# IPv6 Deployment Case Studies

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# Introduction

- Activities about IPv6 transition in Japan
- Summary of Deployment Guideline
  - Transition scenarios in enterprise networks
- Case Studies
  - Closed network case
    Trial introduction is easy.
  - VoIP network case
    Applying IPv6 to VoIP is effective.
  - Streaming network case
    IPv6 over IPv4 for IPv6-multicast is also effective.
- Some considerations

Review Sheet

# Features of IPv6

**Flexible Address-Design**

**(1) Un-exhaustible Address Space**
- —Simplified networks
- —Enhancement capability for the next coming terminals

**(2) Simple Address Architecture**
- —Easy to design

**Improving Network Operation**

**(3) Plug and Play (PnP)**
- —Maintenance-free user-terminals

**Various Solutions for End-users**

**(4) Tough Security Function**
- —End-to-end secure environment is possible. (PnP security is a remaining problem.)

**(5) Mobile IP, Multicast**
- —Newly values added to networks

**(6) Flexible QoS Control**
- —Maintaining optimum communication-quality

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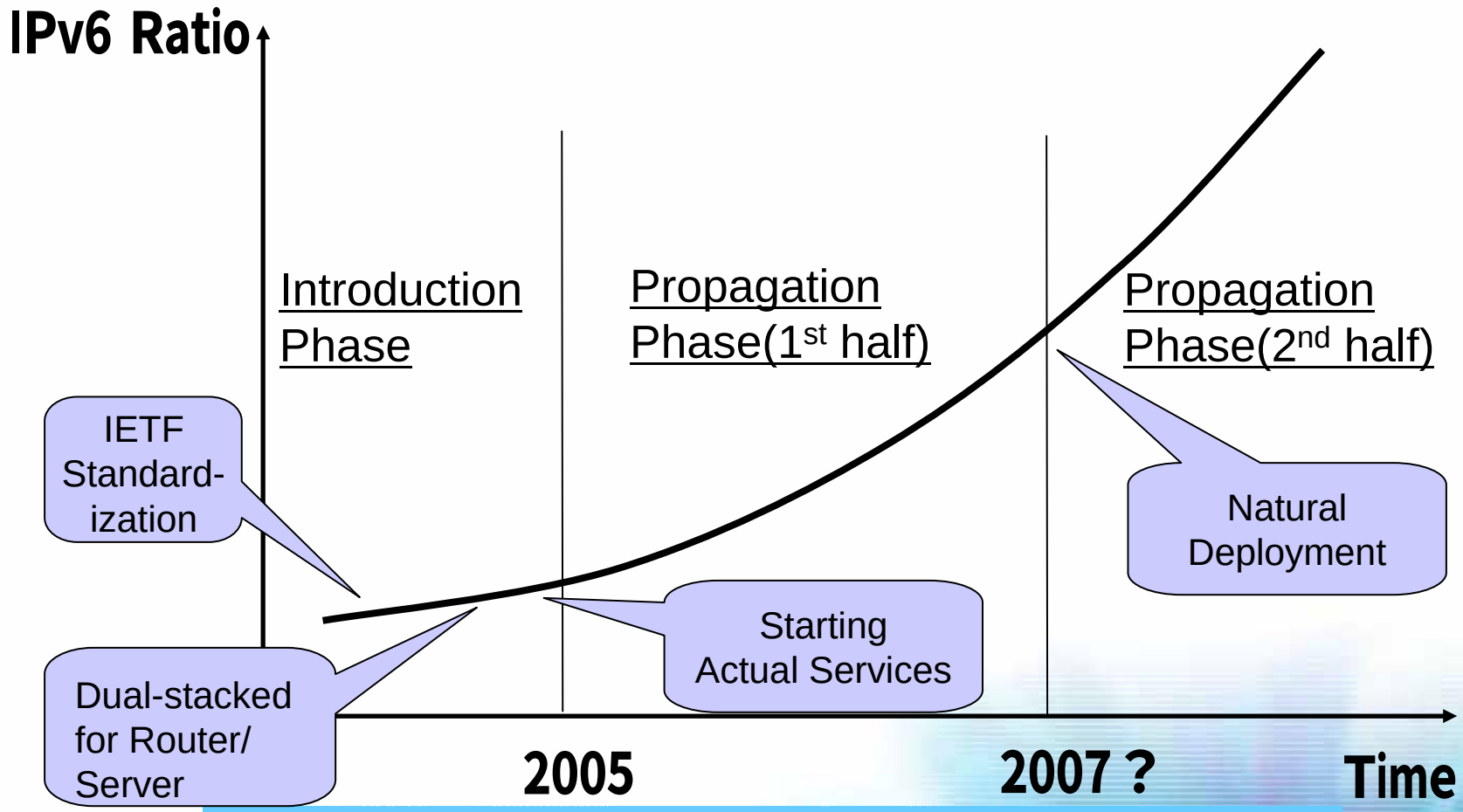
# Current Status of IPv6 Deployment




Now: End of Introduction Phase
=Needs more energy for the Propagation Phase

# Example -Service-

- Multicast streaming using IPv6: BIGLOBE TV
  http://bbtv.biglobe.ne.jp/4md/
  - Using IPv6 access lines owned by NTT-east
  - Multi-channel IP Television and VOD services
  - "4th Media", the next generation media following to broadcasting, satellite broadcasting and cable TV
- IPv6 telephone service: BIGLOBE TV-phone
  http://phone.biglobe.ne.jp/tvphone/pn/
  - Using IPv6 access lines owned by NTT-east/west

New services have already started in Japan !

# Example -Enterprise-

- Introduction of INTEC intranet:
  http://www.intec.co.jp/news/n_050111_1.html
- Introduction of KDDI-lab intranet:
  http://it.nikkei.co.jp/it/news/newsCh.cfm?i=2005012007558j0&h=1
- Introduction of Saitama-Mediawave:
  http://japan.cnet.com/news/ent/story/0,2000047623,20080083,00.htm

Building ”IPv6 intranets” had been starting.

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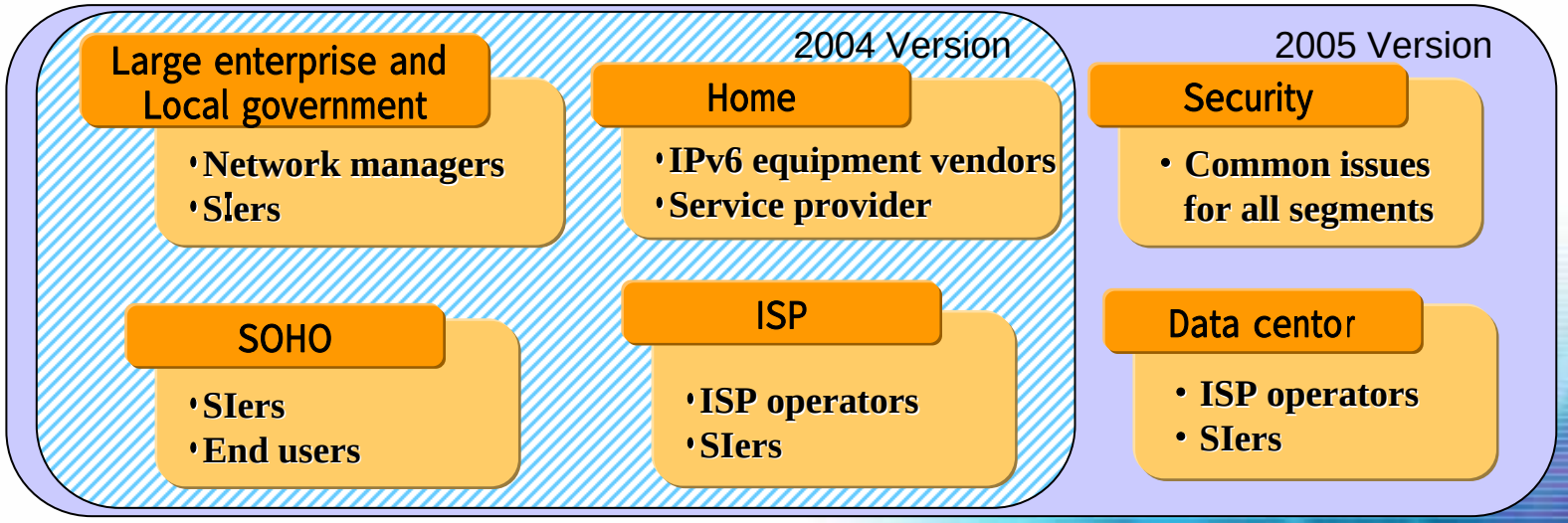
# IPv6 Deployment Guideline

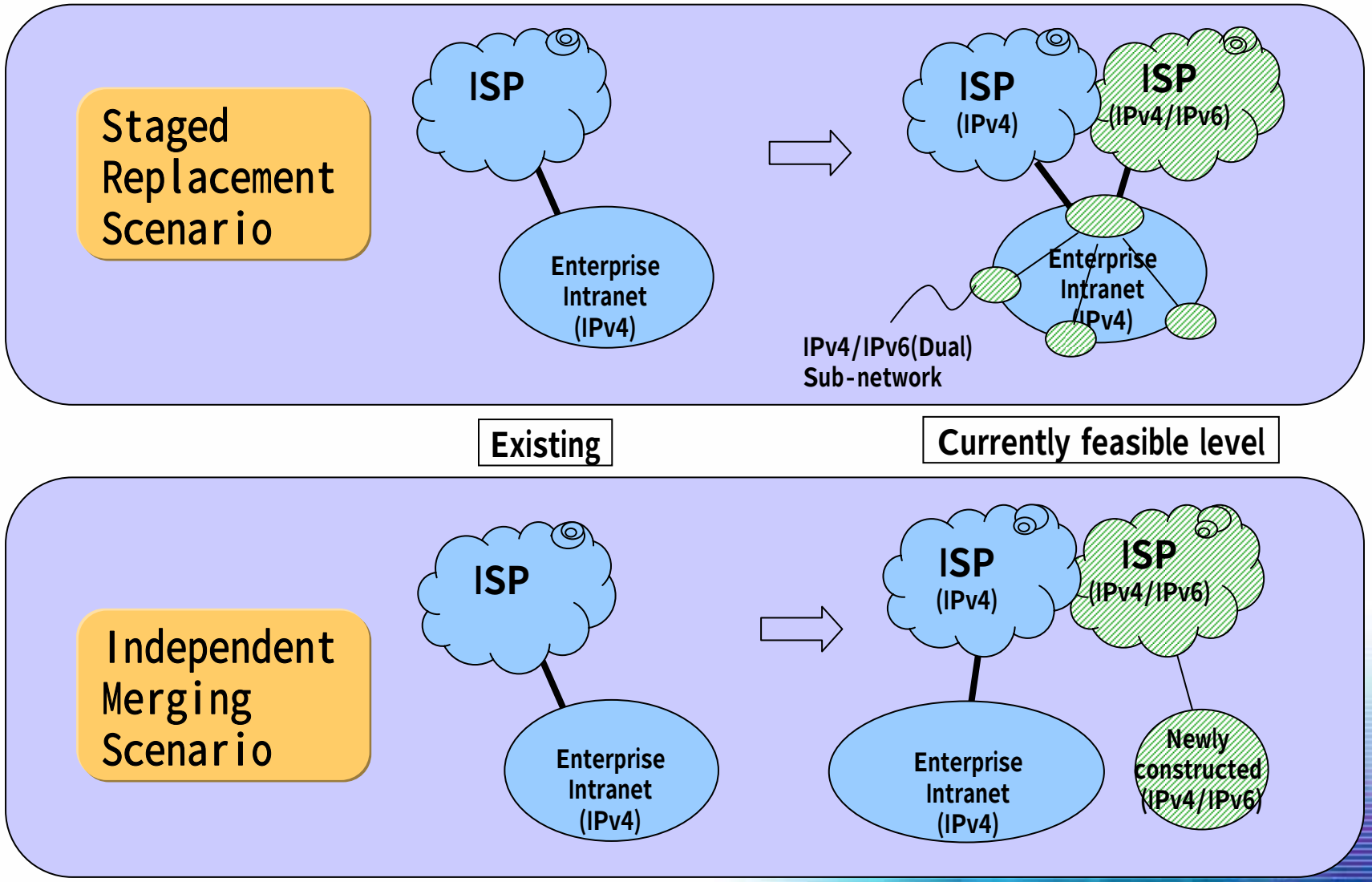
- IPv6 Promotion Council / Deployment WG
  - To accumulate know-how which is necessary for IPv6 transition on the IPv6 Deployment Guideline
- IPv6 Deployment Guideline
  - Discussed about 6 segments(2005 Version)

The guideline clarifies transition-process for users in each segment.



