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APNIC

APNIC Seminar

"International Seminar on Internet Resource Management"

27 November 2003

Phnom Penh, Cambodia

Nurani Nimpuno, APNIC

Overview

- IP Addresses
  - What's an IP address?
- History of the RIRs
  - The development of the RIR system
- Intro to APNIC
  - APNIC structure, membership and services
- IP address management
  - Evolution of address management
  - IP address policy

- Policy development
  - APNIC community
  - How to participate in the open policy development process
- Global allocation data
  - Global Internet Resources statistics
- APNIC allocation data
  - Internet Resources statistics in the AP
- IPv6
  - Introduction to the next generation protocol

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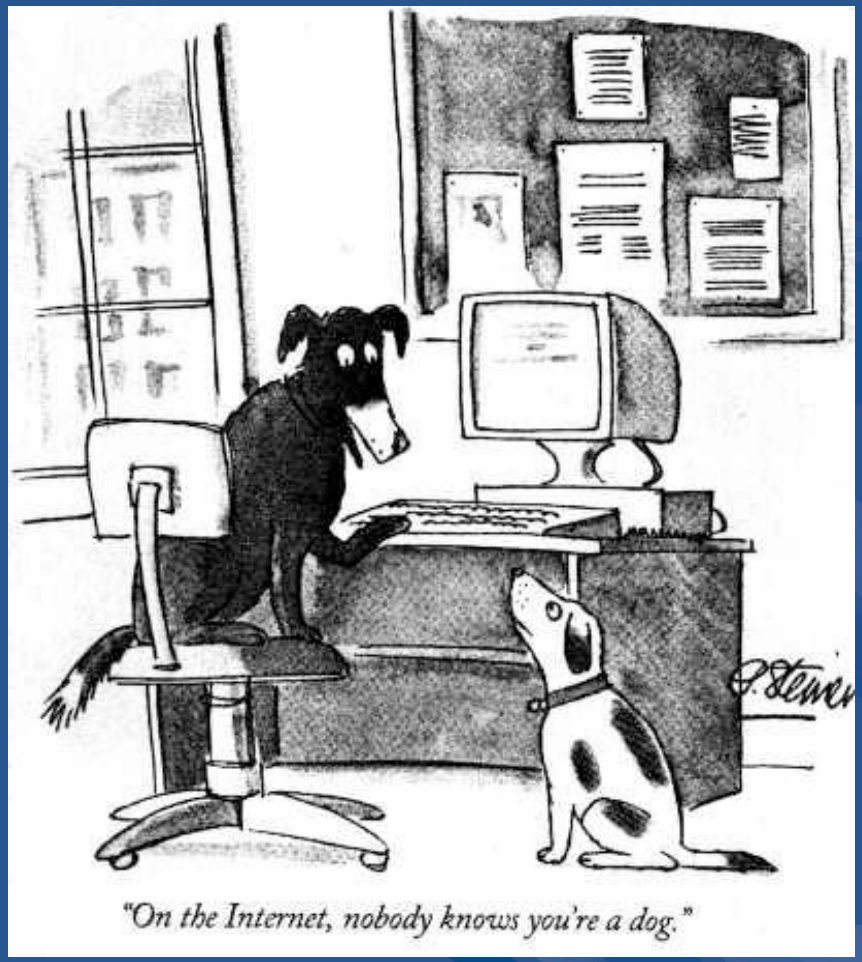
Internet Protocol Addresses

What are they like and how are the managed?

“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!

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Internet for everything!

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What is an IP Address?

Overview

- What is an IP address?
  - …and what it is not
- Internet address routing
- What is an IP address like?
  - IP address characteristics

What is an Address?

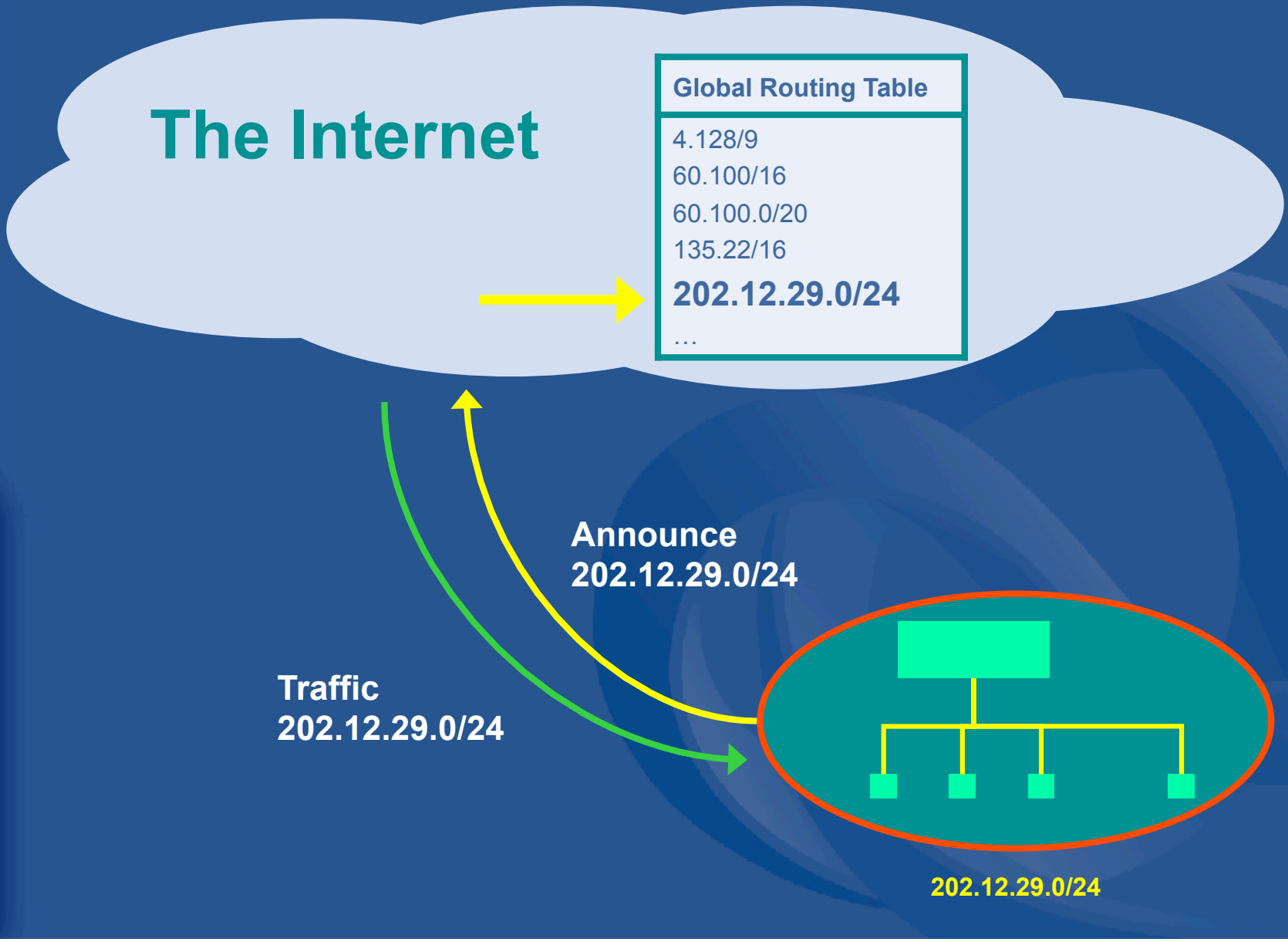
- An identifier which includes information about how to find its subject
  - (according to some rules of interpretation)
- Normally hierarchical
  - Each part provides more specific detail
- For example…
  - APNIC, Level 1, 33 Park Rd, Milton, Brisbane, Australia
  - www.apnic.net
  - pwilson@apnic.net

What is an IP address?

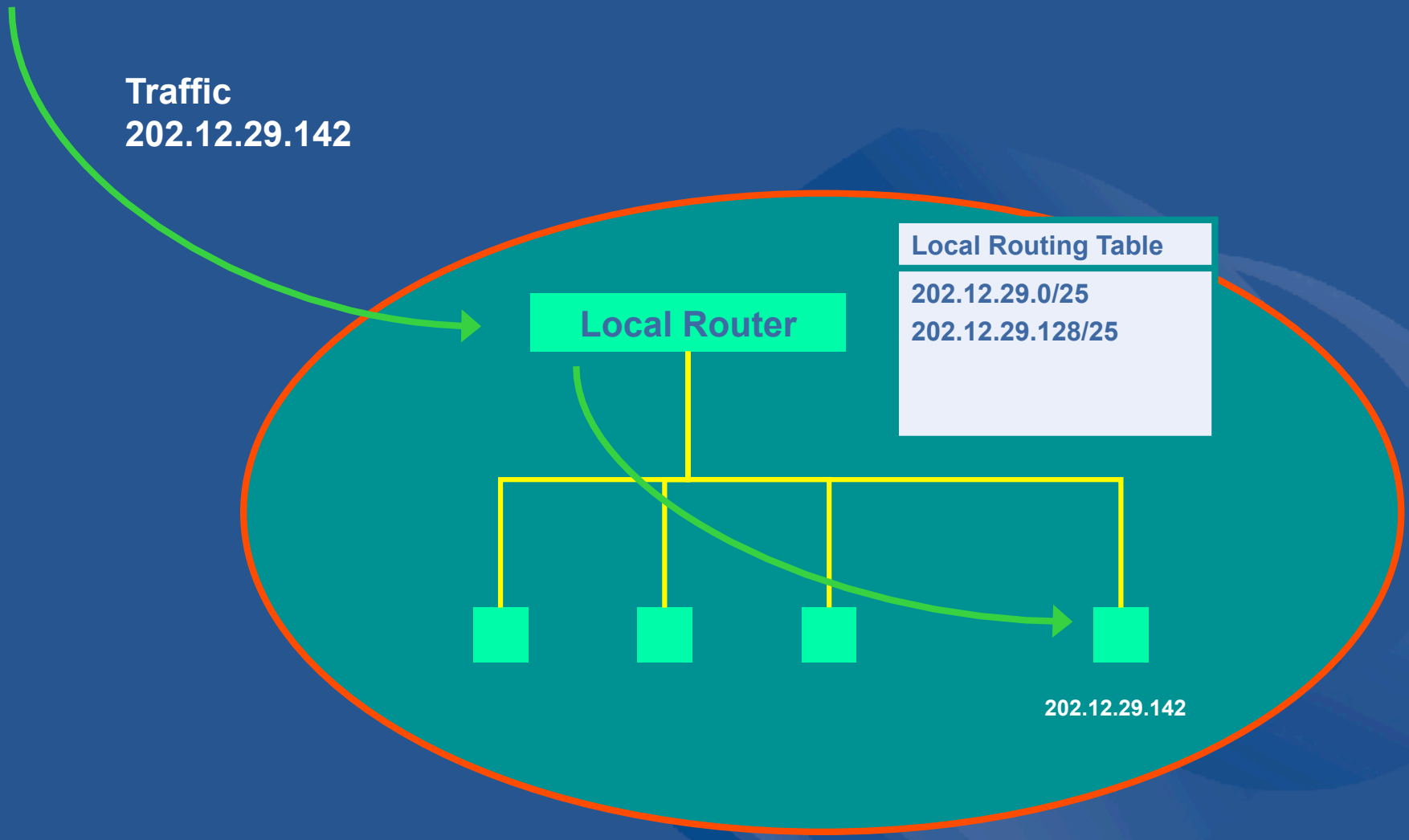
- *Internet identifier including information about how to reach a location*
  (via the Internet routing system)
- IPv4: 32-bit* number
  - 4 billion different addresses available
- IPv6: 128-bit number
  - 340 billion billion billion billion addresses available
- For example…
  - 202.12.29.142
  - A computer within APNIC's network (202.12.29/24)

* bit = binary digit

Internet address routing



Internet address routing

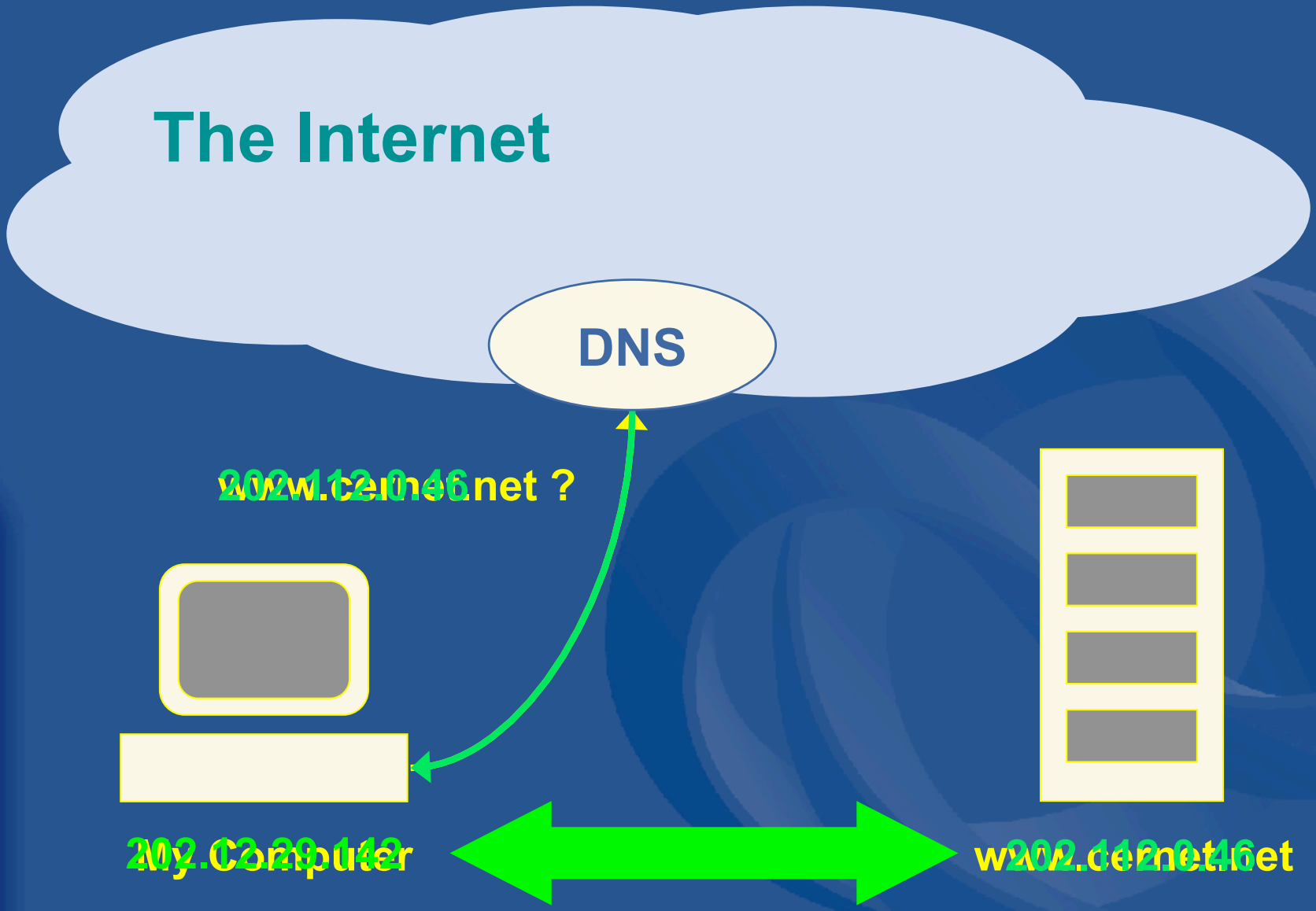


What else is an IP address?

- IP addresses are…
  - Internet infrastructure addresses
  - a finite Public Resource
  - not “owned” by address users
  - not dependent upon the DNS

- IP does not mean “Intellectual Property”

IP addresses vs domain names



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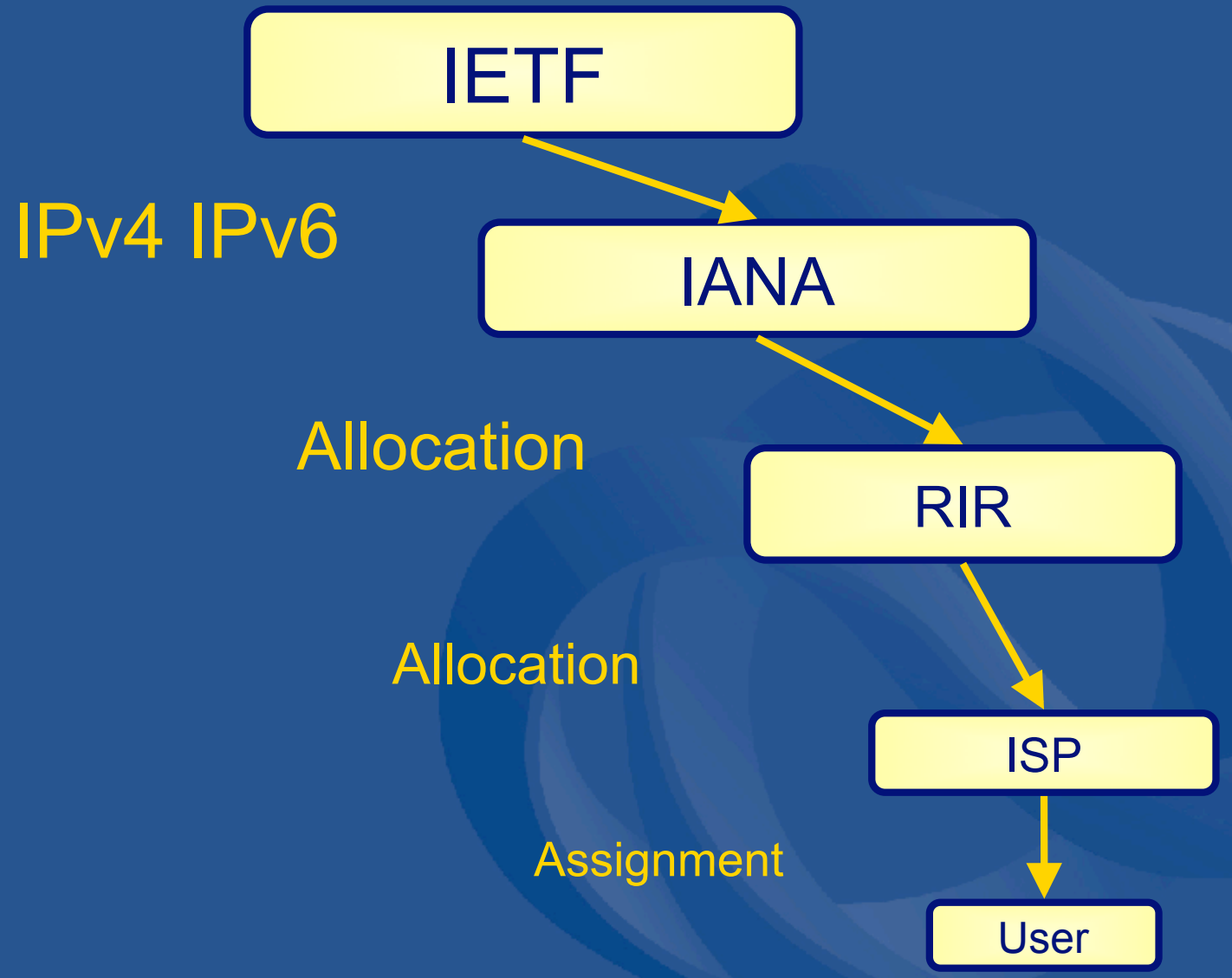
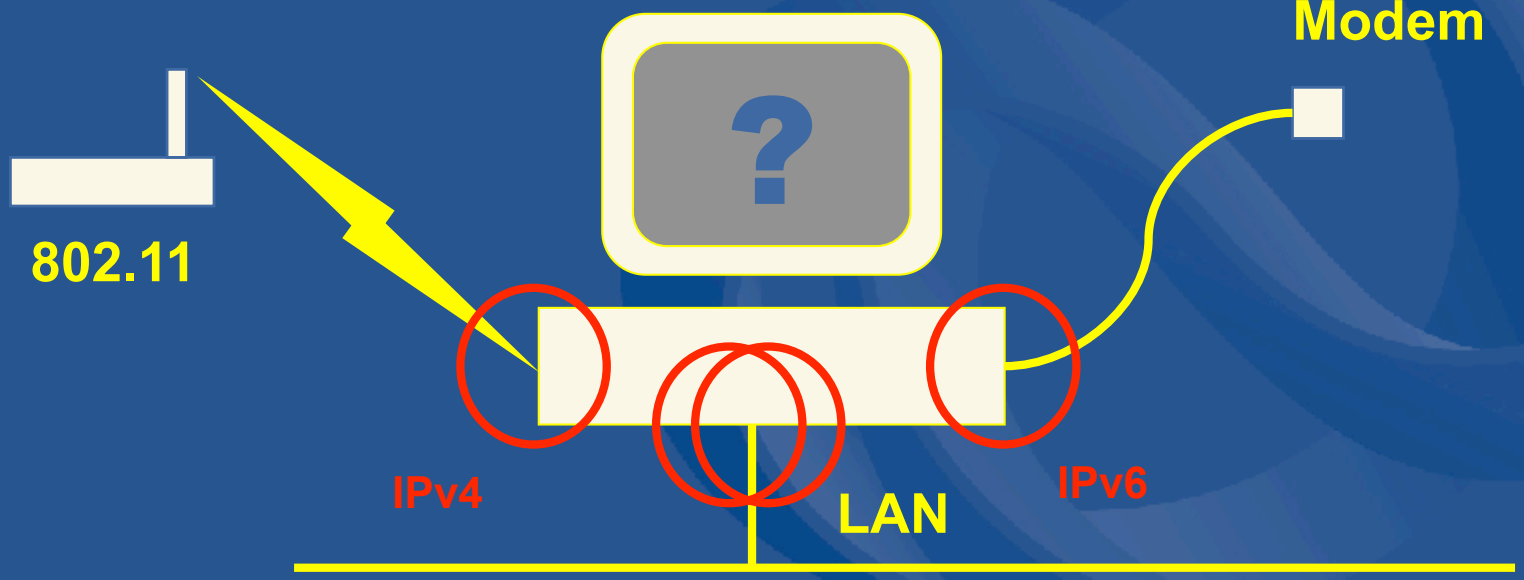
IP Address Characteristics

Where do IP addresses come from?



What is “my” address?

