IPv6
Lesson 2:
deployment and operational issues

Jun-ichiro itojun Hagino, Ph.D
KAME project/iijlab
itojun@iijlab.net

Tutorial overview

- Jan 8, 2003
  - IPv6 protocol itself (packet format, ...)
  - Impact/relationship to other internet protocols (such as TCP/HTTP)
  - Implementation status
- Jan 15, 2003
  - Deployment status
  - Operational issues, clues, tips
  - (UNIX socket API programming for IPv6)

Prerequisite

- Knowledge of
  - IPv4, TCP, UDP, routing in the internet
- SOI courses
  - IPv6 tutorial by kazu/itojun
- Books (not mandatory to read, but are informative)
  - Huitema, "IPv6: the new internet protocol"
  - Stevens, "TCP/IP illustrated vol.1"
  - Stevens, "UNIX network programming"

Why transition to IPv6?

Why transition to IPv6? - or why IP?

- Internet technologies are getting deployed everywhere
- Always-on connectivity is changing the world
- Every equipment has to be always-on, IP connected
  - Fridge, microwave, taxicabs, cellphones, gaming machines
  - Reduced cost of network operation, easier deployment of new apps, tighter integration with IP services (like email/web), wide variety of new applications/chances
- Use of IP = layer 2 independent
  - Can use cellular, 802.11, GbE, whatever available
  - Can switch to latest/cheapest technology as they become available

Why transition to IPv6?

- IPv4 supports up to 4 billion nodes only!
  - From address allocation efficiency, 100s of millions is the real upper limit
  - The limit is coming closer very quickly
    - Human population on the planet: 6 billion
- IPv4 has to be re-engineered
  - Was designed in 1970s, has a lot of missing features
- IPv6 expands IP address to 128bits
- Supporting 3.4 x 10^38 nodes
  - Should be enough for my lifetime at least...
- IPv6 incorporates recently-deployed technologies
  - Autoconfiguration and IPsec are mandatory
  - More friendly with mobilility/diffserv

Emerging new applications

- Monitoring
  - Taxicabs/vehicles as distributed sensors
  - Wiper switch = rain sensor
- Additional services
  - Coffee shops/PC-ban connected to the net 24x7, with 802.11
  - Supply additional services (like wireless Internet accesses) to attract customers
- Peer-to-peer
  - Gaming servers are suffering from excessive load due to client-client communication, resulting in giant server farms
  - If clients can communicate directly with each other, server could become smaller
    - With NAT, we can't do it/doesn't scale
- Kill legacy service appliances
  - Make cellphone a simple VoIP device, no need to deploy proprietary cellphone switches = reduced cost

"Killer apps" discussion is moot

- There are some people who are just waiting for killer apps on IPv6...
- IPv6 address space itself enables "killer apps"
- "Killer apps" can only appear after IPv6 deployment reaches certain level
  - Web was successful because IPv4 was already everywhere (universities, corporates)
  - Unless we have certain level of IPv6 deployment, we will never see "killer app"
- We need to deploy IPv6 to certain level, then killer apps will pop up

IPv6 deployment strategies and current status (ISP POV)

Transition in Japan (from ISP POV)

- Who are we (as IIJ)
- Japanese ISP status on IPv6
- What motivates Japanese ISPs to IPv6?
- IPv6 backbone design
- IPv6 services design
- Customer profile
- Technologies/equipments needed (input to vendors)

Who is IIJ, what kind of IPv6 services offered?

- One of the very first commercial ISPs in Japan
  - (and probably one of the biggest)
- Operational since 1992, IPv6 since 1998
- Connectivity services
  - 2001:240::/32, 3ffe:8020::/28
  - IPv6 tunnel service - since 1999
  - IPv6-only leased line service - since 2000
  - IPv4/v6 dual stack leased line service - since 2001
  - Commercial service, not experimental
- Other services
  - Web server hosting, with IPv4/v6 dual stack support
  - Data center with IPv6 connectivity
  - IPv4/v6 router "SEIL"
  - Consultation - help people design IPv6 network
  - Participate/contribute to KAME, IETF and others
    - KAME: IPv6 stack for BSDs (*BSD, MacOSX, and routers)

