Migration to IPv6
– IPv6 Operation –

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What is need for migration to IPv6

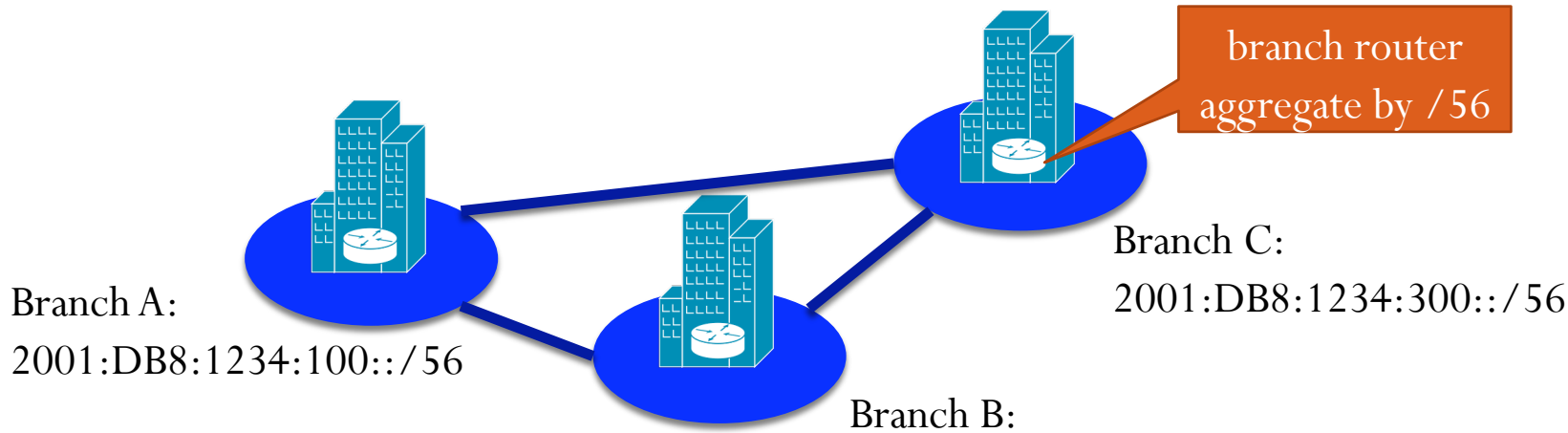
- Address assignment
- Routing support
- DNS support on resource record and transport
- Application support on server

Link-local address assignment

- Link-local address is scoped to intra-link communication
- IPv6 support stateless address autoconfiguration
  - When host connects with network, link-local address is generated using interface ID made from unique MAC address
- We need only to enable IPv6 for communicating with hosts on the same link.

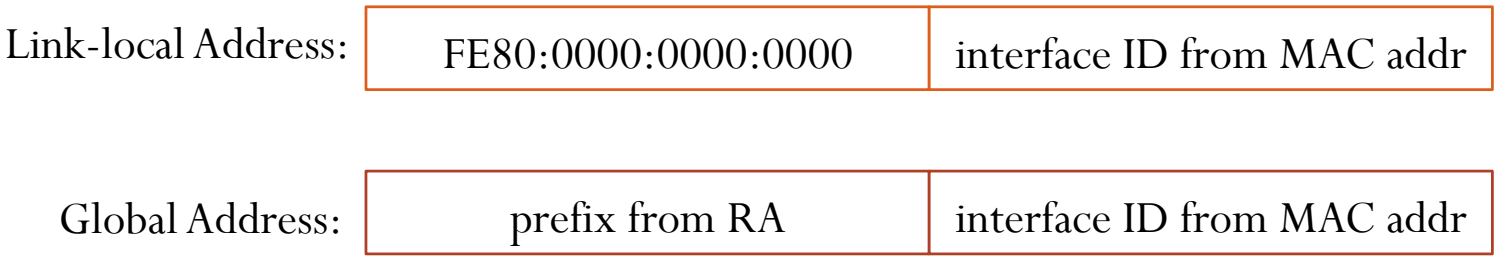
Address assignment for network

- IPv6 site assigned global address by /48 prefix and can use 80 bits (16 bits subnet ID + 64 bits interface ID) at the site
- Length of subnet ID bits is fixed, therefore we does not need to think about subnet mask like IPv4
- If the site consist of branches over some cities, it is good idea using structured and aggregatable subnet ID



Address assignment for host

- IPv6 support stateless address autoconfiguration
  - When host connects with network, link-local address is generated using interface ID made from unique MAC address
  - host receive RA (router advertisement) from local router, and global address is generated using prefix of RA and interface ID
  - Operator need only to configure RA at router



