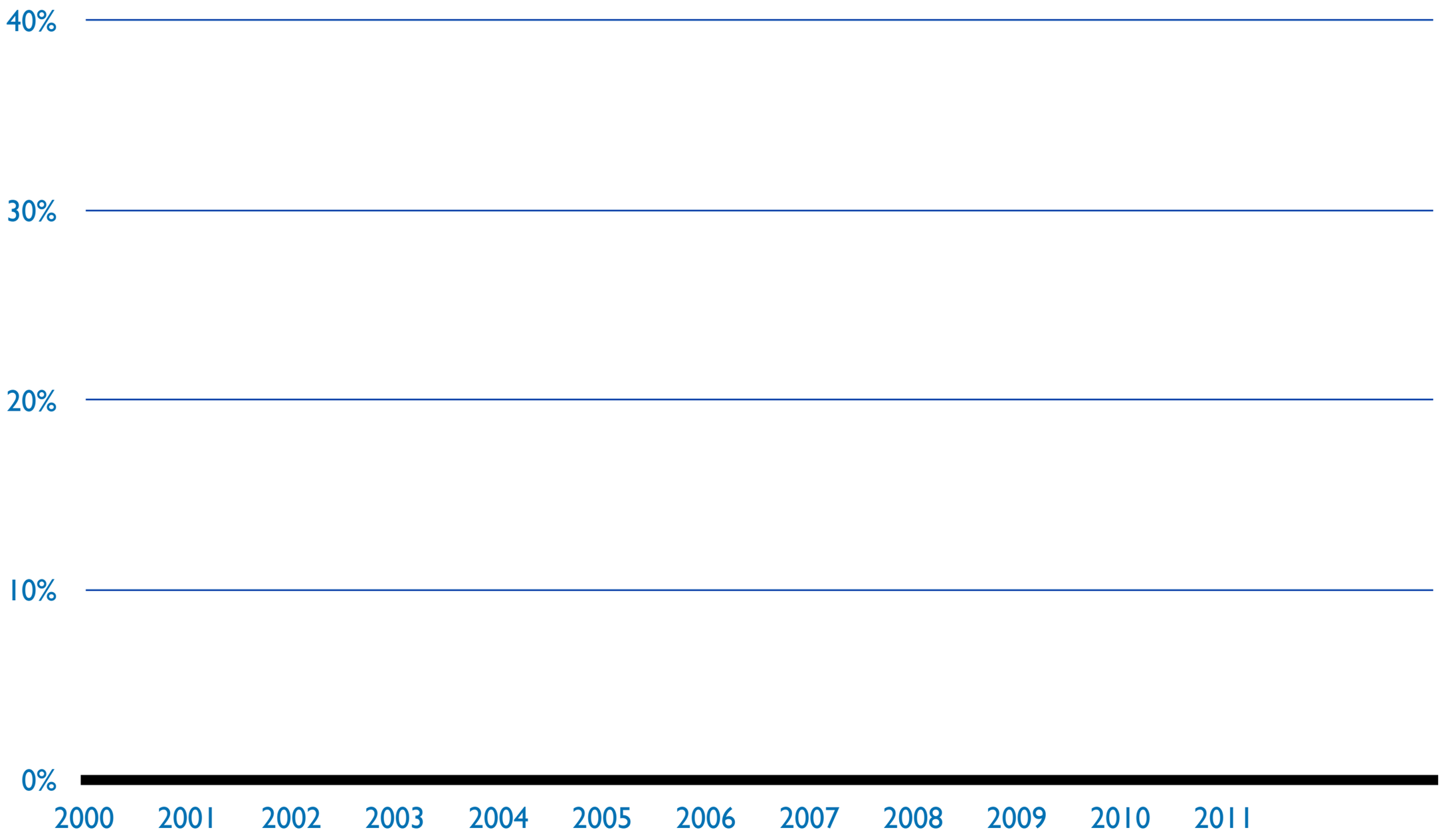
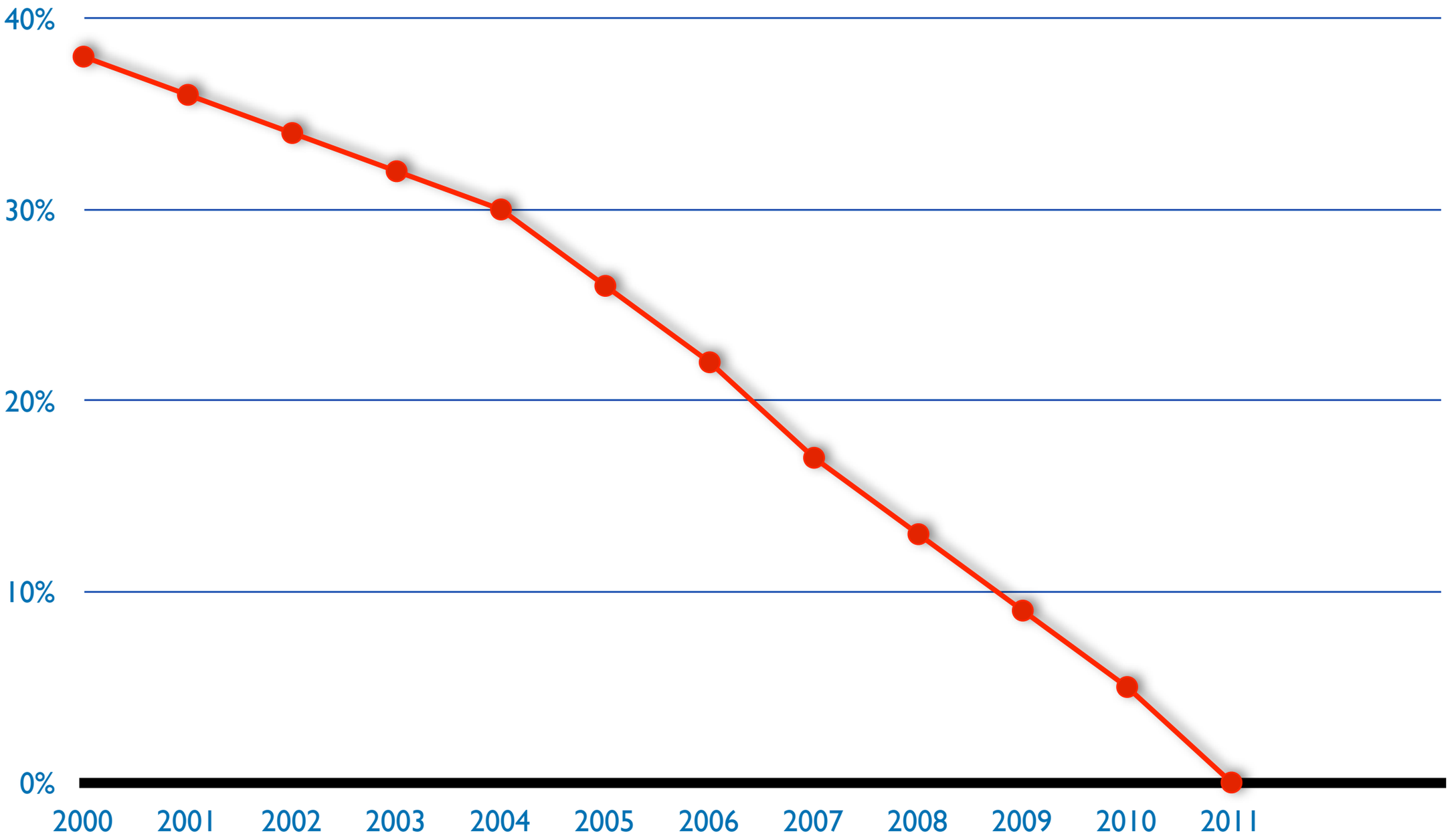
IANA IPv4 Pool



IANA IPv4 Pool



IPv6 Tutorial

World IPv6 Launch
Amsterdam Science Park
Ferenc Csorba
Nathalie Trenaman

Agenda

- The Registry System
- IPv4?
- IPv6 Basics
- Getting It
- Creating an Addressing Plan
- Transitioning Mechanisms
- Deployment Statistics
- More Information

