APNIC IPv6 Tutorial

Global IPv6 Summit in China 2008

April 15, 2008

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Overview

- IPv6 addressing - notation and prefixes
- APNIC IPv6 policy update
- How to request IPv6 addresses
- IPv4 address space exhaustion
- IPv6 allocation statistics
- IPv6 global routing table update

IPv6 addressing

Size of the IPv6 address space

- An IPv6 address is 16 octets (128 bits)

- This would allow every person on the planet to have their own internet as large as the current Internet

- It is difficult to foresee running out of IPv6 addresses (???!!!)

IPv6 Colon Hexadecimal Notation - 1

- Although the large address solves the problem of insufficient capacity, humans now will have trouble using the addresses

- The dotted decimal notation used for IPv4 does not make such addresses sufficiently compact:

104.230.140.100.255.255.255.0.0.17.2.128.150.10.255.255

IPv6 Colon Hexadecimal Notation - 2

- IPv6 designers propose using colon hexadecimal notation in which the value of each 16-bit quantity is represented in hexadecimal separated by colons:

  68E6:8C64:FFFF:FFFF:0:1180:96A:FFFF

- Allows for zero compression

  FF05:0:0:0:0:0:0:B3

  becomes:

  FF05::B3

  but this can only be done once in an address

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, ex: A2FE)
  - 16 bit number is converted to a 4 digit hexadecimal number

- Example:
  - 2001:DB8:124C:C1A2:BA03:6735:EF1C:683D

  – Abbreviated form of address
  - 2001:DB8:0023:0000:0000:036E:1250:2B00
  - →2001:DB8:23:0:0:36E:1250:2B00
  - →2001:DB8:23::36E:1250:2B00
  - (Null value can be used only once)

IPv6 address prefix

- When you do IPv6 subnetting, you need to think in bits value not in hexadecimal value
- 2001:1::/32
  - =2001:0001::/32
  - Hex 2001 = Binary 0010 0000 0000 0001 = /16
  - Hex 0001 = Binary 0000 0000 0000 0001 = /32
- 2001:2:3::/48
  - =2001:0002:0003::/48
  - Hex 2001 = Binary 0010 0000 0000 0001 = /16
  - Hex 0002 = Binary 0000 0000 0000 0010 = /32
  - Hex 0003 = Binary 0000 0000 0000 0011 = /48
- So /64s in 2001:2:3::/48 are
  - 2001:0002:0003:0001::/64
  - 2001:0002:0003:0002::/64
  - 2001:0002:0003:0003::/64
  - Etc.
  - 16 bits of address space
    - You can have 65536 /64s in one /48 IPv6 address

IPv6 address prefix

- When you do IPv6 subnetting, you need to think in bits value not in hexadecimal value
- 2001:1::/32
    - =2001:0001::/32
    - Hex 2001 = Binary 0010 0000 0000 0001 = /16
    - Hex 0001 = Binary 0000 0000 0000 0001 = /32
- How about /47s in 2001:1::/32?
    - Hex 2001 = Binary 0010 0000 0000 0001 = /16
    - Hex 0001 = Binary 0000 0000 0000 0001 = /32
    - Hex 0000 = Binary 0000 0000 0000 00X0 = /47
    - So bit "X" keep changing:
    - Binary 0000 0000 0000 0000 = Hex 0000
    - The first /47 is 2001:0001:0000::/47
    - ---
    - Binary 0000 0000 0000 0010 = Hex 0002
    - So the second /47 is 2001:0001:0002::/47
    - ---
    - Binary 0000 0000 0000 0100 = Hex 0004
    - So the third /47 is 2001:0001:0004::/47
    - ---
    - Binary 0000 0000 0000 0110 = Hex 0006
    - So the forth /47 is 2001:0001:0006::/47
    - ---
    - Binary 0000 0000 0000 1000 = Hex 0008
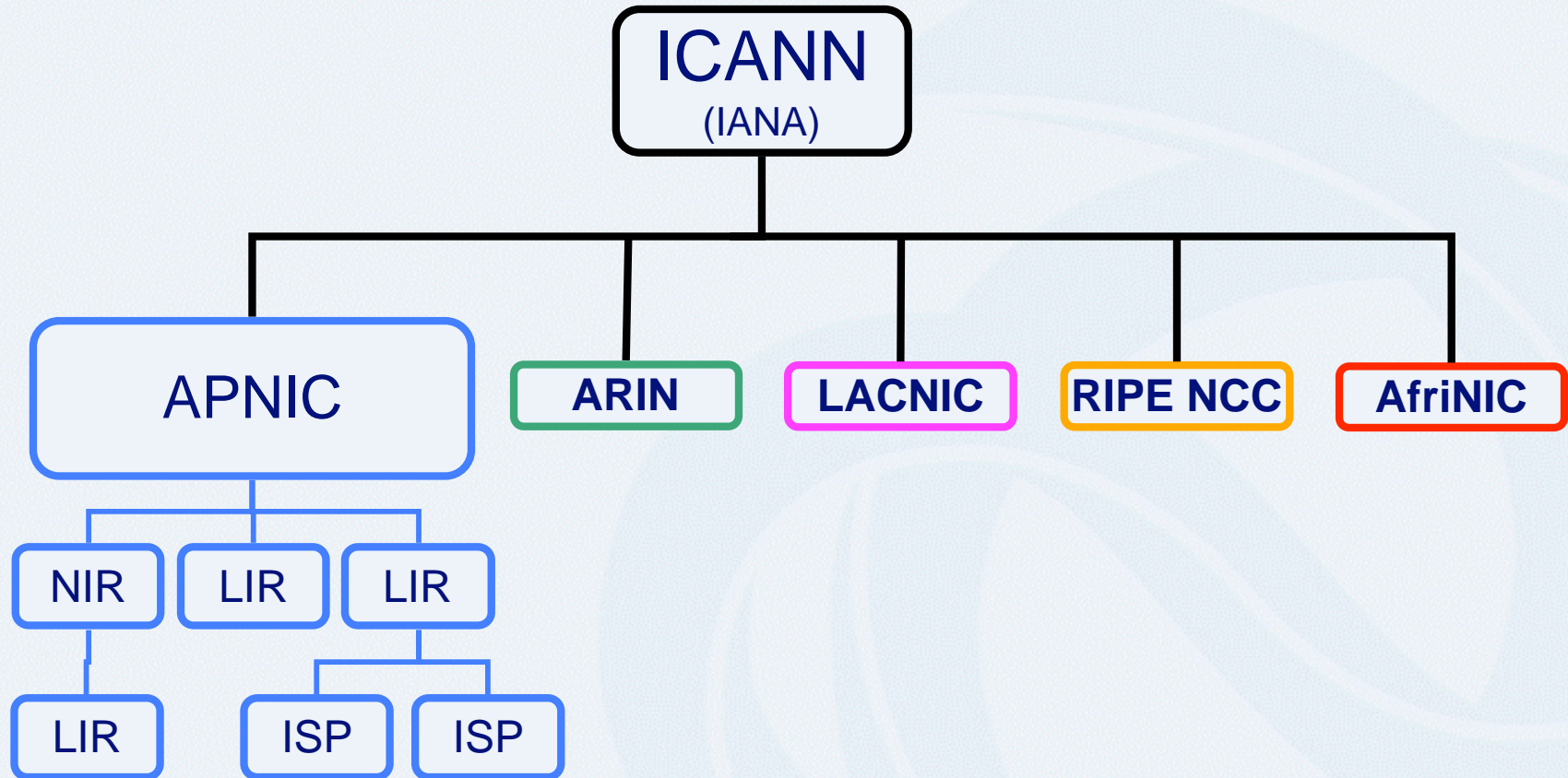   - So the fifth /47 is 2001:0001:0008 ::/47

