APNIC Internet Resource Management Seminar

- U Connect 2005 -

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Introduction

Presenters

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Overview

Introduction

- Introduction to APNIC
- What's IP?

The past

- The Internet in the beginning…
  - Early address distribution models
  - Problems of the past

The present

- The Internet Today
- The RIR system & APNIC
  - Classless addressing
  - Address management
    - Policy development
  - Problems and challenges

The Future

- The Internet in the Future
- IPv6

Who are You?

- Regulator?
- ISP?
  Government?
- Technical?
- Administrative?
- APNIC member?
- New to APNIC?

?

Asia Pacific Network Information Centre

APNIC

Introduction to APNIC

Asia Pacific Network Information Centre

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

APNIC mission statement

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

Internet Resources

- Internet resources are
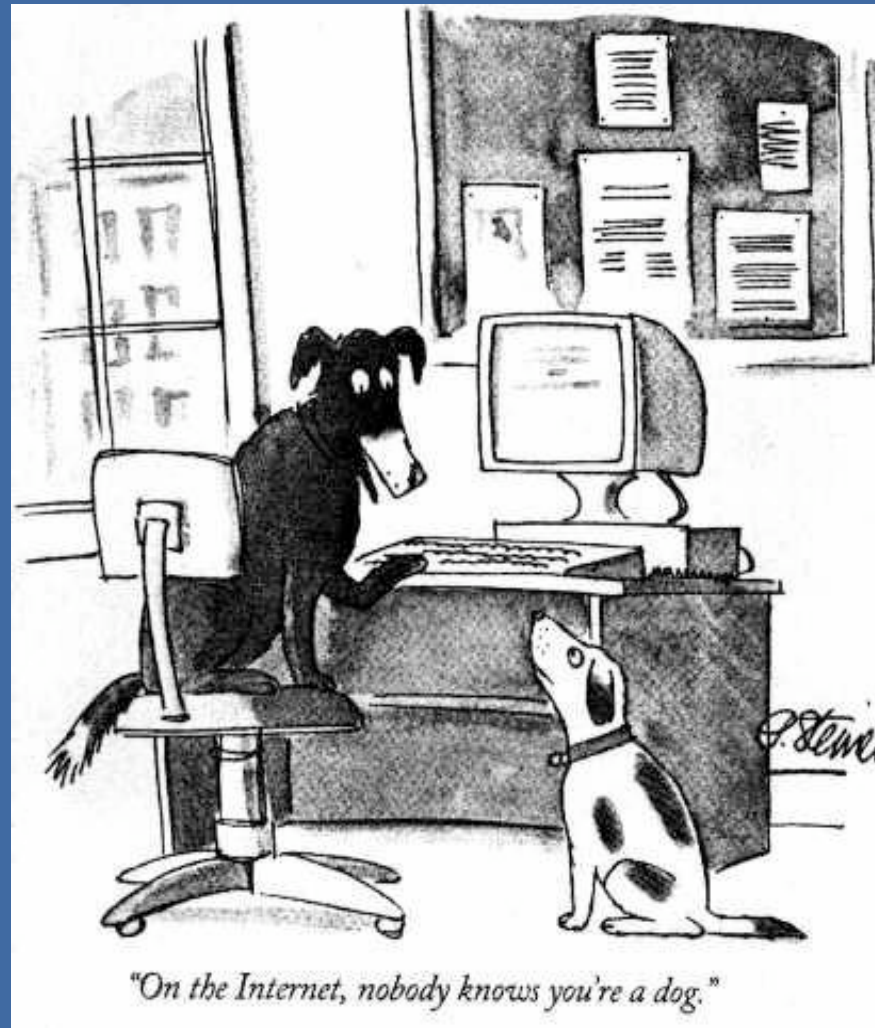 - IP addresses
  - AS numbers

- But what are IP addresses…?

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Internet Protocol Addresses

*What are they like and
how are the managed?*

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"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)
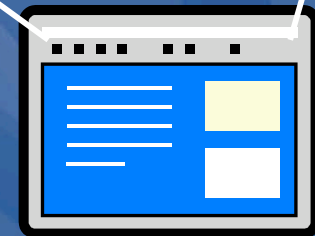
What is an Address?

- 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…

www.apnic.net

APNIC
Level 1, 33 Park Rd
Milton, Brisbane
Australia

helpdesk@apnic.net

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

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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

Where are IP Addresses used?

```
Received: from guardian.apnic.net (int-
  gw.staff.apnic.net [192.168.1.254]) by
  hadrian.staff.apnic.net (8.9.3/8.9.3) with ESMTP
  id MAA11387 for <training@staff.apnic.net>; Thu,
  30 Nov 2000 12:54:40 +1000 (EST)
Received: (from mail@localhost) by
  guardian.apnic.net (8.9.3/8.9.3) id MAA12692 for
  <training@staff.apnic.net>; Thu, 30 Nov 2000
  12:54:39 +1000 (EST)
Received: from whois1.apnic.net (203.37.255.98) by
  int-gw.staff.apnic.net via smap (V2.1) id
  xma012681; Thu, 30 Nov 00 12:54:17 +1000
Received: (from http@localhost) by ns.apnic.net
  (8.9.3/8.9.3) id MAA127157; Thu, 30 Nov 2000
  12:54:18 +1000 (EST)
Date: Thu, 30 Nov 2000 12:54:18 +1000 (EST)
Message-Id: <200011300254.MAA127157@ns.apnic.net>
To: training@apnic.net
From : training@apnic.net
Subject: Training Feedback - Singapore
```
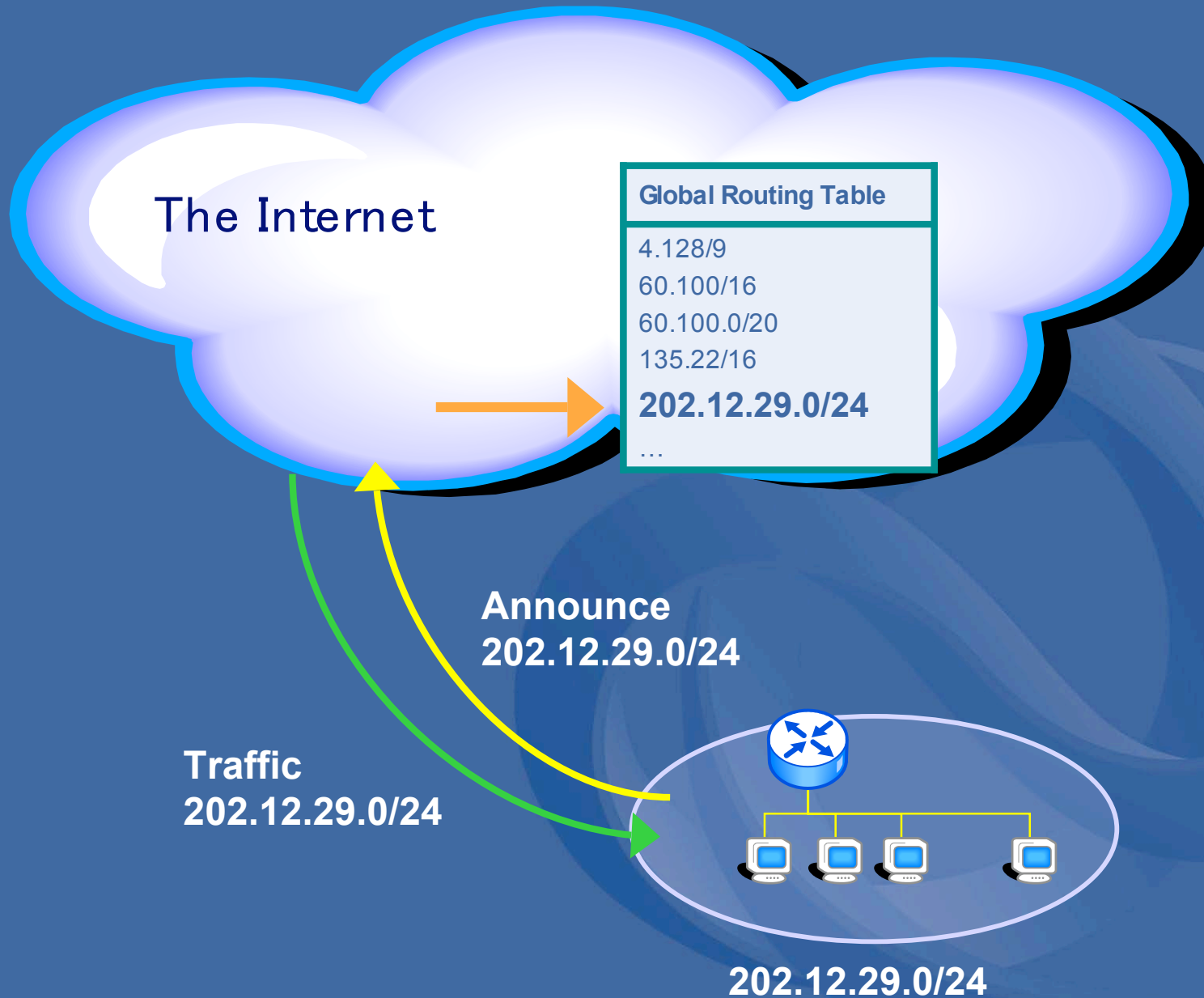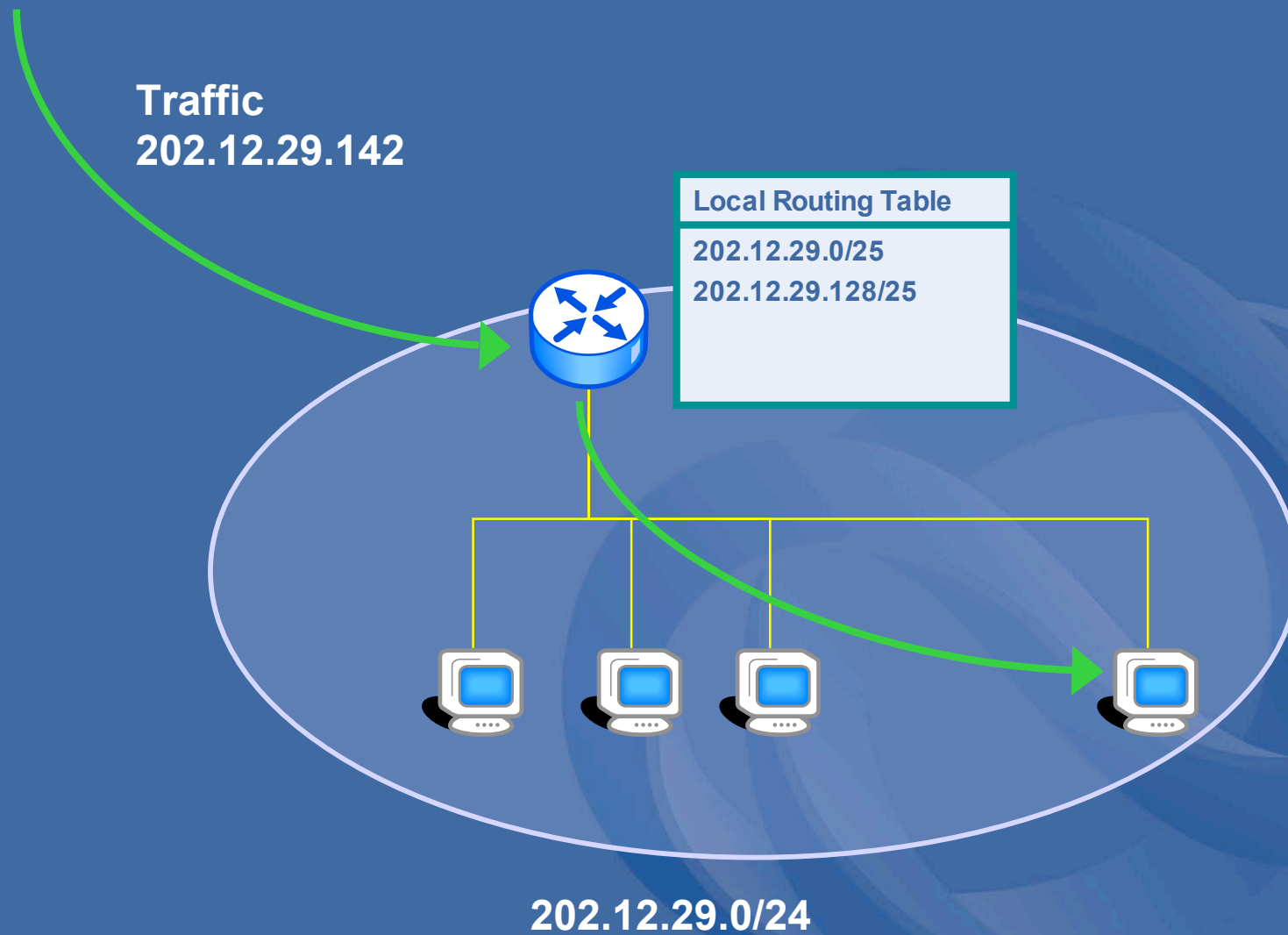
Internet address routing

The Internet

Global Routing Table

4.128/9
60.100/16
60.100.0/20
135.22/16
202.12.29.0/24
...

