

IPv4 Address Lifetime SANOG IV

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Research activity
conducted by Geoff Huston
and supported by APNIC

Are we running out of IP addresses?

- Recent media reports claiming we are running out of IP addresses
 - Some claim we've already run out in some parts of the world
- But what are the facts?
 - *Is the IPv4 sky falling?*
- Geoff Huston, chief scientist at APNIC, has studied the IPv4 consumption rates

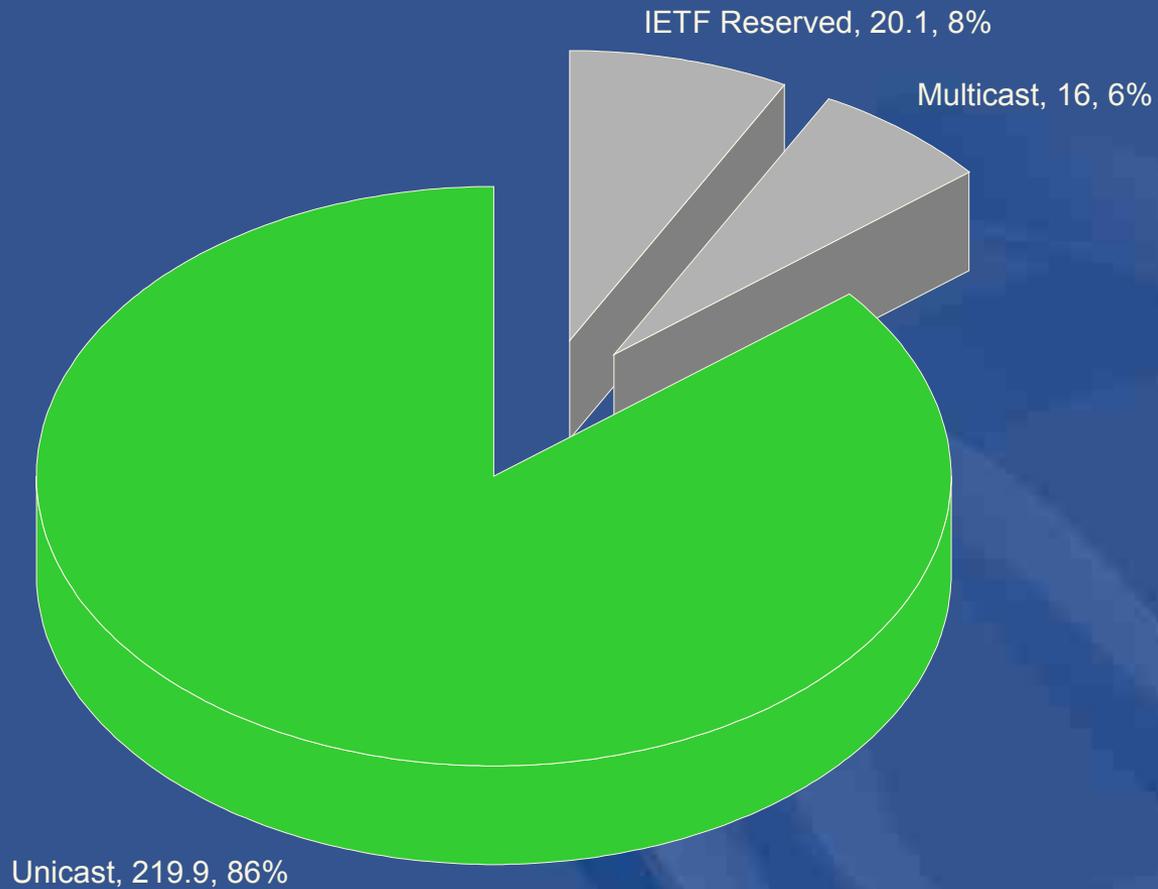


Modeling the Process

1. IETF definition of IPv4
 - Source: IETF standards (RFCs)
 - Delegation of address space for IANA administration
2. IANA allocations to RIRs
 - Source: IANA IPv4 Address Registry
 - Allocation of /8 blocks to RIRs and others
3. RIR allocations to ISPs
 - Source: RIR Stats files
 - Allocation of blocks to LIRs
4. ISP announcements
 - Source: BGP routing table
 - Amount of address space advertised

