Basic IPv6 Tutorial

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Overview

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

IPv4?

Section 1

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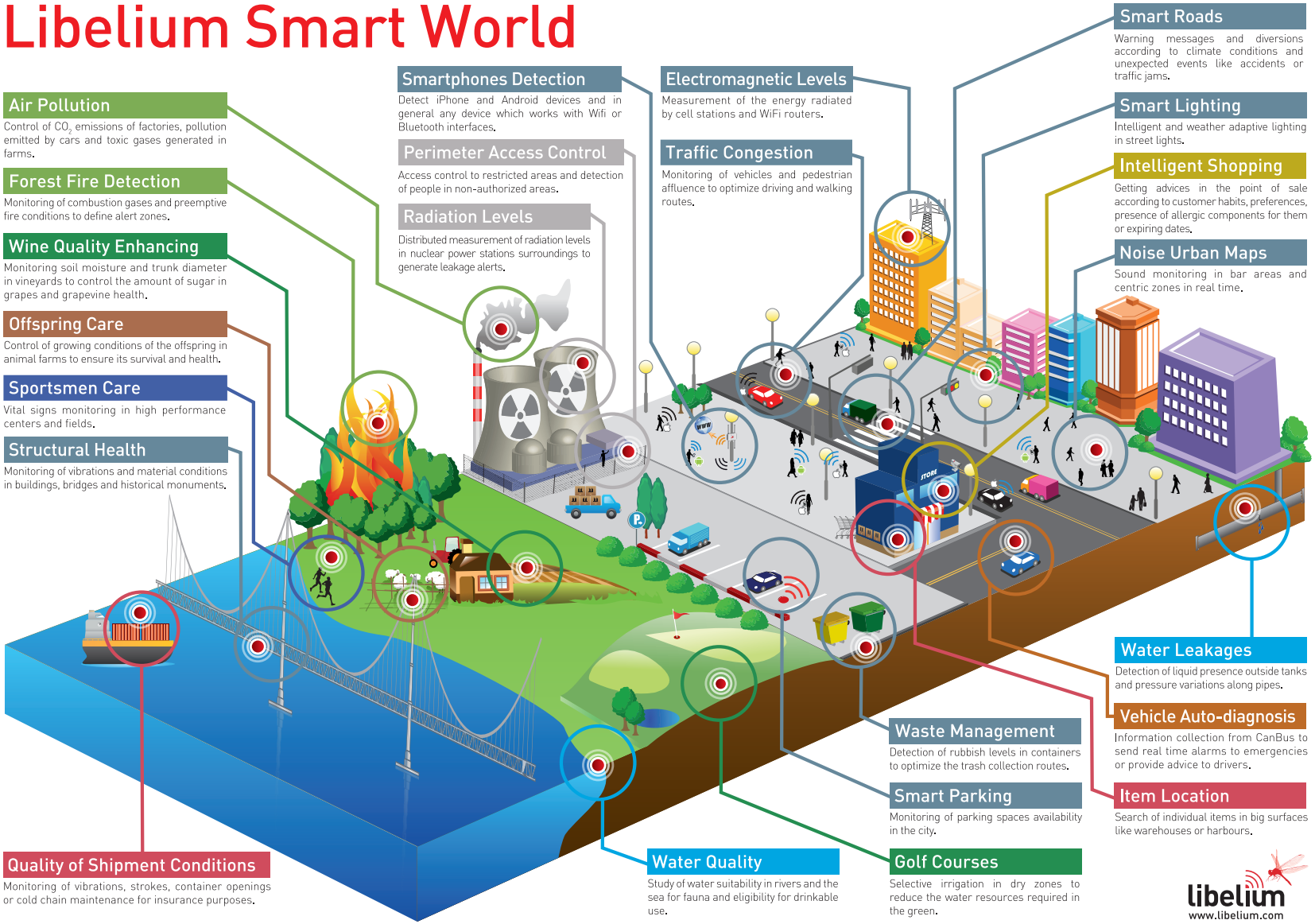
“On 14 September 2012, the RIPE NCC ran out of their regular pool of IPv4”

RIPE NCC

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?