IPv6 policy and procedures

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IPv6 Address Policy

- IPv6 Address Allocation and Assignment Policy
  - http://www.apnic.net/docs/policy/ipv6-address-policy.html
- APNIC guidelines for IPv6 allocation and assignment requests
  - http://www.apnic.net/docs/policy/ipv6-guidelines.html

Some definitions

- RIR – Regional Internet Registry
- NIR – National Internet Registry
- LIR – Local Internet Registry (Top level ISP)
- End Site defined as an end user of an ISP where the ISP:
  - Assigns address space to the end user
  - Provides Internet transit service to the end user
  - Advertises an aggregate prefix route that contains the end user's assignment
- POP – Point of Presence

Internet Registry Structure

```
                          ICANN
                          (IANA)

   APNIC        ARIN    LACNIC   RIPE NCC   AfriNIC

  NIR   LIR   LIR

  LIR   ISP   ISP
```

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')

IPv6 initial allocation

- **Initial allocation criteria**
  - Plan to connect 200 end sites within 2 years
    - Default allocation ("slow start")
- **Initial allocation size is /32**
  - Provides 16 bits of site address space

| 32 bits | 48 bits | 128 bits |

  - Larger initial allocations can be made if justified according to:
    - IPv6 network infrastructure plan
    - Existing IPv4 infrastructure and customer base
- **License model of allocation**
  - Allocations are not considered permanent, but always subject to review and reclamation

IPv6 customer assignments

- Assignment /48 - /64 for all end sites (POP also defined as end site)
  - Defined in revised policy – effective19 March 2007
  - Provides for up to 16 bits of space for subnets

48 bits	64 bits	128 bits

- Other assignment sizes
  - /64 only one subnet
  - /128 only one device connecting

- Larger assignments (to ISP)- Multiple /48s
  - Should be reviewed by RIR/NIR
    - Follow second opinion procedure

IPv6 IXP assignment

- Criteria
  - Demonstrate 'open peering policy'
  - 3 or more peers

- Assignment size: /48
  - All other needs should be met through normal processes
  - /64 holders can "upgrade" to /48
    - Through CNNIC / APNIC
    - Need to return /64

IPv6 Critical Infrastructure Assignment

- Organisations seeking assignment for critical infrastructure must be an actual operator of the network infrastructure performing the following functions:
  - root domain name system (DNS) server
  - global top level domain (gTLD) DNS server
  - country code TLD (ccTLDs) DNS server
  - Regional Internet Registry (RIRs)
  - National Internet Registry (NIRs)

* Minimum assignment size is /48

IPv6 Multihoming Assignment

- An organisation is eligible to receive a portable assignment from APNIC if it:

- is currently multihomed with provider-based addresses, or demonstrates a plan to multihome within three months and,

- agrees to renumber out of previously assigned address space.

* Minimum assignment size is /48

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Proposed policy

- Initial allocation criteria be changed
  - From
    - Have a plan for making at least 200 assignments to other organizations within two years.
  - To
    - Have a plan for making at least 200 assignments to other organizations within two years,
      - OR
    - Be an existing LIR with IPv4 allocations from an RIR/NIR which makes IPv6 assignments and/or sub-allocations to other organizations and announces the allocation in the inter-domain routing system within two years.

Proposed policy…cont.

- Reached consensus at the APNIC 25
- Final call for comments ends on 29 April 2008
- How to participate in the final call?
  - Subscribe to http://mailman.apnic.net/mailman/listinfo/sig-policy
  - Post your comments to this thread
    - Final call for comments - prop-057: Proposal to change IPv6 initial allocation criteria

Obtaining IPv6 addresses

Where to request IPv6 addresses?

- 1. From your upstream ISP
  - Receive an assignment or sub-allocation
  - Address space is non-portable
- 2. From CNNIC
  - CNNIC member
  - Address space is portable
- 3. From APNIC
  - APNIC member
  - Address space is portable

Note: 6bone address is no longer available

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APNIC

Request IPv6 addresses from APNIC

- Become APNIC member
  - http://www.apnic.net/member/index.html
- IPv6 Allocation Request Form
  - http://ftp.apnic.net/apnic/docs/ipv6-alloc-request
- IPv6 Portable Assignment Request Form
  - http://www.apnic.net/services/portable-assign/index.html

How do I apply for IPv6 addresses?

Check your eligibility for IPv6 addresses

Read IPv6 policies

http://www.apnic.net/docs/policy/ipv6-address-policy.html

Read IPv6 guideline

http://www.apnic.net/docs/policy/ipv6-guidelines.html

Do you have an APNIC account?

If not, become an APNIC member or open a non-member account

Complete an IPv6 address request form

Submit the form hostmaster@apnic.net

Questions:
email: helpdesk@apnic.net

Helpdesk chat: http://www.apnic.net/helpdesk

APNIC Helpdesk chat

IPv4 unallocated address space exhaustion

RIR and Internet resource management

Growth of global routing table

Sustainable growth?

Dot-Com boom

Projected routing table growth without CIDR

CIDR deployment

Active BGP entries (FIB)

Date

(graph x-axis: 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06)

(graph y-axis: 0, 50000, 100000, 150000, 200000, 250000)

http://bgp.potaroo.net/as1221/bgp-active.html
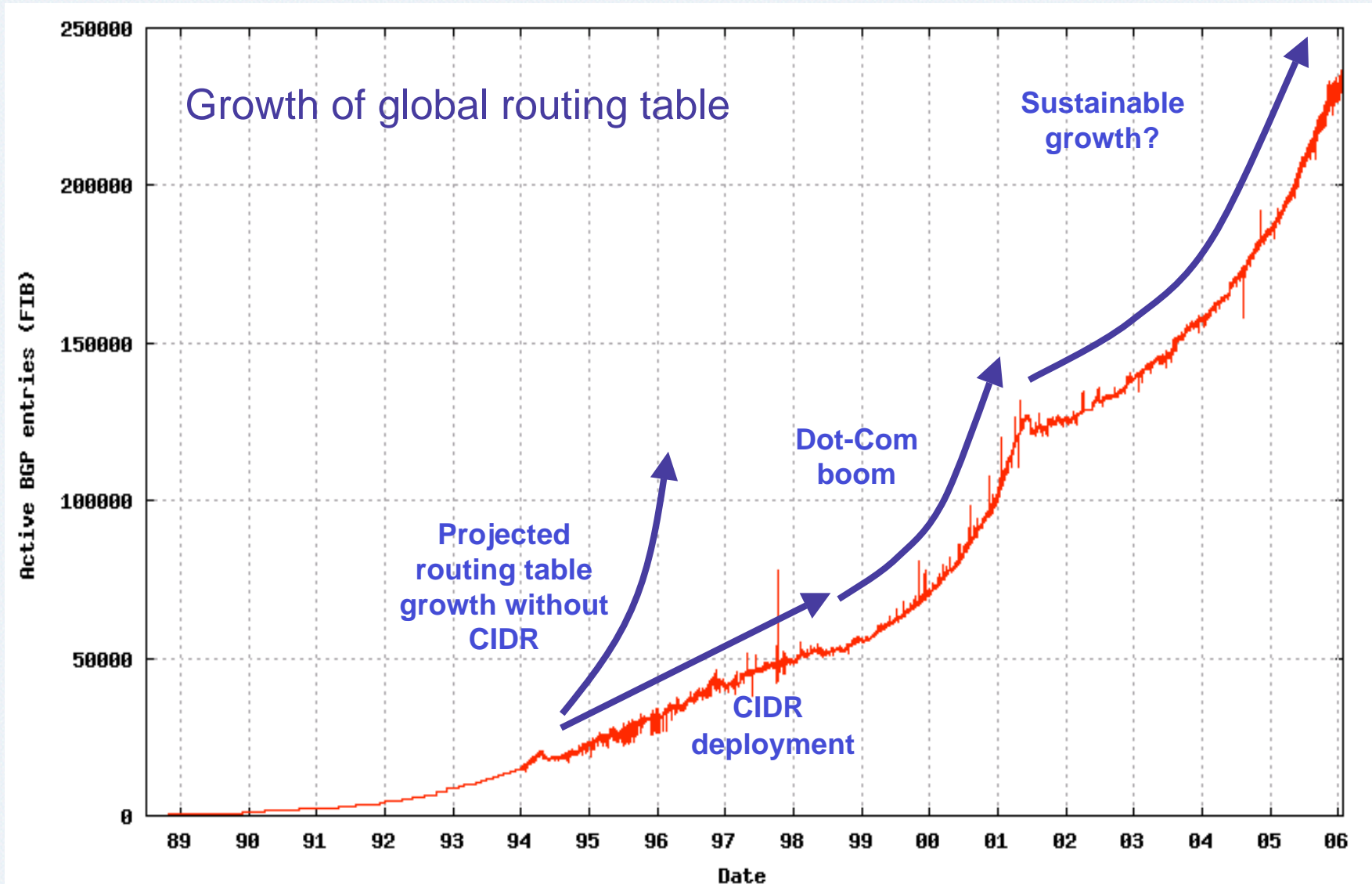
IPv4 Address Pool – June 2005

