From IPv4 only To v4/v6 Dual Stack - IETF72 IAB Technical Plenary –

extended version

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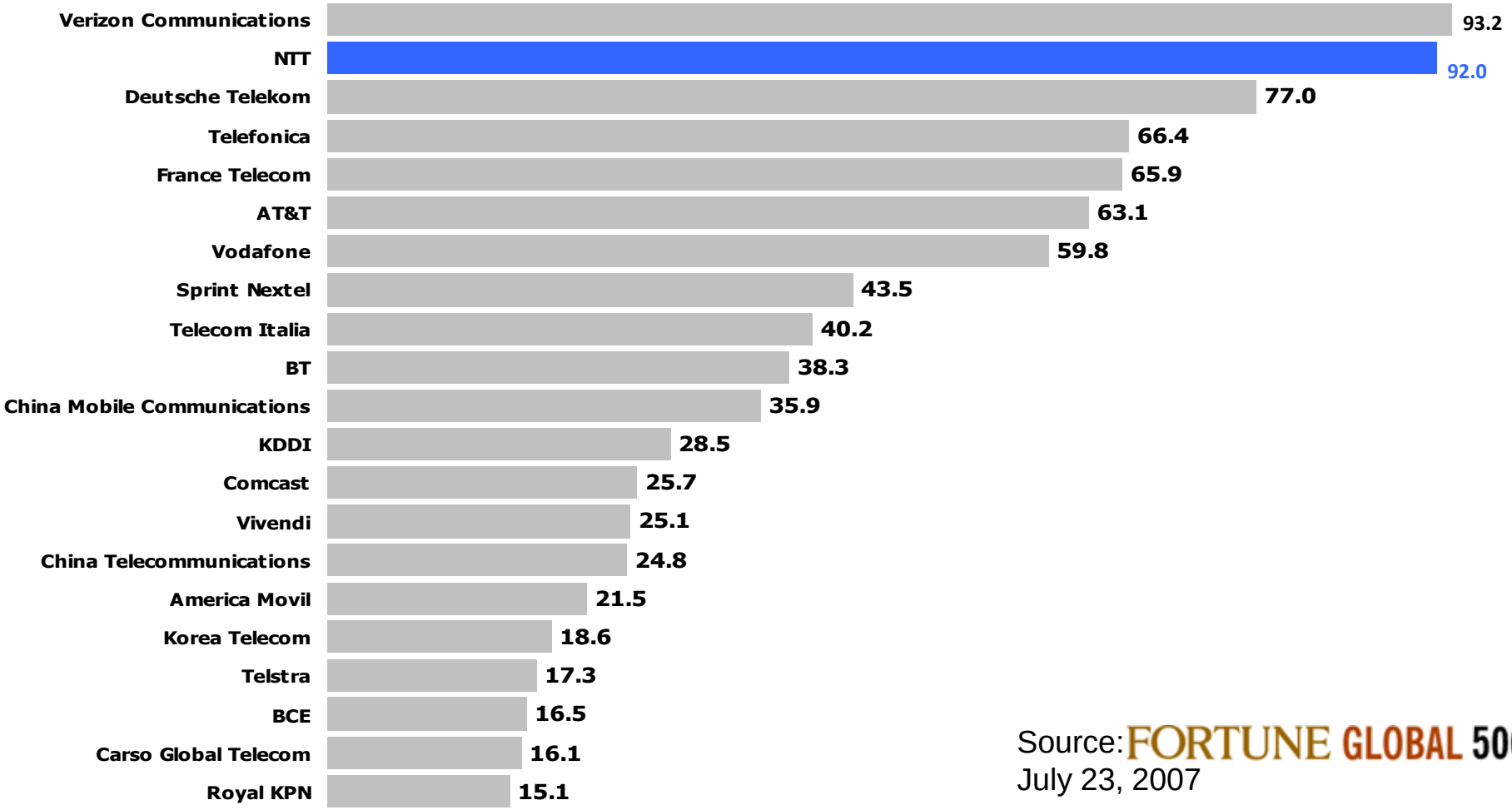
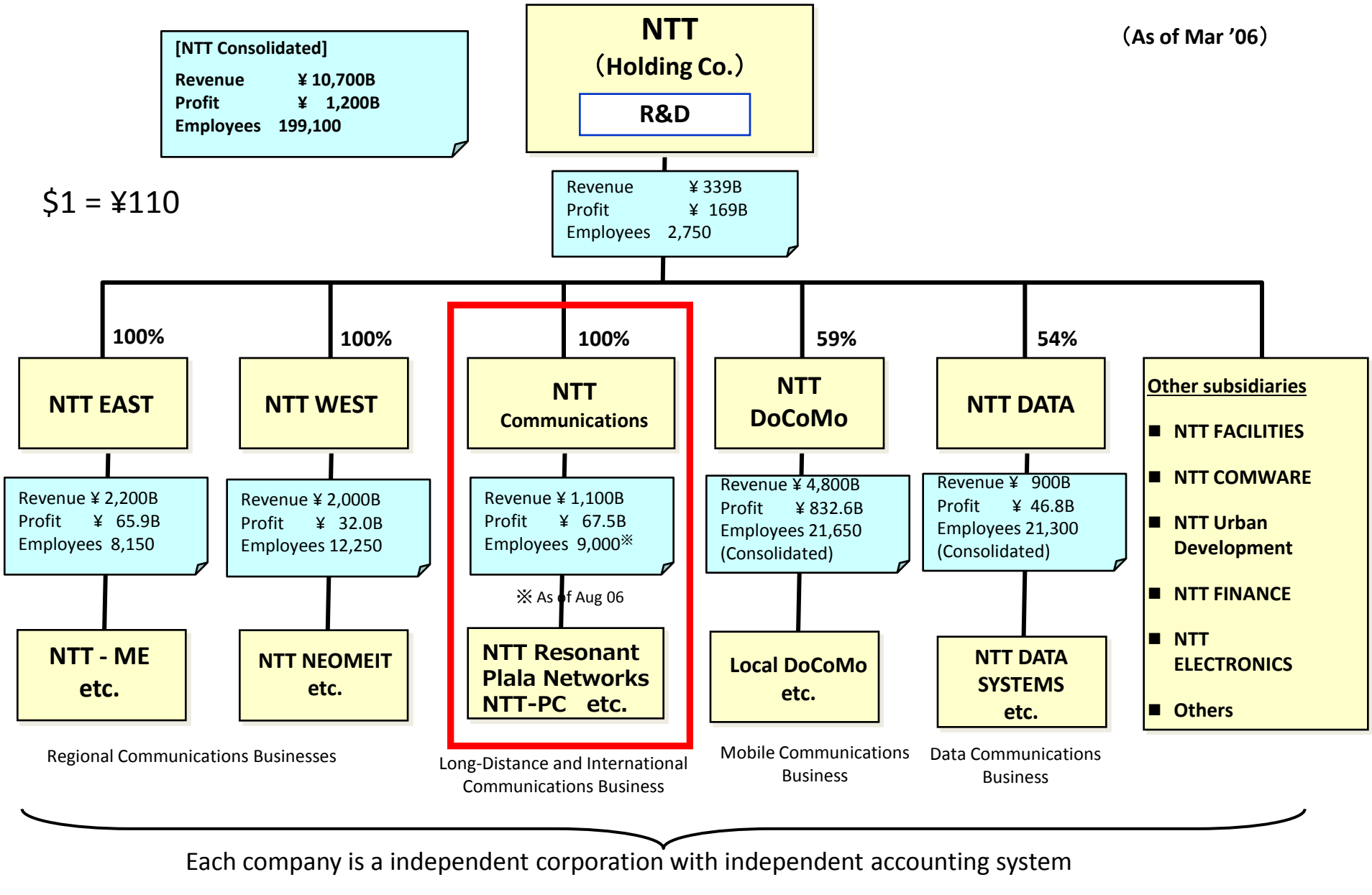
Who is NTT?

(Nippon Telegraph and Telephone)

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



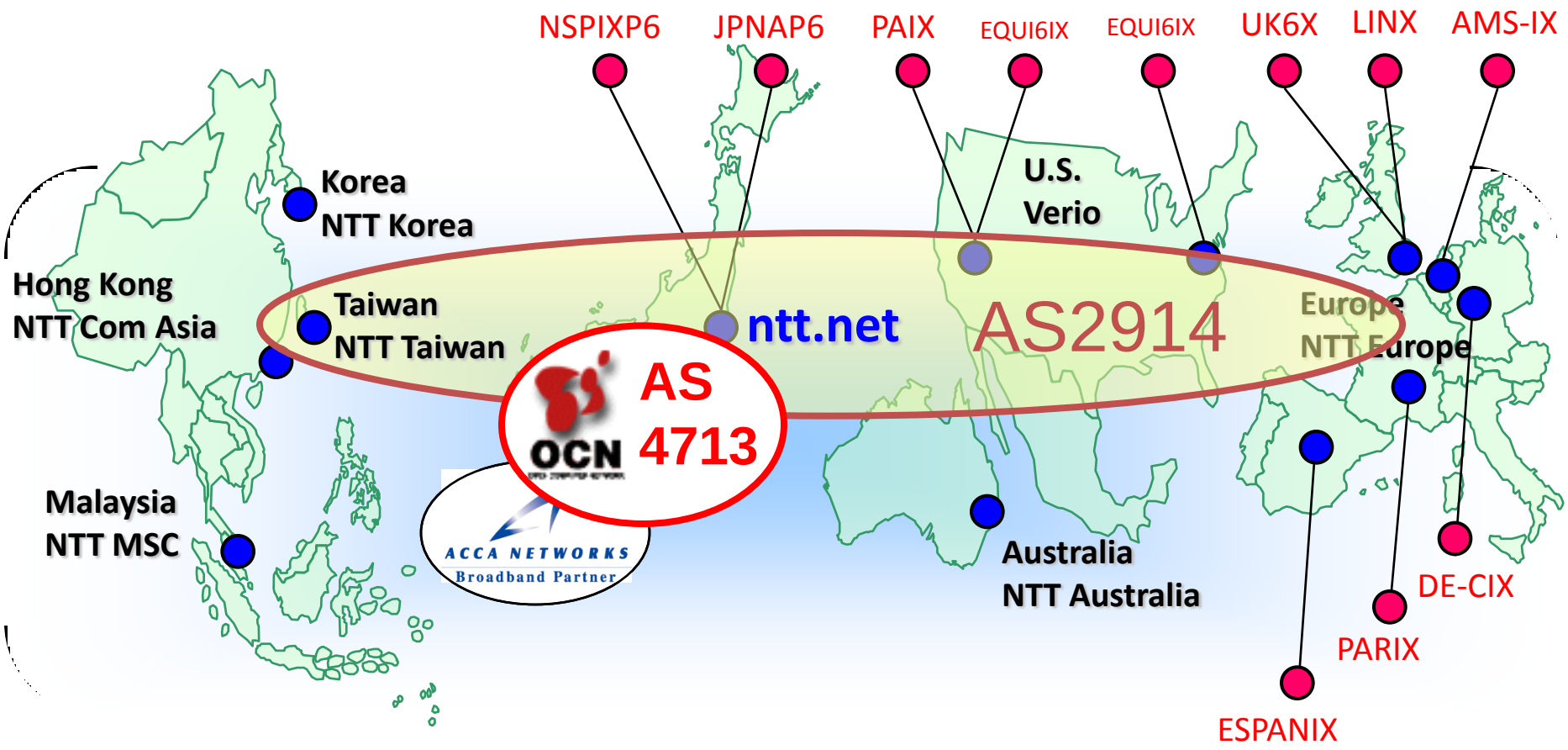
Source: FORTUNE GLOBAL 500
July 23, 2007

