



dailymotion

# Practical intro to web performance

**Jakub Gieryluk**

Riviera Dev 2019

# Agenda

## Network performance

- ❖ Latency
- ❖ Waterfall
- ❖ Visual comparison tools

## Runtime performance / JavaScript

- ❖ Bundle analysis & Code splitting
- ❖ Dependencies & 3rd parties
- ❖ DevTools perf panel

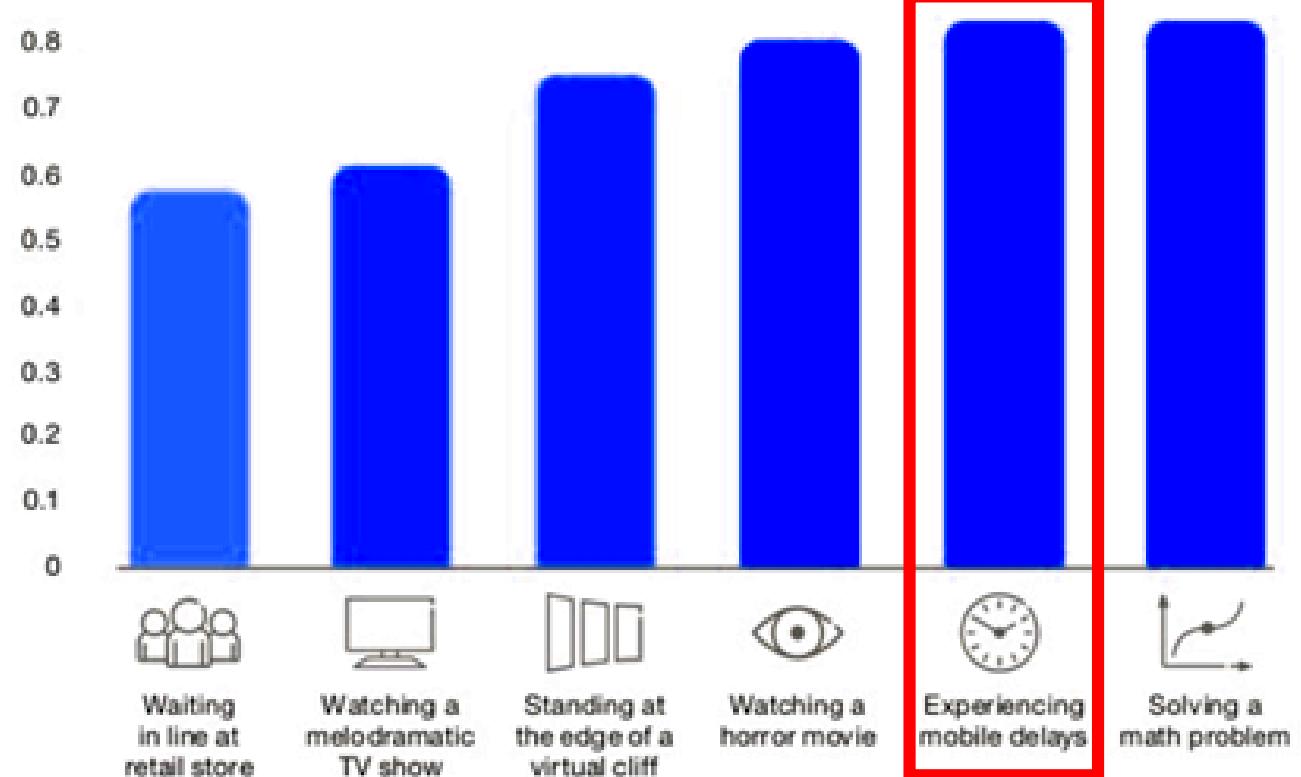


# Why performance matters, for users

## Money

- ⌚ Users with **limited data plans**
- 👤 Users **commuting**
- ✈️ Users in **roaming**
- Digital exclusion**
  - poor connectivity areas
  - developing markets

## Stress



Source: Ericsson ConsumerLab, Neurons Inc., 2015

<https://whatdoesmysitecost.com>

<https://www.slideshare.net/Ericsson/ericsson-mobility-report-the-stress-of-streaming-delays>

# Why performance matters, for CEOs



Amazon sees a 1% decrease in revenue for every 100ms increase in load time.

<https://wpostats.com>

## QUICK START

# PageSpeed Insights: Lighthouse Online + CrUX

Real-world analytics

Key metrics

Actionable items

<https://developers.google.com/speed/pagespeed/insights/>



<https://www cnn.com>

The speed score is based on the lab data analyzed by Lighthouse.

Analysis time: 4/19/2019, 3:52:05 PM

Scale: 90-100 (fast) 50-89 (average) 0-49 (slow)

### Field Data

Over the last 30 days, the field data shows that this page has a **Slow** speed compared to other pages in the Chrome User Experience Report. We are showing the 90th percentile of FCP and the 95th percentile of FID.

First Contentful Paint (FCP)	5.8 s ▲
2% 55% 43%	61% 26% 13%
<a href="#">Show Origin Summary</a>	

### Lab Data

Lighthouse analysis of the current page on an emulated mobile network. Values are estimated and may vary.

First Contentful Paint	9.1 s ▲
Speed Index	19.5 s ▲
Time to Interactive	34.6 s ▲
First Meaningful Paint	9.6 s ▲
First CPU Idle	13.4 s ▲
Estimated Input Latency	720 ms ▲

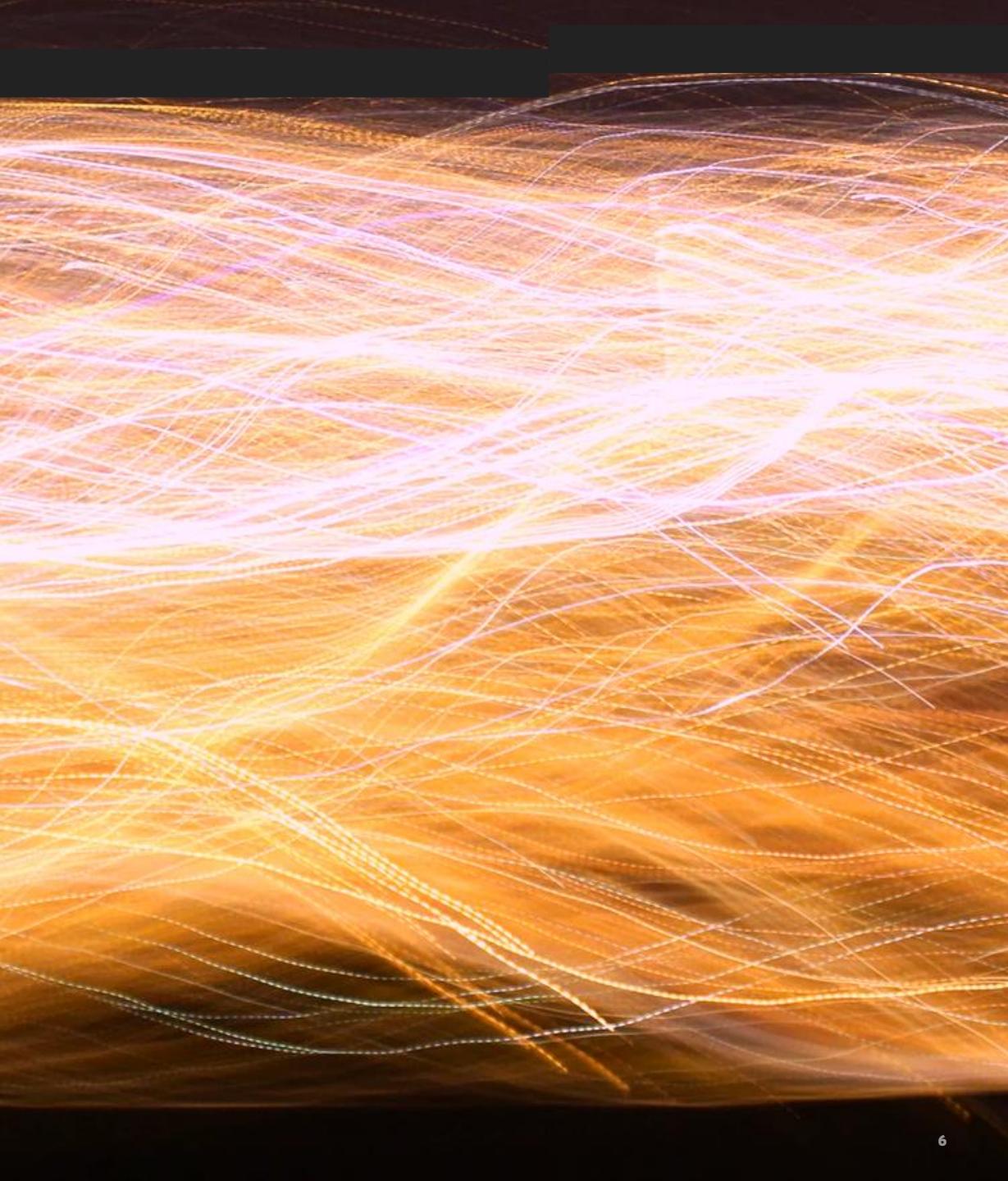


### Opportunities

These optimizations can speed up your page load.

Opportunity	Estimated Savings
1 Defer offscreen images	5.22 s ▼
2 Serve images in next-gen formats	1.56 s ▼
3 Avoid multiple page redirects	1.26 s ▼
4 Remove unused CSS	0.9 s ▼
5 Efficiently encode images	0.75 s ▼
6 Enable text compression	0.24 s ▼

# **Network performance**



# Latency

Latency = length of the pipe



Bandwidth =  
diameter  
of the pipe



WHAT LATENCY

FEELS PRETTY FAST TO ME

NETWORK PERF / LATENCY

# Check latency around the world

**Example:**  
Not geo-distributed (yet) backend

<https://tools.keycdn.com/performance>

The screenshot shows a web browser window with two tabs titled "Web Performance Test - 14+ GL". The main content area is the KeyCDN website, featuring the KeyCDN logo and navigation links for Site Speed Test, Performance Test, IP Location Finder, Ping Test, DNS Lookup, HTTP/2 Test, and More. Below this is a section titled "Web Performance Test URL Speed" with a sub-instruction "A free online web performance test. Query a single asset from 14 test locations." A form field contains the URL "https://www.dailymotion.com/" and a blue "Test" button. The main focus is a table titled "Performance Results" with columns for Location, Status, Cache, ETag, Length, DNS, Connect, TLS, and TTFB. The table lists 14 locations with their respective test results. The rows are color-coded: Paris (green), Amsterdam (green), Singapore (red), Sydney (red), Tokyo (black), and Bangalore (green). The "Connect" column for Paris shows a value of 1.372 ms, which is highlighted in green.

Location	Status	Cache	ETag	Length	DNS	Connect	TLS	TTFB
Frankfurt	200	na	na	na	4.326 ms	9.431 ms	29.48 ms	66.813 ms
New York	200	na	na	na	4.339 ms	10.12 ms	30.539 ms	67.174 ms
Miami	200	na	na	na	31.491 ms	117.379 ms	246.224 ms	515.205 ms
Dallas	200	na	na	na	7.167 ms	121.01 ms	252.97 ms	511.477 ms
San Francisco	200	na	na	na	7.242 ms	158.138 ms	334.717 ms	670.095 ms
Seattle	200	na	na	na	7.199 ms	145.806 ms	302.739 ms	611.727 ms
Toronto	200	na	na	na	7.153 ms	93.287 ms	195.846 ms	402.856 ms
London	200	na	na	na	15.455 ms	17.904 ms	51.734 ms	109.181 ms
Paris	200	na	na	na	7.663 ms	1.372 ms	20.817 ms	45.862 ms
Amsterdam	200	na	na	na	3.515 s	10.942 ms	34.247 ms	71.221 ms
Singapore	200	na	na	na	7.572 ms	193.114 ms	398.483 ms	811.888 ms
Sydney	200	na	na	na	7.23 ms	307.965 ms	630.017 ms	1.271 s
Tokyo	200	na	na	na	7.372 ms	230.541 ms	472.593 ms	950.198 ms
Bangalore	200	na	na	na	7.051 ms	137.989 ms	288.749 ms	588.433 ms

Location	Status	Cache	ETag	Length	DNS	Connect	TLS	TTFB
Germany Frankfurt	200	na	na	na	4.326 ms	9.431 ms	29.48 ms	66.813 ms
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India Bangalore	200	na	na	na	7.051 ms	137.989 ms	288.749 ms	588.433 ms

**NETWORK PERF / LATENCY**

# Check latency around the world

**Example:**  
Geo-distributed static content  
(via CDN)

<https://tools.keycdn.com/performance>

The screenshot shows a web browser window with two tabs open, both titled "Web Performance Test - 14+ Gl". The active tab displays the KeyCDN website at <https://tools.keycdn.com/performance>. The page header includes the KeyCDN logo and navigation links for Site Speed Test, Performance Test, IP Location Finder, Ping Test, DNS Lookup, HTTP/2 Test, and More. Below the header, a section titled "Web Performance Test URL Speed" with the subtitle "A free online web performance test. Query a single asset from 14 test locations." contains a form with a URL input field containing "https://s2-ssl.dmcn.net/PLqq0/x120-3WX.jpg" and a blue "Test" button. The main content area is titled "Performance Results" and features a table with 14 rows, each representing a location and its performance metrics. The columns are: Location, Status, Cache, ETag, Length, DNS, Connect, TLS, and TTFB. The table shows varying latencies, with Sydney having the lowest overall time (158.957 ms) and Tokyo having the highest (63.93 ms). The table is styled with alternating row colors and green boxes highlighting specific values.

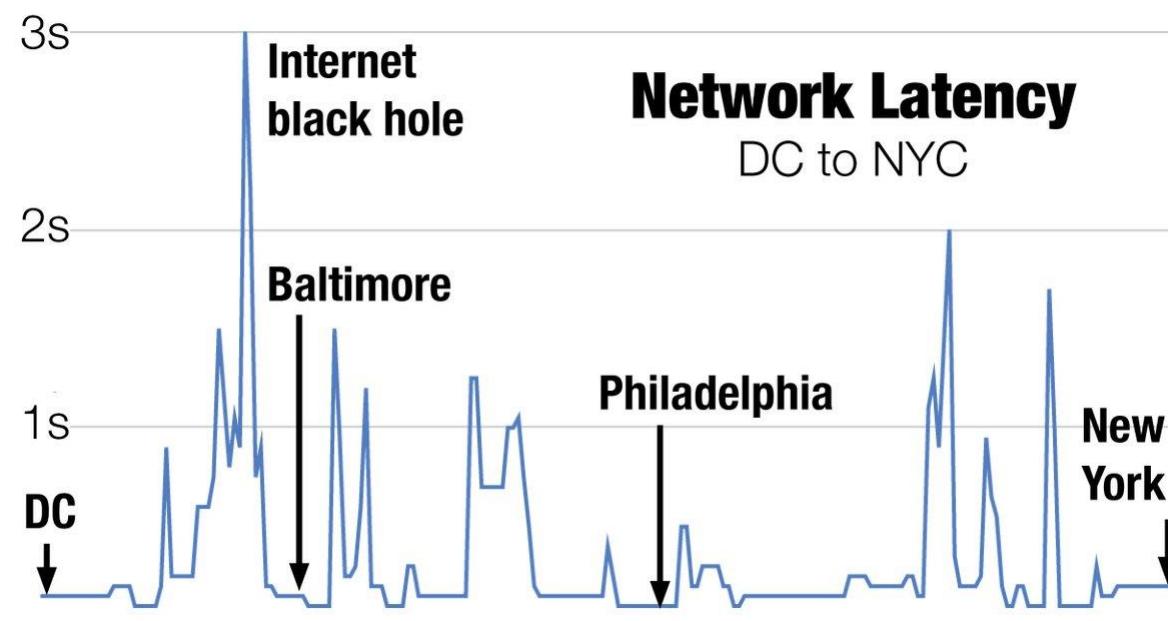
Location	Status	Cache	ETag	Length	DNS	Connect	TLS	TTFB
Frankfurt	200	na	na	4076	4.36 ms	1.979 ms	10.926 ms	22.022 ms
New York	200	na	na	4076	28.452 ms	0.484 ms	20.843 ms	32.407 ms
Miami	200	na	na	4076	31.35 ms	0.958 ms	15.092 ms	125.932 ms
Dallas	200	na	na	4076	63.492 ms	1.6 ms	14.05 ms	128.386 ms
San Francisco	200	na	na	4076	63.789 ms	2.744 ms	21.379 ms	26.9 ms
Seattle	200	na	na	4076	63.714 ms	0.542 ms	14.434 ms	173.732 ms
Toronto	200	na	na	4076	63.409 ms	11.732 ms	33.216 ms	57.591 ms
London	200	na	na	4076	31.434 ms	1.302 ms	23 ms	26.588 ms
Paris	200	na	na	4076	31.463 ms	1.892 ms	20.709 ms	30.141 ms
Amsterdam	200	na	na	4076	3.516 s	0.722 ms	14.659 ms	17.252 ms
Singapore	200	na	na	4076	128.144 ms	158.957 ms	333.894 ms	653.067 ms
Sydney	200	na	na	4076	7.199 ms	1.582 ms	19.728 ms	23.801 ms
Tokyo	200	na	na	4076	63.93 ms	1.064 ms	11.917 ms	23.902 ms
Bangalore	200	na	na	4076	127.813 ms	1.825 ms	19.563 ms	178.786 ms

# Mobile latency



Katie Hempenius  
@katiehempenius

I measured network latency as I traveled between DC & NYC by train:



# WebPageTest



## NETWORK PERFORMANCE

# WebPageTest

<https://www.webpagetest.org/>

The screenshot shows the WebPageTest homepage. At the top, there's a navigation bar with links for HOME, TEST HISTORY, FORUMS, DOCUMENTATION, and ABOUT. Below the navigation is a main heading "Test a website's performance" with a sub-section for "Advanced Testing". A blue arrow points to the "Advanced Testing" tab. In the center, there's a form for entering a website URL (<https://www.rivieradev.fr/>), selecting a test location (set to "Moto G (gen 4)"), choosing a browser (set to "Android Devices - Dulles, VA" with "Moto G (gen 4)" selected), and setting advanced options like the number of tests (Up to 9). To the right of the form is a large yellow "START TEST" button. Below the form is a world map with numerous red location pins placed across various continents and oceans, indicating global testing locations.

# WebPageTest: resources review

**WEBPAGETEST**

HOME TEST RESULT TEST HISTORY FORUMS DOCUMENTATION ABOUT

Need help improving?

Web Page Performance Test for <https://rivieradev.fr/>

From: Strasbourg, France - Chrome - Cable  
4/19/2019, 9:47:33 AM

First Byte Time	Keep-alive Enabled	Compress Transfer	Compress Images	Cache static content	Effective use of CDN
A	A	A	B	C	X

Summary Details **Performance Review** Content Breakdown Domains Processing Breakdown Screenshot Image Analysis Request Map

**Full Optimization Checklist**

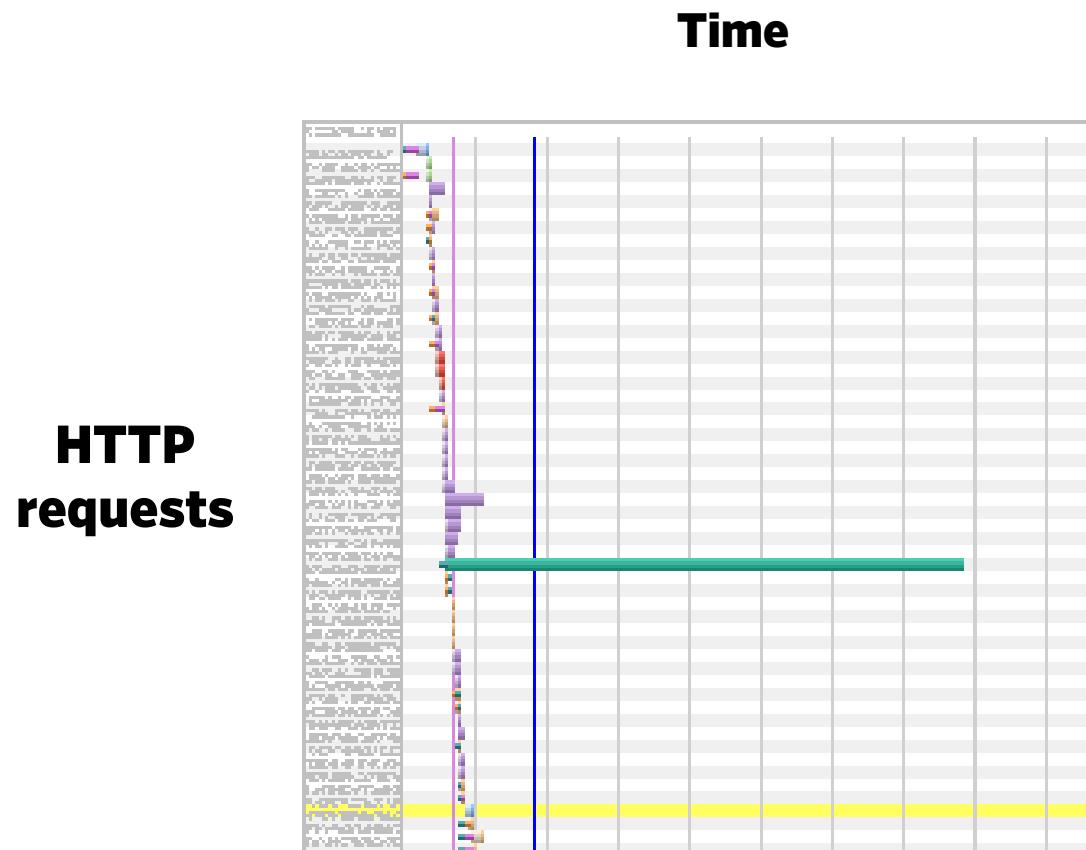
Step	Keep-Alive	GZip	Compress Img	Progressive	Cache Static	CDN Detected
Step_1	100%	97%	89%	81%	76%	61%
1: rivieradev.fr - /	✓	✓			⚠️	✗
2: rivieradev.fr - style.css	✓	✓			⚠️	✗
3: rivieradev.fr - logo_RD_full_white.svg	✓	⚠️			⚠️	✗
4: fonts.googleapis.com - css	✓	✓			⚠️	✓
5: rivieradev.fr - ...ery.countdown.min.js	✓	✓			⚠️	✗
6: use.fontawesome.com - all.js	✓	✓			✓	✓
7: code.jquery.com - jquery-3.1.1.min.js	✓	✓			✓	✓
8: rivieradev.fr - navbar-animated.js	✓	✓			⚠️	✗
9: cdnjs.cloudflare.com - swiper.min.css	✓	✓			✓	✓
10: rivieradev.fr - map.js	✓	✓			⚠️	✗
11: rivieradev.fr - schedule-filter.js	✓	✓			⚠️	✗

# The waterfall: basics

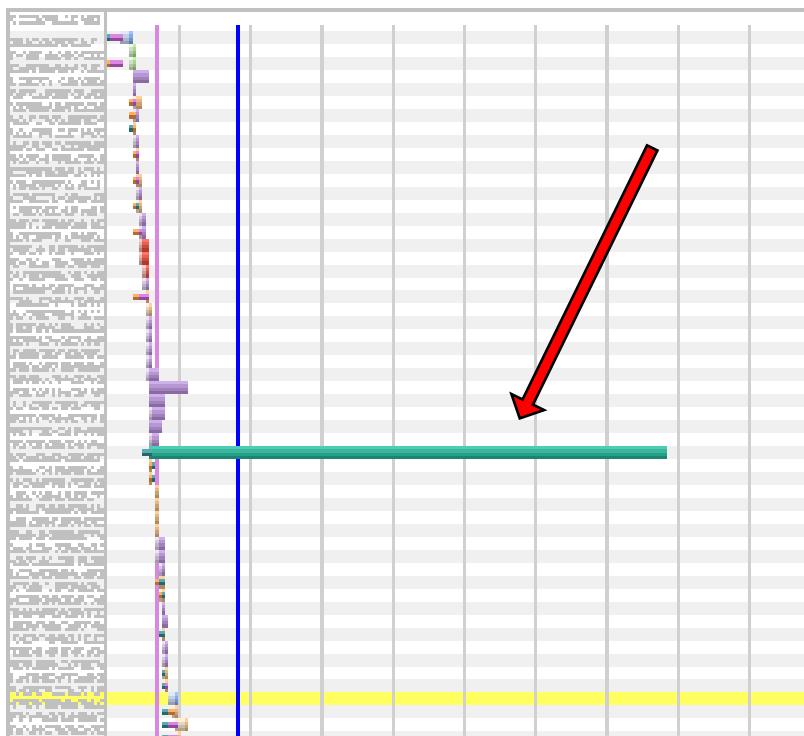
using WebPageTest



# The waterfall



# Waterfall anti-patterns: (unused) massive subresource



Doug Sillars @dougsillars

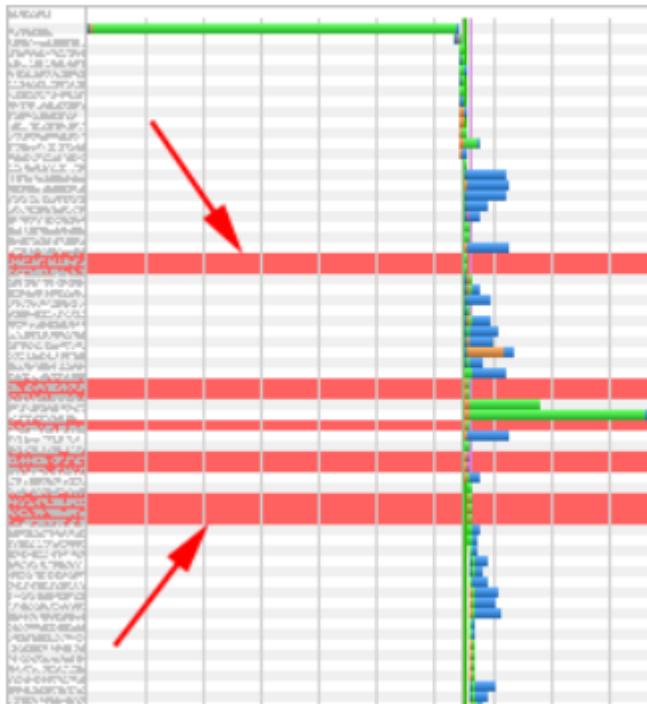
Following

This website forgot to autoplay their hero video (and no controls to start playback):

```
<video class="hero-canvas_video" loop muted preload="auto" poster="poster.jpg">
```

They download the whole thing - all 28 MB of it - there's just literally no way to see it.

# Waterfall anti-patterns: a lot of red

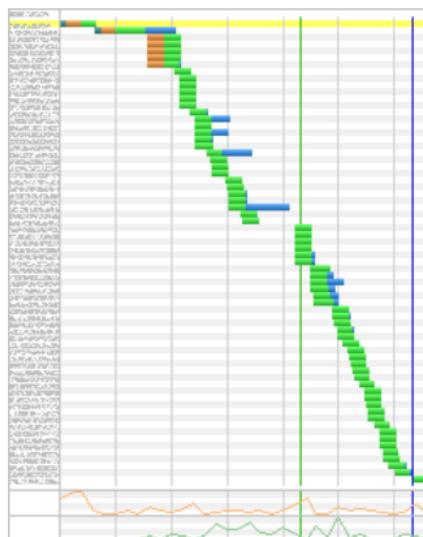


Red lines = HTTP 4xx responses  
(404 not found etc...)

