

IPv6 Tutorial

RIPE61, Rome



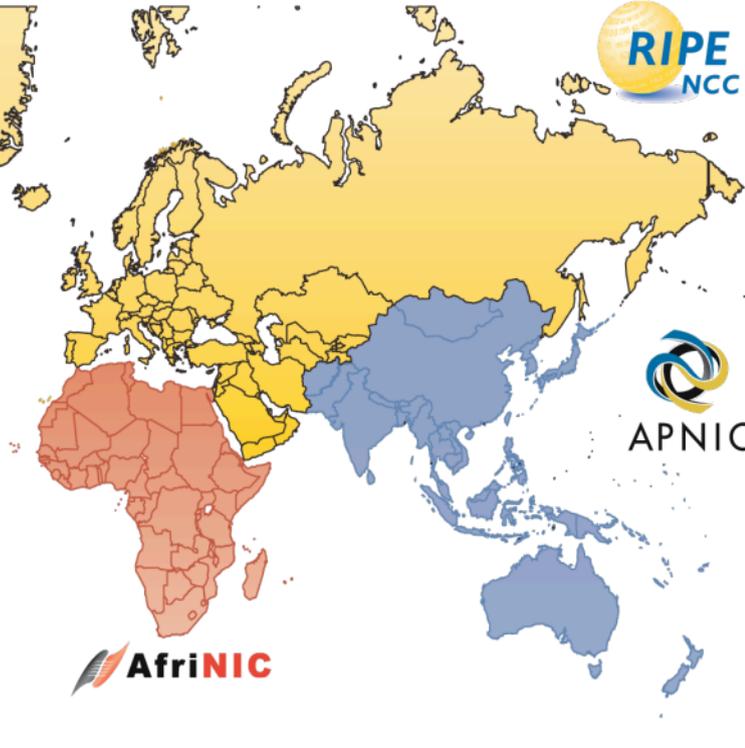
RIPE NCC

- One of the five Regional Internet Registries
- Support coordination of Internet operations
- Not for profit membership organisation
- Over 7000 active members
 - 650 new members in 2009

