An Economic Perspective on IPv6 Transition

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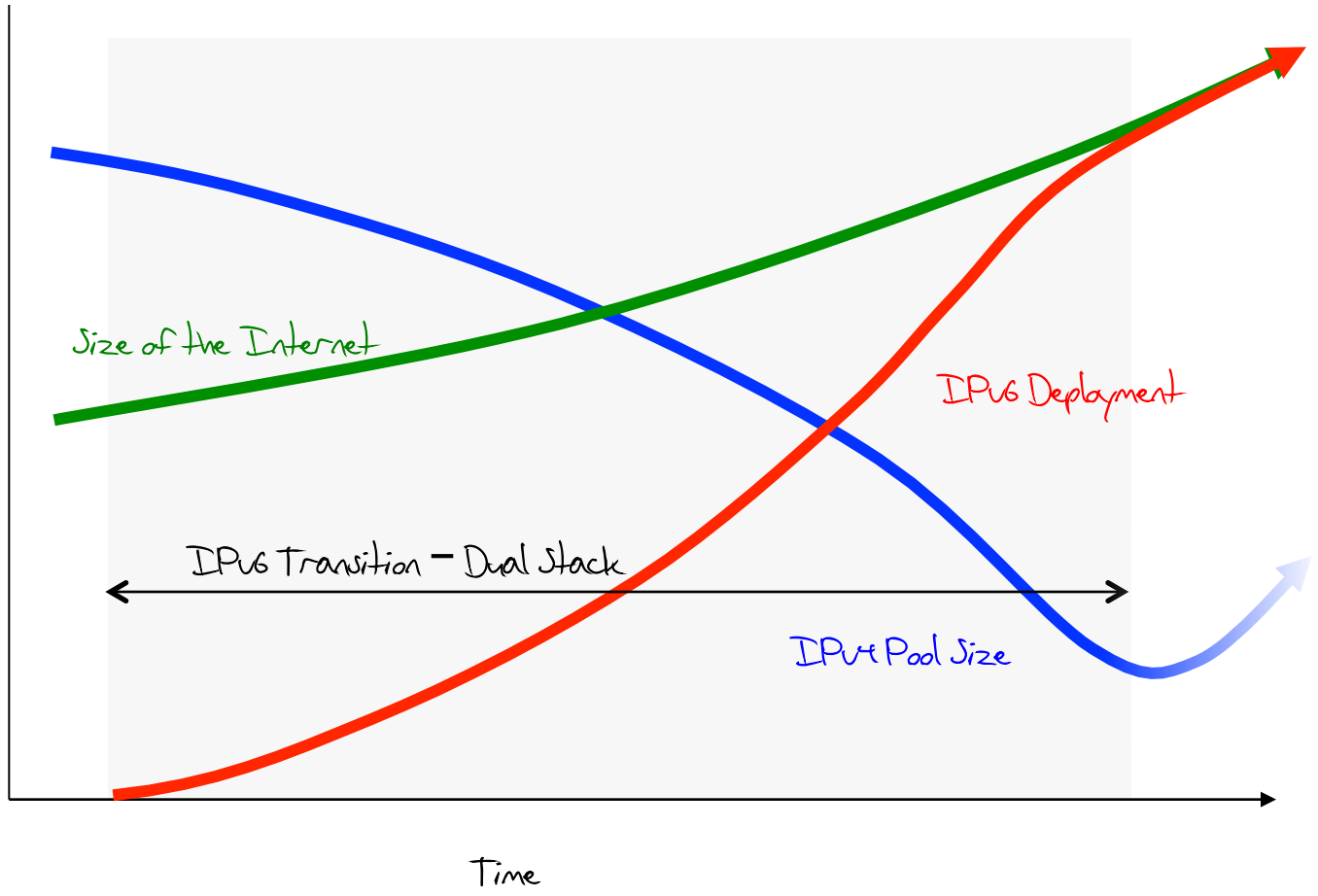
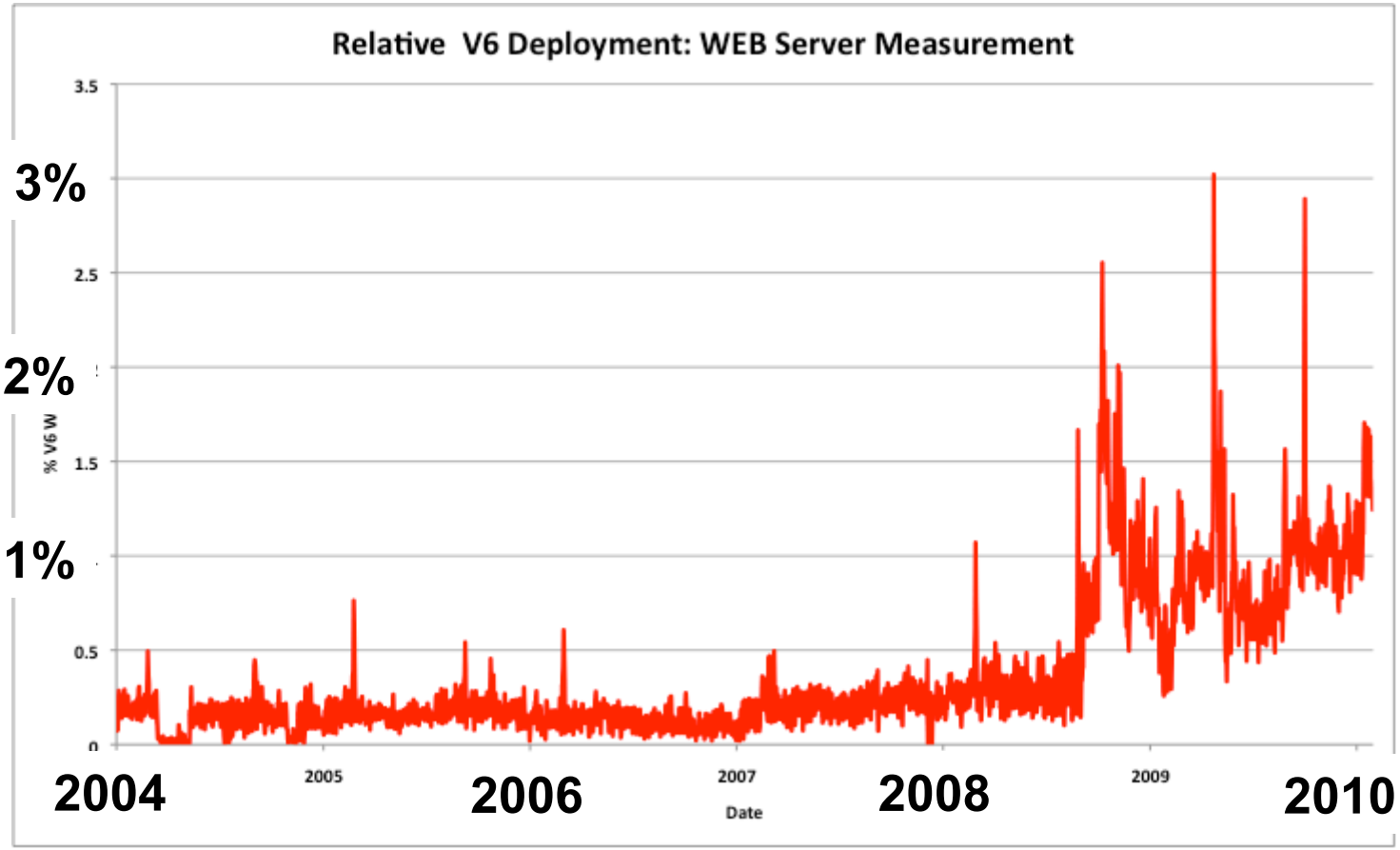
APNIC

