

# Understanding Resource Priorities Andy Davies · Sep 2020

https://www.flickr.com/photos/volvob12b/8096363022



# Ever wondered why pages load in the order they do?

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### Ever wondered why pages load in the order they do?

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		0.5	1.0	1.5	2.0	2.5





HOLD

### Prioritisation helps fetch the content in the most efficient order



MARATHON







VERSUS

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Business



#### Primark post-lockdown sales head for £2bn

Owner AB Foods says the High Street chain's sales since reopening have been stronger than expected.

C 25m Business

#### • Primark says no to £30m job retention payment



Crime agency under fire over bank signature forgery

Train services increase



### Several factors affect how resources are prioritised

- Browser
- Network Conditions
- Server / CDN
- Protocol
- Content Type
- Markup and Page Construction

### The browser is where it all starts...

- HTML is parsed incrementally, but...
- Synchronous script elements block the parser until
- script has loaded and executed
- pending stylesheets have loaded

Stylesheets block rendering of content below them



#### Some resources are discovered late

Fonts and background images - when the render tree is built

Script injected resources - when the script executes

@imported stylesheets - when the outer stylesheet is parsed



# Render or parser blocking resources get higher priority







Visible Images Images

**Non-Blocking Scripts** 

**Prefetches** 





### Some content is useful even when we only have part of it

#### HTML

Can incrementally parse the HTML fetch etc.

#### **Bitmap Images**

Size information can be extracted, of that's by scan line)

#### Can incrementally parse the HTML looking for new elements, resources to

#### Size information can be extracted, can be rendered progressively (even if

#### For other content we need it all

#### Styles

Whole stylesheet needs to be downloaded to build CSS Object Model

#### Scripts

Whole script is needed before it can be executed (can be parsed) incrementally in some browsers)

#### Fonts

Whole font is needed before it can be applied





## What does this look like in an actual browser?



wait	dns	connect	ssl	html		js	CS	88	image	fl	lash	f	ont	vic	deo	othe	m US	3 Executi	or
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2456 ms

#### "The Stair Step"

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8.	andydavies.git	t-awesome.mi	n.css		99	ms	
87.	andydavies.githuk	.io - style.	css		102	2 ms	
8.	andydavies.git	.o – jquery.m	in.js			<b>19</b> 5 ms	
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₿10.	andydavies.git	io – slick.m	in.js			225 m:	8
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🖰 6.	andydavies.gitt-awesome.min.css	16	i6 ms
87.	andydavies.github.io – style.css	92 r	ns
8.	andydavies.gito – jquery.min.js	15	1 ms
Δ9.	andydavies.git bootstrap.min.js	18	81 ms
≙10.	andydavies.gitio – slick.min.js		237 ms
₿11.	andydavies.gitnouislider.min.js	1	91 ms
₿12.	andydavies.gitquery.zoom.min.js		261 ms
₿13.	andydavies.gitdummy-js-async.js		239 ms
≙14.	andydavies.gitdummy-js-defer.js		260 ms
₿15.	andydavies.github.io – logo.png		555 ms
≜16.	andydavies.gito – product01.png		
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### Chrome adapts its approach for slower networks

	wai	t dns	connect	ssl	html	js	
Ste	p_1				1	2	3
	1.	andydavies.git	yles-in-foot.	.html	12	97 ms	1
$\bigcirc$	2.	andydavies.git	.bootstrap.mi	n.css		716 ms	\$
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	5.	andydavies.git	ouislider.mi	n.css		697 ms	\$
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# Prioritisation in HTTP/1.x vs HTTP/2

#### HTTP/1.x

Browser builds a list of resources in priority order 6 TCP connections per origin (can be more or less than 6)



- When a connection becomes free... requests next highest priority resource in list

# Prioritisation in HTTP/1.x vs HTTP/2

#### HTTP/1.x

Browser builds a list of resources in priority order 6 TCP connections per origin (can be more or less than 6)

**Browser is in control** 



- When a connection becomes free... requests next highest priority resource in list

# Prioritisation in HTTP/1.x vs HTTP/2

#### HTTP/2

Requests are sent to the server Relative priority and dependency information attached to request Priority information can be updated

Each connection has it's own set of priority information and is unaware of others

