

CGN in real form

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NTT Communications
2014 Feb. for APRICOT



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Today's talk

- Some knowledge about CGN we recently got
 - About recent CGN machines
 - Internet applications through CGN implemented network
- How IPv6 deployment helps situations
 - From our experiences of dual stack deployment
- In this presentation, I'd like to use the term "CGN" as "IPv4 address sharing mechanism among different ISP subscribers" as its definition.
 - So, NAT444, DS-Lite, what ever... are CGN in this presentation
 - However so, I'd like to talk about mostly CGN as NAT444 device

Who I am

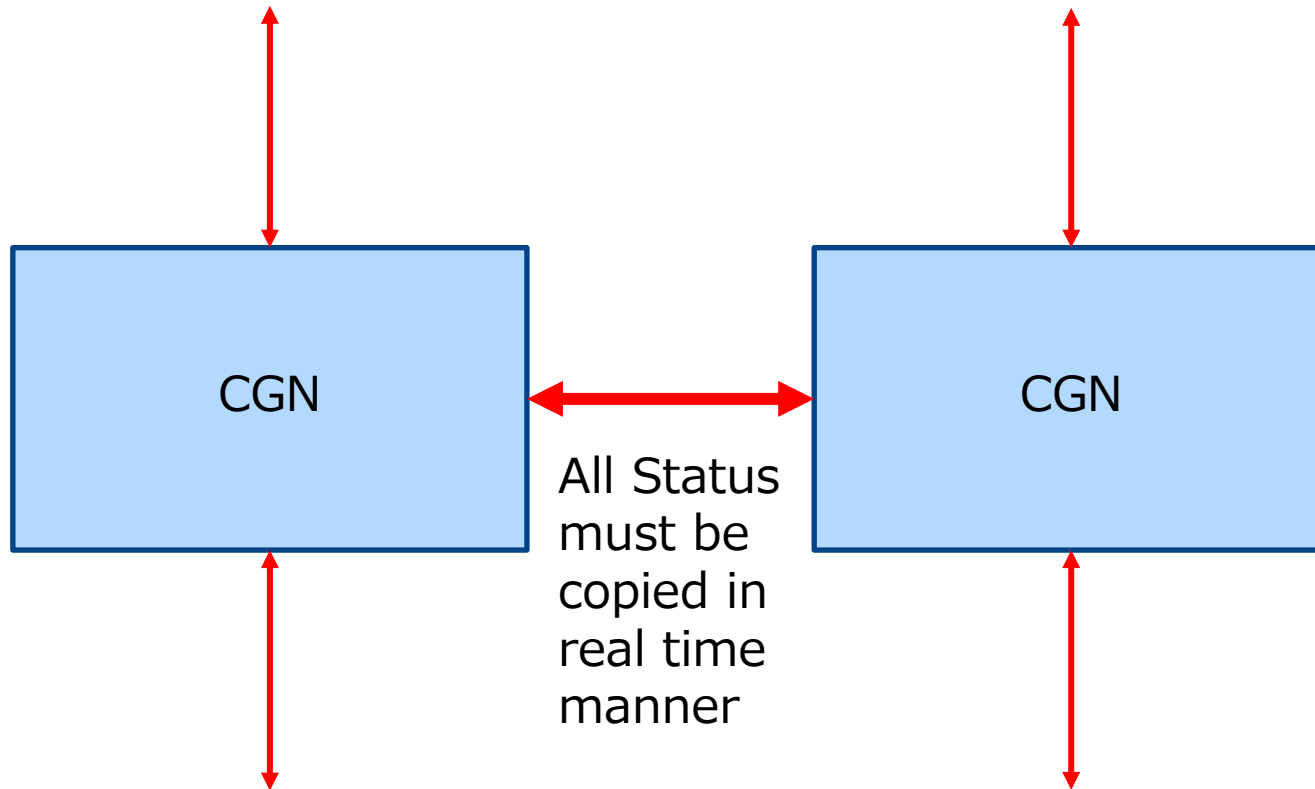
- Director, Network and Security technologies, Innovative IP Architecture Center, NTT Communications
- One of authors of RFC6888 (Common Requirements for Carrier-Grade NATs (CGNs))
- Also I am quite IPv6 person
 - RFC3769 Requirements for IPv6 Prefix Delegation
 - RFC4241 A Model of IPv6/IPv4 Dual Stack Internet Access Service
- Please check out <http://www.nttv6.jp/~miyakawa/>

Recent CGN implementations

Recent CGN implementations

- 10M-100M concurrent sessions at the maximum
- 10k-50k new connections per second can be processed
- High Availability support
- 1U – 4U form appliance
- 1G-40G bps Ethernet interface
- Usually, specification on catalogue is way better than actual performance
 - Double or triple, sometime
 - Like 0-400m (or ¼ mile) speed performance of a car

