Asia Pacific Network Information Centre

APNIC

APNIC IPv6 Activities: Past, Present and Future

Paul Wilson
APNIC

Overview

- The Past
  - Introduction to APNIC
  - History of the RIR System
- The Present
  - APNIC Membership
  - Internet resource status – IPv4 and IPv6
  - IPv6 policy status
- The Future
  - Address management policies
  - How long will IPv6 last?

Introduction to APNIC

What is APNIC?

- Regional Internet Registry (RIR) for the Asia Pacific Region
  - Regional authority for Internet Resource distribution
  - IP addresses (IPv4 and IPv6), AS numbers, reverse DNS delegation
  - Provide services to ~800 ISPs
- Industry self-regulatory body
  - Established in 1993, in the “Internet Tradition”…
  - Consensus-based, open and transparent
  - Non-profit, neutral and independent
  - Open membership-based structure

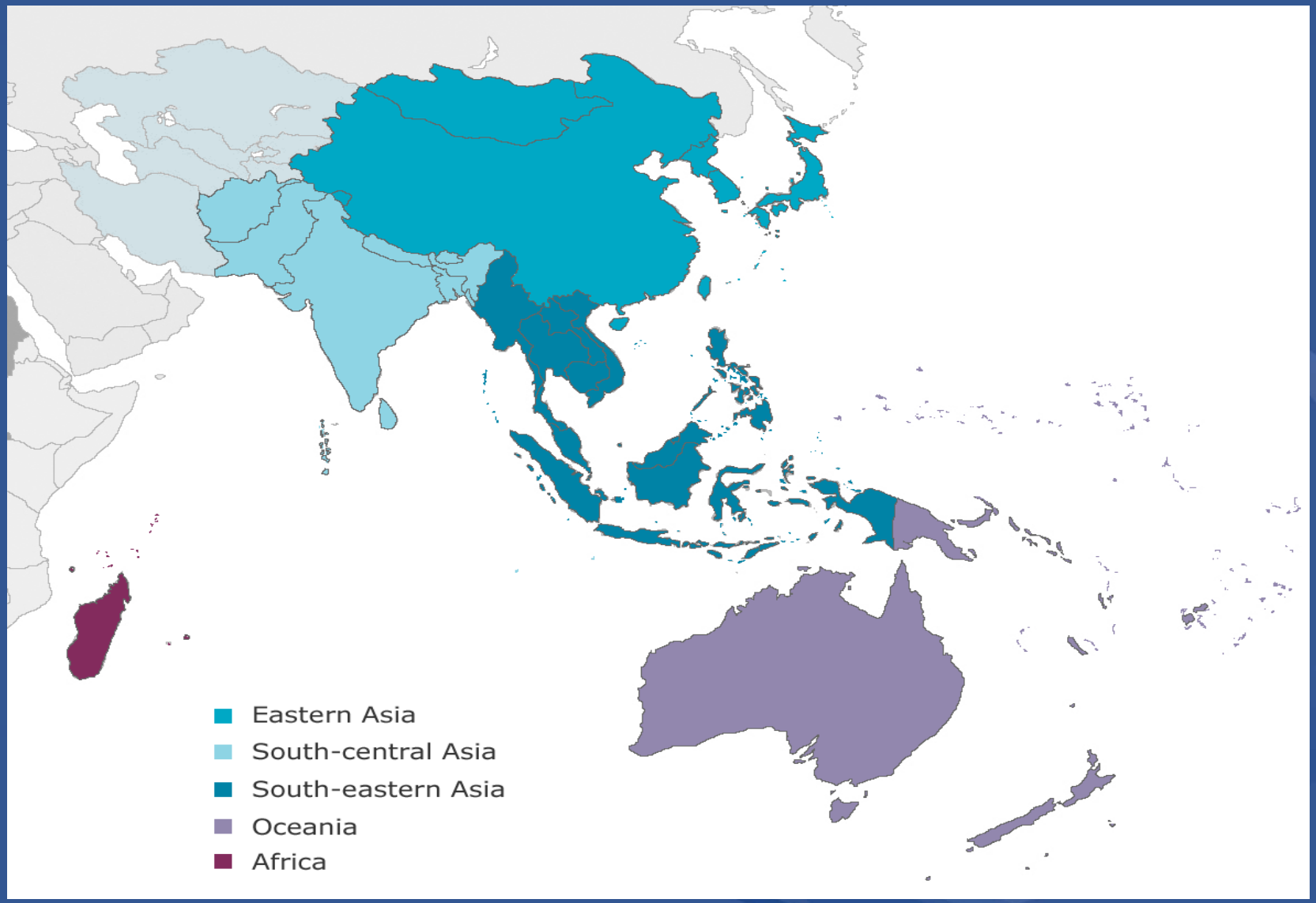
What does APNIC do?

1. Internet resource management
   - IP address allocation to ISPs and NIRs
   - IP address assignment to end users
   - AS number assignments
2. Resource registration
   - Authoritative registration server: *whois.apnic.net*
   - Internet Routing Registry: *irr.apnic.net*
3. DNS management
   - Delegate reverse DNS zones/domains
   - Authoritative DNS servers
     - *in-addr.arpa, ip6.arpa (ip6.int)*

What else does APNIC do?

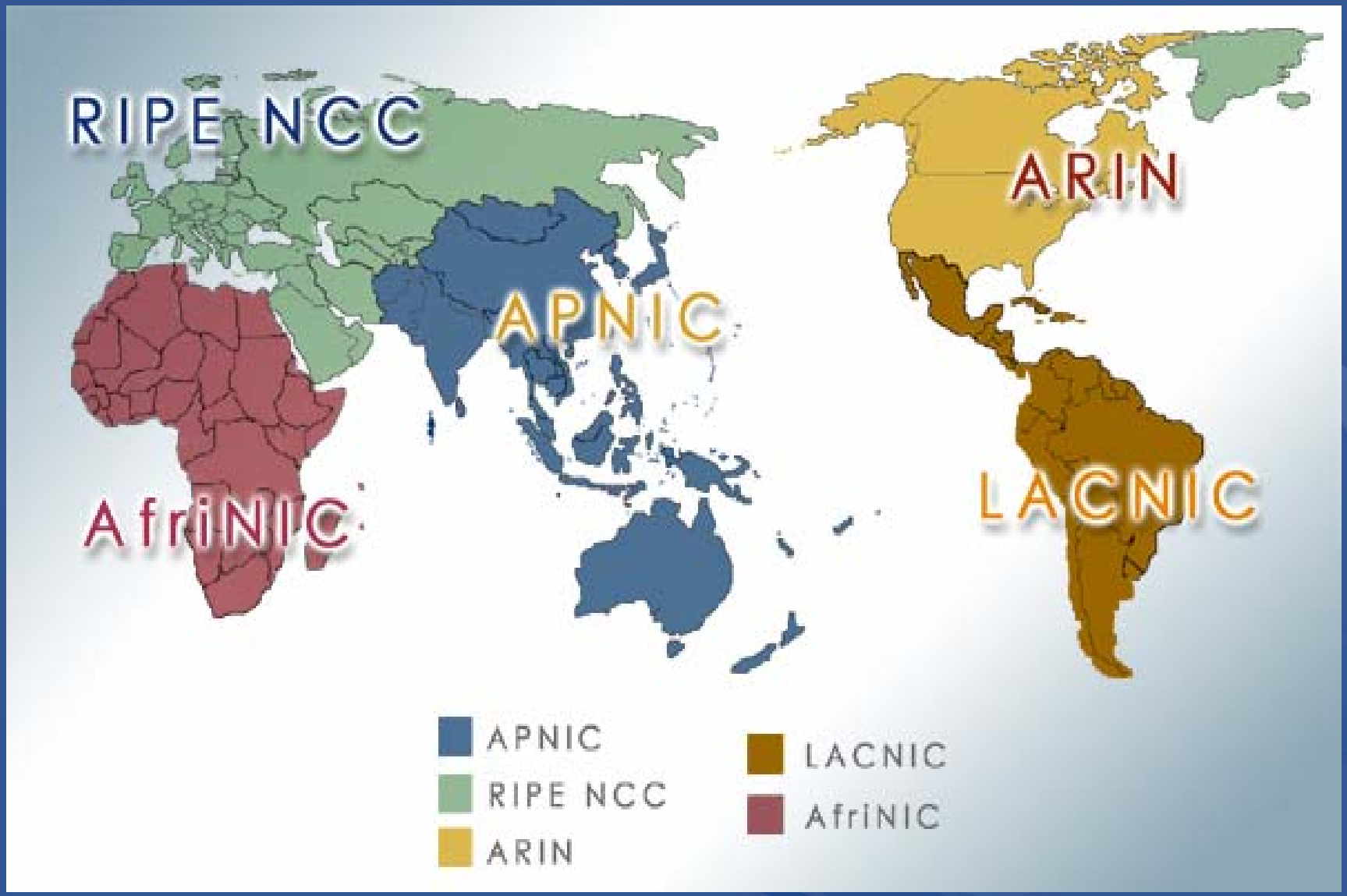
- Policy development and coordination
  - APNIC Open Policy Meetings: 2 per year
    - SIGs, WGs, BOFs, Training
  - ASO and ICANN processes
  - Liaison: IETF, ITU etc
- Training and outreach
  - Frequent regional training courses
  - Presentations ay seminars, conferences etc
- Publications
  - Newsletter, web site, mailing lists etc
  - Regional and global resource reports

Where is APNIC?



