Whirlwind tour through the HTTP2 spec

Full Stack Fest 2016 – 06.09.2016 – Ole Michaelis (Jimdo)

QUICK FAQ

IS IT REALLY DONE?

YES!

IS SSL MANDATORY?

No! But...

IS HTTP/2 MADE BY GOOGLE?

No!

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BUT WHAT'S SPDY THEN?

Another Protocol!

IS HTTP/2 PLAIN TEXT?

No!

ARE HEADERS COMPRESSED?

YES!

WILL HTTP/1.1 STILL WORK?

YES!

A BRIEF HISTORY

Sir Tim Berners-Lee's
World Wide Web

1989

1991

HTTP V0.9

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HTTP V1.0 *draft*

1992

1996

HTTP V1.0
RFC 1945

HTTP/1.1
RFC 2068

1997

1998

RFC 2326

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1999 — HTTP/1.1 *RFC 2616*

2007 — IETF forms HTTPbis WG

early 2012 — Call for Proposals for HTTP/2

Nov. 2012 — First HTTP/2 draft based on Google's SPDY

HTTP/1.1 split

2014

RFC 7230
Message Syntax & Routing

RFC 7231
Semantics and Content

RFC 7232
Conditional Requests

RFC 7233
Range Requests

RFC 7234
Caching

RFC 7235
Authentication

May 2015

HTTP/2 RFC 7540

End of 2015:

22% of all Internet Traffic is HTTP/2

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HTTP BASICS

PLAIN TEXT

```
👌  ~  telnet google.com 80
Trying 173.194.39.2...
Connected to google.com.
Escape character is '^]'.
GET / HTTP/1.1
Host: google.com

HTTP/1.1 302 Found
Cache-Control: private
Content-Type: text/html; charset=UTF-8
Location: http://www.google.de/?
```

