

The background features a vibrant, abstract design. On the left, there are horizontal, wavy bands of color in shades of red, orange, yellow, and green. On the right, a bright white light source emits a series of colorful rays in shades of blue, cyan, and yellow, creating a sunburst effect.

cisco *Live!*

Let's go

#CiscoLiveAPJC



The bridge to possible

Let's Deploy IPv6 NOW!

Nicole Wajer – Technical Solutions Architect
@Vlinder_NL
BRKENT-2109

CISCO *Live!*

#CiscoLiveAPJC

Cisco Webex App

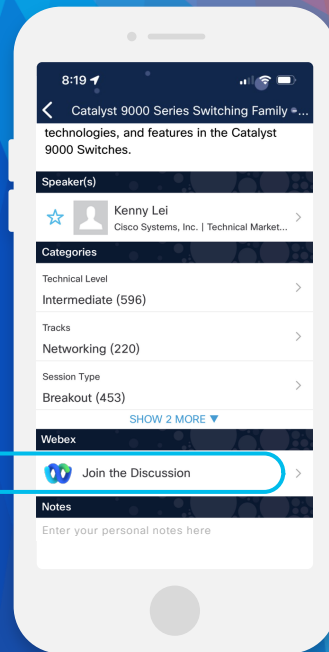
Questions?

Use Cisco Webex App to chat with the speaker after the session

How

- 1 Find this session in the Cisco Live Mobile App
- 2 Click “Join the Discussion”
- 3 Install the Webex App or go directly to the Webex space
- 4 Enter messages/questions in the Webex space

Webex spaces will be moderated by the speaker until December 22, 2023.



<https://ciscolive.ciscoevents.com/ciscolivebot/#BRKENT-2109>







How is IPv6 like broccoli?



Nicole



Nicole Wajer ✓

Chief Stroopwafel Officer



Nicole Wajer
Technical Solutions Architect
🐦 @vlinder_nl



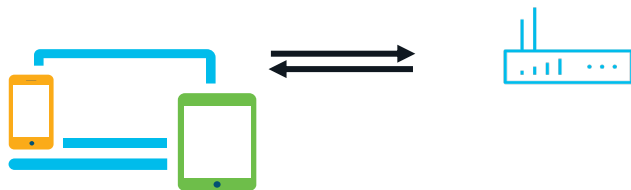
Agenda

- What should you know?
- Use Case 1 – Working from Home and IPv6
- Use Case 2 – IPv6 in your Enterprise
- Use Case 3 – IPv6 Only?