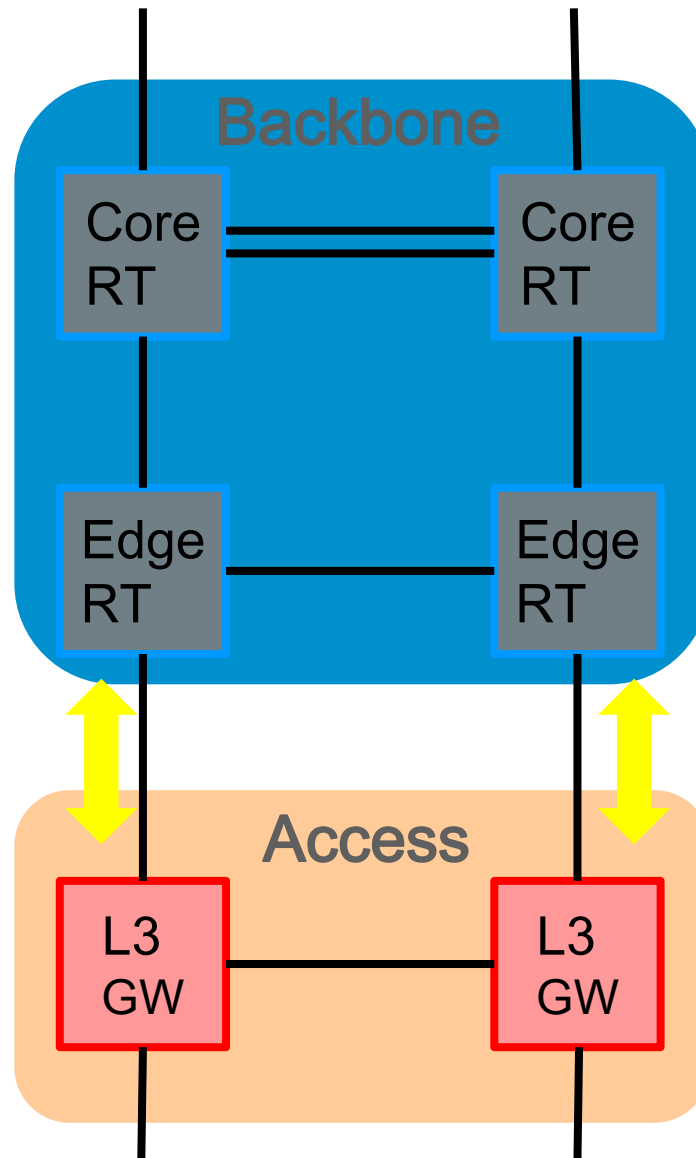
HA of CGN (Active-Stand-by or Act-Act)



Actual CGN implementations check sheet

| Sample | A | B | C |
|----------------------------------|---|----------------------|------------------------------|
| Max Concurrent Session (catalog) | 67M | 60M | 36M |
| Max Concurrent Session (actual) | 16M | 23M | 25M |
| Chassis | 1U | 8U | 2U |
| DNS ALG | Supported | Supported | Supported |
| Impact of Fullcone NAT | <1024 port is not fullcone. 1024<= port is fullcone and consumes double resources | No special treatment | No special treatment |
| Log | Adequate | Too much | Insufficient |
| Log server | Can be multiple | Only single machine | Can be multiple but some bug |
| High Availability | Supported | Not checked yet | Bug |
| ... | | | |

Sample network design (before CGN)



