
# IPv6

## The Internet's Best Kept Secret

Nicole Wajer – Chief Stroopwafel Officer

# Nicole

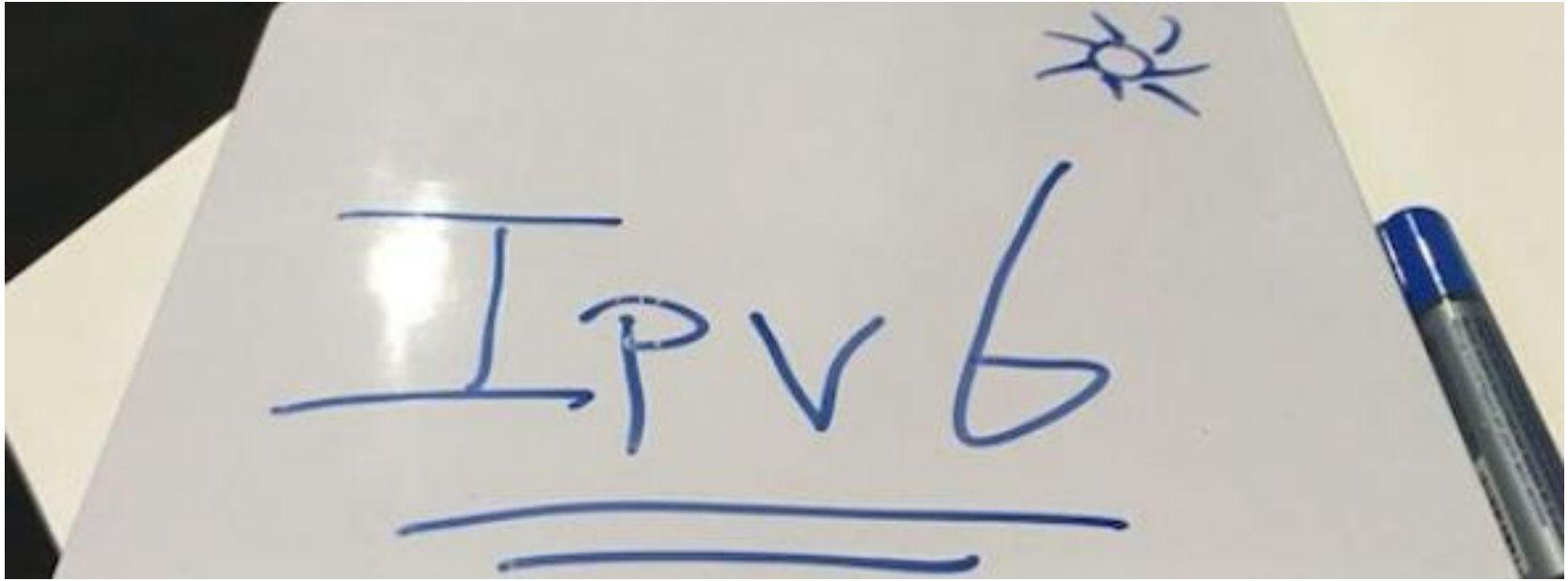

cisco Live!
Amsterdam
Daelmans
Stroopwafel


Lollipopman


IPV6

# How is IPv6 like Broccoli ?

# Don't Panic: Welcome to the Galaxy of IPv6



# The Answer to Life, the Universe, and Everything (But Nobody's Using It)

APNIC

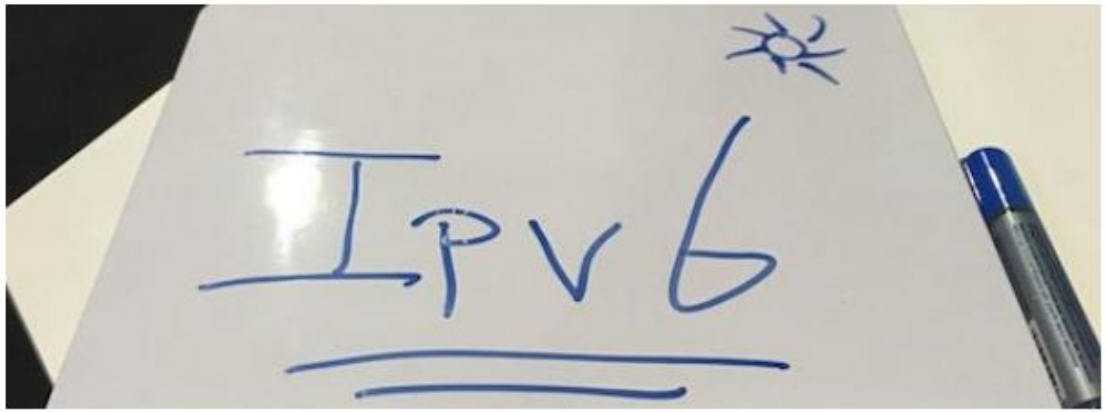
Get IP | Manage IP | Training | Events | Insights | Community | Blog

## IPv6? Nobody uses IPv6

By Nicole Wajer on 4 Sep 2018

Categories: Development Tech matters

Tags: enterprise, Guest Post, IPv6

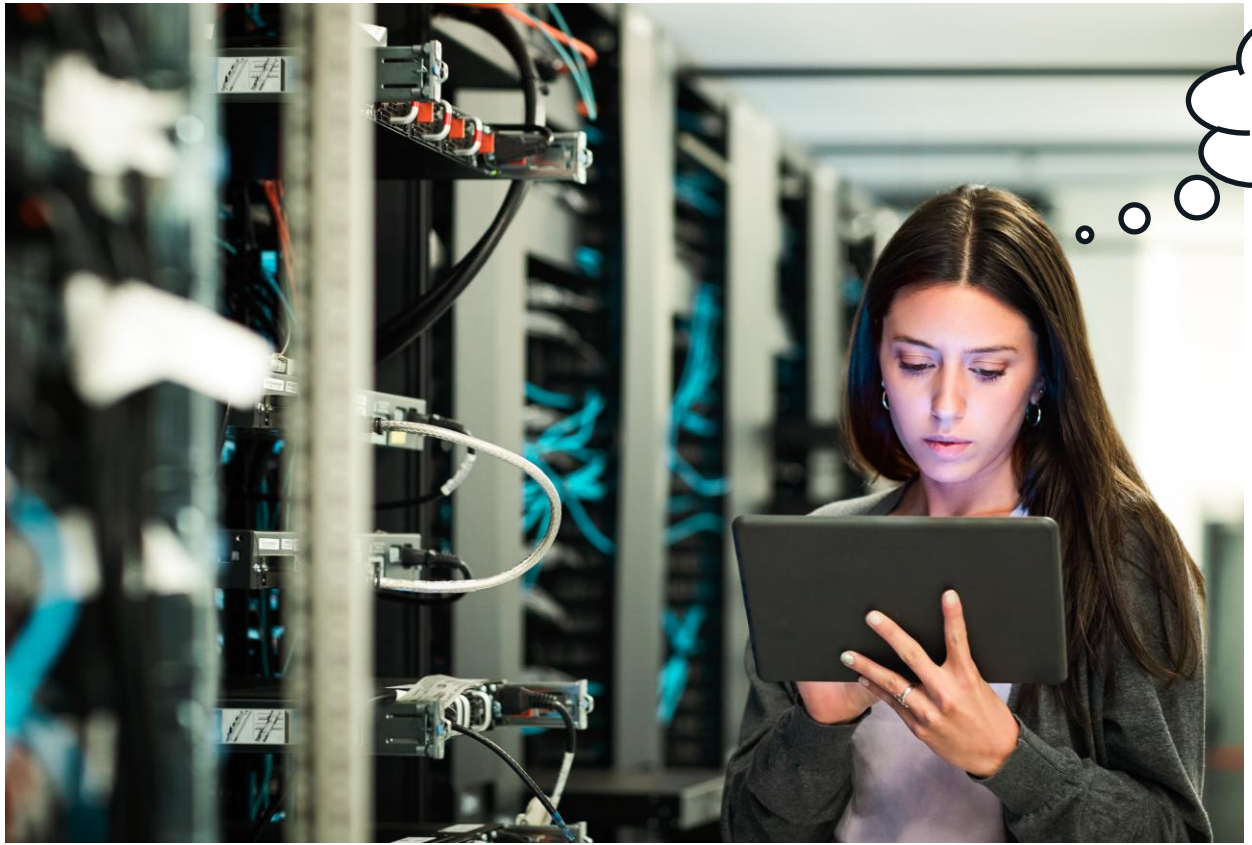



- https://blog.apnic.net/2018/09/04/ipv6-nobody-uses-ipv6/


This doesn't scale. I want everything connected
I don't need IPv6! I have NAT!

