IPv6 Addressing Fundamentals

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Swiss IPv6 Council
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Agenda

- RIPE Policies
- What ranges can I get, and where?
- Allocation Process
- How do I use this space?
- IPv6 Addressing Guidelines
- Recommendations

RIPE NCC - who are we?

RIPE NCC

- Located in Amsterdam
- Not for profit organisation
- One of the 5 Regional Internet Registries

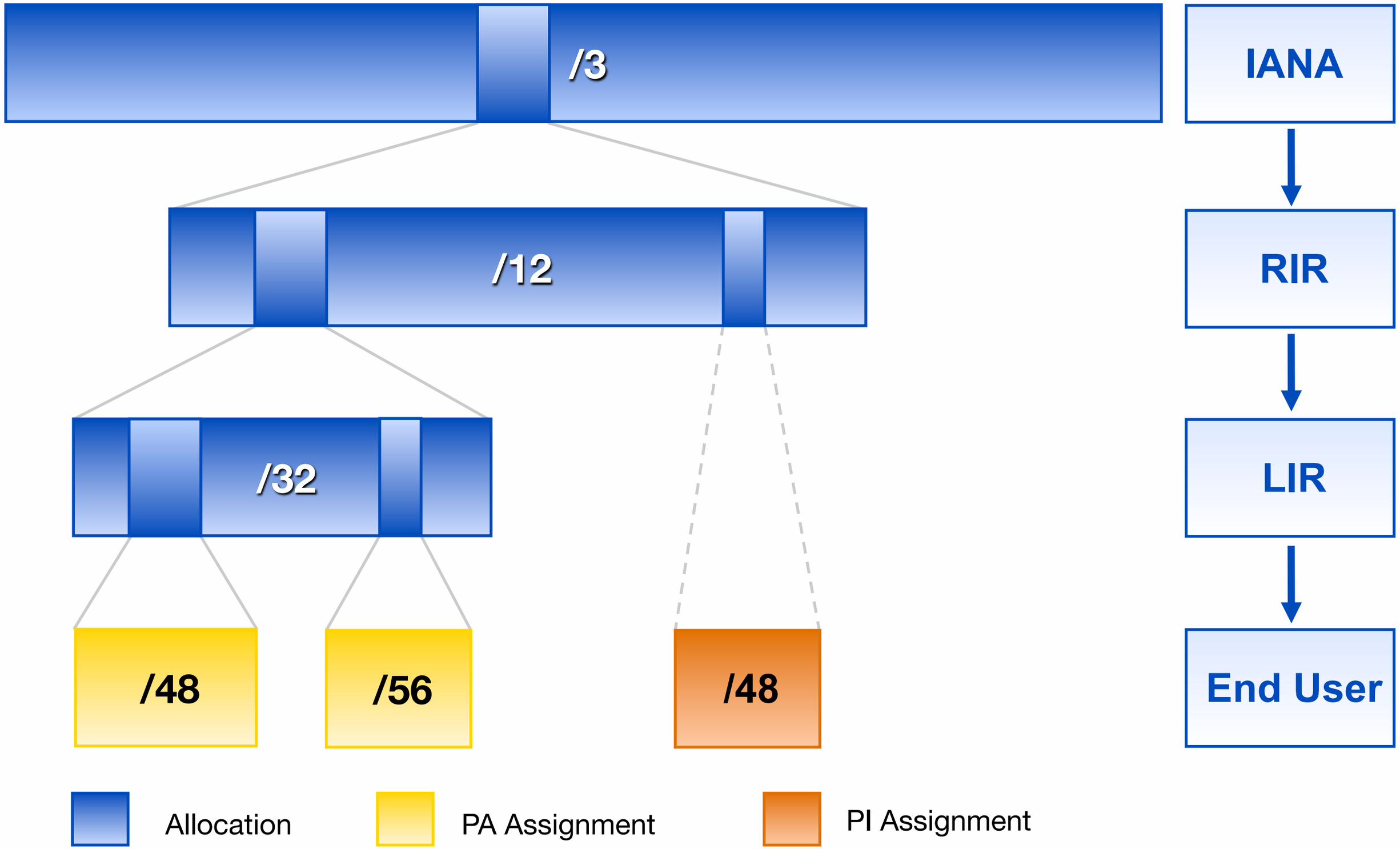
“On 14 September 2012, the RIPE NCC ran out of their regular pool of IPv4”

RIPE NCC

IPv6 Policies

Section 1

IP Address Distribution



RIPE Policies

- IPv6 Address Allocation & Assignment Policy
- RIPE-589
- Made by the RIPE Community
- Consensus is the key