The IPv6 Transition Plan



Measured IPv6 Deployment



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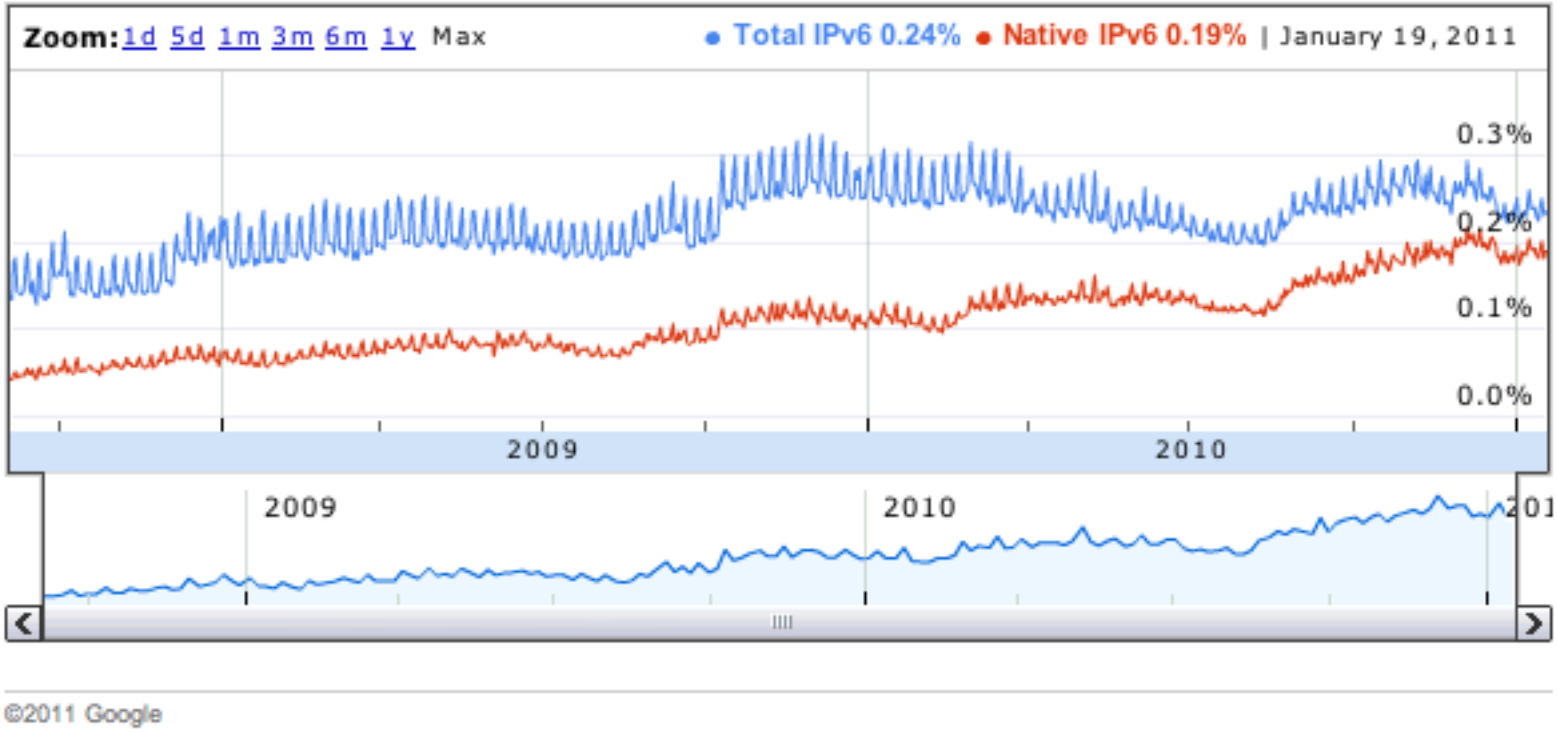
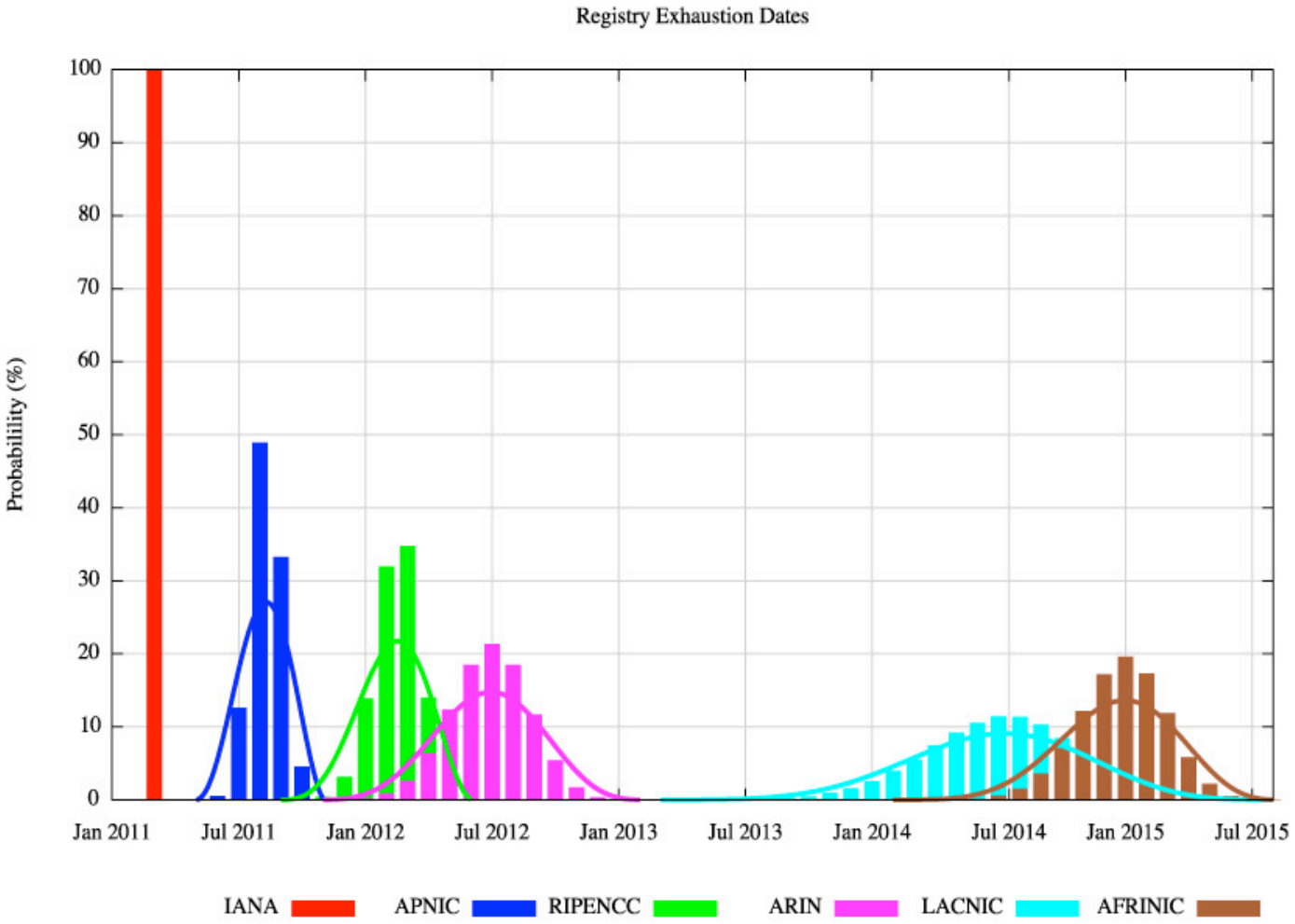


http://www.google.com/intl/en/ipv6/statistics/

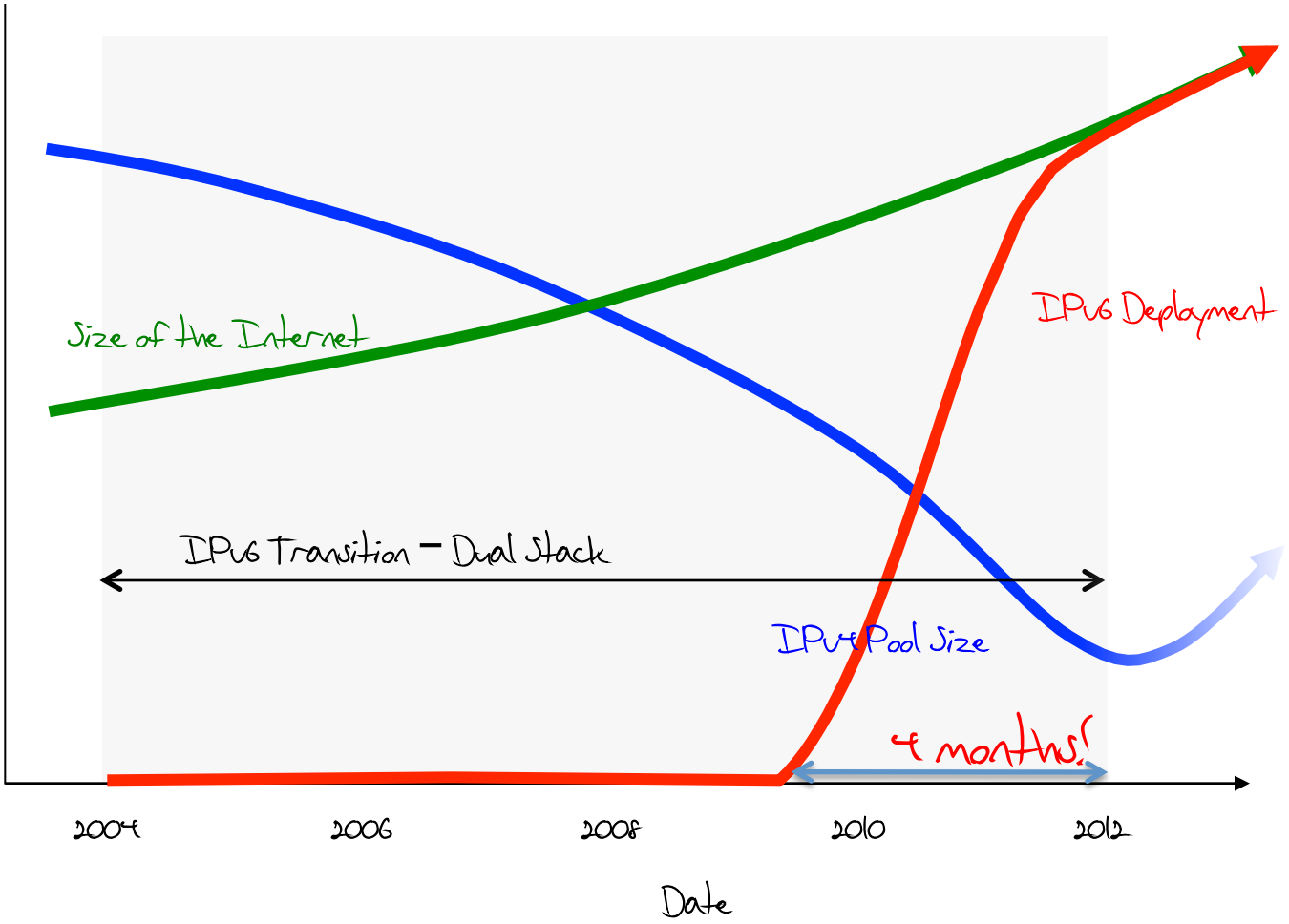
Measured IPv6 Deployment

http://www.potaroo.net/stats/1x1/sitec/v6hosts.png

IPv4 Exhaustion



The IPv6 Transition Plan - V2.0



Is this Plan Feasible?