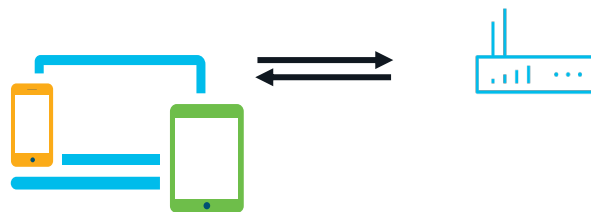
interface ID Assignment

IPv4 and IPv6 way

Manual Configuration



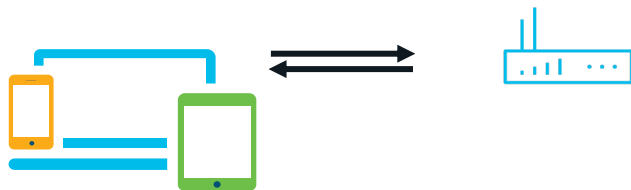
DHCP



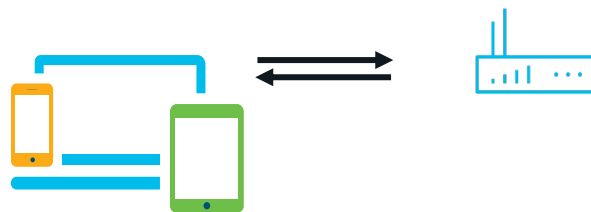
IPv6 interface ID Assignment

IPv6 way

State Less Address Auto Configuration
SLAAC EUI64

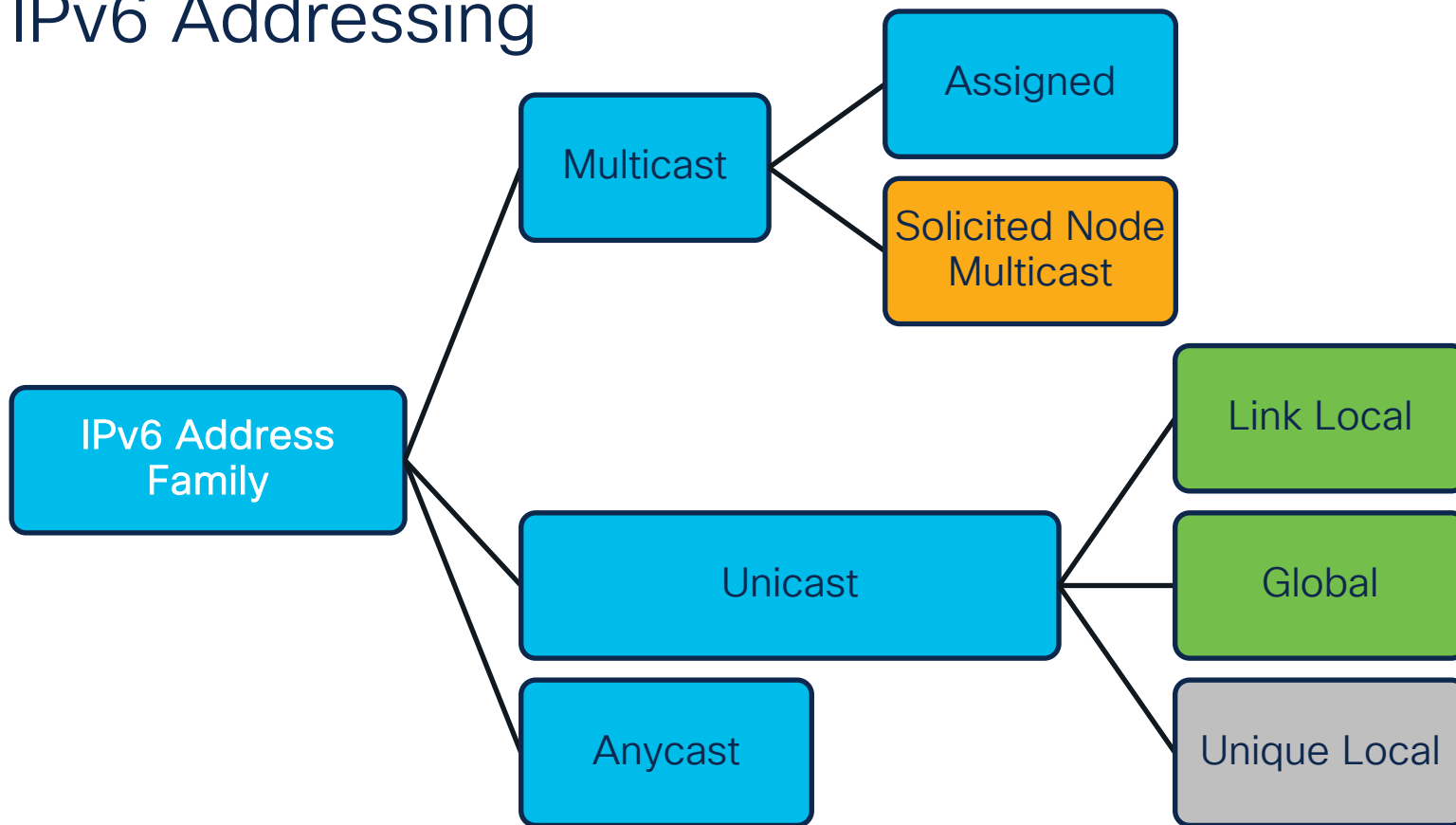


SLAAC
Temporary Addresses formally known
Privacy Extensions



*Secure Neighbor Discovery SeND

IPv6 Addressing



IPv6 Addresses Format

- Full IPv6 address (128 bits represented by 32 Hex characters)
 - Generally, 50% for network ID, 50% for interface ID, current best practice
 - Meaning a Subnet Prefix is generally a /64
- Leading 0's can be omitted
- The double colon (::) can appear only once

Global Prefix (48) Subnet (16) Interface Id (64)

2001:0db8:4646:0001:0000:0000:0000:1e2a



2001:db8:4646:1:0:0:0:1e2a



2001:db8:4646:1::1e2a

Types of Unicast IPv6 Addresses

Link-Local address

- First **64** bits are fixed
- Interface Identifier can be modified
- Encoding external identifiers for troubleshooting
- VLAN number
 - Router IDs
 - IPv4 address
- Possible to leverage for IGP routing

Types of Unicast IPv6 Addresses

Link-Local address

Unique Local Address

- Not recommended for end-point addressing (RFC6724)
 - Unless in a closed system
 - In Dual-Stack environment the Legacy protocol takes precedence
- Needs Translation (NPTv6 or NAT66) on Internet Edge

Types of Unicast IPv6 Addresses

Link-Local address

Unique Local Address

Global Address

- Vast number of prefixes
- Manage just one address space

Link-Local address

Non routable exists on single layer 2 domain (fe80::/10)

fe80:0000:0000:0000:xxxx:xxxx:xxxx:xxxx

Unique Local Address

Routable within administrative domain (fc00::/7)

fc00:~::~:~::~:~::~:~::~:****:xxxx:xxxx:xxxx:xxxx

fd00:~::~:~::~:~::~:~::~:****:xxxx:xxxx:xxxx:xxxx

Global Address

Routable across the Internet (2000::/3)

Documentation Prefix 2001:0db8::/32

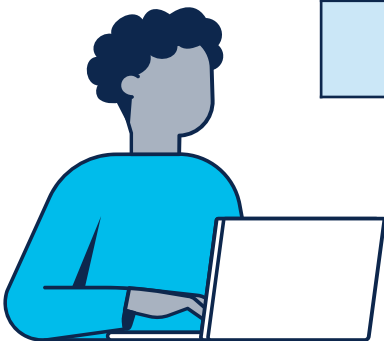
2000:****:****:****:xxxx:xxxx:xxxx:xxxx

3fff:****:****:****:xxxx:xxxx:xxxx:xxxx

Neighbor Discovery Protocol – (NDP)

Overview

IPv4	IPv6
ARP Request	Neighbor Solicitation
ARP Reply	Neighbor Advertisement
Broadcast	Solicited Node Multicast



Neighbor Discovery Protocol – (NDP)

Configuration



I should use **Link Local**
(**fe80::/64**) as NDP's
source!

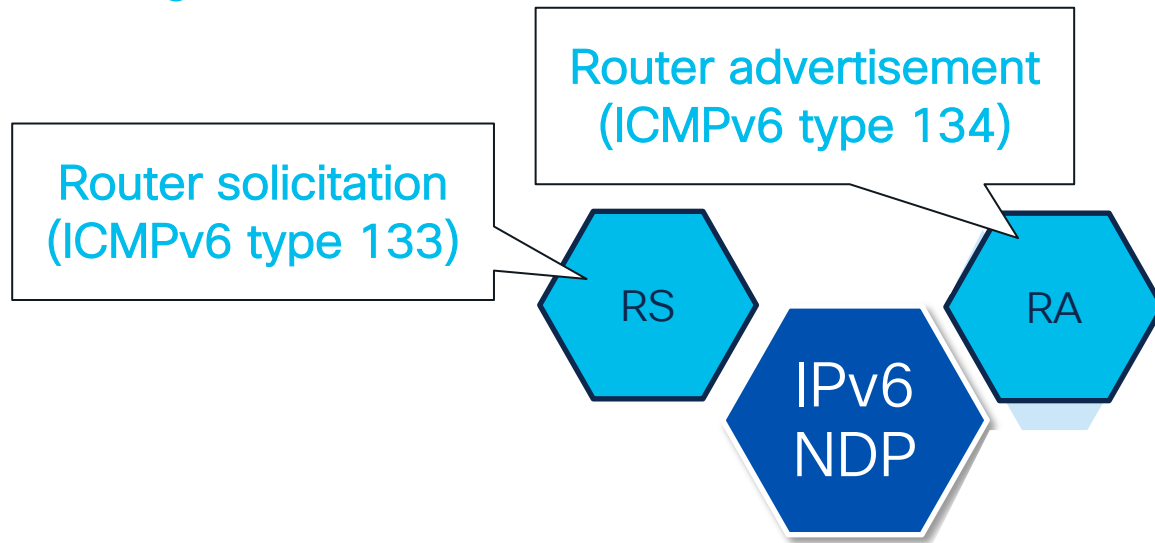
And I need to set the
hop limit to **255**...



IPv6
NDP

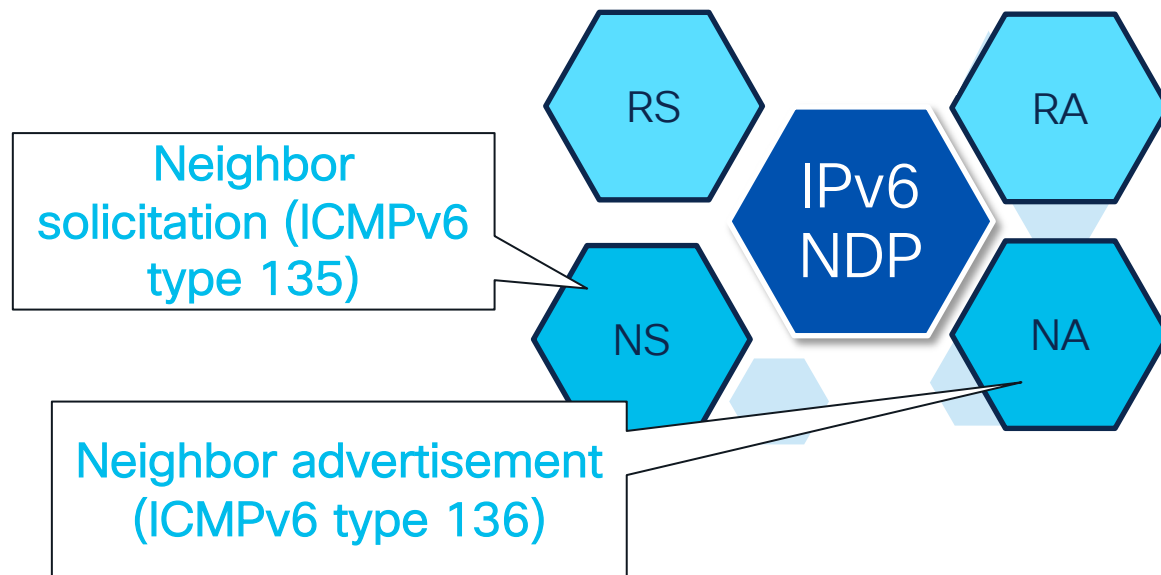
Neighbor Discovery Protocol – (NDP)