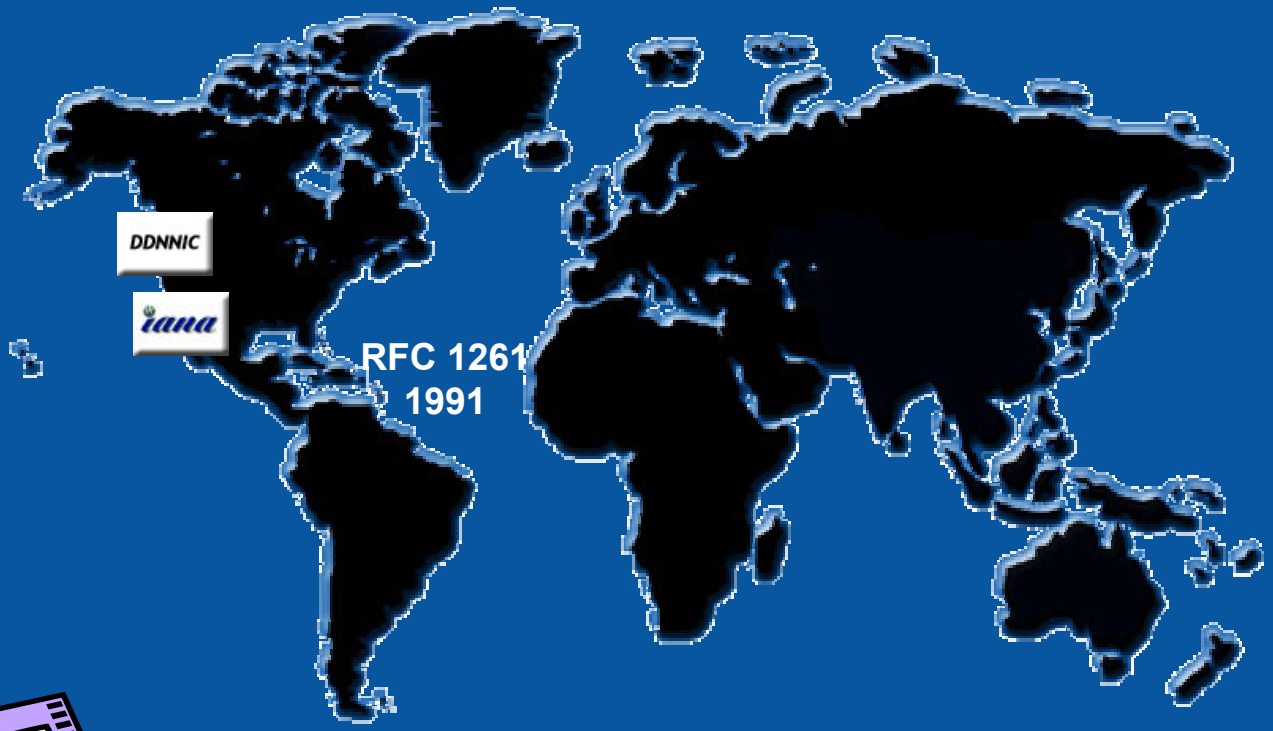
Ref http://www.un.org/depts/dhl/maplib/worldregions.htm

Where is APNIC?



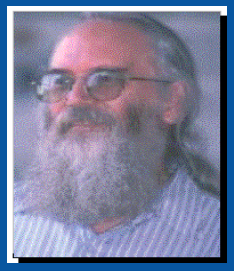
History of the RIR System

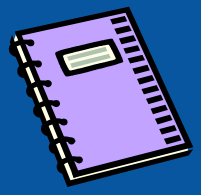
Pre 1992



RFC 1020
1987

RFC 1261
1991





RFC 790
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**."