Deploy IPv6 across some 2 billion users, with more than a billion end hosts, hundreds of millions of routers, firewalls and middleware units, audit billions of lines of configuration codes and filters, and audit hundreds of millions of ancillary support systems - ***all within the next 120 days***.

Is this Plan Feasible?

No.

What now?

The Economics of Technology Evolution

Why are we facing IPv4 address exhaustion?

Why have we left it so long to engage with the transition to IPv6?

What can we learn from economics?

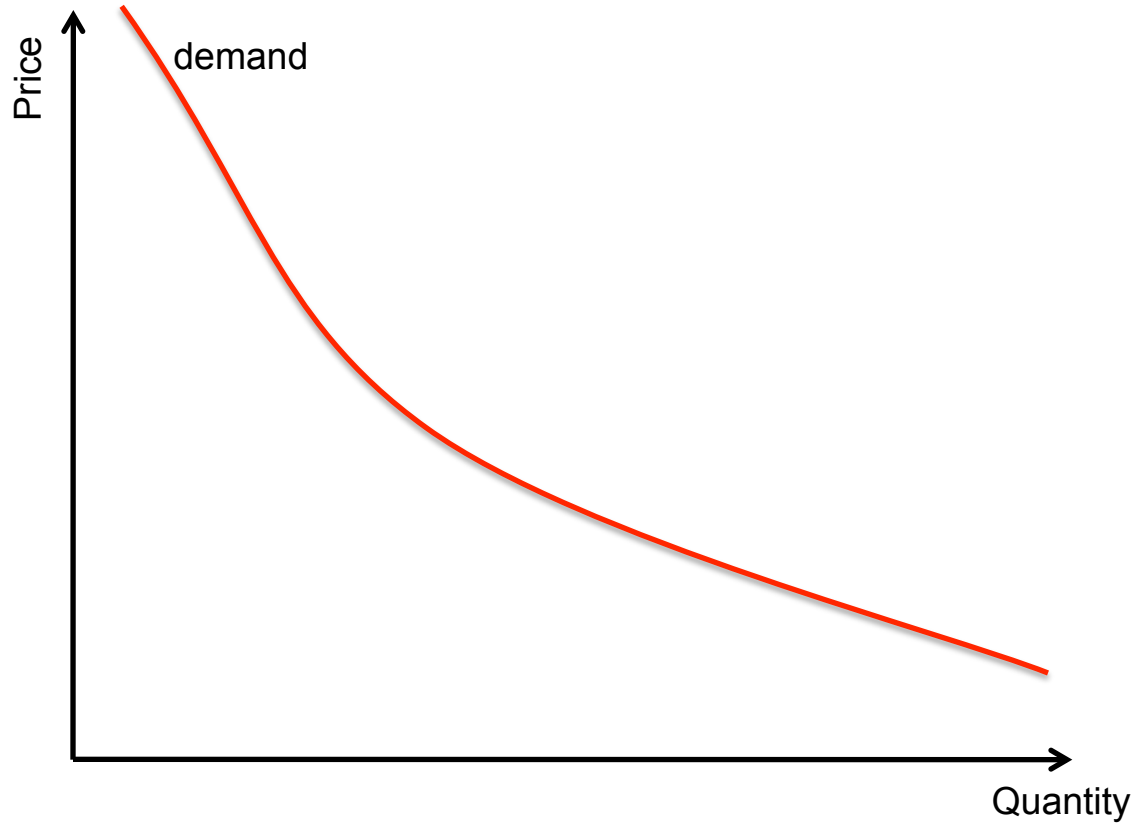
Lessons from the Past

If this transition to IPv6 is proving challenging, then how did we ever get the IPv4 Internet up and running in the first place?

Can demand and supply models of markets show us what happened in the switch from telephone networks to IP networks?