RIPE / RIPE NCC

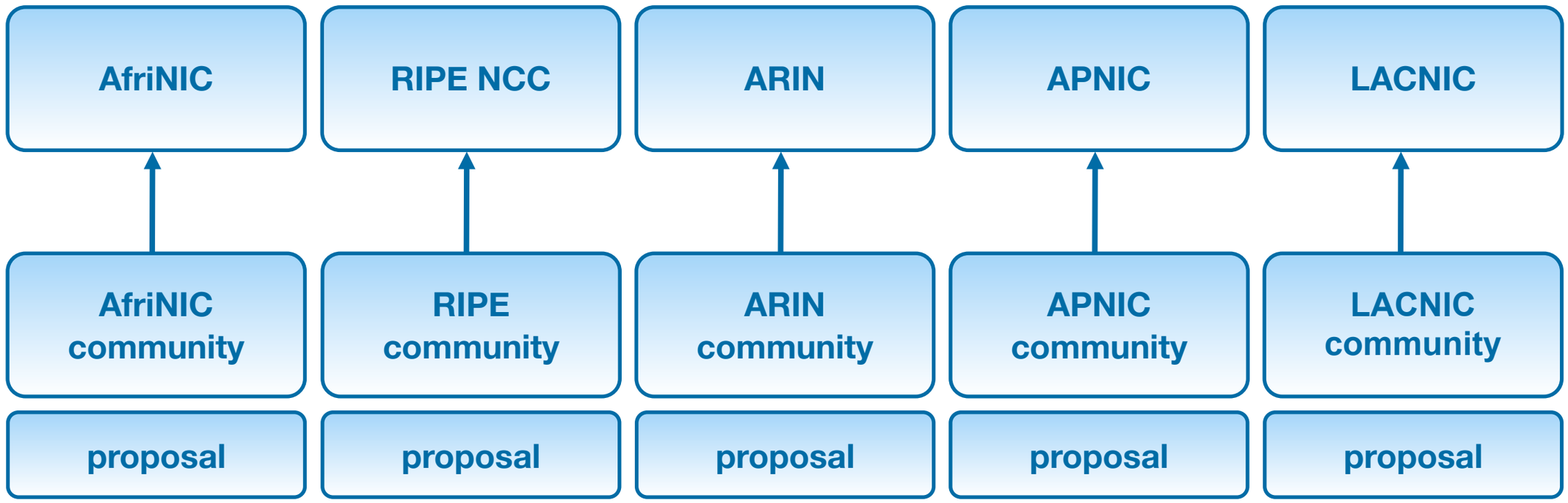
RIPE

- Open community
- Develops addressing policies
- Working group mailing lists

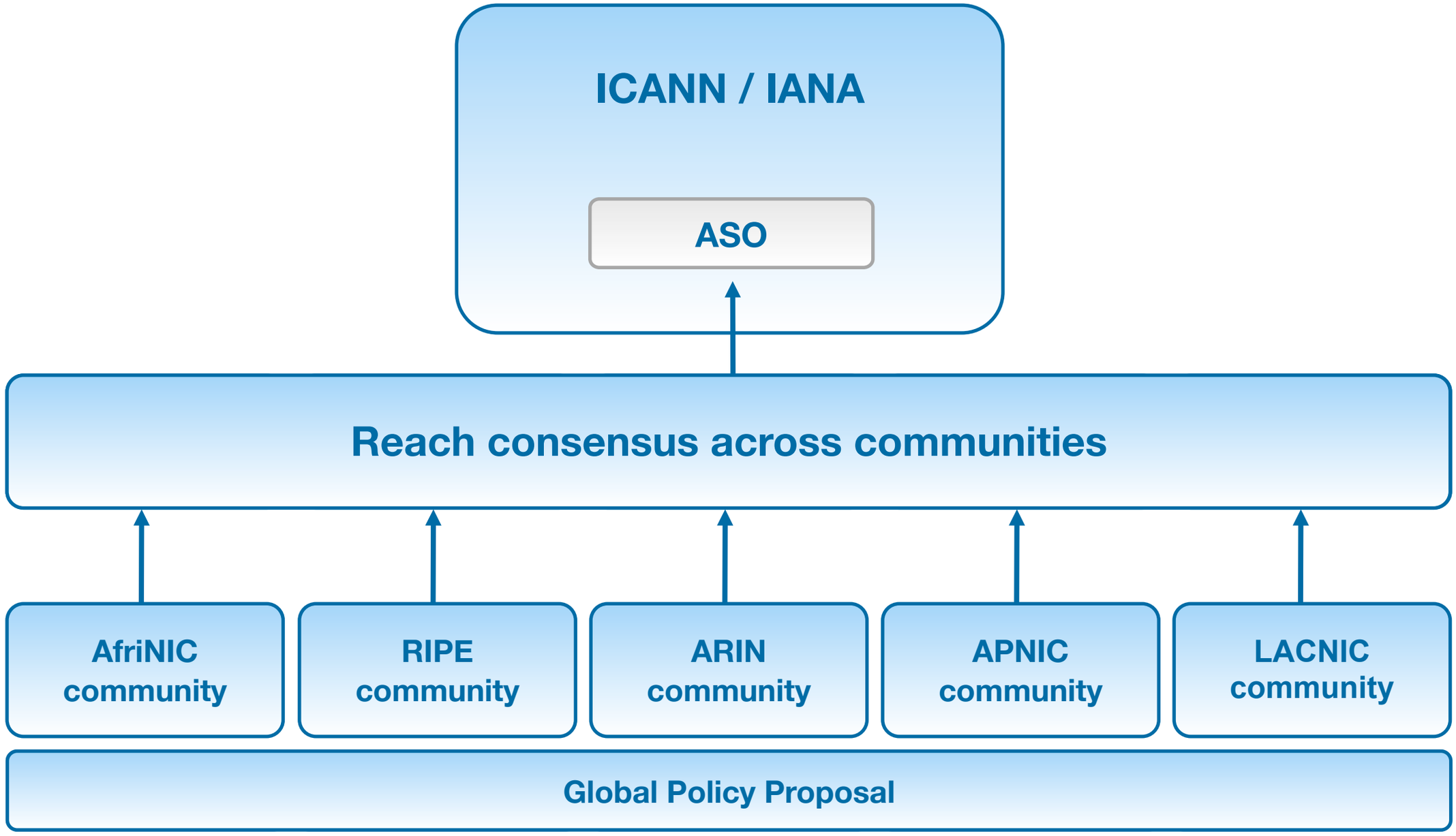
RIPE NCC

- Located in Amsterdam
- Not for profit membership organisation
- One of five RIRs

Who makes policies?



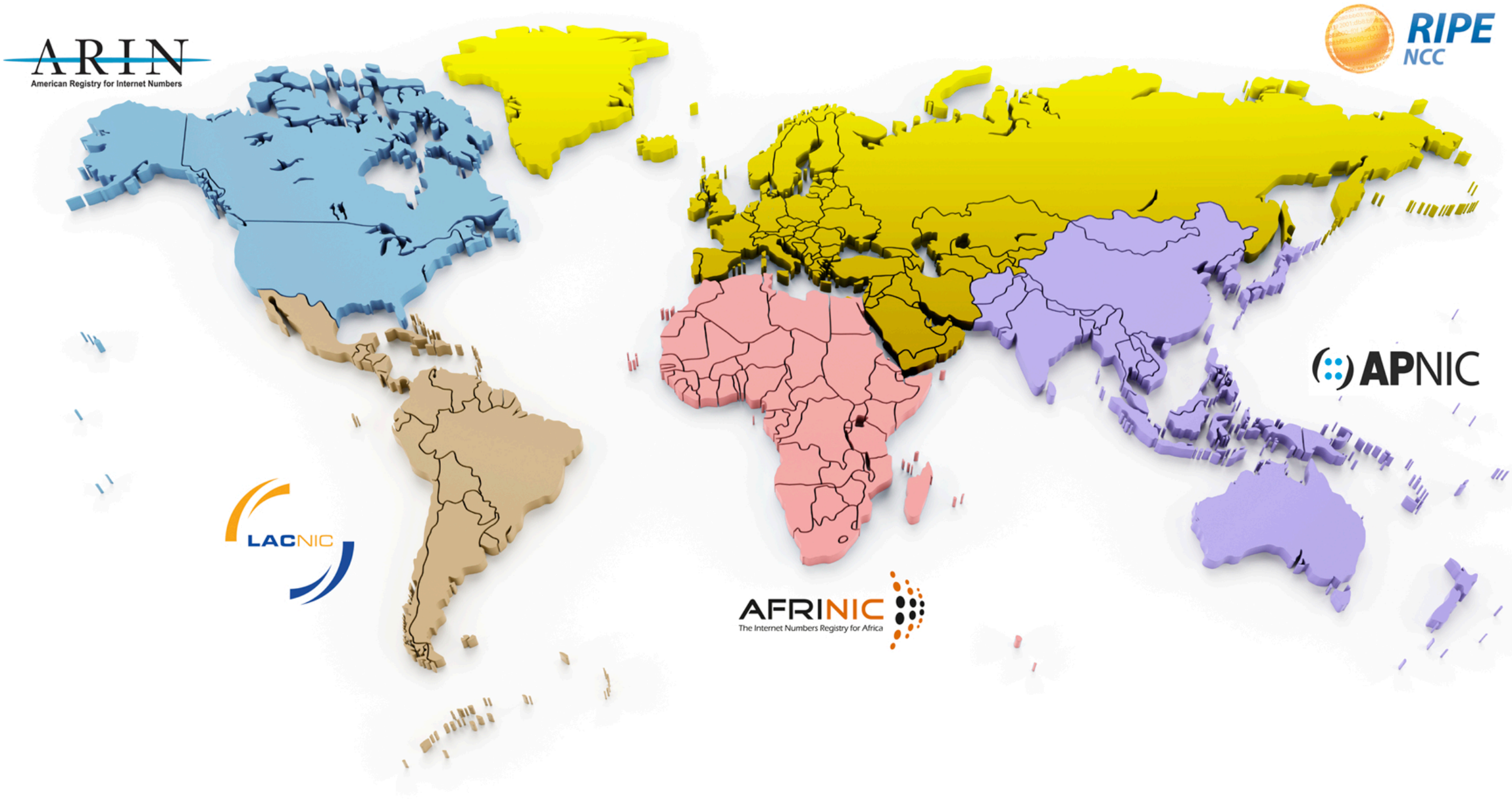
Who makes policies?



