IPv4 Address Lifetime

Presented by
Nurani Nimpuno, APNIC

**Research activity
conducted by Geoff Huston
and supported by APNIC**

Background

- All four RIRs publish their allocation data
    - Part of RIR responsibility
    - Published in response to need and increased interest in IPv4 consumption rates
        - http://www.aso.icann.org/stats/

- Few attempts in the past to predict future trends and consumption rates
    - Some based on market predictions, technology growth
    - Task not easy due to imperfect data
        - Recent efforts made by RIRs to clean up data

- Geoff Huston, chief scientist in the Internet area at Telstra, has studied the IPv4 allocation data
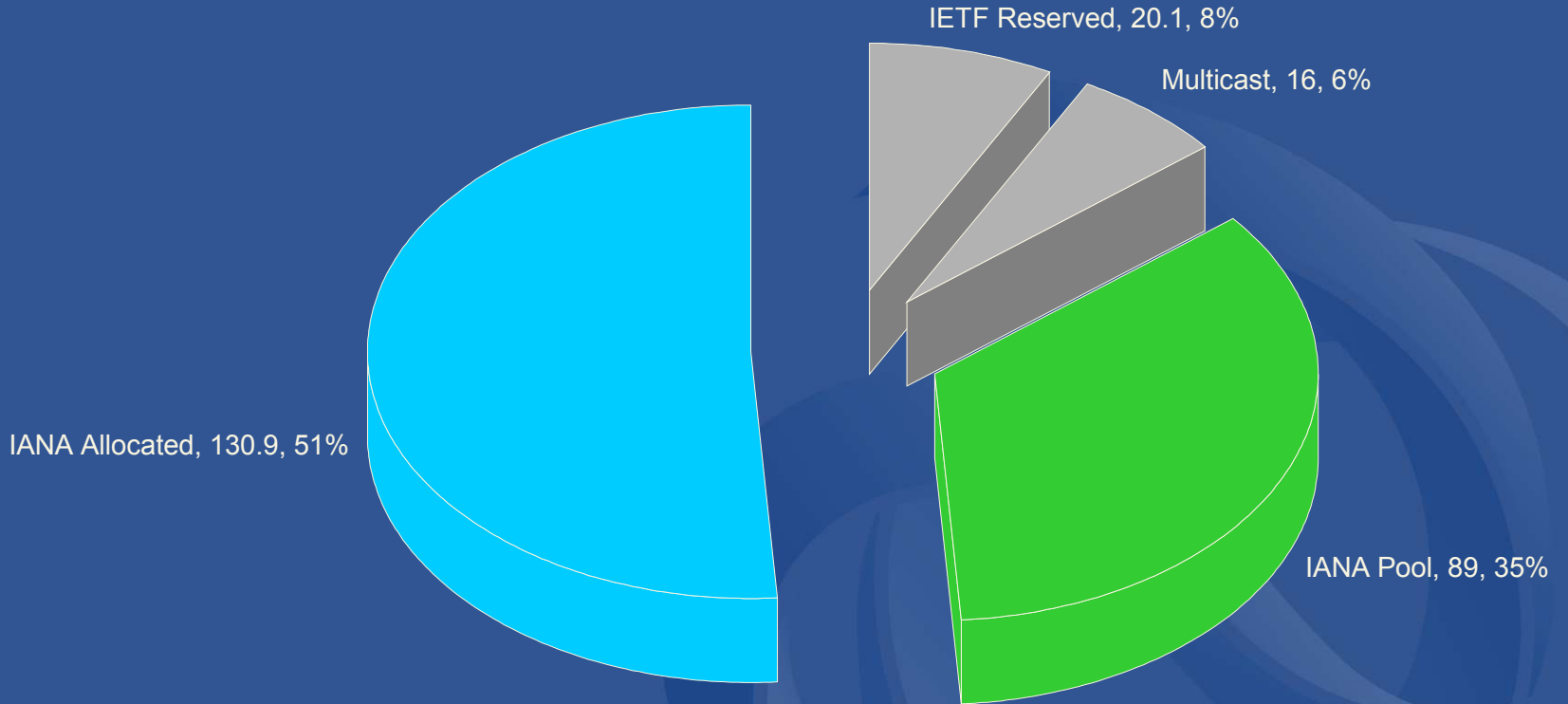   - Projections based on current and past utilisation rates

