Internet Resource Seminar

U-Connect 2006

Almaty, Kazakhstan, 12 September 2006

APNIC & RIPE NCC

Presenters

- Joint seminar today with the presenters from both the RIPE NCC & APNIC

- Arno Meulenkamp, RIPE NCC

- Leo Vegoda, RIPE NCC

- Miwa Fujii, APNIC

- Nurani Nimpuno, APNIC

Overview

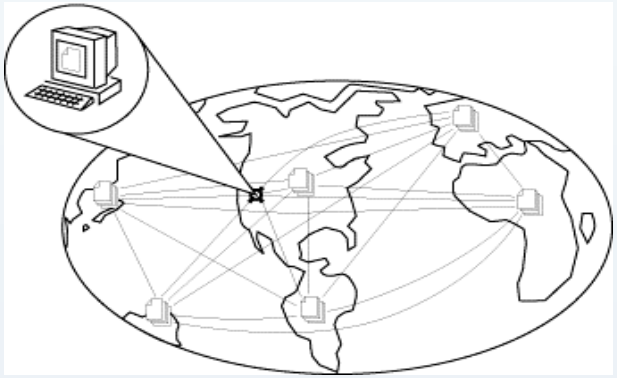
- The Internet and IP addresses
  - an introduction
- History of the Internet
  - Early distribution models
  - The RIR system
- The Internet today
  - Slashes & bits
  - IP address management
- The future and IPv6

The Internet and IP

What it is and how it works

What Is the Internet?

- A network of networks, joining many government, university and private computers together and providing an infrastructure for the use of E-mail, bulletin boards, file archives, hypertext documents, databases and other computational resources
- The vast collection of computer networks which form and act as a single huge network for transport of data and messages across distances which can be anywhere from the same office to anywhere in the world.

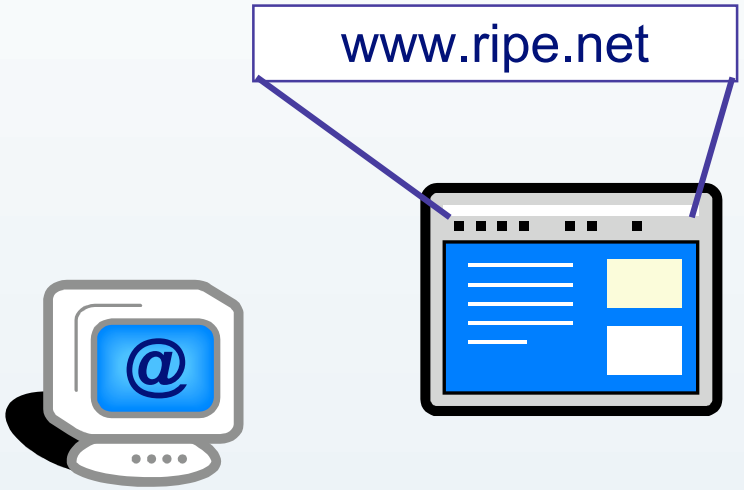


What is the Internet?

- A “Network of Networks”
  - Independent networks can join a single seamless global infrastructure
- A “Dumb” network
  - TCP/IP: simple end-end packet delivery and session control
  - “Intelligence” is in applications, at the edges
- Open standards
  - Anyone can implement standards
  - Nobody needs to pay license fees
- Minimal administration
  - No centralised operational control
  - Minimal centralised administration
  - Distribution of administrative functions

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…



hostmaster@ripe.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

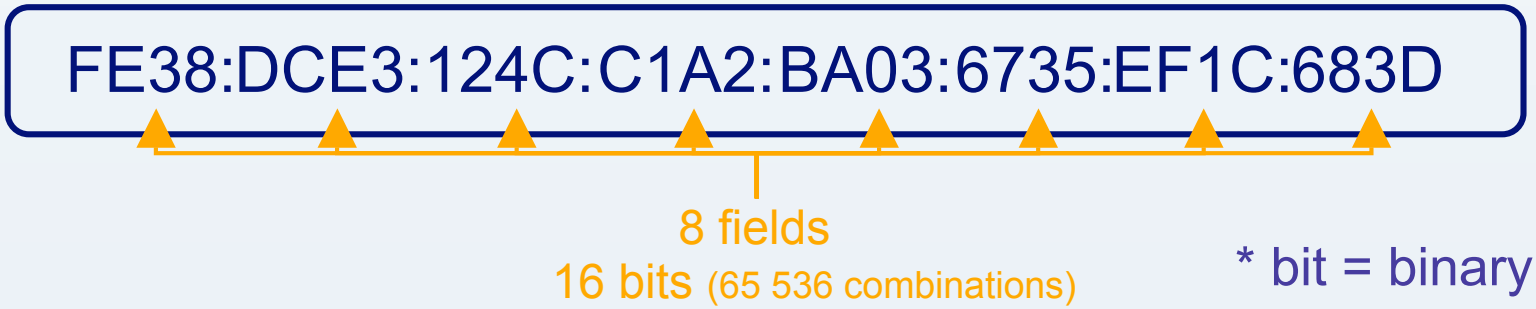
  Example:

IPv6

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

  Addresses available: 340 billion billion billion billion

  Example:

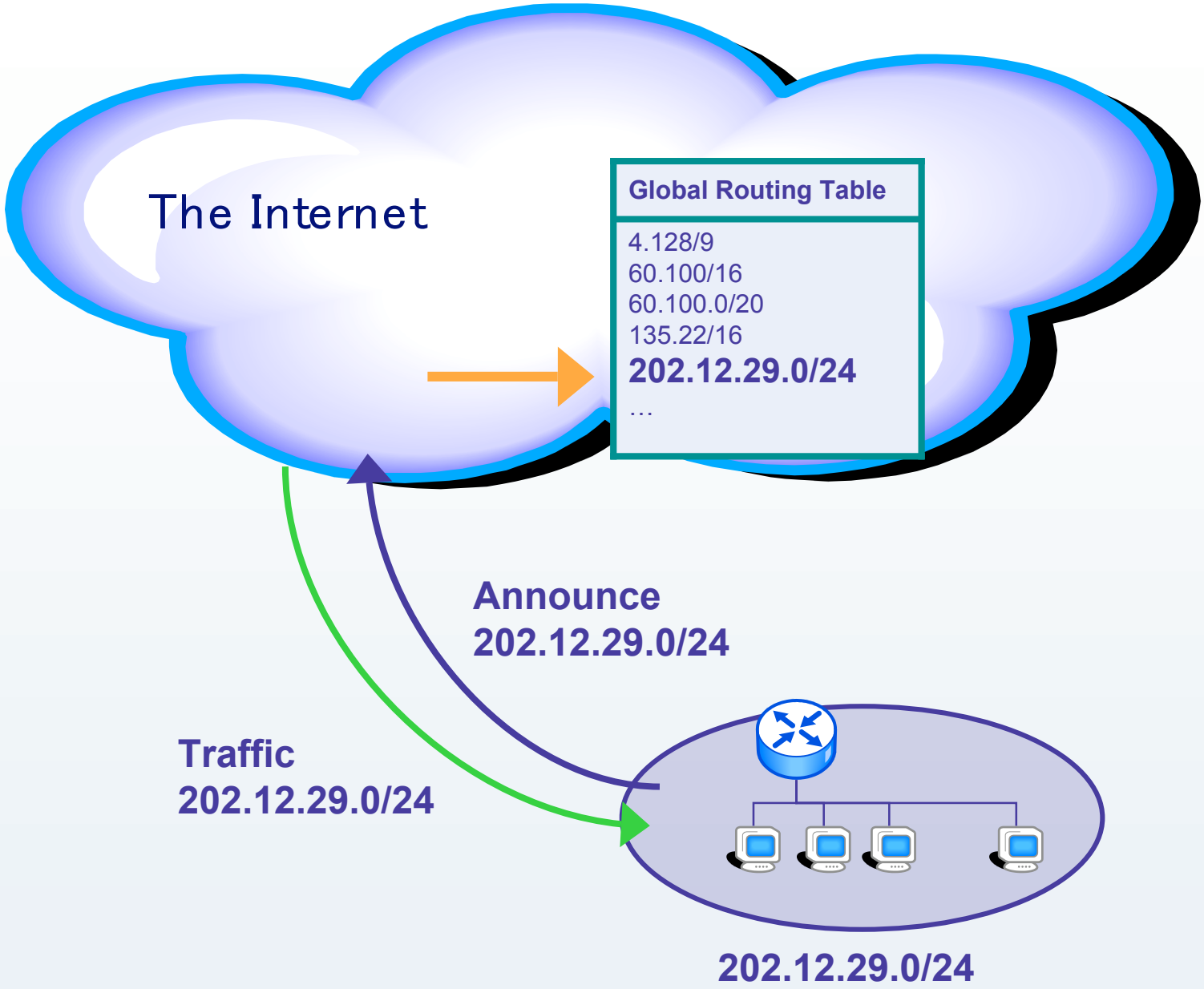


* bit = binary digit

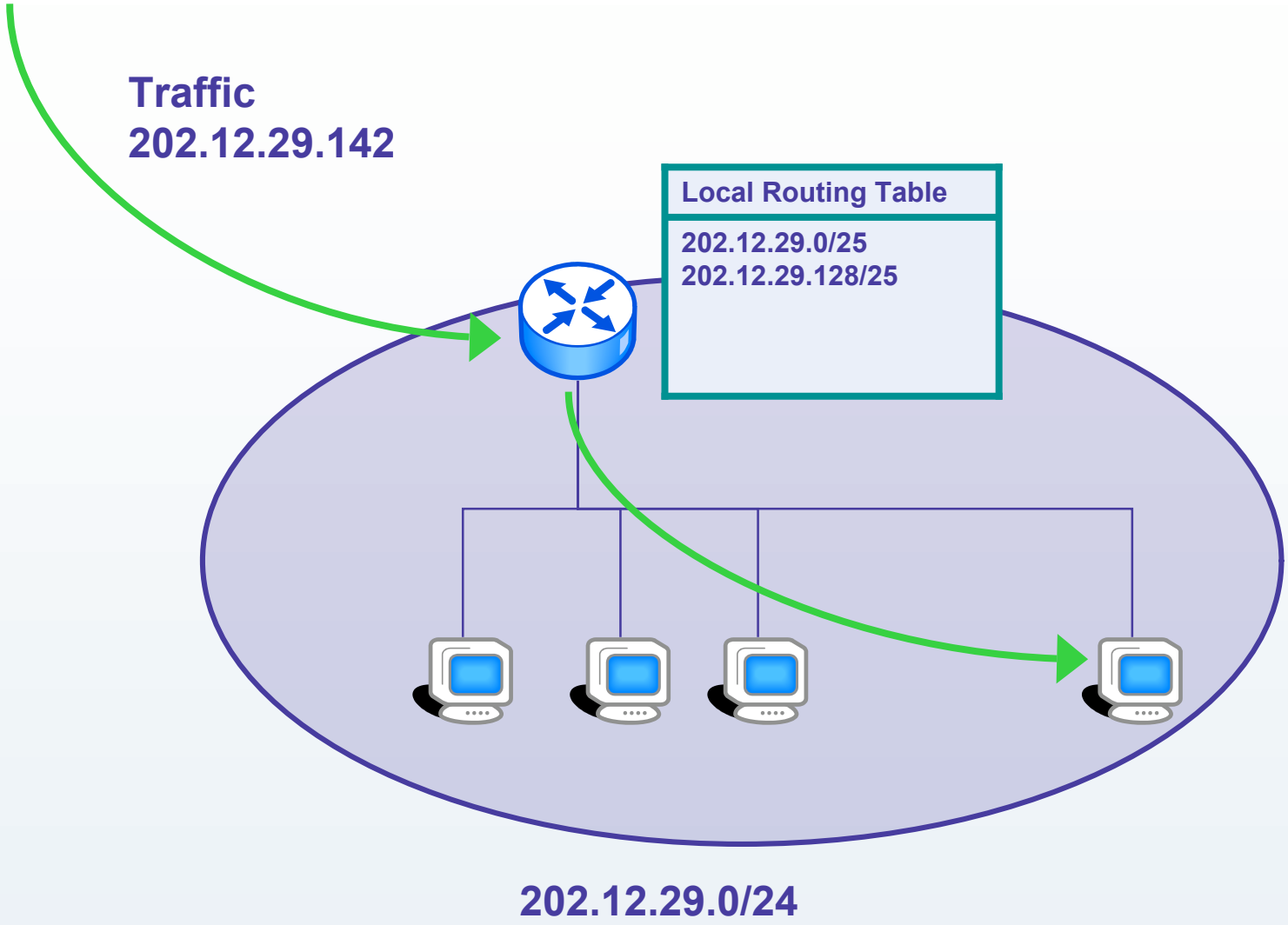
Where are IP Addresses used?

```
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
```