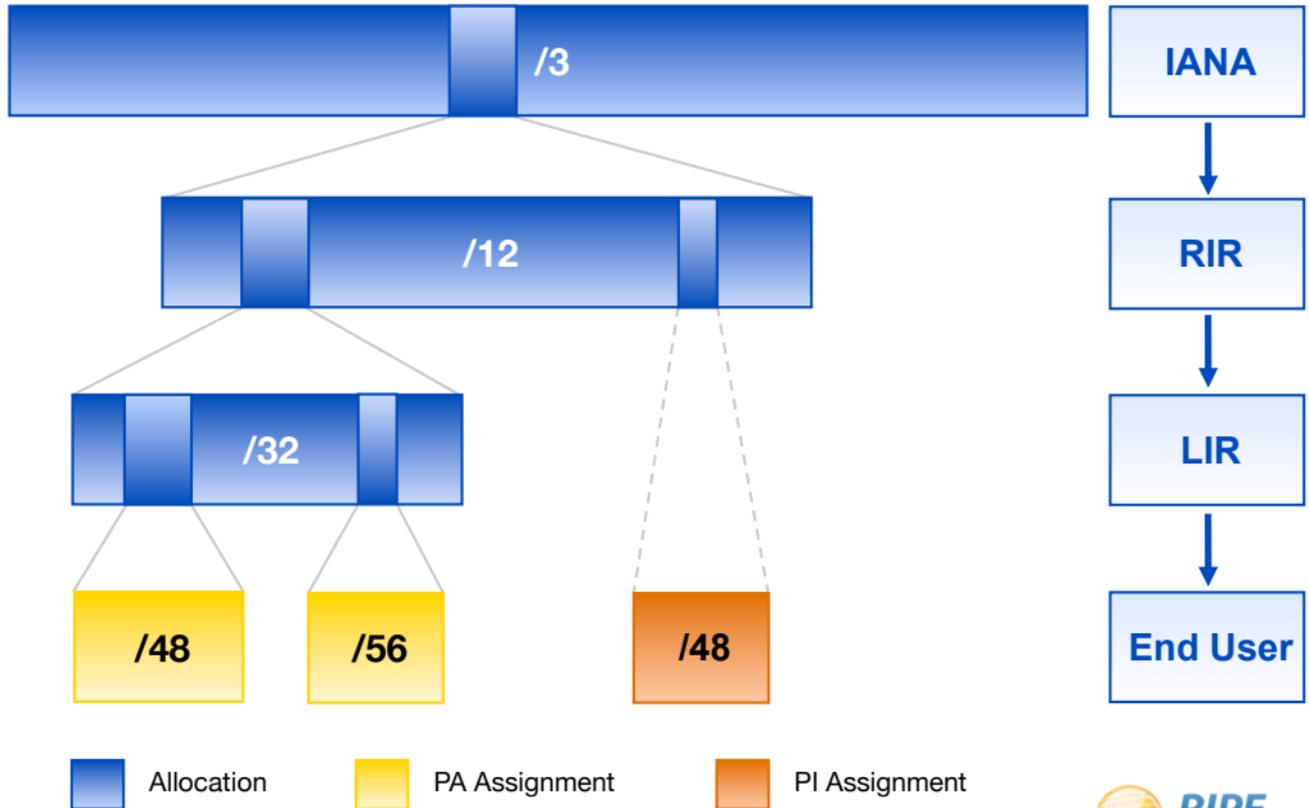
- Neutral, Impartial, Open, Transparent

The 5 RIRs

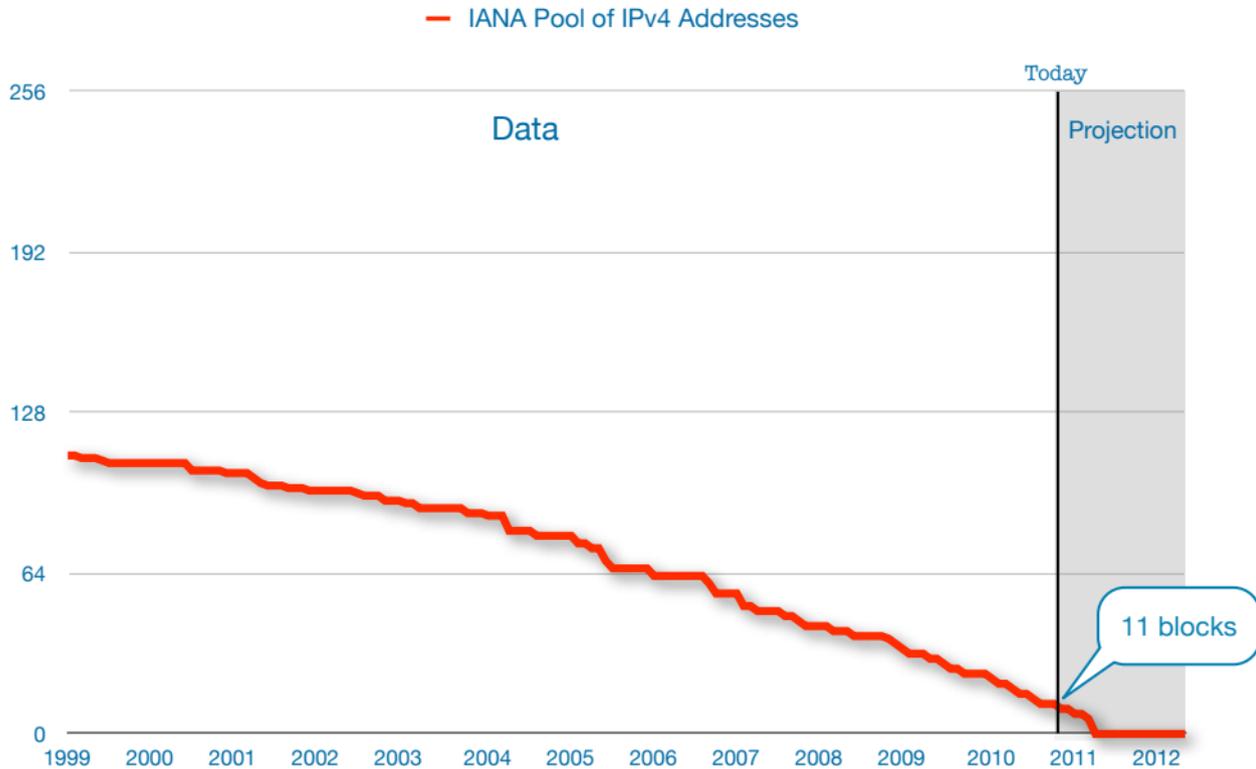
ARIN
American Registry for Internet Numbers



