

# Lightning-Fast Web Performance

Scott Jehl, WebPageTest Team



**WebPageTest**  
by catchpoint<sup>®</sup>

# Course Agenda

1. Introduction
2. Why Performance Matters
3. **Metrics! How do we define fast?**
4. Identifying Performance Problems
5. Making Things Faster
6. Wrapping Up

Metrics.

**How do we define fast?**

**Time to First Byte**

**Fully Loaded**

**Document Complete**

**First Paint**

**First Contentful Paint**

**Speed Index**

**Page Weight**

**Time To Interactive**



## User-centric performance metrics



When a user navigates to a web page, they're typically looking for visual feedback to reassure them that everything is going to work as expected.

**Is it happening?** Did the navigation start successfully? Has the server responded?

**Is it useful?** Has enough content rendered that users can engage with it?

**Is it usable?** Can users interact with the page, or is it still busy loading?

**Is it delightful?** Are the interactions smooth and natural, free of lag and jank?

To understand when a page delivers this feedback to its users, we've defined several new metrics:

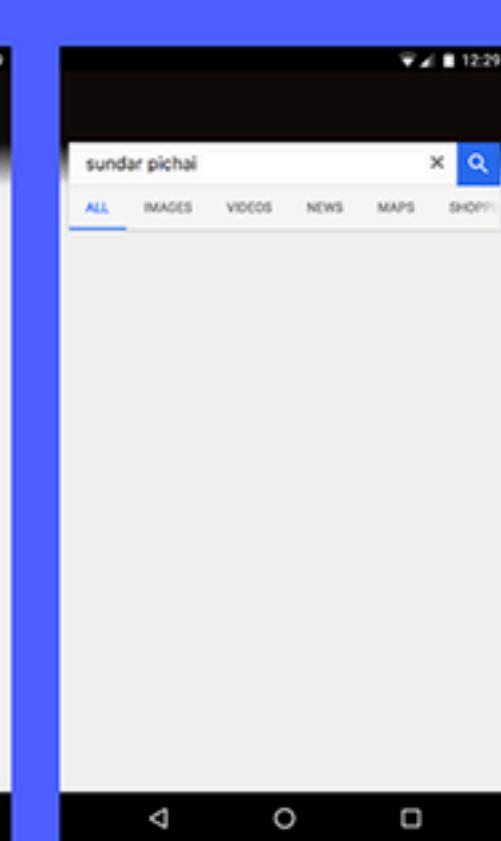


"Is it happening?"



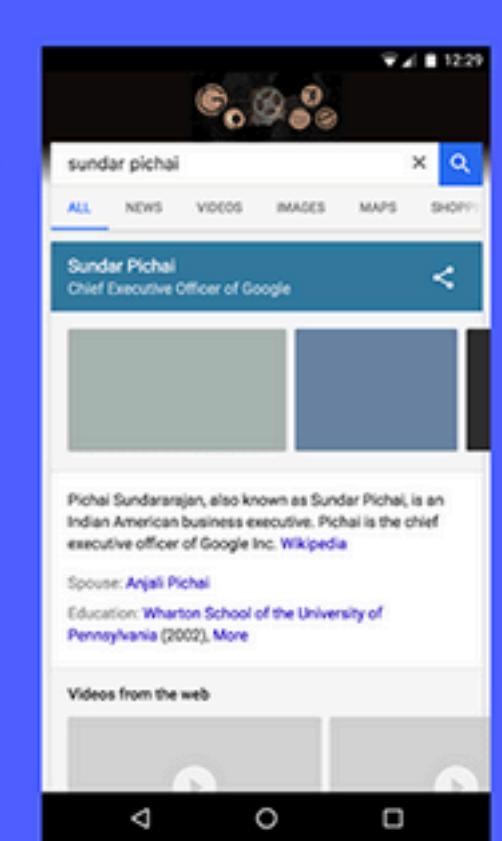
First Paint  
(FP)

"Is it useful?"



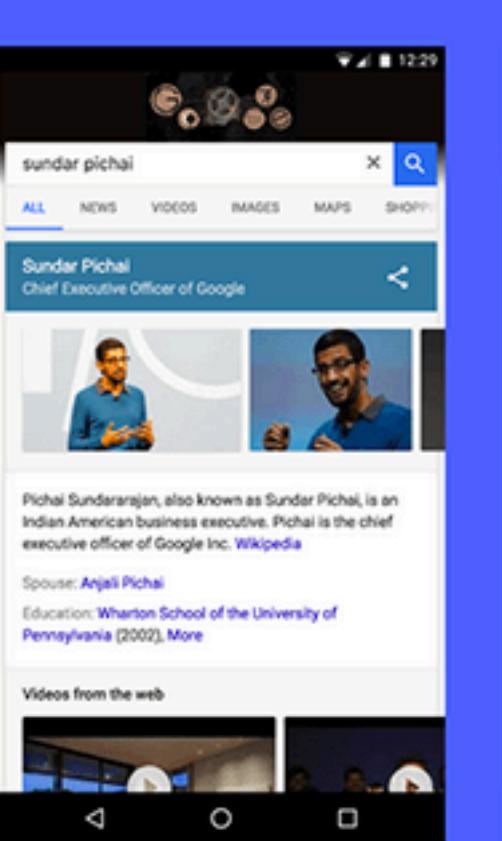
First Contentful  
Paint (FCP)

"Is it useful?"

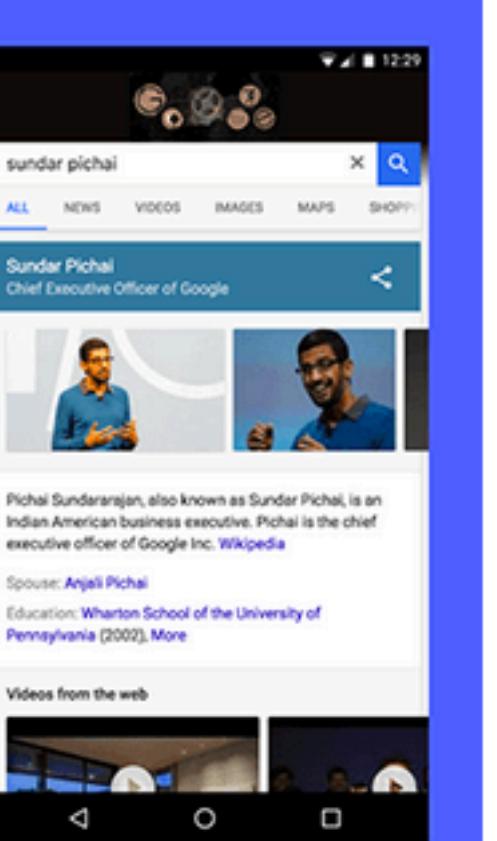


First Meaningful  
Paint (FMP)

"Is it usable?"



Time to  
Interactive (TTI)



DOMContent  
Loaded (DCL)

Fully  
(

..... Visually Complete (VC) .....



PageSpeed  
Insight #1



Key UX  
Factor



Key UX  
Factor



PageSpeed  
Insight #2



TTFB

# Time to First Byte

---

the time between clicking a link and the first bit of content coming in.

# What contributes to TTFB?

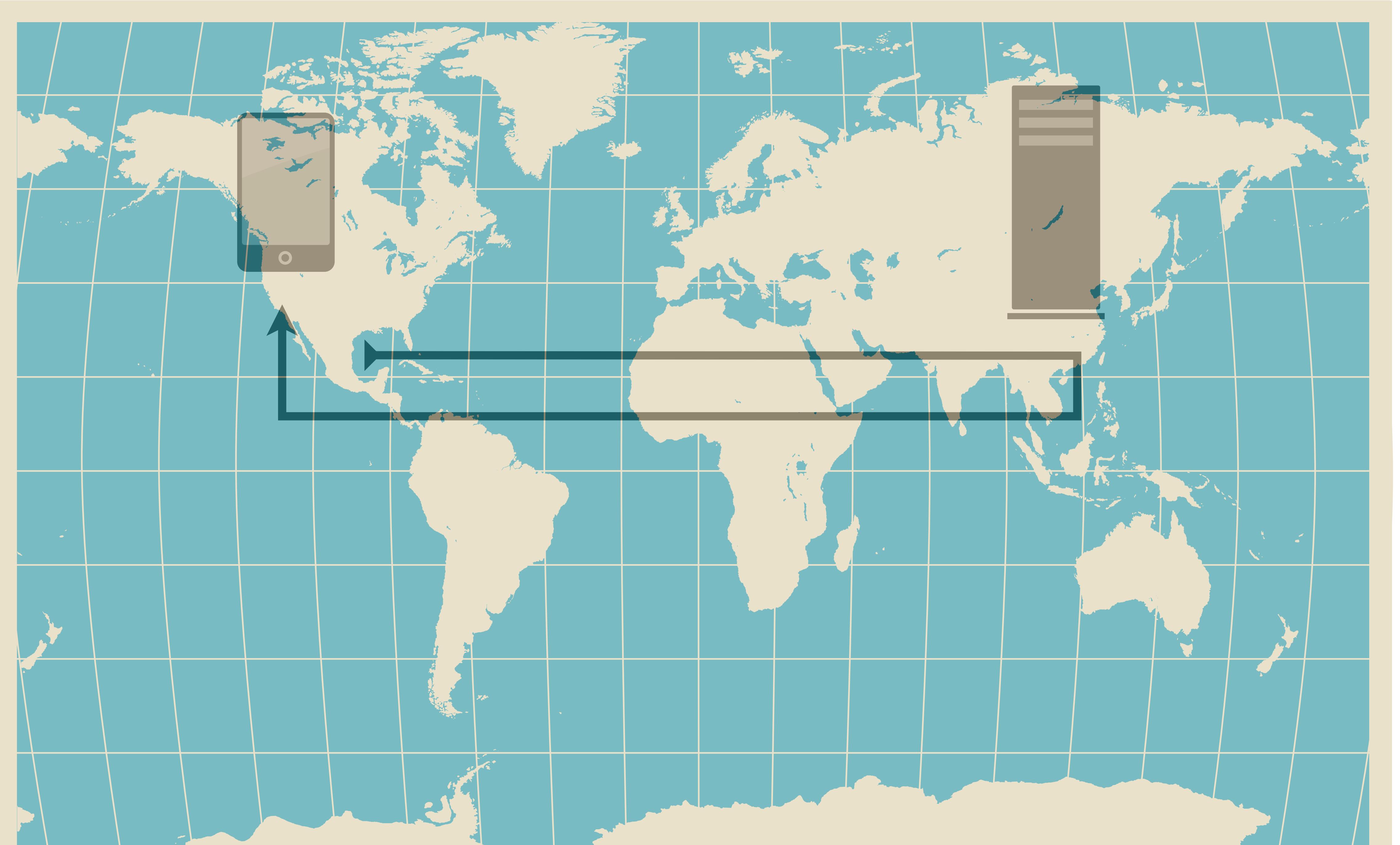
- Initial request to a website
- DNS resolution to a server's IP address
- Establish connection with the server
- Secure connection with the server
- Potential redirects
- Response

