IPv6 in Global Networks

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November 19, 2008

- # Who is NTT?
- # Our Network Overview
  - ## IPv6/IPv4 Dual Stack Backbone
  - ## Our 5 Years Experience with Dual Stack
- # What is Happening Today?
  - ## IPv4 Depletion
  - ## Initiatives in Japan
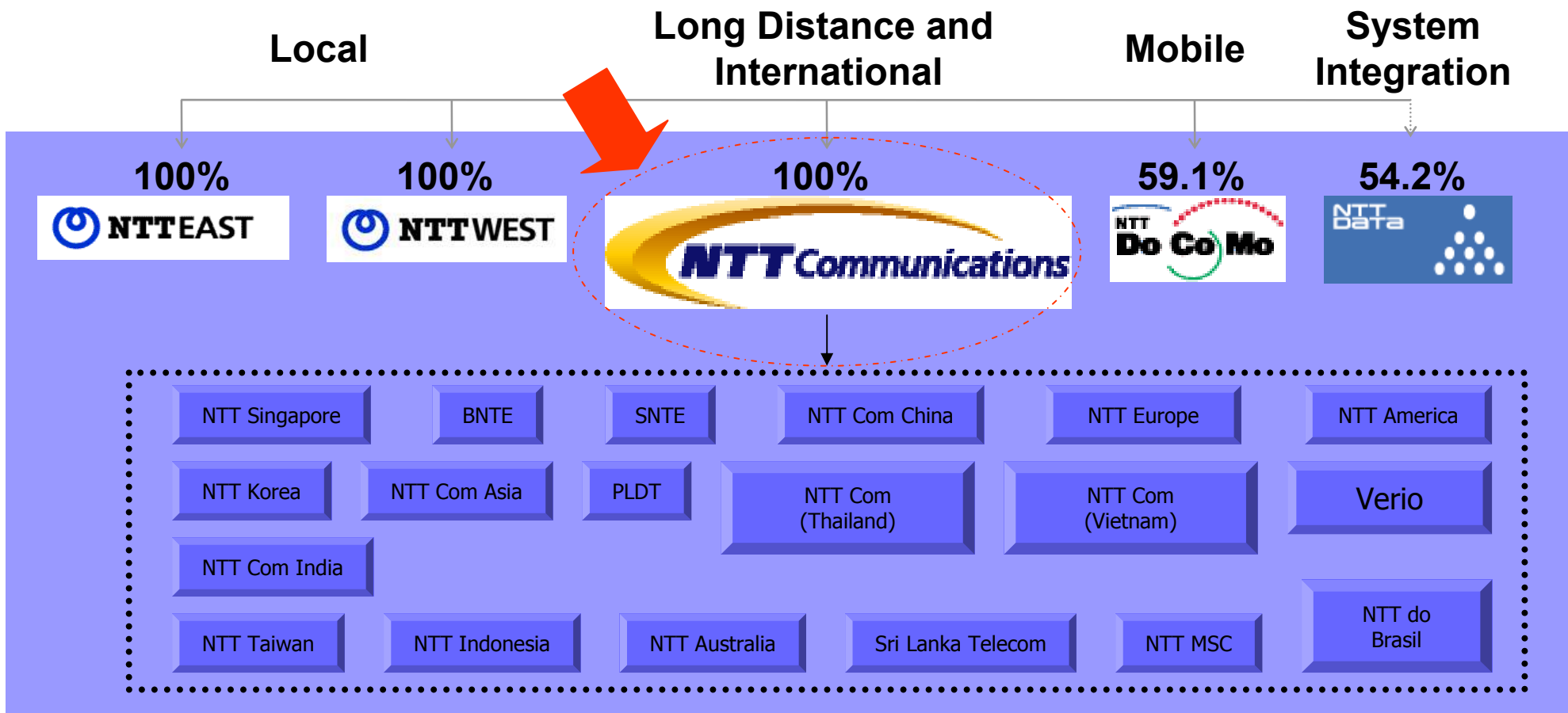- # Products and Services Offered by NTT over IPv6
- # Summary and Conclusion

Who is NTT?

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Who are we?

Operating Revenue	US$ 89.0 billion
Net Income	US$ 5.3billion
Employees	193,850

As of Mar 31, 2008 US$=¥120

Local   **Long Distance and International**   **Mobile**   **System Integration**

100%   **100%**   **100%**   **59.1%**   **54.2%**

NTT EAST   NTT WEST   NTT Communications   Do Co Mo   NTT DaTa

NTT Singapore	BNTE	SNTE	NTT Com China	NTT Europe	NTT America
NTT Korea	NTT Com Asia	PLDT	NTT Com (Thailand)	NTT Com (Vietnam)	Verio
NTT Com India					
NTT Taiwan	NTT Indonesia	NTT Australia	Sri Lanka Telecom	NTT MSC	NTT do Brasil

Corporate Statistics of NTT Communications
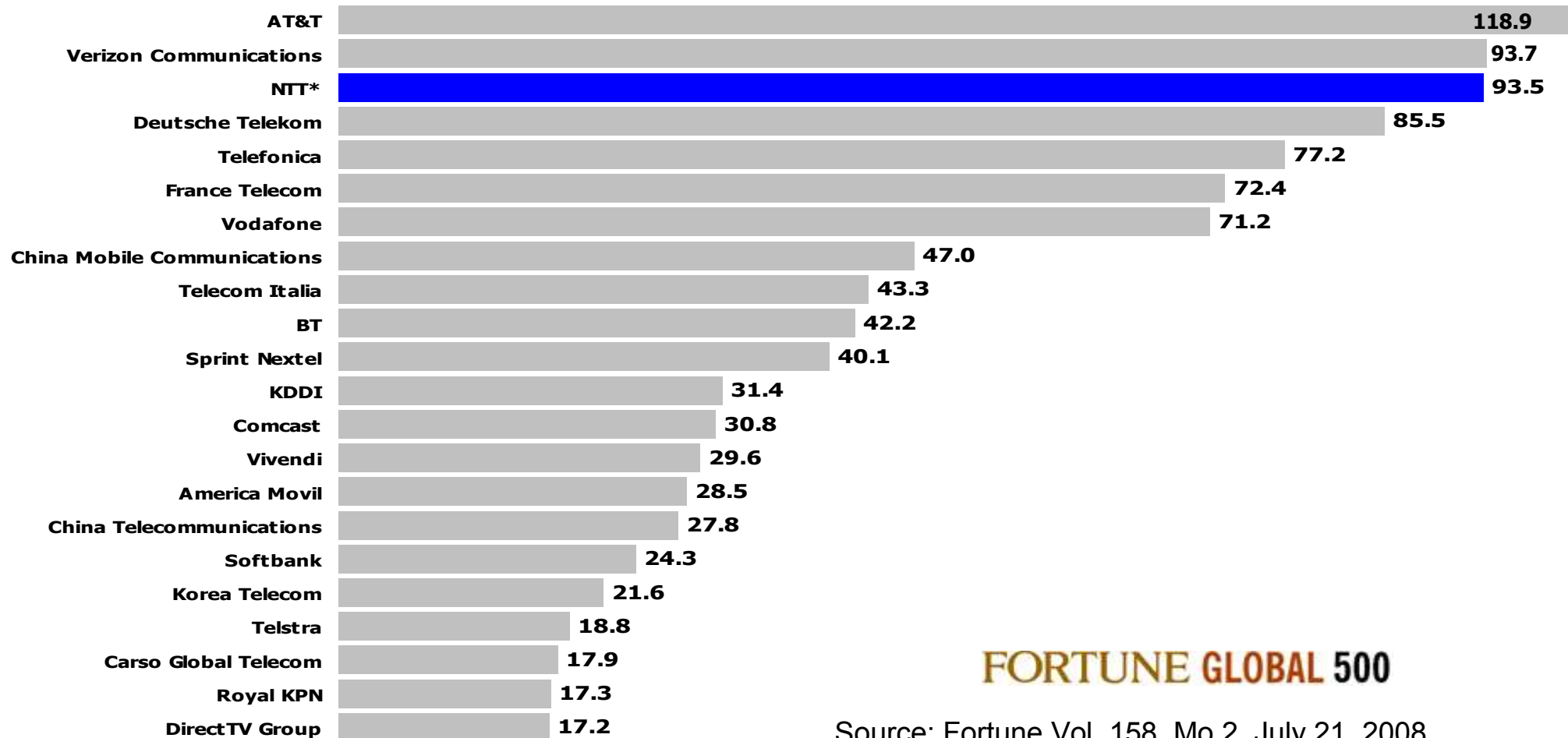
- **Company Name**   **NTT Communications Corporation**

- **Established Date**   **July 1, 1999**
  (As a 100% subsidiary of NTT)

- **Employees**   **8,650 (as of June 30, 2008)**

- **Subsidiaries and**   **85**
  Affiliated Companies

- **Capital**   **US $ 1.76 billion ***

- **Operating Revenue**   **US $ 9.60 billion***

- **Net Income**   **US $ 0.5 billion***

- **Business**   **Long Domestic Distance**
                                      / International (Voice/Data),
                                      IP Services, System Integration
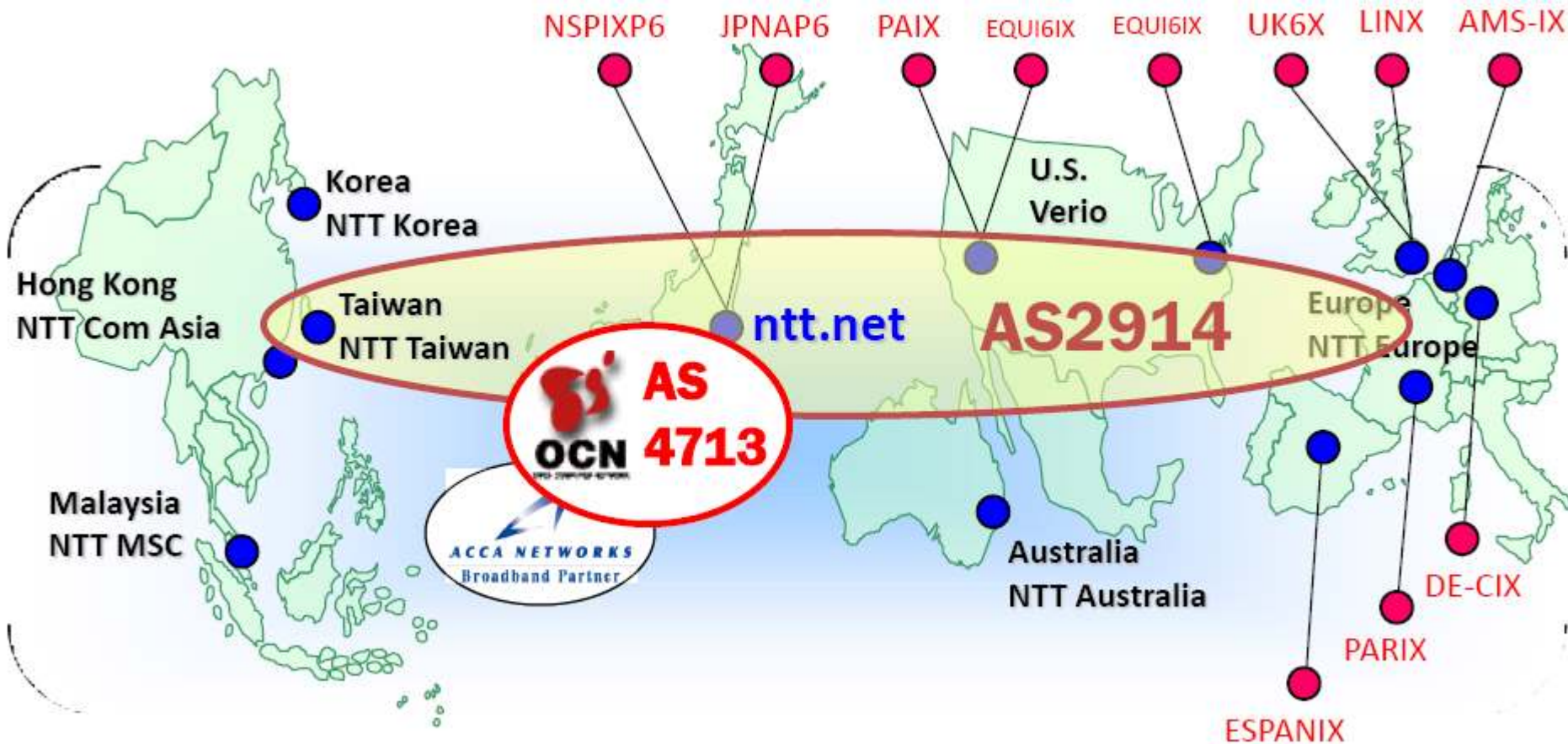
**as of fiscal year ended March 31, 2008 (rate: US$= ¥120)*

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Who is NTT?