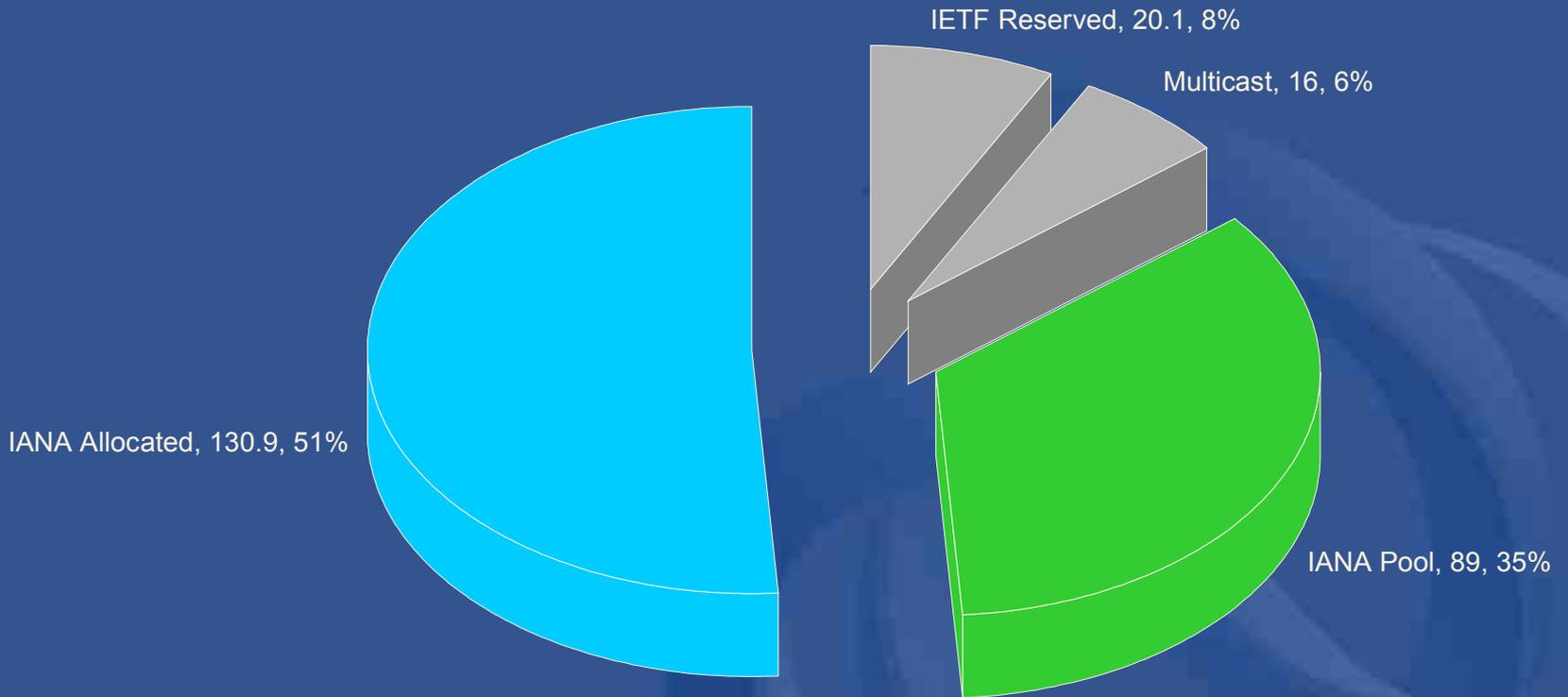


1. IETF Delegations – IPv4



by /8 block equivalents

IANA Allocations - Current

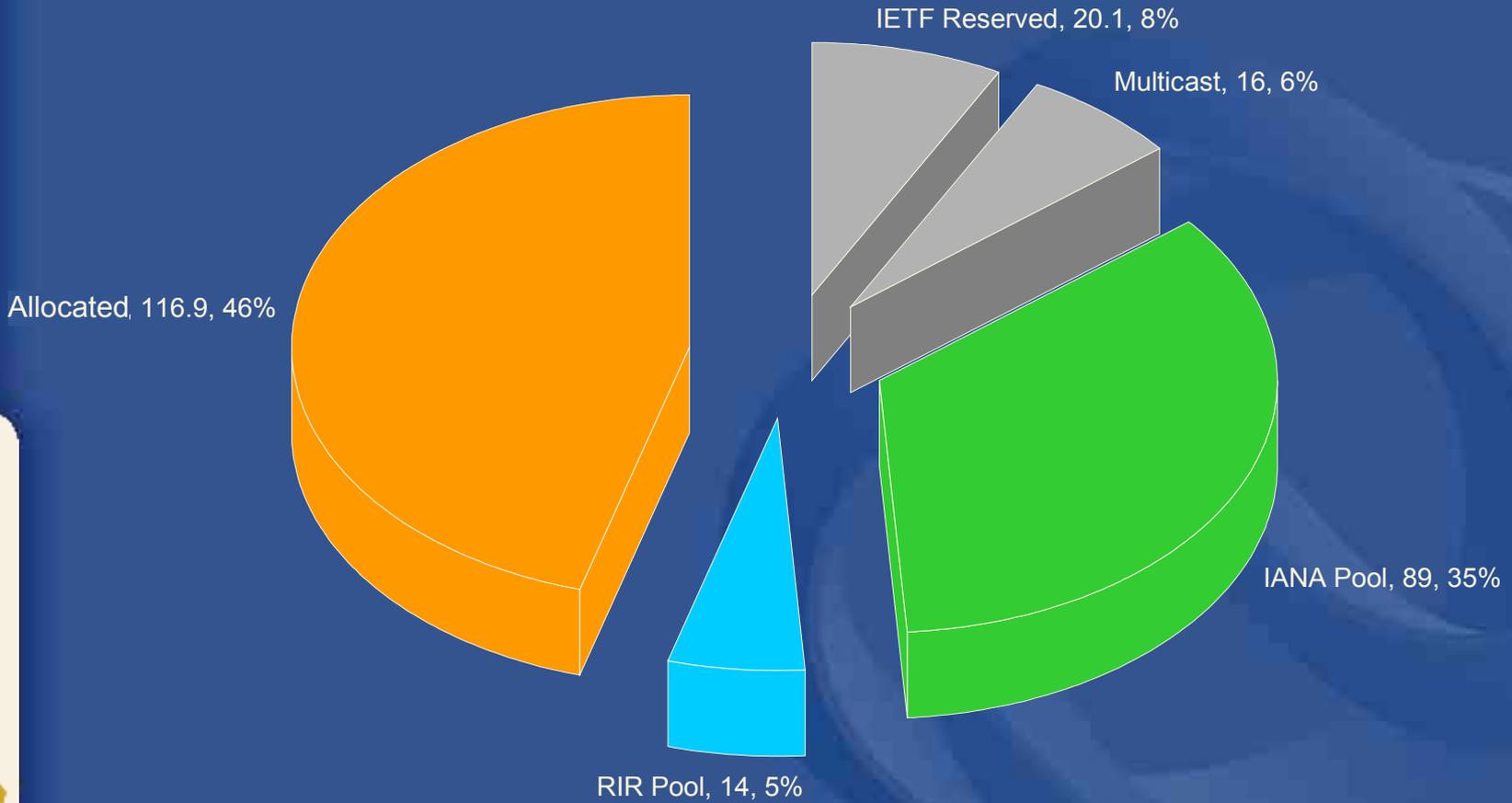


IANA Allocations - Historical

IANA Allocated IPv4 /8 Address Blocks

