

**From IPv4 only
To v4/v6 Dual Stack**

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First of all

- Please **do not misunderstand** the following presentation 😊
- I am going to talk about most conservative scheme called “Dual Stack”
- Our aim to examine “Large Scale NAT (as known as Carrier Grade NAT)” is just to keep our service **backward compatible** with IPv4
- **Our goal** is introduce (native) **IPv6 more widely**

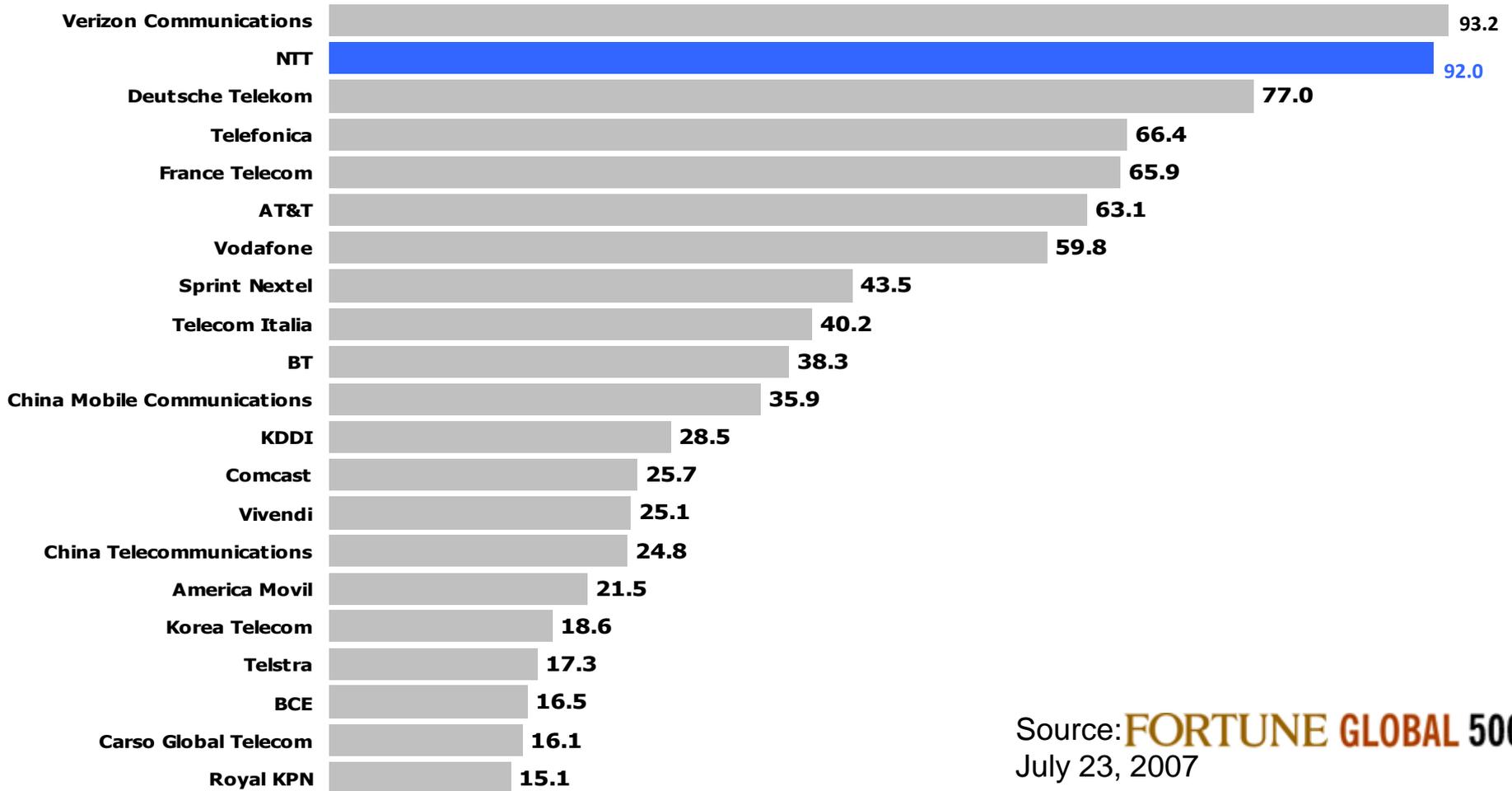
Also

- We do not think that our scheme called “Double NAT” is the best in any case.
- If we can replace our customers’ CPE router, “A+P” / “Dual Stack Lite” is better than this.
- However so, still we feel that “IPv6 + Double NAT” is **the only solution** in the case of that we **can not replace** customers’ CPE routers and it would be likely situation in various places on the Earth.

Who is NTT?

(Nippon Telegraph and Telephone)

World's Top 21 Telecom Companies by Revenue (\$US Billion)



Source: **FORTUNE GLOBAL 500**
July 23, 2007

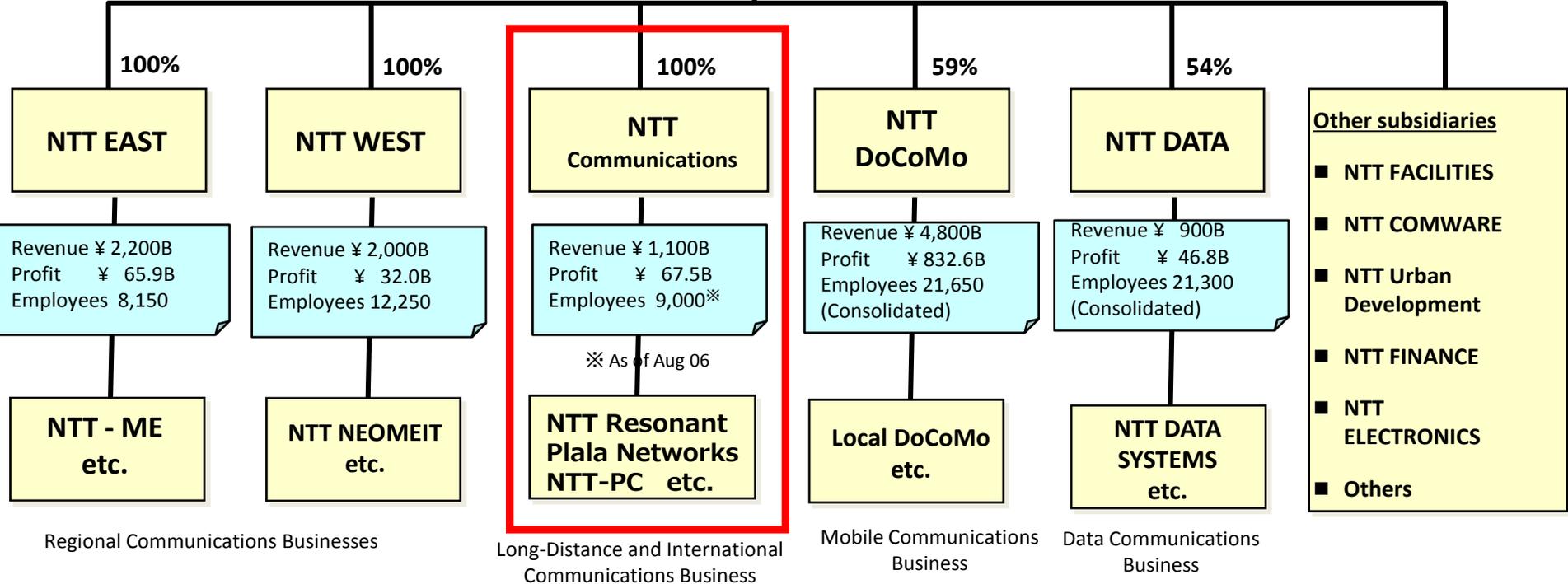
(As of Mar '06)

