第二届

前端开发者年度大会

FEDAY

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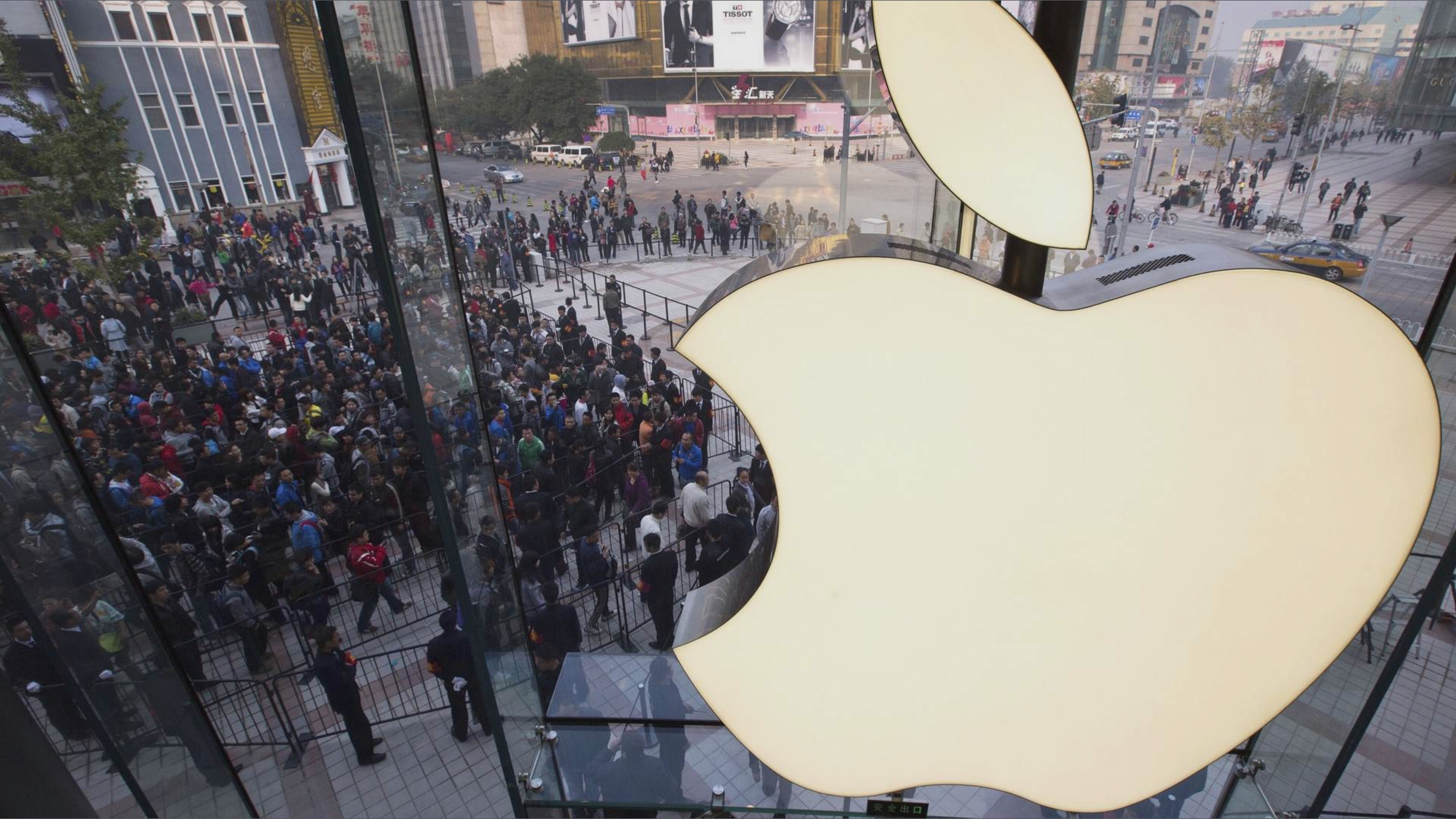
Web Performance in the Age of HTTP/2

Holger Bartel | @foobartel | FEDay, Guangzhou, China, 19/03/2016

@foobartel

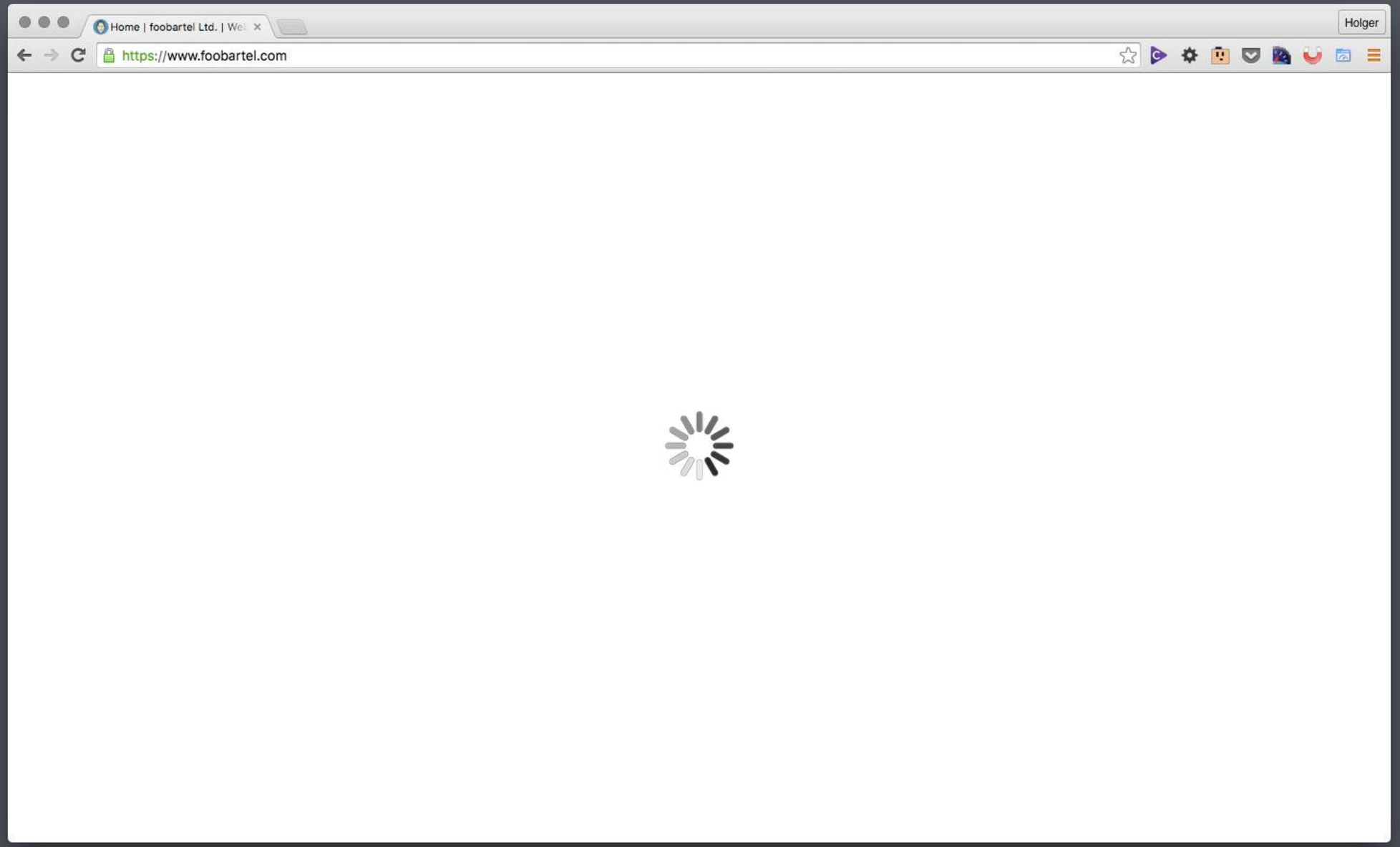
Also on Sina Weibo! ;)


TISSOT
安全出口


SCIENCE FICTION
& FANTASY


EXIT
S&R
Volume Shopping
THANK YOU
for shopping at S&R
We look forward to your next visit.
CLOSE


CHINA IMMIGRATION INSPECTION


Home | foobartel Ltd. | We
Holger
https://www.foobartel.com

Waiting

Nobody likes to wait.