RIPE NCC Tasks

- IP addresses
  - IPv4 eg. 193.0.0.203
  - IPv6 eg. 2001:db8:240:11::c100:1319
- Autonomous System Numbers (ASN)
- Other public services
  - Training Services
  - RIPE Database
  - K-root name server
  - Measurement tools
  - E-learning
  - RIPE Labs
  - RIPE Stat
  - RIPE Atlas

The five RIRs

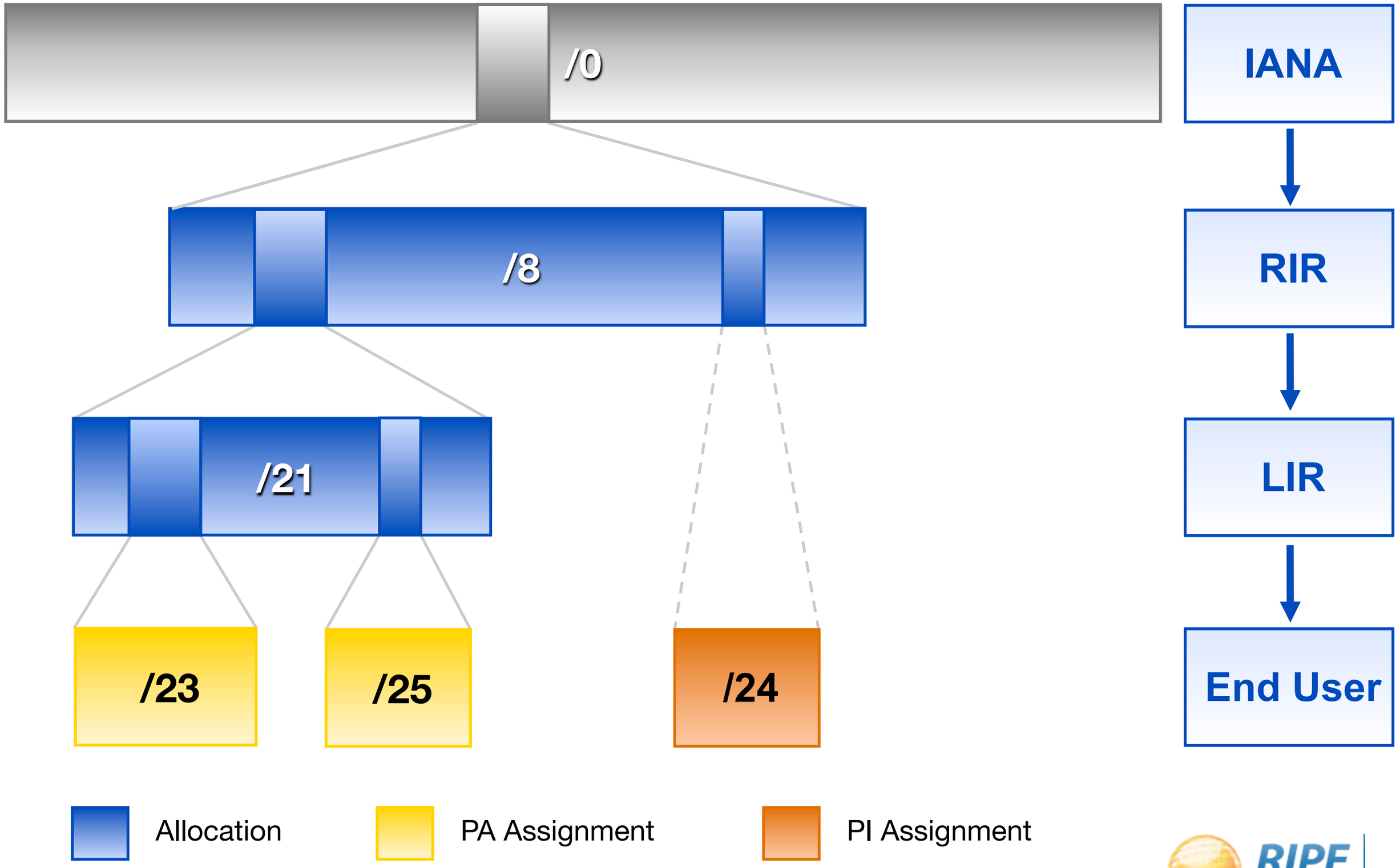


Registration

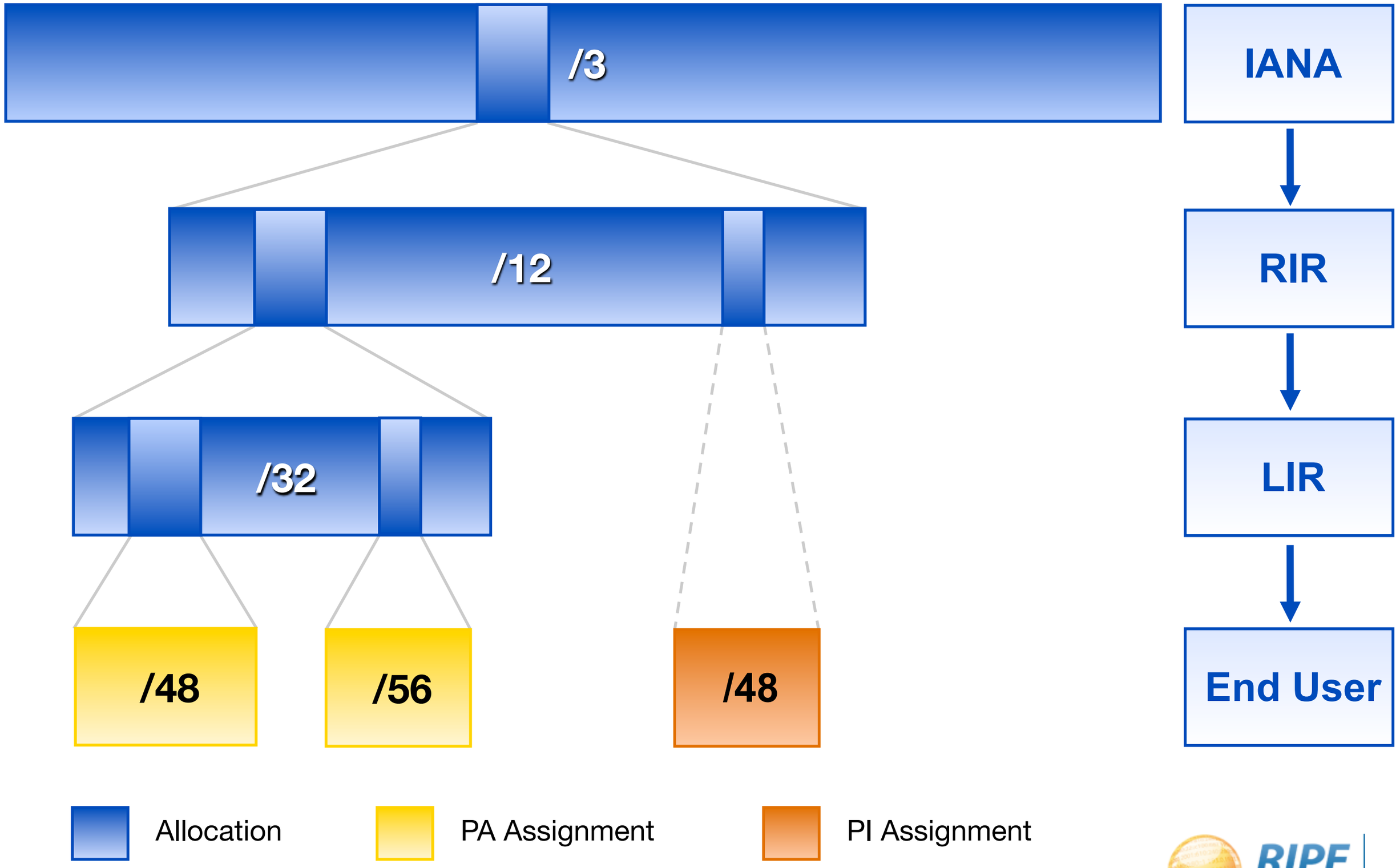
Conservation

Aggregation

IPv4 Address Distribution

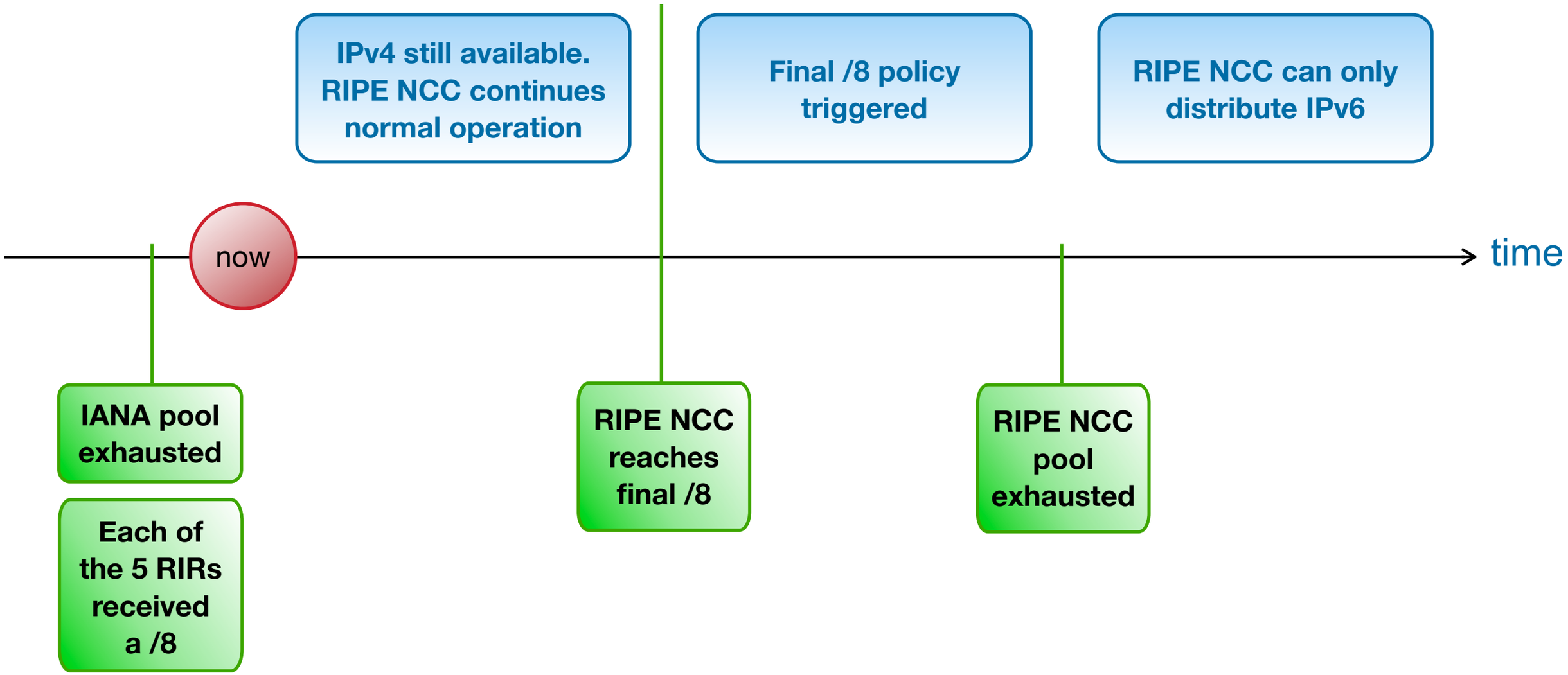


IPv6 Address Distribution



IPv4?