STATELESS

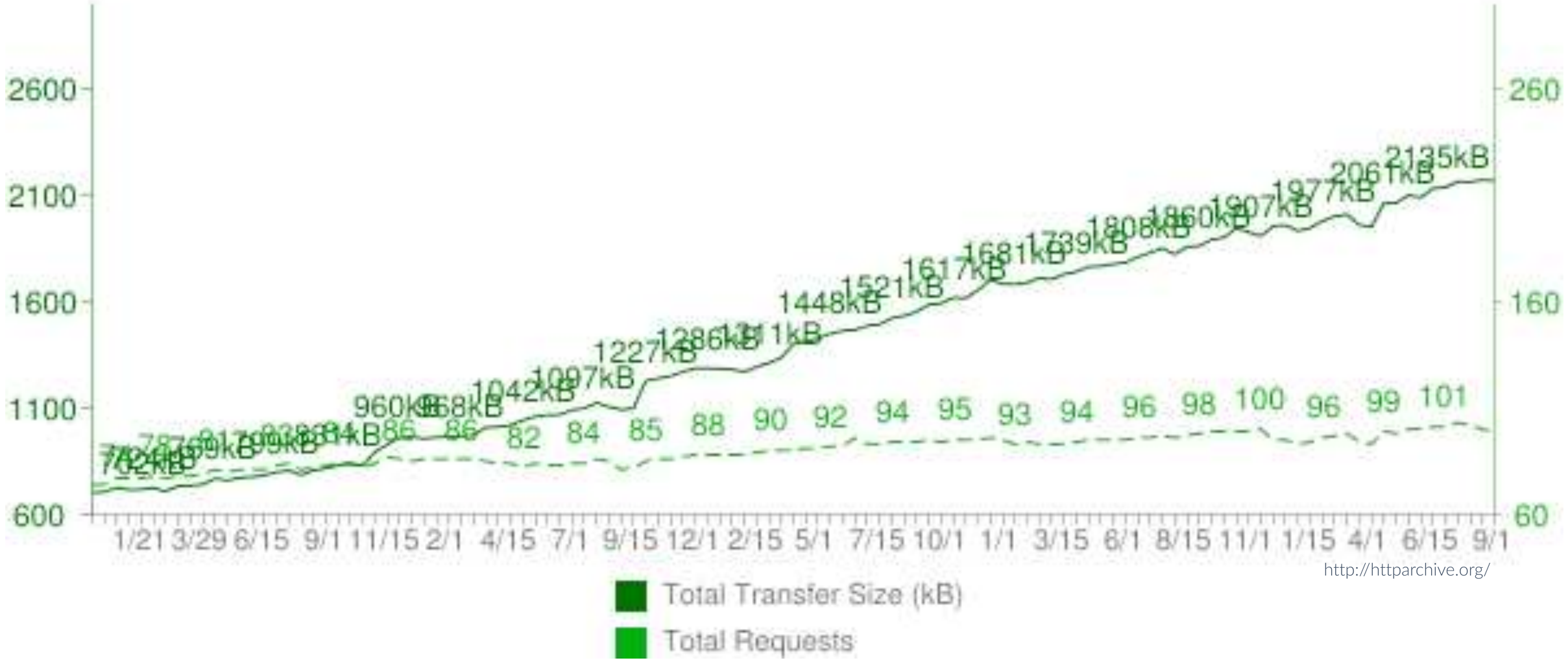
SUPER FLEXIBLE

HTTP/1.1

PROBLEMS

THE WEB MATURED

Total Transfer Size & Total Requests



http://httparchive.org/

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CONNECTIONS

38 PER PAGE

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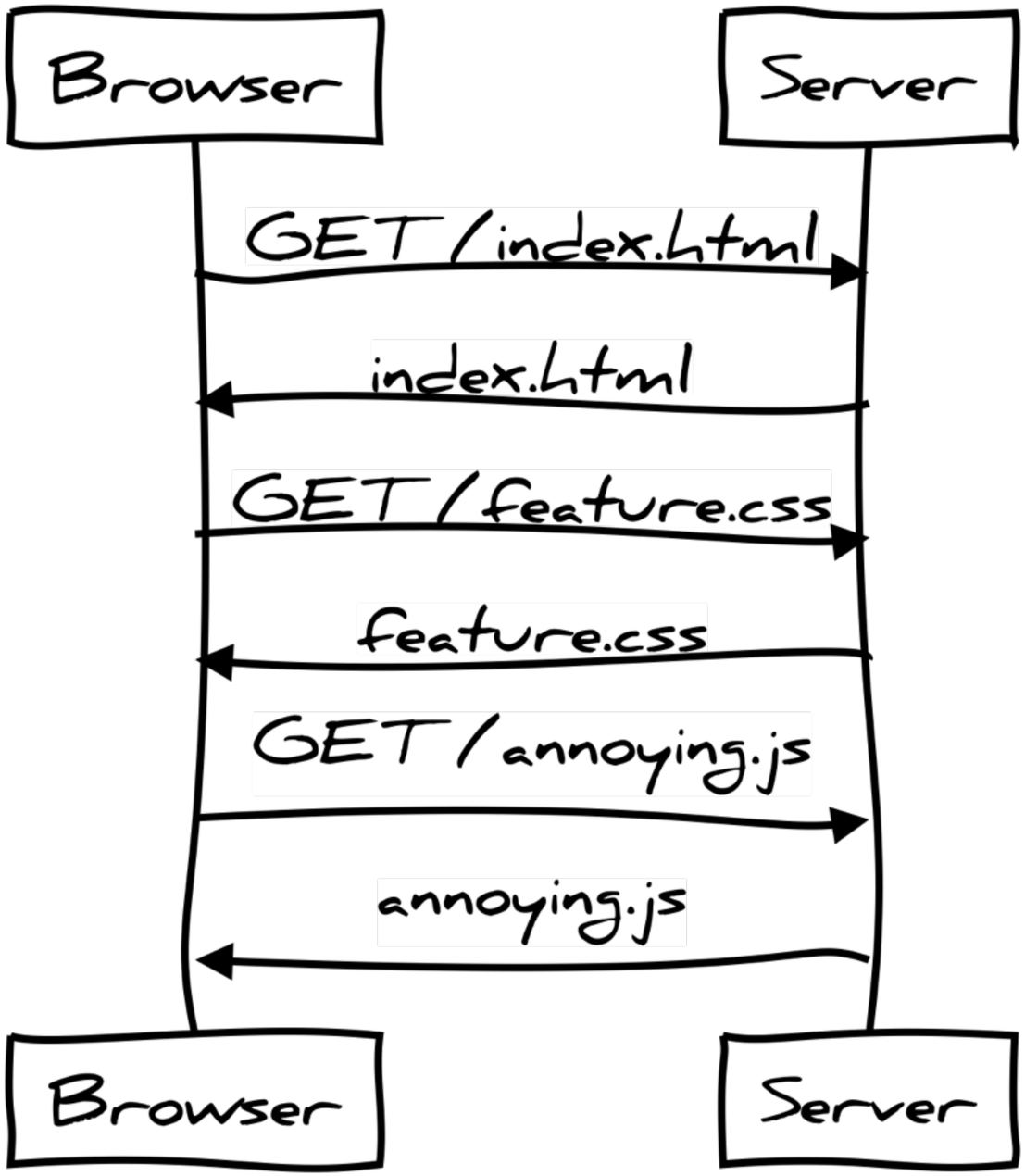
REQUEST BONANZA