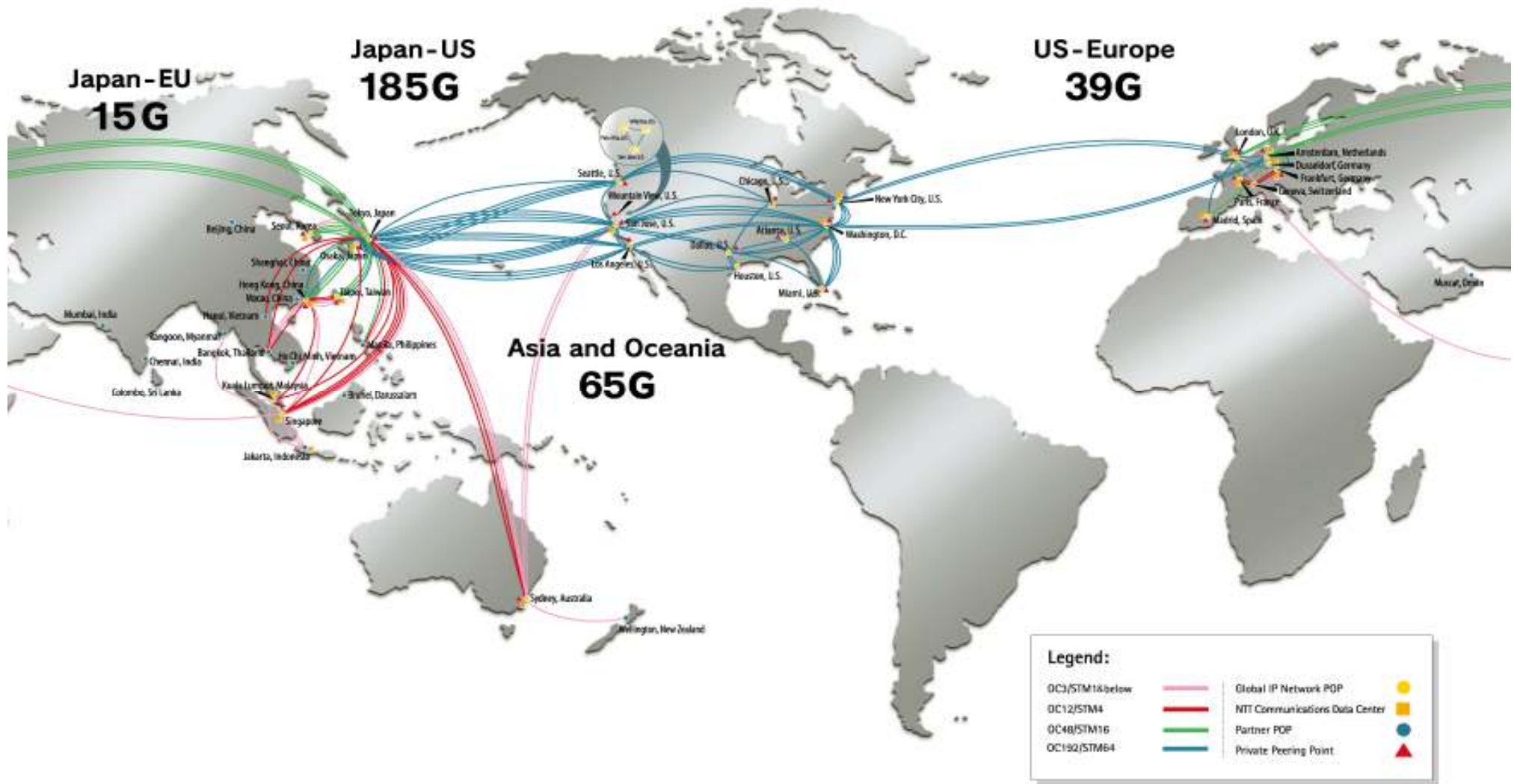## World's Top 22 Telecom Companies by Revenue ($US Billion)

Company	Revenue
AT&T	118.9
Verizon Communications	93.7
NTT*	93.5
Deutsche Telekom	85.5
Telefonica	77.2
France Telecom	72.4
Vodafone	71.2
China Mobile Communications	47.0
Telecom Italia	43.3
BT	42.2
Sprint Nextel	40.1
KDDI	31.4
Comcast	30.8
Vivendi	29.6
America Movil	28.5
China Telecommunications	27.8
Softbank	24.3
Korea Telecom	21.6
Telstra	18.8
Carso Global Telecom	17.9
Royal KPN	17.3
DirectTV Group	17.2

FORTUNE GLOBAL 500

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

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Our Network Overview

AS2914 （GIN）： Global Internet Backbone
AS4713 （OCN）： Japanese Domestic Internet Backbone

NTT Communications Global IP Network
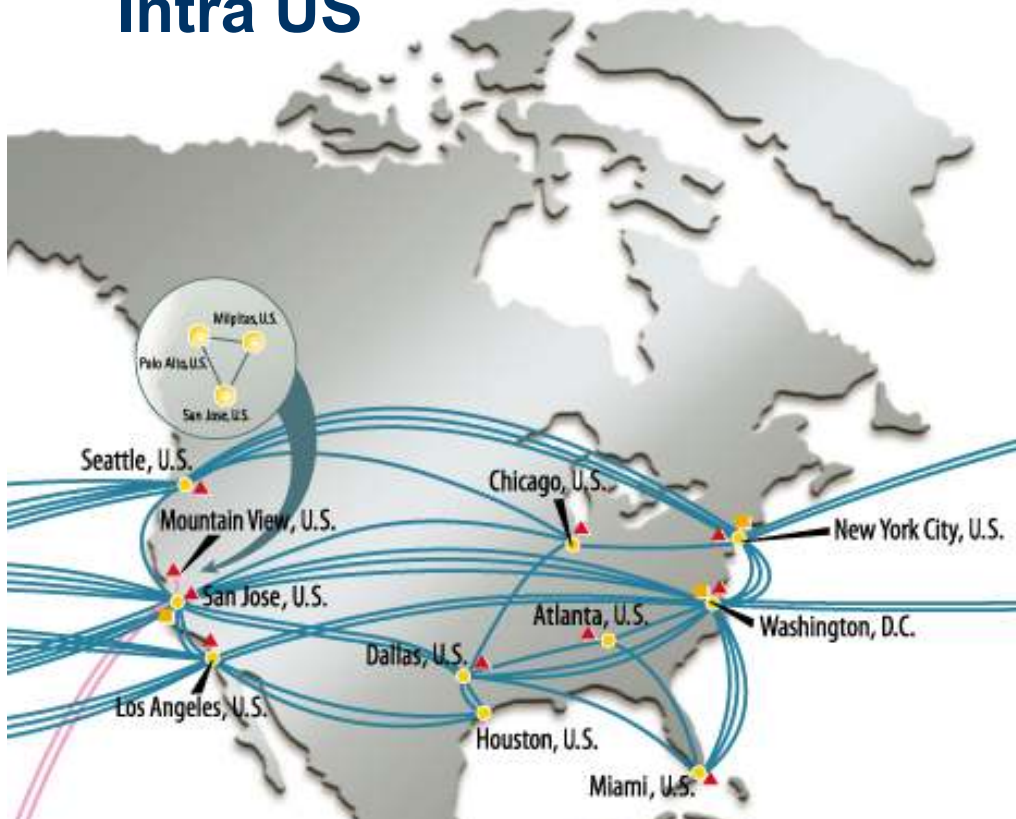
Asia and Oceania

65G

Connectivity from GIN backbone to major Asian countries & regions
China: **21.0 Gbps**
Hong Kong: **26.7 Gbps**
Taiwan: **14.6 Gbps**
Korea: **10.0 Gbps**

(as of April 2007)

Legend:
OC3&below/STM1		Global IP Network POP	● (yellow)
OC12/STM4		NTT Communications Data Center	■ (yellow)
OC48/STM16		Partner Data Center	■ (blue)
OC192/STM64		Partner POP	● (blue)
		Private Peering Point	▲ (red)

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ntt.net

Intra US

Legend:

OC3&below/STM1	——	Global IP Network POP	● (yellow)
OC12/STM4	——	NTT Communications Data Center	■ (orange)
OC48/STM16	——	Partner Data Center	■ (blue)
OC192/STM64	——	Partner POP	● (blue)
		Private Peering Point	▲ (red)

Intra Europe

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NTT's History and IPv6

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 worlds first IPv6 connectivity services on a commercial basis

2002: World Communications Awards (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 Awards "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

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NTT Communications IPv6/IPv4 Dual Stack Backbone

NTT Communications Global IP Backbone

HK6IX NSPIXP6 JPNAP6 PAIX EQUI6IX EQUI6IX ESPANIX PARIX UK6X LINX AMS-IX DE-CIX

Korea

Taiwan

Hong Kong

Malaysia

Singapore

Japan

Australia

The U.S.
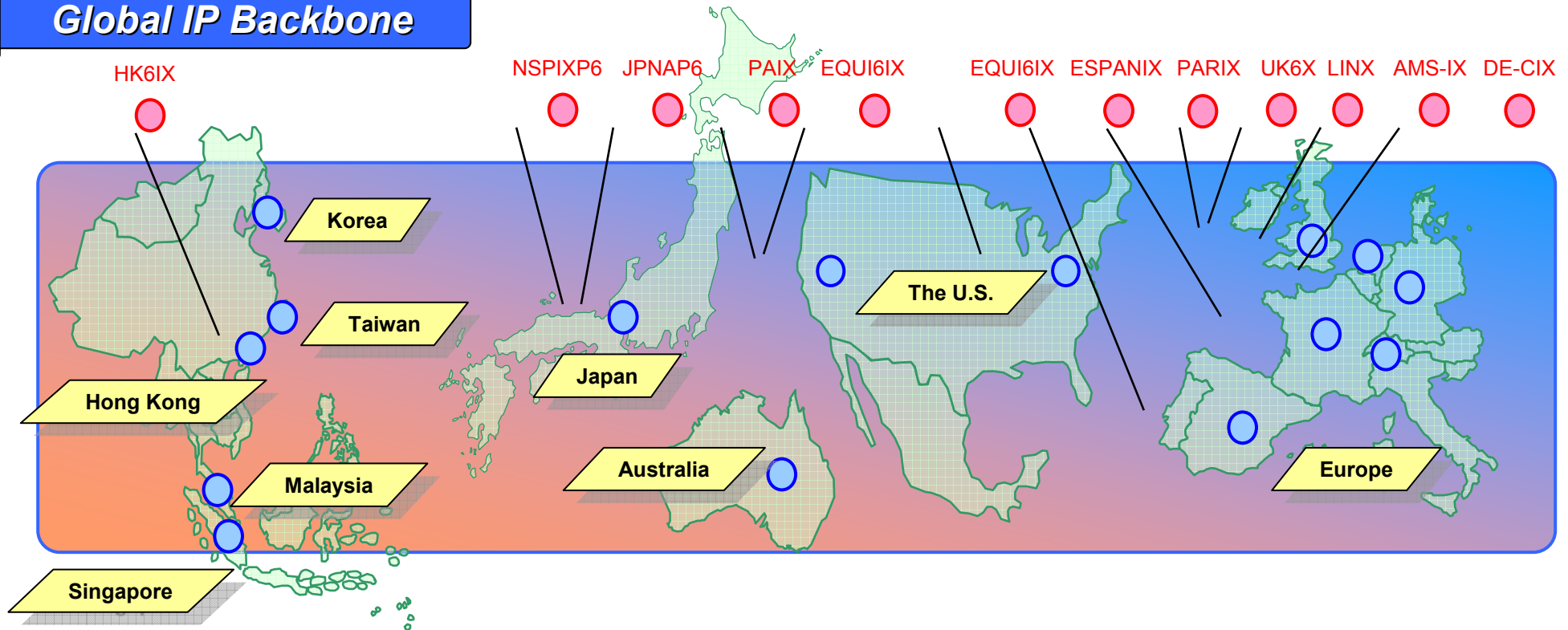
Europe

Our Strength

- IPv6/IPv4 dual stack backbone
- Global IPv6 networks covering Asia, US, Europe
- Worldwide IPv6-IX Connectivity

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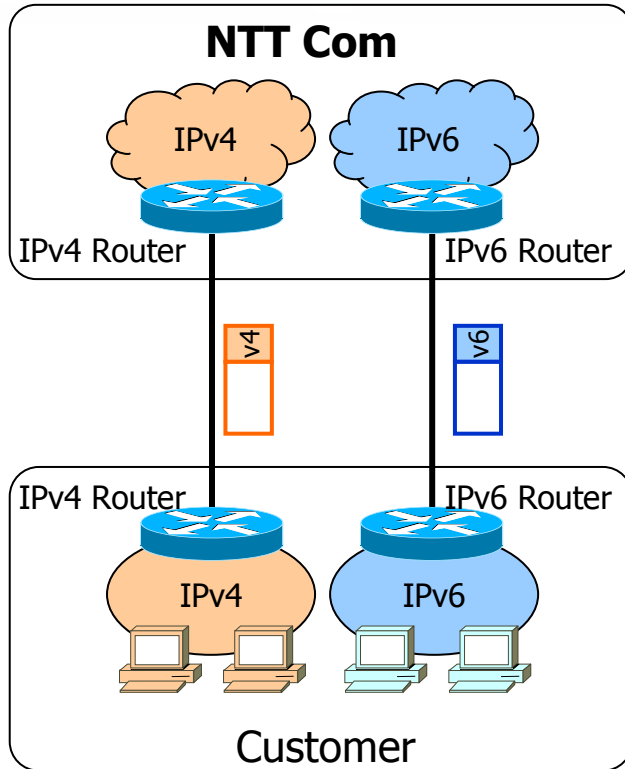
IPv6 Native Service

Provides customers IPv6 network transit service globally by connecting directly to the Global IP Network through IPv6 Protocol.
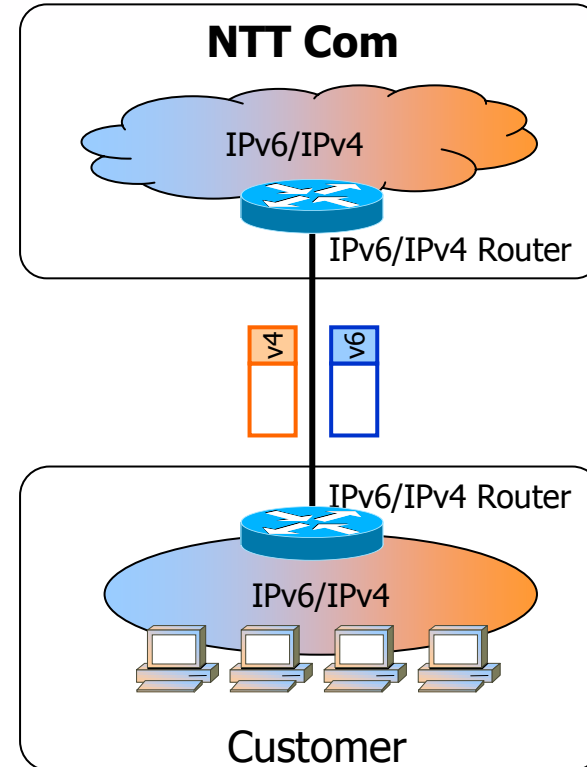
IPv6/IPv4 Dual Service

Provides both IPv6 and IPv4 connectivity to the Global IP Network using only one access circuit.