# The Vogons of the Internet: Understanding IPv4 vs IPv6

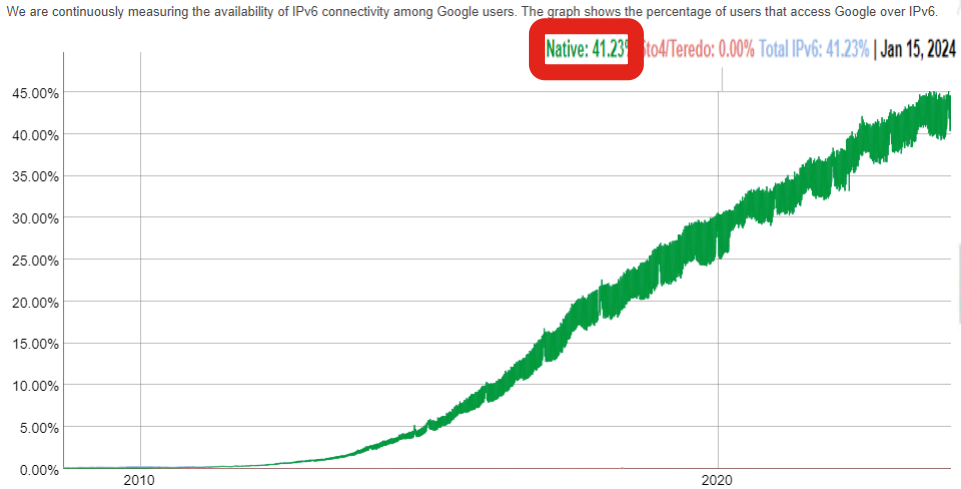
# Two-Headed Beast: IPv6 Adoption in Enterprises vs. the Rest of the Galaxy



# The Internet's Best Kept Secret: Mostly Harmless, Mostly Invisible

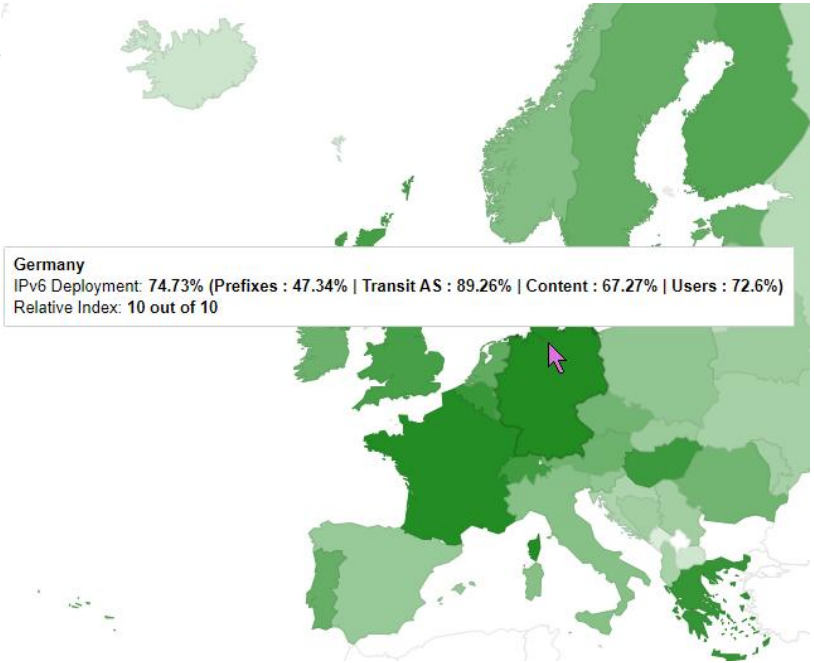

## IPv6 Adoption Statistics

### Global Traffic %




https://www.google.com/intl/en/ipv6/statistics.html

### Per country adoption (Germany)




https://6lab.cisco.com

# The Internet's Best Kept Secret: Mostly Harmless, Mostly Invisible

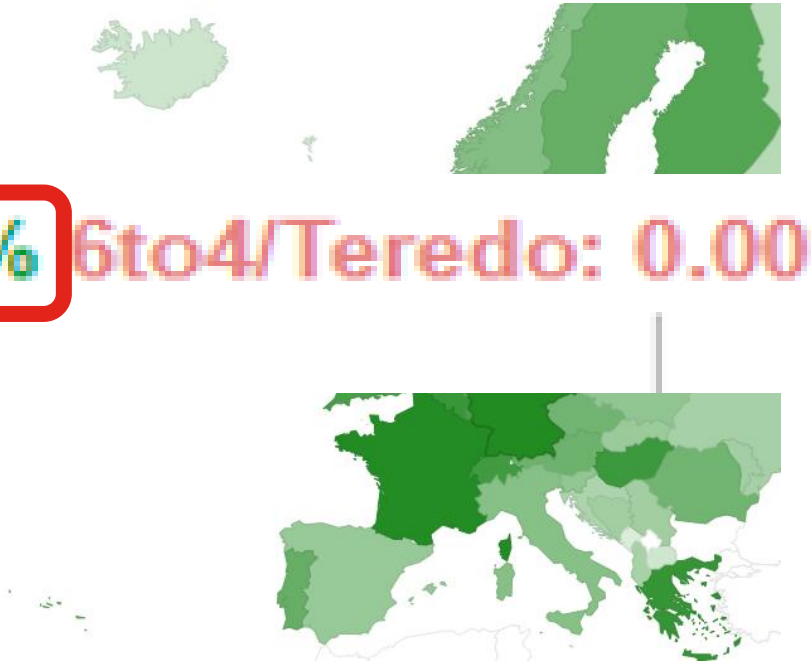
## IPv6 Adoption Statistics

### Global Traffic %


Native: 41.23% 6to4/Teredo: 0.00%

https://www.google.com/intl/en/ipv6/statistics.html

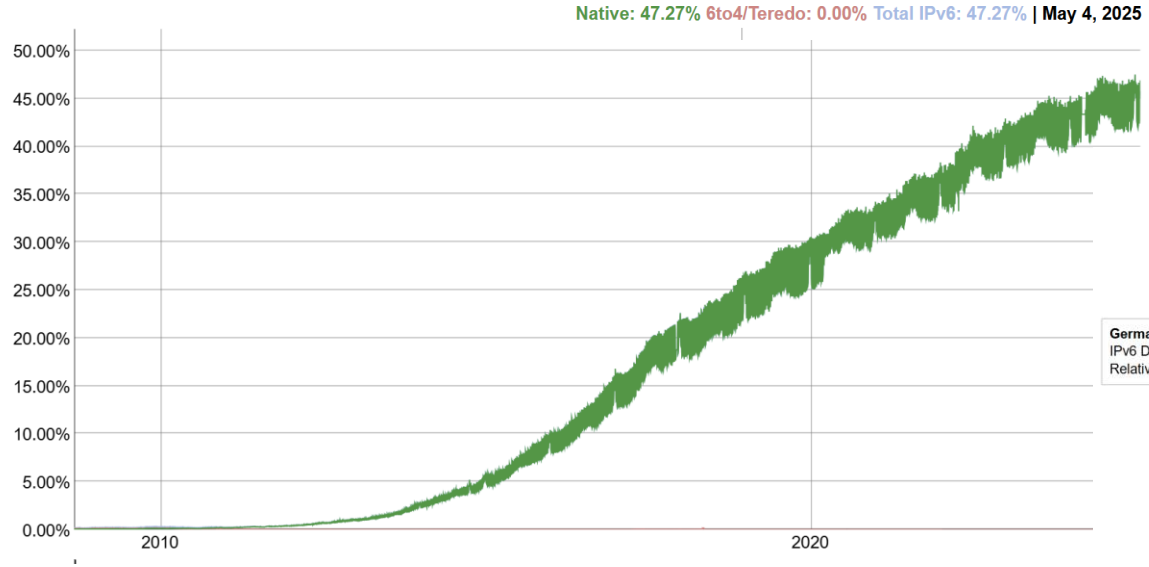
### Per country adoption (Germany)



https://6lab.cisco.com

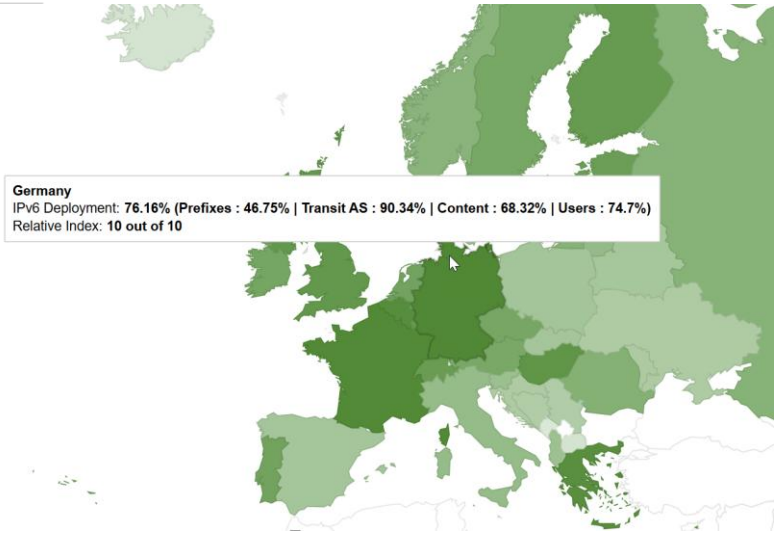
# IPv6 Adoption


## Google Global Traffic %




https://www.google.com/intl/en/ipv6/statistics.html

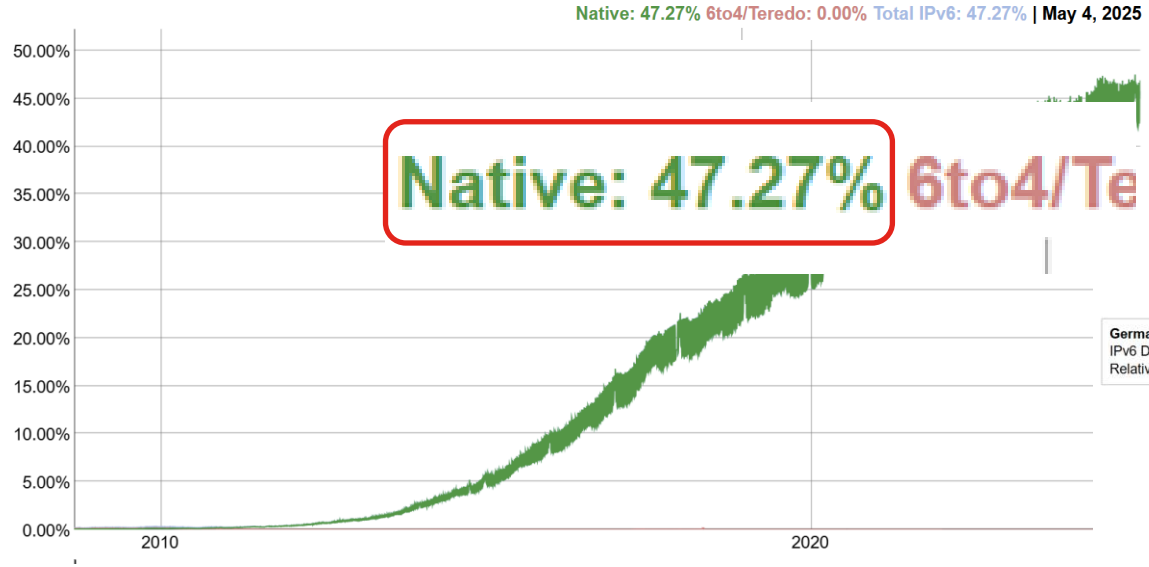
## Per country adoption (Germany)