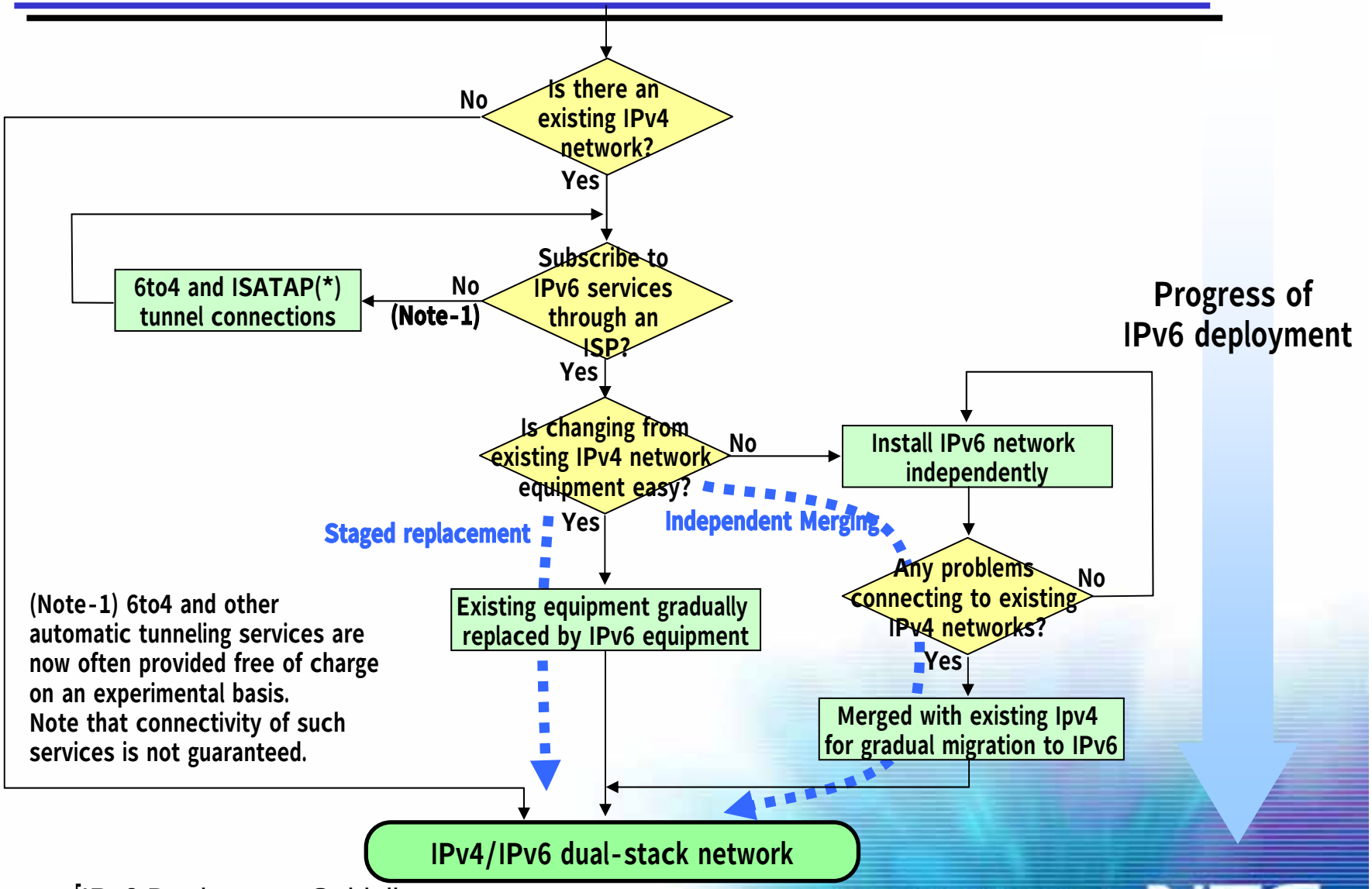

Reference: http://www.v6pc.jp/jp/wg/transWG/index.html

# Two Transition Scenarios




Reference:「IPv6 Deployment Guideline」

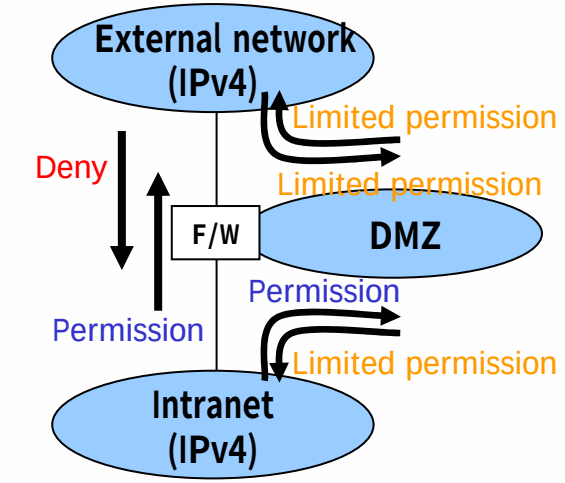
# Flow of IPv6 Network Building



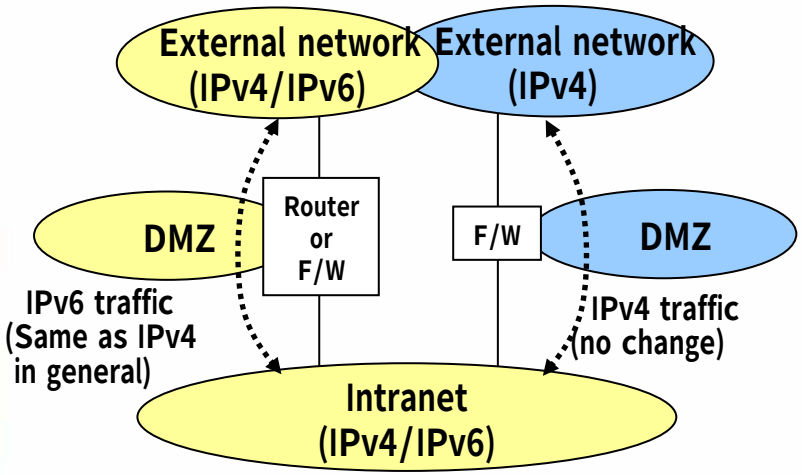

Reference:「IPv6 Deployment Guideline」

# Converting Intranet-Gate to IPv6

<Current Structure>




<Structure after IPv6 deployment>




Reference: 「IPv6 Deployment Guideline」

<Required functions as an intranet gate at existing networks>

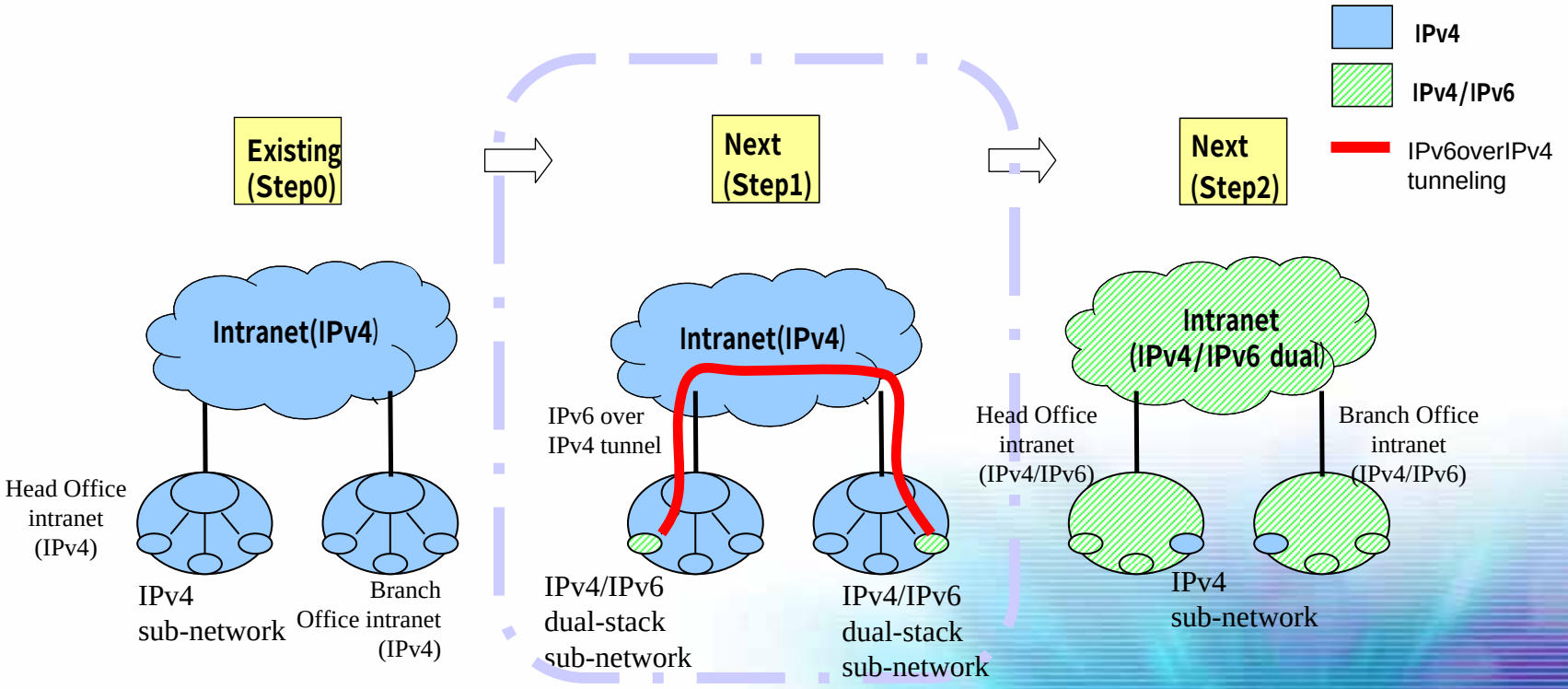
- Filtering
- Logging
- NAT (Network Address Translation)
- Virus check
- Remote access
- IDS (Intrusion Detection System)

→IPv4 enables firewalls, NAT and the other functions listed above.
(IPv6 also requires these functions except NAT.)

The structure of the existing IPv4 section does not need to be changed in installing IPv6, but an IPv4/IPv6 router (ideally providing an firewall) should be installed. New IPv4/IPv6 routers should only process IPv6 traffic and perform the same type of filtering as IPv4.
IPv4 traffic is handled by the existing IPv4 section.

# Staged Replacement Scenario

- Step 0：Existing network（only IPv4）
- Step 1：IPv6 “islands” are connected with IPv6 over IPv4 tunneling.（Currently feasible level）
- Step 2：IPv4/IPv6 dual-stacked environment




Reference:「IPv6 Deployment Guideline」

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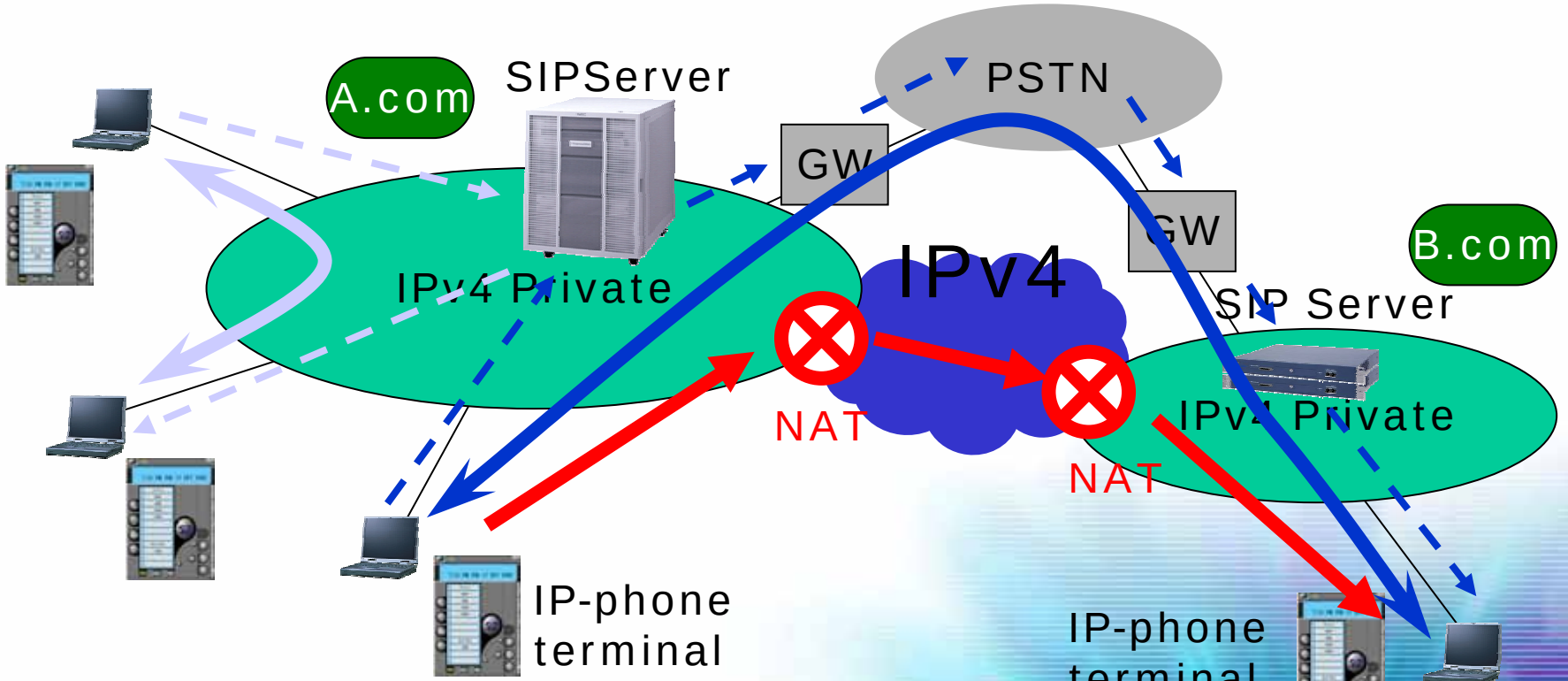
# IPv6 Applications

- IP-Phone ✔
  - VoIPv6 using SIP protocol
- Streaming ✔
  - Making use of multicast for streaming contents
- PnP service discovery ✔
  - Easy configuration for users
- File Sharing
  - Dynamic sharing-group generation
- TV conference
  - Saving costs of business trips
- Network monitoring and control
  - Monitoring and control from everywhere
- User management
  - User information (especially IPv6 address) management

