IP Addresses: A critical resource for Asia-Pacific Internet development

China Inet 2000, Beijing, 6-9 June 2000

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Director General, APNIC

IP Addresses: A critical resource

- Introducing APNIC
  - Regional Internet Registry (RIR) for the Asia-Pacific region
- IP Address Management
  - History, policies and procedures
- Asia-Pacific Infrastructure Trends
  - Growth in infrastructure deployment as reflected by Internet resource consumption
  - Transition to IPv6

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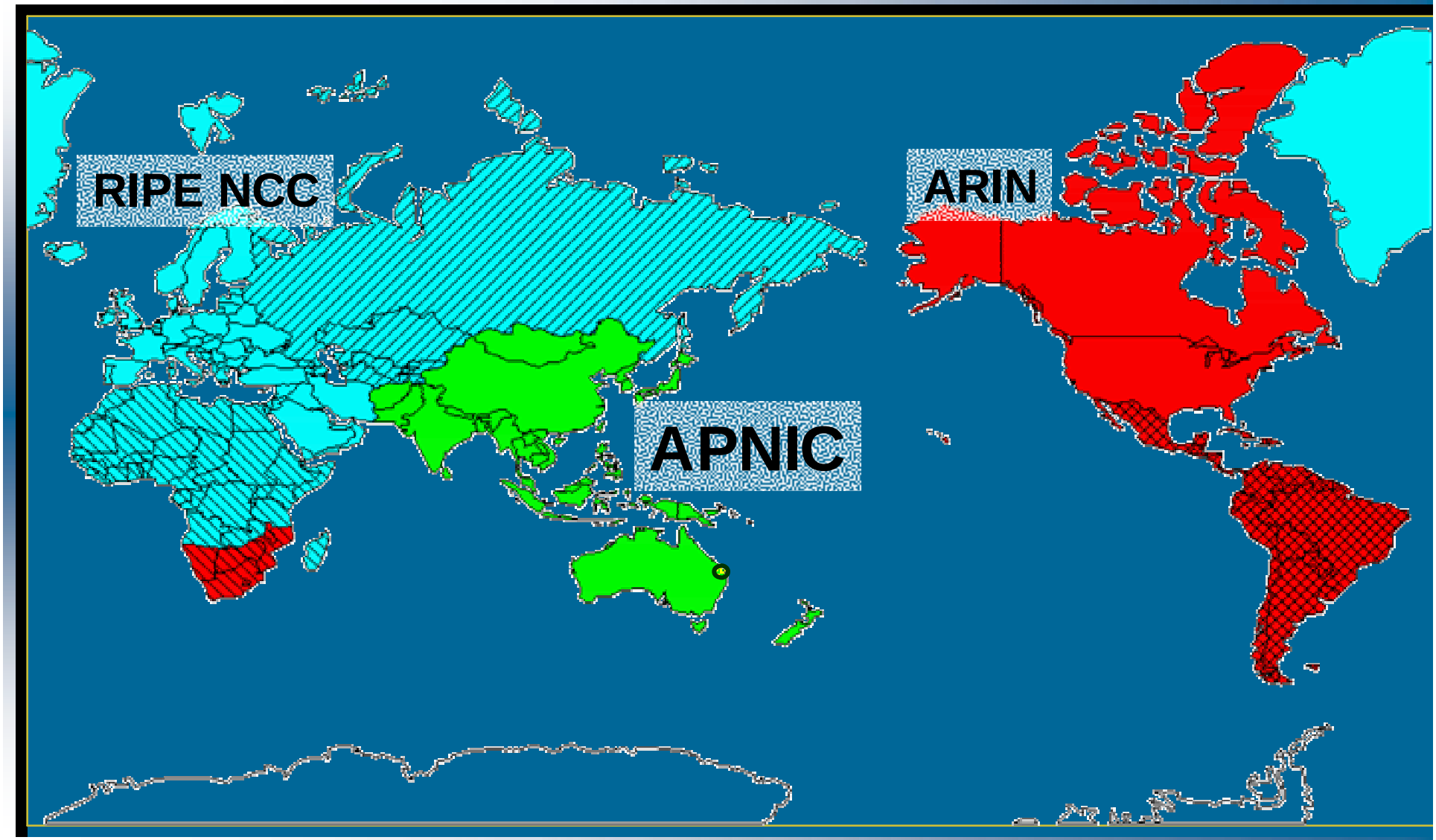
What is APNIC?

- Regional Internet (Address) Registry
  - Regional authority for IP address distribution
- Membership-based, non-profit, impartial and independent organisation
- Established 1993, Tokyo, Japan
  - Under authority of IANA
  - Relocated in 1998 to Brisbane, Australia
- Undergoing rapid growth and development
  - In line with Asian economic recovery...

Since January 1999...

- APNIC membership
  - Increased 105% - from 246 to 505
- APNIC staff
  - Increased 160% - from 8 to 21
- Service activity
  - Processed over 25,000 tickets
- Total allocations
  - Increased 63% - from 1.6 to 2.6 x /8

Where is APNIC?



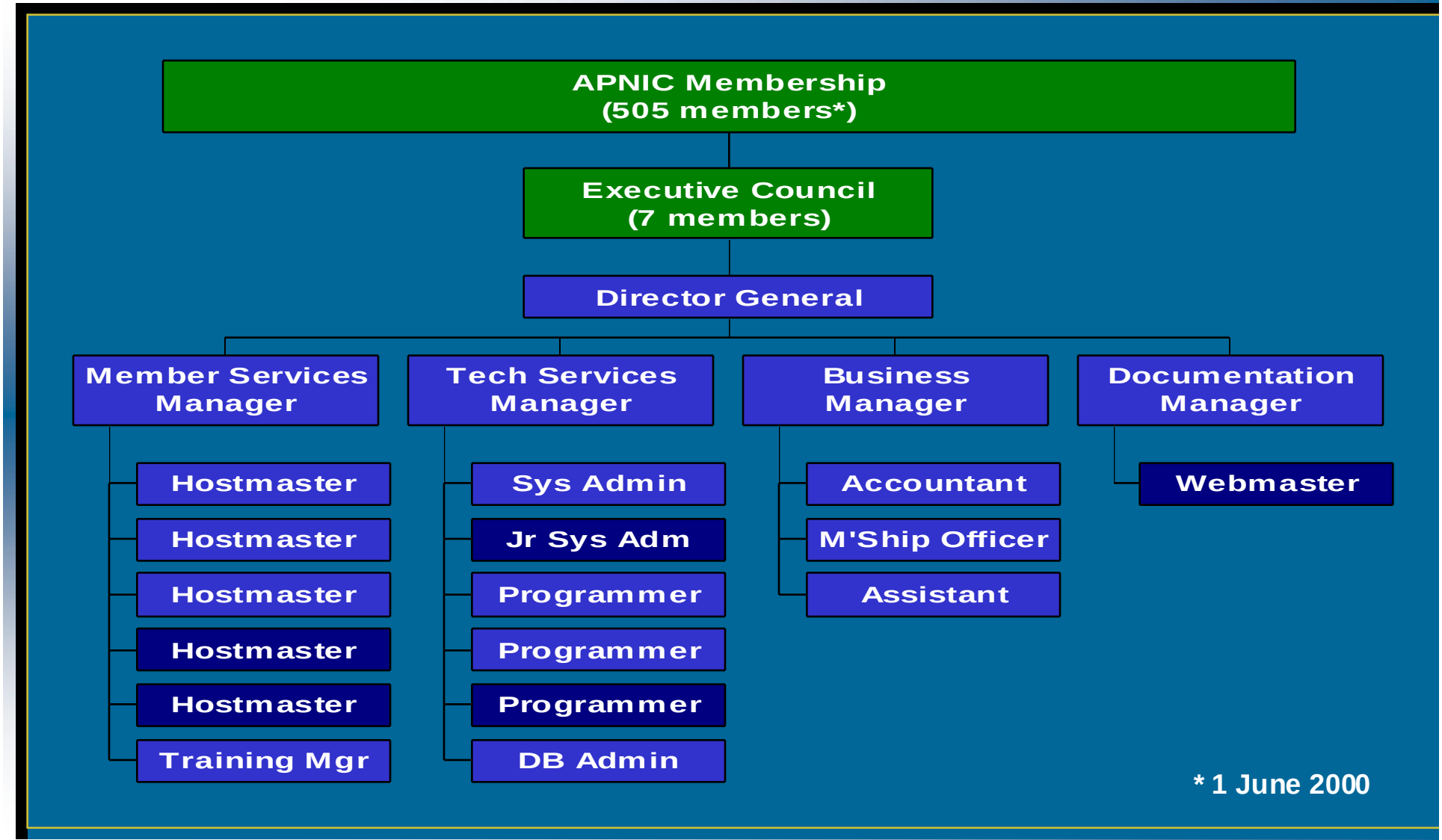
What does APNIC do?

- Internet resource management
  - IP address allocation and assignment
  - AS number assignments
- Resource registration
  - Authoritative registration server: *whois*
- DNS management
  - Reverse domains: *in-addr.arpa*
  - **Not**: Conventional DNS registration

What does APNIC do?

- Training courses
  - Launched in 1999
  - Subsidised for APNIC members
- Representation and coordination
  - Regional representation at Internet meetings
  - Coordination with RIRs, IANA, ICANN etc
- Information dissemination
  - APNIC meetings, Web site, mailing lists
  - Reports and statistics (increasingly)

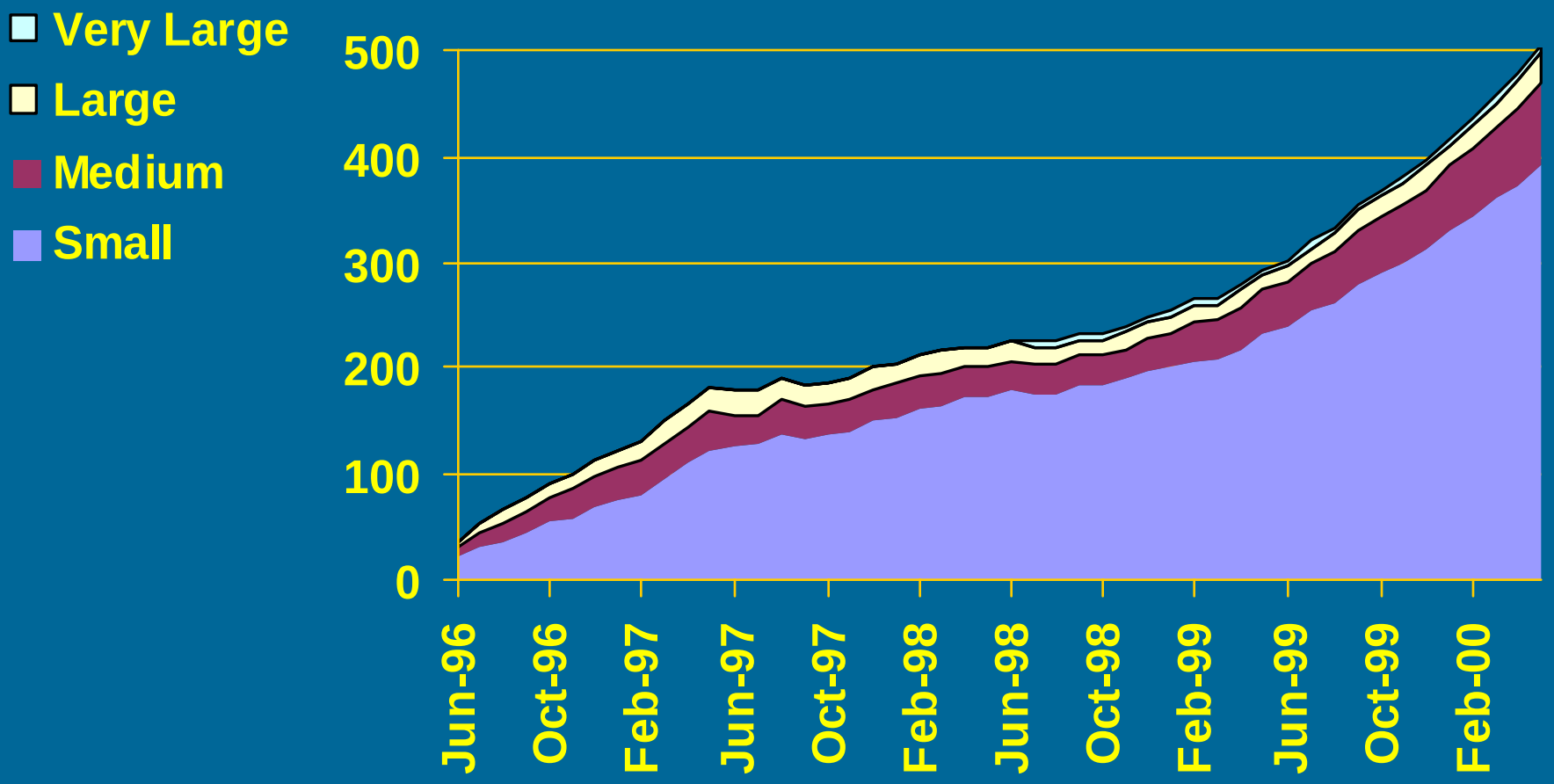
How does APNIC look?



