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NTT Communications

Rocky Mountain IPv6 Summit

IPv6 Deployment and Commercial Applications at NTT

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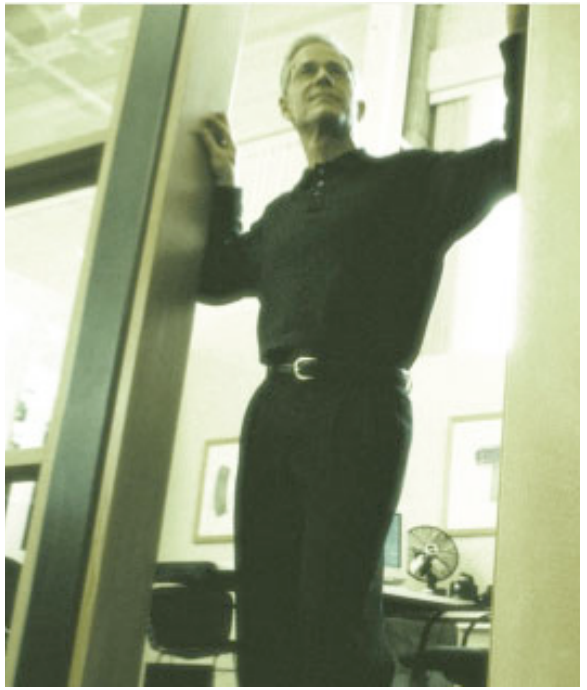
NTT America - Global IP Network
April 22, 2009

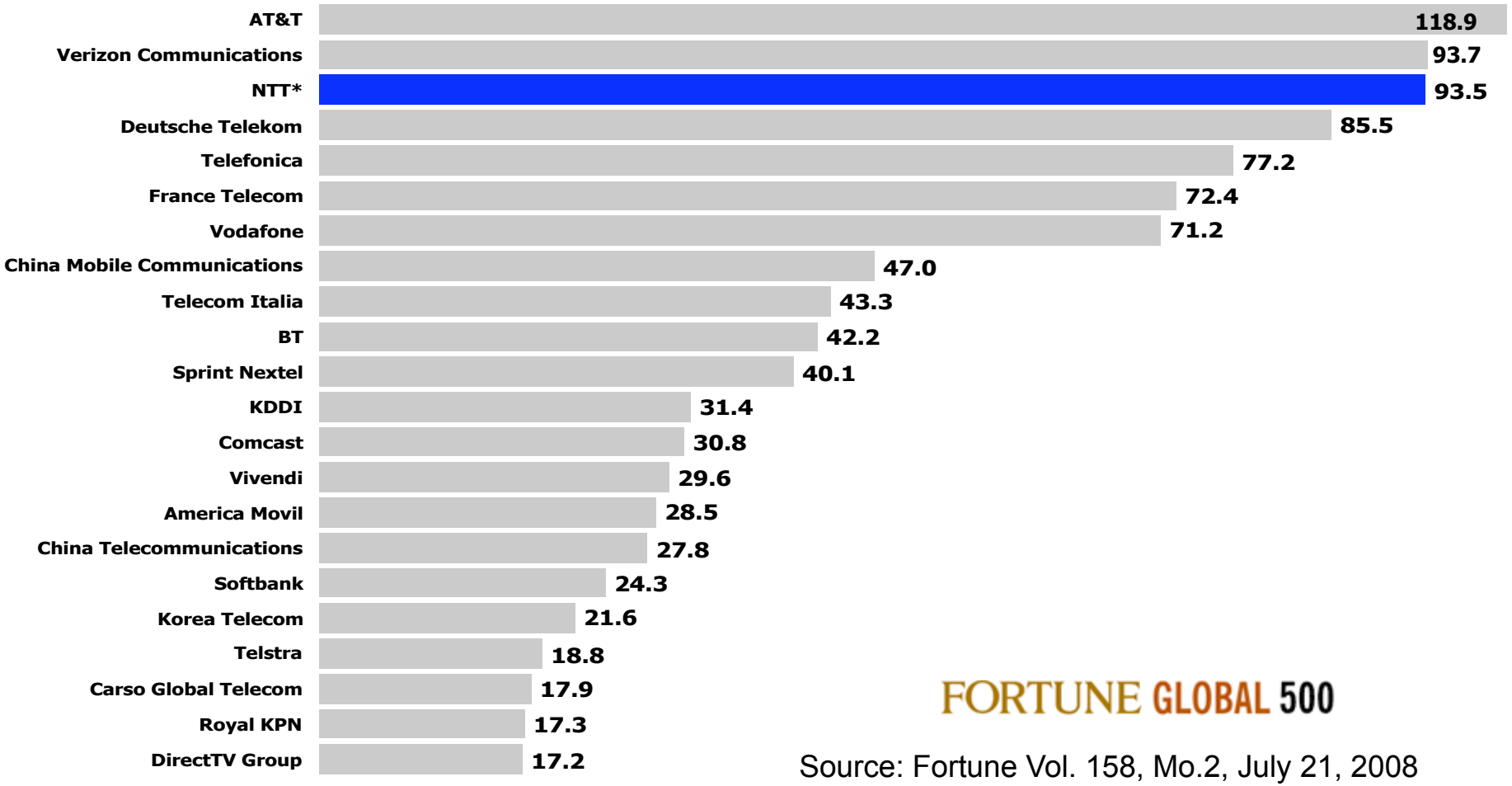
Agenda

- **About NTT**
- NTT - A global IPv6 deployment case study
  - Adoption considerations
  - An Adoption how-to
- IPv6 beyond the transition
  - Hikari-TV
  - Earthquake warning service



Who is NTT?