[NTT Consolidated]	
Revenue	¥ 10,700B
Profit	¥ 1,200B
Employees	199,100



Revenue	¥ 339B
Profit	¥ 169B
Employees	2,750

\$1 = ¥110

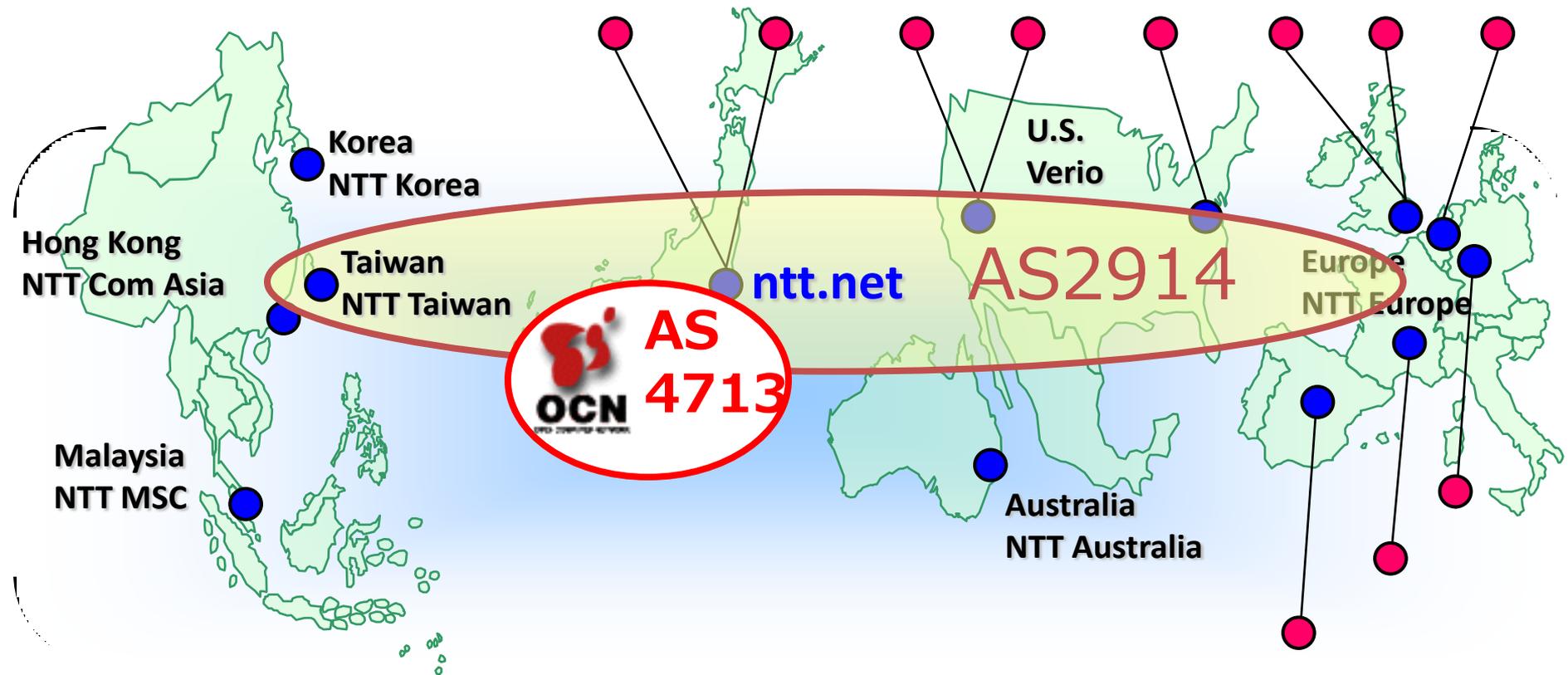


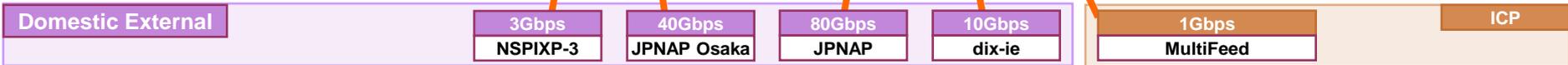
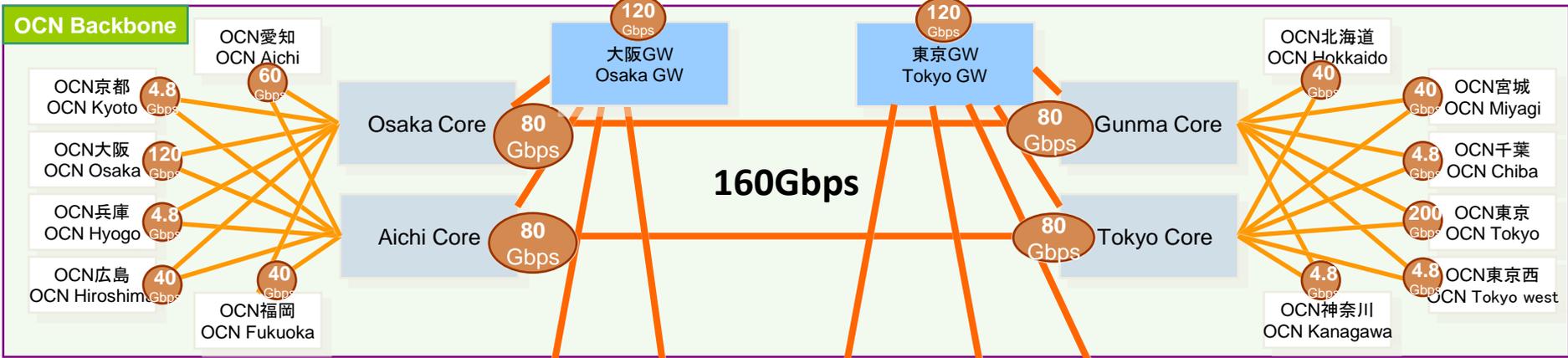
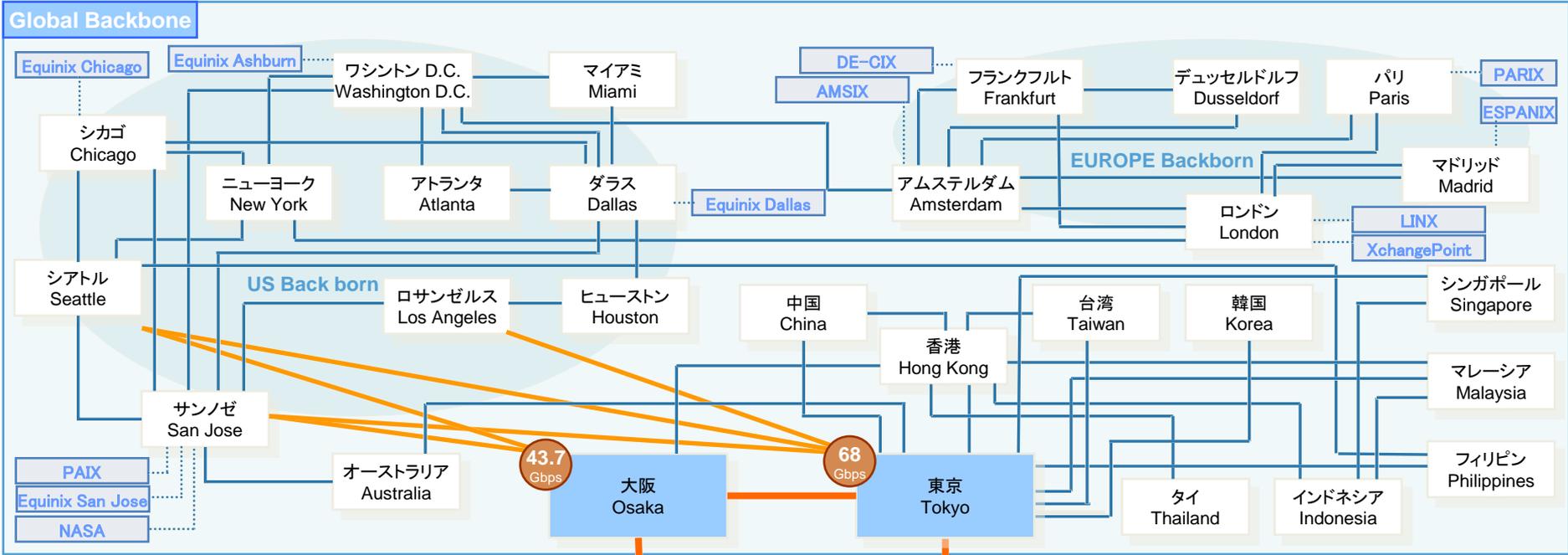
Each company is a independent corporation with independent accounting system

NTT Communications' two ASes

AS2914 (ex-Verio) as global backbone

AS4713 (OCN) as Japanese Domestic service





**Japan-US
185G**

**US-Europe
39G**

**Asia-Oceania
52G**

For details visit
<http://www.ntt.net>

(as of July 2008)



Now we also have Japan-EU (via Russian route) at 15G since last Fall

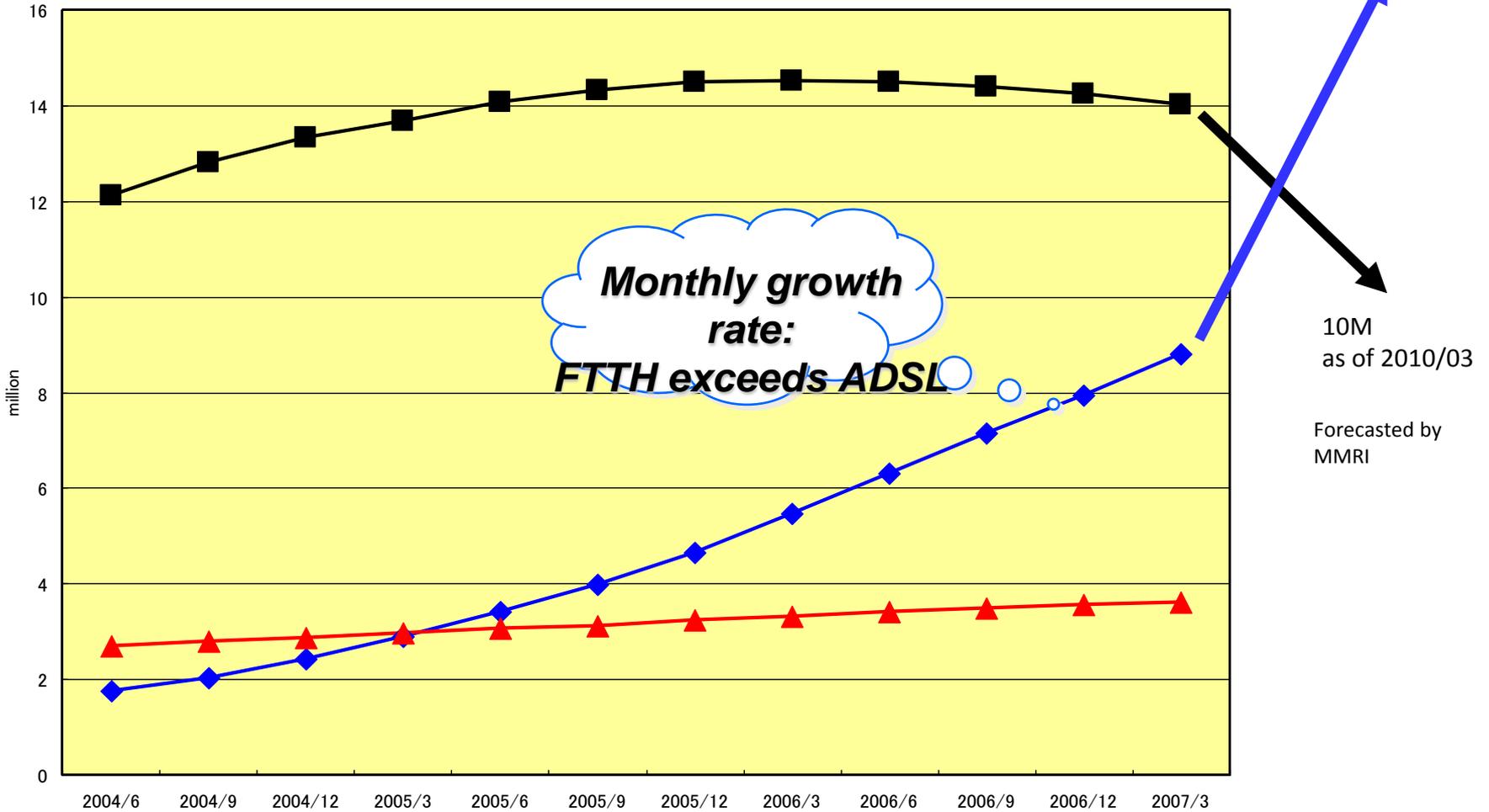
NTT Communications' IPv6 service

- almost everything is ready -

- Now
 - Leased line
 - Data center
 - Hosting
 - ADSL (native : RFC4241 + a bit enhancement)
 - FTTH (softwire [L2TP] based)
 - “Native” is on the way... 😊
 - Transit
 - And more..