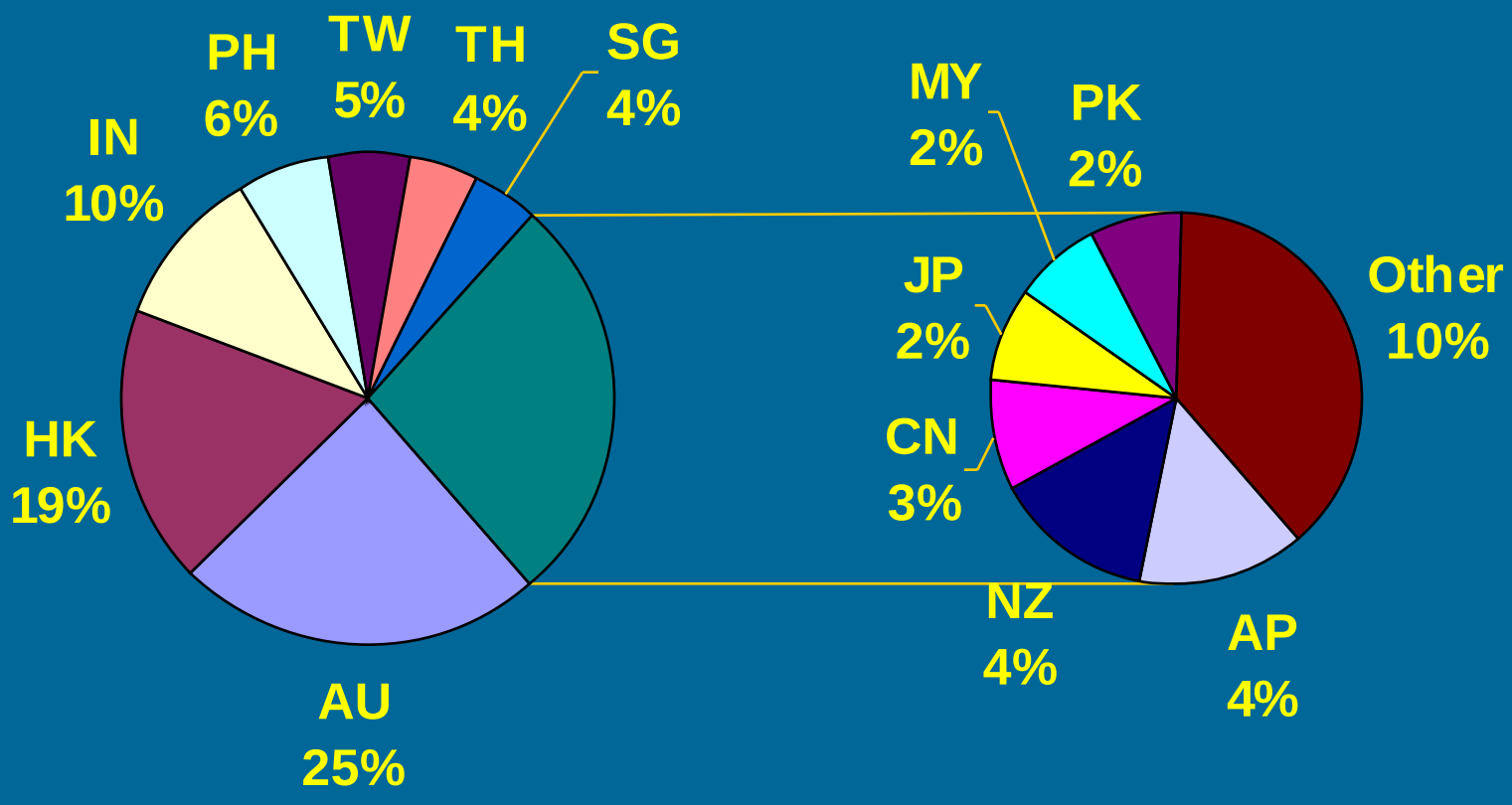
Who are APNIC members?

- Membership is Open
  - Large and small ISPs, multinational organisations, National Internet Registries
  - Requirements: Membership agreement
    Location in the AP region
- Benefits of Membership
  - Resource allocation and registration
  - Free attendance and voting at APNIC meetings
  - **NOT**: Automatic or easier address allocation

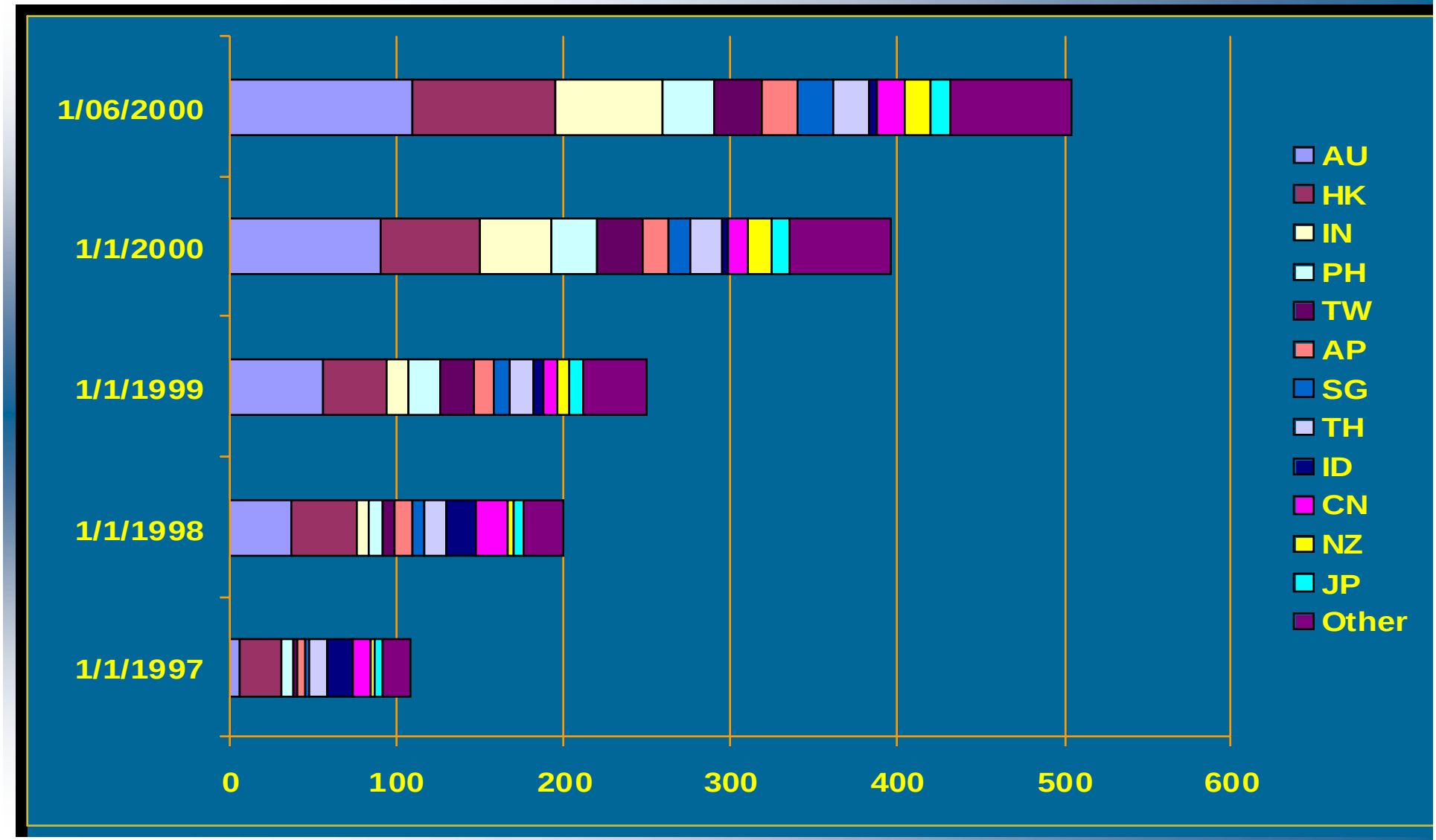
How many APNIC members?



Where are APNIC members?



