

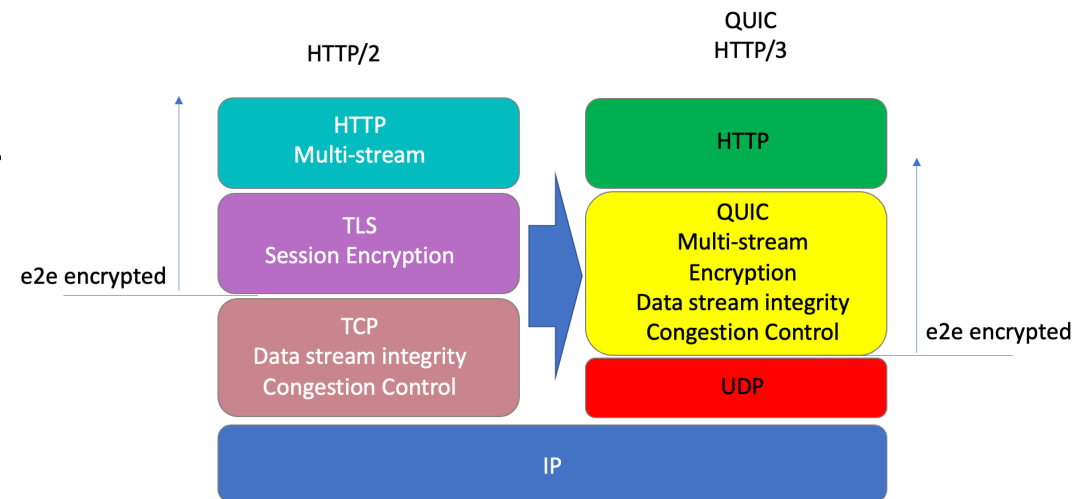
Triggering QUIC

Geoff Huston AM

APNIC

What's QUIC?

- An end-to-end encrypted transport protocol, providing more flexibility, faster connection setup, and a larger set of transport services than TCP
- Operates over UDP port 443



Triggering QUIC in HTTP

Method 1 - Use content-level Alt-Svc controls to trigger the client to use the QUIC transport protocol (if it can):

- Add **Alt-Svc: h3=" :443"** to the HTML headers of content

Setting Expectations

- Chrome has a dominant share of browser instances - roughly, some 65%*
- Chrome has been supporting a switch to QUIC via the Alt-Svc directive since 2020



Chromium Blog

News and developments from the open source browser project

Chrome is deploying HTTP/3 and IETF QUIC

Wednesday, October 7, 2020

QUIC is a new networking transport protocol that combines the features of TCP, TLS, and more. HTTP/3 is the latest version of HTTP, the protocol that carries the vast majority of Web traffic. HTTP/3 only runs over QUIC.

Setting Expectations

- Chrome has a dominant share of browser instances - roughly, some 65%*
- Chrome has been supporting a switch to QUIC via the Alt-Svc directive since 2020

So, we should expect up to 65% of clients will try to connect using QUIC if the server signals it supports QUIC - right?

Chrome is deploying HTTP/3 and IETF QUIC

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The Alt-Svc Trigger

- This trigger is only effective when the client contacts this server for the second time
 - But HTTP/1.1 and HTTP/2.0 use session persistence to keep the original TCP/TLS session open, so the condition where a client needs to open a new connection is less likely to occur
 - The per-server Alt-Svc information is cached by the user for only 24 hours by default

The Alt-Svc Trigger

- This trigger is only effective when the client contacts this server for the second time

- But HTTP/1.1 and HTTP/2.0 use session persistence to keep the TCP/TLS session open, so the condition for the trigger is not met when the connection is lost.

So, QUIC use will only be visible when a server is visited by a client for a second time AFTER the keep-alive expires.

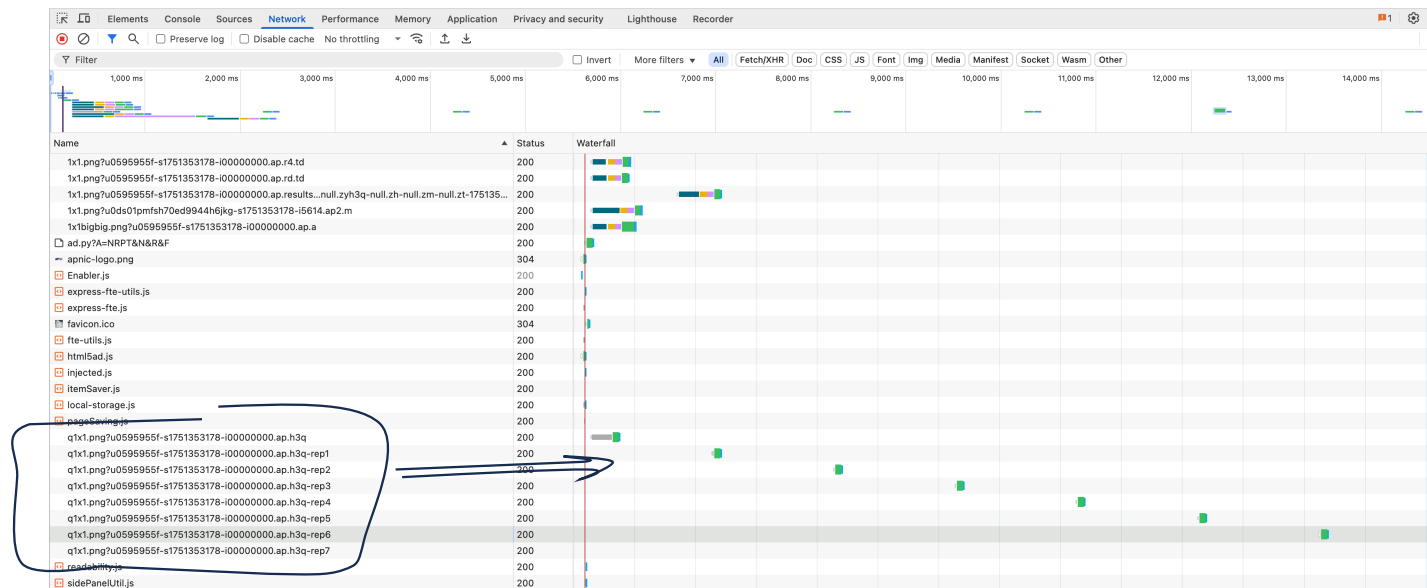
w

oy

APNIC's measurement

We need to trigger the conditions of a second fetch in the measurement:

- Set the server keepalive time to 1 second
- Request the same web object a total of 8 times using 2 second intervals between requests



The Second Way: Use the DNS!