ISPs situation in Japan wrt IPv6

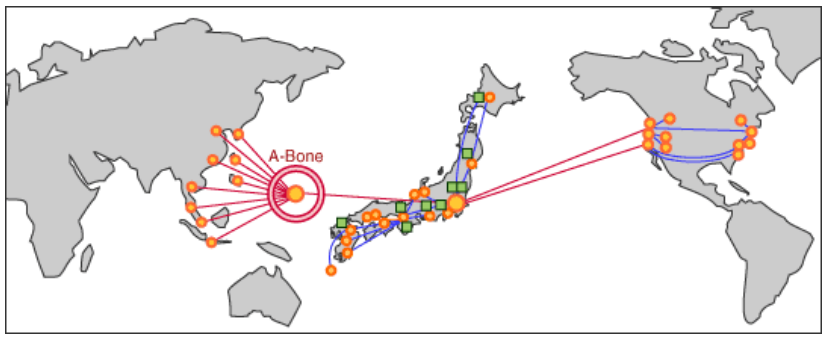
- 5+ ISPs are offering commercial services
  - tunnel, leased lines
- 25+ ISPs are offering experimental services
- 5+ IPv6 IXes are operational
  - (both commercial and academic)
  - 45+ ISPs are participating NSPIXP6
- at least 1200 to 1500 /48 sites are in Japan
  - We can't count 6to4 sites reliably (so there could be more)

Why are we doing it so early

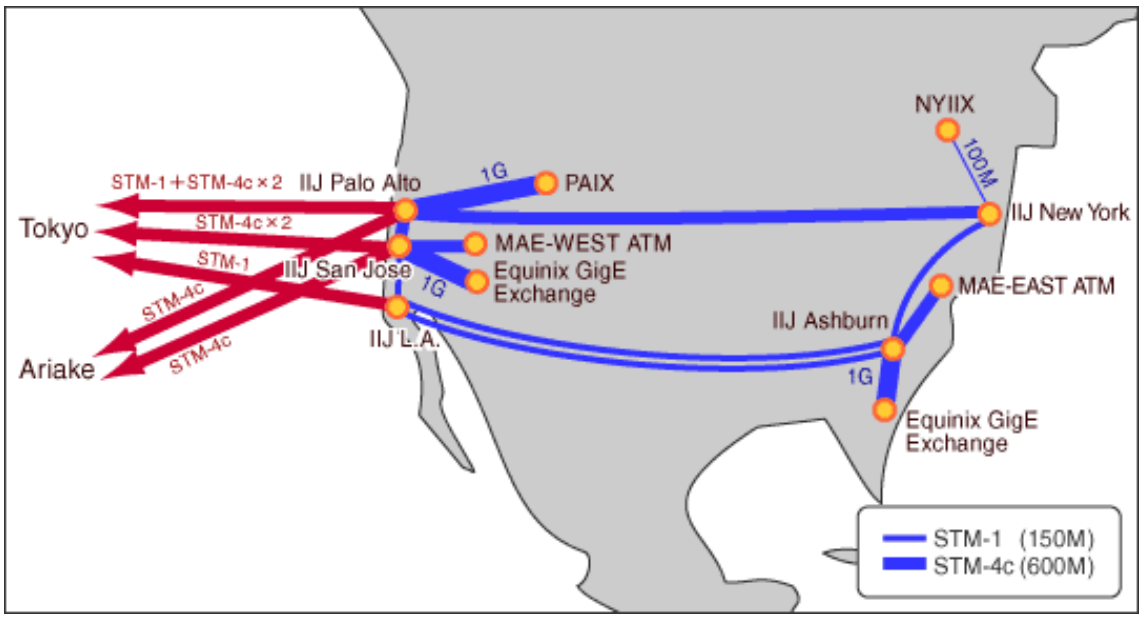
- For us, it is not early at all!
- ISPs need to act proactively
  - By the time customers start asking for IPv6, we need a working backbone - need to be prepared
  - We need to gather operational experiences much earlier than customers
  - Break the chicken-and-egg problem
- By starting early we can earn more experiences earlier than others
- IPv6 creates a new (and huge) market opportunities
  - We'll lose potential market/customer we you don't act sooner!
- Our mission: make IPv6 the default IP protocol

