Challenges in IPv6 Address Management

Paul Wilson
Director General
APNIC

Asia Pacific Network Information Centre

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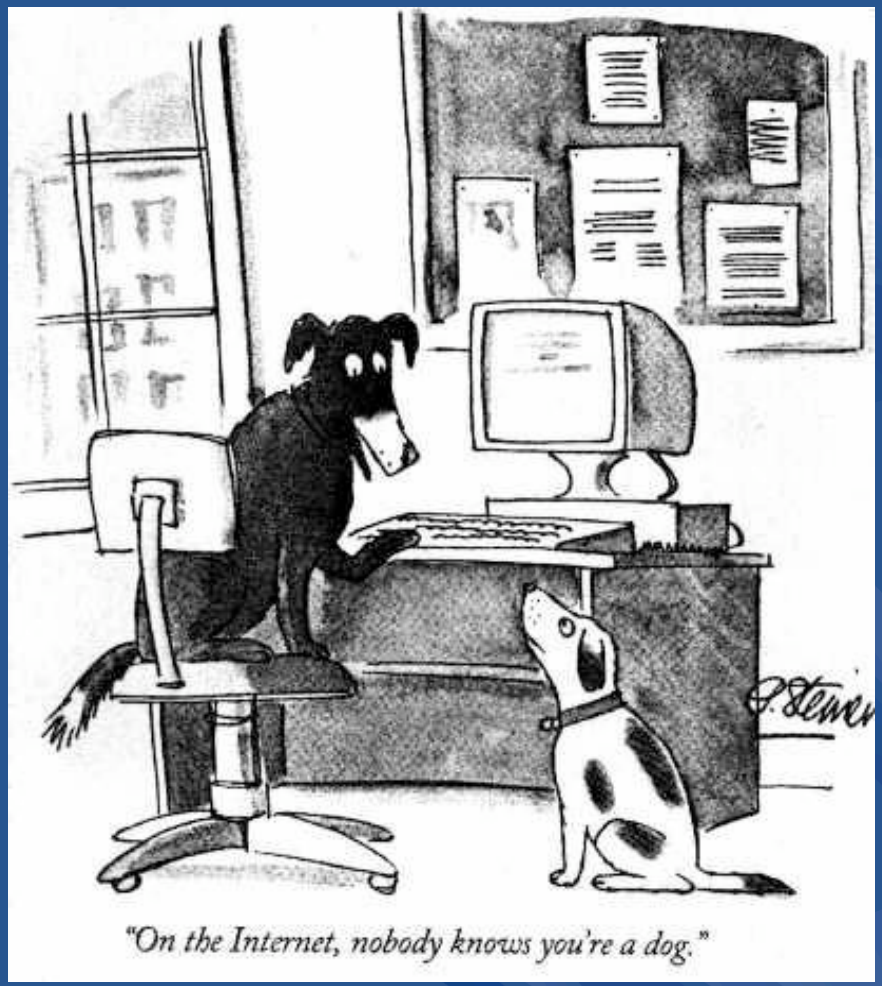
What is an IP Address?

“On the Internet, nobody knows you’re a dog…”



“On the Internet, nobody knows you’re a dog.”

by Peter Steiner, from The New Yorker, (Vol.69 (LXIX) no. 20)

“On the Internet…”
you are nothing but an IP Address!

What is an IP Address?

IPv4: 32 bits

2^{32} = 4,294,967,296 addresses
= 4 billion addresses

e.g. 202.12.29/24 (network address)
202.12.29.142 (host address)

IPv6: 128 bits

2^{128} = 340,282,366,920,938,463,463,374,607,431,770,000,000
= 340 billion billion billion billion addresses ?

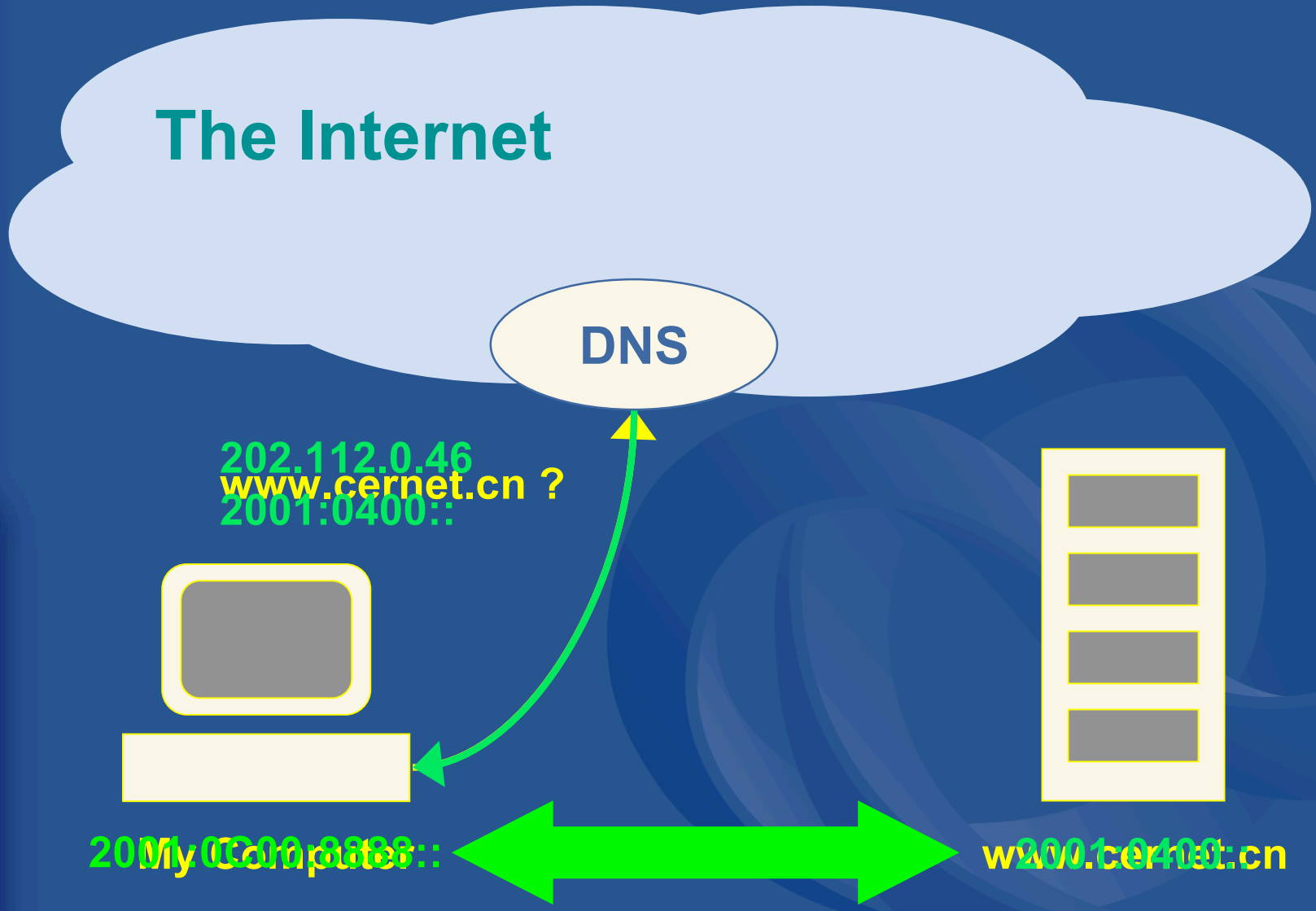
e.g. 2001:0400::/32 (network address)
2001:0400:3c00:af92:: (host address)

What is an IP Address?