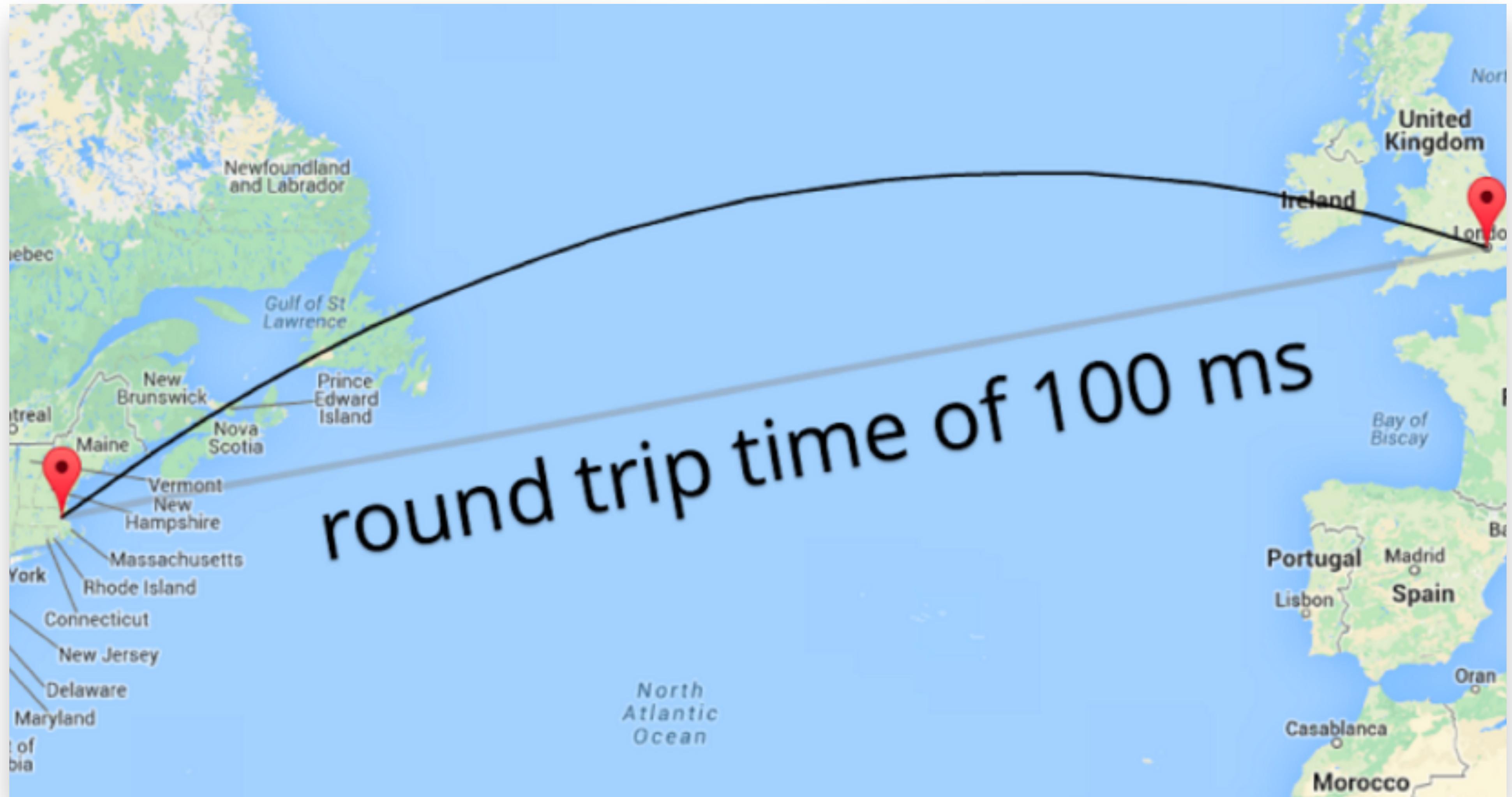
“  
when it comes to your web browsing  
experience, it turns out that **latency, not**  
**bandwidth**, is likely the constraining factor  
today.

Ilya Grigorik



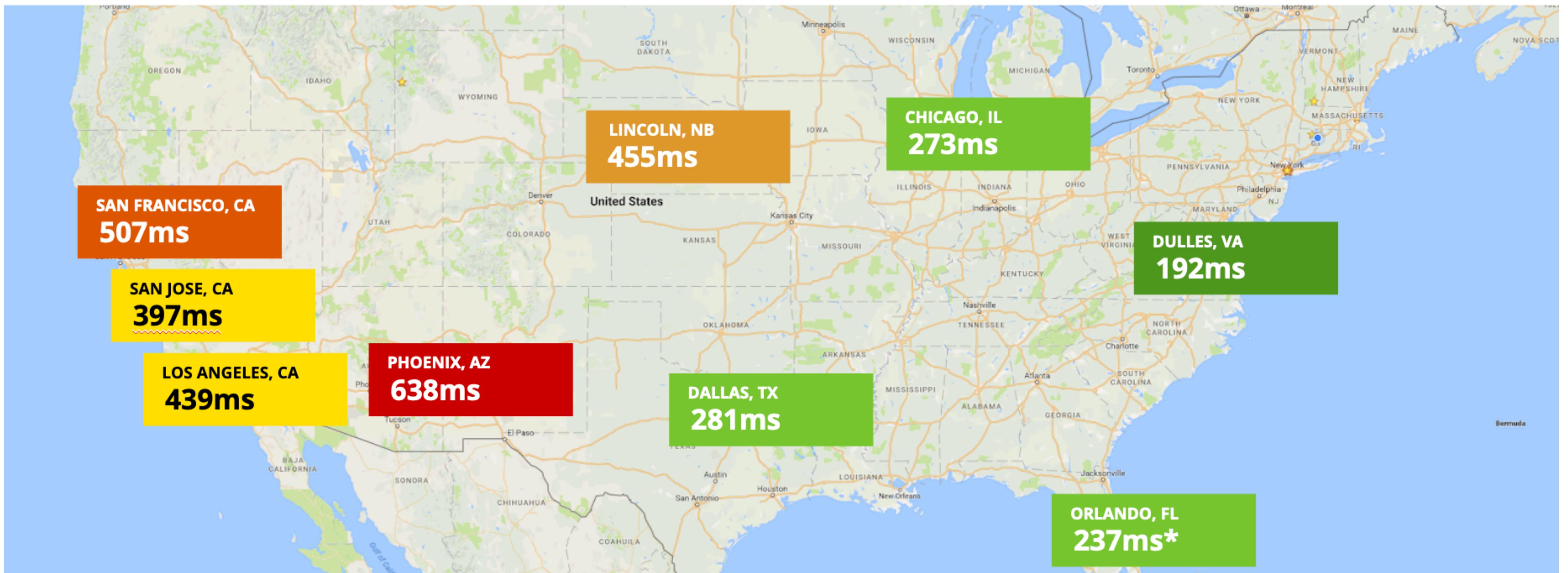
<https://www.igvita.com/2012/07/19/latency-the-new-web-performance-bottleneck/>





# Baseline HTML: Cable TTFB Timing

**Problem:** Server round trip time varies by geography



```
Scott:fgwebsite scottjehl$ ping filamentgroup.com
PING filamentgroup.com (45.55.52.167): 56 data bytes
64 bytes from 45.55.52.167: icmp_seq=0 ttl=54 time=114.374 ms
64 bytes from 45.55.52.167: icmp_seq=1 ttl=54 time=85.538 ms
64 bytes from 45.55.52.167: icmp_seq=2 ttl=54 time=94.589 ms
64 bytes from 45.55.52.167: icmp_seq=3 ttl=54 time=85.624 ms
64 bytes from 45.55.52.167: icmp_seq=4 ttl=54 time=84.436 ms
64 bytes from 45.55.52.167: icmp_seq=5 ttl=54 time=84.156 ms
64 bytes from 45.55.52.167: icmp_seq=6 ttl=54 time=84.339 ms
64 bytes from 45.55.52.167: icmp_seq=7 ttl=54 time=84.541 ms
64 bytes from 45.55.52.167: icmp_seq=8 ttl=54 time=84.145 ms
64 bytes from 45.55.52.167: icmp_seq=9 ttl=54 time=85.546 ms
^C
--- filamentgroup.com ping statistics ---
10 packets transmitted, 10 packets received, 0.0% packet loss
round-trip min/avg/max/stddev = 84.145/88.729/114.374/9.051 ms
Scott:fgwebsite scottjehl$
```

# Server time impacts on TTFB

- Generally, static pages need less server time
- Dynamic pages tend to use more server time