Libelium Smart World

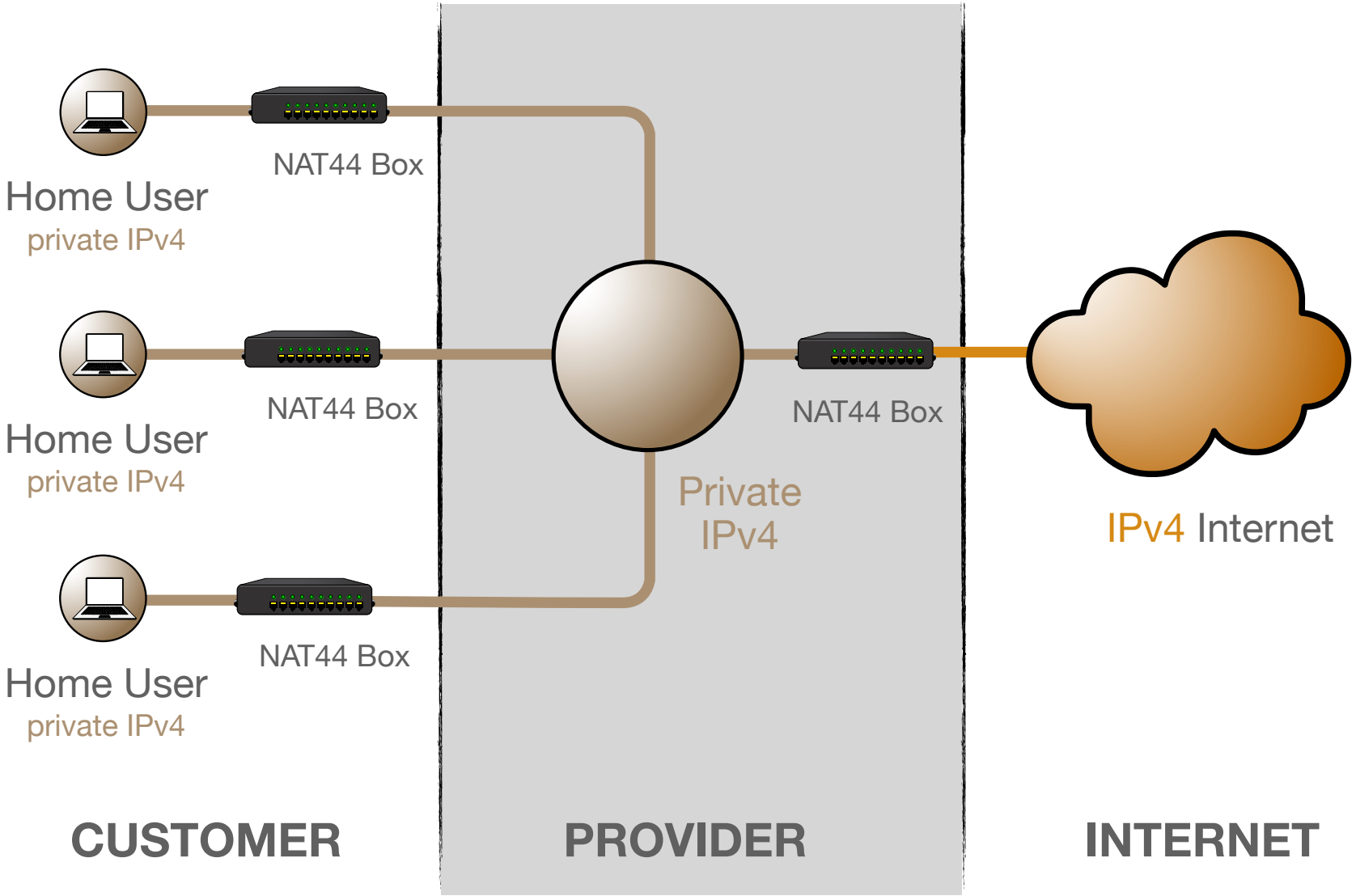


http://www.libelium.com/top_50_iot_sensor_applications_ranking

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

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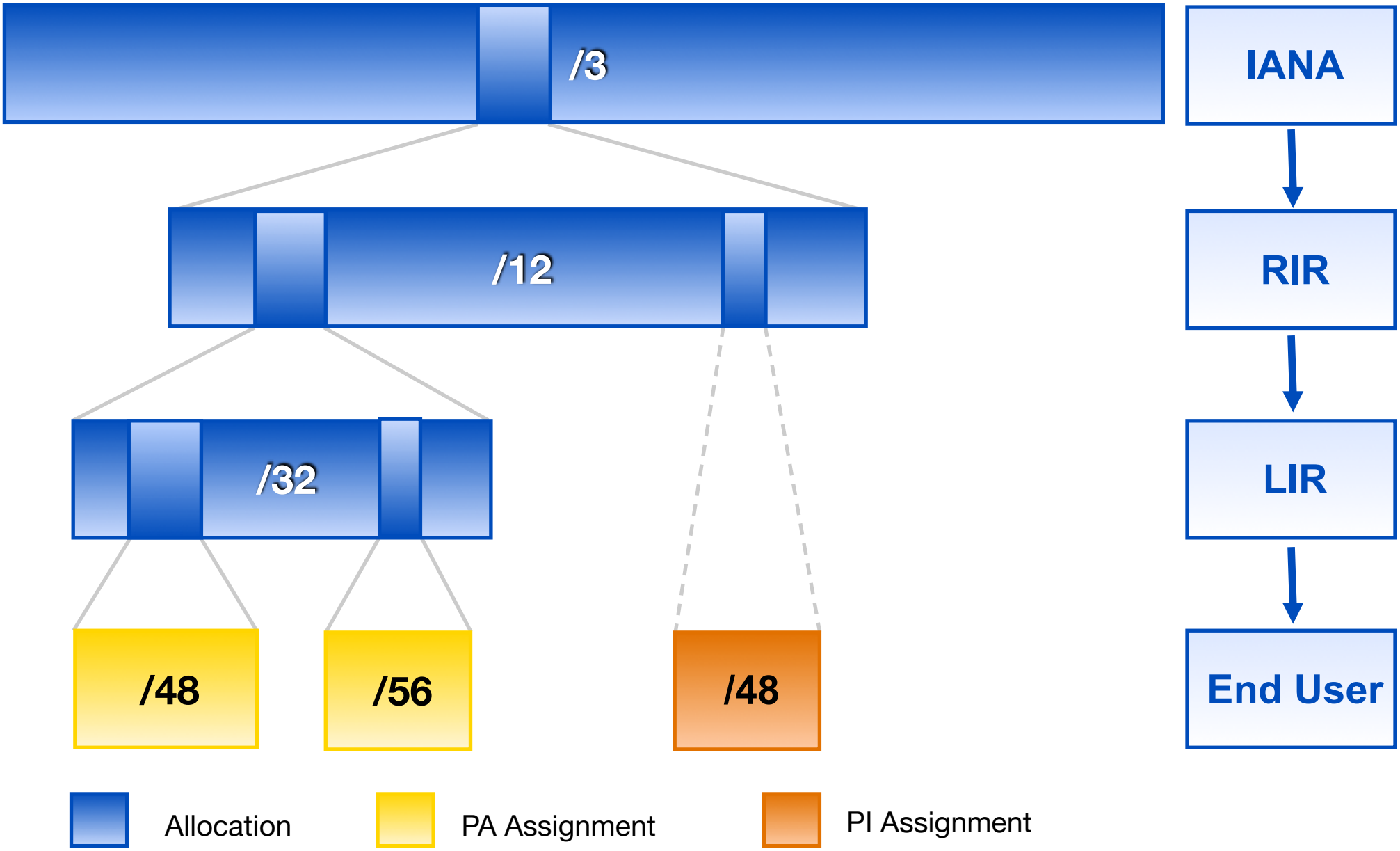
IP Address Distribution



PHILOSOPHY CHANGE

IPv4 -> IPv6: What Philosophy Change?