Method 1 - Use content-level Alt-Svc controls to trigger QUIC:

- Add **Alt-Svc: h3=" :443"** to the HTML headers
- This allows Chrome to use QUIC from the second (and subsequent) access

Method 2 - Use the DNS to trigger QUIC:

- Set up an **HTTPS** record for the service name, with value: **alpn="h3"**
- This allows Safari to use QUIC from the first access

Safari supports QUIC via the DNS

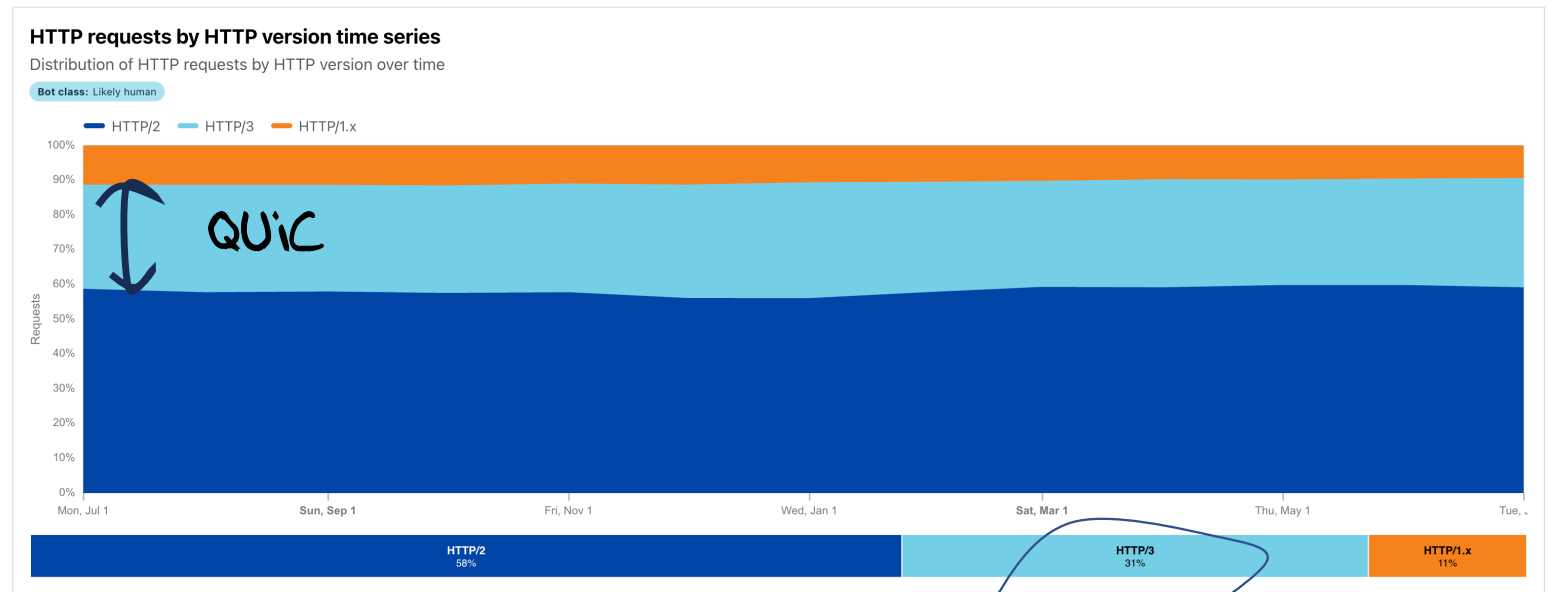
- Apple's Safari is now supporting QUIC, using an HTTPS query/response in the DNS, where the **apln** directive can specify the use of the HTTP/3 protocol to access this service
- QUIC can be triggered immediately (no wait for the second visit), so presumably, if the client performs a DNS HTTPS query, and the response indicates that the server supports QUIC, then the client should use QUIC for the connection

Setting Expectations

- Chrome has a dominant share of browser instances - roughly, some 65%*
- Apple Safari is now supporting QUIC, using the DNS HTTPS trigger
- So, a QUIC-aware server platform should be seeing **up to 85%** of its sessions using QUIC
 - This figure is probably not achievable as the content level control requires some precise conditions for the “second” visit for Chrome:
 - long enough between visits for the session keepalive timer to expire
 - Short enough such that the local cache of server capabilities has not expired