- IP Address = Network interface address
  - Not a computer’s address
  - Nor a person’s address

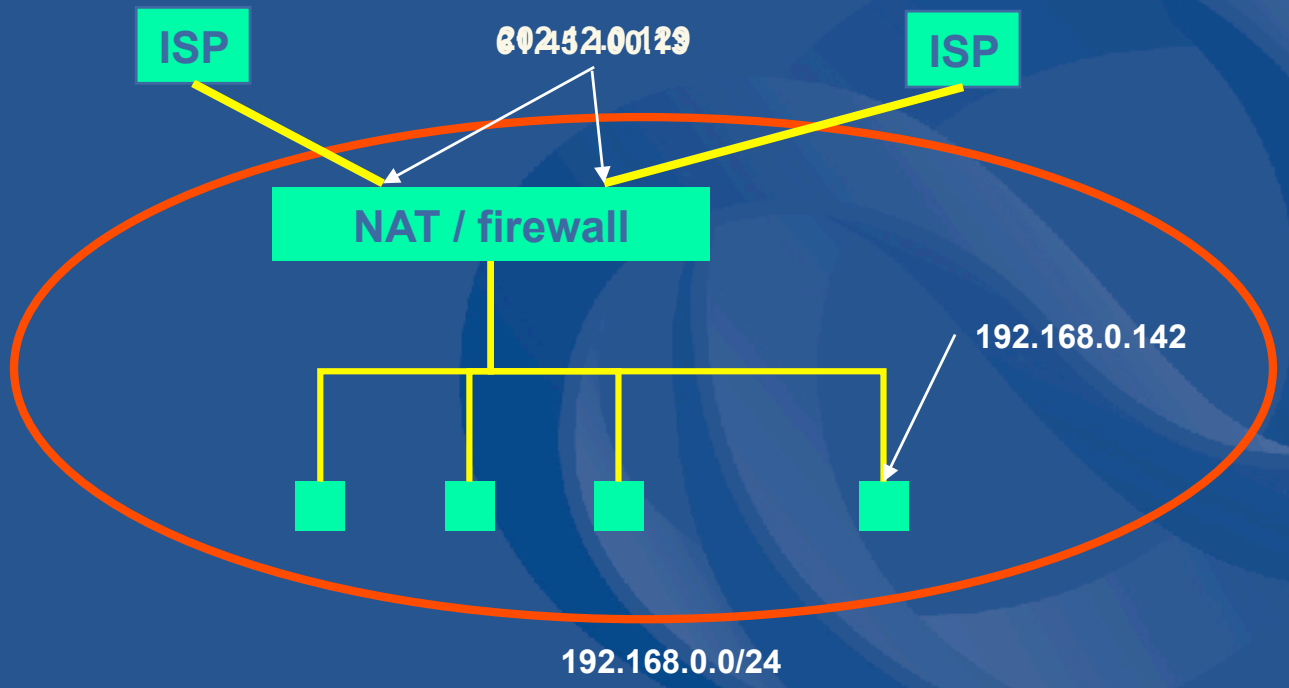


Is “my” address permanent?

- No - Customer addresses often change
  - Dialup addresses are “dynamic”…

Is “my” address unique?

- Not necessarily…
  - Public IP address = unique
  - Private* IP address = non-unique



* RFC 1918

Summary so far

- IP Addresses identify location
  - Provide specific information for routing
- IP Addresses identify interfaces
  - Not computers, companies or users
- IP Addresses often change
  - And may not be unique

Questions ?

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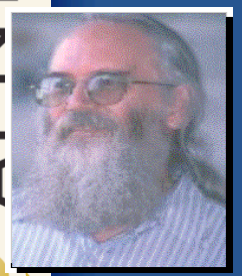
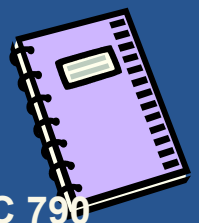
History of the RIR System

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

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1996

RFC 2050
1996

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1997

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1998

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1999

ASO MoU

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2002

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2003

Emerging RIR

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Introduction to APNIC

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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, in-addr.arpa delegation
- Established 1993
  - Operating within ICANN (IANA) structure
  - Pilot project of APNG in Tokyo, Japan
  - Relocated to Brisbane, Australia in 1998

About APNIC

- Industry self-regulatory body
  - –Participation by those who need and use Internet resources
  - –Consensus-based, open and transparent
  - –Non-profit, neutral and independent

- Membership-based structure
  - –Open to any interested party
  - –Provides formal structure for cost recovery, election of representatives etc

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APNIC mission statement

"Addressing the challenge of responsible Internet resource distribution in the Asia Pacific region."

What does APNIC do?

- Resource services
  - IPv4, IPv6, ASNs, in-addr.arpa, whois

- Policy development and implementation
  - Membership reviews and approves policy

- Resource registration
  - Authoritative registration server: whois

What else does APNIC do?

- Information dissemination
  - APNIC meetings
  - Web and ftp site mailing lists
    - http://www.apnic.net/net_comm/lists/index.html
- Training courses & open seminars
  - So far held
    - 26 trainings in 13 countries during last 2.5 years
  - Planned schedule
    - http://www.apnic.net/training
  - Subsidised for APNIC members

APNIC partners

- APNIC works closely with
  - The APNIC Membership
  - Asia Pacific peak bodies in Internet industry, technology, policy and law
    - APNG, APIA, APAN, APTLD, APRICOT
      - Co-founder of APRICOT
  - Other Regional Internet Registries (RIRs)
    - ARIN, RIPE NCC, LACNIC, (AFRINIC)
  - Other leading Internet organisations
    - IANA, ICANN, IETF, IEPG, ISOC etc.

Where is APNIC?

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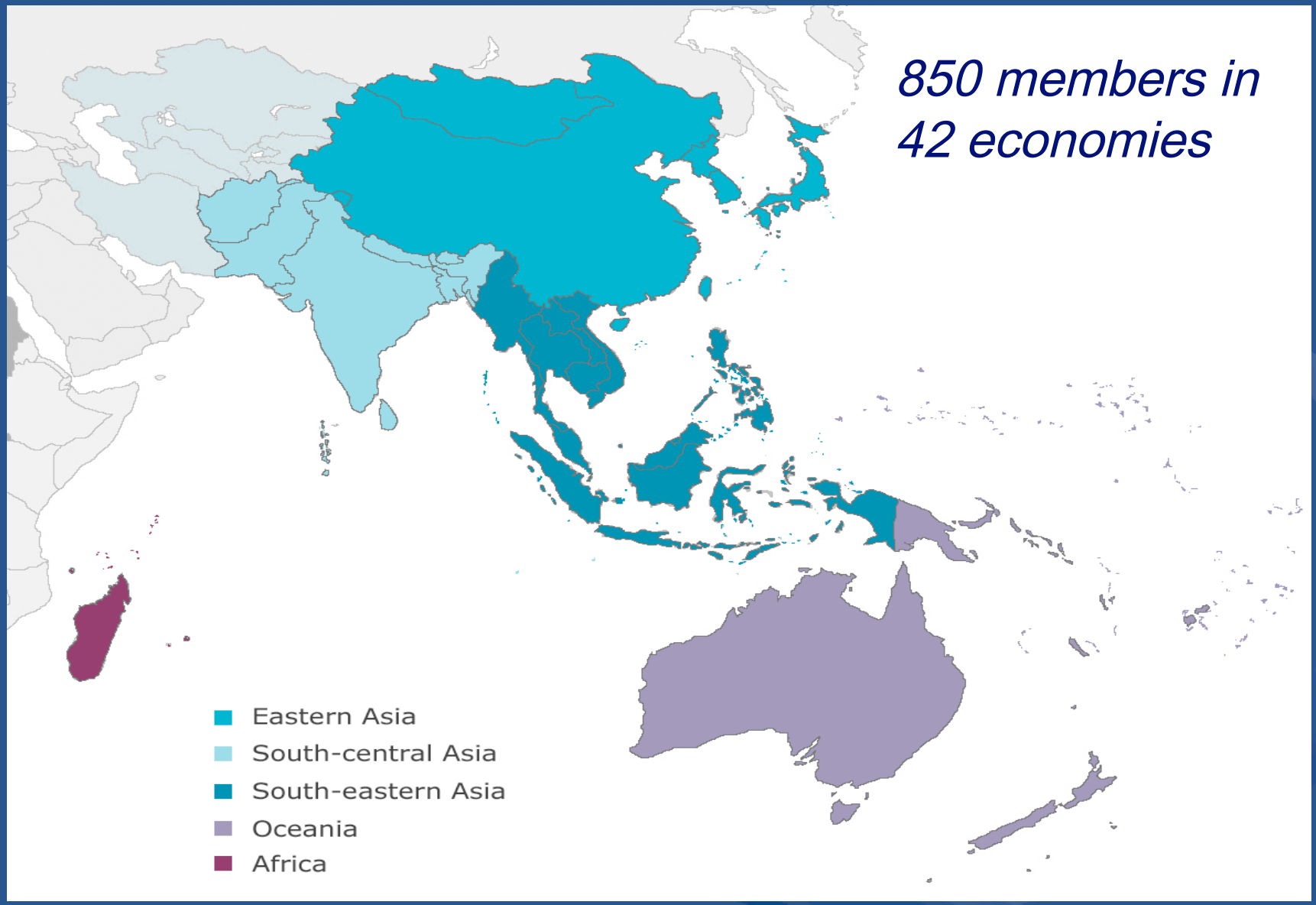
APNIC region



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

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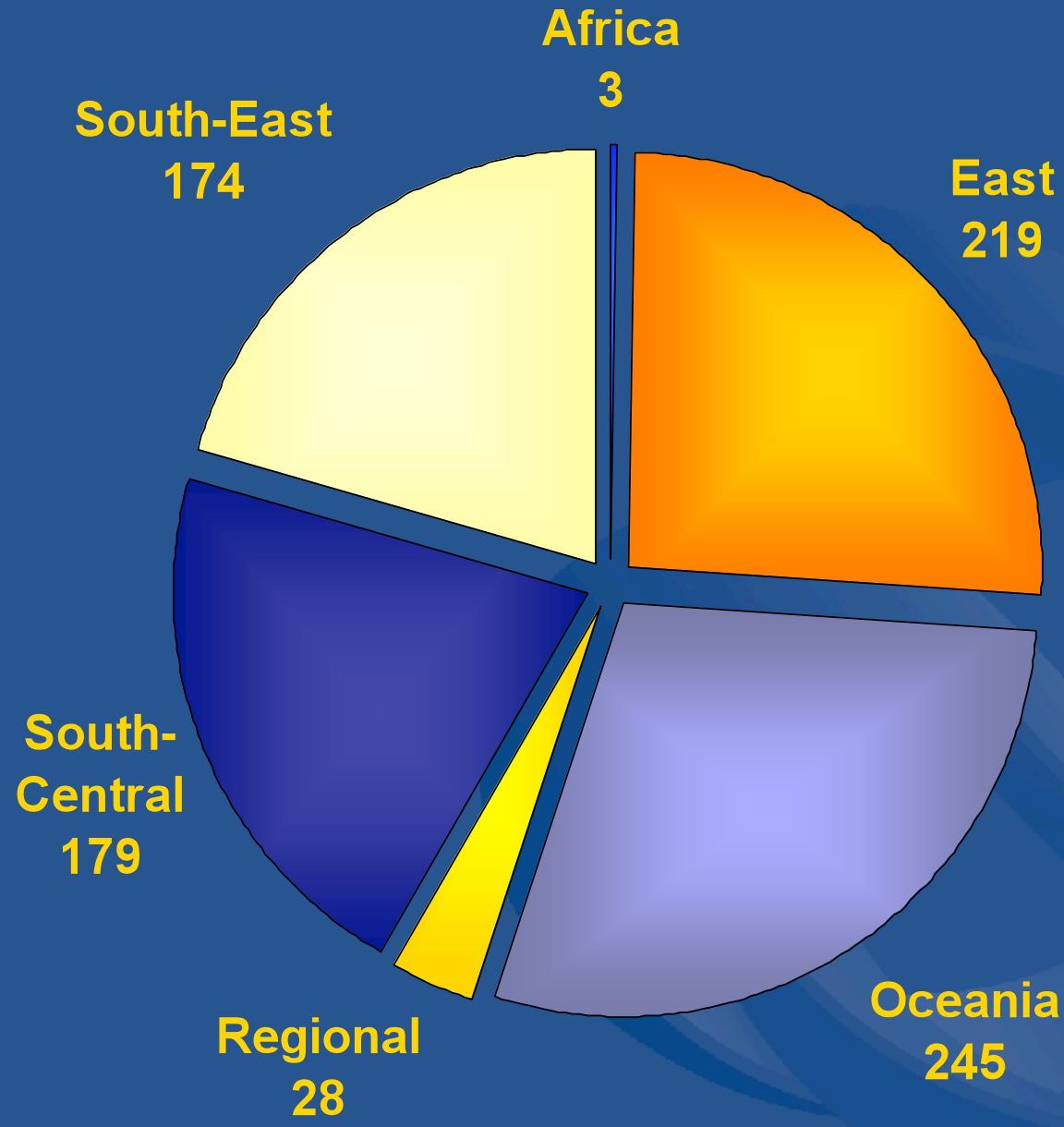
Membership sub-regions



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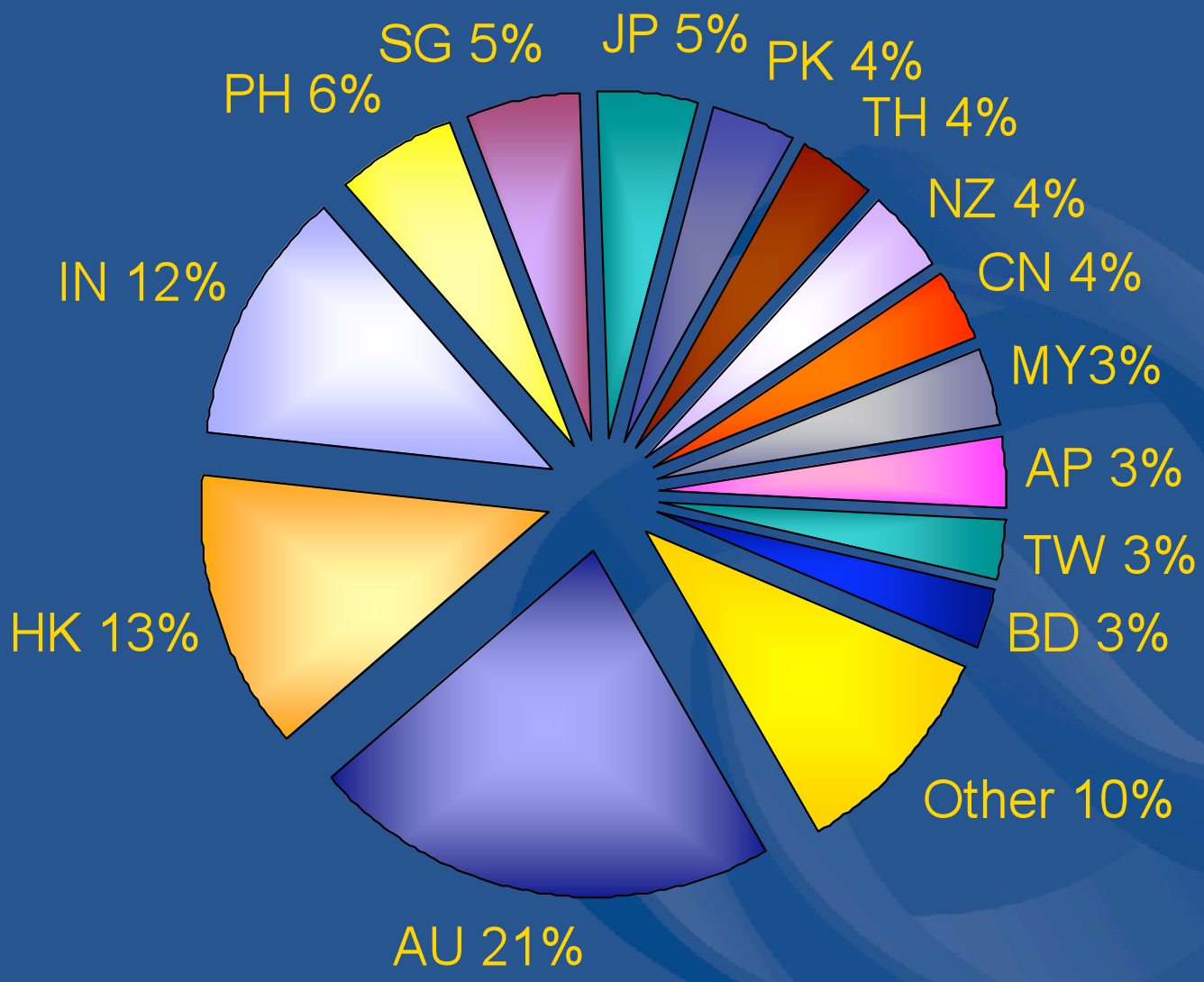
APNIC membership



Last update: 20 Oct

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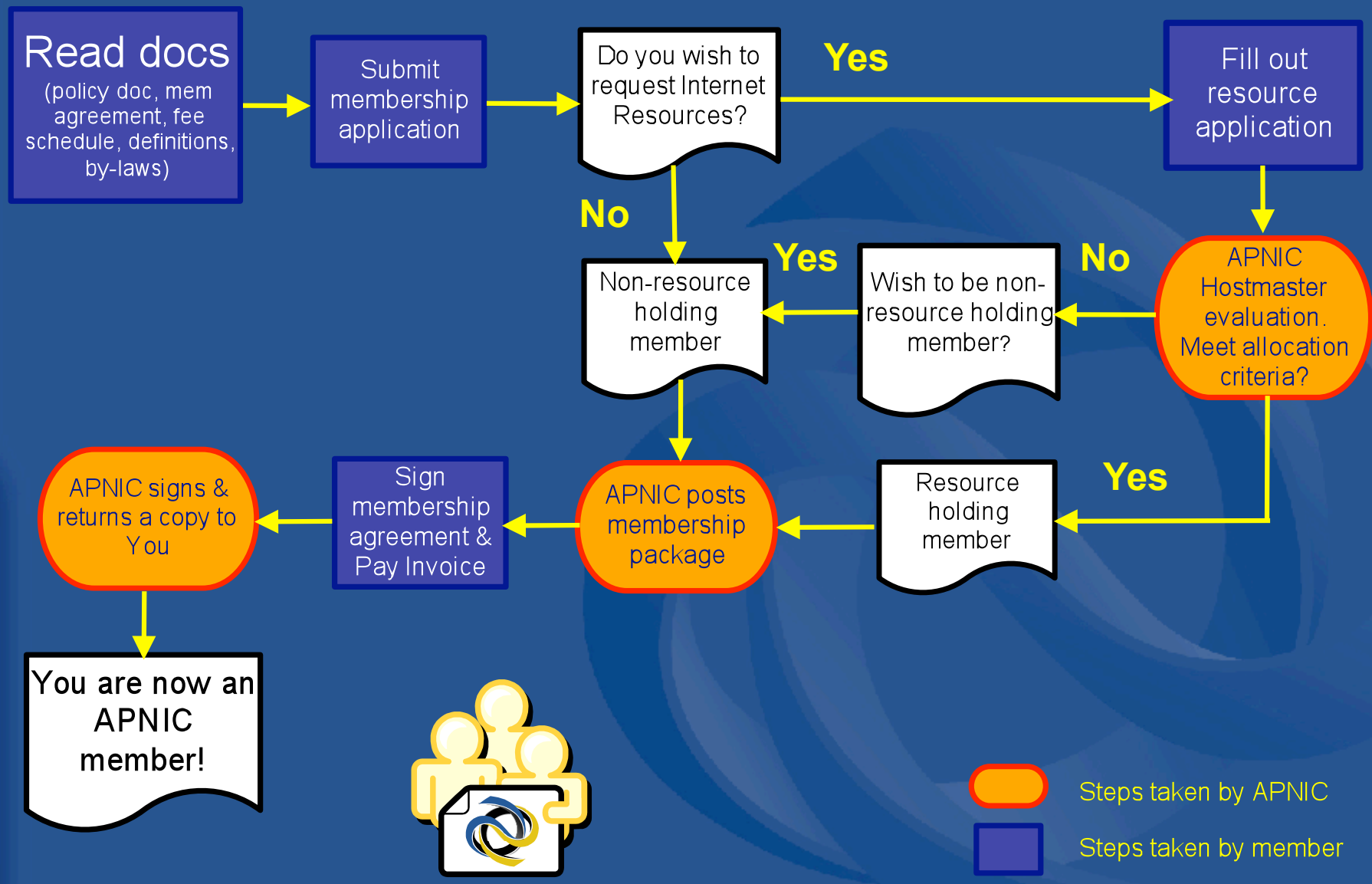
How to become a member



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Membership fee structure

Membership tier	Annual fee (US$)	IPv4 space held	IPv6 space held
Associate	$625	None	None
Very small	$1,250	< (incl) /22	< (incl) /35
Small	$2,500	/22 - (incl) /19	/35 - (incl) /32
Medium	$5,000	/19 - (incl) /16	/32 - (incl) /29
Large	$10,000	/16 - (incl) /13	/29 - (incl) /26
Very large	$20,000	/13 - (incl) /10	/26 - (incl) /23
Extra large	$40,000	> /10	> /23

For more information see: http://www.apnic.net/member/

Benefits of APNIC membership

Free attendance at APNIC Members Meetings

Resource Services & Registration Services

Voting rights at APNIC Meetings

Participation in APNIC community

Influence in APNIC Activities

Subsidised APNIC training

- *NOT: Automatic or easier resource allocation*

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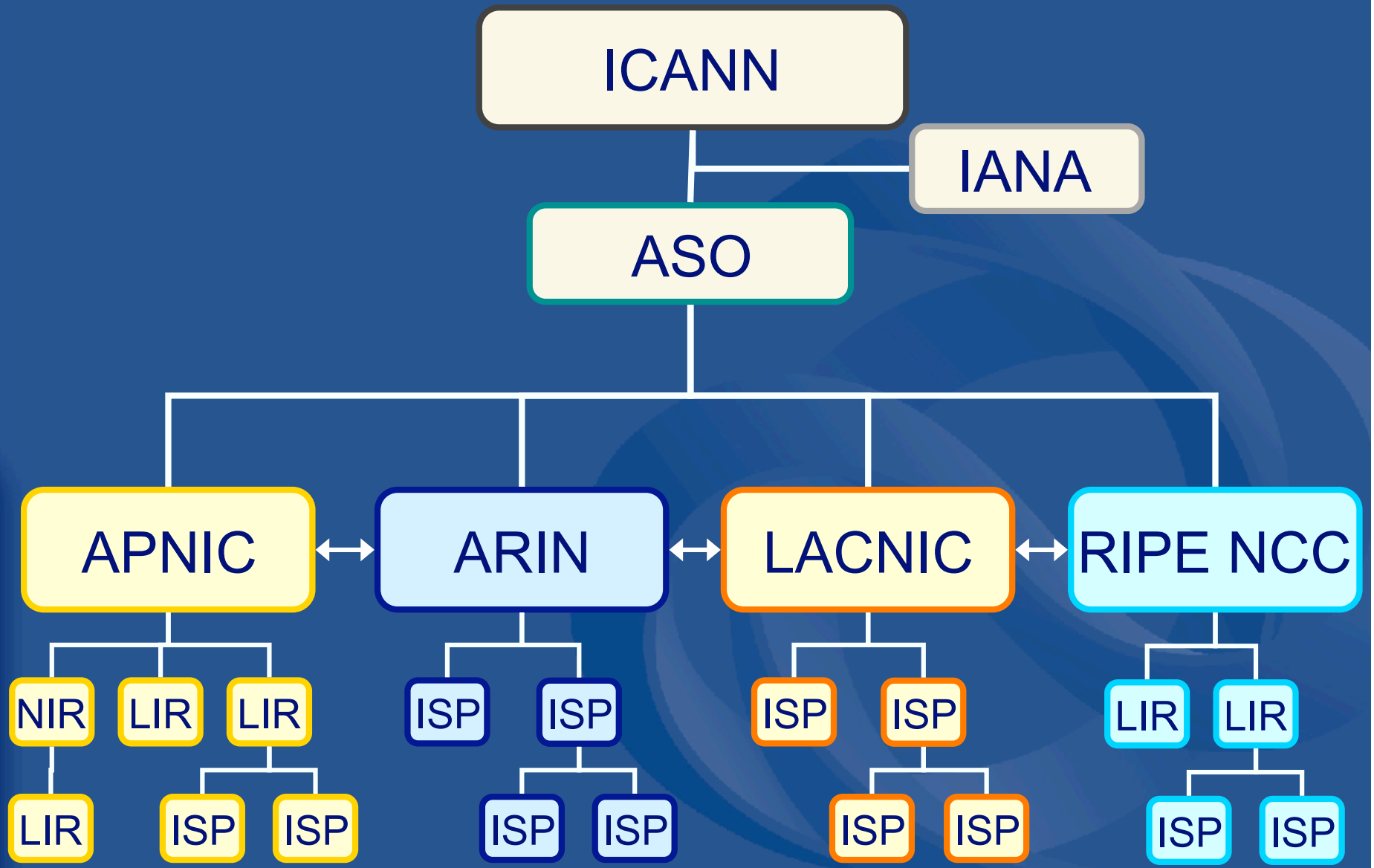
APNIC is not…

- Not a network operator
  - Does not provide networking services
    - Works closely with APRICOT forum
- Not a standards body
  - Does not develop technical standards
    - Works within IETF in relevant areas (IPv6 etc)
- Not a domain name registry or registrar
    - Will refer queries to relevant parties

Internet Registry structure



APNIC services & activities

Resources Services

- IPv4, IPv6, ASN, reverse DNS
- Policy development
  - Approved and implemented by membership
- APNIC whois db
  - whois.apnic.net
  - Registration of resources

Information dissemination

- APNIC meetings
- Web and ftp site
- Mailing lists
  - Open for anyone!
- Training Courses
  - Subsidised for members
- Co-ordination & liaison
  - With membership, other RIRs & other Internet Orgs.

