

IPv6 Test Pod - Project Update

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ABOUT INTERNET2



NETWORK

High-Speed National Research & Education Network (NREN)

- US Optical and Packet backbone
- 46 POPs around the US
- 100GE / 400GE connections to connectors/members
- International peerings to other NRENs
- I2PX - Internet2 Peering Exchange - cloud/commercial peerings
- L2VPN & L3VPN solutions



CLOUD

InCommon / Trust & Identity

- Federated single sign on across members
- eduroam - authenticated roaming between campuses



SECURITY

Community

- Member-run non-profit organization



COMMUNITY

AGENDA

- Events in IPv6
- Measuring IPv6 adoption
- IPv6-only Networks and Transition Technologies
- The IPv6 Test Pod Project
- Current Project Status



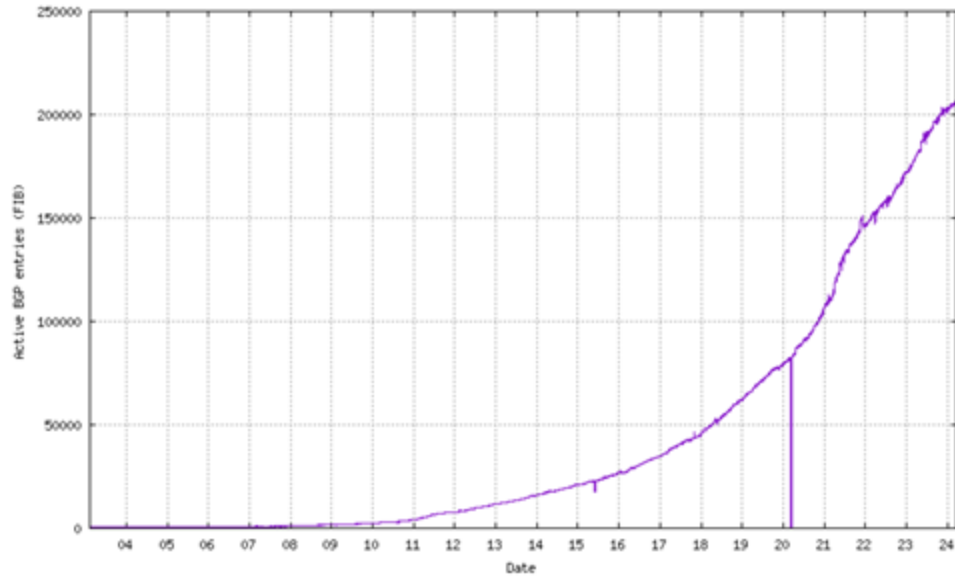
Events in IPv6

- 1998 December - IPv6 Draft Standard Released
- 2011 June - World IPv6 Test Day
- 2012 June - World IPv6 Launch
- 2015 September - ARIN Free IPv4 pool depleted
- 2017 July - IPv6 Standard Ratified
- 2020 December - US Gov IPv6-Only Mandate
- 2024 March - draft-link-v6ops-6mops-00