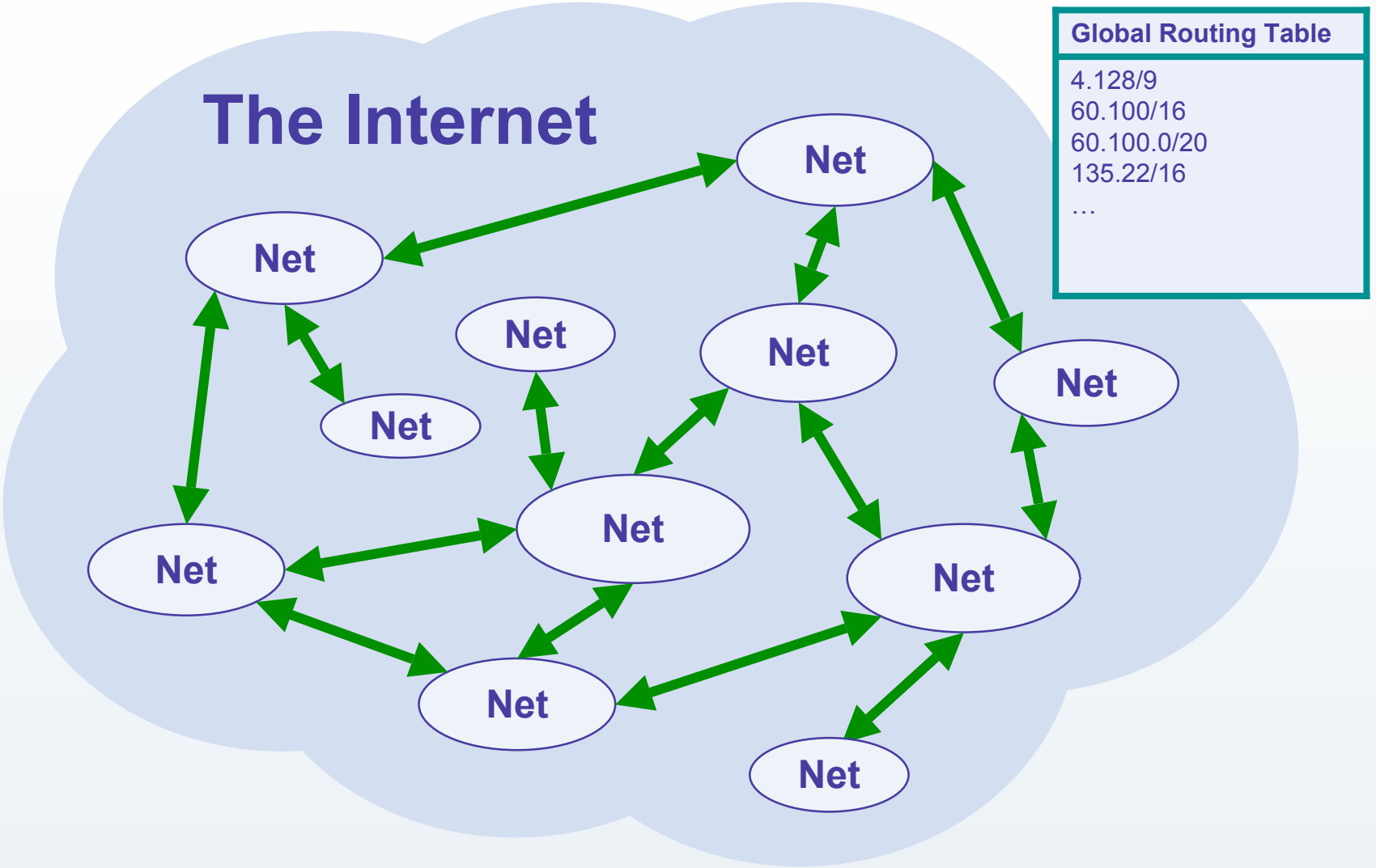
Internet address routing



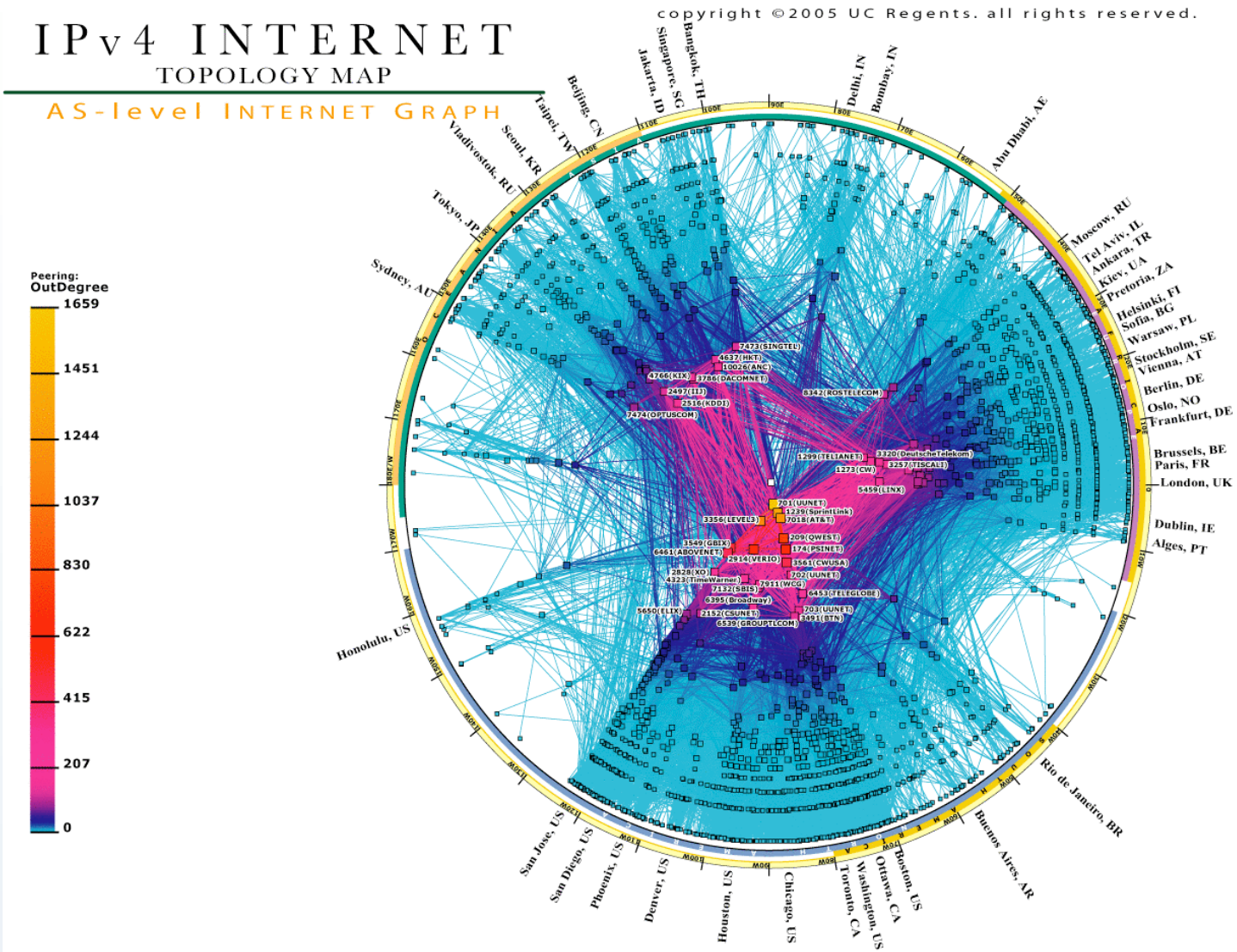
Internet address routing



Global Internet routing



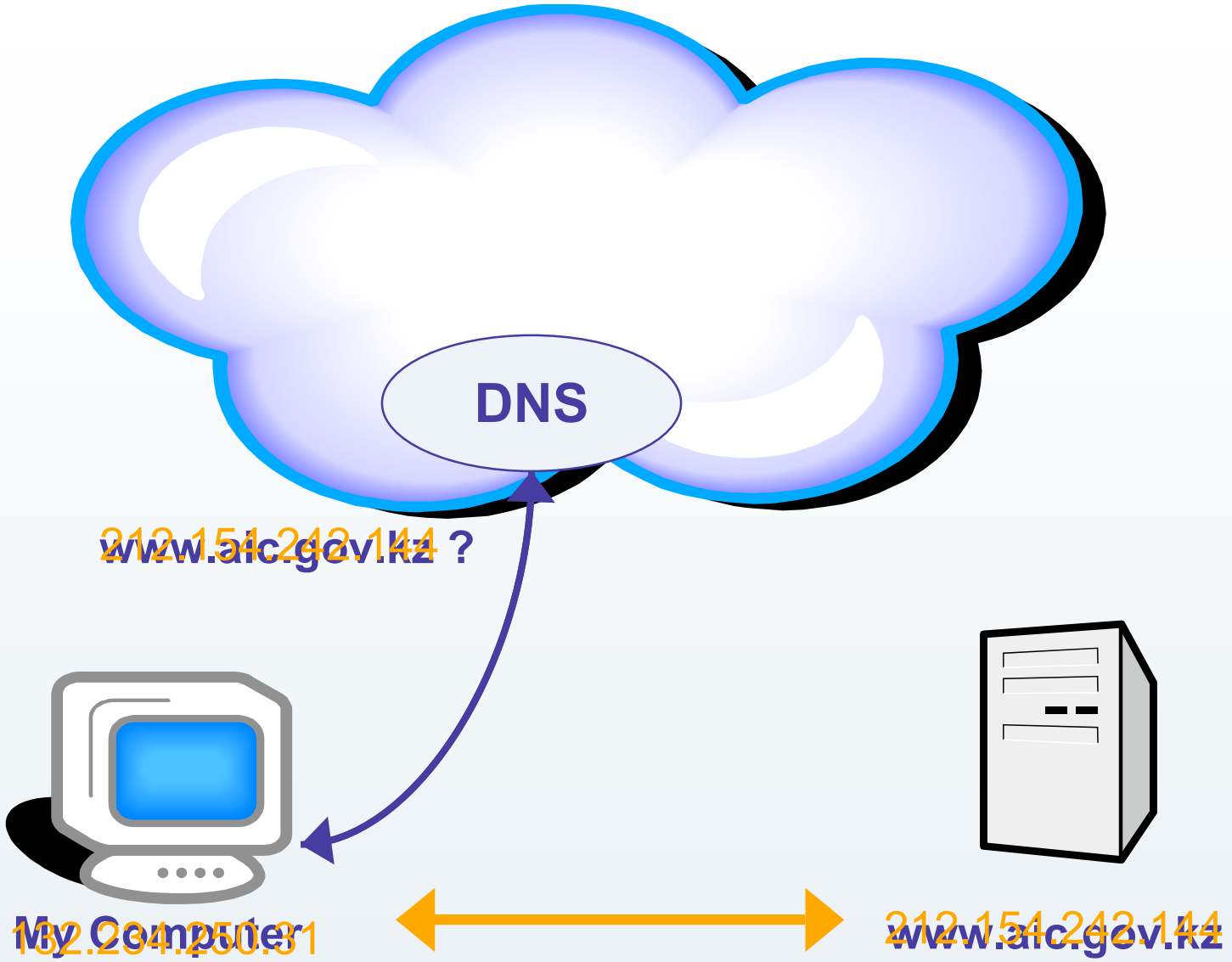
Global Internet routing



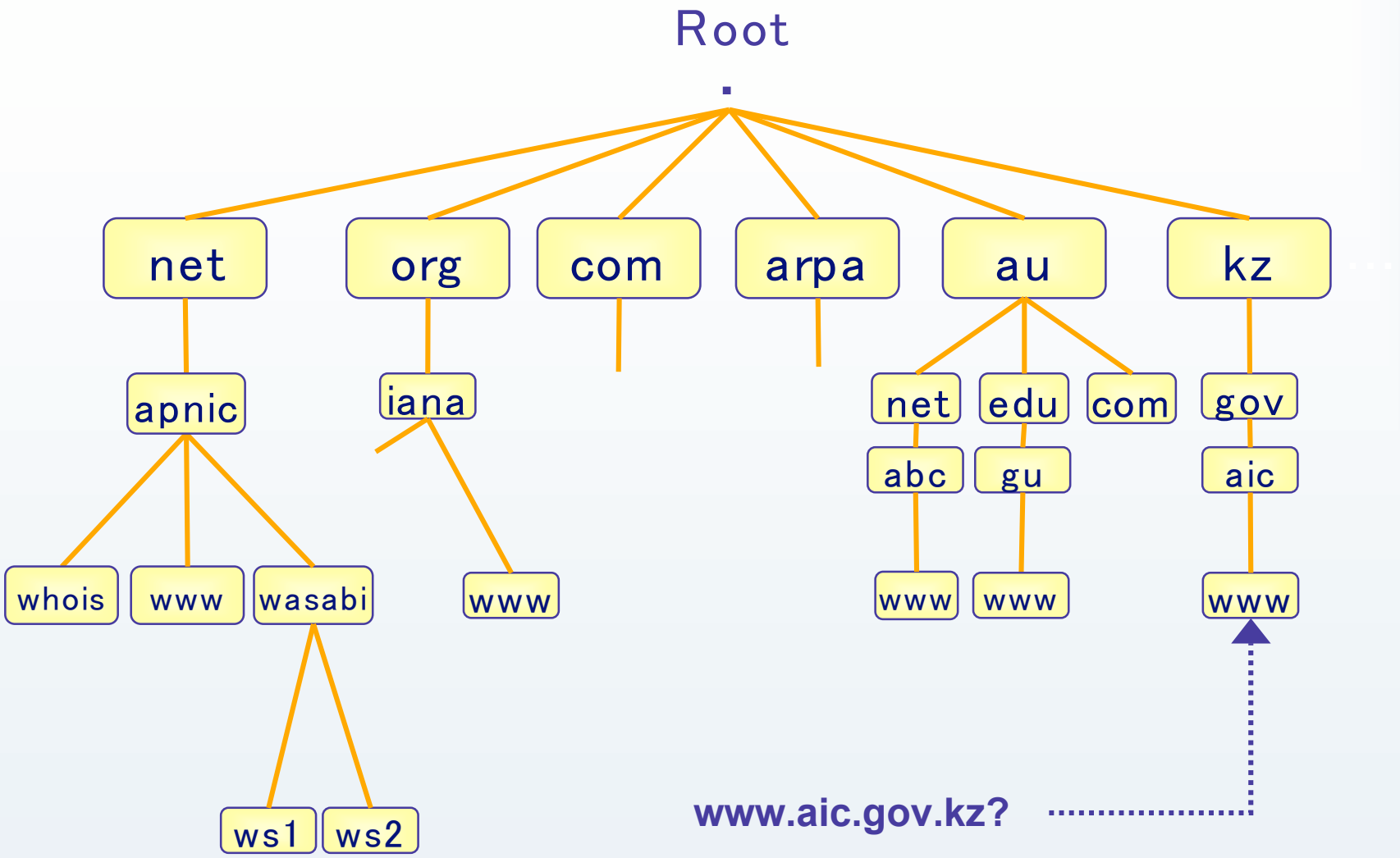
What is a domain name?

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

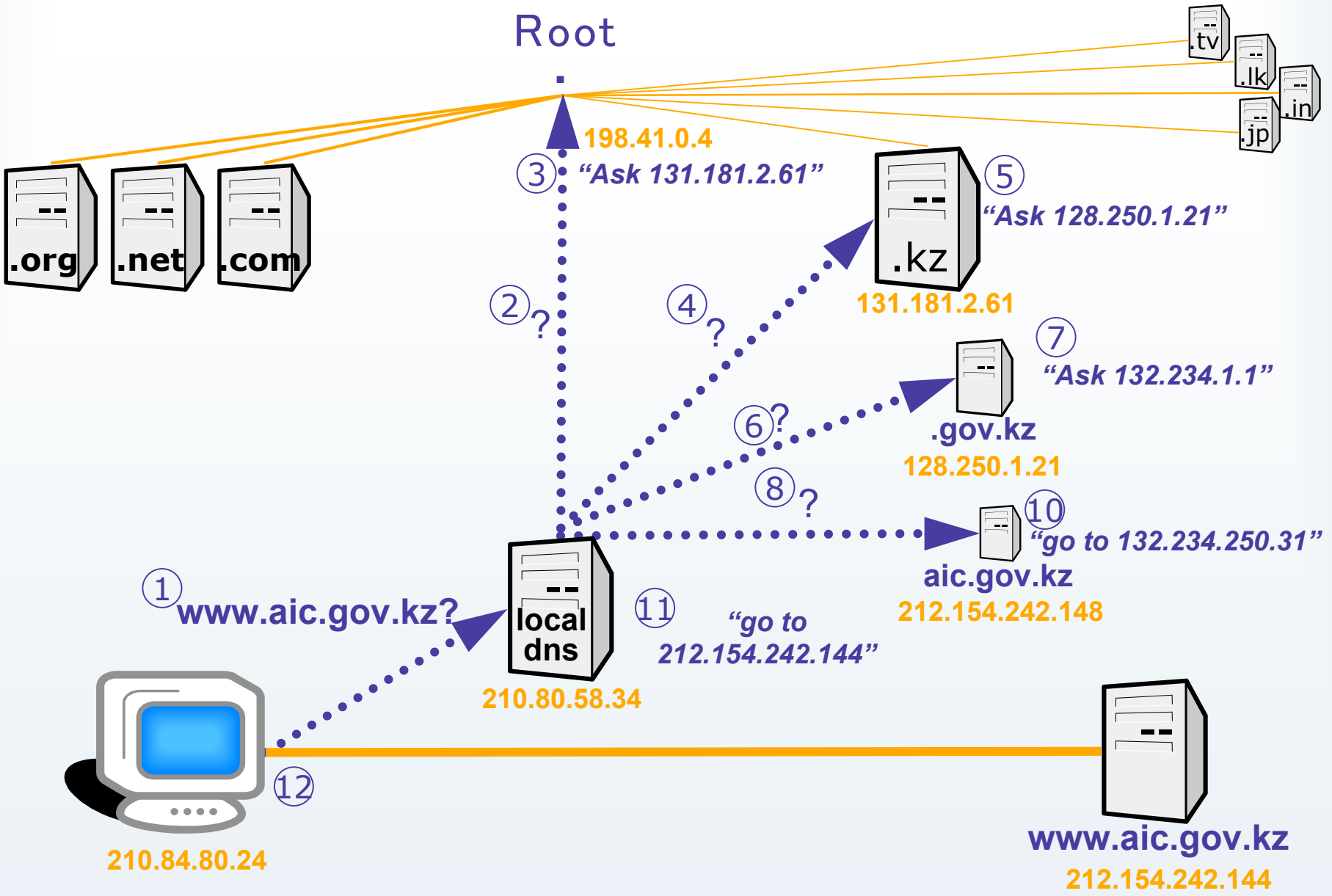
IP addresses vs domain names



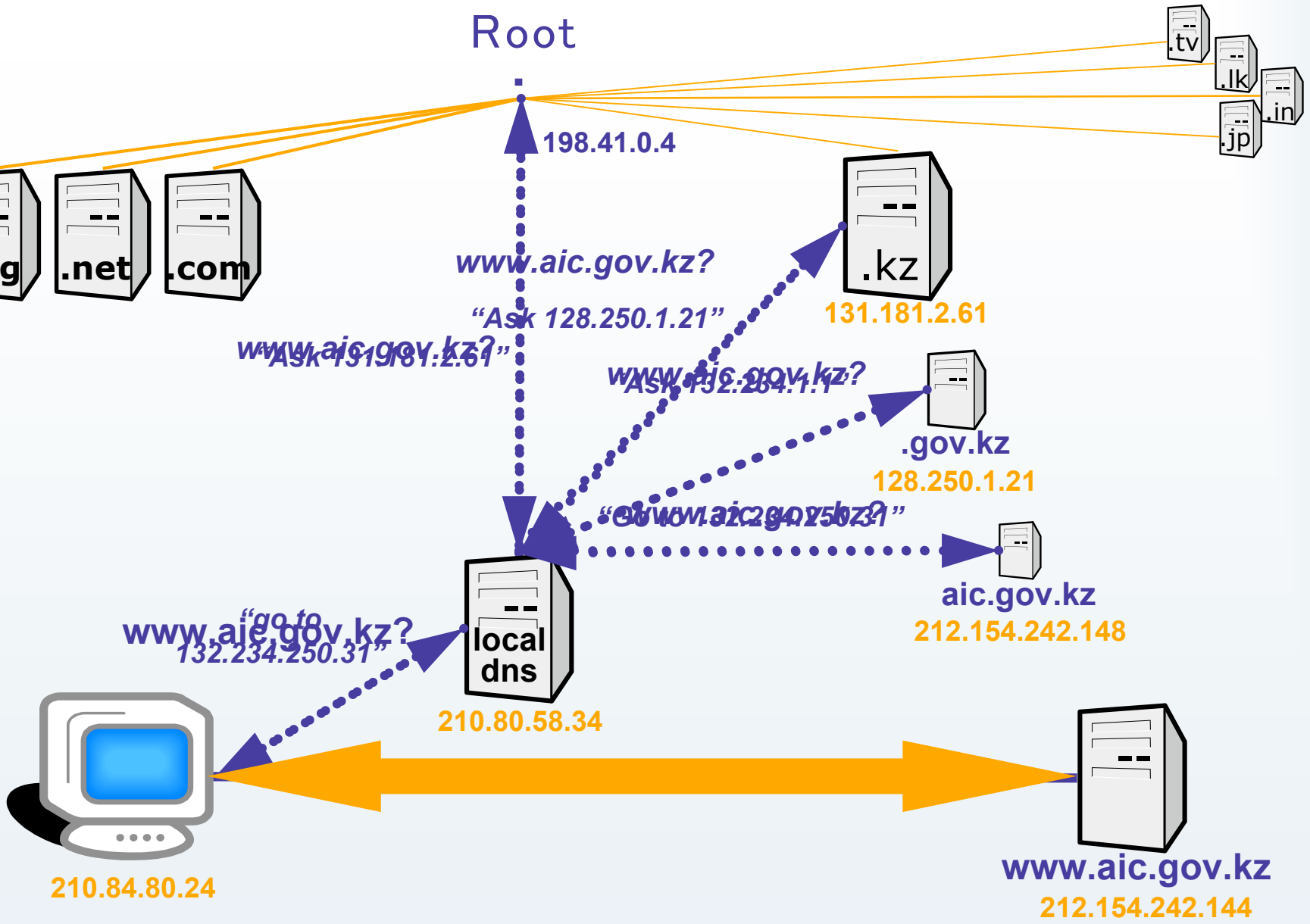
The DNS tree


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

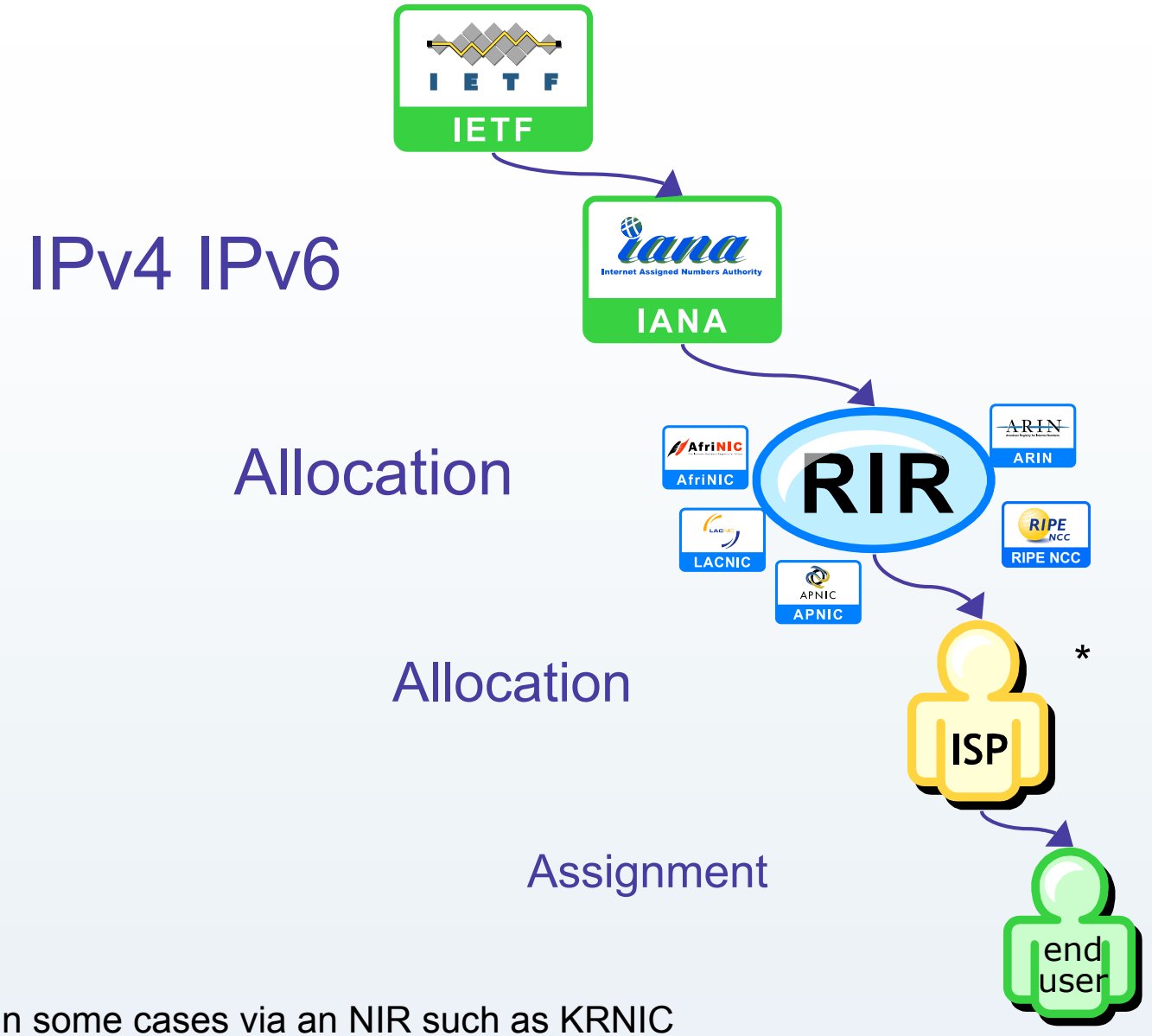
Querying the DNS – It's all about IP!



