



**RIPE NCC**  
RIPE NETWORK COORDINATION CENTRE

# Introduction to IPv6

Webinar

RIPE NCC Learning & Development



**This session is being recorded**

# Take two polls!

Tell us about yourself!





# Overview

## IPv6 Address Basics

**Exercise:** Address Notation

**Q&A**

**Getting it**

**Q&A**

**Exercise:** Making Assignments

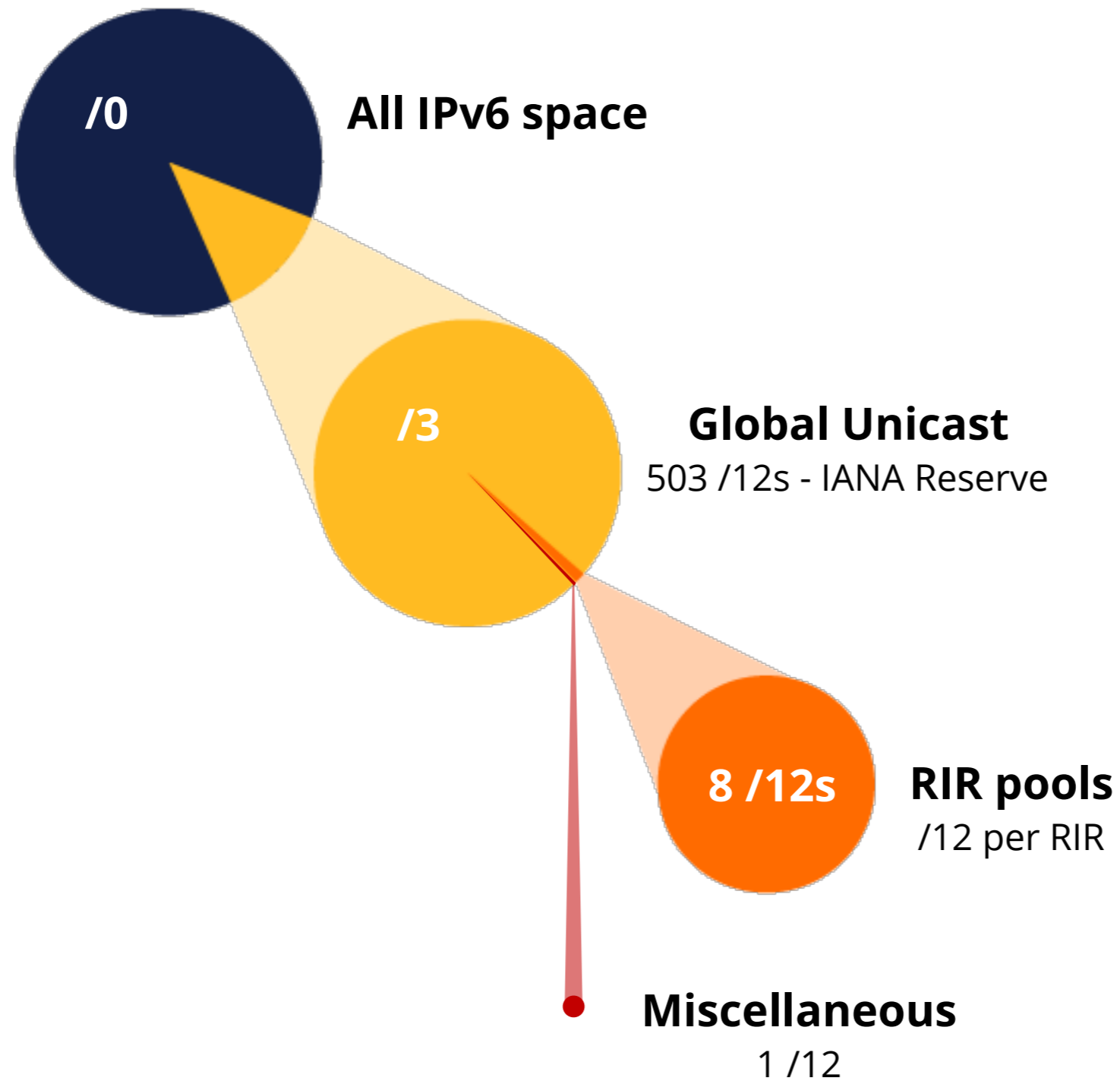
**Q&A**

**Key Takeaways and Tips**



# IPv6 Address Basics

# IP Address Distribution



# RIR Pools



**October 2006**

<b>RIR</b>	<b>IPv6 Range</b>
<b>AFRINIC</b>	2C00:0000::/12
<b>APNIC</b>	2400:0000::/12
<b>ARIN</b>	2600:0000::/12
<b>LACNIC</b>	2800:0000::/12
<b>RIPE NCC</b>	2A00:0000::/12

**June 2019**

<b>RIPE NCC</b>	2A10:0000::/12
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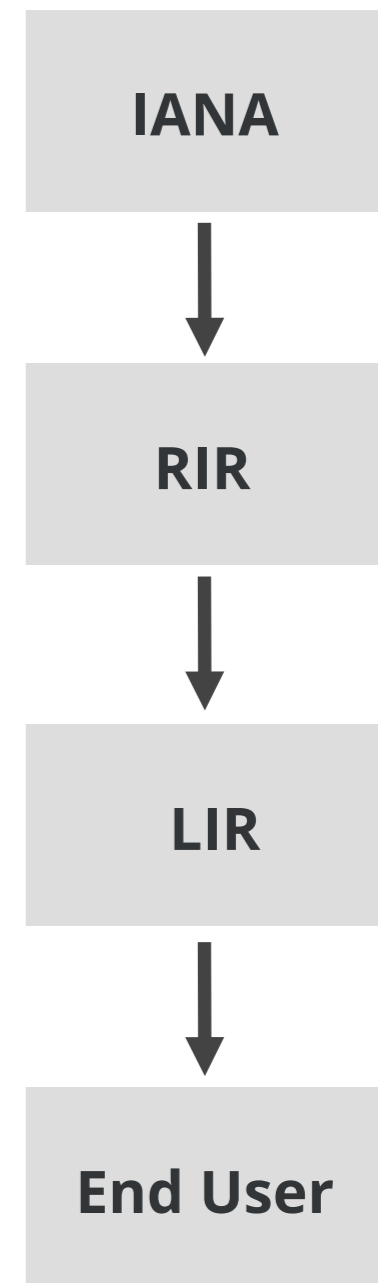
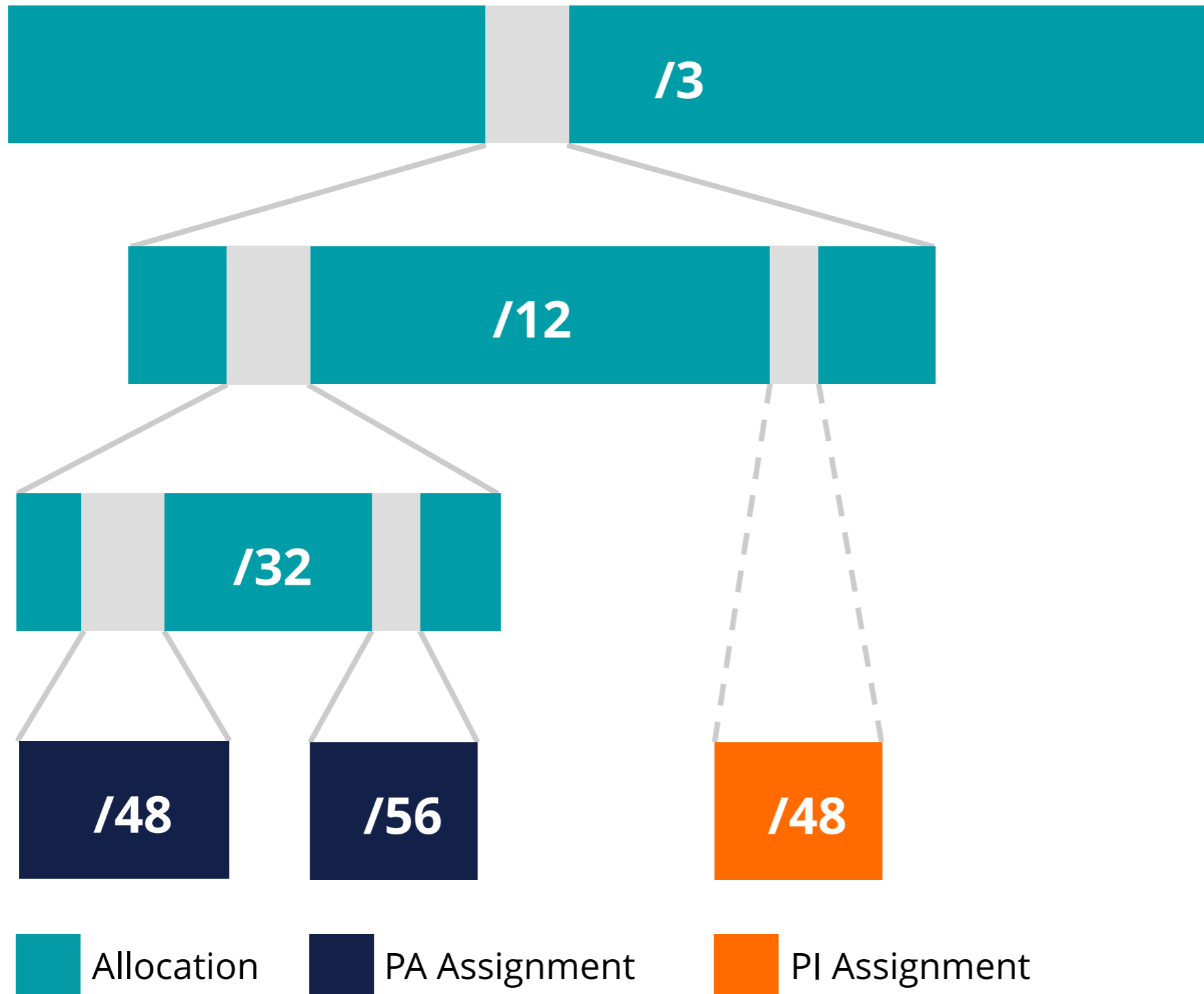
**November 2019**