1992

RFC 1366
Geographic Allocations

1993

RFC 1466
1993

1996

RFC 2050
1996

1997

1998

IAB asks RIRs to prepare for IPv6 allocations

1999

ASO MoU

First IPv6 policy released

2002

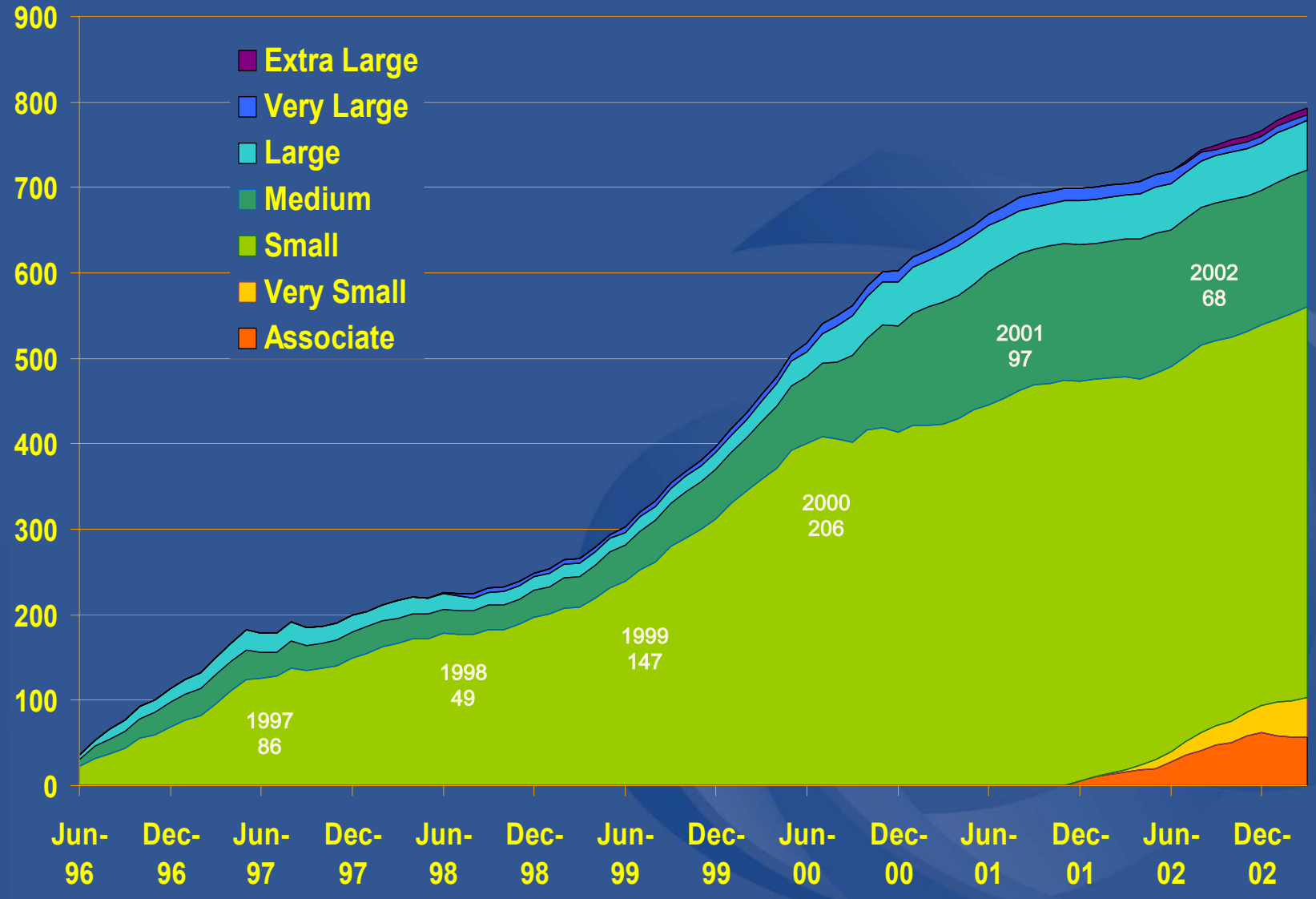
Second IPv6 policy released

2003

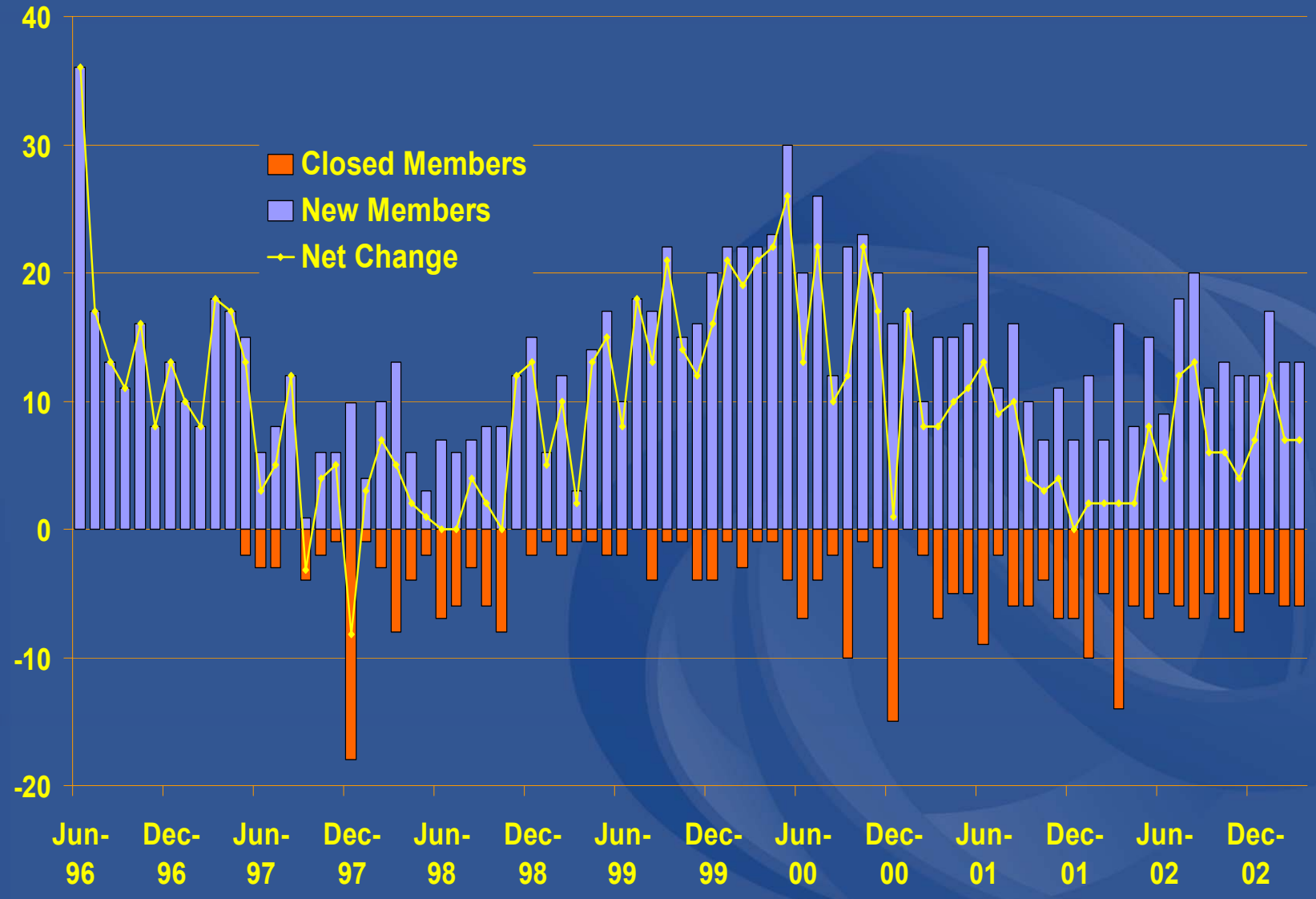
Emerging RIR

APNIC Membership

Total APNIC Membership



Total APNIC Membership