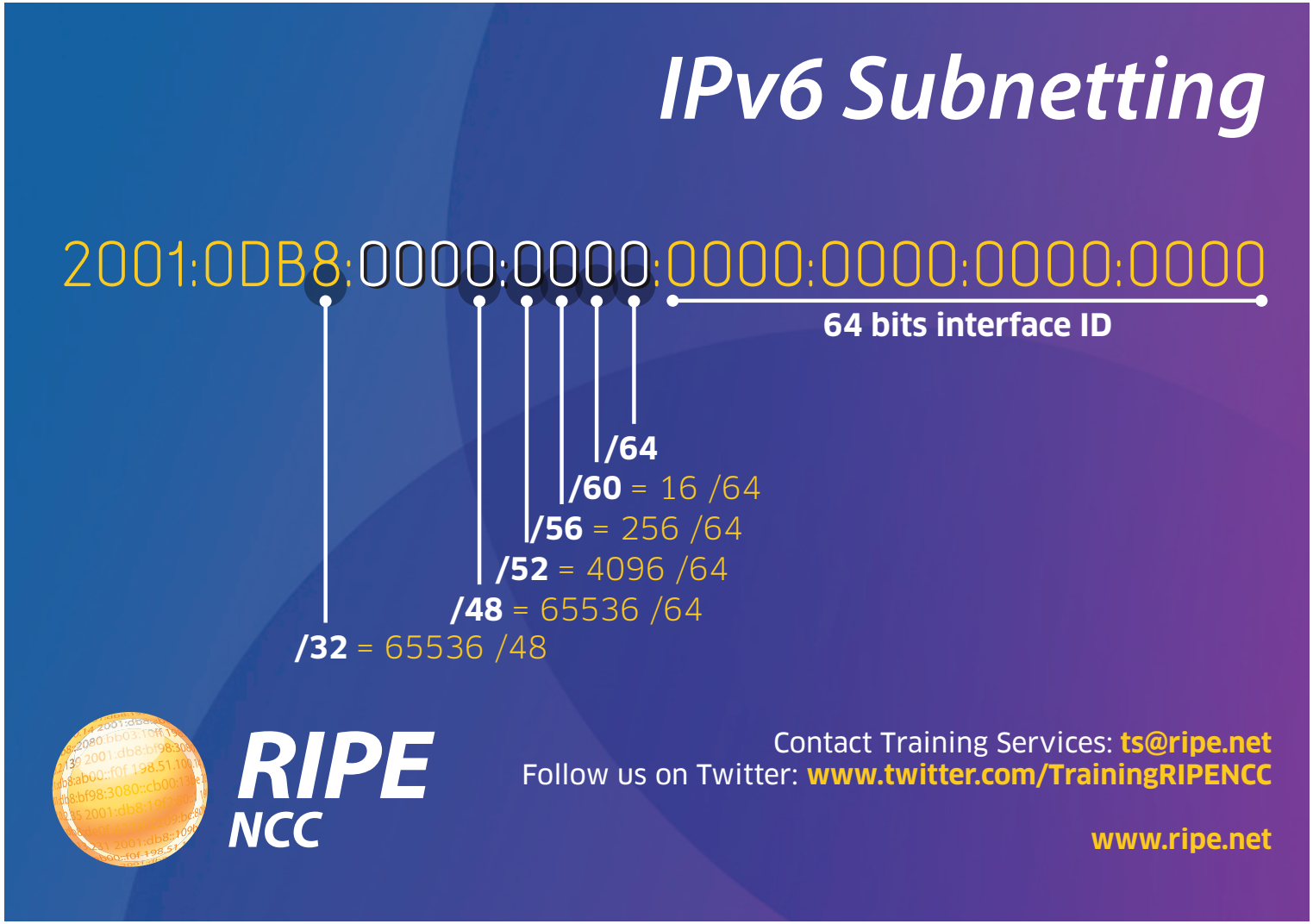
~~How many IP addresses do I need?~~

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

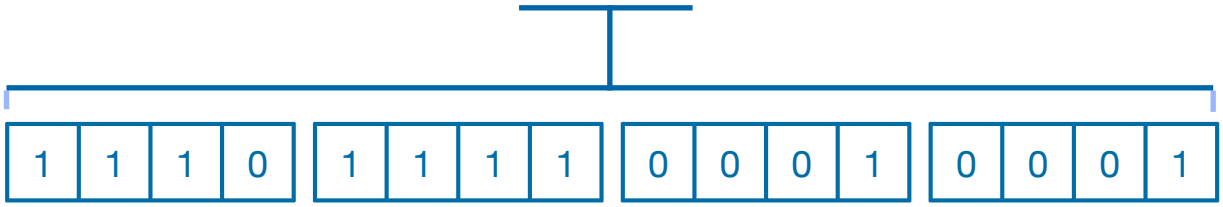

IPv6 Subnetting
2001:0DB8:0000:0000:0000:0000:0000:0000
64 bits interface ID
/64
/60 = 16 /64
/56 = 256 /64
/52 = 4096 /64
/48 = 65536 /64
/32 = 65536 /48
RIPE NCC
Contact Training Services: ts@ripe.net
Follow us on Twitter: www.twitter.com/TrainingRIPENCC
www.ripe.net

