



## IPv6 & the IETF



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***With many thanks to Fred Baker, Jari Arkko, Geoff Huston, Eliot Lear, and many others***

# Changing Conversations

- Used to be:
  - “Do we really need IPv6?”
  - “What’s the Business Case?”
- Now I hear:
  - “I need server load-balancing... and better MIB support”
  - “Why is my ping time longer? .. Actually, mine is shorter!”

**“Why should I deploy IPv6?” is slowly being drowned out by  
“How do I deploy IPv6”**

# Number of Documents at Various Status

## Documents about IPv4/IPv6

### 7 Document Statuses

- Standards
  - Best Current Practice (146)
  - Proposed Standard (1450)
  - Draft Standard (91)
  - Full Standard (77)
- Nonstandards
  - Historic/Obsolete/Just Plain Old (1724)
  - Informational (1510)
  - Experimental (255)

IETF Status	IPv4	IPv6
Informational	933	374
Experimental	151	59
Best Current Practice	86	34
Proposed Standard	772	407
Draft Standard	48	17
Full Standard	48	5

# General Areas IETF Is Working on IPv6

- Cross-Registry Information Service
- Addressing
- Dynamic Host Configuration
- Autoconfiguration
- IP over Various Technologies
- Mobility
- Multihoming
- IPv6 Maintenance
- IPv6 Operations

- Translation-Based Transition Technologies
  - IPv4/IPv6 NAT
  - IPv6/IPv6 NAT
- Tunnel-Based Transition Technologies
- Source Address Validation
- Routing
  - Especially Mobile Ad-Hoc Routing
  - Also Global Routing Operations
- Sensor Networks

# The Goal...

- In general, the goal is to “Continue the growth 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.”
- For us, the goal is:

**Continue the growth 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.

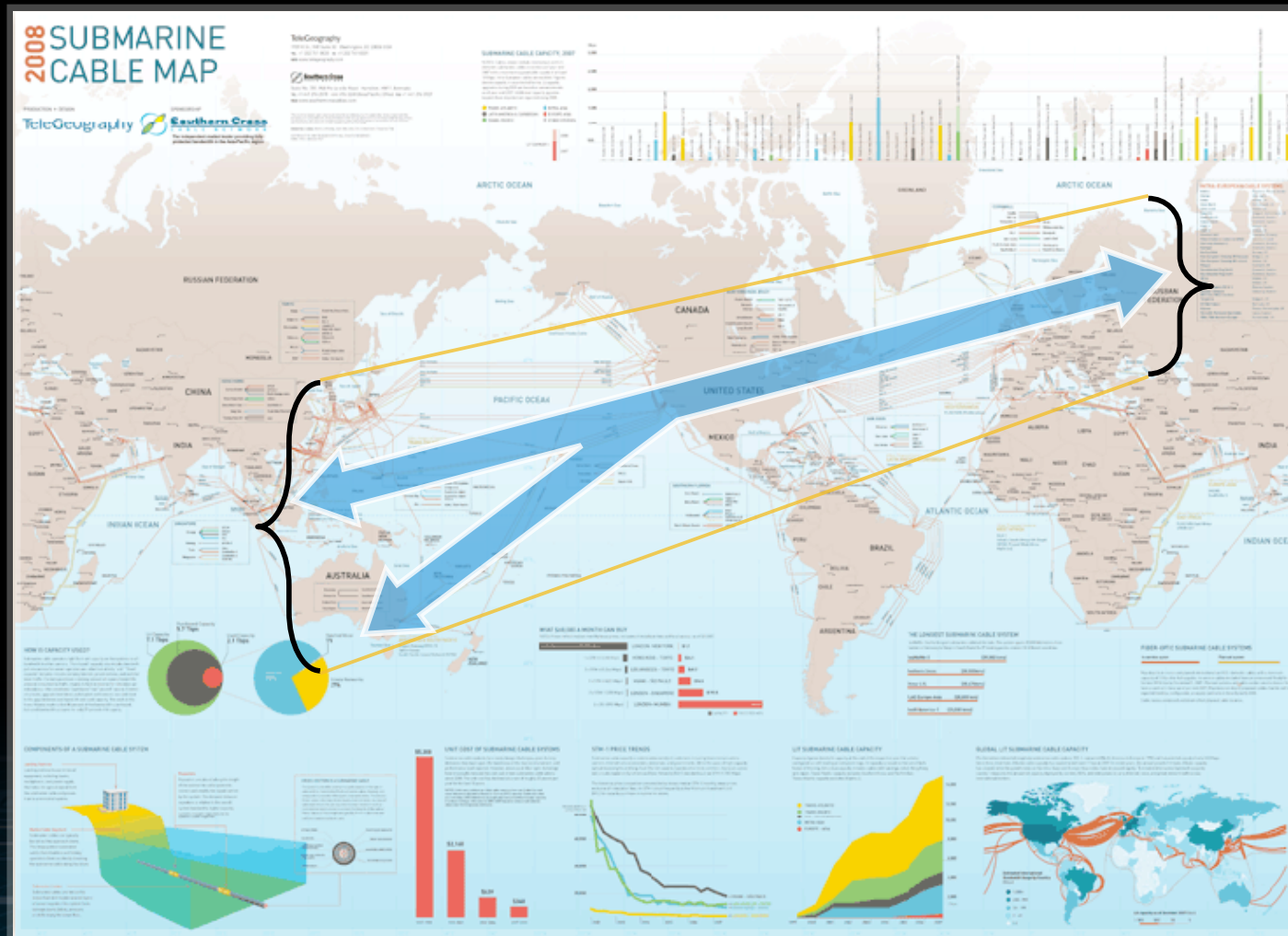
At some point, IPv4 is no longer needed.