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

IETF Reserved, 20.1, 8%

Multicast, 16, 6%

Unicast, 219.9, 86%
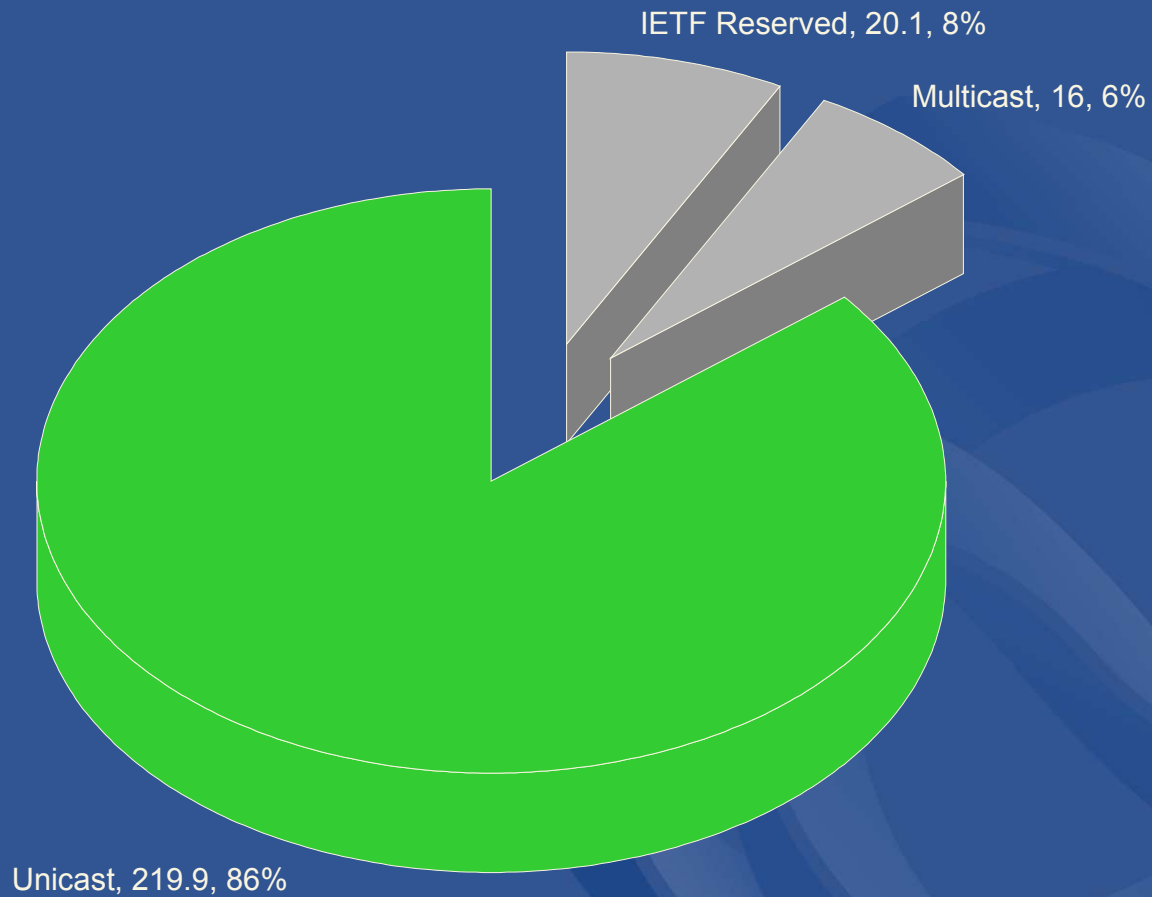
by /8 block equivalents

