Mission ~~Im~~Possible

Turning IPv4 Off in an Enterprise Network

(High-level overview - come to the side meeting for the full version)

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Image source: https://freesvg.org/magical-unicorn

Motivation

Running out of **private** IPv4 addresses

Dogfood and testing

Dual stack is hard

Source: www.wikipedia.org

"Entities should not be multiplied without necessity."

William of Ockham

Network Overview

- SLAAC-only (no DHCPv6 for address assignment)
- NAT64/DNS64 to access IPv4-only destinations
  - NAT64 at the site edge
  - Router Advertisements options for DNS64 and PREF64
- Centralized DHCPv4 infrastructure
- Wired ports: 802.1x + dynamic vlan assignment

Previously on…

2020: IPv6-only Guest WiFi and wired networks

Dedicated IPv4-enabled SSID and wired vlan for fallback

Reclaimed a lot of IPv4 addresses

More details: "The Day I Broke All the Treadmills" RIPE81 presentation

IPv6-Only Guest: Lessons Learned

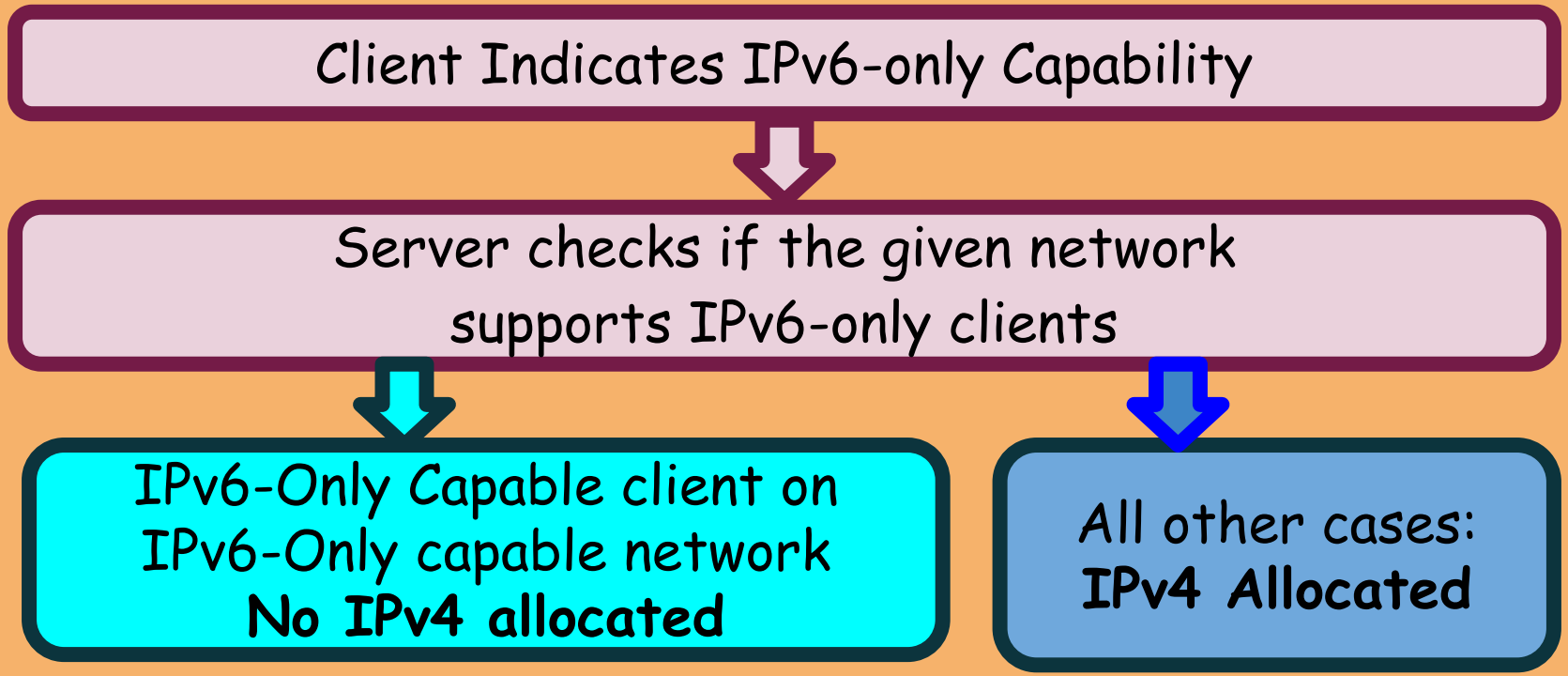
Dedicated SSID/VLAN: not a good idea

- Confusing for users
- Higher IPv4 consumption
- Lower visibility to issues
- Scalability concerns
- Operational complexity

