Beyond the IPv4 Internet

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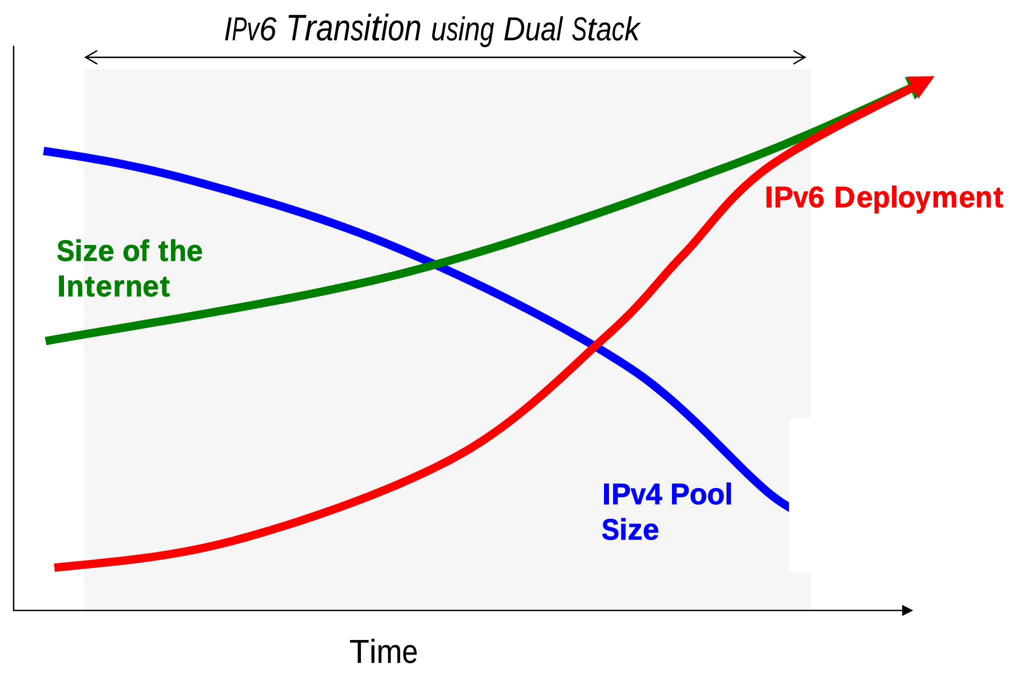
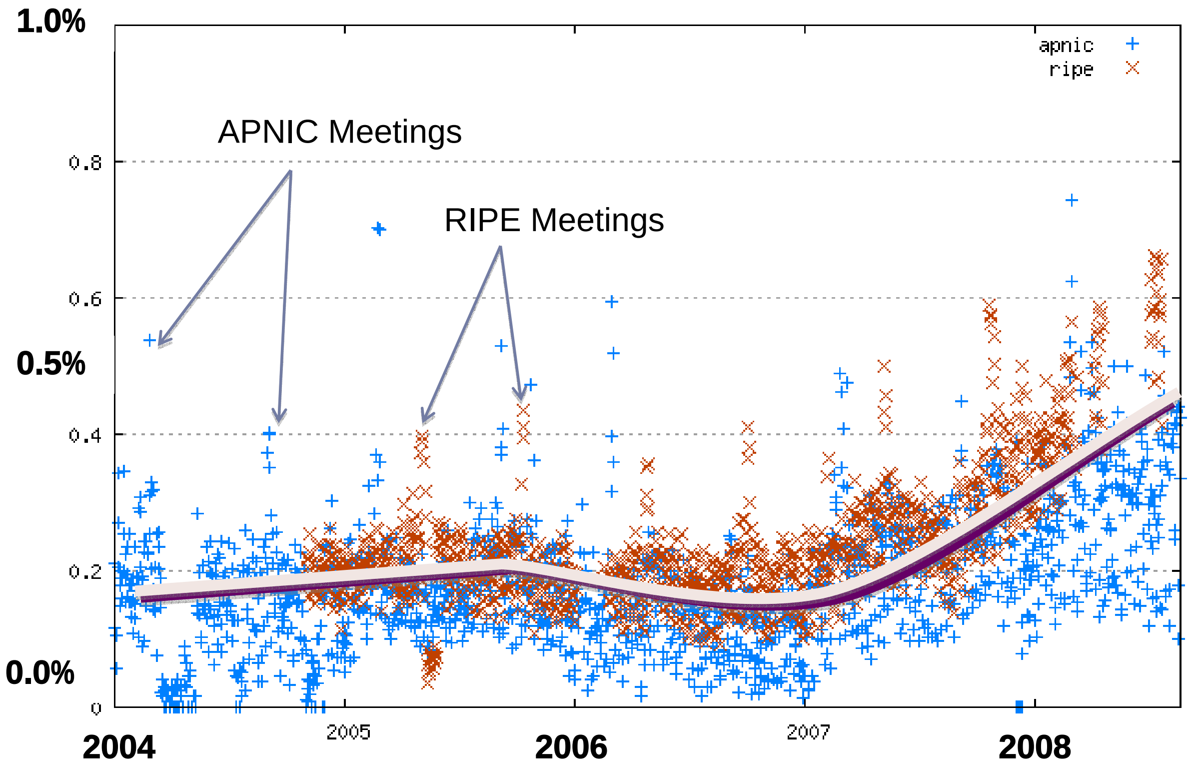
The Original Plan for IPv6 Transition