World's Top 22 Telecom Companies by Revenue ($US Million)



FORTUNE GLOBAL 500

Source: Fortune Vol. 158, Mo.2, July 21, 2008

NTT Communications IPv6 Service History

1996: NTT Labs started one of the world's largest global IPv6 research networks

1998: Verio begins participation in PAIX native IPv6 IX

1999: NTT Com begins IPv6 tunneling trial for Japanese customers

2000: Verio obtains IPv6 sTLA from ARIN

2001: NTT Com pioneers world's first IPv6 connectivity service on a commercial basis

2002: World Communications Association (WCA) awards NTT Communications with "Best Technology Foresight" for its IPv6 global products

2003: NTT/VERIO launches IPv6 Native, Tunneling, and Dual Stack commercial service in North America

2003: *Communications Solutions Magazine* names NTT/VERIO IPv6 Gateway Services "Product of the Year"

2004: NTT IPv6 Native and Dual Stack services available around the globe

2004: NTT Com wins the World Communications Association "Best New Service" award for IPv6/IPv4 Global Dual Service

2005: Dual stack Virtual Private Server released.

First ISP to offer an IPv6 managed firewall service

10/2006: Launched the NTT

Communications IPv6 Transition Consultancy

2/2007: Awarded GSA Schedule 70 contract for IPv6 IP transit

1/2008: NTT America demos IPv6 at ICAC at U.S. Senate

3/2008: IDC names NTT America Top 20 IPv6 Influencer Working with the U.S. Government

4/2008: NTT Com named Best Wholesale Carrier at the Telecom Asia Awards for Global IP Network Service and services incorporating IPv6 and advanced security technologies

5/2008: European Commission invites NTT America to speak at European IPv6 Day

1/2009: NTT America demos IPTV over IPv6 at ICAC at U.S. Senate

NTT America Customer Profile

- Approximately 14% of our customers purchase IPv6 transit.
- Over 47 Gbps of purchased IPv6 or dual stack capacity.

January 2009 IPv6 Customer Breakdown	
Education & Government	6%
Hardware & Manufacturing	19%
Internet & Telecom	64%
Webhosting & Web Services	11%
Total	**100%**

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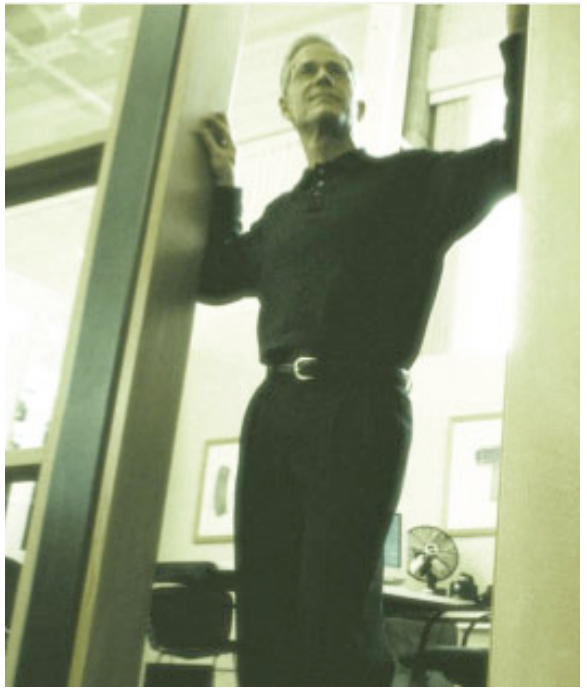

Backbone Upgrade Considerations

- All backbone equipment needs to be audited and upgraded if necessary:
  - Chassis, cards, memory, etc.
  - Operating systems
- What features will be offered and can the network support these features.
- How will deployment take place:
  - Core first then the aggregation routers
  - Both at the same time
  - Set up an entire separate (parallel) network
  - Use tunnels
- A test environment needs to be set up. (everything needs to be tested)

Support Infrastructure

- Router configuration tools.
- Route Registry.
- Address allocation database and procedures.
- DNS support. (records and access method)
- Customer interfaces. (looking glass, control panels, etc.)
- Access feature support:
  - Access methods (TDM, Ethernet, Frame, etc.)
  - Features (shadow, managed router, etc.)
  - Consulting services
- Billing system support.

Monitoring and Support

- Network Monitoring.
- Troubleshooting tools.
- Training for NOC and IPeng personnel.
- SLA monitoring and display tools.
- Any other support and monitoring tools will need to be upgraded.

Non-technical Issues

- Collateral needs to be developed.
- Decide which verticals to target.
- PIQs need to be revamped for IPv6.
- Business partnerships (if needed) to support the product.

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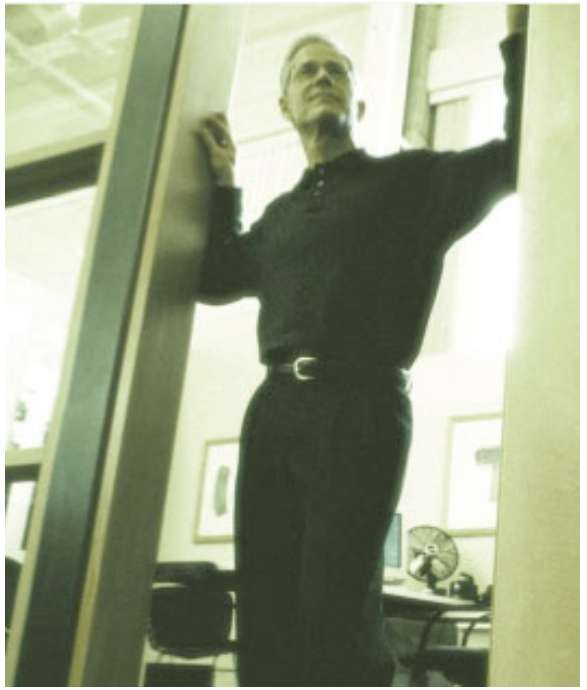
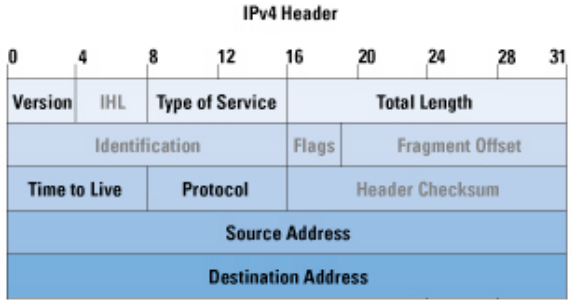