<b>ARIN</b>	2630:0000::/12
-------------	----------------

**November 2024**

<b>APNIC</b>	2410:0000::/12
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# IP Address Distribution







# 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

# Multiple address types



Addresses	Range	Scope
Unspecified	::/128	n/a
Loopback	::1	host
IPv4-Embedded	64:ff9b::/96	n/a
Discard-Only	100::/64	n/a
Link Local	fe80::/10	link
<b>Global Unicast</b>	<b>2000::/3</b>	<b>global</b>
Unique Local	fc00::/7	global
Multicast	ff00::/8	variable

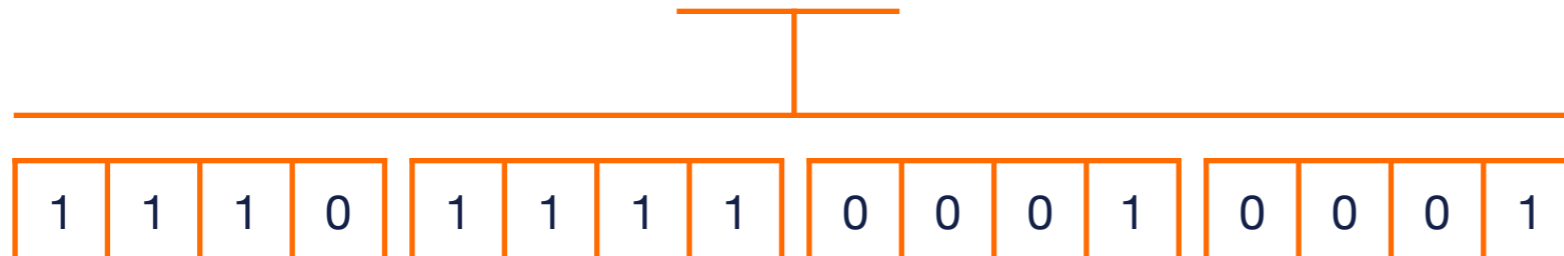
# Address Notation



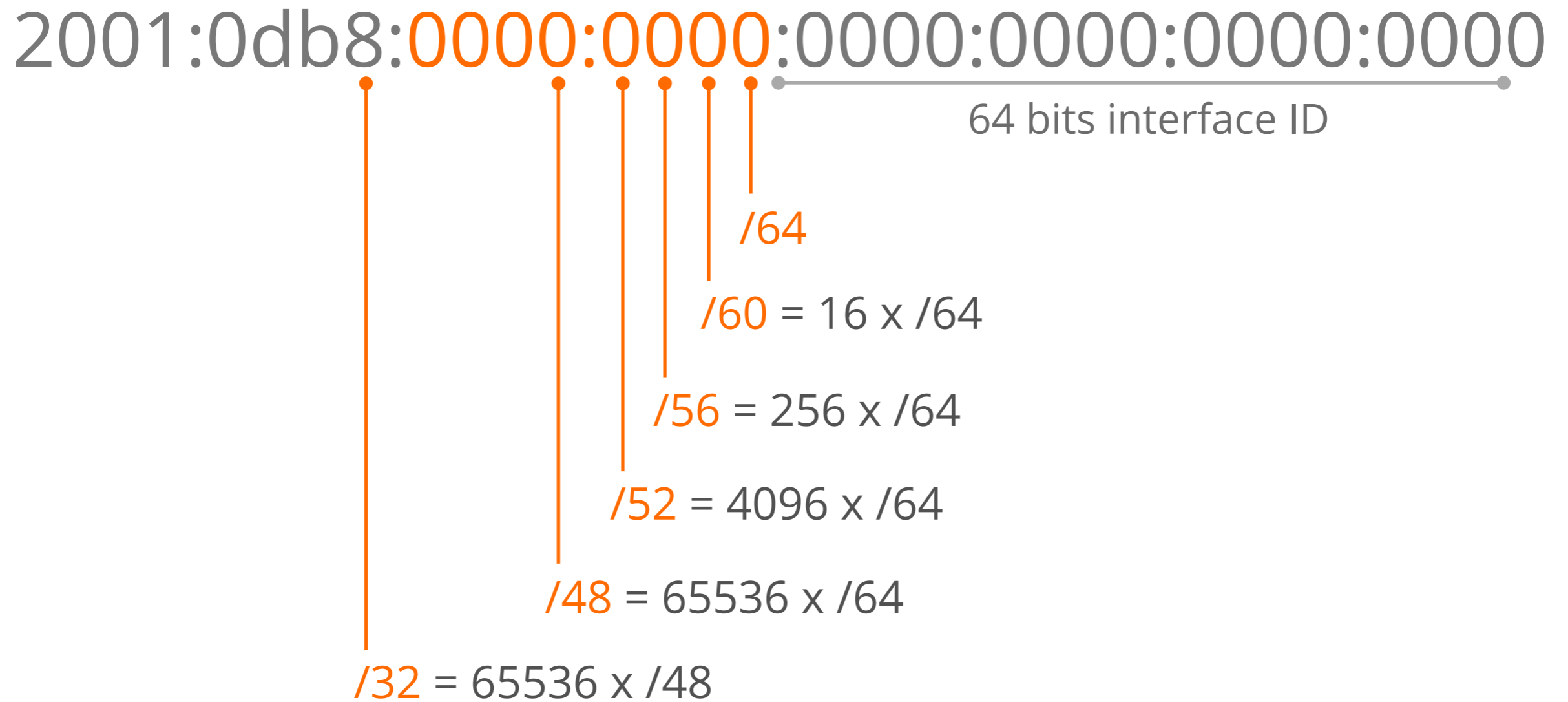
2001:0db8:003e:ef11:0000:0000:c100:004d

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

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



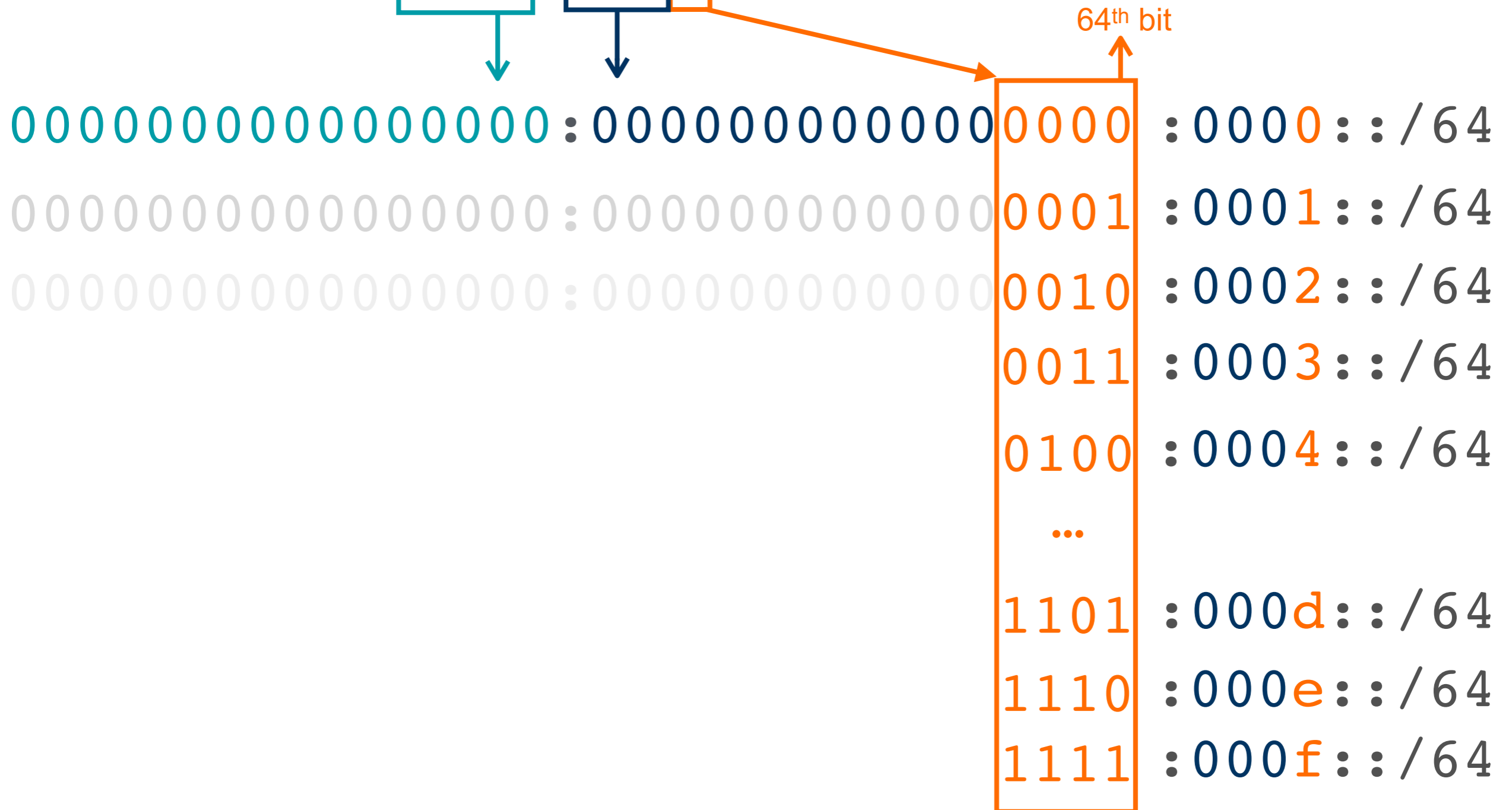
# IPv6 Subnetting



# IPv6 Subnetting - /64 subnets



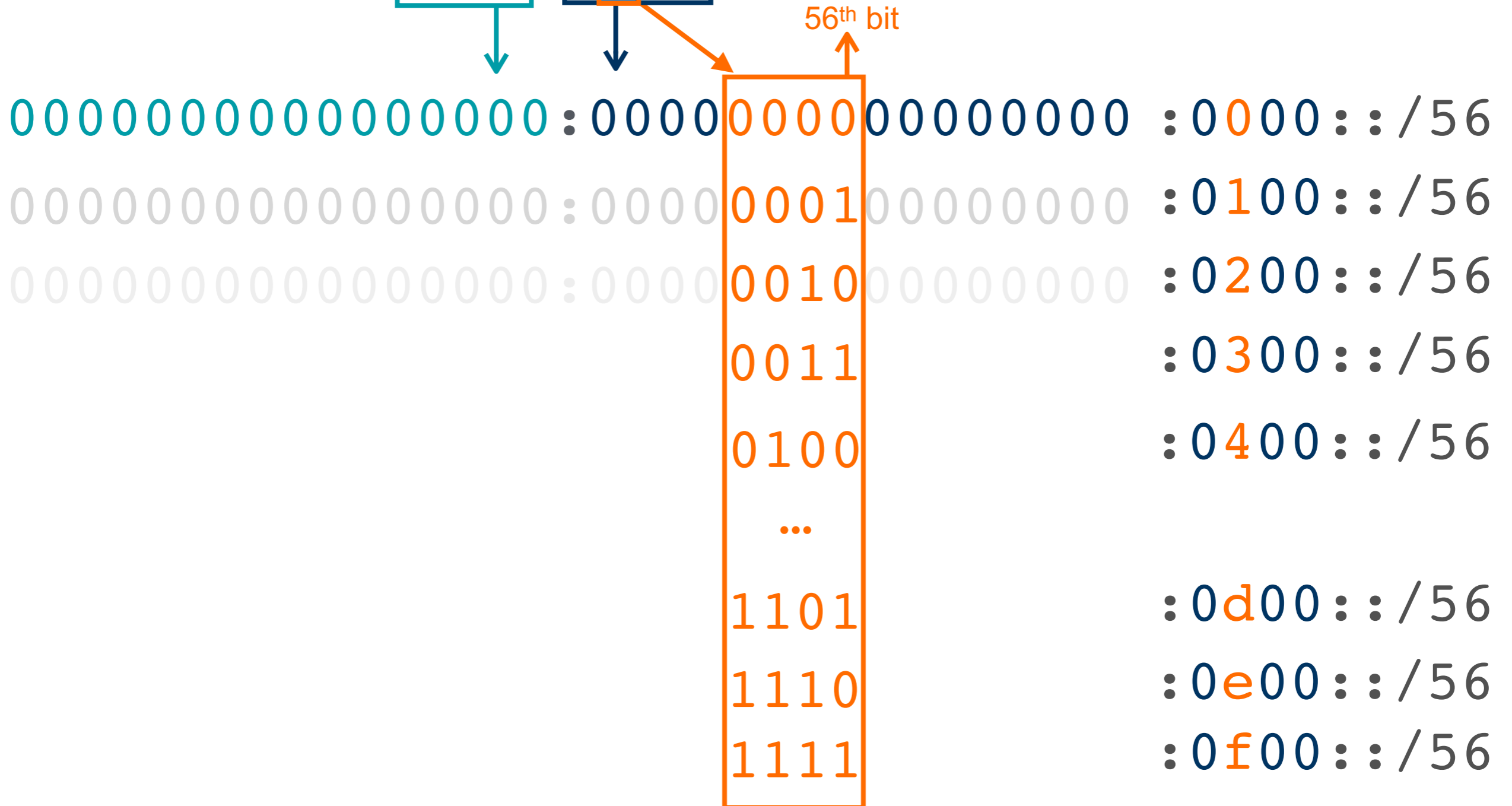
2001:0db8:0000:0000::/32



# IPv6 Subnetting - /56 subnets



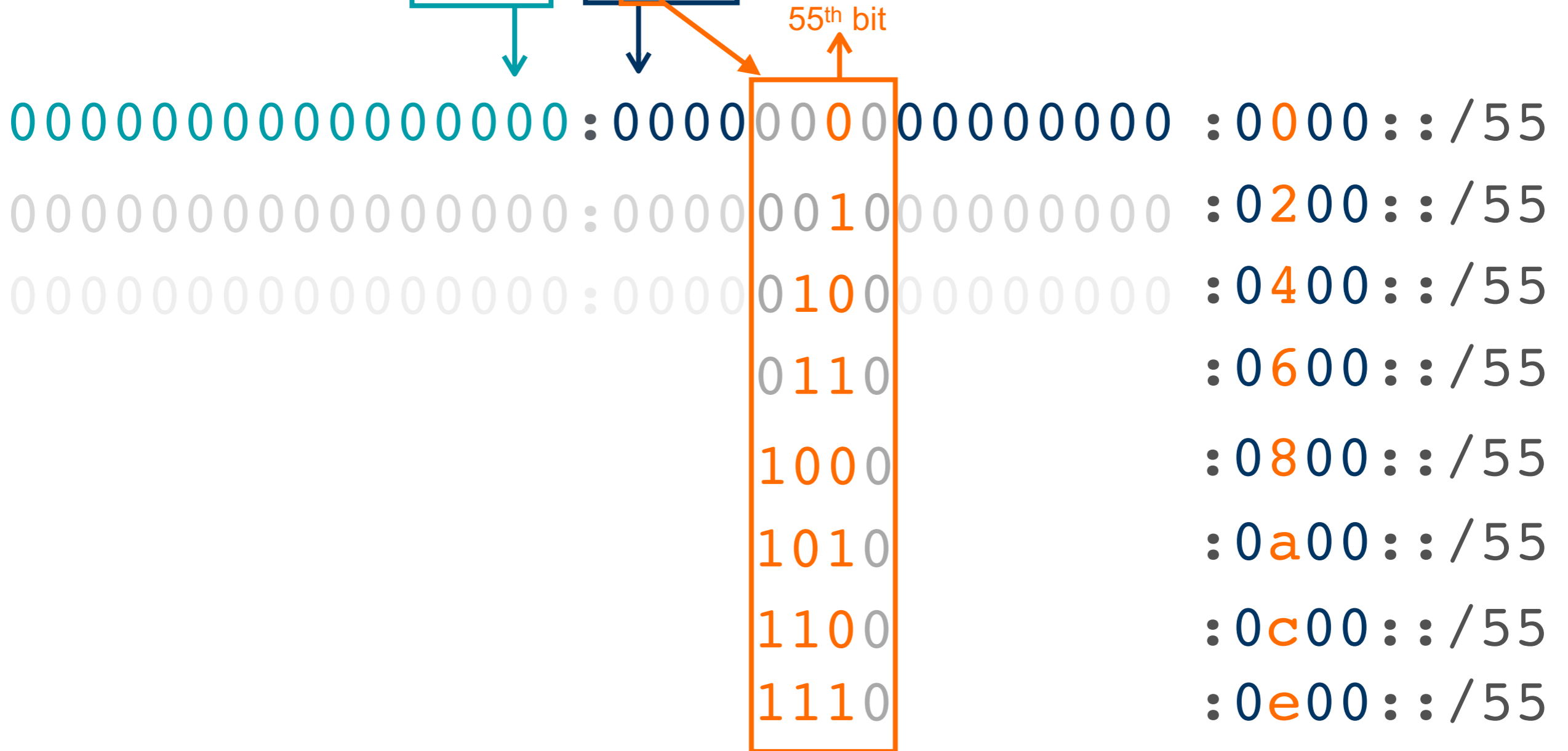
2001:0db8:0000:0000::/32



# IPv6 Subnetting - /55 subnets



2001:0db8:0000:0000::/32