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

RIPE NCC

IPv6 in the RIPE Database

Section 2

RIPE NCC

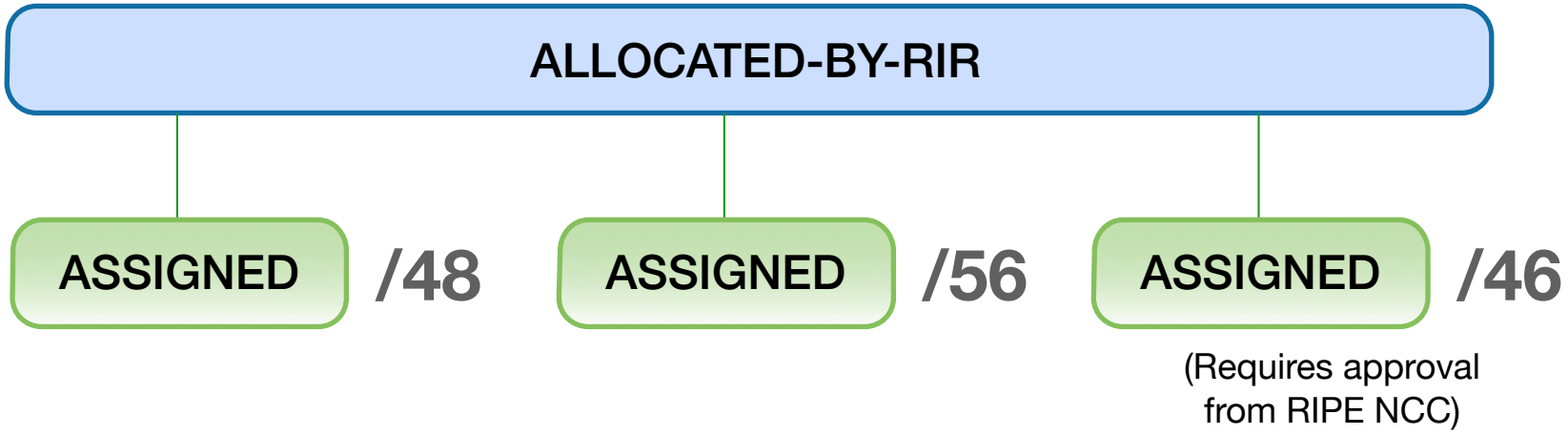
Customer Assignments

- **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

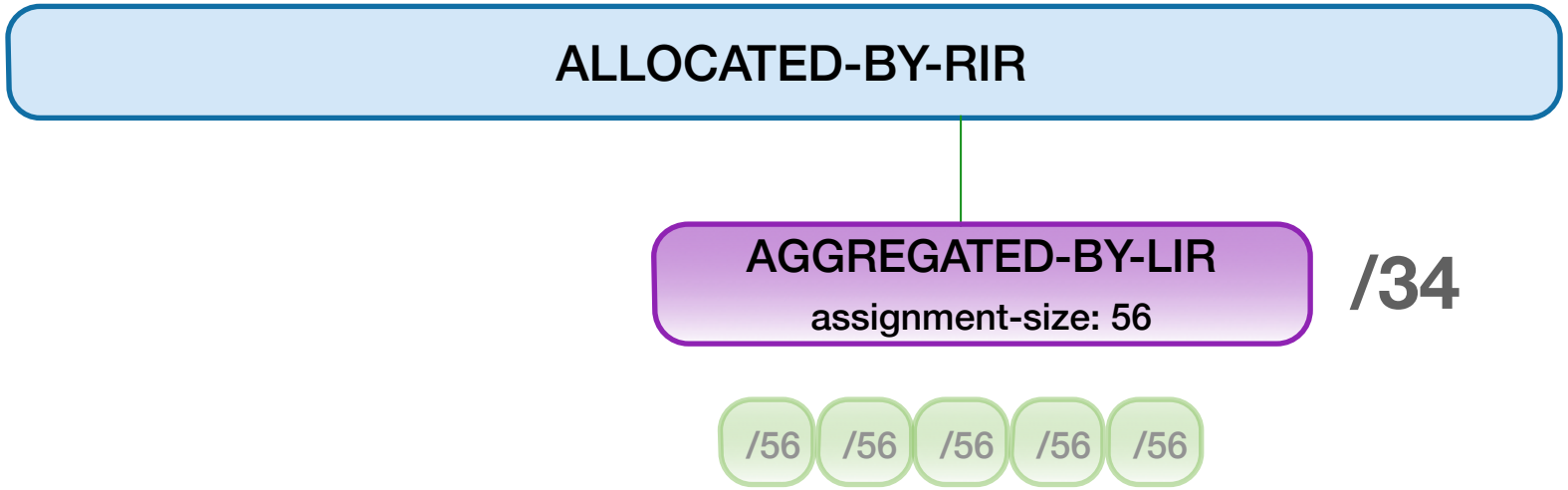
IPv4	IPv6
ALLOCATED PA	ALLOCATED-BY-RIR
ASSIGNED PA	ASSIGNED
ASSIGNED PA	AGGREGATED-BY-LIR
SUB-ALLOCATED PA	ALLOCATED-BY-LIR
ASSIGNED PI	ASSIGNED PI

Using ASSIGNED



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

Using AGGREGATED-BY-LIR

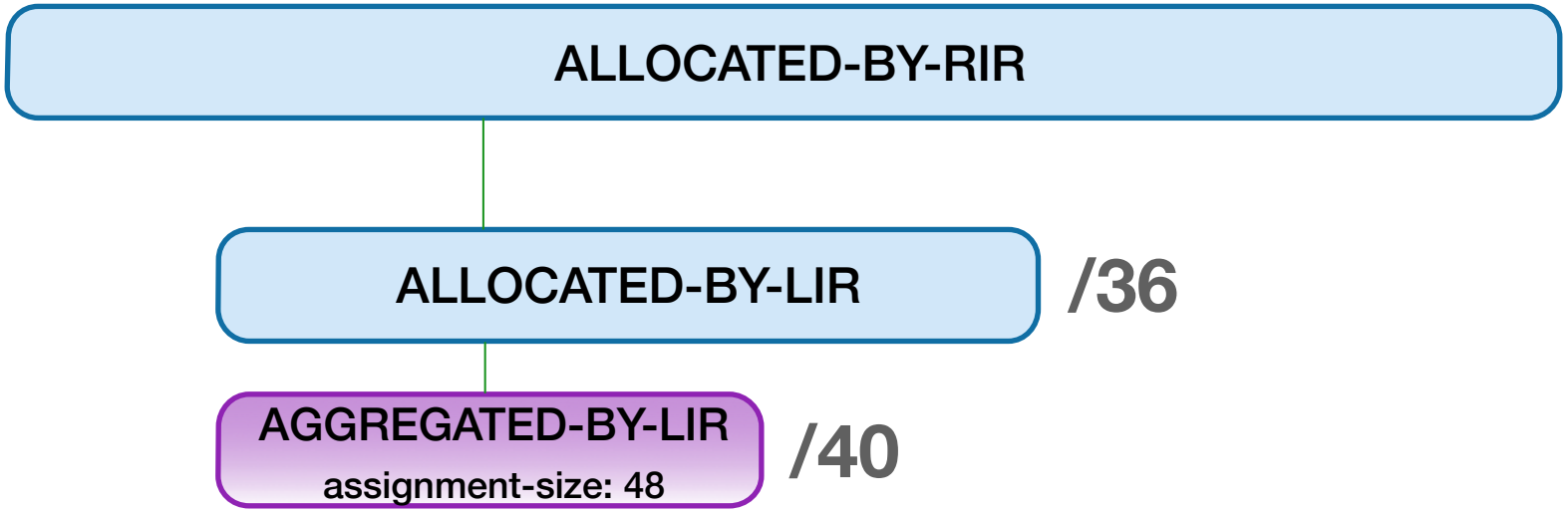


- **Can be used to group customers**
  - broadband, for example
- **“assignment size” = assignment of each customer**

