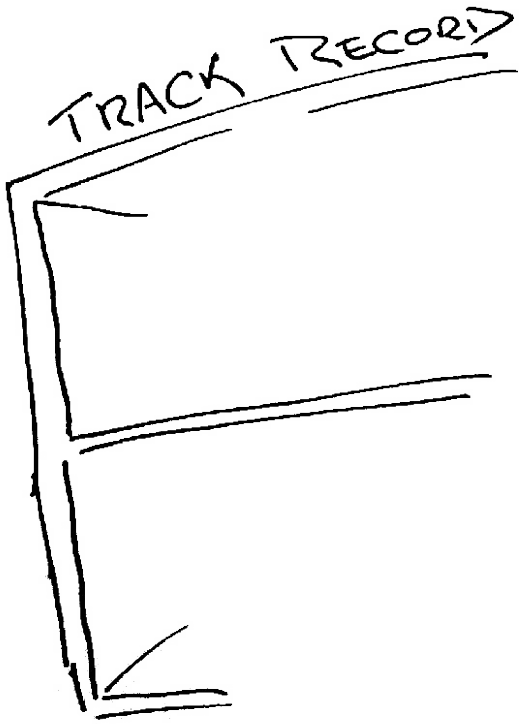
IPv4 Address Exhaustion: A Progress Report

Geoff Huston

Chief Scientist

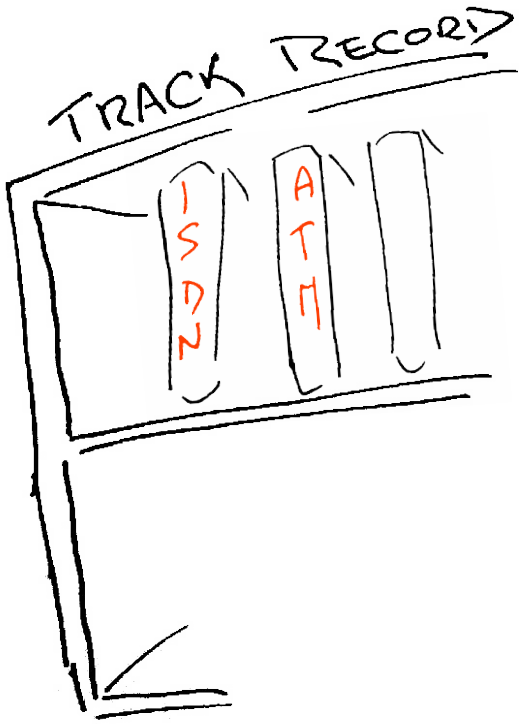
APNIC

The mainstream telecommunications industry has a rich history



The mainstream telecommunications industry has a rich history

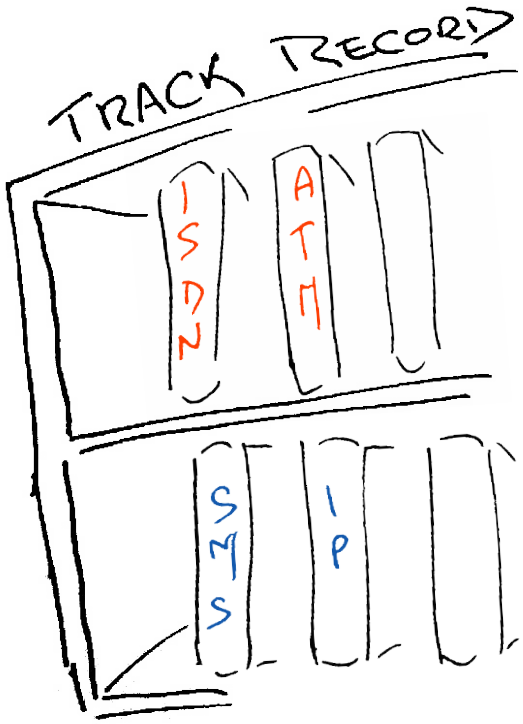
…of making very poor technology choices



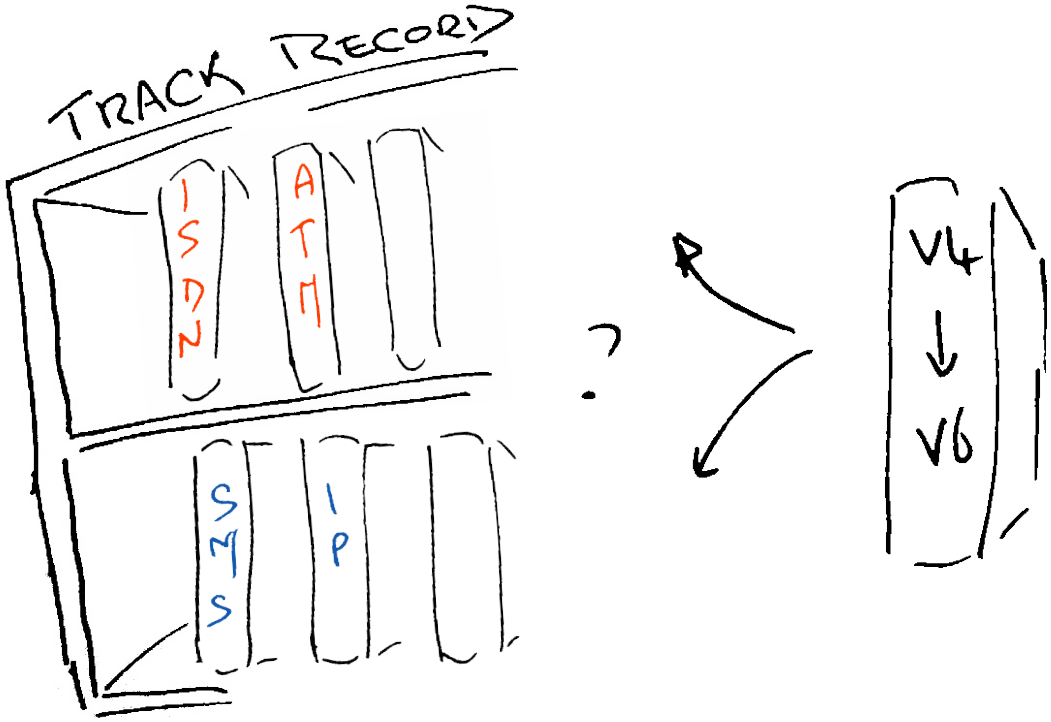
The mainstream telecommunications industry has a rich history

…of making very poor technology guesses

and regularly being taken by surprise!



So, how are we going with the IPv4 to IPv6 transition?



Do we really need to worry about this?

Do we really need to worry about this?

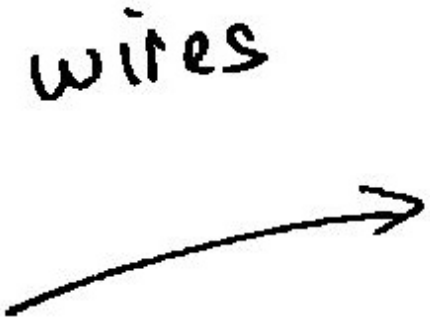
Surely IPv6 will just happen – its just a matter of waiting for the pressure of IpV4 address exhaustion to get to sufficient levels of intensity.