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

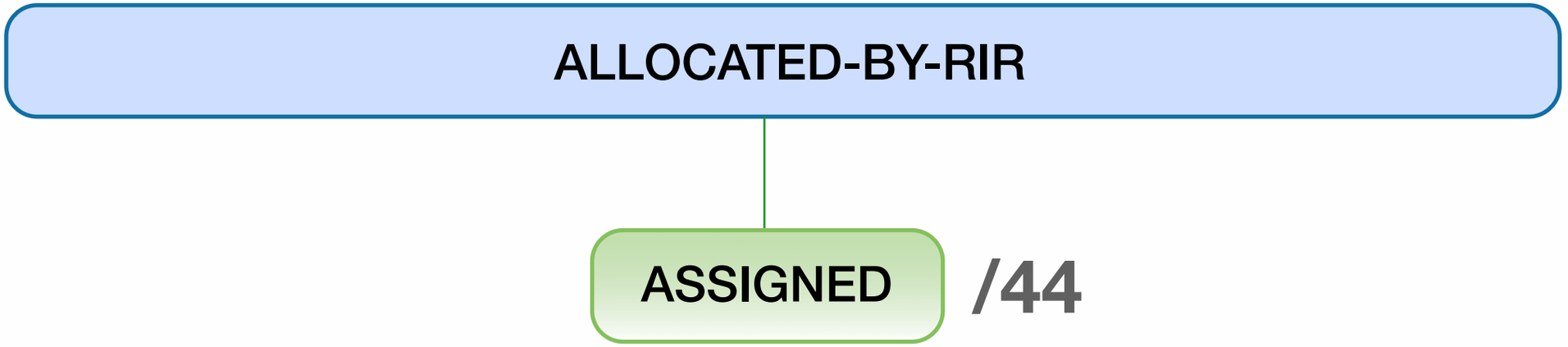
Customer Assignments

- 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

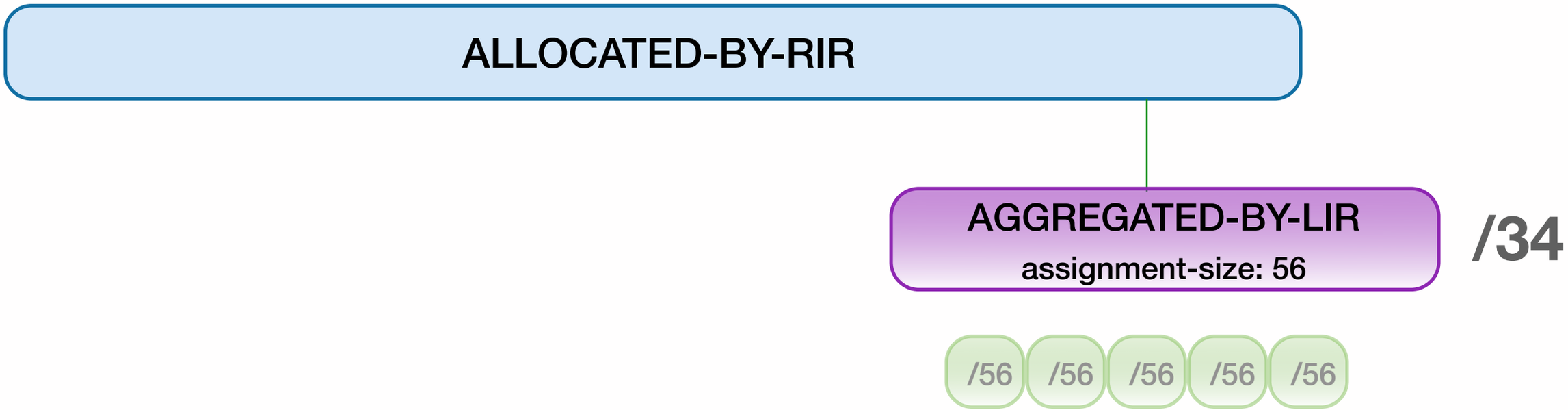
IPv4	IPv6
ALLOCATED PA	ALLOCATED-BY-RIR
ASSIGNED PA	ASSIGNED
ASSIGNED PA	AGGREGATED-BY-LIR
SUB-ALLOCATED PA	ALLOCATED-BY-LIR
ASSIGNED PI	ASSIGNED PI

Using ASSIGNED



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

Using AGGREGATED-BY-LIR

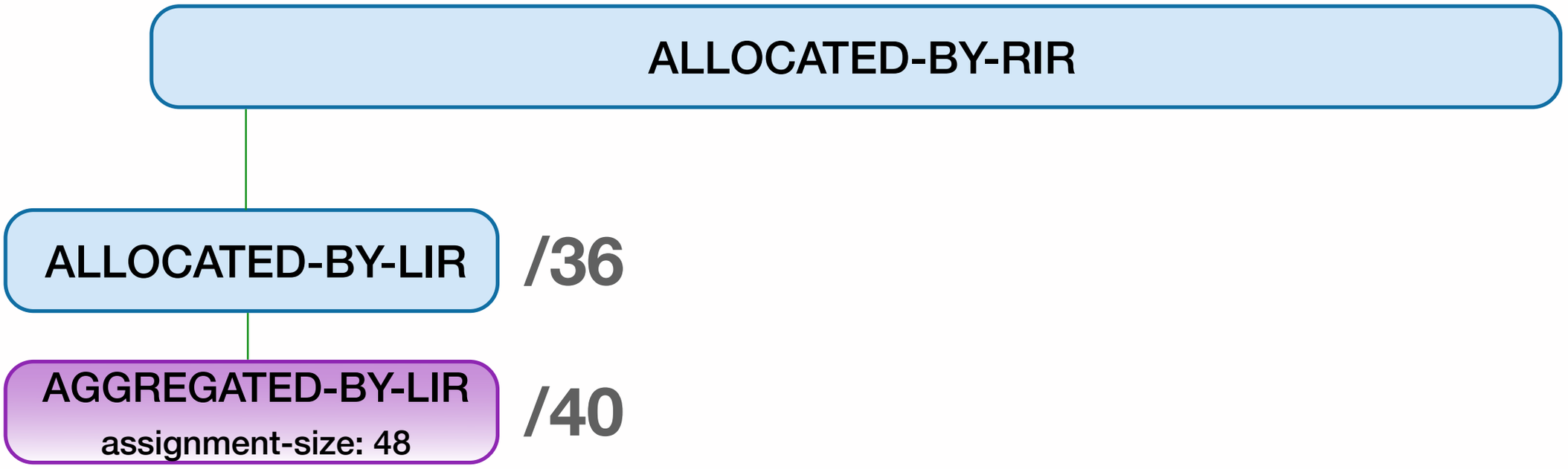


- Can be used to group customers
  - broadband, for example
- “assignment size” = assignment of each customer