IPv4 exhaustion phases



“Run Out Fairly”

- Gradually reduced allocation and assignment periods
- Needs for “Entire Period” of up to...
  - 12 months (January 2010)
  - 9 months (July 2010)
  - **6 months (January 2011)**
  - 3 months (July 2011)

- 50% has to be used up by half-period

Allocations From the Final /8

- When the RIPE NCC reaches the final /8:
  - Every member can get a **/22** (1024 addresses)
  - Only if they already have IPv6 addresses
  - Only when there is justified need

- Current policy does not allow for PI assignments
  - Policy proposal 2012-04 under discussion
  - Intends to allow for PI assignments

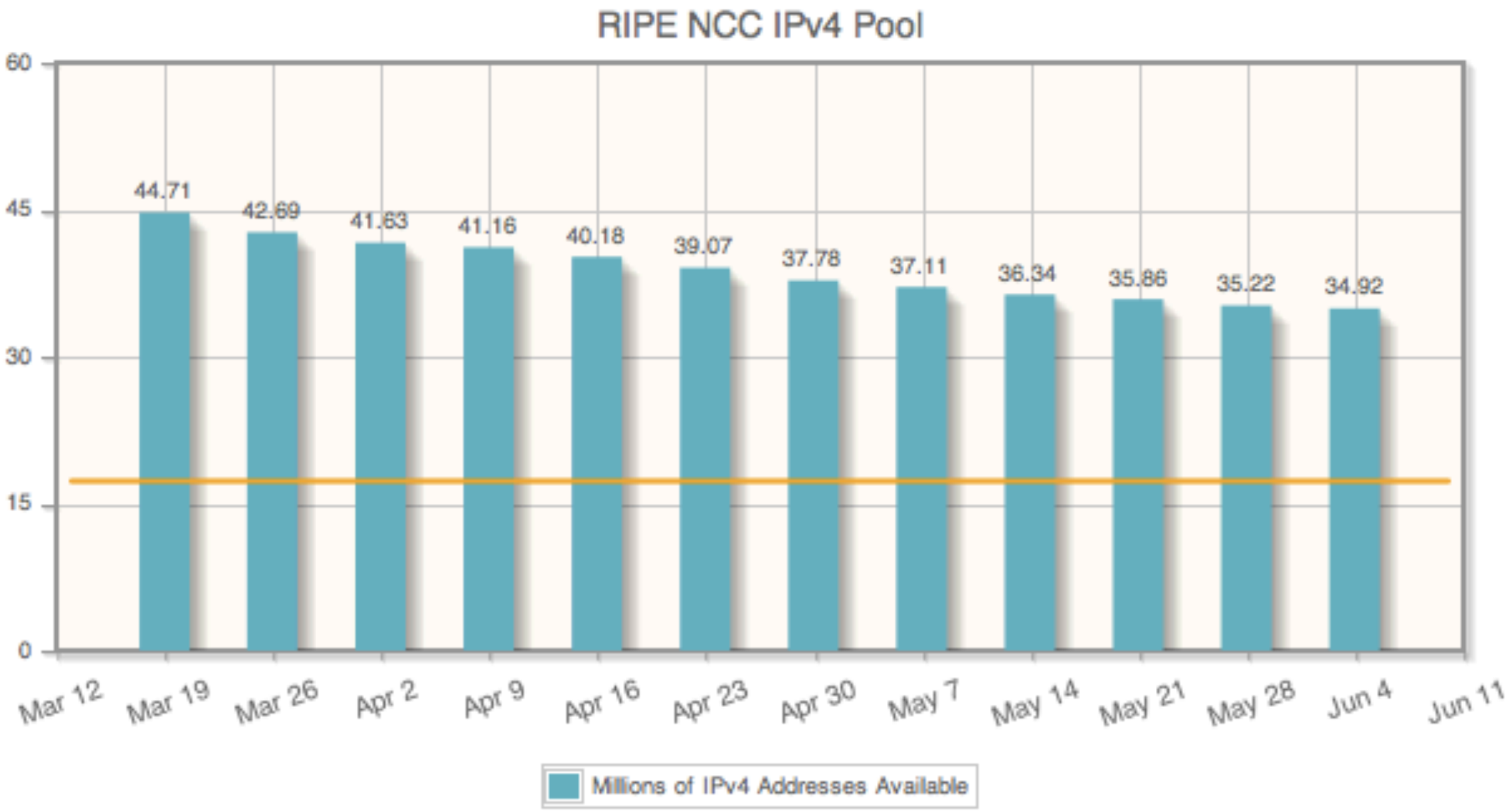
IPv4 Address Transfers

- Transfers allowed between RIPE NCC Members
  - Only if they are not in use
  - Receiver can prove he needs them
  - Minimum size is a /21

- Inter RIR transfers are being discussed
  - policy proposals 2012-02 and 2012-03
  - Change the allocation period back to 24 months
  - Allow transfers to and from the RIPE NCC region

RIPE NCC IPv4 Pool

04 Jun 2012



IPv6 Basics

Internet Protocol Version 6

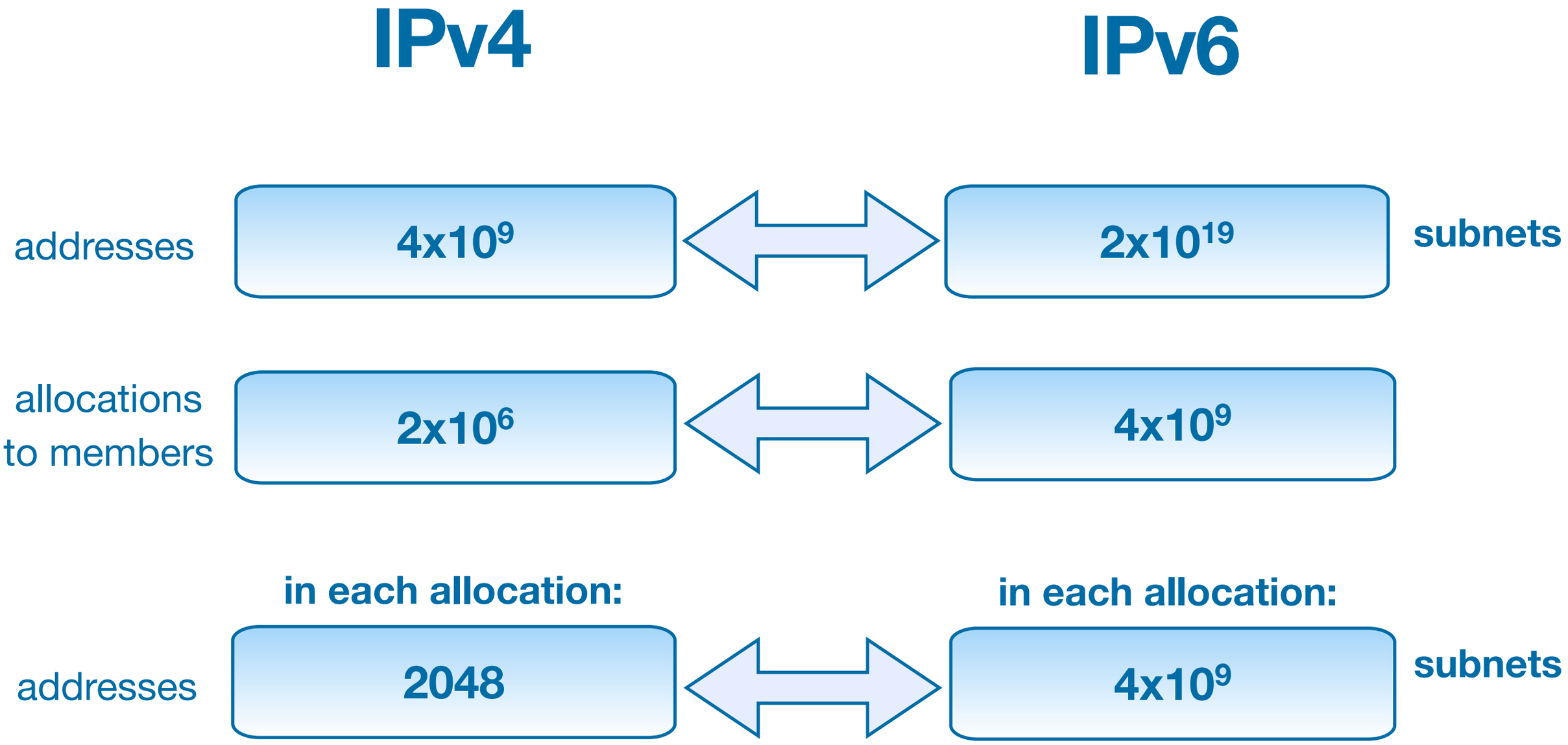
- Developed by the IETF in the early nineties
- Became a standard in 1995
- Uses 128 bit addresses
  - Instead of IPv4's 32 bits