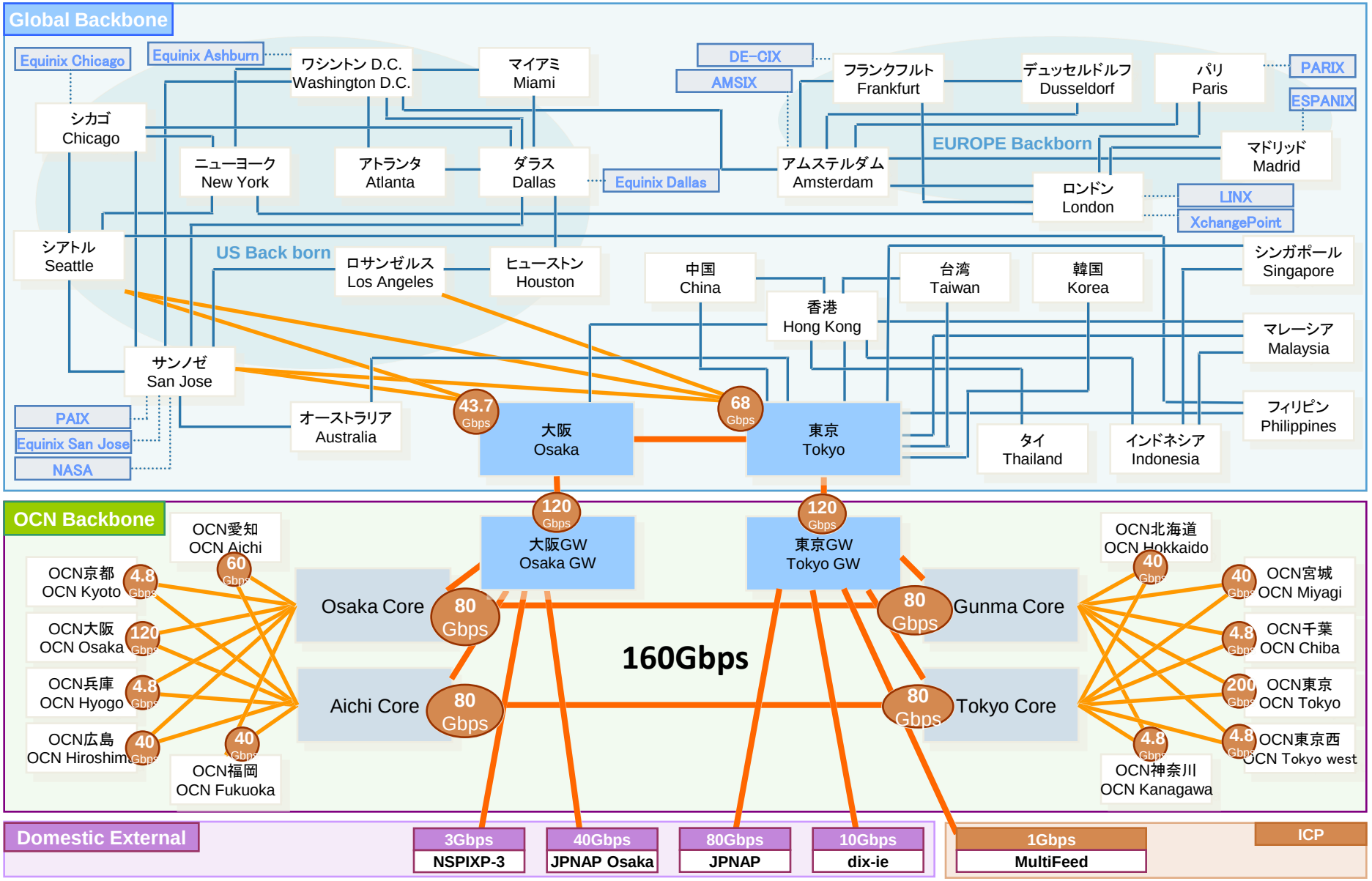

[NTT Consolidated]
Revenue ¥ 10,700B
Profit ¥ 1,200B
Employees 199,100
NTT
(Holding Co.)
R&D
(As of Mar '06)
$1 = ¥110
Revenue ¥ 339B
Profit ¥ 169B
Employees 2,750
100%
100%
100%
59%
54%
NTT EAST
NTT WEST
NTT Communications
NTT DoCoMo
NTT DATA
Other subsidiaries
■ NTT FACILITIES
■ NTT COMWARE
■ NTT Urban Development
■ NTT FINANCE
■ NTT ELECTRONICS
■ Others
Revenue ¥ 2,200B
Profit ¥ 65.9B
Employees 8,150
Revenue ¥ 2,000B
Profit ¥ 32.0B
Employees 12,250
Revenue ¥ 1,100B
Profit ¥ 67.5B
Employees 9,000※
※ As of Aug 06
Revenue ¥ 4,800B
Profit ¥ 832.6B
Employees 21,650
(Consolidated)
Revenue ¥ 900B
Profit ¥ 46.8B
Employees 21,300
(Consolidated)
NTT - ME etc.
NTT NEOMEIT etc.
NTT Resonant
Plala Networks
NTT-PC etc.
Local DoCoMo etc.
NTT DATA SYSTEMS etc.
Regional Communications Businesses
Long-Distance and International Communications Business
Mobile Communications Business
Data Communications Business
Each company is a independent corporation with independent accounting system

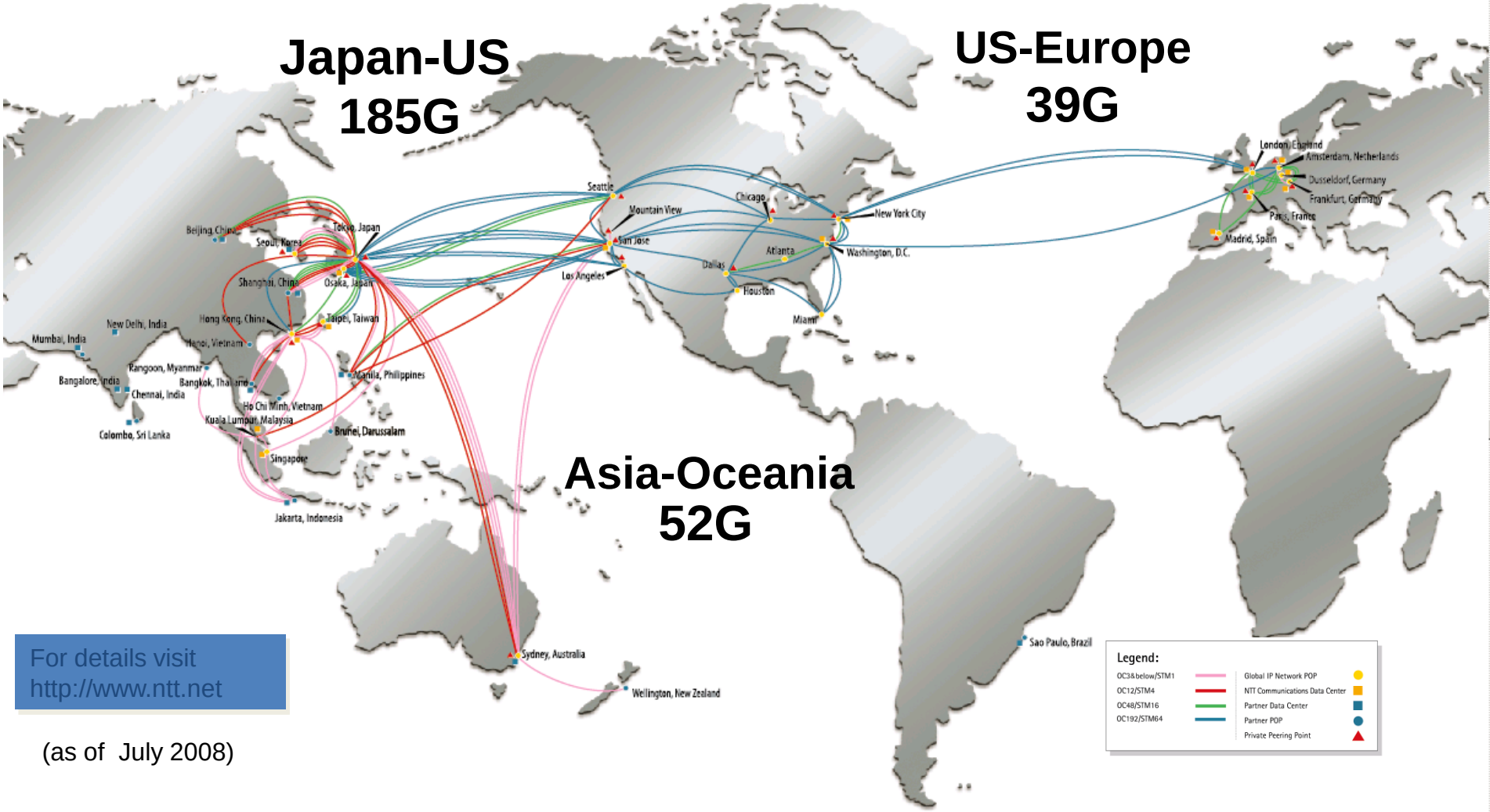
NTT Communications' two ASes

AS2914 (ex-Verio) as global backbone

AS4713 as Japanese Domestic service




Global Backbone
Equinix Chicago
Equinix Ashburn
ワシントン D.C.
Washington D.C.
マイアミ
Miami
DE-CIX
AMSIX
フランクフルト
Frankfurt
デュッセルドルフ
Dusseldorf
パリ
Paris
PARIX
ESPANIX
シカゴ
Chicago
EUROPE Backborn
マドリッド
Madrid
ニューヨーク
New York
アトランタ
Atlanta
ダラス
Dallas
Equinix Dallas
アムステルダム
Amsterdam
ロンドン
London
LINX
XchangePoint
シアトル
Seattle
US Back born
ロサンゼルス
Los Angeles
ヒューストン
Houston
中国
China
台湾
Taiwan
韓国
Korea
シンガポール
Singapore
香港
Hong Kong
マレーシア
Malaysia
サンノゼ
San Jose
フィリピン
Philippines
PAIX
Equinix San Jose
NASA
オーストラリア
Australia
43.7 Gbps
大阪
Osaka
68 Gbps
東京
Tokyo
タイ
Thailand
インドネシア
Indonesia
OCN Backbone
OCN愛知
OCN Aichi
OCN北海道
OCN Hokkaido
120 Gbps
大阪GW
Osaka GW
120 Gbps
東京GW
Tokyo GW
OCN京都
OCN Kyoto
4.8 Gbps
60 Gbps
40 Gbps
OCN宮城
OCN Miyagi
OCN大阪
OCN Osaka
120 Gbps
Osaka Core
80 Gbps
80 Gbps
Gunma Core
4.8 Gbps
OCN千葉
OCN Chiba
160Gbps
OCN兵庫
OCN Hyogo
4.8 Gbps
Aichi Core
80 Gbps
80 Gbps
Tokyo Core
200 Gbps
OCN東京
OCN Tokyo
OCN広島
OCN Hiroshima
40 Gbps
40 Gbps
4.8 Gbps
4.8 Gbps
OCN東京西
OCN Tokyo west
OCN福岡
OCN Fukuoka
OCN神奈川
OCN Kanagawa
Domestic External
3Gbps
NSPIXP-3
40Gbps
JPNAP Osaka
80Gbps
JPNAP
10Gbps
dix-ie
1Gbps
MultiFeed
ICP



