Internet Evolution and IPv6

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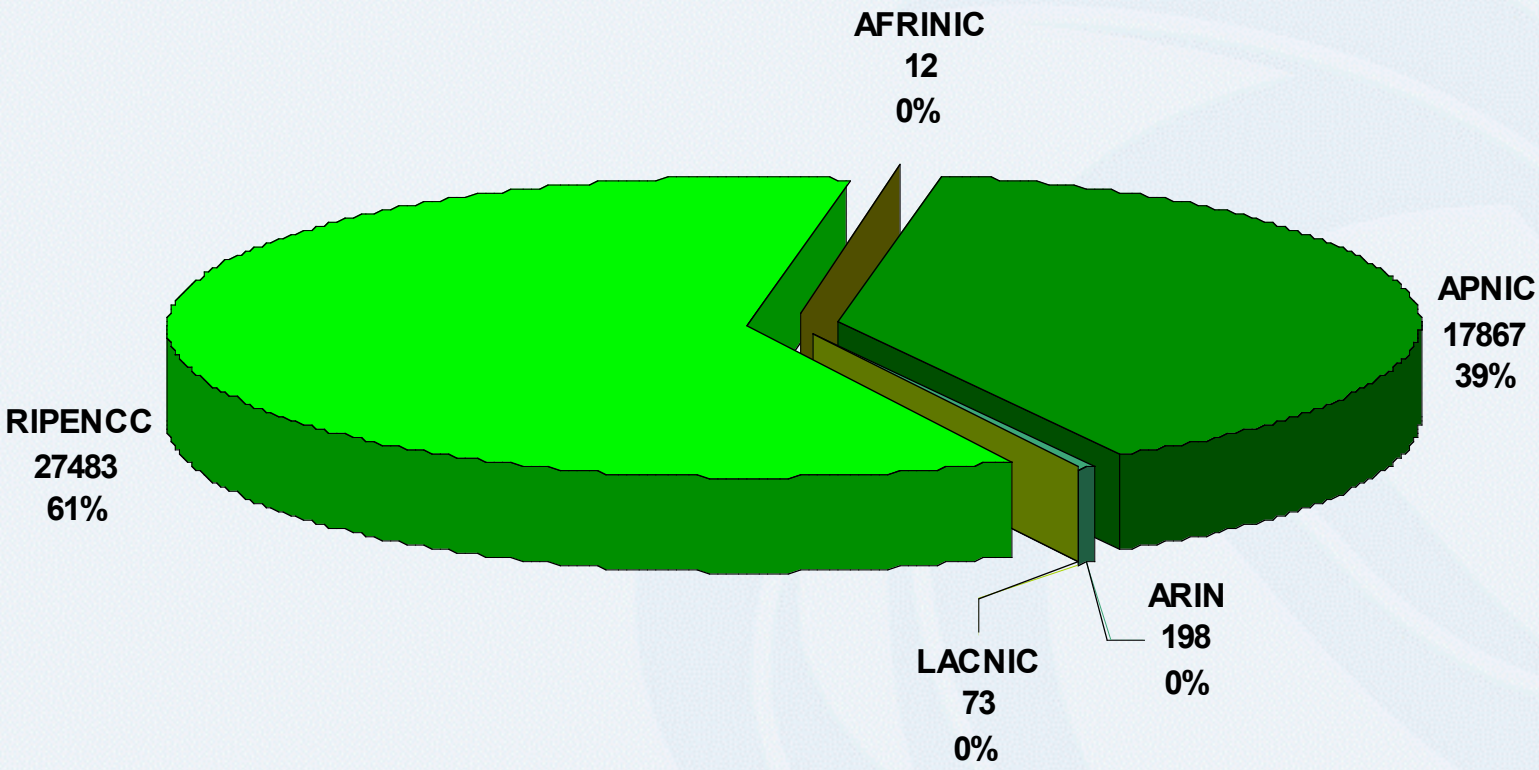
Overview

- Where is IPv6 today?
  - Address space deployment
  - Compared with IPv4
- Do we actually need IPv6?
  - If so, why and when?
  - Are there any alternatives?
- How will it happen?
  - Evolution
  - Revolution
- The opportunity of IPv6

Where is IPv6 today?