- IPv4 and IPv6 are not compatible
  - They can't talk to each other without help

340282366920938463463374607431768211456

(4294967296)

IPv4 vs IPv6 (rounded off)



Address Notation

2001:0db8:003e:ef11:0000:0000:c100:004d

Address Notation

2001:0db8:003e:ef11:0000:0000:c100:004d

2001:db8:3e:ef11:0:0:c100:4d

Address Notation

2001:0db8:003e:ef11:0000:0000:c100:004d

2001:db8:3e:ef11:0:0:c100:4d

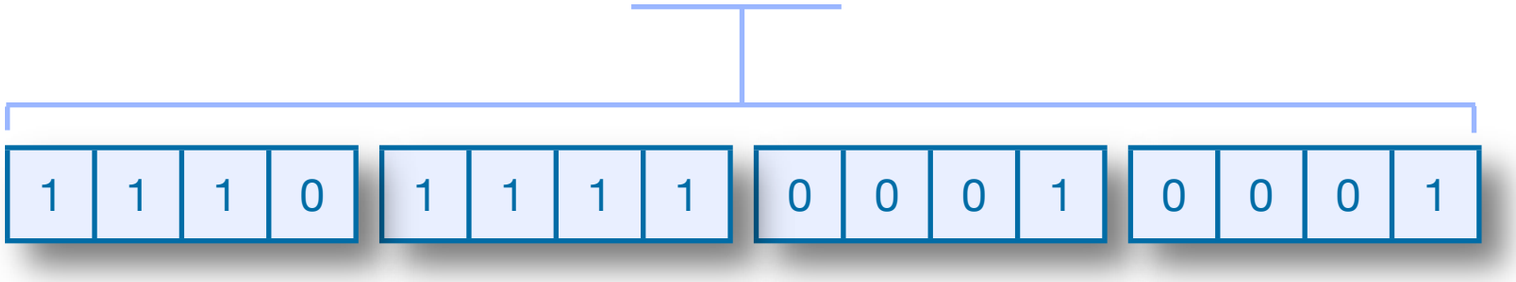
2001:db8:3e:ef11::c100:4d

Address Notation

2001:0db8:003e:ef11:0000:0000:c100:004d

2001:db8:3e:ef11:0:0:c100:4d

2001:db8:3e:ef11::c100:4d



Quiz 1

- How do you correctly compress the following IPv6 address:

2001:0db8:0000:0000:b450:0000:0000:00b4

A 2001:db8::b450::b4

B 2001:db8::b450:0:0:b4

C 2001:db8::b45:0000:0000:b4

D 2001:db8:0:0:b450::b4

Answer

A 2001:db8::b450::b4

B 2001:db8::b450:0:0:b4

C 2001:db8::b45:0000:0000:b4

D 2001:db8:0:0:b450::b4

IPv6 Subnetting

- Subnets follow CIDR rules:
  - A subnet boundary can be anywhere
  - Subnet mask is noted with a “/”, e.g. /64

- The standard says every subnet must be a /64
  - Defines the host part of the address to be 64 bits
  - Exception is /127 for point-to-point on routers

IPv6 Subnetting

2001:0DB8:0000:0000:0000:0000:0000:0000

64 bits interface ID

/64

/60 = 16 /64

/56 = 256 /64

/52 = 4096 /64

/48 = 65536 /64

/32 = 65536 /48

RIPE NCC

Contact Training Services: **ts@ripe.net**

Follow us on Twitter: **www.twitter.com/TrainingRIPENCC**

www.ripe.net

RIPE NCC

Multiple addresses

Addresses	Range	Scope
Loopback	::1	host
Link Local	fe80::/10	link
Unique Local	fc00::/7	global
Global Unicast	2000::/3	global
6to4	2002::/16	global
Multicast	ff00::/8	variable
Teredo	2001::/32	global

Getting It

Getting an IPv6 allocation

- To qualify, an organisation must:
  - Be a member of the RIPE NCC
  - Have a plan for making assignments

- Minimum allocation size /32

- Allocation size is based on customer numbers and growth, not on transition technique!

Customer Assignments

- Every “end site” can be assigned up to a /48 without prior approval of the RIPE NCC
  - That is 65536 subnets per site
  - If you need more, ask for approval first
  - Or make a sub-assignment

- Assignments for your own infrastructure
  - /48 per Point of Presence
  - One additional /48 for the core network

Provider Independent Assignments

- PI assignments in IPv6
  - Must have a contract with an LIR
  - Minimum assignment size is a /48
  - More if there is justified need

- No sub-assignments are allowed
  - Not even a single address for the connection
  - If you have customers, you can not use PI for them

Quiz 3

- How many /64-s in a /48?

- How many /64-s in a /56?

- How many /56-s in a /48?

Answer

- How many /64-s in a /48? 65536

- How many /64-s in a /56? 256

- How many /56-s in a /48? 256

Registration in the RIPE Database

- All sub-allocations and assignments must be registered to make them valid

- Large numbers of assignments can be grouped
  - Status “AGGREGATED-BY-LIR”
  - Indicates multiple assignments
  - Size indicated by “assignment-size”

Reverse DNS

2001:db8:3e:ef11::c100:4d

Reverse DNS

2001:db8:3e:ef11:::c100:4d

Reverse DNS

2001:0db8:003e:ef11:0000:0000:c100:004d

Reverse DNS

2001:0db8:003e:ef11:0000:0000:c100:004d

8.b.d.0.1.0.0.2.ip6.arpa

Reverse DNS

2001:0db8:003e:ef11:0000:0000:c100:004d

8.b.d.0.1.0.0.2.ip6.arpa

d.4.0.0.0.0.1.c.0.0.0.0.0.0.0.0.1.1.f.e.e.
3.0.0.8.b.d.0.1.0.0.2.ip6.arpa PTR
yourname.domain.tld

Reverse DNS

2001:0db8:003e:ef11:0000:0000:c100:004d

8.b.d.0.1.0.0.2.ip6.arpa

d.4.0.0.0.0.1.c.0.0.0.0.0.0.0.0.1.1.f.e.e.
3.0.0.8.b.d.0.1.0.0.2.ip6.arpa PTR
yourname.domain.tld

d.4.0.0.0.0.1.c.0.0.0.0.0.0.0.0.1.1.f.e.e.3.0.0.8.b.d.0.1.0.0.2.ip6.arpa PTR yourname.domain.tld

Reverse DNS in the RIPE Database

```
domain:      8.b.d.0.1.0.0.2.ip6.arpa
descr:       Yourname Reverse Domain
org:         Yourdomain Ltd
admin-c:     XY123-RIPE
tech-c:      NT1031-RIPE
zone-c:      NT1031-RIPE
nserver:     alpha.yourdomain.tld
nserver:     beta.yourdomain.ltd
mnt-by:      GAMMA-MNT
mnt-lower:   BETA-MNT
changed:     joedoe@yourdomain.tld  20110428
source:      RIPE
```

IPv6 in the Routing Registry

Route6 object:

```
route6:     2001:db8::/32
origin:     AS65550
```

Aut-num object:

```
aut-num:    AS65550
mp-import:  afi ipv6.unicast from AS64496 accept ANY
mp-export:  afi ipv6.unicast to AS64496 announce AS65550
```

Creating an Addressing Plan

Why Create an IPv6 Addressing Plan?

- Mental health during implementation(!)
- Easier implementation of security policies
- Efficient addressing plans are scalable
- More efficient route aggregation

IPv6 Address Management

- Your Excel sheet might not scale
  - There are 65.536 /48s in a /32
  - There are 65.536 /64s in a /48
  - There are **16.777.216** /56s in a /32

- Find a suitable IPAM solution

Addressing Plans for ISPs

- A /48 per pop can be used
  - separate blocks for infrastructure and customers
  - document address needs for allocation criteria

- Use one /64 block (per site) for loopbacks
  - One /128 per device
  - One /64 contains enough /128s for 18.446.744.073.709.551.616 devices

Administrative Ease

- If possible assign on 4 bit boundaries
  - Matches a hexadecimal digit
  - Easier to read and remember
  - Aligns with reverse DNS zones

- Possibly follow the structure of the network or organisation
  - Can aid in access control and troubleshooting

Point-to-Point Connections

- How much space for point-to-point connections?
  - RFC4291: Interface IDs are required to be /64
  - RFC3627: Use of /127 between routers considered harmful
  - RFC6547: RFC3627 to Historic Status
  - RFC6164: Using /127 on Inter-Router links

- Be safe: reserve a /64, assign a /127 per point-to-point connection

Making Customer Assignments

- Don’t be too conservative
- Assign a generous amount of subnets
- /56 is a popular size for residential
  - Allows for 256 subnets
  - Future proof
- Business customers often get a /48
- You don’t want to renumber later on