APNIC

25%

available

Other

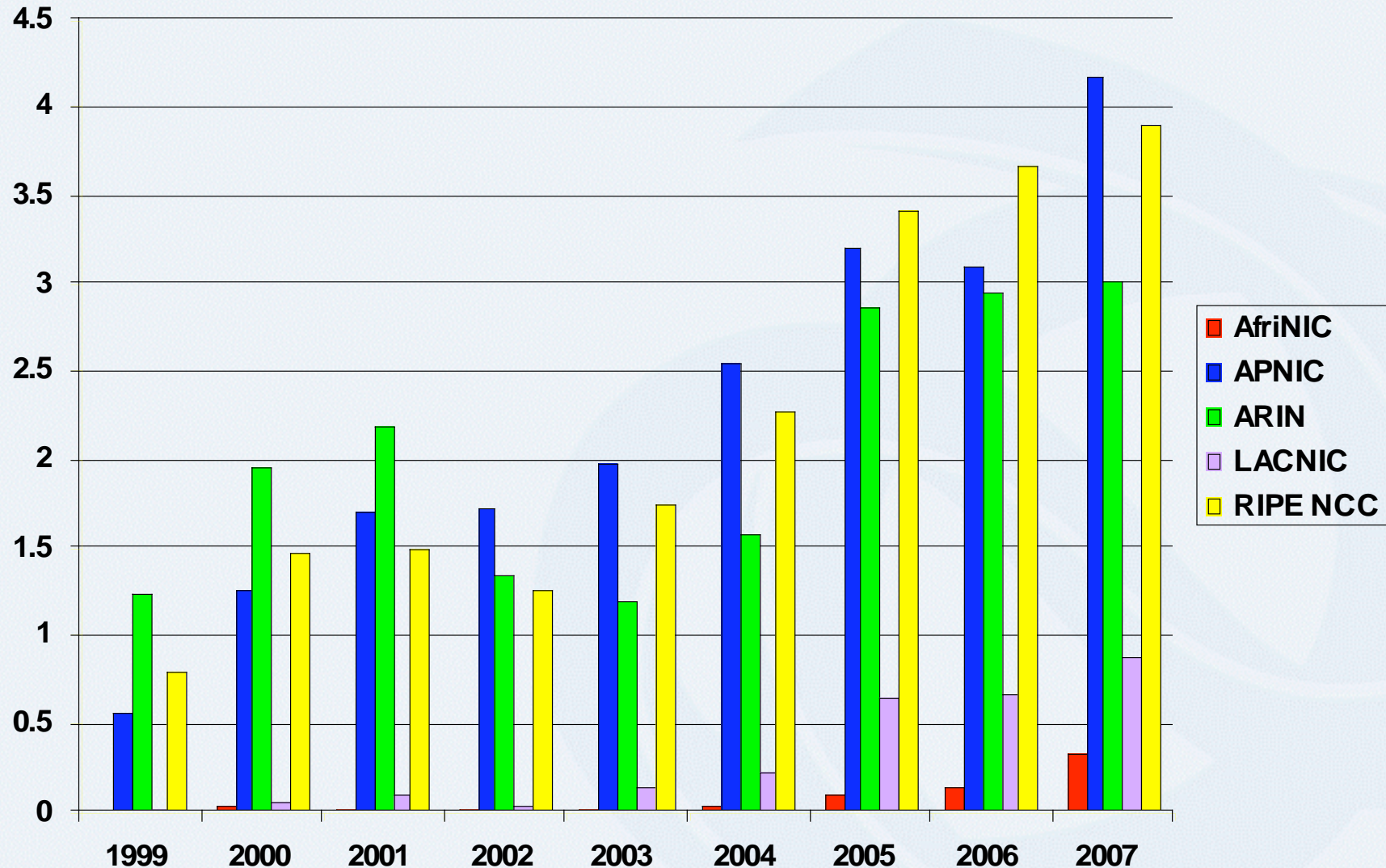Central
Registry

APNIC

LACNIC

ARIN

AfriNIC

RIPE NCC

source: http://potaroo.net
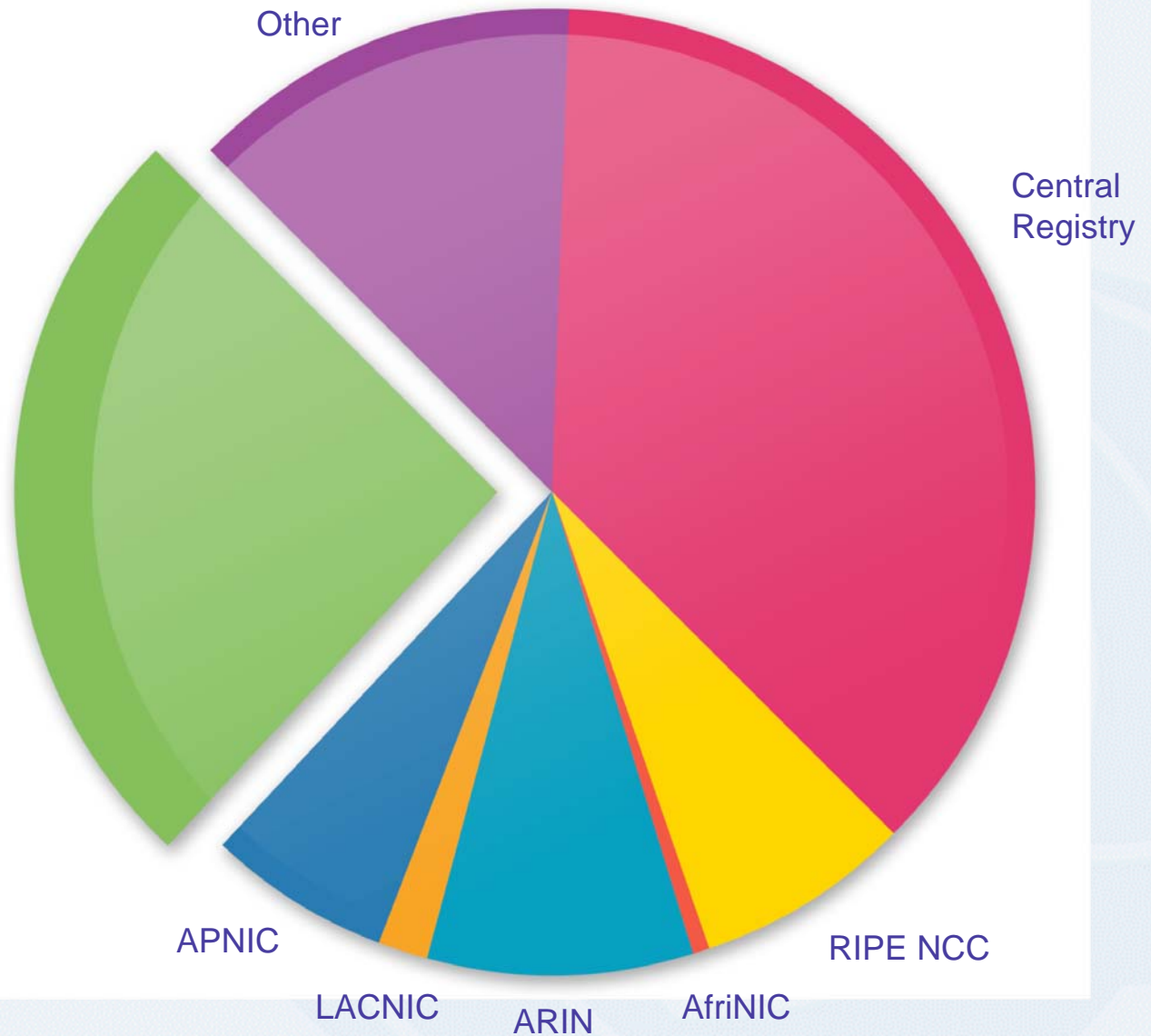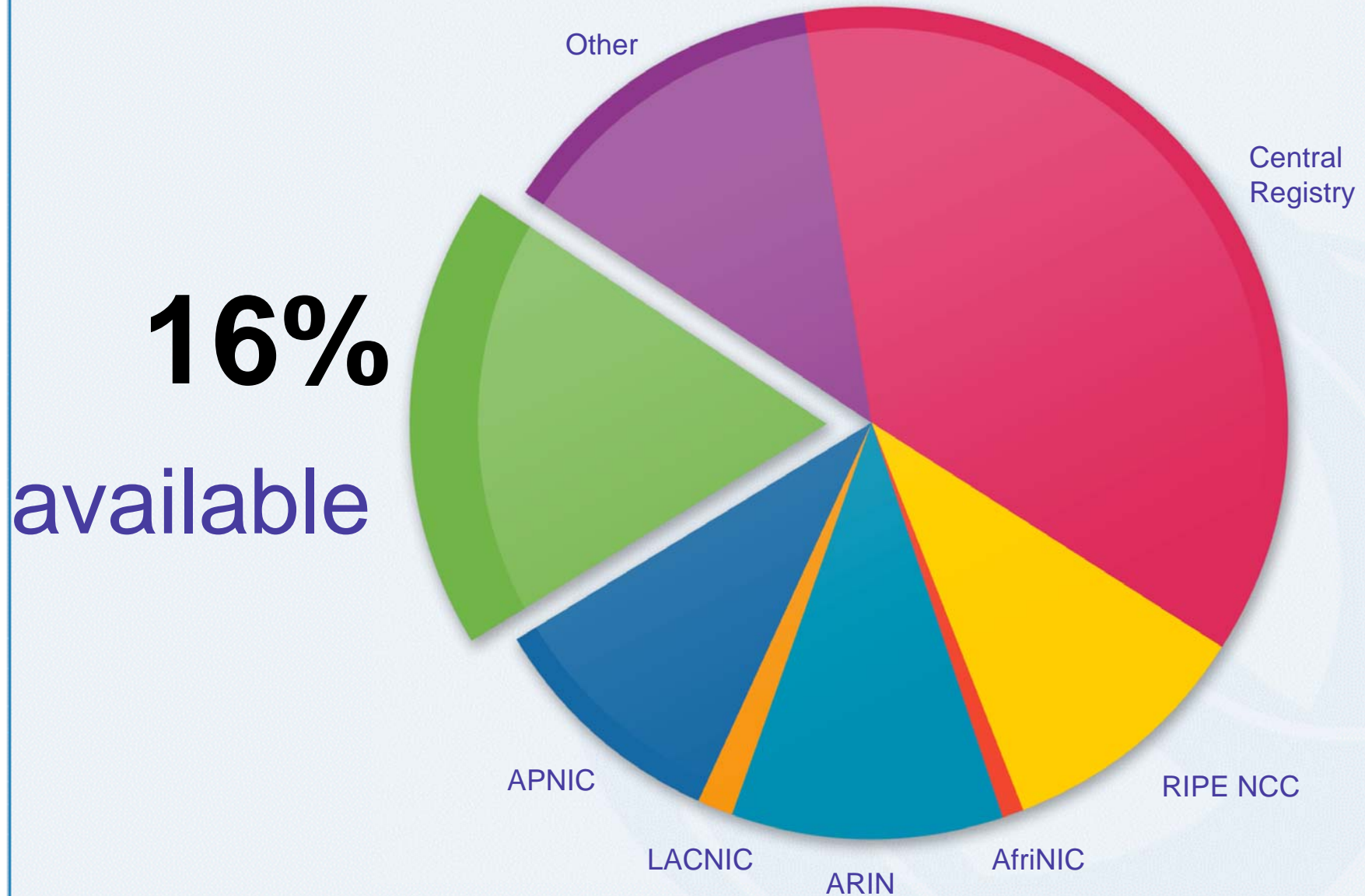
IPv4 Allocations RIRs to LIRs/ISPs

Yearly Comparison (/8s)

ARIN announcement – May 2007

- ARIN board advises Internet community on migration to IPv6
  - 21 May 2007
  - http://www.arin.net/announcements/20070521.html
    - The ARIN resolution on IPv6 migration
  - IPv6 Information Centre
    - http://www.arin.net/v6/v6-info.html

ARIN announcement – May 2007

- ARIN Board of Trustees
  - Advises the Internet community that to migration to IPv6 is necessary
  - Directs ARIN staff to take all necessary measures to assure veracity of IPv6 address applications to ARIN
  - Requests to ARIN Advisory Council to consider change ARIN's Internet Number Resource Policies to encourage migration to IPv6 where possible

LACNIC announcement – 20 June 2007

- We do not wish to create panic, but IP version four addresses are on the way to depletion. Therefore, **we recommend preparing regional networks as soon as possible for using the Internet protocol version six**. There are still many aspects that need to be decided in relation to the consumption of IPv4 addresses that remain unutilized. The impact of some of these decisions could allow us more time, while others could bring IPv4 depletion date even closer. LACNIC will periodically report to the community so that we can all be prepared,"

AfriNIC resolution – 25th July 2007

- "Resolution [#200707.01]: "Noting the imminent exhaustion of the IPv4 address central pool, the AfriNIC Board resolves that efforts to draw the public's attention to the problem and potential solutions such as IPv6 be intensified, and instructs the staff to take appropriate action in this regard".

