

# IPv6 Tutorial

RIPE61, Rome

# RIPE NCC

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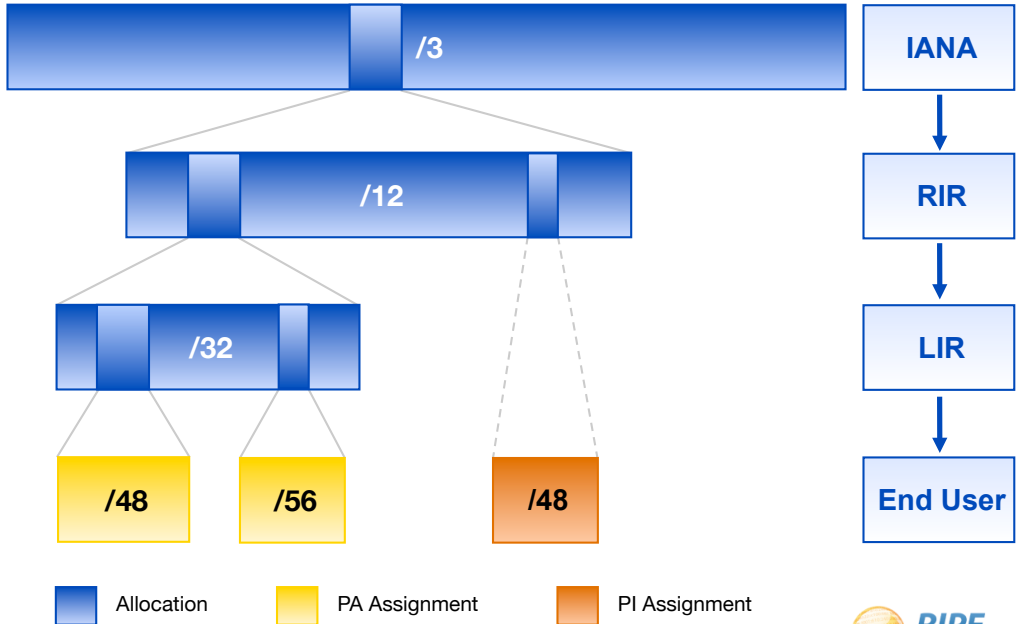
- One of the five Regional Internet Registries
- Support coordination of Internet operations
- Not for profit membership organisation
- Over 7000 active members
  - 650 new members in 2009
- Neutral, Impartial, Open, Transparent

# The 5 RIRs

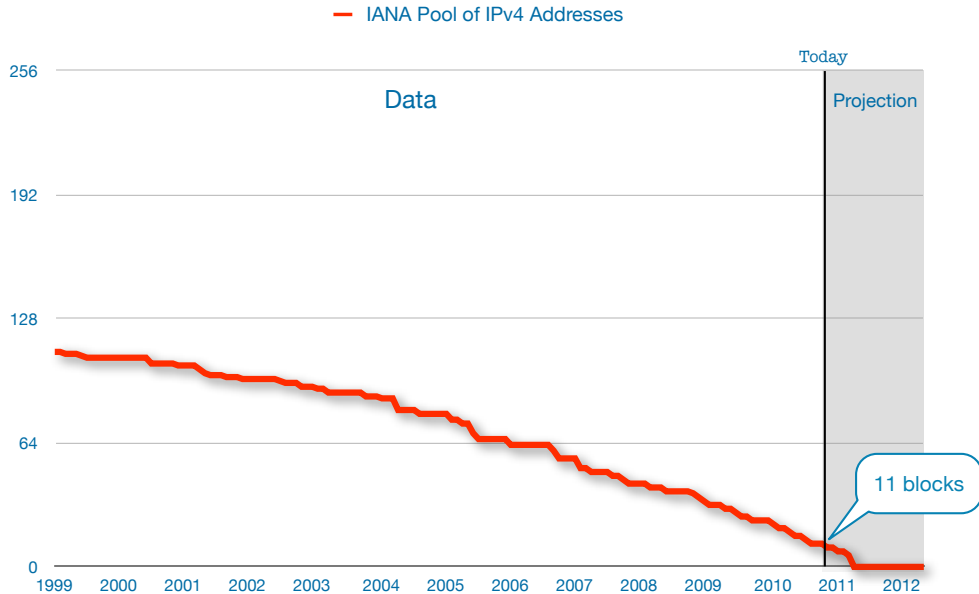
**ARIN**  
American Registry for Internet Numbers



