

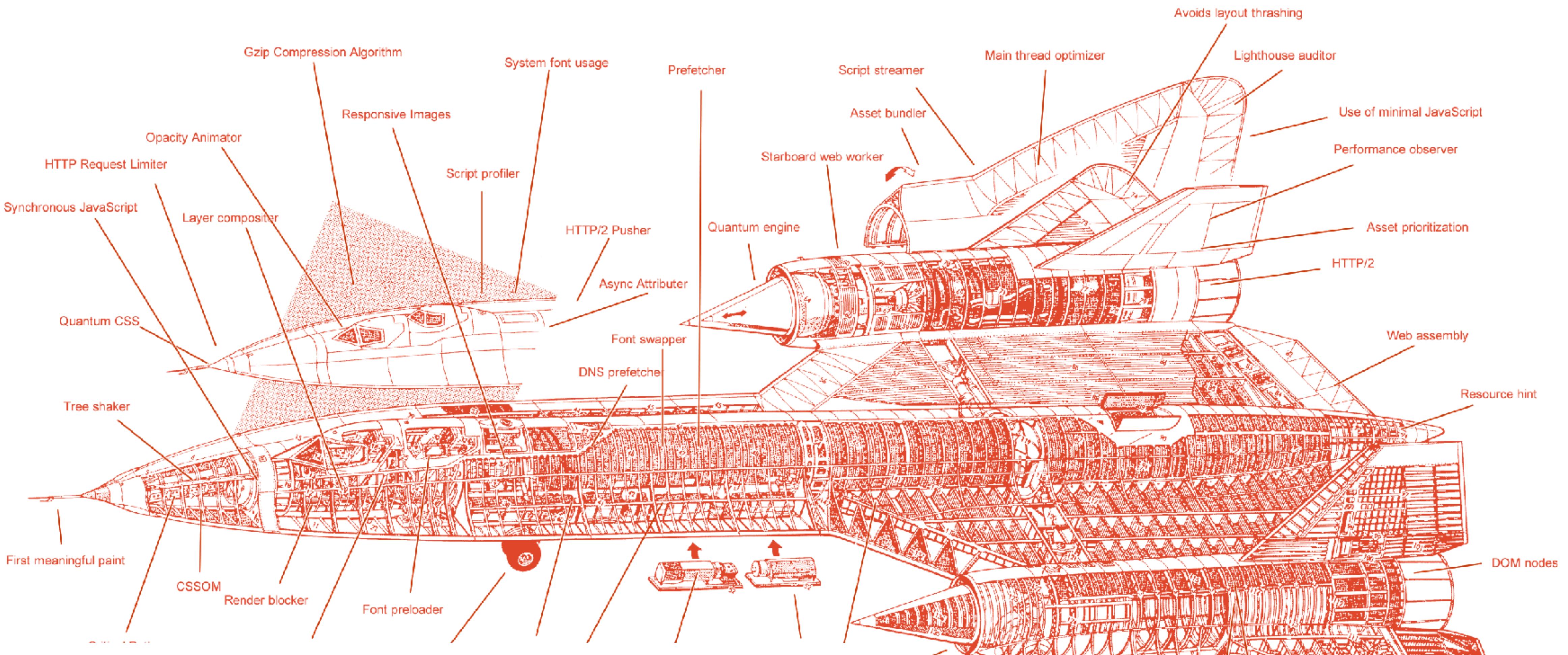
# Deep Dive into Front-end Web Performance

Mike Herchel

Senior Front-end Dev at Lullabot // @mikeherchel

# CLICK THE DAMNED BUTTON!

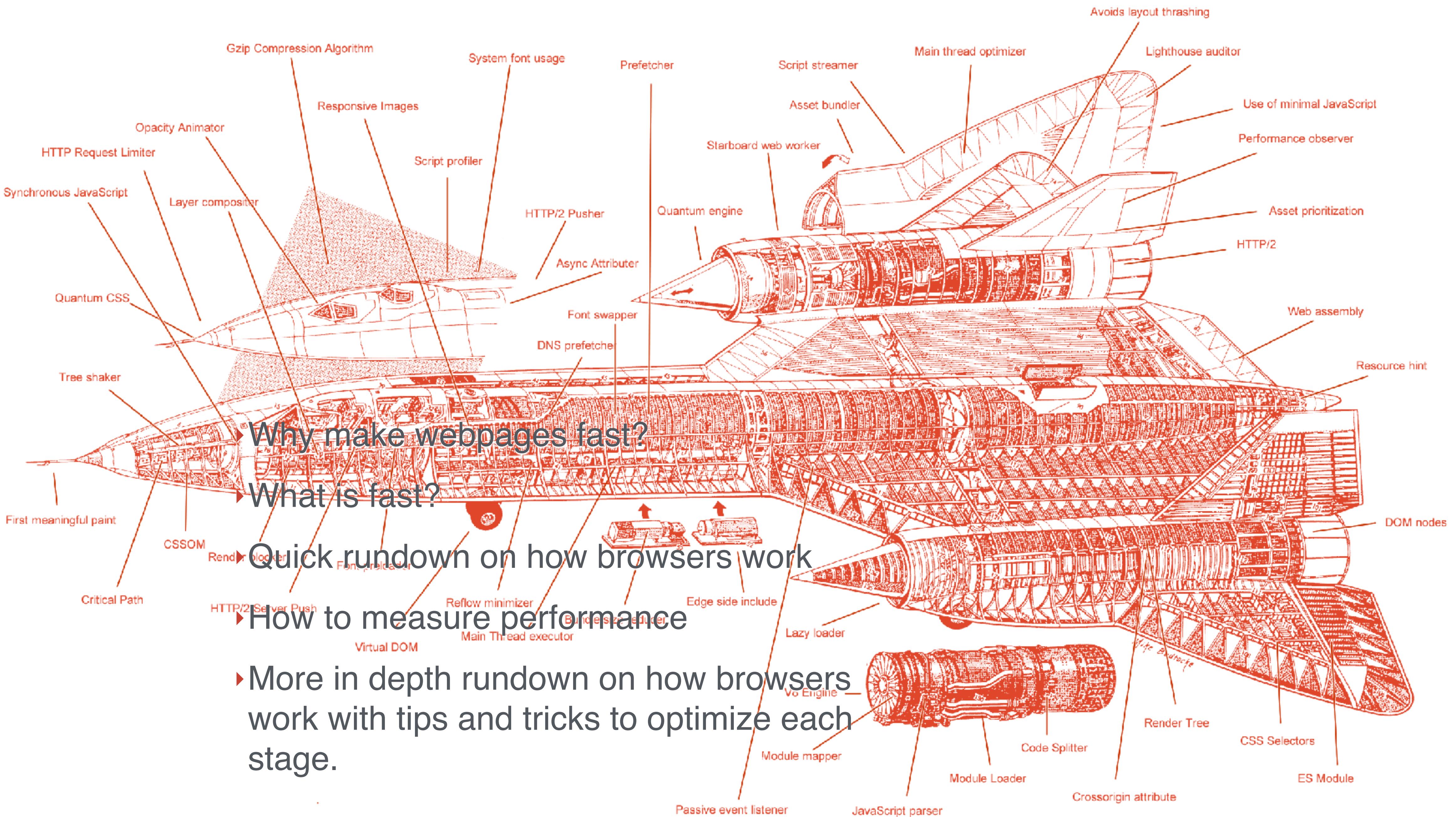




# Deep Dive into Front-end Web Performance

Mike Herchel

Senior Front-end Dev at Lullabot // @mikeherchel





**Mike Herchel**

**Millie Herchel**

**Dexter  
Herchel**

A close-up portrait of a man with a shaved head and glasses, smiling. He is wearing a light blue button-down shirt. A white speech bubble with a black outline is positioned to the right of his head, containing text.

Why do webpages  
need to be so fast?



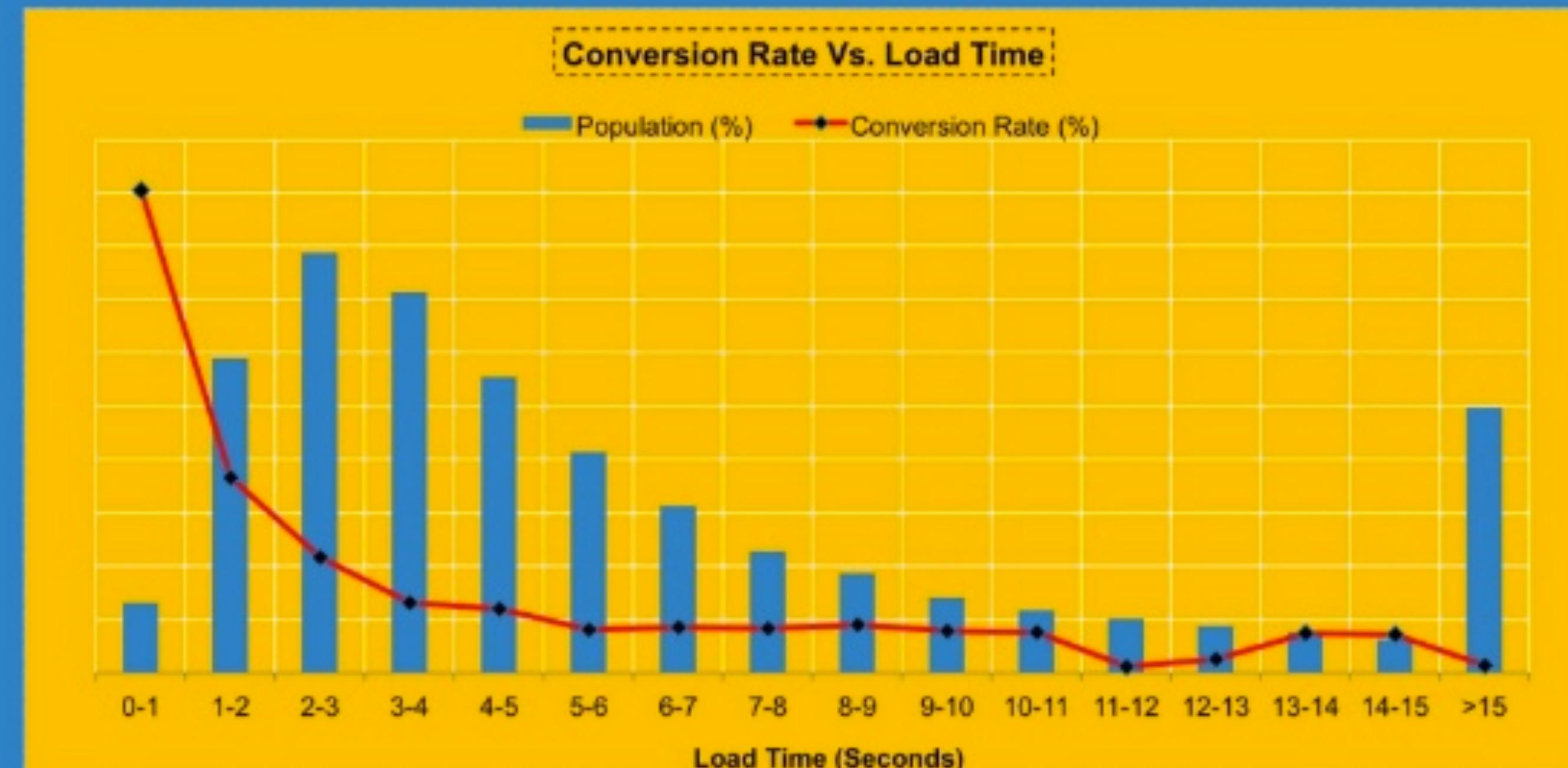
53% of mobile site visits are abandoned if pages take longer than 3 seconds to load.

– <https://www.doubleclickbygoogle.com/articles/mobile-speed-matters/>

## Impact of site performance on overall site conversion rate....

### Baseline – 1 in 2 site visits had response time > 4 seconds

- \* Sharp decline in conversion rate as average site load time increases from 1 to 4 seconds
- \* Overall average site load time is lower for the converted population (3.22 Seconds) than the non-converted population (6.03 Seconds)



Note: Load Time here is the time taken from head of the page to page ready (T\_Page)



Mobile sites load in 5  
seconds earn up to 2x  
more mobile ad revenue.

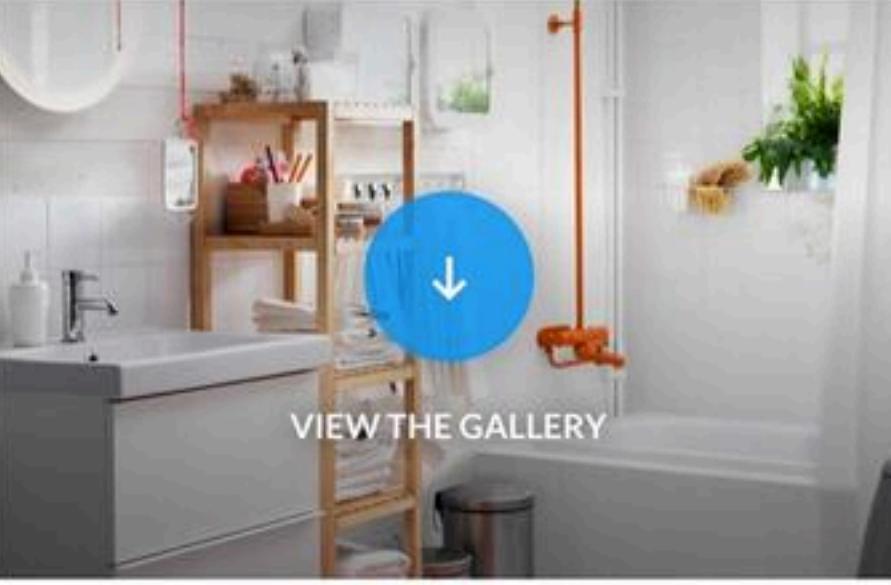
– <https://www.doubleclickbygoogle.com/articles/mobile-speed-matters/>

“For screen reader users, [slow websites are] exacerbated: visual content streams in while an auditory progress counter struggles to reach 100% so the page can be consumed.”

– <https://marcysutton.com/accessibility-and-performance/>



 This Old House

  
VIEW THE GALLERY

Browse more in [Home Interiors and Bathrooms](#)

## 13 Big Ideas for Small Bathrooms

The right colors, lighting, and fixtures will help create the



[REQUEST YOUR \\$1000](#)

 Privacy

### Rich, Asian-Inspired Design

  
PHOTO: COURTESY NATIONAL KITCHEN & BATH ASSOCIATION

This homeowner wanted to bring her home out of the 1980s with...

[Continue reading ...](#)

[REQUEST YOUR \\$1000](#)

 \*Details Apply

### CLICK HERE

### Day At The Beach

  
PHOTO: COURTESY NATIONAL KITCHEN & BATH ASSOCIATION

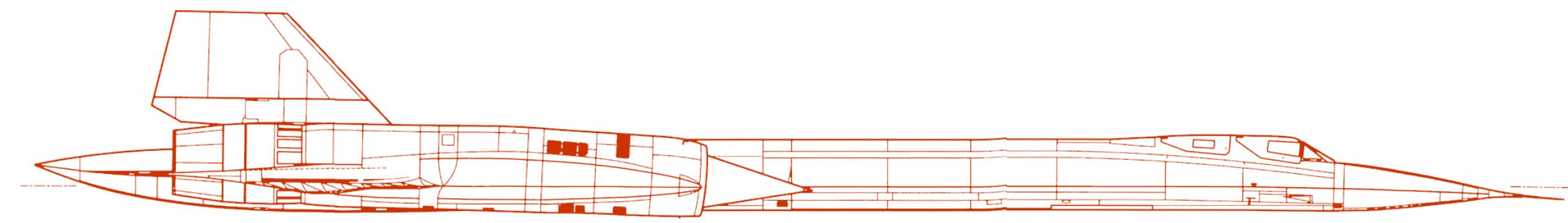
This homeowner wanted to bring her home out of the 1980s with...