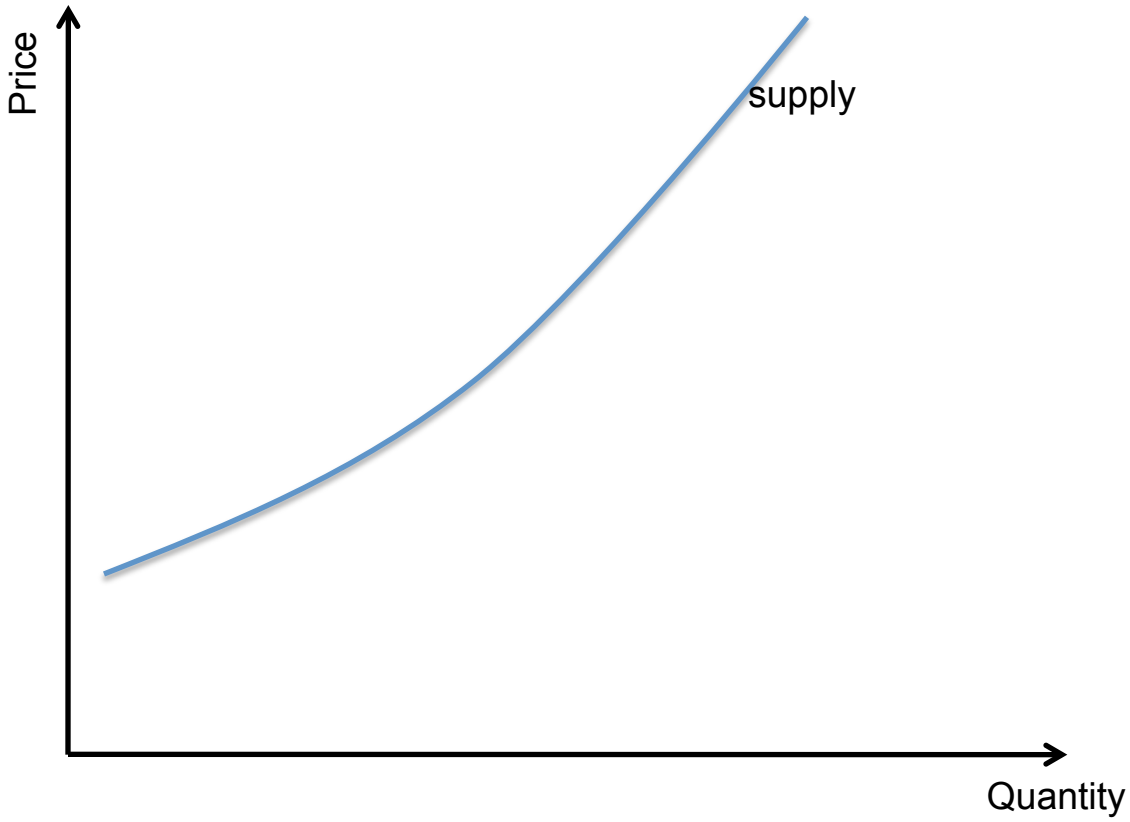
Market Supply and Demand Model

Market Supply and Demand Model



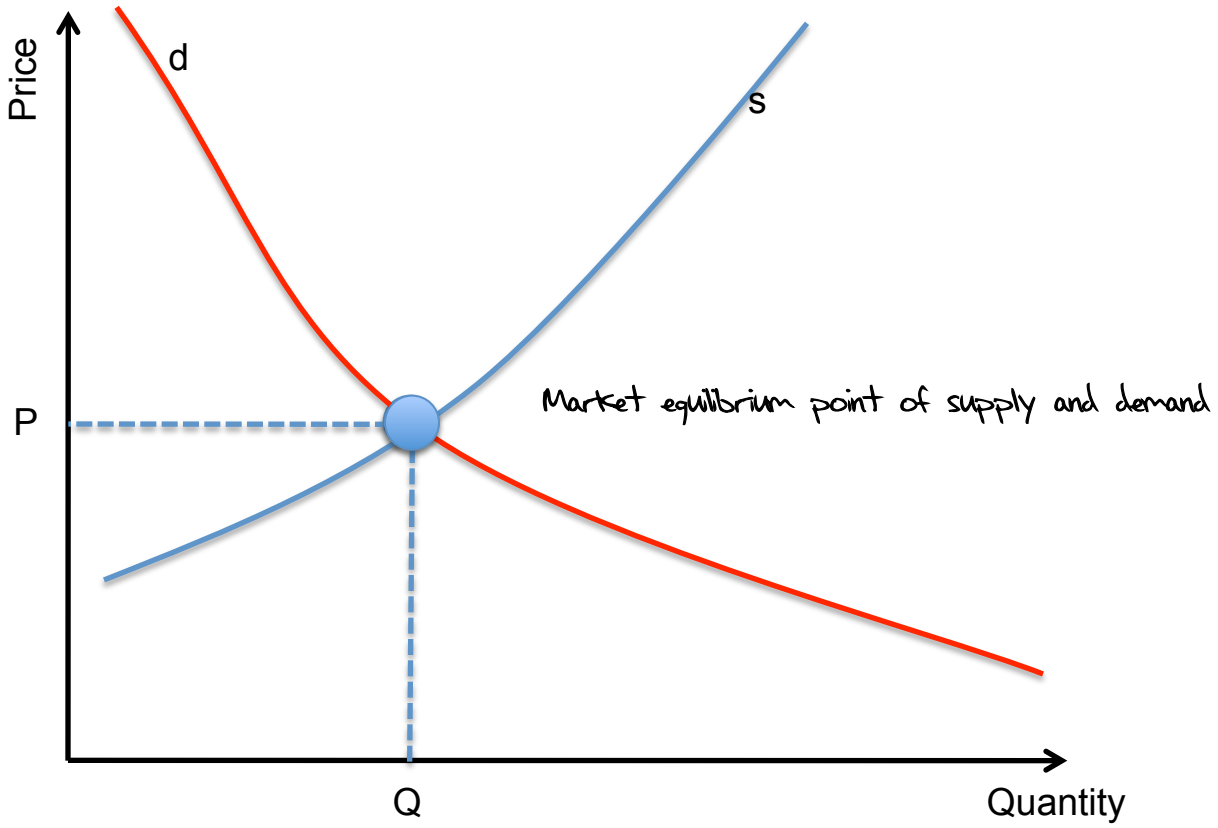
As price increases, the level of demand will decrease

Market Supply and Demand Model



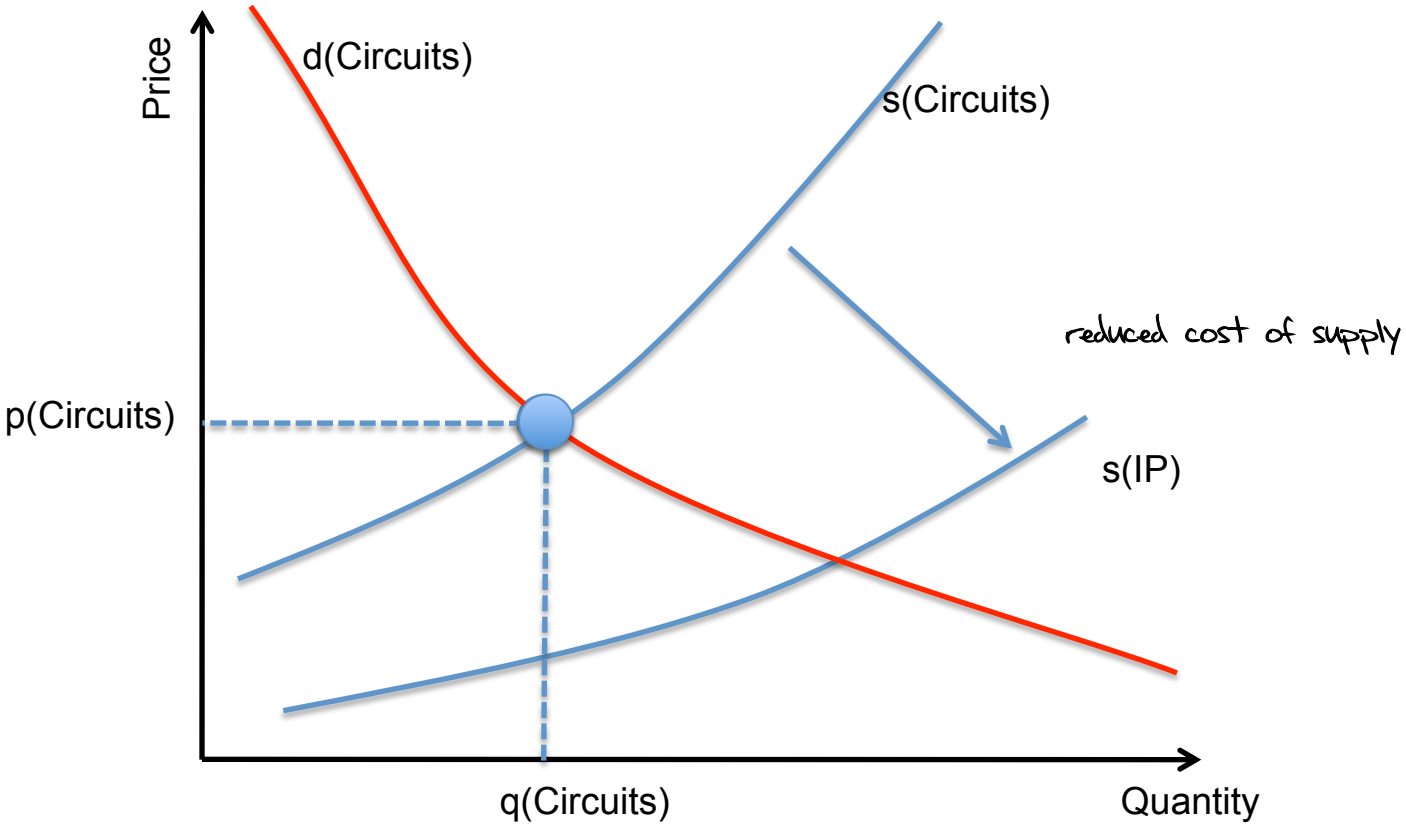
As price increases, the incentive to supply the market will increase

Market Supply and Demand Model



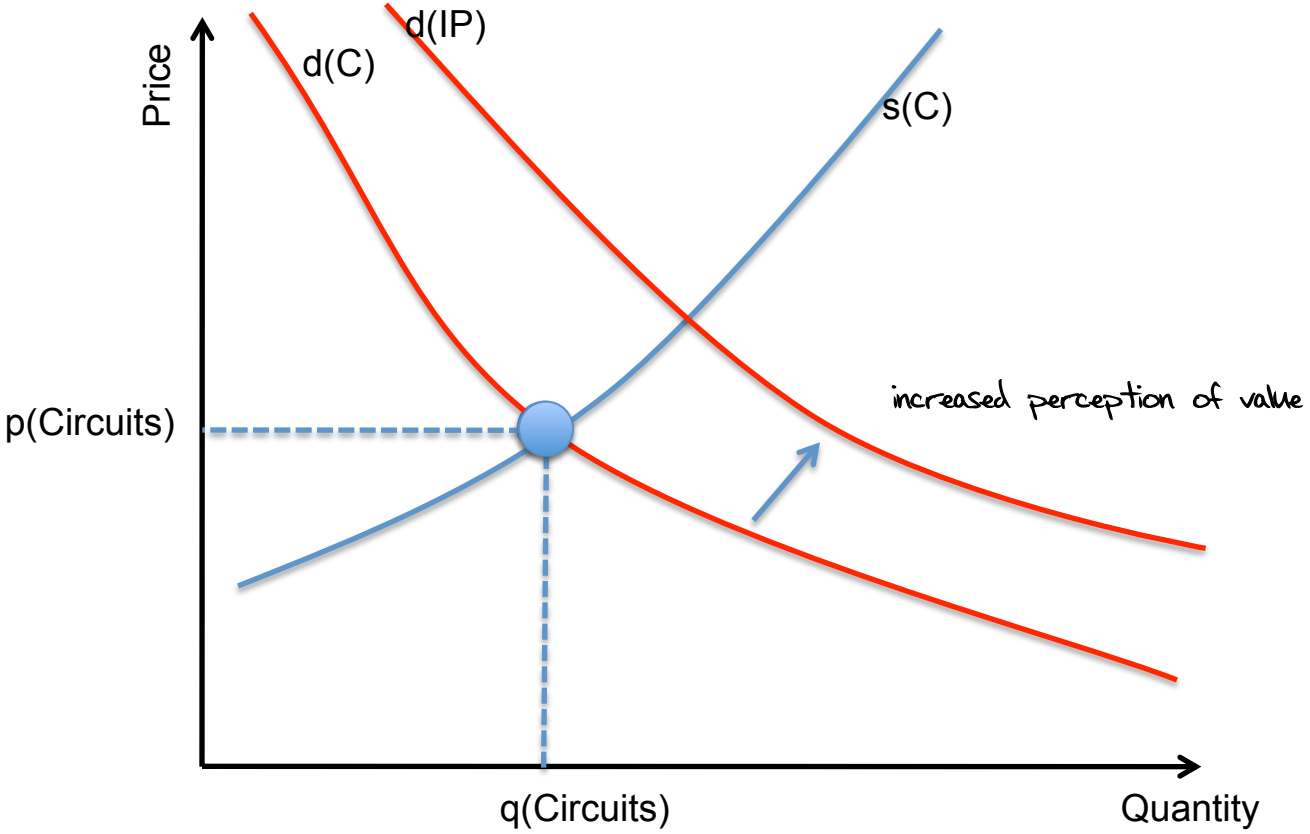
A market equilibrium exists at a price point that balances demand and supply