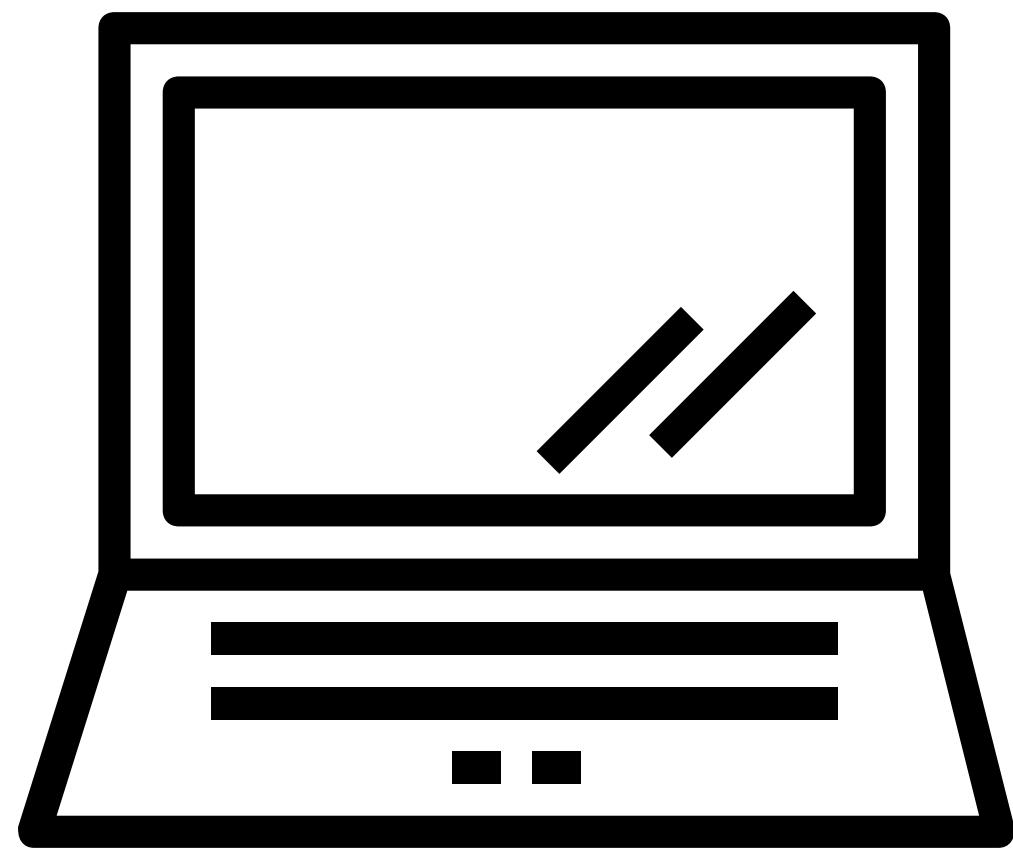
Every 3rd party request:  
**New connection process**

FP

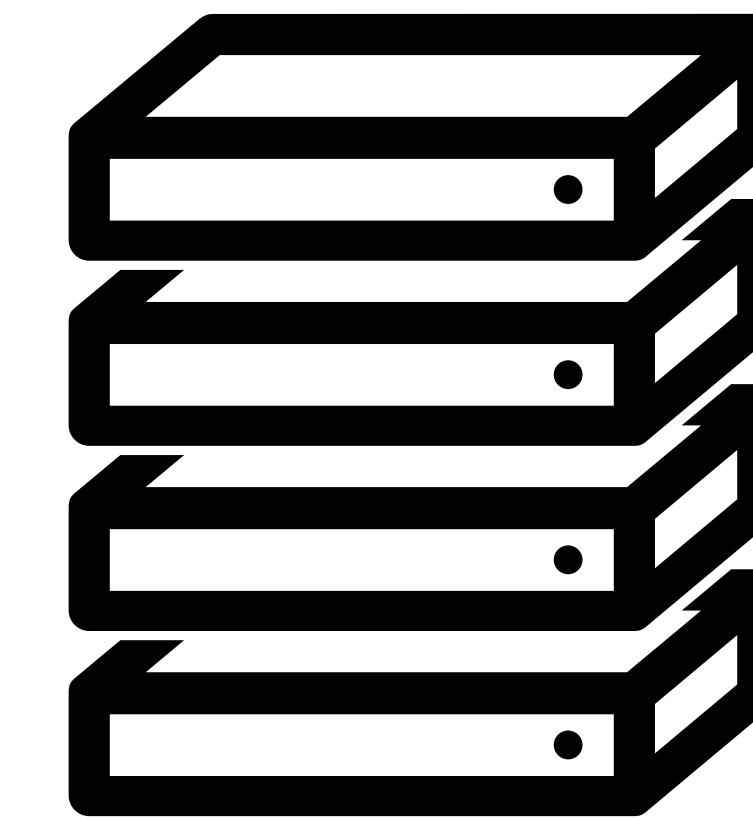
# First Paint

---

The first time pixels start to become visible to  
the user.



**Example.com please!**



**Sure! Here's the HTML first.**

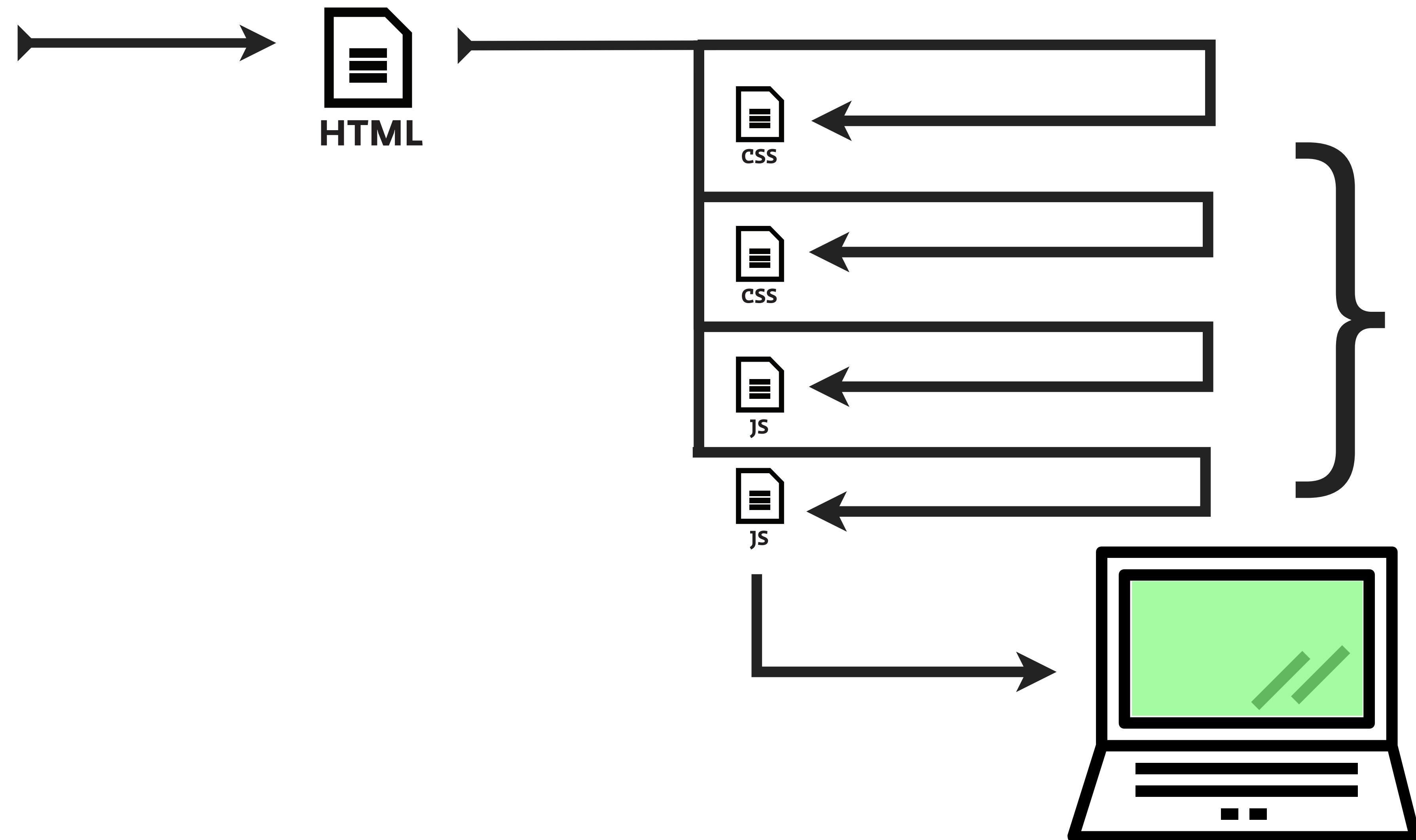
# The render blockers

```
<head>
```

```
  <link rel="stylesheet" href="site.css">
```

```
  <script src="site.js"></script>
```

```
</head>
```



**BLANK  
SCREEN**

**BLANK  
SCREEN**

TRENDS: Maximalism | New 'Harry Potter' | LaCroix | Mystery shipwreck | Motley

# Trump threatens escalating tariffs on Mexico

Today in politics

Top stories

ANALYSIS

Trump admitted something we knew, then took it back

LaCroix sales are in a 'free fall'

TOP STORIES

The President promises that the rising tariffs would stay in place until immigration flows are cut off

FMP

# First Meaningful Paint

---

The time when requested content (article body, etc) starts to render meaningfully.

LCP

# Largest Contentful Paint

---

The render time of the largest content element  
visible in the viewport.

## First Contentful Paint

The number of seconds from the time the navigation started until the page's primary content appears on the screen.

MEDIAN DESKTOP

**2.2 seconds**    **6.4 seconds**  
▼21.4%                      ▲33.3%

MEDIAN MOBILE

### Timeseries of First Contentful Paint



Source: [httparchive.org](http://httparchive.org)

