

Internet Evolution and IPv6

IPv6 Summit, Beijing, China

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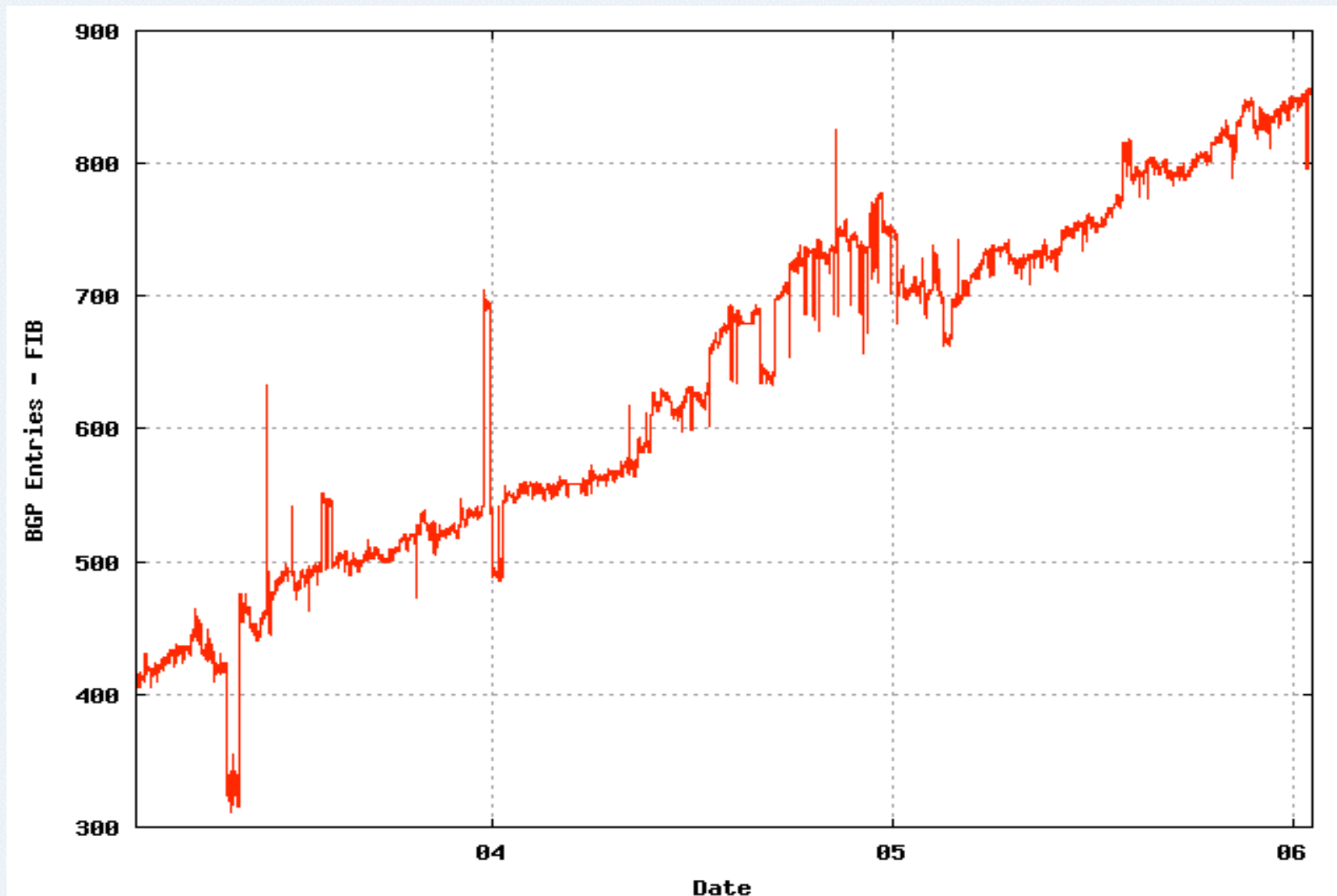
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Overview

