

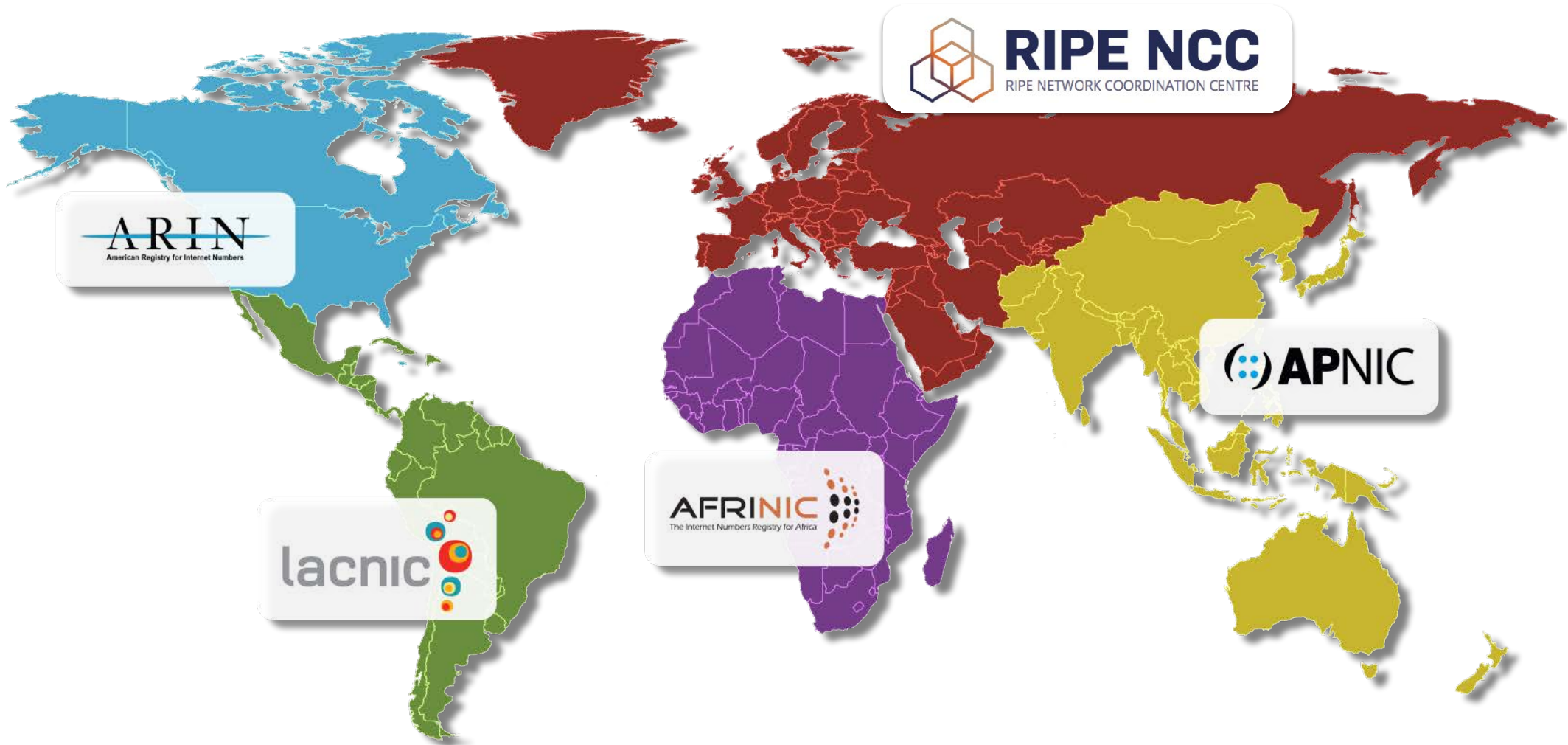


**RIPE NCC**

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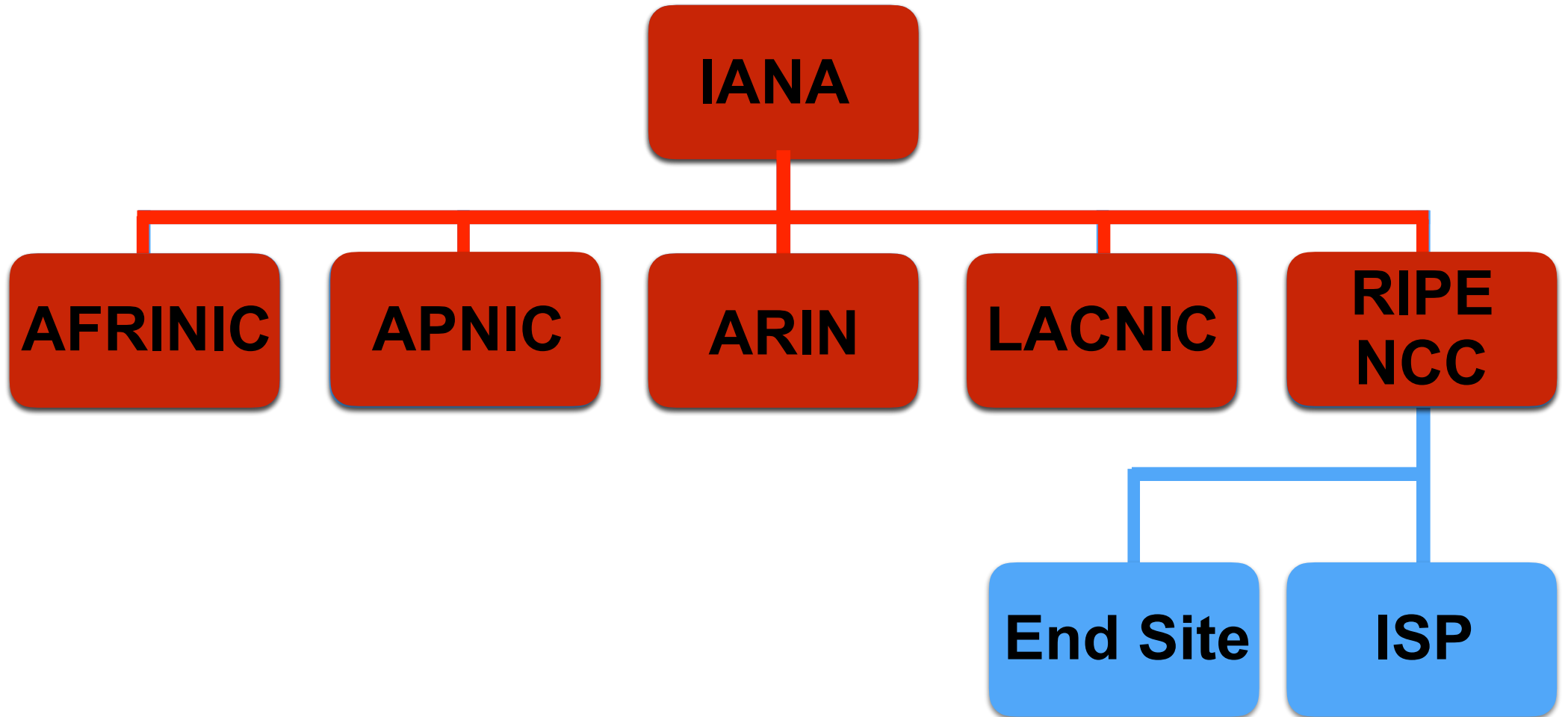
# IPv6 in Depth <<<Kinda >>>

# Regional Internet Registry (RIR)



Regional Internet Registries (RIRs) manage, distribute, and register Internet number resources within their respective regions.

# IPv4 Depletion





# Post IPv4 Depletion

- On 14 September 2012, the RIPE NCC began to allocate IPv4 address space from the last /8 of IPv4 address space it holds.
- RIPE NCC members can request a one time /22 allocation (1,024 IPv4 addresses).

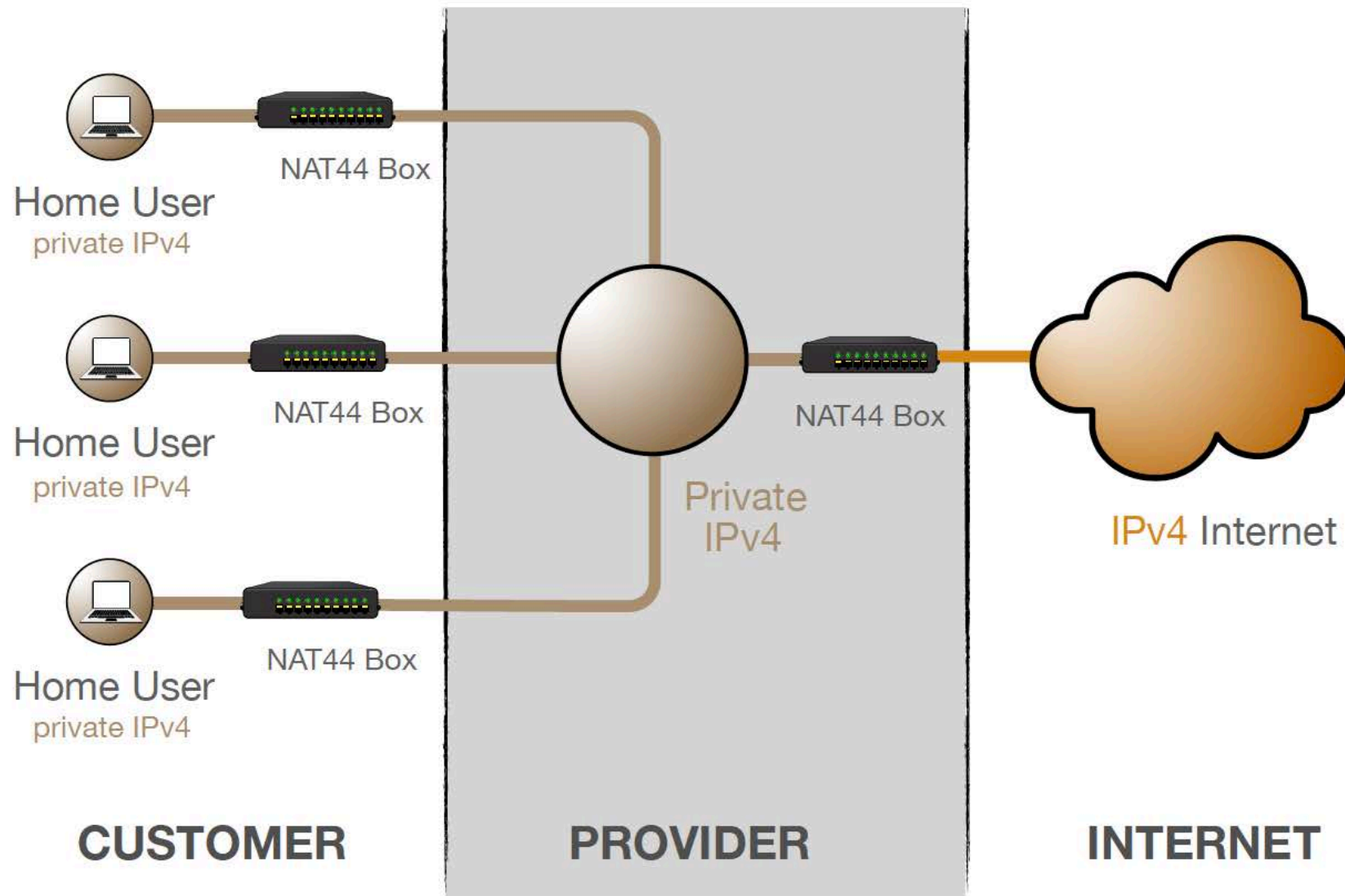
<https://www.ripe.net/publications/ipv6-info-centre/about-ipv6/ipv4-exhaustion>