https://6lab.cisco.com

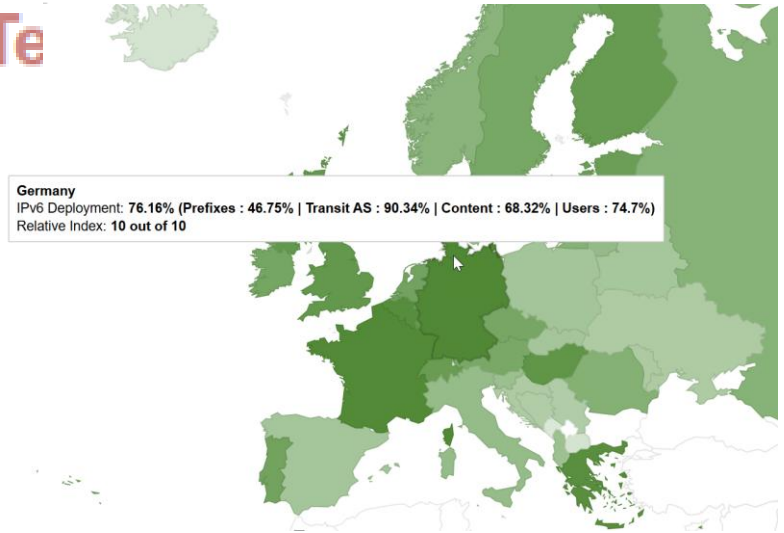
# IPv6 Adoption


## Google Global Traffic %




https://www.google.com/intl/en/ipv6/statistics.html

## Per country adoption (Germany)

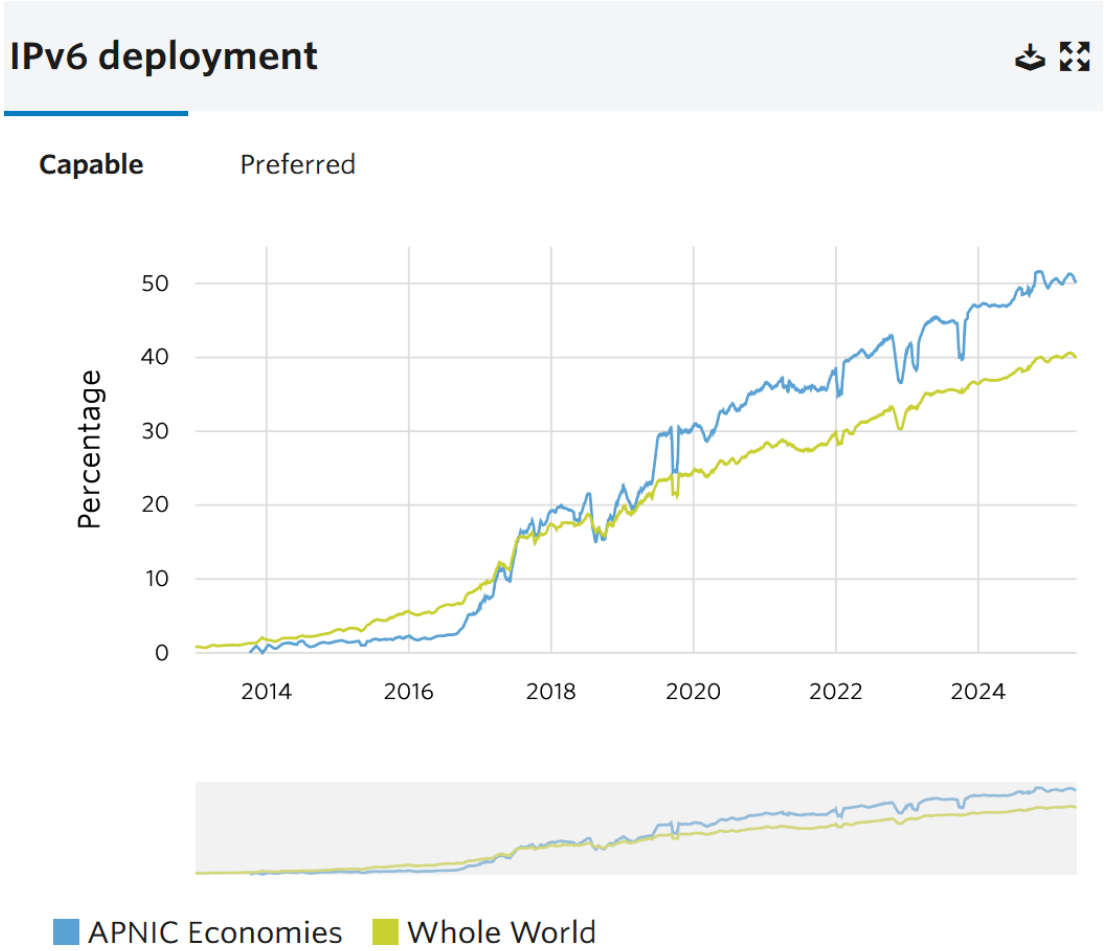



https://6lab.cisco.com

# IPv6 Adoption

APNIC

**IPv6 capability reaches 50% in the Asia Pacific region**



# The Reality Today*

Client OS

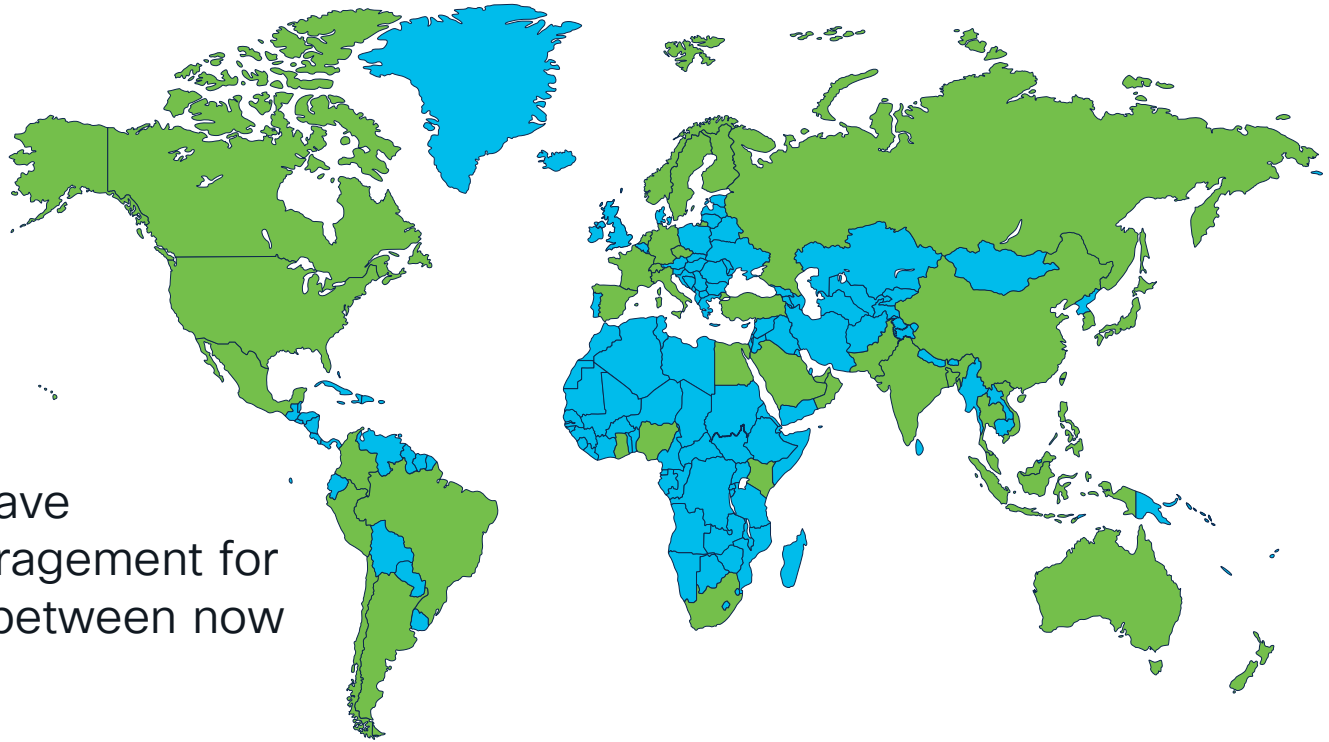
ISP

Internet

Enterprise Network

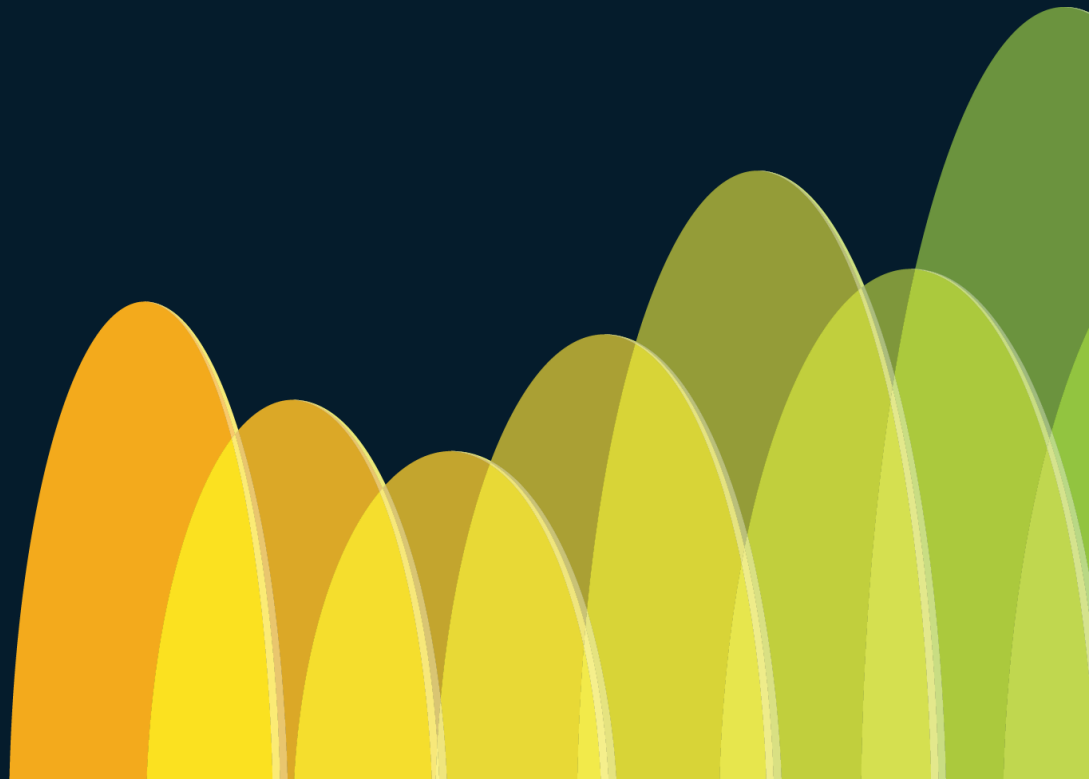
* A generalization

# Country “Mandates”

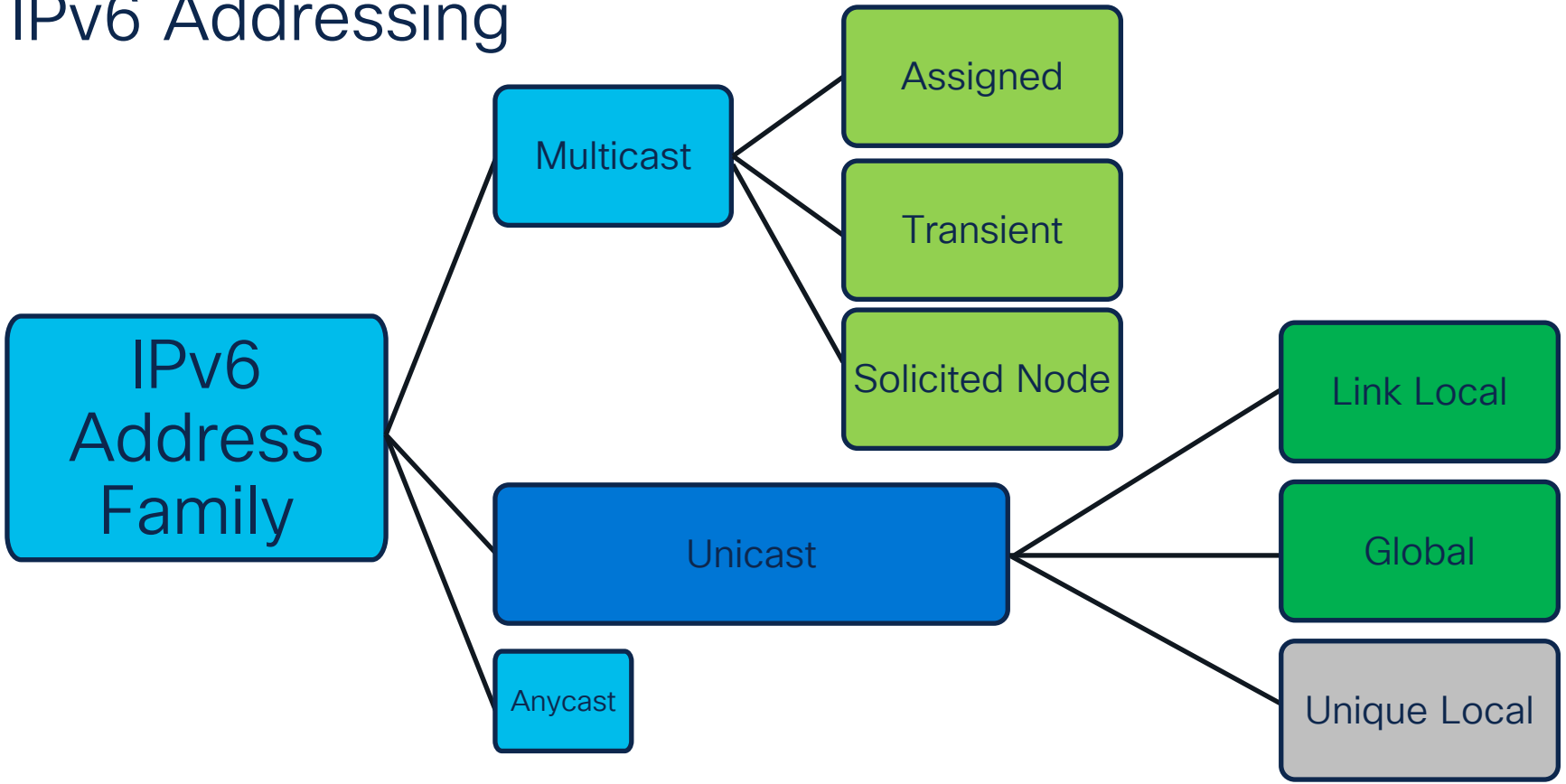


50+ countries have mandate/encouragement for IPv6/IPv6-only between now and 2030+.

# 128 Bits of Addressing



# IPv6 Addressing



# IPv6 Address rules (RFC 5952)

Lower case, suppress leading / compress consecutive zeros

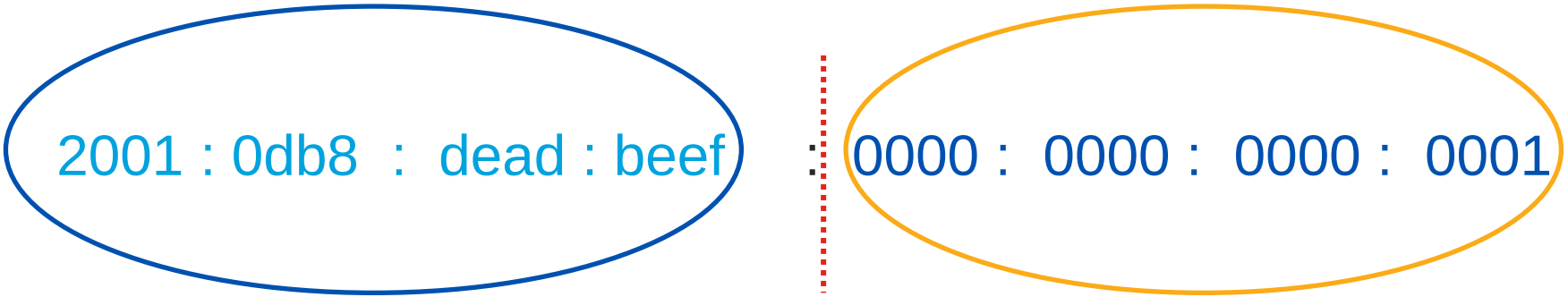
2001:0db8:0046:a1d1:0000:0000:0000:0001

2001:db8:46:a1d1:0:0:0:1

2001:db8:46:a1d1::1

# The IPv6 Address – Practical View

- IPv6 addresses are 128 bits long
  - Segmented into 8 groups of four HEX characters
