

IPv6 deployment for Enterprise/Sysadmins

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The background features a dark blue horizontal band across the middle. Above and below this band, there are various colorful diamond and square shapes in shades of teal, yellow, red, and grey, some of which are overlapping or faded. The text "The only constant is change" is centered in white on the dark blue band.

The only constant is change

‘Cause the IETF likes change...

- **SLAAC vs DHCP**
- **Identifying users/machines**
- **Interface “magic”**
- **Org/political challenges**

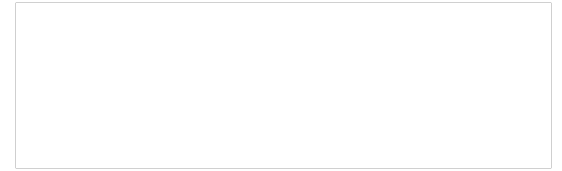
‘Cause the IETF likes change...

- **App changes (esp. browsers)**
- **Policy changes (PTR)**
- **Security and “broadcast domain” changes**
- **IPSEC**
- **Continually evolving ecosystem**



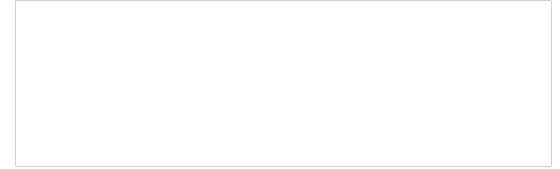
McDUID

DUID > Mac address



- **Mac address as ID is flawed:**
 - Not always unique
 - Can be altered
 - Multi-interface hosts confuse things
- **But it's works for a huge percentage of the internet**
- **DUID (DHCP Unique Identifier) is the replacement in IPv6**

What DUIDs do right

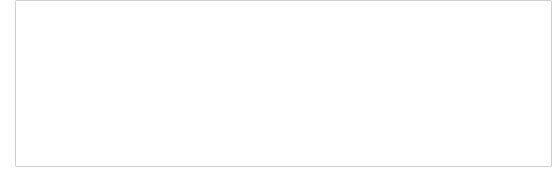


- **One DUID per DHCP server or client**
- **One Identity Association (IA) per network interface on a host**
- **A host can DHCP for all interfaces via DUID/IA as unique key**

Where DUIDs don't work...

- **Anyone using mac address for identification or filtering**
- **Anyone trying to correlate IPv4 and IPv6 to the same machine/user**
- **Persistent storage of DUID may cause surprises**

But I do dual stack...

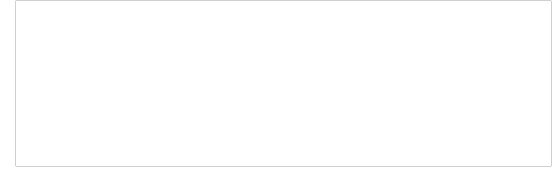


- **How to correlate all addrs to same client:**
 - **draft in ietf: draft-ietf-dhc-dhcpv6-client-link-layer-addr-opt (headed to IESG)**
 - **circuit-id/remote-id work as with DHCPv4**

An abstract graphic featuring a dark blue horizontal band across the center. Above and below this band are various colorful diamond shapes in shades of teal, yellow, red, and grey, some overlapping and some floating. The title 'Happy Eyeballs' is centered in white text on the dark blue band.

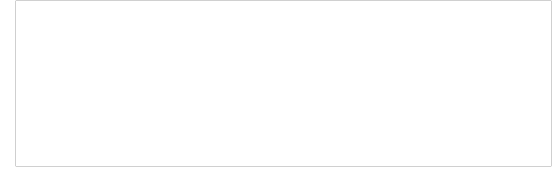
Happy Eyeballs

IPv6. Yes. Have some.



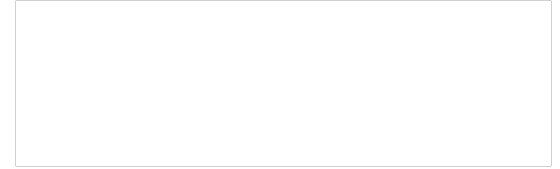
- **Original plan: Always use IPv6/AAAA if available**
- **Result: poor user experience (long timeouts, use of slower links, etc.)**

Err... We meant Happy...



- **Next attempt was to specify draft/RFC**
- **“But that doubles DNS traffic”...**
- **And OS and browser folks both dived on it**

Hence “Hampering Eyeballs”

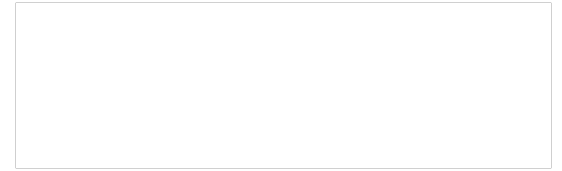


- **Testing by Geoff Huston** (<https://labs.ripe.net/Members/emileaben/hampered-eyeballs>)
- **Problems with browsers**
- **Lots of problems with OS X**
- **Windows trying to fix at network layer...**

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How do it know?