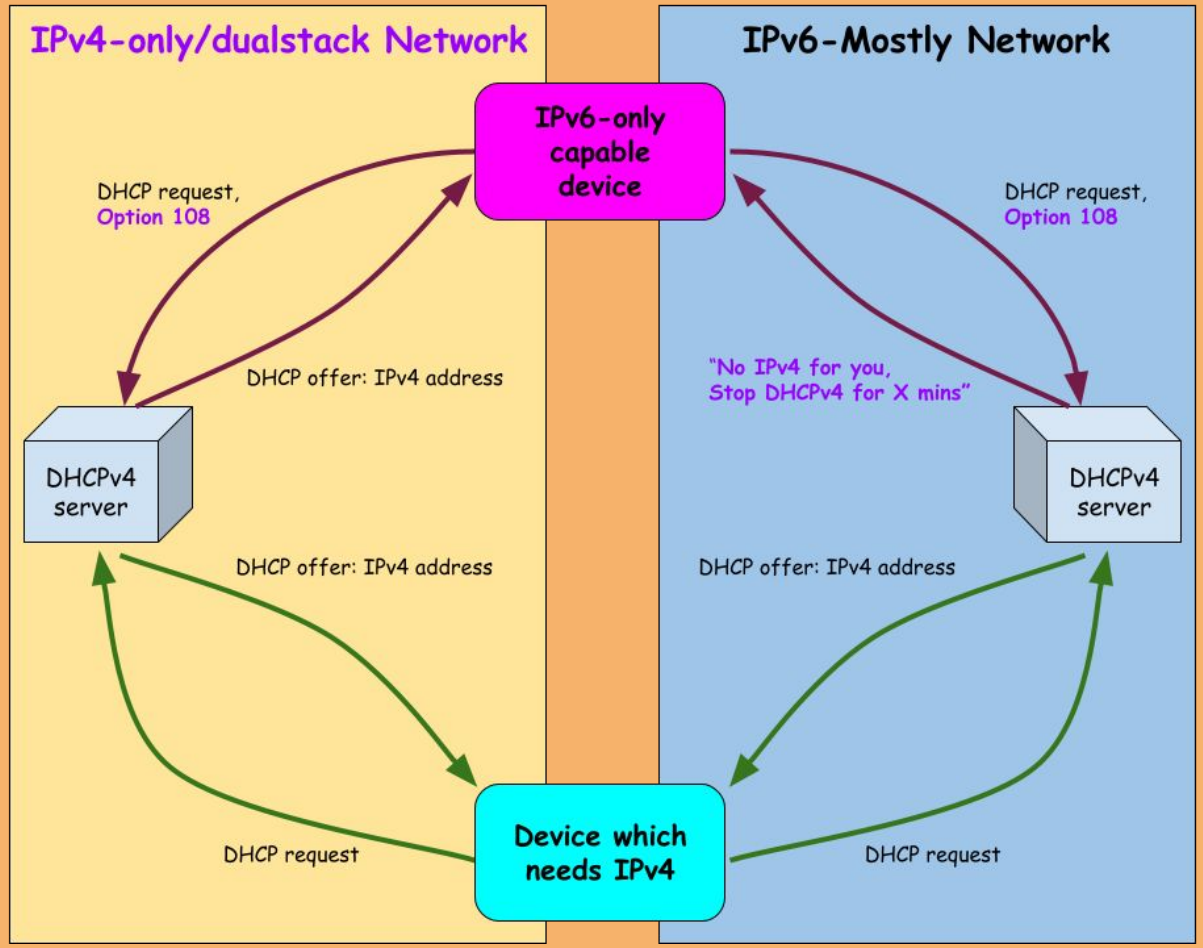
We need something better!

