IPv6 Transition & Operational Reality

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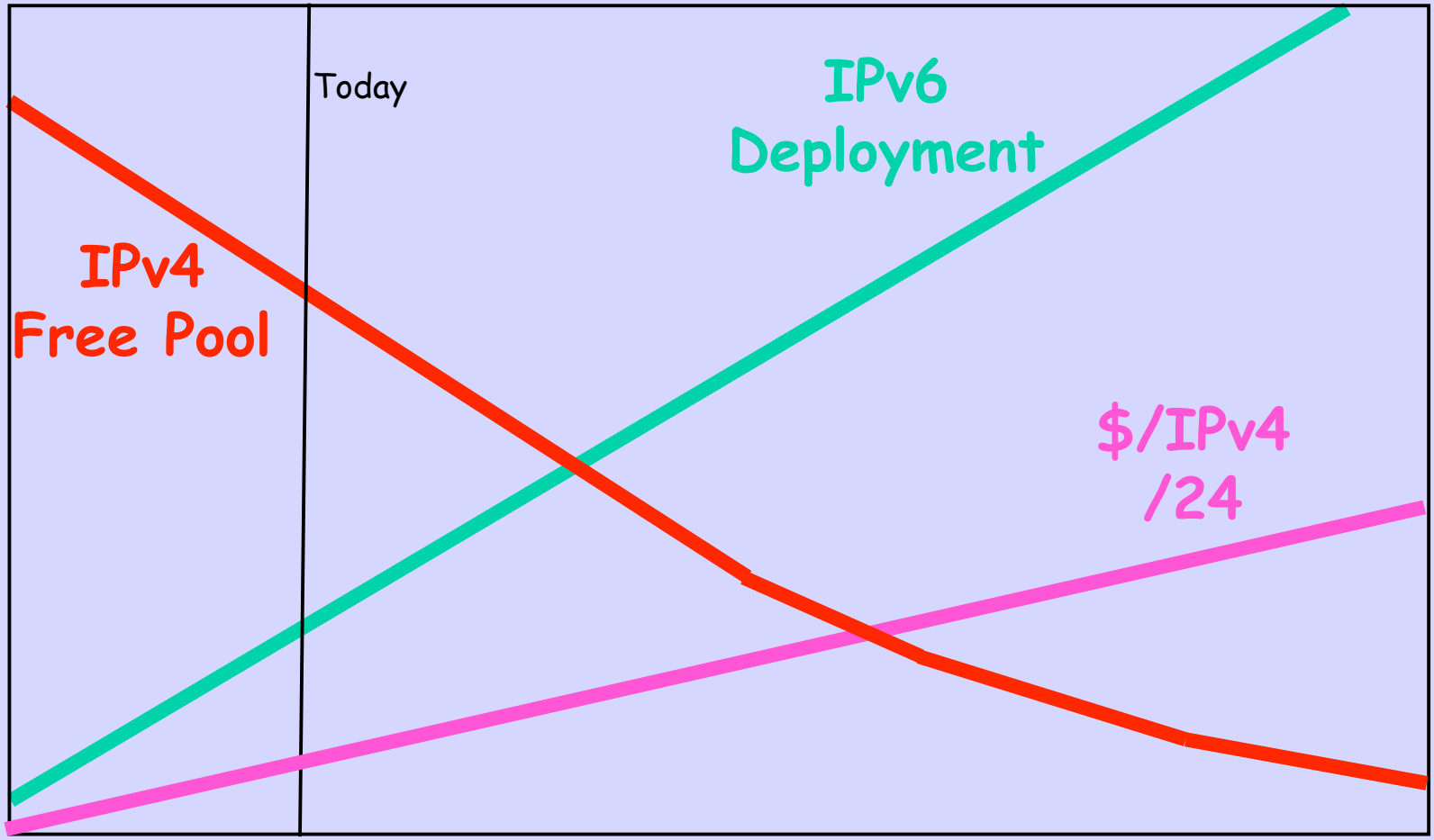
http://rip.psg.com/~randy/070906.v6-op-reality.pdf