Zoom

1m

3m

6m

YTD

1y

3y

All

From

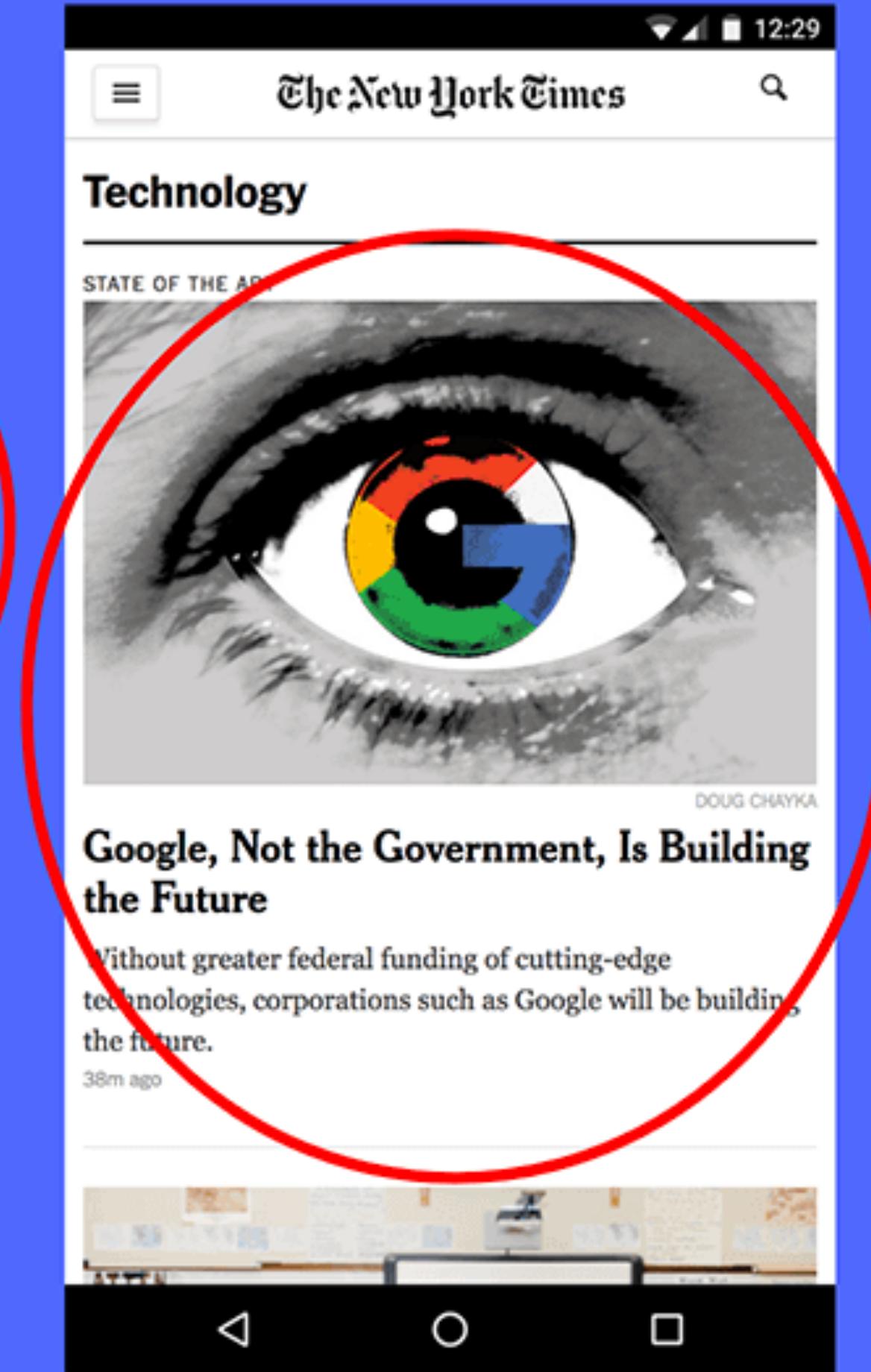
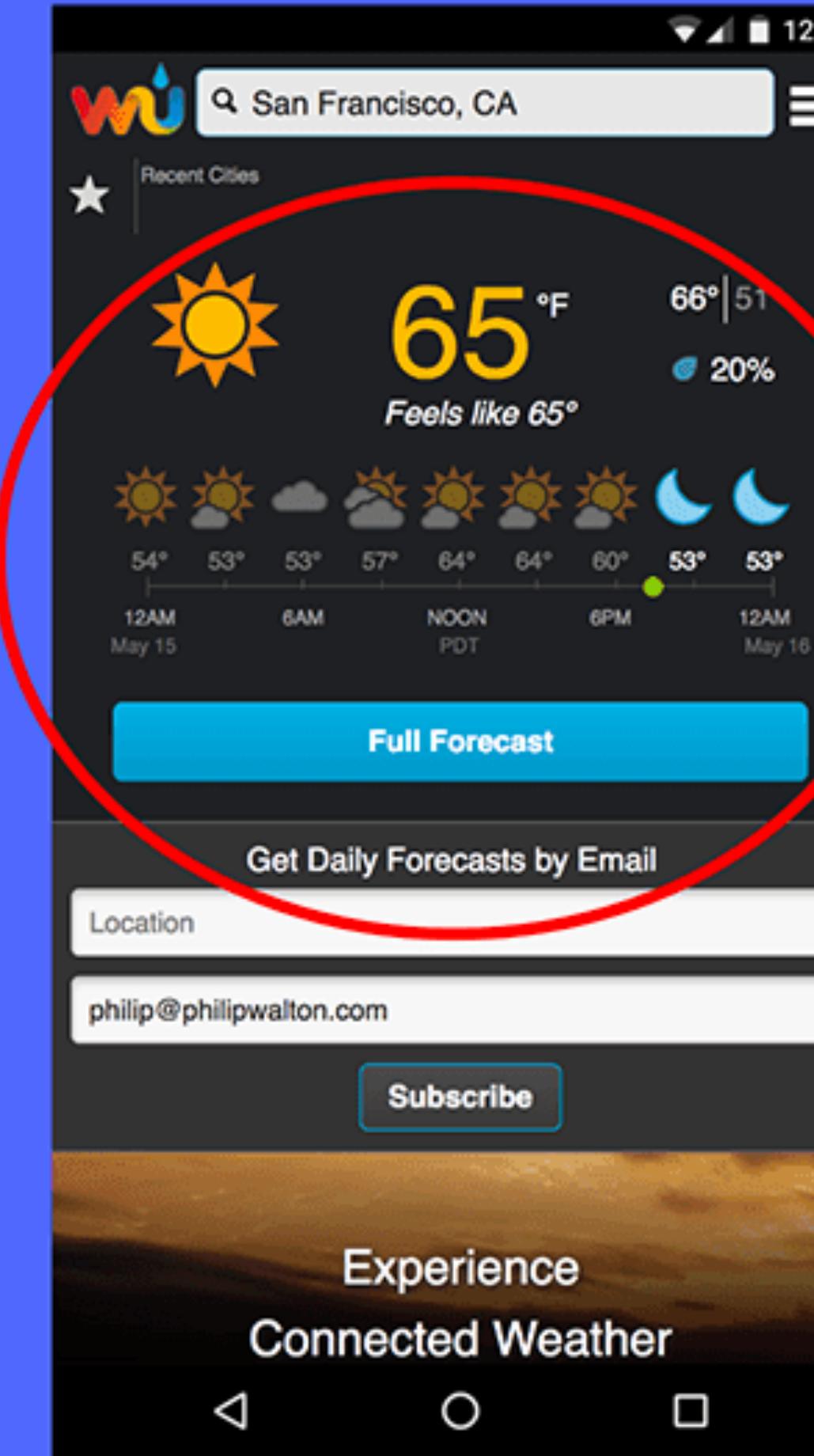
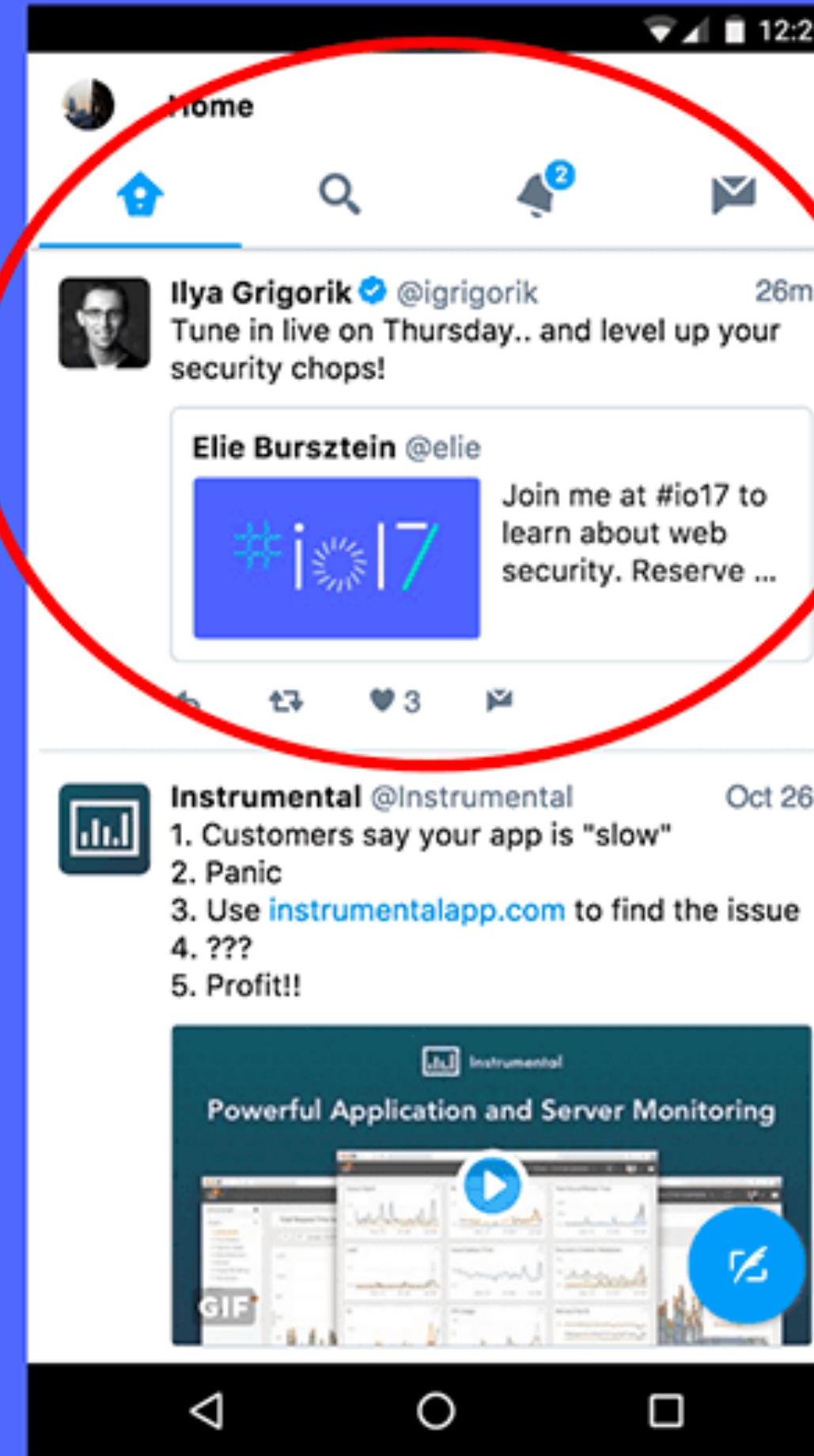
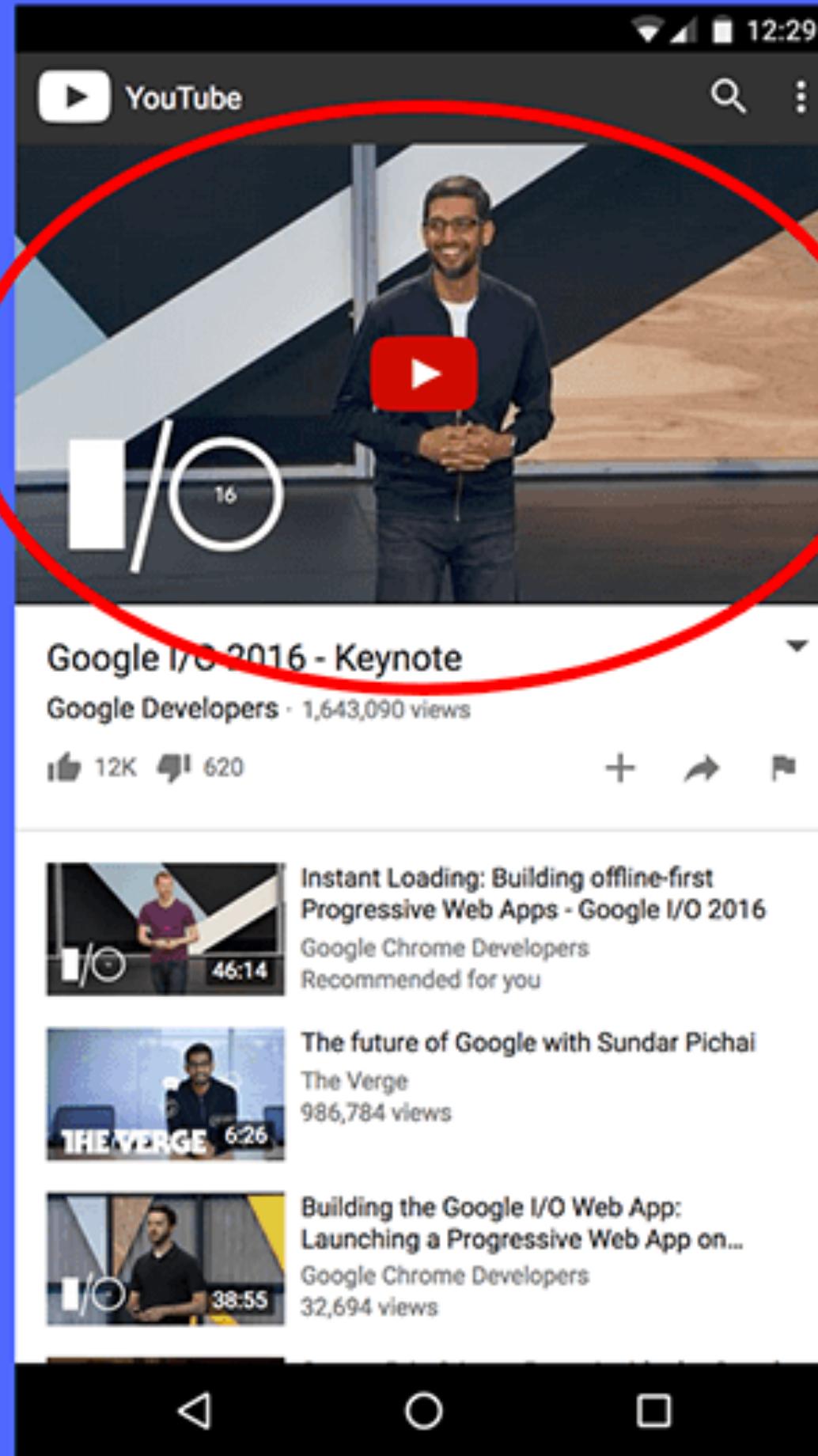
Jul 1, 2016