Cloudflare's Numbers - 31%

12 Month Time Series



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12 Month Time Series

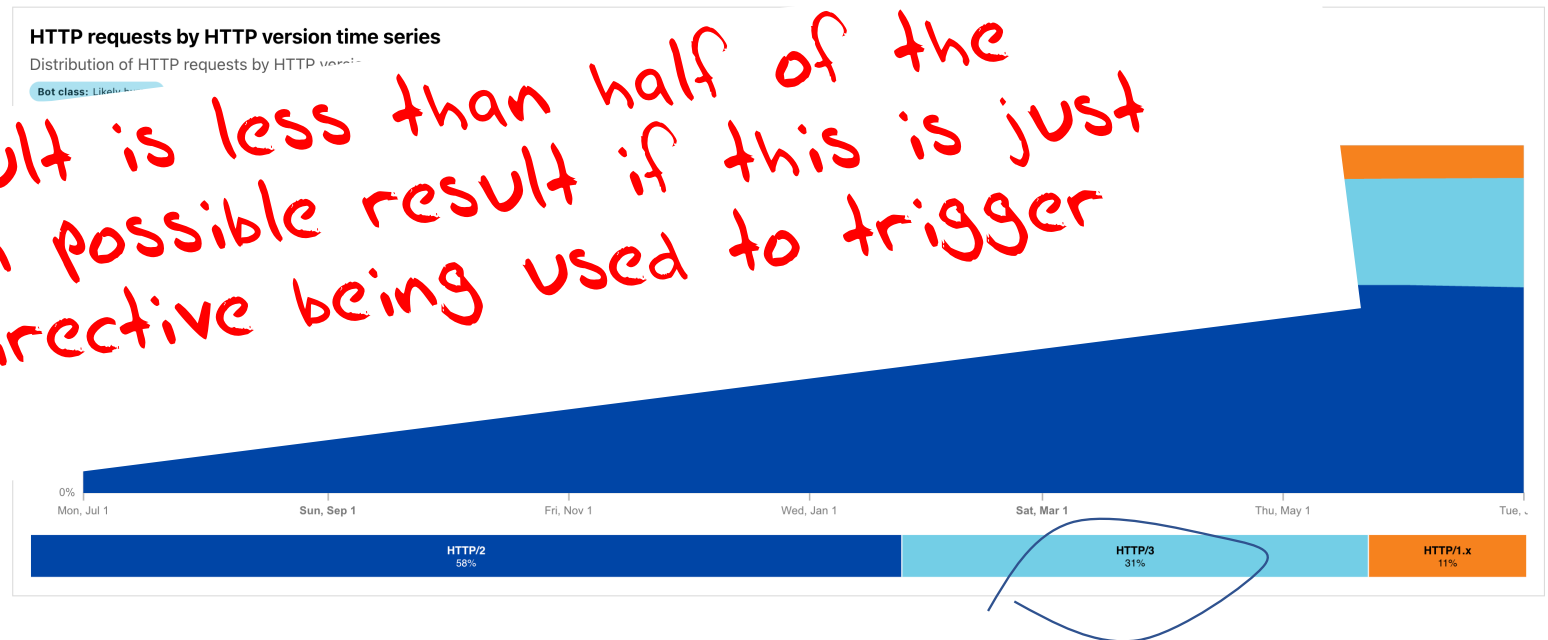


HTTP requests by HTTP version time series

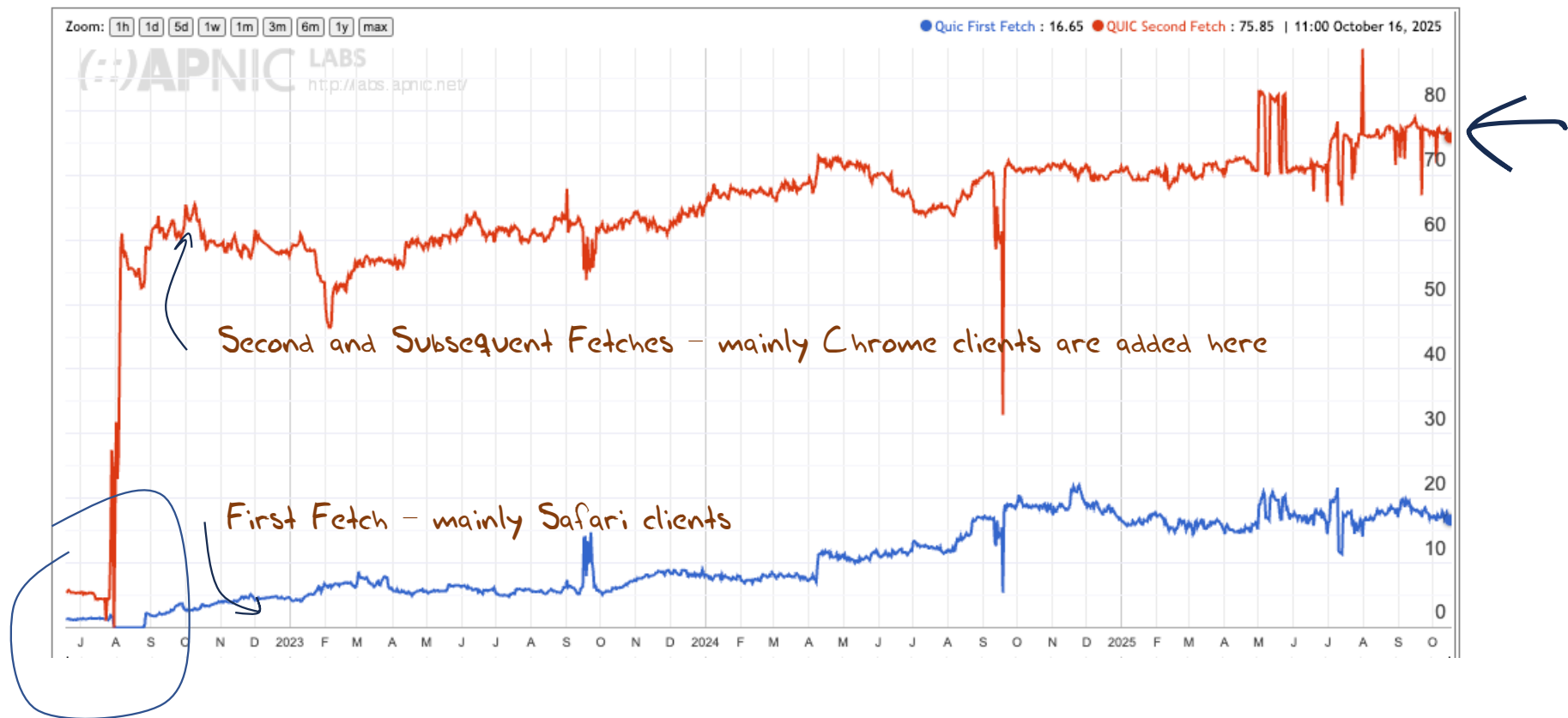
Distribution of HTTP requests by HTTP version

Bot class: Likely

That result is less than half of the maximum possible result if this is just alt-svc directive being used to trigger QUIC



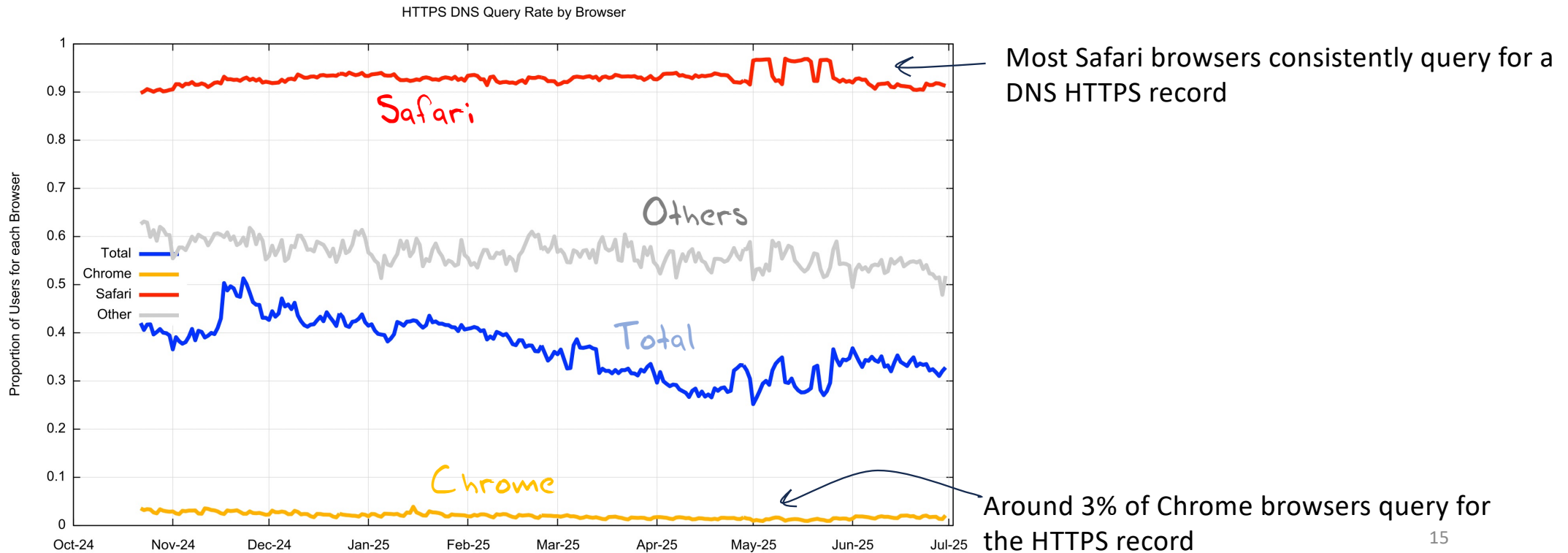
APNIC's Numbers - 75%



Playing with keepalive parameters!