✔: More effective applications compared with using IPv4

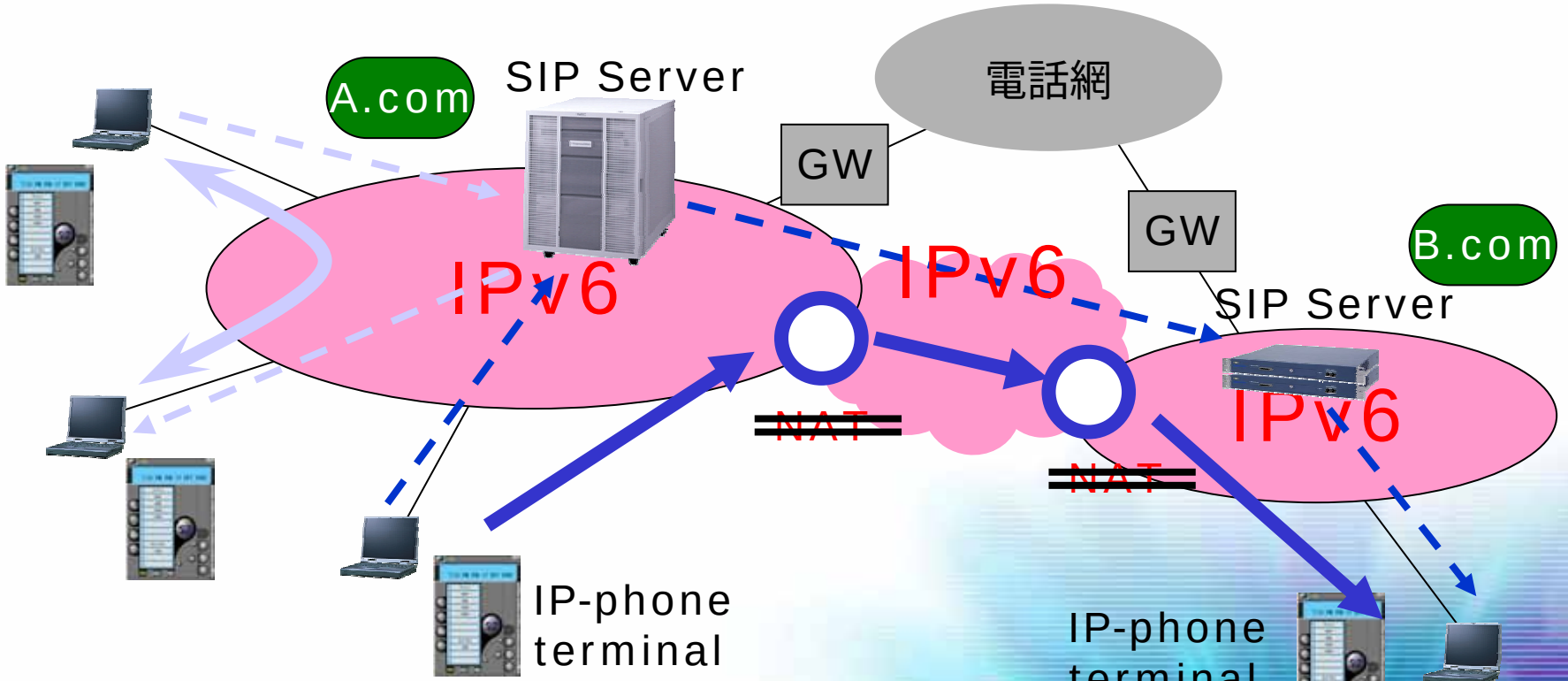
# Current IP-Phone Network

- IPv4 private addresses are used in intranets.
- It is difficult to connect end-to-end call between different intranets.



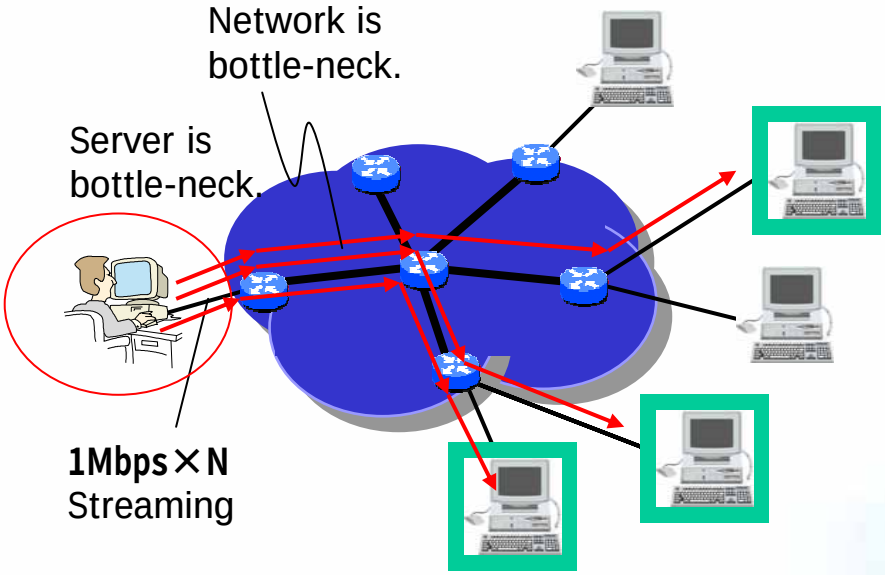
# ① IP-Phone using IPv6

- IP-phone is most general among P2P applications.
- It is easy to connect directly between different intranets.

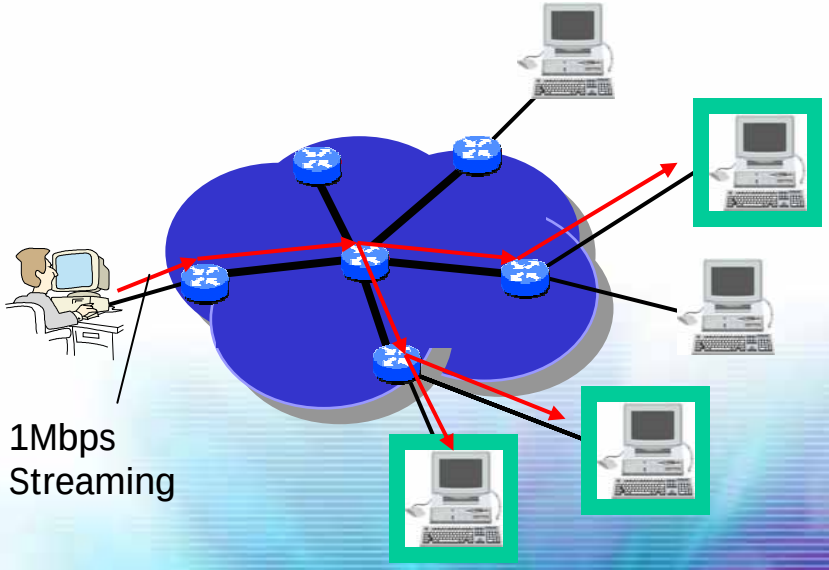


# ② Streaming on IP multicast

- IP multicast is effective for real-time streaming.
  - Saving traffic increase as terminals increase
  - Saving server resource
- IPv6 is ready for multicast environment.
  - IPv6 ready means IP multicast ready.



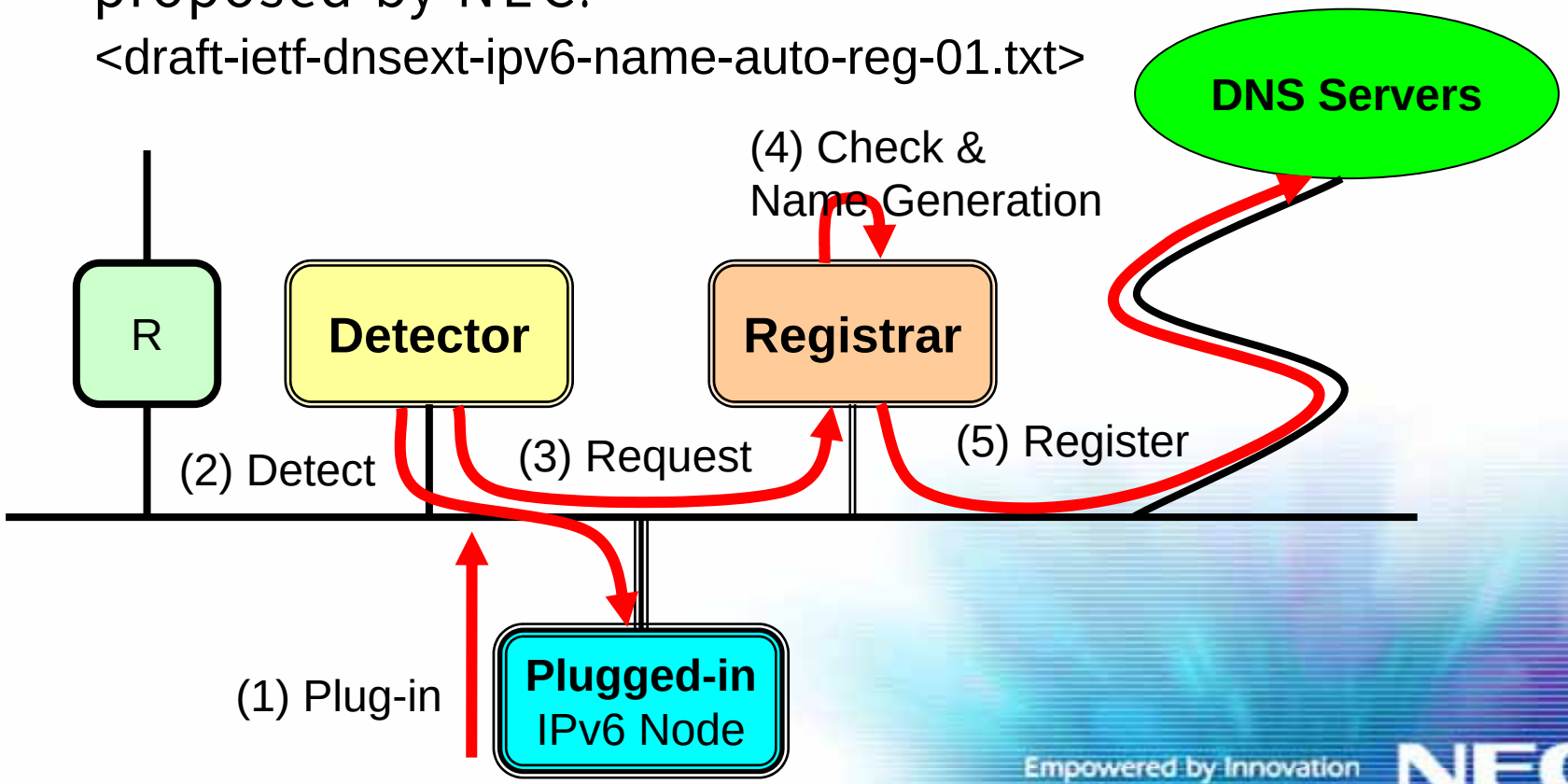

**1 stream by server-to-client**




**Multicast streaming**

# ③ PnP Service Discovery

- PnP service discovery is effective by using IPv6 protocol mechanism.
- This example is PnP auto-registration to DNS proposed by NEC.
  <draft-ietf-dnsext-ipv6-name-auto-reg-01.txt>



# Reasons for Deploying IPv6 Now in an Enterprise

(1) Deploying an IPv6 network environment ahead of competitors
- IPv6 is deployed as part of long-term equipment planning with the objective to enable use of future network applications ahead of the competition.

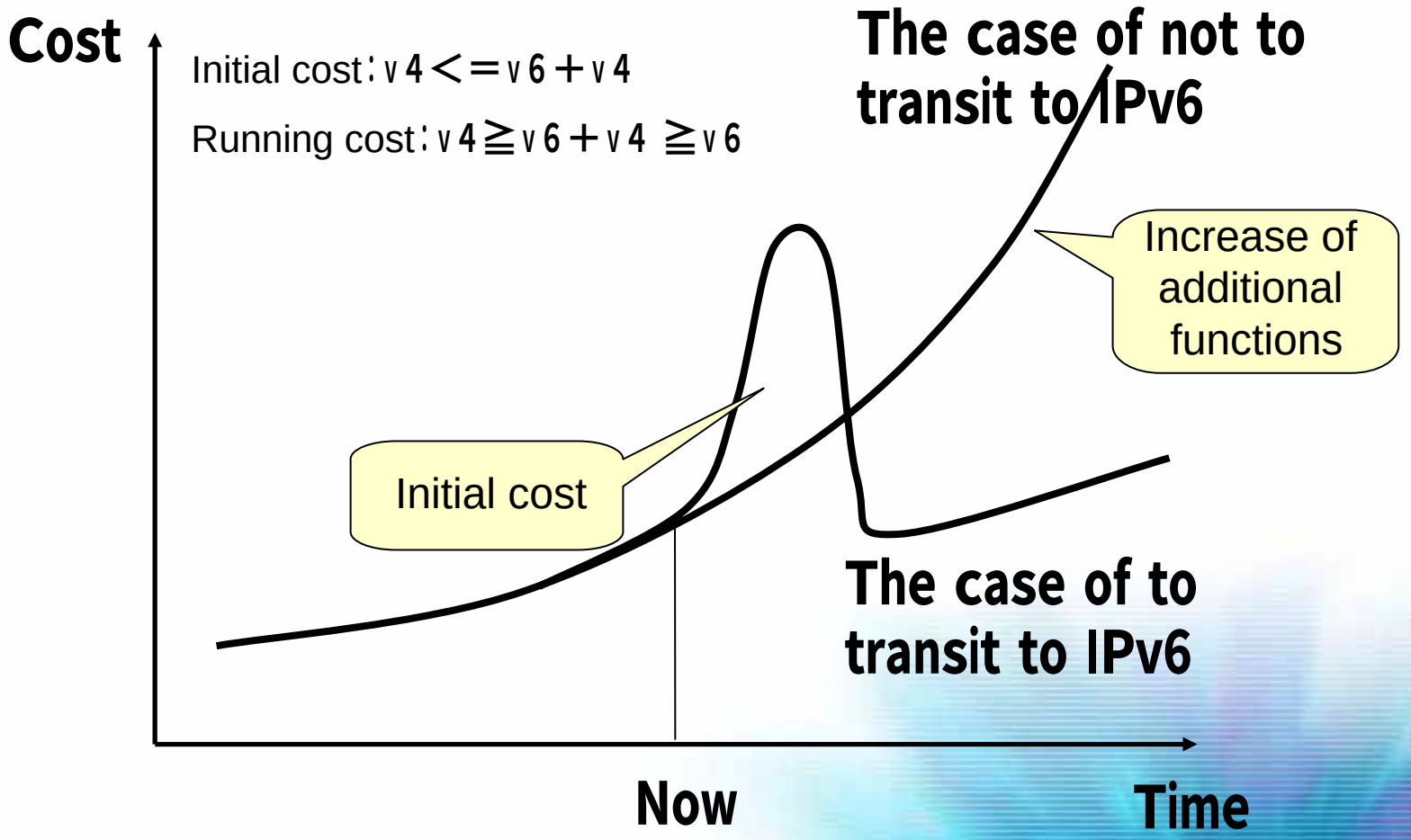
(2) Deploying IPv6 by installing new IPv6 compatible applications (VoIP, etc.)
- Business trips, meetings and other business functions can be made more efficient. Work at home will also be possible.
- Security can be performed on an individual basis rather than be an organization-wide concern.

