Microsoft

Microsoft CSEO: Ongoing journey to IPv6-only

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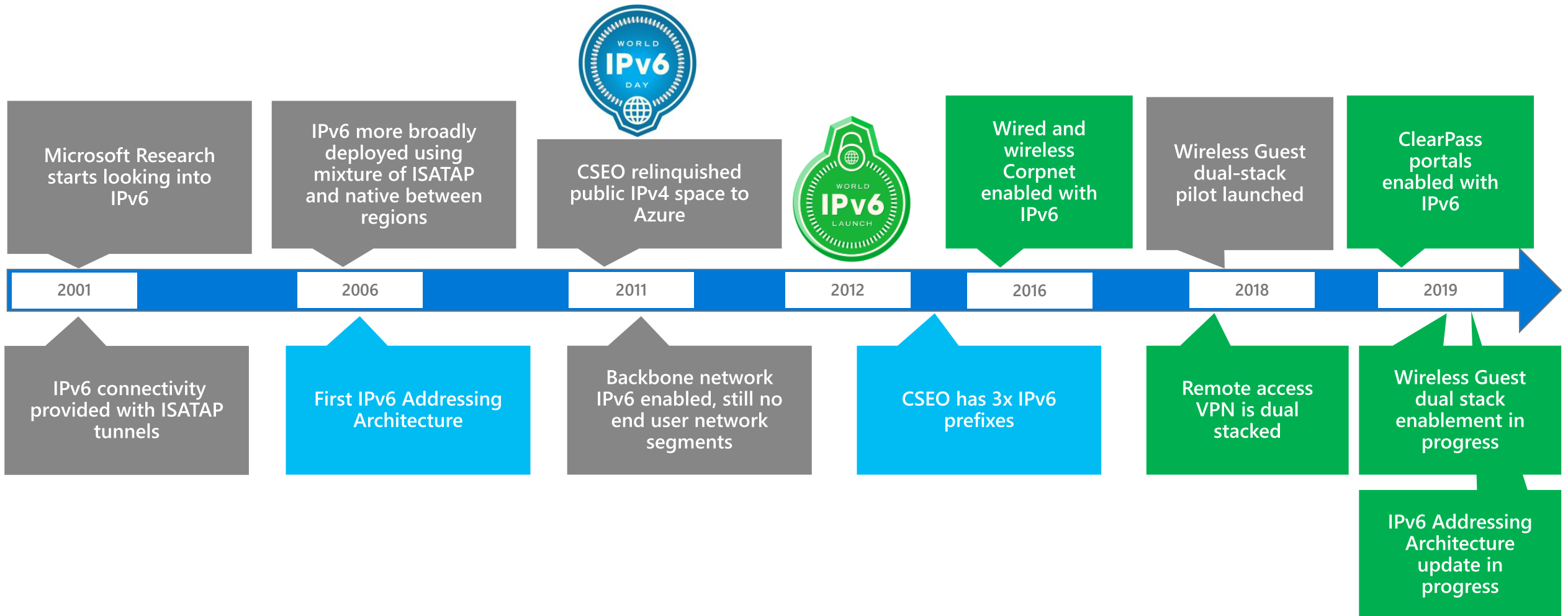UK IPv6 Council Annual Meeting
London
12 December 2019

Network Overview

- Four regions with smaller campuses and branch offices
  - Puget Sound (Redmond, WA) – the main campus
  - North America, Europe/Middle East/Africa, and Asia Pacific
  - 790+ locations
- On-premise DCs and services in Azure
- Branches WAN connectivity is MPLS, Internet through dedicated Edge locations
- ~ 149K+ employees (~250K end users)
- ~ 2200 LOB applications managed by Microsoft CSEO
- ~ millions of devices use the networks daily
- ~ 80K DNS request/second

NEW: Network Segmentation initiative in progress

Past & Present of Dual-stack in CSEO/Microsoft

2001 — Microsoft Research starts looking into IPv6

2006 — IPv6 more broadly deployed using mixture of ISATAP and native between regions

2011 — CSEO relinquished public IPv4 space to Azure

2012

2016 — Wired and wireless Corpnet enabled with IPv6

2018 — Wireless Guest dual-stack pilot launched

2019 — ClearPass portals enabled with IPv6

IPv6 connectivity provided with ISATAP tunnels

First IPv6 Addressing Architecture

Backbone network IPv6 enabled, still no end user network segments

CSEO has 3x IPv6 prefixes

Remote access VPN is dual stacked

Wireless Guest dual stack enablement in progress

IPv6 Addressing Architecture update in progress

Since 2018: the biggest change was the mindset – it's OUR problem to solve.