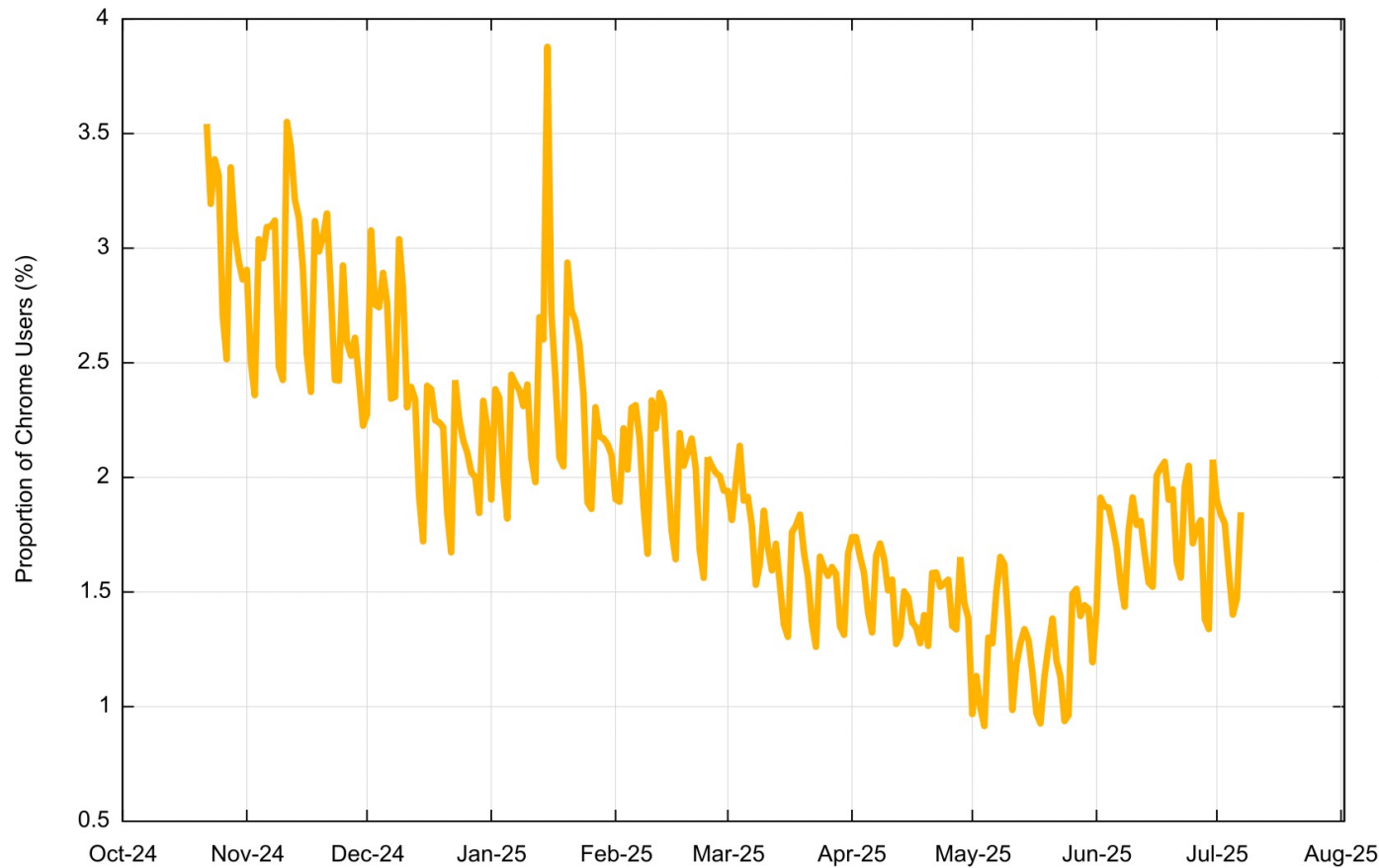
Method 2 - DNS HTTPS Query Rate

How many users are generating DNS HTTPS Queries?



