Beyond IPv4 Unallocated Address Space Exhaustion

Geoff Huston
Chief Scientist
APNIC

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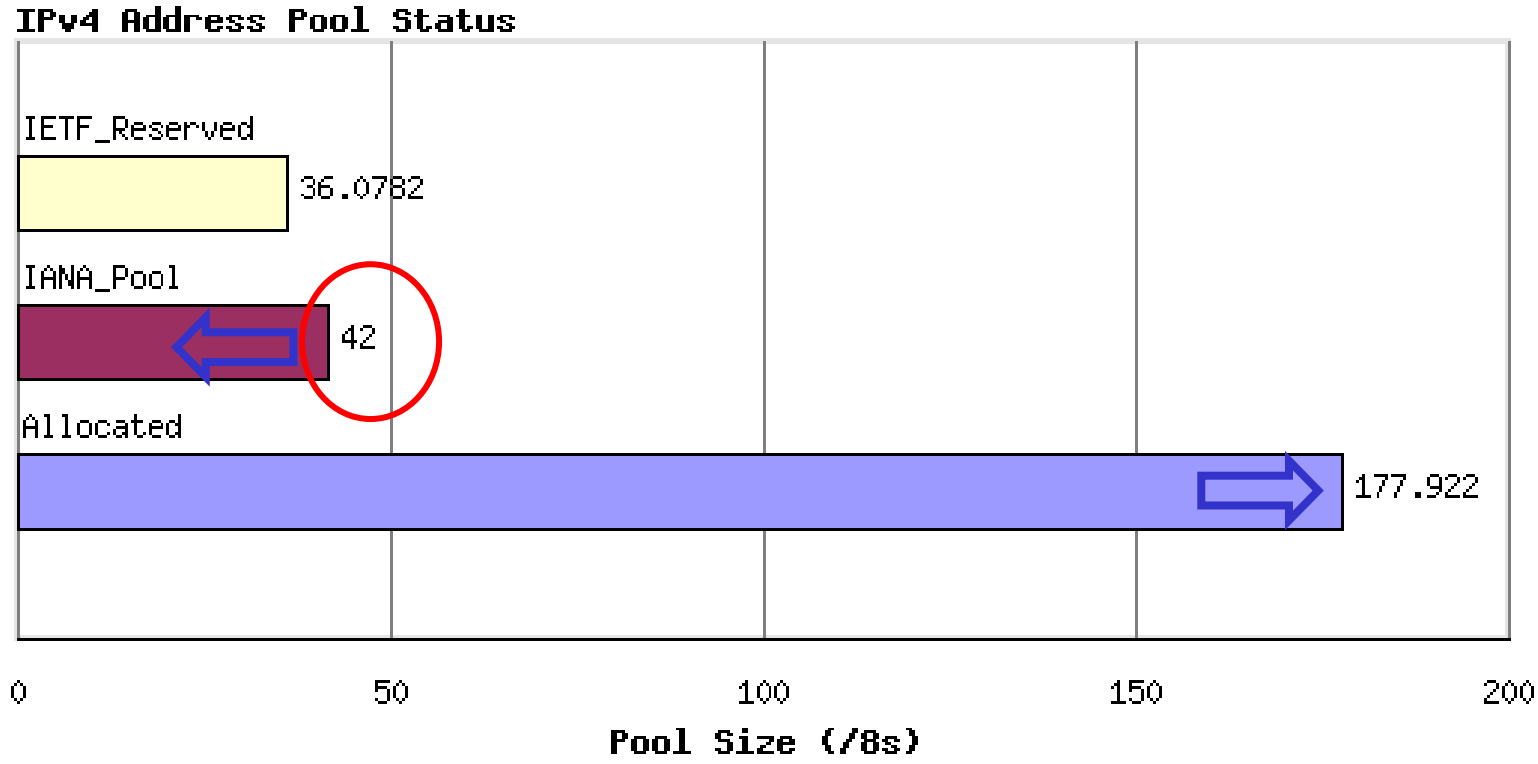
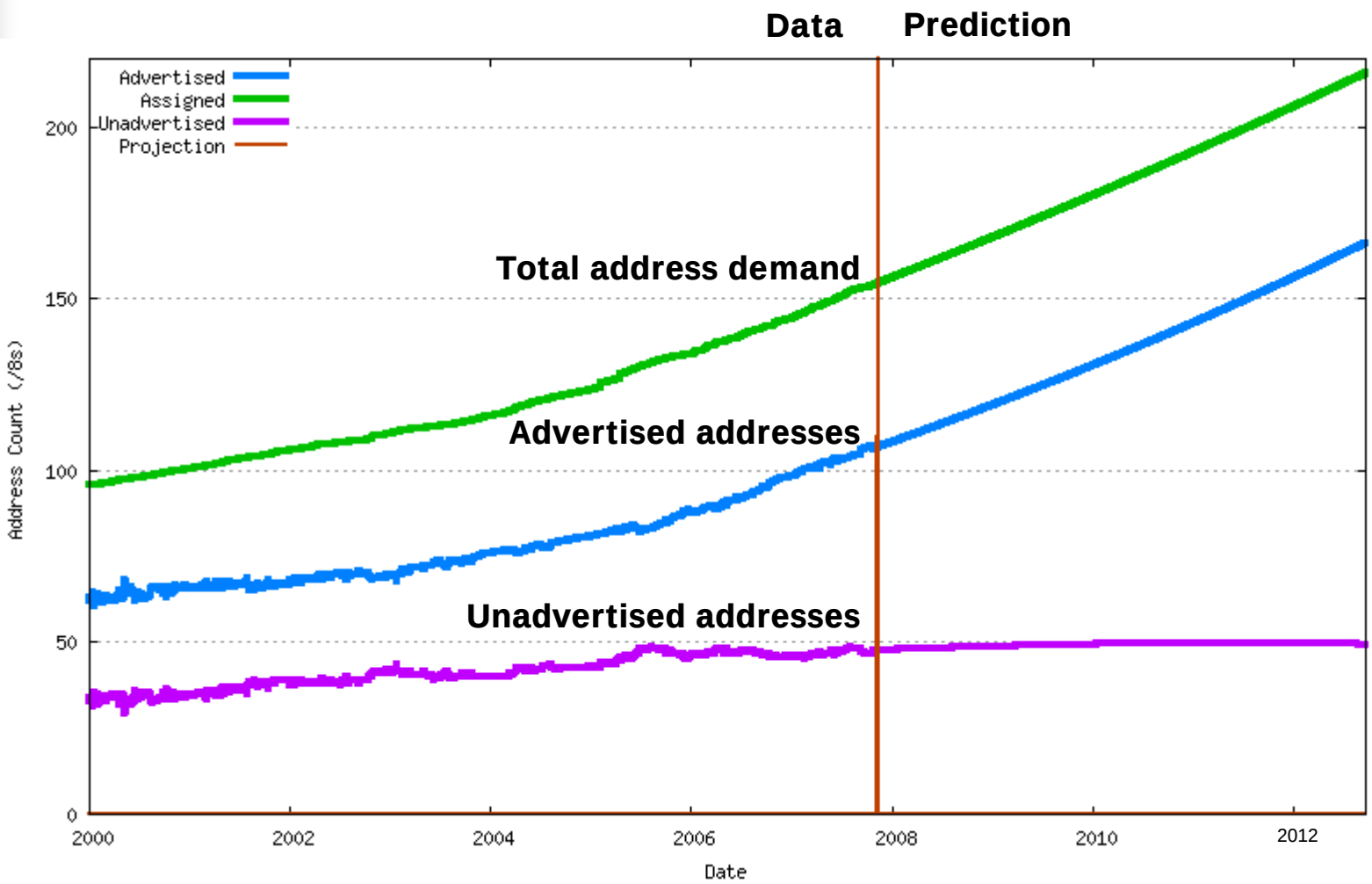
Religion, Technology, Engineering and The End of the World as We Know It