(3) Setting up an environment for IPv6 development
- The objective is to develop IPv6 products.

(4) Improving the corporate image, presence, marketing expertise and customer appeal
- The introduction of advanced technology is expected to improve the corporate image.

Reference: 「IPv6 Deployment Guideline」

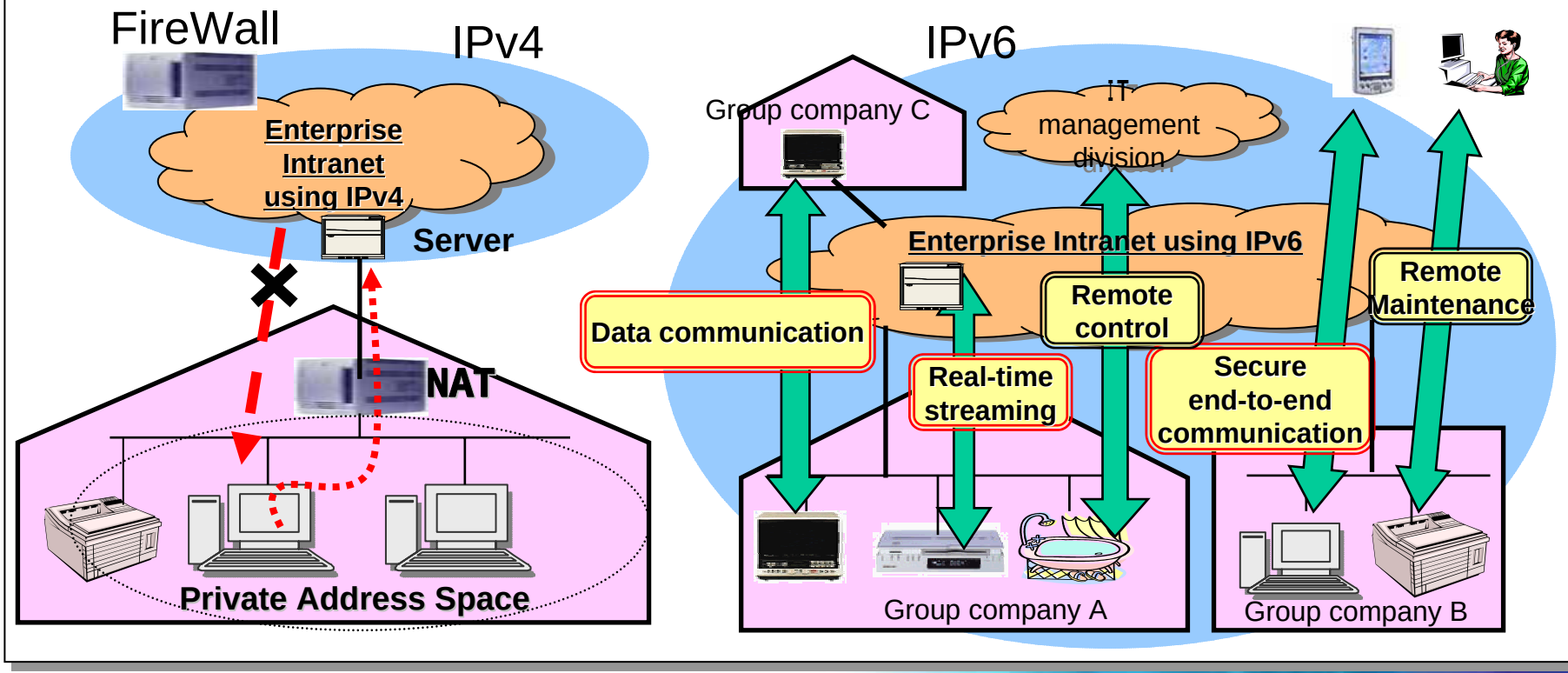
# Effect of IPv6 Introduction



# Future Network Image Making Use of IPv6

**IPv4 (= Server-Based Communication)**
- NAT, which solves complex addressing policy, is a barrier of communication.
- Uni-directional initiation from a client
- Uneasy access from non-PC terminals

**IPv6 (= Peer-to-Peer Communication)**
- NAT-less communication enables free-access with proper security between various organization.
- Bi-directional initiation from every terminal
- Easy access from non-PC terminals



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# Deploying IPv6 in Closed Networks

- **Why closed network?**
  An enterprise networks is :
  - an independent network which connects enterprise members using TCP/IP technology.
  - a managed network where the enterprise policy is applied.

  **At first, IPv6 deployment as a closed network is preferable**
  **Security issues concerning external networks are too much to handle in the beginning.**

- **What application?**
  File sharing service on IPv6
  - Merit : Realizing information sharing among inter-div. because no firewall update is required.
- IPv6 address?
- IPv6 inter-site connection?

# IPv6 Address (1/3)

## <Obtaining an IPv6 assignment>

- Contract with an ISP which provides IPv6
  → Every end-user can obtain a /48 global prefix.

## < Obtaining an IPv6 assignment – ISP independent – >

- Use any temporary addresses
- Assign 『Global unique local address (fc00::/7) 』

⇒ **ISP-independent addresses are not recommended.**

## <Site-Local address>

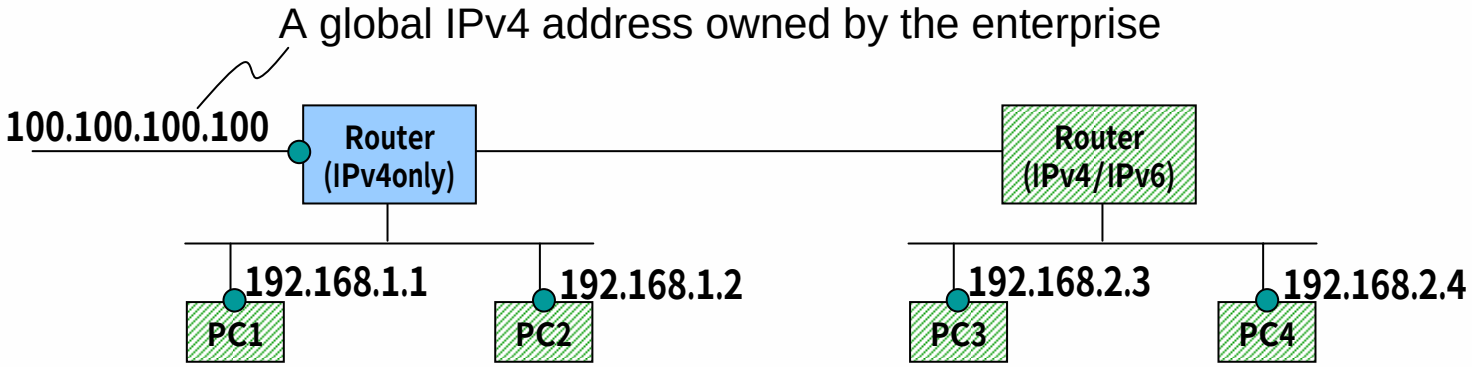
- RFC3871：Prohibited implementation of site-local

⇒ **Site-local should not be used.**

# IPv6 Address (2/3)

## ISP-dependent address

- Using a global IPv4 address which is assigned from an ISP and the rule of 6to4 address generation, unique temporary address can be obtained.




| | IPv4 address | IPv6 address |
|---|---|---|
| PC1 | 192.168.1.1 | 2002:6464:6464:1:0000:5efe:c0a8:0101 |
| PC2 | 192.168.1.2 | 2002:6464:6464:1:0000:5efe:c0a8:0102 |
| PC3 | 192.168.2.3 | 2002:6464:6464:2: [EUI-64] |
| PC4 | 192.168.2.4 | 2002:6464:6464:2: [EUI-64] |

ISATAP 192.168.1.2

6to4 100.100.100.100

Reference: 「IPv6 Deployment Guideline」

# IPv6 Address (3/3)

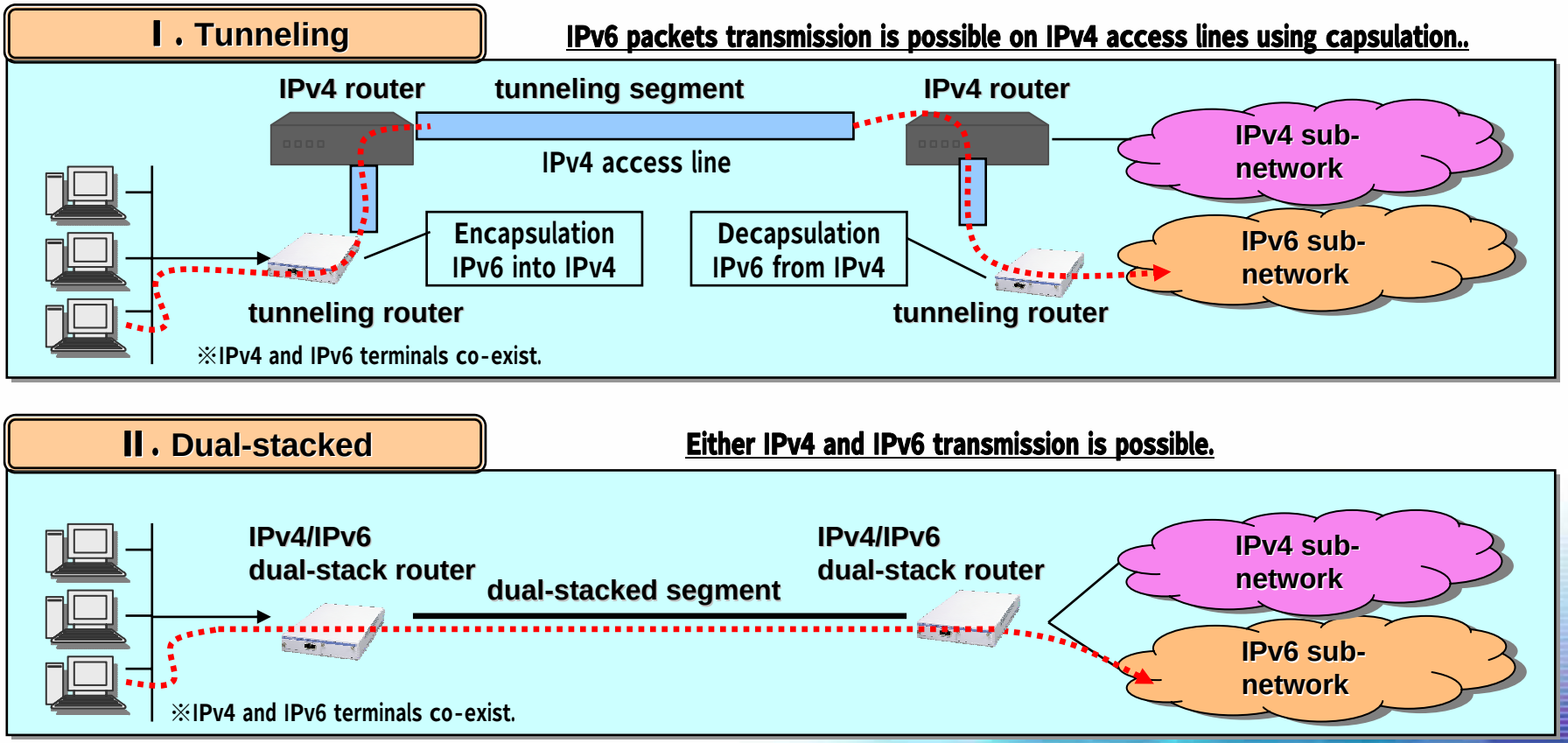
## Global /32 address

- For an enterprise to obtain a /32 prefix,
  - It must be an LIR (Local Internet Registry)
    - Needs to manage address assignment
  - It must not be an end site
    - the enterprise itself has to assign prefixes to end-sites
  - plan to provide IPv6 connectivity to organizations to which it will assign /48s, by advertising that connectivity through its single aggregated address
  - have a plan for making at least 200 /48 assignments to other organizations within two years.

- In the IPv6 Address Allocation and Assignment Policy guideline.....
  - A large organization providing IPv6 connectivity to its group companies or subsidiaries and restricting connectivity to its own network

# Inter-Site Connection (1/2)

There are two major site connection services.