# IPv6 Address Notation

Exercise



# Question #1

You have a /32 prefix starting with **2001:0db8**.

How do you search for it in the RIPE Database?

# Question #1 Answer

You have a /32 prefix starting with **2001:0db8**.

How do you search for it in the RIPE Database?

- a. 2001:0db8
- b. 2001:0db8/32
- c. 2001:0db8::- d. 2001:db8::

## Question #2

How do you correctly compress the following IPv6 address:

2001:0db8:0000:0000:0000:0000:0000:0c50

# Question #2 Answer

How do you correctly compress the following IPv6 address:

2001:0db8:0000:0000:0000:0000:0000:0c50

- a. 2001:0db8:0:0:0:0:0:0c50
- b. 2001:0db8::0c50
- c. 2001:db8::c50
- d. 2001:db8::c5

# Question #3

How do you correctly compress the following IPv6 address:

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

# Question #3 Answer

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

## Question #4

How do you correctly compress the following IPv6 address:

2001:0db8:00f0:0000:0000:03d0:0000:00ff

# Question #4 Answer

How do you correctly compress the following IPv6 address:

2001:0db8:00f0:0000:0000:03d0:0000:00ff

- a. 2001:0db8:00f0::3d0:0:00ff
- b. 2001:db8:f0:0:0:3d0:0:ff
- c. 2001:db8:f0::3d0:0:ff
- d. 2001:0db8:0f0:0:0:3d0:0:0ff



# Question #5

How do you correctly compress the following IPv6 address:

2001:0db8:0f3c:00d7:7dab:03d0:0000:00ff

# Question #5 Answer

How do you correctly compress the following IPv6 address:

2001:0db8:0f3c:00d7:7dab:03d0:0000:00ff

- a. 2001:db8:f3c:d7:7dab:3d:0:ff
- b. 2001:db8:f3c:d7:7dab:3d0:0:ff
- c. 2001:db8:f3c:d7:7dab:3d0::ff
- d. 2001:0db8:0f3c:00d7:7dab:03d::00ff

# Question #6

How do you access your IPv6 web server at **2001:db8::8080** on port 8080 using a web browser?

# Question #6 Answer

How do you access your IPv6 web server at

**2001:db8::8080** on port 8080 using a web browser?

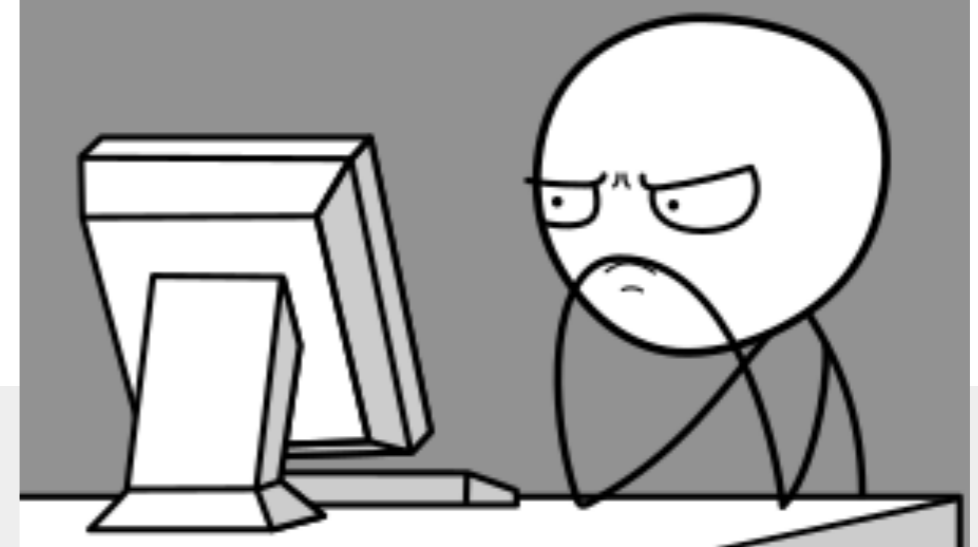
- a. `http://2001:db8::8080:8080`
- b. `http://2001:0db8:0000:0000:0000:0000:0000:8080:8080`
- c. `http://[2001:db8::8080]:8080`
- d. You cannot use the IPv6 address, you have to rely on DNS

# IPv6 Notation - RFC 5952



For more information, please read RFC 5952:

“A Recommendation for IPv6 Address Text Representation”



