Asia Pacific Network Information Centre

APNIC

Welcome!

APNIC Internet Resource Management Seminar

International Conference on Internet Resource Management

- e Connect 2004 -

12 October 2004, Colombo, Sri Lanka

In collaboration with

ICTA & KRNIC

Introduction

Presenters

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Outreach & Training

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Research & Liaison Officer

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?

ISP?
Regulator?
Government?

Technical?

Administrative?

APNIC member?

New to APNIC?

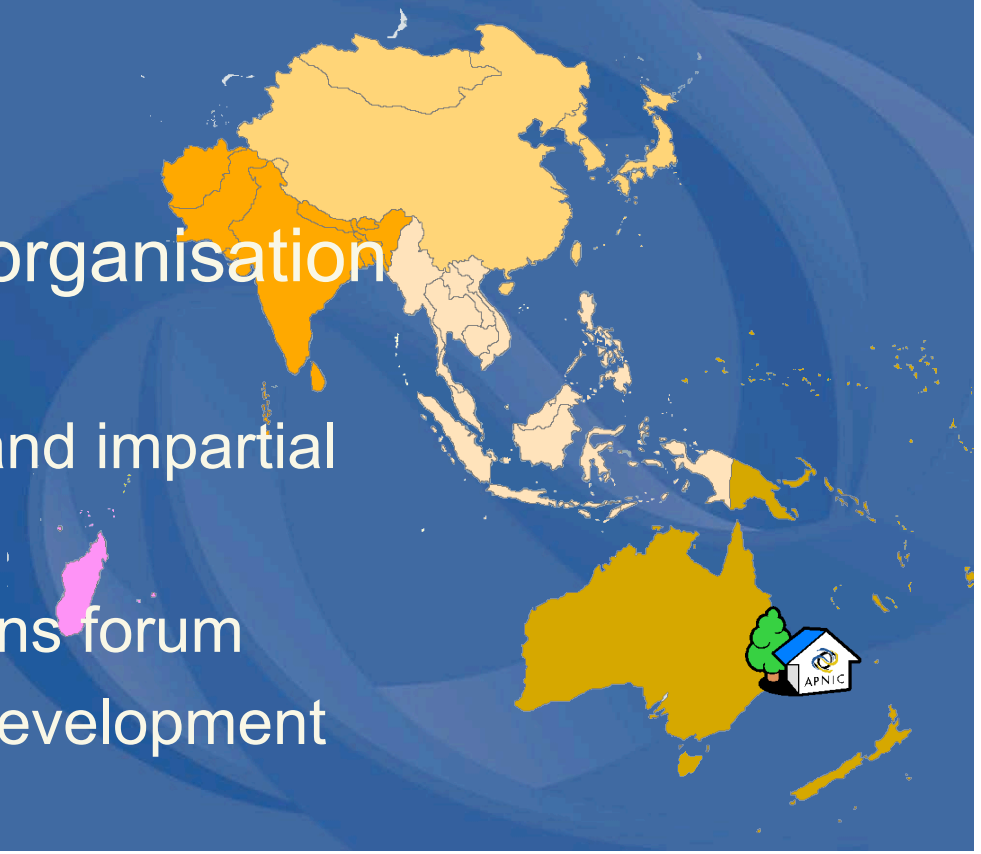
?

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."

Asia Pacific Network Information Centre

APNIC

Internet Resources

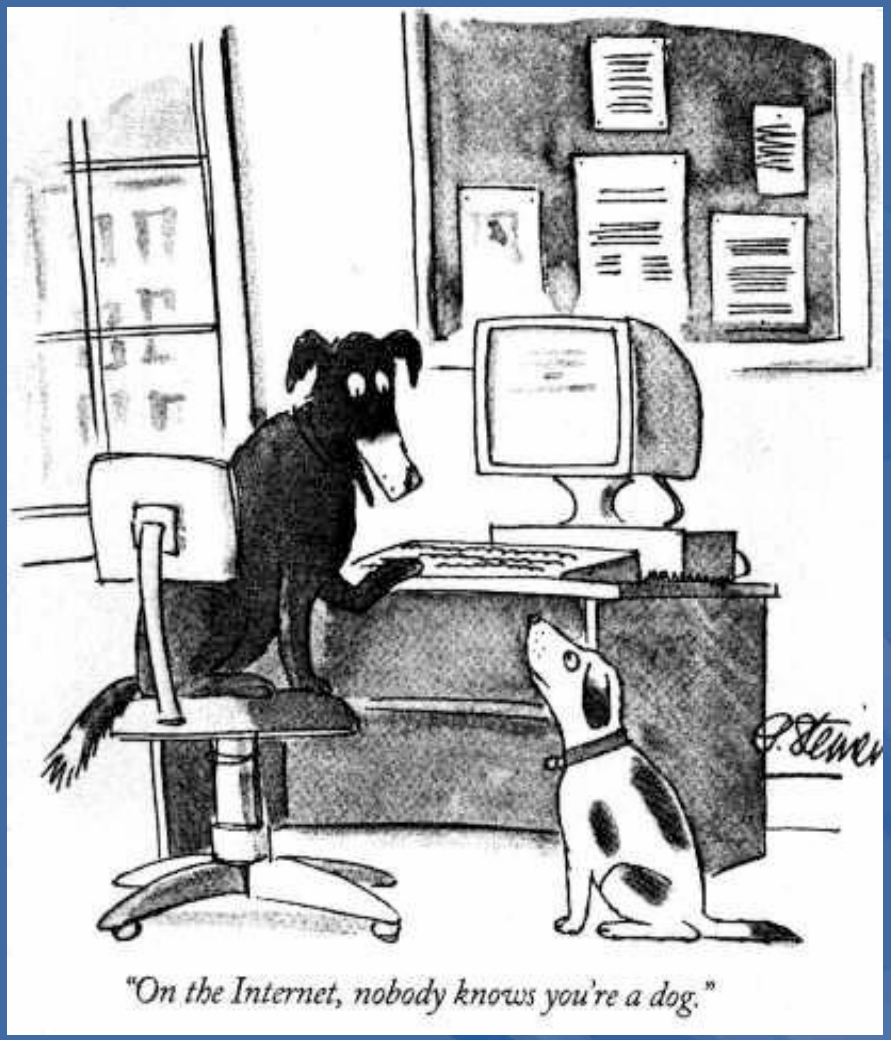
- Internet resources are
  - IP addresses
  - AS numbers

- But what are IP addresses…?

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!

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

pwilson@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

IPv4 and IPv6 addresses

IPv4

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

  Addresses available: ~4 billion

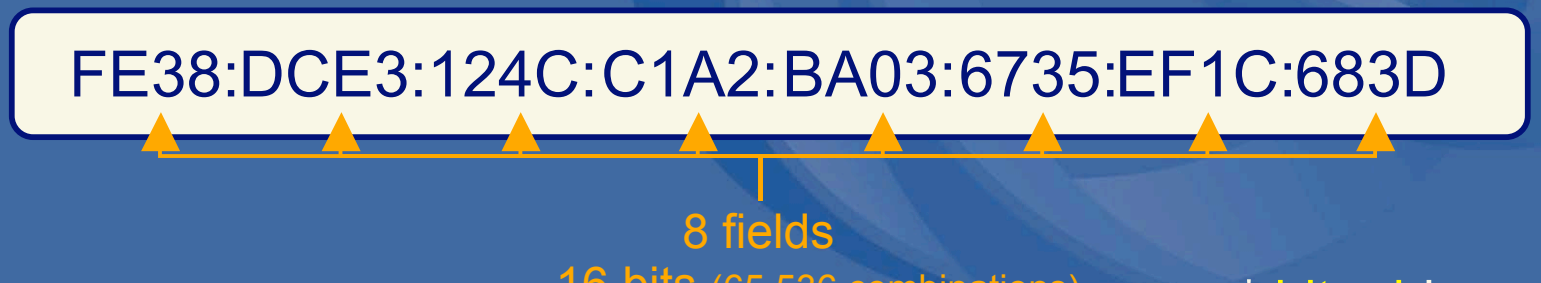
  Example:

IPv6

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

  Addresses available: 340 billion billion billion billion

  Example:

