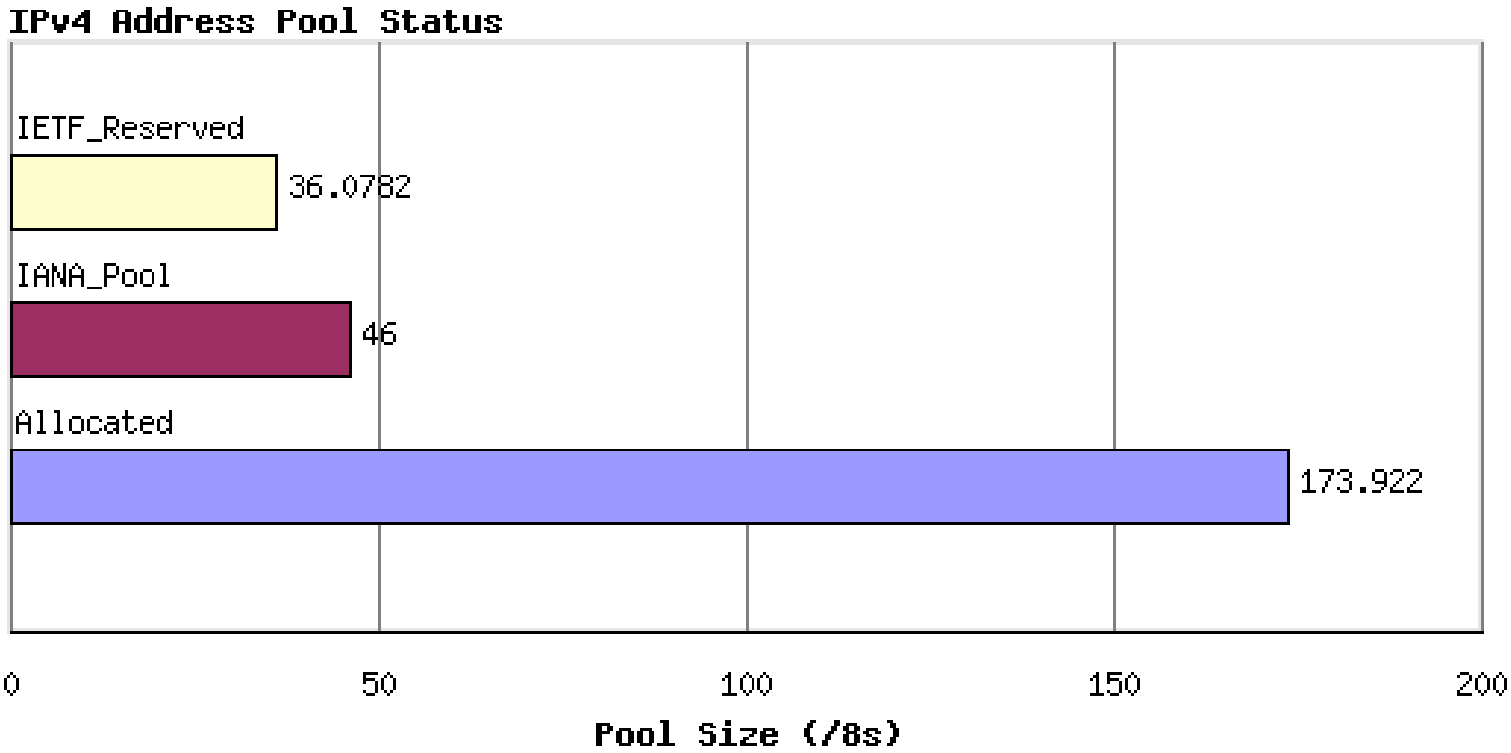

Religion,
Politics and the End of the World
IPV4

IPv4 Unallocated Address Space Exhaustion

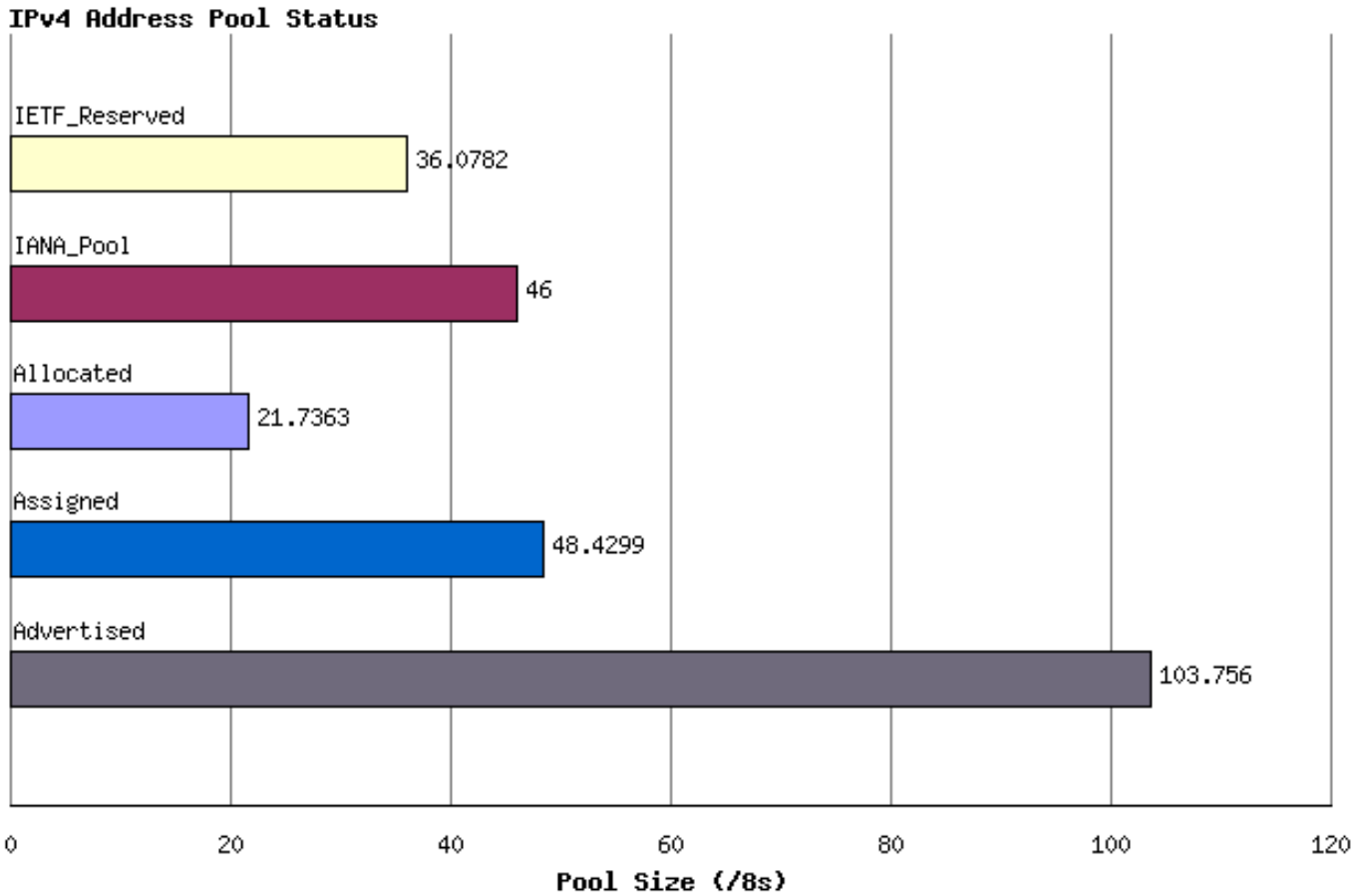
Geoff Huston
Chief Scientist