Chrome Browser HTTPS Query Rate

DNS HTTPS Daily Query Rate for Chrome Browser

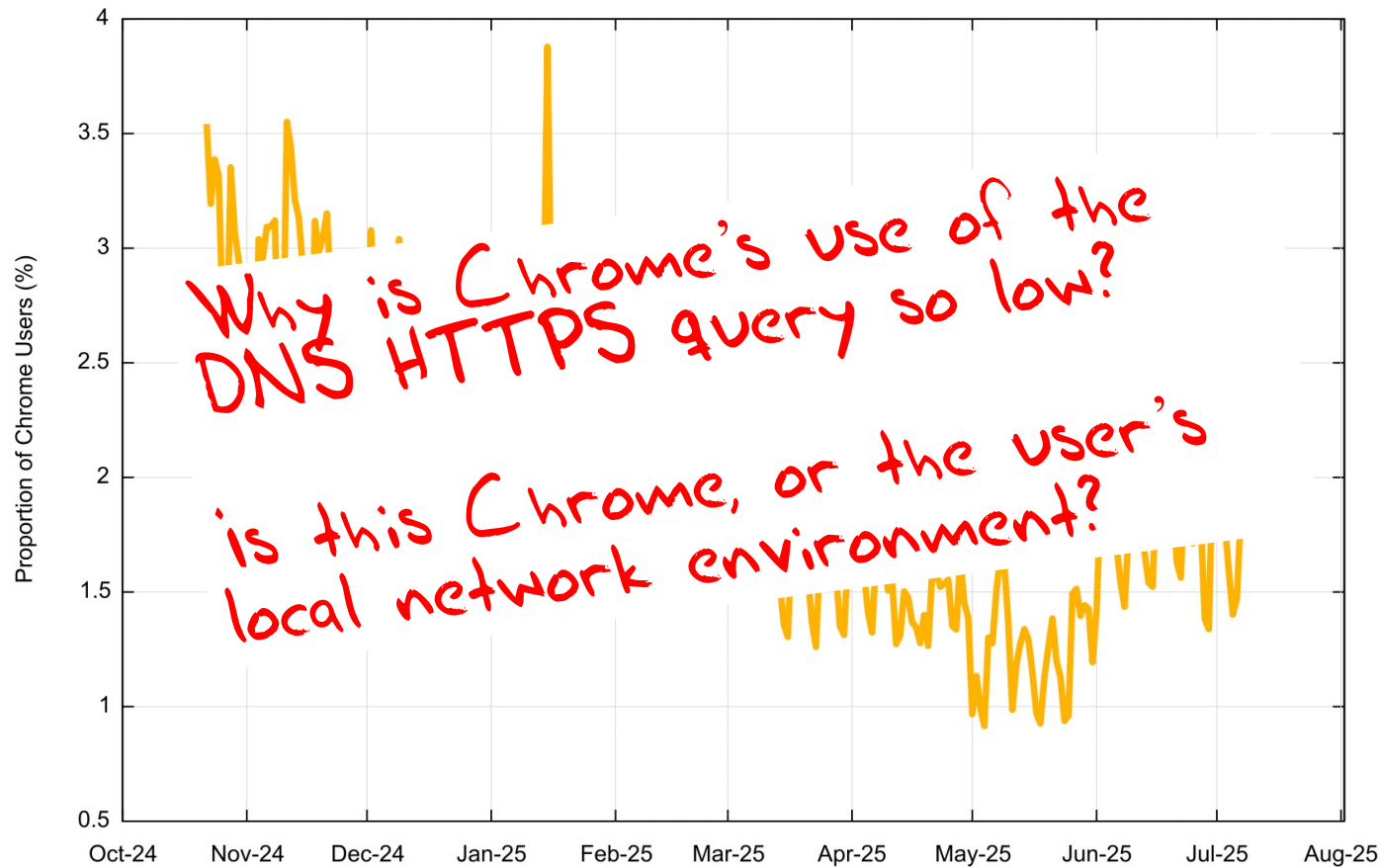


There is a strong weekly pattern in this data where weekend query rates are lower than weekday query rates

Query rates halved between October 2024 and May 2025, then rose across June 2025

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DNS HTTPS Daily Query Rate for Chrome Browser



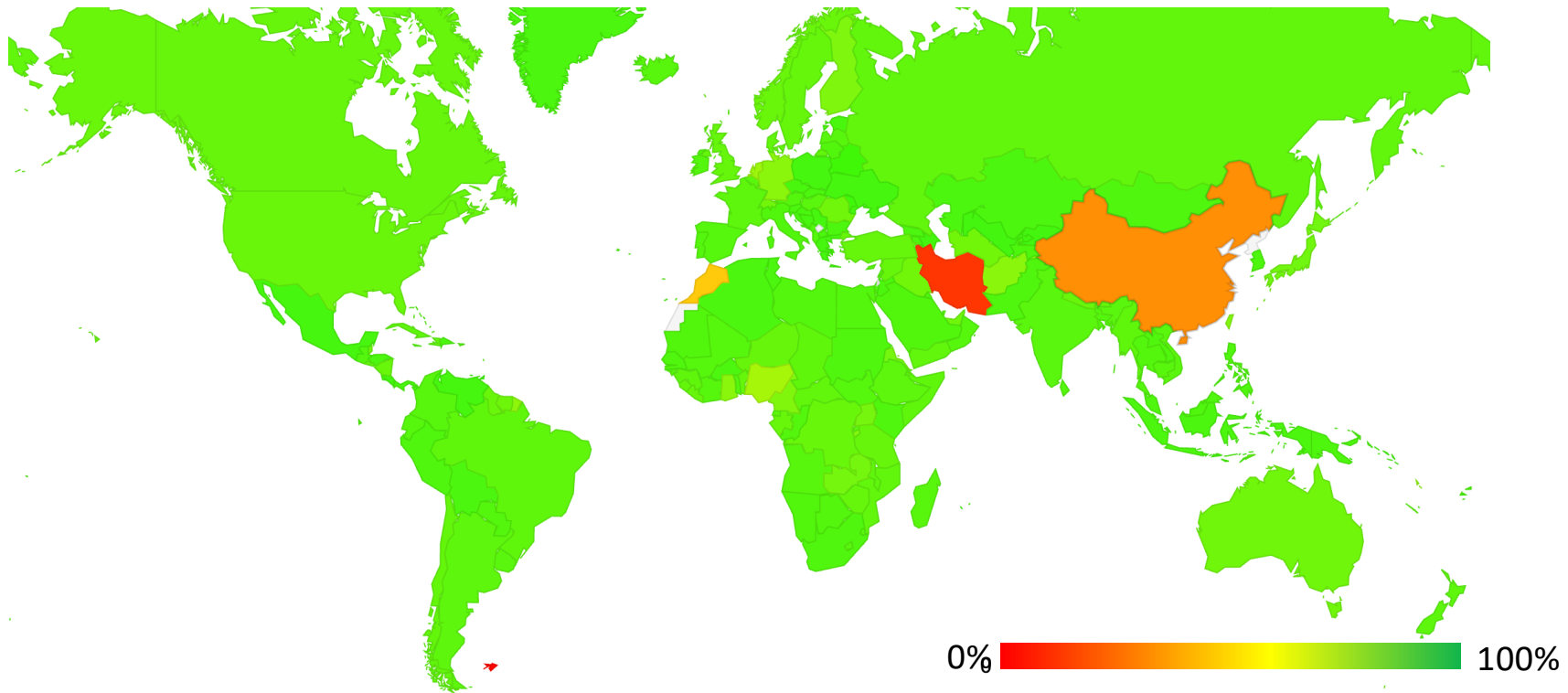
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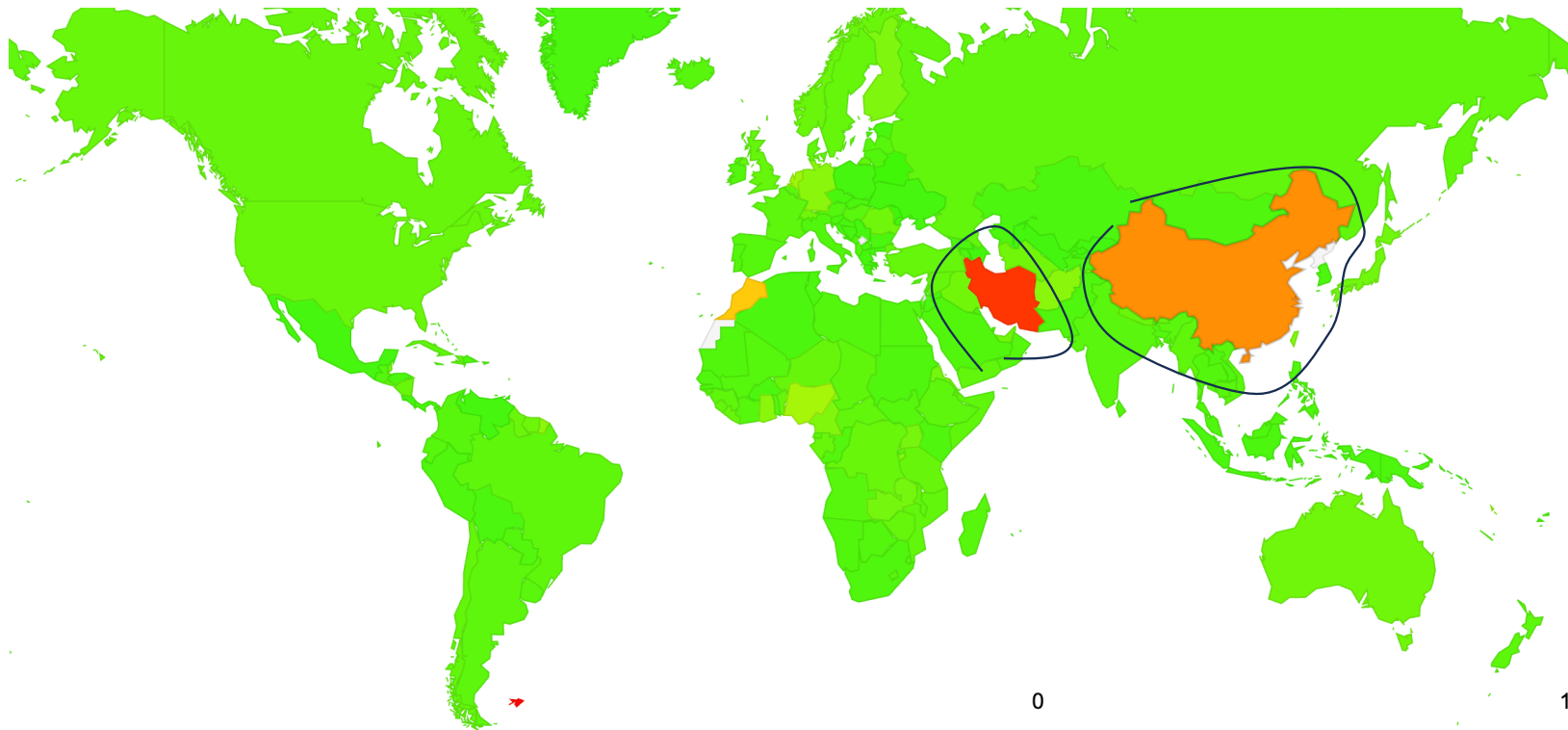
QUIC Use