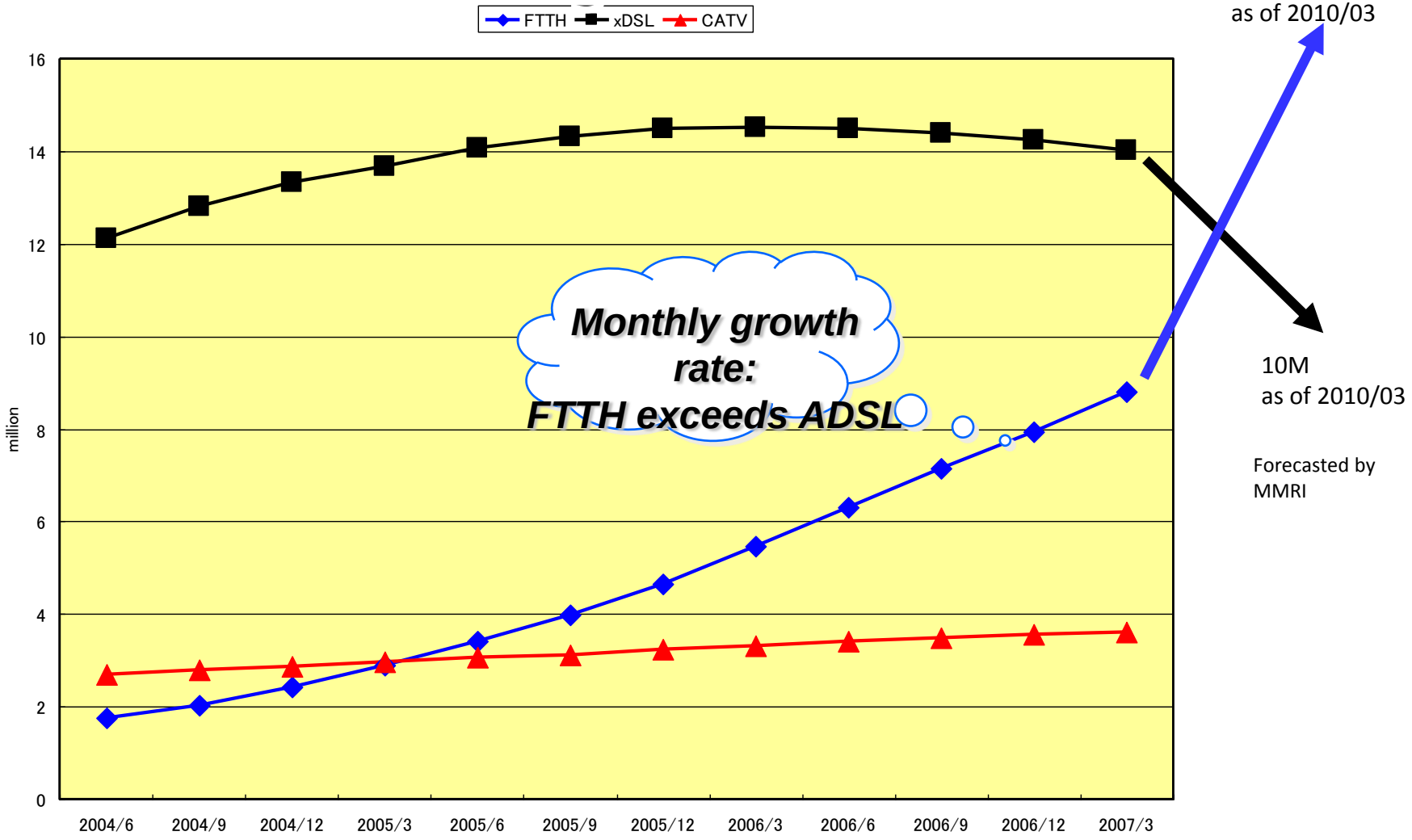
For details visit
http://www.ntt.net

(as of July 2008)

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



Source: Statistics from Ministry of Internal Affaires and Communications

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 broad band, 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.

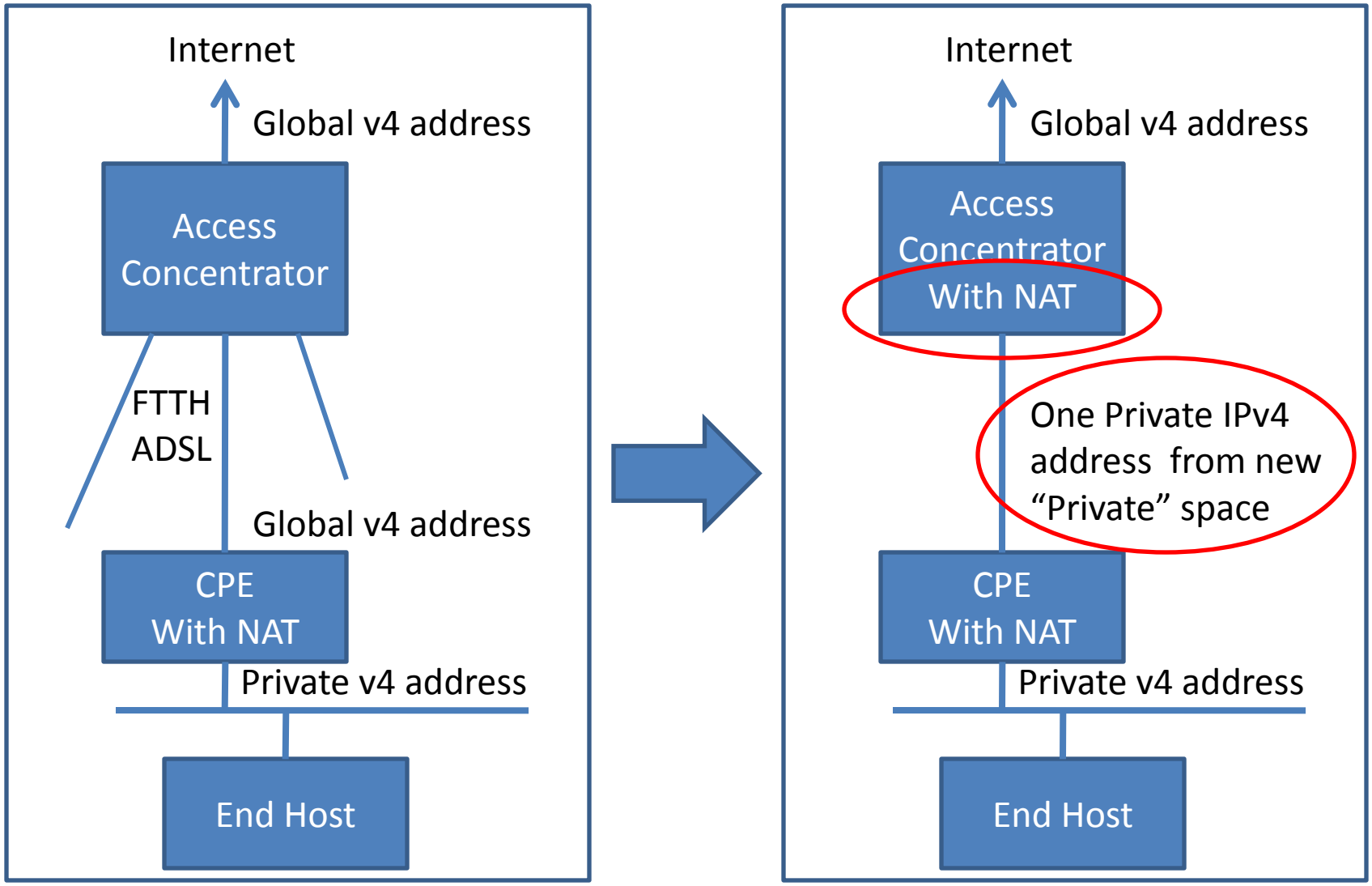
However IPv6 is ready for network equipment and PCs, we don't think that all the servers and machines support IPv6 before IPv4 address completion.

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” maybe better.