IP Address Distribution

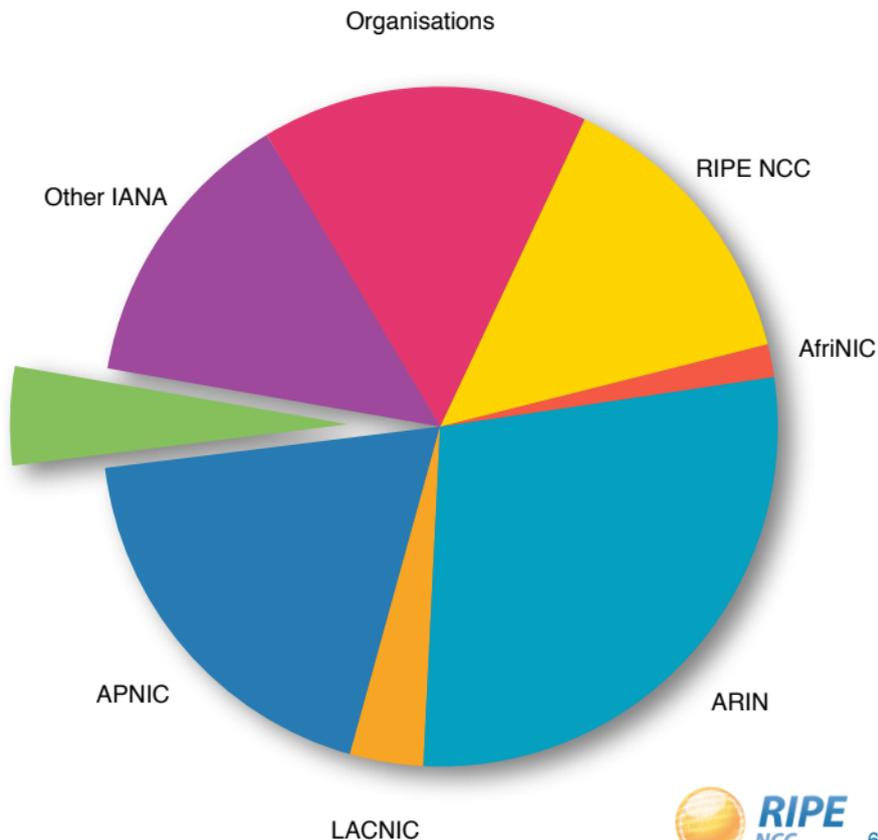


IPv4 Allocation Timeline



IPv4 Address Pool

4%
available



Reaching the next billion

- Around 1.9 billion Internet users now
 - five times as many as there were in the year 2000
 - around 29% of all people
- Mobile phones are becoming Internet devices
- The Internet of things

Wait and See?



Reduced Assignment Periods

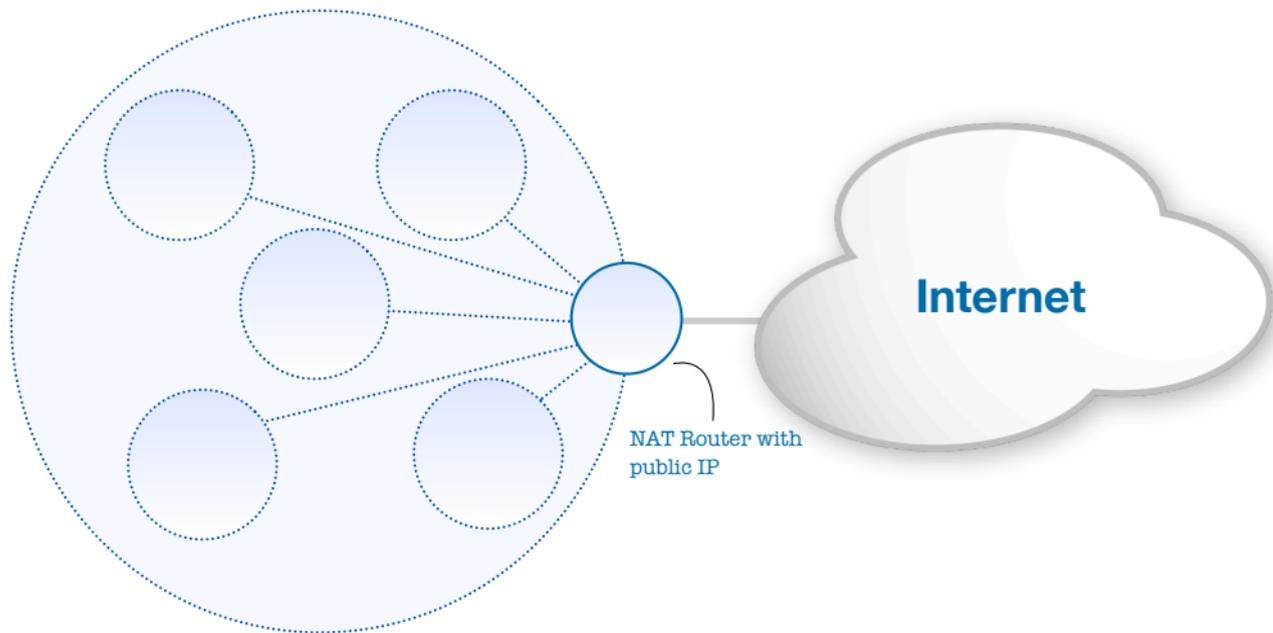
- Used to be: 24 months
- January 2010: 12 months
- July 2010: 9 months
- January 2011: 6 months
- July 2011: 3 months

