IPv4 & IPv6 address allocation - What are all those numbers about?

"IPv6 for e-business"

Australia, March, 2007

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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, in-addr.arpa delegation
- Membership-based organisation
  - Established 1993
  - Non-profit, neutral and impartial

Not operations forum

Not standards development

Services provided by APNIC

- Internet resource distribution & registration
  - IP addresses (IPv4, IPv6), AS numbers, reverse DNS delegations
  - whois.apnic.net
- Training and education
  - IRME, DNS, Routing and IPv6 workshops, Spam & Security tutorials
    - Subsidised for members
- Regional networking
  - Participation and representation
  - IETF, ITU, APT, PITA, APEC, SANOG, ISOC, etc.
- Information dissemination
  - APNIC Meetings
  - Publications
    - Web and ftp site
    - Newsletters, global resource reports
  - Mailing lists (Open for all)
- Policy coordination
  - APNIC Open Policy Meetings
    - 2 per year
- Critical infrastructure services
  - Working with root operators (F, I, J, K, M)

IP addressing

What is an IP address?

- Internet identifier including information about how to reach a location
  - (via the Internet routing system)
  - IP = Internet Protocol
    - (A Protocol is “an agreed upon convention for communication”)
- Public infrastructure addresses
  - Every device must have an IP address
  - Every globally-reachable address is unique

IPv4 and IPv6 addresses

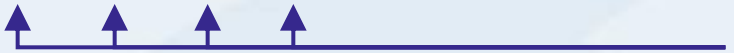
IPv4

- 32-bit* number (2^{32})

  Addresses available: ~4 billion

  Example:

202.12.29.142



4 fields

8 bits (256 combinations)

IPv6

- 128-bit* number (2^{128})

  Addresses available: 340 billion billion billion billion

  Example:

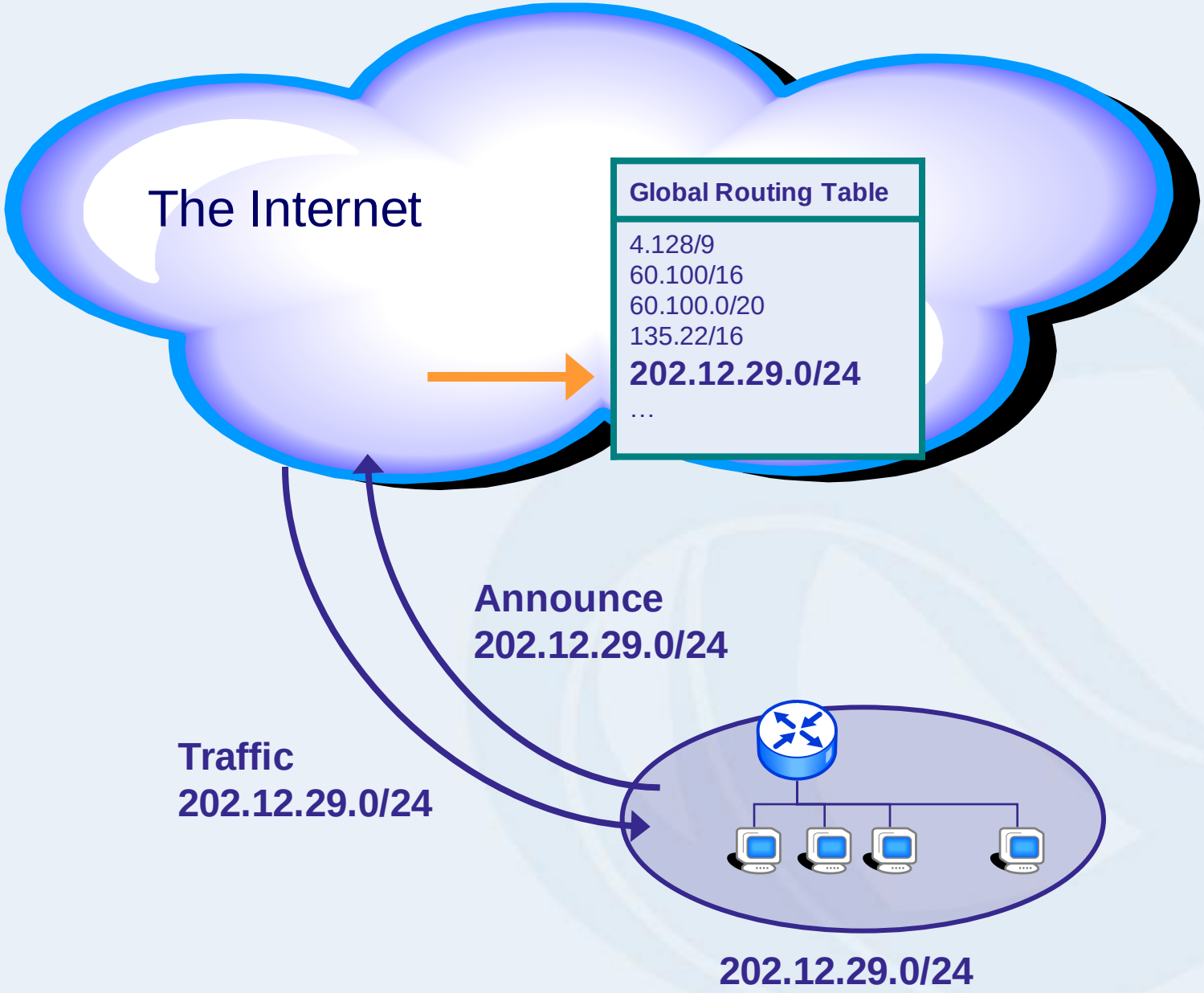
FE38:DCE3:124C:C1A2:BA03:6735:EF1C:683D

8 fields

16 bits (65 536 combinations)

* bit = binary digit

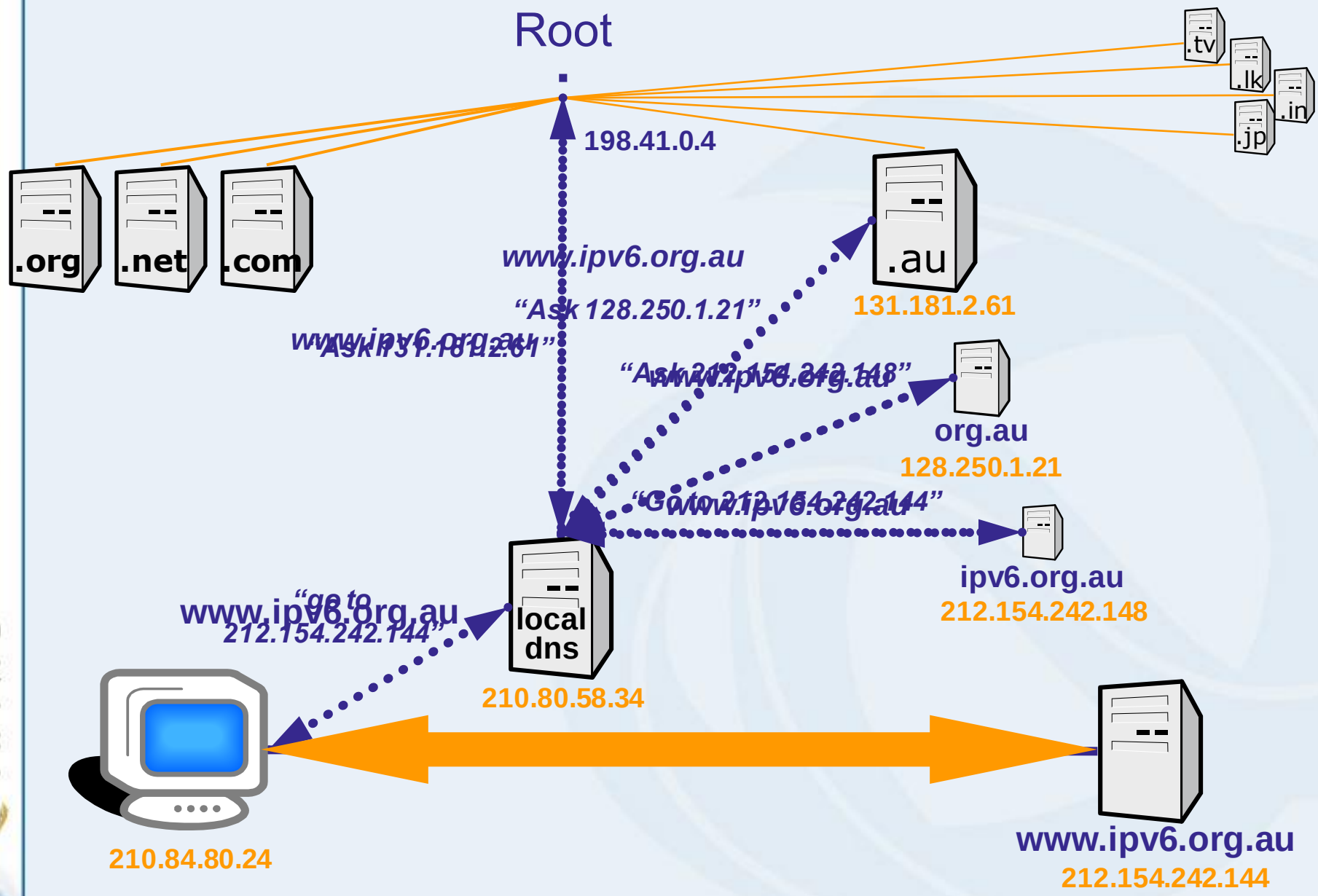
Internet address routing



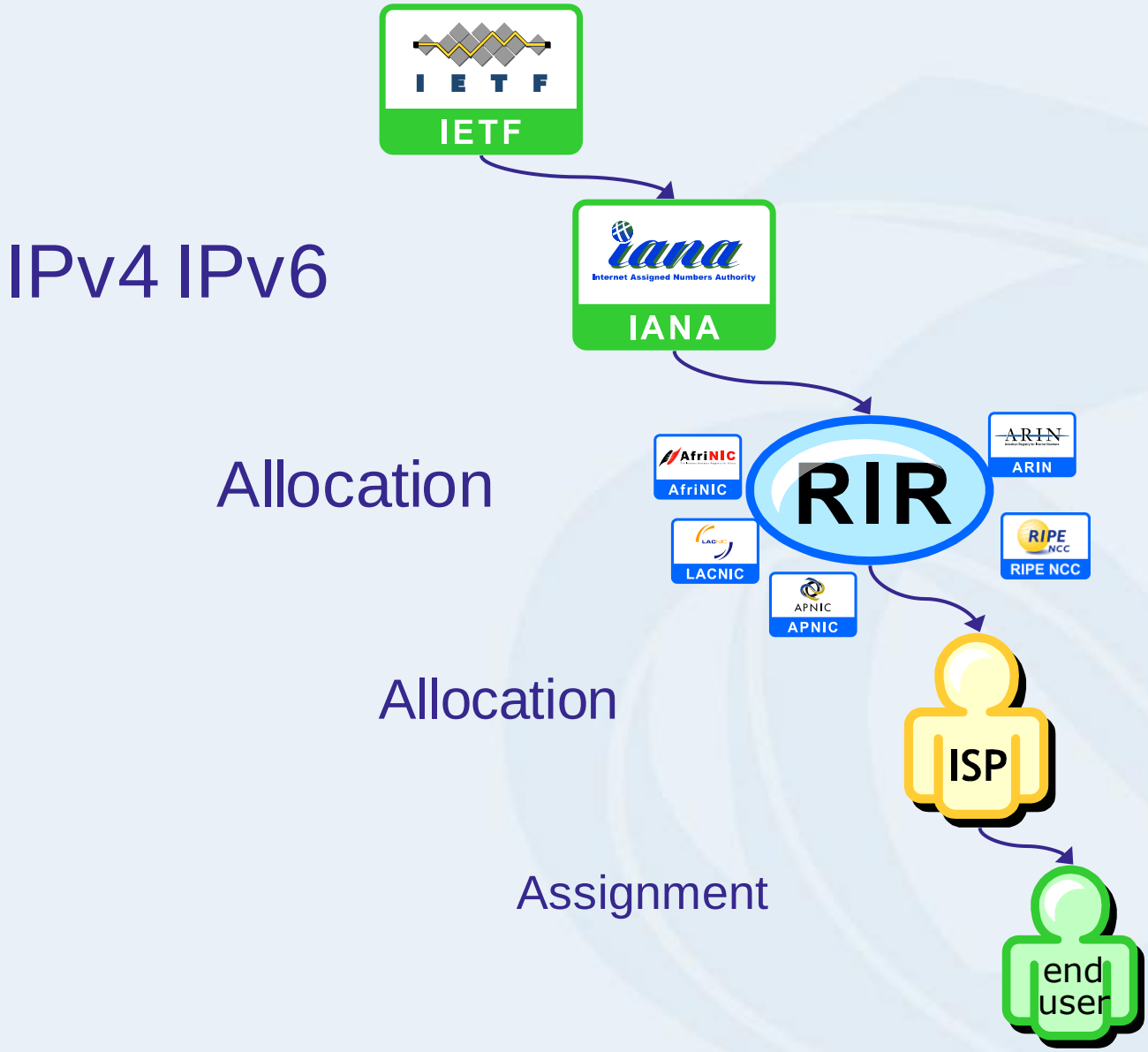
What is a domain name?