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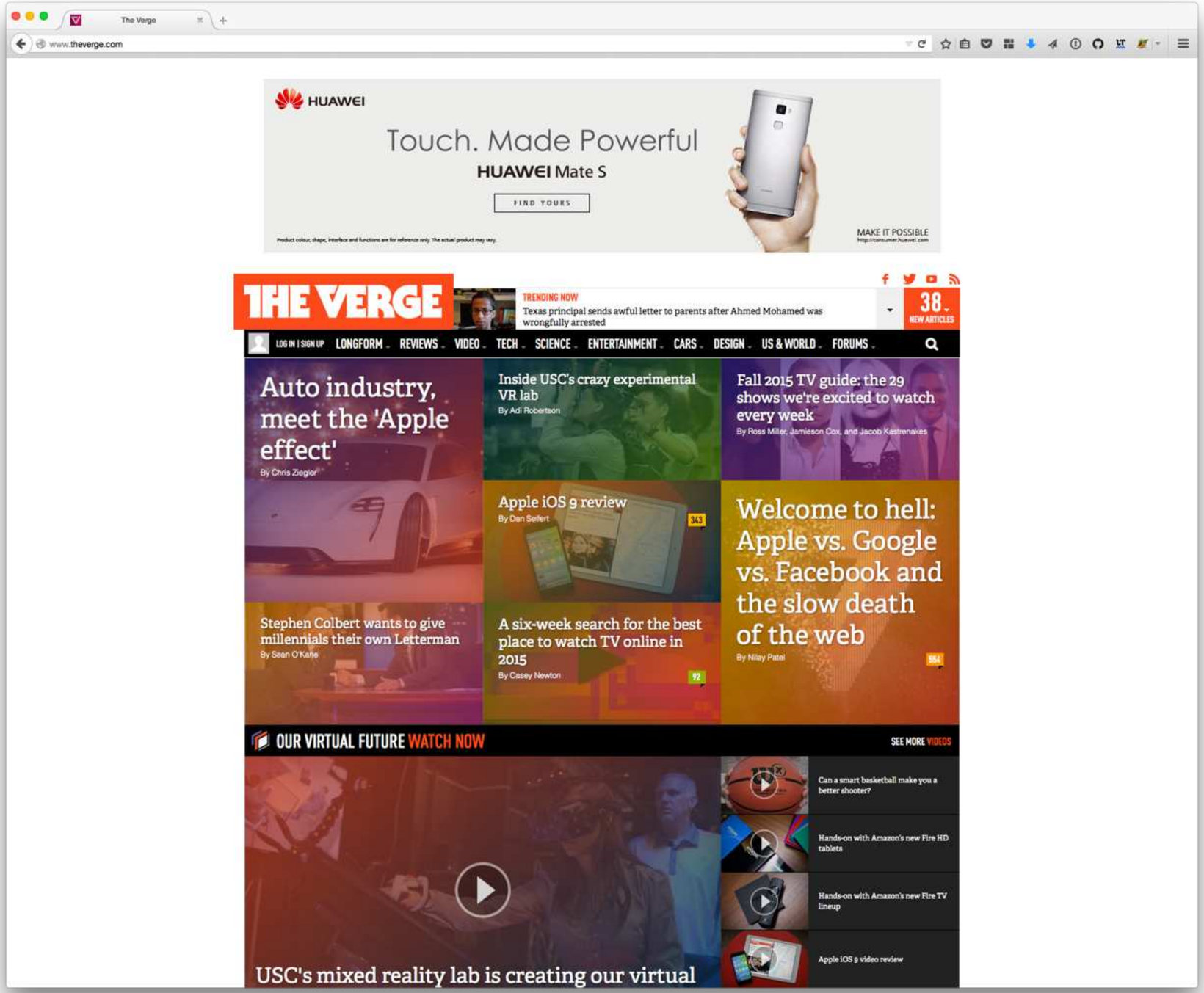
LATENCY!



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Elements Network Sources Timeline Profiles Resources Audits Console

View: Preserve log Disable cache DSL (2 Mbps 5ms RT)

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

Recording frames...

50 ms 100 ms 150 ms 200 ms 250 ms 300 ms 350 ms 400 ms 450 ms 500 ms 550 ms 600 ms 650 ms 700 ms 750 ms 800 ms 850 ms 900 ms 950 ms 1000 ms

Name	Method	Status	Protocol	Type	Initiator	Size	Time	Cache-Control	Timeline - Start Time

No requests captured. Reload the page to see detailed information on the network activity.