Technology Change: Supply Schedule Shift



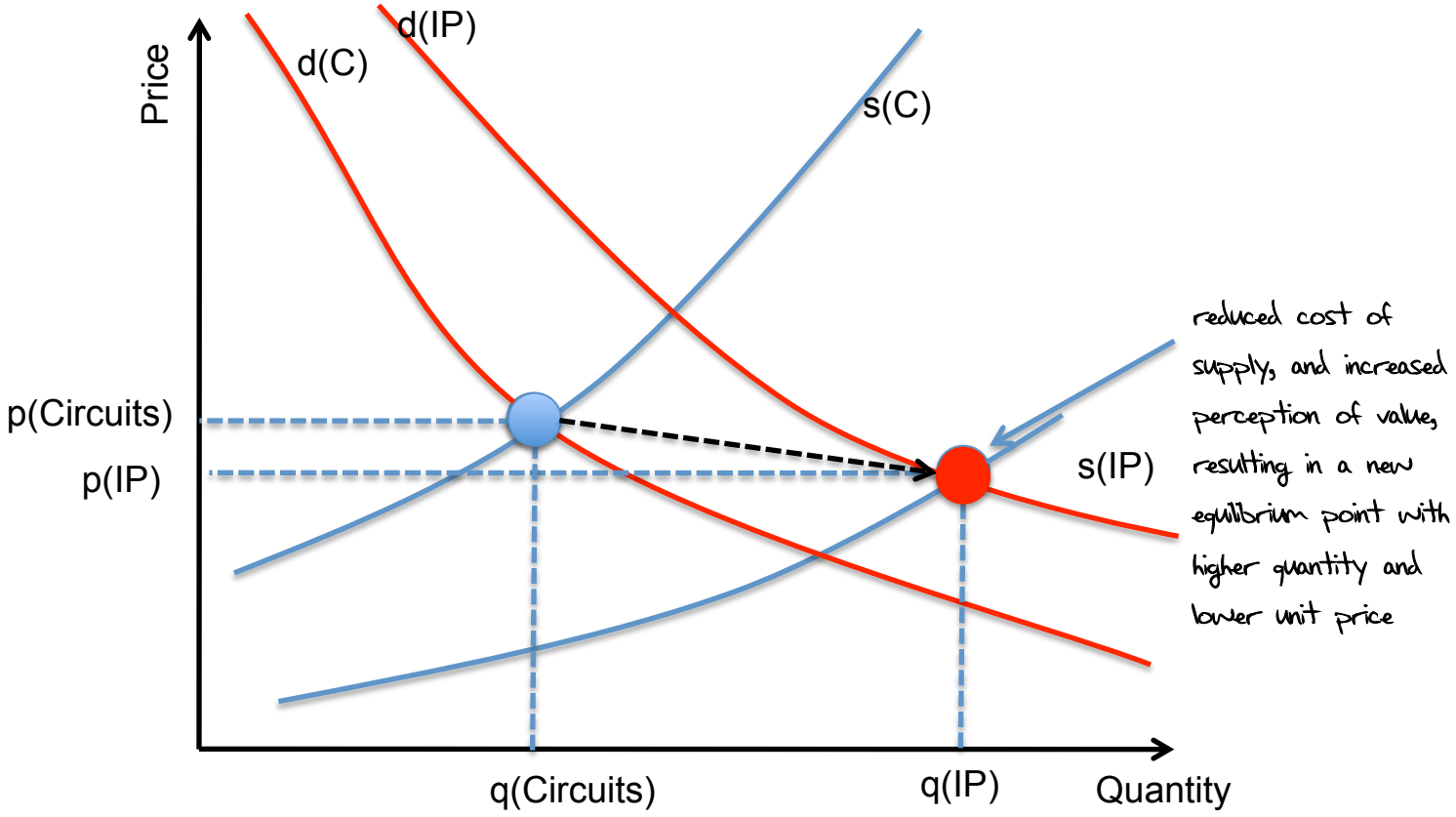
The shift from circuit switching to packet switching allowed for cheaper services

Technology Change: The Demand Schedule Shift



The shift from telephony to data networks allowed for a broader use model

Circuits to IP Packets: The Demand Schedule Shift

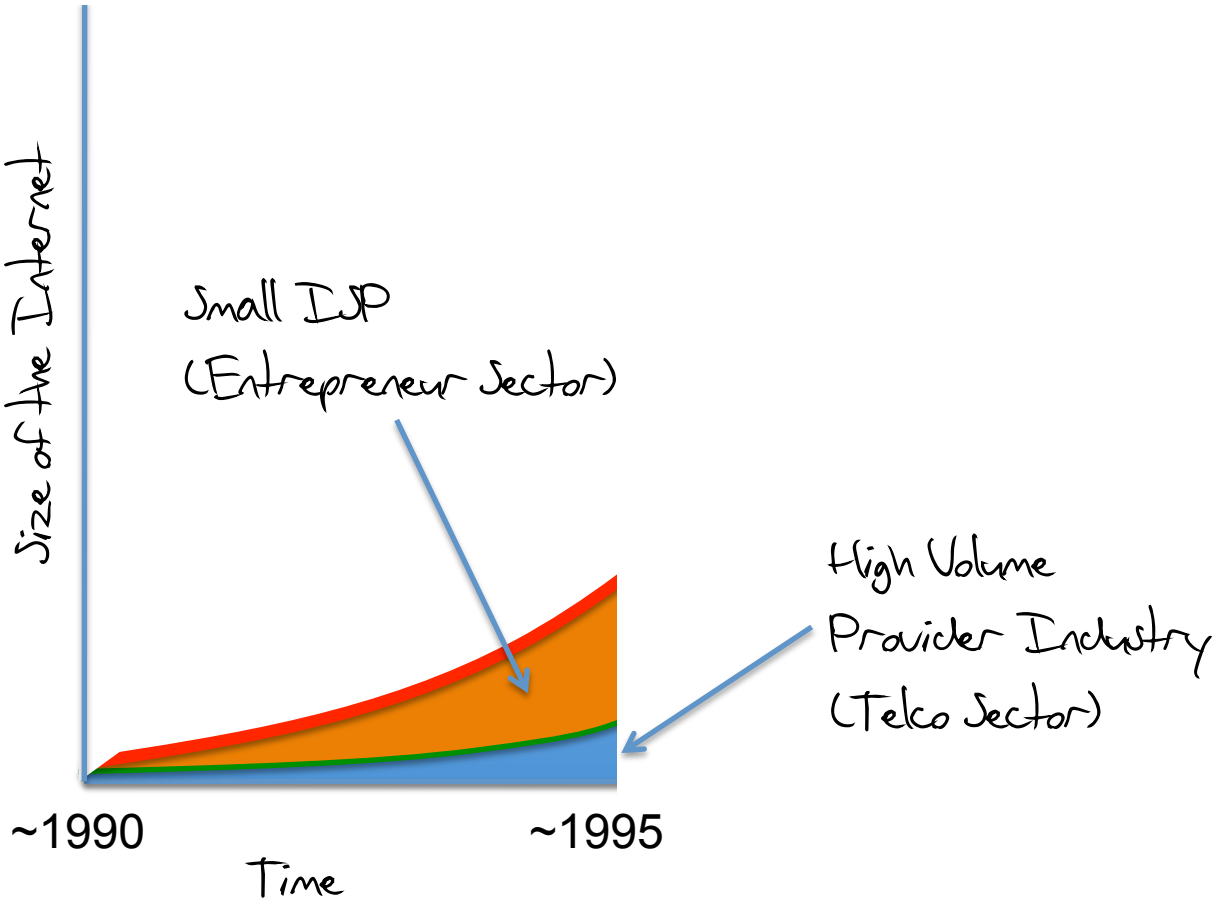


IPv4 Deployment

IP networks exposed new market opportunities in a market that was actively shedding many regulatory constraints

- presence of agile high-risk entrepreneur capital willing to exploit short term market opportunities exposed through arbitrage of circuits
- volume-based suppliers initially unable to redeploy capital and process to meet new demand
  - unable to cannibalize existing markets
  - unwilling to make high risk investments