3

Dual-stack on Corporate & Guest Networks

- For IPv6 addressing: SLAAC + Stateless DHPCv6 (& RDNSS)

- Guest Wireless infrastructure requires quite a lot of work
  - Authentication and Authorization Portal (ClearPass) needed to be dual-stacked - completed
  - IPv6 peering and routing enabled for Guest VRF globally - work in progress
  - Ansible Playbooks of dual-stack deployment on 1400+ wireless Controllers (Aruba and Cisco) – work in progress

- Internal resources still IPv4-only – Azure Express Route dependency
  - IPv6 must be enabled end to end to reap the benefits
  - Impact on user IPv6 traffic levels (today at ~20%)
  - Azure IPv6 in VNETs is available as of summer 2019
  - Express Route peering is getting there

Remote Access VPN – Dual-stack & beyond

- Fully dual-stacked
  - Deployed in H1 CY2018, native Windows VPN client and thick client
  - ~250,000 users
- It works on IPv6-only through NAT64 ☺
- VPN is a big consumer of IPv4 address space
  - We want IPv6-only inside the VPN tunnel

- Initial IPv6-only test in autumn 2017 discovered vendor's dependency on IPv4
  - Engineering code in autumn 2018, production code in early 2019!
- IPv6-only User Pilot is ready to go
  - NAT64/DNS64 for IPv4-only corporate resources
  - We perform split-tunneling – Internet traffic not sent through VPN

IPv6-only

Why are we working towards IPv6-only?

IPv4
(CSEO private space = 9M, only X % left)

IPv4 is fragmented and being depleted

IPv4 cannot support demands of IoT & Modern Engineering

Overlapping IPv4 with M&A and Microsoft Partners

Two protocols on network = increased operational complexity

Governments and industry require IPv6-only compliance

E360 IPv6 allocation is virtually unlimited

IPv6 prefixes assigned to E360 are globally unique

IPv6-only = one protocol to manage and secure

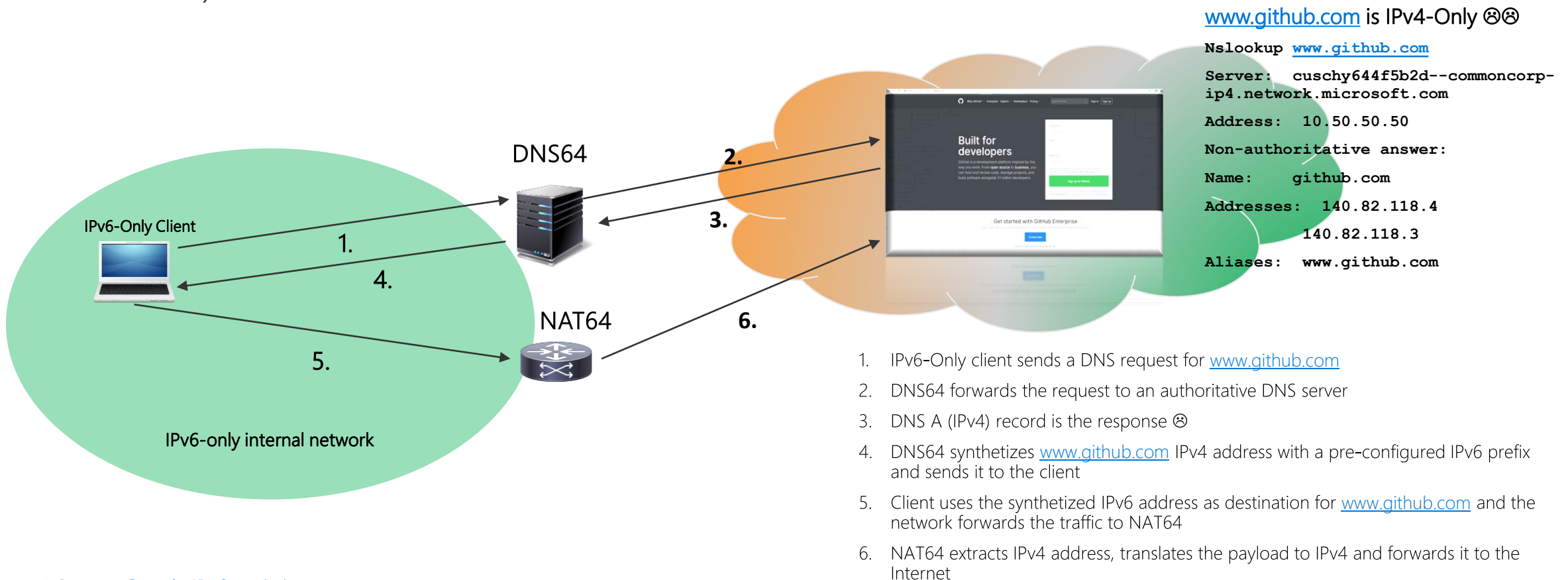PGs develop IPv6-only compliant products = benefit for Microsoft customers & industry