dynamic
routing
protocol

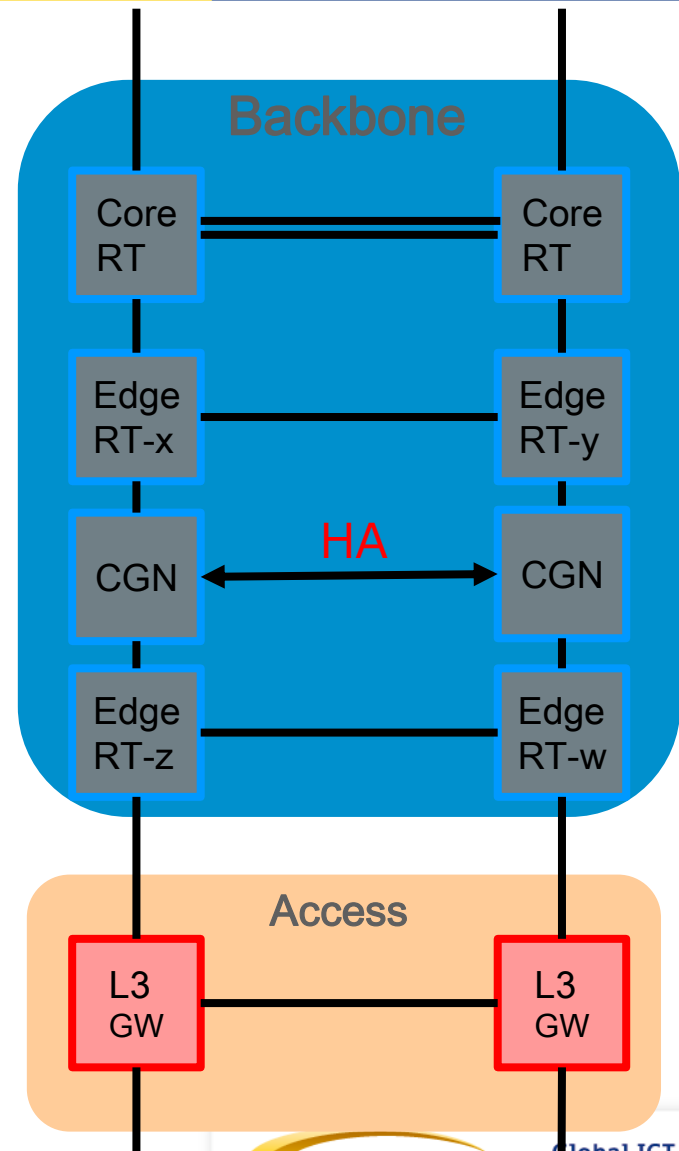
Example of CGN introduction

- Usually, CGN can not speak BGP so that it is impossible to place CGNs at
 - eBGP border
 - iBGP border



Sample Design Policy

- Divide edge router to two routers and place CGNs in between to use dynamic routing protocol
- Activate HA between CGNs to ensure the service



Very important tips

- IPv6 should (or must) be introduced when CGN needed to be there, because...
 - CGN is quite expensive device
 - ✓ And no hope to recover the cost...
 - **IPv6 introduction saves many TCP sessions today !**
- So, CGN machines must support IPv6 forwarding

Internet Application with CGN

How many TCP or UDP sessions in applications ?

It is very important to observe how many TCPs and UDPs are used in applications to identify the best parameters of CGN configuration.
We have observed following applications last year (2013).

| Application Type | Application (or web site) |
|------------------------------------|--|
| Web mail | Gmail, Yahoo! mail, Hotmail |
| Video Stream | Ustream, YouTube, Nico Nico Douga, Hulu, Dailymotion, Daum, QQ |
| Video Stream (with adult contents) | fc2, dmm.co.jp, xvideos |
| Portal Site | Yahoo.co.jp |
| EC Site | Rakuten, amazon.com, apple.com |
| Search Engine | google |
| Online PC game | Aeria Games ,Ameba pig, Nexon, 777town, Hangame |
| On line banking | Muzuho Bank , DC CARD |
| SNS (Twitter) | Twitter |
| SNS (Facebook) | Facebook |
| Media | iTunes |
| Cloud service | Drop Box, Evernote |
| IM (Intastant Messenger) | Skype messenger |
| VoIP | Skype voip |
| ftp | FFFTP |
| ssh | putty |

results

We show the average of the number of the sessions used by application types

| | Web mail | Video | Video (Adult) | Portal | EC | blog | Search | Online game |
|----------------|----------|-------|---------------|--------|----|------|--------|-------------|
| # of TCP | 65 | 83 | 47 | 36 | 45 | 61 | 8 | 95 |
| port 80 | 35 | 77 | 47 | 34 | 43 | 59 | 8 | 86 |
| port 443 | 30 | 6 | 0 | 2 | 2 | 2 | 0 | 9 |
| # of DNS query | 20 | 20 | 4 | 13 | 11 | 17 | 4 | 19 |

| | Online Banking | Twitter | Facebook | iTunes | Cloud | IM | VoIP | ftp | ssh |
|----------------|----------------|---------|----------|--------|-------|----|------|-----|-----|
| # of TCP | 20 | 33 | 51 | 20 | 29 | 66 | 18 | 7 | 1 |
| port 80 | 2 | 1 | 40 | 1 | 23 | 5 | 0 | - | 0 |
| port 443 | 18 | 32 | 11 | 19 | 6 | 18 | 5 | - | 0 |
| other TCP | - | - | - | - | - | 43 | 13 | 7 | 1 |
| # of DNS query | 4 | 12 | 18 | 7 | 6 | 17 | 4 | 2 | 0 |

Impact on IPv6 introduction

IPv6 introduction impact

- Also we'd like to know how much IPv6 introduction could impact to the application behavior in general.
- We have evaluated this when we supported HTML5J conference which 1000+ users attended last year.

