The Day I Broke All the Treadmills

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IETF108, July 2020

This talk is about

IPv6-Only Enterprise Network

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

Motivation

Running out of **private** IPv4 addresses

Dogfood and testing

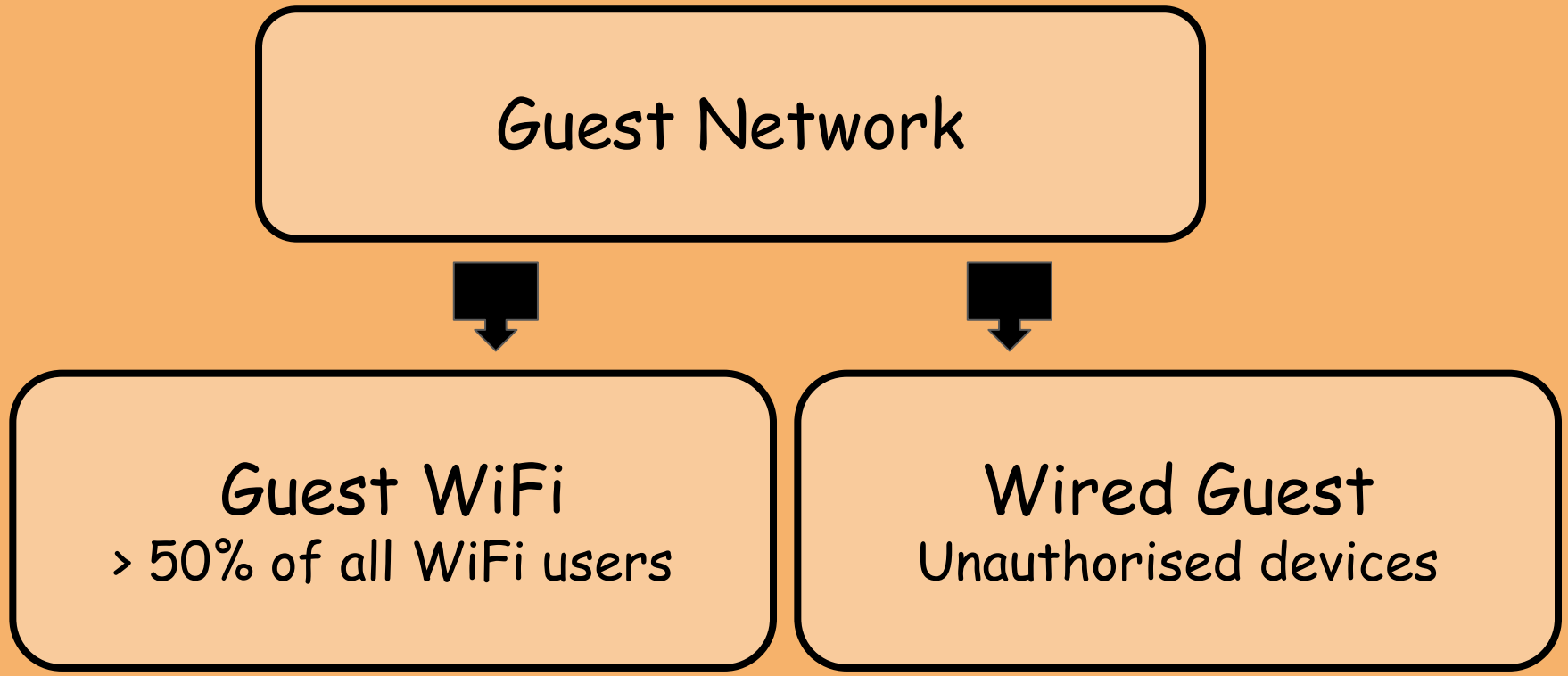
Dual stack is hard

Source: www.wikipedia.org

"Entities should not be multiplied without necessity."