AGGREGATED-BY-LIR in the RIPE DB

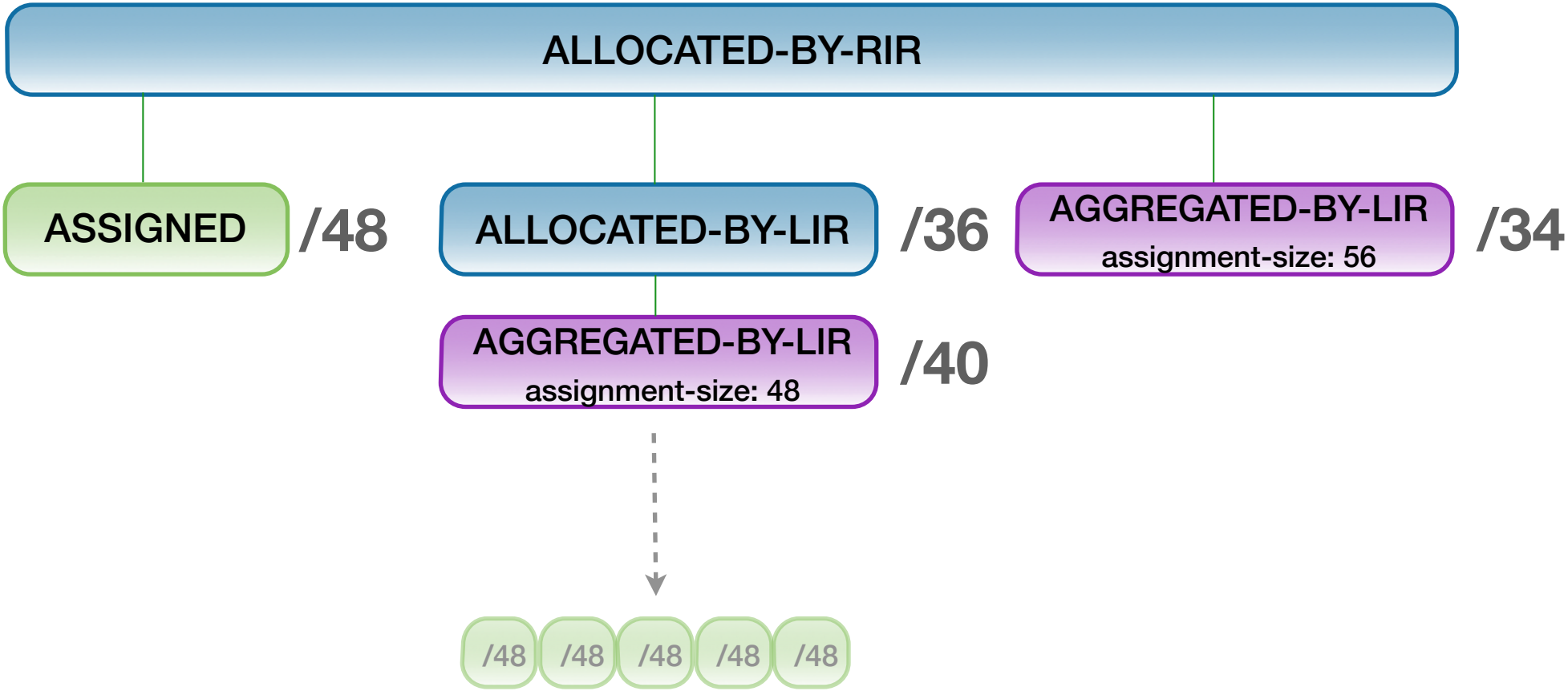
inet6num:	2001:db8:1000::/36
netname:	Brightlife
descr:	Broadband services
country:	NL
admin-c:	BN649-RIPE
tech-c:	BN649-RIPE
status:	**AGGREGATED-BY-LIR**
assignment-size:	**48**
mnt-by:	BRIGHTLIFE-MNT
notify:	noc@example.net
changed:	noc@example.net 20130218
source:	RIPE

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

Making Assignments

Exercise

RIPE NCC

Making Assignments Exercise

Fridge6!

Quiz!

Exercise

RIPE NCC

Take the Quiz!

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

Let’s play!

IPv6 Addressing Plans

Section 3

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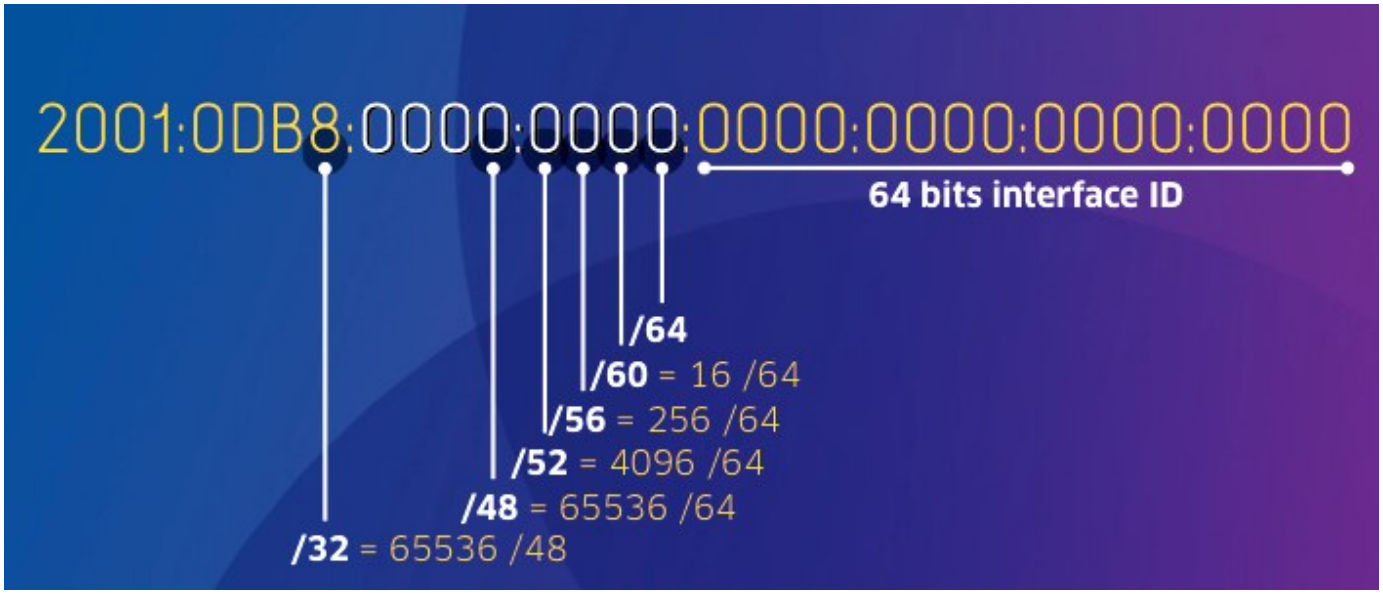
Why Create an IPv6 Addressing Plan?