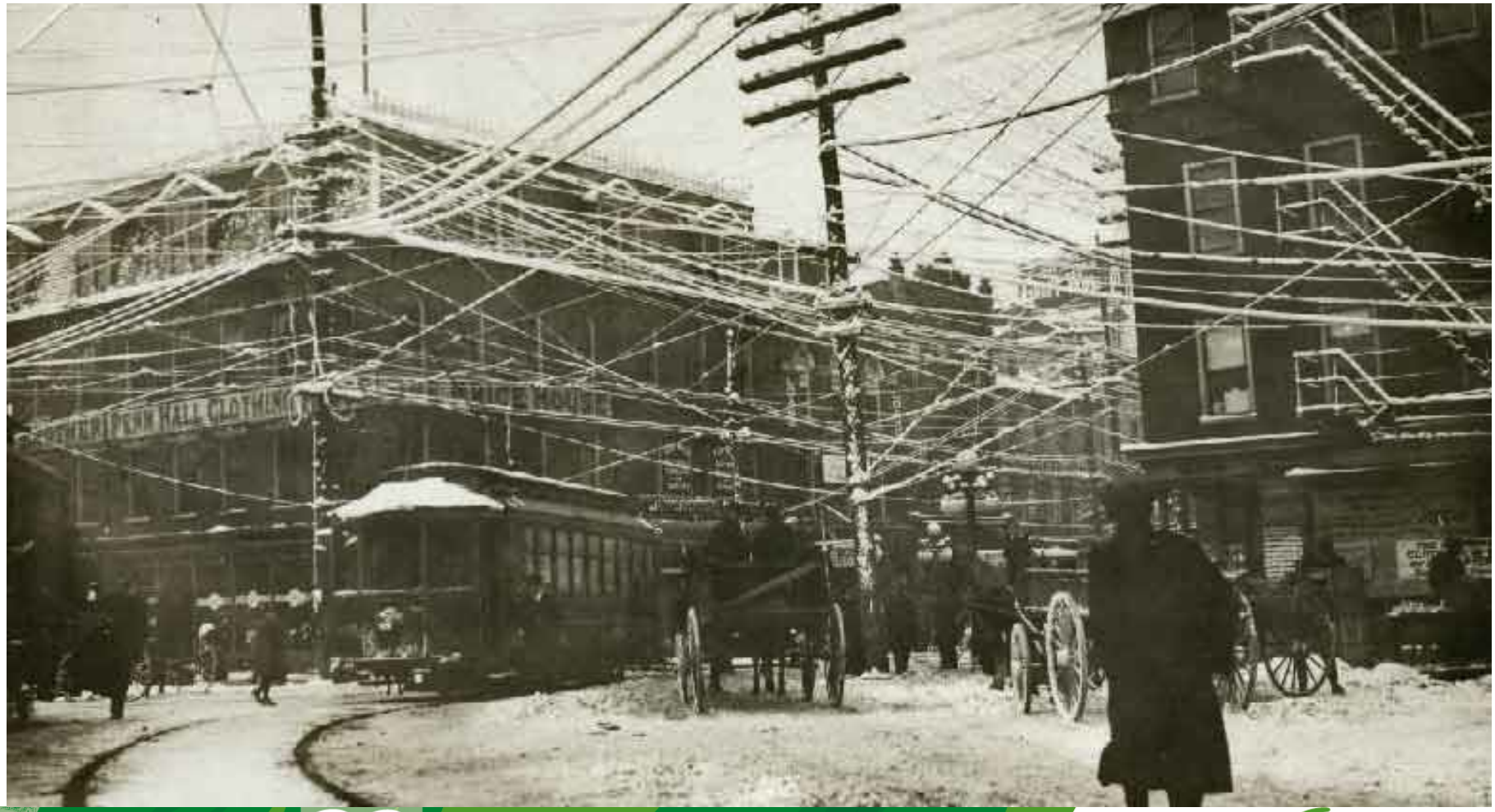
Do we really need to worry about this?

Surely IPv6 will just happen – its just a matter of waiting for the pressure of IpV4 address exhaustion to get to sufficient levels of intensity.

Or maybe not – let's look a bit closer at the situation

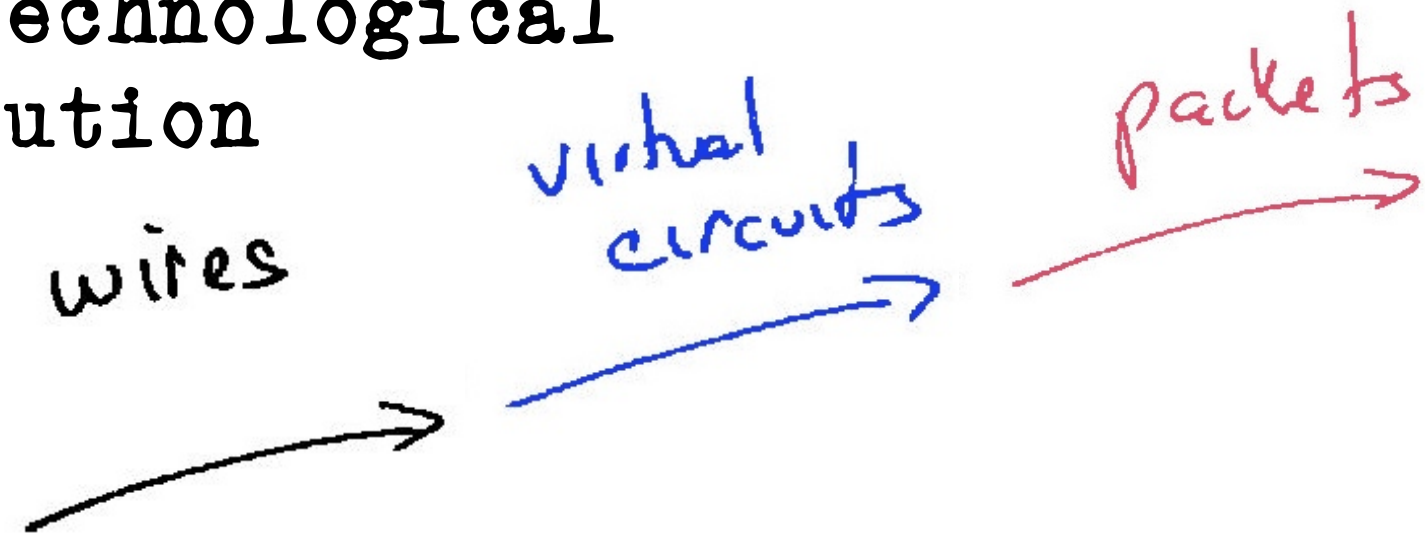
The "inevitability" of technological evolution