[Continue reading ...](#)

 Privacy

STEPS // How to Build a Simple Deck

- [Project Overview](#)
- [Attach the Ledger](#)
- [Protect the Ledger](#)
- [Set Footings and Piers](#)
- [Install Post Bases and Side Rim Joists](#)
- [Install Front Rim Joist, Beams, and Interior Joists](#)
- [Attach Trim and Decking](#)



**WHAT IS FAST?**

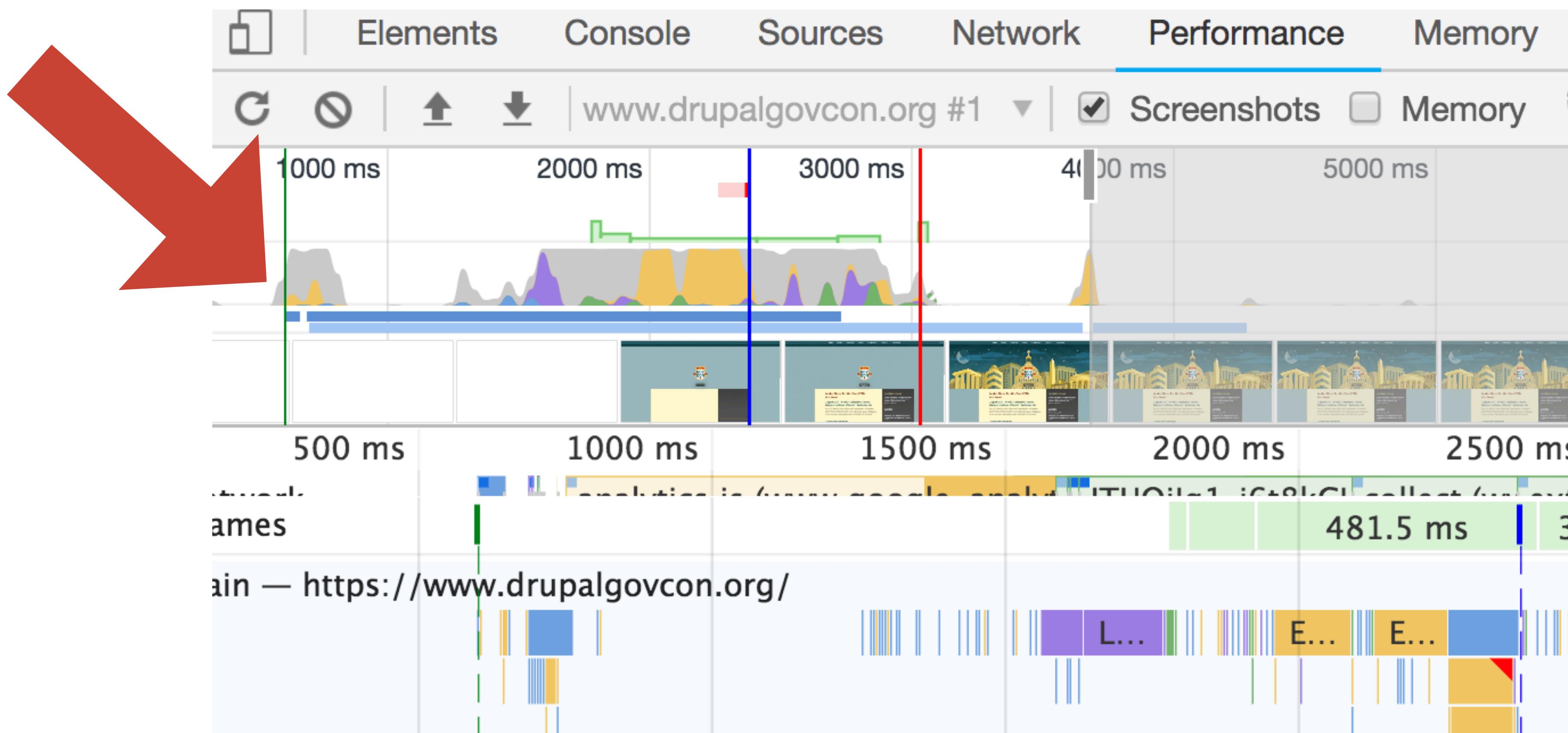
# FRONTEND PERFORMANCE METRICS

- Time to First Byte
- Time to First Meaningful Paint
- Time to First Interactive
- Speed Index

# TIME TO FIRST BYTE

- Time from when you begin navigation until the first byte of the html file hits your browser.
- Delays here can indicate backend performance issues.
- Effective caching really helps with this (Drupal FTW)
- CDNs can dramatically help. They position content closer to the user.

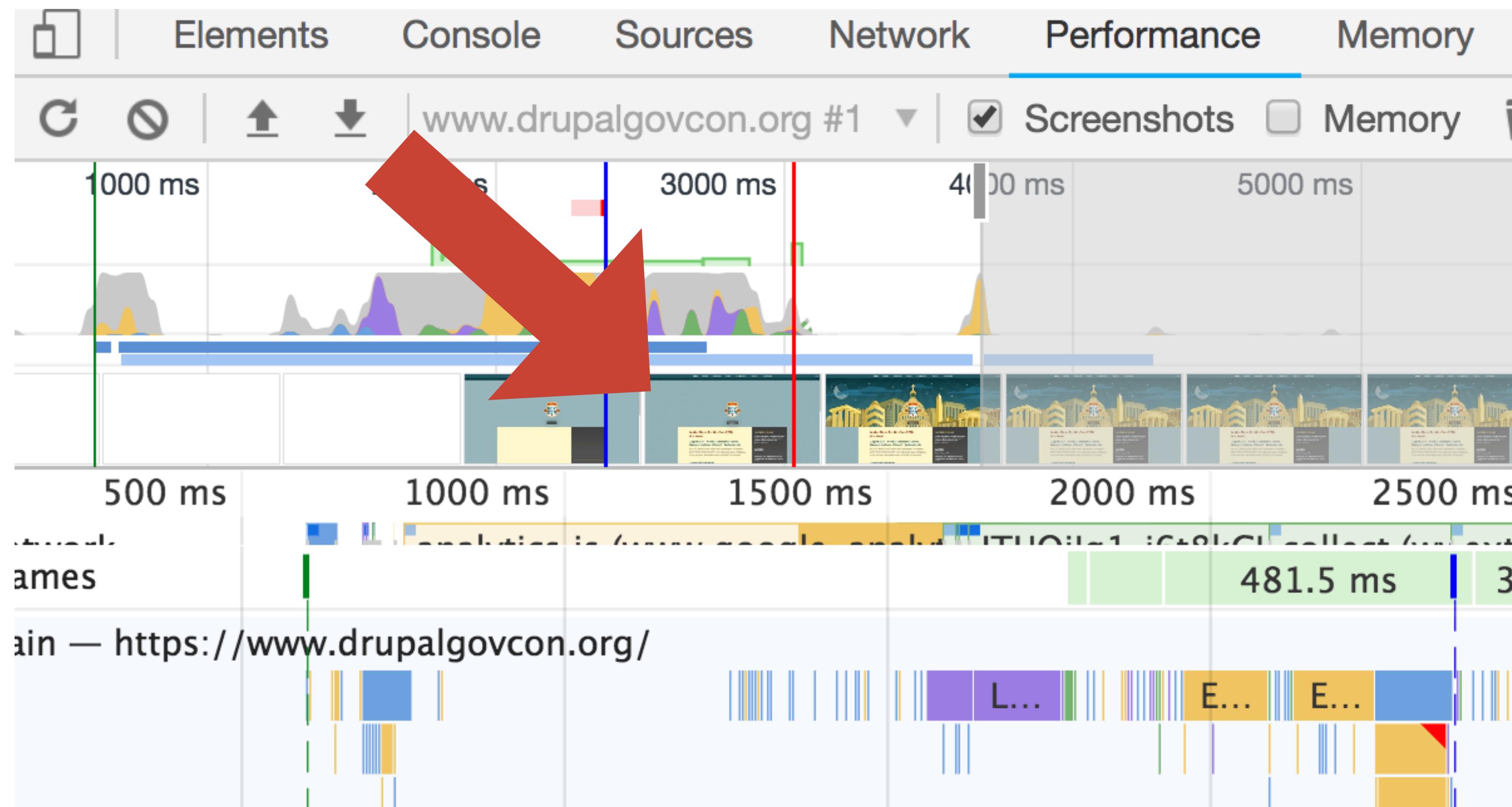
# TIME TO FIRST BYTE



# TIME TO FIRST MEANINGFUL PAINT

- ▶ Primary content is visible.
- ▶ Marks the paint event that follows the most significant change to layout.
- ▶ Can be ambiguous.

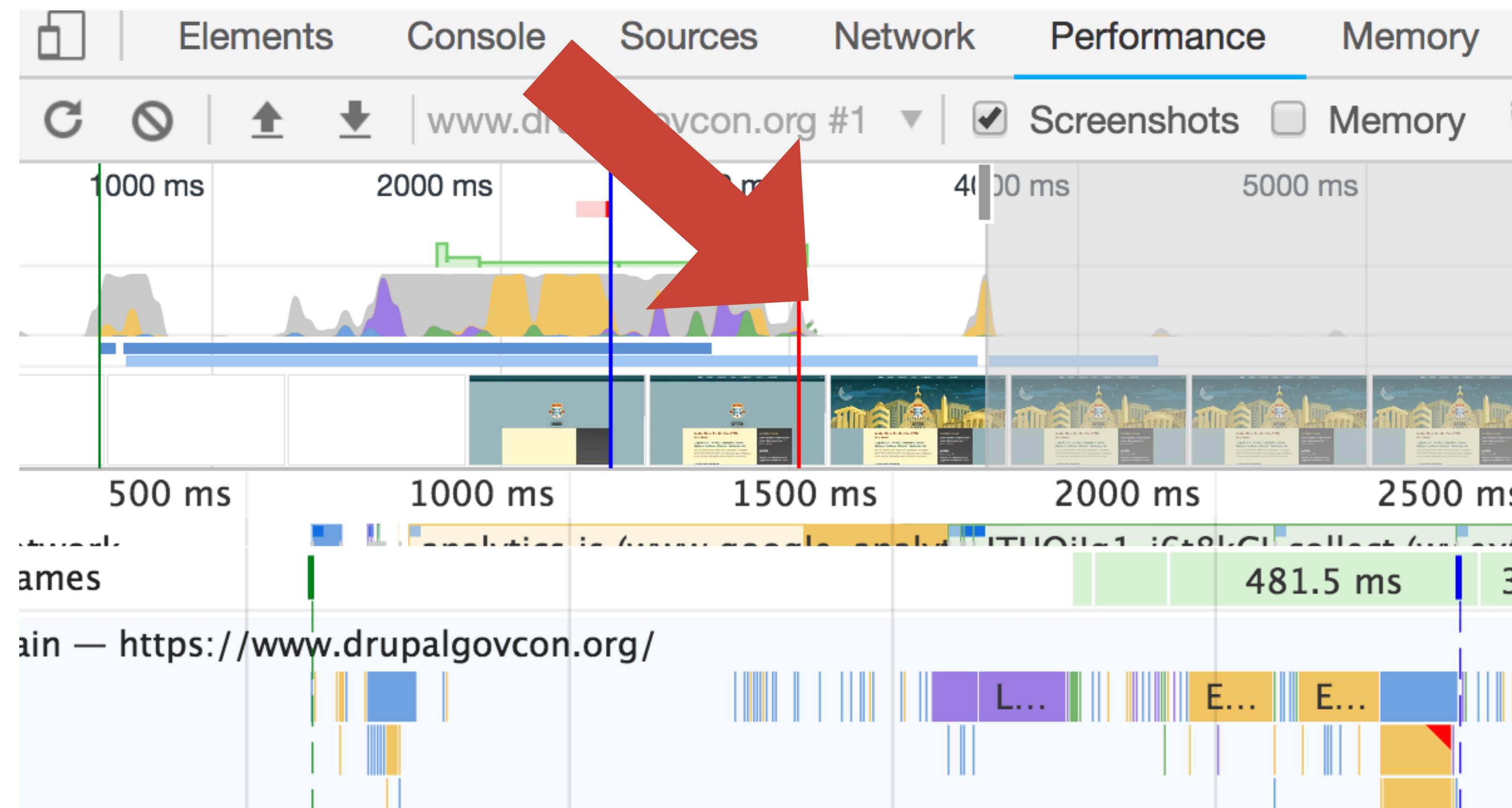
# TIME TO FIRST MEANINGFUL PAINT



# TIME TO INTERACTIVE

- ▶ Load is finished, and main thread work is done
- ▶ Consistently interactive

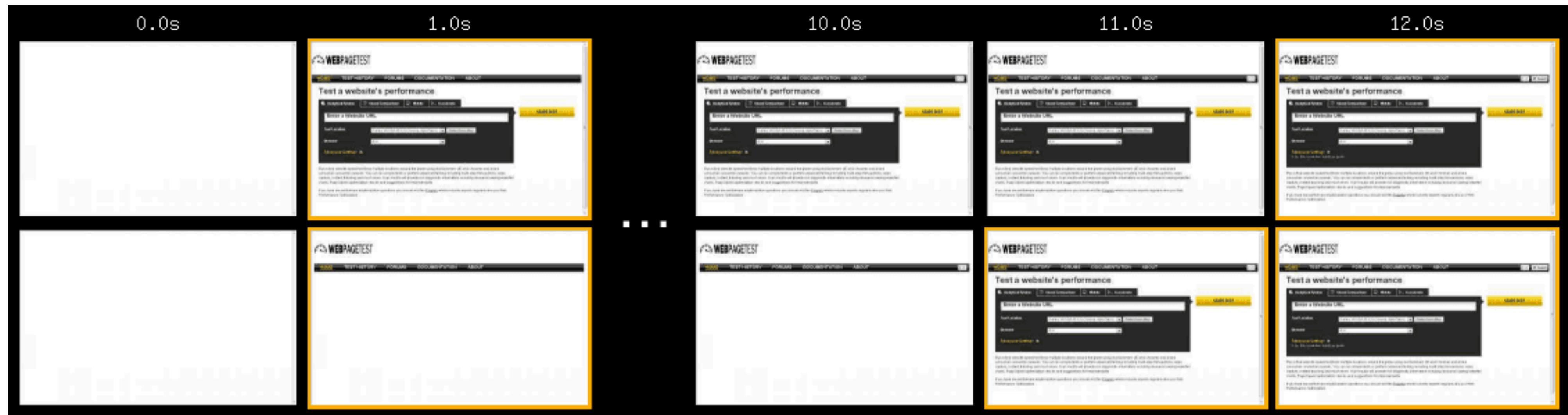
# TIME TO INTERACTIVE



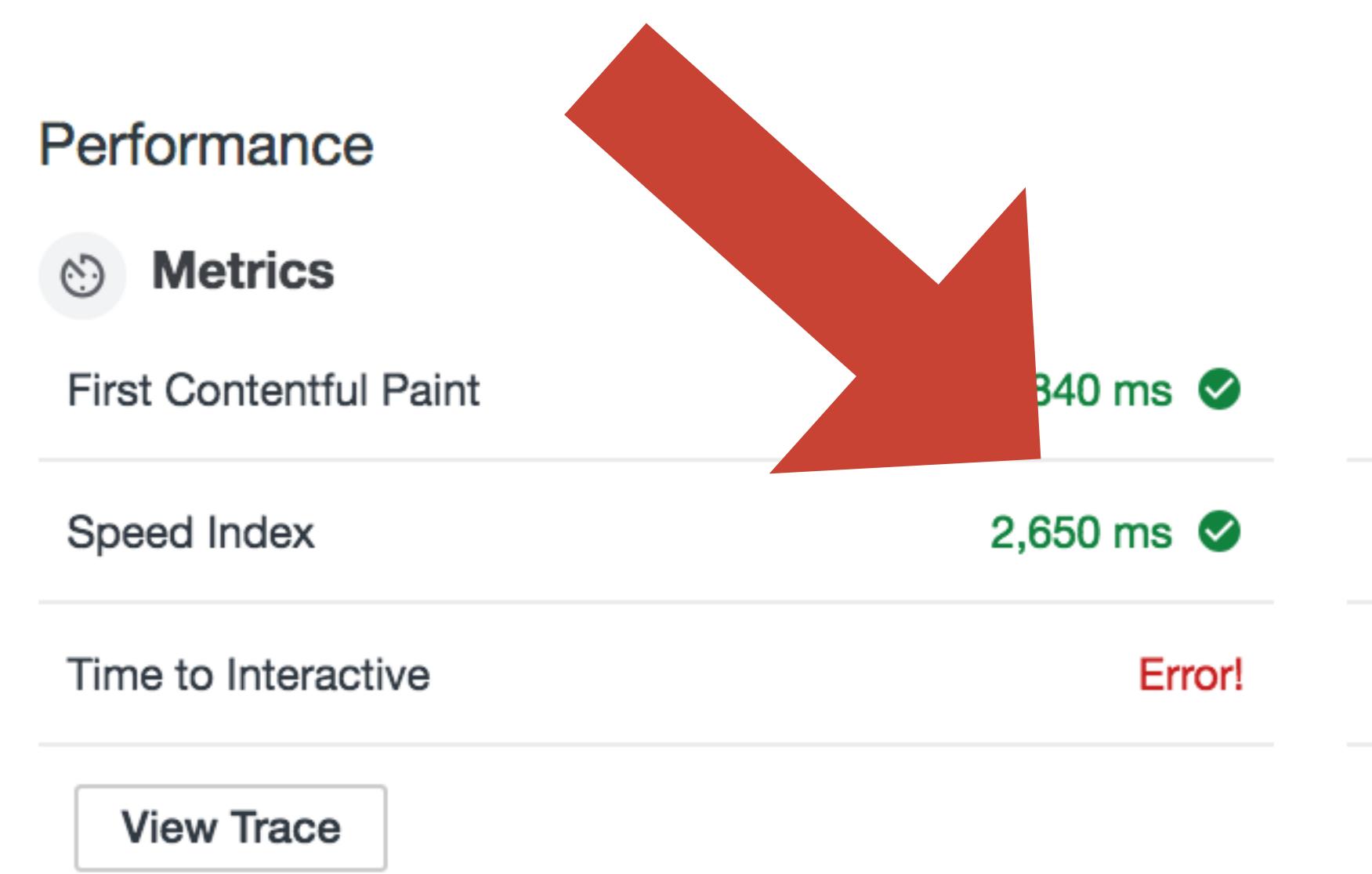
# SPEED INDEX

- ▶ Calculated value
- ▶ Average time at which visible parts of the page are displayed
- ▶ How quickly does the page approach visually complete?
- ▶ Essentially the time it takes for average pixel to paint (milliseconds)