IANA Allocations - Current

IETF Reserved, 20.1, 8%

Multicast, 16, 6%

IANA Allocated, 130.9, 51%

IANA Pool, 89, 35%

IANA Allocations - Historical

IANA Allocated IPv4 /8 Address Blocks

RIR Allocations - Current

IETF Reserved, 20.1, 8%

Multicast, 16, 6%

Allocated, 116.9, 46%

IANA Pool, 89, 35%

RIR Pool, 14, 5%
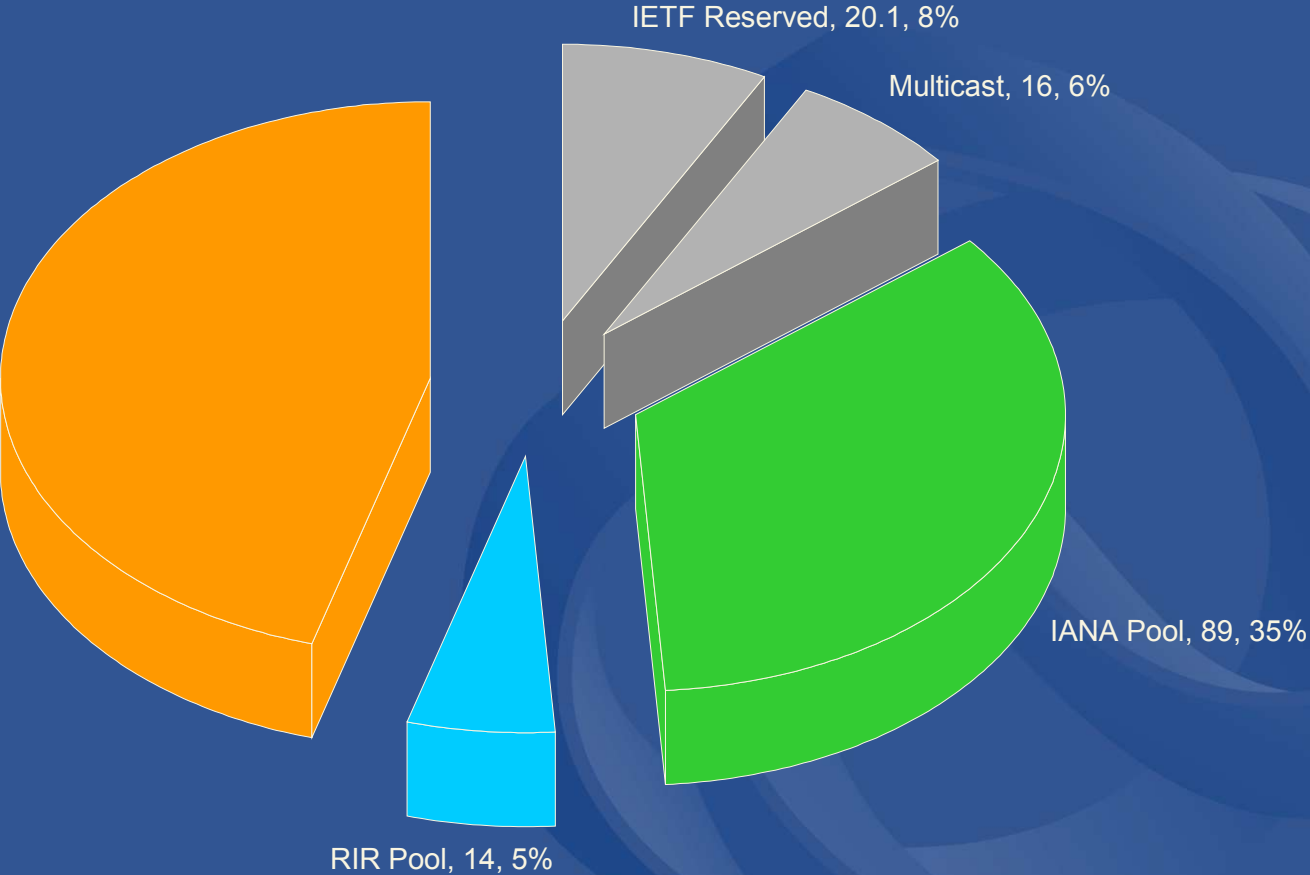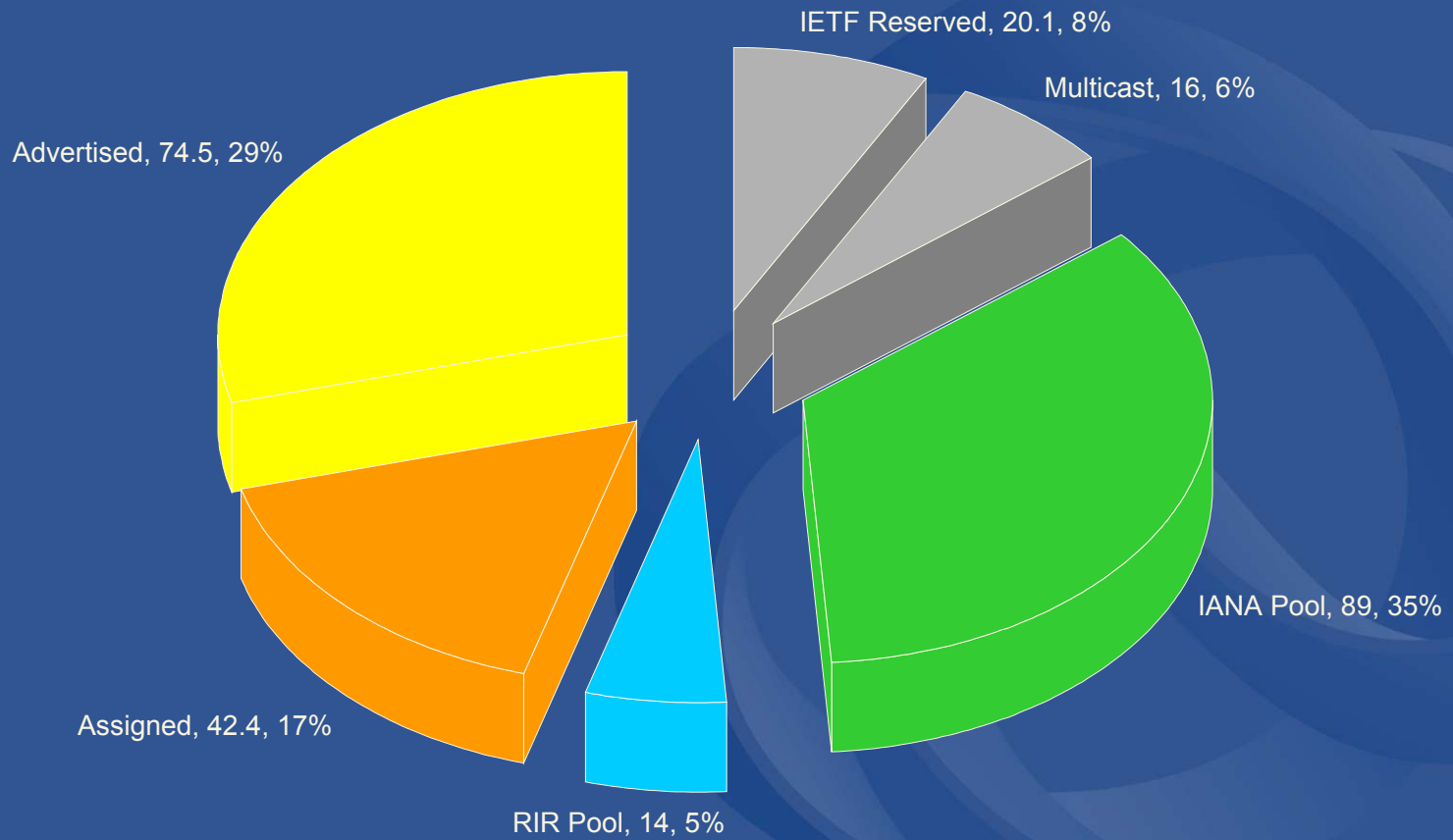
RIR Allocations - Historical