William of Ockham

Project Scope



Design Elements

DNS64

Google Public DNS64

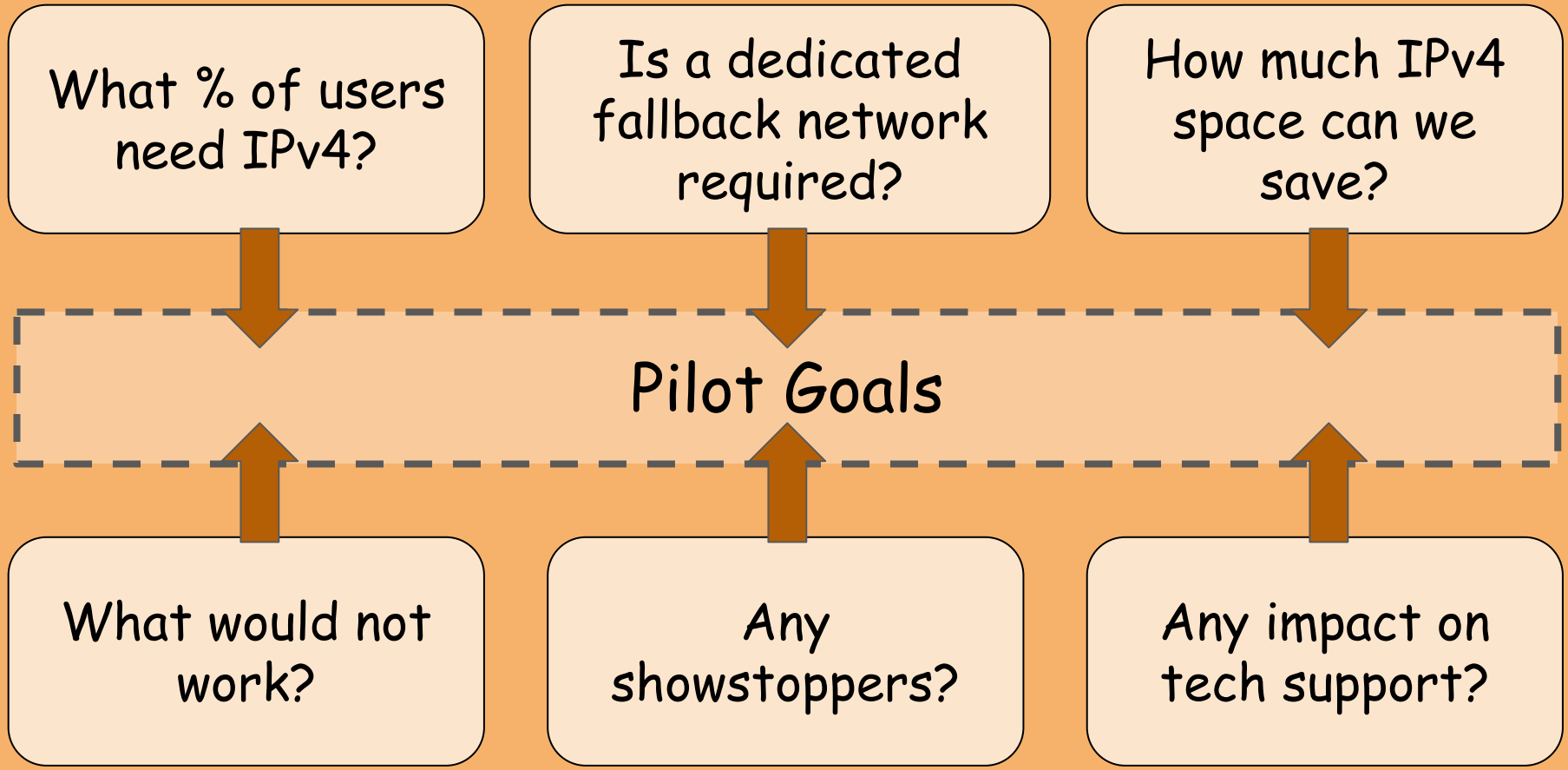
Provided via RDNSS

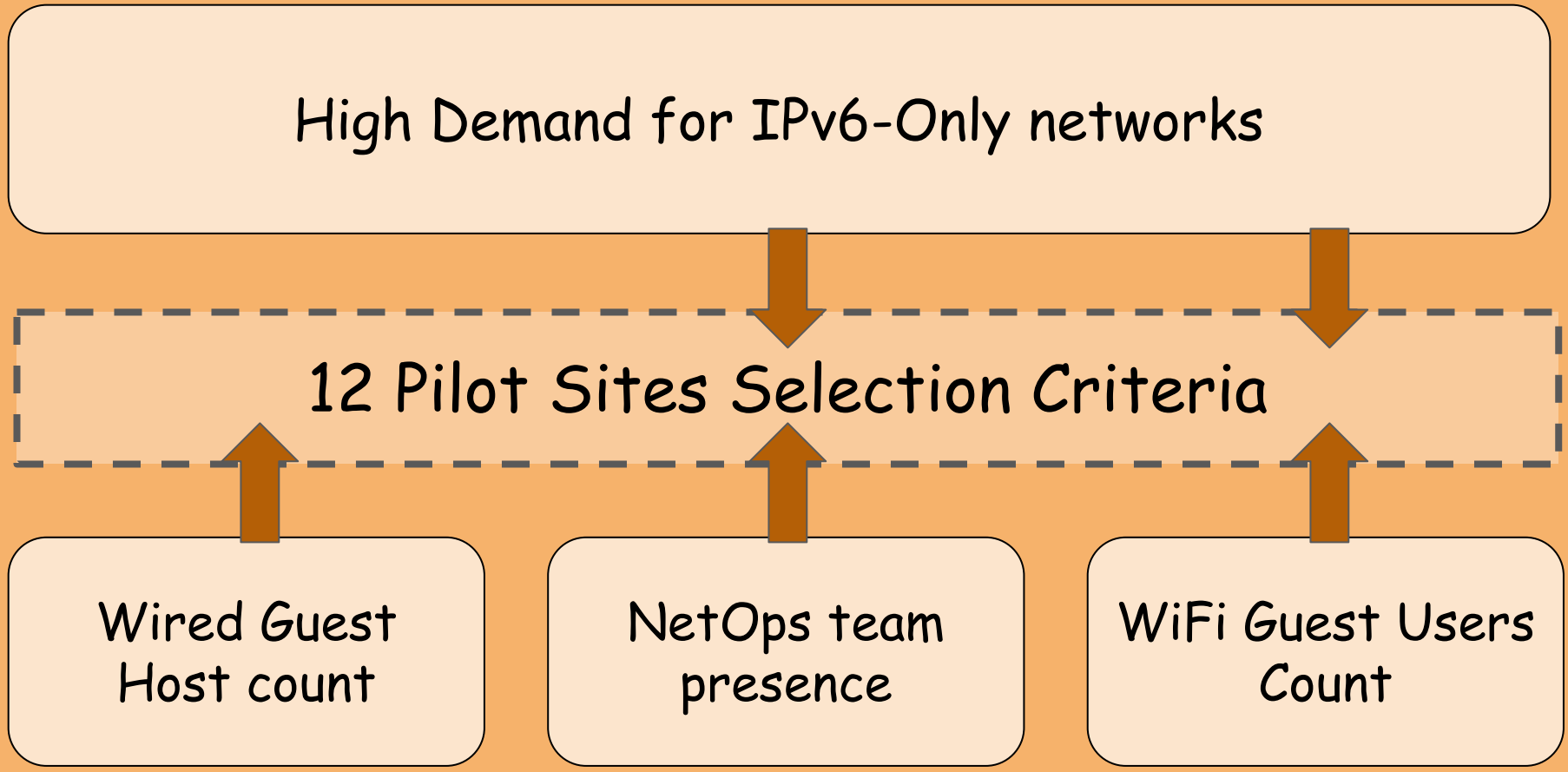
NAT64

Same devices as NAT44

Located at the site edge

SLAAC-Only Network


What % of users need IPv4?
Is a dedicated fallback network required?
How much IPv4 space can we save?
Pilot Goals
What would not work?
Any showstoppers?
Any impact on tech support?


High Demand for IPv6-Only networks
12 Pilot Sites Selection Criteria
Wired Guest Host count
NetOps team presence
WiFi Guest Users Count