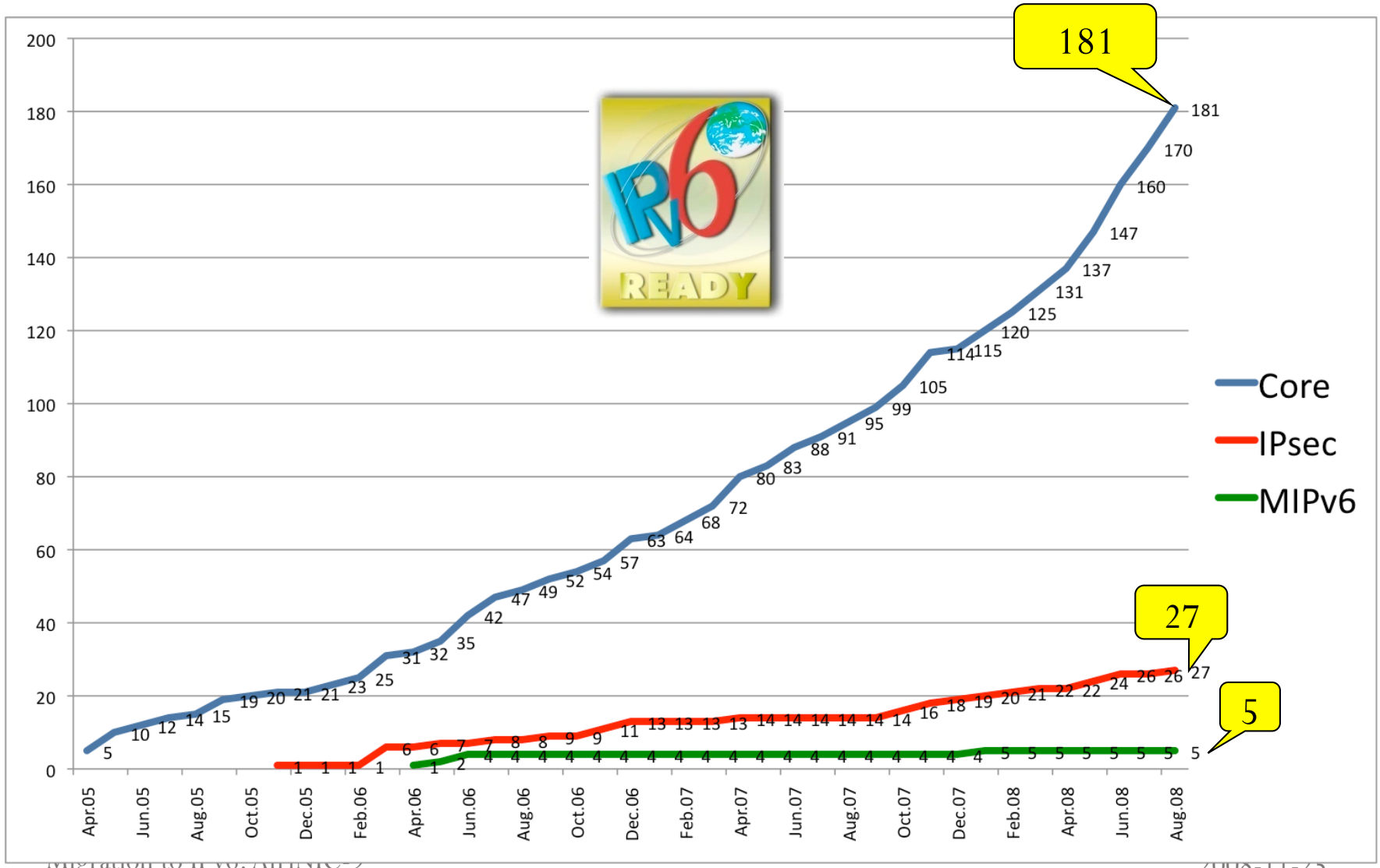
Routing support

- Many router vendors support IPv6 now
  - A lot of devices are approved "IPv6 Ready Logo Program" from IPv6 Forum

- Quagga (GPL licensed) is routing software suite supports major IPv6 routing protocols
  - PC + UNIX + Quagga = IPv6 Router

as of Aug 31 2008

Phase-2 Logo Approved Devices



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Phase-2 Logo trend by nation (core)

USA has been "serious"

IPv4 / IPv6 dual routing operation

- If it's running routing protocols of same type for IPv4 / IPv6
  - Configuration parameters have been similar well under same topology and same policy
  - Cost of management increases a little from only IPv4
- otherwise …
  - Planning for IPv6 network is needed separately form IPv4
  - Double cost of management is needed