RIR Assigned IPv4 /8 Address Blocks
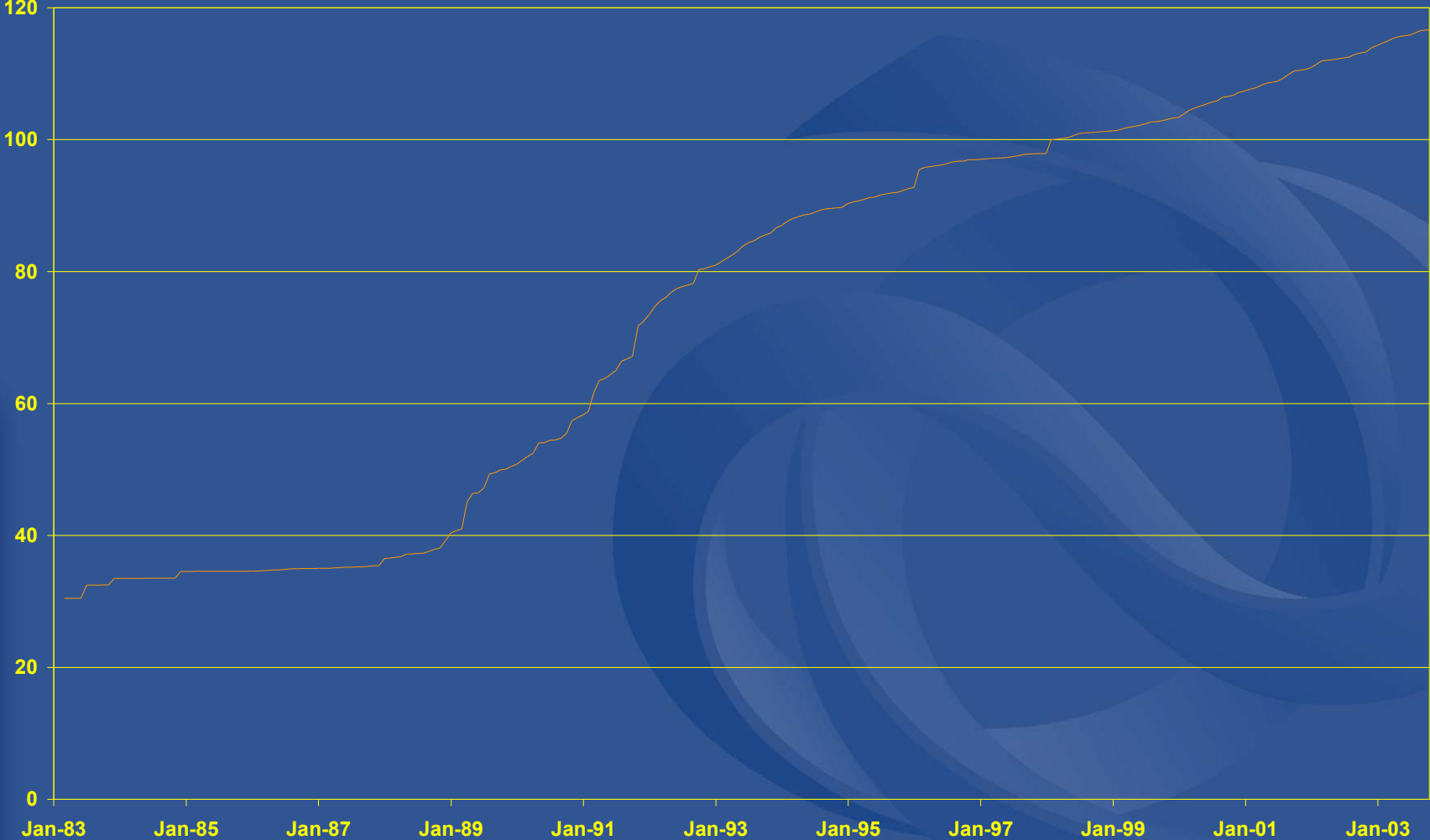
BGP Routing Table