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IPv6/IPv4 Dual Service

NTT Communications

IPv6 / IPv4

IPv6/IPv4 router

v6   v4

Customer   IPv6/IPv4 router
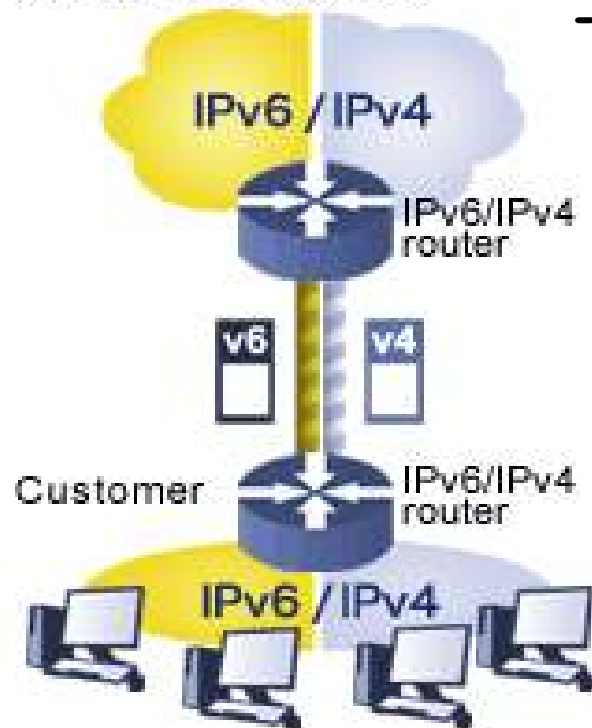
IPv6 / IPv4

IPv6/IPv4 Dual Stack Backbone has shown a good performance without any critical problems so far.
- core routers / routing protocols generally look good enough to handle current IPv6 traffic.

But still, we have some operational difficulties:

- stats tools are not available on IPv6 environment
   IPv6 MIB support, SNMP over IPv6 support ...
- IPv6-enabled irrd/whois have been released, but poor performance yet...
- There are only few collectors which are capable of netflow v9

For future IPv6 traffic engineering, we need RSVP-TE for IPv6 and LDP for IPv6

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IPv6 INTERNET
TOPOLOGY MAP 2008
AS-level INTERNET GRAPH
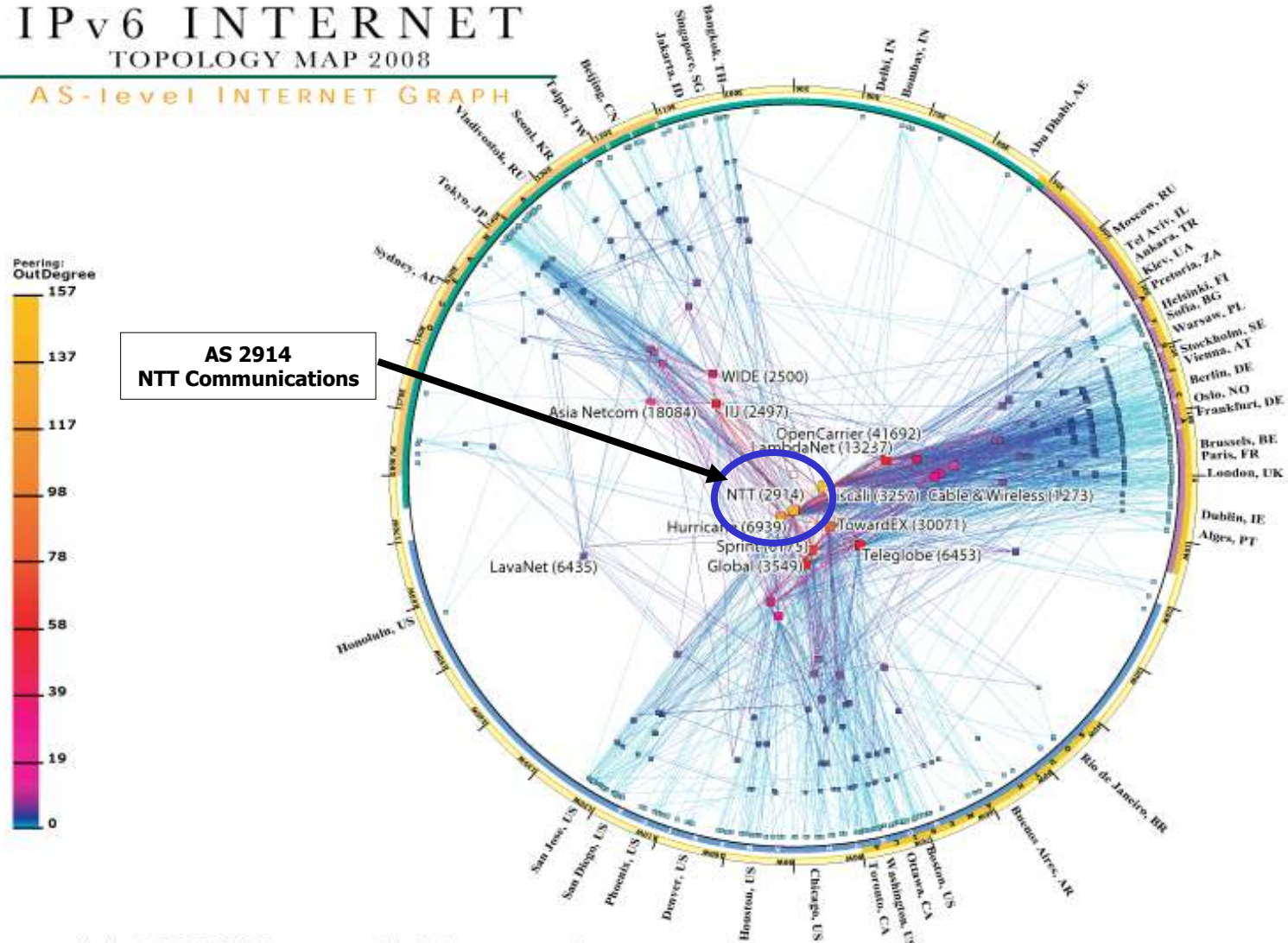
AS 2914
NTT Communications

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captured on 17th Nov, 2007
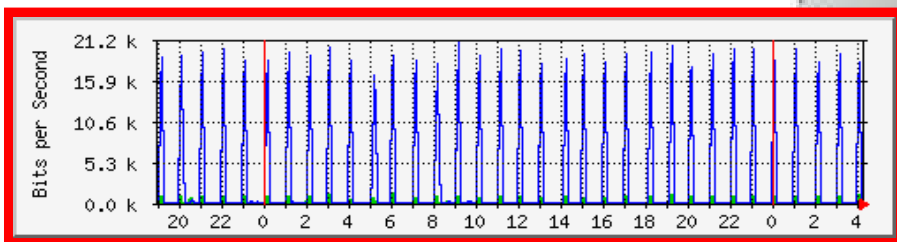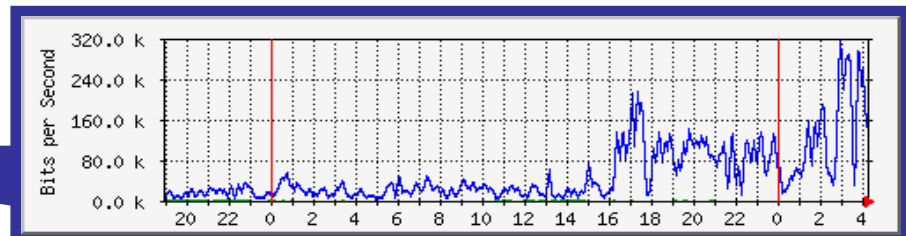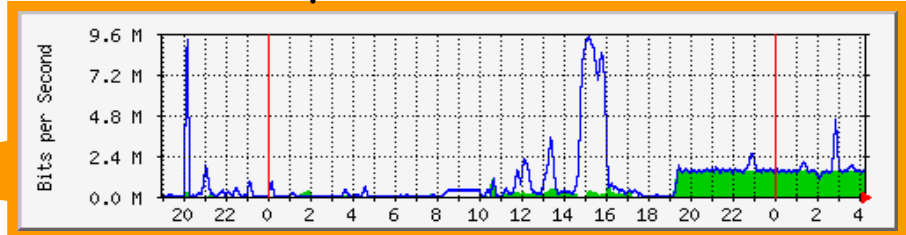
What Is Happening Today?

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–IPv4 Addresses: *4,294,967,296*
–World's Population: *about 6,300,000,000*
–IPv6 Addresses: *340,282,366,920,938,463,463,374,607,431,768,211,456*

Address Abundance: Comparative Examples

（IPv4）A Bucket Full of Sand
（IPv6）Sand Volume Equivalent to the Sun

（IPv4）1mm in Length
（IPv6）84,000 Times Wider than the Diameter of the Galaxy

IPv6 realizes a wide variety of applications and services in a simple and scalable manner with no concerns of IP address limitations or depletion

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IPv4 Address Exhaustion

The IPv4 address pool is expected to be run out around 2010, according to the most reliable predictions.

-After 2010, ISP cannot have new customer and enterprise system cannot be expanded on the current system.
-ISPs system engineers have to consider the impact on their business from now.

Prediction of exhaustion date by Geoff Huston APNIC
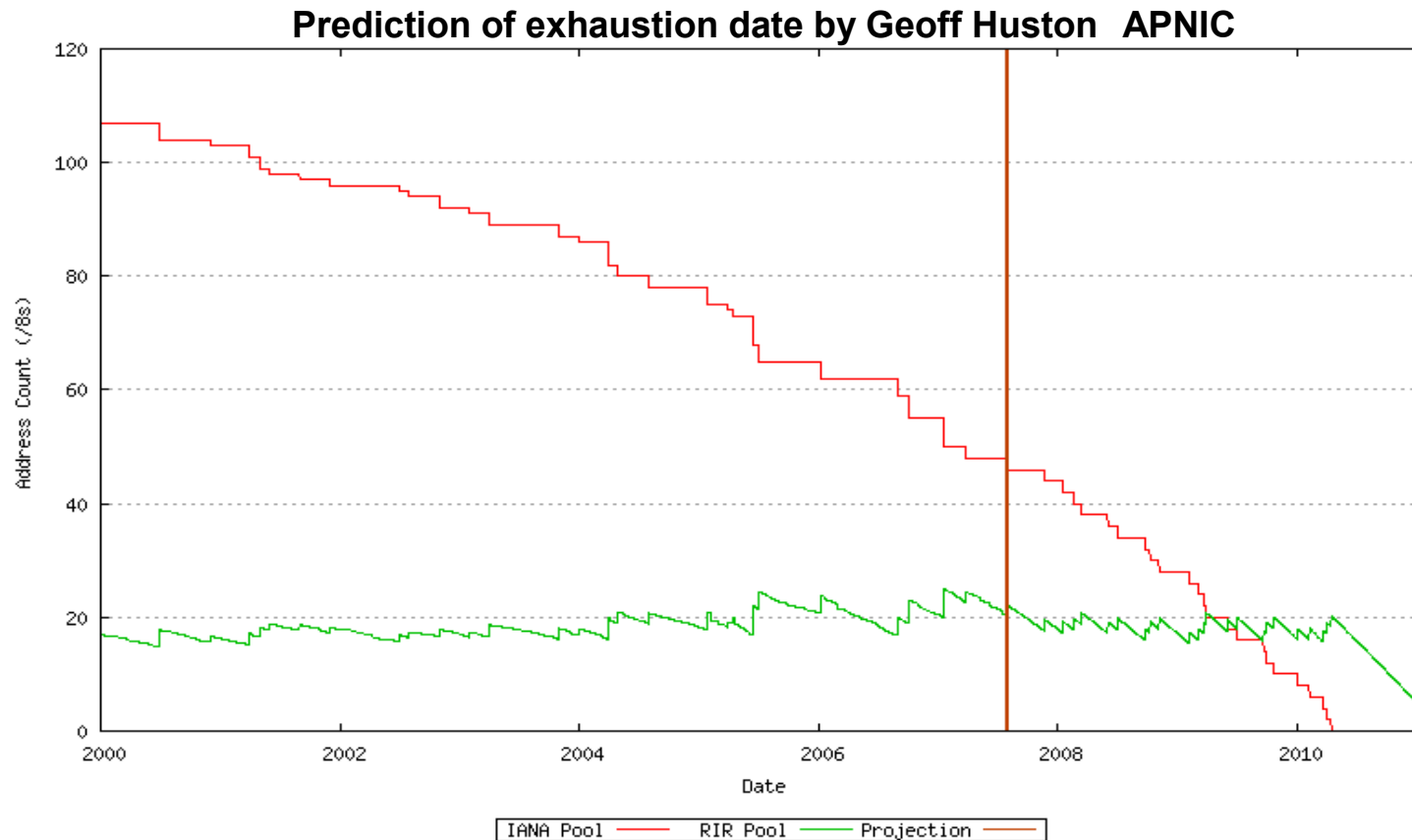
The red line indicates the number of /8 address blocks remaining in the IANA free pool.
The green line indicates the number of /8 address blocks available in RIR free address pools.
The vertical line indicates today.