# Inter-Site Connection (2/2)

Site connection services in Japan
(depends on each country)

| | Dual-stacked | Tunneling(IPv6overIPv4) |
|---|---|---|
| Frame relay | Yes.(Note-1) | Yes. |
| Leased line | Yes.(Note-1) | Yes. |
| IP-VPN | Possibly No.(Note-2) | Yes. |
| Wide area Ether | Yes.(Note-1) | Yes. |

(Note-1) Enables conversion of terminal equipment to IPv6(This is not dependent on IP address, but requires verification from the service provider.)
(Note-2) Requires verification from the service provider.

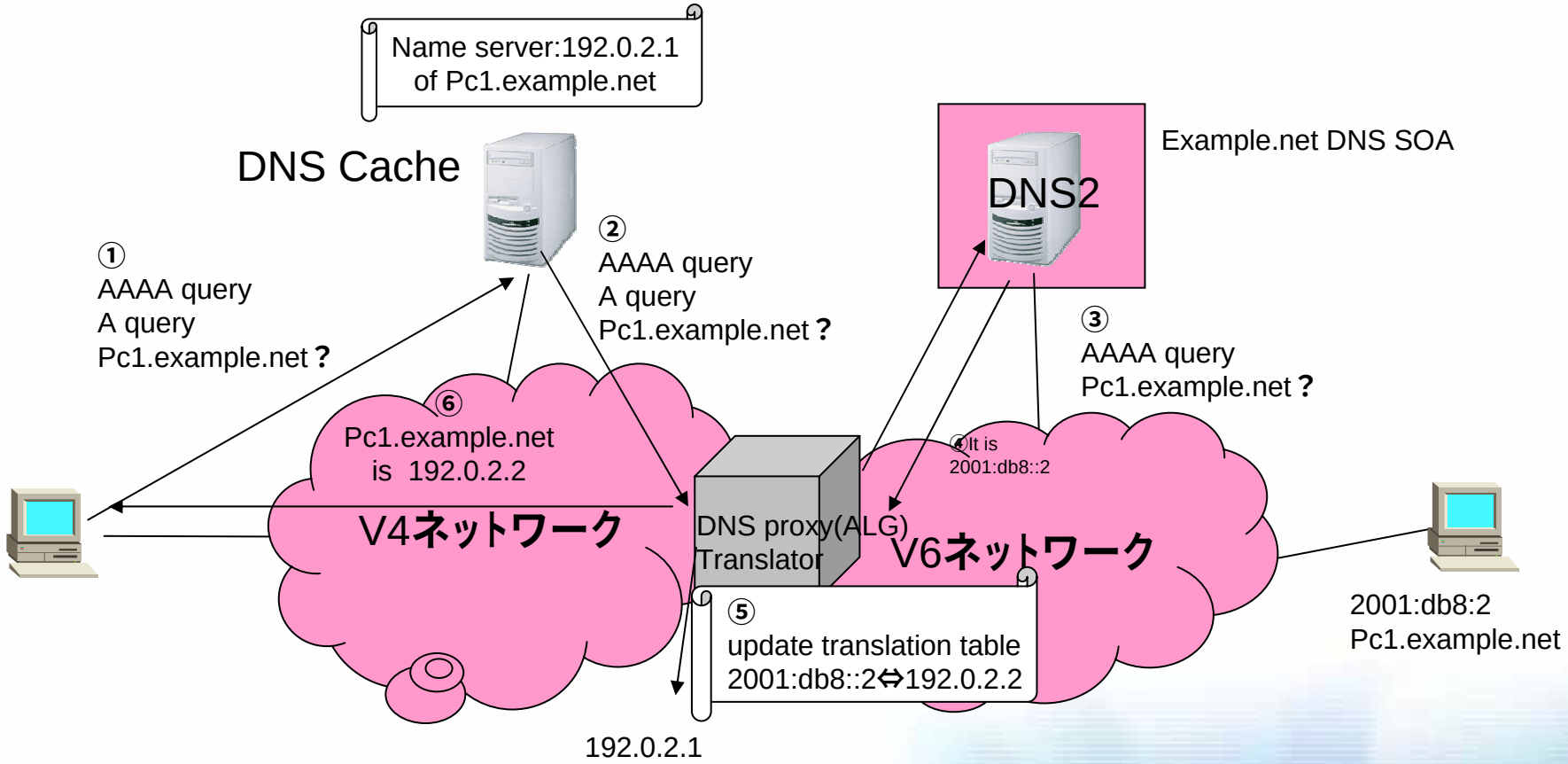
# End-to-End Environment

Possible end-to-end communication
when IPv4 and IPv6 terminals co-exist.

| End-to-End Communication | | Destination | | |
|---|---|---|---|---|
| | | IPv4 Single-stacked | IPv6/IPv4 Dual-stacked | IPv6 Single-stacked |
| Source | IPv4 Single-stacked | ○(by IPv4) | ○(by IPv4) | × |
| | IPv6/IPv4 Dual-stacked | ○(by IPv4) | ○(by IPv6) | ○(by IPv6) |
| | IPv6 Single-stacked | × | ○(by IPv6) | ○(by IPv6) |

○:possible, ×:impossible

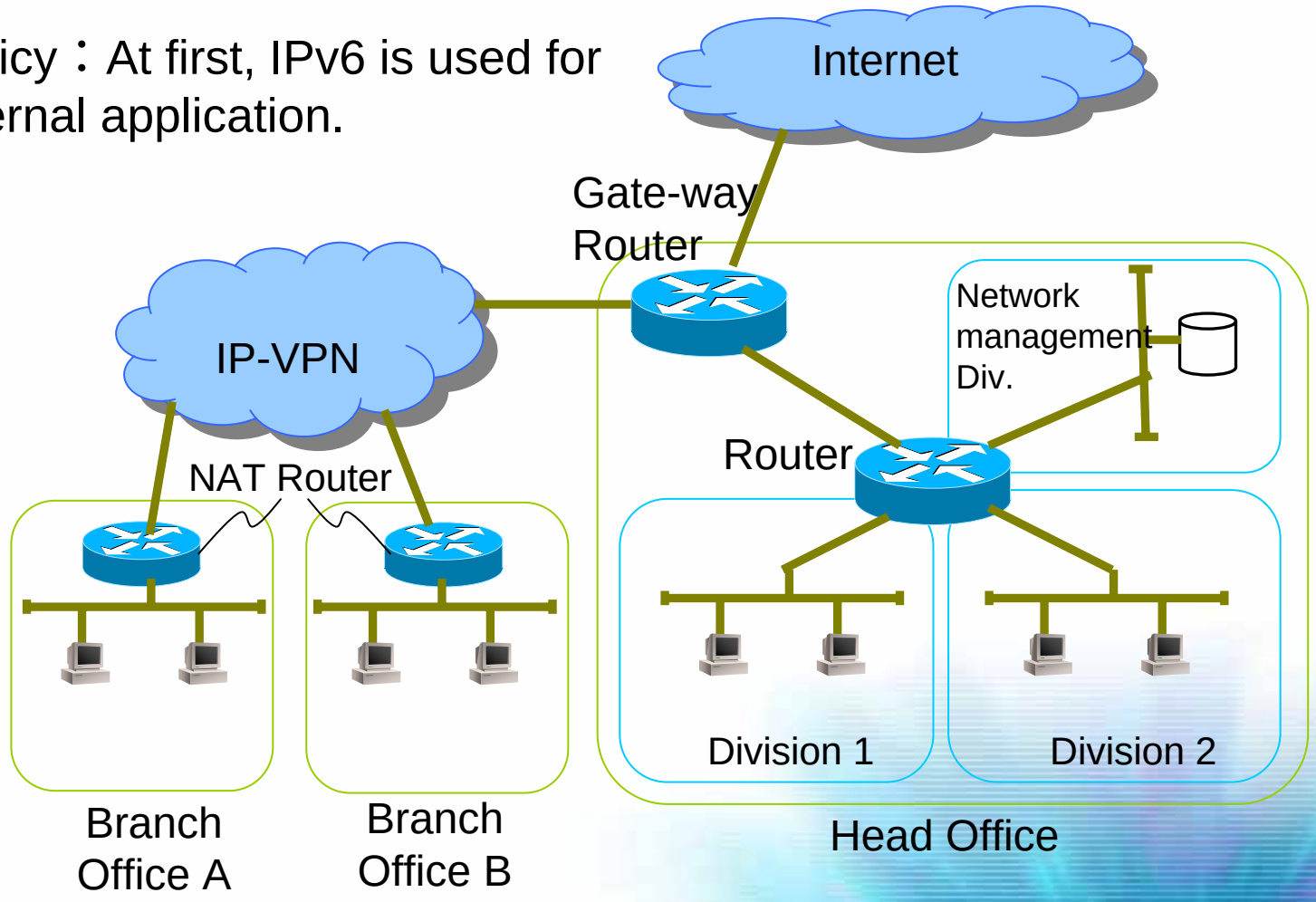
# IPv6/IPv4 Translator




※IPV6/IPv4 translator will be required
in many cases when migration is proceeding.

# Migration Image at Enterprise Intranet (1/3)

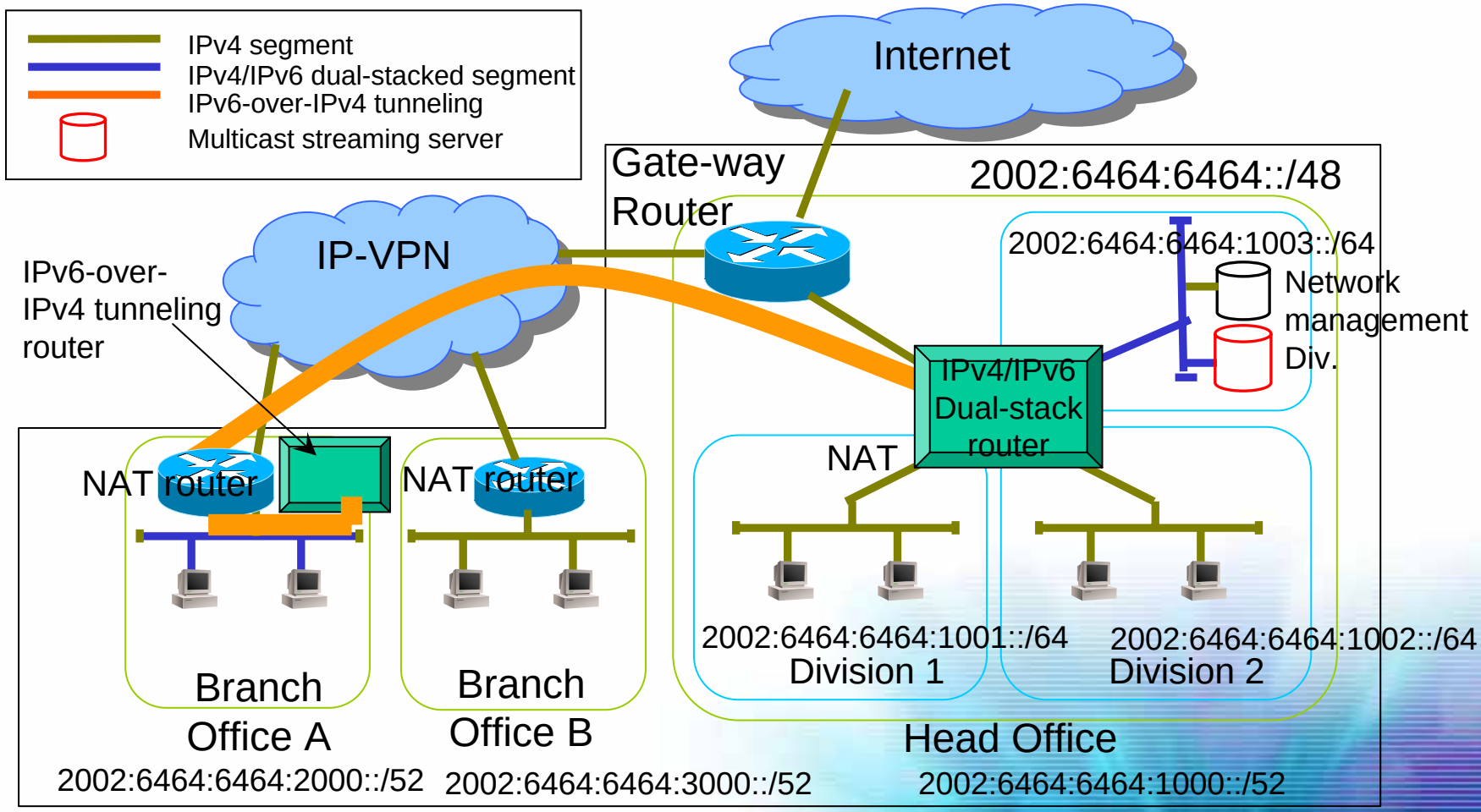
Policy：At first, IPv6 is used for internal application.