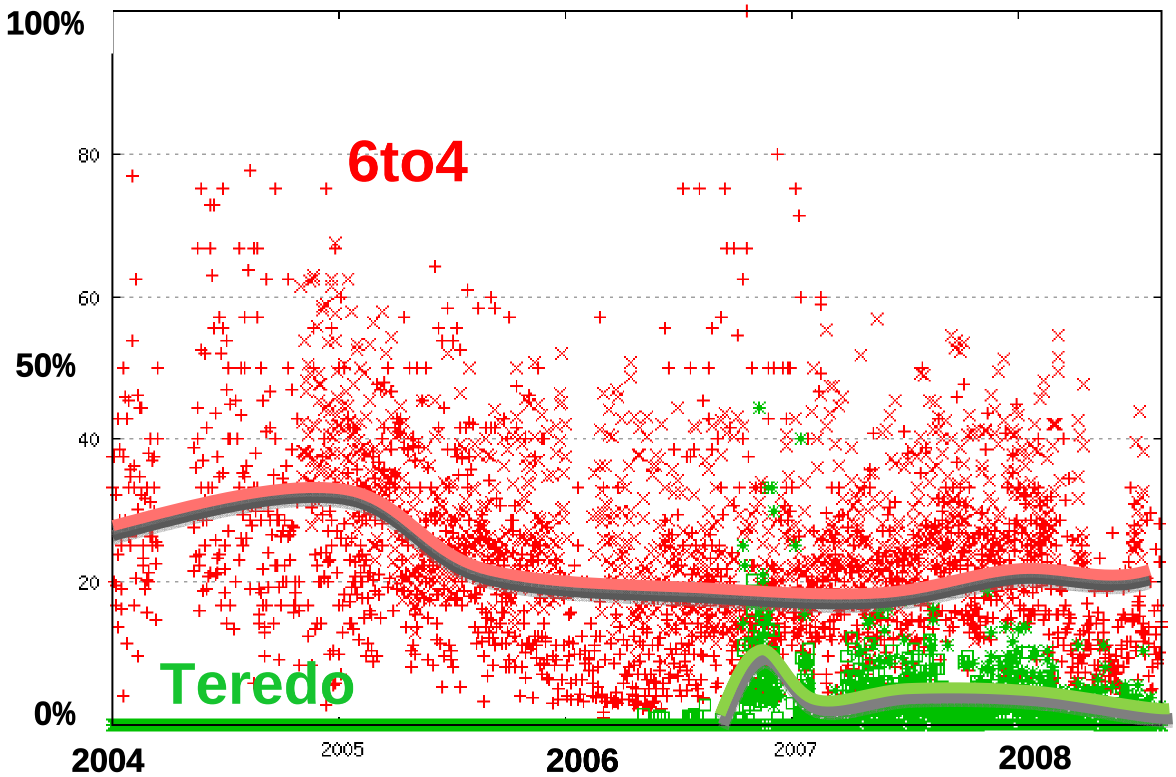
Web Server Access Statistics
Daily % of IPv6 access 1994 - today



