Basic IPv6 Tutorial

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Overview

- IPv4?
- IPv6 Addresses
- IPv6 in the RIPE Database
- IPv6 Addressing Plans
- Tips

IPv4?

Section 1

“On 14 September 2012, the RIPE NCC ran out of their regular pool of IPv4”

Reaching the next billion

- **Around 2.4 billion internet users now**
  - around 35% of all people
- **Mobile phones are becoming internet devices**
- **The Internet of things**
  - How will the Internet look like in 5 years?

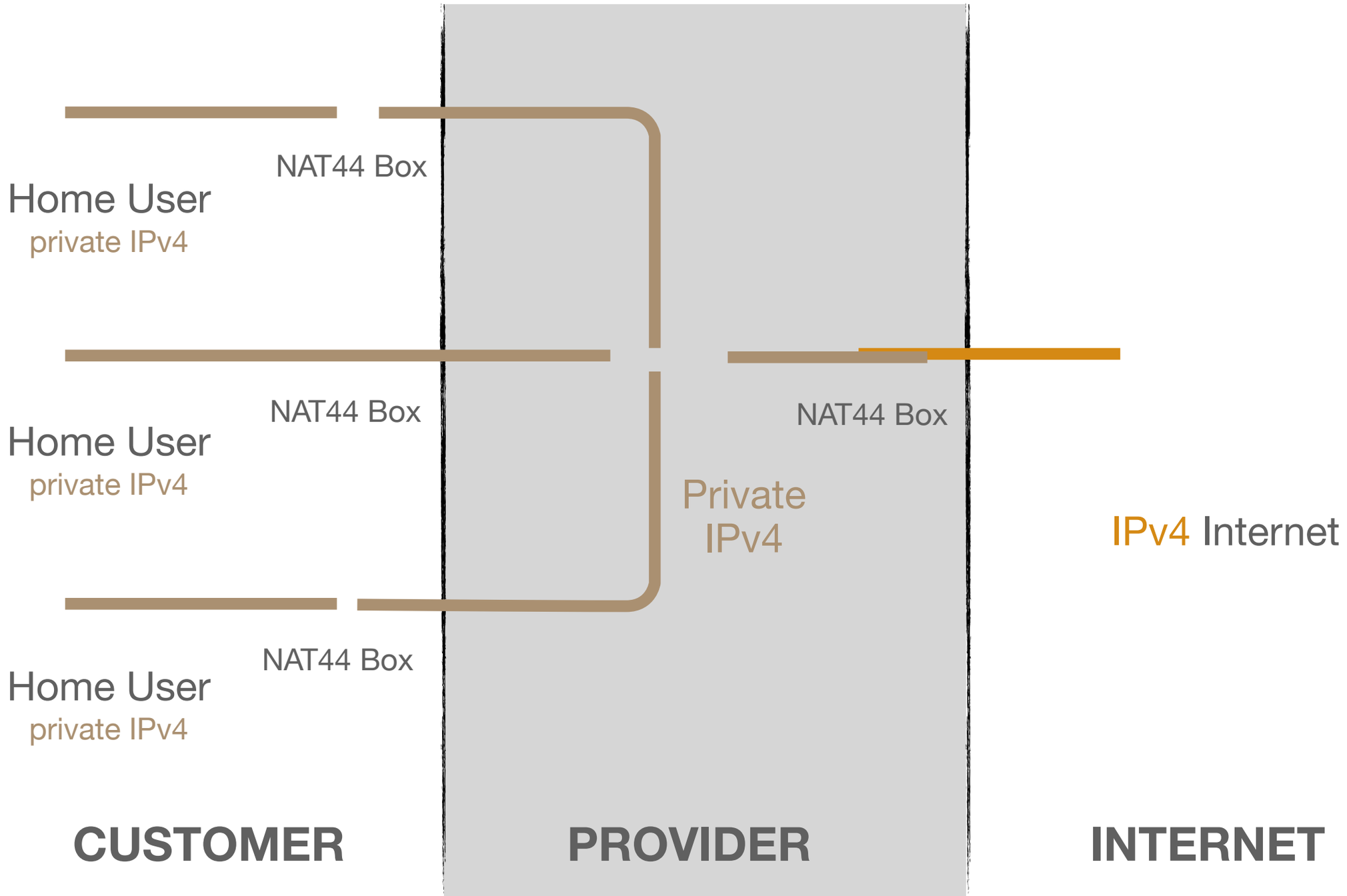
The Internet of Things

http://www.libelium.com/top_50_iot_sensor_applications_ranking

Network Address Translation

- Extends the capacity of the IPv4 address space by sharing an IPv4 address between clients
- Fairly common technology, used everywhere
- Breaks the end to end connectivity model
- **It doesn’t allow communication with IPv6!**
- You are probably going to need it in some form

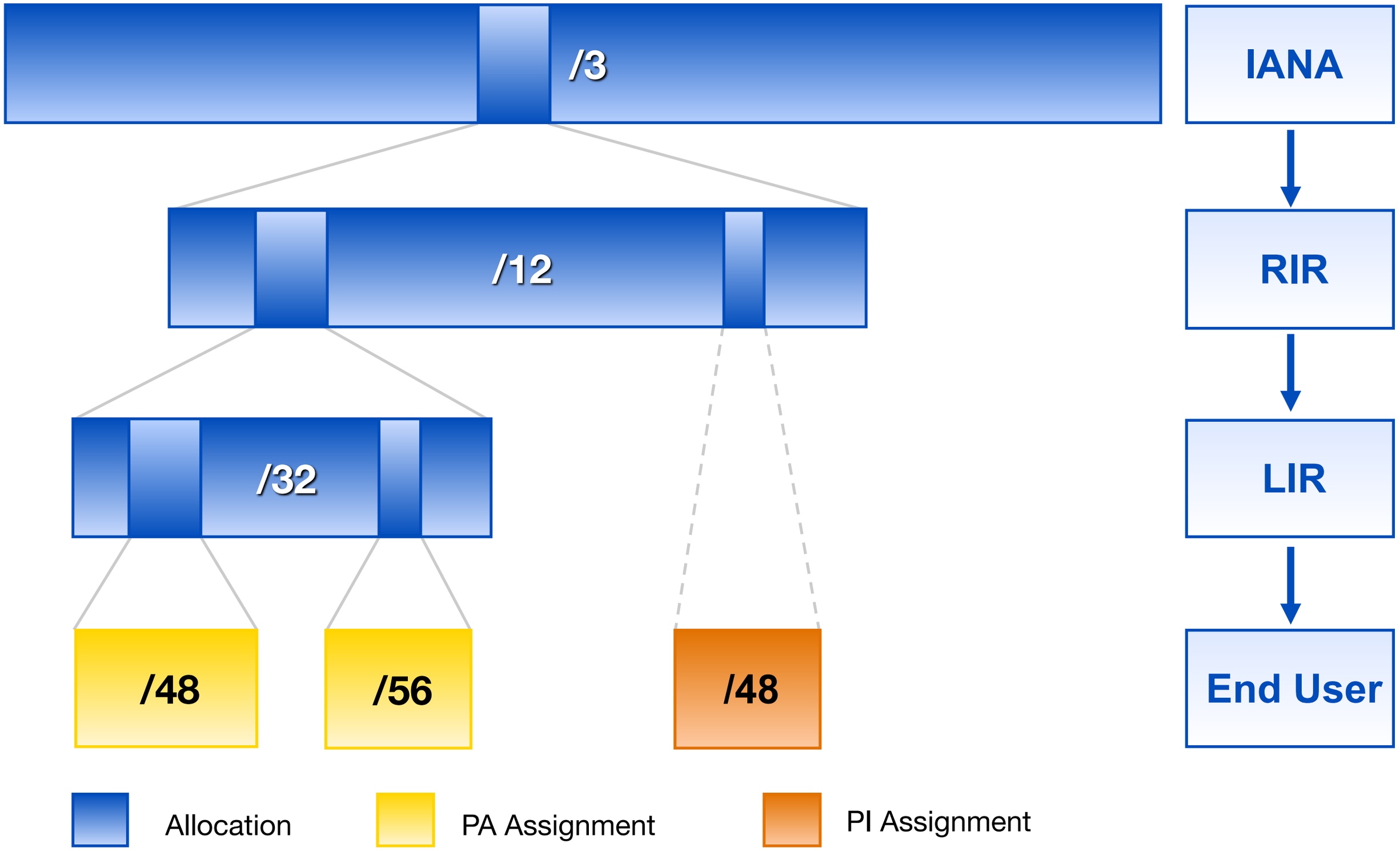
Large Scale NAT



IPv6 Address Basics

Section 2

IP Address Distribution



PHILOSOPHY CHANGE

IPv4 -> IPv6: What Philosophy Change?