Reference: http://www.ipv6style.jp/jp/index.shtml

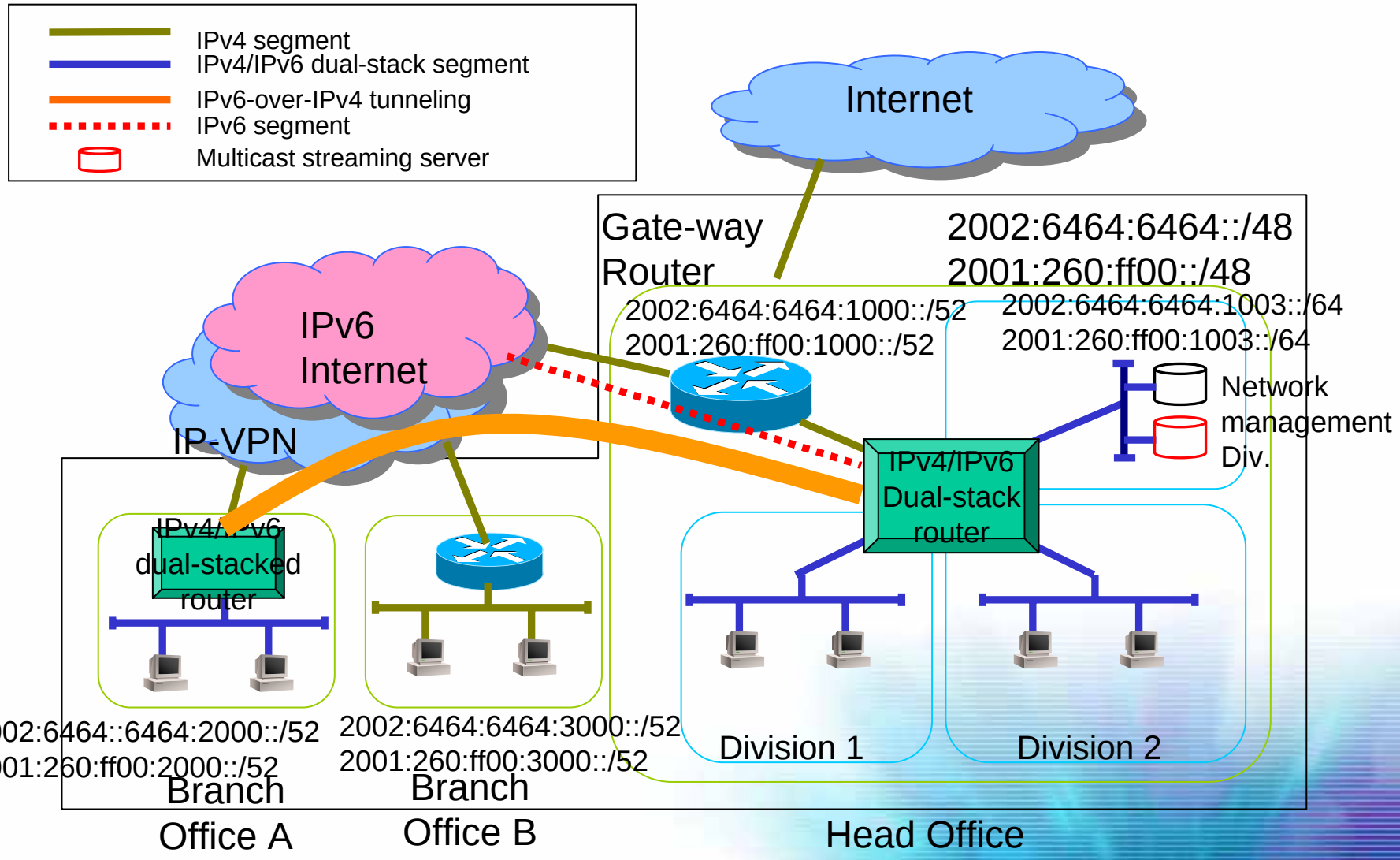
# Migration Image at Enterprise Intranet (2/3)

Generate IPv6 addresses from IPv4 global address, which is assigned for the organization. The address will be unique if the IPv4 is global unique.




Reference: http://www.ipv6style.jp/jp/index.shtml

# Migration Image at Enterprise Intranet (3/3)




Reference: http://www.ipv6style.jp/jp/index.shtml

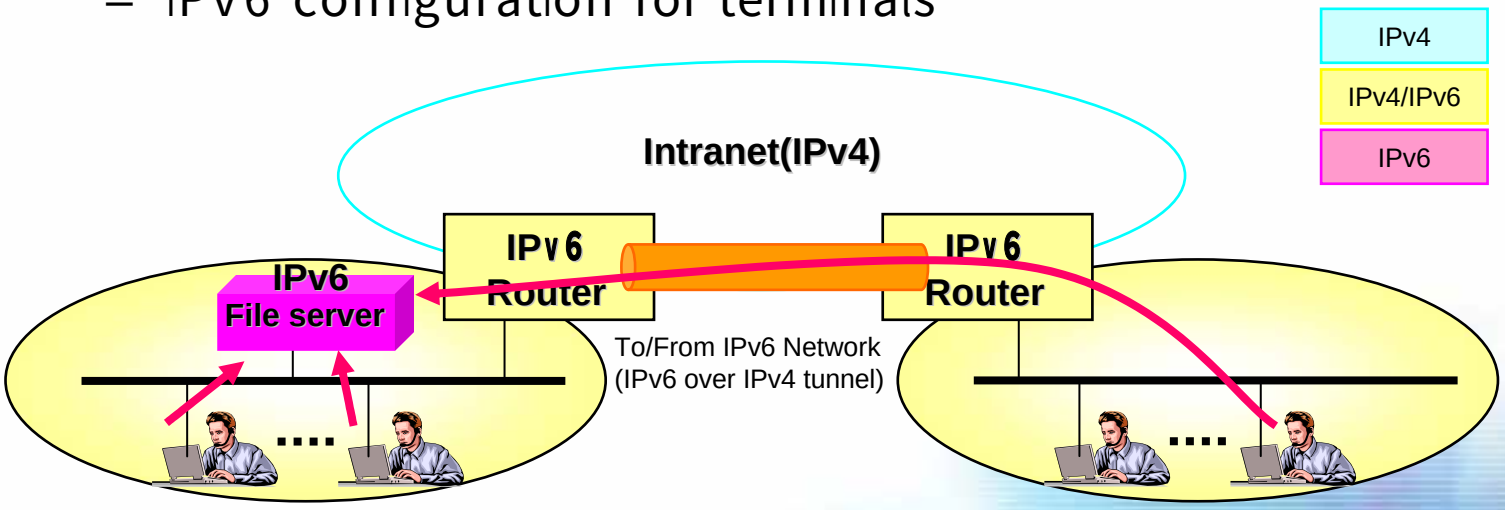
# IPv6 Address Assignment

- IPv6 assignment for closed networks

| Method | Uniqueness | ISP-Independent | for Closed | Note |
|---|---|---|---|---|
| /48 Assignment from ISP | Yes. | No. | Possible | Recommended |
| Temporary Assignment | No. | Yes. | Possible | Not recommended |
| 6to4 Assignment based on IPv4 | Yes. | No. | Possible | Recommended |
| /32 Allocation as a LIR | Yes. | Yes. | Possible | Over Spec.? |

# Others for File Sharing

- Inter-site connection
  - Usually use tunneling service by a provider
  - Can use Dual-stack if it is a confirmed service.
- End-to-end environment
  - IPv6 file-server set-up
  - IPv6 configuration for terminals




Users can easily set-up file-servers, and generate dynamic groups.
IPv4 servers for each division are usually prohibited.

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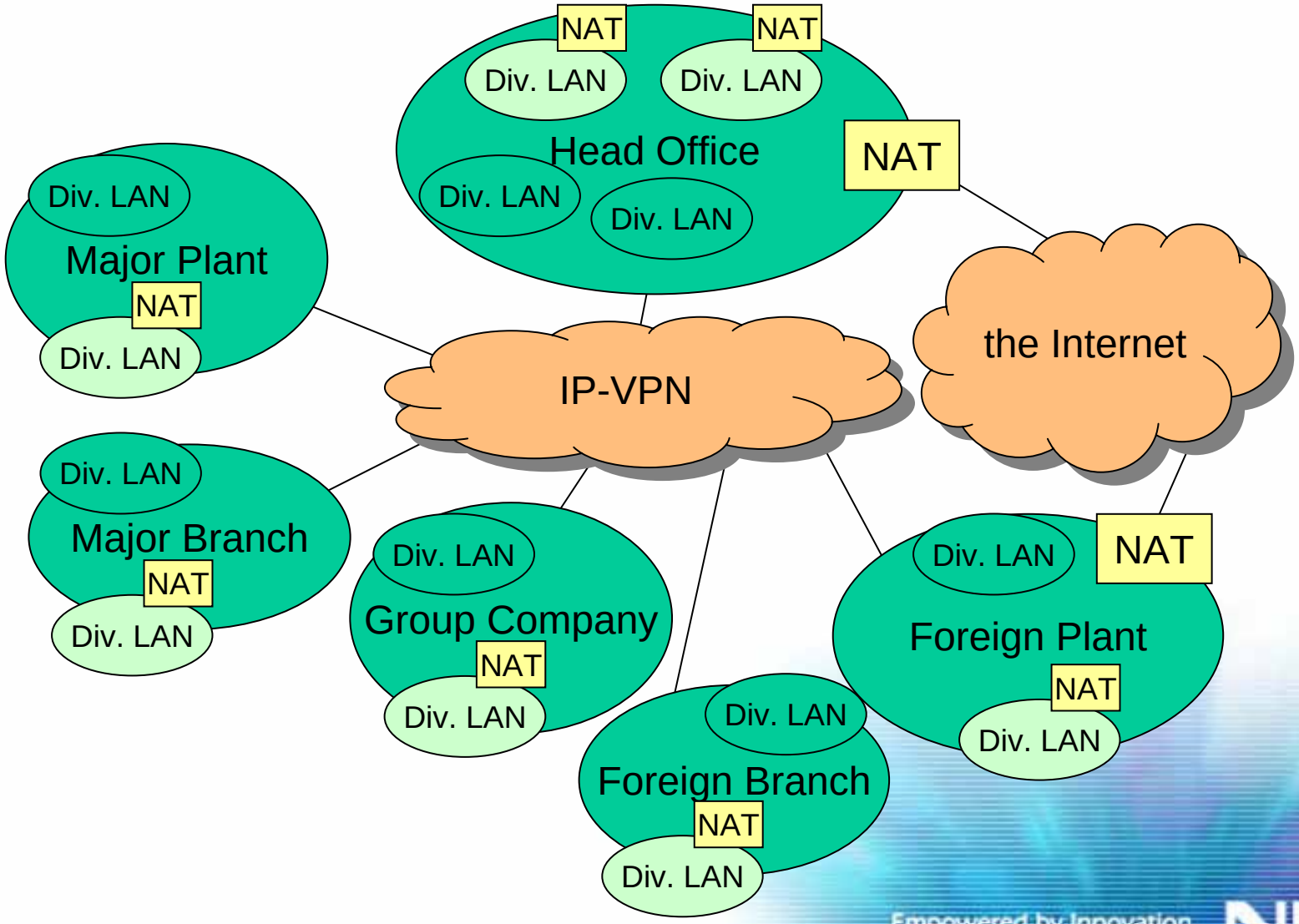
# Example Case

- This case study field is as follows.
  - Main company employs 10,000.
  - Domestic group companies employ 7,000.
  - Foreign group companies employ 5,000.
  - IP-VPN is used for WAN.
  - Network structure is tree headed by the head-office.
  - Each division uses NAT because of address conflict.
  - Major foreign offices are directly connected to the head-office.
  - Internet connectivity:
    - Domestic offices are via the head office.
    - Foreign offices are via major foreign office.

| | Number of sites | Number of employees | sum |
|---|---|---|---|
| Head Office | 1 | 5000 | 5000 |
| Major Plants | 5 | 700 | 3500 |
| Major Branches | 15 | 100 | 1500 |
| | | Domestic total | 10000 |
| Domestic Group Companies | 10 | 700 | 7000 |
| Foreign Major Plants | 5 | 700 | 3500 |
| Foreign Major Branches | 15 | 100 | 1500 |
| | | Foreign total | 12000 |
| | | Total | 22000 |

# Intranet Structure



# Motivation and Problem

- Motivations
  - Obtaining IP-phone merits
    - Simplifying network structure
      ＝Unification of telephone and IP networks
    - Total cost reduction
    - Some enhanced functions
  - Network flexibility for external environment
    - Enterprise M&A
    - Division re-structuring
- Problems
  - Address conflict when enterprise unification occurred
  - Address lack as terminals increase
    ＝Complication of sub-network structure
  - Increase of management costs

# Comparison between IPv4 and IPv6 (1/2)

Check points when building VoIP network using IPv4 private or IPv6 global

| | Item | Positive aspects | Negative aspects |
|---|---|---|---|
| IPv4 | Address assign-ment from ISP | Not necessary | – |
| | Address re-numbering | No problem if proper design is achieved | Possibility of re-numbering operations |
| | NAT | Necessary for NAT equipment or NAT setting on routers | -Increase of managed items<br>-Not managable beyond NAT<br>-Restriction of applications |
| IPv6 | Address assign-ment from ISP | Infinite address space once a global address assigned | Necessary for obtaining a global address |
| | Address re-numbering | Not necessary | – |
| | NAT | Necessary neither NAT equipment nor NAT setting on routers | – |

# Comparison between IPv4 and IPv6 (2/2)

- Building VoIP intranet by using IPv4 is possible
  - making use of proper NAT equipment or settings
  - address planning is achieved
  - re-numbering design cost will be necessary for long time
- Using IPv6 is optimum for medium/long range
  - Not necessary for NAT equipment
  - Not necessary for re-numbering design cost
- P2P through Internet is easy
  - depends on the enterprise security policy

Building IPv6 VoIP intranet is preparation for a next generation communication network.