- Easy to remember (well, sort of) name for a computer or service
  - e.g. apnic.net, www.undp.org, www.ipv6.org.au
- Hierarchical structure providing distributed administration
- Not a proper (or useful!) directory service, but a basic mapping service
  - Technical feat is in distribution and scaling

Querying the DNS – It's all about IP!



Where do IP addresses come from?



What else is an IP address?

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

- IP does not mean “Intellectual Property”

Internet address management

Resource allocation and assignment

Allocation and Assignment

APNIC
Allocates
to APNIC Member

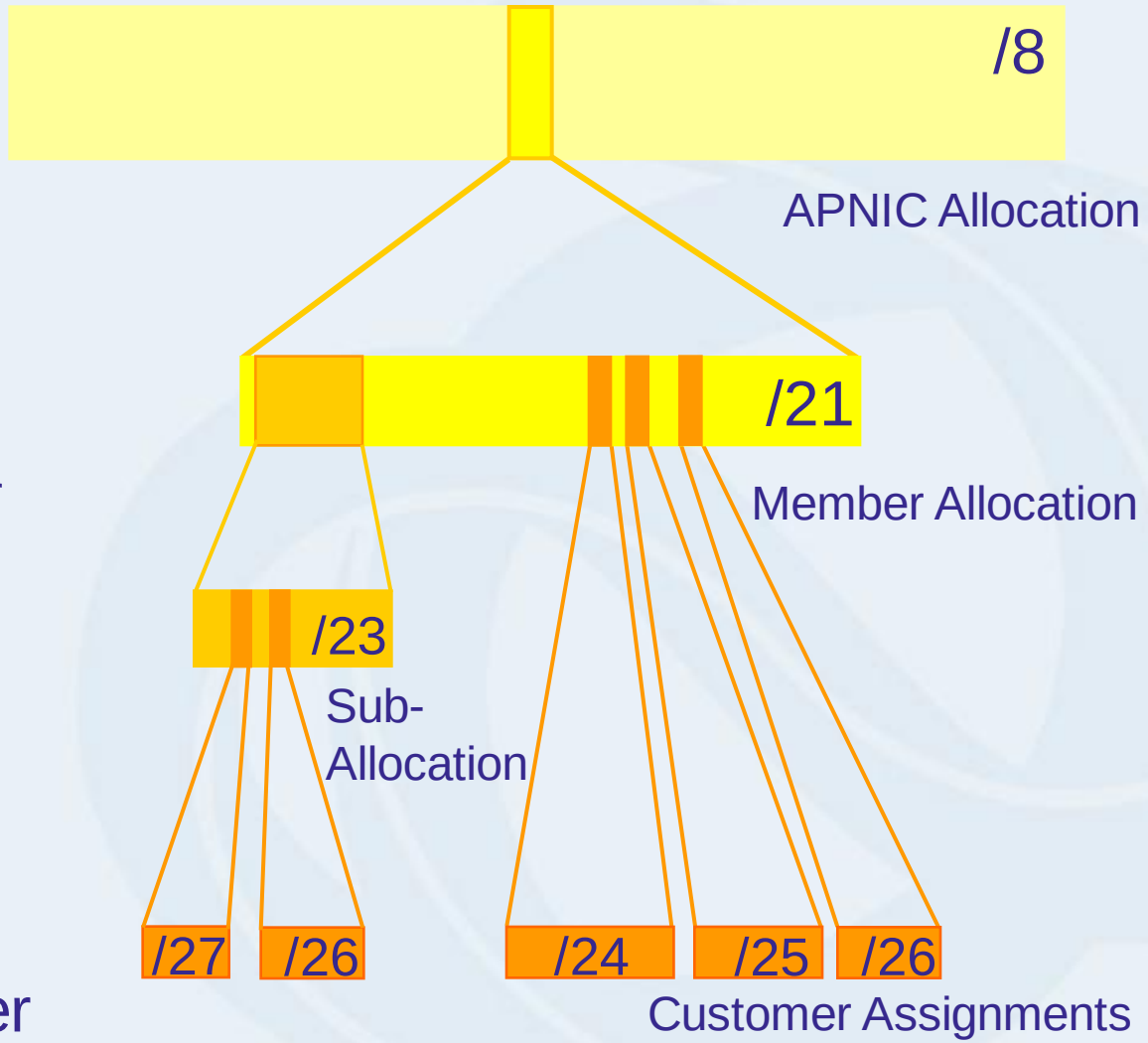
APNIC Member

Allocates
to downstream

Assigns
to end-user

Downstream
Assigns
to end-user

Customer / End User



Policy development

- Industry self-regulatory process
  - Policy is developed by the AP Internet community to suit needs of region
- Decisions made based on consensus
  - http://www.apnic.net/docs/policy/dev/
- Public meetings
  - http://www.apnic.net/meetings/
- Mailing lists
  - http://www.apnic.net/community/lists/