At that point, **turn IPv4 off.**



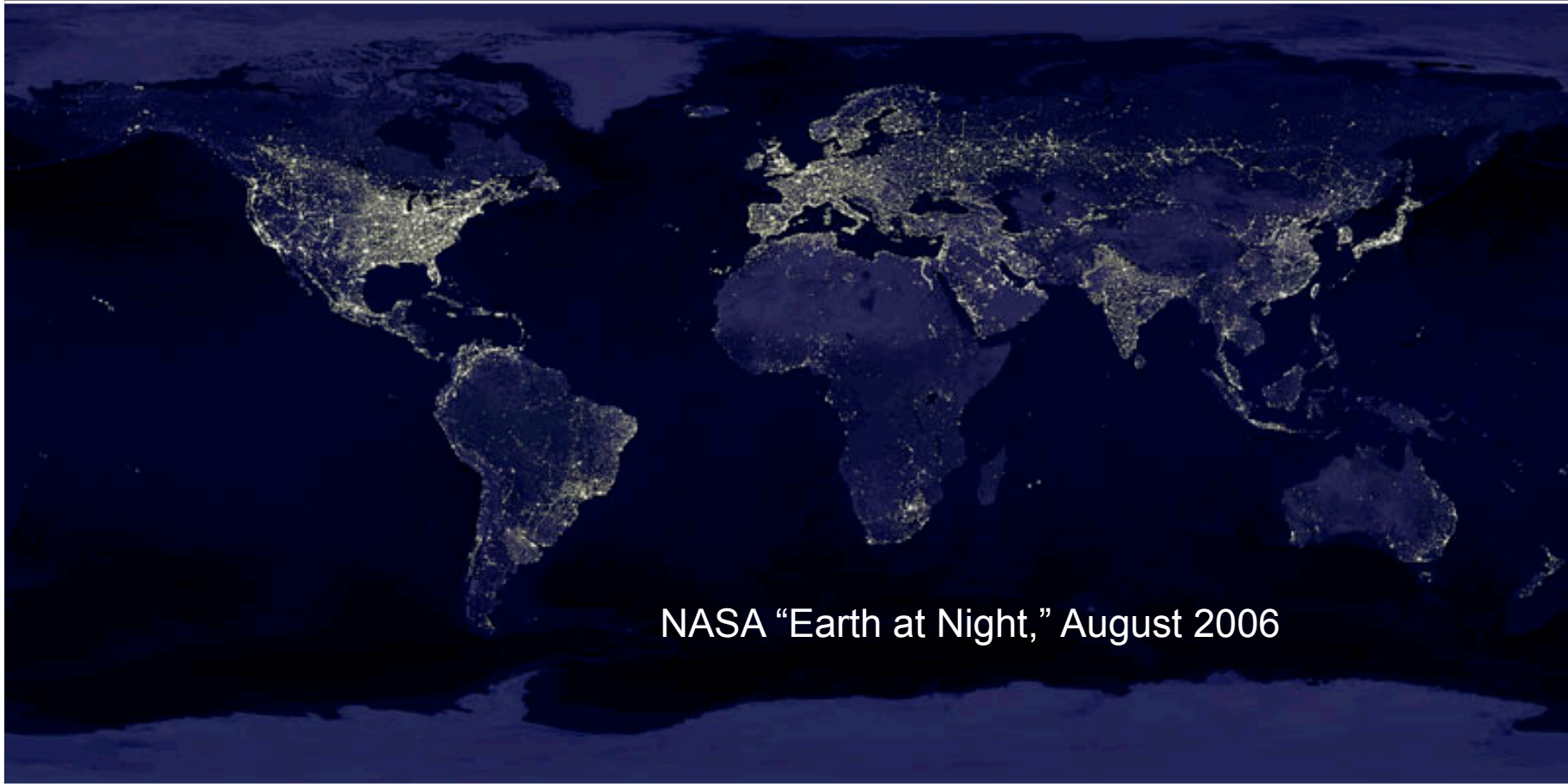
# Where Is the Broadband Internet Today?