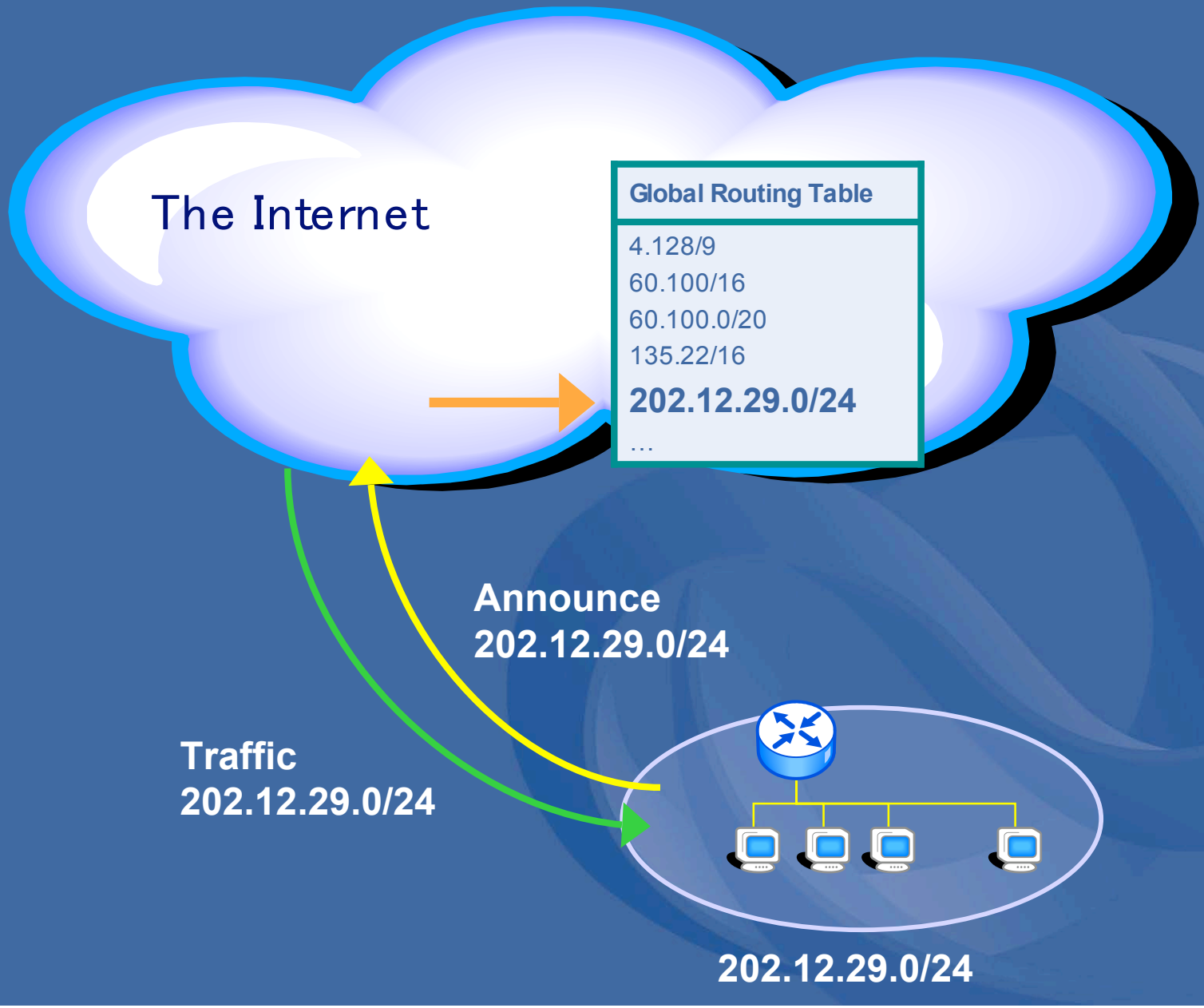


* bit = binary digit

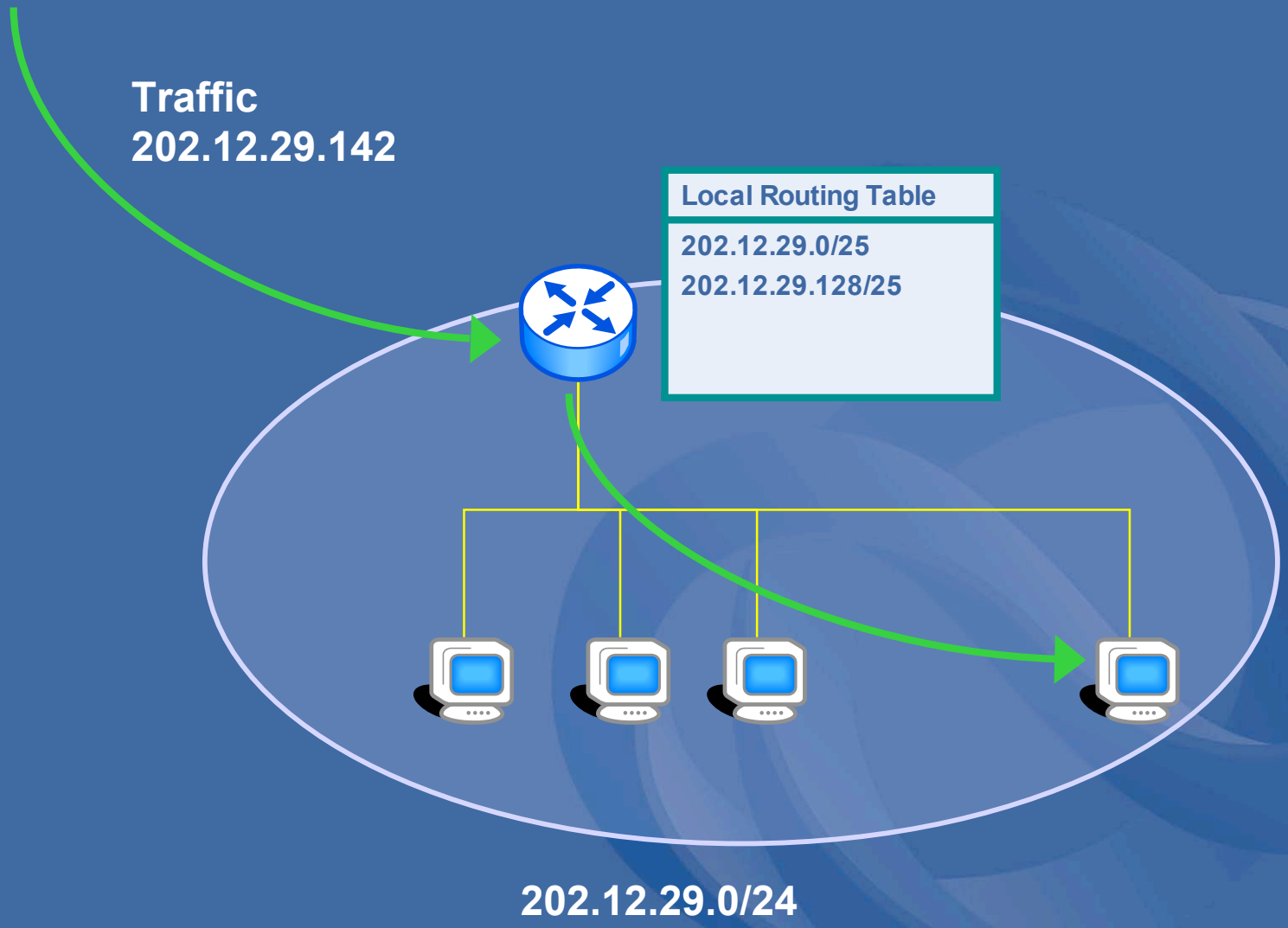
Where are IP Addresses used?

```
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



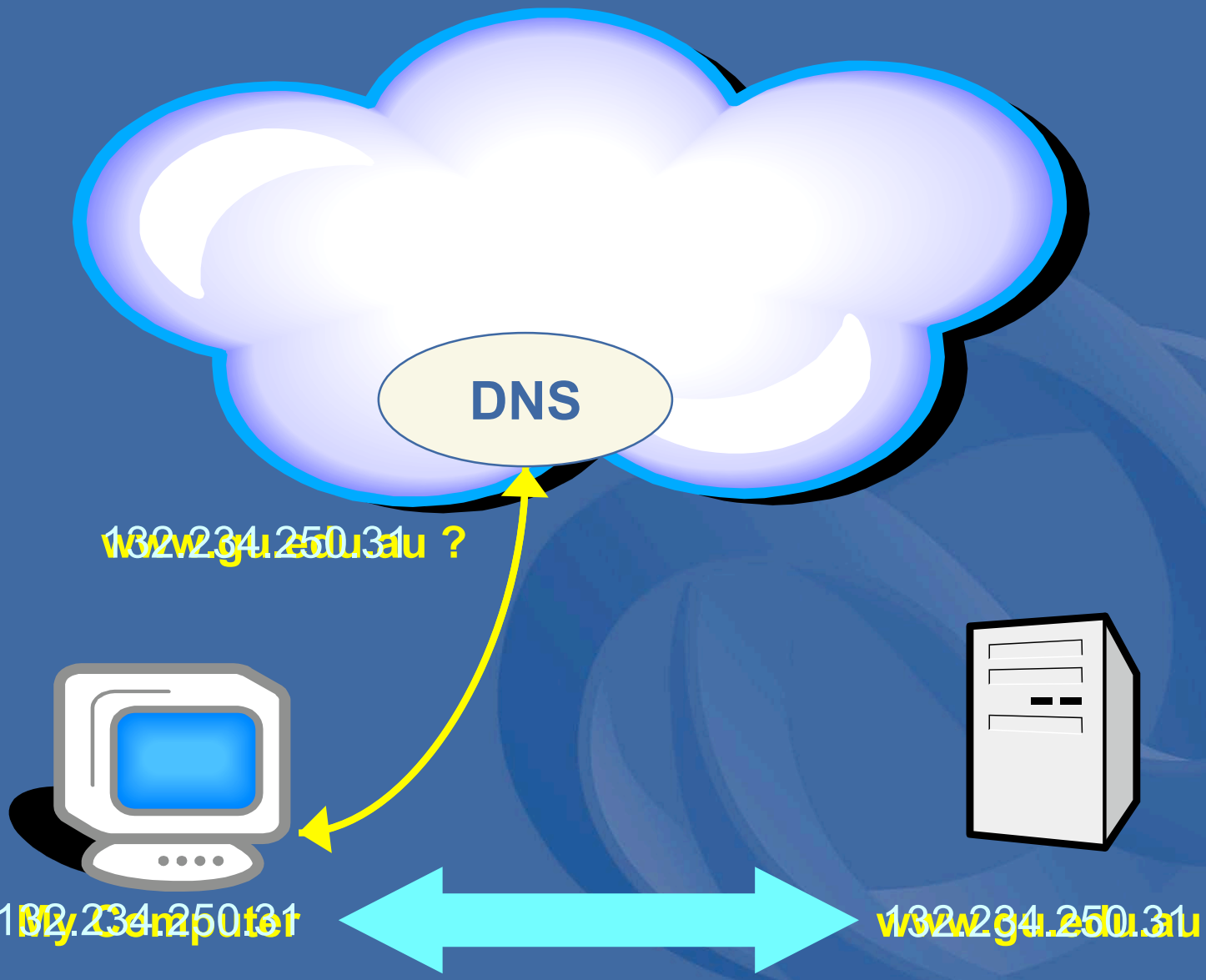
Internet address routing



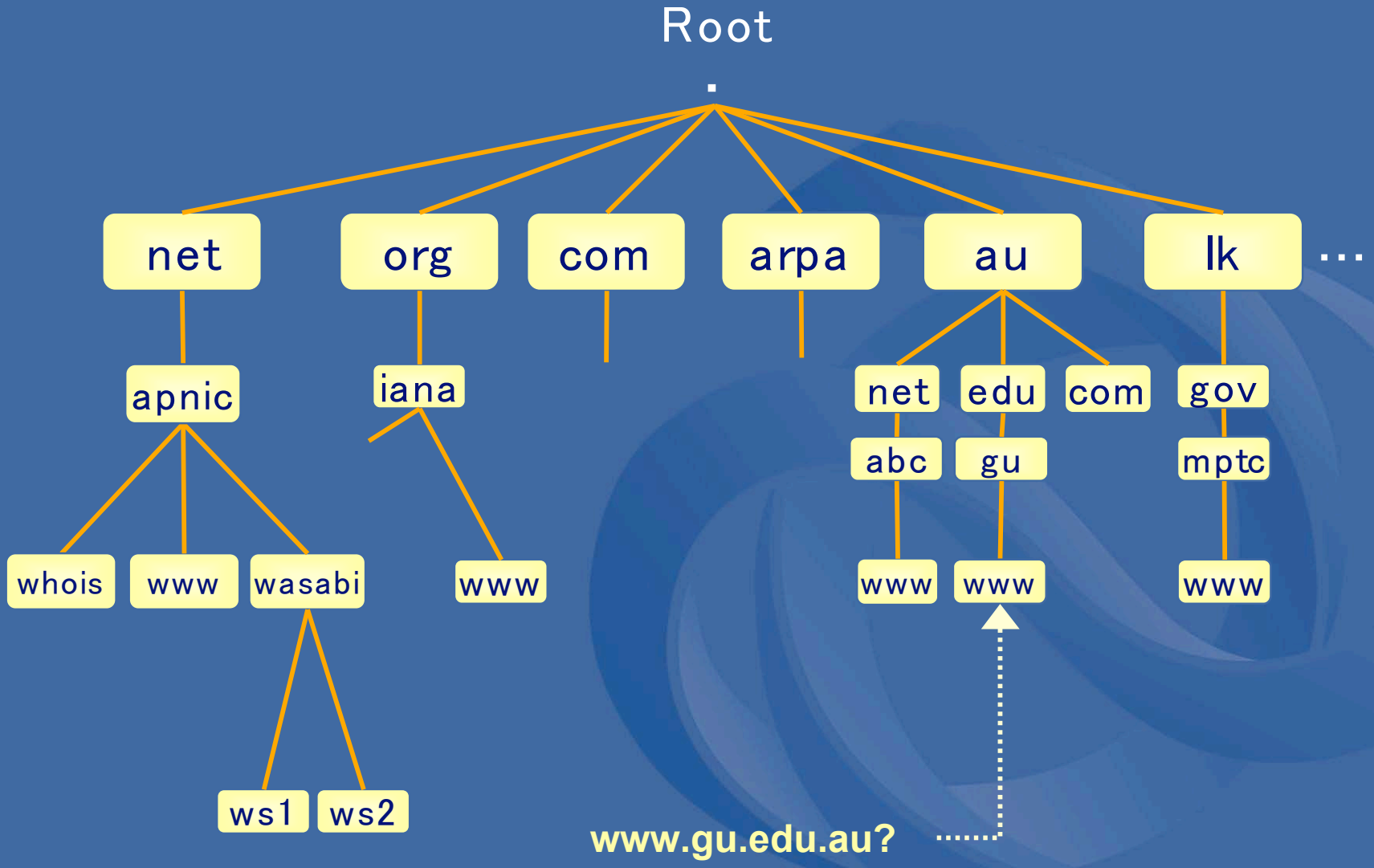
What is a Domain Name?

- Easy to remember (well, sort of) name for a computer or service
  - e.g. apnic.net, www.undp.org, www.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

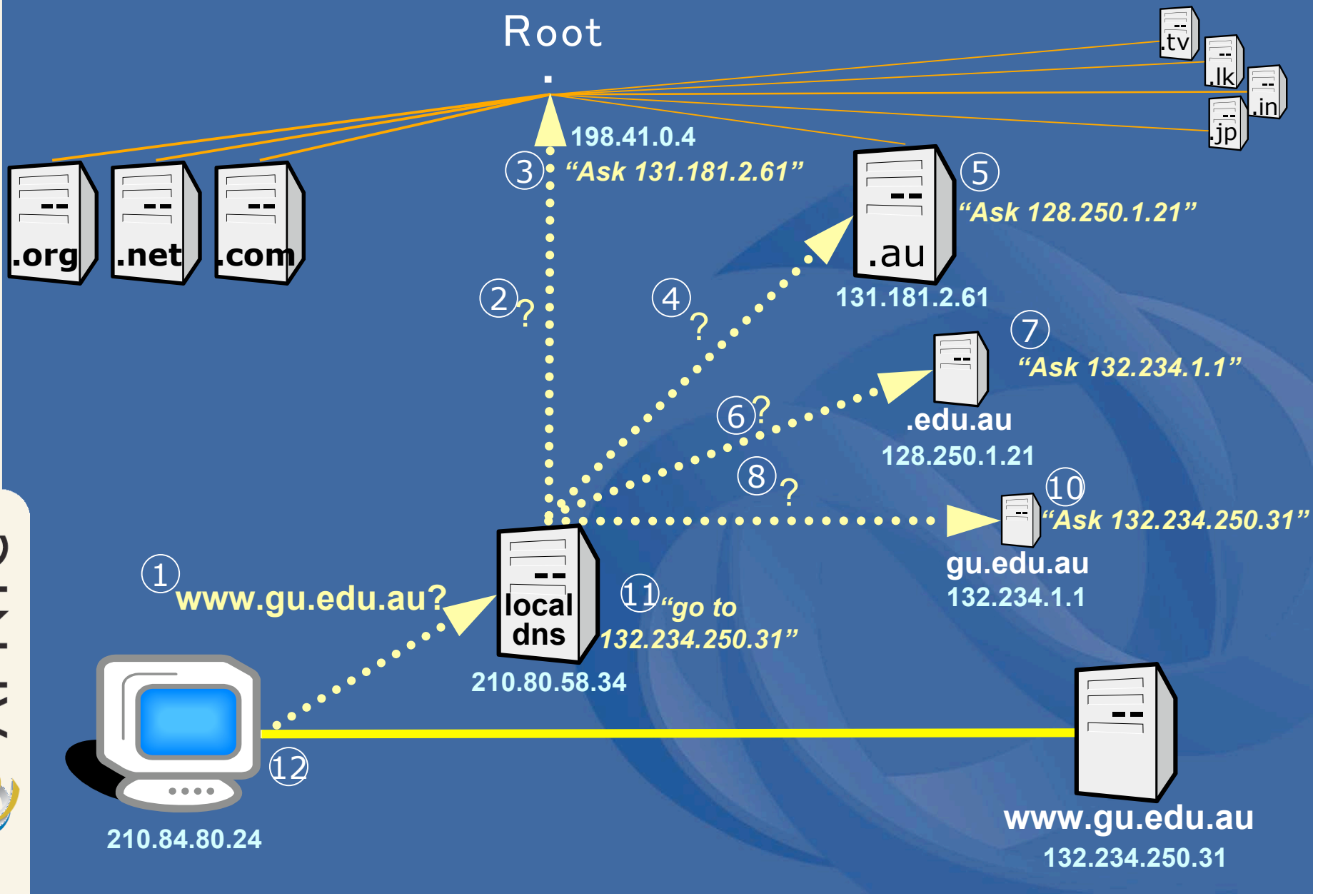
IP addresses vs domain names



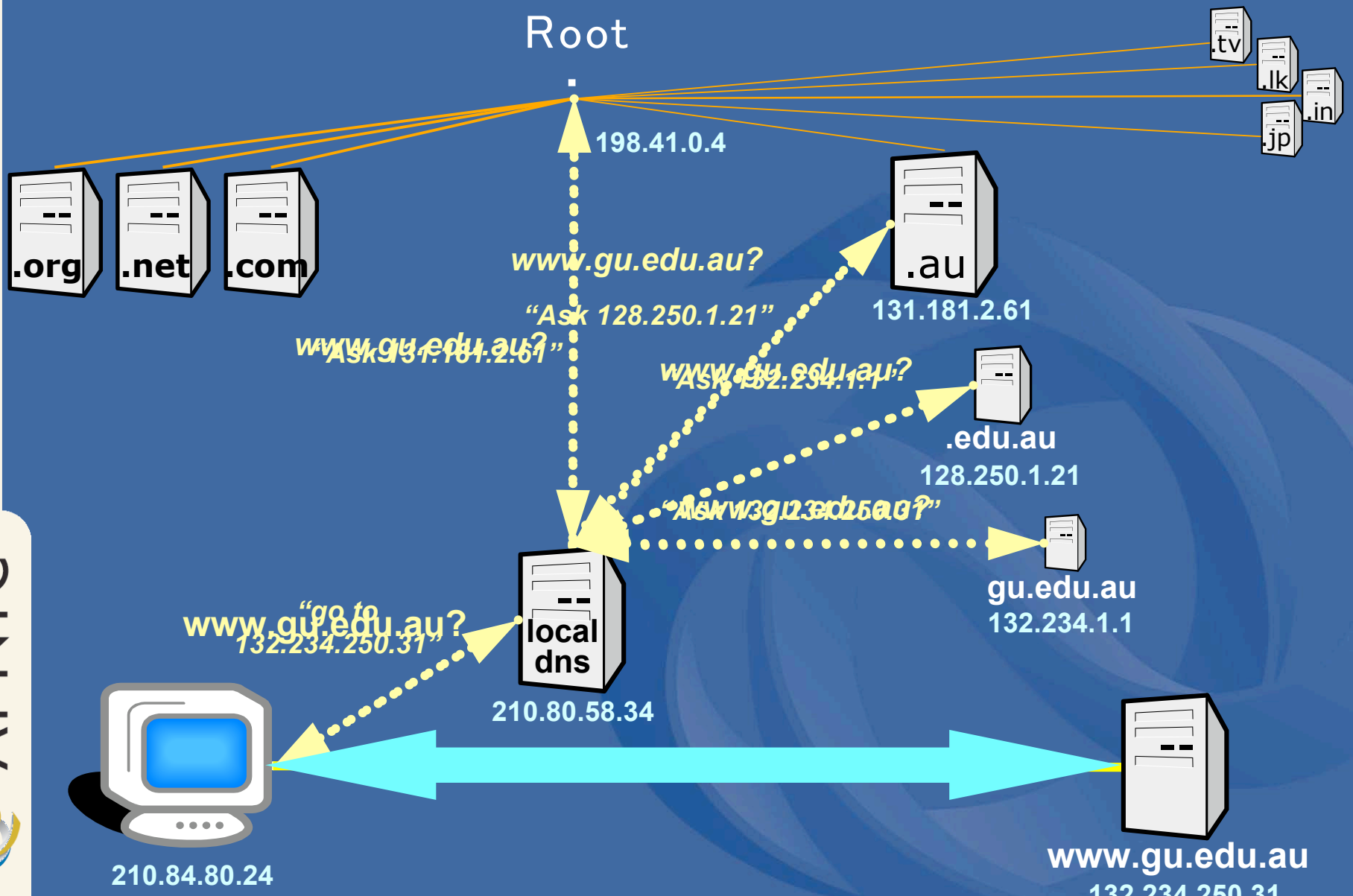
The DNS tree


Root
.
net
org
com
arpa
au
lk
...
apnic
iana
net
edu
com
gov
abc
gu
mptc
whois
www
wasabi
www
www
www
www
ws1
ws2
www.gu.edu.au?

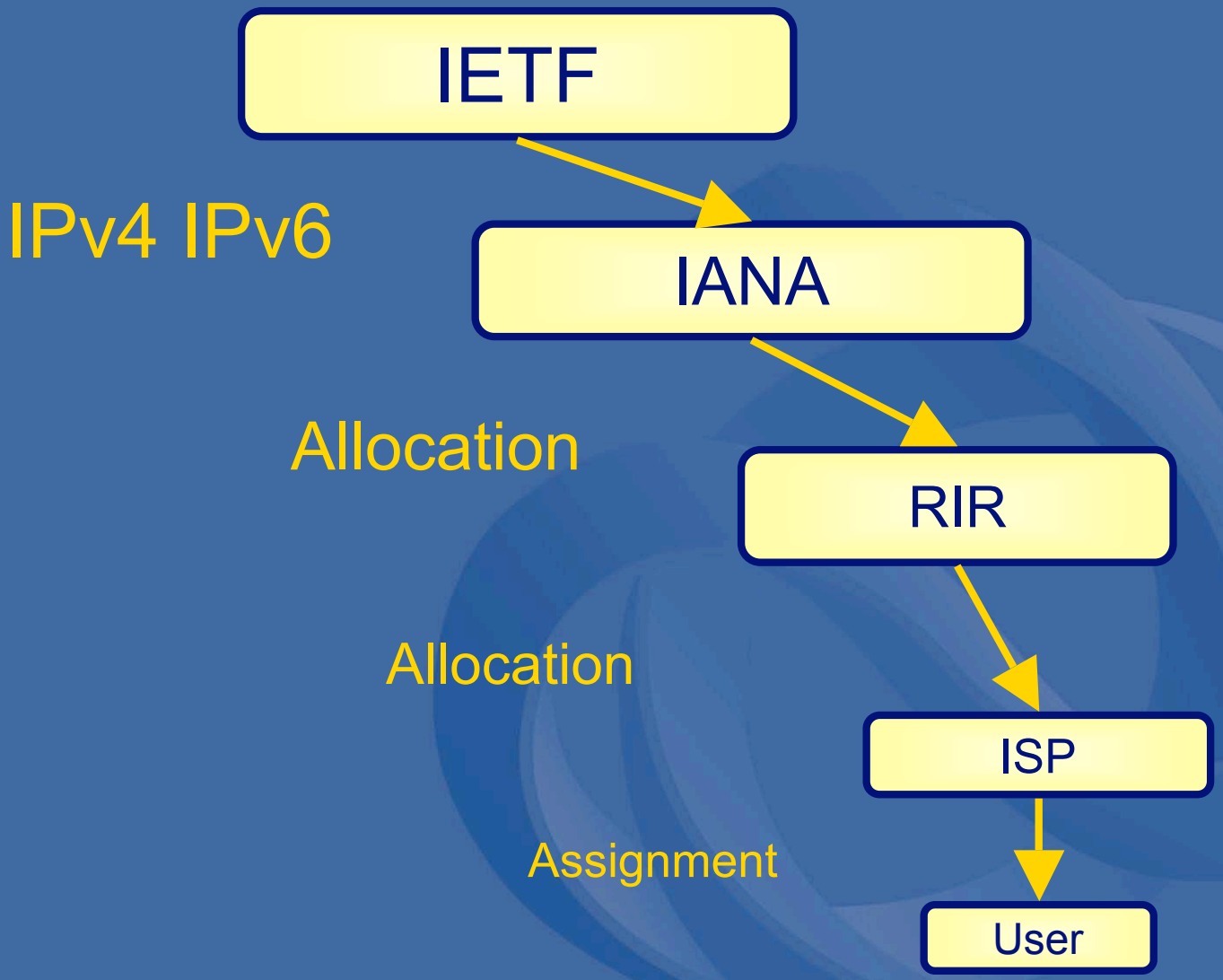
Querying the DNS – It's all about IP!



Querying the DNS – It's all about IP!

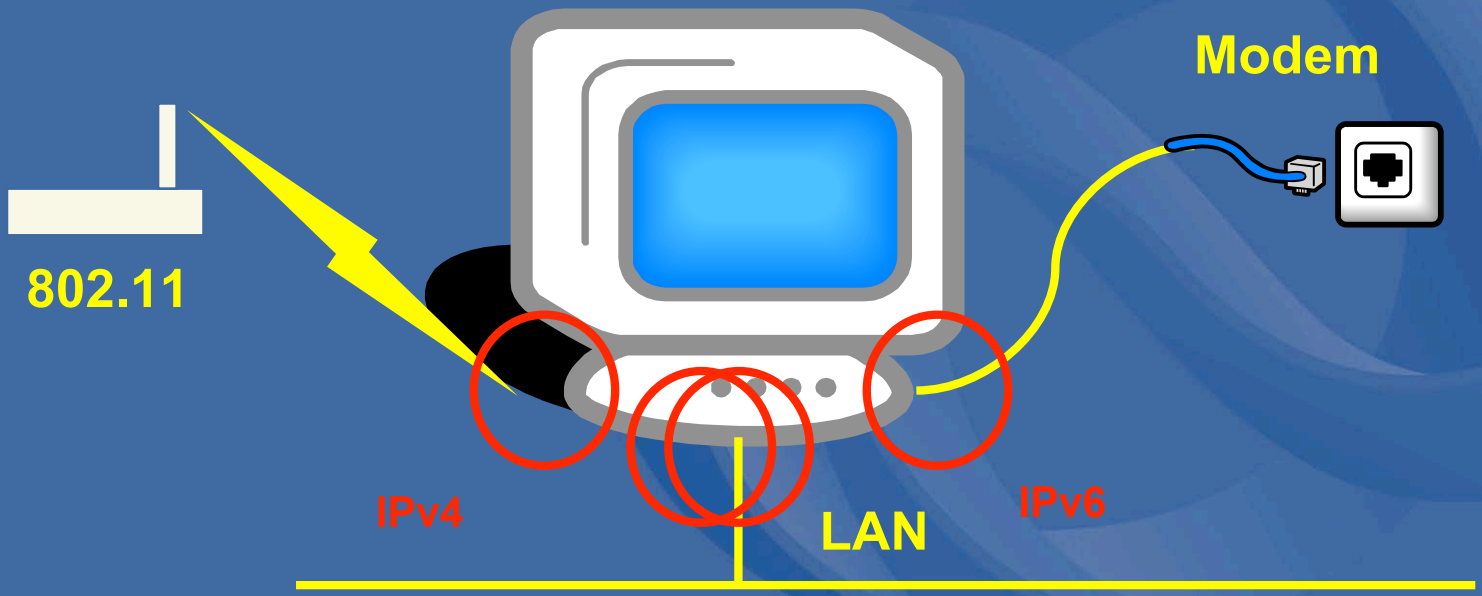


Where do IP addresses come from?



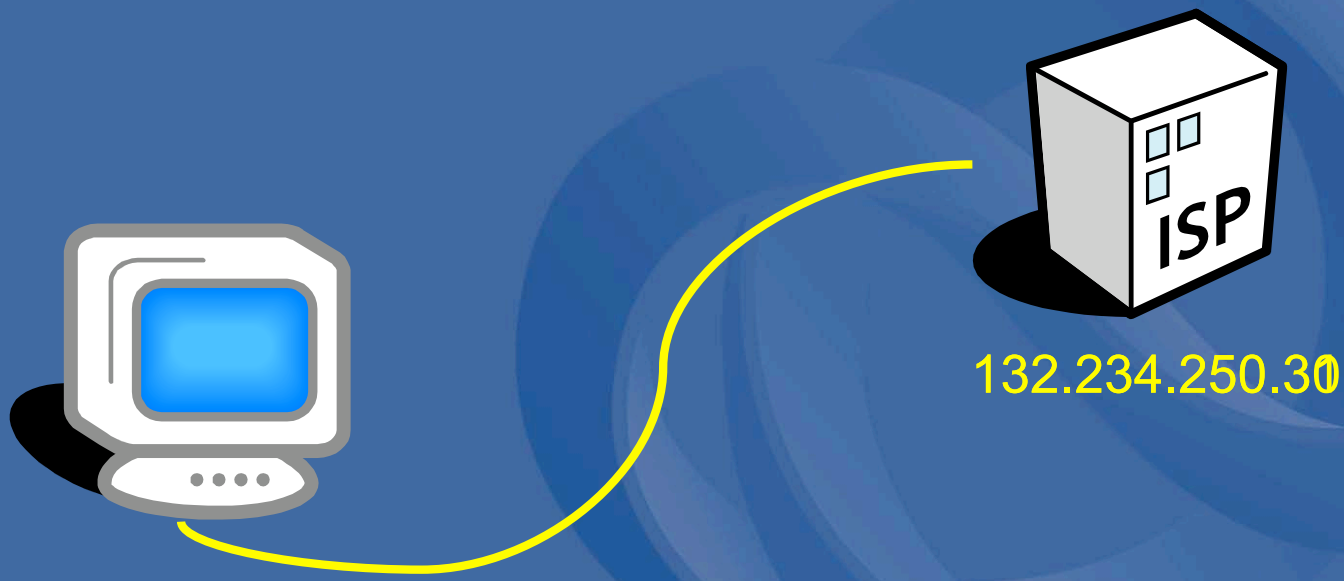
What is “my” address?

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



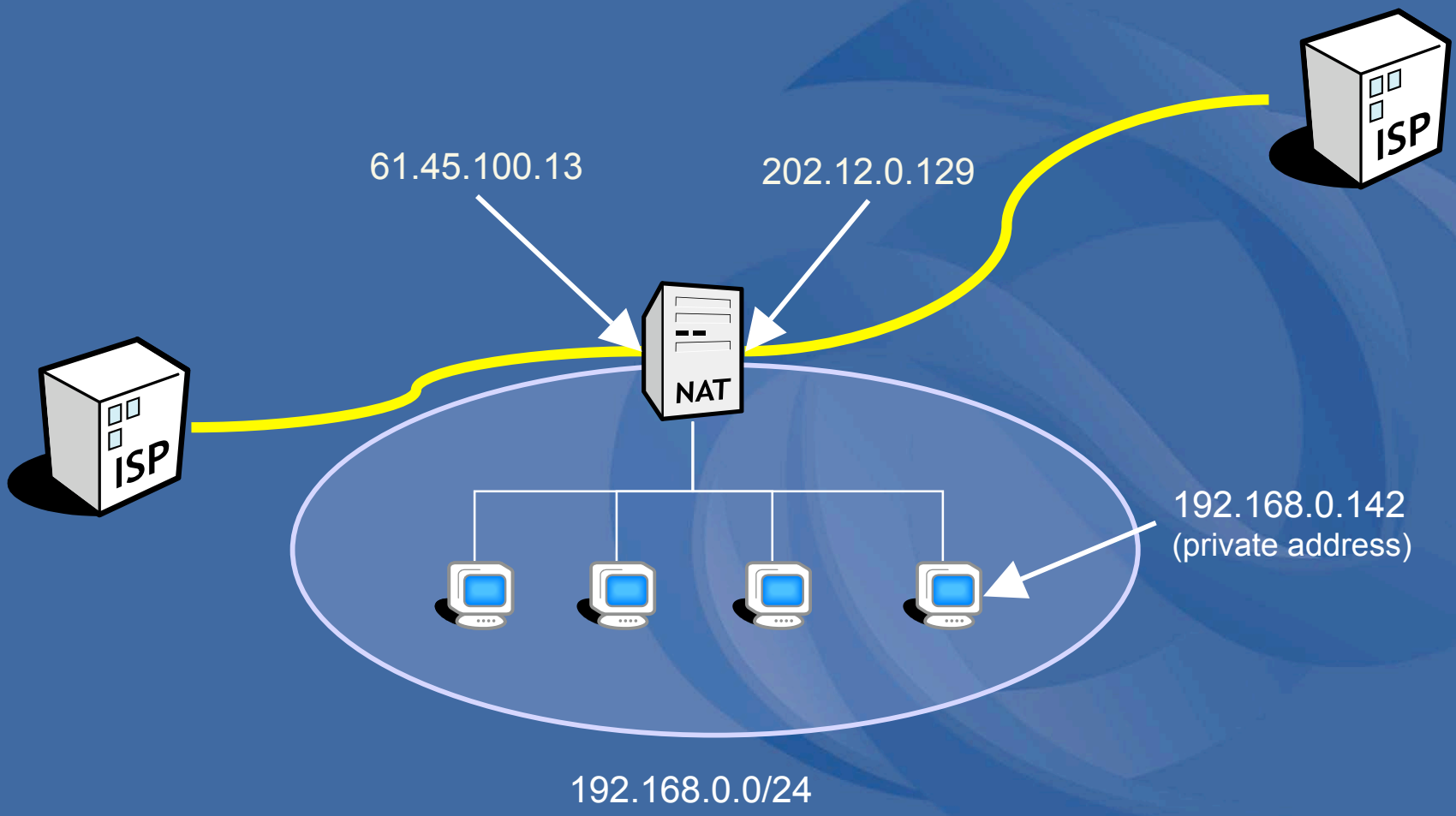
Is “my” address permanent?

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



Is “my” address unique?

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



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”

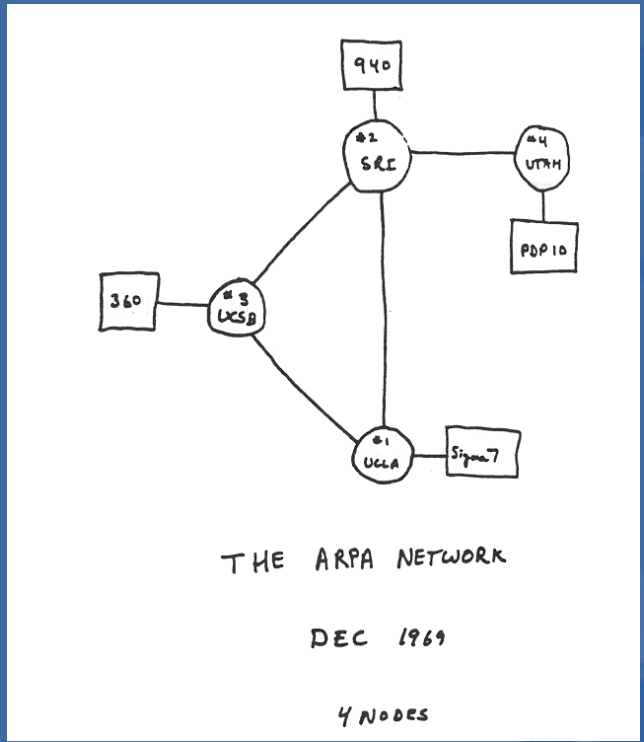
Questions ?

History of the Internet

…and the RIR system

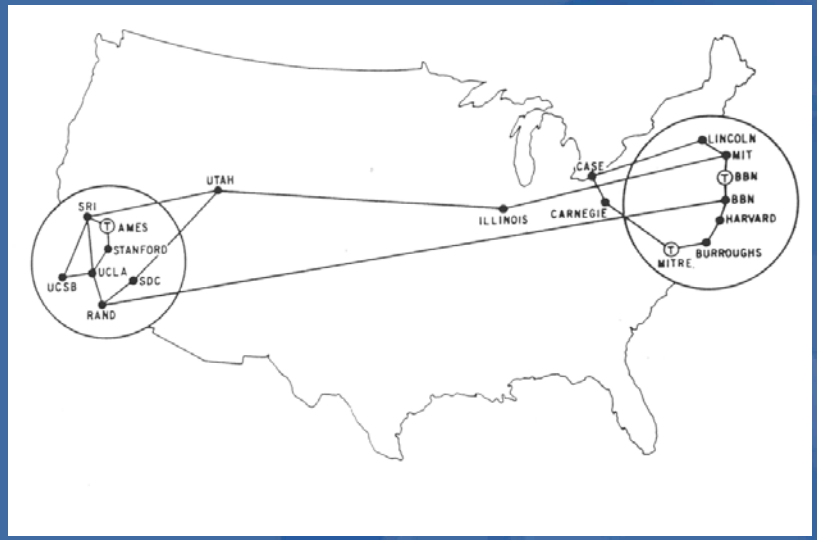
In the beginning…

- 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

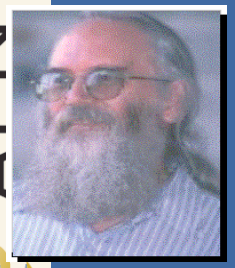


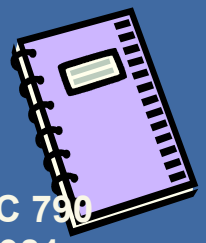
- 1974 - TCP specification by Vint Cerf & Bob Kahn
- 1984 – TCP/IP
  - On January 1, the Internet with its 1000 hosts converts en masse to using TCP/IP for its messaging

Pre 1992

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**."

Address Architecture - History

- Each IP address has two parts
  - “network” address
  - “host” address

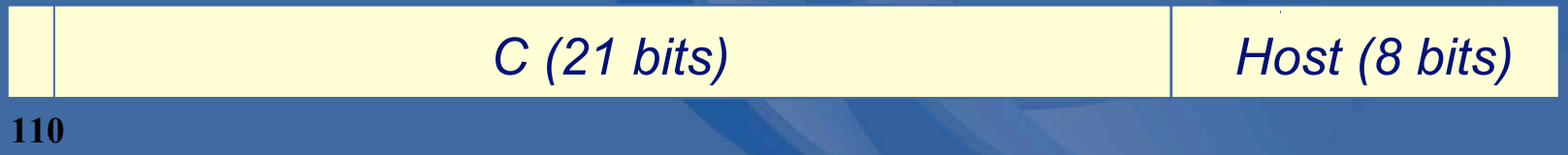
- Initially, only 256 networks in the Internet!
- Then, network “classes” introduced:
  - Class A (128 networks x 16M hosts)
  - Class B (16,384 x 65K hosts)
  - Class C (2M x 254 hosts)

Address Architecture - Classful