Asia Pacific Network Information Centre

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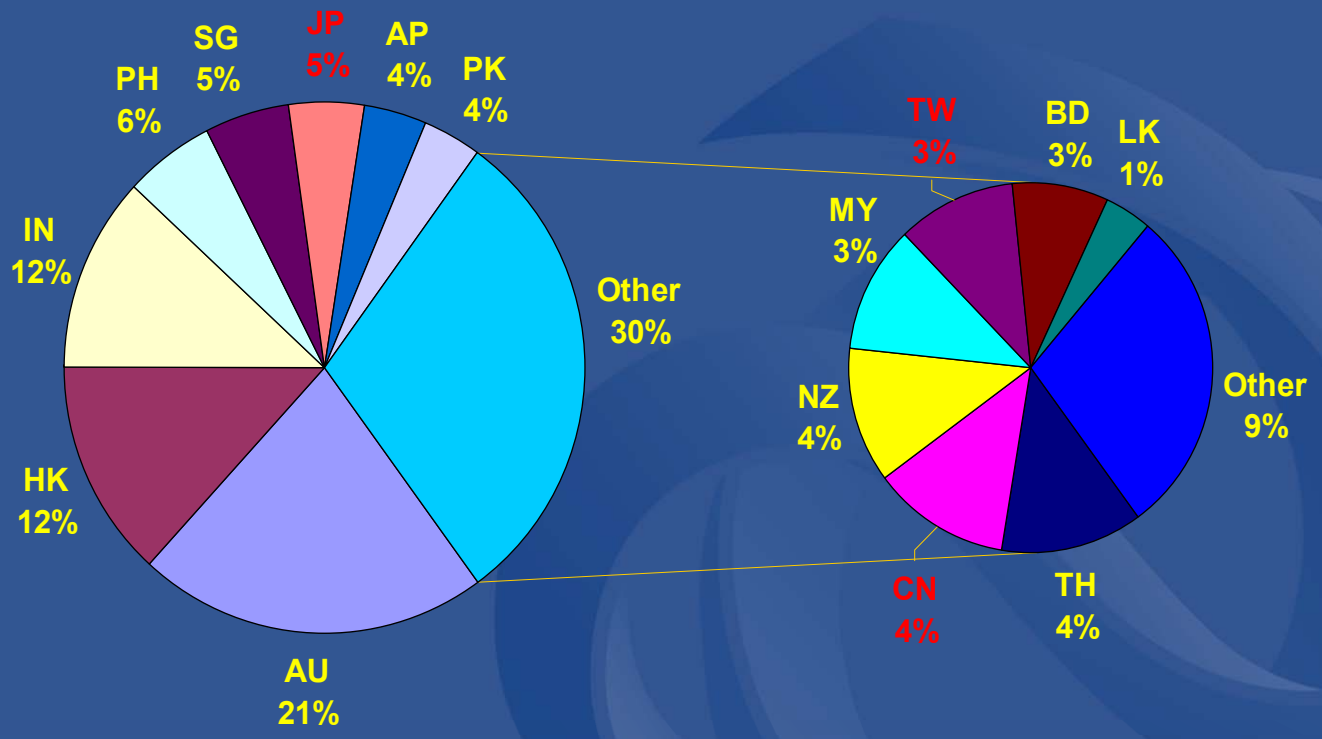
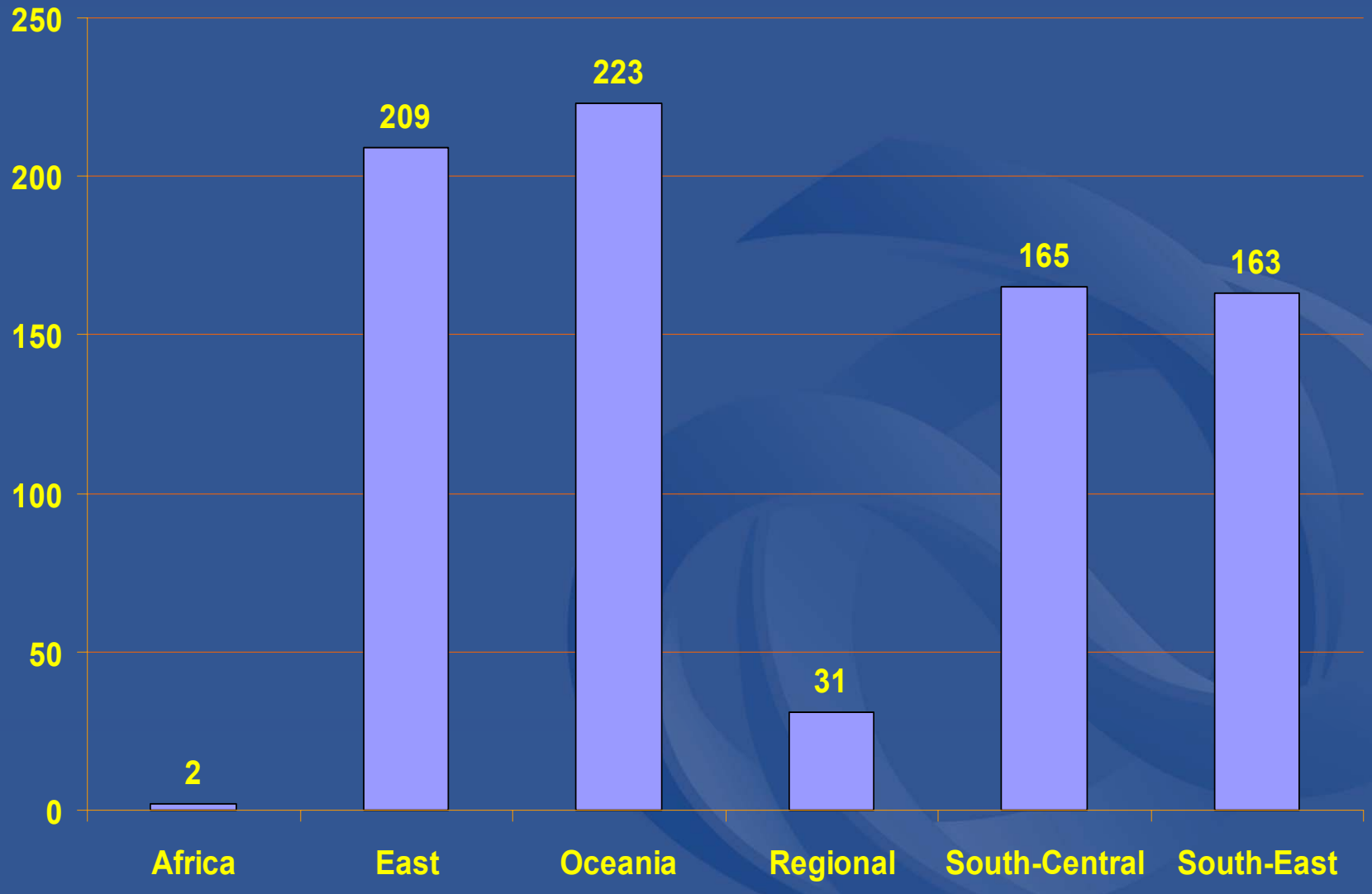
Total APNIC Membership



Sub-regional Distribution



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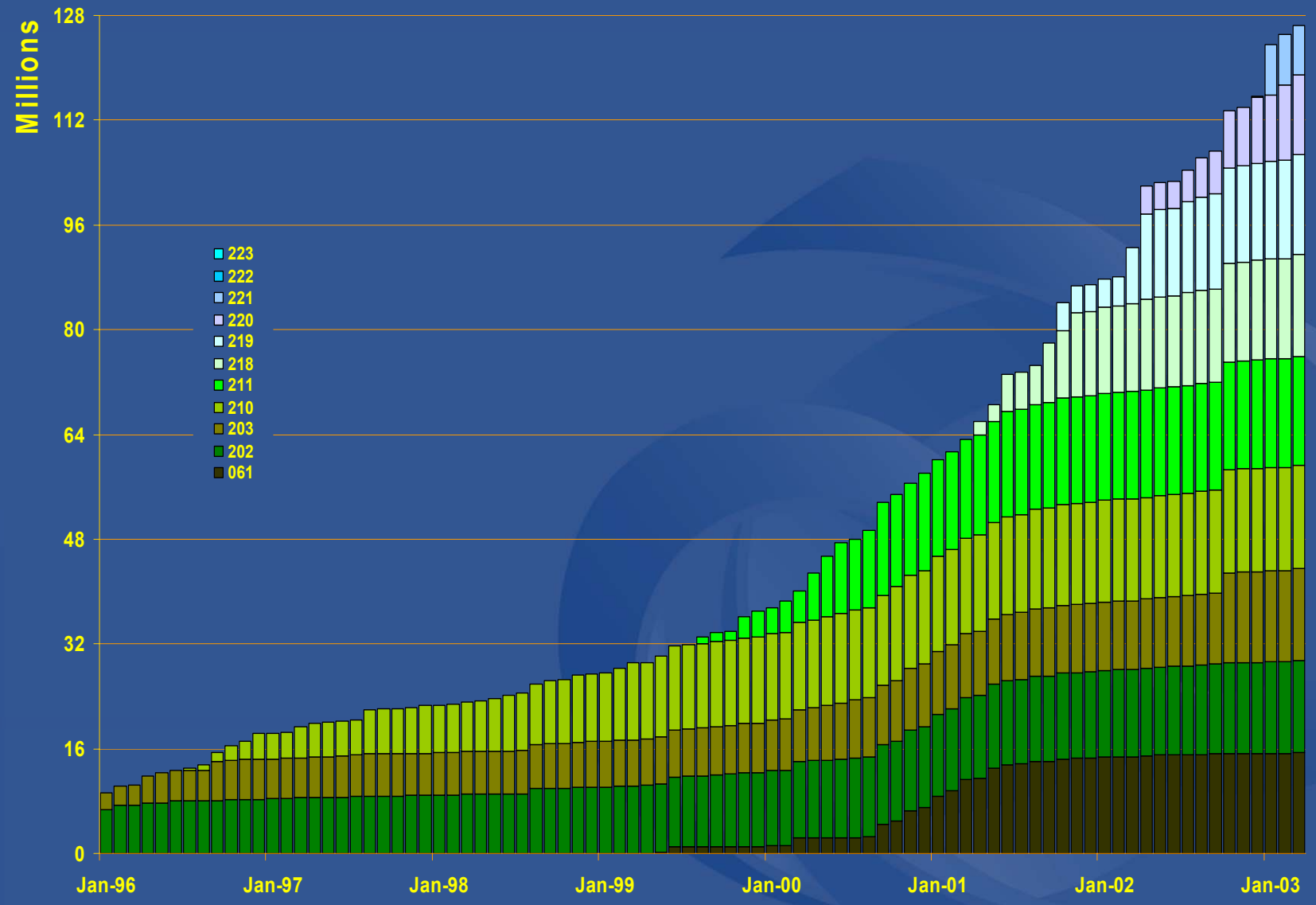
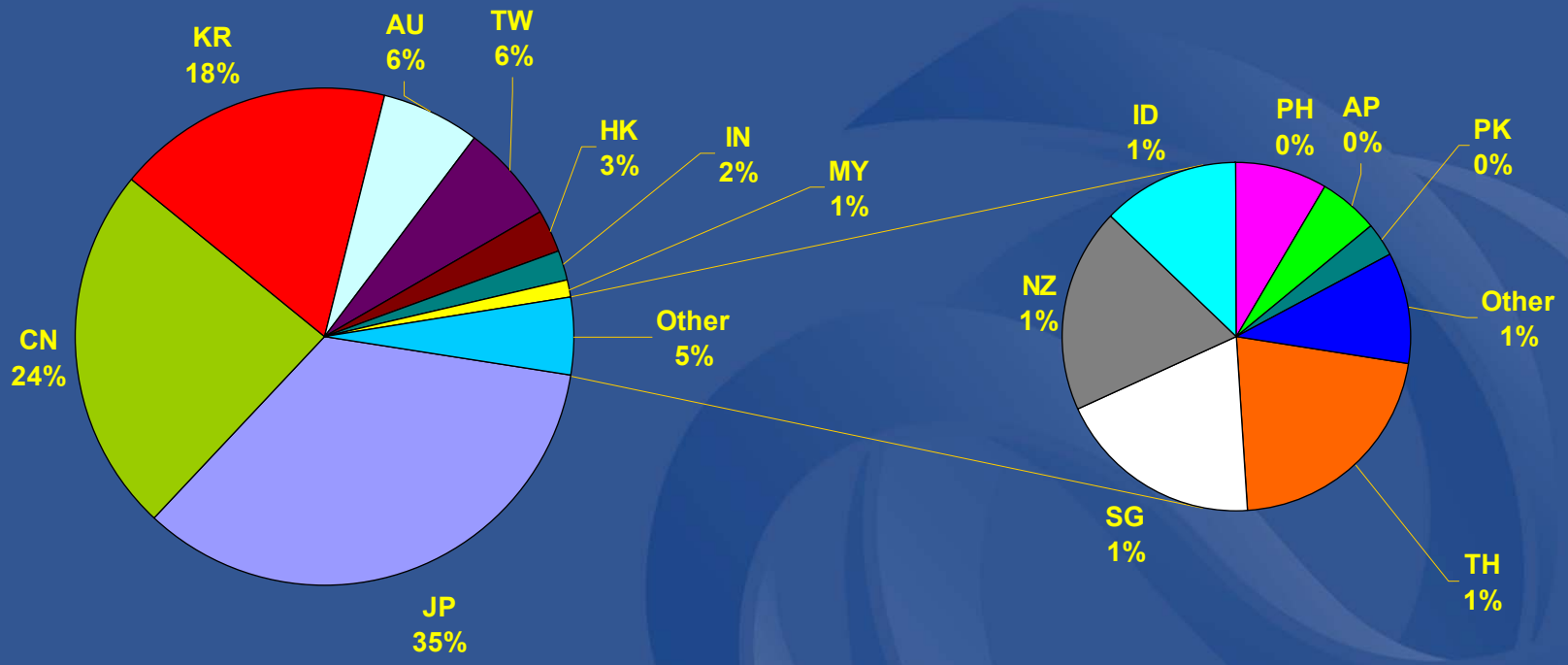
Internet Resource Status