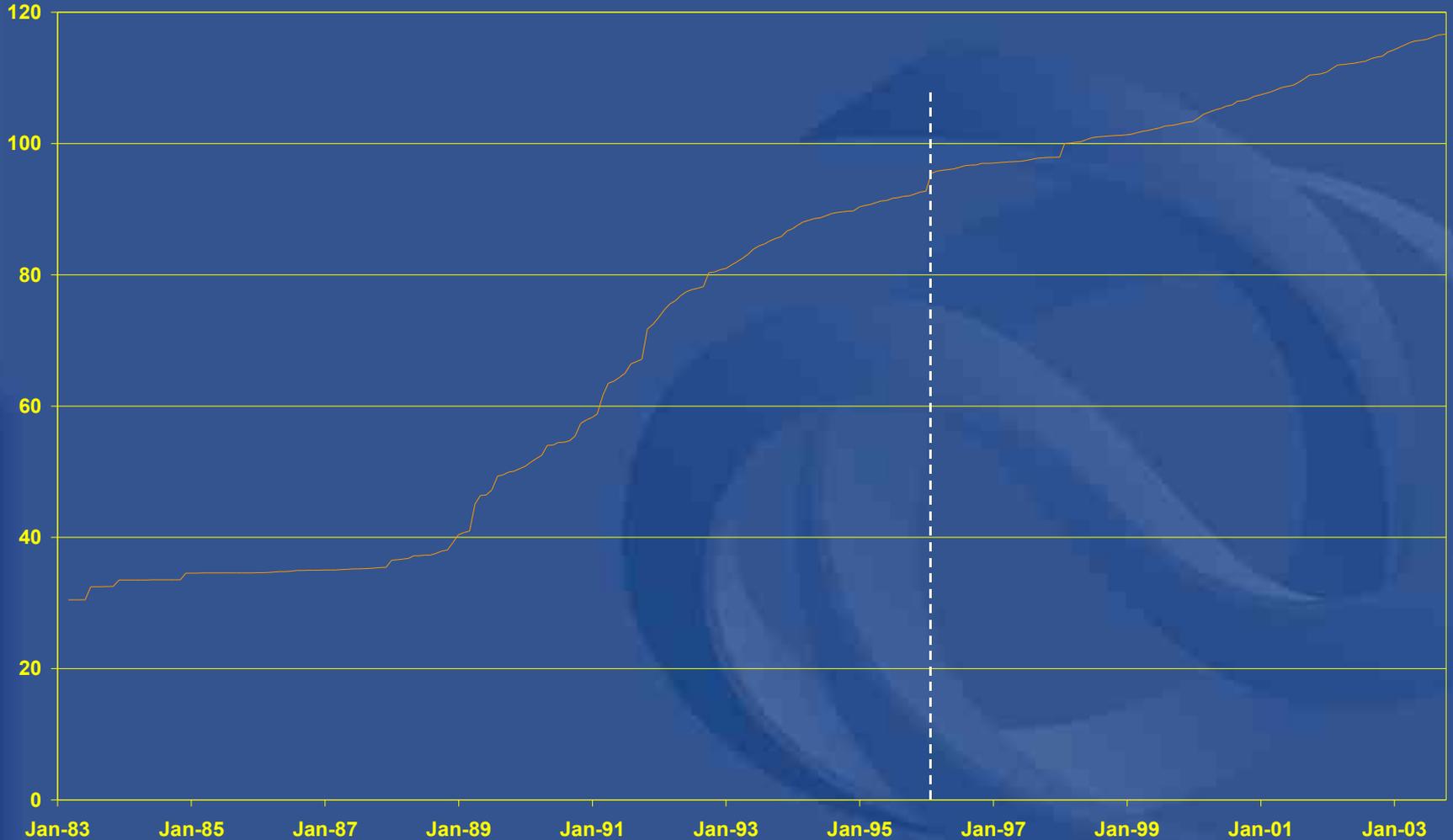


RIR Allocations - Current



RIR Allocations - Historical

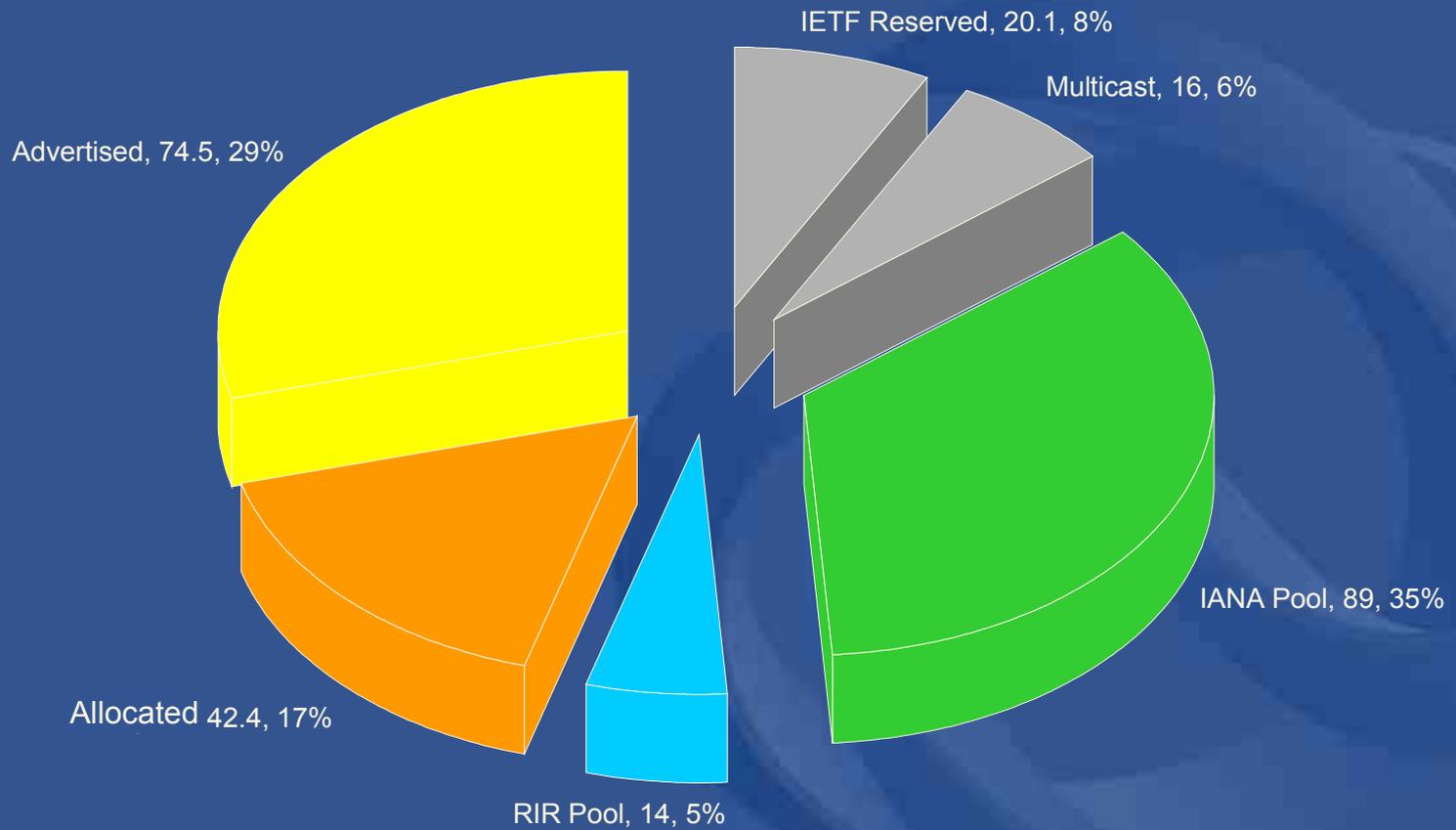
RIR Assigned IPv4 /8 Address Blocks



BGP Routing Table

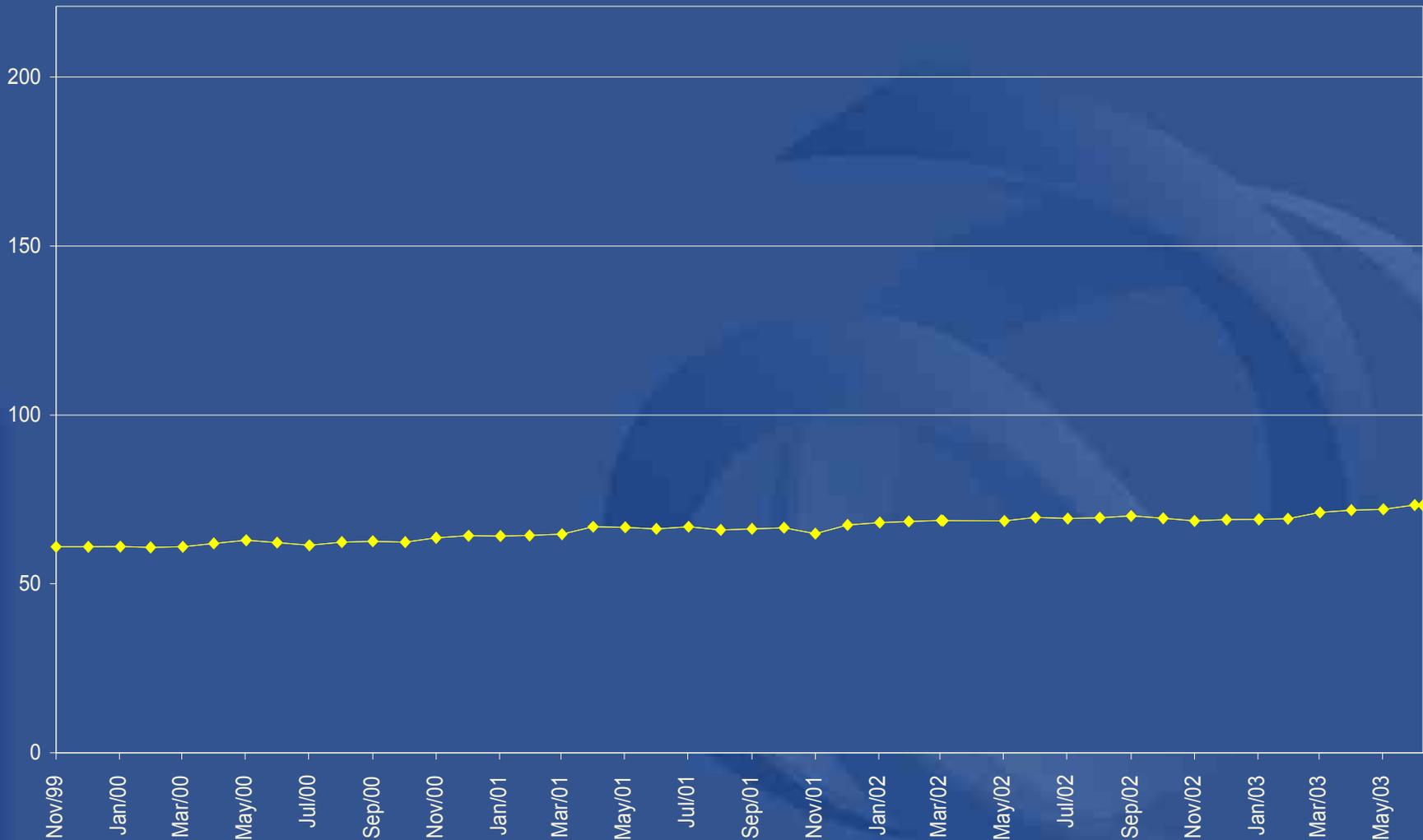
- The BGP routing table spans a set of advertised addresses
 - Representing addresses in use by ISPs
- A similar analysis of usage and projection can be undertaken on this data
- Assumption: BGP routing table represents actual IP address usage
 - Therefore it “drives” the other trends

