

Lightning-Fast Web Performance

Scott Jehl, WebPageTest Team



WebPageTest
by catchpoint[®]

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:

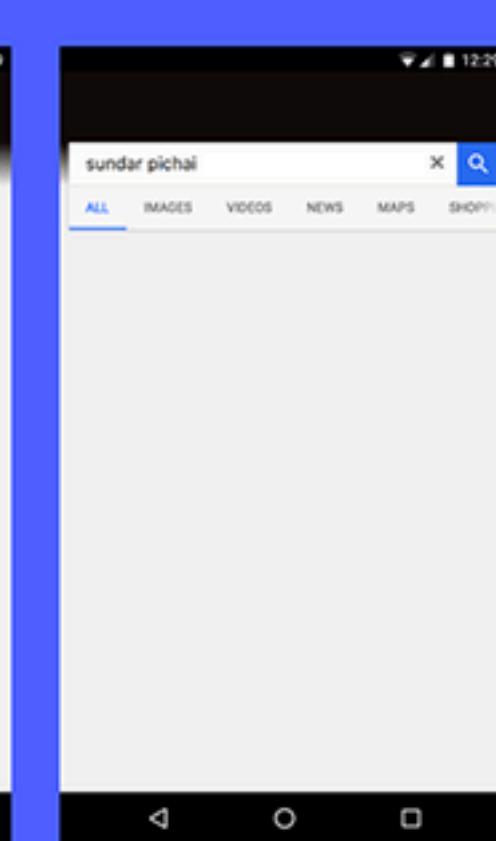


"Is it happening?"



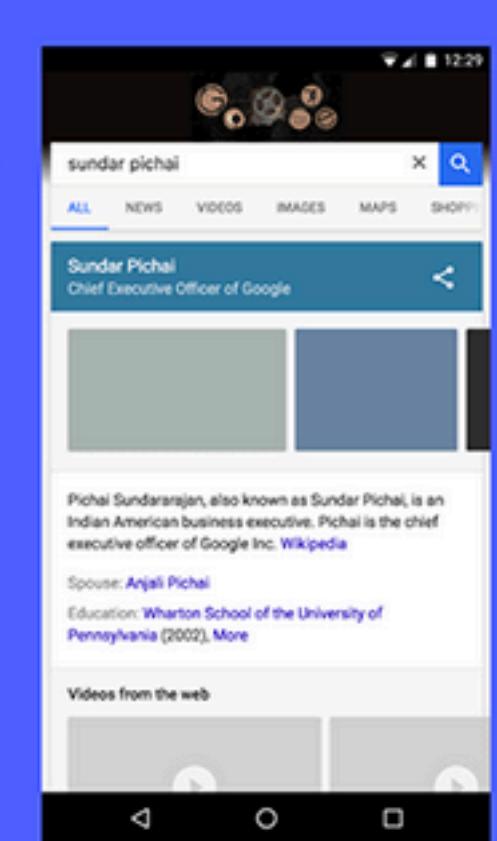
First Paint
(FP)

"Is it useful?"



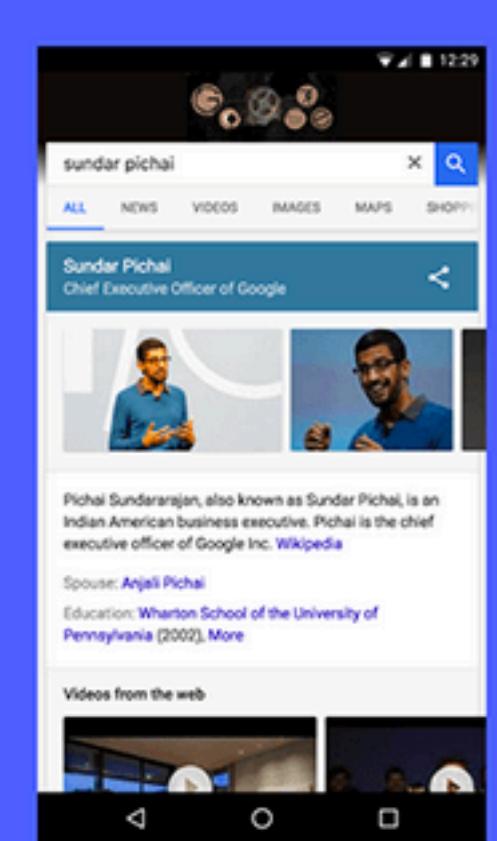
First Contentful
Paint (FCP)

"Is it useful?"

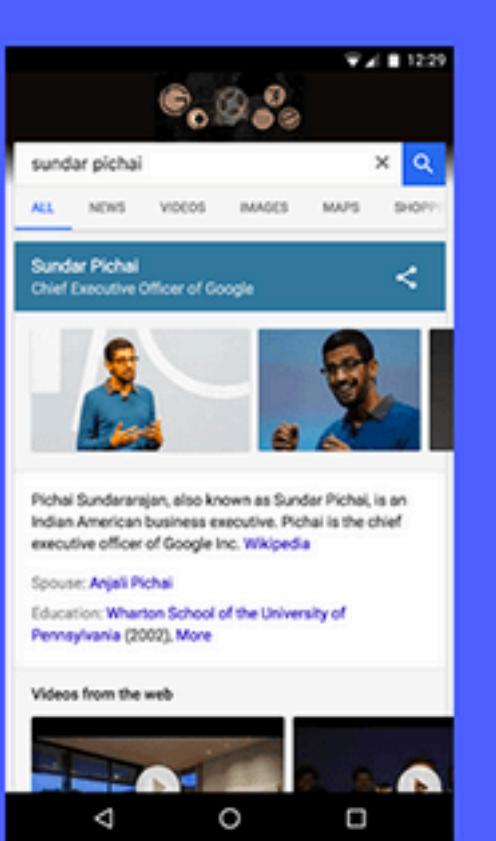


First Meaningful
Paint (FMP)

"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?

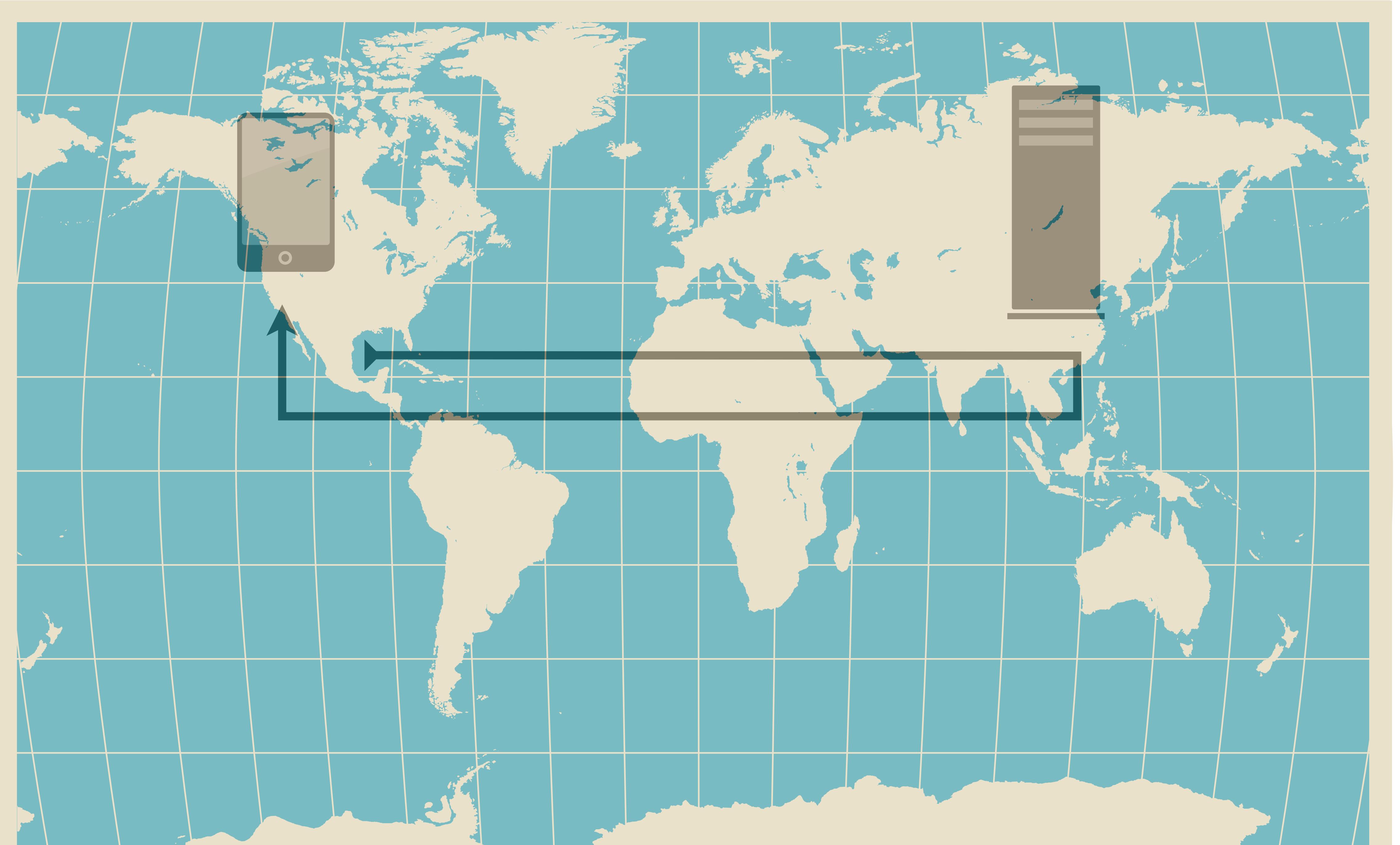
- Initial request to a website
- DNS resolution to a server's IP address
- Establish connection with the server
- Secure connection with the server
- Potential redirects
- Response