And it's been like that for a long time.

Source

waiting

ˈweɪtɪŋ/

noun

1. the action of staying where one is or delaying action until a particular time or event.

"years of waiting"

Source

waiting

ˈweɪtɪŋ/

noun

1. the action of staying where one is or **delaying action** until a particular time or event.

"years of waiting"

Source

Web Performance

User Expectations

Users expect ~2-3 seconds to load a site...

This is a user's definition of 'fast'

And today, we're even aiming to **deliver something** faster

User Expectations

50% of people say they'll **abandon** a page that takes **longer than 4 seconds** to load

User Expectations

Depending on a users location and infrastructure it might take longer

More than 8-10 seconds of load time for sure is pushing it and people **will not wait**

Delay	User perception
0–100 ms	Instant
100–300 ms	Small perceptible delay
300–1000 ms	Machine is working
1,000+ ms	Likely mental context switch
10,000+ ms	Task is abandoned

Source

The unofficial rule of thumb in the web performance community:

Render pages, or at the very least provide visual feedback, in under 250 milliseconds to keep the user engaged!

Source

Our Logical Conclusion:

Faster is Better!

The Impact of Performance

(and why you should care)

40% of surveyed online shoppers will abandon a page that takes more than 3 seconds to load.
— Akamai

Adding half a second to a search results page can decrease traffic and ad revenues by 20%
— Google

Speeding up a fundraising site by 60% increased donations by 14%.
— Obama Campaign

Every additional 100 milliseconds of load time decreased sales by 1%.
— Amazon

Let’s have a look at Global Network Speed

Global Broadband Average

Download: 21.3Mbps

Global Mobile Average

Download: 10.9Mbps

http://www.netindex.com

Top 20 Countries Broadband Download 2012 - 2014

1	NEW ZEALAND	27.27 Mbps
2	UNITED ARAB EMIRATES	23.71 Mbps
3	CHINA	22.46 Mbps
4	TAIWAN	22.27 Mbps
5	DENMARK	21.34 Mbps
6	LUXEMBOURG	21.12 Mbps
7	FRANCE	20.37 Mbps
8	CANADA	19.77 Mbps
9	NETHERLANDS	19.55 Mbps
10	FINLAND	19.00 Mbps
11	SINGAPORE	18.89 Mbps
12	AUSTRALIA	18.36 Mbps
13	SWITZERLAND	17.88 Mbps
14	URUGUAY	17.45 Mbps
15	HUNGARY	16.90 Mbps
16	SOUTH KOREA	16.33 Mbps
17	OMAN	16.18 Mbps
18	NORWAY	16.10 Mbps
19	BELGIUM	16.10 Mbps
20	SLOVENIA	15.84 Mbps

November 2014

Philippines

Download: 3.49Mbps (Mobile roughly the same)

Indonesia

Download: 5.27Mbps (Mobile 2.67Mbps)

USA

Download: 31.3Mbps (Mobile 13.33Mbps)


Sounds pretty good!

3G, Edge, GPRS


3G, Edge, GPRS
or Maybe (Close to) Offline...

This is Why
Faster Sites are Better!

2013 - 2016

Source

Building for Performance

Performance Techniques Today

Concatenation of Files
Image Sprites
Inline Images
Domain Sharding

Rendering Pages

Render-Tree Construction, Layout & Paint

Waiting for DOM and CSSOM to build the render tree.

Render tree contains nodes to render the page.

Layout computes the exact position and size.

Paint turns the render tree into pixels on screen.

Source

Render Blocking CSS

Waiting for CSS

Avoids “Flash of Unstyled Content” (FOUC)

Source

Render Blocking JavaScript

The parser has to stop for scripts before continuing to parse HTML.

JavaScript can query and modify DOM and CSSOM.

JavaScript blocks DOM construction unless explicitly declared as async.

Source

Loading JavaScript

Every request fetched inside of HEAD, will postpone the rendering of the page

Source

Limit HTTP Requests

Every request takes roughly ~200ms

Avoid unnecessary redirects

Source

The Critical Rendering Path

Critical Resource

Critical Path Length

Critical Bytes

Source

Optimising the Critical Rendering Path

Getting stuff on the screen fast

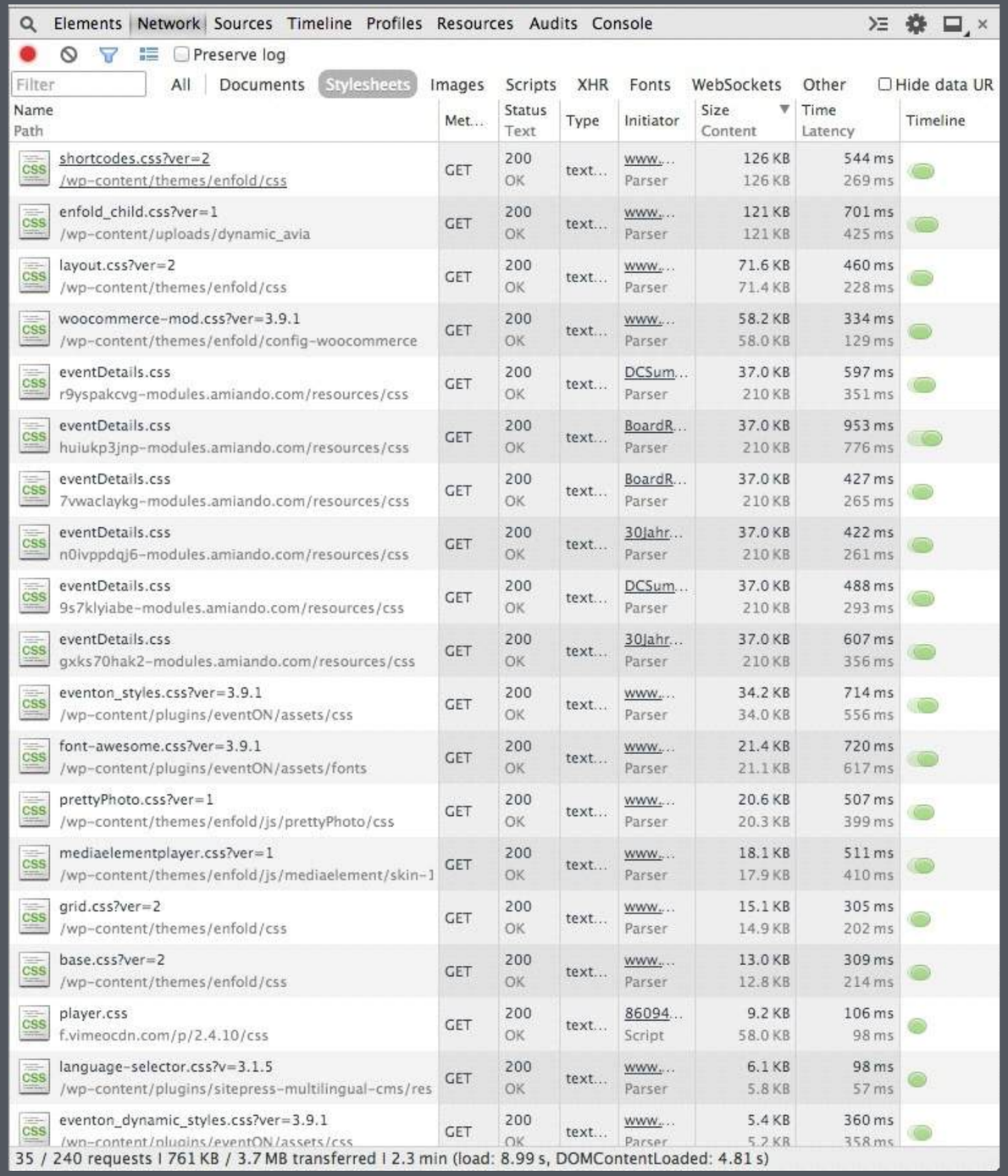
Minimize the number of critical resources.