Address management objectives

Efficient use of resources

Based on demonstrated need

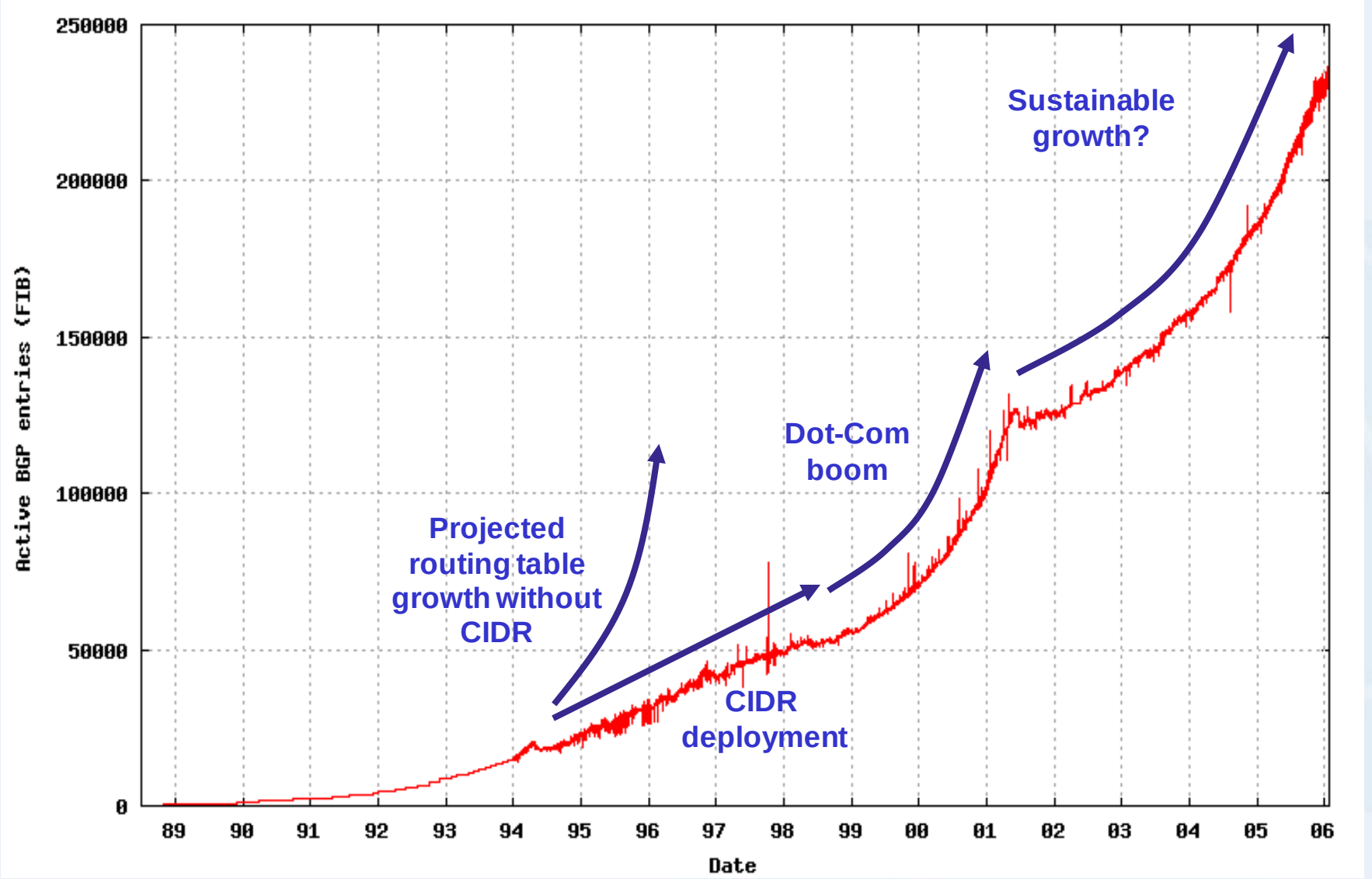
Limit routing table growth

Support provider-based routing

Ensure uniqueness

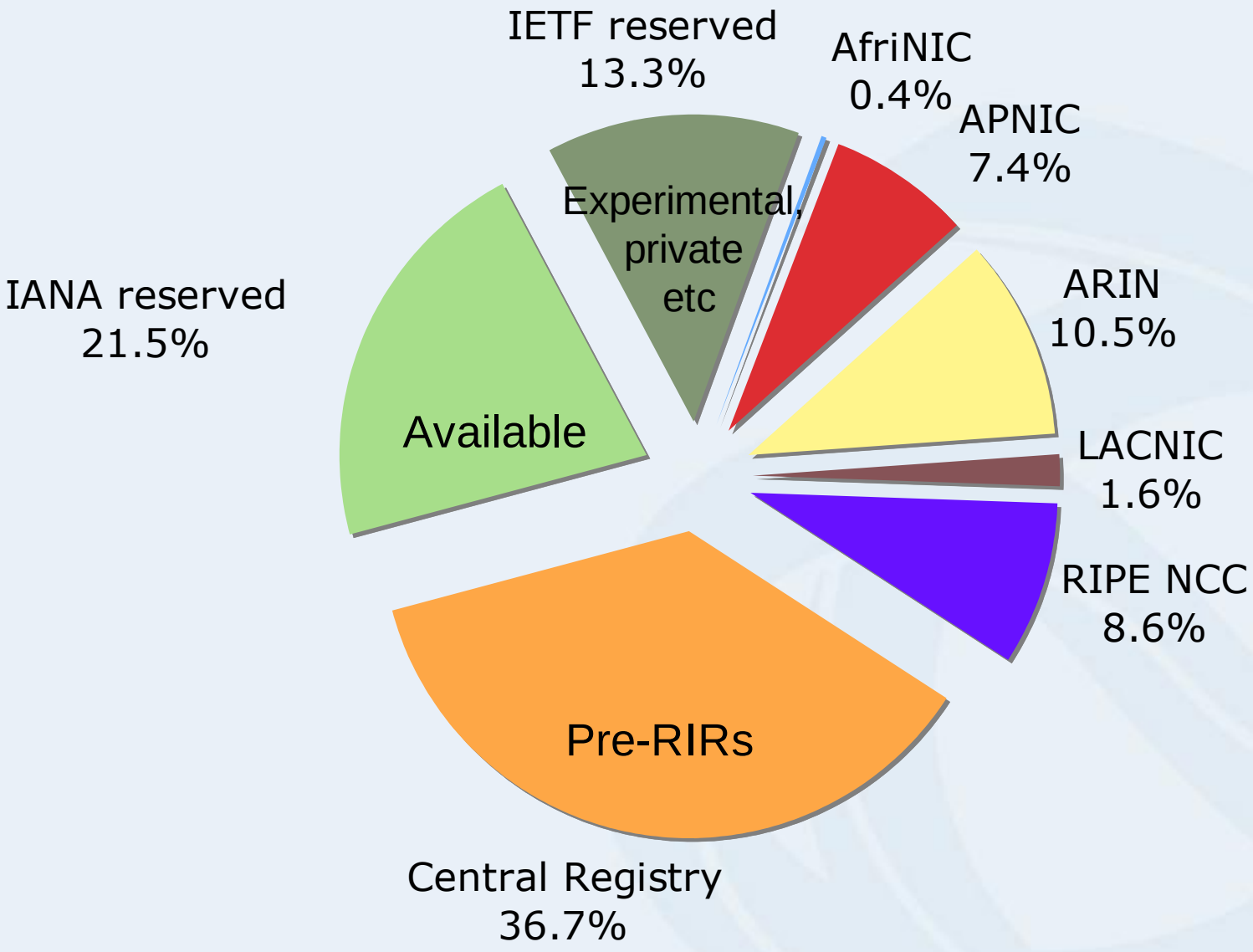
Facilitates troubleshooting

Growth of global routing table



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

Global IPv4 delegations



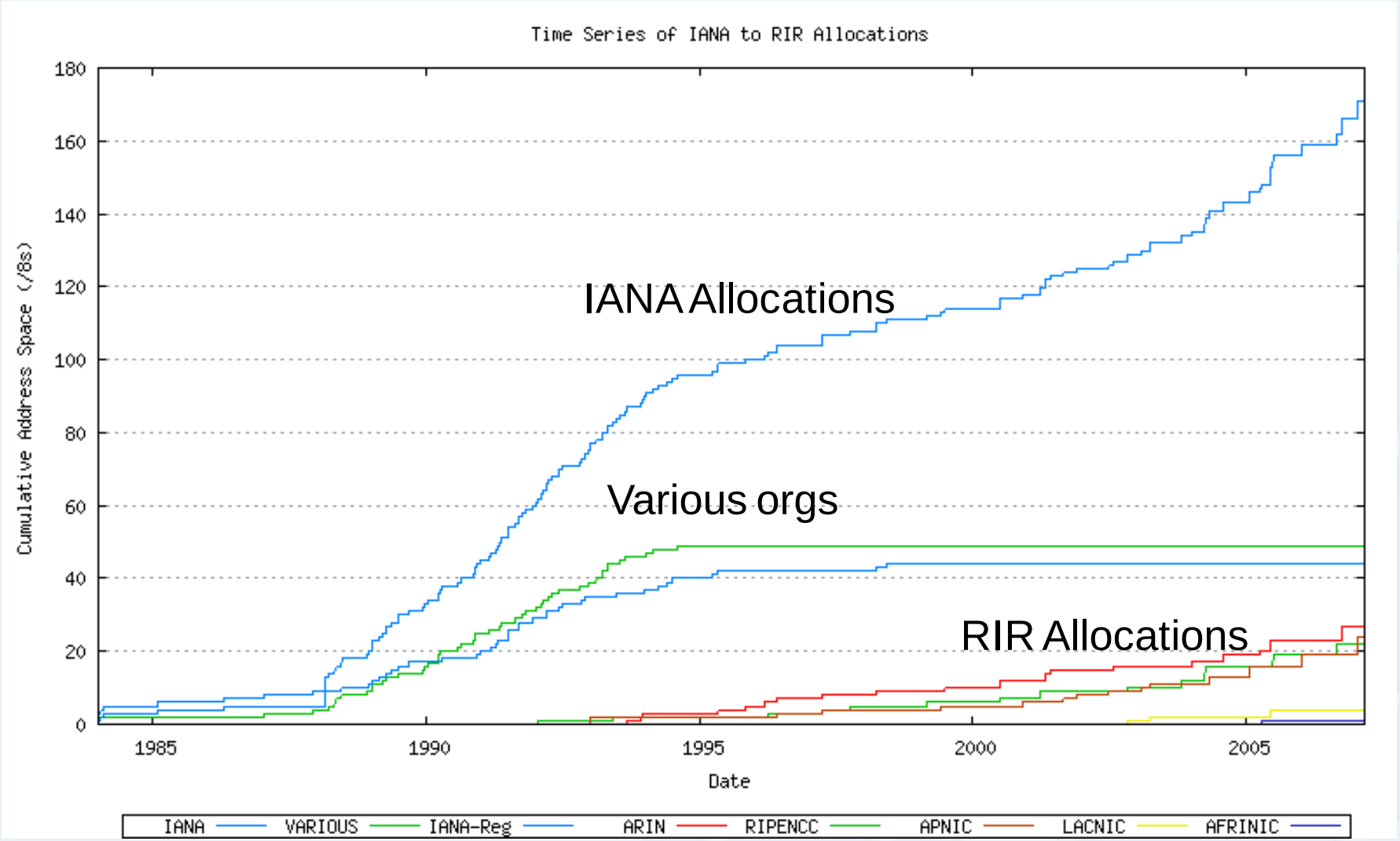
IPv4 Exhaustion

So, are we running out?

Studies in IPv4 exhaustion

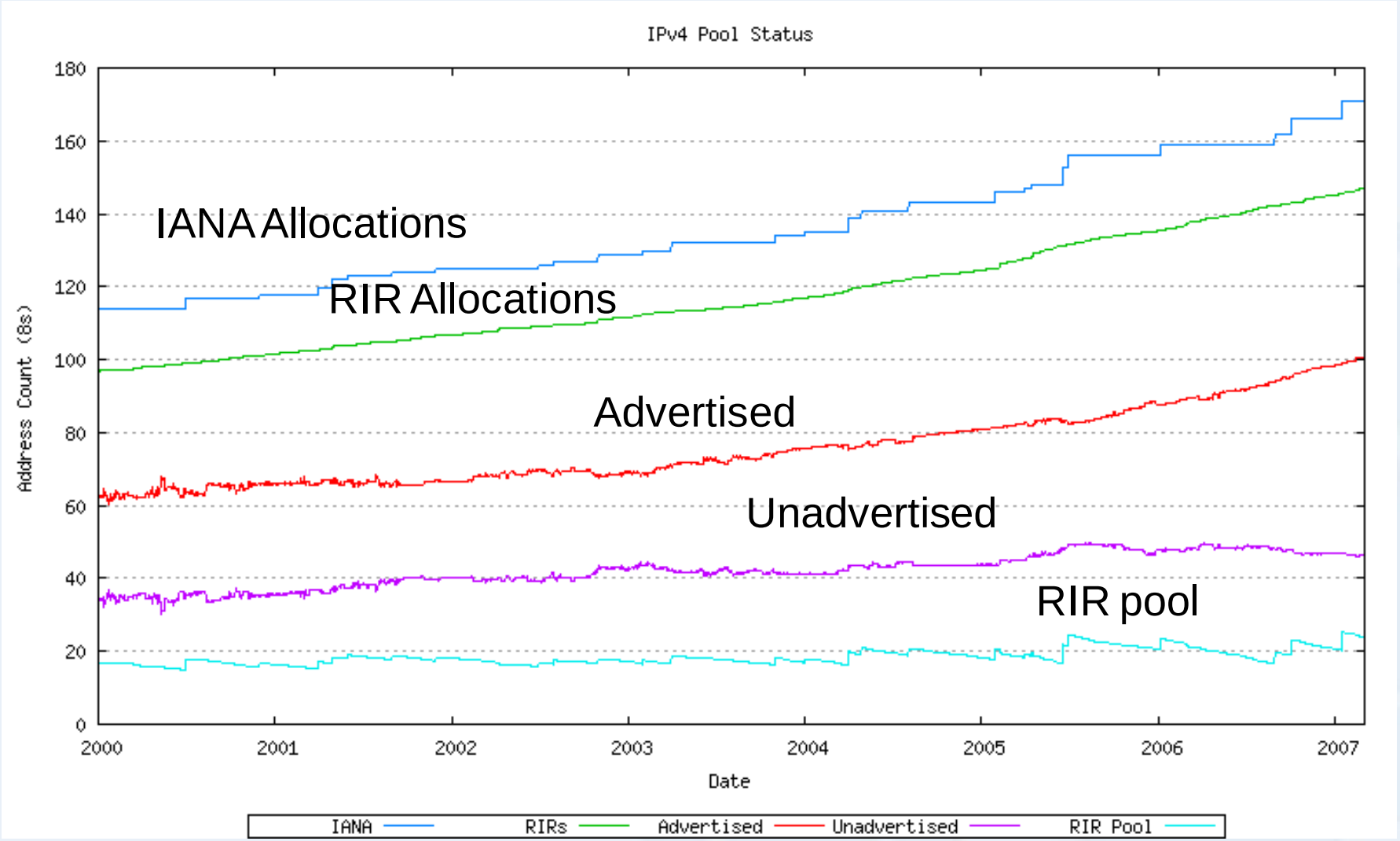
- All RIRs make their allocation publicly available
  - http://www.nro.net/statistics/
- Geoff Huston, chief scientist at APNIC, has studied the IPv4 allocation data
  - Projections based on current and past utilisation rates
  - Three sets of data analysed:
    - IANA allocations to RIRs (IANA IPv4 address registry)
      - Allocation of /8 blocks to RIRs and others
    - RIR allocations to ISPs (RIR statistics files)
      - Allocation of blocks to LIRs
    - ISP announcements (BGP routing table)
      - Amount of address space advertised