# SPEED INDEX



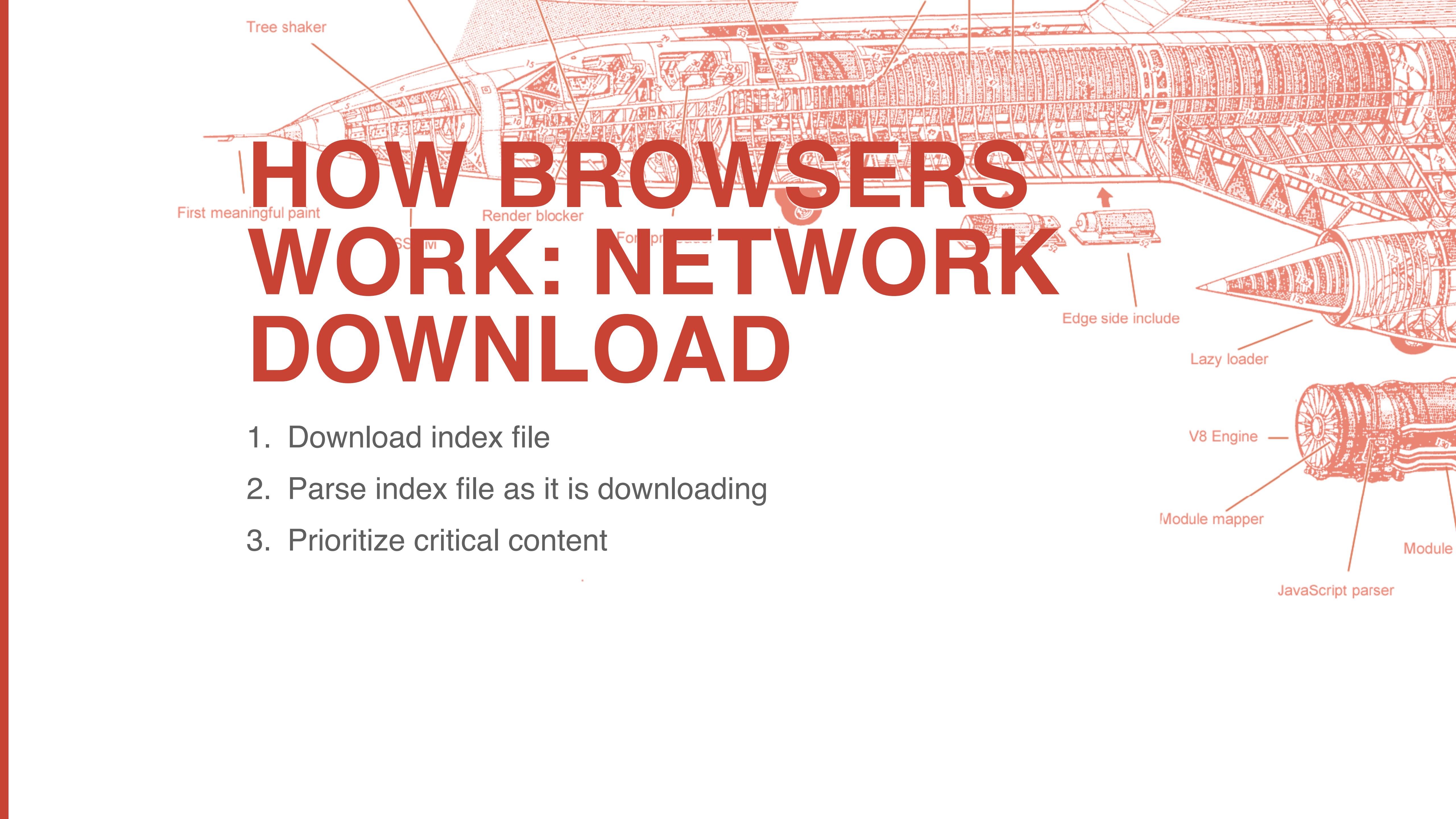
# SPEED INDEX



# **FRONTEND PERFORMANCE METRICS**

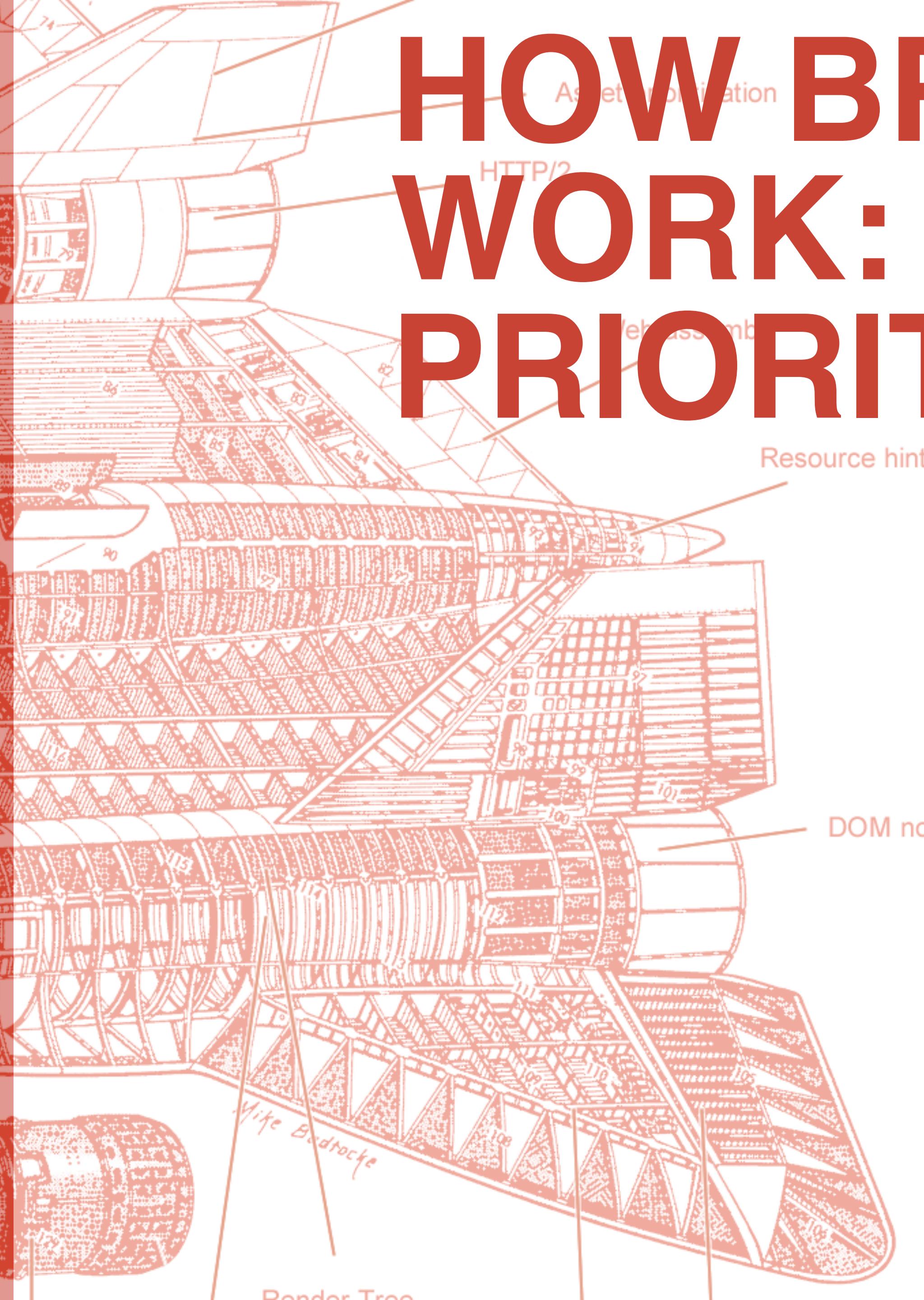
## **ORDER OF IMPORTANCE**

1. Speed Index
2. Time to First Interactive
3. Time to First Meaningful Paint
4. Time to First Byte



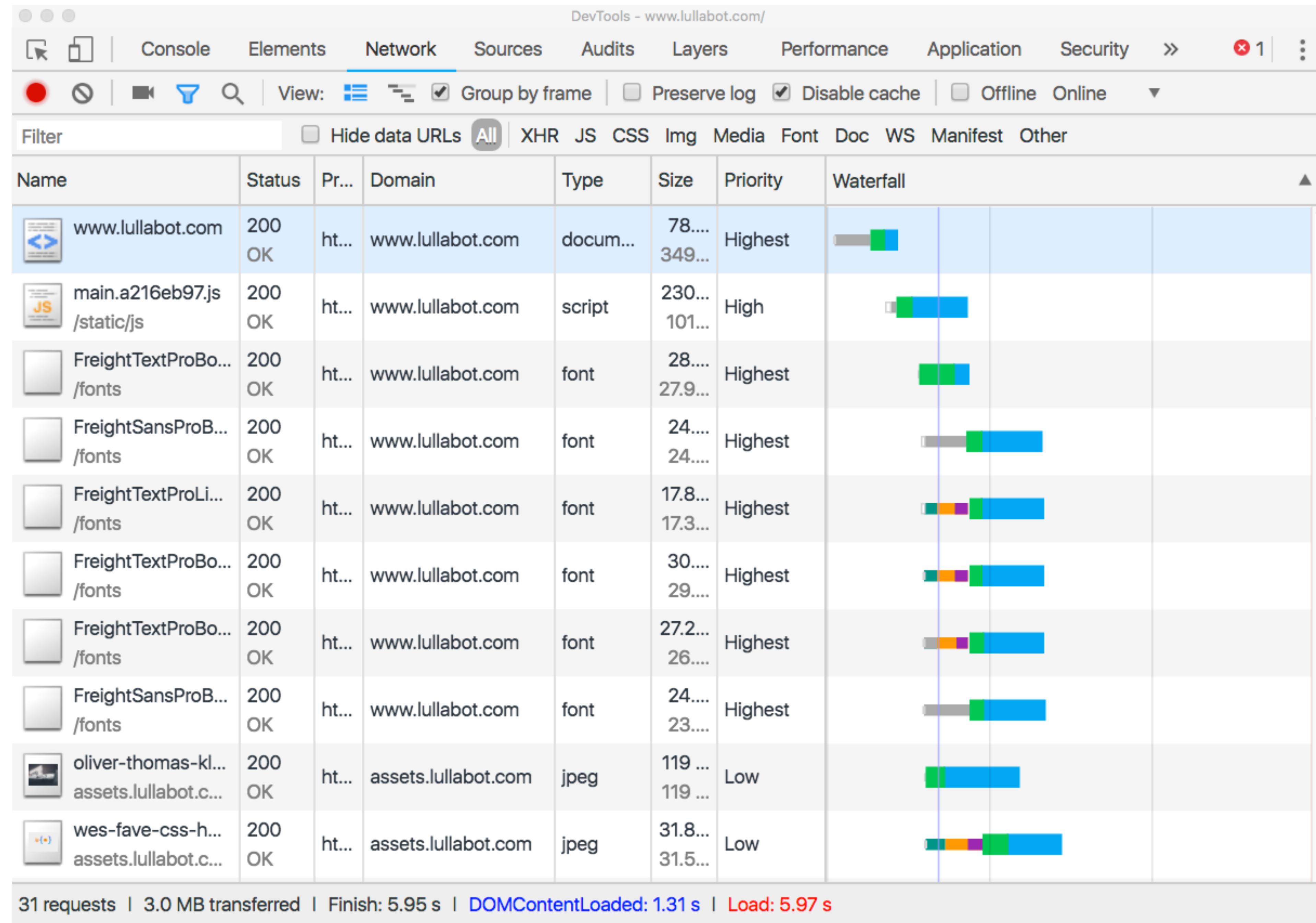
# HOW BROWSERS WORK: NETWORK DOWNLOAD

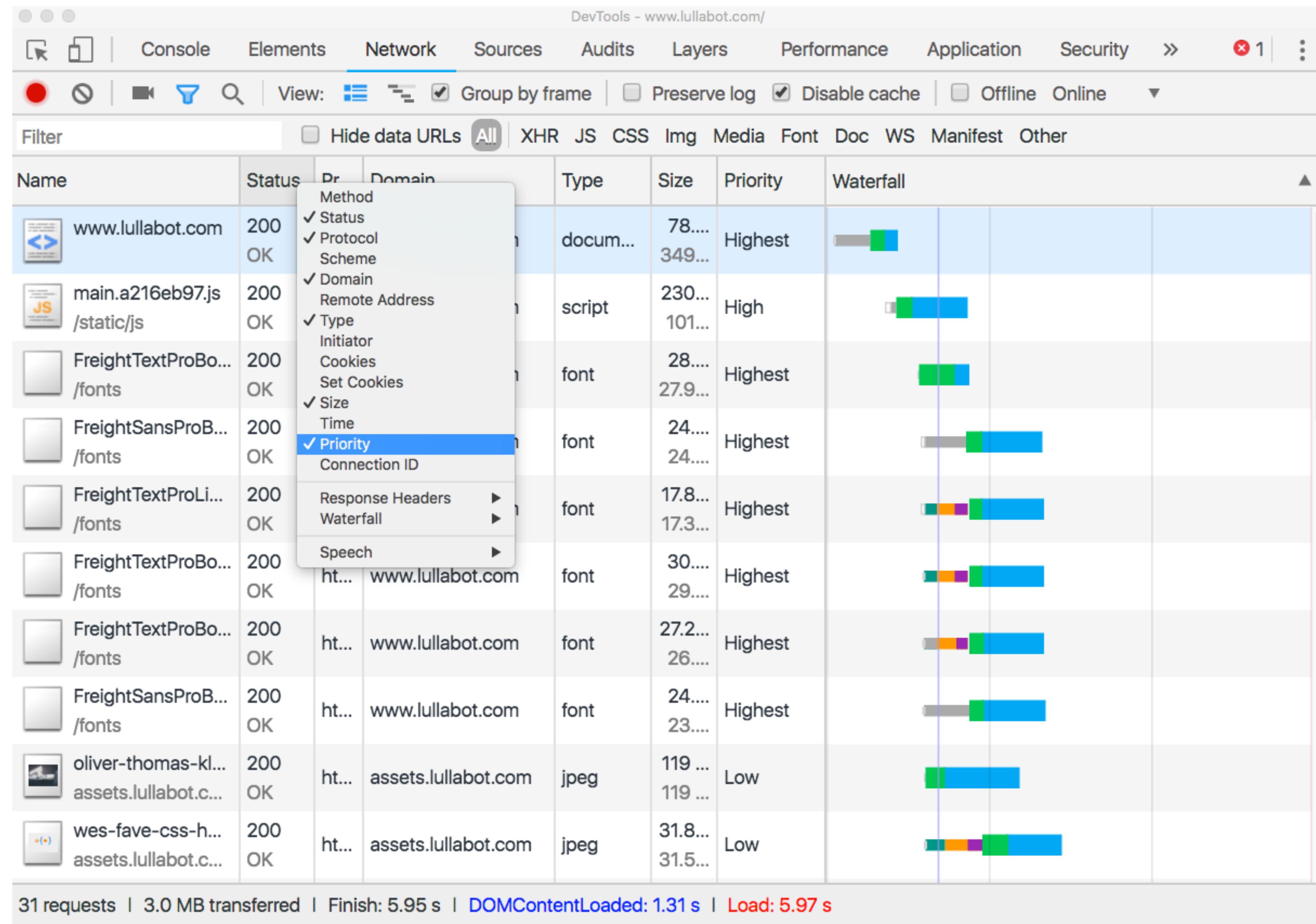
1. Download index file
2. Parse index file as it is downloading
3. Prioritize critical content



# HOW BROWSERS WORK: PRIORITIZING

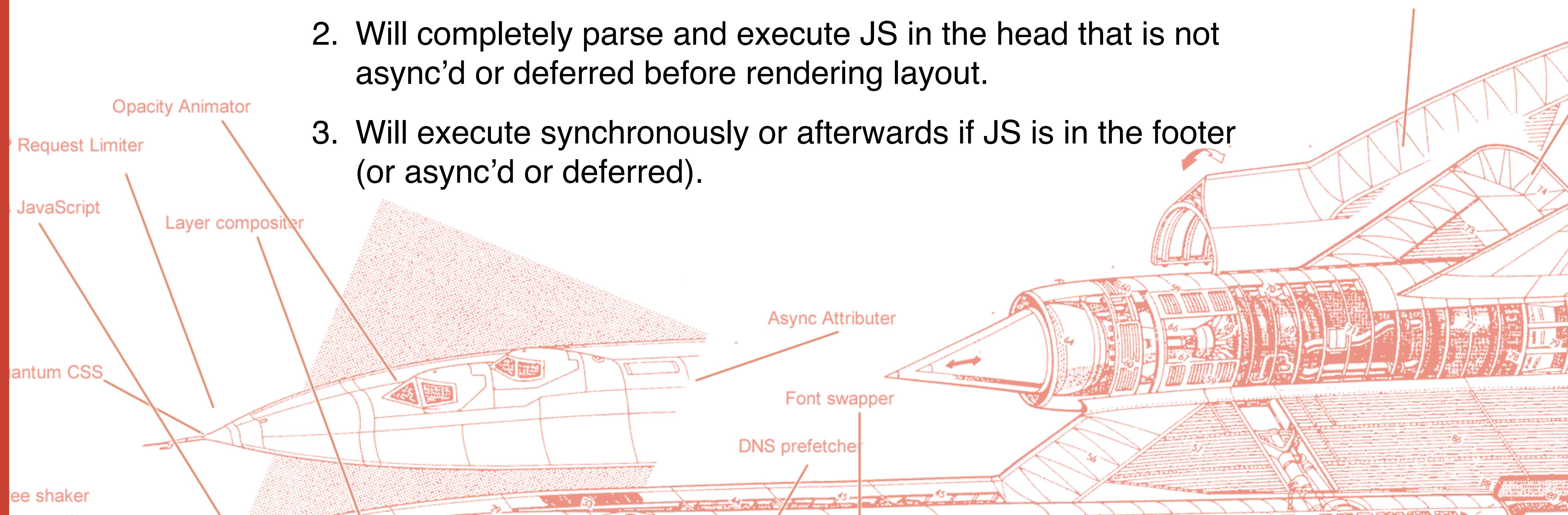
- 1. Highest**
  - ▶ Initial document
  - ▶ Webfonts
  - ▶ CSS
- 2. High**
  - ▶ Script tags in the `<head>`
  - ▶ XHR
- 3. Medium**
  - ▶ Script tags outside of the `<head>`
- 4. Low**
  - ▶ Images