# 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





# Internet Number Resources

There are two types of IP addresses in active use:

## IP version 4 (IPv4)

- Initially deployed: 1 January 1983.
- IPv4 addresses are 32-bit numbers. (4.2 Billion)
- Example: 192.0.2.53
- Still the most commonly used version.

## IP version 6 (IPv6)

- Published by the IETF in 1998.
- IPv6 addresses are 128-bit numbers. (340 Trillion Trillion Trillion)
- Example: 2001:0db8:582:ae33::29



# 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



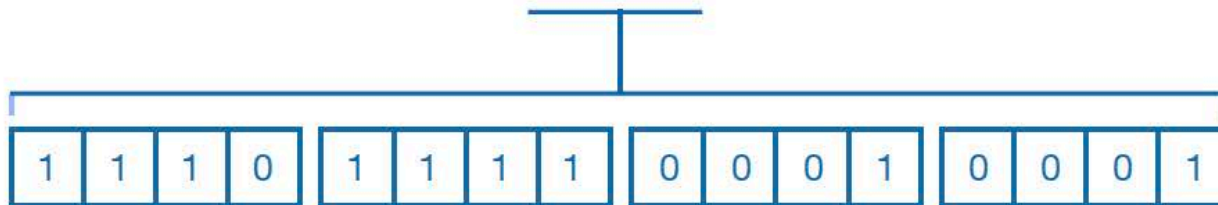


# Address Notation

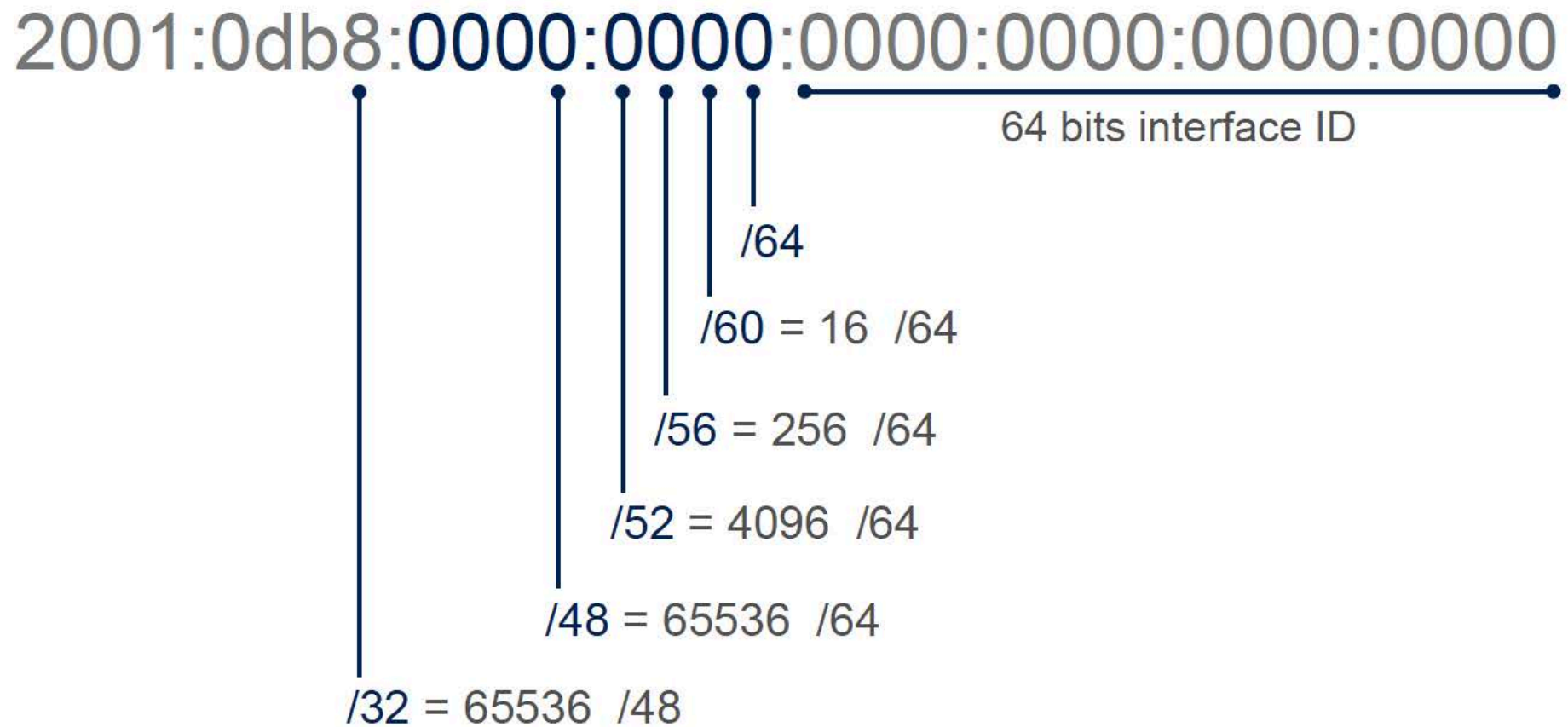
2001:0db8:003e:ef11:0000:0000:c100:004d

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

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



# IPv6 Subnetting

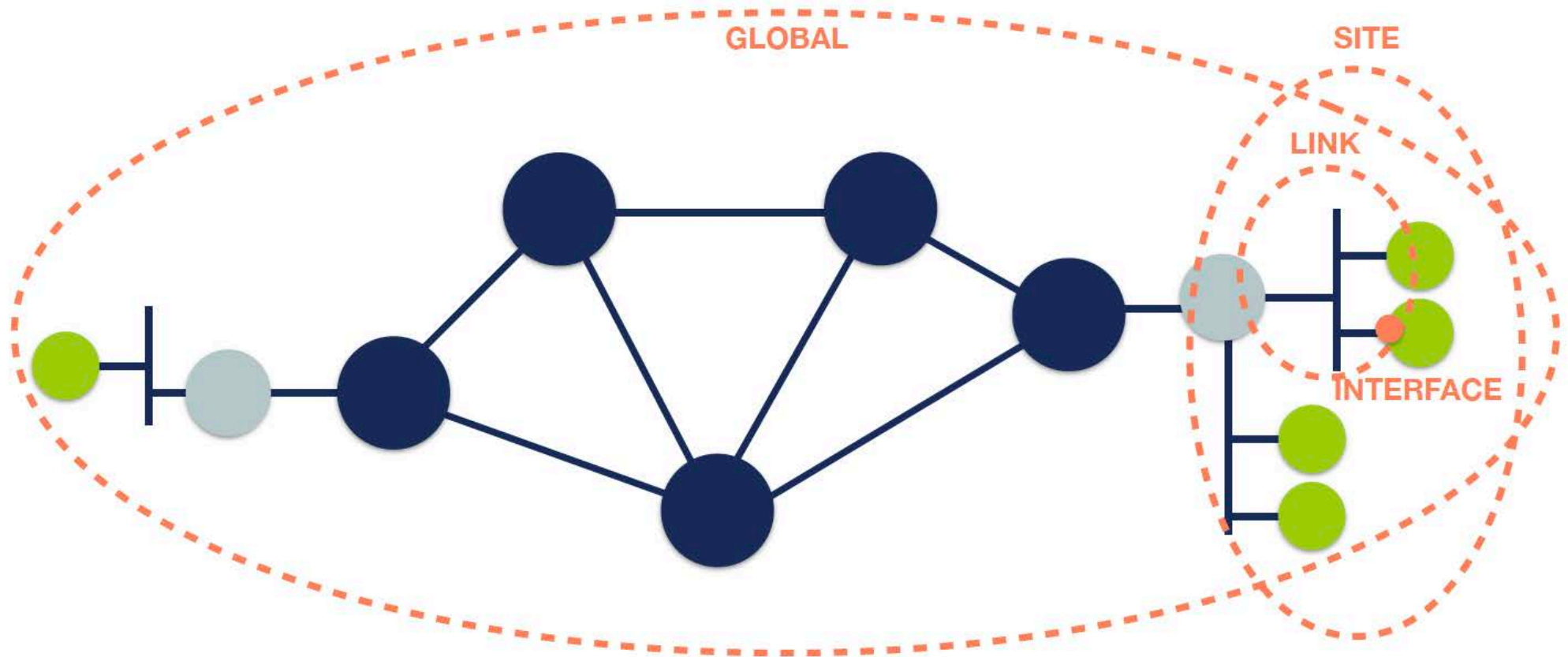


# Multiple address types



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
Global Unicast	2000::/3	global
Unique Local	fc00::/7	global
Multicast	ff00::/8	variable