IPv6-Only Wired Guest Pilot

February - October 2019

Self-service portal to re-enable IPv4 on the port

Users are encouraged to report why they need IPv4

What I Broke Right Away


EXIT

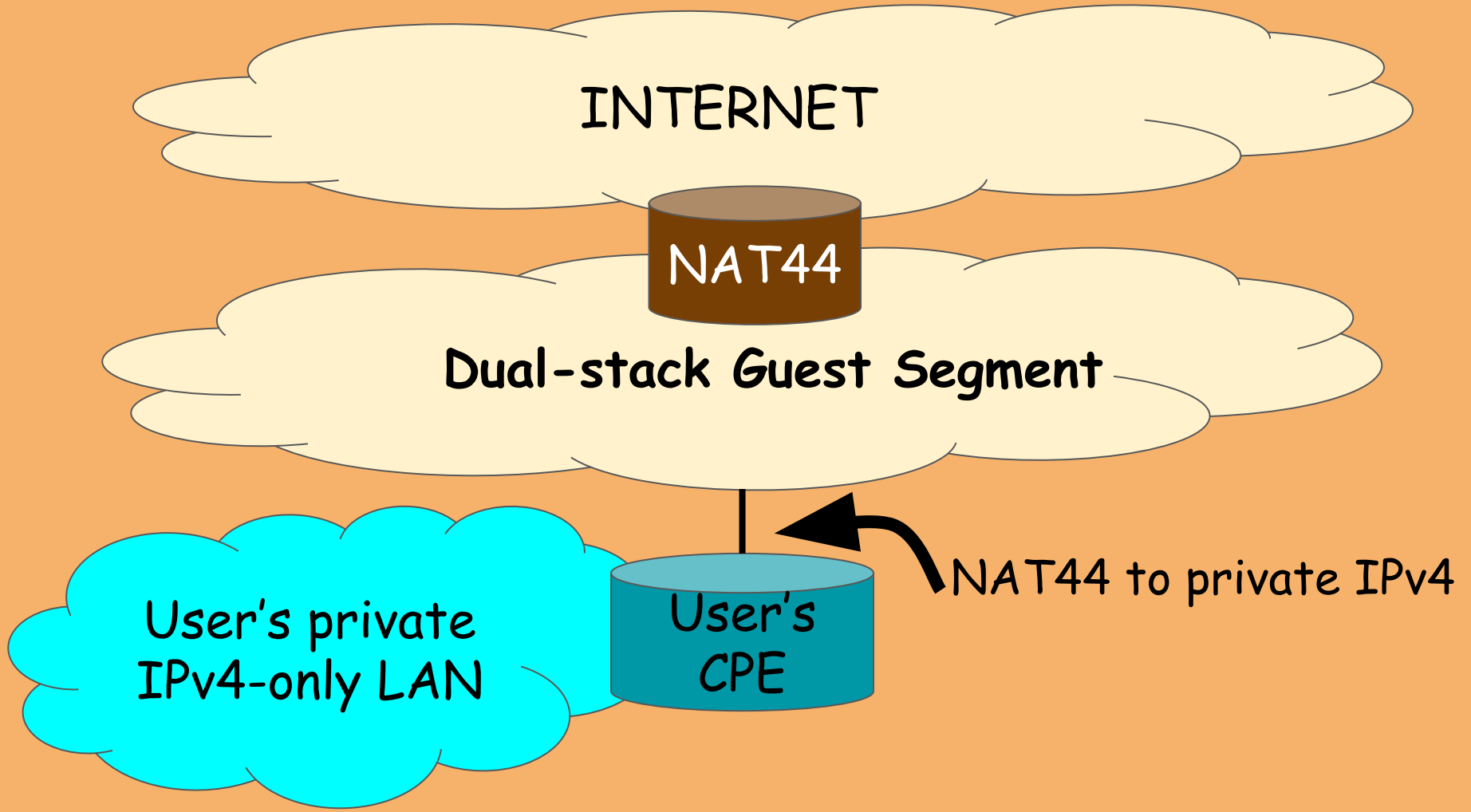
Most sites need <5 IPv4-enabled ports

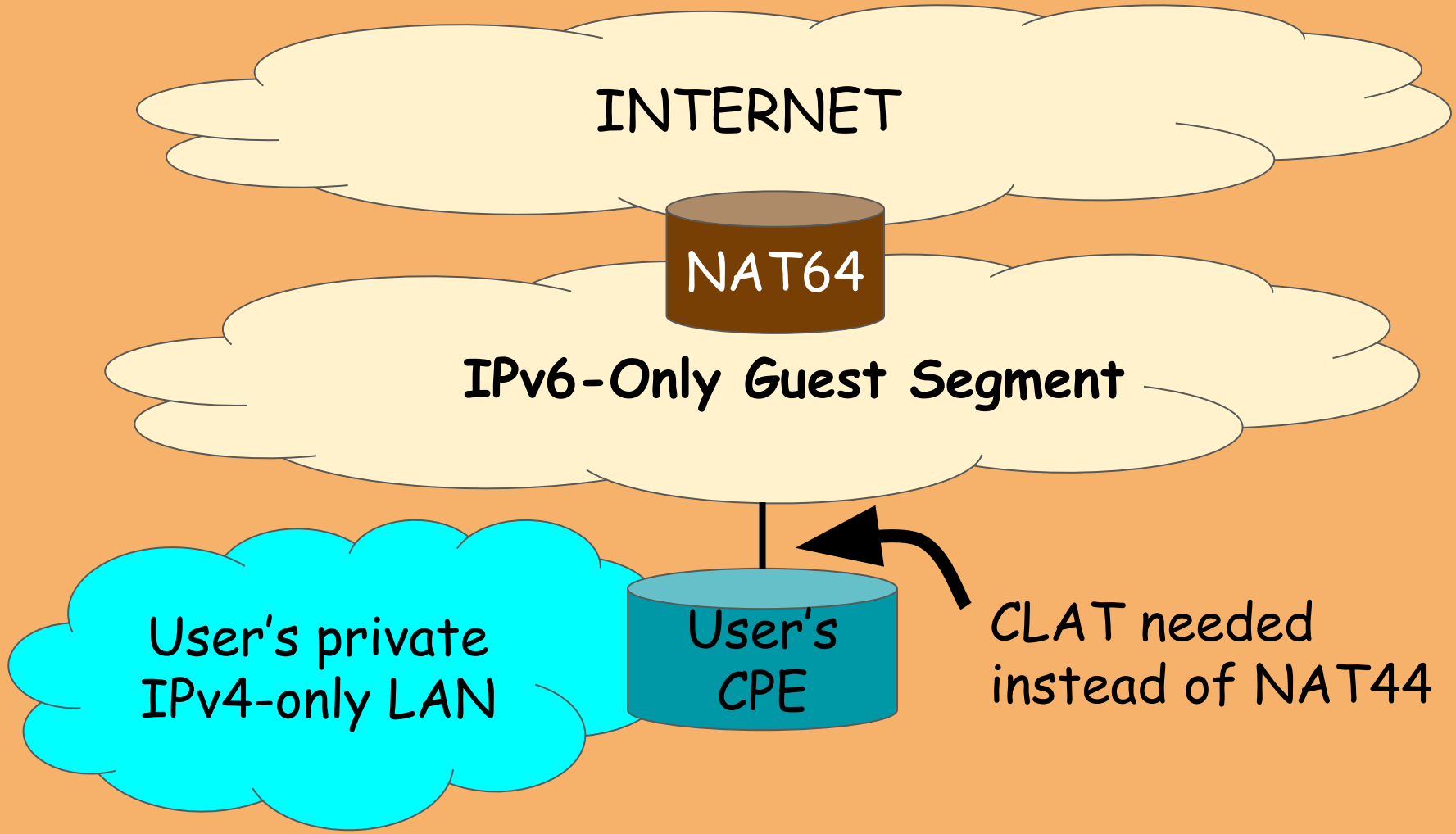
A lot of IPv4 addresses saved

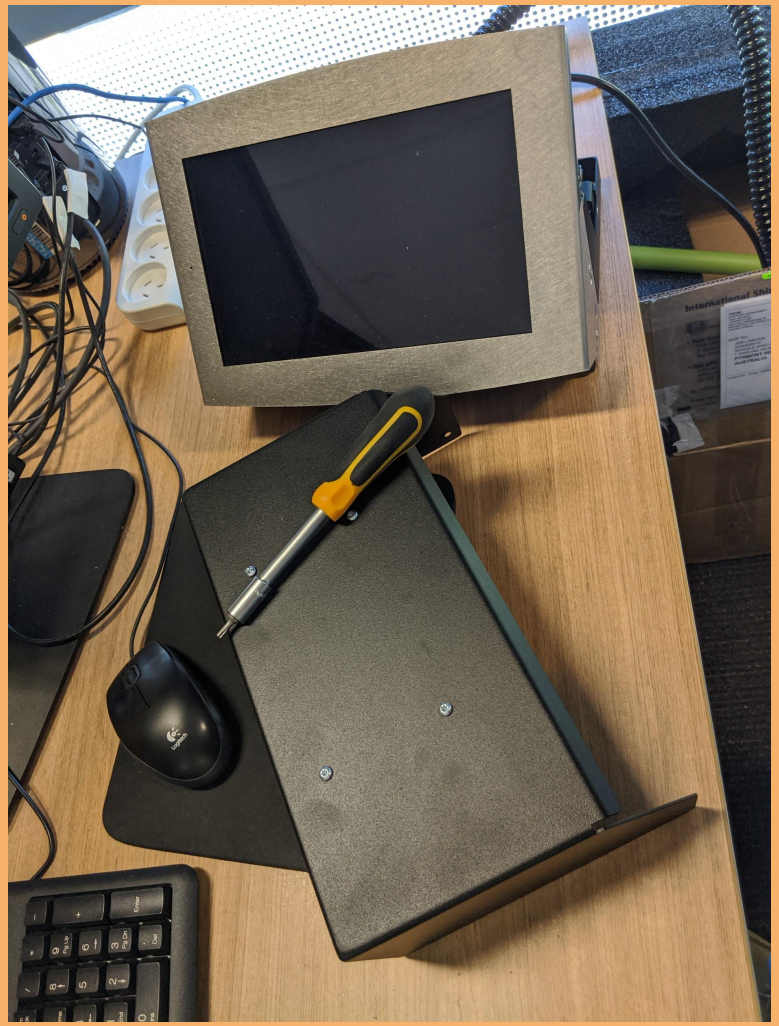
Wired Guest Pilot Results

Main IPv4 use case: Embedded systems/IoT

CPEs need CLAT enabled


INTERNET
NAT44
Dual-stack Guest Segment
NAT44 to private IPv4
User's private
IPv4-only LAN
User's
CPE


INTERNET
NAT64
IPv6-Only Guest Segment
User's private
IPv4-only LAN
User's
CPE
CLAT needed
instead of NAT44



Layer Violation in 2019

Using Torx T15 screwdriver

to enable IPv6 on an appliance.

Shall CPEs detect IPv6-Only/NAT64 and enable CLAT?

RFC7084: No

RFC8585#section-3.2.1: Yes

IPv6-Only Guest WiFi Pilot

Phase 1, Opt-In

June 2018 - March 2019

Dedicated SSID created

Call for volunteers issued

Phase 2, Opt-Out

April - October 2019

Guest WiFi is IPv6-only

Dedicated fallback SSID

Users are encouraged to report issues

Pilot Results

~10% of users moved to new SSID

Users incentives to report bugs