Hot IPv4 / IPv6 Policy Topics

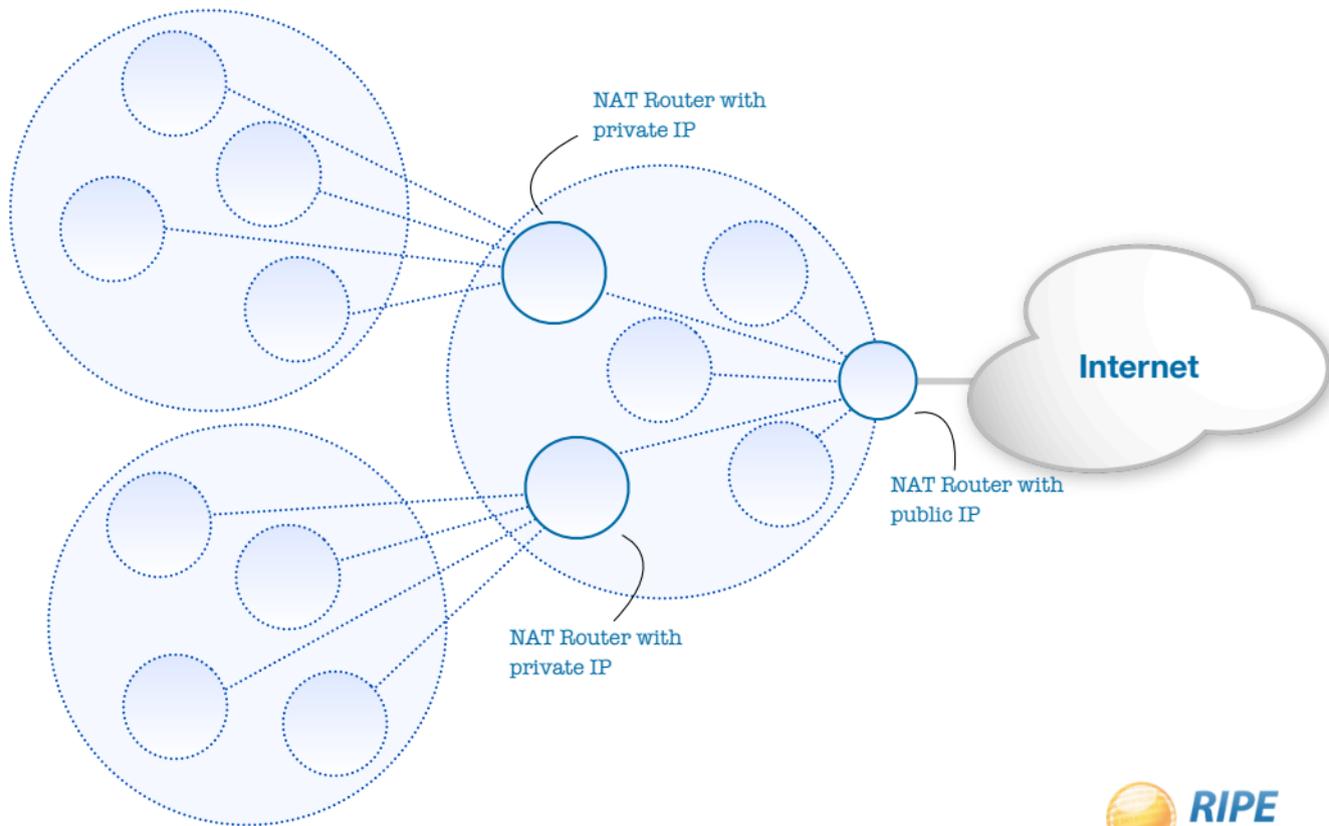
- Ensuring efficient use of historical IPv4 Resources (2008-07)
 - On hold for now because there is no proposer

- Allocations from the last /8 (2010-02)
 - New and existing LIRs can receive only one /22 allocation
 - only if they already have IPv6 space!