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



We need new private space for CGN other than 240/4

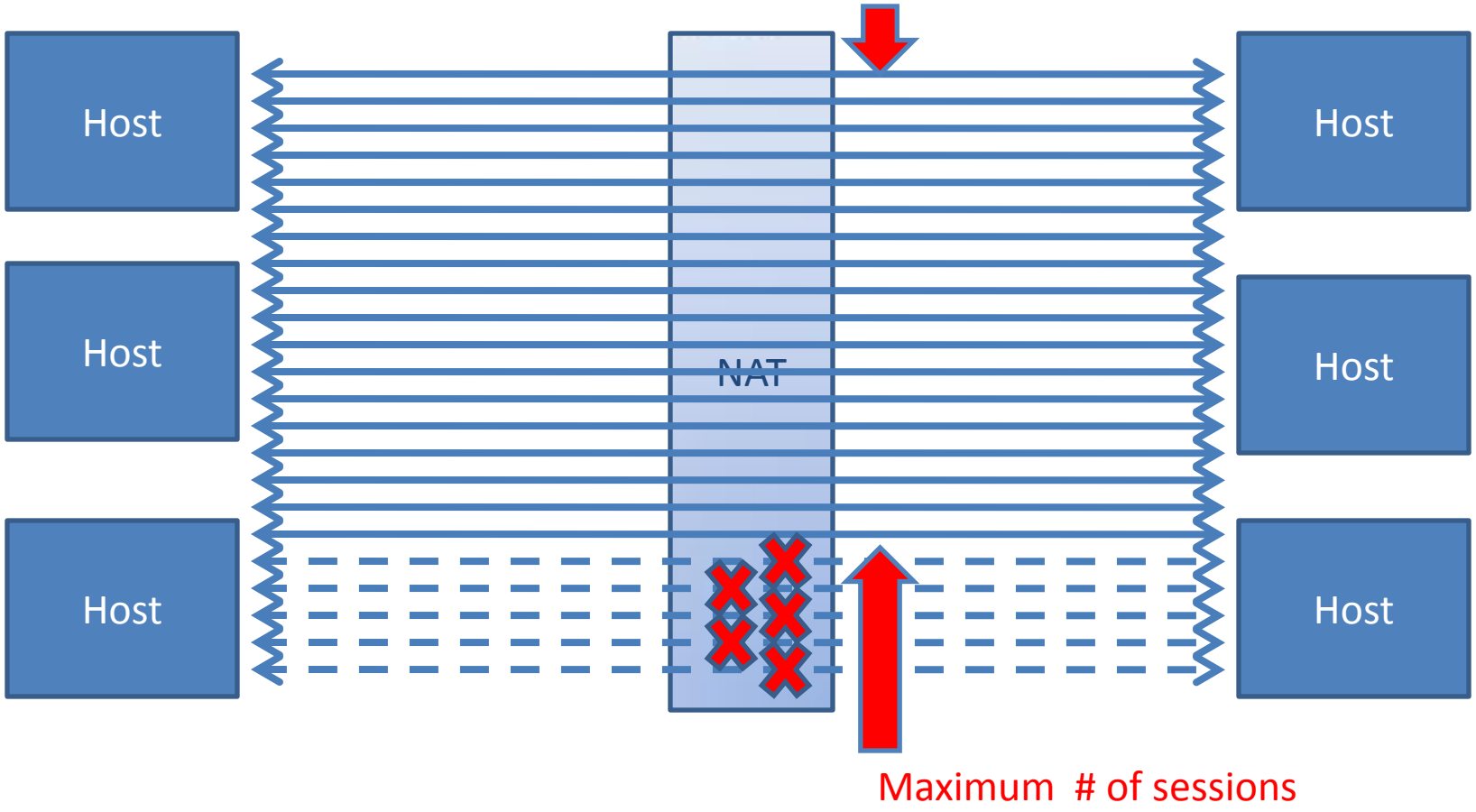
- If we can not get new “private” space, we simply have to use Global IPv4 address space between CGN and CPE which means ISP A uses its own, ISP B must do same thing and so on
- It’s waste of space ! So, we need new “private” space to be shared by ISPs
- Because we’d like to keep CPE router as is, we can not use 240.0.0.0/4 as CGN’s new private space.
  - Simply today’s IPv4 implementation does not work well on 240.0.0.0/4
  - If CPE router firmware can be upgraded, it means that it can be upgraded to IPv6 compatible. Way better.
- “dual stack lite” does not need this but it requires CPE router replacement. This is the pros-and-cons.

- draft-shirasaki-isp-shared-addr-00.txt

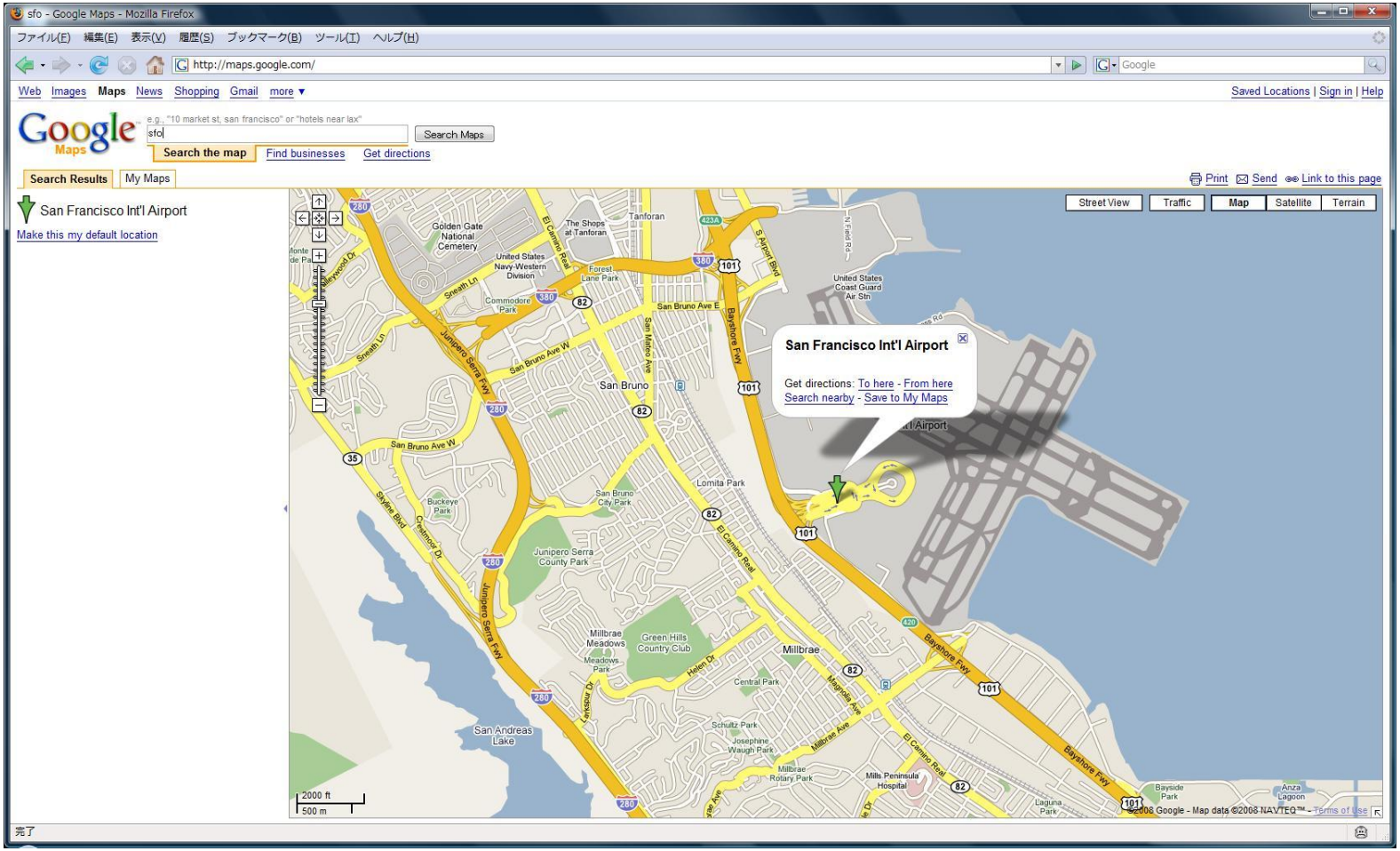
It looks v6 is not needed ?

- Please do not feel safe. CGN (and any other carrier-grade NAT scheme) has serious restrictions.
- 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:

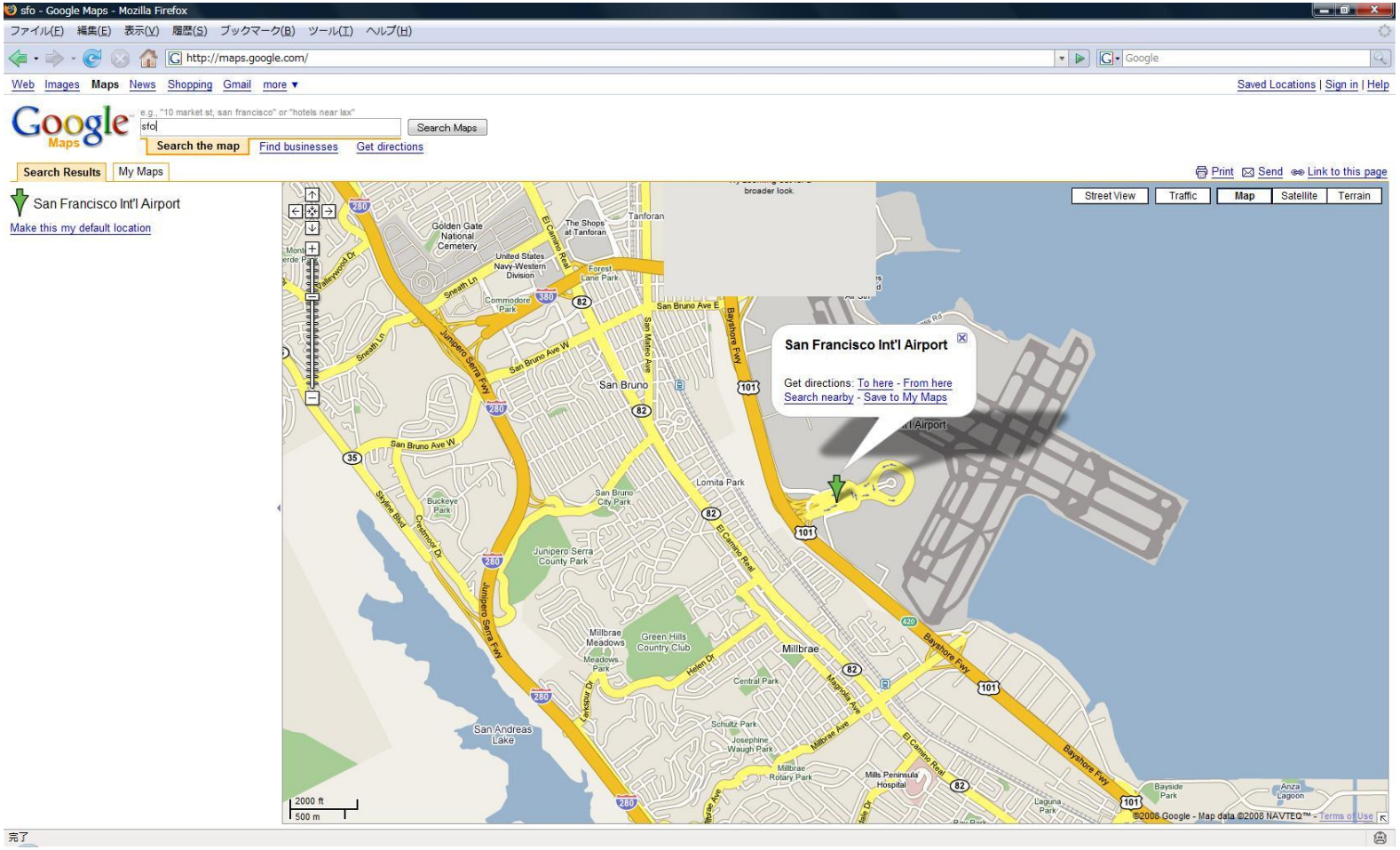
There is a limitation of numbers of sessions which can pass through a NAT