BGP Routing Table - Current



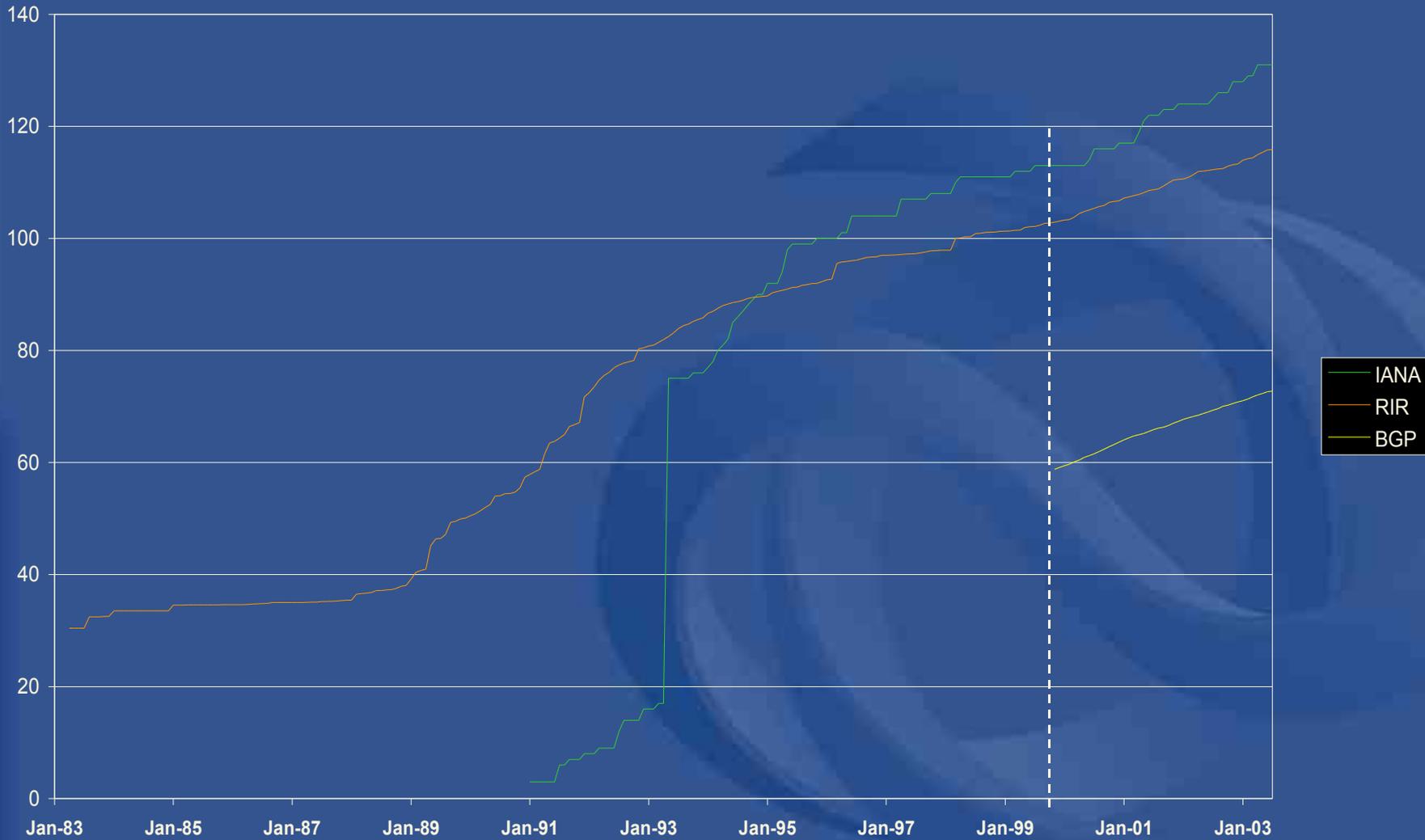
BGP Announcements - Historical

BGP Table - Address Span



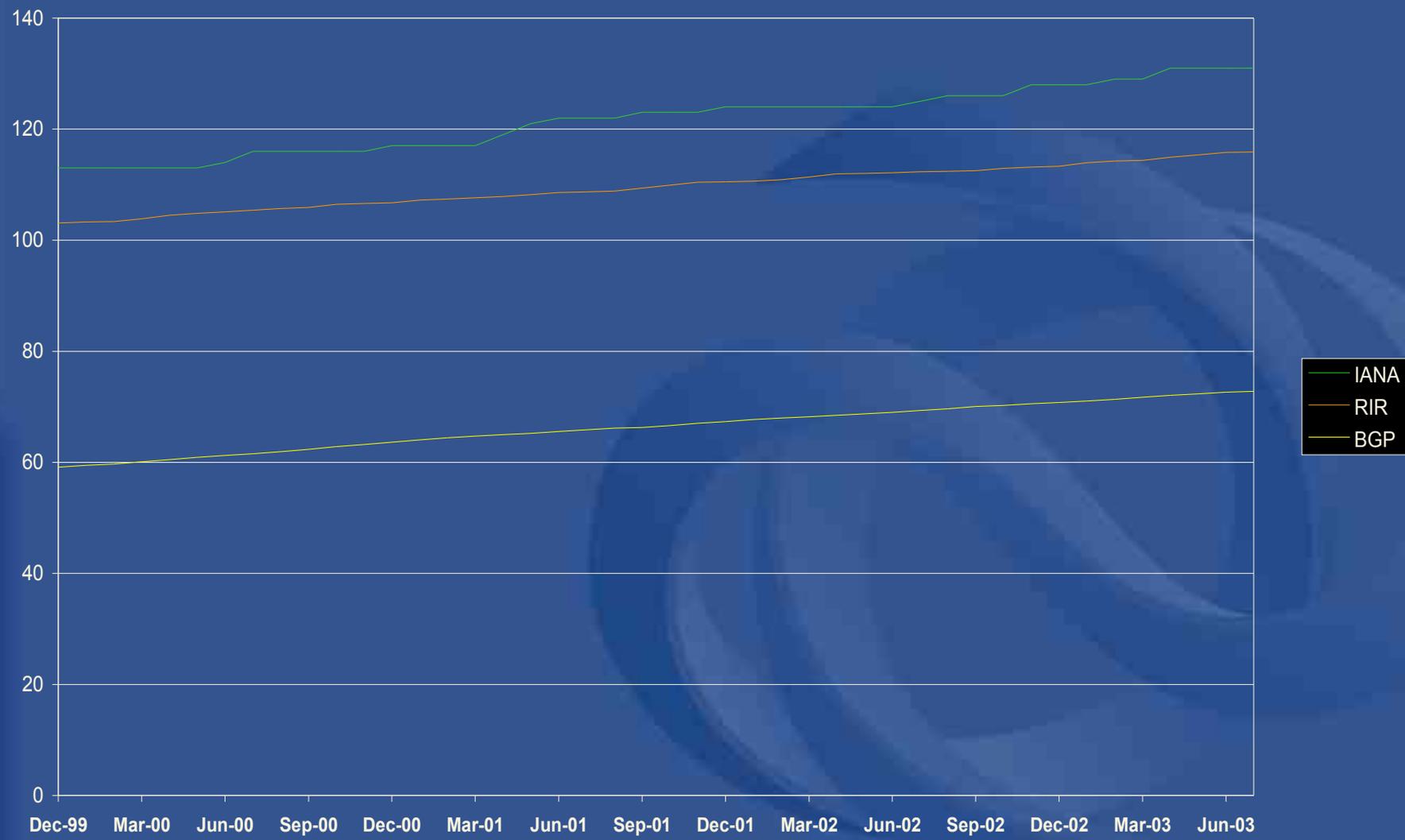
Combining the Data

IPv4 Address Space



Recent Data

IPv4 Address Space



Projections

Projections – IANA & RIR Allocations