HTML5 conference 2013

■ The event

- Date 2013 Nov. 30 (Sat)
- For Web developers and designers
- At NTT Central Education Center (Chofu, Tokyo)

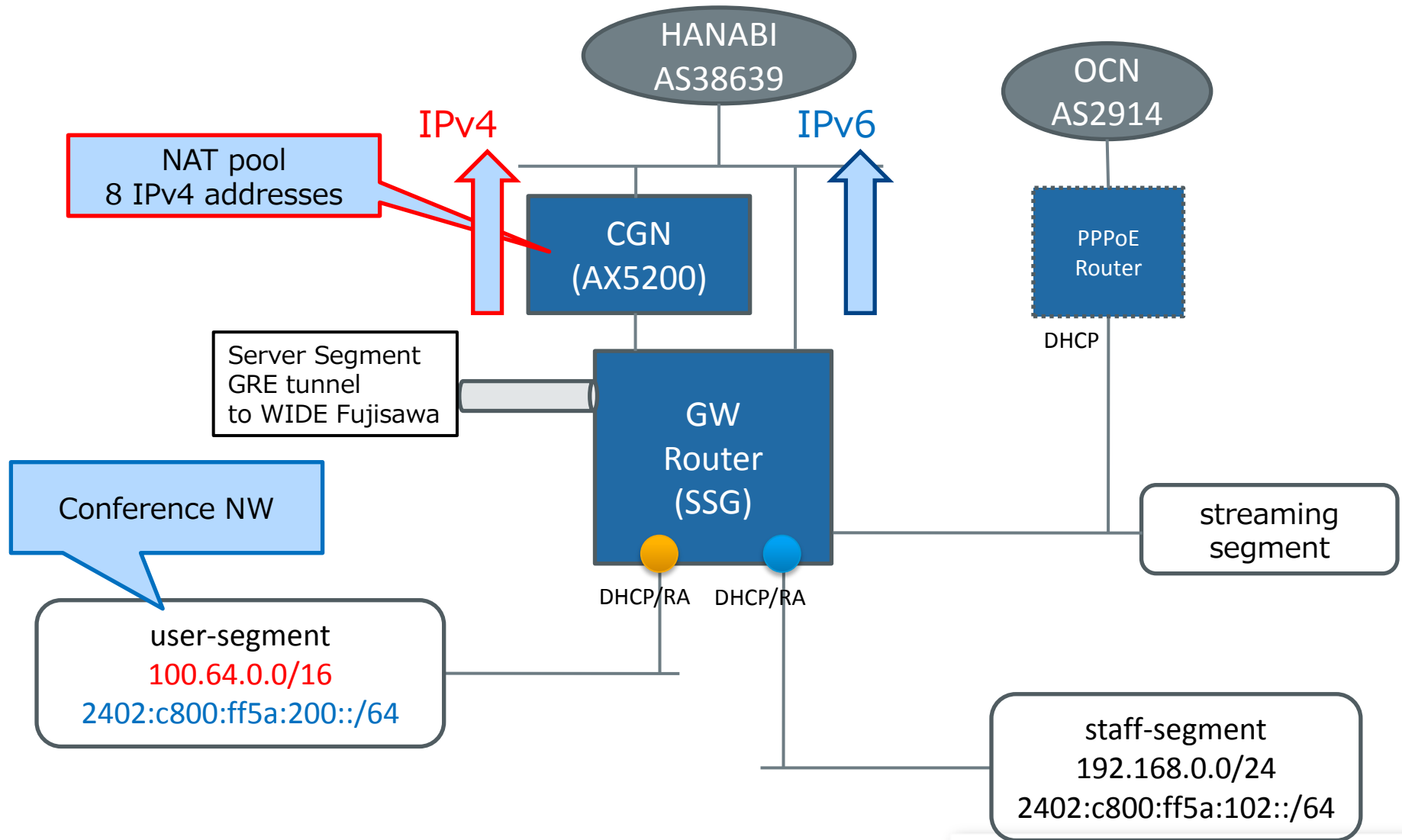
■ Number of the people attended

- General guest : 1003
- From sponsor company : 95
- Speaker : 52
- Invited guest : 10
- Staff / Volunteers : about 140