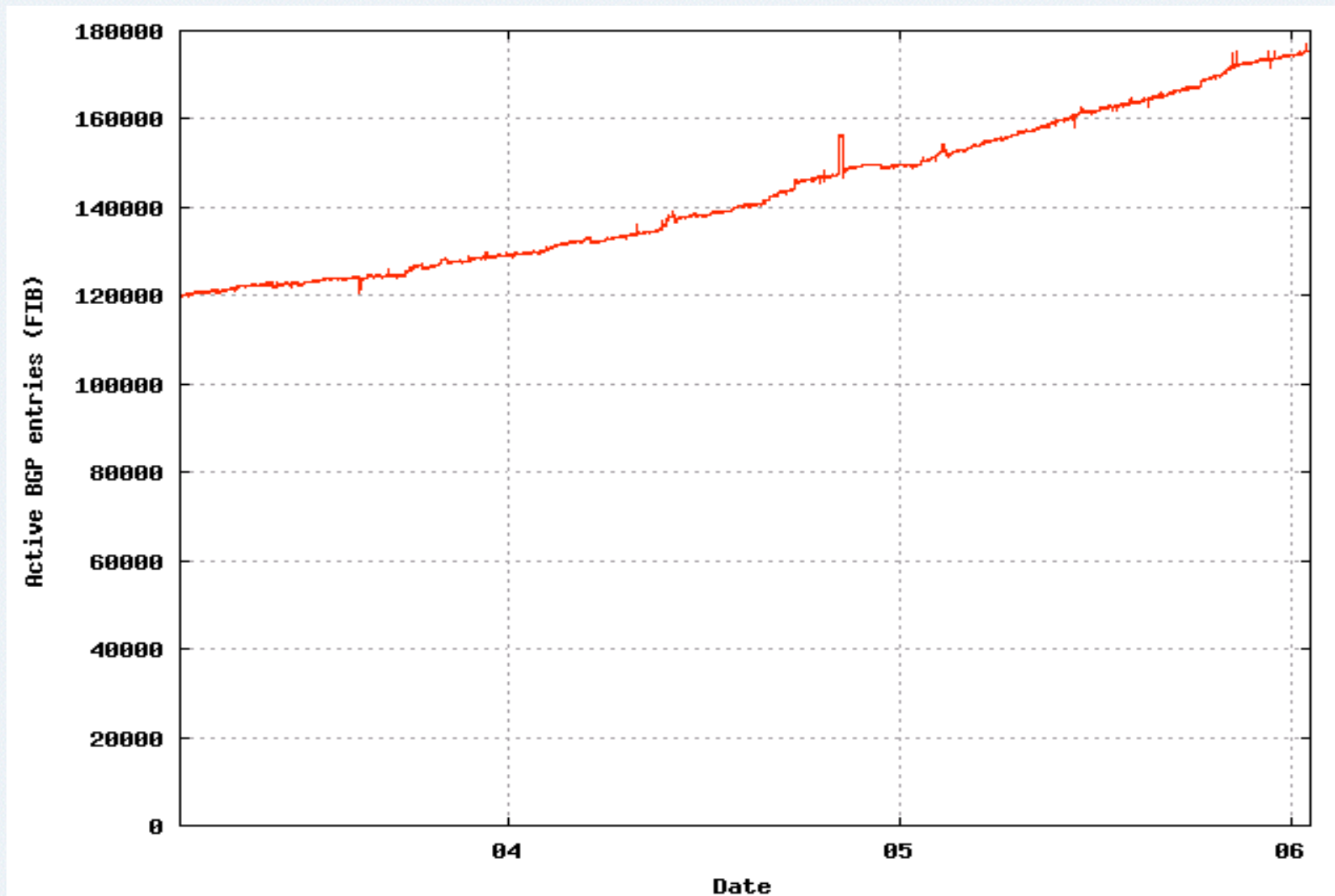
- Where is IPv6 today?
 - In deployment
 - In the industry
- Do we actually need it?
 - If so, why and when?
 - Are there any alternatives?
- How will it happen?
 - Evolution
 - Revolution
- The opportunity of IPv6

Where is IPv6 today?