IPv4 Deployment



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- volume-based suppliers initially unable to redeploy capital and process to meet new demand
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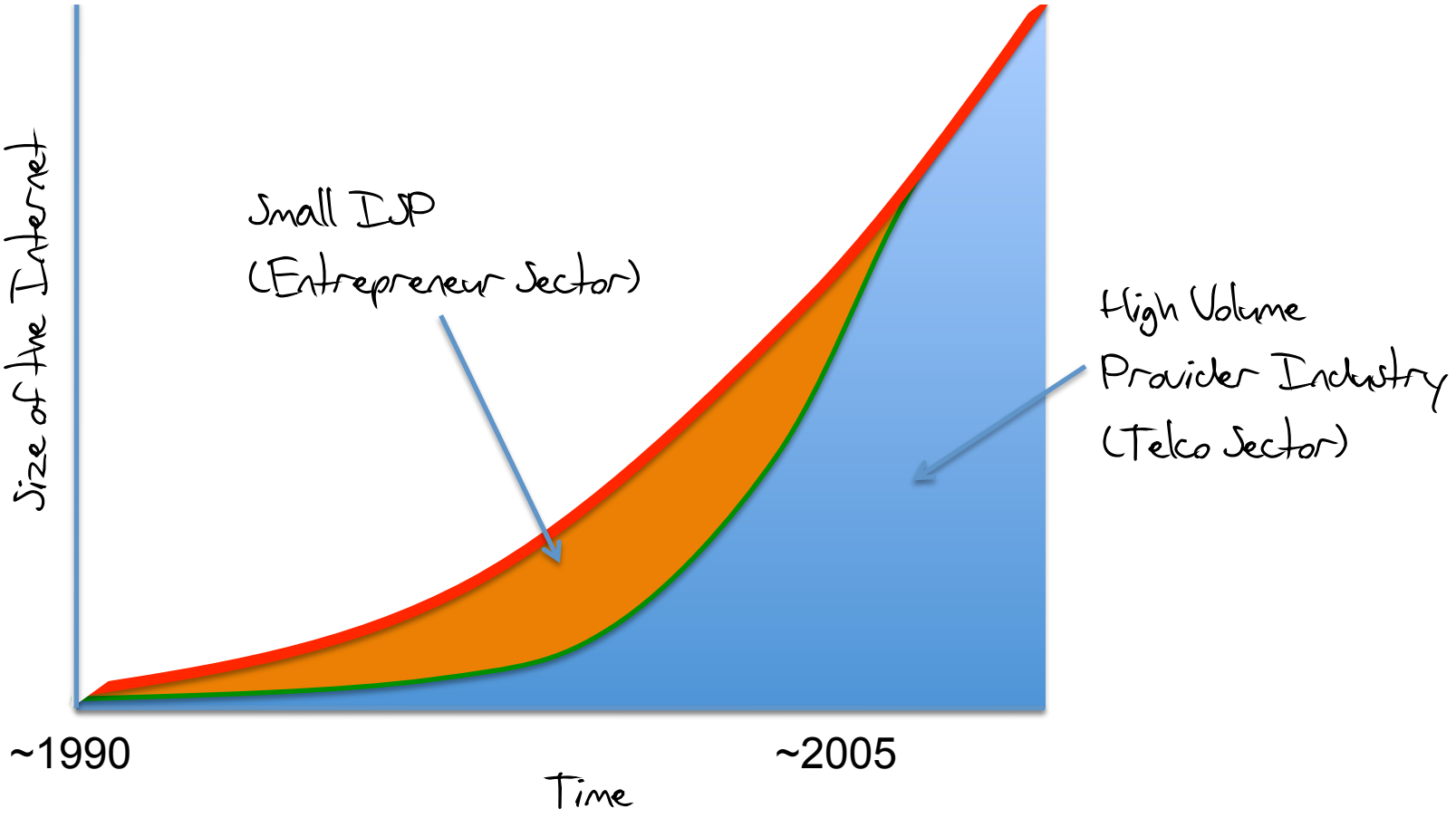
  - unwilling to make high risk investments
- the maturing market represented an opportunity for large scale investment that could operate on even lower cost bases through economies of scale

IPv4 Deployment



What about IPv6 Transition?

Will the same technology, cost and regulatory factors that drove the deployment of the IPv4 Internet also drive this industry through the transition from IPv4 to IPv6?

IPv6 vs IPv4

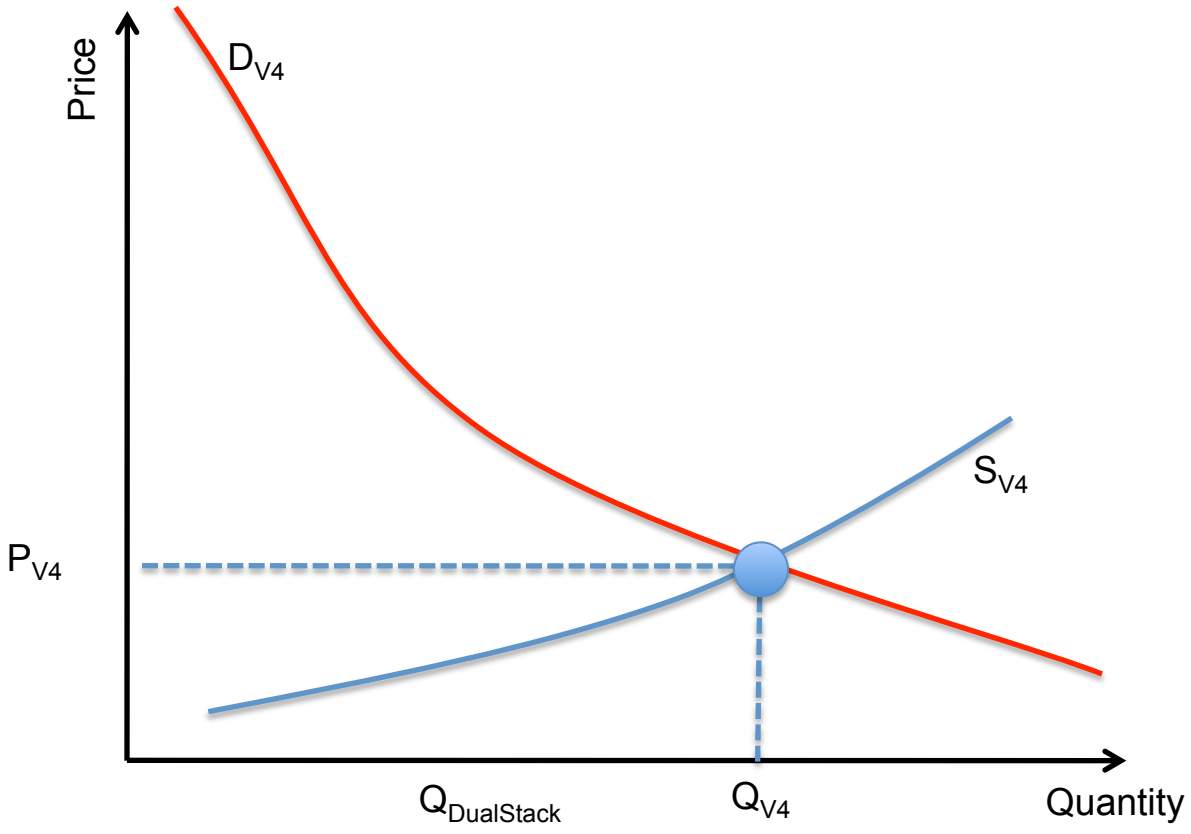
Are there *competitive differentiators*?