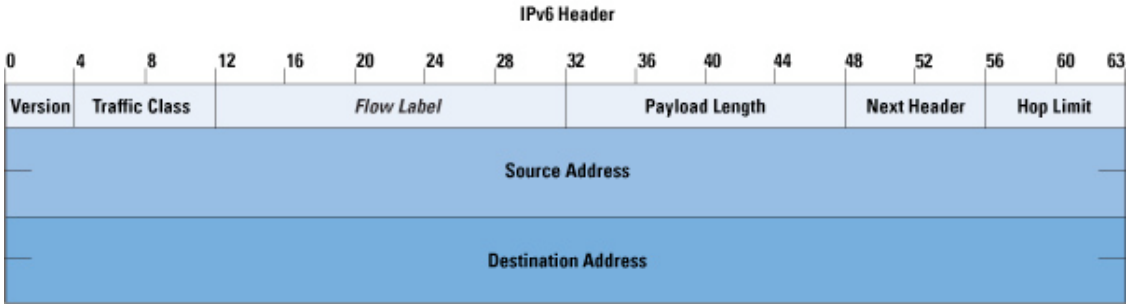
Background - NTT Communications and IPv6

- In 1996 NTT Labs started one of the world's largest global IPv6 research networks.
- Equipment procurement: in 1997 started working with vendors for IPv6 support, and in 1999 started pushing hard for commercial support.
- In 1999 NTT obtained an sTLA from APNIC. (Asia)
- In 2000 an sTLA was obtained from ARIN. (N.A.)
- 6bone was used for testing initially - later a private IPv6 lab in Dallas was used.
- In 2000 IPv6 was officially on NTT Communications' product road map.

Steps For Deploying IPv6

- NTT treated the deployment of IPv6 similar to launching a new product.
  - Set up a core team representing all necessary groups
  - Set up a project plan, document project requirements, design documents, test plans, etc.
  - Deploy IPv6 in a phased approach:
    - (I) Precommercial Phase
    - (II) Commercial
    - (III) Follow up releases





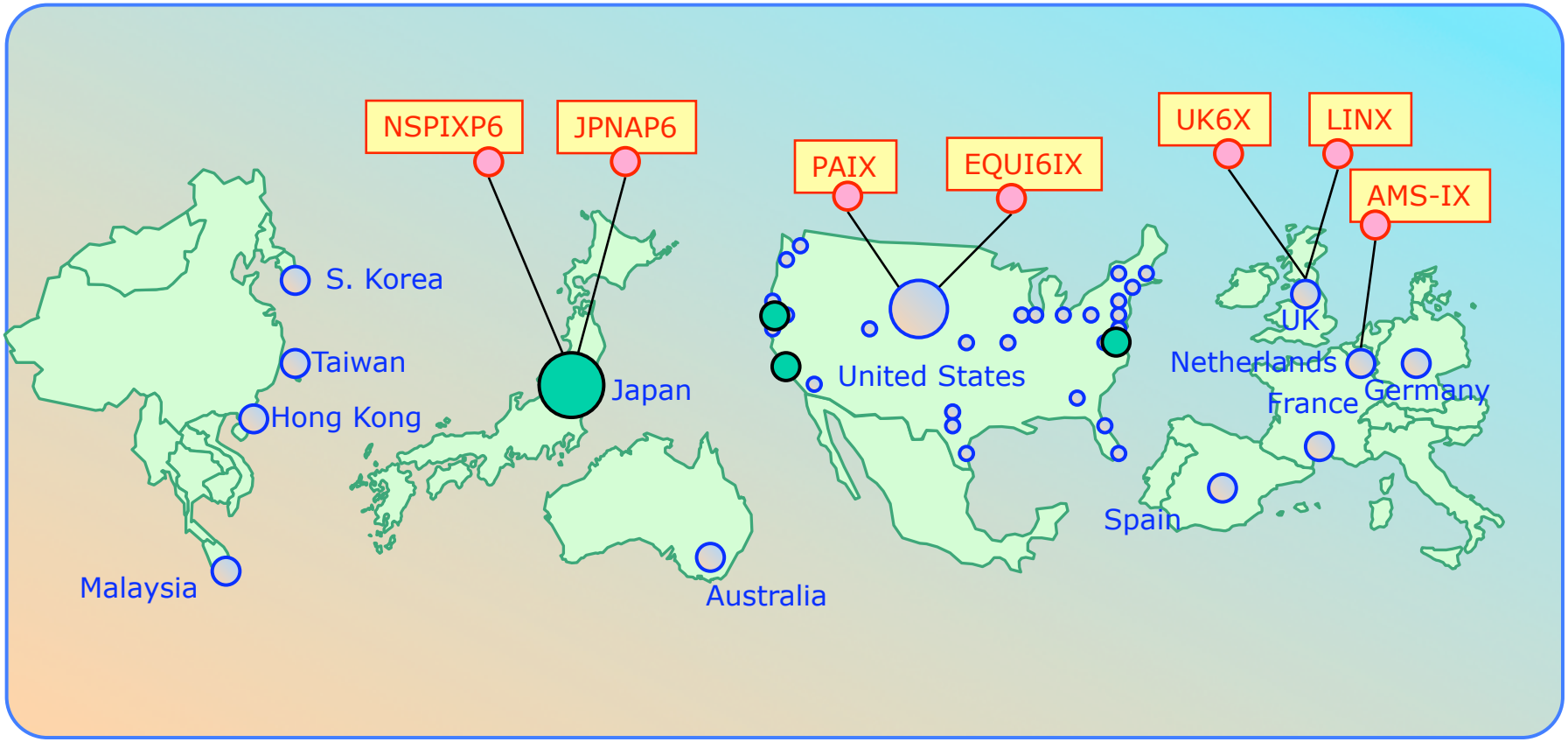
NTT's Pre-commercial IPv6 Service in the US

- In June of 2003, NTT Communications launched pre-commercial IPv6 service in the US.
- Native IPv6 was available in three locations:
  - Bay Area
  - Los Angeles
  - Washington D.C. Area
- Cisco 7206 routers in these three locations running dual stack - tunneling across the backbone. (backbone not dual stack)
- Tunneling (RFC 2893 manually configured IPv6 over IPv4) available in all other POPs. (tunnel built to one of the locations above)

Pre-commercial Service Objectives

- Pre-commercial service was offered from June 2003 to December 2003. (at which time commercial service was launched)
- Pre-commercial objectives:
  - Bring on a small, manageable number of customers
  - Test provisioning and support procedures
  - Train NOC staff
  - Continue JunOS/IOS IPv6 testing
  - Develop internal tools
  - Allowed time to upgrade backbone to dual stack
- Still just a few dual stack routers with tunneling across the backbone everywhere else.