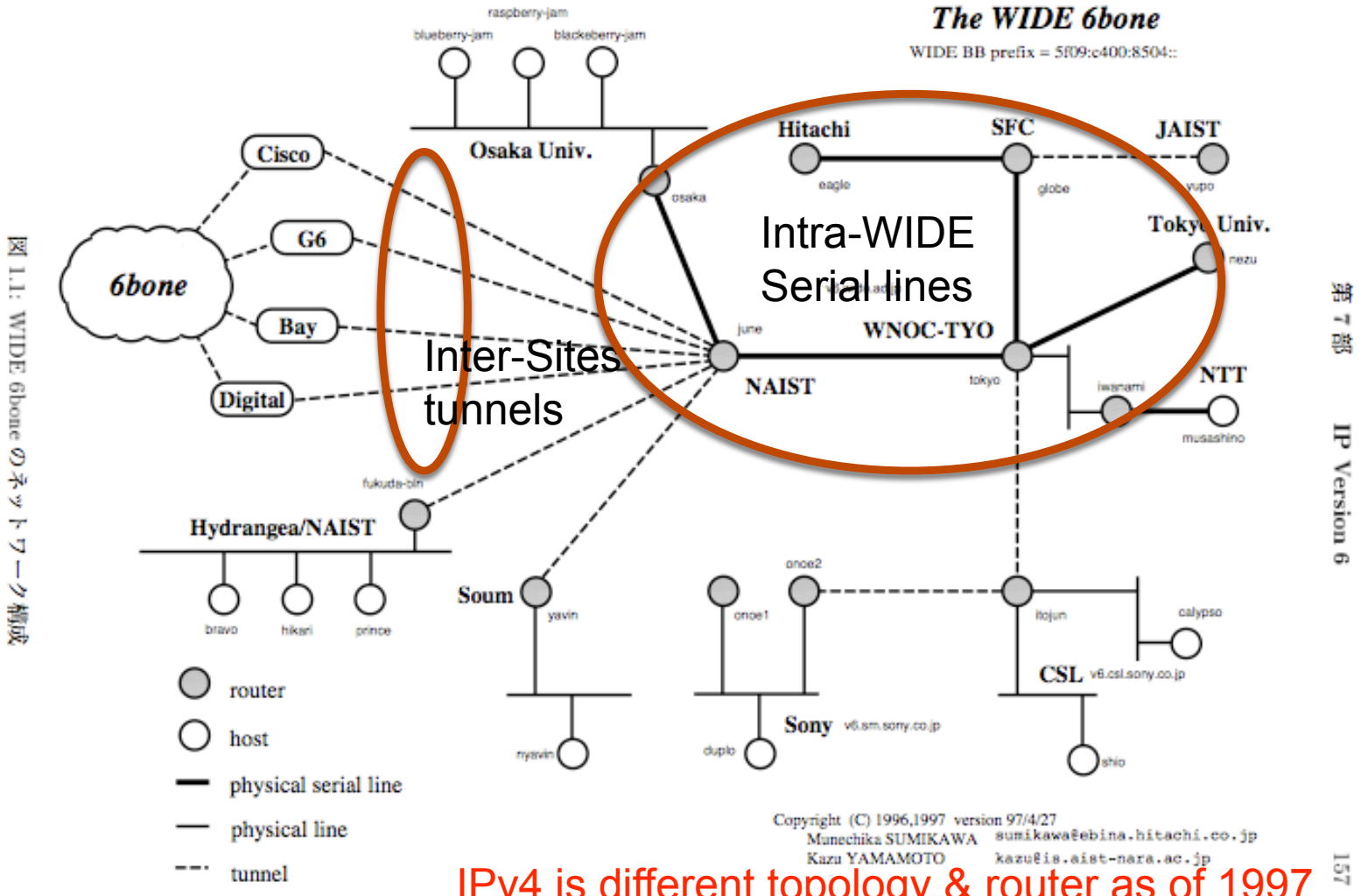
If your upstream network does not support IPv6 ...

- "IPv6 over IPv4 tunnel" is usable to connect IPv6 netowrks over IPv4 network
  - If you are network administrator and want IPv6, this tunnel is one of solutions
  - You need to search the tunnel peer who is nearer on IPv4 topology as possible in order that you use stable IPv6 network
- "6to4" is usable for host on IPv4 only network
  - IPv6 address is generated from global IPv4 address automatically. So the host needs global IPv4 address
  - If you are one of users on IPv4 only network and assigned global address, "6to4" is one of solutions