Neighbor discovery messages



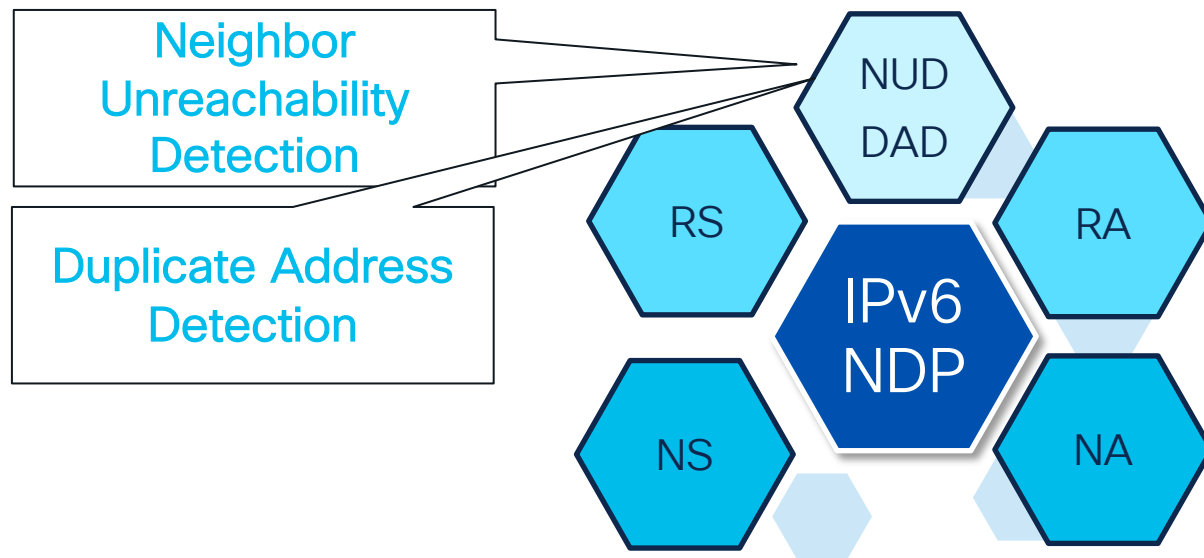
Neighbor Discovery Protocol – (NDP)

Neighbor discovery messages



Neighbor Discovery Protocol – (NDP)

Error detection



RFC6724: Default Address Selection for IPv6

Internet Engineering Task Force (IETF)
Request for Comments: 6724
Obsoletes: [3484](#)
Category: Standards Track
ISSN: 2070-1721

D. Thaler, Ed.
Microsoft
R. Draves
Microsoft Research
A. Matsumoto
NTT
T. Chown
University of Southampton
September 2012

Default Address Selection for Internet Protocol Version 6 (IPv6)

Abstract

This document describes two algorithms, one for source address selection and one for destination address selection. The algorithms specify default behavior for all Internet Protocol version 6 (IPv6) implementations. They do not override choices made by applications or upper-layer protocols, nor do they preclude the development of more advanced mechanisms for address selection. The two algorithms share a common context, including an optional mechanism for allowing administrators to provide policy that can override the default behavior. In dual-stack implementations, the destination address selection algorithm can consider both IPv4 and IPv6 addresses -- depending on the available source addresses, the algorithm might prefer IPv6 addresses over IPv4 addresses, or vice versa.

Default address selection as defined in this specification applies to all IPv6 nodes, including both hosts and routers. This document obsoletes [RFC 3484](#).



For Your
Reference

How does it start?



My Router

```
interface GigabitEthernet2
  description Isolated network for testing
  no ip address
  shutdown
  negotiation auto
  no mop enabled
  no mop sysid
```

How it all started

```
c8k-1#show ipv6 neighbors  
c8k-1#
```

```
c8k-1#show ipv6 interface brief  
GigabitEthernet1      [up/up]  
    unassigned  
GigabitEthernet2      [up/up]  
    FE80::250:56FF:FE8C:F060  
    2001:DB8:0:1::1
```

My House Dual Stack with /48

```
Wireless LAN adapter Wi-Fi:

Connection-specific DNS Suffix  . : 
Description . . . . . : Intel(R) Wi-Fi 6 AX201 160MHz
Physical Address. . . . . : E0-2B-E9-BD-F1-FA
DHCP Enabled. . . . . : Yes
Autoconfiguration Enabled . . . . : Yes
IPv6 Address. . . . . : 2a02:a463:24e5:0 a5de:195b:2833:30b(Preferred)
Temporary IPv6 Address. . . . . : 2a02:a463:24e5:0 9966:abf5:94e0:c970(Preferred)
Link-local IPv6 Address . . . . . : fe80::a5de:195b:2833:30b%19(Preferred)
IPv4 Address. . . . . : 10.11.15.126(Preferred)
Subnet Mask . . . . . : 255.255.255.0
Lease Obtained. . . . . : Friday, June 3, 2022 08:36:09
Lease Expires . . . . . : Monday, June 6, 2022 08:36:09
Default Gateway . . . . . : fe80::764d:28ff:fe1f:2a55%19
                             10.11.15.1
DHCP Server . . . . . : 10.11.15.1
DHCPv6 IAID . . . . . : 199240681
DHCPv6 Client DUID. . . . . : 00-01-00-01-29-F3-02-52-8C-8C-AA-E5-97-C3
DNS Servers . . . . . : 208.67.222.222
                             208.67.220.220
NetBIOS over Tcpip. . . . . : Enabled
```

Setup

- Dual Stack - Internet from Xs4all (also now known as KPN)
- Laptop work in my case Windows Lenovo
- No VPN needed to do my work (except for some special tools)
- Layer 2 home network with Vlan's.

What if you don't have IPv6?



Tunnelbroker Login

Username:

Password:

[Login](#) [Register](#)
[Forgot Password?](#)

Hurricane Electric Free IPv6 Tunnel Broker

IPv6 Tunnel Broker

Check out our new [usage stats!](#)
And then hit up our new [Forums!](#)

Welcome to the Hurricane Electric IPv6 Tunnel Broker! Our free tunnel broker service enables you to reach the IPv6 Internet by tunneling over existing IPv4 connections from your IPv6 enabled host or router to one of our IPv6 routers. To use this service you need to have an IPv6 capable host (IPv6 support is available for most platforms) or router which also has IPv4 (existing Internet) connectivity. Our tunnel service is oriented towards developers and experimenters that want a stable tunnel platform.