~~How many IP addresses do I need?~~

How many subnets do I need?

Subnet always = /64

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

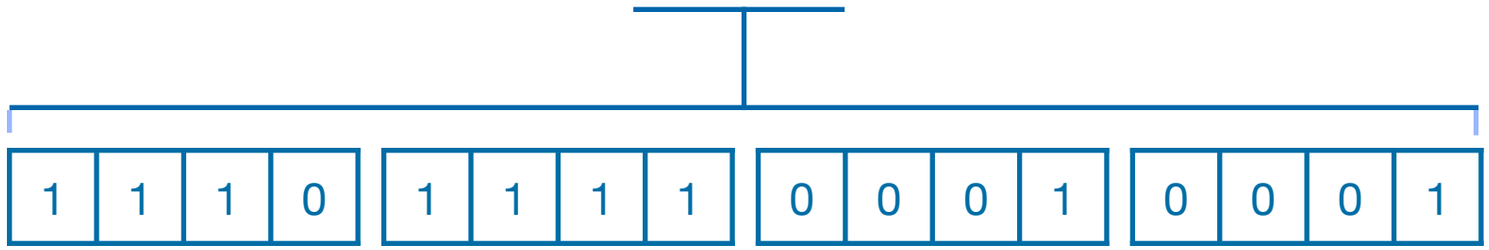
IPv6 Subnetting

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



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
Teredo	2001::/32	global
Multicast	ff00::/8	variable

IPv6 Address Notation

Exercise

IPv6 in the RIPE Database

Section 2

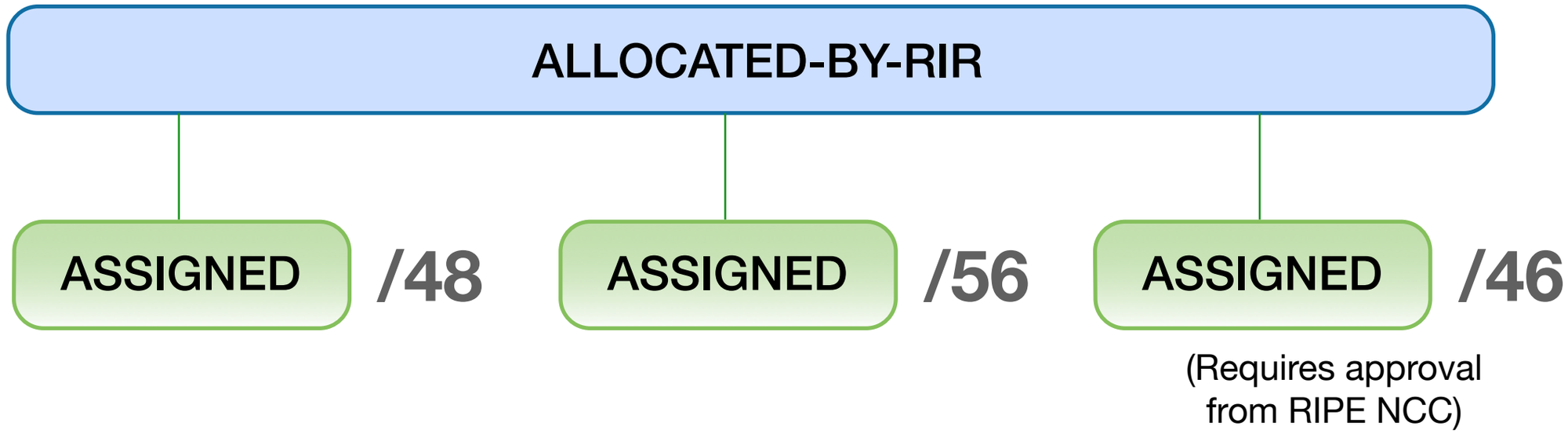
Customer Assignments

- **Give your customers enough addresses**
  - up to a /48
- **For more addresses send in request form**
  - alternatively, make a sub-allocation
- **Every assignment must be registered in the RIPE Database**

Comparison IPv4 and IPv6 status

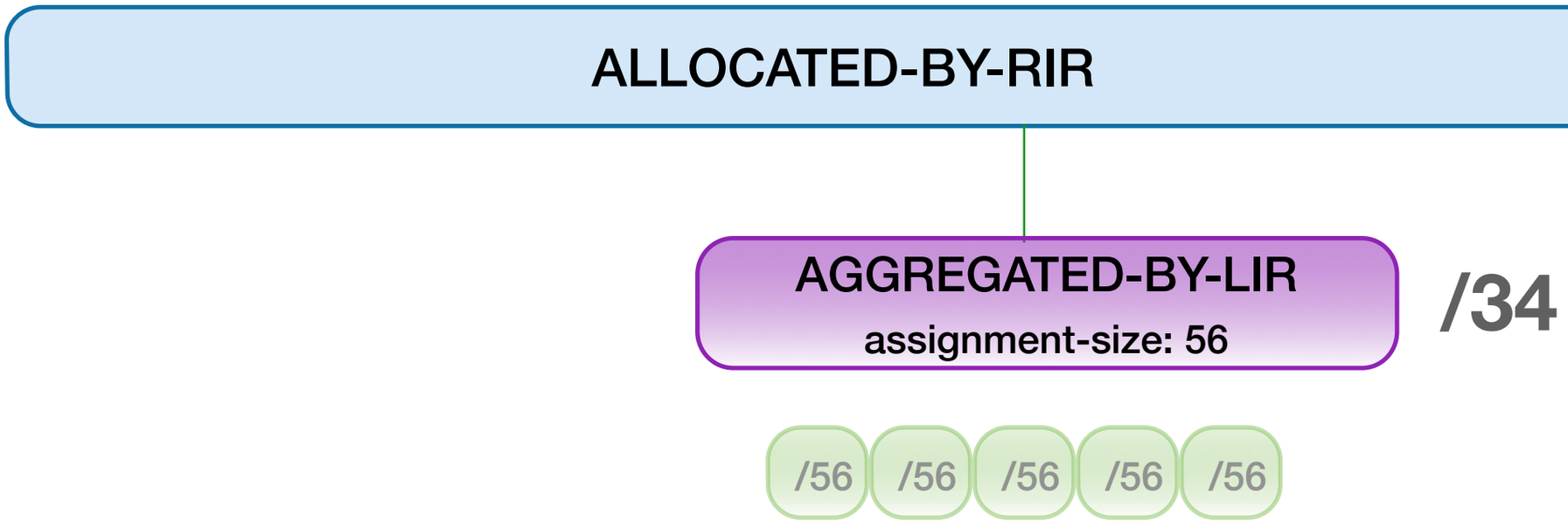
IPv4	IPv6
ALLOCATED PA	ALLOCATED-BY-RIR
ASSIGNED PA	ASSIGNED
ASSIGNED PA	AGGREGATED-BY-LIR
SUB-ALLOCATED PA	ALLOCATED-BY-LIR
ASSIGNED PI	ASSIGNED PI