Announce
202.12.29.0/24

Traffic
202.12.29.0/24

202.12.29.0/24

Internet address routing

**Traffic
202.12.29.142**

Local Routing Table

**202.12.29.0/25
202.12.29.128/25**
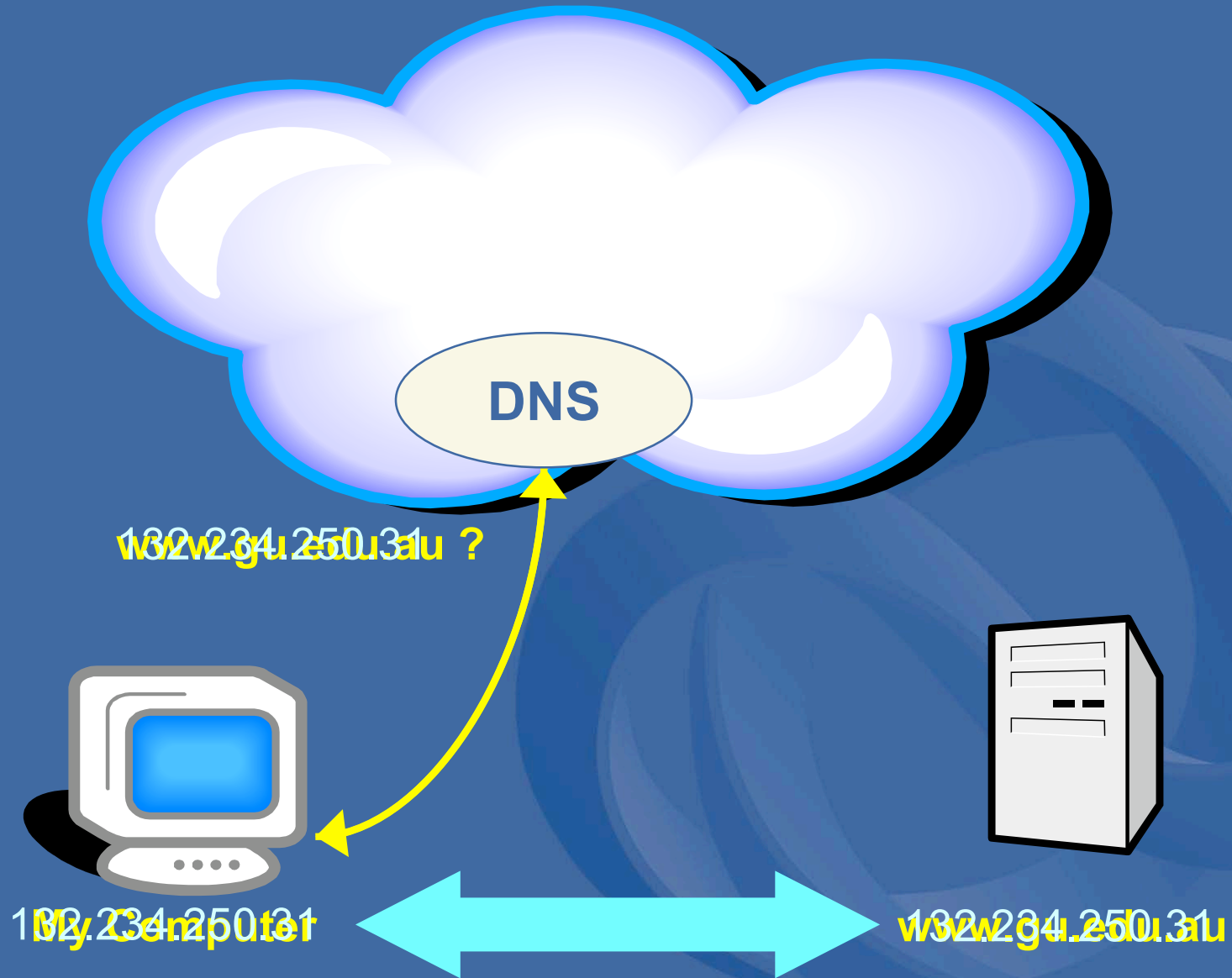
202.12.29.0/24

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.gu.edu.au

- Hierarchical structure providing distributed administration

- Not a proper (or useful!) directory service, but a basic mapping service
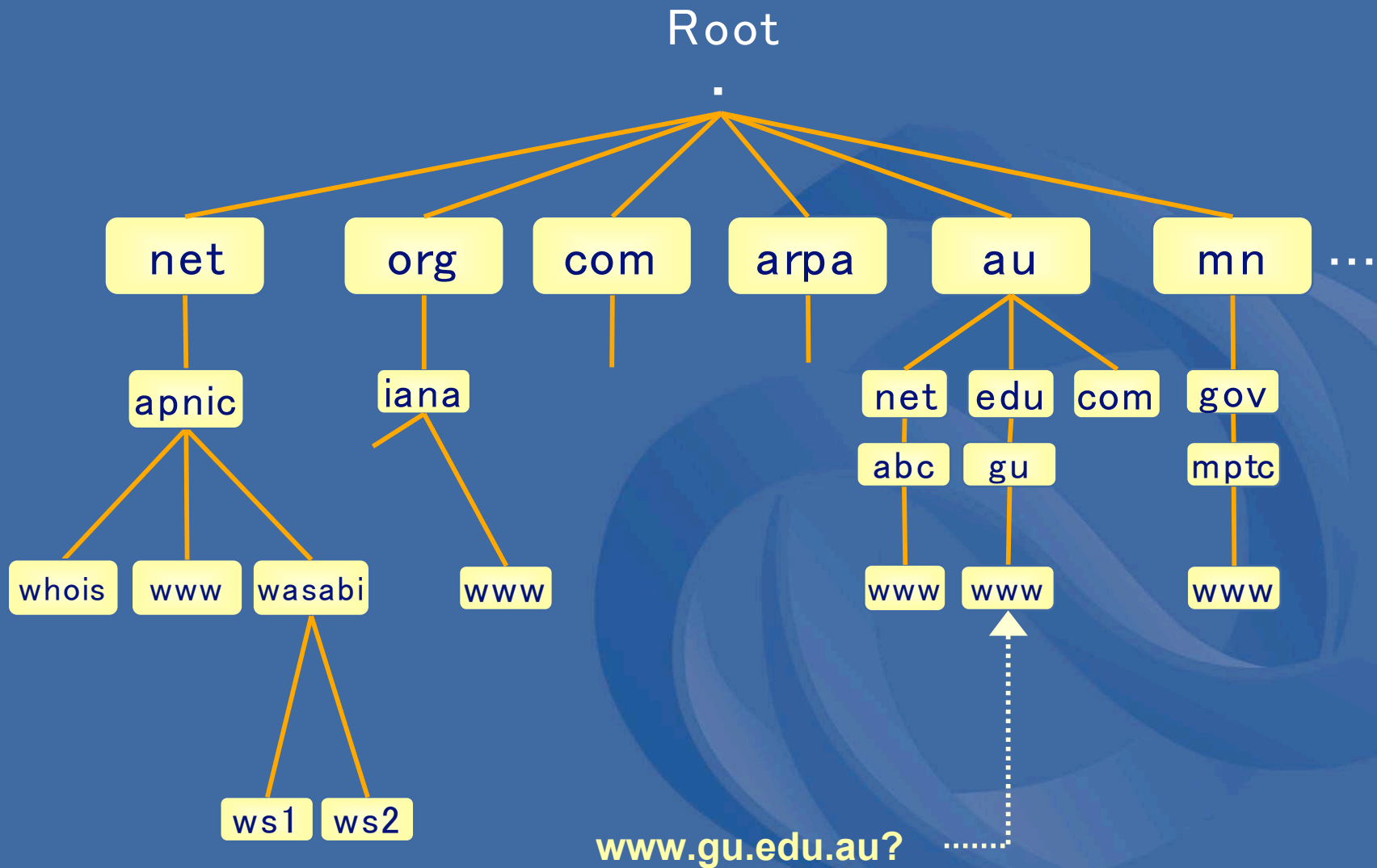 - Technical feat is in distribution and scaling
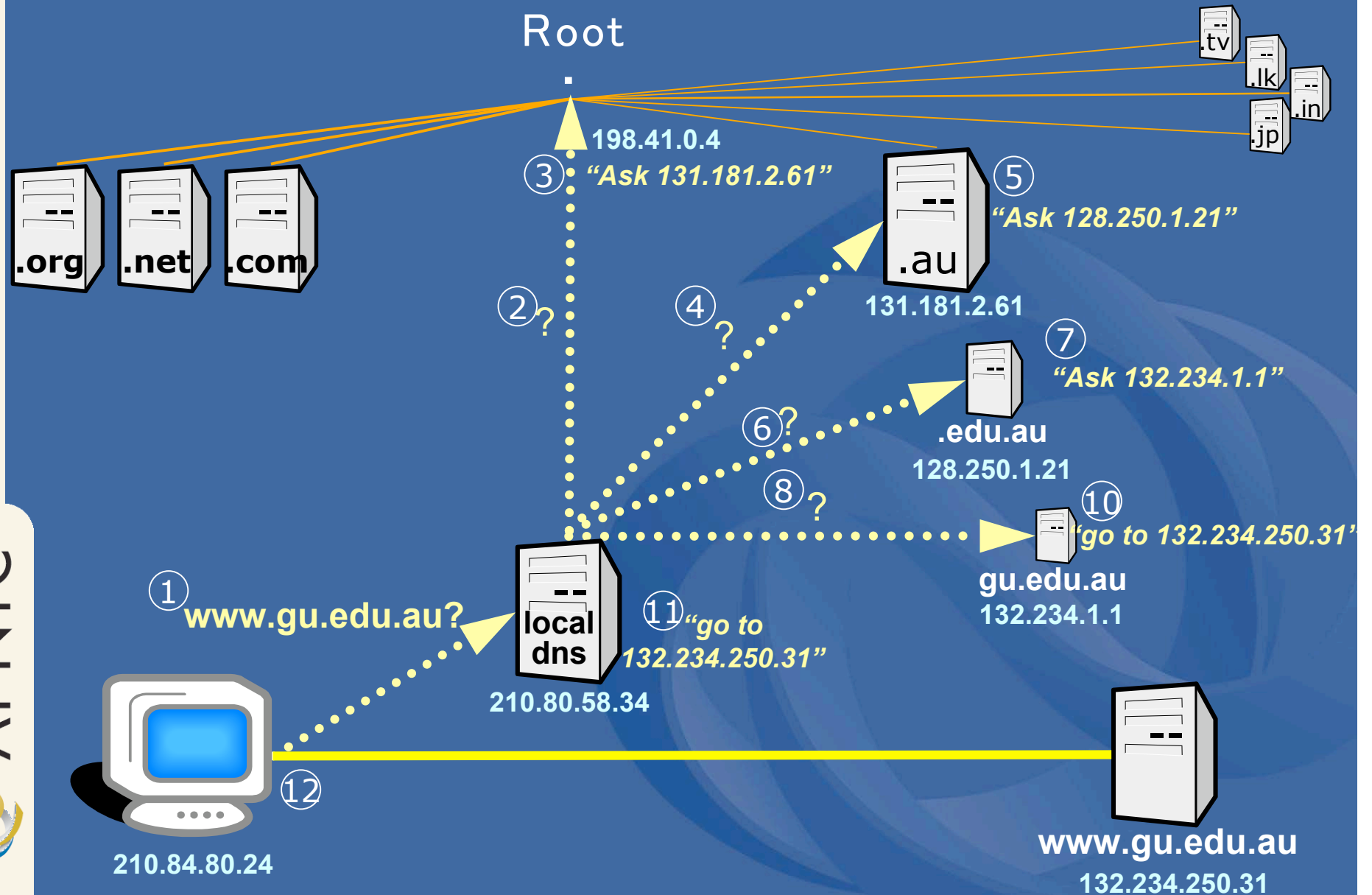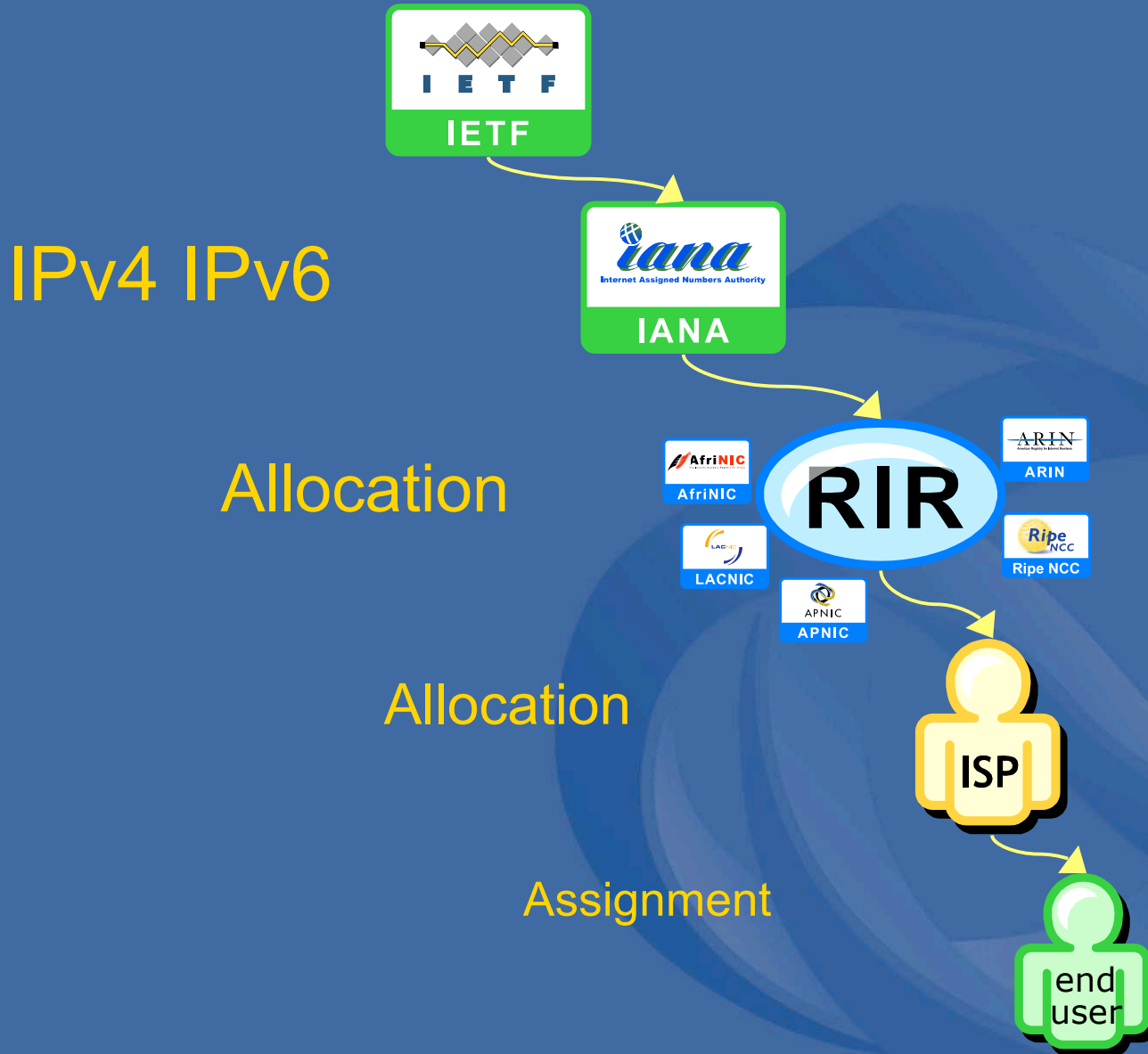
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IP addresses vs domain names

DNS

192.234.250.31 ?
www.gu.edu.au ?

My Computer
192.234.250.31

www.gu.edu.au
192.234.250.31

The DNS tree

Root
.

net   org   com   arpa   au   mn   ...

apnic   iana   net   edu   com   gov

abc   gu   mptc

whois   www   wasabi   www   www   www   www

ws1   ws2

www.gu.edu.au?

Where do IP addresses come from?

IPv4 IPv6

IETF

IANA

Allocation

RIR

AfriNIC

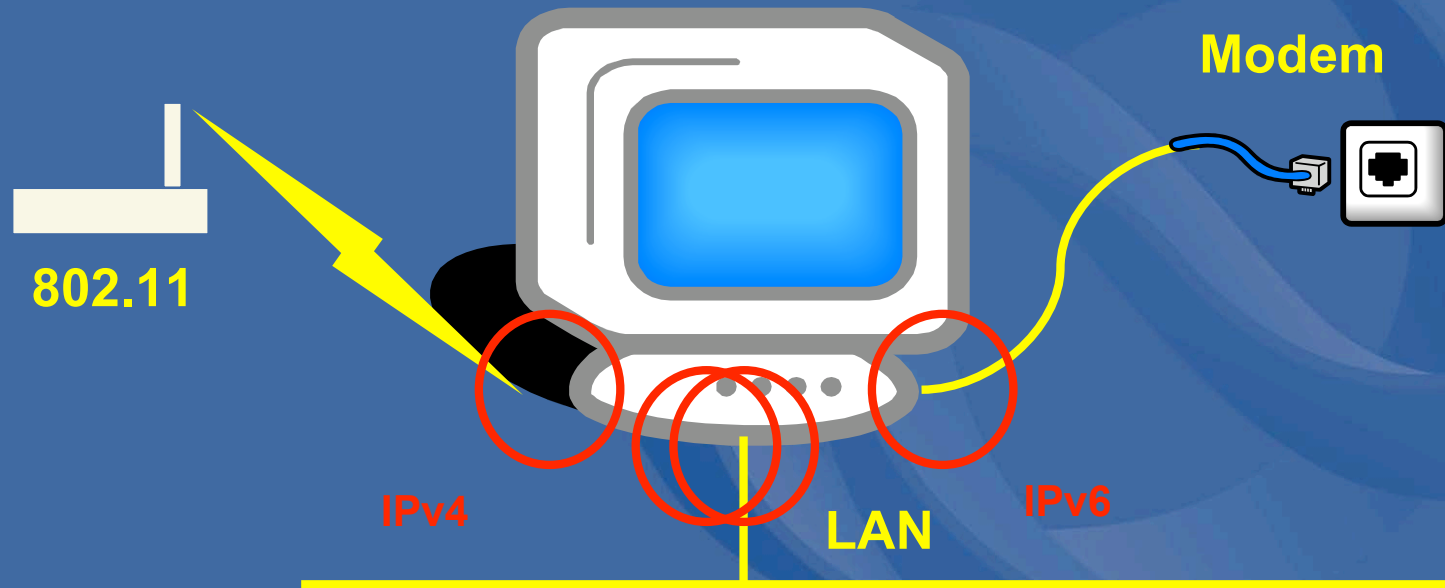ARIN

LACNIC

Ripe NCC

APNIC

Allocation

ISP

Assignment

end user

APNIC

What is "my" address?

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

Modem

802.11

IPv4

LAN

IPv6

Is "my" address permanent?

- No - Customer addresses often change
  - Dialup addresses are "dynamic"…

132.234.250.30

Is "my" address unique?

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

61.45.100.13

202.12.0.129

ISP

ISP

NAT

192.168.0.142
(private address)

192.168.0.0/24

APNIC
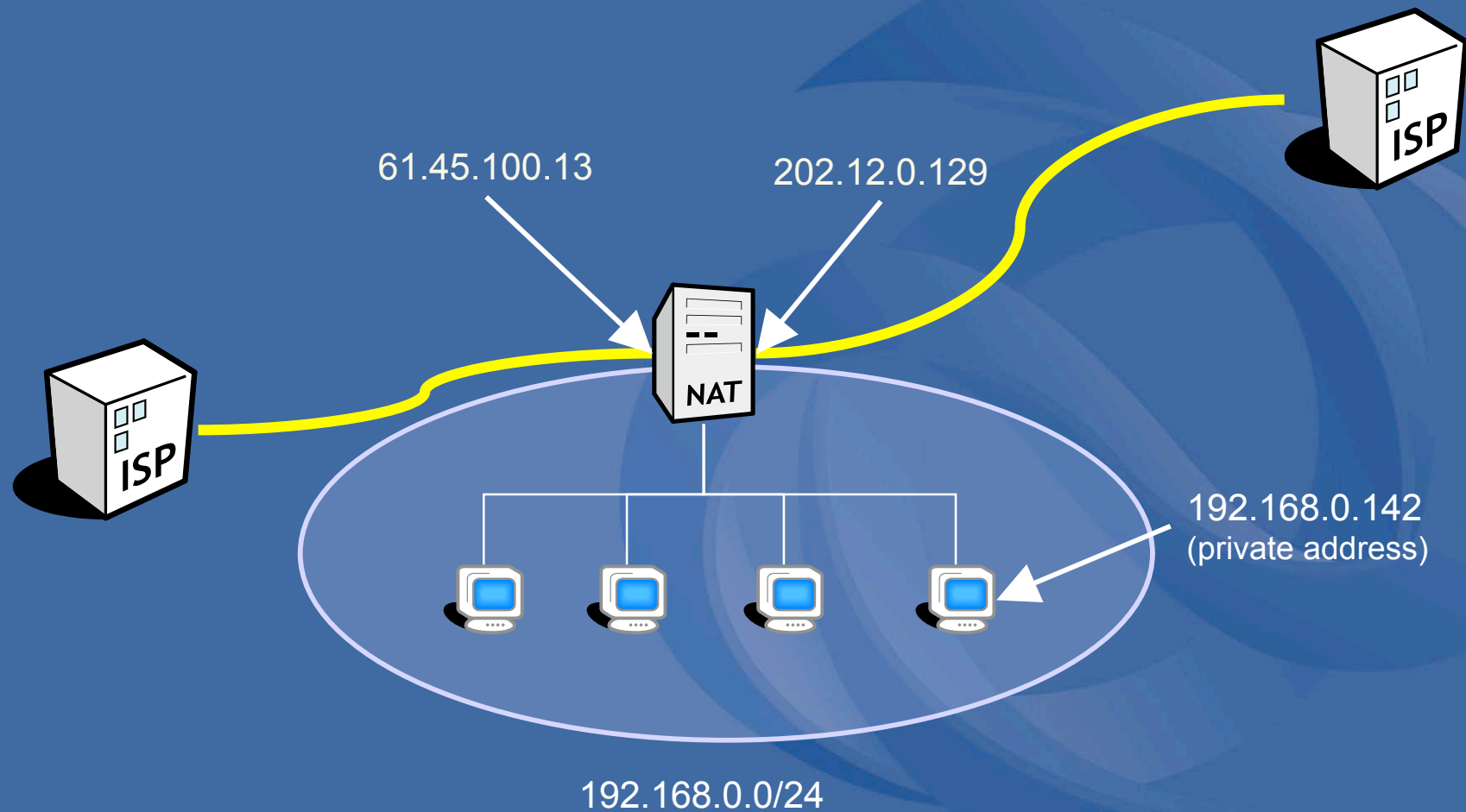
What else is an IP address?

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

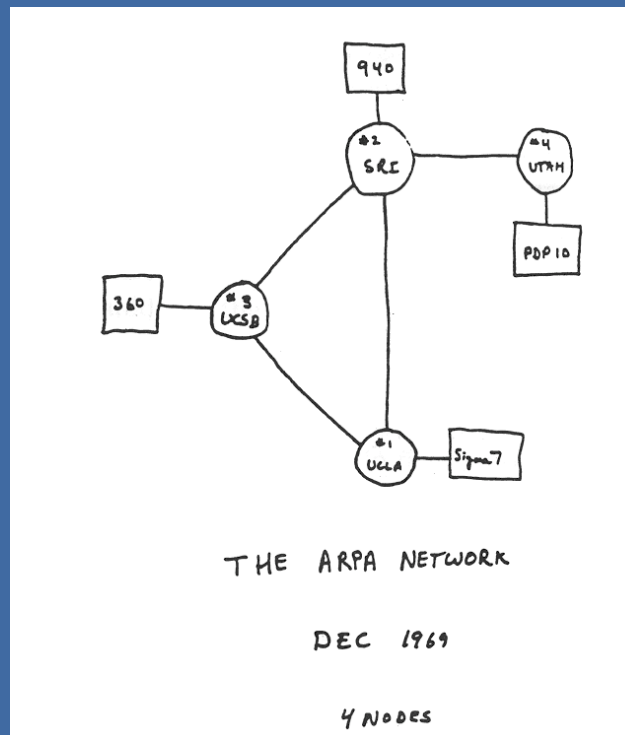- IP does not mean "Intellectual Property"

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Questions ?

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History of the Internet

…and the RIR system

In the beginning…
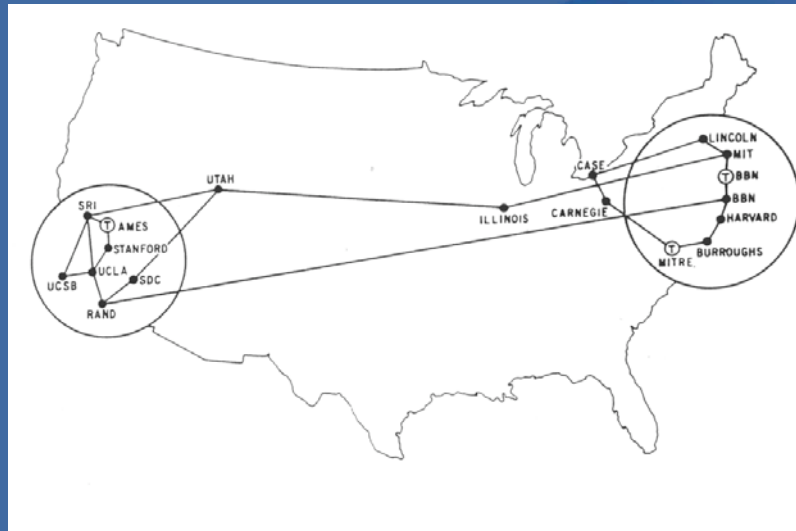
- 1968 - DARPA
  - (Defense Advanced Research Projects Agency) contracts with BBN to create ARPAnet
- 1969 – First four nodes

The Internet is born…

- 1970 - Five nodes:
    - UCLA – Stanford - UC Santa Barbara - U of Utah – BBN
- 1971 – 15 nodes, 23 hosts connected

- 1974 - TCP specification by Vint Cerf & Bob Kahn
- 1984 – TCP/IP
    - On January 1, the Internet with its 1000 hosts converts en masse to using TCP/IP for its messaging
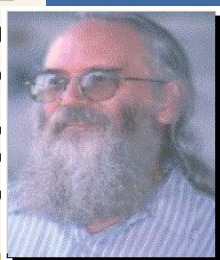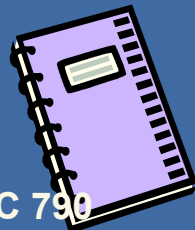
Pre 1992

DDNNIC

iana

RFC 1261
1991

RFC 1020
1987

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**."