Advantages of using our tunnel service over others include:

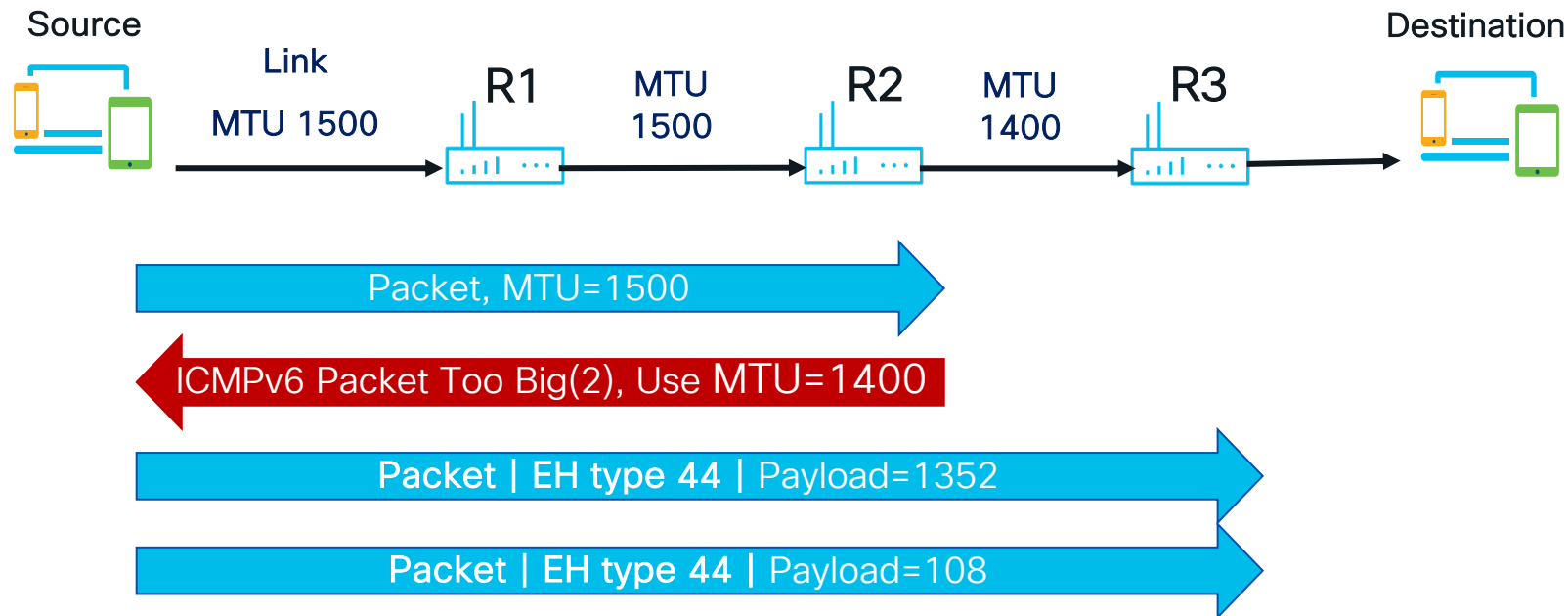
- Run by a Business ISP with 24 x 7 staff at multiple locations and an International backbone ([find out more about IPv6 transit at Hurricane Electric](#))
- Ability to get your own /48 prefix once your tunnel is up
- Ability to use your tunnel now after a simple registration process. (It takes less than a minute.)
- Ability to create your tunnel on geographically diverse tunnel-servers (Dubai, Sydney, Ashburn, Calgary, Chicago, Dallas, Denver, Fremont, Honolulu, Kansas City, Los Angeles, Miami, New York, New York, Palo Alto, Phoenix, San Jose, Seattle, Toronto, Winnipeg, Amsterdam, Berlin, Budapest, Düsseldorf, Frankfurt, Lisbon, London, Paris, Prague, Stockholm, Warsaw, Zurich, Hong Kong, Singapore, Tokyo, Bogota, Djibouti City, and Johannesburg)

If you are a new user please register by clicking on Register below. After registering your password will be mailed to you and you can return here to activate your tunnel.

Upon tunnel activation configuration commands for a variety of platforms will be automatically generated. Once you configure your side you will be able to reach the IPv6 Internet. If you like our service be sure to tell a friend and recommend us to others!

[Sign up now!](#)