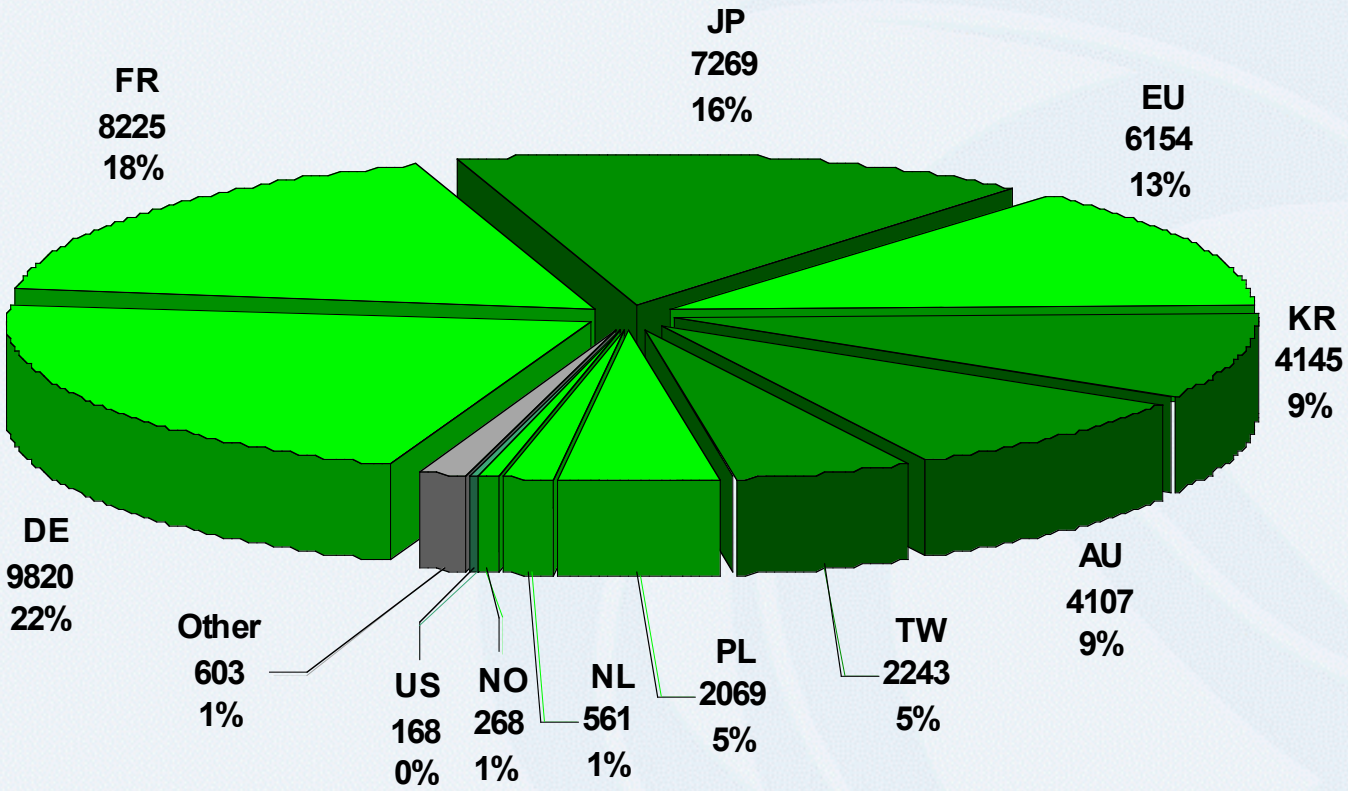
Address space deployment

IPv6 – Global allocations by RIR



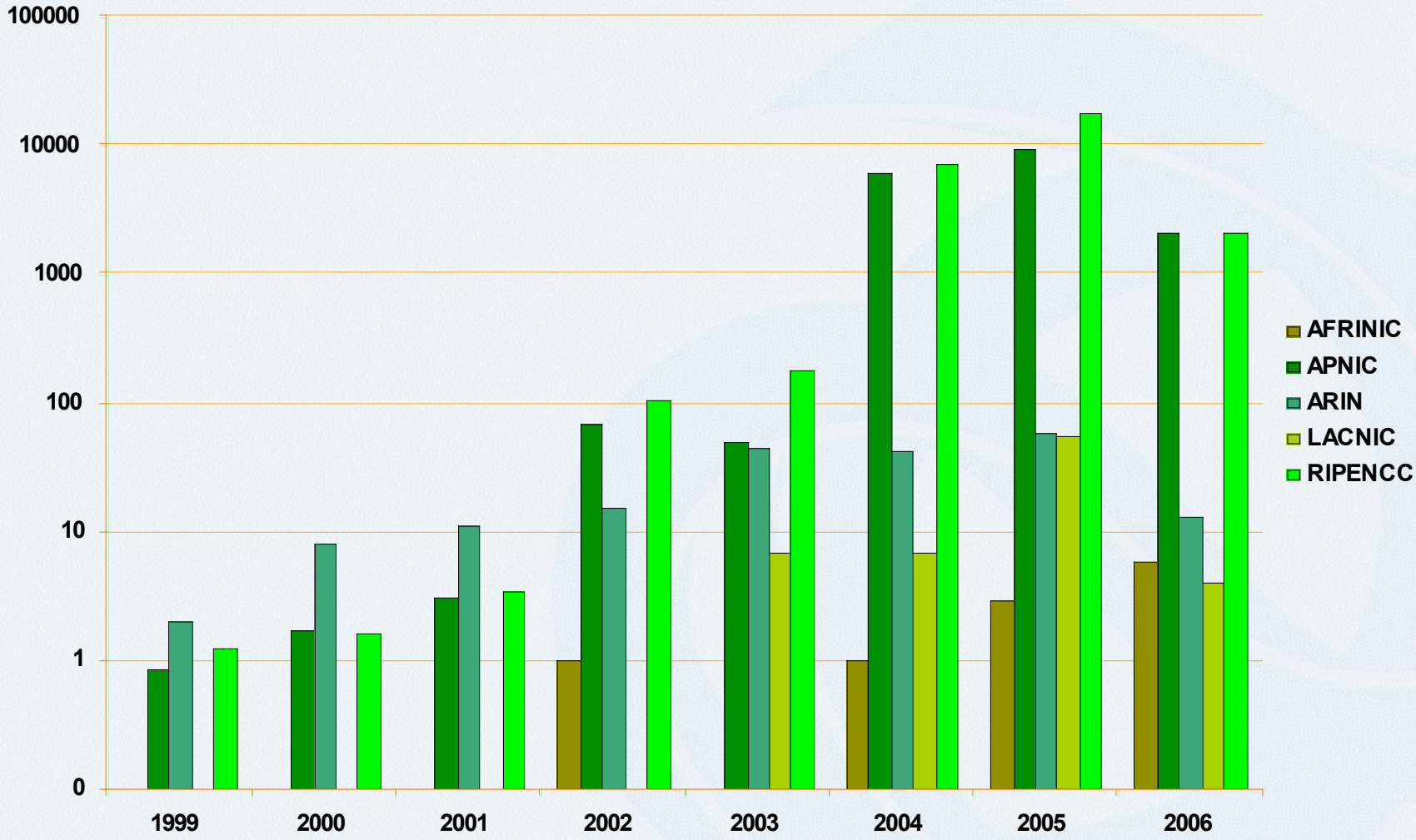
Unit: /32

IPv6 – Global allocations by CC