Network Address Translation = Bad



NAT behind NAT = Worse



IPv6 Basics

IPv6 Address Basics

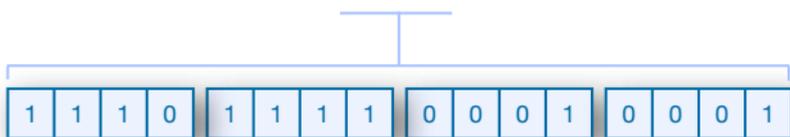
- IPv6 address: 128 bits
 - 32 bits in IPv4
- Every subnet should be a /64
- Customer assignments (sites) between:
 - /64 (1 subnet)
 - /48 (65,536 subnets)
- Minimum allocation size /32
 - 65,536 /48s
 - 16,777,216 /56s

Address Notation

2001:0610:003E:EF11:0000:0000:C100:004D

2001:0610:003E:EF11:0000:0000:C100:004D

2001:610:3E:EF11:0:0:C100:4D

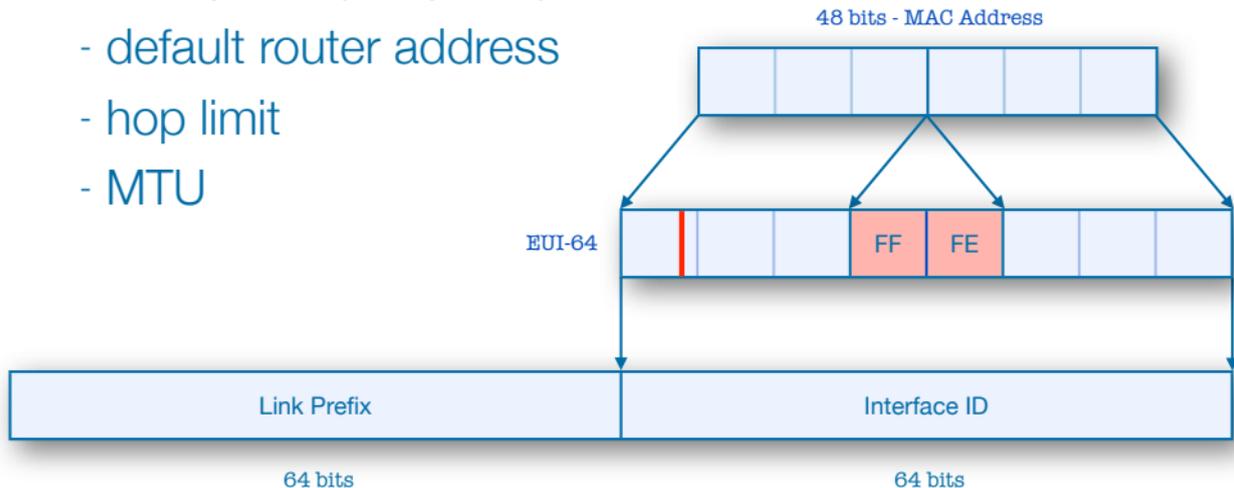


Multiple addresses

Addresses	Range	Scope
Loopback	::1	machine
Link Local	FE80::/10	link layer
Unique Local	FC00::/7	site
Global Unicast	2000::/3	global
6to4	2002::/16	global
Multicast	FF00::/8	variable

IPv6 Stateless Autoconfiguration

- Neighbor Discovery ICMPv6 messages
- host asks for network information:
 - IPv6 prefix (link prefix)
 - default router address
 - hop limit
 - MTU



IPv6 Stateful Autoconfiguration

- DHCPv6
 - used if no router is found
 - or if Router Advertisement Message enables use of DHCP
- With manual configuration subnet sizes other than /64 are possible

Training from scratch is needed?

- IPv4 skills translate well to IPv6 skills
- Concepts have not changed
 - more addresses
 - slightly different features in some parts
- Problems are more psychological than technical!

“96 More Bits, No Magic”

- Gaurab Upadhaya

Addressing Plan

Addressing Plan

- Things to consider
 - administrative ease!
 - use assignments on 4 bit boundary

Addressing Plans

- Number of hosts is irrelevant
- Multiple /48s 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
- /64 for all subnets
 - autoconfiguration works
 - renumbering easier
 - less typo errors because of simplicity

More On Addressing Plans

- For private networks, get ULA
- For servers you want manual config
- Use port numbers for addresses
 - pop server 2001:db8:1::110
 - dns server 2001:db8:1::53
 - etc...