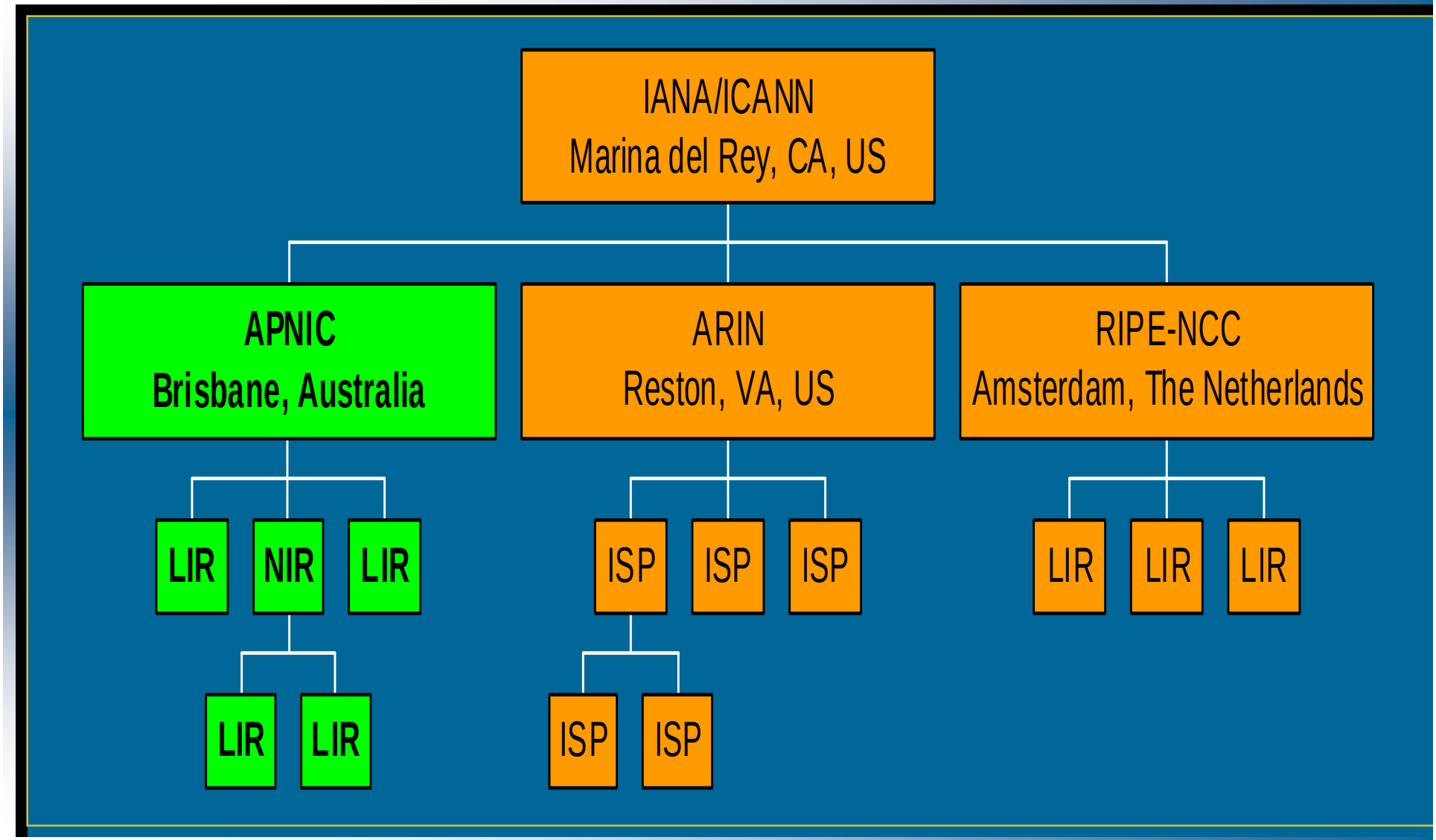
Where are APNIC members?

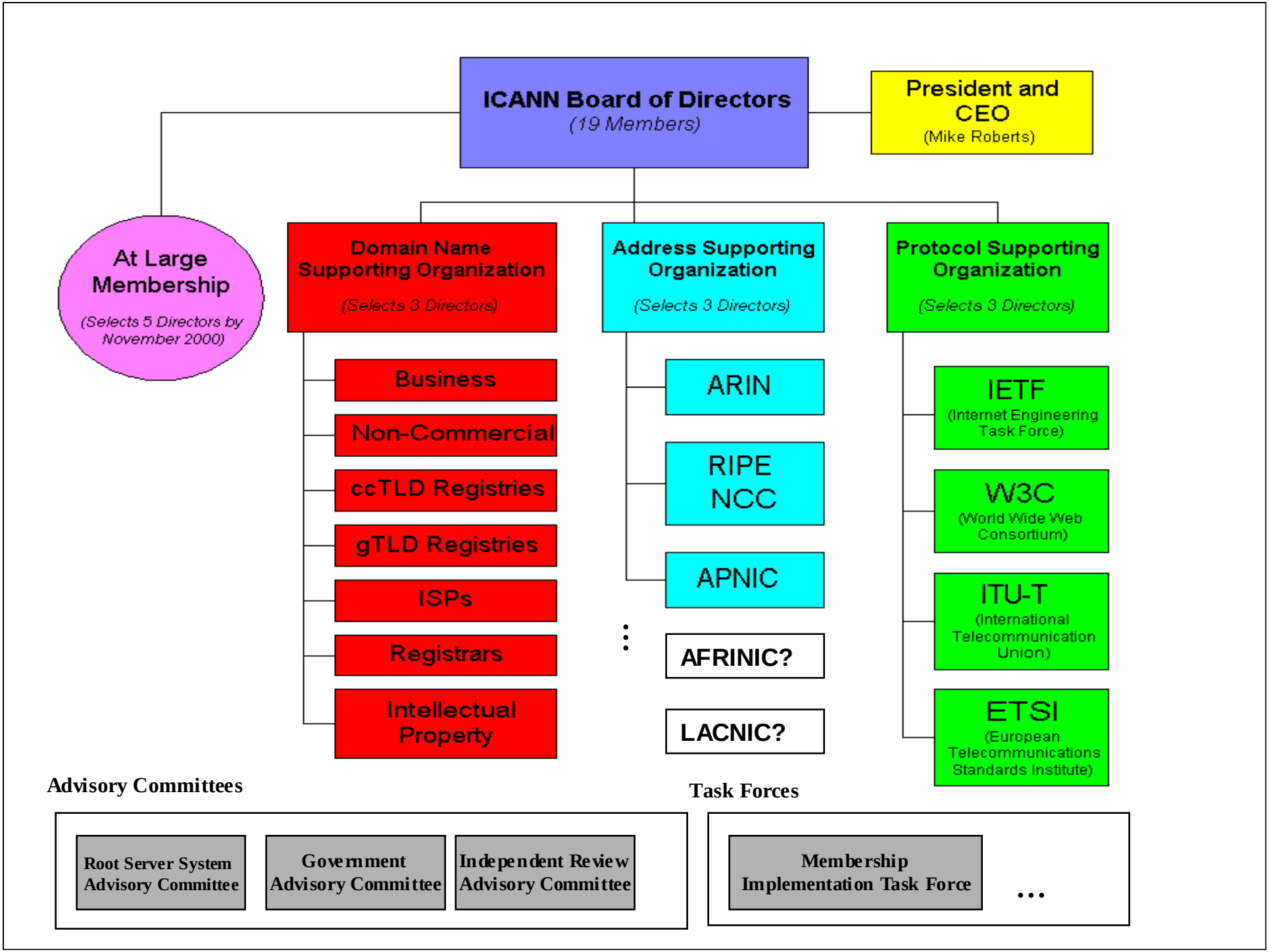


What is the APNIC model?

- Self-regulatory consensus model
  - OPEN
    - Membership
    - Mailing list subscription
    - Policy forum
  - All are welcome to APNIC Meetings!
- Policy making
  - Membership reviews and approves on policy
- Policy implementation
  - Secretariat and Membership

RIR Operational Structure




ICANN Board of Directors
(19 Members)
President and CEO
(Mike Roberts)
At Large Membership
(Selects 5 Directors by November 2000)
Domain Name Supporting Organization
(Selects 3 Directors)
Address Supporting Organization
(Selects 3 Directors)
Protocol Supporting Organization
(Selects 3 Directors)
Business
Non-Commercial
ccTLD Registries
gTLD Registries
ISPs
Registrars
Intellectual Property
ARIN
RIPE NCC
APNIC
AFRINIC?
LACNIC?
IETF
(Internet Engineering Task Force)
W3C
(World Wide Web Consortium)
ITU-T
(International Telecommunication Union)
ETSI
(European Telecommunications Standards Institute)
Advisory Committees
Root Server System Advisory Committee
Government Advisory Committee
Independent Review Advisory Committee
Task Forces
Membership Implementation Task Force
...

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What are IP Addresses anyway?

- IPv4: 32-bit numeric address
  - e.g. 203.37.255.97
  - 4 billion available (though much less in practice)
- IPv6: 128-bit hexadecimal address
  - e.g. 3ffe:0200::
  - 16 billion billion avail (much **much** less in practice)
- *Public infrastructure addresses*
  - **Every device must have an IP address**
  - **Every globally-reachable address is unique**

IP Addresses: Overview

"From" address (32 bits)	"To" address (32 bits)	Version	Contents

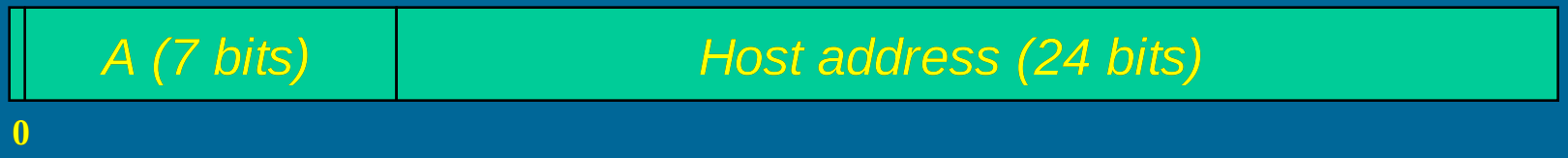
An Internet Packet (IPv4)

Classful Address Architecture

- Each IP address has two parts
  - “network” address
  - “host” address
- Initially, only 256 networks
- Then, network “classes” introduced:
  - Class A (128 networks x 16M hosts)
  - Class B (16,384 x 65K hosts)
  - Class C (2M x 256 hosts)

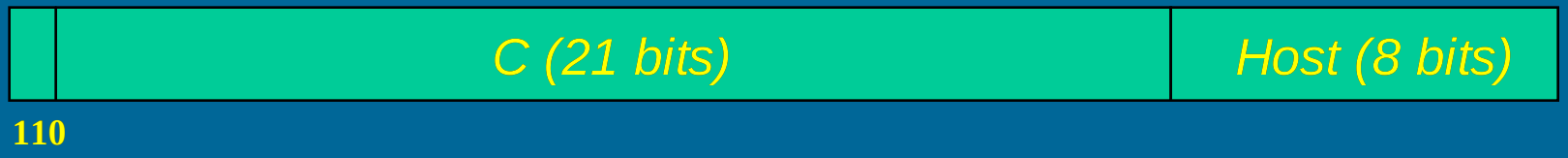
Classful Address Architecture

Class A: 128 networks x 16M hosts (50% of all address space)



Class B: 16K networks x 64K hosts (25%)