Unit: /32

IPv6 – Global allocation growth



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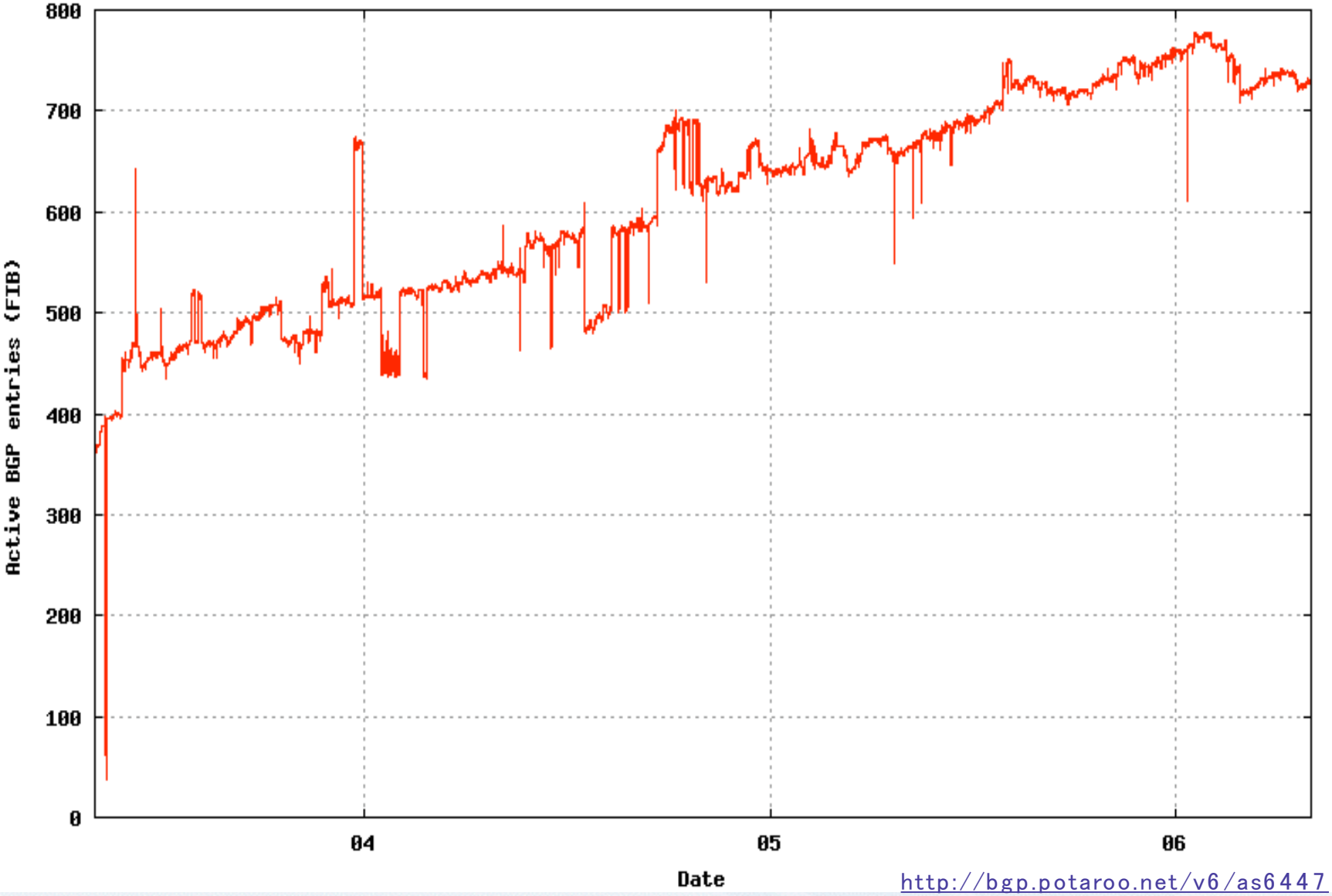
Where is IPv6 today?