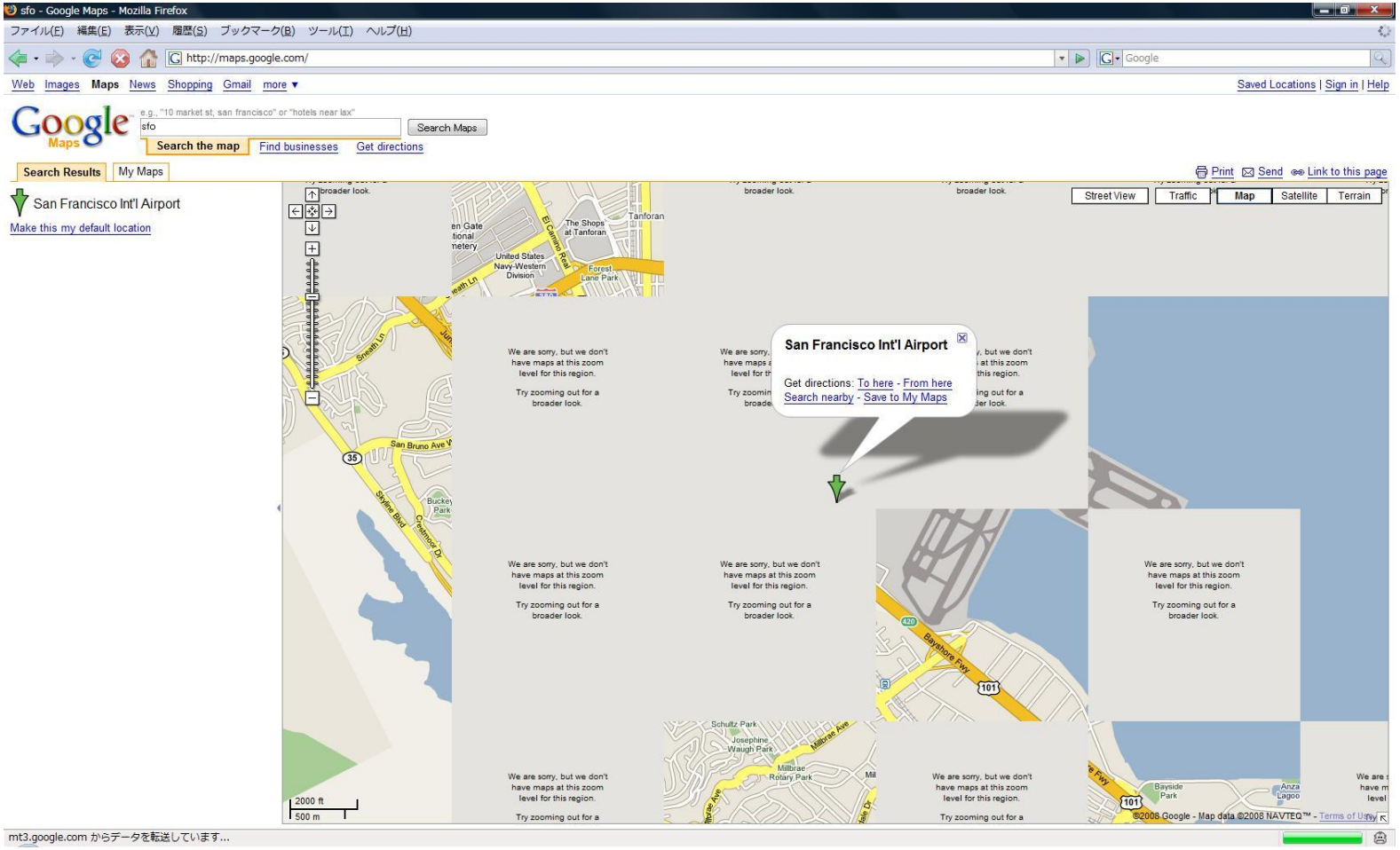
Max 30 Connections



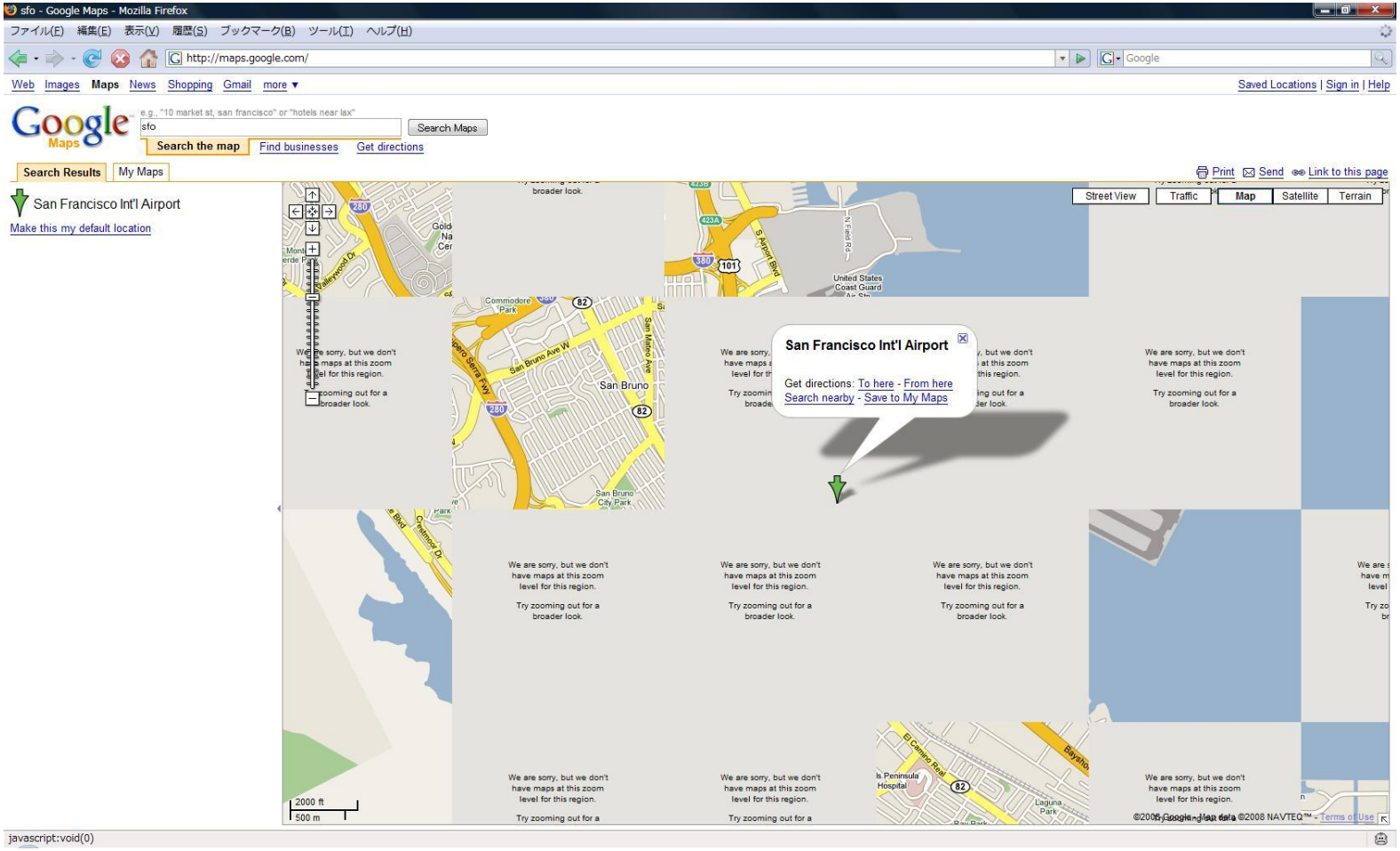
Max 20 Connections



Max 15 Connections



Max 10 Connections



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

Carrier-Grade NAT

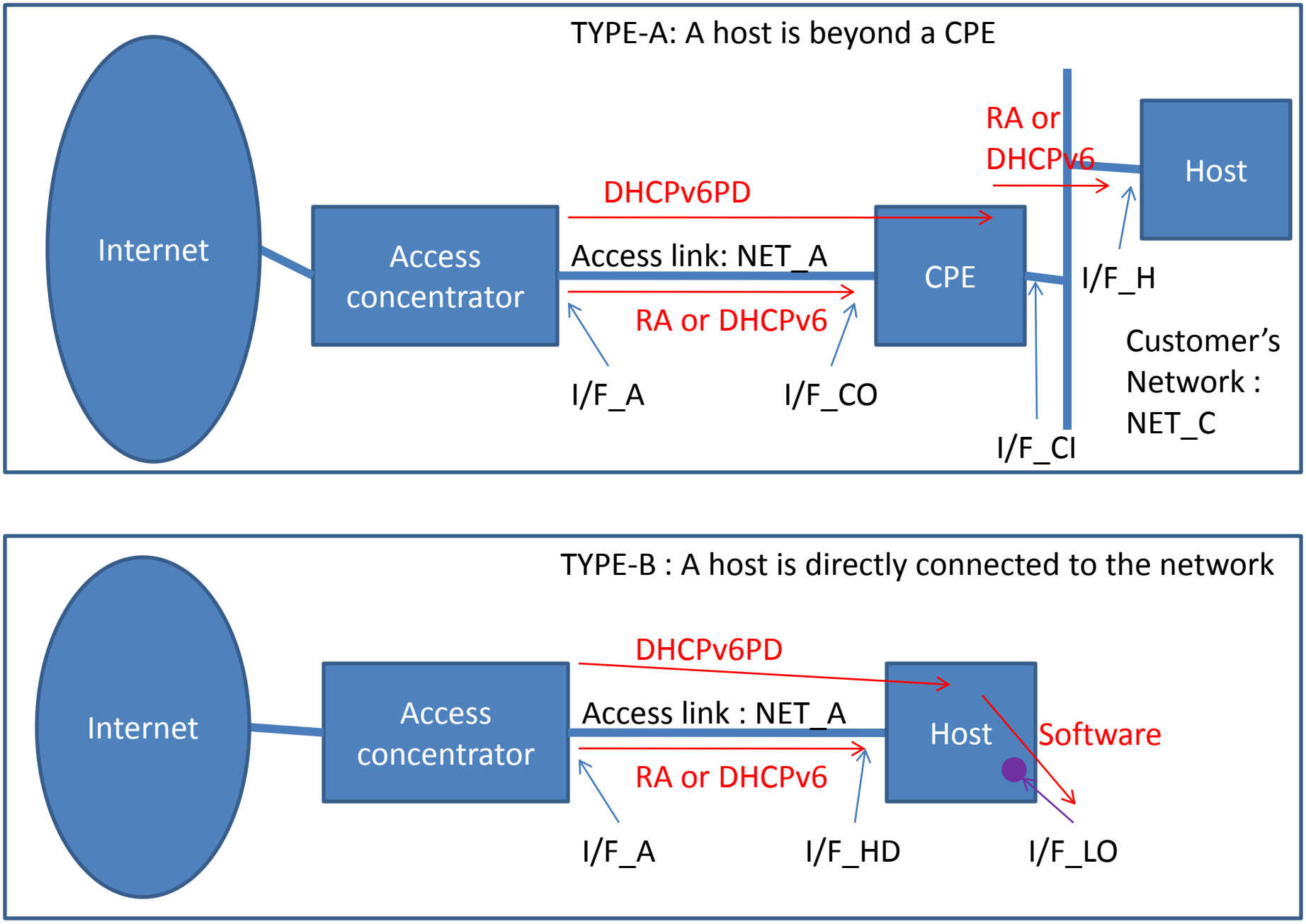
- Scalability
  - >10K users (or contracts)
  - 100s of sessions per user (or contract)
- Maximum Transparency is desired
  - Like SOHO Router, there should be no barrier for application
  - So call “Full-CONE” + “Hairpinning” is ideal
  - Different from NAT for Enterprise
  - draft-nishitani-cgn-00.txt
    - Will be presented at SOFTWIRE and 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
Internet
Access concentrator
DHCPv6PD
Access link: NET_A
RA or DHCPv6
I/F_A
I/F_CO
CPE
RA or DHCPv6
Host
I/F_H
Customer's Network : NET_C
I/F_CI
TYPE-B : A host is directly connected to the network
Internet
Access concentrator
DHCPv6PD
Access link : NET_A
RA or DHCPv6
I/F_A
I/F_HD
Host
Software
I/F_LO