Questions ?

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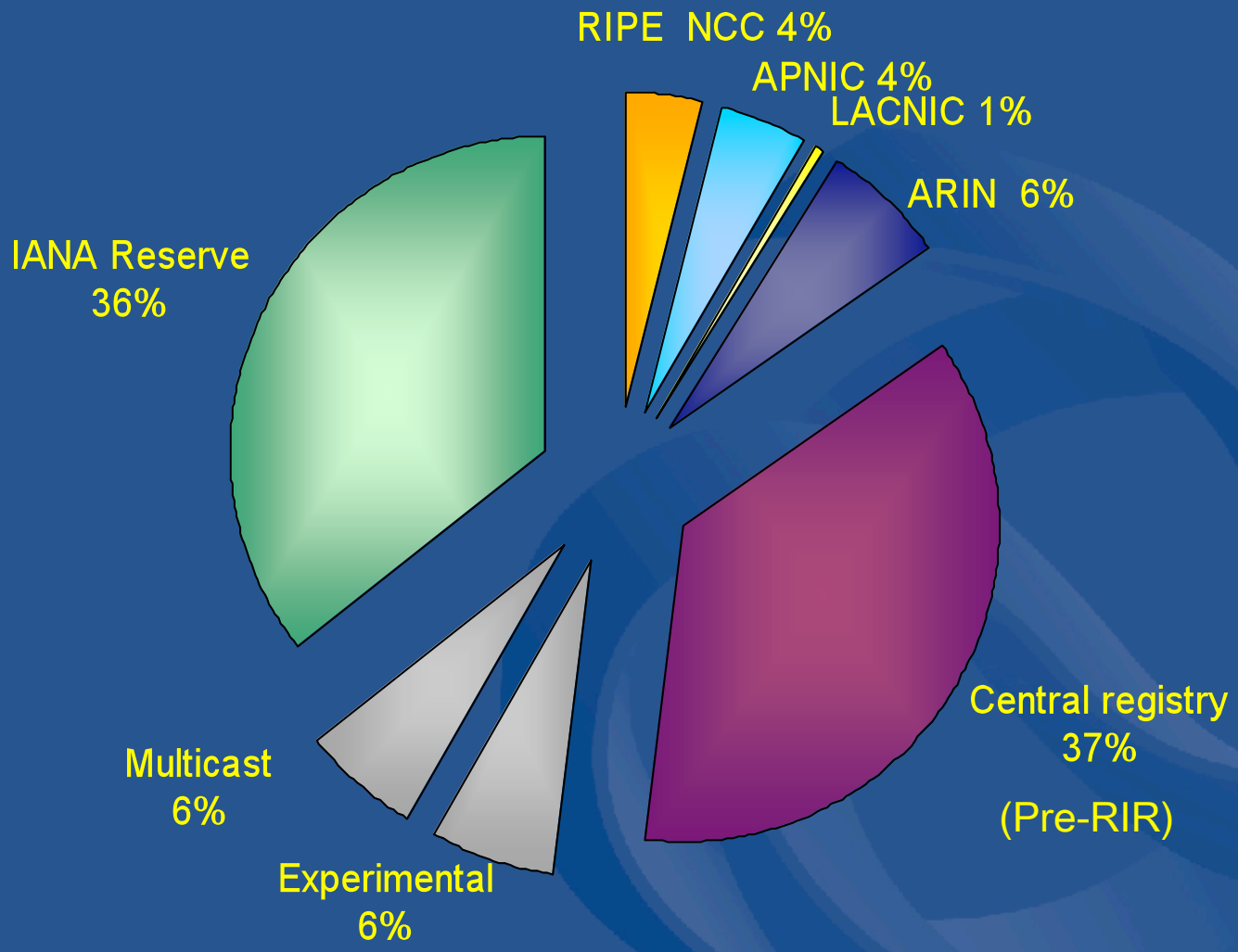
IP Address Management

Internet Registry Allocation and Assignment Policies

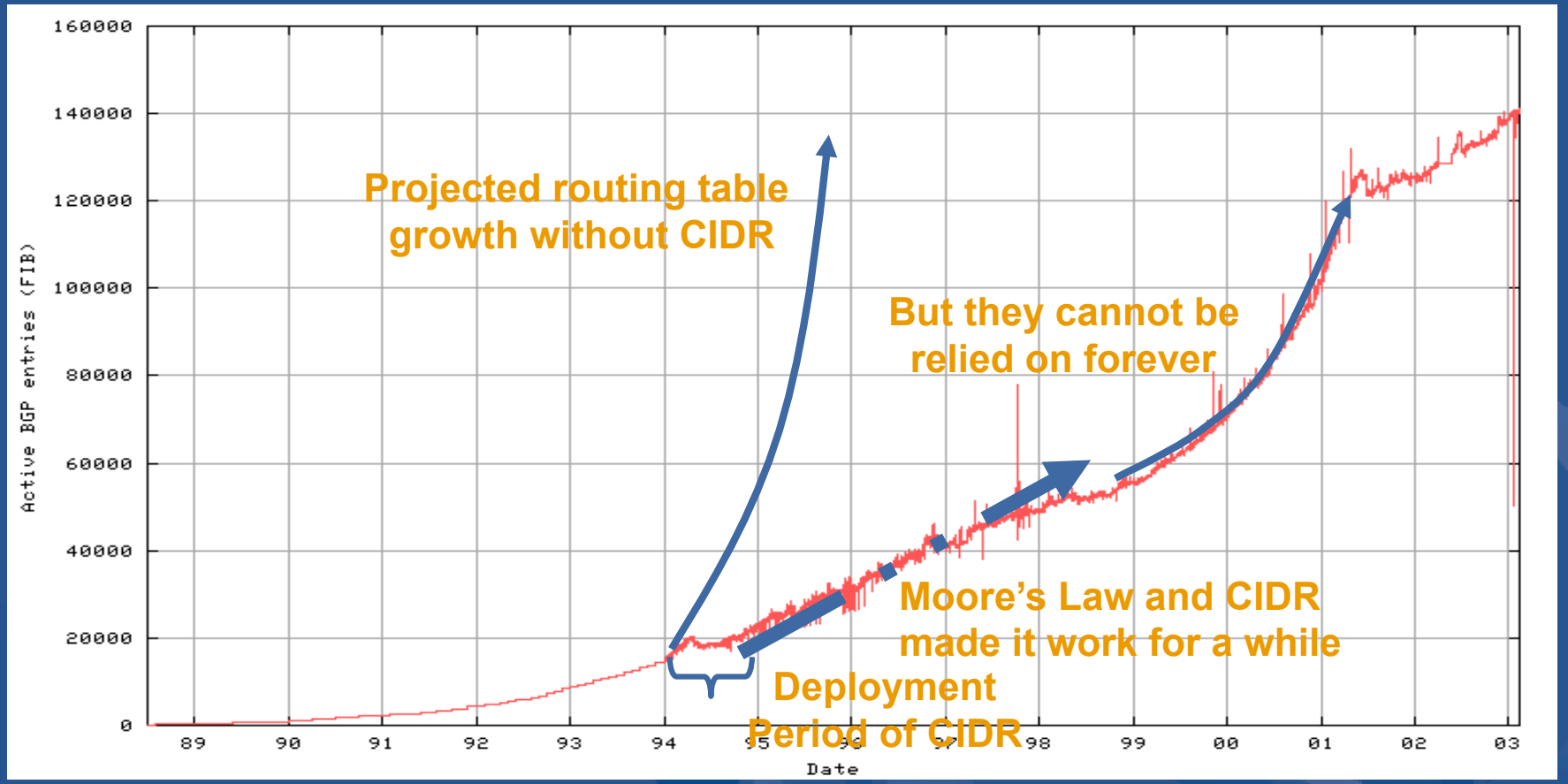
Early Address Management

- Early 1990's: Internet scaling problems
- Address depletion
  - due to classful architecture
  - 3 choices: A, B or C
- Routing table overload
  - Due to lack of route aggregation
- Internet widely projected to fail
  - Growth would stop by mid-'90s
  - Urgent measures required
  - Action taken by IETF / Internet community

Global IPv4 Delegations



Growth of global routing table



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

last updated 12 Feb 2003

Evolution of address management

- 1993: Development of “CIDR”
  - addressed both technical problems
- Address depletion
  - Through more accurate assignment
- Routing table overload
  - Through address space aggregation
- Administrative problems remained
  - Increasing complexity of CIDR-based allocations
  - Increasing awareness of conservation and aggregation goals
  - Need for fairness and consistency

Evolution of address policy

- RFC 1366 (1992)
  - Described the “growth of the Internet and its increasing globalization”
  - Additional complexity of address management
  - Set out the basis for a regionally distributed Internet registry system
- 1990s - establishment of RIRs
  - APNIC, ARIN, RIPE NCC (LACNIC later)
  - Regional open processes
  - Cooperative policy development
  - Industry self-regulatory model

Address management objectives

Conservation

- Efficient use of resources
- Based on demonstrated need

Aggregation

- Limit routing table growth
- Support provider-based routing

Registration

- Ensure uniqueness
- Facilitate trouble shooting

Allocation and assignment

Allocation

"A block of address space held by an IR (or downstream ISP) for subsequent allocation or assignment"

- Not yet used to address any networks

Assignment

"A block of address space used to address an operational network"

- May be provided to LIR customers, or used for an LIR's infrastructure ('self-assignment')

Allocation and assignment

APNIC
Allocates
to APNIC Member

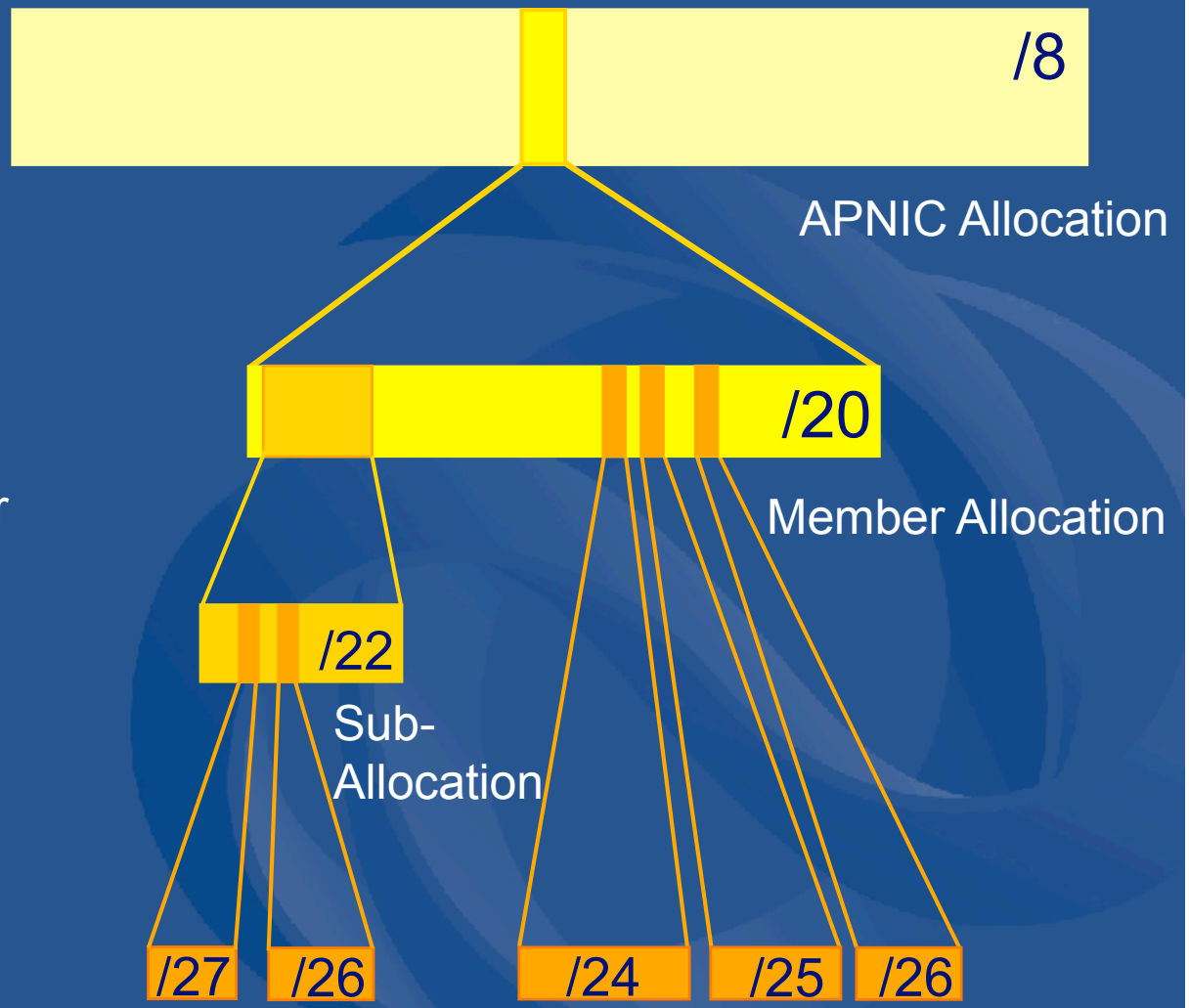
APNIC Member

Allocates
to downstream

Assigns
to end-user

Downstream
Assigns
to end-user

Customer / End User



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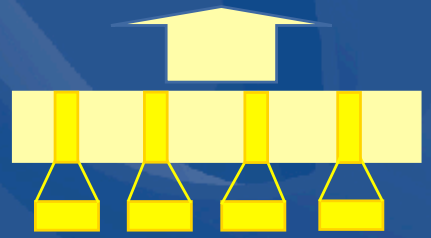
Portable & non-portable

Portable Assignments

- Customer addresses independent from ISP
  - Keeps addresses when changing ISP
- Bad for size of routing tables ☹
- Bad for QoS: routes may be filtered, flap-dampened

Non-portable Assignments

- Customer uses ISP's address space ☺
  - Must renumber if changing ISP
- Only way to effectively scale the Internet

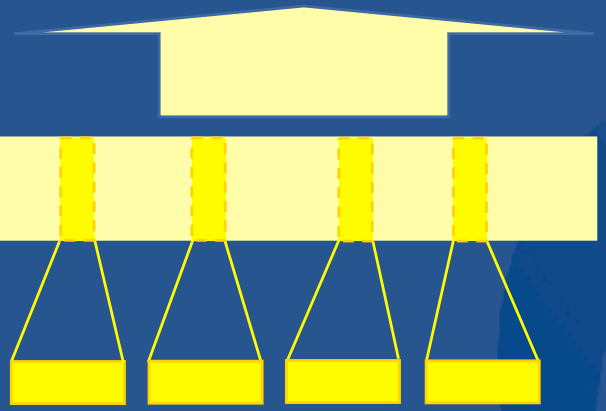


Aggregation and “portability”

Aggregation

BGP Announcement (1)

ISP Allocation

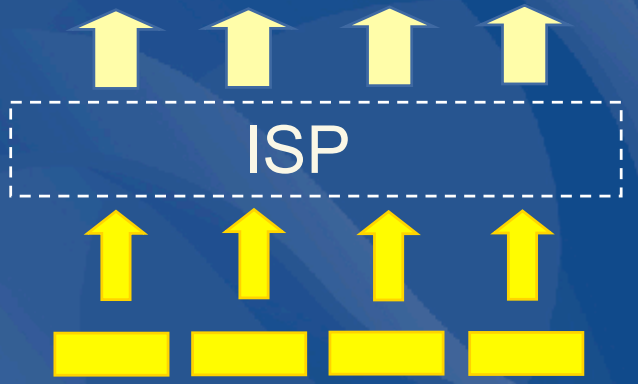


Customer assignments

(non-portable assignments)

No aggregation

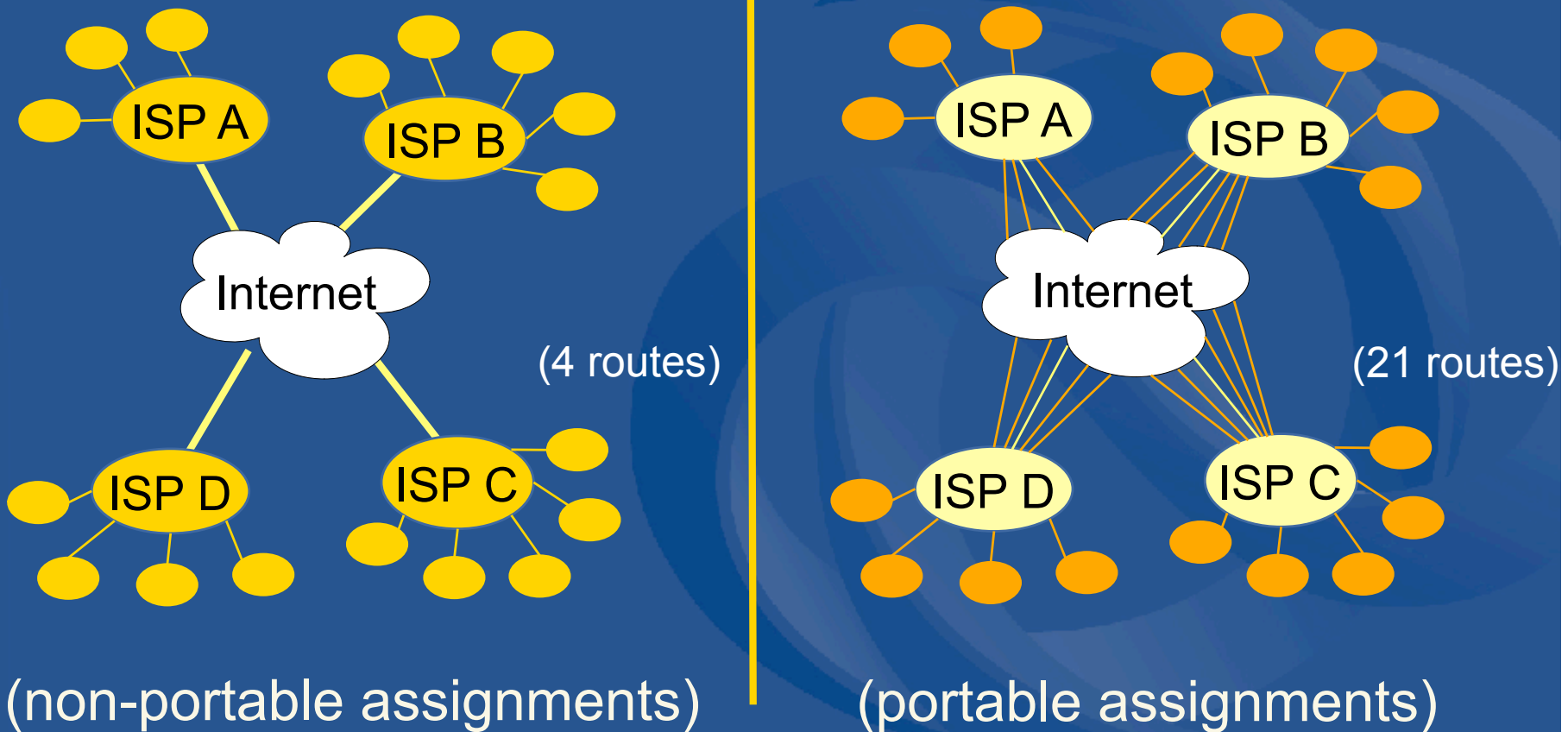
BGP Announcements (4)



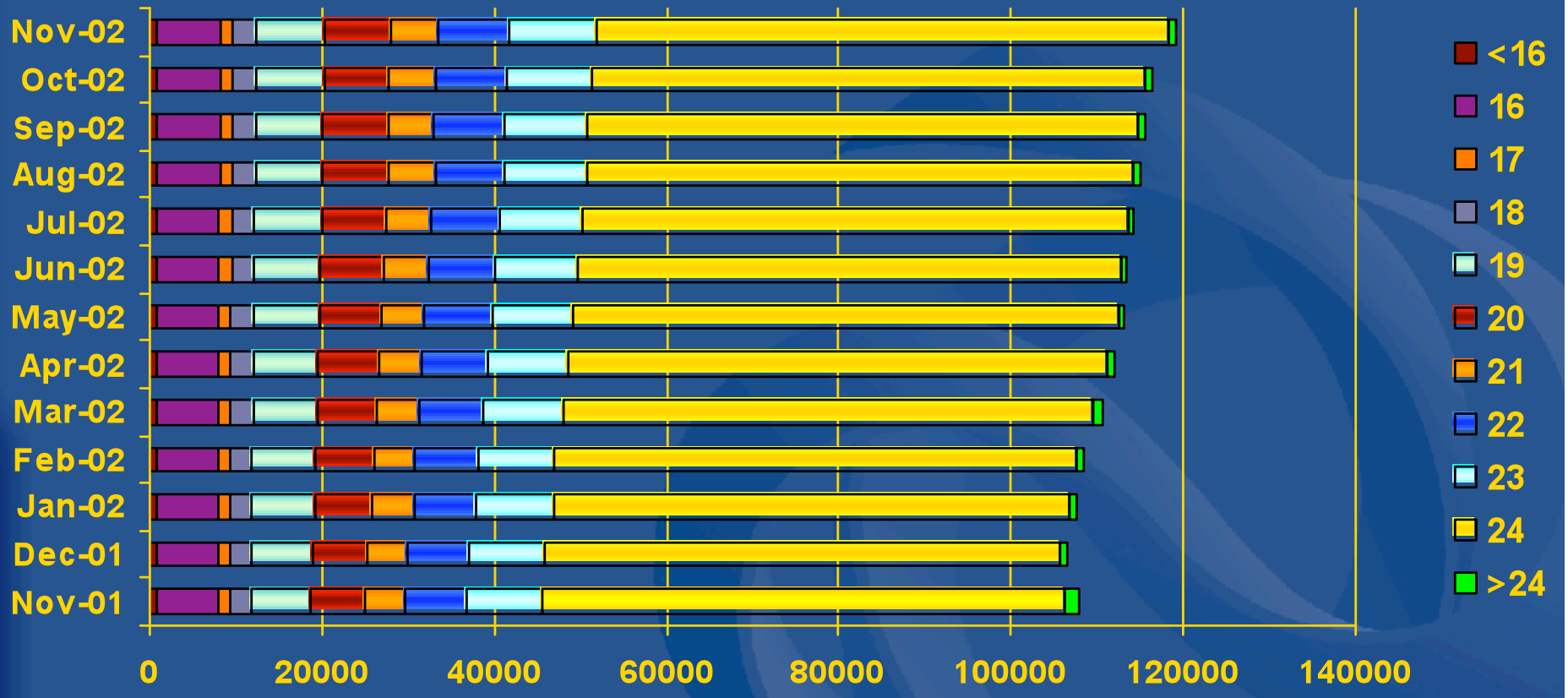
Customer assignments

(portable assignments)

Aggregation and “portability”



Routing table prefix distribution



29 Nov 2002

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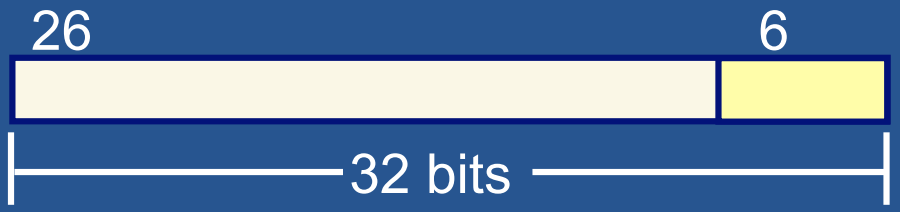
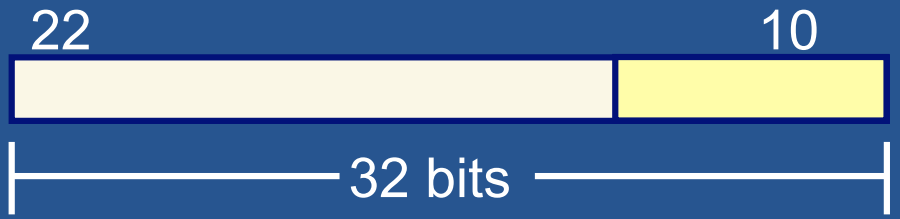
What the heck is a slash?