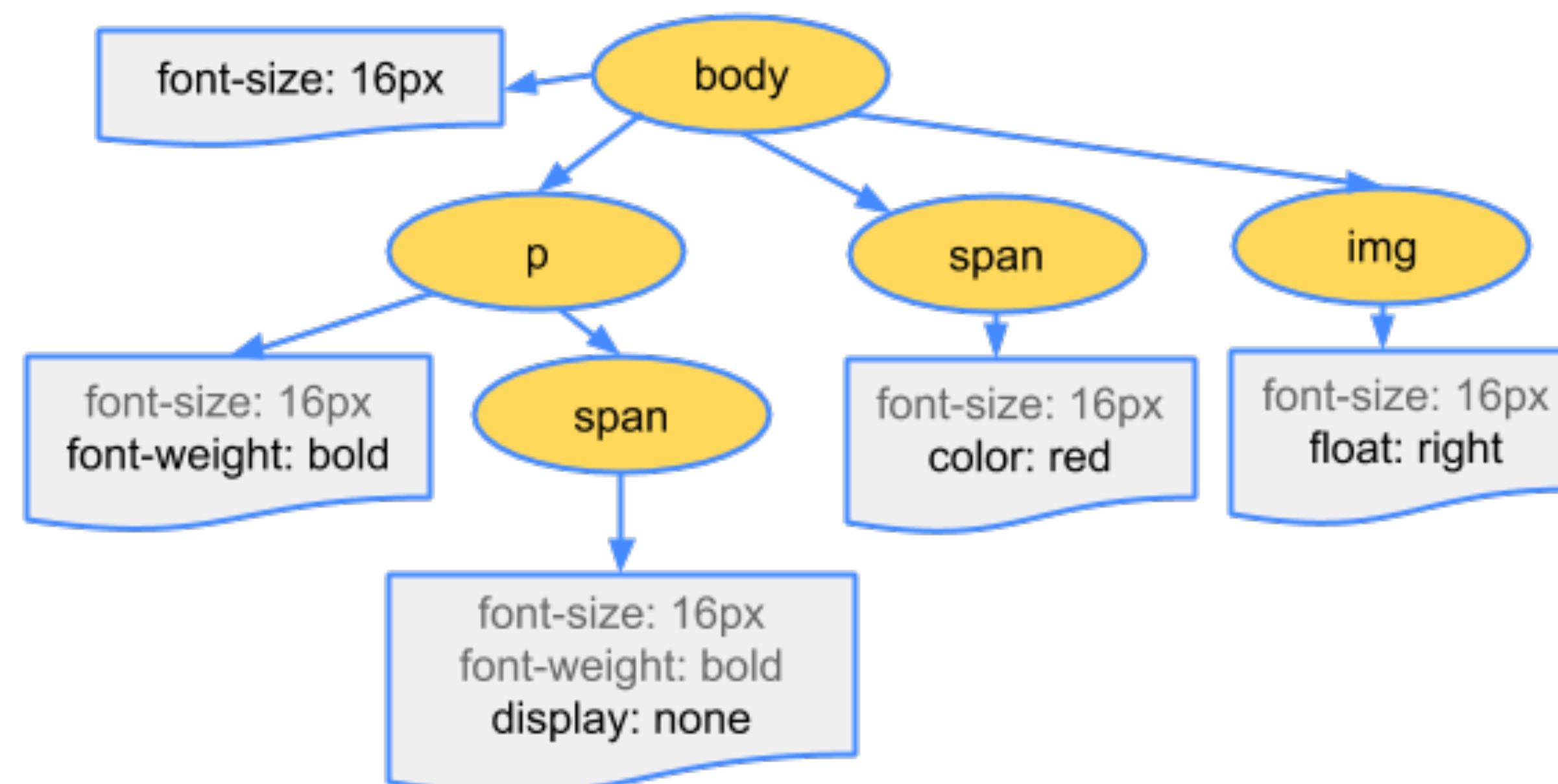


# HOW BROWSERS WORK: PARSE / EXECUTE CSS & JS

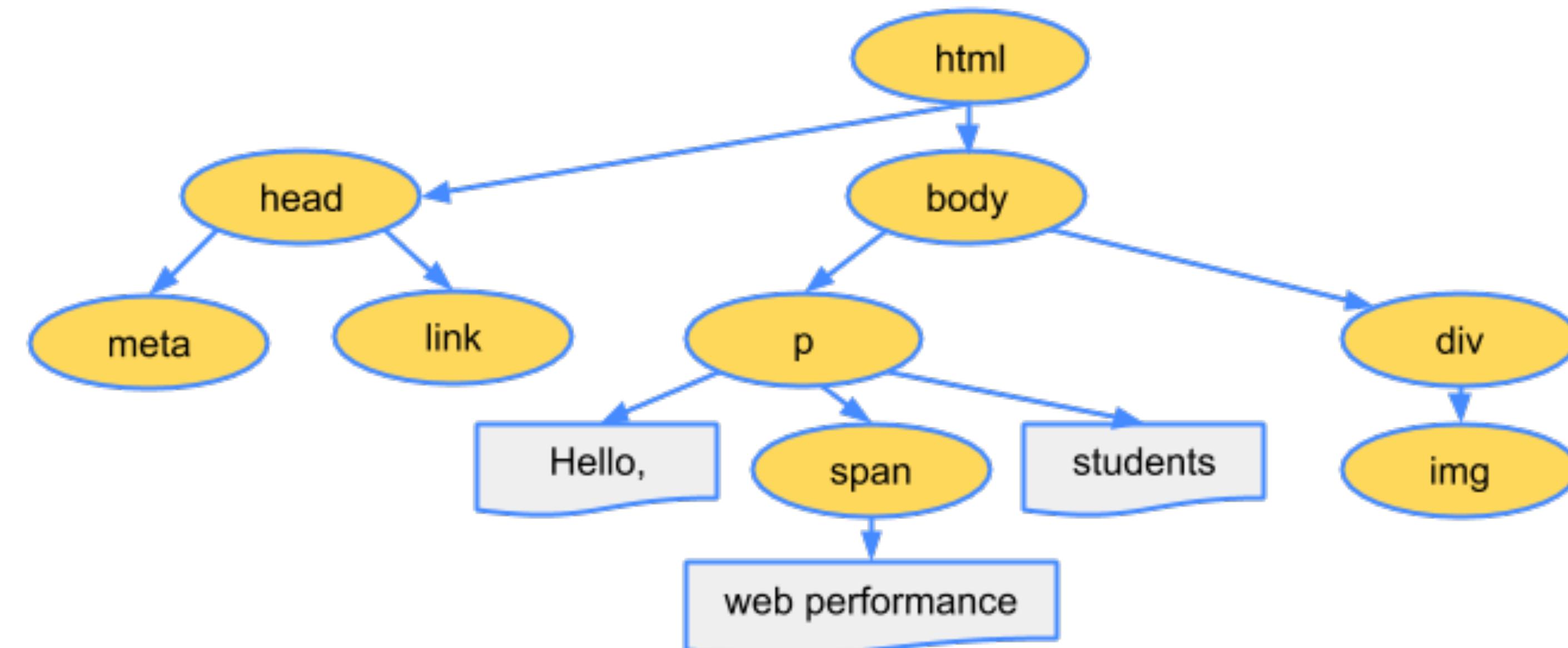
1. Browser parses and executes JS
2. Will completely parse and execute JS in the head that is not async'd or deferred before rendering layout.
3. Will execute synchronously or afterwards if JS is in the footer (or async'd or deferred).



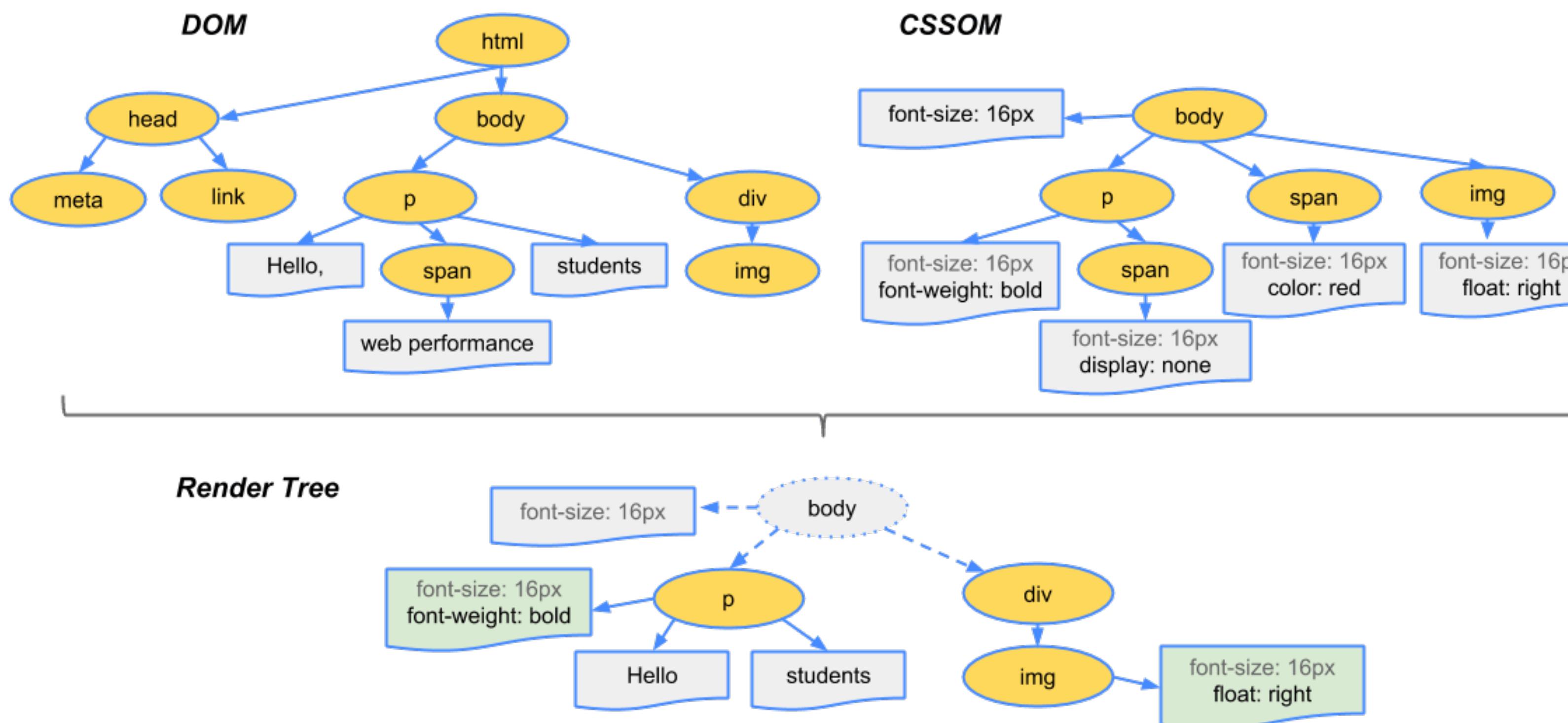
# HOW BROWSERS WORK: CREATING THE CSSOM



# HOW BROWSERS WORK: CREATING THE DOM

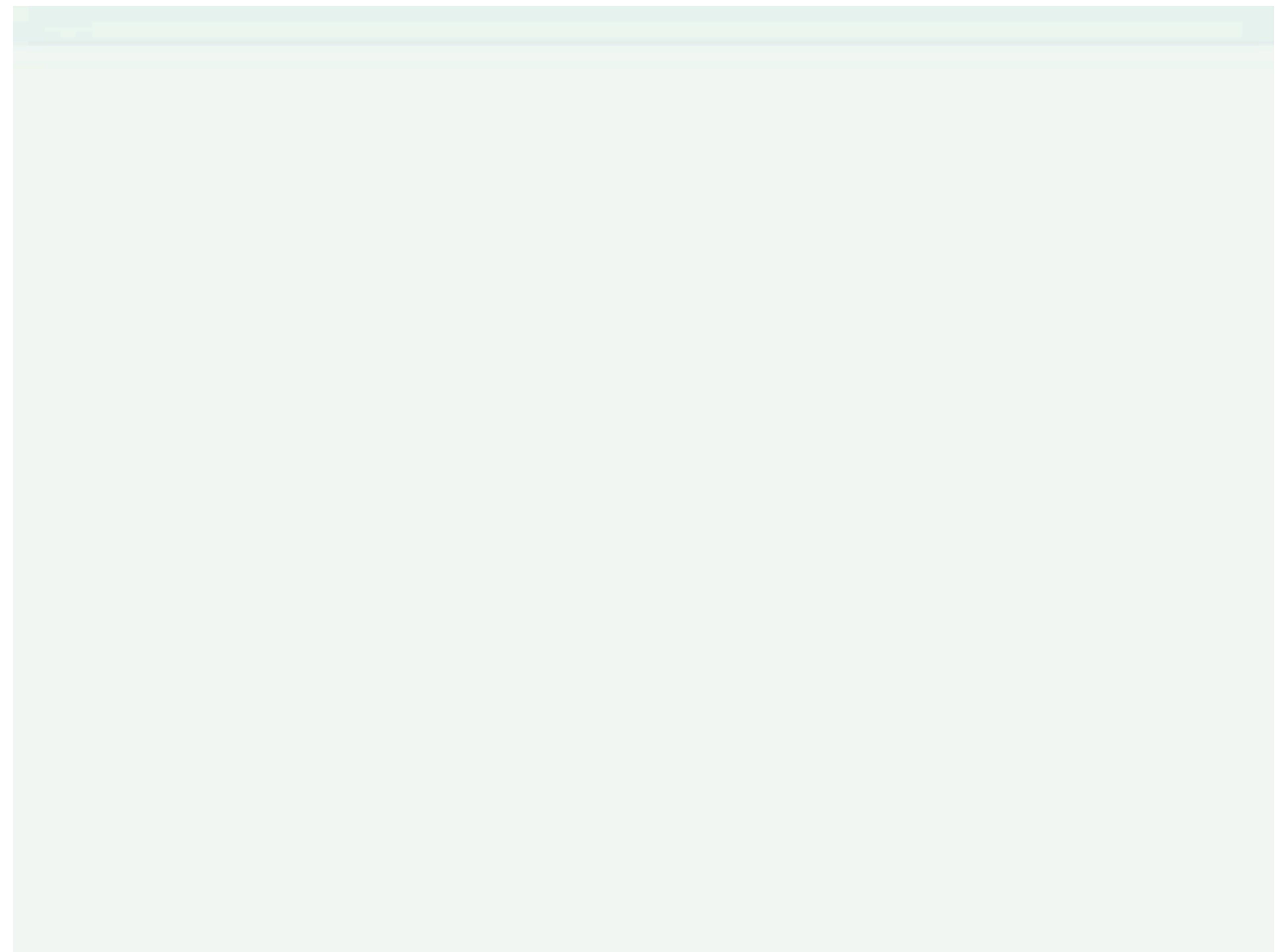


# HOW BROWSERS WORK: CREATING THE RENDER TREE



# AYOUT (AKA REFLOW)

- ▶ Browser calculates how much space it takes to put elements on screen.
- ▶ Calculates where to place the elements on the screen in relation to other elements and the viewport.
- ▶ Expensive.