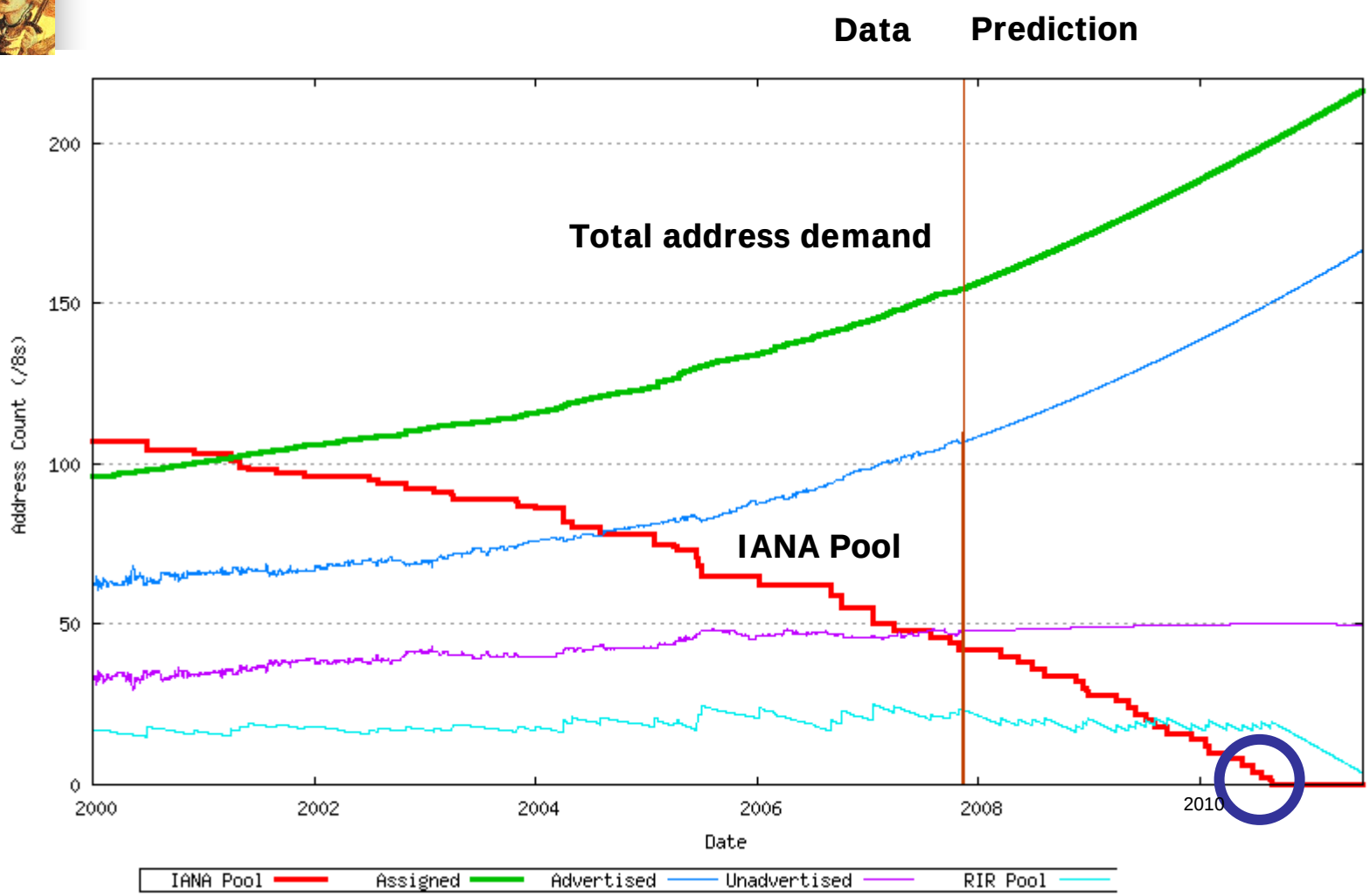
Current Status of IPv4



Predictive Model



IANA Pool Exhaustion



In this model, IANA allocates its last IPv4 /8 to an RIR on the 19th September 2010

The first RIR runs out on the 14th July 2011

This is the model's predicted exhaustion date as of the 19th November 2007. Tomorrow's prediction will be different!

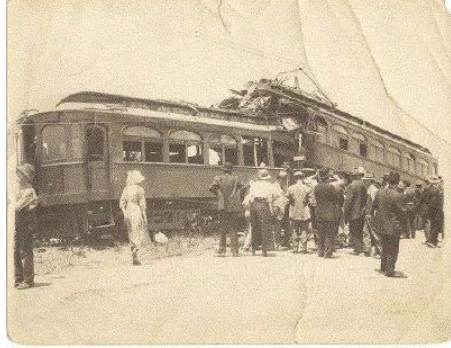
http://ipv4.potaroo.net

It's a pretty poor prediction!