AGGREGATED-BY-LIR in the RIPE DB

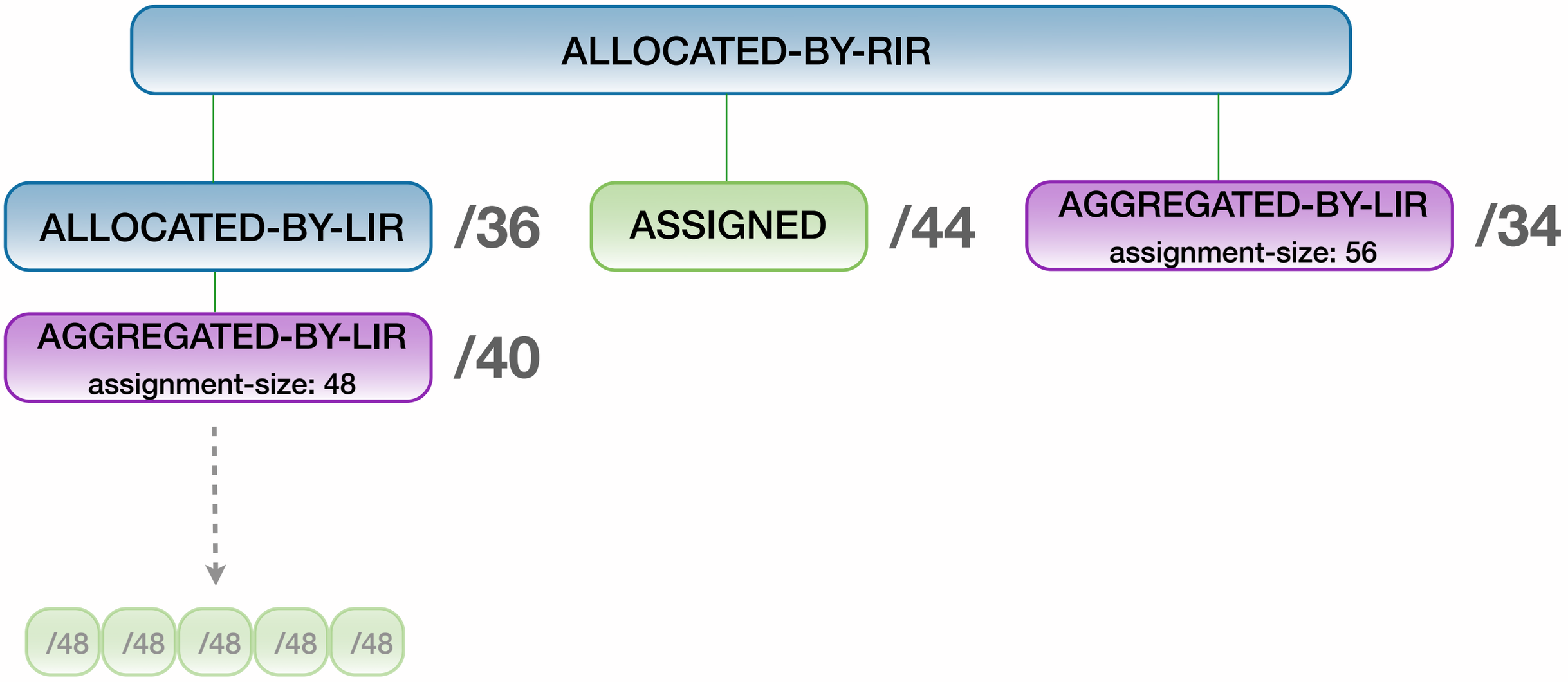

```
inet6num:        2001:db8:1000::/36
netname:         Brightlife
descr:           Broadband services
country:         NL
admin-c:         BN649-RIPE
tech-c:          BN649-RIPE
status:          AGGREGATED-BY-LIR
assignment-size: 48
mnt-by:          BRIGHTLIFE-MNT
notify:          noc@example.net
changed: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

Using ALLOCATED-BY-LIR



- Can be used for customers who expect large growth
  - or for your own infrastructure

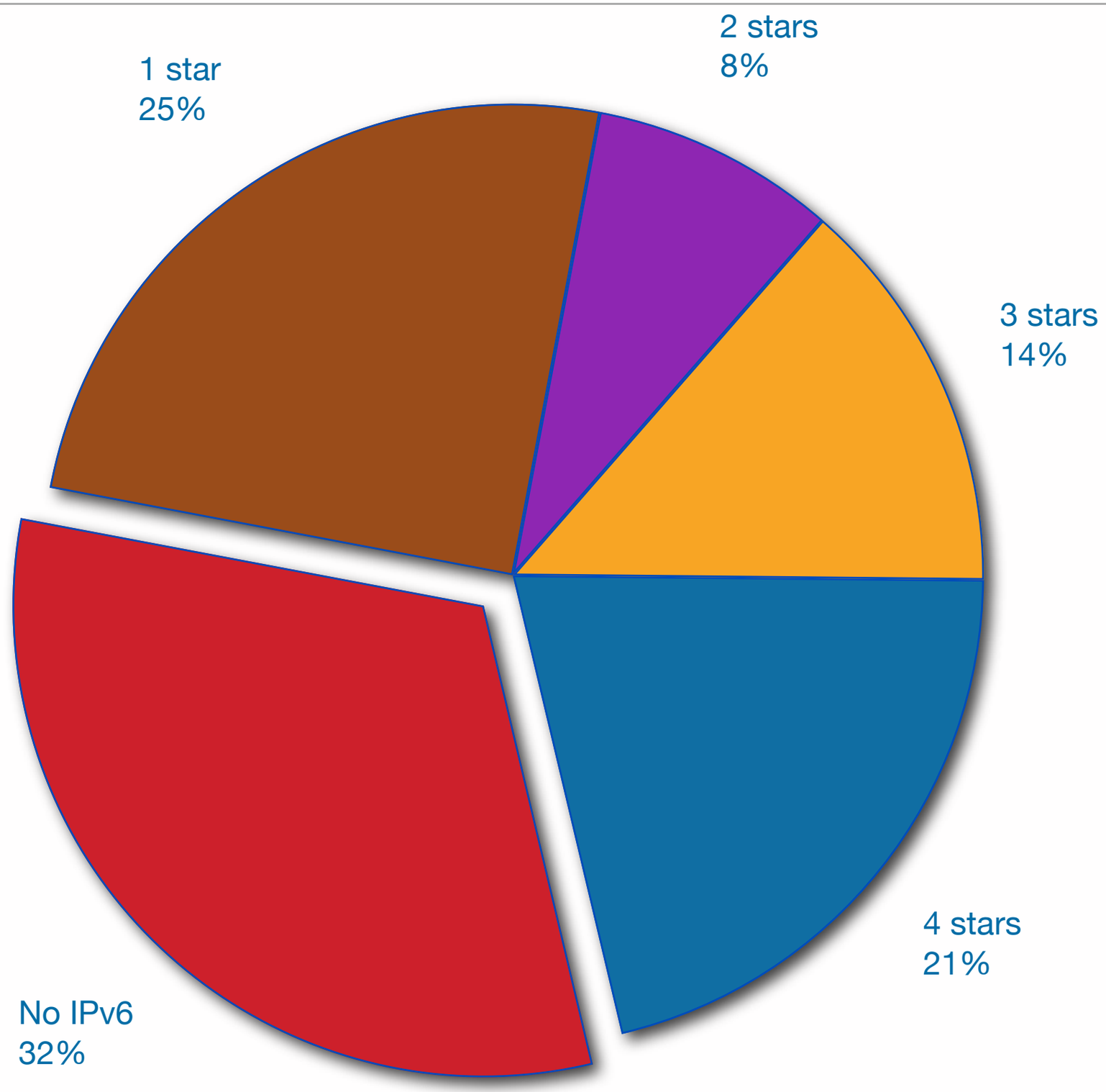
Overview


ALLOCATED-BY-RIR
ALLOCATED-BY-LIR
/36
ASSIGNED
/44
AGGREGATED-BY-LIR
assignment-size: 56
/34
AGGREGATED-BY-LIR
assignment-size: 48
/40
/48
/48
/48
/48
/48

Getting IPv6 PI address space

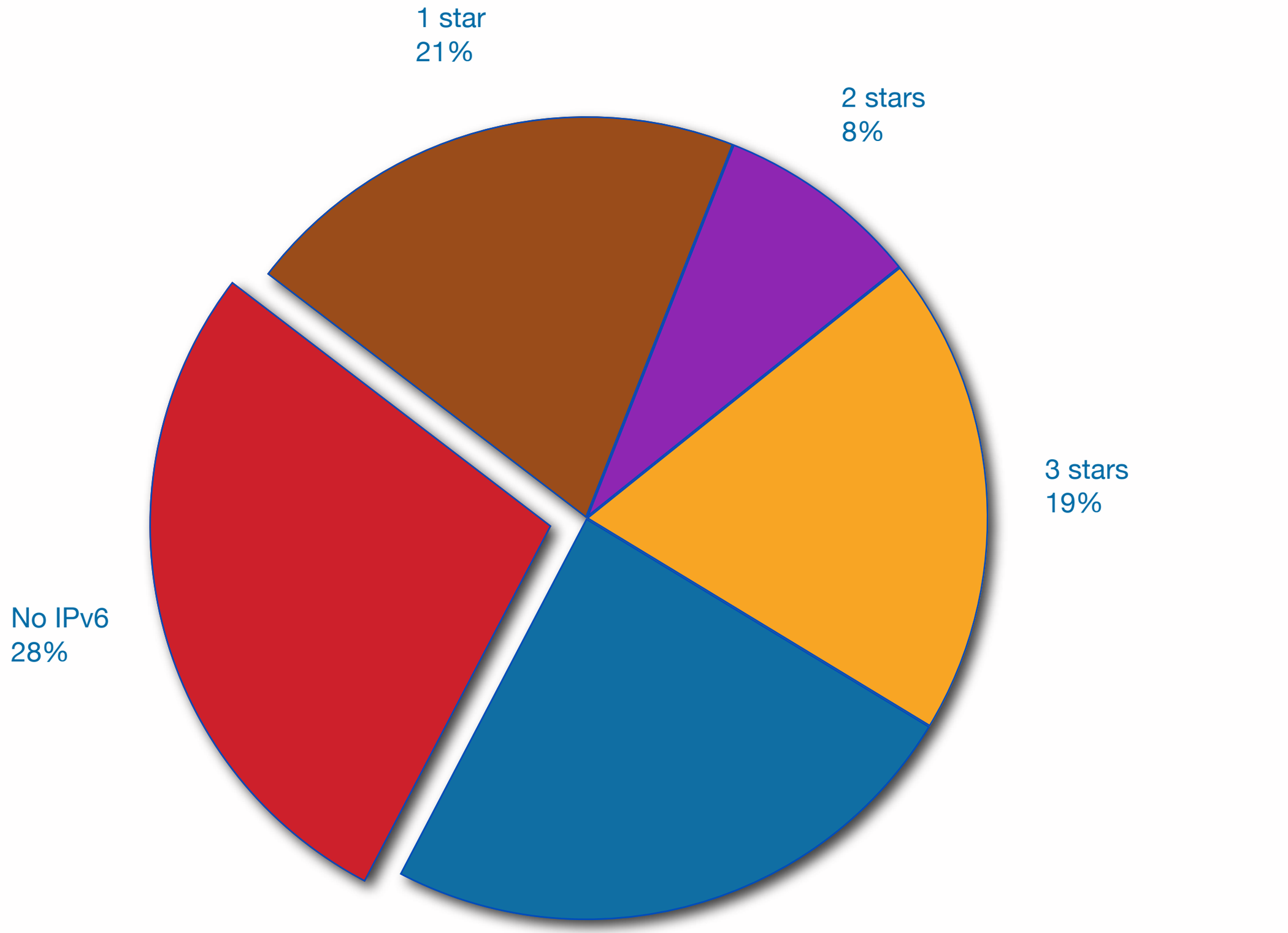
- To qualify, an organisation must:
  - Meet the contractual requirements for provider independent resources
  - LIRs must demonstrate special routing requirements
- Minimum assignment size /48
- PI space can not be used for sub-assignments
  - not even 1 IP address

IPv6 RIPEness: 10238 LIRs



Tips

IPv6 RIPEness: Switzerland 350 LIRs



Tips

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IPv6 Addressing Plans

Section 2

Why Create an Addressing Plan?

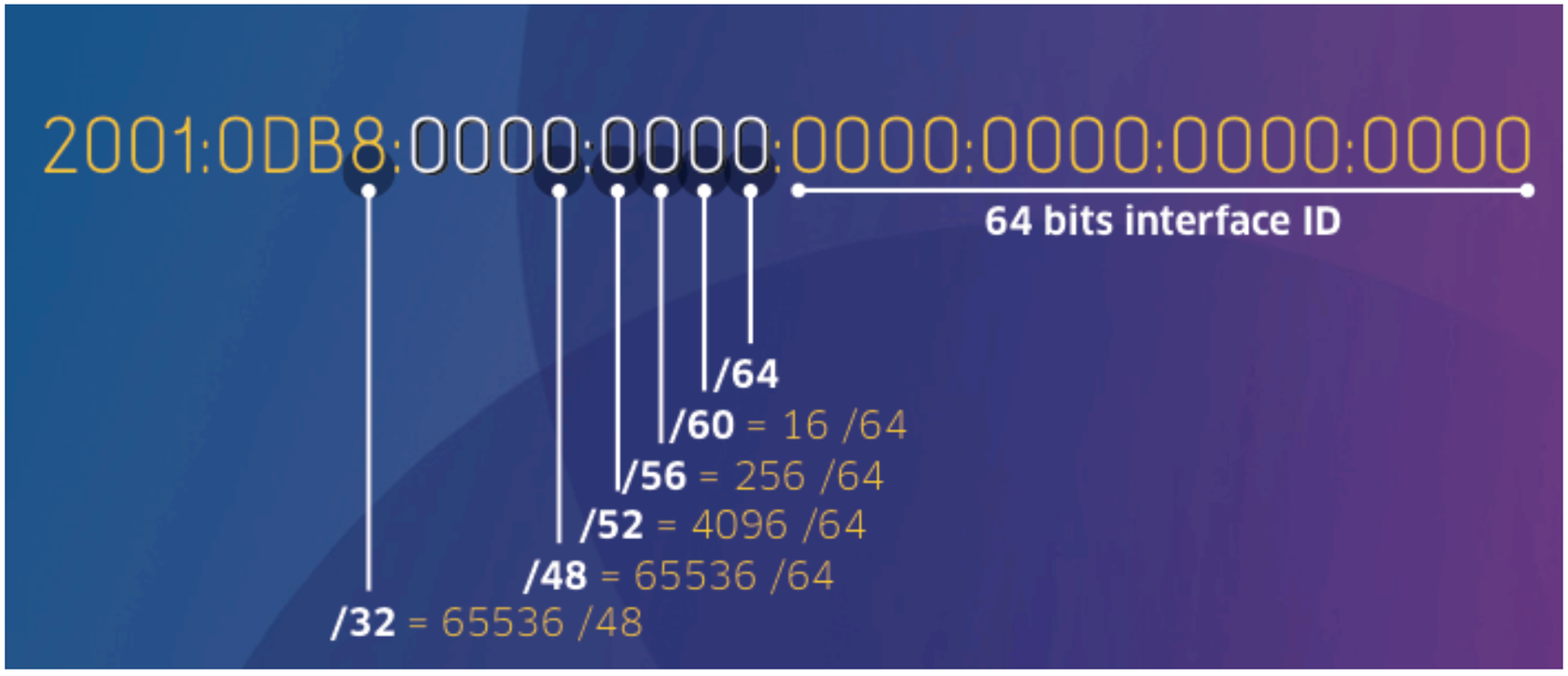
Benefits of an IPv6 Addressing Plan:

- 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