IPv4

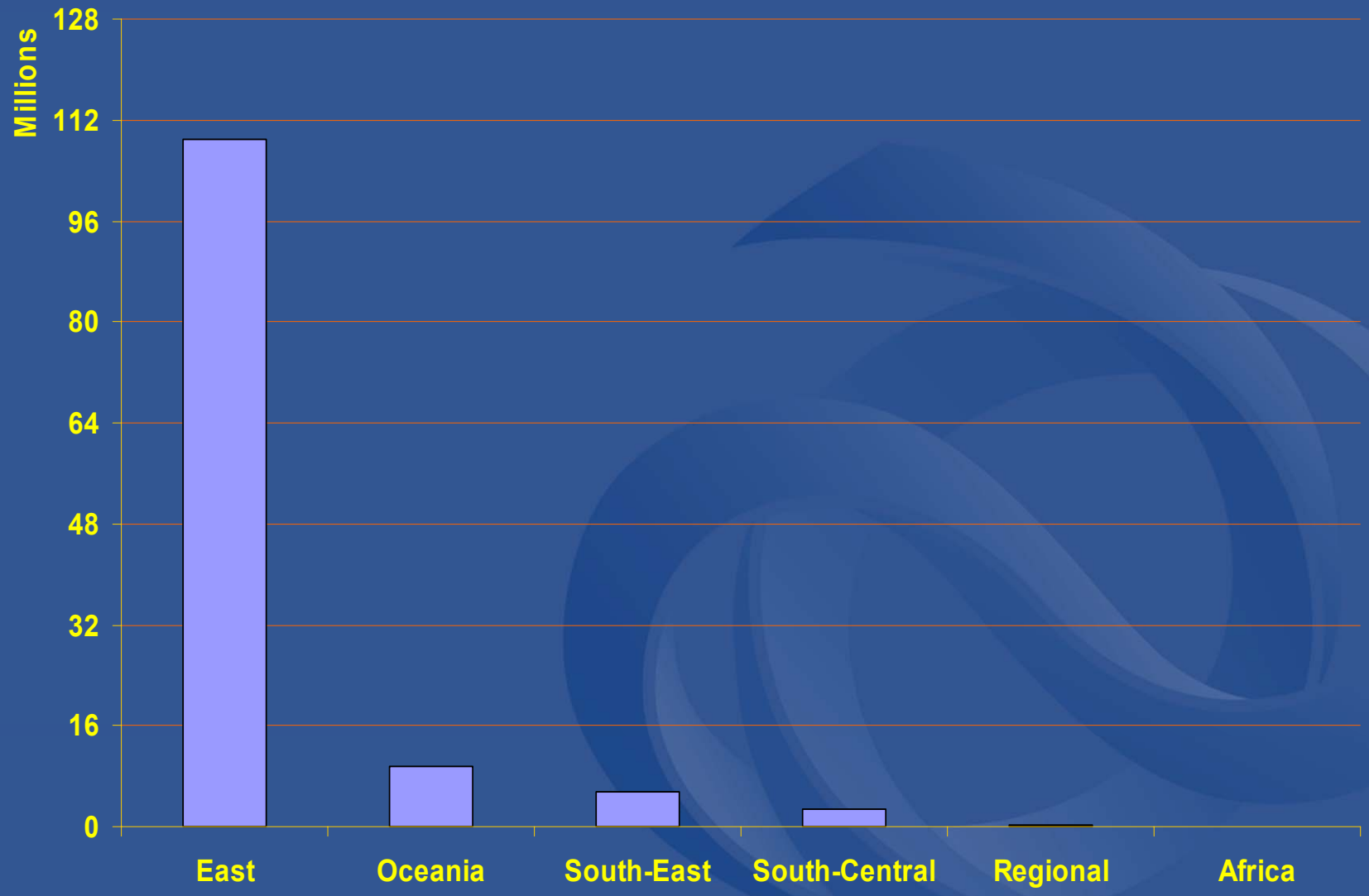
IPv4 Allocations - APNIC



IPv4 Distribution - APNIC



IPv4 Distribution - Sub-regional



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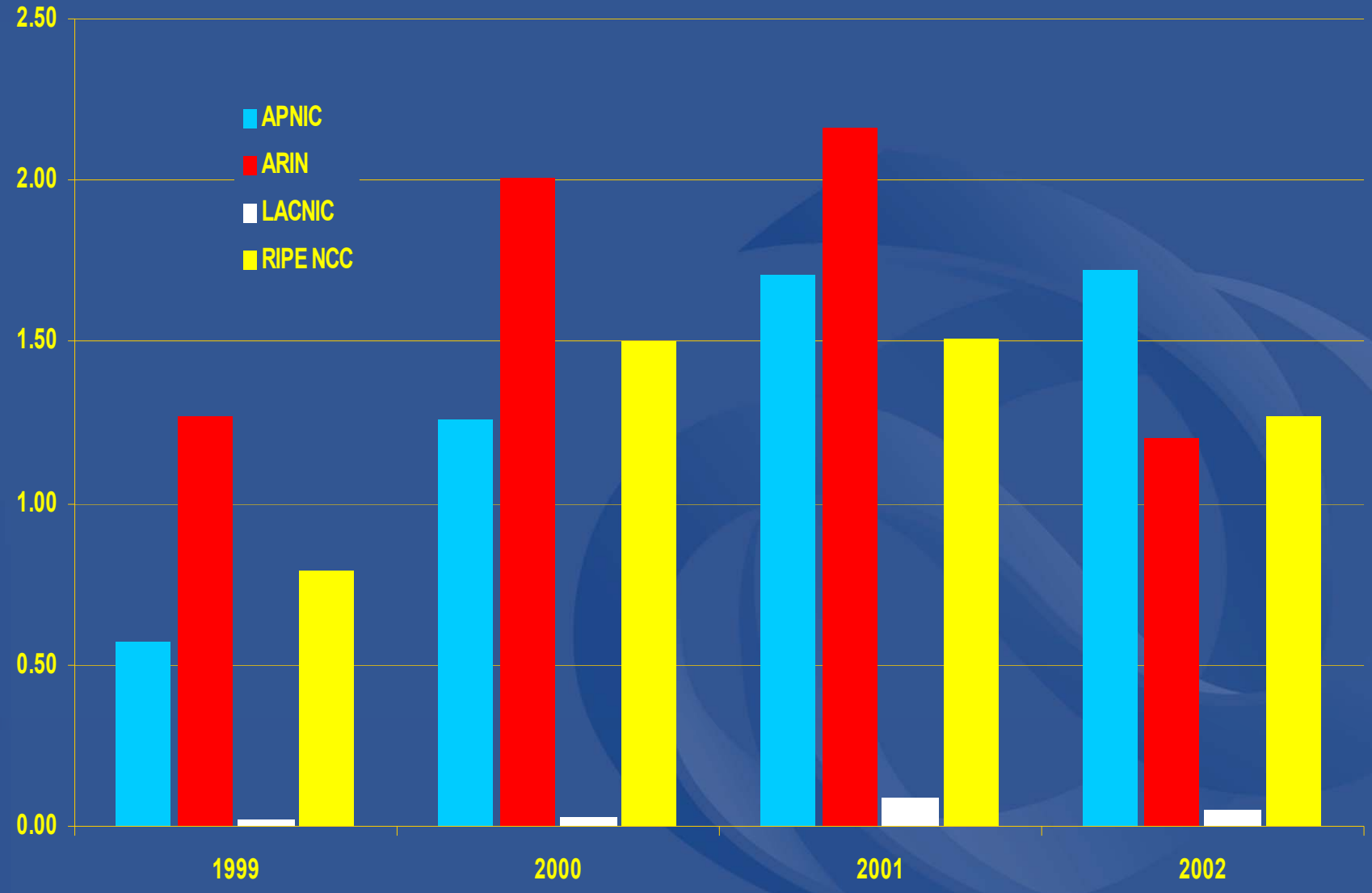
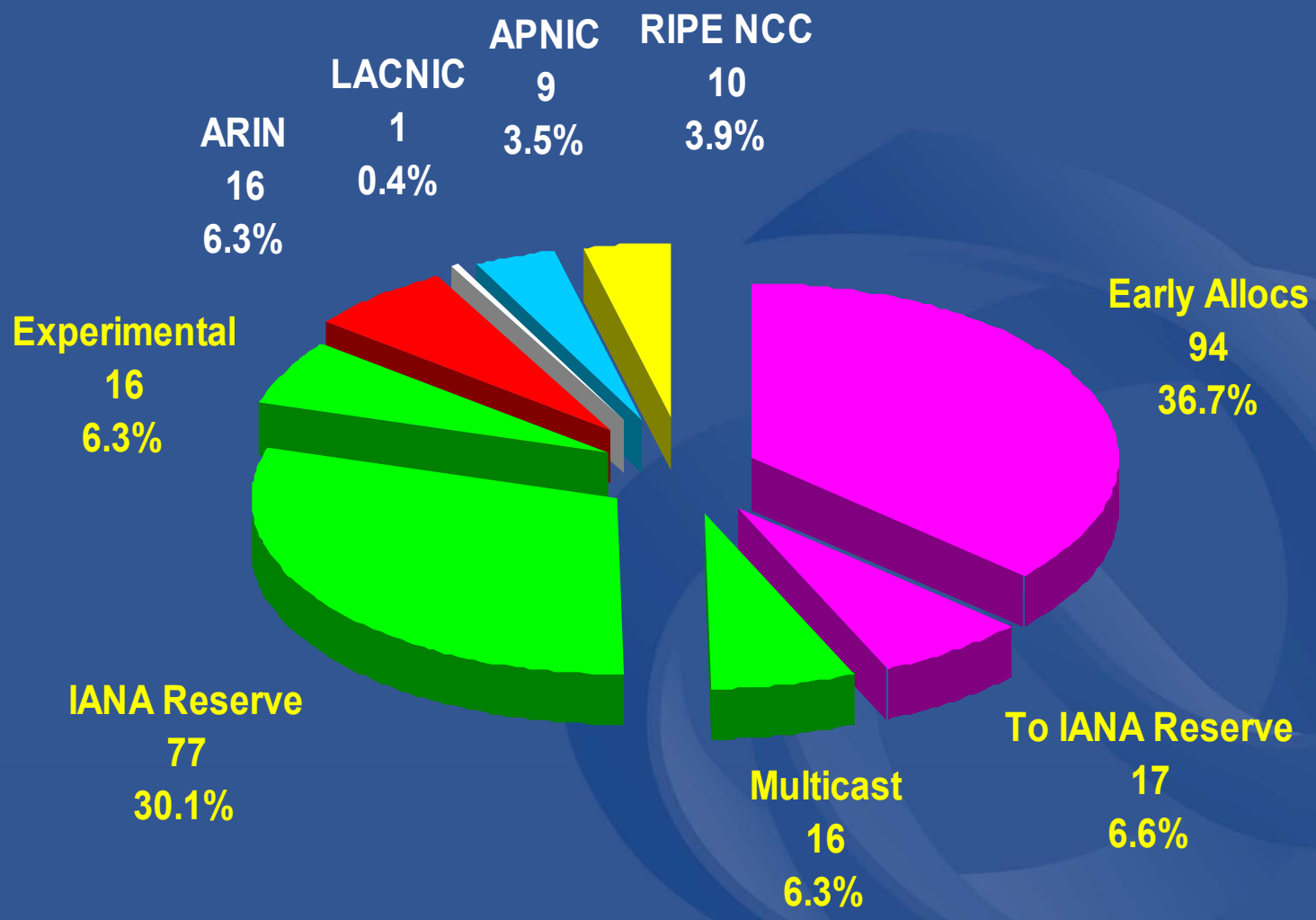
IPv4 Allocations - Global