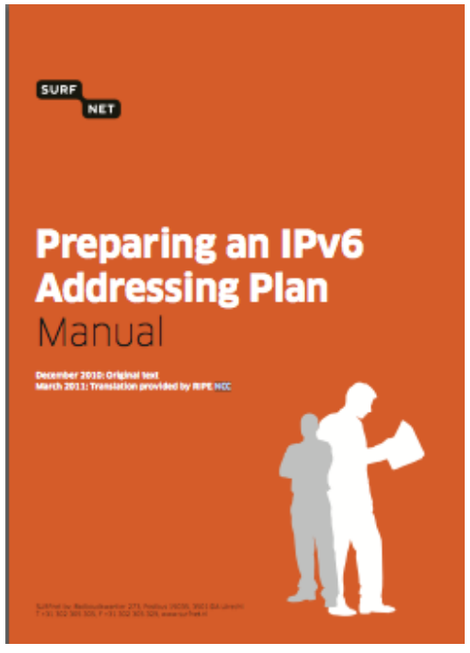
“Smart” Addresses Example

- Assume you got 2001:db8:1234::/48
- In your subnet 2001:0db8:1234:**XYZZ**::/64
  - **X** can represent a location, i.e. “north building”
  - **Y** can represent a function, i.e. “workstations”
  - **ZZ** can represent the specific subnet (number)

- 2001:0db8:1234:1316::/64 could mean:
  - South building, printers, area 16 (accounting)

Customers And Their /48

- Customers have no idea how to handle 65536 subnets!
- Provide them with information
  - https://www.ripe.net/lir-services/training/material/IPv6-for-LIRs-Training-Course/IPv6_addr_plan4.pdf



Transition Mechanisms

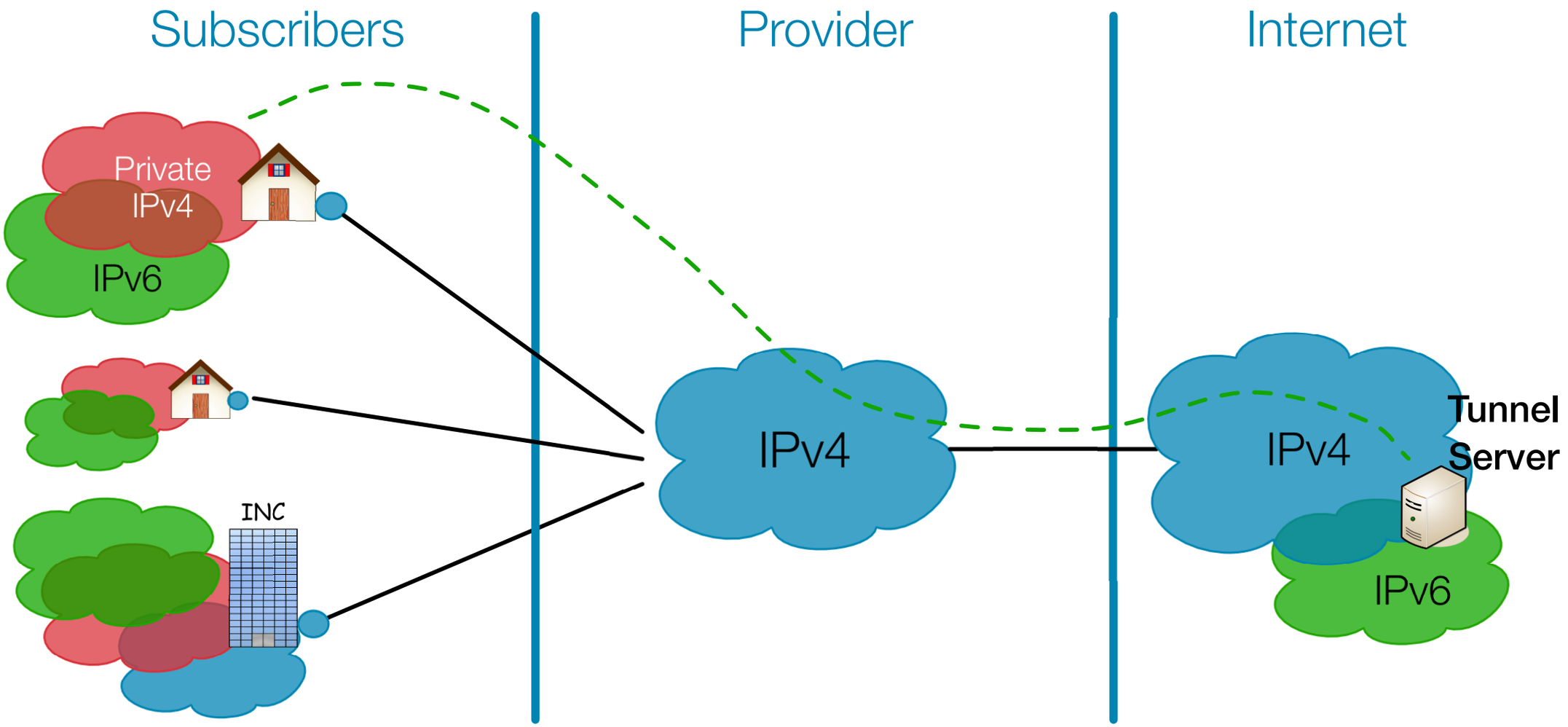
Transitioning: Two Main Methods

- Transporting IPv6 in IPv4
  - 6in4
  - 6to4
  - Teredo
  - 6RD
- Translating IPv6 into IPv4
  - NAT64/DNS64

6in4

- Manually configured tunnels towards a fixed tunnel broker like SixXS, Hurricane Electric or your own system
- Stable and predictable but not easily deployed to the huge residential markets
- MTU might cause issues

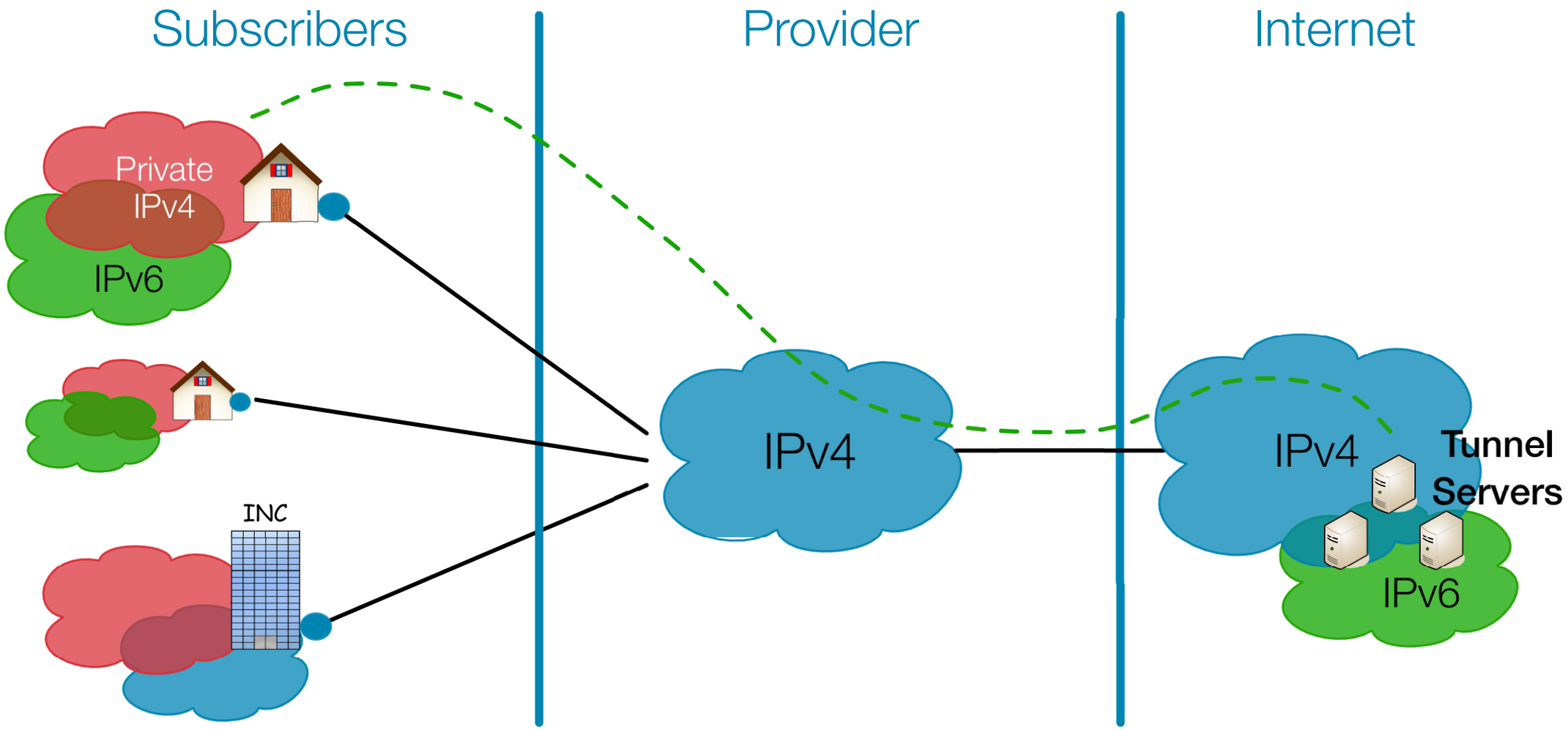
6in4


Subscribers
Provider
Internet
Private
IPv4
IPv6
INC
IPv4
IPv4
Tunnel
Server
IPv6

6to4 and Teredo

- 6to4
  - "Automatic" tunnel, system can configure itself
  - IPv4 address is part of the IPv6 address
  - Requires a public IPv4 address
  - Uses anycast to reach a nearby server
  - Return traffic might choose another server
- Teredo
  - Uses UDP to encapsulate packets
  - Works across (most) NAT implementations