Transition Scenario

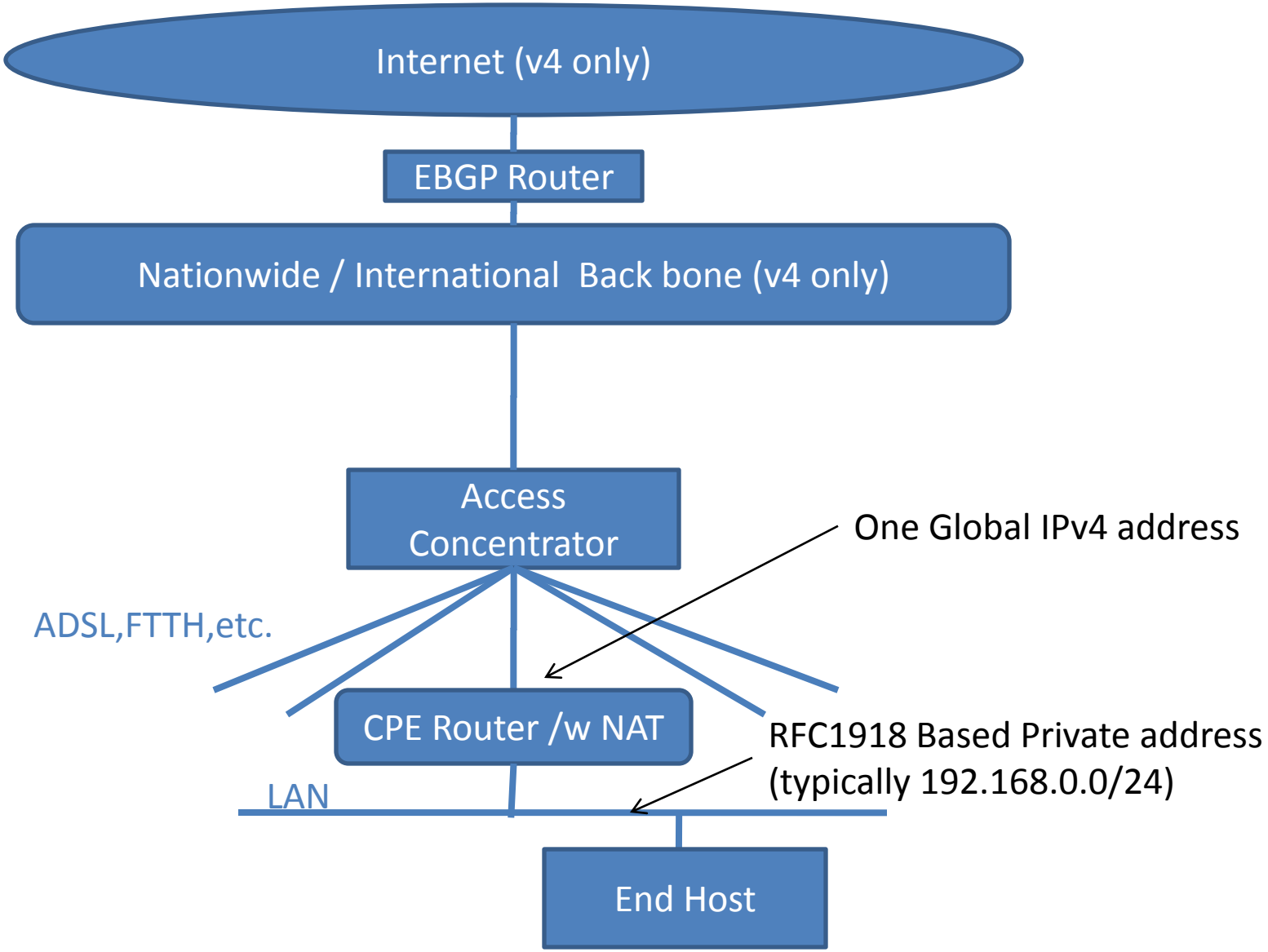
- One possible transition scenario from v4 only to dual stack to v4/v6 will be showed
- I think this is the most conservative and step-by-step

Simple concept

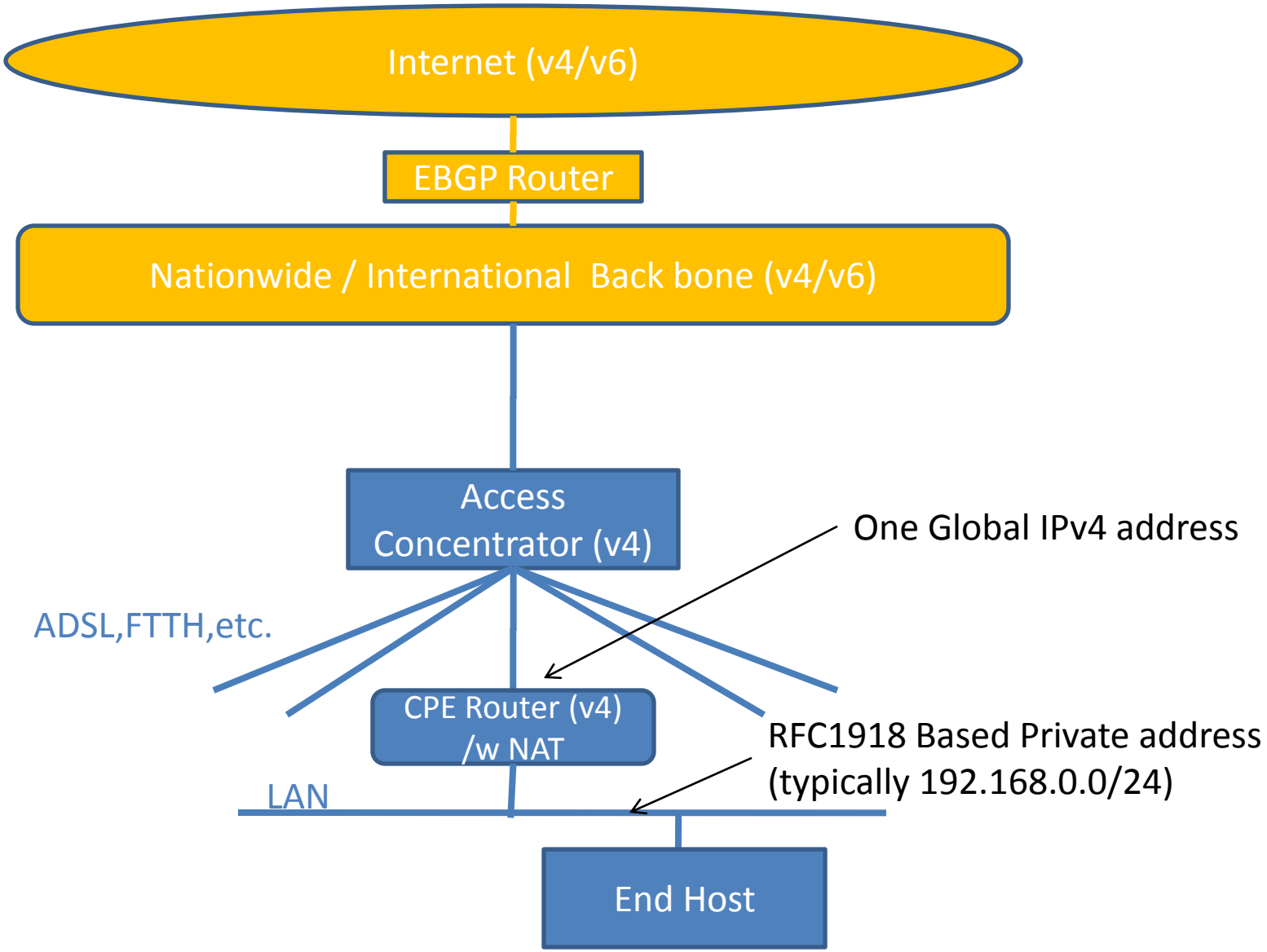
- Customer can be converted one by one
- Customer do not need to purchase any hardware until some stage of conversion
  - Especially he/she uses XP, Vista, Leopard, Linux or BSD

- IPv6 will be main stream eventually
- IPv4 will be for backward compatibility

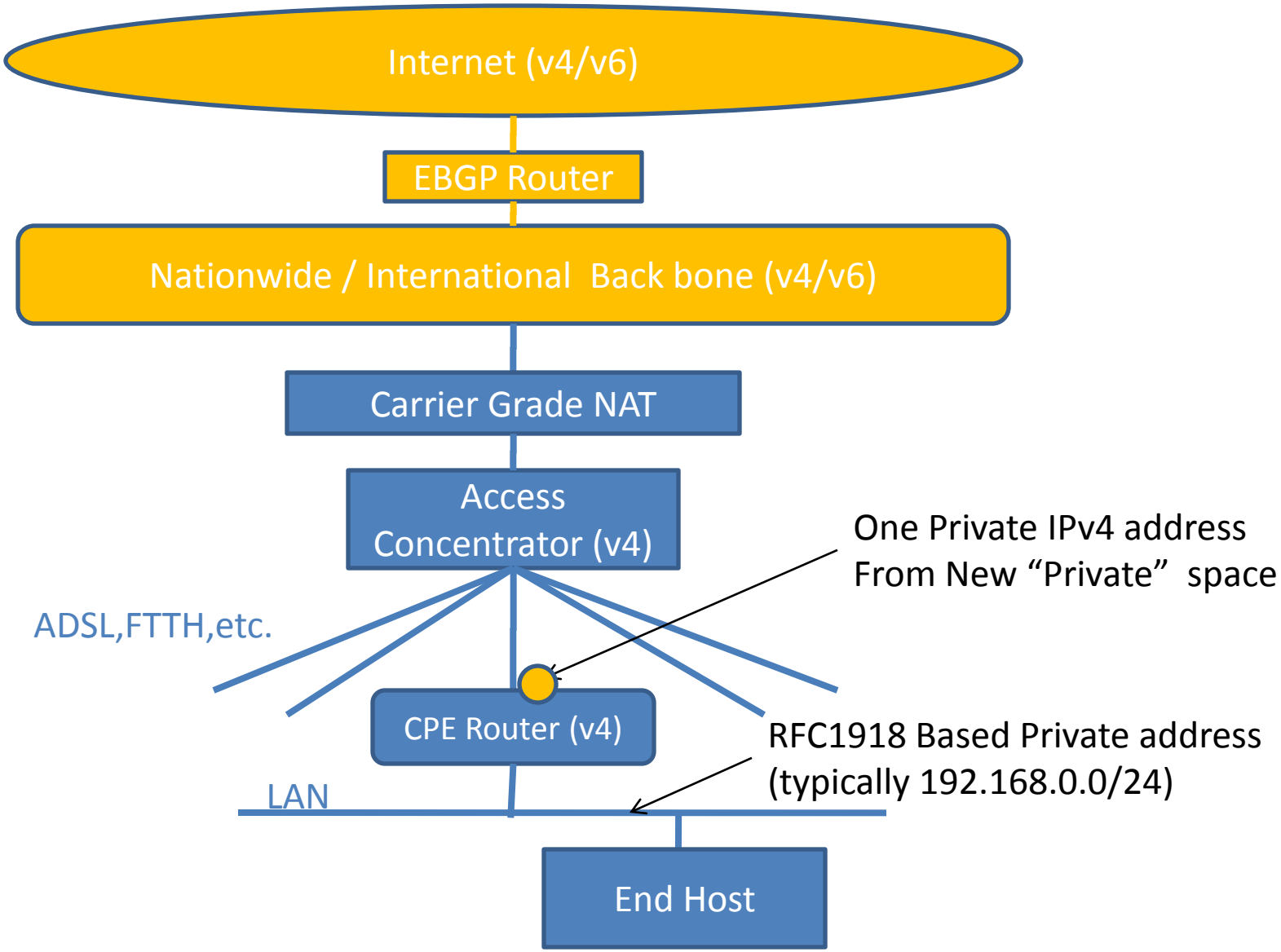
At the beginning: Global v4 only service



