Yahoo! Broadband case study for IPv6 deployment

Introduction

Introduction

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- In the transition state from IPv4 to IPv6, we should consider
  - We cannot assign new global IPv4 addresses for new subscribers
  - The network (particularly access NW) may have only IPv4 capabilities or only IPv6 capabilities
- There are many deployment solutions for such cases
  - IPv6 over IPv4, IPv4 over IPv6 and Protocol Translation, etc.,
- Requirements of each network provider are different depending on various factors, so appropriate solutions are also different
  - For existing user or new user?
  - For existing infrastructure or newly deployed infrastructure?
  - For IPv4 only network or IPv6 only network?
- This presentation shows our case study for the transition at Yahoo! Broadband (Y!BB) which is one of largest ISPs in Japan

Common requirements for all ISPs

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- We should provide both of IPv4 and IPv6 connectivity
- No more IPv4 global address in near future
- No additional ARPU by IPv6 nor sharing global IPv4 address, so additional CAPEX and OPEX should be minimized
- Keeping a record of IP address assignment (and port assignment if NAPT will be used) is mandatory and should have good scalability

Overview of Japanese ISP industry

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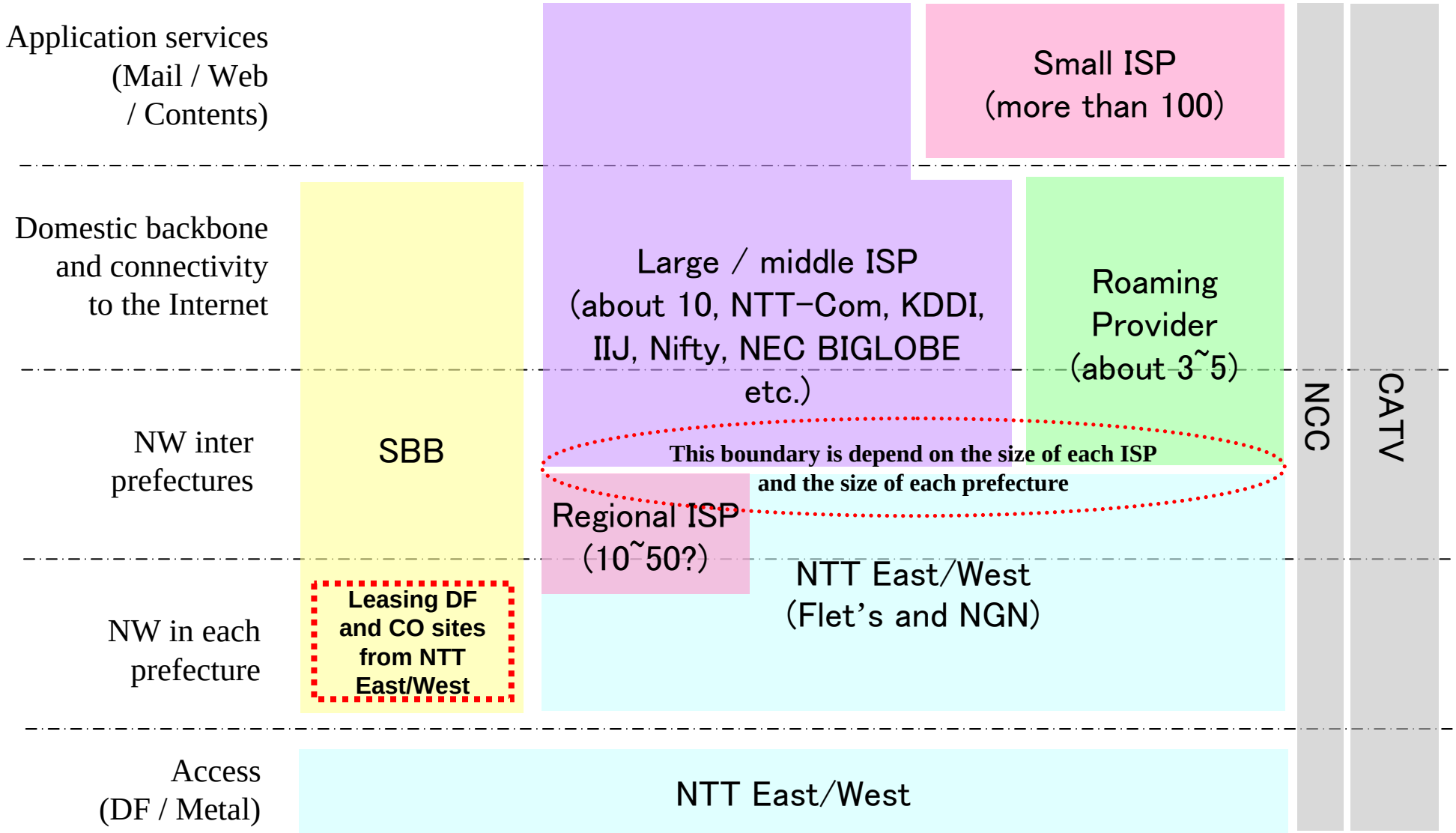

Current situation of Y!BB

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- **Y!BB has two different types of access network**
  1. **ADSL access network**
  2. **FTTH access network**

- **ADSL access network**
  - **Pure IP-based access network (not PPPoE based)**
  - **We built L3 network by ourselves, leasing L1 or L2 circuits from NTT and other carriers**
  - **# of subscribers is slightly decreasing**

- **FTTH access network**
  - **NTT East and West built L3 access network, we are leasing L2 connectivity from them**
  - **# of subscribers is increasing**