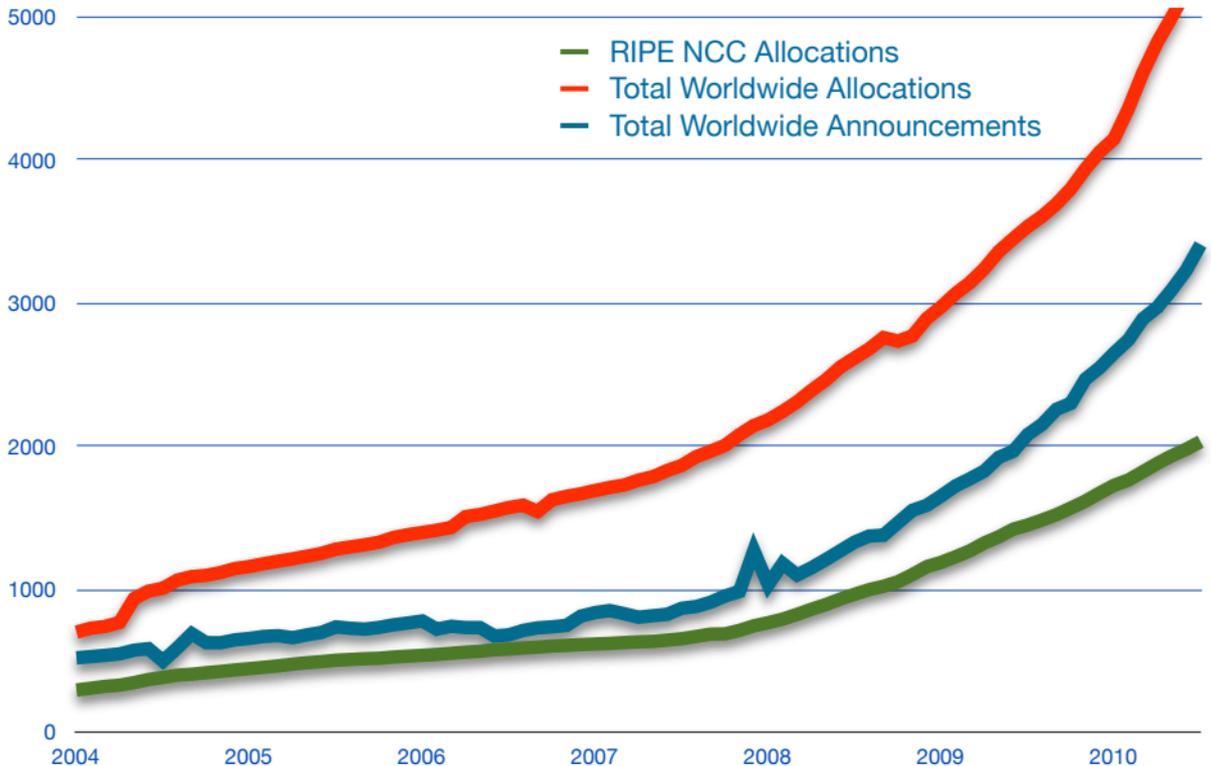
Getting it

Getting an IPv6 allocation

- To qualify, an organisation must:
 - Be an LIR
 - Have a plan for making assignments within two years

- Minimum allocation size /32

IPv6 Allocations and Announcements

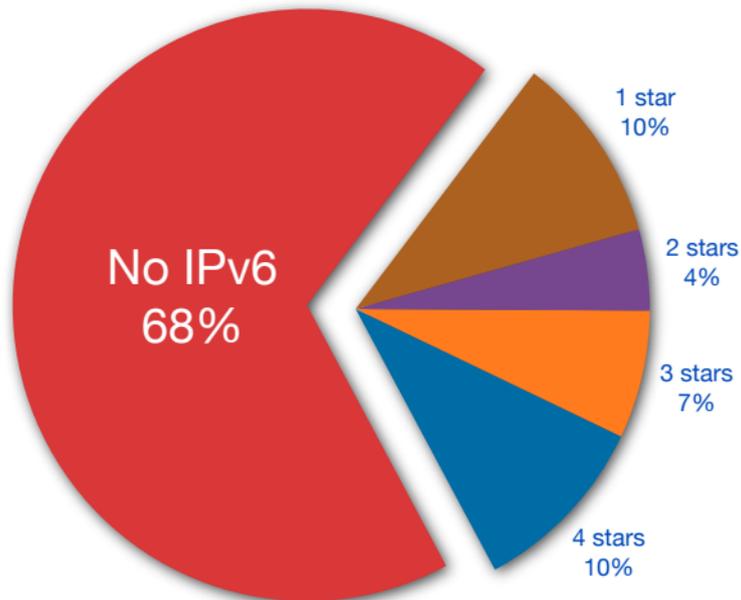


IPv6 Ripeness

- Rating system:
 - One star if the LIR has an IPv6 allocation
 - Additional stars if:
 - IPv6 Prefix is announced on router
 - A route6 object is in the RIPE Database
 - Reverse DNS is set up