Browser expect servers to fulfil requests in the priority provided



# Content from different origins will compete for the network

https://www.flickr.com/photos/39908901@N06/7834345230



# Browsers adopt different approaches to H2 prioritisation

Safari

#### Chromium

(Linear List)







https://github.com/quicwg/wg-materials/raw/master/interim-19-05/priorities.pdf

#### Firefox (Groups)









### And some servers / CDNs ignore it...

#### 3.0s 4.0s NTTP/2 PRIORITIES TEST PAGE BOR CONTRACTOR Wertung the Diffe Constant States. and the same And and the second HTTP/2 priorities test page Nation for 2004 Conner Conduct. Index Arranger phenological teachers and

#### 5.0s



#### HTTP/2 priorities test page Nation for 2004 Connect Conduct. Cably Longer

#### 6.0s

Nation for DOAN Connectionals. Calify Arrays:

HTTP/2 priorities test page

### And some servers / CDNs ignore it...

#### 13.0s

14.0s

#### PRIORITIES TEST PAGE

.....



15.0s

#### 16.0s



#### andydavies / http2-prioritization-issues

### Pat Meenan created a test case and we catalogued the results

F master - F i branch 🛇 U	tags Go to file		
andydavies Remove erroneous .	DS_Store 2b8	80863 on 4 Feb 🕚 <b>34</b> commits	Tracks issues / notes for HTTP/2 prioritization across browsers, CDNs and servers
.github/ISSUE_TEMPLATE	Update issue templates	2 years ago	
images	Switched to the new test and added a LOT of test results	s 2 years ago	nttp2 performance prioritization
LICENSE	Initial commit	2 years ago	🛱 Readme
README.md	Added results for Zeit	7 months ago	MIT License
README.md		Ø	Releases
<b>Tracking HTTP/</b>	2 Prioritization Issues		No releases published Create a new release
Introduction			Packages
HTTP/2 uses multiplexing to su	poort multiple concurrent requests over the same TCP co	nnection	No packages published Publish your first package

uses multiplexing to support multiple concurrent requests over the same TCP connection.

HTTP/2 also has a prioritization scheme (via weights & dependencies) that enables browsers to communicate the relative priority of each request.

Unfortunately not all servers are equal – some don't appear to implement prioritization and so serve responses on a 'first come first served' basis and others that implement prioritization seem to have a few bugs too - and these



🟠 Star

190

#### https://ishttp2fastyet.com













# Almost everyone else has broken HTTP/2 prioritisation





#### <link rel="preload" href="..." as="font" crossorigin/>

...to the rescue?

# Inert, high priority fetch

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# Preload is a tradeoff



#### 0.1s

#### 0.2s



#### Preload is a tradeoff

#### 1.0s





#### 1.1s









#### Preload is a tradeoff




#### Using a known good CDN or server is always better

#### 1.0s



#### 1.5s



AP Contented

NEW PRODUCTS

2.0s

When we explicitly increase the priority of one resource we implicitly decrease the priority of others

# Being selective about what you preload

Ge	ene	rate a c	usto	m Water	fall:										
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Update Waterfall

andwidth Utilization



### You may also see it used in 'hacks' that boost priority

# <link rel="preload" as="script" href="a.js" /> <script async src="a.js"></script></script></script></script></script>

# N3C Community port

#### **TABLE OF CONTENTS**

- Introduction
- Solution 2
- **Effects of Priority Hints** 3
- Examples
- Adoption path 5
- Out of scope
- **Use Cases**

#### **Priority Hints** Draft Community Group Report, 16 February 2020

This version:

https://wicg.github.io/priority-hints

Issue Tracking: GitHub

Editors:

Addy Osmani (Google Inc.) addyosmani@gmail.com Yoav Weiss (Google Inc.) yoav@yoav.ws

Copyright © 2020 the Contributors to the Priority Hints Specification, published by the Web Platform Incubator Community Group under the W3C Community Contributor License Agreement (CLA). A human-readable summary is available.

#### Abstract

Specification of the Priority Hints feature.

# Priority Hints is a proposal to allow finer control of priority

- 7.4 Provide priority signals for markup-based resources 7.5 Provide priority signals for dynamically loaded resources
- 7.6 Provide the ability to re-prioritize a resource in-flight
- Downgrade priority of an iframe and its subresources

Groups.

This specification describes a browser API enabling developers to signal the priority of each resource they need to download. It introduces the importance attribute that may be used with elements such as img, link, script and iframe.