- 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

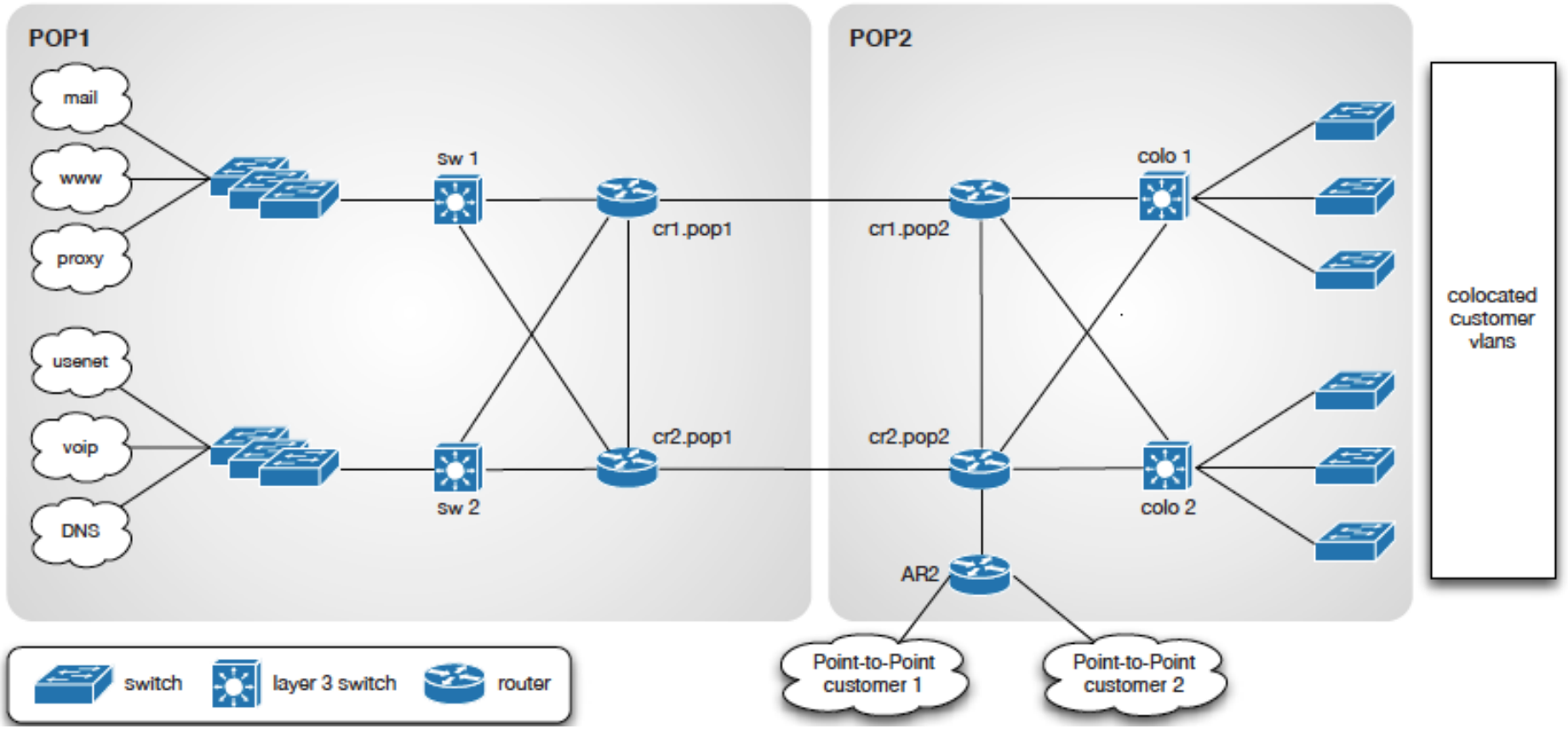
Loopback Interfaces

- **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


POP1
mail
www
proxy
usenet
voip
DNS
sw 1
sw 2
cr1.pop1
cr2.pop1
POP2
cr1.pop2
cr2.pop2
AR2
colo 1
colo 2
colocated customer vlans
Point-to-Point customer 1
Point-to-Point customer 2
switch
layer 3 switch
router

ISP Example

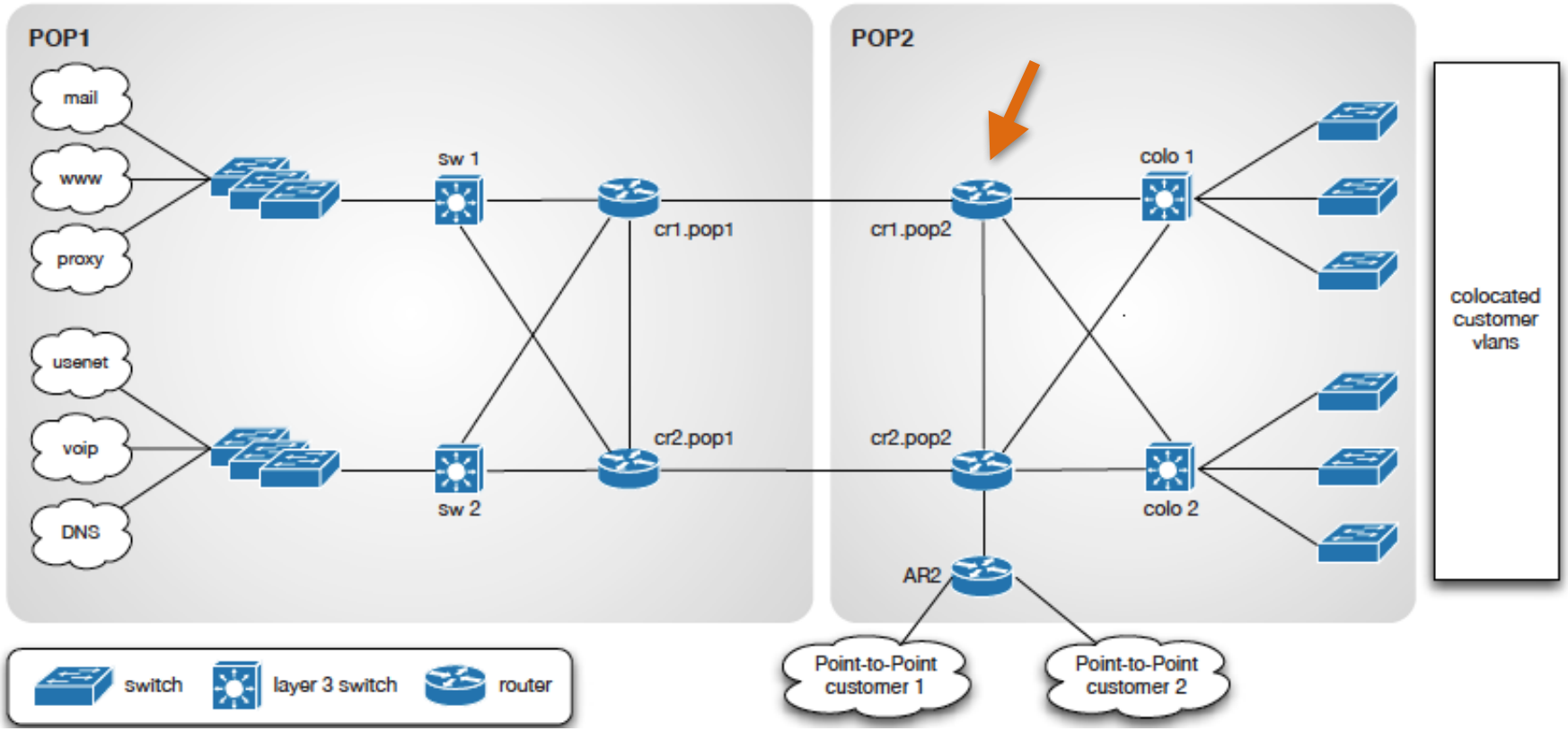
- We will assign a /48 per POP
- We will work on 4-bit boundary