no inherent consumer-visible difference

no visible consumer demand

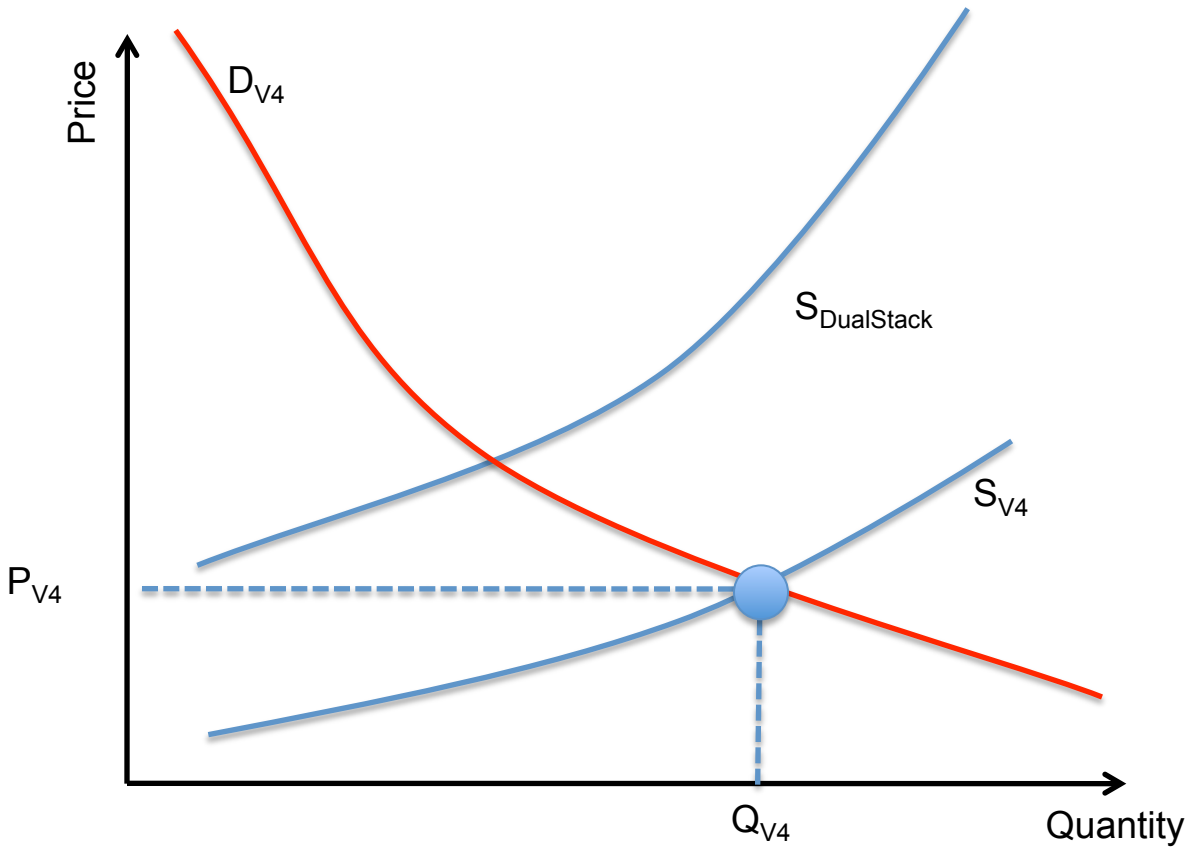
no visible competitive differentiators other than *future risk*

IPv4 to Dual Stack: The Demand Schedule Shift



IPv4 to Dual Stack: The Demand Schedule Shift

Supply side cost increase due to Dual Stack operation



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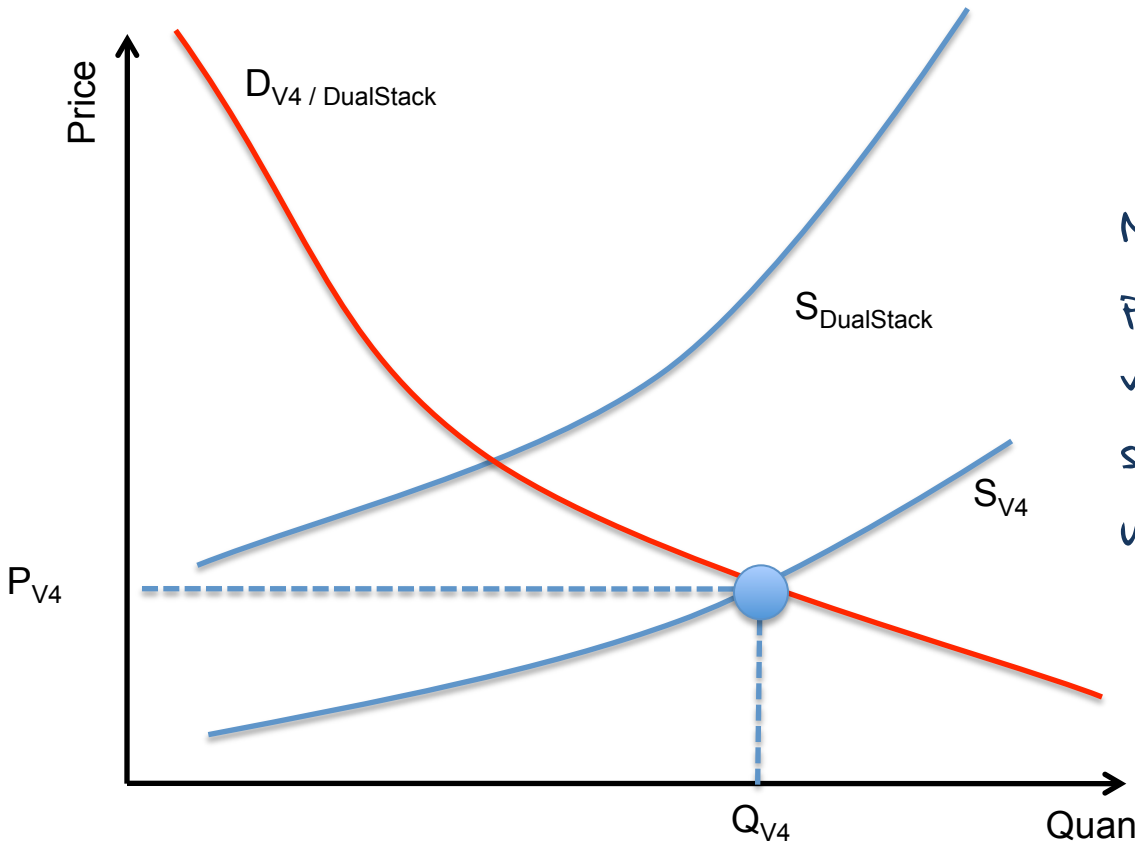

No change in perception of value, so demand schedule is unaltered

IPv4 to Dual Stack: The Demand Schedule Shift

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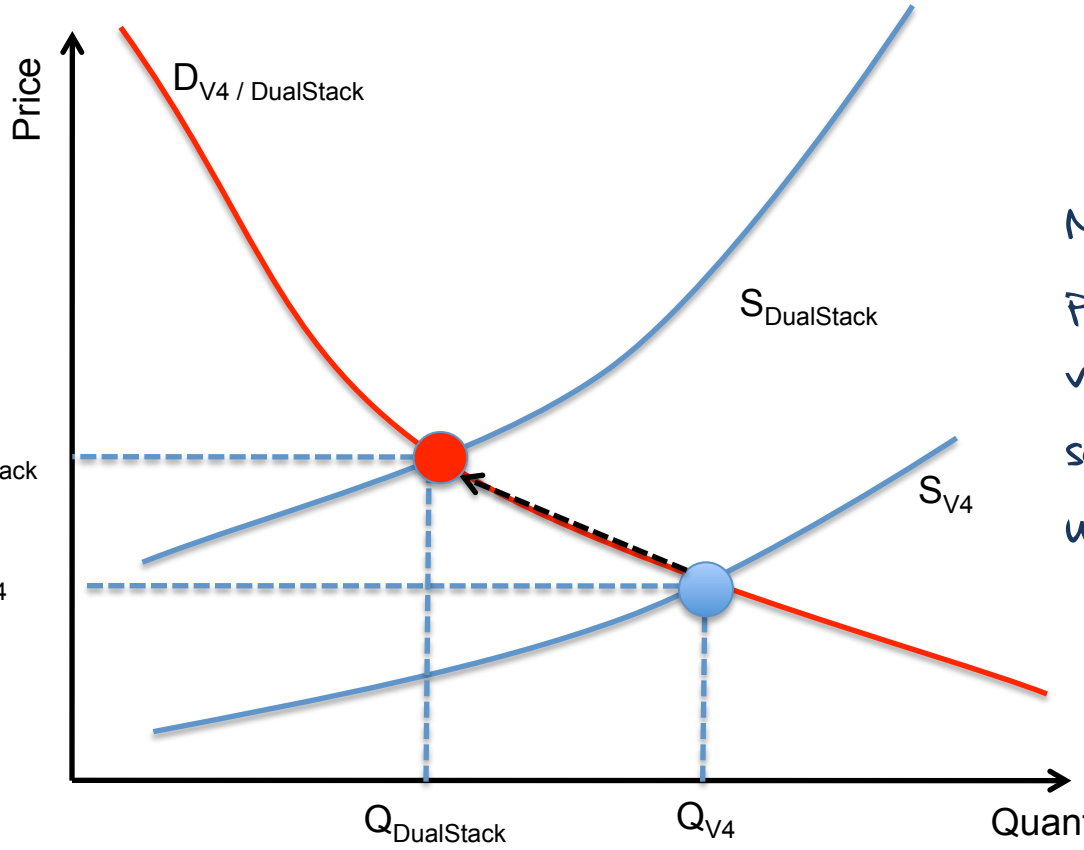


No change in perception of value, so demand schedule is unaltered

Equilibrium point is at a lower quantity if Dual Stack supply costs are passed on to customers

Impasse?