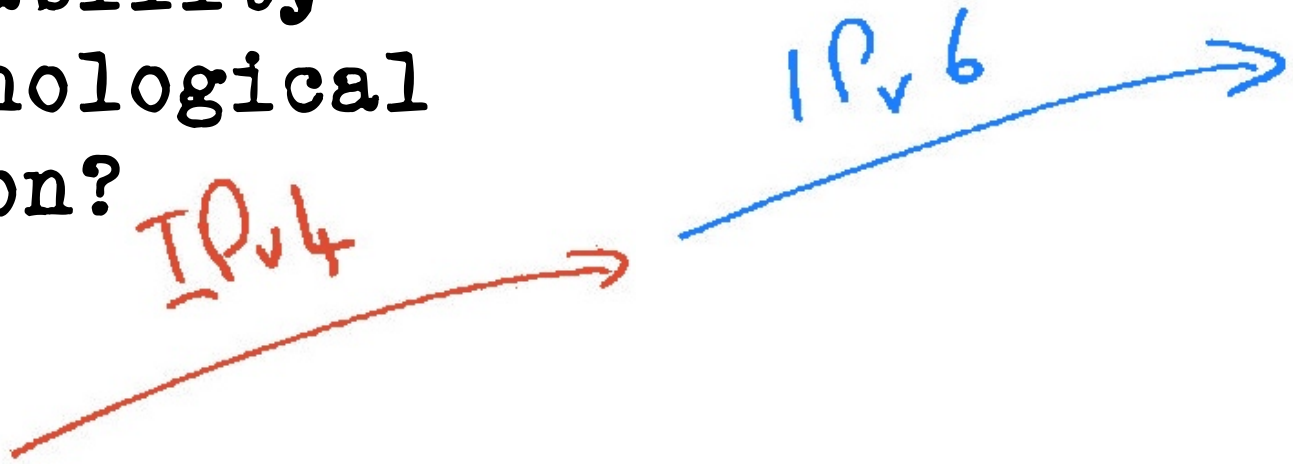


The
"inevitability"
of technological
evolution

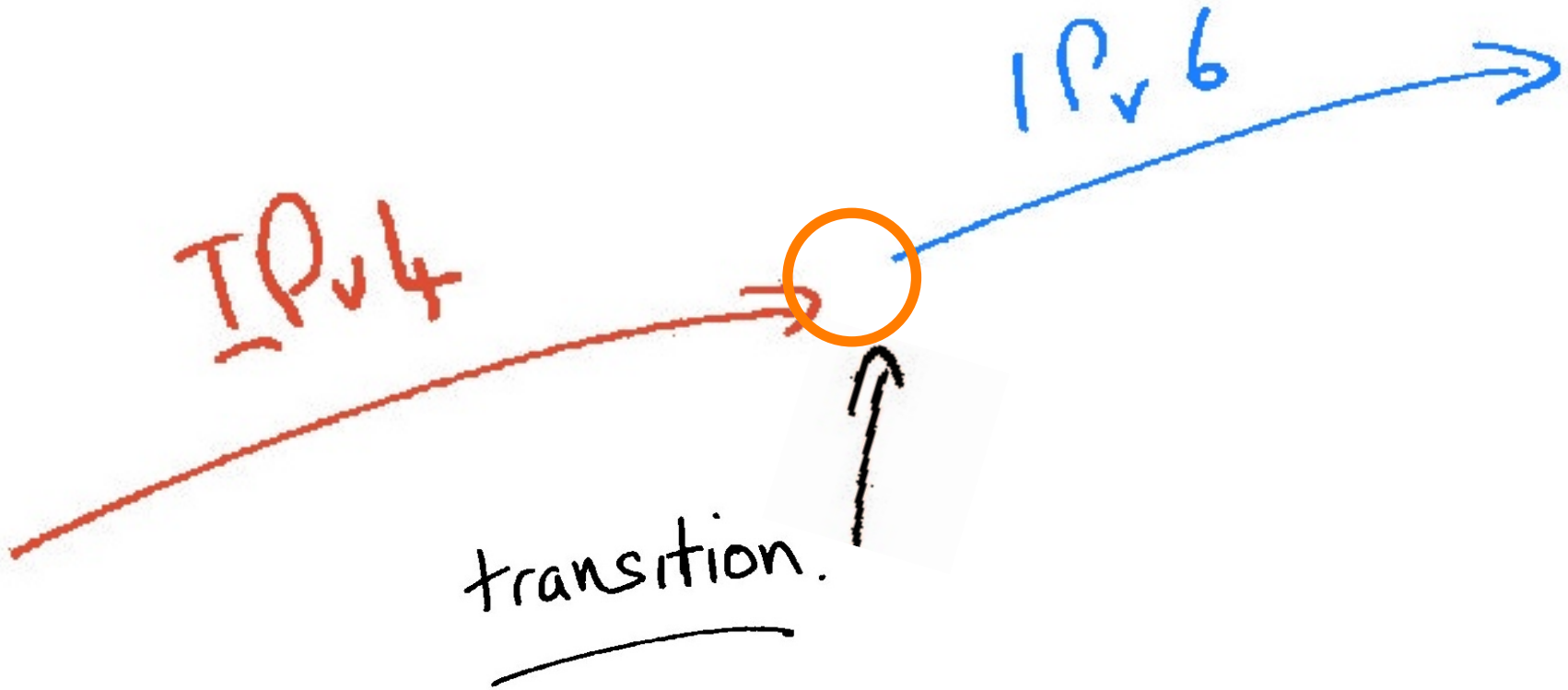
The
"inevitability"
of technological
evolution



The "inevitability" of technological evolution?

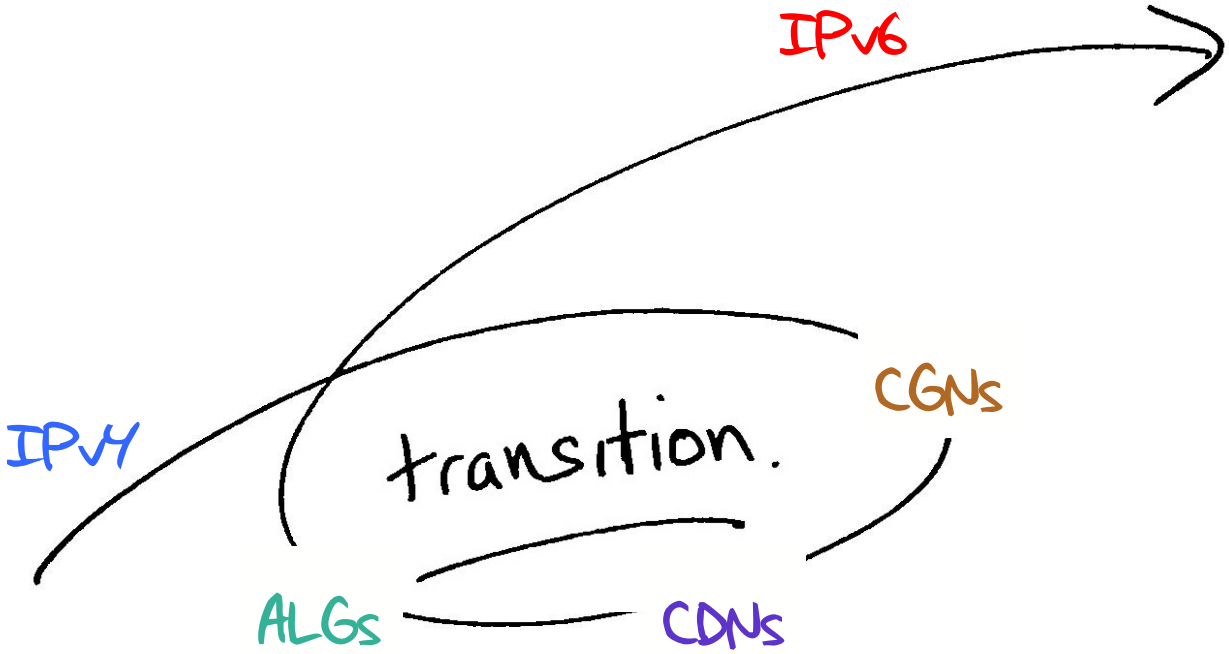


The challenge often lies in managing the transition from one technology to another



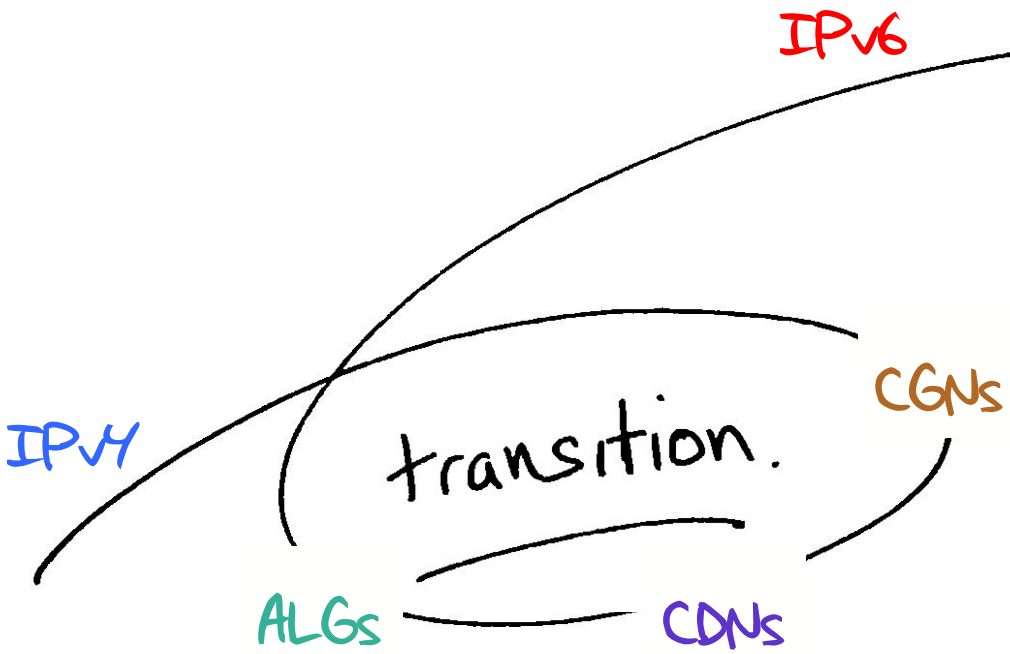
The challenge often lies in managing the transition from one technology to another

To get from "here" to "there" requires an excursion through an environment of CGNs, CDNs, ALGs and similar middleware 'solutions' to IPv4 address exhaustion