http://www.afrinic.net/news/aftt-ipv6200707-00

APNIC community resolution – Sep 2007

- Endorsed at APNIC 24
  - [Community resolution on IPv4 and IPv6 issues, 7 September 2007](#)
- The APNIC community recognises that the current rate of allocation, the remaining free pool of IPv4 address space will be consumed within the next 2 to 4 years
  - Requires a concerted effort by the community
    - Responsible measures for the management of remaining IPv4 address space
    - Promote the adoption of IPv6
    - Call upon the leading senior and expert members to provide strong leadership in the search of solutions to these issues of IPv4 address management and transition to IPv6

RIPE 55 – Oct 2007

- 22 – 26 Oct 2007
  - 375 attendees from 40 countries, including all RIRs' representatives and ICANN
  - Most well attended RIPE meeting

- Highlights
  - Resolution on IPv4 depletion
    - The RIPE community agreed on issuing an statement
  - "RIPE Community Resolution on IPv4 Depletion and Deployment of IPv6"
    - was developed by consensus and
    - will be used as the community's formal position regarding IPv4 depletion.

http://www.ripe.net/ripe/meetings/ripe-55/repo
http://www.ripe.net/ripe/meetings/ripe-55/presentations/steffan-reso

RIPE community resolution – Oct 2007

- IPv4 address is likely to be fully allocated within 2 – 4 years
- IPv6 provides necessary address space for future growth
- We need to facilitate the wider deployment of IPv6
  - Urge the widespread deployment of IPv6
  - High priority by all stakeholders
- We recommends ISPs make their services available over IPv6
- We encourage governments to play their part in the deployment of IPv6
  - To ensure that all citizens will be able to participate in the future information society

IPv6 statistics

IANA IPv6 Allocations to RIRs

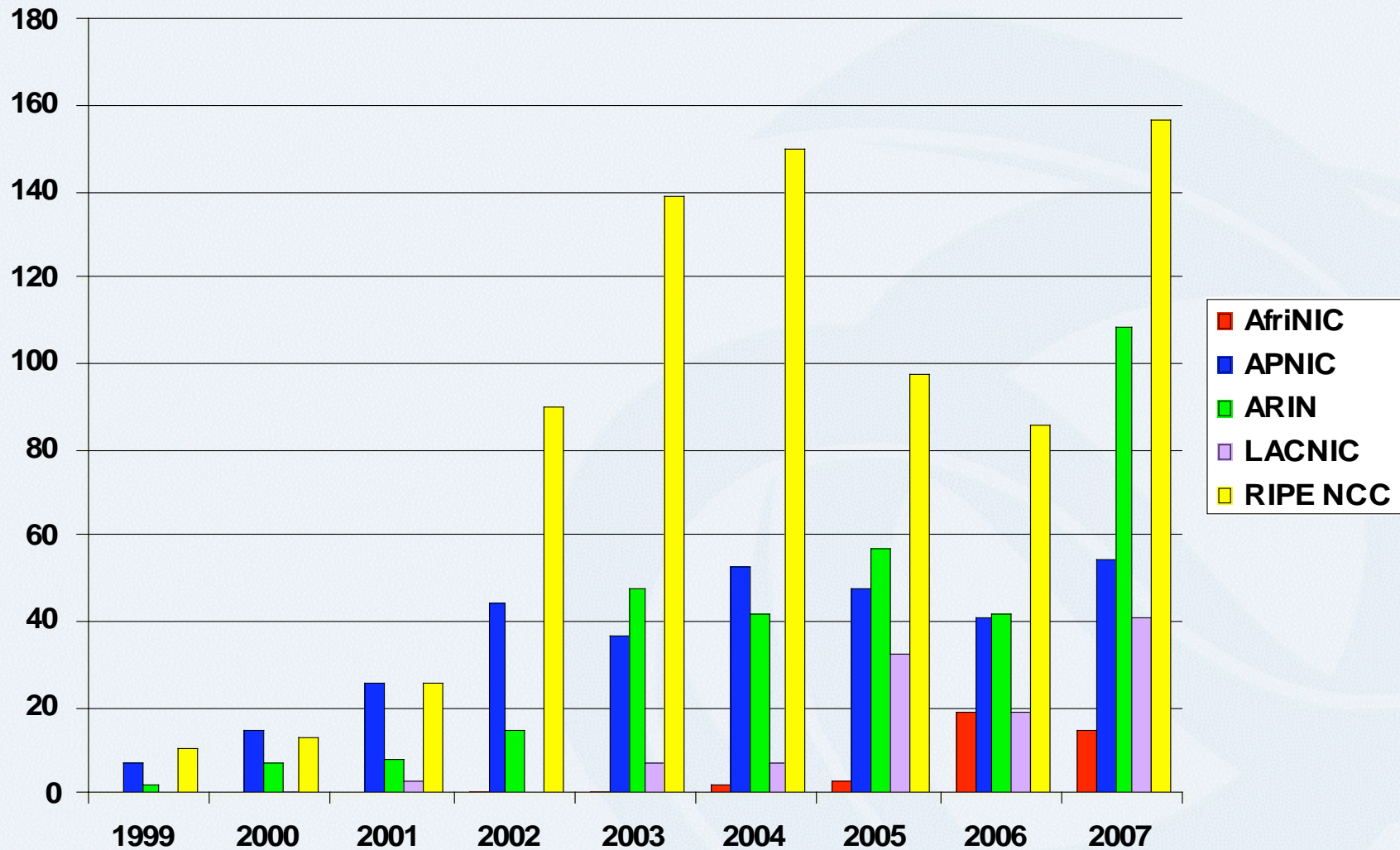## issued as /23s prior to Oct 2006
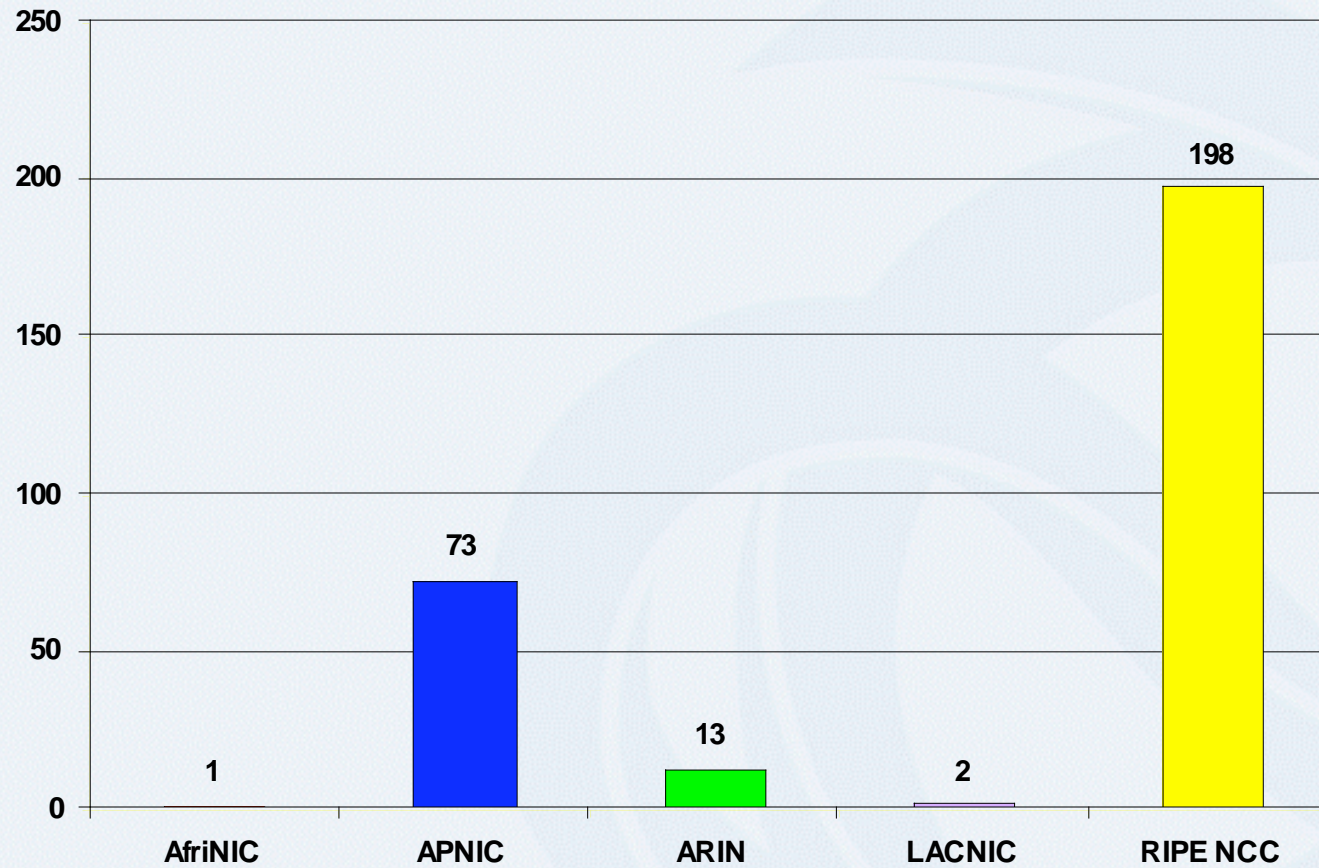
IANA IPv6 Allocations to RIRs
issued in Oct 2006