Some Observations and Measurements

- IPv6 is sitting at 0.5% of IPv4 in terms of host capability

Use of V6 Transition Tools



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AS Count IPv6 : IPv4

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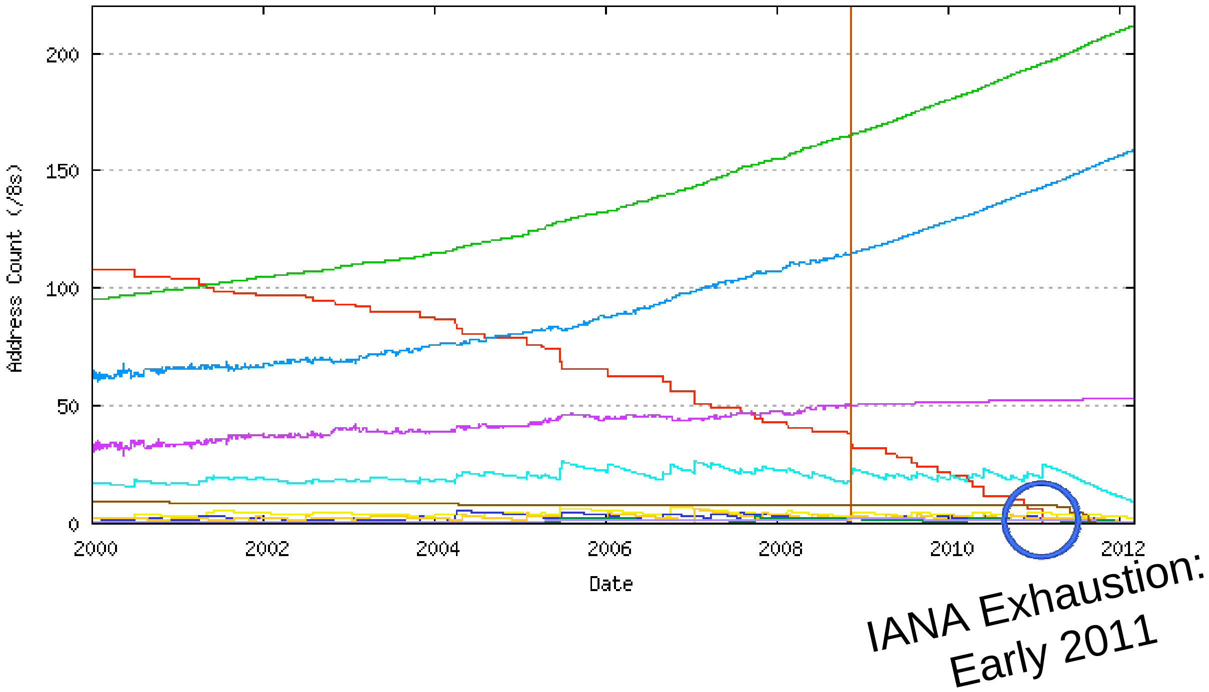
IPv4 Address Exhaustion Model



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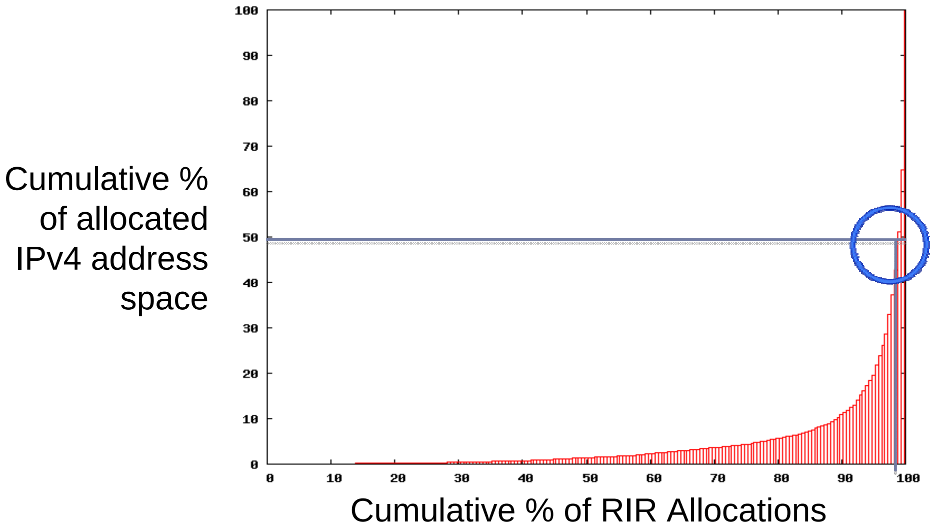
Distribution of IPv4 address allocations 2007 - Present