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Address Architecture - History

- Each IP address has two parts
  - "network" address
  - "host" address

- Initially, only 256 networks in the Internet!
- Then, network "classes" introduced:
  - Class A (128 networks x 16M hosts)
  - Class B (16,384 x 65K hosts)
  - Class C (2M x 254 hosts)

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Address Architecture - Classful

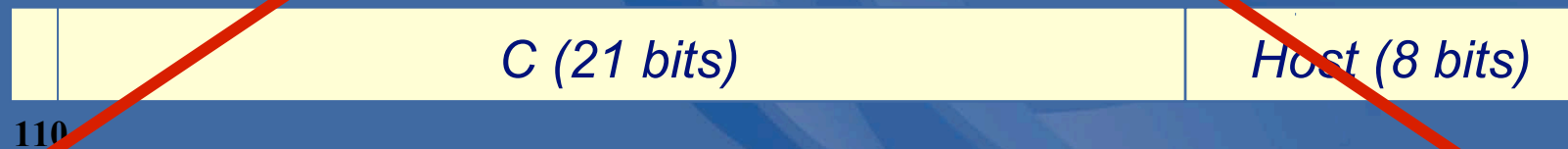Class A: 128 networks x 16M hosts (50% of all address space)

| A (7 bits) | Host address (24 bits) |

0

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

| B (14 bits) | Host (16 bits) |

10

Class C: 2M networks x 254 hosts (12.5%)

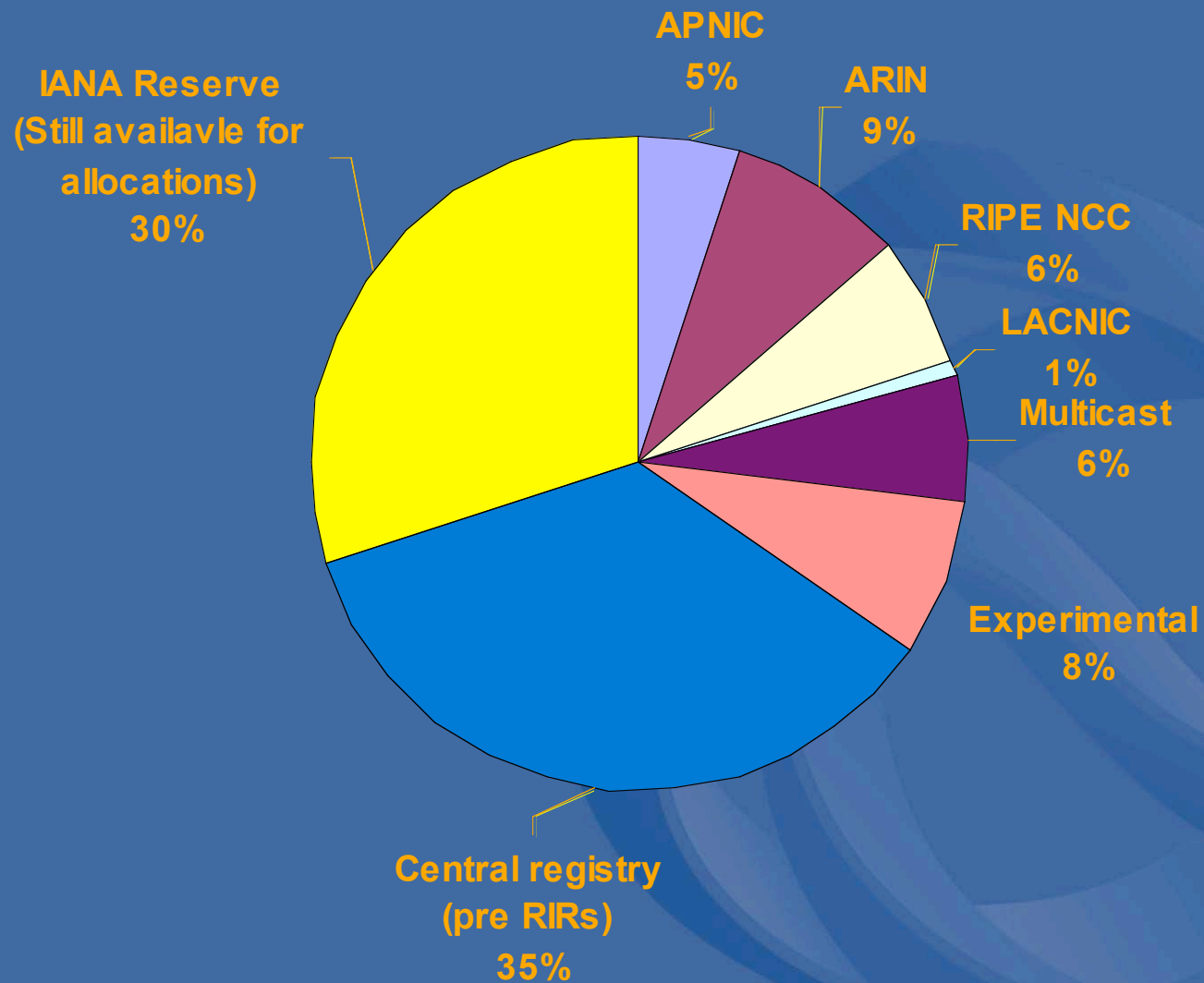| C (21 bits) | Host (8 bits) |

110

Address management challenges 1992

- Address space depletion
  - IPv4 address space is finite
  - Historically, many wasteful allocations

- Routing chaos
  - Legacy routing structure, router overload
  - CIDR & aggregation are now vital

- Inequitable management
  - Unstructured and wasteful address space distribution
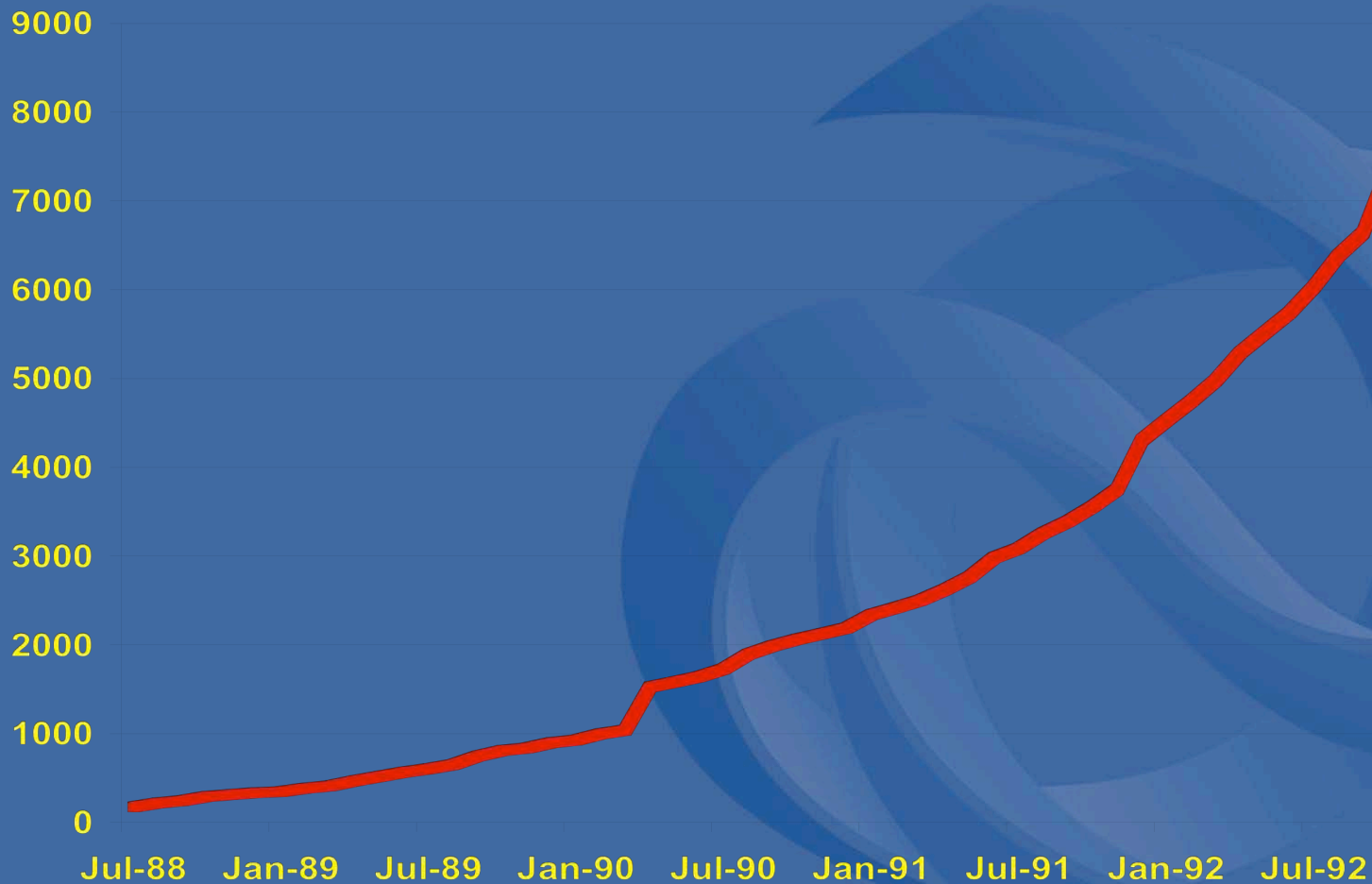
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Global IPv4 delegations

APNIC
5%

ARIN
9%

RIPE NCC
6%

LACNIC
1%

Multicast
6%

Experimental
8%

Central registry
(pre RIRs)
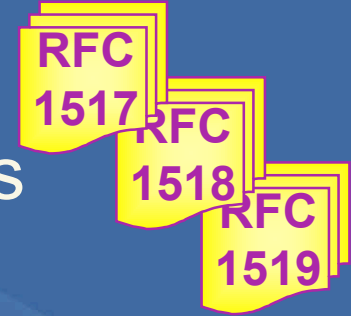35%

IANA Reserve
(Still availavle for
allocations)
30%

Global Routing Table: '88 - '92

Evolution of Address Management

- 1993: Development of "CIDR"
  - addressed both technical problems

Address depletion
→ Through more accurate assignment
- variable-length network address

Routing table overload
→ Through address space aggregation
- " supernetting"

Evolution of address management

- Administrative problems remained
  - Increasing complexity of CIDR-based allocations
  - Increasing awareness of <u>conservation</u> and <u>aggregation</u> goals
  - Need for fairness and consistency

- RFC 1366 (1992)
  - Described the "growth of the Internet and its increasing globalization"
  - Additional complexity of address management
  - Set out the basis for a <u>regionally distributed Internet registry system</u>

RFC
1366

APNIC

Evolution of address policy

- 1990s - establishment of RIRs
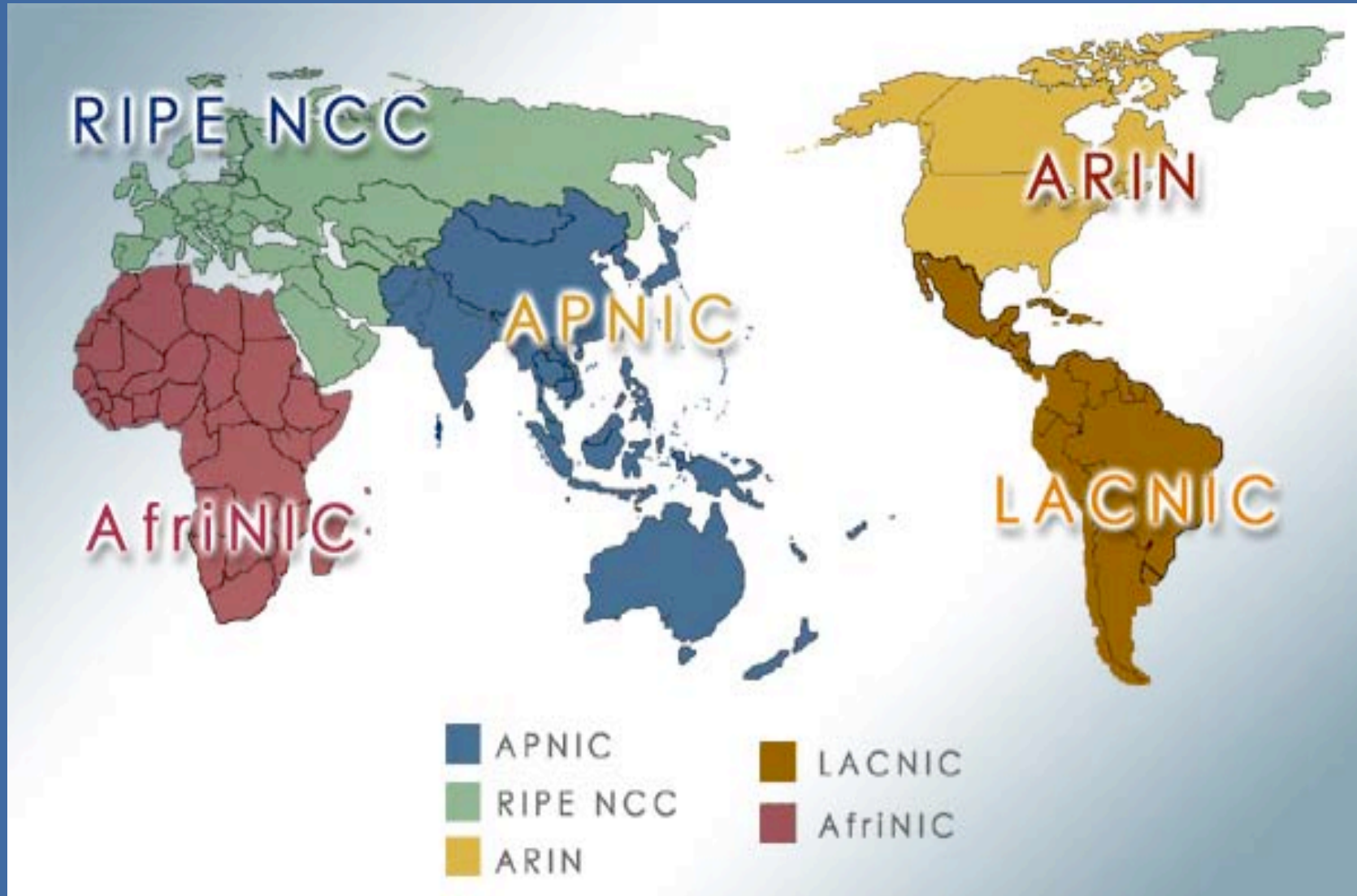 - APNIC, ARIN, RIPE NCC (LACNIC & AfriNIC later)
  - →Regional open processes
  - →Cooperative policy development
  - →Industry self-regulatory model
    - bottom up

| AfriNIC | LACNIC | APNIC | Ripe NCC | ARIN |

AfriNIC community | LACNIC community | APNIC community | ARIN community | RIPE community

Address management today

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

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Uniqueness, fairness and consistency

Questions ?

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The Internet Today

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Internet Growth to date - Hostcount
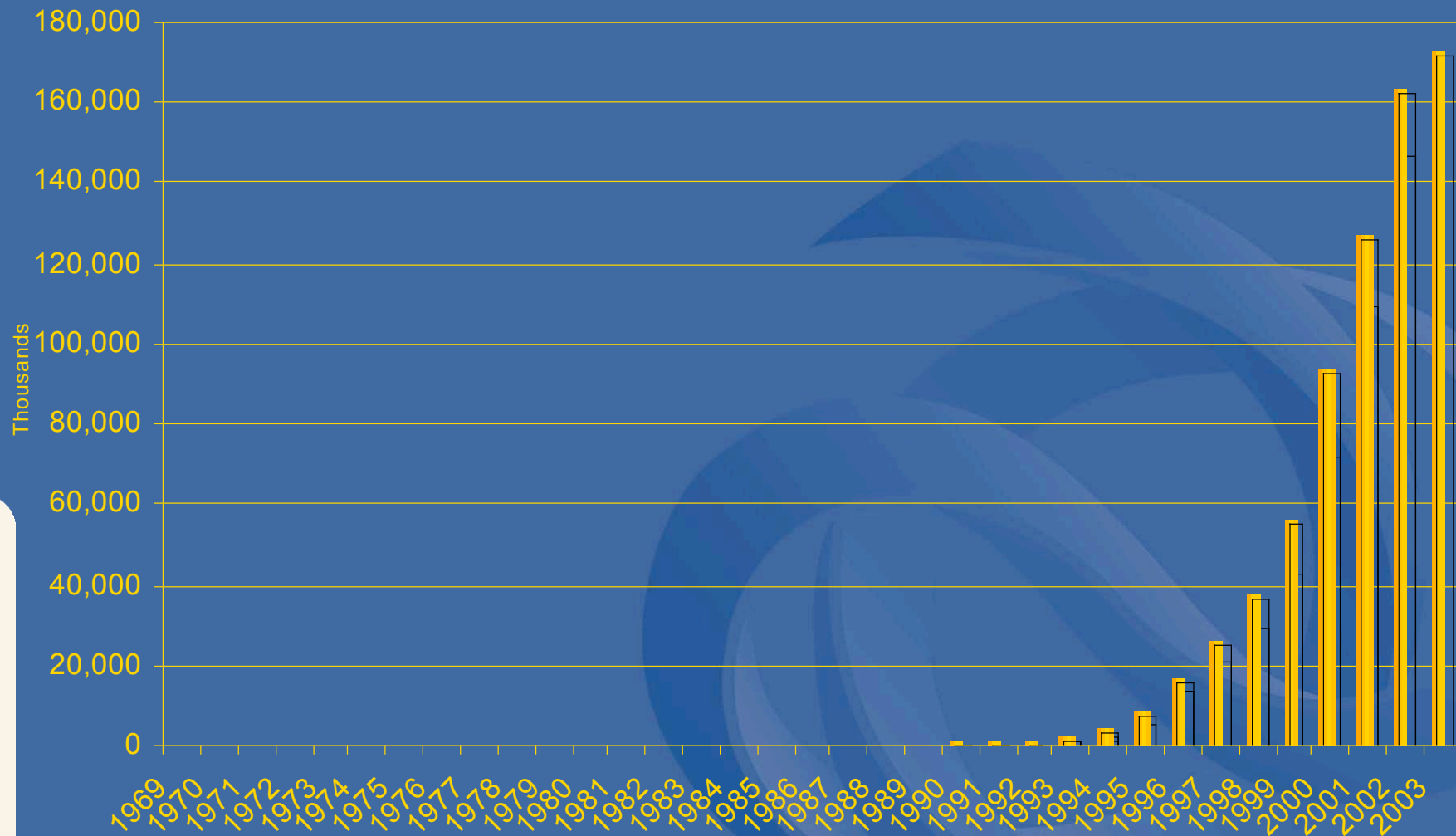
source: http://www.zakon.org/robert/internet/timeline/

Map of the Internet today

http://www.lumeta.com/mapping.html
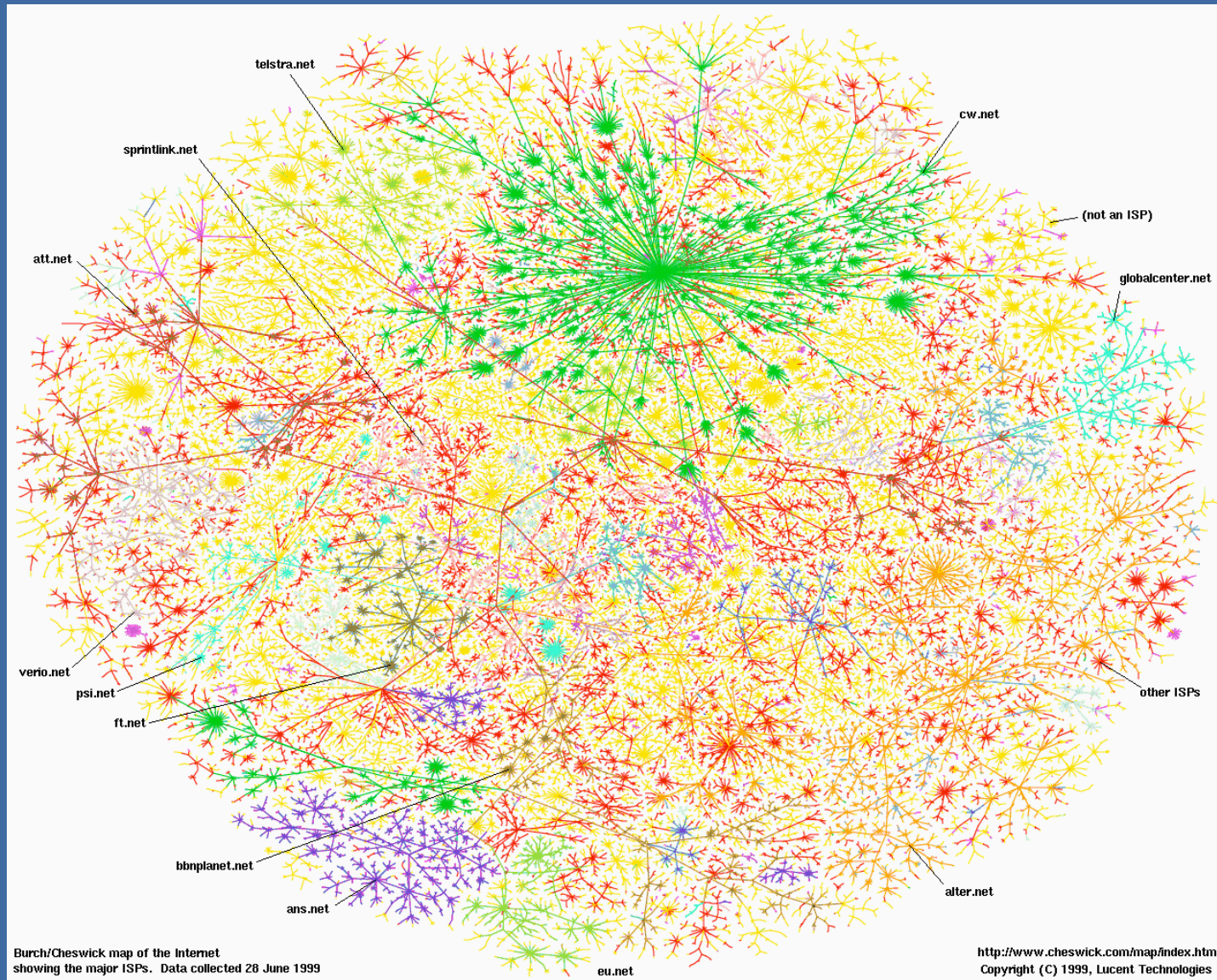
The RIR structure

- Five RIRs today
  - Open
  - Transparent
  - Neutral and impartial

- Addresses distributed fairly
  - Based on need
  - No discrimination
- Not for profit membership organisation
  - Membership open to all interested parties
  - Bottom up, industry self-regulatory structure
- Policies developed by industry at large
  - Through open policy processes
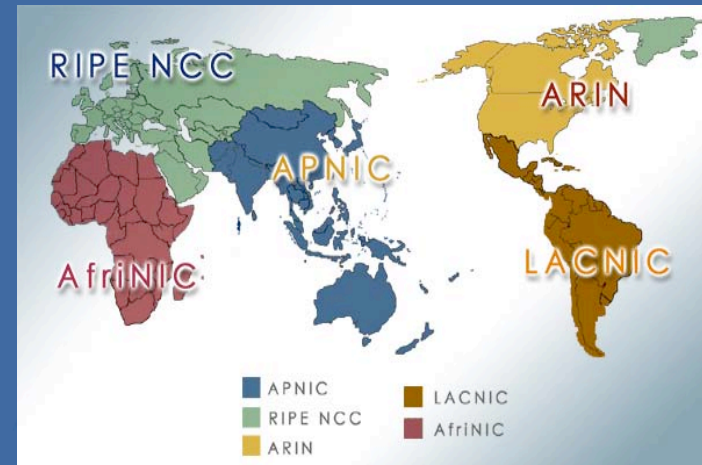
RIR Funding Model

- Not for profit
- Annual service fee
  - No charge per IP address
- Approved by membership
- Open Financial Reporting
  - statements publicly available

What does APNIC do?