Example of Migration

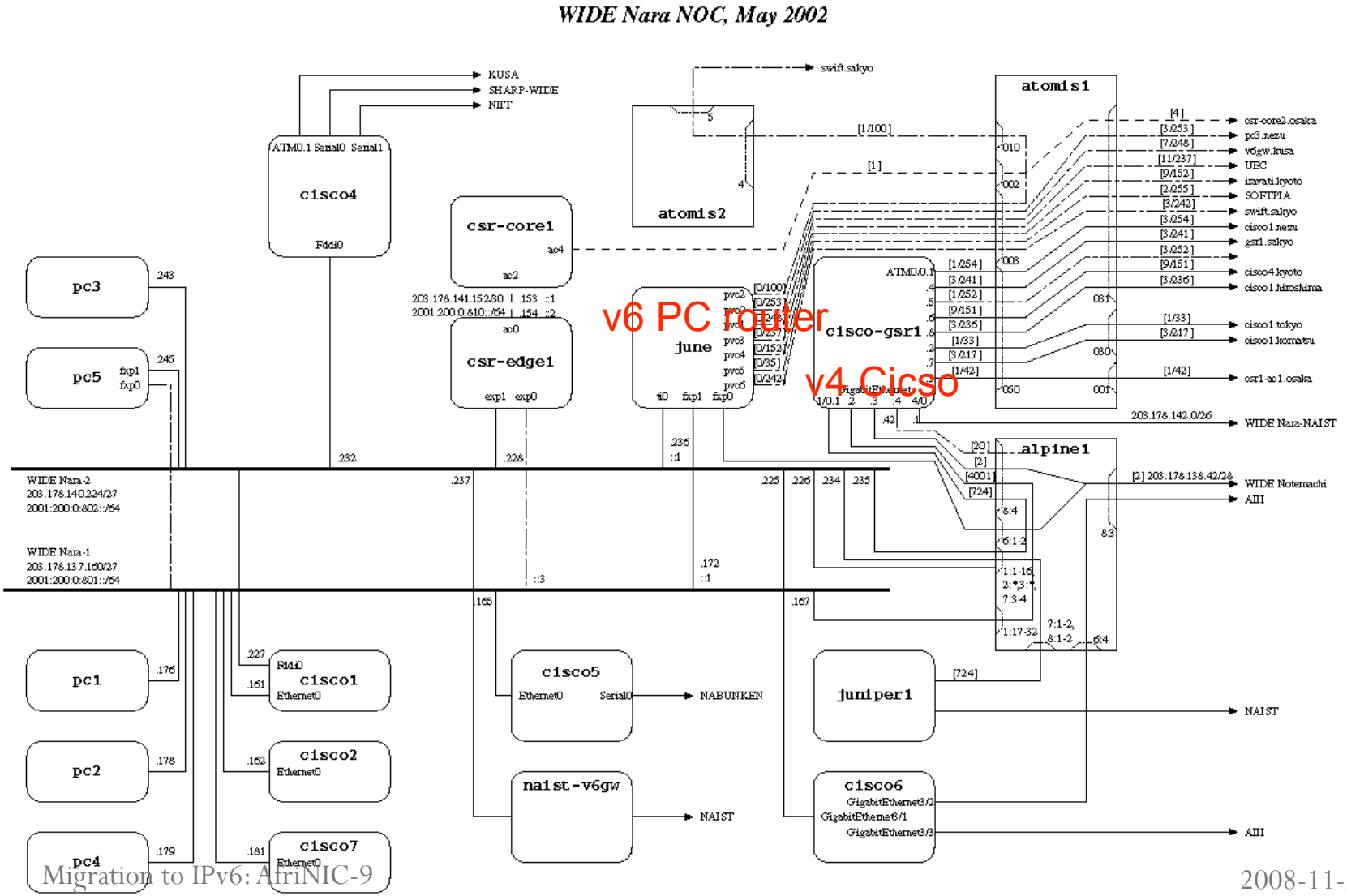
- First, enable one PC router to support IPv6 and connect to other sites with IPv6/IPv4 tunnel
- Next, go on the followings:
  - Enable applications to support IPv6 / IPv4 dual stack
  - Convert connection with other sites to native link from tunnel
  - Enable core routers to support IPv6 / IPv4 and integrate IPv4 / IPv6 networks to one topology
- Last, users will mainly use IPv6 for nice services