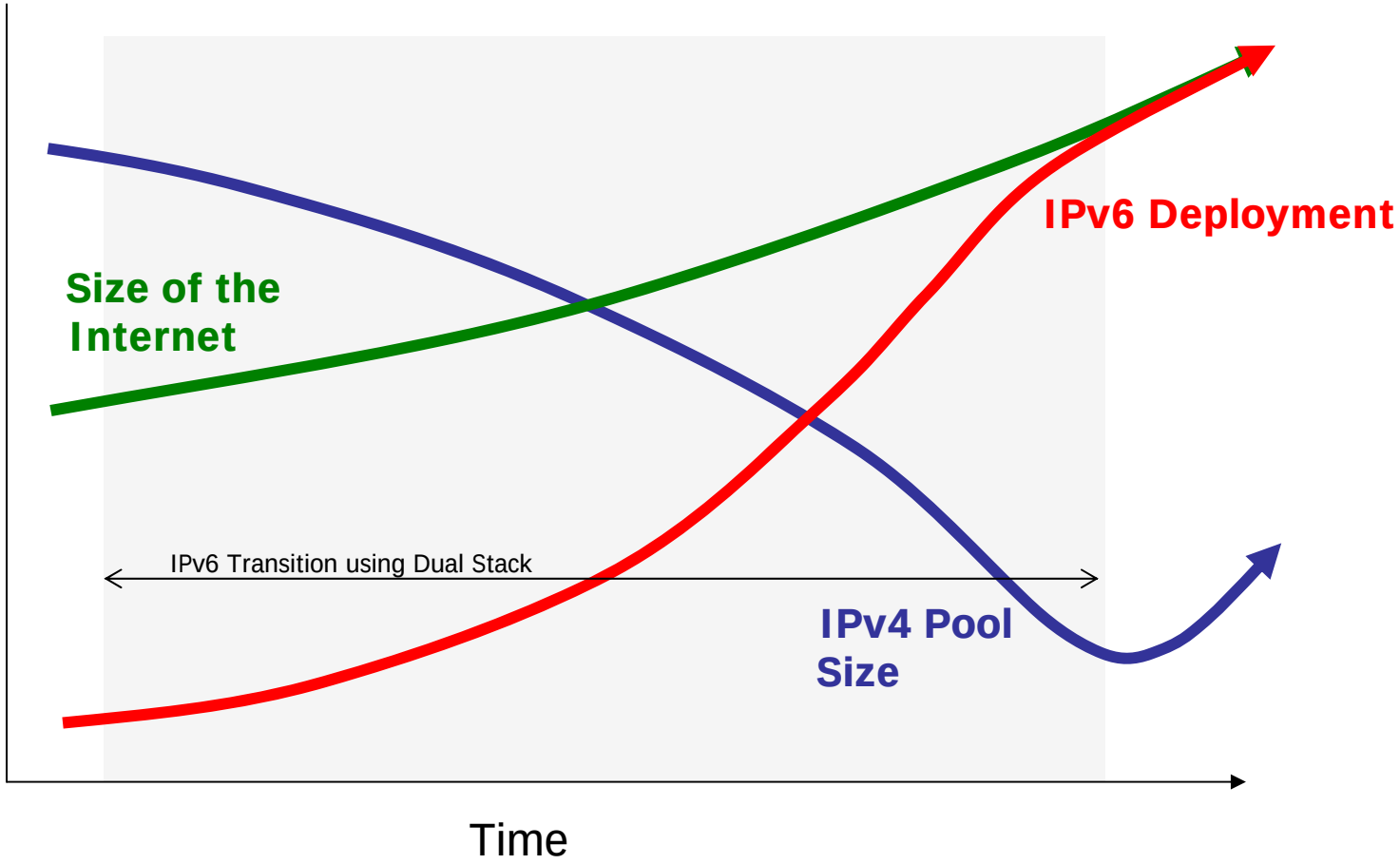
- Assumptions
  - Tomorrow is a lot like today
  - Trends visible in the recent past continue into the future

- This model assumes that there will be no panic, no change in policies, no change in the underlying demand dynamics, no disruptive externalities, no rationing, and no withholding or hoarding!

  - No, really!



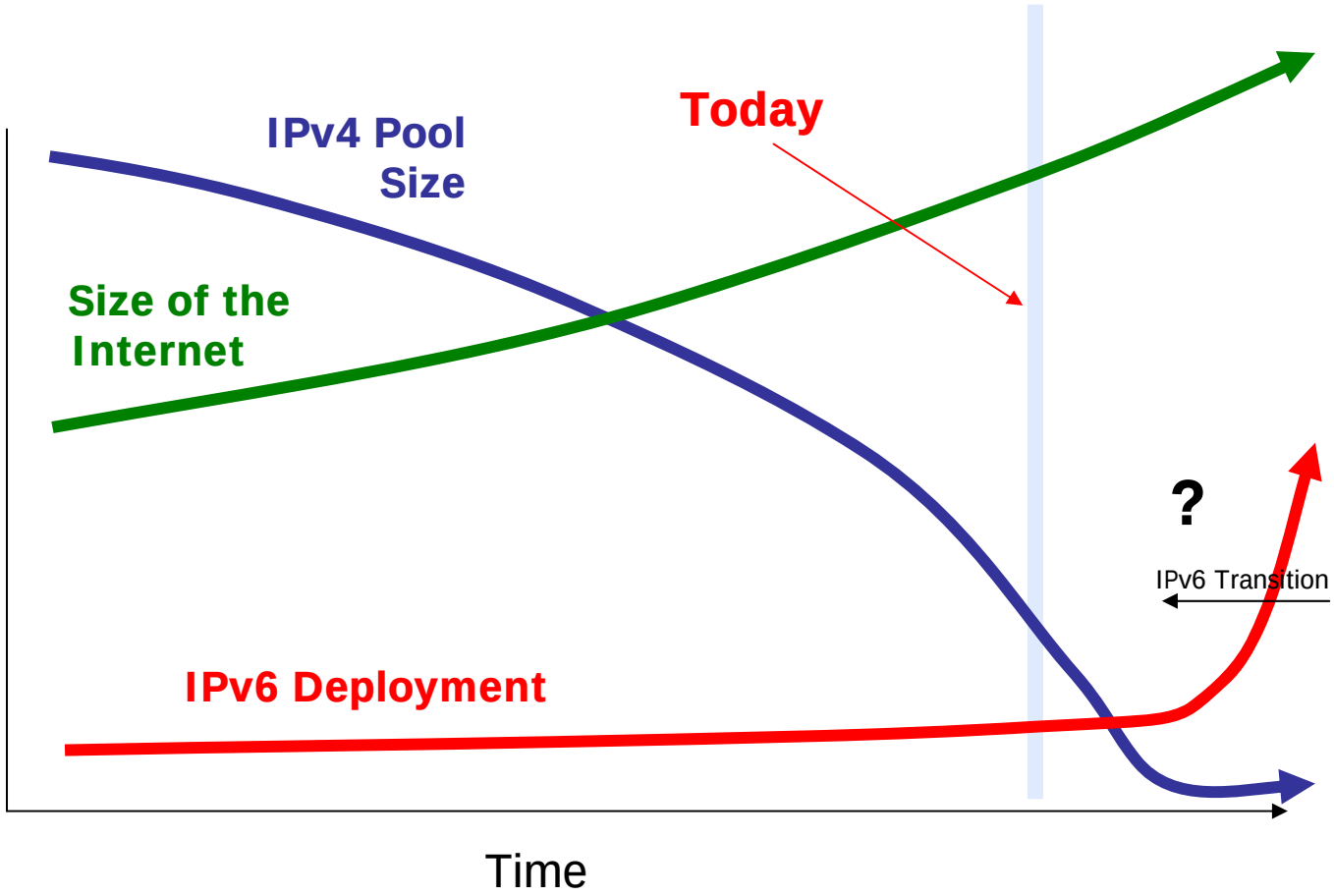
We had a plan ...