## 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

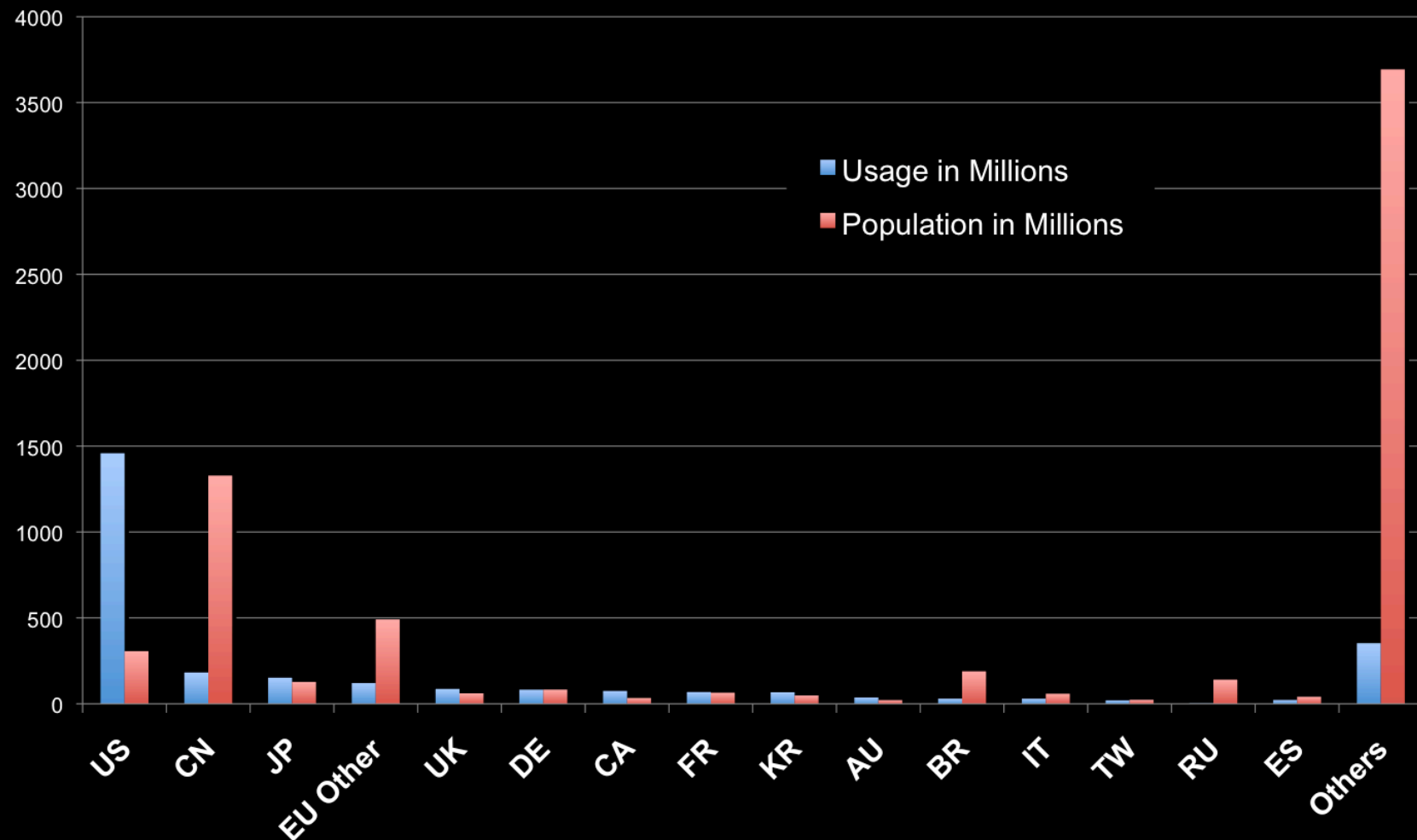
*Internet Map*  
Connection Density



ChrisHarrison.net

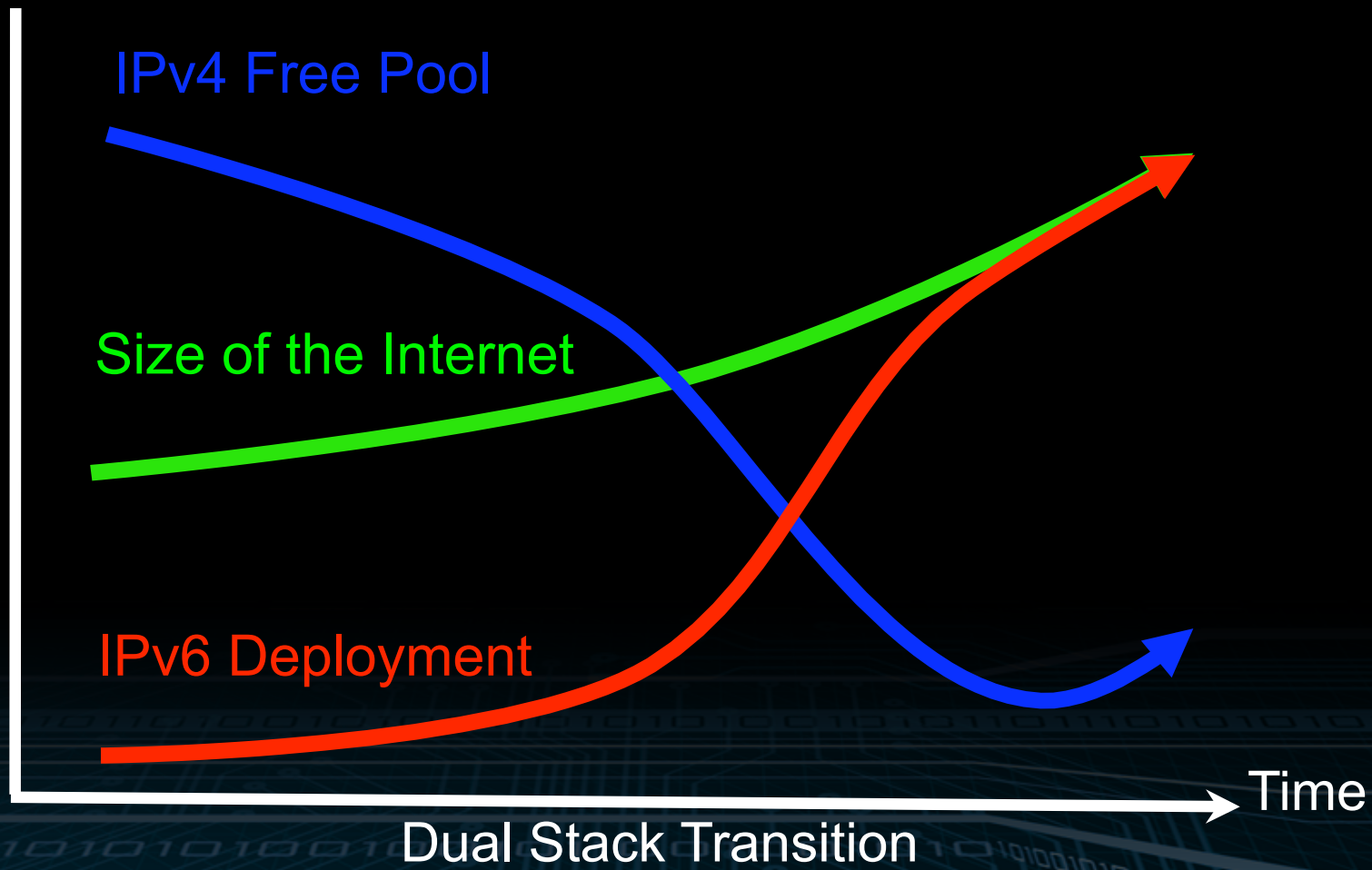