Resource service

- IPv4, IPv6, ASNs
- Reverse DNS delegation
- Resource registration
  - Authoritative registration server
    - whois

Policy development

- Facilitating the policy development process
- Implementing policy changes

Information dissemination

- APNIC meetings
- Web and ftp site
- Publications, mailing lists
- Outreach seminars

http://www.apnic.net/community/lists/

Training & Outreach

- Training
  - Internet Resource management
  - DNS workshops

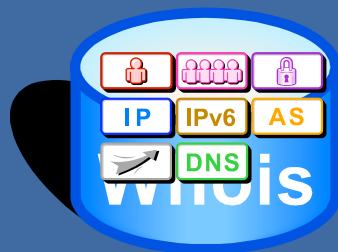- Subsidised for members

Schedule:
http://www.apnic.net/training

The APNIC Whois Database

- The APNIC Whois Database is a *public network management database*
  - It contains information about:

  - Contacts
    - contact persons
    - contact roles/groups
  - Internet resources
    - IPv4 addresses
    - IPv6 addresses
    - AS numbers

  - Routing policy
    - prefixes announced (and much more)
  - Reverse delegation
    - Reverse domains
  - Authorisation
    - data protection

- The APNIC Whois Database is used for
  - Registration of Internet resources (ascertain custodianship)
    - Fulfill responsibility as resource holder
  - Obtain technical contact for a network
  - Troubleshooting
  - Investigate security incidents
    - Finding sources of spam & network abuse

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, SANOG
      - Co-founder of APRICOT

  - Other Regional Internet Registries (RIRs)
    - ARIN, RIPE NCC, LACNIC, AFRINIC

  - Other leading Internet organisations
    - IANA, ICANN, IETF, IEPG, ISOC etc.

APNIC region

*1081 members
in 47 economies*

Jul 2005

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APNIC membership

SG 5% JP 5% PK 4% PH 6% TH 4% IN 12% NZ 4% CN 4% MY 3% HK 13% AP 3% TW 3% BD 3% Other 10% AU 21%

Jul 2005
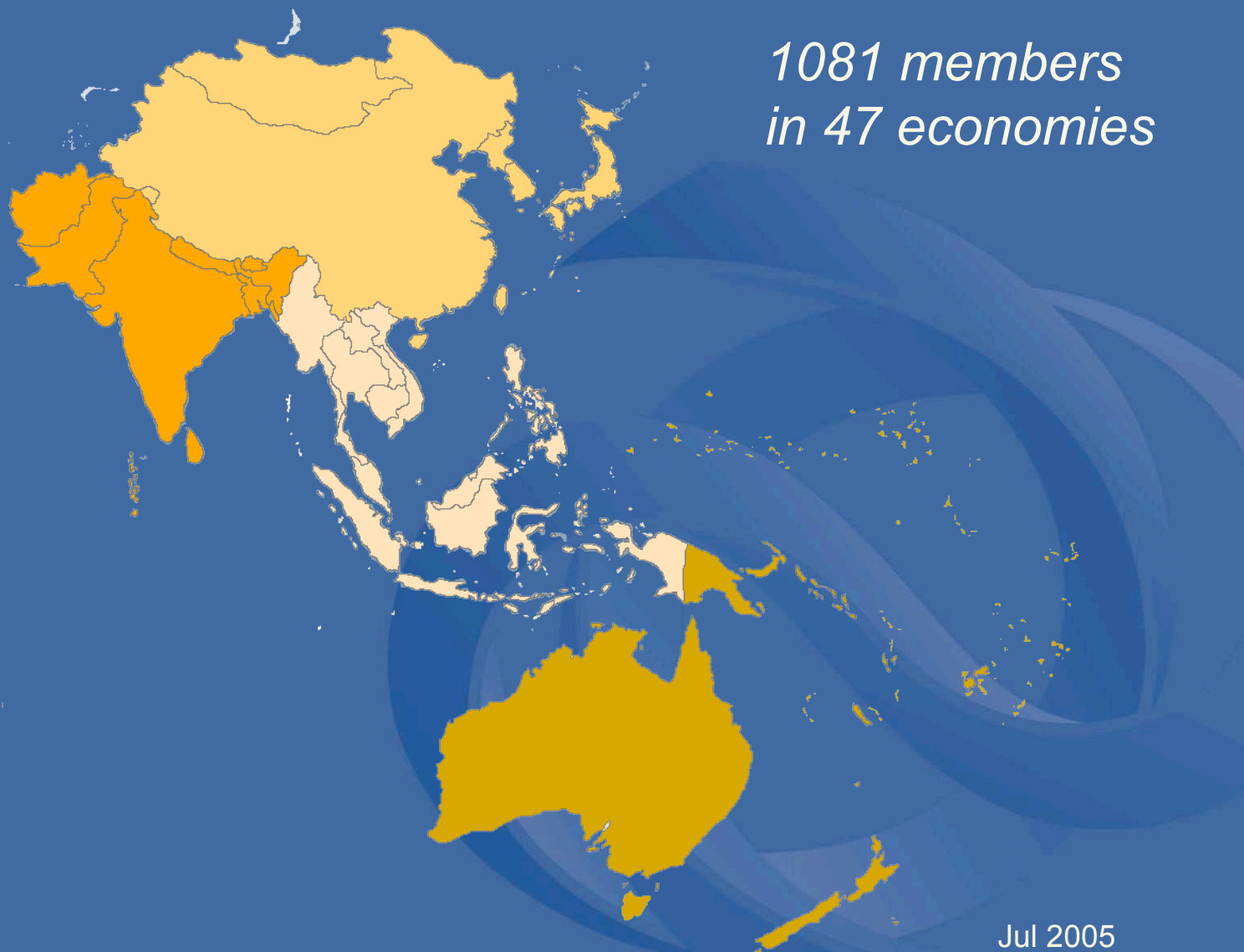
APNIC services & activities
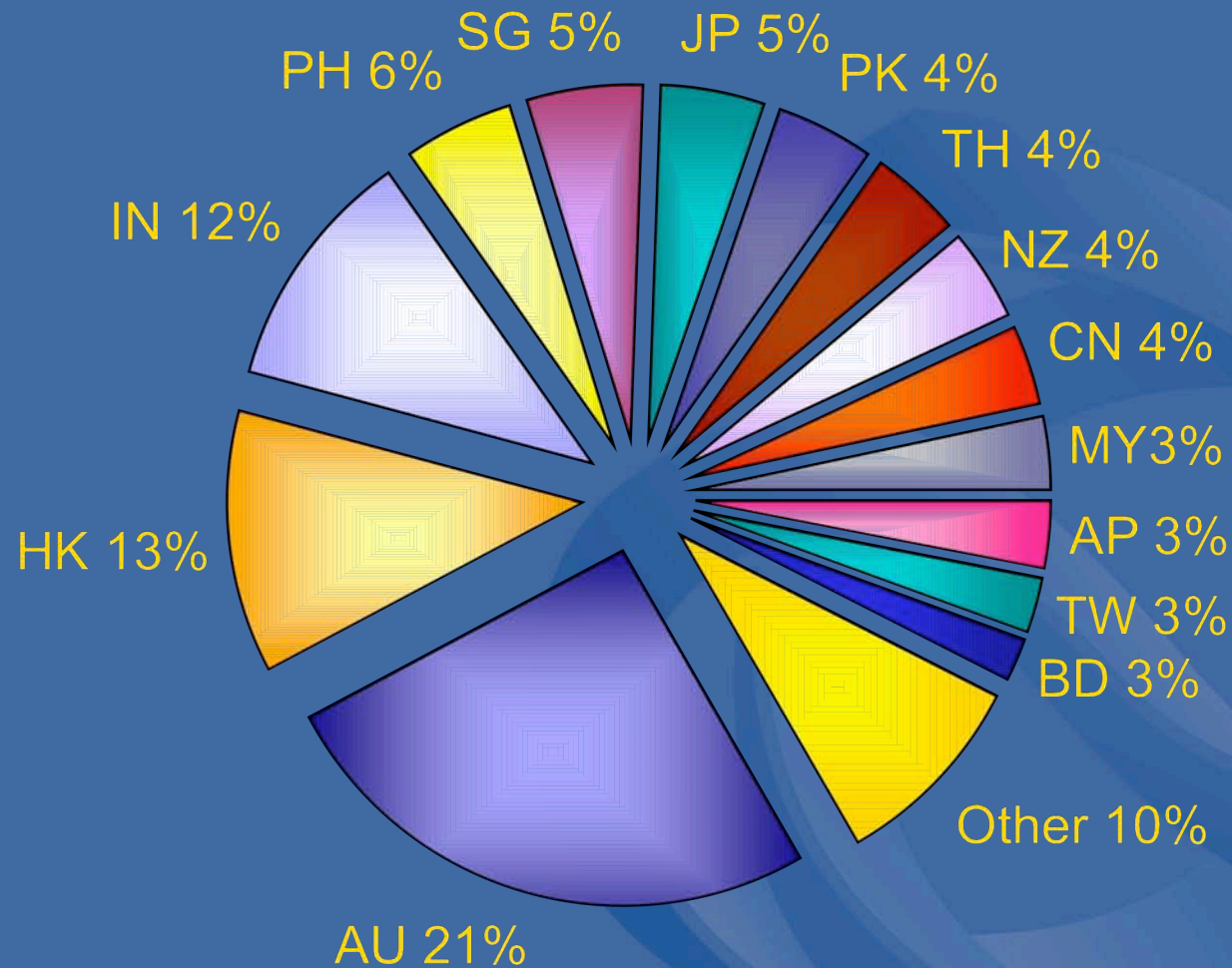
Resources Services

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

Information dissemination

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

Questions ?

APNIC

Classless addressing

Classless & Classful addressing

Classful

128 networks ~~hosts~~
A

~~osts~~
B

~~x 256 hosts~~
C

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
...	...	...	...

- Network boundaries may occur at *any* bit

Classless Addressing - Examples

/10: 4M hosts

Net: 10 bits	Host address: 22 bits

/19: 8190 hosts

Network address: 19 bits	Host: 13 bits

/20: 4094 hosts

Network address: 20 bits	Host: 12 bits

/24: 254 hosts

Network address: 24 bits	Host: 6 bits

/28: 14 hosts

Network address: 28 bits	Host: 4 bits

Slash notation and ranges

- Two ways of representing an address range

<u>"slash" notation</u>
e.g. 172.16.0.0/12

<u>Start- & end address</u>
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 = 192.168.24.0-192.168.24.32
  - 172.16.0.0 – 172.31.255.255 = 172.16.0.0.0/12

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What on earth is a slash?

26 | 6

/26 → 32 - 26 = 6 bits

32 bits

→ /26 = 2^6 = 64

22 | 10

/22 → 32 - 22 = 10 bits

32 bits

→ /22 = 2^{10} = 1024

32 | 0

/32 → 32 - 32 = 0 bits

32 bits

→ /32 = 2^0 = 1
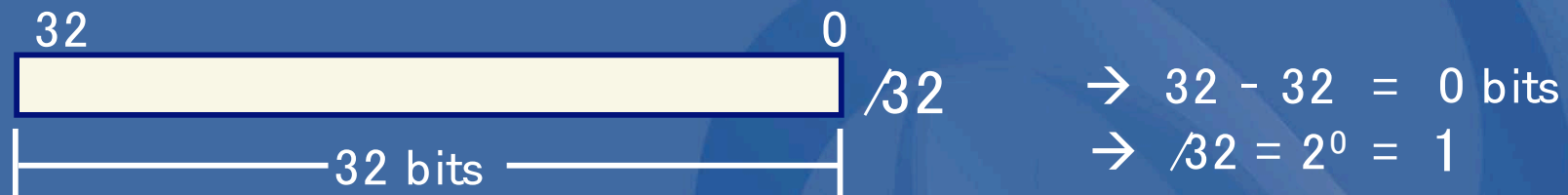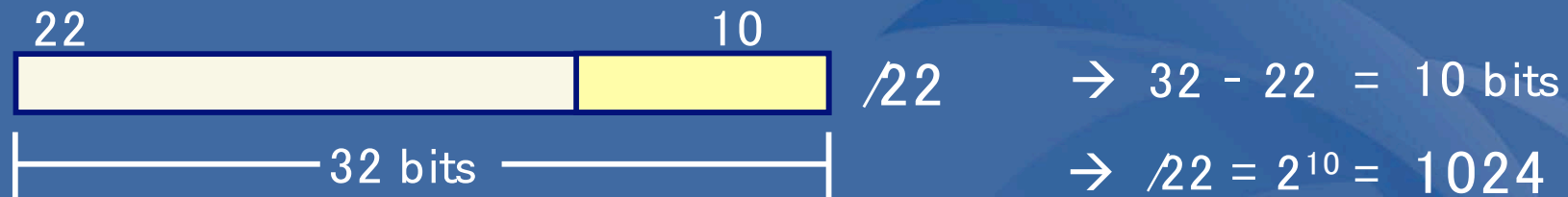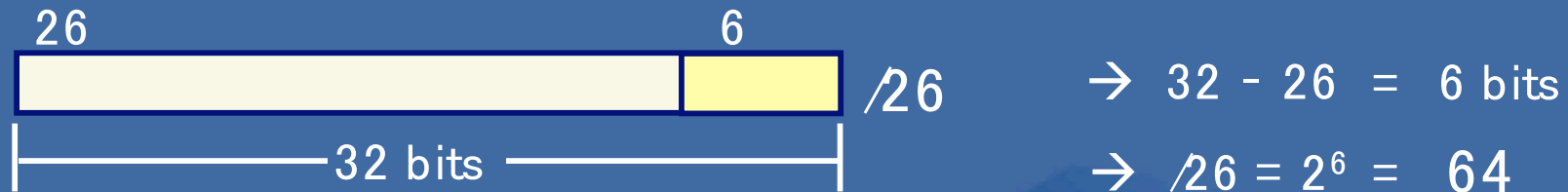
/20 = $2^{(32 - 20)}$ = 2^{12} = 4096

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

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

Ranges and slashes

202.12.29.253
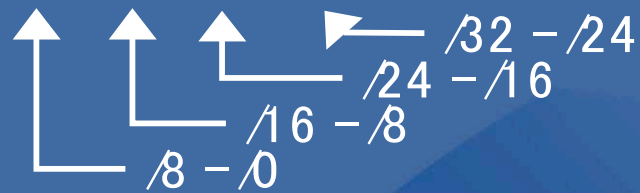
/32 – /24 (e.g. 10.64.56.1/32)
/24 – /16 (e.g. 10.64.56.0/24)
/16 – /8 (e.g. 10.64.0.0/16)
/8 – /0 (e.g. 10.0.0.0/8)

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

Questions ?

Address Management Today

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

/8

APNIC Allocation

/21

Member Allocation

/23

Sub-
Allocation

/27   /26

/24   /25   /26

Customer Assignments
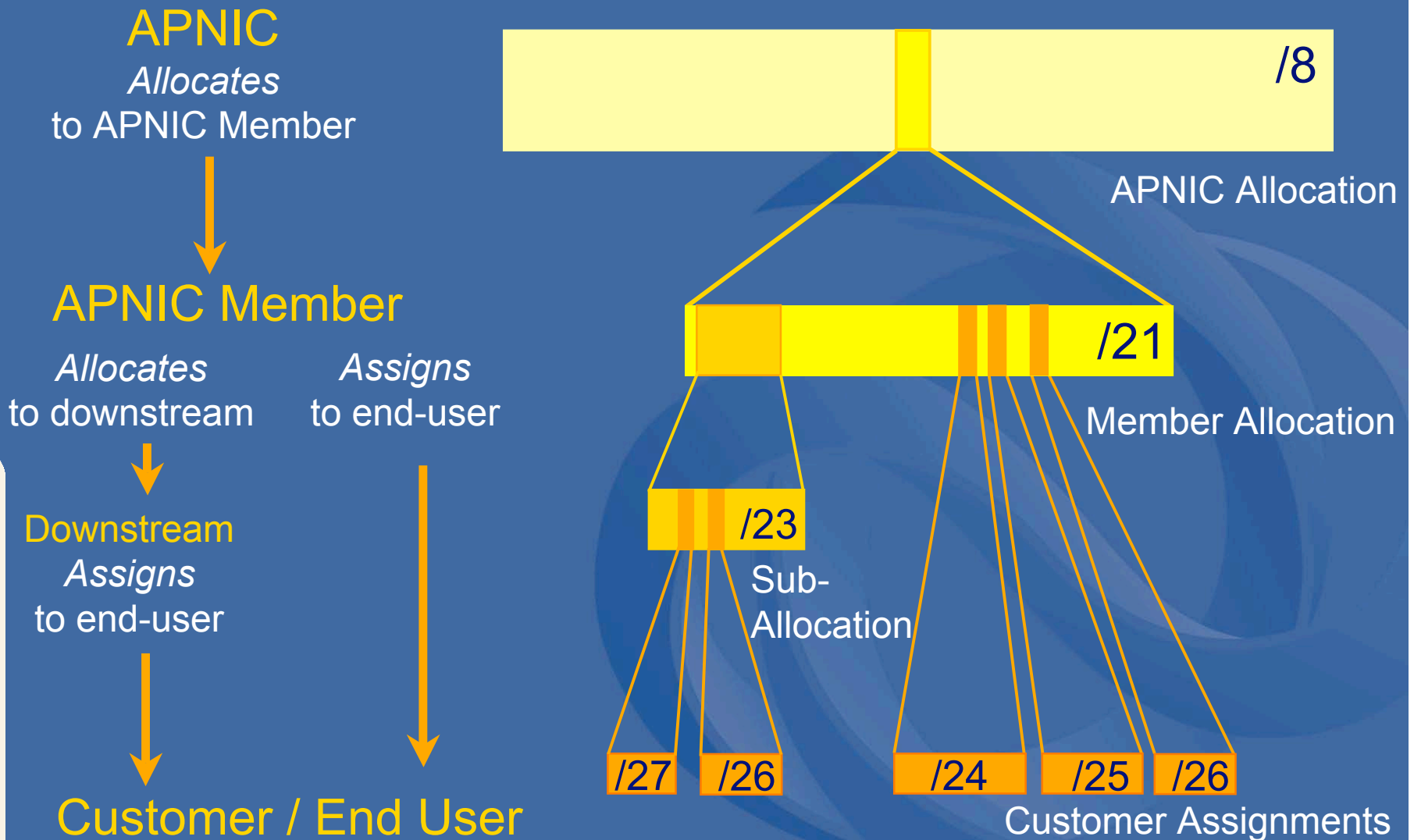
Portable & non-portable

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
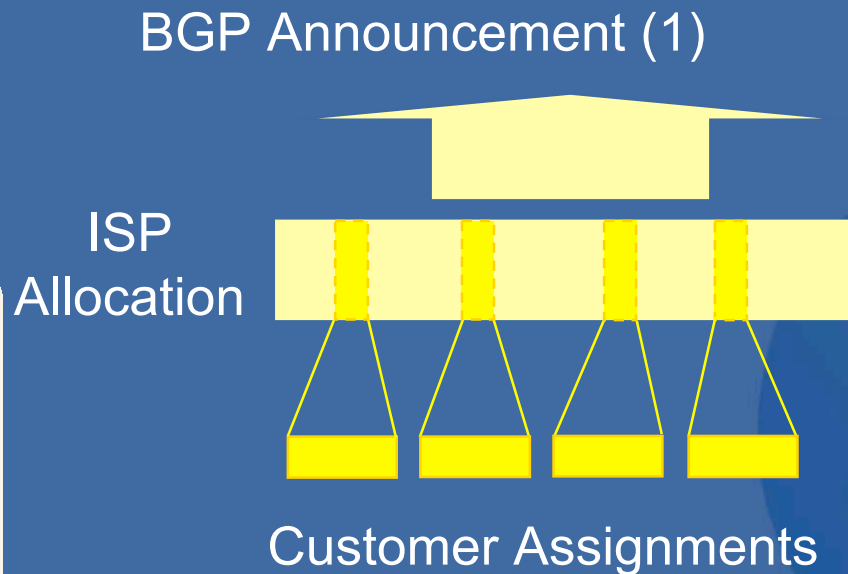
(Non-portable Assignments)