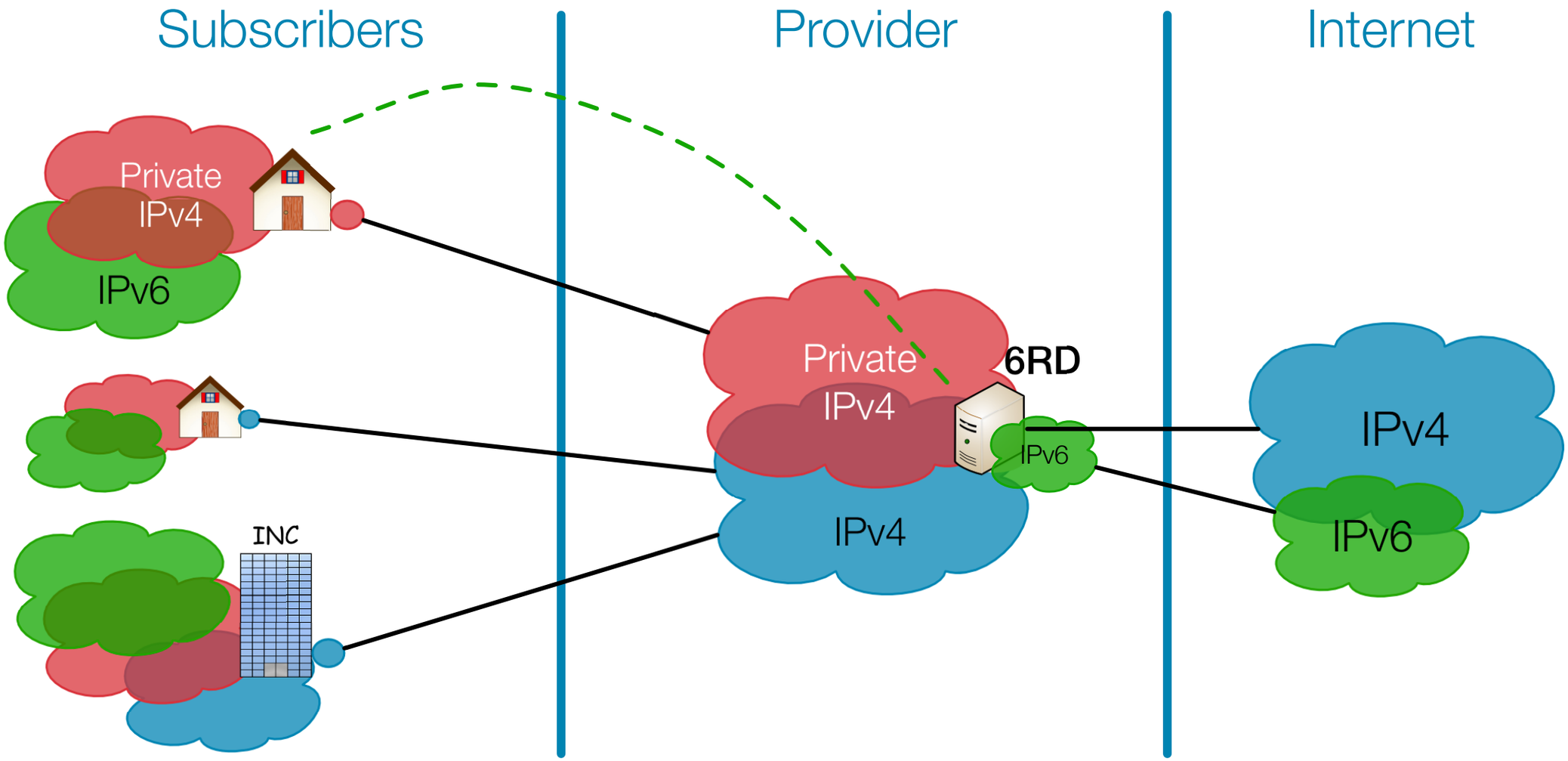
6to4 and Teredo



6RD

- Quite similar to 6to4
  - Encodes the IPv4 address in the IPv6 prefix
- Uses address space assigned to the operator
- The operator has full control over the relay
- Traffic is symmetric across a relay
  - Or at least stays in your domain
- Can work with both public and private space
- Needs additional software for signaling

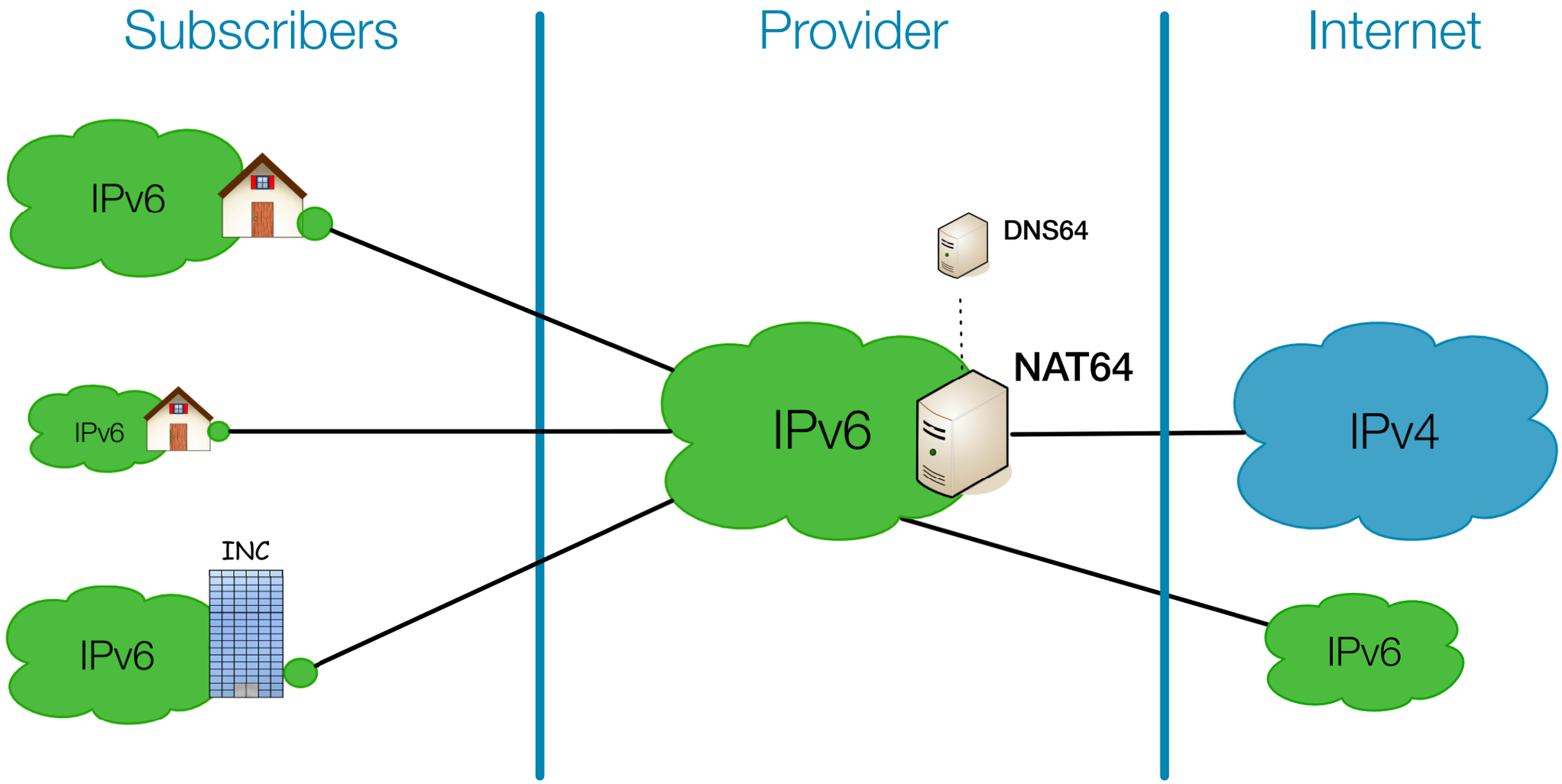
6RD


Subscribers
Provider
Internet
Private
IPv4
IPv6
INC
Private
IPv4
6RD
IPv6
IPv4
IPv4
IPv6

NAT64/DNS64

- Single-stack clients will only have IPv6
- Translator box will strip all headers and replace them with IPv4
- Requires some DNS “magic”
  - Capture responses and replace A with AAAA
  - Response is crafted based on target IPv4 address
- Usually implies address sharing on IPv4

