A View Through Happy Eyeballs

Client-Side IPv6 Metrics

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MAPRG
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Background

• On iOS and macOS, we use the following logic to create connections when we have multiple address options:

• Sort addresses using RFC 6724

• Inspired by RFC 6555 ‘Happy Eyeballs’, prefer to try different address families as first two attempts

• Try addresses in order, with a delay based on expected RTT and variation
Methodology

• Randomly sample 1% of connections made using Apple’s networking library on the Public Beta of iOS 10 and macOS Sierra
  • Number of addresses resolved per family
  • First address family attempted
  • Connected address family
  • Connected address index
  • TCP handshake time
  • Interface Type (Wi-Fi, Cellular, Wired)
How often do we connect over IPv6?
Connection Attempt Breakdown

IPv4 Only Hostnames: 88.707%
IPv4+IPv6 Hostnames: 6.02%
IPv4 Literal: 4.806%
IPv6 Literal: 0.346%
IPv6 Only Hostnames: 0.037%
Connected Address Family Totals

IPv4: 94.29%
IPv6: 5.62%
Connected Address Family

IPv4 + IPv6 Hostnames Only

- IPv4: 12.99%
- IPv6: 87.01%
Connected Address Family

IPv4 + IPv6 Hostnames, Per Network Type

Wi-Fi
- IPv4: 14.67%
- IPv6: 85.33%

Cellular
- IPv4: 10.12%
- IPv6: 89.88%

Wired Ethernet
- IPv4: 34.86%
- IPv6: 65.14%
How often do we need ‘Happy Eyeballs’?
Connected Address Index

Happy Eyeballs Fallback

Number of Addresses Tried Before Connecting

- IPv4 Connected First
- IPv6 Connected First
Connected Address Family

Happy Eyeballs Fallback

IPv4 Attempted First

IPv4 99%
IPv6 1%

IPv6 Attempted First

IPv4 95%
IPv6 5%
How fast is IPv6?
TCP Handshake Latency

Wi-Fi

TCP Handshake Milliseconds

IPv4

IPv6
TCP Handshake Latency

Cellular

IPv6-Promoting Carriers

Other Carriers
TCP Handshake Latency

Wired Ethernet

IPv4

IPv6

0.00%
17.50%
35.00%
52.50%
70.00%
TCP Handshake Latency

Totals - Cumulative

TCP Handshake Milliseconds

IPv4
IPv6

0.00%
25.00%
50.00%
75.00%
100.00%
TCP Handshake Latency

*Wired Ethernet - Cumulative*

- **IPv4**
- **IPv6**

<table>
<thead>
<tr>
<th>TCP Handshake Milliseconds</th>
<th>IPv4</th>
<th>IPv6</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.00%</td>
<td>0.00%</td>
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<td>27.50%</td>
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<td>55.00%</td>
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<td>120</td>
<td>82.50%</td>
<td>82.50%</td>
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<tr>
<td>160</td>
<td>110.00%</td>
<td>110.00%</td>
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</tbody>
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