APNIC

APNIC 24, September 2007

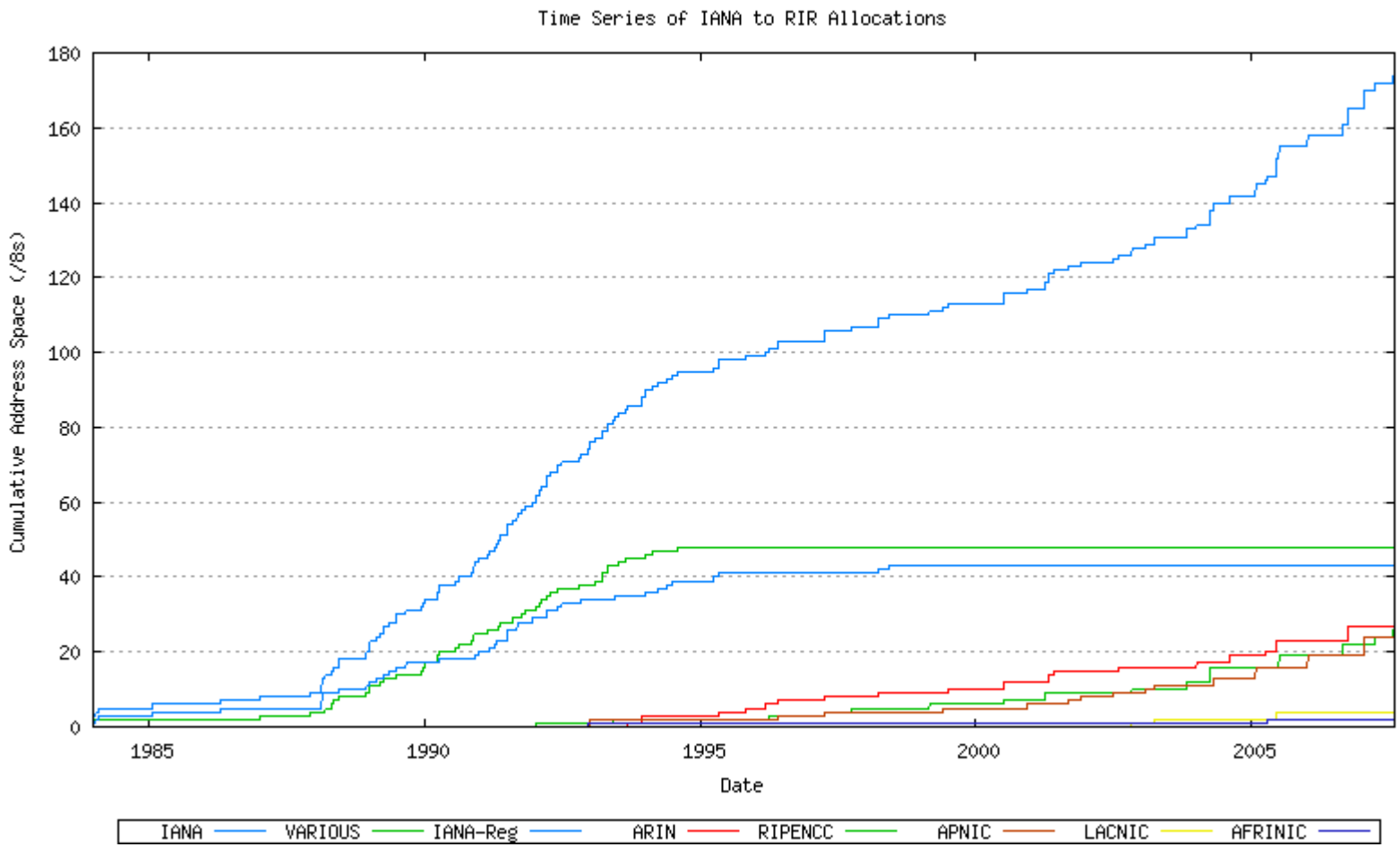
Current Status



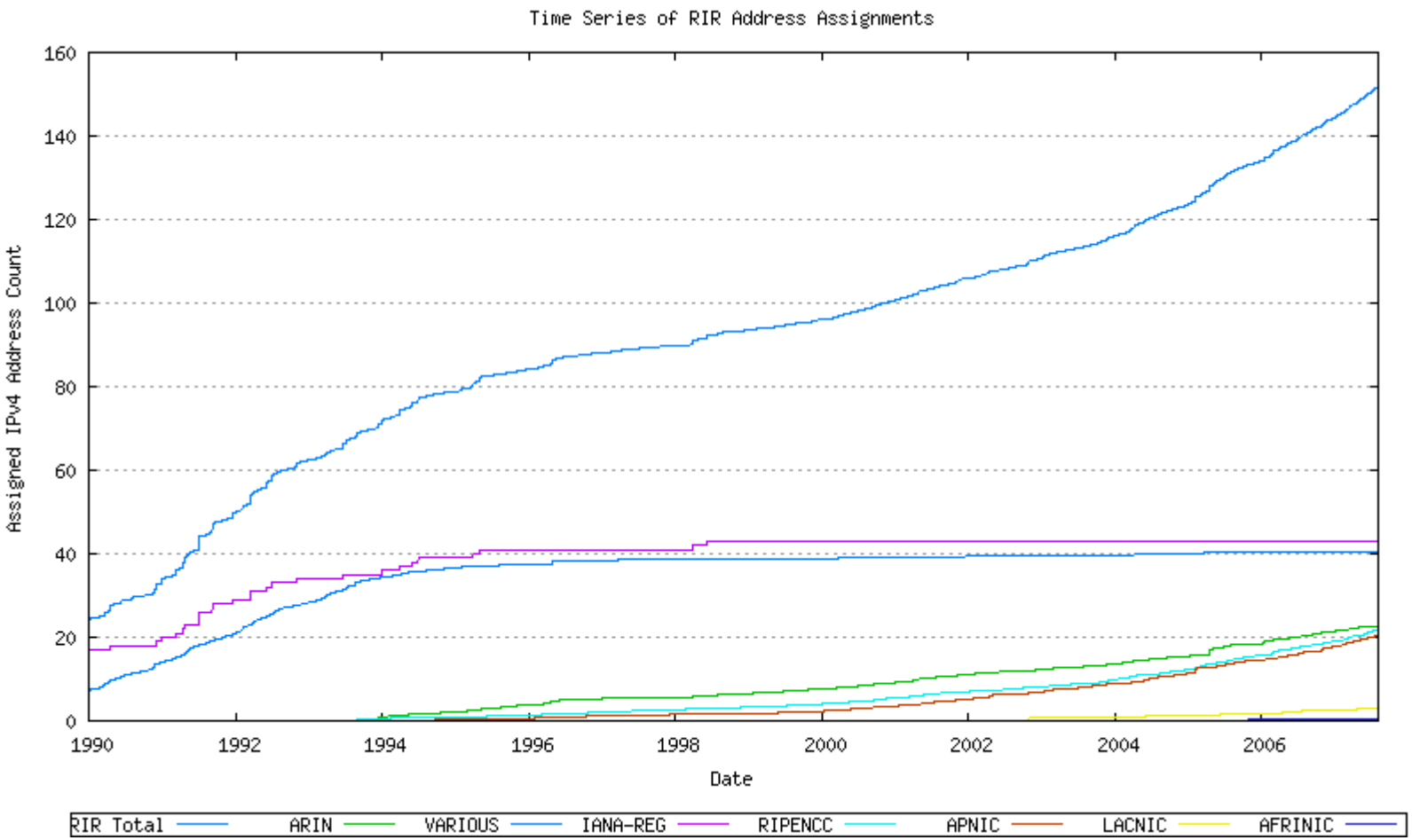
Current Status



IANA to RIRs

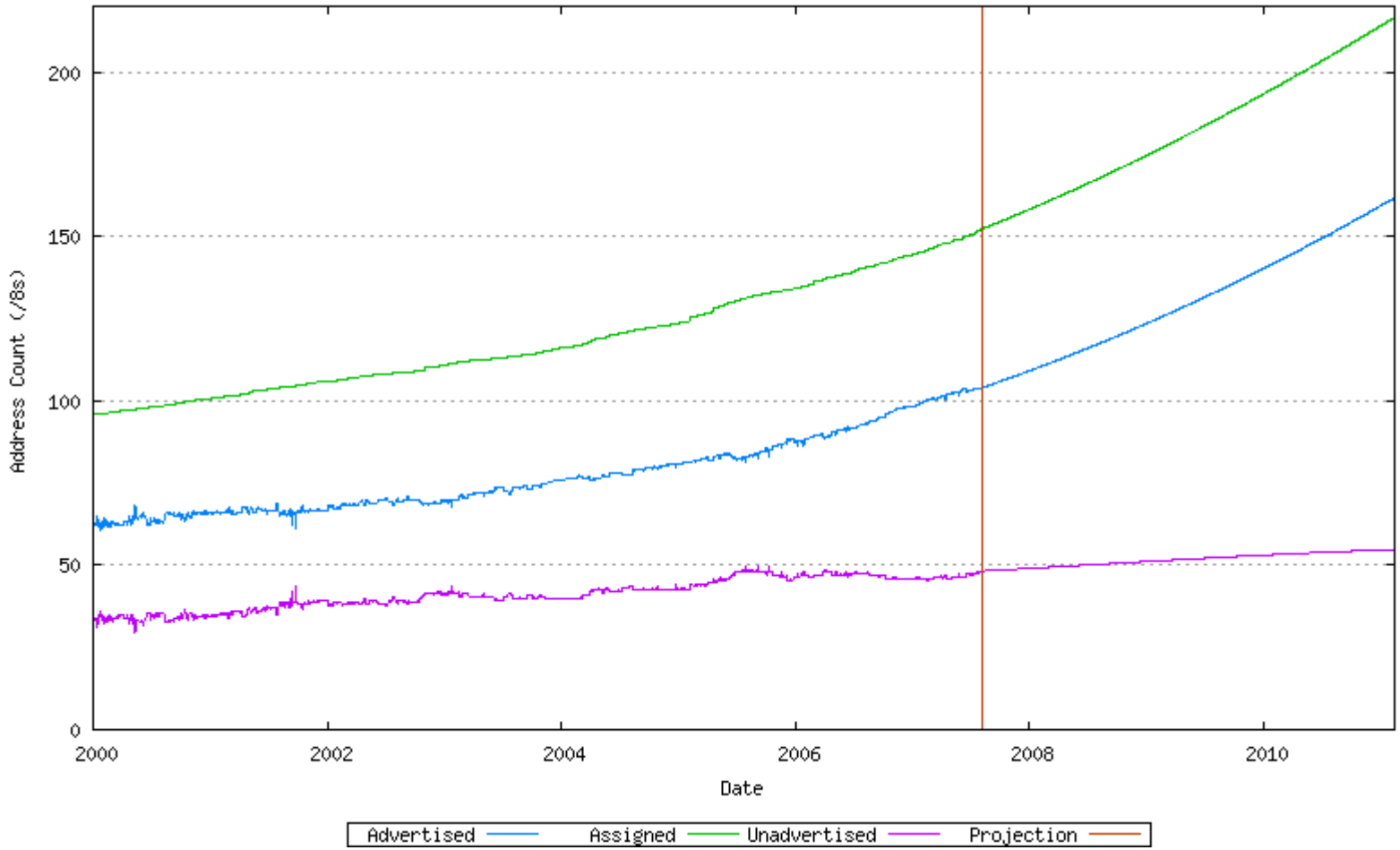

Time Series of IANA to RIR Allocations
Cumulative Address Space (/8s)
180
160
140
120
100
80
60
40
20
0
1985
1990
1995
2000
2005
Date
IANA
VARIOUS
IANA-Reg
ARIN
RIPENCC
APNIC
LACNIC
AFRINIC