Pre-commercial Service Map (June 2003)

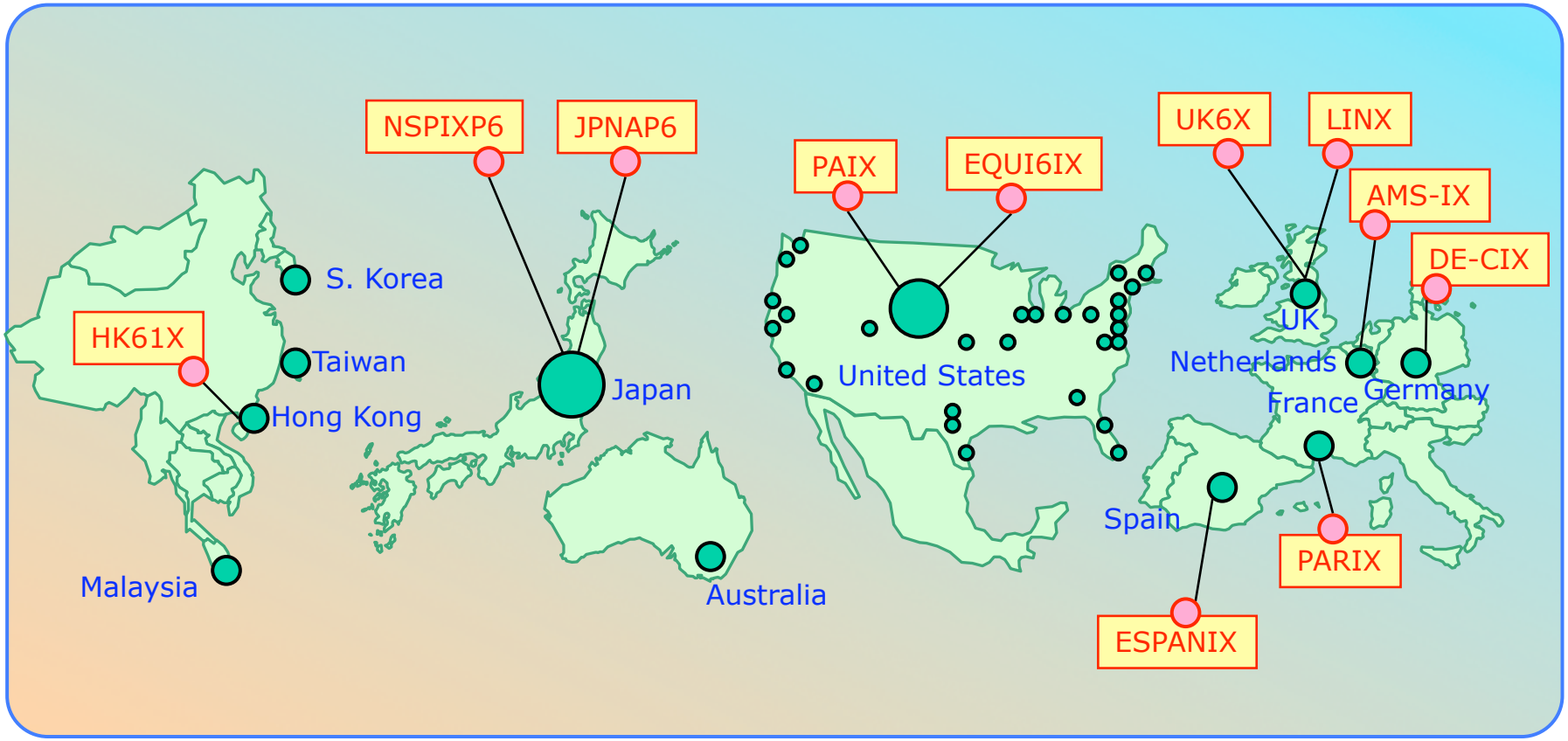


- IPv6 Native Service Availability
- IPv6 Tunneling Service Availability
- IPv6 Primary Exchange Point

NTT's Commercial IPv6 Service Launch

- In 4Q2003 global backbone was upgraded to dual stack. (Asia, Australia, North America, and Europe)
- In December, 2003, three types of IPv6 service were offered on a commercial basis:
  - Native IPv6 (available at every POP)
  - Manually configured IPv6 over IPv4 tunneling
  - Dual stack IPv4/IPv6
- AS2914 core completely dual stack. (globally)
- 7x24 NOC support and SLAs.
- Still service functionality gaps.

Commercial Service Map (December 2003)