■ Achieved 8.8 millions of FTTH on May 2007
 cf. Japanese national popularity: about 120 millions

■ FTTH ■ xDSL ▲ CATV



Monthly growth rate:
 FTTH exceeds ADSL

21.6M
 as of 2010/03

10M
 as of 2010/03

Forecasted by
 MMRI

The number of ISP customers is increasing, but IPv4 global address will exhaust in a few years.

Especially, the number of broadband internet connectivity service is growing. For example, annual growth of our OCN™ (Japanese domestic ISP service) broadband customers is about 700,000.

Also if dial up customers will be converted to always-on broadband, about 10 times larger IP address space will be needed for it.

So, **to keep our business grow**, we need to provide customers with **IPv6 service**.

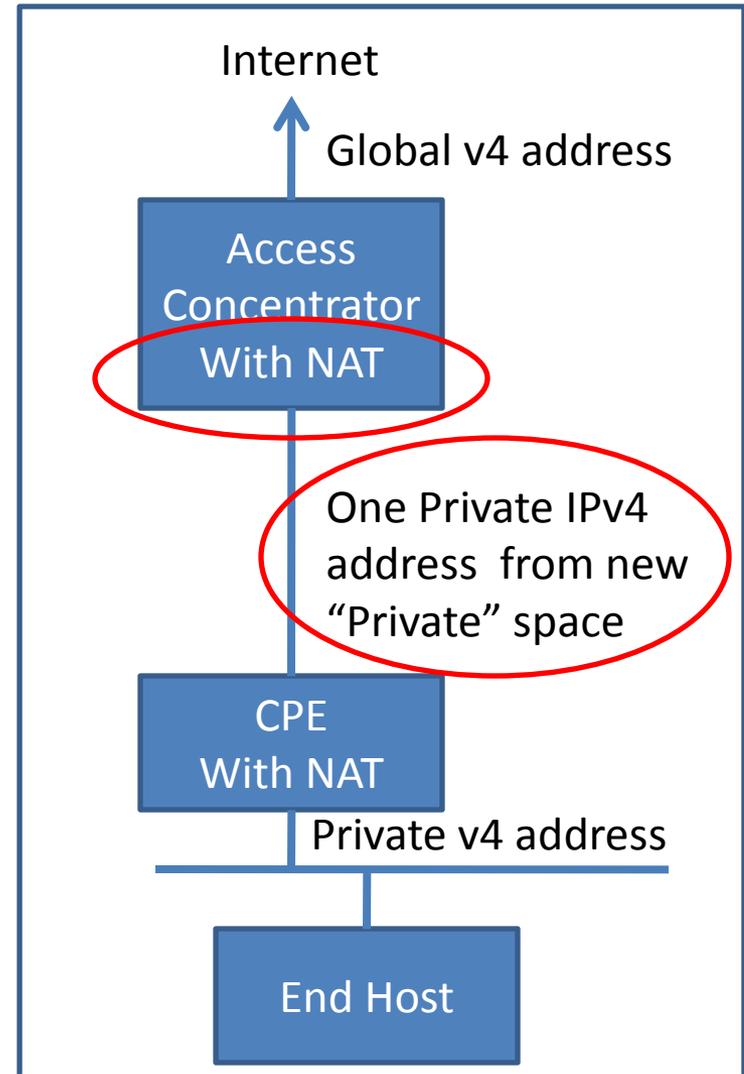
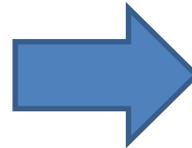
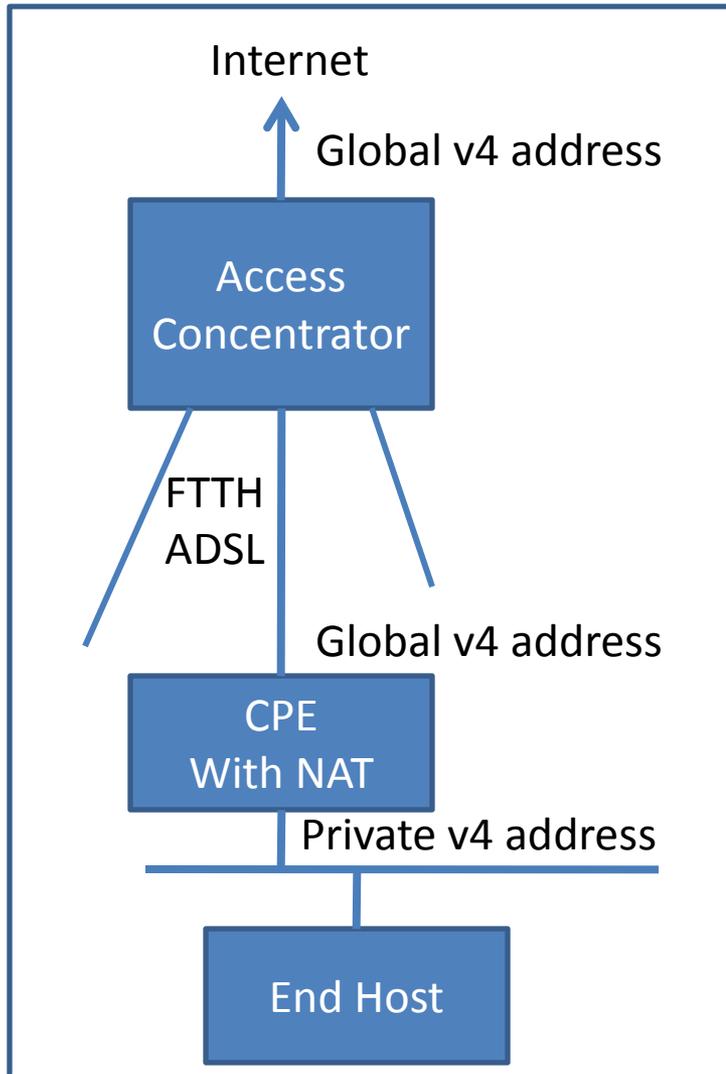
However IPv6 is ready for network equipment and PCs, we don't think that all the servers and machines support IPv6 before IPv4 address completion.

Therefore, we need to **provide some versions of IPv4 connectivity** for customers through some mechanisms at the same time.

Even IPv4 address allocation "completion" comes;

- We need to modify IPv4 access scheme in the ISP environment for our customers
 - To save their old equipments
 - Windows 2000, Windows 98 does not have IPv6 support
 - To make DNS works
 - Windows XP SP2 or SP3 have IPv6 but to resolve DNS name, it uses IPv4 transport only
- If we can not enforce customers to replace or upgrade their CPE router, step-by-step conversion and "incentive" are needed.
 - If we can enforce to replace their CPE router, different scheme like "dual-stack-lite" is better.