IPv6 Deployment
Size of the Internet
IPv6 Transition using Dual Stack
IPv4 Pool Size
Time

Oops!

- We were meant to have completed the transition to IPv6 BEFORE we completely exhausted the supply channels of IPv4 addresses

What's the revised plan?



Now what?

- Some possible scenarios:
  - Rapid IPv6 deployment
  - Persist in IPv4 networks using more NATs
  - Address markets emerging for IPv4
  - Routing fragmentation
  - IPv6 transition

Its Just Business

- This entire network is customer funded
- And customers have absolutely no clue what this IPv6 stuff is about

Business and Customers

- Customers will not pay one cent more unless its faster, better, or fashionable
  - None of which clearly apply to IPv6
- Customers just won't pay a premium for IPv6
  - The consumer expectation that "All technology change is supposed to drive prices down, not up!"
- The existing market for IP goods and services is completely unwilling to fund any transition to IPv6

Business and Economics

- Borrow and Spend?
  - So who is dumb enough to lend to this industry?
  - The excesses of the past decade of boom and bust have left a legacy that condemns the telco industry as clueless and irresponsible
  - No clear indication yet that the early leaders in an IPv6 transition are going to be the winners or the sacrificial lambs sent to the slaughter

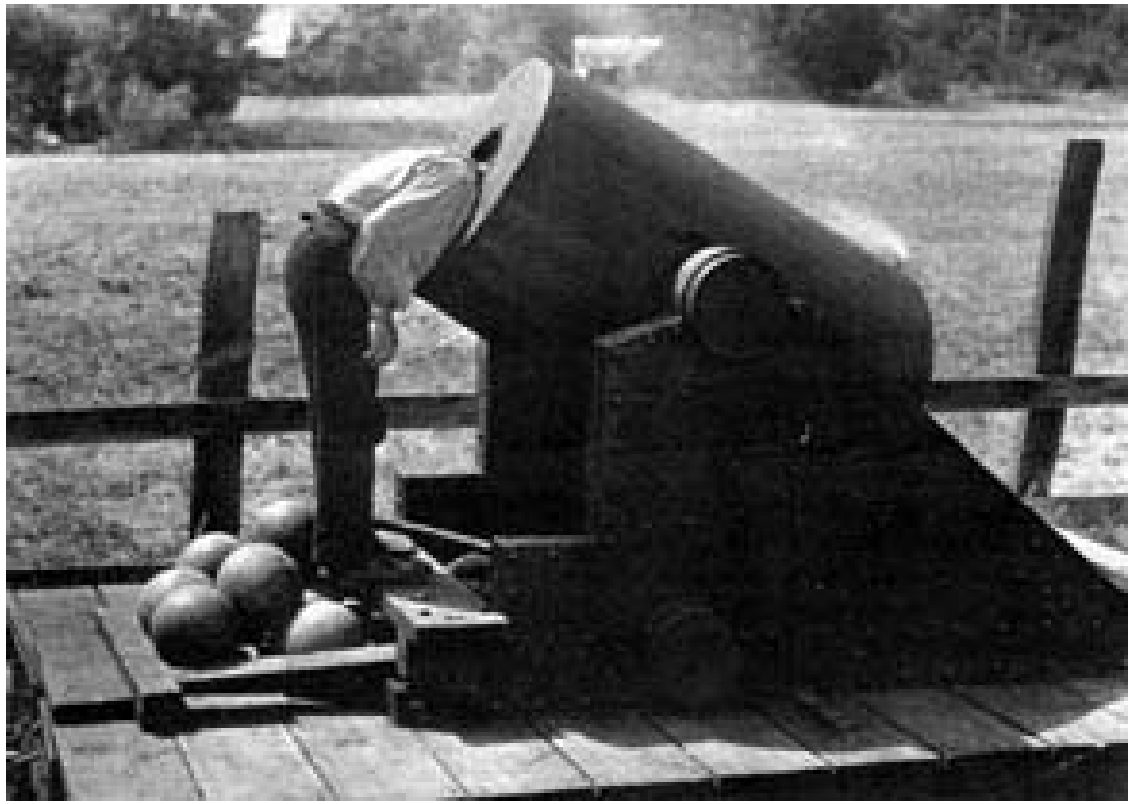
Business and Markets

- New Markets for IPv6?
  - The world of billions of chattering devices unleashing new rivers of gold into the IP industry?
    - Or is this just the economy?
    - There is no new money and these billions of chattering devices will generate much the same revenue as we have today
    - So we have to cram all these billions of new devices trillions of new packets into the same money that we have today.
    - What technology leverage will make tomorrow's networks 1,000 times CHEAPER to deliver an IP packet than today's network?

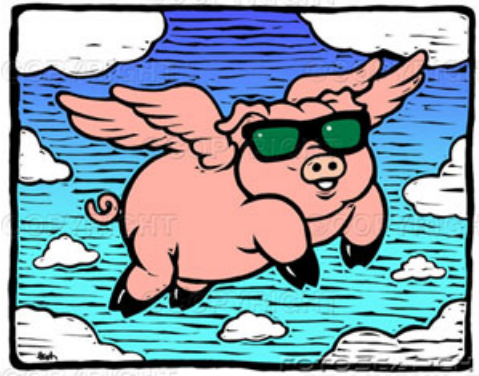
Business and IPv6

- So far IPv6 is a dismal business failure
  - It appears to have all the performance characteristics of a relatively minor incremental change with all the costs of a major forklift upgrade

Its just not looking good is it?