- IPv6 Native Service Availability
- IPv6 Primary Exchange Point

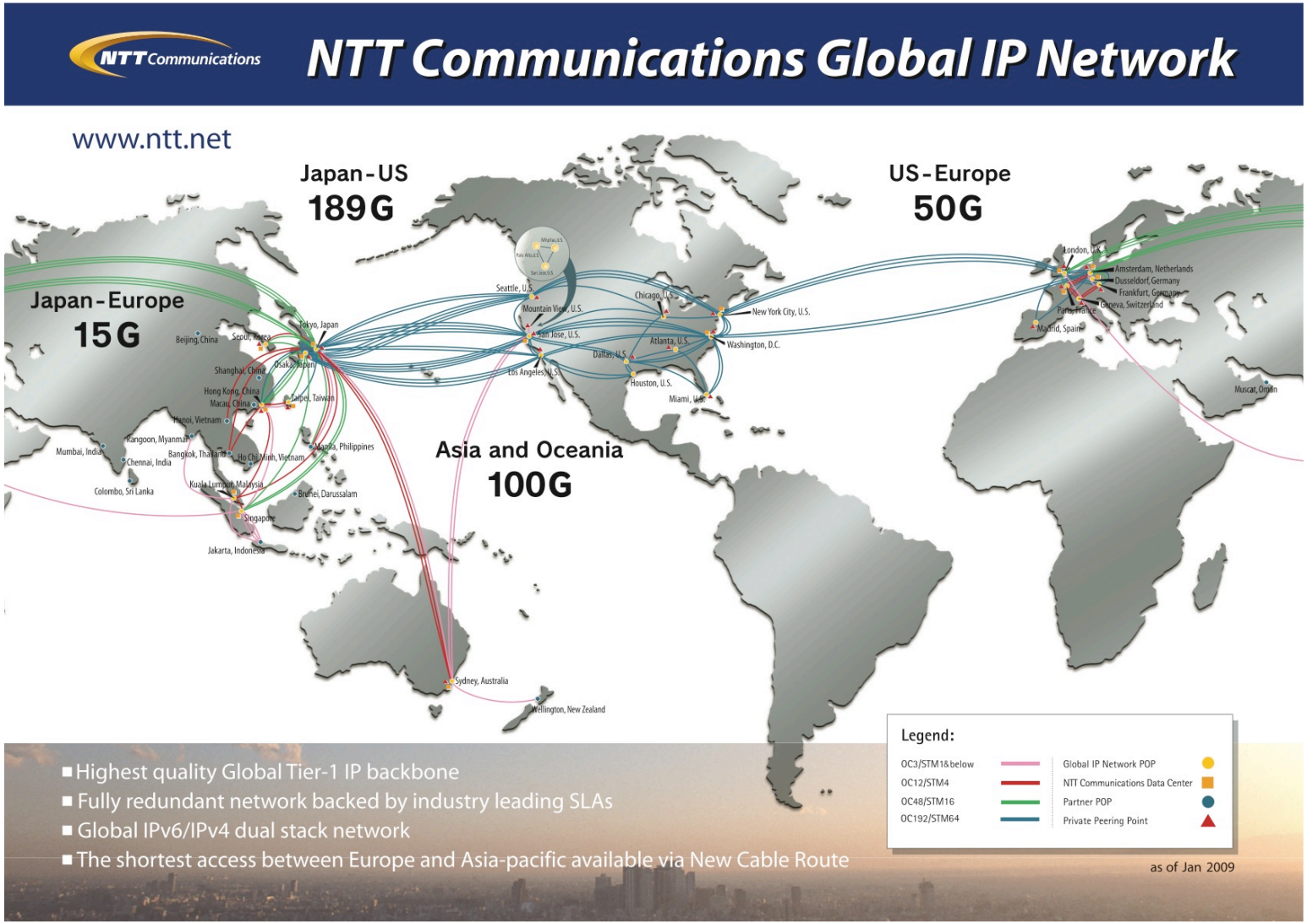
IPv6 Follow Up Releases

- Since the commercial launch in December 2003, follow up releases have been pushed out to fill functionality gaps.
- Added IPv6 support for:
  - Off-net Tunneling
  - Managed Router Service
  - Shadow support for TDM and Ethernet
  - Managed Firewall
  - Dual stack Virtual Private Server
- Our goal and philosophy is to offer all features and services in IPv4 and IPv6. (It doesn't matter which flavor of IP you buy - you can get the same things.)

IPv6/IPv4 Dual Stack Backbone

- IPv6/IPv4 Dual Stack Backbone has shown excellent performance with no critical problems so far.
- Core routers / routing protocols have had no problems handing IPv6 traffic. (in addition to the IPv4 traffic/routing)
- But still, we have some operational gaps:
  - Stats tools are still lacking in the IPv6 environment (IPv6 MIB support, SNMP over IPv6 support…)
  - IPv6 jitter measurement system compatible with our IPv4 system.