Data analysed - IPv4 allocations

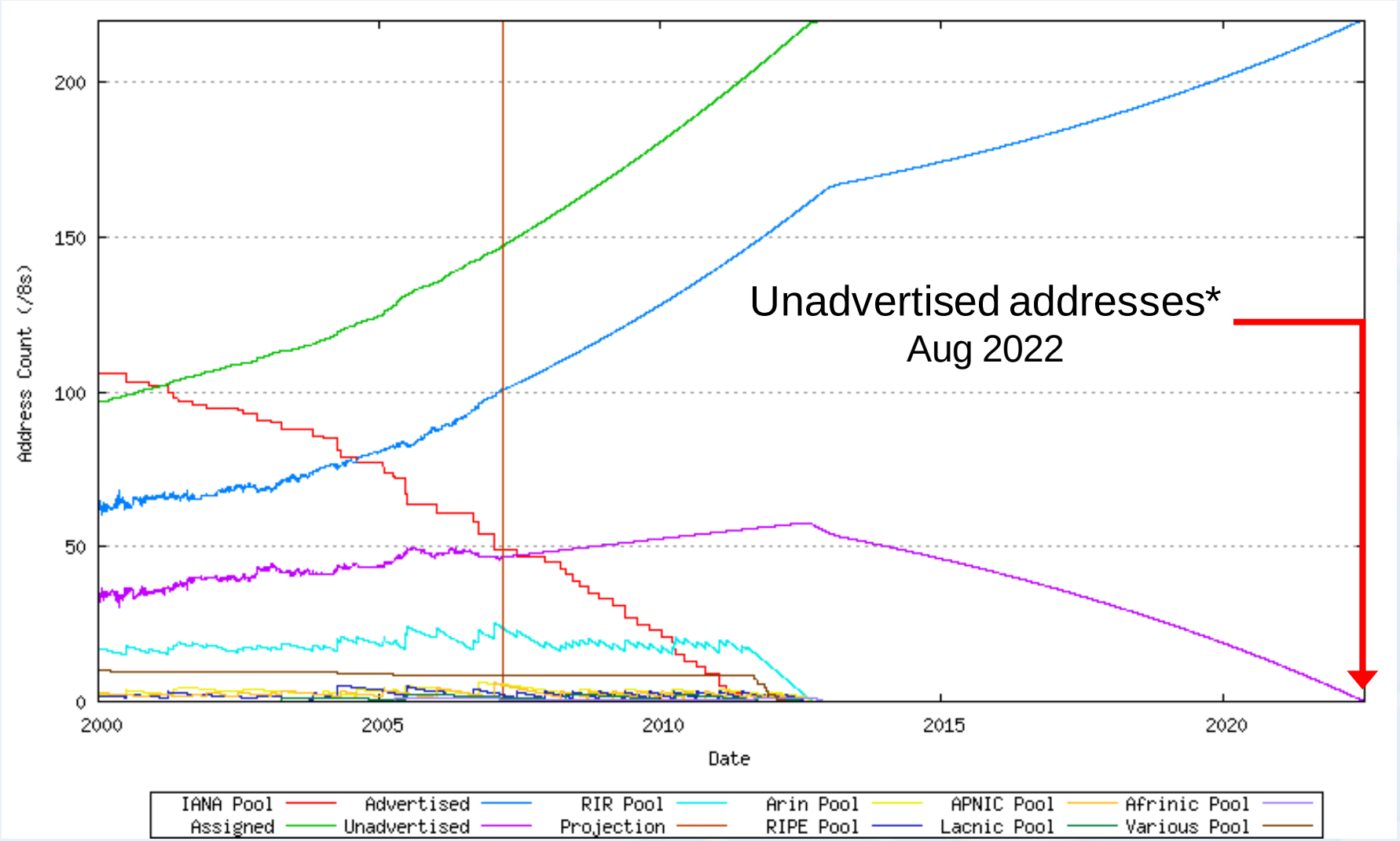


http://www.potaroo.net/tools/ipv4/

Data analysed - complete picture

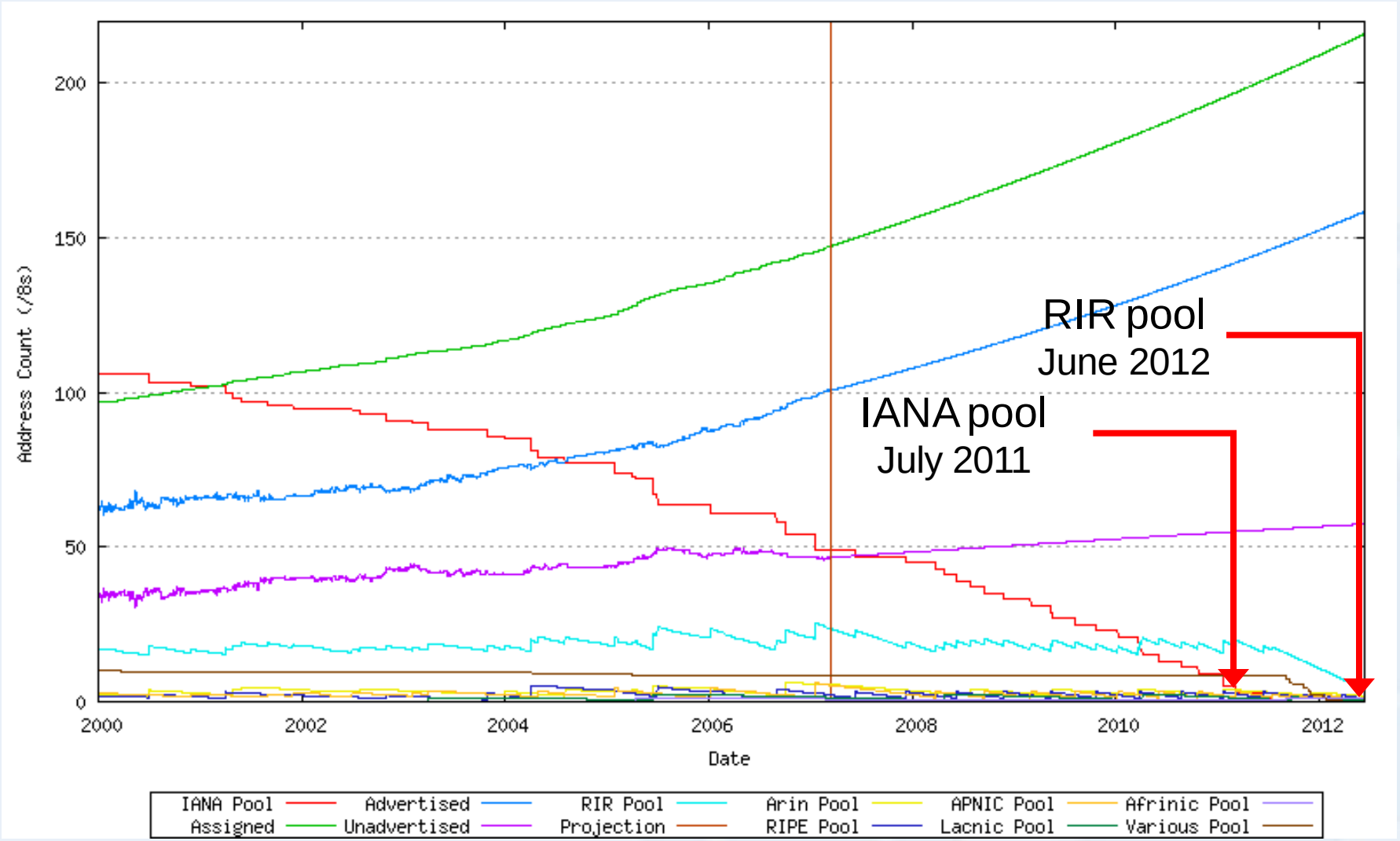


Projection - including all unused pools



*If all IPv4 addresses not in use would be reclaimed and re-allocated

Projection - RIR exhaustion point



As of 5 March 2007

When will we ‘exhaust” IPv4?

A. When will we stop routing IPv4 in our networks?
   - We will probably still route IPv4 for some decades to come

B. When will the RIRs have no more IPv4 addresses to distribute?
   - Sometime between 2010 and 2013

C. When will IANA have no more IPv4 addresses to pass to the RIRs
   - Sometime between 2009 and 2012

IPv4 exhaustion - conclusions

- We are **not** running out of IP addresses now
  - Projections gives us a few more years
    - No need for Denial, Panic, Anger, Blame shifting, Bargaining…
  - Impossible to predict future
    - Policies change
    - New technologies can emerge
    - Market behaviour can change
- IPv6
  - RIRs support the deployment of IPv6
    - IPv6 is available and ready
  - Transition will take time
  - Necessary to start now!

IPv6 address architecture

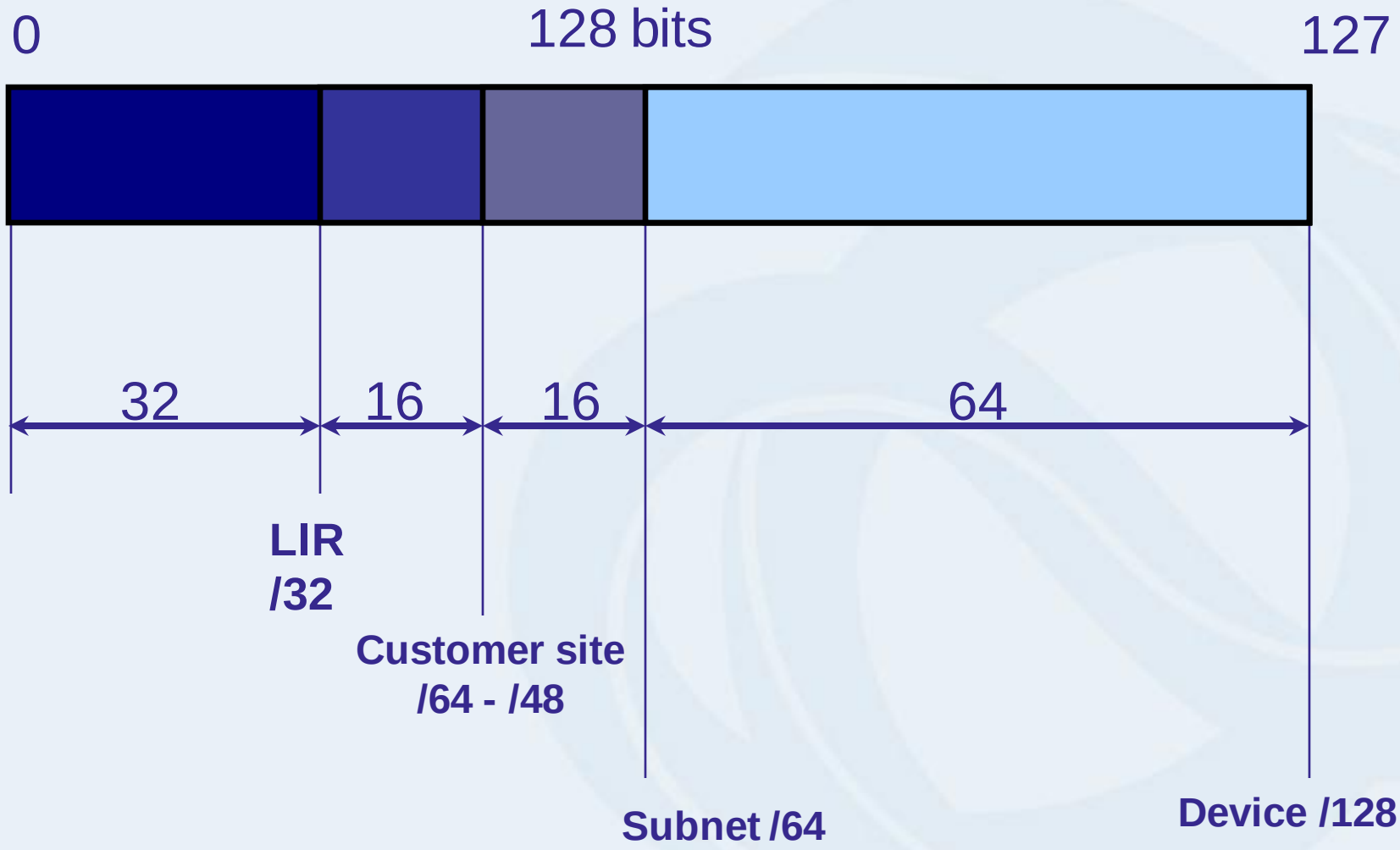
Rationale – why IPv6 was developed?