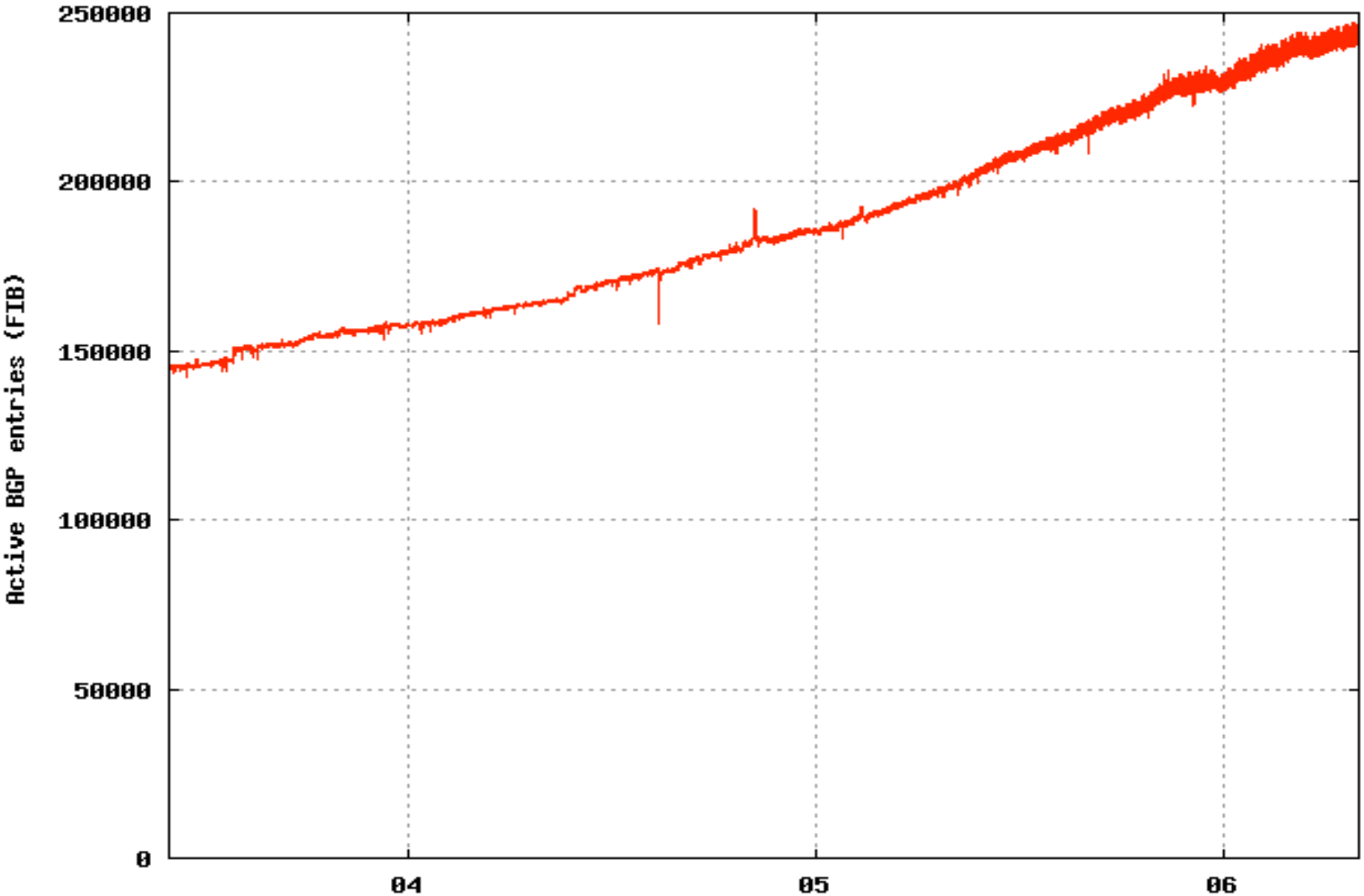
Comparison with IPv4

IPv6 – the BGP view



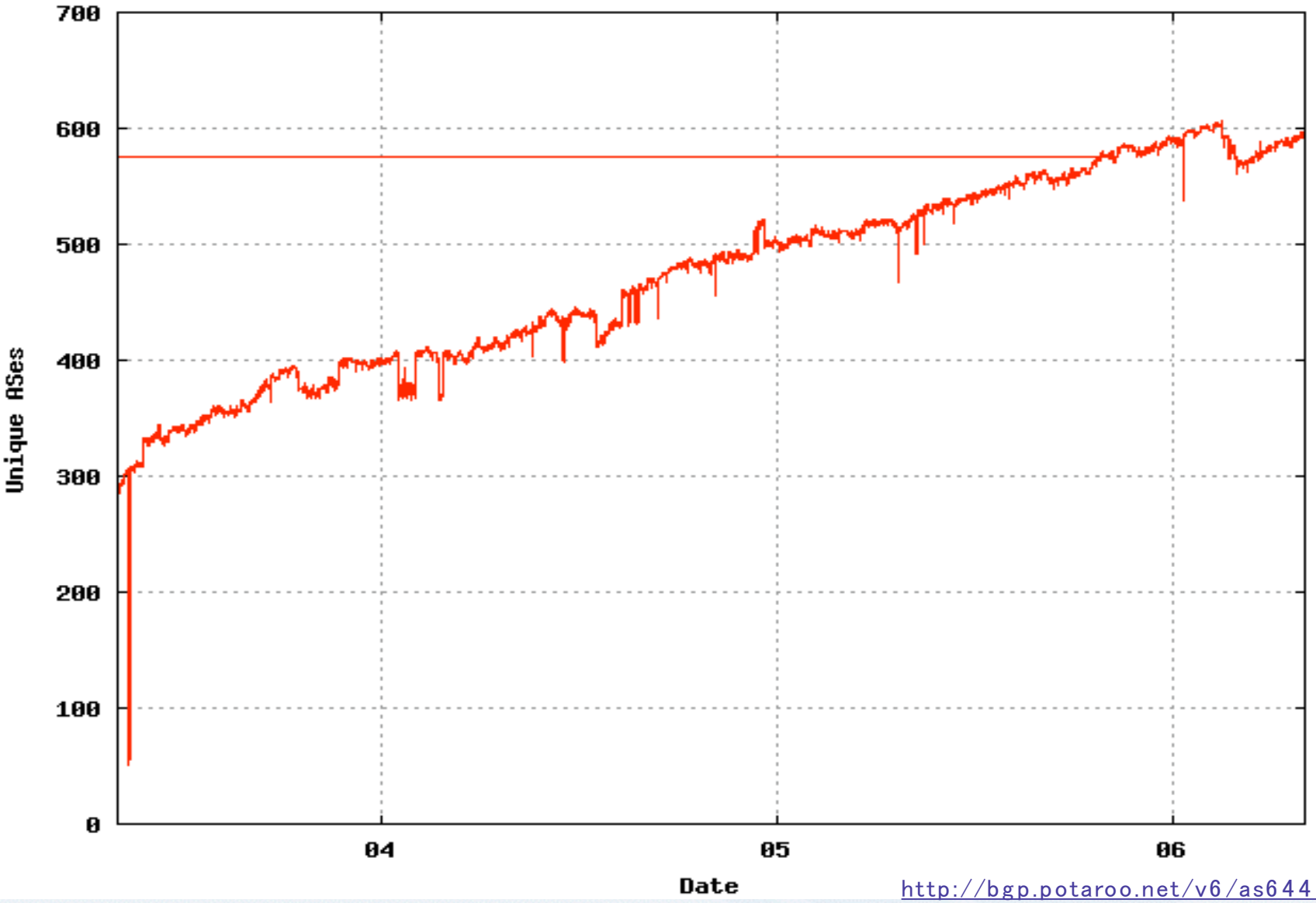
http://bgp.potaroo.net/v6/as6447

IPv4 – the BGP view



http://bgp.potaroo.net/as1221/bgp-active.html

IPv6 – AS Count