ADSL access network vs. FTTH access network

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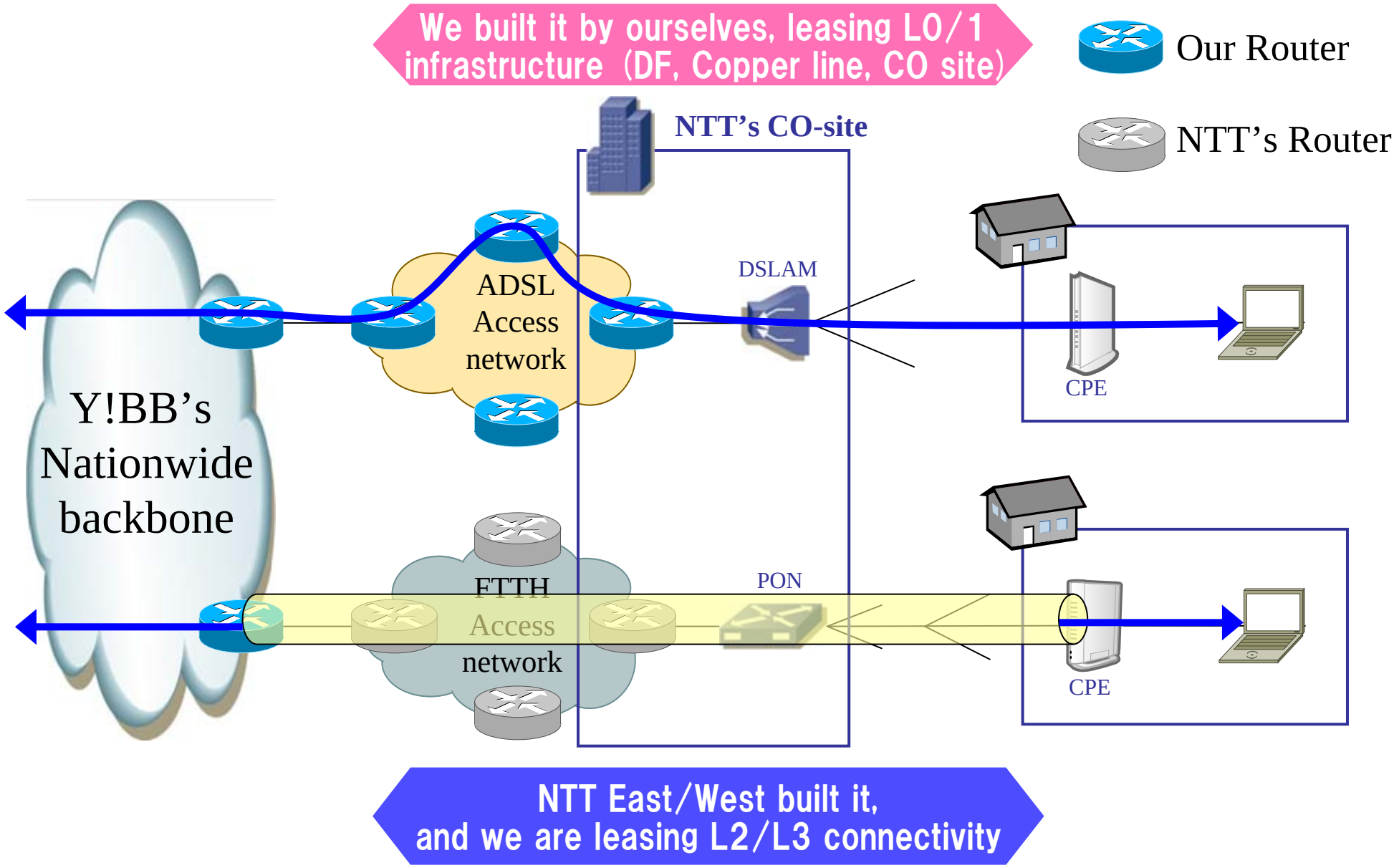

Y!BB case study
for ADSL access network

Conditions and requirements in Y!BB ADSL access network

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- Existing subscribers already have IPv4 global addresses and the # of subscribers is slightly decreasing
  - We don't need to consider how to provide IPv4 connectivity
  - Just using IPv4 global address is enough

- ADSL access network is IPv4 only network
  - Replacing or upgrading all devices to enable IPv6 is not realistic
  - We will need 6 over 4 technology to provide IPv6 connectivity

- Since we are providing ADSL modems as CPEs, we can control software in CPEs
  - On the other hand, we want to minimize configuration cost of CPEs

Our decision - 6RD -

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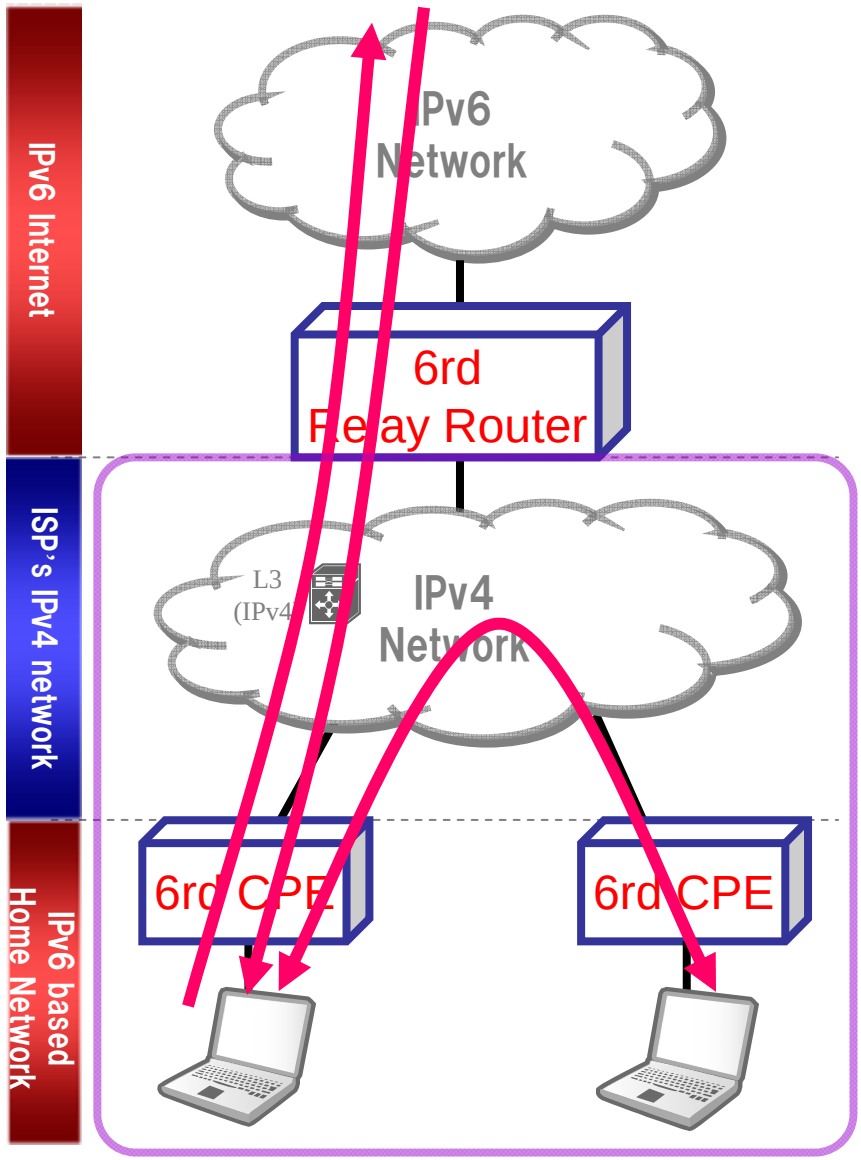