-
- Summary : about 1300



NW Configuration



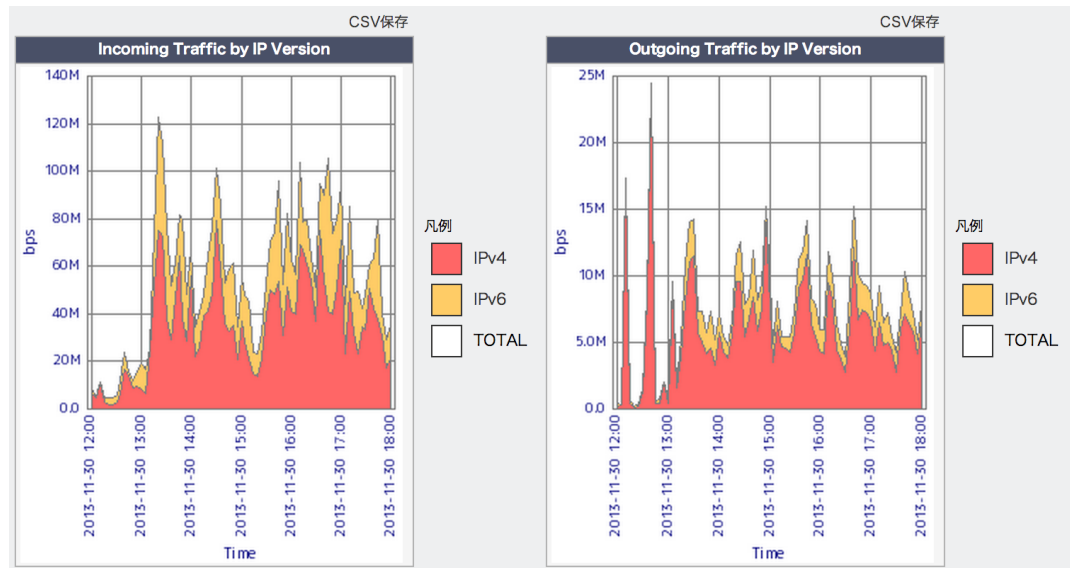
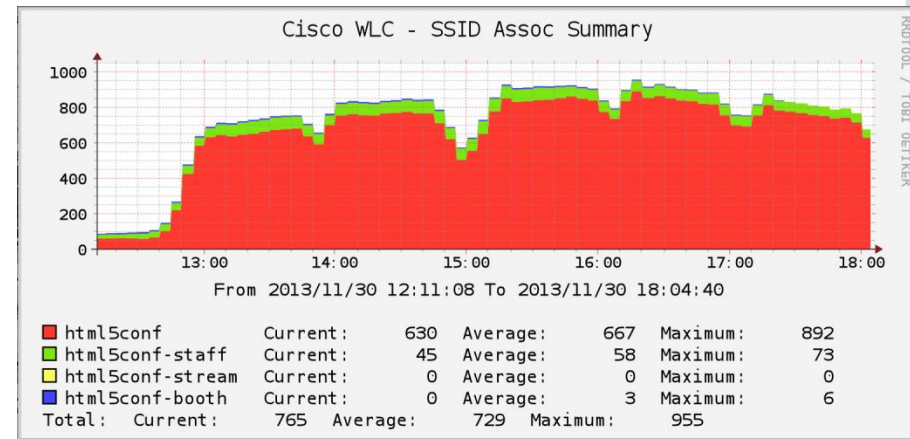
Actual observation

■ Max # of terminals

- 946
(from WLC Assoc. log)

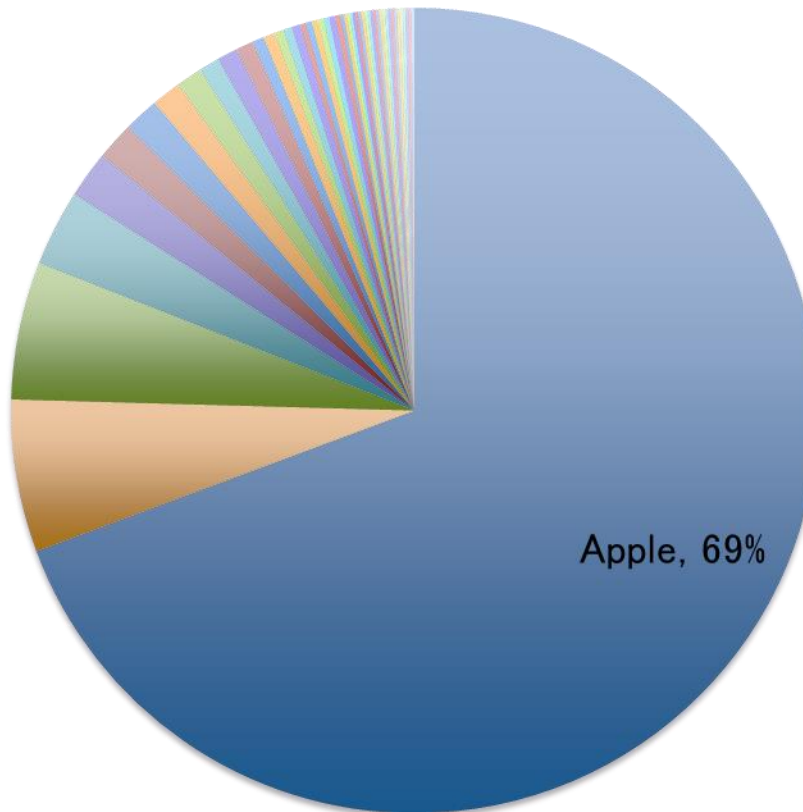
■ Max IPv6 usage (volume)

- 61.24% (13:05)



Which terminal vendors ?