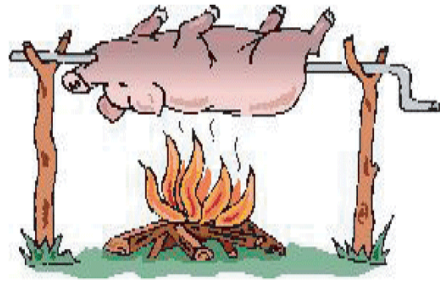
Scenario A:
It's a Matter of Faith



The "lets deploy IPv6 now!" option:

- The global internet adopts IPv6 universally before January 2011 and completely quits all use of IPv4 before well before address pool exhaustion

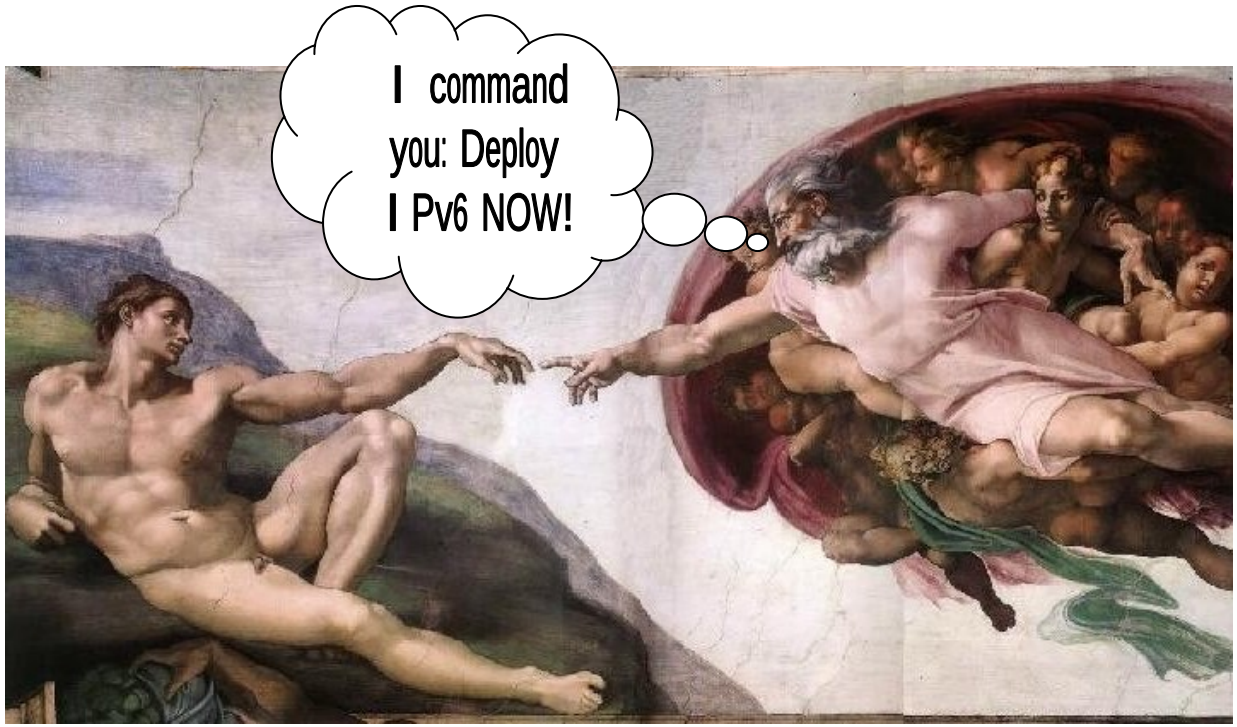
Faith and Reality



- This is not an agile network
- There are no levers for command structures in a deregulated environment
- Trivial changes to the infrastructure take years to deploy
- Non-trivial changes that impact the entire set of supply chains in this industry take far longer
- There is simply no motivation for enterprises to start spending on change anytime soon
  - no fear, no greed
- There is simply no capacity whatsoever for rapid deployment and extensive cost outlays in order to to get to somewhere that is little different from where we are today

Faith and Religion

- This option is simply going to require divine intervention



Scenario B: IPv4 and NATs

The “lets just use more NATs” option

- can we continue to deploy more NATs to stay on IPv4 indefinitely?

NATs now

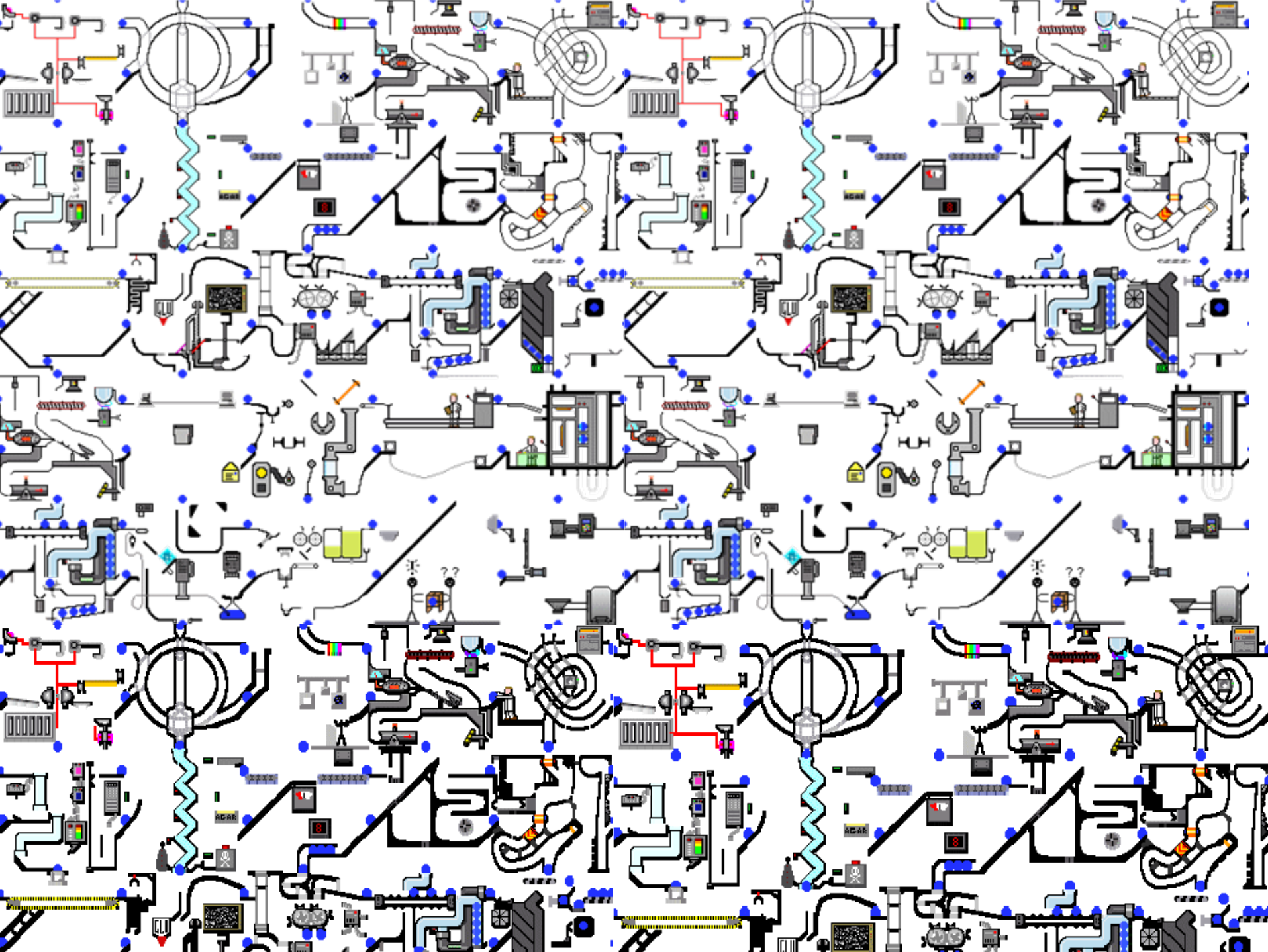
- Today NATS are largely externalized costs for ISPs
  - Customers buy and operate NATS
  - Applications are tuned to single-level NAT traversal
  - Static public addresses typically attract a tariff premium in the retail market
    - For retail customers, IP addresses already have a market price!