This is an unofficial proposal.

(CLA) there is a limited opt-out and other conditions apply. Learn more about W3C Community and Business

#### https://wicg.github.io/priority-hints/



Sometimes seemingly simple changes can have performance implications

#### <liink rel="prefetch" href="..." as="image"</pre>

Inert, low priority fetch for resources likely to be used in the future



Resource fetches required for the next navigation SHOULD have lower relative priority and SHOULD NOT block or interfere with resource fetches required by the current navigation context.

https://www.w3.org/TR/resource-hints/

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### Mix of Safari and poor server prioritisation delays key content

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product04.jpg	jpg	200	Low	17.15 KB	

#### (By default prefetch isn't enabled in Safari ATM)

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### Firefox waits until onload before dispatching prefetches

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ssl

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wait

dns

connect





#### Chrome delays prefetches but still danger of contention

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#### Chrome delays prefetches but still danger of contention

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Safari issue affects prefetcl markup

Directives inserted later e.g. are less likely to be affected

## Safari issue affects prefetch directives inserted early in

#### Directives inserted later e.g. by guess.js or instant.page

### What if a Service Worker made your site slower?

### Competition can come from surprising sources!





#### Competition can come from surprising sources!



### **Competition can come from surprising sources!**







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🖰 8. www.britboot.c oxSharedCart.js			780 ms							
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🖰12. www.britboot.co.uk – style.css		317 ms								
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31. storage.googleresponse.prod.js	34 ms	
32. storage.googlexpiration.prod.js	36 ms	
33. www.britboot.ces-mobile.min.css	530 ms	
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↑43. WWW.britboot.cGetCategories.asp		460 ms

## Service Worker Registration

```
<meta http-equiv="Expires" content="-1" />
<script>
    if ('serviceWorker' in navigator) {
            if (reg.installing) {
                console.warn('[SW] installing');
            } else if (reg.waiting) {
                console. warn ('[SW] installed');
            } else if (reg.active) {
                console. warn ('[SW] active');
            }
        }).catch(function(error) {
            console.error('[SW] Registration failed', error);
        });
    ר
</script>
k rel="StyleSheet" type="Text/css" href="Css/shared.css?v=48">
```

**Service Worker is registered** in the head of the page navigator.serviceWorker.register('/sw.js', {scope: '/'}).then(function(reg) {

#### HTML Page

#### Service Worker

**Service Worker requests** compete with other requests for network bandwidth

# An alternative approach

if ('serviceWorker' in navigator) { window.addEventListener('load', function() { navigator.serviceWorker.register('/sw.js').then(function(registration) { // Registration was successful console.log('ServiceWorker registration successful with scope: ', registration.scope); }, function(err) { // registration failed :( console.log('ServiceWorker registration failed: ', err);

https://developers.google.com/web/fundamentals/primers/service-workers/





# An alternative approach

if ('serviceWorker' in navigator) { window.addEventListener('load', function() { navigator.serviceWorker.register('/sw.js').then(function(registration) { // Registration was successful console.log('ServiceWorker registration successful with scope: ', registration.scope); }, function(err) { This might be ok for a traditional page // registration failed :( console.log('ServiceWorker registration failed: ', err); But is the load event an appropriate tigger in the context of a Single Page App?

https://developers.google.com/web/fundamentals/primers/service-workers/





#### There are other ways we can influence priority too

## Bundling and inlining can override priorities

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#### base64 encoded image within a script

"A low priority resource within a high priority one"



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# Ultimately, there is only a single 'last mile' connection

http://www.flickr.com/photos/7671591@N08/1469828976





# Self-host 3rd-party libraries and unshard domains

https://www.flickr.com/photos/justinknol/6402733575



# Where possible stick to the default priorities

https://www.flickr.com/photos/elsiehui/15599408558



#### **WEBPAGE**TEST

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### If you want to intervene in the priority... test, test and test again

Run a free website speed test from multiple locations around the globe using real browsers (IE and Chrome) and at real consumer connection speeds. You can run simple tests or perform advanced testing including multi-step transactions, video capture, content







# See something that doesn't make sense... Ask Why?

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#### Raise bugs. Request Features

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Callering

SL = DUL-R



# PERFORMANT PAGE LOAD IS JUST THE PROLOGUE.

Emily Hayman, SmashingConf London 2018






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