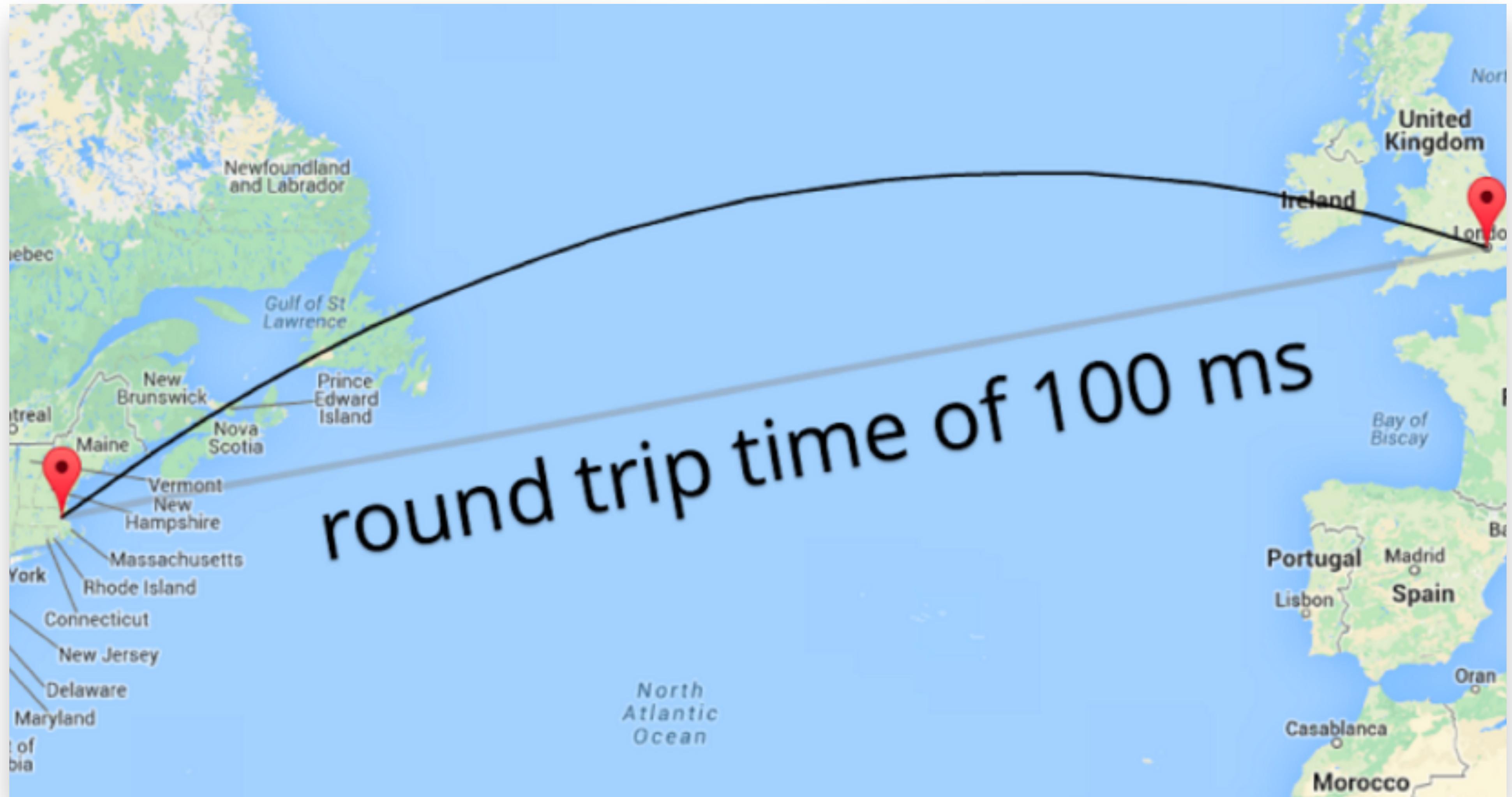
“
when it comes to your web browsing
experience, it turns out that **latency, not**
bandwidth, is likely the constraining factor
today.

Ilya Grigorik



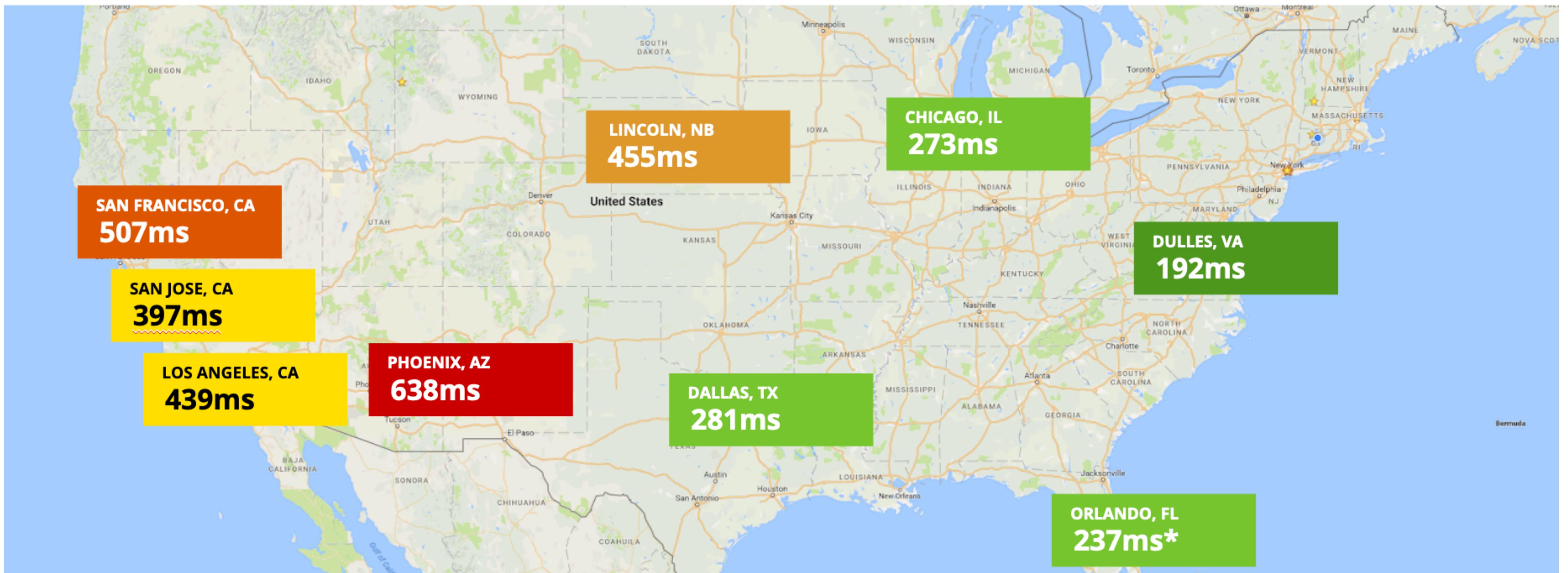
<https://www.igvita.com/2012/07/19/latency-the-new-web-performance-bottleneck/>