- If QUIC access is supported by the current releases by both the major browsers, then we should see a high QUIC use rate when the ability to use QUIC is signaled by both methods (alt-svc and DNS HTTPS)
- What do we see?

Global QUIC Use



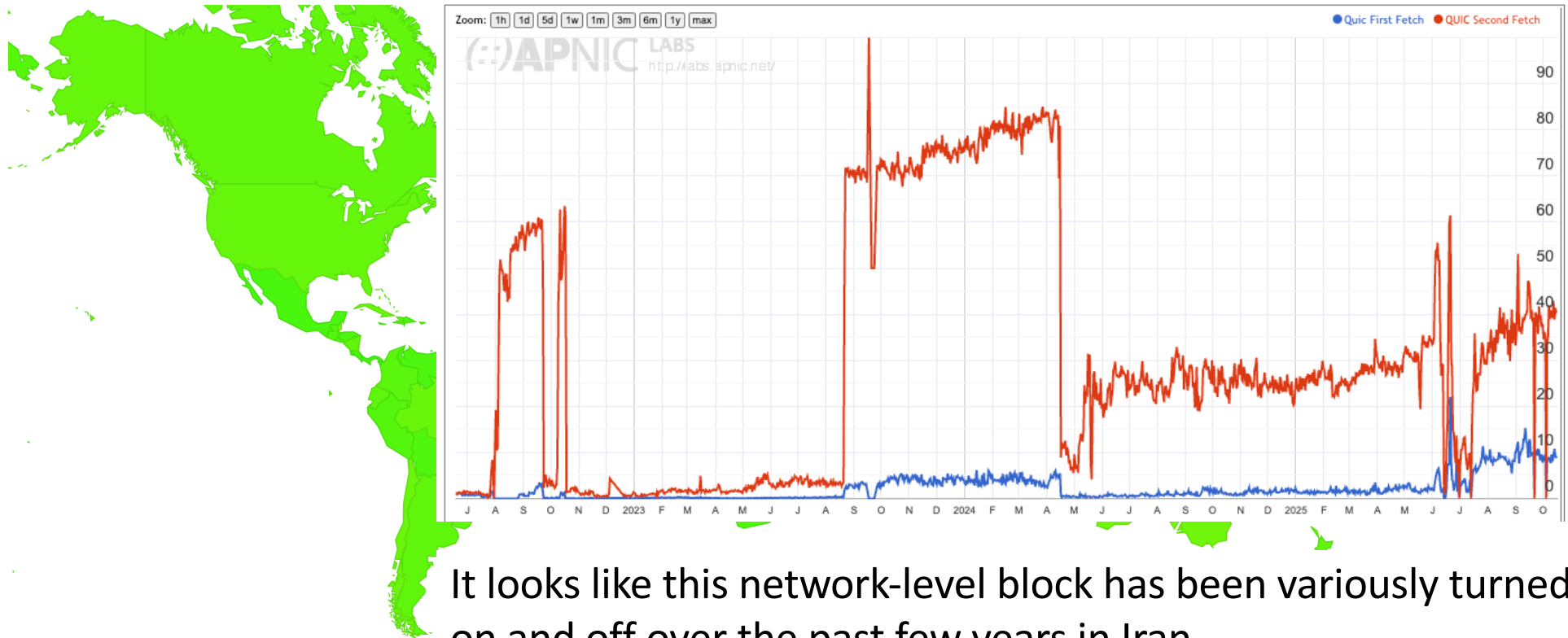
Global QUIC Use



Is there some form of national-level block on UDP port 443 traffic in China and Iran?