IPv6
(trillions of unique addresses)

Since June 2015 Apple AppStore

How does IPv6-Only speak to IPv4-Only? NAT64/DNS64

- 70%* of the Internet is IPv4-only, >66% of our internal applications seem to be IPv4-only too (dependency on Azure ER/Private Connectivity and IPv6)

www.github.com is IPv4-Only ☹☹

```
Nslookup www.github.com

Server:   cuschy644f5b2d--commoncorp-
ip4.network.microsoft.com

Address:  10.50.50.50

Non-authoritative answer:

Name:     github.com

Addresses:  140.82.118.4
            140.82.118.3

Aliases:  www.github.com
```

DNS64

NAT64

IPv6-Only Client

IPv6-only internal network

1. IPv6-Only client sends a DNS request for www.github.com
2. DNS64 forwards the request to an authoritative DNS server
3. DNS A (IPv4) record is the response ☹
4. DNS64 synthetizes www.github.com IPv4 address with a pre-configured IPv6 prefix and sends it to the client
5. Client uses the synthetized IPv6 address as destination for www.github.com and the network forwards the traffic to NAT64
6. NAT64 extracts IPv4 address, translates the payload to IPv4 and forwards it to the Internet

* Source: Google IPv6 statistics

IPv6-only Development Test Network

- Production IPv6-Only network for Product Groups
  - Since April 2017
- Pure Internet connectivity with NAT64/DNS64
  - Test cases focused on consumers & services living on the Internet and in the Cloud
- Testing for Android, iOS, MacOS, Windows, Linux

- Helps to meet the industry and regulatory requirements for Microsoft products
  - Apple AppStore, US Federal Government, State of Washington (USA)
- Deployed in 11 locations (US, Europe, Asia)
  - Product group demand driven
  - Capability to deliver anywhere in the world

IPv6-only Corporate Network Pilot

- Pilot of IPv6-Only Wireless Corpnet since April 2018
  - Opt-in parallel SSID @ 20 sites in USA, EMEA and APAC
  - "Tidier" device mix on wireless than on wired, better control
  - Domain-joined and AAD-joined (Intune managed)

- Support for Windows, Android, iOS, Linux and MacOS devices

- Dependency on NAT64/DNS64 availability in regions

- IPv6 issues with both wireless vendors
  - IPv6 no Internet Connectivity – NDP "proxy" by Aruba Controllers
  - Stateless DHCPv6 issues on Aruba (RDNSS becomes vital)
  - Cisco WLCs randomly de-authenticating IPv6 clients

- Lesson learned
  - Testing deployment with IPv6-only can clean up your production code

Let's be real... IPv6-only is an application problem
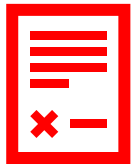
Identified IPv4 Application Dependencies

- Exposed during IPv6-only Pilot since April 2018
  - Cause applications to fail through NAT64 & DNS64