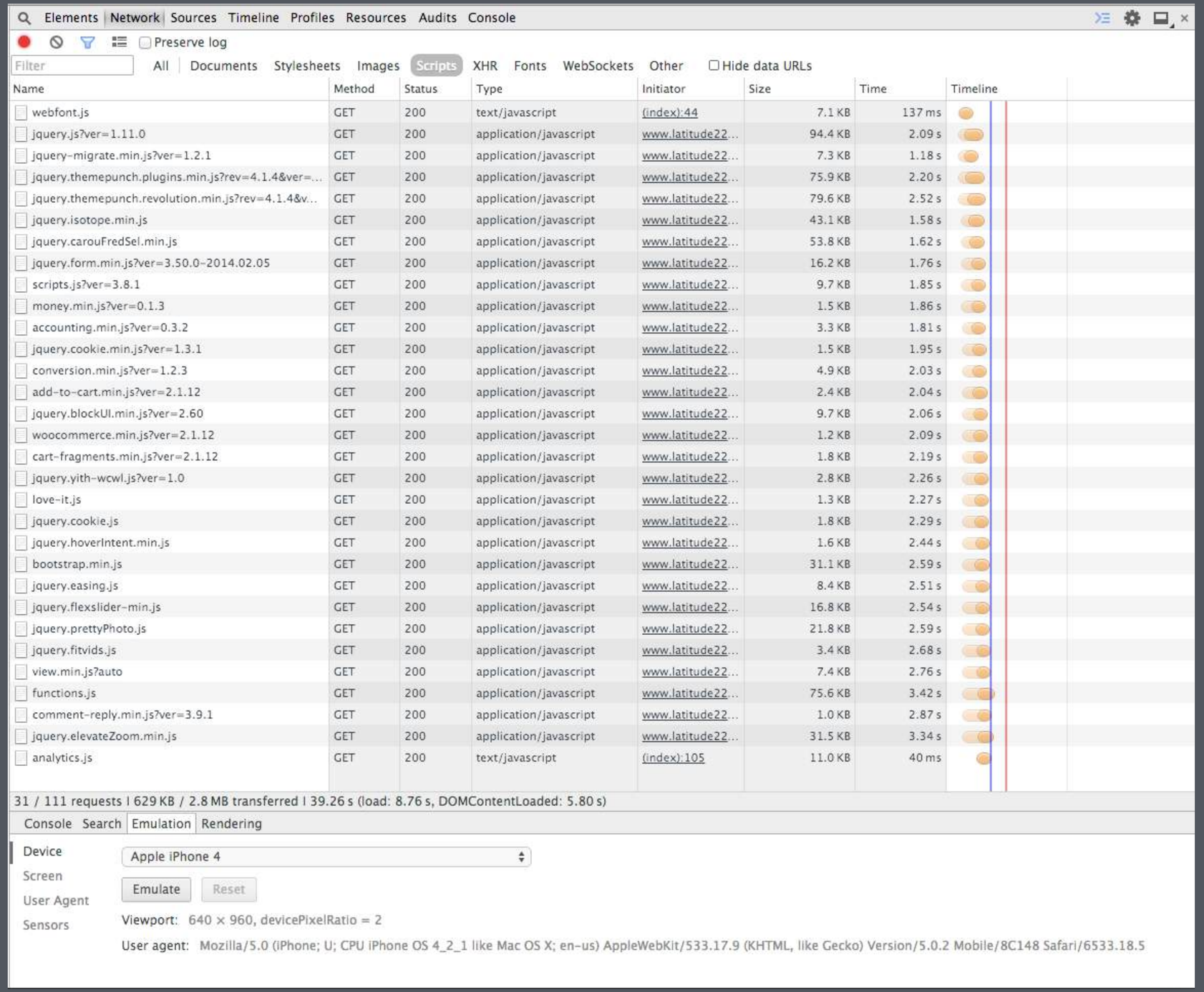
Minimize the number of critical bytes.

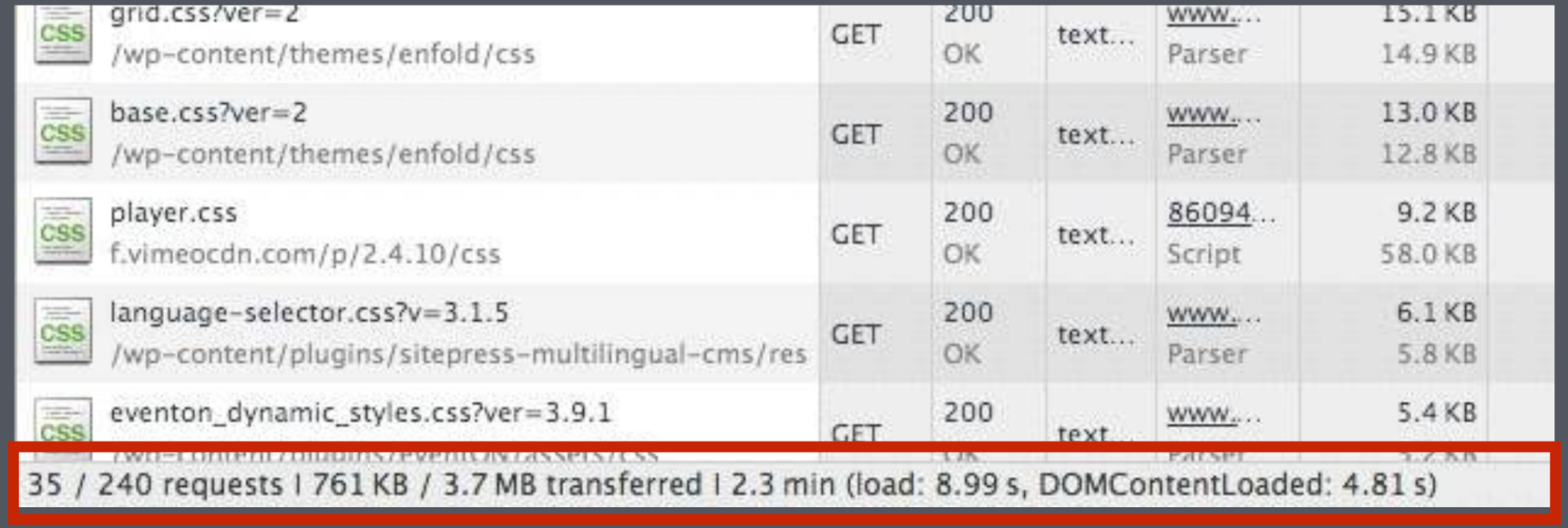
Minimize the critical path length.