NATs on steriods

- Demand for increasing NAT “intensity”
  - Shift ISP infrastructure to private address realms
  - Multi-level NAT deployments both at the customer edge and within the ISP network
    - This poses issues in terms of application discovery and adaptation to NAT behaviours
  - End cost for static public addresses may increase

NAT Futures

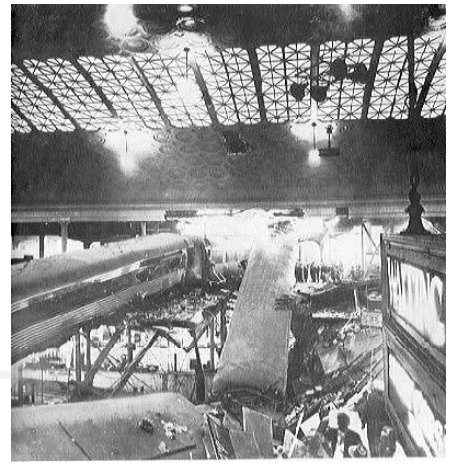
- Are NATs just more of the same?
  - More intense use of NATs does not alter the network's current architectural model
- How far can NATs scale?
  - What are the critical resources here?
    - NAT binding capacity and state maintenance
    - NAT packet throughput
    - Private address pool sizes
    - Application complexity
    - Routing
    - DNS contortions
- "NATS Forever" is a scary proposition in complexity

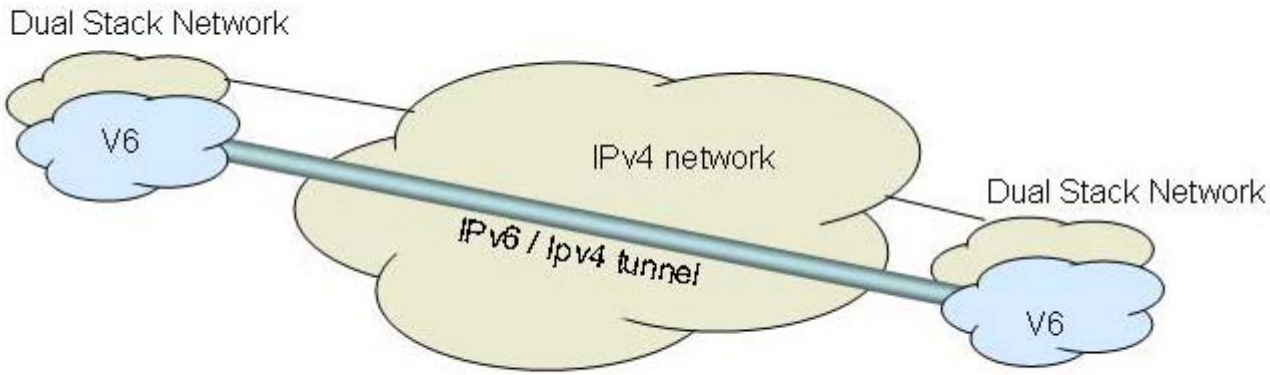


Scenario C: Transition to IPv6

- IPv6 is not backward compatible with IPv4 on the wire
- So the plan is that we need to run some form of a “dual stack” transition process
  - Either dual stack in the host, or dual stack via protocol translating proxies

Dual Stack Transition to IPv6

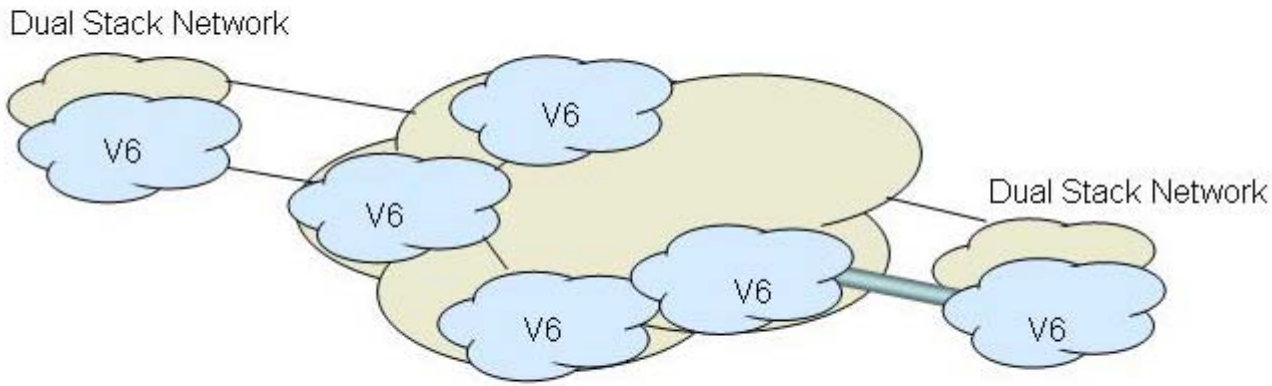




Theology – Phase 1

- "Initial" Dual Stack deployment:
  - *Dual stack* networks with V6 / V4 connectivity
  - Dual Stack hosts attempt V6 connection, and use V4 as a fallback