# IPv4 Address Allocation vs. Population Worldwide

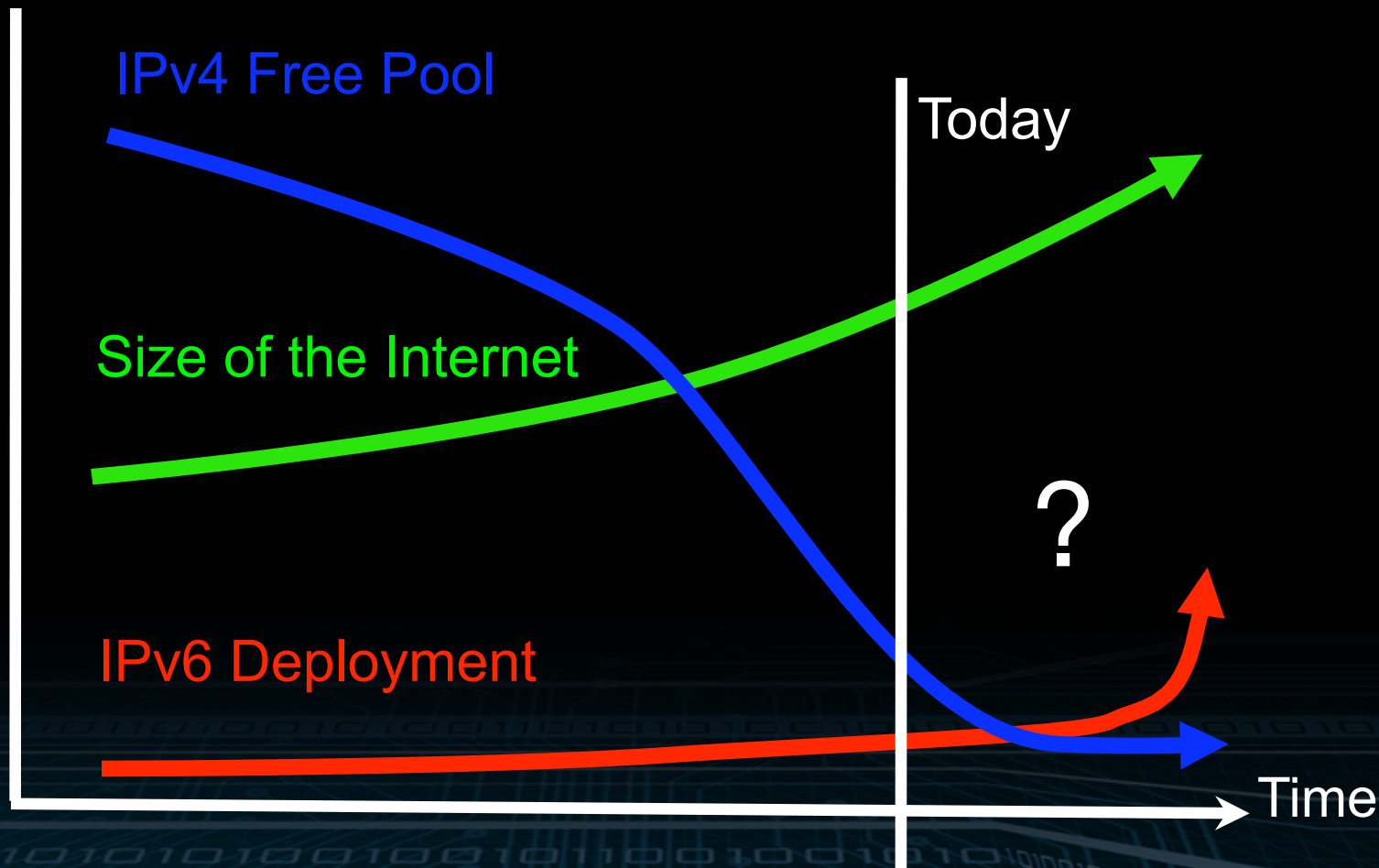


Source: "IPv4 Exhaustion and IPv6 Uptake: A Game of Implementation & Deployment Chicken" by Elliot Lear, Jan 2009