- Internet infrastructure addresses
  - Uniquely assigned to infrastructure elements
  - Globally visible to the entire Internet
- A finite “Common Resource”
  - Never “owned” by address users
- Managed globally under common policies
  - To ensure globally cohesive Internet
  - Policies developed by the Internet community
  - Implemented by cooperative RIR system

- Not dependent upon the DNS

IP addresses are not domain names…

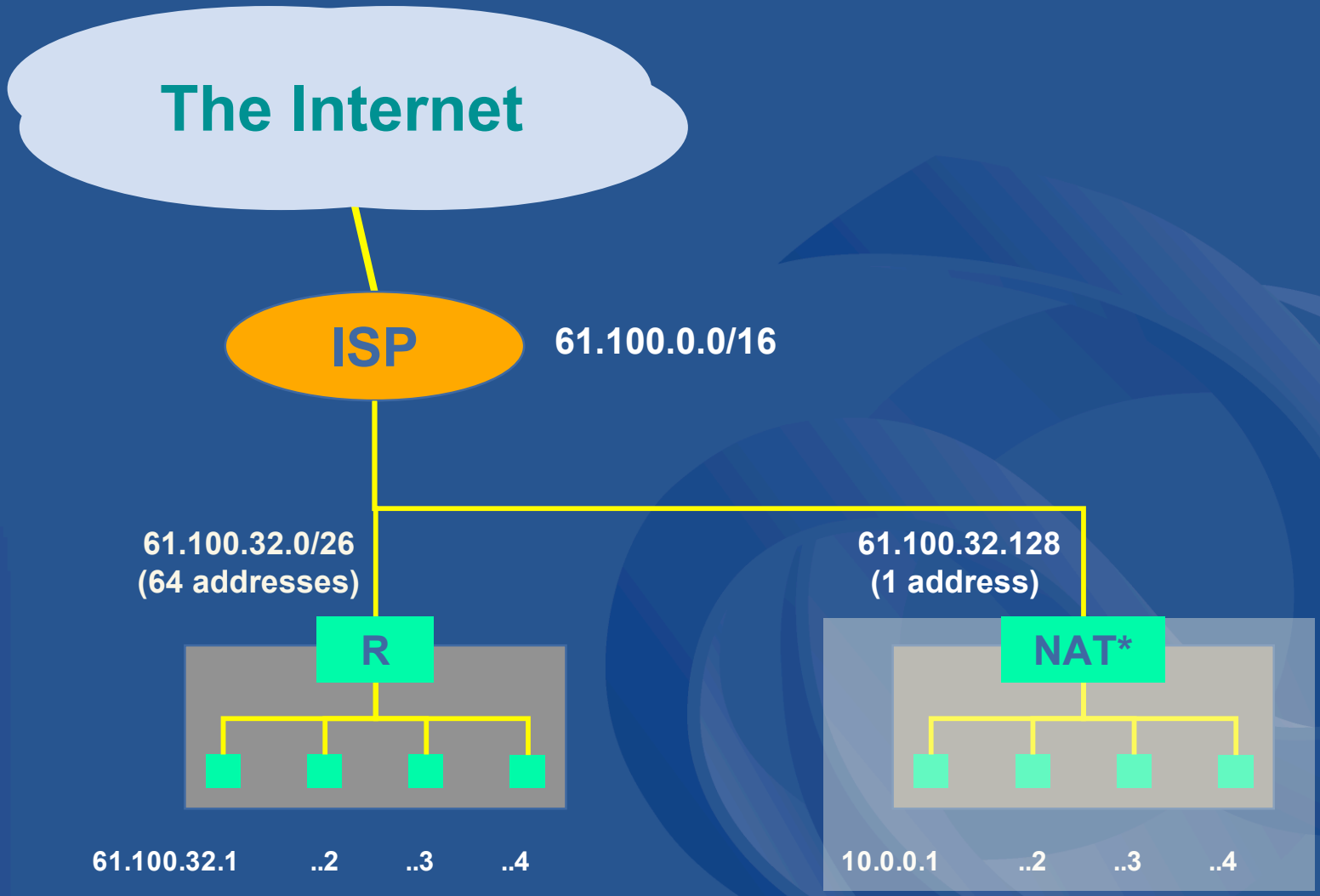


Why IPv6?

Rationale for IPv6

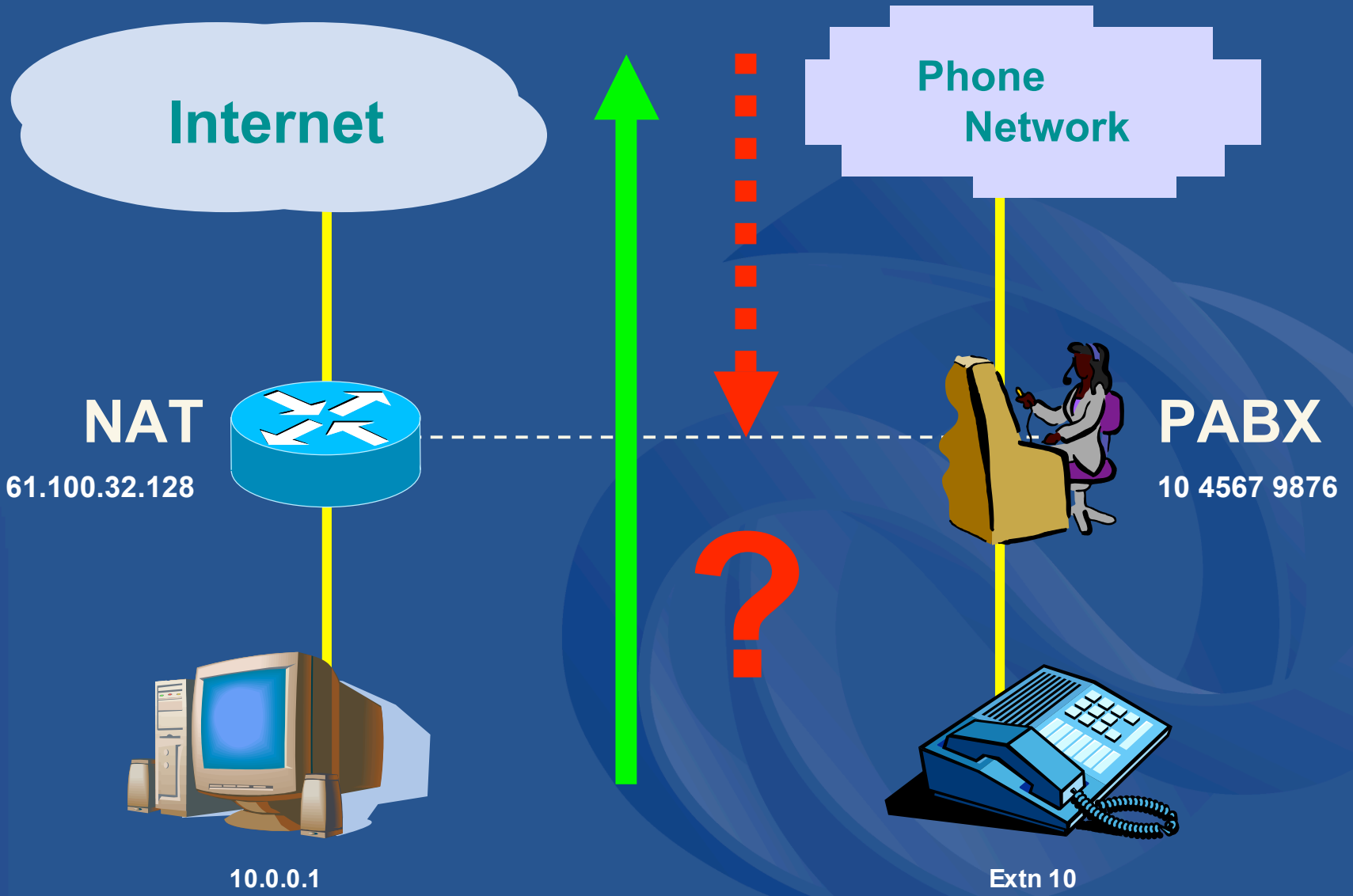
- IPv4 address space consumption
  - Now up to 10 years unallocated remaining
  - More if unused addresses can be reclaimed
  - These are today's projections – reality will definitely be different
- Loss of "end to end" connectivity
  - Widespread use of NAT due to ISP policies and marketing
  - Additional complexity and performance degradation
  - "Fog on the Internet"