# IPv6 Address Scope



fe80::A:b:100

ff01::2

2001:67c:2e:1::c1

FD00:A:B::100

FF05::1:3

ff02::1

# Why Create an IPv6 Addressing Plan?



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





# IPv6 Address Management

- **Your spreadsheet might not scale**
  - There are 65.536 /64s in a /48
  - There are 65.536 /48s in a /32
  - There are 524.288 /48s in a /29
  - There are **16.777.216** /56s in a /32
  - There are **134.217.728** /56s in a /29
- Find a suitable IPAM solution



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# IPv6 In BA

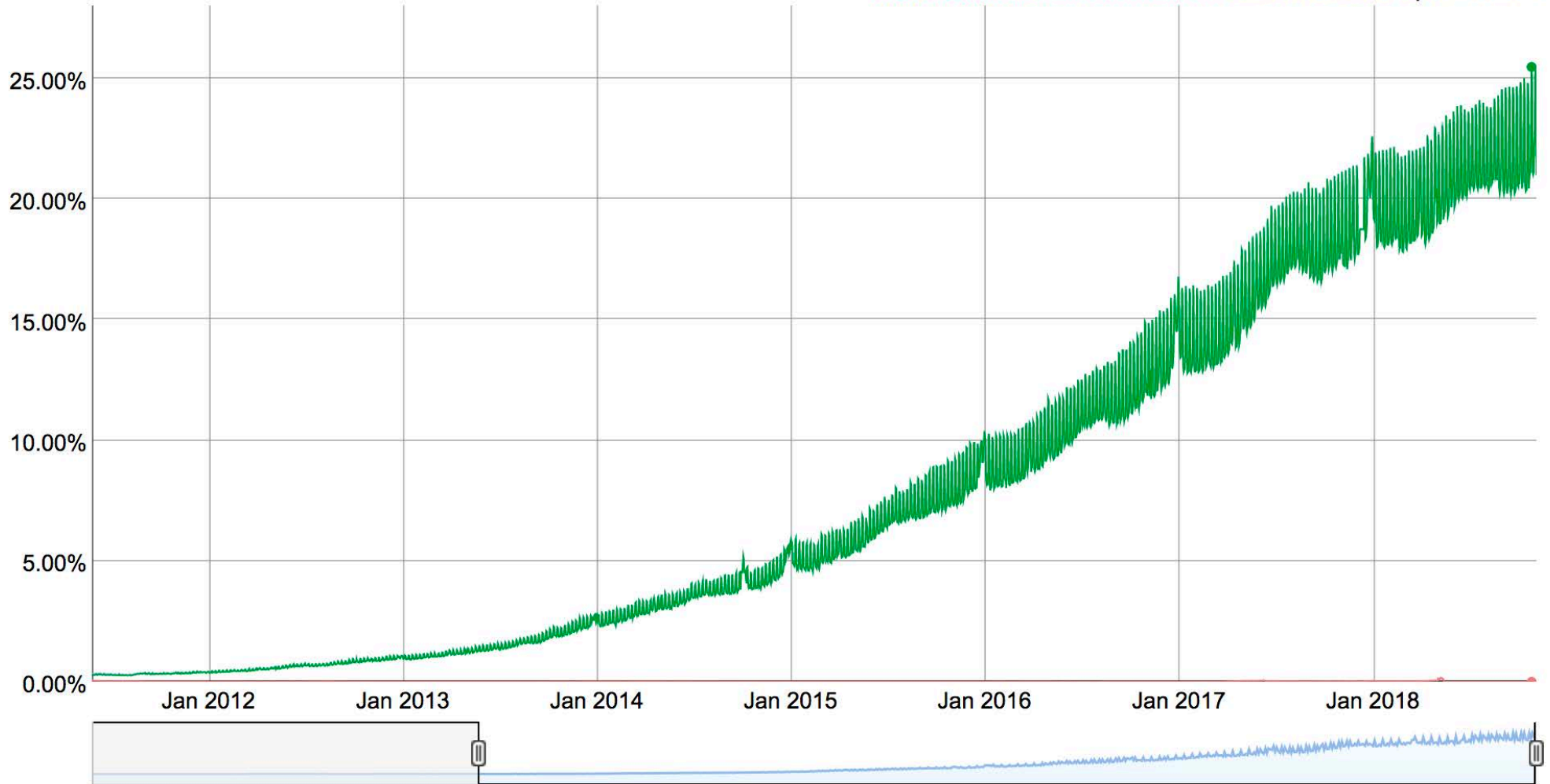
# IPv6 Statistics - Google (1)



## IPv6 Adoption

We are continuously measuring the availability of IPv6 connectivity among Google users. The graph shows the percentage of users that access Google over IPv6.

Native: 25.49% 6to4/Teredo: 0.00% Total IPv6: 25.49% | 27 Oct 2018

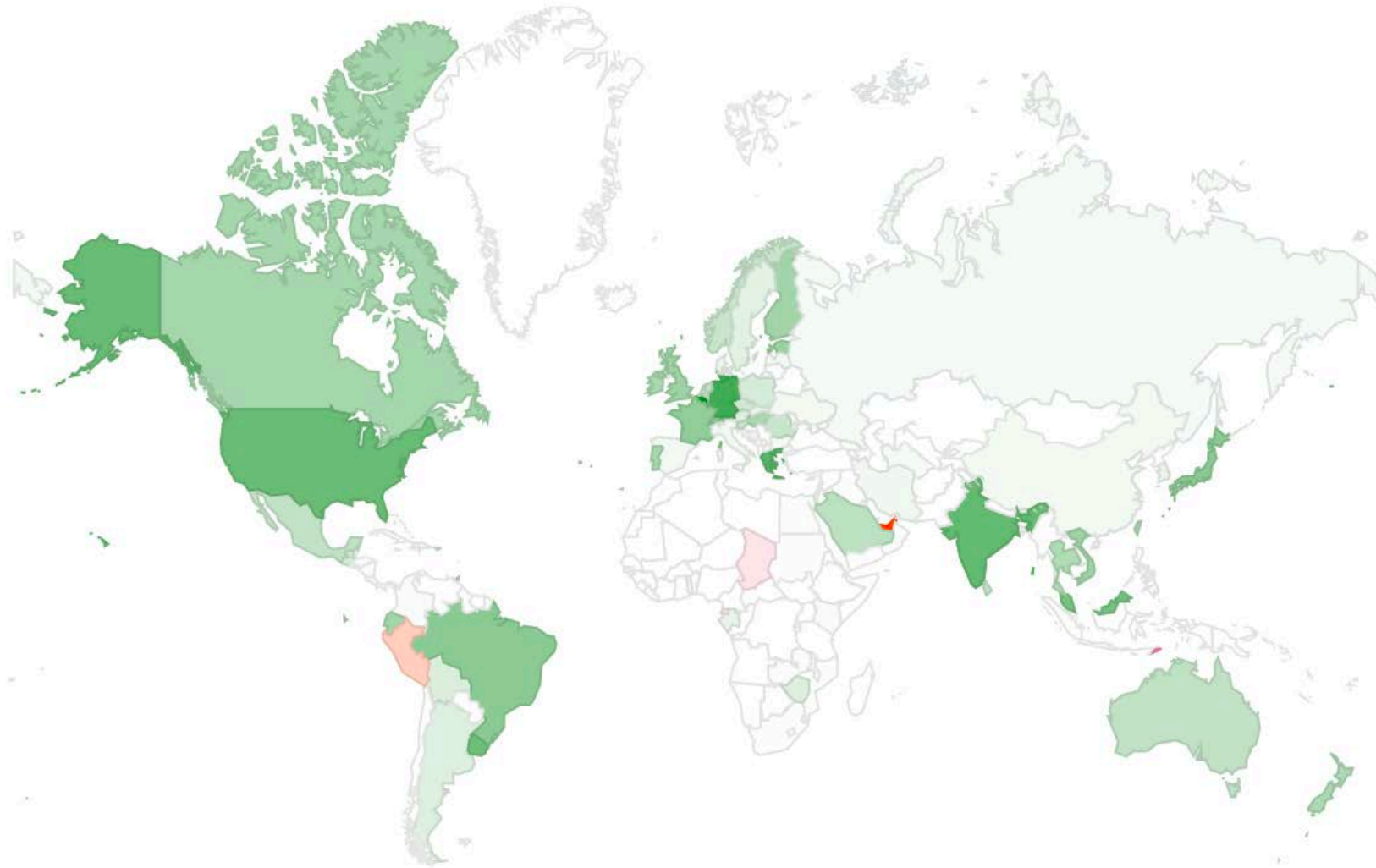


Percentage of IPv6 users that access Google over IPv6

Source: <https://www.google.com/intl/en/ipv6/statistics.html#tab=ipv6-adoption&tab=ipv6-adoption>



