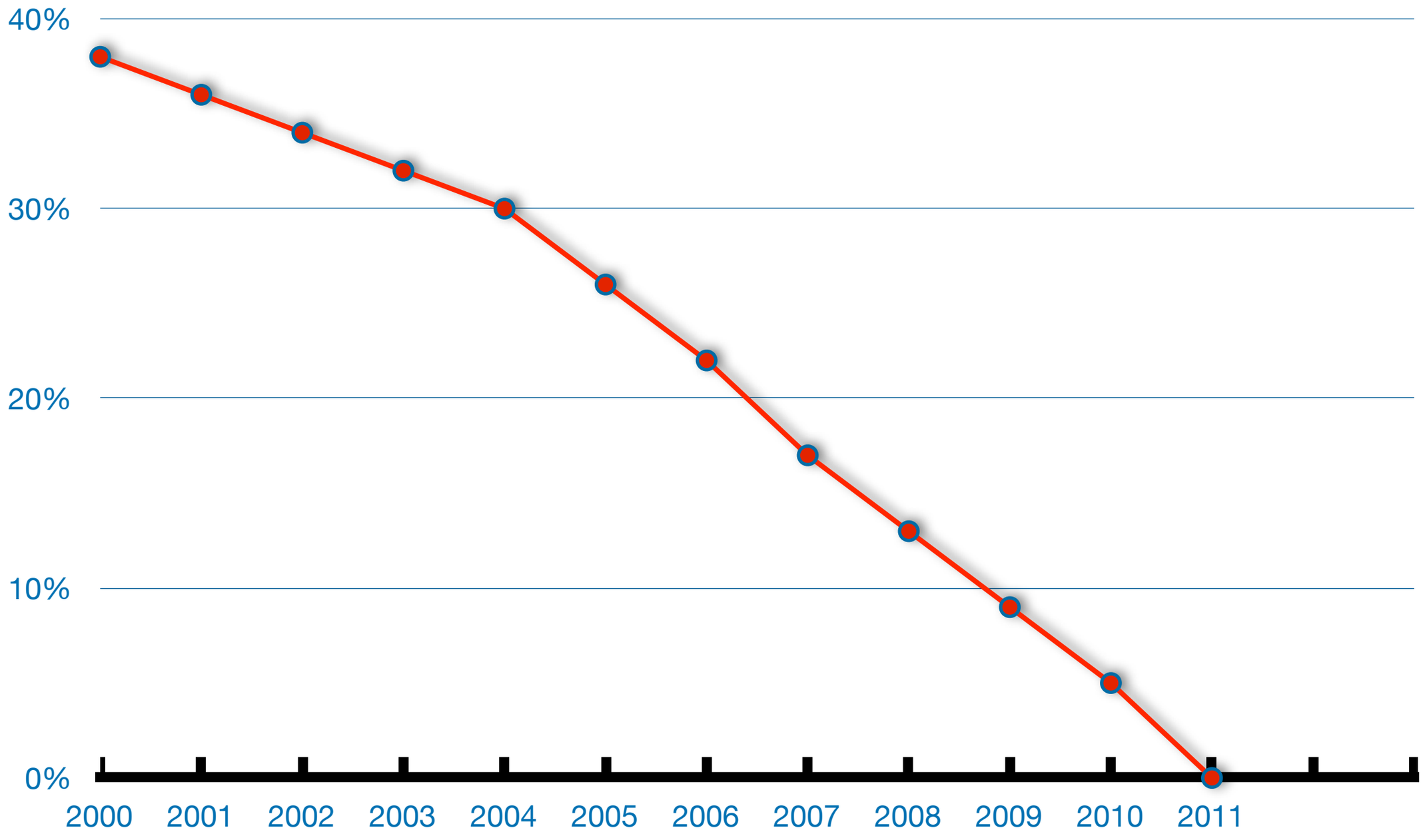
# Tutorial: IPv6 Basics

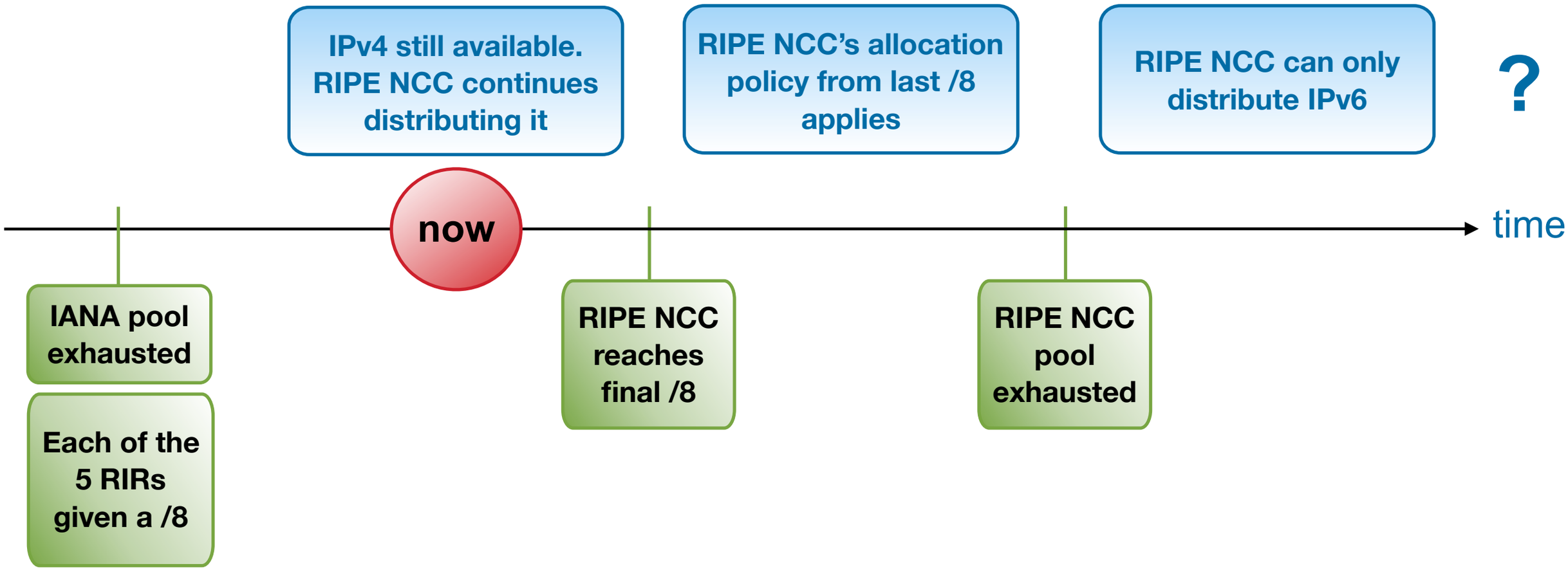
Marco Hogewoning
RIPE NCC Trainer

ENOG3, May 2012

# IANA IPv4 Pool



# IPv4 Exhaustion Phases



# “Run Out Fairly”

- Gradually reduced the allocation and assignment period from the original 24 months to:
  - January 2010: 12 months
  - July 2010: 9 months
  - January 2011: 6 months
  - **July 2011: 3 months**

- 50% has to be in use at half the 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