Most conservative access model changes - introducing “Carrier-Grade NAT” -



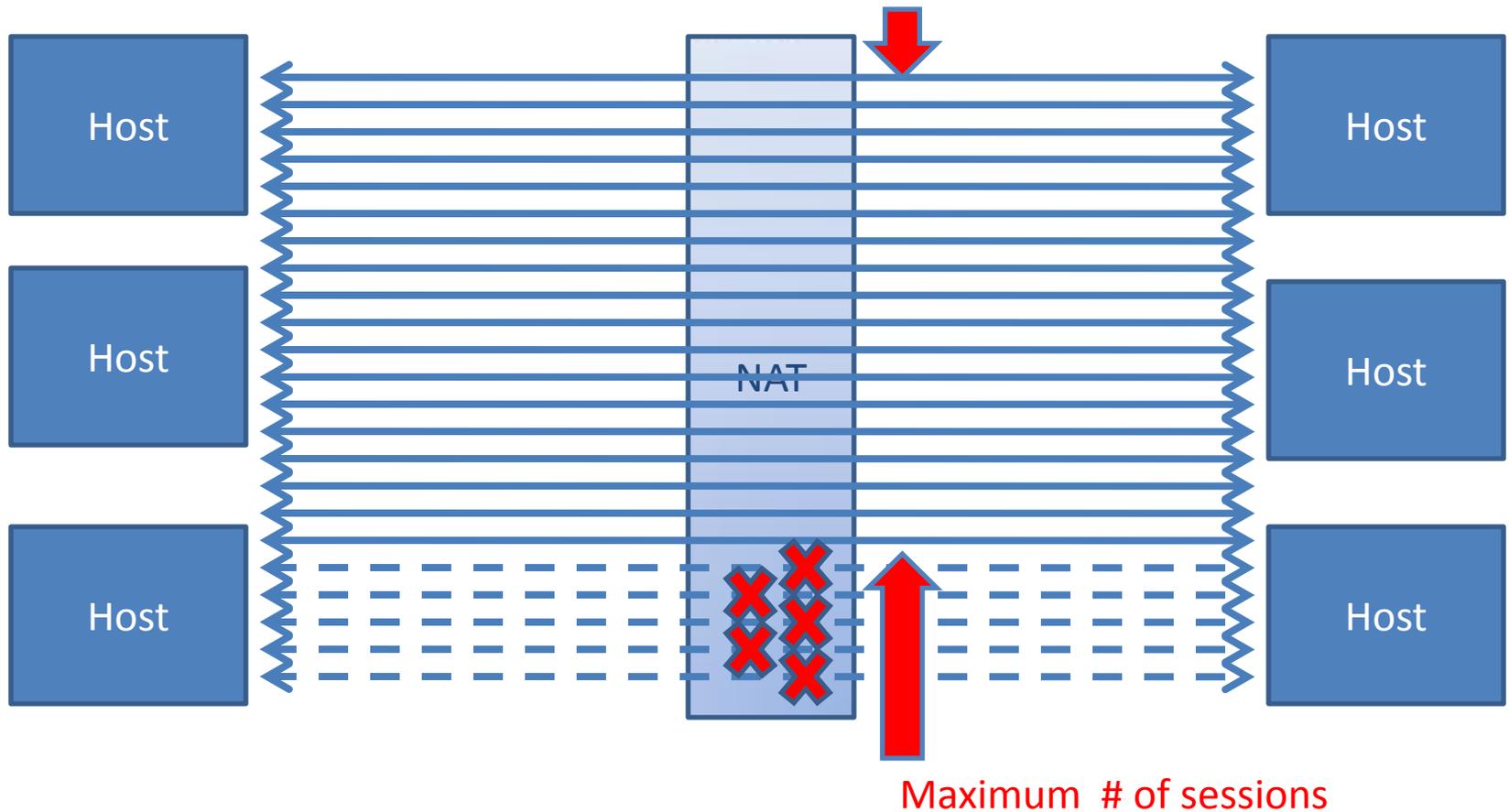
It is better to have new private space

- To save IPv4 address space
- To let end-users can have Global IPv4 address in the same network
 - This means we can MIX the global IPv4 service and shared IPv4 service at the same time.
- Some implementation like Cisco IOS can not work well as NAT box if the shared network and LAN are using same address range such as 10.0.0.0/24
- draft-shirasaki-isp-shared-addr-00.txt
- Authors belong to iTSCOM, KDDI, NTT Communications and IJ (Internet Initiative Japan)

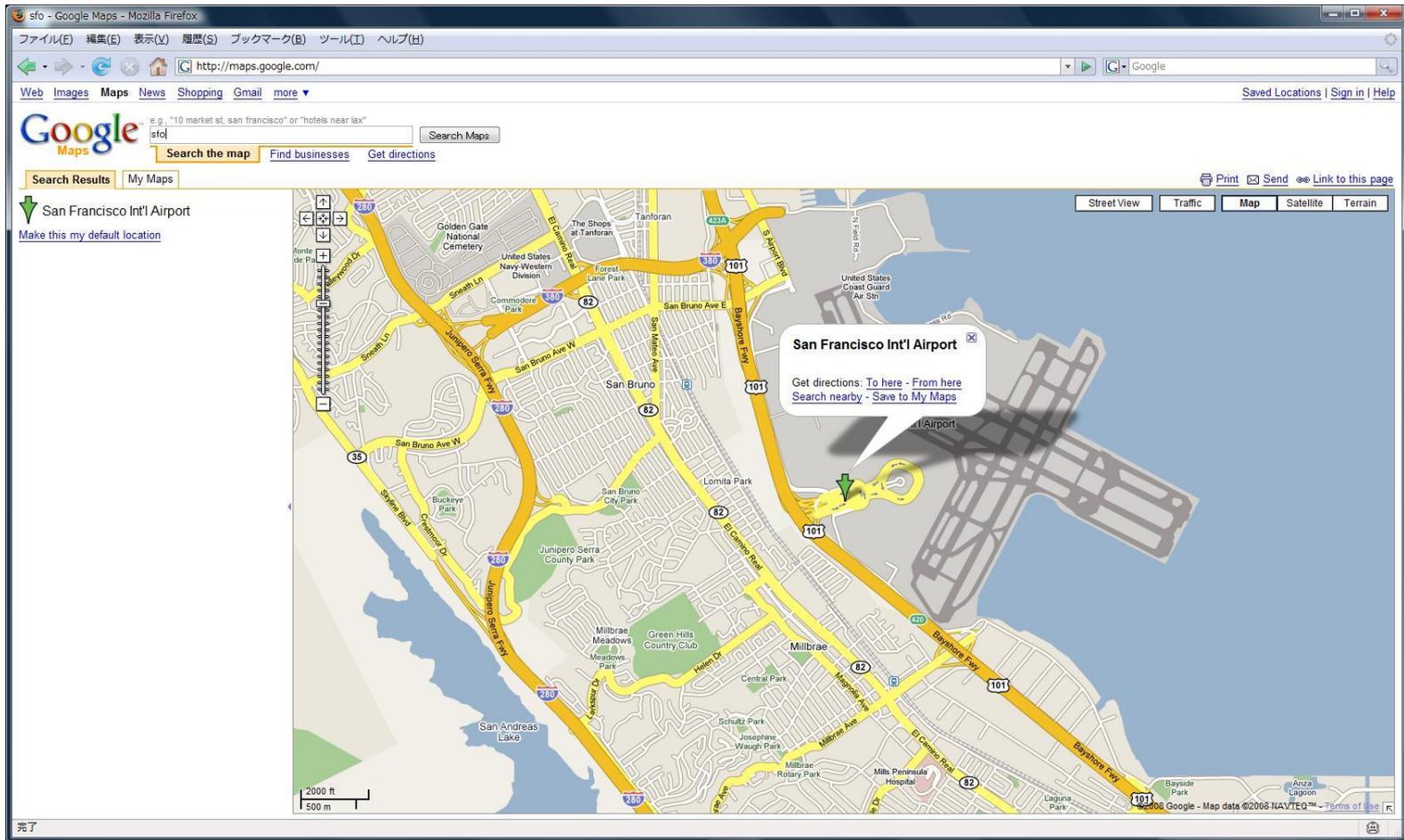
It looks v6 is not needed ?

- Please do not feel safe. **CGN (and any other carrier-grade NAT scheme) has serious restrictions.**
- Please not strongly that CGN is just for backward compatibility
- IPv6 is needed !
- Each customer can have only some “limited” numbers of sessions simultaneously.
 - How many ? Let say... 50 ? 30 ? Because “port number” is just 2bytes which means 64K
 - For example, if 2000 customer shares same Global IPv4 address (please note that this is just for example), only 25 or 30 so sessions can be used by each customer at the worst case.
- Which means that:

There is a limitation of numbers of sessions which can pass through a NAT



Max 30 Connections



Max 20 Connections

The image is a screenshot of a Mozilla Firefox browser window displaying Google Maps. The address bar shows the URL <http://maps.google.com/>. The search bar contains the text "sfo". Below the search bar, the text "San Francisco Int'l Airport" is displayed, along with the option "Make this my default location".

The map shows a route from a starting point (indicated by a green arrow) to San Francisco International Airport. The route is highlighted in yellow and orange, following major roads like Highway 280, Highway 82, and Highway 101. A speech bubble over the airport icon contains the text: "San Francisco Int'l Airport", "Get directions: To here - From here", "Search nearby - Save to My Maps".

At the bottom left of the map, a scale bar indicates 2000 feet and 500 meters. At the bottom right, the copyright notice reads "©2008 Google - Map data ©2008 NAVTEQ™ - Terms of Use".

In the bottom left corner of the browser window, the Japanese characters "完了" (Kwari) are visible, indicating the end of the presentation.

Max 15 Connections

The screenshot shows a Mozilla Firefox browser window displaying Google Maps. The address bar shows the URL <http://maps.google.com/>. The search bar contains the text "sfo". The map is centered on San Francisco, with the San Francisco International Airport (SFO) highlighted. A white speech bubble with a red 'X' icon is overlaid on the map, containing the text "San Francisco Int'l Airport" and "Get directions: [To here](#) - [From here](#) Search nearby - [Save to My Maps](#)".

Multiple grey rectangular error messages are scattered across the map area. Each message contains the text: "We are sorry, but we don't have maps at this zoom level for this region. Try zooming out for a broader look." These messages are repeated several times, indicating a limitation in the map data for the current zoom level.

At the bottom left of the map, there is a scale bar showing 2000 feet and 500 meters. At the bottom right, there is a copyright notice: "©2008 Google - Map data ©2008 NAVTEQ™ - Terms of Usage".

At the very bottom of the browser window, there is a small text line: "mt3.google.com からデータを転送しています..."

Max 10 Connections

The screenshot shows a Mozilla Firefox browser window displaying Google Maps. The address bar contains `http://maps.google.com/`. The search bar has the text "sfo" and a "Search Maps" button. Below the search bar, there are tabs for "Search Results" and "My Maps". A search result for "San Francisco Int'l Airport" is shown with a green arrow icon and the text "Make this my default location". The map displays a street view of San Francisco, with a callout box for "San Francisco Int'l Airport" containing the text "Get directions: To here - From here" and "Search nearby - Save to My Maps". The map also shows various landmarks like "United States Coast Guard A.C. Station" and "El Camino Real". The bottom of the page features a scale bar (2000 ft / 500 m) and copyright information: "©2006 Google Inc. All rights reserved. ©2008 NAVTEQ™ - Terms of Use".

Max 5 Connections



So, We DO NEED IPv6

- Anyway, we do need IPv6 to let rich applications and contents like AJAX based, RSS, P2P ... to survive
 - Such ASPs and applications MUST be converted IPv6 compatible within few years
 - other wise they may lose huge market (for example Asia Pacific region where IPv4 address space is not sufficient)
- But at the same time, we have to extend the life of IPv4 for more 10 years or so at “SO-SO” level to keep old implementations work so far
- Which means, We have to do IPv6/v4 dual stack for a while (let say..until around 2020) and let IPv4 retire step-by-step but still as fast as possible from cost point of view.