IPv6-mostly Network

A network enabling co-existence of IPv6-only and IPv4-enabled devices



RFC8925: Use DHCPv4 to Turn IPv4 Off



Project Scope

Network Infrastructure across all offices globally:

- Corporate WiFi and IPv4-enabled (fallback) Guest WiFi
- Wired user-facing segments

Devices migrated to IPv6-Only:

- All Android, iOS (15+), MacOS 13+
  - send DHCPv4 Option 108
  - support 464XLAT and PREF64
- Opt-in for selected ChromeOS and Linux devices

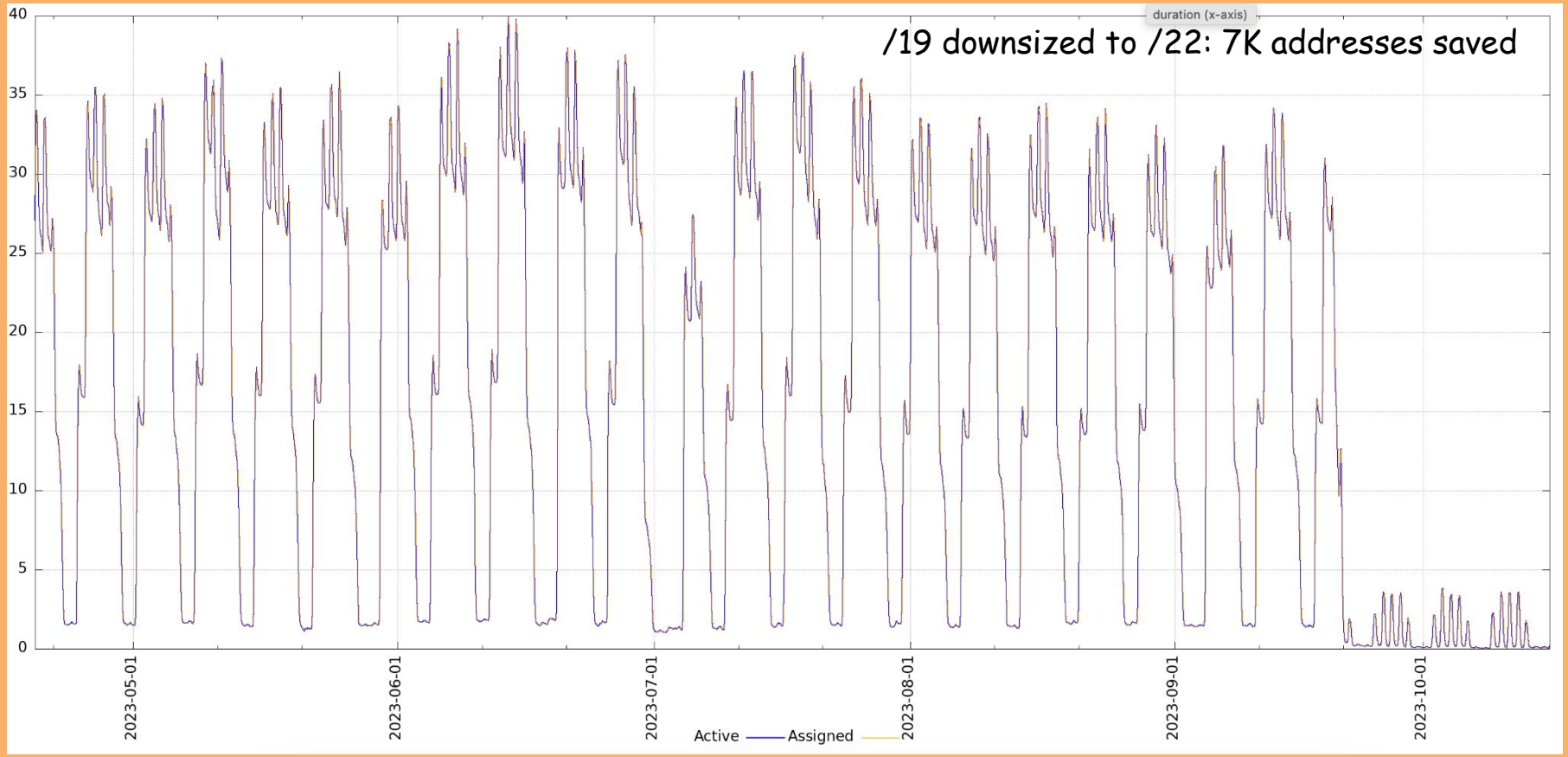
Rollout Schedule: March - Nov 2023

- Pilot in 3 locations for 2 months
- Extended pilot in 5 locations for 1 month
- "Stop the bleeding": enable IPv6-mostly for greenfields
- Incremental rollout in 4 months, enabling Option 108 per subnet (10, 15, 25, 50, 60, 70, 80, **90**, 100% of all networks)