- 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
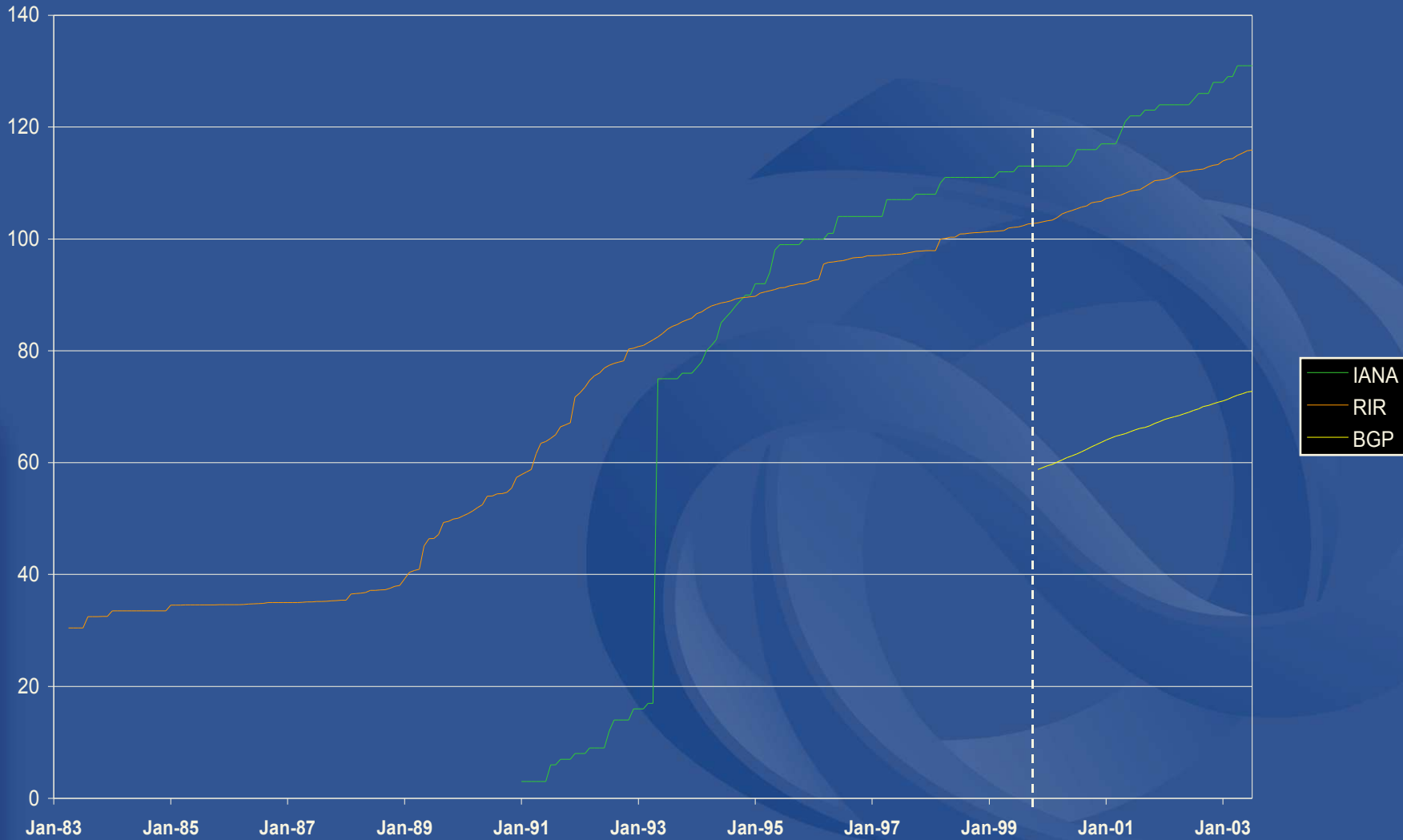
BGP Routing Table - Current