  - Separated by a colon (:)
  - Default is 50% for network ID (/64), 50% for interface ID



# Bypassing the Hyperspace Bypass: How IPv6 Overcomes IPv4 Limitations

IPv6

IPv4

# Different things I can do with IPv6

1. Expose every container with a public IPv6 address

2. Spin up 10M containers every second

3. Burn the address with the container !!

# Different things I can do with IPv6

1. Expose e
container w
public IP
address

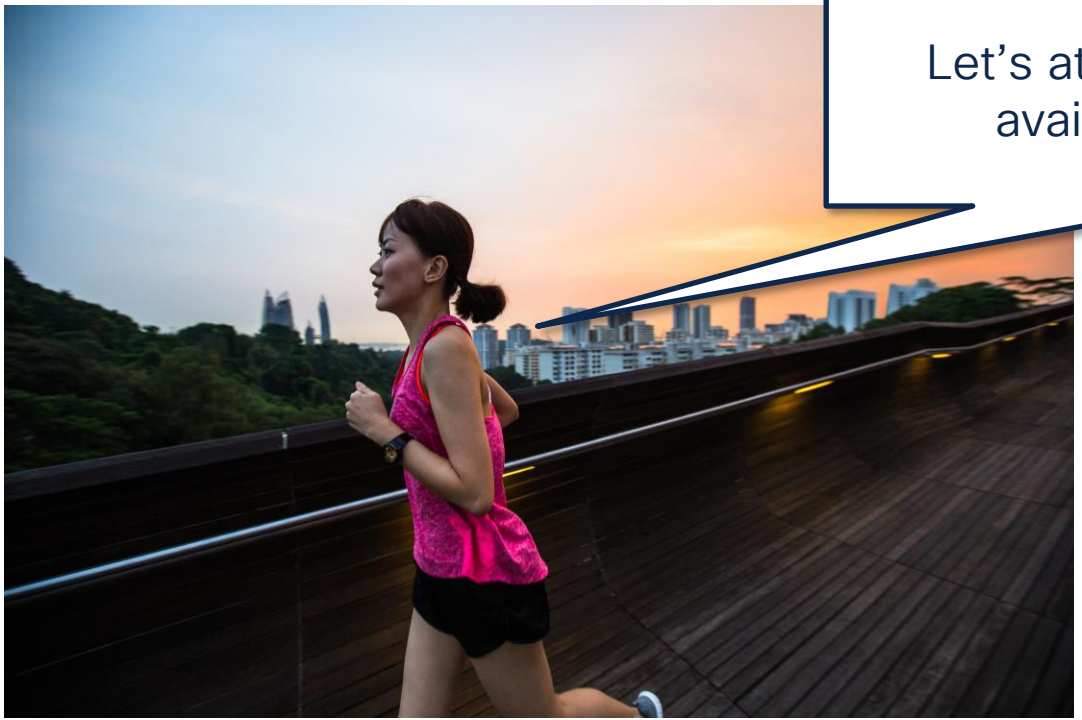
2. Spin up
containers
second

3. Burn t
address wit
containe

# Depleting a /64

Prefix of /64 has
18,446,744,073,709,600,000
IPv6 addresses

# Depleting a /64



Let’s attempt to exhaust all the available IPv6 addresses

# Depleting a /64

We allocate 10,000,000 addresses per second

There are 31,536,000 seconds per year

315,360,000,000,000 addresses per year

# Depleting a /64

18,446,744,073,709,600,000
315,360,000,000,000

# Depleting a /64

58,494 year


We allocate a /48 to a Data Centre Network
Prefix of /64? We need to Scale!