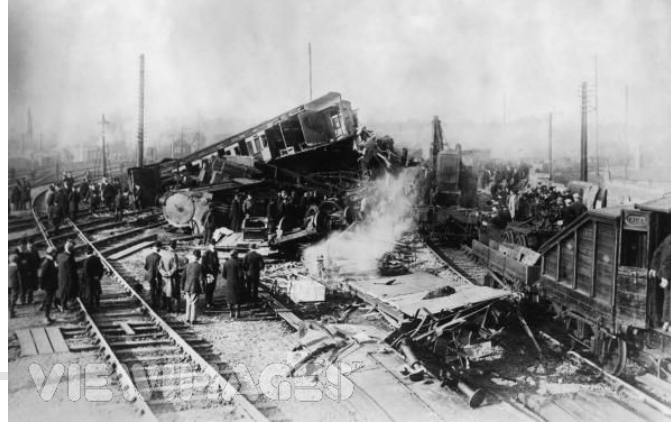
Dual Stack Transition to IPv6

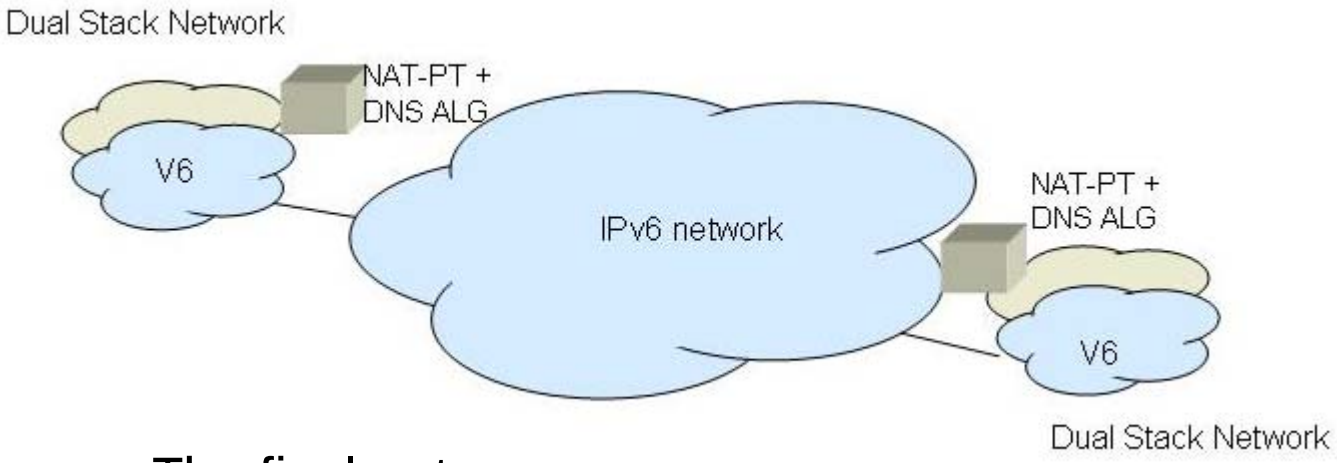


Theology – Phase 2

- “Intermediate”
  - Older V4 only networks are retro-fitted with dual stack V6 support

Dual Stack Transition to IPv6





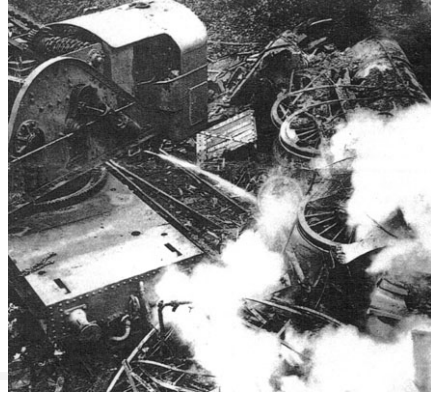
Theology - The final outcome

- "Completion"
  - V4 shutdown occurs in a number of networks
  - Connectivity with the residual V4 islands via DNS ALG + NAT-Protocol Translation
  - Outside the residual legacy deployments the network is single protocol V6

Double or Quits?

- Dual Stack transition is not a binary proposition
  - Its not a case of IPv4 today, IPv6 tomorrow
- Dual Stack transition is an “and” proposition
  - It’s a case of IPv4 and IPv6
  - Double the fun and double the cost?
- But we don’t know for how long
  - So we need to stretch IPv4 out to encompass tomorrow’s Internet, and the day after, and ...

Making IPv4 Last Longer



- Its not the IPv4 address pool that's fully consumed
  - It's the unallocated address pool that's been consumed
  - 20% of the address space is not advertised in global routing
- Its not that every IPv4 address is committed and in use today – far from it!
  - Advertised address pools appear to have end host utilization levels of around 5% - 20%
- So we could buy yourselves into some deviant form of Second Life with IPv4, NATs and address markets
  - But it won't be life as we've known it!

Making IPv4 Last Longer

- For how long?
- For what cumulative address demand?
- For what level of fairness of access?
- At what cost?
- For whom?
- To what end?

- What if we actually achieve what we set out to do?
  - How would the Law of Unintended Consequences apply here?
  - Would this negate the entire “IPv6 is the solution” philosophy?

So what can we do?

What could be useful right now

- Clear and coherent information about the situation and current choices
- Appreciation of our limitations and strengths as a global deregulated industry attempting to preserve a single coherent networked outcome
- Understanding of the larger audience and the broader context in which these processes are playing out
- Some pragmatic workable approaches that allow a suitable degree of choice for players
- Understanding that some transitions are not ‘natural’ for a deregulated industry. Some painful transitions were only undertaken in response to regulatory fiat

What should we preserve?

- The functionality and integrity of the Internet as a service platform
  - Functionality of applications
  - Viability of routing
  - Capability to sustain continued growth
  - Integrity of the network infrastructure

If we can!