Using ASSIGNED



- Status is ASSIGNED
- Minimum assignment size is a /64
- For more than a /48, send a request form

Using AGGREGATED-BY-LIR

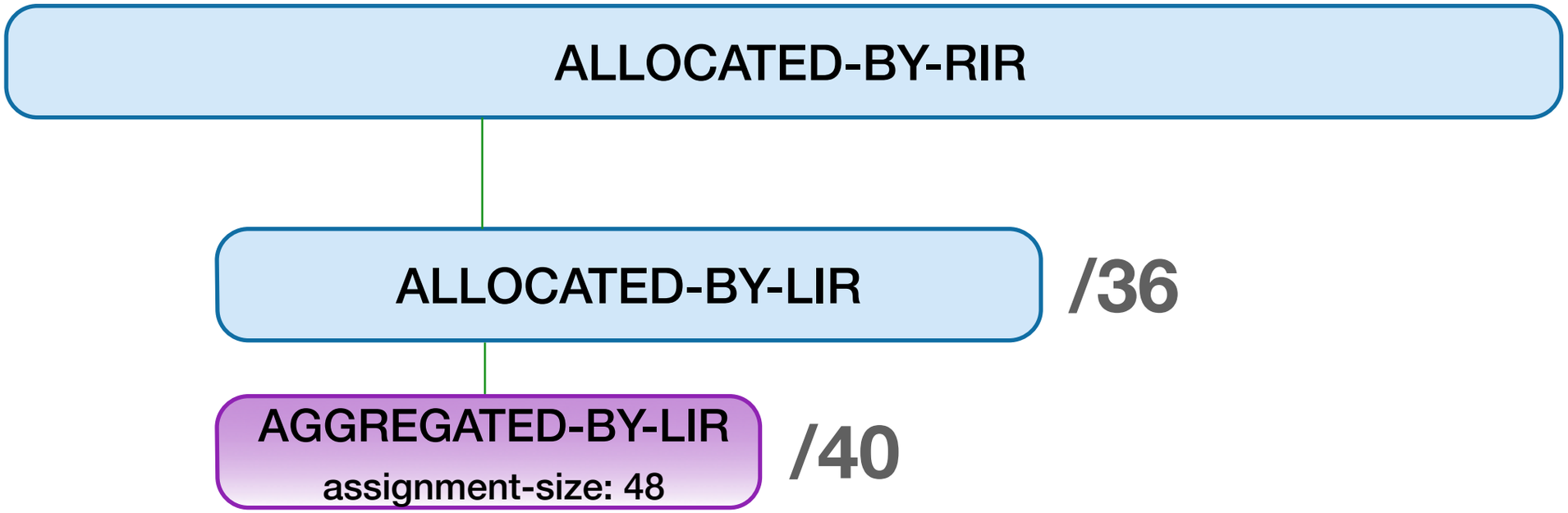


- **Can be used to group customers**
  - broadband, for example
- **“assignment size” = assignment of each customer**

AGGREGATED-BY-LIR in the RIPE DB

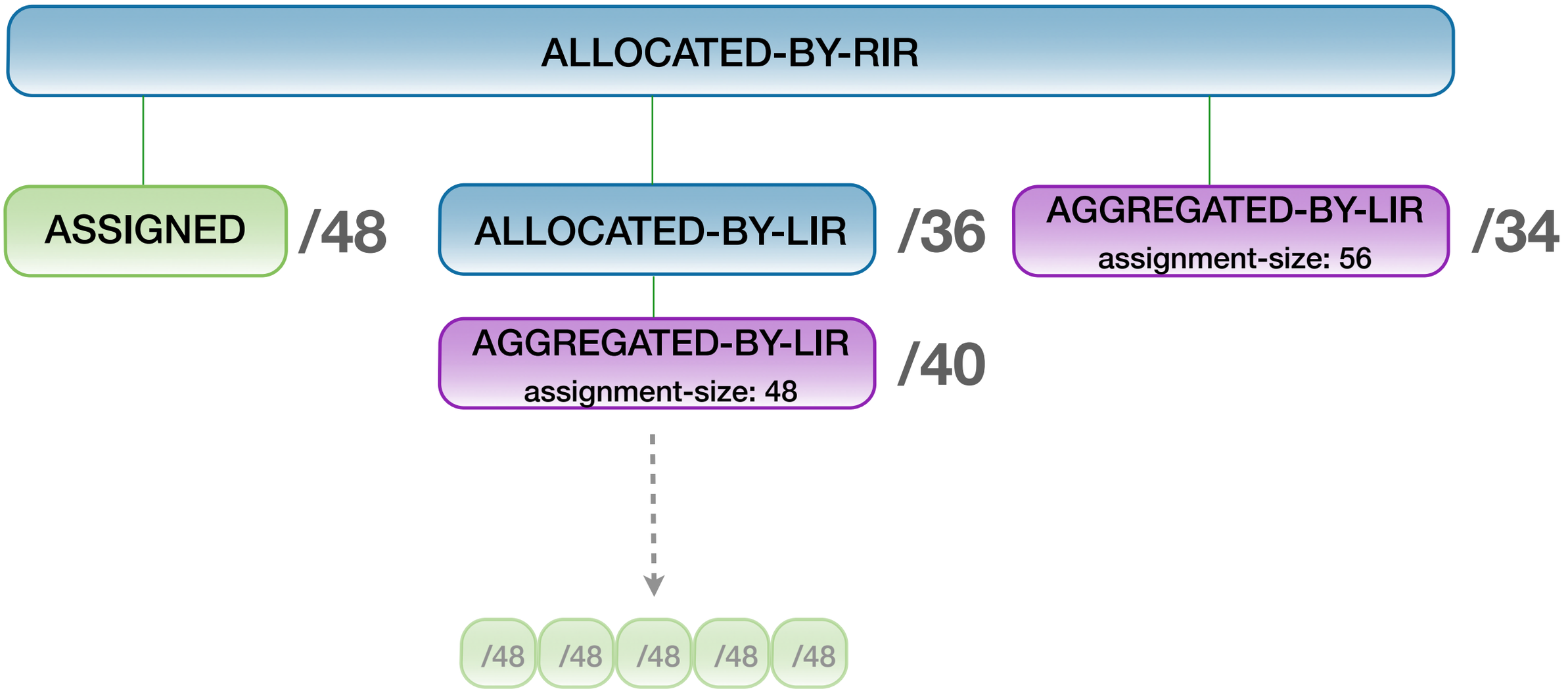
inet6num:	2001:db8:1000::/36
netname:	Brightlife
descr:	Broadband services
country:	NL
admin-c:	BN649-RIPE
tech-c:	BN649-RIPE
status:	**AGGREGATED-BY-LIR**
assignment-size:	**48**
mnt-by:	BRIGHTLIFE-MNT
notify:	noc@example.net
changed:	noc@example.net 20130218
source:	RIPE

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

Overview


ALLOCATED-BY-RIR
ASSIGNED
/48
ALLOCATED-BY-LIR
/36
AGGREGATED-BY-LIR
assignment-size: 56
/34
AGGREGATED-BY-LIR
assignment-size: 48
/40
/48
/48
/48
/48
/48

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 can not be used for sub-assignments**
  - not even 1 IP address!

RIPE Database object


```
inet6num:          2001:db8:1000::/36
netname:           FREEZ
descr:             Freez Fridges
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
changed:           noc@lir-example.com 20110801
source:            RIPE
```

Quiz!

Exercise

Take the Quiz!

- Go to kahoot.it
- Enter the pin code
- Enter a username

Let’s play!