Examples of # of concurrent sessions

Webpage	# of sessions
No operation	5~10
Yahoo top page	10~20
Google image search	30~60
Nico Nico Douga	50~80
OCN photo friend	170~200+
iTunes	230~270
iGoogle	80~100
Rakuten	50~60
Amazon	90
HMV	100
YouTube	90

Large Scale NAT (Carrier-Grade NAT)

- Scalability
 - >10K users (or contracts)
 - 100s of sessions per user (or contract)
- **Maximum Transparency** is desired
 - Like SOHO Router, there should be no barrier for application
 - So call “Full-CONE” + “Hairpinning” is ideal
 - Different from NAT for Enterprise
 - draft-nishitani-cgn-00.txt
 - IETF BEHAVE WG
- High Availability

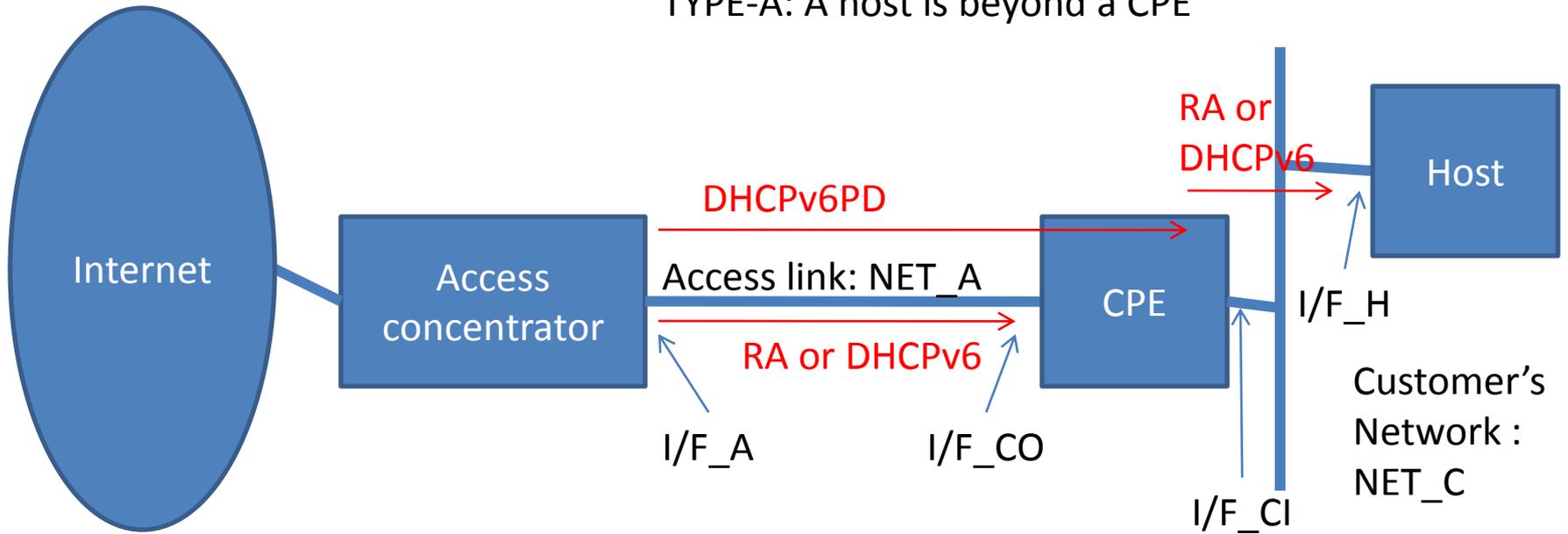
Some additional issues

- NAT-PT (v6 <-> v4 translator) does not work well some time for example , against google cache that has the numeric IP address notation in URL like
 - <http://64.233.169.104/search?q=cache:fTMdGNw-20EJ:www.ntt.com/index-j.html+NTT+Communications&hl=ja&ct=clnk&cd=1>
- Also any application which has numeric IP address in the payload

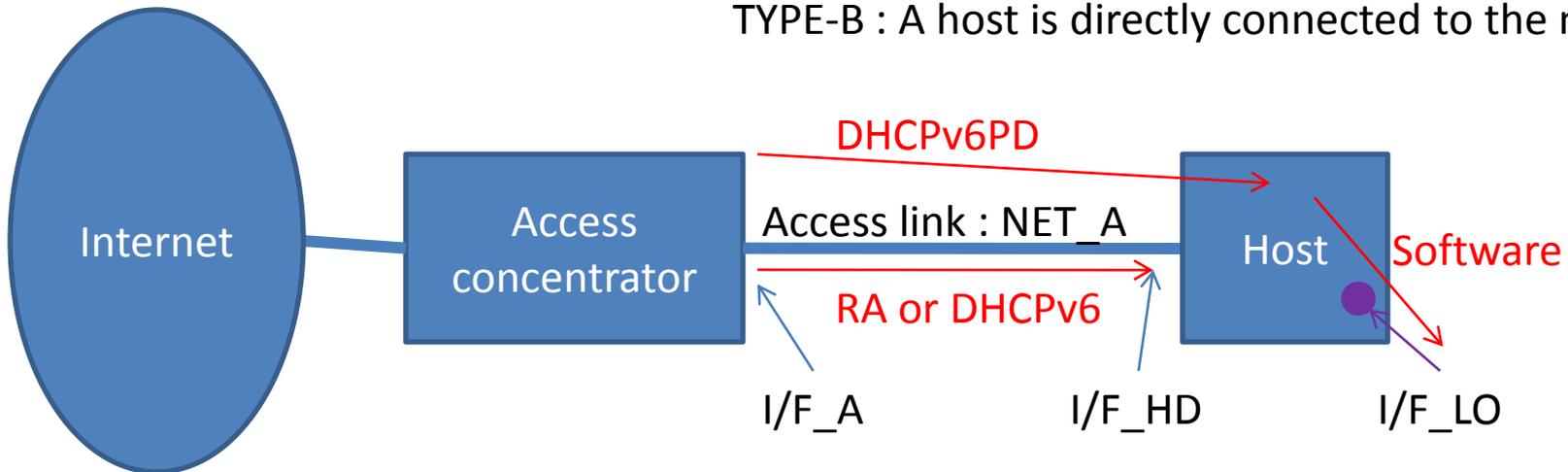
About IPv6 access scheme

- Because some implementations of TCP/IP are now based on strong host model (in RFC1122) and follows RFC3833, we should have global IPv6 address on the link between customer premises and the access concentrator.
- If there is no global address for the uplink, CPE architecture will be limited to weak host model implementation.
- draft-miyakawa-1plus64s-00.txt
- We'd like to cooperate with Broadband Forum (ex DSL Forum) people and folks in v6OPS to get good model.

TYPE-A: A host is beyond a CPE



TYPE-B : A host is directly connected to the network



Transition Scenario

- One possible transition scenario from v4 only to dual stack to v4/v6 will be showed
- I think this is the most conservative and step-by-step

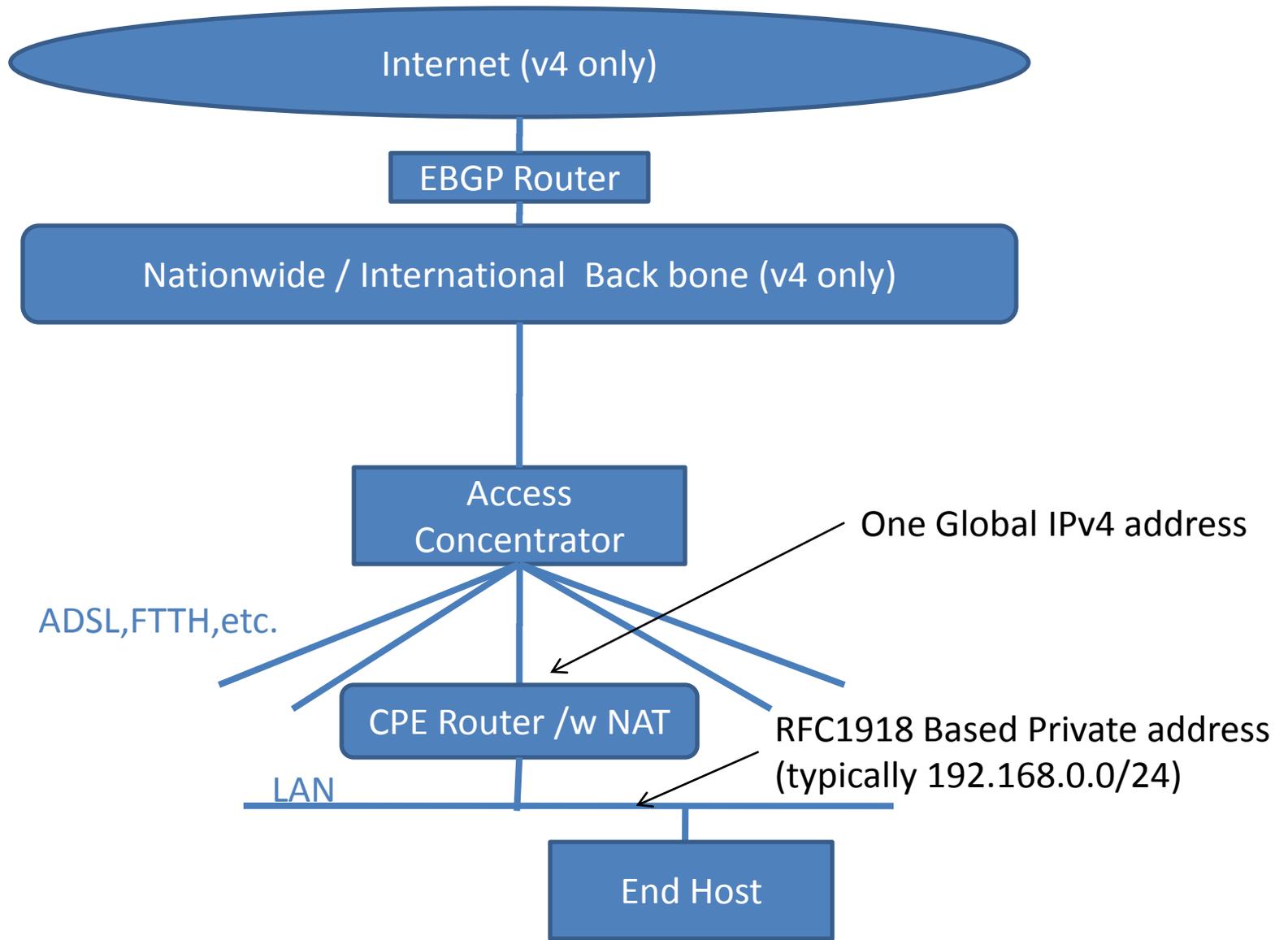
Simple concept

- Customer can be converted one by one
- Customer do not need to purchase any hardware until some stage of conversion
 - Especially he/she uses XP, Vista, Leopard, Linux or BSD
- IPv6 will be main stream eventually
- IPv4 will be for backward compatibility