Customers

Customers should get a large block of addresses

- /48 - Business
- /48 or 56 - Residential

For more than a /48, send a request form

Every assignment must be registered

Example Situation

Customer has 6 functions:

- Servers
- Office PCs
- Network Engineers PCs
- Guests
- VPN (remote workers)
- Infrastructure (point-to-point and loopbacks)

Example Situation

Customer has 3 locations:

- Main building floor 1
- Main building floor 2
- Secondary office

Example Assignment from LIR

The customer gets 2001:0db8:1a2b::/48

Work on 4 bit boundary

- 6 functions, leaves room for 10 new functions
- 3 locations, leaves room for 13 new locations
- We still have 8 bits!
  - Room for 256 networks per function per location

Example Plan 1

Putting this in the address:

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

- F = function (0=infrastructure, 1=servers, 2=office, 3 =engineers, e=vpn, f=guest)
- L = location (0=main building 1, 1=main building 2, 2=secondary office
- XX = Number for network of type +location

Example Plan Usage

Example Plan Usage

2001:0db8:1a2b:1000::/64

Example Plan Usage

2001:0db8:1a2b:1000::/64

- Servers in Main building, floor 1, network 0

Example Plan Usage

2001:0db8:1a2b:1000::/64

- Servers in Main building, floor 1, network 0

2001:0db8:1a2b:1200::/64

Example Plan Usage

2001:0db8:1a2b:1000::/64