Dual Stack IP Backbone - January 2009

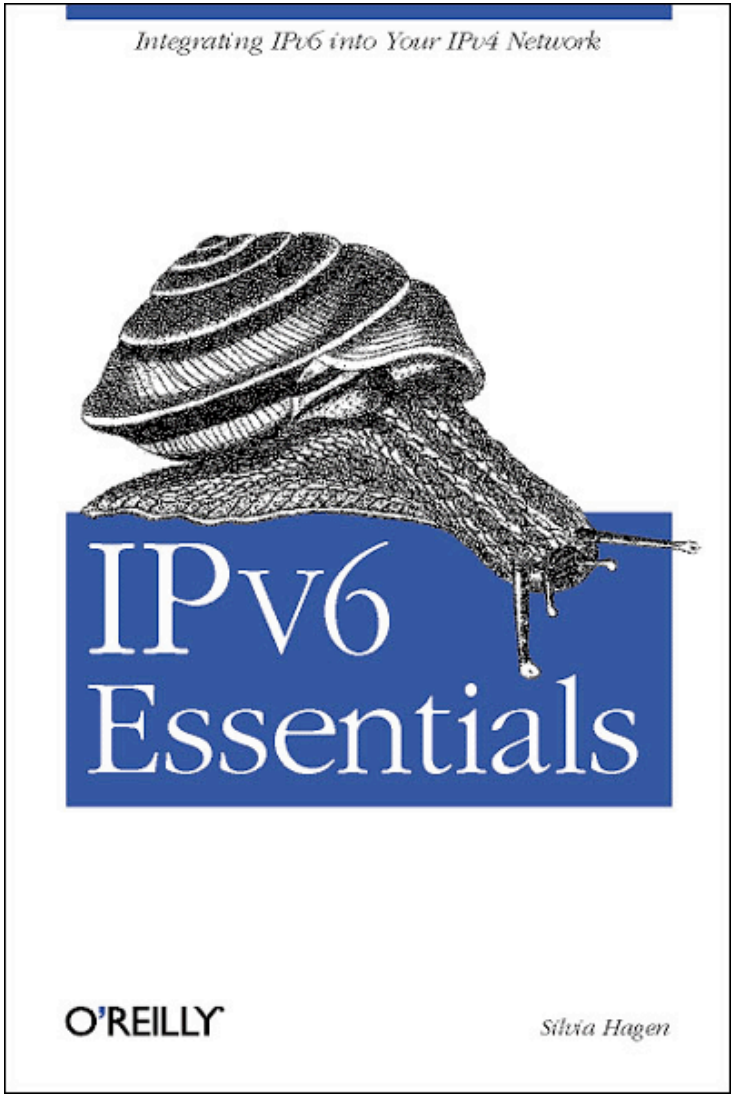


Summary and Recommendations

- Create a core project team with representation from all pertinent groups in your organizations.
- Plan well in advance and make purchasing decisions based on IPv6 support. (NTT had no capital budget specifically for IPv6 deployment)
- Proper planning reduces cost and pain.
- Select the best backbone migration approach for your network - running IPv4/ IPv6 dual stack is recommended if possible.
- Set up a test environment and/or use existing test beds.
- Get training for engineering, provisioning, and support personnel.
- Employ a phased rollout approach
  - Allows to continue testing
  - Get internal resources trained and up to speed
  - Solidify internal processes and tools
  - Can fill in functionality gaps over time
- Make sure your security policy also includes IPv6
- Get outside help if needed.
- IPv6 roll out should be easier today with the increased maturity of IPv6.

The "Snail Book"

- ***IPv6 Essentials*** (O'Reilly) by Silvia Hagen
  - ISBN 0-596-10058-2
  - Chapter 10 includes case studies, including NTT's.
- ***Global IPv6 Strategies*** (Cisco Press) by Patrick Grossetete, Ciprian P. Popoviciu, Fred Wettling
- ***IPv6 Security*** (Cisco Press) by Scott Hogg and Eric Vyncke



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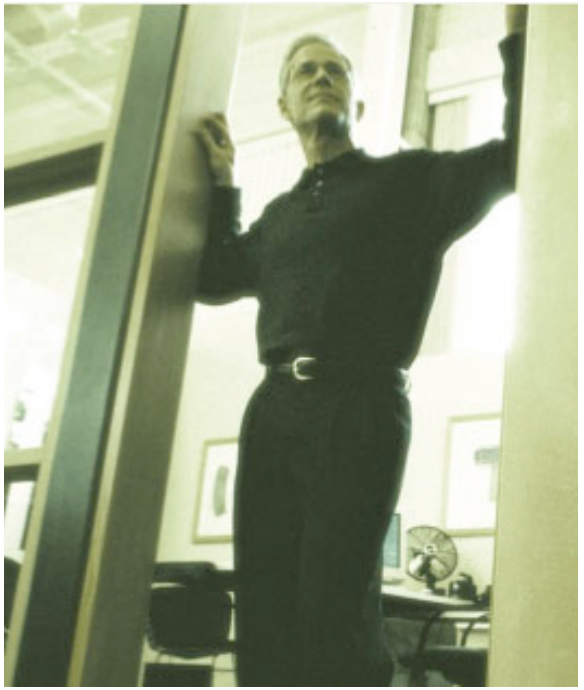
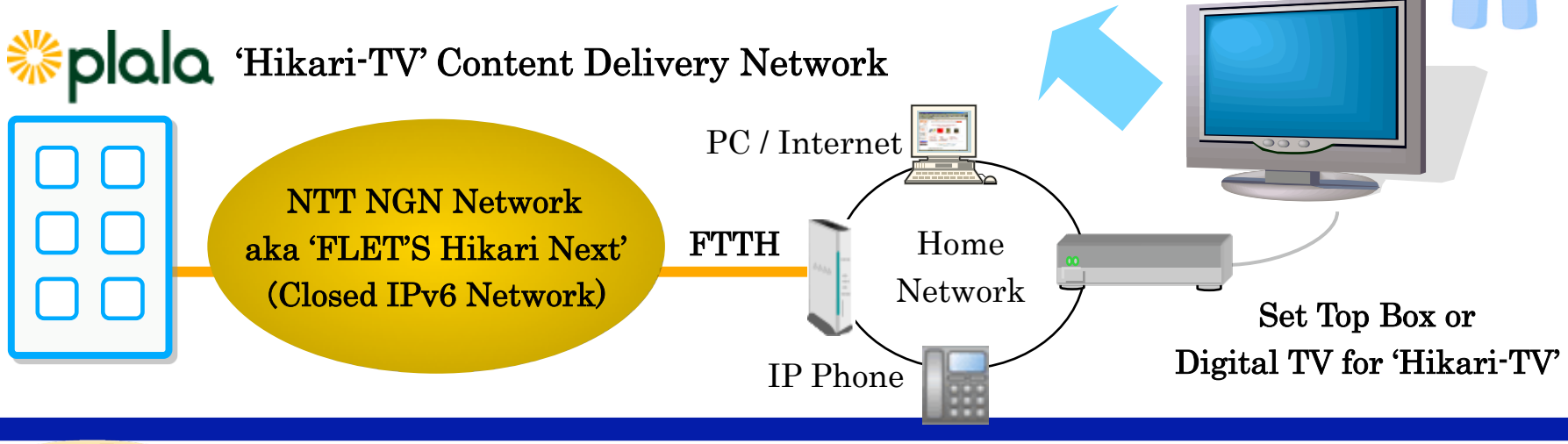


NTT Plala's "Hikari-TV" IPTV Service

Hikari-TV Top Page

- Retransmission of Terrestrial Digital Broadcasting (HD) 'Hikari-TV' is the first RTDB provider.
- Channel service
  76 channels (including HD channels)
- VOD service
  Over 10,000 titles
- Karaoke service
  Over 13,000 titles

plala 'Hikari-TV' Content Delivery Network



Hikari-TV Channel Lineup

Digital terrestrial retransmission (High definition)	Tokyo: NHK General, NHK Education, Nippon Television, TV Asahi, TBS, TV Tokyo, Fuji TV, Tokyo MX, and Open University of Japan Osaka: NHK General, NHK Education, MBS, ABC, TV Osaka, KTV, and Yomiuri TV
Main broadcast channels (12)	Independently produced program (5 channels) Shopping program (7 channels)
Basic channels (40)	Movie, Anime, Drama, Entertainment, Documentary Sports, Music, Hobby, culture, Foreign language, News, weather
Premium channels (23)	Movie, entertainment, and adult programming (23 channels)

* A red-framed box indicates a high-definition channel. A blue underline indicates a popular overseas channel.
* Main broadcast channels, basic channels, and premium channels use H.264 and MPEG-2 as the encoding formats.
The H.264 bitrates are 8 Mbps for HD and 3.7 Mbps for SD. The MPEG-2 bitrates are 4.2 Mbps for HD and 2.5 Mbps for SD.