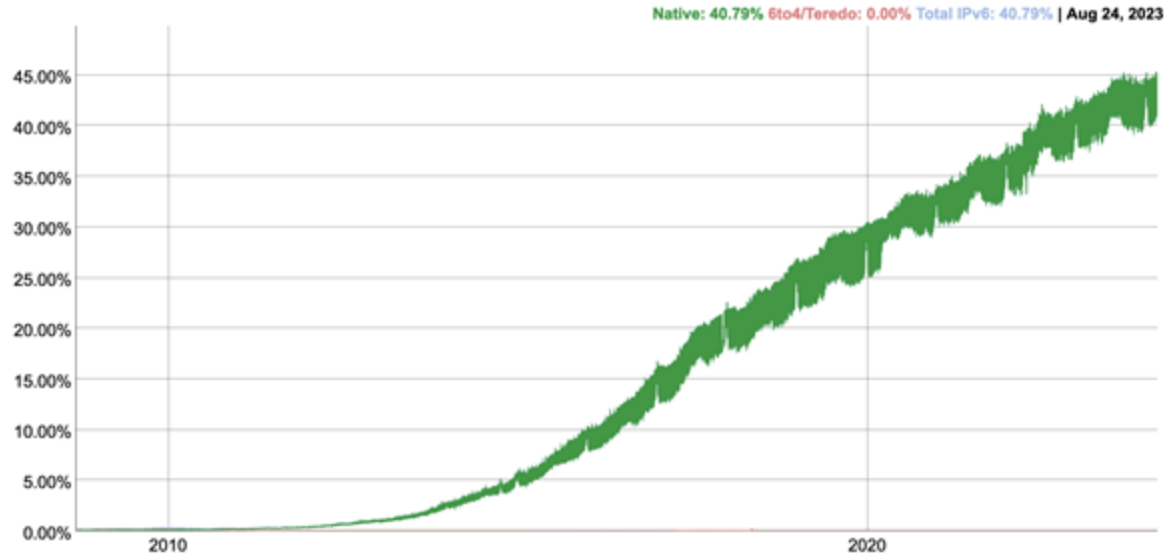
Measuring IPv6 Adoption

IPv6 Adoption - by Prefixes [Potaroo]



Source: <https://bgp.potaroo.net/v6/as2.0/index.html>

IPv6 Adoption - by Traffic [Google]



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

Measuring IPv6 Deployment at Internet2

- IPv6 at end-user networks shows

ASN	IPv4 Traffic	IPv6 Traffic
RIPE-NIC-AS	99.97%	0.03%
UEN-100	97.67%	2.33%
UConn-AS	99.09%	0.91%
UVA-AS	100.00%	0.00%
University of Missouri-AS	99.93%	0.07%
Arizona-AS	100.00%	0.00%
ASU-AS	69.50%	30.50%
Washington State U-AS	98.70%	1.30%
University of Chicago-AS	38.07%	61.93%
ASU-AS	98.55%	1.45%
University of Wisconsin-AS	93.82%	6.18%
Indiana-AS	99.82%	0.18%
Florida-AS	99.85%	0.15%
BlackBerry-AS	100.00%	0.00%



IPv6 Only Networks



Why IPv6-Only?

- IPv6-only is where we really want to be
 - Dual-stack is NOT the end-game
- Operational Simplicity
- Fewer hidden issues [Happy Eyeballs]
- Burden on transition mechanisms [NAT64]
decreases over time

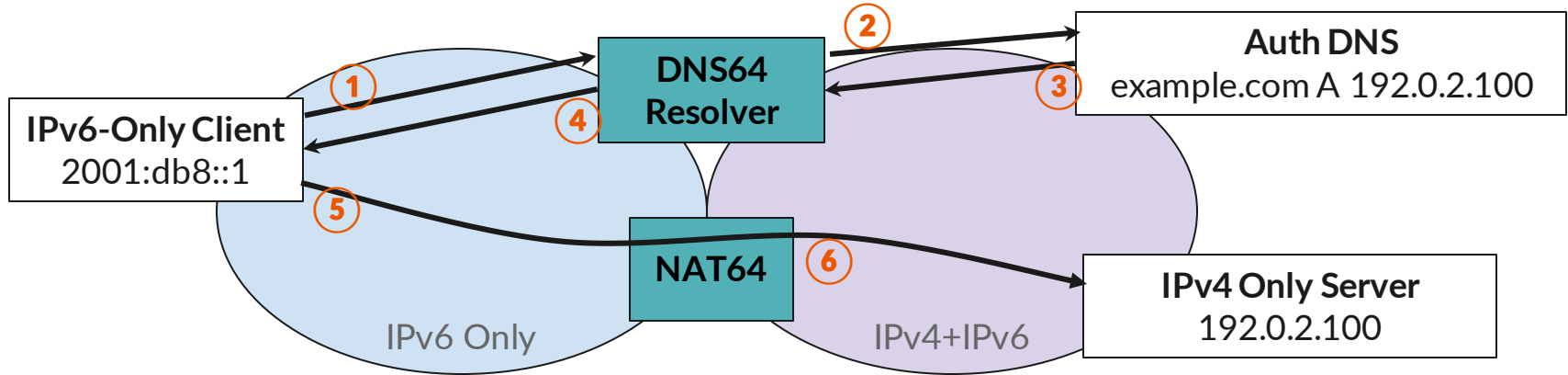


Supporting IPv6 Only

Emerging standards and techniques to keep IPv6-only networks connected to IPv4-only websites