IIJ backbone topology (IPv4)

- Asia, Japan and US (east/west coast)
- Pure IP backbone, no MPLS
- 3Gbps between JP-US

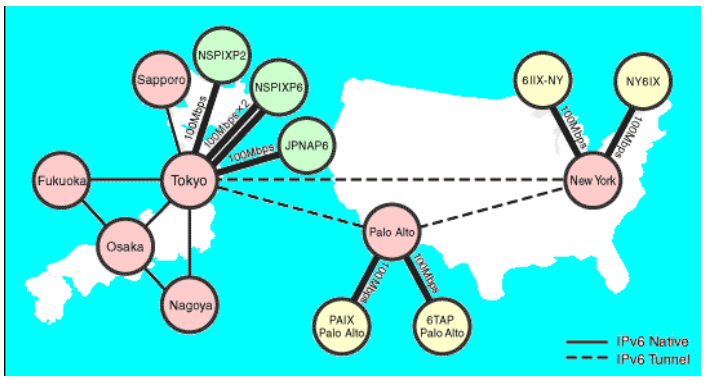


IIJ backbone topology (IPv4)



IIJ backbone topology (IPv6)

- 7 IXes, native peerings with 45 ASes
- Why deploy a separate backbone?
  - CISCO software trains - "S" train for IPv4, "T" train for IPv6
  - Can't compromise IPv4 SLA (stability of IPv4/v6 router)



Backbone design

- keep in mind - "simple, robust and scalable"
  - IPv4/v6 dual stack routers
    - IOS 12.2T images, all recent JunOS, Hitachi, NEC, Fujitsu...
    - PC router with *BSD can easily handle traffic of today - IPv4:IPv6 traffic = 800:1 (measured at Tokyo IX)
  - Routing
    - BGP4+ over IPv6 for IBGP/EBGP
    - RIPng
    - (OSPFv3 - vendor support is still poor)
    - RFC2772-based route filters at EBGP routers
  - Links
    - RFC2893 configured tunnels (within your AS only)
    - IPv6 PPP on leased lines
    - IPv6 over ethernet/ATM/what-have-you

Unified backbone, or separate?

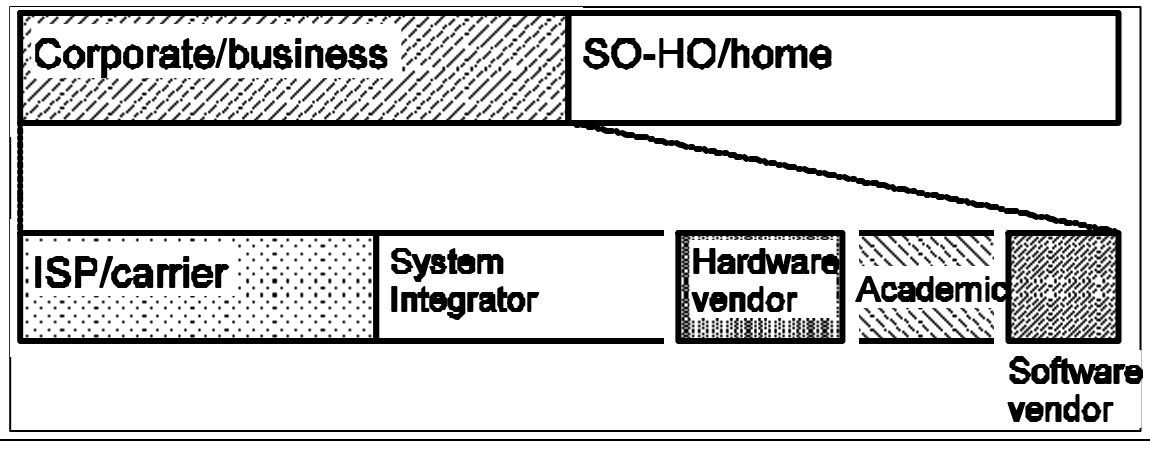
- Separate backbone
  - No SLA comproise to IPv4 services - operators are happy
  - More equipments to babysit
  - Separate bills for leased lines - not pretty
  - Can use IPv6 routers w/ beta firmware, if your IPv6 SLA allows
- Unified backbone
  - Chances for SLA compromise to IPv4 services
    - If IPv4/IPv6 dual stack router is not stable enough
  - Less equipments to babysit
  - Single bill for leased lines
- (tunnel is a complicated beast - be warned)