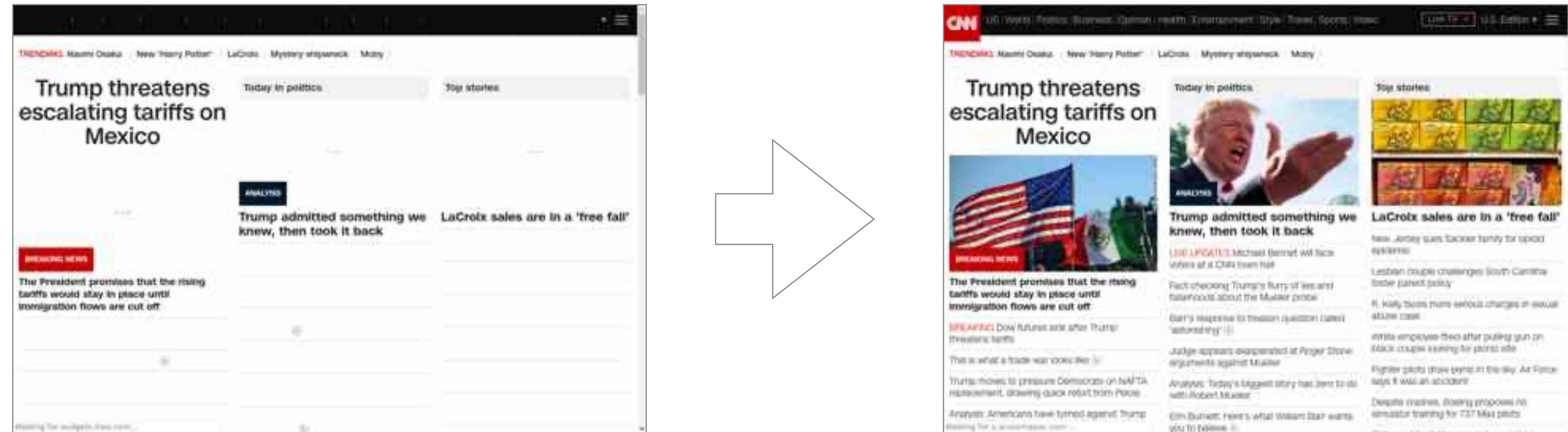
To

Jan 1, 2020



<https://httparchive.org/reports/loading-speed#fcp>





## Early Paints

**Key Probs:** fetching fonts and images sooner, and pre-rendered content

## Meaningful Paint

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**International Space Station**

**Jessica Glenza in New York**

✉ @JessicaGlenza

Fri 7 Jun 2019 12.53 EDT



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## Nasa to allow commercial access to the International Space Station

Move will allow private astronauts to spend up to 30 days in low-Earth orbit and businesses to shoot film and adverts in space



▲ Astronaut Christina Koch: 'Transitioning toward this new model of business is an important step to allow Nasa to move full speed ahead in landing the first woman and the next man on the moon.' Photograph: Handout ./Reuters

Nasa will allow unprecedented commercial access to the [International Space Station](#) (ISS) for marketing, business and space tourism, the agency announced on Friday.