# IPv6 Statistics - Google (2)





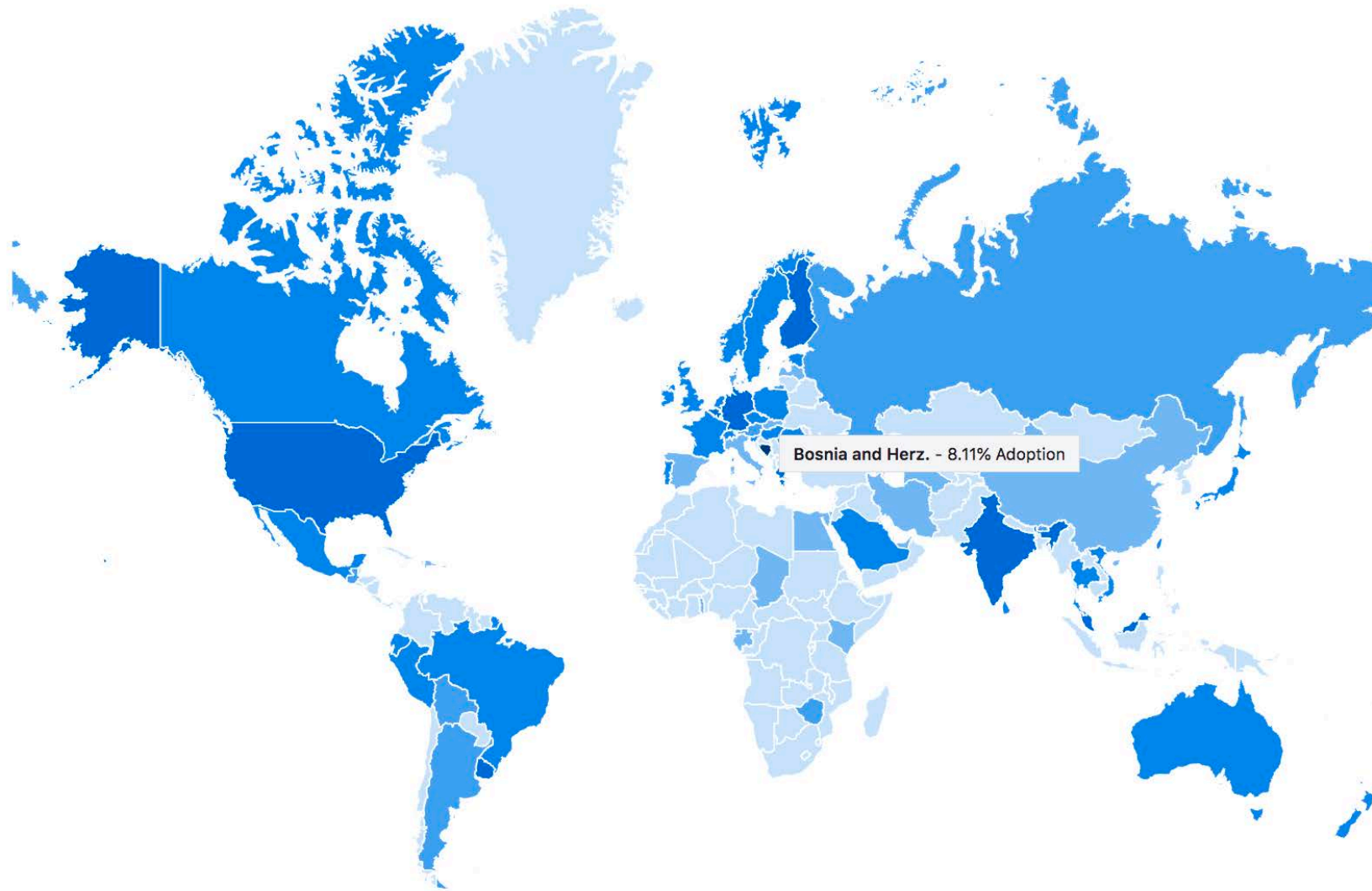
# IPv6 Statistics - Google (3)

n



**Bosnia & Herzegovina**  
IPv6 Adoption: **5.58%**  
Latency / impact: **-70ms / 0%**

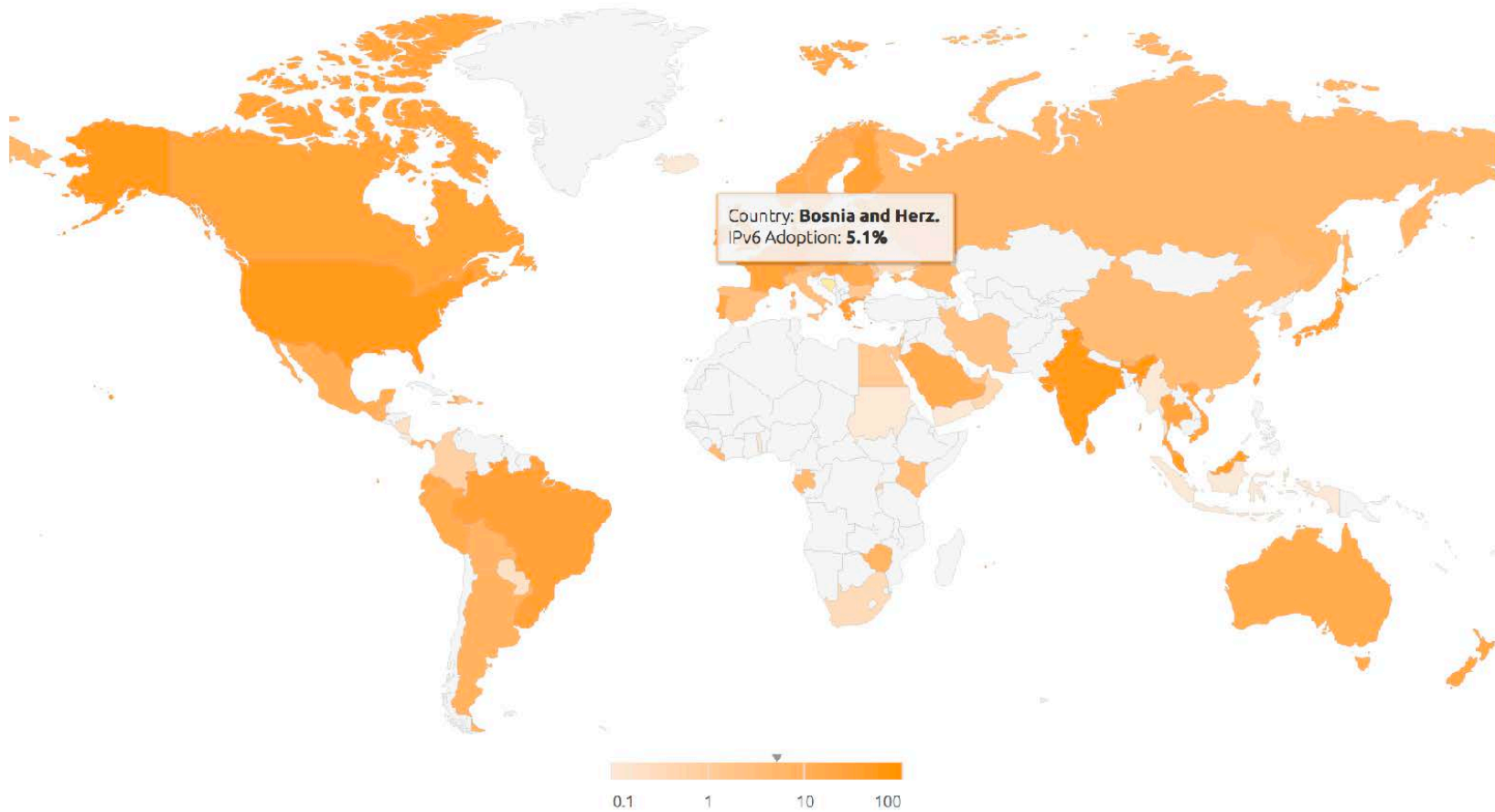
# IPv6 Statistics - Facebook



# IPv6 Statistics - Akamai



IPv6 Adoption By Country



# IPv6 Deployment Status - BA



HURRICANE ELECTRIC  
INTERNET SERVICES

 Search

Networks: Bosnia and Herzegovina

## Quick Links

- [BGP Toolkit Home](#)
- [BGP Prefix Report](#)
- [BGP Peer Report](#)
- [Exchange Report](#)
- [Bogon Routes](#)
- [World Report](#)
- [Multi Origin Routes](#)
- [DNS Report](#)
- [Top Host Report](#)
- [Internet Statistics](#)
- [Looking Glass](#)
- [Network Tools App](#)
- [Free IPv6 Tunnel](#)
- [IPv6 Certification](#)
- [IPv6 Progress](#)
- [Going Native](#)
- [Contact Us](#)



