IPv6 @ Cloudflare (and v6 related items)

SANOG Gurgaon – July/2017

Martin J. Levy @ Cloudflare
// Personal Introduction
Martin J. Levy @ Cloudflare

MY HISTORY
A dedicated IPv6 evangelist. Long time TCP/IP developer/programmer, network operator, peering expert, IETF member, NANOG member, and IP networking development/strategy expert.

MY TERSE RESUME
Bell Labs (New Jersey) – Unix for Unix’s sake, TCP/IP (1982/1983)
Random startups and ISPs (Bay Area)
Concentric/XO (Bay Area) – IP backbone and hosting
Telecom Italia (Rome & Miami) – Global IP backbone
Hurricane Electric (Bay Area) – Global IPv4/IPv6 backbone
Cloudflare (Bay Area) – Global CDN, DDoS, DNS, Security
// The Punchline!
At Cloudflare, IPv6 is always on!
Cloudflare provides performance, security, reliability, and insights to anything connected to the Internet.

// Introduction to Cloudflare
AS13335 / Cloudflare’s Global Anycast Network

- 10% Internet requests everyday
- Speeds up each request by 2x
- EVERYTHING IPv4/IPv6
- 5M HTTP requests/second
- 115 Data centers globally
- 1.2M DNS requests/second
Cloudflare’s benefits
Performance

CDN
Moving content physically closer to visitors with our CDN.

Website Optimization
Cloudflare lets you automatically enable the latest in web technologies.

DNS
Cloudflare is one of the fastest managed DNS providers in the world.

SSL
Modern SSL isn't just for security—it can actually improve the performance of your website.

Dedicated SSL Certificates
With a few clicks within the Cloudflare dashboard, you can easily and quickly issue new certificates, securely generate private keys and more.

Load Balancing
Cloudflare Load Balancing provides load balancing, geo-steering, monitoring and failover for your Internet facing infrastructure enhancing service availability.
Security

**DDoS Protection**
Our enterprise-class DDoS protection network has 20 times more capacity than the largest DDoS attack ever recorded.

**WAF**
Our web application firewall benefits from the collective intelligence of our entire network.

**SSL**
HTTPS is a must-have for modern websites, and Cloudflare makes it easy to configure SSL.

**Secure Registrar**
Registering your domain through Cloudflare is the most secure way to protect your trademark from domain hijacking.

**Dedicated SSL Certificates**
With a few clicks within the CloudFlare dashboard, you can easily and quickly issue new certificates, securely generate private keys and more.

**Rate Limiting**
Rate Limiting gives you granular controls to detect bad traffic, customized rulesets to ensure that your legitimate visitors are not impacted, and insights to improve your security posture as attacks evolve.
Reliability

**DNS**
Cloudflare’s DNS service is powered by the same 102 data center network that powers our DDoS and CDN services. This not only improves DNS resolution times, but also makes DNS-related attacks and outages a thing of the past.

**China Network**
Cloudflare’s China service optimizes Internet connections in mainland China, dramatically improving the viewing experience for visitors in China.

**Predictable Bandwidth Costs**
We believe that you should never be surprised by your monthly bill. Our flat-rate pricing structure makes your CDN and DDoS bandwidth expenses predictable.
Insight

**Enterprise Logs**
For enterprise customers, we can provide consolidated logs from around the world. These are very rich, containing detailed information about every request and response.

**Threat Analytics**
When we identify requests that are threats, we log them and block them. That means we not only protect your site, but also provide insight into the malicious activity we're seeing.

**Rate Limiting**
Rate Limiting gives you granular controls to detect bad traffic, customized rulesets to ensure that your legitimate visitors are not impacted, and insights to improve your security posture as attacks evolve.
A few of our Technology customers

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td><strong>Cisco</strong></td>
<td><strong>VMware</strong></td>
<td><strong>PLEX</strong></td>
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<td><strong>Uber</strong></td>
<td><strong>Parallels</strong></td>
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<td><strong>IBM</strong></td>
<td><strong>Glassdoor</strong></td>
<td><strong>Taringa!</strong></td>
<td><strong>Fitbit</strong></td>
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</table>
Cloudflare has a solid history of giving back to the community, both in open-source software, IETF protocol development, network services, etc.

// Now Down to the Technical Parts ...
The Technical Part

1. Backstory behind the IPv6 switch at Cloudflare
2. Some useful IPv6 data
3. A serious discussion about DNS in a v6 world
4. Why we removed the switch!
IPv6 @ Cloudflare is so
2606:4700::5ca1:ab1e:6810:4737
Cloudflare can be a “bridge” to IPv6
Cloudflare can be a “bridge” to IPv6

IPv6 Compatibility
Enable IPv6 support and gateway.
This setting was last changed a few seconds ago
Cloudflare can be a “bridge” to IPv6

IPv6 Compatibility
Enable IPv6 support and gateway.

This setting was last changed a few seconds ago
Cloudflare can be a “bridge” to IPv6
Five plus years of having the IPv6 switch in our system. The default was “off”.