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IPv4 Address Depletion Forecast

- According to a study by the Ministry of Internal Affairs and Communications…
  - IANA Pool will be gone between mid 2010 and early 2012
  - IPv4 address cannot be supplemented between early 2011 and mid 2013
- According to a study by JPNIC…
  - APNIC/JPNIC inventory depletion will happen between 2010 and 2011

IP Blocks not allocated as of May 1, 2008 =➜ 41
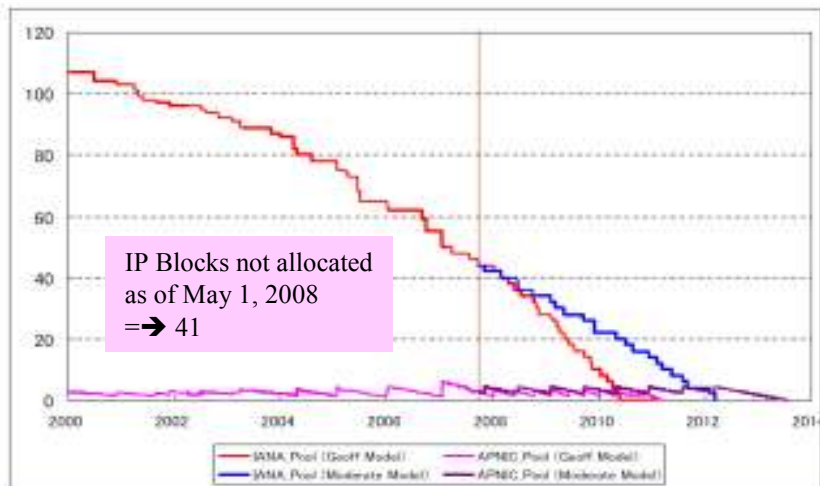
Graph from study by MIC (Oct 16, 2007)

分配可能な /8(x1)の上限数（220）
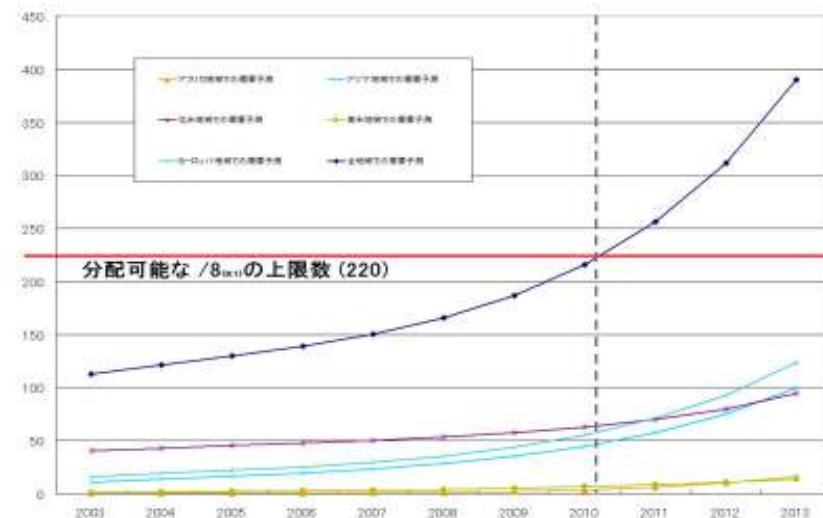
Graph from study by JPNIC (Dec 7, 2007)

JPNIC's approach to IPv4 depletion

JPNIC has started to work on and evaluate concrete measures with organized efforts internally and externally.

• Address Management Policy Evaluation WG has been organized under experts' and executive guidance, and submitted its distribution policy proposal to APNIC.

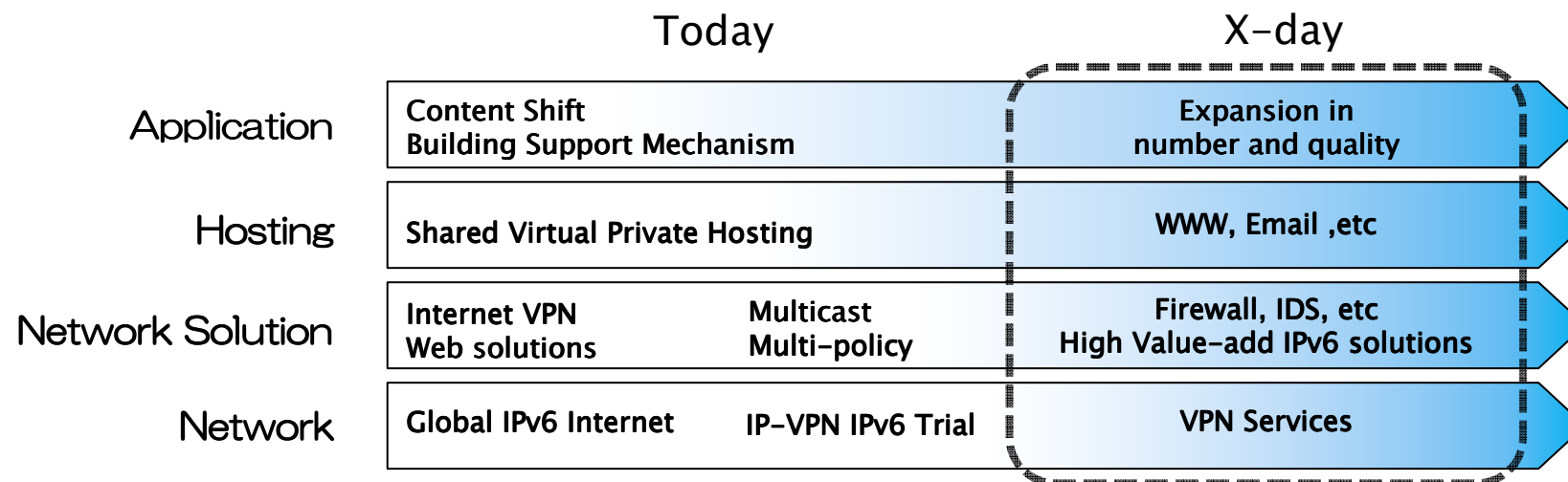"Distribute a single /8 to each RIR at the point when new IANA free pool hits 5*/8"

• Countermeasures for IPv4 Address Inventory Depletion WG has also been organized. It evaluates countermeasures against IPv4 exhaustion on technical standpoint, and expected impact to IPv4 business.

- • How to migrate IPv4 to IPv6 ?
    - IPv4/IPv6 translation ?
- • How to continue IPv4 business with limited number of Address ?
   - private IPv4 address with NAT ?

- **This will impact many services**
- **We all need to be IPv6 ready by the time IPv4 address is gone**
- **In the meantime, people will still use IPv4 after depletion, and there will be a need to maintain existing services with both IPv4 and IPv6**

NTT Communications Current Activities

	Today	X-day
Application	Content Shift Building Support Mechanism	Expansion in number and quality
Hosting	Shared Virtual Private Hosting	WWW, Email ,etc
Network Solution	Internet VPN Multicast Web solutions Multi-policy	Firewall, IDS, etc High Value-add IPv6 solutions
Network	Global IPv6 Internet IP-VPN IPv6 Trial	VPN Services

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Major Issues in the Internet after IPv4 Address Depletion

· no interconnection between IPv4 and IPv6 with client-server model with only IPv6 address
· therefore, people who need to connect between IPv4 and IPv6 need a translator in between
· but, there is no good translator available in the market, and there are discussion on who
  prepares those translators

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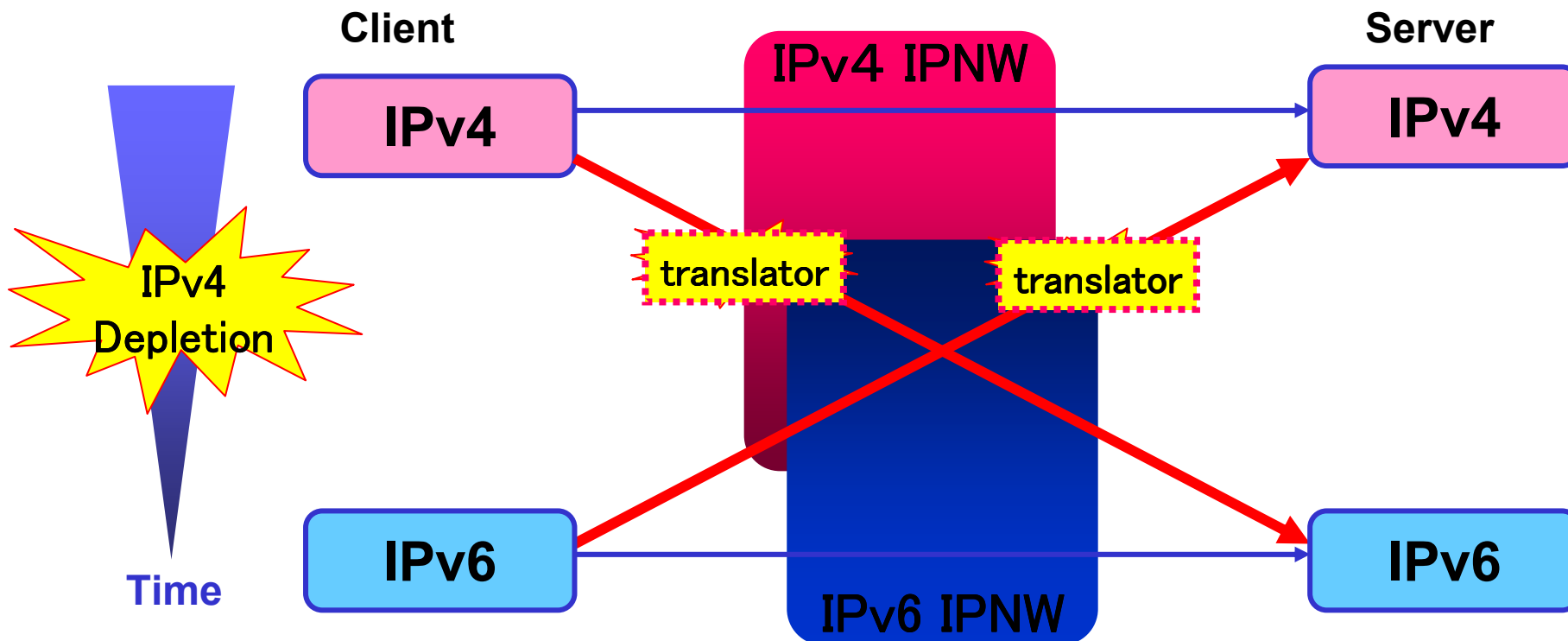
IPv6 Products and Services from NTT

✓Launched in December 2005

✓IPv6 Tunneling Service over IPv4 based on L2TP

✓Fixed IP address and non-fixed IP address to be given
  (Prefix for subnet: /64)

✓Original tunneling software provided for subscribers
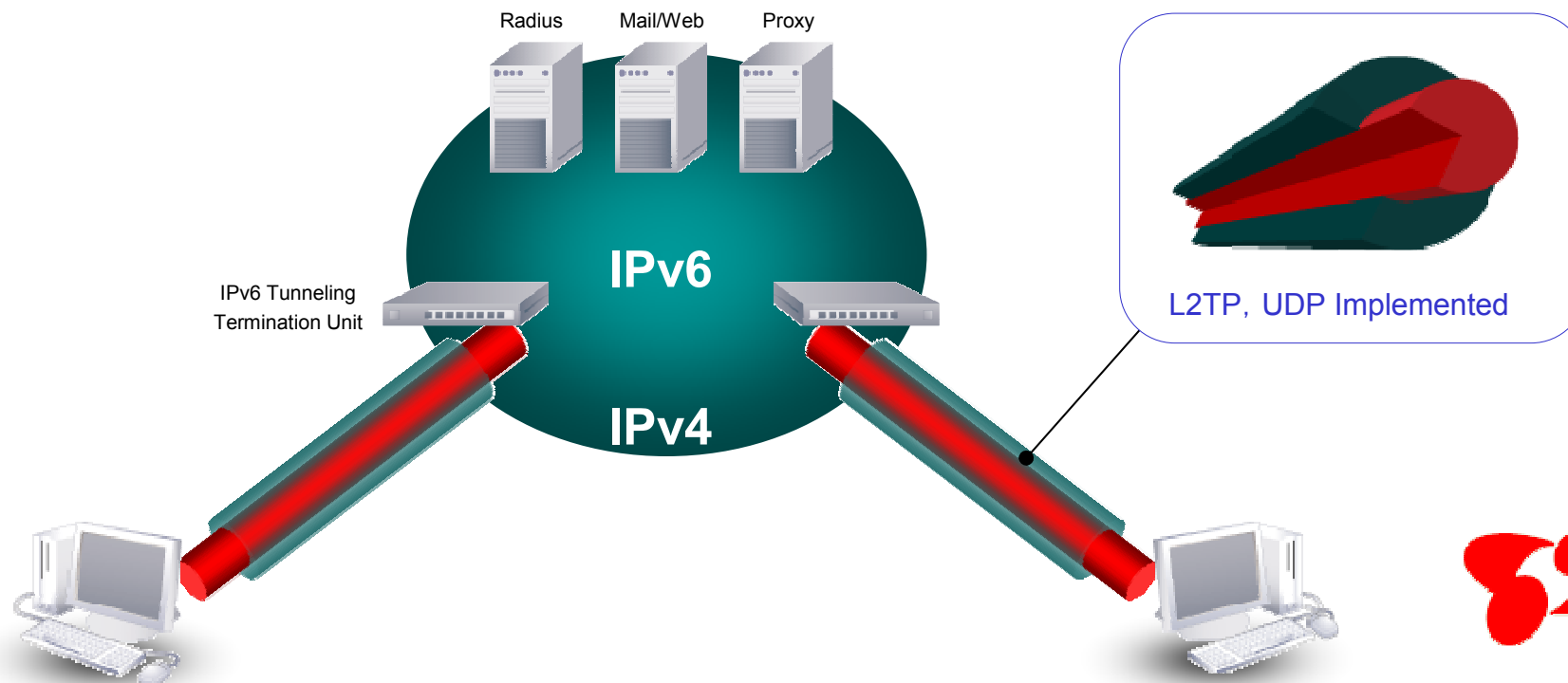
Radius   Mail/Web   Proxy