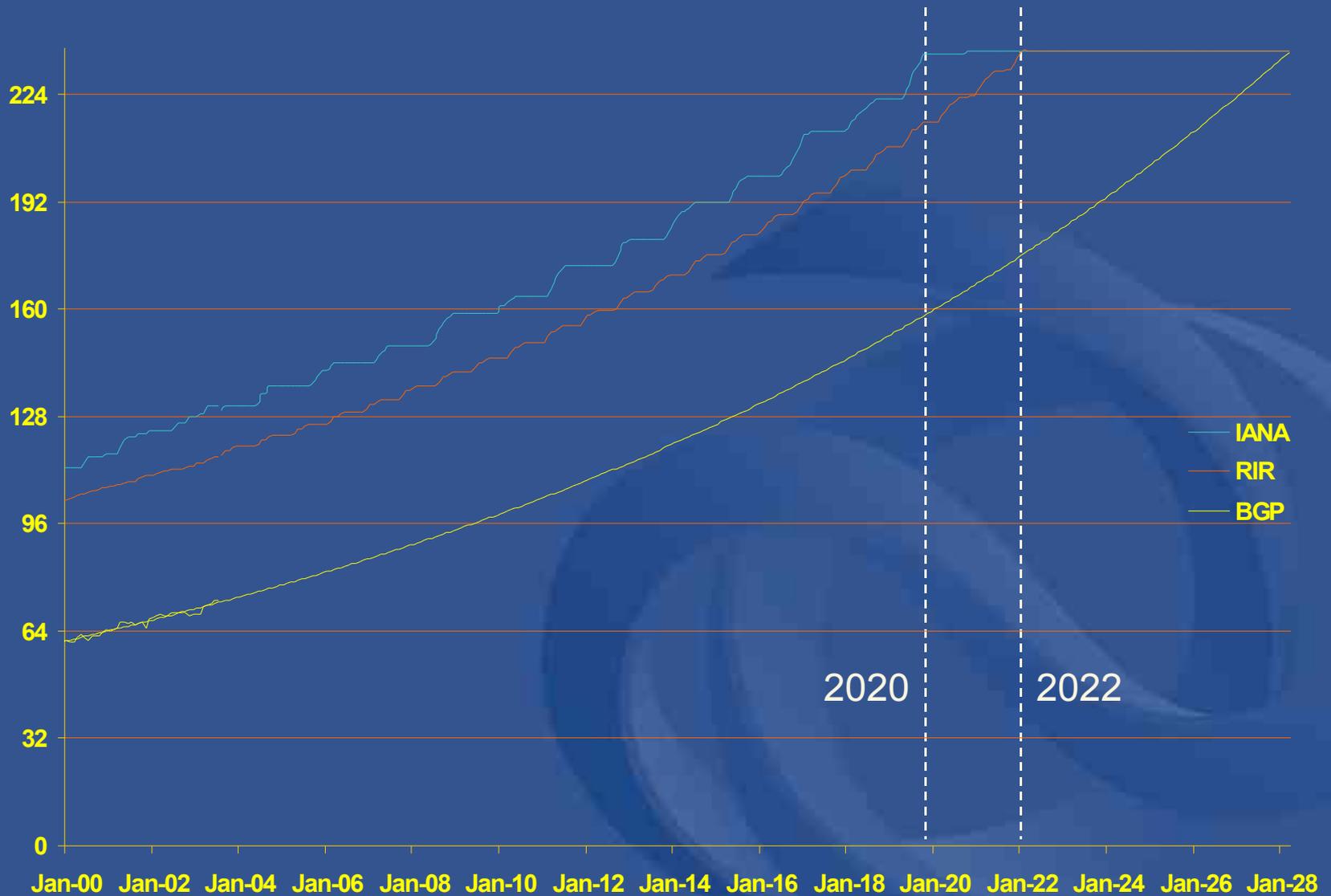
- Any projection is very uncertain because of:
 - Sensitivity of allocation rate to prevailing RIR policies
 - Sensitivity to any significant uptake up of new applications that require end-to-end IPv4 addressing vs use of NATs