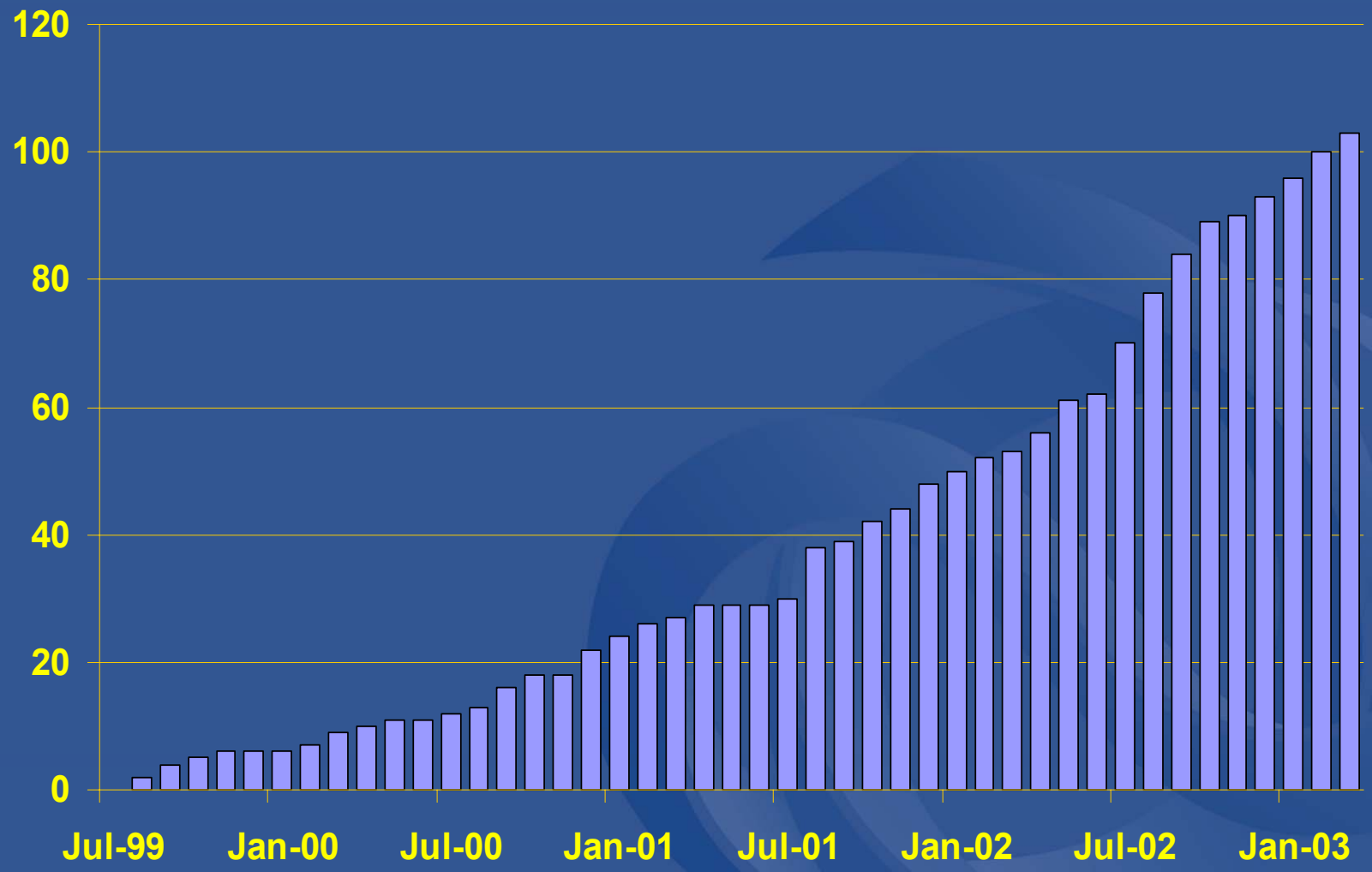
IPv4 Distribution - Global



Internet Resource Status

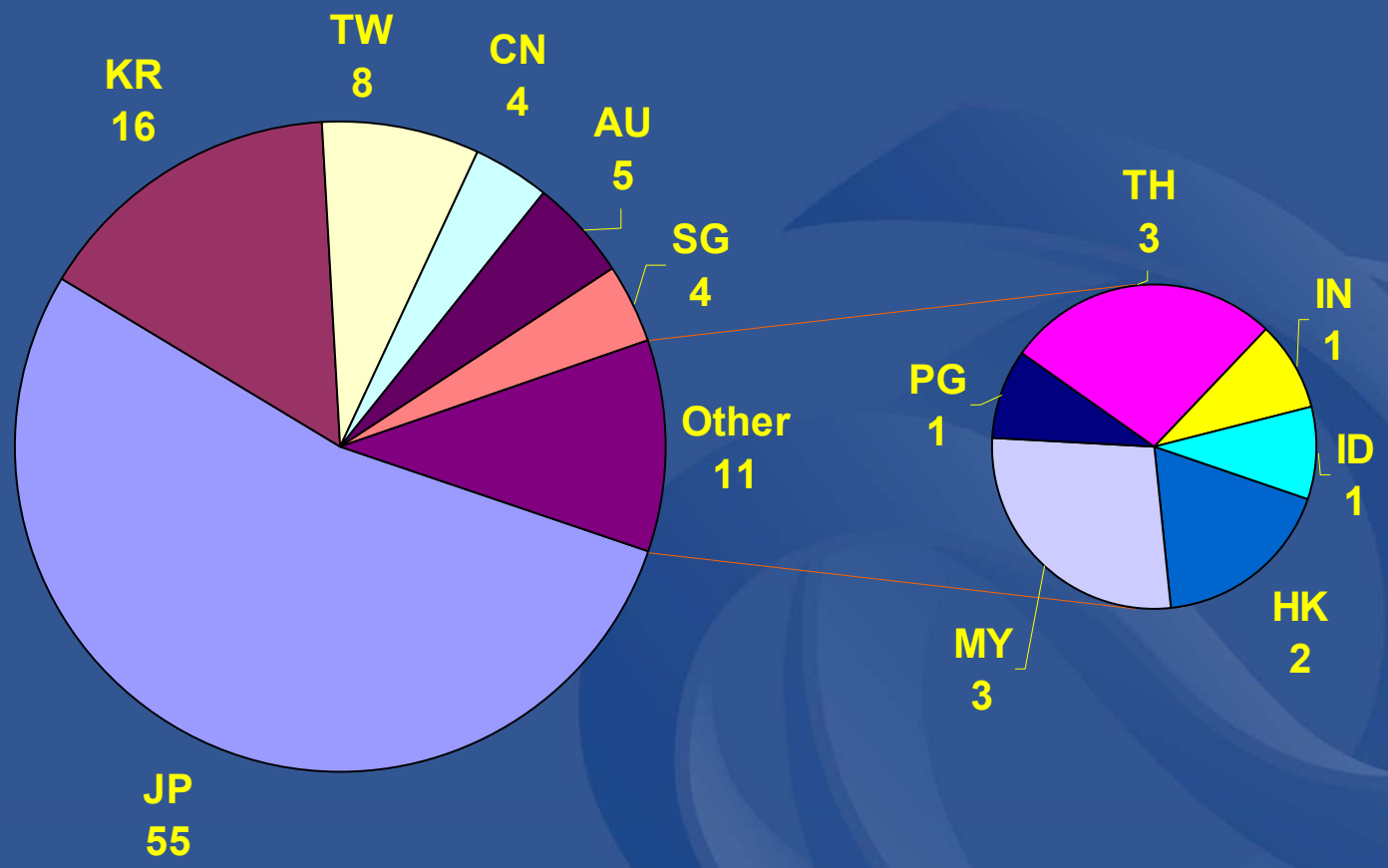
IPv6

IPv6 Allocations - APNIC



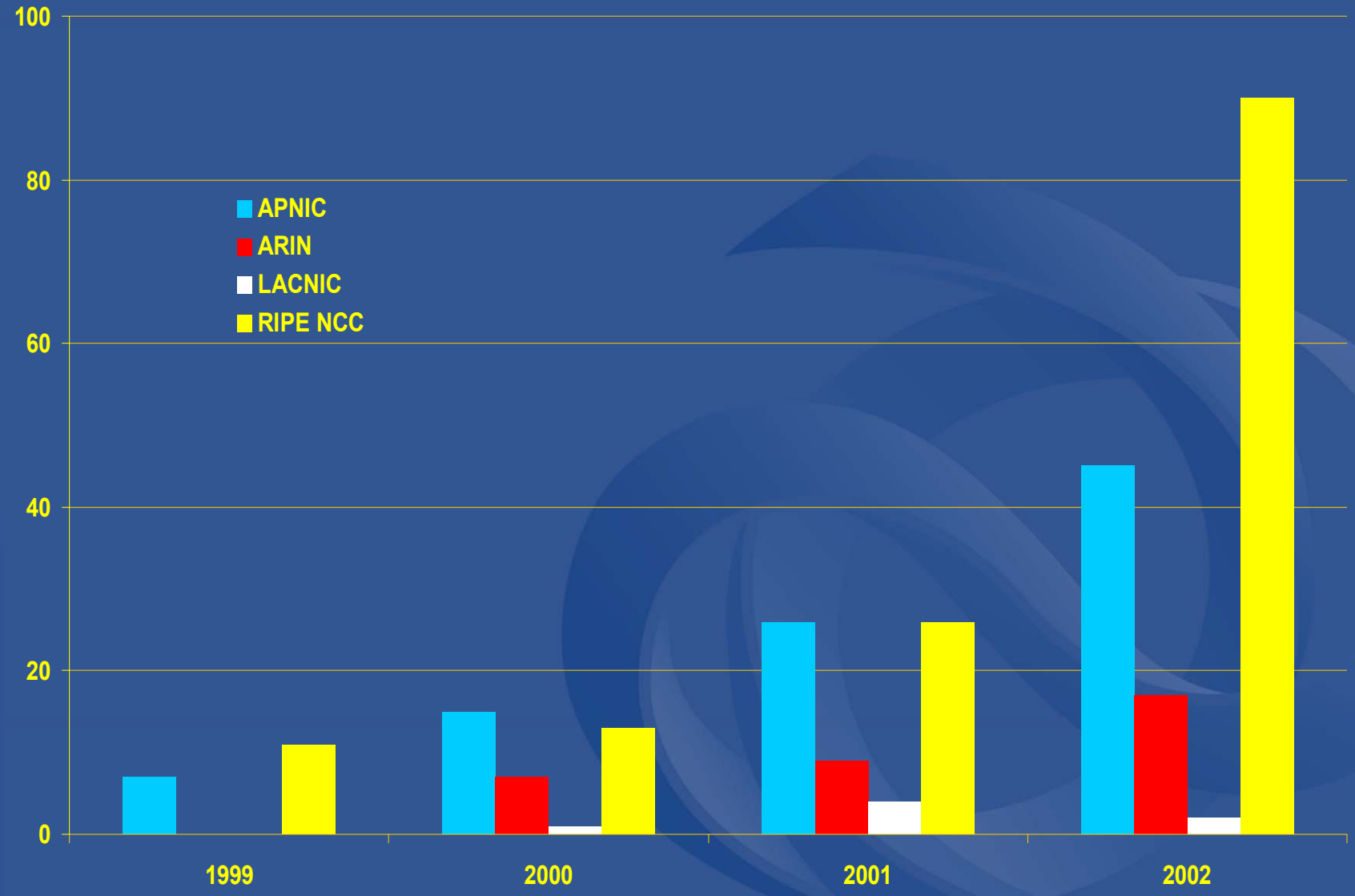
Unit: IPv6 prefix

IPv6 Distribution - APNIC

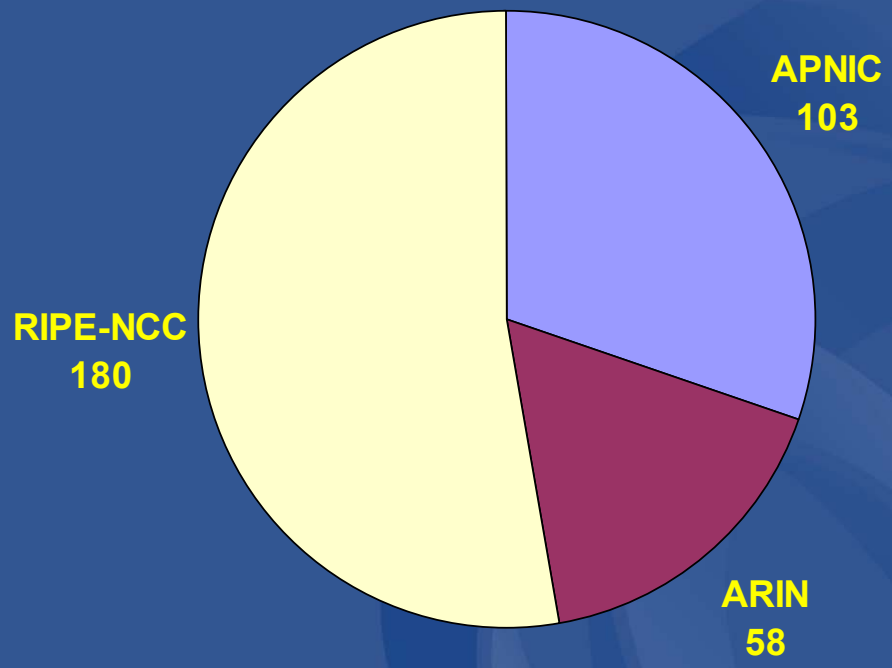


Unit: IPv6 prefix

IPv6 Allocations - Global



IPv6 Distribution - Global



Unit: IPv6 prefix

IPv6 Policy Status

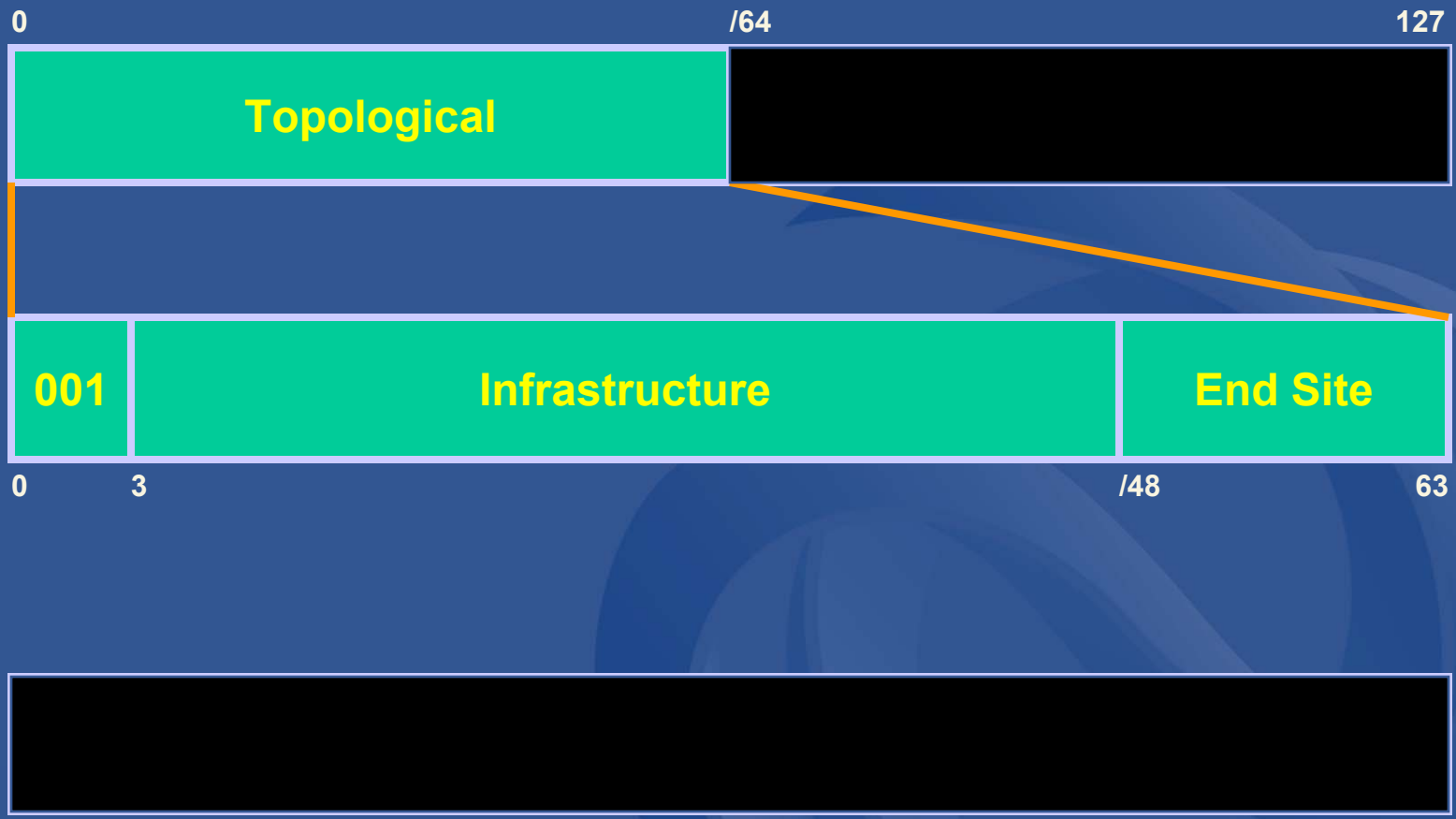
IPv6 Policy - History

- First published in 1999
  - "Provisional IPv6 Policy" adopted by all RIRs
- Policy review during 2001
  - Final policy approved in all RIR regions
    - APNIC: Bangkok, March 2002
    - ARIN: Las Vegas, April 2002
    - RIPE NCC: Amsterdam, May 2002
- New policy established
  - Implemented in APNIC region since 1 July 2002
- Public mailing lists and documentation
  - http://www.apnic.net/ipv6

New IPv6 Policy - Overview

- Addressing structure
- Initial allocation criteria
- Subsequent allocation criteria
- Utilisation requirements
- Address assignment
- Other conditions