- Address depletion concerns
  - Squeeze on available addresses space
    - Probably will never run out, but will be harder to obtain
  - End to end connectivity no longer visible
    - Widespread use of NAT
  - IPv6 provides much larger IP address space than IPv4
- Increase of backbone routing table size
  - Current backbone routing table size > 230K
    - CIDR does not guarantee efficient and scalable hierarchy
    - Routing aggregation is still a concern in IPv6
  - IPv6 address architecture is more hierarchical than IPv4

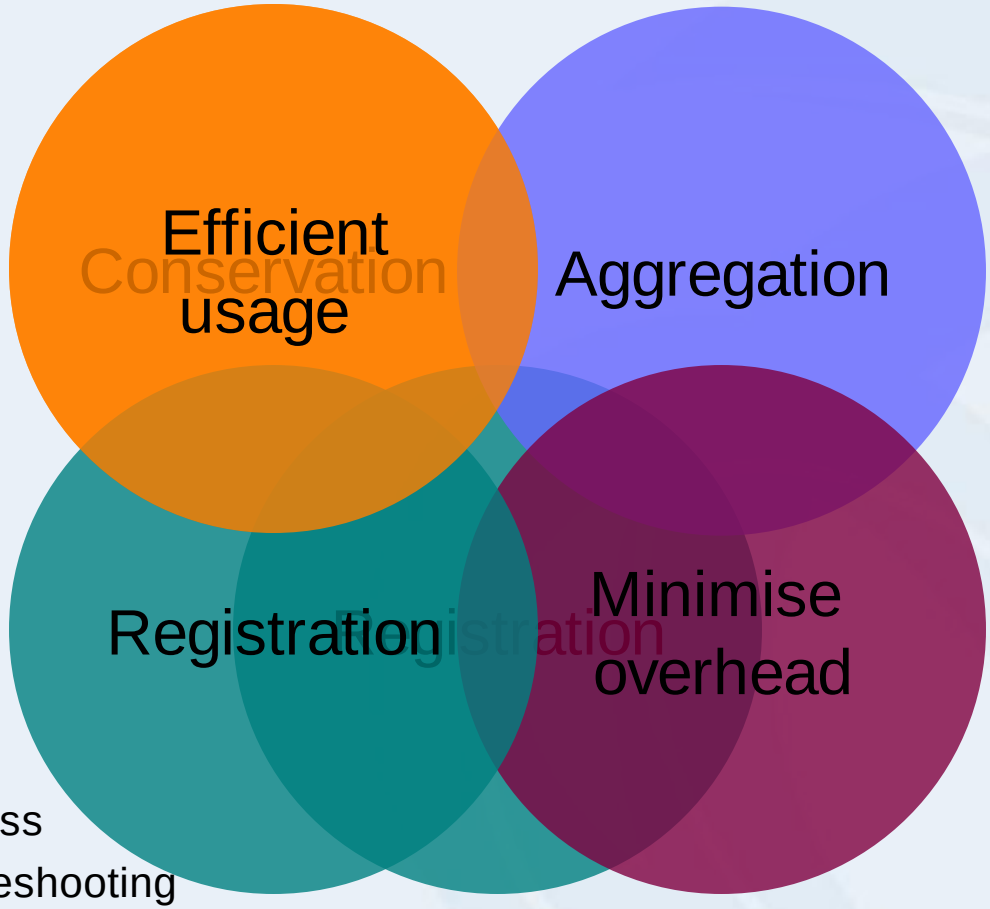
IPv6 addressing

- 128 bits of address space (2^{128})
  - Addresses available: 340 billion billion billion billion
- 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:
    - FE38:DCE3:124C:C1A2:BA03:6735:EF1C:683D
  - Abbreviated form of address
    - 4EED:0023:0000:0000:0000:036E:1250:2B00
    - →4EED:23:0:0:0:36E:1250:2B00
    - →4EED:23::36E:1250:2B00
    - (Null value can be used only once)

IPv6 addressing structure



Address management objectives



IPv6 initial allocation

- Initial allocation size is /32
  - End site assignments /64 - /48
    - (size is up to ISP)
- Initial allocation criteria
  - 'Plan' to connect 200 end sites within 2 years
  - Not be an end-site

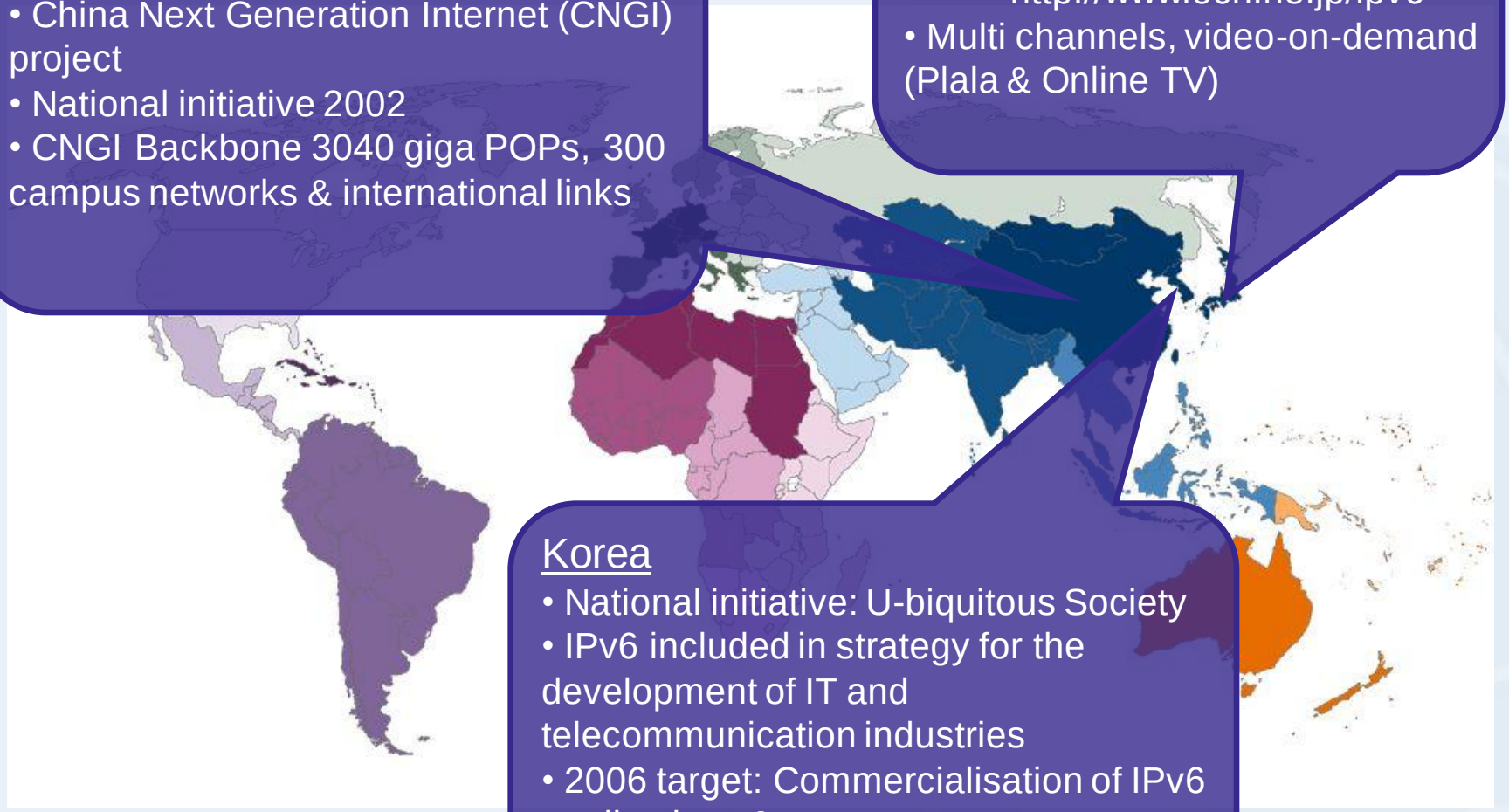
http://www.apnic.net/services/ipv6_guide.html

IPv6 portable assignment for multihoming

- New policy to allow IPv6 portable assignment to end-sites
  - Direct assignment to end site
  - Allows end user organisations to get an independent assignment
    - Size: /48, or a shorter prefix if the end site can justify it
    - To be multihomed within 3 months
  - To be implemented 9 March 2007

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

IPv6 deployment - Asia

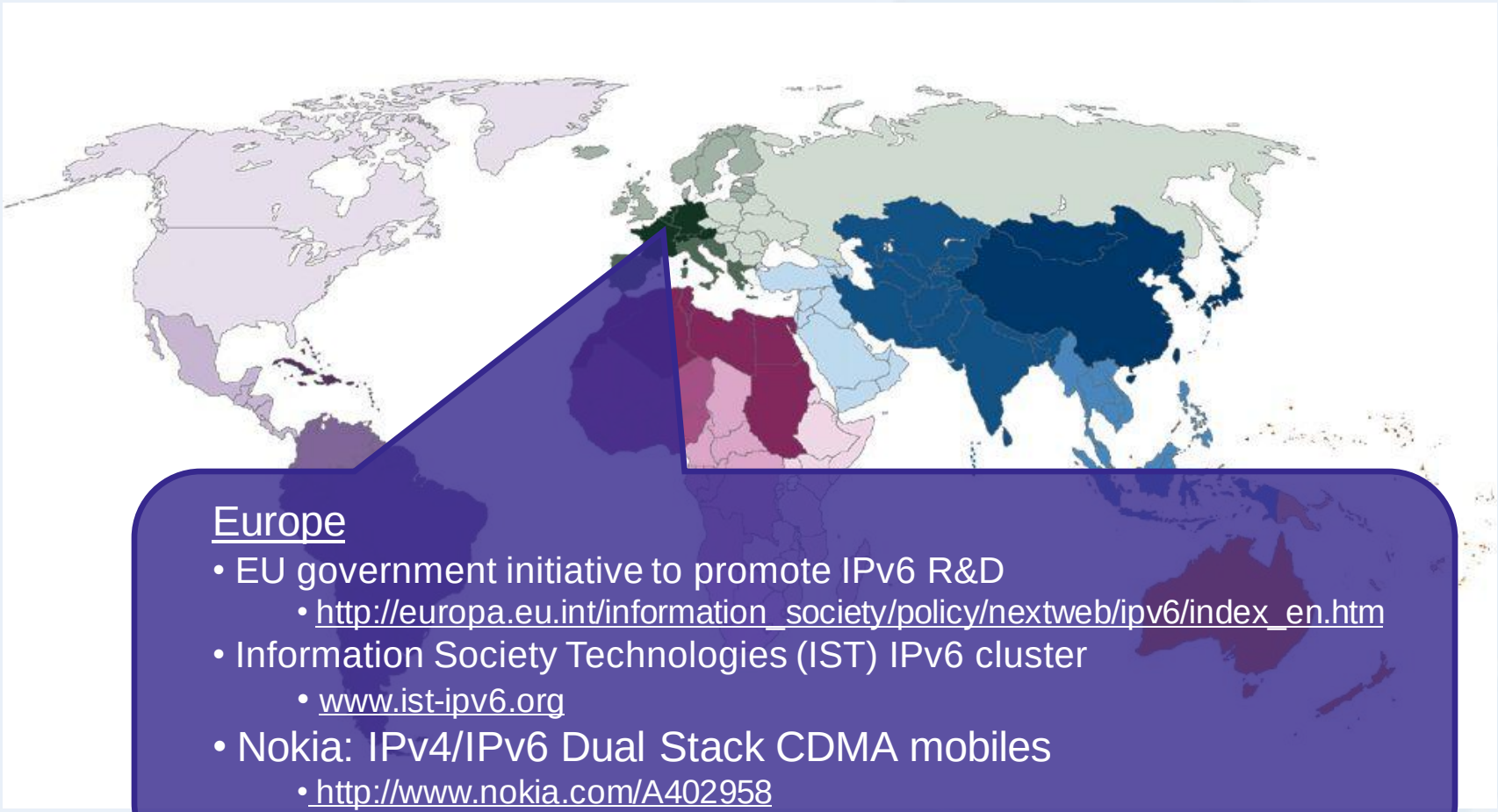


China
- China Next Generation Internet (CNGI) project
- National initiative 2002
- CNGI Backbone 3040 giga POPs, 300 campus networks & international links

Japan
- IPv6 in actual business services
- IPv6 connections to residential users via tunneling (NTT Communications)
  - http://www.ocn.ne.jp/ipv6
- Multi channels, video-on-demand (Plala & Online TV)

Korea
- National initiative: U-biquitous Society
- IPv6 included in strategy for the development of IT and telecommunication industries
- 2006 target: Commercialisation of IPv6 applications & content