## Country Info



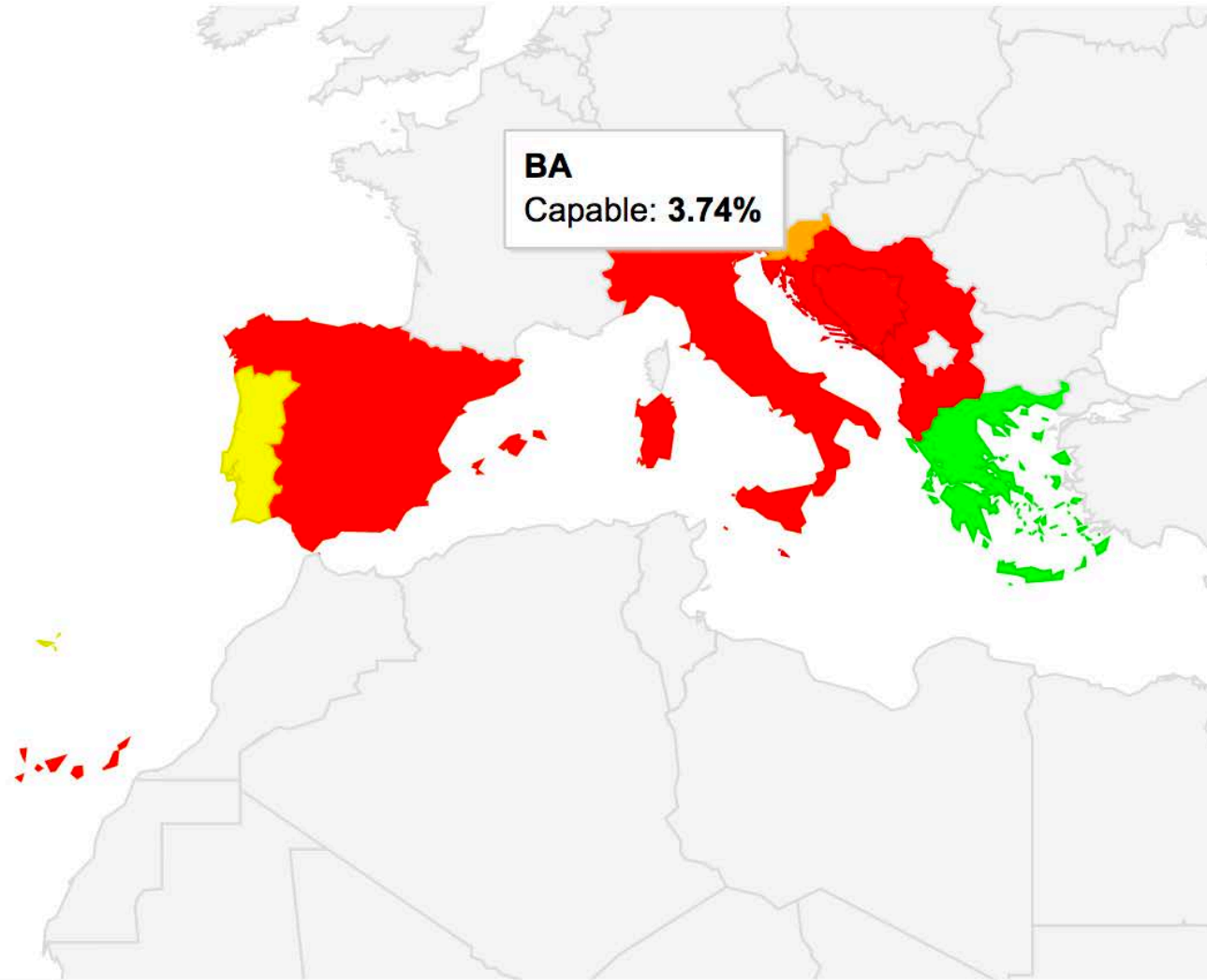
### Networks: Bosnia and Herzegovina

ASN	Name	Adjacencies v4	Routes v4	Adjacencies v6	Routes v6 ↓
<a href="#">AS9146</a>	BH Telecom d.d. Sarajevo	14	109	6	9
<a href="#">AS21107</a>	Blicnet d.o.o.	2	36	2	3
<a href="#">AS25144</a>	"Telekomunikacije Republike Srpske" akcionarsko drustvo Banja Luka	17	207	3	2
<a href="#">AS200698</a>	Globalhost d.o.o.	2	9	1	1
<a href="#">AS200914</a>	Agencija za bankarstvo FBiH	2	1	1	1
<a href="#">AS50537</a>	QSS D.O.O. Sarajevo	2	9	1	1
<a href="#">AS42571</a>	Telrad doo	4	5	1	1
<a href="#">AS198252</a>	ELTA KABEL d.o.o.	5	25	1	1
<a href="#">AS35567</a>	DASTO semtel d.o.o.	5	132	1	1
<a href="#">AS16178</a>	Logosoft , information engineering and Internet providing	8	20	3	1



# IPv6 Capable - BA (1)

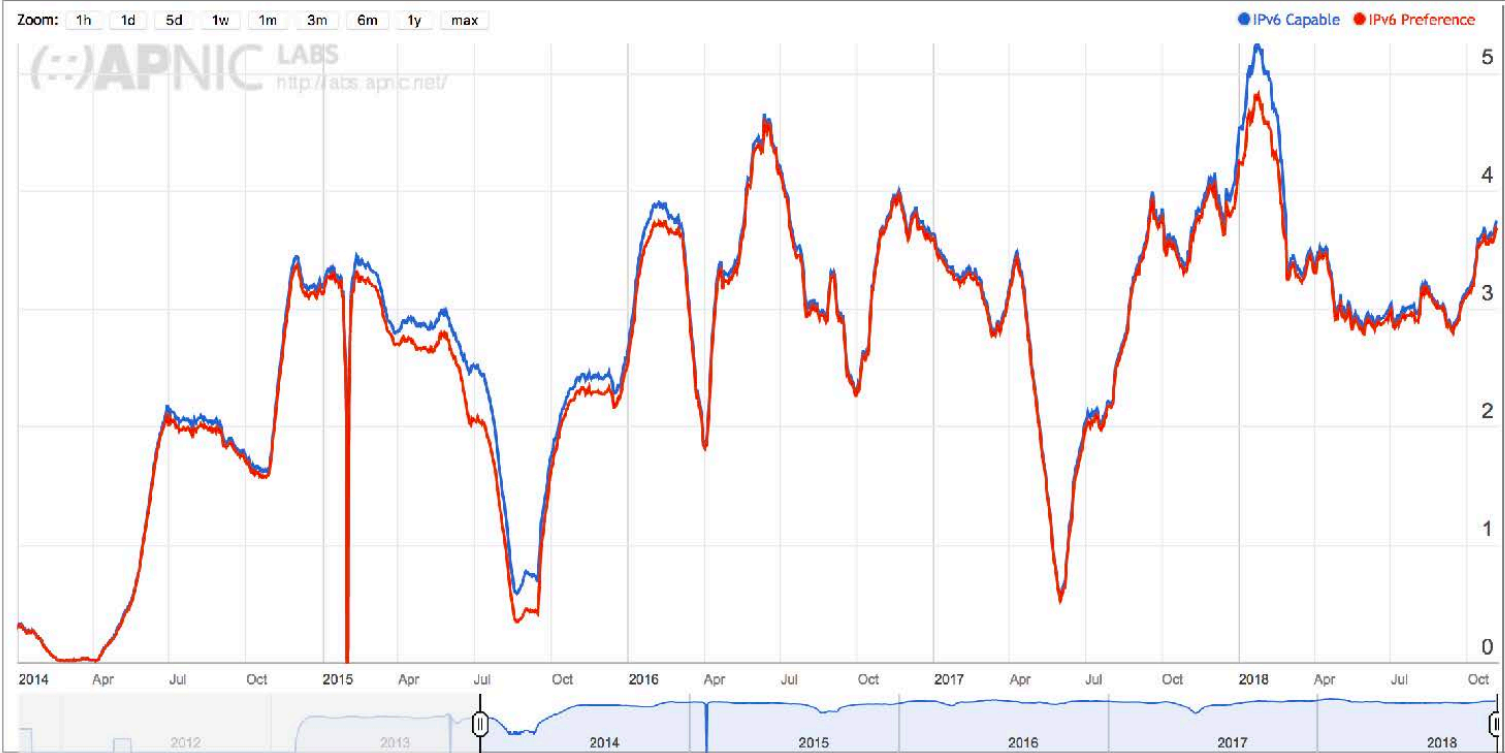
Region Map for Southern Europe (039)





# IPv6 Capable - BA (2)

## Use of IPv6 for Bosnia and Herzegovina (BA)



ASN	AS Name	IPv6 Capable	IPv6 Preferred ▼	Samples
AS9146	BIHNET BIHNET Autonomus System	15.25%	15.06%	125,611
AS200698	GLOBALHOST-BOSNIA-AS	4.13%	3.31%	121
AS59457	AVAX-BOSNIA-AS	0.09%	0.09%	1,086
AS43179	TEAMC-AS	0.06%	0.06%	1,629
AS21107	BLICNET-AS # BLIC.NET AS peering info	0.04%	0.02%	16,682
AS35567	DASTO-BOSNIA-AS	0.02%	0.02%	9,593
AS57888	TELESAT-AS	0.02%	0.02%	6,265
AS9119	SOFTNET-AS Internet Service Provider in Slovenia and South Europe region	0.04%	0.02%	4,783
AS25144	TELEKOM-SRPSKE-AS Kralja Petra I Karadjordjevica 61a	0.01%	0.01%	126,261



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# Getting Started





# How to get started

- Change purchasing procedure (feature parity)
- Check your current hardware and software
- Plan every step and test
- One service at a time
  - face first
  - core
  - customers

# 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)

<https://www.ripe.net/ripe/docs/ripe-554>

# Troubleshooting for ISP Helpdesks



- Most ISP connectivity problems are not IPv6 related
- Helpdesks can get confused!
  - IPv6 is new for them
  - They don't have experience with IPv6 issues
- A generic troubleshooting guide can help!
- Based on the open source testipv6.com tool
- Customisable