- IPv4 address is used as internal ID
- IPv6 prefix which is delegated for each subscriber is derived from global IPv4 address which is assigned for same subscriber
- CPE can automatically configure its delegated IPv6 prefix to home network
- For downstream packet, 6rd relay router can automatically form encap header from dst IPv6 address of incoming packet (without configuring a tunnel for each subs)
- For upstream packet, CPE can figure out tunnel end point (6rd relay router or other CPE) from dst IPv6 address

6rd behavior：Prefix Delegation

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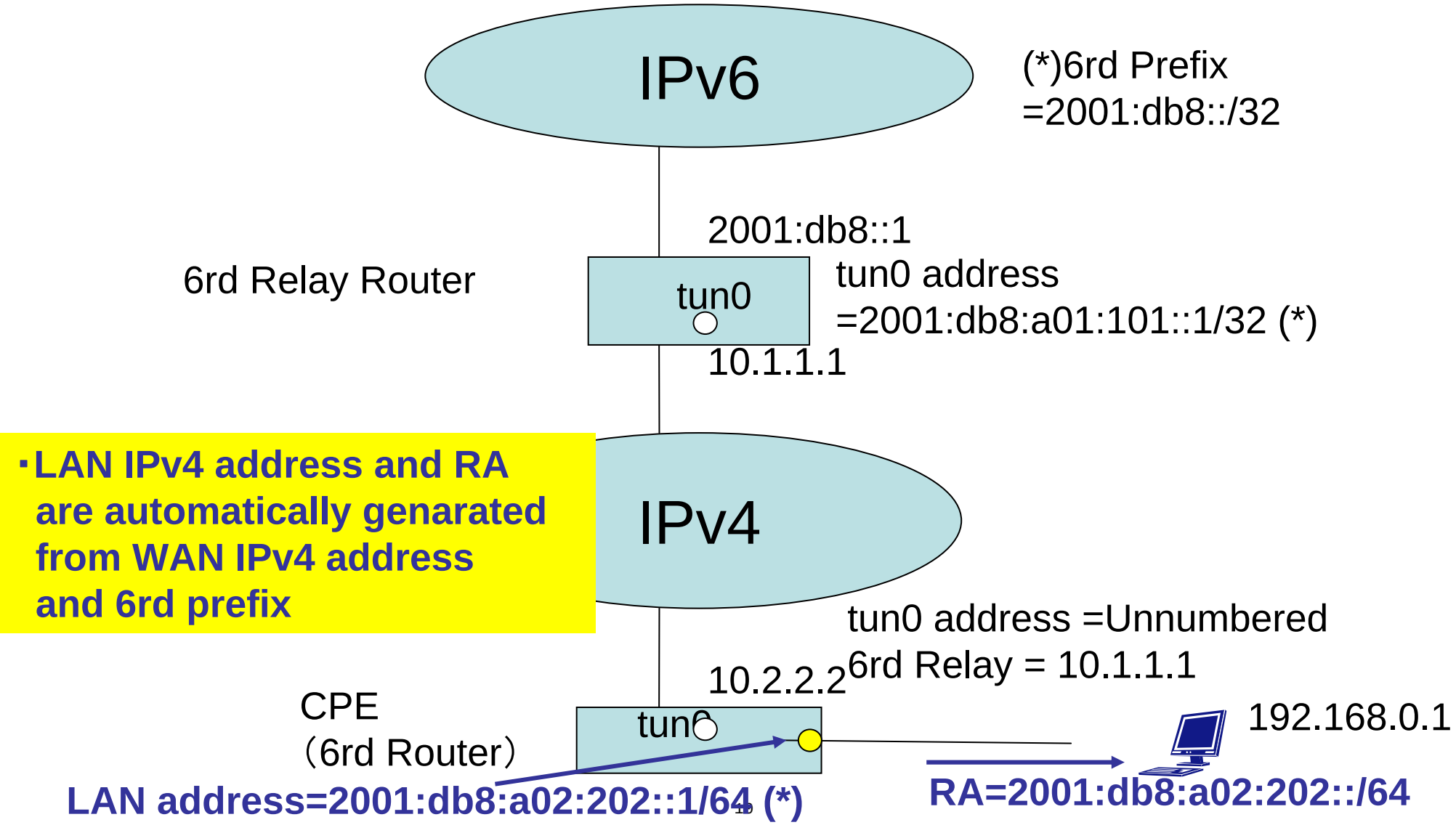

6rd behavior : Packet transfer (Downstream)