// Flipping the Switch!
Nearly five million zones on Cloudflare (at this point)
If the user had never touched the IPv6 switch; then flip it on!
Slow start; then running faster (around ~100,000 zones per day)

for zone in all_zones:
    if zone.ipv6.value == False:
        if zone.ipv6.date == None:
            zone.ipv6.value = True
            zone.ipv6.date = Now()
sleep()
People (Some You May Know) Noticed!

Lee Howard
October 25 at 12:26pm

Somebody's been enabling IPv6 on lots of web sites in the past few months. From 10% to 17% in just three months.
http://www.employees.org/~dwing/aaaa-stats/

Vaihbav Bajpai
@bajpaivaibhav

there is rapid growth in number of AAAA websites from 76K (08/2016) to 109K (10/2016) (source @dan_wing dataset: goo.gl/An3iPX )
12:35 AM - 26 Oct 2016
Eric Vyncke’s graph is it’s full glory!

Cloudflare hits 98.01%

Cloudflare starts process

https://www.vyncke.org/ipv6status/
https://blog.cloudflare.com/98-percent-ipv6/
// Removing the Switch
The Disable IPv6 Switch Goes Away!

Before:
IPv6 Compatibility
Enable IPv6 support and gateway.
This setting was last changed a few seconds ago

After:

... IPv6 is on by default (and unchangeable) for the vast majority** of accounts!

** high paying accounts still get the switch
// Who and What is Driving IPv6?
### Top IPv6 Countries – Belgium

<table>
<thead>
<tr>
<th>Country</th>
<th>Percent Bytes IPv6</th>
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# Top IPv6 Countries – Ireland (kinda)

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81% of Facebook (crawl) traffic from Cloudflare is IPv6-based.
# Top IPv6 Countries – Japan

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Percentage of IPv6 vs. Bandwidth per Network
Top 10 IPv6 (~55% of Cloudflare IPv6 Traffic)

- Comcast (AS7922): 11.8%
- Hetzner (AS24940): 9.2%
- Facebook (AS32934): 6.9%
- AT&T (AS7018): 6.1%
- Sky (AS5607): 5.4%
- Deutsche Telekom (AS3320): 4.5%
- Verizon Wireless Mobile (AS22394): 3.8%
- T-Mobile (AS21928): 3.7%
- Orange France (AS3215): 2.1%
- Liberty Global (AS6830): 1.9%
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<tr>
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<tbody>
<tr>
<td>1</td>
<td>100.0%</td>
<td>Orange Polska</td>
</tr>
<tr>
<td>2</td>
<td>100.0%</td>
<td>China Next Generation Internet</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CERNET2</td>
</tr>
<tr>
<td>3</td>
<td>100.0%</td>
<td>HiNet IPv6 (Taiwan)</td>
</tr>
<tr>
<td>4</td>
<td>96.8%</td>
<td>Telenet (Belgium)</td>
</tr>
<tr>
<td>5</td>
<td>91.5%</td>
<td>Time Warner Cable</td>
</tr>
<tr>
<td>6</td>
<td>88.9%</td>
<td>Sprint</td>
</tr>
<tr>
<td>7</td>
<td>81.0%</td>
<td>Facebook</td>
</tr>
<tr>
<td>8</td>
<td>74.0%</td>
<td>EGIHosting</td>
</tr>
<tr>
<td>9</td>
<td>65.9%</td>
<td>Areti Internet</td>
</tr>
<tr>
<td>10</td>
<td>63.9%</td>
<td>Microsoft</td>
</tr>
<tr>
<td>11</td>
<td>61.8%</td>
<td>Alentus</td>
</tr>
<tr>
<td>12</td>
<td>60.3%</td>
<td>T-Mobile USA</td>
</tr>
<tr>
<td>13</td>
<td>58.8%</td>
<td>Verizon Wireless</td>
</tr>
<tr>
<td>14</td>
<td>57.6%</td>
<td>Chubu Telecommunications Company</td>
</tr>
<tr>
<td>15</td>
<td>48.5%</td>
<td>Sky (UK)</td>
</tr>
<tr>
<td>16</td>
<td>47.8%</td>
<td>Google Fiber</td>
</tr>
<tr>
<td>17</td>
<td>44.6%</td>
<td>AIS Fibre (Thailand)</td>
</tr>
<tr>
<td>18</td>
<td>43.6%</td>
<td>AT&amp;T</td>
</tr>
<tr>
<td>19</td>
<td>43.3%</td>
<td>Hughes Network Systems</td>
</tr>
<tr>
<td>20</td>
<td>43.2%</td>
<td>wilhelm.tel GmbH Norderstedt</td>
</tr>
</tbody>
</table>
IPv6 by Device Type

- Desktop: 12.0%
- Tablet: 18.0%
- Mobile: 24.0%
iOS vs Android

### iOS vs Android - IPv6 Traffic

- **iOS**: 23.5% IPv6, 76.5% IPv4
- **Android**: 18.7% IPv6, 81.3% IPv4
Windows and IPv6

- Windows XP (2001)
- Windows Vista (2007)
- Windows 7 (2009)
- Windows 8 (2012)
- Windows 8.1 (2013)
- Windows 10 (2015)
- Windows Phone

% Traffic Over IPv6
DNS traffic and floods (IPv4 vs IPv6)
IPv6 and DNS

Traffic over IPv6

HTTP
- IPv6: 7.1%
- IPv4: 92.9%

DNS
- IPv6: 7.6%
- IPv4: 92.4%
More v6 addresses != more v6 uniques in DNS
IPv6 Global Map (AAAA queries)
IPv6 Global Map (% Traffic IPv6)
// Deprecated IPv6 DNS – Remember A6?
### Who’s Sending A6?