<https://www.ripe.net/ripe/docs/ripe-631>

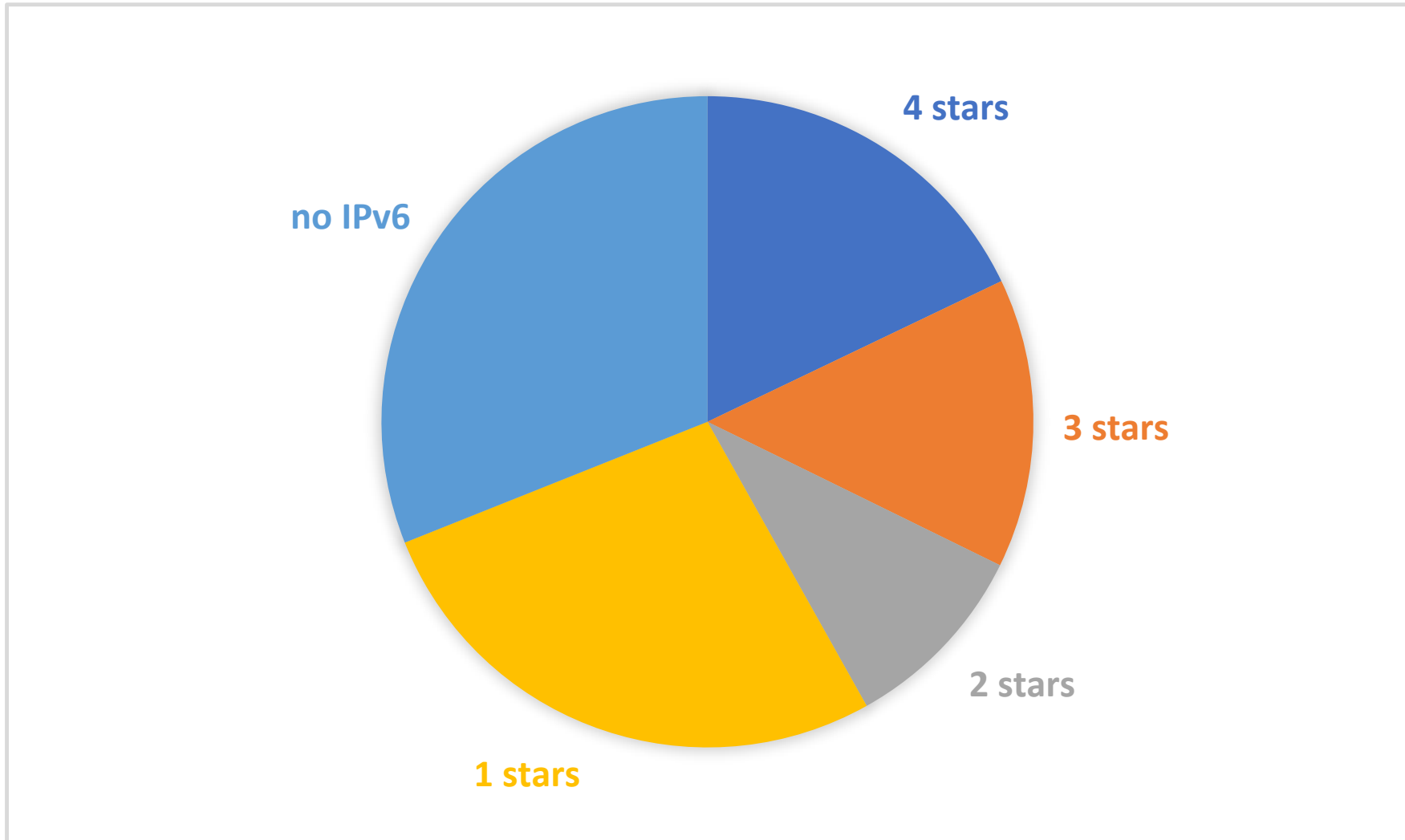




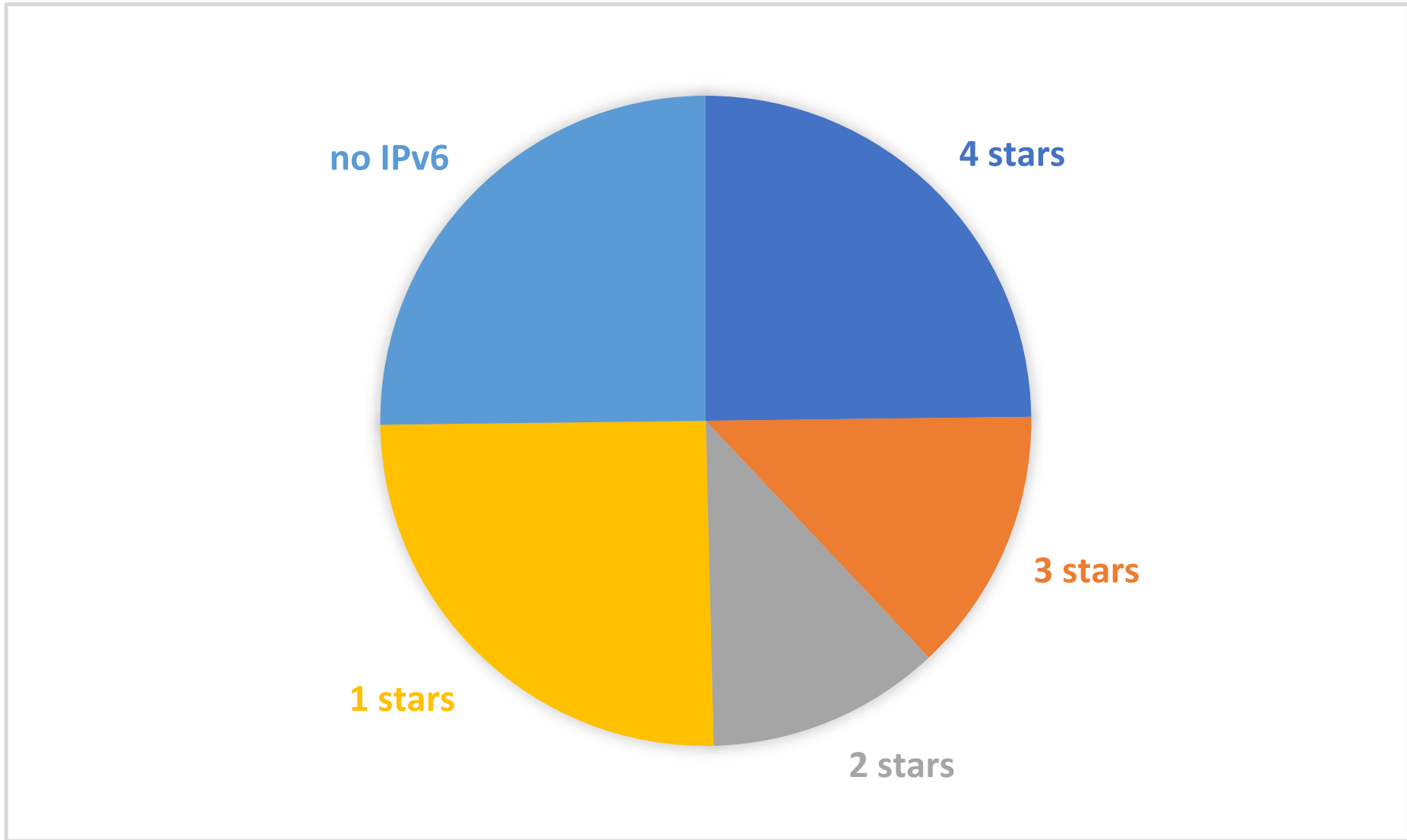
# IPv6 Ripeness

- Rating system:
  - One star if the LIR has an IPv6 allocation
  - Additional stars if:
    - IPv6 Prefix is announced on router
    - A route6 object is in the RIPE Database
    - Reverse DNS is set up
  - A list of 4 star LIRs:
    - <http://ripeness.ripe.net>

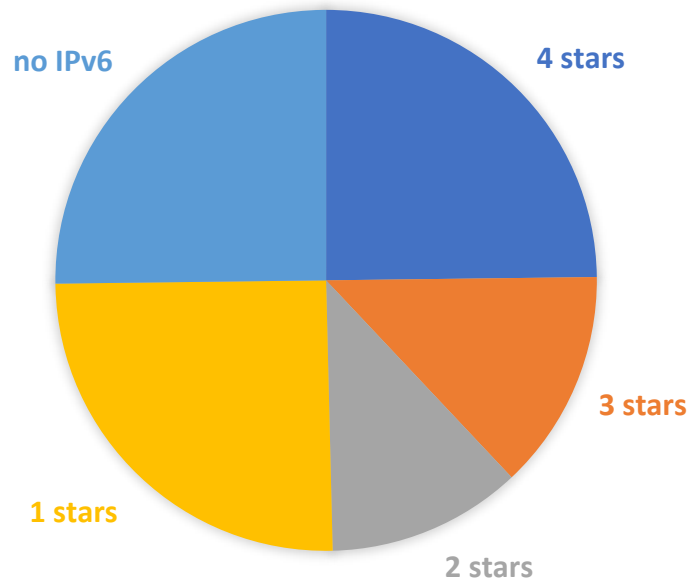
# IPv6 RIPENSS - All LIRs



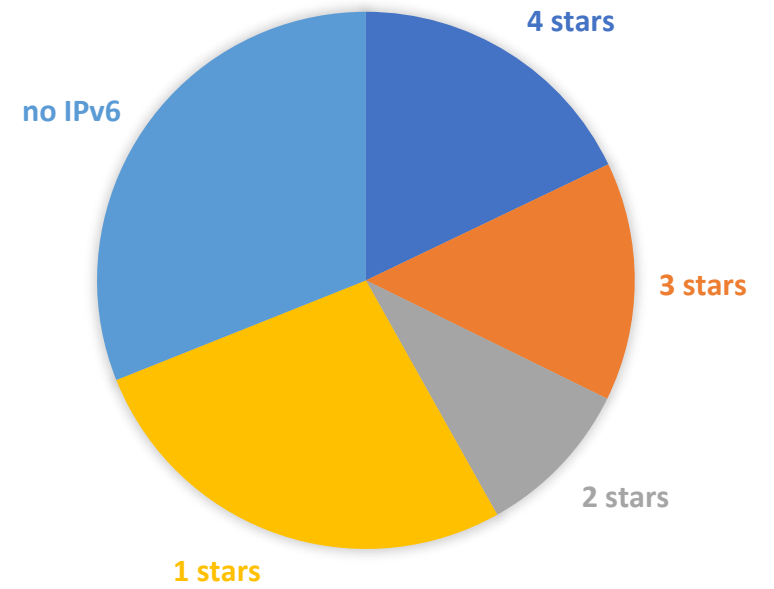
# IPv6 RIPENSS - BA



# IPv6 RIPENSS



BA



All LIRs



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# IPv6 Security Myths





# IPv6 Security Myths (1)

1

2

3

4

5

6

7

8

- IPv6 is more secure than IPv4
- IPv6 has better security and it's built in

## Reason:

- RFC 4294 - IPv6 Node Requirements: IPsec MUST

## Reality:

- RFC 6434 - IPv6 Node Requirements: IPsec SHOULD
- IPsec available. Used for security in IPv6 protocols

# IPv6 Security Myths (2)



1

2

3

4

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6

7

8

- IPv6 has no NAT. Global addresses used
- I'm exposed to attacks from Internet

## Reason:

- End-2-End paradigm. Global addresses. No NAT

## Reality:

- Global addressing does not imply global reachability
- You are responsible for reachability (filtering)

# IPv6 Security Myths (3)



1

2

3

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8

- IPv6 Networks are too big to scan

## Reason:

- Common LAN/VLAN use /64 network prefix
- 18,446,744,073,709,551,616 hosts

## Reality:

- Brute force scanning is not possible [RFC5157]
- New scanning techniques

# IPv6 Security Myths (4)



1

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- IPv6 is too new to be attacked

## Reason:

- Lack of knowledge about IPv6 (it's happening!)