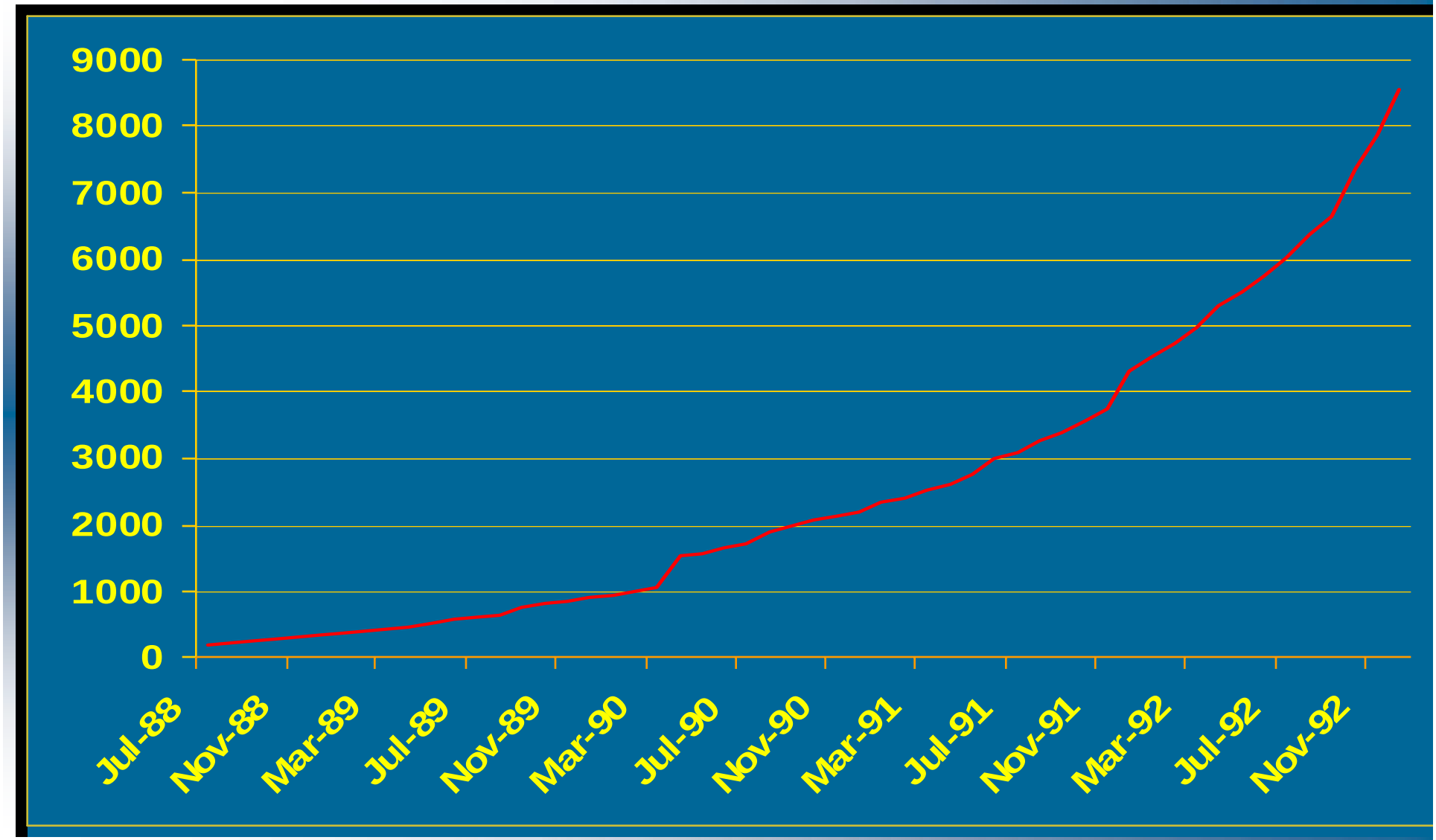
Class C: 2M networks x 256 hosts (12.5%)



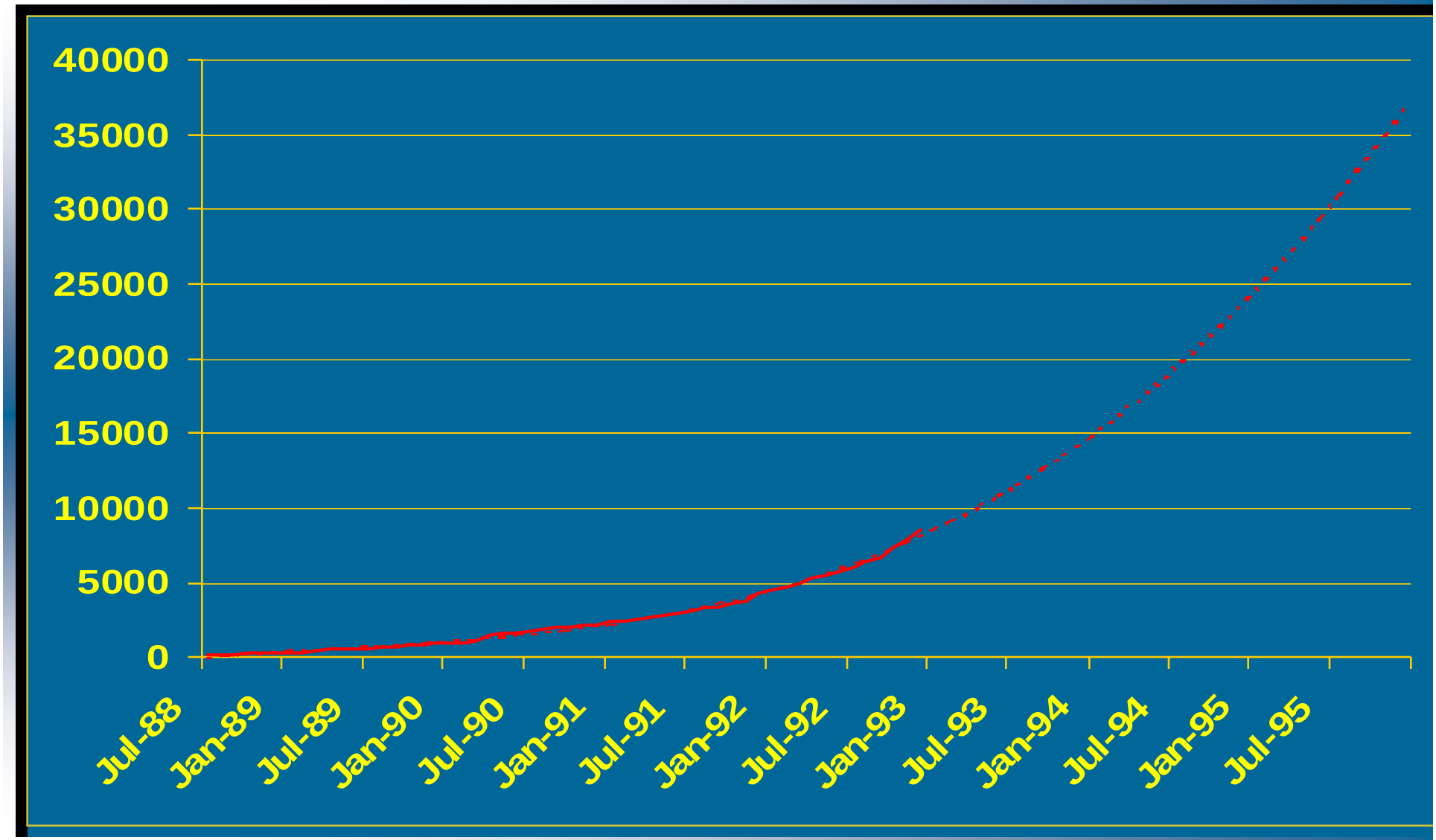
Classful Address Architecture

- By end of 1992, several problems
- Internet address depletion
  - “Generous” allocation policy
  - Many addresses allocated but unused
- Growing routing table
  - Routers overloaded
  - Increasing instability of routing structure

Global Routing Table: ’88 - ’92



Global Routing Table Projection



Classless Address Architecture

- CIDR: Classless Inter-Domain Routing
  - Proposed as “supernetting” in 1992 (RFC1367)
  - Finalised and deployed from 1993 (RFC1519)
- Much higher utilisation through variable-length network address:
    - /10 = 10-bit network + 22-bit host (4M-2 hosts)
    - /19 = 13-bit host (8192-2 hosts)
    - /26 = 4-bit host (16-2 hosts)
- Higher routing efficiency through aggregation