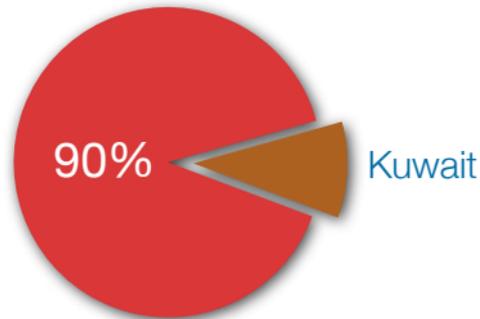
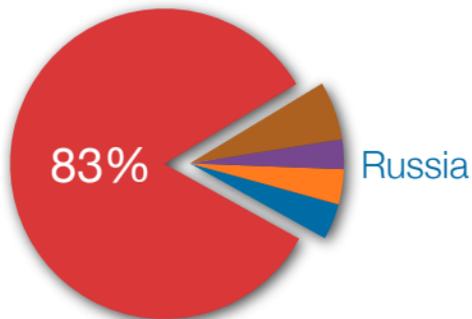
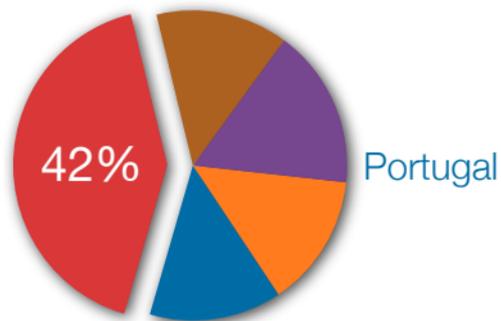
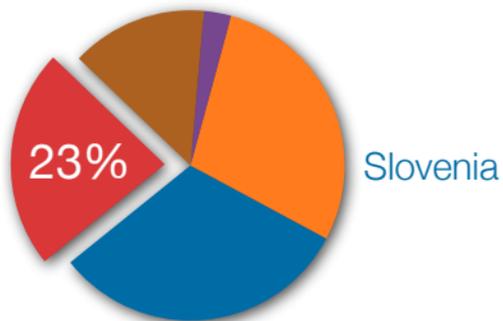
IPv6 RIPLEness – Total Membership

● 1 star ● 2 stars ● 3 stars ● 4 stars ● No IPv6



IPv6 RIPEness – Around The Region

● 1 star ● 2 stars ● 3 stars ● 4 stars ● No IPv6



Customer assignments

- Give your customers enough addresses
 - Up to a /48
- For more addresses, send in request form
 - Alternatively, make a sub-allocation
- Register sub-allocations in the RIPE DB
 - Put Assignments in a database accessible by the RIPE NCC

What does an IPv6 allocation cost?

- /32 = 1 scoring unit
- /31 = 2 scoring units
- points = $\sum (2010 - 1992) \times \text{scoring unit} = 18 \times 1 + \dots$



Category	Number of Scoring Units	Fee (€)
Extra Small	16	€ 1800
Small	- 936	€ 2550
Large	- 7116	€ 4100
Extra Large	> 7116	€ 5500

Getting IPv6 PI address space

- To qualify, an organisation must:
 - Demonstrate it will multihome
 - Meet the contractual requirements for provider independent resources
 - LIRs must demonstrate special routing requirements
- Minimum assignment size /48
- PI space can not be used for sub-assignments

DNS in IPv6 is difficult?

- DNS is not IP layer dependent
- A record for IPv4
- AAAA record for IPv6
- Don't answer based on incoming protocol
- Only challenges are for translations
 - NAT64, proxies

Reverse DNS

2001:610:3E:EF11::C100:4D

Reverse DNS

2001:0610:003E:EF11:0000:0000:C100:004D

.ip6.arpa

d.4.0.0.0.1.c.0.0.0.0.0.0.0.1.1.f.e.e.