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

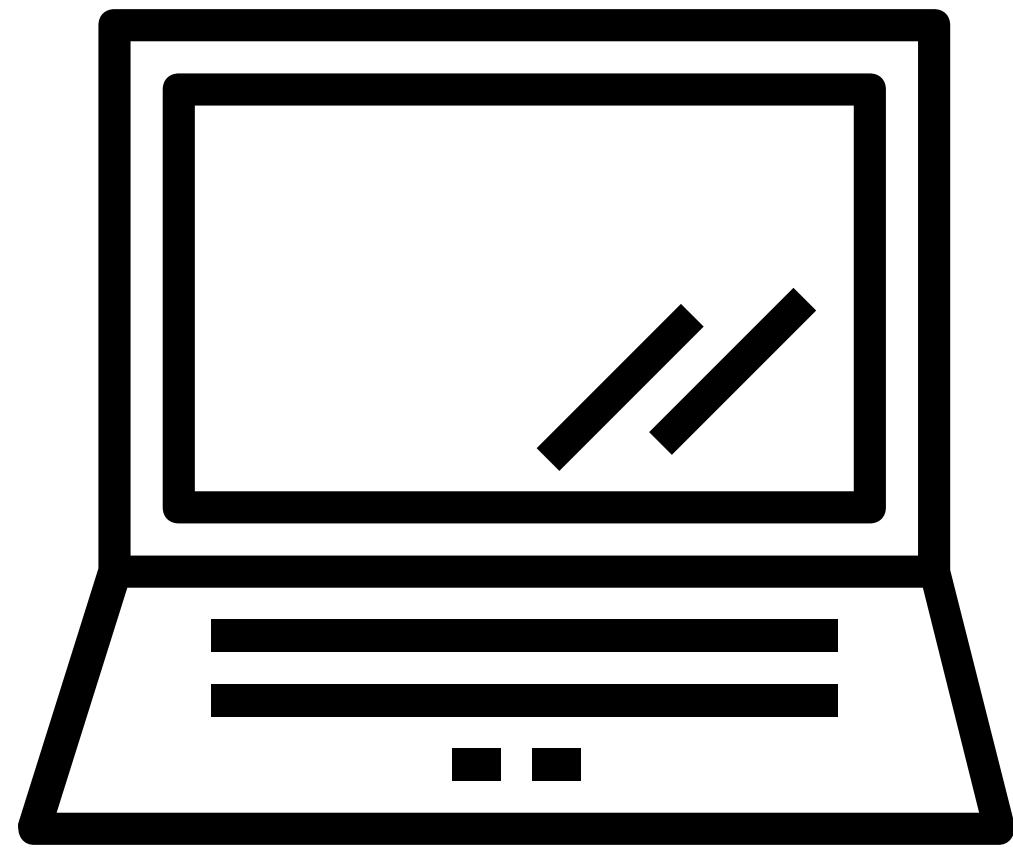
- Generally, static pages need less server time
- Dynamic pages tend to use more server time

Every 3rd party request:
New connection process

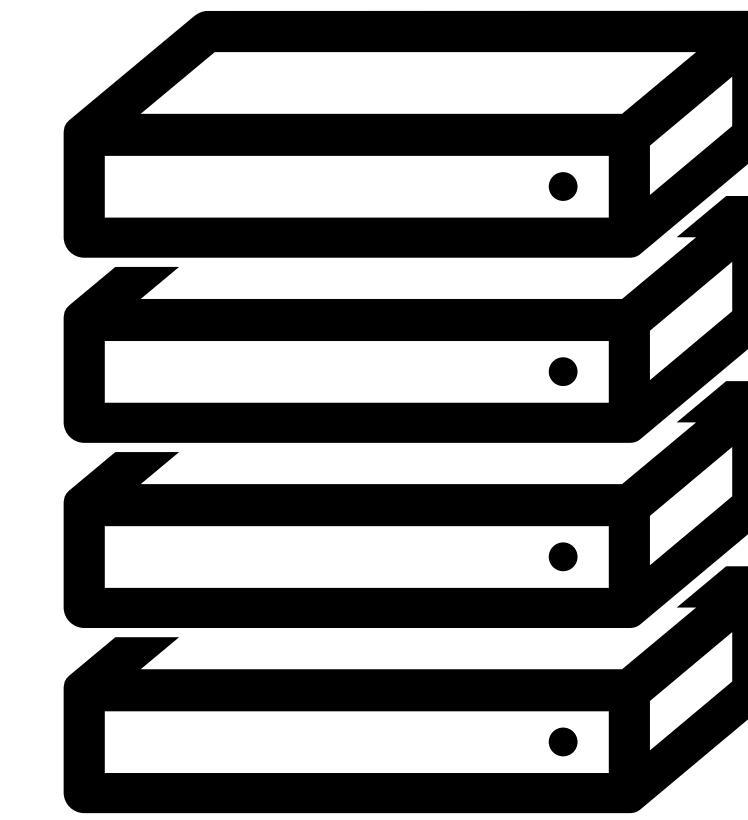
SR

Start Render

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



Example.com please!



Sure! Here's the HTML first.