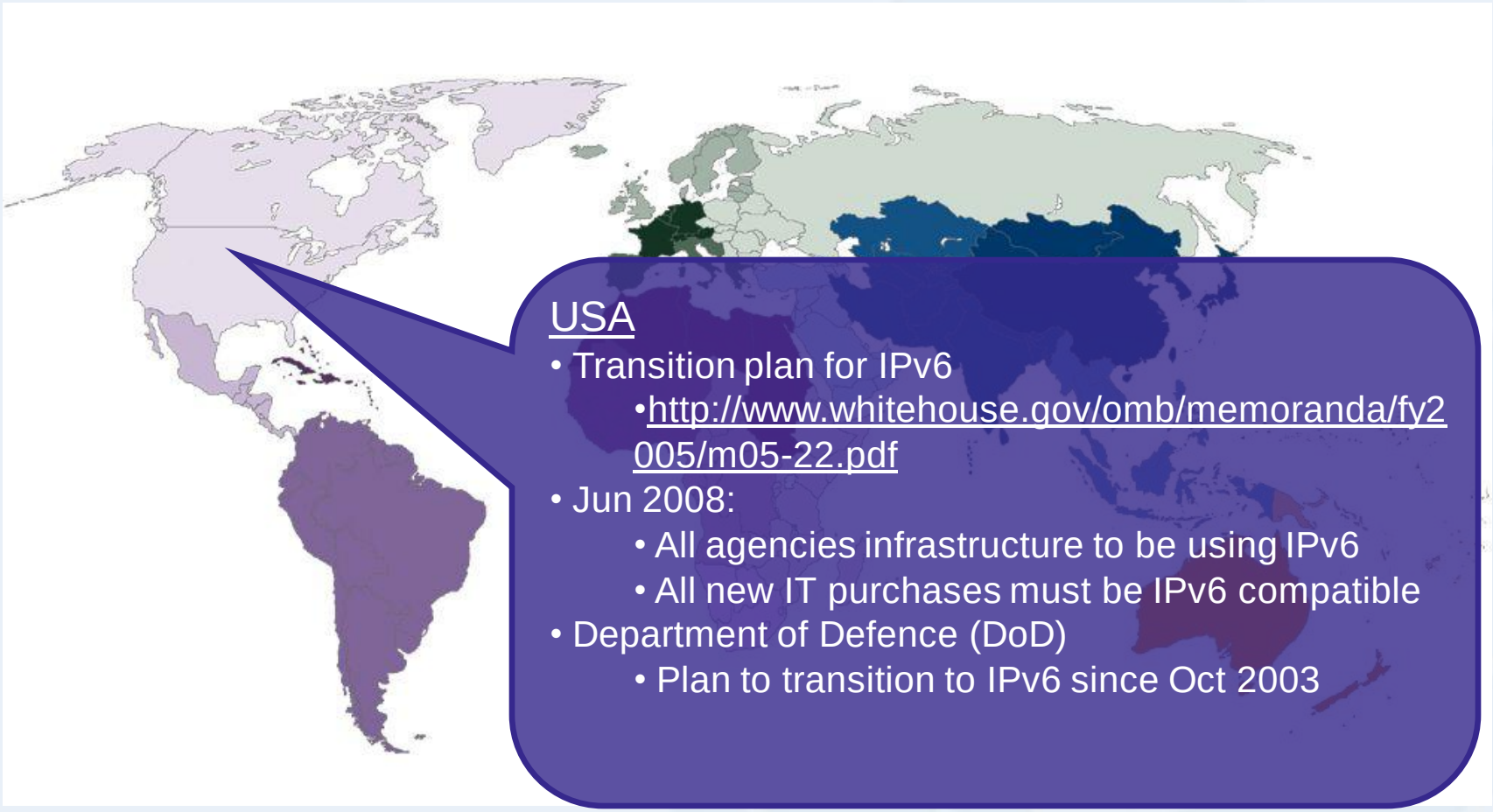
IPv6 deployment - Europe



Europe

- EU government initiative to promote IPv6 R&D
  - http://europa.eu.int/information_society/policy/nextweb/ipv6/index_en.htm
- Information Society Technologies (IST) IPv6 cluster
  - www.ist-ipv6.org
- Nokia: IPv4/IPv6 Dual Stack CDMA mobiles
  - http://www.nokia.com/A402958

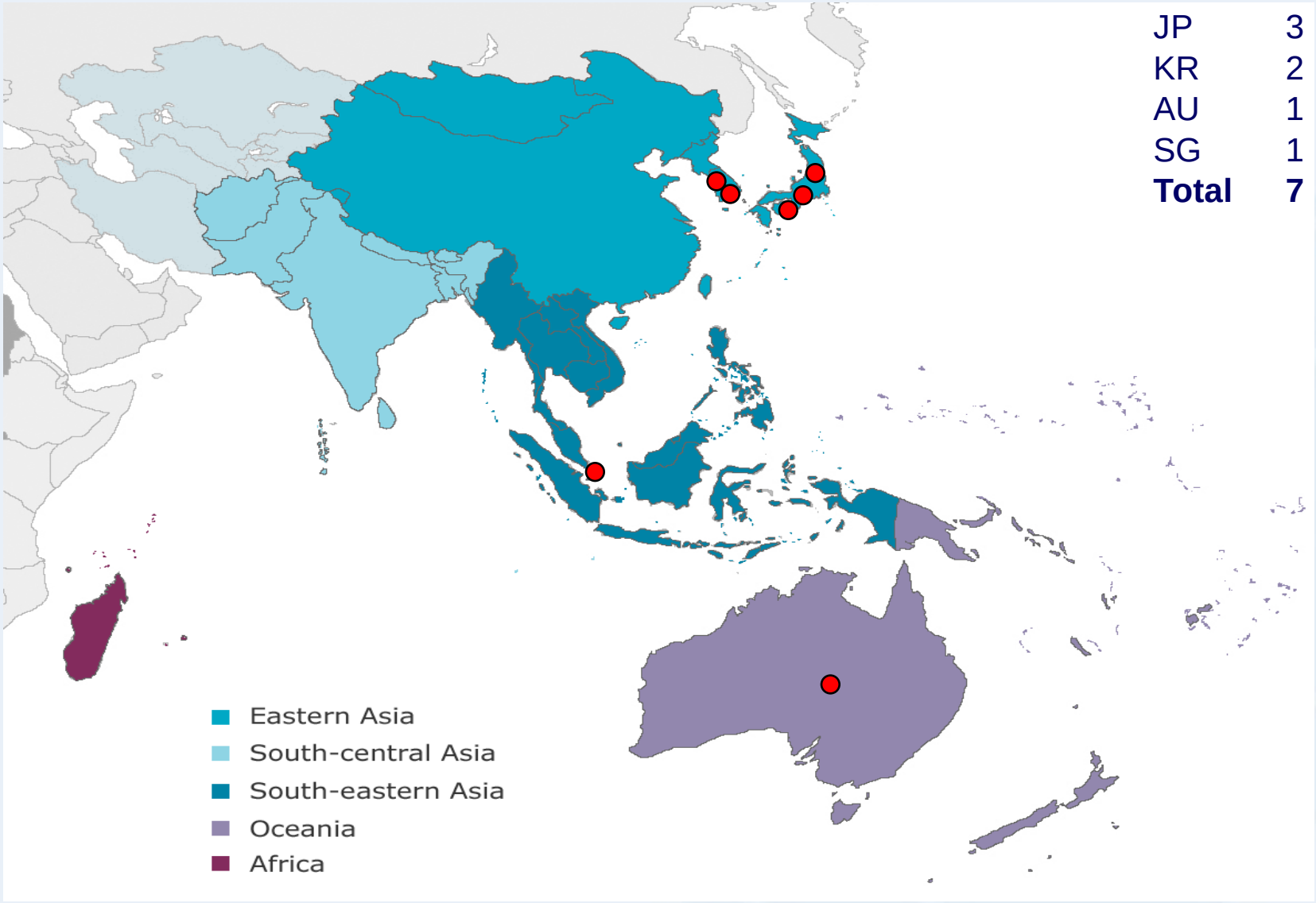
IPv6 deployment - USA



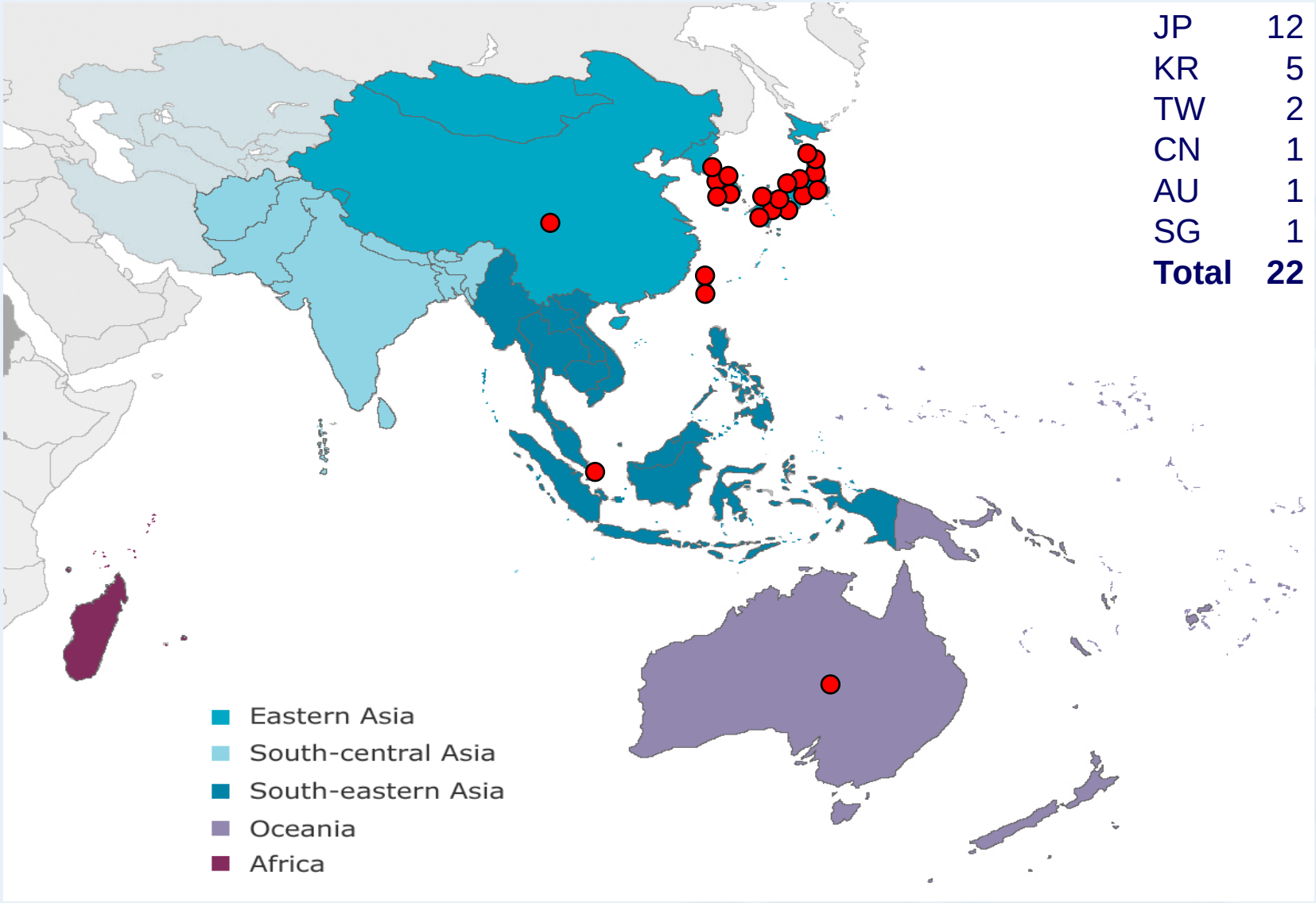
USA

- Transition plan for IPv6
  - http://www.whitehouse.gov/omb/memoranda/fy2005/m05-22.pdf
- Jun 2008:
  - All agencies infrastructure to be using IPv6
  - All new IT purchases must be IPv6 compatible
- Department of Defence (DoD)
  - Plan to transition to IPv6 since Oct 2003