First stage of WIDE 6bone

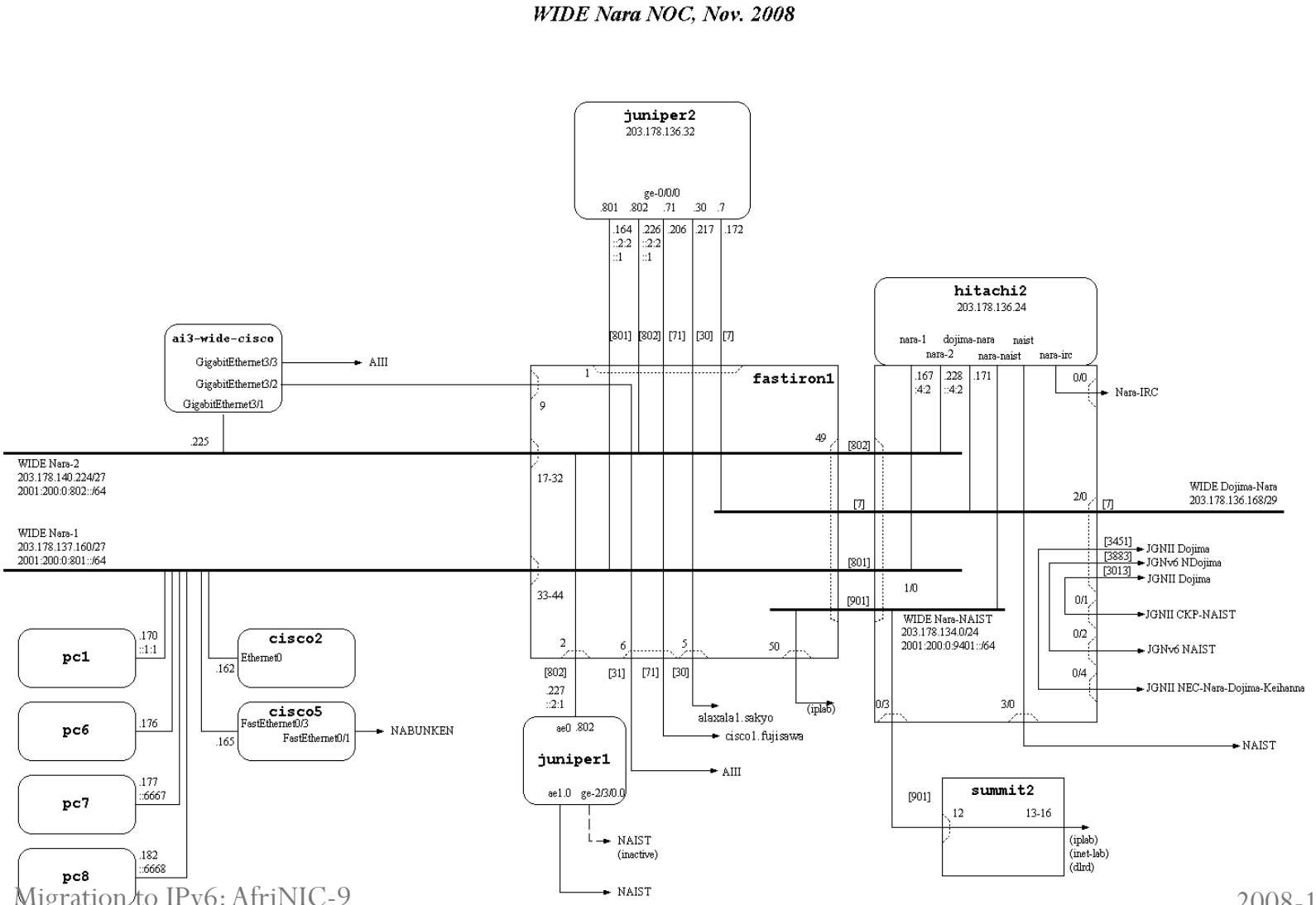


IPv4 is different topology & router as of 1997

Example: IPv6 topology is different from IPv4 (WIDE Nara NOC)



Example: Core routers support IPv4 / Ipv6 dual protocols



Take care about ICMPv6 filtering

- Many sites install firewall at border with external or front of servers. Some sites drop almost all ICMP
- For IPv4 / IPv6 dual stack environment ICMPv6 is more important than for IPv4 only environment. If drop ICMPv6, the following mechanisms works worse:
  - PATH MTU Discovery
  - Fallback to IPv4 from IPv6

