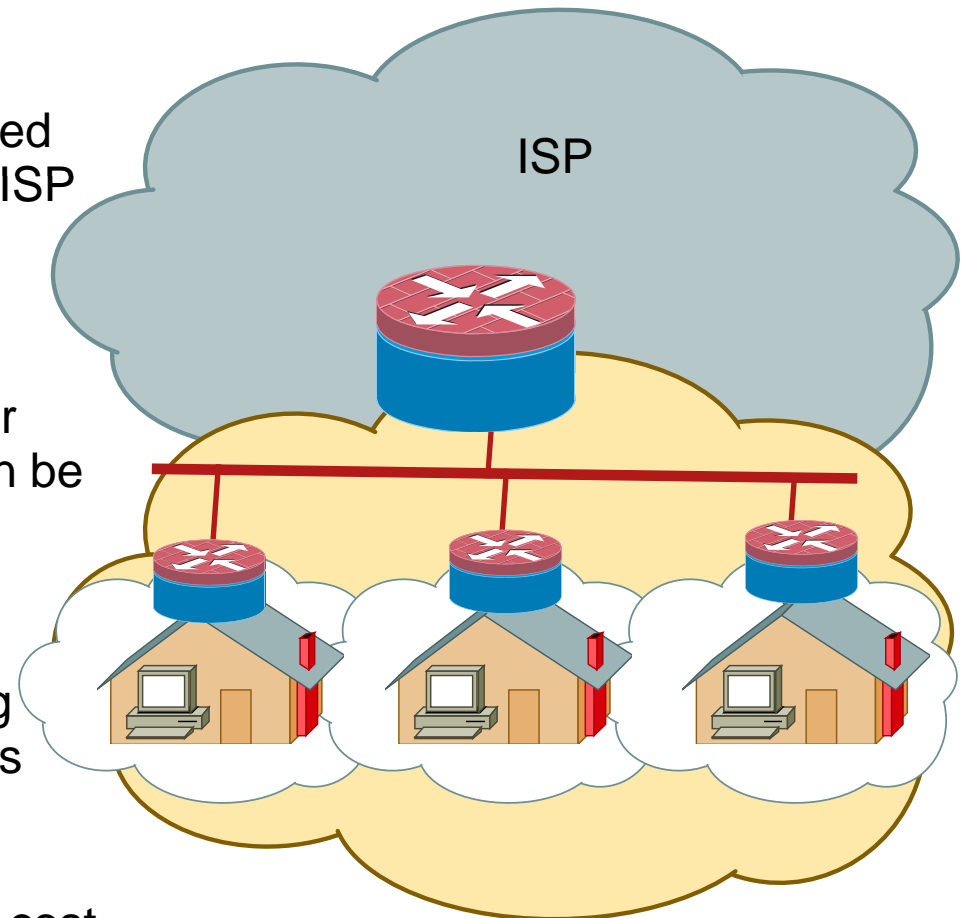
To the extent that names are used for served SOHO/SMB, DNS service can be complicated

- Fred's comment:

ISP NAT is widely used in developing countries to avoid RIR address issues

Actual extension: maybe a few years

Does not avoid ultimate transition, or cost





# Locator/ID Separation Protocol (LISP)

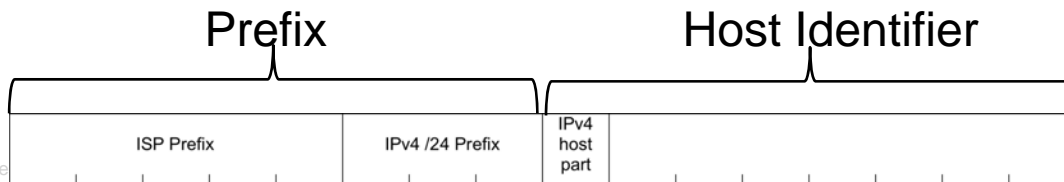
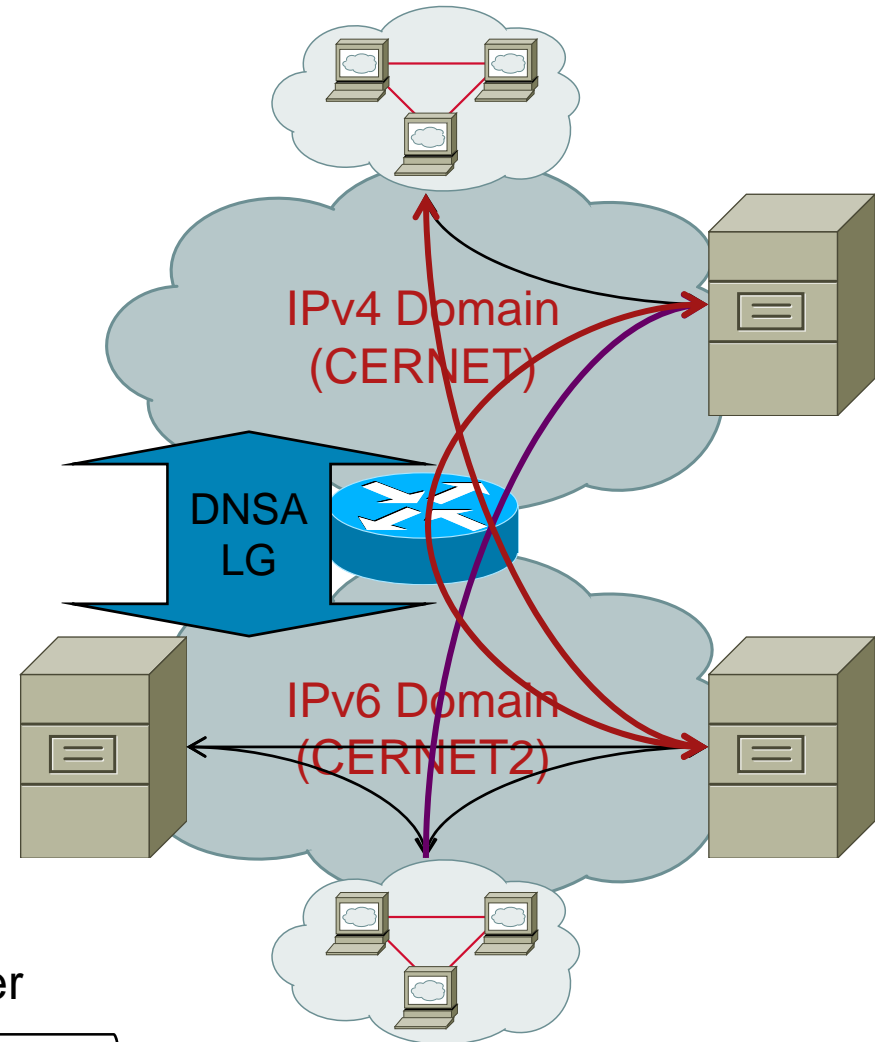
<http://tools.ietf.org/html/draft-farinacci-lisp>

- Premise:
  - Need to separate Endpoint Identity from Network Location
  - Essentially a tunneling overlay
- Proponents argue
  - May enable routing improvements similar to end-to-end MPLS
  - May enable ISPs to ignore IPv6 – keep it in user territory
- Fred's opinion
  - Primarily a Cisco effort
  - Seems pretty complex, and unproven by comparison to commercially deployed approaches like Freenet and IVI

# Prefix-specific Stateless Address Mapping

<http://tools.ietf.org/html/draft-xli-behave-ivi>

- IPv4 prefix
  - “borrowed” in IPv6 domain
  - Stateless and stateful map to IPv6
  - “IVI” contracts “IV <-> VI”
- Connectivity provided:
  - IPv4<-> IPv4
  - IPv6<->IPv6
  - 1:N IPv6 -> IPv4
  - 1:1 IPv6 IVI <-> IPv4
- Attributes:
  - Enables services in both domains
  - Simple, Scalable, 2 years deployed





So what?



# Bottom line

- What we know for sure:

  - The next few years are going to be very interesting

  - Many ISPs are telling their vendors that they are starting wide-scale IPv6 service

  - We will at some point be unable to allocate IPv4 addresses as we have been. That will change business models.

  - Lots of discussion

- What we can presume:

  - Every proposal on the table will be tried. Some will work for a while. All will cost money.

  - All will have a relatively short lifetime, apart from actual transition.

# What we need to do about it:

- Very controversial

Everyone has an opinion; some even agree

- IMHO, it's primarily a question of:

What we are willing to pay, and

How much foresight we are willing to exercise.

- Key actions:

Turn on IPv6 in general operation in the existing IPv4 network and on servers and services.

Do so in a way that facilitates adoption within normal equipment lifetimes

Plan for eventual IPv4 turn-down, several years out