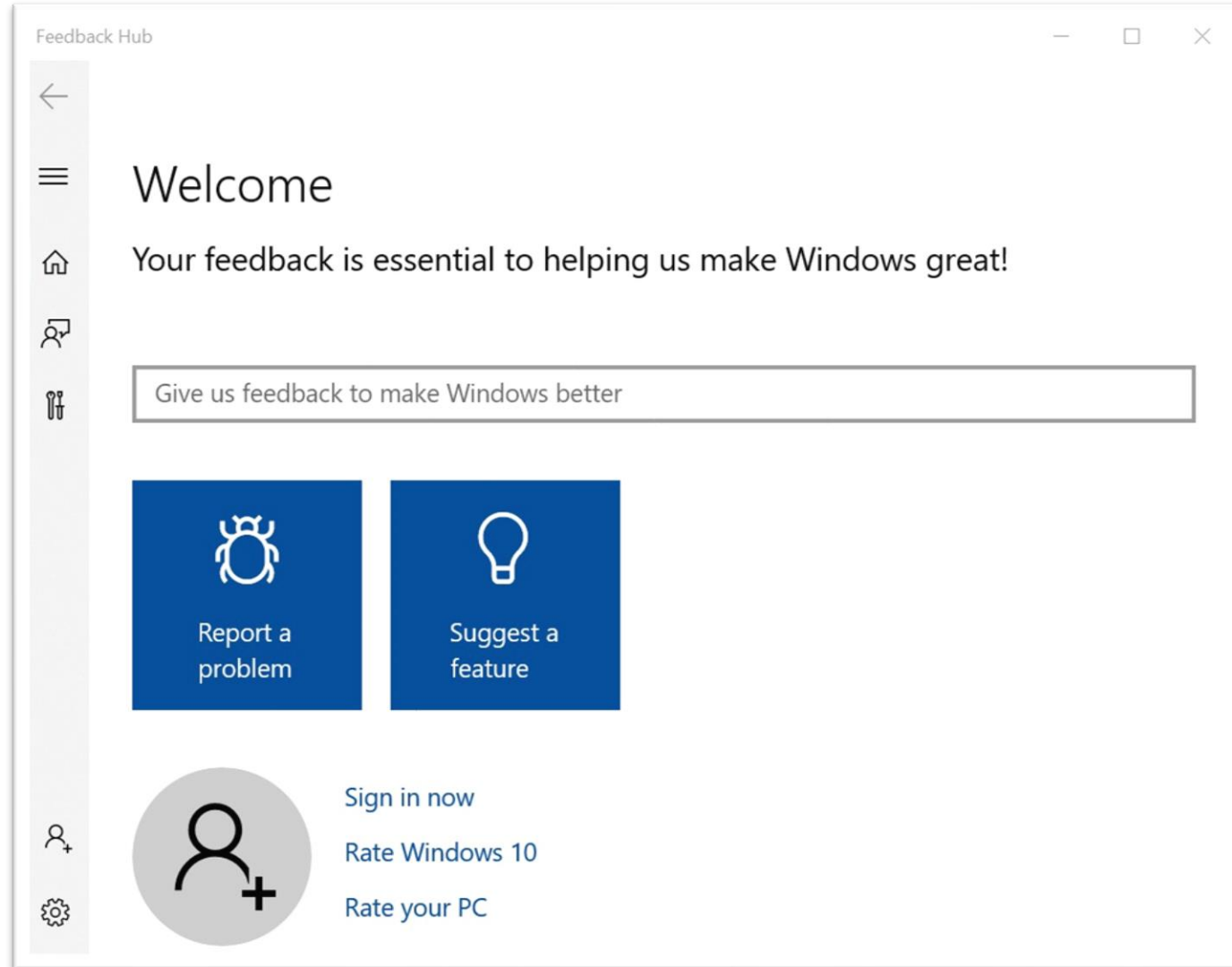|	
Connections to IPv4 addresses	Hardcoded IPv4 addresses
IPv4-only APIs & Function calls	Backend redirects bypass DNS64

Known Applications within Microsoft

- 190+ Business Critical Productivity Apps and Tools (LOB CSEO)
- 2200+ Supported Apps and Tools (CSEO)
- Approximated 40,000 Unsupported 3rd party Apps and Tools