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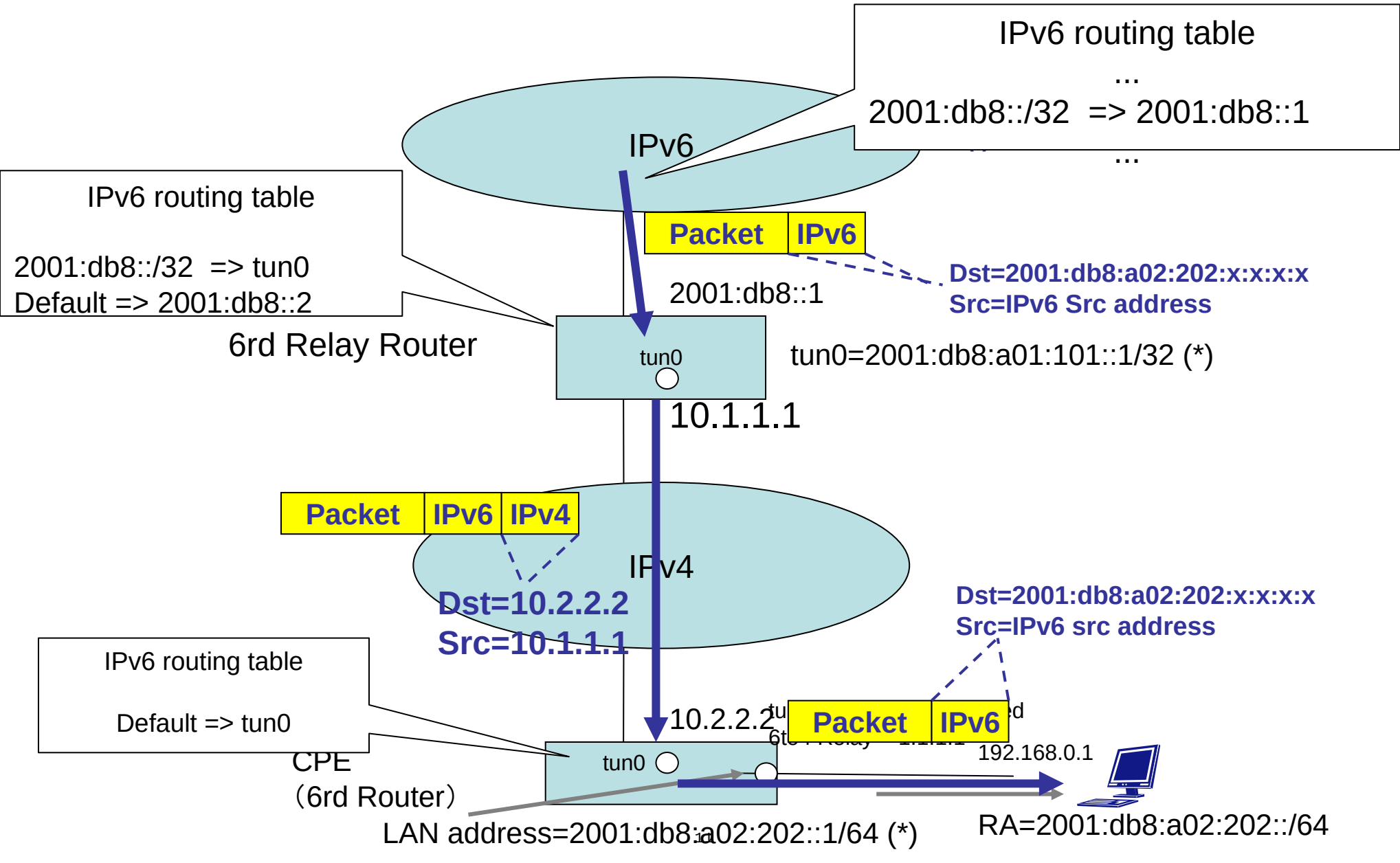