Querying the DNS – It's all about IP!



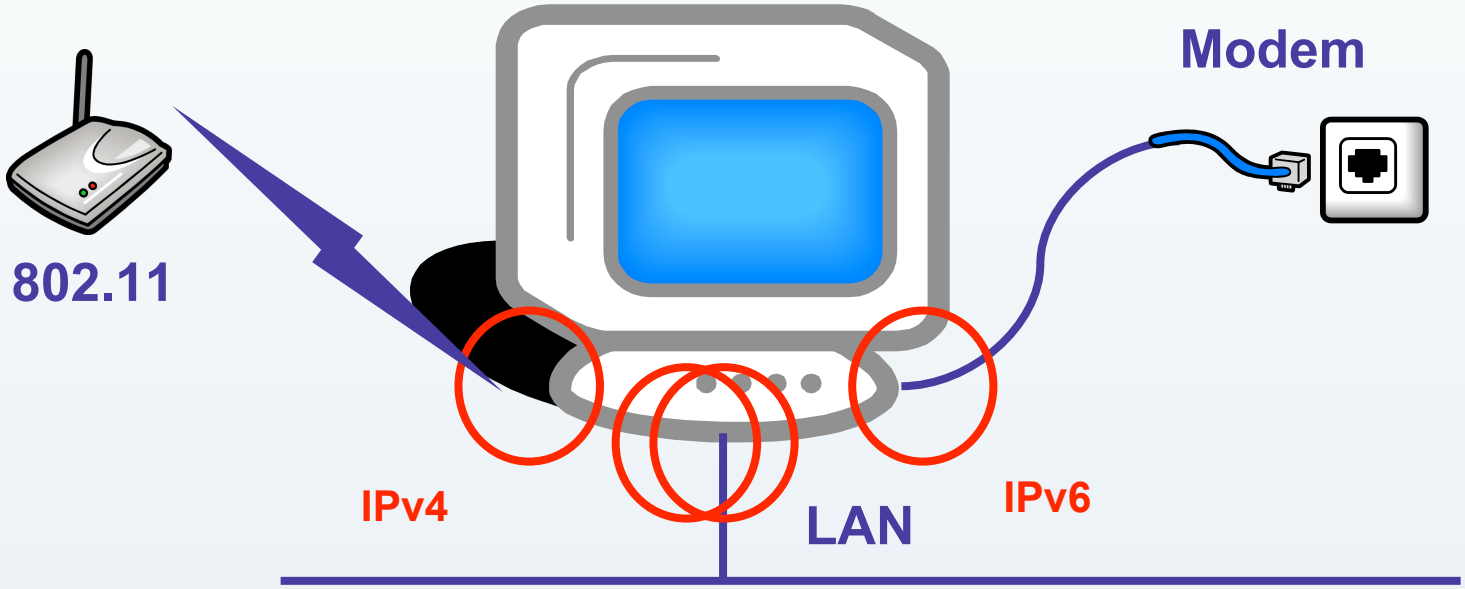
Where do IP addresses come from?



* In some cases via an NIR such as KRNIC

What is “my” address?

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

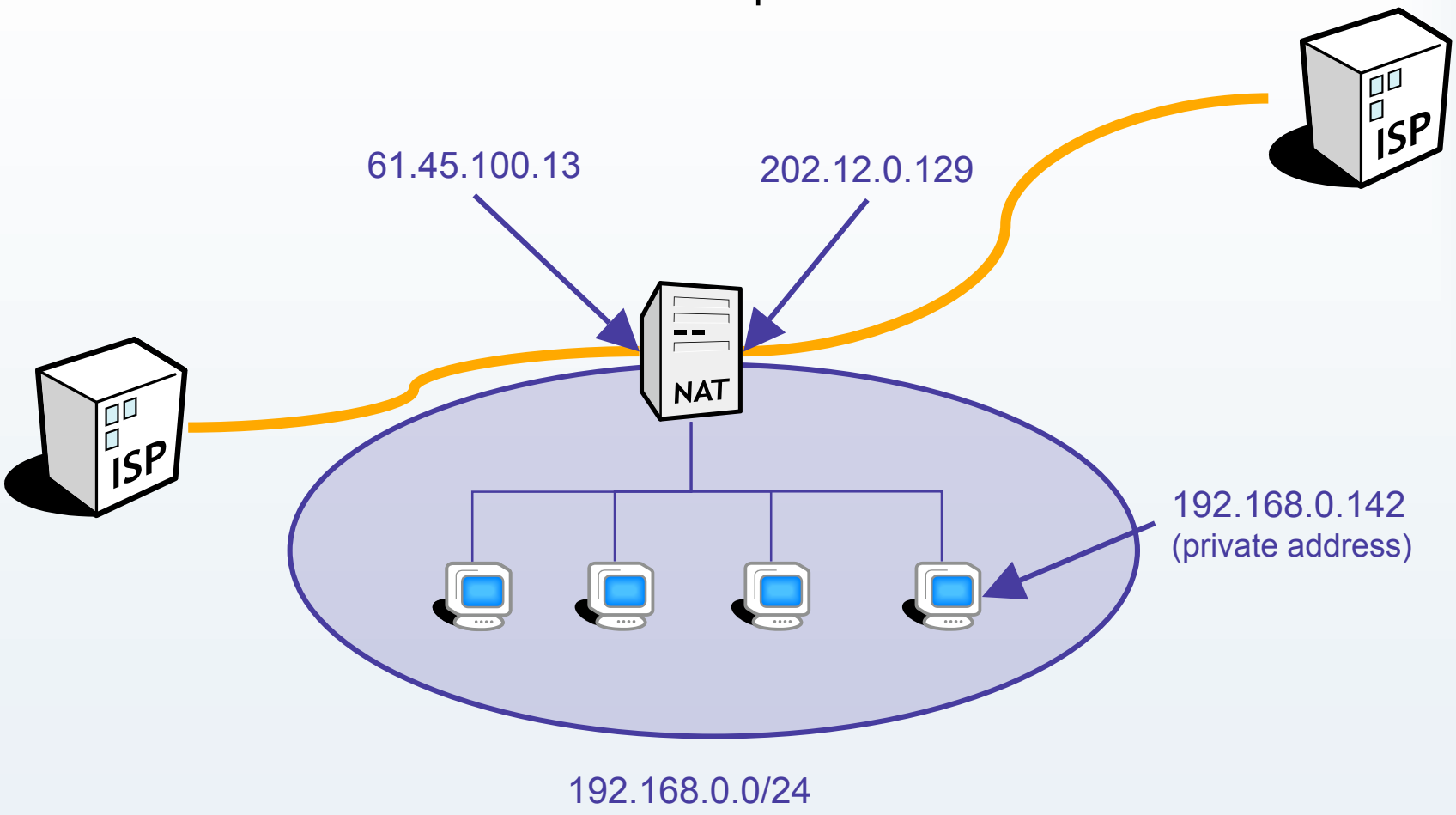


Is “my” address permanent?

- 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 Common Resource
  - not “owned” by address users
  - not dependent upon the DNS

- IP does not mean “Intellectual Property”

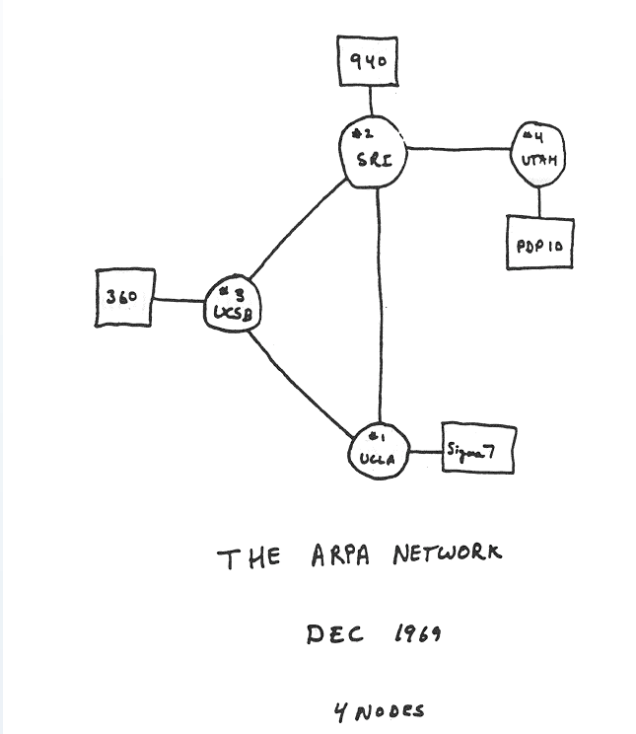
Questions?

Internet history

A look back in time…

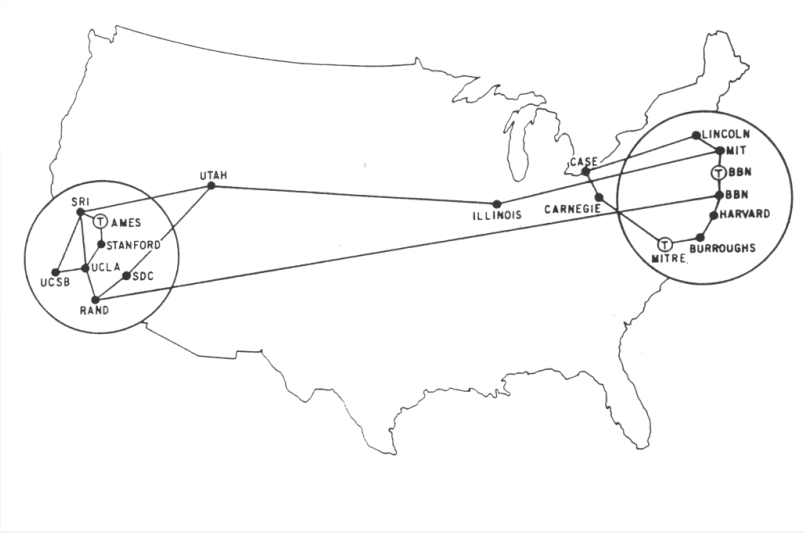
In the beginning…

- 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



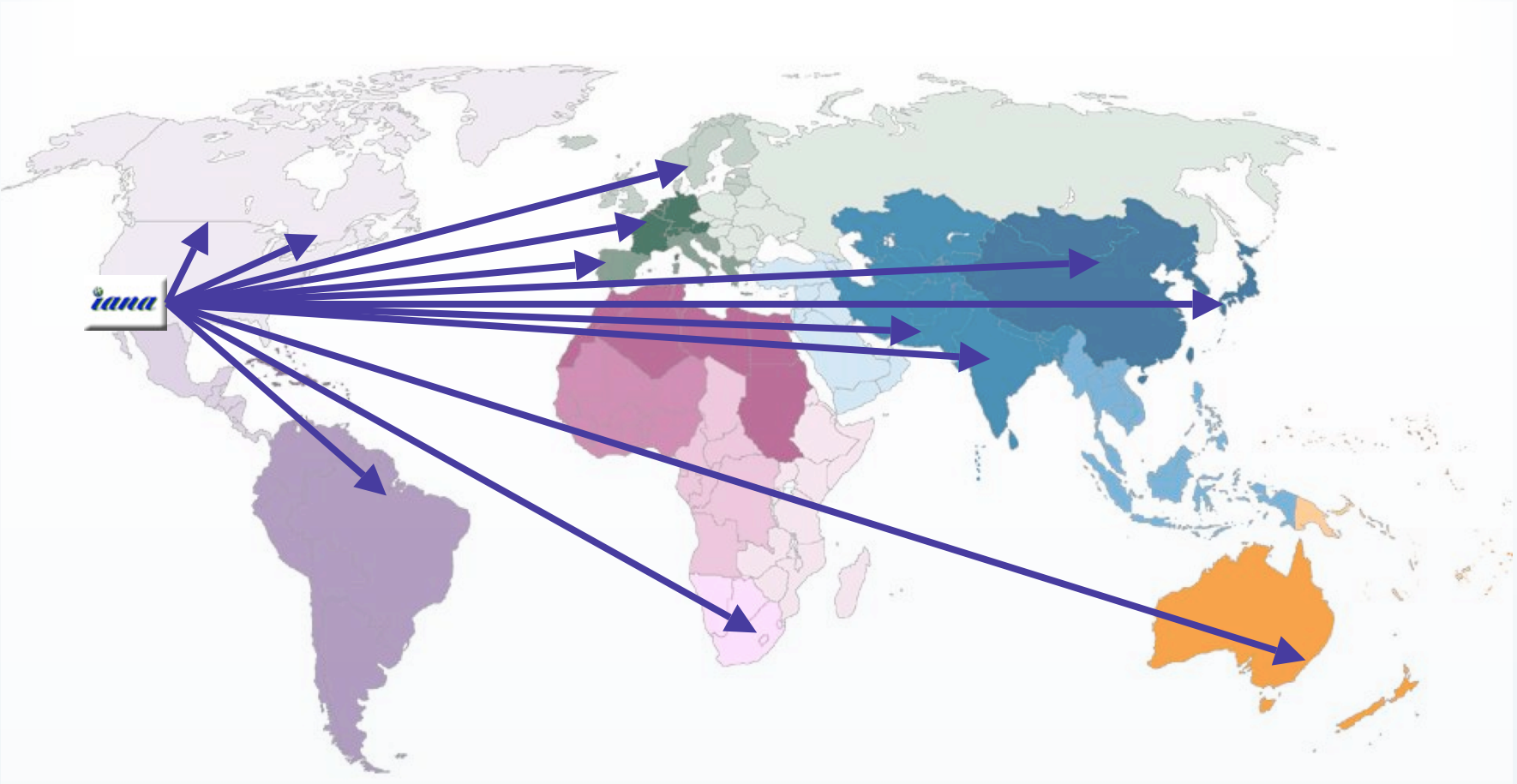
- 1974 - TCP specification by Vint Cert & Bob Kahn
- 1984 - TCP/IP
  - On January 1, the Internet with its 1000 hosts converts en masse to using TCP/IP for its messaging

Address architecture - History

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

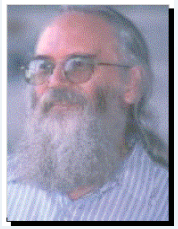
- Initially, only 256 networks in the Internet!
- Then, network "classes" introduced:
  - Class A (128 networks x 16M hosts)
  - Class B (16,384 x 65K hosts)
  - Class C (2M x 254 hosts)

Early years: 1981 – 1992



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**." (RFC 790)