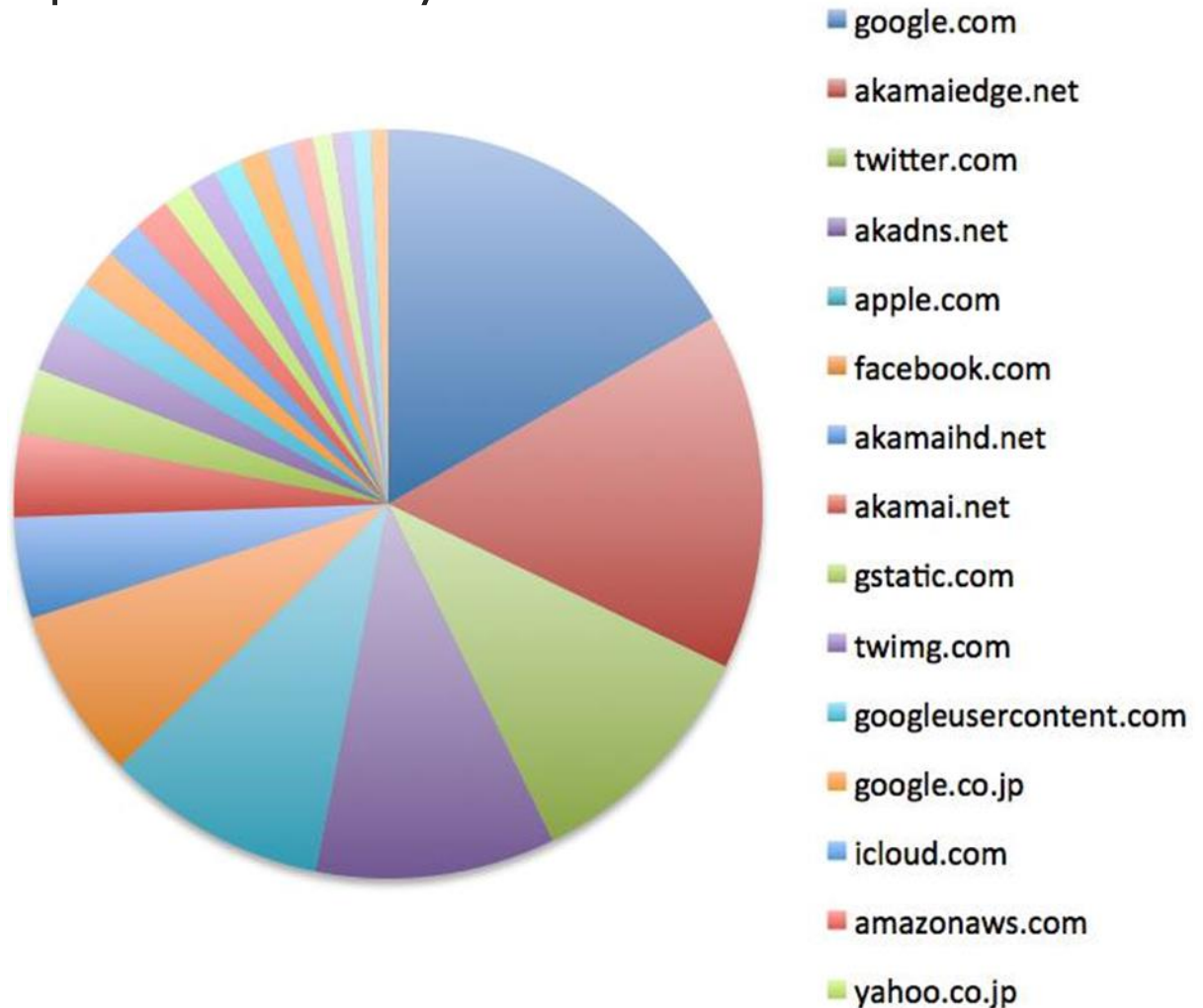
When IPv6 hits the maximum : 13:10
(from MAC address log)



- Apple
- Intel Corporate
- CISCO SYSTEMS, INC.
- ASUSTek COMPUTER INC.
- Microsoft Corporation
- Murata Manufacturing Co.,Ltd.
- Sony Mobile Communications AB
- LG Electronics
- Hon Hai Precision Ind. Co.,Ltd.
- Liteon Technology Corporation
- SAMSUNG ELECTRO-MECHANICS
- Murata Manufacturing Co., Ltd.
- SHARP Corporation
- Asustek Computer Inc
- MITSUMI ELECTRIC CO.,LTD
- Fujitsu Limited