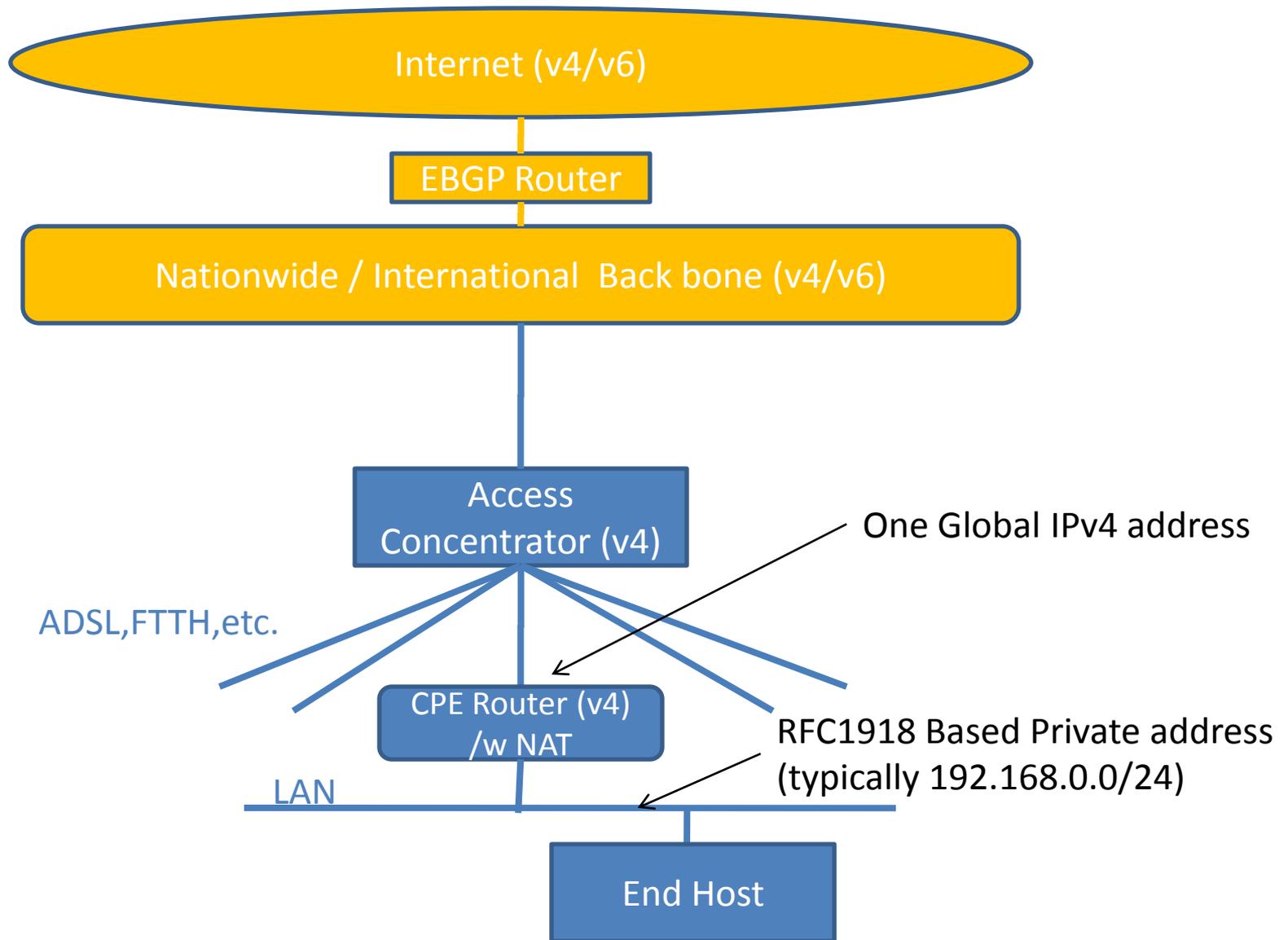
About “SOFTWARE”

- IETF SOFTWARE WG
- SOFTWARE HUB-and-SPOKE model is essentially “IPv6 over L2TP over IPv4”
- Sometime, we have to configure CPE router so that it passes L2TP session but generally speaking, because L2TP is on UDP scheme, it can traverse NAT easily

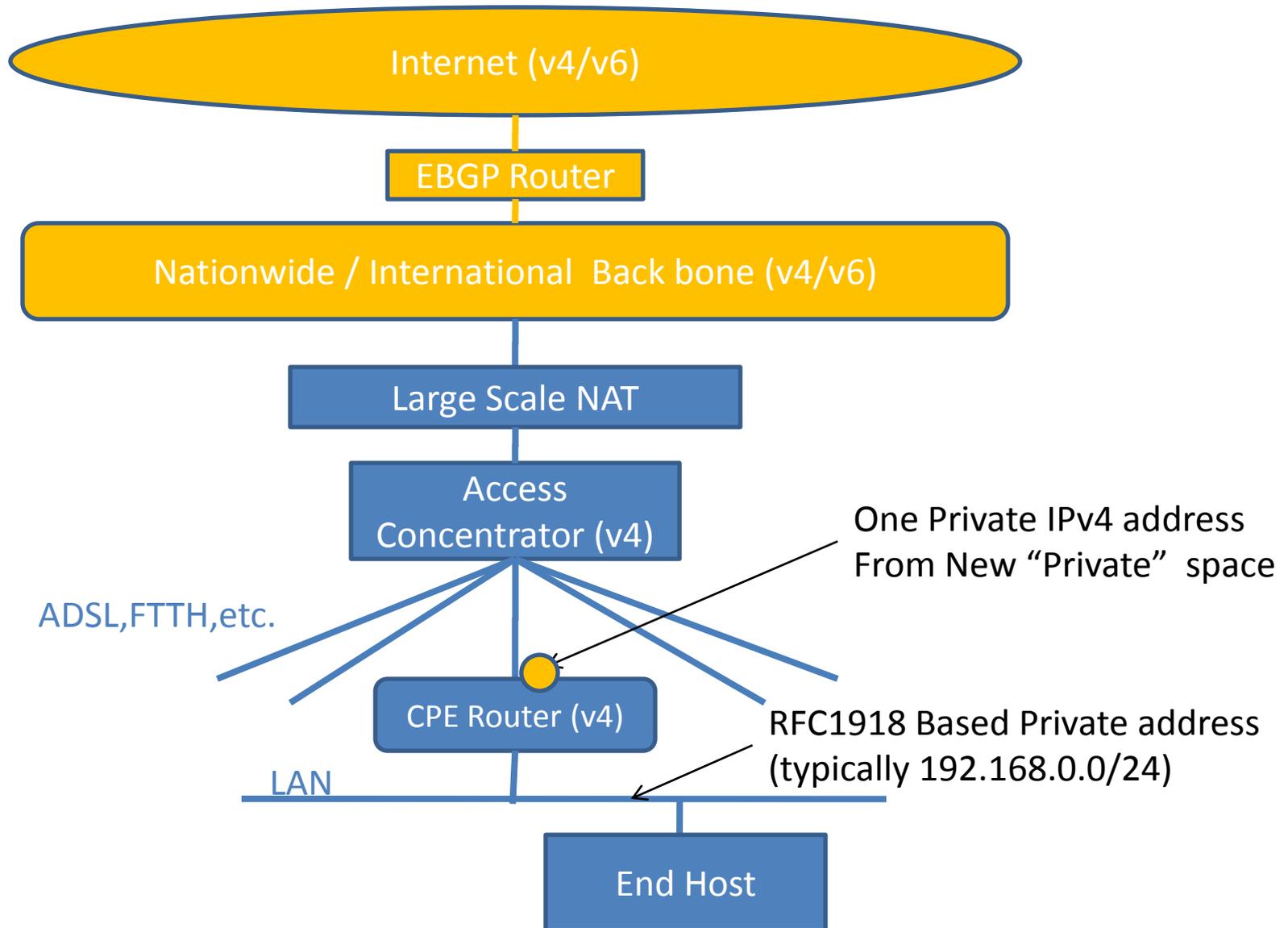
At the beginning: Global v4 only service