IPv6 Addressing Plans

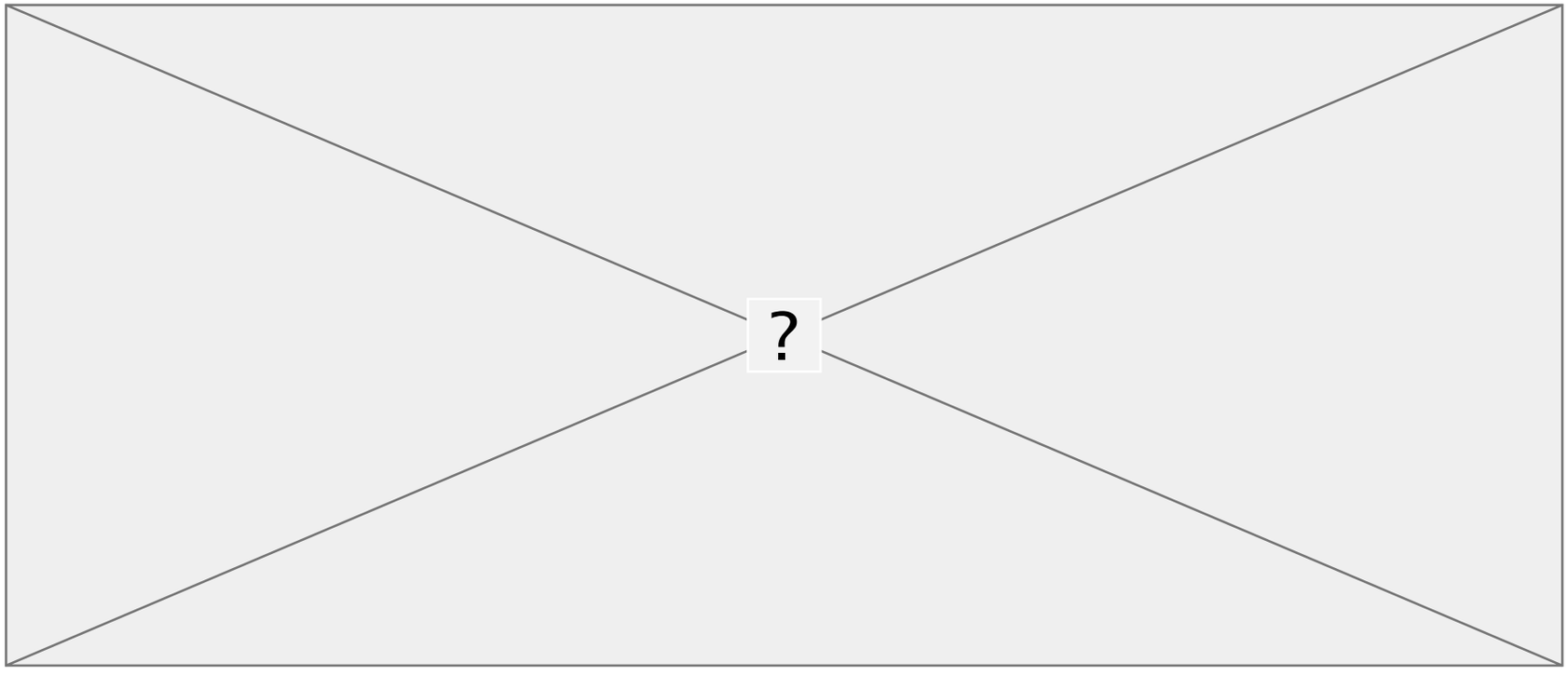
Section 3

Why Create an IPv6 Addressing Plan?

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

4-Bit Boundaries

- IPv6 offers flexibility with addressing plans
- Network addressing can be done on 4-bit boundaries



IPv6 Address Management

- **Your spreadsheet might not scale**
  - There are 512K /48s in a /29
  - 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**

The /64 story..

- “Every interface ID must be a /64” (RFC 4291)
- Because of SLAAC
- Other RFCs followed this
- The only exception is a /127 for point-to-point links

ISP Addressing Plan

- What should an ISP addressing plan contain?
  - Address space for internal use
  - Loopback interfaces
  - Point-to-point connections
    - Servers, routers and other infrastructure at POPs
- Use a /48 per POP
- Address space for customers

Loopback Interfaces

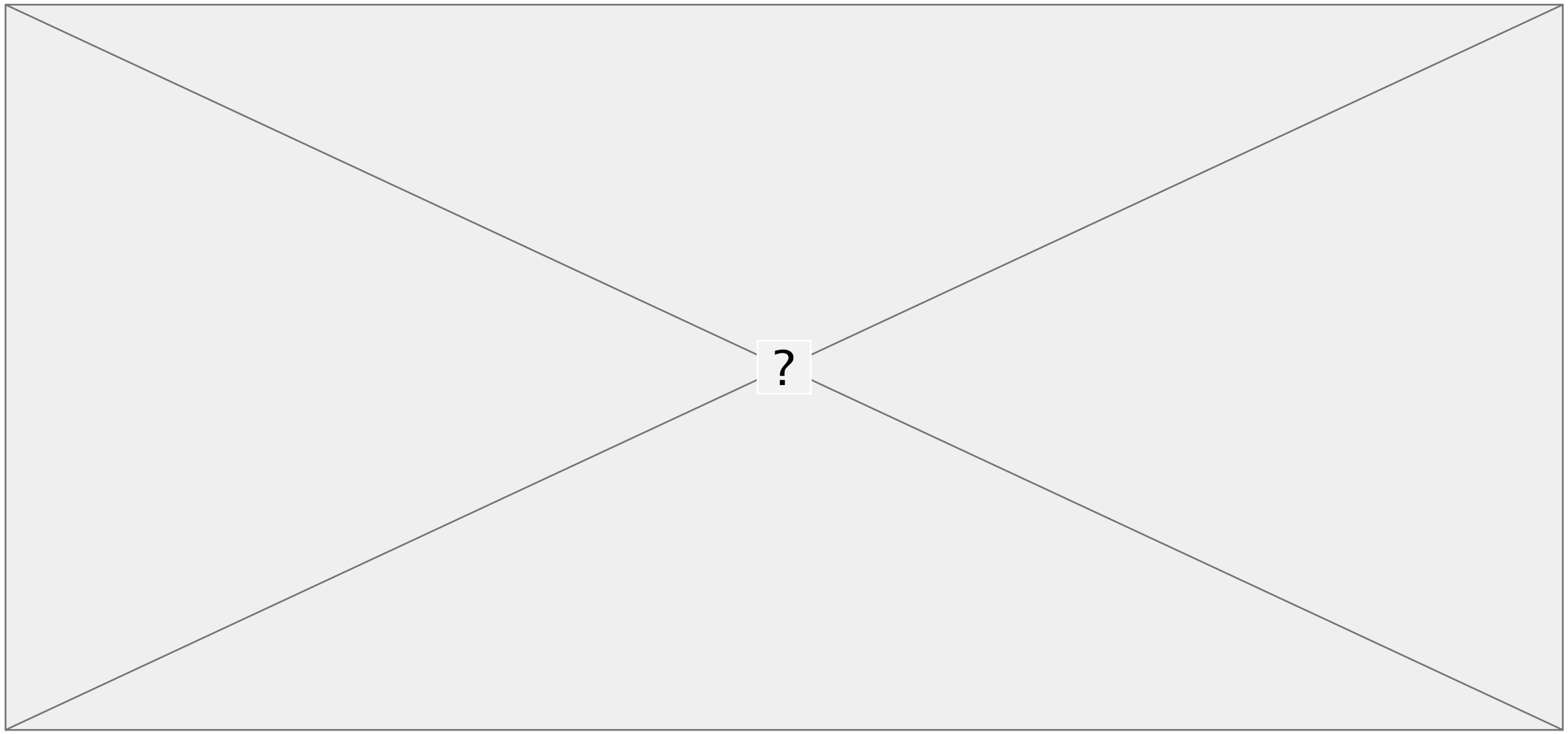
- **One /128 per device**
  - One /64 contains enough addresses for all your manually configured loopback addresses
- **Take an easy to remember block for loopback addresses**

Point-to-point links

- **With old router operating software:**
  - One /64 per point-to-point connection
  - Reserve /64 per point-to-point link, but configure a /127