Path MTU Discovery

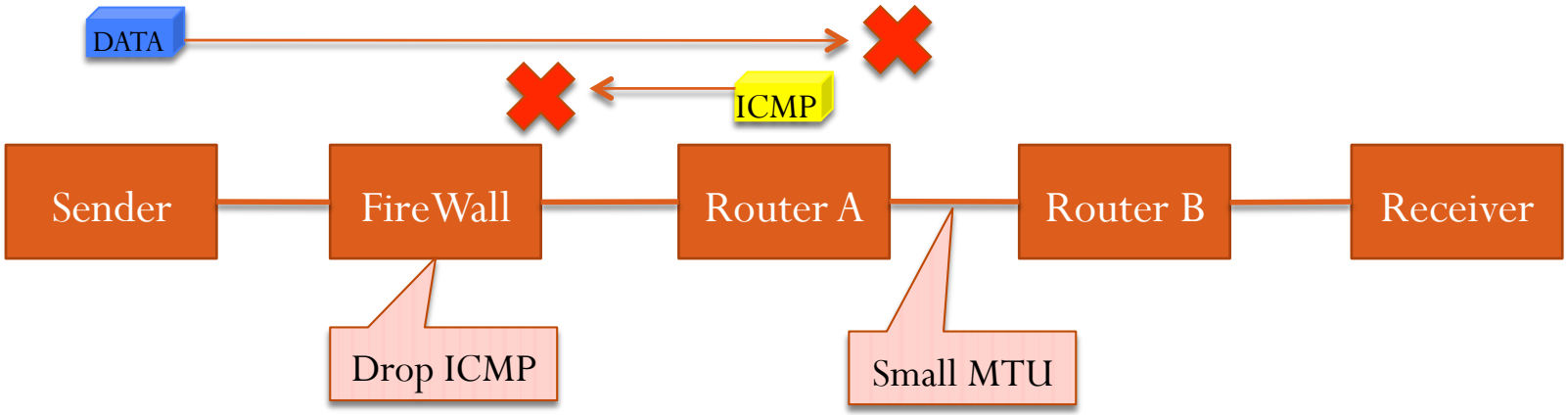
For IPv4 Path MTU Discovery is optional

- When it sets Don't Fragment bit on IP header, Path MTU Discovery works.
- If MTU of next hop is too small for IP packet, the router return ICMP "destination unreachable" message with code "fragmentation needed and DF set"

Path MTU Discovery

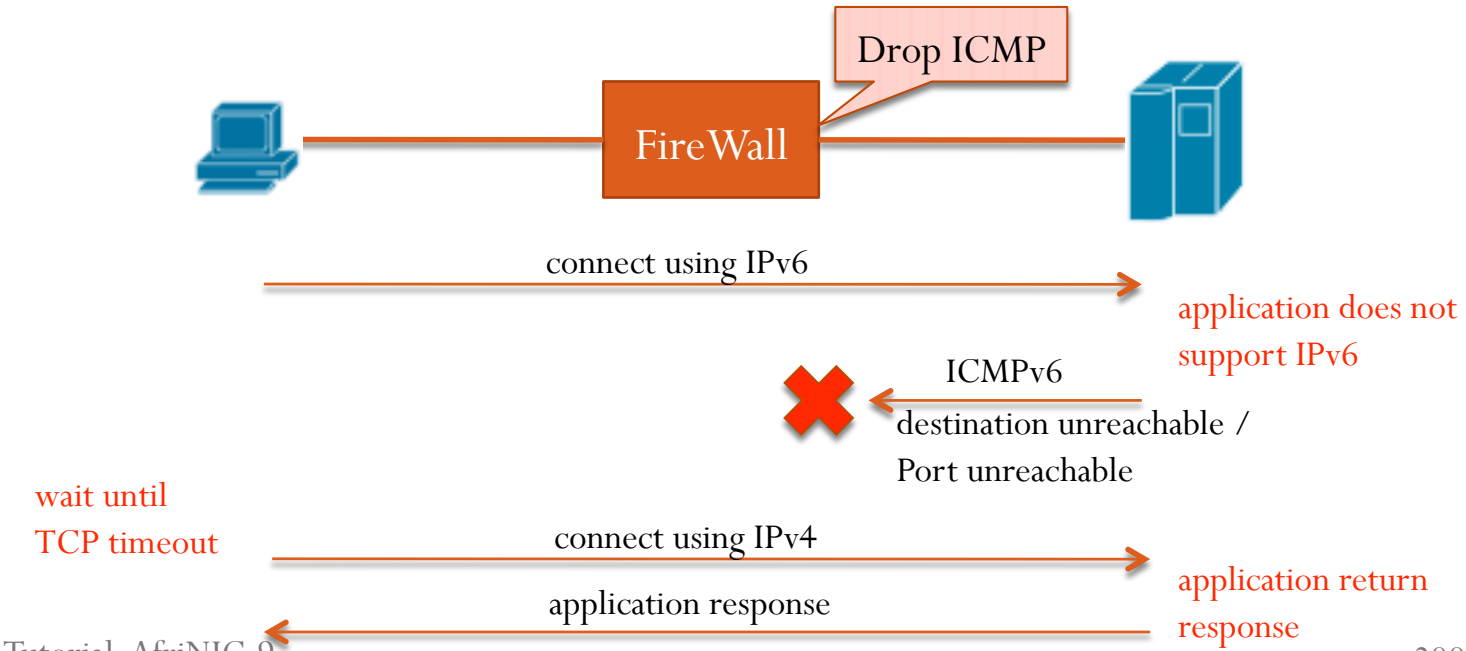
For IPv6 Path MTU Discovery is mandatory

- IPv6 router does not support IP fragmentation to be simplify router implementation
- IPv6 Path MTU Discovery uses ICMPv6 “packet too big” message
- On some situation (e.g. IPv6/IPv4 tunnel, PPP) large packet does not reach the destination if intermediate router drop ICMPv6



Fall back to IPv4 from IPv6

- There are some scenarios of fallback to IPv4 from IPv6
- Sample case: server supports IPv4 / IPv6 dual stack but application does not support IPv6
  - If intermediate router drop ICMPv6, user wait until TCP timeout



DNS support on resource record

- "AAAA" resource record is introduced for IPv6 hostname-to-address mappings

  host-x IN AAAA 2001:BD8:1234:1:2:3:4

- "PTR" resource record and "ip6.arpa" domain support IPv6 address-to-hostname mappings

  $ORIGIN 8.d.b.0.1.0.0.2.ip6.arpa.