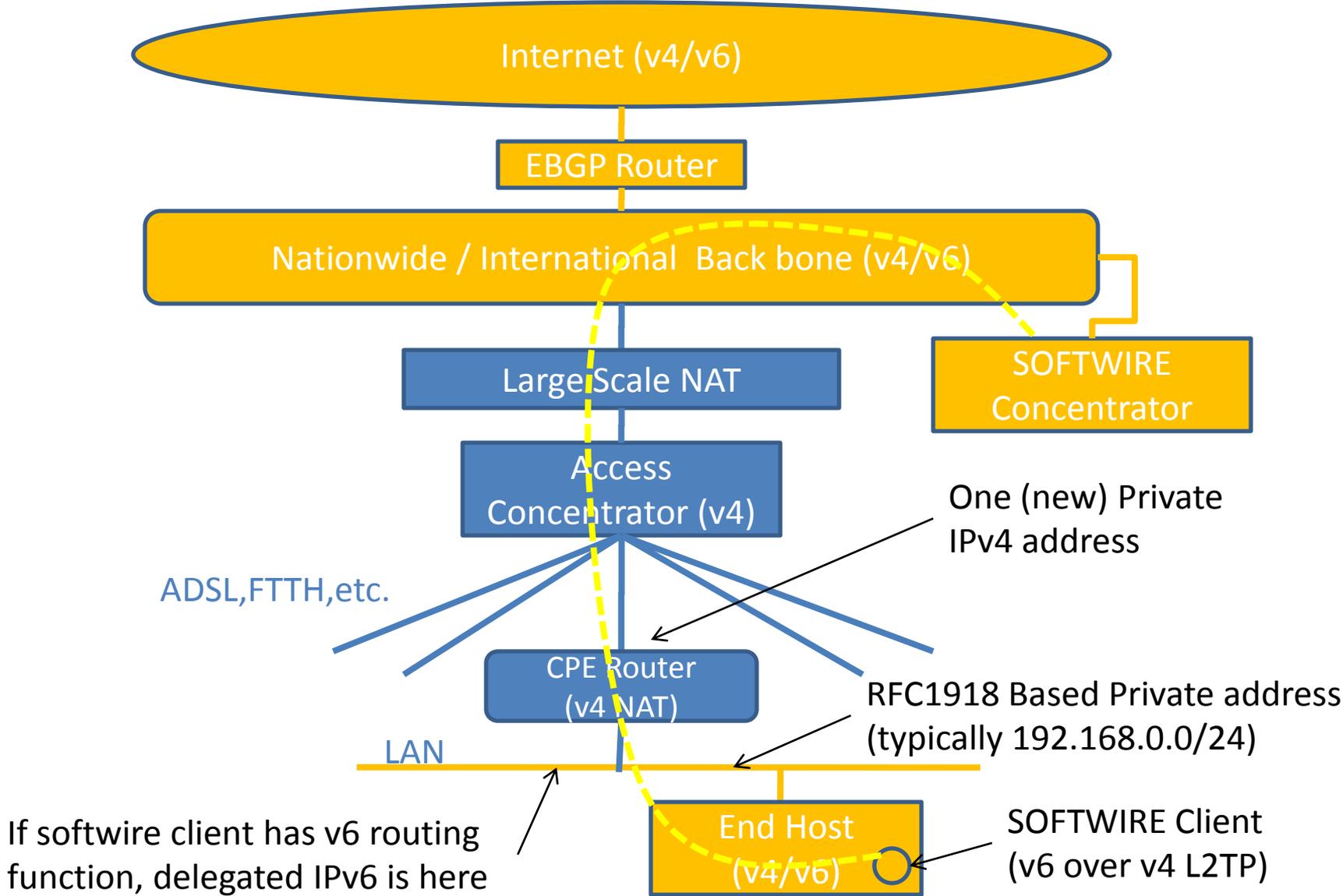
Dual Stack backbone (it's easy)



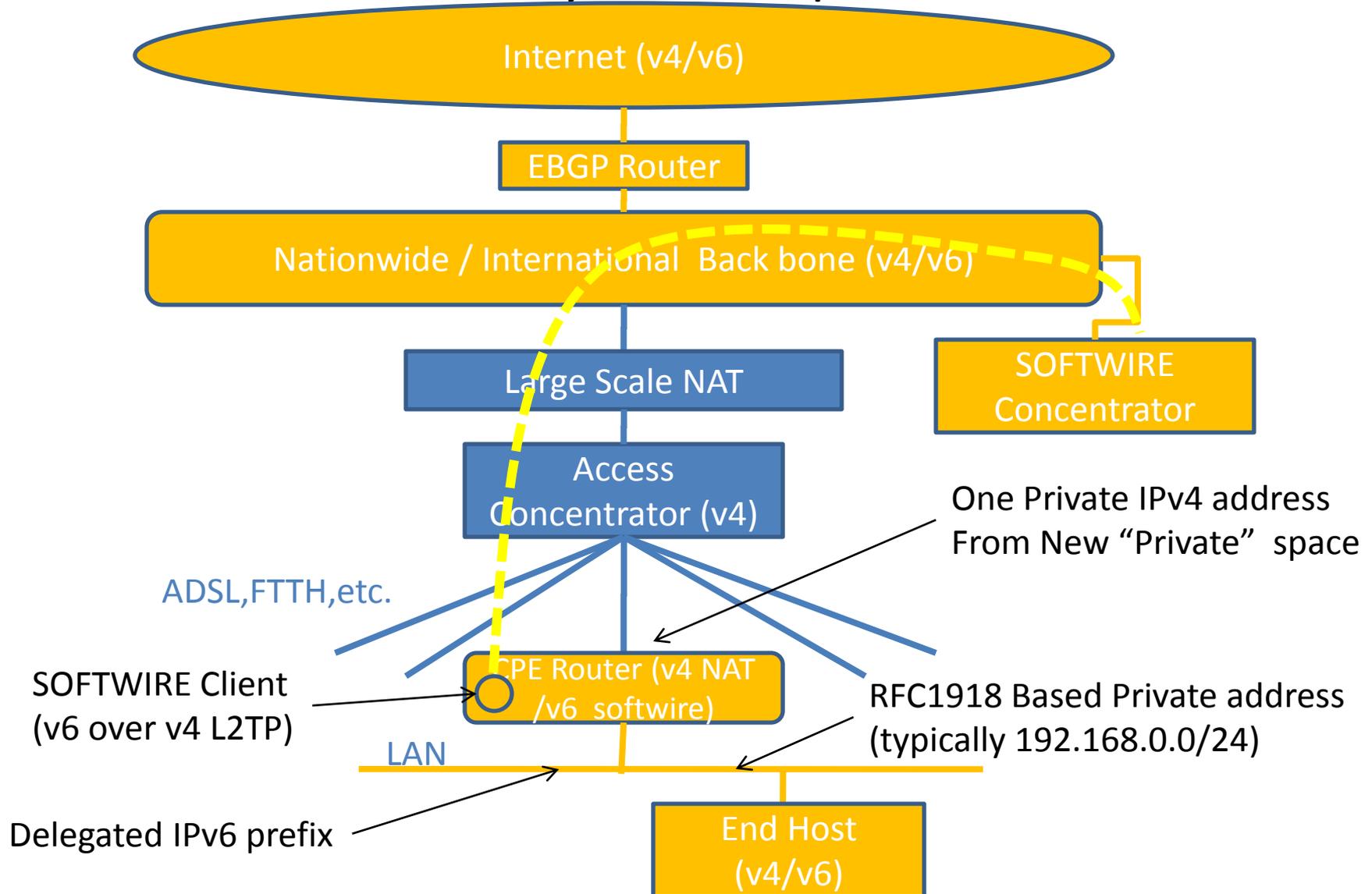
Introducing LSN



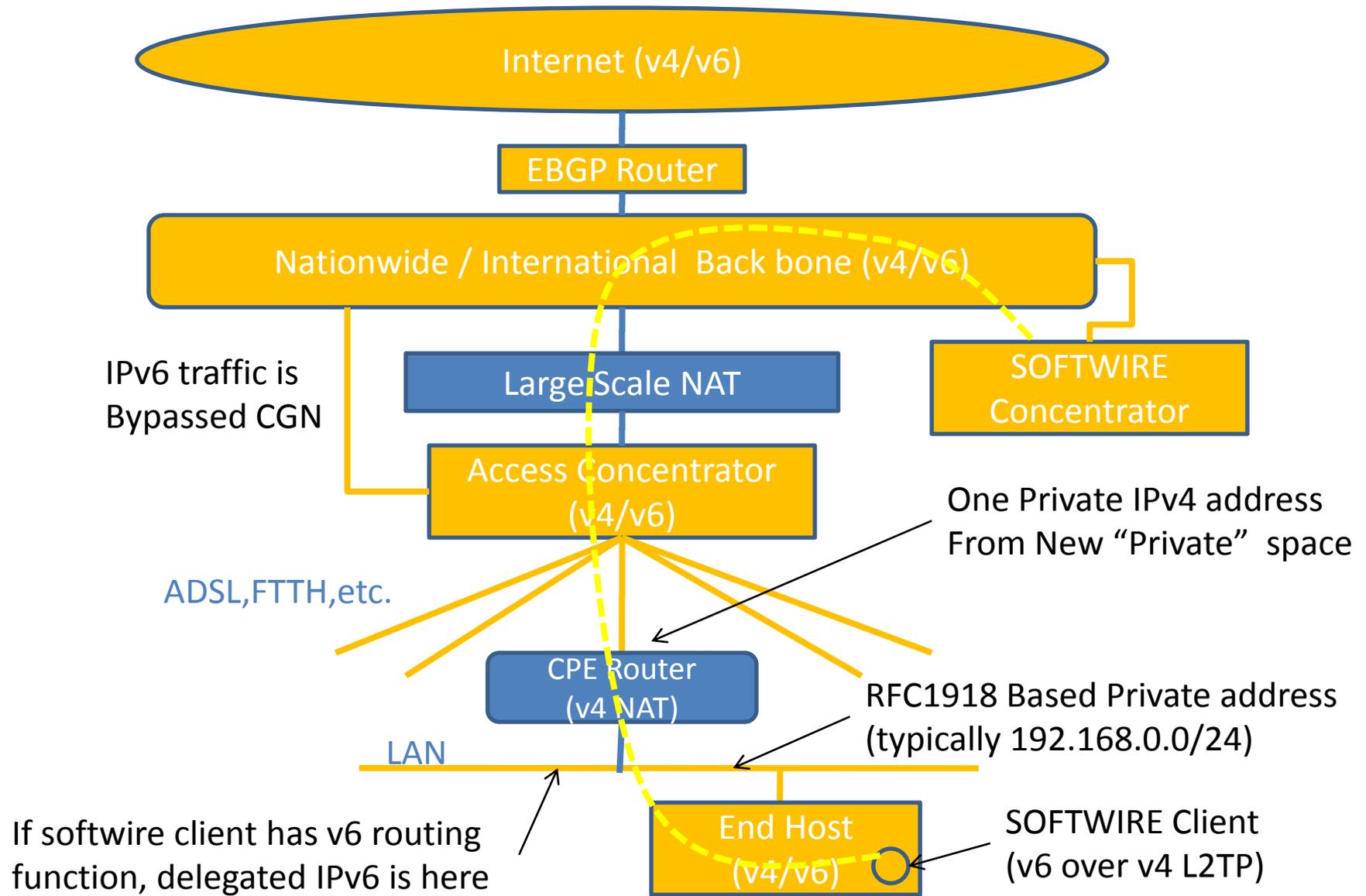
Introducing Softwire (v6 over v4 L2TP)