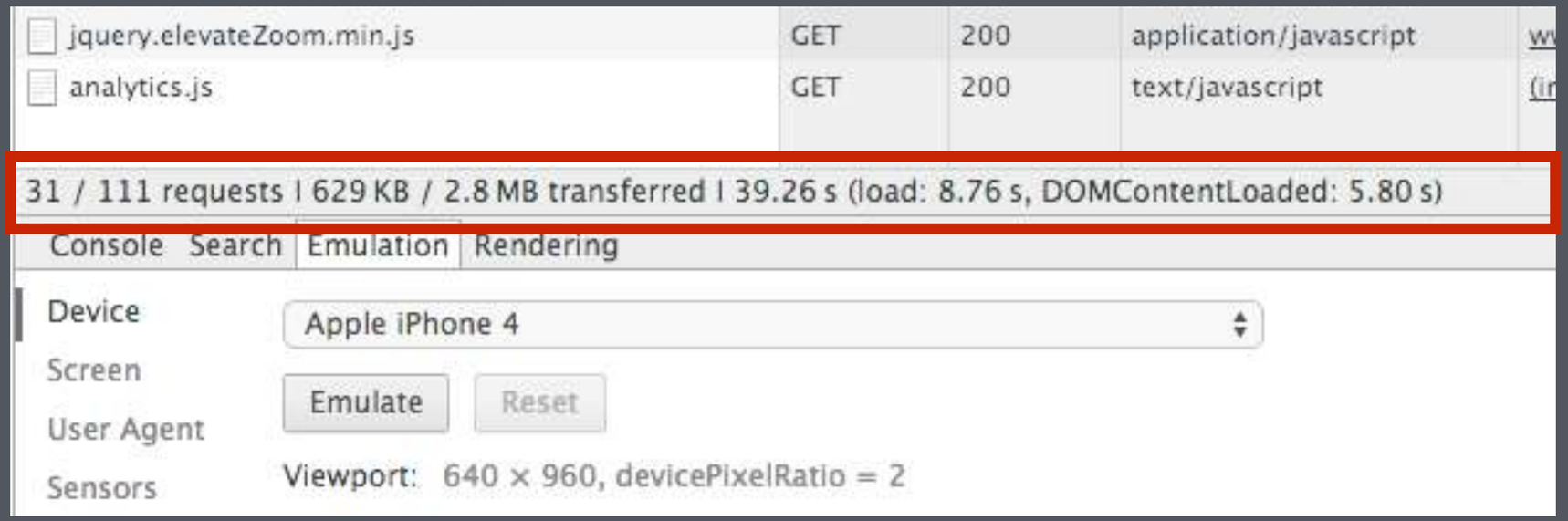
A critical resource is a resource that can block initial rendering of a page.

Source


Elements Network Sources Timeline Profiles Resources Audits Console
Preserve log
Filter All Documents Stylesheets Images Scripts XHR Fonts WebSockets Other Hide data UR
Name Path | Met... | Status Text | Type | Initiator | Size Content | Time Latency | Timeline
shortcodes.css?ver=2 /wp-content/themes/enfold/css | GET | 200 OK | text... | www... Parser | 126 KB 126 KB | 544 ms 269 ms
enfold_child.css?ver=1 /wp-content/uploads/dynamic_avia | GET | 200 OK | text... | www... Parser | 121 KB 121 KB | 701 ms 425 ms
layout.css?ver=2 /wp-content/themes/enfold/css | GET | 200 OK | text... | www... Parser | 71.6 KB 71.4 KB | 460 ms 228 ms
woocommerce-mod.css?ver=3.9.1 /wp-content/themes/enfold/config-woocommerce | GET | 200 OK | text... | www... Parser | 58.2 KB 58.0 KB | 334 ms 129 ms
eventDetails.css r9yspakcvg-modules.amiando.com/resources/css | GET | 200 OK | text... | DCSum... Parser | 37.0 KB 210 KB | 597 ms 351 ms
eventDetails.css huiukp3jnp-modules.amiando.com/resources/css | GET | 200 OK | text... | BoardR... Parser | 37.0 KB 210 KB | 953 ms 776 ms
eventDetails.css 7vwaclaykg-modules.amiando.com/resources/css | GET | 200 OK | text... | BoardR... Parser | 37.0 KB 210 KB | 427 ms 265 ms
eventDetails.css n0ivppdqj6-modules.amiando.com/resources/css | GET | 200 OK | text... | 30Jahr... Parser | 37.0 KB 210 KB | 422 ms 261 ms
eventDetails.css 9s7klyiabe-modules.amiando.com/resources/css | GET | 200 OK | text... | DCSum... Parser | 37.0 KB 210 KB | 488 ms 293 ms
eventDetails.css gxks70hak2-modules.amiando.com/resources/css | GET | 200 OK | text... | 30Jahr... Parser | 37.0 KB 210 KB | 607 ms 356 ms
eventon_styles.css?ver=3.9.1 /wp-content/plugins/eventON/assets/css | GET | 200 OK | text... | www... Parser | 34.2 KB 34.0 KB | 714 ms 556 ms
font-awesome.css?ver=3.9.1 /wp-content/plugins/eventON/assets/fonts | GET | 200 OK | text... | www... Parser | 21.4 KB 21.1 KB | 720 ms 617 ms
prettyPhoto.css?ver=1 /wp-content/themes/enfold/js/prettyPhoto/css | GET | 200 OK | text... | www... Parser | 20.6 KB 20.3 KB | 507 ms 399 ms
mediaelementplayer.css?ver=1 /wp-content/themes/enfold/js/mediaelement/skin-1 | GET | 200 OK | text... | www... Parser | 18.1 KB 17.9 KB | 511 ms 410 ms
grid.css?ver=2 /wp-content/themes/enfold/css | GET | 200 OK | text... | www... Parser | 15.1 KB 14.9 KB | 305 ms 202 ms
base.css?ver=2 /wp-content/themes/enfold/css | GET | 200 OK | text... | www... Parser | 13.0 KB 12.8 KB | 309 ms 214 ms
player.css f.vimeocdn.com/p/2.4.10/css | GET | 200 OK | text... | 86094... Script | 9.2 KB 58.0 KB | 106 ms 98 ms
language-selector.css?v=3.1.5 /wp-content/plugins/sitepress-multilingual-cms/res | GET | 200 OK | text... | www... Parser | 6.1 KB 5.8 KB | 98 ms 57 ms
eventon_dynamic_styles.css?ver=3.9.1 /wp-content/plugins/eventON/assets/css | GET | 200 OK | text... | www... Parser | 5.4 KB 5.2 KB | 360 ms 358 ms
35 / 240 requests | 761 KB / 3.7 MB transferred | 2.3 min (load: 8.99 s, DOMContentLoaded: 4.81 s)


Elements Network Sources Timeline Profiles Resources Audits Console
Preserve log
Filter
All Documents Stylesheets Images Scripts XHR Fonts WebSockets Other
Hide data URLs
Name Method Status Type Initiator Size Time Timeline
webfont.js GET 200 text/javascript (index):44 7.1 KB 137 ms
jquery.js?ver=1.11.0 GET 200 application/javascript www.latitude22... 94.4 KB 2.09 s
jquery-migrate.min.js?ver=1.2.1 GET 200 application/javascript www.latitude22... 7.3 KB 1.18 s
jquery.themepunch.plugins.min.js?rev=4.1.4&ver=... GET 200 application/javascript www.latitude22... 75.9 KB 2.20 s
jquery.themepunch.revolution.min.js?rev=4.1.4&v... GET 200 application/javascript www.latitude22... 79.6 KB 2.52 s
jquery.isotope.min.js GET 200 application/javascript www.latitude22... 43.1 KB 1.58 s
jquery.carouFredSel.min.js GET 200 application/javascript www.latitude22... 53.8 KB 1.62 s
jquery.form.min.js?ver=3.50.0-2014.02.05 GET 200 application/javascript www.latitude22... 16.2 KB 1.76 s
scripts.js?ver=3.8.1 GET 200 application/javascript www.latitude22... 9.7 KB 1.85 s
money.min.js?ver=0.1.3 GET 200 application/javascript www.latitude22... 1.5 KB 1.86 s
accounting.min.js?ver=0.3.2 GET 200 application/javascript www.latitude22... 3.3 KB 1.81 s
jquery.cookie.min.js?ver=1.3.1 GET 200 application/javascript www.latitude22... 1.5 KB 1.95 s
conversion.min.js?ver=1.2.3 GET 200 application/javascript www.latitude22... 4.9 KB 2.03 s
add-to-cart.min.js?ver=2.1.12 GET 200 application/javascript www.latitude22... 2.4 KB 2.04 s
jquery.blockUI.min.js?ver=2.60 GET 200 application/javascript www.latitude22... 9.7 KB 2.06 s
woocommerce.min.js?ver=2.1.12 GET 200 application/javascript www.latitude22... 1.2 KB 2.09 s
cart-fragments.min.js?ver=2.1.12 GET 200 application/javascript www.latitude22... 1.8 KB 2.19 s
jquery.yith-wcwl.js?ver=1.0 GET 200 application/javascript www.latitude22... 2.8 KB 2.26 s
love-it.js GET 200 application/javascript www.latitude22... 1.3 KB 2.27 s
jquery.cookie.js GET 200 application/javascript www.latitude22... 1.8 KB 2.29 s
jquery.hoverIntent.min.js GET 200 application/javascript www.latitude22... 1.6 KB 2.44 s
bootstrap.min.js GET 200 application/javascript www.latitude22... 31.1 KB 2.59 s
jquery.easing.js GET 200 application/javascript www.latitude22... 8.4 KB 2.51 s
jquery.flexslider-min.js GET 200 application/javascript www.latitude22... 16.8 KB 2.54 s
jquery.prettyPhoto.js GET 200 application/javascript www.latitude22... 21.8 KB 2.59 s
jquery.fitvids.js GET 200 application/javascript www.latitude22... 3.4 KB 2.68 s
view.min.js?auto GET 200 application/javascript www.latitude22... 7.4 KB 2.76 s
functions.js GET 200 application/javascript www.latitude22... 75.6 KB 3.42 s
comment-reply.min.js?ver=3.9.1 GET 200 application/javascript www.latitude22... 1.0 KB 2.87 s
jquery.elevateZoom.min.js GET 200 application/javascript www.latitude22... 31.5 KB 3.34 s
analytics.js GET 200 text/javascript (index):105 11.0 KB 40 ms
31 / 111 requests | 629 KB / 2.8 MB transferred | 39.26 s (load: 8.76 s, DOMContentLoaded: 5.80 s)
Console Search Emulation Rendering
Device
Screen
User Agent
Sensors
Apple iPhone 4
Emulate
Reset
Viewport: 640 × 960, devicePixelRatio = 2
User agent: Mozilla/5.0 (iPhone; U; CPU iPhone OS 4_2_1 like Mac OS X; en-us) AppleWebKit/533.17.9 (KHTML, like Gecko) Version/5.0.2 Mobile/8C148 Safari/6533.18.5