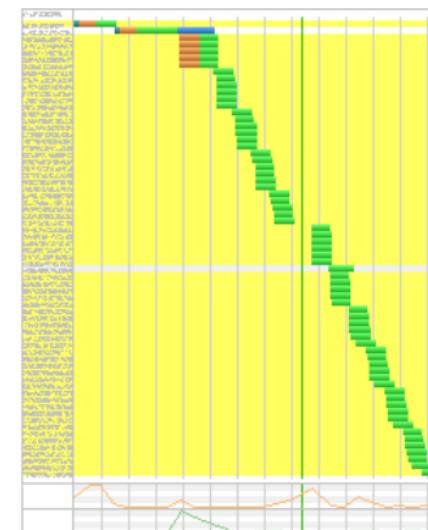
# Waterfall anti-patterns: a lot of yellow

Yellow lines = HTTP 3xx responses

**Conditional responses  
(resource revalidation)**



First View



Repeat View

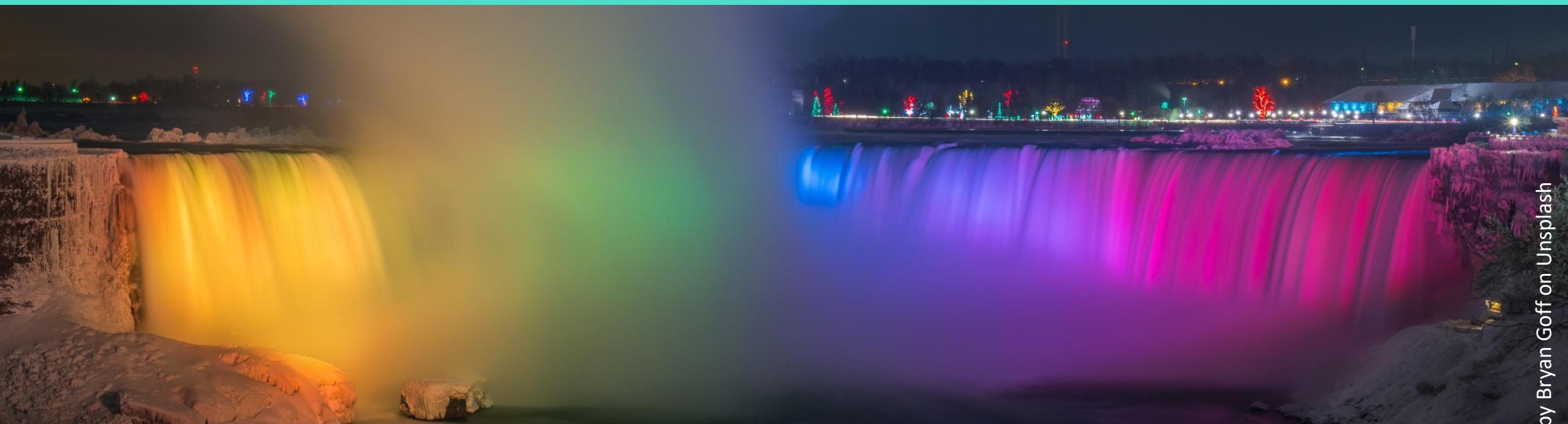
**Redirects**



- Particularly bad if:
- At beginning
  - Multiple
  - Cross-origin

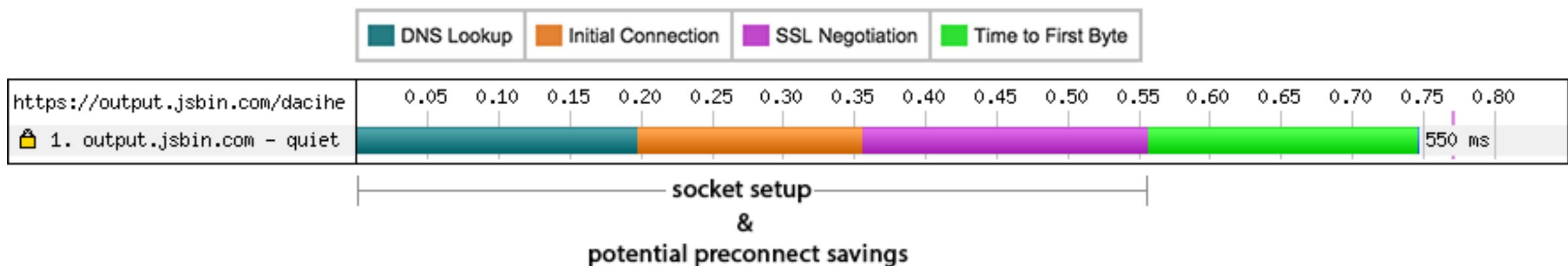
# The waterfall in depth

using WebPageTest



## WATERFALL

# Life of a single HTTP request

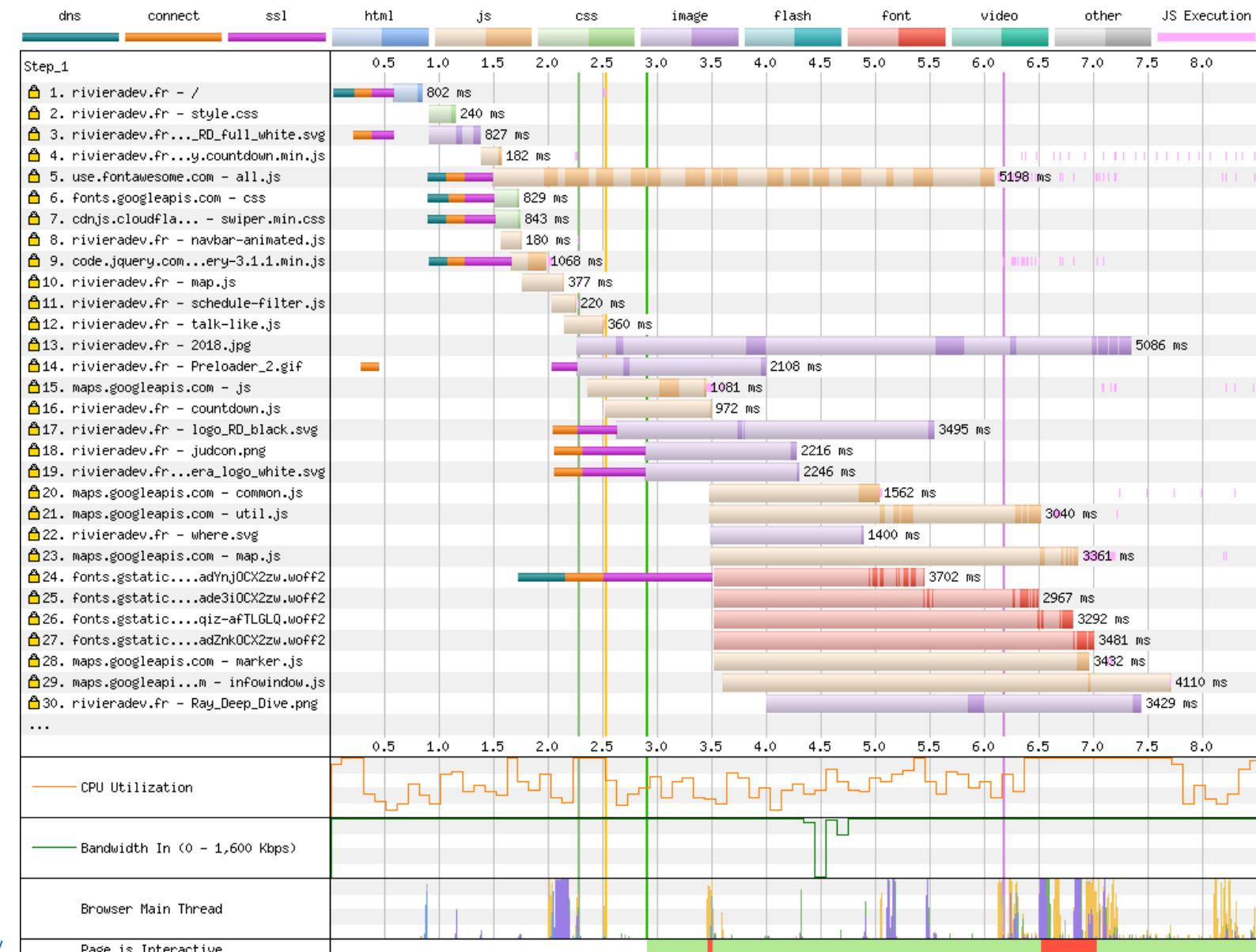


## WATERFALL

# RivieraDEV waterfall analysis

What we can read  
from this waterfall?

(tests done from Strasbourg,  
Chrome, using “3G Fast”  
network throttling)



Test results overview page:

[https://www.webpagetest.org/result/190409\\_JH\\_e24cc615c65463aaa9af8755dbbda34e/](https://www.webpagetest.org/result/190409_JH_e24cc615c65463aaa9af8755dbbda34e/)

## WATERFALL

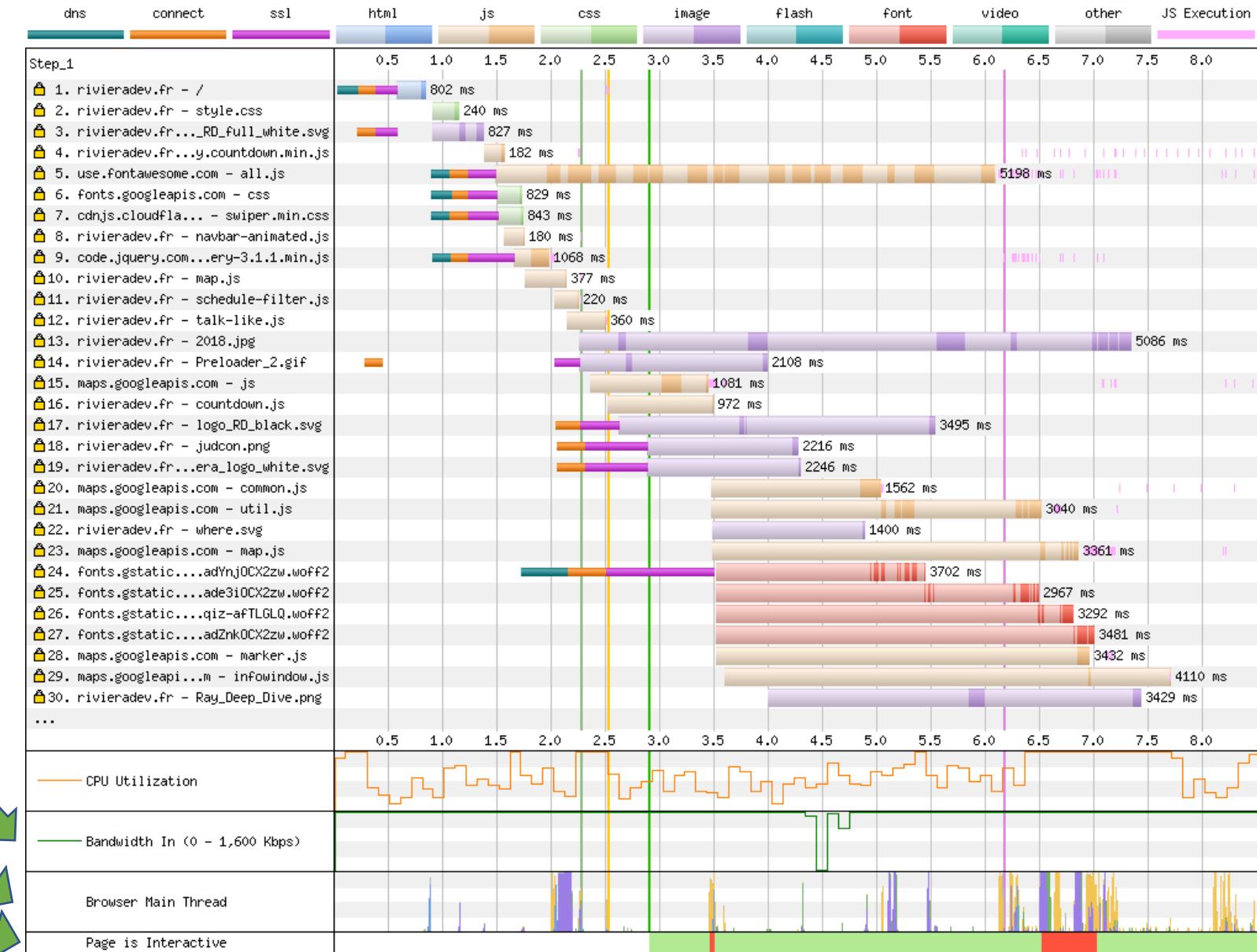
# RivieraDEV waterfall analysis

Some very good things:

High bandwidth utilization

Main thread not too busy   
(reasonable amount of JS)

Page interactive  
almost all the time 



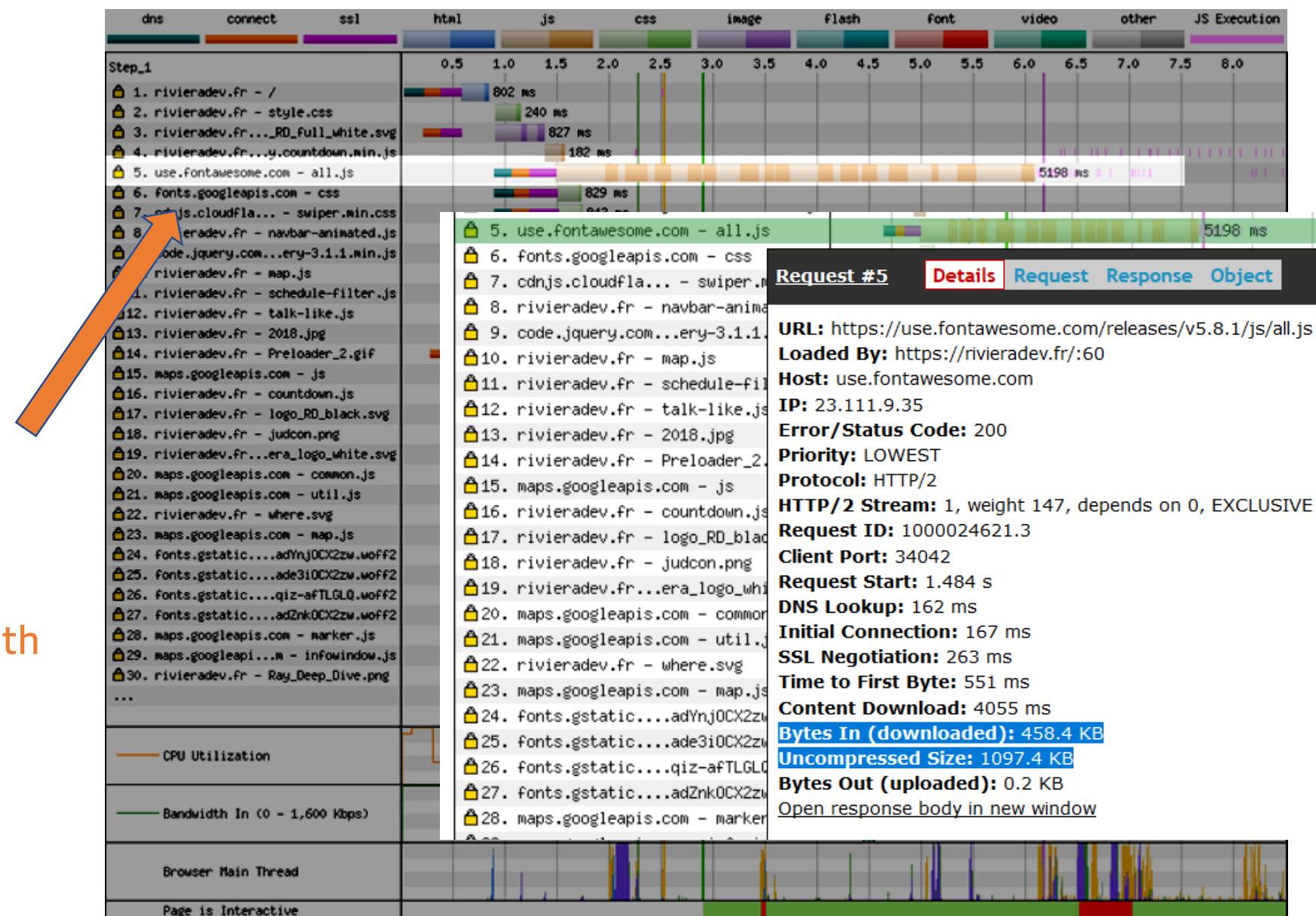
## WATERFALL

# RivieraDEV waterfall analysis

Some things that could be better:

Massive fontawesome download.  
Perhaps could be replaced with a custom build?

Many big frameworks & libs provide custom build option

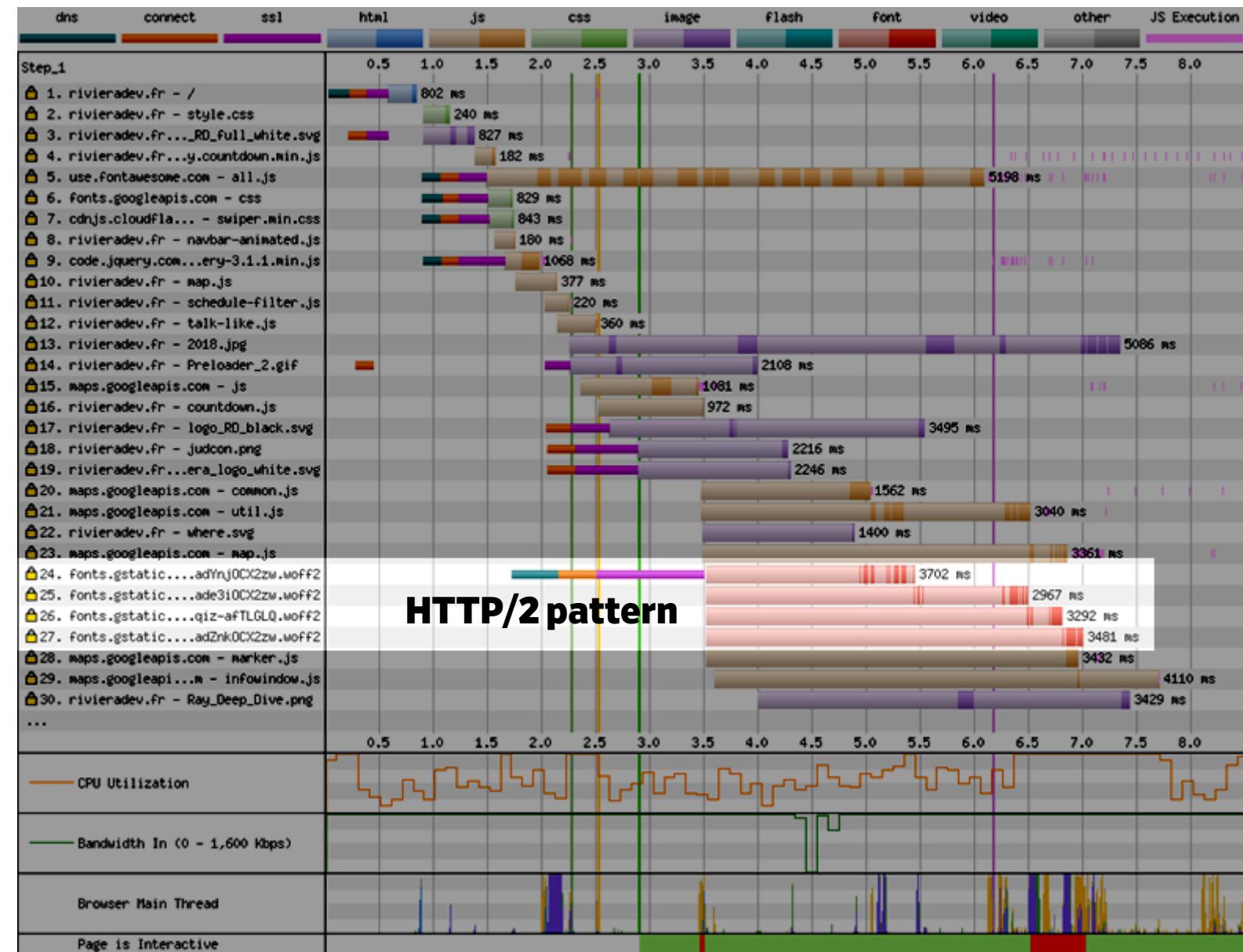


## WATERFALL

# RivieraDEV waterfall analysis

All requests issued at  
the same time, over a  
single HTTP connection

(generally good for  
performance)

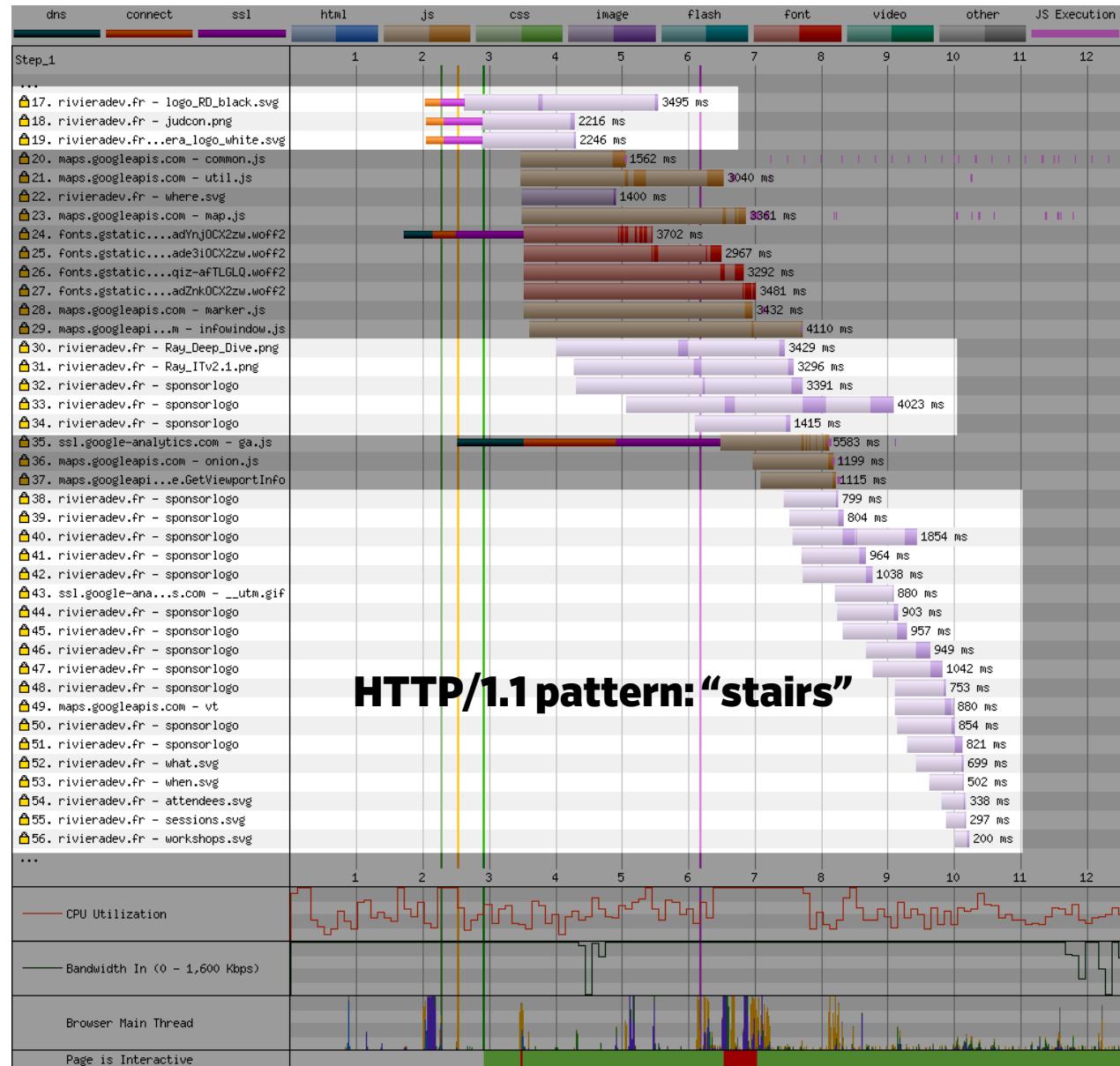


## WATERFALL

# RivieraDEV waterfall analysis

- Browser creates **max. 6** parallel connections per domain...
- ...and sends requests *only when there's an unused connection*

**Not possible to have more than 6 in-flight requests for a given domain**



## WATERFALL

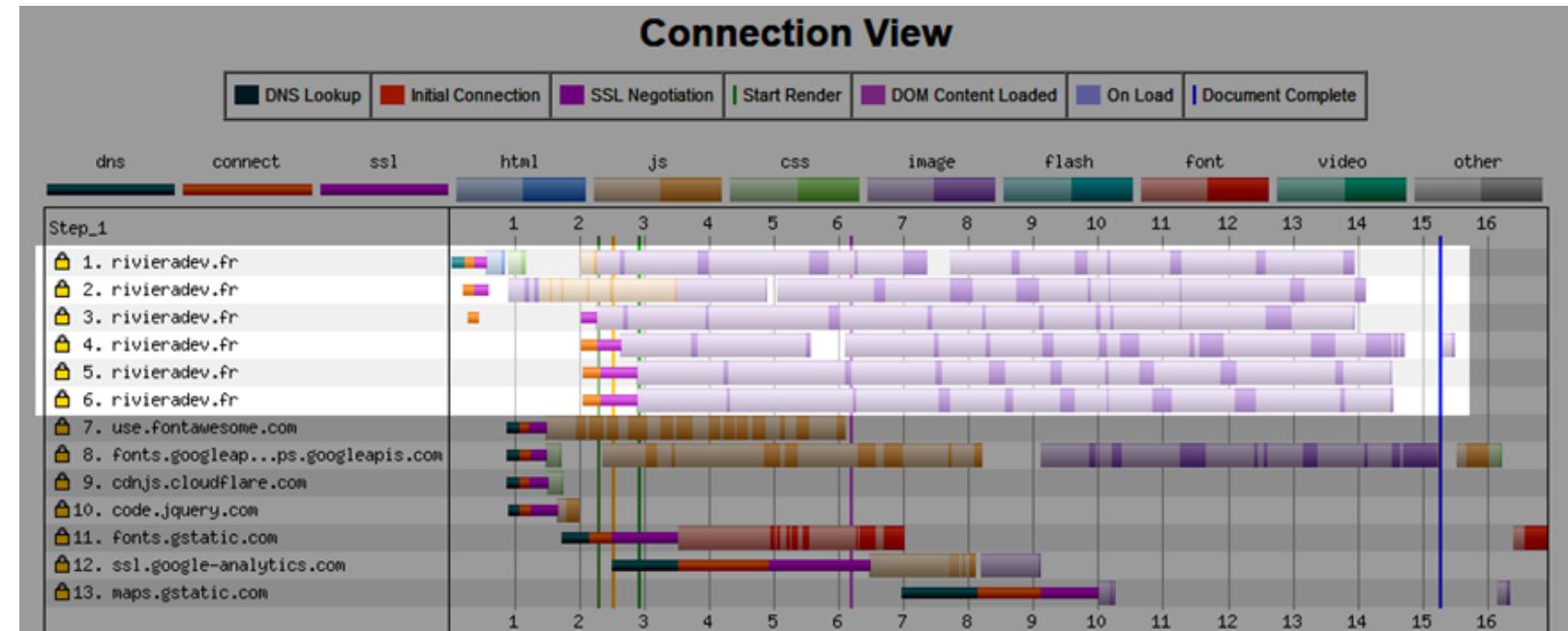
# Connection View

**Lots of static assets requests -> primary use case for HTTP/2**

Each HTTP/1.1 connection:

- starts slow,
- does separate congestion control

**HTTP/1.1 connections  
“fight” with each other**



## WATERFALL

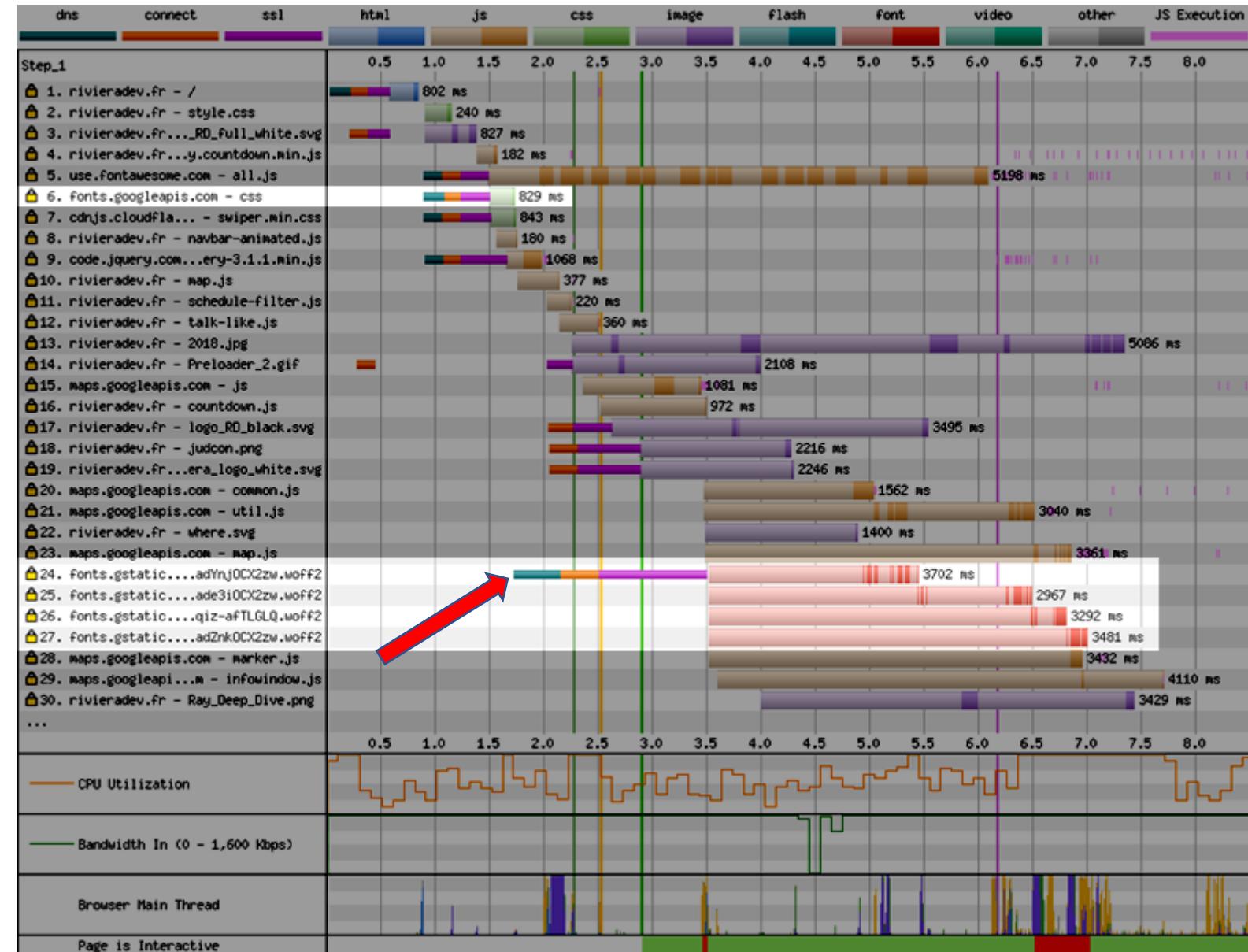
# RivieraDEV waterfall analysis

Back to webfonts - looking closer...

CSS and actual fonts (WOFF2) are **hosted on different servers**.

Hence **DNS+TCP+TLS** set up is needed before fetching them.

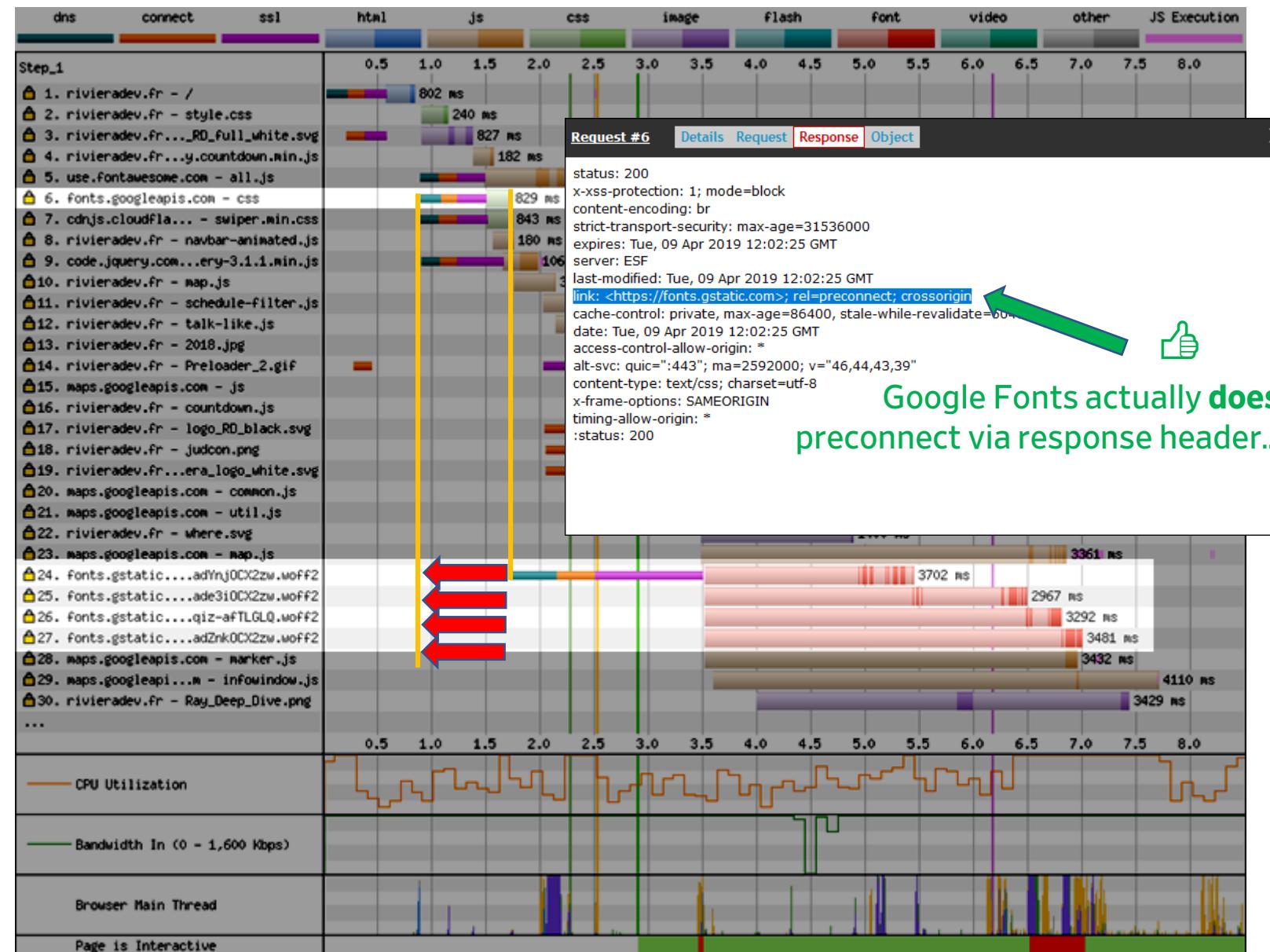
We could do that upfront with `<link rel=preconnect>` in top of HTML response



## WATERFALL

# RivieraDEV waterfall analysis

...but if we did it ourselves, it could start even before CSS request

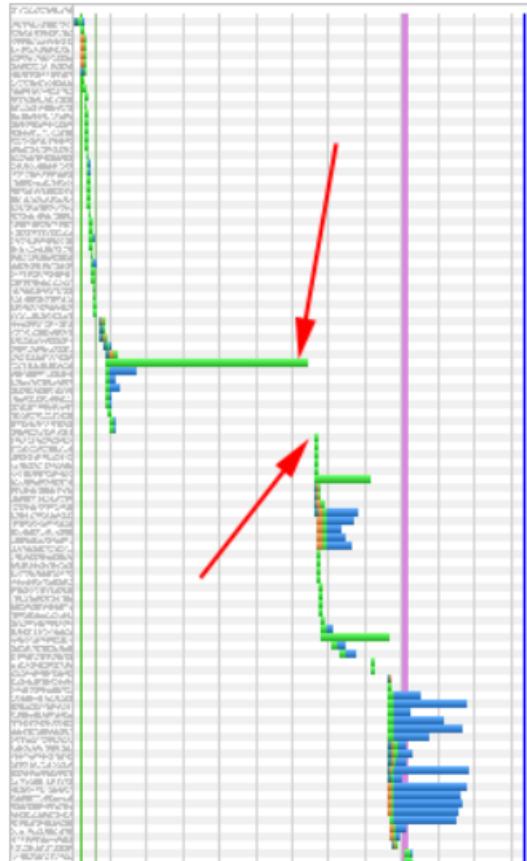


# **WebPageTest: visual tools**



## WATERFALL

# Waterfall anti-patterns: blocking resources



In particular, beware of  
**third-party, blocking JS (and CSS)**

# Third-party blocking resources

Let's try to put in place some chaos...

SPOF = Single Point of Failure

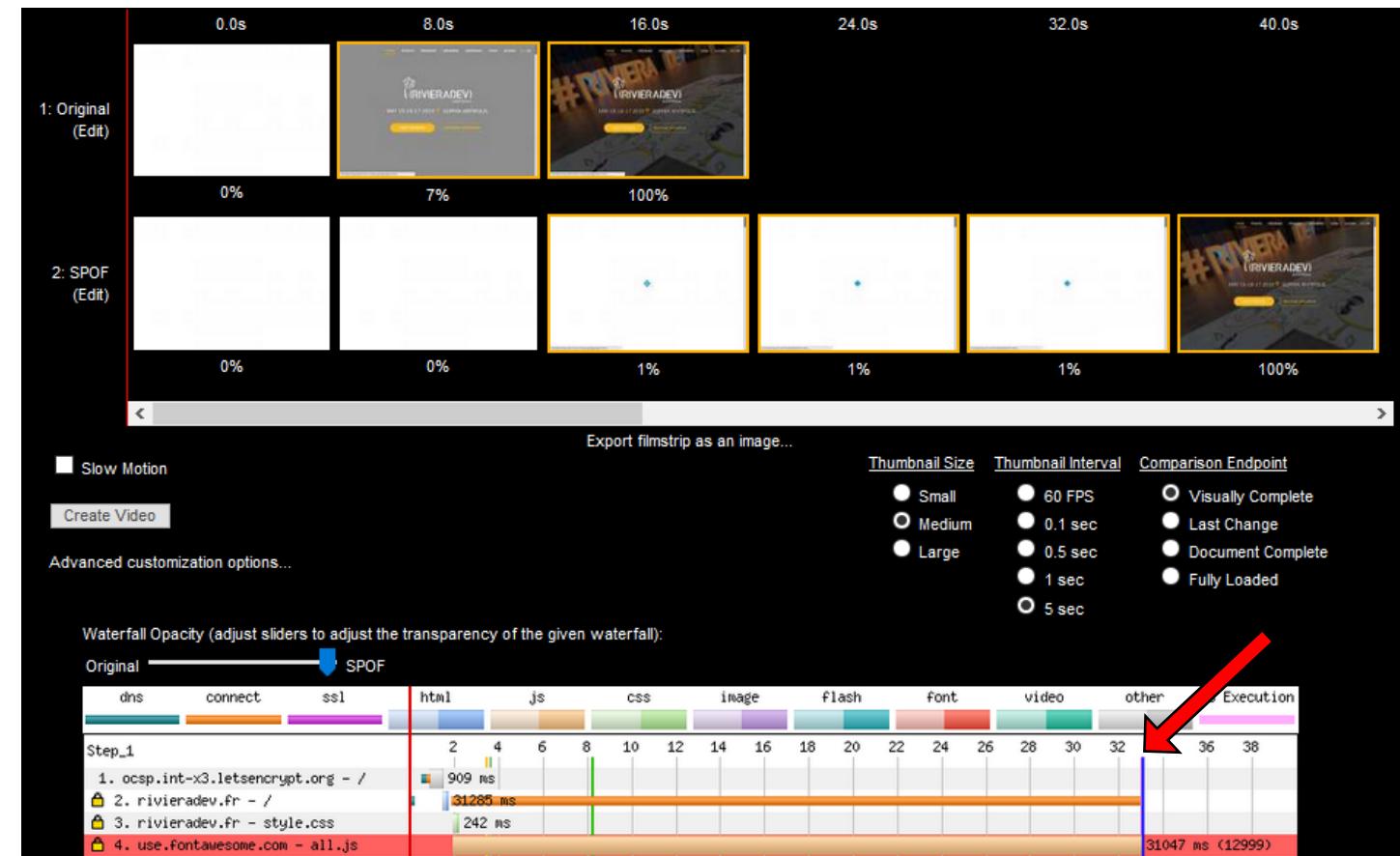
- works best in Firefox;*
- Chrome doesn't show failed requests;*
- iOS agent doesn't support feature*

The screenshot shows a web-based testing interface with a dark theme. At the top, there are four tabs: 'Advanced Testing' (selected), 'Simple Testing', 'Visual Comparison', and 'Traceroute'. Below the tabs, a URL input field contains 'http://rivieradev.fr/'. Underneath the URL, there are two dropdown menus: 'Test Location' set to 'Strasburg, France (Chrome,Firefox,Opera)' and 'Browser' set to 'Firefox'. A red box highlights the 'Firefox' browser selection. Below these, a section titled 'Advanced Settings ▾' has several tabs: 'Test Settings', 'Advanced', 'Chromium', 'Auth', 'Script', 'Block', 'SPOF' (which is highlighted with a red box), and 'Custom'. Under the 'SPOF' tab, there is a descriptive text: 'Simulate failure of specified domains. This is done by re-routing all requests for the domains to [blackhole.webpagetest.org](#) which will silently drop all requests.' Below this, there is a text input field labeled 'Hosts to fail (one host per line)...' containing the text 'use.fontawesome.com' (also highlighted with a red box). The bottom of the interface features a large black bar.

## VISUAL TOOLS / SPOF

# Third-party blocking resources: filmstrip

- It takes the browser 30 seconds to abandon the blackholed request
- **<script defer> is deferred, but still blocking the load event**



[https://www.webpagetest.org/video/compare.php?tests=190418\\_KY\\_1a8895d28357b7620193d8b99145493c%2C190418\\_2C\\_19ed78c24c5a106745227111c731a6a2&thumbSize=150&ival=8000](https://www.webpagetest.org/video/compare.php?tests=190418_KY_1a8895d28357b7620193d8b99145493c%2C190418_2C_19ed78c24c5a106745227111c731a6a2&thumbSize=150&ival=8000)

# Third-party blocking resources: summary

- **Prefer async third parties** than synchronous ones; load them after `load` event
  - Analytics, A/B testing providers, libraries, social widgets...
- **Calculate the risk.** Does a third party provide SLA or historical uptime data?
  - Good sign if the lib is hosted by a reputable CDN provider
- **Self-host (if possible) when unsure**
  - Perhaps have a server-side switch to start serving your own copy instead of 3<sup>rd</sup>-party
- **You don't want a social widget to take down your website**
  - When dealing with social widgets: perhaps load on demand (also good for user privacy)

VISUAL TOOLS / COMPARING TESTS

# Filmstrip comparison

*Tip: always run as a logged-in user, to not lose the test ID*

WEBPAGETEST

HOME TEST RESULT **TEST HISTORY** FORUMS DOCUMENTATION ABOUT

View  test log for URLs containing

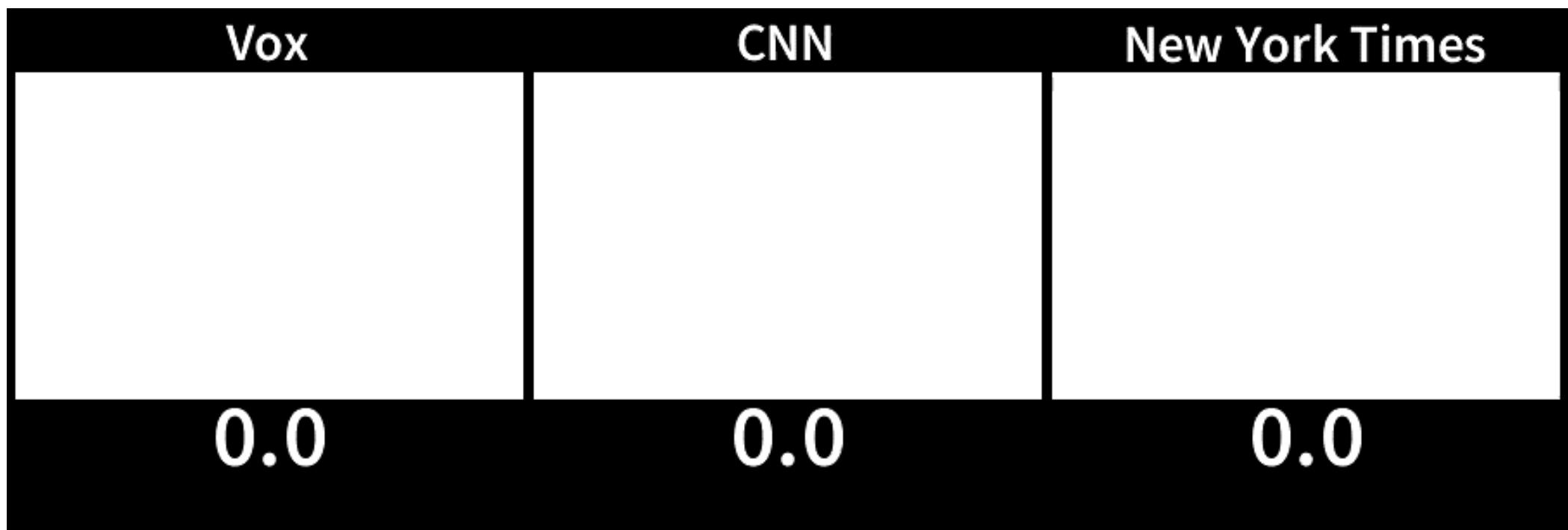
Only list tests which include video  Show repeat view  Do not limit the number of results (warning: WILL be slow)

Clicking on an URL will bring you to that test's results

<input type="checkbox"/> Compare	Date/Time	From	Label	URL
<input checked="" type="checkbox"/>	04/18/19 14:24:53	Strasburg, France - Firefox - 3GFast (video)	<a href="#">SPOF (Edit)</a>	<a href="https://rivieradev.fr/">https://rivieradev.fr/</a>
<input checked="" type="checkbox"/>	04/18/19 14:24:53	Strasburg, France - Firefox - 3GFast (video)	<a href="#">Original (Edit)</a>	<a href="https://rivieradev.fr/">https://rivieradev.fr/</a>
<input type="checkbox"/>	04/18/19 14:17:23	Strasburg, France - Chrome - 3GFast (video)	<a href="#">SPOF (Edit)</a>	<a href="http://rivieradev.fr/">http://rivieradev.fr/</a>
<input type="checkbox"/>	04/18/19 14:17:23	Strasburg, France - Chrome - 3GFast (video)	<a href="#">Original (Edit)</a>	<a href="http://rivieradev.fr/">http://rivieradev.fr/</a>



# Video view comparison



# Agenda

## Network performance

- ❖ Latency
- ❖ Waterfall
- ❖ Visual comparison tools

## Runtime performance / JavaScript

- ❖ Bundle analysis & Code splitting
- ❖ Dependencies & 3rd parties
- ❖ DevTools perf panel



# Runtime performance

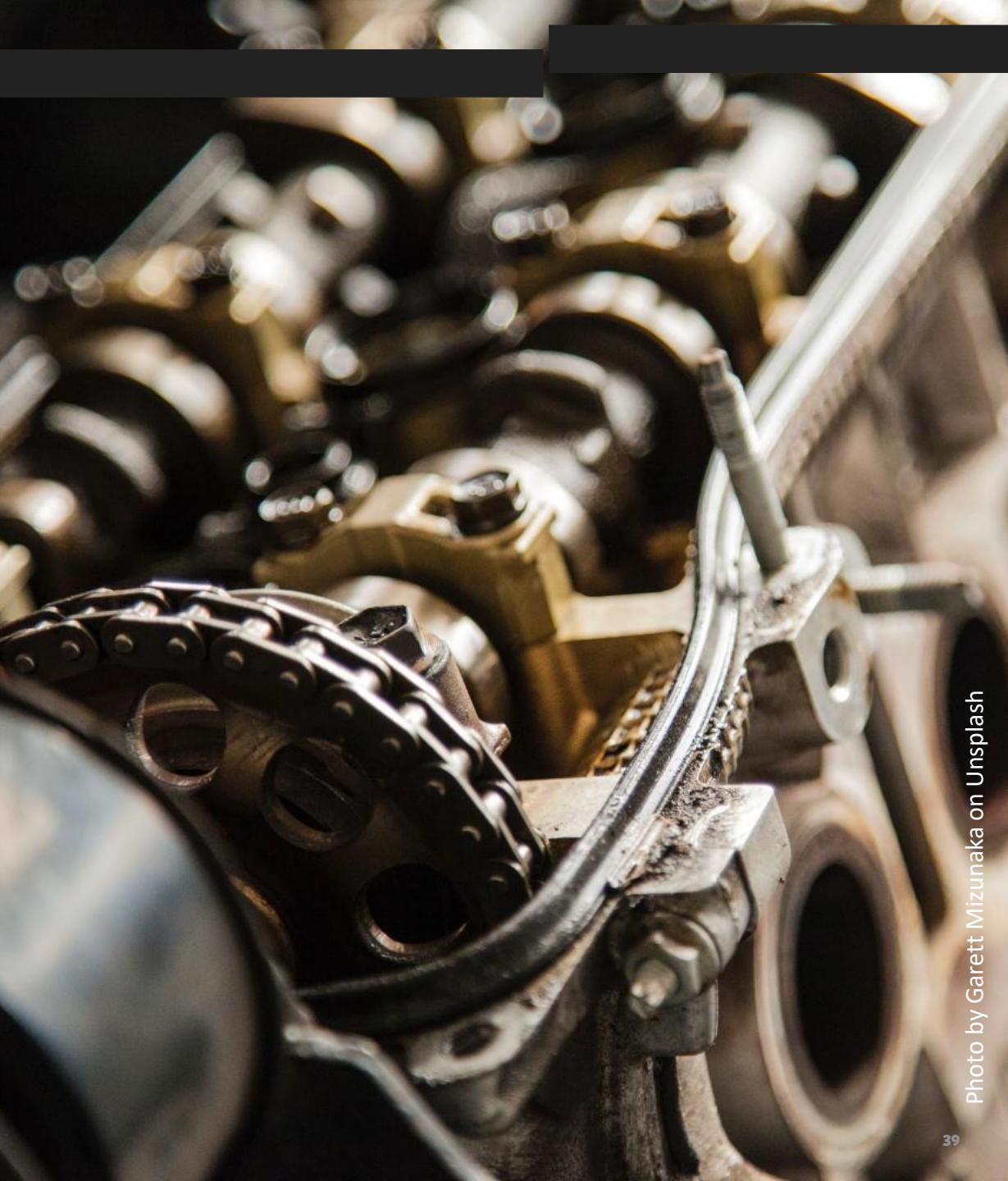
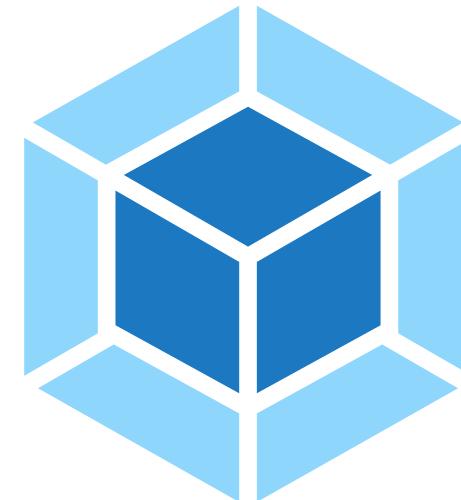


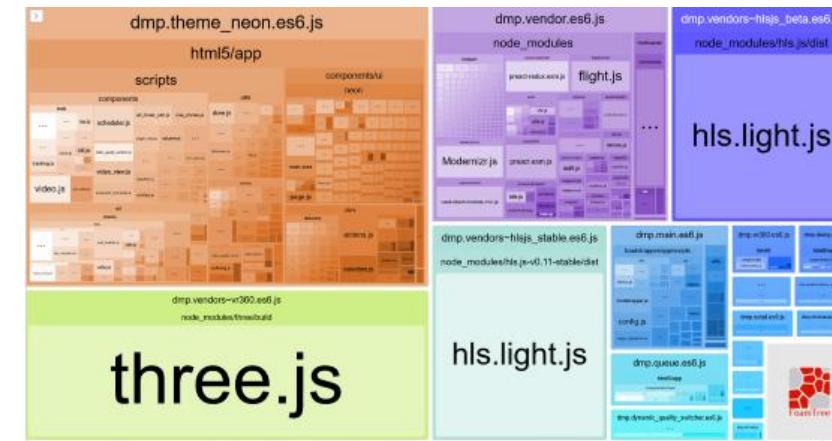
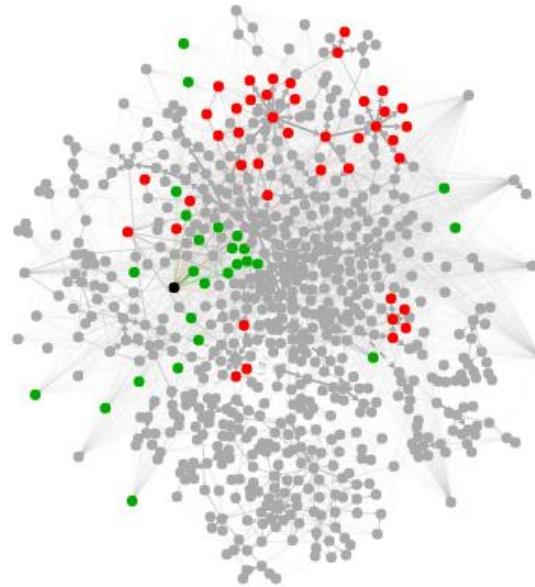
Photo by Garrett Mizunaka on Unsplash