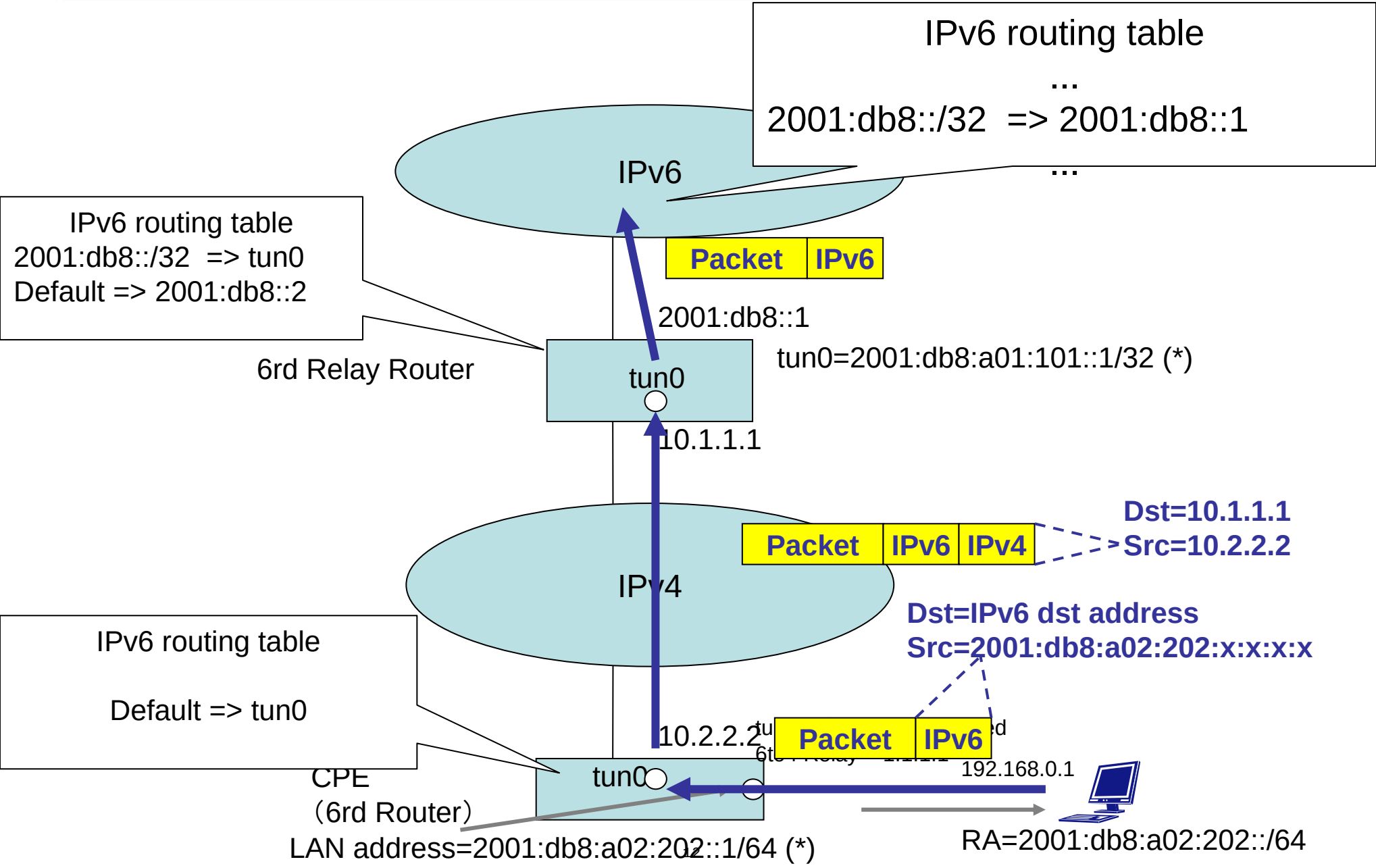
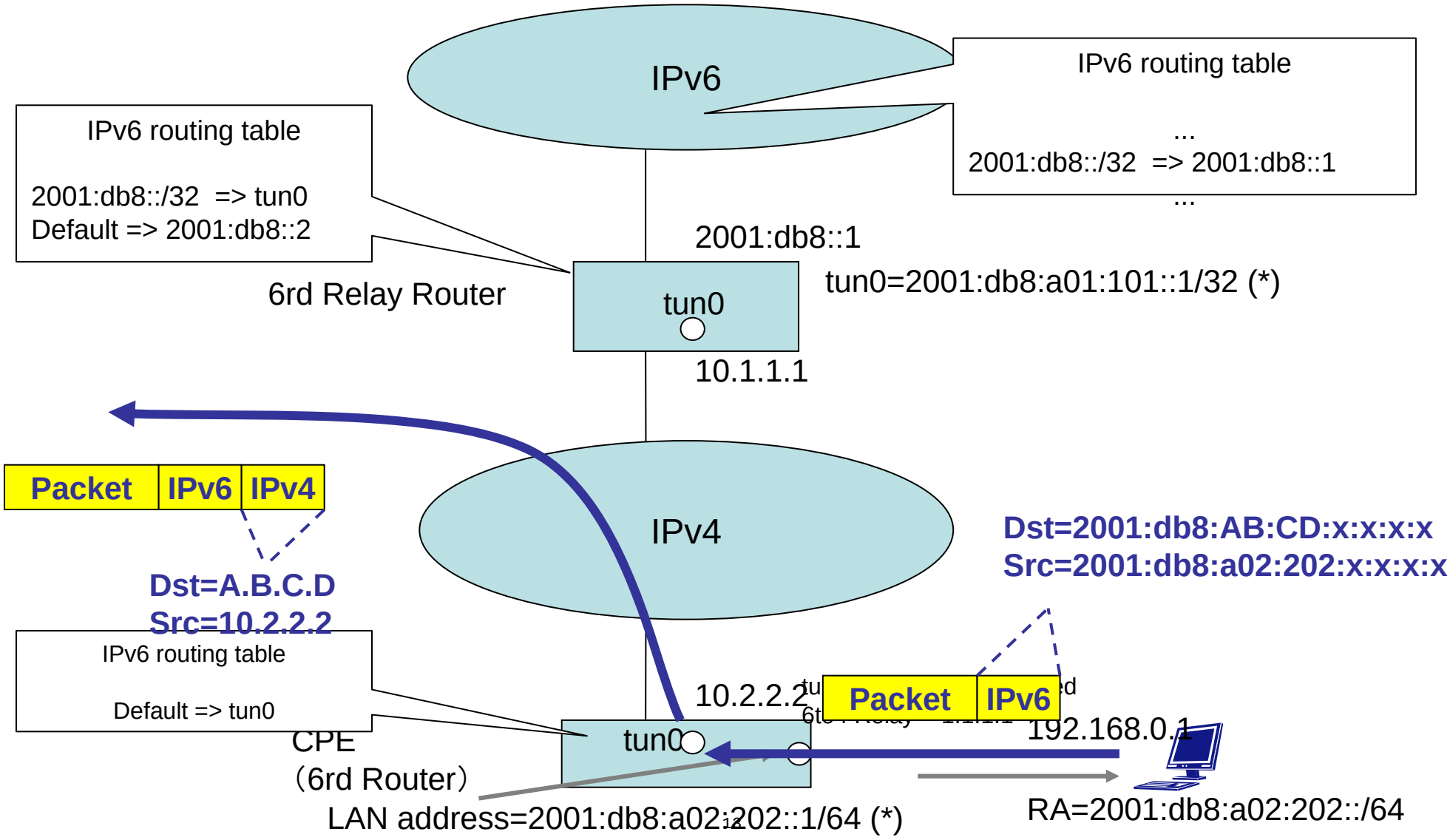