**Link to the RFC:**

<https://datatracker.ietf.org/doc/html/rfc5952>



# Questions





# 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**
  - **Up to a /29** without additional justification
  - More if justified by customer numbers and network extension
  - Additional bits based on hierarchical and geographical structure, planned longevity and security levels





# Customer Assignments

- Give your customers enough addresses
  - **Minimum /64**
  - Up to /48
- Originally, for more than /48, send in request form
- Every assignment **must be registered** in the RIPE Database

# RIPE Policy Proposal 2019-06



- LIR can create assignments larger than /48 **without a request**
- **Will need to justify** it if there is an audit or if LIR requests subsequent allocation

# Comparison IPv4 and IPv6 status



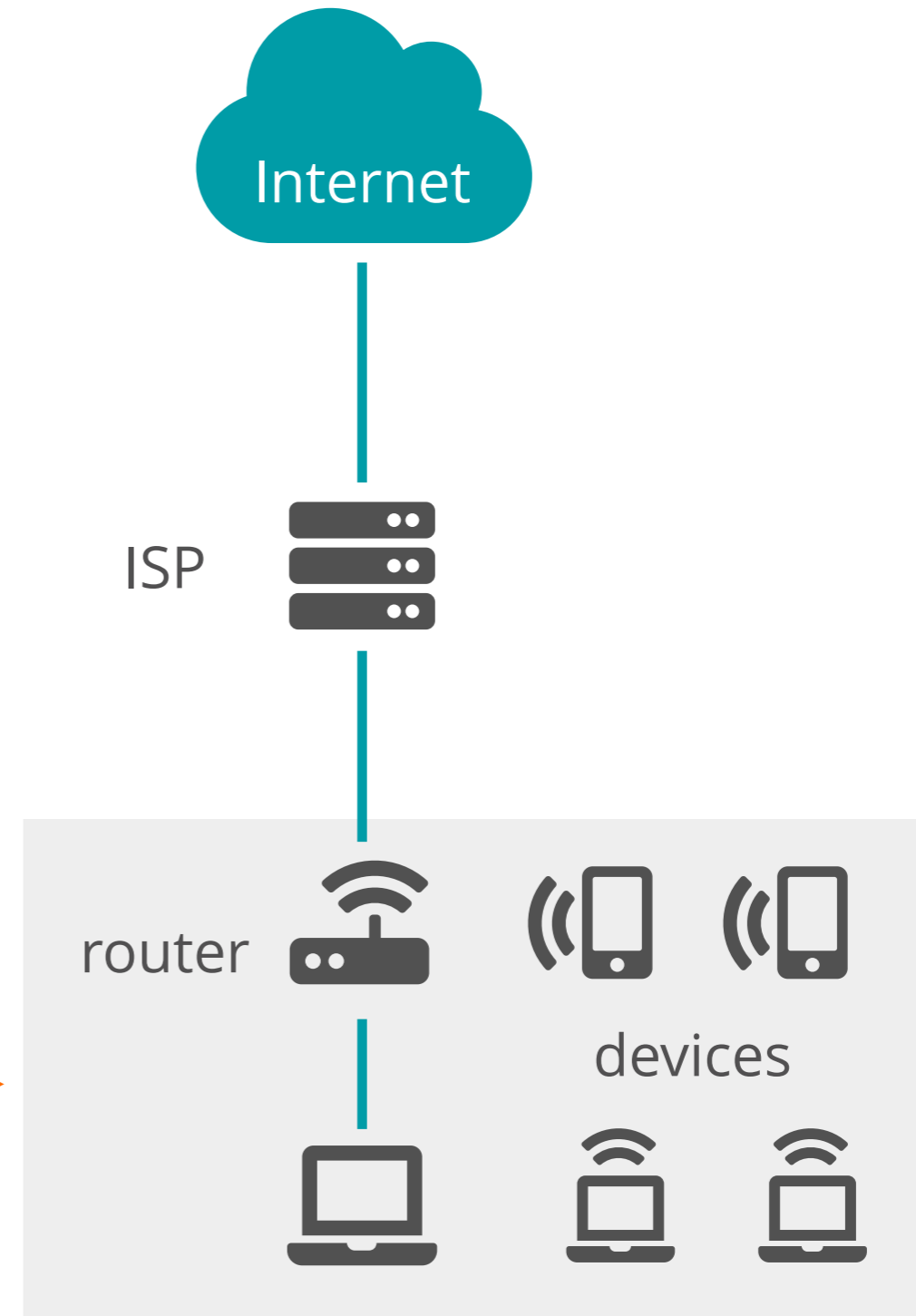
IPv4		IPv6
ALLOCATED PA	<b>Allocation</b>	ALLOCATED-BY-RIR
ASSIGNED PA	<b>Assignment</b>	ASSIGNED
AGGREGATED-BY-LIR	<b>Group of Assignments</b>	AGGREGATED-BY-LIR
SUB-ALLOCATED PA	<b>Sub-Allocation</b>	ALLOCATED-BY-LIR
ASSIGNED PI	<b>PI Assignment</b>	ASSIGNED PI



# Examples ASSIGNED

- One single network
- An individual customer
- Your own infrastructure

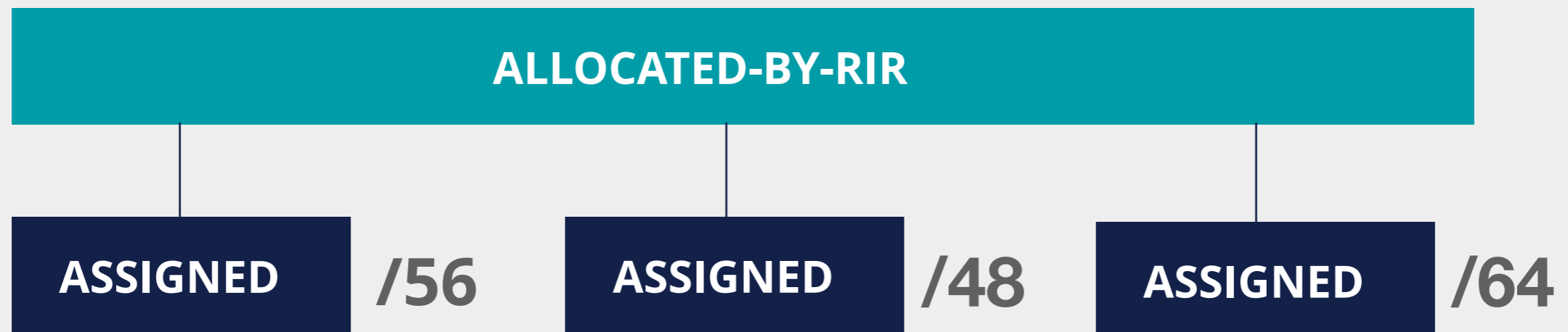
One assignment  
= 'ASSIGNED'