RIR	IPv6 Address
AfriNIC	2C00:0000::/12
APNIC	2400:0000::/12
ARIN	2600:0000::/12
LACNIC	2800:0000::/12
RIPE NCC	2A00:0000::/12

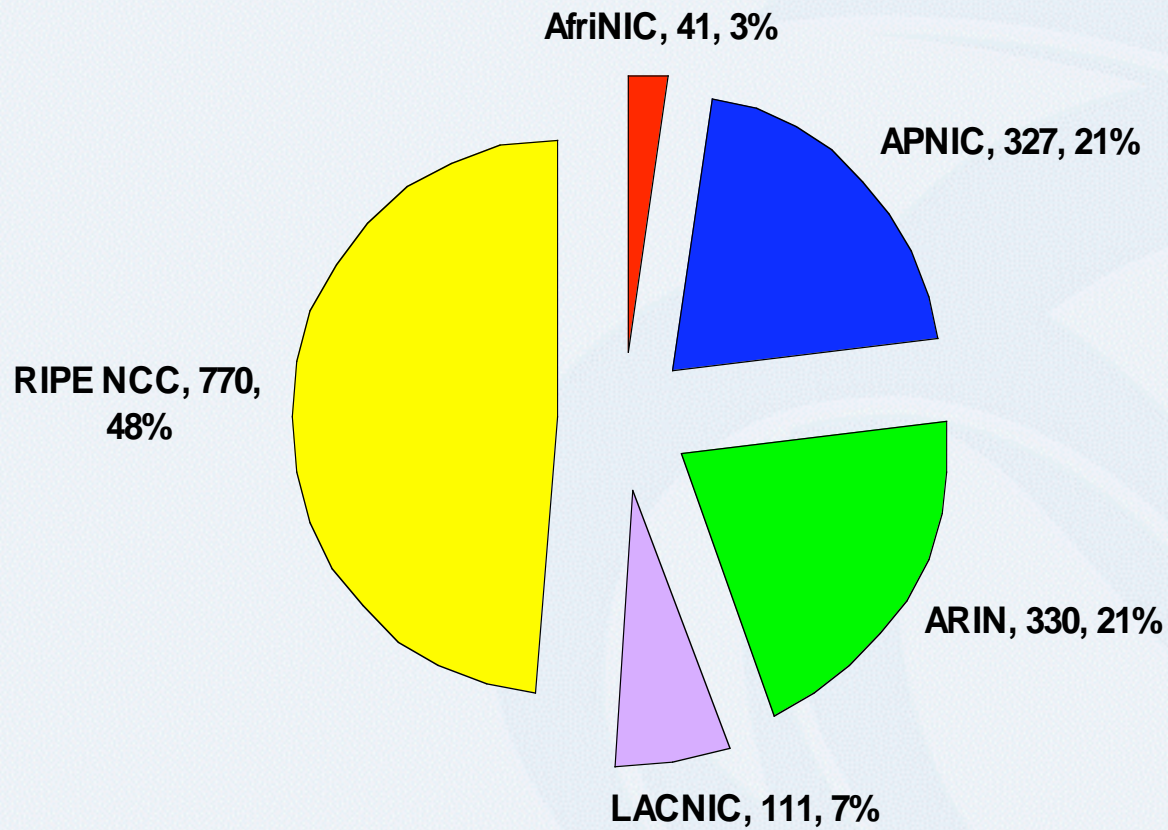Some /23s from the previous slide are incorporated in these /12s