No Aggregation

BGP Announcements (4)

ISP

Customer Assignments

(Portable Assignments)

Aggregation and "portability"

Aggregation

No aggregation

ISP A
ISP B

Internet

(4 routes)

ISP D
ISP C

(non-portable assignments)

ISP A
ISP B

Internet

(21 routes)

ISP D
ISP C
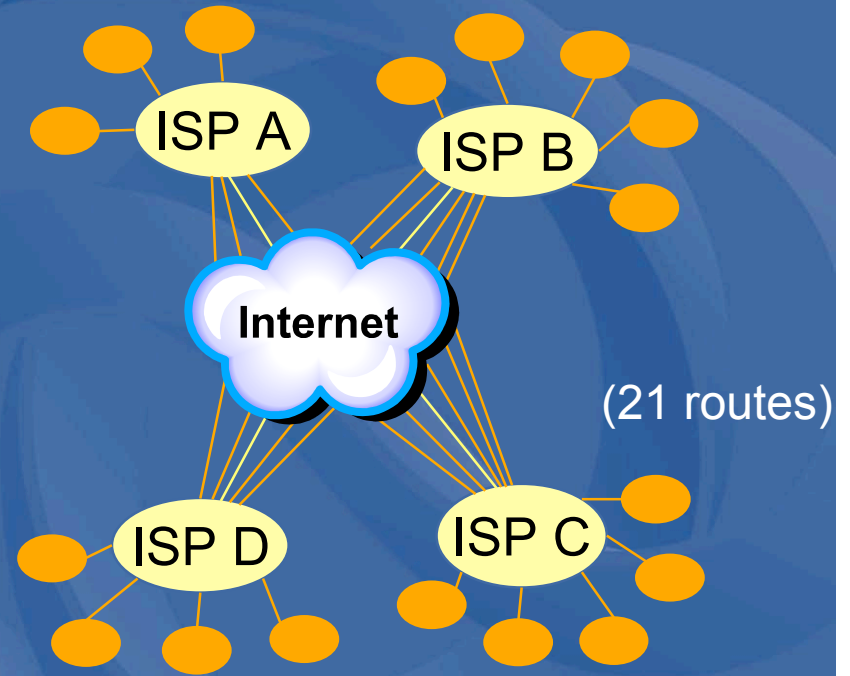
(portable assignments)

APNIC Policies - Background

- ## Scalability of the Internet
  - Early use of "Classful" addressing (A,B,C)
  - CIDR & aggregation are vital

- ## Routing instability
  - Legacy routing structure, Router overload

- ## IPv4 address space is finite
  - Historically, many wasteful, "Classful" assignments

- ## Fairness and Consistency
  - In the interests of the AP and Global communities

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

APNIC

Uniqueness, fairness and consistency

APNIC policy environment

- Routability not guaranteed
  - ISPs determine routability

- Unpredictable growth rates
  - IPv4 deployment levels unanticipated
  - routing problems

- "IP addresses not freehold property"
  - Addresses cannot be bought or sold
    - 'Ownership' is contrary to management goals

- Varying levels of expertise in the region
  - Technical challenge & lack of training
  - Staff turnover in IRs

APNIC policy environment

- APNIC responsibility
  - to represent interests of members
  - to represent interests in the region
  - to ensure collective responsibilities are met

- Collective responsibility
  - to develop policies to meet goals
  - to make appropriate customer agreements
  - to operate in good faith

APNIC policies

- Based on global Internet Registry policies
  - Other RIR policies (developed since)

- Minimum practical allocation: /21
  - "Slow Start" policy for new members

- Allocations are portable
  - Provider responsible for aggregation
  - Customer assignments must be non-portable

http://www.apnic.net/docs/policy/add-manage-policy.html

Where can I get IP addresses?

APNIC /8

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)

A

ISP /21

Member Allocation

B

Sub-allocation

C   C   D

end-user   end-user   end-user
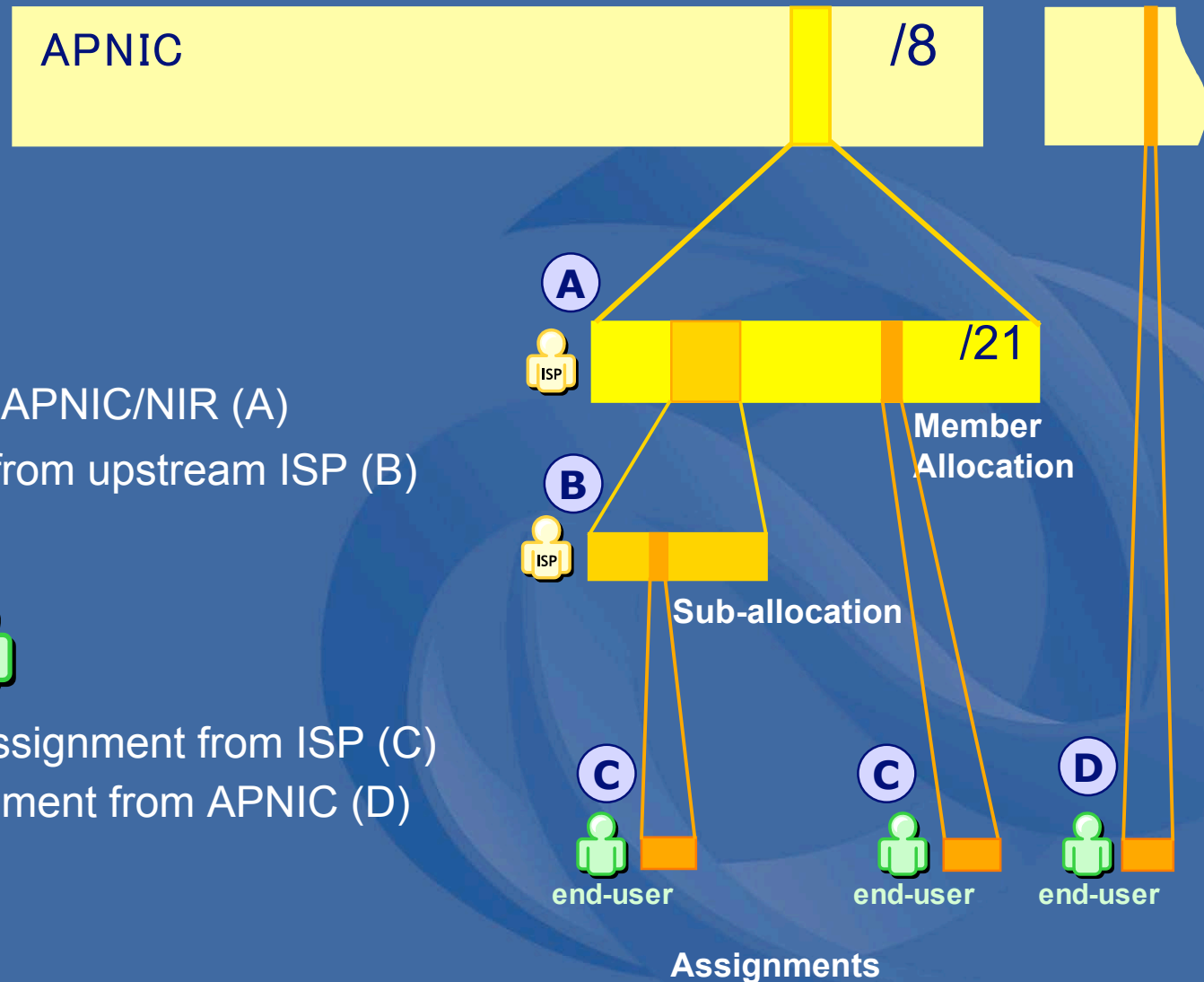
Assignments

Initial IPv4 allocation

- Initial (portable) allocation size and criteria have been lowered:
  - Allocation size: /21 (2048 addresses).
  - The allocation can be used for further assignments to customers or your own infrastructure.

Criteria

1a. Have used a /23 from upstream provider
  - Demonstrated efficient address usage

  OR

1b. Show immediate need for /23
  - Can include customer projections & infrastructure equipment

2. Detailed plan for use of /22 within 1 year
3. Renumber to new space within 1 year

APNIC   /8

/21
Member allocation

Non-portable assignment

Portable assignment
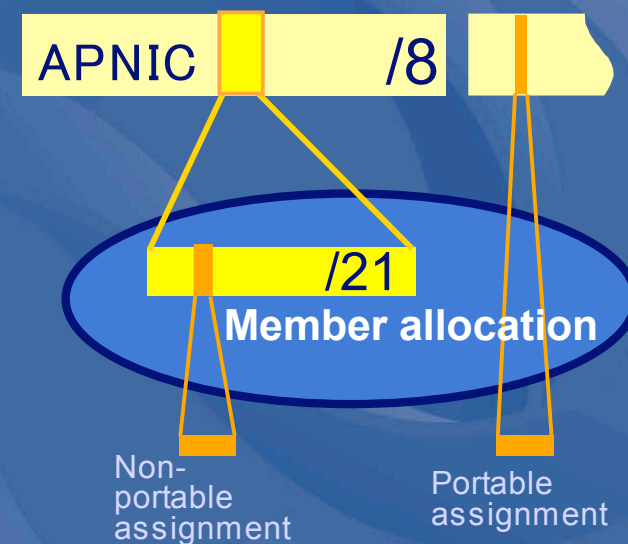
Portable assignments

- Small multihoming assignment policy
  - *For (small) organisations who require a portable assignment for multi-homing purposes*

Criteria

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*

APNIC   /8

/21
Member allocation

Non-portable assignment

Portable assignment
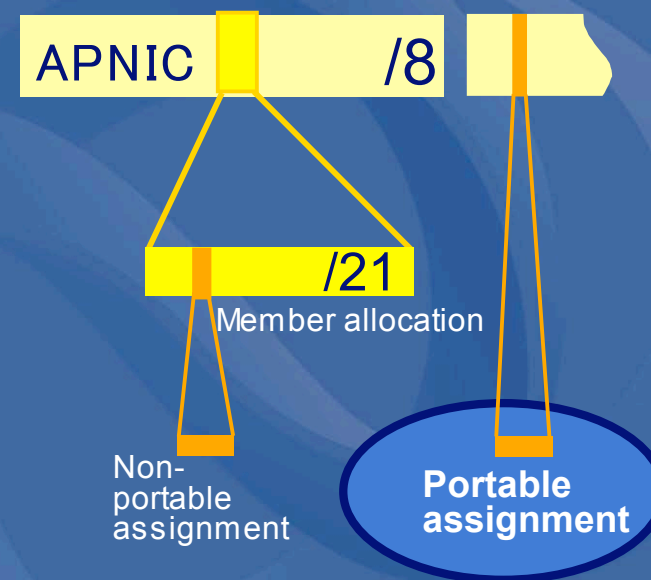
Questions ?

APNIC

Policy Development in the Asia Pacific

The APNIC Community

&

the Policy Development Process

Asia Pacific Network Information Centre

APNIC

The Internet community

Global Internet Community

APNIC Internet Community

APNIC Membership

APAN

SANOG

PITA

IETF

ISP Associations

ISOC

Individuals

APNIC

Policy development cycle

Need
OPEN

Anyone can participate

Evaluate

Discuss

'BOTTOM UP'

TRANSPARENT

Implement

Consensus

Internet community proposes and approves policy
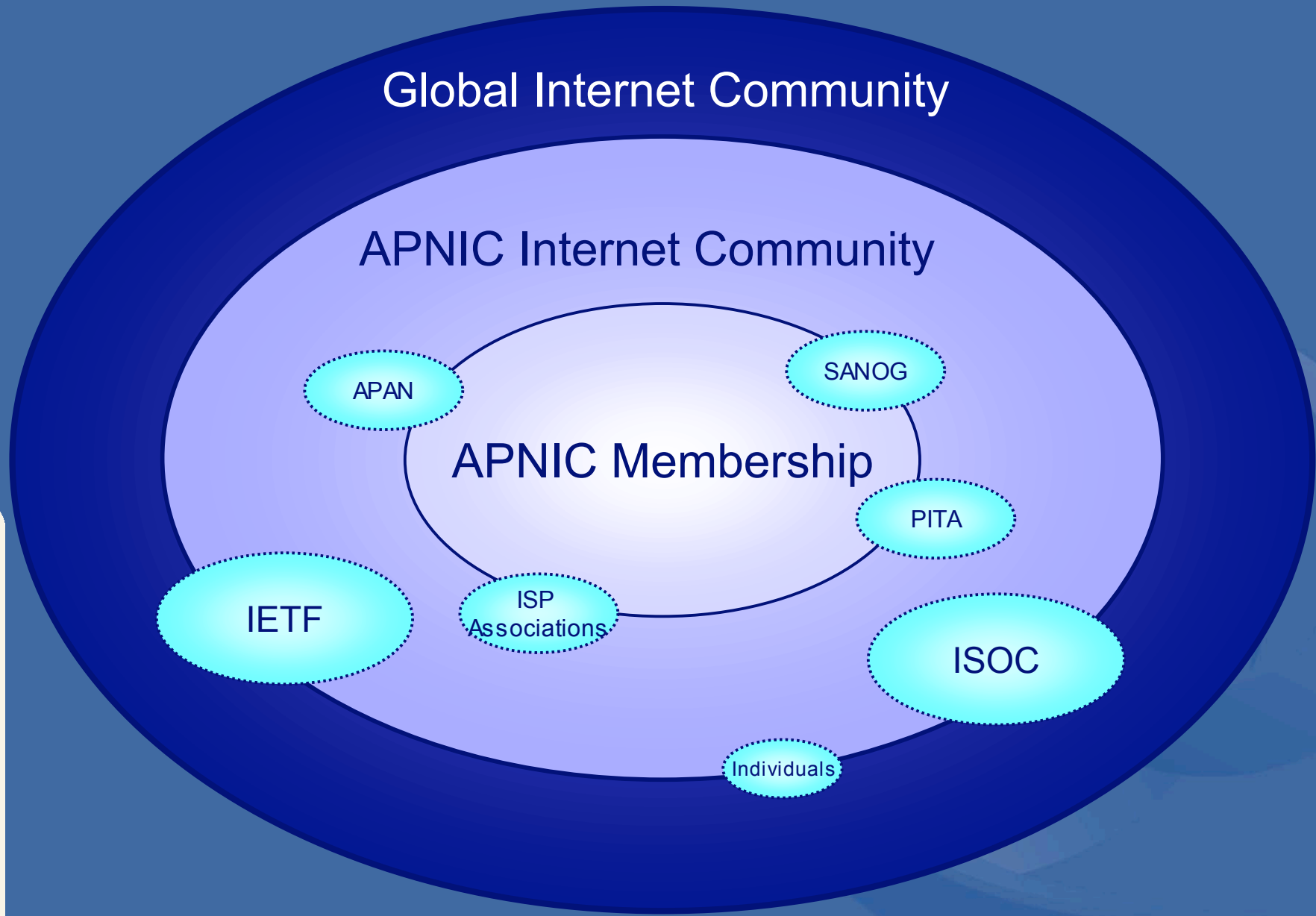
All decisions & policies documented & freely available to anyone
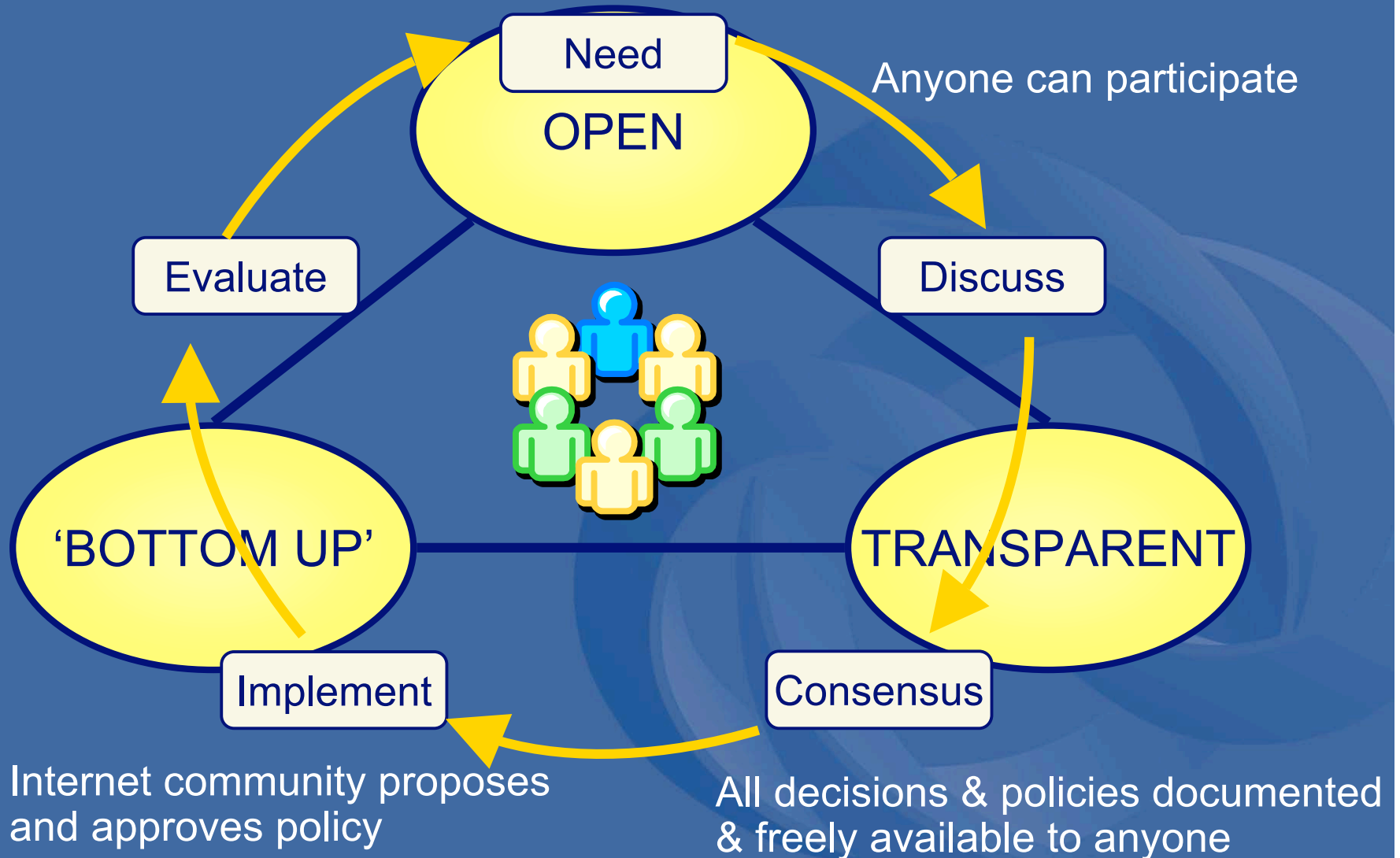
The policy development process

Need Discuss Consensus Implement

Proposal
(4 w before meeting)

ML
discussion

Meeting
discussion

Consensus

Report
to AMM

Consensus

Comment period
(8 weeks)

Consensus

EC endorsement

Implementation
(3 months)
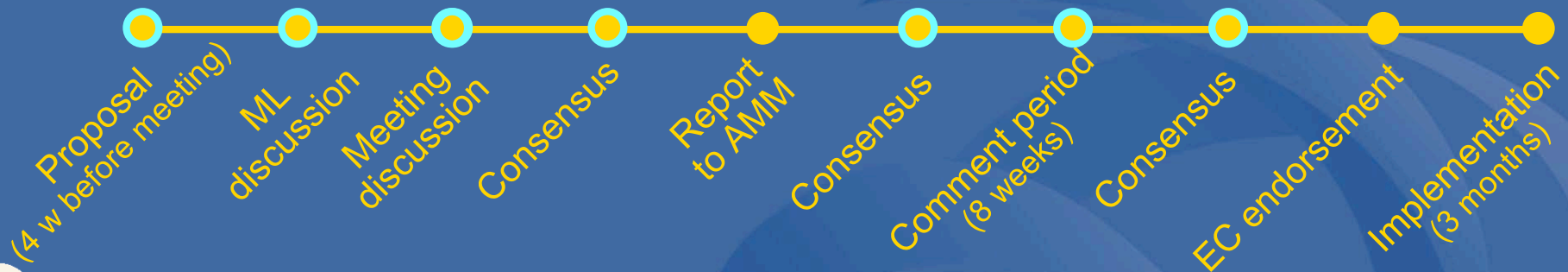
You can participate!