/26

→ 32 – 26 = 6 bits

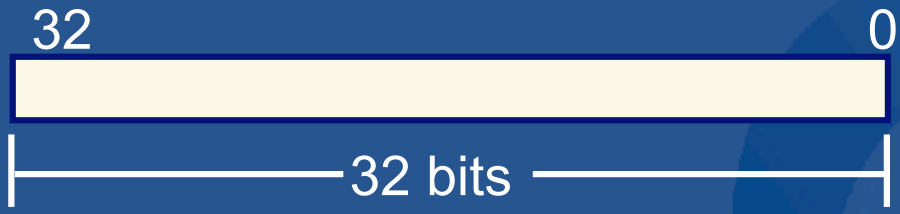
→ /26 = 2^6 = 64



/22

→ 32 – 22 = 10 bits

→ /22 = 2^{10} = 1024



/32

→ 32 – 32 = 0 bits

→ /32 = 2^0 = 1

/20 = $2^{(32-20)}$ = 2^{12} = 4096

/16 = $2^{(32-16)}$ = 2^{16} = 65 536

/0 = $2^{(32-0)}$ = 2^{32} = 4 294 967 296 (~ 4,3 Billion)

Slash notation and ranges

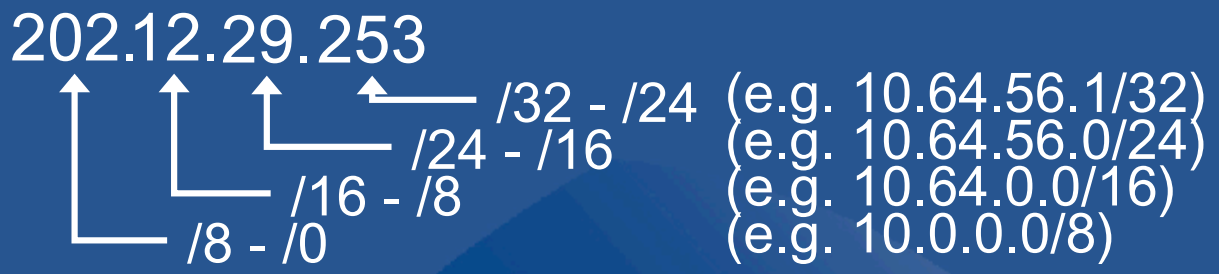
- Two ways of representing an address range

  "slash" notation
  e.g. 172.16.0.0/12

  Start- & end address
  e.g. 192.168.0.0 – 192.168.255.255

- Examples
  - 10.2.64.0/23 = 10.2.64.0 - 10.2.65.255
  - 192.168.24.0/ 27 = 192.168.24.32
  - 172.16.0.0 – 172.31.255.255 = 172.16.0.0.0/12

Ranges and slashes



10.0.0.0 /25 = 10.0.0.0 - 10.0.0.127
→ /25 = 128 addr → 0 - 127

10.0.0.0 /24 = 10.0.0.0 - 10.0.0.255
→ /24 = 256 addr → 0 - 255

10.0.0.0 /23 = 10.0.0.0 - 10.0.1.255
→ /23 = 2 */24s → 0.0 - 1.255

10.0.0.0 /20 = 10.0.0.0 - 10.0.15.255
→ /20 = 16 */24s → 0.0 - 15.255

10.0.0.0 /13 = 10.0.0.0 - 10.7.255.255
→ /13 = 8*/16s → 0.0.0 - 7.255.255

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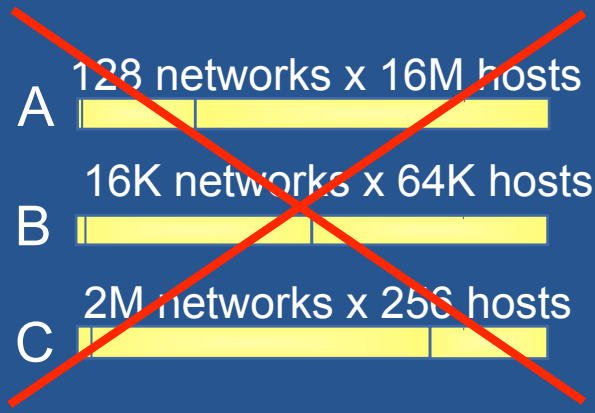
Classful and Classless

- Classful *(Obsolete)*
  - Wasteful address architecture
    - network boundaries are fixed at 8, 16 or 24 bits (class A, B, and C)
- **Classless**
  - Efficient architecture
    - network boundaries may occur at any bit (e.g. /12, /16, /19, /24 etc)
- CIDR
    - Classless Inter Domain Routing architecture
  - Allows *aggregation* of routes within ISPs infrastructure

Best Current Practice

Classless & Classful addressing

Classful



Obsolete
- *inefficient*
- *depletion of B space*
- *too many routes from C space*

Classless

Best Current Practice

Addresses	Prefix	Classful	Net Mask
...	...	...	...
8	/29		255.255.255.248
16	/28		255.255.255.240
32	/27		255.255.255.224
64	/26		255.255.255.192
128	/25		255.255.255.128
256	/24	1 C	255.255.255.0
...	...	...	...
4096	/20	16 C's	255.255.240.0
8192	/19	32 C's	255.255.224
16384	/18	64 C's	255.255.192
32768	/17	128 C's	255.255.128
65536	/16	1 B	255.255.0.0
...	...	...	... *

* See back of slide booklet for complete chart

- Network boundaries may occur at *any* bit

APNIC policy environment

"*IP addresses not freehold property*"

- Assignments & allocations on license basis
  - Addresses *cannot* be bought or sold
  - Internet resources are public resources
  - 'Ownership' is contrary to management goals

- Assignments based on requirements
  - Demonstrated through detailed documentation
  - Assignment should maximise utilisation
    - minimise wastage

- Classless assignments
  - showing use of VLSM

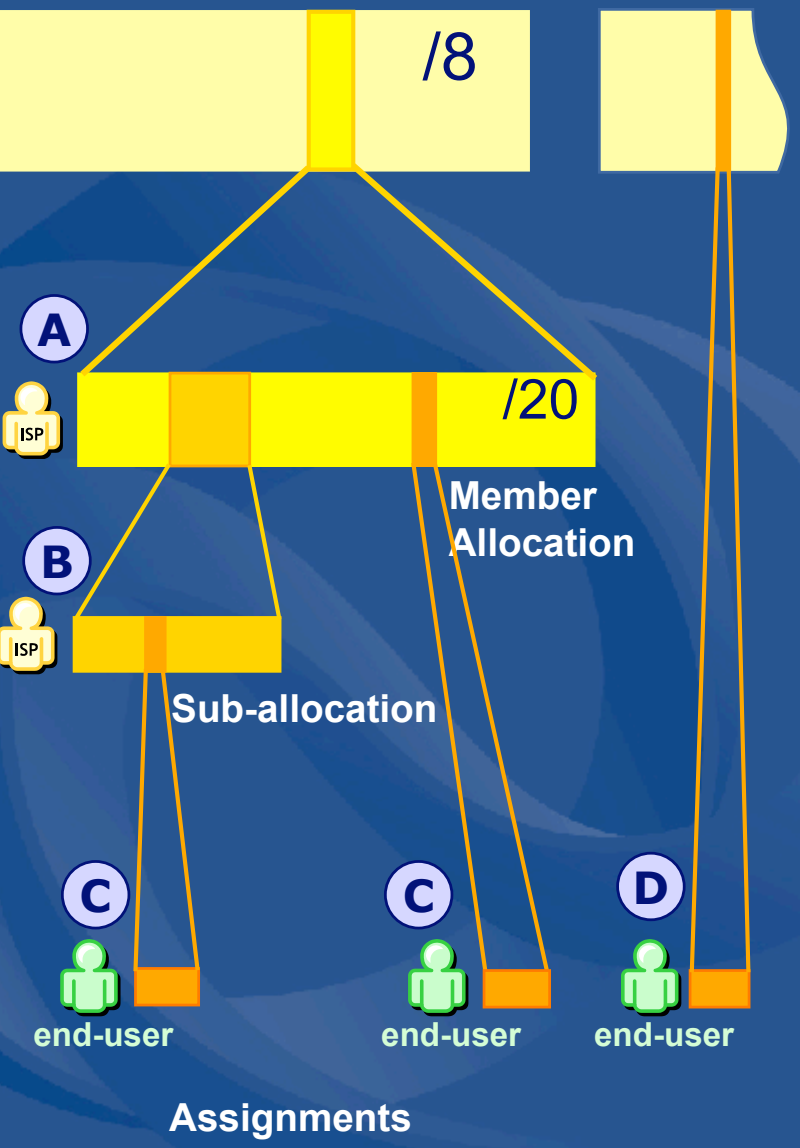
Where can I get IP addresses?

ISP

1. Allocation from APNIC/NIR (A)
2. Sub-allocation from upstream ISP (B)

End-user

1. Non-portable assignment from ISP (C)
2. Portable assignment from APNIC (D)



Initial IPv4 allocation criteria

1a. Have used a /22 from upstream provider

- Demonstrated efficient previous address usage

OR

1b. Show immediate need for /22

- Can include customer projections & infrastructure equipment

2. Detailed plan for use of /21 within a year

3. Renumber to new space within 1 year

- Meet all policy requirements
  - Applicants may be required to show purchase receipts

Small multihoming assignment policy

1a. Applicants currently *multihomed*

OR

1b. Demonstrate a plan to *multihome within 1 month*

2. Agree to renumber out of previously assigned space

- Demonstrate need to use 25% of requested space immediately and 50% within 1 year
- Meet all policy requirements or have the assignment revoked

IPv4 assignment policy for IXPs

IXPs can apply for an assignment of /24 for Transit LAN

Criteria

- 3 or more peers
- Demonstrate “open peering policy”
- Not announce assignment to global routing table

  - APNIC has a reserved block of space from which to make IXP assignments

Questions ?

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Policy Development in the Asia Pacific

The APNIC Community

&

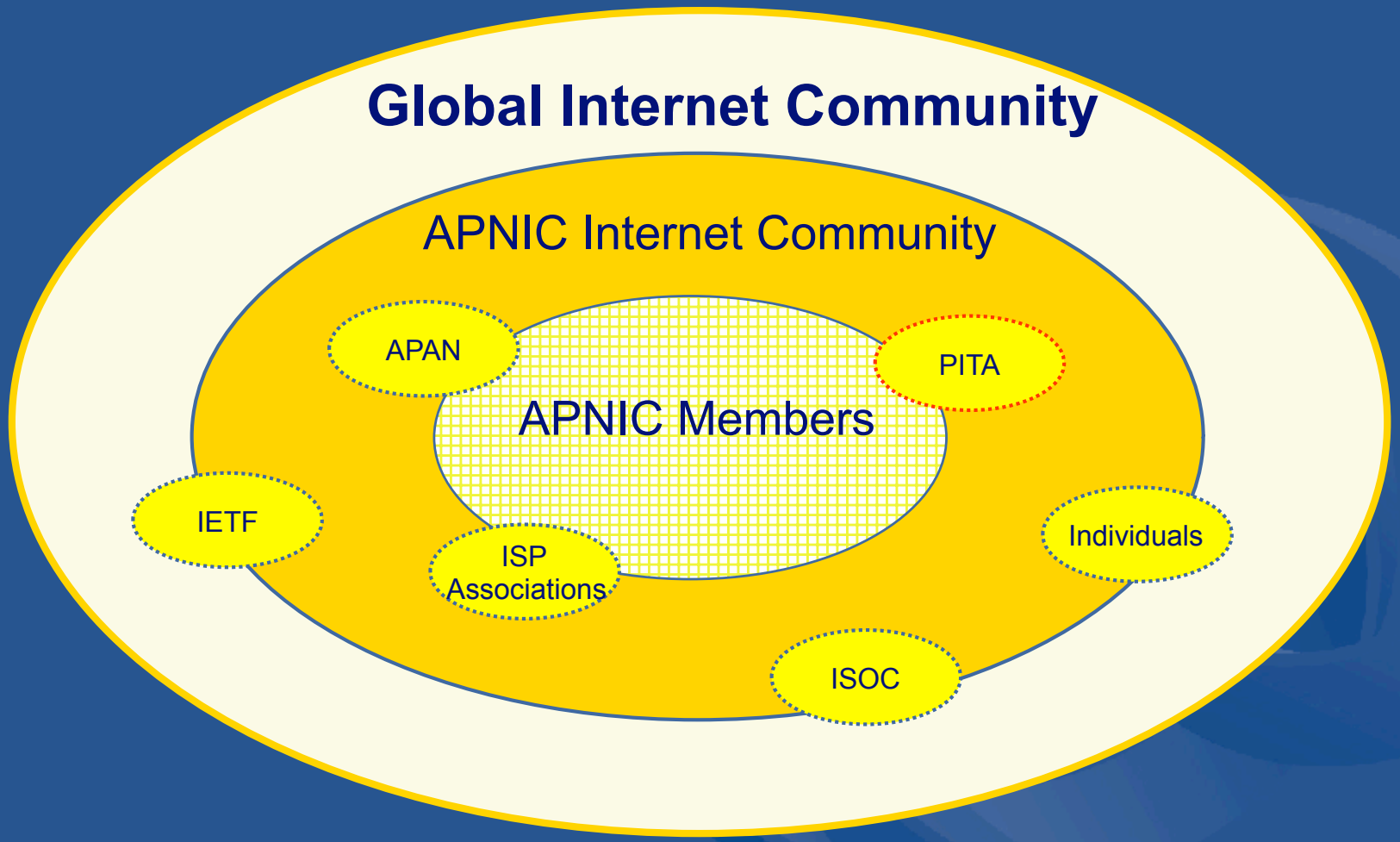
the Policy Development Process

What is the APNIC community?

- **Open** forum in the Asia Pacific
  - Open to any interested parties
- Voluntary participation
- Decisions made by consensus
- Public meetings
- Mailing lists
  - web archived

- *A voice in regional Internet operations through participation in APNIC activities*

Internet community



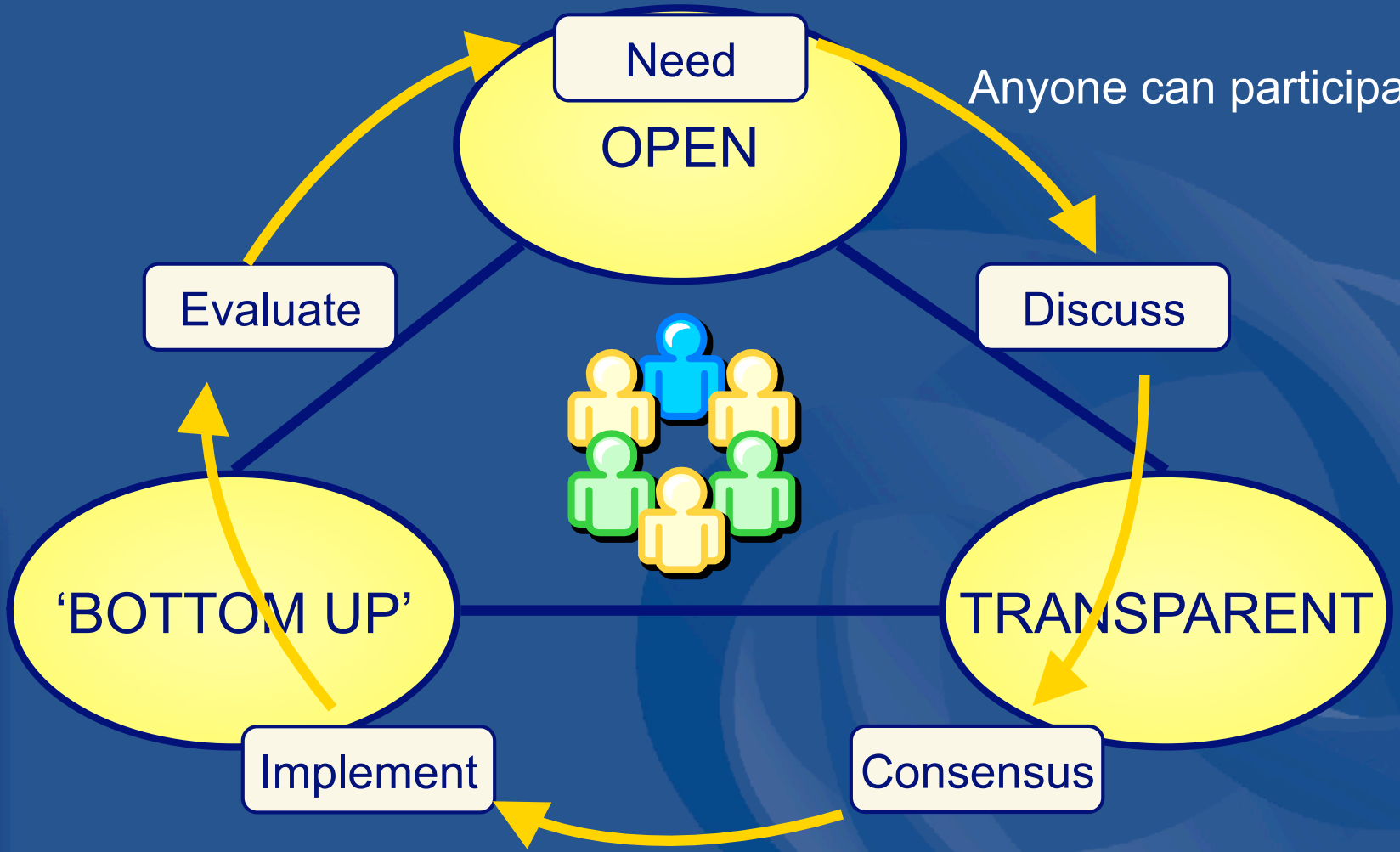
Policy development

- Industry self-regulatory processes
  - Open to all interested parties
  - Facilitated by RIR staff
- Policy implementation
  - RIR processes
  - ISPs and other affected parties

Participation in policy development

- Why should I bother?
  - Responsibility as APNIC member
    - To be aware of the current policies for managing address space allocated to you
  - Business reasons
    - Policies affect your business operating environment and are constantly changing
    - Ensure your ‘needs’ are met
  - Educational
    - Learn and share experiences
    - Stay abreast with ‘best practices’ in the Internet

Policy development cycle



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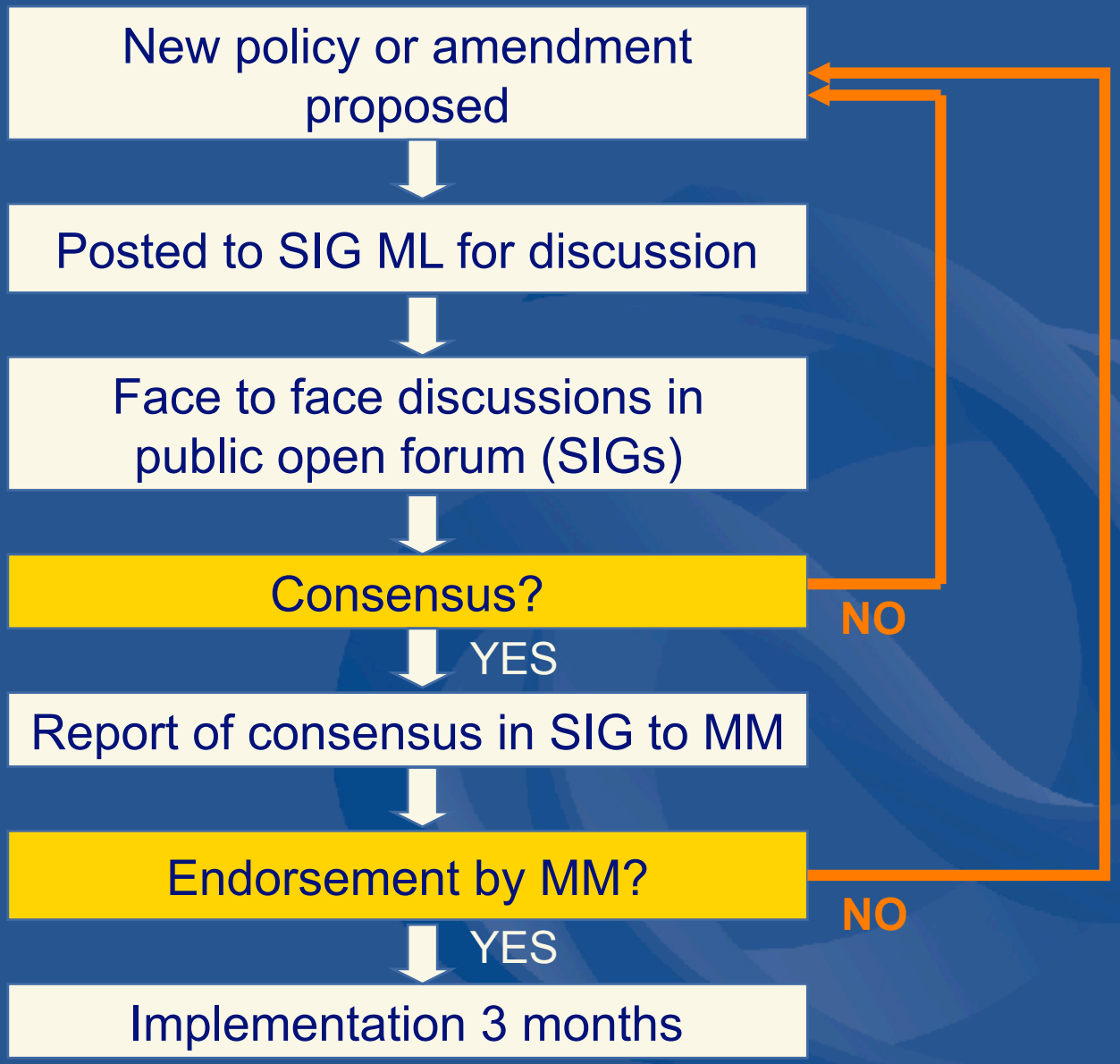
Elements of the process

Policy development in practice



How to make your voice heard

- Contribute on the public mailing lists
  - http://www.apnic.net/community/lists/index.html
- Attend meetings
  - Or send a representative
  - Gather input at forums
- Give feedback
  - Training or seminar events

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Come to the APNIC meeting!