Path MTU Discovery



Traffic @ my home during a workday in 2022

Legacy
Protocol

Bytes	Packets
321.7 MiB	633 278

46.6
%

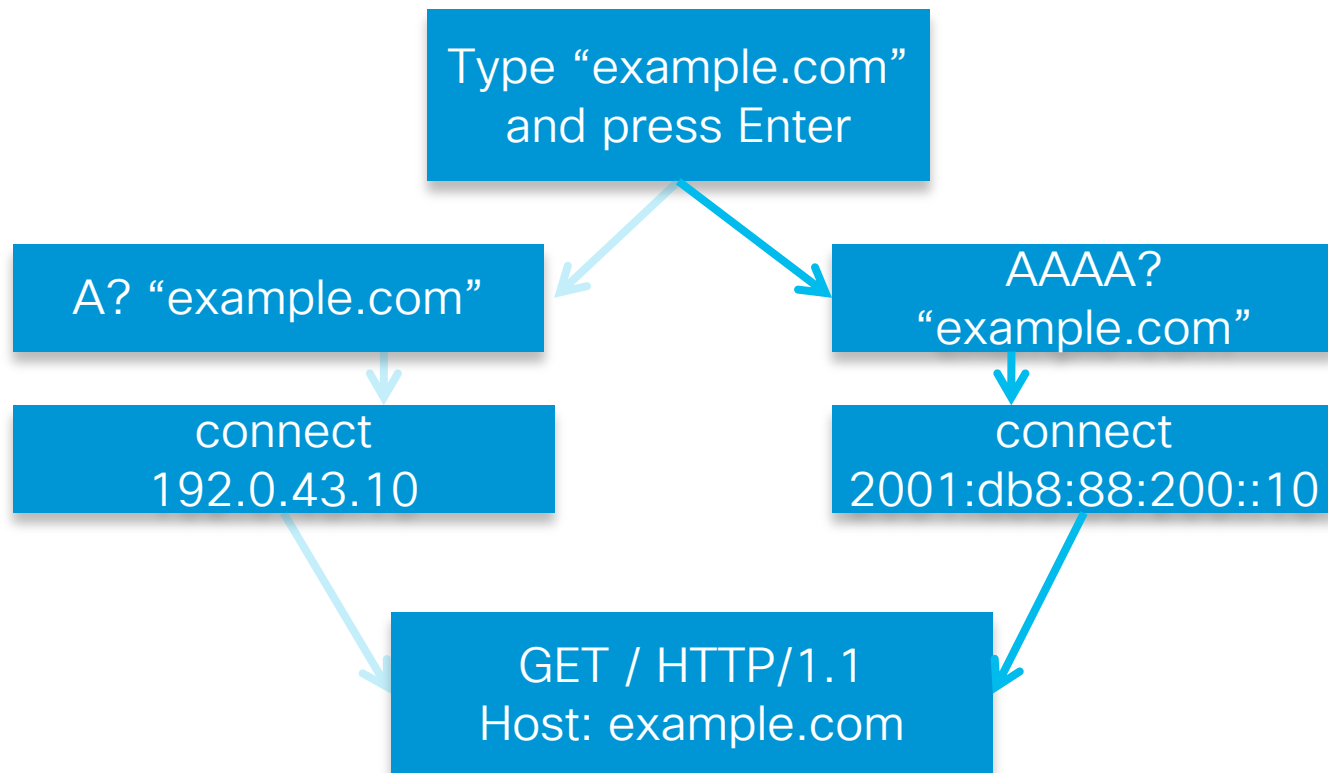


IPv6

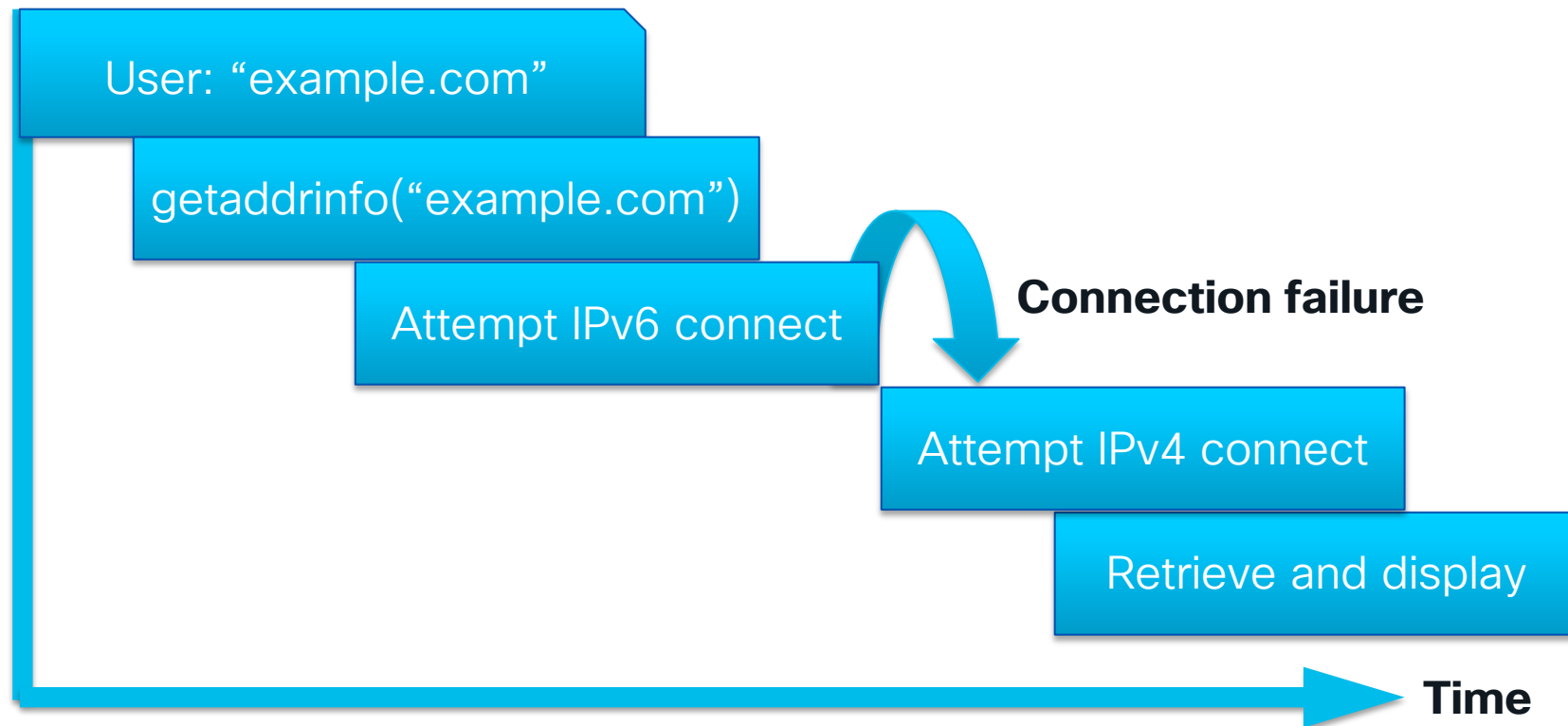
Bytes	Packets
369.4 MiB	474 446

53.4
%

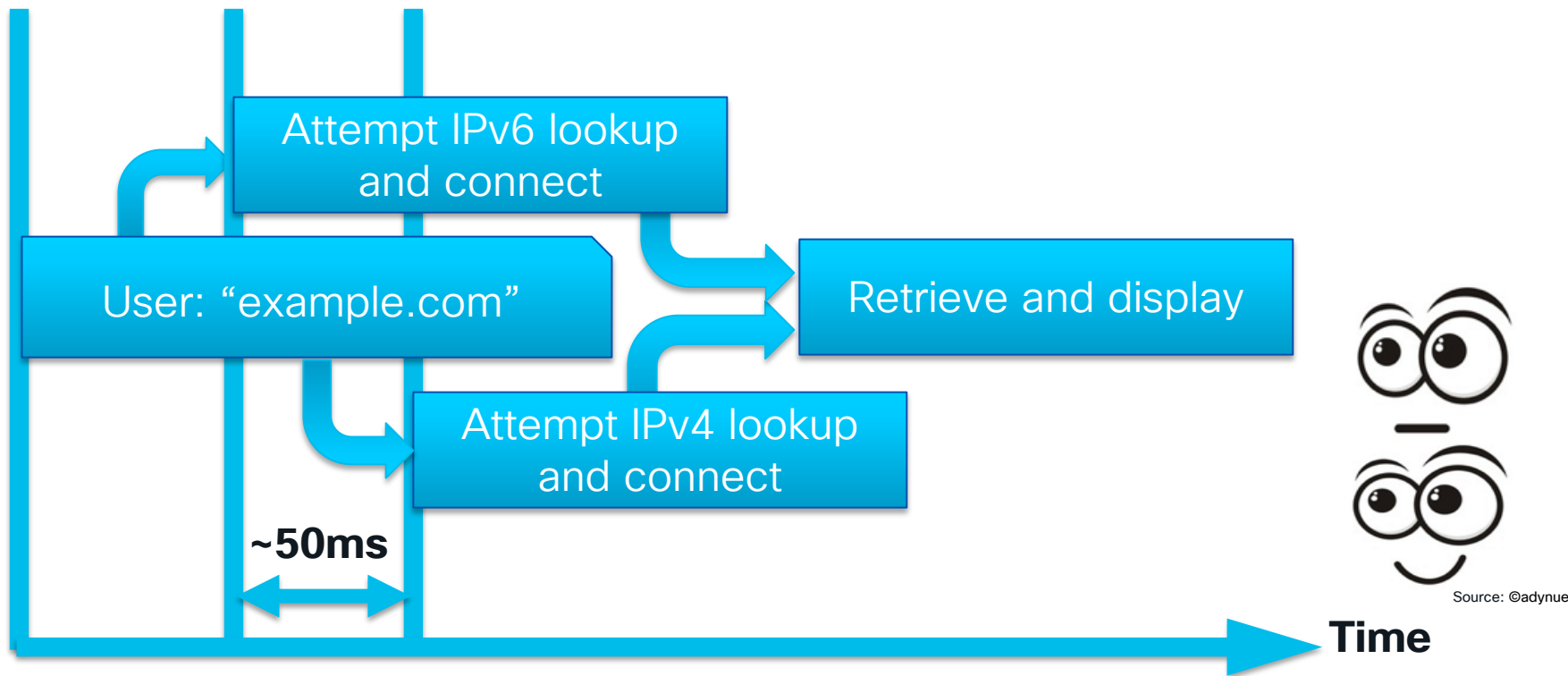
Dualstack: Always remember both protocols