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

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

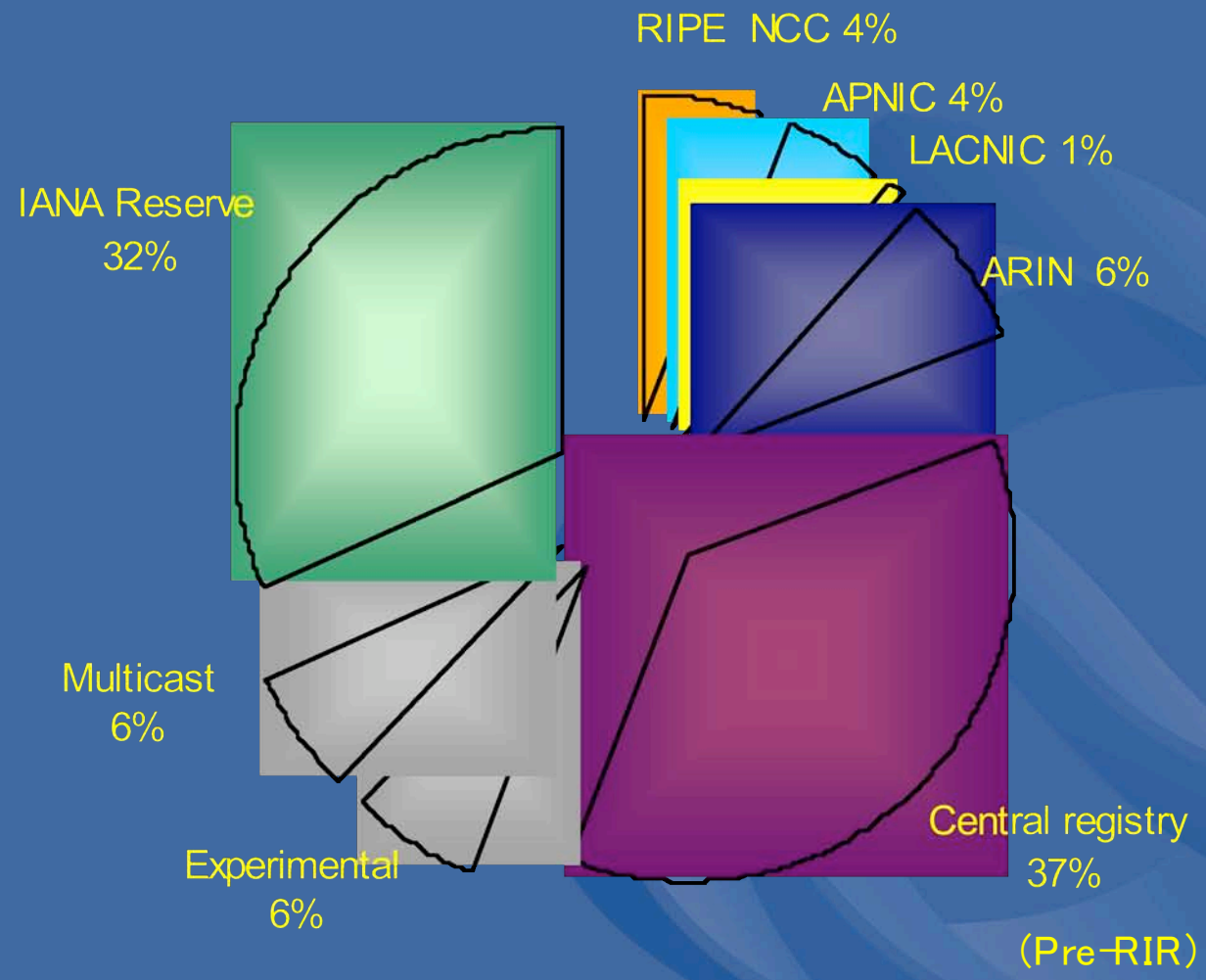
Class C: 2M networks x 254 hosts (12.5%)



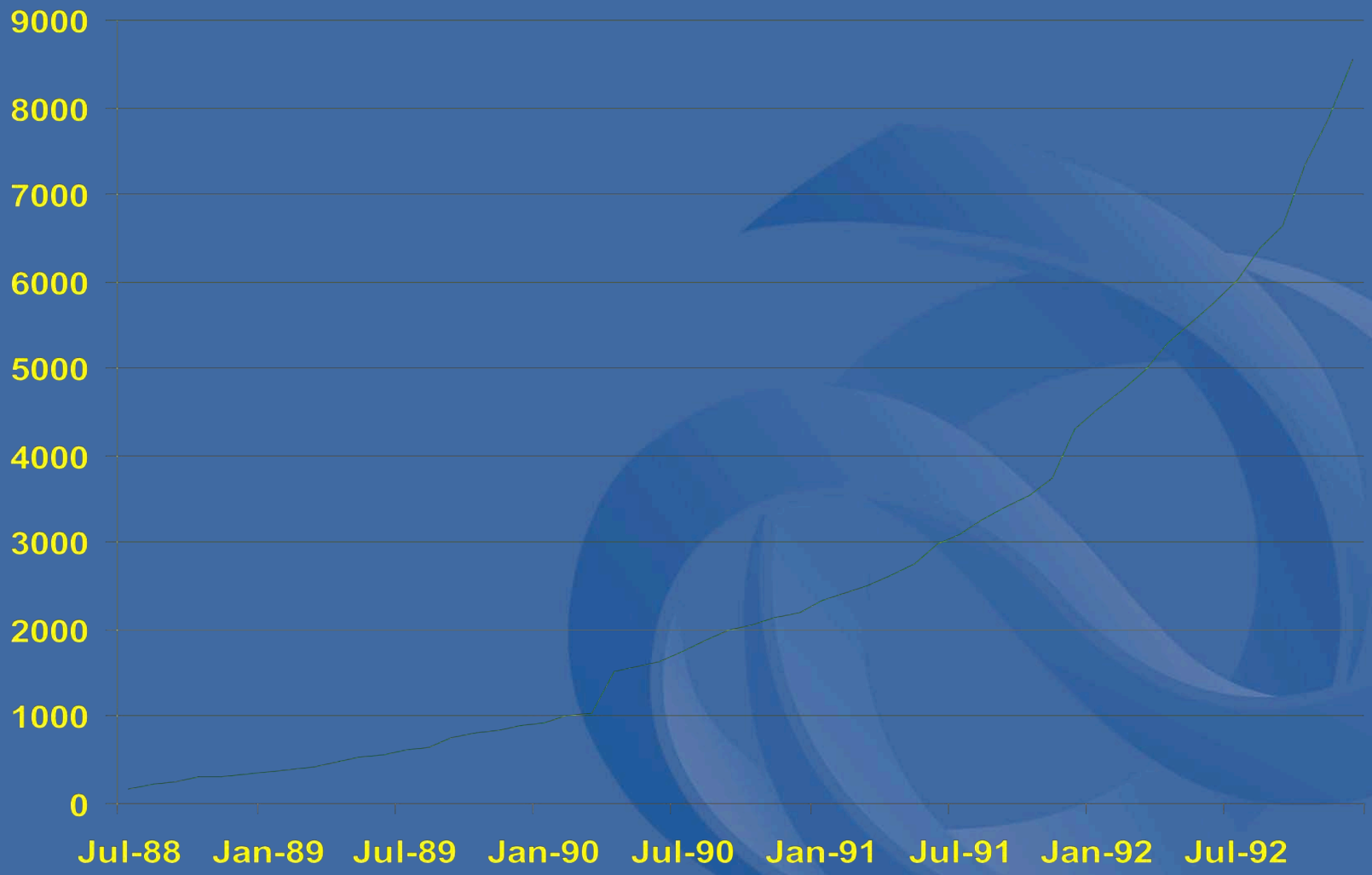
Address management challenges 1992

- 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

Global IPv4 Delegations

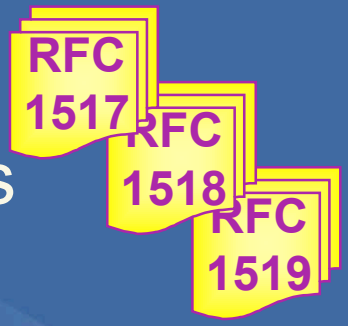


Global Routing Table: ’88 - ’92



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 conservation and aggregation 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 regionally distributed Internet registry system

Evolution of address policy

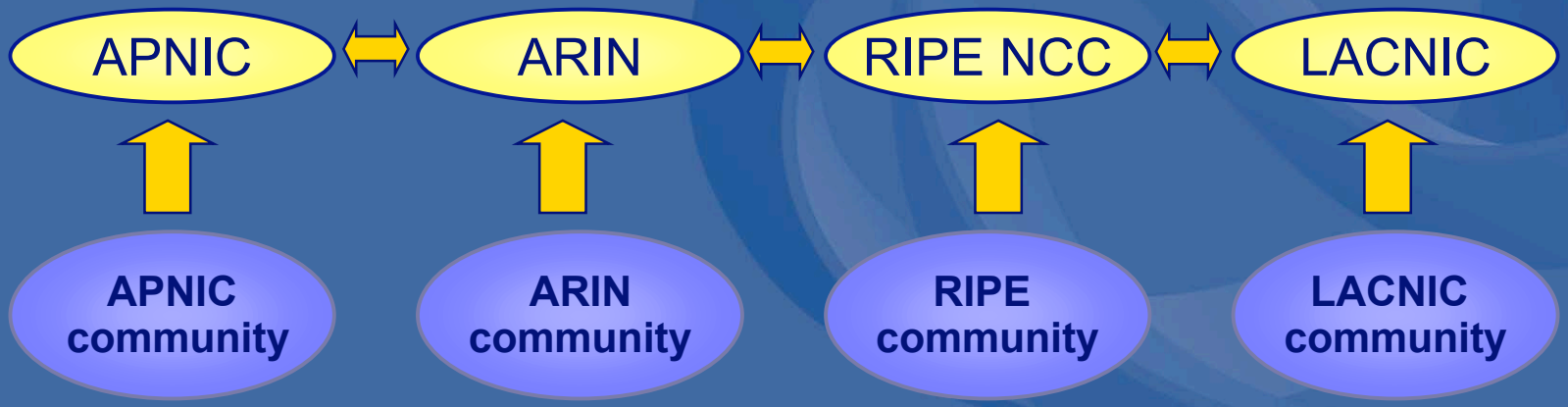
- 1990s - establishment of RIRs
  - APNIC, ARIN, RIPE NCC (LACNIC later)

→Regional open processes

→Cooperative policy development

→Industry self-regulatory model

  - bottom up



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

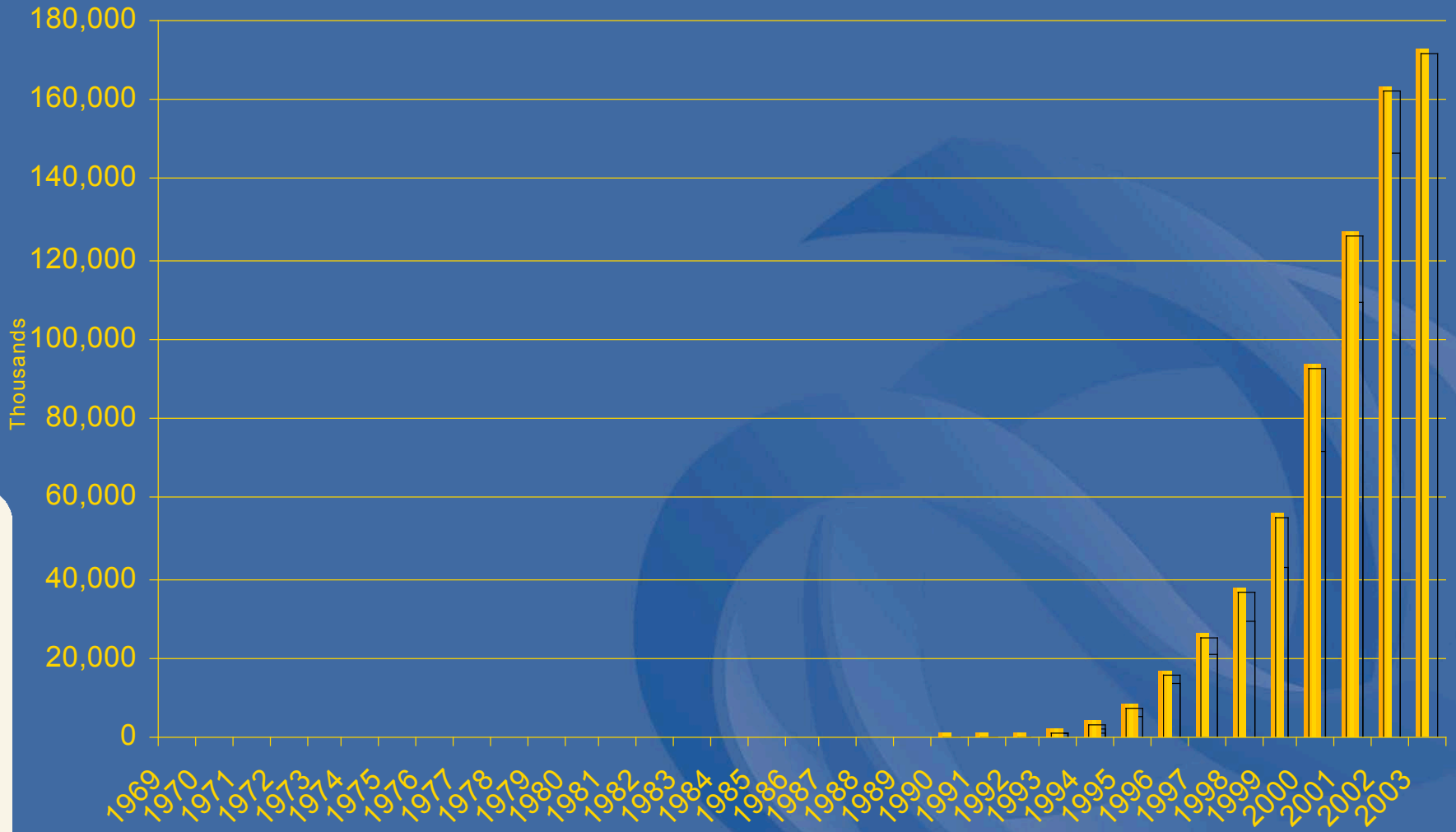
- Ensure uniqueness
- Facilitate trouble shooting

Uniqueness, fairness and consistency

Questions ?

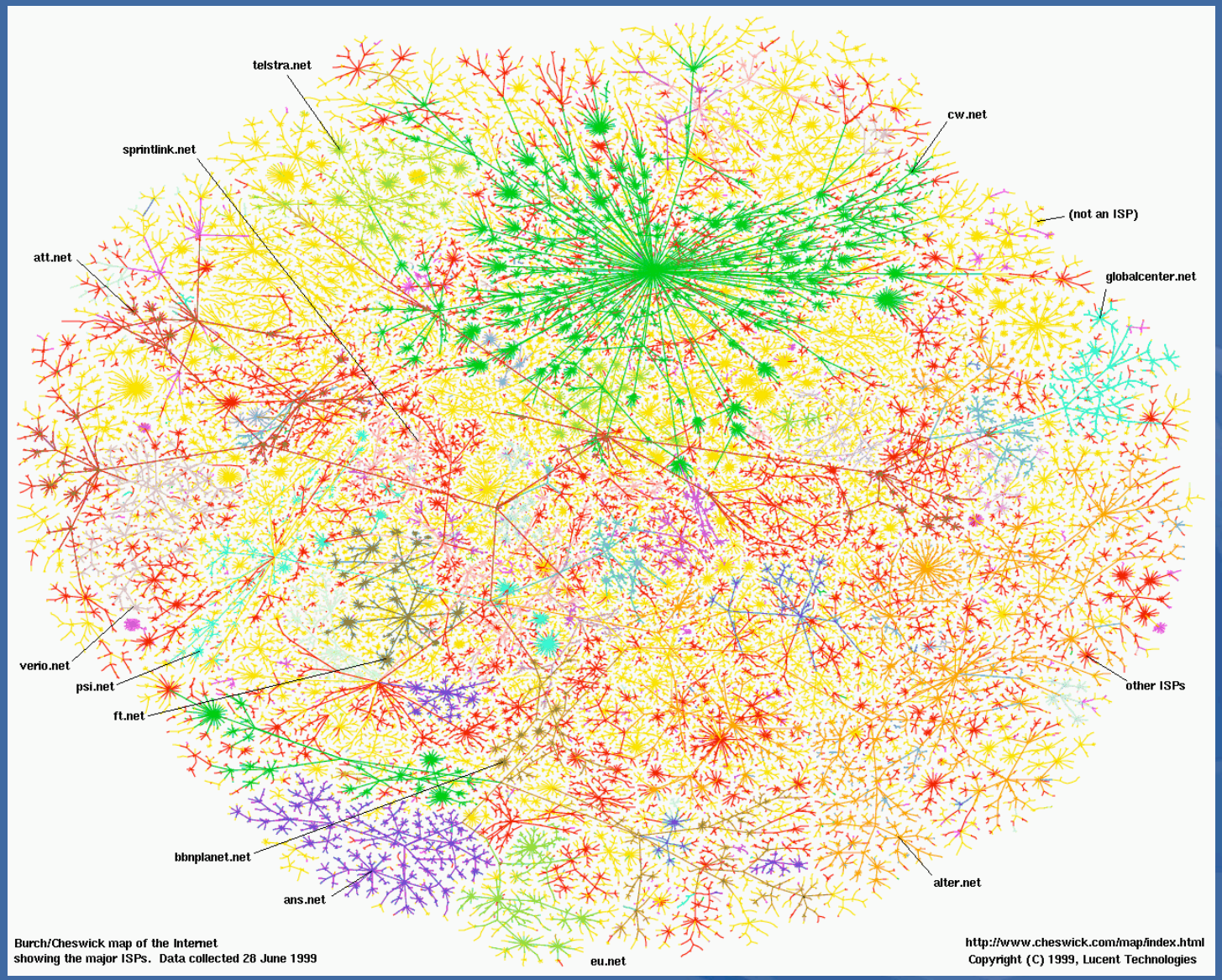
The Internet Today

Internet Growth to date - Hostcount



source: http://www.zakon.org/robert/internet/timeline/

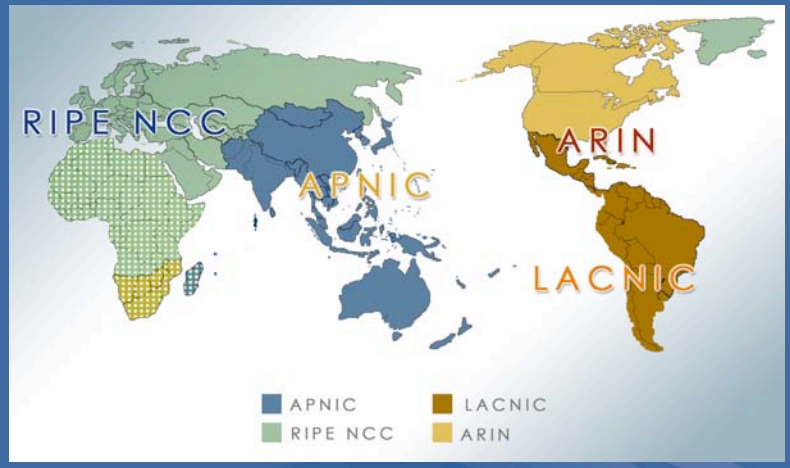
Map of the Internet today



http://www.lumeta.com/mapping.html

The RIR structure

- Four 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

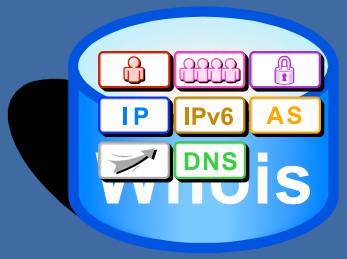
What does APNIC do?

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

- Policy development and implementation
  - Facilitating the policy development process
  - Implementing policy changes

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

What else does APNIC do?

- Information dissemination
  - APNIC meetings
  - Web and ftp site, mailing lists, publications
    - http://www.apnic.net/net_comm/lists/index.html

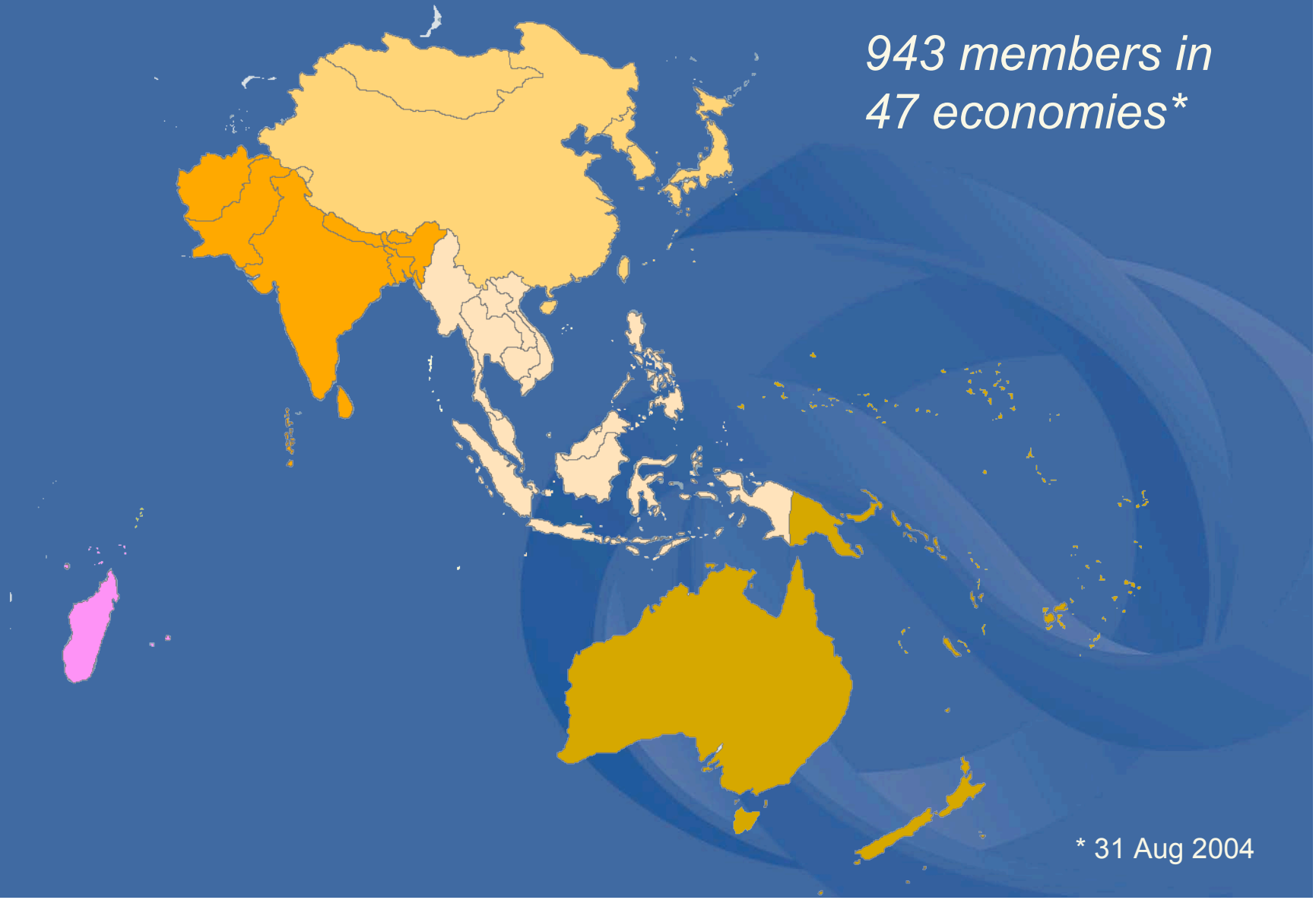
- Training courses & open seminars
  - IRM-I – Basic Internet Resource management
  - IRM-II – Advanced IRM modules
  - DNS workshop
  - Outreach seminars
  - Planned schedule
    - http://www.apnic.net/training
  - Subsidised for APNIC members

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, 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