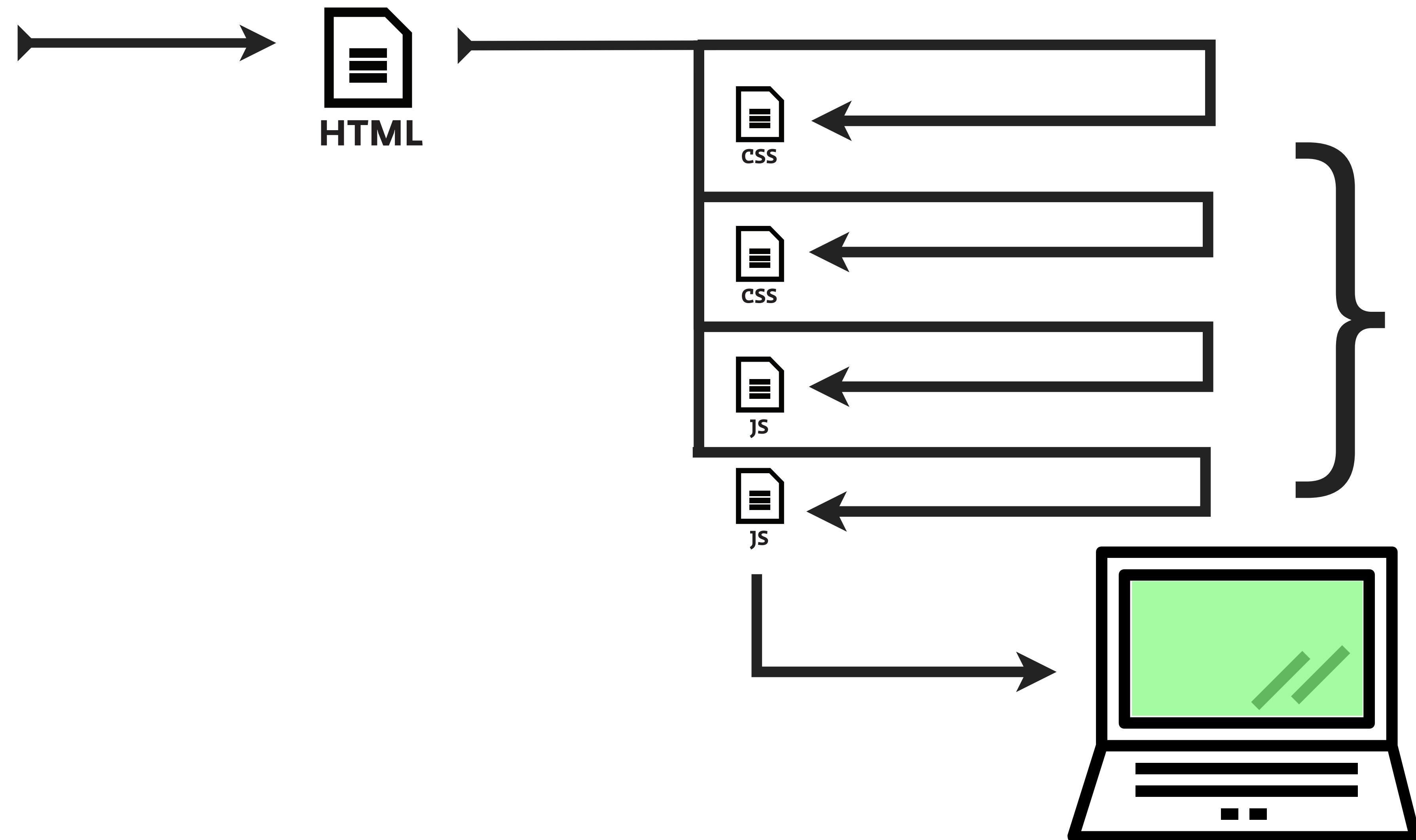
The render blockers

```
<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

FCP

First Contentful Paint

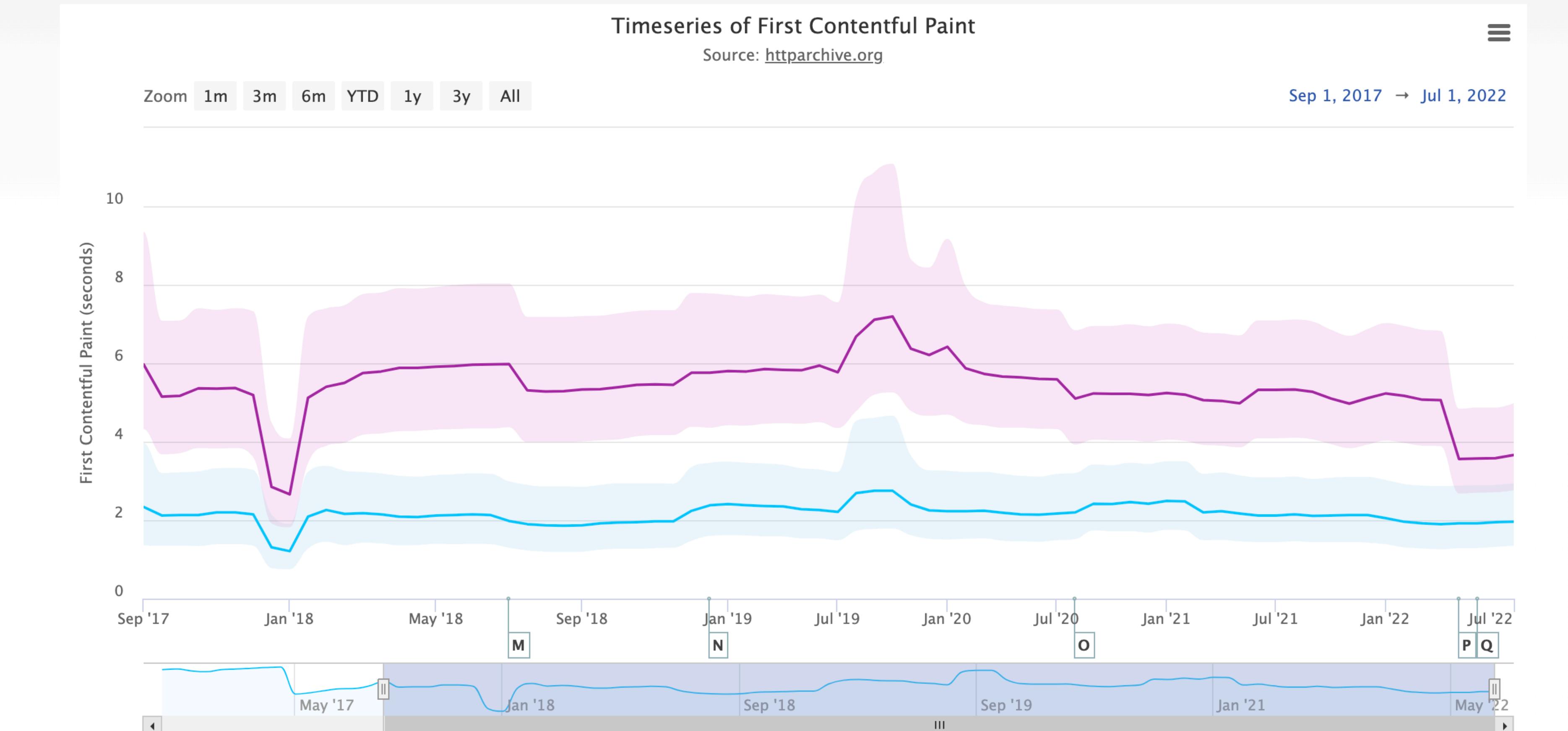
The time when requested content (article body, etc) starts to render meaningfully.

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
2.0 seconds ▼13.0%

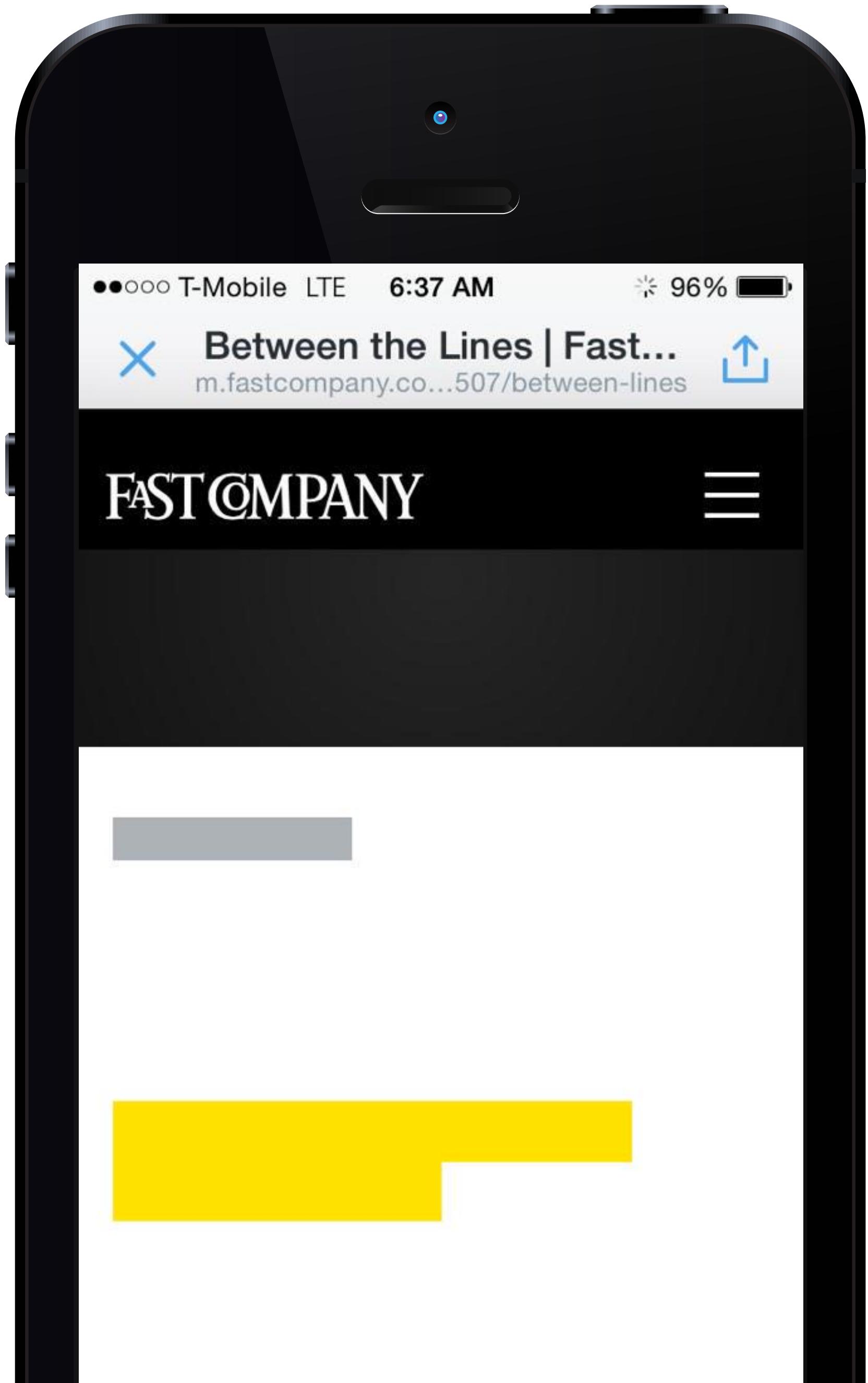
MEDIAN MOBILE
3.7 seconds ▼38.3%



Custom fonts