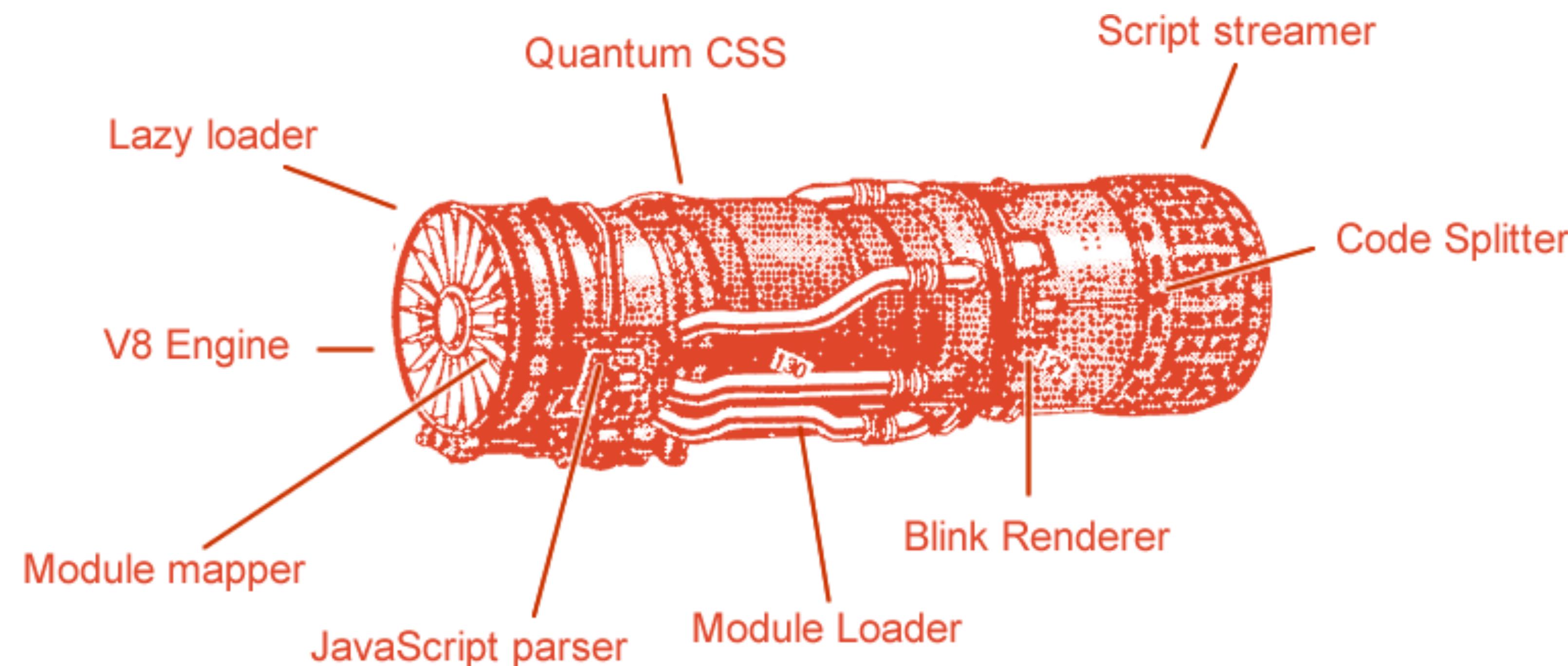
# PAINT

- ▶ The process of filling in pixels.
- ▶ Text, colors, images, borders, etc
- ▶ Expensive.

# COMPOSITING

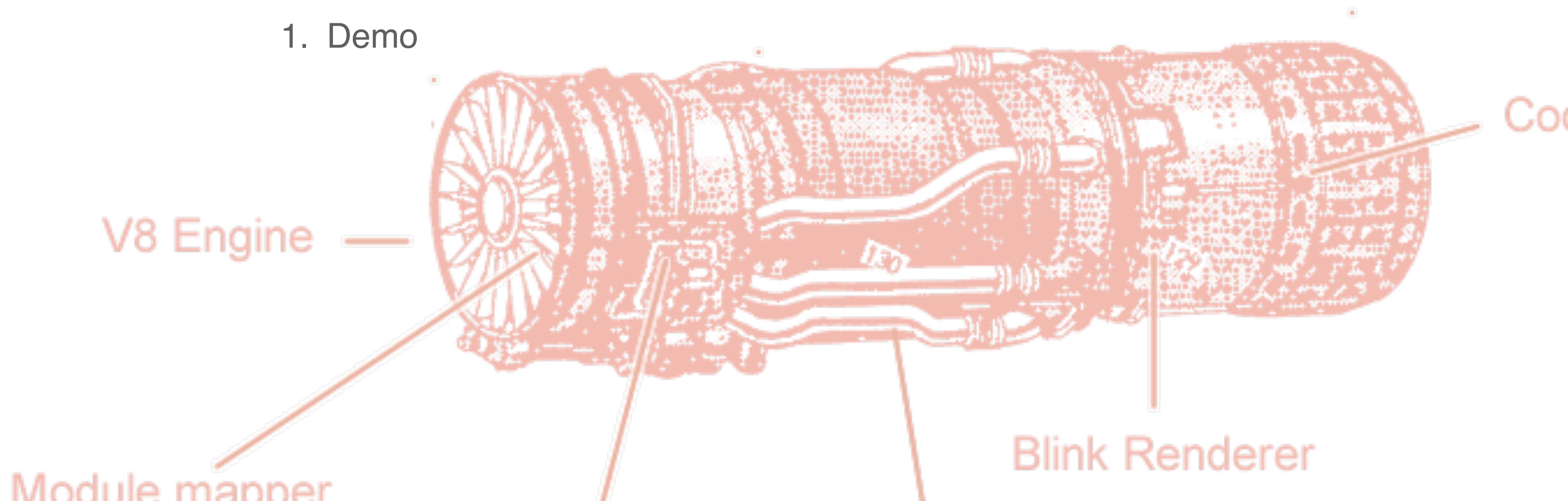
- Multiple layers within browser get placed on the screen.
- Think of these as Photoshop layers - they can easily be moved around
- Cheap!

# MEASURING PERFORMANCE



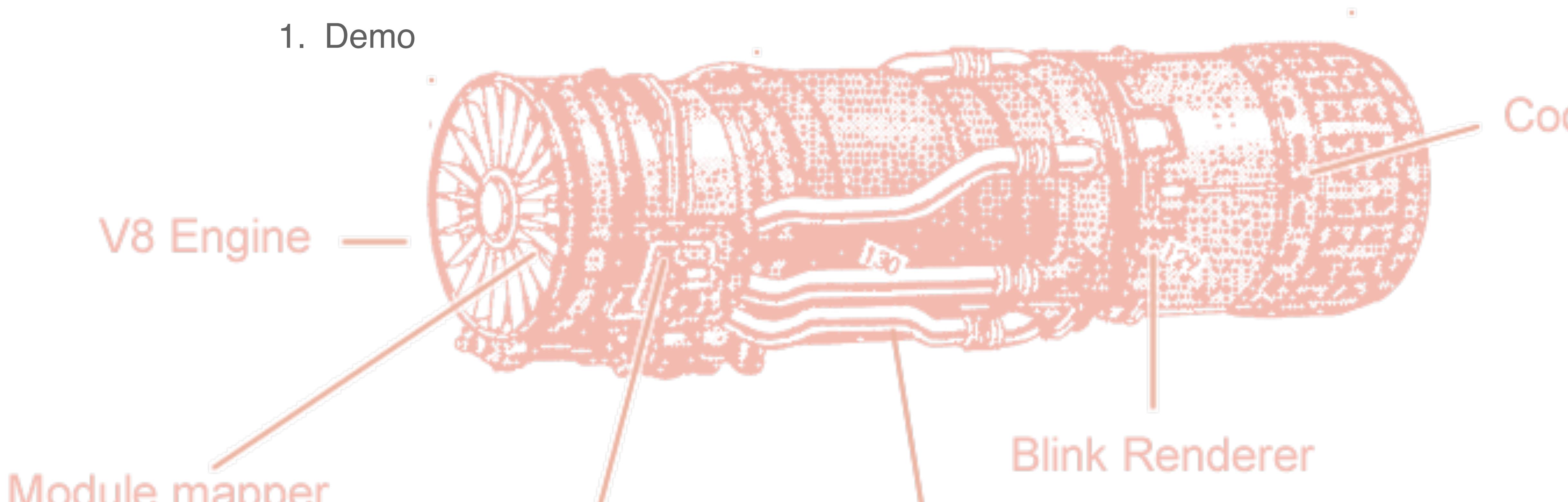
# MEASURING PERF: DEVTOOLS PERFORMANCE

1. Demo



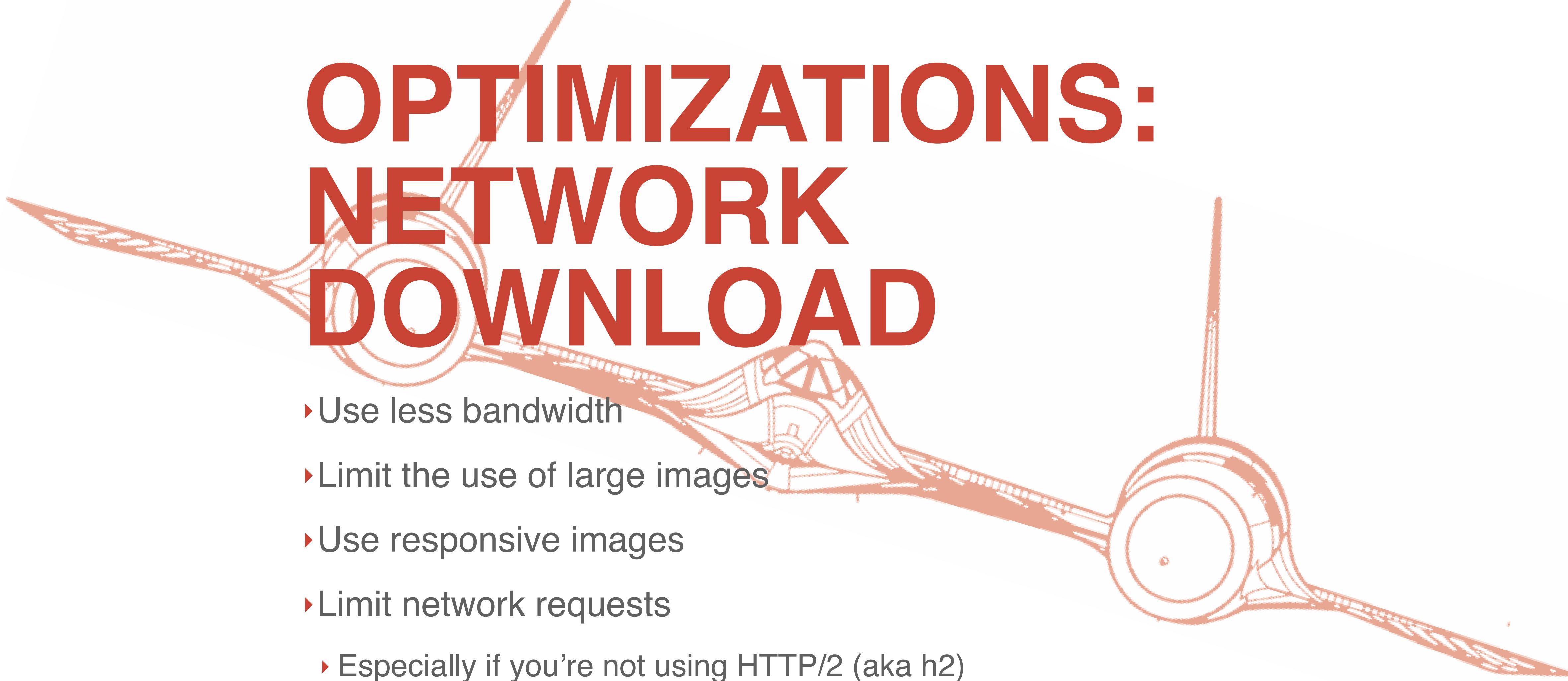
# MEASURING PERF: DEVTOOLS AUDITS TAB

1. Demo



# OPTIMIZATIONS

# OPTIMIZATIONS: NETWORK DOWNLOAD



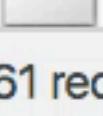
- ▶ Use less bandwidth
- ▶ Limit the use of large images
- ▶ Use responsive images
- ▶ Limit network requests
  - ▶ Especially if you're not using HTTP/2 (aka h2)

DevTools - www.lullabot.com/

Console Elements Network Sources Audits Layers Performance Application Security Memory React x 1 :

View: Group by frame  Preserve log  Disable cache  Offline Online ▾

Filter  Hide data URLs All XHR JS CSS Img Media Font Doc WS Manifest Other

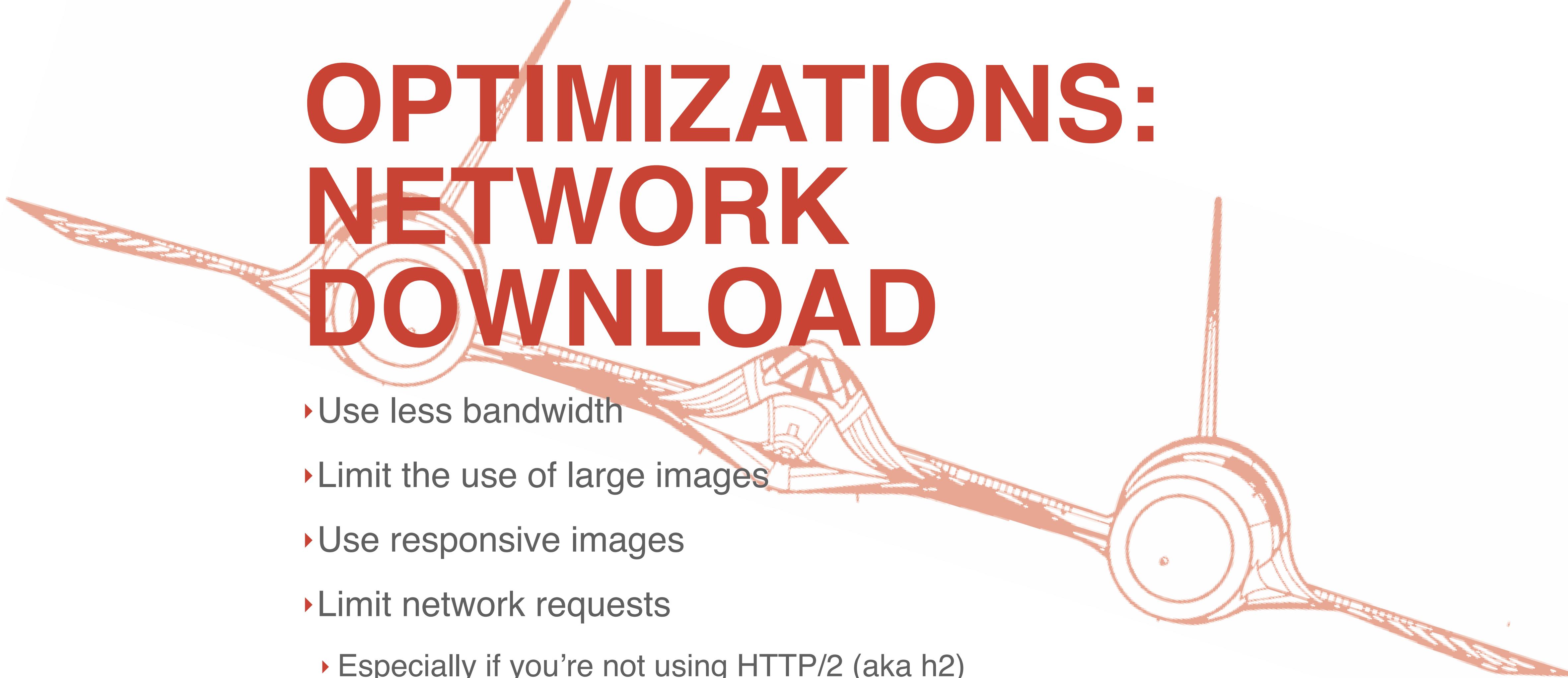
Name	Status	Proto...	Domain	Type	Size	Priority	Waterfall
 www.lullabot.com	200 OK	http/1.1	www.lullabot.com	document	78.3 KB 349 KB	Highest	
 main.a216eb97.js /static/js	200 OK	http/1.1	www.lullabot.com	script	230 KB 1015 KB	High	
 FreightTextProBook.woff2 /fonts	200 OK	http/1.1	www.lullabot.com	font	28.3 KB 27.9 KB	Highest	
 FreightSansProBold.woff2 /fonts	200 OK	http/1.1	www.lullabot.com	font	24.8 KB 24.3 KB	Highest	
 FreightTextProLightItalic.woff2 /fonts	200 OK	http/1.1	www.lullabot.com	font	17.8 KB 17.3 KB	Highest	
 FreightTextProBookItalic.woff2 /fonts	200 OK	http/1.1	www.lullabot.com	font	30.3 KB 29.9 KB	Highest	
 FreightTextProBookLight.woff2 /fonts	200 OK	http/1.1	www.lullabot.com	font	27.2 KB 26.8 KB	Highest	
 FreightSansProBook.woff2 /fonts	200 OK	http/1.1	www.lullabot.com	font	24.3 KB 23.9 KB	Highest	
 oliver-thomas-klein-144899.jpg assets.lullabot.com/styles/dyna...	200 OK	http/1.1	assets.lullabot.com	jpeg	119 KB 119 KB	Low	
 wes-fave-css-hero.jpg assets.lullabot.com/styles/dyna...	200 OK	http/1.1	assets.lullabot.com	jpeg	31.8 KB 31.5 KB	Low	
 ricardo-gomez-angel-365492-u... assets.lullabot.com/styles/dyna...	200 OK	http/1.1	assets.lullabot.com	jpeg	202 KB 202 KB	Low	

61 requests | 6.8 MB transferred | Finish: 54.2 min | DOMContentLoaded: 1.31 s | Load: 5.97 s

# PRPL PATTERN

- ▶ **Push** critical resources for the initial URL route.
- ▶ **Render** initial route.
- ▶ **Pre-cache** remaining routes.
- ▶ **Lazy-load** and create remaining routes on demand.

# OPTIMIZATIONS: NETWORK DOWNLOAD



- ▶ Use less bandwidth
- ▶ Limit the use of large images
- ▶ Use responsive images
- ▶ Limit network requests
  - ▶ Especially if you're not using HTTP/2 (aka h2)

DevTools - pantheon.io/

Console Elements Network Sources Audits Layers Performance Application Security Memory ⚠ 3 :

View: Group by frame  Preserve log  Disable cache  Offline Online ▾

Filter  Hide data URLs All XHR JS CSS Img Media Font Doc WS Manifest Other

Recording network activity...

Perform a request or hit ⌘ R to record the reload.

DevTools - www.lullabot.com/

Console Elements Network Sources Audits Layers Performance Application Security Memory React × 1 :

View: Group by frame Preserve log Disable cache Offline Online ▾

Filter Hide data URLs All XHR JS CSS Img Media Font Doc WS Manifest Other



Recording network activity...