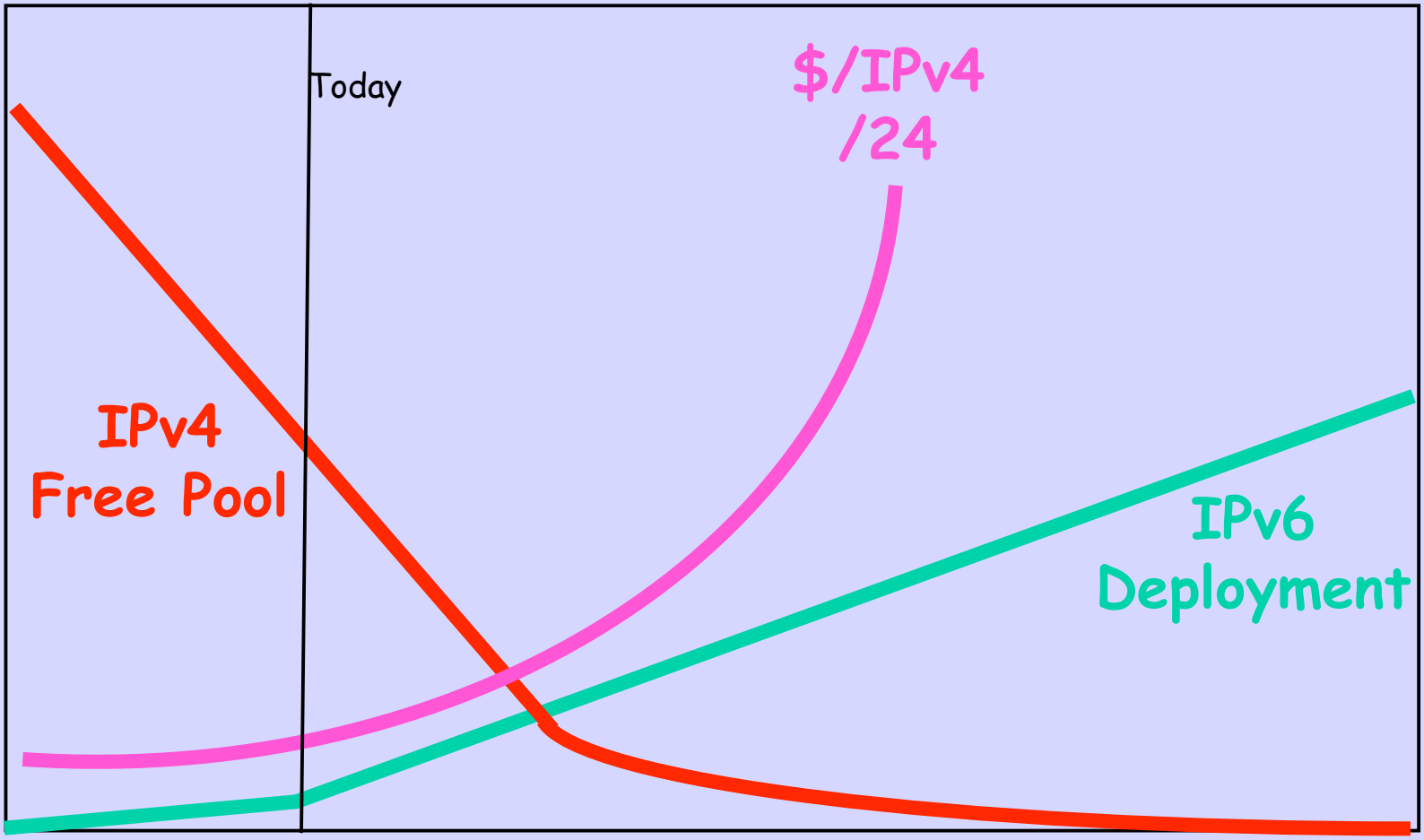
Reality Therapy

- We will transition to IPv6, get over it
- The issues are when and how
- Marketing fantasy is not helping us actually deploy
- This presentation may seem negative, but think of it more as taking off the rose colored glasses so we can see what reality is so we can actually make deployment decisions

What Should Have Happened



What Is Happening?



Why Is This Happening?