## Reality:

- There are tools, threats, attacks, security patches, etc.
- You have to be prepared for IPv6 attacks



# IPv6 Security Myths (5)

1

2

3

4

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7

8

- IPv6 is just IPv4 with 128 bits addresses
- There is nothing new

## Reason:

- Routing and switching work the same way

## Reality:

- Whole new addressing architecture
- Many associated new protocols



# IPv6 Security Myths (6)

1

2

3

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8

- It supports IPv6

## Reason:

- Q: “Does it support IPv6?”
- A: “Yes, it supports IPv6”

## Reality:

- IPv6 support is not a yes/no question
- Features missing, immature implementations, interoperability issues



# IPv6 Security Myths (7)

1

2

3

4

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8

- My network is IPv4 only
- IPv6 is not a security problem

## Reason:

- Networks only designed and configured for IPv4

## Reality:

- IPv6 available in many hosts, servers, and devices
- Unwanted IPv6 traffic. Protect your network



# IPv6 Security Myths (8)

1

2

3

4

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6

7

8

- It's not possible to secure an IPv6 network
- Lack of resources and features

## Reason:

- Considering IPv6 completely different than IPv4
- Think there are no BCPs, resources or features

## Reality:

- Use IP independent security policies
- There are BCPs, resources and features



# Conclusions



- A change of mindset is necessary
- IPv6 is not more or less secure than IPv4
- Knowledge of the protocol is the best security measure

# Don'ts



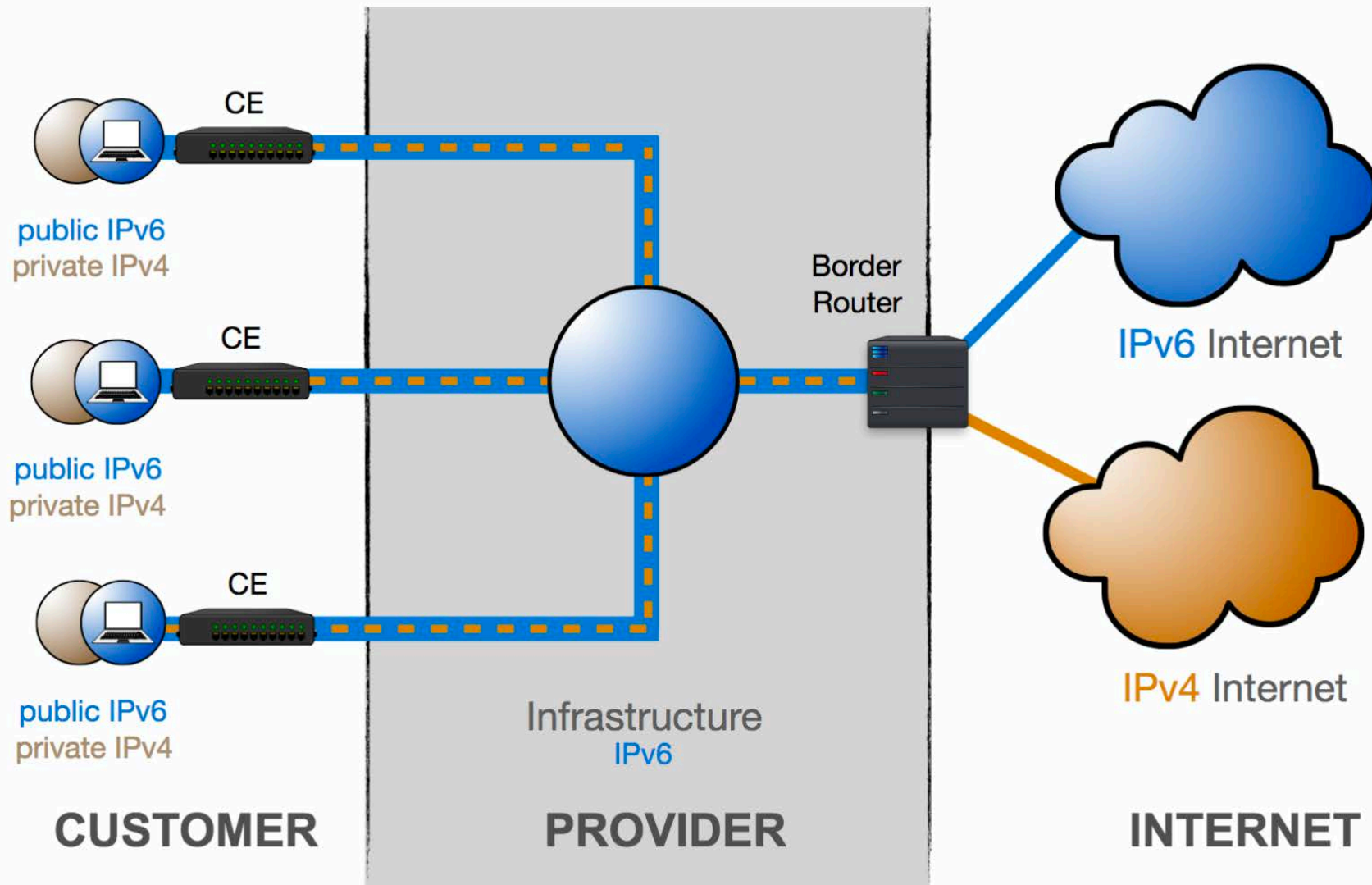
- Don't separate IPv6 features from IPv4
- Don't do everything in one go
- Don't appoint an IPv6 specialist
  - do you have an IPv4 specialist?
- Don't see IPv6 as a product
  - the Internet is the product!



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# Transition Techniques

# MAP-E / MAP-T

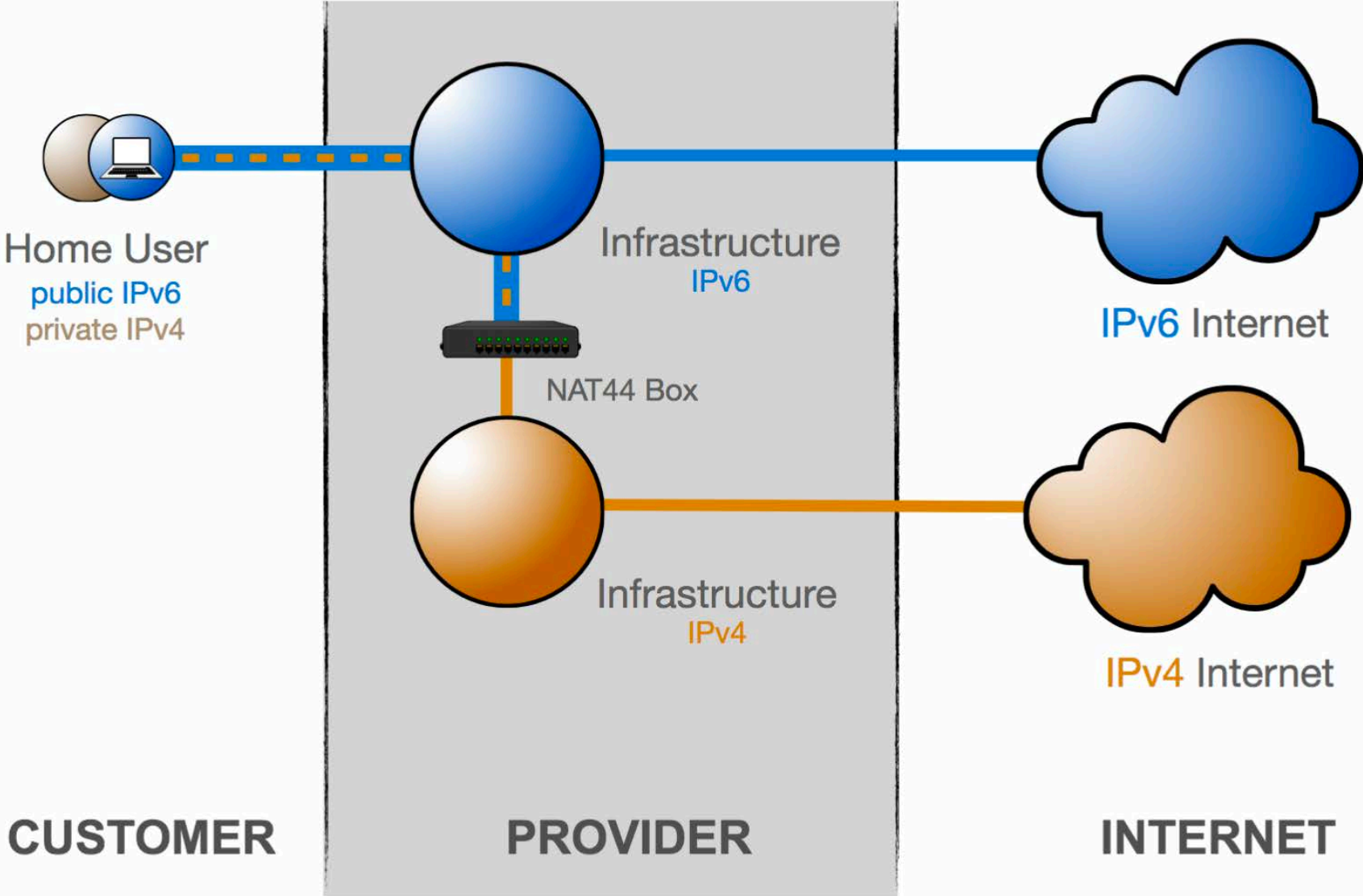


# MAP-E / MAP-T



- IPv4 over IPv6 - Encapsulated or Translated
- Clients get private IPv4 and public IPv6
- IPv4 address/port mapped into IPv6 address
- Stateless NAT44 allows traffic to flow asymmetrically in and out of MAP domain