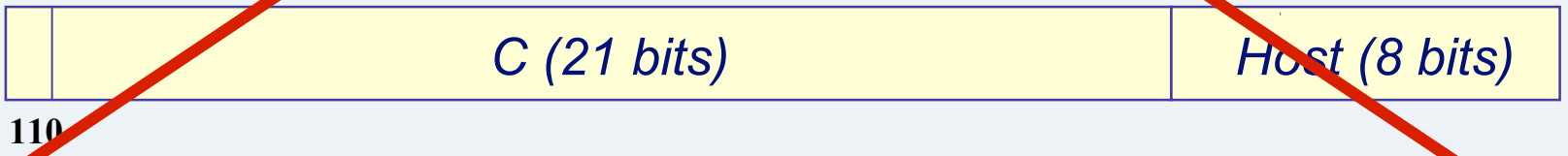


Address architecture - classful

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

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

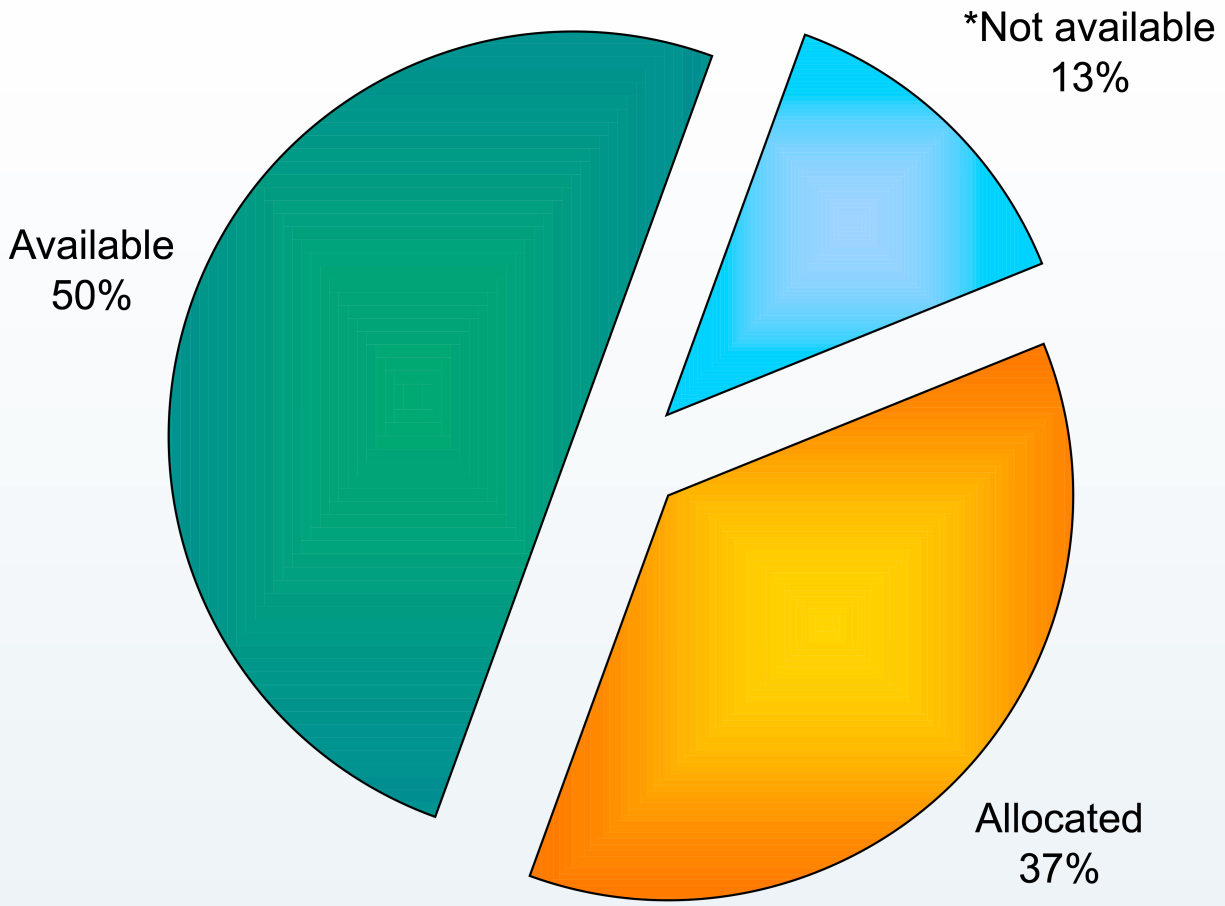
Class C: 2M networks x 254 hosts (12.5%)



Address management challenges 1992

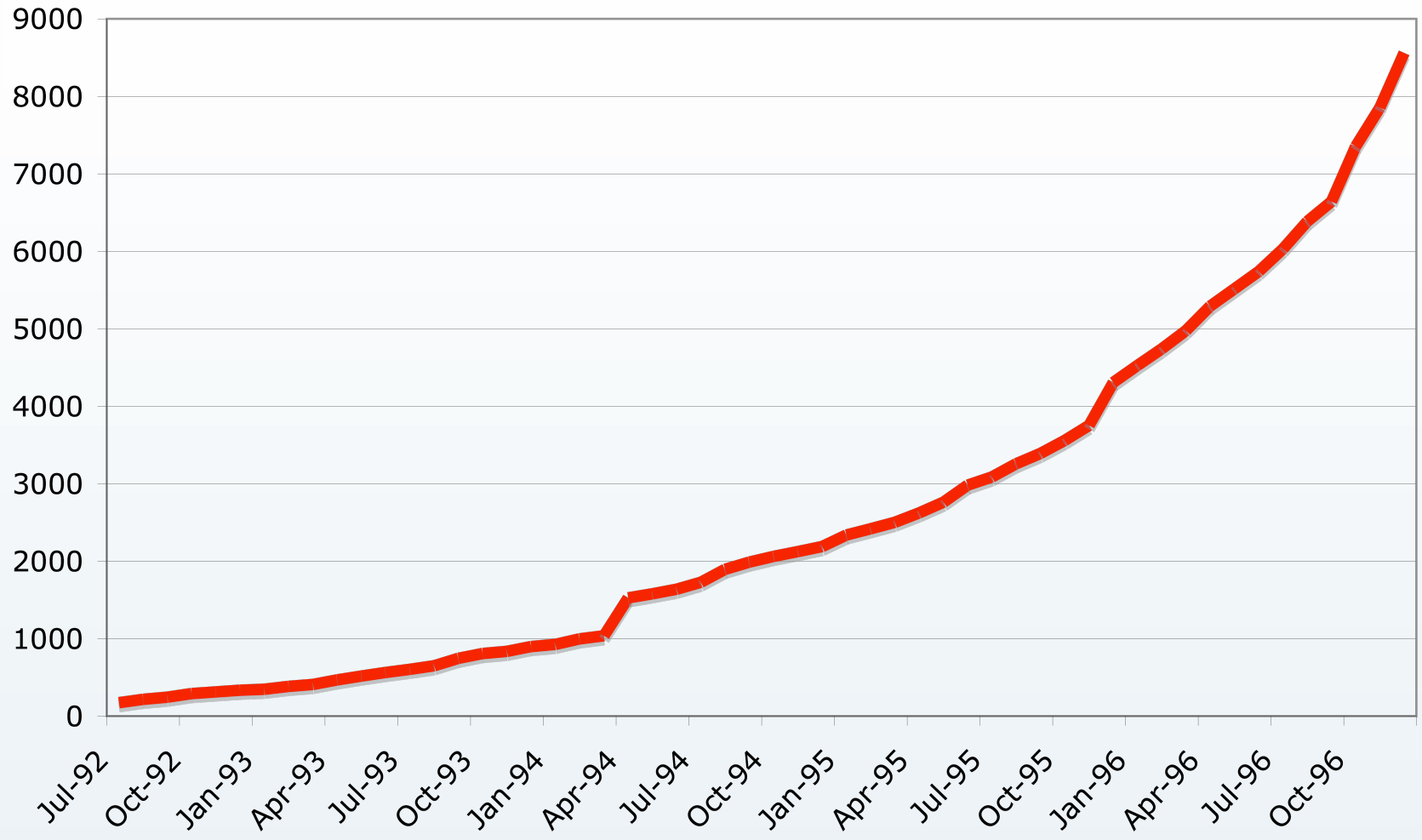
- Address space depletion
  - IPv4 address space is finite
  - Historically, many wasteful allocations
- Routing overload
  - Legacy routing structure, router overload
  - No means to aggregate routing information
- Inequitable management
  - Unstructured and wasteful address space distribution

IPv4 Allocations 1992



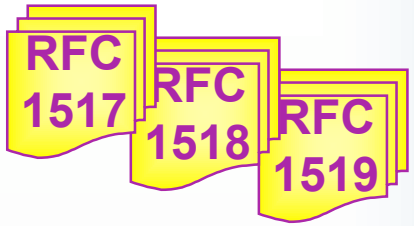
*Multicast, Experimental, Private & Public

Global routing table: ’88 - ’92



Evolution of address management

- 1993: Development of “CIDR”
  - Addressed both technical problems:



1. Address depletion
   - Through more accurate and efficient assignments
     - Variable-length network address
2. 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

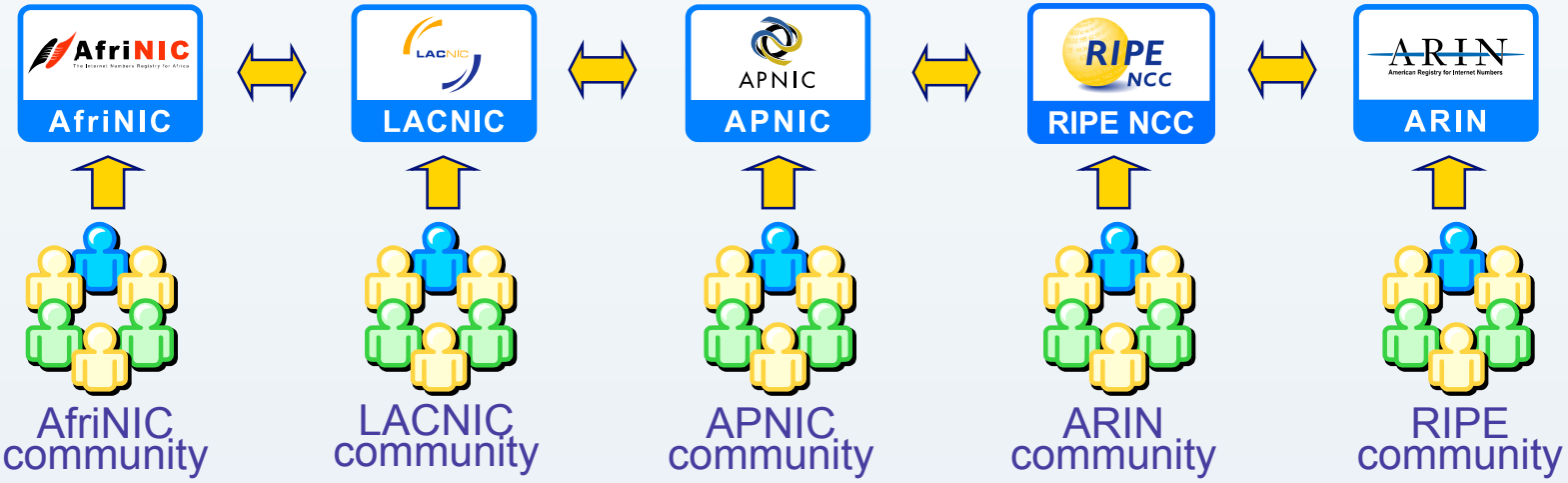
Evolution of address management

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

→Regional open processes

→Cooperative policy development

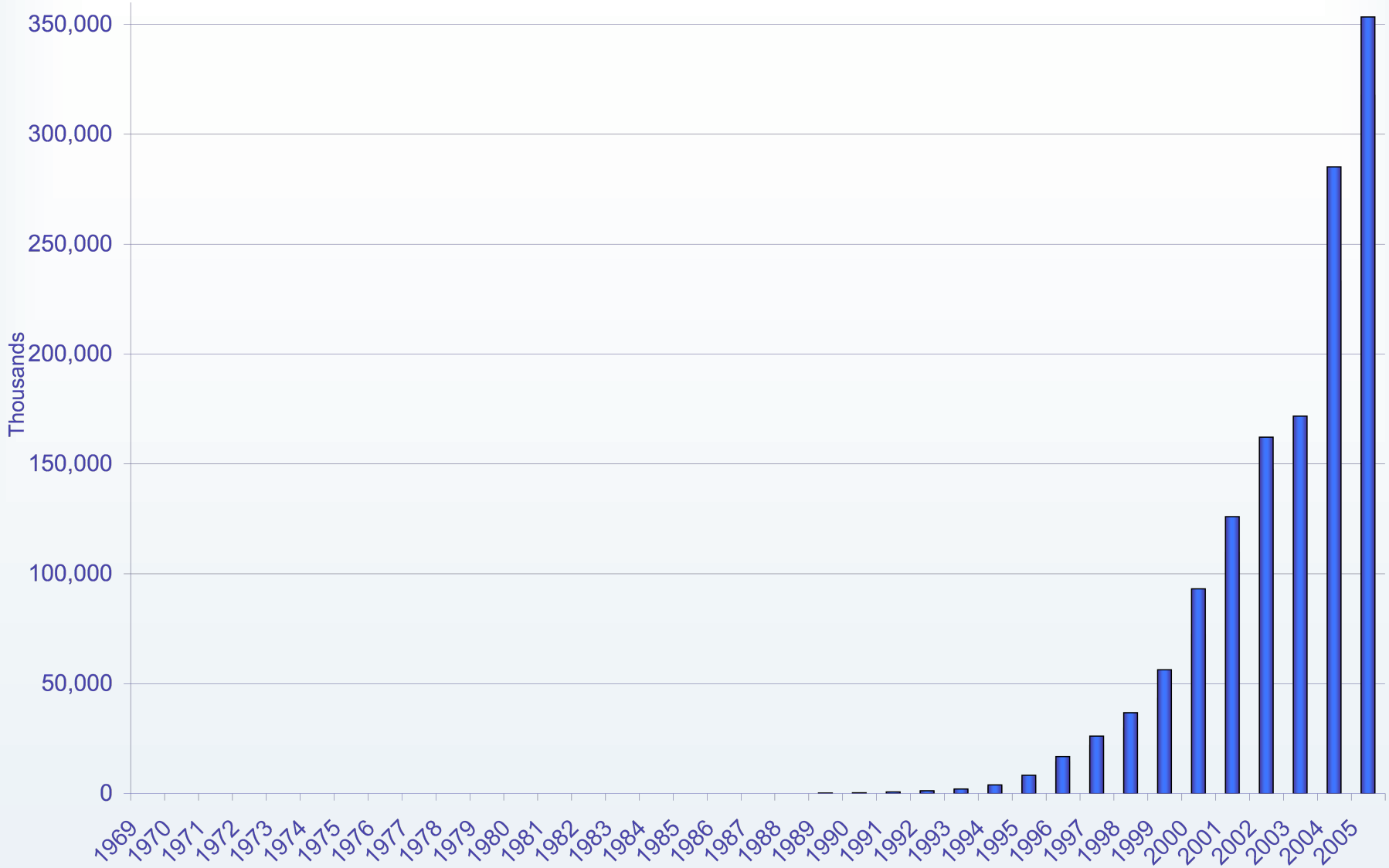
→Industry self-regulatory model



Questions?