RIR Allocations & Assignments

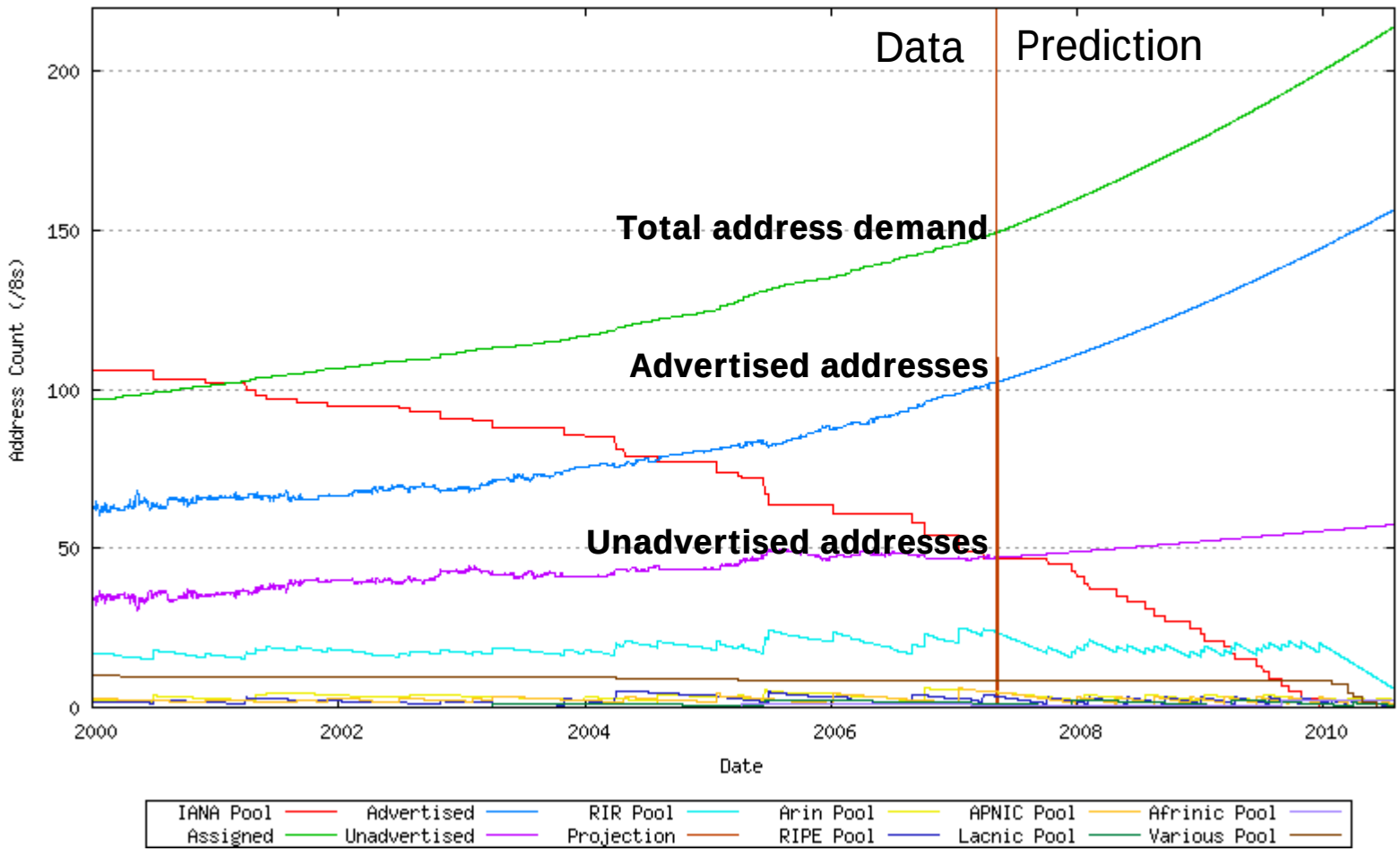


Advertised and Unadvertised Addresses

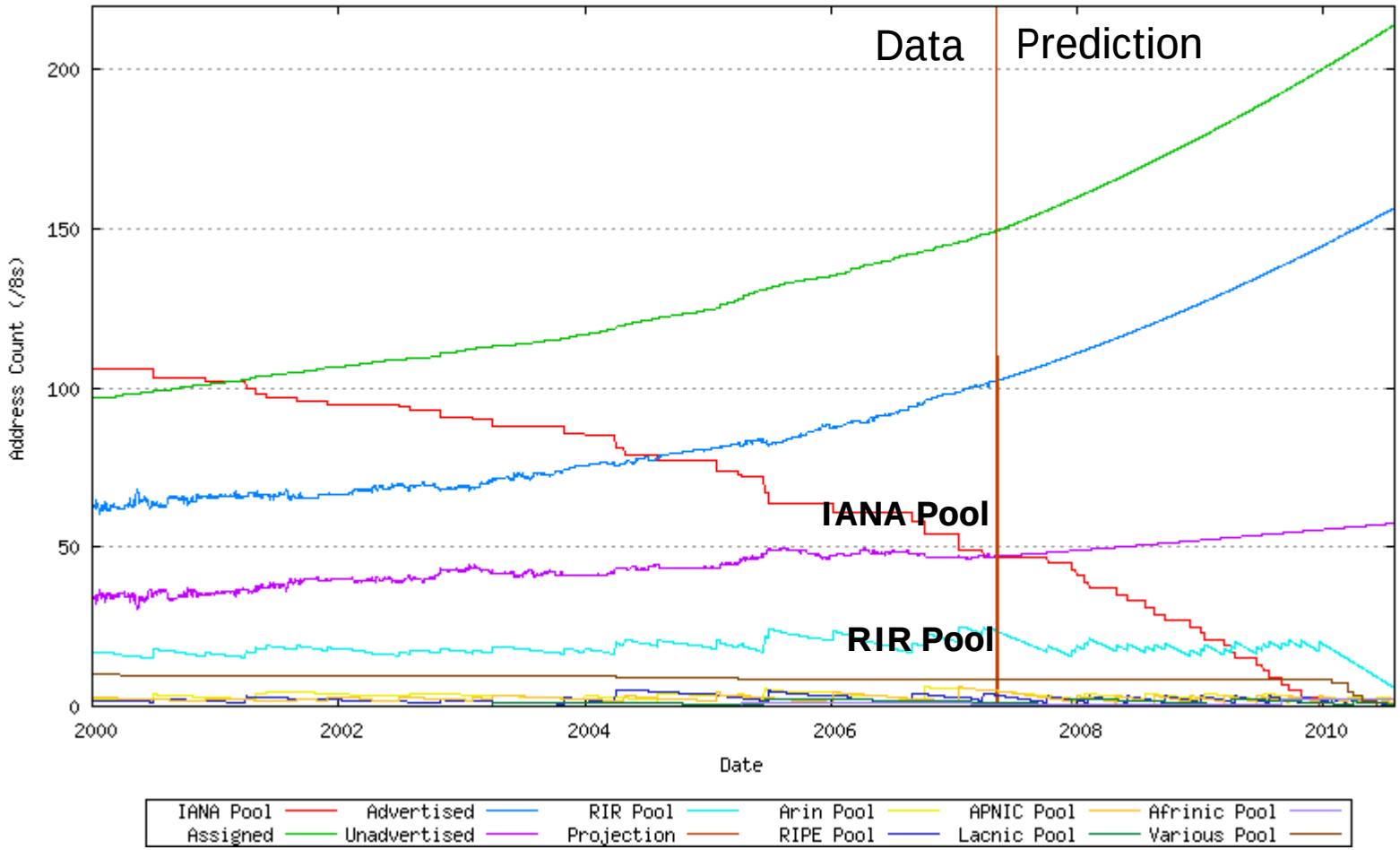
Predictive Model



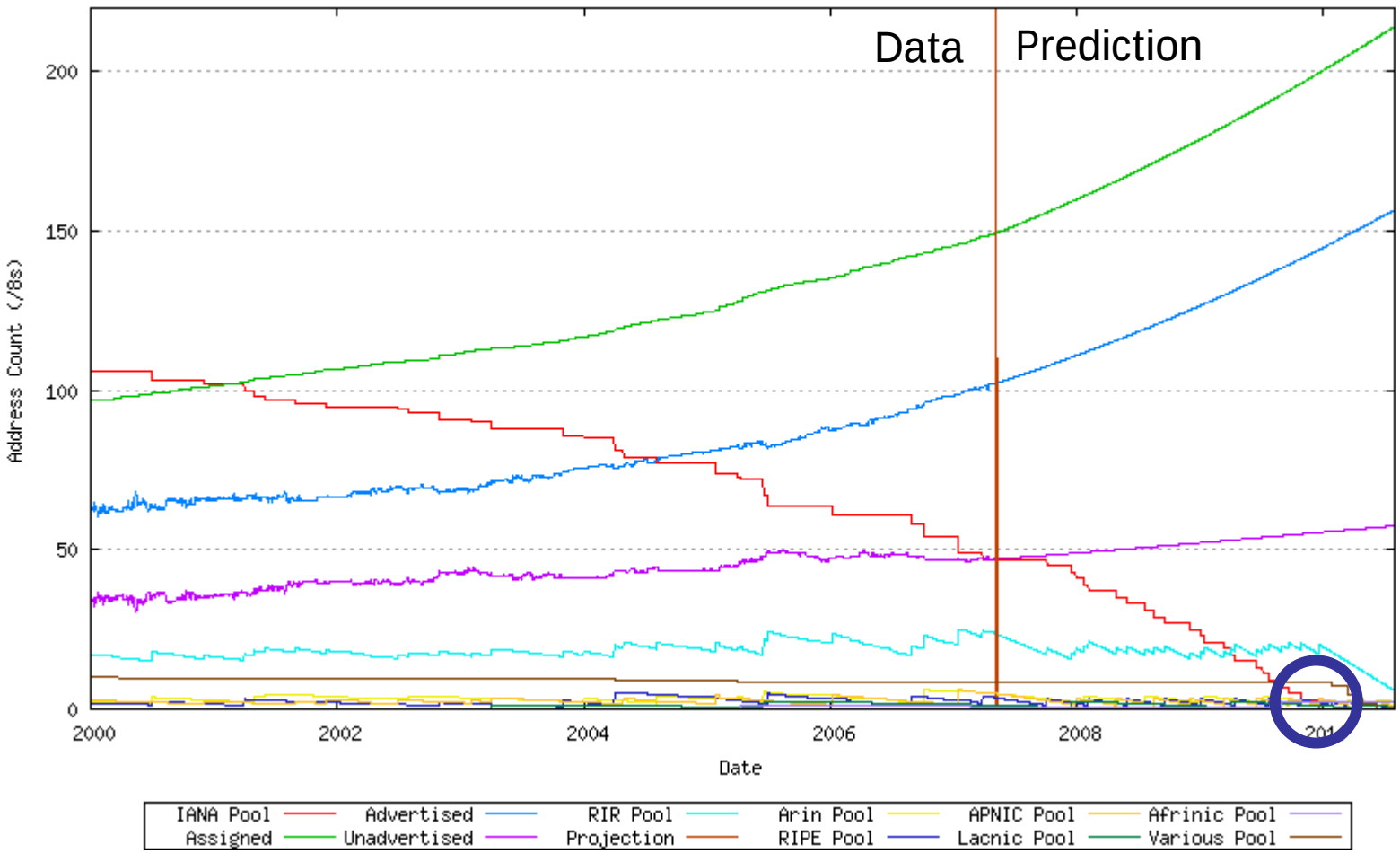
The IPv4 Consumption Model



The IPv4 Consumption Model



The IPv4 Consumption Model



So what?

In this model, IANA allocates its last IPv4 /8 to an RIR on the 22nd April 2010

This is the model's predicted exhaustion date as of the 6th August 2007. Tomorrow's prediction may be different!

IPv4 Consumption 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!

What then?