No transition plan
Declared victory before the hard part started
No real long term plan
No realistic estimation of costs
No support for the folk on the front lines
Victory will be next month
This Describes:

a - The invasion of Iraq
b - IPv6
c - DNSSec
d - All of the above

Myth: IPv4 is Running Out

- IPv4 Free Pool run-out in a few years
- This is almost exactly in line with the graphs of Frank Solensky ten years ago
- IPv4 will go to a *Trading Model*
- Registries will become *Title Agents*, not allocators, of IPv4 space
- ARIN developing full multi-RIR/LIR open source software to certify and verify title to IPv4 and IPv6 resources

Myth: IPv6 Transition is Easy

- IPv6 was designed with no serious thought to operational transition
- IPv6 is **on-the-wire incompatible** with IPv4
- Could have been avoided, e.g. if IPv6 had variable length addressing, IPv4 could have become the 32 bit variant
- There are no simple, useful, scalable translation or transition mechanisms

Myth: IPv6 Eliminates NATs

- An IPv6-**only** site can not reach IPv4 Internet because it can not source packets from an IPv4 address
- There will be significant IPv4-only Internet for a decade or more
- All IPv6 sites will need IPv4 space and will have NATs with ALGs
- IPv6 **increases** NAT use in short and medium term, i.e. a decade or more

Myth: IPv6 Reduces Routing Load

- Multi-homing in IPv6 is the same as in IPv4, there is no new routing model
- Traffic engineering in IPv6 is the same as in IPv4, no new TE model
- Enterprises will slice and dice their IPv6 /32s to handle branches etc.
- The routing table will fragment more and more over time

Myth: Transition Eases Routing

- One possible result is market-based BGP advertisements
- Operationally complex; routing is global so how are settlements distributed?
- This could push back on fragmentation
- But how much can an announcement cost to be less than the cost of running without any IPv4 compatibility

Myth: IPv6 Space is Infinite

- 64 bits goes to every LAN
- This leaves half the bits gone!
- Some folk use /64 for Point-to-Point!
- RIRs are giving away /32s
- In 15 years we will think of these as we now think of legacy /8s in IPv4 space

Myth: IPv6 has Better Security

- IPv6 does nothing IPv4 does not, though it promised to
- IPSec is the recipe in either case
- IPSec does not work well in a mixed IPv4/IPv6 environment (think VPN from an IPv4-only hotel room)
- It is true that address space scanning will be somewhat harder
- Ha Ha, think botnet scanning and a black market in hot space

Myth: IPv6 Increases Battery Life

- The comparison was NAT vs noNAT
- If one compared
  - IPv4 without NAT to IPv6 without NAT
  - Or IPv4 with NAT to IPv6 with NAT
- The results would have been the same
- This tells us more about IPv6 marketing than about technology

Myth: Incremental Deployment

- For an enterprise, the entire chain, from database back end, through applications, through firewalls, to the border router must all support v6 or the enterprise can not deploy
- For ISP, provisioning systems, monitoring, measurement, billing, …
- And everyone needs support from all their vendors

Myth: Routers Fully Support IPv6

- But not 100% in hardware
- Especially not if you add ACLs
- And all vendors are not spinning the ASICs to solve this
- Not all v4 features are supported over IPv6: MIBs, SNMP over v6, …

Myth: No Static Numbering

- IPv6 Auto Configuration is not widely used in enterprise as security policy prefers known (i.e. DHCP) addresses
- Similarly, ISP backbone addresses and customer addresses must be known for logging, audit, CALEA, …

Myth: IPv6 is Deployed

- Pioneers are still moving cautiously
- Early adopters are just starting to enter the game
- Actual measured traffic is very small (so it makes routers look as if they can handle the traffic)
- But there are good anecdotes