# Using ASSIGNED



- Represents one assignment
- Minimum assignment size is a /64



# Using ASSIGNED - Example Object

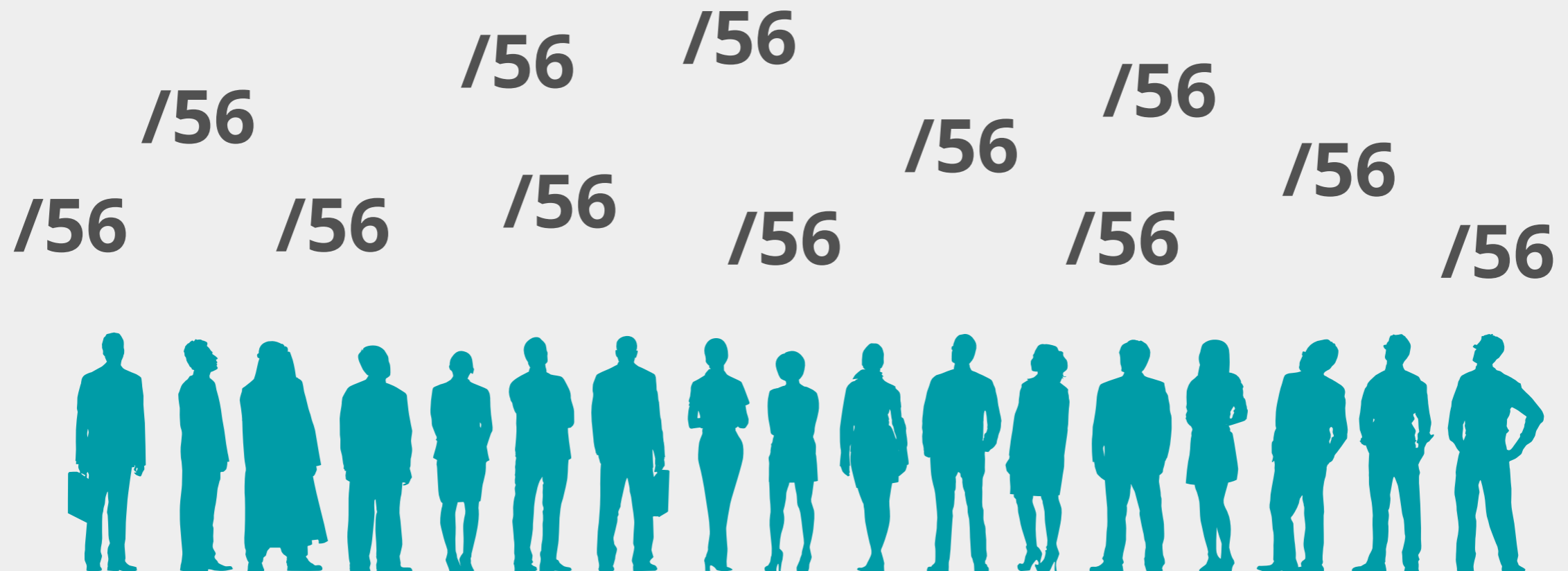


```
inet6num:      2001:db8:1000::/48
netname:        CUSTOMER-NET
country:        NL
admin-c:        ADM321-RIPE
tech-c:         NOC123-RIPE
status:       ASSIGNED
mnt-by:         LIR-MNT
created:        2015-05-31T08:23:35Z
last-modified: 2015-05-31T08:23:35Z
source:         RIPE
```

# Examples AGGREGATED-BY-LIR



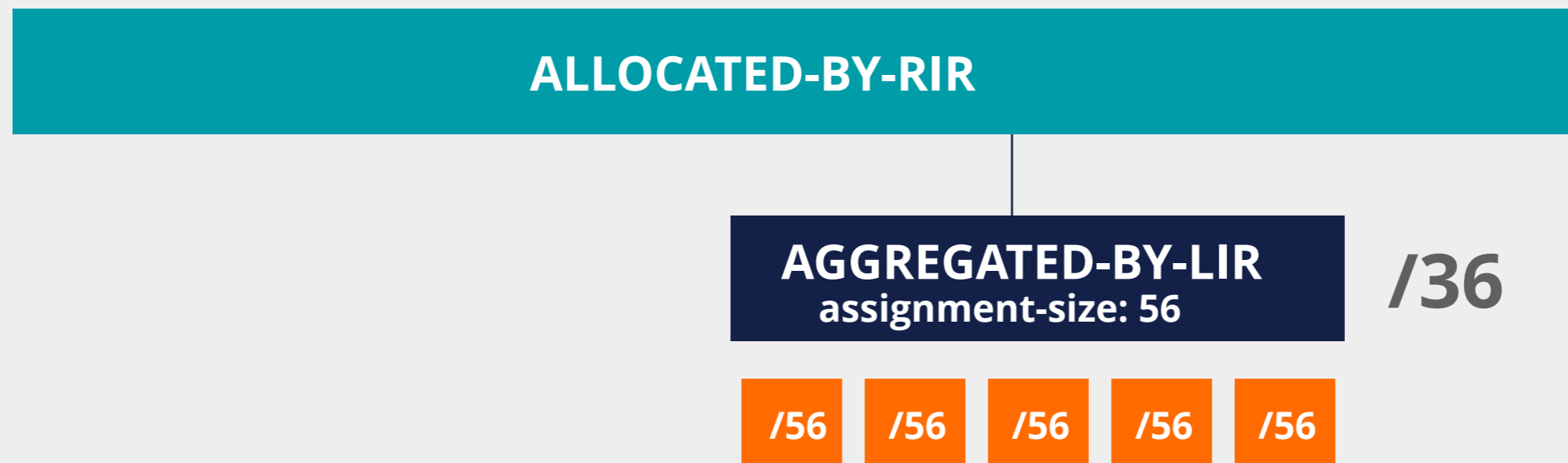
- Group of customers
- Same assignment size





# Using AGGREGATED-BY-LIR

- Can be used to group customers
  - For example: Residential broadband customers
- **“assignment-size:”** = assignment of each customer





# Using AGGREGATED-BY-LIR - Example



```
inet6num:          2001:db8:1000::/36
netname:           DSL-Broadband-Pool
country:           NL
admin-c:           ADM321-RIPE
tech-c:            NOC123-RIPE
status:           AGGREGATED-BY-LIR
assignment-size: 56
mnt-by:           LIR-MNT
notify:           noc@example.net
created:           2015-05-31T08:23:35Z
last-modified:    2015-05-31T08:23:35Z
source:           RIPE
```