3.0.0.0.1.6.0.1.0.0.2.ip6.arpa PTR

yourname.domain.tld

d.4.0.0.0.1.c.0.0.0.0.0.0.0.1.1.f.e.e.3.0.0.0.1.6.0.1.0.0.2.ip6.arpa PTR yourname.domain.tld

IPv6 in the Routing Registry

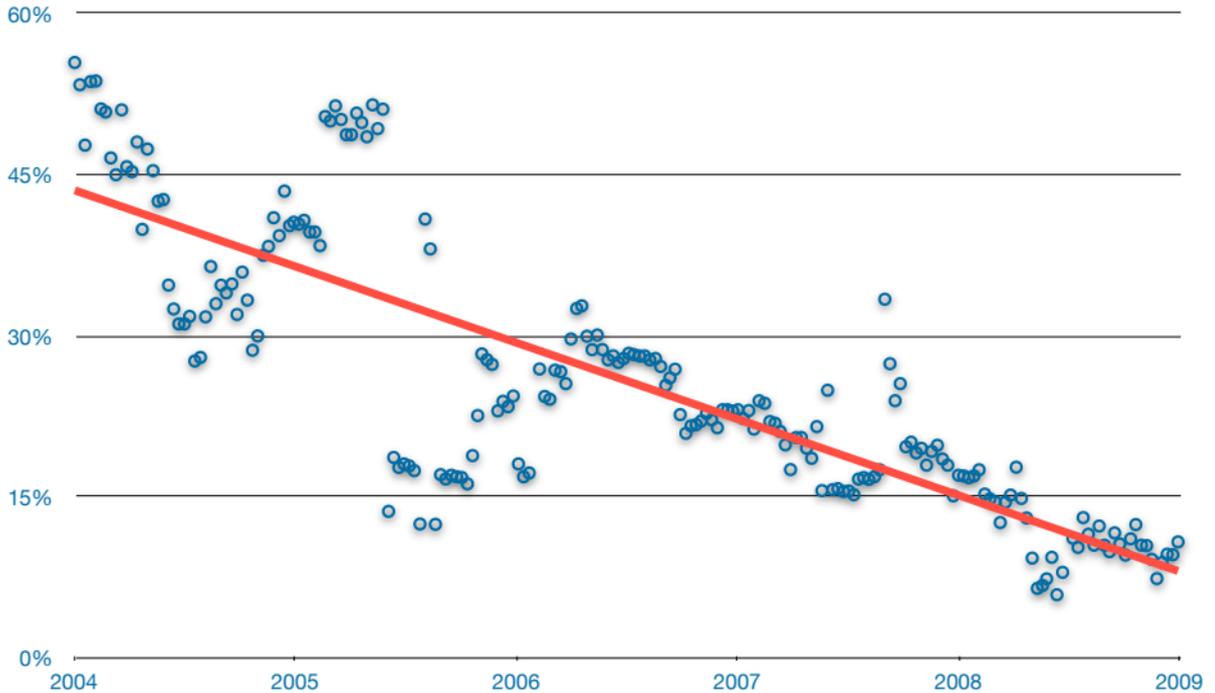
Route object:

```
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
```

IPv6 routing is tunnel hell?



Deploying

Scenario: Do Nothing

- No problems for next few years
- Some people won't be able to use your services
- No extra costs
 - until you hit the wall
- High costs for quick implementation
- Short planning times will mean some things go wrong

Scenario: Do It All Now!

- Hardware may have to be changed
- High investment in time and resources
- No direct return
- High costs for quick implementation
- Short planning times will mean some things go wrong

Scenario: Act Now, Phased Approach

- Change purchasing procedure (feature parity)
- Check your current hardware and software
- Plan every step and test
- One service at a time
 - face first
 - core
 - customers
- Prepare to be able to switch off IPv4

Change your face first

- Web
- Authoritative DNS
- Mail servers

- Outsiders see these services
- Multiple mature implementations exist

Don'ts

- Don't separate IPv6 features from IPv4
- Don't do everything in one go
- Don't appoint an IPv6 specialist
 - do you have an IPv4 specialist?
- Don't see IPv6 as a product
 - the Internet is the product

Do

- Phased approach
- Change requirements for new hardware
- Work outside-in, then inside-out
- Feature parity
- Dual stack
- Think about possible future renumbering

Business Case

- IPv4 is no longer equal to “the Internet”
- Avoiding the issue does not make it go away
- How much are you willing to spend now to save money later?
- Only IPv6 allows continued IP networking growth
- What do you want the Internet to be like in 5 years?

“IPv6, act now!”

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