Phase 1 Results

15 bugs reported

3 bugs fixed

< 5% of users falled back to dual-stack SSID

~25K peak device count

Phase 2 Results

12 bugs reported

4 applications fixed

What % of Users Need IPv4?

WiFi

< 5% fall back to the dual-stack SSID

~10% is using 2.4GHz SSID which is kept dual-stack

Wired

< 5 devices/site normally, ex. For Gym devices

IPv4 Address Space Utilization

WiFi

DHCPv4 pools utilization dropped by **5-8 times**

Matches ~15% of users staying on dual-stack networks

Wired

almost all address space reclaimed

What Does Not Work? (*)

1. Gym Treadmills
2. Spotify application on laptops  upvote, please!
3. 3rd-party VPN systems
4. StarCraft II
5. MacOS internet recovery image

(*) Top 5 by number of user complaints received

Is Dedicated Fallback Network Needed?

Short answer: yes

Wired Network:

Users **MUST** file an request to get IPv4

Exceptions are granted for 18 months

WiFi: dedicated SSID is NOT the best strategy

(see "Lessons Learned")

Are There Any Showstoppers?

Short answer:

No, as long as a fallback mechanism exists.

Long answer:

It depends.

Mobile devices work in 99.9% of all cases

Laptops might be a different story.

What's the Impact on Support Team?