- Servers in Main building, floor 1, network 0

2001:0db8:1a2b:1200::/64

- Servers in Secondary office, network 0

Example Plan Usage

2001:0db8:1a2b:1000::/64

- Servers in Main building, floor 1, network 0

2001:0db8:1a2b:1200::/64

- Servers in Secondary office, network 0

2001:0db8:1a2b:f009::/64

Example Plan Usage

2001:0db8:1a2b:1000::/64

- Servers in Main building, floor 1, network 0

2001:0db8:1a2b:1200::/64

- Servers in Secondary office, network 0

2001:0db8:1a2b:f009::/64

- Guest in Main Building, floor 1, network 9

Example Plan Usage

2001:0db8:1a2b:1000::/64

- Servers in Main building, floor 1, network 0

2001:0db8:1a2b:1200::/64

- Servers in Secondary office, network 0

2001:0db8:1a2b:f009::/64

- Guest in Main Building, floor 1, network 9

Example Plan Usage

Example Plan Usage

2001:0db8:1a2b:0000::1/128

Example Plan Usage

2001:0db8:1a2b:0000::1/128

- loopback address (location doesn't apply!)

Example Plan Usage

2001:0db8:1a2b:0000::1/128

- loopback address (location doesn't apply!)

2001:0db8:1a2b:0102::/64

Example Plan Usage

2001:0db8:1a2b:0000::1/128

- loopback address (location doesn't apply!)

2001:0db8:1a2b:0102::/64

- point-to-point link (0 for infrastructure)

Example Plan Usage

2001:0db8:1a2b:0000::1/128

- loopback address (location doesn't apply!)

2001:0db8:1a2b:0102::/64

- point-to-point link (0 for infrastructure)

2001:0db8:1a2b:e1ab::/64

Example Plan Usage