Prefix	Number of /64 subnets
/48	65.536
/52	4096
/56	256
/60	16
/64	1

- 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

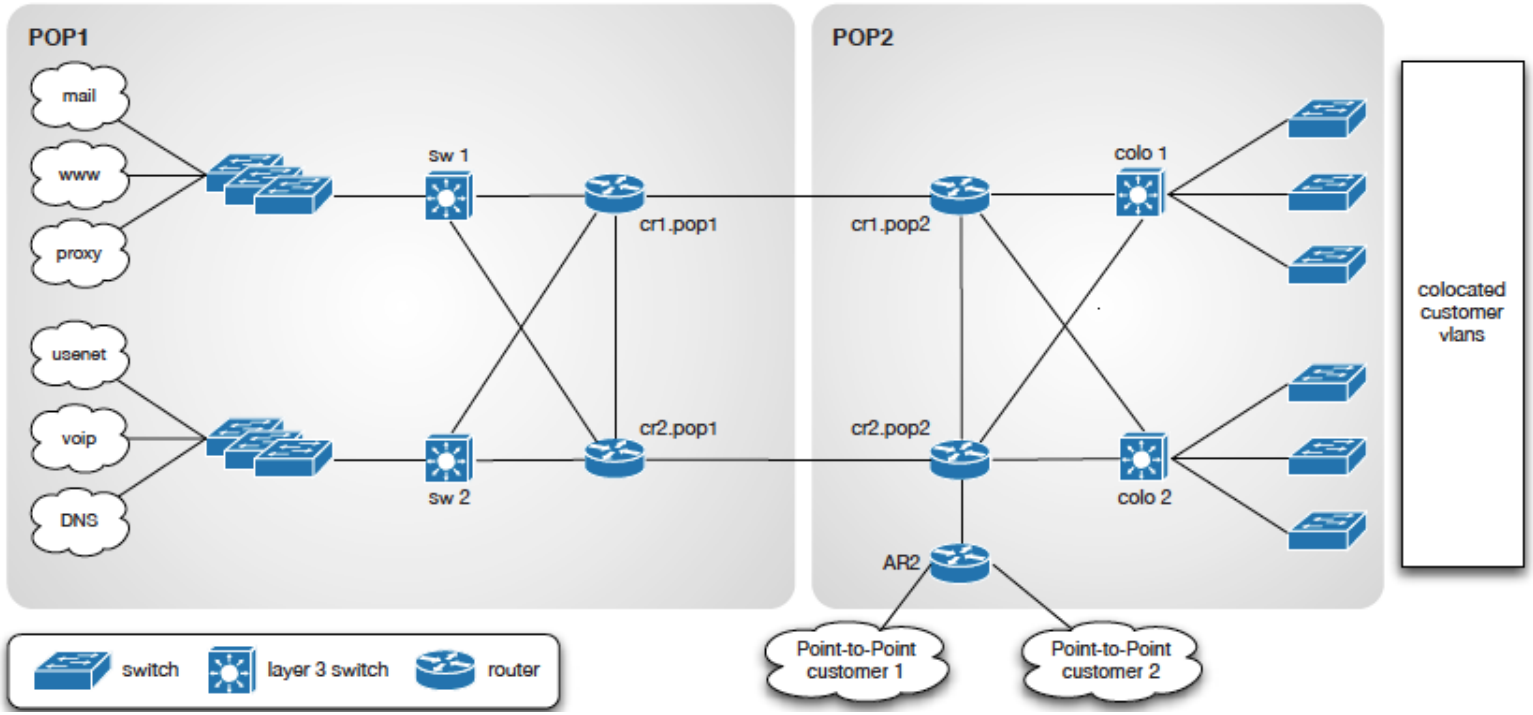
or

2001:0db8:3102::/64

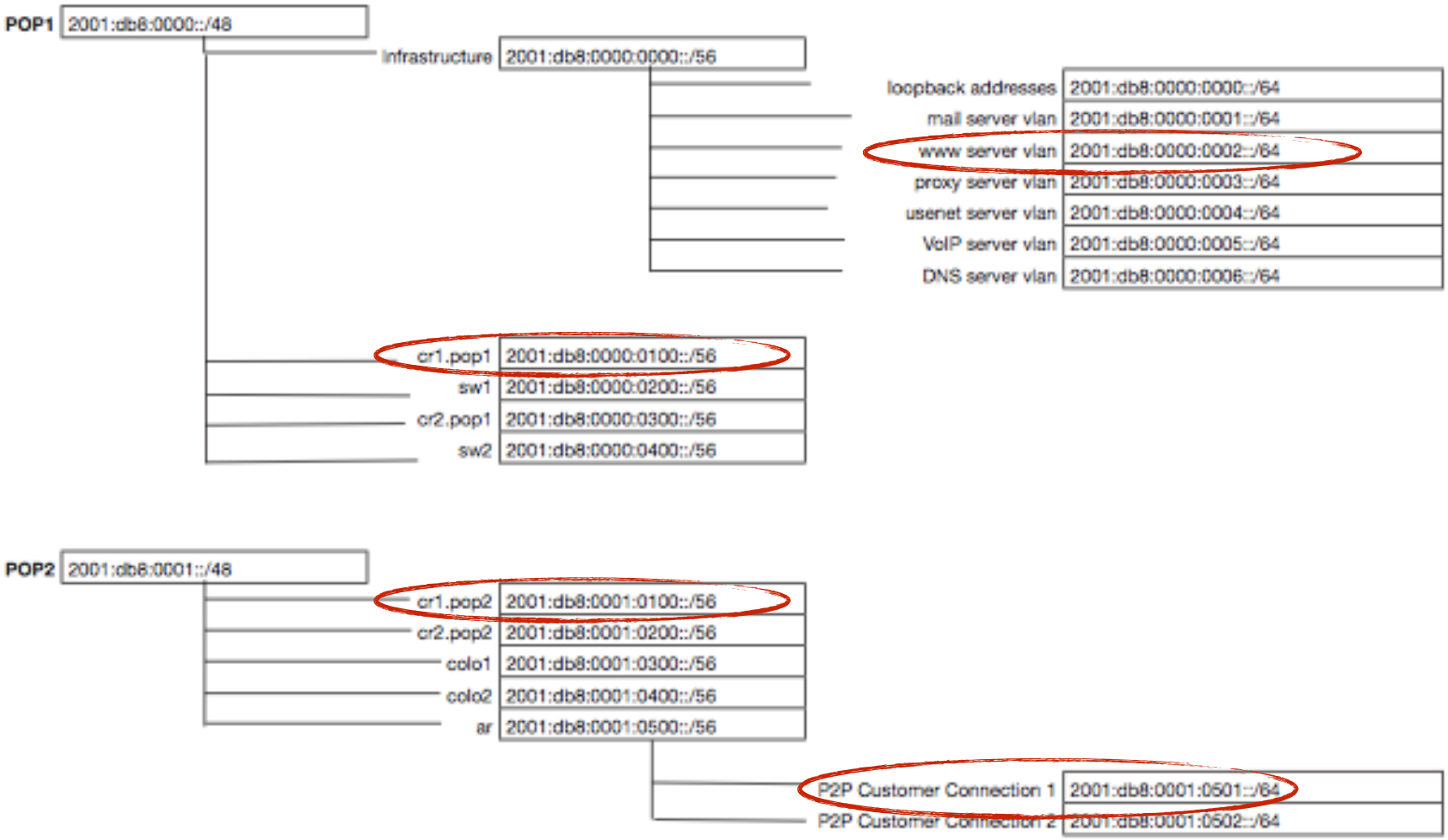
Exercise: Addressing plan

Assignments to:

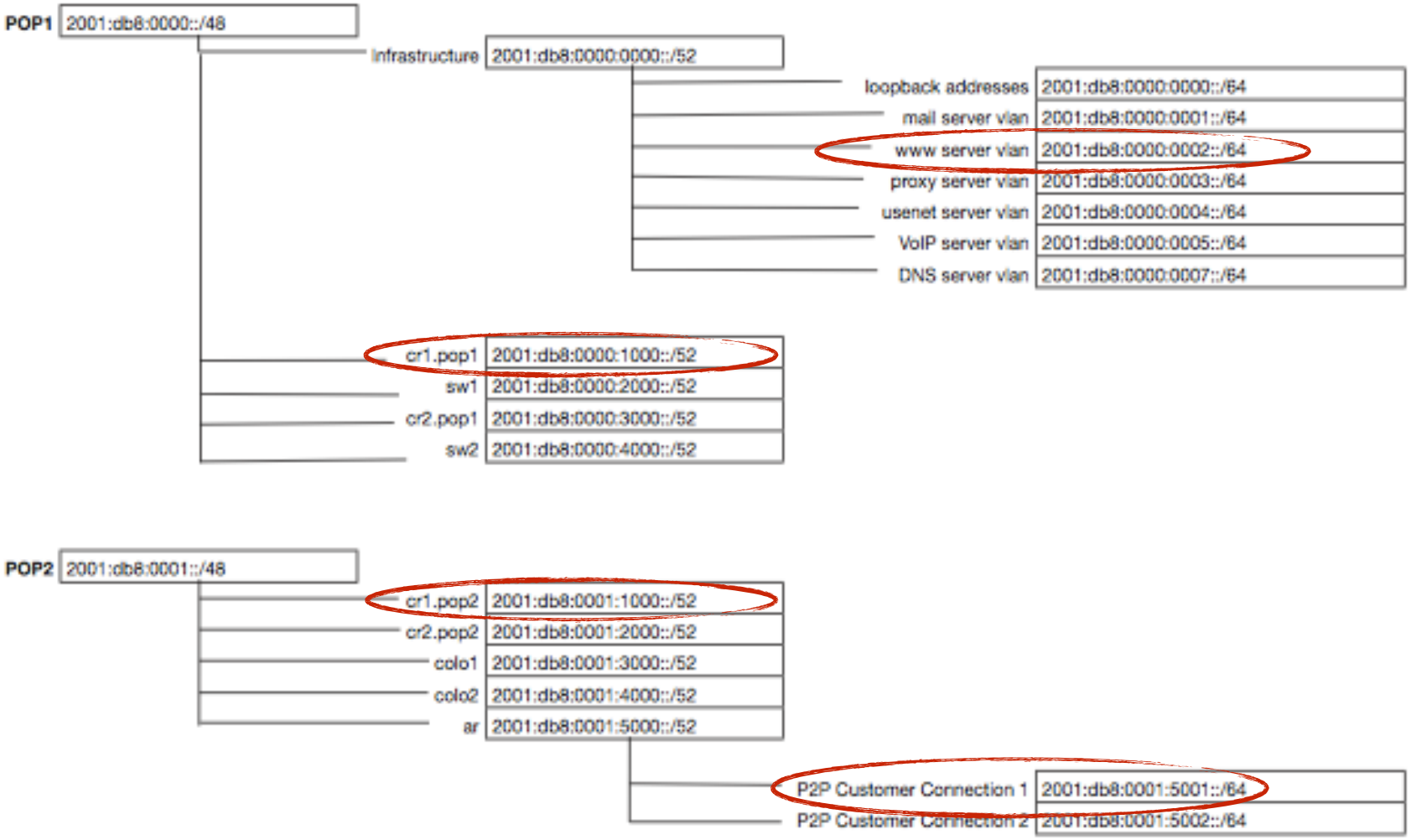
- www VLAN
- colo 1 and colo 2: consider that there are 250 customers behind each colo.
- cr1.pop2 and cr1.pop1
- Point-to-Point customer 1



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 NCC

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

Survey!

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Questions?

The End!

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Finvezh

Кінець

Konec

Kraj

Ënn

Fund

پایان

Son

Kpaj

Lõpp

Beigas

Vége

An Críoch

הסוף

Endir

Fine

Sfârşit

Fin

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Amaia

Loppu

Fim