Service designs

- Connectivity services
  - IPv6-over-IPv4 tunnels
    - one *BSD box can easily terminate 10^3 tunnels
  - Leased lines
  - DSL - needs more vendor support
  - Data center racks - ethernet drop
  - Charging model? by traffic/bandwidth?
- IX services
- Application/hosting
  - Web hosting, email/messaging/VoIP/whatever
- Service/network integration, consultation

Who are the IPv6 customers?

- A couple of /40 delegations
  - Smaller ISPs
- 200+ /48 customers already
  - 10% are leased lines, 90% are tunnels to IPv4 customers



Customers are using...

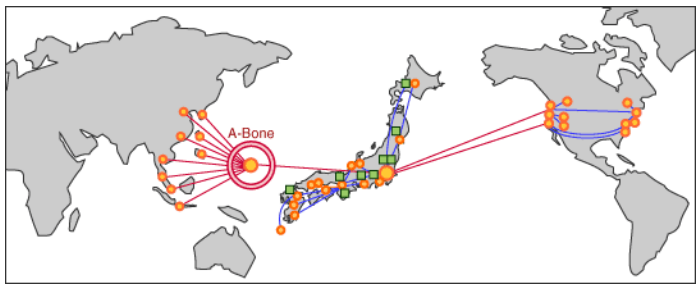
- Honestly we don't know what they are using, really!
- SSH/FTP/IRC/HTTP/SMTP/NNTP are very common
  - People are using those without even noticing
- They could be trying more exotic stuffs
  - Site-locals, router renumbering, IPsec, Translators, other transition tools, VoIP
    - Note all of the current customers are dual-stack sites, otherwise they won't be able to query DNS
- Customers do depend on our IPv6 services
  - it's not a research toy any more

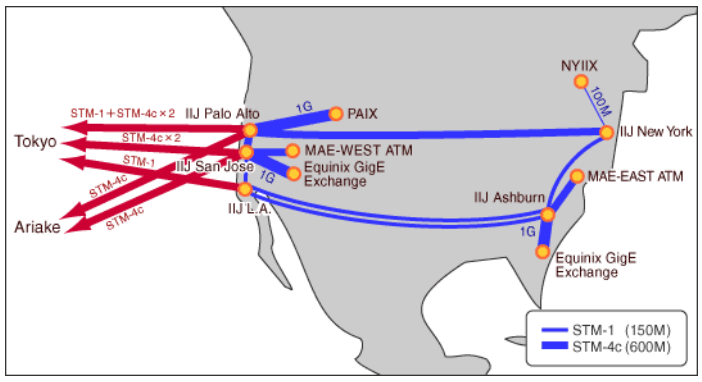
We are waiting for vendors to ship...

- Stabilized IPv6 implementation
- Multicast by IPv6 PIM
  - Waiting for vendor routers support, as we need all routers to speak PIM
- OSPFv3, eventually
  - Again, waiting for vendors to ship/stabilize it
- IPsec for protecting routing protocols
  - No vendor support at all at this point
  - Details are lacking in RFC - "use IPsec" is too vague
- MLD-snooping L2 switches
  - IPv6 multicast traffic leak out from all ports!

How the future IIJ IPv6 backbone will look like

- Unified IPv4/v6 backbone (router vendors, hurry up!)