- NAT64
- DNS64
- 464XLAT
- IPv6-RA w/ PREF64
- DHCP option 108 [IPv6 Mostly]

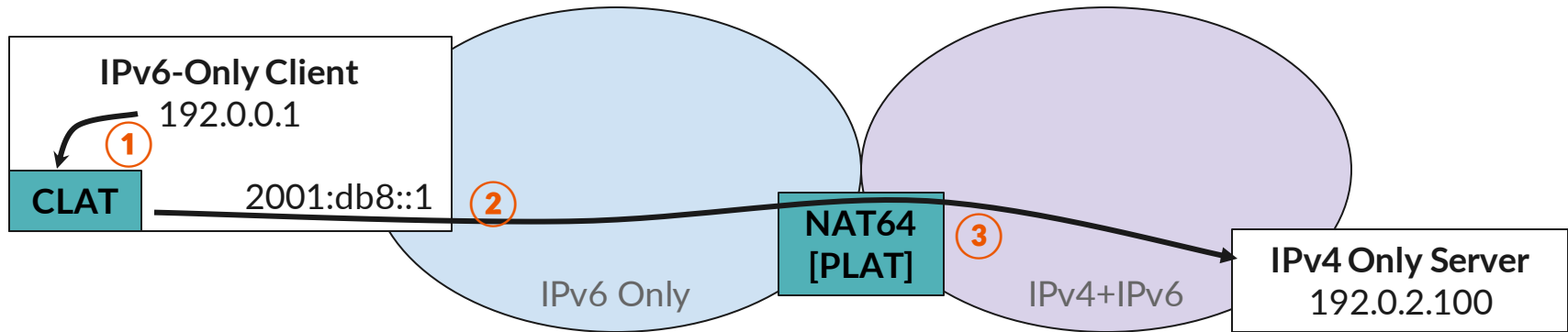
Accessing IPv4 with NAT64 / DNS64



④ DNS64 synthesizes response -- **example.com AAAA 64:ff9b::192.0.2.100**

⑥ Client traffic to **64:ff9b::192.0.2.100** routed through NAT64 appliance, translated to IPv4

Accessing IPv4 with 464XLAT



- ① Client connects to IPv4-only resource through **CLAT**
- ② **CLAT** translates to IPv6, connects to **64:ff9b::192.0.2.100**
- ③ Traffic to **64:ff9b::192.0.2.100** routed through **NAT64 / PLAT** appliance, translated to IPv4



Configuring 464XLAT

RFC 8781 - Discovering PREF64 in Router Advertisements

- Isn't widely supported in most NOS's (yet)
- OS support varies

RFC 8880 - Special Use Domain Name 'ipv4only.arpa'

- **ipv4only.arpa** is a well-known DNS entry with only A records
- If a AAAA record is returned:
 - We know DNS64 is being used
 - We know the NAT64 prefix



OS Support for 464xlat

iOS	Supported
Android	Supported
macOS	Supported
Windows	Supported on LTE only
Linux	No out of the box support, but tools exist



Typical Problems

	IPv6 Only	DNS64/NAT64	464XLAT
No server-side IPv6	Problem	OK	OK
Hard-coded IPv4 literal	Problem	Problem	OK
Application hard-codes Address Family	Problem	Problem	OK
Application and Server support IPv6; SSO does not support IPv6	Problem	OK	OK
Server IPv6 is listed but broken; TCP SYN Proxy breaks Happy Eyeballs	Problem	Problem	Problem