DNS query

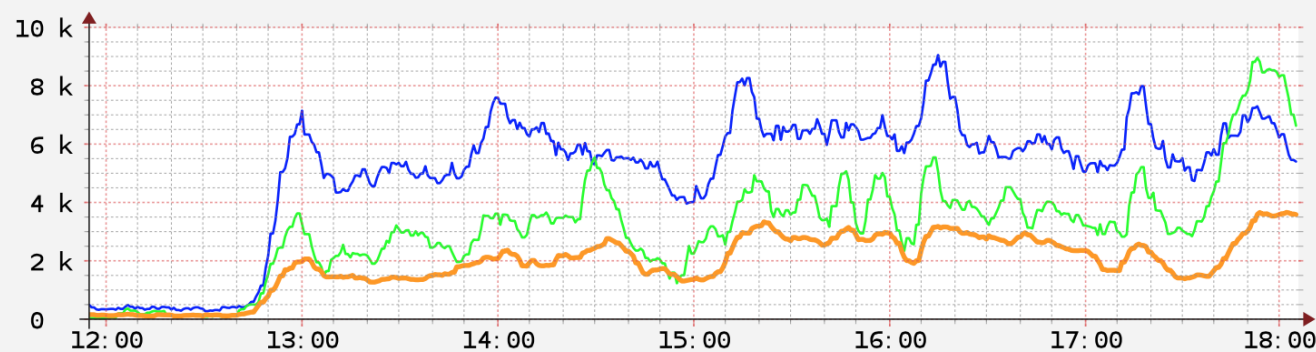
Major sites: IPv6 compatible already



The number of IPv4 sessions through CGN



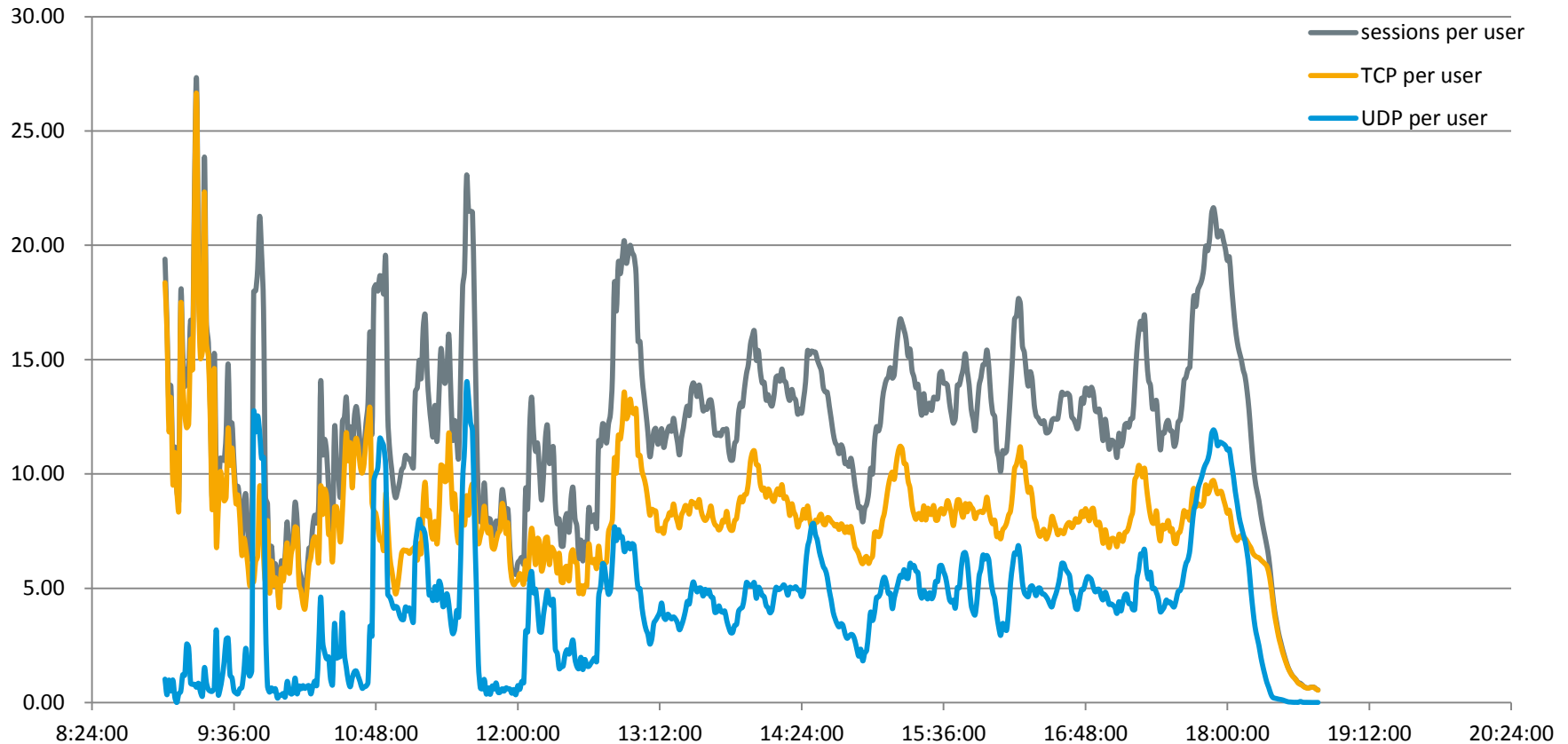
AX-CGN - Sessions



| | | | | |
|-------------------------|----------|------|------|------|
| ■ A10 TCP Sessions | Current: | 5400 | Max: | 9055 |
| ■ A10 UDP Sessions | Current: | 6627 | Max: | 8960 |
| ■ A10 Fullcone Sessions | Current: | 3586 | Max: | 3659 |