943 members in
*47 economies**



* 31 Aug 2004

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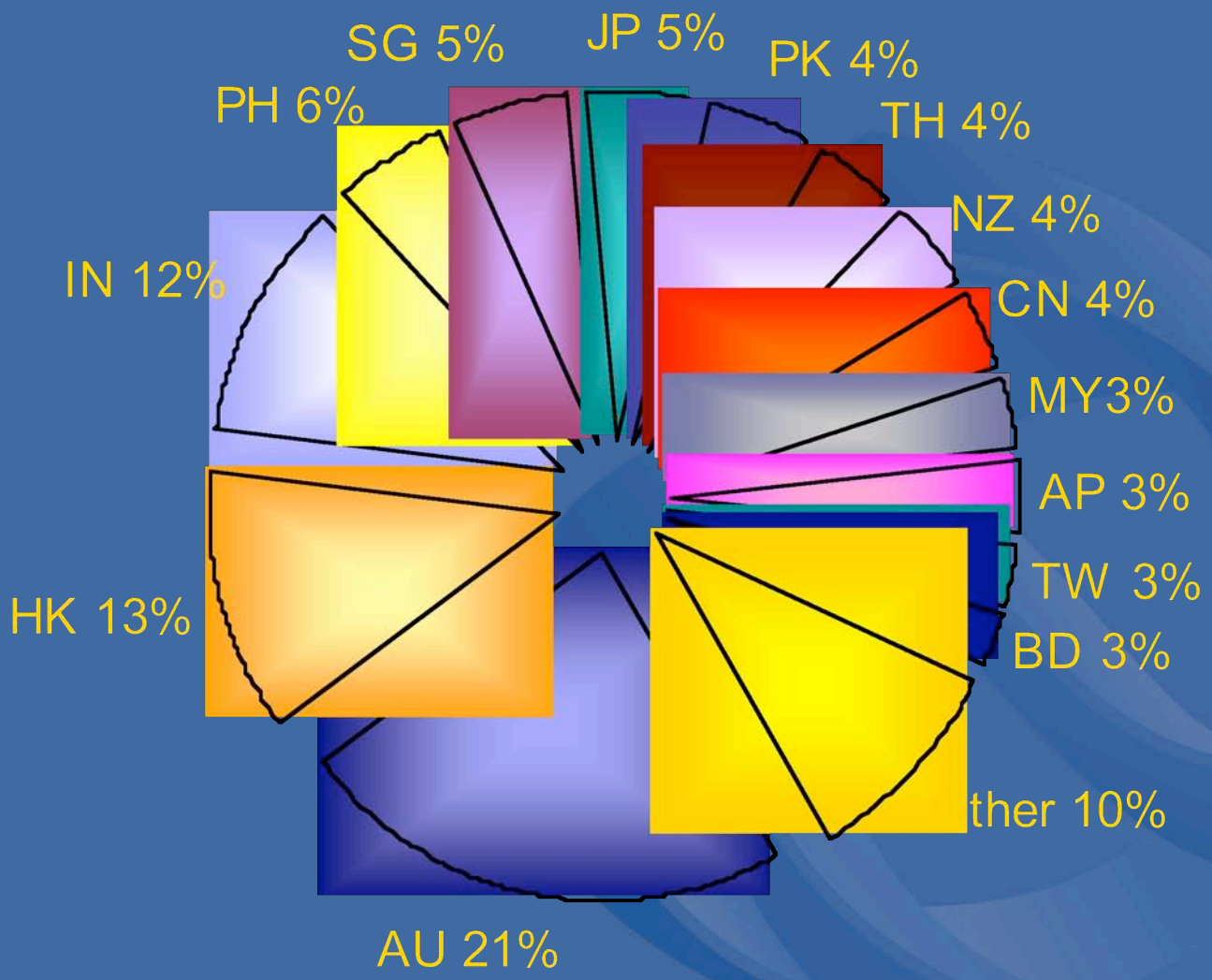
APNIC

APNIC membership



1 Oct 2004

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APNIC

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 ?

Classless addressing

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

Classless Addressing - Examples

/10: 4M hosts

/19: 8190 hosts

/20: 4094 hosts

/24: 254 hosts

/28: 14 hosts

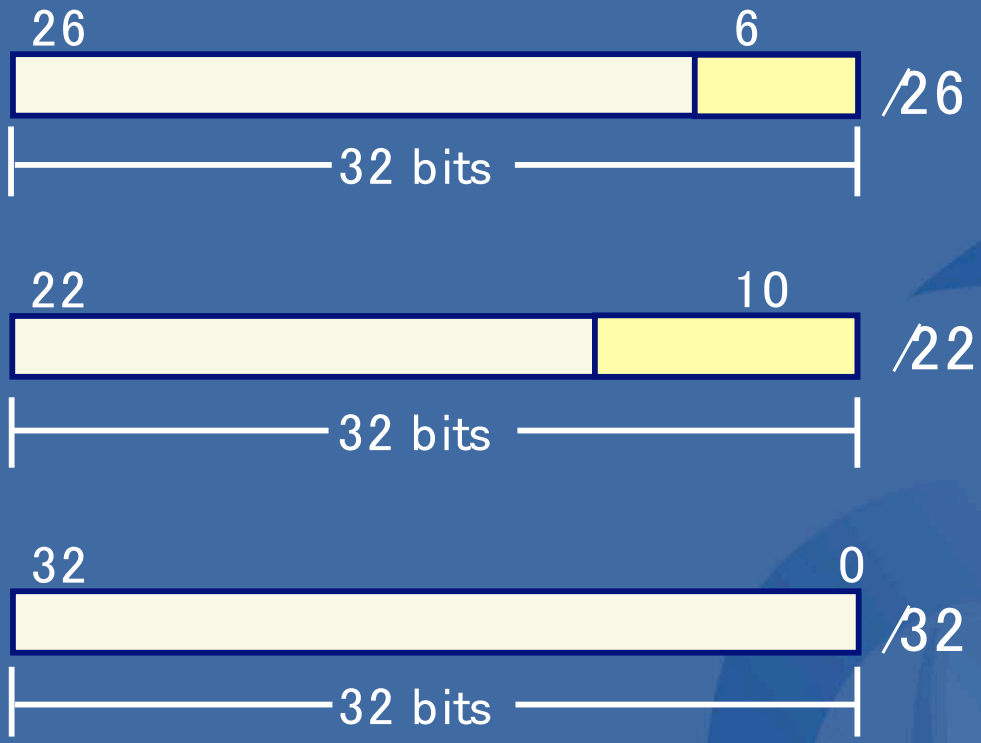
Slash notation and ranges

- Two ways of representing an address range

"slash" notation	Start- & end address
e.g. 172.16.0.0/12	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

What on earth is a slash?

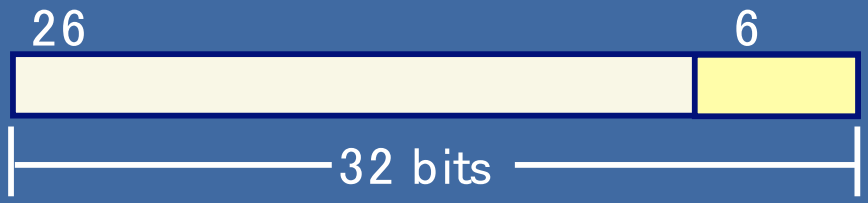


/20 =

/16 =

/0 =

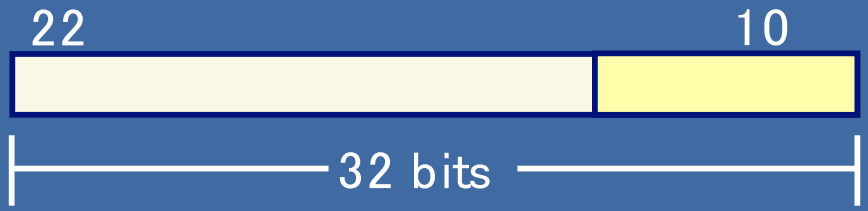
What on earth is a slash?



/26

→ 32 - 26 = 6 bits

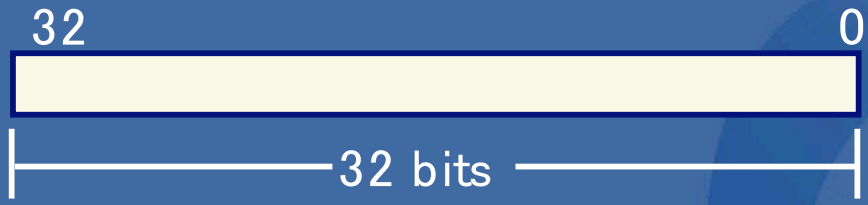
→ /26 = 2^6 = 64



/22

→ 32 - 22 = 10 bits

→ /22 = 2^{10} = 1024



/32

→ 32 - 32 = 0 bits

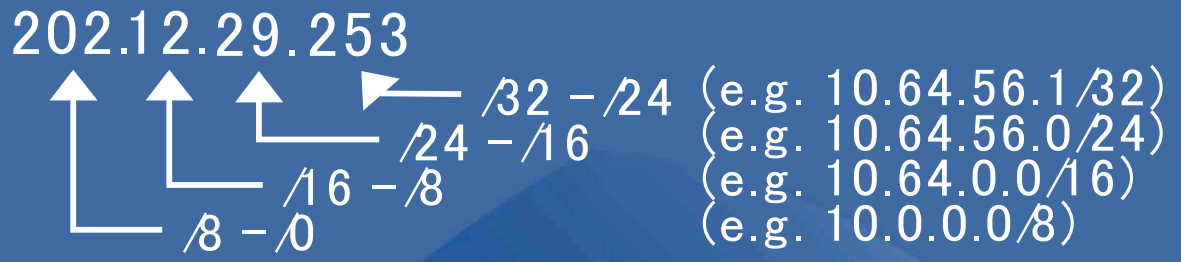
→ /32 = 2^0 = 1

/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)

Ranges and slashes



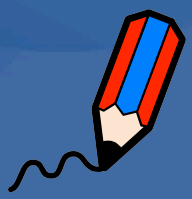
10.0.0.0 /25 = 10.0.0.0 –
→ /25 = addr → 0 –

10.0.0.0 /24 = 10.0.0.0 –
→ /24 = addr → 0 –

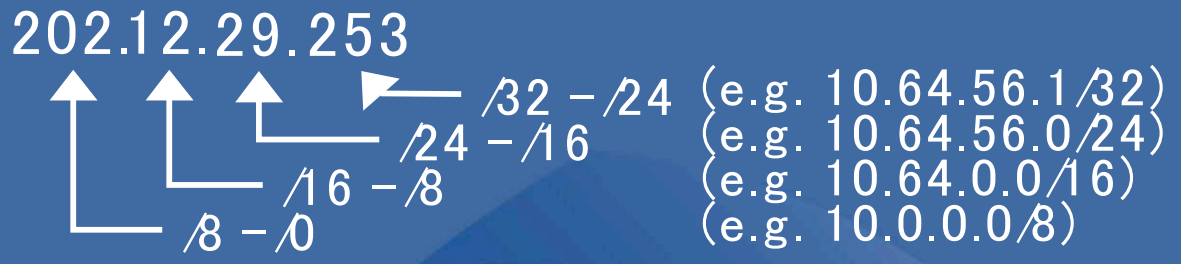
10.0.0.0 /23 = 10.0.0.0 –
→ /23 = */24s → 0.0 –

10.0.0.0 /20 = 10.0.0.0 –
→ /20 = */24s → 0.0 –

10.0.0.0 /13 = 10.0.0.0 –
→ /13 = */16s → 0.0.0 –



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

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

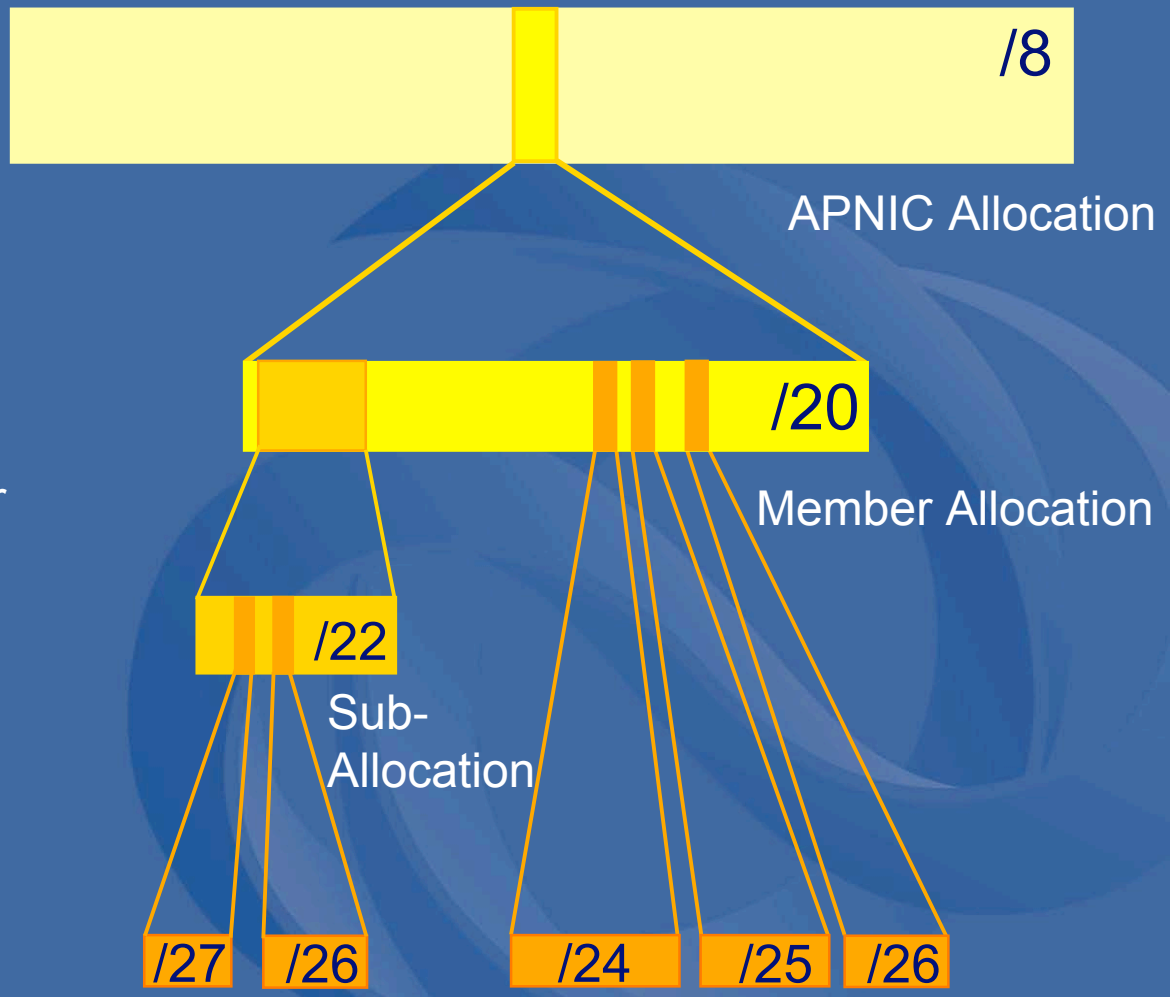
APNIC Member

Allocates
to downstream

Assigns
to end-user

Downstream
Assigns
to end-user

Customer / End User



Portable & non-portable

Portable Assignments

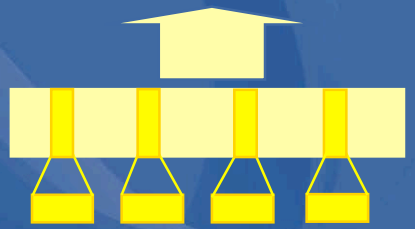
- Customer addresses independent from ISP
  - Keeps addresses when changing ISP
- Bad for size of routing tables
- Bad for QoS: routes may be filtered, flap-dampened

☹

Non-portable Assignments

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

☺

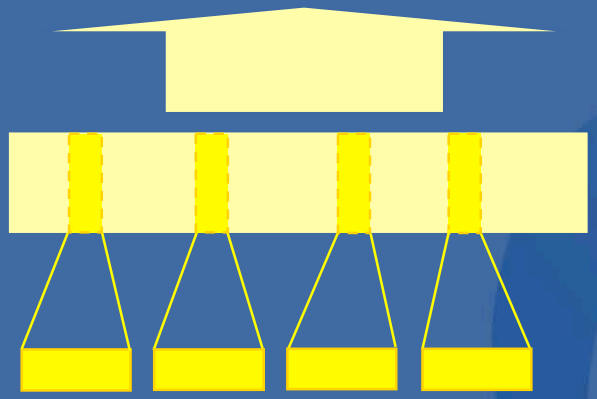


Aggregation and “portability”

Aggregation

BGP Announcement (1)

ISP Allocation