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<tr>
<td>1</td>
<td>AS3462</td>
<td>Data Communication Business Group</td>
</tr>
<tr>
<td>2</td>
<td>AS6181</td>
<td>[CAR-PART.COM]</td>
</tr>
<tr>
<td>3</td>
<td>AS24683</td>
<td>Orenburg State University</td>
</tr>
<tr>
<td>4</td>
<td>AS1221</td>
<td>Telstra Internet</td>
</tr>
<tr>
<td>5</td>
<td>AS2510</td>
<td>FUJITSU LIMITED</td>
</tr>
<tr>
<td>6</td>
<td>AS24945</td>
<td>Telecommunication Company Vinteleport Ltd.</td>
</tr>
<tr>
<td>7</td>
<td>AS7127</td>
<td>Southern California Edison</td>
</tr>
<tr>
<td>8</td>
<td>AS701</td>
<td>MCI Communications Services, Inc. d/b/a Verizon Business</td>
</tr>
<tr>
<td>9</td>
<td>AS12962</td>
<td>First Investment Bank AD</td>
</tr>
<tr>
<td>10</td>
<td>AS1659</td>
<td>Ministry of Education Computer Center</td>
</tr>
</tbody>
</table>
What’s next for IPv6? Fix DNS!
A & AAAA Records - How Silly is this in 2017?

- Separate A & AAAA records
- In a happy-eyeball environment we still need two DNS queries (before any TCP connection can be instigated)

Query for A record

<table>
<thead>
<tr>
<th>Header</th>
<th>QR AA RCODE=NOERROR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question</td>
<td><a href="http://www.example.com">www.example.com</a> IN A</td>
</tr>
<tr>
<td>Answer</td>
<td><a href="http://www.example.com">www.example.com</a>. IN A 192.0.2.1</td>
</tr>
<tr>
<td>Authority</td>
<td>&lt;empty&gt;</td>
</tr>
<tr>
<td>Additional</td>
<td>&lt;empty&gt;</td>
</tr>
</tbody>
</table>

Query for AAAA record

<table>
<thead>
<tr>
<th>Header</th>
<th>QR AA RCODE=NOERROR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question</td>
<td><a href="http://www.example.com">www.example.com</a> IN AAAA</td>
</tr>
<tr>
<td>Answer</td>
<td><a href="http://www.example.com">www.example.com</a>. IN AAAA 2001:db8::1</td>
</tr>
<tr>
<td>Authority</td>
<td>&lt;empty&gt;</td>
</tr>
<tr>
<td>Additional</td>
<td>&lt;empty&gt;</td>
</tr>
</tbody>
</table>
AAAA For Free (When Doing an A Query)!

Cloudflare proposed solution:

1. A + AAAA in new meta-query
2. Resolver asks for A or AAAA
3. If positive answer, the resolver then checks AAAA + A meta-query
4. Resolver remembers whether authoritative server supports meta-query for future queries
5. Resolver adds both A and AAAA to cache
Working code (an IETF must!)

```
$ dig cloudflare.com @ns1.cloudflare.com -t TYPE65535 +short
198.41.215.162
198.41.214.162
2400:cb00:2048:1::c629:d6a2
2400:cb00:2048:1::c629:d7a2
$
```

This is live - try it with any domain on Cloudflare.

```
$ dig taylorswift.com @ashley.ns.cloudflare.com -t TYPE65535 +short
104.16.193.61
104.16.194.61
104.16.191.61
104.16.192.61
104.16.195.61
2400:cb00:2048:1::6810:c33d
2400:cb00:2048:1::6810:c13d
2400:cb00:2048:1::6810:bf3d
2400:cb00:2048:1::6810:c23d
2400:cb00:2048:1::6810:c03d
$
```
IETF draft – pick one, any one (maybe ours?)


Network Working Group
Internet-Draft
Intended status: Standards Track
Expires: September 22, 2016

M. Vavrusa
O. Gudmundsson
CloudFlare Inc.
March 21, 2016

Providing AAAA records for free with QTYPE=A
draft-vavrusa-dnsop-aaaa-for-free-00

Abstract

This document enables DNS servers to include AAAA addresses in the answer section for DNS queries with QTYPE=A in order to reduce the number of resolver round-trips during address lookups, and also provides guidance for recursive DNS servers in accepting such records.

Thank you!
martin@cloudflare.com
@mahtin / @cloudflare