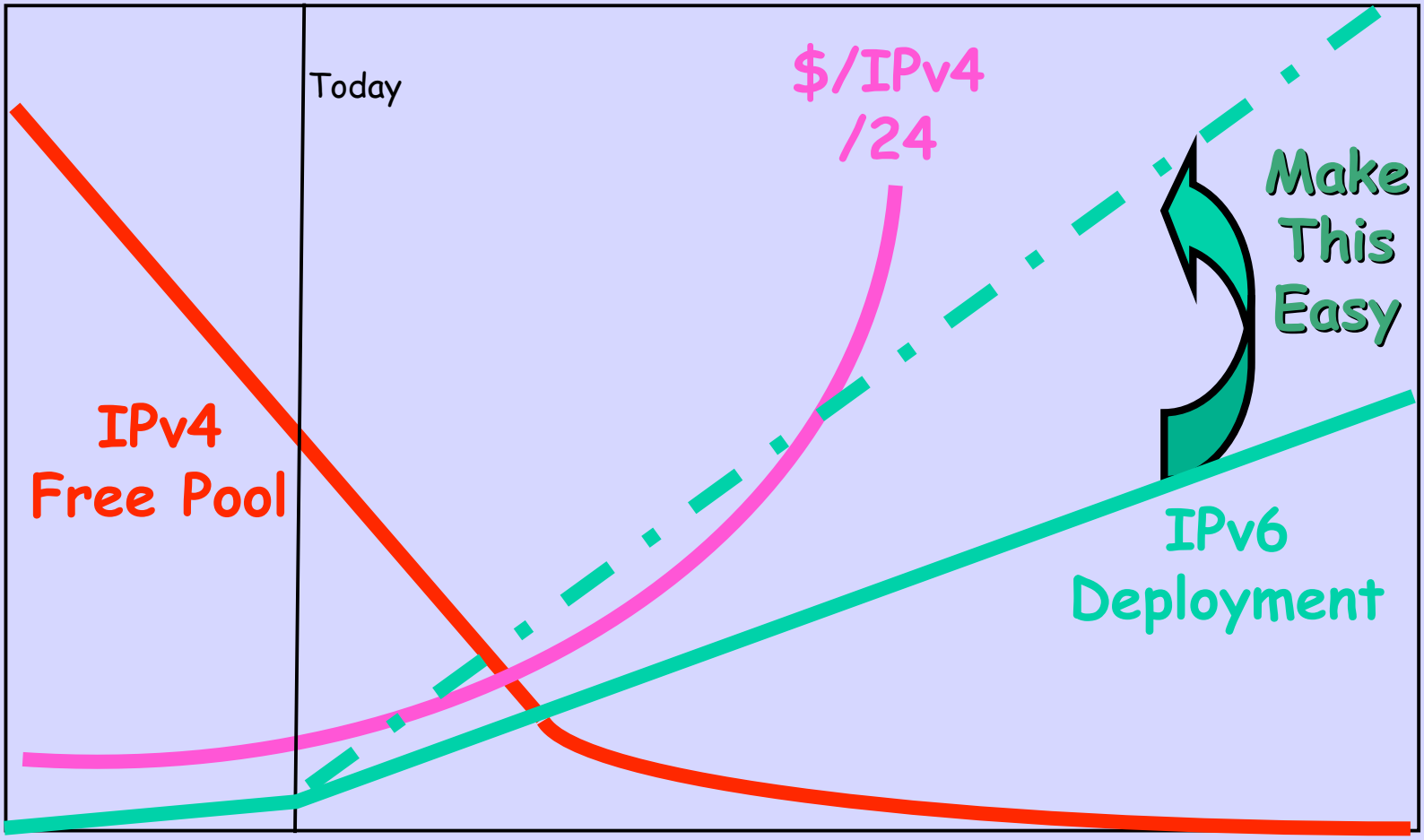
Myth: IPv6 Will Replace IPv4

- Not given current lack of **universal** vendor support from back end to border router
- It is far easier to use NAT and IPv4
- IPv4 with NATs requires no new expense, conversion, training, …
- This is architecturally horrible, it is just financial reality

The Reality

- "96 more bits, no magic"
  -- Gaurab Raj Upadhaya
- But we definitely need more bits!
- The key questions are how to use them?
- How to transition without losing anyone or anything?

What Can We Do?



How?

- Identify current transition problems
- See that they are fixed
- Ask the IETF to fix the outstanding protocol issues
- Push vendors to support IPv6 and the tools for us to transition
- Registries need to prepare to issue titles to IPv4 and IPv6 space

What We Should Not Do

- Pretend that there are no transition problems. It just makes things harder.
- Give away IPv6 space in strange ways to "promote" IPv6. IPv4 run-out will promote IPv6 for us.
- Make messes we will have to live with forever.