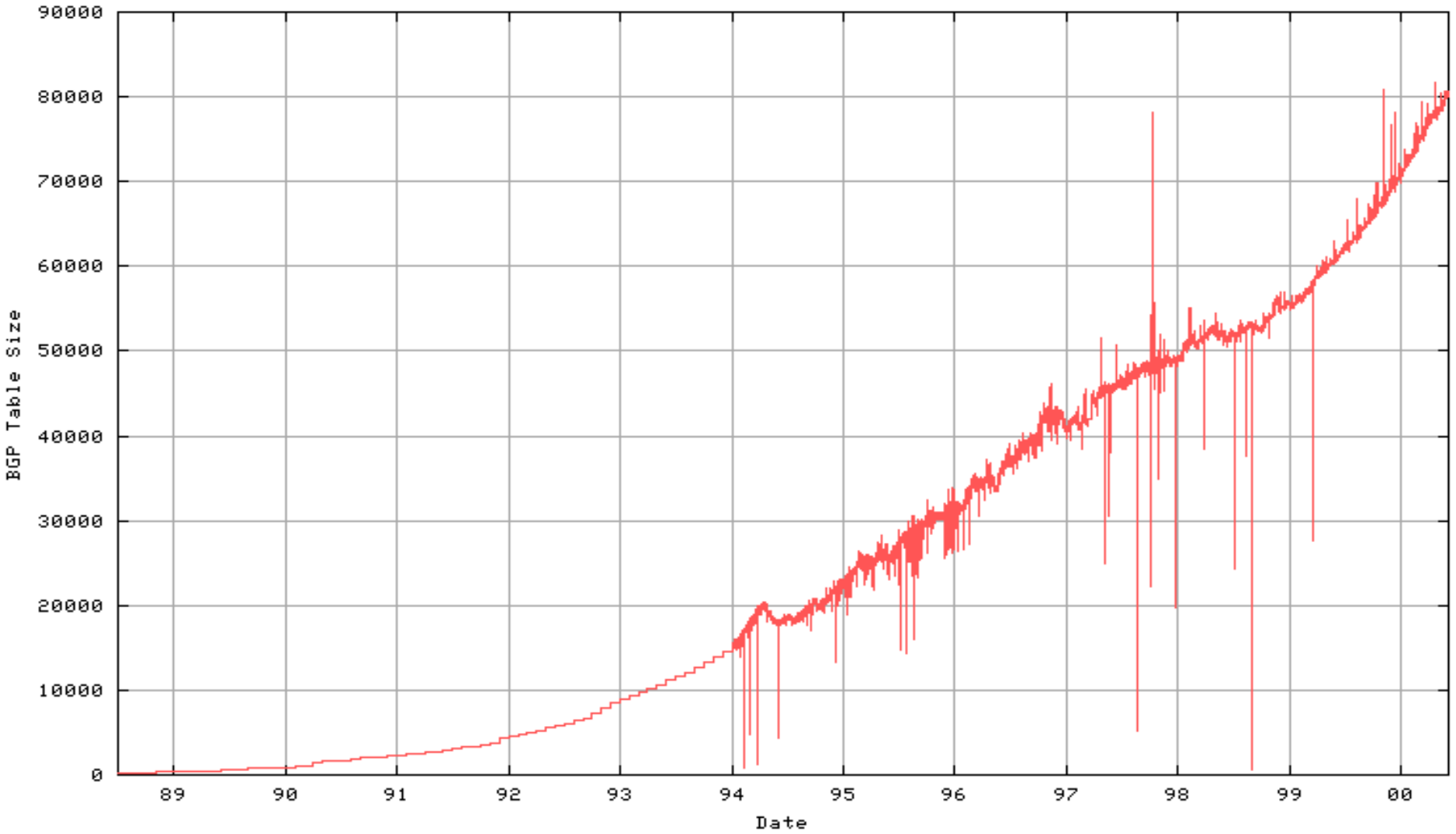
Classless Address Architecture

/10: 4M hosts

/19: 8190 hosts

/26: 14 hosts

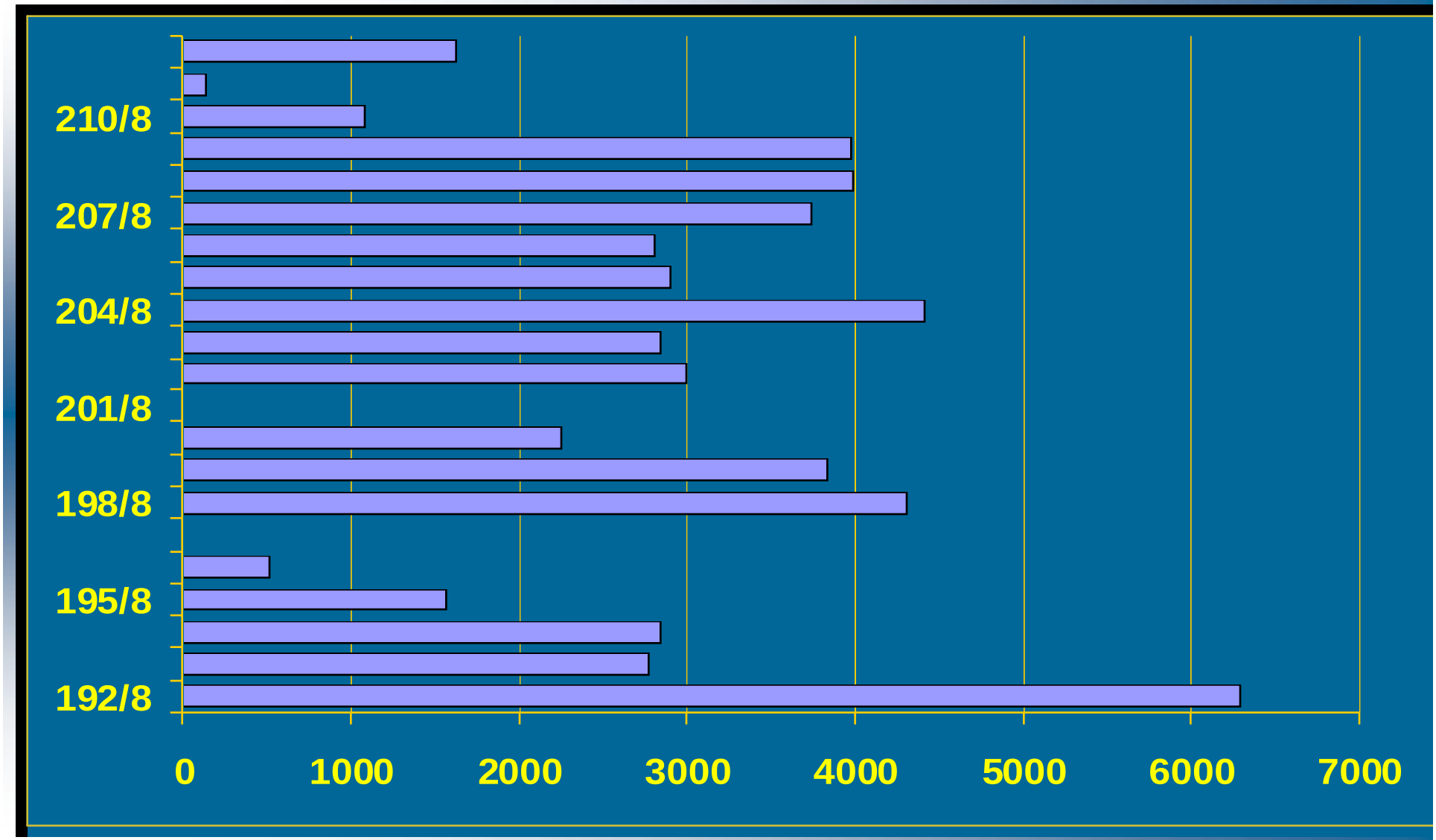
Routing Table Growth: ’88 - 2000



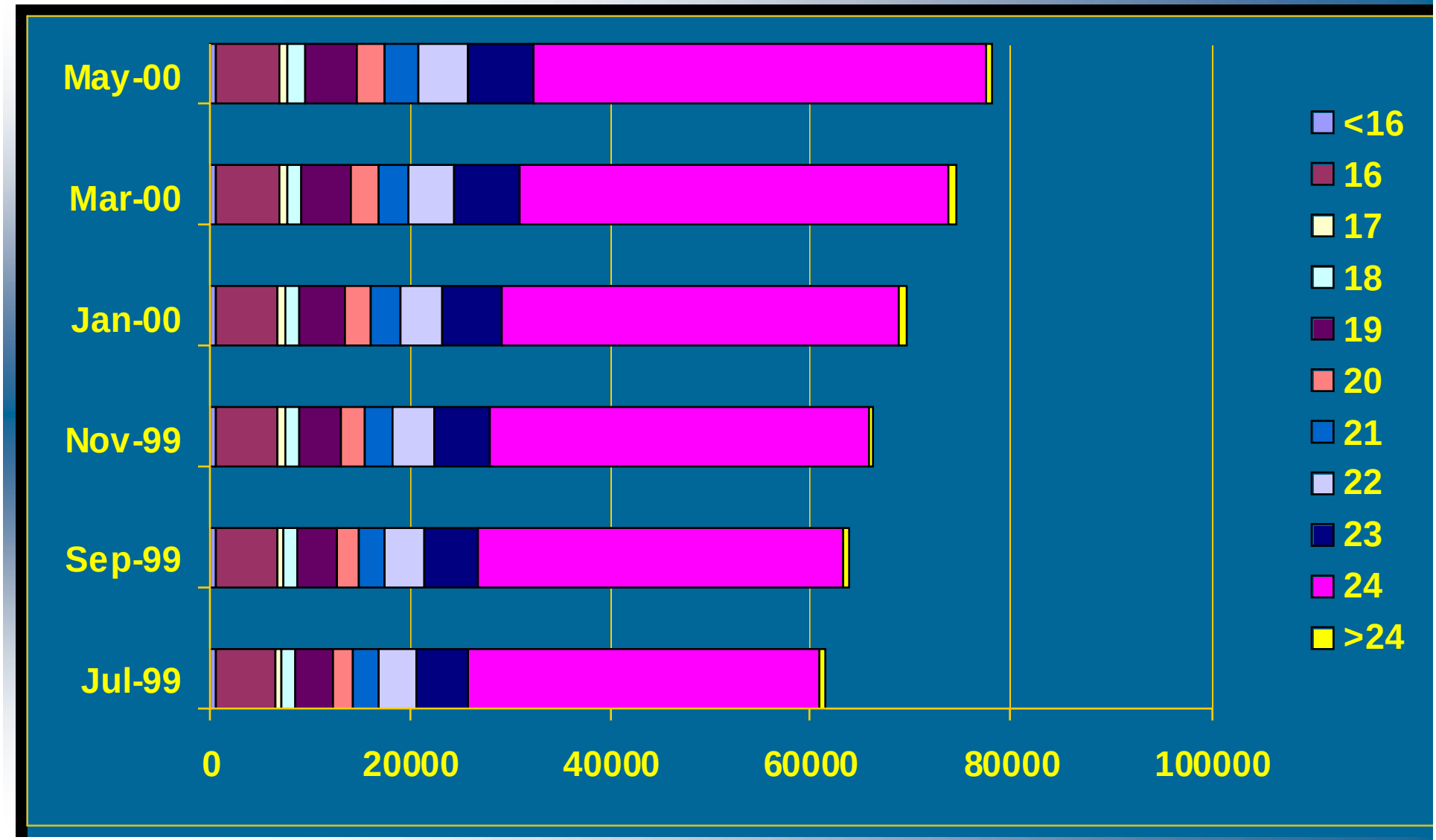
Routing Table Health Report

- Currently 80,000 entries
  - Linear growth: 10,000 routes per year
  - Fluctuation: ± 500 routes per month
- "Swamp" Space
  - 55,000 routes
  - Legacy of classful addressing
  - Former class C blocks: 192/8 - 209/8
- Prefix distribution
  - 45,000 routes are /24 (56% of total)

Routing Table Route Distribution



Routing Table Prefix Distribution



CIDR and the RIR system

- With CIDR came increasing focus on ongoing efficient usage of address space
  - Usage-based request process
  - Provider-based addressing
- Consequently, more administrative management required to meet goals
  - RIRs were in fact proposed in the same set of documents as CIDR itself!
    - RFCs 1338, 1366, 1367, 1466, 1467

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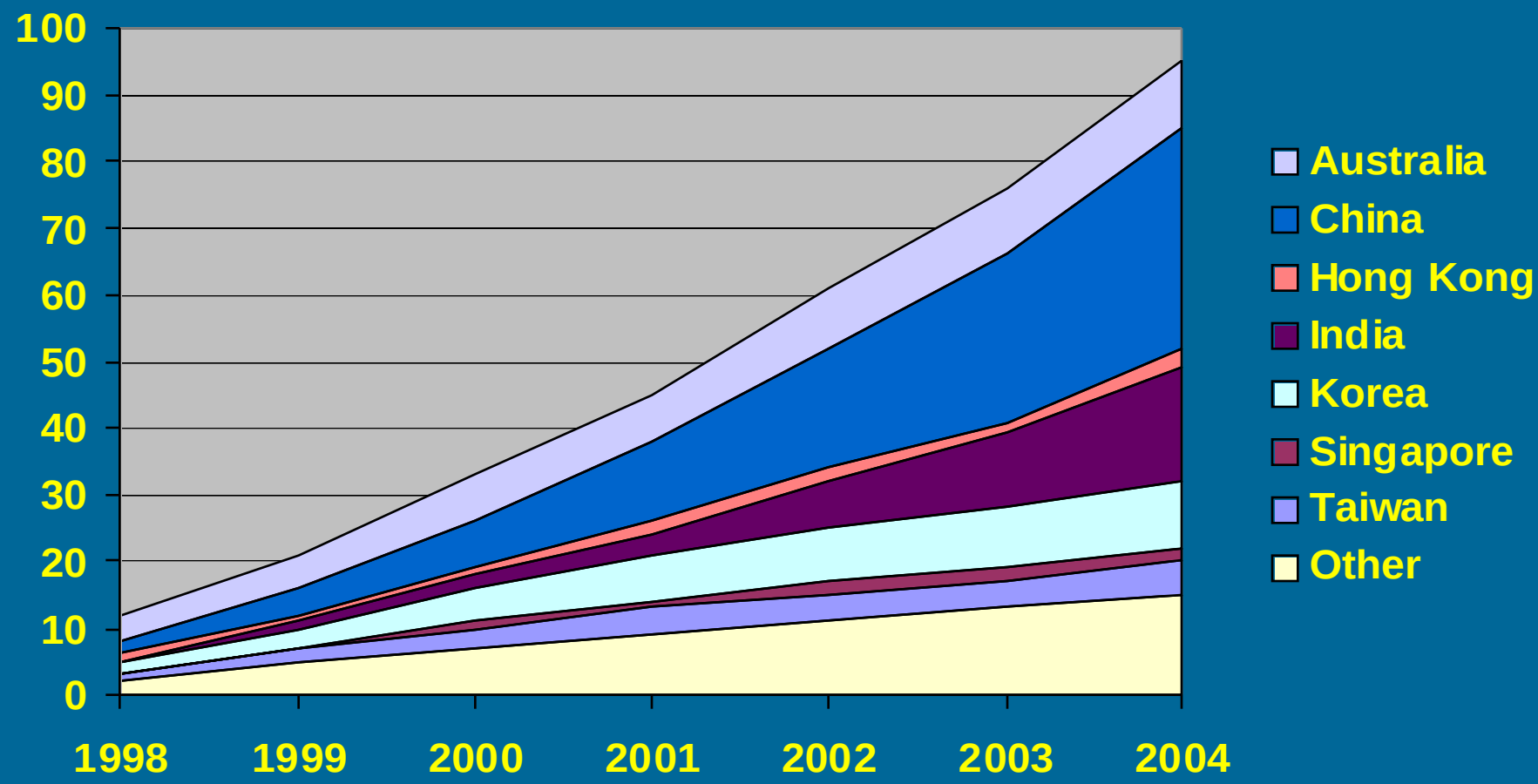
AP Internet User Population