Results

- No blocking issues found
  - A few cosmetic issues: all fixed in MacOS Sonoma
- DHCPv4 utilization drops by 3-4 times (average) on WiFi
- Expecting to reclaim at least 300K addresses

A Random Network: DHCP Utilization Drop



Lesson Learned #0

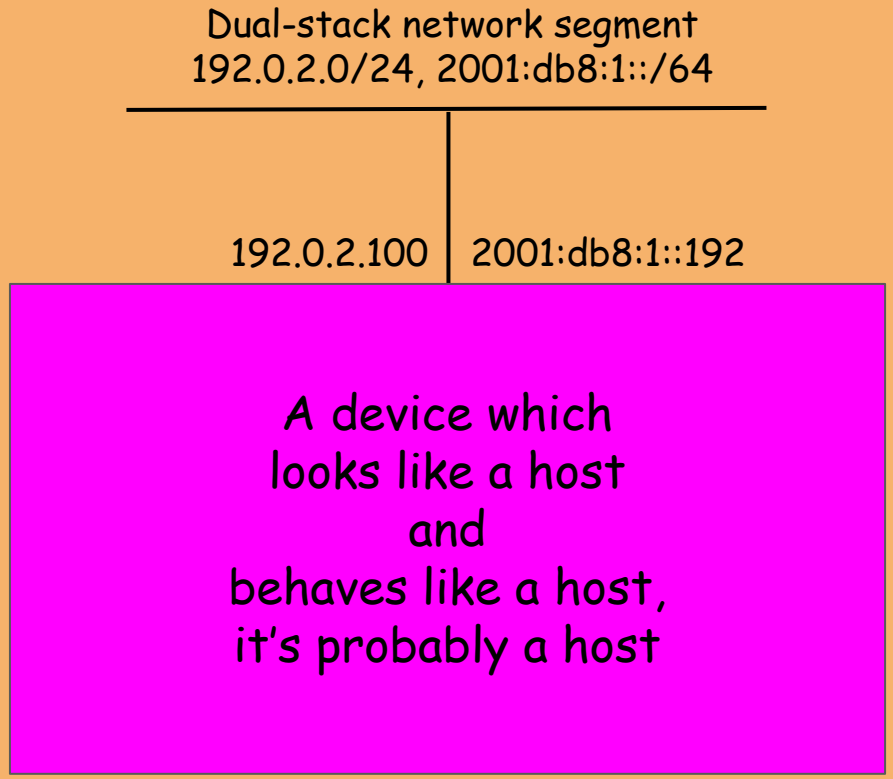
The only way to get IPv6 deployed is to run out of IPv4

Lesson Learned #1: “You Know Nothing, Jon Snow”