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### most viewed in US



Zuckerberg's Hawaii estate: battle's latest turn 'devastates' local family



**Live** Djokovic halted by rain after Nadal beats Federer and Konta misses out on final - as it happened



'Straight pride' group removes Brad Pitt as mascot after backlash



Teenagers held over homophobic attack on two women on London bus

# Data URIs: often blocky as well.

```
</script>



**Scott Jehl** @scottjehl · 6m

I was curious how long browsers these days will wait for a JavaScript file to load before displaying content that comes after it in the page. So I tested it!

Chrome: 30s

Firefox: 30s

Edge: 20s

IE 11: 7s

Safari: 60s

Android Chrome: 63s

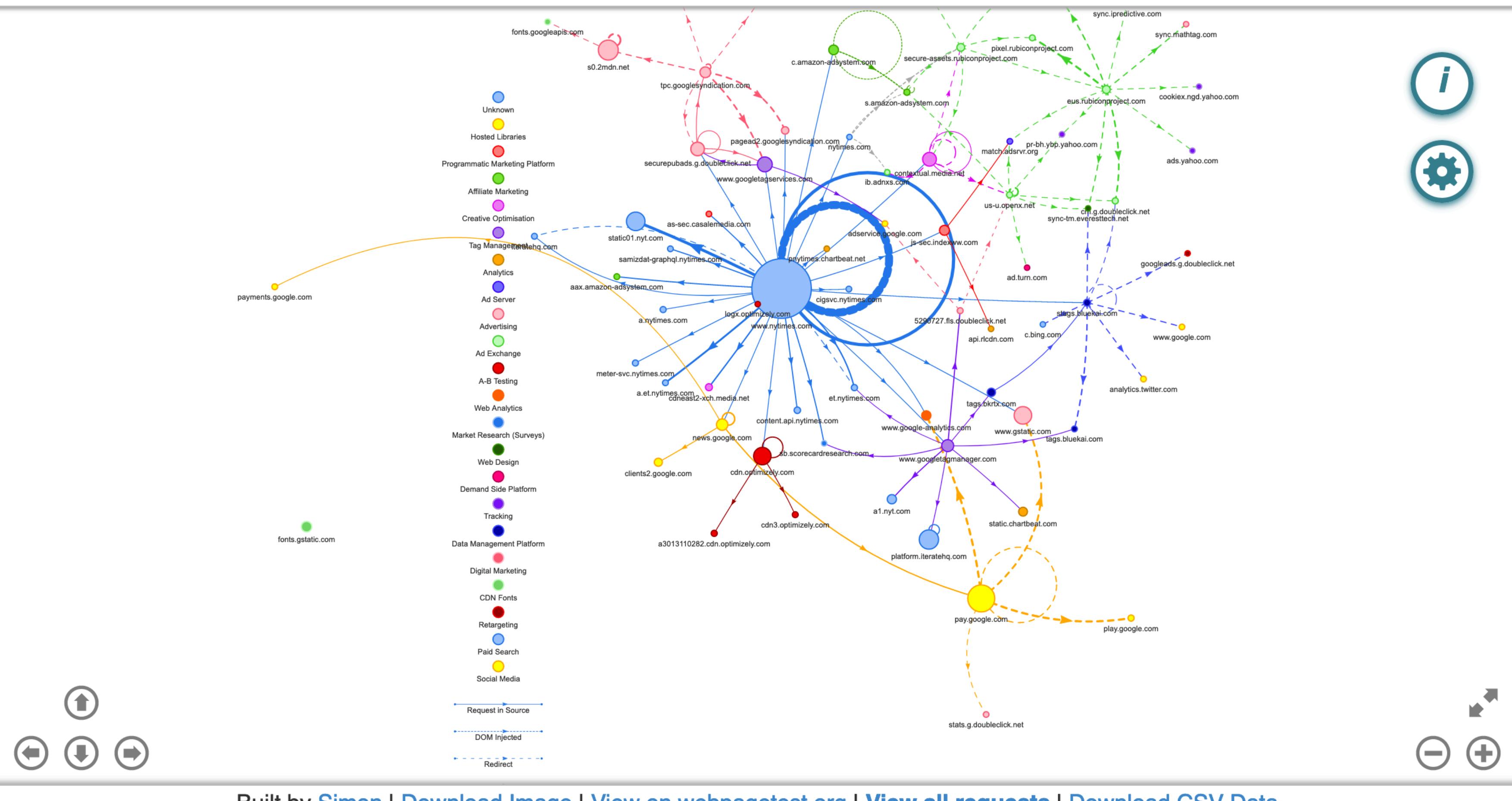
iOS: 75s

Test runs [tinyurl.com/swngjl3](https://tinyurl.com/swngjl3)



<https://twitter.com/scottjehl/status/1229275920600649728>

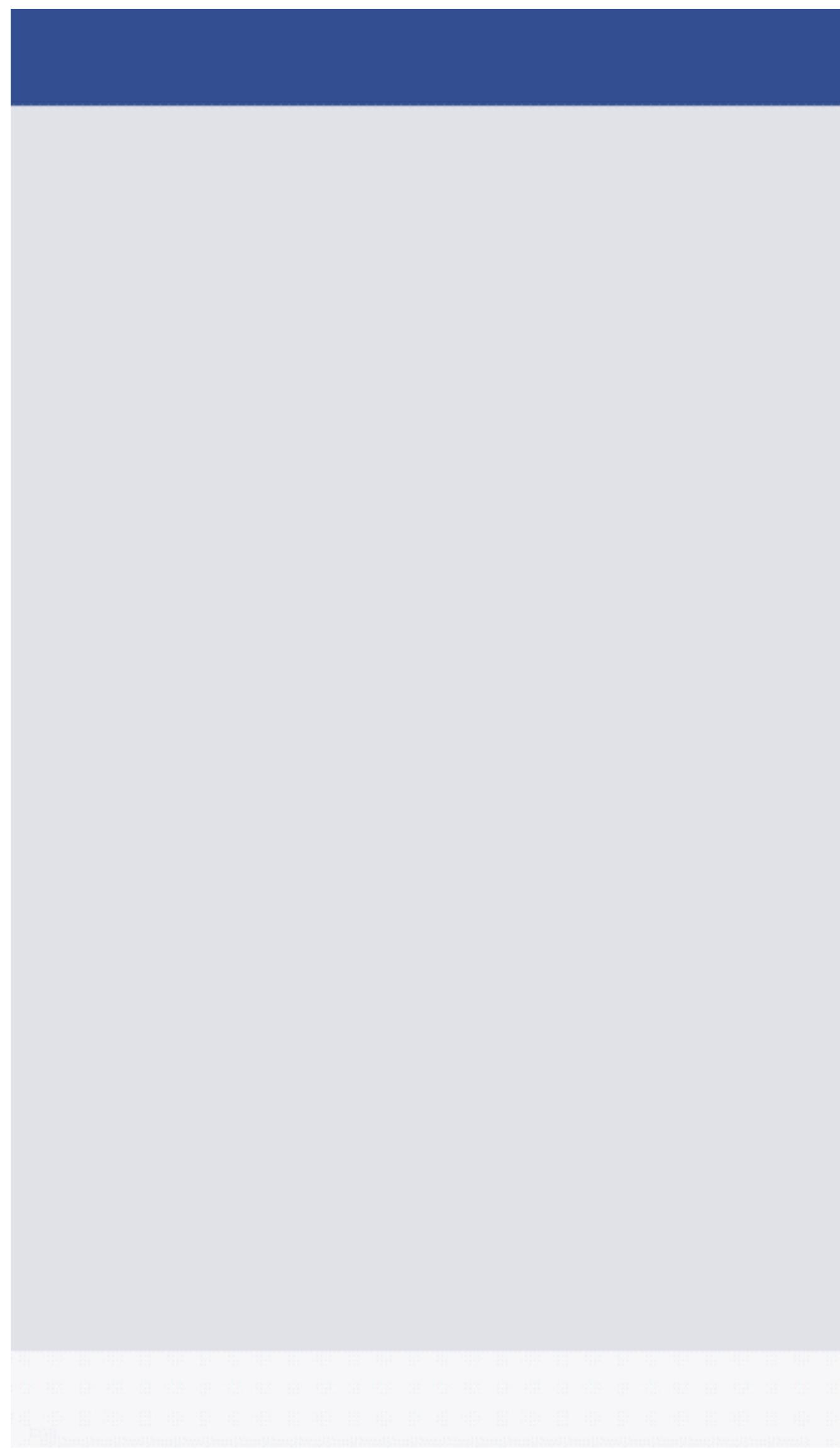
## Request Map for <http://nytimes.com> on Tuesday the 21st of May at 11pm

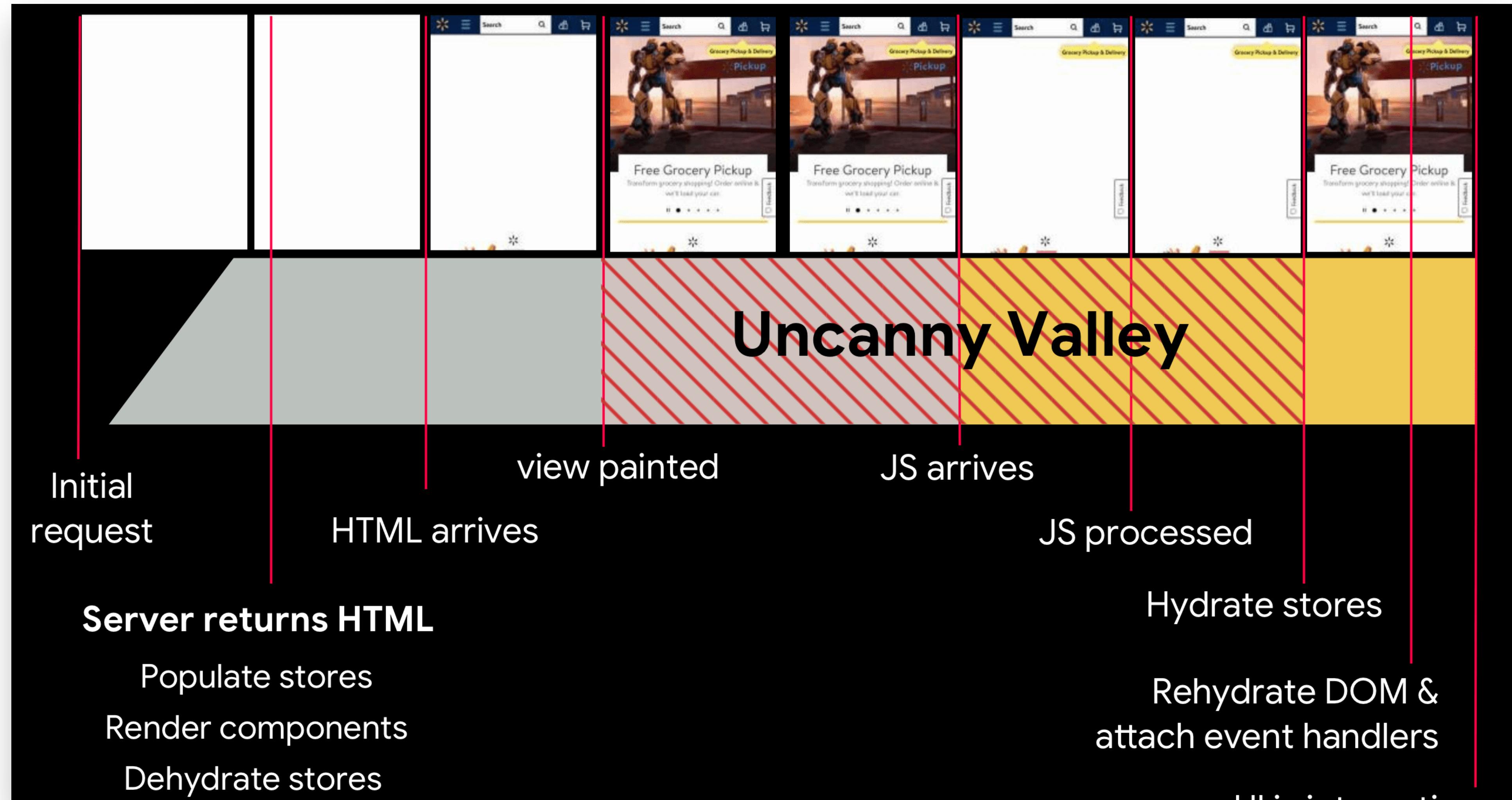


[http://requestmap.webperf.tools/render/190521\\_J6\\_a6cad51d836873feba5c4ecc29824feb](http://requestmap.webperf.tools/render/190521_J6_a6cad51d836873feba5c4ecc29824feb)

# Dynamic Scripts can block render