6rd behavior : Packet transfer (Upstream to external)



6rd behavior : Packet transfer (Upstream to internal)



Why we choose 6RD? - Cost Comparison -

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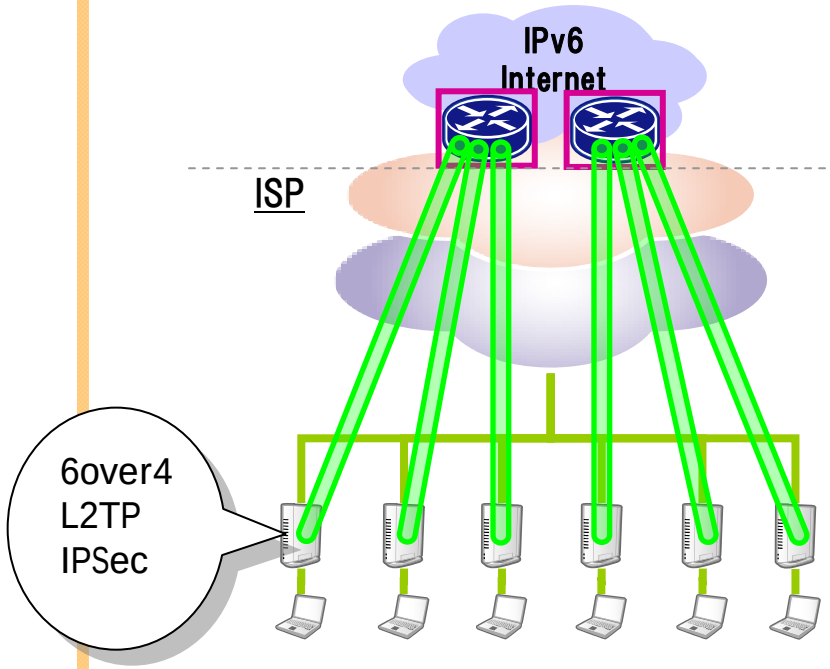
Other Solutions

Each customer needs tunnel state/config

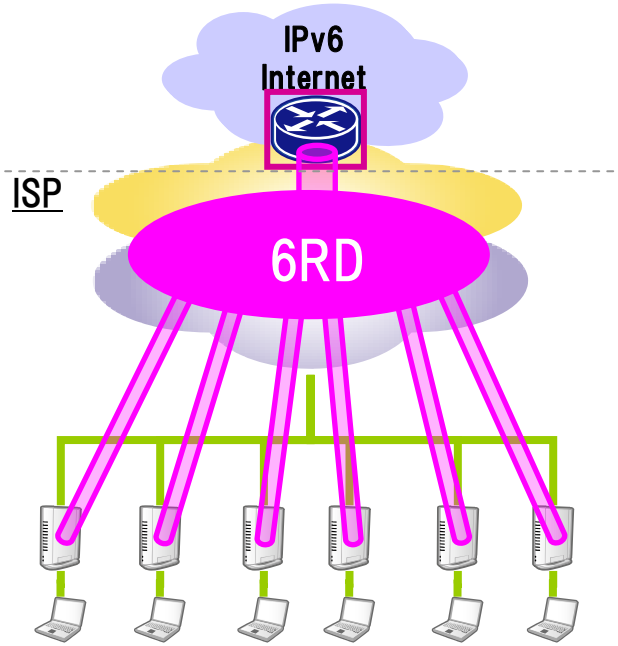


# of user linearly increases cost

CAPEX/ OPEX	Expensive!

6RD

Single tunnel aggregates all customers



Eliminate cost increase with # of user

CAPEX/ OPEX	Cost-Effective!

Facilities cost simulation with modeling method

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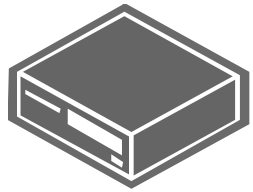
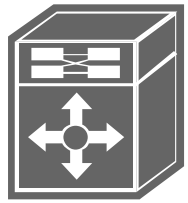
- **Server**
  - Can work as tunnel concentrator and 6rd relay server
  - Uplink 1Gbps
  - 15,000 Session
  - JPY1,500,000
    USD16,667



- **Aggregation Router**
  - Uplink 10Gbps
  - Max Aggregation 10 servers (N+1 Redundancy)
  - JPY3,000,000
    USD33,333



- **Per customer IPv6 traffic**
  - 2.3kbps

How many customers can a server have? - 6rd -

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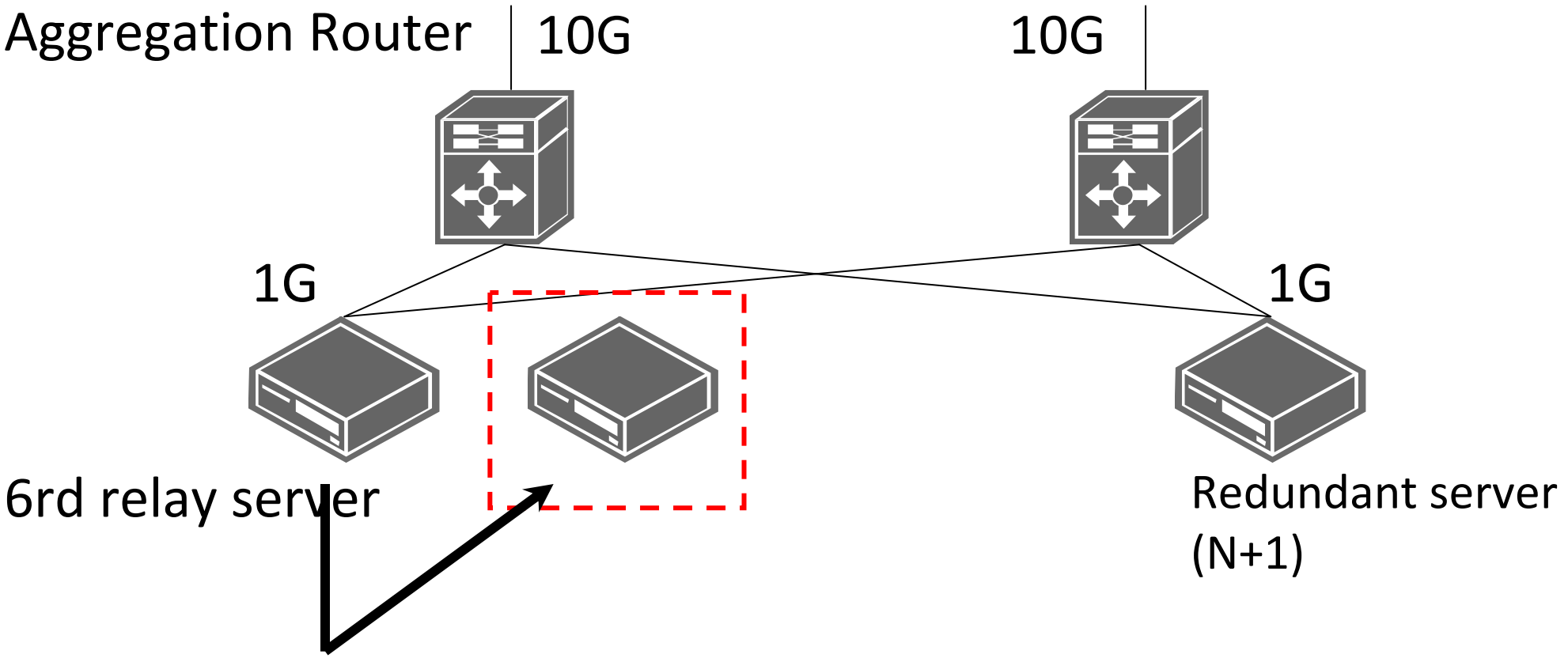