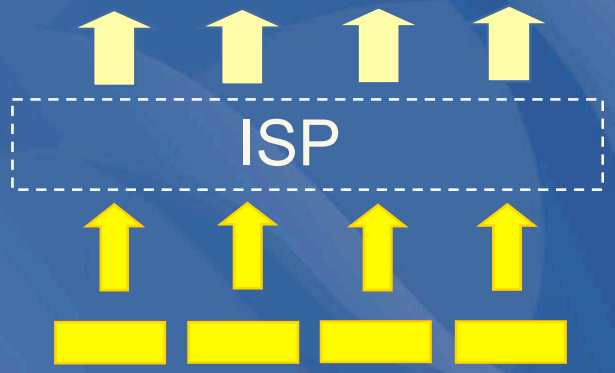


Customer assignments

(non-portable assignments)

No aggregation

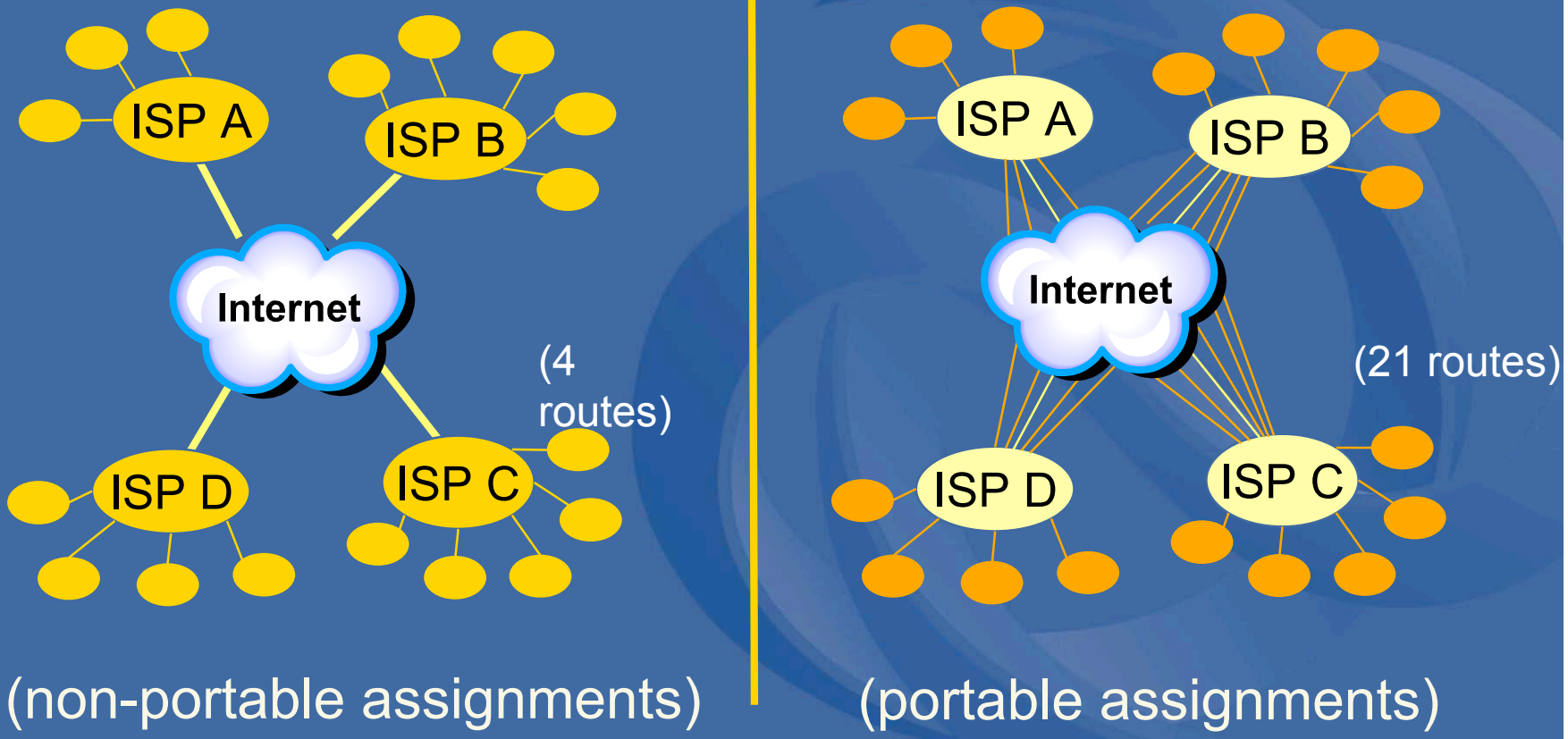
BGP Announcements (4)



Customer assignments

(portable assignments)

Aggregation and “portability”



APNIC Policies - Background

(Recap)

- 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

(Recap)

Conservation

- Efficient use of resources
- Based on demonstrated need

Aggregation

- Limit routing table growth
- Support provider-based routing

Registration

- Ensure uniqueness
- Facilitate trouble shooting

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

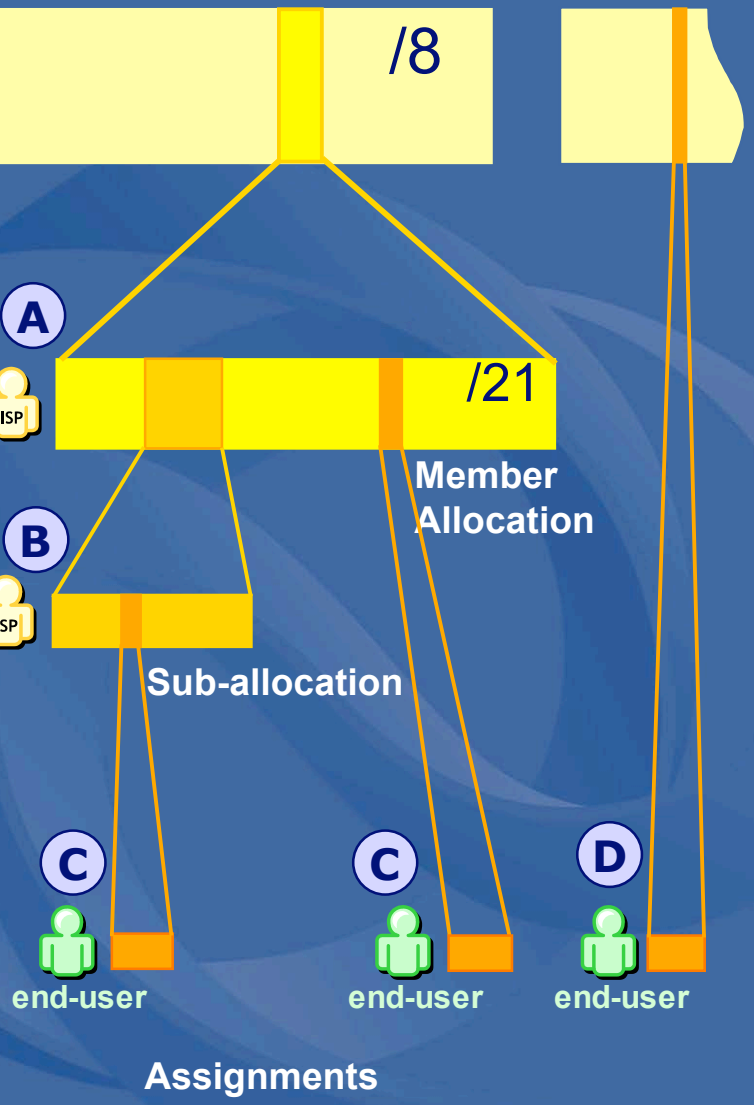
Where can I get IP addresses?

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

- 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.

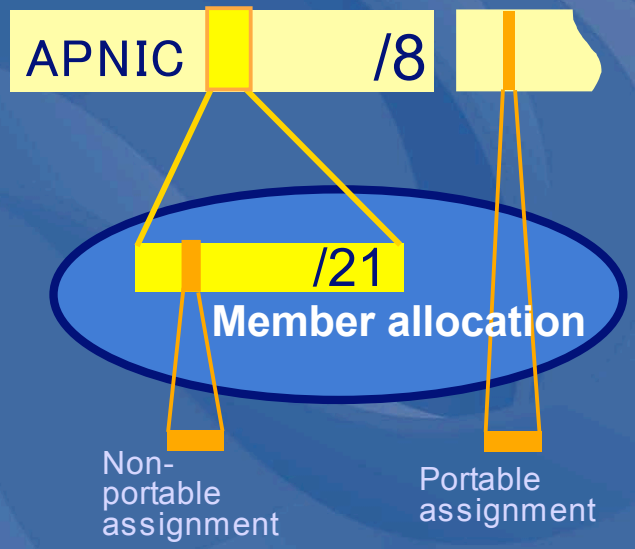
Criteria

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



Portable assignments

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

Criteria

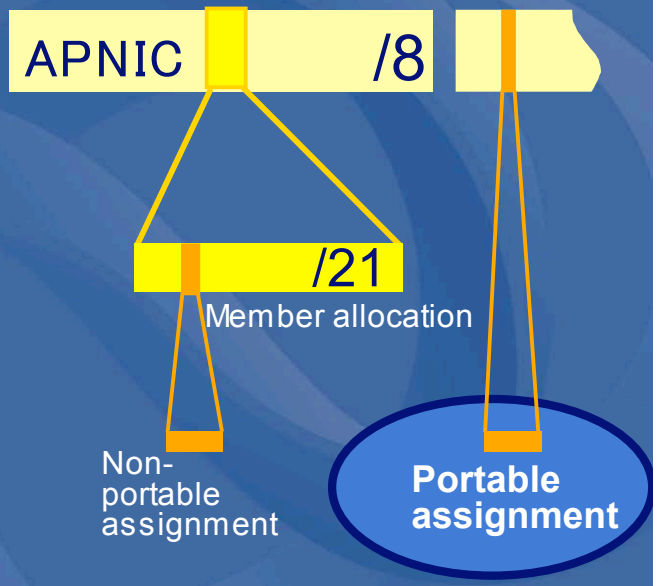
1a. Applicants currently multihomed

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*



Questions ?

Policy Development in the Asia Pacific

The APNIC Community

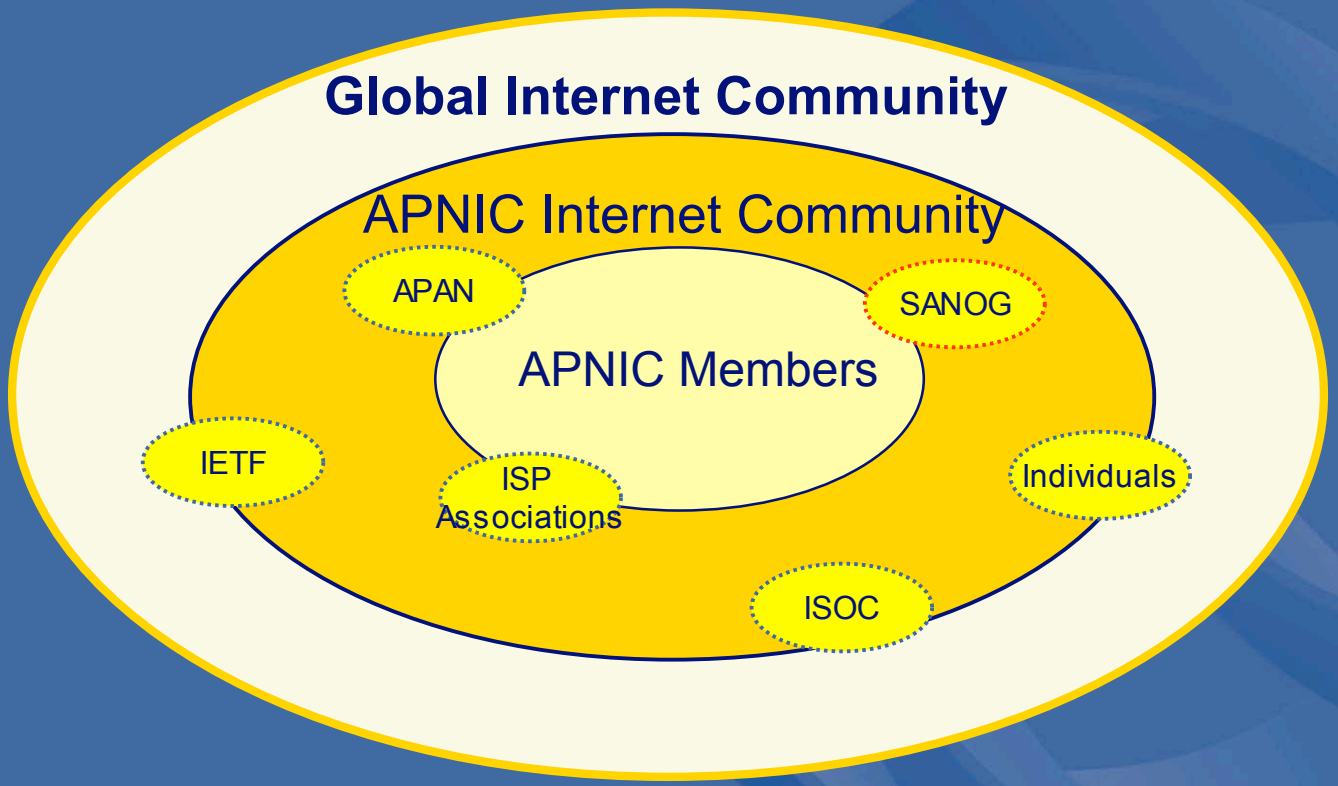
&

the Policy Development Process

You are part of the APNIC community!

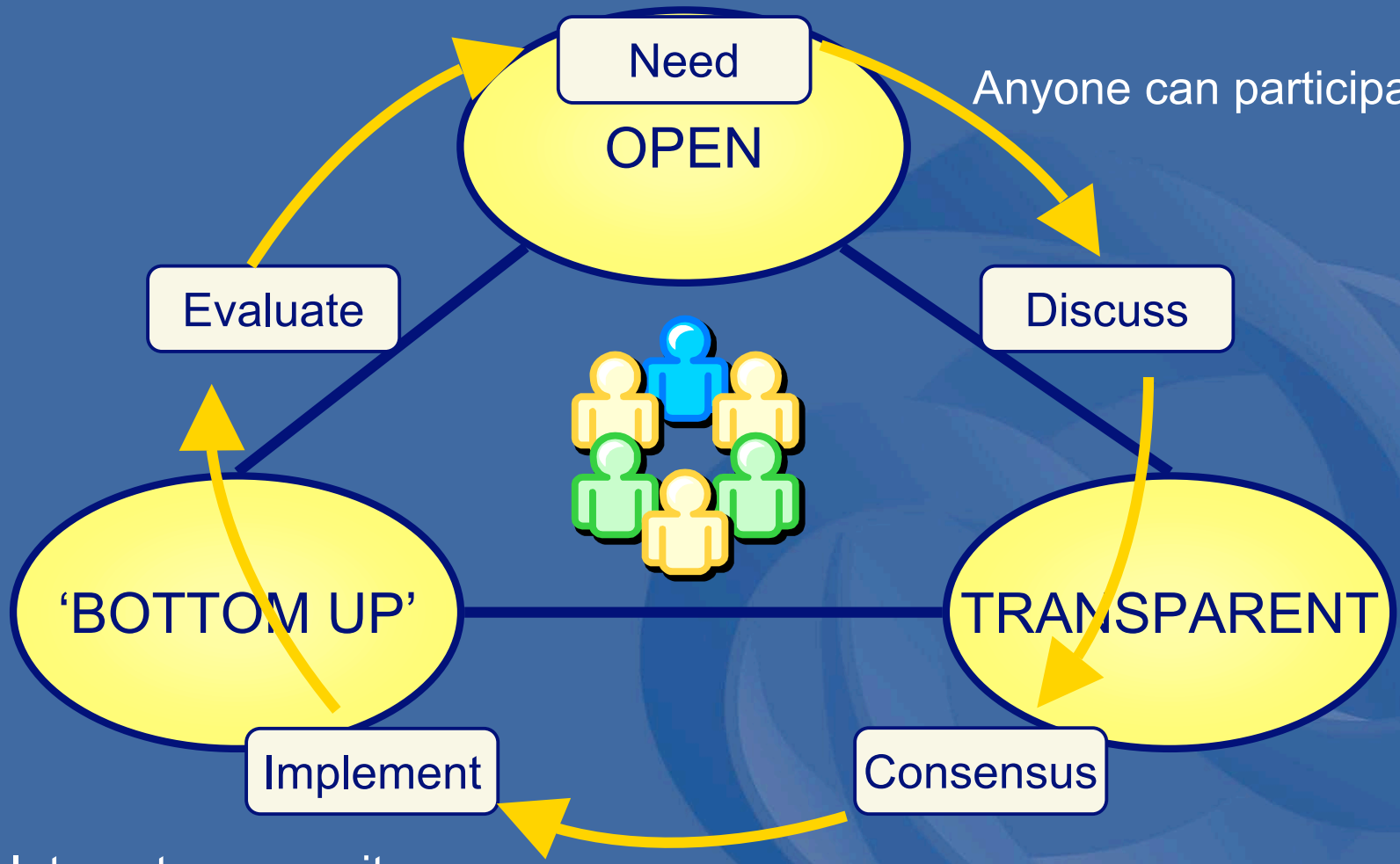
Open forum in the Asia Pacific

Open to any interested parties



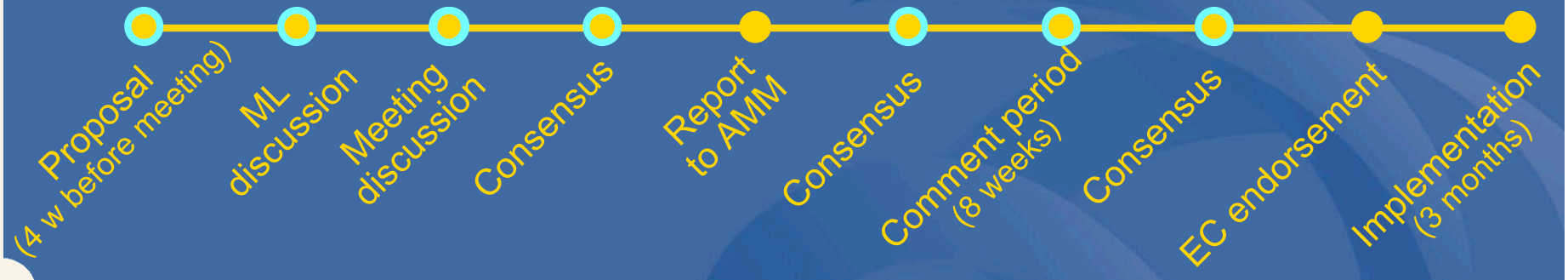
– A voice in regional Internet resource management

Policy development cycle



The policy development process

Need Discuss Consensus Implement



You can participate!

More information about policy development can be found at:

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

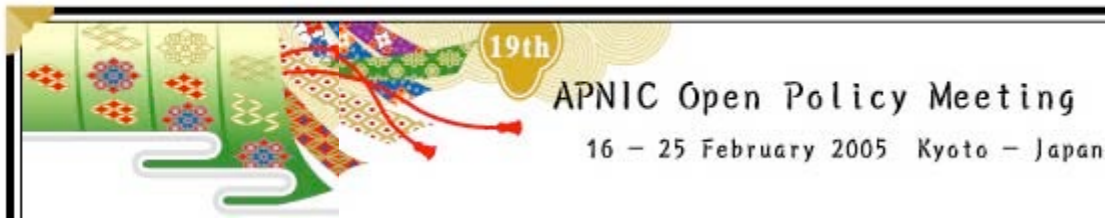
Why should I bother to participate?

- 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

Come to the APNIC meeting!



Next meeting in conjunction with

APRICOT 2005

Kyoto, Japan 16-25 February

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 ?

Problems, Myths & Challenges

What are the issues in Today's Internet?

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

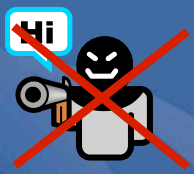
- Secure your networks!