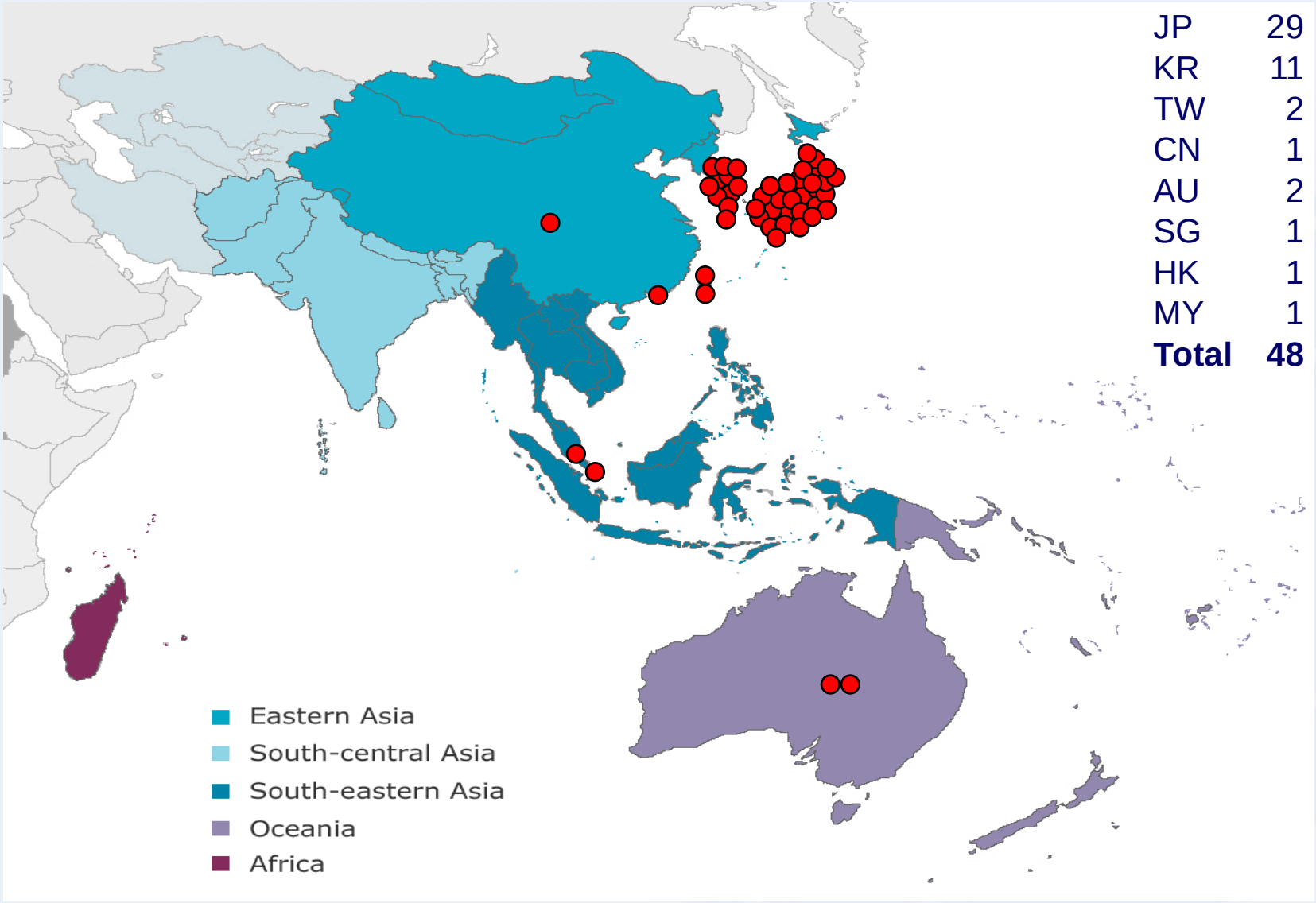
IPv6 Allocations in Asia Pacific 1999



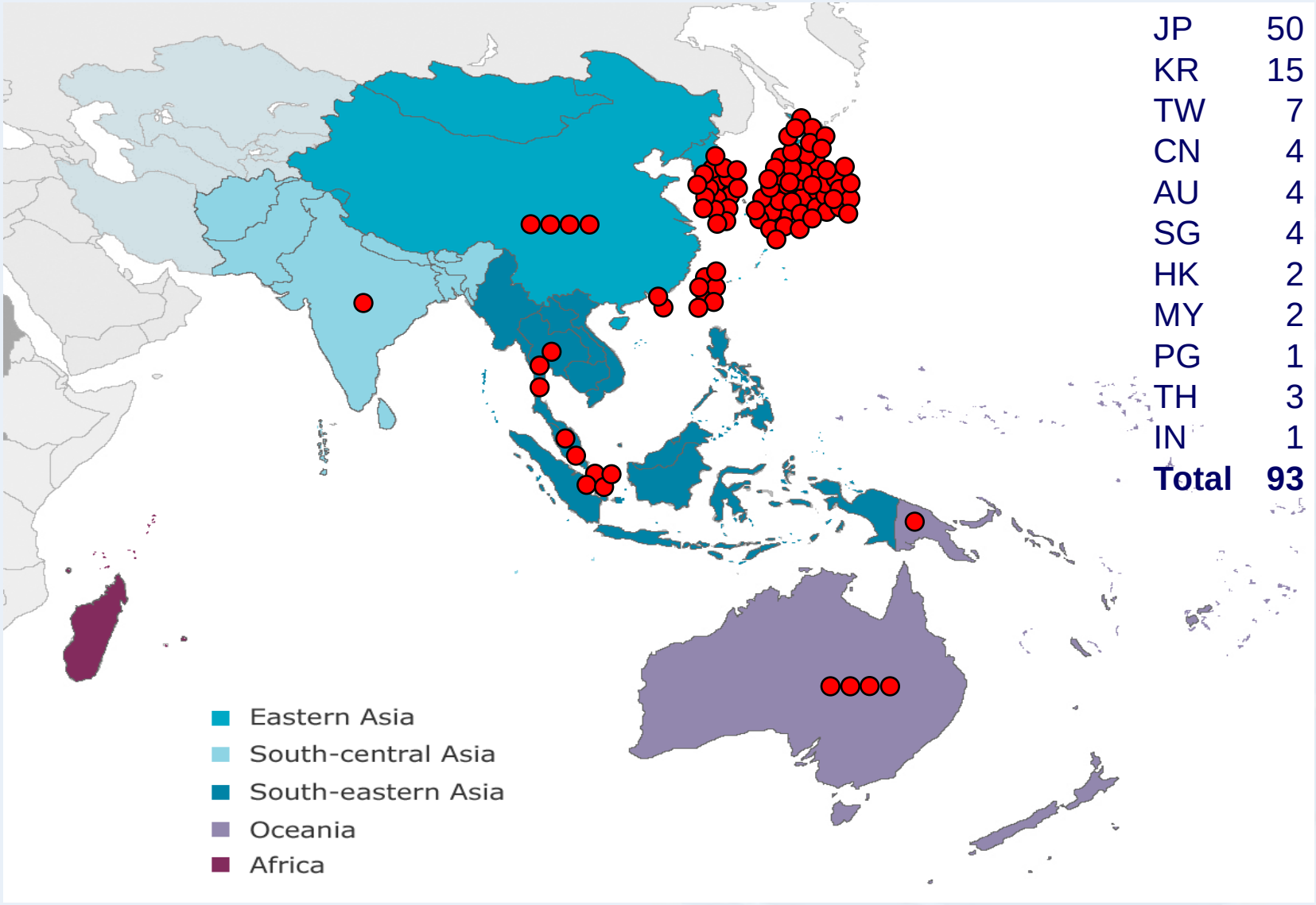
IPv6 Allocations in Asia Pacific 2000 **(cumulative total)**



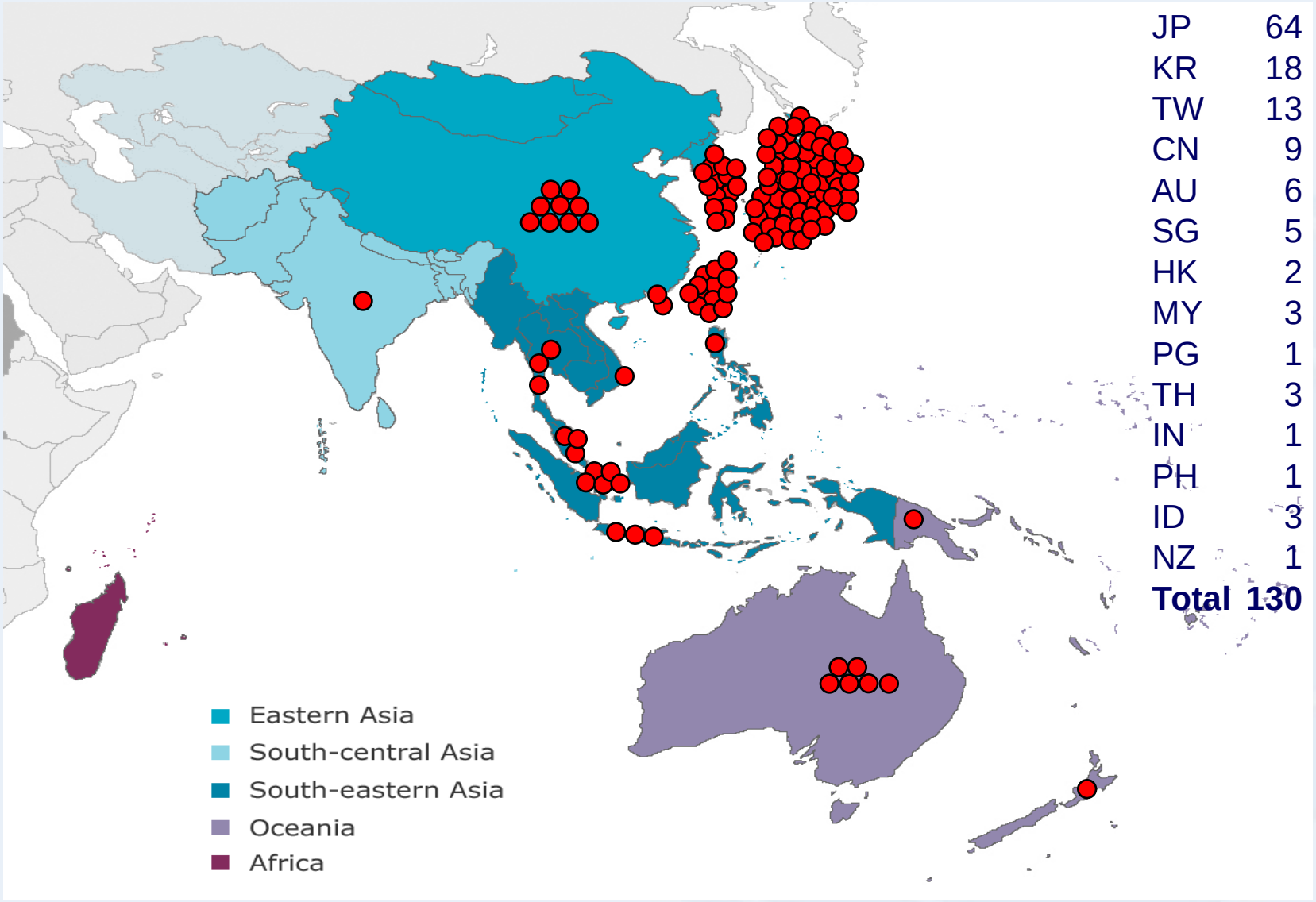
IPv6 Allocations in Asia Pacific 2001 **(cumulative total)**