grid.css?ver=2
/wp-content/themes/enfold/css
GET
200
OK
text...
www...
Parser
15.1 KB
14.9 KB
base.css?ver=2
/wp-content/themes/enfold/css
GET
200
OK
text...
www...
Parser
13.0 KB
12.8 KB
player.css
f.vimeocdn.com/p/2.4.10/css
GET
200
OK
text...
86094...
Script
9.2 KB
58.0 KB
language-selector.css?v=3.1.5
/wp-content/plugins/sitepress-multilingual-cms/res
GET
200
OK
text...
www...
Parser
6.1 KB
5.8 KB
eventon_dynamic_styles.css?ver=3.9.1
GET
200
text...
www...
5.4 KB
35 / 240 requests | 761 KB / 3.7 MB transferred | 2.3 min (load: 8.99 s, DOMContentLoaded: 4.81 s)


jquery.elevateZoom.min.js
GET
200
application/javascript
analytics.js
GET
200
text/javascript
31 / 111 requests | 629 KB / 2.8 MB transferred | 39.26 s (load: 8.76 s, DOMContentLoaded: 5.80 s)
Console
Search
Emulation
Rendering
Device
Screen
User Agent
Sensors
Apple iPhone 4
Emulate
Reset
Viewport: 640 × 960, devicePixelRatio = 2

The History of HTTP


HTTP/0.9 (1991)


HTTP/1.0 (1996)

HTTP/1.1 (1999)

To reduce the load on the server, HTTP/1.1's approach was to limit its TCP connections

"A single-user client should not maintain more than 2 connections with any server or proxy."

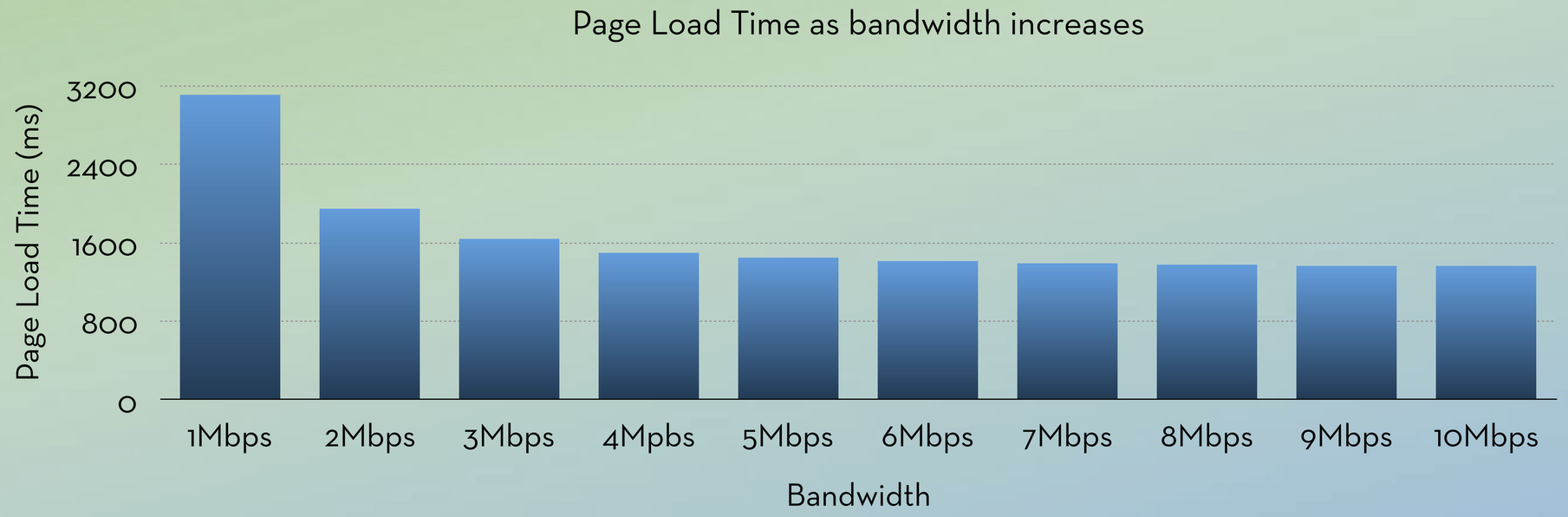
In real life, browsers hold ~6 TCP connections simultaneously per origin.

More Bandwidth Doesn’t Make a Big Difference

An increase from 5Mbps to 10Mbps results in a disappointing 5% improvement in page load times.

Source

Bandwidth & Round-Trip Time


Page Load Time as bandwidth increases
Page Load Time (ms)
3200
2400
1600
800
0
1Mbps
2Mbps
3Mbps
4Mpbs
5Mbps
6Mbps
7Mbps
8Mbps
9Mbps
10Mbps
Bandwidth