Console Search Emulation Rendering

<top frame> Preserve log

Filter Regex Hide network messages All Errors Warnings Info Logs Debug Handled

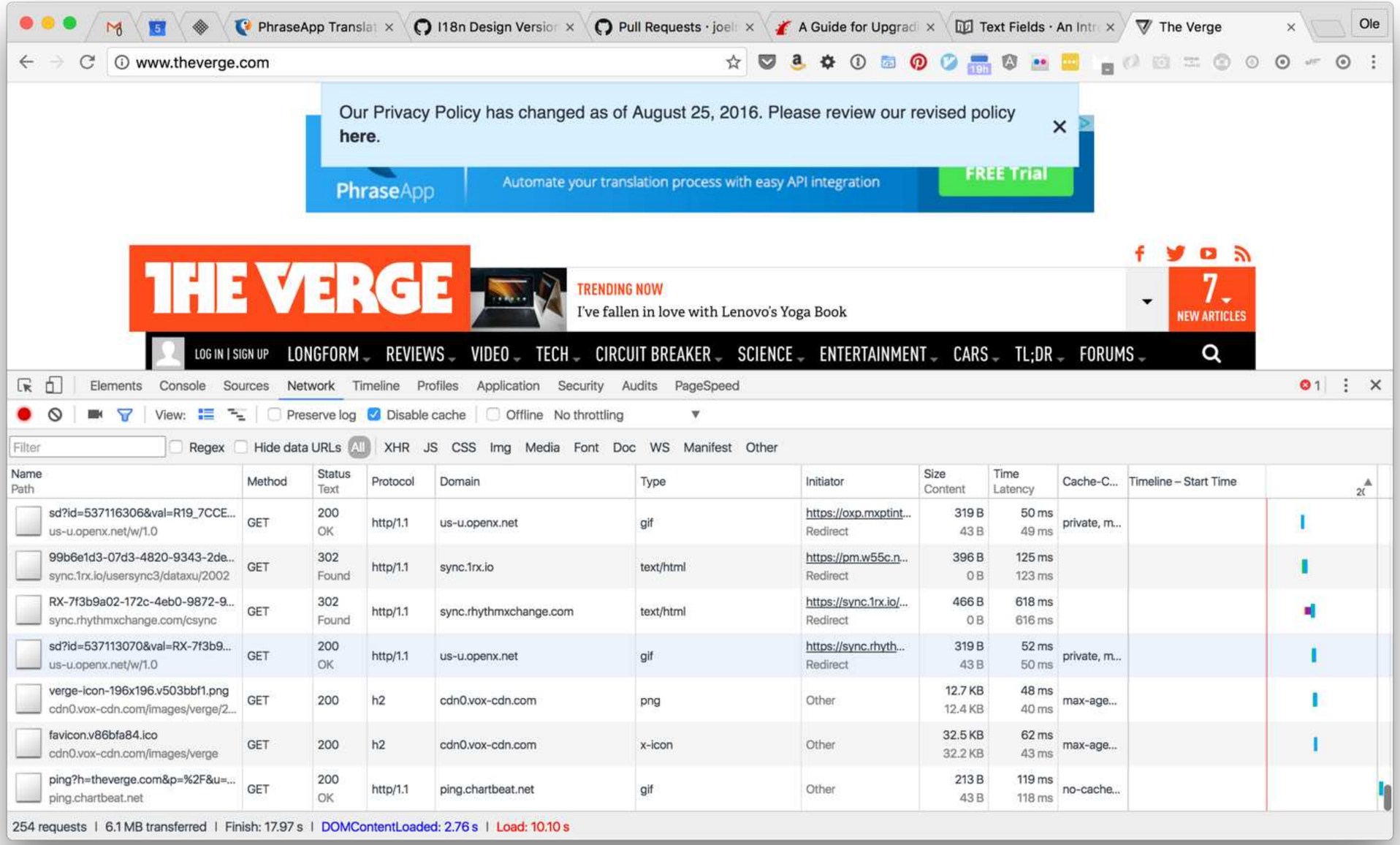
'webkitMovementX' is deprecated. Please use 'movementX' instead. libraries.vc262b07aa2474684.js:2

'webkitMovementY' is deprecated. Please use 'movementY' instead. libraries.vc262b07aa2474684.js:2

Failed to load resource: net::ERR_SSL_PROTOCOL_ERROR https://sc.iasds01.com:80/dtc?asid=4767e789-5d95-11e5-b038-00259086cc10&second_pass=1

Failed to clear temp storage: It was determined that certain files are unsafe for access within a Web application, or that too many calls are being made on file resources. SecurityError