# Cost Analysis (1/2)

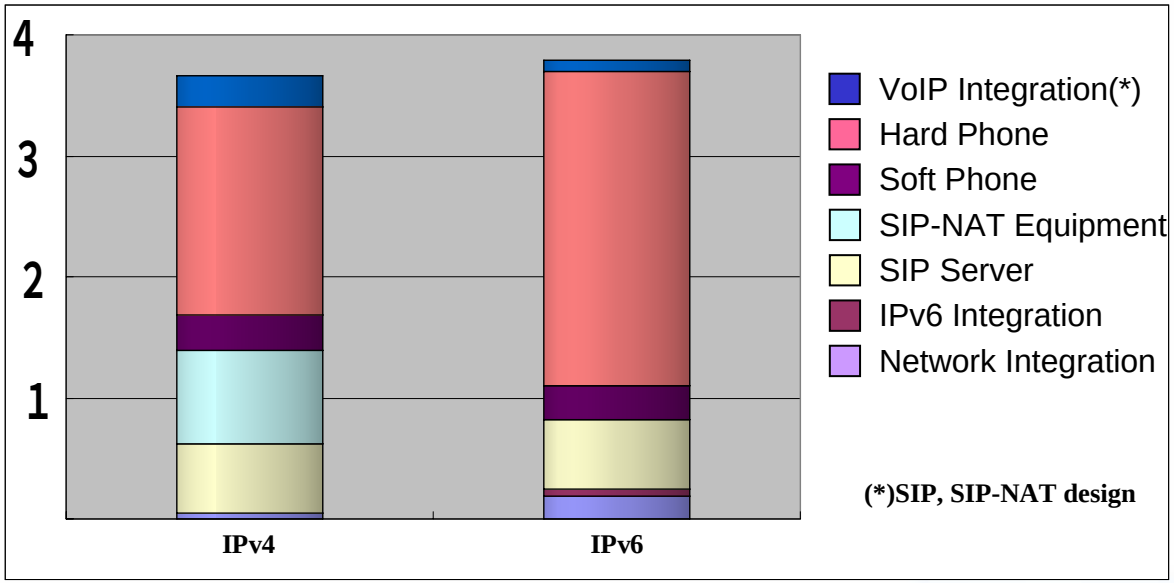
- It may be better IPv6 VoIP. But, how about costs?

- Assume that VoIP network is newly built
  - IPv4 intranet exists (number of equipment)
    - Core routers/switches(125)
    - Other routers/switches(4300)
  - Dual-stacked version-up
    - core routes/swtches(125)
  - Address assignment cost for SIP terminals are considered
  - Hardware/software SIP terminal = 1:1
  - SIP-NAT equipment is necessary for NAT gates
- Initial cost
  - SIP server(1)
  - SIP NAT(160)
  - SIP terminals (hard, soft= 11000 , 11000)
  - Integration cost
    - IPv4: VoIP design, NAT design and SIP-NAT design
    - IPv6: IPv6 design cost
- Running cost
  - Management cost
  - Maintenance cost

# Cost Analysis (2/2)

## Initial Cost

**There are little difference between IPv4 and IPv6.**




## Running Cost

**The difference between IPv4 and IPv6 is SIP-NAT maintenance cost.**

***Here, IPv6 initial cost difference will be recovered within a year.***

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# Example Case

- Assume as follows
  - Main company employs 10,000.
  - Domestic group companies employ 7,000.
  - Live streaming using satellite channel
  - Delivery sites in main company: 20
  - Delivery sites in group companies:10
  - Group companies connect with the intranet of main company

| | Number of sites | Number of employees | Sum |
|---|---|---|---|
| Head Office | 1 | 5000 | 5000 |
| Major Plant | 5 | 700 | 3500 |
| Major Branch | 15 | 100 | 1500 |
| Group Compnay | 10 | 700 | 7000 |
| | | Total | 17000 |

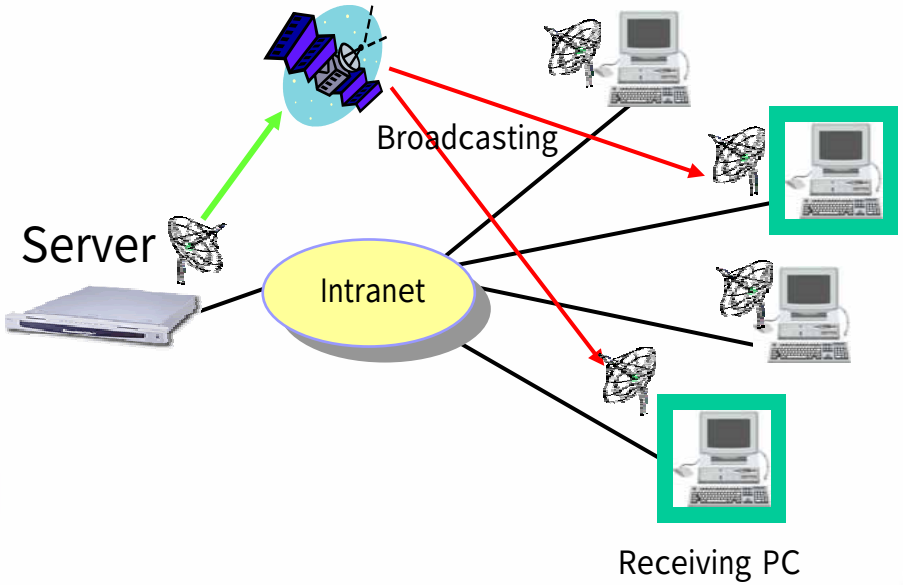
# Live Delivery by Satellite and IP

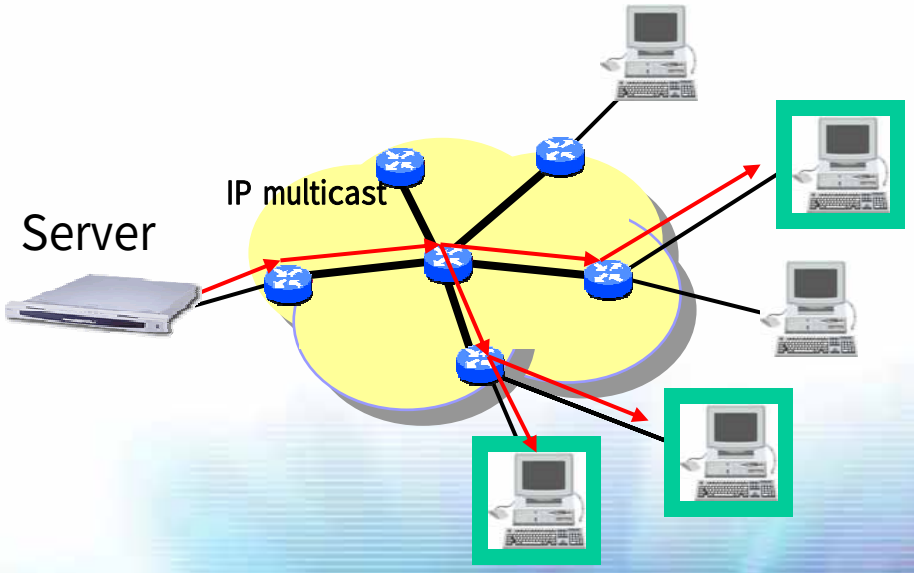
## Satellite broadcasting

- Suitable for broad areas, huge number of sites because of wireless broadcasting
- Necessary number of channels should be contracted.

## IP multicast

- Traffic does not increase as terminals increase because of multicast
- Saving server resource because of sending one stream to many clients




Existing Solution

Transition?

Next Solution?

# Comparison between Satellite and IP

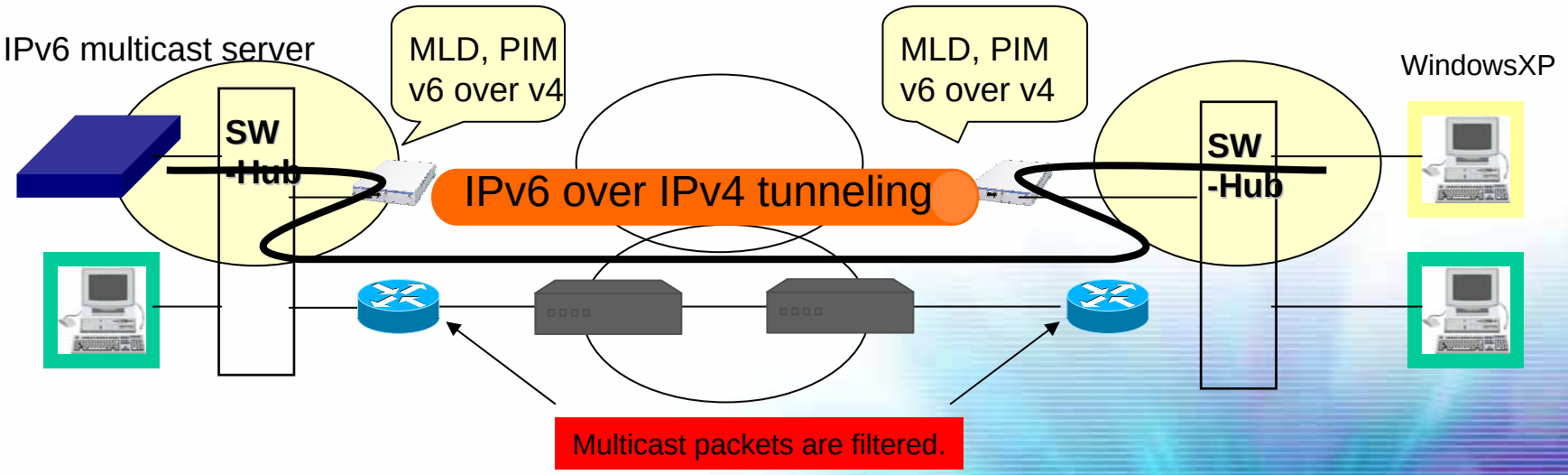
Check points when building IP multicast network

| | Item | Positive aspects | Negative aspects |
|---|---|---|---|
| Satellite | Live delivery function | Be able to receive everywhere if the receiver is placed | Fix number of channels based on the contract |
| | Flexibility | – | Fix number of channels, Limited source (ex. studio) |
| | Cost | – | Expensive, Fixed cost |
| IP multicast | Live delivery function | Be able to receive everywhere if the intranet is reachable | – |
| | Flexibility | Flexible number of channels, Unlimited source (IP reachable) | – |
| | Cost | IP multicast version-up is required, but not expensive. | Intranet is required, if there are not IP-reachable. |

# IPv6 multicast using IPv6 over IPv4 tunneling

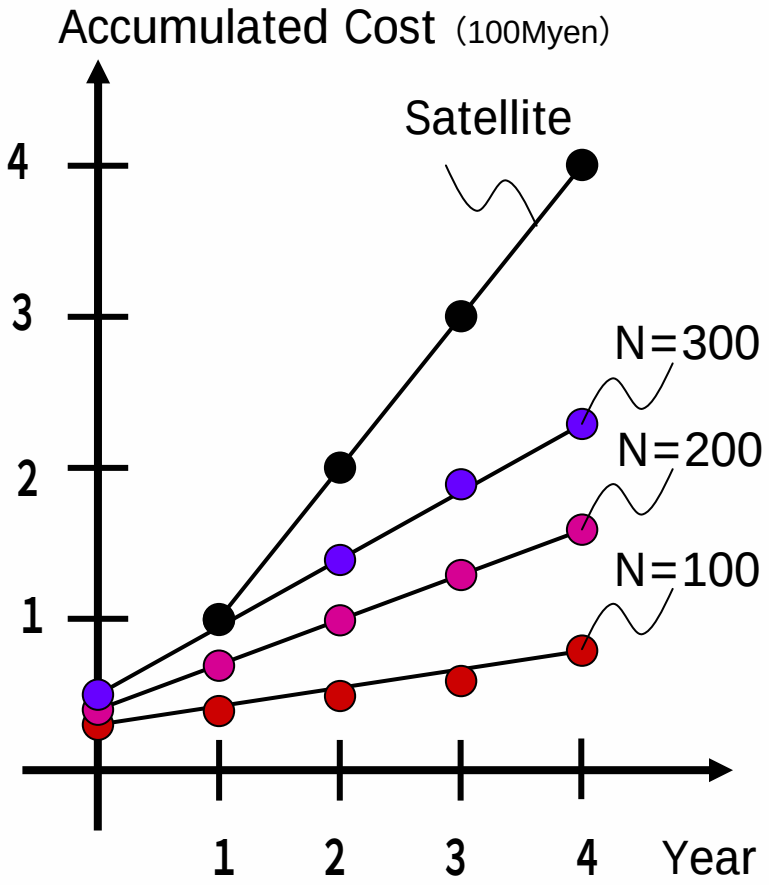
## Why IPv6 using tunneling?

- IPv6 multicast version-up for all core routers is costly in one time.
- And, division firewalls cannot pass multicast streaming.
  Solution：Deliver IPv6 multicast using (IPv6 over IPv4).
  Feature:
  - Easy to pass division firewall



# Cost Analysis

- IP multicast using tunneling is cost effective during IPv6 transition.




| | IP-multicast | |
|---|---|---|
| Initial Cost | 500 | IPv6 tunneling routers |
| | 20×N | IPv6 tunneling termination routers |
| Sum(10Kyen) | 500+20*N | |
| Running Cost | 50 | IPv6 tunneling aggregation router |
| (/year) | 10×N | IPv6 tunneling service |
| | 2×N | IPv6 tunneling termination routes |
| Sum(10Kyen) | 50+12*N | |

N: Number of sites where tunnel terminated

# IPv6 Address Assignment

- IPv6 assignment for VoIP and streaming networks

| Method | Uniqueness | ISP-Independent | for VoIP or Streaming | Note |
|---|---|---|---|---|
| /48 Assignment from ISP | Yes. | No. | Possible | Recommended |
| Temporary Assignment | No. | Yes. | Impossible | Not recommended |
| 6to4 Assignment based on IPv4 | Yes. | No. | Temporarily Possible | Only for Intranet |
| /32 Allocation as a LIR | Yes. | Yes. | Possible | Maybe recommended for huge enterprises |

# Consideration of Case Studies

- Flexibility for changing, which will be occurred M&A, re-structuring and etc., is required.