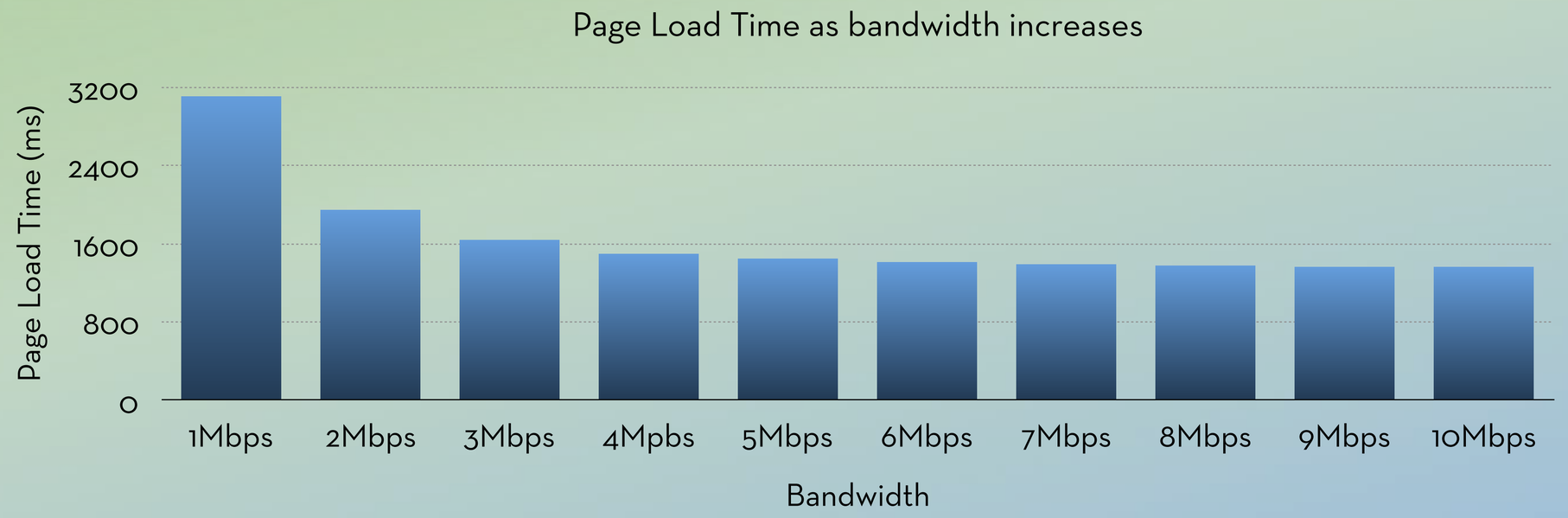
Source

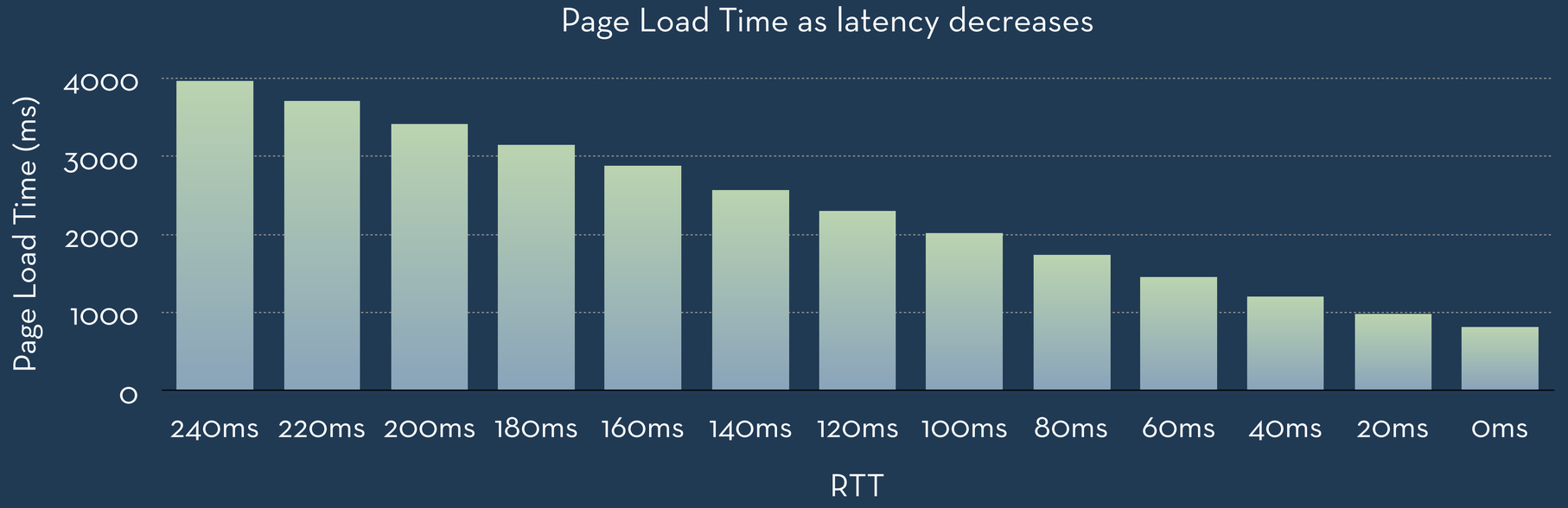
Round-trip-times (RTT) have a bigger impact on performance, more than bandwidth does.

Source

Round-trip-times (RTT) have a bigger impact on performance, more than bandwidth does.

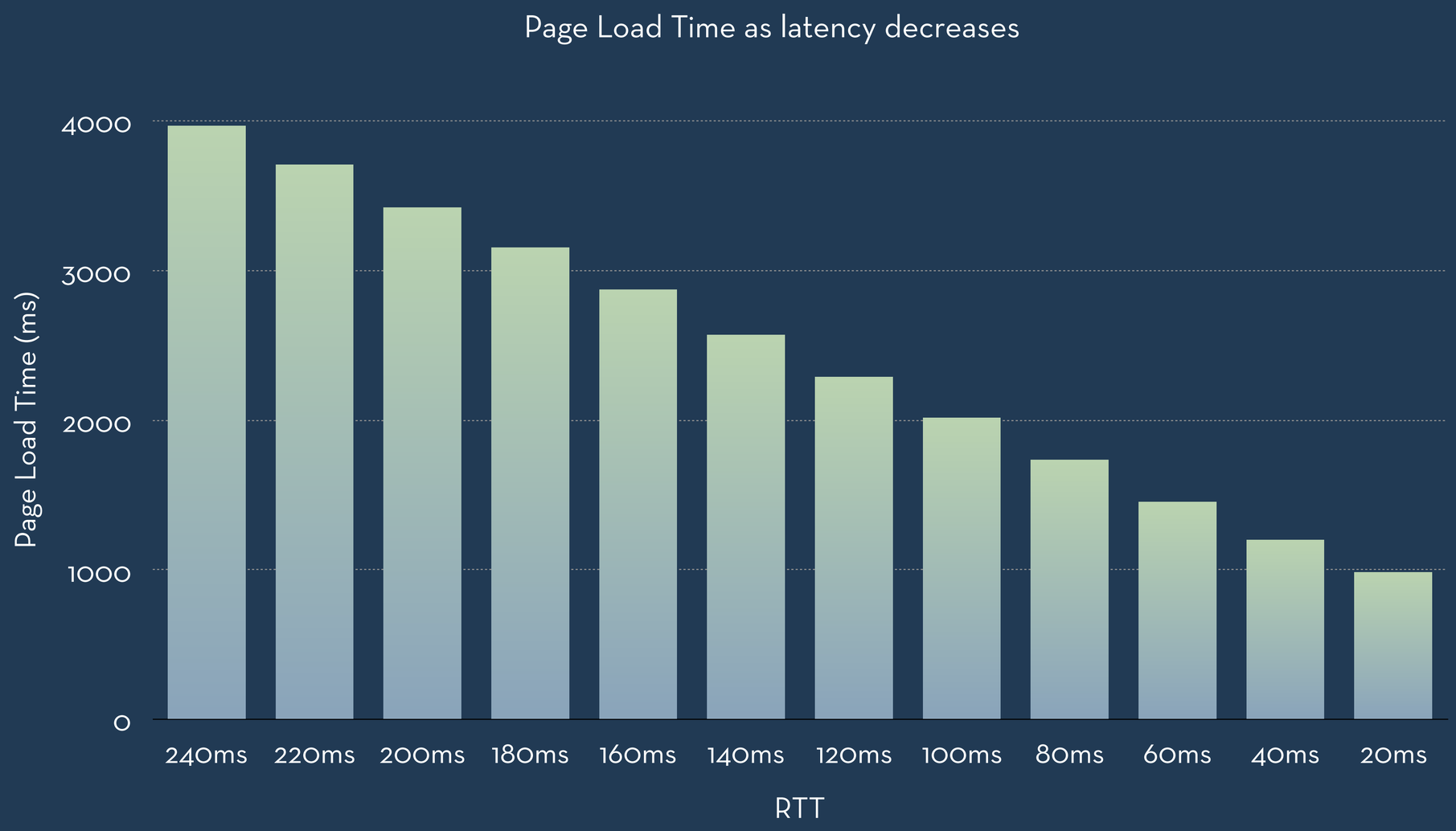
Source


Page Load Time as bandwidth increases
Page Load Time (ms)
3200
2400
1600
800
0
1Mbps
2Mbps
3Mbps
4Mpbs
5Mbps
6Mbps
7Mbps
8Mbps
9Mbps
10Mbps
Bandwidth