```
document.write('<script src="hello.js"></script>');
```





TTI

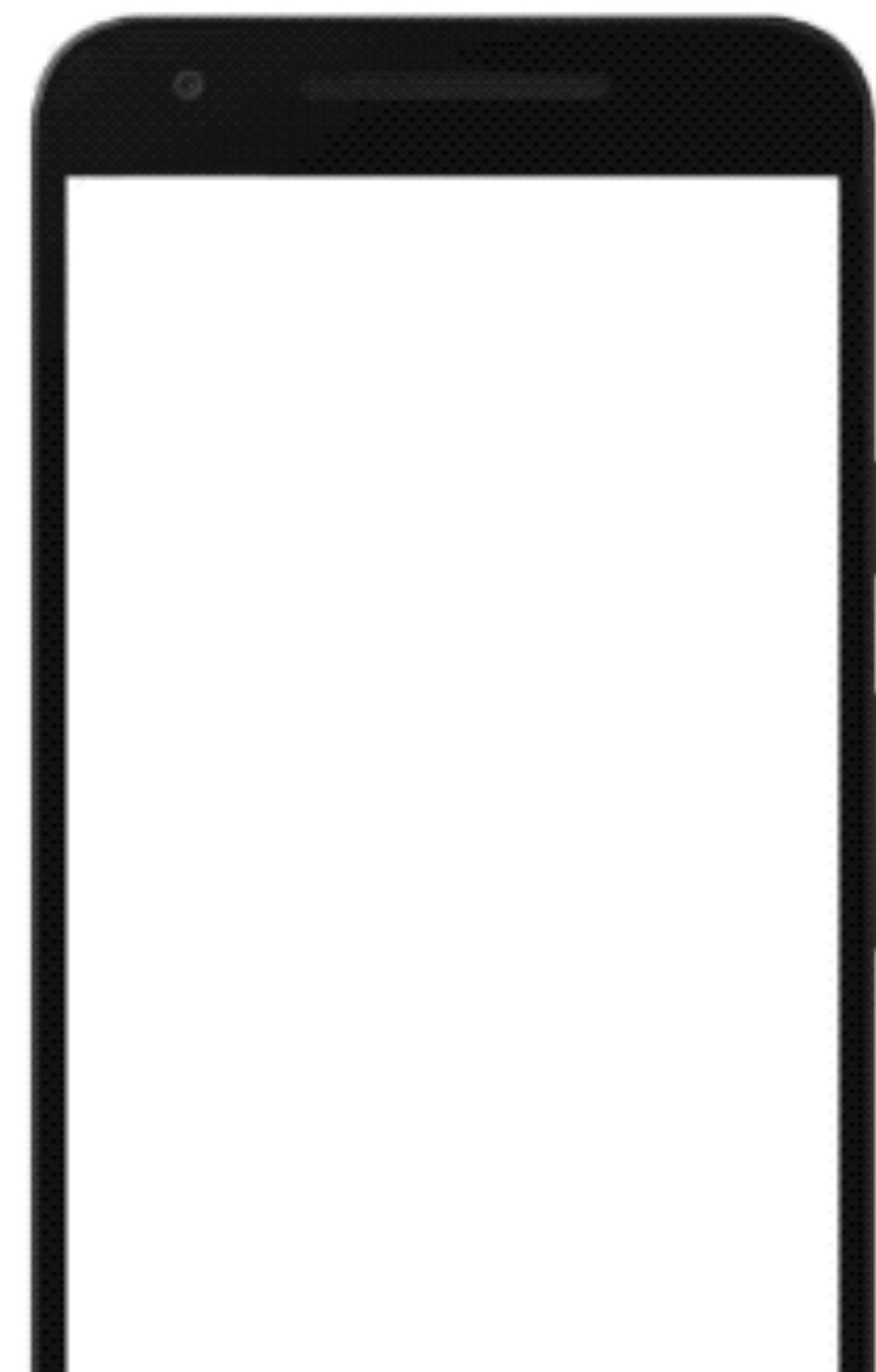
# Time To Interactive

---

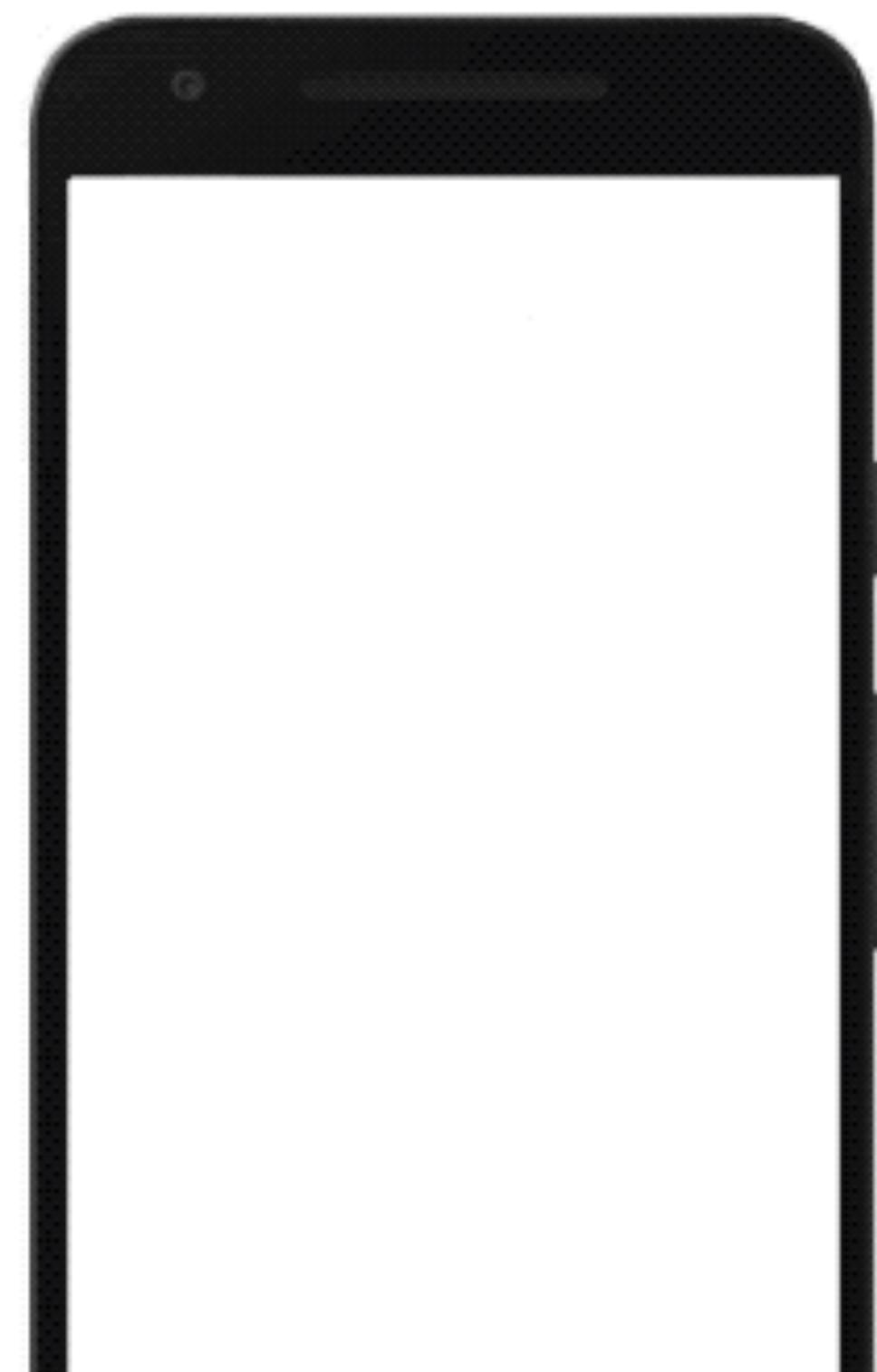
The time at which a page becomes interactive (events wired up, etc).

# TIME TO INTERACTIVE

0s 00



0s 00



<https://medium.com/@addyosmani/the-cost-of-javascript-in-2018-7d8950fbb5d4>

# Time to Interactive

The number of seconds from the time the navigation started until the CPU had at least 5 seconds of quiescence. This metric comes from [Lighthouse](#) as is only available in mobile tests. [Read more.](#)

MEDIAN MOBILE

9.3 seconds

▼23.1%

## Timeseries of Time to Interactive



Source: [httparchive.org](#)

Zoom

1m

3m

6m

YTD

1y

3y

All

From

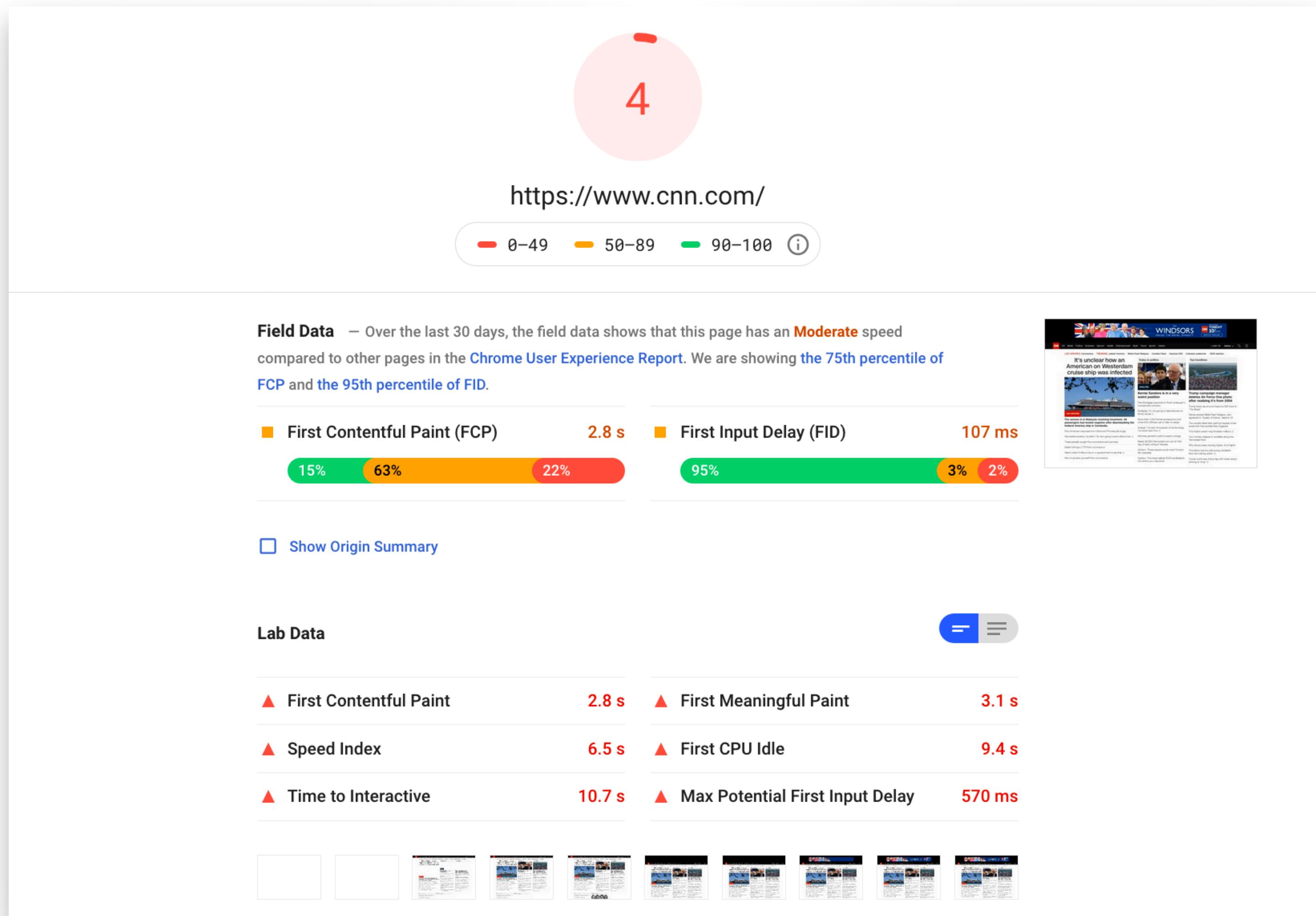
Mar 1, 2016

To

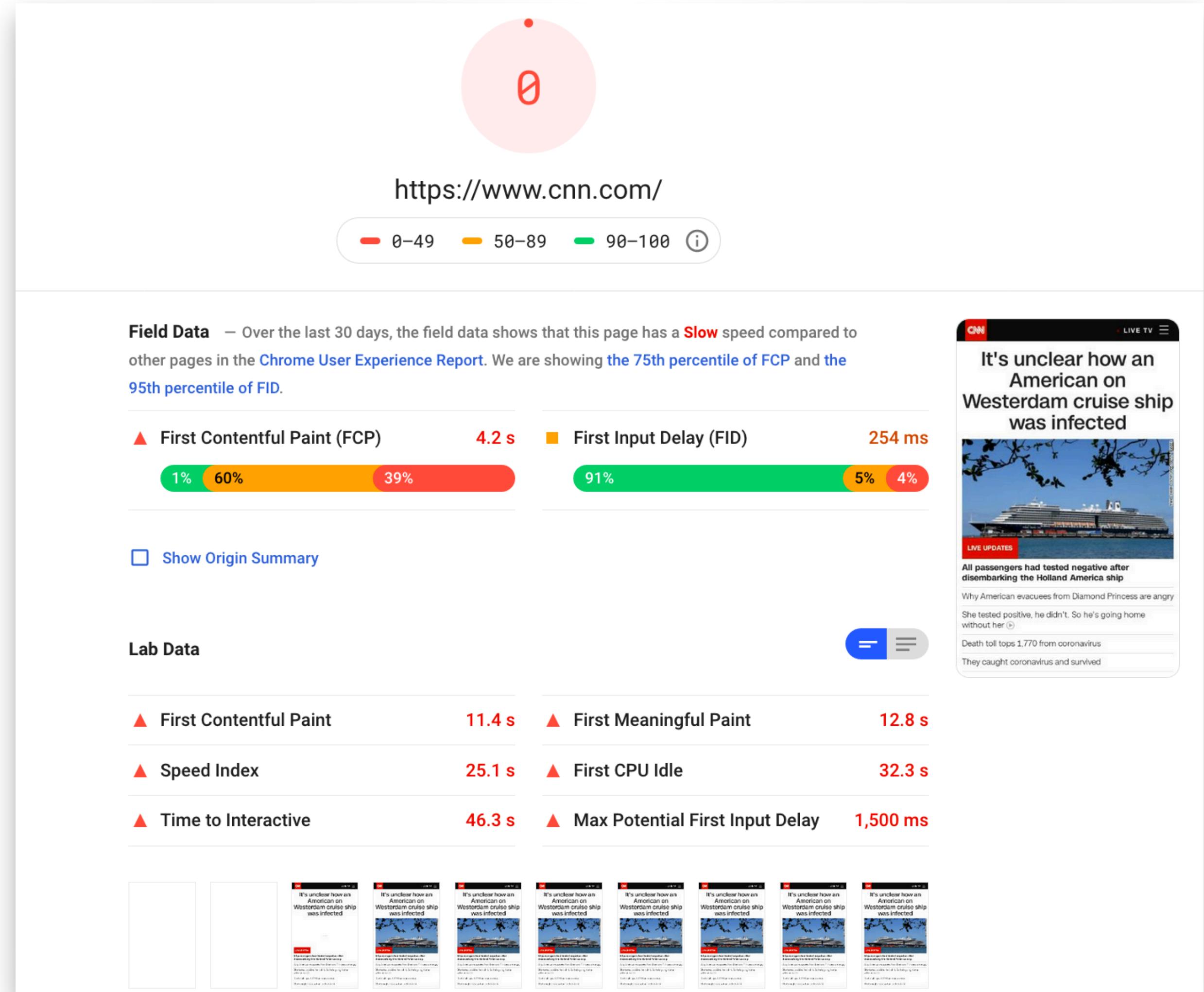
May 1, 2019



<https://httparchive.org/reports/loading-speed#ttci>



<https://developers.google.com/speed/pagespeed/insights/?url=cnn.com&tab=desktop>



<https://developers.google.com/speed/pagespeed/insights/?url=cnn.com&tab=desktop>

“

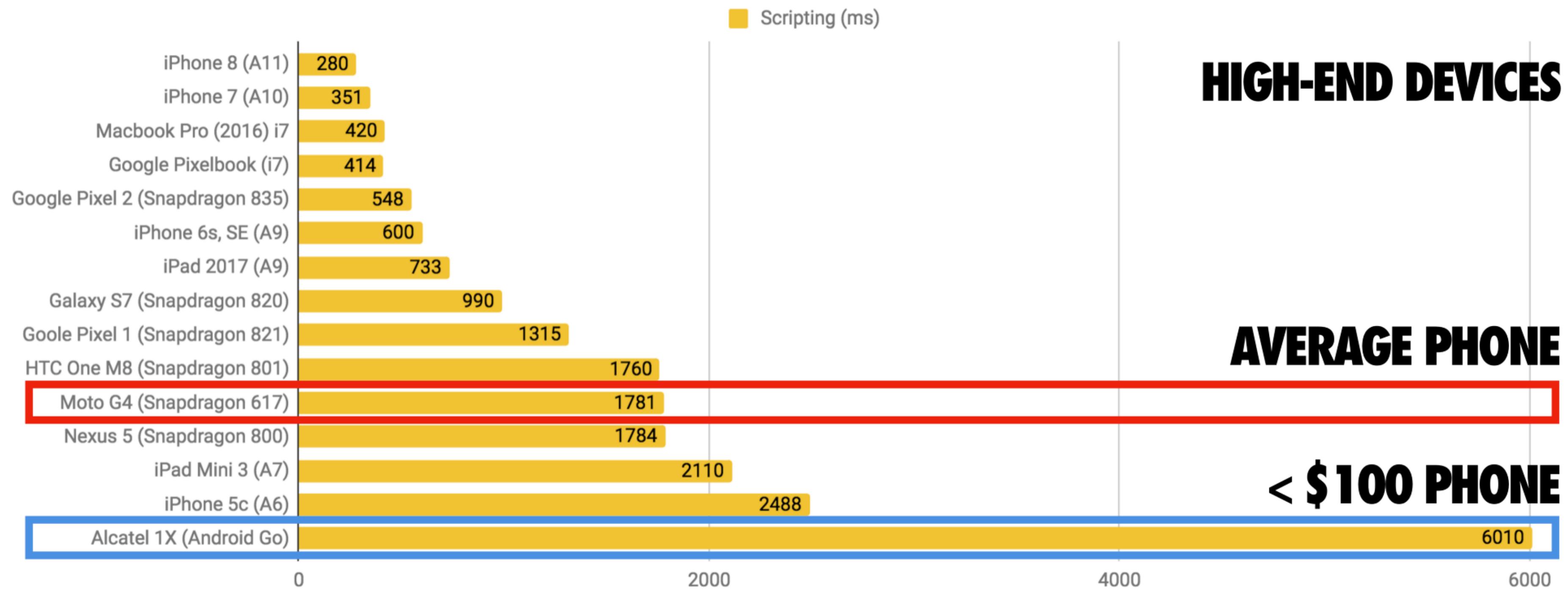
we feel your baseline should be getting interactive in under 5 seconds on a slow 3G connection on a median mobile device.