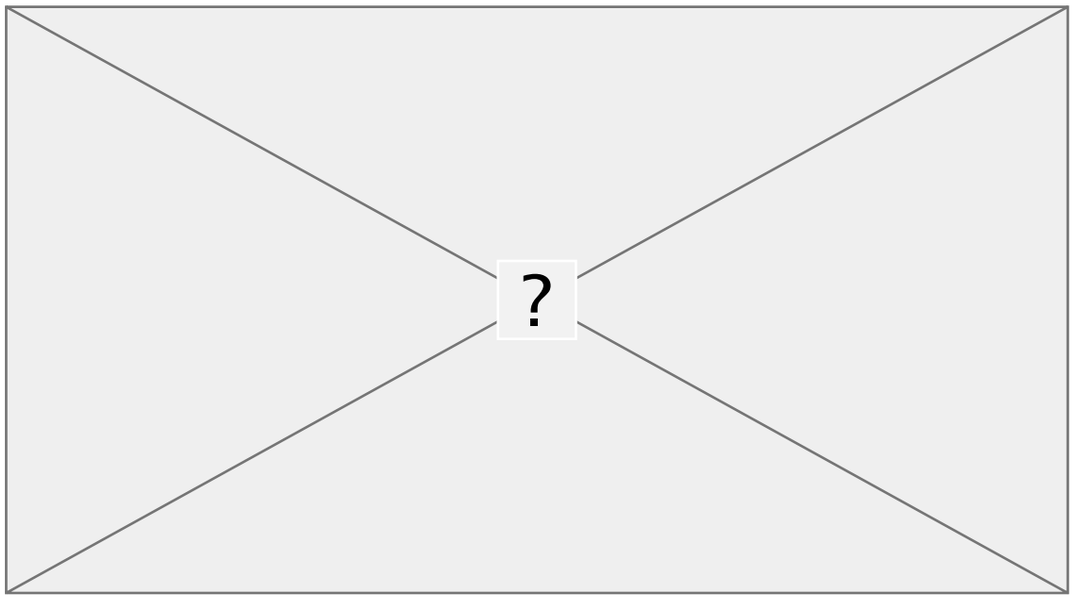
- **With new router operating software:**
  - RFC 6164
  - Configure a /127 per point-to-point connection

ISP Example



ISP Example

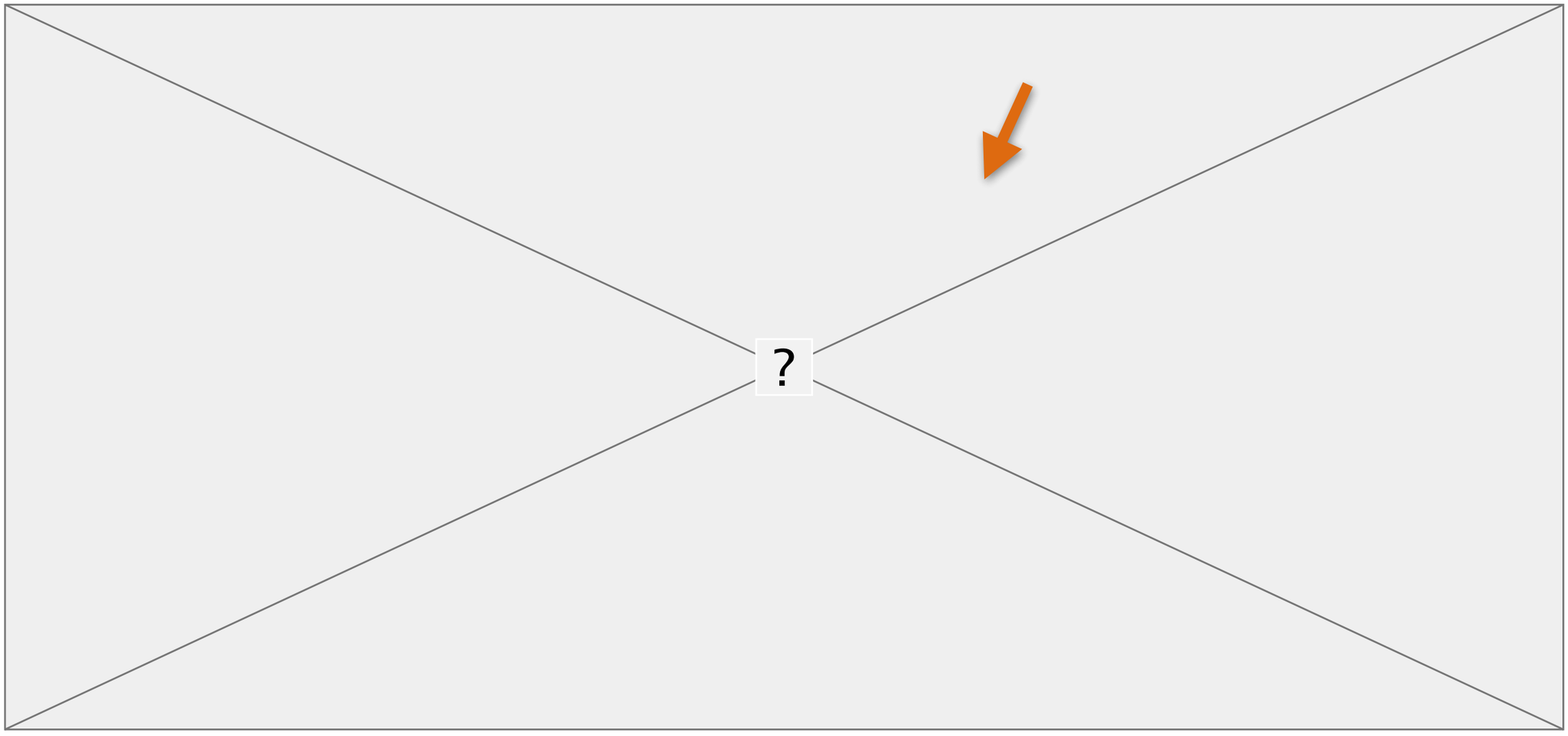
- We will assign a /48 per POP
- We will work on 4-bit boundary



- Look at the number of point-to-point links
- Just to be sure, we reserve a /64 per link!

Take the poll!

How much would you assign to cr1.pop2?



ISP Guidelines

- **In common cases:**
  - One /48 per POP
  - Calculate growth
  - Make it scalable

Customers

- Customers should get a large block of addresses
  - /48 for business customers
  - /48 or /56 for residential customers
- For more than a /48, send a request form
- Every assignment must be registered

Example Situation (Customers)

- **A customer has 6 functions**
  - Servers
  - Office PCs
  - Network Engineer PCs
  - Guests
  - VPN (remote workers)
  - Infrastructure (point-to-point and loopbacks)

Example Situation (Customers)

- **A customer has 3 locations**
  - Main building, floor 1
  - Main building, floor 2
  - Secondary office

Example Situation (Customers)

- A customer receives 2001:0db8:1a2b::/48
- Work on 4-bit boundary
  - 6 functions (leaves room for 10 more functions)
  - 3 locations (leaves room for 13 more locations)
  - We still have 8 bits!
    - Room for 256 networks per function per location

Example Plan (Customers)

- Putting this in the address:

  2001:0db8:1a2b:**FLXX**::/64

  - **F** = Function (0=infrastructure, 1=servers, 2=office, 3=engineers, 4=VPN, f=guests)
  - **L** = Location (0=main building 1, 1=main building 2, 2=secondary office)
  - **XX** = Number of network of type + location

Example Plan (Customers)

- 2001:0db8:1a2b:1000::/64
  - Servers in Main Building, floor 1, network 0
- 2001:0db8:1a2b:1200::/64
  - Servers in the secondary office, network 0
- 2001:0db8:1a2b:f209::/64
  - Guest in secondary office, network 9

Example Plan (Customers)

- 2001:0db8:1a2b:0000::1/128
  - Loopback address (infrastructure, location doesn’t apply)
- 2001:0db8:1a2b:0102::/127
  - Point-to-point link (infrastructure, location doesn’t apply)
- 2001:0db8:1a2b:41ab::/64
  - VPN in main office, floor 1, user 171

Alternatives (Customers)

- The previous example is just an idea
  - ✓ Adapt as necessary

- 2001:0db8:1a2b:FFLX::/64
  - 256 functions
  - 16 locations
  - 16 networks per function per location

Summary (Customers)

- **Tips:**
  - Work on 4-bit boundary
  - Group subnets by function
  - Group subnets by location
  - Make a scalable addressing plan

Exercise!