>



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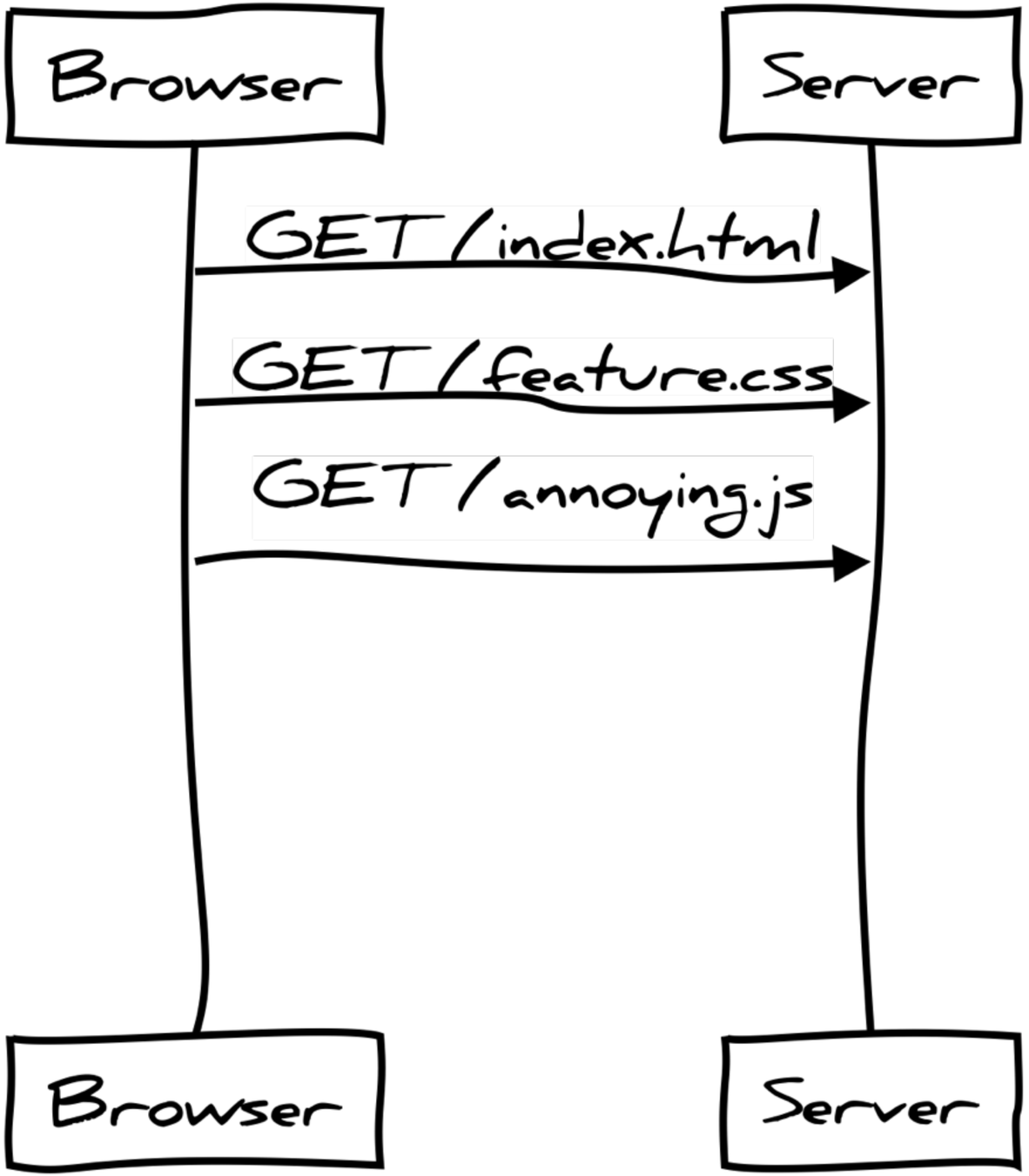
HOL* BLOCKING!

*Head of Line



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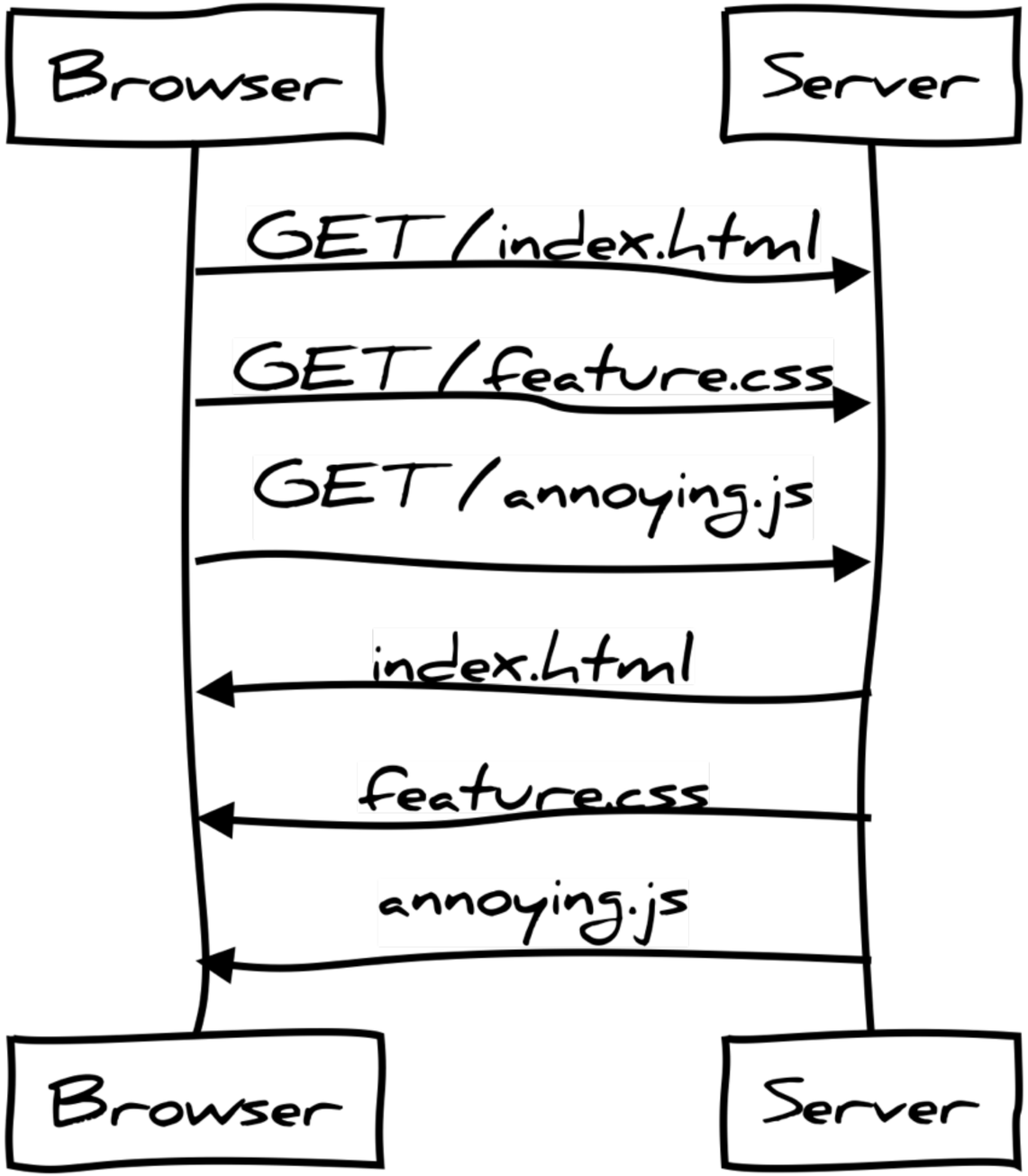