BGP Announcements - Historical

BGP Table - Address Span
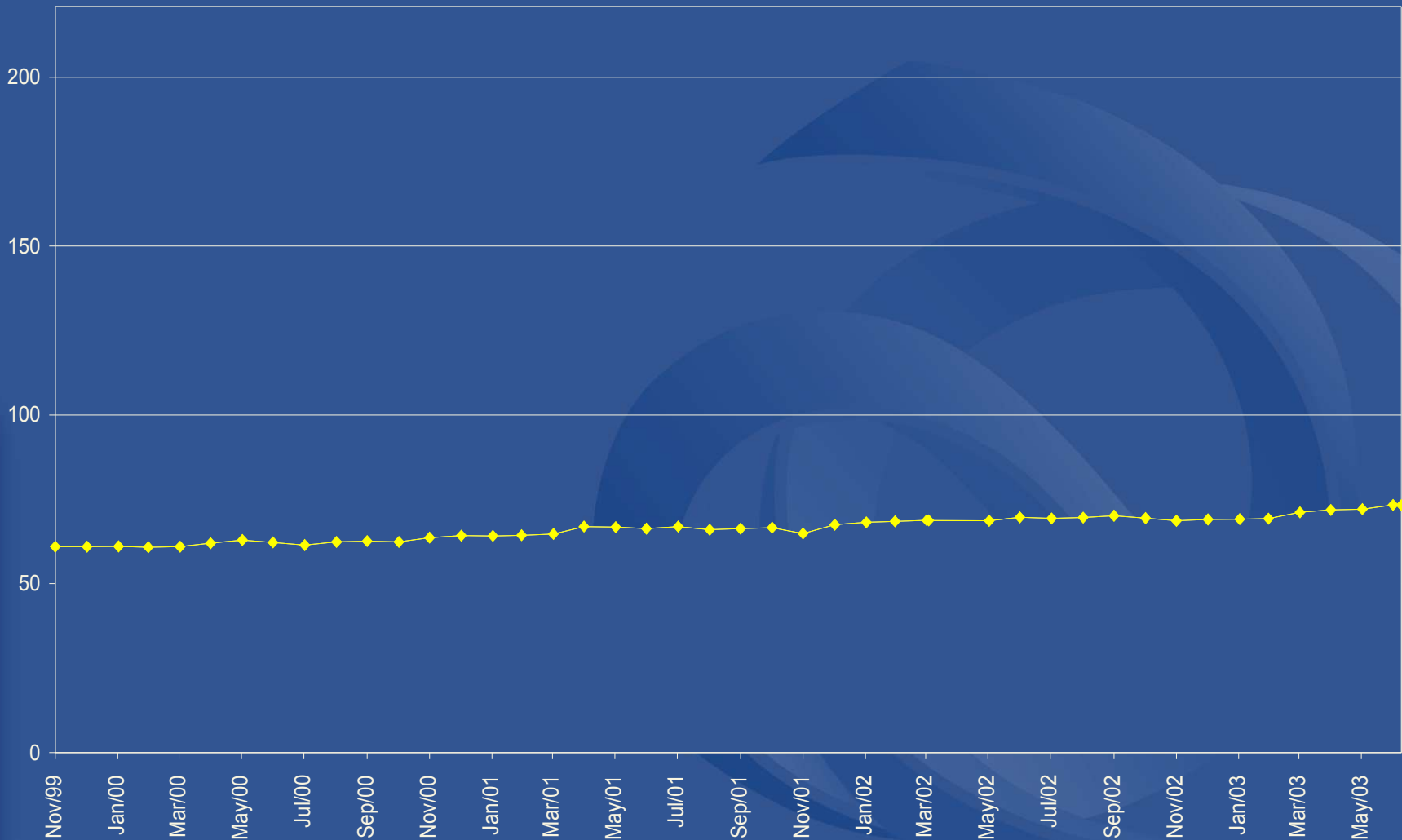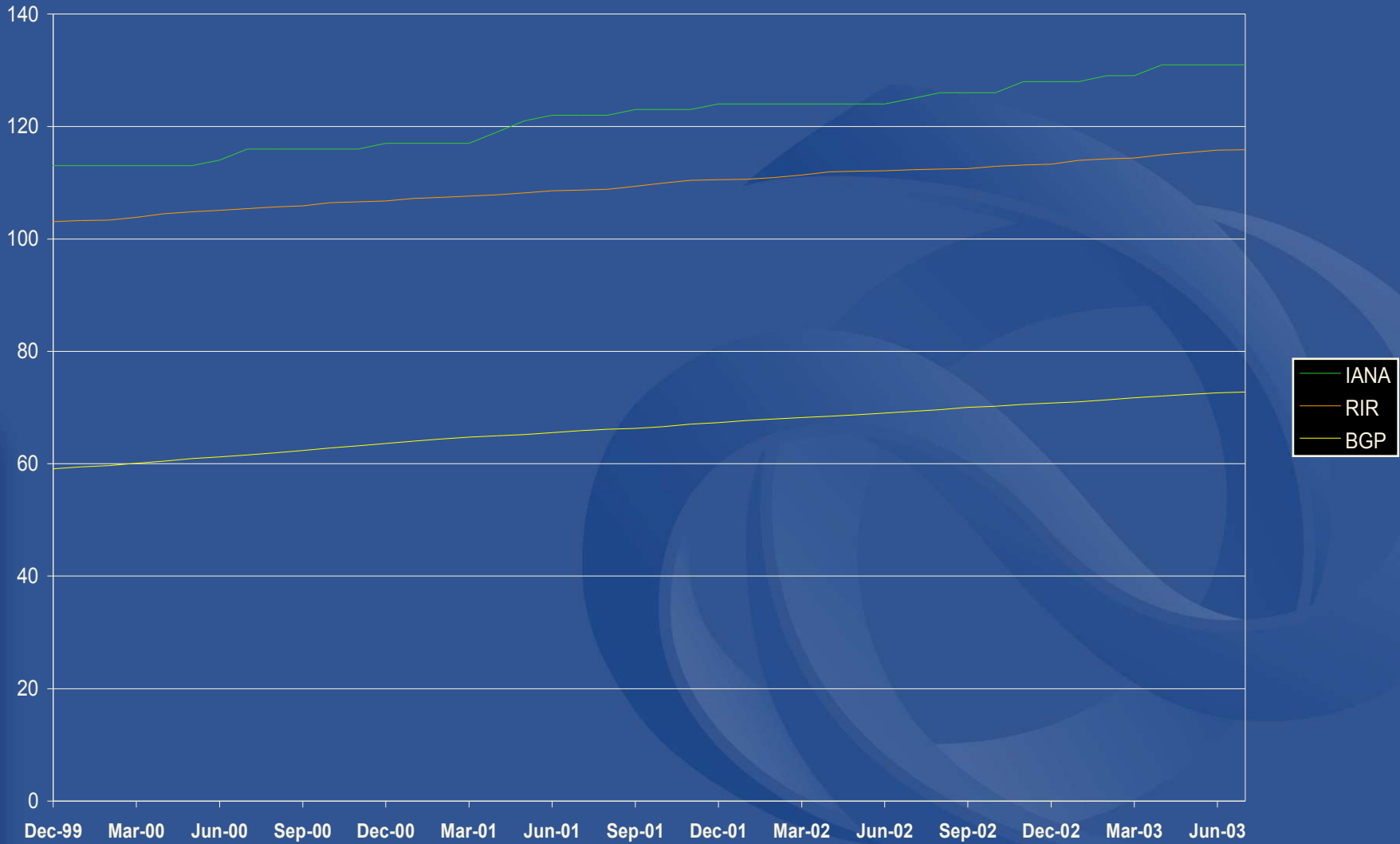
Combining the Data