What is the IPv6 address for an engineer's PC,

in the main building floor 2,

for computer number 2?

Example:

2001:0db8:1a2b:FLXX::/64

- **F= Function (0=infrastructure, 1=servers, 2=office, 3=engineers, 4=VPN, f=guests)**
- **L= Location (0=main building 1, 1=main building 2, 2=secondary office)**
- **XX= Number of network of type + location**

Answers

What is the IPv6 address for an engineer's PC,

in the main building floor 2,

for computer number 2?

Example:

2001:0db8:1a2b:FLXX::/64

- **F= Function (0=infrastructure, 1=servers, 2=office, 3=engineers, 4=VPN, f=guests)**
- **L= Location (0=main building 1, 1=main building 2, 2=secondary office)**
- **XX= Number of network of type + location**

2001:0db8:3101::/64

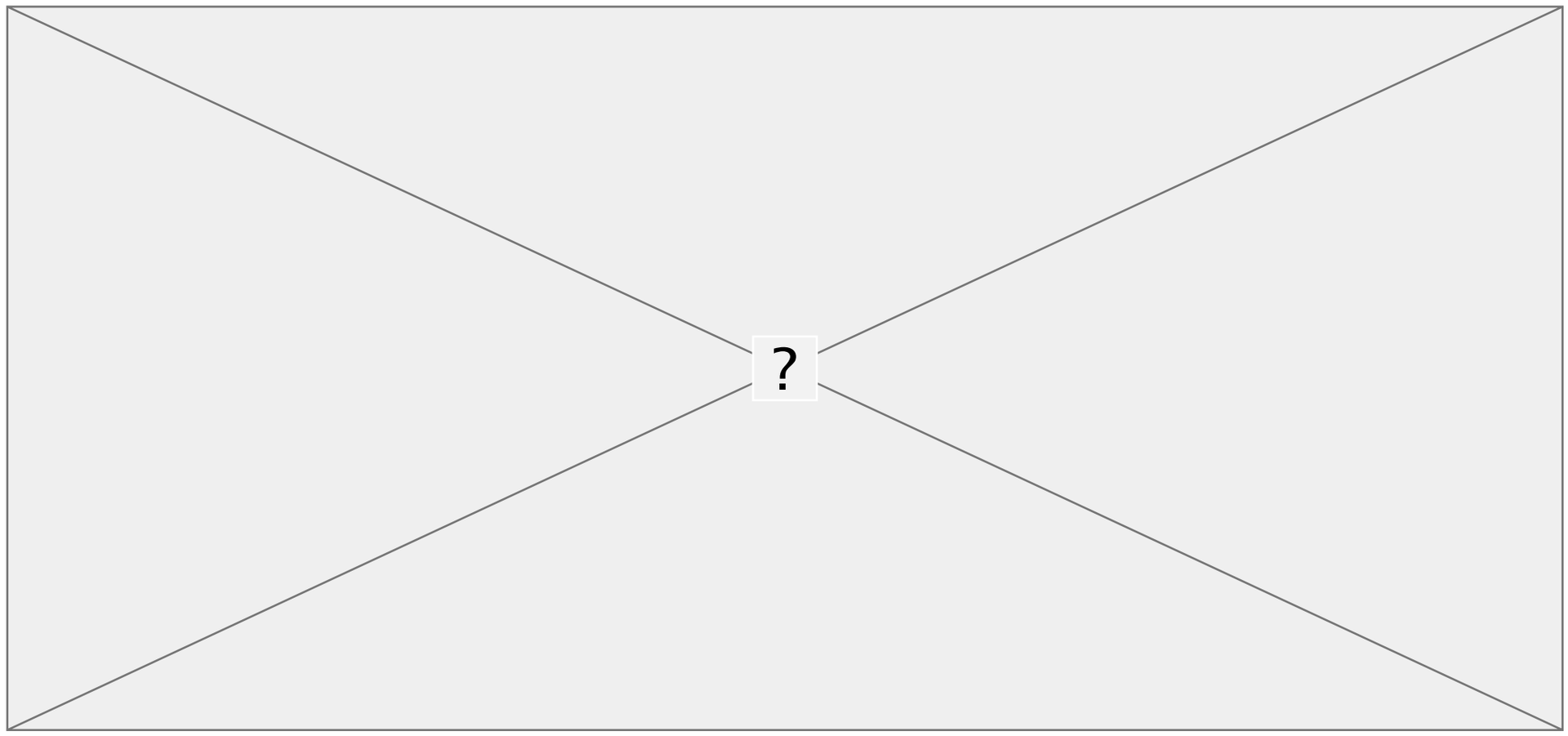
or

2001:0db8:3102::/64