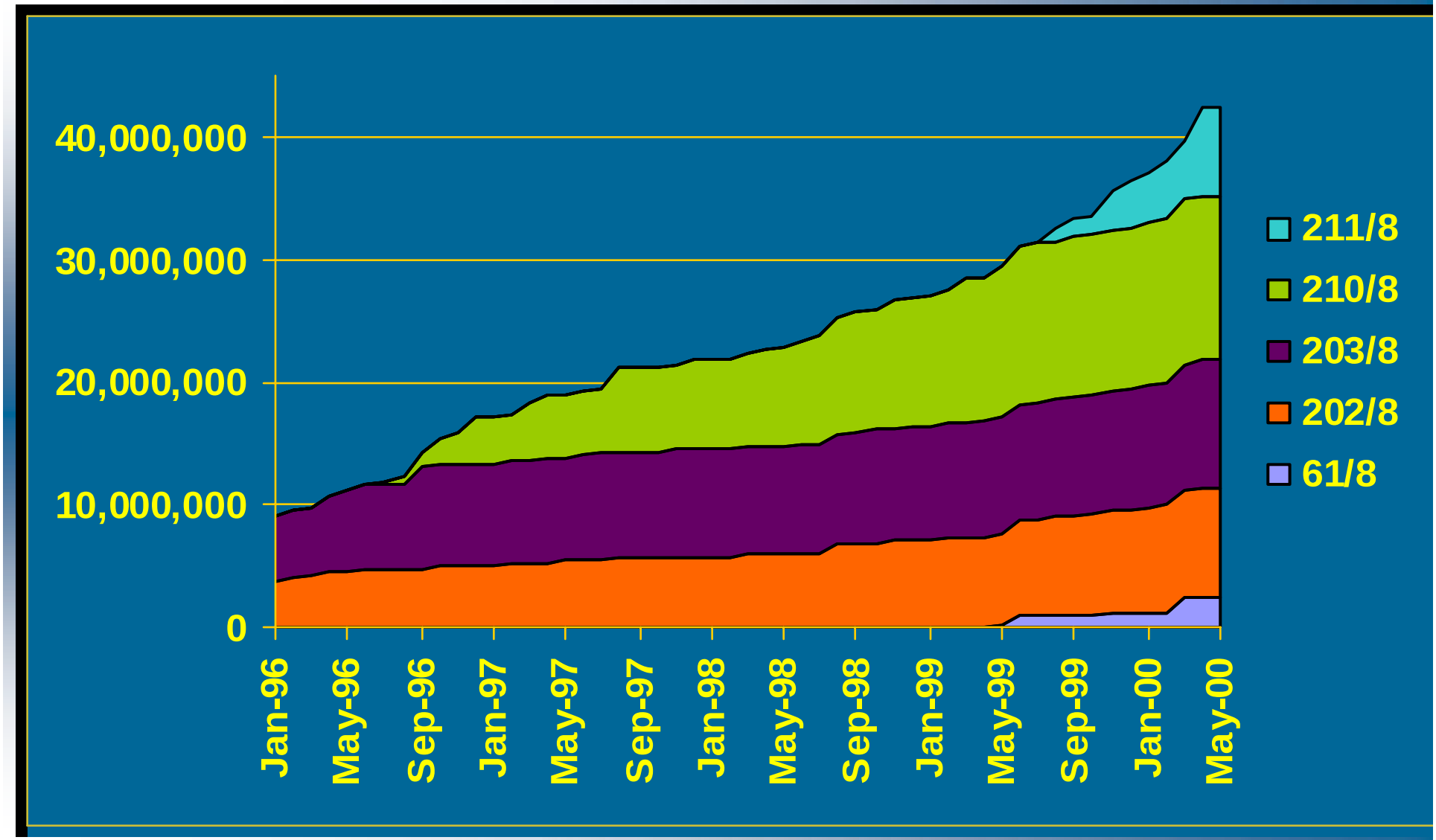


Source: Morgan Stanley Dean Witter

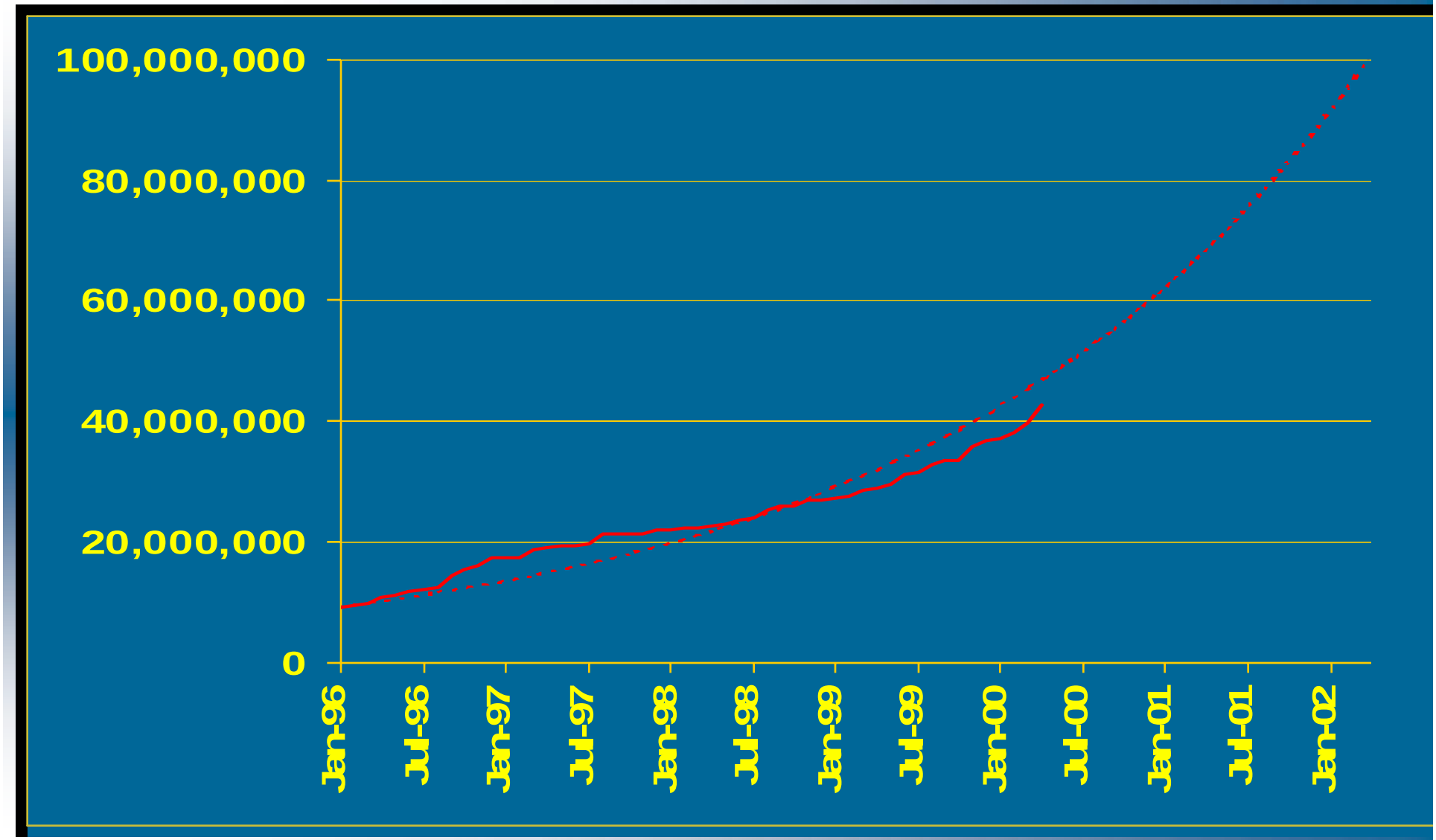
IPv4 Address Space Usage

- Consumption rate (3 years)
  - 590,000 IPv4/month (0.42 x /8 p.a.)
  - 22 ASN/month (264 p.a.)
- Consumption rate (1999)
  - 807,000 IPv4/month (0.58 x /8 p.a.)
  - 27 ASN/month (324 p.a.)
- Consumption rate (last 6 months)
  - 1,499,051 IPv4/month (1.07 x /8 p.a.)
  - 49 ASN/month (590 p.a.)