Almost none.

Keys to success: **Plan Ahead!**

- Let users know about the change
- Provide users with fallback mechanisms
- Provide the support team with
  - Troubleshooting flowcharts
  - Known Issues page

Lessons Learned

“Just disable IPv6”

is never a good workaround.

How would you re-enable IPv6 on all those devices?

The only way to get

IPv6 operational experience

is

to turn off IPv4

What Do Happy Eyeballs Hide?

Network Issues

- Packetloss “by design”: draft-ietf-v6ops-nd-cache-init
- Vendor Bugs/Broken IPv6

Process Issues

- IPv4-first Operations Mindset
- Designs with IPv4 dependencies

Early Adopters Are Crucial

Willing to try IPv6-only

Capable of reporting issues

Maximum issues found

Minimal user impact

IPv6(only) Support Requirement

IPv6/IPv6-only support requirements in RFPs must be:

- Explicit
- Specific

"IPv6 Support"

RDNSS
Management over v6
464XLAT

Dedicated SSID/Network: Not Ideal

Dual-stack SSID naming is hard:

Less "attractive" than IPv6-only one

Intuitive enough so users would use it

- *Guest-V4 ?*
- *Guest-IPv4 ?*
- *Guest-do-not-use-this-until-nothing-else-works?*

Dedicated SSID/Network: Not Ideal

No control over SSID chosen by a device.