2001:0db8:1a2b:0000::1/128

- loopback address (location doesn't apply!)

2001:0db8:1a2b:0102::/64

- point-to-point link (0 for infrastructure)

2001:0db8:1a2b:e1ab::/64

- VPN in main office, floor 1, user 171

Example Plan Usage

2001:0db8:1a2b:0000::1/128

- loopback address (location doesn't apply!)

2001:0db8:1a2b:0102::/64

- point-to-point link (0 for infrastructure)

2001:0db8:1a2b:e1ab::/64

- VPN in main office, floor 1, user 171

Example Plan Usage

2001:0db8:1a2b:0000::1/128

- loopback address (location doesn't apply!)

2001:0db8:1a2b:0102::/64

- point-to-point link (0 for infrastructure)

2001:0db8:1a2b:e1ab::/64

- VPN in main office, floor 1, user 171

Alternatives

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

End User Summary

Tips:

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

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 space for 18.446.744.073.709.551.616 devices

Take an easy to remember block for loopbacks

- 2001:0db8:1a2b:0000:0000:0000:0000:0000

Point-to-Point Interfaces

One /64 per point-to-point connection

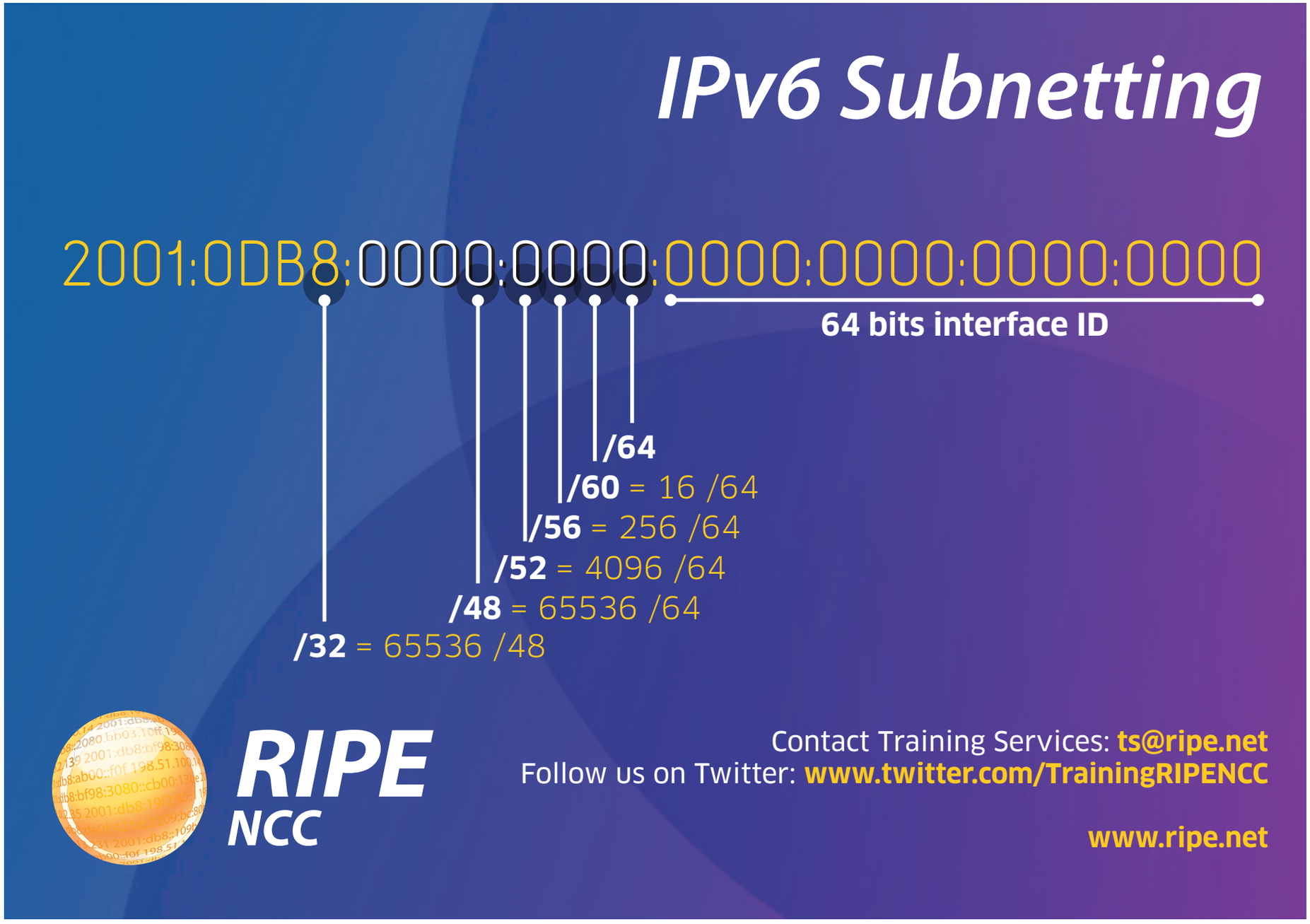
- Reserve 1 /64 for the link, but configure a /127 (RFC6164)

ISP Guidelines

In common cases:

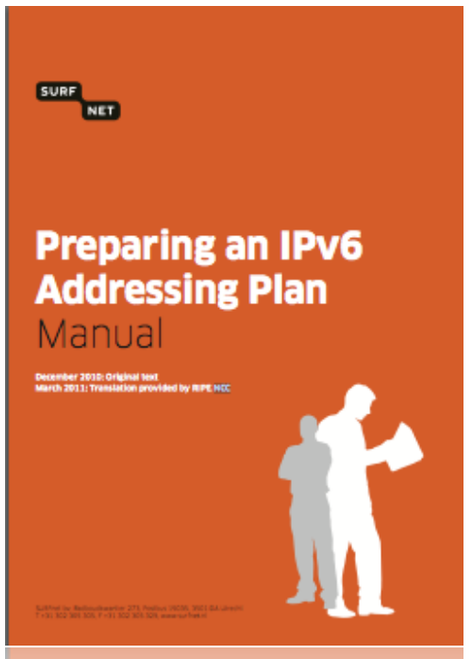
- One /48 per PoP
- Calculate growth
- Make it scalable

- 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