More information about policy development can be found at:

http://www.apnic.net/docs/policy/dev

Why should I bother to participate?

- Responsibility as an 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
  - Money matters $$

- Educational
  - Learn and share experiences
  - Stay abreast with 'best practices' in the Internet

APNIC

Training

APNIC Open Policy Meeting

- *"Inside the APNIC Open Policy Meeting"*
  - A documentary about the APNIC meetings

Questions ?

APNIC

Asia Pacific Network Information Centre
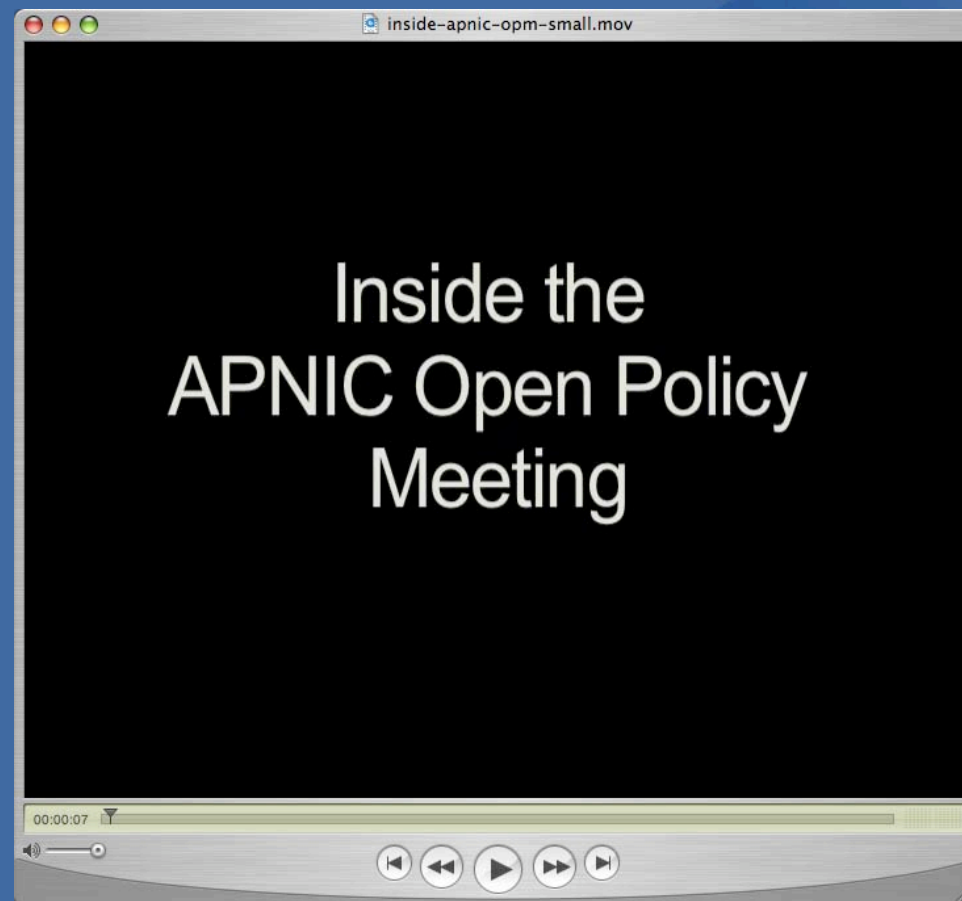
Problems, Myths & Challenges

What are the issues in Today's Internet?

APNIC

Problems in Today's Internet

- Spam
  - Unsolicited Commercial Email (UCE)
  - Spam volume is exploding
    - Single spammer can send 200 million messages a day
    - 8% of internet e-mail in 2001, 64% of internet e-mail in 2004

- Network abuse
  - APNIC does not regulate conduct of Internet activity
  - Investigation possibilities
    - Cooperation of the network administrators
    - law enforcement agencies

- Hijacking
  - Individuals making unauthorised changed to (legacy) IP address records in WHOIS
    - gives the illusion that the individual now has authority over resource records

Problems in Today's Internet

- Security
  - Unauthorized Intrusions
  - Denial of Service (DoS) Attacks
  - Viruses, Worms, Trojan Horses (Backdoors)
  - Internal Attacks
  - Non-compliance

  - *Secure your networks!*
    - Stay abreast – educate your staff
      - (Good workshops at APRICOT)

What do the RIRs do?

- Whois Database – *an important resource!*
  - Troubleshooting
  - Tracking source of abuse
  - APNIC now protecting address space to prevent hijacking
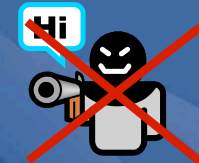
- Information dissemination
  - Open Policy meetings
    - Technical talks & tutorials
  - Publications & research

- Education
  - Training courses, workshops and seminars
    - Like this one! ☺

What can You do?

- Participate in the APNIC community
  - As a member / Internet organisation
    - Policy affects You!
    - Share Your views and experience
    - Stay abreast with latest developments!
      - Secure your networks!

  - As a regulator / policy maker
    - You have a role to play – stay informed!
    - *Strengthen relationship with APNIC!*

- APNIC Partners
  - APNIC has established relationships with a number of regional and global organisations:

ASO   Autonomica
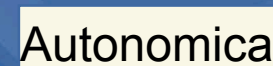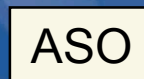
Other perceived "threats"

- ## NAT?

192.168.2.3 → [NAT] → 202.12.29.211

  - ### (Network Address Translation)

  - ## Different opinions

NATs are Evil

Well, Maybe just Bad for You

APNIC / Kuala Lampur
2004.02.26

Randy Bush <randy@iij.com>
Keith Moore <moore@cs.utk.edu>

    - ### Some people believe NAT is useful
    - ### Some people claim that "NAT is Evil"

http://www.apnic.net/meetings/17/docs/sigs/policy/addrpol-pres-randy-nats.pdf
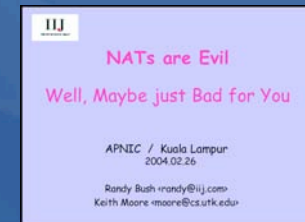
- ## Use entirely up to individual organisation

- ## Considerations:

  - ### Breaks end-to-end model, increases complexity, makes troubleshooting more difficult, introduces single point of failure

Other Hot Topics - Internet Governance

- What is Internet Governance?
- May include any aspect of the Internet which requires regulation, coordination or oversight
  - Cybercrime, security, spam, phishing, hacking
  - Content regulation
  - Commerce, trade and taxation
  - Intellectual property
  - Telecommunications regulation, competition policy
  - Development and facilitation, capacity building
  - Equity of access
  - Technical standards and coordination
- None of these are entirely new areas

WSIS

- Intergovernmental summit hosted by UN
- WSIS scope covers all aspects of ICTs
  - Content, crime, digital divide, ecommerce, capacity building, financing…
  - Internet Governance: names and numbers, interconnection, security…
- Outcomes: "Declaration" and "Plan of Action"
  - Guidance to UN and Governments
  - Non-binding, but highly influential
- RIRs position
  - Promote the need for continued stability in IP address distribution systems
  - Dispel misconceptions and misunderstanding
  - Promote a position of "do no harm", and be mindful of cross-impacts

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The RIR structure

- Industry self-regulatory structures
  - Non-profit, open membership bodies
- Open and transparent processes
  - Consensus-based decision-making
  - Policy development
  - Flexibility allows adaptation to Industry changes
  - Open participation
  - Democratic, bottom-up processes
- Membership structure
  - 100% Self-funded through membership fees
  - National Internet Registries
    - National representative bodies

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Questions ?

APNIC

Asia Pacific Network Information Centre

The Internet Tomorrow

What will happen with the Internet?

APNIC

Are we running out of IP addresses?

- ## Some media reports claiming we are running out of IP addresses
  - Some claim we've already run out in some parts of the world

- ## But what are the facts?
  - *Is the IPv4 sky falling?*

- ## Geoff Huston, Internet research scientist at APNIC, has studied the IPv4 consumption rates

http://www.apnic.net/news/hot-topics/index.html#other

IPv4 Lifetime

- ## IPv4 Address Space Report (Geoff Huston)

  This report is generated automatically on a daily basis, and reflects the application of best fit models to historical data relating to the growth in the address space advertised in the BGP routing table. The underlying assumptions made in this predictive model is that the previous drivers in address consumption will continue to determine future consumption rates, and that growth in consumption rates will continue to operate in a fashion where the growth rate is constant rather than increasing or decreasing.

- ## Data analysed:
  - ### IANA – RIR Allocations
  - ### RIR – ISP/LIR Allocations
  - ### BGP routing table
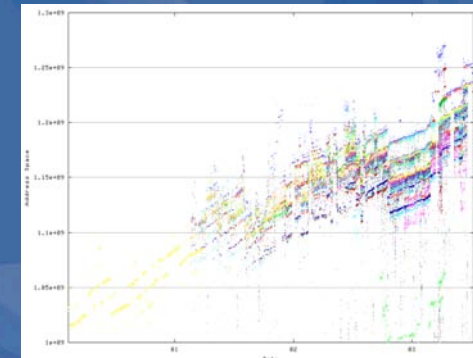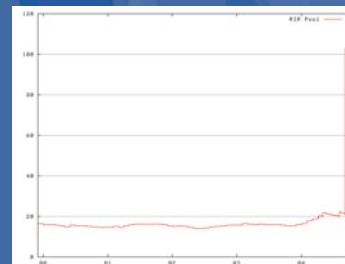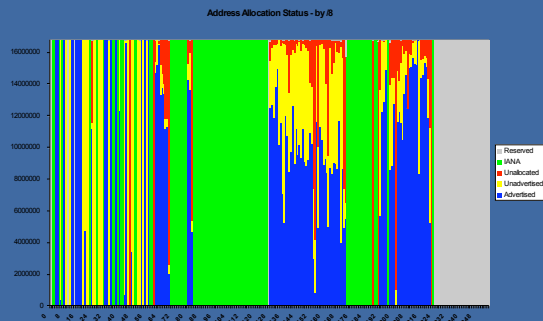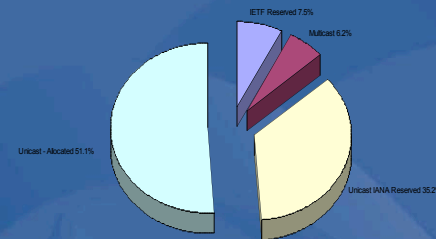
IPv4 Lifetime

- Complete Exhaustion of all available IPv4 Address Space:
  September 2022
- Exhaustion of the IPv4 Unallocated Address Pool
  November 2013

IPv4 Model
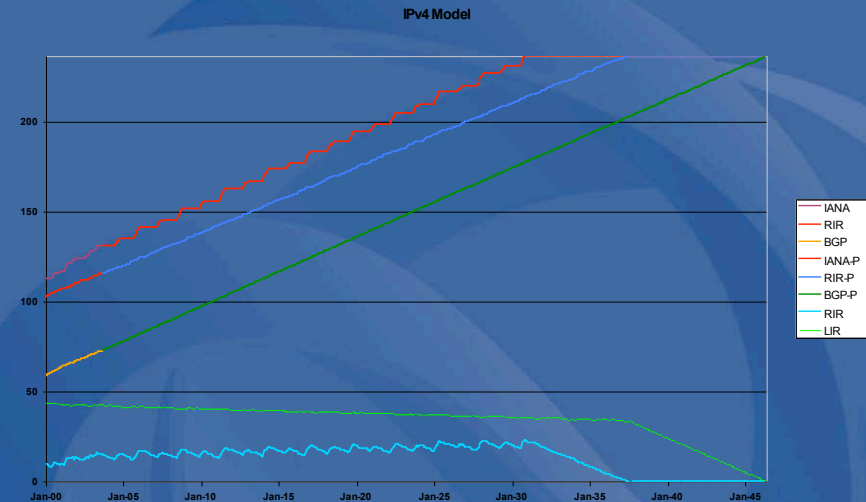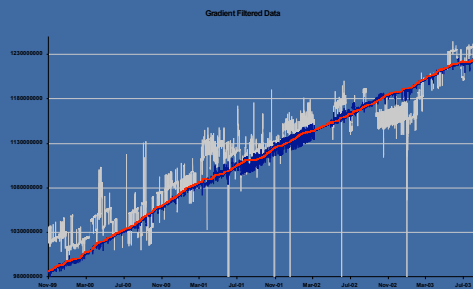
Summary:

"Don't make all those Hostmasters redundant, just yet. We will need them…"

http://bgp.potaroo.net/ipv4/

Concluding thoughts…

- Analysis of IPv4 allocation rates and the BGP routing table
    - Conclusions based on a model – reality will be different!
        - Many uncertainties with this projection

- IPv4 address space not yet exhausted
    - But impossible to predict future
        - Policies & market change, new technologies emerge

- Responsible management essential to future Internet

- IPv6
    - Necessary to start now – transition will take time!
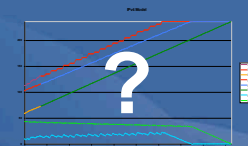
IPv6 - Internet for everything!

Questions ?

APNIC
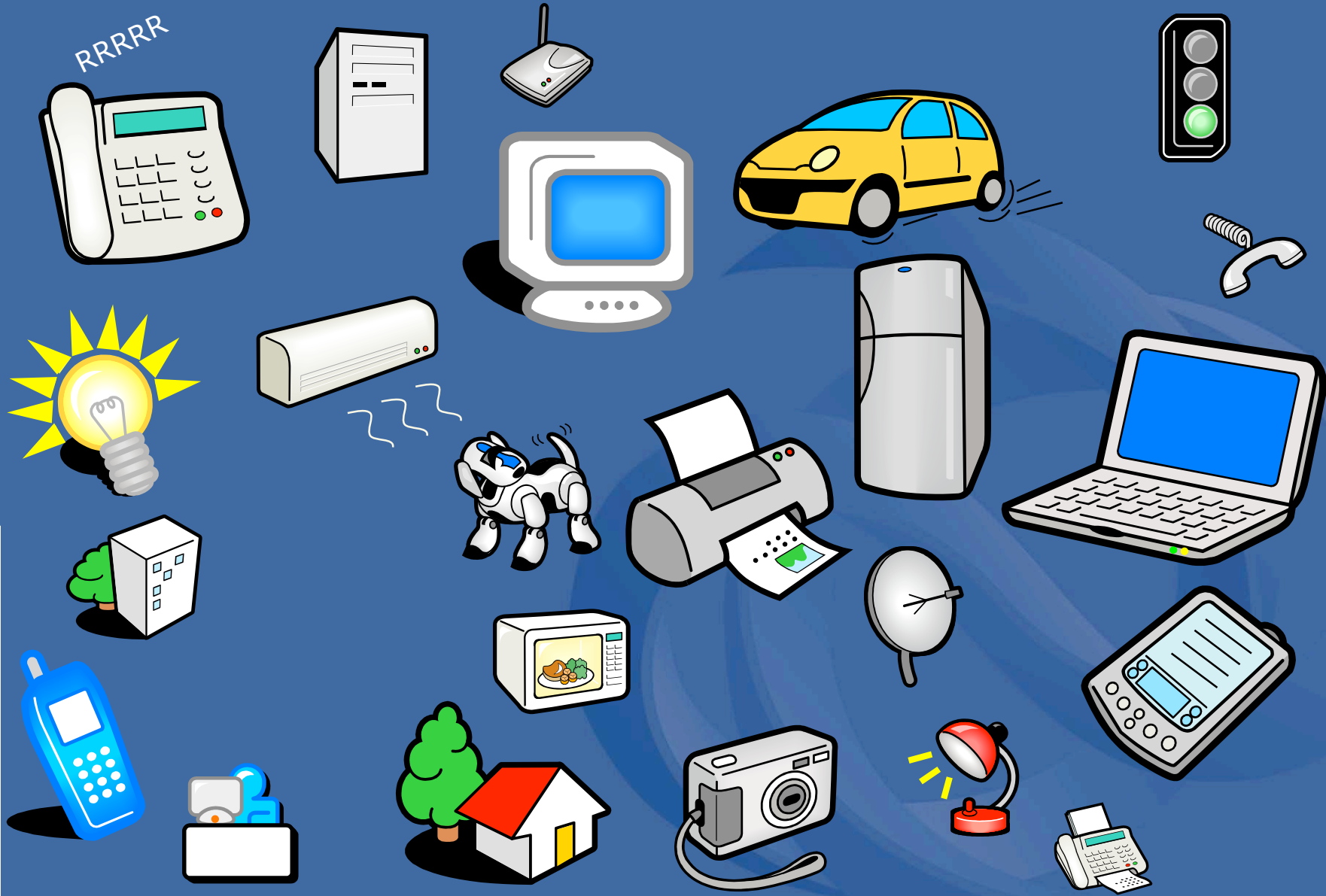
IPv6

Overview, Policies & 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)

- Needs to improve Internet environment
  - Encryption, authentication, and data integrity safeguards
  - Plug and Play

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:
    - 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 address topology