Perform a request or hit ⌘ R to record the reload.

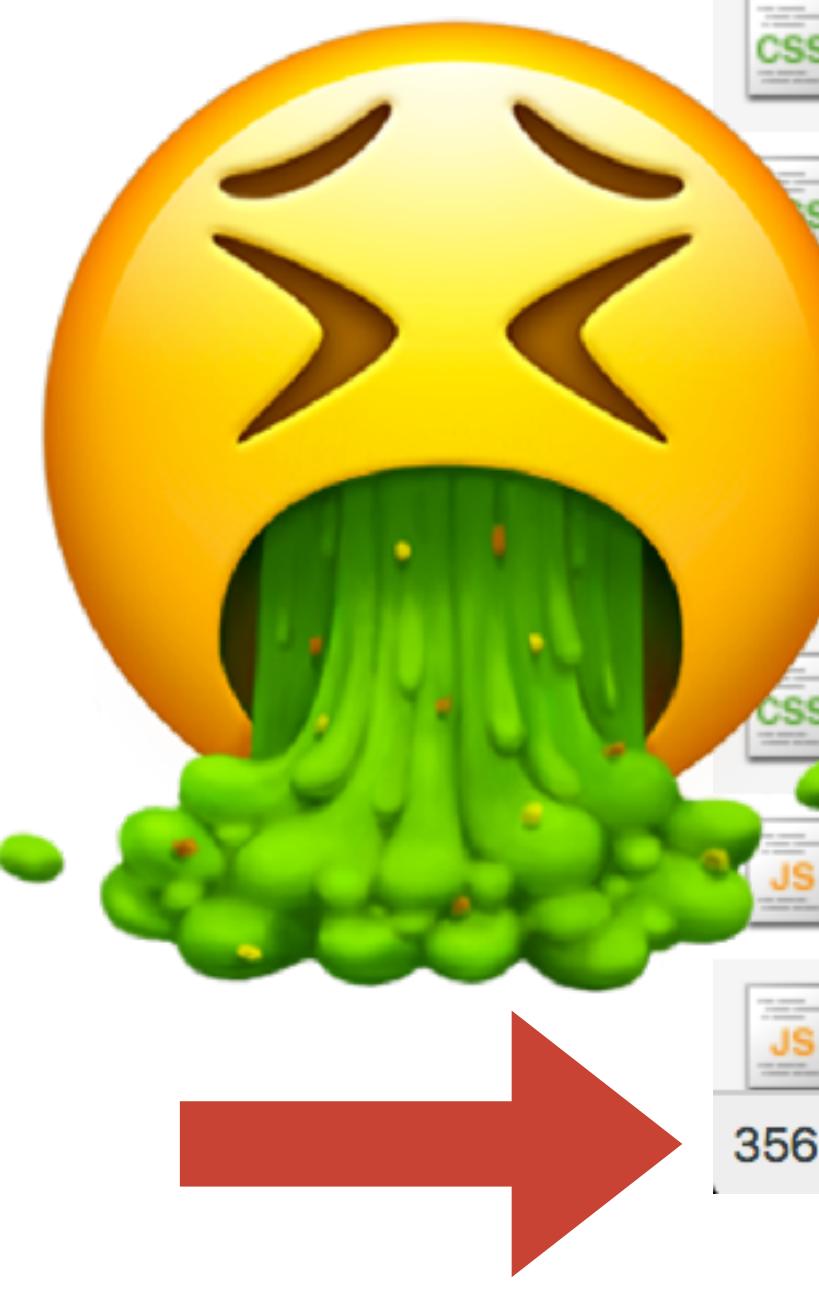
DevTools - www.syfy.com/

Console Elements Network Sources Audits Layers Performance Application Security Memory » 2 23 :

View: Group by frame Preserve log Disable cache Offline Online

Filter Hide data URLs All XHR JS CSS Img Media Font Doc WS Manifest Other

Name	Stat...	Protocol	Do...	Type	Size	Priority	Waterfall
www.syfy.com	200 OK	http/1.1	ww...	document	51.... 26...	Highest	
SYFY_Hero-Regular.w...	200 OK	http/1.1	ww...	font	18.... 18....	High	
SYFY_Sidekick-Regul...	200 OK	http/1.1	ww...	font	17.... 17.1...	High	
GT-Cinetype-Syfy-Lig...	200 OK	http/1.1	ww...	font	35.... 35....	High	
fonts.css	200 OK	http/1.1	ww...	stylesheet	83.... 2.8...	Highest	
css_2VWmjUt59_T44...	200 OK	http/1.1	ww...	stylesheet	4.1 ... 18....	Highest	
css_XW3gNESJAy-c...	200 OK	http/1.1	ww...	stylesheet	2.8... 8.2...	Highest	
css_DJZUQV8aF7QE...	200 OK	http/1.1	ww...	stylesheet	1.1 ... 1.8 ...	Highest	
css_rHwRbYMQjmOp...	200 OK	http/1.1	ww...	stylesheet	90.... 81...	Highest	
js_1S3DvBE0uhZ-Vbv...	200 OK	http/1.1	ww...	script	76.... 36...	High	
js_pREQwMBF3pMD3...	200 OK	http/1.1	ww...	script	49.... 12...	High	



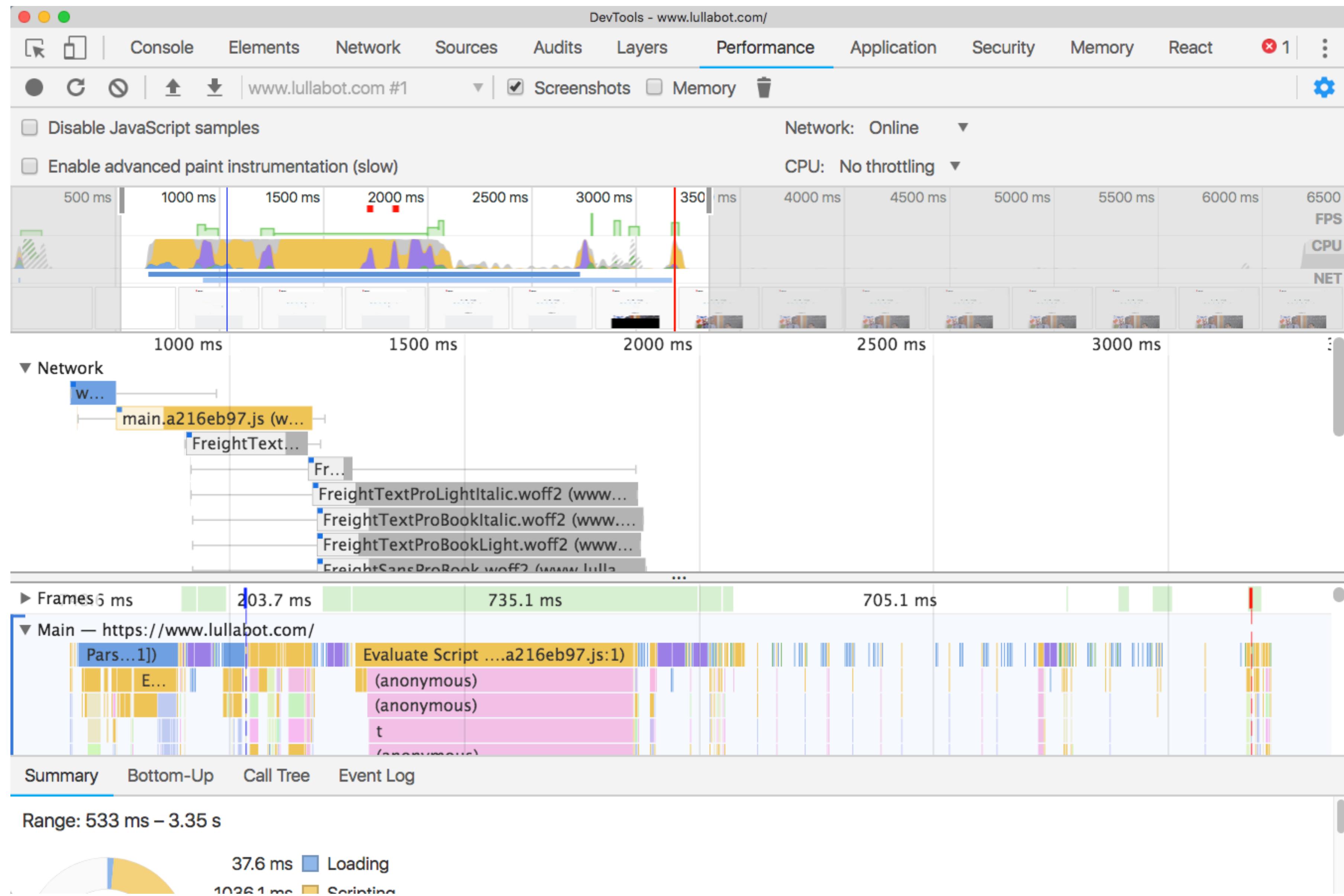
356 requests | 7.1 MB transferred | Finish: 1.2 min | DOMContentLoaded: 3.51 s | Load: 15.83 s

# RESOURCE HINTS

- Link tags inserted in <HEAD> that tell the browser to reach out and download or connect to resources
  - `<link rel='preload' ...>`
  - `<link rel='dns-prefetch' ...>`
  - `<link rel='preconnect' ...>`

# PRELOAD IN ACTION

```
1 <!DOCTYPE html>
2 <html lang="en">
3
4 <head>
5   <meta charset="utf-8">
6   <meta name="viewport" content="width=device-width,initial-scale=1,shrink-to-fit=no">
7   <meta name="theme-color" content="#000000">
8   <link rel="manifest" href="/manifest.json">
9   <link rel="icon" type="image/png" href="/favicon.png" />
10  <title>Lullabot</title>
11  <link href="https://api.lullabot.com" rel="preconnect" crossorigin>
12  <link href="https://assets.lullabot.com" rel="preconnect" crossorigin>
13  <link rel="preload" href="/static/js/main.a216eb97.js" as="script" />
14 <style type="text/css">
15   @font-face {
16     font-family: 'FreightTextPro';
17     font-weight: 300;
18     font-style: normal;
19     src: url('/fonts/FreightTextProBookLight.woff2') format('woff2'), url('/fonts/FreightTextProBookLight.woff') format('woff')
20   }
21
22   @font-face {
```



# PRECONNECT IN ACTION

```
1  <!DOCTYPE html>
2  <html lang="en">
3
4  <head>
5      <meta charset="utf-8">
6      <meta name="viewport" content="width=device-width,initial-scale=1,shrink-to-fit=no">
7      <meta name="theme-color" content="#000000">
8      <link rel="manifest" href="/manifest.json">
9      <link rel="icon" type="image/png" href="/favicon.png" />
10     <title>lullabot</title>
11     <link href="https://api.lullabot.com" rel="preconnect" crossorigin>
12     <link href="https://assets.lullabot.com" rel="preconnect" crossorigin>
13     <script src="https://cdn.jsdelivr.net/npm/main@216c307.js" as="script">
14
15     <style type="text/css">
16         @font-face {
17             font-family: 'FreightTextPro';
18             font-weight: 300;
19             font-style: normal;
20             src: url('/fonts/FreightTextProBookLight.woff2') format('woff2'), url('/fonts/FreightTextProBookLight.woff') format('woff')
21         }
22
23         @font-face {
24             font-family: 'FreightTextPro';
25             font-weight: 300;
26             font-style: italic;
27             src: url('/fonts/FreightTextProLightItalic.woff2') format('woff2'), url('/fonts/FreightTextProLightItalic.woff') format('wo
```

DevTools - www.lullabot.com/

Console Elements Network Sources Audits Layers Performance Application Security Memory React × 1 :

View: Group by frame Preserve log Disable cache Offline Online

domain:assets.lullabot.com Hide data URLs All XHR JS CSS Img Media Font Doc WS Manifest Other

Search headers and response bodies for domain:assets.lullabot.com Find All

Name	Status	Proto...	Domain	Type	Size	Priority	Waterfall
william-bout-264826.jpg	200 OK	http/1.1	assets.lullabot.com	jpeg	238 KB 237 KB	Low	
oliver-thomas-klein-144899.jpg	200 OK	http/1.1	assets.lullabot.com				
lightning-sky-storm-53459.jpg	200 OK	http/1.1	assets.lullabot.com				
wes-fave-css-hero.jpg	200 OK	http/1.1	assets.lullabot.com				
img_1600g.jpg	200 OK	http/1.1	assets.lullabot.com				
hero-david-pisnoy-545993-uns...	200 OK	http/1.1	assets.lullabot.com				
syfy_the-expande_promo-image...	200 OK	http/1.1	assets.lullabot.com				
hero_nyu-langone.jpg	200 OK	http/1.1	assets.lullabot.com				
hero_b2x_0.jpg	200 OK	http/1.1	assets.lullabot.com				

Queued at 877.64 ms

Started at 886.41 ms

Resource Scheduling

Queueing 8.77 ms

Connection Start

Stalled 10.19 ms

DNS Lookup 152.12 ms

Initial connection 161.55 ms

SSL 113.51 ms

Request/Response

Request sent 0.12 ms

Waiting (TTFB) 45.65 ms

Content Download 661.81 ms

Explanation 1.05 s

9 / 29 requests | 2.2 MB / 2.7 MB transferred | Finish: 3.12 s | DOMContentLoaded: 987 ms | Load: 3.13 s

DevTools - www.lullabot.com/

Console Elements Network Sources Audits Layers Performance Application Security Memory React × 1 :

View: Group by frame Preserve log Disable cache Offline Online

domain:api.lullabot.com Hide data URLs All XHR JS CSS Img Media Font Doc WS Manifest Other

Search headers and response body main:api.lullabot.com Find All

Name	Proto...	Domain	Type	Size	Priority
_all_docs?include_docs=true api.lullabot.com/lullabot	http/1.1	api.lullabot.com	fetch	402 B 0 B	High
_all_docs?include_docs=true api.lullabot.com/lullabot	http/1.1	api.lullabot.com			
_all_docs?include_docs=true api.lullabot.com/lullabot	http/1.1	api.lullabot.com			
_all_docs?include_docs=true api.lullabot.com/lullabot	http/1.1	api.lullabot.com			
_all_docs?include_docs=true api.lullabot.com/lullabot	http/1.1	api.lullabot.com			
_all_docs?include_docs=true api.lullabot.com/lullabot	http/1.1	api.lullabot.com			
_all_docs?include_docs=true api.lullabot.com/lullabot	204 No Content	http/1.1	fetch	401 B 0 B	High
_all_docs?include_docs=true api.lullabot.com/lullabot	200 OK	http/1.1	text/plain	1.0 KB 831 B	High

Queued at 1.76 s  
Started at 1.76 s

Resource Scheduling TIME

Queueing 0.73 ms

Connection Start TIME

Stalled 2.74 ms

Request/Response TIME

Request sent 0.13 ms

Waiting (TTFB) 45.80 ms

Content Download 162.67 ms

Explanation 212.08 ms

10 / 29 requests | 12.7 KB / 2.7 MB transferred | Finish: 3.12 s | DOMContentLoaded: 987 ms | Load: 3.13 s