The NAT problem



*AKA home router, ICS, firewall

The NAT problem

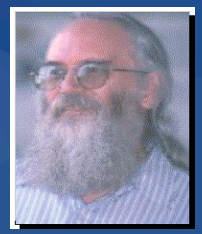


How are IP Addresses managed?

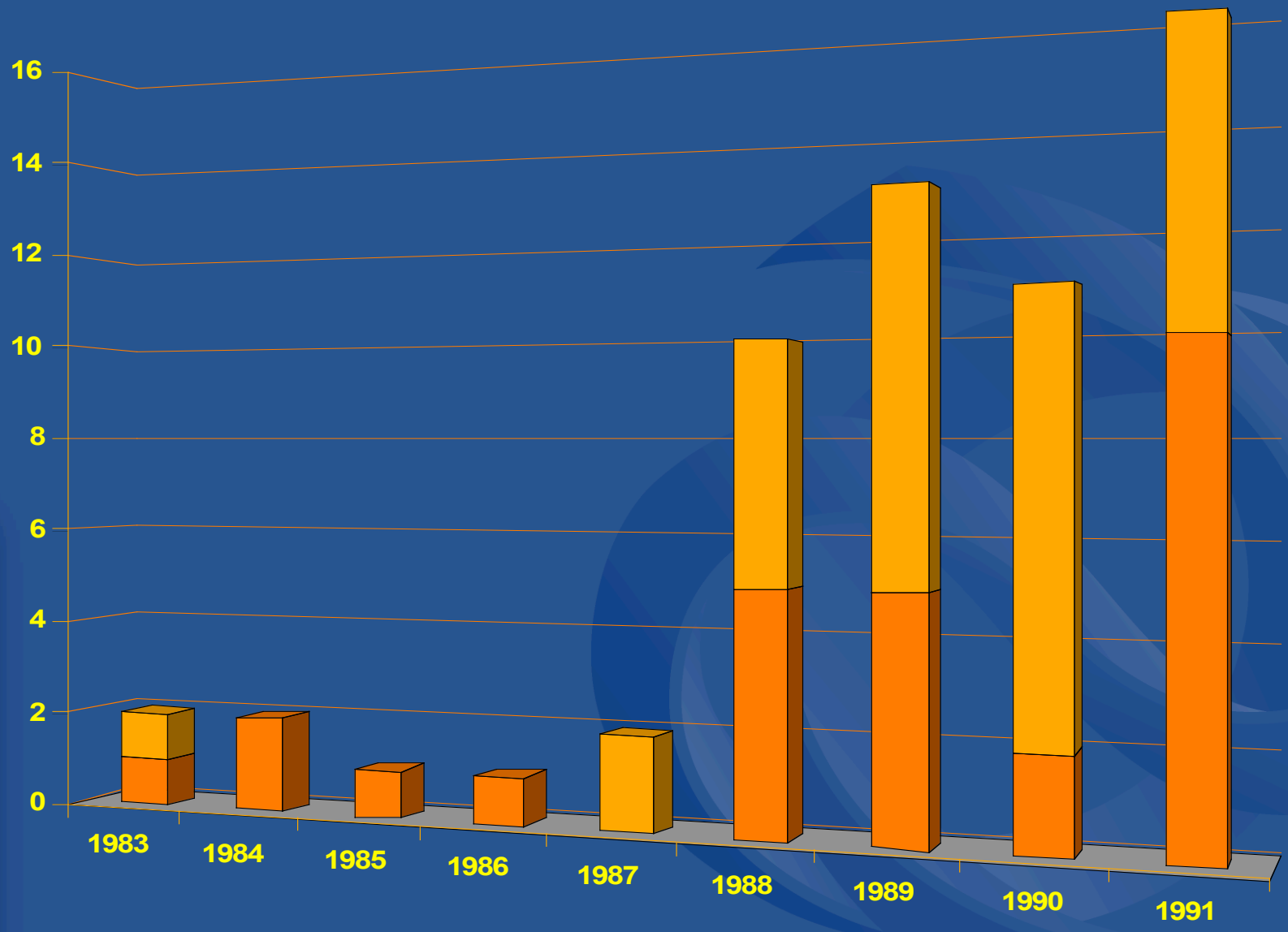
The early years: 1981 – 1992

1981:

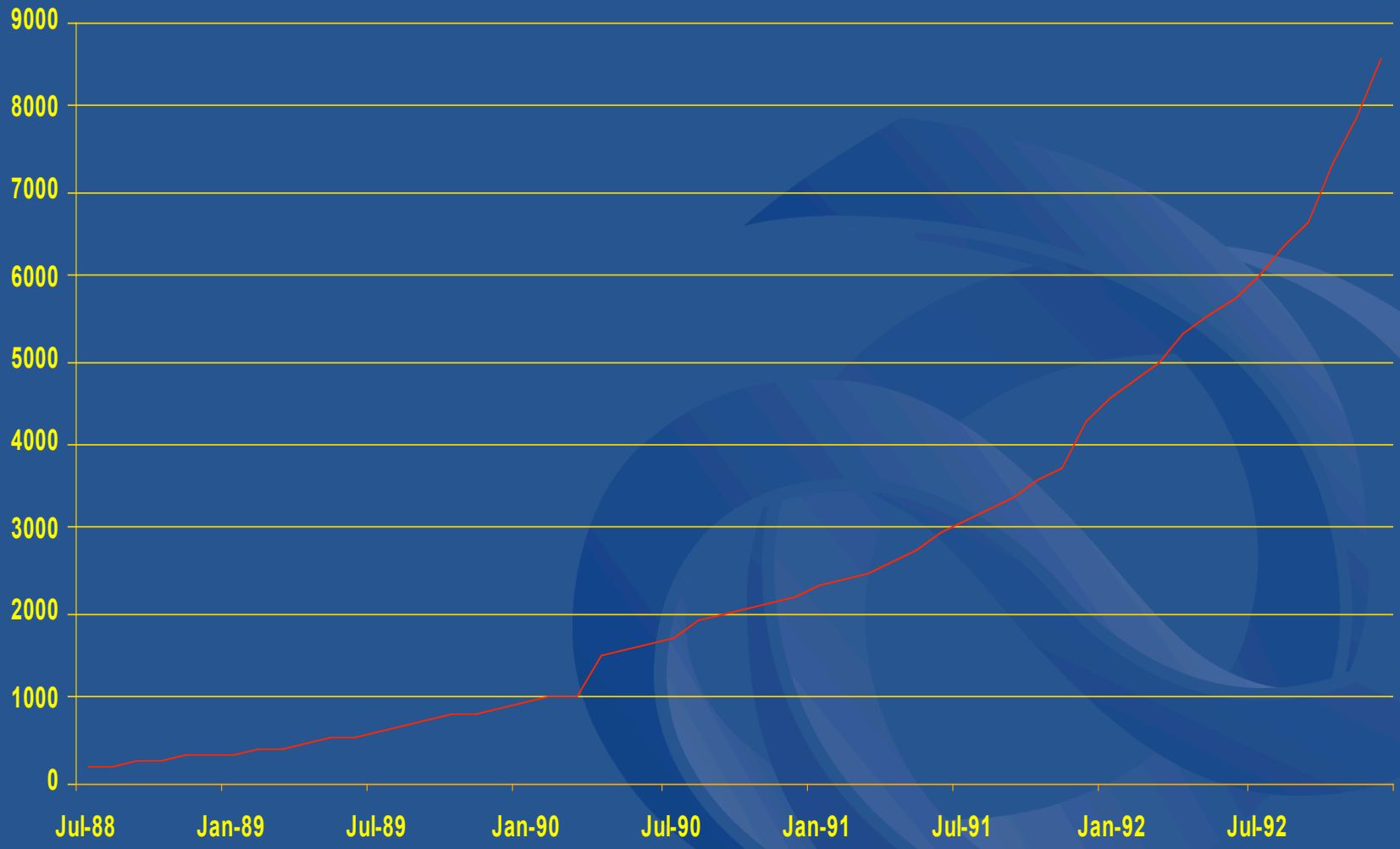
"The assignment of numbers is also handled by Jon. If you are developing a protocol or application that will require the use of a link, socket, port, protocol, or network number **please contact Jon to receive a number assignment**." (RFC 790)