Projections – BGP Data

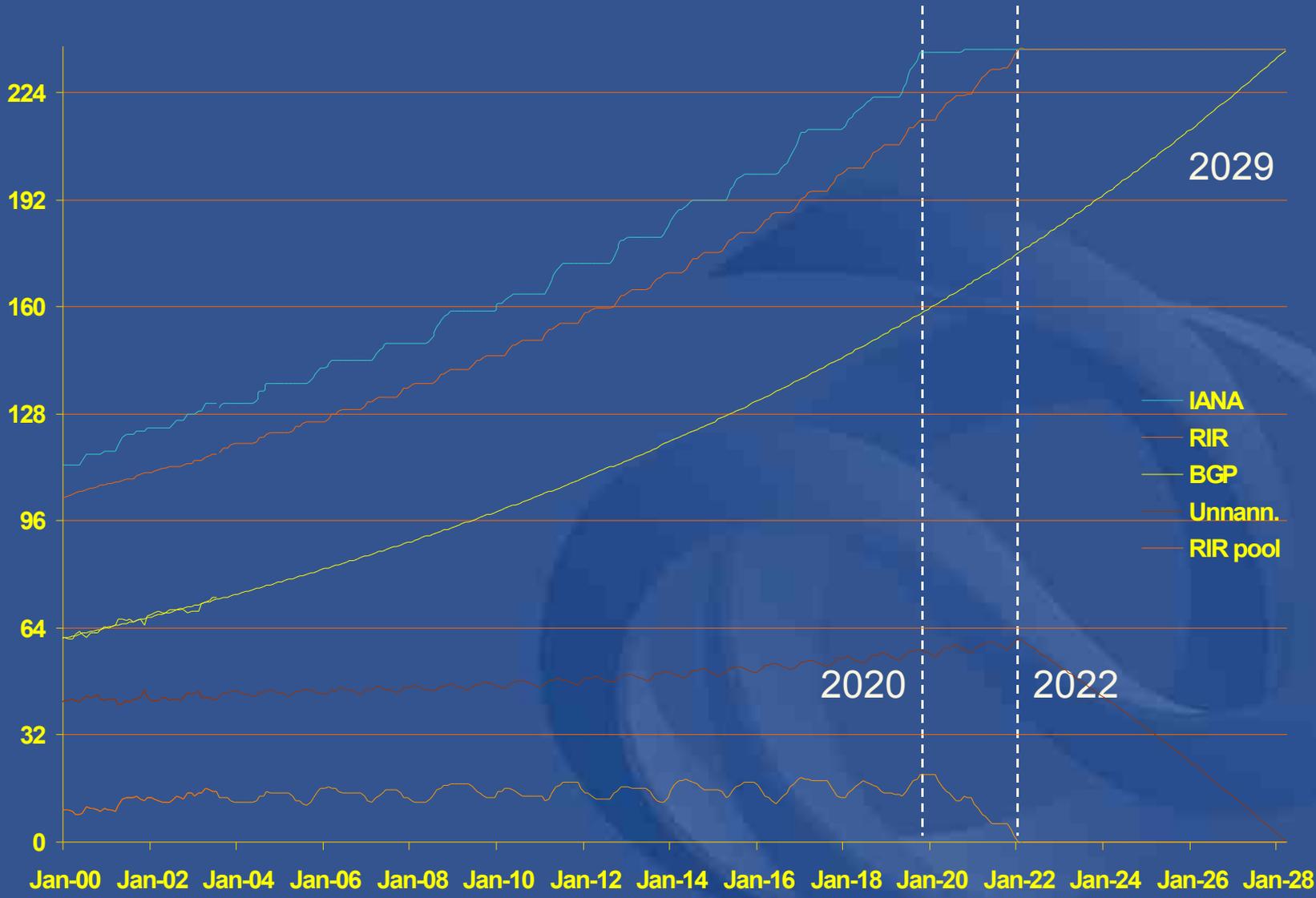
- 3 year data baseline
 - Much shorter baseline than the IANA and RIR projections
 - Considerable uncertainties with this projection
- First order differential of total BGP announcement
 - Until 2000, exponential growth
 - Since 2000, oscillating differential and overall deceleration
 - Last 6 months, differential approaching 0 (i.e. no growth)
- Linear fit seems most appropriate for this data