Of the 12,649 individual IPv4 address allocations since January 2007, only 126 individual allocations account for 50% of the address space.
55 of these larger allocations were performed by APNIC, and 28 of these were allocated to China.
41 were performed by ARIN and 39 of these were allocated to the US



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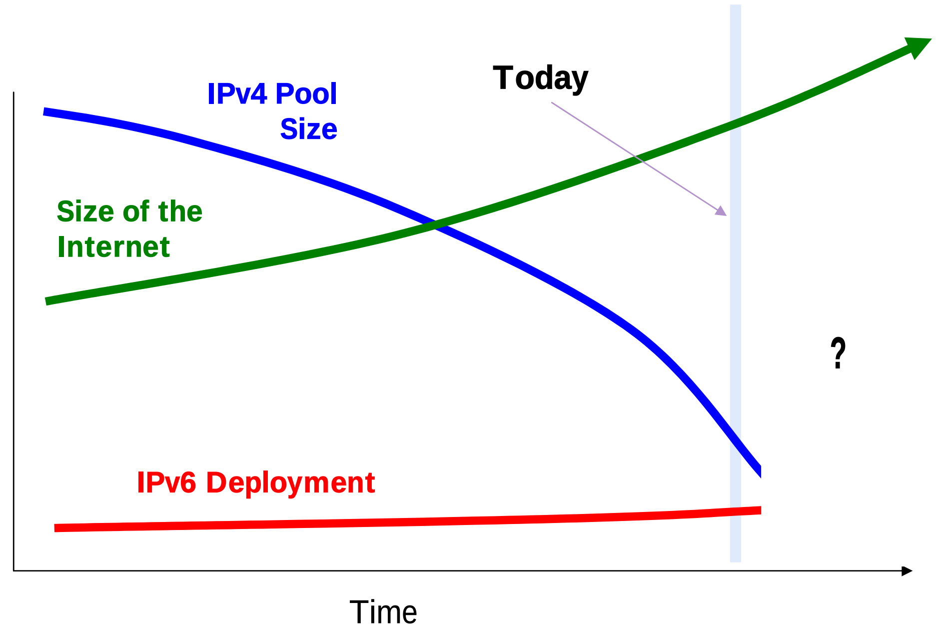
- Large-scale capital-intensive deployments are driving IPv4 demand today

The Current Situation



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- Large-scale capital-intensive deployments are driving IPv4 demand
- We cannot avoid the situation of IPv4 demand outliving the remaining pool of unallocated IPv4 addresses

Constraints

- It's clear that we are going to have to use Dual Stack IPv4/IPv6 transition for some time well beyond the exhaustion of the IPv4 unallocated free pool
- We are going to have to use IPv4 to span an Internet that will be very much larger than today during the final stages of this transition to IPv6
- It's also evident that we cannot expect any new technology to assist us here in the short or medium term
- We must support uncoordinated piecemeal deployment of transitional tools and various hybrid IPv4 and IPv6 elements in the Internet for many years to come

Constraints

- Its also clear that the brunt of any transitional effort will fall on the large scale deployments, and not on the more innovative small scale networked environments
- We have to recognise that IPv6 is an option, not an inevitable necessity, and it is competing with other technologies and business models for a future
  - Of these choices, IPv6 is not the preferred outcome for every player