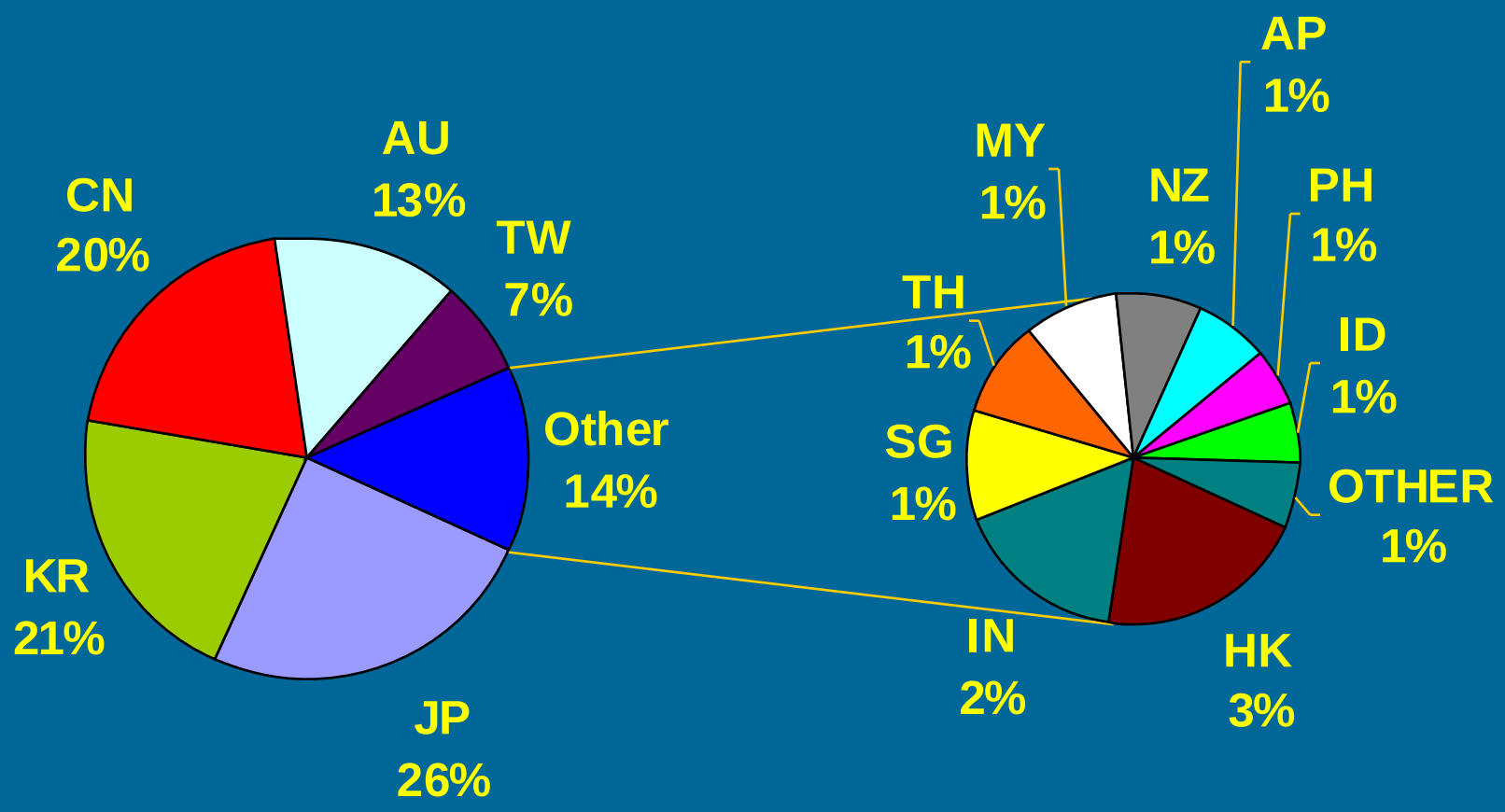
IPv4 Address Space Usage



IPv4 Address Space Usage



IPv4 Allocations - Distribution



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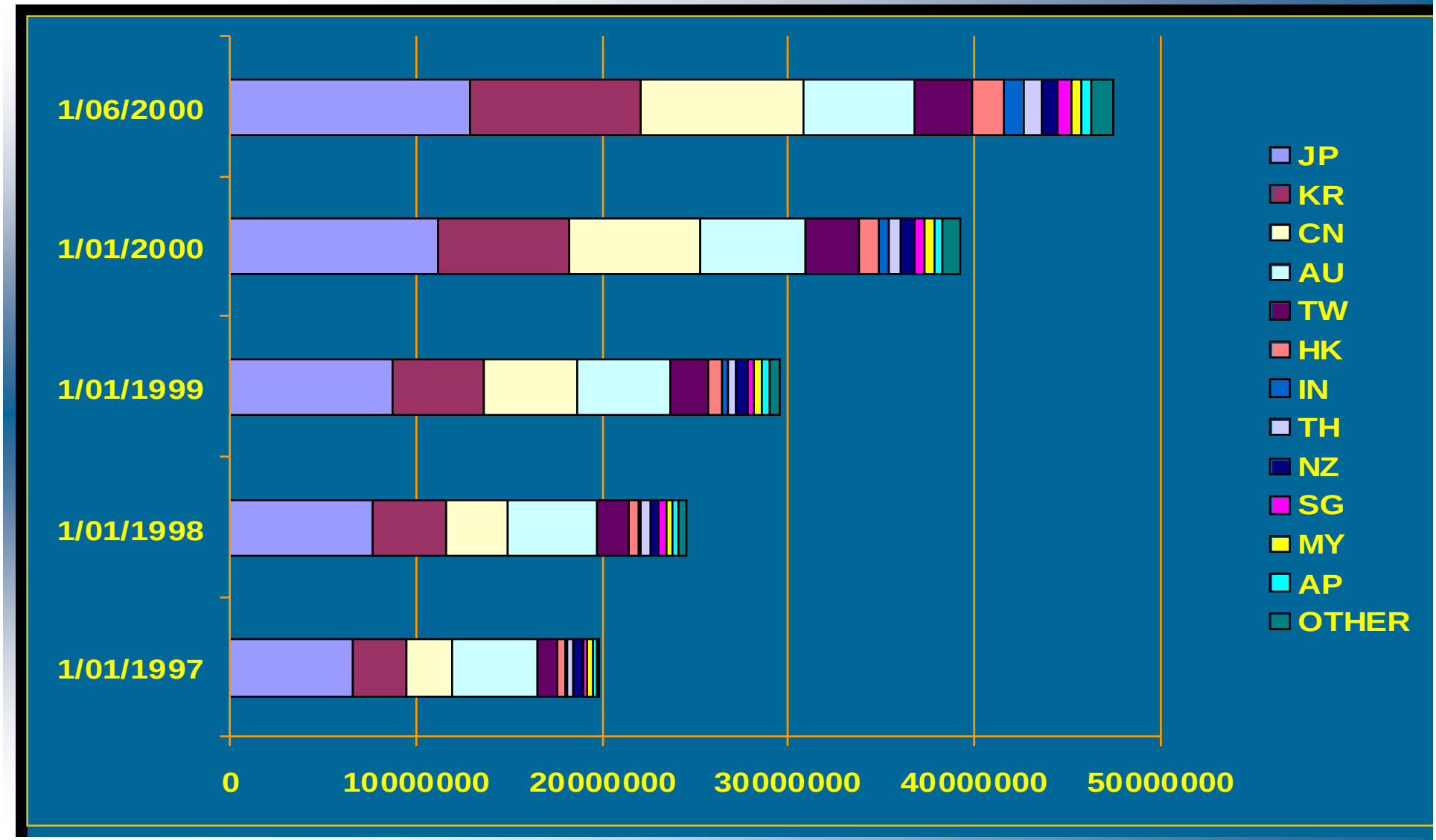
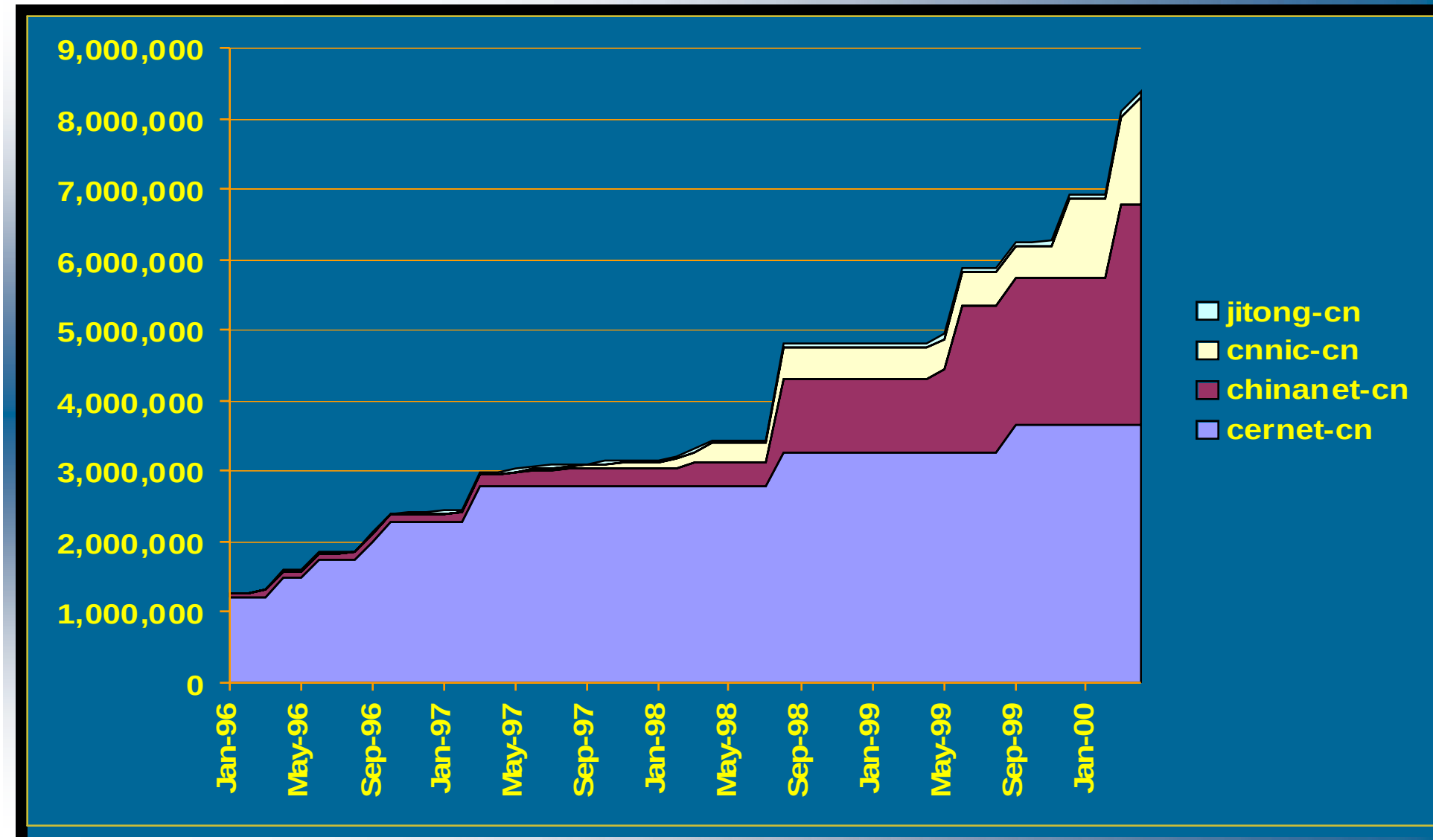