The problem: RFC3484, if IPv6 connection fails



RFC8305 in a nutshell (RFC6555 Obsolete)



RFC8305: Happy Eyeballs: Success with Dual-Stack Hosts

Internet Engineering Task Force (IETF)
Request for Comments: 6555
Category: Standards Track
ISSN: 2070-1721

D. Wing
A. Yourtchenko
Cisco
April 2012

Happy Eyeballs: Success with Dual-Stack Hosts

Abstract

When a server's IPv4 path and protocol are working, but the server's IPv6 path and protocol are not working, a dual-stack client application experiences significant connection delay compared to an IPv4-only client. This is undesirable because it causes the dual-stack client to have a worse user experience. This document specifies requirements for algorithms that reduce this user-visible delay and provides an algorithm.



For Your
Reference

Lessons learned – working from Home

- Every OS nowadays has IPv6 standard enabled
- 99% It just works without knowing
- Path MTU discovery issues is a
- ICMPv6 should not be filtered but still is

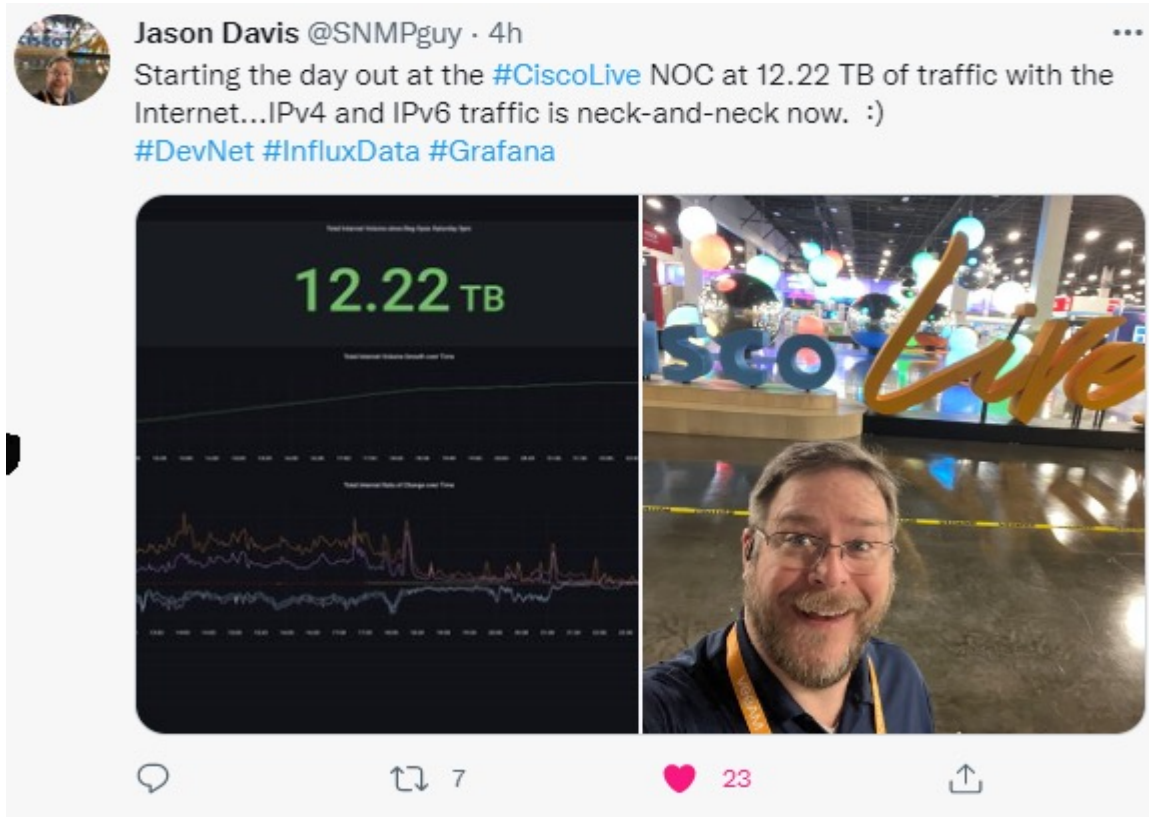


IPv6 in the Enterprise

IT department is Melbourne



Traffic @ Cisco Live Vegas 2022



Traffic @ Cisco Live Vegas 2023



Nicole Wajer
@vlinder_nl

51% #IPv6 at pre #CiscoLive



Jason Davis @SNMPguy · Jun 2

How about a bit of pre-#CiscoLive NOC stats info? The core network was brought up Tuesday and since then the set-up crew has generated 3 Terabytes of traffic with the Internet

And yes @vlinder_nl - IPv6 is >50%



IPv6 in the Enterprise

- Most companies will go **now** Dual Stack (the time is now!)
- ICMPv6 is your friend!
- Don't try to force 1:1 feature comparison with the Legacy Protocol
- IPv6 address plan is so much easier than the 1990's.
- Leave the legacy protocol behind – **Let it Go**





To SLAAC or not to SLAAC ?

- Pros of using SLAAC
 - No need to do stateful DHCP
 - Wide device support (Android!)
 - “IPv6 way”
- Cons of using SLAAC
 - Some stacks (iOS) are very aggressive with temp. addresses
 - More volatility in the binding table/ND
 - Address tracing is harder

Question: Would you run both SLAAC and DHCPv6 and why ?



Nicole – I haven't started where should I start?