# IP Address Distribution

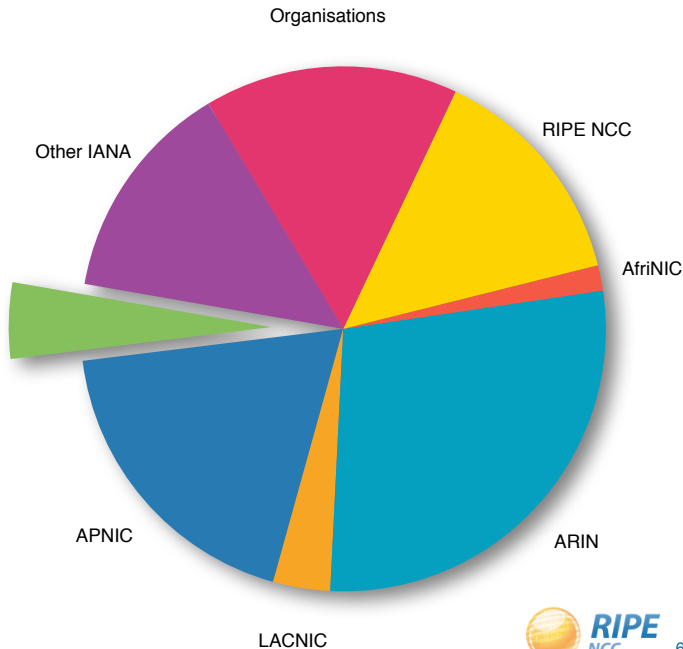


# IPv4 Allocation Timeline



# IPv4 Address Pool

4%  
available



# Reaching the next billion

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- 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

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

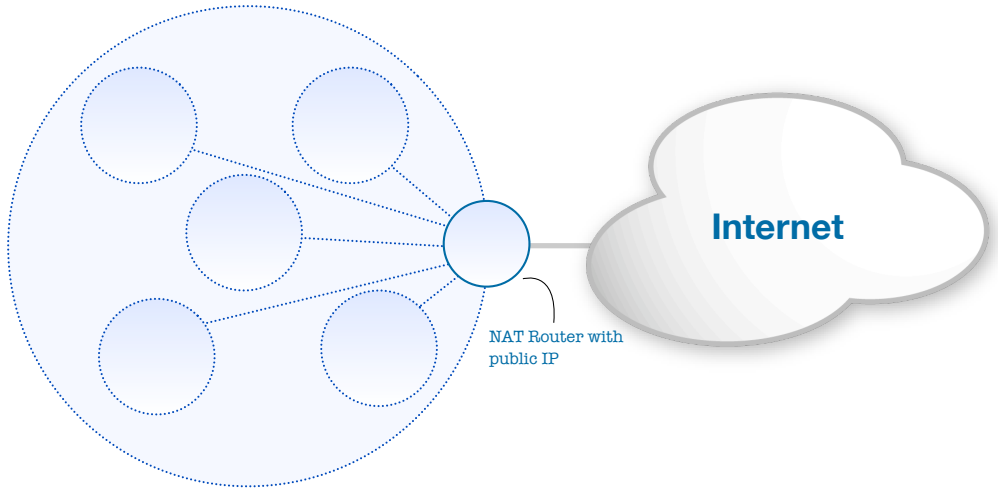
# Hot IPv4 / IPv6 Policy Topics

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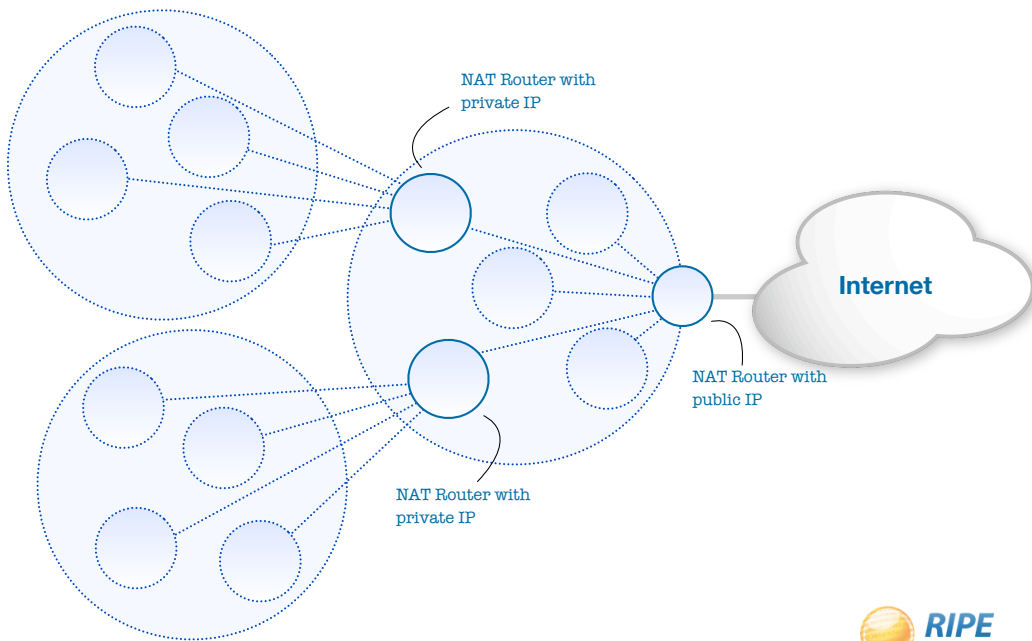
- Ensuring efficient use of historical IPv4 Resources (2008-07)
  - On hold for now because there is no proposer
- Allocations from the last /8 (2010-02)
  - New and existing LIRs can receive only one /22 allocation
  - only if they already have IPv6 space!