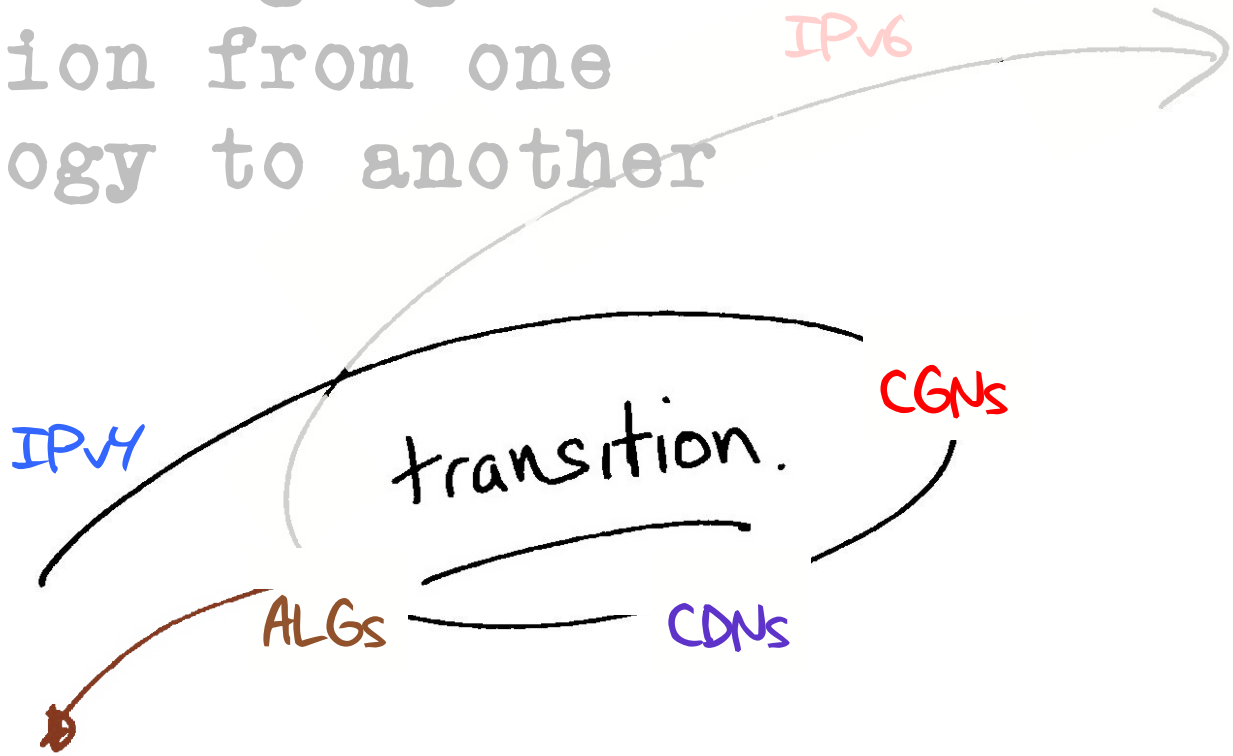
The challenge often lies in managing the transition from one technology to another

To get from "here" to "there" requires an excursion through an environment of CGNs, CDNs, ALGs and similar middleware 'solutions' to IPv4 address exhaustion



Transition requires the network owner to undertake capital investment in network service infrastructure. What lengths will the network owner then go to to protect the value of this additional investment by locking itself into this "transitional" service model for an extended/indefinite period?

The challenge often lies in managing the transition from one technology to another



The risk in this transition phase is that the Internet heads off in a completely different direction!

How can we "manage" this transition?

How can we "manage" this transition?

To ensure that the industry maintains collective focus on IPv6 as the objective of this exercise!

How can we "manage" this transition?

To ensure that the industry maintains collective focus on IPv6 as the objective of this exercise!

And to ensure that we do not get distracted by attempting to optimize what were intended to be temporary measures

Challenges:

1. This is a deregulated and highly competitive environment

Challenges:

1. This is a deregulated and highly competitive environment

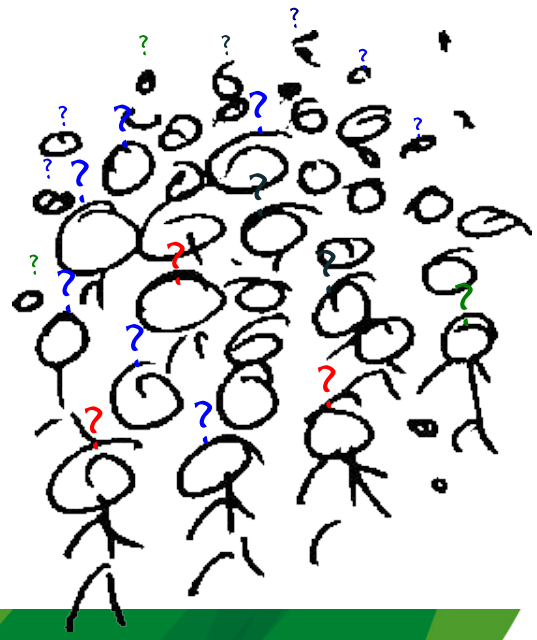
It is NOT a case of a single "either/or" decision

Challenges:

1. This is a deregulated and highly competitive environment

There are many different players

Each with their own perspective



Challenges:

1. This is a deregulated and highly competitive environment

There are many different players

Each with their own perspective

And all potential approaches will be explored!

Challenges:

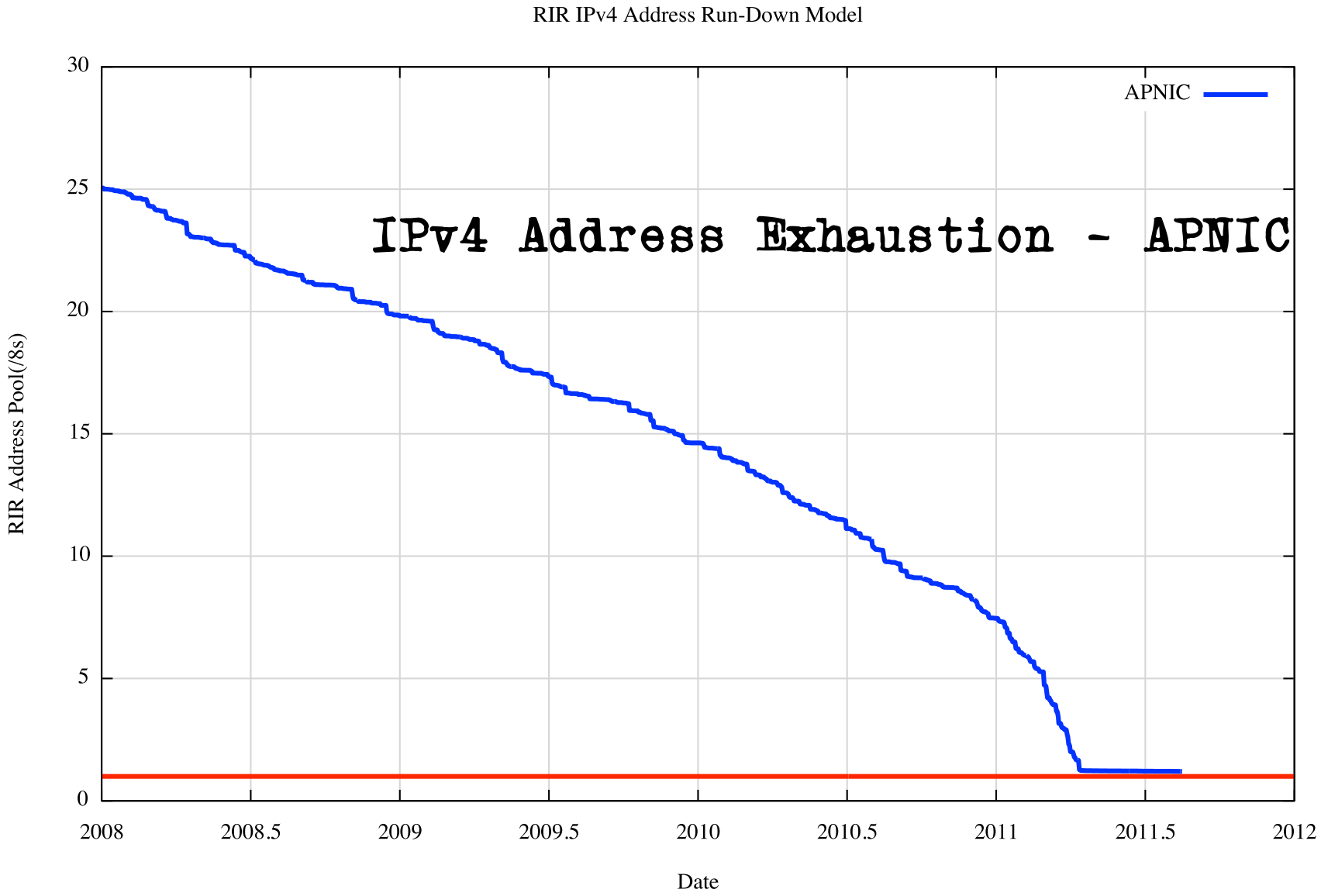
1. This is a deregulated and highly competitive environment