```
@font-face {  
    font-family: "Open Sans";  
    src: url("OpenSans.woff2") format("woff2")  
}
```

```
body {  
    font-family: "Open Sans";  
}
```



The New York Times

Tuesday, May 21, 2019

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S&P 500 +0.85% ↑Dow +0.77% ↑Nasdaq +1.08% ↑ **82°F**
85° 69°

Mililani Town, HI

WASHINGTON

Democrats Divided Over Trump's Stonewalling as Calls for Impeachment Inquiry Grow

- Democrats were at odds about how to fight the latest defiance of a House subpoena, this time by the former White House counsel Donald McGahn.
- Some progressive lawmakers are pushing for the first time for an impeachment inquiry, over leaders' objections.

1h ago [841 comments](#)

Donald F. McGahn II, the former White House counsel, skipped a House Judiciary Committee hearing on President Trump's attempts to obstruct the Russia investigation. Erik S Lesser/EPA, via Shutterstock

Trump Expected to Pick Hard-Liner for Immigration Post

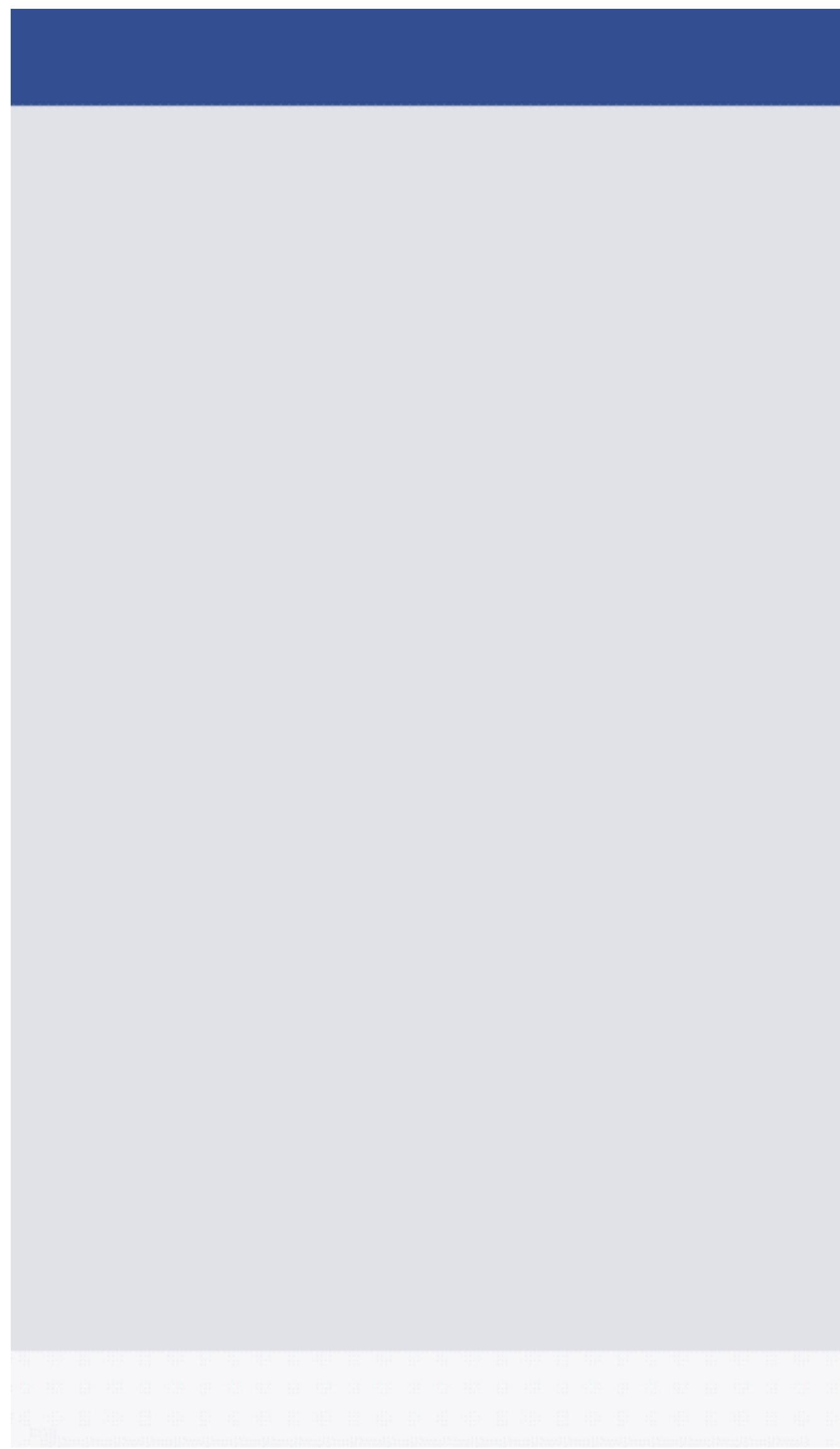
The job's duties and title are still being decided, but Ken Cuccinelli, a former Virginia attorney general, is expected to become a policy coordinator.

8h ago [122 comments](#)

<script src="path-to-some-advertisement.js"></script>

Data URIs: often blocky as well.