# Network Address Translation = Bad

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# NAT behind NAT = Worse



# IPv6 Basics

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# IPv6 Address Basics

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- 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

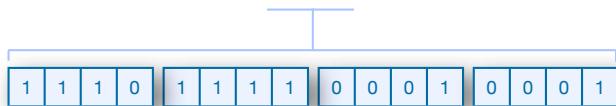
# Address Notation

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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

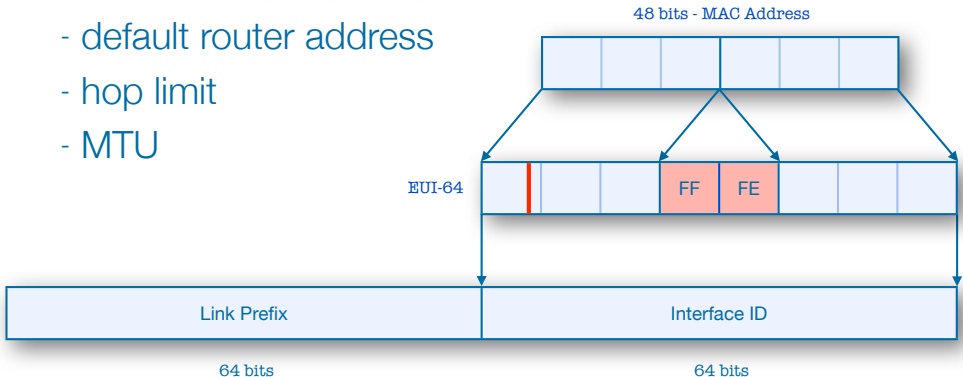
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Addresses	Range	Scope
Loopback	::1	machine
Link Local	FE80::/10	link layer
Unique Local	FC00::/7	site
Global Unicast	2000::/3	global
6to4	2002::/16	global
Multicast	FF00::/8	variable



# 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

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- 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?

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- 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

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# Addressing Plan

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

# Addressing Plans

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- 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

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- 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

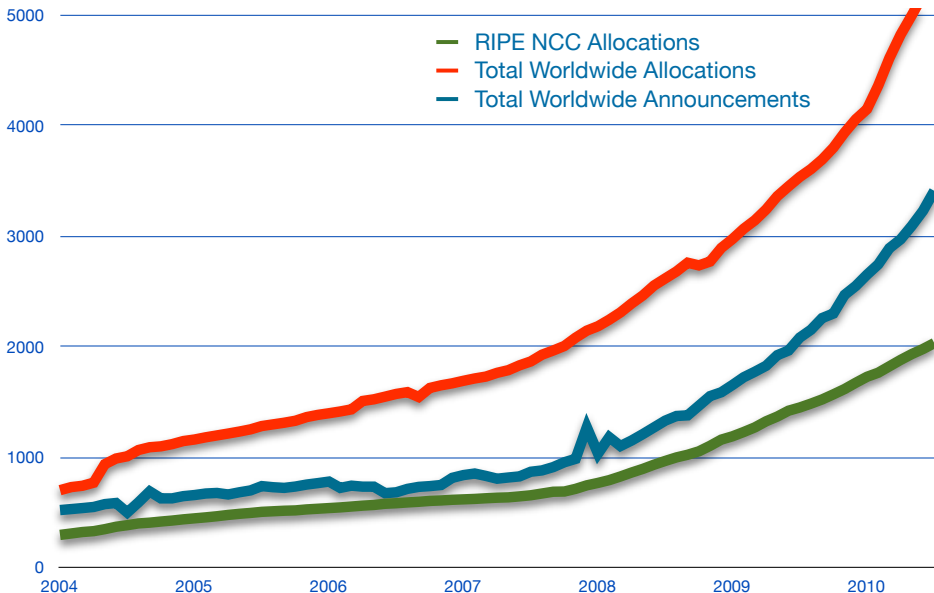
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# Getting an IPv6 allocation

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- 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