IPv6

IPv6 Tunneling
Termination Unit

L2TP, UDP Implemented

IPv4

OCN

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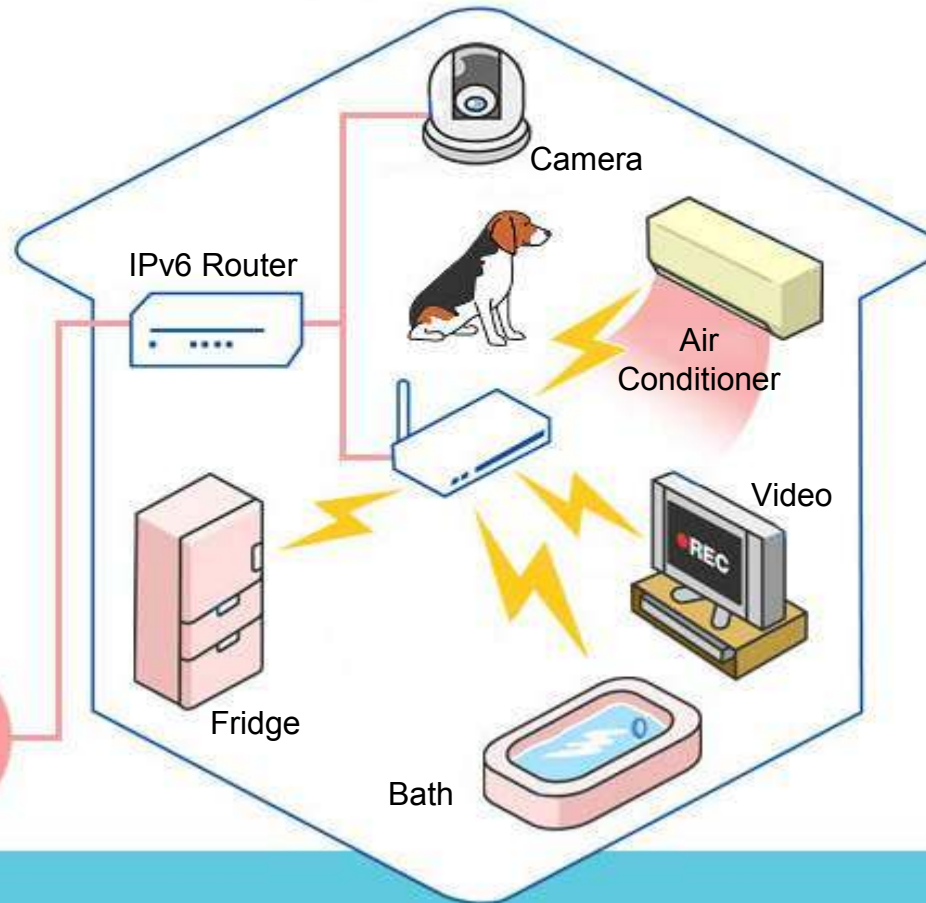
OCN IPv6 has an option to control IPv6 devices using non-native consoles such as mobile phones or PDAs
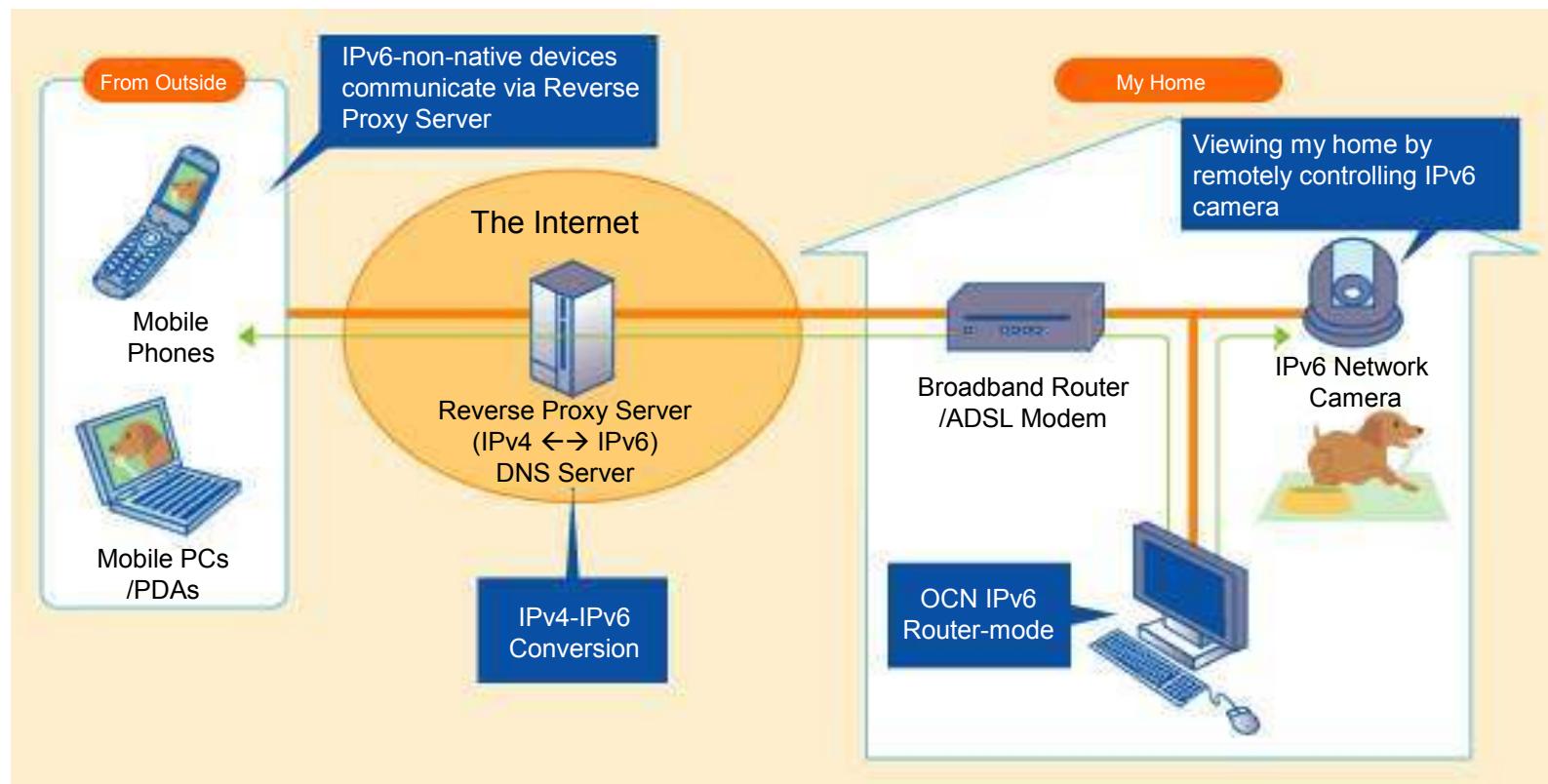
OCN IPv6 Mobile: Control Panel

Managed by Web Interface

- ## Rev-Proxy
  - **IPv4/IPv6 Translator**

- ## DNS
  - **IPv6 zone**

- 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.
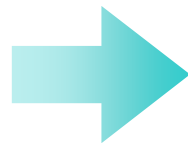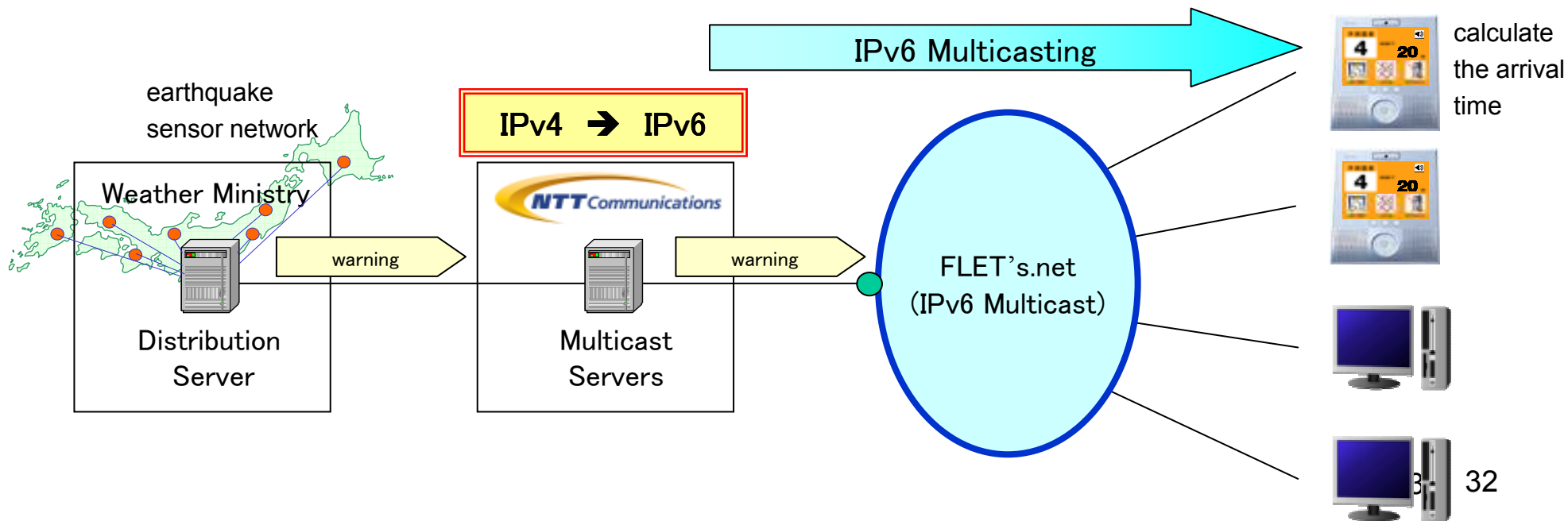- Commercially launched July 1, 2007

30
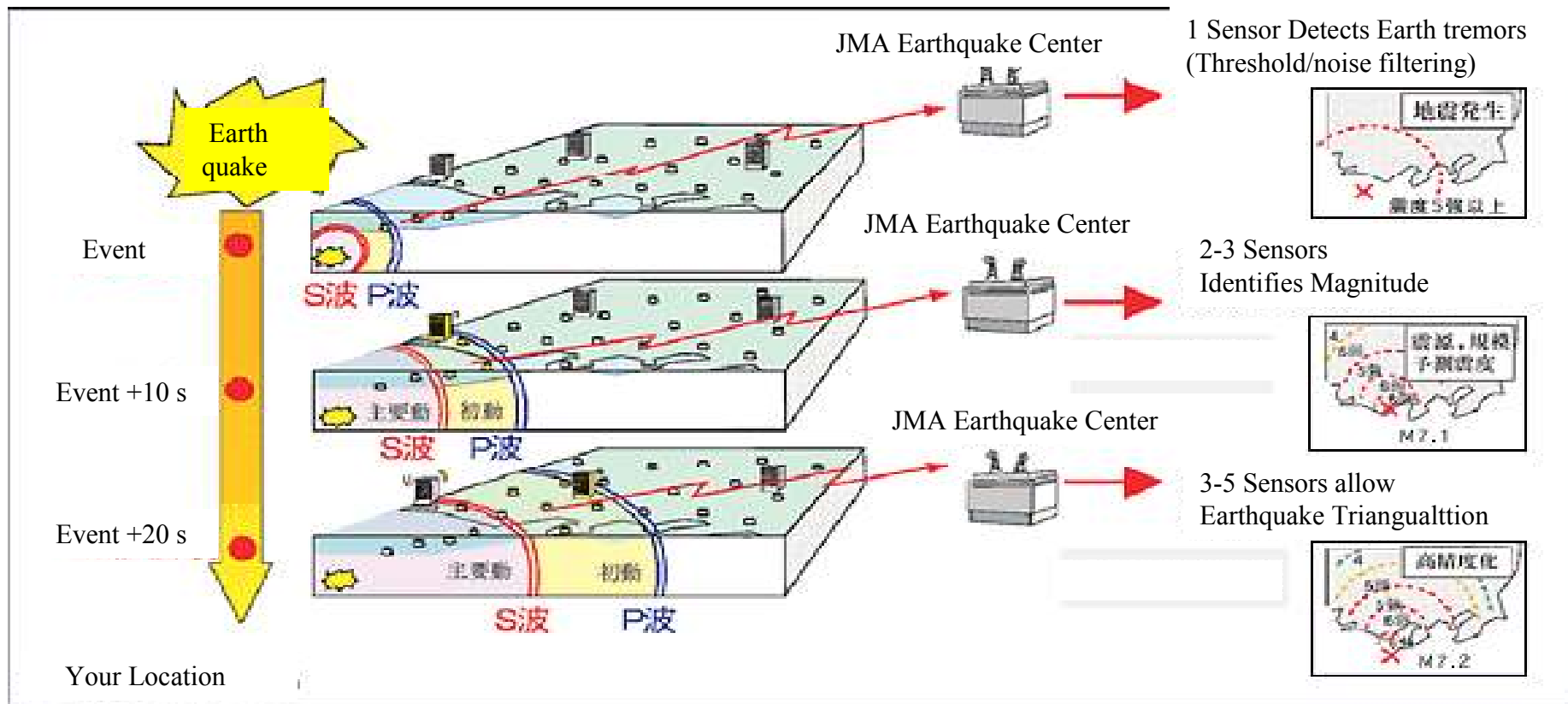
Earthquake warning *system*

Normal status

The system informs the warning via IPv6 multicast network before earthquake arrives.