- 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! ☺
      - And the IRM-II training course, Friday 15th october

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:

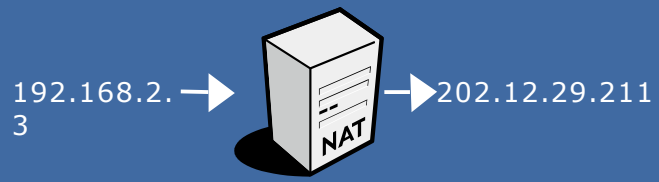
What else can You do?

- Participate in the SANOG community
  - South Asian Network Operators Group
    - *Regional forum to discuss operational issues and technologies*
    - Educational as well as co-operation
- Stay abreast
  - Adhere to Best Current Practices (BCPs)!
- Educate your staff and your customers

- You have a role to play!

Other perceived “threats”

- NAT?
  - (Network Address Translation)



RFC 1631

- Different opinions
  - 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

RFC 2993

RFC 1814

Other perceived “threats”

- ~~IP address exhaustion?~~
  - Media reports claiming we are running out of IP addresses
    - Some claim we’ve already run out in some parts of the world
  - *This is a myth!*
    - We’re not running out of IP addresses now

32% of the IPv4 Address Pool still **Available**

- Growing routing table
  - Still very much a problem
  - Now ~142k entries
    - http://www.cidr-report.org/
  - CIDR & aggregation are vital

Questions ?

The Internet Tomorrow

What will happen with the Internet?

Are we running out of IP addresses?

- Recent 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

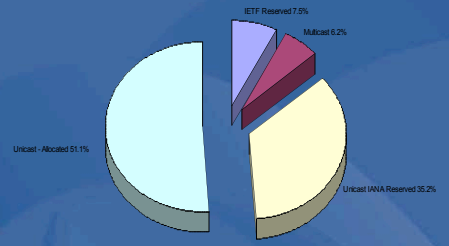
http://www.apnic.net/news/hot-topics/index.html#other

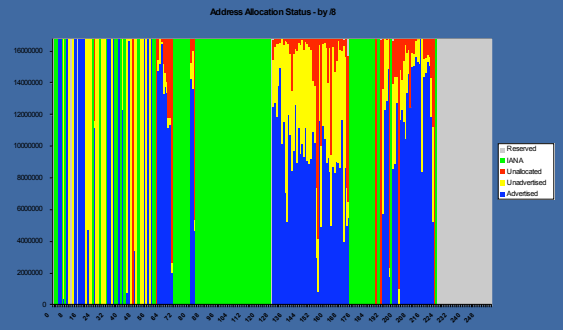
IPv4 Lifetime

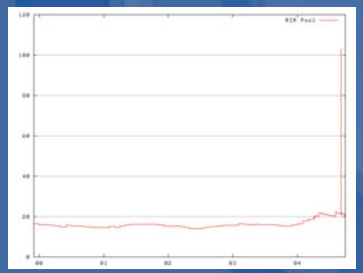
- IPv4 Address Space Report (Geoff Huston)

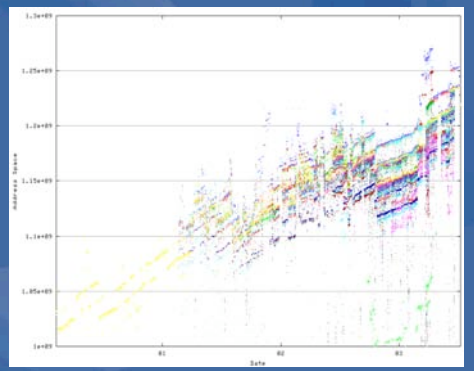
  This report is generated automatically on a daily basis, and reflects the application of best fit models to historical data relating to the growth in the address space advertised in the BGP routing table. The underlying assumptions made in this predictive model is that the previous drivers in address 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



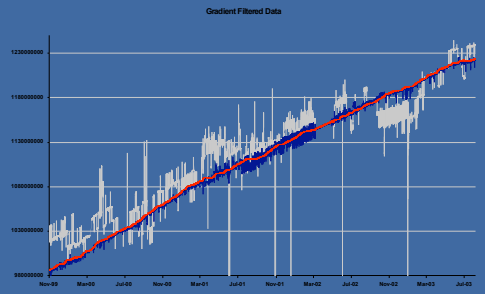


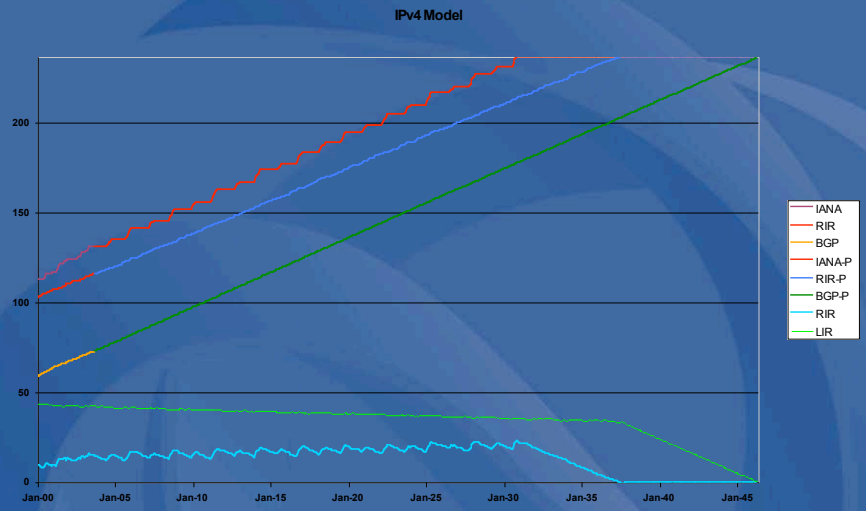




IPv4 Lifetime

- Complete Exhaustion of all available IPv4 Address Space:
  September 2040
- Exhaustion of the IPv4 Unallocated Address Pool
  November 2018