LIR

ISP

ISP

ISP

Public Topology
**(Transit providers,
ISPs & Exchanges)**

**Site Topology
(LAN)
&
Interface ID (link)**

Customer site

Customer site
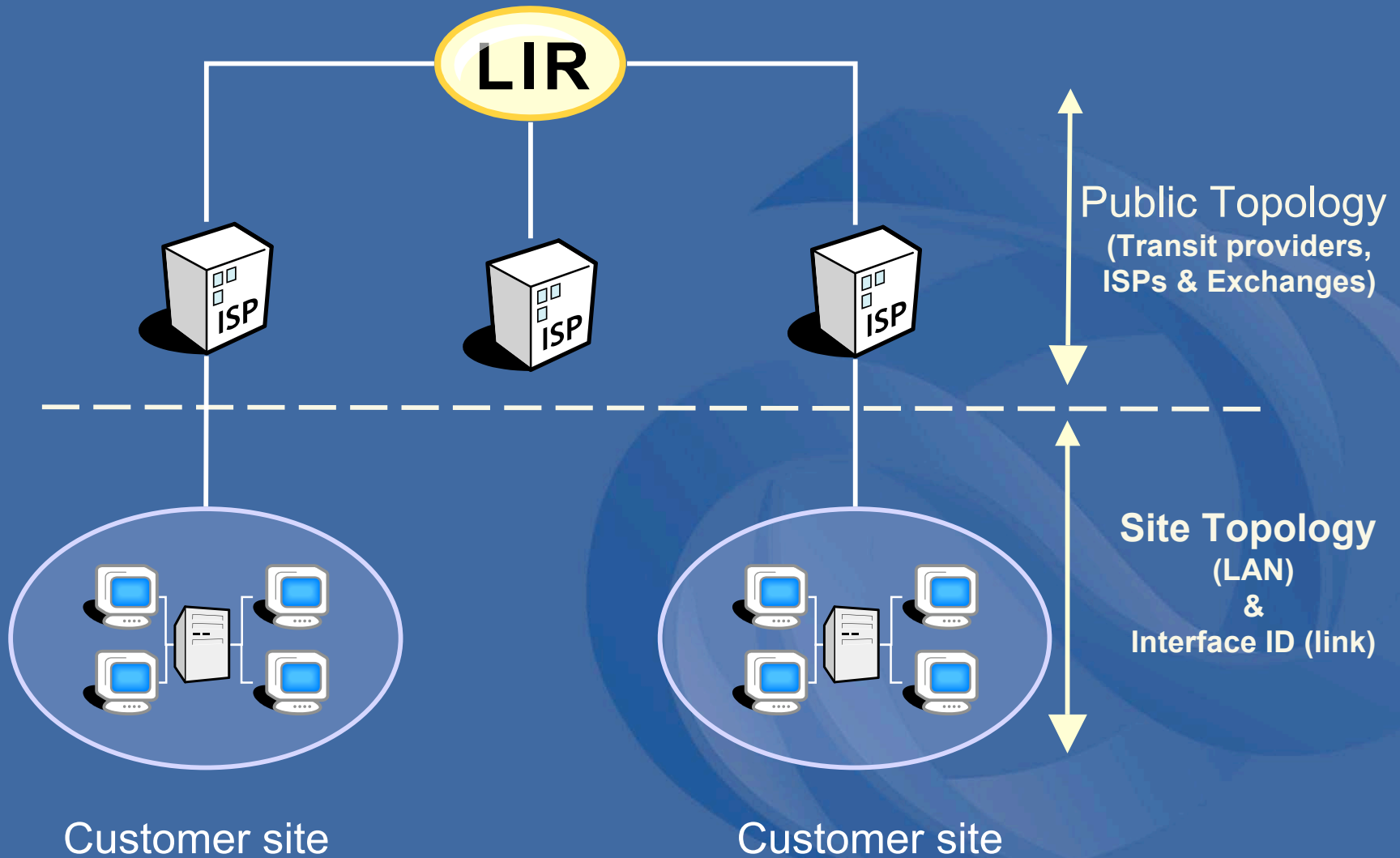
IPv6 addressing structure

128 bits

0   127

| 32 | 16 | 16 | 64 |

LIR /32

Customer Site /48

Subnet /64

Device /128

IPv6 experiments

Light

PC

Air conditioner

Home hub

Mobile viewer

Access point

IPv6 network

Home router

Home hub

IPv6-washing machine   IPv6-refrigerator   IPv6-microwave

———— Ethernet
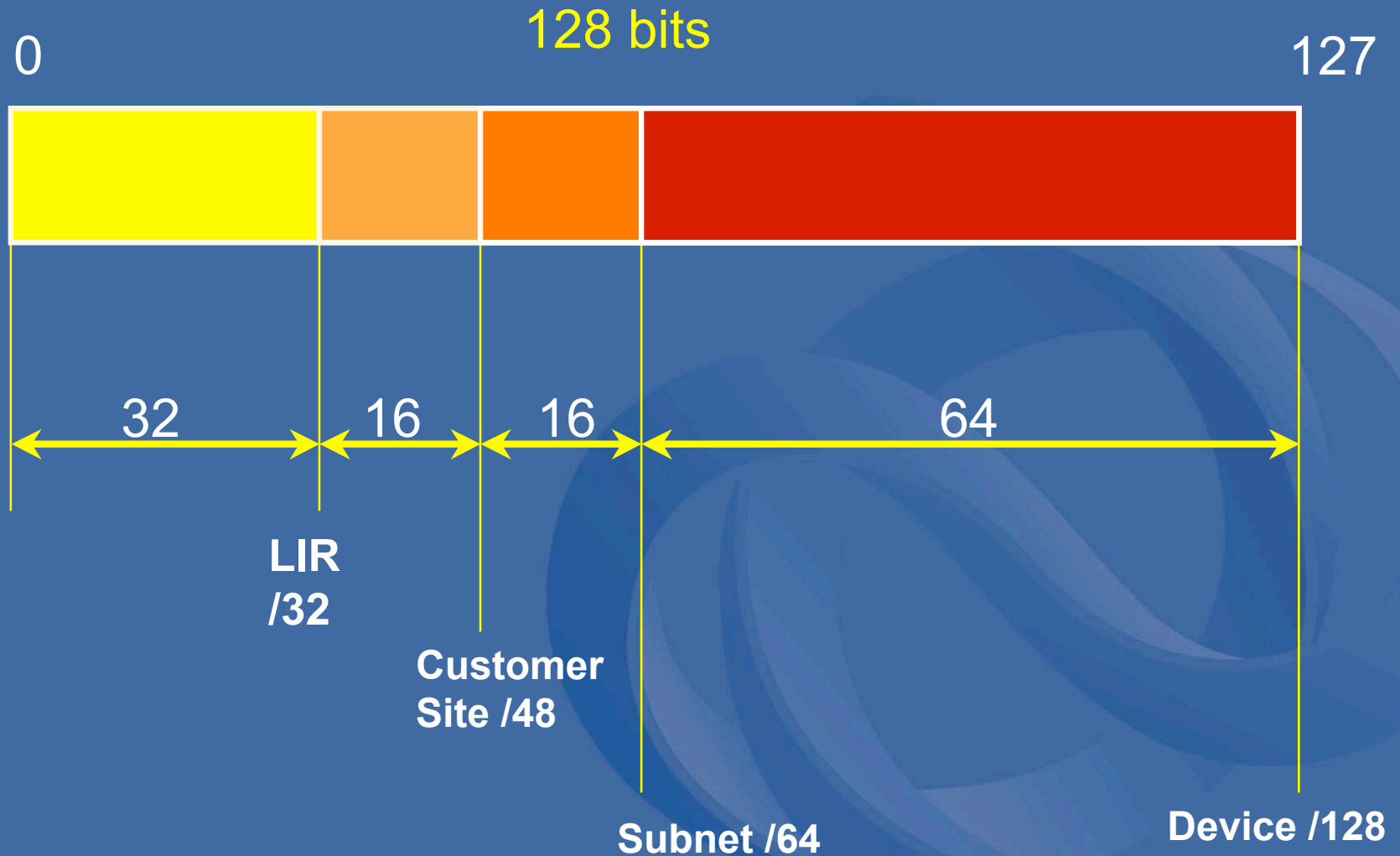
⚡ Wireless
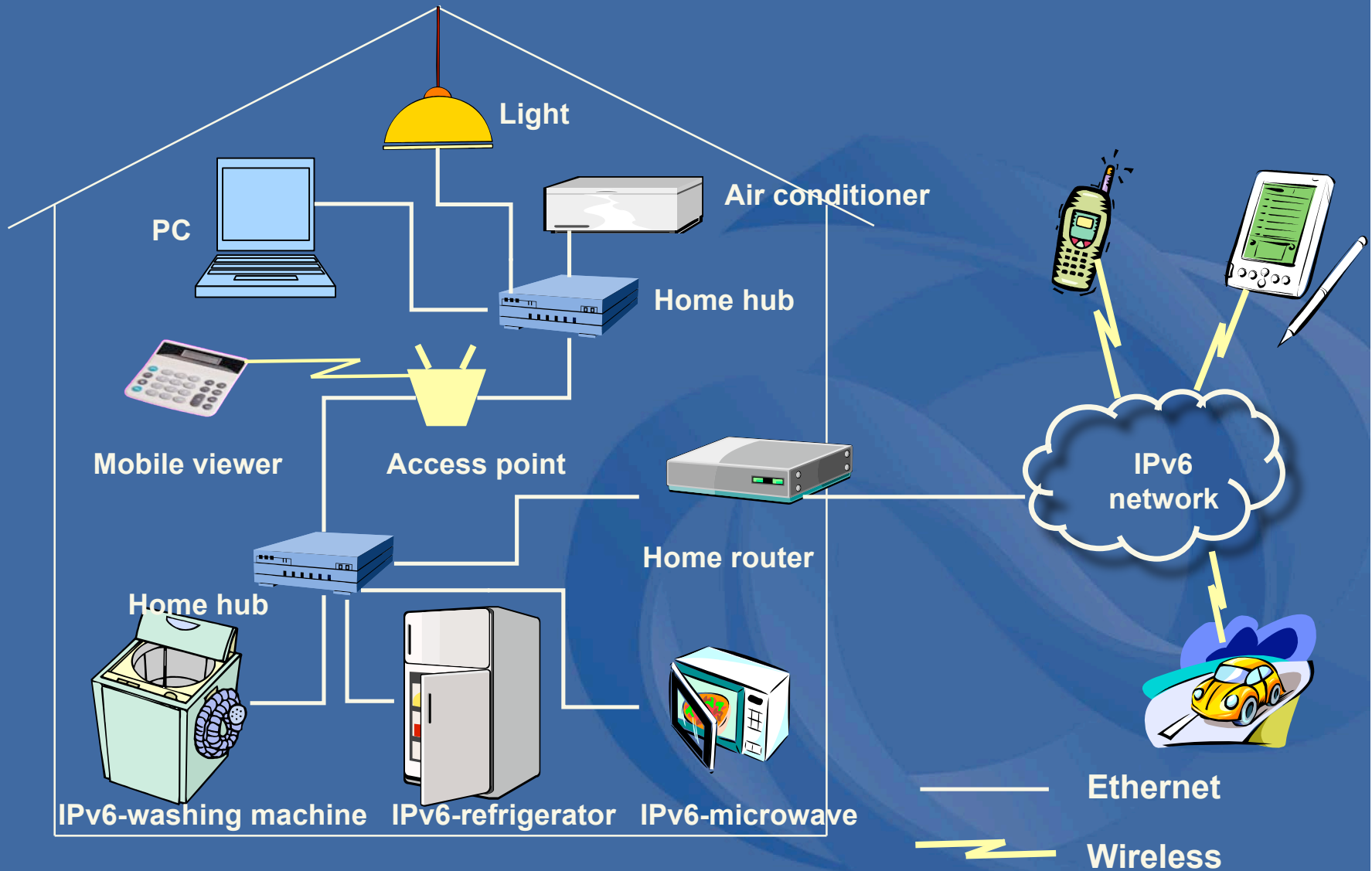
IPv6 address policy goals

Efficient address usage
- Avoid wasteful practices

Aggregation
- Hierarchical distribution
- Limit routing table growth

Registration
- Ensure uniqueness
- Facilitate troubleshooting

Minimise overhead
- Associated with obtaining address space

Uniqueness, fairness and 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

IPv6 Resource Guide
    http://www.apnic.net/services/ipv6_guide.html

Current IPv6 discussions

- Multihoming
  - Still no solution for this

- How long will IPv6 last?
  - Is current policy reasonable and conducive to a long-term deployment of IPv6?
    - Proposal to increase IPv6 usage efficiency:
    - http://www.apnic.net/docs/policy/proposals/prop-031-v001.html

IPv4 to IPv6 transition

- Commonly used transition techniques

  - Dual Stack Transition
    - To allow IPv4 and IPv6 to co-exist in the same devices and networks
  - Tunneling
    - To avoid order dependencies
  - Translation
    - To allow IPv6 only devices to communicate with IPv4 only devices

IPv6 Allocations in Asia Pacific 1999

JP 3
KR 2
AU 1
SG 1
Total **7**

Eastern Asia
South-central Asia
South-eastern Asia
Oceania
Africa
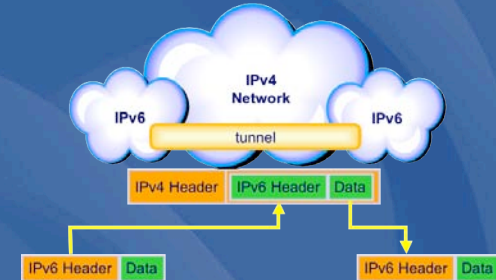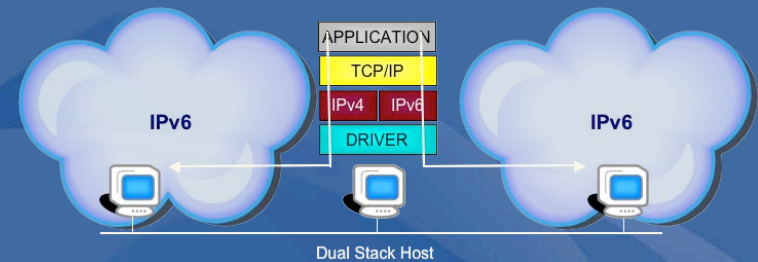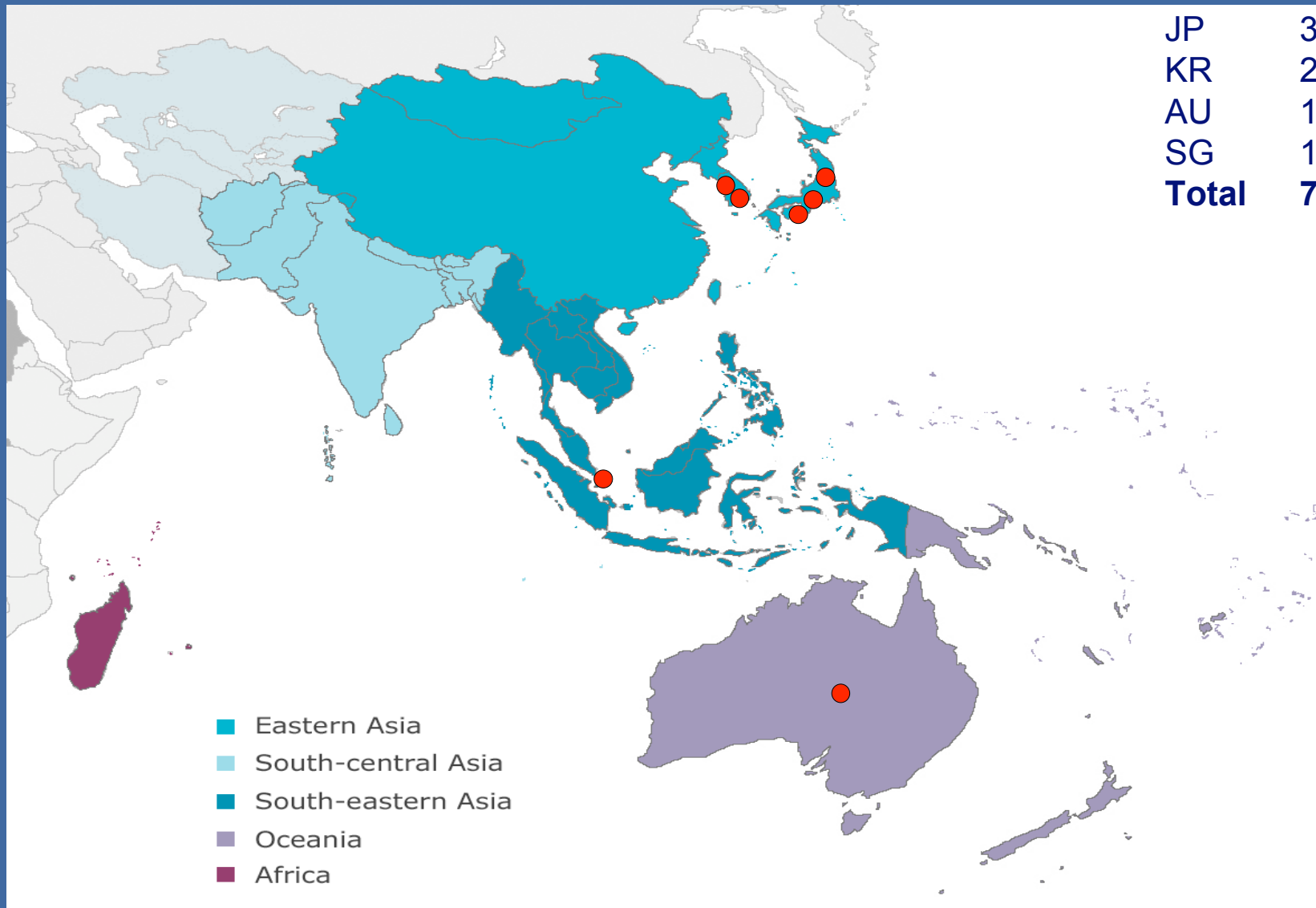
IPv6 Allocations in Asia Pacific 2000
(cumulative total)

JP	12
KR	5
TW	2
CN	1
AU	1
SG	1
Total	**22**

- Eastern Asia
- South-central Asia
- South-eastern Asia
- Oceania
- Africa

Asia Pacific Network Information Centre

APNIC
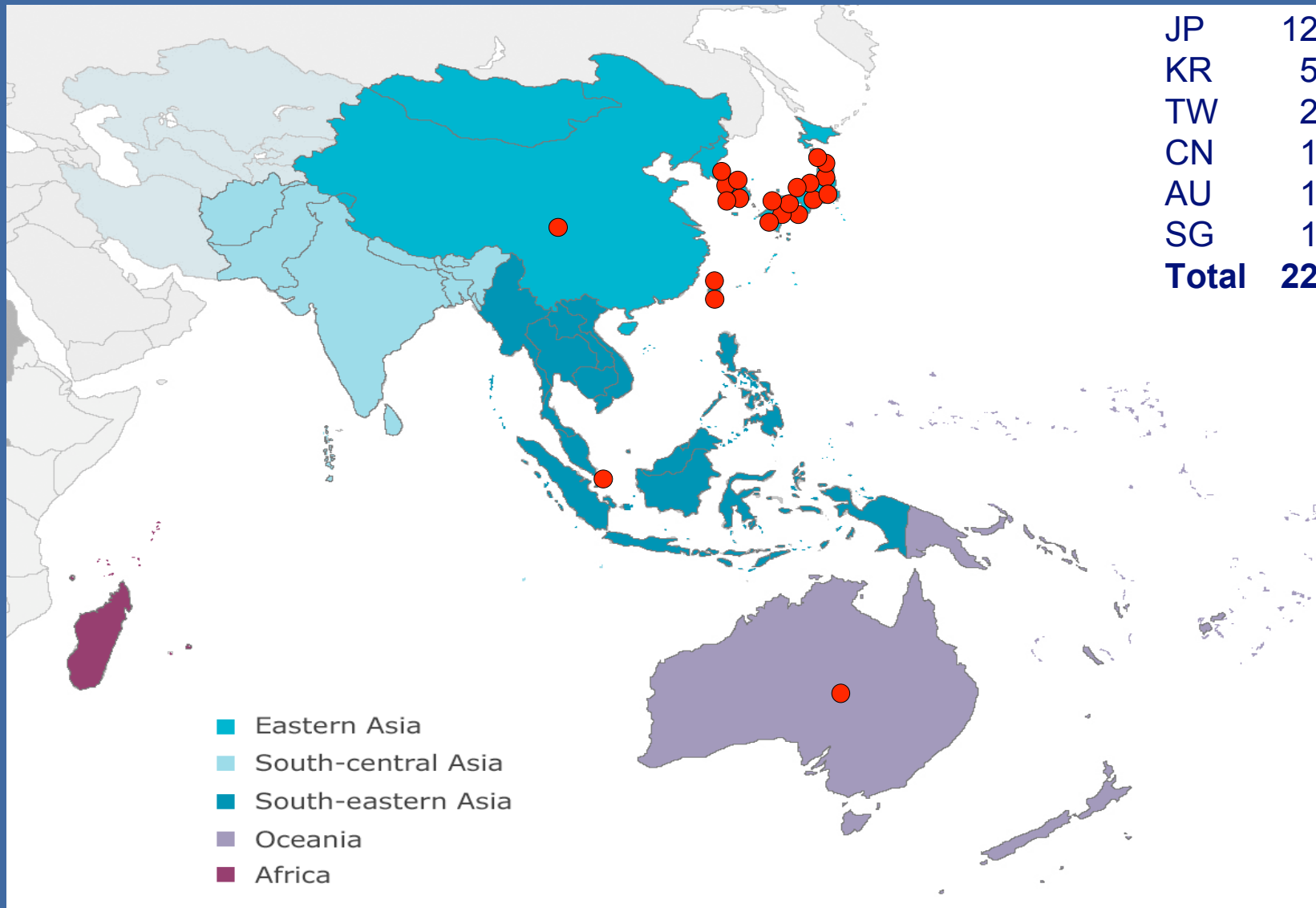
IPv6 Allocations in Asia Pacific 2001
(cumulative total)
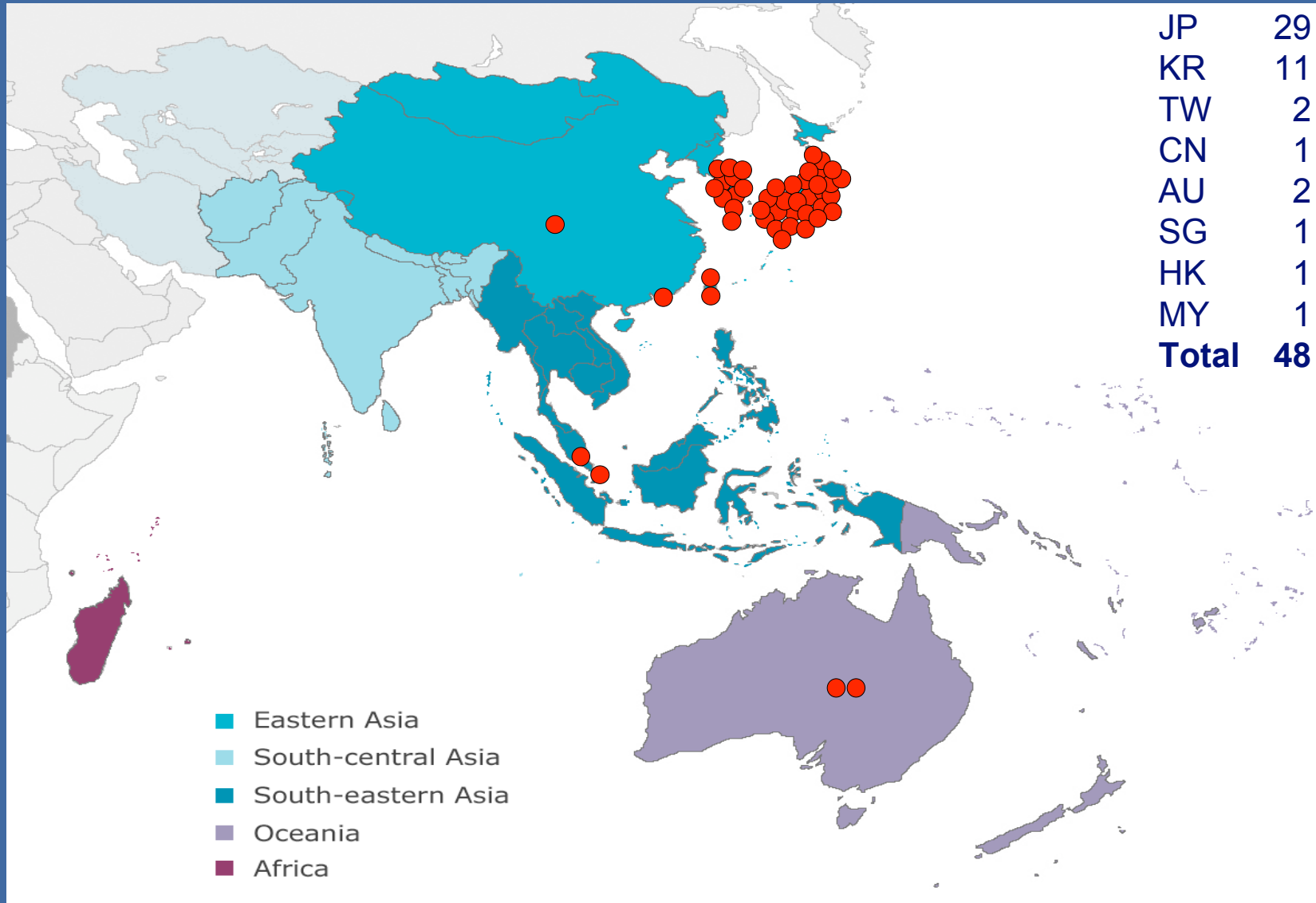
IPv6 Allocations in Asia Pacific 2002
(cumulative total)