DTVs and Set Top Boxes for Hikari-TV

- 'Hikari-TV' content delivery platform is based on IPTV standard specifications provided by 'IPTV Forum Japan' (www.iptvforum.jp, Japanese only)
- 'Hikari-TV' provides several types of Set Top Boxes (STB).
- TOSHIBA and SHARP provide Digital TVs that include the 'Hikari-TV' function.

ひかりTV

PM-700
(Hikari-TV STB)

TOSHIBA

REGZA ZH70000 & Z7000
(DTV, JAPAN MODEL)

Broadband Button
for 'Hikari-TV'

IPv6 Network Architecture

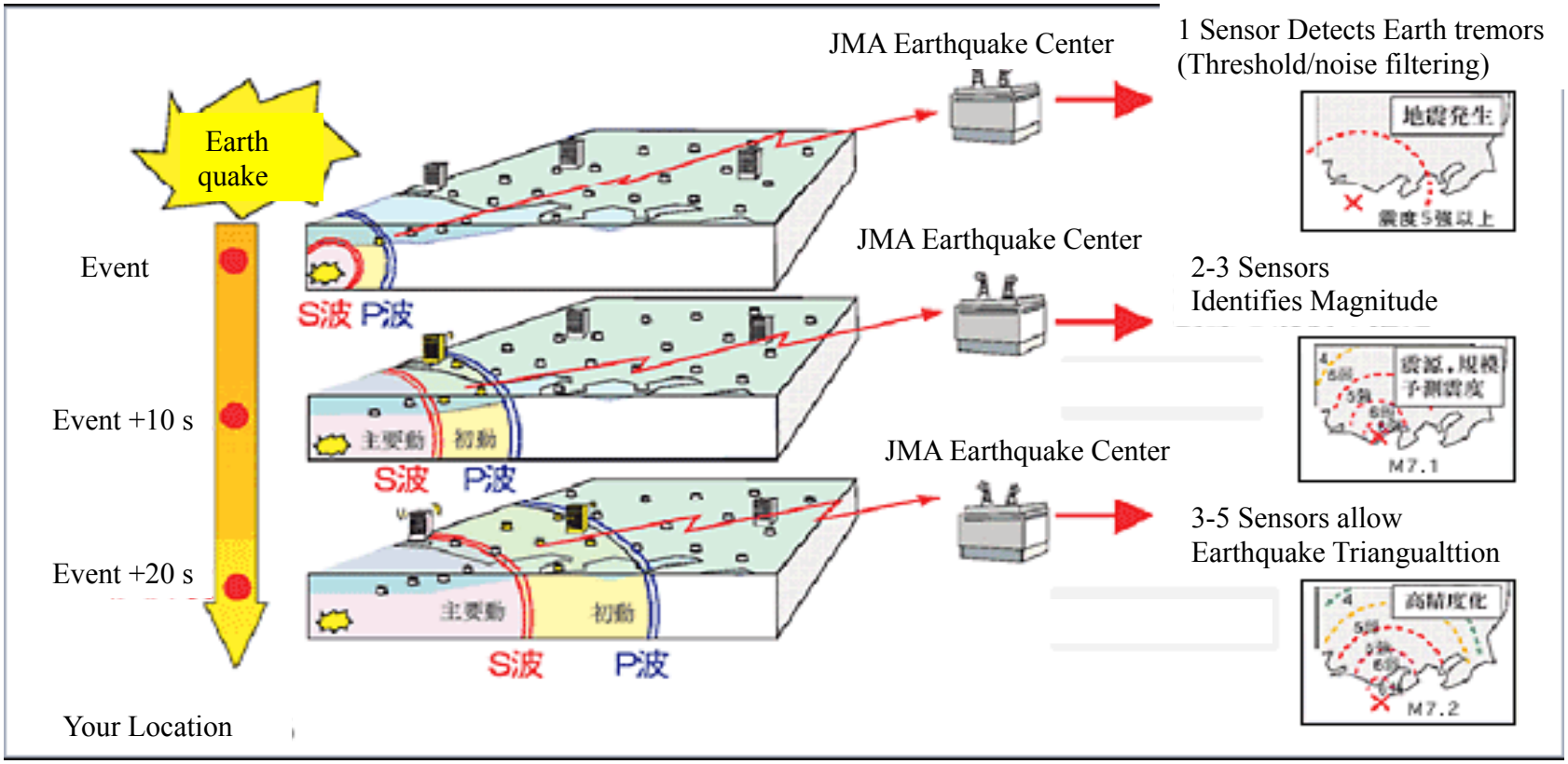
NTT's FLETS Hikari Next network (aka the NGN) is a closed IPv6 network. Here are the primary reasons that IPv6 was used instead of IPv4.

1. Scalability for a large number of always-on customers.
   - Basically infinite address space.
   - Each customer is routed a /48 (2^16 64 bit subnets)
2. End to end IP address transparency
   - Customers have unique IP address, which simplifies applications like VoIP, multicast (used in IPTV and EQ warning system) and P2P applications.
3. Lower capital and operational expense.
   - Simple, hierarchical network configuration.
4. Multicast enabled and QoS support.
   - The NGN uses multicast and QoS to support the applications that run over it. IPv6 offers a number of enhancements in these areas.
5. The NGN network is a closed network and built from scratch.
   - The designers had a clean slate and selected the best protocol.
   - Why would you not use the next generation of the IP protocol - IPv6!