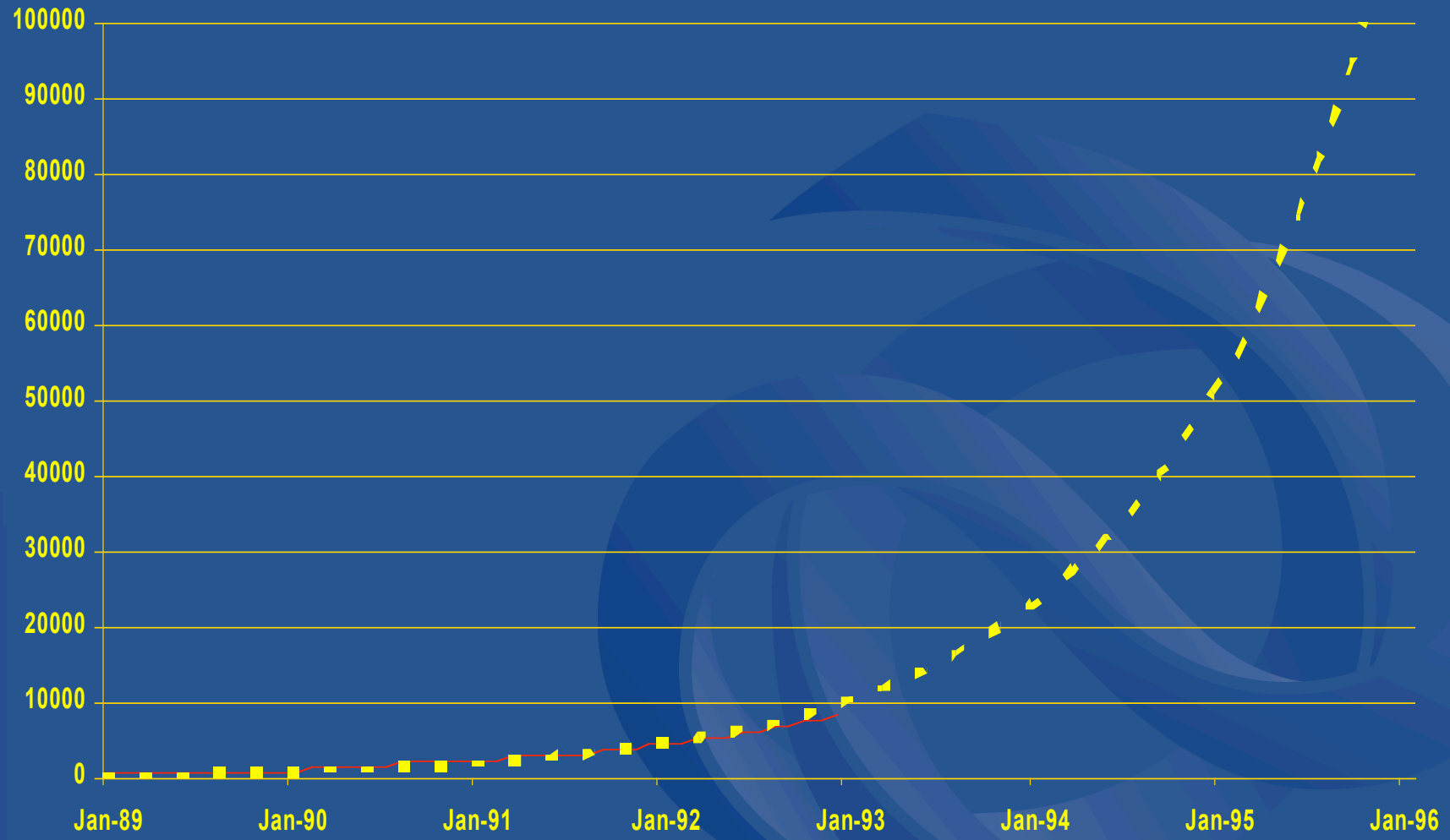
IANA address consumption



Global routing table: ’88 – ’92



Global routing table: Projection



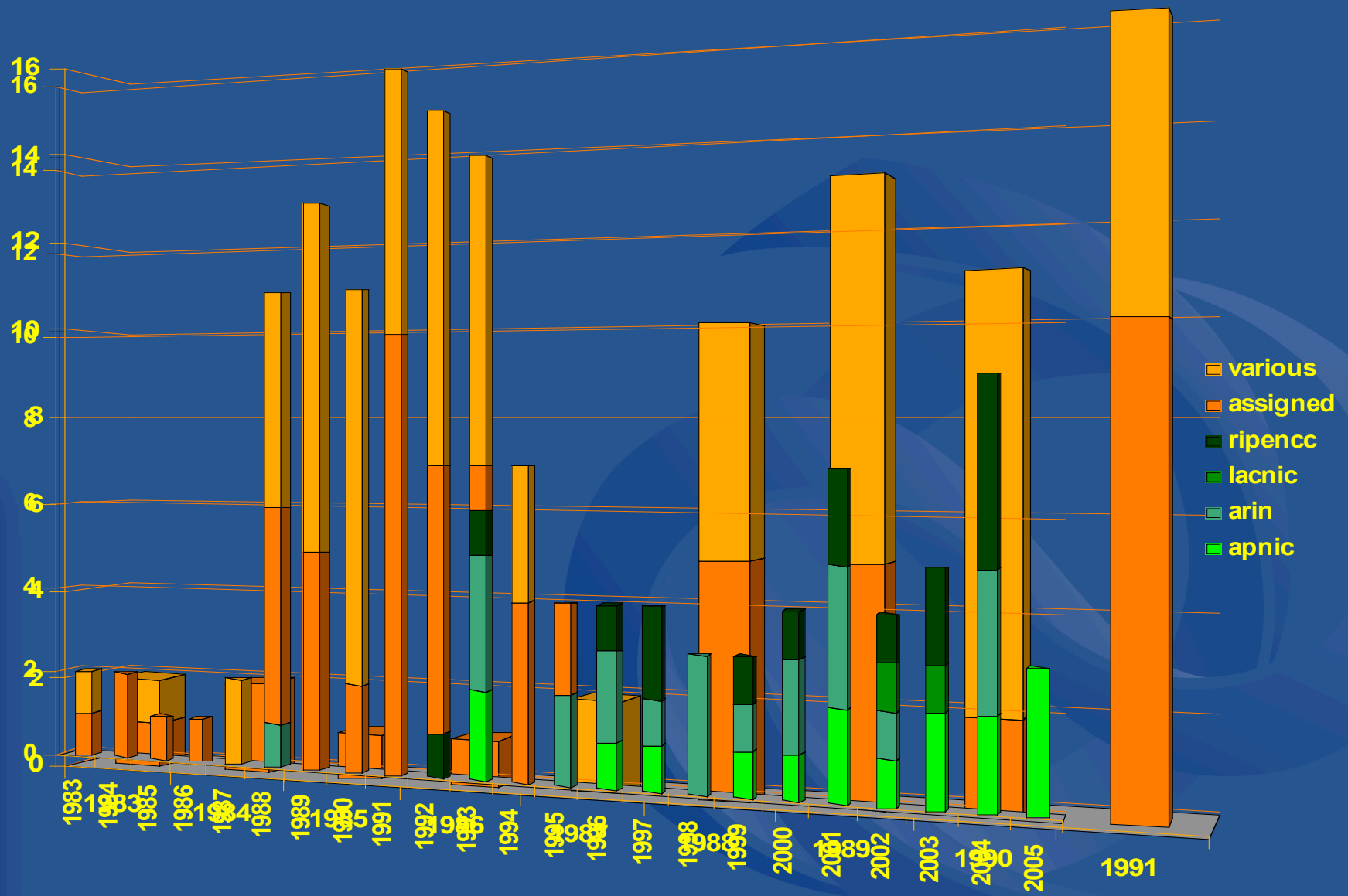
The boom years: 1992 – 2001

1992:

"It has become clear that … these problems are likely to become critical within the next one to three years." (RFC1338)

"…it is [now] desirable to consider delegating the registration function to an organization in each of those geographic areas." (RFC 1366)

IANA address consumption



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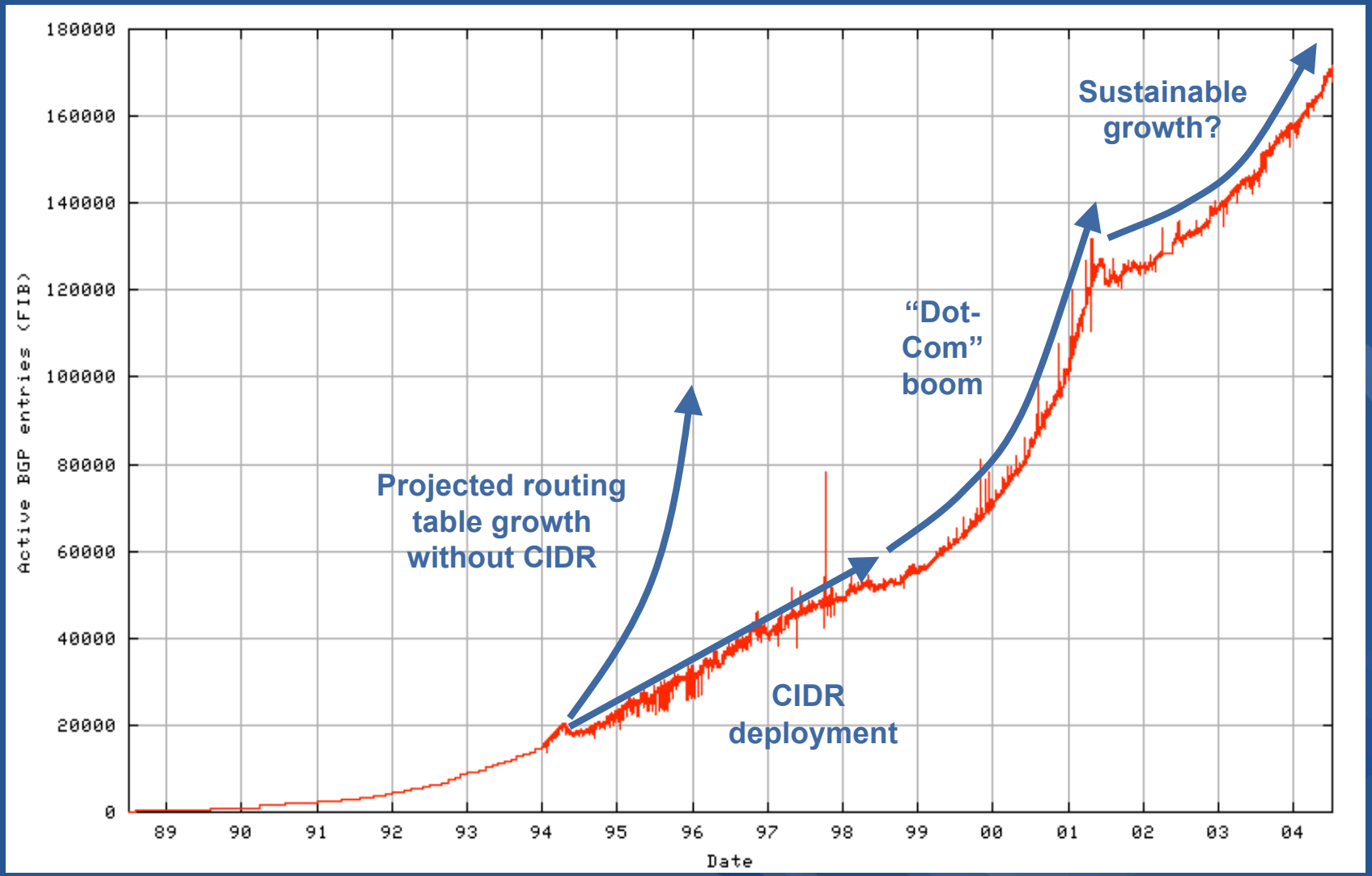
Global routing table