Next meeting in conjunction with

APRICOT 2004

Kuala Lumpur, Malaysia, 18-27 February 2004

Fellowship program registration now open!

- Participate in policy development
- Attend workshops, tutorials & presentations
- Exchange knowledge and information with peers
- Stay abreast with developments in the Internet
- View multicast online
- Provide your input in matters important to you

http://www.apnic.net/meetings/

Questions ?

- Policy making process description
  - http://www.apnic.net/docs/policy/dev/index.html

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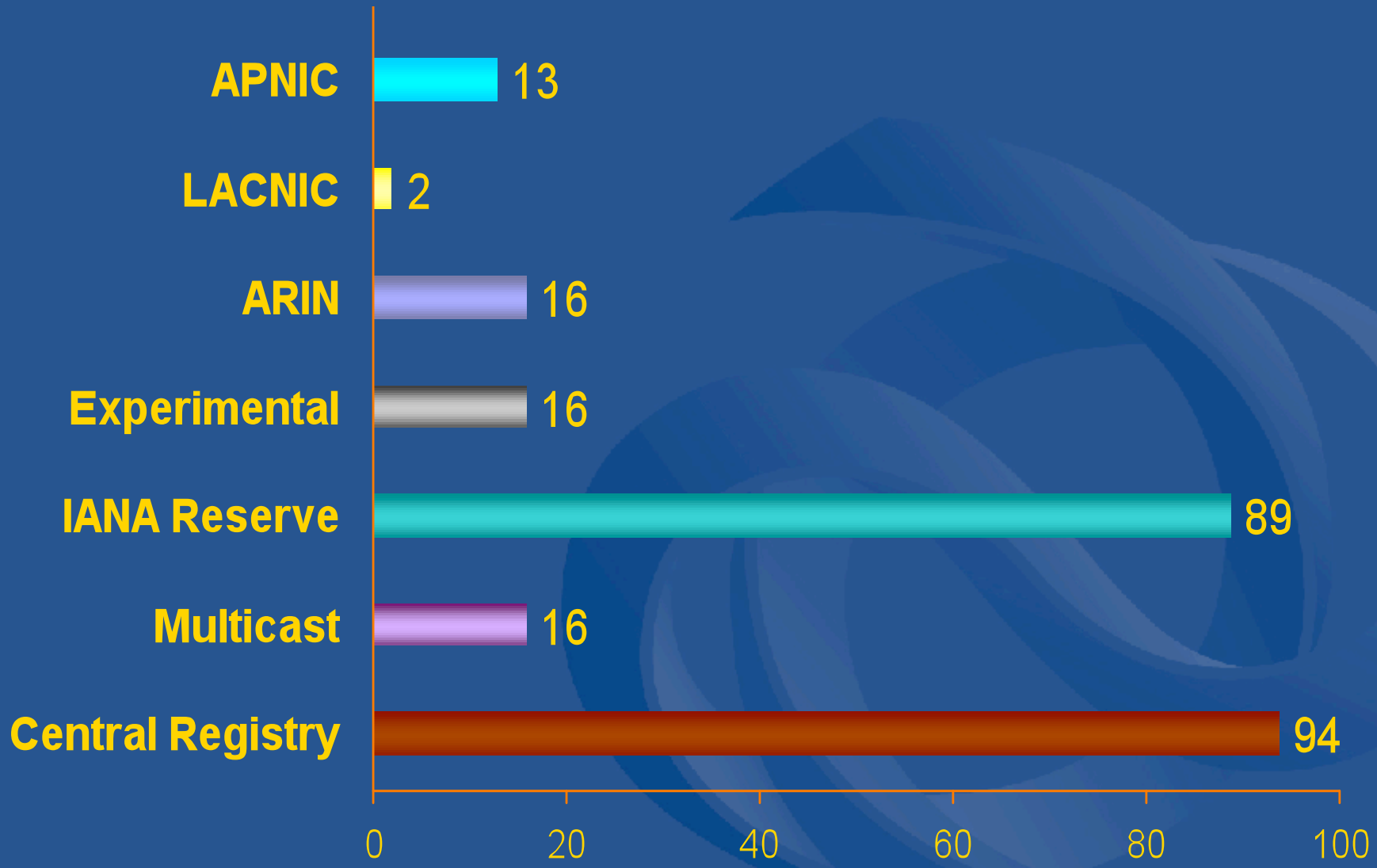
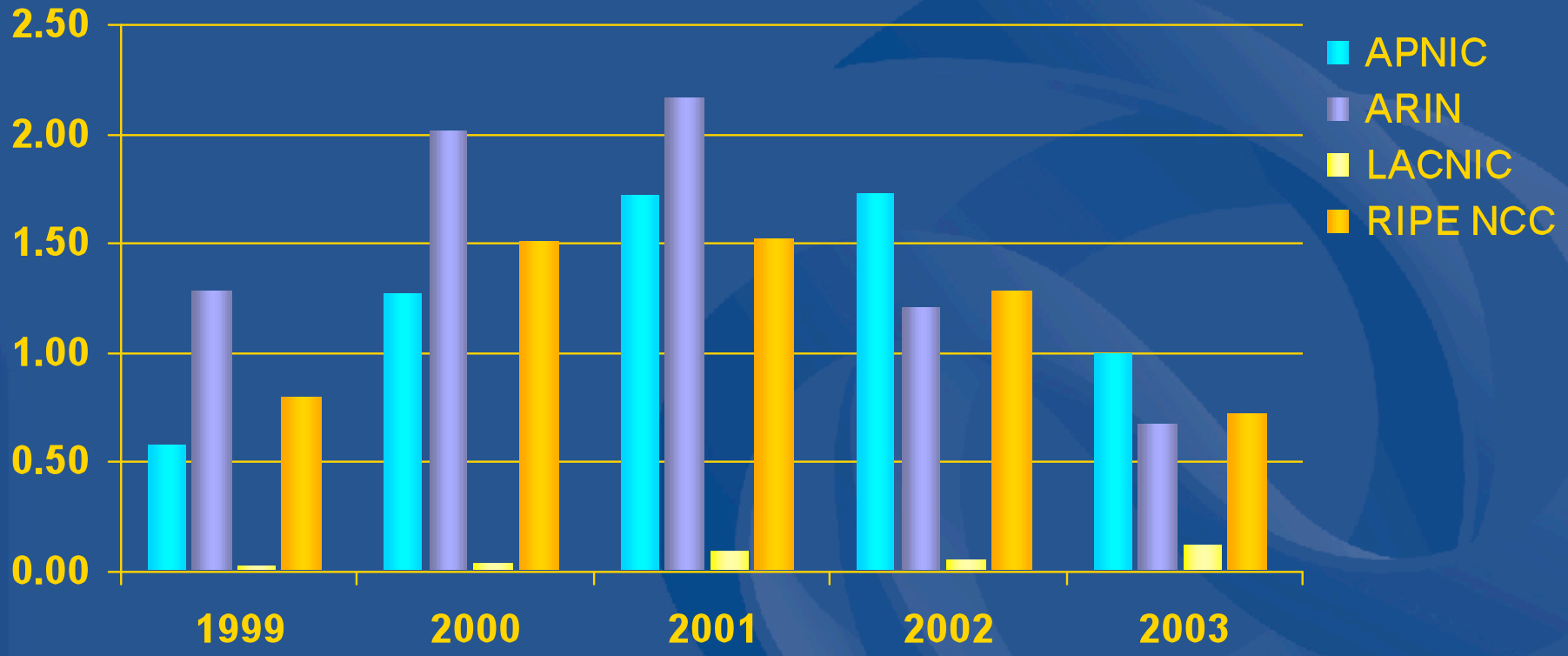
Global Internet Resource Statistics

IPv4 /8 address space status



IPv4 allocations from RIRs to LIRs/ISPs - Yearly comparison



As of 30 June 2003

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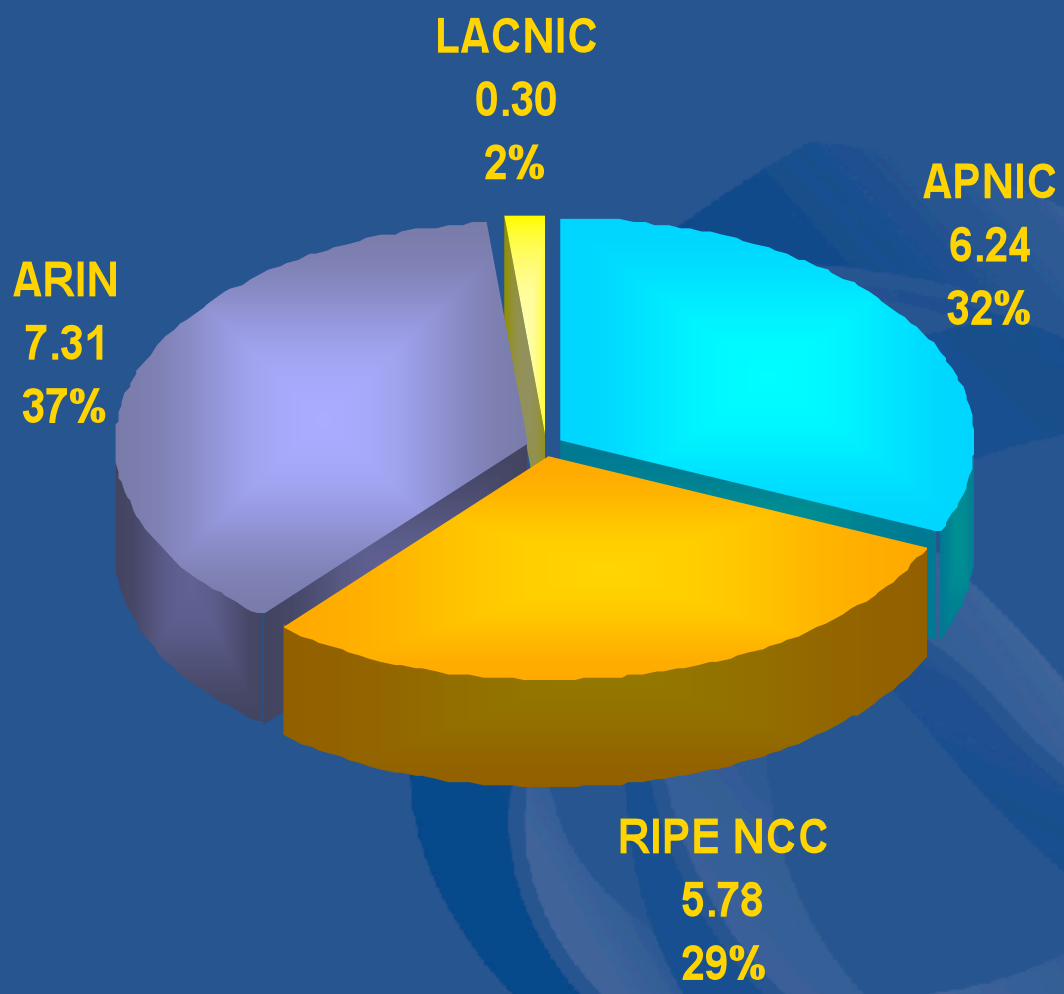
IPv4 allocations from RIRs to LIRs/ISPs - Cumulative total



1 Jan 99 – 30 June 03

Asia Pacific Network Information Centre

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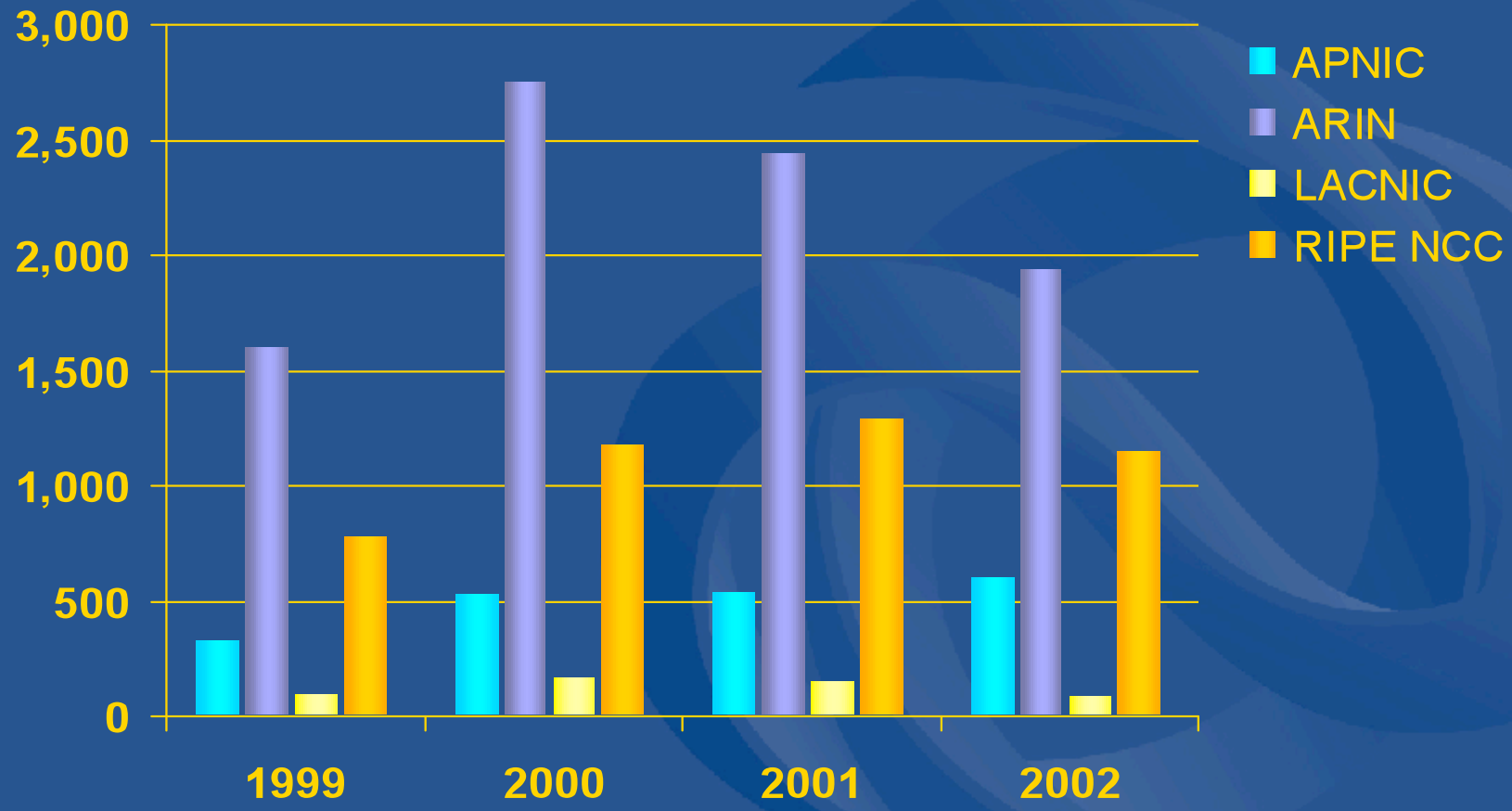
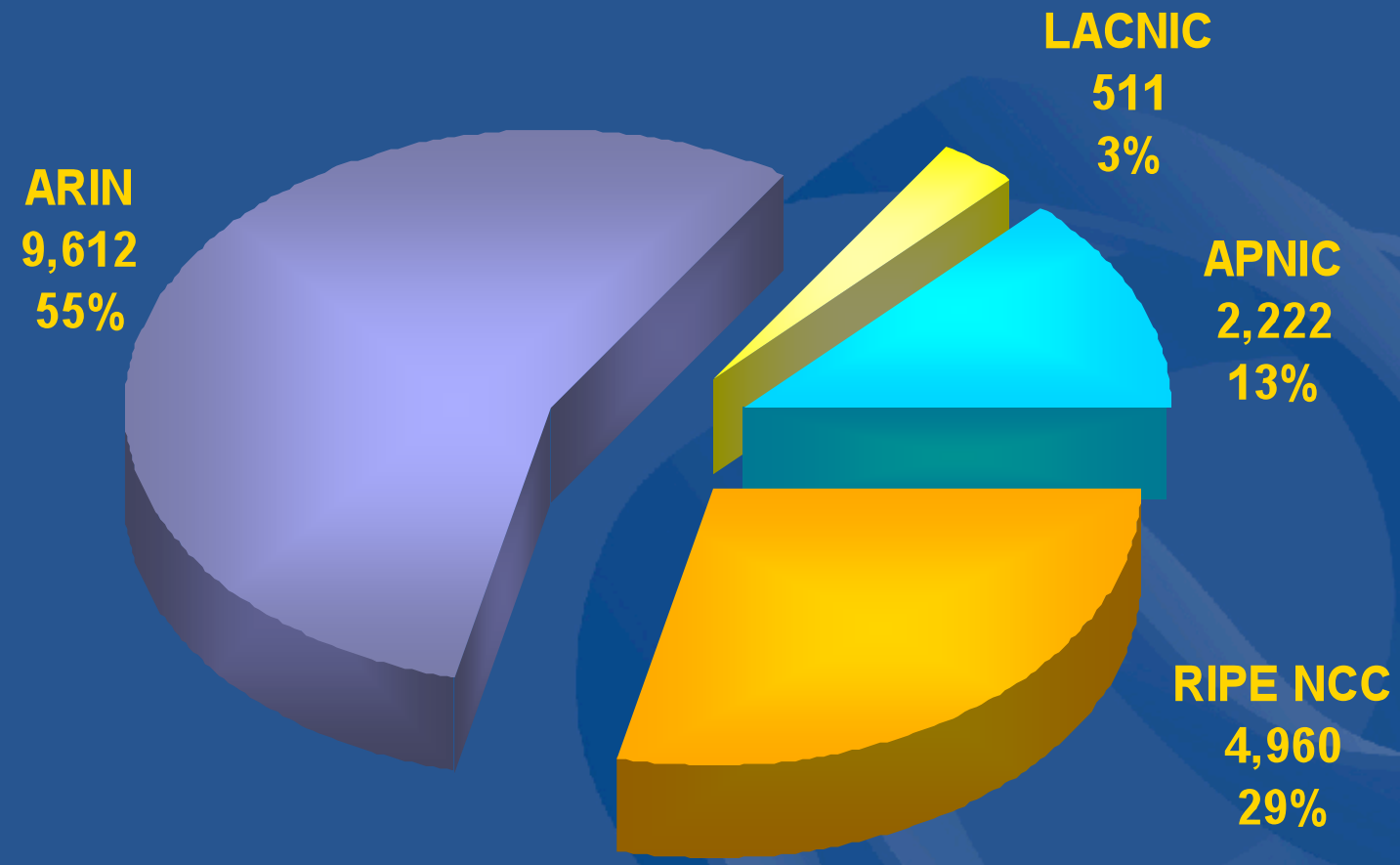
ASN assignments from RIRs to LIRs/ISPs - Yearly comparison