Conclusion

- To see the real effect of IPv6 it MUST be end to end
  - Otherwise you'll see trend inline with Alexa Top 1000
- Dual stack is BUSINESS AS USUAL
  - <u>Don't ask users</u> if they want it, deploy it!
- Dual stack hides issues with IPv6 implementation
  - You better verify on IPv6-only
- IPv6-only is our destination, the journey ahead is still long (application dependency)
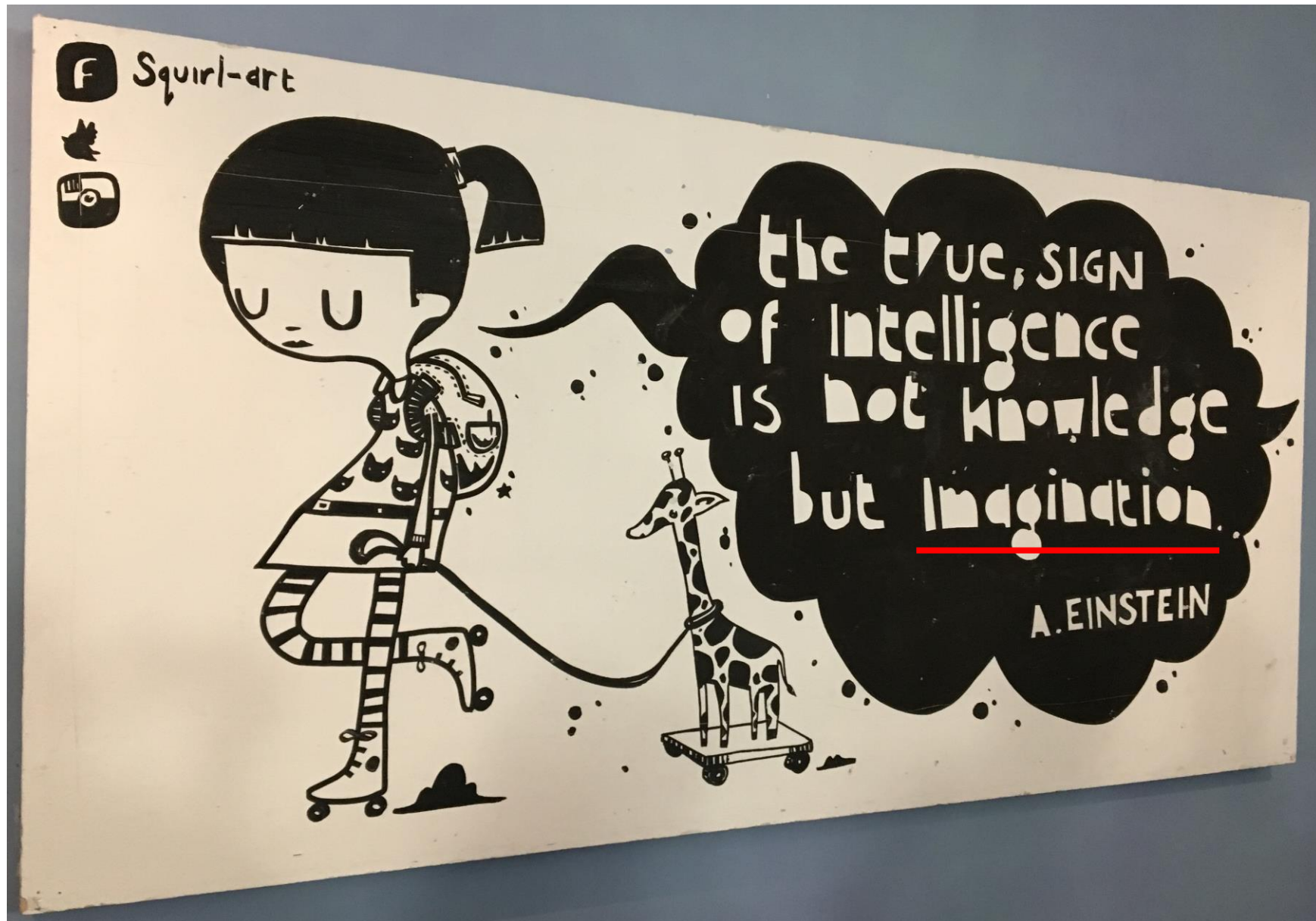
Submit your IPv6 issues with Windows

Photo: V. McKillop © Squirl-art

Thank you! ♥ IPv6