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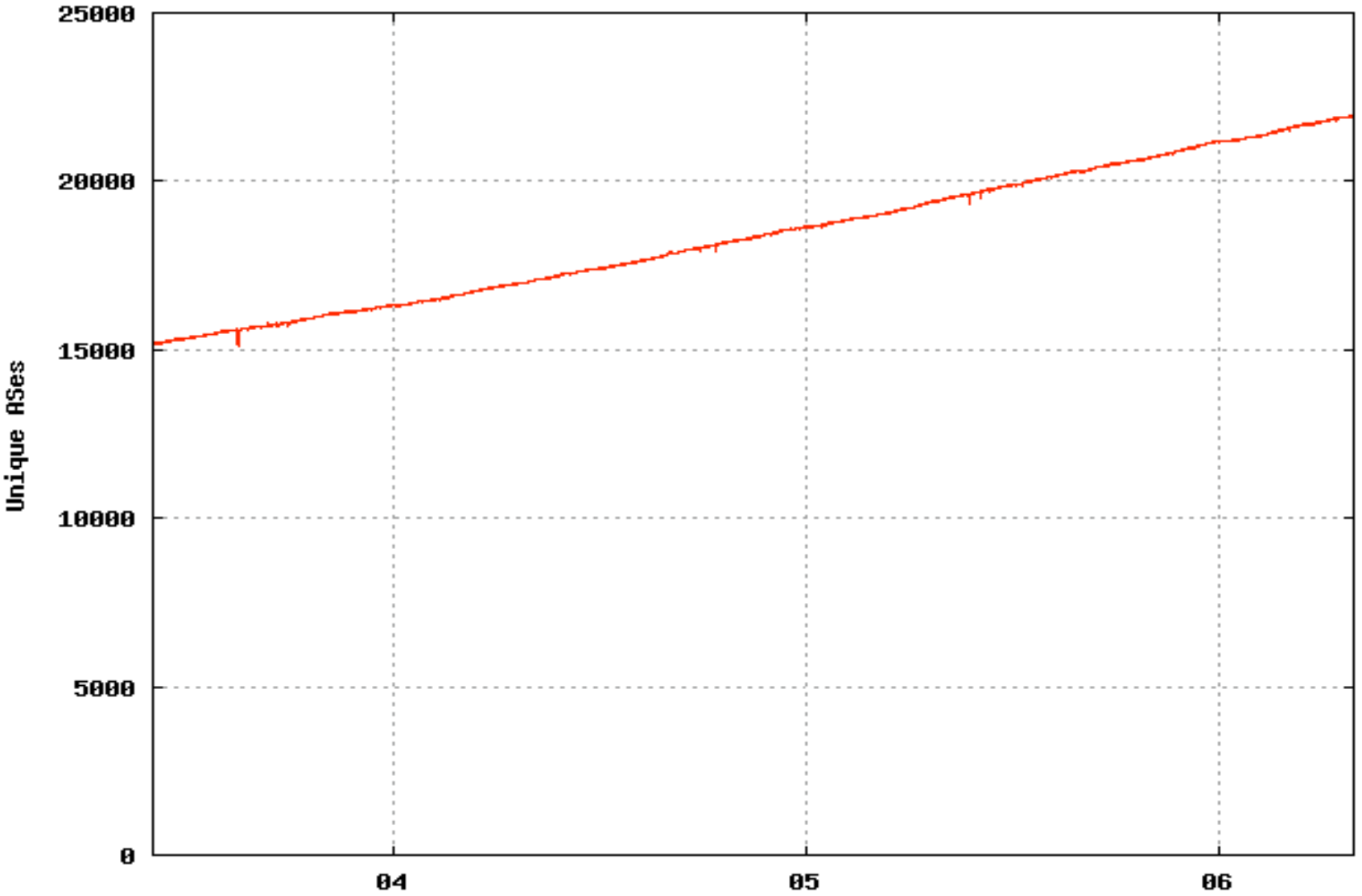
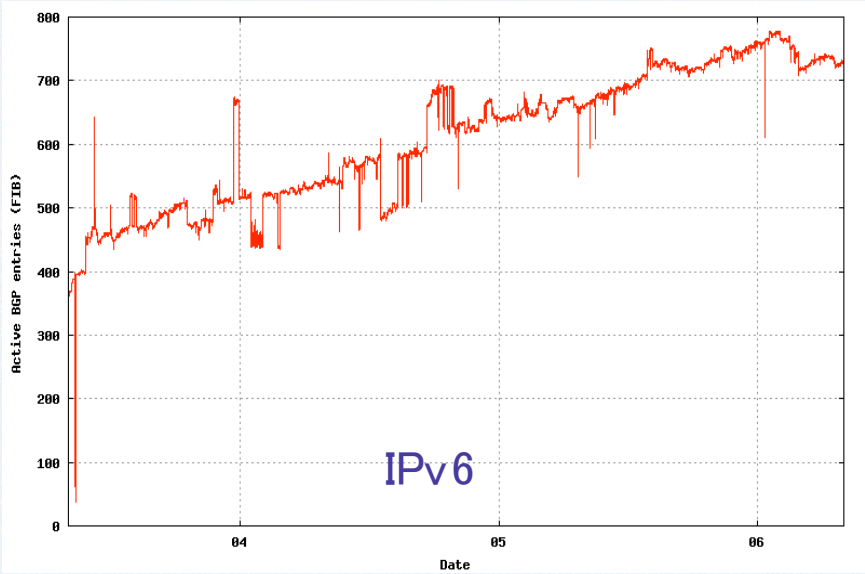
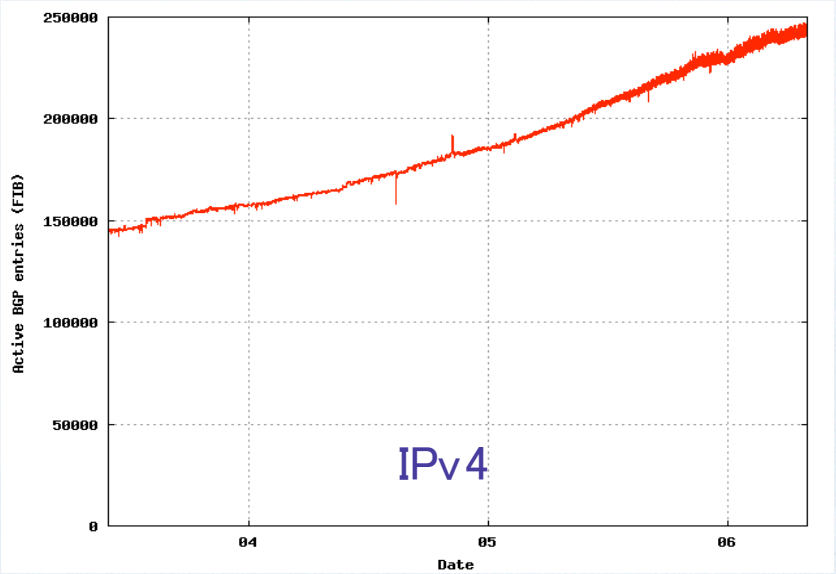
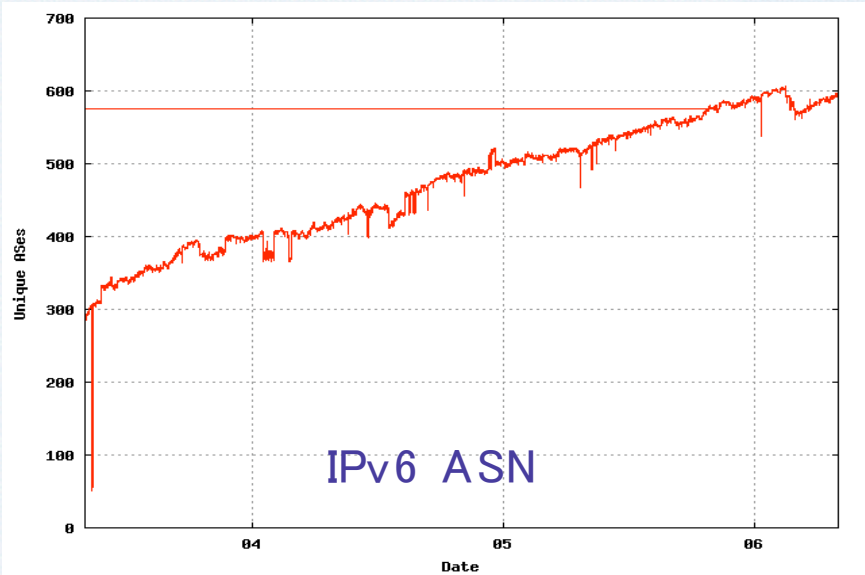
IPv4 – AS Count