IPv4 Address Space

Recent Data
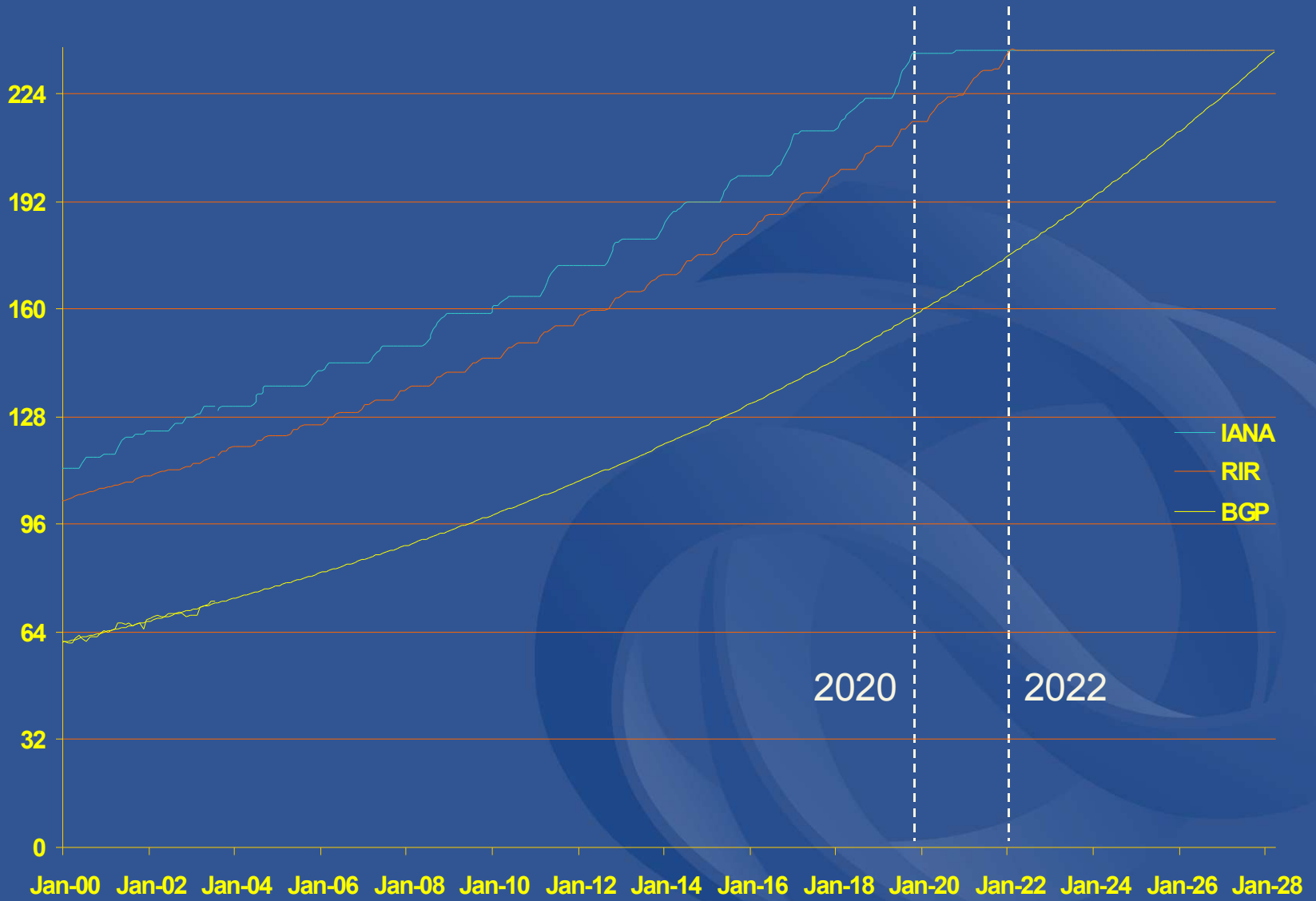

IPv4 Address Space

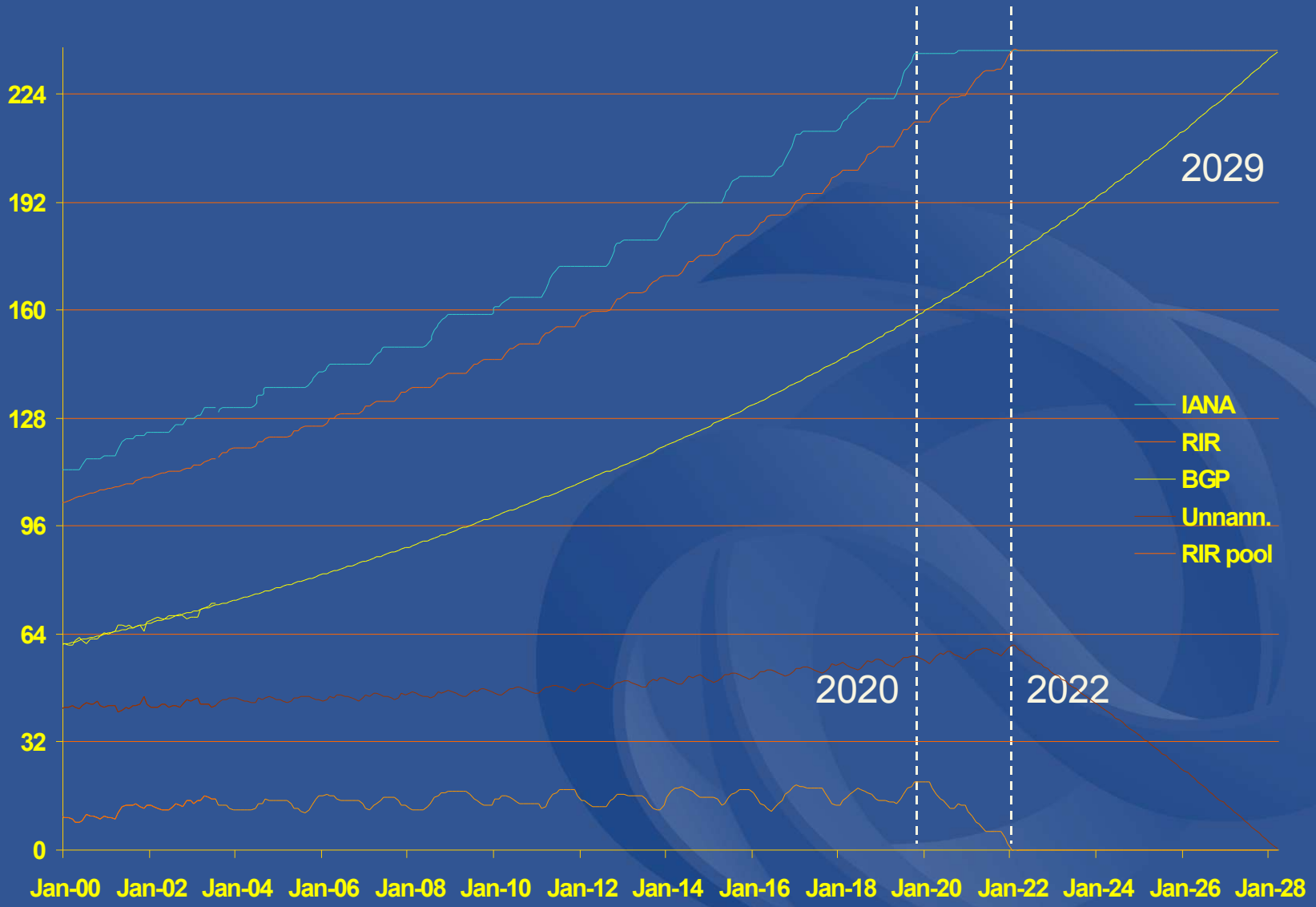# Projections

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

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