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HOL* BLOCKING RECAP

ORDER MATTERS!

HOL* BLOCKING RECAP

SLOWEST BLOCKS!

HOL* BLOCKING RECAP

NO WORKAROUND!

HOL* BLOCKING RECAP

OFTEN UNUSED!

WE
ENDEAVORED

SPRITING

CONCATENATING

DOMAIN SHARDING

INLINING

PRELOADING HACKS!

COOKIE FREE DOMAINS*

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HTTP/2 TO THE RESCUE

COMPATIBLE

UPGRADE FROM HTTP/1.1

Non Secure

HTTP

HTTPS

TLS-ALPN

RFC 7301

```
Client                                              Server

ClientHello                  -------->          ServerHello
  (ALPN extension &                                 (ALPN extension &
   list of protocols)                                selected protocol)
                                                  Certificate*
                                                  ServerKeyExchange*
                                                  CertificateRequest*
                             <--------            ServerHelloDone
Certificate*
ClientKeyExchange
CertificateVerify*
[ChangeCipherSpec]
Finished                     -------->
                                                  [ChangeCipherSpec]
                             <--------            Finished
Application Data             <------->            Application Data
```

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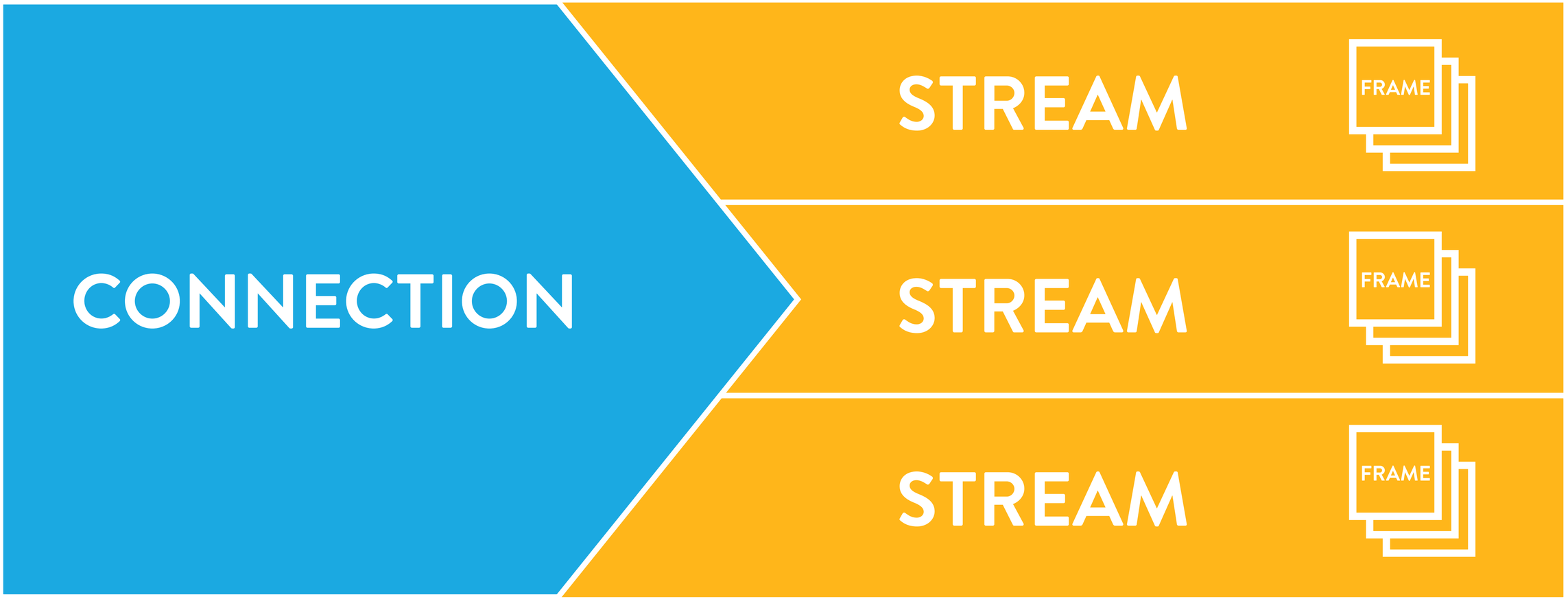
HEADSUP:

h2 vs. h2c

MULTIPLEXED

HTTP/2 CONNECTIONS



FRAMES

BINARY

FRAME LAYOUT

```
+-----------------------------------------------+
|                 Length (24)                   |
+---------------+---------------+---------------+
|   Type (8)    |   Flags (8)   |
+-+-------------+---------------+-------------------------------+
|R|                 Stream Identifier (31)                      |
+=+===============================================================+
|                   Frame Payload (0...)                      ...
+---------------------------------------------------------------+
```