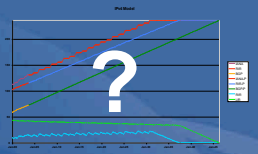
Summary:

"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



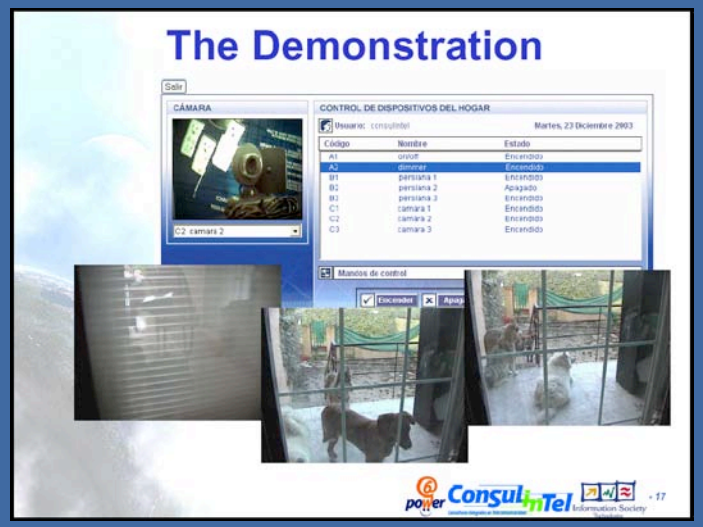
- IPv4 address space not yet exhausted
  - But impossible to predict future
    - Policies & market change, new technologies emerge
- Responsible management essential to future Internet
- IPv6
  - Necessary to start now – transition will take time!

A Glimpse of the Future….

Interesting experiments…

- iCAR (Internet CAR)
  (Nagoya, Japan)
  - Built-in car computers
    - 1500 IPv4 & 70MIPv6 ready taxies
    - IP-enabled wipers – sends info back to central

http://www.wide.ad.jp/about/research.html



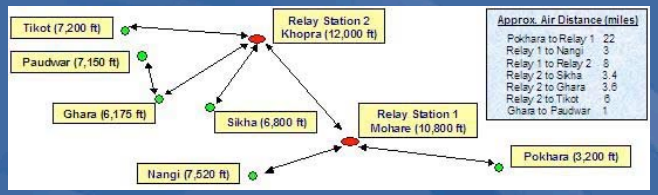
http://www.ipv6-es.com

Jordi Palet's IPv6 enabled home network

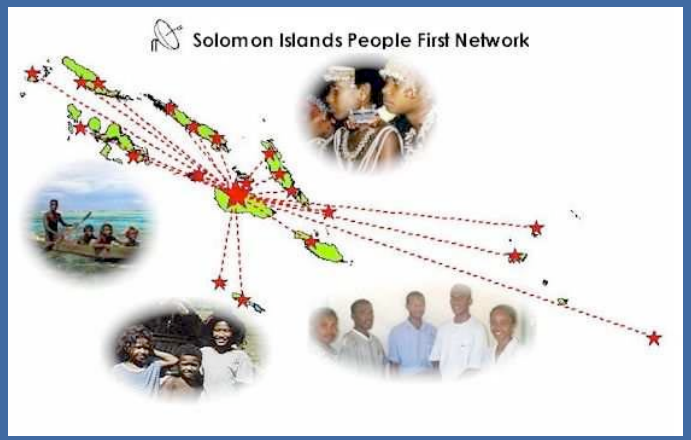
- Allows him to communicate with his dogs when away on travel ☺

Experiments

- Nepal Wireless
  - Five villages in rural Nepal connected through wireless
    - introducing new technology to villagers, most of whom had never seen computers until a few years ago



http://nepalwireless.net/



http://www.peoplefirst.net.sb/

Solomon Islands

People First Network (PFnet)

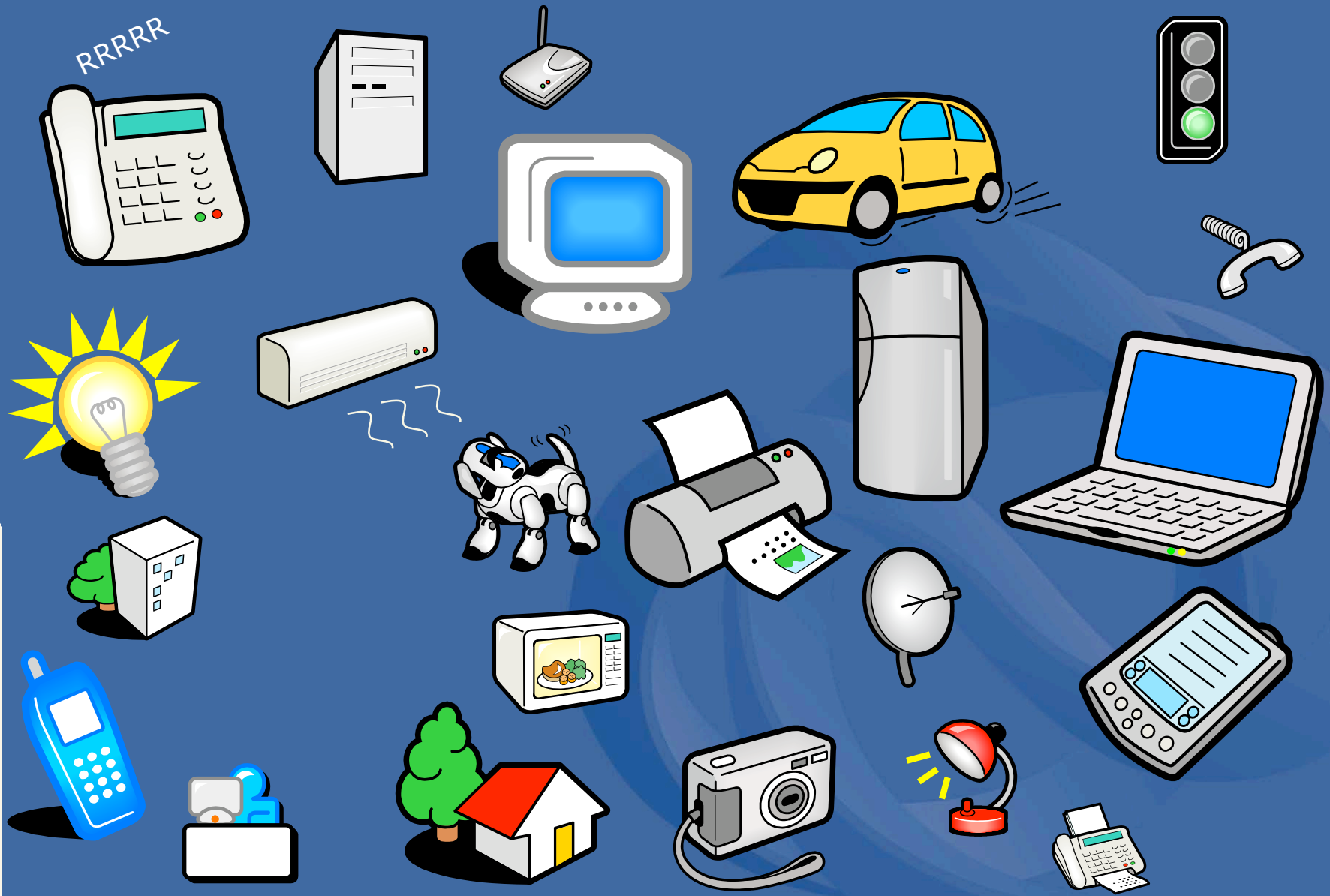
- Distance Learning Trials and Research
- Wireless email

Questions ?

IPv6

Overview, Policies & Statistics

IPv6 - Internet for everything!



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

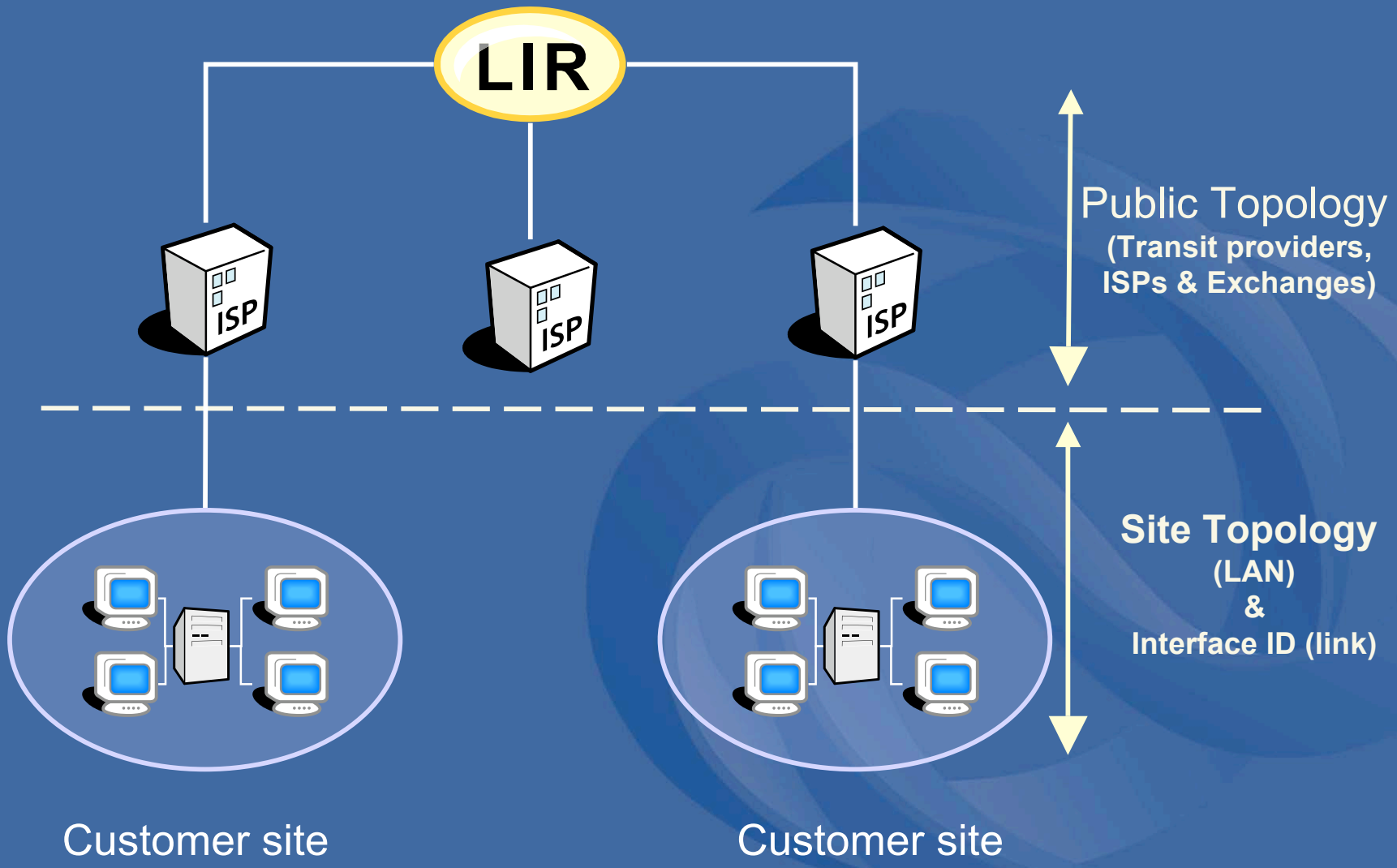
- Example:
  - FE38:DCE3:124C:C1A2:BA03:6735:EF1C:683D
  - Abbreviated form of address
    - 4EED:0023:0000:0000:0000:036E:1250:2B00

    →4EED:23:0:0:0:36E:1250:2B00

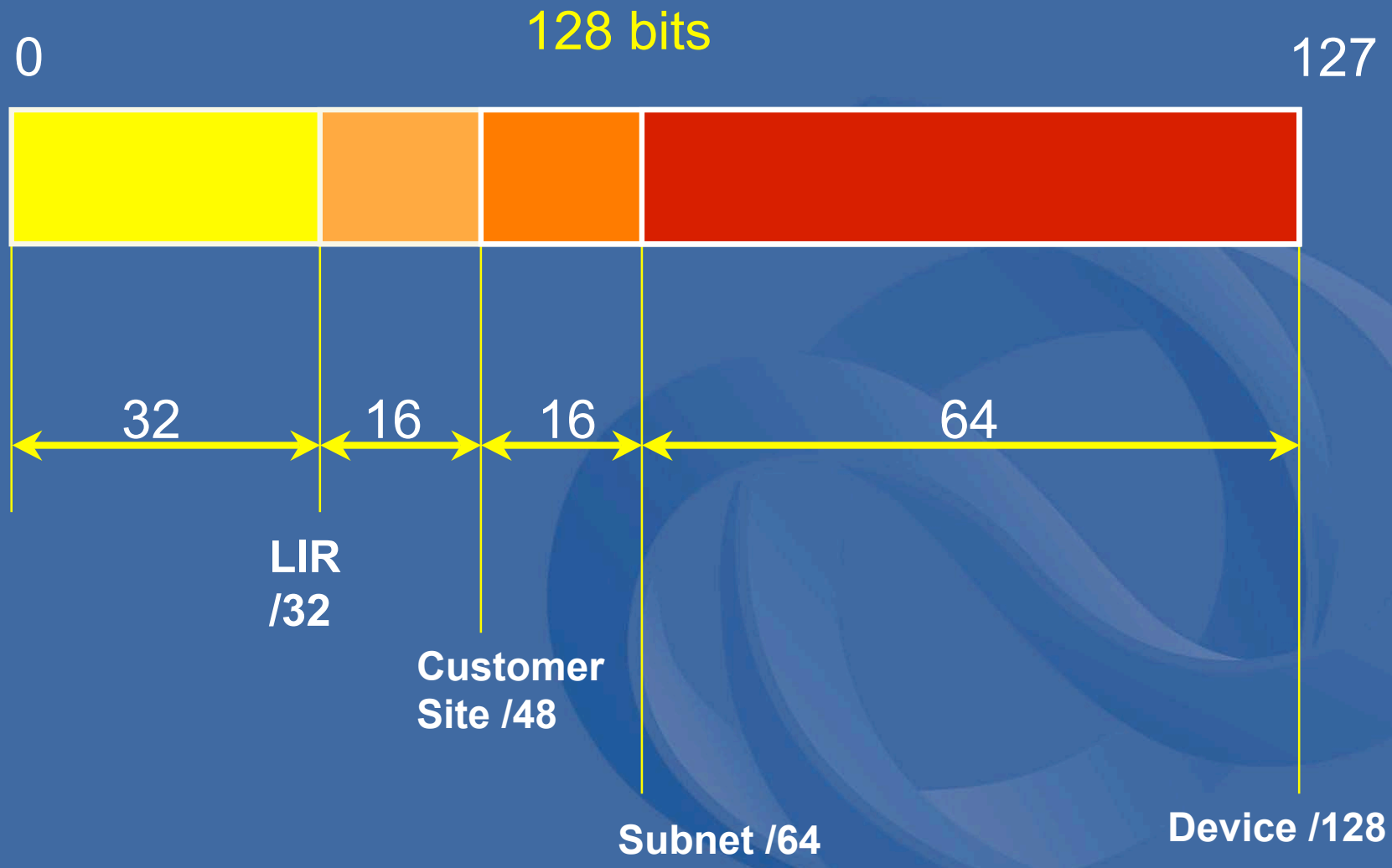
    →4EED:23::36E:1250:2B00

    (Null value can be used only once)

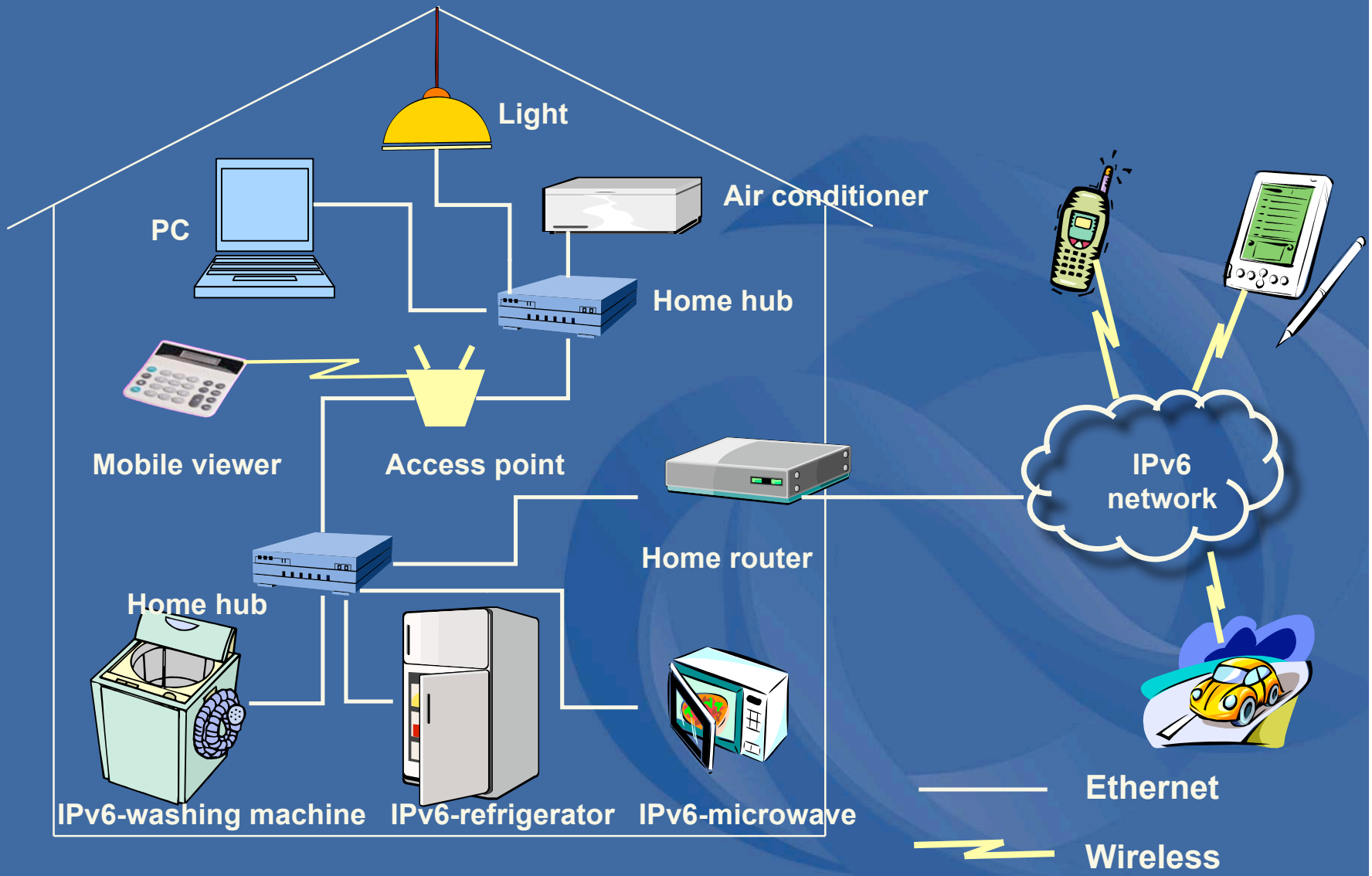
IPv6 address topology



IPv6 addressing structure



IPv6 experiments



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

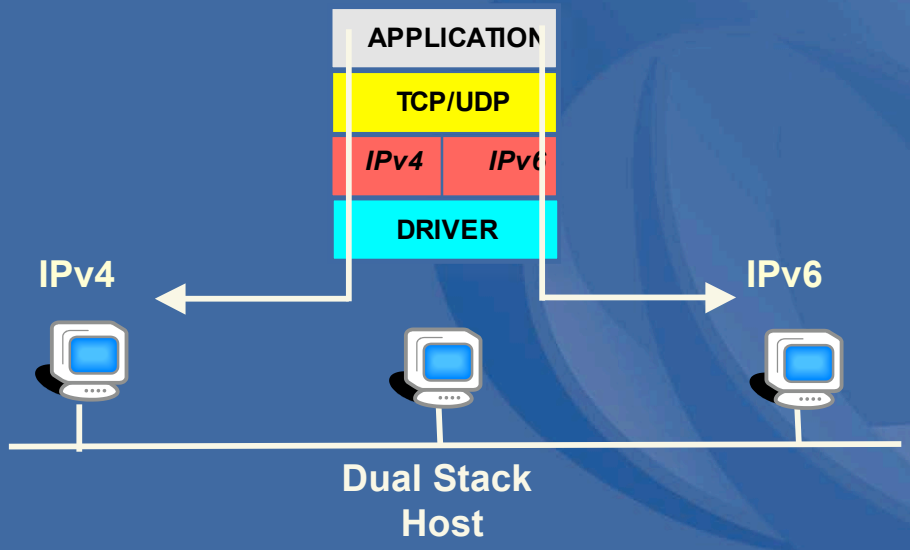
IPv6 Resource Guide
http://www.apnic.net/services/ipv6_guide.html

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

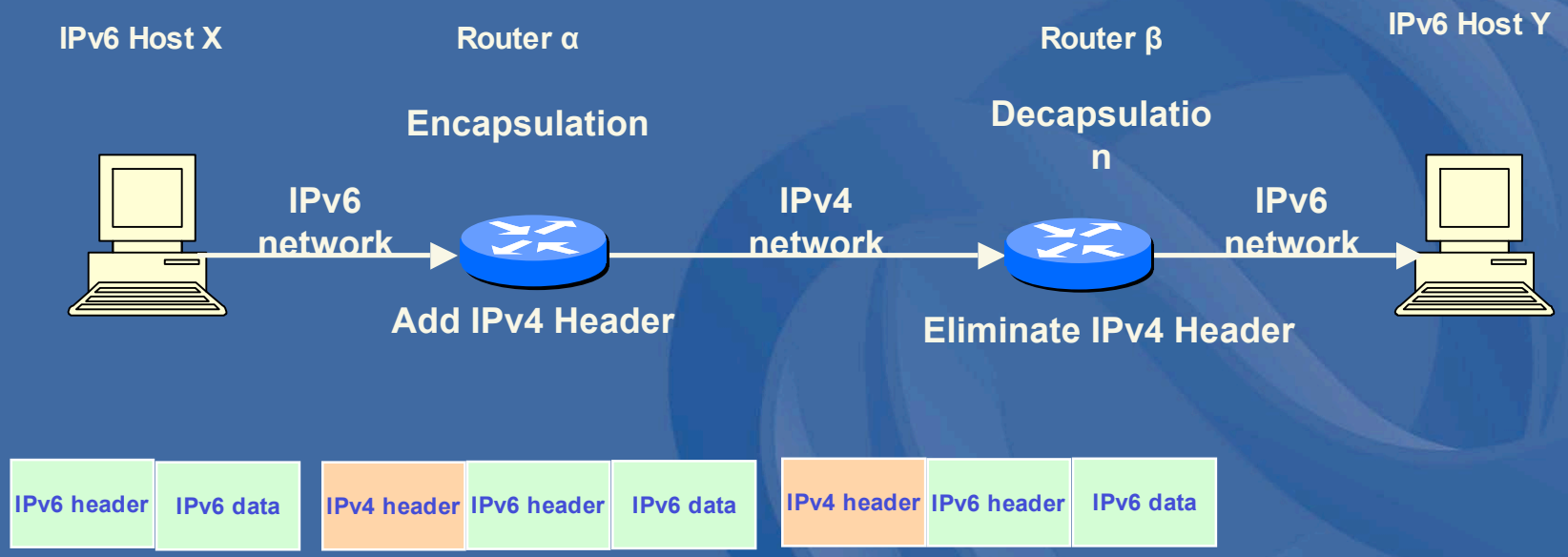
Dual stack transition

- Dual stack = TCP/IP protocol stack running both IPv4 and IPv6 protocol stacks simultaneously