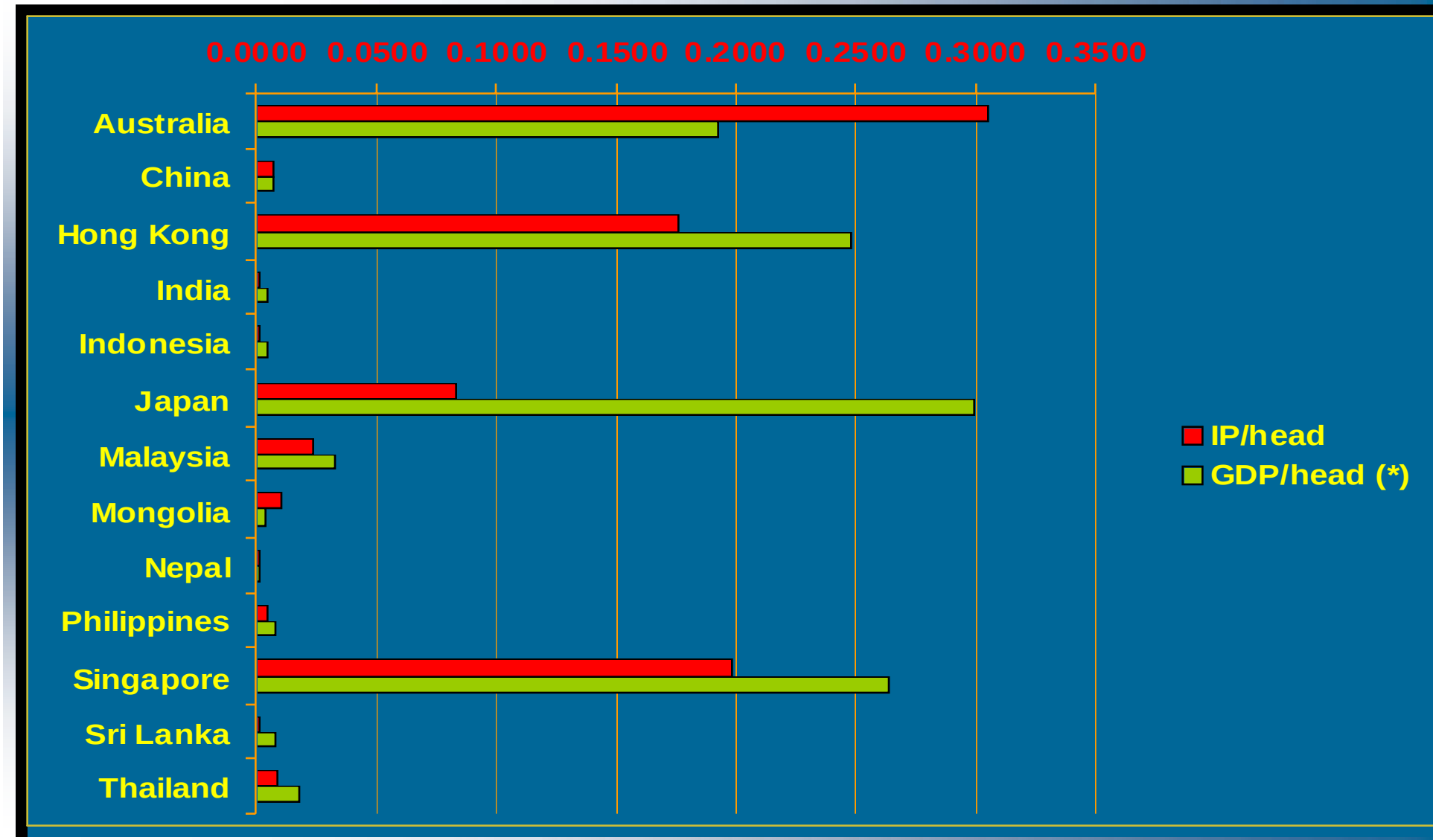
IPv4 Allocations - China



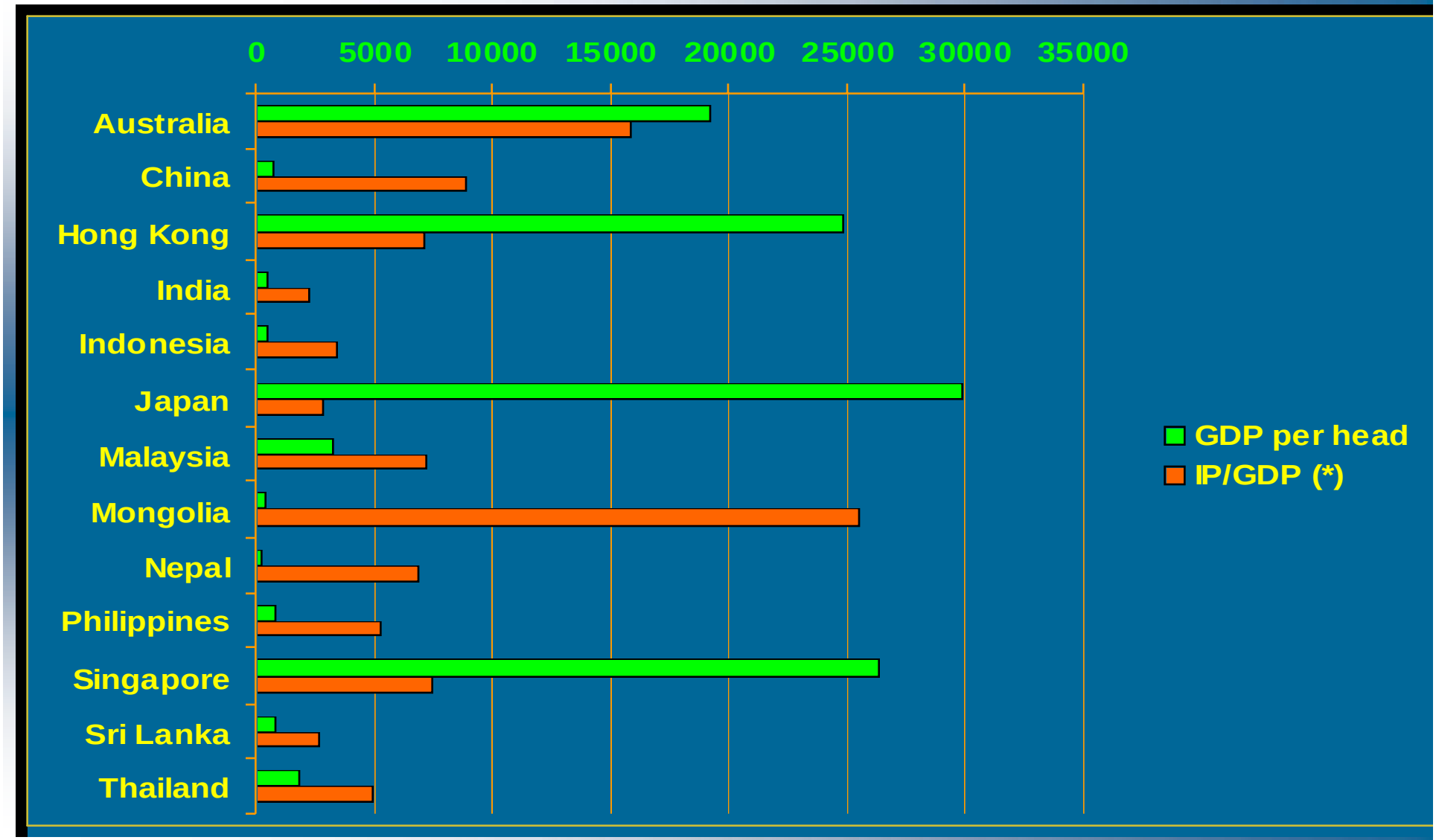
Predicting the Future

- IP addresses mirror Internet growth
  - Represent deployed infrastructure
  - APNIC can provide objective, factual info
- Need more analysis of data and trends
  - Allocation patterns per country over time
  - Correlation of IP addresses with…
    - Population, GDP, etc
  - Comparison with other regions

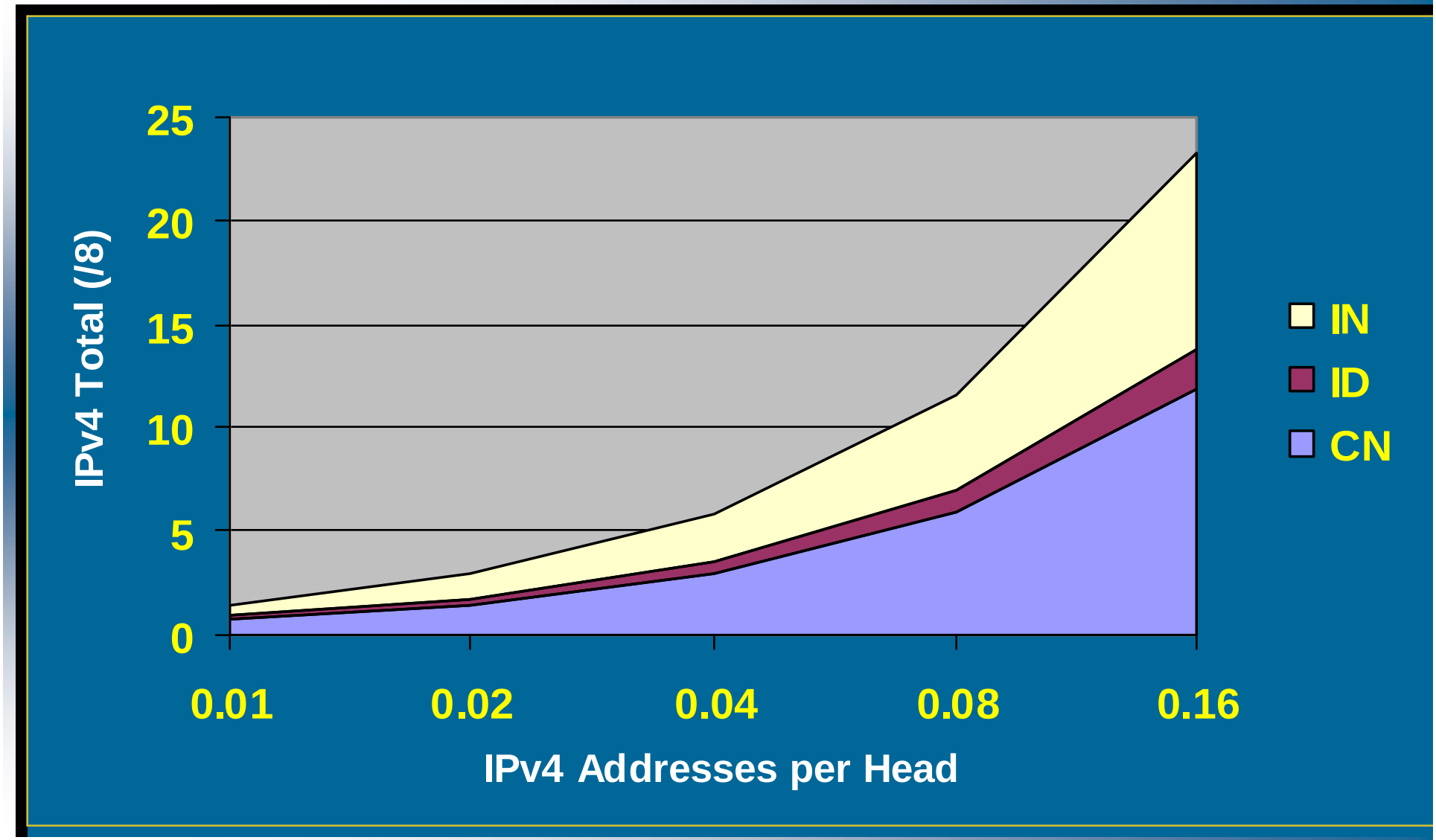
IP usage & GDP per Head



GDP per Head & IP usage per GDP



Potential Growth: CN,IN,ID



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IPv6 Allocations - Background

- 1998: Request from IAB for RIRs to develop IPv6 allocation service
- 1999: Joint RIR IPv6 policy document released (May)
- “subTLA” allocations now underway
- Allocations to date:
  - APNIC: 12
  - ARIN: 5
  - RIPE NCC: 17

IPv6 Allocations - Distribution

Date	Organisation	Economy
13/08/99	WIDE Project	JP
27/08/99	National University of Singapore	SG
16/09/99	Connect.com.au	AU
22/09/99	NTT	JP
6/10/99	Korea Research and Education Network	KR
27/10/99	JENS	JP
24/11/99	Electronics and Telecomms Research Institute	KR
8/02/00	Chunghwa Telecom	TW
8/03/00	Internet Initiative Japan	JP
14/03/00	IMNET	JP
26/04/00	CERNET	CN
2/05/00	Infoweb	JP

Critical Future Development

- Drivers for IPv6 deployment...
  - New services for users? No.
  - New users for ISPs? No.
  - New ISPs for vendors? No.
- Conclusion: IPv6 not required by existing ISPs for several, or many, years
  - However, transition will take many years
- New ISP services expected to drive IPv6
  - i.e. Mobile phones (primarily 3G)
  - other devices (appliances, e-commerce etc)

Conclusion: Participating in APNIC

Meetings

Mailing Lists etc

APNIC Participation

- APNIC mailing lists
  - apnic-talk, apnic-members, apnic-announce
  - sig-routing, sig-policy, sig-dns etc
- APNIC web site
  - http://www.apnic.net
  - documents, minutes, archives, forms, tools
- APNIC Meetings
  - Held twice per year (once with APRICOT)
  - Open to all

APNIC Meeting October 2000

- Second APNIC meeting in 2000
- New meeting format
  - 3 day meeting
  - Policy and Technical Tracks
  - SIGs and Plenary sessions
- Wed 25 to Fri 27 October 2000
  - Novotel, Brisbane, Australia
  - see http://www.apnic.net
- All welcome!!!

Thank you!

Paul Wilson
pwilson@apnic.net

http://www.apnic.net