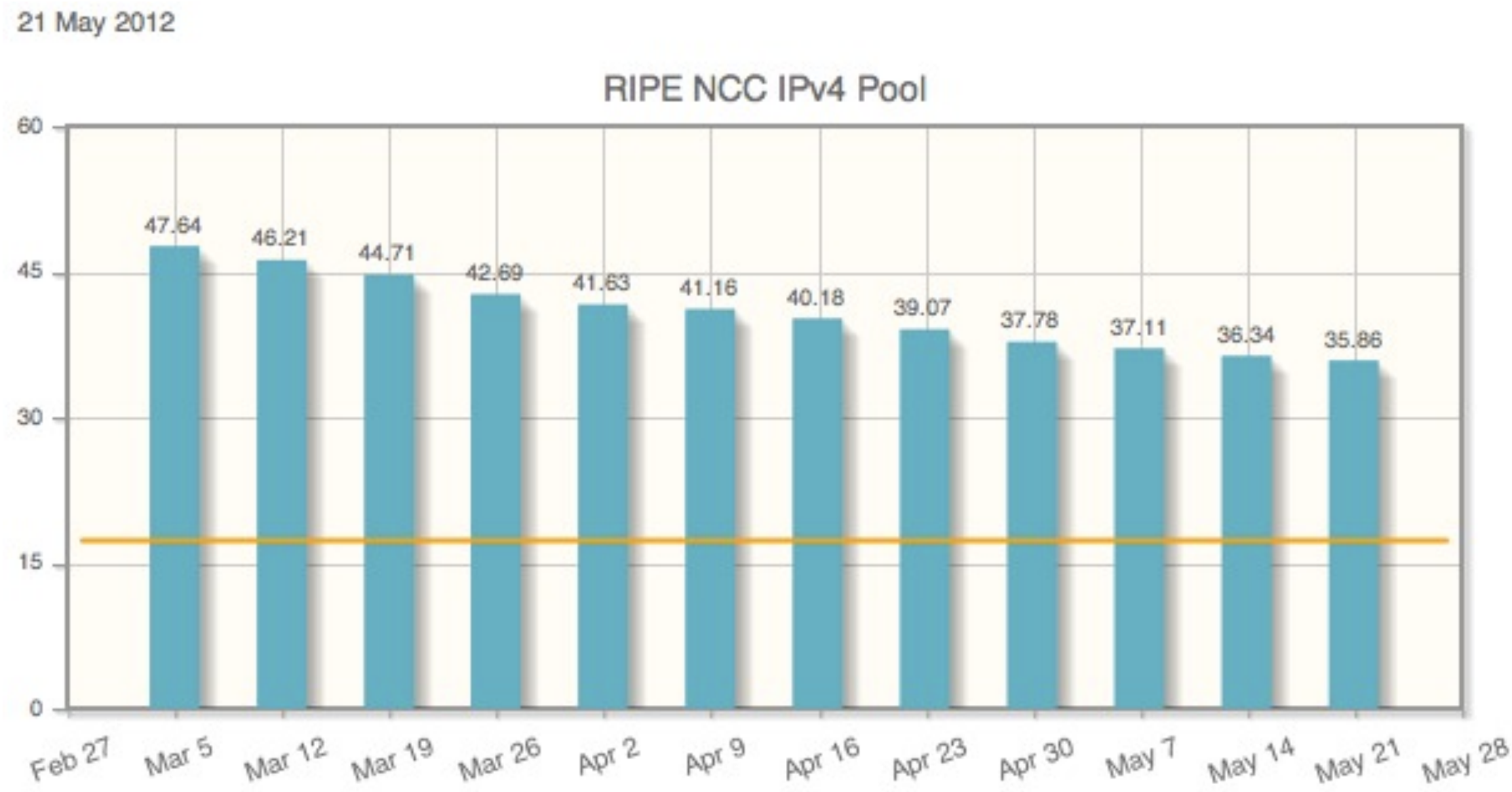
- Current policy does not allow for PI assignments
  - Policy proposal 2012-04 under discussion
  - Intends to allow for PI assignments

# 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



# Sustaining Growth

- IPv4 will not be able to sustain the growth of the Internet:
  - More people online every year
  - Multiple devices per person
  - The Internet of Things

- The world needs an alternative

# IPv6

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# 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)

# IPv6 Addresses

- Addresses are written down using hexadecimal:
  - 0 1 2 3 4 5 6 7 8 9 a b c d e f
- Grouped in 8 blocks of 4 digits
- Separated by colons

**2001:0db8:3042:0002:5a55:caff:fef6:bdbf**

# IPv6 Address Notation

- Addresses can be shortened
  - Leading zeroes can be removed
  - Multiple sequences of “0000” can be removed, replacing them with a double colon “::”

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2001:db8:0:0:5a55:302:fef6:12