# **Bundle analysis & code splitting**

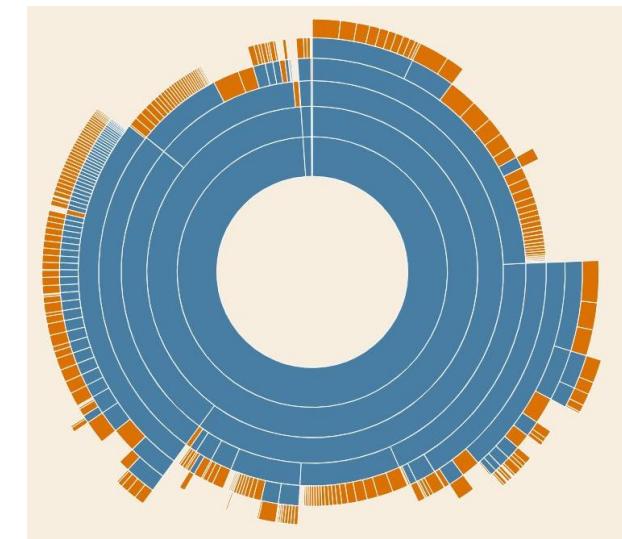


## BUNDLE ANALYSIS

# Webpack bundle tools



webpack-bundle-analyzer



id	name	size	chunks	flags
444	./node_modules/three/build/three.js	985 KIB	vendors~vr360	built
660	./node_modules/hls.js/dist/hls.light.js	584 KIB	vendors~hlsjs_beta	built
661	./node_modules/hls.js-v0.11-stable/dist/hls.light.js	508 KIB	vendors~hlsjs_stable	built
145	./html5/vendor/comscore/comscore.streaming.6.1.0.170130.min.js	103 KIB	vendor	built
150	./node_modules/vast-client/dist/vast-client-module.min.js	51 KIB	vendor	built

**Tip: disable module concatenation when analyzing the bundle**

```
{config: {optimization: {concatenateModules: false}}}
```

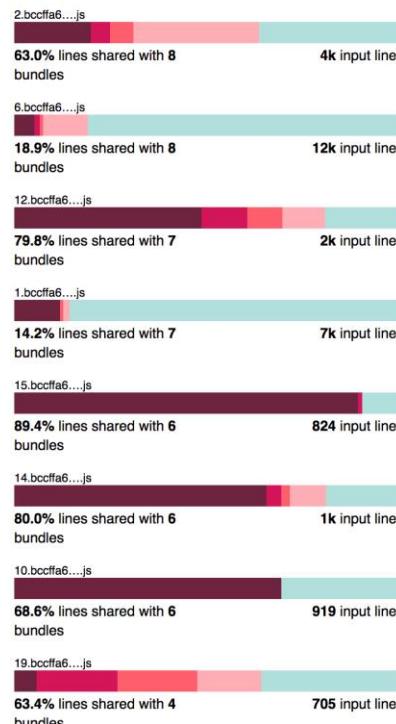
## BUNDLE ANALYSIS

# Bundle tools: Bundle Buddy

<https://github.com/samccone/bundle-buddy>

Find duplicated code across the chunks

### Bundle Buddy



Source File  
Grey = no  
overlapping,  
otherwise colored by  
degree of overlap



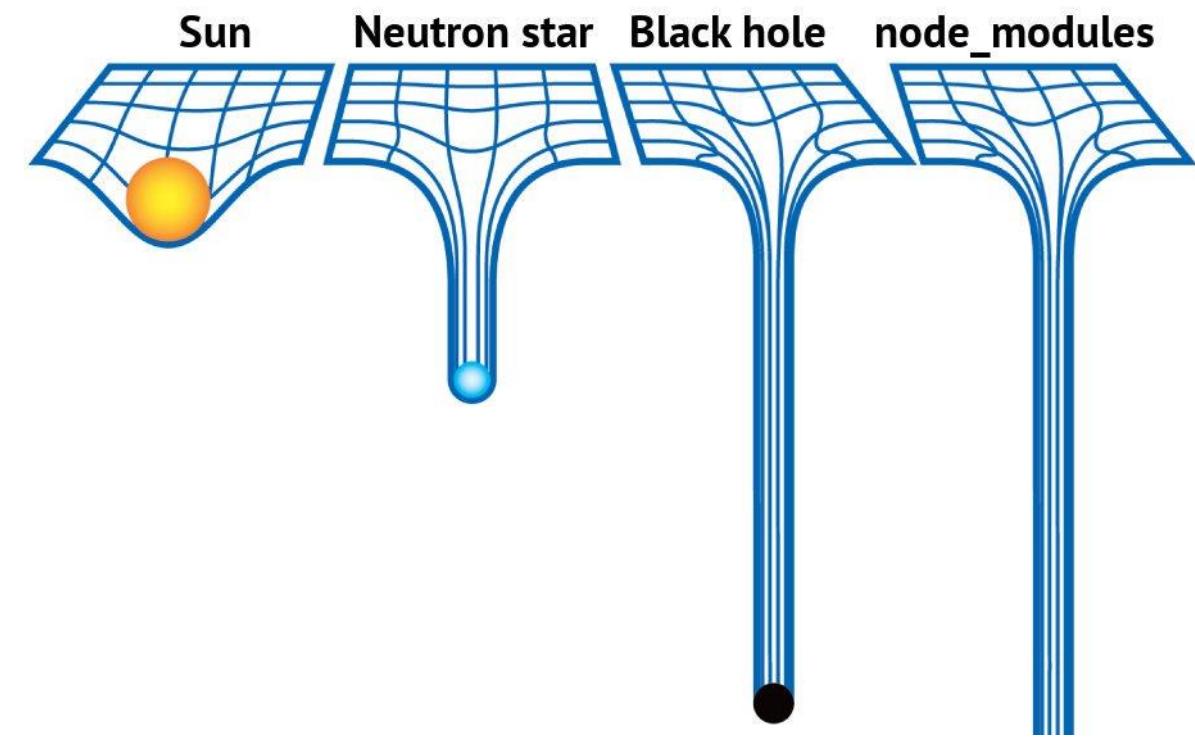
Bundle File  
Inner pie chart  
shows overlapping  
code



1069 files were bundled into 13 bundles. Of those, 9 bundles have overlaps

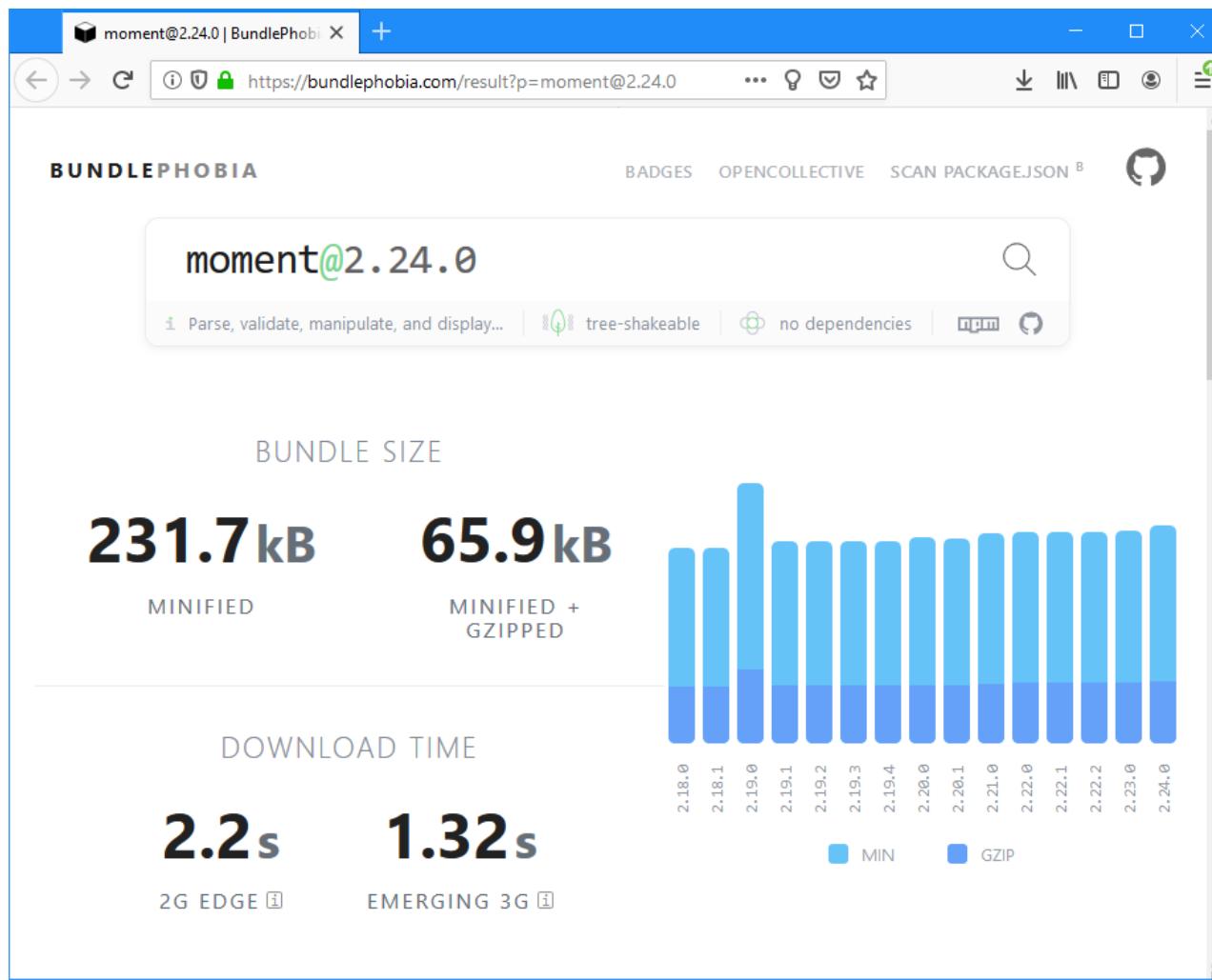
See details by: Clicking on a file in the left nav, or a bundle in the network graph

# Dependencies



## DEPENDENCIES

# Bundlephobia - check size of npm packages



<https://bundlephobia.com/>

## Similar Packages NEW

General purpose date-time utilities

dayjs

2KB immutable date time library alternative to Moment.js with the same modern API

96 %  
SMALLER

**2.71 kB**  
MIN +  
GZIP

date-fns

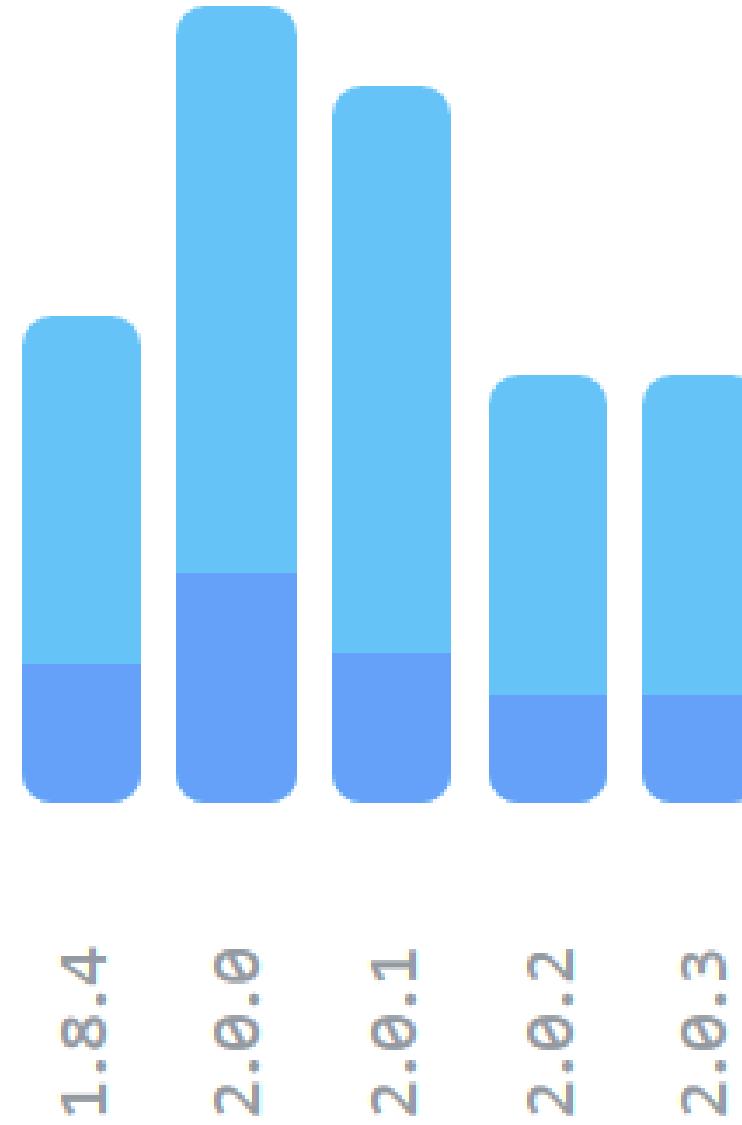
Modern JavaScript date utility library

90 %  
SMALLER

**6.54 kB**  
MIN + GZIP

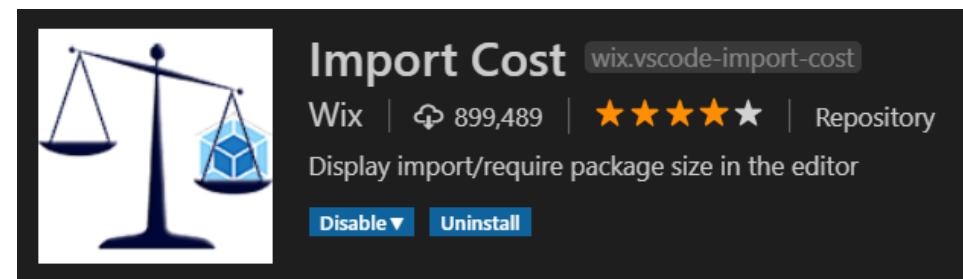
# Bundlephobia

- Check for regressions before updating a dependency
- Contrary, maybe there's a new, smaller version available
- **Import `package.json` to analyze all your deps**



## DEPENDENCIES

# Import Cost - vscode extension

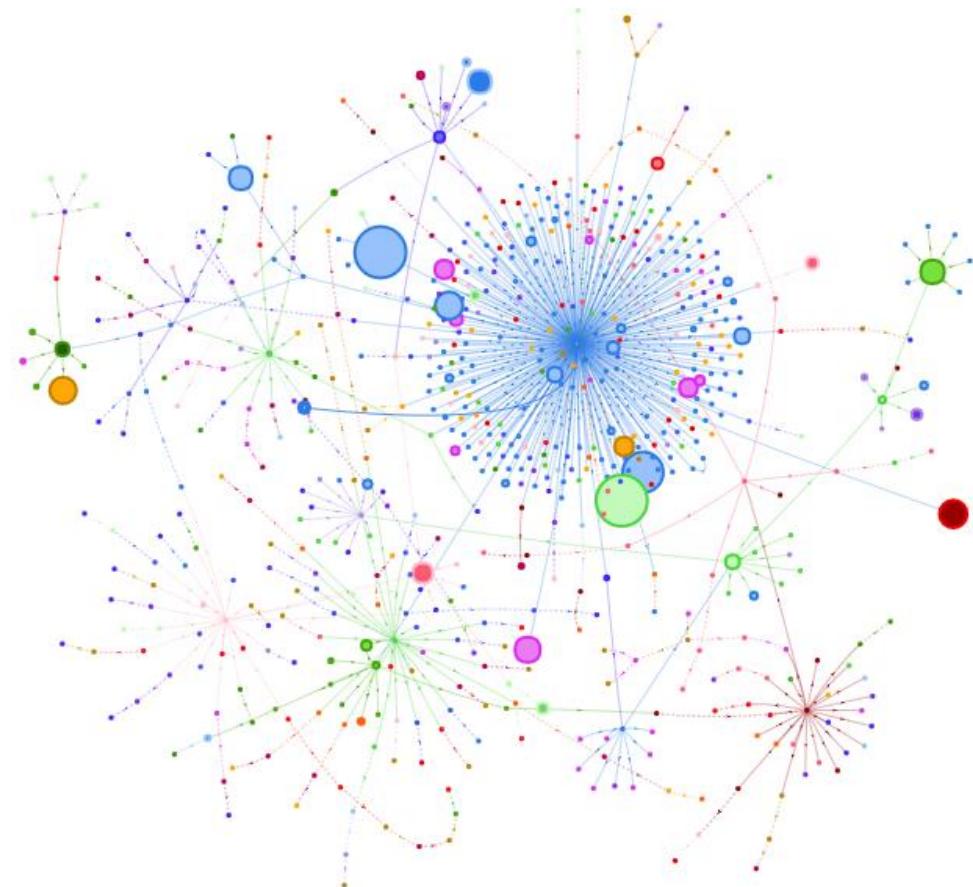
A screenshot of the VS Code code editor showing an 'App.js' file. The sidebar on the left has a document icon with a '1' notification. The code editor shows the following lines:

```
JS App.js ●  
1  
2 | const {uniqueId} = require('lodash') 70KB  
3  
4
```

The '70KB' label is color-coded in red, indicating the size of the 'lodash' module being imported.

# Third-parties

Request Map for <http://www.nba.com> on Thursday the 18th of April at 3pm



**[requestmap.herokuapp.com](https://requestmap.herokuapp.com)**

[https://requestmap.herokuapp.com/render/190418\\_PQ\\_4b776cc76ed8388b44883c5ee3147a23/](https://requestmap.herokuapp.com/render/190418_PQ_4b776cc76ed8388b44883c5ee3147a23/)

## THIRD-PARTIES

# Dealing with third parties

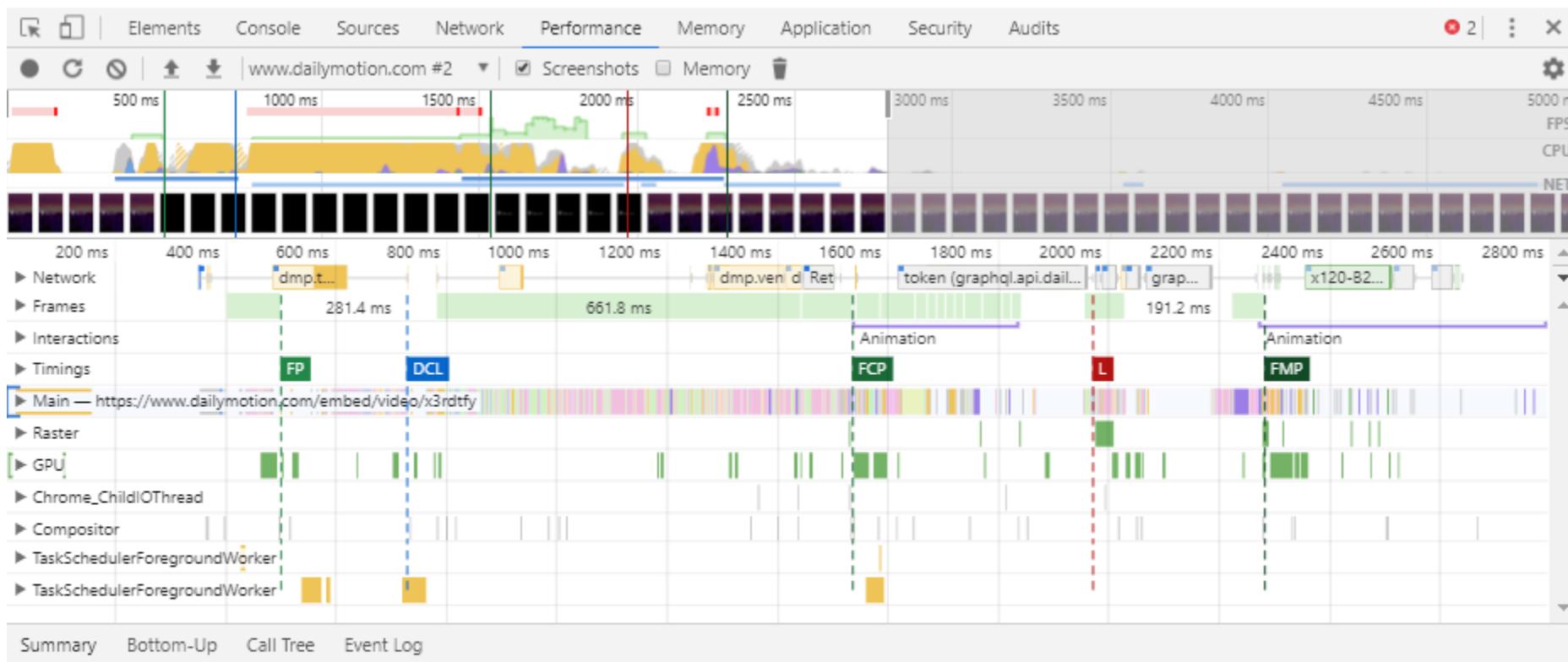
- Visualize:
  - <http://requestmap.herokuapp.com/>
- Compare impact of different 3<sup>rd</sup>-party providers:
  - <https://github.com/patrickhulce/third-party-web>
  - <https://www.thirdpartyweb.today>
- How to deal with 3<sup>rd</sup> parties:
  - Harry Roberts @ performance.now:  
<https://youtu.be/bmIUYBNKja4>
- Put process on adding new tags:
  - <https://medium.com/the-telegraph-engineering/improving-third-party-web-performance-at-the-telegraph-a0a1000be5>

# **Chrome DevTools performance panel**

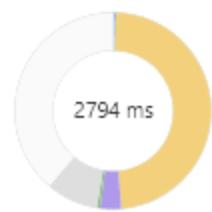


CHROME DEVTOOLS

# Performance panel



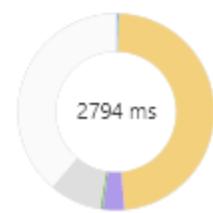
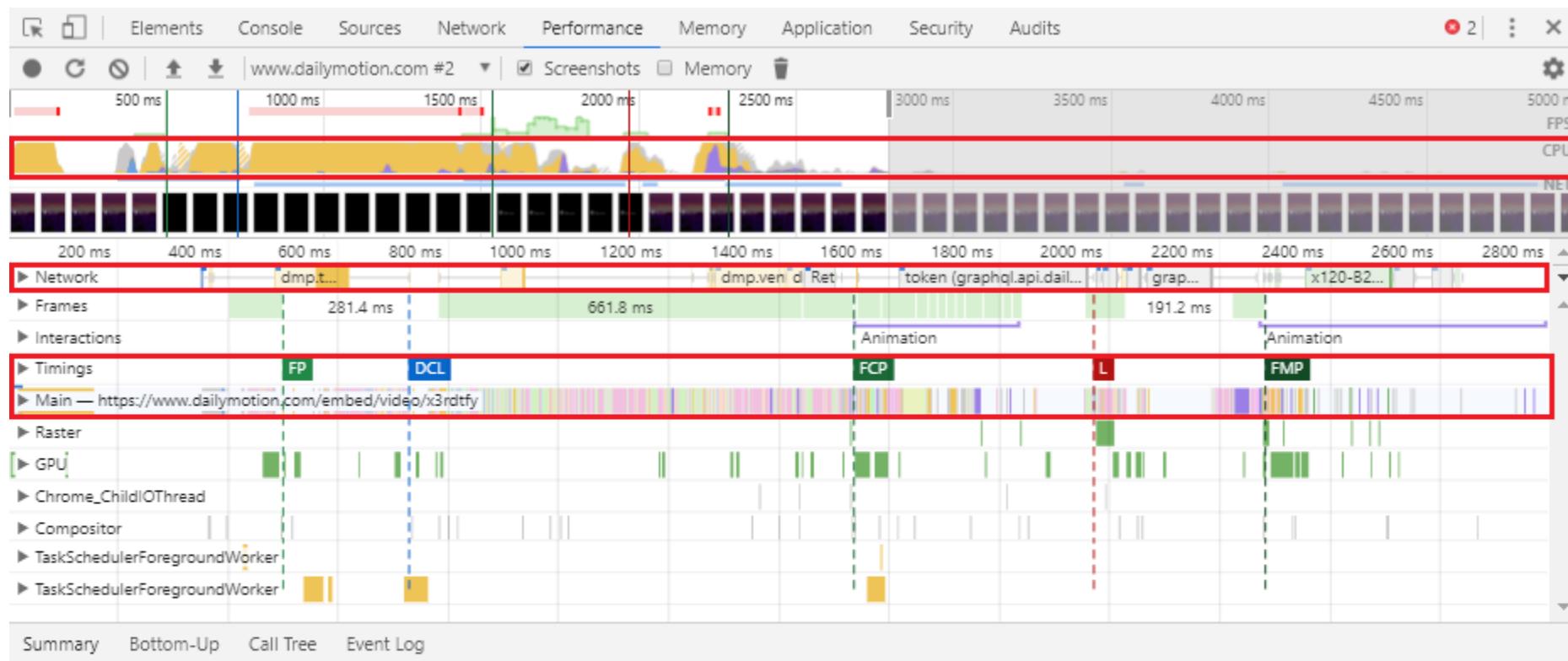
Range: 0 – 2.79 s



13.4 ms	Loading
1345.2 ms	Scripting
97.6 ms	Rendering
15.0 ms	Painting
238.9 ms	System
1083.6 ms	Idle

