IPv4 Exhaustion and IPv6 State of the Union

Brian E Carpenter

THE UNIVERSITY OF AUCKLAND

NEW ZEALAND

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Crowded beach in New Zealand

IPv4 exhaustion

- It's beyond debate, it's started.
    - symptom: 1.0.0.0/8 allocated to APNIC
- Estimated exhaustion of addresses at global registry (IANA): *Oct 1, 2011*
- Estimated exhaustion of addresses at regional registries (ARIN, etc.): *Sept 4, 2012*
- Get the latest estimates at
    http://www.potaroo.net/tools/ipv4/
- Estimated exhaustion of addresses among ISPs: *now through 2015*

What happens next?

- Hoarding and horse trading of residual IPv4 space

- Multiple layers of NAT

- Progressive deployment of IPv6
  - Millions of mobile users with no IPv4 address

- An indefinite period of IPv4/IPv6 interworking

  - This concerns you *especially* if you operate IPv4-only services. Users who only have IPv6 access need to reach you.

IPv6 - Outline

- The Great Disillusionment
- What the IETF has been up to in the last year
  - tunnels++
  - NAT++
  - operations
- What ISPs are doing and planning

Disillusionment:
Reality breaks in, as always

- When the IETF first considered deployment scenarios, the idea was that IPv6 would deploy before IPv4 ran out.

FAIL

- This changes the available transition models.
  - Service providers will still need to offer dual stack services, of course.

- More need for interworking than ever expected.
  - The only commercially sane assumption is that v6 clients will need to access v4 services indefinitely.

- This has been driving IETF work for a couple of years.

Tunnels: the SOFTWIRE WG

- "discovery, control and encapsulation methods for connecting IPv4 networks across IPv6 networks and IPv6 networks across IPv4 networks in a way that will encourage multiple, inter-operable implementations."

- <u>Dual Stack Lite</u> - share IPv4 addresses among customers by combining IPv4-in-IPv6 and NAT. Driven by Comcast broadband model.

- <u>6rd</u> - blend of 6to4 and ISATAP providing automatic tunneling of IPv6-in-IPv4 to ISP subscribers. Deployed by Freenet.FR

- Older mesh and hub+spoke models also documented, using GRE, IP-in-IP, L2TPv3, IPsec and MPLS.
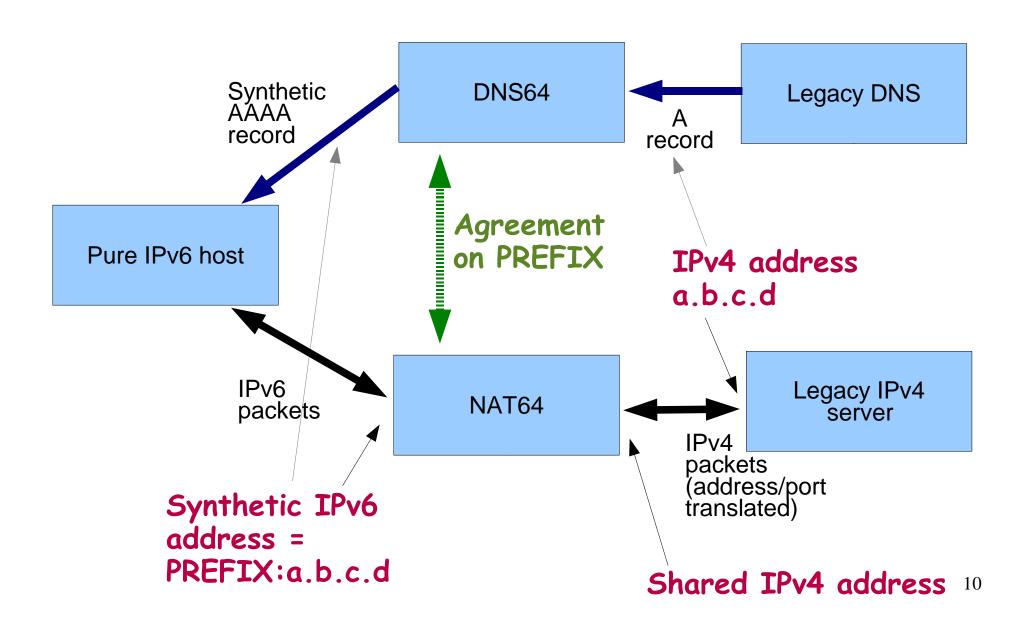
Ain't misBEHAVing: NAT64

- *Reminder:* the old NAT-PT specification was deprecated, mainly due to irreconcilable differences with DNS.