Addy Osmani



<https://medium.com/@addyosmani/the-cost-of-javascript-in-2018-7d8950fbb5d4>

# 2018 JAVASCRIPT PROCESSING TIMES



Tests run during July, 2018 on hardware running the latest versions of Android and iOS available

1MB JS UNCOMPRESSED (200KB min/compressed)



“

When creating great user experiences,  
managing CPU usage is now just as  
important as fast networks.

Mark Zeman, SpeedCurve



<https://speedcurve.com/blog/your-javascript-hurts/>

Other

# Important Metrics...

---

First Input Delay... First CPU Idle....

Total blocking time... Cumulative layout shift...

Still important:

# Fully Loaded

---

Not a user-perceivable metric (*until they check their data bill!*)

## Total Kilobytes

The sum of transfer size kilobytes of all resources requested by the page.

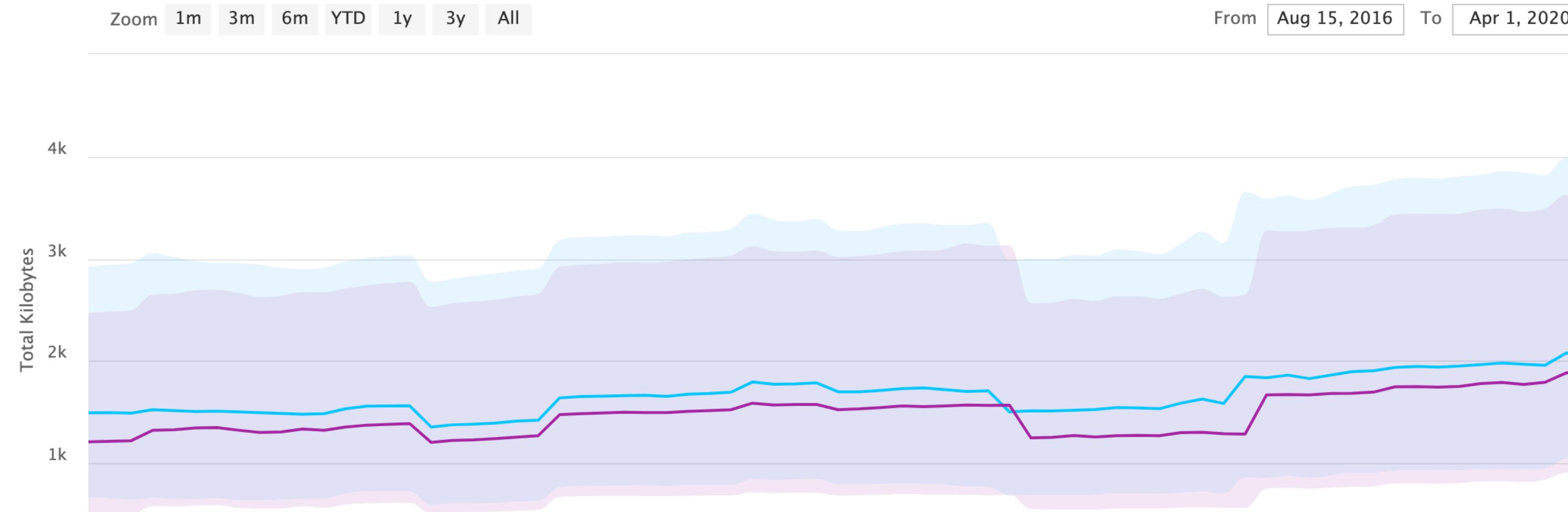
See also: [State of the Web](#)

MEDIAN DESKTOP  
**2031.9 KB**  
▲36.1%

MEDIAN MOBILE  
**1864.2 KB**  
▲54.1%

### Timeseries of Total Kilobytes

Source: httparchive.org



<https://httparchive.org/reports/page-weight>

# Lightning-Fast Web Performance

Scott Jehl, WebPageTest Team



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