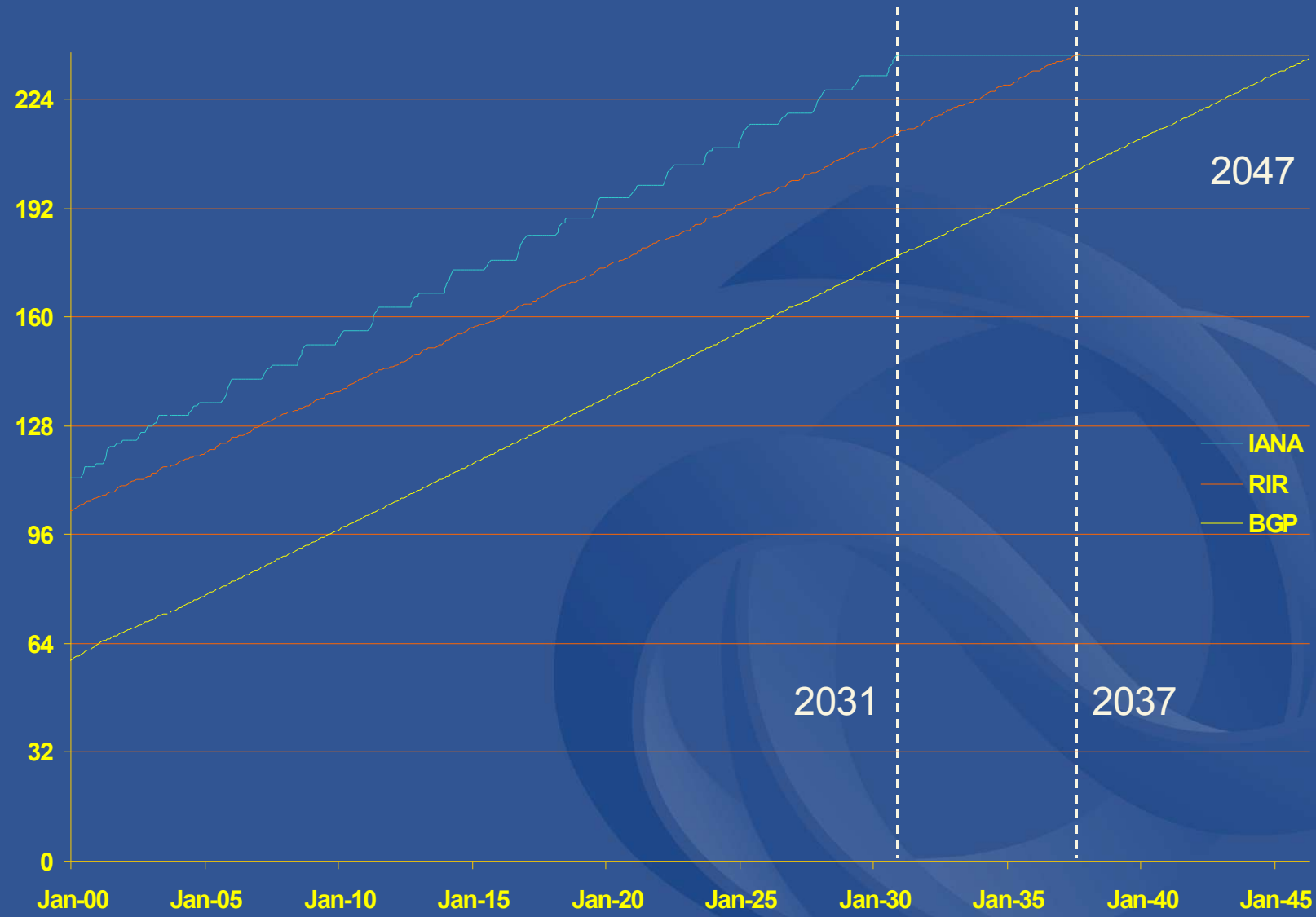 - Linear fit seems most appropriate for this data

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

- Responsible management essential to keep the Internet running

Questions?

gih@telstra.net