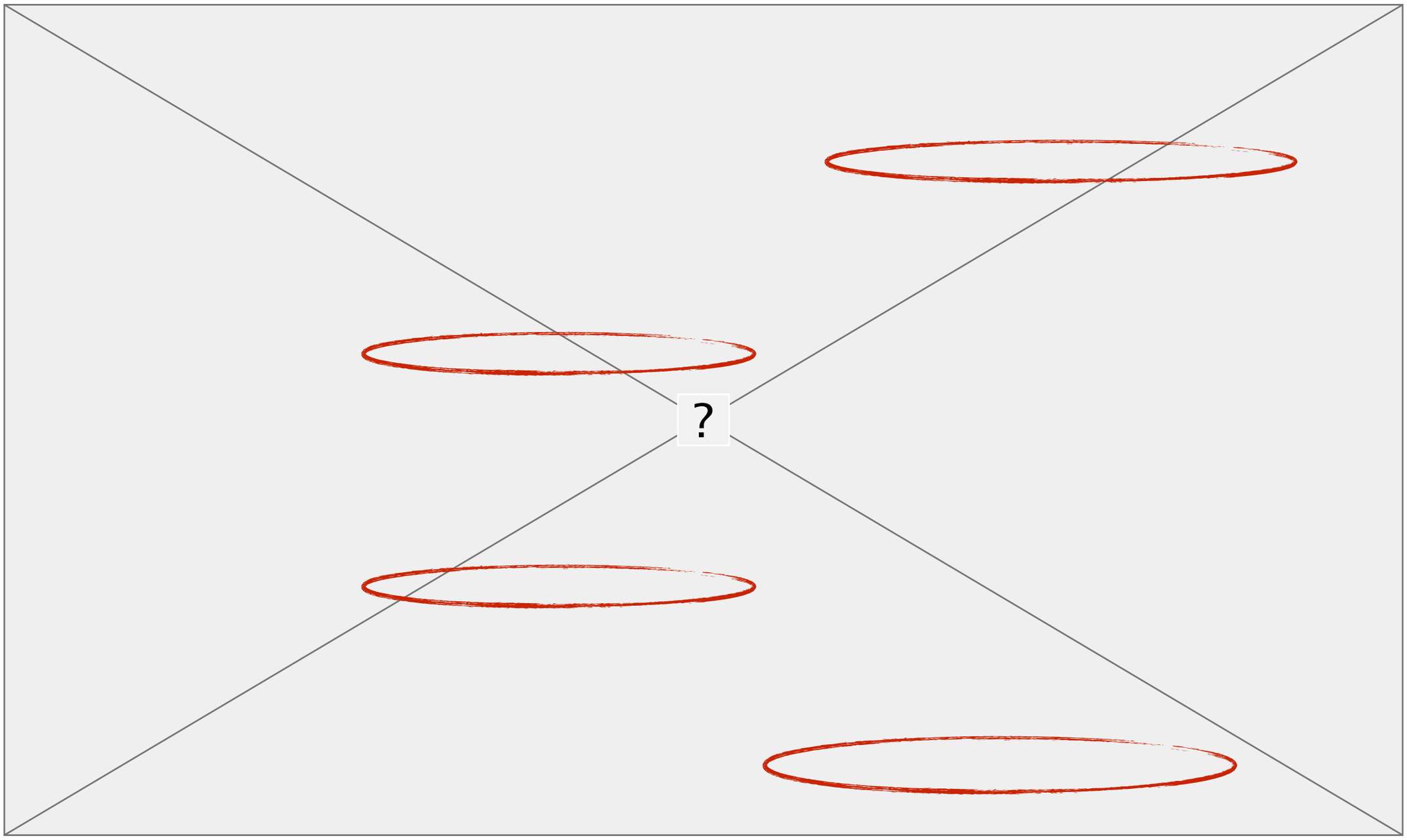
Exercise: Addressing plan

Assignments to:

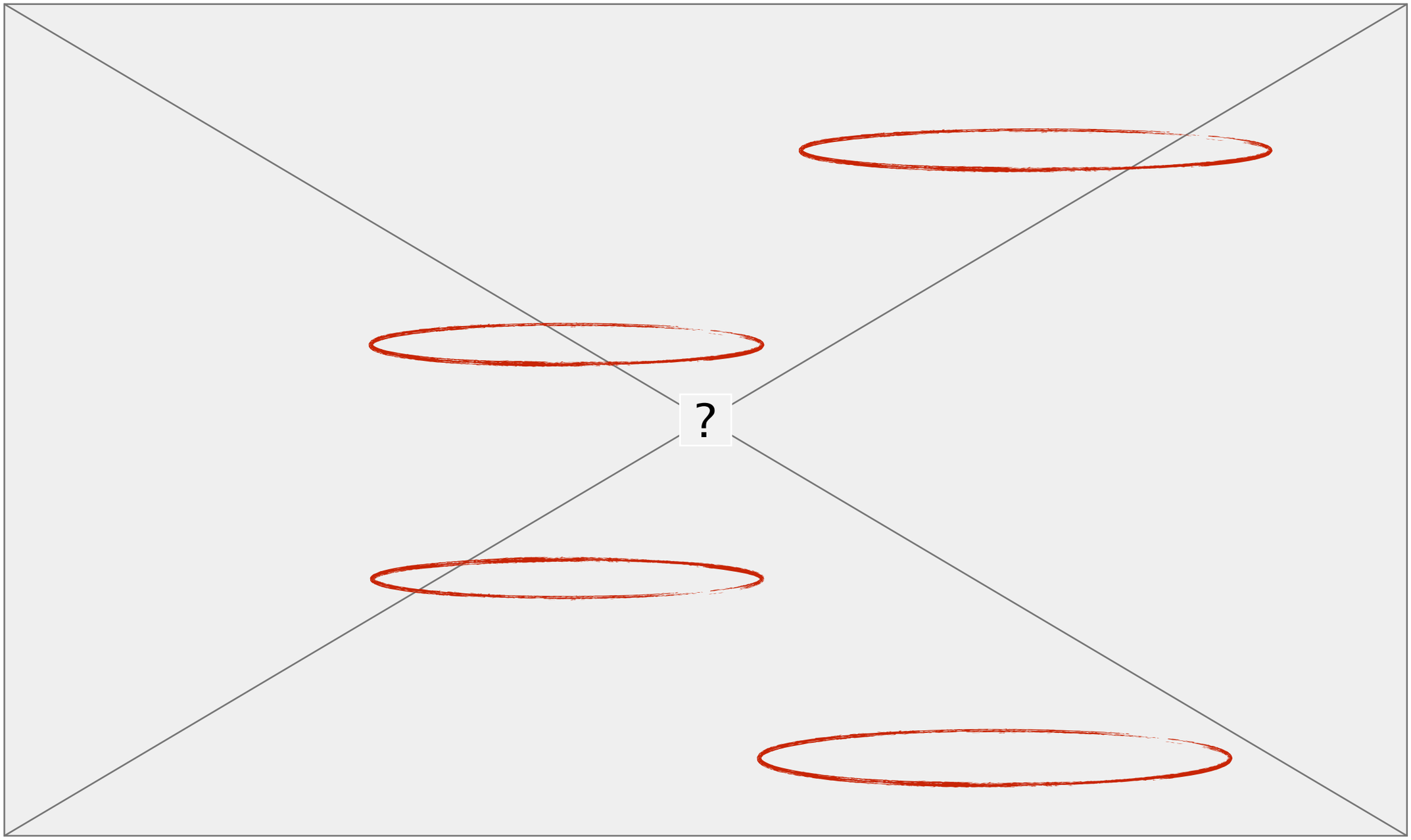
- **www VLAN**
- **colo 1 and colo 2: consider that there are 250 customers behind each colo.**
- **cr1.pop2 and cr1.pop1**
- **Point-to-Point customer 1**



Addressing plan: solution 1



Addressing plan: solution 2



Addressing plans: Summary

- **Number of hosts in a /64 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**

More on Addressing Plans

- For private networks, consider ULA
- For servers you want a manual configuration
- Use port numbers for addresses
  - pop server 2001:db8:1::110
  - dns server 2001:db8:1::53
  - etc…

Tips

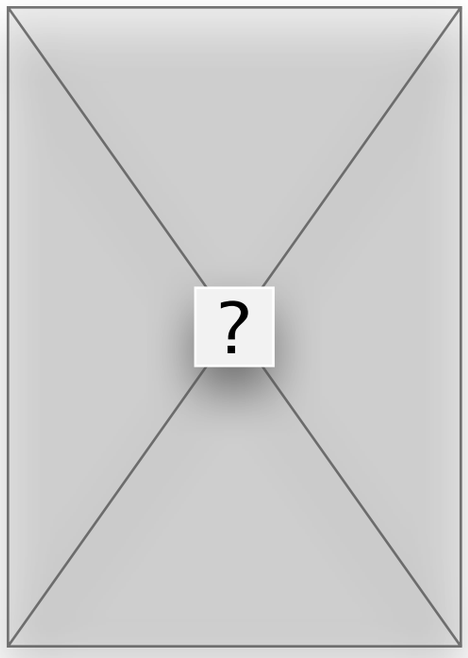
Section 9

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)