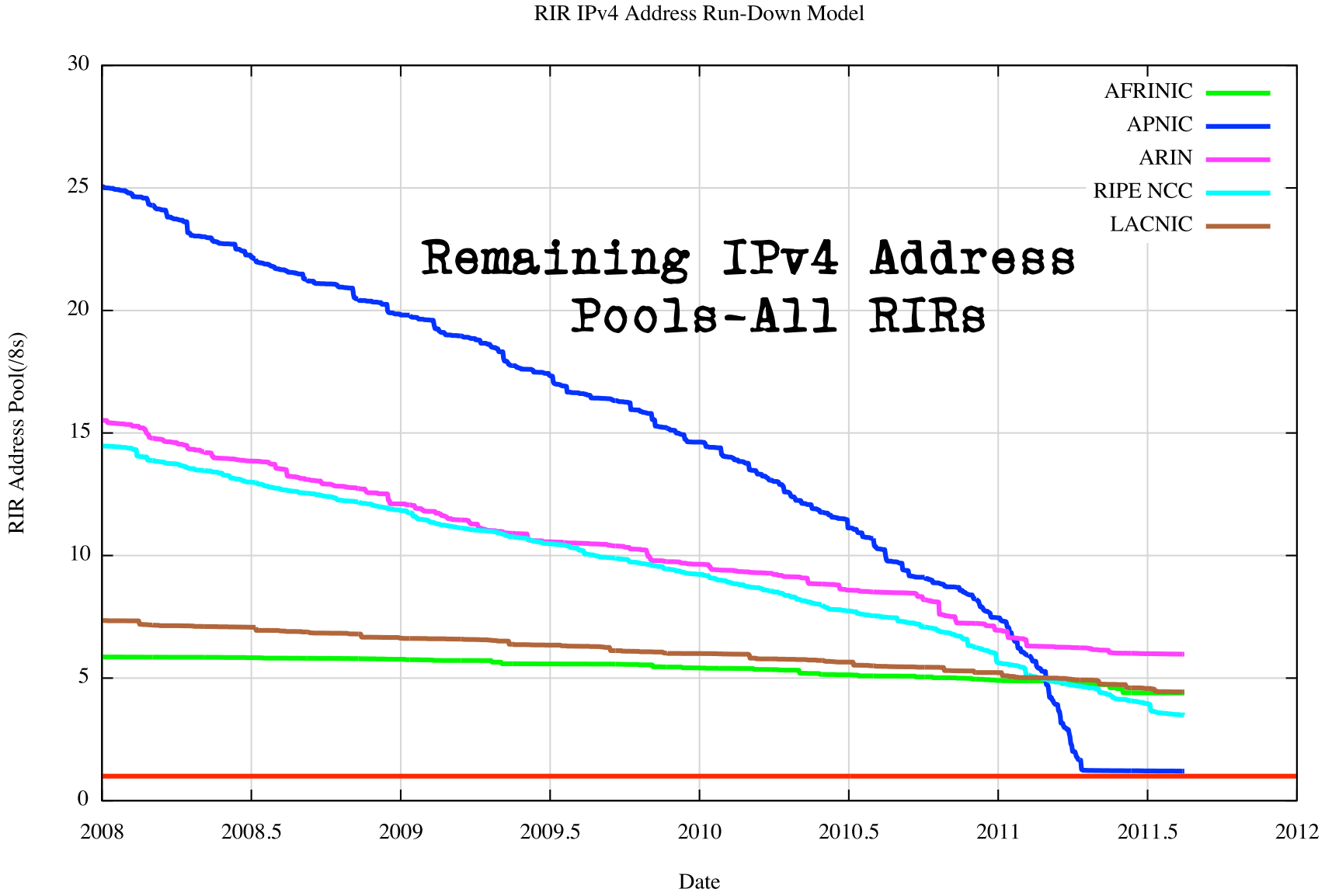
   There is no plan, just the interplay of various market pressures

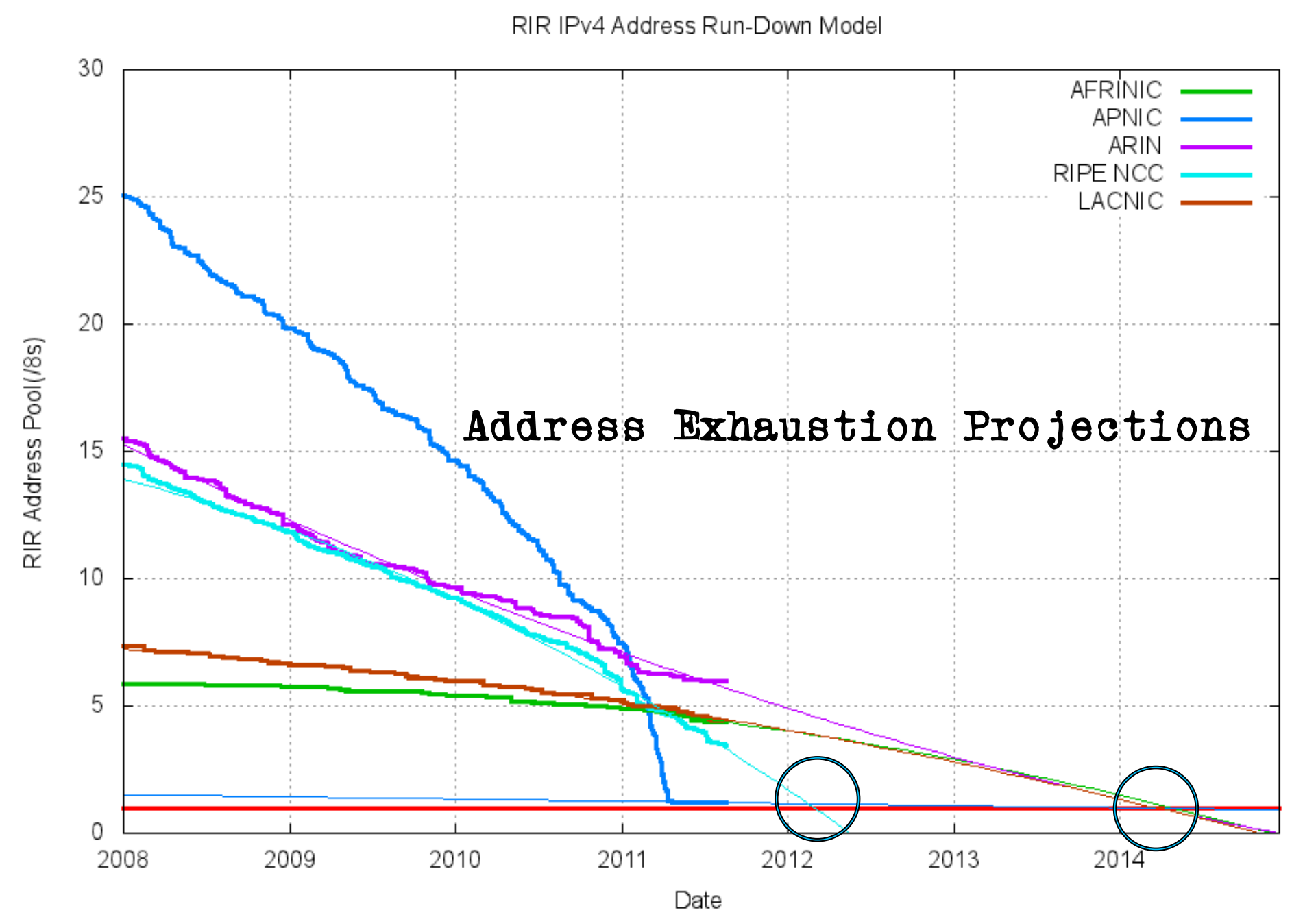
Challenges:

1. This is a deregulated and highly competitive environment
   There is no plan, just the interplay of various market pressures

2. Varying IPv4 Address Exhaustion Timelines


RIR IPv4 Address Run-Down Model
IPv4 Address Exhaustion - APNIC
APNIC
RIR Address Pool(/8s)
Date
30
25
20
15
10
5
0
2008
2008.5
2009
2009.5
2010
2010.5
2011
2011.5
2012