IPv6 Test Pod Grant

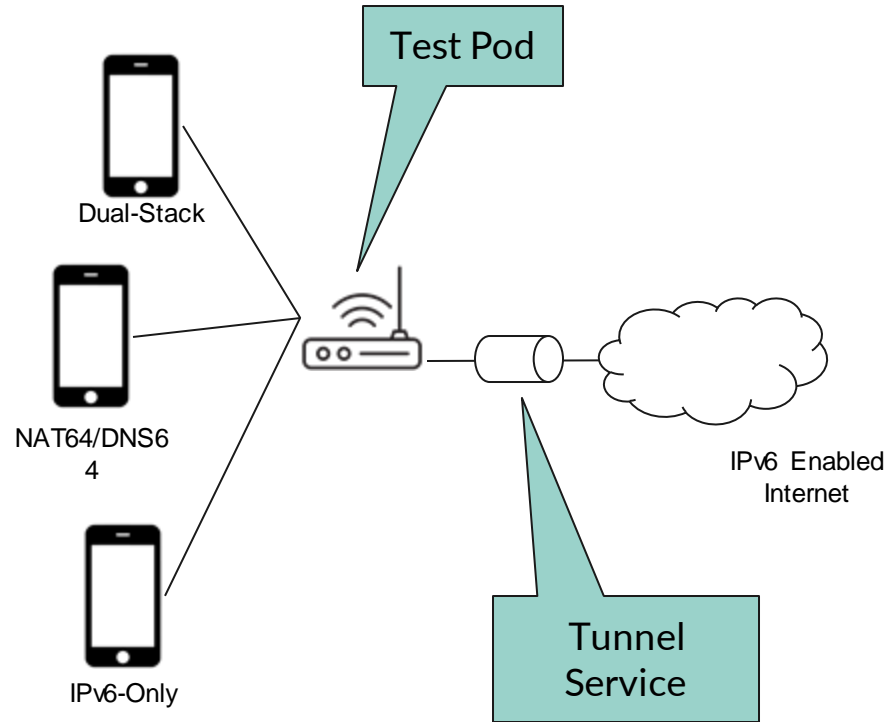


Getting a Lab Set up

1. Understand all the options
2. Get access to IPv6
3. Piece together a solution with a mix of equipment
 - a. NAT64 - not well supported in lower end platforms
 - b. DNS64 - independent server/container
 - c. PREF64 - may not be supported in NOS that supports NAT64
4. Setup multiple test environments
 - a. Dual Stack
 - b. DNS64 + NAT64
 - c. NAT64 + PREF64
 - d. IPv6 only
5. Still do your day job

IPv6 Test Pod

- \$7,000 ARIN Grant
- Target making client-side testing easy
- Inexpensive device (<\$150)
- Creates 3+ wifi+wired networks for testing: dual-stack, nat64, ipv6-only
- Uses an a tunnel for IPv6
- Service includes tunnel termination
- Comes pre-configured, plug-in and go
- Distributed at no-cost to participant
- Inspired by [RIPE ATLAS](#) probes





Target Users

- **App Developer** - Wants to test a client-side app in a v6-only environment. The back-end infrastructure is supposed to be configured, but happy eyeballs and a dual-stacked server may be hiding problems.
- **IT Support** - Has a set of applications they want to test for an IPv6-only environment, but the rest of the organization doesn't have time/resources to set up the test bed.
- **Network Engineer** - Who has been asked to research NAT64/DNS64; lab environment setup would take days/weeks



Project Timeline

Month 0-6 – Purchase initial batch of test hardware, Evaluate software

Month 3-9 – Collect applications, Configure & distribute devices,

Month 9-12 – Gather feedback from participants, Summarize in report



Ways to Participate

- jharr@internet2.edu
- ipv6-pod.info
 - Submit an application for a test pod
 - Mail list - <https://lists.internet2.edu/sympa/info/ipv6-pod-announce>