http://bgp.potaroo.net/as1221/bgp-active.html

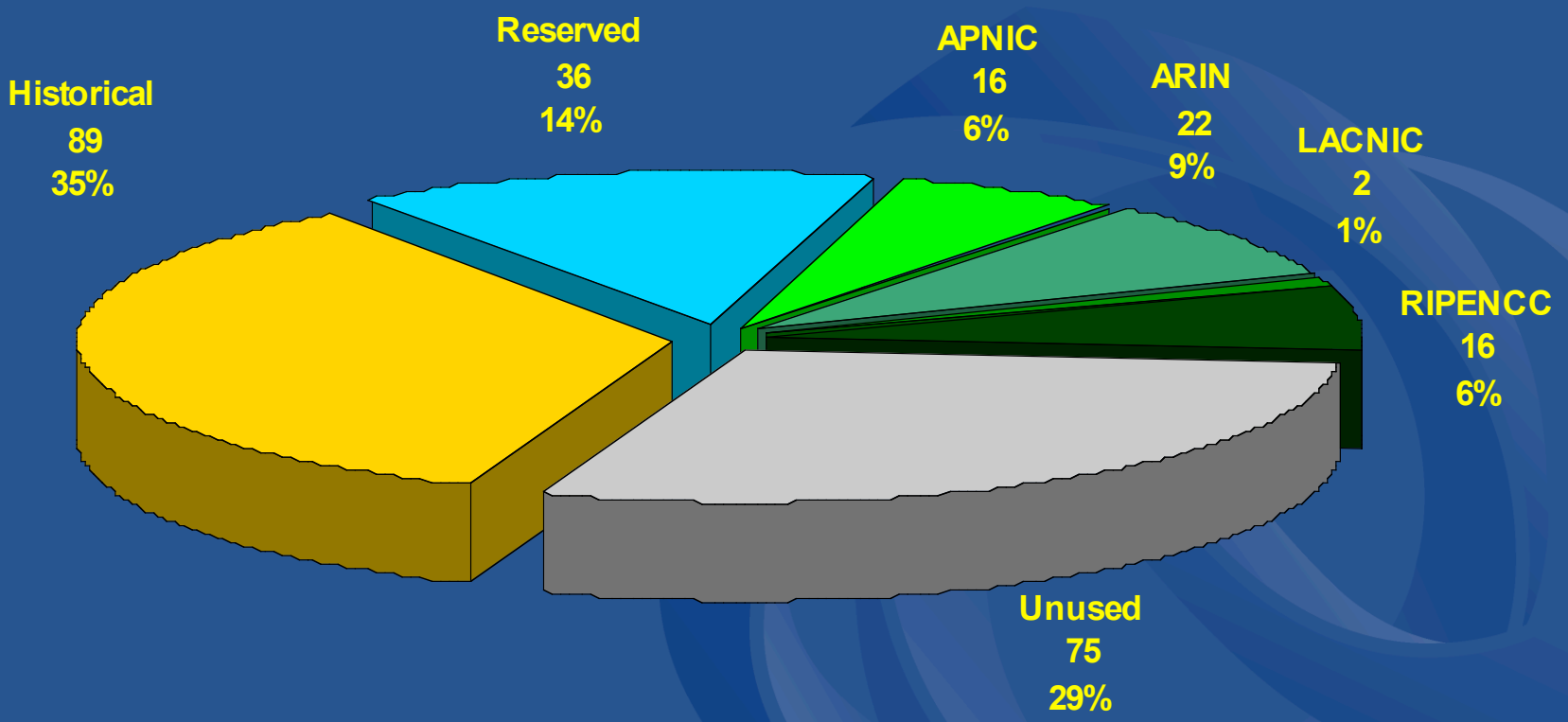
Recent years: 2002 – 2005

2004:

Establishment of the
Number Resource Organisation

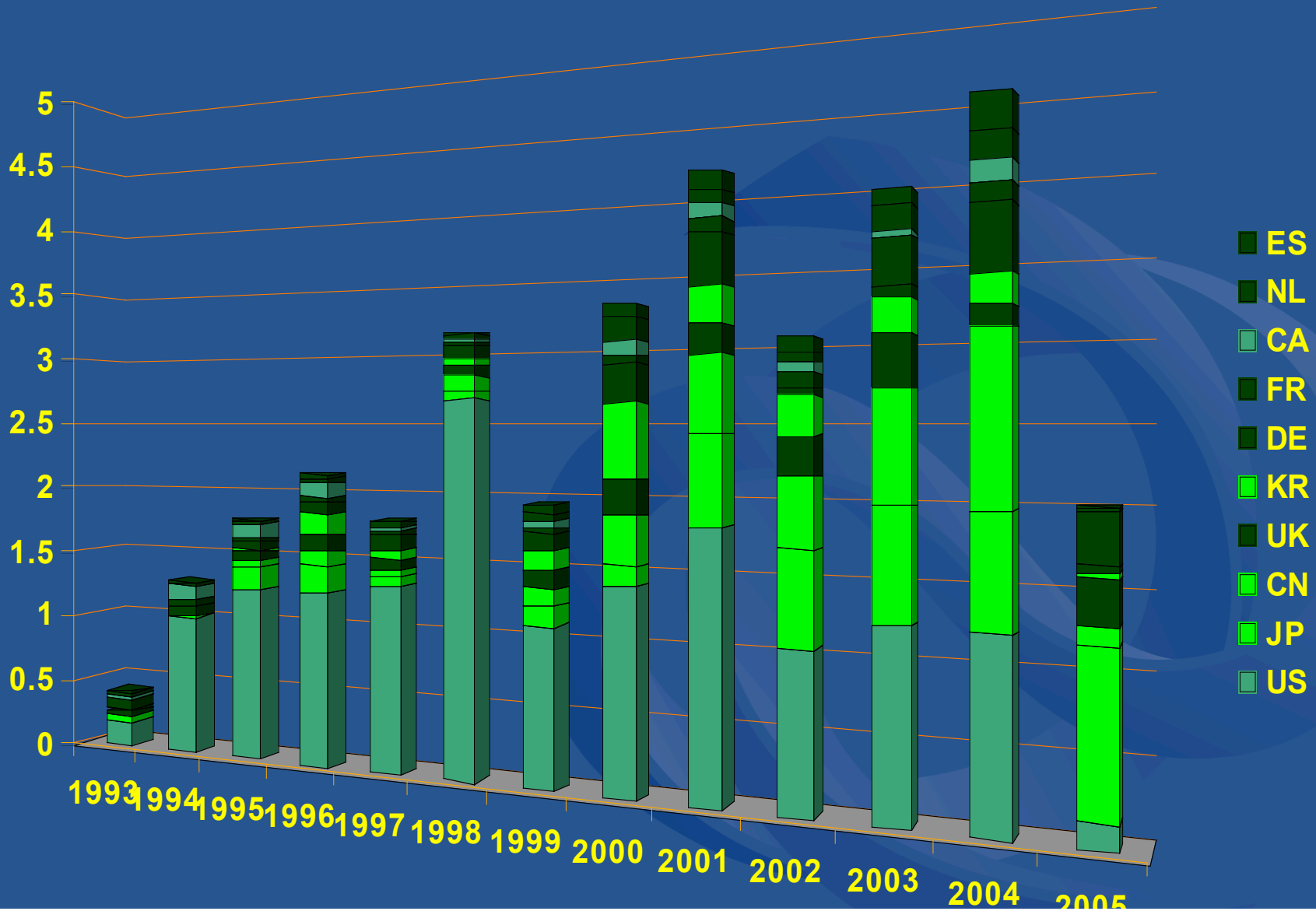
NRO

IPv4 distribution – Global

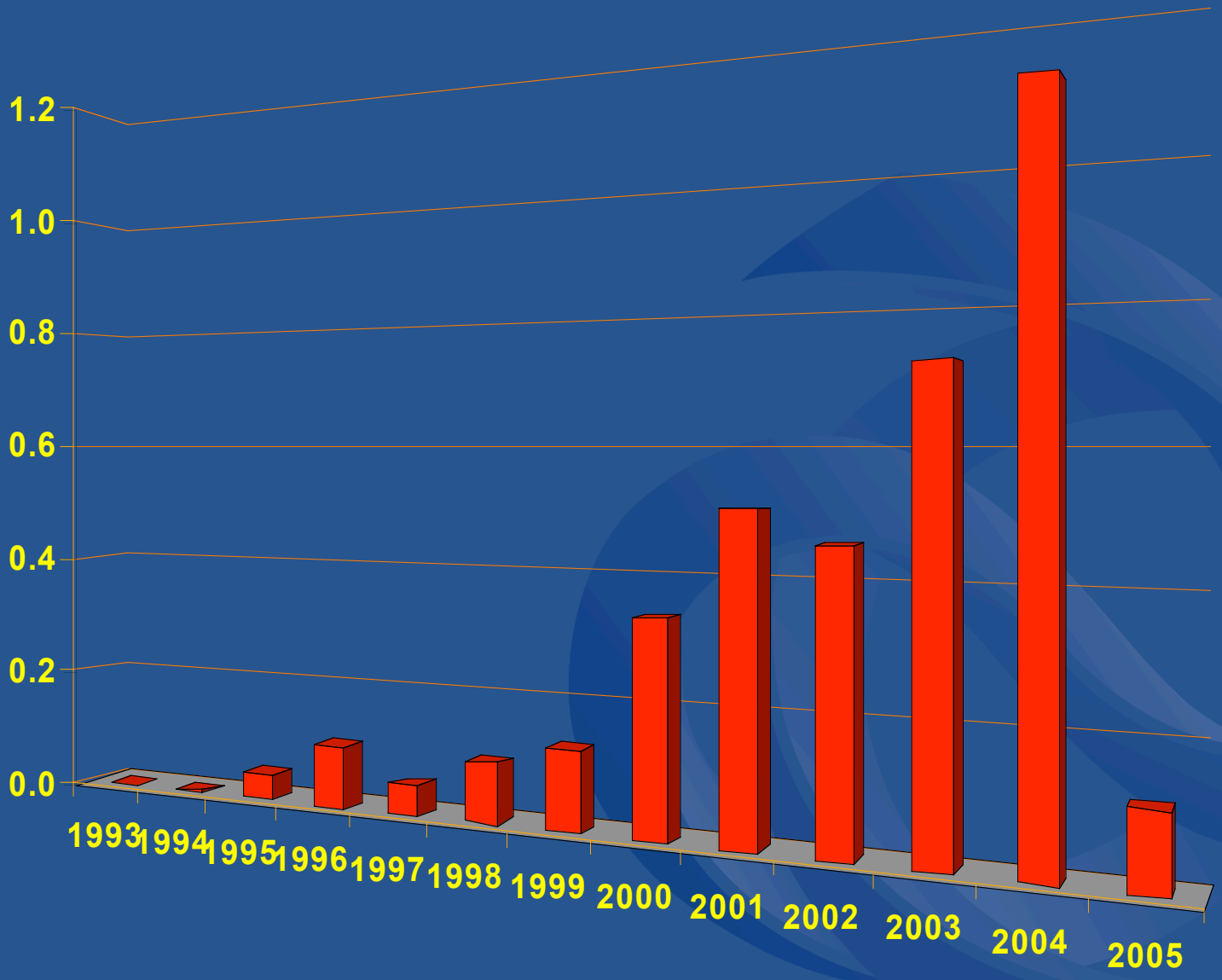


IPv4 distribution – Regional

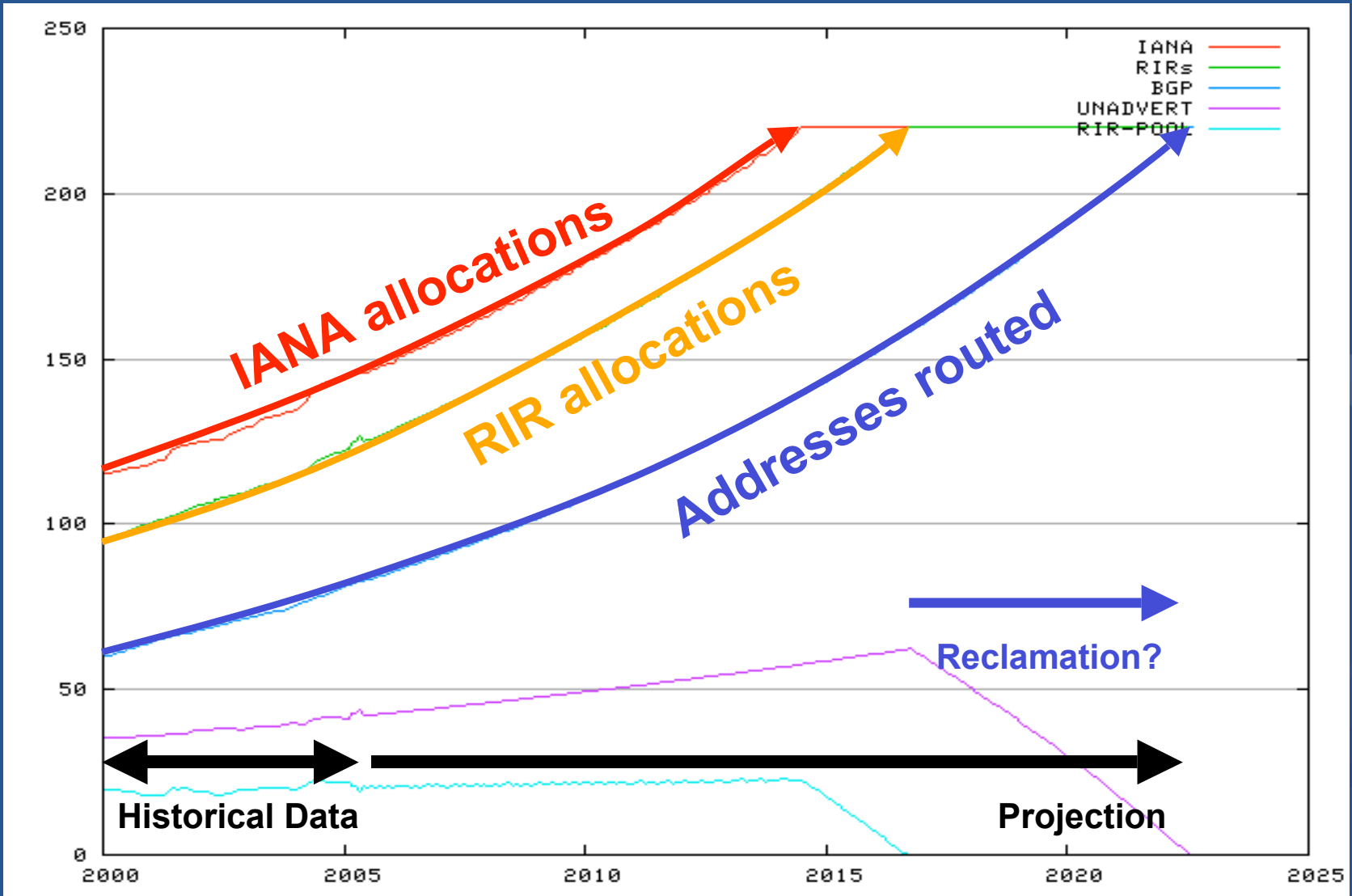
IPv4 Allocations – Global top 10



IPv4 allocations – CN



IPv4 lifetime



http://bgp.potaroo.net/ipv4

Regional Internet Registries

What are RIRs?