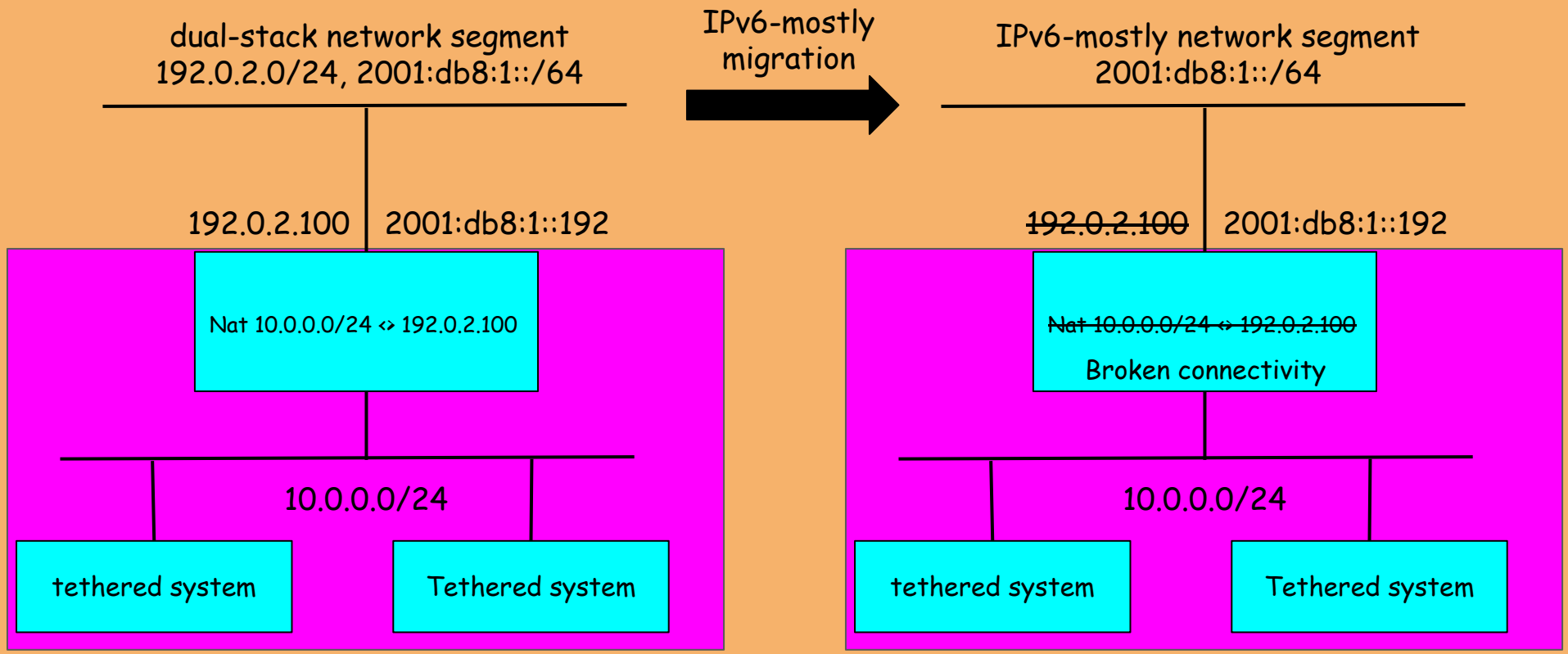
You do not really operate IPv6 until you turn IPv4 off

- Happy Eyeballs hide the problems
  - *“My workstation loses IPv6 DNS for a few mins after waking up”*
- Users do not report issues
- Issues are not getting fixed