Informing the Warning

予報震度 6弱 20秒

4 20

IPv6 Multicasting

calculate the arrival time

earthquake sensor network

IPv4 ➔ IPv6

Weather Ministry

NTT Communications

warning

warning

FLET's.net
(IPv6 Multicast)

Distribution Server

Multicast Servers

4 20

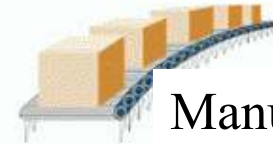4 20

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Reaching People

Broadcast
Media

At Work

Landline/ Celluar
Telecommunications

At Home

Construction/
Service

Manufacturing

At School

Elevators
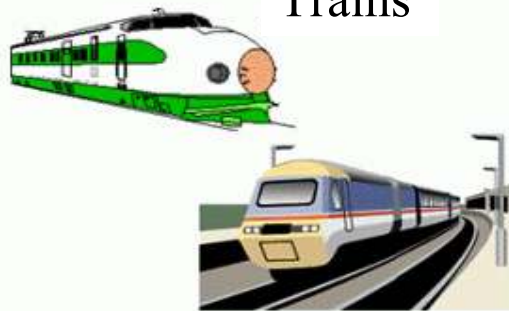
Public Utilities

Application examples from the HP of Japan Meteorological Agency

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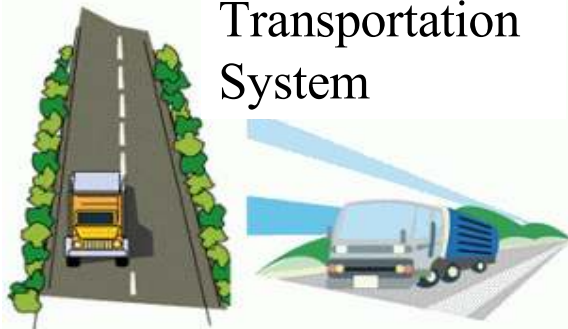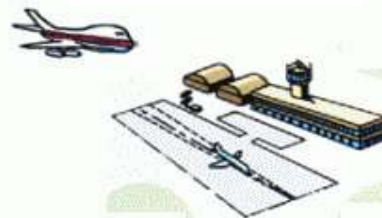# Potential Applications

Trains

Tsunami Barrier

Wide Area Broadcast

Intelligent
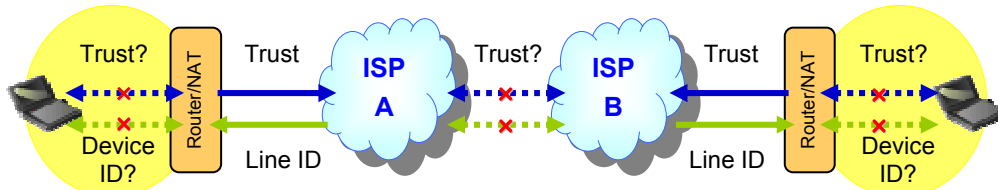Transportation
System

Airports

Traffic Signaling System

Cruse Liners

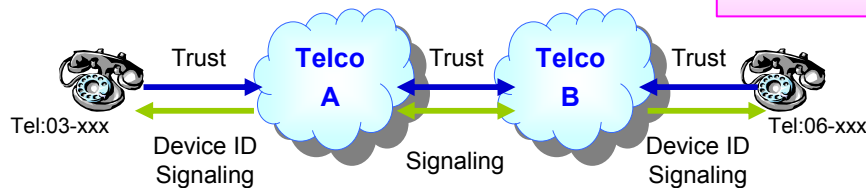Application examples from the HP of Japan Meteorological Agency

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m2m-x : Building an Ultimate Network

The Internet Model

Trust? | Trust | ISP A | Trust? | ISP B | Trust | Trust?
Device ID? | Line ID | | | | Line ID | Device ID?

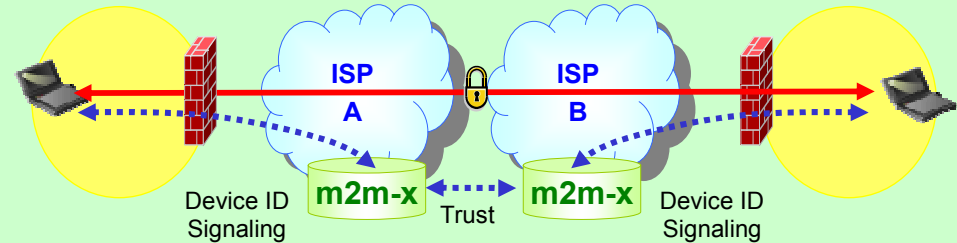| ❌ | Security | Interconnection at Conduit Level |
		Incapable of Blocking Malicious Users
❌	Easiness	Unable to Manage Communication Based on Device IDs not Fully Given and Coordinated
✅	Low Cost	Provision of Conduit + D.I.Y. Work

Sampling from Both Worlds

Telephone Model

Trust | Telco A | Trust | Telco B | Trust
Tel:03-xxx | Device ID Signaling | Signaling | Device ID Signaling | Tel:06-xxx

✅	Security	Interconnection at Signaling Level
		Capable of Blocking Malicious Users
✅	Easiness	Able to Manage Communications by Device ID (Telephone Number) and Signaling
❌	Low Cost	Signaling and Data Channel Exchange Based on Costly Circuit-switch

m2m-x Model

ISP A | ISP B
Device ID Signaling | m2m-x | Trust | m2m-x | Device ID Signaling

✅	Security	Interconnection at Signaling Level
		Capable of Blocking Malicious User
✅	Easiness	Able to Manage Communications by Device ID and Signaling
✅	Low Cost	Lower Cost Achieved Having Data Channel Bypassing the Server

- Secured, easy and low-cost new IP network by "signaling authentication"
- FMC and NGN will also adopt the same architectural philosophy

m2m-x Technology
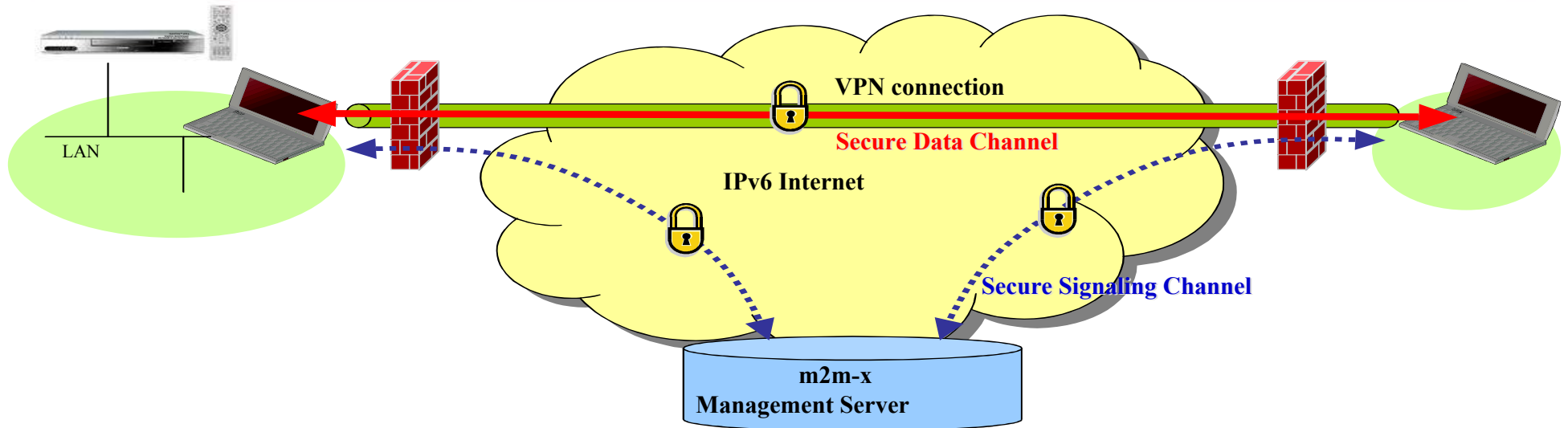
- m2m-x = machine to machine security (authentication and encryption) anytime, anywhere
- Designed to facilitate secure communications between appliances, computers, and any other device
- Based on IPsec and SIP
- Authentication, connection management, and configuration is controlled by a central m2m-x management server
- After necessary connection management by m2m-x server, data communications between devices is conducted peer-to-peer with IPsec encryption with no intervention by the m2m-x server

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m2m-x (Machine to Machine for any[thing|place|time])

m2m-x Management Server

Secure, Easy and Low-priced

Mobile Phone Gateway

IPv6 Internet

Enterprise Network

Home Network
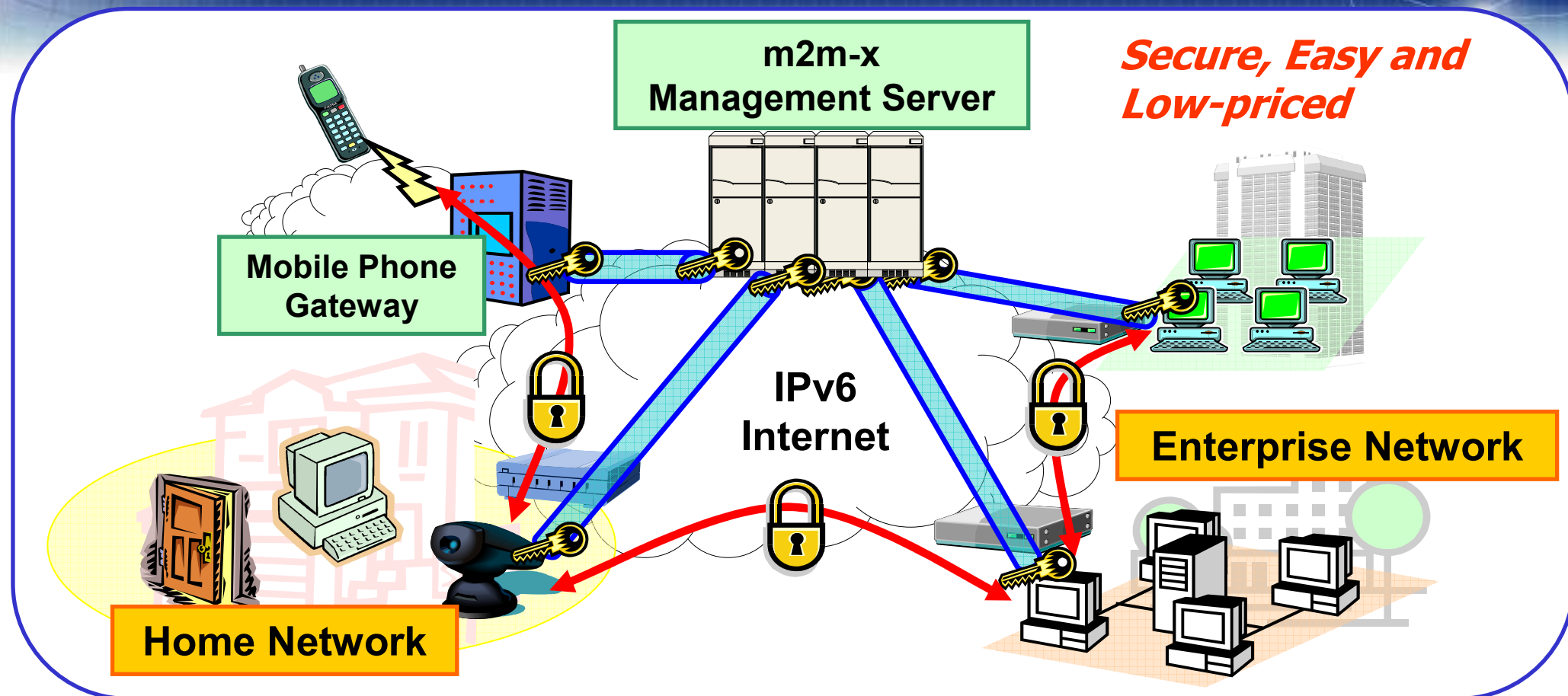
m2m-x Management Server functions:
- *Authentication*
- *Access control*
- *Issuance/distribution of encryption keys*
- *Visible only for authorized peers*
- *Firewall control*

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m2m-x Example: Smart Home Security System

Remote

- Home owner @Mobile
- Home owner @Office
- Security Officer

Mobile Network

GW

m2m-x Management Server **3PCC**

Security Controller **PS**

Home

Camera — Intruder — Sensor

Restricted Area

3PCC: 3rd Party Call Control,
PS: Presence Server
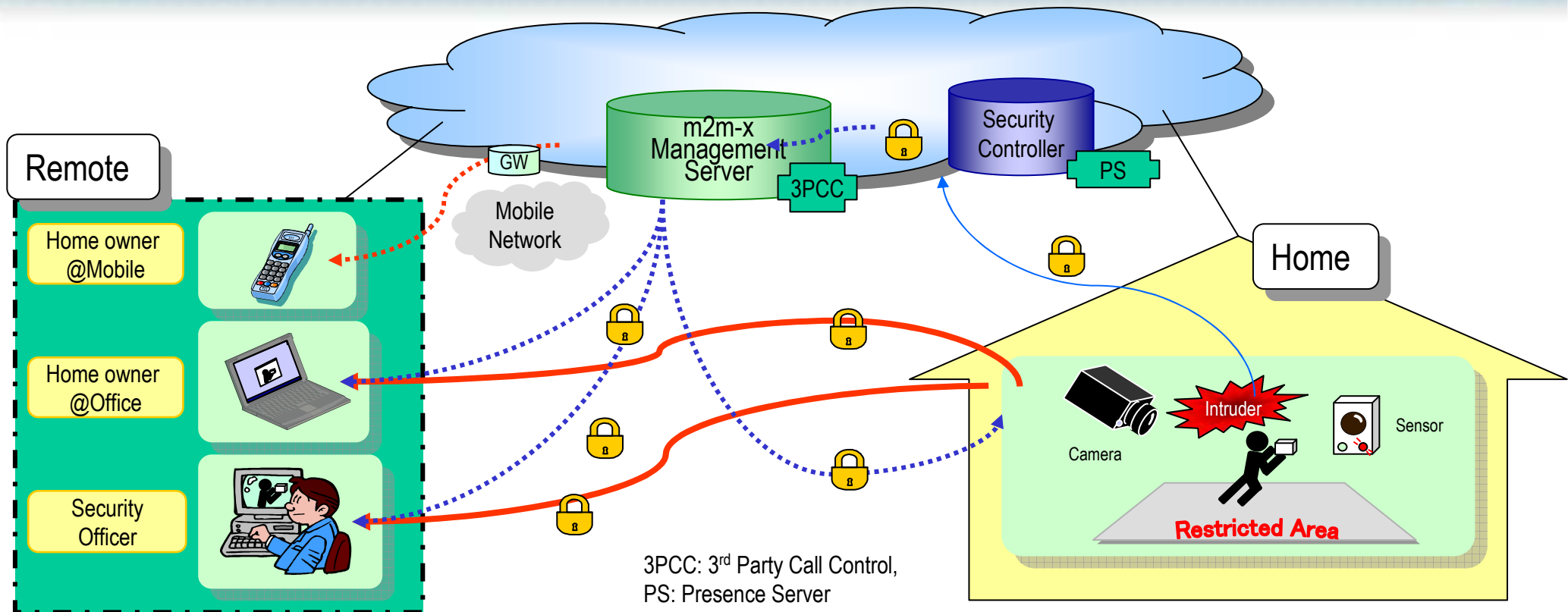
Upon detecting an intruder, the system instantly finds the current location of the authorized watcher (e.g. home owner) and establishes a video connection.