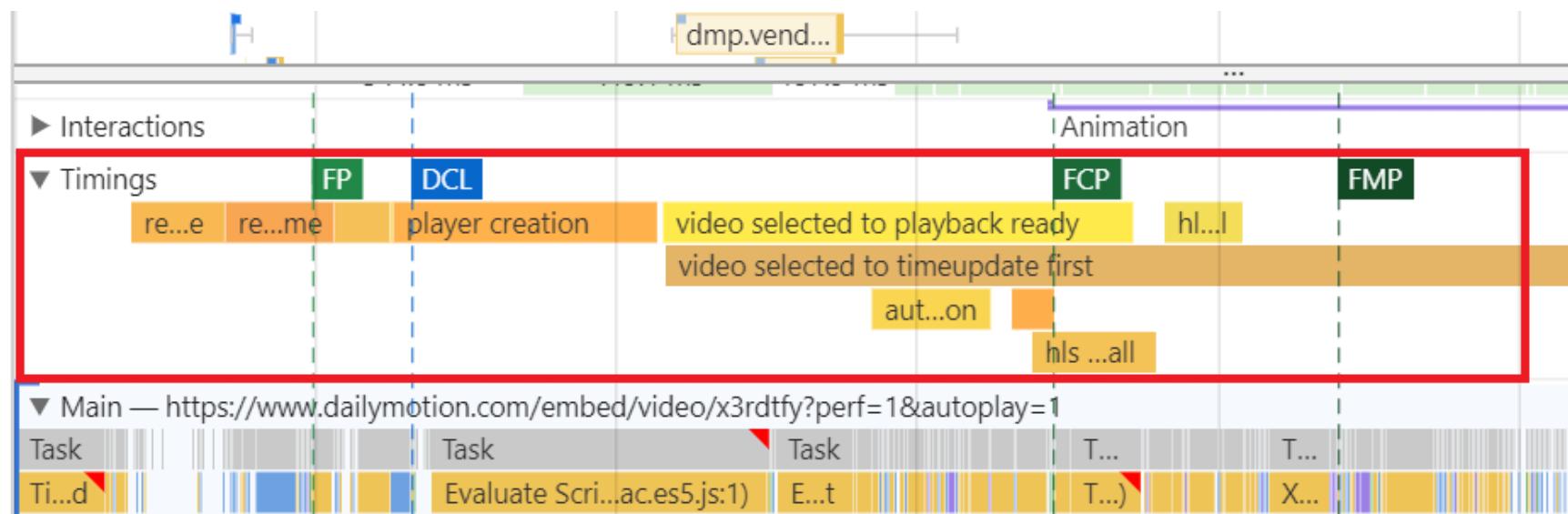
## CHROME DEVTOOLS

# Performance panel



# User Timing API

Useful to correlate network & JS activity with what the code is doing



```
performance.mark("startMark")
```

```
performance.mark("endMark")
```

```
performance.measure("myDiff", "startMark", "endMark")
```

# Performance panel

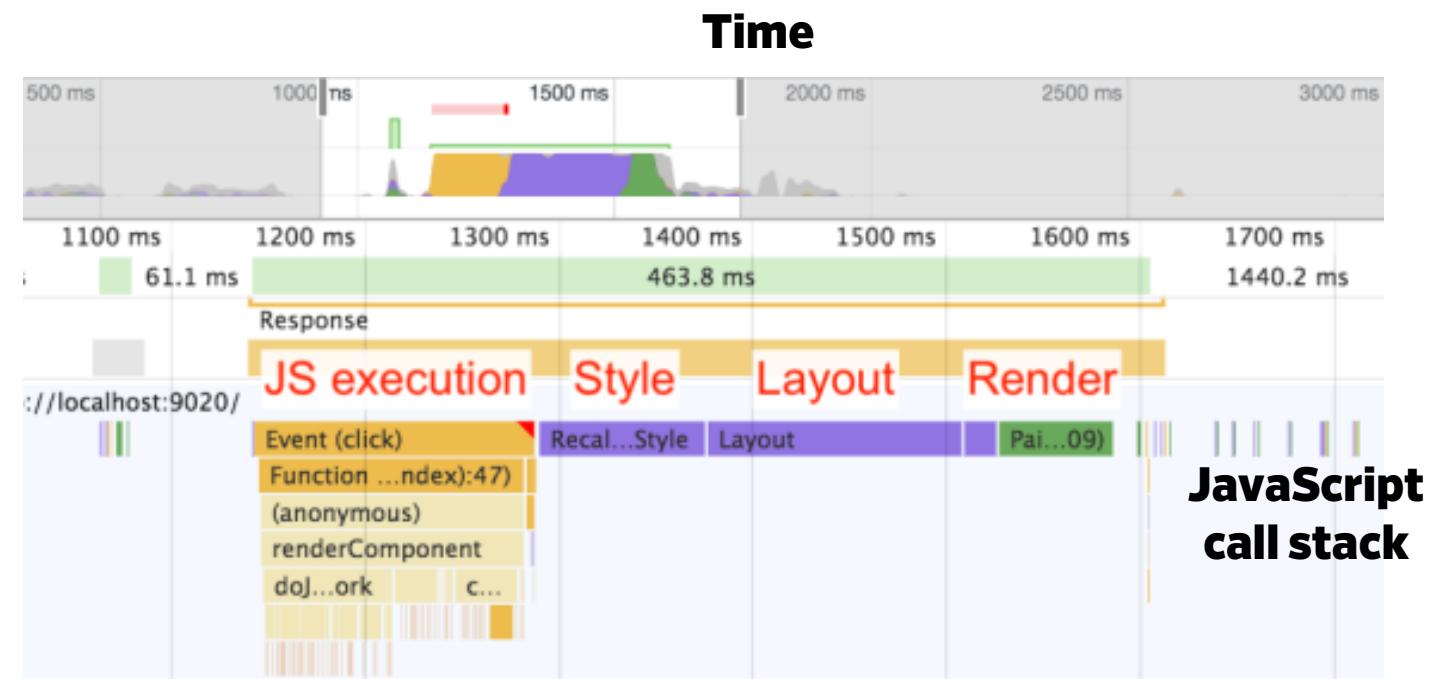
What do the colors mean?

**Golden** = JS

**Dark violet** = layout

**Dark green** = render

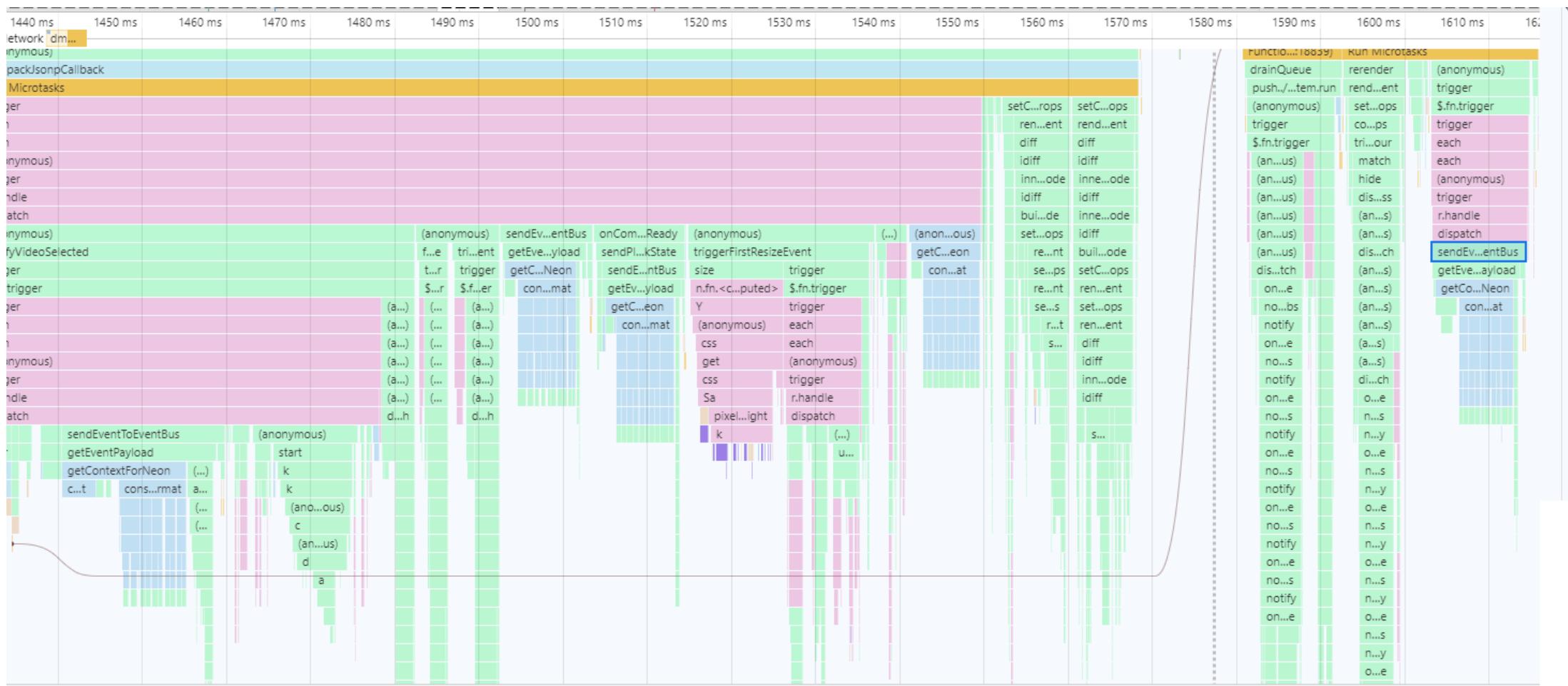
**All else** = random colors,  
fixed color per file



# JavaScript flame chart

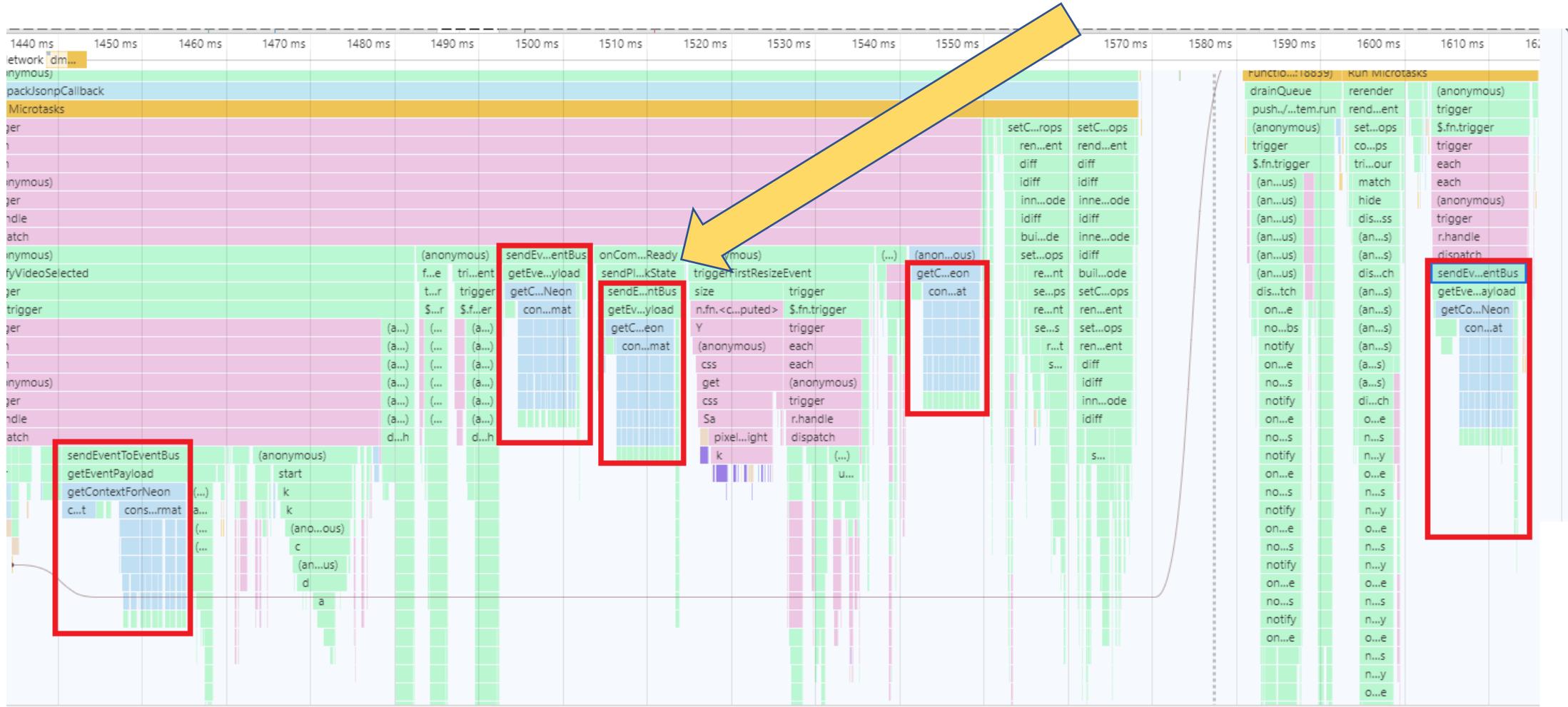
Zoom in and look for repeated patterns

*Mr. Obvious Tip:  
Disable minification*



# JavaScript flame chart

Reading the same cookie over and over. Expensive!



# Forced layout recalculation (reflow)

  
Red triangle over  
purple square  
**= forced reflow**

  
If part of JS call stack,  
**multiple times**  
= bad sign



## Typical issues:

- Reading layout props *in arbitrary JS functions*
- Reading layout props *after writing*

## Solutions:

- **Read layout *in requestAnimationFrame()* callbacks (it's free)**
- Batch DOM reads and writes, in correct order (**first reads, then writes**)

# Experimental features



## EXPERIMENTAL FEATURES

# Feature policy: browser as a linter

- Feature-Policy
  - Enforce rules in staging environment
  - **No need to run any tools - immediate feedback**

**Feature-Policy: oversized-images 'none'**

- Feature-Policy-Report-Only
  - Deploy to production to gather real-world data, without enforcing

<https://featurepolicy.info/>

The screenshot shows a browser window titled "Welcome - Riviera DEV" with the URL "rivieradev.fr". The page content displays "Our Sponsors" with sections for "Platinum" and "Gold" sponsors, each accompanied by a small placeholder image icon and file size (37 KB and 15 KB respectively). At the bottom of the page, the browser's developer tools are open, specifically the "Console" tab. A red error message is visible in the console output: "17:42:41.881 [Violation] Feature policy violation: oversized-images is not allowed in this document." The console also shows other standard browser logs and settings.

# Web debugging proxies



## SWISS-ARMY KNIFE TOOLS / WEB DEBUGGING PROXIES

# Fiddler

The screenshot shows the Progress Telerik Fiddler Web Debugger interface. The main window displays a list of network sessions. A context menu is open over the session at index 30, which is highlighted in blue. The menu items visible are "Simulate Modem Speeds", "Simulate 3G", "Disable Caching" (which is also highlighted in blue), and "Cache Always Fresh". The Fiddler interface includes various toolbars, a status bar at the bottom, and several panes on the right side showing details like Request Headers, Response Headers, and Cache information.

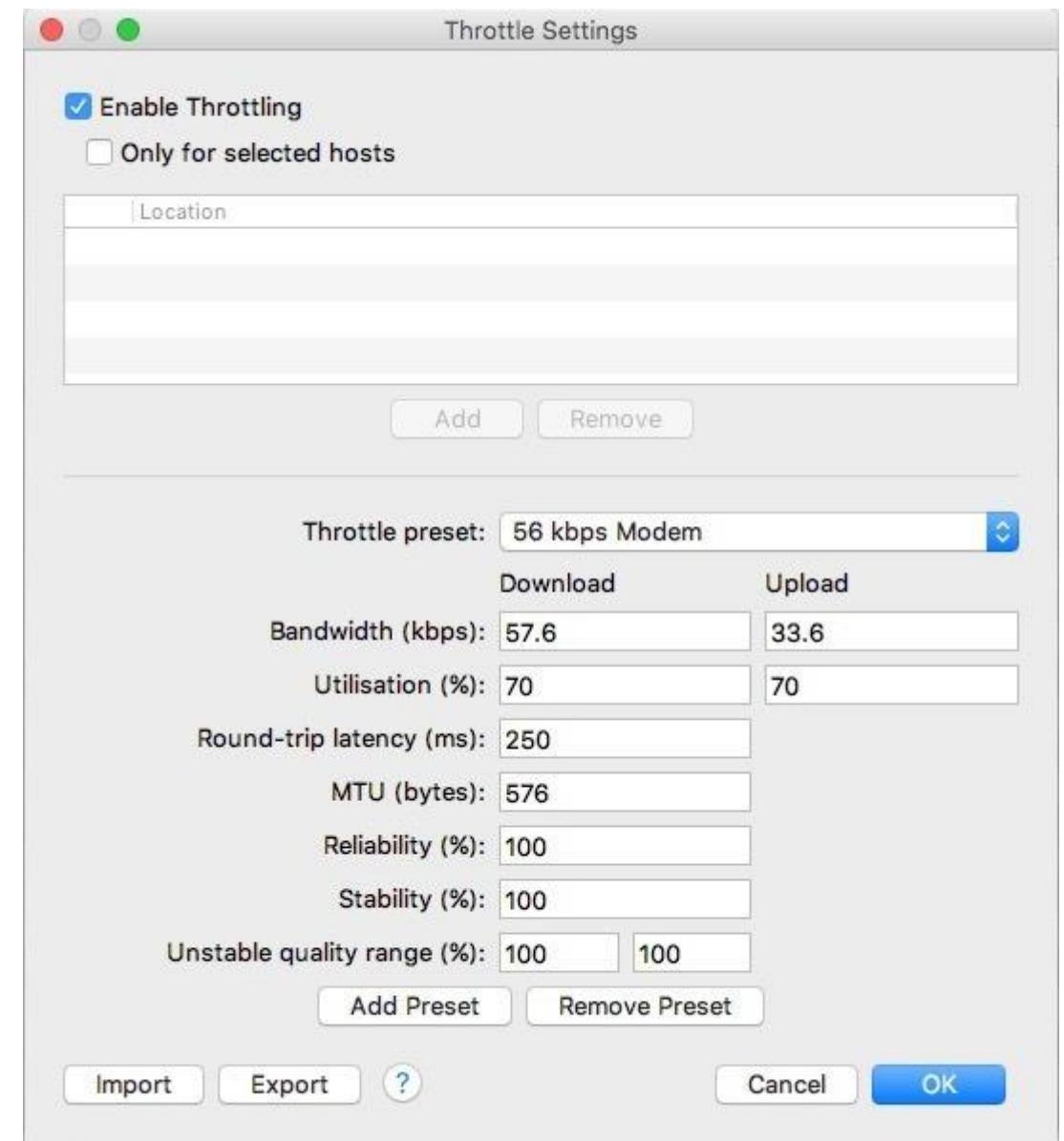
#	Process	Host	URL	Content-Type	Body	Caching
8	firefox:...	rivieradev.fr:443	/	text/html; charset=iso...	289	no-cache
9	firefox:...	rivieradev.fr:443	/public/stylesheets/style.css	text/css; charset=utf-8	41.883	max-age=3600
10	firefox:...	fonds.googleapis.com:443	/public/stylesheets/style.css	text/css; charset=utf-8	81.795	max-age=3600
11	firefox:...	cdnjs.cloudflare.com:443	/public/images/logos/logo_RD_ful...	image/svg+xml	19.134	max-age=3600
12	firefox:...	rivieradev.fr:443	/public/images/mascotte/Ray_IT...	image/png	32.321	max-age=3600
13	firefox:...	rivieradev.fr:443	/application/javascript	image/svg+xml	4.256	max-age=3600
14	firefox:...	rivieradev.fr:443	/application/javascript	image/svg+xml	1.370	max-age=3600
15	firefox:...	rivieradev.fr:443	/application/javascript	image/png	42.758	max-age=3600
16	firefox:...	rivieradev.fr:443	/application/javascript	image/png	8.400	max-age=3600
17	firefox:...	rivieradev.fr:443	/application/javascript	image/svg+xml	17.382	max-age=3600
18	firefox:...	rivieradev.fr:443	/application/javascript	application/javascript	5.339	max-age=3600
19	firefox:...	rivieradev.fr:443	/application/javascript	image/png	38.867	no-cache
20	firefox:...	rivieradev.fr:443	/application/javascript	image/png	147.210	no-cache
21	firefox:...	rivieradev.fr:443	/application/javascript	application/javascript	1.805	max-age=3600
22	firefox:...	rivieradev.fr:443	/application/javascript	image/png	1.760	max-age=3600
23	firefox:...	maps.googleapis.com:443	/application/javascript	image/png	0	no-cache
24	firefox:...	rivieradev.fr:443	/application/javascript	application/javascript	8.455	max-age=3600
25	firefox:...	rivieradev.fr:443	/application/javascript	image/png	12.905	no-cache
26	firefox:...	rivieradev.fr:443	/application/javascript	application/javascript	2.726	max-age=3600
27	firefox:...	rivieradev.fr:443	/application/javascript	image/png	5.837	no-cache
28	firefox:...	rivieradev.fr:443	/application/javascript	image/png	15.755	no-cache
29	firefox:...	rivieradev.fr:443	/application/javascript	image/png	55.755	no-cache
30	firefox:...	rivieradev.fr:443	/application/javascript	image/png	1760	no-cache
31	firefox:...	rivieradev.fr:443	/application/javascript	image/png	1760	max-age=3600
32	firefox:...	rivieradev.fr:443	/application/javascript	image/png	1760	max-age=3600
33	firefox:...	rivieradev.fr:443	/application/javascript	image/png	1760	max-age=3600
34	firefox:...	rivieradev.fr:443	/application/javascript	image/png	1760	max-age=3600
35	firefox:...	rivieradev.fr:443	/application/javascript	image/png	1760	max-age=3600
36	firefox:...	rivieradev.fr:443	/application/javascript	image/png	1760	max-age=3600
37	firefox:...	rivieradev.fr:443	/application/javascript	image/png	1760	max-age=3600
38	firefox:...	rivieradev.fr:443	/application/javascript	image/png	1760	max-age=3600
39	firefox:...	rivieradev.fr:443	/application/javascript	image/png	1760	max-age=3600

# Charles Proxy

## Advanced throttling options

Throttling also possible  
in Fiddler, although:

- no dedicated UI (via FiddlerScript)
- less sophisticated



# Caveats

**Some proxies downgrade HTTP/2 to HTTP/1.1**  
which may notably affect how resources are loaded:



- Fiddler
- BrowserStack
- ...

**Be careful** when benchmarking / comparing.

# The ultimate tools



## THE ULTIMATE TOOLS

# View source (CTRL-U)

### Watch out for:

- random "no one knows why we have this stuff"
- massive inline base64 content

```
685 8.174-8.231a8.236 8.236 0 0-4.63-7.42.67.67 0 0 1-.891.66.66 0 0 1 .885-.312a9.571 9.571 0 0 1 19 10.412c0 :  
55.72.72 0 0 1 .892-.44413.054.931a.67.67 0 0 1 .452.865L6.909 4.773a.72.72 0 0 1-.9.431.67.67 0 0 1-.441-.8621.497-1  
674-.02-.674-.376z" fill="currentColor"/>
```

```
]:t,this.attachedTo.push(e.node),t},this.removeInstance=function(e){delete this.instances[e.identity];var  
'(e.node);t>-1&&this.attachedTo.splice(t,1),Object.keys(this.instances).length||i.removeComponentInfo(this)),this.isAttachedTo=f  
ncts=[],this.addBind=function(e){this.events.push(e),i.events.push(e)},this.removeBind=function(e){for(var n=0,r=r=this.events[n];n  
allInstances={},this.events=[{}]).call(this),this.addInstance=function(e){var t=this.findComponentInfo(e);||(t=new n(e.constr  
t),r,t),this.removeInstance=function(e){var t=this.findComponentInfo(e);t&&t.removeInstance(e),delete this.allInstances[e.ident  
(e);t>-1&&this.components.splice(t,1)},this.findComponentInfo=function(e){for(var r=e.attachTo;r:e.constructor,n=0,r;r=this.com  
fo=function(e){return this.allInstances[e.identity][|null]},this.getBoundEventNames=function(e){return this.findInstanceInfo(e).eve  
iceInfoByNode=function(e){var t=[];return Object.keys(this.allInstances).forEach(function(n){var r=this.allInstances[n];r.insta  
,r,s=arguments.length,o=1,a=new Array(s-1);o<s?o+=1:a[o-1]=arguments[o];if(n){r=t,apply(null,a),r&&(a[a.length-1]=r);var  
c=(this,indInstanceInfo(this));&&r.removeBind(n);for(var s=0,o=o;i.events[s];s+=t(o,n)&&i.events.splice(s,1)),i.trigger=function()  
,this.withRegistration=function(){this.after("initialize",function(){i.addInstance(this)}),this.ondown("on",on),this.after("off",  
"trigger",i.trigger),this.ondown("teardown",function(){obj:i,fnName:"teardown"}))}return new n().apply(t,r),void 0==i||(e.exports=i),funct  
ionaryIsEnumerable("getOwnPropertyDescriptor");if(t){try{Object.getOwnPropertyDescriptor(Object,"keys")})catch(e){return t}va  
,toArray:function(e,t){t||0;for(var n=e.length,r=new Array(n),i=0;i<n;i++)r[i]=t[i];return r},merge:function(){var e=argume  
nts[n];return t[0]=(),0==t[t.length-1]&&(t.pop(),t.unshift(!0)),$.extend.apply(void 0,t),push:function(e,t,n){return e&&Objec  
+t+" while running in protected mode");object"=typeof e[r]&&object"=typeof t[r].push([e,r]):e[r]=t[r],this),getE  
'e=arguments;return function(){for(var t=arguments,n=e.length,i=n-1;n>0;i--)t[e[n].apply(void 0,t)];return t[0]}},uniqueArra  
y:function(e){return n.debounce(function(e,t,n){var r,i;return"number"!=typeof t&&(t=100),function(){var s=this,o=arguments,a=function(){r=nul  
l timeout(a,t),c&&(i=e.apply(s,o)),i},throttle:function(e,t){var n,r,i,s,o;a;"number"!=typeof t&&(t=100);var c=this.debounce(funct  
,c());return i||(i=setTimeout(u,t),s=o!=0:(s=10,a=e.apply(r)),c(),a),countThen:funcion(e,t){return function(){if(!--e)ret  
urn s},forEach:function(s){if(it.isPropagationStopped())||(i=r.closest(s)).length{return n||(),t.currentTarget=n.el=i[0],e[s].appl  
yments,n)},propertyWritability:function(e,n,r){e.hasOwnProperty(n)&&Object.defineProperty(e,n,{writable:r}),mutateProp  
ertyDescriptor(e,n).writable,Objec.defineProperty(e,n,{writable:!0});r.call(e),Objec.defineProperty(e,n,{writable:  
i):r.call(e));re  
on(e,t,n){use strict";function r(e){e&&e.events.slice().forEach(function(e){var t=e.type;e.element&&t.unshift(e.element),"fun  
ction back);this.off().apply(this,t),e.instance))function i(e,t){try{window.postMessage(t,"*")})catch(t){n.warn.call(this,[  
'Event ",e,"  
data in events."].join(""))}}function s(e){n.warn.call(this,[  
'Attribute ",e," defaults to an array or object.',  
'Enclose this in  
ction o(e){var t=e;r;if(this.attrDef=new this.attrDef.enabled&&window.console){for(var r in this.attrDef.prototype)t.push(i);r=Ob  
l unused attribute "+r+"");break})}for(var i in this.attrDef.prototype){if(void 0==i){if(null==this.attr[i])throw new Err  
n.enabled&&object"=typeof this.attr[i]&&s.call(this,i)else this.attr[i]=e[i];"function"=typeof this.attr[i]&&(this.attr[i]-thi  
his,"defaultAttrs will be removed in a future version. Please use attributes.");var t=Objec.create(e),for(var r in this.defaults)  
this,r);this.attr=t,Objec.keys(this.defaults)[{}].forEach(function(e){if(null==this.defaults[e]&&null==this.attr[e])throw new  
Err,r);function c(e){return function(t,n){var r=e.target,trigger(r,e);function u(){this.trigger=function(){var e,t,r,s,o;a=argume  
nts[0],s=arguments[1];(e=this.$node,s=arguments[0]),s.defaultBehavior&&(o=s.defaultBehavior,s=$.Event(s.type),t=s.type)|s,n.en  
ns="http://www.w3.org/2000/svg"><path fill="none" stroke="currentColor" d="M4.2h4.2V0m0 16v-4.2H0M11.8 0v4.2H16m0 7.6h-4.2V16"/></symbol><symbol  
fill="none" stroke="currentColor" d="M4.2h4.2V0m0 16v-4.2H0M11.8 0v4.2H16m0 7.6h-4.2V16"/></symbol><symbol  
fill="none" stroke="currentColor" d="M10.5 17.3L19.9.2c1-1.5-2.2 1.5-3.6 0-2.8-2.4-5.1-5.3-5.1-2.1 0-3.9 1.2-4.7 2.9C9.7 1.7 7.9.5 5.8.5 2.9.5!  
tpp://www.w3.org/2000/svg"><path fill="currentColor" stroke="currentColor" d="M10.5 17.3L19.9.2c1-1.5-2.2 1.5-3.6 0-2.8-2.4-5.1-5.3-5.1-2.1 0-3.9 1.2-4.7 2.9C9.7 1.7 7.9.5 5.8.5 2.9.5!</symbol><symbol  
fill="none" stroke="currentColor" d="M10.5 17.3L19.9.2c1-1.5-2.2 1.5-3.6 0-2.8-2.4-5.1-5.3-5.1-2.1 0-3.9 1.2-4.7 2.9C9.7 1.7 7.9.5 5.8.5 2.9.5!  
4.492-1.78V.695h4.323V.101z"/></symbol><symbol viewBox="0 0 82.7 1103" id="np_paddle" fill="currentColor" d="M44.977 29.985h6.663v24.987h-6.663z-m14.992 0 6.663z!"></symbol><symbol viewBox="0 0 849" fill="none" stroke="currentColor" d="M44.977 29.985h6.663v24.987h-6.663z!"></symbol>
```

- whitespace and comments not stripped out
- duplicated code or markup etc.