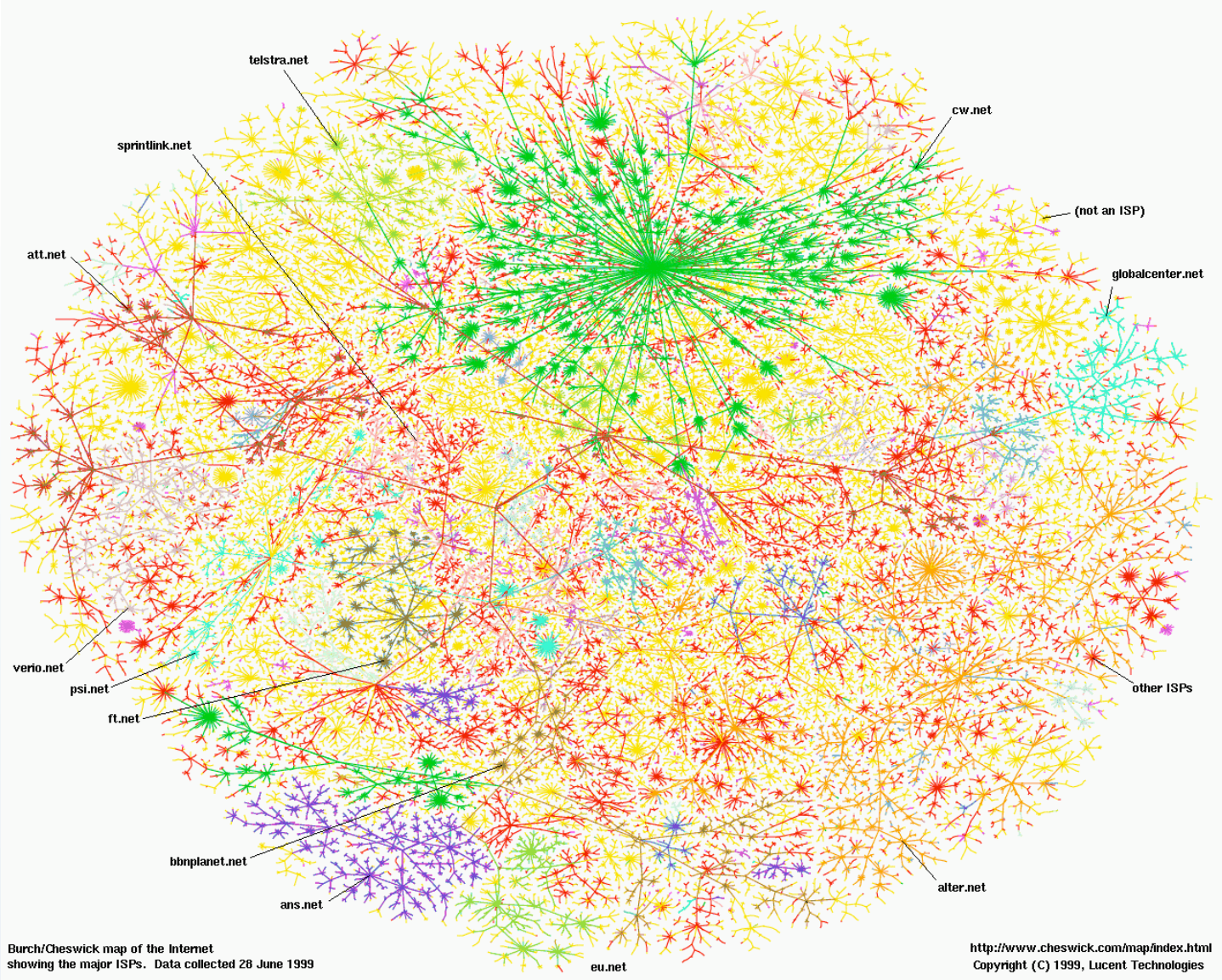
Today

Internet growth to date - Hostcount



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

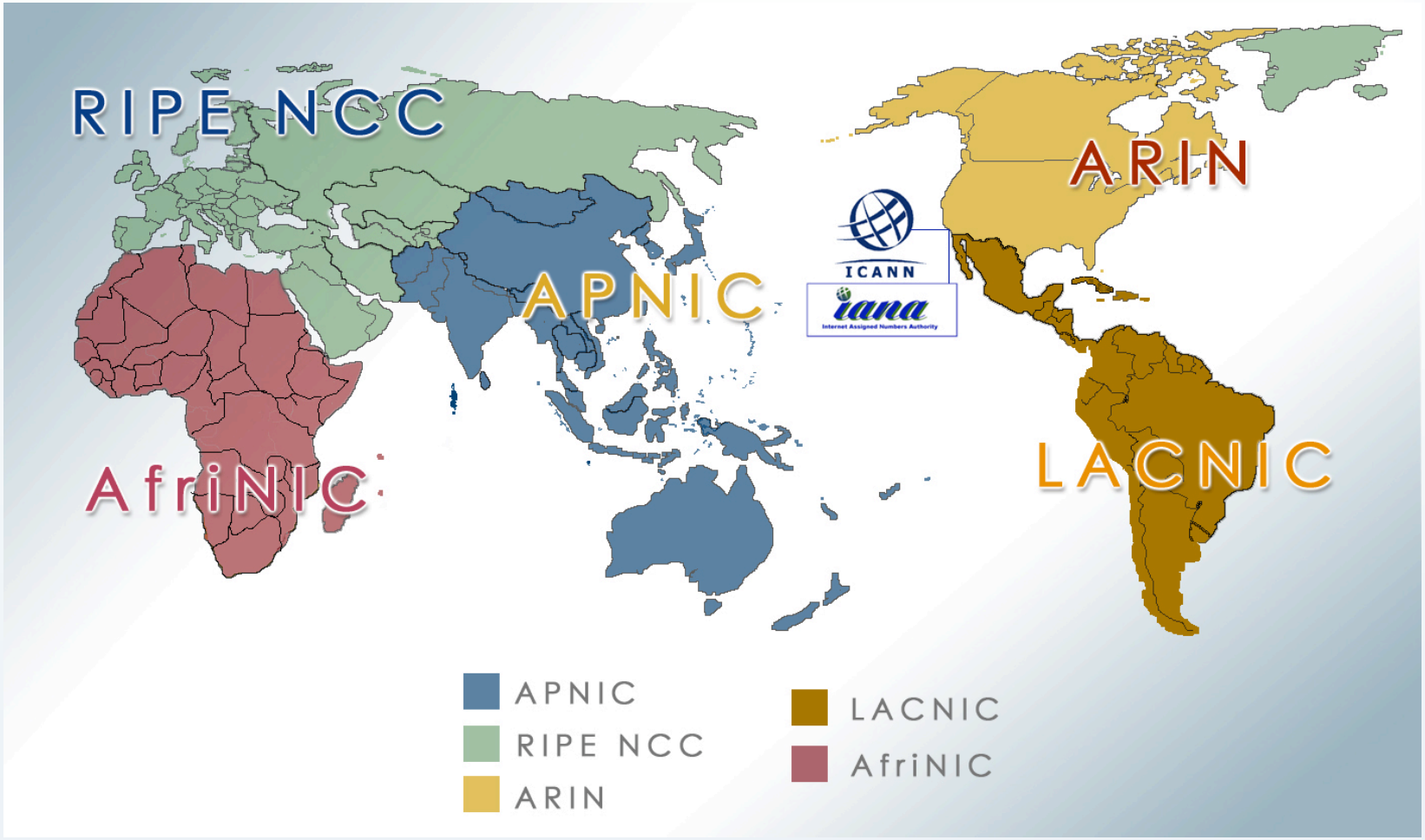
Map of the Internet today



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

Address management today

- Five RIRs



Address management objectives

Efficient use of resources

Based on demonstrated need

Limit routing table growth

Support provider-based routing

Ensure uniqueness

Facilitates troubleshooting

RIRs are…

- Regional Internet Registries
  - Distributing Internet resources in their respective regions
  - Representative of ISPs in their regions
- Member organisations
  - Open to all
  - Non-profit, neutral and independent
- First established in early 1990's
  - By consensus of the Internet community
    - Responding to needs
- In the "Internet Tradition"
  - Consensus-based, open and transparent

Why are there five RIRs?

- Each RIR represents their region while working towards global coordination
- Principles are the same for all RIRs
  - Conservation, aggregation, registration
  - Bottom-up, open, transparent, self-regulatory
- Specific policies or services may vary
  - To meet regional needs
    - Different economical situations, topology etc
    - Different cultural and language needs
- RIRs work very closely together
  - Policy work is coordinated
  - NRO was created as a central point of contact for all five RIRs

What do the RIRs do?

- Internet resource allocation
  - IPv4 and IPv6 addresses, AS numbers
  - Registration services (“whois”)
- Policy development and coordination
  - Open Policy Meetings and processes
- Training and outreach
  - Training courses, seminars, conferences…
  - Liaison: IETF, ITU, APT, PITA, APEC…
- Publications
  - Newsletters, reports, web site…

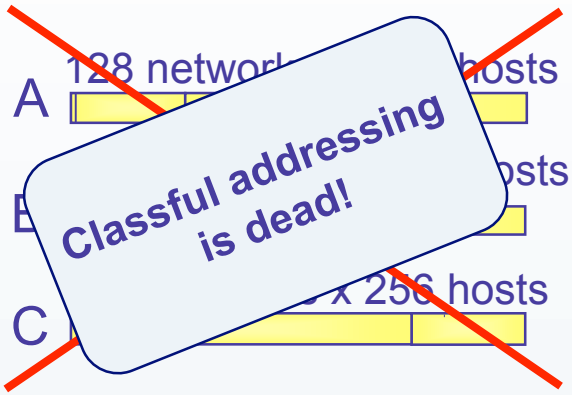
Questions?

Slashes and bits

Classless addressing and binary numbers

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

- Network boundaries may occur at *any* bit

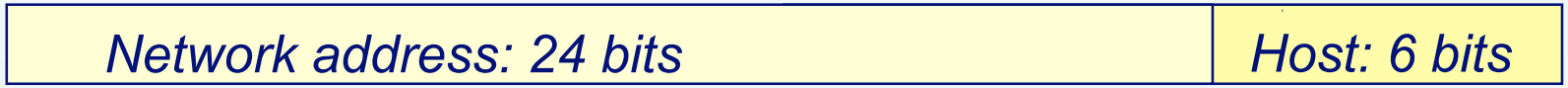
Classless addressing - examples

/10: 4M hosts

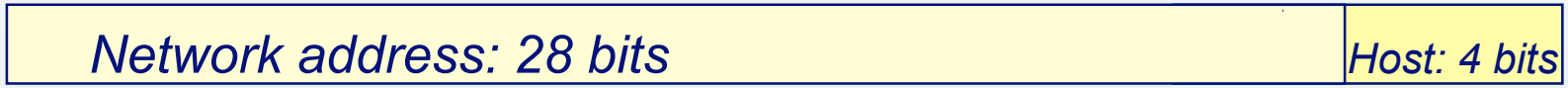
/19: 8190 hosts

/20: 4094 hosts

/24: 254 hosts



/28: 14 hosts



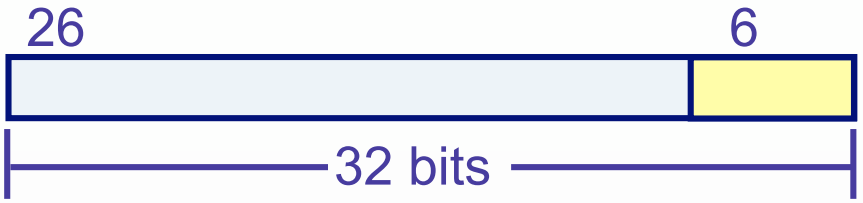
Slash notation and ranges

- 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 = 192.168.24.0-192.168.24.32
  - 172.16.0.0 – 172.31.255.255 = 172.16.0.0.0/12

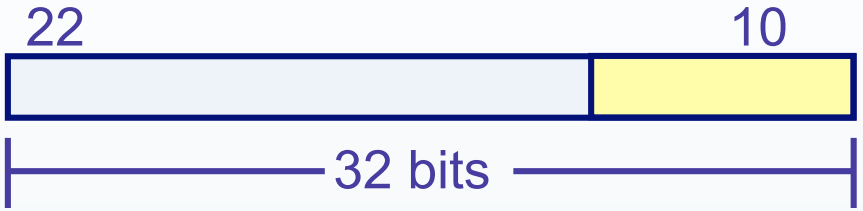
What on earth is a slash?



/26

→ 32 – 26 = 6 bits

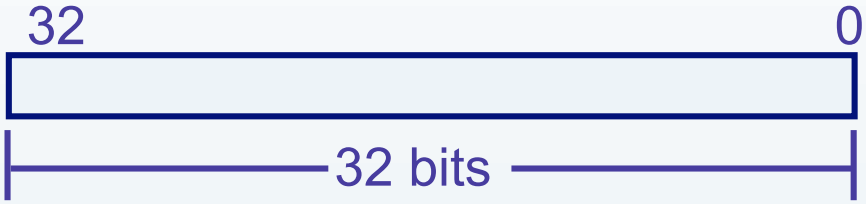
→ /26 = 2^6 = 64



/22

→ 32 – 22 = 10 bits

→ /22 = 2^{10} = 1024



/32

→ 32 – 32 = 0 bits

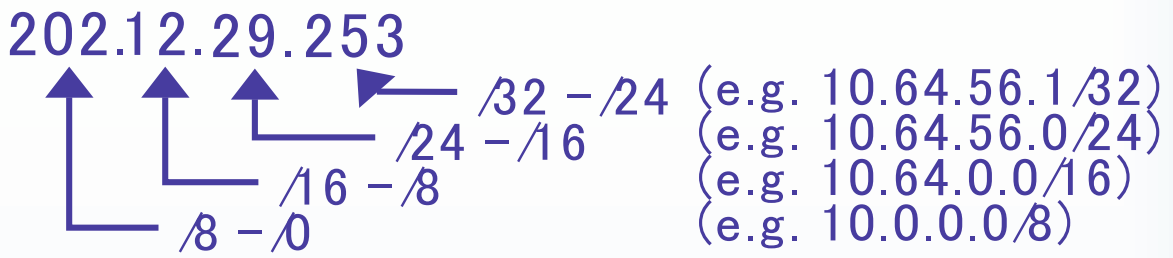
→ /32 = 2^0 = 1

/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 – 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?

RIR policy principles

Policy and policy development
in the RIPE NCC region

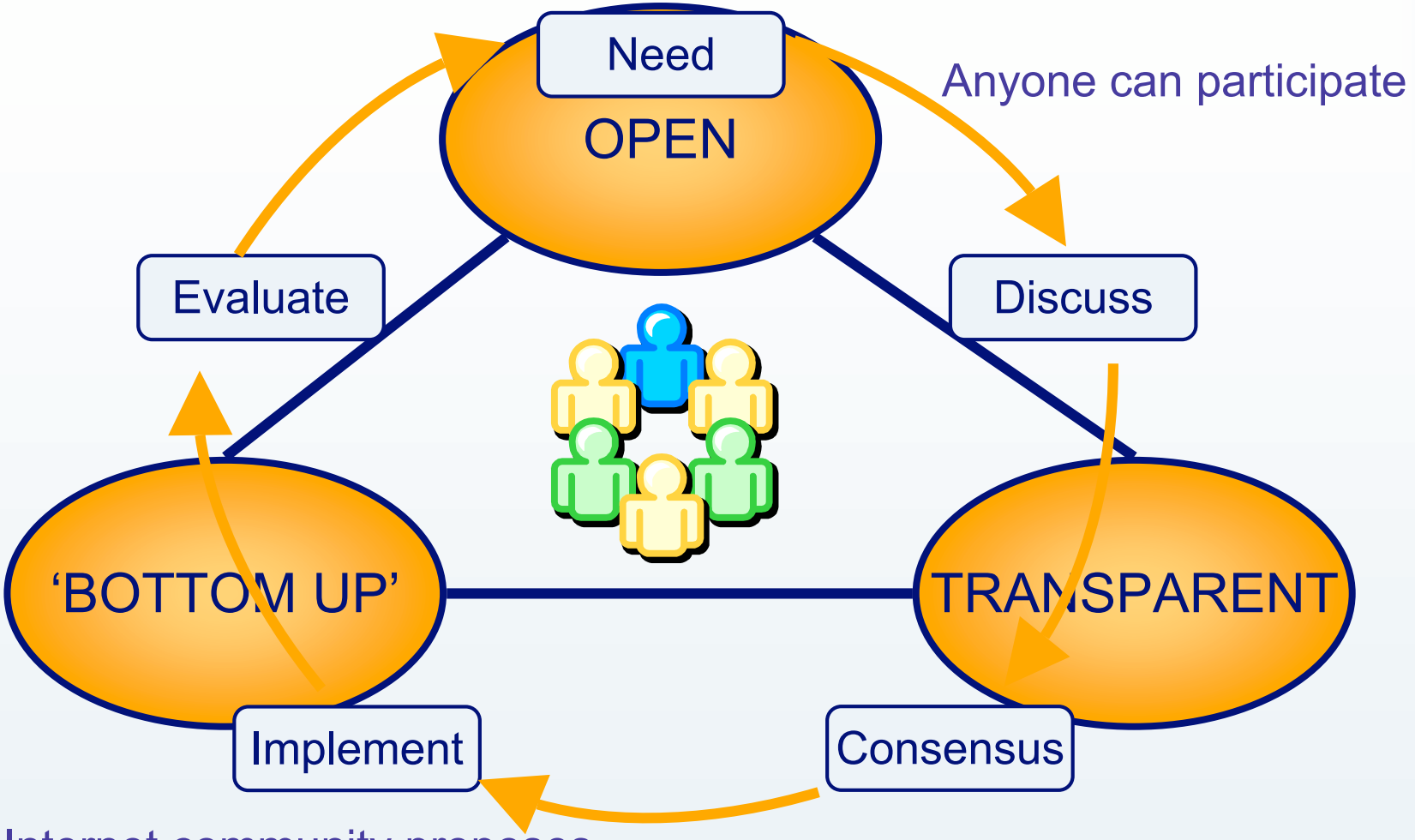
What is Internet resource policy?

- RIR policies provide guidelines for the usage and administration of Internet resources (IP addresses, AS numbers etc)
  - rules for resource allocation
  - guidelines
  - recommendations
  - Best Common Practice (BCP)

How are policies developed?

- Policies are developed by the Internet community at-large
  - Open to all
    - Includes representatives from ISPs, telcos, governments, regulators, end-users etc
- The RIRs do not set policy
  - But facilitate the policy development process
- Principles:
  - Open
  - Transparent
  - Bottom-up

RIR Policy Coordination

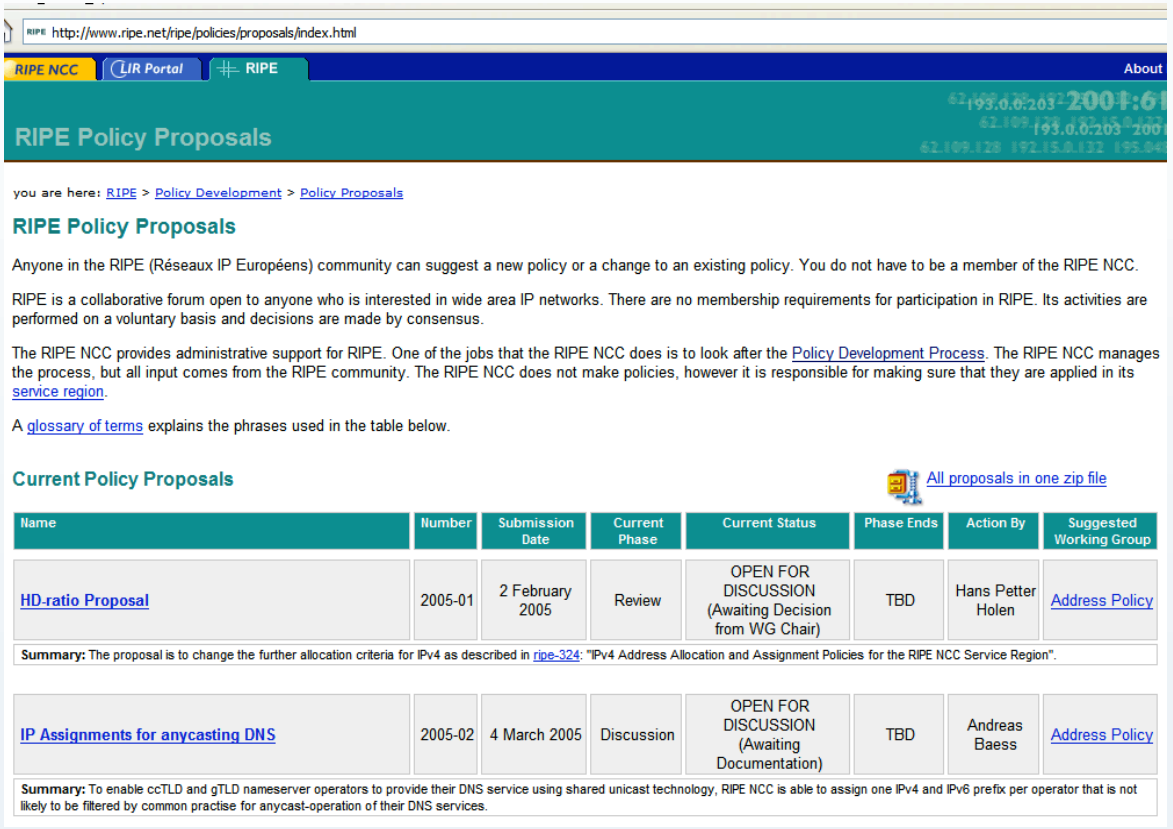


RIPE Policy Development Process (PDP)

- Creating a proposal
- Phases
  - Discussion Phase
  - Review Phase
  - Concluding Phase

All documented

- Process itself at (ripe-350):
  - http://www.ripe.net/ripe/docs/pdp.html
- Proposal Index
  - Timelines
  - Status
  - Archive



http://www.ripe.net/ripe/policies/proposals/index.html

RIPE NCC | LIR Portal | RIPE | About

RIPE Policy Proposals

you are here: RIPE > Policy Development > Policy Proposals

RIPE Policy Proposals

Anyone in the RIPE (Réseaux IP Européens) community can suggest a new policy or a change to an existing policy. You do not have to be a member of the RIPE NCC.

RIPE is a collaborative forum open to anyone who is interested in wide area IP networks. There are no membership requirements for participation in RIPE. Its activities are performed on a voluntary basis and decisions are made by consensus.

The RIPE NCC provides administrative support for RIPE. One of the jobs that the RIPE NCC does is to look after the Policy Development Process. The RIPE NCC manages the process, but all input comes from the RIPE community. The RIPE NCC does not make policies, however it is responsible for making sure that they are applied in its service region.

A glossary of terms explains the phrases used in the table below.