RRDTool / TOBI OETIKER

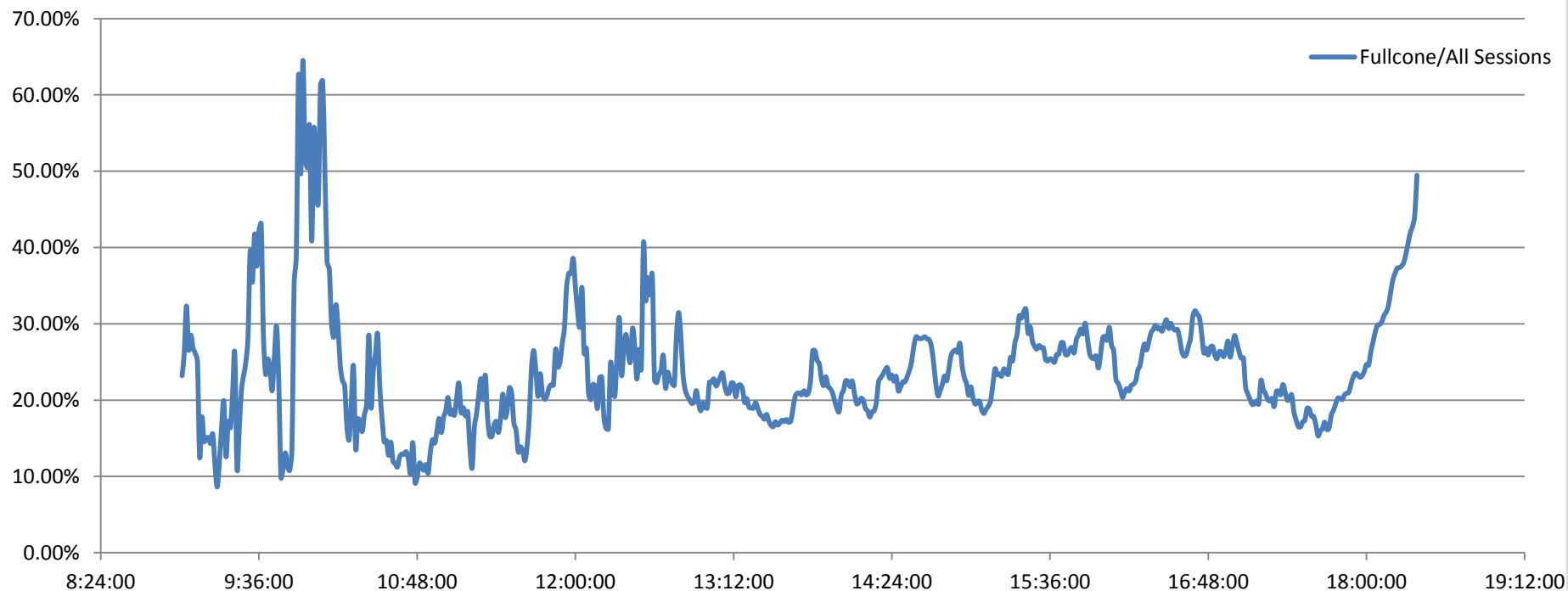
The number of sessions per user



It was limited by almost 30 or so, because off load to IPv6

Percentage of High-Port

Fullcone/All Sessions



Over 60% of sessions are over 1024 which requires FullCone that consumes many CGN resources

As a result

- Even today, only google, facebook and few sites are IPv6 ready but they are so major. So, if we introduce IPv6, about 40-50% traffic (by volume of the number of the packet) will be carried by IPv6.
- Also quite many TCP sessions is also diverted to IPv6 transport so that we could reduce the impact on CGN quite a lot.
- Many applications uses non-well-known port (1024+) so that CGN will be loaded heavily.

At the end

CGN now a days – at a glance -

- There are several CGN implementations commercially available in the market today
 - Works good mostly, but some issues especially around HA (High Availability) functions sometime
 - Catalogue specs are a bit suspicious ... ☺
 - Careful network design is needed
- Many cellular phone operators have been deployed CGN in their network most aggressively recently
 - Some terrestrial services are following this trend
- IPv6 introduction will help CGN load a lot to reduce the cost

Acknowledgement

- This research and experiment are conducted under the great support of Ministry of Internal Affairs and Communications of Japan
- I thank all my colleagues working on this research in and out of my company very much