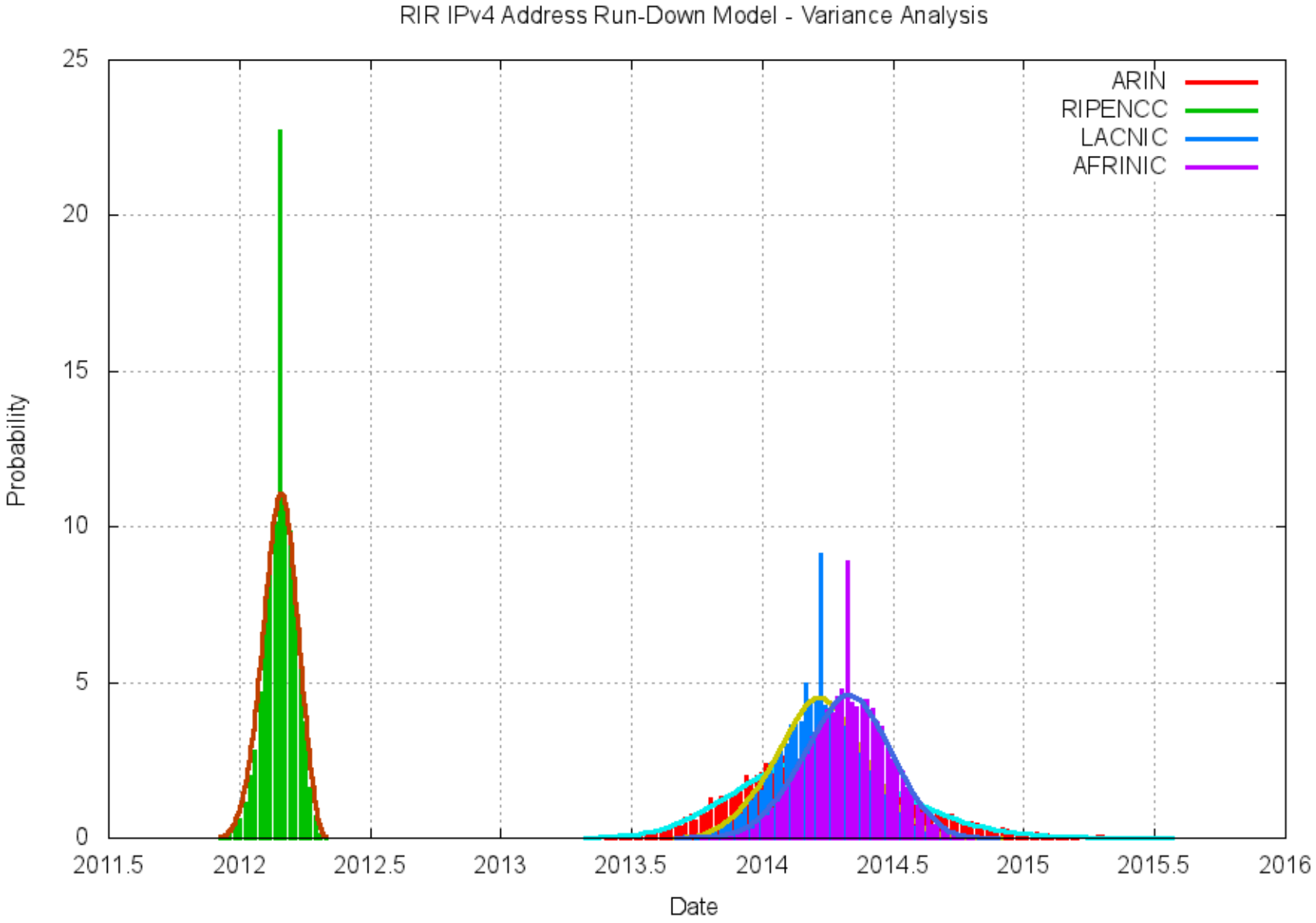

RIR IPv4 Address Run-Down Model
Remaining IPv4 Address Pools-All RIRs
AFRINIC
APNIC
ARIN
RIPE NCC
LACNIC
RIR Address Pool(/8s)
Date
0
5
10
15
20
25
30
2008
2008.5
2009
2009.5
2010
2010.5
2011
2011.5
2012

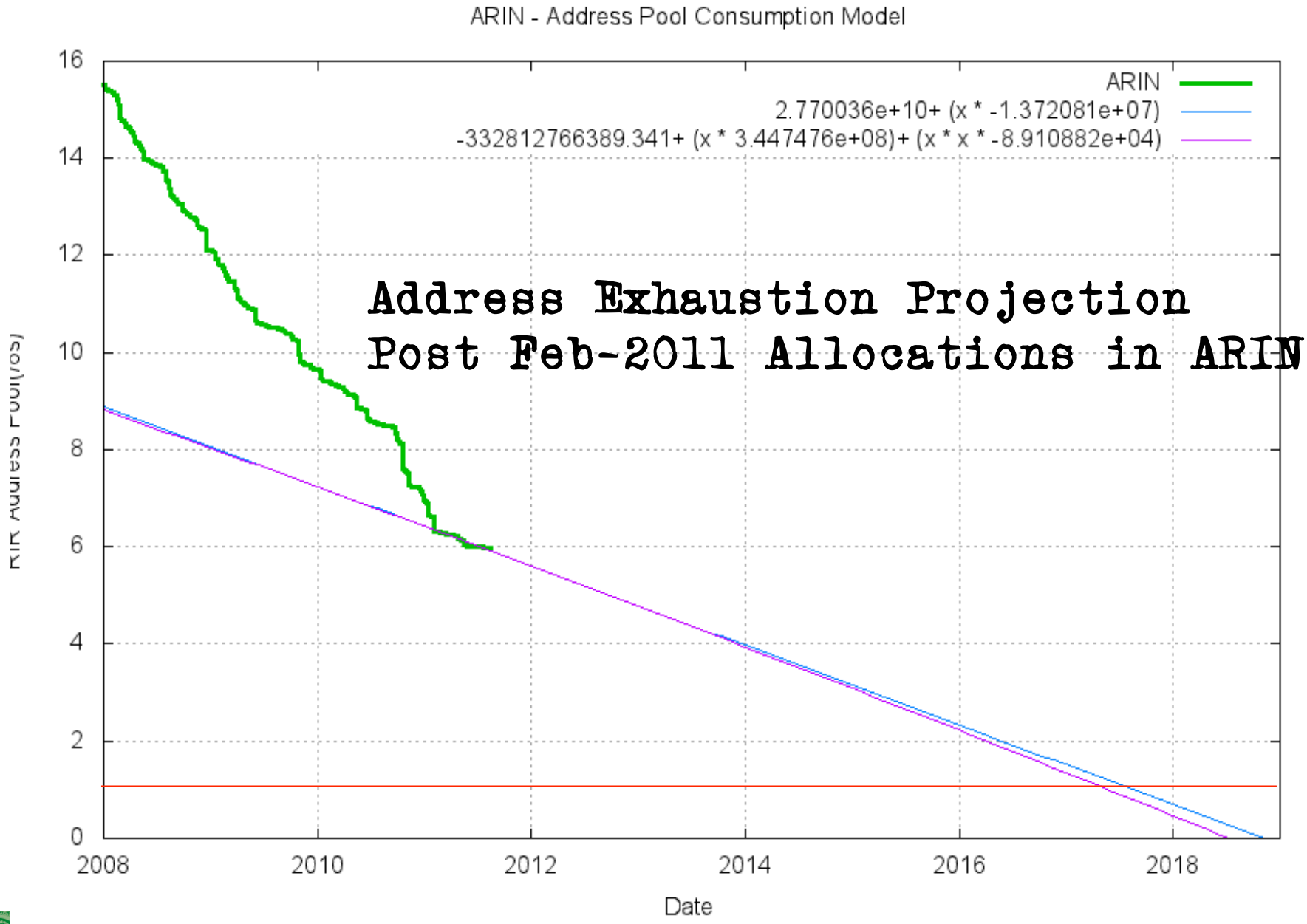

RIR IPv4 Address Run-Down Model
AFRINIC
APNIC
ARIN
RIPE NCC
LACNIC
Address Exhaustion Projections
RIR Address Pool(/8s)
Date
0
5
10
15
20
25
30
2008
2009
2010
2011
2012
2013
2014

Exhaustion Predictions

RIR	Predicted Exhaustion Date *	Remaining Address Pool (19 Aug 2011)
APNIC	19 April 2011 (actual)	1.20 /8s (0.3 /8s rsvd)
RIPE NCC	25 February 2012	3.47 /8s
LACNIC	22 March 2014	4.43 /8s
ARIN	23 March 2014	6.00 /8s
AFRINIC	28 April 2014	4.38 /8s

** Here "exhaustion" is defined as the point when the RIR's remaining pool falls to 1 /8*


RIR IPv4 Address Run-Down Model - Variance Analysis
ARIN
RIPENCC
LACNIC
AFRINIC
Probability
Date
0
5
10
15
20
25
2011.5
2012
2012.5
2013
2013.5
2014
2014.5
2015
2015.5
2016


ARIN - Address Pool Consumption Model
ARIN
2.770036e+10+ (x * -1.372081e+07)
-332812766389.341+ (x * 3.447476e+08)+ (x * x * -8.910882e+04)
Address Exhaustion Projection
Post Feb-2011 Allocations in ARIN
RIR Address Pool(/8s)
Date
0
2
4
6
8
10
12
14
16
2008
2010
2012
2014
2016
2018

Reality Acceptance

Reality Acceptance

Or not

Is IPv4 address exhaustion a "here and now" problem or a "imminent future" problem?

Reality Acceptance

Or not

Is IPv4 address exhaustion a "here and now" problem or a "imminent future" problem?

"It's not happening until its happening to me!"