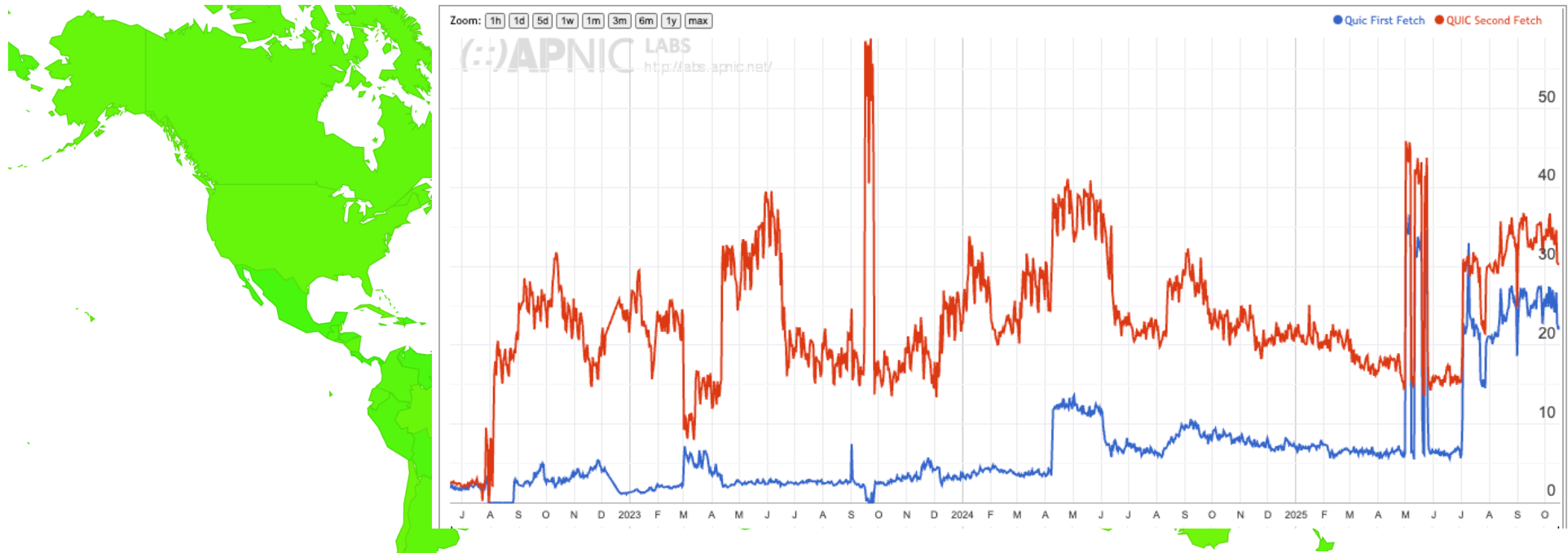
Global QUIC Use

Use of HTTP/3 for Iran (Islamic Republic of) (IR)



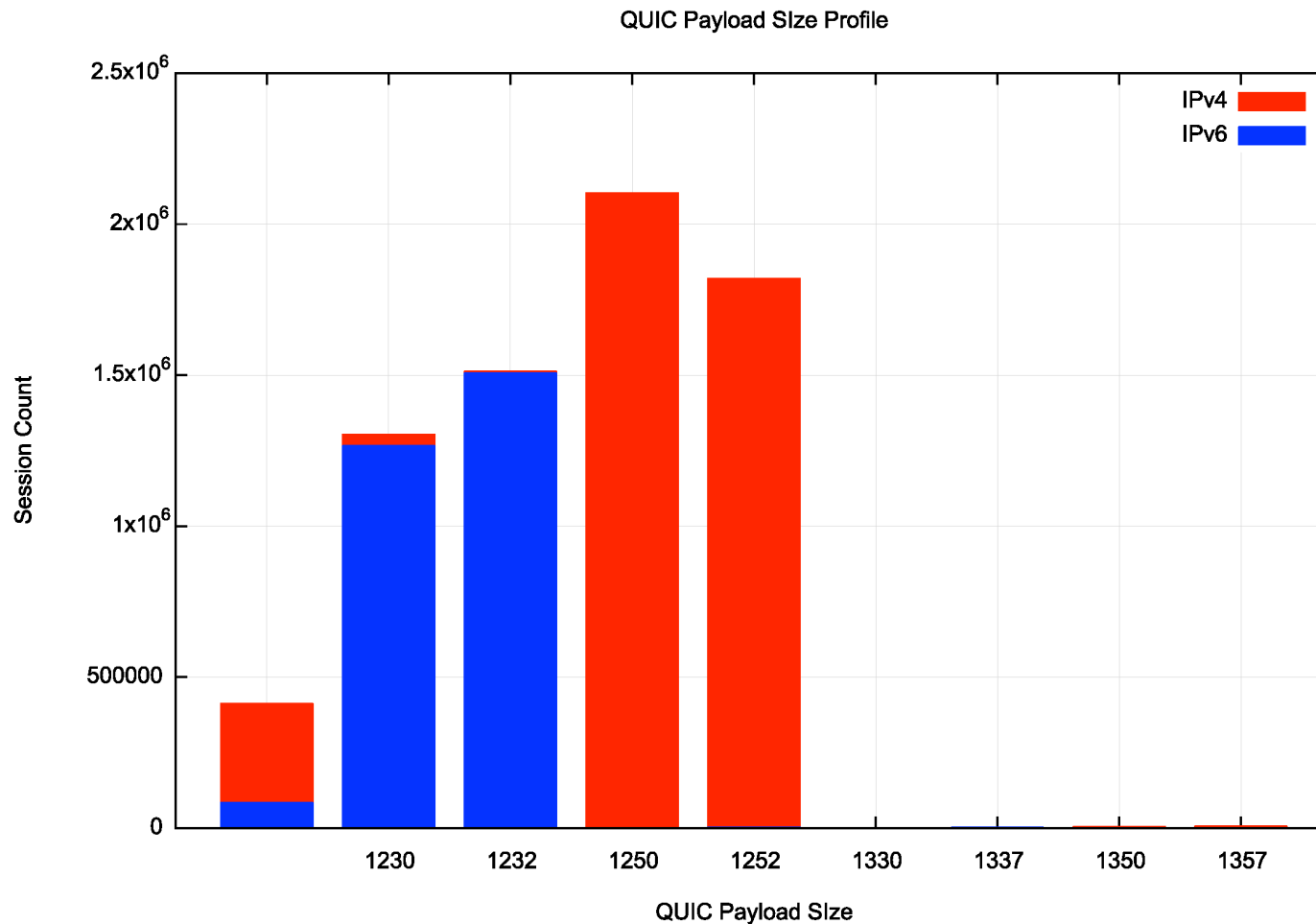
Global QUIC Use

Use of HTTP/3 for China (CN)



It looks like there is some form of network-level block operating in China, but its effects are not uniform across all China's networks

QUIC Payload Sizes



This data has been collected from a single day of measurement (4/6/25)

This disparity between V4 and V6 appears to reflect a popular implementation's design choice to aim at an IP MTU of 1,280 bytes

QUIC Use

- If QUIC access is supported by the current releases by both the major browsers then we should see a high QUIC use rate when the ability to use QUIC is signaled by both methods (alt-svc and DNS HTTPS)
- What do we see?
- In most locales the **alt-svc** method of triggering QUIC is supported by browsers and network infrastructure
- What about the DNS HTTPS method of triggering QUIC?
 - Who uses a DNS HTTPS query?
 - Are HTTPS responses being filtered by DNS infrastructure in some cases?