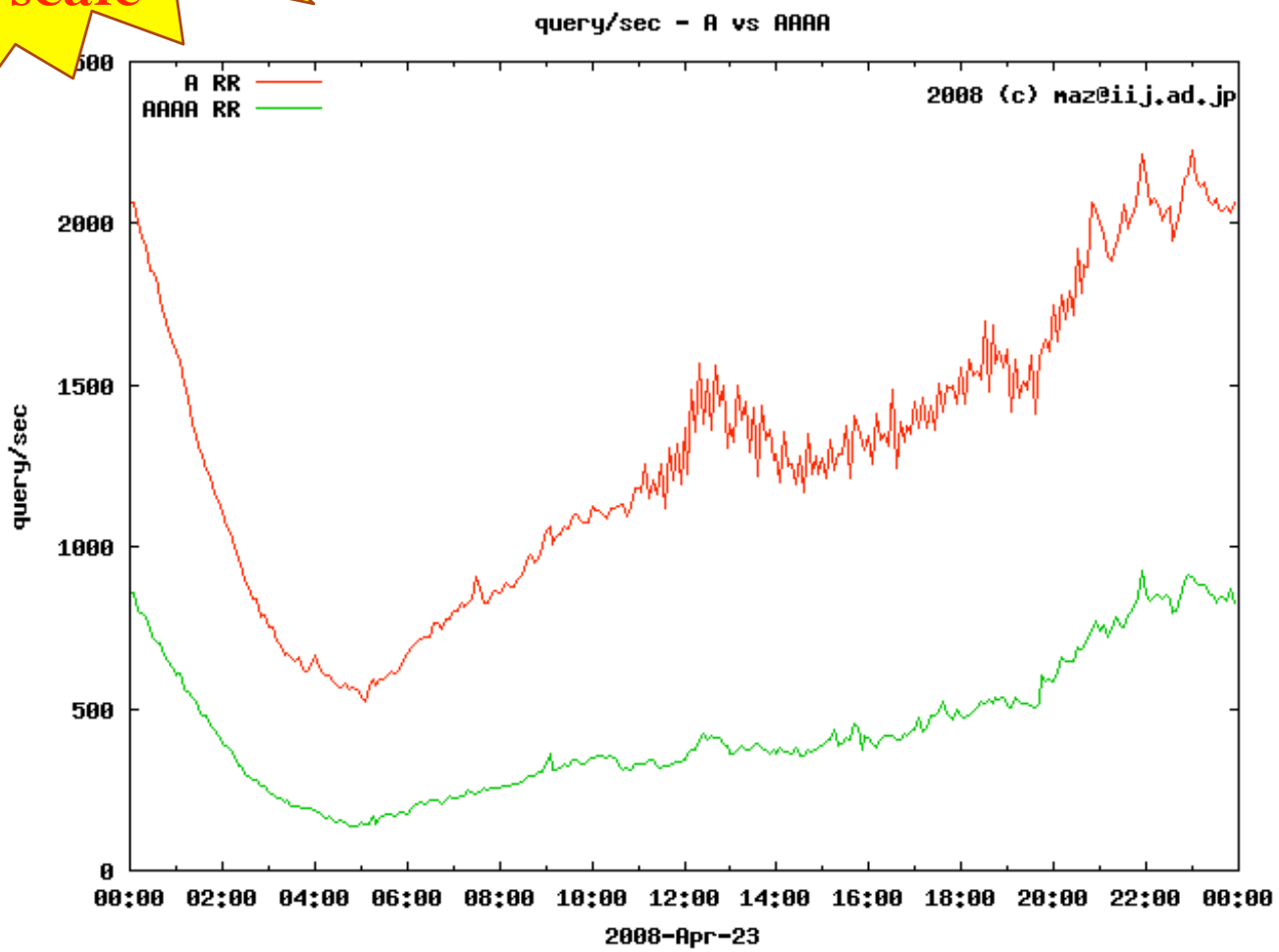
  4.0.0.0.3.0.0.0.2.0.0.0.1.0.0.0.4.3.2.1 IN PTR host-x.example.com