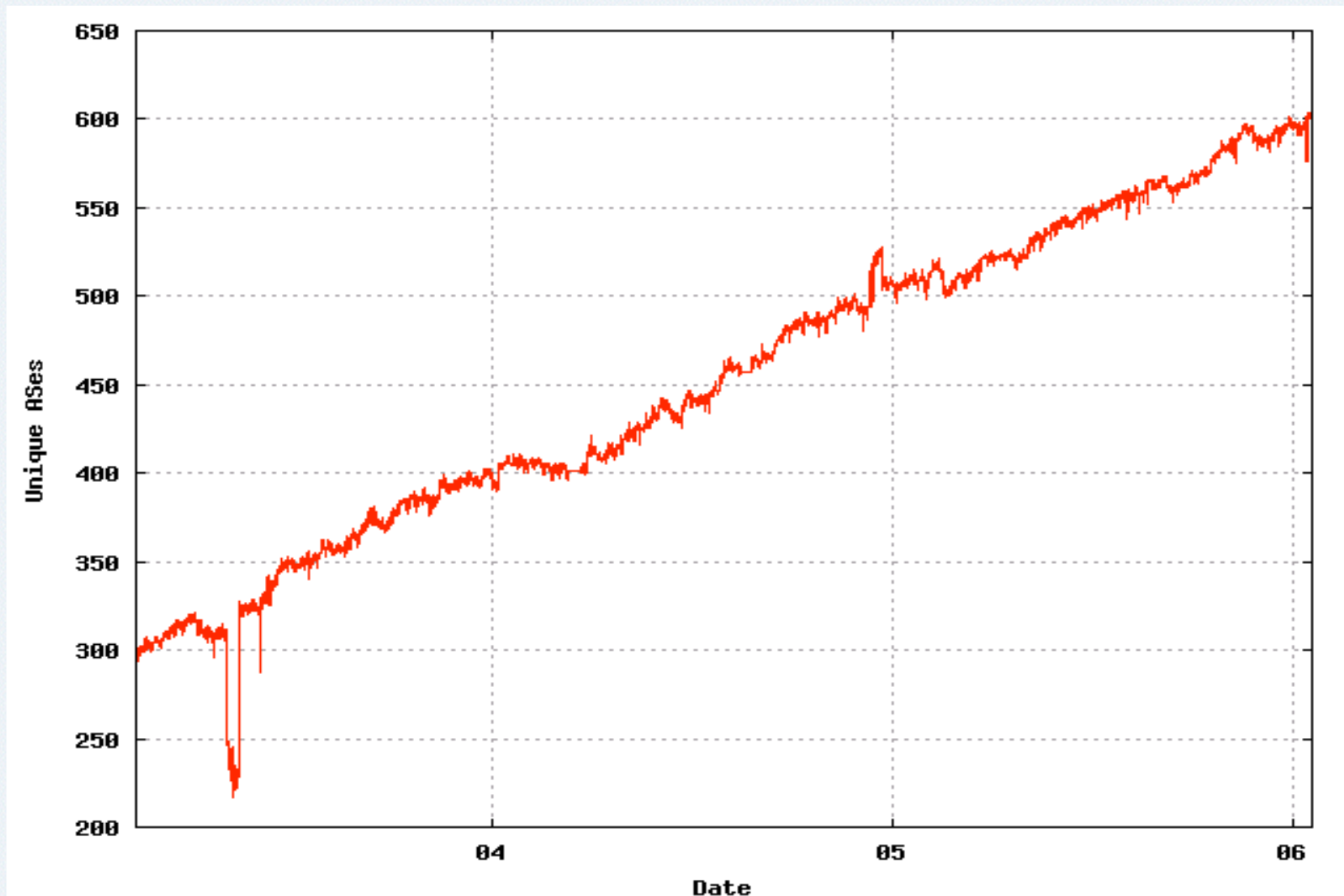
IPv6 – the BGP view



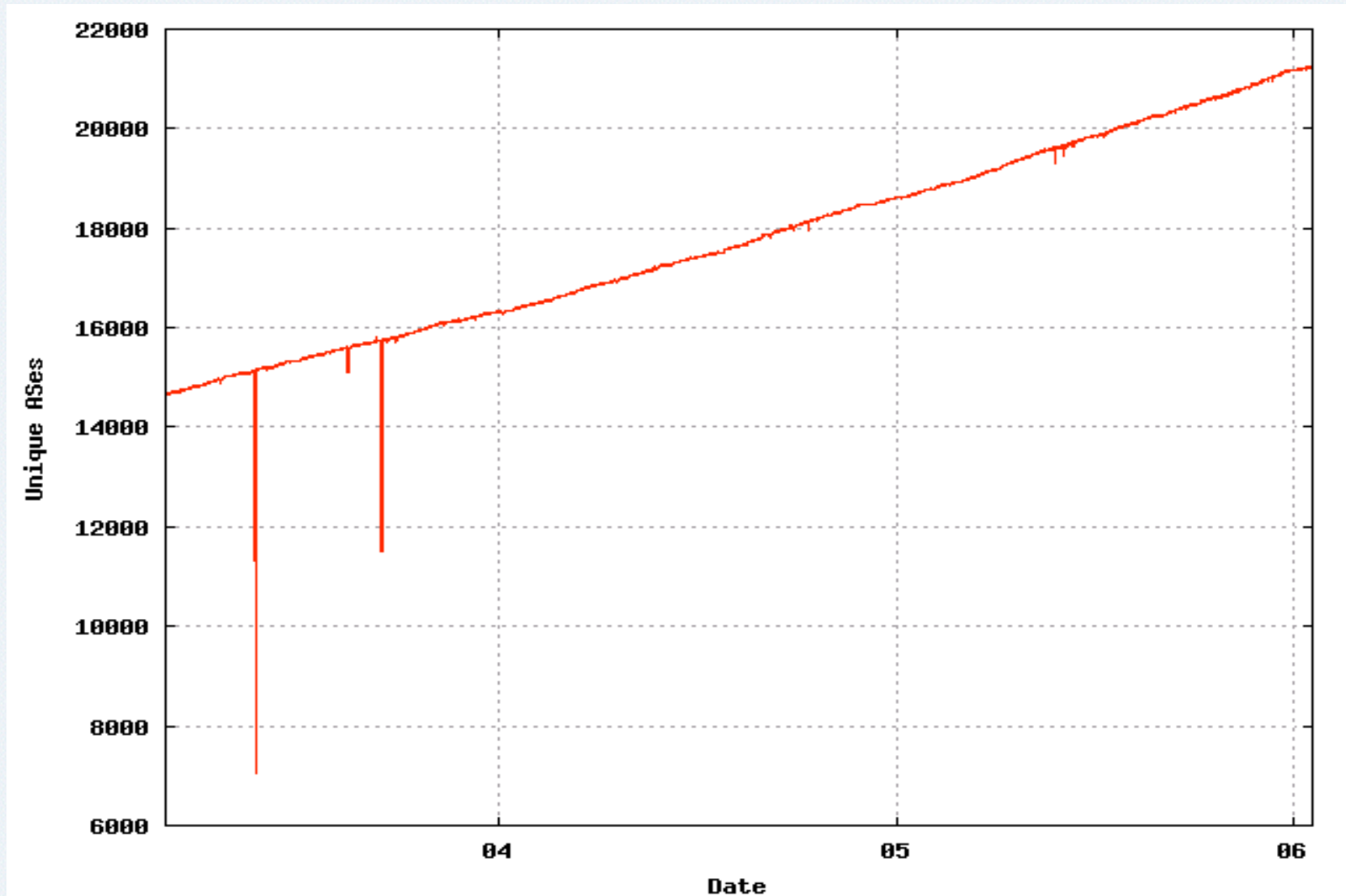
IPv4 – the BGP view



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?

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

Rationale for IPv6

- Limitations of IPv4 address space
 - Around 7 years unallocated space 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
 - “Everything over HTTP”
 - “Fog on the Internet”
 - Brian Carpenter, IETF, RFC 2775
- Note: IPv6 has many other features
 - But in fact all are available in IPv4

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”

The problem is reality

- Technical
 - IPv6 is stable and well tested
 - But many technical issues being debated...
 - “The perfect is the enemy of the good”
 - Industry needs confidence and certainty
- Business
 - NAT has worked too well
 - Existing industry based on network complexity, address scarcity, and insecurity
 - Lack of investor interest in more infrastructure costs
 - Short term interests do not match long term common imperatives
 - IPv6 promotion may have been too much too early
 - IPv6 may be seen as “tired” and 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...

In conclusion...

The IPv6 Challenge

- 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 IPv6 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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Original paper by Geoff Huston: <http://www.potaroo.net>