Current Policy Proposals

All proposals in one zip file

Name	Number	Submission Date	Current Phase	Current Status	Phase Ends	Action By	Suggested Working Group
HD-ratio Proposal	2005-01	2 February 2005	Review	OPEN FOR DISCUSSION (Awaiting Decision from WG Chair)	TBD	Hans Petter Holen	Address Policy
Summary: The proposal is to change the further allocation criteria for IPv4 as described in ripe-324: "IPv4 Address Allocation and Assignment Policies for the RIPE NCC Service Region".							
IP Assignments for anycasting DNS	2005-02	4 March 2005	Discussion	OPEN FOR DISCUSSION (Awaiting Documentation)	TBD	Andreas Baess	Address Policy
Summary: To enable ccTLD and gTLD nameserver operators to provide their DNS service using shared unicast technology, RIPE NCC is able to assign one IPv4 and IPv6 prefix per operator that is not likely to be filtered by common practise for anycast-operation of their DNS services.							

Overview for 2005

- 12 proposals in 2005
  - 1 IPv4
  - 4 IPv6
  - 1 AS Numbers
  - 1 Multi-protocol
  - 2 Tidying-up policy documents
  - 3 RIPE NCC activities
- 2 Withdrawn
- 2 Completed

Current proposals

- Discussion Phase
  - IP Assignments for Anycasting DNS
  - IPv6 Initial Allocation Criteria
  - Amend the IPv6 Assignment and Utilisation Requirement
  - 4-Byte AS Numbers
- Review Phase
  - HD-ratio for IPv4
  - IPv6 Blocks from IANA to RIRs

IPv4

- HD-ratio for evaluating IPv4 usage efficiency
  - Proposal to use a ratio, rather than a fixed percentage, to evaluate how efficiently addresses are used in a network.
  - Ratio of unassigned to assigned space
  - Providing more hierarchy for network organisation

AS numbers

- 4-Byte AS Numbers
  - Timeline for introduction of a massively expanded number space. It will allow over 4 billion independent networks

Research proposals

- Consumer Broadband Monitoring Feasibility
  - Performance testing prototype
- Multicast Monitoring on RIPE NCC Test Traffic Boxes
  - Add multicast testing to Test Traffic Boxes

Some numbers….

- Number of subscribers for Address Policy WG mailing lists: 1587
- Number of posts about the proposals in the AP WG mailing list: 809 from 144 unique individuals
- Number of online webcast streams: 227
- Number of unique jabber/irc users: 65

RIPE 53

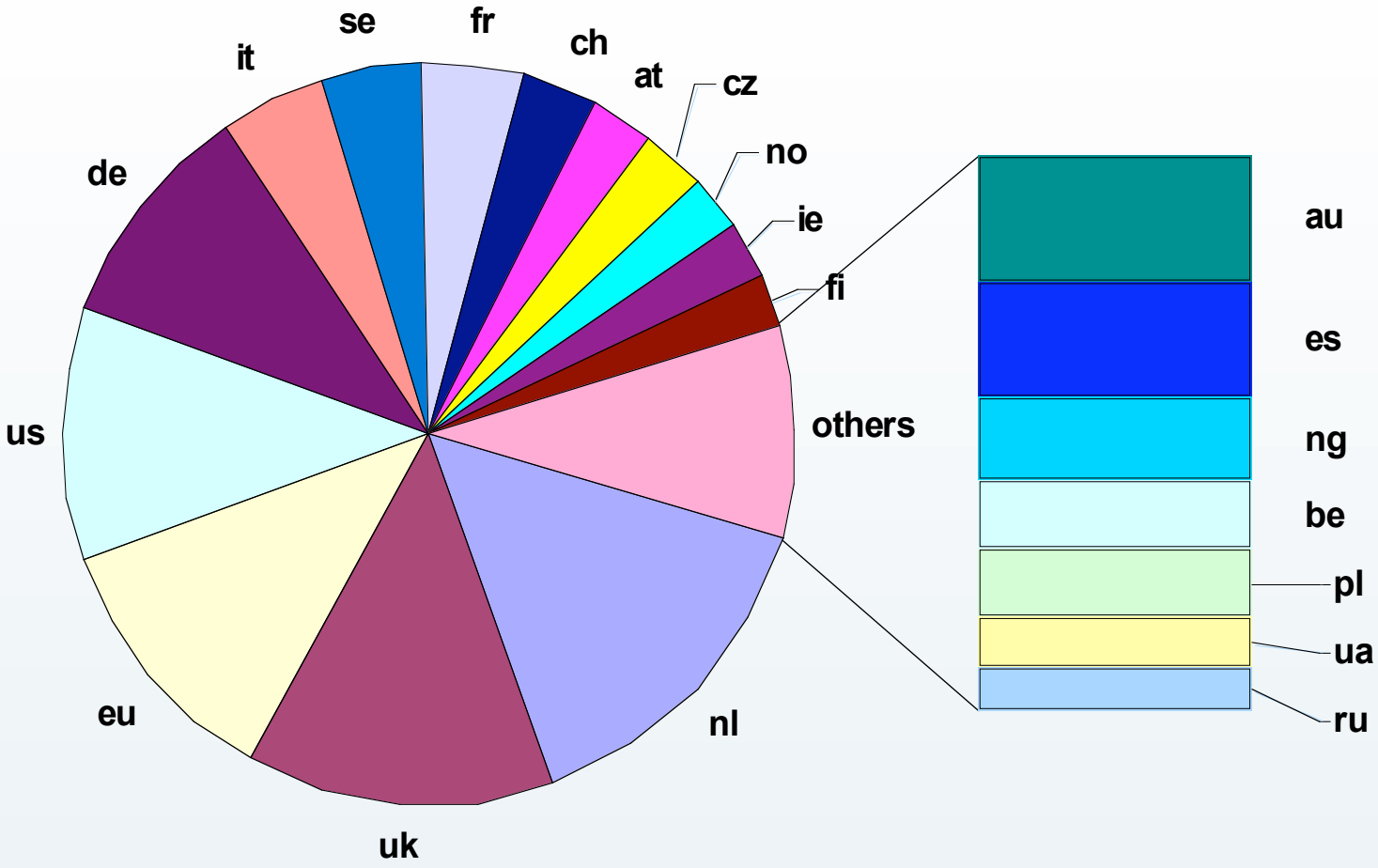
Date: 2-6 October

City: Amsterdam

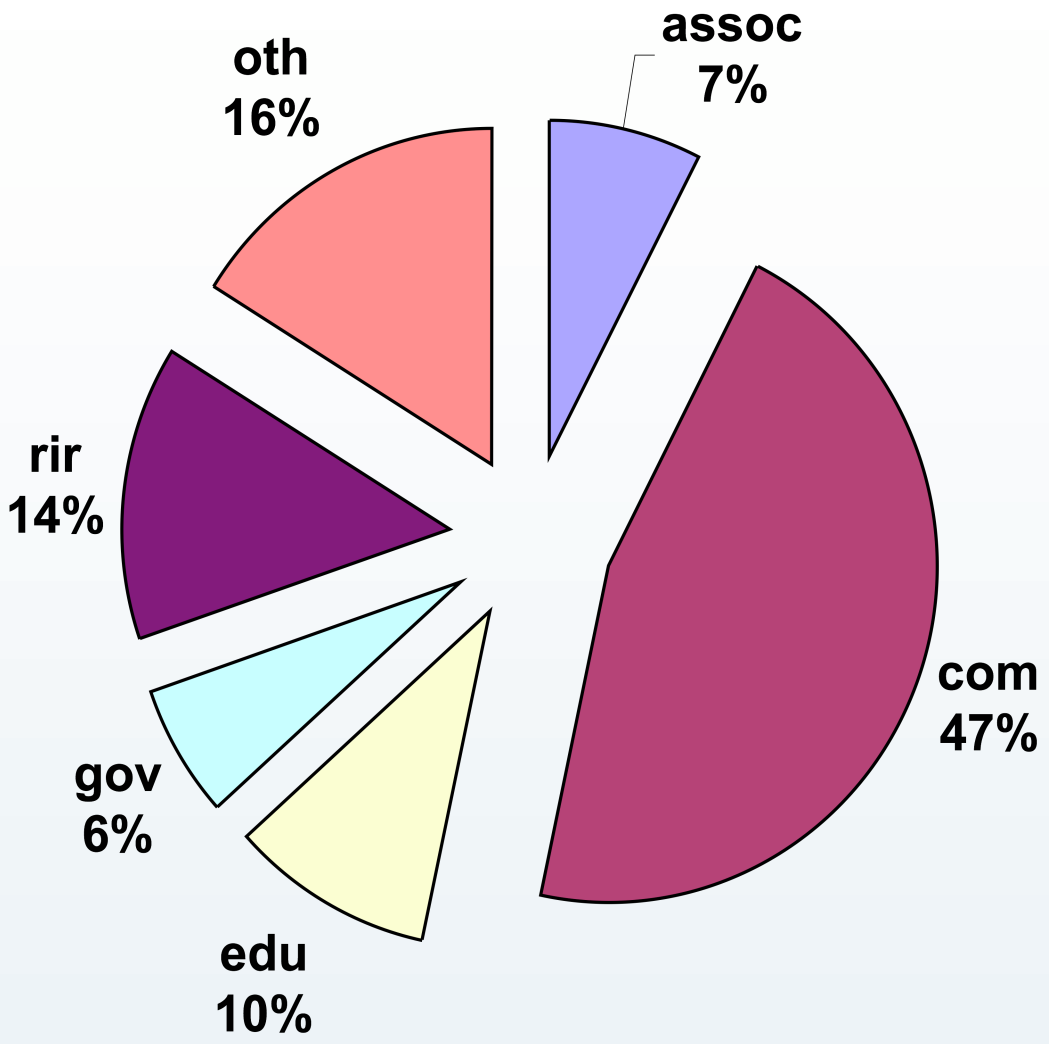
Weather: 287°K

http://ripe.net/ripe/meetings/ripe-53/

Recent RIPE meeting attendance per country



Recent RIPE meeting attendance by organisational category



Policy proposal archives

- AfriNIC

  http://www.afrinic.net/policy.htm
- ARIN

  http://www.arin.net/policy/proposals/proposal_archive.html
- APNIC

  http://www.apnic.net/docs/policy/proposals/archive.html
- LACNIC

  http://lacnic.net/en/politicas/propuesta-politicas.html
- RIPE

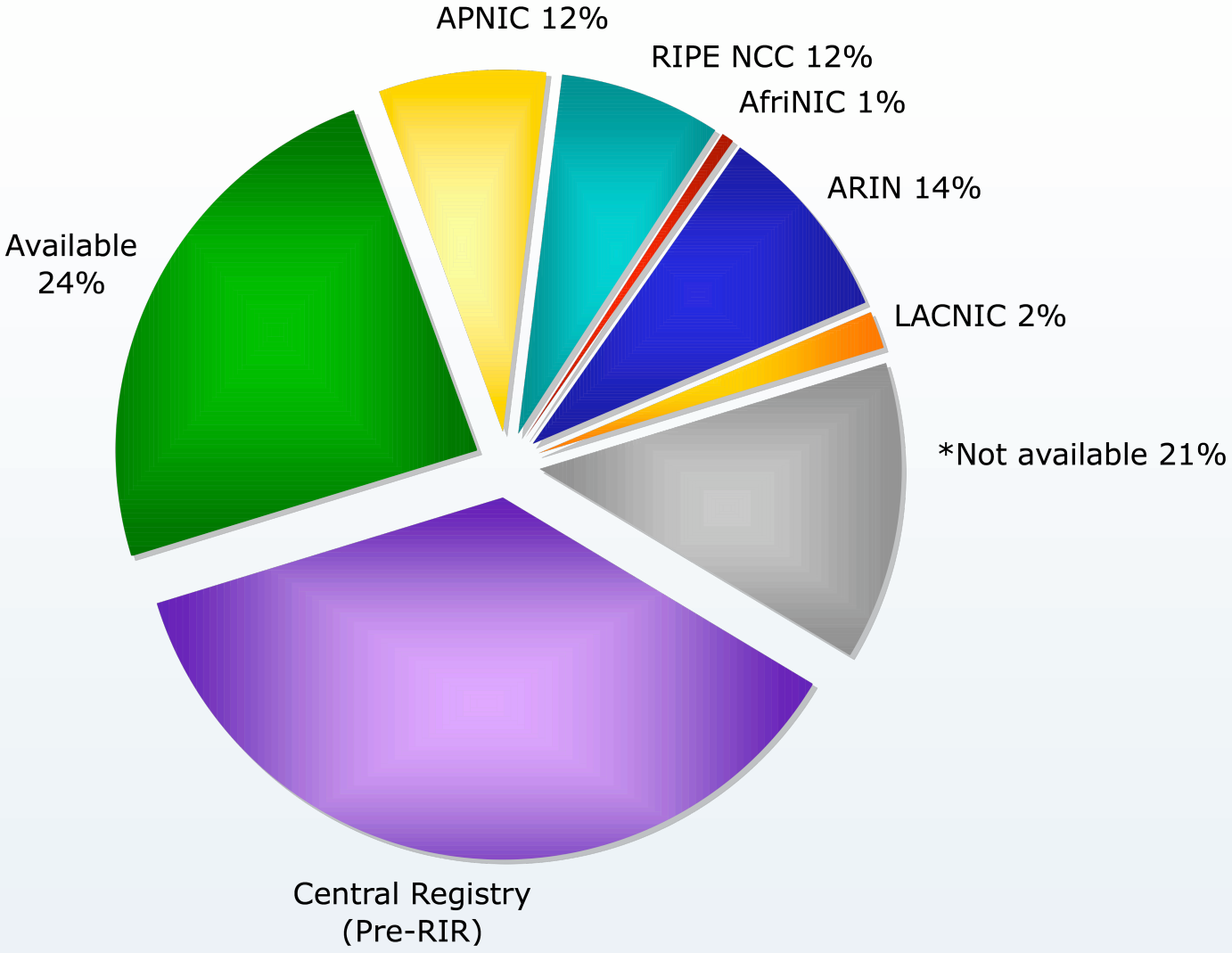
  http://www.ripe.net/ripe/policies/proposals/

Questions?