- Address notation is longer than IPv4, but only so

Source ; Mr.Matsuzaki of IIJ

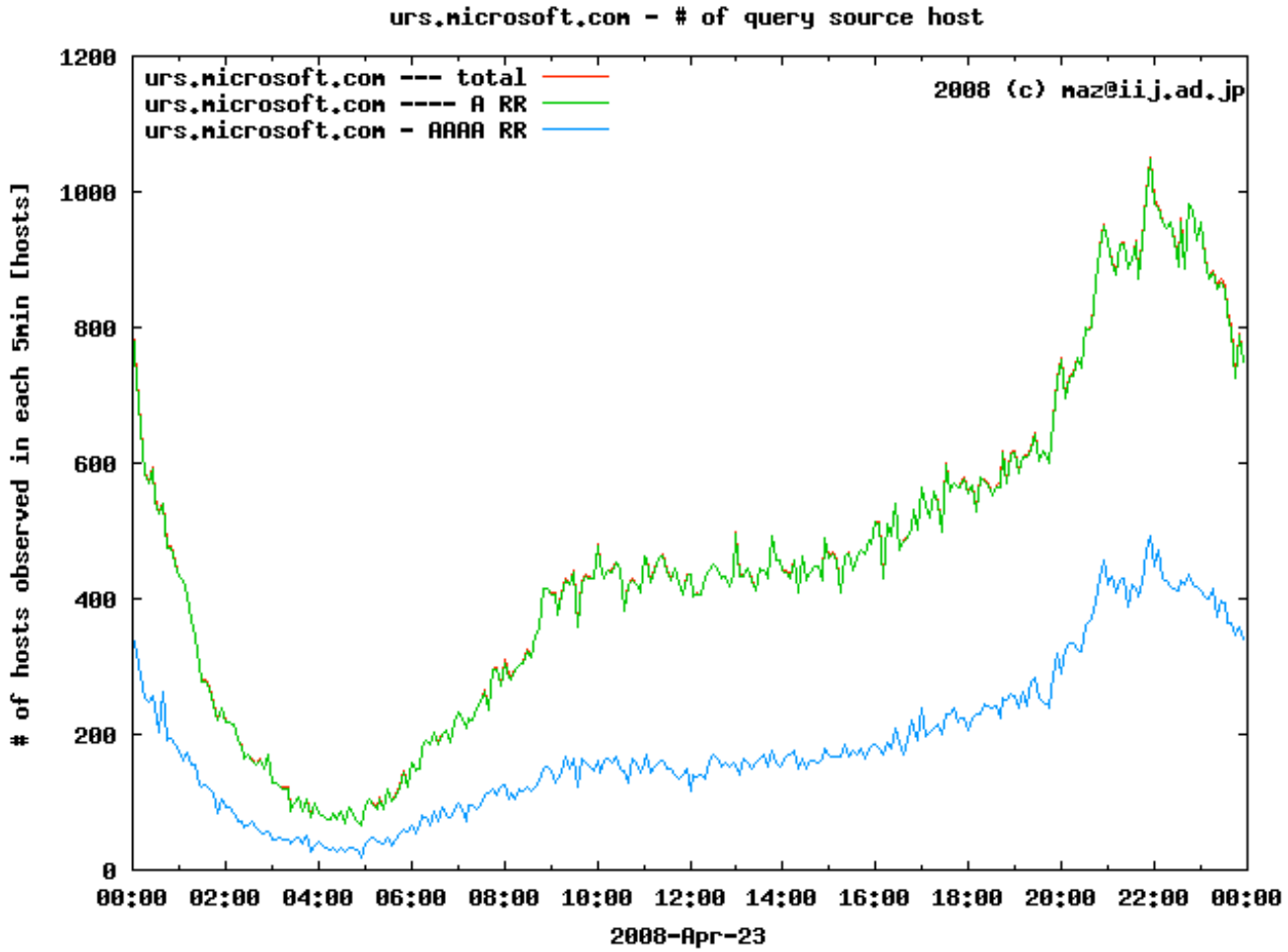
Linier scale, not log-scale

A vs AAAA



Source ; Mr.Matsuzaki of IIJ

Number of source node for Queries



Application support on server

- Many OS support IPv6 now
  - MS Windows, Mac OS X, Solaris
  - FreeBSD, NetBSD, GNU/Linux
- Many Applications support IPv6 now
  - Sendmail, Postfix, Cyrus IMAP, Mozilla Thunderbird
  - Apache Web Server, Mozilla Firefox

Some additional issues

- NAT-PT (v6 ↔ v4 translator) does not work well
  - e.g. against google cache that has numeric IP address notation in URL like:
    http://209.85.175.132/search?q=cache:i-zEsc35yEMJ:en.wikipedia.org/wiki/IPv6+IPv6
- Also any application which has numeric IP address in the payload

Conclusion

- IPv6 is not difficult. IPv6 network operation requires a little know-how
- Many devices support IPv6 now
- For the begging of IPv6, IPv6 over IPv4 is one of solutions. But for stable network, reduce tunnel
- But there are some open issue for internet application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Thank you