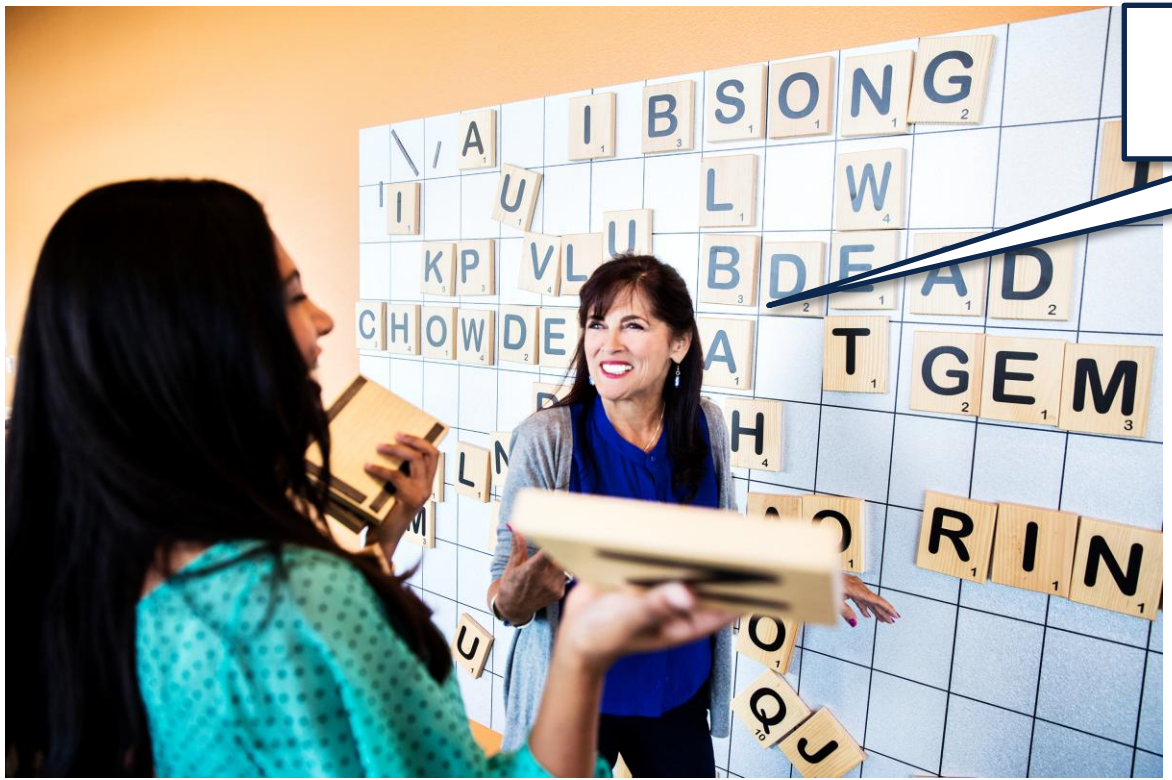
# Depleting a /48

A /48 contains 65,536 /64's

It takes 58,494 years to deplete a /64 at 10M addresses per second

315,360,000,000,000 addresses per year

# Depleting a /48



# Depleting a /48

3.8B years


Nobody
uses IPv6!

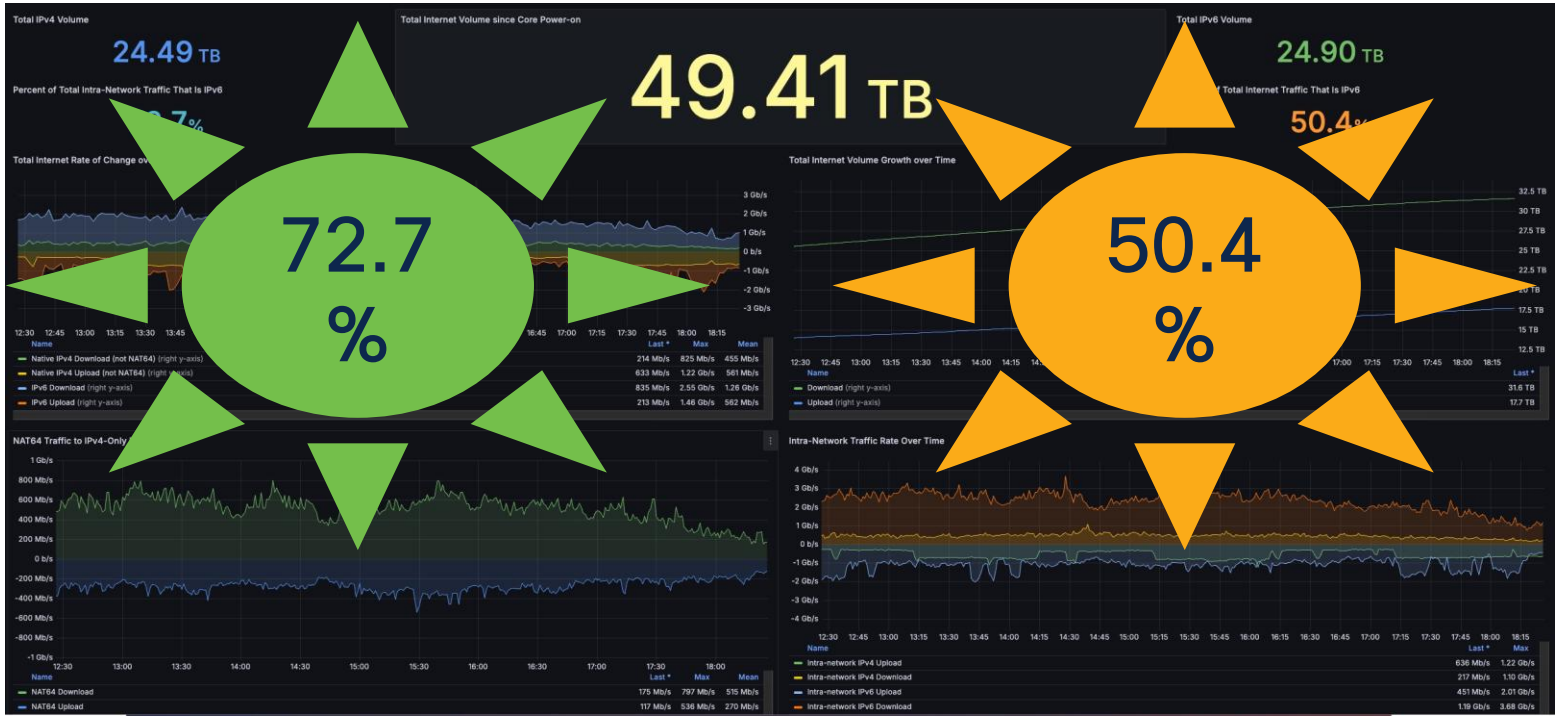
# Marvin's Paradox: The Hidden and Underappreciated Usage of IPv6

## Traffic @ Cisco Live Amsterdam 2024


46.8%

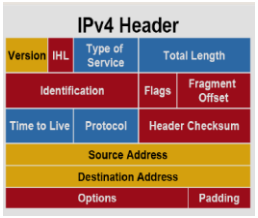
# Cisco Live Amsterdam 2025

# Cisco Live Amsterdam 2025

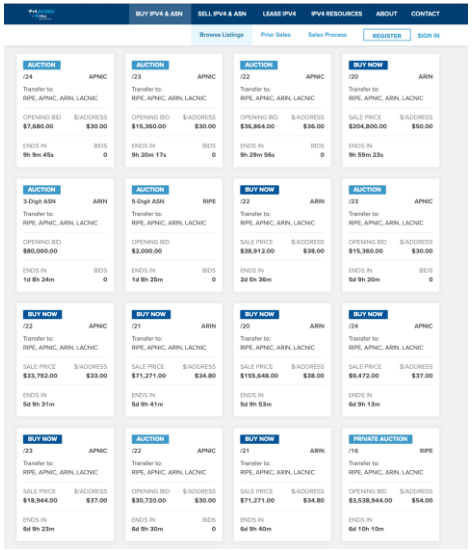



Is there a business case deploying IPv6?

# Legacy IP (IPv4) more expensive than Broccoli




€



https://auctions.ipv4.global/

€

**€ 42.20 Per Year**

AWS News Blog

## New – AWS Public IPv4 Address Charge + Public IP Insights

by Jeff Barr | on 28 JUL 2023 | in Amazon EC2, Announcements, Launch, News | Permalink | Comments | Share

00:00 00:00

Voiced by Amazon Polly

We are introducing a new charge for public IPv4 addresses. Effective February 1, 2024 there will be a charge of $0.005 per IP per hour for all public IPv4 addresses, whether attached to a service or not (there is already a charge for public IPv4 addresses you allocate in your account but don't attach to an EC2 instance).

**Public IPv4 Charge**

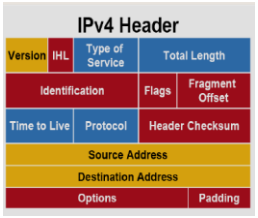
As you may know, IPv4 addresses are an increasingly scarce resource and the cost to acquire a single public IPv4 address has risen more than 300% over the past 5 years. This change reflects our own costs and is also intended to encourage you to be a bit more frugal with your use of public IPv4 addresses and to think about accelerating your adoption of IPv6 as a modernization and conservation measure.