# DS-lite

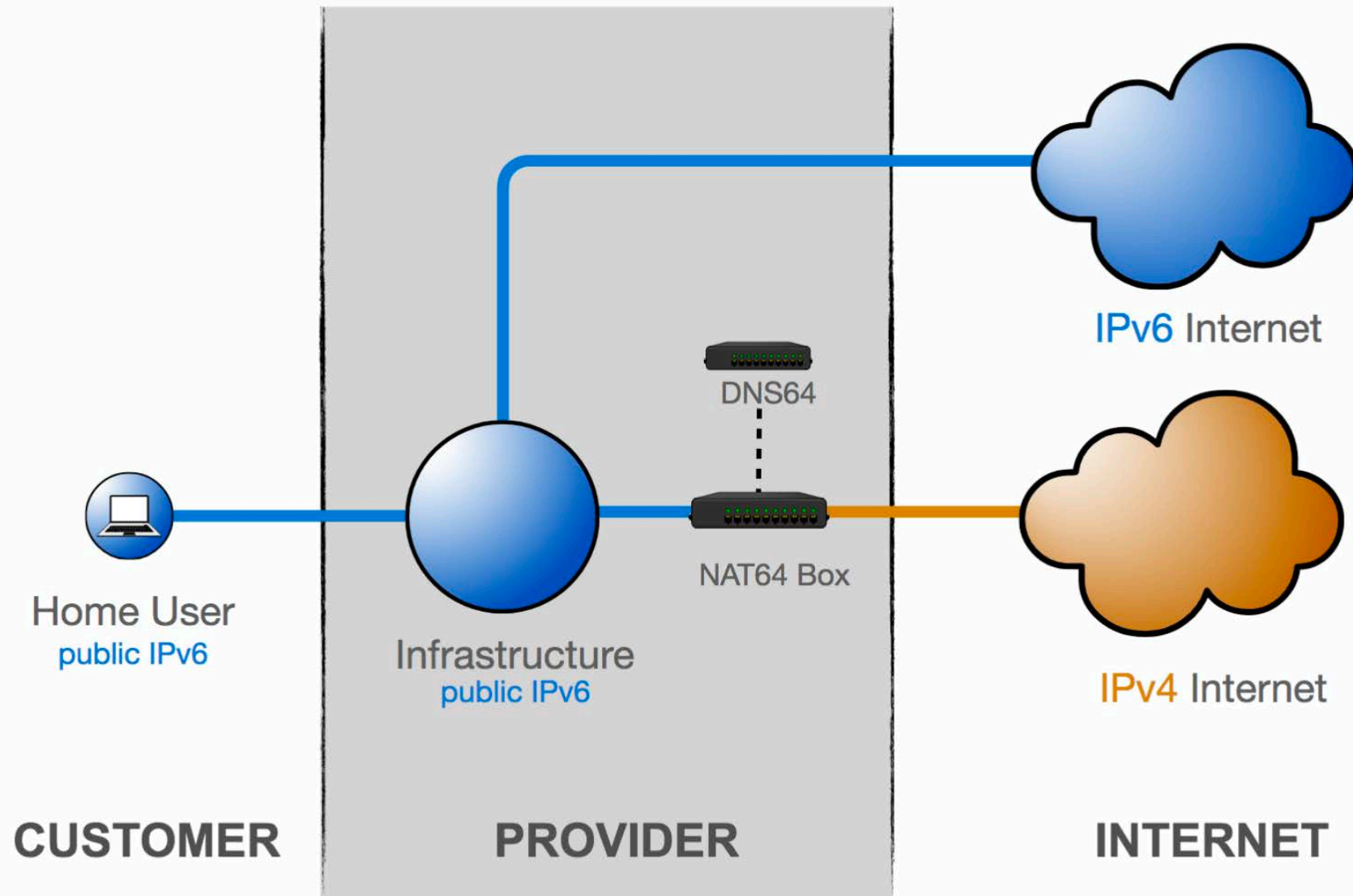




# DS-lite

- Tunnelling 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

# NAT64 / DNS64



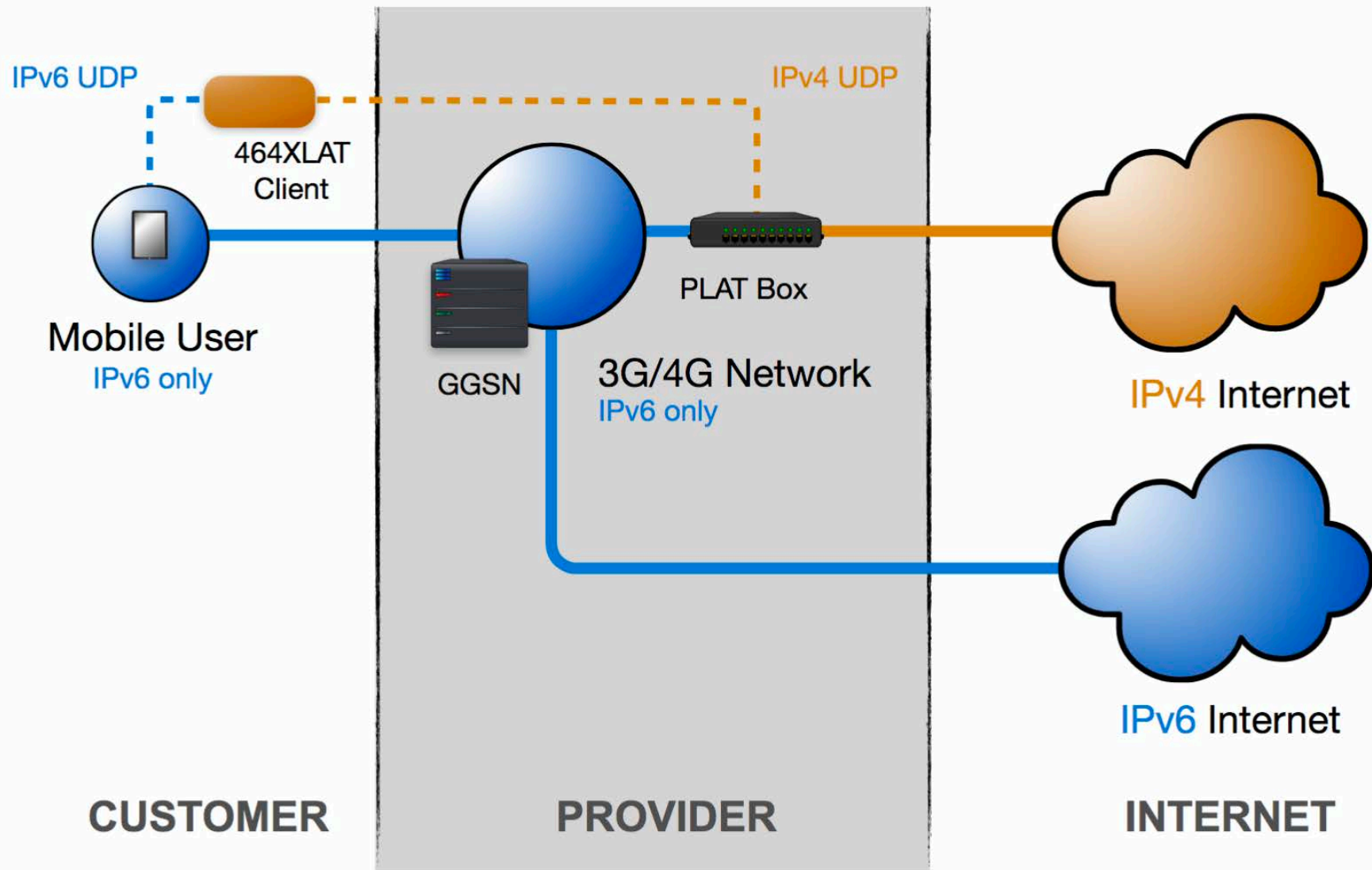


# NAT64 / DNS64



- 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

# 464XLAT





# 464XLAT

- Extension to NAT64 to access IPv4-only applications (like Skype or Whatsapp)
- Handset pretends there is an IPv4 address (CLAT) and sends IPv4 packets in UDP over IPv6

# Case Study: T-Mobile US Goes IPv6- only Using 464XLAT



T-Mobile in the United States was running out of IPv4 addresses and needed an IPv6 transition strategy. Their solution was 464XLAT and IPv6-only.

After launching this solution on 8 million phones T-Mobile has seen 27% of all traffic on these phones be native IPv6, and as the graph below shows, that number is still growing. If your organisation doesn't have a plan yet for IPv6, what are you waiting for?



# Questions



[hmi@ripe.net](mailto:hmi@ripe.net)