Features: *Secured communication*: m2m-x security   *Strict Authorization*: No third party eavesdropping
        Application Integration: Uses SIP 3PCC for connection establishment
Other Applications: Office-building, Industry, Campus, Home security, Emergency Services, Remote Health Care
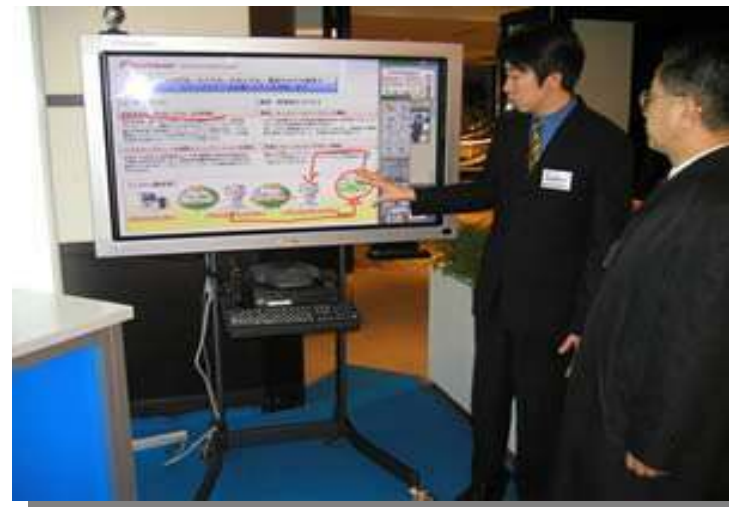
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m2m-x Trials (2004.1Q-)

PlayStation 2 with USB camera

Takara : IP Thread Telephone

Toshiba : Home appliance network

Pioneer : Cyber Conference System

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Sanyo Electric : IPv6 Multimedia Player

Matsushita Electric Works : Home System

Ricoh : Ubiquitous Printing System

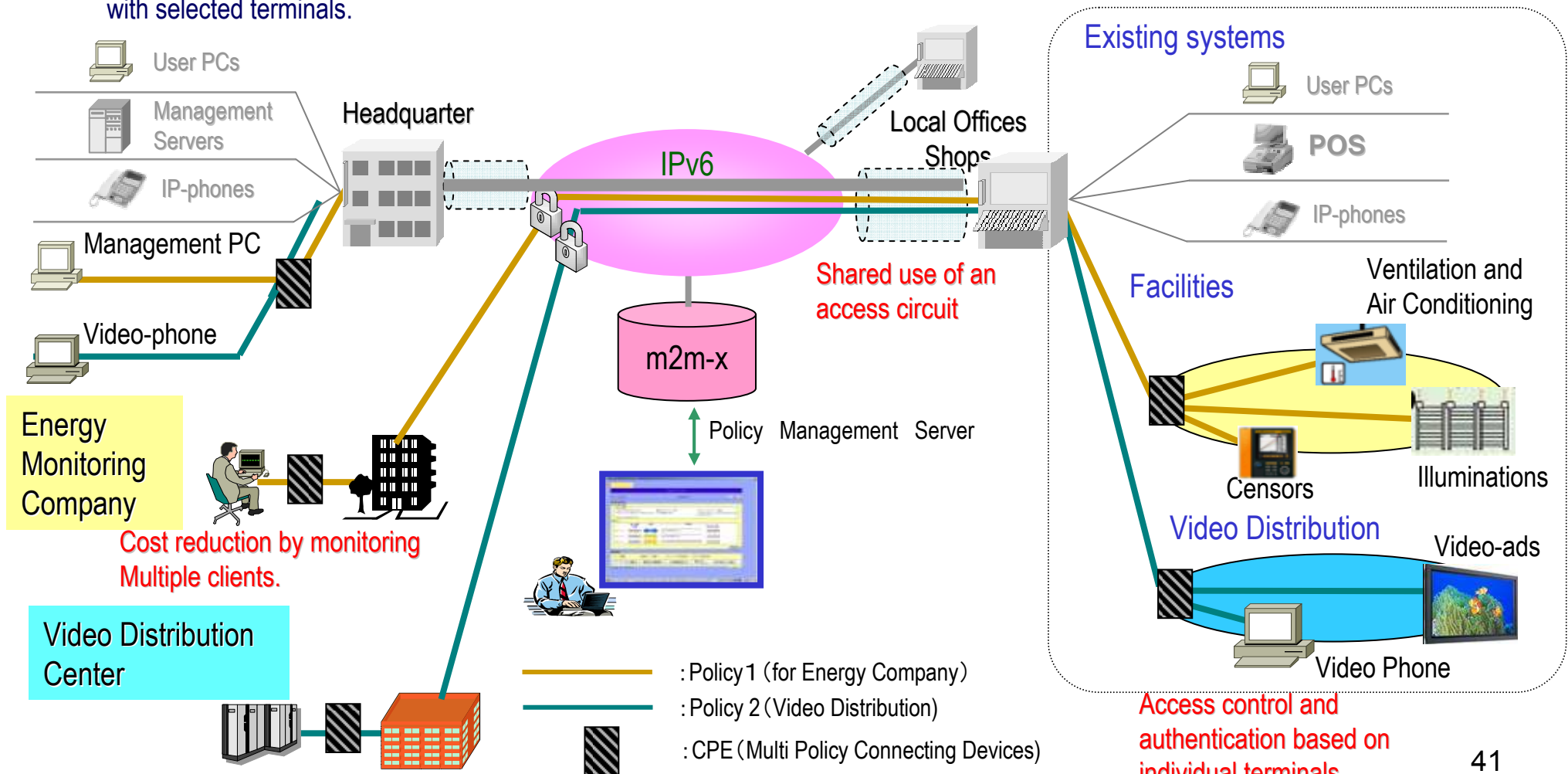
Nextech : Mah-jongg Game on Line

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Cost reduction by integrating different systems with different destinations to a single access circuit

➤ Enables constructing multiple secured network over a single access circuit
➤ Enables centralized and simultaneous configuration changes of different locations by a central policy management server
➤ Enables flexible control, for example, managing a system from multiple locations and establishing connections only
 with selected terminals.

User PCs
Management Servers
IP-phones

Headquarter

IPv6

Existing systems

User PCs

POS

IP-phones

Local Offices
Shops

Shared use of an
access circuit

Management PC

Video-phone

m2m-x

Facilities

Ventilation and
Air Conditioning

Energy
Monitoring
Company

Cost reduction by monitoring
Multiple clients.

Policy Management Server

Censors

Illuminations

Video Distribution

Video-ads

Video Distribution
Center

Video Phone

─────── : Policy 1 （for Energy Company）

─────── : Policy 2 （Video Distribution）

▨ : CPE（Multi Policy Connecting Devices）

Access control and
authentication based on
individual terminals.

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m2m-x: machine to machine for any[thing|place|time]

Multi-Policy VPN

- multi vendor system (thermometer, facility management system, elevator monitoring system ...)

- each vendor can reach its equipment remotely for responsive support

- **remote access can be restricted properly with IPv6 Multi-Policy VPN**
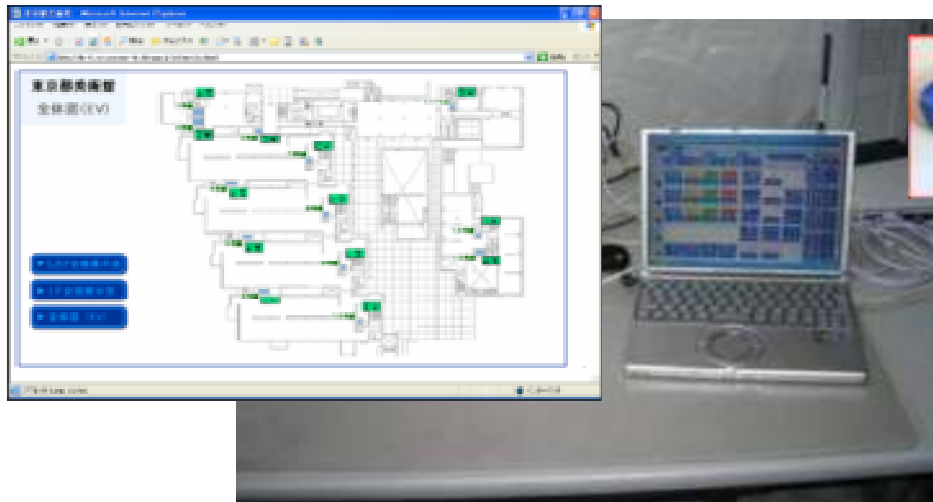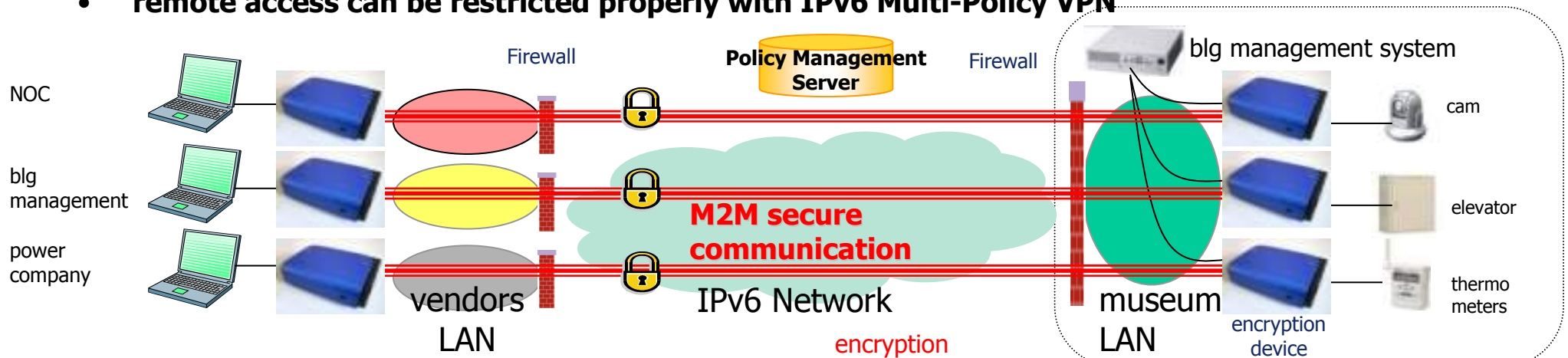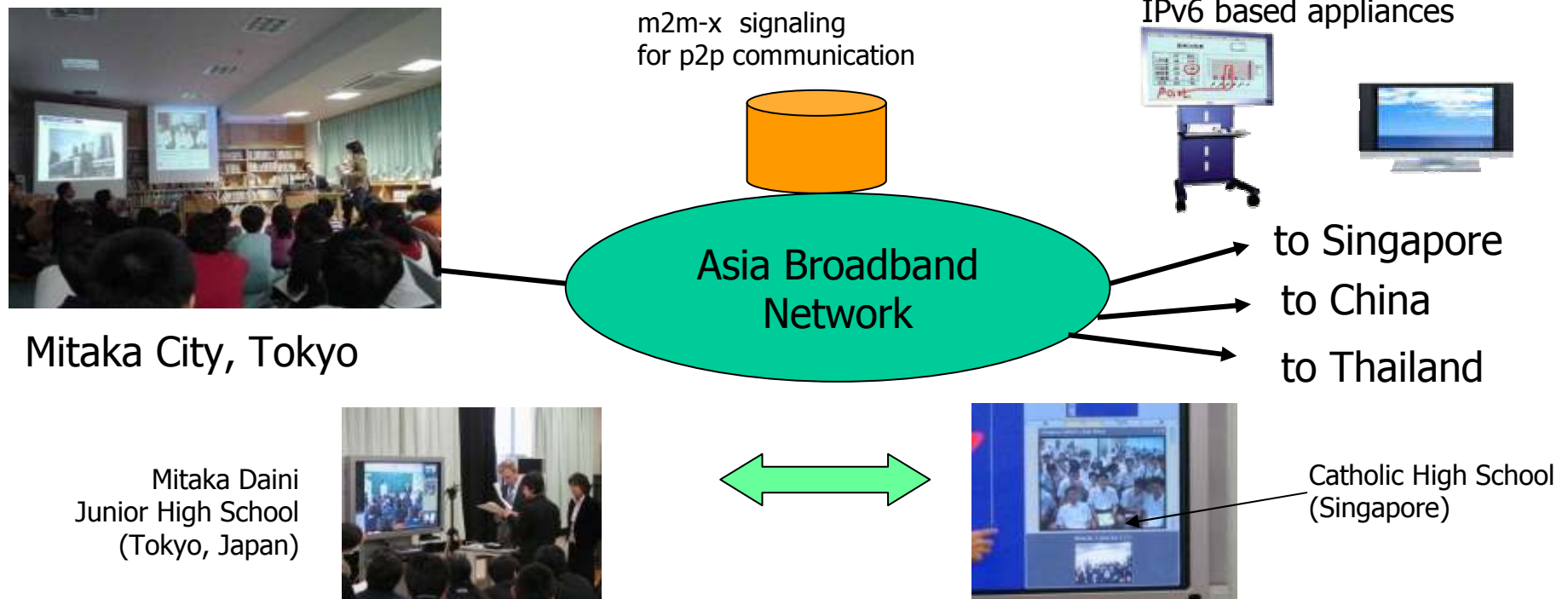
other IPv6 Solutions

- Convenience Store
  - Multicast network provides data simultaneously.
  - 7,000+ stores in nation-wide in Japan.