# The Plan



# The Reality



# IETF Discussions on Transition Plans



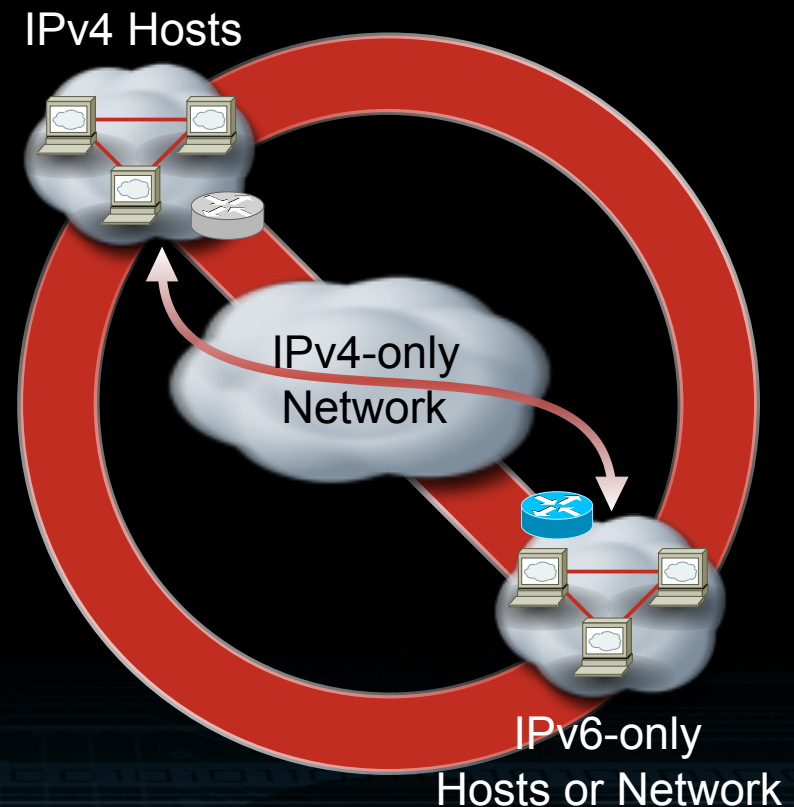
# Unworkable Approach to Transition: Expect IPv4 and IPv6 to Directly Interwork

## ■ Problem:

We are running out of IPv4 addresses.