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

The IPv4 NAT Option

- Today NATS are largely externalized
  - Customers buy and operate NATS
  - Applications are tuned to single-level NAT traversal
- Demand for increasing NAT “intensity”
  - 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

NATs Futures

- NATs represent just more of the same
  - NATs are already extensively deployed today
  - More intense use of NATs does not alter the networks architecture
- Can NATs scale?
  - Not well known
  - What is the critical resource here?
    - Private address pools
    - NAT binding capacity
    - Application complexity

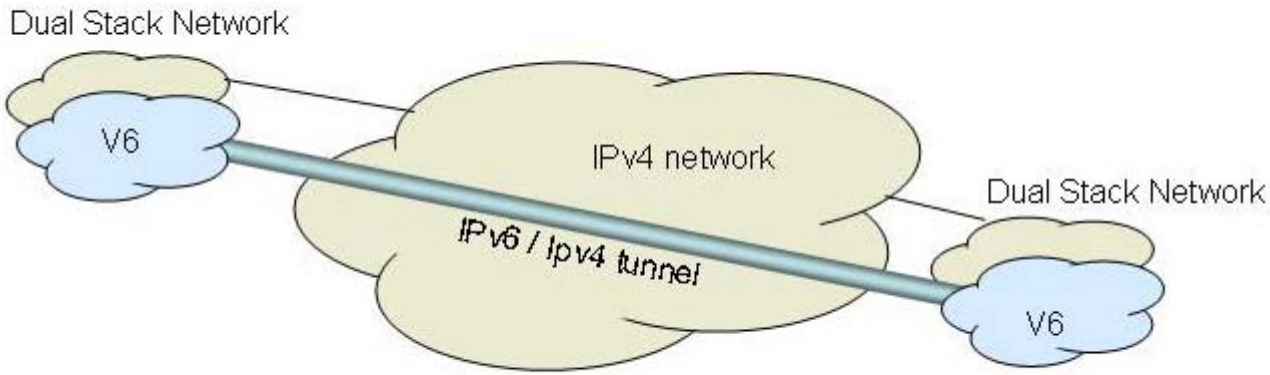
NAT Futures

- Do we need to go further?
  - Expand Private address pool via Class E space for private use
  - NAT + DNS ALG to allow bi-directional NAT behaviours
  - Explicit application access to NAT binding functions
- When does IPv6 get to look cheaper?

We had another plan...

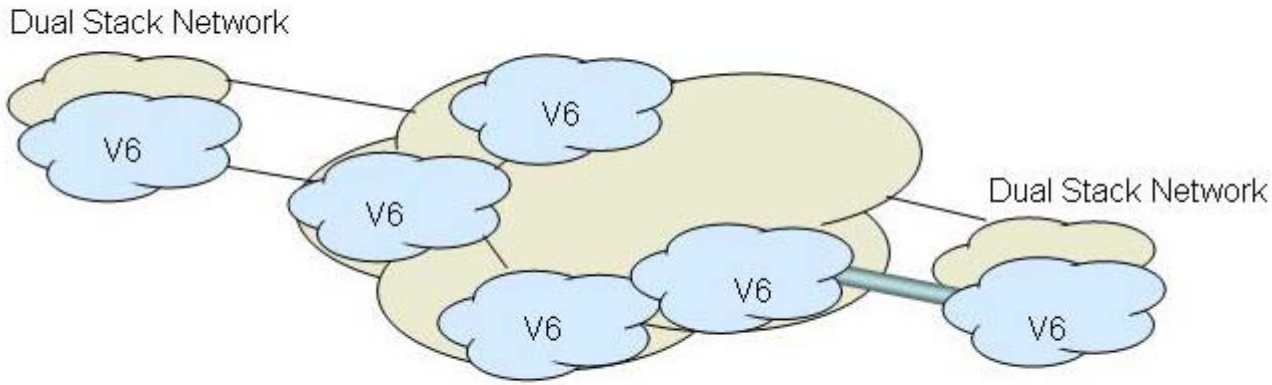
- Transition to IPv6
  - But IPv6 is not backward compatible with IPv4
  - So the proposal was to run a “dual stack” transition process

Dual Stack Transition to IPv6



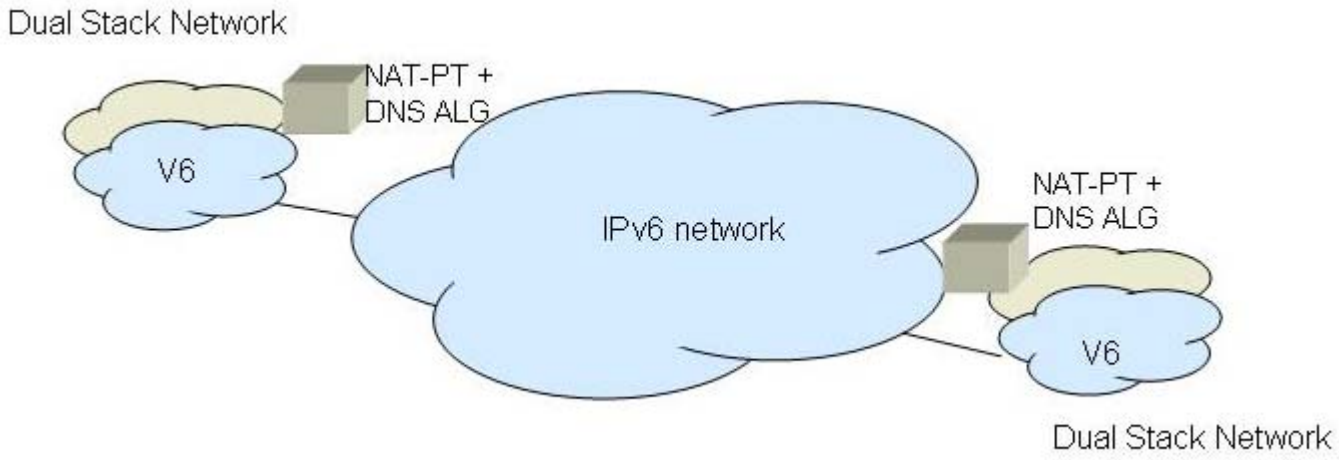
- "Initial" Dual Stack deployment:
  - *Dual stack* networks with V6 / V4 connectivity
  - Dual Stack hosts attempt V6 connection, and use V4 as a fallback