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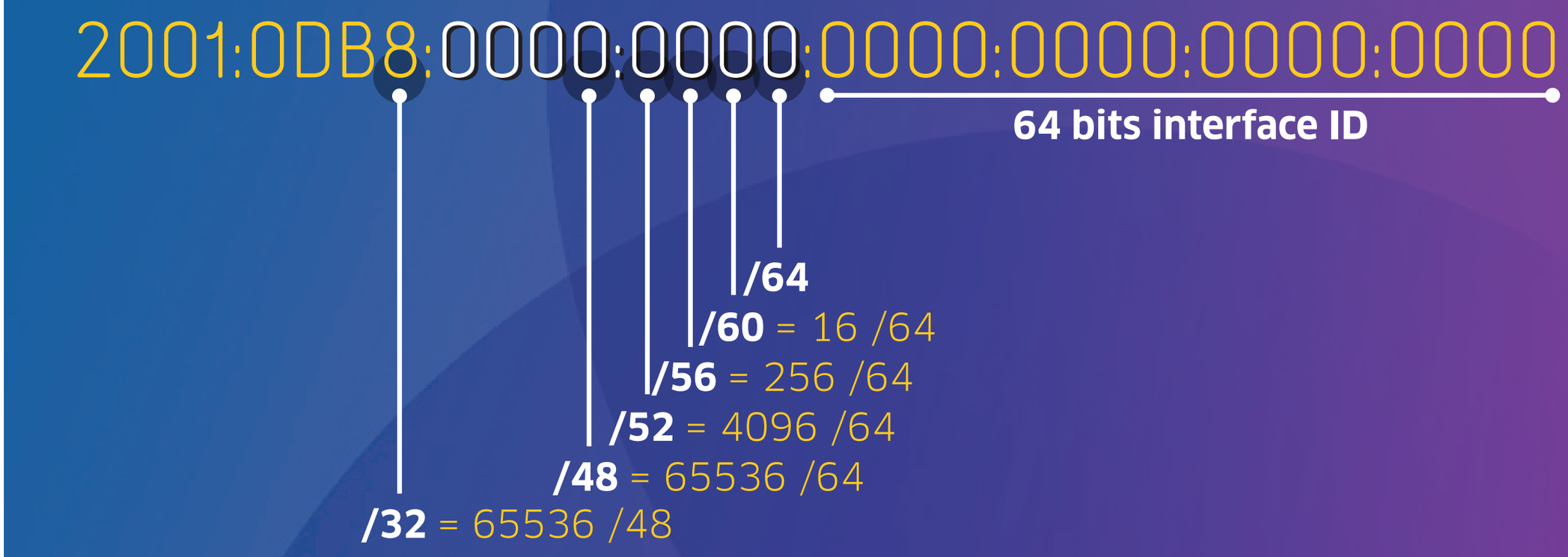
2001:db8:0:0:5a55:302:fef6:12