This change applies to all AWS services including Amazon Elastic Compute Cloud (Amazon EC2), Amazon Relational Database Service (RDS) database instances, Amazon Elastic Kubernetes Service (EKS) nodes, and other AWS services that can have a public IPv4 address allocated and attached, in all AWS regions (commercial, AWS China, and GovCloud). Here's a summary in tabular form:

| Public IP Address Type | Current Price/Hour (USD) | New Price/Hour (USD) (Effective February 1, 2024) |
|---|---|---|
| In-use Public IPv4 address (including Amazon provided public IPv4 and Elastic IP) assigned to resources in your VPC, Amazon Global Accelerator, and AWS Site-to-site VPN tunnel | No charge | $0.005 |
| Additional (secondary) Elastic IP Address on a running EC2 instance | $0.005 | $0.005 |
| Idle Elastic IP Address in account | $0.005 | $0.005 |

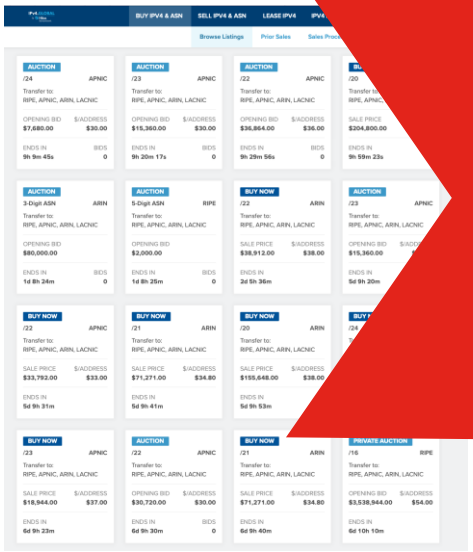
https://aws.amazon.com/blogs/aws/new-aws-public-ipv4-address-charge-public-ip-insights/

# Legacy IP (IPv4) more expensive than Broccoli




€ €

**€ 42.20 Per Year**



https://auctions.ipv4.global/

AWS News Blog

**New – AWS Public IPv4 Address Charge + Public IP Insights**

by Jeff Barr | on 28 JUL 2023 | in Amazon EC2, Announcements, Launch, News | Permalink | Comments | Share

00:00 00:00

Voiced by Amazon Polly

…es. Effective February 1, 2024 there will be a charge of $0.005 …attached to a service or not (there is already a charge for public …'t attach to an EC2 instance).

…easingly scarce resource and the cost to acquire a single public IPv4 address … years. This change reflects our own costs and is also intended to encourage …e of public IPv4 addresses and to think about accelerating your adoption of IPv6 … measure.

…s including Amazon Elastic Compute Cloud (Amazon EC2), Amazon Relational …es, Amazon Elastic Kubernetes Service (EKS) nodes, and other AWS services that …d attached, in all AWS regions (commercial, AWS China, and GovCloud). Here's

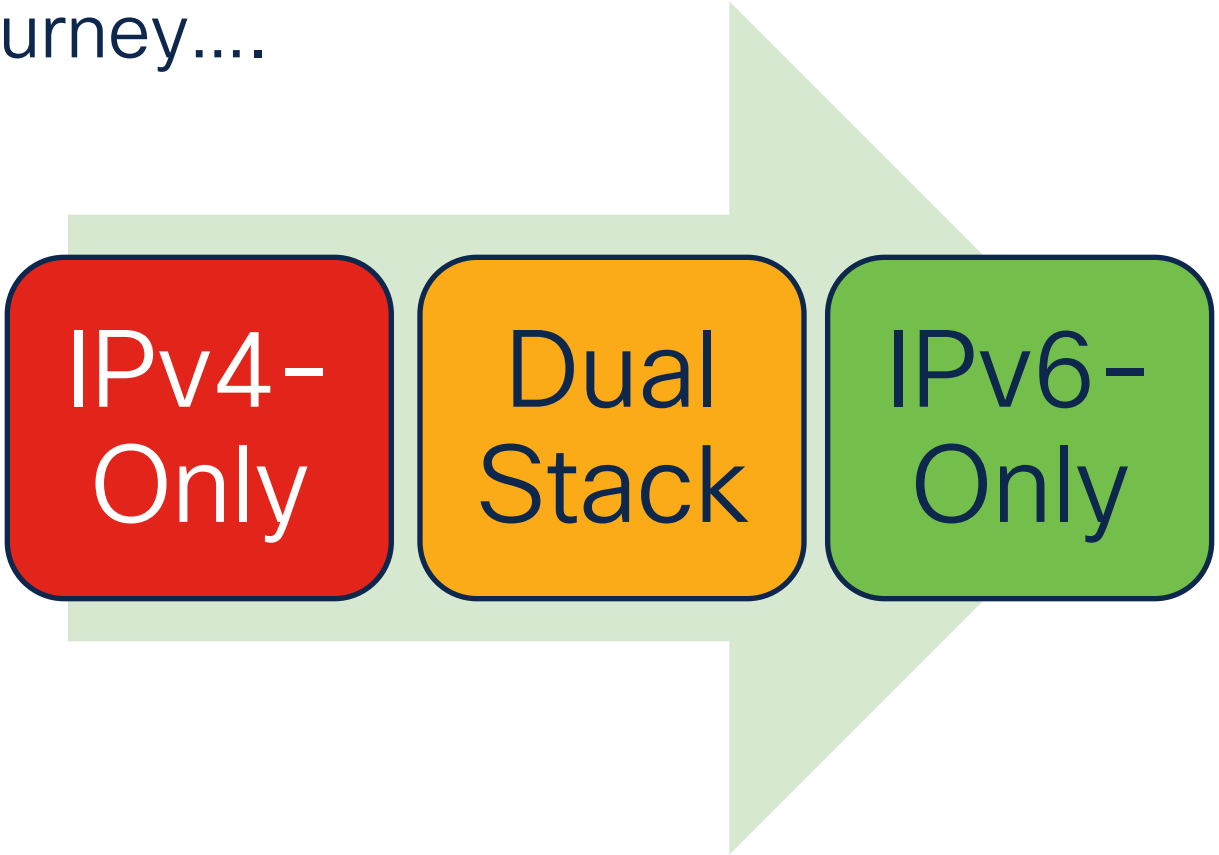
| | … Price/Hour (USD) | New Price/Hour (USD) (Effective February 1, 2024) |
|---|---|---|
| …ge | | $0.005 |
| Additional (secondary) Elastic IP Address on a running EC2 instance | $0.005 | $0.005 |
| Idle Elastic IP Address in account | $0.005 | $0.005 |

https://aws.amazon.com/blogs/aws/new-aws-public-ipv4-address-charge-public-ip-insights/

# The transition towards IPv6-only

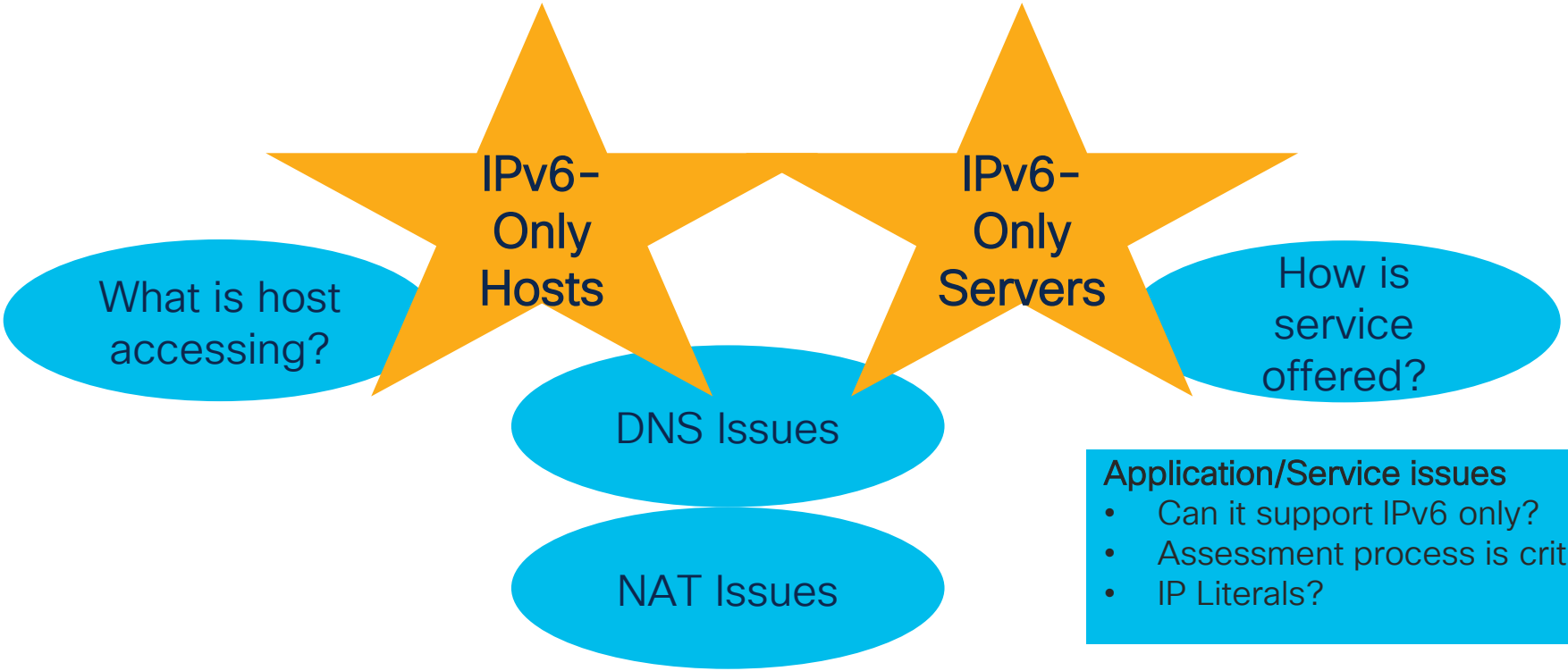
Source: Nicole Wajer

# The Journey....



# The life on an IPv6-only island/world

## What do I need to be concerned about?




**Application/Service issues**

- Can it support IPv6 only?
- Assessment process is critical
- IP Literals?