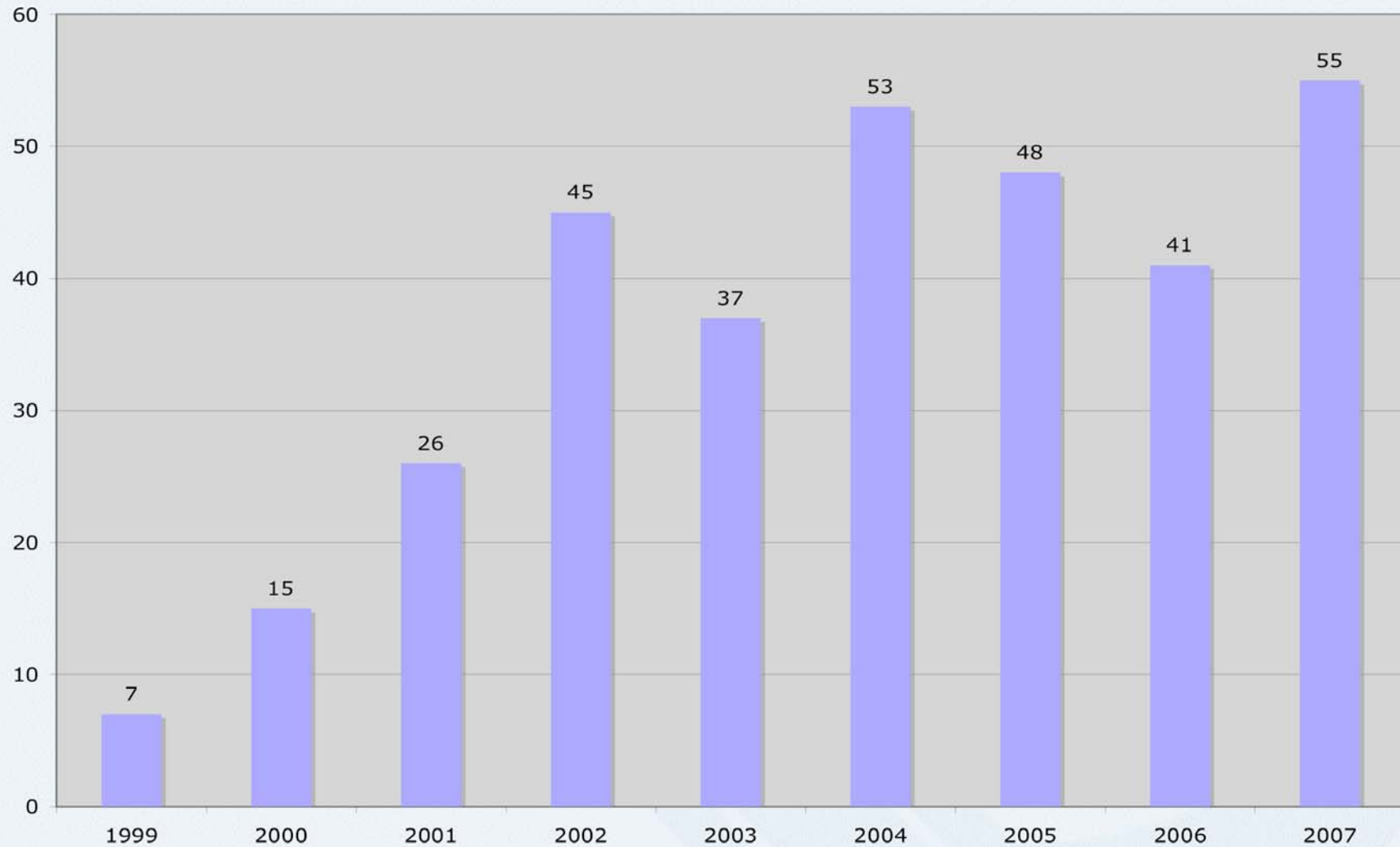# IPv6 Allocations RIRs to LIRs/ISPs
Yearly Comparison
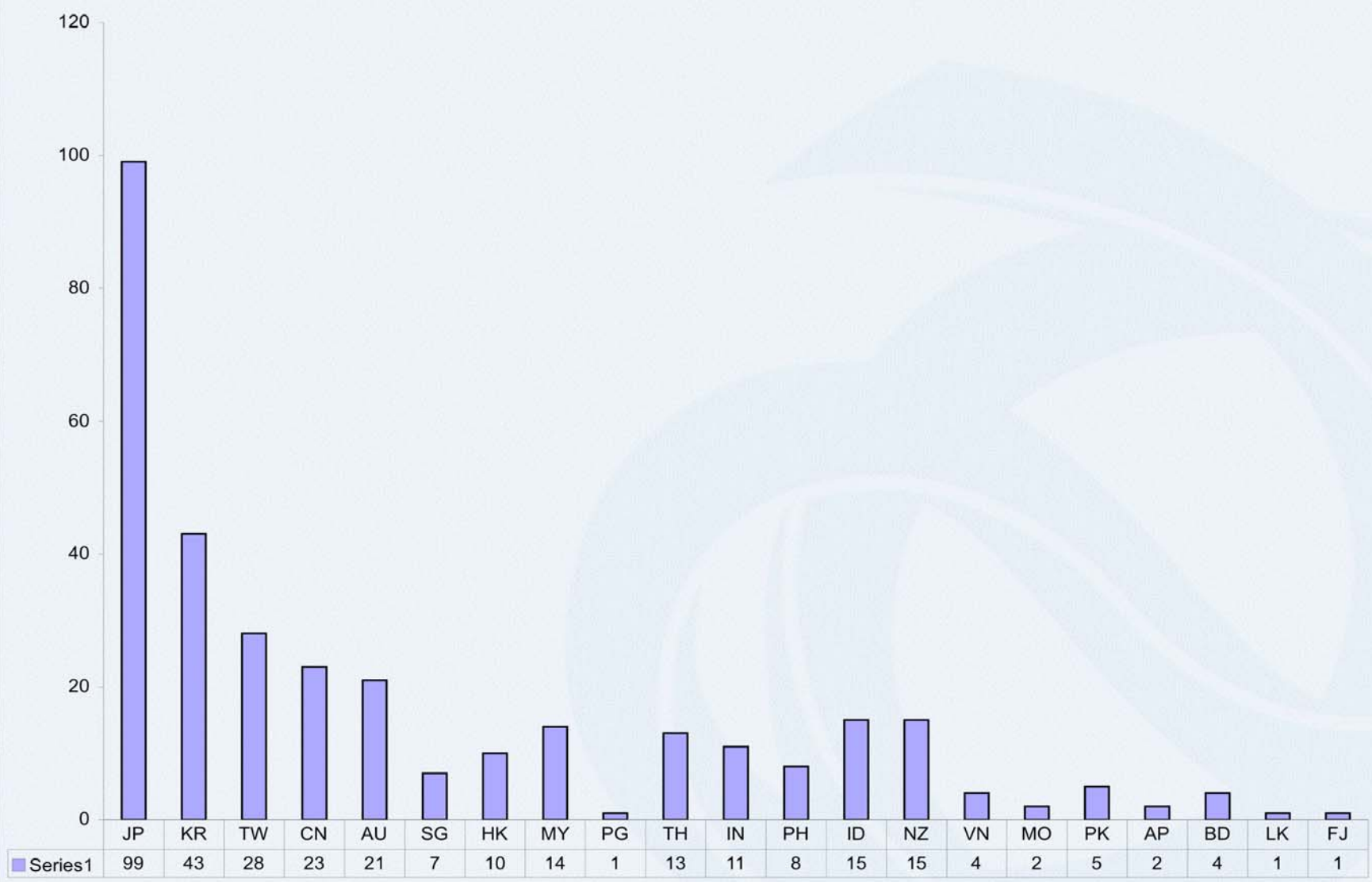
IPv6 Allocations RIRs to LIRs/ISPs
Cumulative Total (Jan 1999 – Dec 2007)