- Regional Internet Registries
  - Industry self-regulatory bodies
  - Non-profit, neutral and independent
  - Open membership-based structures
- Internet resource allocation and registration
  - Primarily, IP addresses – IPv4 and IPv6
- Policy development and coordination
  - Open Policy Meetings and processes
- Training and outreach
  - Training courses, seminars, conferences…
- Publications
  - Newsletters, reports, web site

What is APNIC?

- RIR for Asia Pacific region
  - Established 1993, Tokyo
  - 1010 members in 45 of 62 AP economies
  - 45 staff, 18 nationality/language groups
- National Internet Registry structure
  - All NIR follow same policies
  - Very close cooperation with CNNIC and others
- Other activities
  - Liaison: IETF, APT, PITA, APEC, ISP-A's
  - ITU Sector Member
  - UN ECOSOC consultative status
  - Deployment of rootservers…

Internet infrastructure support

- 'Anycast' root server deployments
  - Substantial funding by APNIC
  - Working with root operators (F, I, K, M)
  - 10+ deployed to 2004
  - Work in progress
    - AU (K), JP (K), IN, SG, KH, PK, CN
- Beijing
  - 90% of queries now handled locally

http://www.apnic.net/services/rootserver

What is APNIC?

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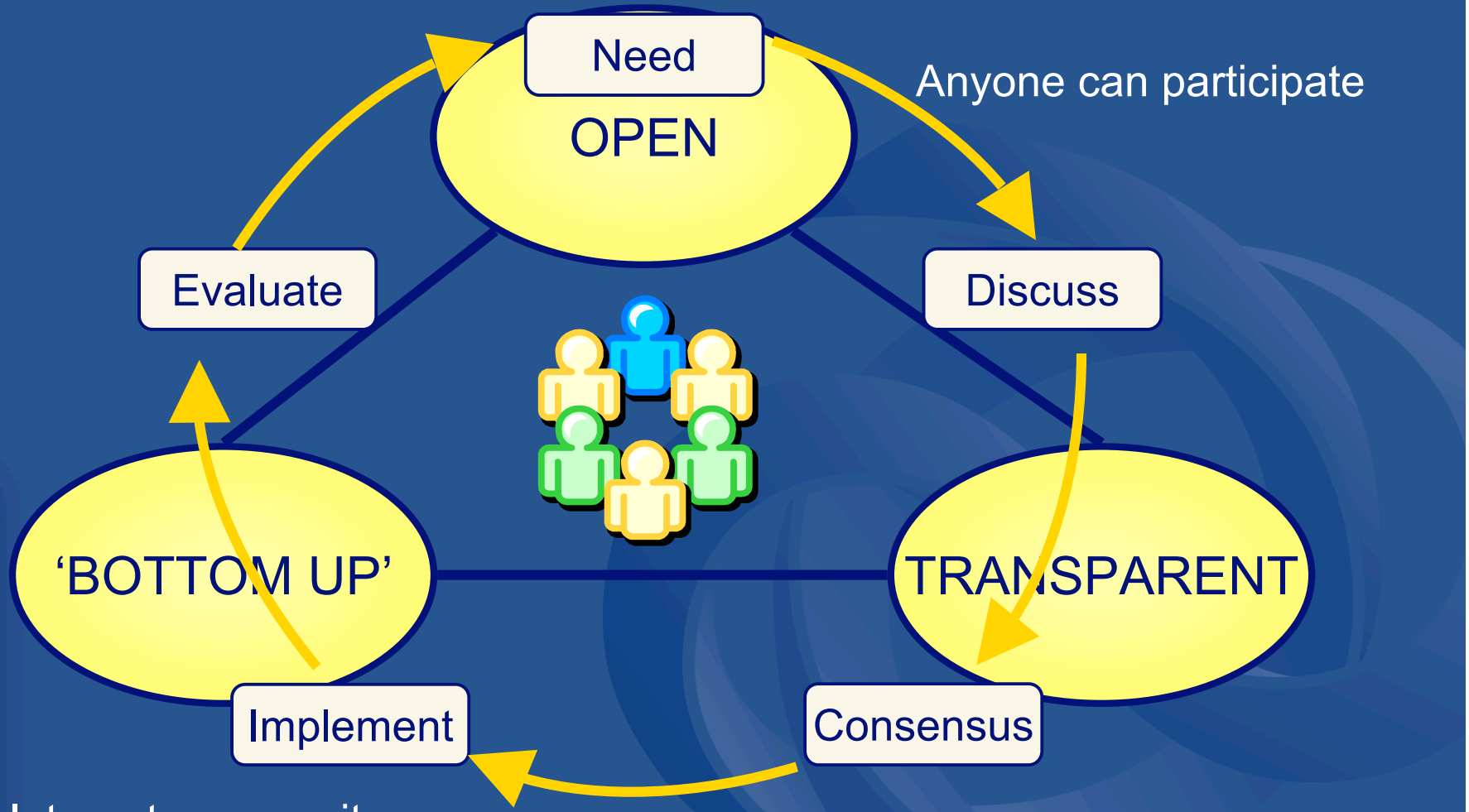
IP Address Policies

IP address management policies

- Fundamental technical principles
  - Provider-based addressing
  - Objective demonstrated need
  - Conservation, aggregation and registration
- Administrative policies
  - “Common resources” – not owned
  - Management in common interest
  - First-come-first-served allocation
- Constantly evolving through policy process
  - By consensus of Internet operator community
  - Process is open to all interested parties

RIR policy coordination



Global policy coordination

- Local actions have global impact
  - Consumption or wastage of common resource
  - Global routing table growth
- Bad behaviour can isolate entire networks and countries
  - E.g. Spam and hacking
- Inconsistent policies also cause global effects
  - E.g. Fragmentation of IP address space
  - If widespread, Internet routing is fragmented
  - End of global end-end routability
- Address policies must be globally consistent
  - RIRs work hard to ensure this

Recent proposals

- IPv6 reservations for all countries
  - Based on fair measure (population)
  - Could help to ensure fairness in future
  - Technical impacts need to be studied
- IPv6 allocations to all countries
  - Strong risk of diverging policies
  - 250 different policy systems?
  - Likely to seriously impact global Internet
- Parallel allocation systems
  - Competing systems may exhaust limited IP address resource
  - Implications should be studied

Summary

IP address policy

- A global internet needs global policy
  - RIRs and NRO achieve this
  - 10+ years of successful experience
- Policy fragmentation
  - Internet fragmentation, loss of global routing
- IPv4 has a long history
  - Result of early allocations is unfair distribution
  - RIRs have ensured that current allocation policies are fair to all
- IPv6 is being managed better from the start
  - RIR system is responsible and fair
  - Policy will continue to evolve with the Internet

IPv6 – Internet for everything!

IPv6 – Summary

- The good news…
  - IPv6 is available now!
  - IPv6 addresses are very easy to obtain
- The not so good news…
  - Complexity: cost and learning curve
  - Demand? Do users want it? "Chicken and Egg"
- The reality: A long transition
  - "Changing engines mid-flight"
  - Long process – 10 years to complete?

- The critical message: Start now!

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Thank You