As of 30 June 2003

ASN assignments from RIRs to LIRs/ISPs - Cumulative total



1 Jan 99 – 30 June 03

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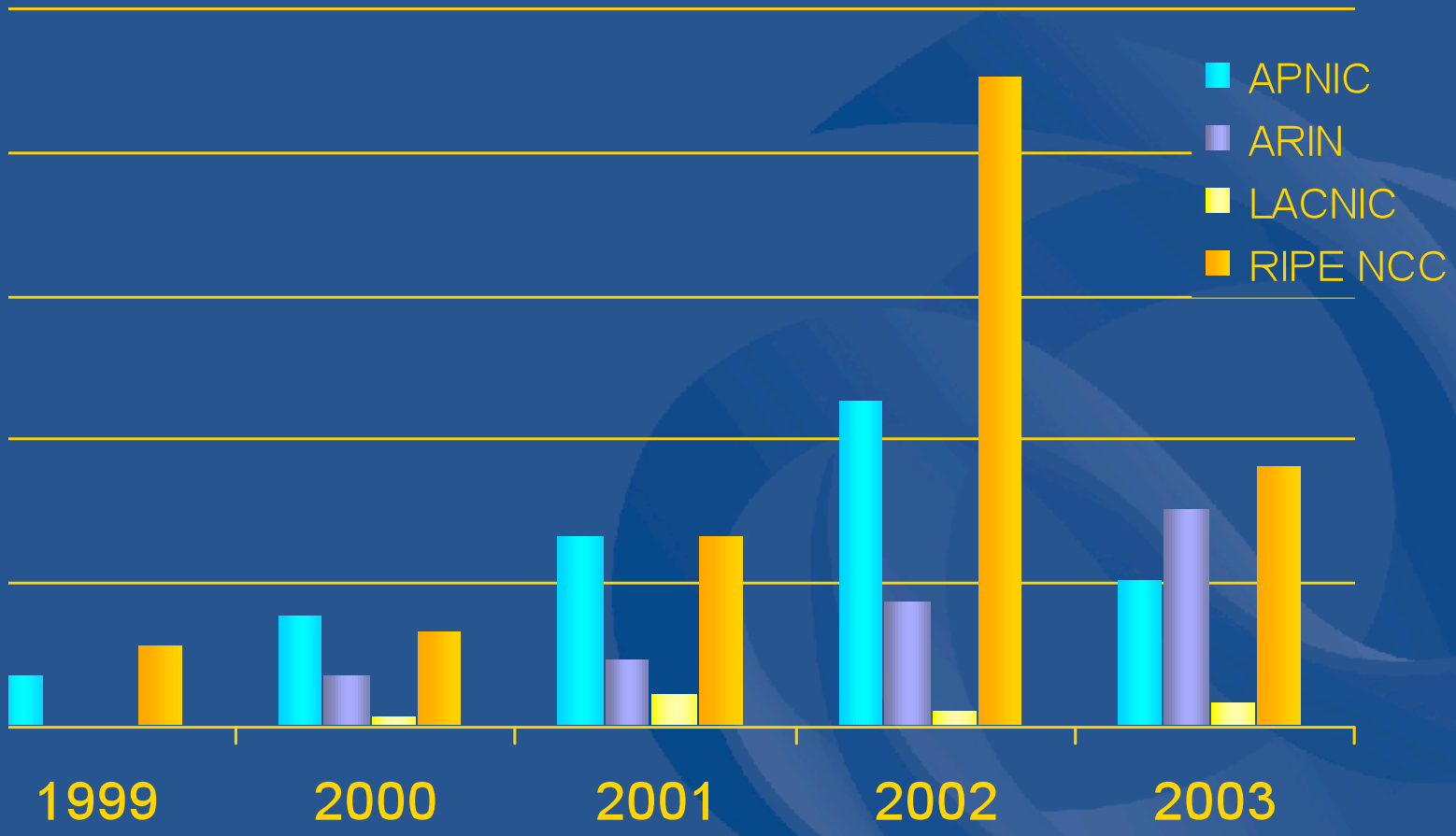
IPv6 allocations from RIRs to LIRs/ISPs - Yearly comparison



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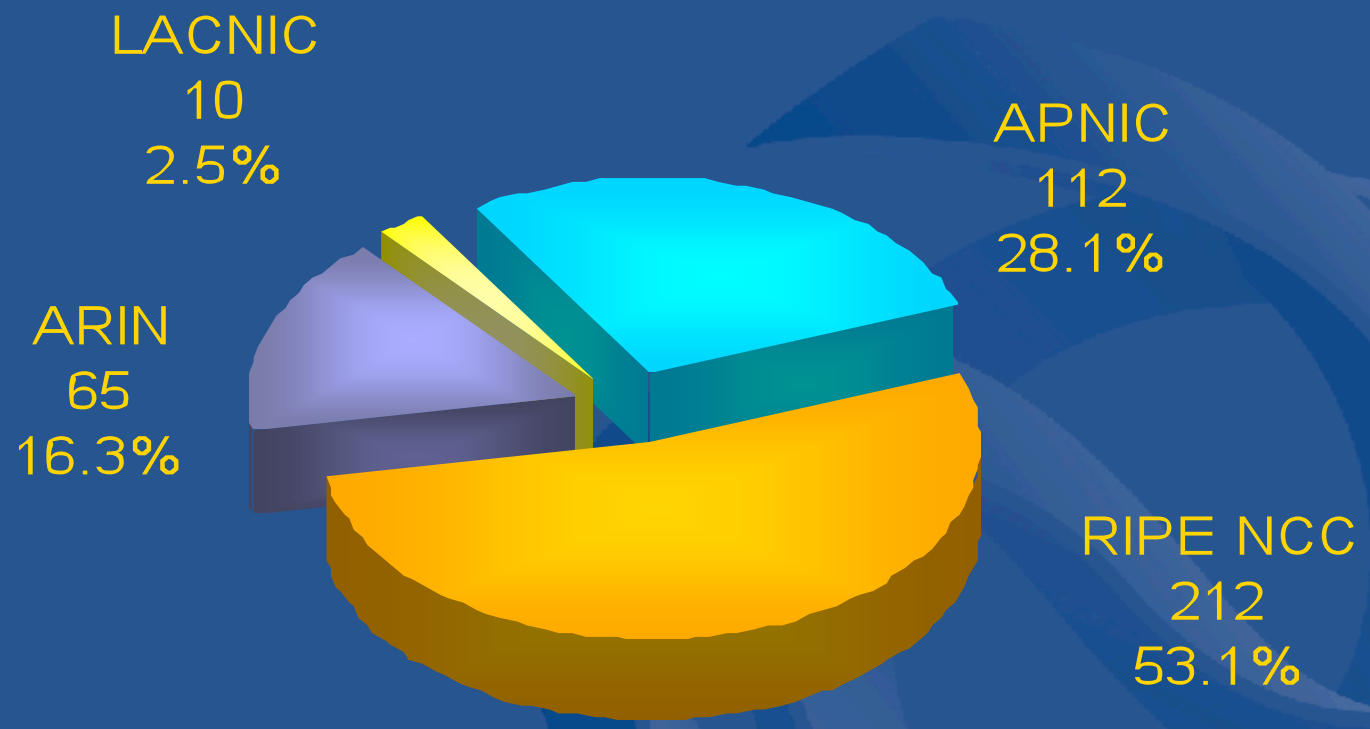
IPv6 allocations from RIRs to LIRs/ISPs - Cumulative total



1 Jan 99 – 30 June 03

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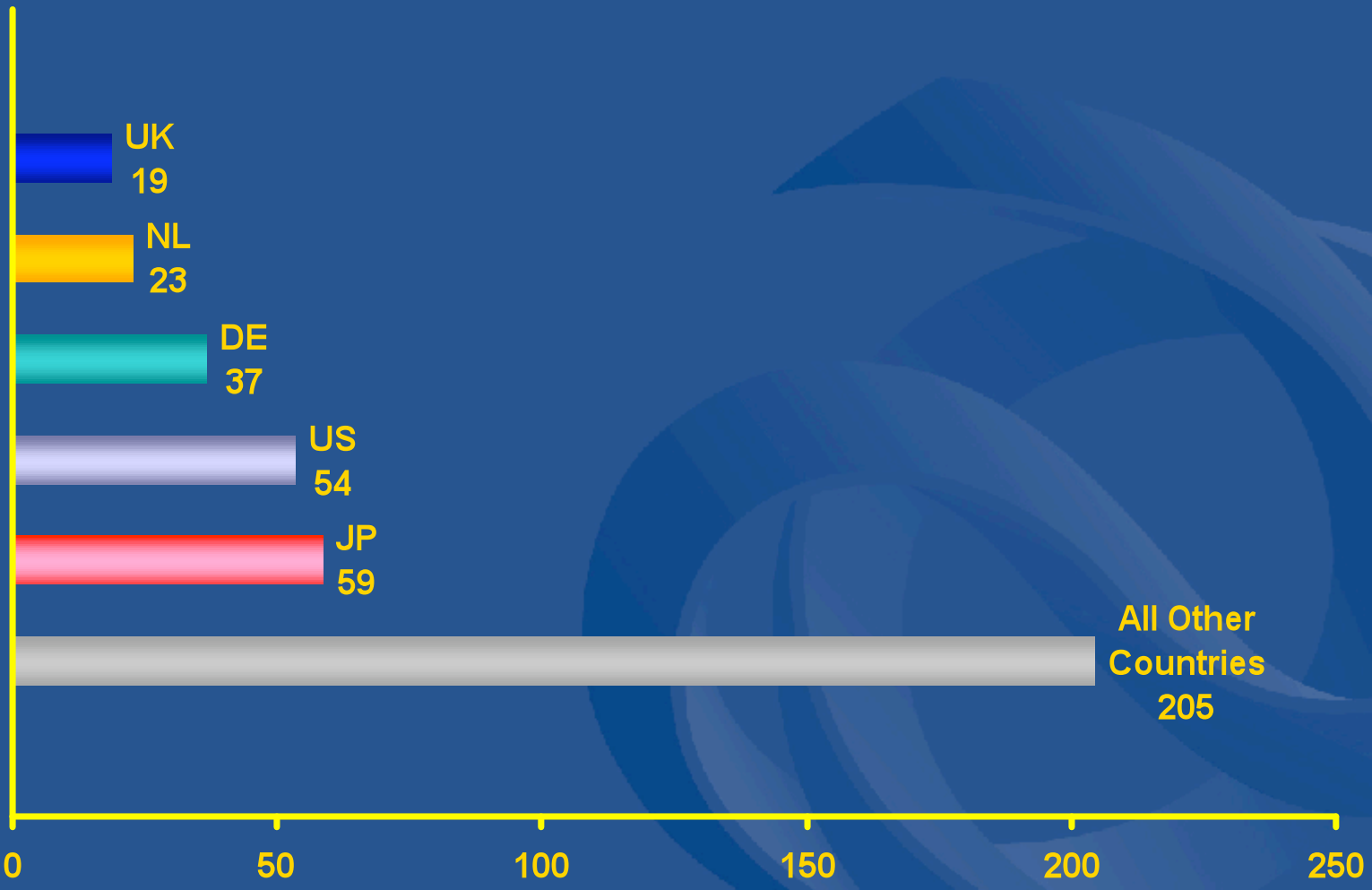
Total IPv6 allocations from RIRs to LIRs/ISPs by country



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Links to RIR statistics

- Raw Data/Historical RIR Allocations:

  http://www.aso.icann.org/rirs/stats/index.html
  http://www.iana.org/assignments/ipv4-address-space

- RIR Stats:

  http://www.apnic.net/info/reports/index.html

  http://www.arin.net/statistics/index.html

  http://www.lacnic.net/en/est.html

  http://www.ripe.net/ripencc/pub-services/stats

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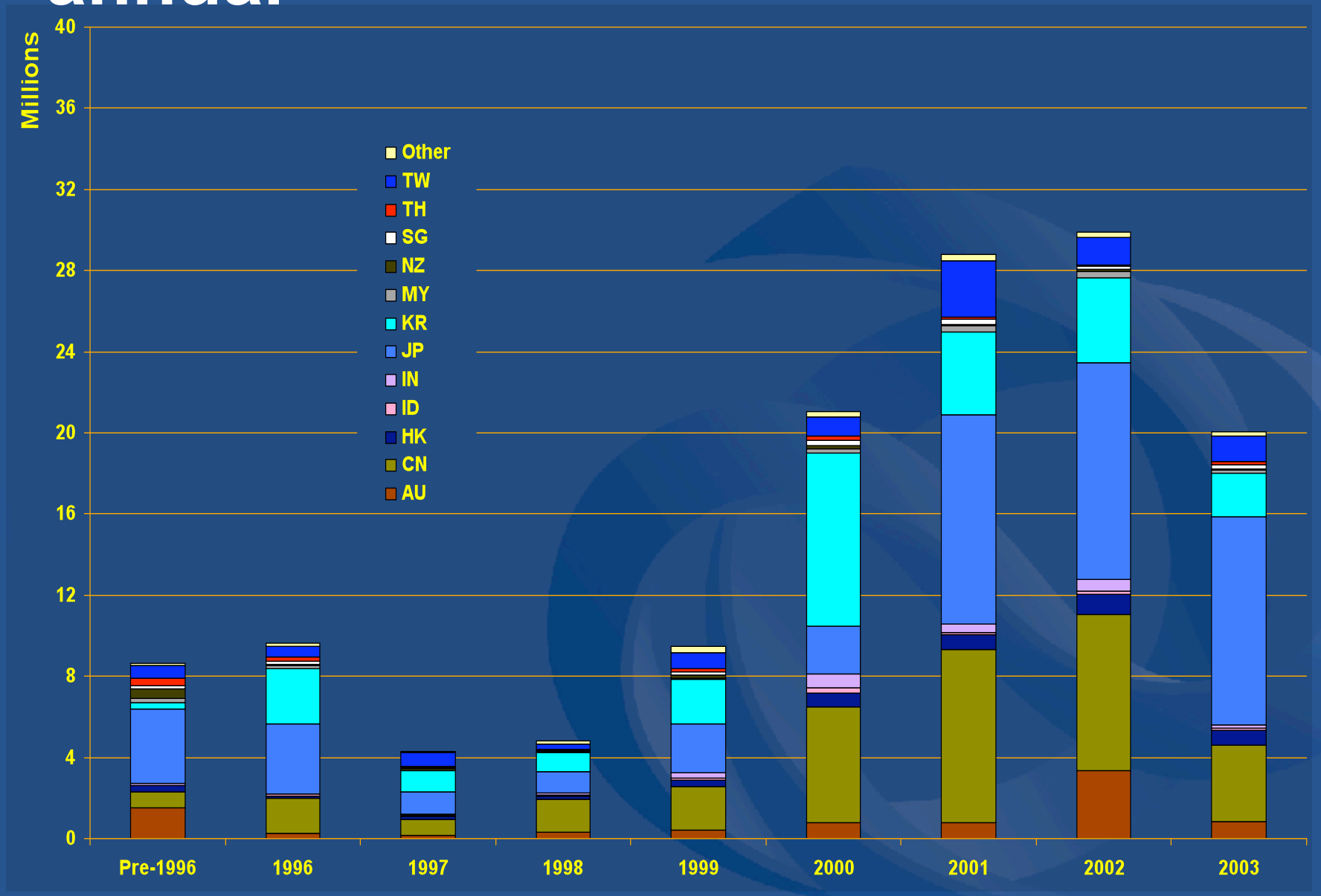
APNIC Internet Resource Allocation

IPv4 addresses allocated - annual



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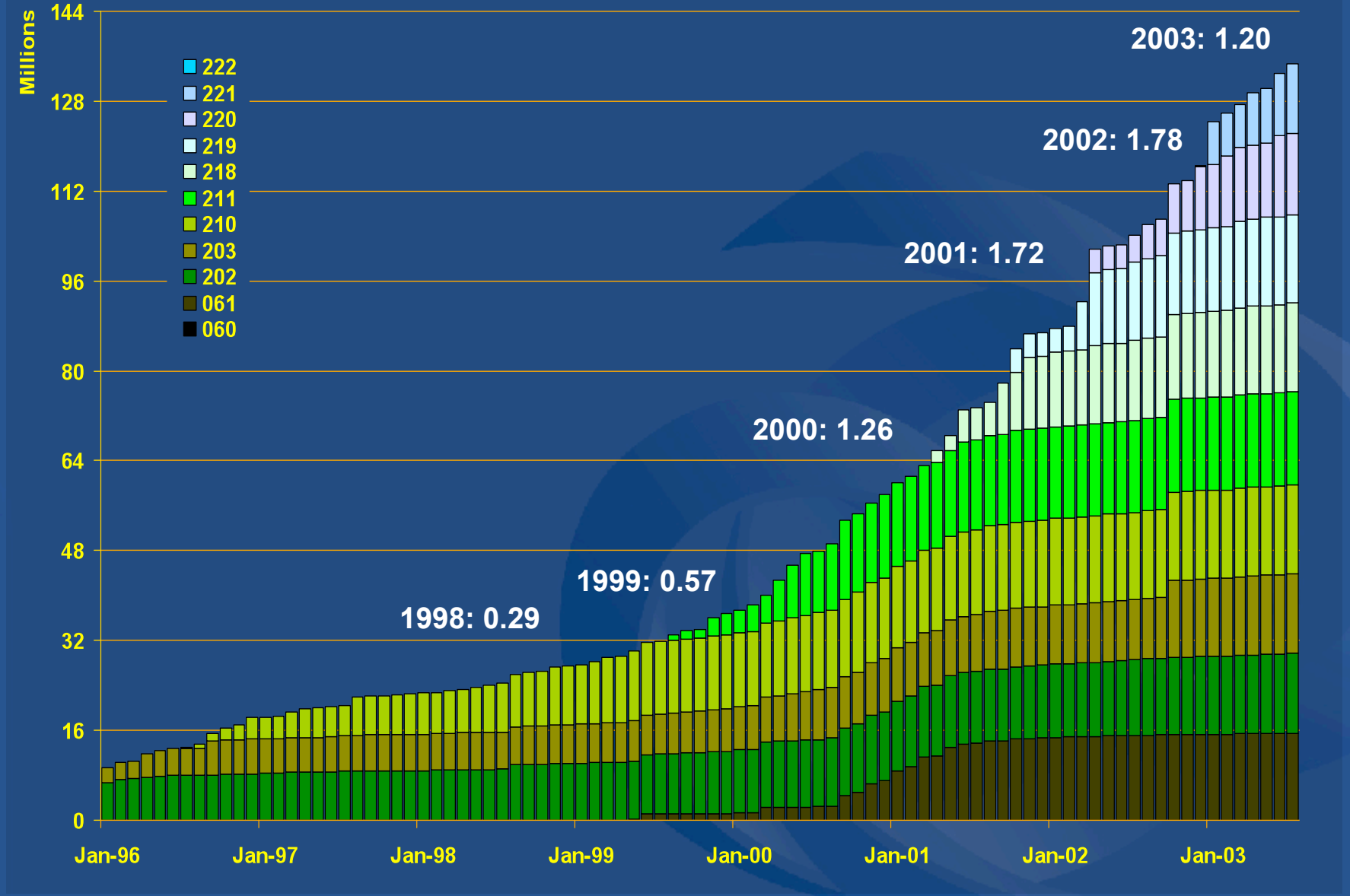
IPv4 addresses allocated - cumulative



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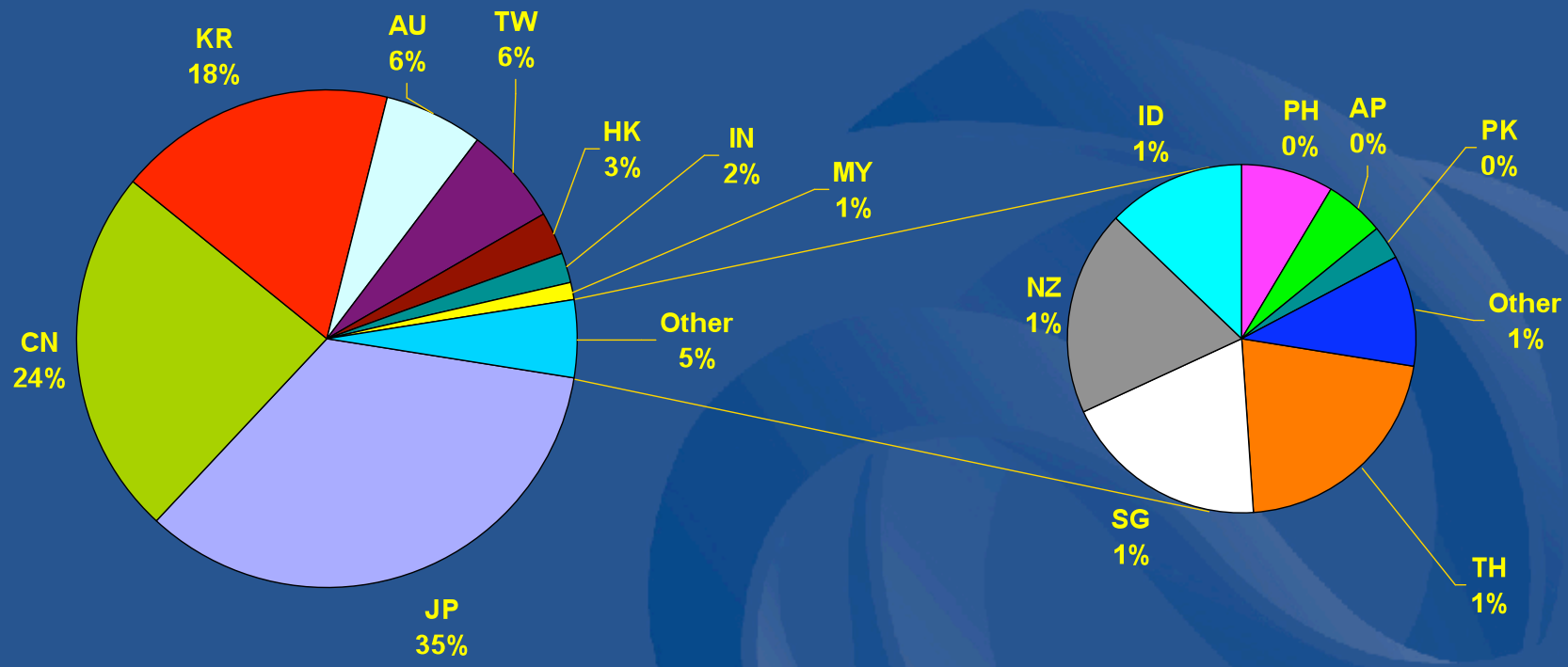
IPv4 distribution in Asia Pacific



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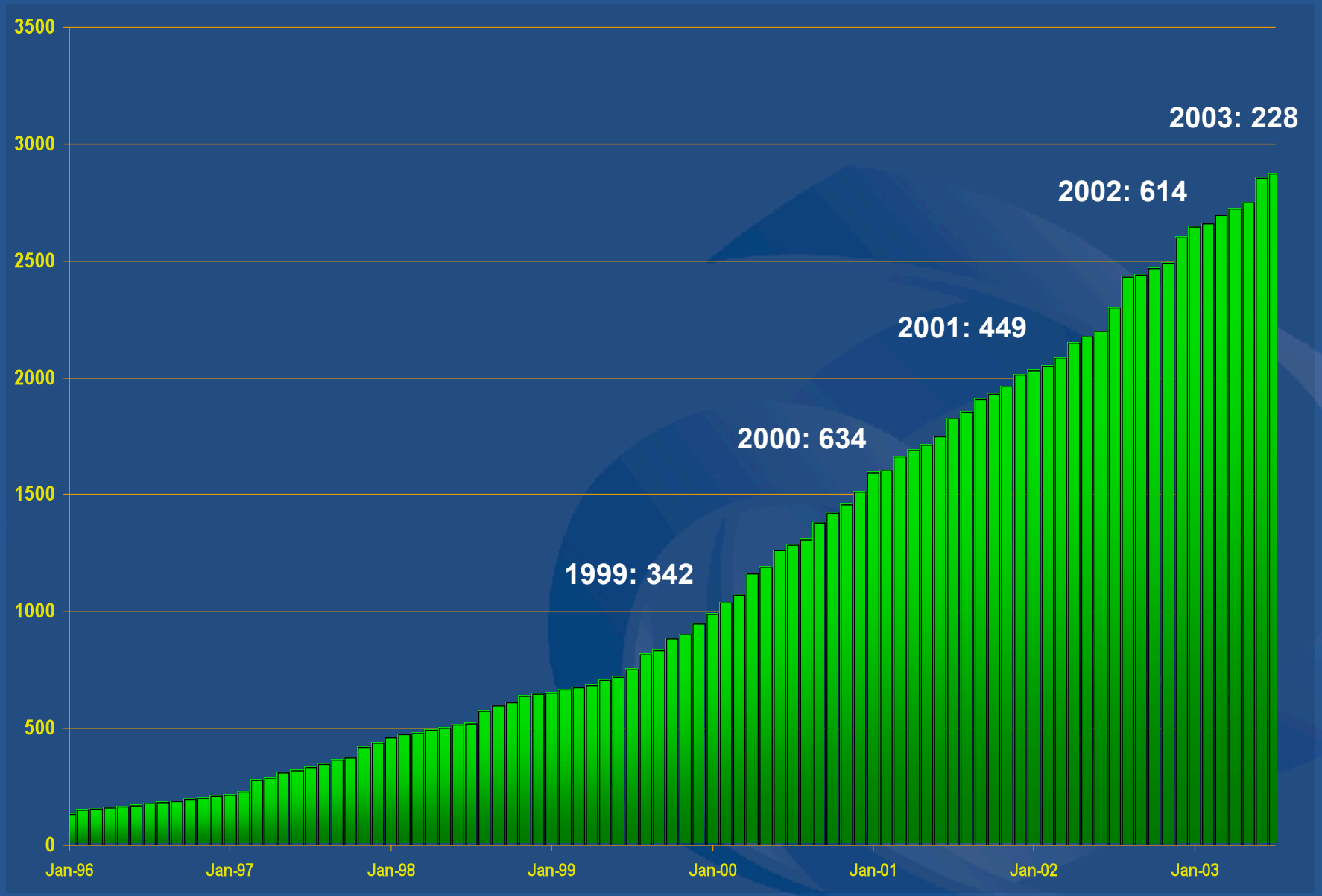
ASNs allocated in Asia Pacific