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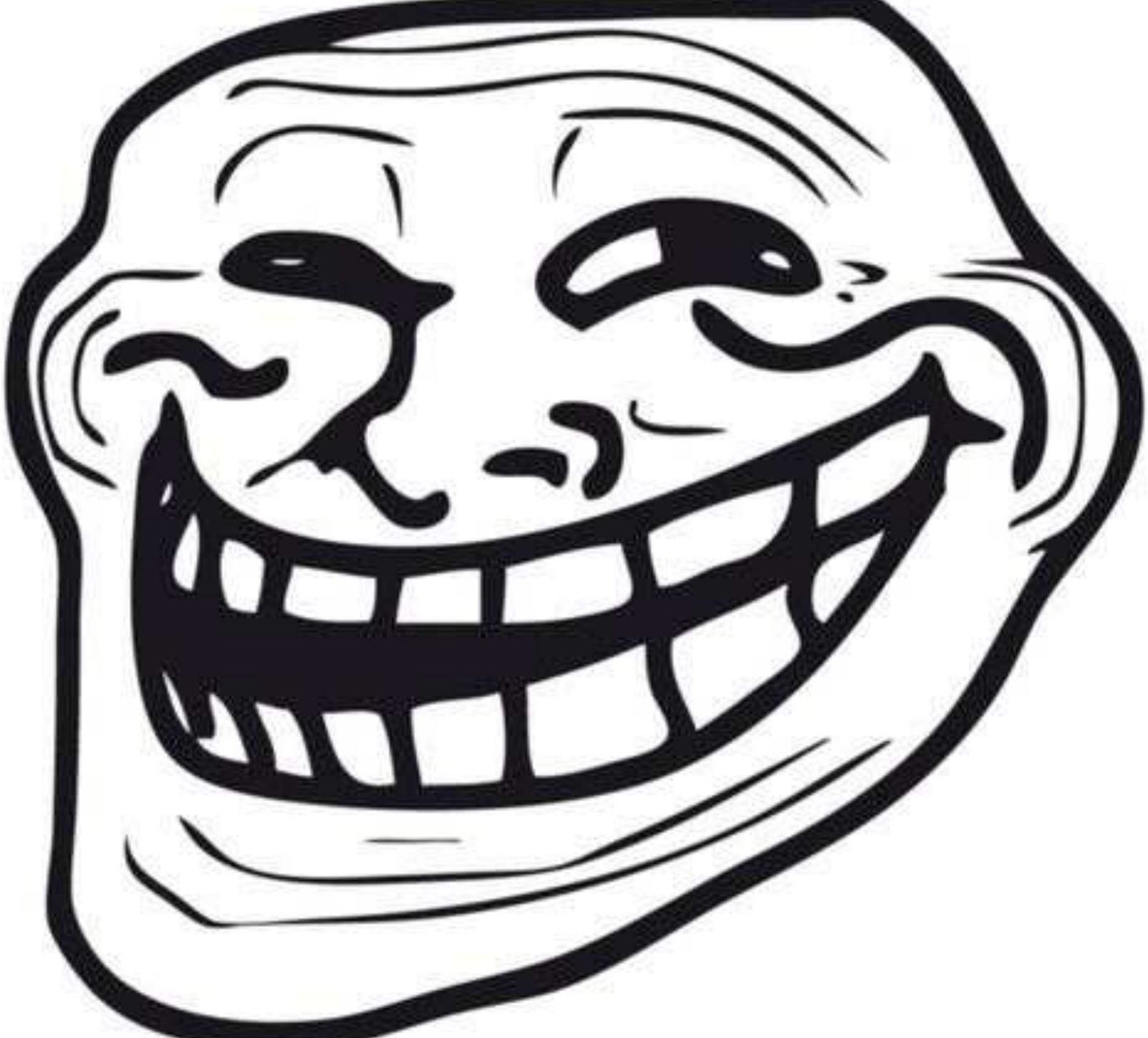

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TYPES

DATA 0x0

```
+---------------+
|Pad Length? (8)|
+---------------+-----------------------------------------------+
|                             Data (*)                        ...
+---------------------------------------------------------------+
|                           Padding (*)                       ...
+---------------------------------------------------------------+
```

PRIORITY 0x2

```
+-+-------------------------------------------------------------+
|E|                 Stream Dependency (31)                      |
+-+-------------+-----------------------------------------------+
|   Weight (8)  |
+-+-------------+
```

RST_STREAM 0x3

```
+-----------------------------------------------------------------+
|                          Error Code (32)                        |
+-----------------------------------------------------------------+
```

SETTINGS 0x4

```
+-------------------------------+
|       Identifier (16)         |
+-------------------------------+-------------------------------+
|                         Value (32)                            |
+---------------------------------------------------------------+
```

a bunch more...