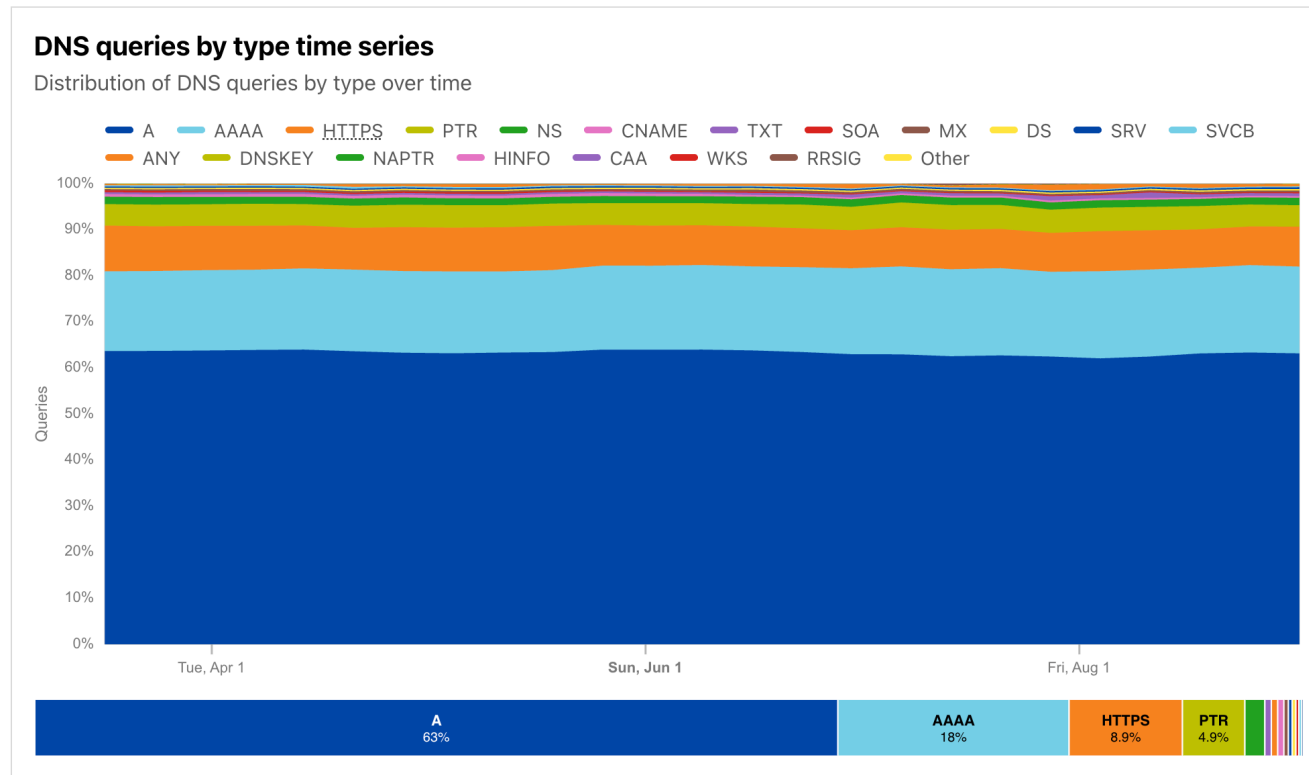
The DNS HTTPS record

- The HTTPS record can also contain **ipv4hint** and **ipv6hint** attributes
- Any A and AAAA records for a name will be used by a client in preference to these hint attributes
- But if there is no A and no AAAA record in the zone, then a HTTPS-aware client will be forced to use these address hint attributes
- Let's try that, and allow the client to use either HTTP/2 OR HTTP/3:

```
test_name      IN      HTTPS  1      .      alpn="h2,h3" ipv4hint=192.0.2.1 ipv6hint=2001:db8::1
```

DNS HTTPS Use Rate

How many users actually generate DNS HTTPS queries?



DNS Query Data from
Cloudflare Radar

A – 63%

AAAA – 18%

HTTPS – 8.9%

DNS HTTPS Use Rate

How many users can use DNS HTTPS responses?

Data collected over a 24-hour period (7/7/2025)

	All			Chrome			Safari			Others	
Samples	13,177,108			9,487,295			3,602,160			87,653	-
DNS HTTPS Query	3,708,895	28.1%		157,695	1.7%		3,506,664	97.3%		44,536	50.8%
Web Fetch (h2/h3)	3,480,873	26.4%		5,957	0.1%		3,469,867	96.3%		5,049	5.8%
Web Fetch (QUIC)	2,710,668	20.6%		4,793	0.1%		2,701,516	75.0%		4,359	5.0%



Few Chrome users (1.7%) perform an HTTPS query, and even fewer (0.1%) followup with a fetch of the web object.

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Why is Safari not using QUIC in 25% of cases?

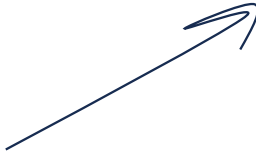
Most Safari users (97.3%) perform an HTTPS query, and most (96.3%) followup with a fetch of the web object. Fewer users (75%) prefer to use QUIC to perform web object retrieval when given the choice.

Does Safari also use alt-svc?

How many users can use QUIC when there is only an **alt-svc** directive and **no** DNS HTTP record?

Data collected over a 24-hour period (10/7/2025)

	All			Chrome			Safari			Others	
Samples	14,163,673			9,788,178			4,251,430			124,065	
TCP First Fetch	14,055,816	99.2%		9,787,962	100.0%		4,151,937	97.7%		115,917	93.4%
QUIC First Fetch	107,857	0.8%		216	0.0%		99,493	2.3%		8,148	6.6%
QUIC 2nd Fetch	9,183,332	64.8%		8,966,915	91.6%		122,086	2.9%		94,331	76.0%



Most Chrome users (91.6%) perform a QUIC retrieval on the subsequent fetch.



Few Safari users (2.9%) perform a QUIC retrieval in the subsequent fetch, indicating that the browsers are NOT following the alt-svc directive

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No, Safari does not appear to use the alt-svc directive

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Conclusions/Questions

- If you want to serve content over QUIC you have to support BOTH QUIC trigger methods of a DNS HTTP record AND an alt-svc directive to signal QUIC capability to Chrome and Safari clients.
- Why doesn't Chrome also use the HTTPS query?
 - Are they concerned about the greater DNS query load that would result from such a change?
- Why doesn't Safari also use the alt-svc directive?
- Why do 24% of Safari users NOT perform a QUIC fetch despite a HTTPS record being queried?
- Why do 2% of Safari users perform an initial QUIC fetch when there is no DNS HTTPS trigger?

Thanks!