Earthquake Warning Alert System

- Earthquake wave consists of two waves:
  - P: comes first, with less energy
  - S: comes later, with massive energy
- Japan Meteorological Agency has 1000+ sensors all over Japan
- Detection of the P-wave by sensors are processed at the JMA's server which identifies the probable epicenter, magnitude, and direction of wavefront travel within 2 seconds
- A partnership of NTT Communications with Halex Corp. and VAL Lab in Japan, connects our IPv6 network, information distribution server and receipt software to JMA's server so that the earthquake warning information can be distributed BEFORE the MASSIVE ENERGY hits the people, buildings and city/ community infrastructure
- This system can be developed to initiate automated fire-suppression system, to automatically stop elevators, close natural gas and petroleum pipeline valves, etc.
- Makes use of the IPv6 Internet and Multicast.
- Commercially launched July 1, 2007

Earthquake Warning Alert System

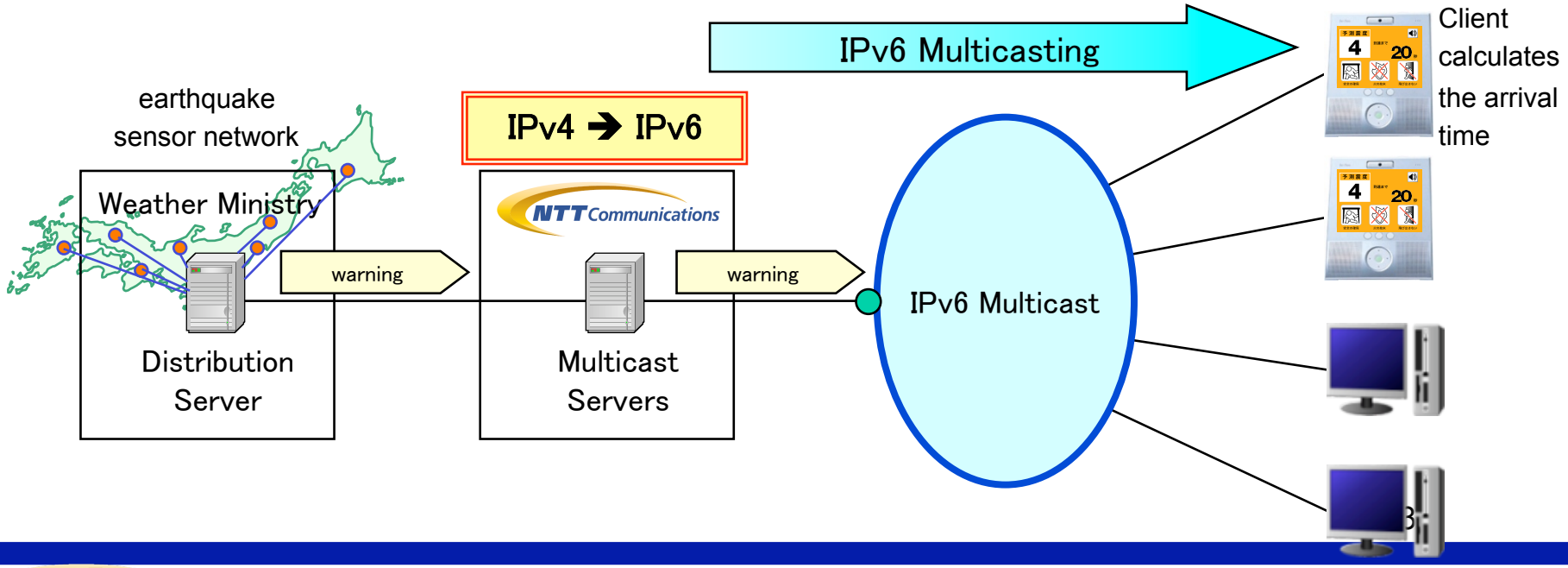


Earthquake Warning Alert System

Normal status

The system provides a warning via an IPv6 multicast network before the earthquake arrives.

Warning Notification



Earthquake Warning Alert System

Reaching People

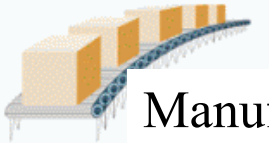
Broadcast Media

At Work

Landline/Celluar Telecommunications

At Home

Construction/ Service



Manufacturing

At School

Elevators

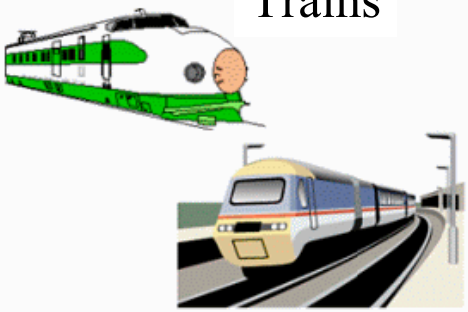
Public Utilities

Application examples from the HP of Japan Meteorological Agency

Earthquake Warning Alert System

Potential Applications

Trains

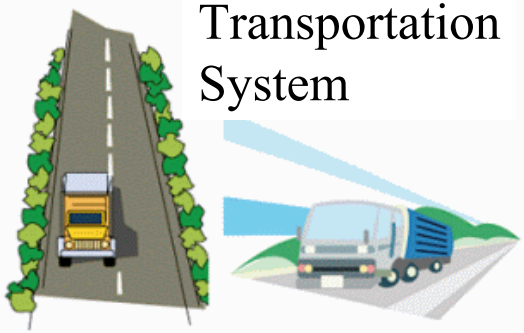


Tsunami Barrier

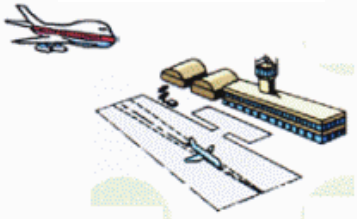
Wide Area Broadcast

Traffic Signaling System

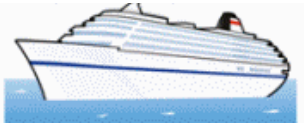
Intelligent Transportation System



Airports



Cruise Liners



Application examples from the HP of Japan Meteorological Agency

NTT's IPv6 Microsite: http://v6atwork.com

Questions - cody@us.ntt.net