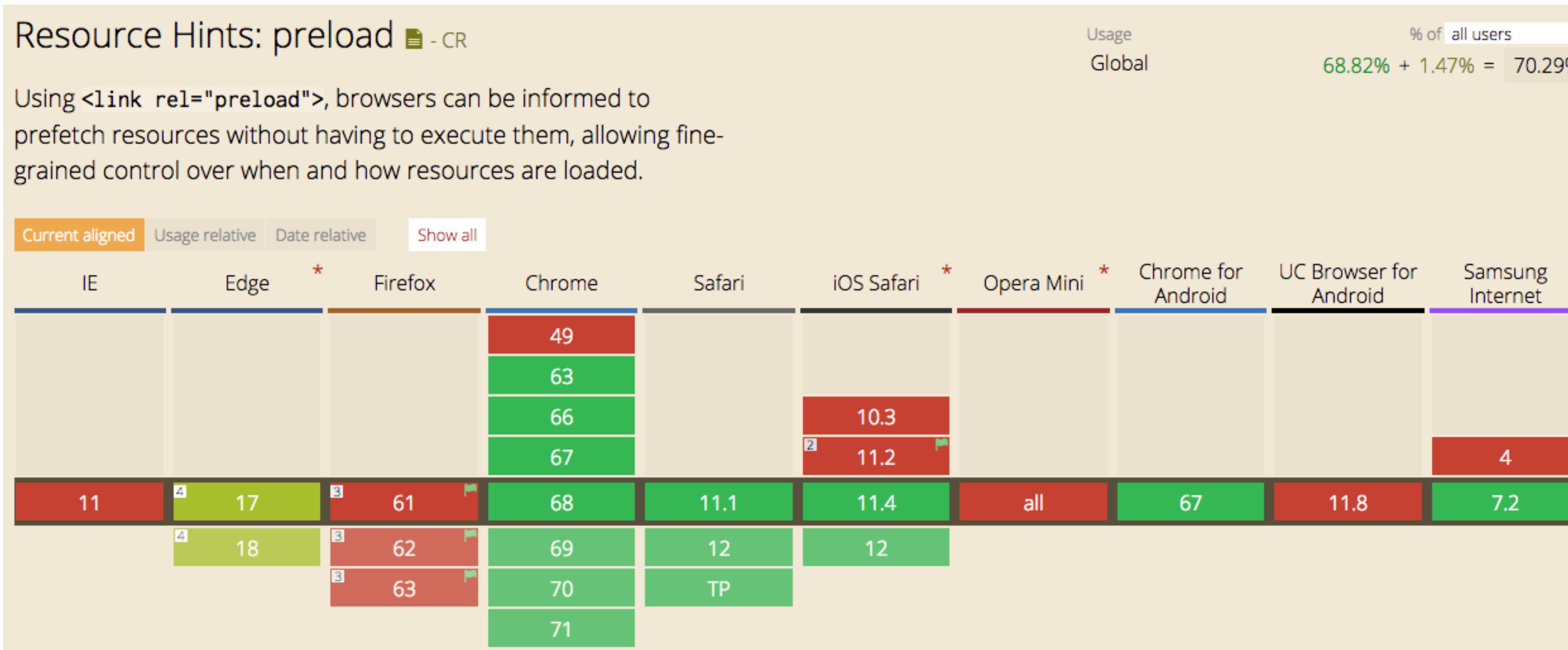
# ALL TOGETHER NOW...

```
<!DOCTYPE html>
<html lang="en" dir="ltr">

<head>
  <meta name="viewport" content="initial-scale=1.0, width=device-width">
  <meta name="theme-color" content="#eef1e">
  <link rel="preload" href="/sites/all/themes/zeus/fonts/tablet_gothic/360074_3_0.woff2" as="font" type="font/woff2" crossorigin>
  <link rel="preload" href="/sites/all/themes/zeus/fonts/tablet_gothic/360074_2_0.woff2" as="font" type="font/woff2" crossorigin>
  <link rel="preload" href="/sites/all/themes/zeus/fonts/tablet_gothic/360074_4_0.woff2" as="font" type="font/woff2" crossorigin>
  <link rel="preload" href="/sites/all/themes/zeus/fonts/tablet_gothic/360074_1_0.woff2" as="font" type="font/woff2" crossorigin>
  <link rel="preload" href="/sites/all/themes/zeus/fonts/tablet_gothic_condensed/360074_5_0.woff2" as="font" type="font/woff2" crossorigin>
  <link rel="preload" href="/sites/all/themes/zeus/fonts/adelle/360074_0_0.woff2" as="font" type="font/woff2" crossorigin>
  <link rel="preload" href="/sites/all/themes/zeus/images/new-design/homepage/hero-image-primary--small.jpg" as="image" media="(max-width: 640px)">
  <link rel="preload" href="/sites/all/themes/zeus/images/new-design/homepage/hero-image-primary--med.jpg" as="image" media="(min-width: 640px) and (max-width: 980px)">
  <link rel="preload" href="/sites/all/themes/zeus/images/new-design/homepage/hero-image-primary--med-large.jpg" as="image" media="(min-width: 980px) and (max-width: 1200px)">
  <link rel="preload" href="/sites/all/themes/zeus/images/new-design/homepage/hero-image-primary.jpg" as="image" media="(min-width: 1200px)">
  <link rel="preconnect" href="https://fonts.googleapis.com">
  <link rel="preconnect" href="https://app-ab05.marketo.com">
  <link rel="preconnect" href="https://cdnjs.cloudflare.com">
  <link rel="preconnect" href="https://cdn.optimizely.com">
  <link rel="preconnect" href="https://logx.optimizely.com">
  <link rel="preconnect" href="https://static.olark.com">
  <meta http-equiv="Content-Type" content="text/html; charset=utf-8" />
  <script type="text/javascript">
    window.NREUM || (NREUM = {}), __nr_require = function (e, t, n) {
      function r(n) {
        if (!t[n]) {
          var o = t[n] = {
            exports: {}
          };
          e[n][0].call(o.exports, function (t) {
            var o = e[n][1][t];

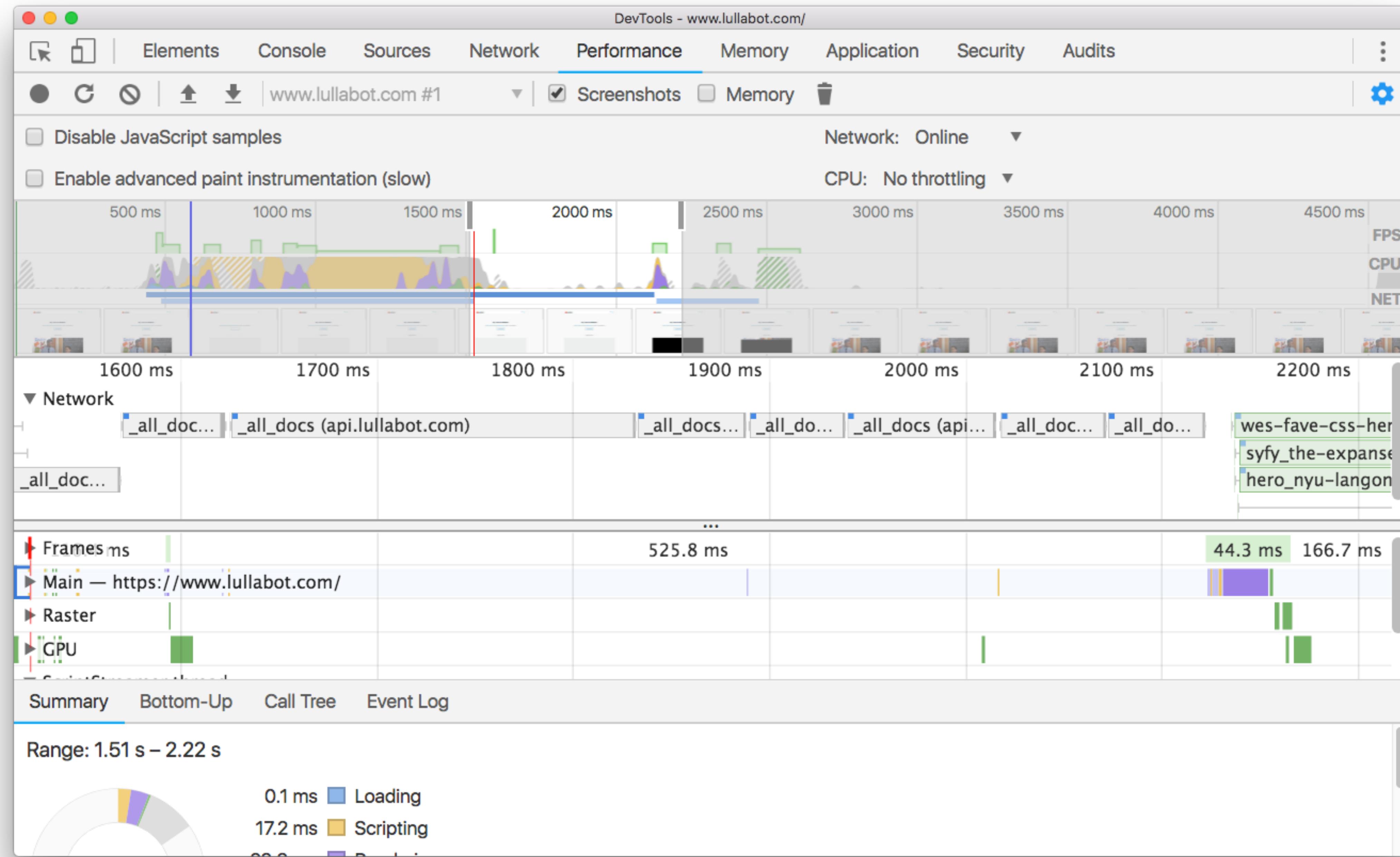
```

# START USING TODAY!

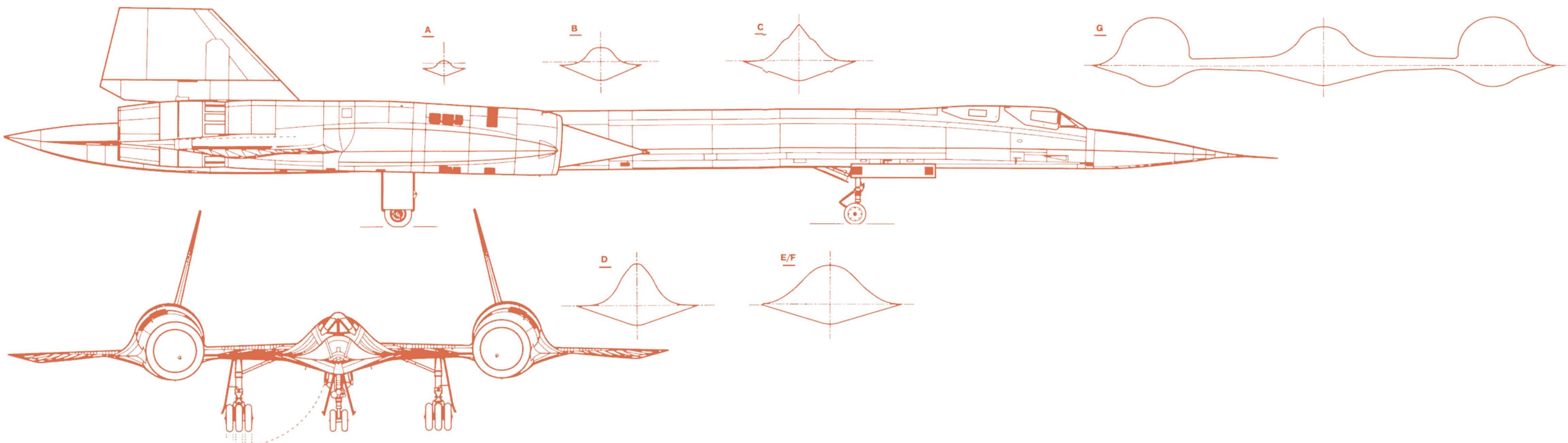


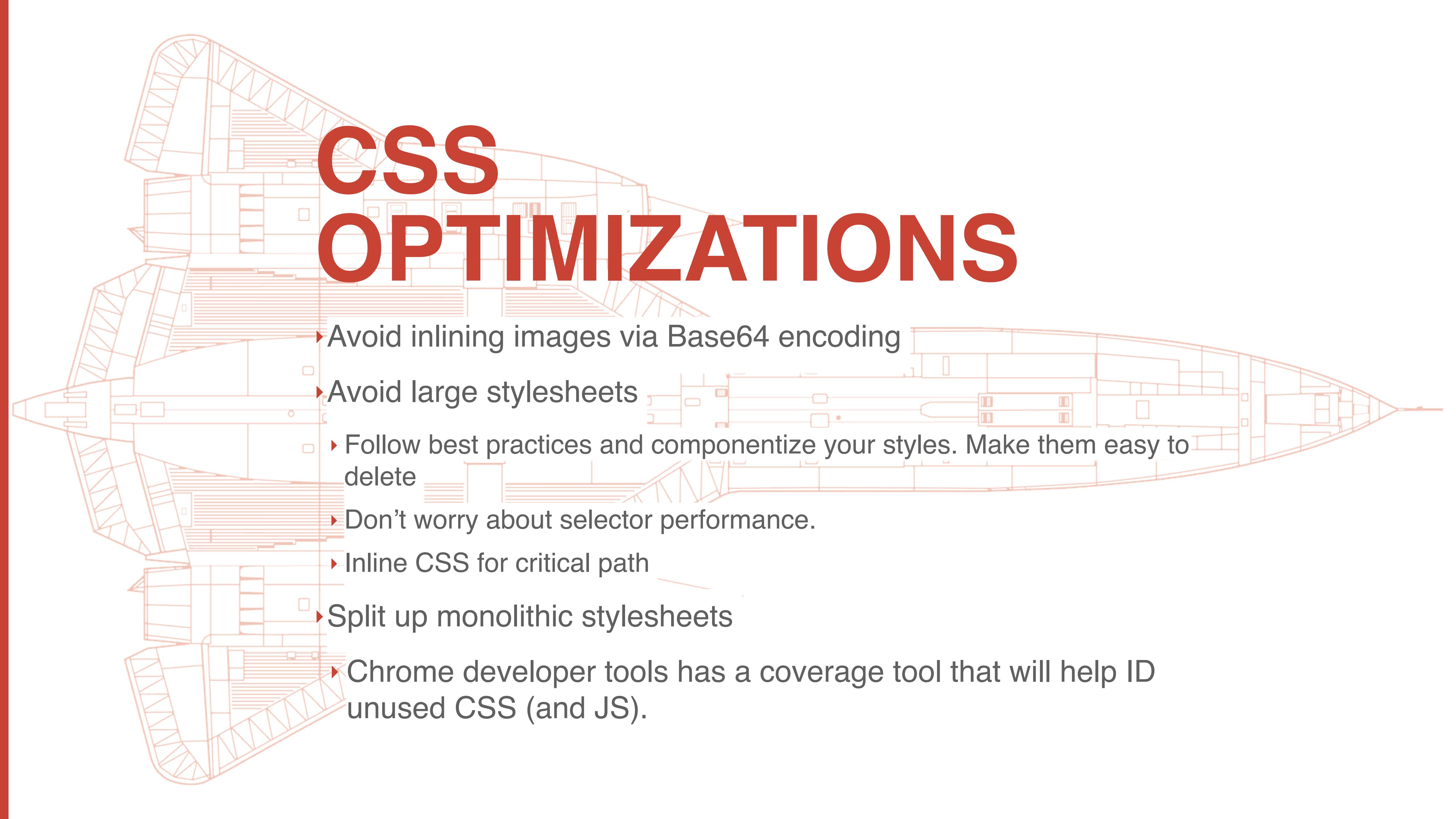
# OPTIMIZATIONS: NETWORK

- ▶ Avoid chaining dependencies (eg. ES6 imports triggering file download, which triggers another file download etc)



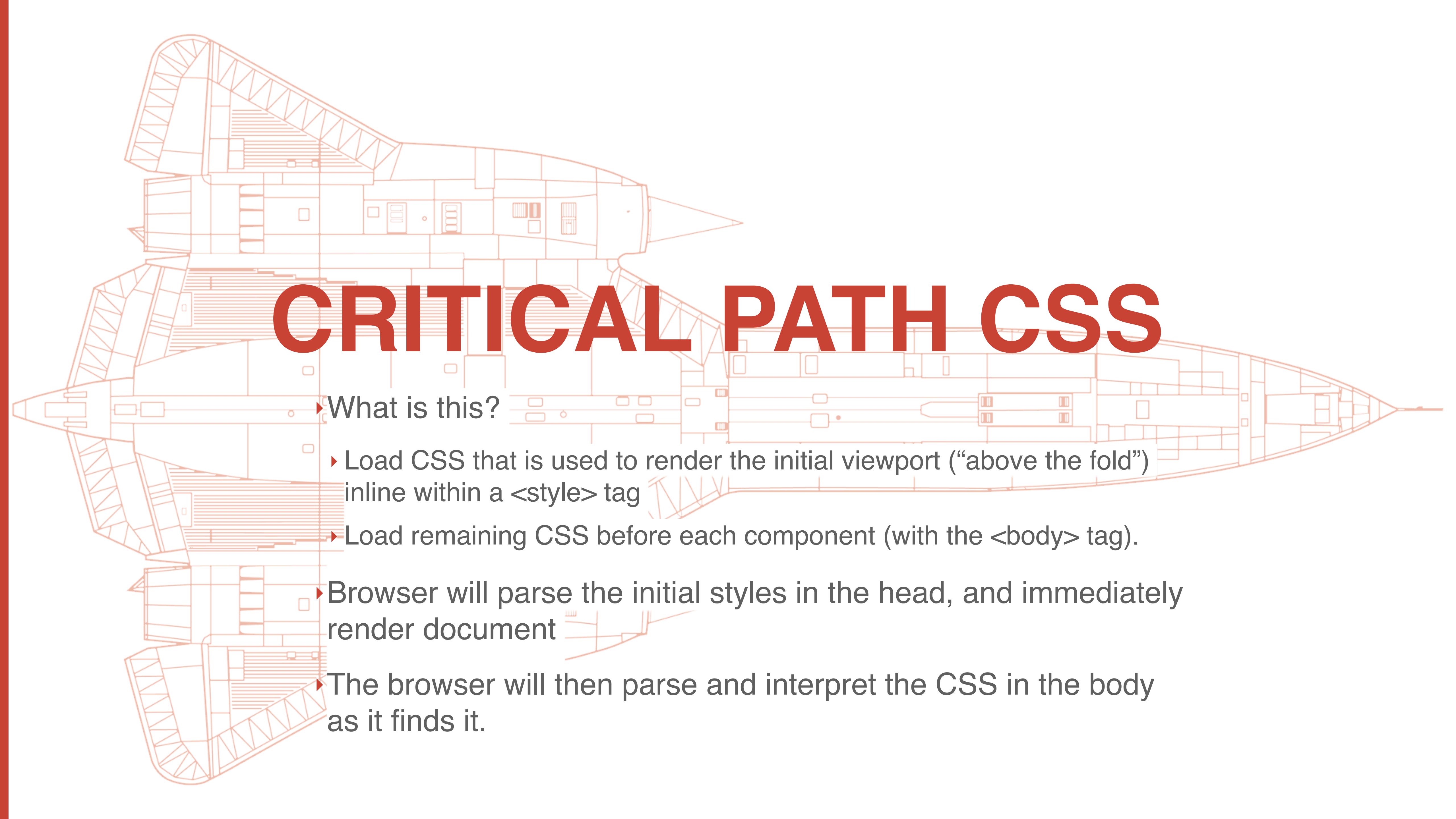
# OPTIMIZATIONS: RENDERING





# CSS OPTIMIZATIONS

- ▶ Avoid inlining images via Base64 encoding
- ▶ Avoid large stylesheets
  - ▶ Follow best practices and componentize your styles. Make them easy to delete
  - ▶ Don't worry about selector performance.
  - ▶ Inline CSS for critical path
- ▶ Split up monolithic stylesheets
- ▶ Chrome developer tools has a coverage tool that will help ID unused CSS (and JS).