AfriNIC, 41, 3%
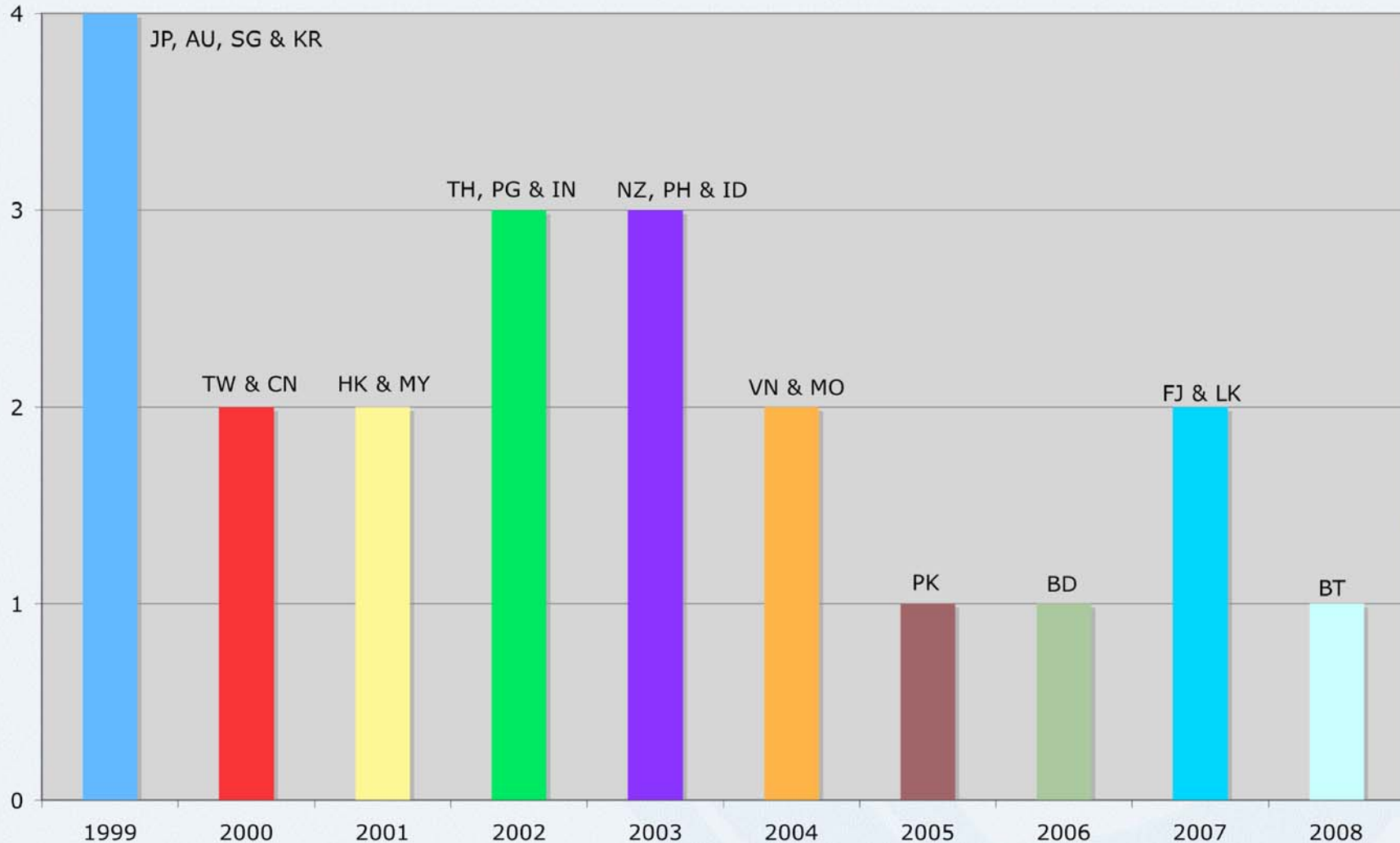
APNIC, 327, 21%

RIPE NCC, 770, 48%

ARIN, 330, 21%

LACNIC, 111, 7%

APNIC allocations by year

APNIC allocations by economy

	JP	KR	TW	CN	AU	SG	HK	MY	PG	TH	IN	PH	ID	NZ	VN	MO	PK	AP	BD	LK	FJ
Series1	99	43	28	23	21	7	10	14	1	13	11	8	15	15	4	2	5	2	4	1	1

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Economy uptake by year in AP region

Total: 21 Economies

IPv6 Global Routing table update

IPv6 global routing table - 2007

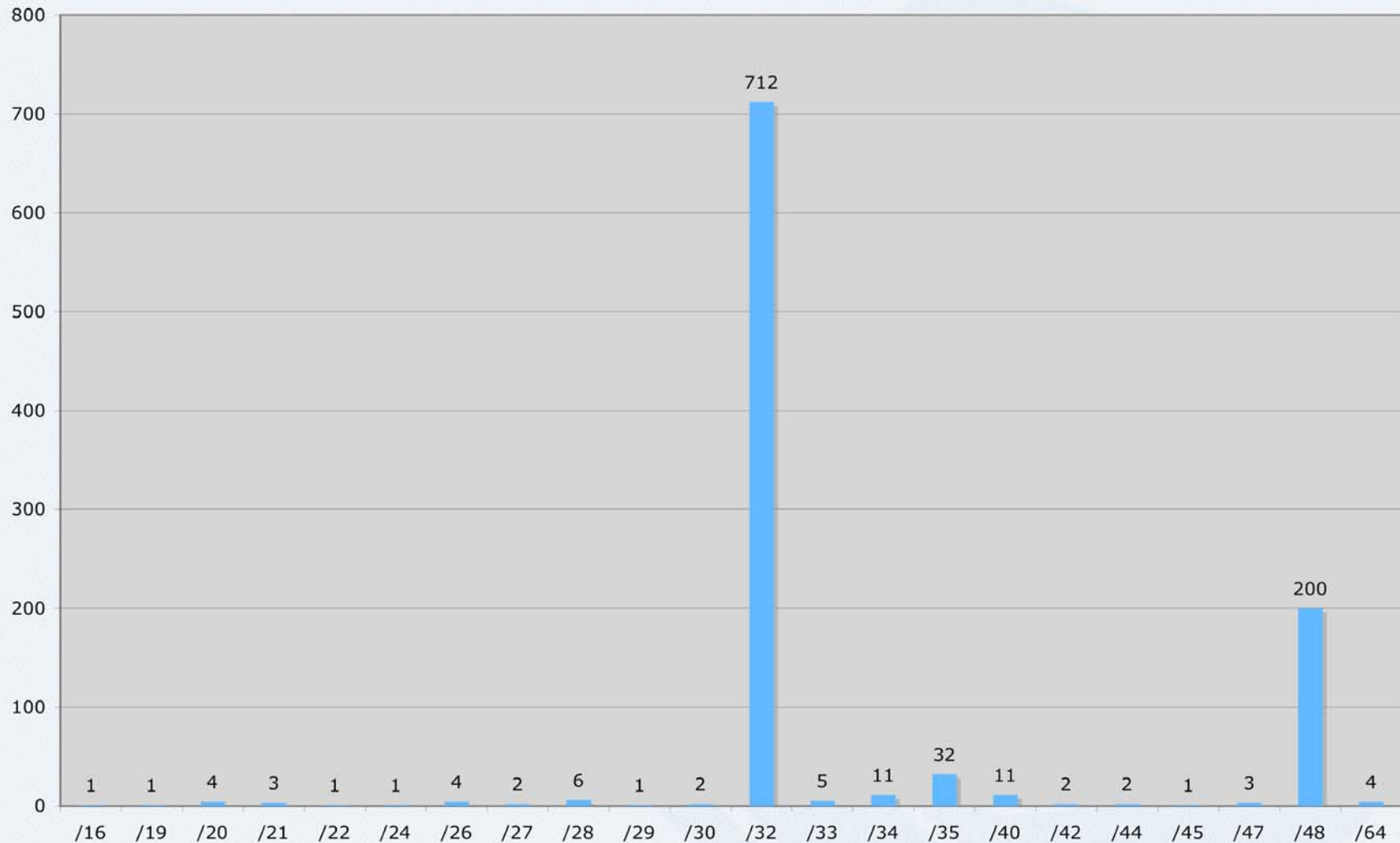# IPv6 global routing table - 2008

Data from APNIC Brisbane router on 13 Feb 2008

IPv6 transit exchange

- APNIC facilitated service
  - Research and development effort
  - Support IPv6 deployments in Asia Pacific
    - Awareness and understanding of IPv6 networks
  - Continue to run as long as the participants require
  - Advertise and negotiate peers for 2byte & 4byte ASNs
  - Is an MPLA style service. Will re-advertise all routes presented to us

IPv6 transit exchange…cont.

- Joining the APNIC IPv6 transit exchange
  - Email the following details to peering@apnic.net with the subject line "IPv6TE request"

✓ Organisation ✓ Contact name ✓ Contact email address ✓ Contact phone number	✓ IPv4 tunnel endpoint ✓ Md5 string (optional) ✓ AS number ✓ IPv6 prefixes

  - More information is at:
    http://icons.apnic.net

Thanks!

APNIC