2001:db8::5a55:302:fef6:12

# 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

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# Getting IPv6 Addresses

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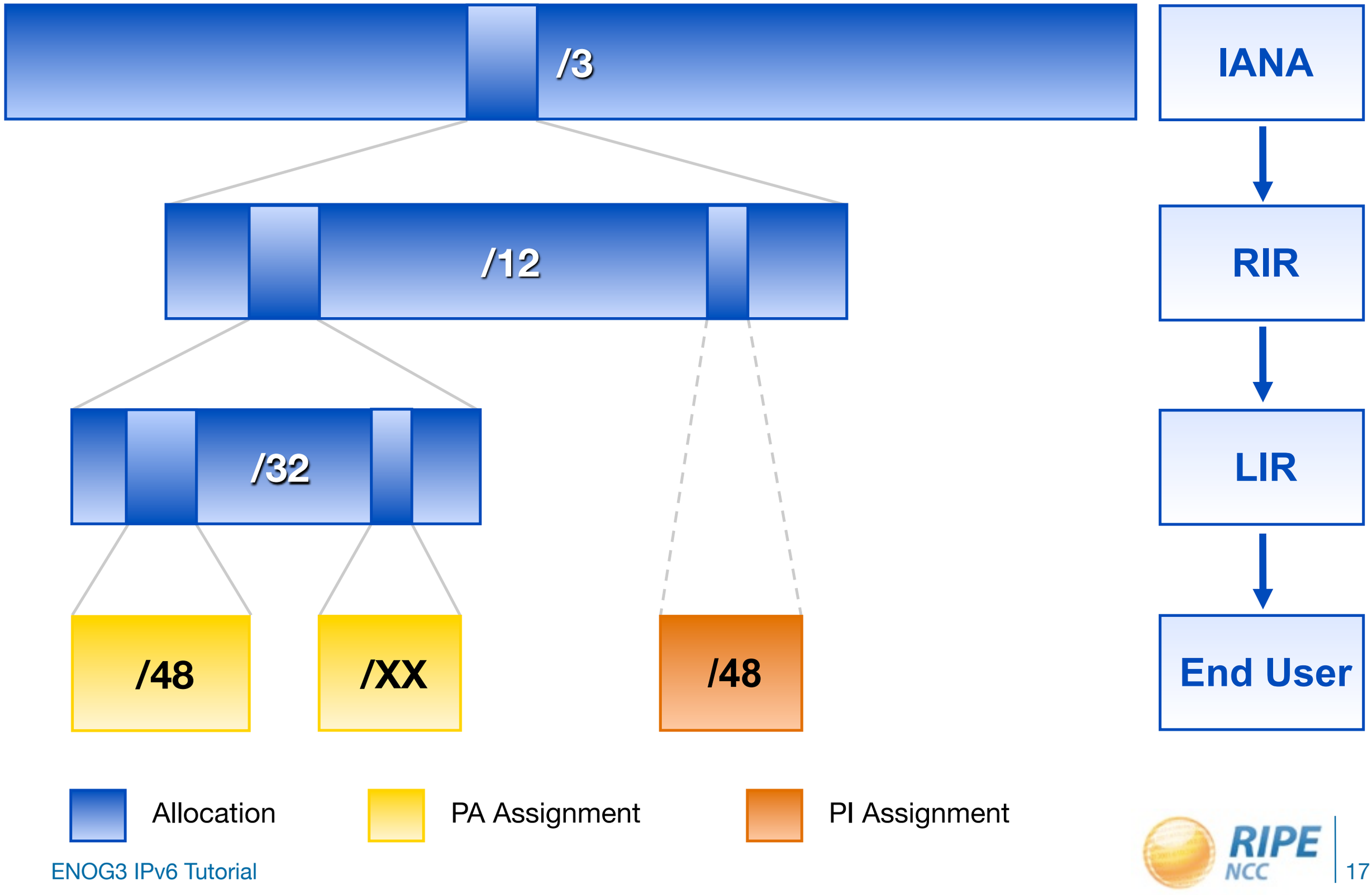
# IPv6 Address Distribution



# Provider Aggregatable IPv6

- To receive an IPv6 Allocation
  - Be a member of the RIPE NCC
  - Have a plan to deploy IPv6
- Minimum allocation size is /32
  - More if you can prove you have the customers

# 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 addresses also possible 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

# 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”

# Grouping Assignments

| | |
|---|---|
| inet6num: | 2001:db8:1000::/36 |
| netname: | My-ASSIGNMENTS |
| descr: | Represents multiple customers |
| descr: | Colocation services |
| country: | NL |
| admin-c: | BN649-RIPE |
| tech-c: | BN649-RIPE |
| **status:** | **AGGREGATED-BY-LIR** |
| **assignment-size:** | **48** |
| mnt-by: | ISP-MNT |
| notify: | noc@example.net |
| changed: | noc@example.net 20110218 |
| source: | RIPE |

# Creating an Addressing Plan

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# Aggregation vs Conservation

- In IPv4 you can only get the addresses you need
  - Number of machines is what counts
  - Multiple small assignments are common
  - Administrative ease is not allowed

- IPv6 takes a different approach
  - Number of machines is no longer important
  - Aggregation gets a much bigger role

# Count the Number of Subnets

- Every subnet has to be a /64
  - Number of hosts becomes irrelevant (2^64)

- Keep some room for growth
  - We can’t predict the future
  - A single subnet probably is not enough
  - You can assign up to a /48 if needed

# 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

# 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

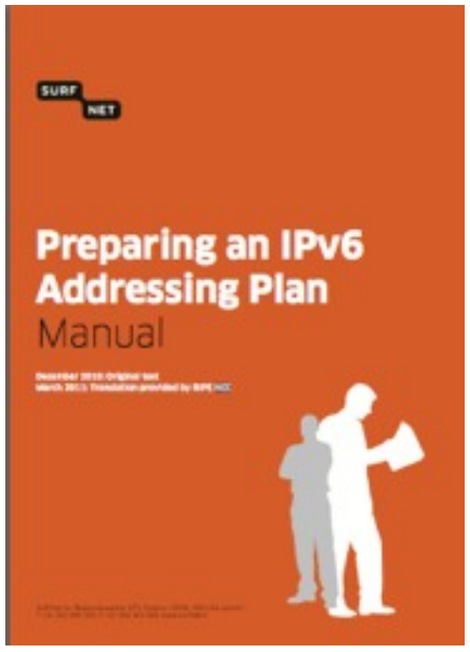
# “Smart” Addresses Example

- 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)