IPv6 Address Structure

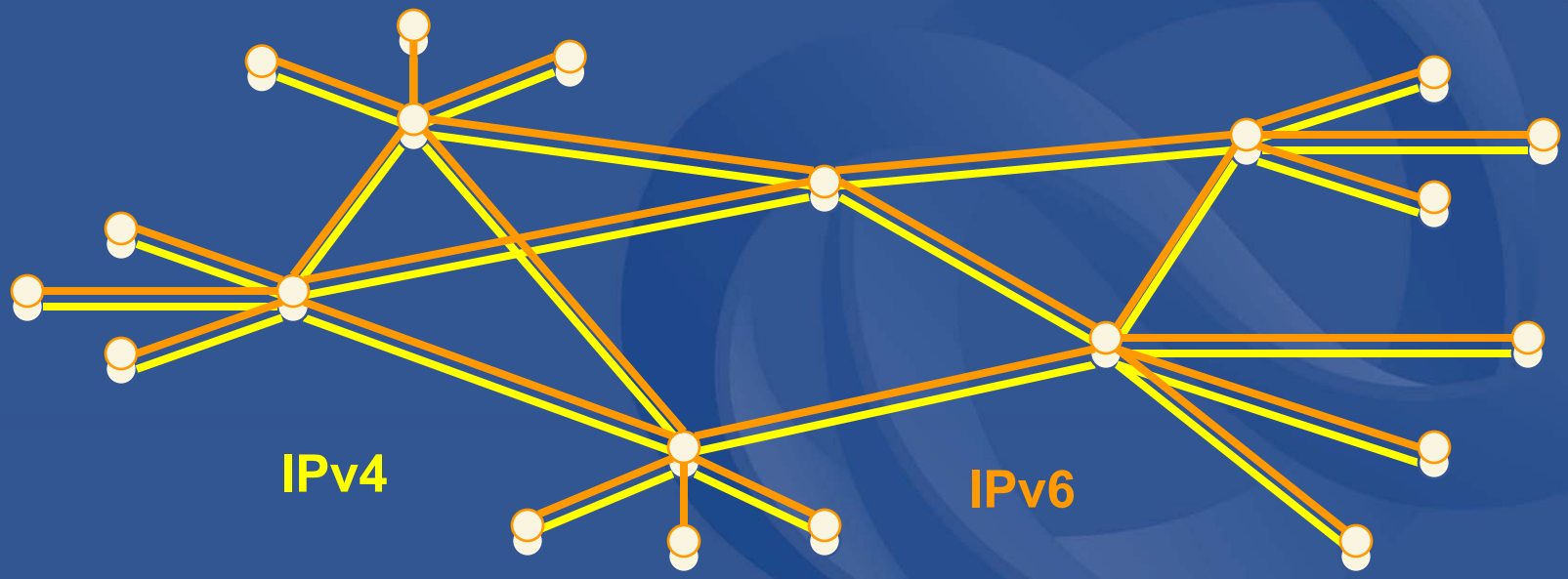


IPv6 Allocation Criteria

- Initial allocation size is /32
  - Allocated to any IPv6 LIR (ISP) planning to connect 200 End Sites within 2 years
  - This is the default initial allocation to “new” ISPs (“slow start” policy)
  - Provides 16 bits of site address space
- Larger initial allocations can be made if justified according to:
  - IPv6 network infrastructure plan
  - Existing IPv4 infrastructure and customer base

IPv6 Allocation Criteria

- Existing ISP infrastructure
  - Policy assumes that transition is inevitable
  - Large IPv4 ISPs will receive IPv6 allocations consistent with the scale of existing networks



IPv6 Assignments

- Default assignment /48 for all End Sites
  - Providing /16 bits of space for subnets
- End Site defined as an end user of an ISP where:
    - The ISP assigns address space to the end user
    - The ISP provides Internet transit service to the end user
    - The ISP advertises an aggregate prefix route that contains the end user's assignment
  - ISP POPs are also defined as End Sites
  - /48s will also be assigned for sub-assignment of /64 and /128 to mobile devices, sensors etc

IPv6 Assignments

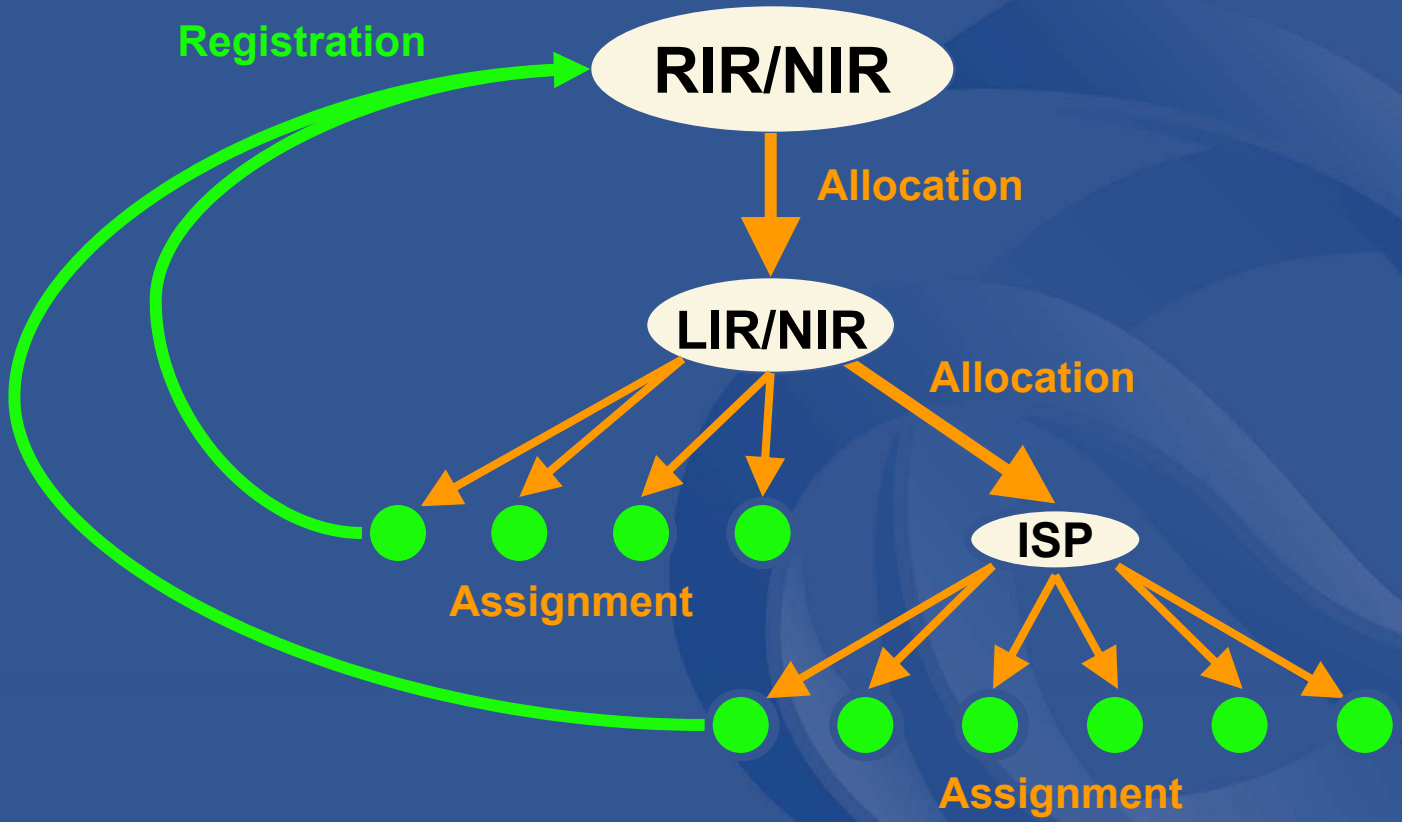
- Larger assignments: Multiple /48s
  - Some end sites will need more than one /48
  - Requests to be reviewed at RIR level
- Smaller assignments: /64
  - Single subnet devices should receive /64 only
  - e.g. simple mobile phone
- Smaller assignments: /128
  - Devices with no subnets should receive /128 only
  - E.g. remote sensor
- See RFC3177 (Sep 2001)

IPv6 Assignments

- IPv6 assignments to End Sites are used to determine utilisation of IPv6 address blocks
  - Intermediate allocation hierarchy not considered
  - All assignments must be registered
  - Utilisation is determined from registrations
- Intermediate allocation and assignment practices are the responsibility of the LIR…

IPv6 Registration

- LIR is responsible for all registrations



IPv6 Utilisation Requirement

- Subsequent allocation may be requested when IPv6 utilisation requirement is met
- Utilisation of IPv6 address space is measured differently from IPv4

IPv6 Utilisation Requirement

- Under IPv4, address space utilisation measured as simple percentage:

$$Utilisation = \frac{assigned}{available}$$

- IPv4 utilisation requirement is 80%
  - When 80% of address space has been assigned or allocated, LIR may receive more
  - E.g. ISP has assigned 55,000 addresses from /16

$$\frac{assigned}{available} = \frac{55{,}000}{65{,}536} = 84\%$$

IPv6 Utilisation Requirement

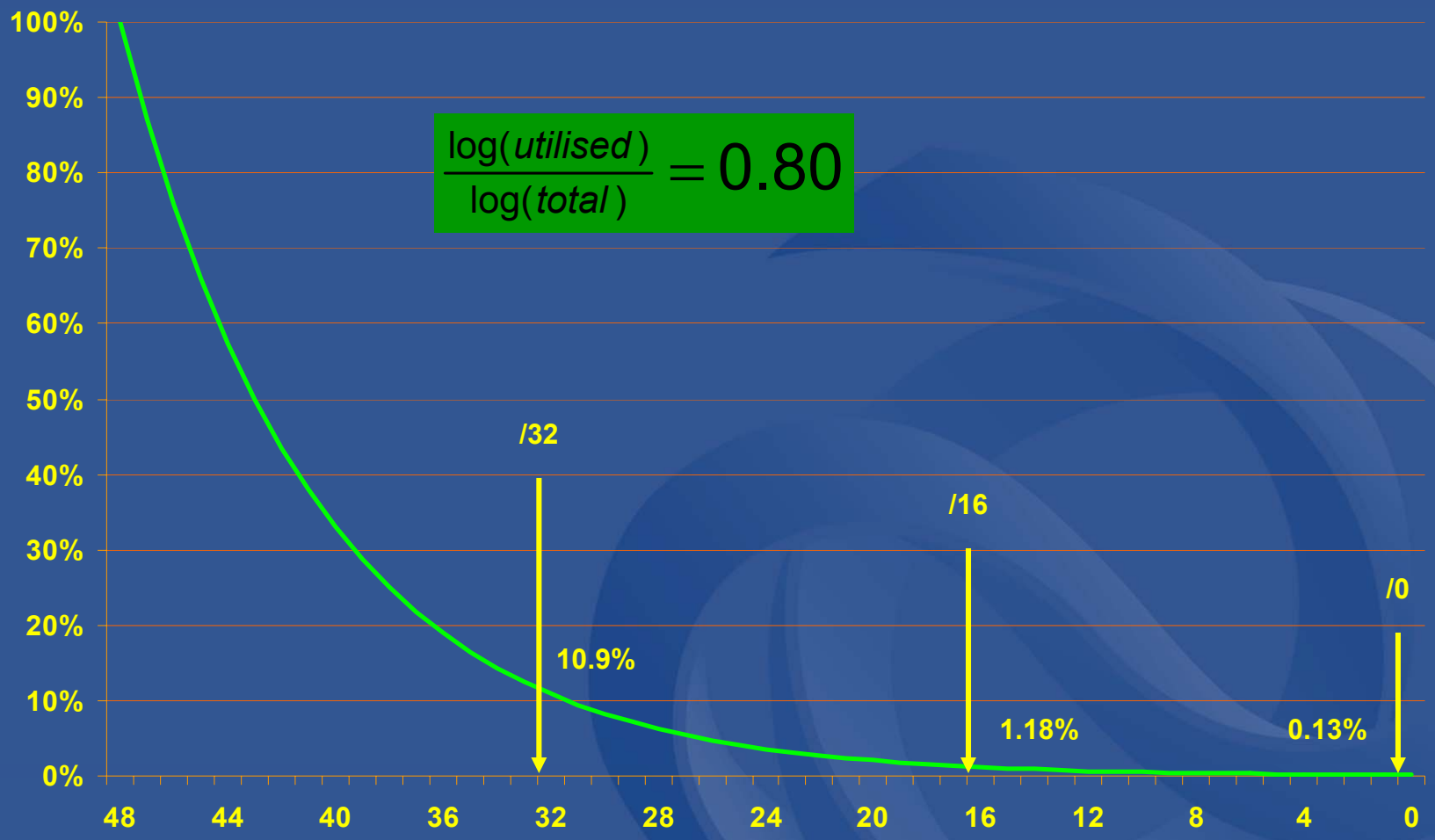
- Under new IPv6 policy utilisation is determined by HD-Ratio (RFC 3194):