Devices switching between SSIDs.

Onces SSID remembered - no way back.

Consider do not broadcast the fallback SSID

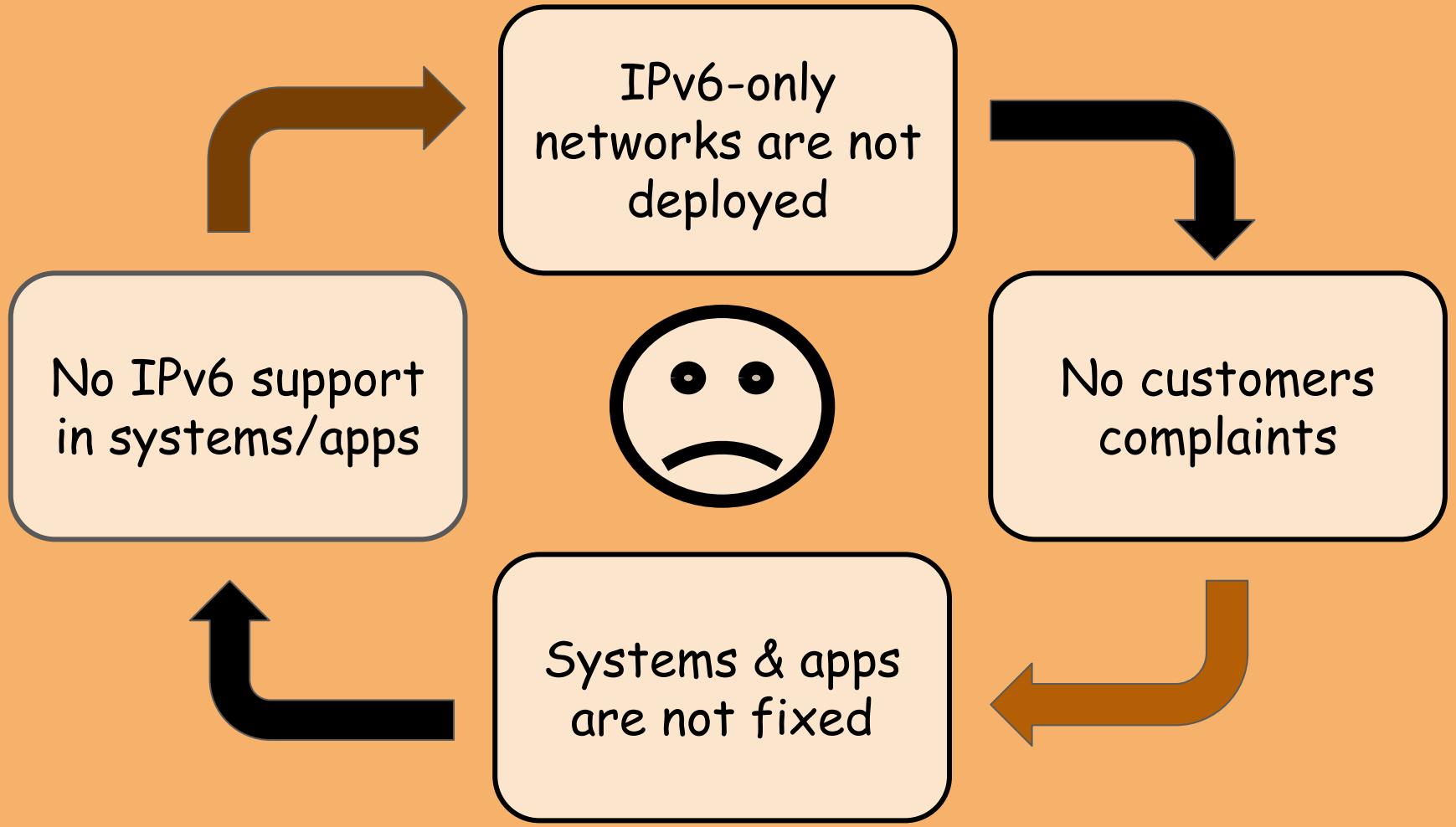
Dedicated SSID/Network: Not Ideal (III)