Page Load Time as latency decreases
Page Load Time (ms)
4000
3000
2000
1000
0
240ms
220ms
200ms
180ms
160ms
140ms
120ms
100ms
80ms
60ms
40ms
20ms
0ms
RTT

Source

“HTTP2 produces the biggest performance gains on mobile bc it remedies high latency”
— @patrickhamann #smashingconf


Page Load Time as latency decreases
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4000
3000
2000
1000
0
240ms
220ms
200ms
180ms
160ms
140ms
120ms
100ms
80ms
60ms
40ms
20ms
RTT

Source

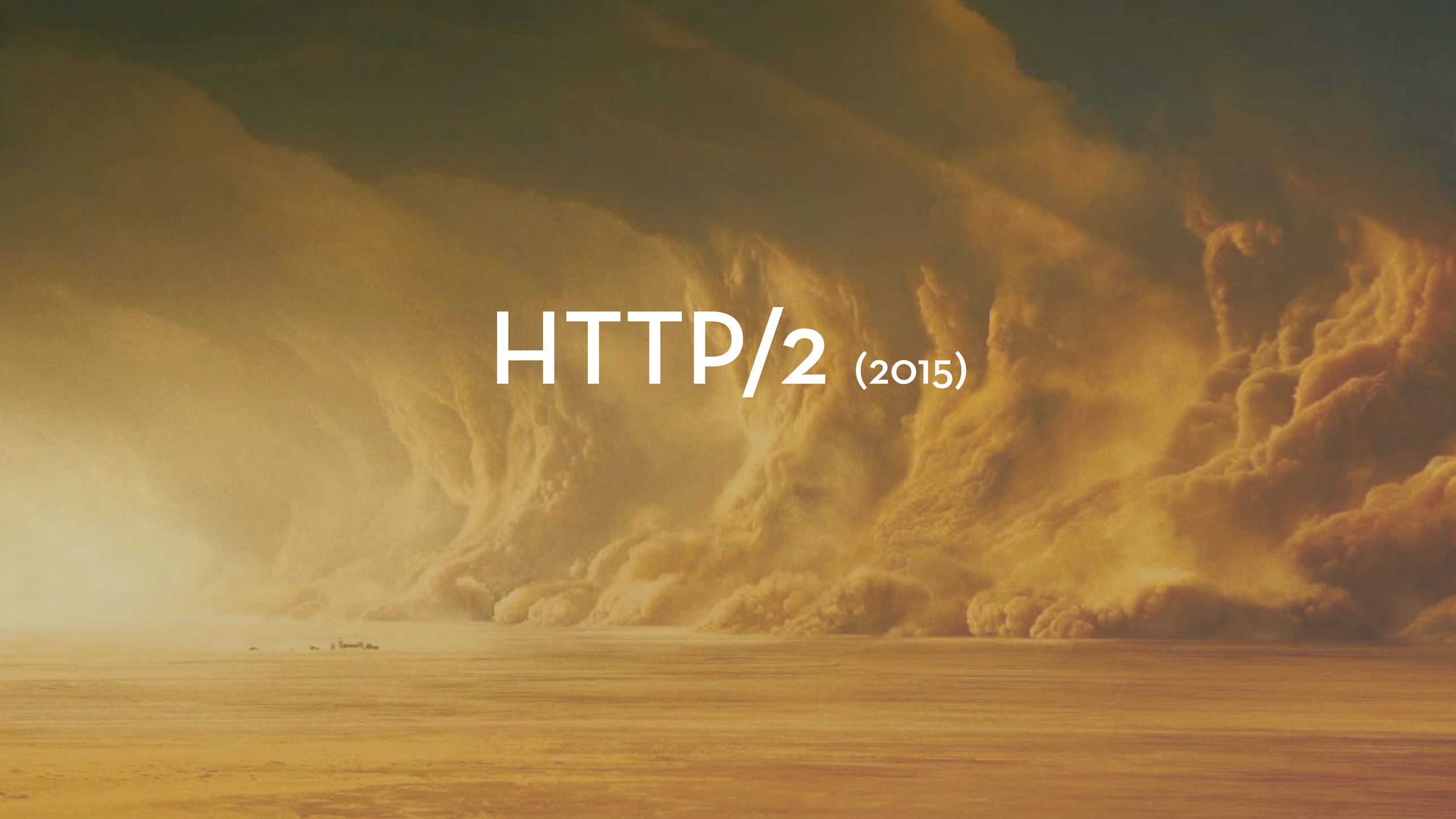

SPDY (2010)

Multiplexing: allow concurrent requests across a single TCP connection;

Allow browsers to **prioritise assets** so that vital resources of a page could are sent first;

Compress and reduce HTTP **headers**;

Server push: A server can push important resources to the browser before being asked for them.


HTTP/2 (2015)

Networking protocol for **low-latency transport** of content over the web.

Originally started out from the SPDY protocol, now **standardised as HTTP version 2**.

- Multiplexing
- Compressed headers
- Asset Prioritisation & Dependencies
- Server Push
  (saves the time it takes the client to ask for the resources)

HTTP/2 is backwards-compatible
with HTTP/1.1

Building for Performance with HTTP/2

What do you need to enable HTTP/2?

SSL/TLS required

Leveraging additional benefits of SSL

Google* uses secure connections as a ranking signal, and browsers are starting to flag non-https websites as ‘not secure’.

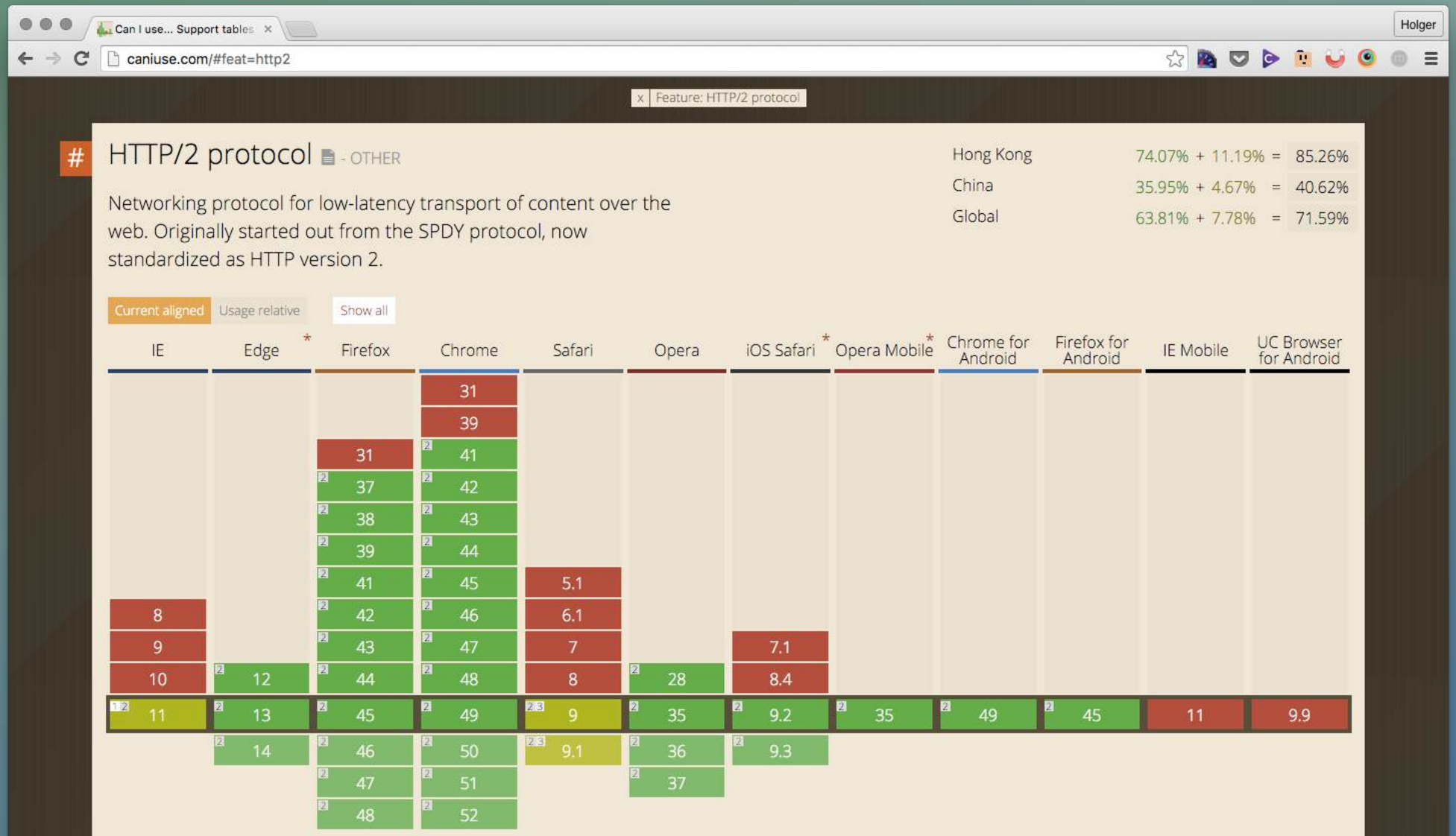
Some HTML5 APIs will also require secure connections in the future (e.g. Geolocation).