- Intelligent Building "Saitama-wave"
  - Facility network is worked on IPv6 network
  - NTT Facilities provide IPv6 Building Automation System and sensors.
  - Large number of sensors are connected and distinguished with plenty of IPv6 address.

- MIC project : "RFID-Tag system"
  - Quality of beef is guaranteed with networked RFID-Tag System.
  - RFID readers are secure-connected with IPv6 IPSec technology.
  - RFID-Tag system traces from processing plant to home.

- International Joint IT Experiment in Asia
  - Theme: e-trade, multi-language, IPv6 communication, collaboration and International IX
  - Field: long distance education, medical treatment, etc.
  - IPv6 supports P2P communication and collaboration

Low Delay, P2P Direct and Secure Communication

m2m-x signaling
for p2p communication

IPv6 based appliances

Asia Broadband Network

Mitaka City, Tokyo

to Singapore
to China
to Thailand

Mitaka Daini
Junior High School
(Tokyo, Japan)

Catholic High School
(Singapore)

2007: medical treatment and education collaboration between Japan and Thailand

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(This project is supported by MIC)

National Project : Sensor Network

Culture Exchange, Tele-education

Compare and Discussion

Hiroshima municipal technical high school, Hiroshima

Satit Kaset School, Bangkok

Hiroshima

Bangkok

Weather Sensor   UV Sensor

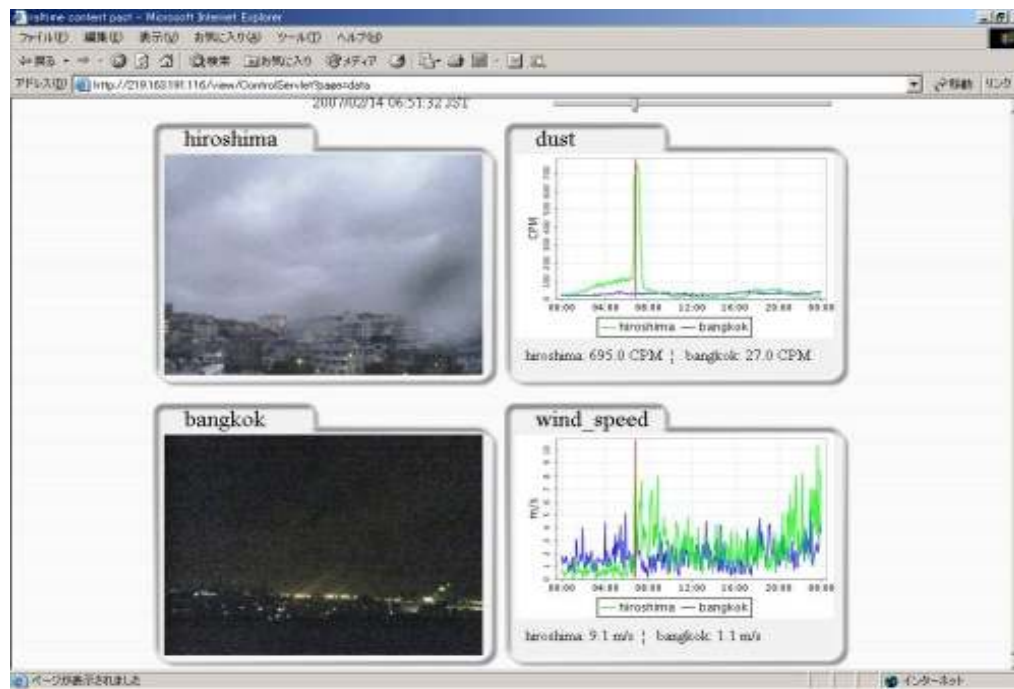IP Camera   Dust Sensor
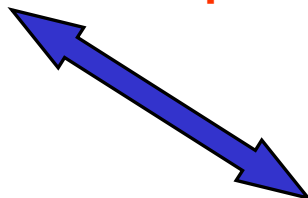
Sensors and Cameras

Data Viewer

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IPv6 Products sold in Japan

Windows Vista
Microsoft Corporation

Antivirus Software
Trend Micro Incorporated

Networked Audition Machine
Yokogawa Electric

IPv6 phone
FreeBit Co. Ltd:

Field Server & Sensor
Yokogawa Electric
 - "Fis" Environment Analysis System

Printers
-Panasonic Communications
-Ricoh Company Ltd.

TV with IPv6 STB
Toshiba Co.

TV Conference
Tandberg

IPv6 Camera
Panasonic Communications

IP Video Phone
NTT Regional.

Total Building System
Matsushita Electric Works
 - EMIT System

Remote Camera Server:
Chuo Electronics co.,Ltd（CEC）:
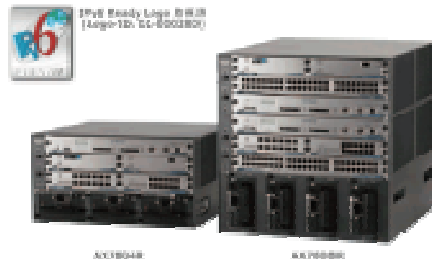
Router
ALAXALA Network Corporation:
- High-end gigabit router

Translator
SEIKO Precision Inc.:
-Network Time Server
-IPv4 / IPv6 Translator

Broadband Router:
YAMAHA Corporation:
- Broadband VoIP Router

Home Router
corega K.K.

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Summary and Conclusion

Why IPv6?

People are interested in for non-internet use (Intranet, IPVPN)

Positively

- **Value Adding**
  - IPv6 supports brand-new IP equipments and enables IP systems
  - Higher reliability / maintenanceablity / scalability
- **Low Cost**
  - IPv6 provides Network Integration and simple / smart IP Network

Negatively ...

- **IPv4 Address exhaustion**
- **Government Policy**
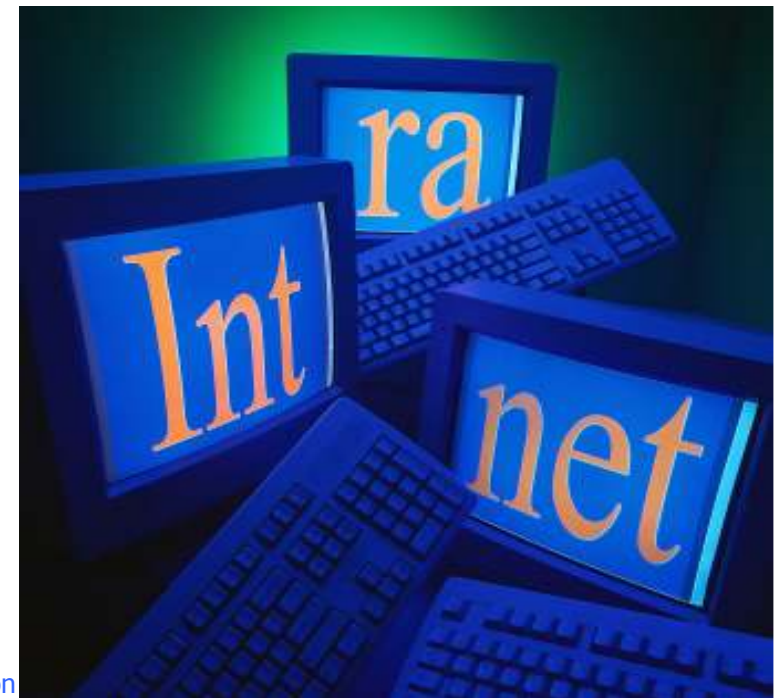
Today…

- –Leased line

- –Data center

- –Hosting

- –ADSL (native: RFC4241 + a bit enhancement)
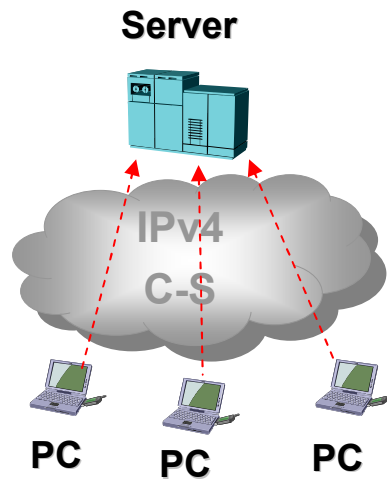
- –FTTH (softwire[L2TP] based)

"Native" is on the way… ☺

- –Transit

- –And more..

Big Picture of Our Goal

Now: Client-Server Model

✓*PC-oriented, One-way or Archive style Communication*
✓*Evil of Anonymity, D.I.Y Connection*

Server

IPv4 C-S

PC **PC** **PC**

Future: Machine-to-Machine(M2M) Model

✓*All IP, bidirectional and real-time communication*
✓*Assignable ID per Machine, Managed Connection*

CAD Collaboration **IC Card** **MFP** **Building/Facility Management**

DTV

PVR

Office Network

Sensor Network

Home Security

Home Network

IPv6 M2M

Monitor Camera

CO2 Management

Mobile Network

Data Center

Digital Cam

Mobile Phone

Mobile Player

Contents

Remote Assistance

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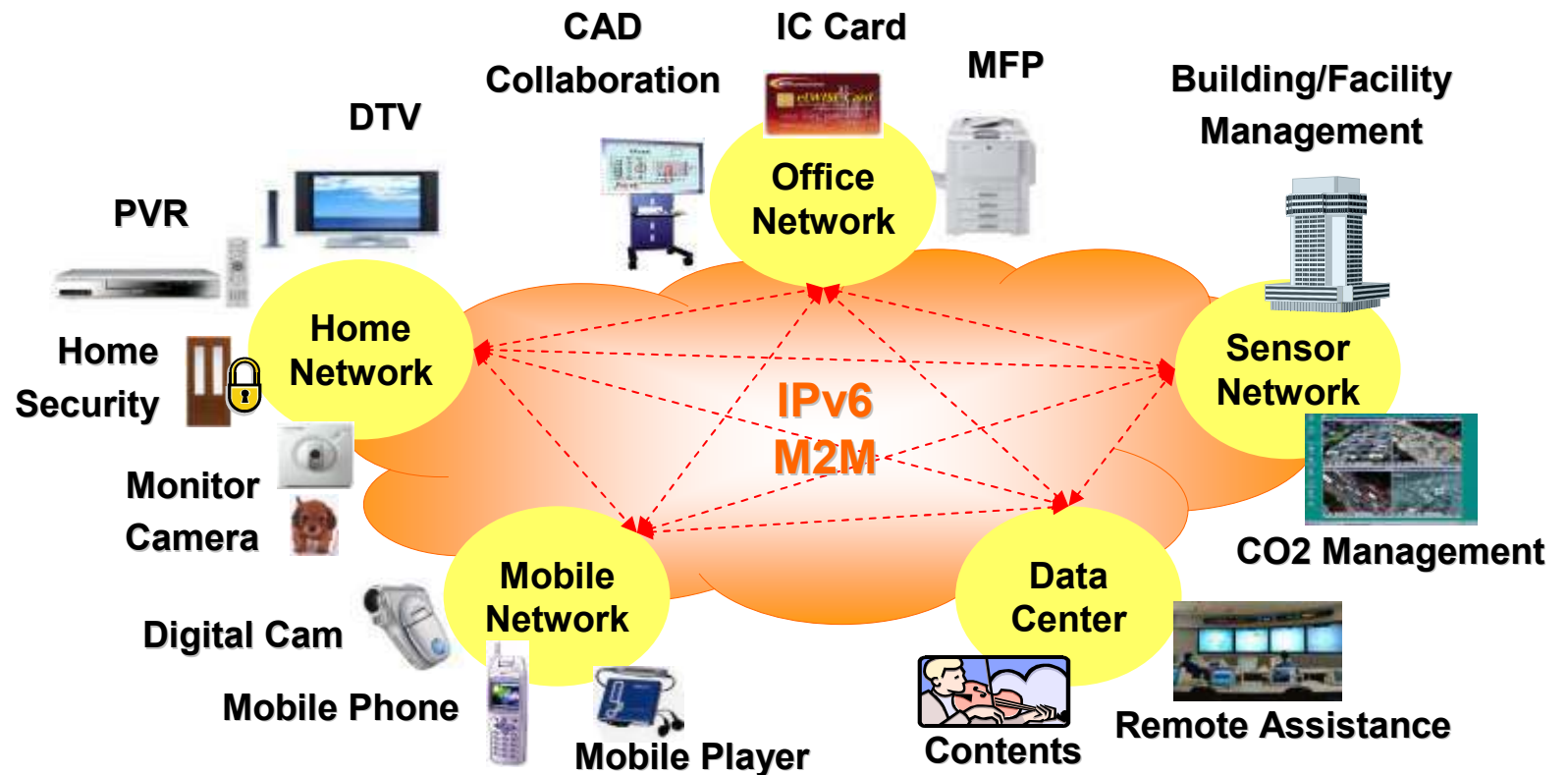
NTT Communications' IPv6 Road Map

ntt.net

Today

| 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 |

Platform Services

m2m-x — Trial

VOD

VPS Server Hosting（IPv4/IPv6 Dual） — Trial

Connectivity Services

IPv6 IPVPN (JP)

OCN IPv6 for Consumer (JP)

Dual Transit (JP)

Dual Transit (Global)

Native Transit (Global) — Dual ADSL (JP) — Trial

Europe | Japan | HK | Other Asia Pacific, USA

Configured Tunnel — Trial | Commercial

Global Backbone

Trial | Commercial | Dual Stack

Thank you for your attention

http://www.v6.ntt.net
kempei.fukuda@ntt.com