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/IPv6_addr_plan4.pdf



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Transition Mechanisms

Section 4

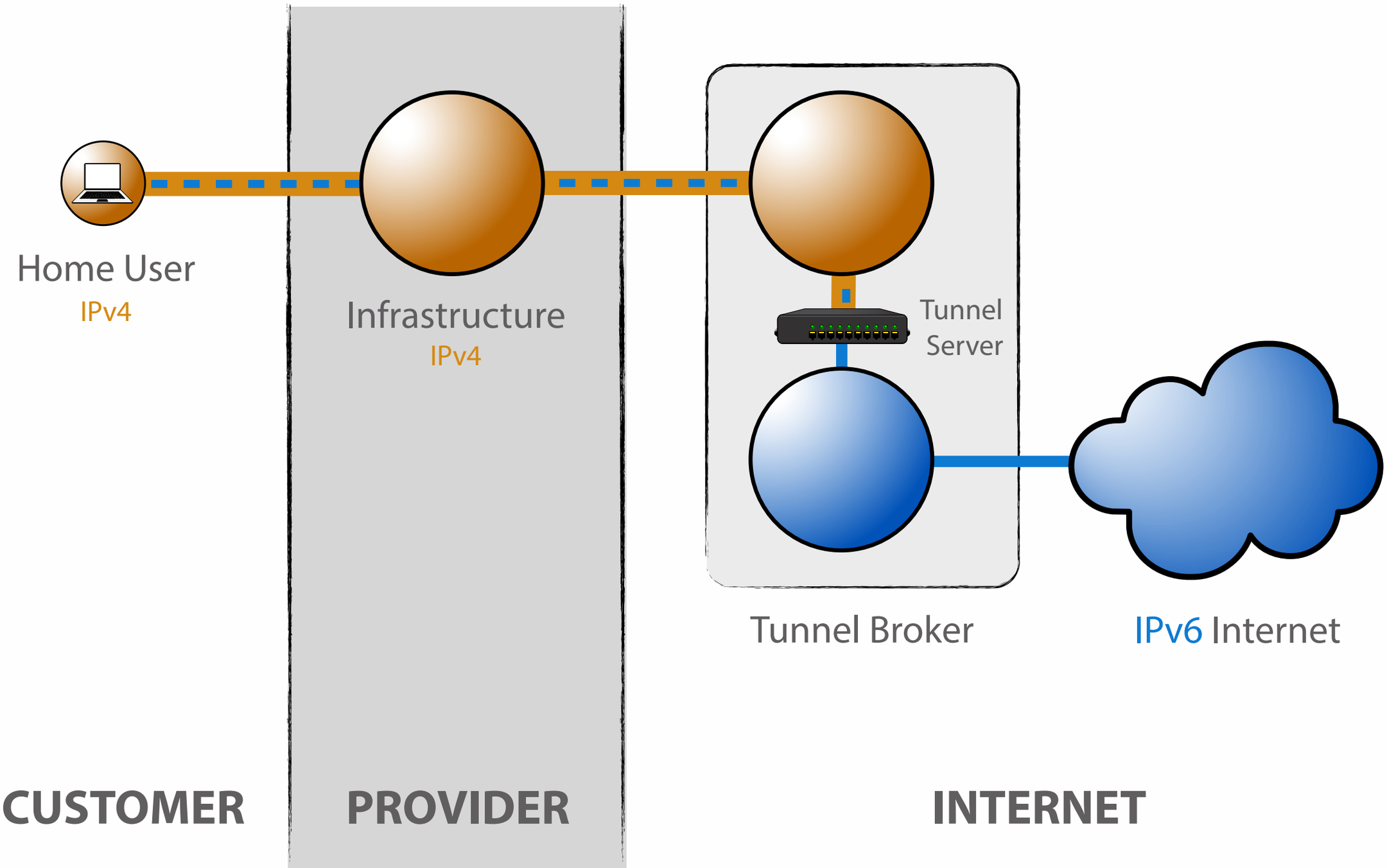
Transitioning: Solving Two Problems

- **Maintaining connectivity to IPv4 hosts by sharing IPv4 addresses between clients**
  - Extending the address space with NAT/CGN/LSN
  - Translating between IPv6 and IPv4
- **Provide a mechanism to connect to the emerging IPv6-only networks**
  - Tunneling IPv6 packets over IPv4-only networks

- Manually configured tunnels towards a fixed tunnel broker like SixXS, Hurricane Electric or your own system

- Stable and predictable but not easily deployed to the huge residential markets

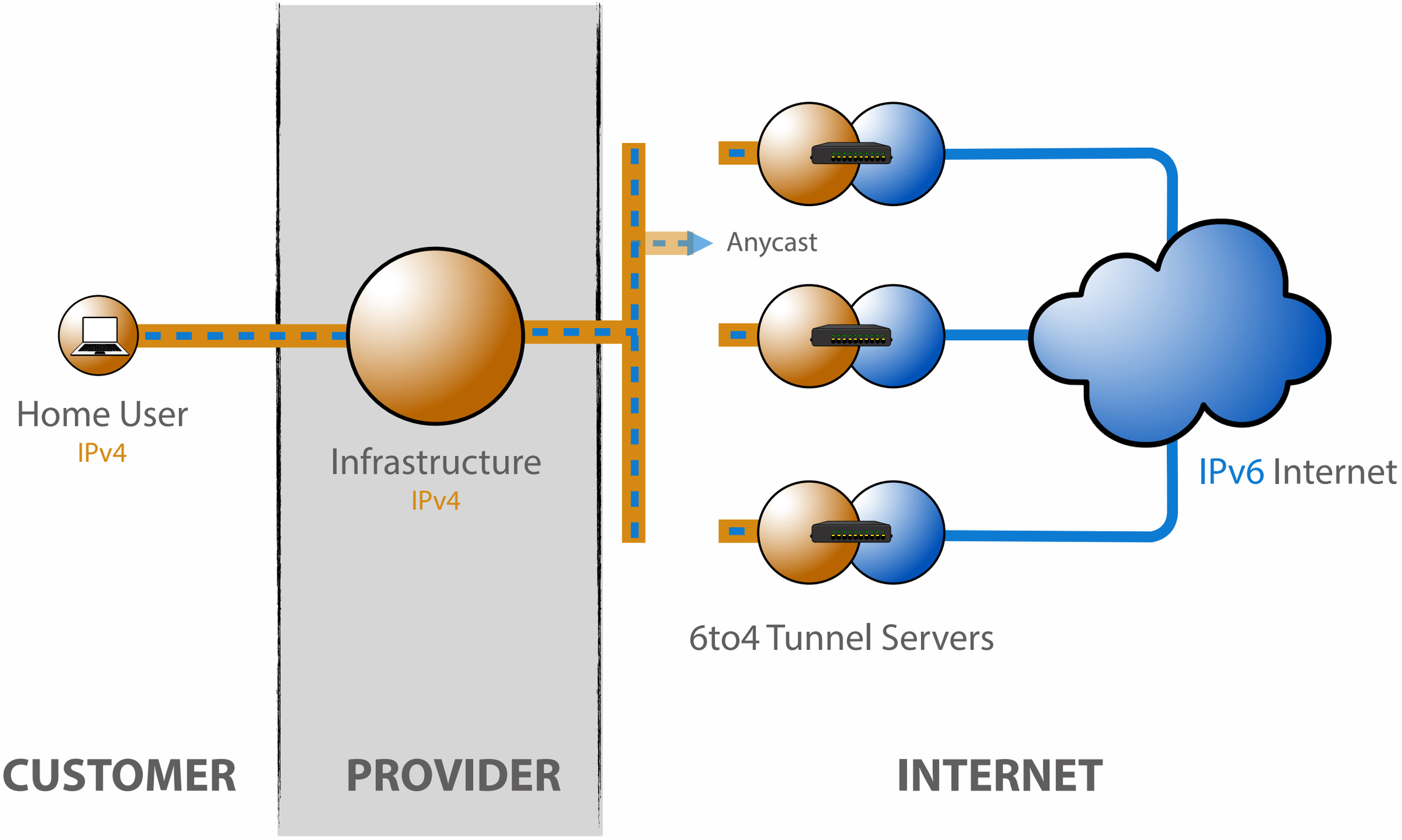
- MTU might cause issues


Home User
IPv4
Infrastructure
IPv4
Tunnel
Server
Tunnel Broker
IPv6 Internet
CUSTOMER
PROVIDER
INTERNET

6to4 and Teredo

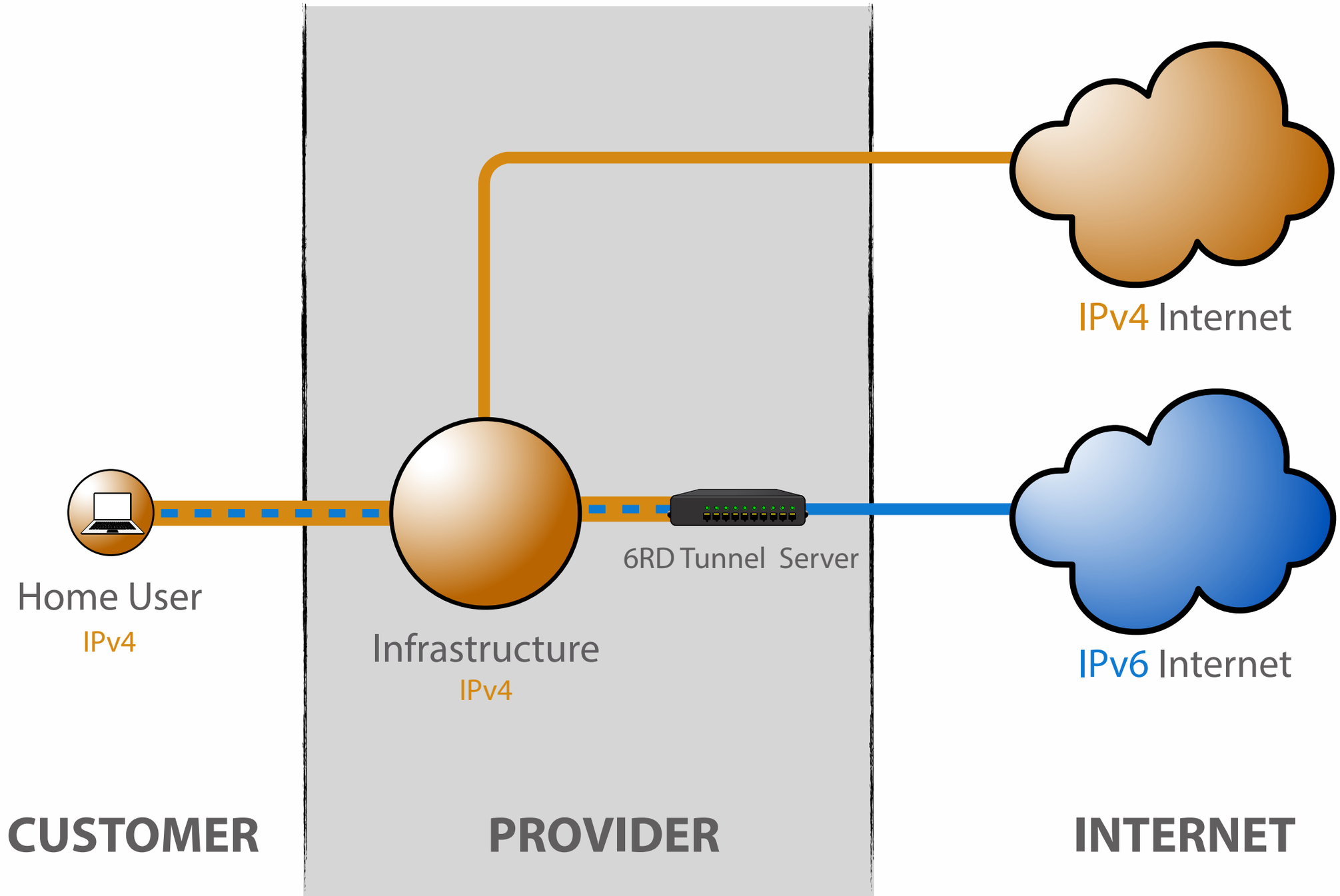
- **6to4**
  - "Automatic" tunnel, system can configure itself
  - IPv4 address is part of the IPv6 address
  - Requires a public IPv4 address
  - Uses anycast to reach a nearby server
    - Return traffic might choose another server
- **Teredo**
  - Uses UDP to encapsulate packets
  - Works across (most) NAT implementations

6to4 and Teredo



- **Quite similar to 6to4**
  - Encodes the IPv4 address in the IPv6 prefix
- **Uses address space assigned to the operator**