- Useful at the early phase of transition

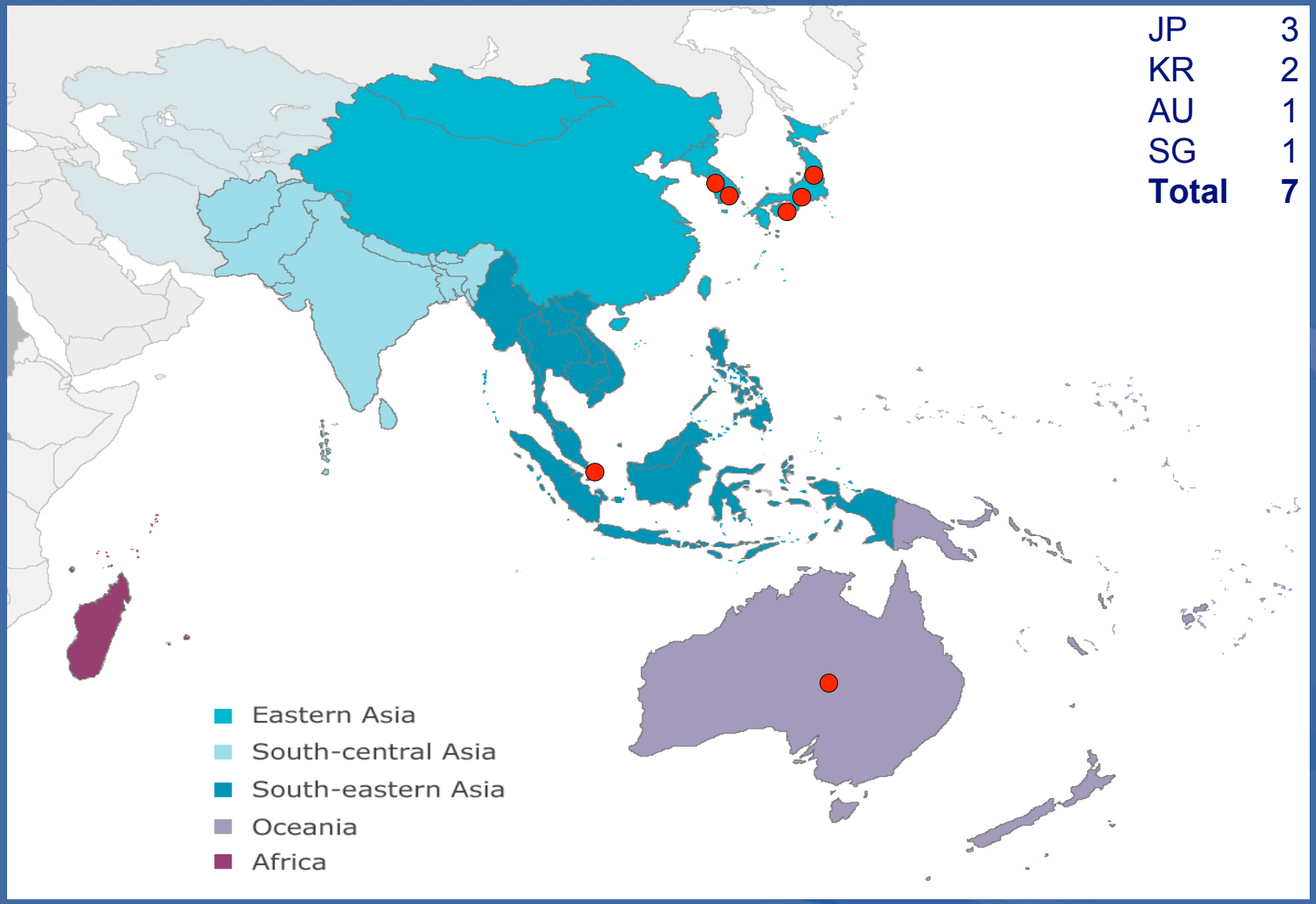


Tunneling

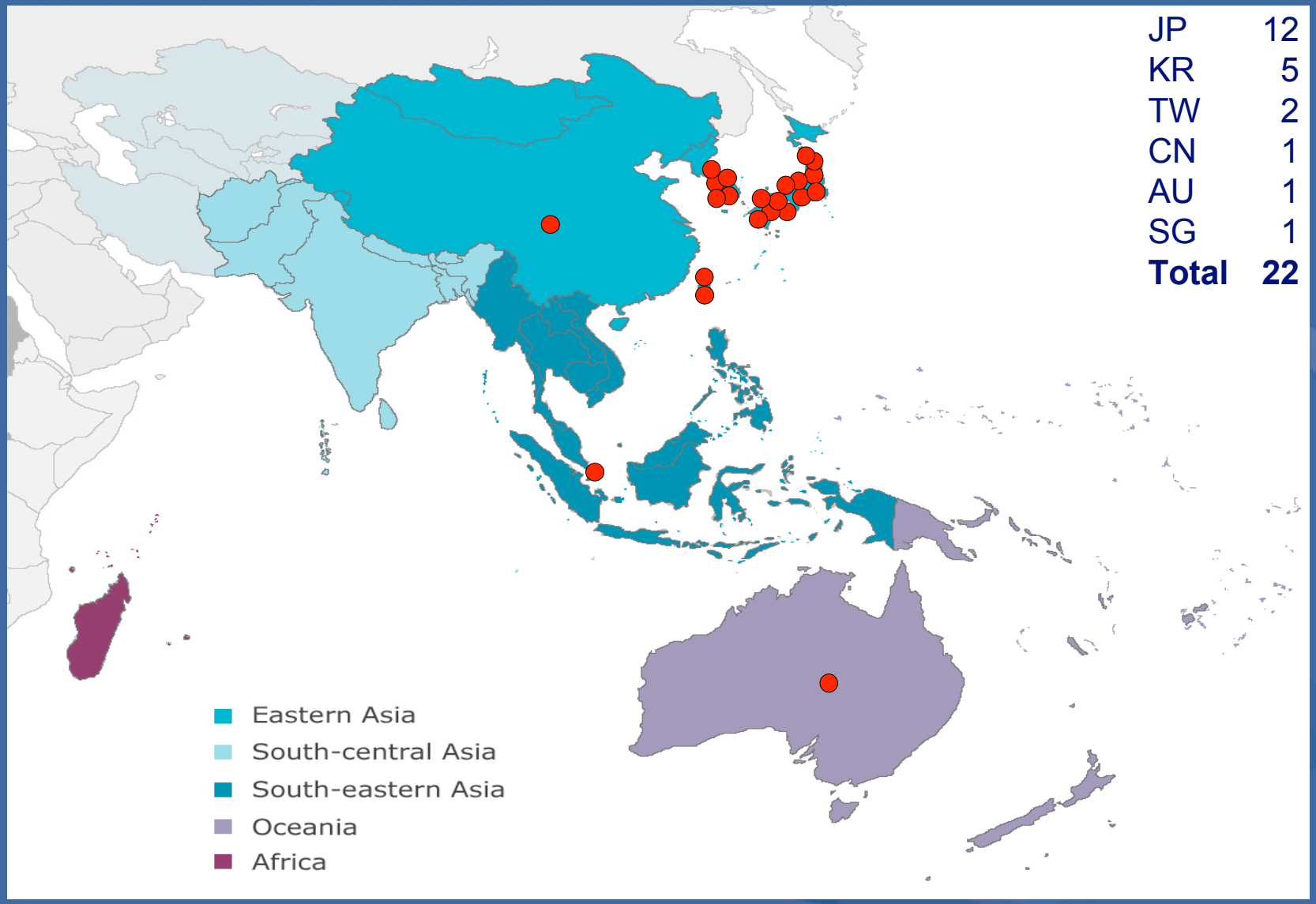
- Commonly used transition method
- IP v6 packet encapsulated in an IPv4 header
- Destination routers will decapsulate the packets and send IPv6 packets to destination IPv6 host



IPv6 Allocations in Asia Pacific 1999



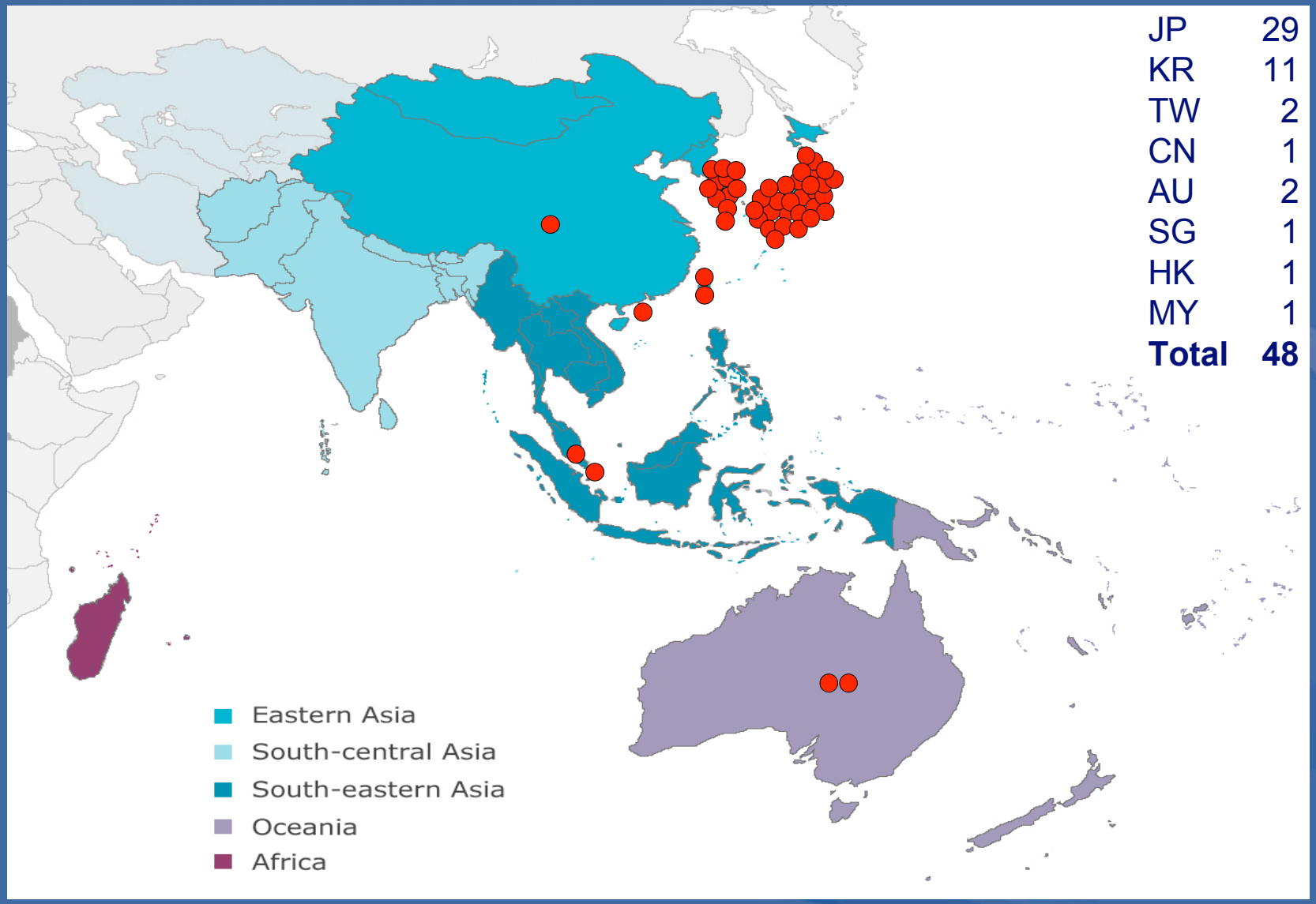
IPv6 Allocations in Asia Pacific 2000
(cumulative total)



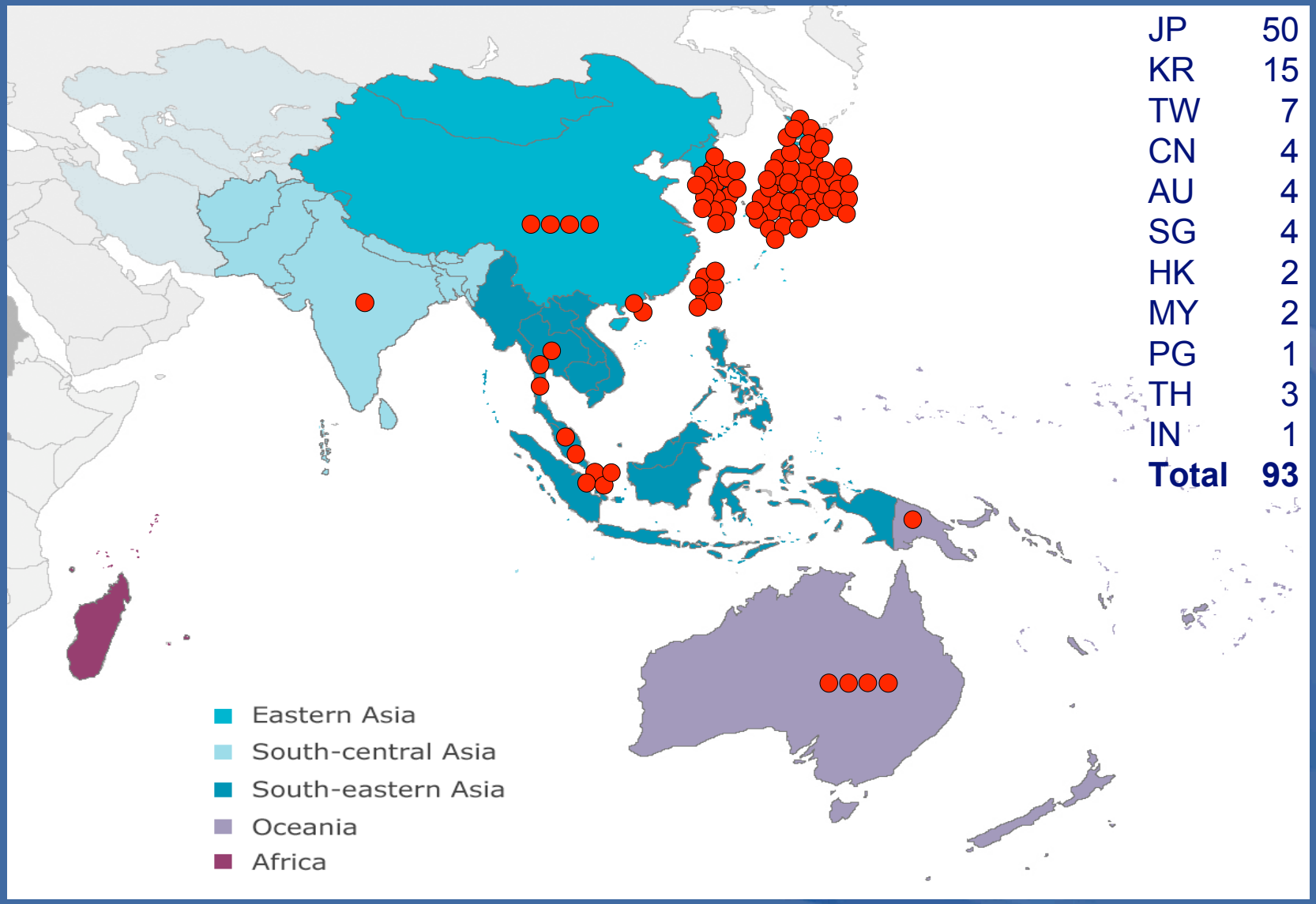
Asia Pacific Network Information Centre

APNIC

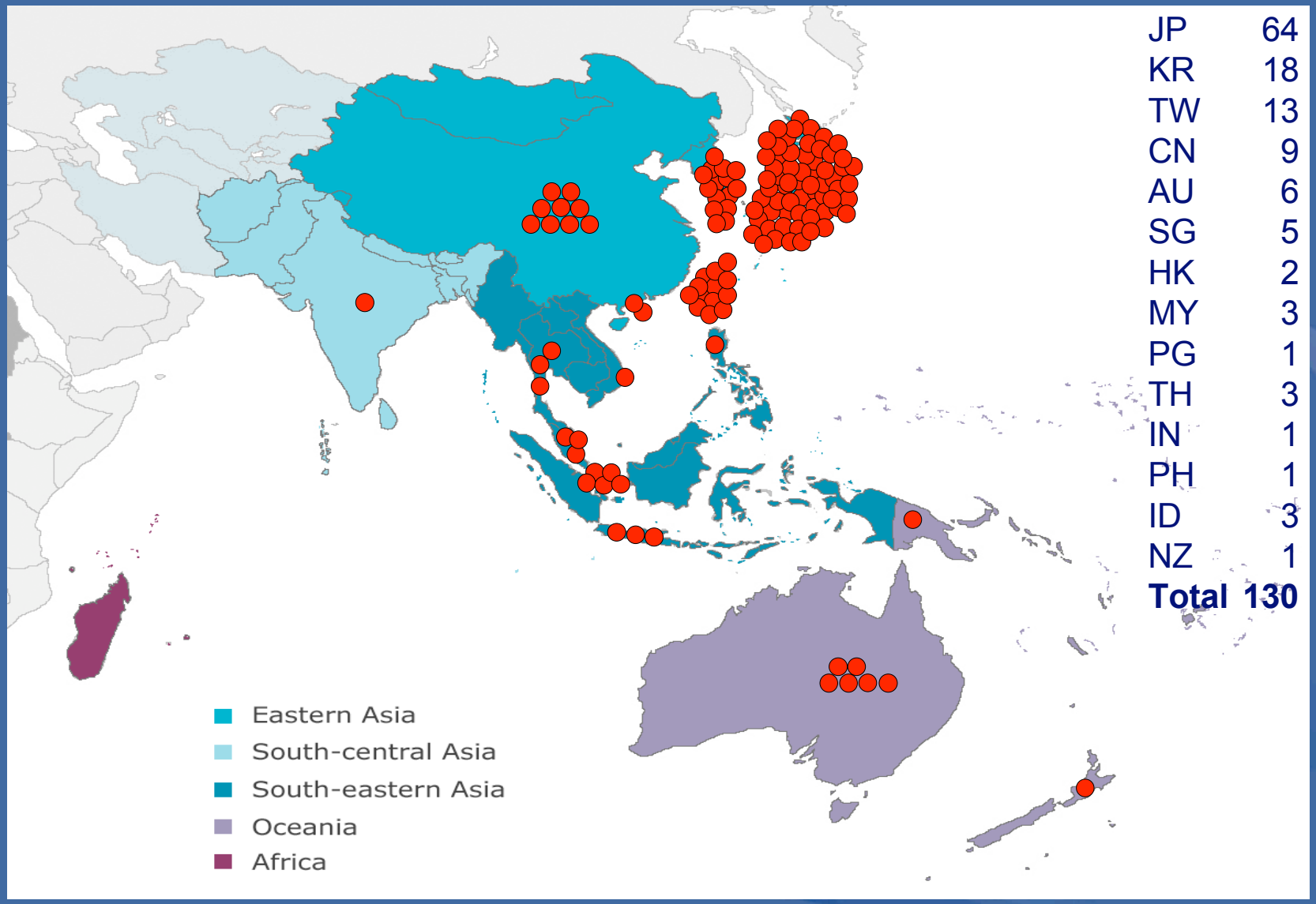
IPv6 Allocations in Asia Pacific 2001
(cumulative total)



IPv6 Allocations in Asia Pacific 2002
(cumulative total)

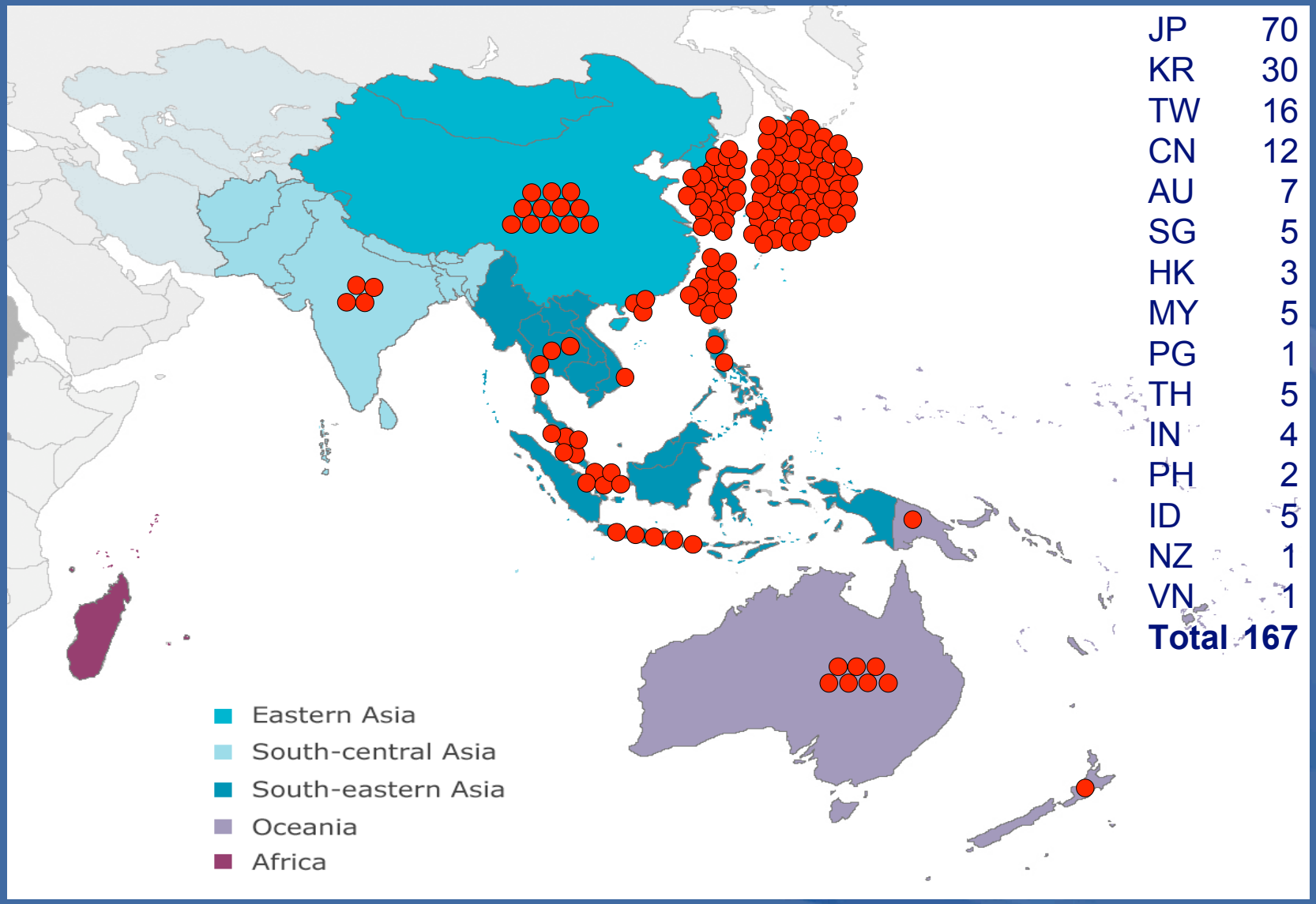


IPv6 Allocations in Asia Pacific 2003
(cumulative total)



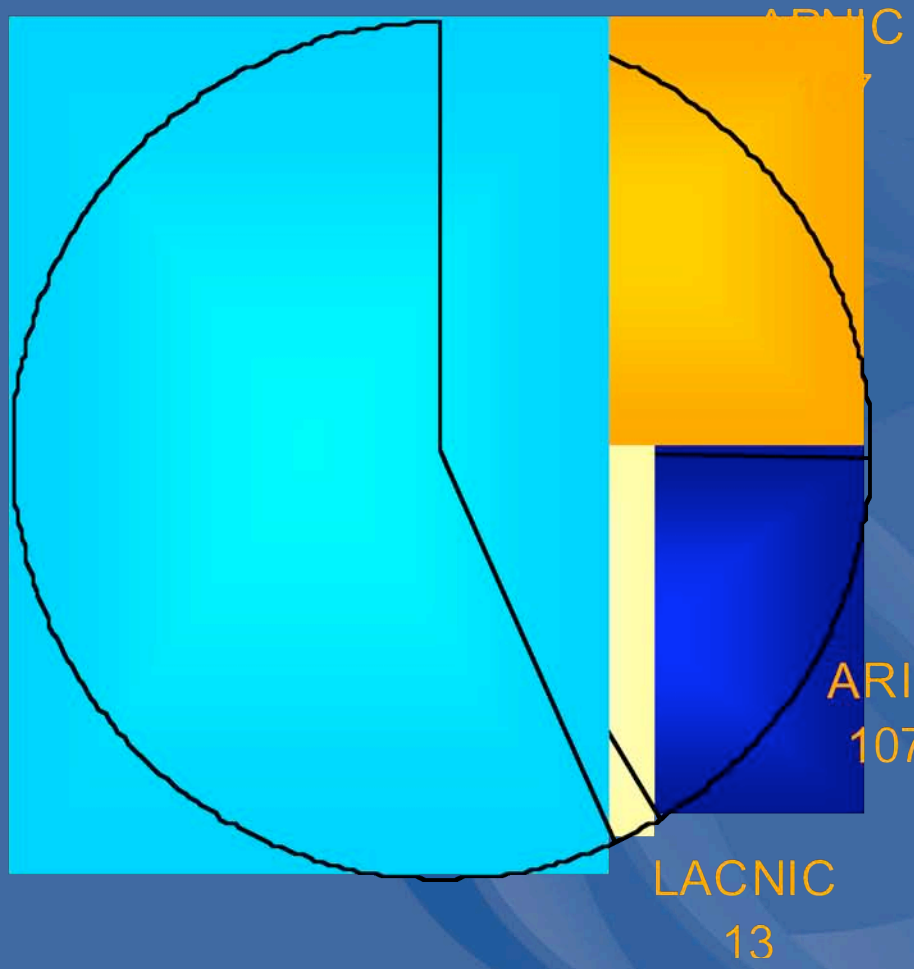
IPv6 Allocations in Asia Pacific 2004

(cumulative total to September 2004)



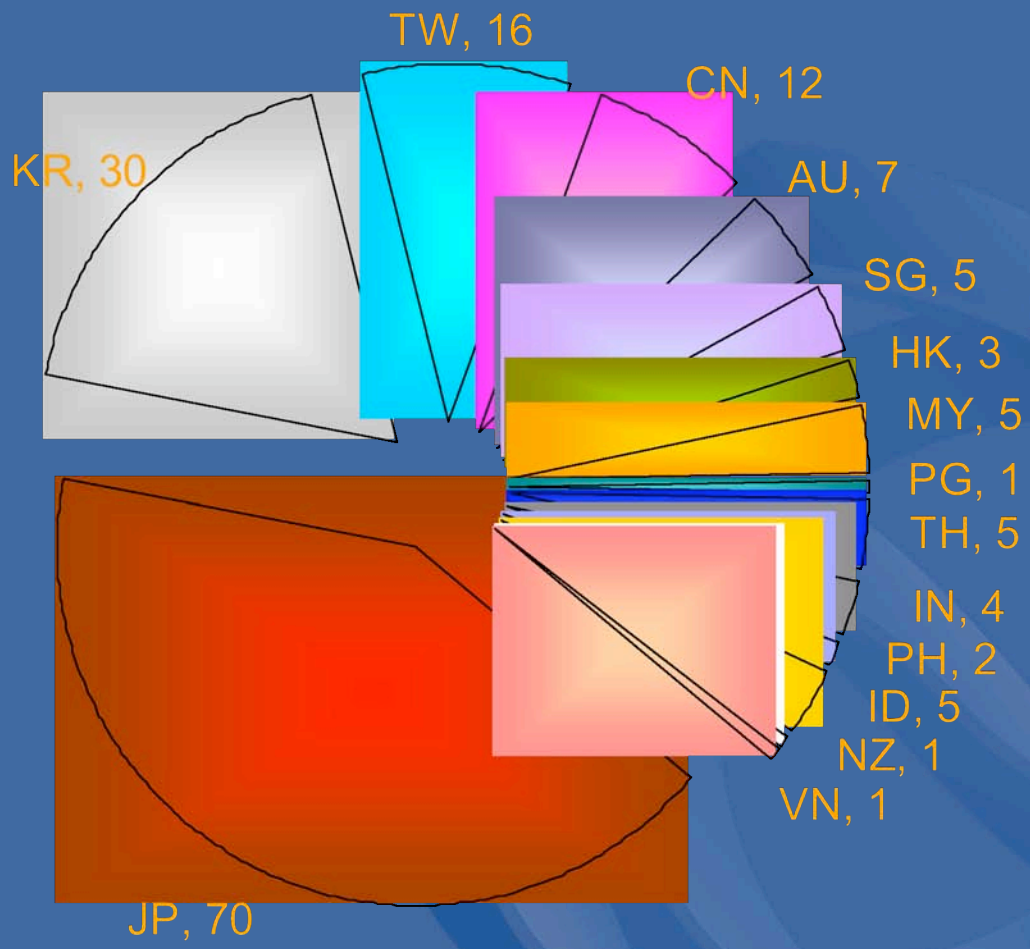
JP	70
KR	30
TW	16
CN	12
AU	7
SG	5
HK	3
MY	5
PG	1
TH	5
IN	4
PH	2
ID	5
NZ	1
VN	1
Total	**167**

RIR IPv6 Allocations



September 2004

APNIC IPv6 Allocations by Economy



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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 ?

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
- RIRs do NOT advocate NAT
  - Choice entirely up to ISP/user
  - Be aware of disadvantages with NAT
- Visit the source for address statistics / policies.
- Take part in policy making process!

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

Nurani, Kapil & Champika

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

Useful references – APNIC community

- APNIC website:
  - www.apnic.net
- APNIC members
  - http://www.apnic.net/members.html
- APNIC mailing lists
  - http://www.apnic.net/net_comm/lists/
- APNIC meetings
  - http://www.apnic.net/meetings

Useful references – APNIC guides

- IPv4 guide
  - http://www.apnic.net/services/ipv4_guide.html
- IPv6 guide
  - http://www.apnic.net/services/ipv6_guide.html
- ASN guide
  - http://www.apnic.net/services/asn_guide.html
- Whois Database guide
  - http://www.apnic.net/services/whois_guide.html
- FAQs
  - http://www.apnic.net/info/faq/

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