IPv4 and IPv6 are noninteroperable.

If we simply deploy IPv6 networks, they won't be able to talk with IPv4-only hosts.





# Preferred Approach to Transition: RFC 4213 Dual-Stack Deployment

## ■ **Solution:**

Hosts today are IPv4+IPv6:

Windows Vista, Macintosh,  
Linux, BSD

Make the network IPv4+IPv6.

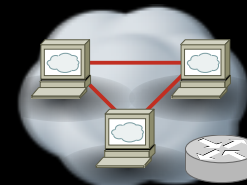
When forced to deploy IPv6-only  
networks, they will be able to talk  
with other hosts.

## ■ **But...**

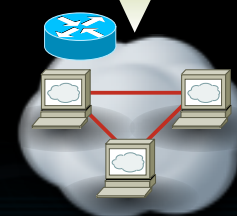
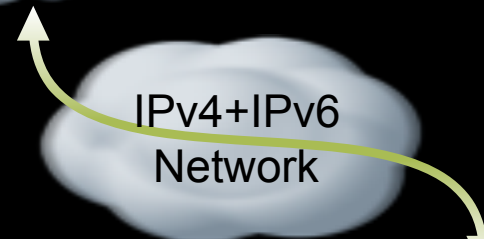
We have run out of time for this to  
be smooth