- To get to an IPv6 network we need to operate a dual stack hybrid model for a transitional period
- But the higher cost and lower perception of utility of imply that there is no ‘natural’ market driver to propel either producers or consumers into a dual stack transition service

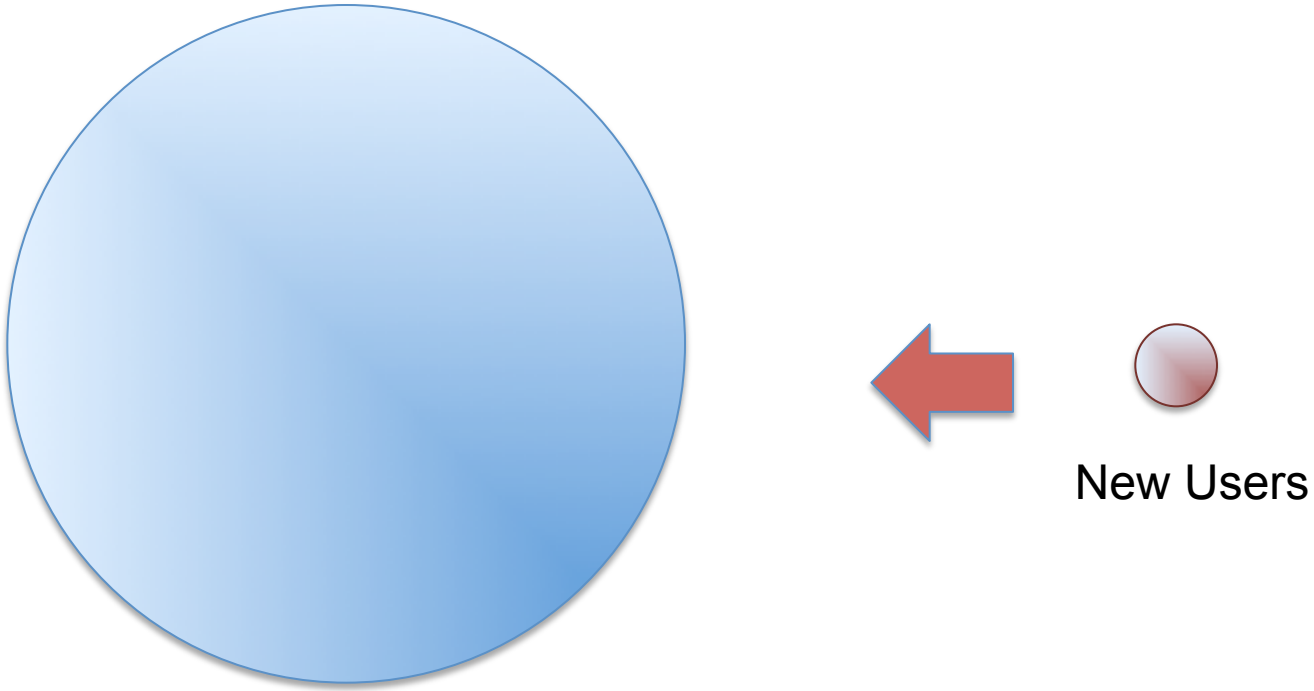
Something has to break!

Demand appears to be constantly increasing, not slowing

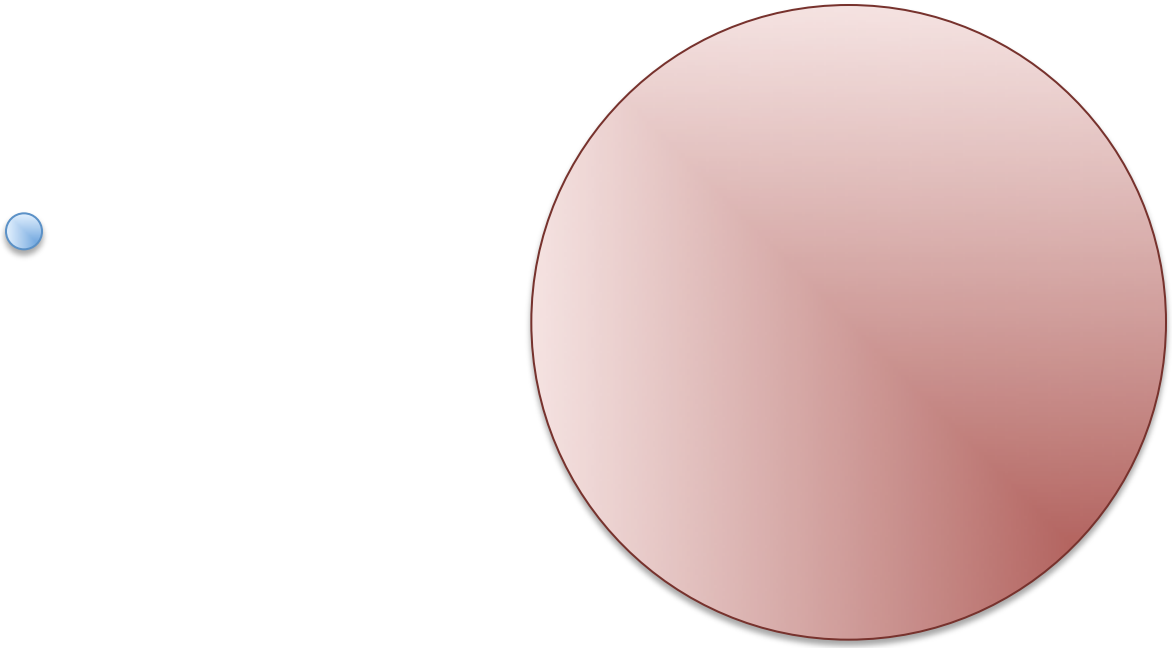
And our stocks of IPv4 addresses are finite, and addresses are about to jump in price

So how might this be resolved?

The Expanding Internet



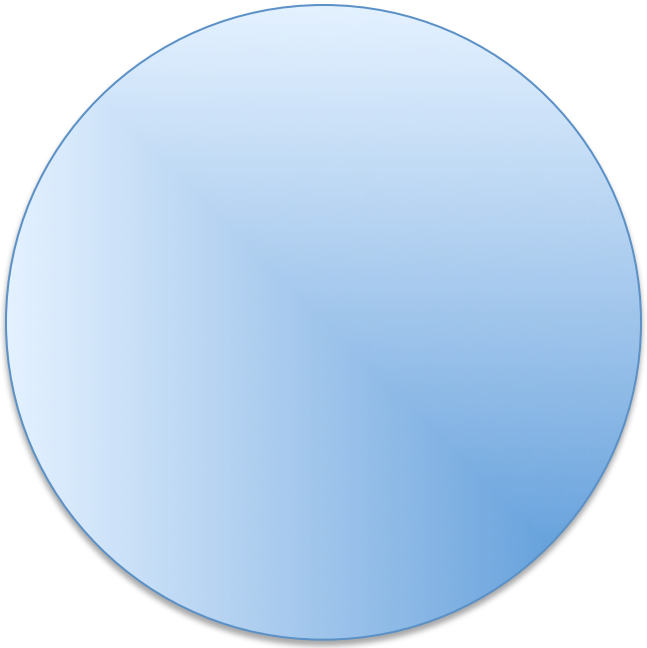
Asymmetric Need for IPv6



Existing Base of IPv4 Users

New Users

Asymmetric Cost of IPv6



Existing Base of IPv4 Users

New Users

Impasse 2.0

- It's the new users and new uses of the Internet that are are the immediate beneficiaries of an IPv6 network, and the immediate victims of continued stasis in IPv4
- But the incremental economic value of these additional users and uses does not appear to outweigh the costs of transition in the installed base
- And the larger the installed base of IPv4, the greater the economic resistance to change

“Tipping Points”

If the value of the new users and uses is disproportionately high, compared to the installed base, the actions of this small subset of users can influence the actions of the installed base

Such situations can lead to a “tipping point” where adoption of a new technology by a small set of influencers can direct a far larger market

The Mobile Internet

The mobile “smartphone” market retailed 300M units in 2010
(Gartner)

This market sector:

- earns the highest margin per user
- is growing at the fastest rate
- will be one of the first to feel the impacts of address scarcity
- should be able to provide clear market impetus in the transition to IPv6

But…

- Public or Private?

  Will the mobile market continue to open their users to the entire Internet or head back into private walled gardens and lock up users and content?

  - Google's Android model
  - Apple's App Store and the iPhone model

Why are we wedged on IPv6?

Much of the answer to the question:

"where to now?"

for the Internet depends on the direction being taken by the mobile sector in response to address scarcity.

So why is this not just a simple case of "just use IPv6 and lets move on!" ?

Why are we wedged on IPv6?

Cost and Benefit are not aligned:

Those folk who have been historical "losers" with the open Internet - the carriers - are now being asked to make the bulk of the investment in IPv6 access infrastructure

They are understandably reluctant to make further investments that in the end just worsen their long term revenue prospects

Why are we wedged on IPv6?

Cost and Benefit are not aligned:

Those folk who have benefitted from an open network in the past are increasingly ambivalent about open networks and IPv6 into the future

They are now part of the set of entrenched incumbents, with market positions to protect

Why are we wedged on IPv6?

Cost and Benefit are not aligned:

Those folk with the most to gain in the longer term from continuation of an open network - consumers - do not necessarily act from day to day in their own long term interests

i.e. consumers are unwilling to fund this transition through higher prices for Internet services

Is the Open Pendulum swinging back?

Continued delay by incumbents to embrace IPv6 allows further consolidation, and increased ability by incumbents to define (and limit) the parameters of future competition.

What is at risk here is the future of a truly open public network infrastructure

If we really want to keep a truly Open Internet...

Then we need to alter the market environment to favor the rapid adoption of IPv6!

Working out how to do this on the fly is proving to be extremely challenging

Thank You