Need the server when 430,000 customers increase

How many customers can a server have?
- Other solutions -

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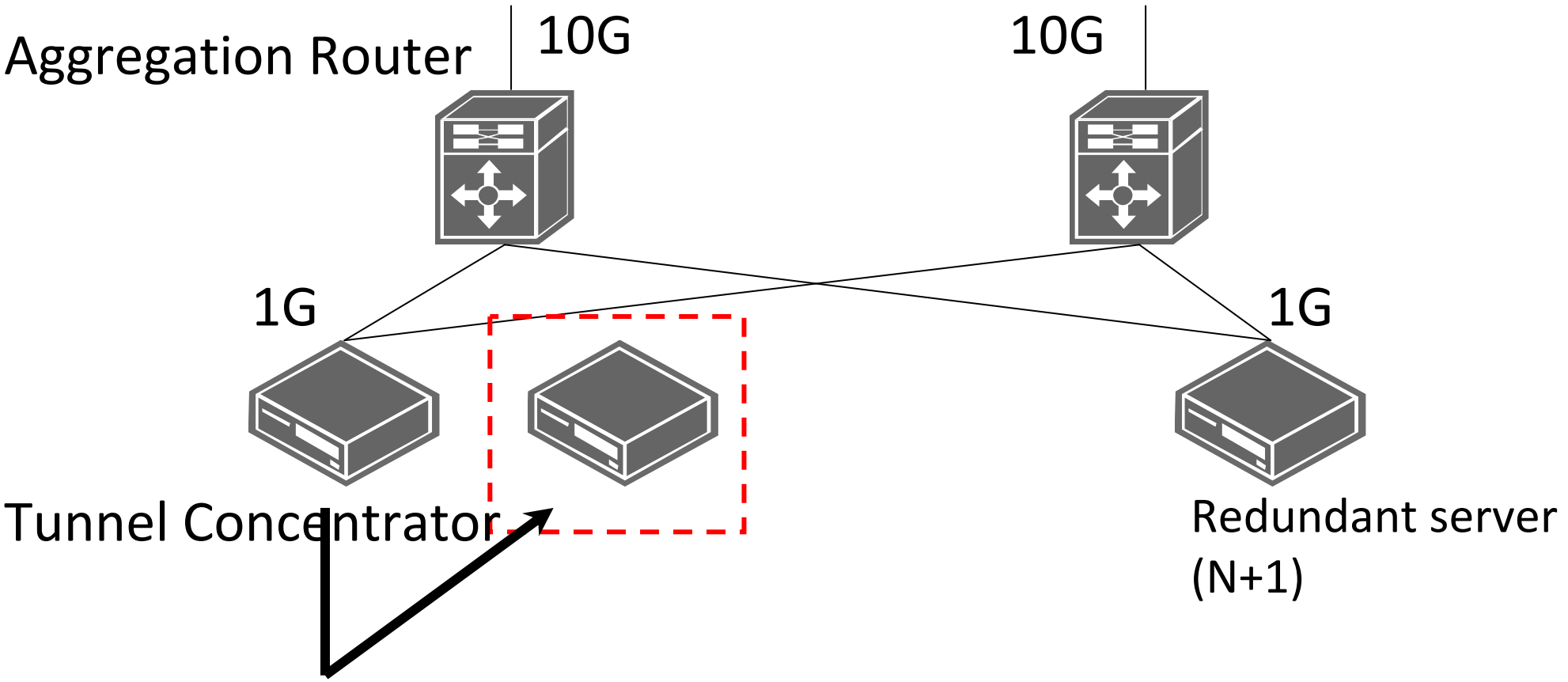

Need the server when 15,000 customers increase

How much does it cost to provide IPv6 service for One million customers?

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	6rd	Other solution
# of server	4	74
# of aggregation router	2	14
cost	JPY1,200万 USD133,333	JPY15,200万 USD1,688,888

Cost Effective!

Y!BB case study
for FTTH access network

Background

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- NTT East and West assign their own IPv6 address for each user, but this address is not for the internet connectivity

- # of customer is increasing
  - We need to provide both of IPv4 and IPv6 service over NTT's network
  - We should share a IPv4 global address between multiple customers

- Big Question
  - How to provide OUR IPv6 service over other SP's IPv6 network?
  - How to share one IPv4 address with many customers?