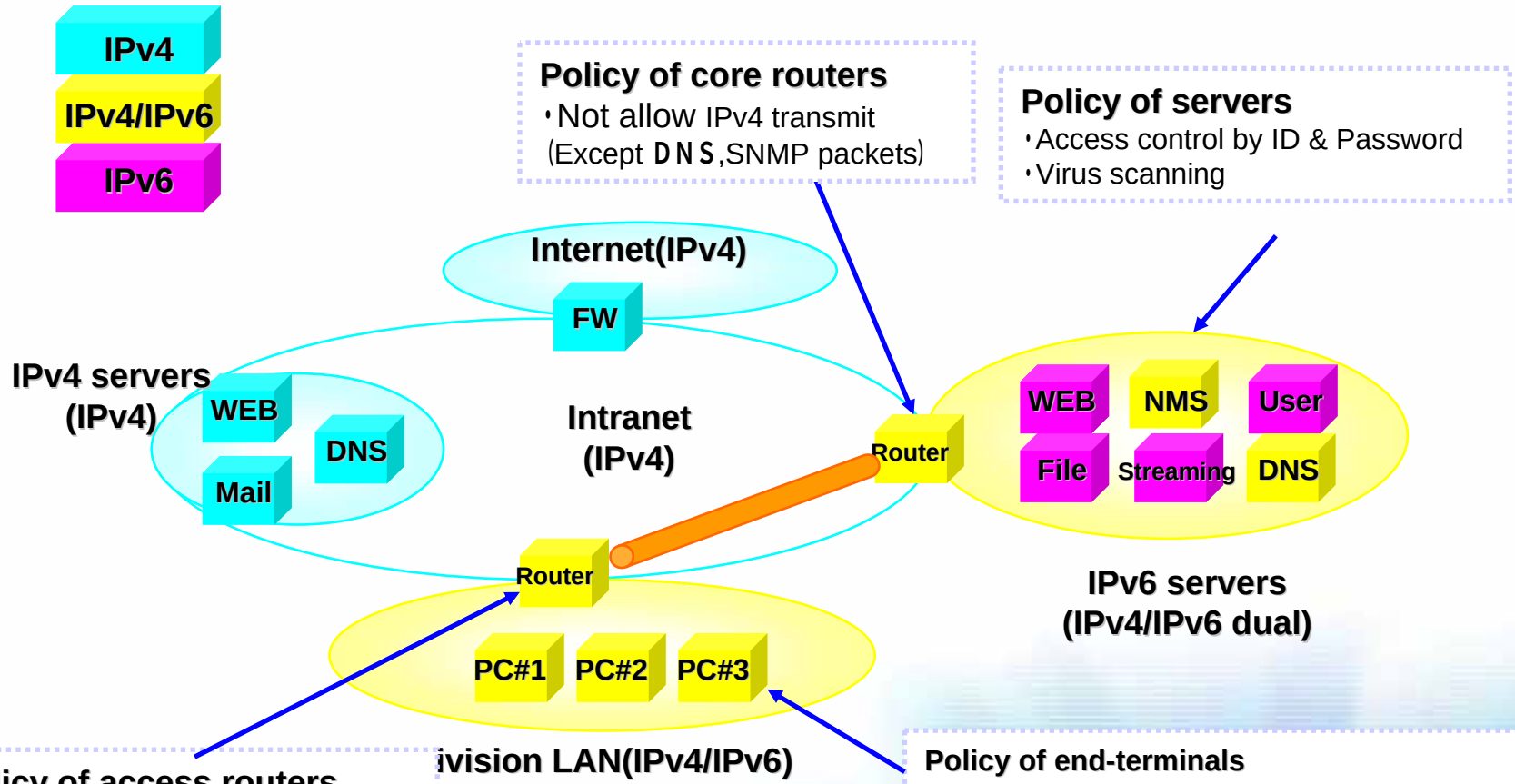
**If IPv4 will be used, design and operation costs are continuously increasing.**

- If P2P applications and other application, which have impacts to the existing networks, will be introduced, IPv4 networks will not work.

**The simple and optimized networks are required, that can enable new applications such as P2P and multicast, etc.**

# Contents

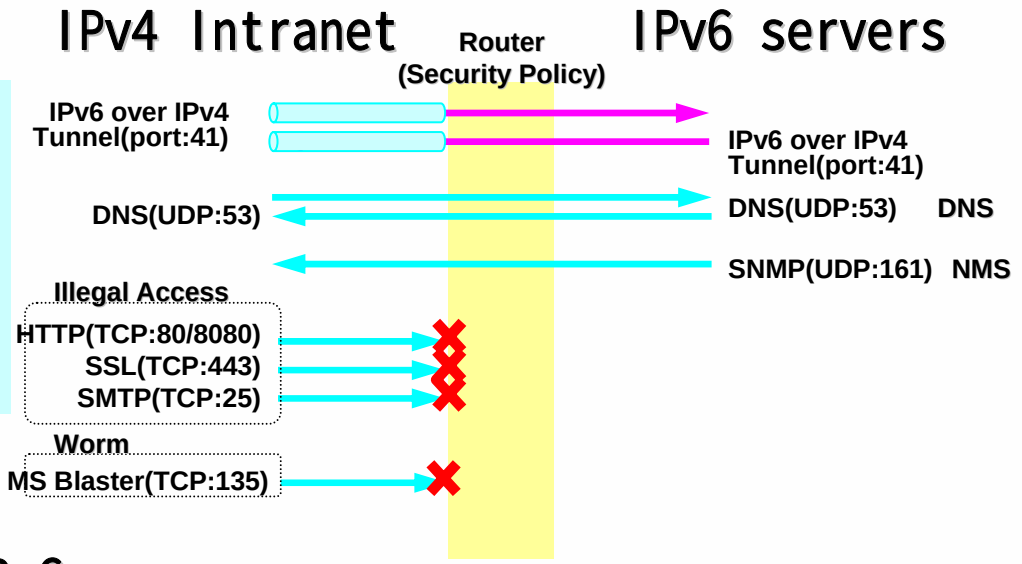
# Example of Security Policy

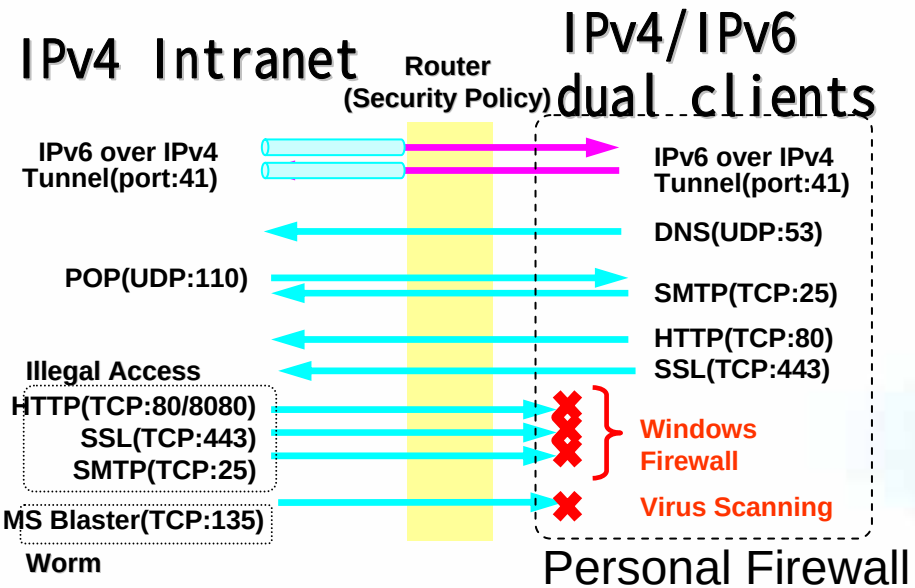


# Packet Filtering Policy

## Server segment

- IPv4 attacks are eliminated because of IPv6 native operation (exception exists)
- Some protocols (DNS of Windows, SNMP) use IPv4 transport




## IPv6 / IPv4 dual clients

- IPv4 filtering for IPv4 existing services (E-mail,WEB, etc.) is not changed.
- IPv6 access by domain-name used existing DNS server
- IPv6 filtering is basically not used.
- Each personal firewall is activated for illegal accesses or worms.

# Problems of Terminal Management

Issues in Enterprise Network

- Address management
  - Anonymous address makes difficult to manage terminals.
- Software-update management
  - O.S. and Software version should be maintained because of security issues.
- PFW (Personal firewall) configuration
  - PFW should be maintained properly, so that each user may not change the configuration.

**To solves above problems, some terminal management methods is required for enterprise propagation.**

# Another Meaning of IPv6 Introduction

- The first step of the next generation networks

【Before Integration】

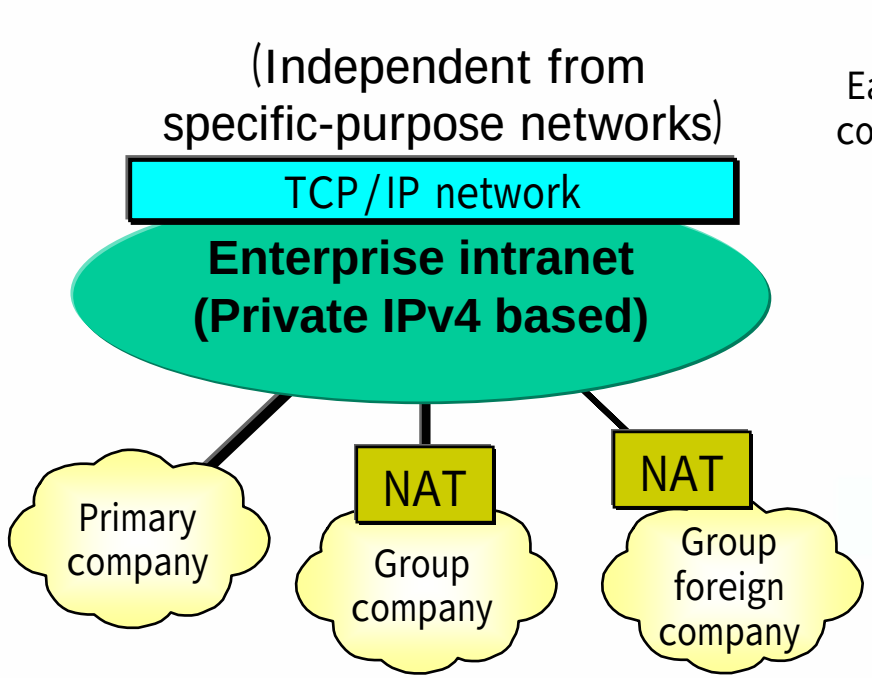
・Not seamless network by NAT,F/W
→Difficult to introduce SIP, multicast, etc.

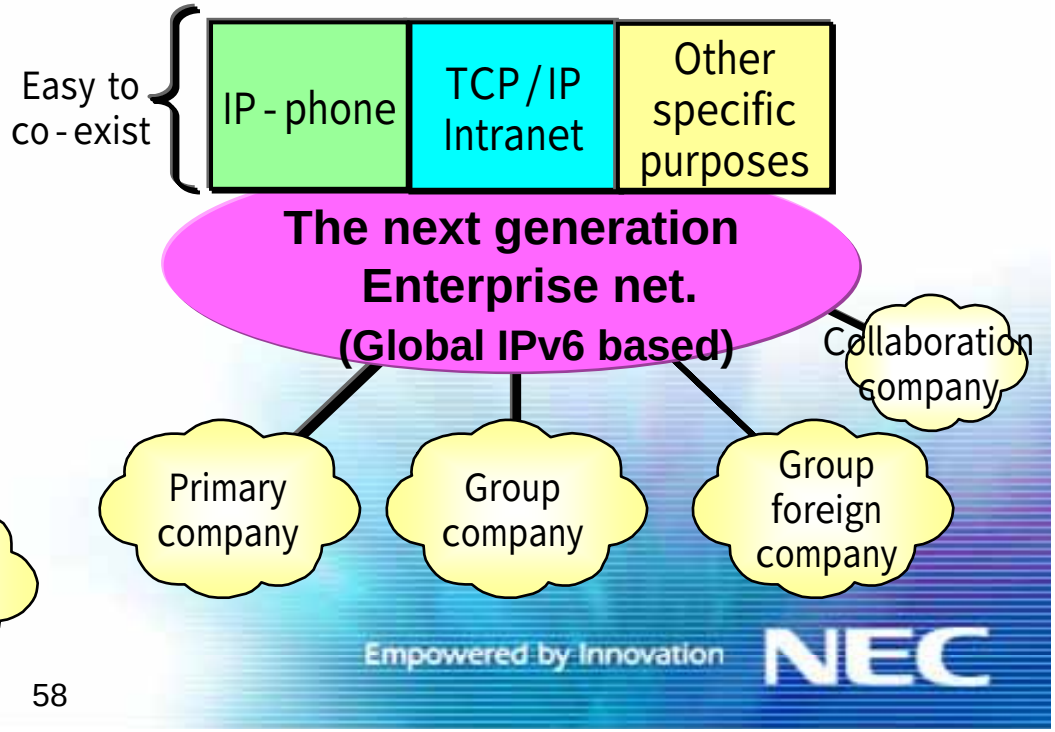
・Other networks are required for specific purposes.

【After Integration】

・Easy to build a seamless network by IPv6
→Easy to introduce SIP, multicast, etc.

・Possible to integrate specific networks



# Summary

- Case studies:
  (1) IPv6 intranet building
  – File sharing service maybe useful.
  (2) VoIP network building
  – VoIP introduction costs for an enterprise using IPv4 and IPv6 have little difference.
  – But, medium-long range costs may increase in IPv4.
  (3) Streaming network building
  – IPv6 tunneling technique is useful for cost reduction.
- It is time for transition !
  – It is better to introduce a small part of the intranet to get IPv6 transition know-how.
  – Next, let's build new VoIP, streaming, etc. networks for creative works !

Thank you.

Any questions?

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