Implications

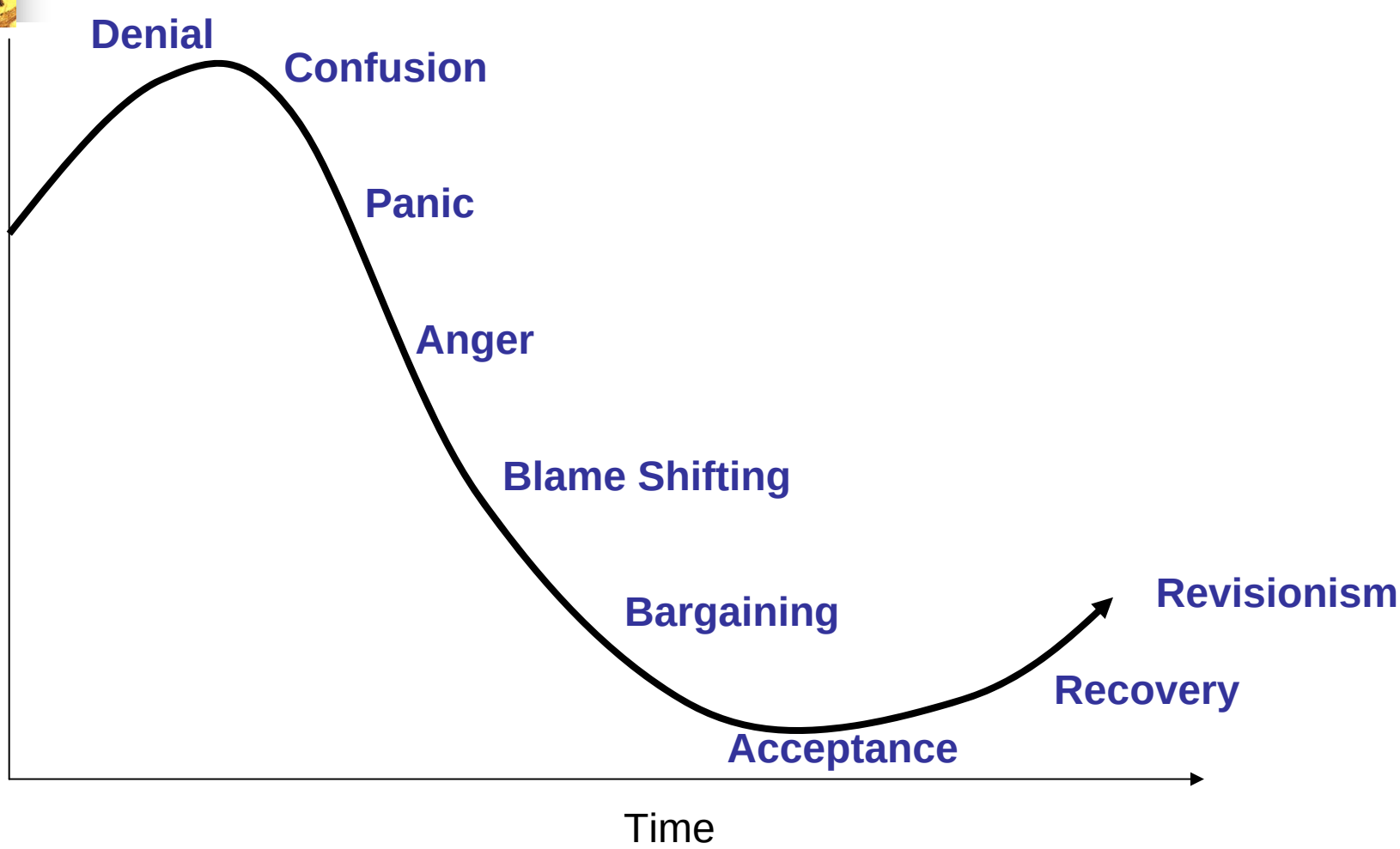
It is likely that there will be some disruptive aspects of this situation that will impact the entire industry

- the original transition plan is a business failure
- resolution of this failure is now going to be tough

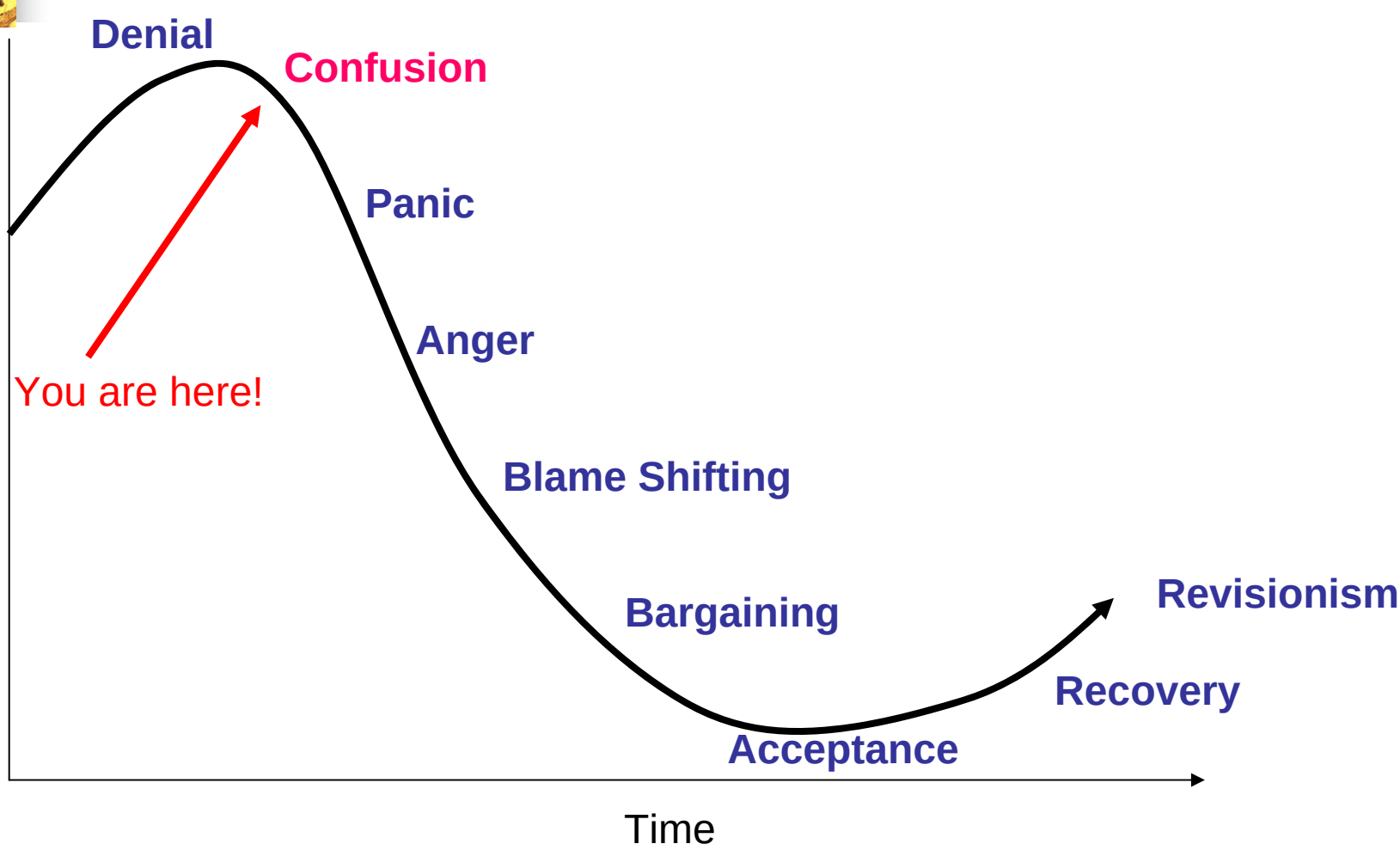
This will probably not be seamless nor costless

And will probably involve various forms of regulatory intervention, no matter what direction we might take from here

Coping with Crises



Coping with Crises



Thank You


STOP
ALL DRIVERS
WAIT HERE
FOR INSTRUCTIONS