Areas of Concern/Study

- Global Issues
- Administrative Infrastructure
- Layers 1 and 2
- Backbone Engineering
- Last Mile/Kilometer
- Consumer/SOHO Self-Installed CPE
- Enterprise
- Server Farm
- Campus
- Exchange Points
- Applications
- Telephony
- More?

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IPv4 / IPv6 Operational Transition Information Collection

ARN Announcement http://www.arin.net/announcements/20070521.html

Goal Statement

Information Gathering

- Call for Input
- Contributors
- Organizers

Areas of Investigation

- Global Issues
- Administrative Infrastructure
- Layers 1 and 2
- Backbone Engineering
- Last Mile
- Consumer/SOHO Self-Installed CPE
- Enterprise
- Server Farm
- Campus
- Exchange Point
- Applications
- Telephony

Resources

- http://www.internet2.edu/presentations/jt2007feb/20070213-broersma.ppt
- http://ipv6.internet2.edu/merit/
- http://ipv6samurais.com/ipv6samurais/demystified/
- http://www.ipv6-to-standard.org/

Stories of Pioneers

Other

- Players and roles
- Transition mechanisms

Global Issues

- How does a user at a v6-only site get to the Internet, i.e. a v4-only site?

  They don't!

- What can be done to help as much as possible?

Administrative Infrastructure

- DNS
  - BIND 9 seems to fully support IPv6
  - Registrars need to support delegation to IPv6 nameservers
  - Registrars need to support IPv6 glue records
- RIRs – ARIN developing open source package for X.509 certification of resource 'ownership'

Layers 1 and 2

- DOCSIS 3.0 for Cable
  - MTU limit of 1518
  - CMTS support lacking
- 802
  - All media protocols support IPv6
  - While the protocols support IPv6, this does not at all mean that implementations do

Backbone Engineering

- Core Routing – conversion to dual stack is slow
- IS-IS support good, sp,e OSPFv3 implementations reported as weaker
- Provisioning, Address Assignment, DNS, …
- DHCPv6 and DNS Integration
- Monitoring and Measurement over v6?
- New line cards are often required!

The Last Kilometer

- Authentication and session setup, e.g. PPPoE, IPoE, DHCP
- Provisioning, back-end database, ...
- "How to scale the routing/provisioning combo to deal with million of customers using stable prefix delegation?"

Consumer Self-Installed CPE

- $50 DSL Modems do not support v6
- $50 Firewalls do not support v6
- Teredo does not really scale
- shim6 is not deployable due to security and routing model issues

Enterprise

- Databases, PeopleSoft, Siebold, Business Applications, …
- Firewalls, VPNs, Access, …
- Millions of lines of in-house code
- NFS Appliances, unknown
- If one link in the business application production chain is not there, it does not transition

Server Farm

- Lack of wide availability of V6 transit, especially as a non-beta service
- Very limited selection of hardware load balancers which support IPv6
- Storage Networks? (unknown)
- Back-end systems need reworking
- Akamai and other CDN providers

Campus

- Apache is OK, Squid is not
- Wireless provisioning is weak
- Perl inet_ntoa(inet_aton($ip)) does not work
- EUI-64 makes some host based access control very complicated
- P2P Applications, status unknown

Exchange Point

- Management & Measurement
- NTP and other IX services
- "With IPv6 in the switch requirements, two vendors declined to bid."
- From an IXP operators' list
  >> Switching on IPv6 at the IXP
  > Challenge(s): someone to make use of
  > it....

Applications

- Where is the web page with a matrix of application by platform showing which are v6 capable and clickable link on how to turn it on?
- Many applications which support v6 have sufficiently poor performance that early adopters are being told to turn v6 off
- XP will not work in a v6-only environment, because it does not support DNS queries over IPv6

SMTP: An Example

- Email/SMTP is a mandatory application
- Everyone needs to be able to send email to arbitrary recipients, i.e. everyone else
- But, due to SPAM, no one can run an open SMTP relay
- So all IPv6 sites need to have the ability to SMTP to arbitrary IPv4 sites
- Therefore everyone needs private dual stack relay until the world is all dual stack SMTP

  [example by Jeffrey Streifling]

Telephony

- SIP inter-networking between IPv6 only UE and IPv4 only UE
- SIP, RTP, H323, NAT traversal, …

Why is Japan in Better Shape?