```
</script>');
```



LCP

Largest Contentful Paint

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

CNN

Visual stories >

US

...

...

...

CNN

Who has qualified for the September debates, so far

Only eight candidates have already qualified for the third Democratic debate hosted by ABC and Univision

How to make money with merch from a viral debate moment

Anderson Cooper: This is the question for 2020 Democrats

Whether you trust scientists may depend on your political party, survey says



LIVE TV

Who has qualified for the September debates, so far

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LIVE TV

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LIVE

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FCP

LCP

CLS

Cumulative Layout Shift

The additive impact of layout instability while a page is loading.

CLS

Cumulative Layout Shift



<https://web.dev/cls/>

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International Space Station

Jessica Glenza in New York

✉ @JessicaGlenza

Fri 7 Jun 2019 12.53 EDT



16

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



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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

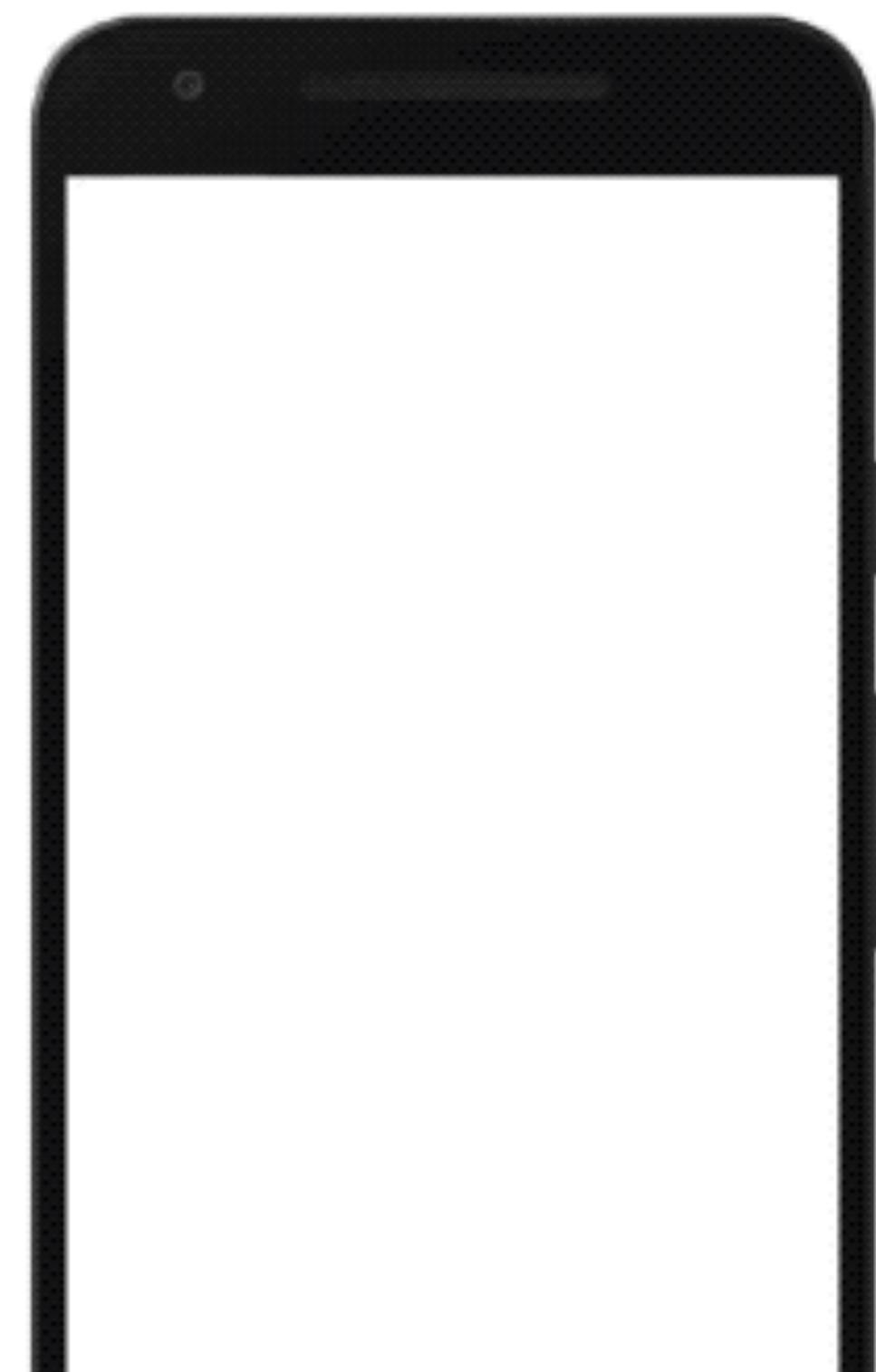
TTI

Time To Interactive

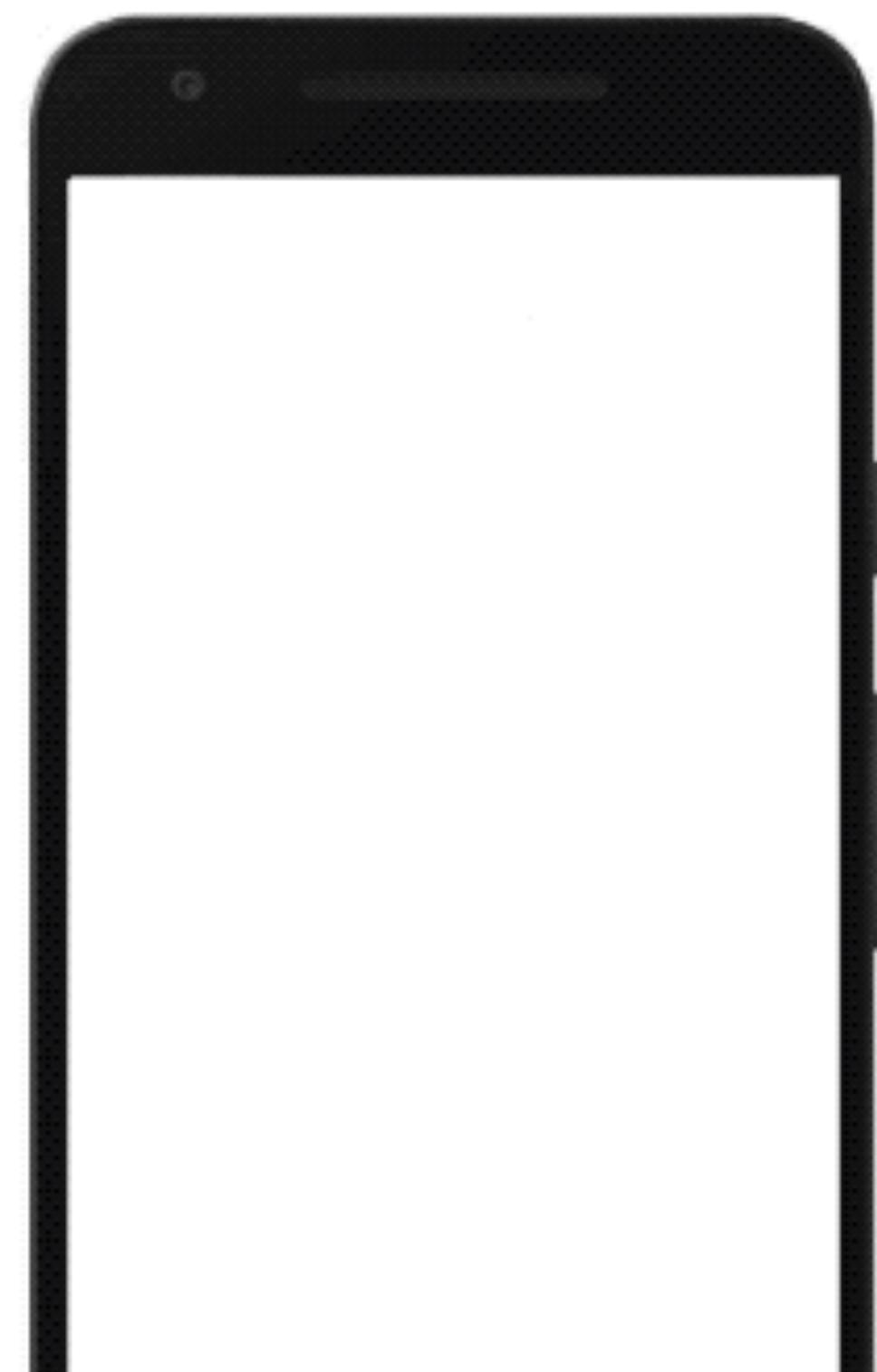
The time at which a page becomes interactive (events wired up, etc).

TIME TO INTERACTIVE

0s 00



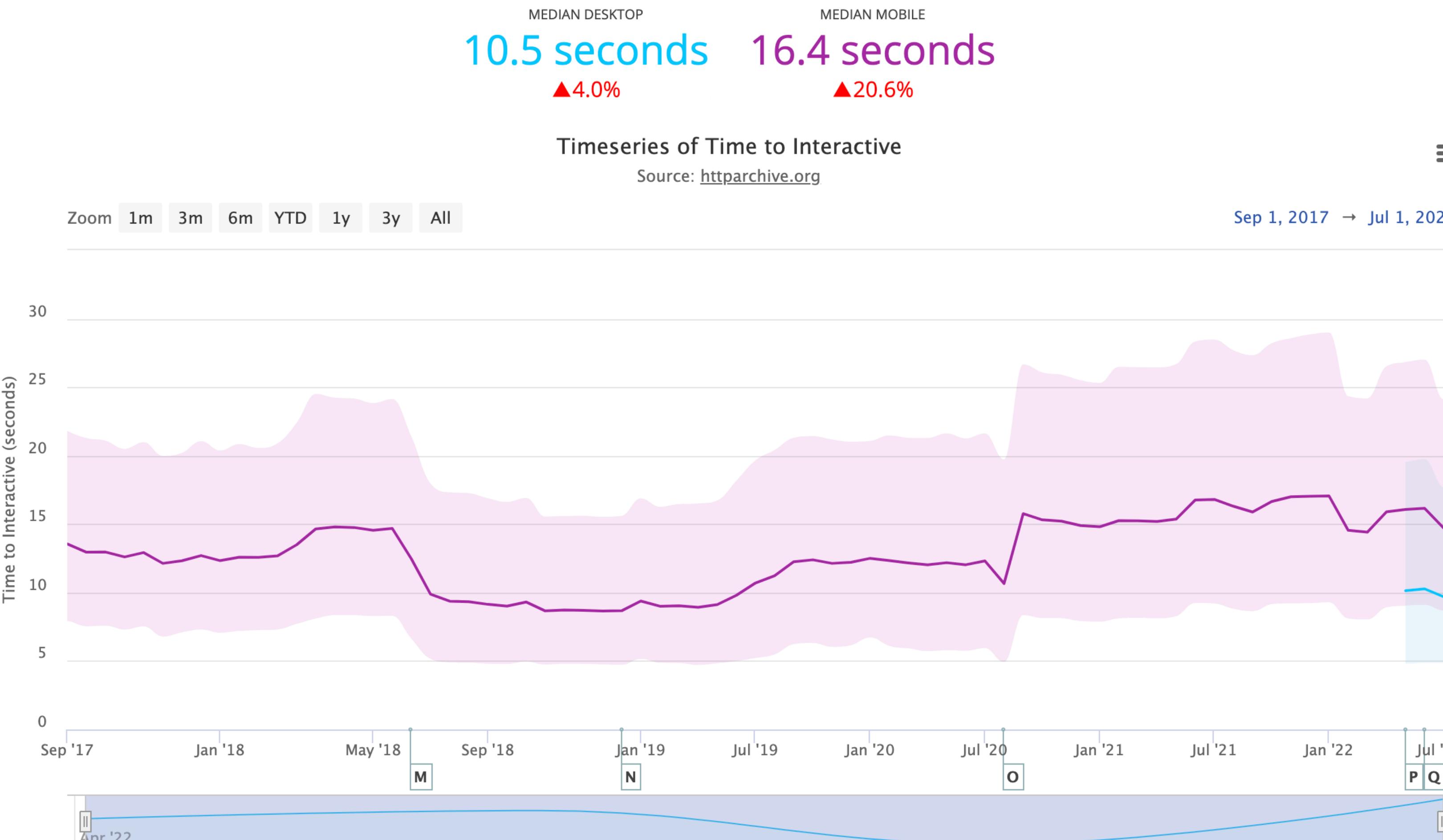
0s 00

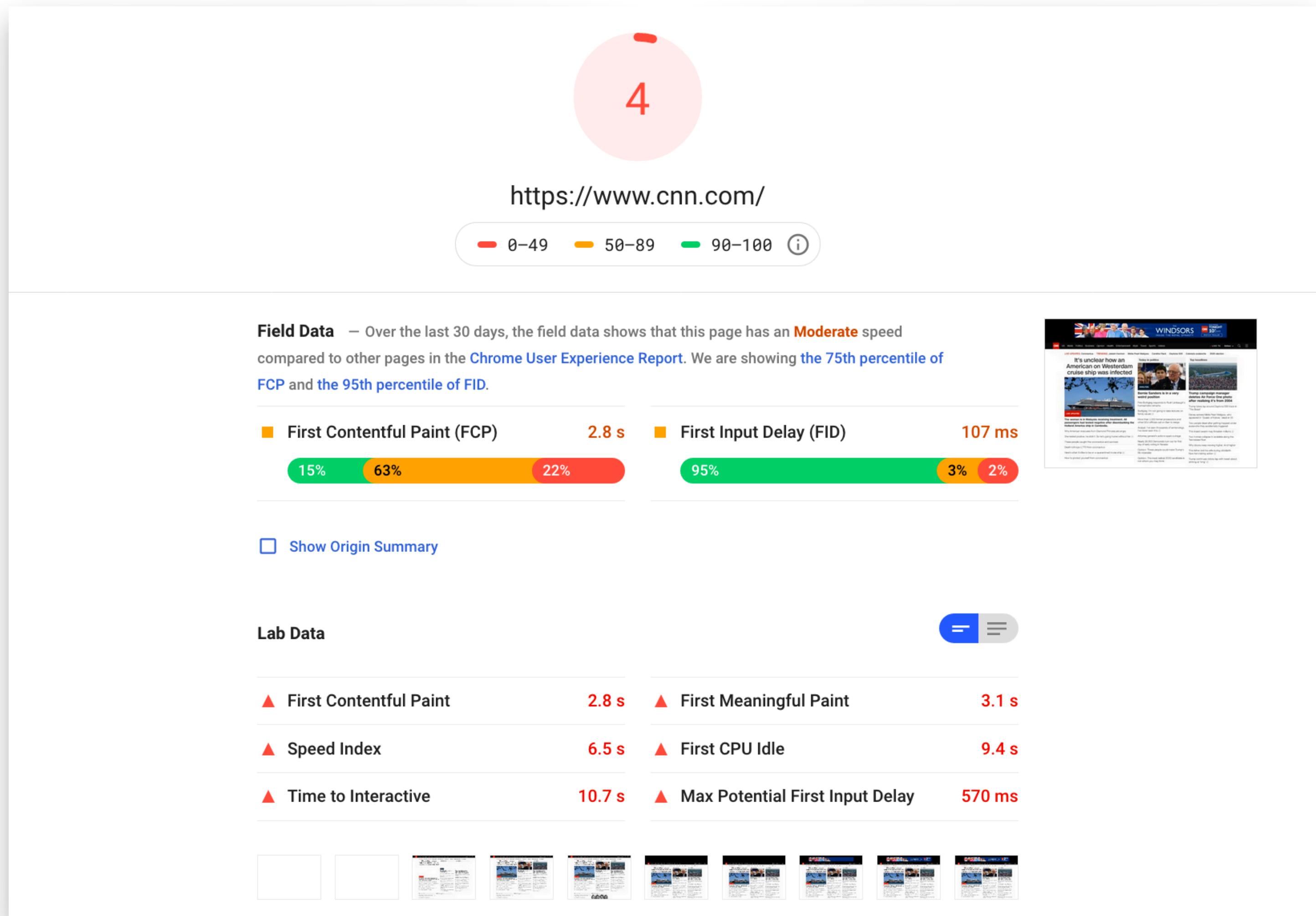


<https://medium.com/@addyosmani/the-cost-of-javascript-in-2018-7d8950fbb5d4>

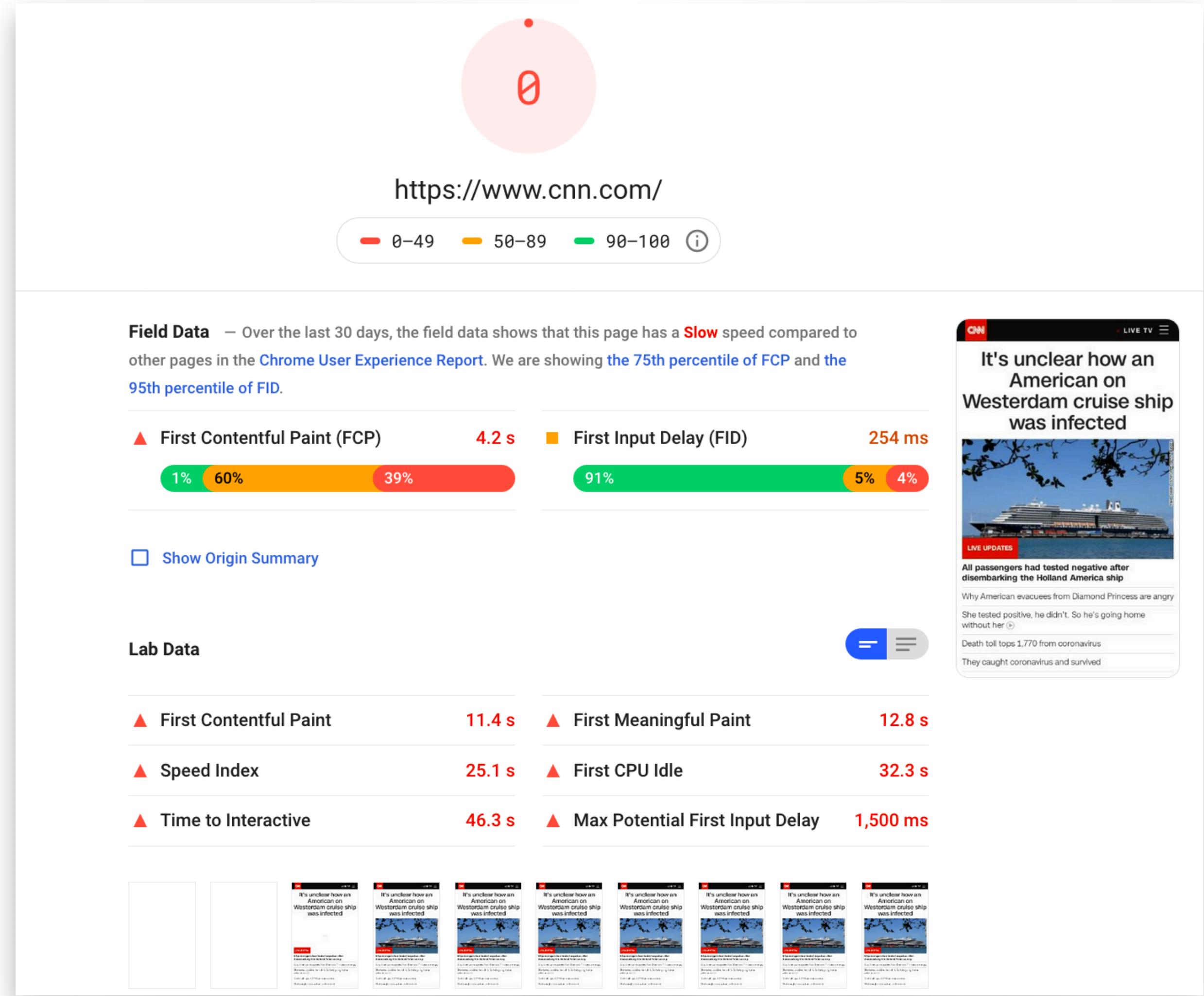
Time to Interactive

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](#). [Read more about First Interactive and First Consistently Interactive](#).





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



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

“

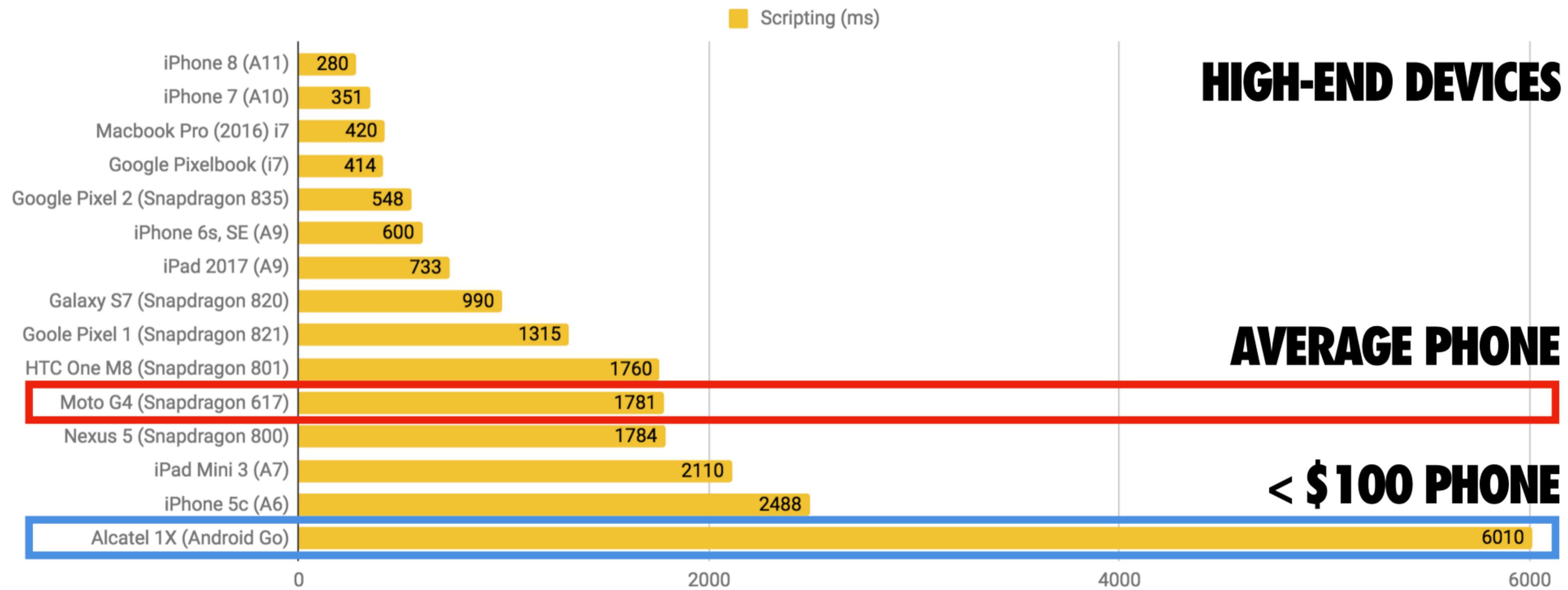
we feel your baseline should be getting interactive in under 5 seconds on a slow 3G connection on a median mobile device.

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/>

TBT