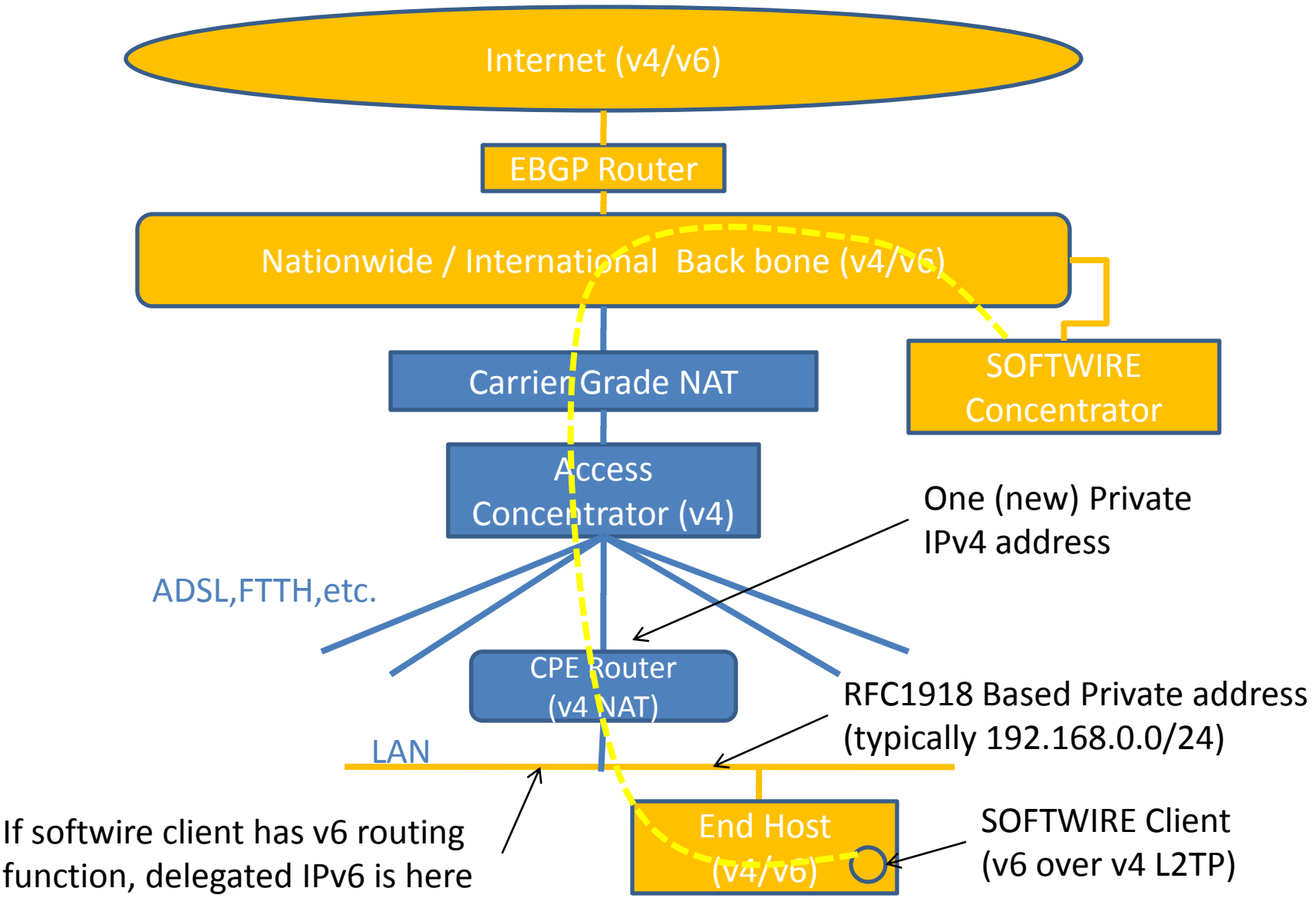
Dual Stack backbone (it's easy)



Introducing CGN

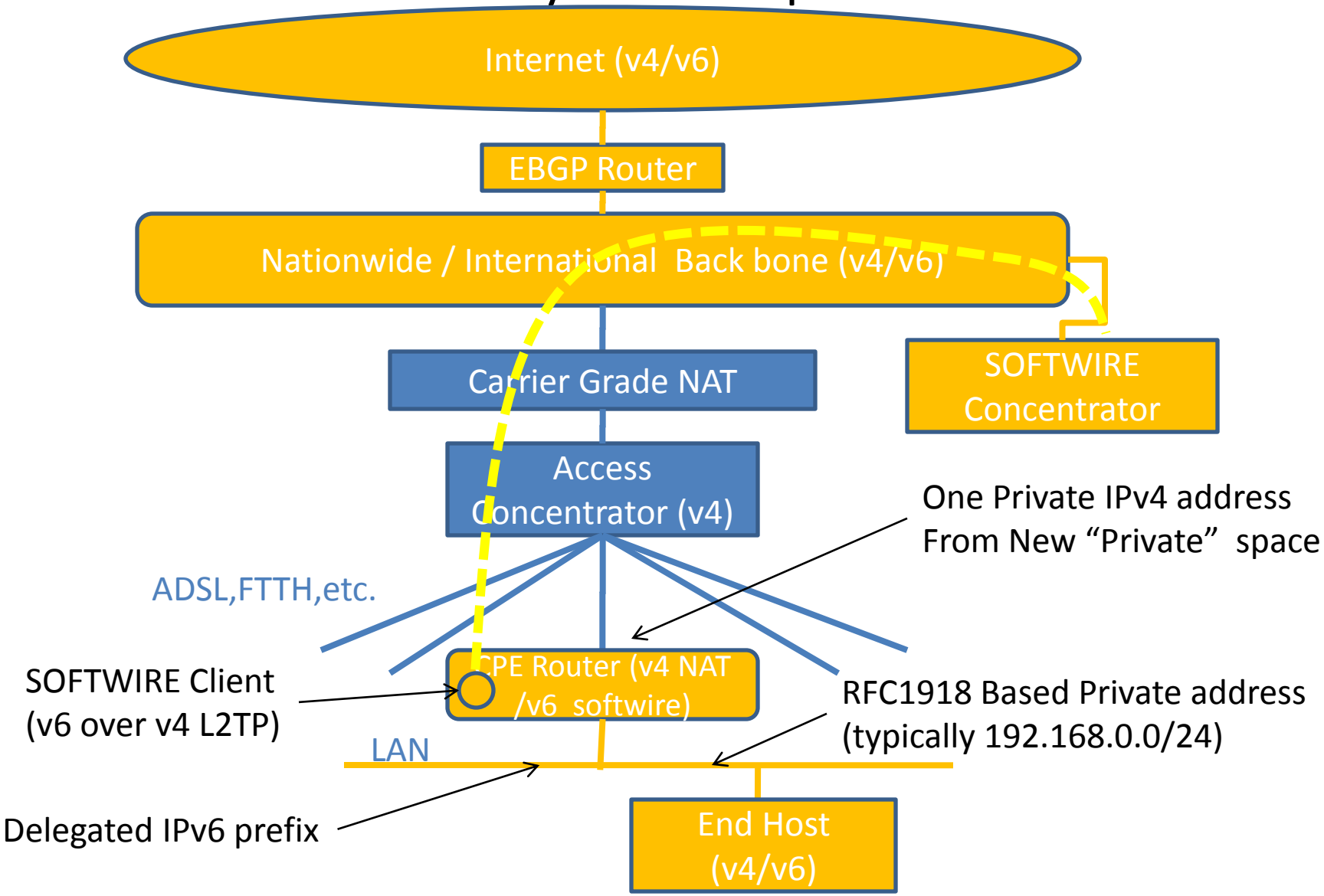


Introducing Softwire (v6 over v4 L2TP)