Challenges:

1. This is a deregulated and highly competitive environment
   There is no plan, just the interplay of various market pressures

2. Varying IPv4 Address Exhaustion Timelines
   Exhaustion is occurring variously over a period of many years

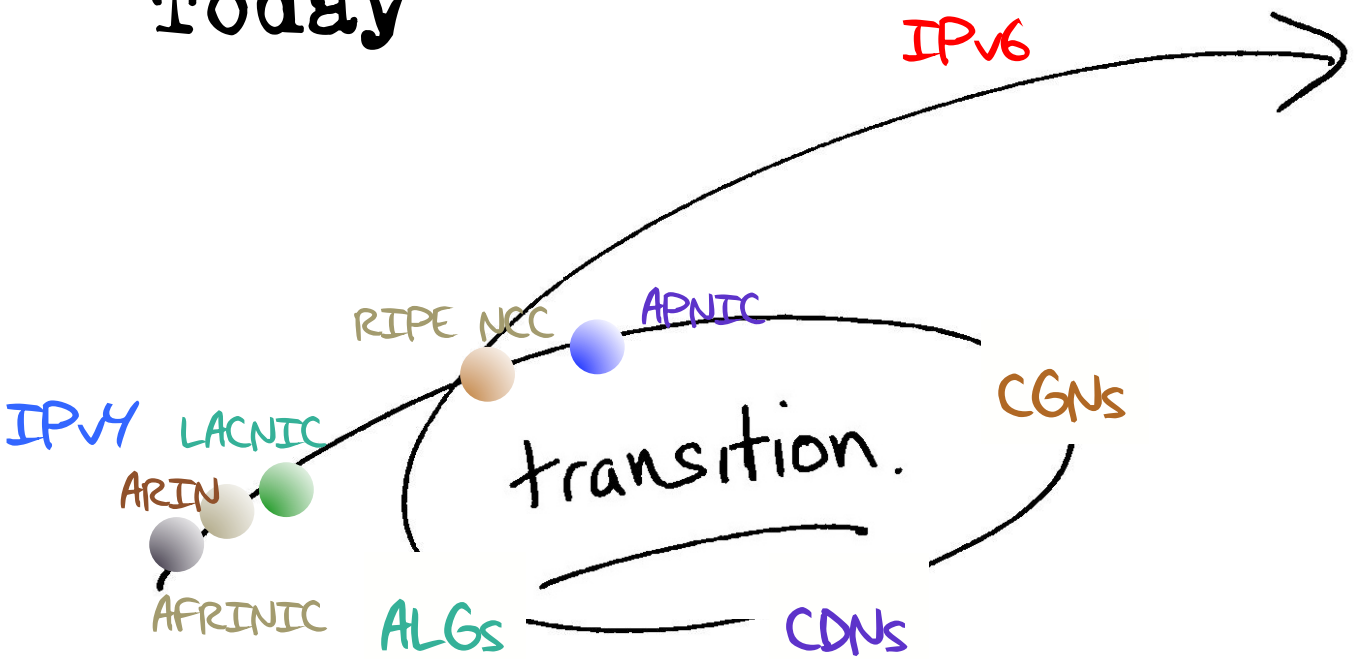
Challenges:

1. This is a deregulated and highly competitive environment
   There is no plan, just the interplay of various market pressures

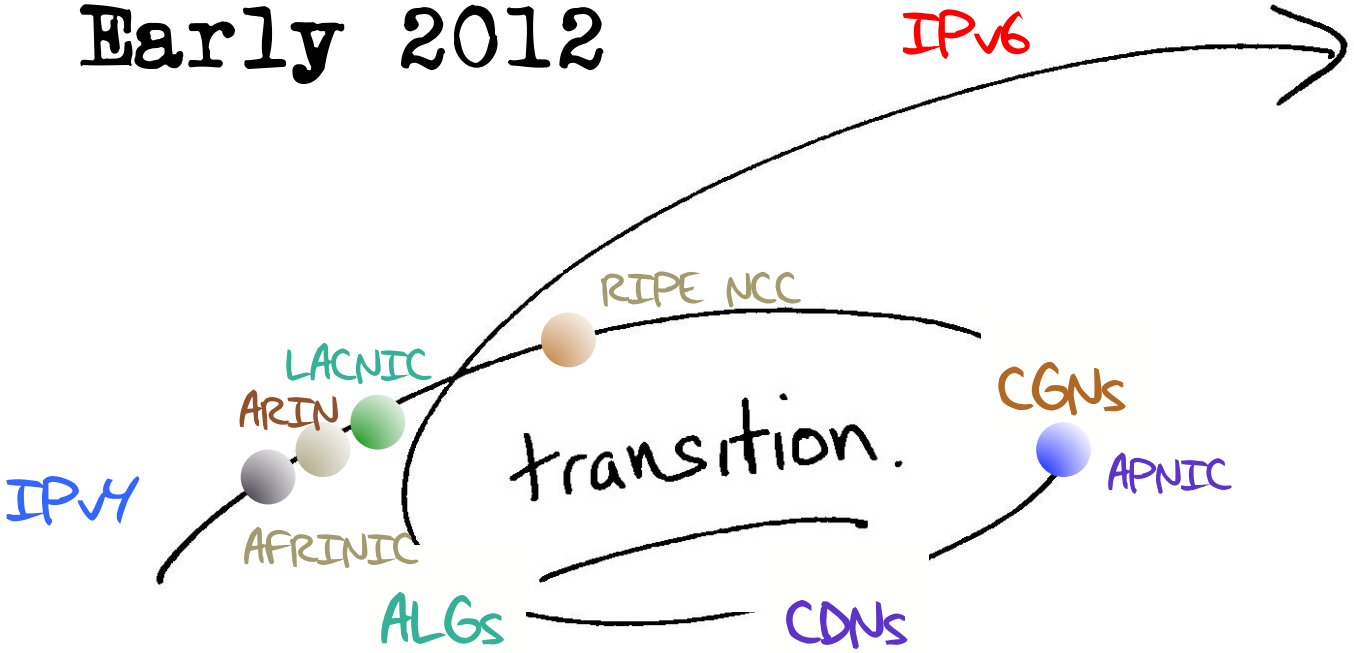
2. Varying IPv4 Address Exhaustion Timelines
   Exhaustion is occurring variously over a period of many years

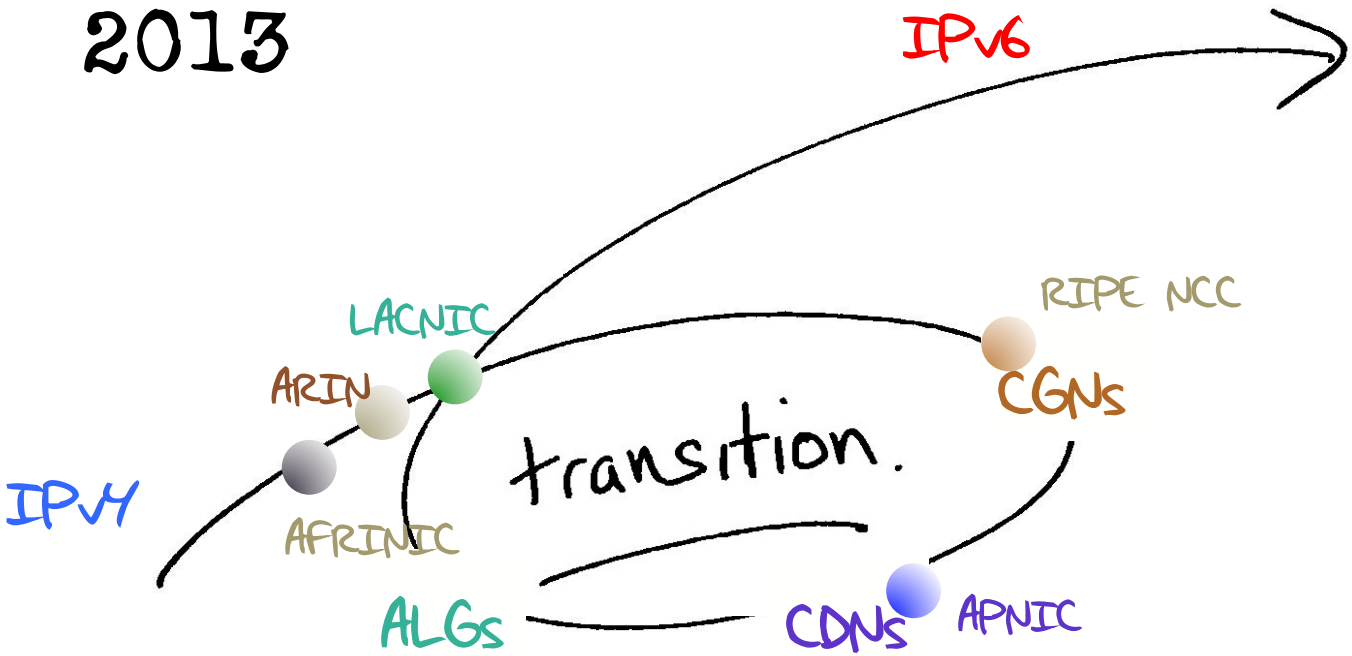
3. Regional Diversity

Today


IPv6
RIPE NCC
APNIC
IPv4
LACNIC
ARIN
AFRINIC
transition.
CGNs
ALGs
CDNs

Early 2012


IPv6
RIPE NCC
LACNIC
ARIN
IPv4
AFRINIC
transition.
CGNs
APNIC
ALGs
CDNs


2013
IPv6
LACNIC
RIPE NCC
ARIN
CGNs
transition.
IPv4
AFRINIC
ALGs
CDNs
APNIC

By 2013 it is possible that different regions will be experiencing very different market pressures for the provision of Internet services, due to differing transitional pressures from IPv4 exhaustion

By 2013 it is possible that different regions will be experiencing very different market pressures for the provision of Internet services, due to differing transitional pressures from IPv4 exhaustion

What's the level of risk that the differing environments of transition lead to significantly different outcomes in each region?