Dual Stack Transition



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

Dual Stack Transition

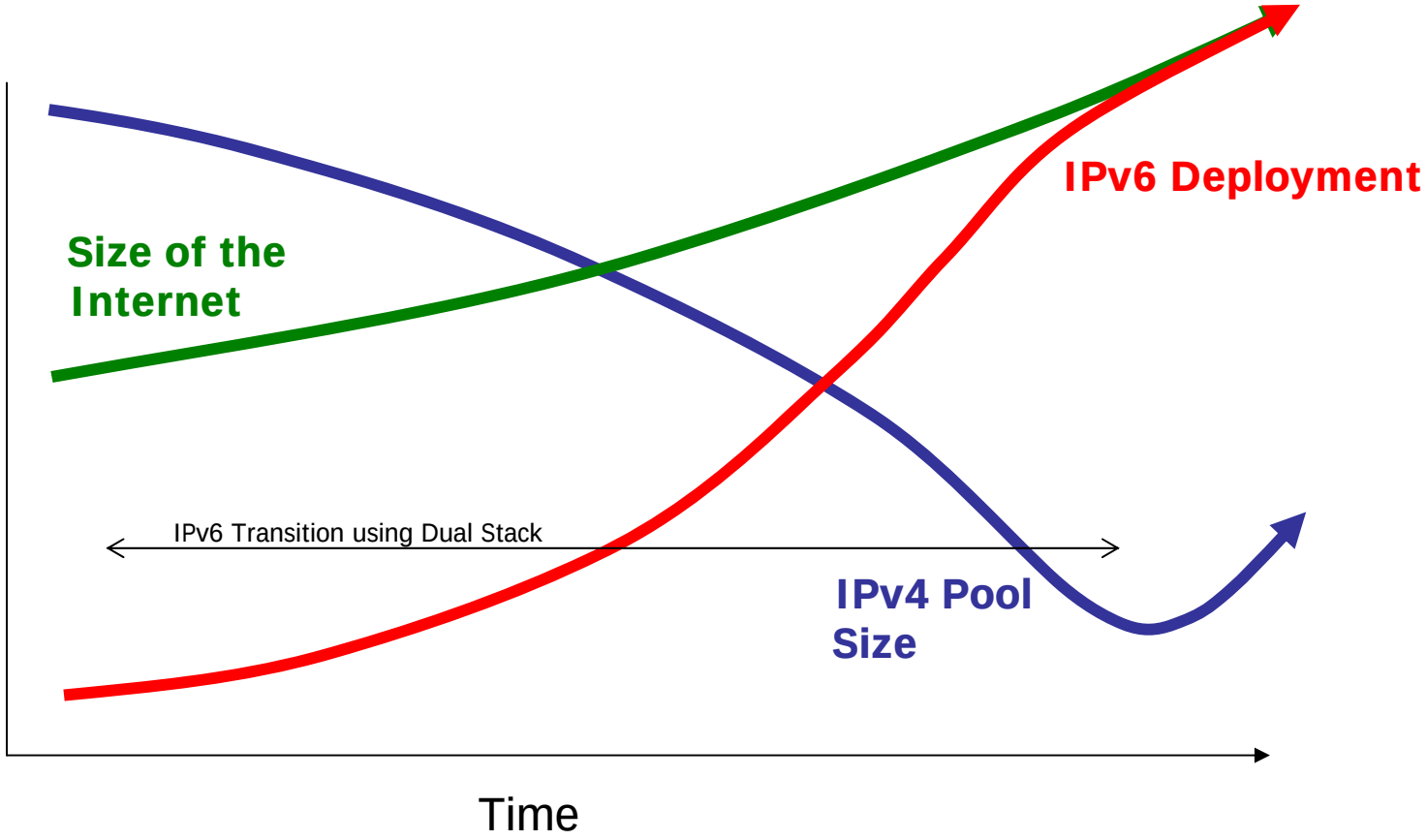


- "Completion"
  - V4 shutdown occurs in a number of networks
  - Connectivity with the residual V4 islands via DNS ALG + NAT-Protocol Translation

Dual Stack Assumptions

- That we could drive the entire transition to IPv6 while there were still ample IPv4 addresses to sustain the entire network and its growth
- Transition would take some years to complete
- Transition would be driven by individual local decisions to deploy dual stack support
- The *entire* transition would complete *before* the IPv4 unallocated pool was exhausted

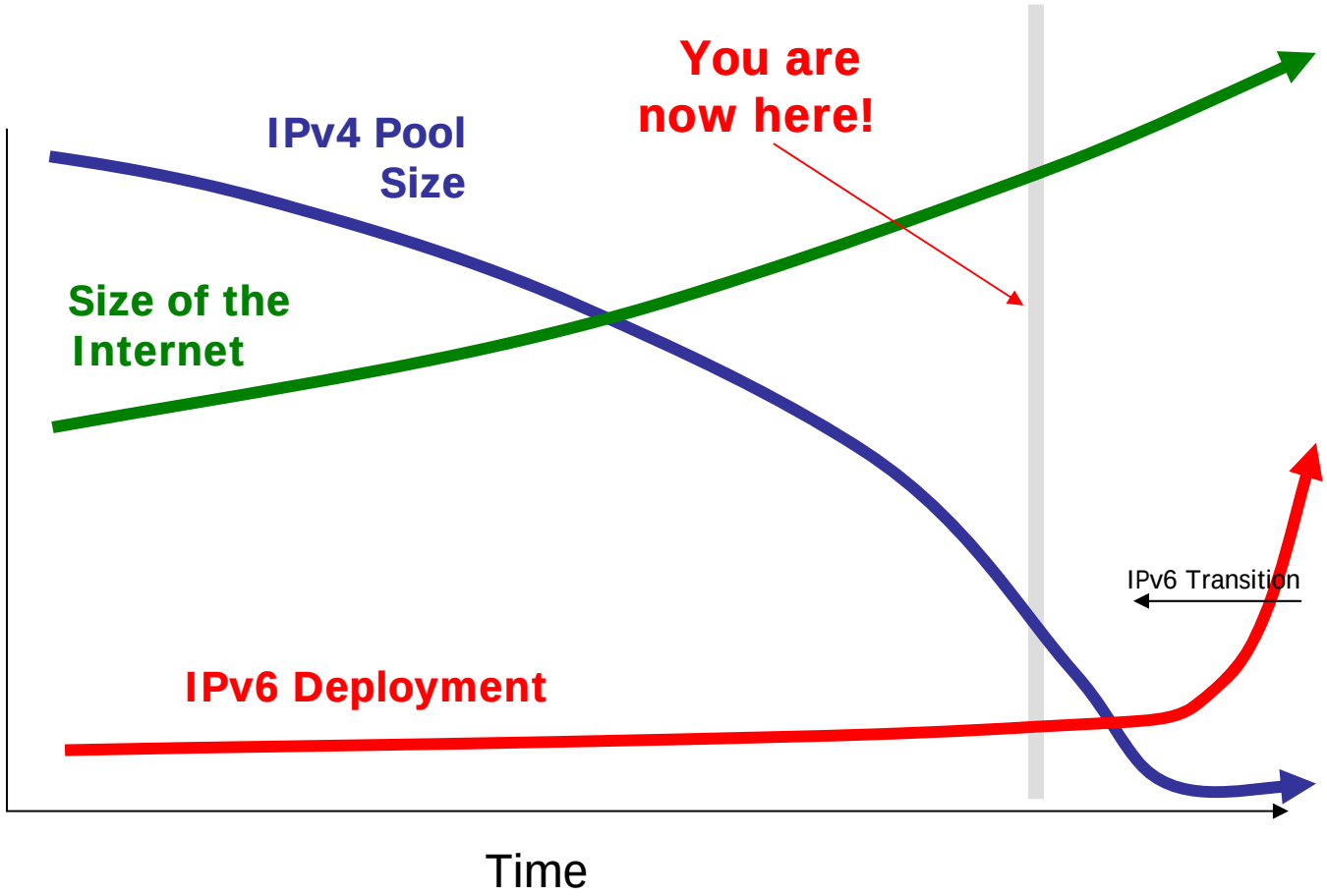
We had a plan ...