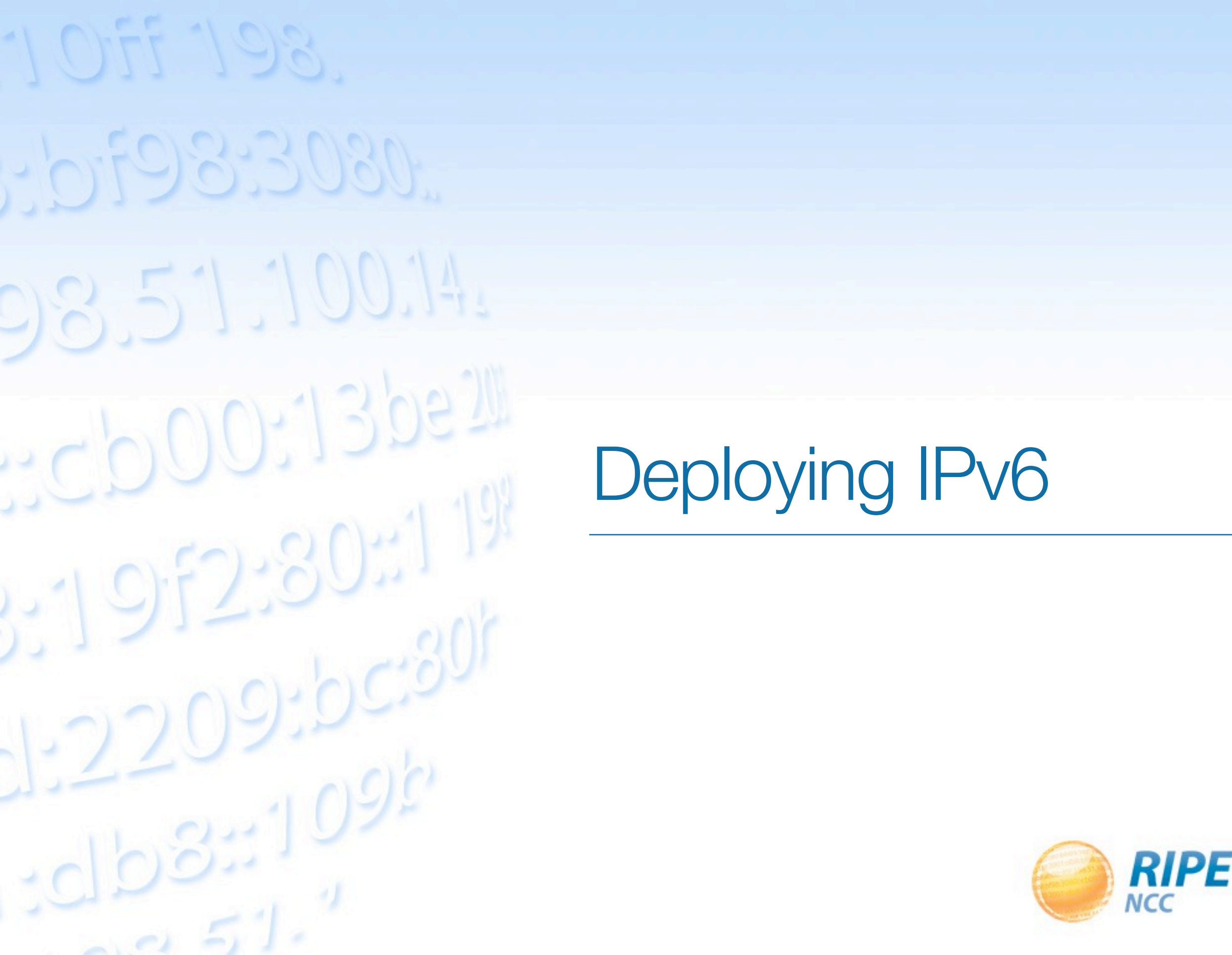
# Need Help Making a Plan?