# DiffTool

Beautify and diff your bundles before shipping to production

```

11  var n = window.dmpJsonp;
12  window.dmpJsonp = function o(a, c, s) {
13 -  for (var i, u, d = 0, l = [], f; d < a.length; d++) u = a[d], r[u] && l.push(r[u][0]), r[u] = 0;
14  for (i in c) Object.prototype.hasOwnProperty.call(c, i) && (e[i] = c[i]);
15 -  for (n && n(a, c, s); l.length;) l.shift();
16  if (s)
17 -  for (d = 0; d < s.length; d++) f = t(t.s = s[d]);
18 -  return f
19 }

11  var n = window.dmpJsonp;
12  window.dmpJsonp = function o(a, c, s) {
13 +  for (var i, u, d = 0, f = [], l; d < a.length; d++) u = a[d], r[u] && f.push(r[u][0]), r[u] = 0;
14  for (i in c) Object.prototype.hasOwnProperty.call(c, i) && (e[i] = c[i]);
15 +  for (n && n(a, c, s); f.length;) f.shift();
16  if (s)
17 +  for (d = 0; d < s.length; d++) l = t(t.s = s[d]);
18 +  return l
19 }

```

Find unexpected issues, like:

- **Non-deterministic build** which affects client-side **cache reuse**
- Regressions when updating tools or dependencies

# Summary

## Network performance

- ❖ Latency
- ❖ Waterfall
- ❖ Visual comparison tools

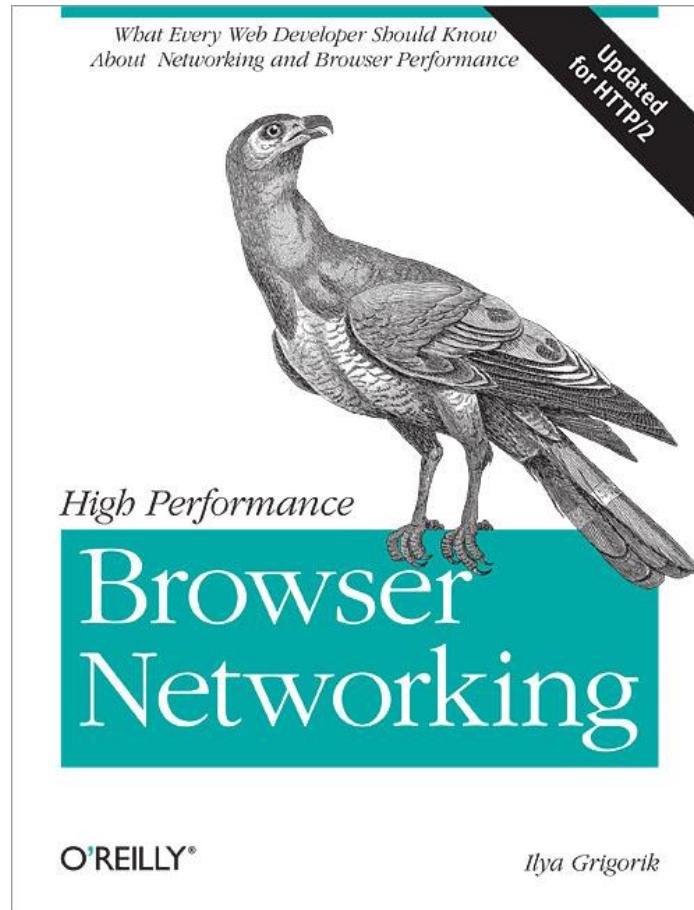
## Runtime performance / JavaScript

- ❖ Bundle analysis & Code splitting
- ❖ Dependencies & 3rd parties
- ❖ DevTools perf panel



[LEARN MORE](#)

# Understanding the building blocks



- High Performance Browser Networking
  - Read for free at <https://hpbn.co>
- High Performance Networking in Chrome
  - <https://www.aosabook.org/en/posa/high-performance-networking-in-chrome.html>
- Check my blog article
  - <https://calendar.perfplanet.com/2018/getting-started-with-web-performance-2019-beginners-guide/>
- More perf-oriented articles, books, slides, videos:
  - <https://calendar.perfplanet.com>
  - <https://www.perf-tooling.today/>



# Thank you!

**Slides available at**

<https://jakub.gieryluk.net/slides/rivieradev>

**Find me on Twitter**



**\_\_jakub\_g**

# Bonus content

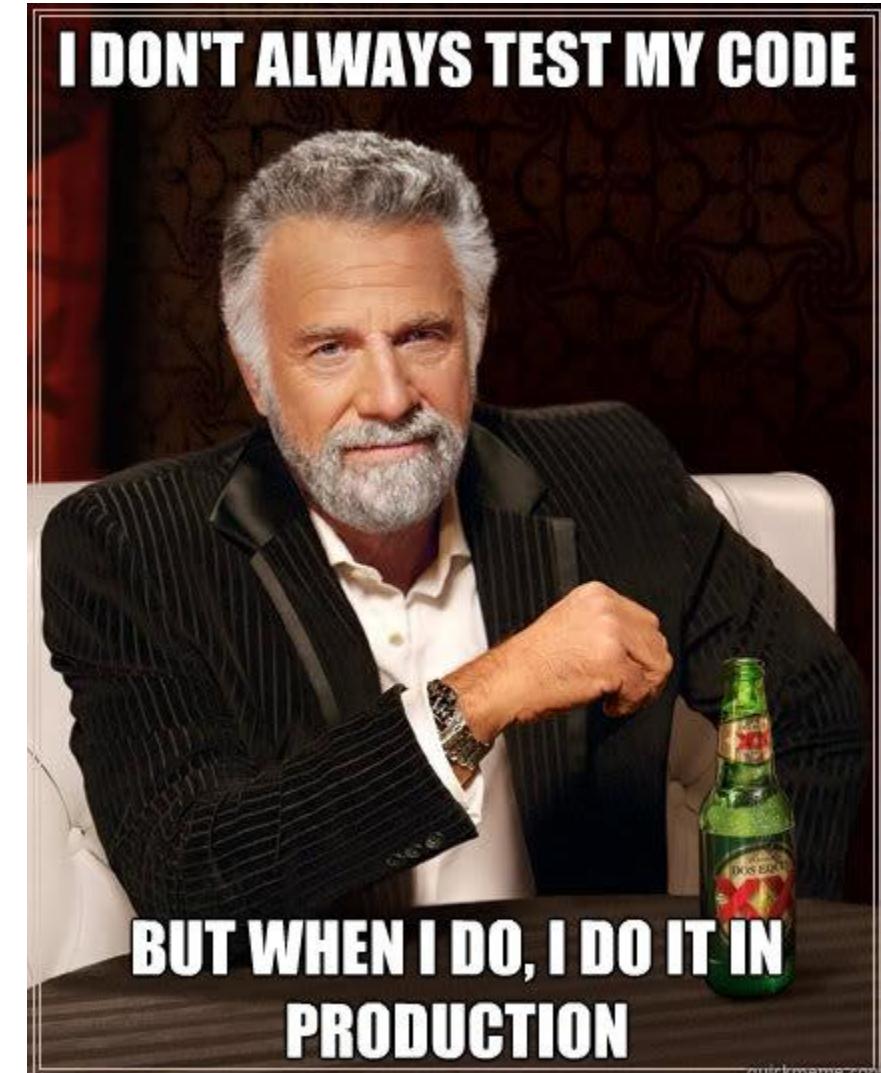
THE ULTIMATE TOOL

# Test in production

Some insights can only be drawn from A/B testing in production.

You can never simulate all real-world traffic patterns in the lab.

- Push to prod
- **gather RUM data**
- iterate



# Aspects of front-end performance

## Loading



Initial load time

## Runtime

Responding to  
user input

Scrolling & animations  
performance

## Indirect

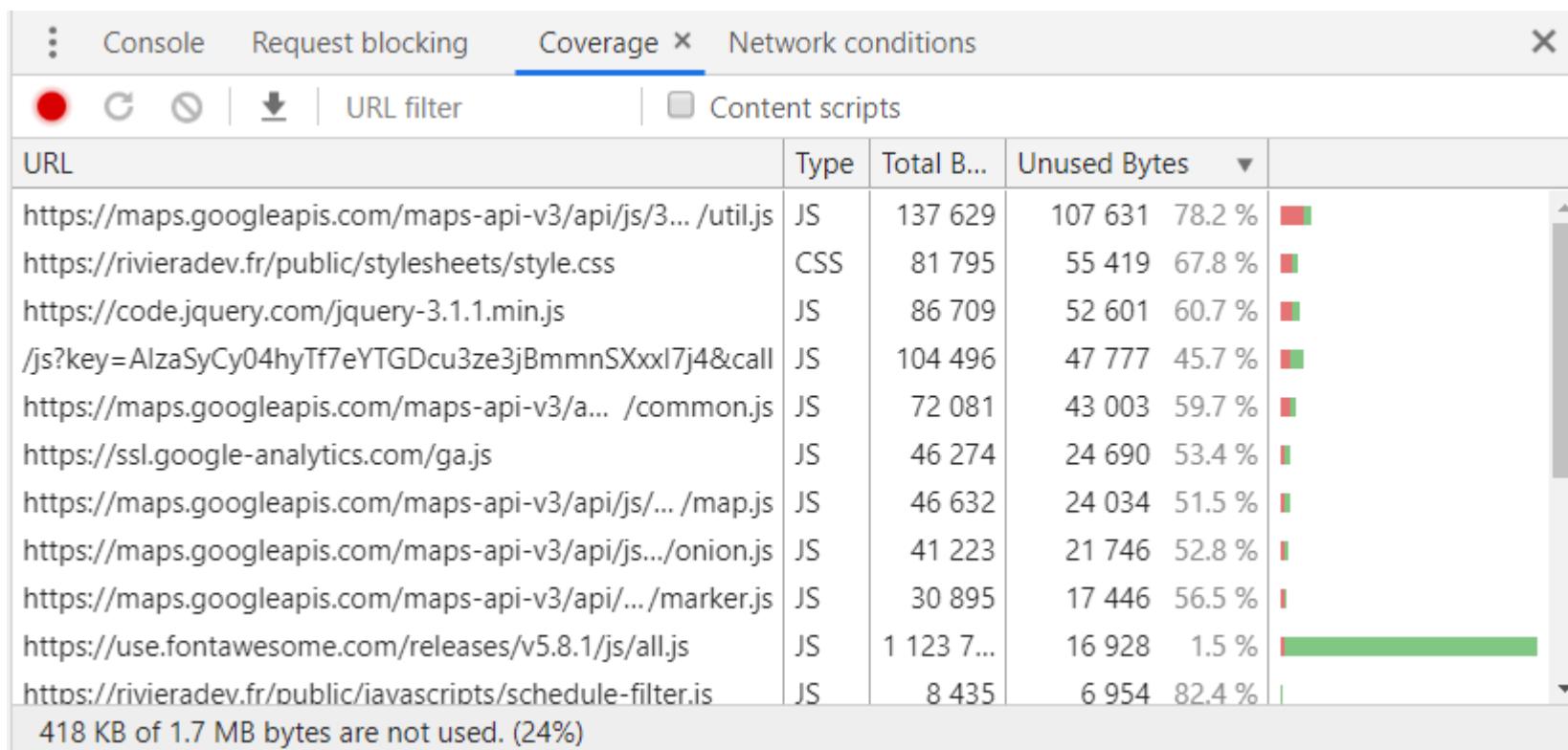


Battery life

## CHROME DEVTOOLS

# Runtime code coverage tool

- Can give idea about **code splitting opportunities**
- May find some dead files



The screenshot shows the Chrome DevTools Coverage tab. The tab bar includes Console, Request blocking, Coverage (which is selected), and Network conditions. Below the tab bar are icons for red circle, green circle, blue square, and a download arrow, followed by a URL filter input field and a Content scripts checkbox. The main area is a table with the following columns: URL, Type, Total B..., Unused Bytes, and a percentage column. The table lists various resources with their respective types, total byte counts, unused byte counts, and usage percentages. A large green progress bar at the bottom indicates that 418 KB of 1.7 MB bytes are not used, which is 24%.

URL	Type	Total B...	Unused Bytes	%
https://maps.googleapis.com/maps-api-v3/api/js/3... /util.js	JS	137 629	107 631	78.2 %
https://rivieradev.fr/public/stylesheets/style.css	CSS	81 795	55 419	67.8 %
https://code.jquery.com/jquery-3.1.1.min.js	JS	86 709	52 601	60.7 %
/js?key=AlzaSyCy04hyTf7eYTGDcu3ze3jBmmnSXxl7j4&call	JS	104 496	47 777	45.7 %
https://maps.googleapis.com/maps-api-v3/a... /common.js	JS	72 081	43 003	59.7 %
https://ssl.google-analytics.com/ga.js	JS	46 274	24 690	53.4 %
https://maps.googleapis.com/maps-api-v3/api/js/... /map.js	JS	46 632	24 034	51.5 %
https://maps.googleapis.com/maps-api-v3/api/js.../onion.js	JS	41 223	21 746	52.8 %
https://maps.googleapis.com/maps-api-v3/api/.../marker.js	JS	30 895	17 446	56.5 %
https://use.fontawesome.com/releases/v5.8.1/js/all.js	JS	1 123 7...	16 928	1.5 %
https://rivieradev.fr/public/javascripts/schedule-filter.js	JS	8 435	6 954	82.4 %

418 KB of 1.7 MB bytes are not used. (24%)

## WATERFALL

# Waterfall anti-patterns: network silence

- Network silence = opportunity for an early fetch
- Also, **grouped requests are more battery-efficient**

*[In Pandora music streaming application], **analytics beacons** [sent every 60 seconds] accounted for **0.2% bytes and 46% power consumption***

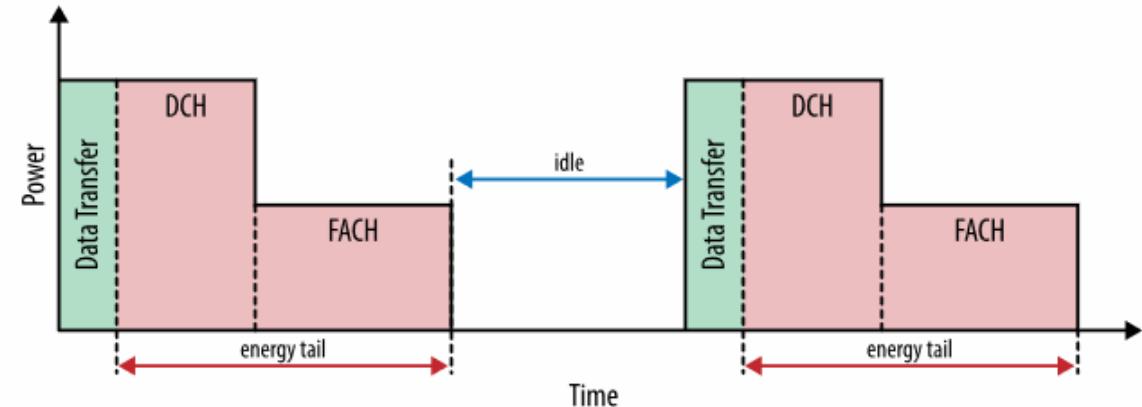


Figure 7-9. HSPA+ energy tail due to DCH > FACH > IDLE transitions

<https://hpbn.co/mobile-networks/>

<https://hpbn.co/optimizing-for-mobile-networks/>

# WebPageTest: killer features

- Testing from all over the world
  - “*the site is slow in Brazil*” (*maybe slow local ad?*)
  - “*the site is down in Indonesia*”
  - *Can capture response bodies*
- All kinds of browsers and devices
- Same UI regardless of browser tested
- Permanent, shareable test results
  - WPT URL = proof of bug / problem



Test Location Dulles, VA - Thinkpad T430 (Chrome,Firefox,Edge,IE 11)

Browser Chrome

Advanced Settings ▾

Test Settings Advanced

Connection

Number of Tests to Run Up to 9

Repeat View

Microsoft Edge Canary (Chromium) Selected

IE 11

A screenshot of the WebPageTest configuration interface. It shows a dropdown for 'Test Location' set to 'Dulles, VA - Thinkpad T430 (Chrome,Firefox,Edge,IE 11)'. A dropdown for 'Browser' has 'Chrome' selected. Under 'Advanced Settings', the 'Advanced' tab is selected. In the 'Connection' section, 'Up to 9' tests are specified. The 'Repeat View' section shows 'Microsoft Edge Canary (Chromium)' selected, with a blue highlight and a mouse cursor pointing at it. Other options listed in the dropdown include Chrome, Canary, Firefox, Firefox Beta, Firefox Nightly, Firefox ESR, Microsoft Edge {EdgeHTML}, Microsoft Edge Dev (Chromium), and IE 11.

# WebPageTest: more strong points

- Can gather lots of low-level data
  - tcpdump, advanced HTTP/2 info, Chrome timeline, Chrome tracing data...
- Data can be exported in HAR format
- Automation possible
  - REST API, npm package (<https://www.npmjs.com/package/webpagetest>)
- Free, open source, not for profit (PHP, <https://github.com/WPO-Foundation/webpagetest>)

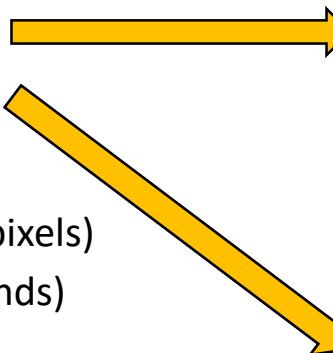
# WebPageTest: caveats

- Public instance = test only public websites (production)
  - Although you can set up a private instance
- Small differences in detail level between browsers
  - Most notably: some data can't be gathered on iOS

## WEBPAGETEST: EVEN MORE FEATURES

# Hidden features

- CPU throttling via URL param
- CPU throttling via mobile emulation
- Custom waterfall URL params:
  - &width=2000 (width of waterfall in pixels)
  - &max=30 (width of waterfall in seconds)
  - &ut=1 (show User Timing marks)
  - ...
- Several more “hidden features” via URL params (check up docs): high quality images, experimental timings etc.
- **Just click around any links on WebPageTest.org to discover features**
- See also:
  - <https://deanhume.com/ten-things-you-didnt-know-about-webpagetest-org/>



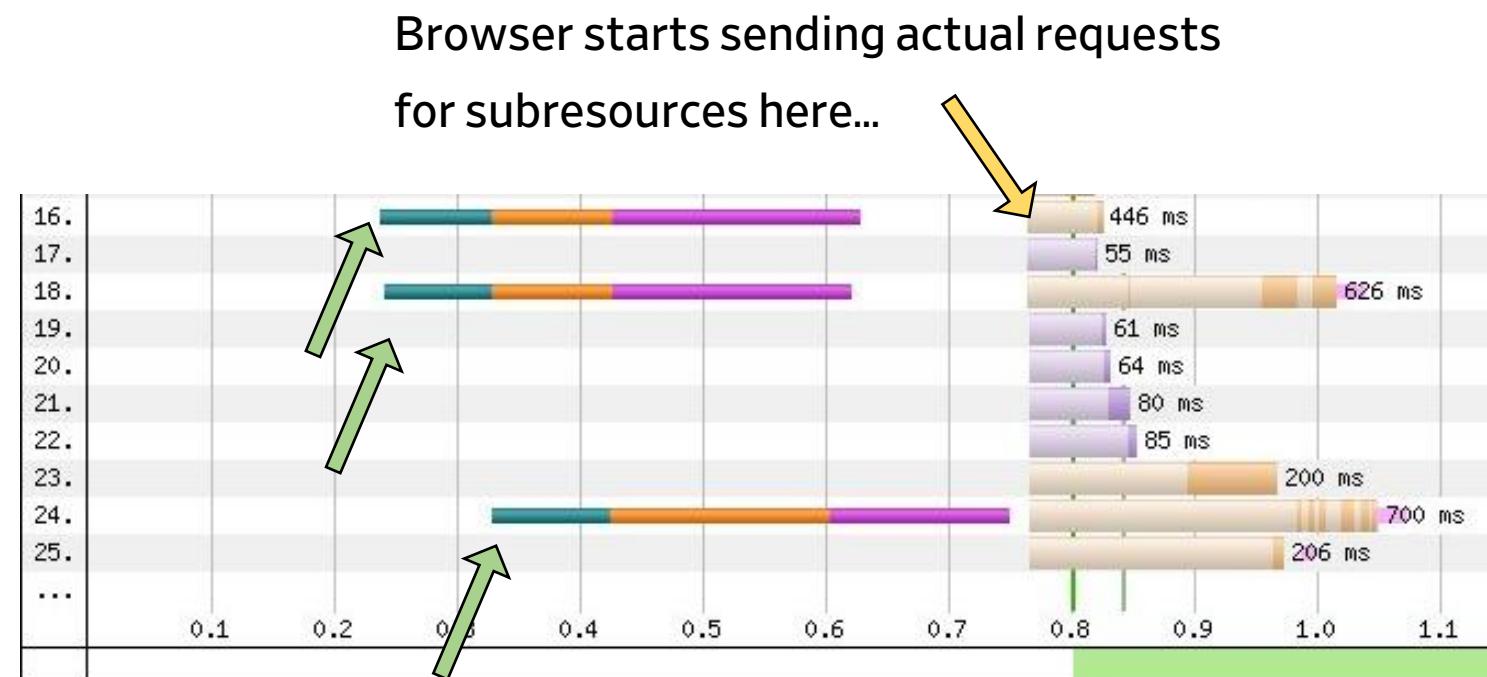
The screenshot shows the WebPageTest interface with a blue header bar. Below it is a browser-like toolbar with back, forward, and refresh buttons, and a URL field containing [https://www.webpagetest.org/?throttle\\_cpu=2.5](https://www.webpagetest.org/?throttle_cpu=2.5). The main area is titled "Advanced Settings" with a dropdown menu. A tab bar at the top of this section includes "Test Settings", "Advanced" (which is selected), "Chromium", "Auth", "Script", "Block", "SPOF", and "Custom". Under "Advanced", there are several checkboxes and dropdown menus. One dropdown menu under "Emulate Mobile Browser" is open, showing a list of devices: Motorola G (gen 4), Android, Motorola G (gen 4), Nexus 5, Nexus 5X, Google Pixel, Google Pixel XL, and Google Pixel 2. The "Nexus 5X" option is highlighted with a blue selection bar and a cursor icon. Other sections visible include "Capture Lighthouse Report", "Capture Dev Tools Timeline", "Capture Chrome Trace", "Trace Categories", and "Capture Network Log".

([https://github.com/WPO-Foundation/webpagetest/blob/master/www/settings/mobile\\_devices.ini](https://github.com/WPO-Foundation/webpagetest/blob/master/www/settings/mobile_devices.ini))

## WATERFALL

# Waterfall good patterns: preconnect “gaps”

...but since connection  
was initiated before  
with **<link rel=preconnect>**,  
it avoids 400ms penalty



## WATERFALL BASICS

# Bonus: keep your favicons at bay

 **Doug Sillars** +  
@dougsillars

Following

According to the April 1 [@httparchive](#), there are ~600k favicons that throw a 404. With 5M sites in the database, that's 12% of sites missing the favicon.



@rem @rem

Now that Chrome has a default favicon (that I recognise), it really stands how (and it's surprising me) how many sites \*don't\* have a favicon - either as /favicon.ico or as a metatag.

7:32 AM - 1 May 2019



**Doug Sillars** + @dougsillars · May 1

The largest 404 favicon weighs in at 6.1 MB (it reloads the HTML)

...but why is the website HTML 6.1 MB?

Name	Status	Type	Ini...	Size
 favicon.ico <a href="/site/wp-content/uploads/2012/09">/site/wp-content/uploads/2012/09</a>	404	text/html	Ot...	6.1 MB 6.0 MB

<https://twitter.com/dougsillars/status/1123460280581853186>

Put a small 16x16 **favicon.ico** in the root of the domain  
Make sure your 404/500 pages are **small and self-contained**

## WATERFALL

# More waterfall analyses

Jake Archibald wrote...

## Who has the fastest website in F1?

Posted 19 March 2019

I was trying to make my predictions for the new Formula One season by studying the aerodynamics of the cars, their cornering speeds, their ability to run with different amounts of fuel. Then it hit me: I have no idea what I'm doing.