Internet Engineering Task Force (IETF)
Request for Comments: 8925
Updates: 2563
Category: Standards Track
Published: October 2020
ISSN: 2070-1721

L. Colitti
Google
J. Linkova
Google
M. Richardson
Sandelman
T. Mrugalski
ISC

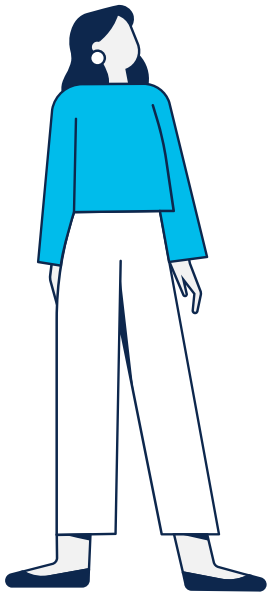
RFC8925

# IPv6-Only Preferred Option for DHCPv4

**Abstract**

This document specifies a DHCPv4 option to indicate that a host supports an IPv6-only mode and is willing to forgo obtaining an IPv4 address if the network provides IPv6 connectivity. It also updates RFC 2563 to specify DHCPv4 server behavior when the server receives a DHCPDISCOVER not containing the Auto-Configure option but containing the new option defined in this document.

# The Journey....

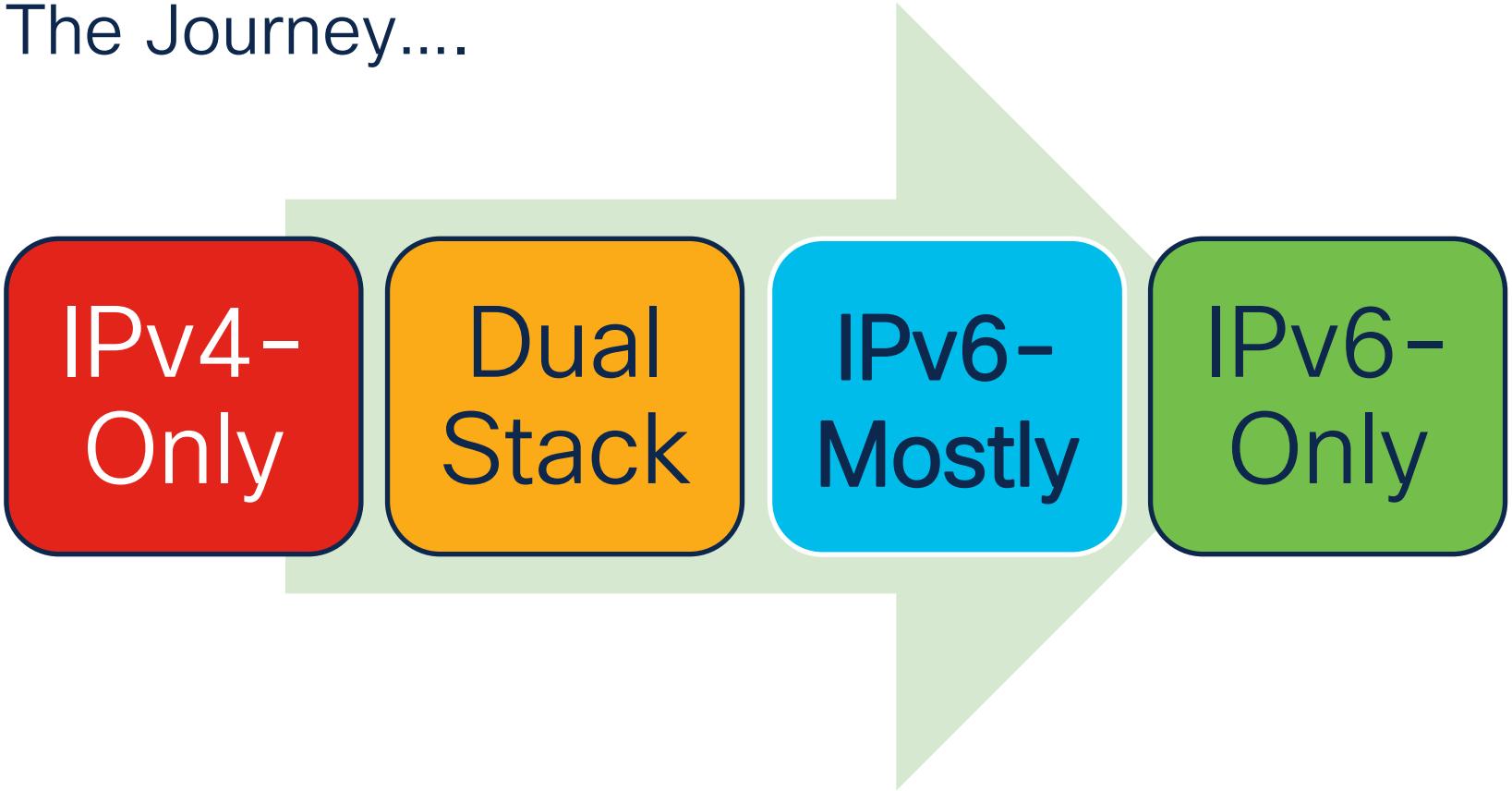


IPv4-Only

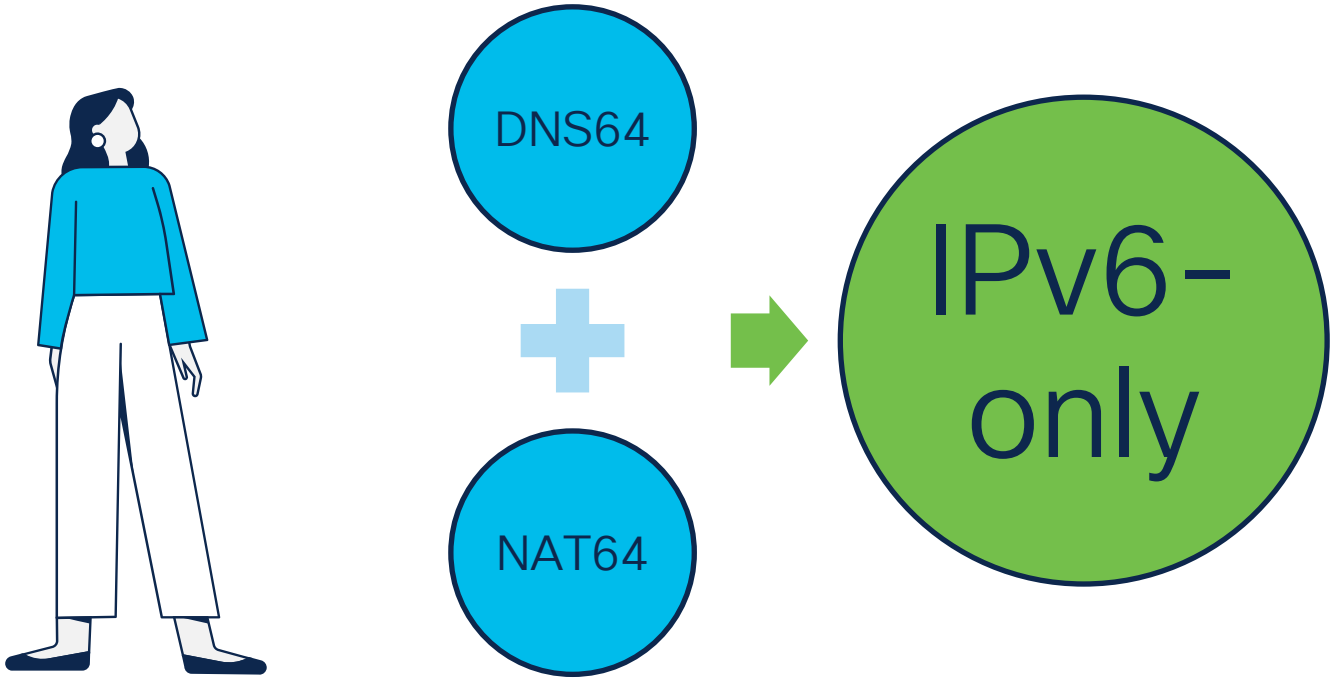
Dual Stack

IPv6-Only

# The Journey....

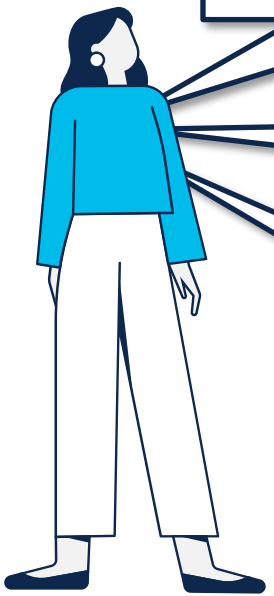


# IPv6-only enterprise talking with Legacy World



# What is required in my network for IPv6-Mostly?

SLAAC for Customer-Side Translator (CLAT) address assignment (no DHCPv6 ☹)