- Surfnet, the Dutch NREN, prepared a document
  - How to divide your /48 on a site?
- Available in English on our website




https://www.ripe.net/lir-services/training/material/IPv6-for-LIRs-Training-Course/IPv6_addr_plan4.pdf

# Deploying IPv6



# Deploying IPv6

- IPv4 and IPv6 are not compatible by design
  - Allows to deploy IPv6 without breaking things
- To communicate freely a computer needs both an IPv4 and IPv6 address
  - This is known as “Dual Stack”
- It is all about adding IPv6 to your network
  - IPv4 will remain as well for now

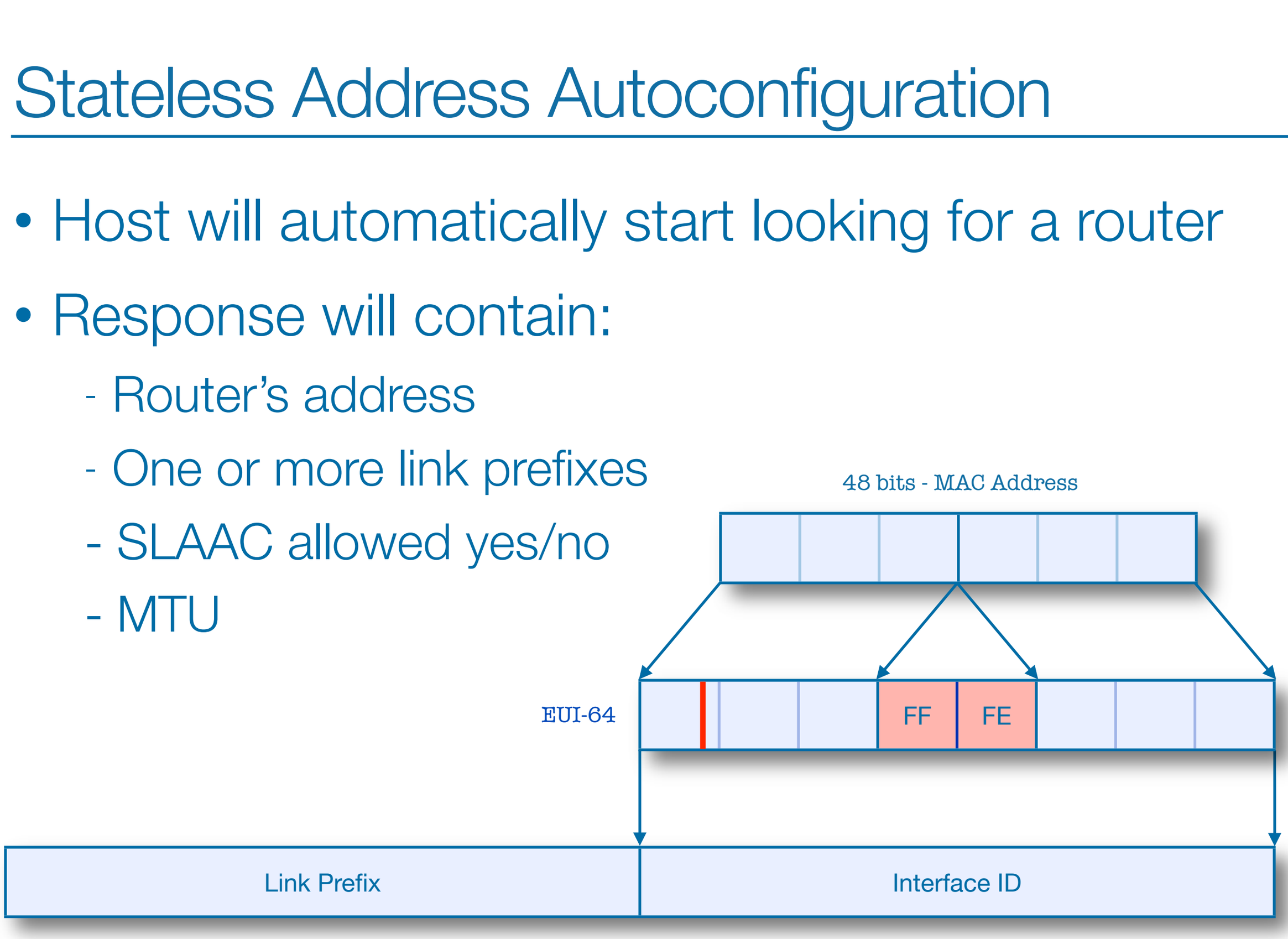
# IPv6 on the LAN

- Configuration can happen automatically:
  - Discovering your default gateway
  - Assigning yourself an address
  - Get a DNS resolver address

- All based on ICMPv6
  - Uses multicast

# Stateless Address Autoconfiguration

- Host will automatically start looking for a router
- Response will contain:
  - Router's address
  - One or more link prefixes
  - SLAAC allowed yes/no
  - MTU



# DHCPv6

- You can use DHCPv6 to get additional info
  - DNS Resolver addresses

- Alternatively you can also use it to handout IPv6 addresses:
  - Controlled by the network operator
  - Switch of SLAAC in the router advertisements

# Privacy Concerns

- SLAAC uses a modified mac address
- Makes it possible to trace a device
- Can be a security risk as well

- RFC 4941 “Privacy Extensions”:
  - Use random 64 bit number for the host part
  - Change the number regularly

# Security Considerations

- Everybody can claim to be a router
  - Use RA Guard to filter unauthorised RAs (RFC 6105)
  - SEND under development as alternative (RFC 3971)
- Leaking route advertisements
  - Cisco switches on RA by default
  - Windows, OS X and others will default accept
  - A machine can easily get IPv6 unnoticed

# DNS

- Works the same as IPv4
  - AAAA record for IPv6 addresses
- Host can request both A and AAAA records
  - When Dual Stacked (IPv4 and IPv6)
  - Use the one that performs best
- Always advertise both IPv4 and IPv6