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?



Implications

- Whether its NATs OR transition to IPv6
  - IPv4 addresses will continue to be in demand beyond the date of exhaustion of the unallocated pool
  - But the mechanisms of management of the address distribution and registration function will necessarily change

Making IPv4 Last Longer

- Some ideas so far:
  - Encourage NAT deployment
  - Larger Private Use Address Pool
  - Policies of rationing of remaining IPv4 space
  - Undertake efforts of IPv4 Reclamation
  - Deregulate Address Transfers
  - Support Address Markets
  - Speed up IPv6 Transition process

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

What's needed right now

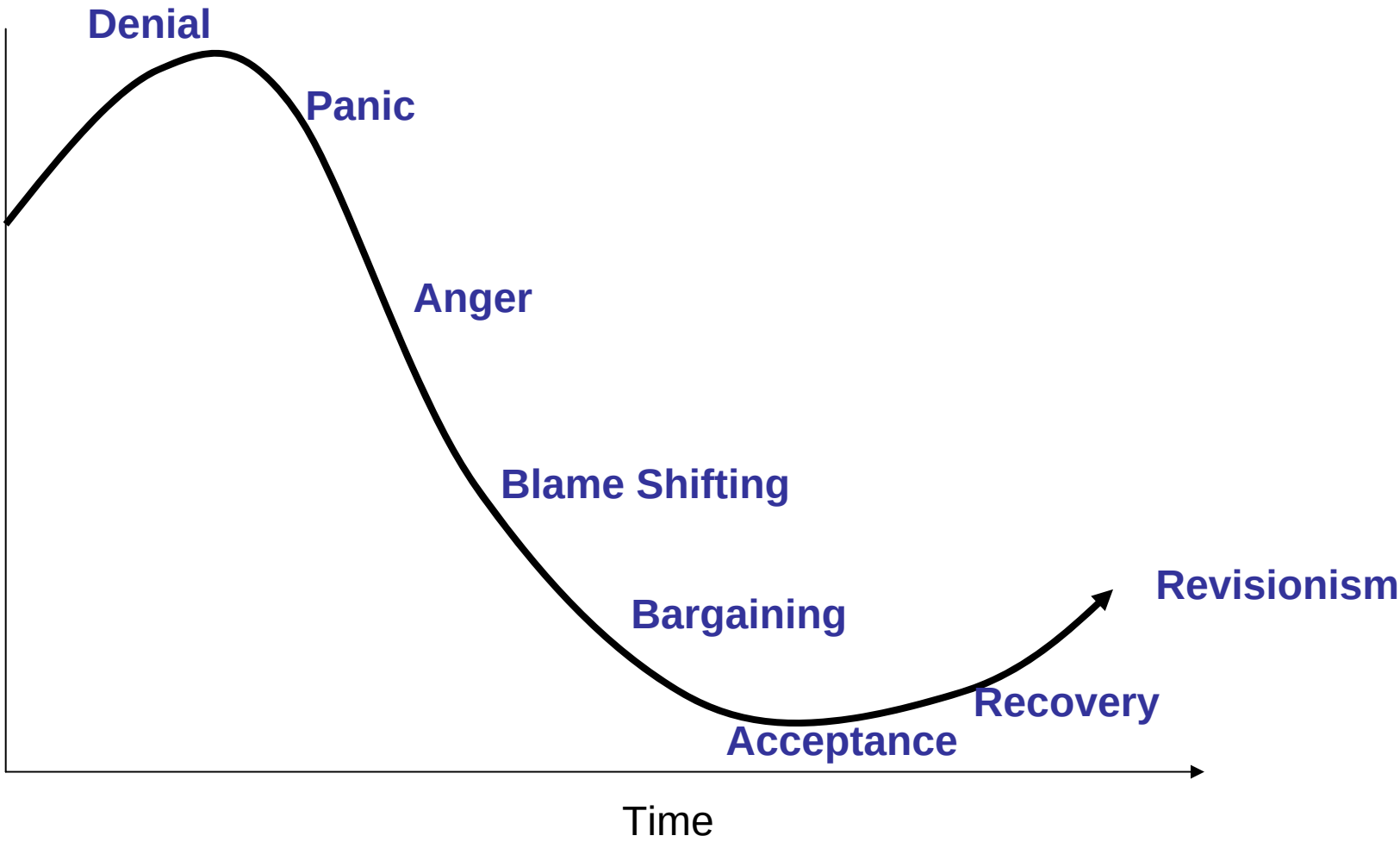
- Clear and coherent information about the situation and current choices
- Understanding of the implications of various options
- Appreciation of our limitations and strengths as a global deregulated industry supporting a single networked outcome
- A set of pragmatic workable approaches that allow choices for players

Implications

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

This will probably not be seamless nor costless

Coping with Crises



Coping with Crises – IPv4 Exhaustion