Source/Destination Address



- **Multiple interfaces w/ multiple addrs**
- **Multiple prefixes**
- **Dual stack...**
- **How to choose...**
- **RFC 6724 (formerly RFC 3484)**

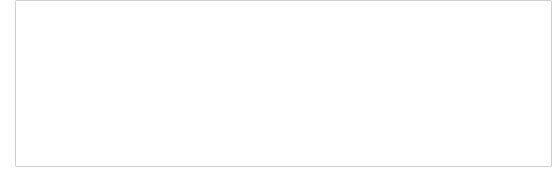
RFC 6724 (was 3484)

- **Types of addrs:**
 - IPv6: GUA, ULA, Link Local, privacy
 - IPv4: public, APIPA, 1918

- **Some better than others**
 - Consider scope, type, prefix length
 - Avoid deprecated

- **Allow local policy overrides**

Debugging will be fun



- **Decisions time/context sensitive**
- **How to train staff and users**
- **Local tools to dump all info**
- **Packet sniffers?**

The background features a dark blue horizontal band across the middle. Above and below this band, there are various colorful diamond and square shapes in shades of teal, yellow, red, and grey, some of which are overlapping or faded. The text "Who owns what" is centered within the dark blue band.

Who owns what

Turf wars

- **Who assigns IP addrs**
- **Who owns DHCP servers**
- **Who owns DNS**
- **Who owns routers/Ras**
- **Who supports OS/apps**

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Apps

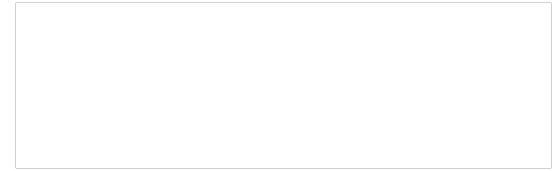
We'll make up our own darned minds

- **OS makes decisions on DNS lookups and using v4 vs v6**
- **Browsers and other apps do own DNS lookups and picking of v4 vs v6**
- **How to debug...**

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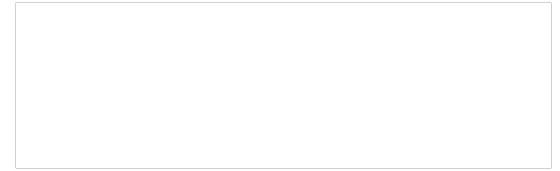
Reverse/PTR goo

How did we do it IPv4



- **By hand (ow)**
- **Scripts**
- **\$GENERATE**
- **IPAM**

How would that work for IPv6



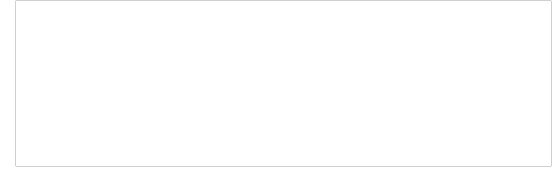
- **A single subnet is a /64**
- **A /64 has 18 quintillion (4 bil x 4 bil) addrs**
- **A PTR record has 34 labels in IPv6**
- **Anyone got a computer with enough disk or RAM to hold one /64 zone file?**

So what are we left with?

- **Admit that PTRs are pointless**
- **Pre-populate (assuming FTL travel...)**
- **Pre-populate statics for routers & big servers**
- **As above plus DHCP server adding clients**
- **Lie on the fly (if not doing DNSSEC)**

The image features a dark blue horizontal band across the center. Above and below this band, there are several colorful diamond shapes in shades of teal, yellow, red, and grey, some of which are overlapping. The word "Security" is written in white, bold, sans-serif font, centered within the dark blue band.

Security



**IPSEC in IPv6 is better than IPv4
because it was designed in and
mandated.**

And the reality

- **RFCs said “MUST” support IPSEC (but softening to “SHOULD”...)**
- **Didn’t define “support”, let vendors do it**
- **Vendors shipped, didn’t enable**
- **No PKI...**

- **Required for:**
 - **DAD**
 - **Finding routers (RA/SLAAC)**
 - **Finding servers (DHCP)**
 - **PMTUD**
 - **Connectivity (echo request/response)**
 - **Network errors**

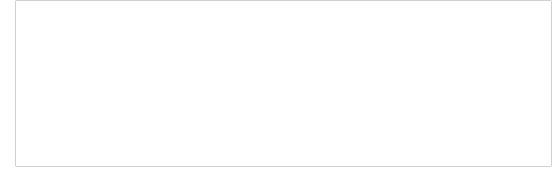
ICMPv6 Filtering

- **Filter it all and you don't have a useful network**
- **ICMPv6 much more detailed/precise in types and functions**
- **RFC 4890 has excellent filtering practices**

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And what don't we know yet

Default route



- **Multiple default routes from RAs**
- **No more HSRP/VRRP! Maybe...**
- **But does this actually work?**
- **Not all OSs did the right thing (Fedora, ???)**

What else will we find...

- **AlX makes multiple AAAA/ip6.arpa queries with no working IPv6 stack**
- **Changing A/O/M bits... Interesting... (see draft-liu-bonica-dhcpv6-slaac-problem)**
- **And there will be more...**



Questions?

A decorative graphic consisting of numerous overlapping squares and diamonds in various colors including teal, yellow, red, grey, and green. These shapes are scattered across the slide, with a higher concentration in the top right and bottom right corners, and a few smaller ones near the center.

Thank you!