** Baidu Analytics includes a site speed section, so they might follow this trend in the future.*

Serving HTTP/2

Apache Module mod_http2

HTTP/2 supporting browsers



Under HTTP/2, some of our current best practices might impact performance negatively.

Let's look at the new anti-patterns.

HTTP/1.x  HTTP/2

What has Changed?

Concatenation of Files

This was a workaround for the lack of parallelism in HTTP/1.x to reduce requests;

Combining multiple files into one and fetch with one request.

Need to wait of the entire file/response to arrive

Requests are cheap!

- Structure code to only deliver what's needed
- No need for additional build process steps
- Optimise caching policies depending on change frequency of files

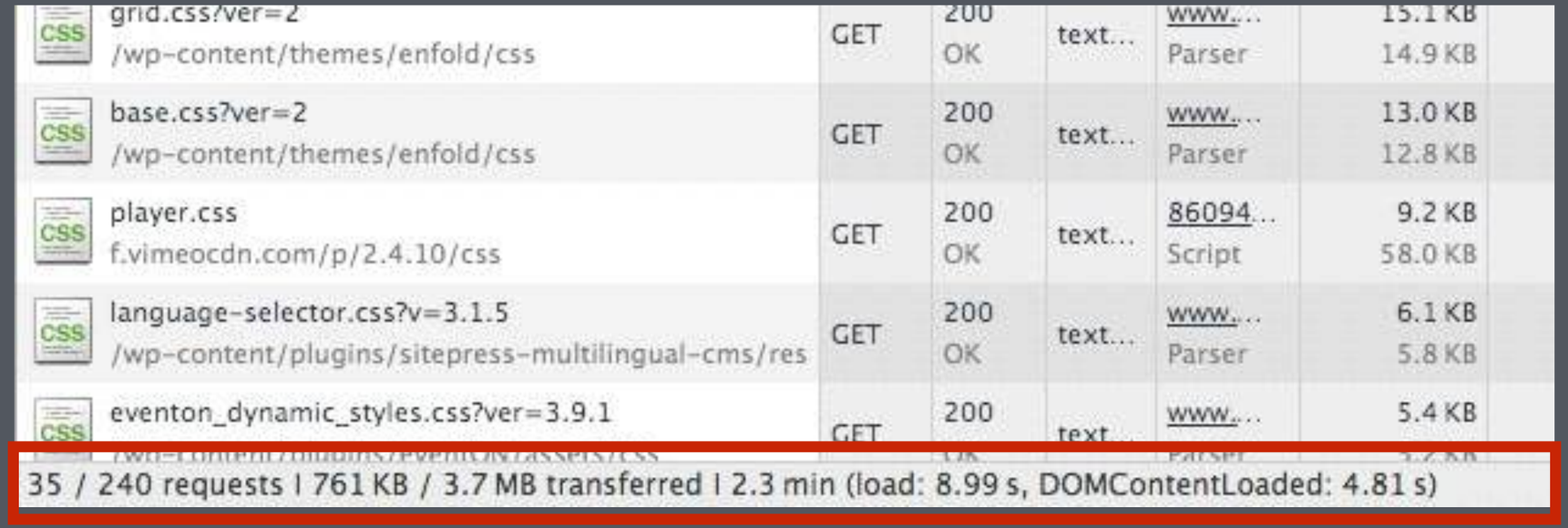

grid.css?ver=2
/wp-content/themes/enfold/css
GET
200
OK
text...
www...
Parser
15.1 KB
14.9 KB
base.css?ver=2
/wp-content/themes/enfold/css
GET
200
OK
text...
www...
Parser
13.0 KB
12.8 KB
player.css
f.vimeocdn.com/p/2.4.10/css
GET
200
OK
text...
86094...
Script
9.2 KB
58.0 KB
language-selector.css?v=3.1.5
/wp-content/plugins/sitepress-multilingual-cms/res
GET
200
OK
text...
www...
Parser
6.1 KB
5.8 KB
eventon_dynamic_styles.css?ver=3.9.1
GET
200
text...
www...
5.4 KB
35 / 240 requests | 761 KB / 3.7 MB transferred | 2.3 min (load: 8.99 s, DOMContentLoaded: 4.81 s)

Image Sprites

Thanks to the new multiplexing ability of HTTP/2 resources don't need to be queued anymore.

Nevertheless, depending on the kind of image, and how they are used, spriting can still be the better option in regards to compression and file size.

Inline Images

Another workaround for the lack of parallelism in HTTP/1.x

Besides increasing the file size of stylesheets etc., the resource can’t be cached and asset re-use will create unnecessary overhead

Prioritisation features of HTTP/2 can’t be used

Domain Sharding

And one more workaround for the lack of multiplexing in HTTP/1.x

Browsers can handle ~6 connections per origin, but domain sharding allows us to (theoretically) extend this to an unlimited amount of connections.

Domain sharding will have a negative impact when used with HTTP/2.

Source

	HTTP1.x	HTTP2
Reduce DNS lookups	✓	✓
Reuse TCP connections	✓	✓
Use a Content Delivery Network	✓	✓
Minimize number of HTTP redirects	✓	✓
Eliminate unnecessary request bytes	✓	✓
Compress assets during transfer	✓	✓
Cache resources on the client	✓	✓
Eliminate unnecessary resources	✓	✓
Apply domain sharding	Revisit (max 2)	Remove
Concatenate resources	Careful & consider caching	Remove
Inline resources	Careful & consider caching	Remove (Server Push)

Source

Getting to HTTP/2

Make the move to TLS & add a secure connection to your site

(This can be done at any time and brings some additional benefits, even without HTTP/2)

Make sure your server supports HTTP/2

(Confirm with your hosting provider, roll your own or use a HTTP/2 supporting CDN service)

Prepare your assets & adjust the build process for HTTP/2

(Adjust to output the required files that best suit your needs and test your choices)

Check Analytics & confirm your user's browser support

(This could affect users with older browsers negatively, and check for majority support)

Implement your favourite HTTP/2 best practices and adjust your caching policies

(Measure your performance before and after the update and share your results with the world!!)

谢谢!