IPv6: Launching Our New Internet Protocol

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Future growth challenges with IPv4

> 4,000,000,000

Tags IPv4 Ports

Today

Subtended NATs
Address+Port routing
More specific routes
Routing table growth
Shorter IP Leases
Camping on bogon space
Application Gateways
Reviving 240
Shared-SP IPv4 space

"Usable" Global IPv4 Addresses
Addresses in Global Routing Tables

Routed IPv4 Addresses

Sources: IMS Research, Intel, Ericsson, Cisco
IPv6 – “Full Spectrum” Internet

IPv6

IPv4

CGN

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Enterprise routers with IPv6 enabled

Cisco Services Study
of over 800 Enterprises

Enterprise Technical Advisory Board Survey

“When are you planning to deploy IPv6 in production”

July 2010

- No plans: 40%
- 24 months: 32%
- 12 months: 4%
- 6 months: 2%
- In Progress: 4%

April 2011

- No plans: 25%
- 24 months: 18%
- 12 months: 25%
- 6 months: 14%
- In Progress: 28%
IPv6 enabled homes

- Large Un-named ISP
  - Feb-11
  - Feb-12
  - Dec-12
CGN Bypass

2011 2013 2015

CGN Only

2011 2013 2015

6rd + CGN
IPv6-only mobile devices with NAT64
Stateful NAT64 - overview

Stateful NAT64 allows the hosts on the IPv6 network connect to the IPv4 Internet, by dedicating an IPv6 prefix which will represent the translated IPv4 Internet. This allows a twofold use:

- IPv6-enable the internal IPv4-only services
- allow internal IPv6-only network to talk(∗) to IPv4 Internet

In this example, it is possible to model both. We need “stateful” translation because the initiators are on IPv6 side – so after translation the addresses “shrink” – thus IPv6 is mapped into much smaller IPv4 global pool.
Stateful NAT64 – example configuration

```
nat64 prefix stateful 2610:d0:1208:cafe::/96
nat64 v4 pool NAT64GLOBAL 153.16.17.82 153.16.17.82
nat64 v6v4 list NAT64LIST pool NAT64GLOBAL overload
nat64 logging translation flow-export v9 udp dest 192.168.0.2 9995
ipv6 access-list NAT64
    permit ipv6 any 2610:d0:1208:cafe::/96
```
Stateful NAT64 – packet flow

```
asrlknat64-xtr# show nat64 trans

tcp  72.163.4.161:80  [2610:d0:1208:cafe::48a3:4a1]:80
     153.16.17.82:1056  [2607:f128:42:73::2]:37897
```

IPv4-only servers

- Source: 153.17.16.82:1056
- Destination: 72.163.4.161:80

IPv6-only client

- Source: [2610:d0:1208:cafe::72.163.4.161]:80
- Destination: [2607:f128:42:73::2]:37897

IPv6 Internet

- Source: [2607:f128:42:73::2]:37897
- Destination: [2610:d0:1208:cafe::72.163.4.161]:80
NAT64: Beware of becoming an open relay

1. IPv4 translated traffic is “router-originated” routing-wise, based on IPv6 traffic

2. IPv4 and IPv6 security policies need to be consistent!
DNS64

DNS64 creates synthetic AAAA record for the host based on A record if no real AAAA record exists in DNS. This allows to automatically direct IPv6-only clients to the correct address within NAT64 prefix.