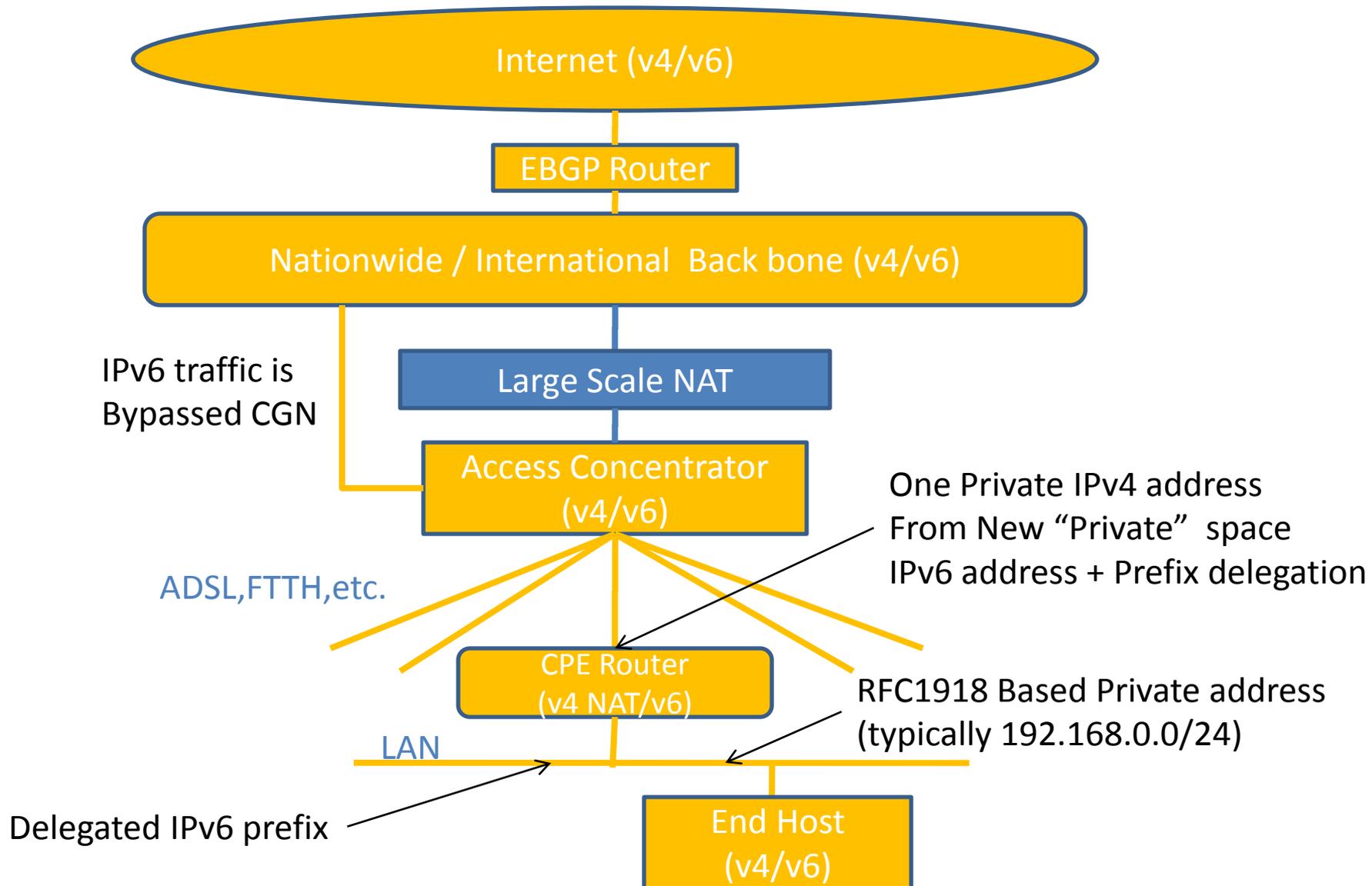
Softwire termination on CPE router looks tricky but in-expensive



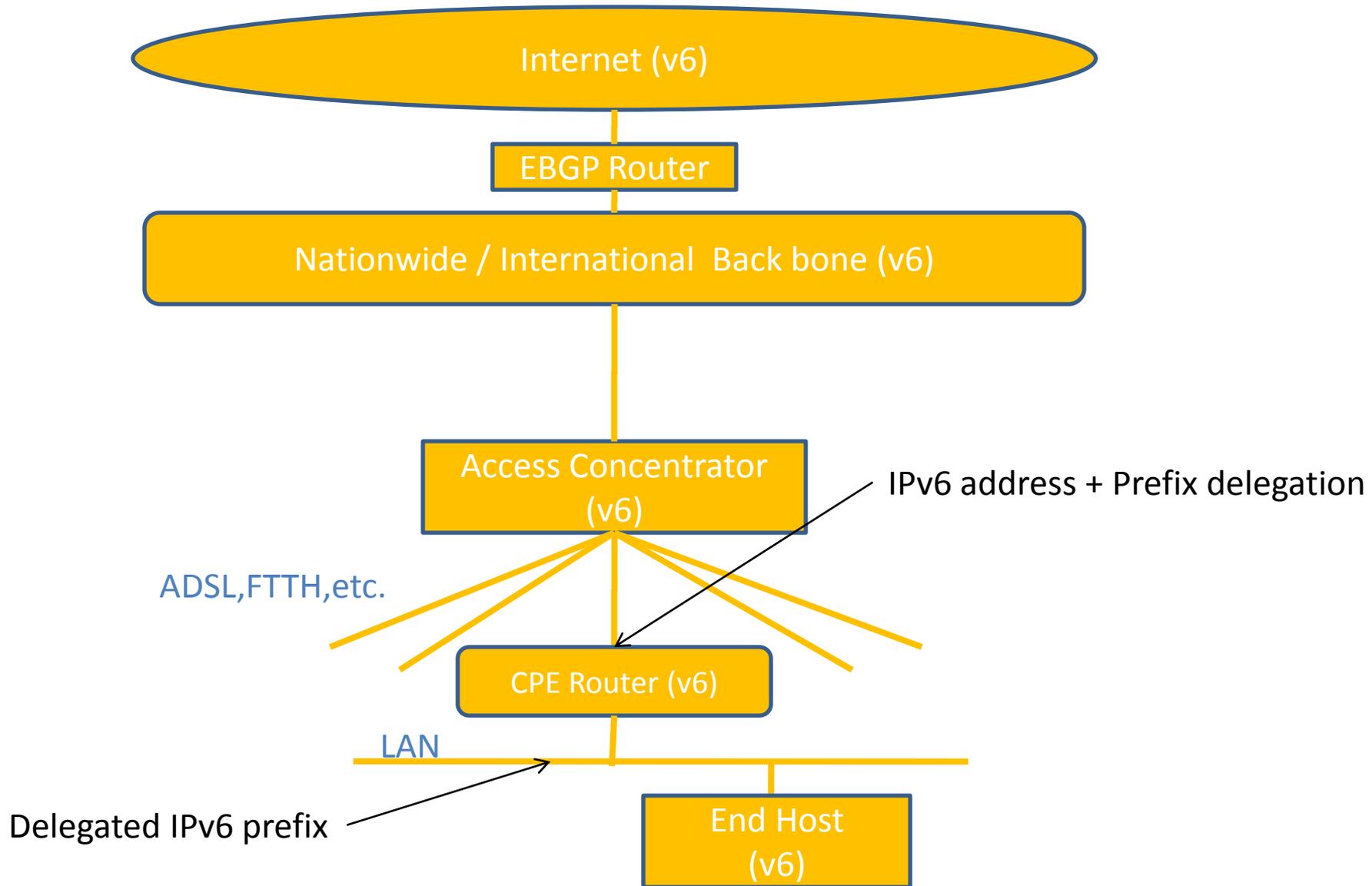
Native IPv6 service but CPE router is not ready



Replace CPE router to IPv6 compatible



Pure v6 world



We will do

- Actually, NTT group already has commercialized IPv6 service for VoIP, IPTV and so on for millions of customers
- Now we have a beta testing ISP facility for complete dual stack with LSN environment in a data center in down town Tokyo and several LSN vendors are bringing their prototype implementations into this network. We know more facts in details.
- **We are really happy if we could help ISPs especially in Asia Pacific** area (but not limited to) that will be facing same problems
- So please do not hesitate to contact with us

Enterprises

- We already have some requests from ASPs, usual enterprises, governmental organizations and schools for IPv4/v6 dual stack deployment support