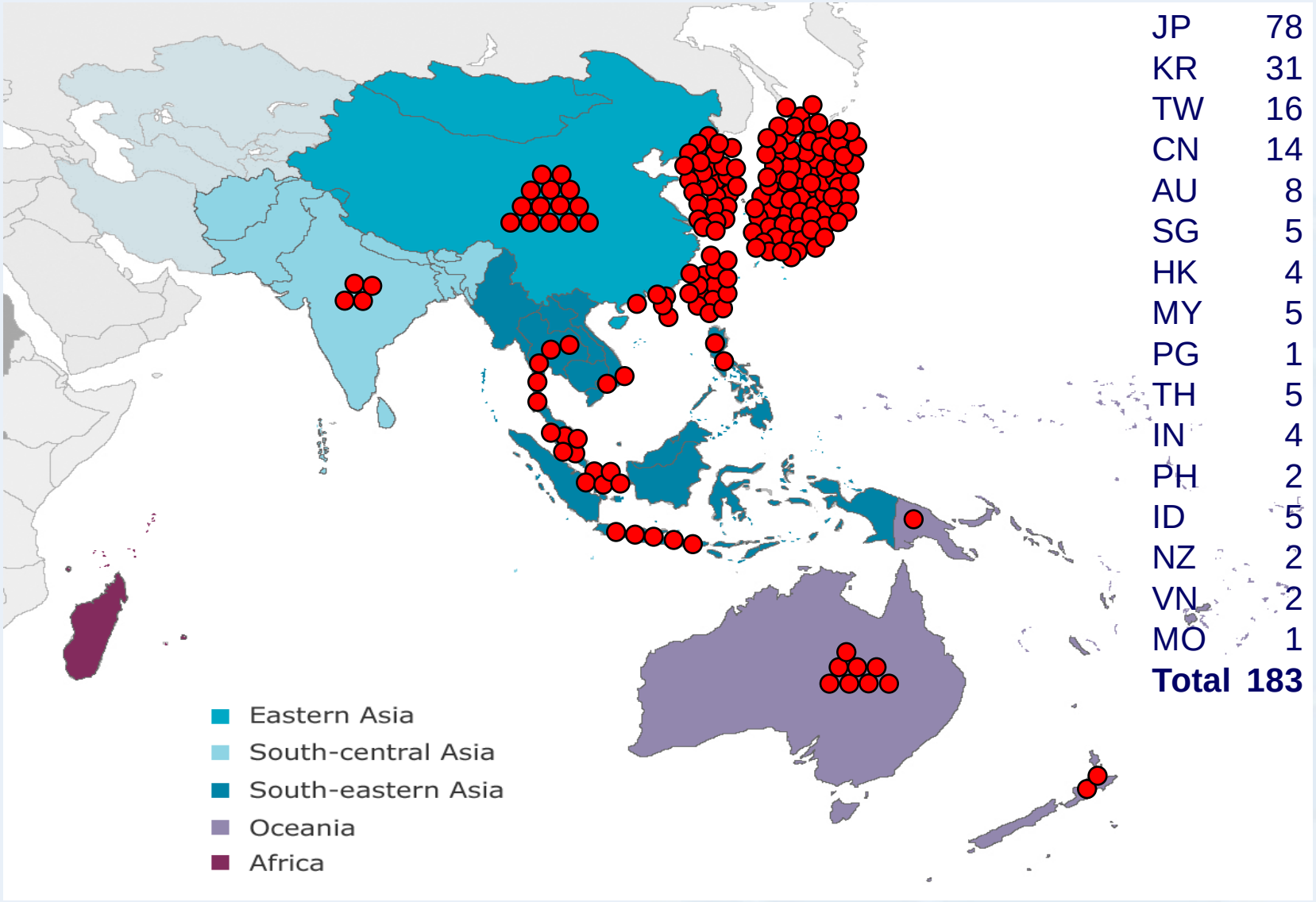
IPv6 Allocations in Asia Pacific 2002 **(cumulative total)**



IPv6 Allocations in Asia Pacific 2003
(cumulative total)

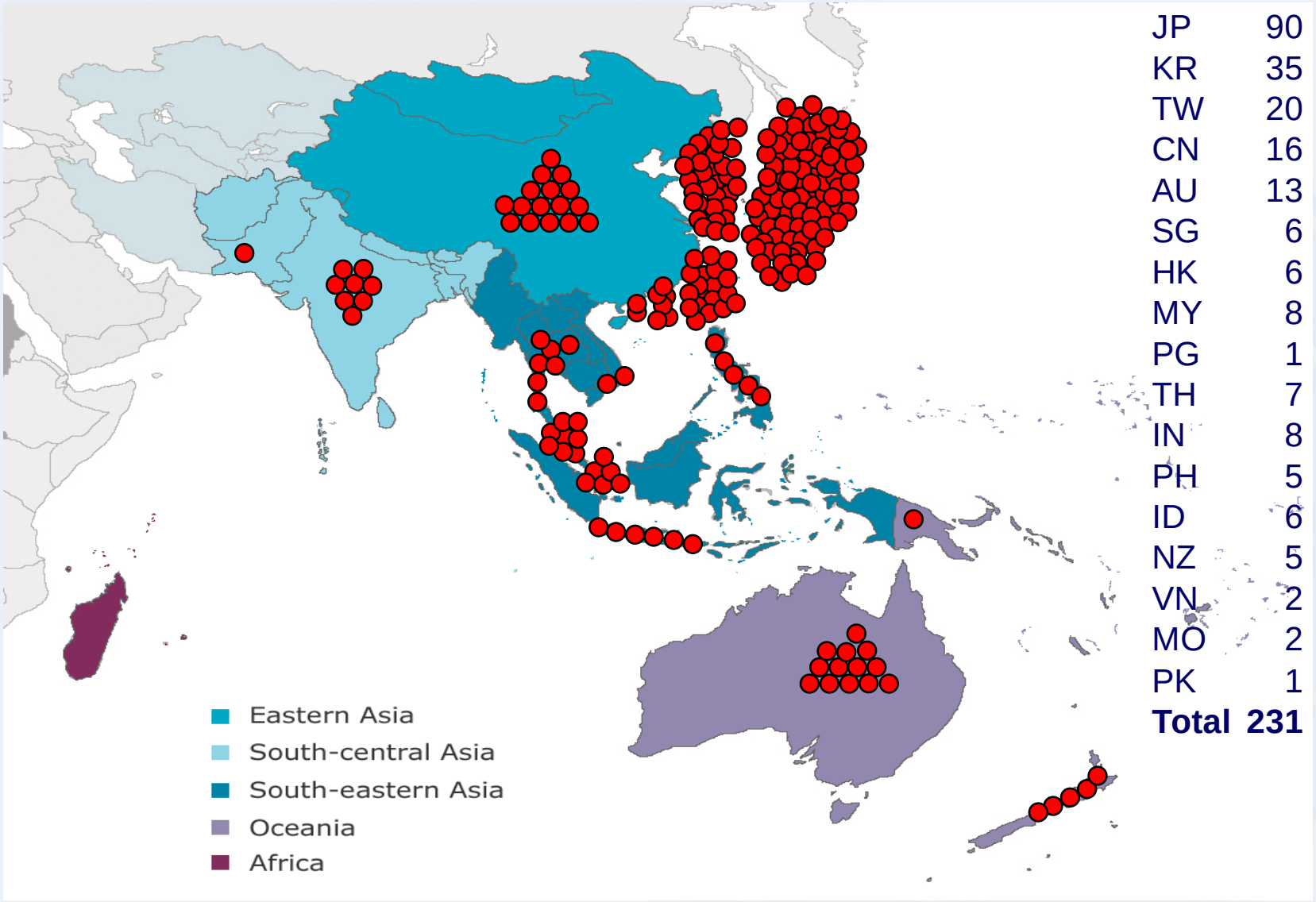


IPv6 Allocations in Asia Pacific 2004 **(cumulative total)**



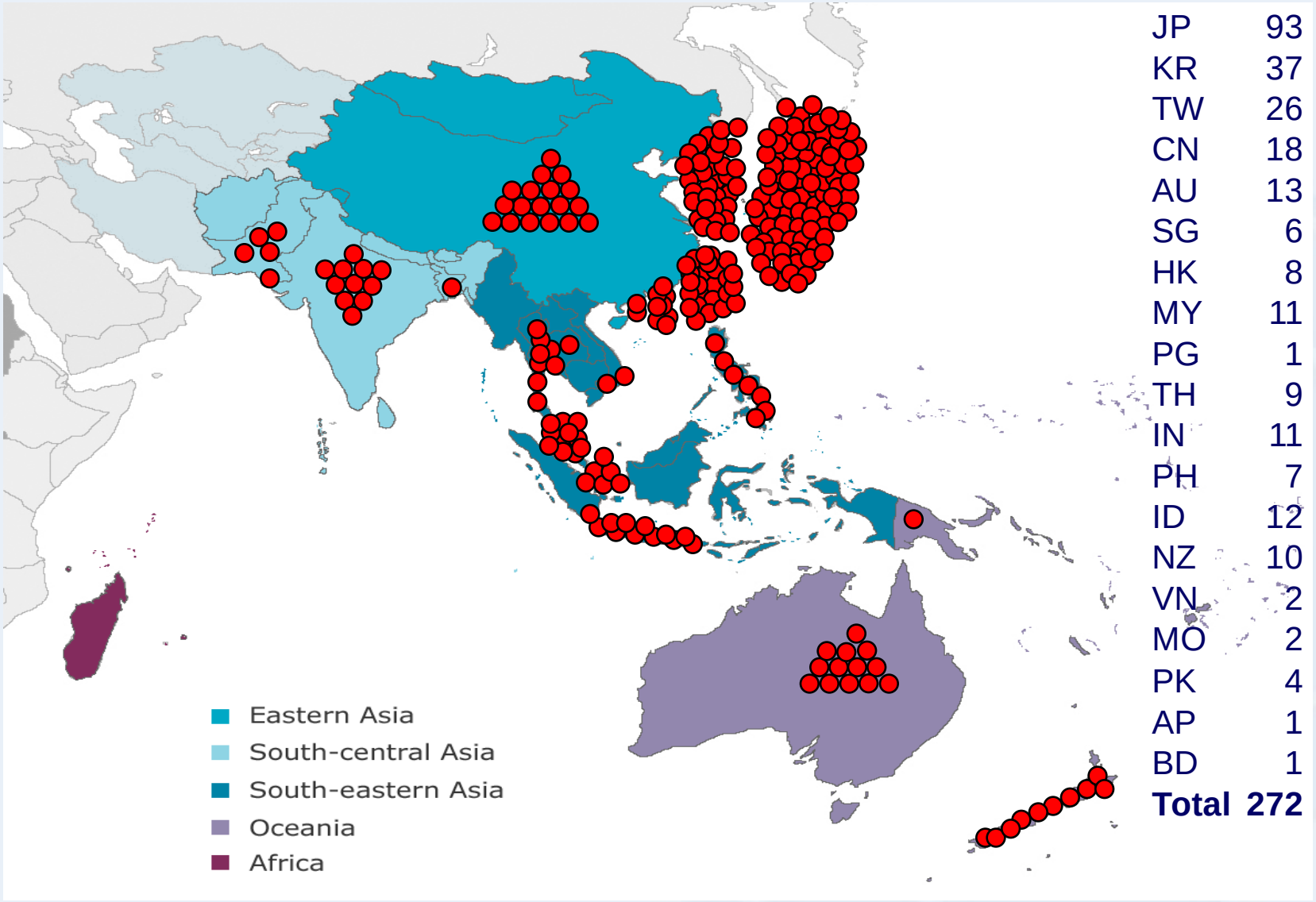
JP	78
KR	31
TW	16
CN	14
AU	8
SG	5
HK	4
MY	5
PG	1
TH	5
IN	4
PH	2
ID	5
NZ	2
VN	2
MO	1
Total	**183**

IPv6 Allocations in Asia Pacific 2005
(cumulative total)



JP	90
KR	35
TW	20
CN	16
AU	13
SG	6
HK	6
MY	8
PG	1
TH	7
IN	8
PH	5
ID	6
NZ	5
VN	2
MO	2
PK	1
Total	**231**

IPv6 Allocations in Asia Pacific 2006 **(cumulative total)**



JP	93
KR	37
TW	26
CN	18
AU	13
SG	6
HK	8
MY	11
PG	1
TH	9
IN	11
PH	7
ID	12
NZ	10
VN	2
MO	2
PK	4
AP	1
BD	1
Total	**272**

IPv6 - Internet for everything!

Thank you

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www.apnic.net

Material available at:
http://www.apnic.net/community/presentations/other.html