# CRITICAL PATH CSS

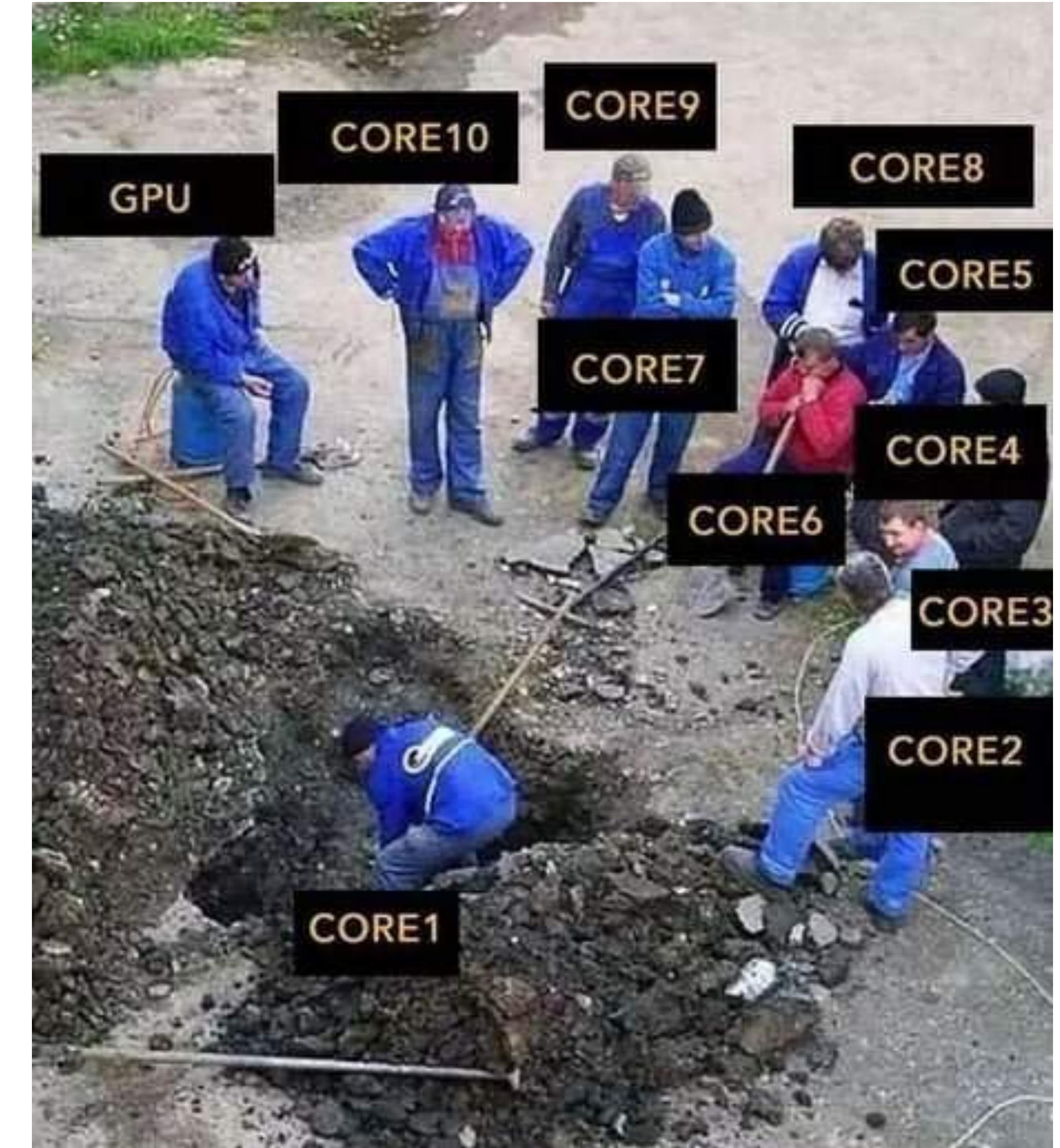
- ▶ What is this?

- ▶ Load CSS that is used to render the initial viewport (“above the fold”) inline within a `<style>` tag
- ▶ Load remaining CSS before each component (with the `<body>` tag).
- ▶ Browser will parse the initial styles in the head, and immediately render document
- ▶ The browser will then parse and interpret the CSS in the body as it finds it.

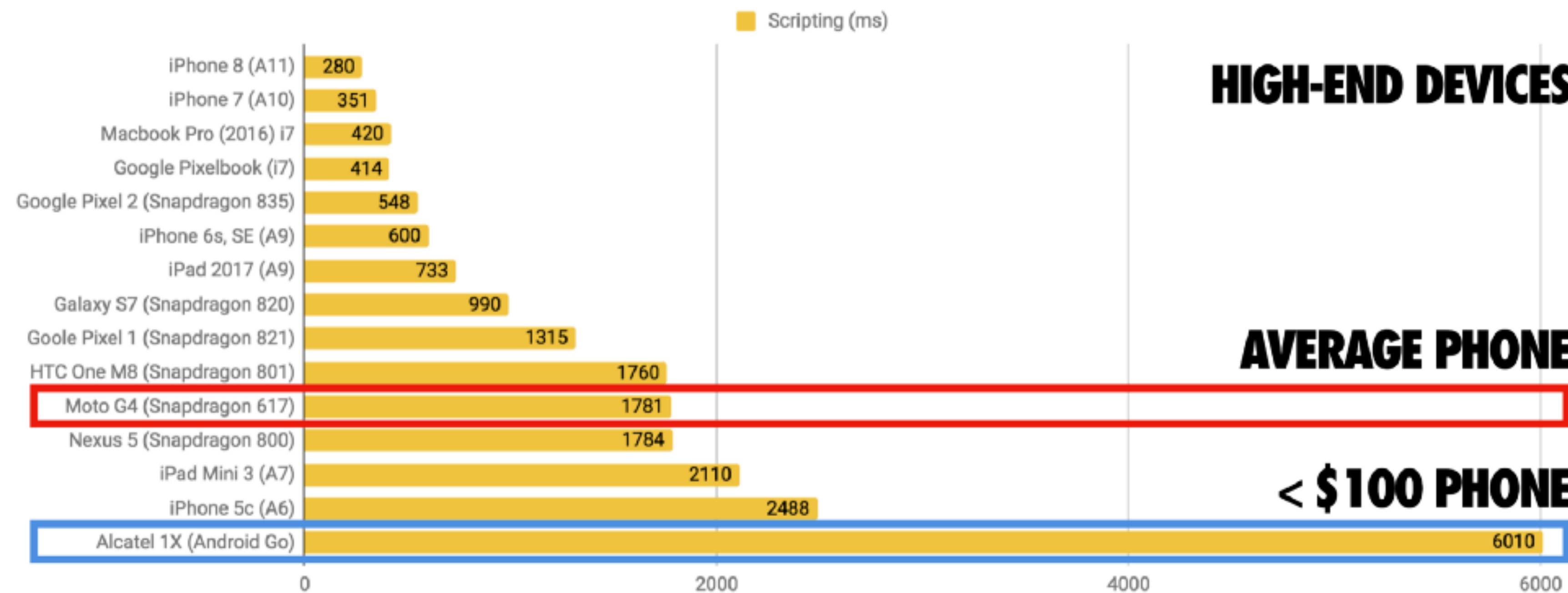
# OPTIMIZE YOUR JAVASCRIPT

- Less JavaScript the better!

# JAVASCRIPT MAIN THREAD EXECUTION



# 2018 JAVASCRIPT PROCESSING TIMES



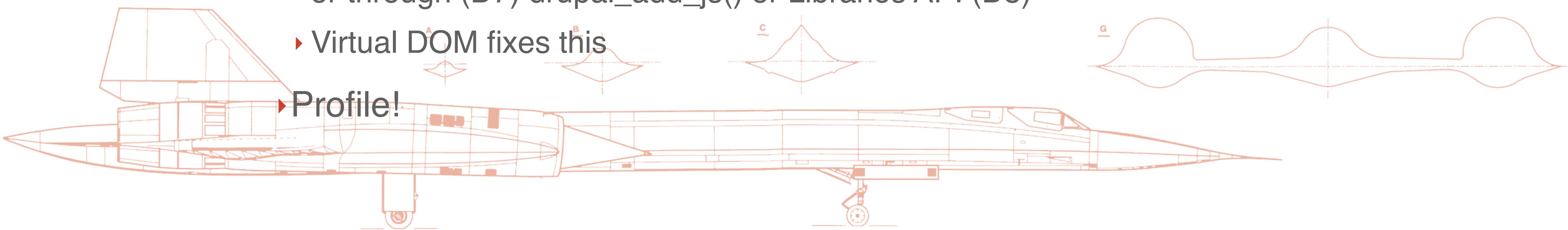
Tests run during July, 2018 on hardware running the latest versions of Android and iOS available

1MB JS UNCOMPRESSED (200KB min/compressed)

Processing (parse/compile) times for 1MB of uncompressed JavaScript (<200KB minified and gzipped) manually profiled on real devices. ([src](#))

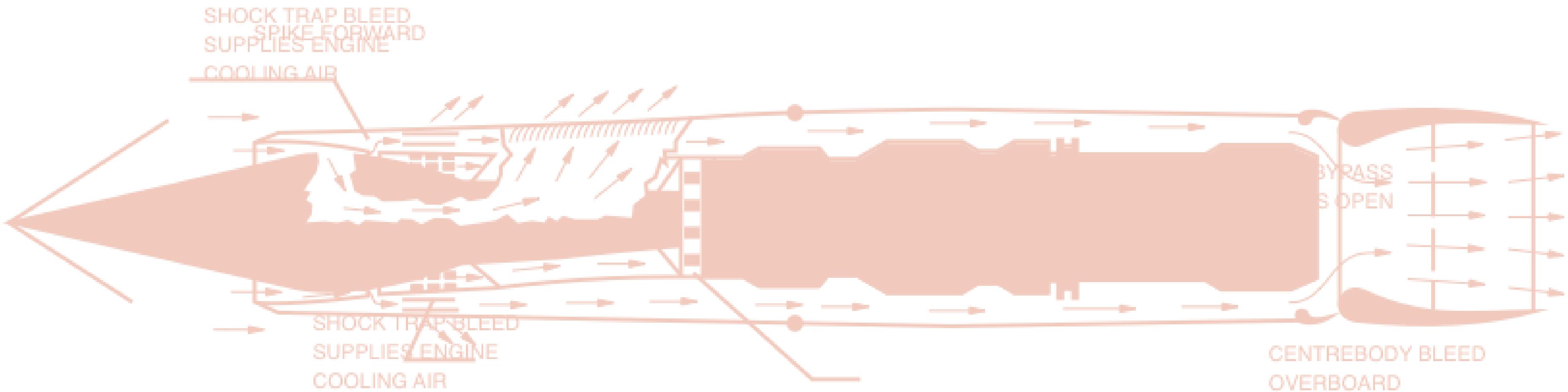
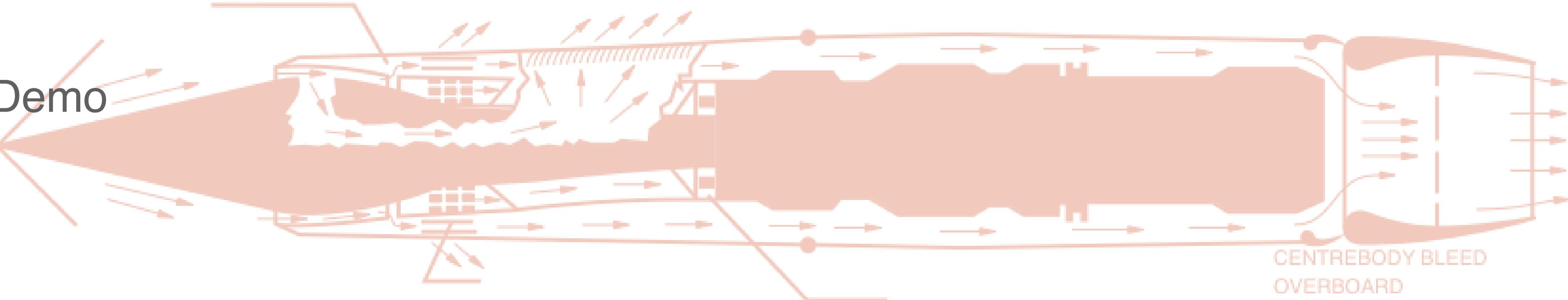
# OPTIMIZE YOUR JAVASCRIPT

- ▶ Less JavaScript the better!
- ▶ Identify unused code through Chrome DevTools coverage tool.
- ▶ Identify 💩💩💩 third party scripts.
- ▶ Code split
  - ▶ Either automatically through build tool (webpack)
  - ▶ or through (D7) drupal\_add\_js() or Libraries API (D8)
  - ▶ Virtual DOM fixes this
- ▶ Profile!



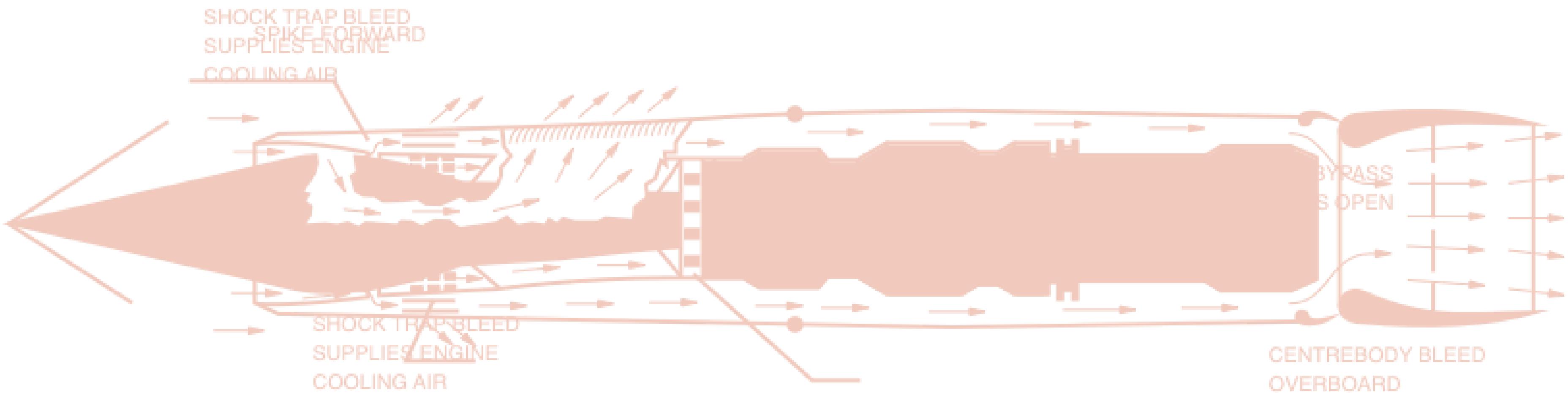
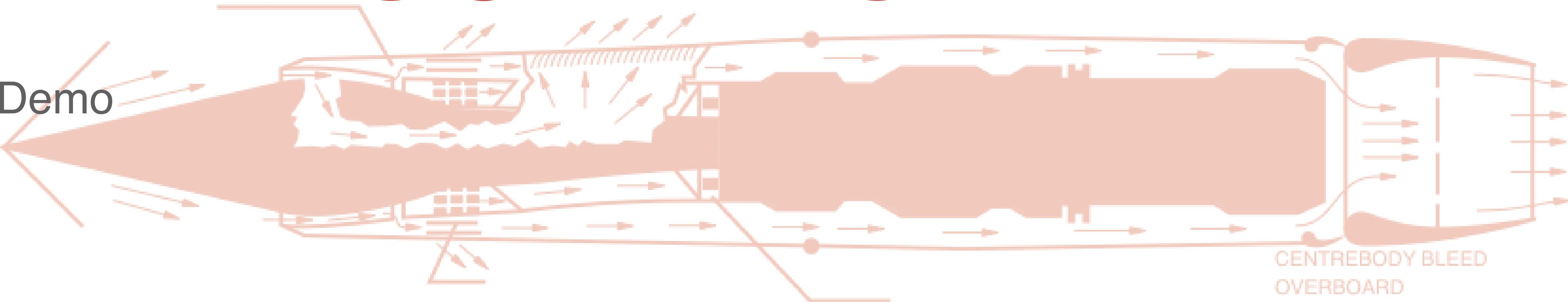
# PROFILING JAVASCRIPT

1. Demo



# IDENTIFY 💩 3RD PARTY SCRIPTS

1. Demo



# KEY TAKEAWAYS

## (START DOING THIS TODAY!)

- ▶ Learn how to identify performance issues
  - ▶ Learn the metrics
  - ▶ Practice measuring these
  - ▶ Find the bottlenecks on your site!
- ▶ Optimize your images
- ▶ Start using resource hints today!
  - ▶ Preload your fonts!
  - ▶ Async and then preload your scripts

# **MAKE THE WEB A BETTER PLACE!**

Don't let proprietary solutions win!

Mike Herchel  
Senior Frontend Developer at Lullabot  
@mikeherchel