- However, many operators (especially in the mobile "LTE" world) are convinced that they will soon have millions of IPv6-only subscribers needing access to legacy IPv4-only services.
{Argument about exactly what the economic incentives are deleted - but just imagine selling mobiles that can't reach PayPal.}

- Therefore, the BEHAVE WG has taken up the NAT64 challenge.

NAT64 only solves one problem

- IPv6-only client (no v4 address, no v4 connectivity) needs to initiate communication with an IPv4-only server.

    - As stated, this requirement cannot be met by the conventional dual stack approach.

    - Whatever *you* may believe, some ISPs believe this is vital, and their suppliers believe they'd like the business.

- NAT64 doesn't tackle any other cases.

- NAT64 comes with a separate DNS64 magic box

    - NAT-PT came with a built-in DNS ALG

Components

Synthetic
AAAA
record

DNS64

A
record

Legacy DNS

Pure IPv6 host

Agreement
on PREFIX

IPv4 address
a.b.c.d

IPv6
packets

NAT64

Legacy IPv4
server

IPv4
packets
(address/port
translated)

Synthetic IPv6
address =
PREFIX:a.b.c.d

Shared IPv4 address

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V6OPS activity

- "The IPv6 Operations Working Group (v6ops) develops guidelines for the operation of a shared IPv4/IPv6 Internet..."

- Current work includes:
  - Requirements for CPE routers
  - IPv6 Deployment in Internet Exchange Points
  - Incremental Carrier-Grade NAT (CGN) for IPv6 Transition
  - ISP scenarios generally.

Recent survey of ISPs
(by Sheng Jiang (Huawei) and me)

- 30 ISPs replied

- 66% European ISPs, others from NA and AP

- Commercial ISPs operating nationally predominate

- 30 customers up to 40 million

    - some very large providers chose not to answer about the number of customers

http://www.cs.auckland.ac.nz/~brian/ISP-v6-QQ.pdf

Bias

- Those who chose to reply were self-selected and we can make no claim of statistical significance or freedom from bias in the results.

- In particular, we assume that ISPs with a pre-existing interest in IPv6 are more likely to have replied than others.

IPv6 requirement

- 60% of ISPs report that some big customers are requesting IPv6 already
- When will 10% of your customers require IPv6?
  - 2010 to 2017
- When will 50% of your customers require IPv6?
  - 2011 to 2020
- When do *you* require IPv6 to be a standard service?
  - 2010 to 2015; most common answer = 2011

Crystal ball

- What is your planned date for regular IPv6 service?
  - *latest* date given was 2013
- When will IPv6 be 50% of traffic?
  - the most common answer is 2015

Service status

- 40% of respondents have IPv6 now as a regular service
  - in general it is used by fewer than 1% of customers
- 47% of respondents have IPv6 deployment in progress or planned
  - these all plan at least beta-test service in 2010

Equipment unable to support IPv6

- CPE, CPE, CPE, CPE, CPE, CPE, CPE, CPE, CPE

- Handsets

- DSLAMs

- Routers (including several specific models)

- Traffic management boxes; load balancers

- VPN boxes

- Management interfaces & systems

- Firewalls

- Billing systems.

IPv4-IPv6 interworking

- 57% of ISPs don't expect IPv6-only customers
  - Mobile operators are certain they will have millions.
  - 5 ISPs report customers who explicitly refused to consider IPv6.
- How long will users run IPv4-only applications?
  - The most frequent answer is "more than ten years".
- Is IPv6-IPv4 interworking at the the IP layer needed?
  - 90% say yes
    - 30% plan NAT-PT or NAT64
    - 23% rely on dual stack
    - the others are in *duh!* space

Some quotes

- "Just do it, bit by bit. It is very much an 'eating the elephant' problem, but at one mouthful at a time, it appears to be surprisingly easy."

- "We are planning to move all our management addressing from IPv4 to IPv6 to free up IPv4 addresses."

- "Customer support needs to be aware that IPv6 is being started in your network, or servers. We experienced many IPv6 blocking applications, applications that do not fall back to IPv4, etc. The most difficult part may be to get engineers, sales, customer support personnel to like IPv6."

Summing up

- IPv6 is coming, after a long wait
  - Not really hard, subject to equipment and software releases

- BUT...
  - There will be many millions of IPv6-only users
  - IPv4 coexistence and interworking is needed indefinitely
  - If you are running IPv4-only services, this is *not* somebody else's problem