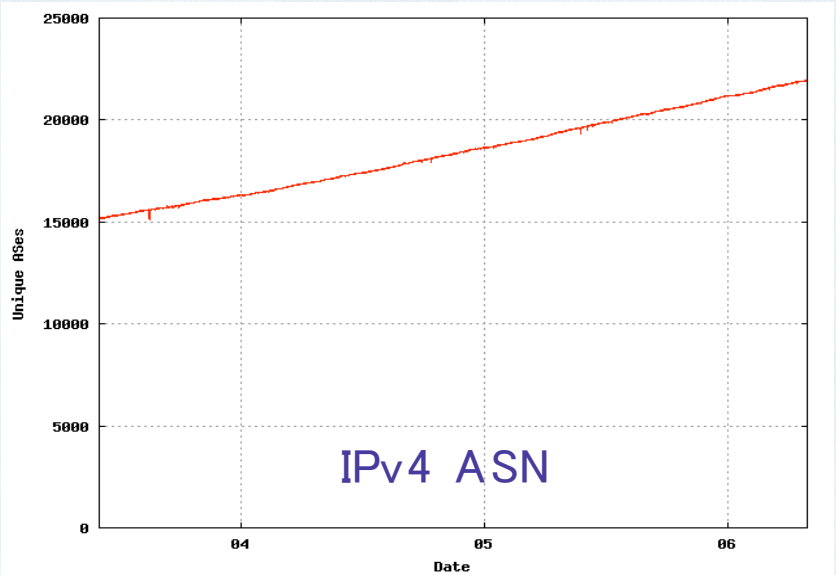


Those graphs again…









Where is the Industry?