Challenges

- This is a challenging combination of circumstances
  - It requires additional large-scale capital investment in switching infrastructure and service delivery mechanisms
  - There is no corresponding incremental revenue stream to generate an incremental return on the invested capital
  - The depreciated value of the existing capital investment in an IPv4 infrastructure is unaltered
  - The major benefits of the IPv6 investment appear to be realized by new market entrants rather than existing incumbents, yet the major costs of transition will be borne by the incumbent operators in the market

The Current Situation

- No clear consumer signals
  - Users needs are expressed in terms of services, not protocols
  - No value is being placed on IPv6 by the end consumer

The Current Situation

- Lack of business imperatives
  - No immediate underlying business motivation to proceed with this transition for established service enterprises with a strong customer base
  - Perception that the costs and benefits of investment in IPv6 transition are disconnected

The Current Situation

- No clear public policy stance
  - Uncertainty: Having deregulated the previous structure of monopoly incumbents and encouraged private investment in communications services there is now no clear stance from a regulatory perspective as to what actions to take
  - Risks of Action: No strong desire to impose additional mandatory costs on incumbent operators, or to arbitrarily impose technology choices upon the local industry base
  - Risks of Inaction: No strong desire to burden the local user base with inefficient suppliers and outmoded technologies as a result of protracted industry inaction

Some Thoughts

- A Conservative View
  - Risk inaction for a while longer until clearer signals emerge as to the most appropriate investment direction
  - Wait for early adopters to strike a viable market model to prompt larger providers enter the mass consumer market with value and capital

Some Other Thoughts

- A more Radical View
  - Take high risk decisions early and attempt to set the market direction
  - Deploy service quickly and attempt to gain an unassailable market lead by assuming the role of incumbent by redefining the market to match the delivered service

Further Thoughts

- Public Sector View
  - Its about balance, efficiency and productive private and public sector infrastructure investments that enable leverage to economic well-being
  - Its about balance between:
    - industry regulatory policies for the deployment of services to meet immediate needs, with
    - public fiscal policies to support capital investments to sustain competitive interests in the short term future, with
    - social policies to undertake structural investments for long term technology evolution

What to do?

- What can we do about this transition to IPv6?
  - Is the problem a lack of information about IPv4 and Ipv6? Do we need more slidepacks and conferences to inform stakeholders?
  - Should we try to energise local communities to get moving?
  - Should we try to involve the public sector and create initial demand for IPv6 through public sector purchases?
  - Should we try to invoke regulatory involvement?
  - Should we set aspirational goals?
  - Should we attempt to get the equipment vendors and suppliers motivated to supply IPv6 capability in their products?
  - Or should we leave all this to market forces to work through?

- I have a couple of my own modest suggestions …

Today's Tasks

- Get moving on today's issues

Operational Tactics: Tomorrow’s Internet

- Can we leverage investments in IPv6 transitional infrastructure as a ‘natural’ business outcome for today’s Internet?
- How do we mitigate IPv4 address scarcity? By attempting to delay and hide scarcity or by exposing it as a current business cost?
- Do we have some viable answers for the near term? Do the emerging hybrid V4/V6 NAT models offer some real traction here in terms of scaleable network models for tomorrow’s networks?
- What’s the timeline to deployment for these hybrid NAT approaches?

More Tasks for Today

- And also work on the longer term direction

Overall Strategy: Where is this leading?

- What's the research agenda?
- What can we learn from this process in terms of architectural evolution of networking services?
- What's important here? IPv6? Or a service evolution that exploits a highly networked environment? Why do today's services need protocol uniformity in our networks? Can we build a stable service platforms using hybrid IP protocol realms?
- How do we evolve our current inventory of wires, radios and switches into tomorrow's flexible and agile network platforms to allow for innovation in services to meet users' demands?

Where Next?

- Perhaps all this is heading further than just IPv6
- Perhaps we are starting to work on the challenges involved in identity-based networked services as a further evolutionary step in networking architecture

One evolutionary view of network architecture

circuit networking
- shared capable network with embedded applications
- simple 'dumb' peripherals

packet networking
- simple datagram network
- complex host network stacks
- simple application model

identity networking?
- sets of simple datagram networks
- locator-based host network stacks
- identity-based application overlays

Thank You