- Folk with vision (i.e. Murai) convinced the government that early movement to IPv6 was wise for Japan
- Government $upport$ IPv6 research
- Government $upport$ IPv6 development by industry, vendors, …
- Government give$ tax incentive$ to enterprises which become v6 compatible

How You Can Help

http://www.civil-tongue.net/clusterf/

write to randy@psg.com
if you can contribute

Please!

Thanks To

Internet Society for Support of Operational Transition Analysis

ARIN
for Research Support

Internet Initiative Japan

IPv6 Transition: Some To Dos

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http://rip.psg.com/~randy/070906.v6-to-do.pdf

Principle: One Internet

- Under no circumstances can we allow the Internet to fragment
- During transition, everybody still needs to talk to everyone else at will
- And it would be good if the End to End principle could be kept as much as possible

Principle: Dual Stack

- The core needs to be dual IPv4/IPv6 during all of transition or kludges will escalate horrifyingly
- The further dual stack goes toward the edge (enterprise, net services, consumer, …) the easier it will be
- Configuration, Management, and Measurement need to be simplified

Five Phases

- Denial, from both 'sides':
  - We can ignore brain-dead IPv6
  - IPv6 is perfect and those greedy fools just have to deploy it
- Dual stack with IPv4 Dominant
- Dual stack with both widely used
- Dual stack with IPv6 Dominant
- The IPv6 Internet (getting ready for IPv10 transition:)

Principle: NATs

- End to End Principle is **very** desirable
- But IPv6 on the wire is incompatible with IPv4
- During transition there will be NATs
- Get over it
- But we need to make it so they can fade away and not be there forever

NAT-PT

- At the edge, the enterprise, consumer, etc. need to run IPv6 but need to talk to both IPv4 and IPv6 services
- When IPv6 becomes dominant, the IPv4 sites will still need to talk to the then predominantly IPv6 Internet
- The IETF needs to standardize 4/6 NAT for ICMP, UDP, TCP, RTP, maybe how ALGs plug in, especially DNS ALG

IVTF and Reality

- In July 2007, the IVTF published RFC 4966 "Reasons to Move the Network Address Translator – Protocol Translator (NAT-PT) to Historic Status"
- This tells you a lot about the IVTF, their level of operational clue, and how much they care about religion as opposed to IPv6 deployabilty

NAT-PT & Security

- DNSsec has to terminate on the NAT if translating
- IPSec can transit NAT-PT
- DNS, SMTP, and HTTP ALGs will be critical

Pressure on Routing

- IPv4 address space price escalation and the consequential NATs will put serious new pressure on routing
- If it takes a $10m router to deal with 2m routes and churn then 96% of ISPs die and enterprises can not be DFZ multi-homed
- So **all sized routers**, from enterprise border to ISP core, need to handle **>2m routes with churn**

Do Not Hack!

- Do not accept hacks around the routing scaling problem such as tunneling from enterprise border to some $10m 'core' router
- Think TLA/NLA and be fearful ☺
- Think ten Monopoly ISPs and be very very fearful

Forwarding is Behind

- Because of lack of market, it will be five years before **all** major router vendors support dual stack at line rate with ACLs
- Some vendors are not even spinning the ASICs for all platforms and line cards
- Needs to be **all vendors** because ISPs can not be vendor-locked by transition
- So we are not interested in "We can do it, they can't" marketing nonsense.

ULA is a Problem

- Because ULA is address-based
- 'Borders' need to filter packets
- To not leak and not accept leaks, needs both source and destination filters
- On some hardware, some ACLs drive packets to the slow path
- Give them real IPv6 space and tell them to just not announce it to the DFZ

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Summary

- IETF
  - NAT-PT
  - Kill ULA and prevent kludges
- Routers
  - Dual Stack on the Fast Path with ACLs
  - 2+m Routes with churn on all routers
- ISPs
  - Dual Stack to the Customer Edge
- Government: incent, don't regulate

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Rob Austein & Russ Housley