Today

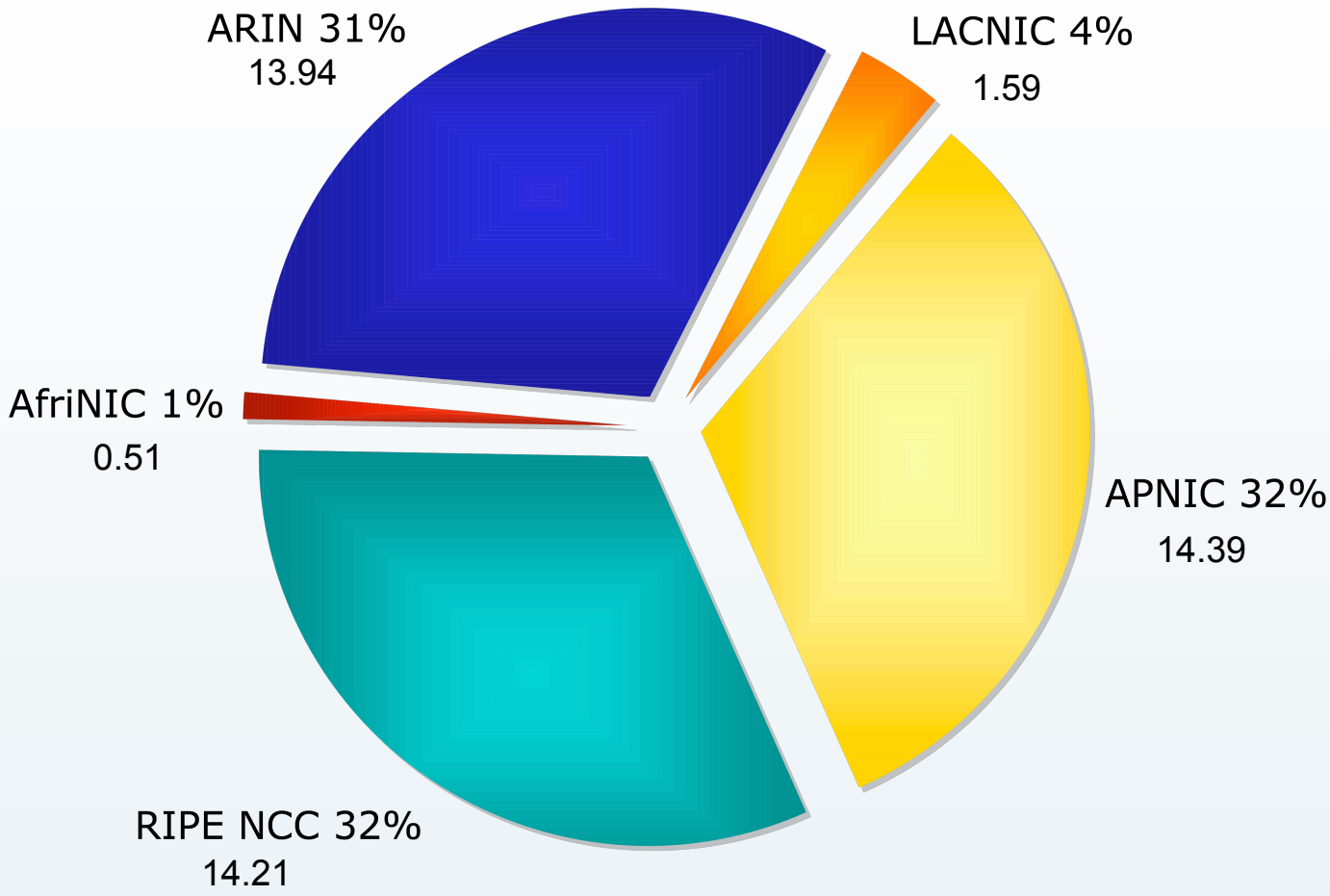
Status of Internet resources today

Status of IPv4 address space



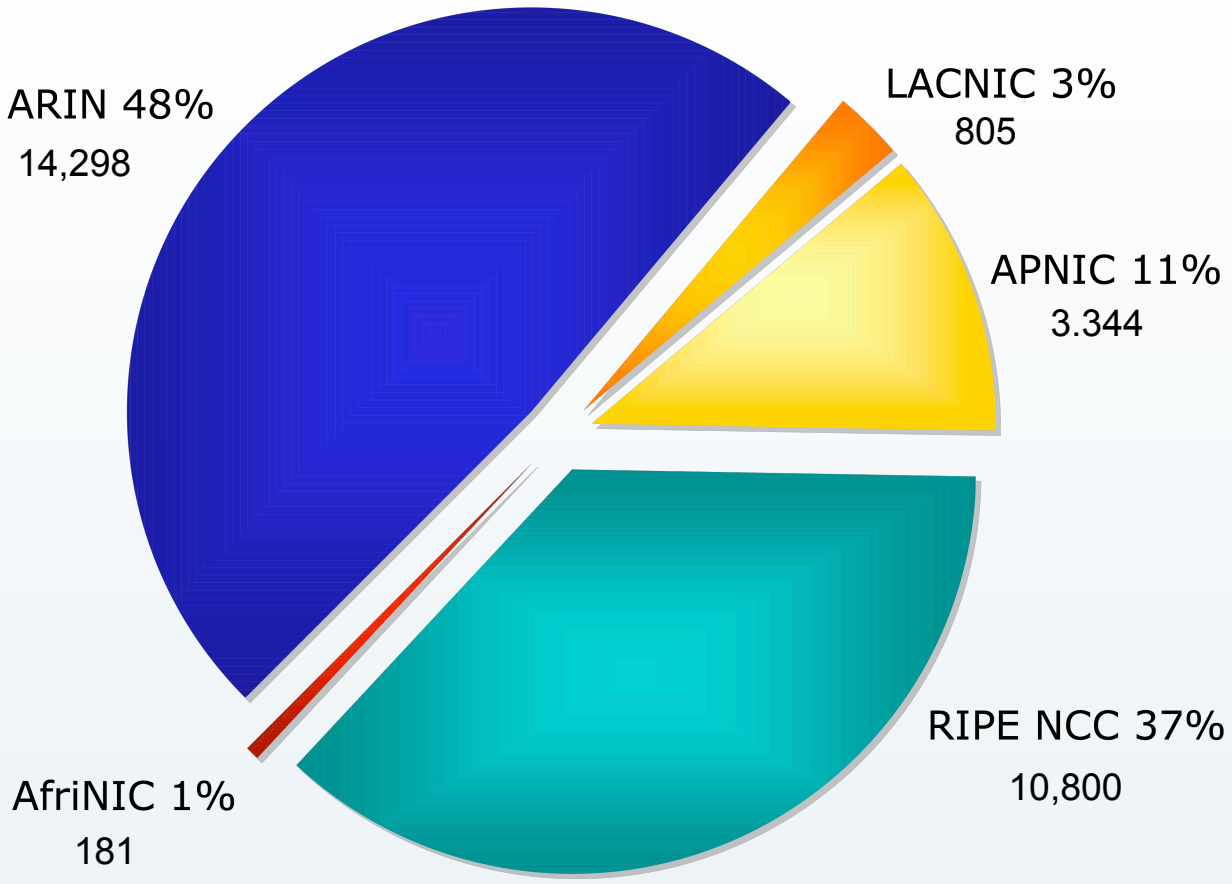
*Multicast, Experimental, Private & Public

IPv4 Allocations
from RIRs to LIRs / ISPs (/8s)



Cumulative Total (Jan 1999 – Jun 2006)

ASN Allocations
from RIRs to LIRs / ISPs



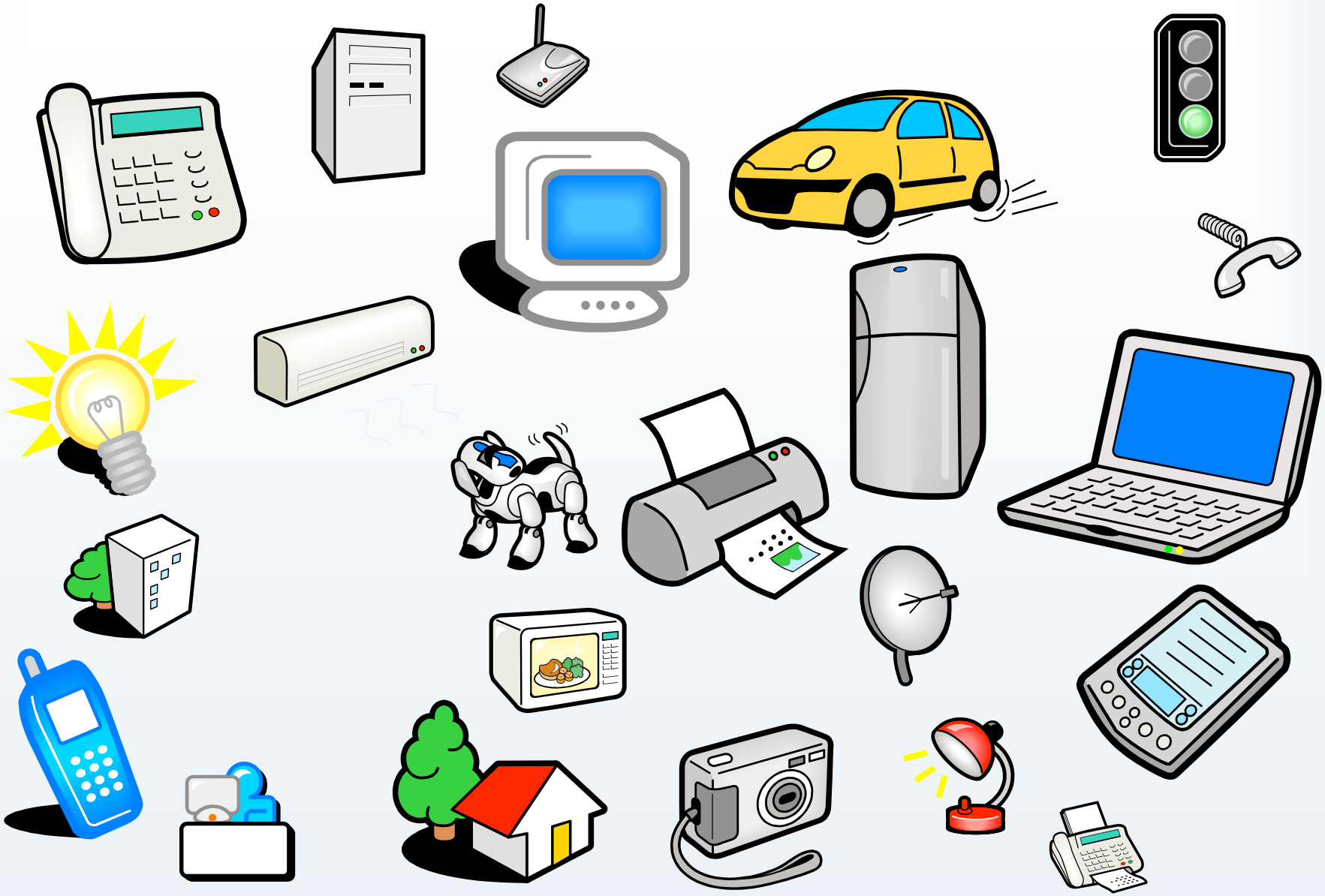
Cumulative Total (Jan 1999 – Jun 2006)

Questions?

So what about the future…?

IPv6

IPv6 - Internet for everything!



Rationale

- Address depletion concerns
  - Squeeze on available addresses space
- End to end connectivity declining
    - 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

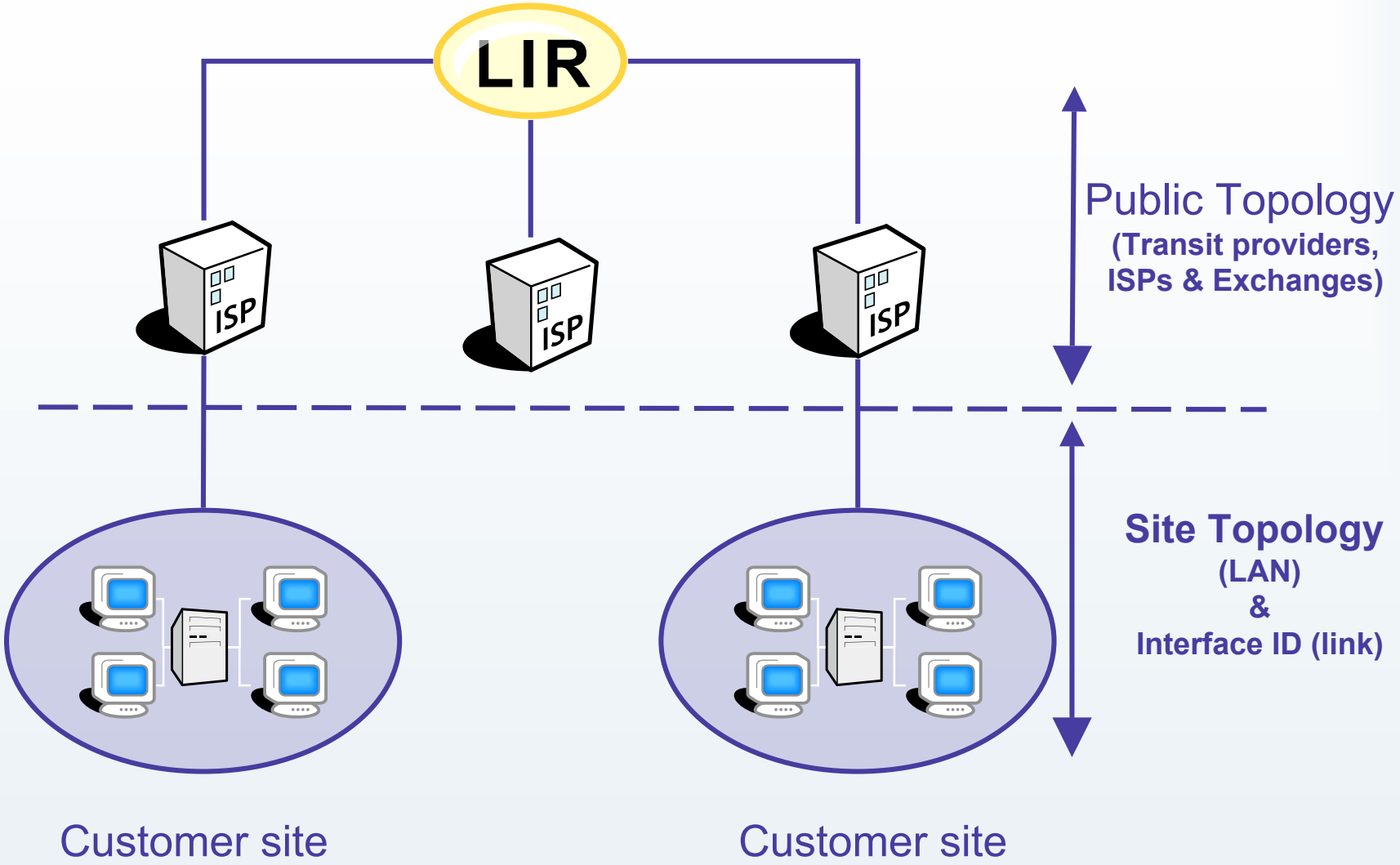
- Example:
  - FE38:DCE3:124C:C1A2:BA03:6735:EF1C:683D
  - Abbreviated form of address
    - 4EED:0023:0000:0000:0000:036E:1250:2B00

    →4EED:23:0:0:0:36E:1250:2B00

    →4EED:23::36E:1250:2B00

    (Null value can be used only once)

IPv6 address topology



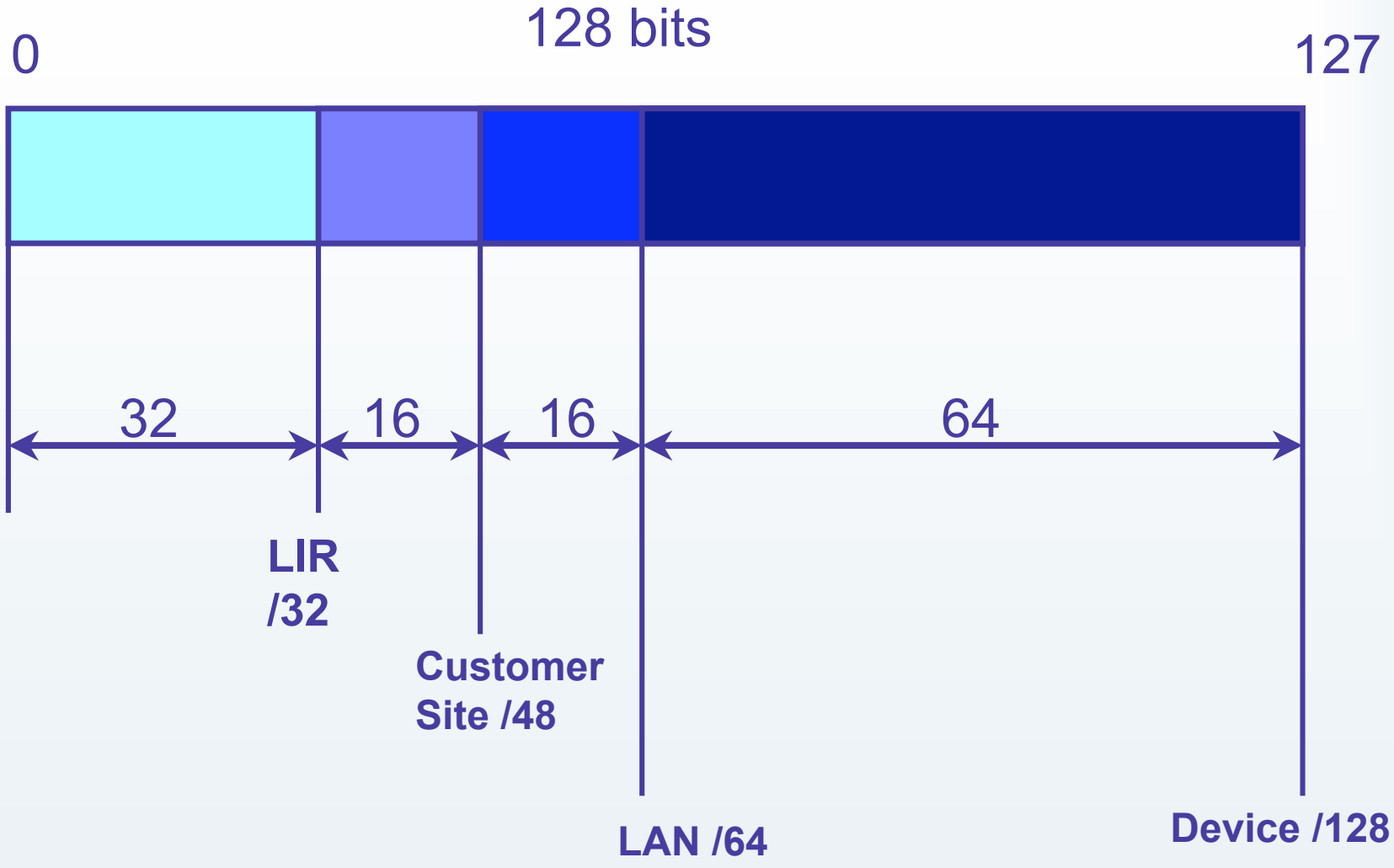
First IPv6 allocation

- If you
  a) are an LIR (RIPE NCC member)
  b) not an End Site
  c) plan to provide IPv6 connectivity to aggregated "customers", who are assigned /48s
  d) plan to assign 200 /48s within two years