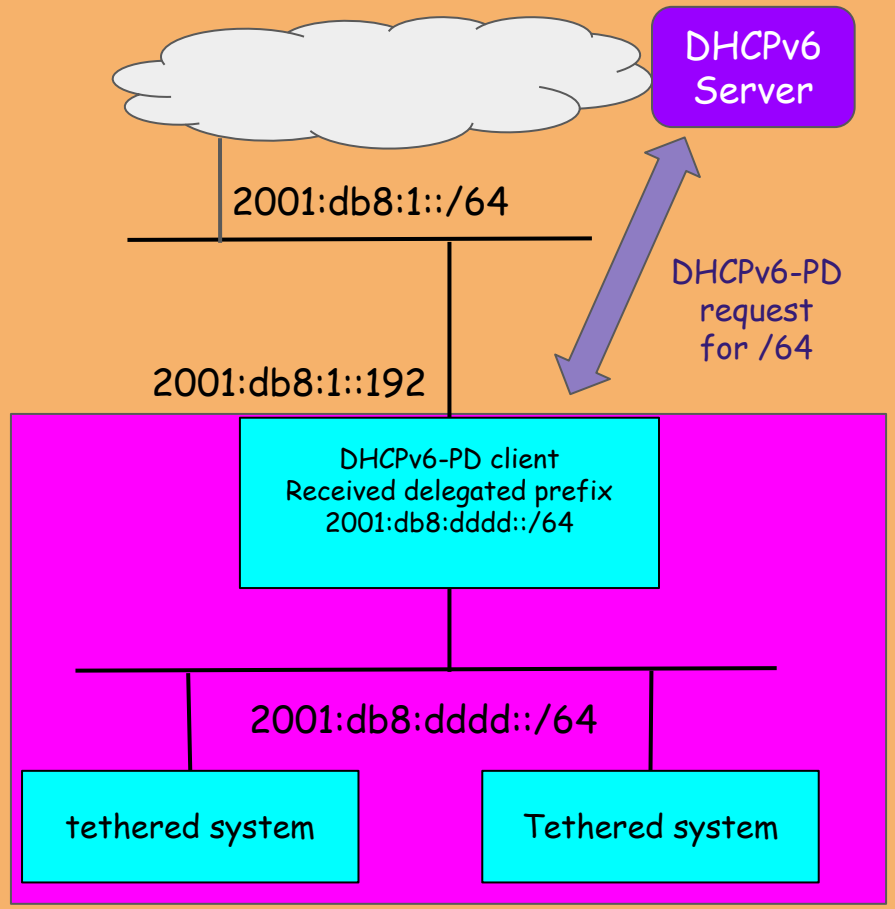
Discovery #1: ~~Duck~~ Host Test



..or is it a router?



Solution: DHCPv6-PD



Other Keys To Success

- Having IPv6 enabled on endpoints ;)
- Allowing extension headers
  - Fragment header
    - Almost inevitable for NAT64 + UDP
  - ESP
    - Required by WiFi calling and VPNs
- Default Address Selection Rule 5.5
  - Critical when clients move between segments

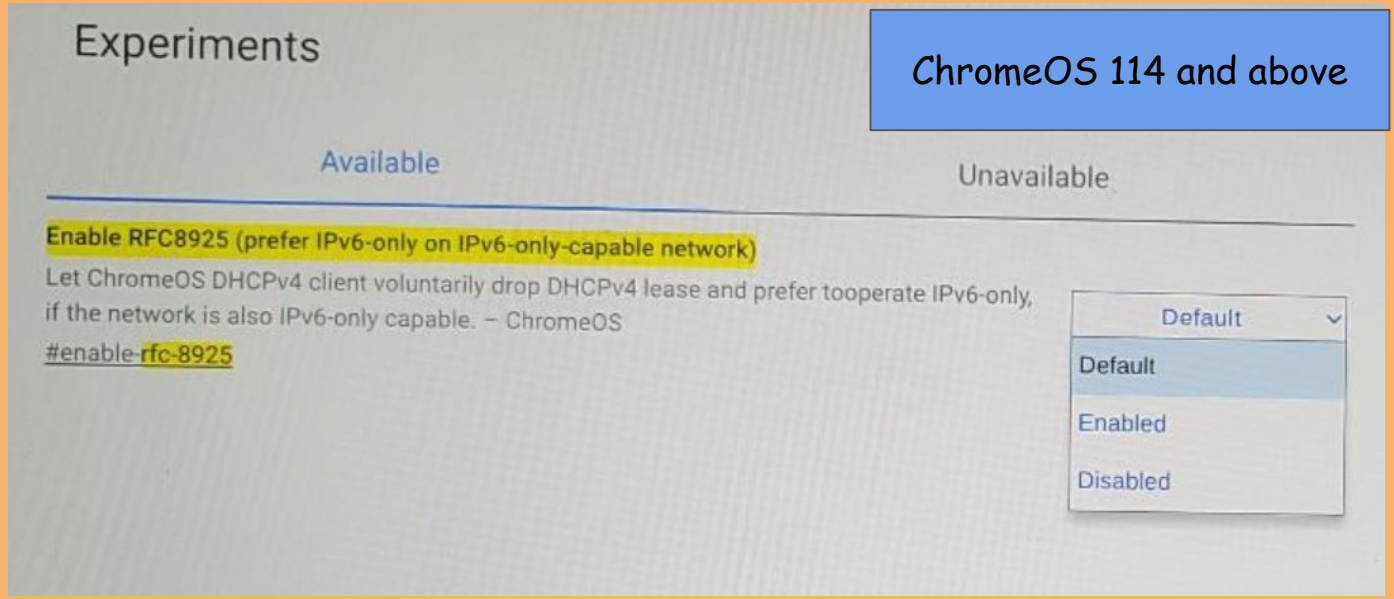
More details in the side-meeting talk

New Drafts

- Using DHCPv6-PD to Allocate Unique IPv6 Prefix per Client in Large Broadcast Networks (draft-ietf-v6ops-dhcp-pd-per-device)
- 464 Customer-side Translator (CLAT): Node Recommendations (draft-link-v6ops-claton)
- Using Subnet-Specific Link-Local Addresses (draft-link-v6ops-gulla)

Next Steps

2024: Migrate ChromeOS and Linux endpoints



QUESTIONS?