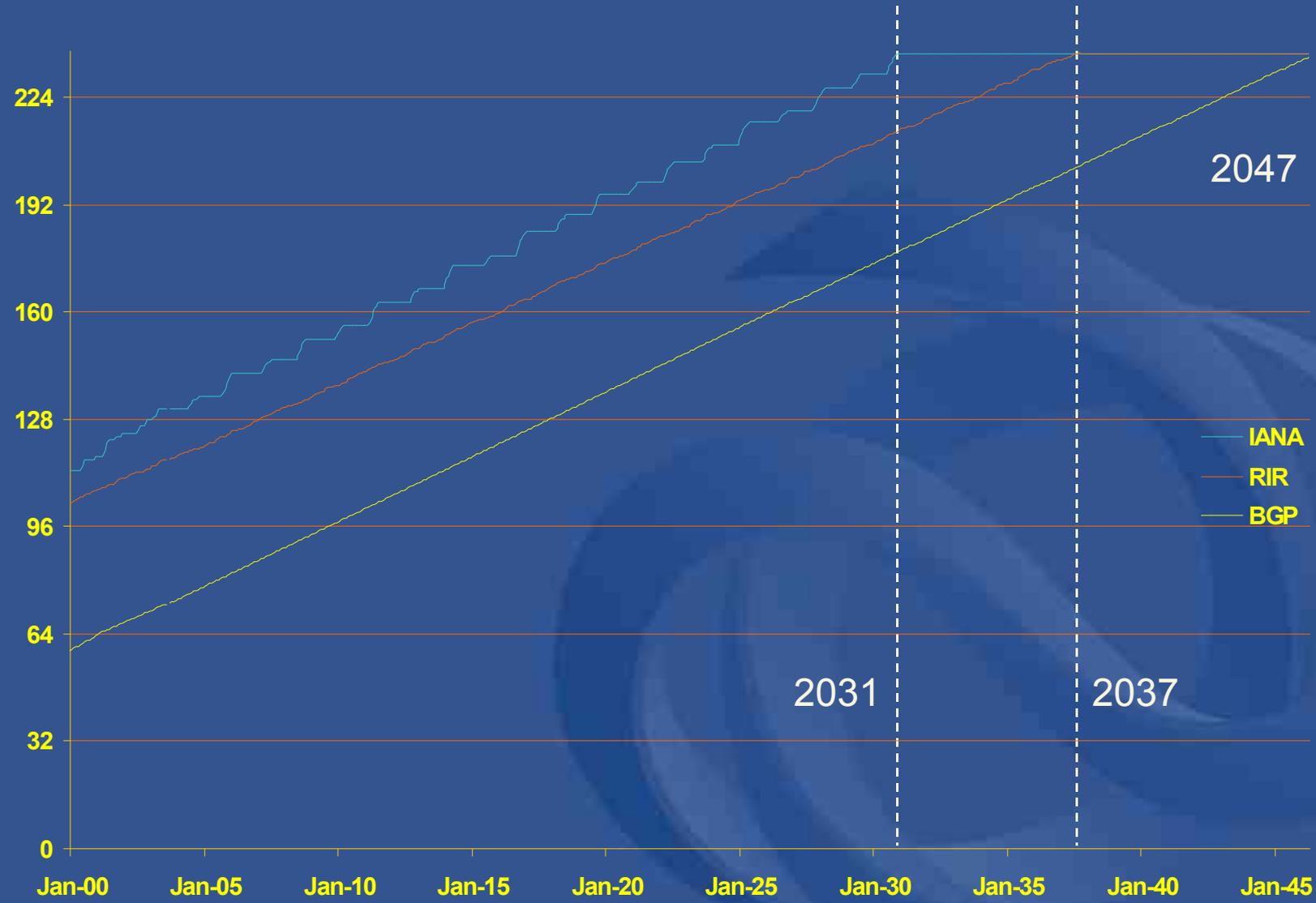
Process model - exponential



Process model - exponential



Process model - linear



Methodology and Caveats

- Projection of based on 2000-2003 data
 - IANA and RIR allocation practices
 - BGP-based demand model
- Incorporating
 - RIR unallocated pool
 - Total address space including allocated but unannounced
- Exponential growth model
 - Address space lasts until **2022**
 - (or **2029** if all unannounced space recovered)
- Linear growth model
 - Address space lasts until **2037** (or **2047**)

Some Big Issues

- This is just a model - reality will be different!
- Will the BGP routing table continue to reflect allocation rates?
- Is the model of the unannounced pools and RIR holding pools appropriate?
- Externalities...
 - What are the underlying growth drivers (applications and services) and how are these best modeled?
 - What forms of disruptive events would alter this model, and to what extent?

Concluding thoughts...

- IP address management
 - Result of 20 year evolution on the Internet
 - Supported Internet growth to date
- We are not running out of IP addresses now
 - But impossible to predict future
 - Policies change
 - New technologies can emerge
 - Market behaviour can change

What about IPv6?

- RIRs support the deployment of IPv6
 - Transition will take time
 - Necessary to start now
 - IPv4 was slow to start, but grew exponentially over the last 10 years
 - Don't get left behind!
 - Be future ready!
- Responsible management essential to keep the Internet running

Questions?

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<http://www.potaroo.net>

<http://www.potaroo.net/ispcolumn/2003-07-v4-address-lifetime/ale.pdf>