- Frontend webservice
- DNS
- Email gateway
- <one size does not fit all>





NIST guidelines for secure IPv6 deployment; RFC4890

Table 3-7. ICMPv6 Recommended Filtering Actions – Must Not Drop & Should Not Drop

Message (Type)	Must Not Drop		Should Not Drop	
	Transit	Local	Transit	Local
Maintenance of Communication:	Allow non-local when associated with allowed connections			
Destination Unreachable (1) – All codes	•	•		
Packet Too Big (2)	•	•		
Time Exceeded (3) – Code 0 only	•	•		
Parameter Problem (4) – Codes 1 and 2 only	•	•		
Connectivity Checking:	Allow/disallow non-local based on topology/information concealment policy			
Echo Request (128)	•	•		
Echo Response (129)	•	•		
Address Configuration and Router Selection:	Allow in link-local traffic only			
Router Solicitation (133)		•		
Router Advertisement (134)		•		
Neighbor Solicitation (135)		•		
Neighbor Advertisement (136)		•		
Inverse Neighbor Discovery Solicitation (141)		•		
Inverse Neighbor Discovery Advertisement (142)		•		
Link-Local Multicast Receiver Notification:	Allow in link-local traffic only			
Listener Query (130)		•		
Listener Report (131)		•		
Listener Done (132)		•		
Listener Report v2 (143)		•		

See BRKSEC-3200
in On Demand
Library

<http://csrc.nist.gov/publications/nistpubs/800-119/sp800-119.pdf>
<http://www.ietf.org/rfc/rfc4890.txt>

“Dual Stack where you can Tunnel where you must”



“IPv6-Only where you can, Dual Stack where you must”



IPv4 with NAT

@stubarea51



IPv6 without NAT



For @Nicole Wajer but she is using the 🏠

Lessons learned – IPv6 in the Enterprise

- Every OS nowadays has IPv6 standard enabled
- Test your applications
- NAT is not security
 - An IPv6 Firewall is so much better
- Dual Stack is NOT your end goal

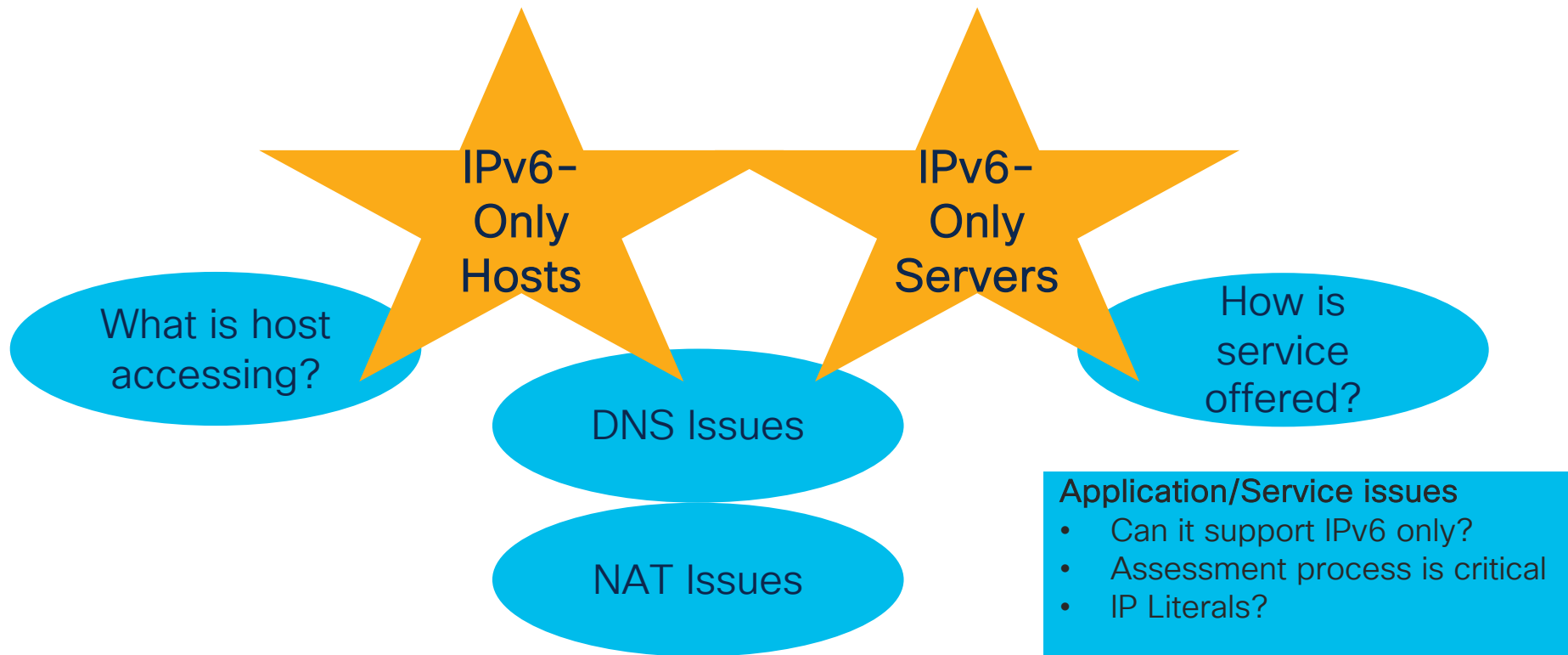


IPv6-only?

Is it possible?



What do I need to be concerned about?



What do you need?

- DNS64
- NAT64
- RDNSS
- DHCPv6 and/or SLAAC



IPv6-only

- It's not so lonely
- IPv4-stacked turned off on OS and nothing else done breaks 50%.
- Test your applications there might be hidden legacy protocol code left



Quiz time!



- External can join this space!



Everything you wanted to know about ...
Cisco's Internet Highway of IPv6

<https://eurl.io/#Pw7m5J7S->
(external room)



*"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





IPv6 is good for you, but nice to eat. So is broccoli





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with the best of the best.



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Thursday	9:30am – 4:00pm
Friday	10:30am – 1:30pm

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We would love to know your feedback on this session!

- Complete a minimum of four session surveys and the overall event surveys to claim a Cisco Live T-Shirt
- If you complete before leaving the room pick up a Stroopwafel!



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- Book your one-on-one Meet the Expert meeting
- Attend the interactive education with DevNet, Capture the Flag, and Walk-in Labs
- Visit the On-Demand Library for more sessions at www.CiscoLive.com/on-demand



The bridge to possible

Thank you

CISCO *Live!*

#CiscoLiveAPJC

Resources

Enterprise IPv6 Guidance

- RFC 7381 enterprise IPv6 guidelines
- White paper – Cisco.com
- Cisco Presslive Lesson

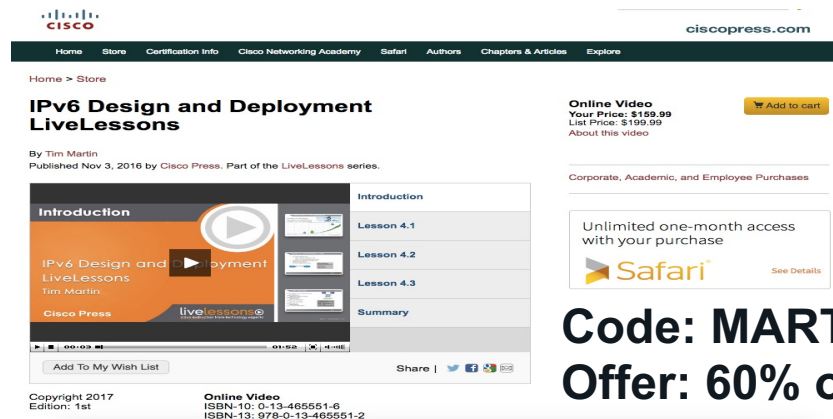
Internet Engineering Task Force (IETF)
Request for Comments: 7381
Category: Informational
ISSN: 2070-1721

