



Google and IPv6

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Why IPv6 at Google?

- IPv4 exhaustion number one threat to Internet growth.
- After exhaustion:
 - Significant pressure to band-aid networks with NAT.
 - Ubiquitous NAT has chilling effects upon:
 - Ability to operate networks.
 - Ability to scale networks.
 - Cost of scaling networks.
 - Operation of AJAX-y applications.
- IPv6 is the cleanest solution to IPv4 lock-in.



The IPv6 killer application?

- IPv6 does offer new features, but its main feature is address space.
 - Security, mobility, ... can be done in IPv4 too.
 - Increased address space cannot be done in IPv4.
 - NAT is expensive to deploy.
 - NAT is expensive to maintain.
 - NAT is expensive to work around.
- The main reason to deploy IPv6 is risk mitigation.
- In a sense, the killer application of IPv6 is the Internet.

Why IPv6 at Google?

- When the day comes that users only have IPv6, Google needs to be there.
- If we can serve our users better over IPv6, we will.
 - IPv6 can have lower latency and packet loss.
 - ... and we have user reports to prove it.
 - AJAX applications break behind excessive NAT.
 - Connections exhaust public IP port space.
 - NAT traversal complicates apps like Google Talk.
 - Developer time better spent elsewhere.
- IPv6 is good for the Internet, and we want to help.



What we have done so far

- IPv6 websites:
 - ipv6.google.com (Mar 2008)
 - ipv6.google.cn (Aug 2008)
 - ipv6.google.co.jp (Oct 2008)
- IPv6 network rollout.
- IPv6 evangelism:
 - Google IPv6 conference (Jan 2008)
 - Conference talks, panels, blackout sessions, ...
- Google over IPv6 (Jan 2009)
 - Encourage "production-ready" IPv6.



What we learned

- Bad news: feature parity not quite there yet.
 - Traffic engineering more difficult.
 - Funky NAT-PT implementations.
 - Load-balancer support not mature yet.
- Bad news: IPv6 Internet currently not in great shape.
 - Tunnels.
 - Long AS paths.
- Good news: adequate for initial deployment!
 - We can live without all this today.
 - Representative IPv6 latency penalty ~150ms.

What we learned

- Crucial to dispel notion that IPv6 is "experimental".
 - IPv6 must be a production service.
 - Monitored, supported, designed as per IPv4.
- How to achieve this?
 - Make NOC/decision-makers aware of IPv6.
 - Scale down, but don't skimp.
 - Design as closely to IPv4 as possible.
 - Make the principle of least surprise work for you

What we learned

- We are preferring peering over transit for IPv6.
 - "Google over IPv6" programme flushes out:
 - IPv6 configuration problems.
 - Organisational configuration problems.
- This may not work for you.
 - Enterprises will require a business case analysis.

What can enterprises do?

- How to deploy IPv6?
 - Number of dimensions to consider:
 - Technical/Administrative/Operational/Financial/Internal-facing/External-facing...
 - Key points:
 - You are going to have to spend money.
 - Portions can fit in around cyclical upgrade activity.
 - Don't think of adoption as competitive advantage.
 - Pressure your vendors now - particularly ISPs.

What can enterprises do?

- Analysis process:
 - Do you offer externally-facing Internet services?
 - Do you require externally-facing Internet services?
 - Do you offer Internet connectivity to anyone else?
 - Do you have software that might depend on IPv4?
 - Do your staff know what it is/how to manage it/how to sell it?
 - What is your risk budget?

What can enterprises do?

- Analysis process:
 - Do you offer externally-facing Internet services?
 - Make them natively reachable over IPv6.
 - If out-sourced, pressure vendor.
 - Don't let them use sub-standard SLAs.
 - If in-housed, kick off a deployment program.
 - Generally: add IPv6 requirements to tender documents.

What can enterprises do?

- Analysis process:
 - Do you have software/configurations that might depend on IPv4?
 - In other words, will break in presence of IPv6.
 - Can be difficult to establish this.
 - Audit not only your code, but the dependencies.
 - Simple: log parsers, ACLs, ...
 - Hard: un-tested components, monitoring software, ...
 - Kick off audit process.

On IPv6 licensing

- Some vendors charge separately for IPv6 support.
- Suppose it's \$10k per router:
 - Red tape blocks initial experimentation / deployment.
 - Need to cut \$30k PO to try IPv6 on 3 routers.
 - Bulk upgrade price blocks full rollouts.
 - Have 100 routers? That will be \$1M, please...
- Charging separately for IPv6 *will* hinder adoption.
 - Absorb cost by raising price of base image or HW.
 - The Internet will thank you.
 - The same goes for ISPs, exchanges, ...



Questions?