JP	50
KR	15
TW	7
CN	4
AU	4
SG	4
HK	2
MY	2
PG	1
TH	3
IN	1
Total	**93**

Legend:
- Eastern Asia
- South-central Asia
- South-eastern Asia
- Oceania
- Africa
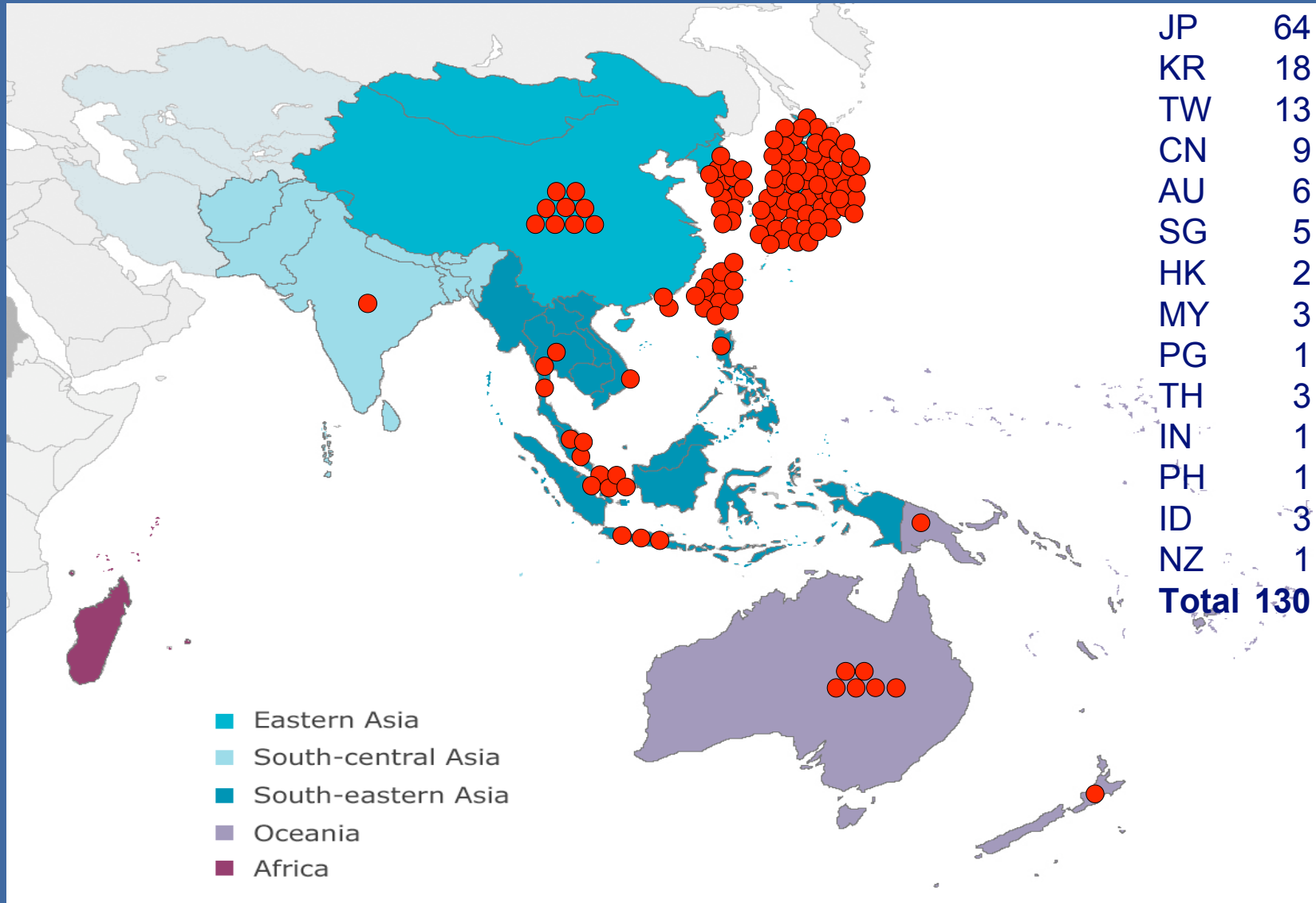
IPv6 Allocations in Asia Pacific 2004
(cumulative total)

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**

Eastern Asia
South-central Asia
South-eastern Asia
Oceania
Africa
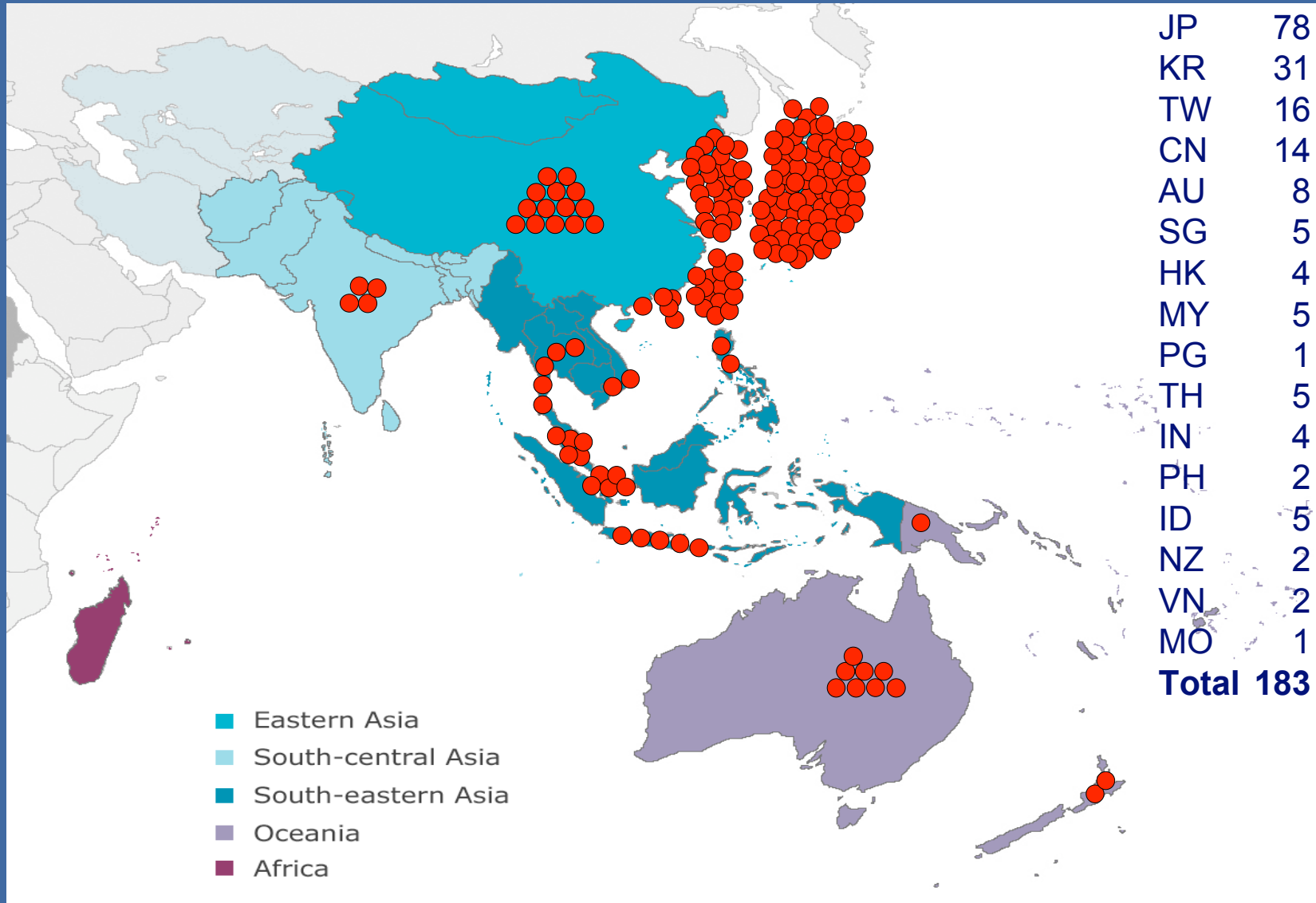
IPv6 Allocations in Asia Pacific 2005
(cumulative total to July 2005)

JP	86
KR	34
TW	17
CN	15
AU	10
SG	6
HK	5
MY	7
PG	1
TH	6
IN	6
PH	5
ID	5
NZ	5
VN	2
MO	2
PK	1
Total	**213**

Legend:
- Eastern Asia
- South-central Asia
- South-eastern Asia
- Oceania
- Africa

APNIC — Asia Pacific Network Information Centre

RIR IPv6 Allocations

APNIC — 213

Ripe NCC — 406

ARIN — 118

LACNIC — 13
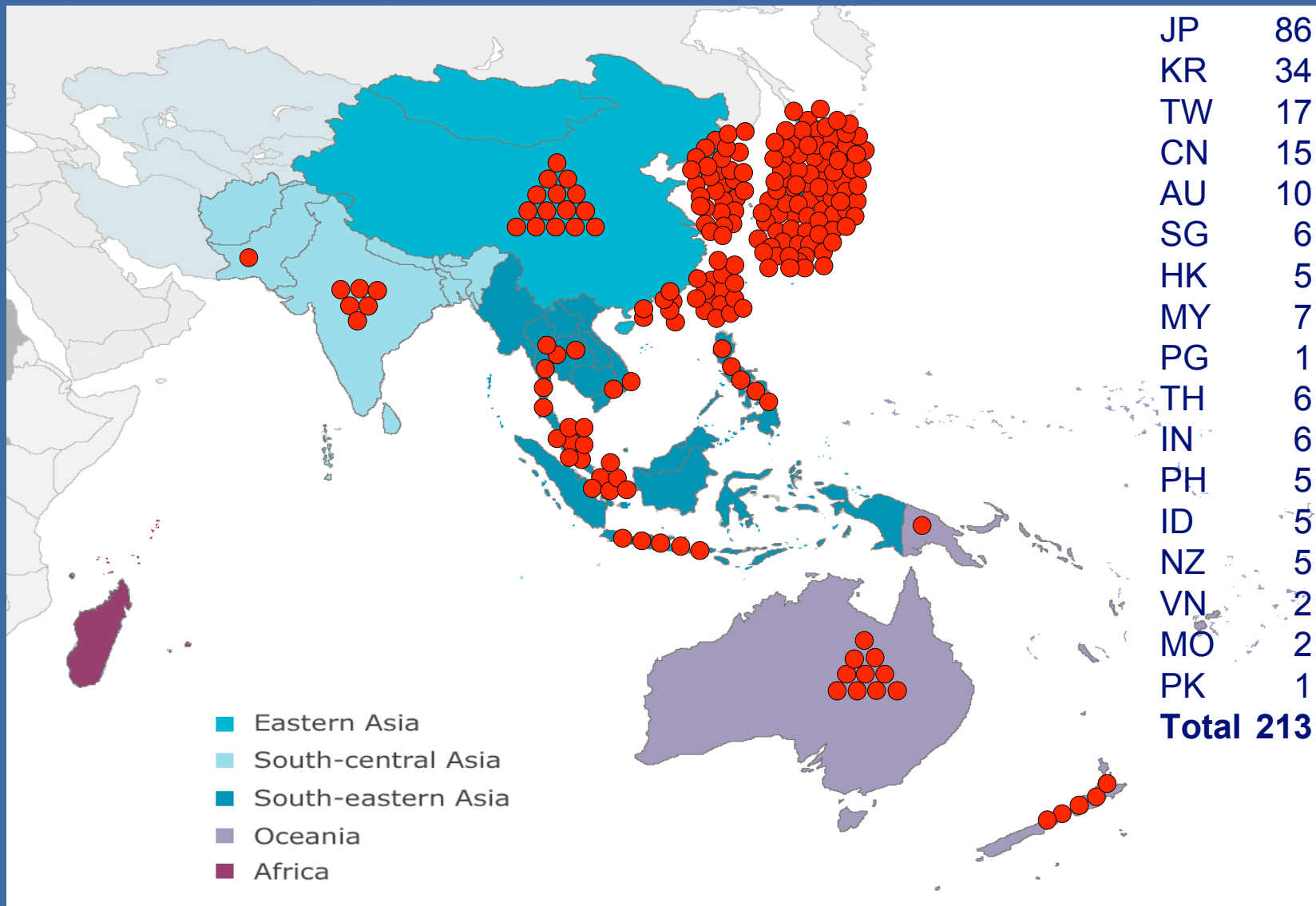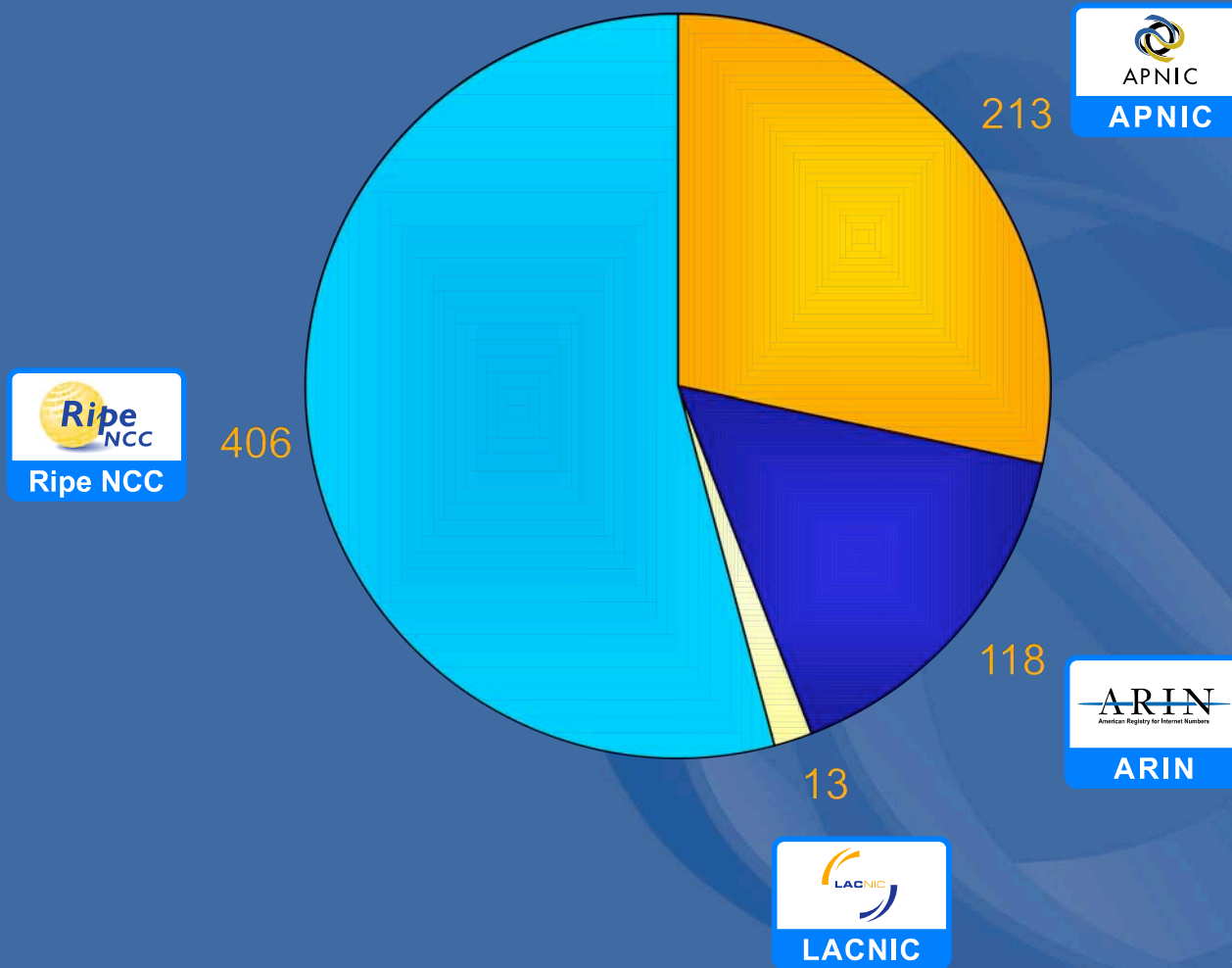
July 2005

Questions ?

Summary - myth debunking

- IPv4 address exhaustion is NOT imminent.
- RIRs support IPv6 deployment
  - Transition will take time – start now!
- No discrimination in IP address distribution
  - Newcomers can still get addresses
- Take part in the decision making process!
  - Voice your opinions

Summary

- IP address management
  - Result of 20 year evolution on the Internet
    - Supported Internet growth to date
  - Responsible management essential to keep the Internet running

- What's next?
  - Don't miss out!
    - Invest in education
    - Participate in the APNIC community
      - You have a role to play
  - IPv6
    - Transition will take time – start now!

Questions ?

Thank you

APNIC

Presentation will be available at:
http://www.apnic.net/community/presentations/other.html

References

Additional Reading

Introduction

Regional Registry web sites

- APNIC:

  http://www.apnic.net

- ARIN:

  http://www.arin.net

- LACNIC:

  http://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

Asia Pacific Network Information Centre

APNIC

Introduction to APNIC & IP Policy

Classless techniques

- CIDR

  http://www.ietf.org/rfc/rfc1517-19.txt

- Network Addressing when using CIDR

  ftp://ftp.uninett.no/pub/misc/eidnes-cidr.ps.Z

- Variable Length Subnet Table

  http://www.ietf.org/rfc/rfc1878.txt

Private Address Space

- Address Allocation for Private Internets

  http://www.ietf.org/rfc/rfc1918.txt

- Counter argument: "Unique addresses are good"

  http://www.ietf.org/rfc/rfc1814.txt

APNIC

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 discussions relevant to APNIC community & members
- apnic-announce
  - Announcements of interest to the AP community
- sig-policy
  - IPv4 and IPv6 allocation and assignment policies
- global-v6
  - Global IPv6 policy mailing list

- subscribe via <list-name>-request@lists.apnic.net
- archives:

    http://ftp.apnic.net/apnic/mailing-lists

    http://www.apnic.net/net_comm/lists/

The RIR System

"Development of the Regional Internet Registry System"

Internet Protocol Journal

Vol. 4, Number 4

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

- RFC2050: Internet Registry IP allocation Guidelines

    http://www.ietf.org/rfc/rfc2050.txt

Asia Pacific Network Information Centre

APNIC

APNIC Database

APNIC Database Documentation

- Updating information in the APNIC Database
  http://ftp.apnic.net/apnic/docs/database-update-info

- Maintainer & Person Object Request Form
  http://ftp.apnic.net/apnic/docs/mntner-person-request

- APNIC Maintainer Object Request
  http://www.apnic.net/apnic-bin/maintainer.pl

- APNIC Whois Database objects resource guide
  http://www.apnic.net/services/whois_guide.html

Reverse DNS

Request Forms

- Guide to reverse zones

    http://www.apnic.net/db/revdel.html

- Registering your Rev Delegations with APNIC

    http://www.apnic.net/db/domain.html

Relevant RFCs

- Classless Delegations

    http://www.ietf.org/rfc/rfc2317.txt

- Common DNS configuration errors

    http://www.ietf.org/rfc/rfc1537.txt

APNIC

Other supplementary reading

Operational Content Books

- *ISP Survival Guide*, Geoff Huston
- *Cisco ISP Essentials*, Philip Smith

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://www.ietf.org/rfc/rfc1997.txt

  http://www.ietf.org/rfc/rfc1998.txt

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://www.ietf.org/rfc/rfc2267.txt

Other Supplementary Reading

- Dampening case studies at

  http://www.cisco.com/warp/public/459/16.html

- Traceroute Server

  http://nitrous.digex.net

- Network Renumbering Overview: Why Would I Want It and What Is It Anyway?

  http://www.ietf.org/rfc/rfc2071.txt

- Procedures for Enterprise Renumbering

  http://www.isi.edu/div7/pier/papers.html

- NAT

  - The IP Network Address Translator

  http://www.ietf.org/rfc/rfc1631.txt

IPv6

- 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

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