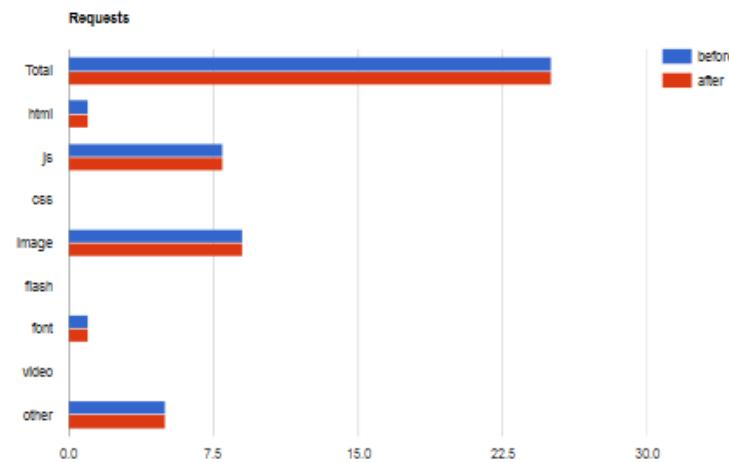
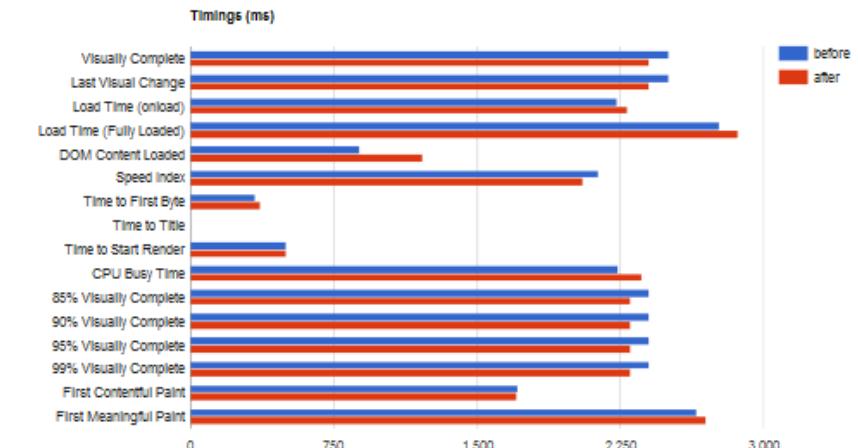
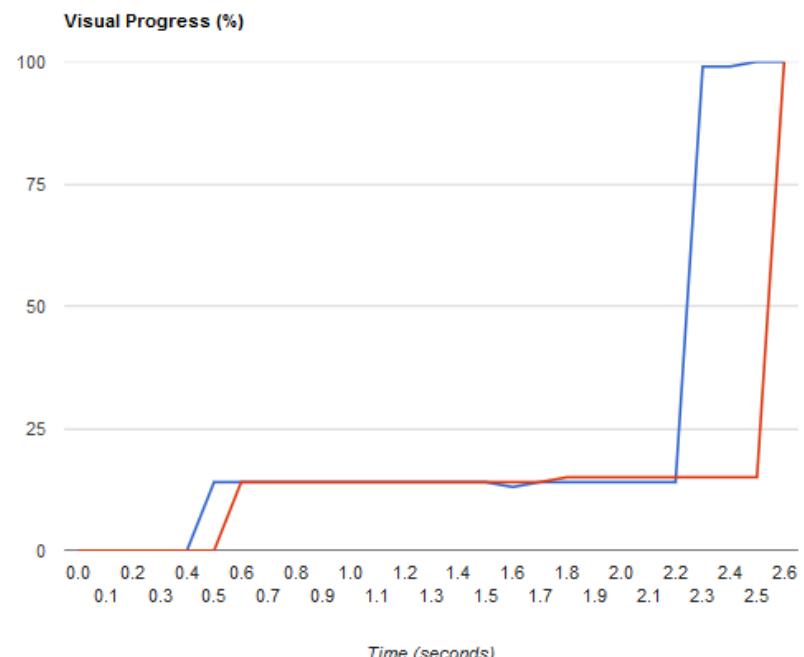
So, I'm going to make my predictions the only way I know how: By comparing the performance of their websites. That'll work right?

<https://jakearchibald.com/2019/f1-perf/>

## WEBPAGETEST: COMPARING TESTS

# Visual comparison

- Useful for “before / after” comparisons after shipping code changes
- Re-run the tests multiple times, **compare graphs with the waterfall**, to not draw accidental conclusions



## CONTENT DELIVERY NETWORKS

# Compare CDNs

<https://www.cdnperf.com/cdn-compare>



No Charges for Requests	✗	✓	✓	✗	?	✓	✓	✓	✓	✓	✓	?
Bandwidth Pricing US&EU	\$0.085	\$0.087/GB	\$0.04/GB	\$0.12/GB	?	\$0.10/GB	?	?	\$0.37/GB	?	?	\$6000 min. / year
Points of Presence	100+	53	33	57	32	22	100+	100+	43	80+	100+	
<b>Main Features</b>												
Origin Pull	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Origin Push	?	✓	✓	✗	✓	✓	✓	✓	✓	✓	✓	✓
Instant Purge	?	✓	✓	✓	✓	✓	?	?	✓	✓	✓	?
Real-time Statistics	?	?	✓	✓	?	✓	✓	✓	✓	✓	✓	✓
Raw Logs	✓	✓	✓	✓	✓	✓	✓	?	?	?	?	✓
Origin Shield	✗	✗	✓	✓	?	✓	✓	✓	?	?	?	?
Custom Rules	?	?	✓	?	?	✓	?	?	?	?	?	?
CORS	?	?	✓	✓	?	✓	?	?	?	?	?	?
GZIP Compression	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Brotli Compression	✗	?	✓	?	?	?	?	?	?	?	?	?
HTTP/2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
ALPN	✓	?	✓	✓	✓	✓	✓	✓	?	?	?	?
Purge By Tag	?	?	✓	✓	?	?	?	?	?	?	?	?
Stale-While-Revalidate	✗	?	✓	✓	✓	?	?	?	?	?	?	?
Byte-range Requests	✓	✓	✓	✓	✓	✓	?	?	?	?	?	?
100% SSD	?	✓	✓	✓	?	✓	?	?	?	?	?	?
IPv6	✓	✓	?	?	?	?	?	?	?	?	?	?

<http://cdncomparison.com/>

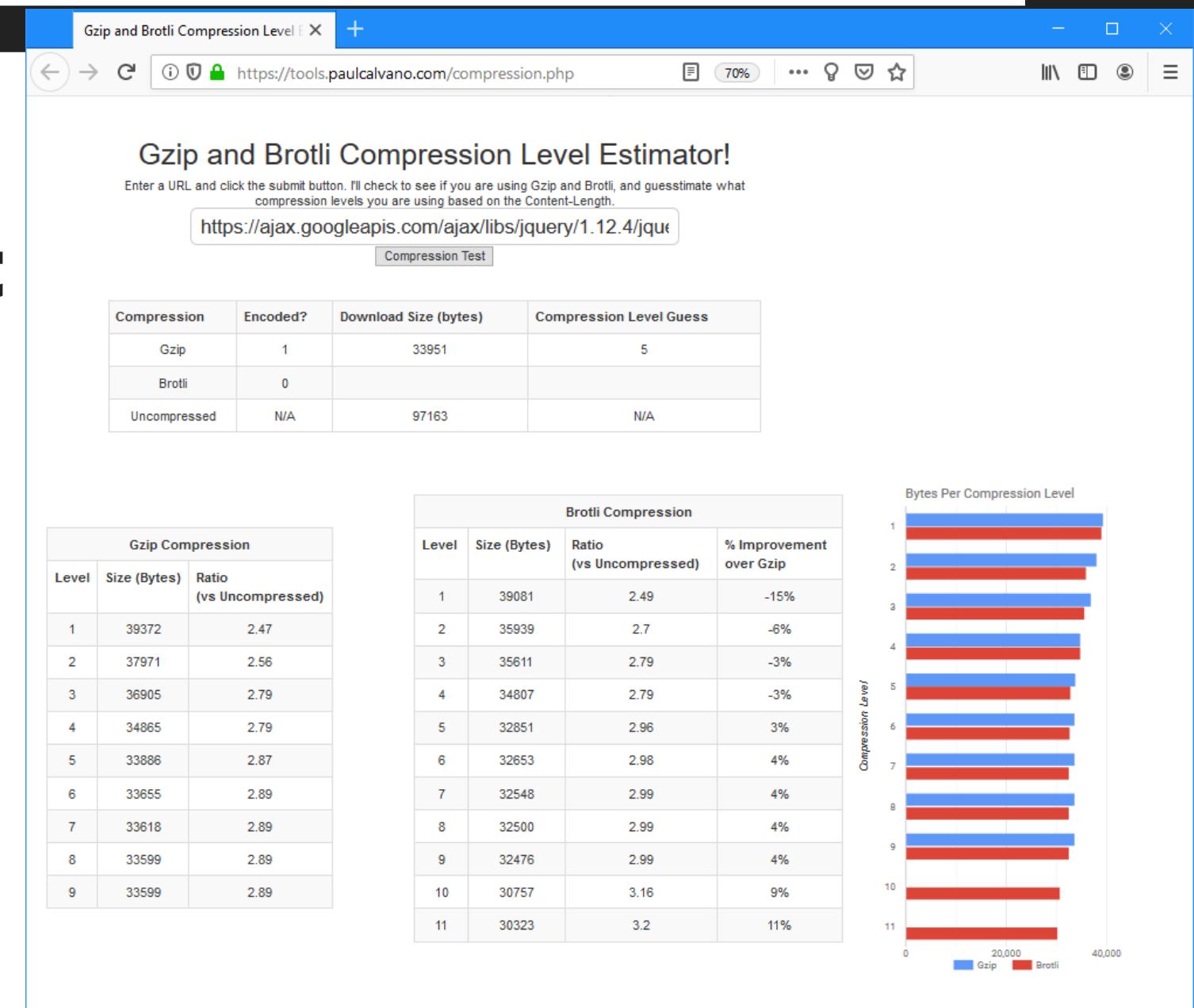
## COMPRESSION

# Consider brotli for static content

- Supported by all modern browsers (~90%), fall back to gzip
- Decompression speed on par with gzip
- Compression speed: slow on level 10/11 (*not suitable for dynamic content*)
- Supported by some CDNs (but not all of them yet)
- Some CDNs can recompress to brotli even if your server does not serve brotli
- **You can build static brotli assets at build time**

<https://tools.paulcalvano.com/compression.php>

<https://paulcalvano.com/index.php/2018/07/25/brotli-compression-how-much-will-it-reduce-your-content/>



# Images

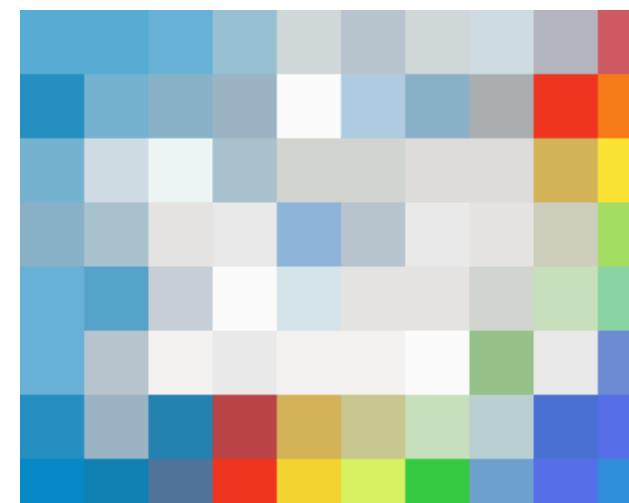


Image credit: Tobias Baldauf

## IMAGES

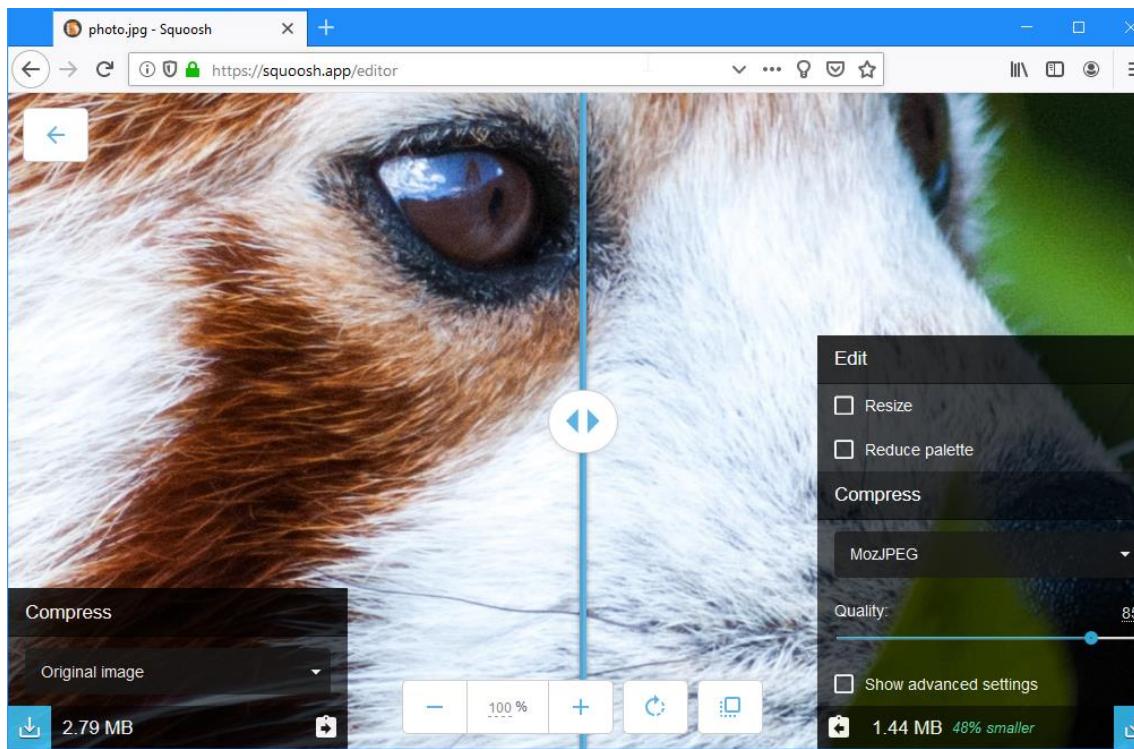
# Compression is not everything

- **Modern JPEG encoders and decoders are very good and highly optimized**
- **WEBP does not support progressive rendering**, contrary to JPEG
- JPEG-XR: uses much more CPU than JPEG, and is IE/EdgeHTML-only
- WEBP: still not supported in Safari, and (reluctantly) just landed in Firefox
- Verdict:
  - stick to JPEG, compress better (upgrade your encoder), **use progressive JPEG**
  - use lossless WEBP instead of PNG if not afraid of complexity
- Kornel Lesiński | Image Optimization | performance.now() 2018  
(<https://youtu.be/jTXhYj2aCDU>)
- Tobias Baldauf:
  - <https://calendar.perfplanet.com/2016/even-faster-images-using-http2-and-progressive-jpegs/>
  - <https://calendar.perfplanet.com/2018/dont-use-jpeg-xr-on-the-web/>

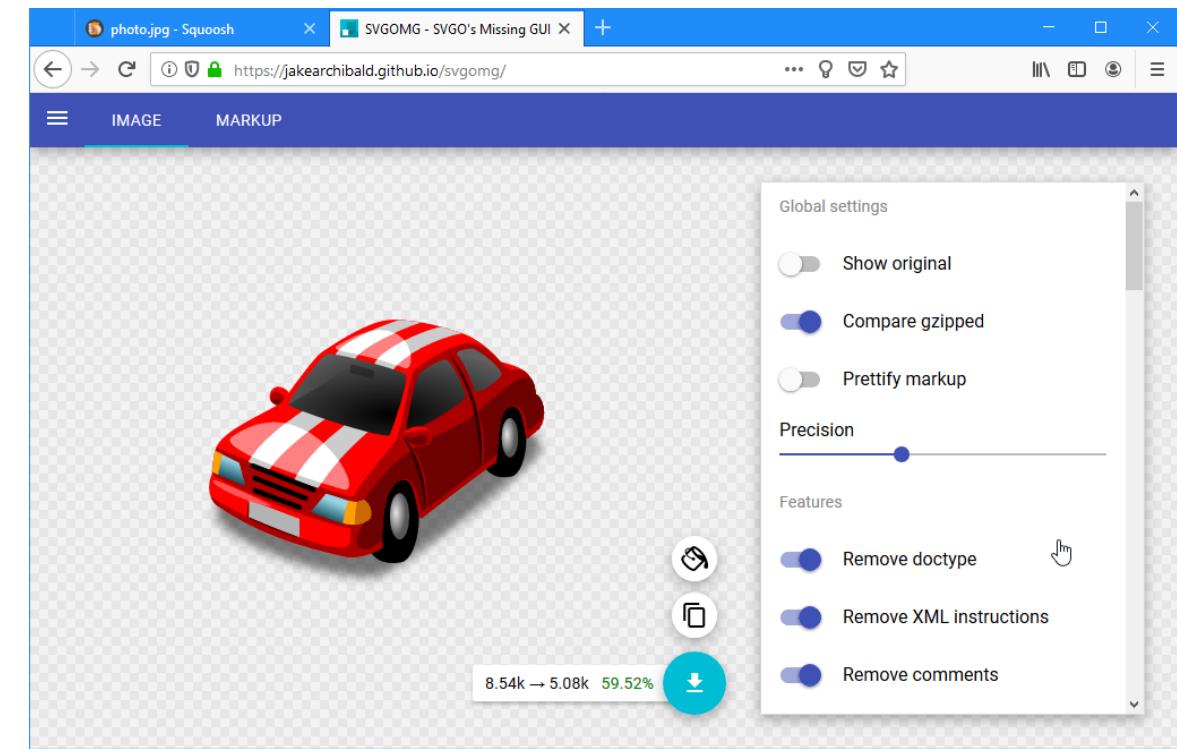
## IMAGES

# Manual image optimization tools

Raster: <https://squoosh.app/>



SVG: <https://jakearchibald.github.io/svgomg/>



See also: <https://imageoptim.com/mac> - <https://imageoptim.com/versions> - <https://www.sarasoueidan.com/blog/svgo-tools/>

## IMAGES

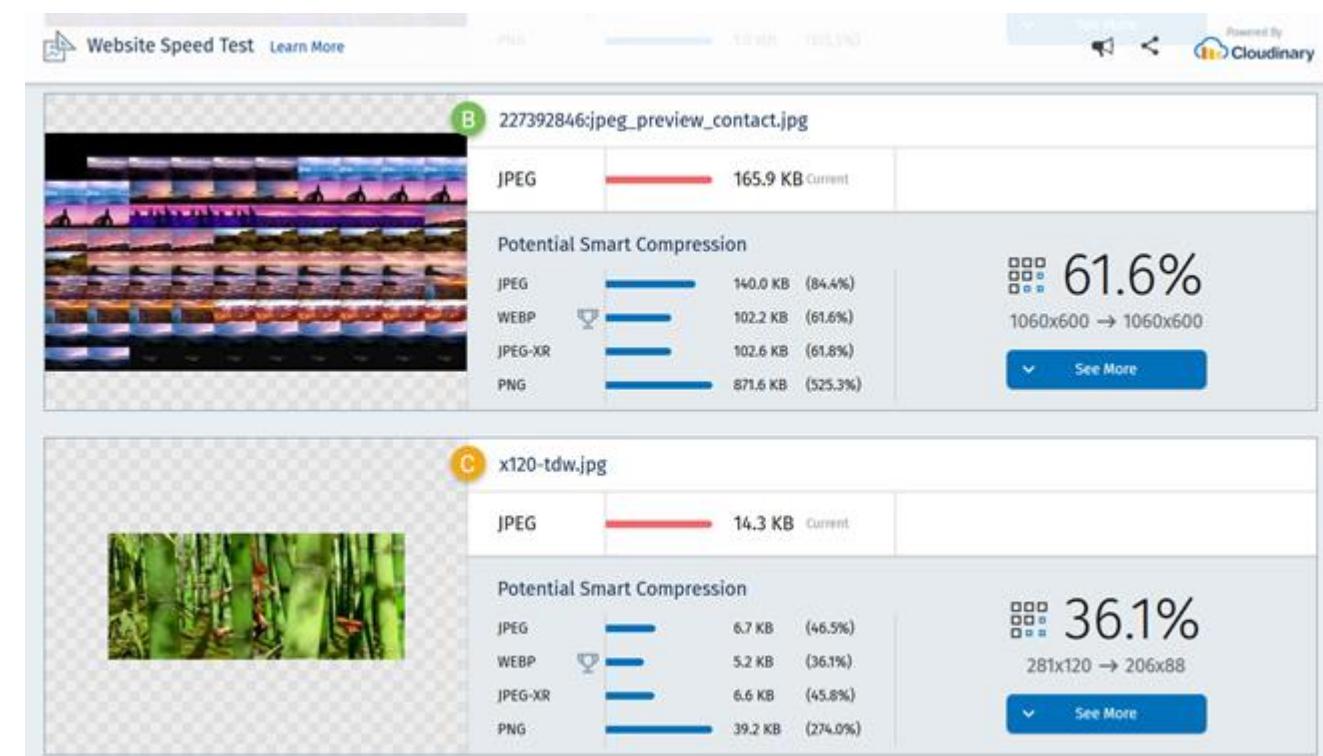
# Automatic image optimization

### Commit / build time

- <https://jamiemason.github.io/ImageOptim-CLI/>
- <https://github.com/sindresorhus/gulp-imagemin>

### Through CDN

- Cloudinary: specialized CDN
  - **optimizes images on-the-fly**
  - serves the most suitable file type, depending on the browser support
- Test tool:  
<https://webspeedtest.cloudinary.com/>
  - Finds poorly compressed images
  - Finds images that are scaled down by the browser



# Fiddler: features (perf and beyond)

- Inspecting traffic
- Rewriting traffic (AutoResponder)
  - Supports **adding latencies** to single responses
  - Ad-hoc **changes in production without deploying**
- Allows customization with FiddlerScript and extensions
  - **Custom arbitrary traffic manipulations**
    - Including general or per-domain traffic throttling
    - Redirect production traffic from Android/iOS to localhost for debugging

# Fiddler: strong points

- Works for traffic from **all web browsers**  with same UI
  - Configure once, have same behavior in all clients
- Allows being configured as a **proxy for external devices** (Android, iOS) 
- Import/export sessions (including HAR format)
  - Including importing sessions into AutoResponder
  - Ask a user for HAR/SAZ file (or get it from WebPageTest), **reproduce exact experience on your machine** (*except dynamic JS-generated requests*)

# Fiddler: caveats

- Windows-only
  - See Charles Proxy for a cross-platform alternative
- **Downgrades traffic to HTTP/1.1**
  - Keep in mind when enabled, as this can lead to false discoveries
- Traffic throttling is easier with Charles
- Like each MITM proxy, requires some setup for HTTPS decryption
  - Particularly onerous on recent iOS, Android and a bit in desktop Firefox
- FiddlerScript is JScript.NET (kind of like a mix of JavaScript and C#) and not modular

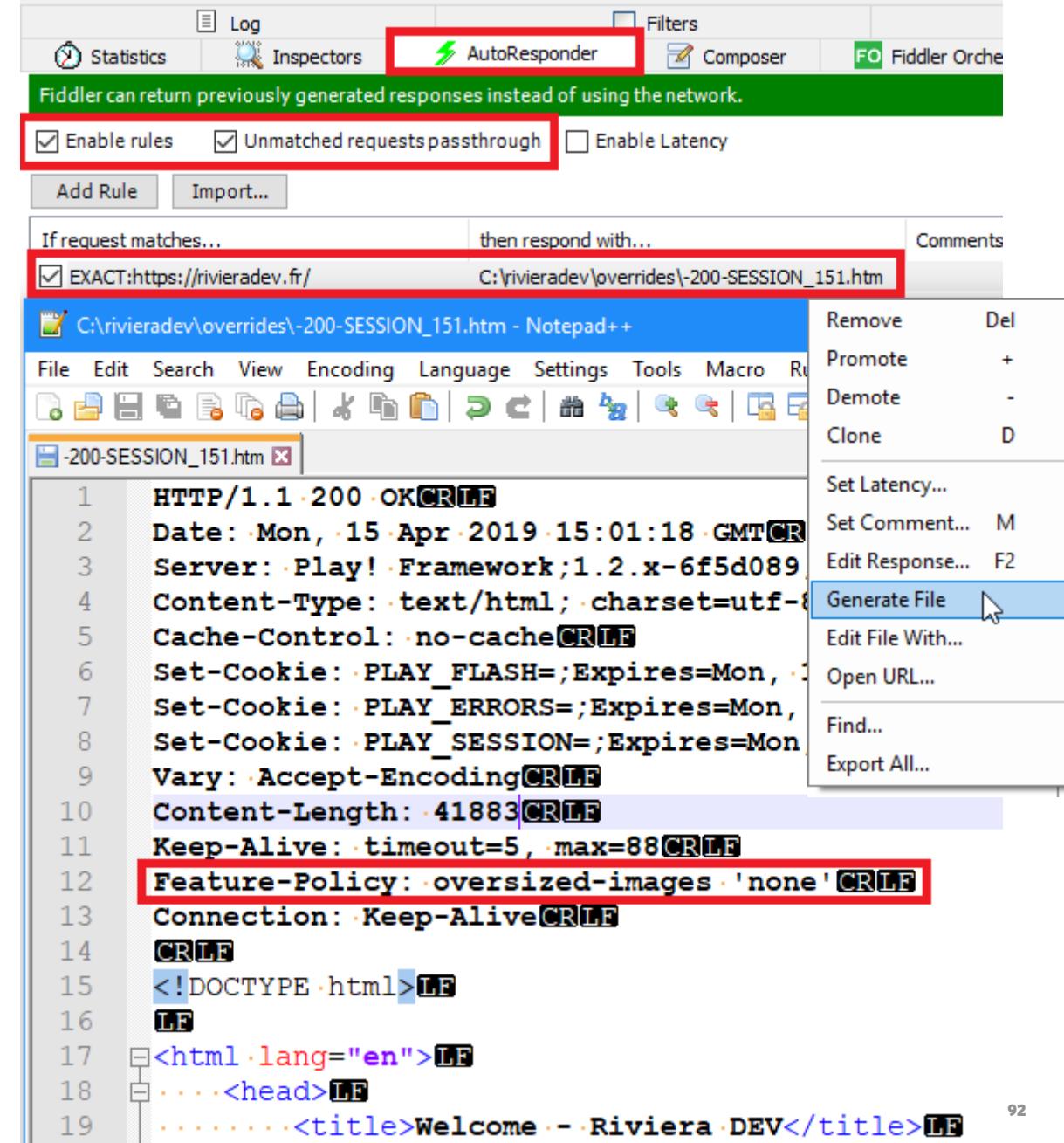
# Fiddler in action: changing response via FiddlerScript

```
static function OnBeforeResponse(oSession: Session) {  
    ...  
    if (oSession.HostnameIs("rivieradev.fr") &&  
        oSession.PathAndQuery.Equals("/"))  
    {  
        oSession.utilDecodeResponse();  
        oSession.oResponse["Feature-Policy"] =  
            "oversized-images">'none'";  
        oSession["ui-comments"] = "Changed in script"  
    }  
}
```

## SWISS-ARMY KNIFE TOOLS

# Fiddler in action: changing response via AutoResponder

- Select a session; strip gzip encoding in Inspectors tab
- Drag'n'drop the session to AutoResponder tab > right click > Generate File
- **Pro-tip: Remove `Content-Length` header when changing response body**
- *You can remove all headers from response if they are not important*



## EXPERIMENTAL FEATURES

# Feature policy: browser as a runtime linter

- Find out about perf / privacy issues
- Disable features for 3rd-parties
- **Disable unused features to prevent future regressions**  
(new developer in the team etc.)

The screenshot shows a browser window titled "Feature policy" with the URL <https://featurepolicy.info>. The page displays a list of browser features, each with a compatibility table for Chrome, Firefox, and Edge, and a classification as either "Policy" or "Feature".