Two candidates for IPv6 connectivity

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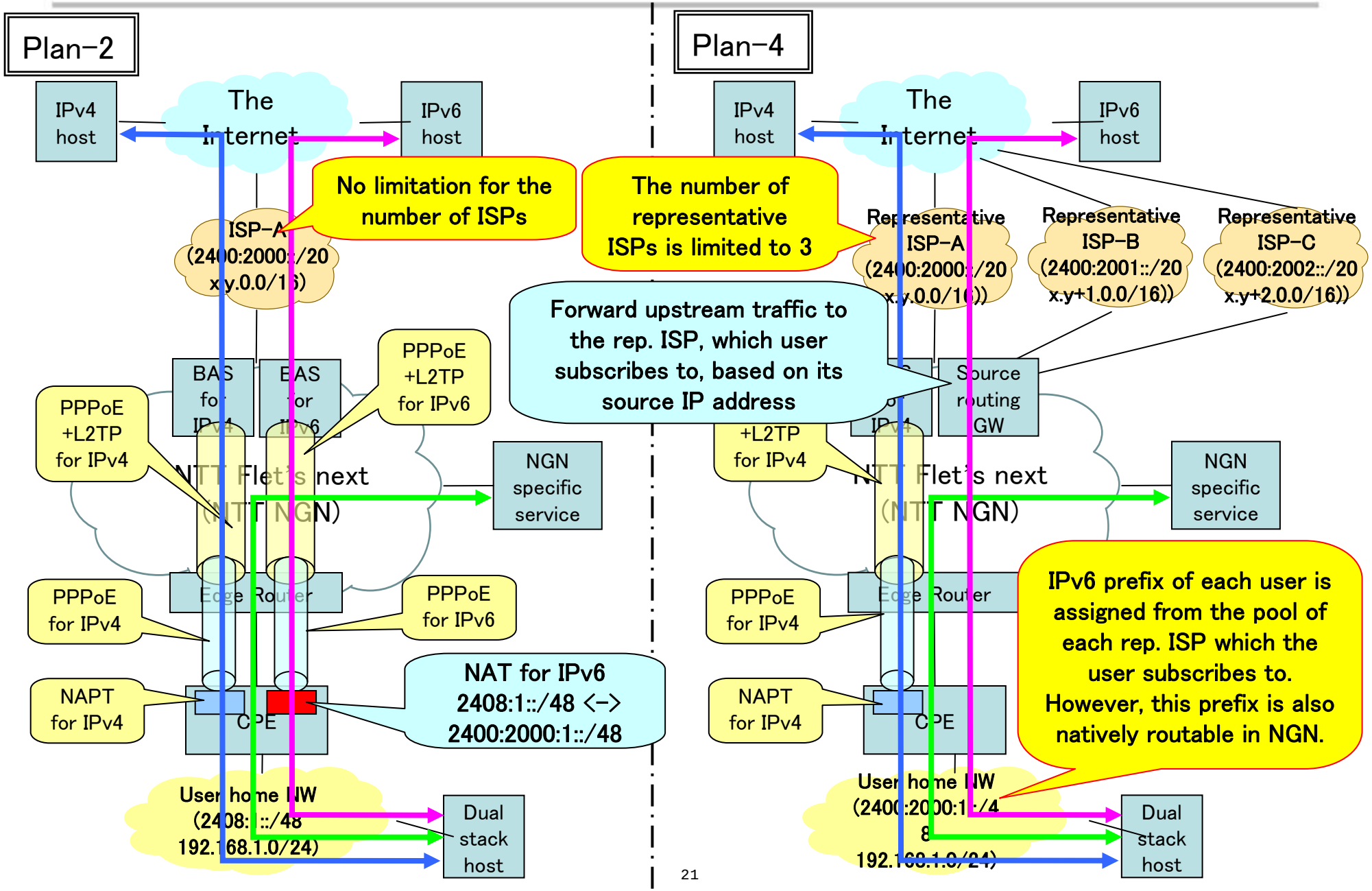

Candidate solutions for IPv4 connectivity

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- We need to provide IPv4 connectivity over IPv6 network, sharing a global IPv4 address between multiple subscribers
- Possible solutions are;
  - DS-Lite + LSN with dynamic port assignment
  - DS-Lite + LSN with fixed port assignment
  - DS-Lite + A+P
  - Etc.
- What's critical point for us?
  - Scalability for keeping a record of IP address assignment and port number assignment

LSN or A+P

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- All of them use L4 port number as a part of host identifier, in addition to IP address

- Major technical differences are;
  - Port assignment aspect
    - LSN with dynamic port assignment assigns unique L4 port number for each session whenever new session is initiated
    - A+P and LSN with fixed port assignment assign unique range of L4 port numbers for each subscriber when a IP address is assigned to
  - Location of address and port translation
    - Center side in LSN
    - CPE side in A+P

Common issues for address sharing

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- Common issues for address sharing techniques
  - Src port number should be logged to access log on server side in addition to src IP address (for abuse etc.)
  - Max number of concurrent session for each user is limited
  - Since randomness of port number is restricted, it may have some impacts for security
  - Some protocols, which contain L4 port number in its payload, may be impacted and ALGs are required
    - However, NAPT also has same issue, and we already overcame it.

- These issues should be overcame since it is common for address sharing solutions, and we believe we can do it

Scalability of LSN with dynamic port assignment

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- **Session table which LSN box with dynamic port assignment should maintain**
  - **(Size per session)= Private src address (32bit) + Private src port (16bit) +Global src address (32bit) + Global src port (16bit) = 12Byte**
  - **(Table size per million users) = (Size per session) * (Max # of concurrent session per million users) = 12Byte * 19M sessions = 228MByte**
- **Session log which LSN box with dynamic port assignment should store**
  - **(Size per session) = Private src address (32bit) + Private src port (16bit) +Global src address (32bit) + Global src port (16bit) + Timestamp (64bit) = 20Byte**
  - **(Monthly log size per million users) = (Size per session) * (Total # of sessions per million users in one day) * 180days = 20Byte * 8.6G sessions/day * 180days = 30.96TB/6month**

Even though it seems these impacts are acceptable, we still want to minimize cost since there is no additional ARPU.

Summary

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- To provide IPv6 connectivity for our ADSL access network
  - We will use 6rd since it is cost effective, scalable, and minimum CPE configurations
- To provide IPv6 connectivity for our FTTH access network
  - We will use “Plan-4” since it is more scalable for number of subscribers and doesn’t require NAPT for IPv6
  - (Please re-think more clear name > Ichiro)
- To provide IPv4 connectivity for our FTTH access network
  - Even though cost effectiveness and scalability of LSN is acceptable, we are still investigating better solution including A+P