What kind of technologies are important? (1)

- Robust and stable routers!
  - so that we can unify IPv4/v6 backbone
- Make SO-HO/home routers IPv6 ready
- IPv6 support in DSL aggregators and stuff
- IPv6-ready root/ccTLD/gTLD DNS servers
  - To allow deploying IPv6-dominated/IPv6-only network
- More educational materials for IPv6

What kind of technologies are important? (2)

- Monitoring tools IPv6 support
  - SNMP, ping, whatever
- New security model/tool for IPv6, something better than firewall
- Prefix delegation
  - automate address space assignment from ISP to customer

How you can start?

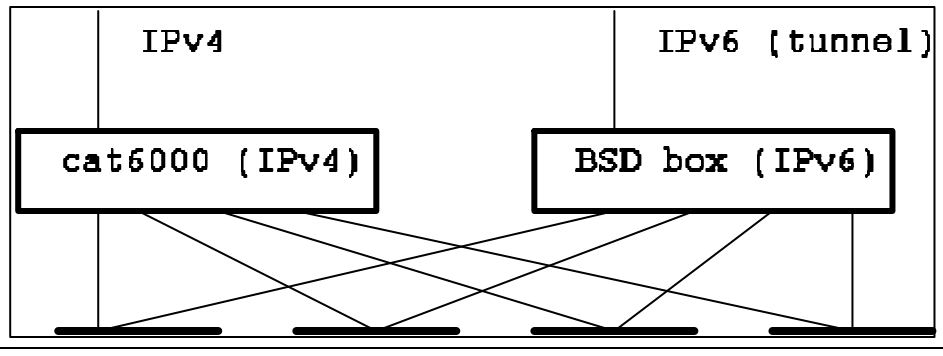
- In general
  - Raise awareness, educate, advocate
- Customer appliances
  - Coordinate with ISPs, deploy IPv6 into the products
  - Design products with IPv6 in mind - it will give you various advantages
  - Game consoles are good place to start - you can include the whole IP stack into CD/DVD
- ISP - deploy IPv6 network, start IPv6 services
  - Even if an experimental one, important to make it available
  - Otherwise customers cannot use it
- Server farms/service providers
  - Make sure your server/services are IPv6 ready

Where are the market possibilities?

- Customer appliances
  - New designs/applications that take advantage of IPv6
- ASP/integration services
  - Help people deploy/transition to IPv6, design IPv6 network
  - Provide transition tools
- Routers
  - Core routers
    - Japanese vendors are trying to get market share
  - SO-HO/home routers
    - if you have contacts, please let me know!
- ISP
  - Deploy and provide IPv6 services earlier than others
- Others
  - Domains where IP technology has not reached yet (taxicabs)

How you can deploy IPv6 to your campus?

- You should deploy IPv6 to every IPv4 segments
  - Separate IPv6/v4 segments do not make sense
- L2/L3 switch based deployment (cisco catalyst 6000)
  - create a trunk port that can access all ethernet segments
  - put a BSD box to the trunk port
  - BSD box behaves as the IPv6 router for every segments
  - BSD box tunnels IPv6 traffic to outside using IPv6-over-IPv4 tunnel
- If you have multiple campuses in remote locations
- If you have some routers that cannot be upgraded to IPv6
  - Have IPv6 router at each locations, establish IPv6-over-IPv4 tunnel between campuses



Summary

- Why transition to IPv6?
- Transition in Japan (from ISP POV)
  - ISPs should deploy IPv6 now, if not yesterday
    - Or you will lose your potential customers!
  - No need to deploy fancy IPv6 network
    - Keep it simple and robust, that's what the Internet is about
- Market possibilities
- How you can start

Homework assignment

- 1. Understand/investigate IPv6 activity in your country
  - check www.6bone.net and see if your country has pTLA address space assignment (3ffe:xxxx::/32)
  - check www.apnic.net and see if your country has sTLA address space assignment (2001:xxxx::/32)
- 2. Understand/investigate ISP's awareness to IPv6 in your country
  - Contact your university's ISP/other ISPs if they plan to start IPv6 services
  - If so, ask when will it be
  - If not, ask the reasons why, and try to convince them to start IPv6 services