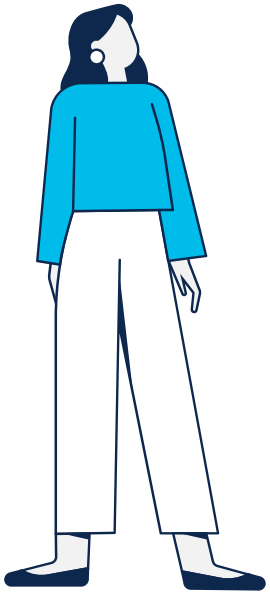


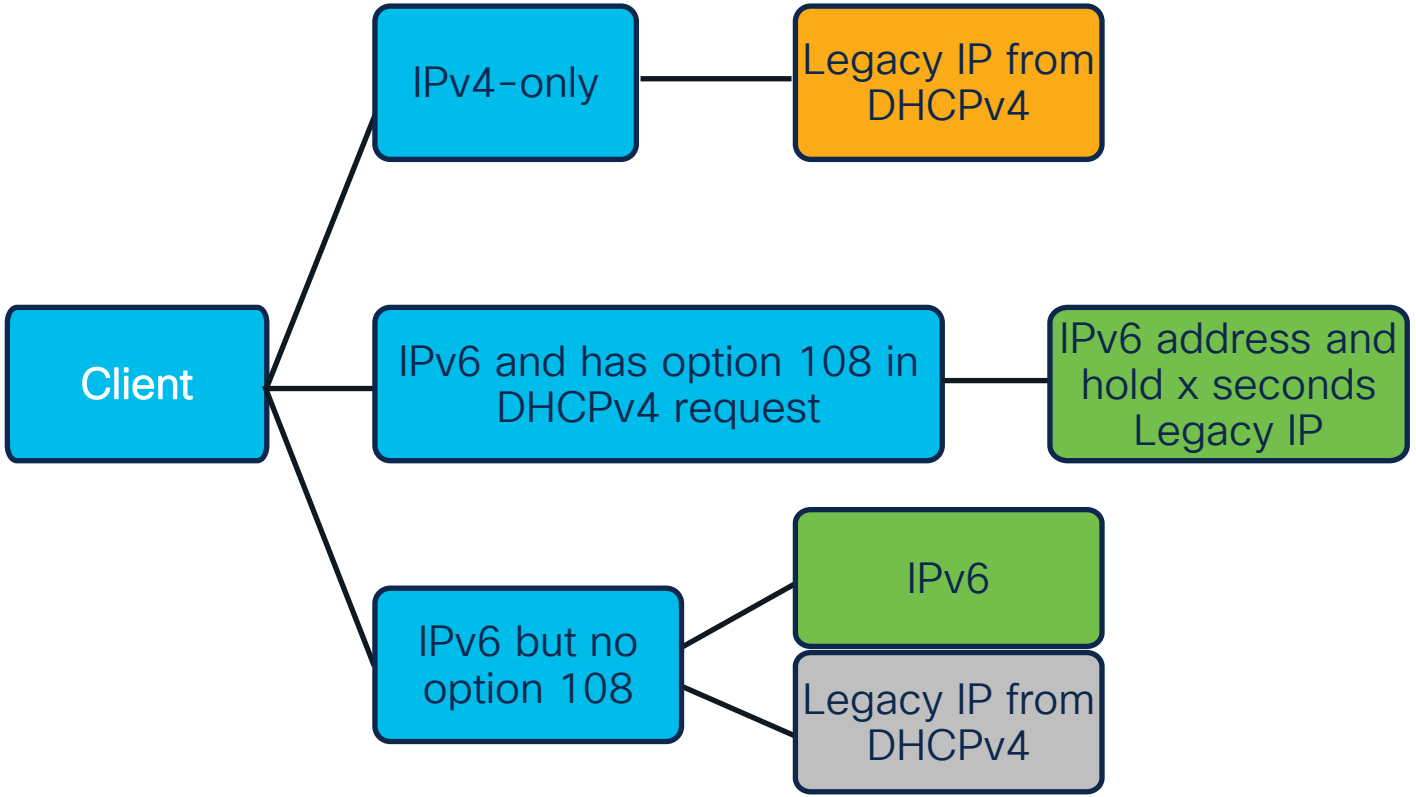
NAT64 to access IPv4-only destinations

- Router Advertisement option for NAT64 Prefix (PREF64)
- ipv4only.arpa DNS lookup via DNS64 for NAT64 Prefix

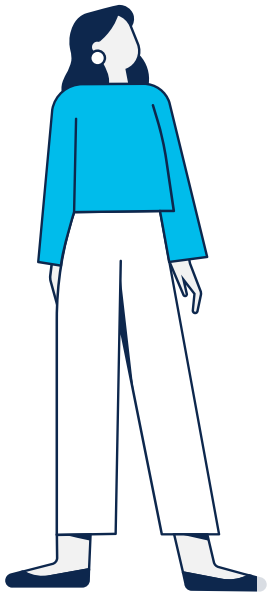
DHCPv4 infrastructure Option 108

# How does IPv6-mostly work?





# How does IPv6-mostly work?



**IPv6 address and hold x seconds Legacy IP**

DHCPv4 option 108

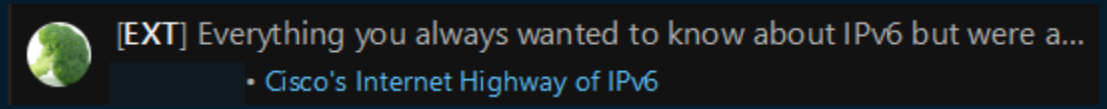
**“keep DHCPv4 running with a backoff timer, just in case IPv4 needs to be re-enabled”**


I would love
to Deploy
IPv6 NOW!

# So Long, and Thanks for All the Fish: The Future of IPv6


*"IPv6 is Internet broccoli. Good for us in the long run but no immediate sugar rush from deploying it now"*

Shameless self promotion of my own Quotes - Nicole Wajer




https://eurl.io/#Pw7m5J7S-


CISCO Live!
Amsterdam | February 6–10, 2023
Daelmans
Stroopwafel


cisco
Thank you

# Training Options

- HexaBuild
  - https://hexabuild.arlo.co/w/
- Pluralsight
  - https://www.pluralsight.com/courses/ipv6-introduction-to-protocol
  - https://www.pluralsight.com/courses/ipv6-microsoft-windows
- NterOne
  - https://www.nterone.com/training/cisco/courses/ip6fd
- O'Reilly LiveLessons
  - https://www.oreilly.com/videos/ipv6-design-and/9780134655529
- Rick Graziani – YouTube Playlist
  - https://www.youtube.com/playlist?list=PLMLm7-g0V0kfGg8g8KutNFK7rS3laA9QQ

**Cisco Live! (On-Demand)**

IPv6:: It's Happening! – BRKIPV-2191 – Nathan Sherrard

https://www.ciscolive.com/c/dam/r/ciscolive/global-event/docs/2023/pdf/BRKIPV-2191.pdf

What Do you Mean there isn't a Broadcast? – BRKIPV-1616 – Fish Fishburne

https://www.ciscolive.com/c/dam/r/ciscolive/global-event/docs/2023/pdf/BRKIPV-1616.pdf

Deploying IPv6 in the Cloud – BRKIPV-3927 – Shannon McFarland

https://www.ciscolive.com/c/dam/r/ciscolive/global-event/docs/2023/pdf/BRKIPV-3927.pdf

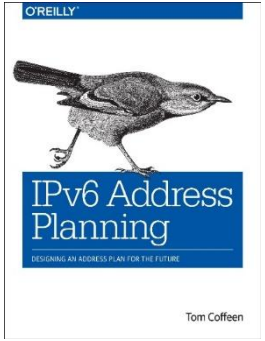
The Hitchhiker's Guide to Troubleshooting IPv6 - BRKENT-3340 – Nicole Wajer

https://www.ciscolive.com/c/dam/r/ciscolive/emea/docs/2024/pdf/BRKENT-3340.pdf

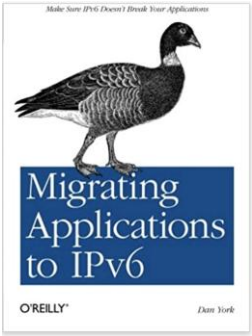
# Resources - Books


https://www.amazon.com/IPv6-Fundamentals-Straightforward-Approach-Understanding/dp/1587144778


https://www.oreilly.com/library/view/dns-and-bind/9781449308025/




https://www.amazon.com/IPv6-Address-Planning-Designing-Future/dp/1491902760




https://www.oreilly.com/library/view/migrating-applications-to/9781449309688/

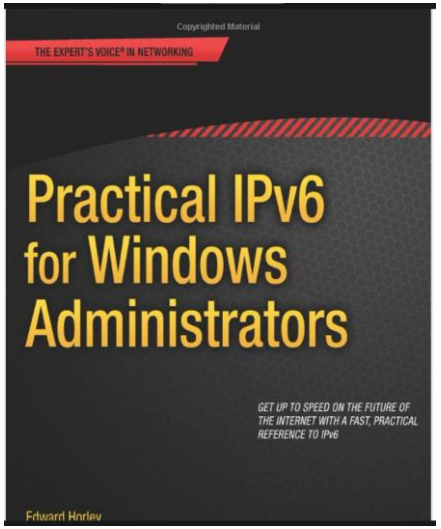
Additional Books:

Cisco Press - https://www.ciscopress.com/store/ipv6-design-and-deployment-livelessons-9780134655512

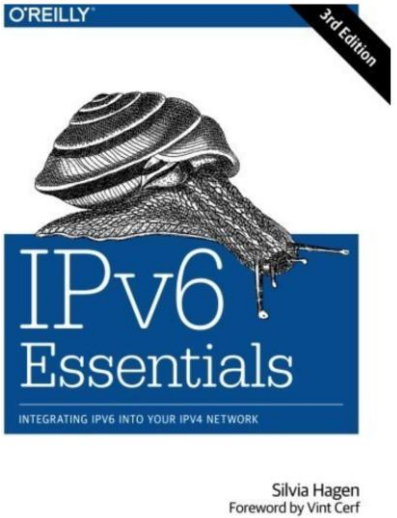
Cisco Press - https://www.ciscopress.com/store/ipv6-fundamentals-livelessons-a-straightforward-approach-9781587204579

O'Reilly Media – https://www.oreilly.com/library/view/introduction-to-ipv6/9781771375269/

# More Books




https://amzn.eu/d/1GhV2Gn




https://amzn.eu/d/i5PVjAs

# Online References


IPv6 Buzz Podcast - https://packetpushers.net/series/ipv6-buzz/

Infoblox IPv6 Center of Excellence - https://blogs.infoblox.com/category/ipv6-coe/

ARIN IPv6 Information - https://www.arin.net/resources/guide/ipv6/

APNIC IPv6 Information - https://www.apnic.net/community/ipv6/

RIPE IPv6 Info Centre - https://www.ripe.net/publications/ipv6-info-centre

Akamai IPv6 Adoption Visualization - https://www.akamai.com/internet-station/cyber-attacks/state-of-the-internet-report/ipv6-adoption-visualization

Cisco 6lab - https://6lab.cisco.com/

Google IPv6 Statistics - https://www.google.com/intl/en/ipv6/statistics.html

Tunnelbroker Hurricane Electric - https://tunnelbroker.net/

World IPv6 Launch - https://www.worldipv6launch.org/

# IPv6 troubleshooting for Helpdesks

- http://isp.testipv6.com ➔


https://www.ripe.net/ripe/groups/tf/bcop/ipv6-troubleshooting-for-residential-isp-helpdesks