In the mean time, we forgot how to  
operate multiprotocol networks

IPv4+IPv6 Hosts



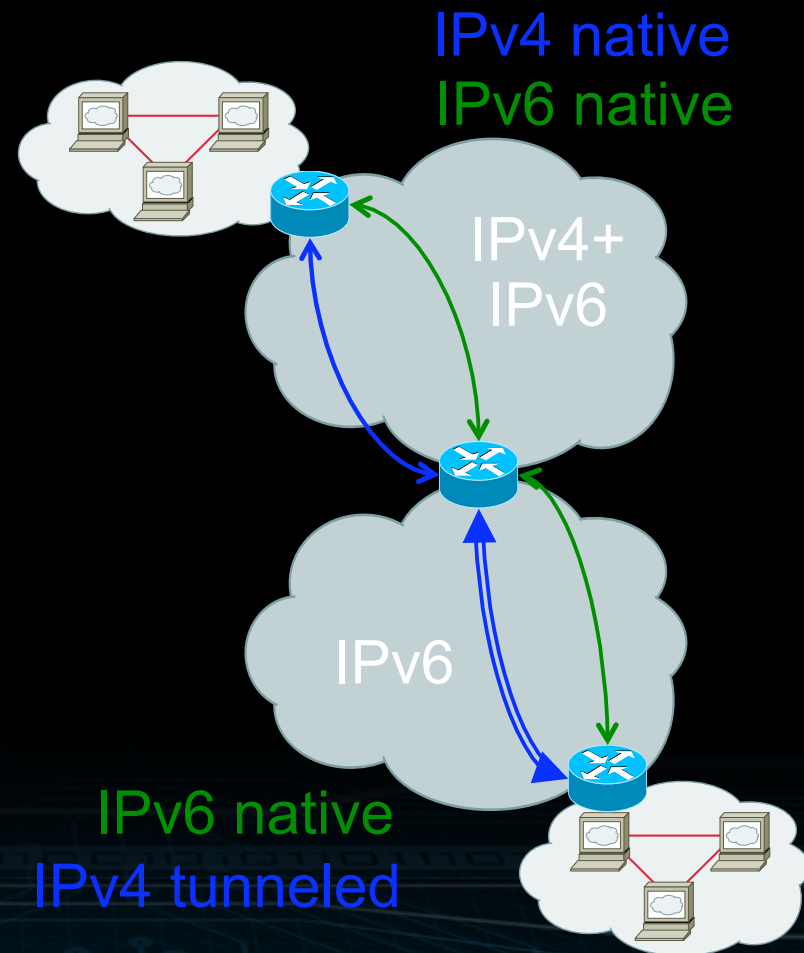
IPv4+IPv6  
Network



IPv6-only  
Hosts or Network

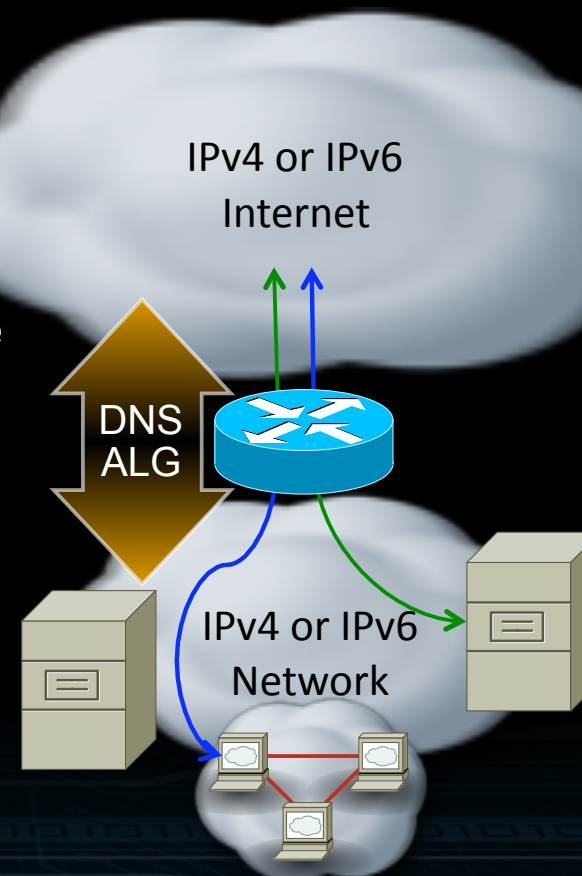
# IETF **softwires** Working Group

- Connecting islands of one address family over islands of another
- “Hubs and Spokes” and “Mesh” solutions
- Dual-stack Lite



# IETF **behave** Working Group

- IPv4/IPv6 Translation
- Temporary tool to help coexistence and transition
- IPv4 Addresses
  - May be embedded in an IPv6 prefix in the IPv6 domain
  - Stateless and stateful translation modes
- Connectivity Provided:
  1. An IPv6 network to IPv4 Internet
  2. IPv6 Internet to an IPv4 network
  3. An IPv4 network to IPv6 Internet
  4. IPv4 Internet to an IPv6 network



# Work on IPv6 continues...

- IPv6 "Maintenance" WGs

- 6man** - Fixing bugs in current IPv6 specifications (e.g., improvements on address selection - RFC 3484)

- v6ops** - Operational guidance and more... address allocation, firewalls, broadband network deployments, IPv6 home router, etc...

- IPv6 "New features" WGs

- savi** - "IP Source Guard" or "First Hop Security" for IPv6 & IPv4

- csi** - Secure Neighbor Discovery (SEND)

- dhc** - Broadband Forum asking for IPv6 support

- mext, mip4, netlmm** - enabling IPvX/IPvY combinations

- 6lowpan & roll** - IPv6-only Sensor Networking

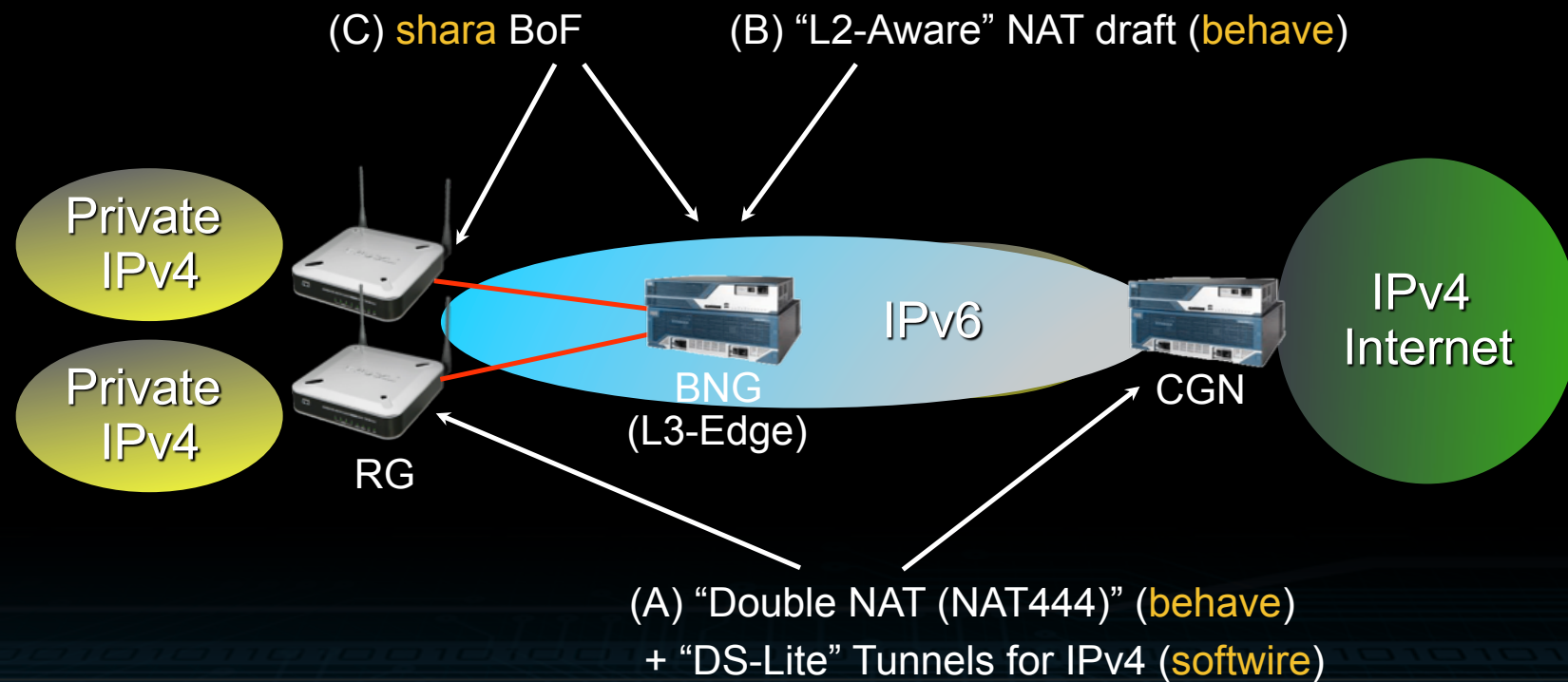
# Next week in S.F.