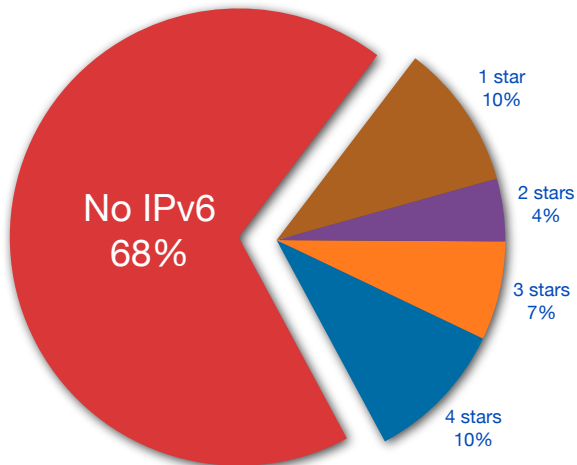
# IPv6 Ripeness

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- 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

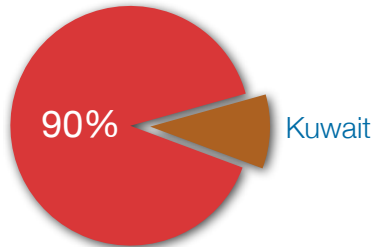
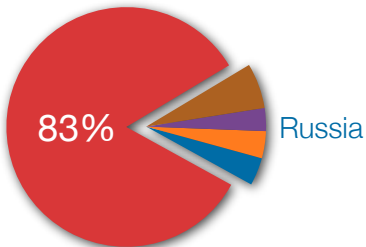
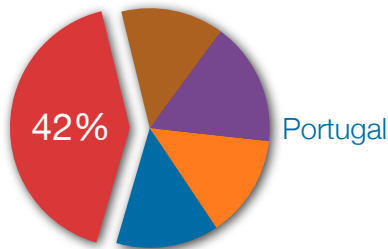
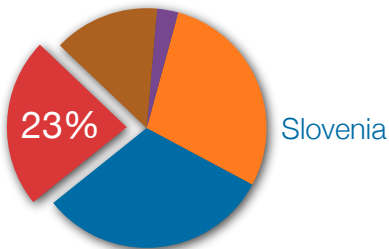
# IPv6 RIPEness – Total Membership

● 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

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- 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	Free IPv6	Fee (€)
Extra Small	< 16	-
Small	16 - 936	€ 1800
Medium	936 - 7116	€ 2550
Large	> 7116	€ 4100
Extra Large	> 7116	€ 5500



# Getting IPv6 PI address space

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- 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?

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- 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

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

# Reverse DNS

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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

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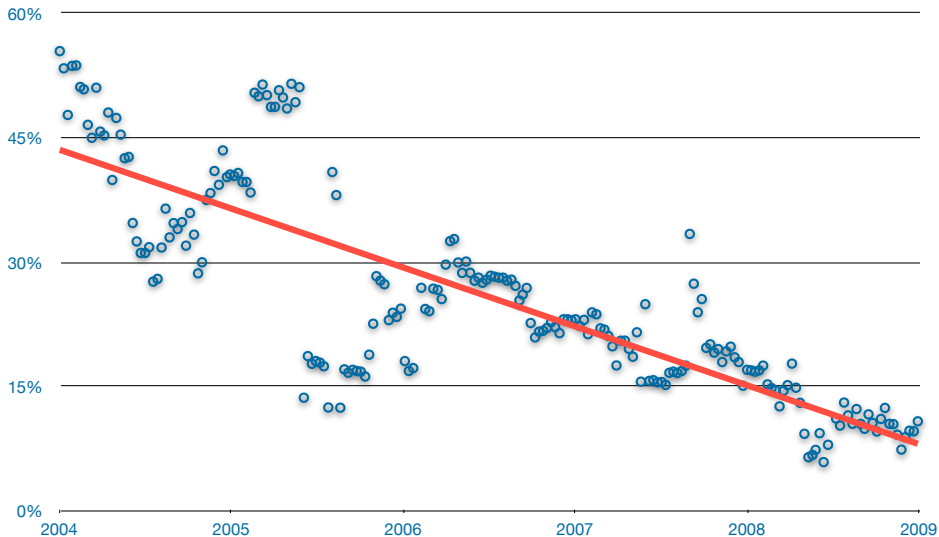
## Route object:

```
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

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## Scenario: Do Nothing

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- 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!

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- 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

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- 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

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- Web
- Authoritative DNS
- Mail servers
  
- Outsiders see these services
- Multiple mature implementations exist

# Don'ts

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- 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

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

# Business Case

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- 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!”*

# Follow us!

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@TrainingRIPENCC

The End!

Край

Y Diwedd

النهاية

Соңы

Կէրջ

Fí

Finis

Ende

Finvezh

Liðugt

Кінець

Konec

Kraj

Ěnn

Fund

پایان

Lõpp

Beigas

Vége

Son

Kraj

An Críoch

הסוף

Fine

Endir

Sfârșit

Fin

Τέλος

Einde

Конец

Slut

Slutt

დასასრული

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Loppu

Tmiem

Koniec