NAT64/DNS64

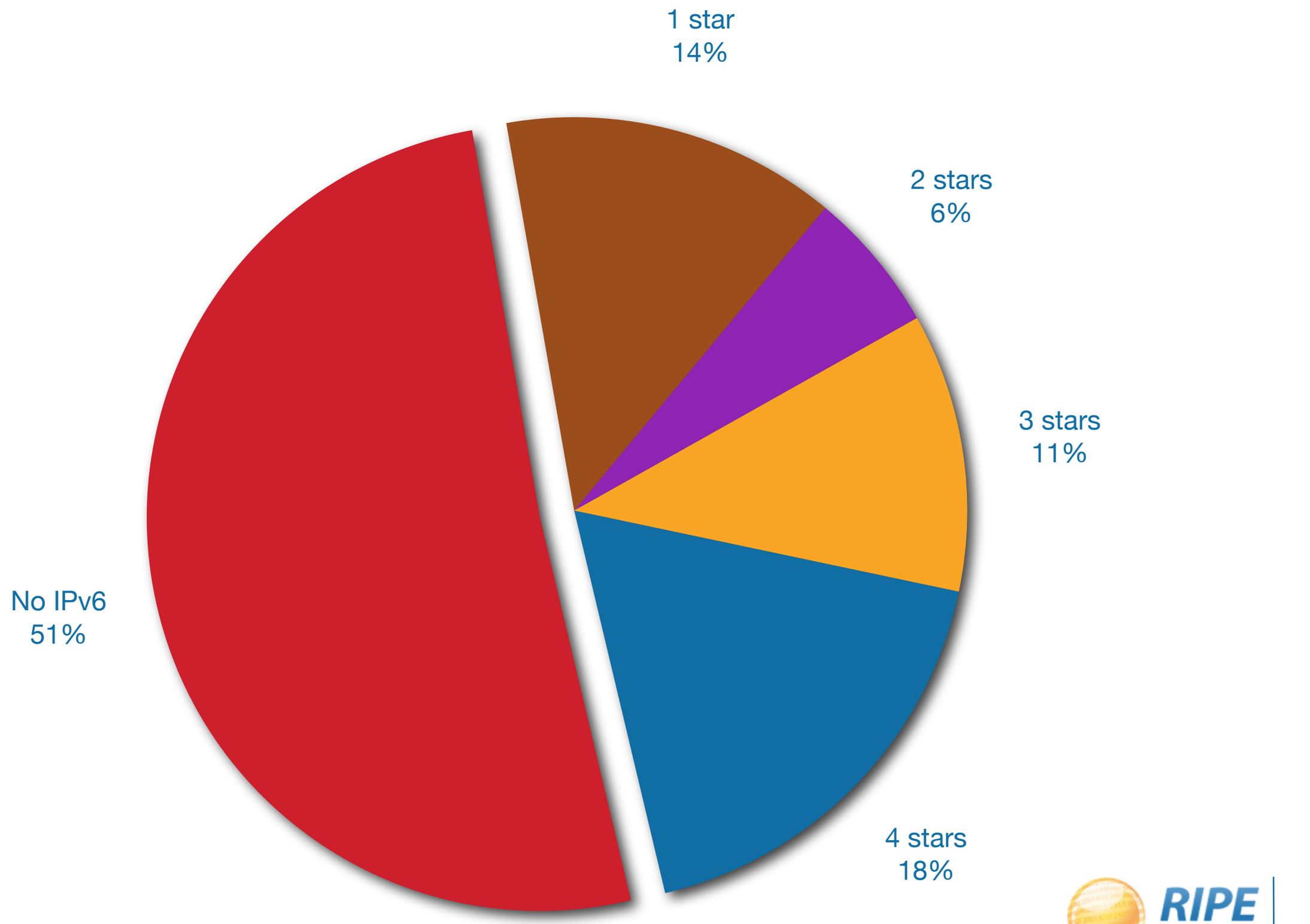

Subscribers
Provider
Internet
IPv6
IPv6
INC
IPv6
DNS64
NAT64
IPv6
IPv4
IPv6

Deployment Statistics

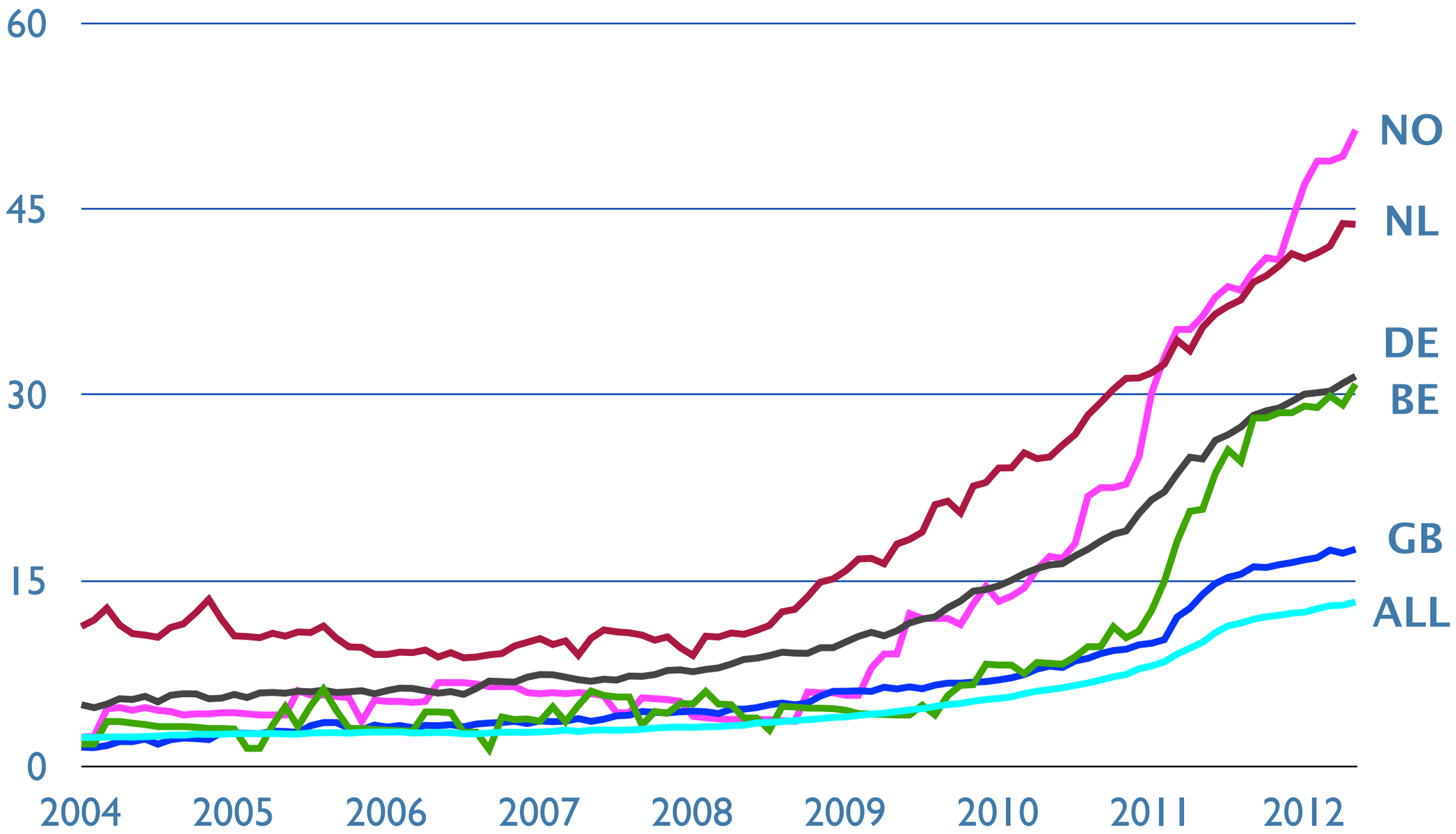
IPv6 RIPEness

- Rating system:
  - One star if the member has an IPv6 allocation
  - Additional stars if:
    - IPv6 Prefix is visible on the internet
    - A route6 object is in the RIPE Database
    - Reverse DNS is set up
  - A list of all 4 star LIRs: http://ripeness.ripe.net/

IPv6 RIPEness: 8201 LIRs



IPv6 enabled ASNs



More Information

RIPE NCC IPv6 Training Course

- Open to all members free of charge
- One day course in which you learn:
  - How to create a deployment plan for your organisation
  - How to make an addressing plan
  - How to make assignments
  - How to deploy alternative transitioning techniques

- See http://www.ripe.net/lir-services/training

RIPE-554 Document

- "Requirements for IPv6 in ICT Equipment"
- Best Current Practice describing what to ask for when requesting IPv6 Support
- Useful for tenders and RFPs

- Originated by the Slovenian Government
  - Adopted by various others (Germany, Sweden)
- Updated yesterday!

IPv6 CPE Survey

- Originally it was very hard to get IPv6 ready CPE

- Things have changed quite a bit
  - Lot of vendors produce IPv6 ready CPE

- Working on an updated version
  - Will ask vendors for the latest status

IPv6 Act Now

- Dedicated website about IPv6 Deployment
  - http://www.ipv6actnow.org

- ipv6actnow@ripe.net
  - One contact point for IPv6 matters
  - Feedback, suggestions and comments

Also useful

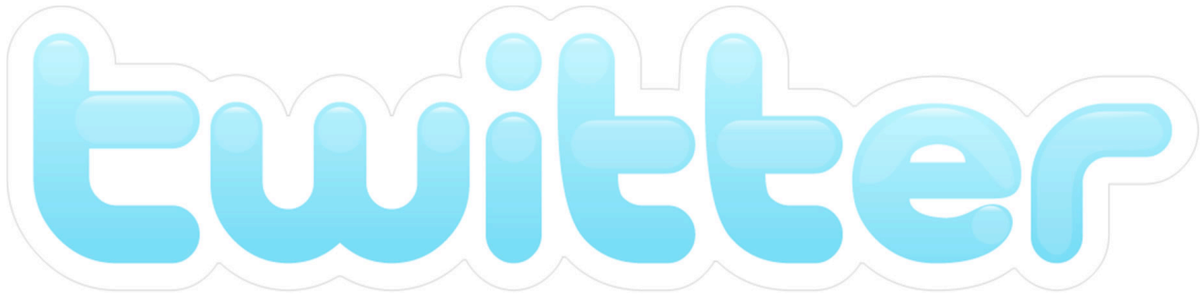
Websites

- http://www.getipv6.info/
- http://www.ipv6actnow.org
- http://datatracker.ietf.org/wg/v6ops/
- http://www.ripe.net/ripe/docs/ripe-554.html

Mailing lists

- http://lists.cluenet.de/mailman/listinfo/ipv6-ops
- http://www.ripe.net/mailman/listinfo/ipv6-wg

Follow Us



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Questions?