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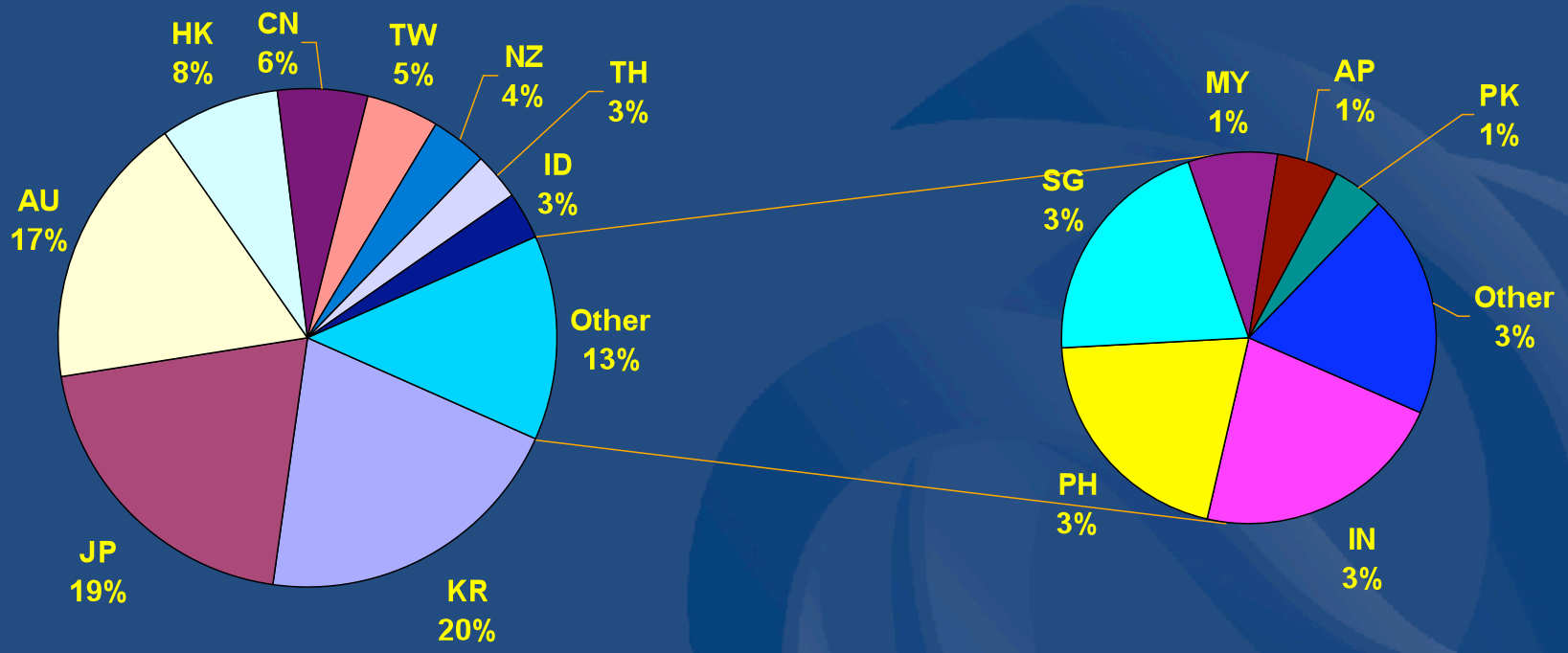
ASN distribution in Asia Pacific



Questions ?

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IPv6

Overview, Policies & Procedures

Overview

- Rationale
- Addressing
- Features of IPv6
- IPv6 Policies & Procedures
- Statistics

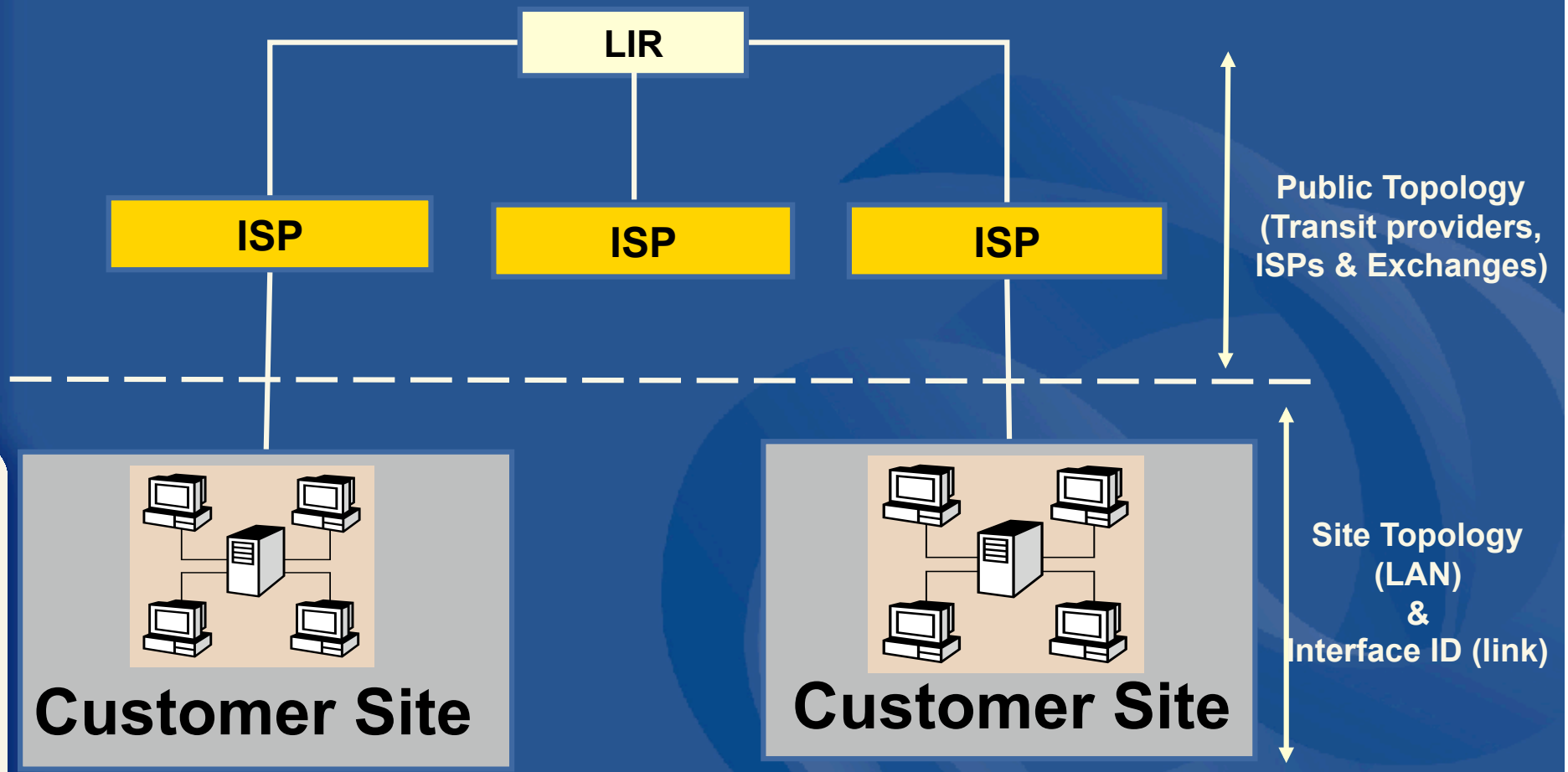
Rationale

- Address depletion concerns
  - Squeeze on available addresses space
- End to end connectivity no longer visible
    - Widespread use of NAT
- Scalability
  - Increase of backbone routing table size
    - Hierarchical routing (CIDR)

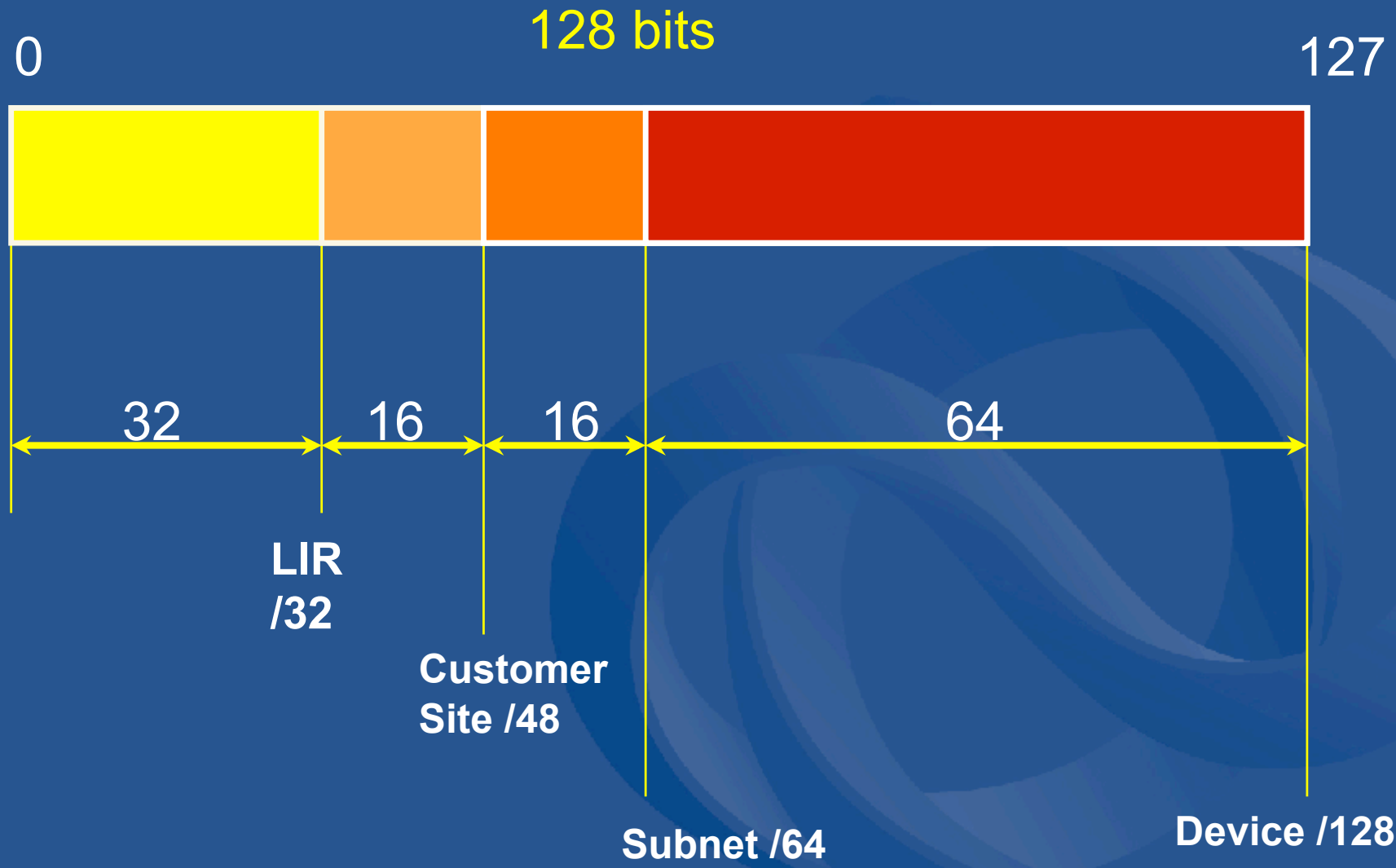
IPv6 addressing

- 128 bits of address space
- Hexadecimal values of eight 16 bit fields
  - X:X:X:X:X:X:X:X (X=16 bit number, eg: A2FE)
  - 16 bit number is converted to a 4 digit hexadecimal number
- Example:
  - FE38:DCE3:124C:C1A2:BA03:6735:EF1C:683D
  - 4EED:23:0:0:0:36E:125:2B
  - 32CB:10A2:0000:0000:0000:0000:3EFC:3C2A can be represented as 32CB:10A2::3EFC:3C2A

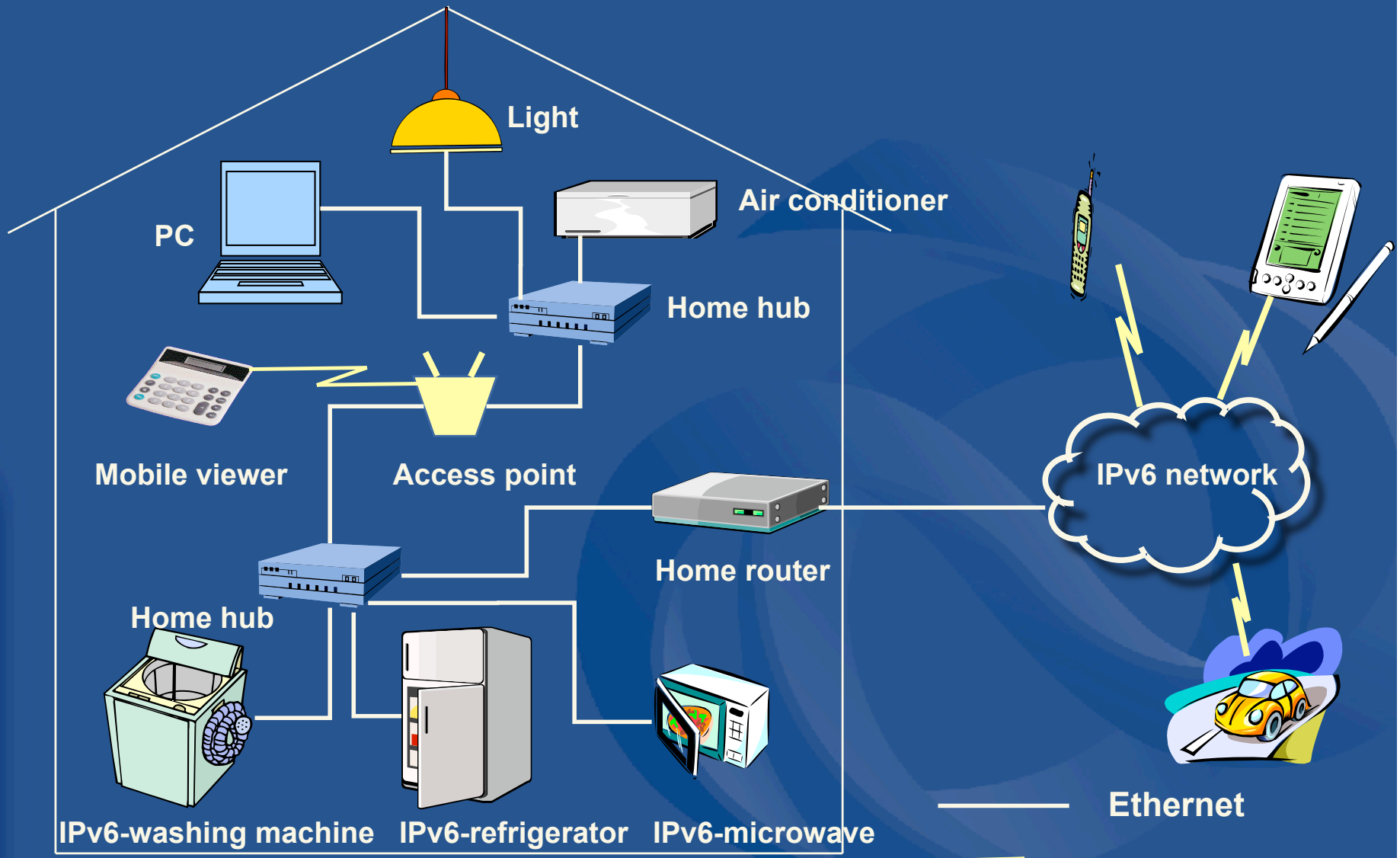
IPv6 addressing



IPv6 addressing structure



IPv6 experiments



IPv6 policy - history

Public mailing lists and documentation
http://www.apnic.net/ipv6

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IPv6 address policy goals

- Efficient address usage
  - Avoid wasteful practices
- Aggregation
  - Hierarchical distribution
  - Aggregation of routing information
  - Limiting no of routing entries advertised into the Internet
- Minimise overhead
  - Associated with obtaining address space
- Registration, Uniqueness, Fairness & consistency

IPv6 initial allocation criteria

- Be an LIR
  - Not be an end site
- Plan for at least 200 /48 assignments to other organisations within 2 years
- Plan to provide IPv6 connectivity to organisations and to end sites

  - Initial allocation size: /32

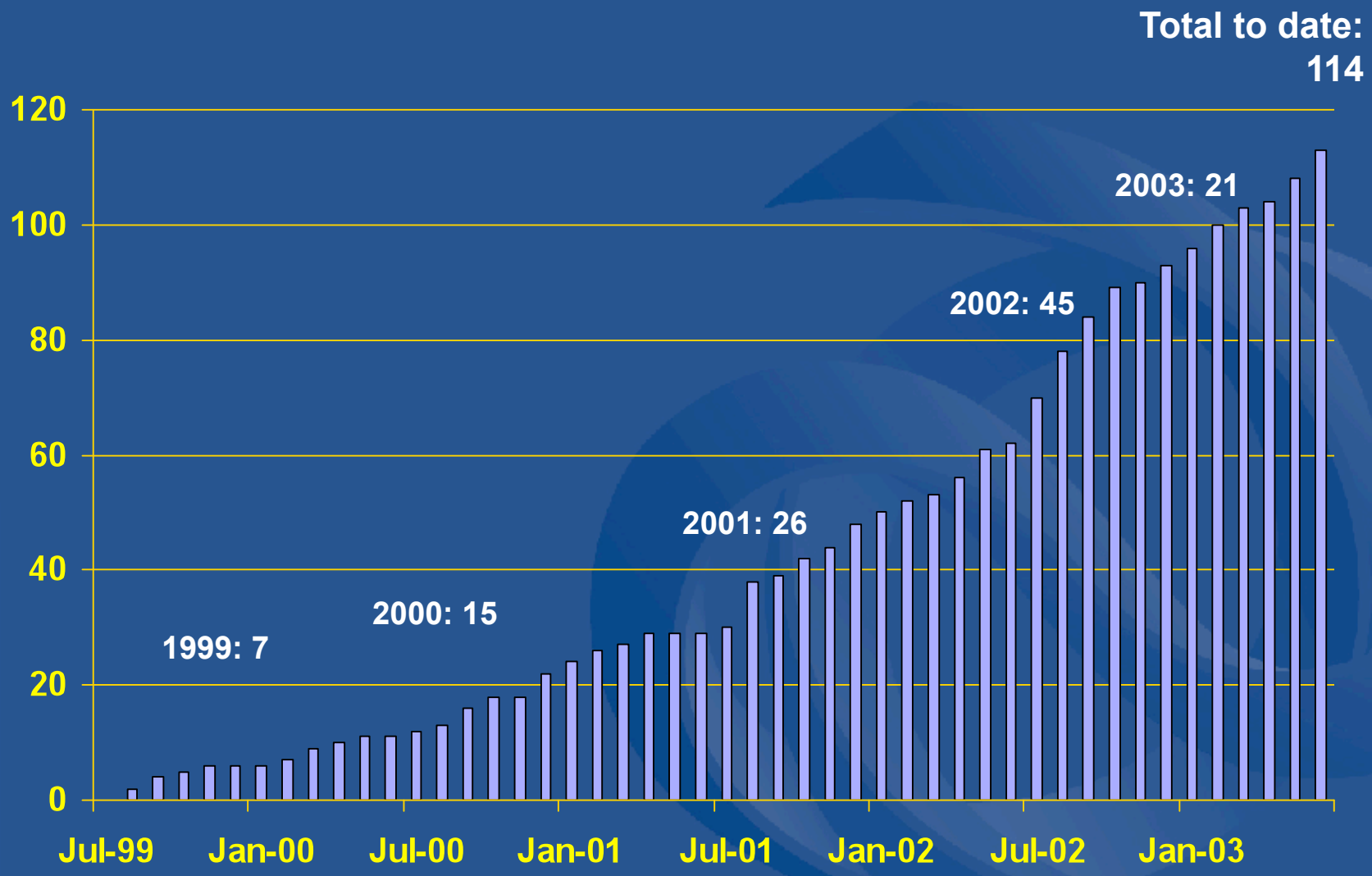
Portable IPv6 assignments for IXPs

- Demonstrate ‘open peering policy’
- 3 or more peers

- Portable assignment size: /48
  - All other needs should be met through normal processes

  - /64 holders can “upgrade” to /48
    - Through NIRs/ APNIC
    - Need to return /64