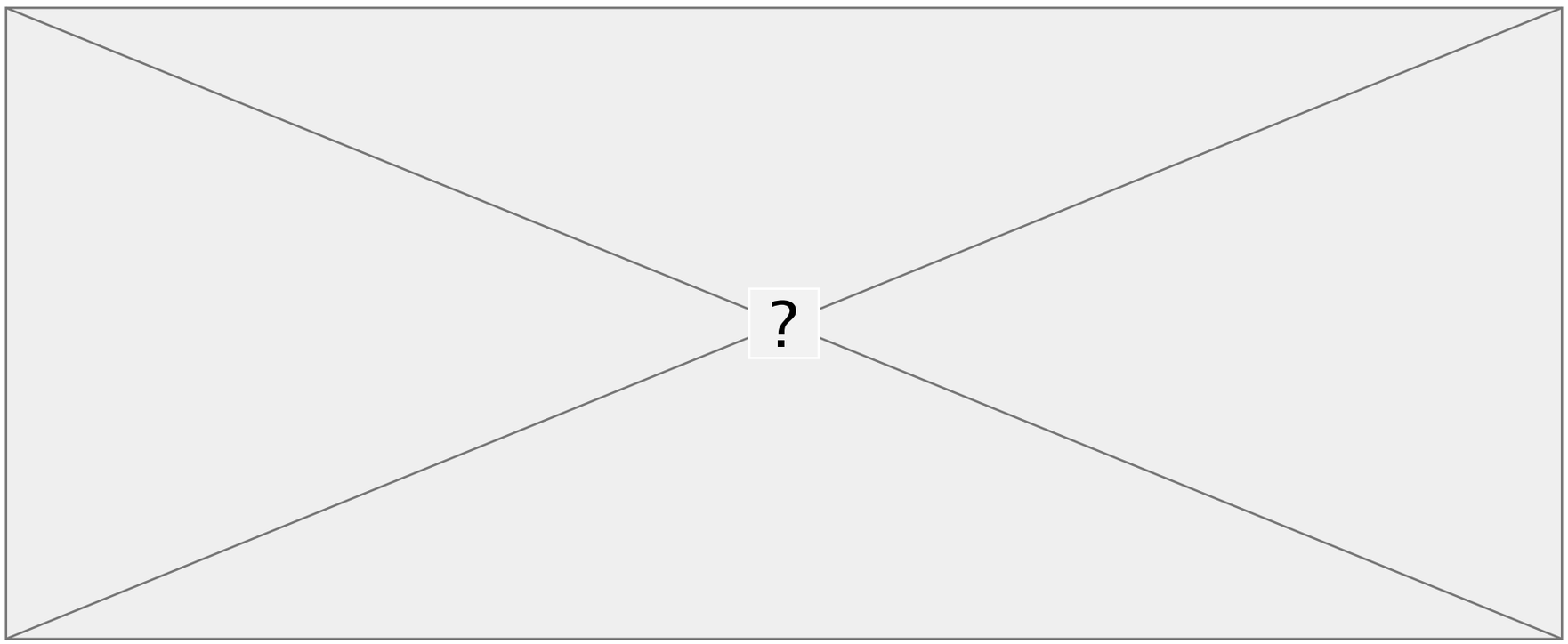
Customers And Their /48

- 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/Preparing-an-IPv6-Addressing-Plan.pdf



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



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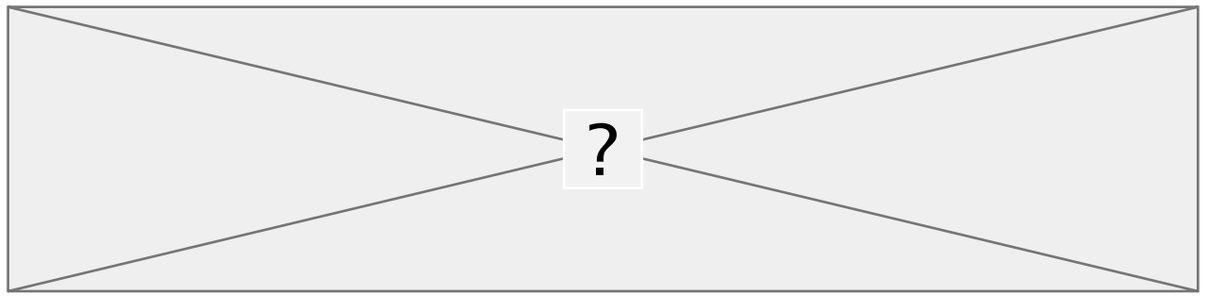
http://academy.ripe.net

Follow us!



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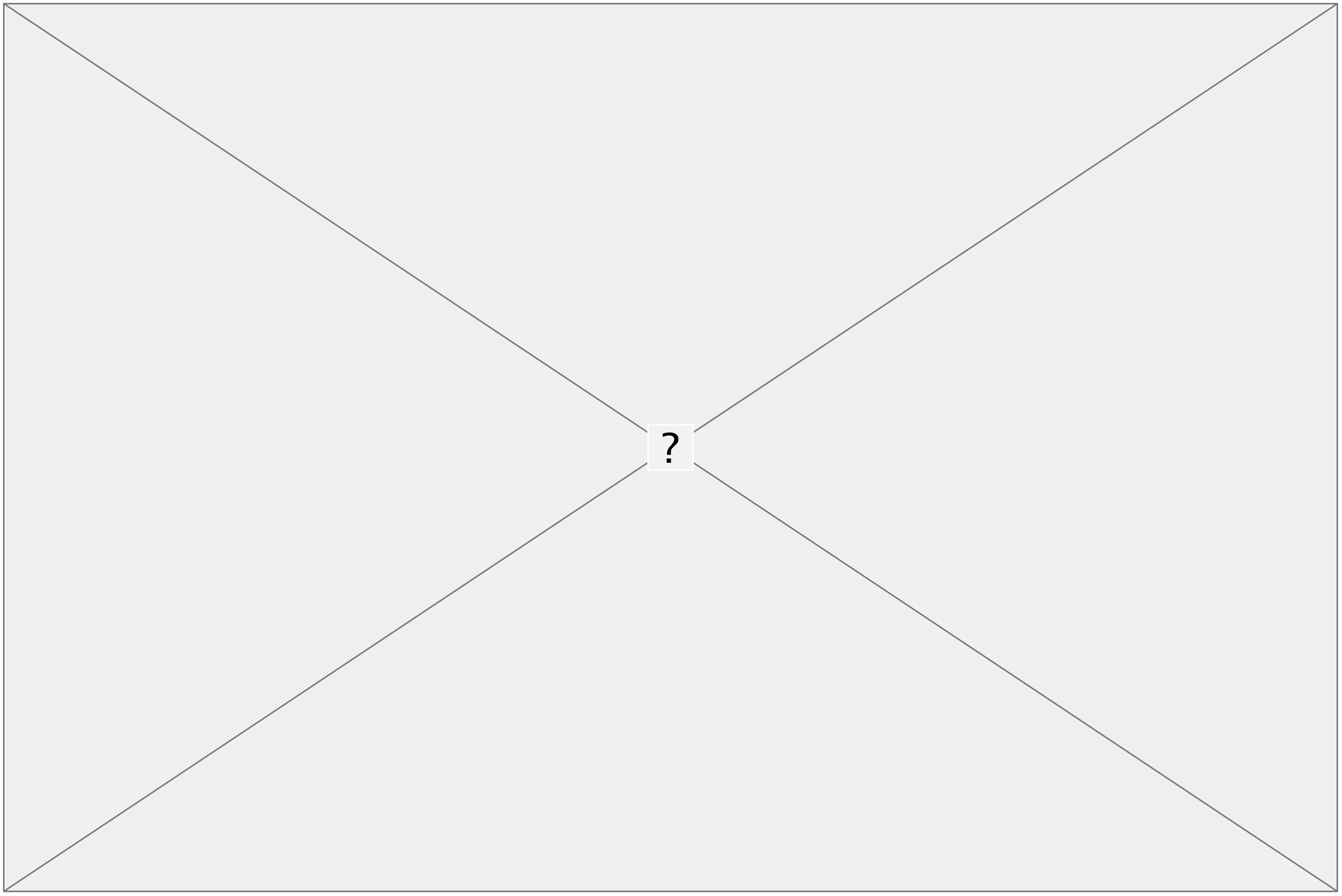
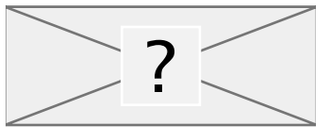
Questions?





The End!

Край

Y Diwedd

Fí

Finis

Соңы

Վերջ

النهاية

Liðugt

Ende

Finvezh

Кінець

Konec

Kraj

Ënn

Fund

پایان

Son

Крај

Lõpp

Beigas

Vége

An Críoch

סוף

Endir

Fine

Sfârşit

Fin

Τέλος

Einde

Конец

Slut

Slutt

დასასრული

Pabaiga

Tmiem

Koniec

Amaia

Loppu

Fim