- **The operator has full control over the relay**
- **Traffic is symmetric across a relay**
  - Or at least stays in your domain
- **Can work with both public and private space**
- **Needs additional software for signaling**

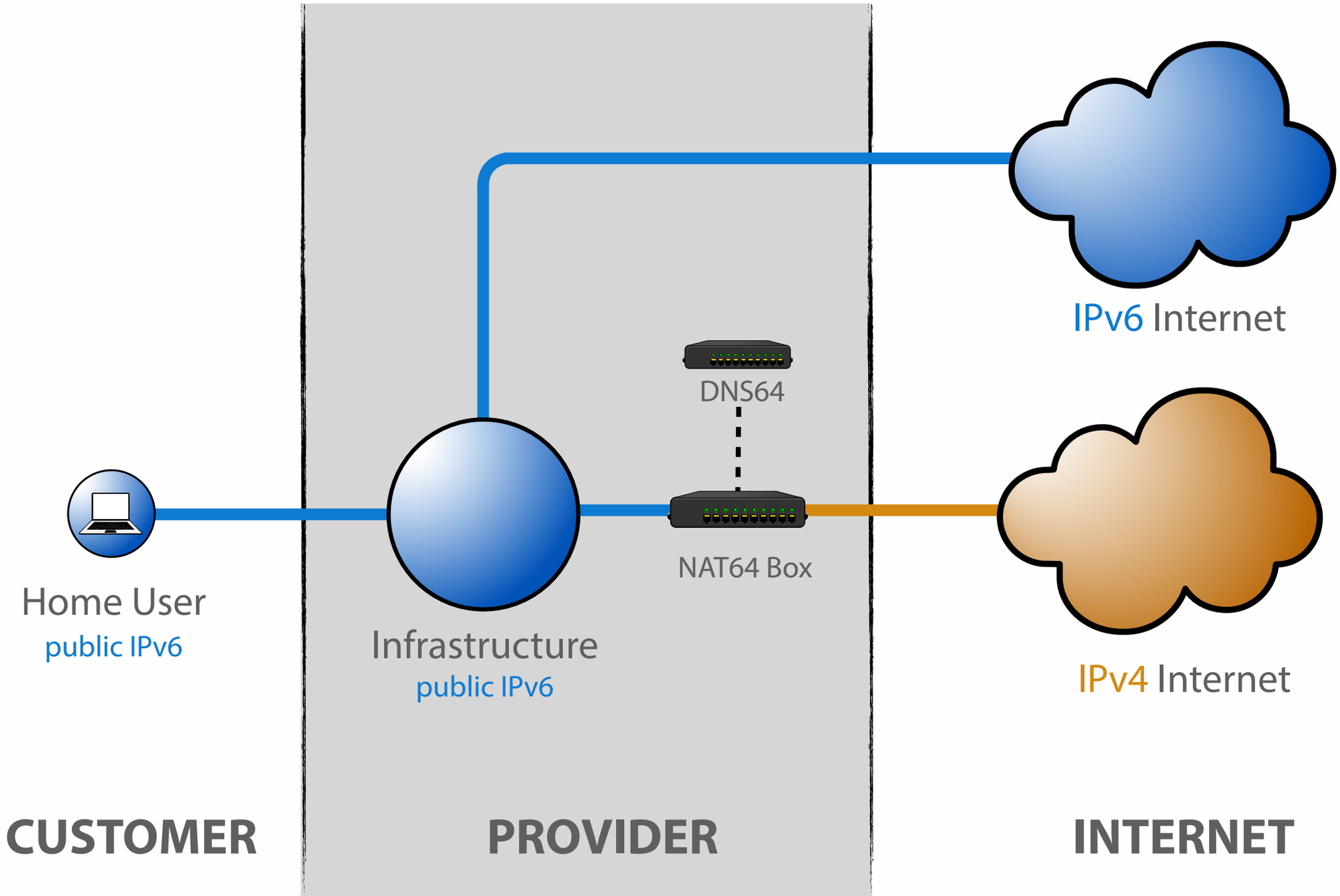
6RD


IPv4 Internet
IPv6 Internet
6RD Tunnel Server
Home User
IPv4
Infrastructure
IPv4
CUSTOMER
PROVIDER
INTERNET

NAT64/DNS64

- Single-stack clients will only have IPv6
- Translator box will strip all headers and replace them with IPv4
- Requires some DNS “magic”
  - Capture responses and replace A with AAAA
  - Response is crafted based on target IPv4 address
- Usually implies address sharing on IPv4

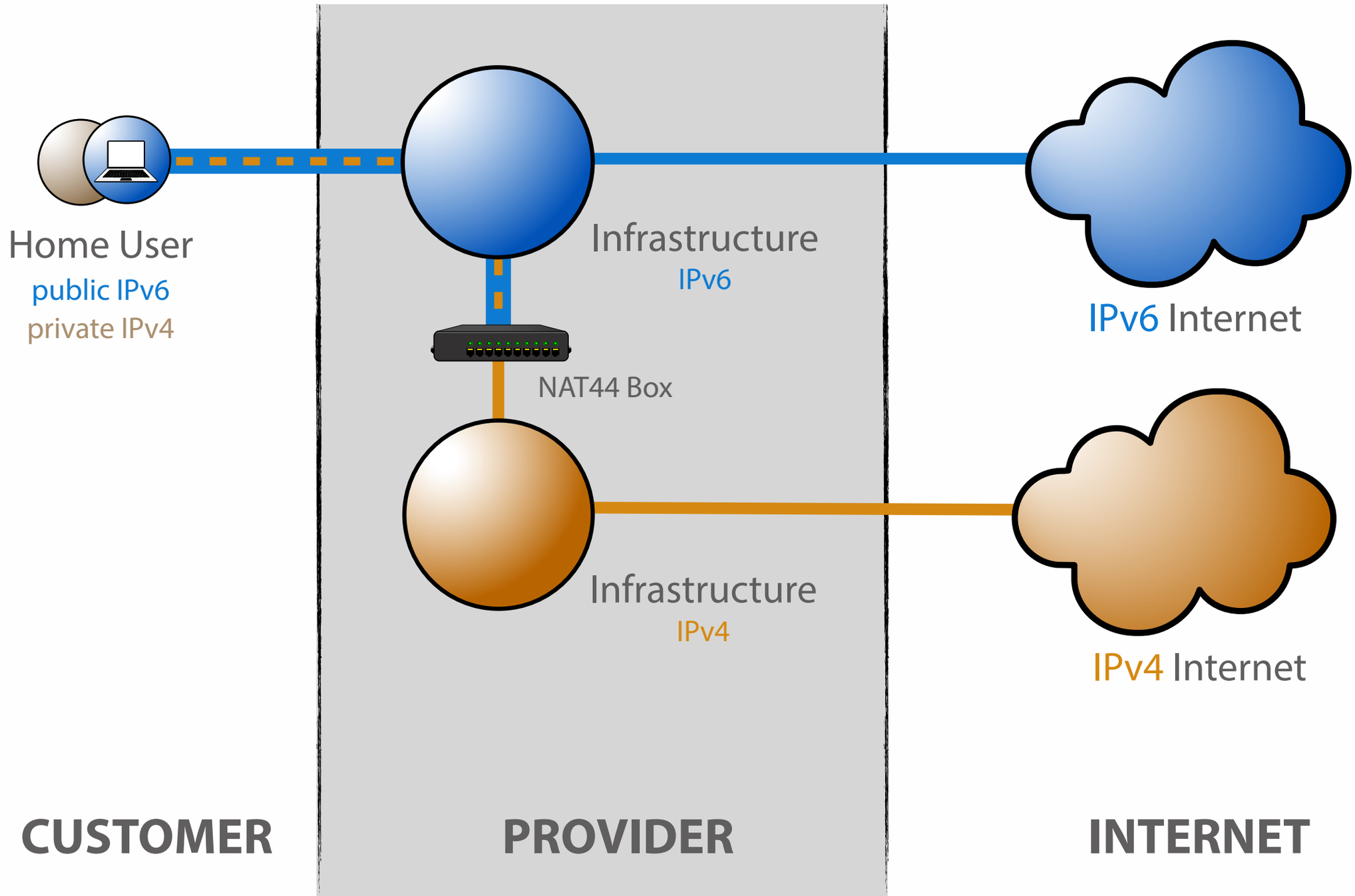
NAT64/DNS64


IPv6 Internet
DNS64
NAT64 Box
Home User
public IPv6
Infrastructure
public IPv6
IPv4 Internet
CUSTOMER
PROVIDER
INTERNET

DS-lite

- Tunneling IPv4 over IPv6
- Allows clients to use RFC1918 addresses without doing NAT themselves
- NAT is centrally located at the provider
- Client's IPv6 address is used to maintain state and to keep clients apart
  - Allows for duplicate IPv4 ranges

DS-lite


Home User
public IPv6
private IPv4
Infrastructure
IPv6
NAT44 Box
Infrastructure
IPv4
IPv6 Internet
IPv4 Internet
CUSTOMER
PROVIDER
INTERNET

Also useful

- Websites
  - http://www.getipv6.info
  - http://www.getipv6.info
  - 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

nathalie@ripe.net