K. Chittimani
Dropbox, Inc.
T. Chown
University of Southampton
L. Howard
Time Warner Cable
V. Kuarsingh
Dyn, Inc.
Y. Pouffary
Hewlett Packard
E. Vyncke
Cisco Systems
October 2014

Enterprise IPv6 Deployment Guidelines

Abstract

Enterprise network administrators worldwide are in various stages of preparing for or deploying IPv6 into their networks. The administrators face different challenges than operators of Internet access providers and have reasons for different priorities. The overall problem for many administrators will be to offer Internet-facing services over IPv6 while continuing to support IPv4, and while introducing IPv6 access within the enterprise IT network. The



Home > Store

IPv6 Design and Deployment LiveLessons

By Tim Martin
Published Nov 3, 2016 by Cisco Press. Part of the LiveLessons series.

Introduction

- Lesson 4.1
- Lesson 4.2
- Lesson 4.3
- Summary

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ISBN-13: 978-0-13-465551-2



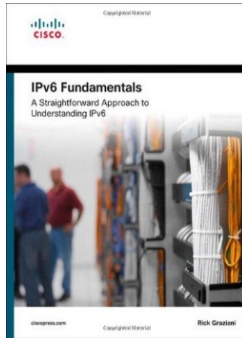
White Paper

IPv6 for the Enterprise in 2015

Over 83 percent of the world's population no longer has access to the legacy variant of the commodity we have become familiar with as a "public Internet address." Put another way, in North America, Latin America, Asia, and Europe, the IPv4 address pool is already entirely depleted.

Code: MARTIN60
Offer: 60% off
ISBN: 9780134655512

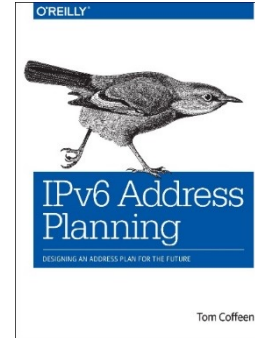
Resources – Books



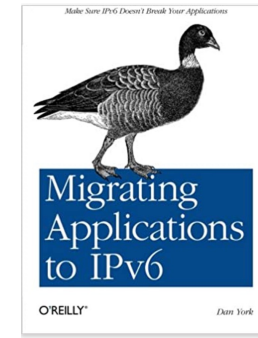
<https://www.amazon.com/IPv6-Fundamentals-Straightforward-Approach-Understanding/dp/1587144778>



<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/>

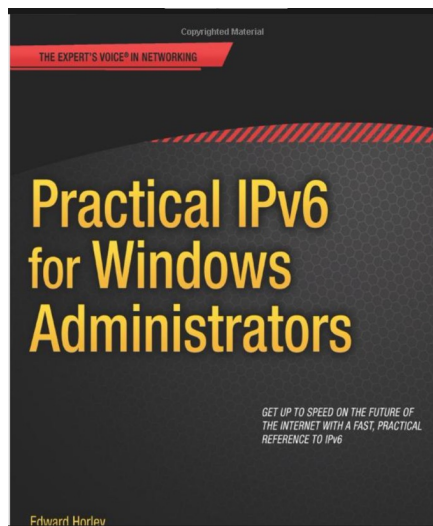
Additional Books:

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

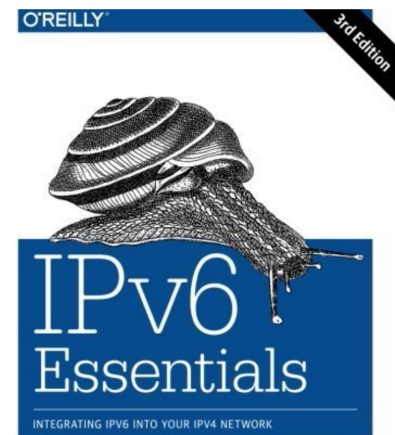
Cisco Press – <https://www.ciscopress.com/store/ipv6-fundamentals-livelessons-a-straightforward-approach-9781587204579>

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>

Training Options

HexaBuild

<https://hexabuild.arlo.co/w/>

A Cloud Guru / Linux Academy

<https://acloud.guru/learn/aws-ipv6>

Pluralsight

<https://www.pluralsight.com/courses/ipv6-introduction-to-protocol>

<https://www.pluralsight.com/courses/ipv6-microsoft-windows>

NterOne

<https://www.nerone.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-g0V0kfGg8g8KutNEK7rS3laA9QQ>

Cisco Live! (On-Demand)

IPv6 Deployment Jim Bailey BRKRST-2619

<https://www.ciscolive.com/on-demand/on-demand-library.html#/session/16360600310450017ZOr>

<https://www.ciscolive.com/c/dam/r/ciscolive/emea/docs/2020/pdf/BRKRST-2619.pdf>

IPv6 The Protocol Tim Martin BRKIP6-2191

<https://www.ciscolive.com/on-demand/on-demand-library.html#/session/16360597967430017R0b>

<https://www.ciscolive.com/c/dam/r/ciscolive/emea/docs/2020/pdf/BRKIP6-2191.pdf>

Enterprise IPv6 Deployment Nicole Wajer BRKIP6-2301

<https://www.ciscolive.com/on-demand/on-demand-library.html#/session/163605981240500175QJ>

<https://www.ciscolive.com/c/dam/r/ciscolive/emea/docs/2019/pdf/BRKIP6-2301.pdf>

IPv6 troubleshooting for Helpdesks

- <http://isp.testipv6.com> →

Test IPv6

FAQ

Mirrors

Test your IPv6 connectivity.

For the Help Desk

Summary

Tests Run

Share Results / Contact

Other IPv6 Sites

Your Internet help desk may ask you for the information below.

Help desk code: 46

Dual Stack

IPv4: Good, AS109 - CISCOSYSTEMS - Cisco Systems, Inc.,US

IPv6: Good, AS109 - CISCOSYSTEMS - Cisco Systems, Inc.,US

OtherSites: 52/52 good

IPv4 address: 173.38.209.8

IPv6 address: 2001:420:c0c1:17:f121:40c4:c046:ce86

More information about this page, including how to bookmark it: [faq_helpdesk.html](#).

If your Internet help desk asks you to mail the 'results url', copy and paste the following UI current numeric Internet Protocol address(es). We do not recommend posting this link on

<http://isp.testipv6.com/?ip4=173.38.209.8&ip6=2001:420:c0c1:17:f121:40c4:c046:ce86&a=ok;>



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

The background is a vibrant, abstract graphic. On the left, there are horizontal, wavy bands of color in shades of red, orange, yellow, and green. On the right, a bright white light source emits a series of colorful rays in shades of blue, green, and yellow, creating a sunburst effect.

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Let's go

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