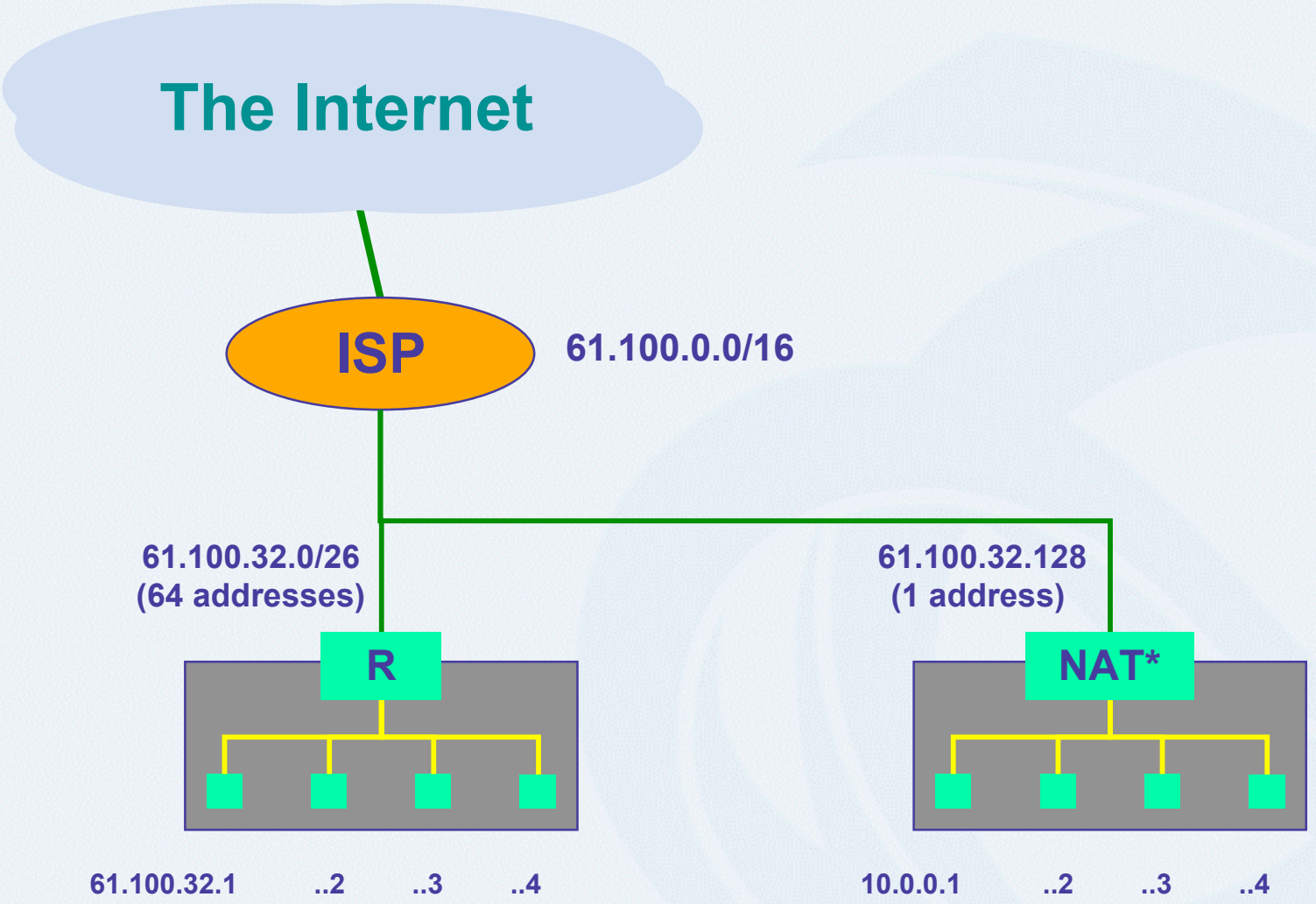
- Post-bust conservatism…
  - Optimism is no substitute for knowledge, capability and performance!
- Industry consolidation replaces explosive expansionist growth
  - Investment programs must show assured returns, across their entire life cycles
  - Reduced investment risk means reduced innovation and 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