  - Do not make a decision based on who asks

# Reverse DNS

- RIPE NCC delegates on allocation or assignment
- Example prefix 2001:db8::/32

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8.b.d.0.1.0.0.2.ip6.arpa

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8.b.d.0.1.0.0.2.ip6.arpa

2001:db8:3042:2:5a55:caff:fef6:bdbf

f.b.d.b.6.f.e.f.f.f.a.c.5.5.a.5.2.0.0.0.2.4.0.3.8.b.d.0.1.0.0.2 PTR host.example.org

# IPv6 Domain Object

```
domain:         4.6.0.0.c.7.6.0.1.0.0.0.2.ip6.arpa
descr:          RIPE Meetings
admin-c:        JDR-RIPE
tech-c:         OPS4-RIPE
zone-c:         OPS4-RIPE
nserver:        server.ripemtg.ripe.net
nserver:        sec1.authdns.ripe.net
mnt-by:         RIPE-NCC-MNT
mnt-lower:      RIPE-NCC-MNT
changed:        bit-bucket@ripe.net 20091002
source:         RIPE
```

# Making the Plan

# Make Sure You Have a Plan

- In the near future you need IPv6
- Take a phased approach:
  - Make an inventory of what you need
  - When purchasing add demand for IPv6 support
  - Identify which elements need replacing
  - Plan every step and test it before deploying
- No longer depend on IPv4 alone

# Business Case

- The Internet is no longer equal to IPv4
  - Make sure there is feature parity
- Don’t make IPv6 a product
  - It is Internet connectivity you are selling
- Spent money now to save it later

# IPv6 Act Now!

(but take it slowly)

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# 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-501Document

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

- Originated in the Slovenian Government
  - Adopted by various others (Germany, Sweden)
- Will be updated soon now

# 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

# Other Sources

- RIPE IPv6 Working Group
  - http://www.ripe.net/ripe/groups/wg/ipv6
- Cluenet mailing list
  - http://lists.cluenet.de/mailman/listinfo/ipv6-ops
- ARIN IPv6 Wiki
  - http://www.getipv6.info/index.php
- ENOG mailing list
  - http://www.enog.org/mailing-list/

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# Questions?