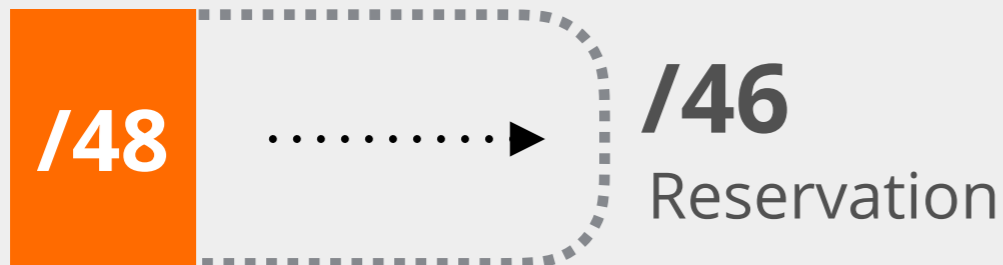
# Examples ALLOCATED-BY-LIR



## Reservation for a large customer



Large Customer



## Branch office or department



Branch Office

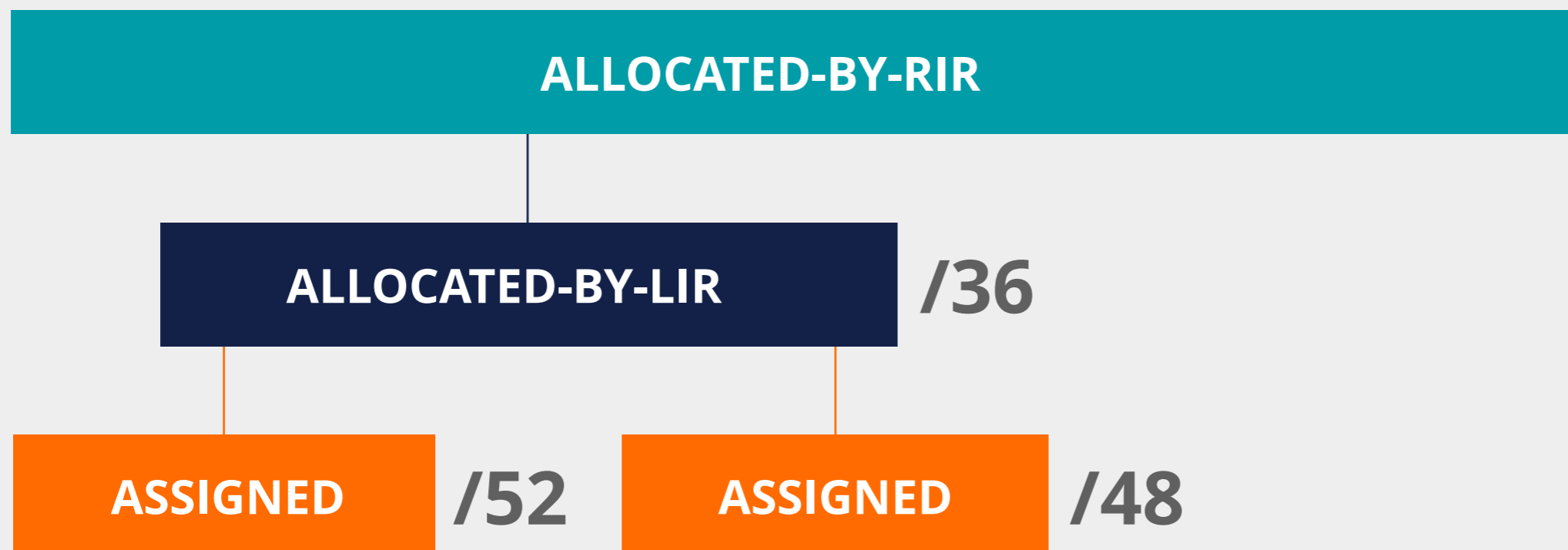


# Using ALLOCATED-BY-LIR



Can be used for customers with **potential for growth**

- Or for your own infrastructure
- Or to delegate address space to a downstream ISP

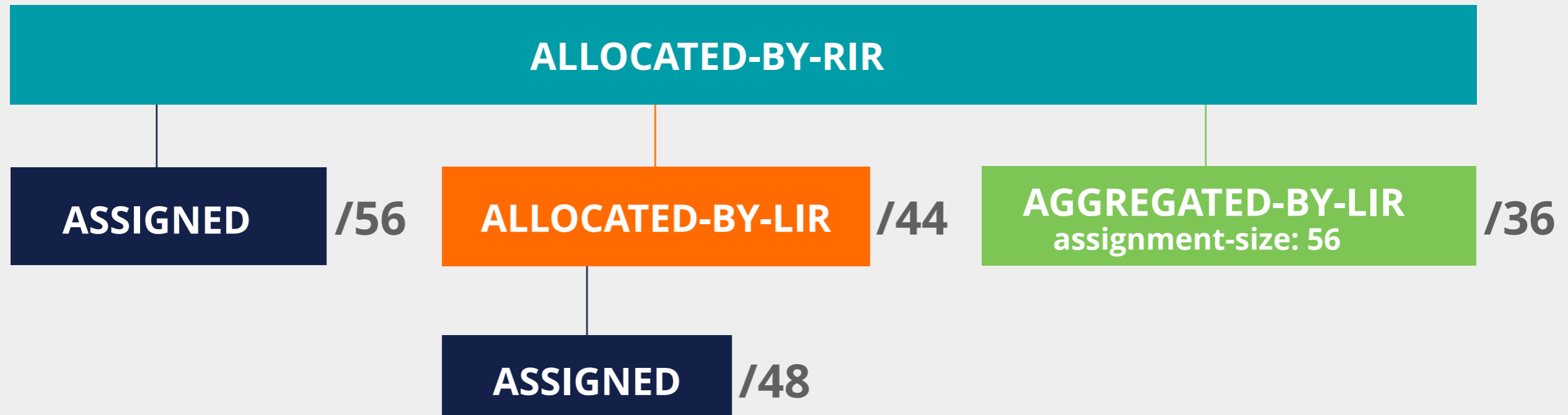


# Using ALLOCATED-BY-LIR - Example



```
inet6num:      2001:db8:50::/44
netname:       Branch-Office-Network
country:       NL
admin-c:       ADM321-RIPE
tech-c:        NOC123-RIPE
status:        ALLOCATED-BY-LIR
mnt-by:        LIR-MNT
mnt-lower:     BRANCH-OFFICE-MNT
notify:        noc@example.net
created:       2015-05-31T08:23:35Z
last-modified: 2015-05-31T08:23:35Z
source:        RIPE
```

# Overview



# Getting IPv6 PI Address Space



- To qualify, an organisation must:
  - **Meet** the contractual **requirements** for provider independent resources
  - LIRs must demonstrate special **routing requirements**
- Minimum assignment size: **/48**
- PI space **cannot** be used for sub-assignments



# Unique Local Addresses

- Prefixes from `fc00::/7`
  - Only from the `fd00::/8` block
- Should **not** be routed on the Internet
- Generate a random 40-bit Global ID and insert it into `fdxx:xxxx:xxxx`

Global ID:        `da24154e1d`

Prefix:            `fd``da:2415:4e1d``::/48`



# Questions





**Let's take a  
5 minute  
break!**



WELCOME

WE ARE

**OPEN**

PLEASE COME IN





# Making Assignments

Exercise

# Create assignments for a smart city!





# Context

- You work for the LIR: **nl.ripencc-ts**
- Your LIR has a /32 allocation: **2001:db8::/32**
- Your customer Future Casa is working on a project called “Smart Home 6”
- They need IPv6 addresses from your address space
- Future Casa wants to connect **1 million** Smart Homes



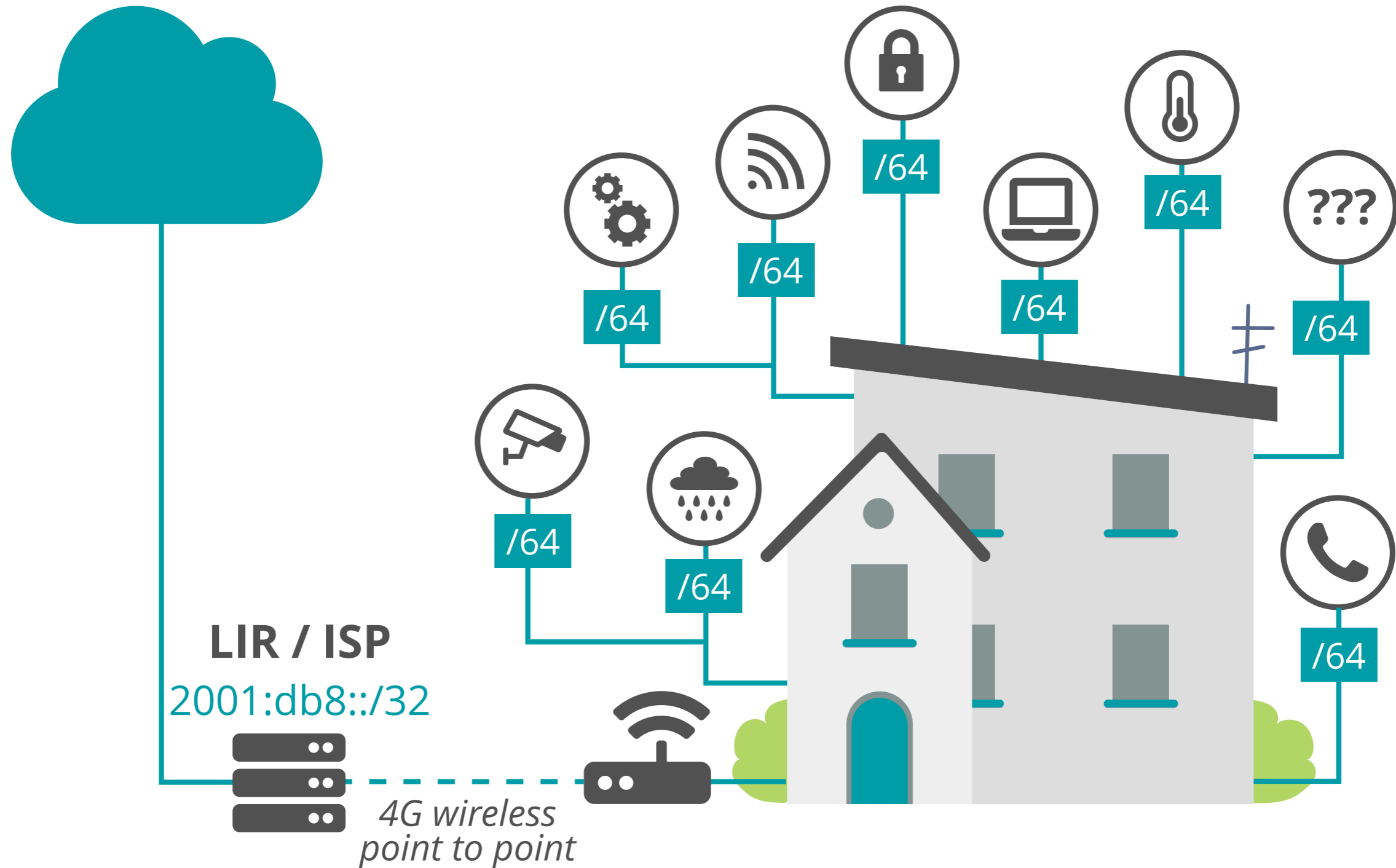
# Product Description

- Each home will be equipped with a 4G-enabled base unit
- The base unit will be the central gateway for smart services inside the house
- Each smart service runs on a **dedicated subnet**
- Services can be enabled or disabled at any point from a user's smartphone app
- Future Casa will be rolling out **new services in the future**

# Smart Home 6 Network Diagram



## IPv6 Internet





# Activity 1



# Take the poll!

Which prefix should you assign to each smart home?