By 2013 it is possible that different regions will be experiencing very different market pressures for the provision of Internet services, due to differing transitional pressures from IPv4 exhaustion

Will we continue to maintain coherency of a single Internet through this transition?

What's the level of risk that the differing environments of transition lead to significantly different outcomes in each region?

The Myth of the Long Term Plan

The Myth of the Long Term Plan

"Transition will take many years...

5 years, maybe 10 years, maybe longer"

The Myth of the Long Term Plan

"Transition will take many years...

5 years, maybe 10 years, maybe longer"

Are we still firmly committed to the plans we had 5 years ago?

How about our 10 year old plans?

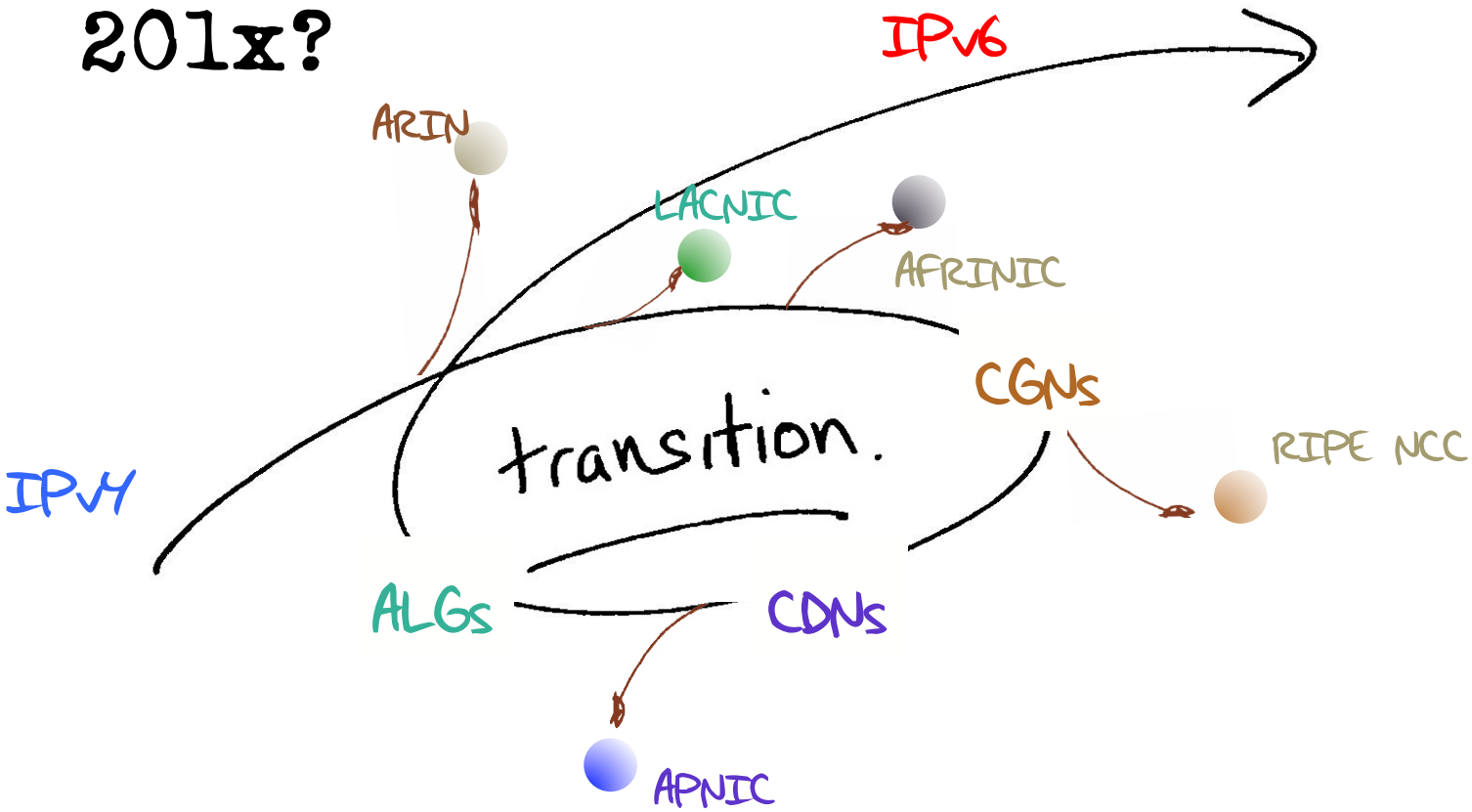
The Myth of the Long Term Plan

"Transition will take many years...

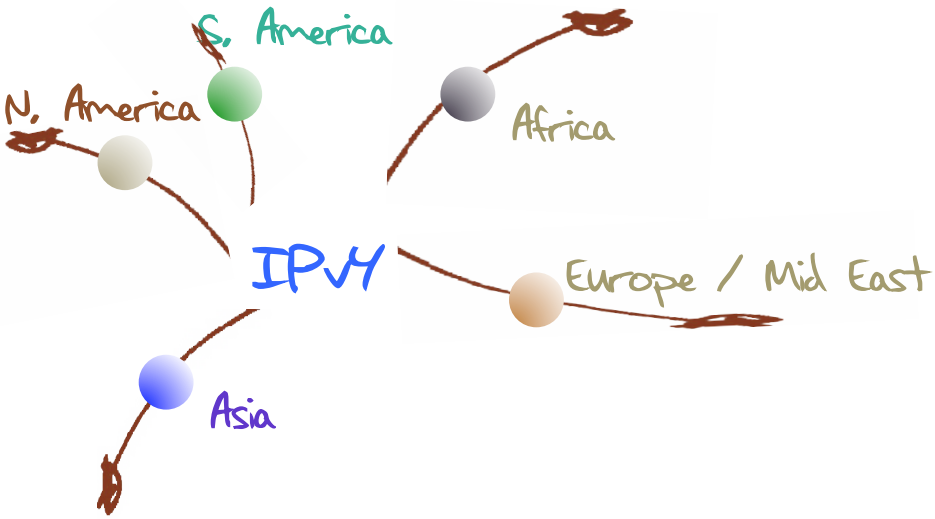
5 years, maybe 10 years, maybe longer"

Are we still committed to the plans we had 5 years ago? How about our 10 year old plans?

The longer the period of transition, the higher the risk of losing the plot and heading into other directions


201x?
IPv6
ARIN
LACNIC
AFRINIC
CGNs
transition.
RIPE NCC
IPv4
ALGs
CDNs
APNIC

20xx?



Challenges:

1. This is a deregulated and highly competitive environment
   There is no plan, just the interplay of various market pressures

2. Varying IPv4 Address Exhaustion Timelines
   Exhaustion is occurring variously over a period of many years

3. Regional Diversity
   Market pressures during an extended transition may push the Internet along different paths in each region

Can we help the Internet through this transition?

Can we help the Internet through this transition?

Or at least, how can we avoid making it any worse?

Three thoughts...

Three thoughts...

If we want one working Internet at the end of all this, then keep an eye on the larger picture

think about what is our common interest here

and try to find ways for local interests to converge with common interests

Three thoughts...

Addresses should be used in working networks, not hoarded

scarcity creates pain and uncertainty

extended scarcity prolongs the pain and increases the unpredictability of the entire transition process

Three thoughts...

A rapid transition represents the best chance of achieving an IPv6 network as an outcome

The more time we spend investing time, money and effort in deploying IPv4 address extension mechanisms, the higher the risk that we will lose track of the temporary nature of transition

If we are truly committed to achieving a single and coherent IPv6 Internet then perhaps its necessary to compress the timelines for transition, not extend them!

Thank You!