Total Blocking Time

The total amount of time interaction is blocked between FCP and TTI.

INP

Interaction to Next Paint

The time it takes a page to visually respond to user interaction.

INP

Interaction to Next Paint



FID

First Input Delay

The interaction delay after the first user interaction with the page.

(Loading)

LCP

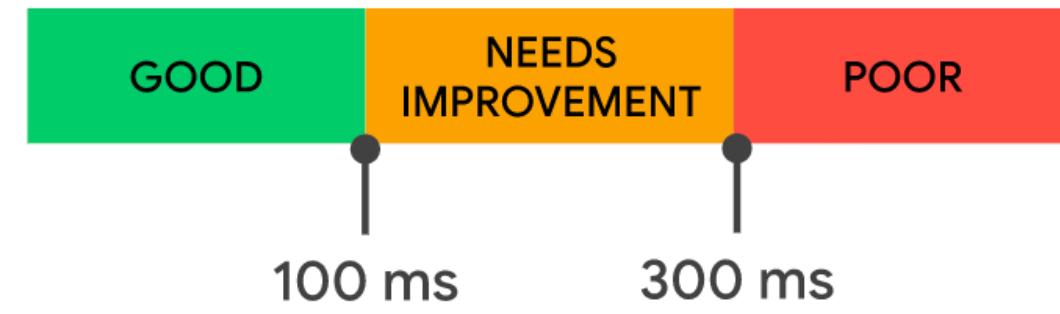
Largest Contentful Paint



(Interactivity)

FID

First Input Delay



(Visual Stability)

CLS

Cumulative Layout Shift



Still important:

Fully Loaded

The time at which all page assets have finished loading.

Still important:

Total Bytes

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](#)

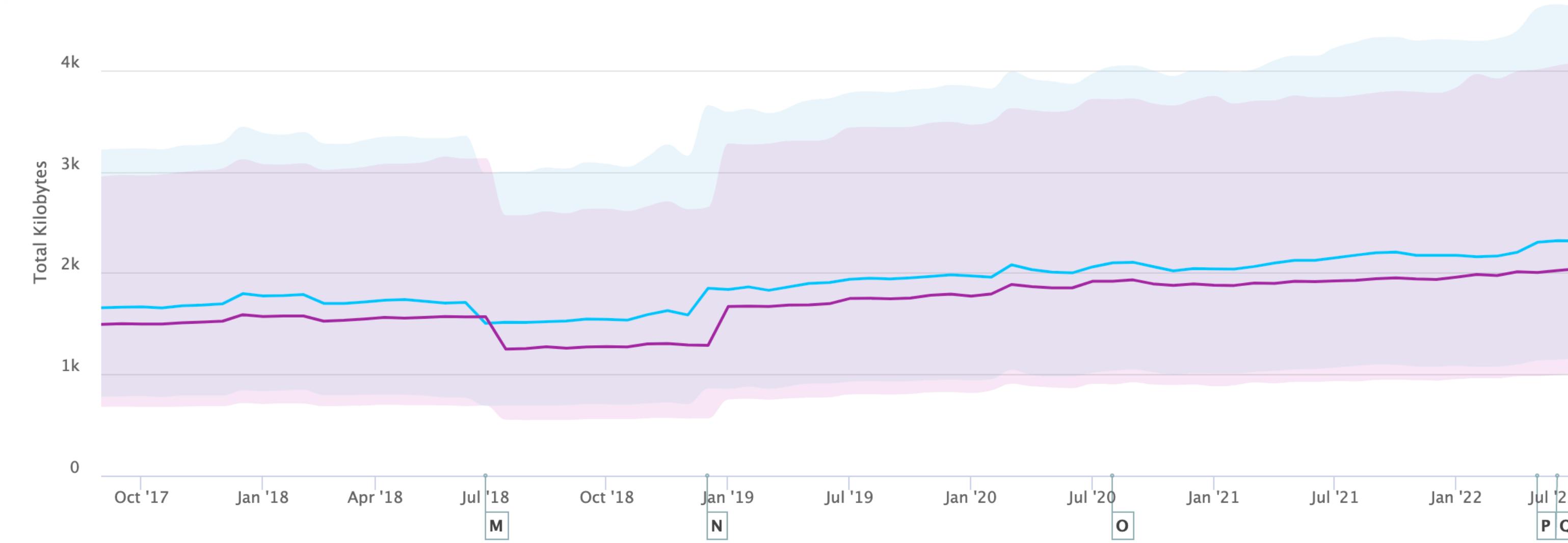
MEDIAN DESKTOP MEDIAN MOBILE
2314.4 KB 2040.4 KB
▲39.8% ▲36.8%

Timeseries of Total Kilobytes

Source: [httparchive.org](#)

Zoom 1m 3m 6m YTD 1y 3y All

Sep 1, 2017 → Jul 1, 2022



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

Lightning-Fast Web Performance

Scott Jehl, WebPageTest Team



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