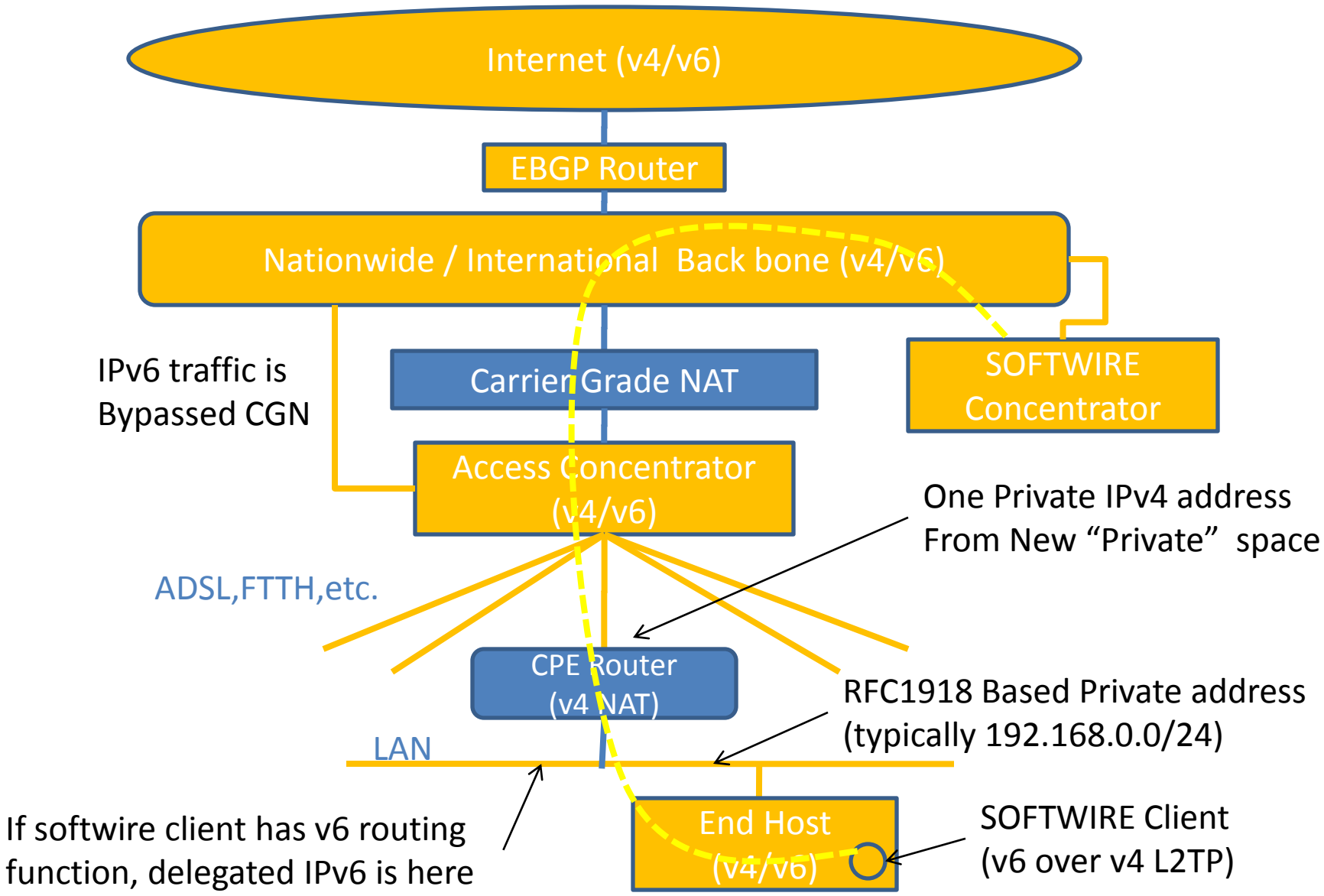


Softwire termination on CPE router

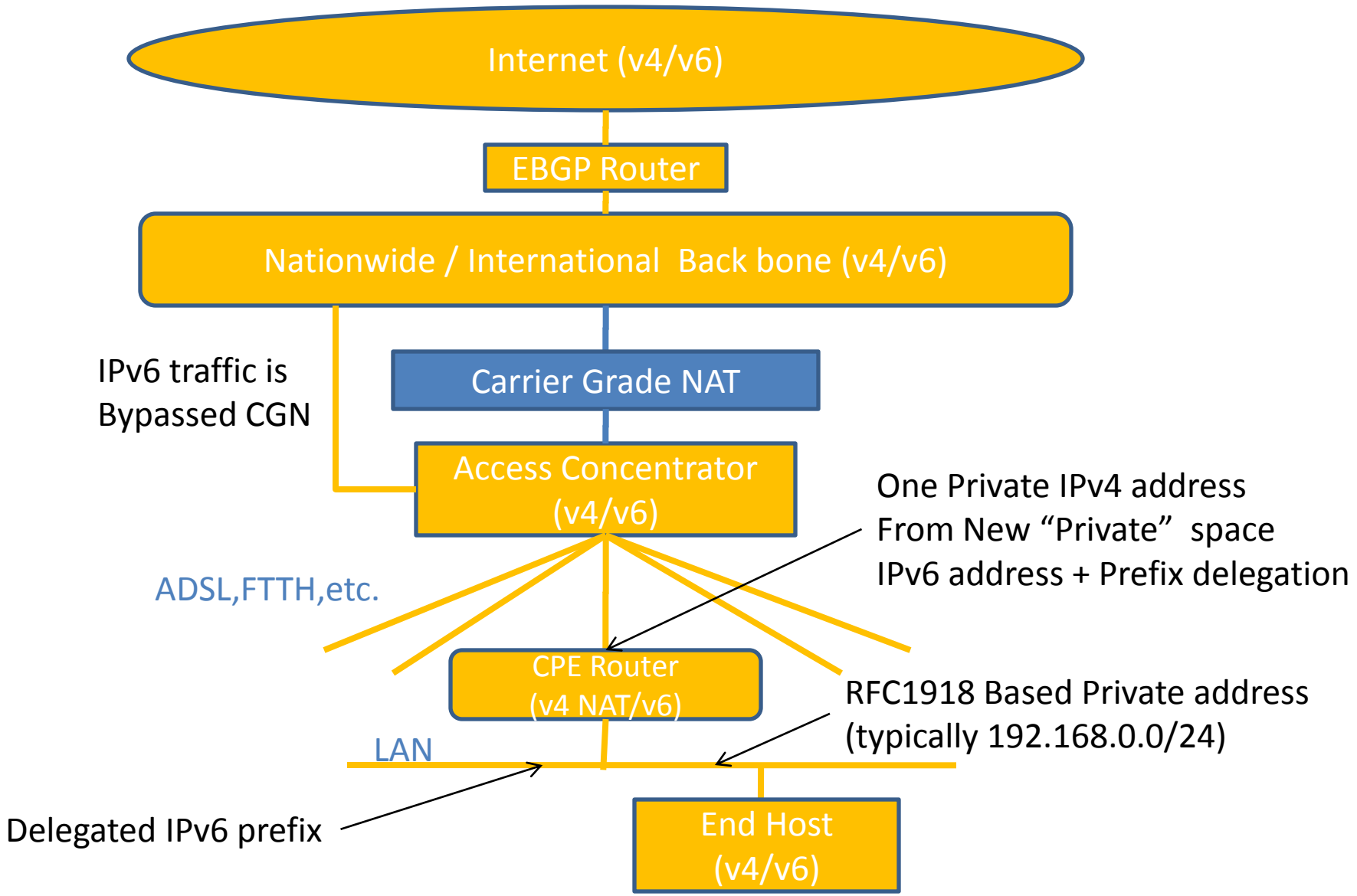
looks tricky but in-expensive



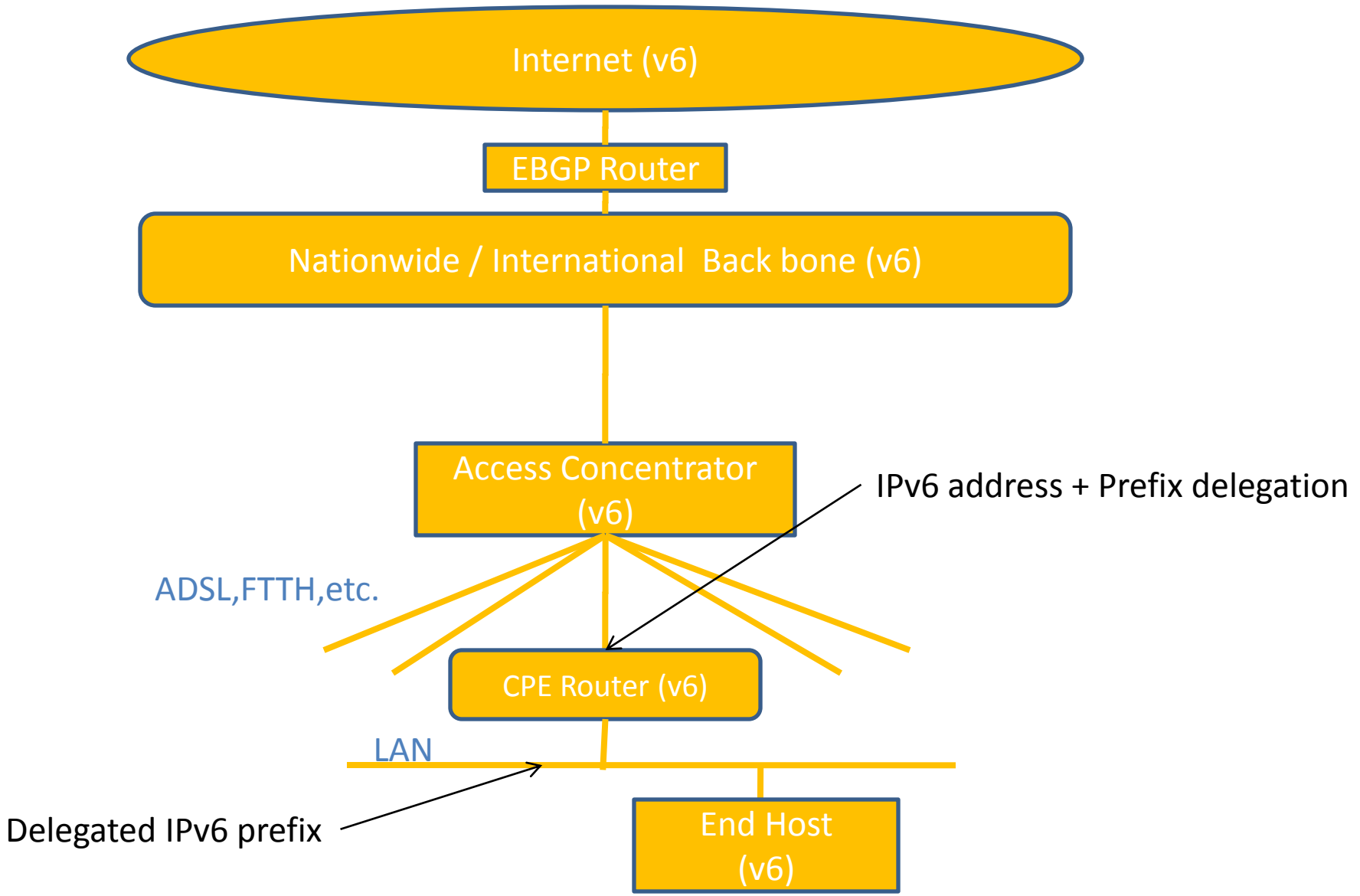
Native IPv6 service but CPE router is not ready



Replace CPE router to IPv6 compatible



Pure v6 world



We will do

- Actually, NTT group already has commercialized walled garden IPv6 service for VoIP, IPTV and so on for 5+ millions of customers
- We are now constructing a beta testing ISP facility for complete dual stack with CGN environment in a data center in down town Tokyo
- Our new service with CGN is planned to start by year 2010 Spring
- We are really happy if we could help ISPs especially in Asia Pacific area (but not limited to) that will be facing same problems

Enterprises

- We already have some requests from ASPs, usual enterprises, governmental organizations and schools for IPv6 deployment support especially for their out side system like web and E-mails first
- Eventually, their internal system will follow

These are important things to be considered

- We think that we still need
  - Simple security scheme for IPv6 should be nailed down
    - draft-ietf-v6ops-cpe-simple-security-02
  - New “private” address space allocation for carrier / provider access network behind CGN
    - draft-shirasaki-isp-shared-addr-00.txt
  - And some more…
- Also we need implementations
  - IPv6 DNS deployment should be more popular
  - MPLS support
  - Firewall
  - Load Balancer