Going IPv6 Only

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Introduction

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@ipv4depletion
Agenda

- T-Mobile’s journey to become IPv4 independent
- Retries, Returns and Happy Eyeballs
- Background NAT64, DNS64, 464XLAT, Prefix discovery
- Application level fallback to IPv4
- Some best practices and learnings from rolling out and running an IPv6 only network
T-Mobile Customer Base

• Android 4.3 + have support for IPv6 + 464XLAT

• At WWDC 2015 Apple announced the transition to IPv6-only network services in iOS 9. Starting June 1, 2016 all apps submitted to the App Store must support IPv6-only networking.

• iOS 10.3 is IPv6 only on the T-Mobile network

10 Million IPv6 only clients on the T-Mobile network today!
Our path to become independent of IPv4

% IPv6

http://www.worldipv6launch.org/
measurements/

May-13  Nov-13  Jun-14  Dec-14  Jul-15  Jan-16  Aug-16  Mar-17  Sep-17  Apr-18  Oct-18
The remaining 6%

- TMUS Enterprise clients
  - Guests are dual stack

- Really old handsets
  - [https://developer.android.com/about/dashboards/](https://developer.android.com/about/dashboards/)

- Retries over IPv4 for one or another reason *

- Tethering (for some devices)

- Roaming
  - APN roaming protocol is IPv4

* See next slide
Retries, Returns and Happy Eyeballs

Check Happy Eyeballs: http://he.test-ipv6.com/

IPv6

IPv4

Induce failure Remove failure

Some browsers stay IPv4
DNS64/NAT64/464XLAT (RFC6146,6147,6877)

V6 Internet

V4 Internet

v6 only

464XLAT

AAA

64:ff9b:0:0:0:0:0:1

NAT64

DNS64

A 192.0.1.1
Discovery of IPv6 Prefix (RFC 7050)

- Alternative to hardcoded pref64
- Sends DNS query for ipv4only.arpa AAAA
- Extract the pref64
Application level fallback

- NSURLSession on IPv6 Only Apple devices handles IPv4 literals and Happy Eyeballs at the application level

IPv4 fallback mechanisms are moved from
The OS to the Application level.

IPv6 Only Learnings

- Invest in IPv6 like you do with your retirement plan
- Determine what sites/apps are important
- Proactively scan top sites
- Reach out to broken sites
- Don’t try to fix things with local overrides
- Scan social media for direct customer feedback
- Don’t try to change the world and keep things in perspective
Questions?
Android Interfaces

Network Info II app can be found in Google/Apple Store
Failure scenarios

Network related failures

- Special use – Special use AAAA record such as ::1, link-local, etc (common)
  Pks.fi

- Routing – AAAA returned, but unable to connect to the IP, :: (very common)
  Airtel.in

DNS Related failures

- RCODE – Does not return EMPTY NOERROR or NXDOMAIN (rare)
- Flag – Does not return the AA flag in the empty answer (rare)
- SOA – Does not provide SOA for the same domain as asked for (somewhat common)
  Photo site
- Major cloud storage app
- Timeout – Simply does not return anything when asked for AAAA (common)
  www.sky.com.mx

http://www.employees.org/~dwing/aaaa-stats/
Testbed for failure scenarios

example:

dig @2001:4860:4860::6464 soa.dns64.lagerholm.com AAAA

dig @2001:4860:4860::6464 flag.dns64.lagerholm.com AAAA

dig @2001:4860:4860::6464 rcode.dns64.lagerholm.com AAAA

dig @2001:4860:4860::6464 timeout.dns64.lagerholm.com AAAA

Expected result:

timeout.dns64.lagerholm.com. 3 IN AAAA 64:ff9b::6464:6464
## Results response to failure scenarios

<table>
<thead>
<tr>
<th></th>
<th>Google DNS64 As of 6/10/2018</th>
<th>Secure64 CEM 3.2.4 A</th>
<th>Bind</th>
<th>Unbound 1.7.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soa</td>
<td>SERVFAIL</td>
<td>OK</td>
<td>SERVFAIL</td>
<td>OK</td>
</tr>
<tr>
<td>Timeout</td>
<td>OK</td>
<td>SERVFAIL</td>
<td>TIMEOUT</td>
<td>TIMEOUT *</td>
</tr>
<tr>
<td>Flag</td>
<td>SERVFAIL</td>
<td>SERVFAIL</td>
<td>SERVFAIL</td>
<td>OK</td>
</tr>
<tr>
<td>Rcode (RFC required)</td>
<td>OK</td>
<td>OK</td>
<td>SERVFAIL</td>
<td>OK</td>
</tr>
</tbody>
</table>

* On first try and after TTL expire