Even worse for wired LAN: twice more VLANs

Desirable:

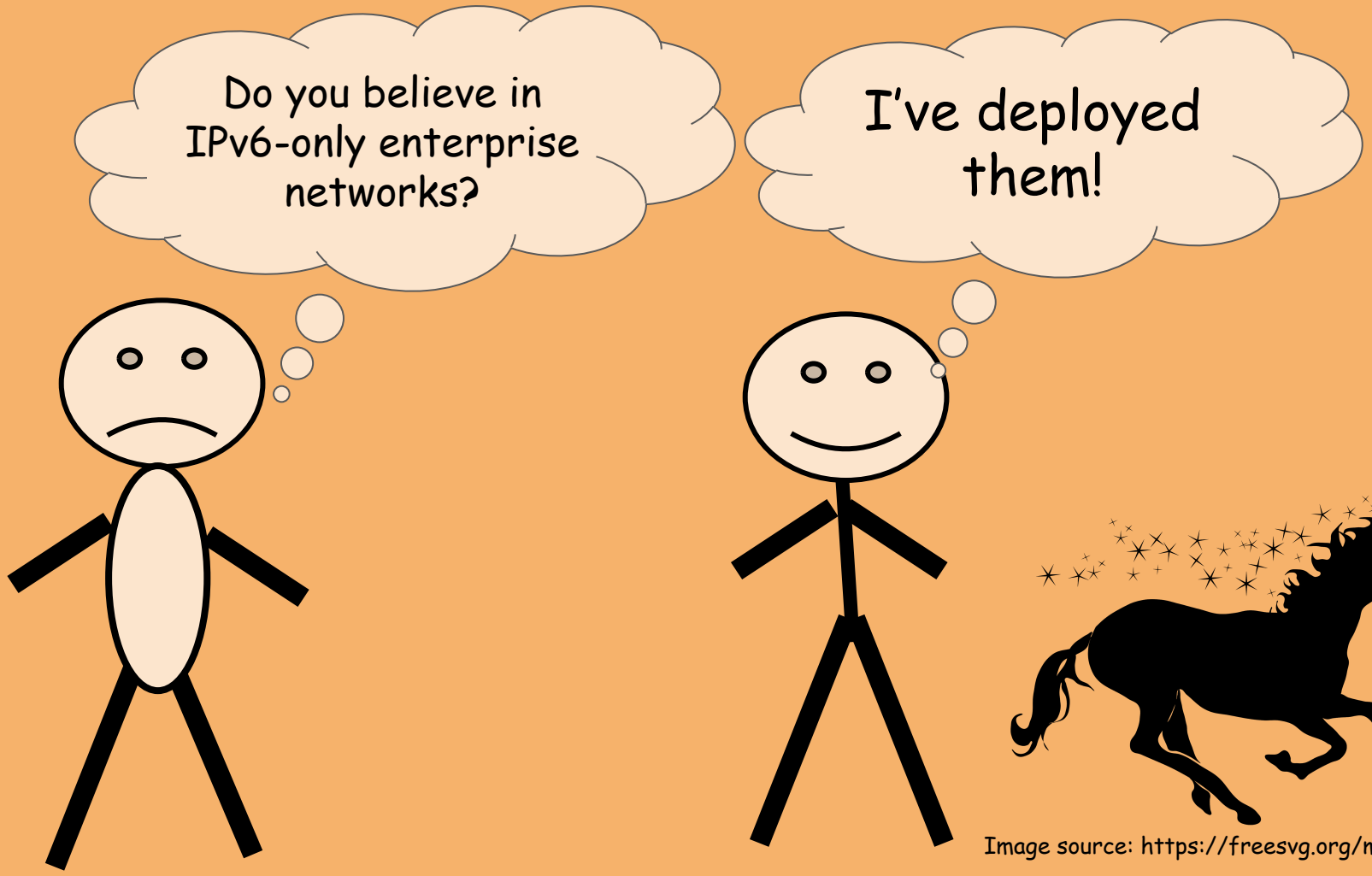
IPv6-only and IPv4-enabled hosts coexistence

Hence, draft-ietf-dhc-v6only


IPv6-only networks are not deployed
No customers complaints
Systems & apps are not fixed
No IPv6 support in systems/apps

July 2020

Majority of offices
have
IPv6-only Guest network



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