## IPv6 Address Independence BoF - 6ai

- Yes, this is about IPv6 NAT
  - Renumbering
  - Multihoming
  - “Topology Hiding”
  - ...and so on
- Fear that if IPv6 NAT is going to exist, we'd rather have a specification than leave programmers to their creative vices.



## Also: Carrier Grade NATs, Sharing IPv4 Addresses, and a Shared SP Prefix...



# Recent IPv6 Success Stories...

- Google over IPv6

- Dec 5, 2007 – Challenged to deploy IPv6 by IETF 73

- Jan 2008 – First production IPv6 router

- Oct 2008 – First “trusted tester” receives AAAA for [www.google.com](http://www.google.com)

- Nov 16, 2008 – Challenge met at IETF 73

- Free Telecom

- Nov 7, 2007 – “6rd” presented, decided to deploy

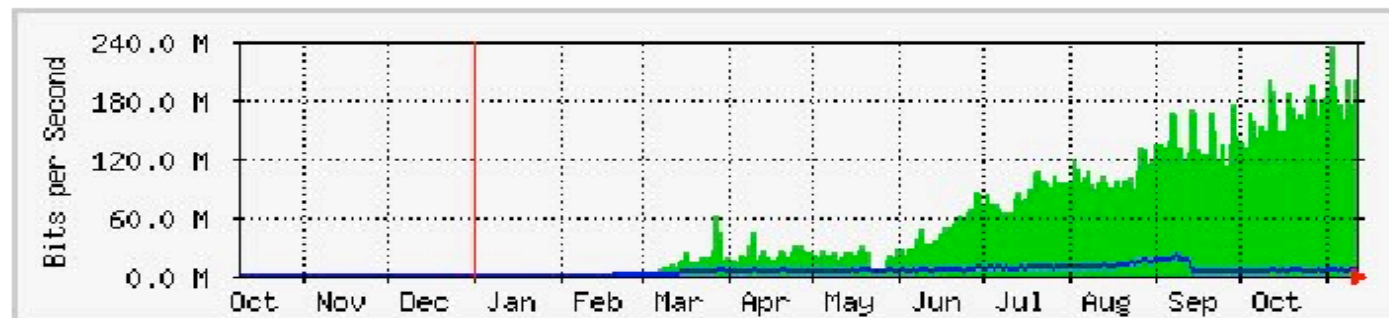
- Dec 11, 2007 - “Opt-in” service made available to 3M subscribers,  
250K sign up right away

- March 2008 – Deployed “telesite” IPv6-only service to all 3M  
subscribers

# How did they do it?

1. Turned on what they could
2. Found out what was broken and what was not
3. Filled in the gaps

'Yearly' Graph (1 Day Average)



	Max	Average	Current
<b>In</b>	233.9 Mb/s (2.3%)	72.6 Mb/s (0.7%)	199.7 Mb/s (2.0%)
<b>Out</b>	19.3 Mb/s (0.2%)	5713.0 kb/s (0.1%)	5593.4 kb/s (0.1%)

# Conclusion...

- IPv6 is ready for deployment, and there is a great deal of implementation to build upon
- It won't be perfect, system-level gaps exist, but the best way for us to find them at this stage is to deploy, deploy, deploy
- Bring your experience back into the IETF, and help us help others
- Thank you, and have a great conference.