# Calculations...

- **/64 = 1 subnet**
  - Not enough. We need one subnet alone for the p2p conn.
- **/63 = 2 subnets**
  - Not enough subnets.
  - Not on the 4-bit boundary!
- **/60 = 16 subnets**
  - Is it enough to meet the future needs?
  - You want to avoid having to renumber!



# Calculations...

- **/56 = 256 subnets**

- Sounds reasonable. How many subnets can a house need?

- **/52 = 4096 subnets**

- More than enough.

- **/48 = 65K subnets**

- Definitely more than enough.



# Activity 2

# Take the poll!

Given that each smart home will be assigned a **/56**, what is the total address space required for **1 million** smart homes?



3 min.



# Calculations...



One million smart homes

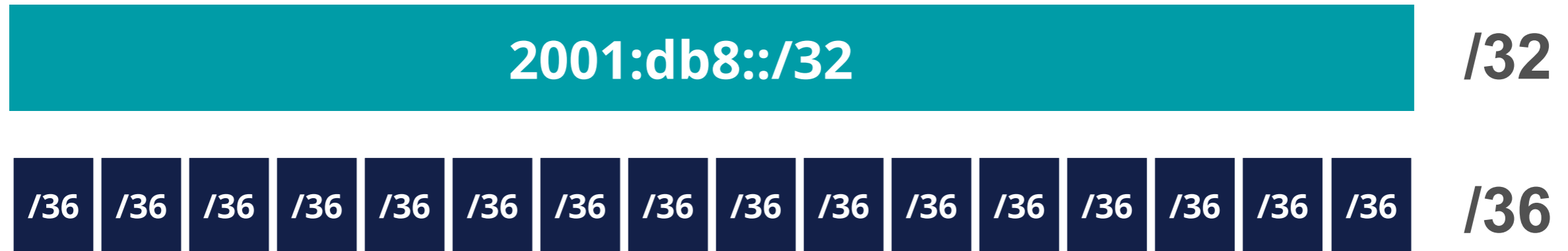
X

/56 per home

=

**/36**

# Possible options for /36 subnets



2001:db8:0000::/36

2001:db8:1000::/36

2001:db8:2000::/36

2001:db8:3000::/36

2001:db8:4000::/36

2001:db8:5000::/36

2001:db8:6000::/36

2001:db8:7000::/36

2001:db8:8000::/36

2001:db8:9000::/36

2001:db8:a000::/36

2001:db8:b000::/36

2001:db8:c000::/36

2001:db8:d000::/36

2001:db8:e000::/36

2001:db8:f000::/36



# Activity 3



# Take the poll!

You have decided to use **2001:db8:1000::/36** for the Smart Homes project.

What **status** would you use to register this address space in the RIPE DB?



# Solution RIPE Database object



```
inet6num: 2001:db8:1000::/36
netname: SMART-HOME-6
descr: Smart Home 6 network
country: NL
admin-c: RM1204-RIPE
tech-c: RM1204-RIPE
status: AGGREGATED-BY-LIR
assignment-size: 56
mnt-by: LIR-MNT
notify: noc@lir-example.com
created: 2015-05-31T12:34:01Z
last-modified: 2015-05-31T12:34:01Z
source: RIPE
```

# Solution RIPE Database object



```
inet6num: 2001:db8:1000::/36
netname: SMART-HOME-6
descr: Smart Home 6 network
country: NL
admin-c: RM1204-RIPE
tech-c: RM1204-RIPE
status: ALLOCATED-BY-LIR
mnt-by: LIR-MNT
mnt-lower: SMART-CASA-MNT
notify: noc@lir-example.com
created: 2015-05-31T12:34:01Z
last-modified: 2015-05-31T12:34:01Z
source: RIPE
```



# Questions





# Key Takeaways and Tips

- Get your allocation from the RIPE NCC
- Study your address space needs factoring in **future growth**
- Register **every assignment** in the RIPE Database
- Plan every step and test
- Check your hardware and software



# RIPE-772 Document

- “Requirements for IPv6 in ICT Equipment”
  - Best Current Practice describing what to ask for when requesting IPv6 Support
  - Useful for tenders and RFPs
  - Original version was ripe-554
  - Ripe-554 Originated by the Slovenian Government
  - Adopted by various others (Germany, Sweden)

**Link to the document:**

**<https://www.ripe.net/publications/docs/ripe-772>**



# Customers And Their /48

- Customers have no idea how to handle **65,536 subnets!**
- Provide them with information!



**Link to the document:**

<https://www.ripe.net/support/training/material/basicipv6-addressing-plan-howto.pdf>

# What's Next in IPv6



## Webinars

**Attend another webinar live wherever you are.**

- ❖ Introduction to IPv6 (2 hrs)
- ❖ IPv6 Addressing Plan (1 hr)
- ❖ Basic IPv6 Protocol Security (2 hrs)
- ❖ IPv6 Associated Protocols (2 hrs)
- ❖ IPv6 Security Myths, Filtering and Tips (2 hrs)



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- ❖ IPv6 Fundamentals (8.5 hrs)
- ❖ Advanced IPv6 (17 hrs)
- ❖ IPv6 Security (8.5 hrs)



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- ❖ IPv6 Fundamentals (15 hrs)
- ❖ IPv6 Security (24 hrs)



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- ❖ IPv6 Security - Expert



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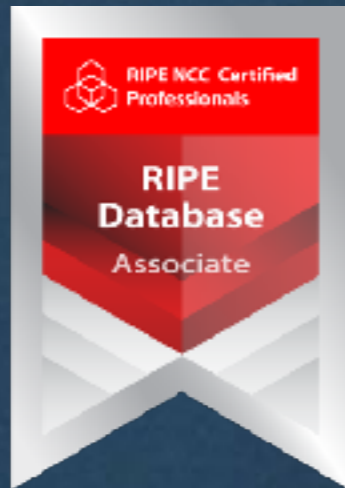
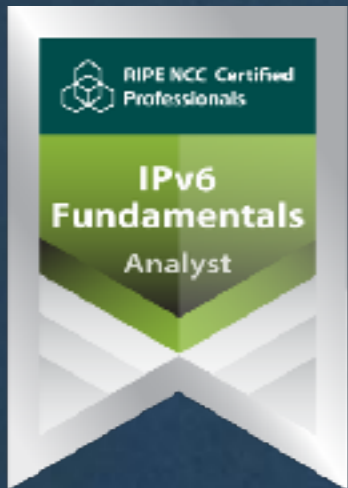


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Son      டாசாஸ்ருலி      қтырз      Kінецъ      Finis  
Lõpp      Amaia      תסוה      Tmiem      Kraja  
Sfârșit      Loppu      Slutt      Liðugt      Kraj  
Kraj      النهاية      Конец      Fund  
Fine      Fin      Fí      Konec      Τέλος  
Einde      Край  
Slut      Pabaiga  
Fim      Beigas



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