Feature	Chrome	Firefox	Edge	Classification
accelerometer	69			Accelerometer DeviceMotion
ambient-light-sensor	69			
autoplay				Policy Feature
camera	60	65		Feature
document-domain	72	65		Policy Feature
document-write	74			Feature
encrypted-media	60	65		Policy Feature
font-display-late-swap	74			Feature
fullscreen	60	65		Feature
geolocation	60	65		Policy
gyroscope	69			
layout-animations	74			
lazyload				
legacy-image-formats	68			
magnetometer	69			
microphone	60	65		Policy Feature
midi	60	65		Policy Feature
oversized-images	72			
payment	60	65		Policy Feature
picture-in-picture	74			
speaker	60			
sync-script				
sync-xhr	65			Feature
unoptimized-images	72			
unsized-media	66			
usb	60			Feature
vertical-scroll				
vr	62			Feature
wake-lock				Feature

Browser support data courtesy of MDN's [public browser-compat-data project](#).

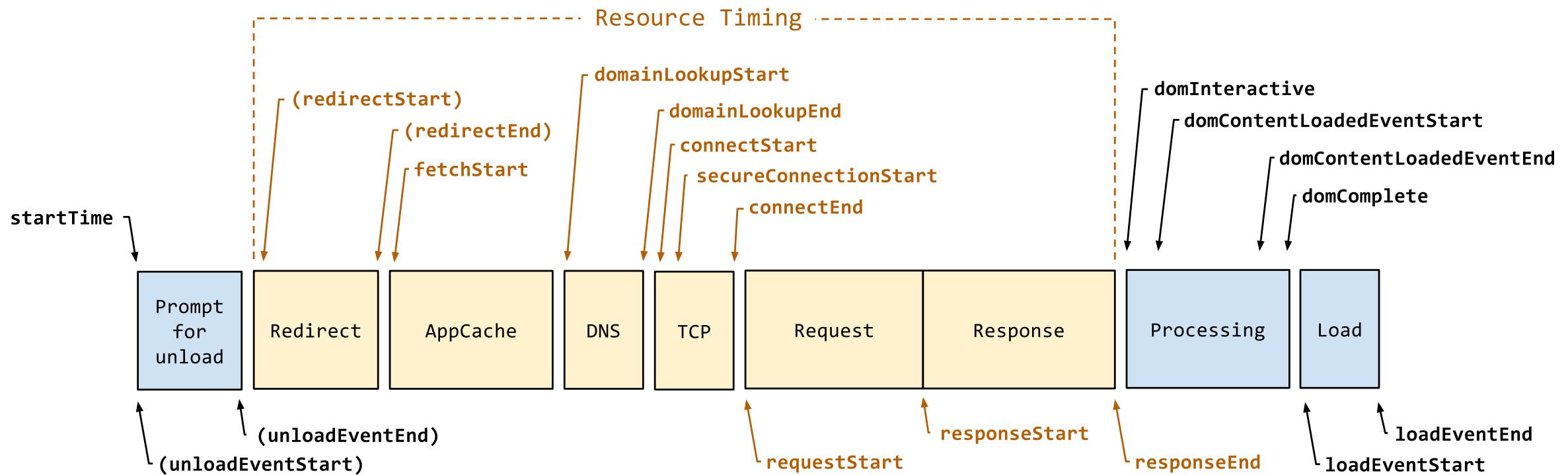
<https://featurepolicy.info/>

# Measuring & Browser APIs



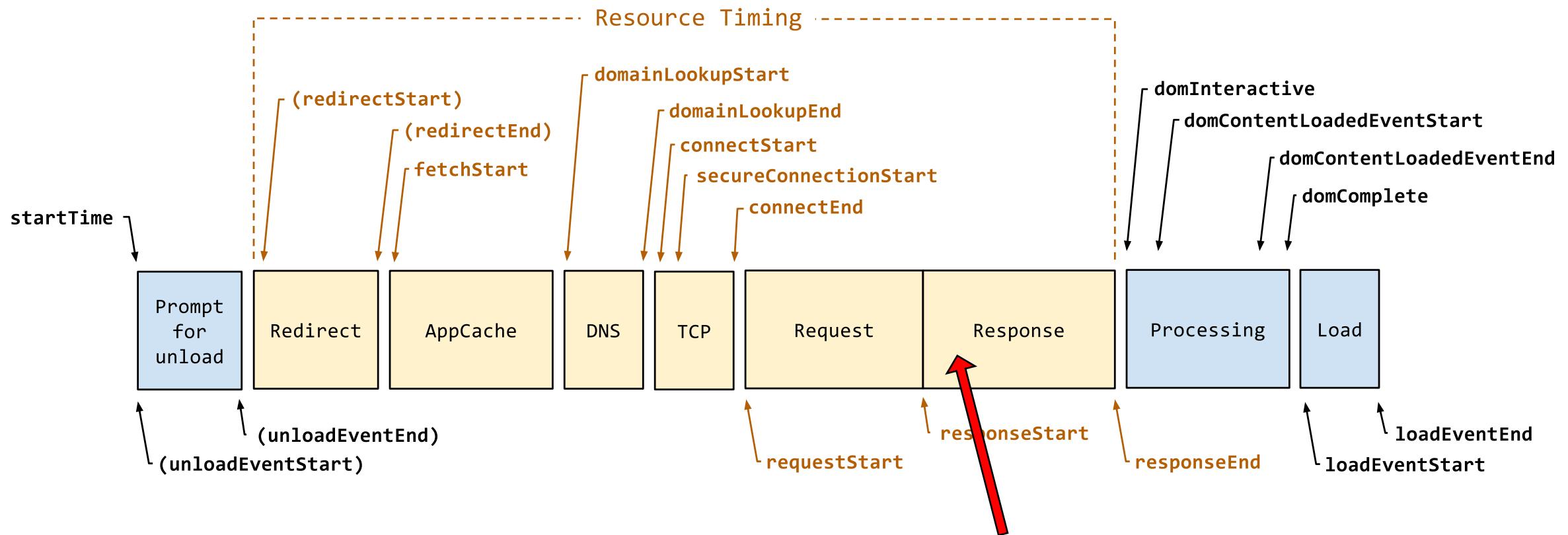
## MEASURING

# Navigation Timing & Resource Timing



## MEASURING

# Navigation Timing & Resource Timing



(note that many things can be happening here already, including JS execution – thanks to streaming HTML parsers)

## MEASURING

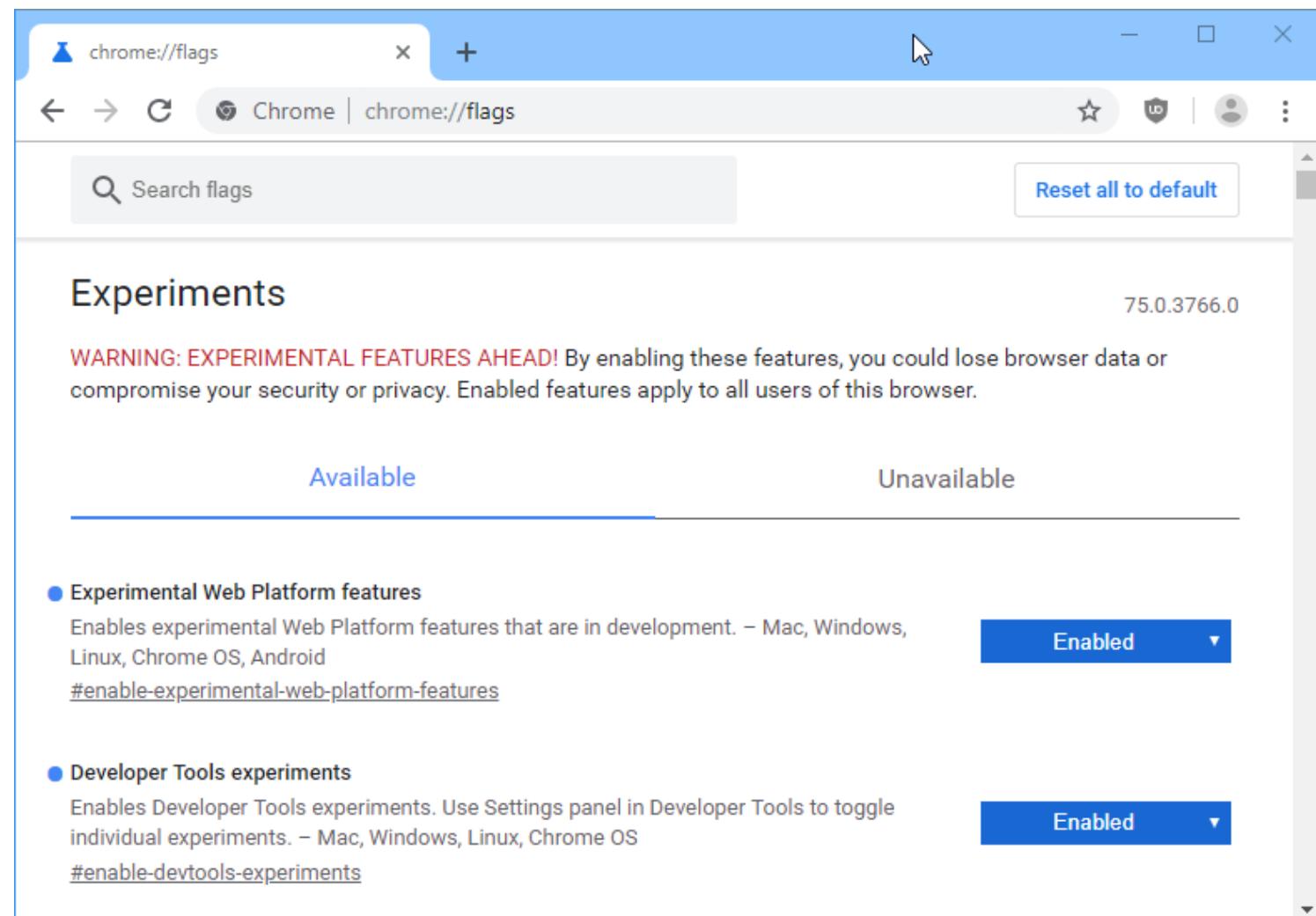
# Navigation Timing & Resource Timing

- Other APIs
  - Use `performance.now()` instead of `Date.now()`
  - `performance.getEntries()` / `performance.getEntriesByType()`
- Gotchas
  - Wrong values due to taking measurements before available
  - Unexpected negative values or diffs (browser bugs)
  - User Timing L2 has some limitations that L3 will fix
  - Observer effect
- Consider using a library like <https://github.com/akamai/boomerang>

## EXPERIMENTAL FEATURES

# Use dev versions of browsers

- DevTools evolve fast, add new features, console warnings etc. **Use Chrome Beta/Canary, Firefox Dev/Nightly**
- Tip: Press `F1` in Chrome/Firefox DevTools to enable many features



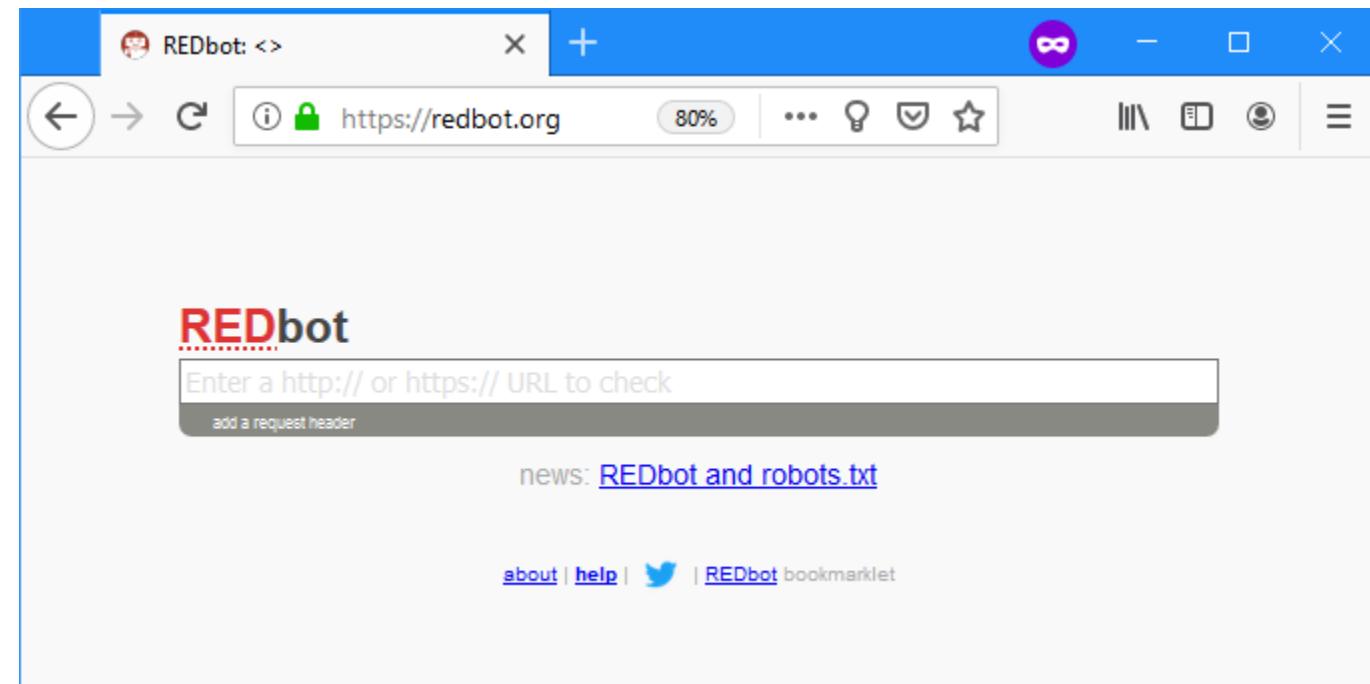
# Redbot - online HTTP linter

## Usage

- Checks HTTP responses for validity according to HTTP specs
- Finds invalid / contradictory / useless response headers
- Analyzes caching, revalidation, content negotiation etc.

## Constraints

- Checks `robots.txt`, needs permission for `RED` User-Agent
- Reads HTML, but doesn't execute JS



add a request header

```

HTTP/1.1 200 OK
Cache-Control: no-cache, no-store, no-transform
Pragma: no-cache
Content-Type: text/html; charset=utf-8
Expires: -1
X-UA-Compatible: IE=Edge;chrome=1
X-Content-Type-Options: nosniff
X-Frame-Options: SAMEORIGIN
X-Activity-Id: 8958aa96-266e-4be8-b9e4-3d2690fd05be
MS-CV: DIIeWbR3h0SYEtB5.0
X-AppVersion: 1.0.7027.5989
X-Az: {did:92e7dc58ca2143cfb2c818b047cc5cd1, rid: OneDeployContainer, sn: marketingsites-prod-odeastasia, dt: 2018-05-03T20:14:23.4188992Z, bt: 2019-03-29T11:19:38.000000Z}
ms-operation-id: f44999f133adff4a89ee171e1fdae56e
P3P: CP="NON DSP ADM DEV PSD OUR IND STP PHY PRE NAV UNI"
Access-Control-Allow-Methods: HEAD,GET,POST,PATCH,PUT,OPTIONS
X-XSS-Protection: 1
Content-Length: 158459
X-EdgeConnect-MidMile-RTT: 227
X-EdgeConnect-Origin-MEX-Latency: 101
Date: Fri, 05 Apr 2019 14:45:35 GMT
Connection: keep-alive
TLS_version: tlsv1.2
Strict-Transport-Security: max-age=31536000
Set-Cookie:akacd_OneRF=1562251535~rv=71~id=44f9ceai197ca1bf0e212eed77db4879; path=/; Expires=Thu, 04 Jul 2019 14:45:35 GMT
Set-Cookie:akacd_OneRF=1562251535~rv=71~id=44f9ceai197ca1bf0e212eed77db4879; path=/; Expires=Thu, 04 Jul 2019 14:45:35 GMT
X-RTag: RT

```

response headers: 1,194 bytes body: 158,459 bytes

[view body](#) [view har](#) [validate body](#) [check embedded](#)**General**

- ✖ The Expires header's value isn't a valid date.
- ✖ The X-UA-Compatible header's syntax isn't valid.
- ⚠ The Pragma header is deprecated.
- ⓘ This response explicitly sets a rendering mode for Internet Explorer 8.
- ⚠ The P3P header is deprecated.
- ✓ The Content-Length header is correct.

**Security**

- ⓘ This response enables XSS filtering in IE8+.
- ⓘ This response instructs Internet Explorer not to 'sniff' its media type.
- ⓘ This response prevents some browsers from rendering it within a frame on another site.

**Content Negotiation** ([Content Negotiation response](#) - 2 problems)

- ✖ The resource doesn't send Vary consistently.
- ⓘ The response body is different when content negotiation happens.
- ✓ Content negotiation for gzip compression is supported, saving 77%.

**Caching**

- ⚠ Pragma: no-cache is a request directive, not a response directive.
- ⓘ This response can't be stored by a cache.

add a request header

```
HTTP/1.1 200 OK
Cache-Control: no-cache, no-store, no-transform
Pragma: no-cache
Content-Type: text/html; charset=utf-8
Expires: -1
X-UA-Compatible: IE=Edge;chrome=1
X-Content-Type-Options: nosniff
X-Frame-Options: SAMEORIGIN
X-Activity-Id: 8958aa96-266e-4be8-b9e4-3d2690fd05be
MS-CV: DIIeWbR3h0SYEtB5.0
X-AppVersion: 1.0.7027.5989
X-Az: {did:92e7dc58ca2143cfb2c818b047cc5cd1, rid: OneDeployContainer, sn: marketingsites-prod-oceastasia, dt: 2018-05-03T20:14:23.4188992Z, bt: 2019-03-29T11:19:38.000000Z}
ms-operation-id: f44999f133adff4a89ee171e1fdae56e
P3P: CP="NON DSP ADM DEV PSD OUR IND STP PHY PRE NAV UNI"
Access-Control-Allow-Methods: HEAD,GET,POST,PATCH,PUT,OPTIONS
X-XSS-Protection: 1
Content-Length: 158459
X-EdgeConnect-MidMile-RTT: 227
X-EdgeConnect-Origin-MEX-Latency: 101
Date: Fri, 05 Apr 2019 14:45:35 GMT
Connection: keep-alive
TLS_version: tlsv1.2
Strict-Transport-Security: max-age=31536000
Set-Cookie:akacd_OneRF=1562251535~rv=71~id=44f9cea1197ca1bf0e212eed77db4879; path=/; Expires=Thu, 04 Jul 2019 14:45:35 GMT
Set-Cookie:akacd_OneRF=1562251535~rv=71~id=44f9cea1197ca1bf0e212eed77db4879; path=/; Expires=Thu, 04 Jul 2019 14:45:35 GMT
X-RTag: RT
```

response headers: 1,194 bytes    body: 158,459 bytes

[view body](#)[view har](#)[validate body](#)[check embedded](#)

## General

- ✖ The Expires header's value isn't a valid date.
- ✖ The X-UA-Compatible header's syntax isn't valid.
- ⚠ The Pragma header is deprecated.
- ⓘ This response explicitly sets a rendering mode for Internet Explorer 8.
- ⚠ The P3P header is deprecated.
- ✓ The Content-Length header is correct.

## Security

- ⓘ This response enables XSS filtering in IE8+.
- ⓘ This response instructs Internet Explorer not to 'sniff' its media type.
- ⓘ This response prevents some browsers from rendering it within a frame on another site.

## Content Negotiation (Content Negotiation response - 2 problems)

- ✖ The resource doesn't send Vary consistently.
- ⓘ The response body is different when content negotiation happens.
- ✓ Content negotiation for gzip compression is supported, saving 77%.

## Caching

- ⚠ Pragma: no-cache is a request directive, not a response directive.
- ⓘ This response can't be stored by a cache.

<https://www.microsoft.com/fr-fr/>[add a request header](#)

URI	status	size	shared	private	age	freshness	IMS	INM	gzip	partial	notes
<a href="https://www.microsoft.com/fr-fr/">https://www.microsoft.com/fr-fr/</a>	200	154k	✗	✗	-	-	✗	✗	77%	✗	1 2 3 4 5 6
<b>Head Links (3)</b>											
<a href="https://c.s-microsoft.com/mscc/statics/mscc-0.4.1.m">https://c.s-microsoft.com/mscc/statics/mscc-0.4.1.m</a>	200	1k	✓	✓	0	0	✓	✗	55%	✗	7 8 9 10 6 11 12
<a href="https://www.microsoft.com/mwf/css/MWF_20190102_1362">https://www.microsoft.com/mwf/css/MWF_20190102_1362</a>	200	373k	✓	✓	0	273 days 17 hr	✓	✗	89%	✗	5 13 6
<a href="https://www.microsoft.com/onerfstatics/marketingosit">https://www.microsoft.com/onerfstatics/marketingosit</a>	200	78k	✓	✓	0	363 days 5 hr	✓	✗	85%	✗	5 13 6
<b>Script Links (3)</b>											
<a href="https://c.s-microsoft.com/mscc/statics/mscc-0.4.1.m">https://c.s-microsoft.com/mscc/statics/mscc-0.4.1.m</a>	200	3k	✓	✓	0	0	✓	✗	55%	✗	7 8 9 14 6 11 12
<a href="https://mem.gfx.ms/meversion?partner=MSHomePage&amp;mar">https://mem.gfx.ms/meversion?partner=MSHomePage&amp;mar</a>	200	18k	✓	✓	0	1 day	✗	✗	65%	✗	13 6
<a href="https://www.microsoft.com/onerfstatics/marketingosit">https://www.microsoft.com/onerfstatics/marketingosit</a>	200	84k	✓	✓	0	165 days 2 hr	✓	✗	65%	✗	5 13 6
<b>Image Links (8)</b>											
<a href="https://img-prod-cms-rt-microsoft-com.akamaized.net">https://img-prod-cms-rt-microsoft-com.akamaized.net</a>	200	3k	✓	✓	0	1 day 10 hr	✓	✗	✗	✗	13 15
<a href="https://img-prod-cms-rt-microsoft-com.akamaized.net">https://img-prod-cms-rt-microsoft-com.akamaized.net</a>	200	34k	✗	✓	0	15 hr 40 min	✓	✗	✗	✗	
<a href="https://web.vortex.data.microsoft.com:443/collect/v">https://web.vortex.data.microsoft.com:443/collect/v</a>	200	43	✗	✗	-	-	✗	✗	✗	✗	16 3 4 5
<a href="https://www.microsoft.com/onerfstatics/marketingosit">https://www.microsoft.com/onerfstatics/marketingosit</a>	200	265	✓	✓	0	225 days 9 hr	✓	✗	✗	✗	5 13
<a href="https://www.microsoft.com/onerfstatics/marketingosit">https://www.microsoft.com/onerfstatics/marketingosit</a>	200	532	✓	✓	0	236 days 21 hr	✓	✗	✗	✗	5 13
<a href="https://www.microsoft.com/onerfstatics/marketingosit">https://www.microsoft.com/onerfstatics/marketingosit</a>	200	43	✓	✓	0	144 days 23 min	✓	✗	✗	✗	5 13
<a href="https://www.microsoft.com/onerfstatics/marketingosit">https://www.microsoft.com/onerfstatics/marketingosit</a>	200	340	✓	✓	0	238 days 42 min	✓	✗	✗	✗	5 13
<a href="https://www.microsoft.com/onerfstatics/marketingosit">https://www.microsoft.com/onerfstatics/marketingosit</a>	200	332	✓	✓	0	238 days 9 hr	✓	✗	✗	✗	5 13

[view har](#)

<https://www.microsoft.com/fr-fr/>[add a request header](#)

URI	status	size	shared	private	age	freshness	IMS	INM	gzip	partial	notes
<a href="https://www.microsoft.com/fr-fr/">https://www.microsoft.com/fr-fr/</a>	200	154k	✗	✗	-	-	✗	✗	77%	✗	1 2 3 4 5 6

Head Links (3)	status	size	shared	private	age	freshness	IMS	INM	gzip	partial	notes
<a href="https://c.s-microsoft.com/mscc/statics/mscc-0.4.1.m">https://c.s-microsoft.com/mscc/statics/mscc-0.4.1.m</a>	200	1k	✓	✓	0	0	✓	✗	55%	✗	7 8 9 10 6 11 12
<a href="https://www.microsoft.com/mwf/css/MWF_20190102_1362">https://www.microsoft.com/mwf/css/MWF_20190102_1362</a>	200	373k	✓	✓	0	273 days 17 hr	✓	✗	89%	✗	5 13 6
<a href="https://www.microsoft.com/onerfstatics/marketingosit">https://www.microsoft.com/onerfstatics/marketingosit</a>	200	78k	✓	✓	0	363 days 5 hr	✓	✗	85%	✗	5 13 6

#### Script Links (3)

<https://c.s-microsoft.com/mscc/statics/mscc-0.4.1.m>  
<https://mem.gfx.ms/meversion?partner=MSHomePage&mar>  
<https://www.microsoft.com/onerfstatics/marketingosit>

#### Image Links (8)

<https://img-prod-cms-rt-microsoft-com.akamaized.net>  
<https://img-prod-cms-rt-microsoft-com.akamaized.net>  
<https://web.vortex.data.microsoft.com:443/collect/v>  
<https://www.microsoft.com/onerfstatics/marketingosit>  
<https://www.microsoft.com/onerfstatics/marketingosit>  
<https://www.microsoft.com/onerfstatics/marketingosit>  
<https://www.microsoft.com/onerfstatics/marketingosit>  
<https://www.microsoft.com/onerfstatics/marketingosit>

## Notes

1. The Expires header's value isn't a valid date.
2. The X-UA-Compatible header's syntax isn't valid.
3. The Pragma header is deprecated.
4. Pragma: no-cache is a request directive, not a response directive.
5. The P3P header is deprecated.
6. The resource doesn't send Vary consistently.
7. The ETag header's syntax isn't valid.
8. The Content-MD5 header is deprecated.
9. This response allows a cache to assign its own freshness lifetime.
10. The Content-MD5 header is incorrect.
11. The ETag doesn't change between negotiated representations.
12. An If-None-Match conditional request returned the full content unchanged.
13. Cache-Control: public is rarely necessary.
14. The Content-MD5 header is incorrect.
15. The 304 response is missing required headers.
16. The Expires header's value isn't a valid date.

# Redbot - problems it solves

- Response **headers with syntax errors are ignored**
- Some headers have non-intuitive syntax.  
**Easy to make a typo**, or forget to escape a special character
- Some response headers were useful a decade ago or two, **but now are implied or ignored** and just waste bandwidth
- Contradictory rules **make debugging much harder**



# Redbot - problems it solves

- Improperly configured caching -> browsers **defaulting to heuristics** to decide about cacheability
- If you're **behind a cache** (load balancer / CDN etc.), wrong config can have serious consequences
- Non-HTTPS assets might be improperly processed by intermediaries (ISP caches etc.)

## See also

- <https://github.com/vfaronov/httpolice> – a similar *offline* command line tool which analyzes HAR files

## Caching resources

- <https://csswizardry.com/2019/03/cache-control-for-civilians/>
- [https://www.mnot.net/cache\\_docs/](https://www.mnot.net/cache_docs/)

# Final words

- Tools have bugs
- Browsers have bugs and “features” and magic behaviors
  - Often indistinguishable
- Your tools also have bugs or are lying to you
  - Chrome: incognito = no preconnect
  - Chrome automatically preconnects to top domains [heuristics]
  - Firefox 66 preconnect broken