$$Utilisation_{HD} = \frac{\log(assigned)}{\log(available)}$$

- IPv6 utilisation requirement is HD=0.80
  - Measured according to end-site assignments only (intermediate allocations are ignored)
  - E.g. ISP has assigned 10,000 addresses from /32

$$\frac{\log(assigned)}{\log(available)} = \frac{\log(10,000)}{\log(65,536)} = 0.83$$

IPv6 utilisation (HD = 0.80)



RFC3194 “The Host-Density Ratio for Address Assignment Efficiency”

Subsequent Allocation

- Subsequent allocation can be made when ISP's existing address space reaches utilisation of HD = 0.80
- Other address management policies should also be met
  - Correct registrations
  - Correct assignment practices etc
- Subsequent allocation size is at least double
  - Resulting IPv6 Prefix is at least 1 bit shorter
  - Or sufficient for at least 2 years requirement

Other conditions

- License model of allocation
  - Allocations are not considered permanent, but always subject to review and reclamation
  - Licenses renewed automatically while addresses in use, consistent with policies
- Existing /35 Allocations
  - A number of /35s have been assigned under provisional IPv6 policy
  - Holders of /35s are eligible to request /32

IPv6 Policy - Summary

- New policy now active globally
- Policy is subject to review
  - Policies evolve as experience is gained
  - Any member of the community may propose changes, alternatives
- Review is starting now
  - Initial allocation criteria under review
  - Size of initial allocation may be reviewed
- Public mailing lists and documentation
  - http://www.apnic.net/ipv6

IPv6 Resource Management - RIR Proposal

Background and Motivation

- IANA-RIR allocation system
  - Unchanged in 10+ years
  - Major IPv4 address space fragmentation
    - Many ISPs have many separate prefixes
  - IPv6 should not go the same way
- Proposal for new system for IPv6
  - Designed to minimise fragmentation
    - Most ISPs will have 1 prefix for many years
- Document development
  - Document jointly authored by RIRs
  - Published as *ripe-261*

Current Allocation System

- IANA allocates to RIR
  - RIR maintains a pool of addresses
  - Attempts to maximise aggregation within pool
    - Short-term reservations
    - Sparse allocation
- RIRs allocate to LIRs/ISPs
  - When pool runs low, RIR receives more from IANA
  - Subsequent allocations to existing ISPs cannot be aggregated

Current Allocation System (v4)

❶ 212/8

❹ 213/8

❷ 212.100/16

❸ 212.101/16

212.100/15

❺ 213.50/16

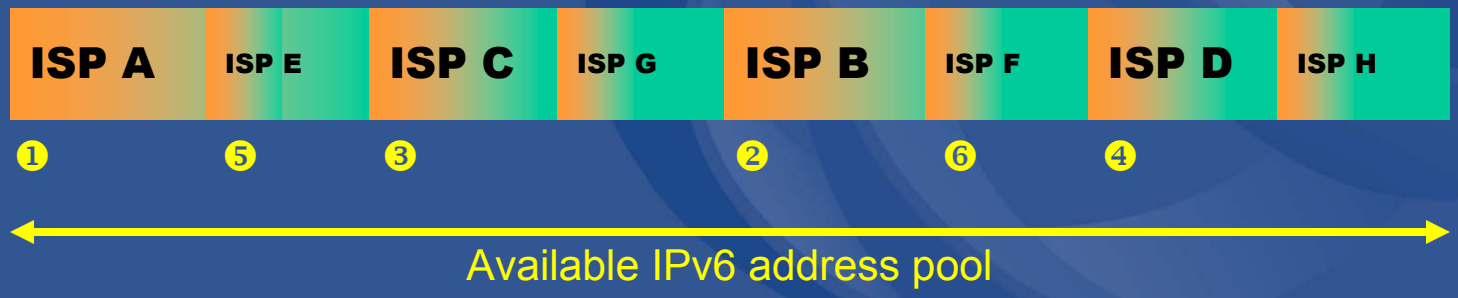
ISP has 2 prefixes after 3 requests!

Current Allocation System

- IPv4
  - IANA to RIR allocation unit: /8
  - RIR to LIR/ISP: /20… /10…
  - Many ISPs have multiple prefixes
- IPv6
  - IANA to RIR allocation unit: /23 (64 x /29)
  - RIR to LIR/ISP: /32 minimum
  - IPv6 swamp is being created already
    - Maximum reservation per ISP is /29

Proposal

- "Sparse Allocation" system
  - Maximise "distance" between separate portable allocations
  - Maximise chance of aggregation of subsequent allocations
  - Implemented as list of address prefixes to be allocated in order
- For example…



Proposal

- Sparse allocation system will maximise aggregation
  - Simple system, easily understood
    - Otherwise known as “binary chop”
  - Used in practice by RIRs already (IPv4)
    - Within large address blocks (e.g. /8)
  - Used in other allocation systems
    - e.g. dynamic memory allocation

Proposal

- Benefits increase as address pool increases
  - System breaks down in “overflow condition”
    - i.e. where pool becomes too crowded or full, and another pool must be allocated
  - Therefore RIRs propose to share a single global pool
    - Known as Common Address Pool (CAP)
    - Managed by RIRs jointly, under “Common Registry Service” (CRS)

Proposal

- CAP needs to be as large as possible
  - to ensure long life of single pool
  - to avoid unaggregatable allocations
- So…
  - IANA to allocate 2000::/3 (FP001) for CAP
    - For management by CRS
    - This address space already designated by IETF as Global Unicast, for allocation by RIRs

Allocation Request Process

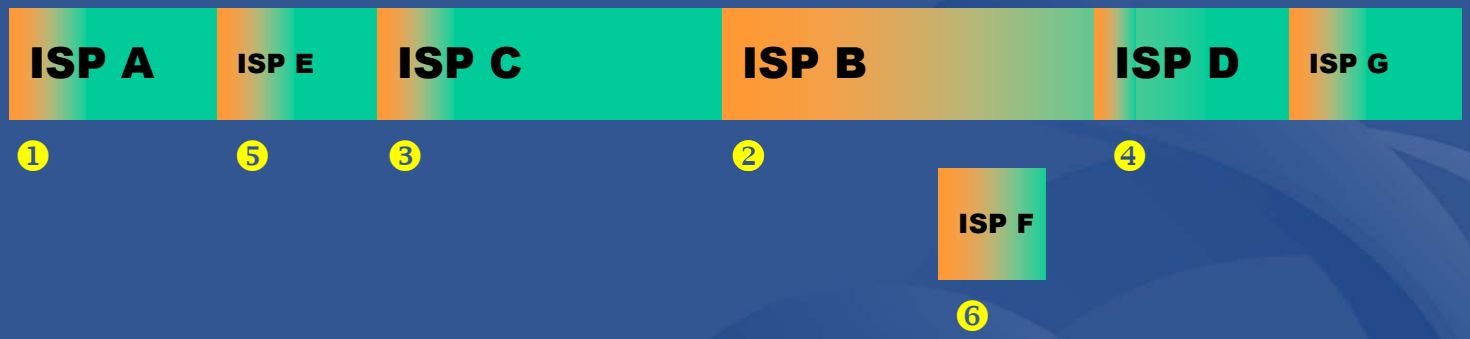
1. First IPv6 allocation to ISP
   - RIR sends request to CRS for new block of specified size
   - CRS allocates next entry from list of start addresses
2. Subsequent allocation to ISP
   - RIR sends request to CRS for expansion of existing allocation for that ISP (to certain specified size)
   - CRS provides extension of existing allocation
     - If extension is not available, new prefix must be allocated

Avoiding Fragmentation

- Distance between neighboring allocations is initially very large
  - "Dumb" algorithm can be used initially
- However, some ISP allocations will grow faster
  - Threatening to "collide" with neighbour
- "Smarter" algorithm for new allocations
  - e.g. If existing preceding allocation has grown to occupy more than a certain % of address space available to it, select next start address from the list

Avoiding Fragmentation

- "Smarter" algorithm…



However note that this is a far future scenario…

Other Details

- Review of allocation process
  - Initial set of allocations limited to 2048
  - Providing each ISP with up to /14 (!)
    - Commence review after 1024th entry (2-3 years?)
- Common Registry Service (CRS)
  - Function to rotate between RIRs
  - 'Master' server at one RIR
    - Mirror servers elsewhere
- Reverse DNS requirements (ip6.arpa)
  - CRS administers master DNS server
  - Other RIRs will be mirrors of master

Disadvantages

- Requires single large allocation
  - Maybe “Putting all our eggs in one basket”
  - RIR proposal is to utilise very large block, only one-eighth of IPv6 address space
- Not possible to identify specific blocks allocated to specific RIRs/regions
  - e.g. for filtering purposes
  - RIRs note that this is not possible in IPv4 due to historical allocations

Further information

- Document available from
  - http://www.ripe.net/ripe/docs/ipv6-sparse.html
- APNIC IPv6 SIG
  - http://www.apnic.net/meetings
  - http://www.apnic.net/lists

How Long will IPv6 last?

How long will IPv6 last?

- IPv6 address space is not very large, under current allocation policies
  - Total of 36 site addresses per person in 2010 (10 billion population)
  - Space will be rapidly exhausted, and policies will require review
- How will we do the next transition?
  - Has anyone thought about this?
- More in Expert Panel session
  - Morning Session C, 4 April 2003

Thank You

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