This functionality is provided by bind since 9.8.0 – and in our example bind runs on a linux vm in a container on asr1k

CNR’s DNS server can also be used to perform the same function.
IPv6 “What Works” in Apps

IPv6 “Brokenness” in Apps

85%

15%
Business case for IPv6

1. Full Spectrum Internet
2. CGN bypass
3. IPv6-only mobile devices
Slovenia and IPv6: #2 worldwide*

*top 50 .si sites from Alexa rating;
Source: http://www.vyncke.org/ipv6status/
What do I do before June 6\textsuperscript{th} 2012?
Short-term: IPv6 frontend

Server Load Balancer
http proxy

IPv6 Internet

ACE-30

IPv4-only Host

IPv6

IPv4

Stateful NAT64

IPv6 Internet

ASR1000

IPv6

IPv4

Software Proxy
Web Tier

IPv6 Internet

Apache
-MSFT

IPv6

IPv4

IPv4-only Host

PortProxy

IPv4

IPv4-only Host
Midterm: dualstack – "Happy Eyeballs"
Longterm possibility: IPv6-only with translation
NAT64: Stateless IP/ICMP translation (aka IVI)

RFC6052
RFC6145

IPv6::/0

IPv4 0.0.0.0/0

IPv6-mapped 2001:db8::/96
NAT64: SIIT packet flow

IPv4

Stateless NAT64

2001:db8::192.0.2.1

DNS

A: 192.0.2.1
AAAA: 2001:db8::192.0.2.1

s: 1.1.1.1:1056
d: 192.0.2.1:80

s: 2001:db8::1.1.1.1:1056
d: 2001:db8::192.0.2.1:80
V6-only SIIT: pros and cons

- No IPv4 on the server
- IPv4 clients served as IPv6
- Original IPv4 remains known (geolocation, etc)
- Stateless: easy redundancy, flow count does not matter
  - Need to inject /128s
Static NAT64

IPv4 0.0.0.0/0
IPv6-mapped IPv4 address 2001:db8::/96
IPv6 ::/0

Public IPv4 192.0.2.1/32
Static NAT64 packet flow

IPv4

Stateless NAT64

2001:db8::192.0.2.1

DNS

A: 192.0.2.1
AAAA: 2001:db8:c001::1

s: 1.1.1.1:1056
d: 192.0.2.1:80

s: 2001:db8::1.1.1.1:1056
d: 2001:db8:c001::1:80
A word of caution

- IPv4 header overhead ≠ IPv6 header overhead
- Beware potential MTU issues
- Fragmentation in IPv4 and IPv6 done differently
- => Test extensively in the lab if it works for your traffic!
Practical experiences
IPv6 World Congress 2012, Paris

- Demo of WLC 7.2 code
- 30 APs, ~1400 clients
- Fully up by 3 people in less than a day
- Dualstack SSID and IPv6-only SSID with NAT64+DNS64
IPv6 on Wireless: First Hop Security

IPv6 > RA Guard

IPv6 RA Guard on WLC: Enabled
IPv6 RA Guard on AP: Enable
RA Dropped per client:
IPv6 on Wireless: First Hop Security

Neighbor Binding Timers

- Down Lifetime (0-86400)
- Reachable Lifetime (0-86400)
- Stale Lifetime (0-86400)
Clients by vendor

- Apple: 437
- Others: 19
- Epigram: 1
- Huawei: 5
- Universal Global: 4
- Rim Testing: 3
- Azurewave: 8
- Palm: 3
- Liteon: 10
- Unknown: 6
- Research In Motion: 7
- Murata: 13
- Gemtek: 12
- Nokia: 21
- Motorola: 14
- Sony: 18
- Rim: 28
- Hon Hai Precision: 51
- Samsung: 40
- HTC: 48
- Intel: 320

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ND vs. ARP cache entries
Clients by address type

- 114 IPv6-only / (706+701+114) = 7.5%

7.5% IPv6-only
iPad&iPhone and IPv6

- IPv6-only works, but need to wait till DHCPv4 times out
- Temporary addresses:
  New association = new address!
  WLC cache = 8 addr. Tune the timers!
The results of the IPv6-only+NAT64 test

- What worked well:
  - Everyday browsing
  - Facebook 😊

- Users complained about:
  - Apple Facetime
  - Most of the VPNs
IPv6-only server experiment

- NOC management VM host short on IPv4 addresses
- Instead of getting extra IPv4, configured static NAT64 on ASR1k
- It worked and noone noticed
Conclusions

• Join the IPv6 launch
• Help fix the 15%