IPv6 Addresses Allocated



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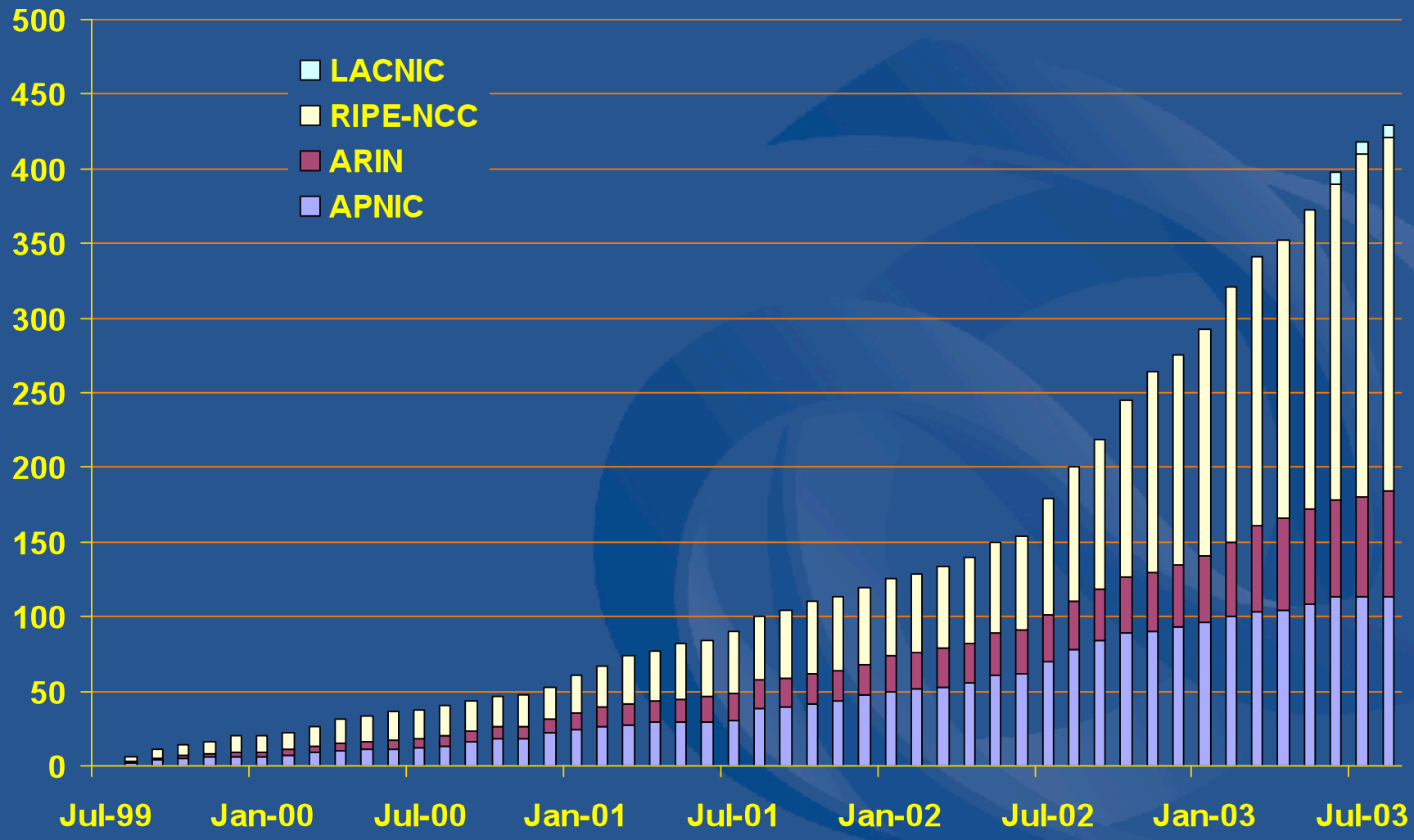
IPv6 Addresses Allocated



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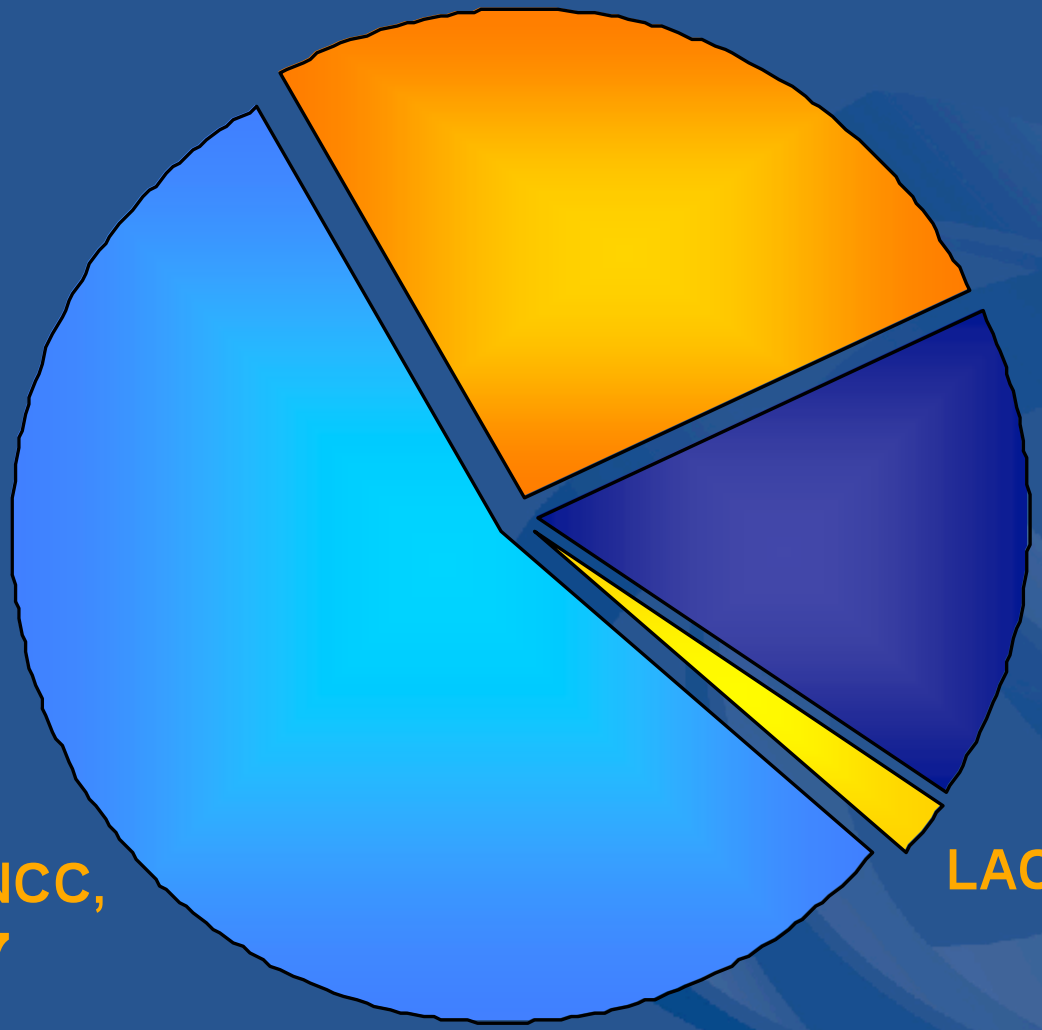
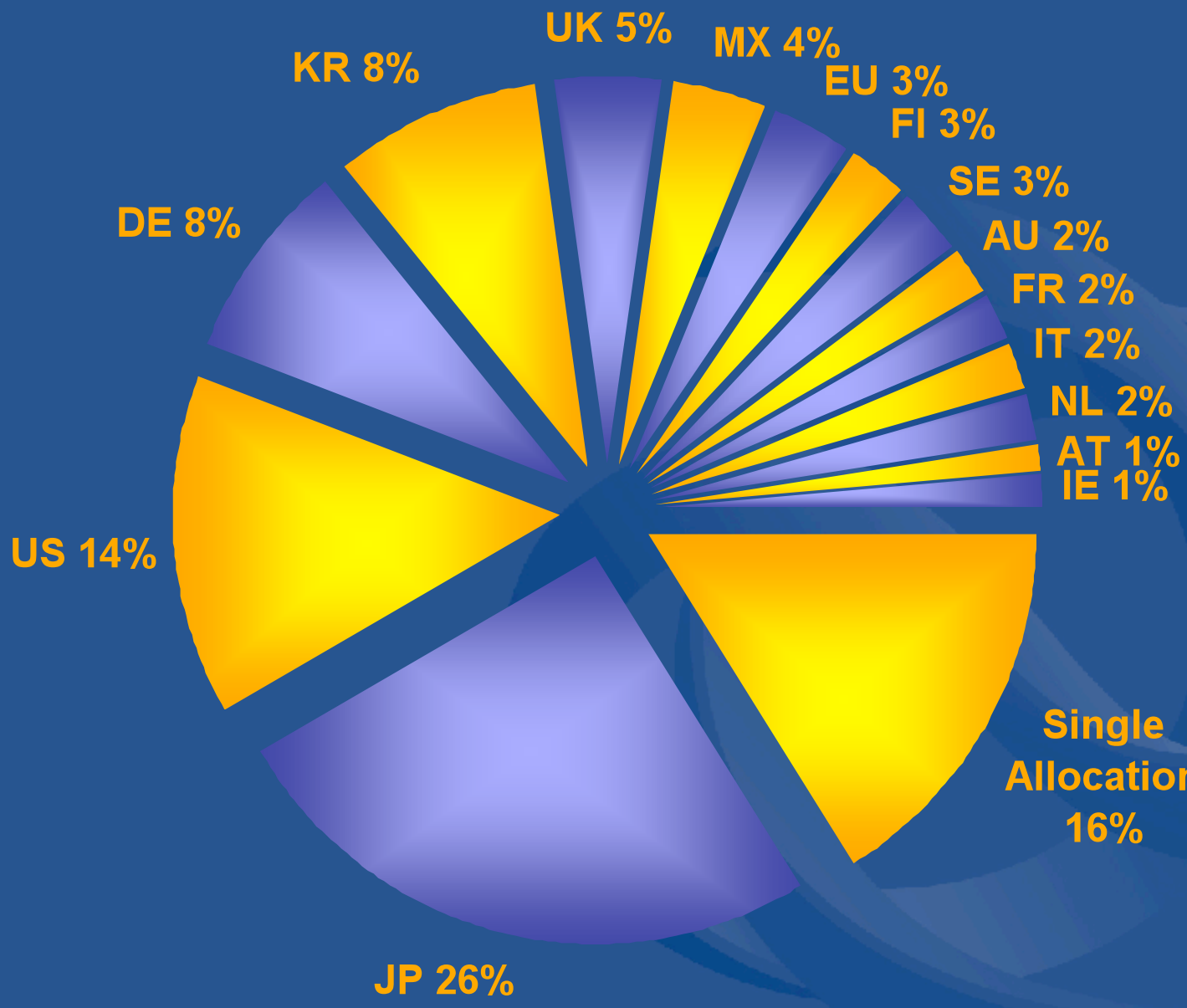
IPv6 distribution per RIR



Last updated Oct 2003

IPv6 Allocations - Global



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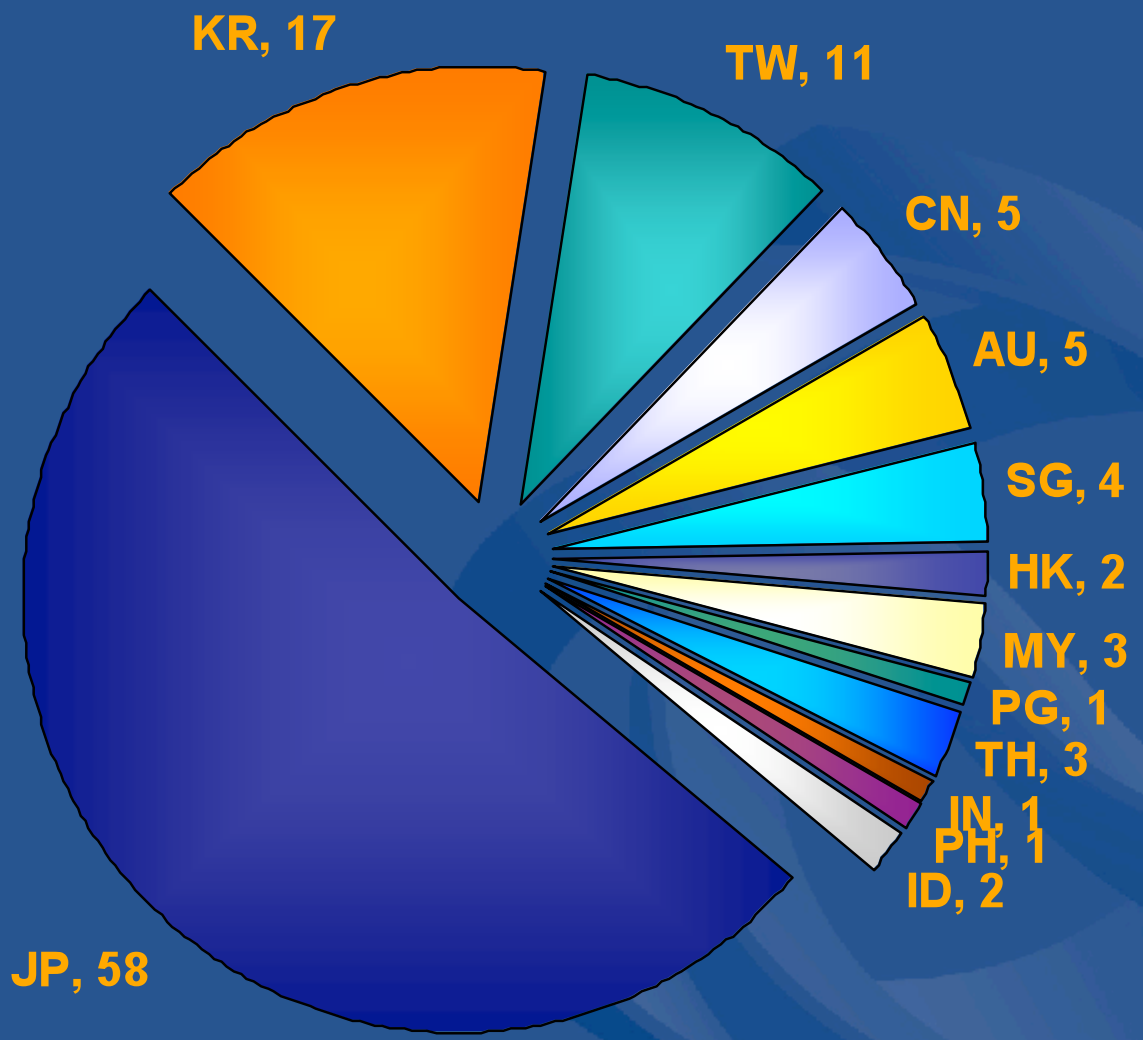
IPv6 allocations in AP



Last updated Oct 2003

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References

- IPv6 Resource Guide
  - http://www.apnic.net/services/ipv6_guide.html
- IPv6 Policy Document
  - http://www.apnic.net/policies.html
- IPv6 Address request form
  - http://ftp.apnic.net/apnic/docs/ipv6-alloc-request
- Useful reading:
  - "The case for IPv6": http://www.6bone.net/misc/case-for-ipv6.html

FAQ

- http://www.apnic.net/info/faq/IPv6-FAQ.html

Questions ?

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Thank you

nurani@apnic.net

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Supplementary Reading

Introduction

- Regional Internet Registry web sites
  - APNIC
    - http://www.apnic.net
  - ARIN
    - http://www.arin.net
  - LACNIC
    - www.lacnic.net
  - RIPE NCC
    - http://www.ripe.net
- APNIC past meetings
    - http://www.apnic.net/meetings

Introduction

- APNIC members
  - http://www.apnic.net/members.html
- Membership
  - Membership procedure
    - http://www.apnic.net/membersteps.html
  - Membership application form
    - http://www.apnic.net/apnic-bin/membership-application.pl
  - Membership fees
    - http://www.apnic.net/docs/corpdocs/FeeSchedule.htm

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Member Services Helpdesk

- One point of contact for all member enquiries

Helpdesk hours

9:00 am - 7:00 pm (AU EST, UTC + 10 hrs)

ph: +61 7 3858 3188 fax: 61 7 3858 3199

- *More personalised service*
  - Range of languages:
    Cantonese, Filipino, Mandarin, Thai, Vietnamese etc.

- *Faster response and resolution of queries*
  - IP resource applications, status of requests, obtaining help in completing application forms, membership enquiries, billing issues & database enquiries

APNIC & IR policies

- Classless techniques/CIDR
  - http://nori.apnic.net/ietf/rfc/rfc1517.txt
  - http://nori.apnic.net/ietf/rfc/rfc1518.txt
  - http://nori.apnic.net/ietf/rfc/rfc1519.txt
  - Network Addressing when using CIDR
    - ftp://ftp.uninett.no/pub/misc/eidnes-cidr.ps.Z
  - Variable Length Subnet Table
    - http://nori.apnic.net/ietf/rfc/rfc1878.txt

Private address space

- Private Address Space
  - Address Allocation for Private Internets
    - http://nori.apnic.net/ietf/rfc/rfc1918.txt
  - Counter argument: Unique addresses are good
    - http://nori.apnic.net/ietf/rfc/rfc1814.txt

Bit boundary chart

addrs	bits	pref	class	mask
1	0	/32		255.255.255.255
2	1	/31		255.255.255.254
4	2	/30		255.255.255.252
8	3	/29		255.255.255.248
16	4	/28		255.255.255.240
32	5	/27		255.255.255.224
64	6	/26		255.255.255.192
128	7	/25		255.255.255.128
256	8	/24	1C	255.255.255
512	9	/23	2C	255.255.254
1,024	10	/22	4C	255.255.252
2,048	11	/21	8C	255.255.248
4,096	12	/20	16C	255.255.240
8,192	13	/19	32C	255.255.224
16,384	14	/18	64C	255.255.192
32,768	15	/17	128C	255.255.128
65,536	16	/16	1B	255.255
131,072	17	/15	2B	255.254
262,144	18	/14	4B	255.252
524,288	19	/13	8B	255.248
1,048,576	20	/12	16B	255.240
2,097,152	21	/11	32B	255.224
4,194,204	22	/10	64B	255.192
8,388,608	23	/9	128B	255.128
16,777,216	24	/8	1A	255
33,554,432	25	/7	2A	254
67,108,864	26	/6	4A	252
134,217,728	27	/5	8A	248
268,435,456	28	/4	16A	240
536,870,912	29	/3	32A	224
1,073,741,824	30	/2	64A	192

APNIC mailing lists

- apnic-talk
  - Open discussion relevant to APNIC community and members
    - e.g. policies, procedures etc
- apnic-announce
  - Announcements of interest to the AP community
- ipv6-registry
  - IPv6 allocation and assignment policies

- http://www.apnic.net/net_comm/lists/
  - subscribe via <majordomo@apnic.net>
  - archives at
    - http://ftp.apnic.net/apnic/mailing-lists

The RIR system

- "Development of the Regional Internet Registry System"
  - Internet Protocol Journal
    - Short history of the Internet
  - http://www.cisco.com/warp/public/759/ipj_4-4/ipj_4-4_regional.html

Policies & policy environment

- Policy Documentation
  - Policies for address space management in the Asia Pacific region
    - http://www.apnic.net/docs/policy/add-manage-policy.html
  - Internet Registry IP allocation Guidelines
    - http://nori.apnic.net/ietf/rfc/rfc2050.txt

Address request procedures

- Addressing Guidelines
  - Designing Addressing Architectures for Routing & Switching Howard C. Berkowitz
- Address Request Forms
  - ISP Address Request Form
    - http://www.apnic.net/services/ipv4/
  - Second-opinion Request For
    - http://cgi.apnic.net/apnic-bin/second-opinion-request.pl
  - No Questions Asked
    - http://ftp.apnic.net/apnic/docs/no-questions-policy

APNIC Database

- APNIC Database Documentation
  - http://ftp.apnic.net/apnic/docs/database-update-info
  - http://ftp.apnic.net/apnic/docs/maintainer-request
  - http://www.apnic.net/apnic-bin/maintainer.pl
  - http://www.apnic.net/services/whois_guide.html
- RIPE Database Documentation
  - http://www.ripe.net/ripe/docs/databaseref-manual.html
- Database ‘whois’ Client
  - http://ftp.apnic.net/apnic/dbase/tools/ripe-dbase-client.tar.gz
  - http://www.apnic.net/apnic-bin/whois2.pl

Reverse DNS

- Request Forms
  - http://www.apnic.net/db/revdel.html
  - http://www.apnic.net/db/domain.html
- Classless Delegations
  - http://nori.apnic.net/ietf/rfc/rfc2317.txt
- Common DNS configuration errors
  - http://nori.apnic.net/ietf/rfc/rfc1537.txt

AS assignment procedures

- ASN policy document
  - http://www.apnic.net/docs/policy/asn-policy.html
- ASN request form
  - http://www.apnic.net/db/aut-num.html
- Using a Dedicated AS for Sites Homed to a Single Provider
  - http://nori.apnic.net/ietf/rfc/rfc2270.txt
- Guidelines for the creation, selection, and registration of an AS
  - http://nori.apnic.net/ietf/rfc/rfc1930.txt

IPv6

- IPv6 Address Allocation & Assignment Policy
  - http://ftp.apnic.net/apnic/docs/ipv6-address-policy
- IPv6 Address request form
  - http://ftp.apnic.net/apnic/docs/ipv6-alloc-request
- FAQ
  - http://www.apnic.net/info/faq/IPv6-FAQ.html

IPv6

- The case for IPv6
  - draft-ietf-iab-case-for-ipv6-06.txt
    - http://www.6bone.net/misc/case-for-ipv6.html
- Internet Protocol Version 6 (IPv6) Addressing Architecture
    - http://nori.apnic.net/ietf/rfc/rfc3513.txt
- IPv6 Stateless Address Autoconfiguration
    - http://nori.apnic.net/ietf/rfc/rfc2462.txt

IPv6

- The H Ratio for Address Assignment Efficiency
  - http://nori.apnic.net/ietf/rfc/rfc1715.txt
- The Host-Density Ratio for Address Assignment Efficiency: An update on the H ratio
  - http://nori.apnic.net/ietf/rfc/rfc3194.txt

IPv6: HD ratio 0.8

IPv6 prefix	Site addr bits	Total site addrs in /48s	Threshold	Util%
42	6	64	28	**43.5%**
36	12	4096	776	**18.9%**
35	13	8192	1351	**16.5%**
32	16	65536	7132	**10.9%**
29	19	524288	37641	**7.2%**
24	24	16777216	602249	**3.6%**
16	32	4294967296	50859008	**1.2%**
8	40	1099511627776	4294967296	**0.4%**
3	45	35184372088832	68719476736	**0.2%**

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

Other supplementary reading

- Operational Content Books
  - ISP Survival Guide - Geoff Huston
- BGP Table
  - http://www.telstra.net/ops/bgptable.html
  - http://www.merit.edu/ipma/reports
  - http://www.merit.edu/ipma/routing_table/mae-east/prefixlen.990212.html
  - http://www.employees.org/~tbates/cidr.hist.plot.html
- Routing Instability
  - http://zounds.merit.net/cgi-bin/do.pl

Other supplementary reading

- Routing & Mulithoming
  - Internet Routing Architectures - Bassam Halabi
  - BGP Communities Attribute
    - http://nori.apnic.net/ietf/rfc/rfc1997.txt
    - http://nori.apnic.net/ietf/rfc/rfc1998.txt
  - Using a Dedicated AS for Sites homed to a Single Provider
    - http://nori.apnic.net/ietf/rfc/rfc2270.txt

Other supplementary reading

- Filtering
  - Egress Filtering http://www.cisco.com/public/cons/isp
  - Network Ingress Filtering: Defeating Denial of Service Attacks which employ IP Source Address Spoofing
    - http://nori.apnic.net/ietf/rfc/rfc2267.txt
- Dampening
  - case studies at http://www.cisco.com/warp/public/459/16.html
- Traceroute Server
  - http://nitrous.digex.net

Other supplementary reading

- Renumbering
  - Network Renumbering Overview: Why Would I Want It and What Is It Anyway?
    - http://nori.apnic.net/ietf/rfc/rfc2071.txt
  - Procedures for Enterprise Renumbering
    - http://www.isi.edu/div7/pier/papers.html
- NAT
  - The IP Network Address Translator
    - http://nori.apnic.net/ietf/rfc/rfc1631.txt