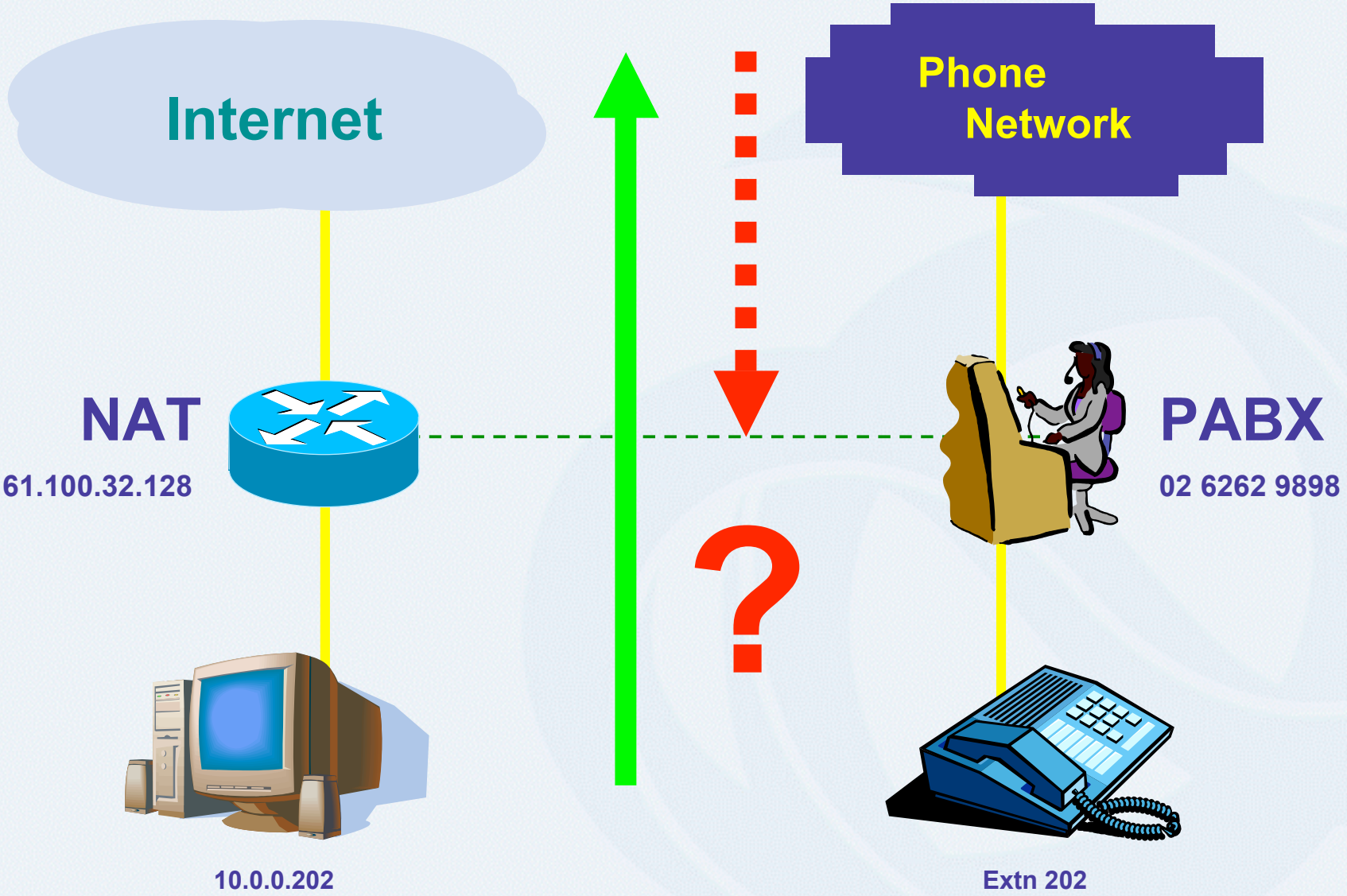
- According to some: *We "ran out" of IPv4 addresses a long time ago*
  - …when NAT deployment started in earnest.
  - In today's retail market one public IPv4 address can cost as much as Mbit DSL
- Applications are now engineered for NAT
  - Client-initiated transactions
  - Application-layer identities
  - Server agents for multi-party rendezvous
  - Multi-party shared NAT state
- Ever increasing complexity, cost and performance penalty

The NAT problem



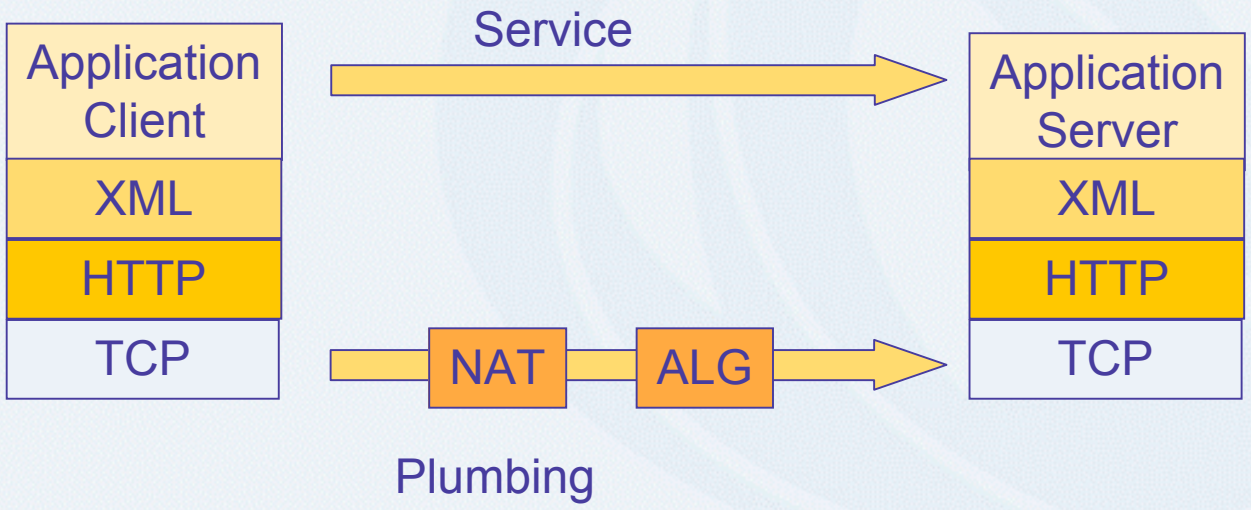
*AKA home router, ICS, firewall

The NAT problem



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



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
  - “Fog on the Internet”
    - Brian Carpenter, IETF, RFC 2775
  - “Everything over HTTP”
- Yes, we seem to need something new
  - But is IPv6 the only solution?

Is IPv6 the only solution?

- Is there an alternative protocol?
  - Basic problem is well understood: 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 trade-offs…
  - Arguably not.

How can 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 are still 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 vs long term imperatives
  - IPv6 promotion - 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 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 ends
  - 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 even trillions…

In conclusion…

The IPv6 Challenge

- There are too few compelling feature or revenue levers in IPv6 to drive new investments in existing service platforms
- But 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
- The revolution could start any time
- Be prepared!

Thank you

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