Internet Evolution and IPv6

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Overview

• Where is IPv6 today?
  – In deployment
  – In the industry

• Do we actually need it?
  – If so, why and when?
  – Are there any alternatives?

• How will it happen?
  – Evolution
  – Revolution

• The opportunity of IPv6
Where is IPv6 today?
IPv6 – the BGP view
IPv4 – the BGP view
IPv6 – AS Count
IPv4 – AS Count
Where is the Industry?

• Post-bust…
  – Optimism is no substitute for knowledge, capability and performance!

• Conservative consolidation replaces explosive expansionist growth
  – Investment programs must show assured returns, across their entire life cycles
  – Reduced investment risk means reduced innovation and experimentation

• Reducing emphasis on brand new services
  – …and more on returns from existing infrastructure investments (value-adding, bundling etc)
Do we need IPv6?
Rationale for IPv6

• Limitations of IPv4 address space
  – Around 7 years unallocated remaining
    • Based on current exponential growth rates
  – More if unused addresses can be reclaimed
    • …or less if allocation rates increase

• Loss of “end to end” connectivity
  – Widespread use of NAT, ALGs, Firewalls
  – “Active middleware”
  – “Fog on the Internet”
    • Brian Carpenter, IETF, RFC 2775

• Note: IPv6 has many other features
  – But in fact all are available in IPv4
The NAT problem

The Internet

ISP 61.100.0.0/16

61.100.32.0/26 (64 addresses)

R

61.100.32.1 .2 .3 .4

NAT*

61.100.32.128 (1 address)

10.0.0.1 .2 .3 .4

*AKA home router, ICS, firewall
The NAT problem

Internet

NAT
61.100.32.128

10.0.0.202

Phone Network

PABX
02 6262 9898

Extn 202
Everything over HTTP

- The Internet promises “everything over IP”
  - But NATs get in the way
- Services collapsing into a small set of protocols
  - Based on an even more limited set of HTTP transactions between servers and clients
  - Independent of IPv4 or IPv6
The (IPv4) Internet Today

• According to some: *We “ran out” of IPv4 addresses a long time ago*
  – …when NAT deployment started in earnest.
  – In today’s retail market one public IPv4 address can cost as much as Mbit DSL

• Applications are now engineered for NAT
  – Client-initiated transactions
  – Application-layer identities
  – Server agents for multi-party rendezvous
  – Multi-party shared NAT state

• Ever increasing complexity, cost and performance penalty
Is IPv6 the only solution?

• Is there an alternative protocol?
  – Basic problem: multiplex a common communications bearer
  – Not many different approaches are even possible.

• How long would a new design take?
  – A decade or longer
  – IPv6 has taken 12+ years so far

• Would a new design effort produce a new and different architecture?
  – Or would it produce the same response to the same set of common constraints?
  – …with possibly a slightly different set of design trade-offs…
How will IPv6 happen?
What’s the motivation?

• Collectively, we all need IPv6
  – But individually, it seems we are happy to wait
  – We have different motivations, because the current costs are not evenly shared

• Long term, we want…
  – ISPs: Cheaper, simpler networks
  – Developers: Cheaper, more capable applications
  – Users: More applications, more value

• Short term, we can expect…
  – ISPs: no user demand, more cost
  – Developers: no market without users and ISPs
  – Users: no difference at all
  – No reward for early adopters

• … it’s the old “Chicken and Egg” syndrome…
How can it happen?

• From biology and politics, we have two basic options

• **Evolution** …
  – Gradual migration of existing IPv4 networks and their associated service market to IPv6
  – “IPv6 is the friend of IPv4”

• **Revolution** …
  – Opening up new applications with IPv6 that compete with IPv4 for industry resources, and for overall market share
  – “IPv4 is the enemy”
Technical Reality

- IPv6 is stable and well tested
- But many technical issues being debated...
  - Addressing Plan
  - Stateless auto-configuration
  - Unique Local Addresses
  - Flow Label, QoS, Security, Mobility
  - Multi-addressing
  - Routing capabilities
- “The perfect is the enemy of the good”
  - The basics need to be agreed and resolved
  - Industry needs confidence and certainty
Business Reality

- Deployment by regulation or fiat has rarely worked
- “Everything over HTTP” has worked too well
- Existing industry based on network complexity, address scarcity, and insecurity
- Prospect of further revenue erosion from simpler cheaper network models
- Lack of investor interest in more infrastructure costs
- Lack of revenue model to match incremental costs
- Short term interests do not match long term common imperatives
- IPv6 promotion may have been too much too early – these days IPv6 may be seen as tired not wired
The result...

- Short term business pressures support the case for further deferral of IPv6 infrastructure investment
- There is insufficient linkage between the added cost, complexity and fragility of NAT-based applications and the costs of infrastructure deployment of IPv6
- An evolutionary adoption seems very unlikely in today’s environment
  – …or in the foreseeable future
The IPv4 revolution

• The 1990’s – a new world of…
  – Cheaper switching technologies
  – Cheaper bandwidth
  – Lower operational costs
  – The PC revolution, funded by users

• The Internet boom
  – The dumb (and cheap) network
  – Technical and business innovation at the edges
  – Many compelling business cases for new services and innovation
An IPv6 revolution...

• The 2000’s – a new world of…
  – Commodity Internet provision, lean and mean
  – Massive reduction in cost of consumer electronics
  – A network-ready society

• The IPv6 boom?
  – “Internet for Everything”
  – Serving the communications requirements of a device-dense world
  – Device population some 2–3 orders of magnitude larger than today’s Internet
  – Service costs must be cheaper by 2-3 orders of magnitude – per packet
IPv6 – From PC to iPOD to iPOT

- A world of billions of chattering devices

- Or trillions…
The Opportunity
The IPv6 Condition

- There are no compelling feature or revenue levers in IPv6 that will drive new investments in existing service platforms
- The silicon industry has made the shift from value to volume years ago
- The Internet industry must follow
  - From value to volume in IP(v6) packets
  - Reducing packet transmission costs by orders of magnitude
  - To an IPv6 Internet embracing a world of trillions of devices
  - To a true utility model of service provision
The Opportunity

• IPv6 as the catalyst for shifting the Internet infrastructure industry a further giant leap into a future of truly ubiquitous commodity utility plumbing!

• Evolution takes millions of years
• A revolution could happen any time
• Be prepared!
Thank you

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