- Send an "IPv6 first allocation request form" to the RIPE NCC

- Minimum allocation size /32
  – Assignment policy being discussed

IPv6 addressing structure

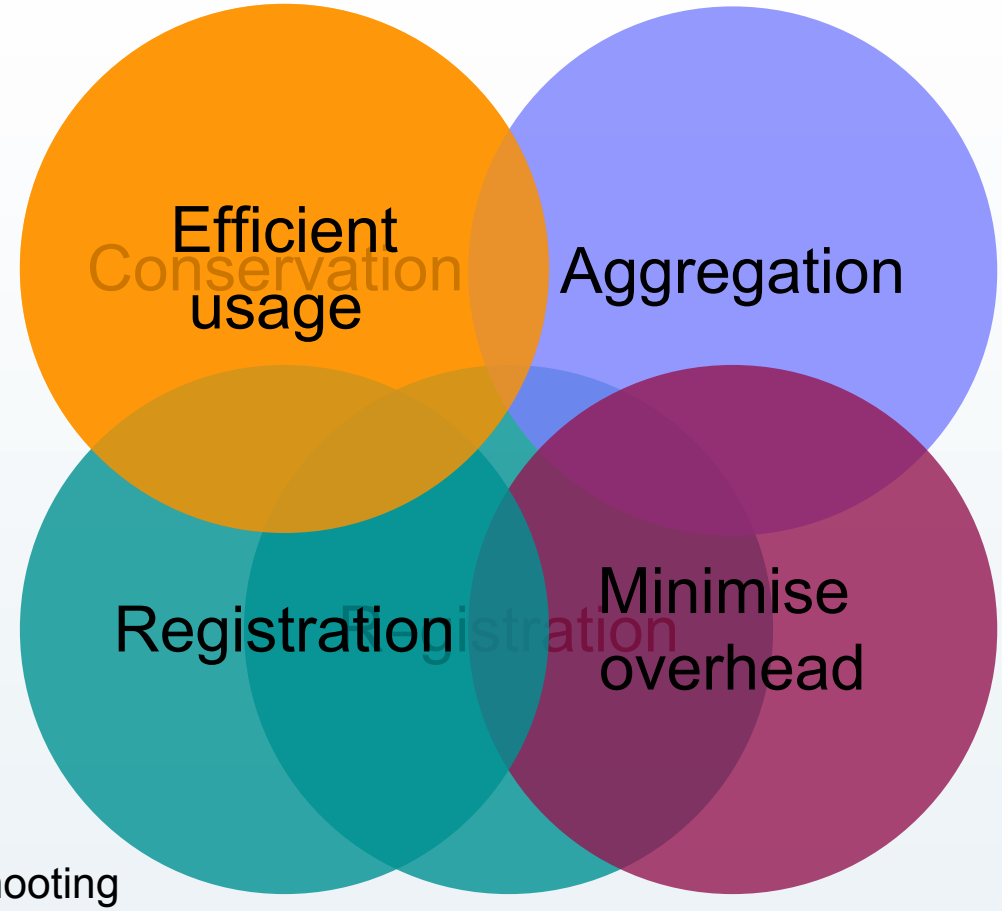


Address management objectives

IPv6

Efficient use of resources

Avoid wasteful practices



Limit routing table growth

Hierarchical distribution

Ensure uniqueness

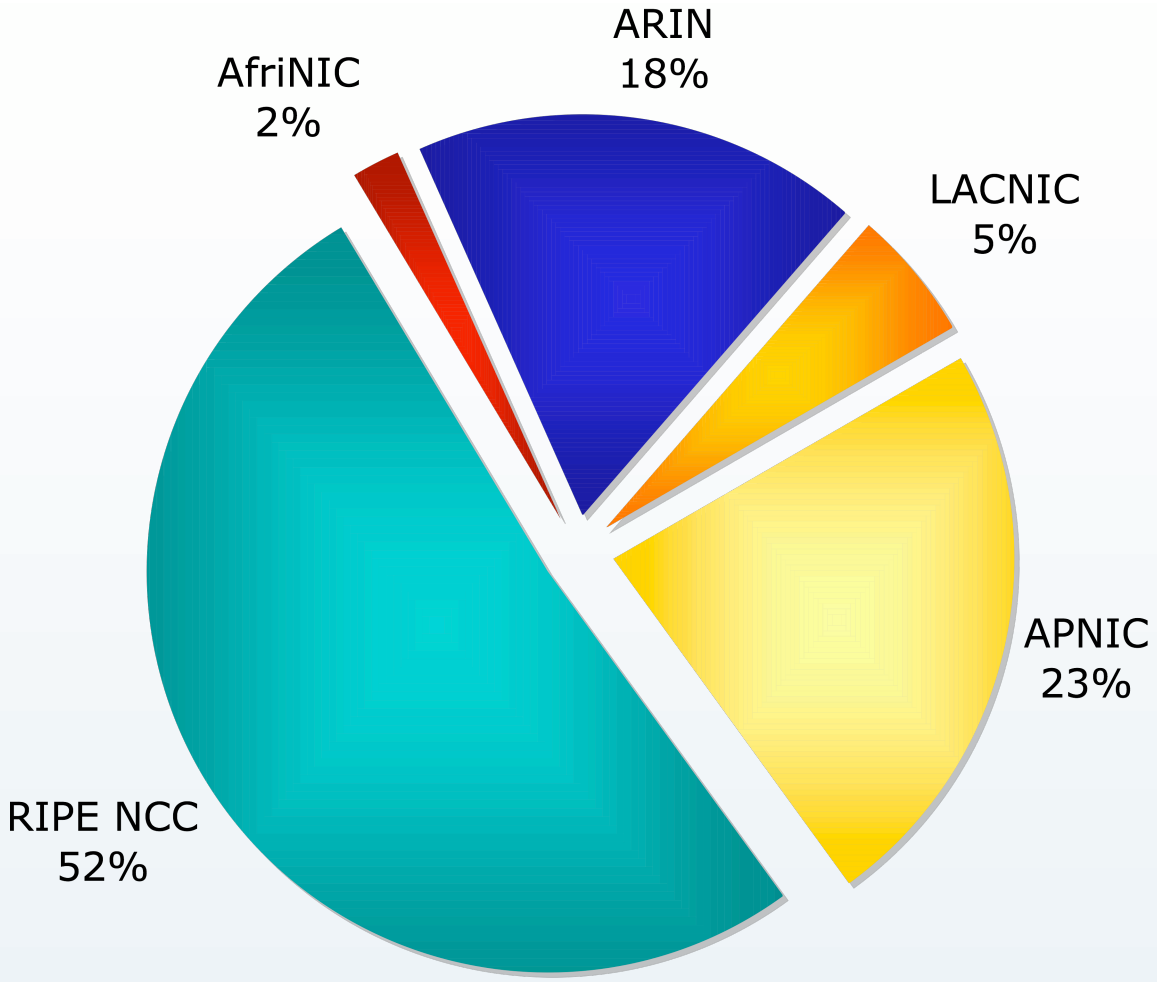
Facilitates troubleshooting

Ease of access to resources

IPv6 Blocks from IANA to RIRs - Global Policy

- Minimum allocation /12
- Allocation should cover 18 months needs
- Further allocation
  - The RIR's AVAILABLE SPACE is less than 50% of a /12.
  - The RIR's AVAILABLE SPACE is less than its established NECESSARY SPACE for the following nine months.
    - AVAILABLE SPACE = CURRENTLY FREE ADDRESSES + RESERVATIONS EXPIRING DURING THE FOLLOWING THREE MONTHS - FRAGMENTED SPACE
    - NECESSARY SPACE = AVERAGE NUMBER OF ADDRESSES ALLOCATED MONTHLY DURING THE PAST SIX MONTHS * LENGTH OF PERIOD IN MONTHS

IPv6 Allocations
from RIRs to LIRs / ISPs



Cumulative Total (Jan 1999 – Jun 2006)

Questions?

IPv6 deployment country report

China

- China Next Generation Internet (CNGI) project
  - Started in 2002 with national initiative
  - CNGI backbone: 30-40 giga PoPs, 300 campus networks and international links
  - Following NSPs joined:
    - CERNET
    - China Telecom
    - Unicom
    - Netcom/CSTNET
    - China Mobile
    - China Railcom
- Annual IPv6 Global summit in China
  - April 2006
  - http://www.ipv6.net.cn/2006/en

Korea

- National level initiative
  - Construction of U-biquitous Society
  - IPv6 is as one of IT839 strategies
    - IT839 – Strategy for the development of the IT and telecommunication industries
- Korea Telecom
  - 2006 target
    - Commercialisation of IPv6 applications and contents
      - Multimedia contents and network/mobile games
      - Multimedia Message Service (MMS)
- IPv6 Forum Korea
  - http://www.ipv6.or.kr/eng

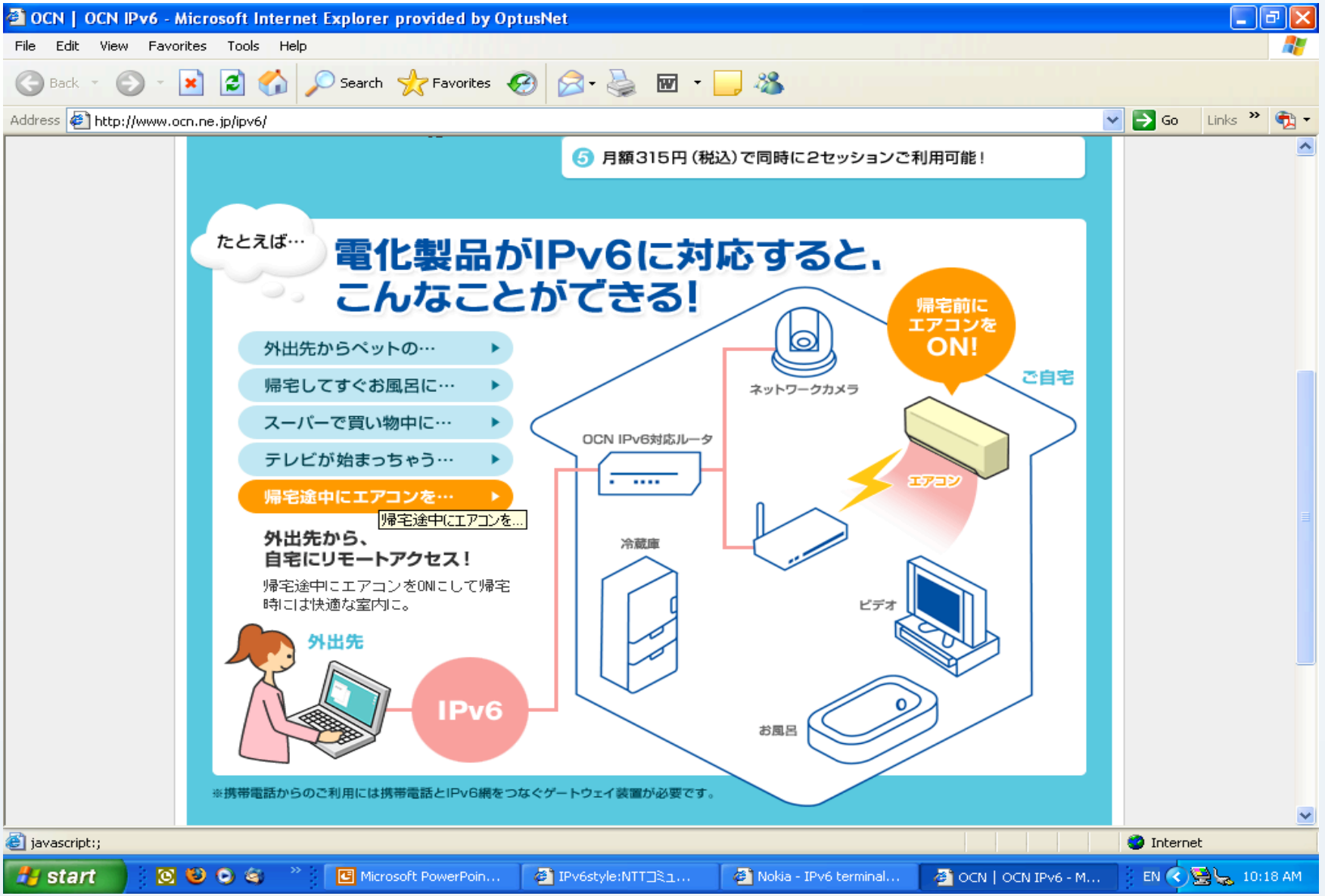
Japan

- Continuing R&D but start utilising IPv6 in actual business services
  - NTT Communications: Nov 2005
    - http://www.ocn.ne.jp/ipv6
    - IPv6 connection services to residential users via tunnelling
    - /64 per end user
  - Plala and OnlineTV: July 2004
    - 4th Media Service
    - Multi channels and video on demand distribution services via IPv6 multicast
    - http://www.plala.or.jp/access/living/releases/nr04_jul/0040708_1.html
    - http://www.ipv6style.jp/jp/news/2004/0712_plala.shtml

Japan – OCN IPv6

Japan – OCN IPv6

Japan – OCN IPv6



Europe

- EU government initiative to promote IPv6 R&D
  - http://europa.eu.int/information_society/policy/nextweb/ipv6/index_en.htm
  - Information Society Technologies (IST) IPv6 Cluster
  - http://www.ist-ipv6.org/
    - Provides comprehensive Information for policy makers, journalist, ISP, manager, engineer, end user

Europe

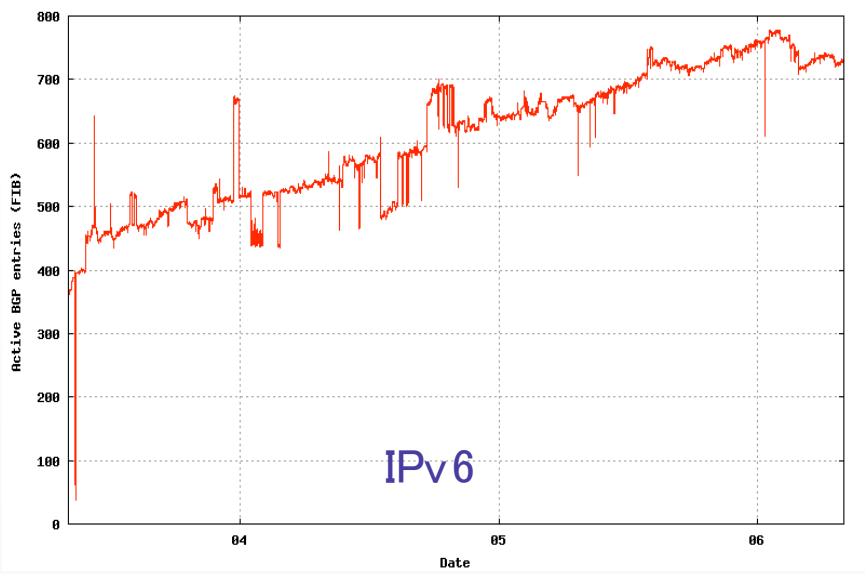
- NOKIA
  - IPV4/IPv6 dual stack CDMA mobile phone in 2003
  - Collaboration with NTT Communications to develop a Radio Frequency Identification (RFID) terminal implemented with Mobile IPv6, IPSec and RFID
    - http://www.nokia.com/A402958

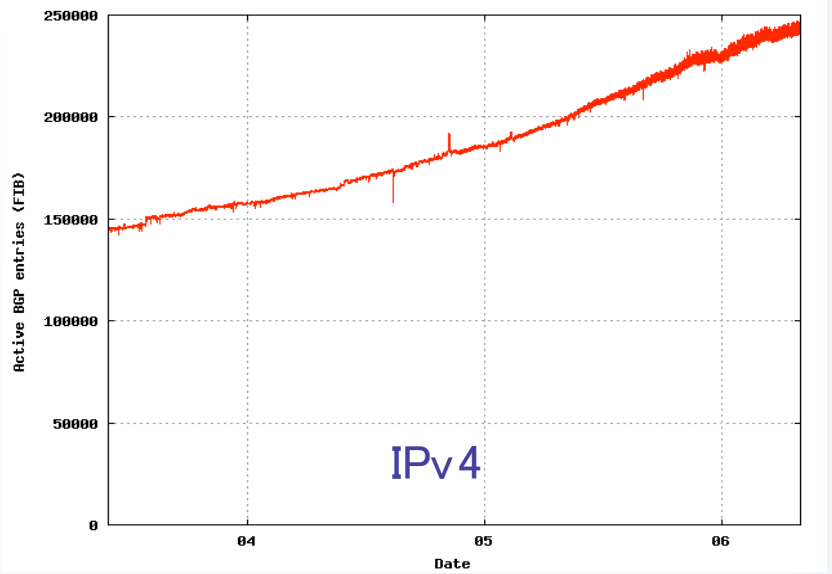
USA

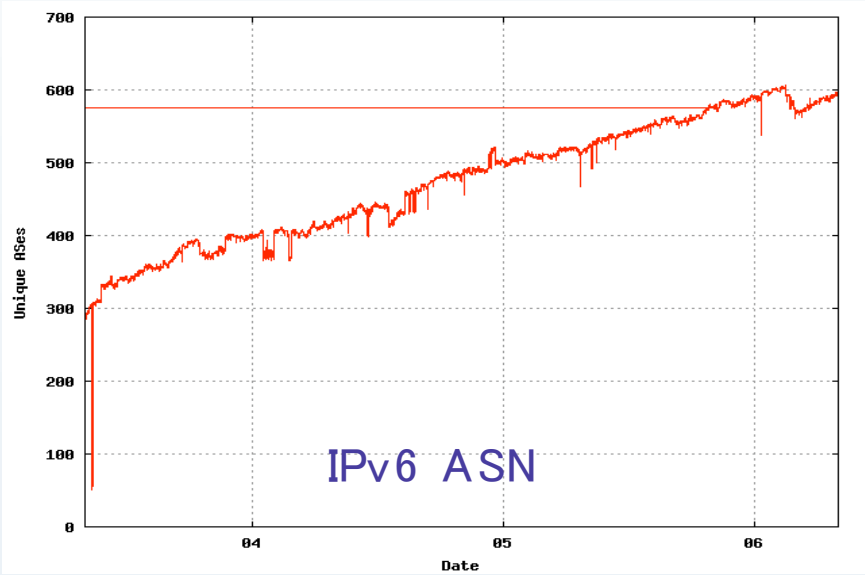
- Transition plan for IPv6
- http://www.whitehouse.gov/omb/memoranda/fy2005/m05-22.pdf
  - Issued by Office of Management and Budget (Aug 2005)
    - Set Jun 2008: All agencies' infrastructure (network backbone) must be using IPv6
    - All new IT purchases must be IPv6 compatible
- Department of Defence (DoD)
  - Plan to transit to IPv6 since Oct 2003

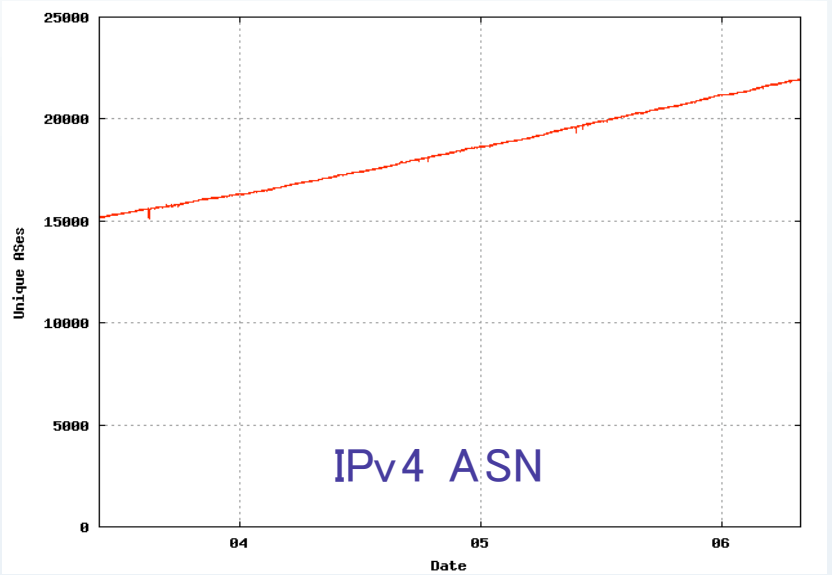
Where is IPv6 today?

The BGP count and AS count









Where is the Industry?

- Post-bust conservatism…
  - Investment programs must show assured returns, across their entire life cycles
  - Reduced investment risk
    - Reduced innovation and experimentation
- Reducing emphasis on brand new services
  - …and more on returns from existing infrastructure investments (value-adding, bundling etc)

The IPv6 Opportunity

- Volume over value
  - Supporting a network infrastructure that can push down unit cost of packet transmission largely
  - IPv6 will push the industry into providing
    - Even “thicker” transmission systems
    - Simpler, faster switching systems
    - Utility-based provider industry
    - Lightweight application transaction models
- Evolution takes millions of years
- The revolution could start any time
- Be prepared!

IPv6 – From PC to iPOD to iPOT

- A world of billions of chattering devices

- Or even trillions…

Questions?

Summary

Summary

- IP address management
  - Result of 20 years evolution of the Internet
    - Supported Internet growth to date
- No discrimination in IP address distribution
  - Newcomers can still get addresses
- Come to a RIPE meeting!
  - Participate in the open processes
- Responsible management essential to keep the Internet running

Thank You

Miwa Fujii, APNIC
Nurani Nimpuno, APNIC
Leo Vegoda, RIPE NCC
Arno Meulenkamp, RIPE NCC