PING 0x6 /w ACK

```
+-----------------------------------------------+
|         0000 0000 0000 0000 0100 0000         |
+---------------+---------------+---------------+
|   00000110    |    00000001   |
+-+-------------+---------------+-------------------------------+
|0|            010 0001 1100 0000 1111 1111 1110 1110           |
+-+-----------------------------------------------------------+
|            10010000 11010100 00001100 11110100                |
|            10100000 11011011 10100010 00110100                |
+---------------------------------------------------------------+
```

length (64)

stream id

flags: ACK (0x6)

opaque data (64)

HTTP/2

FEATURES

SERVER PUSH!

PUSH_PROMISE 0x5

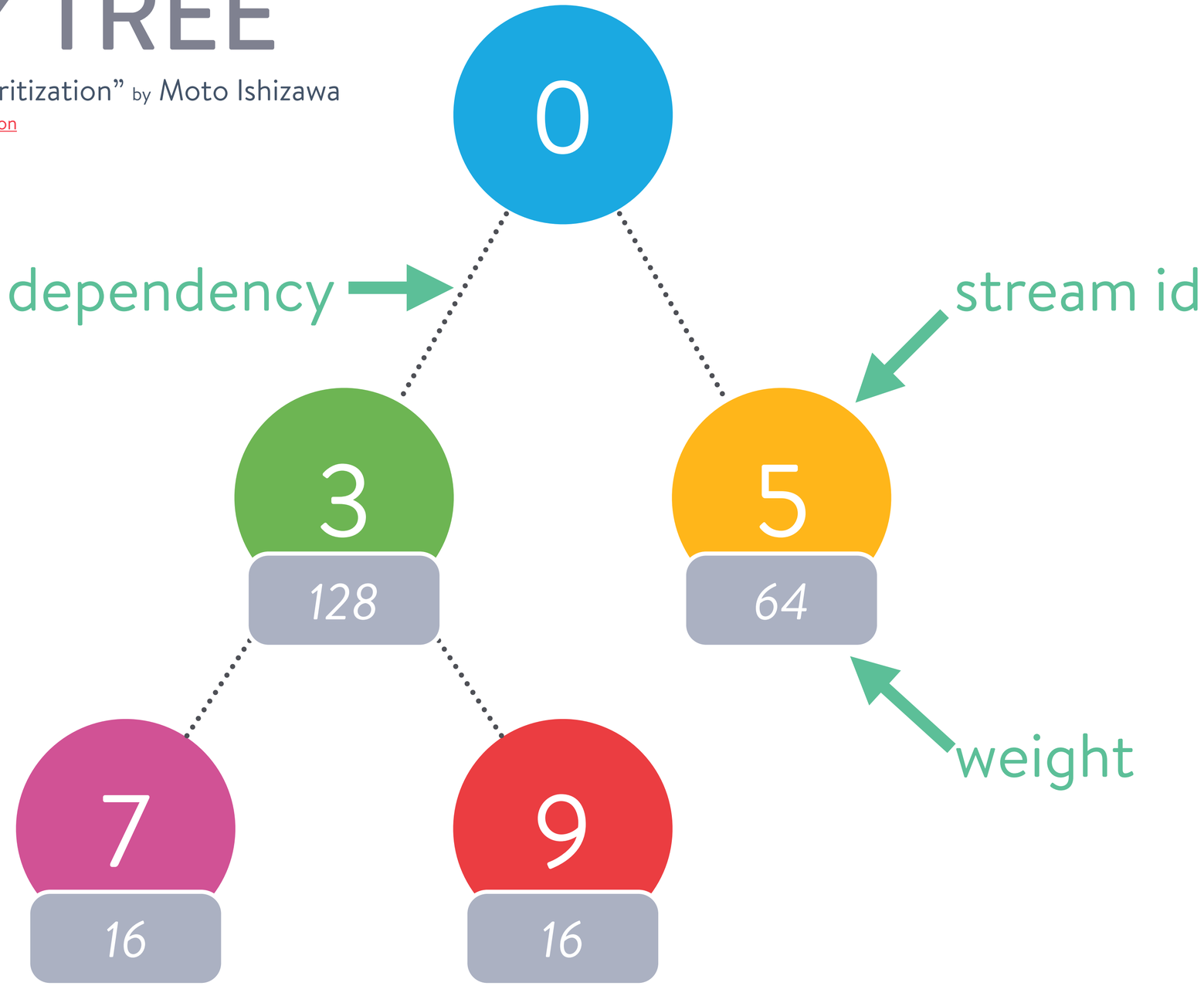
```
+---------------+
|Pad Length? (8)|
+-+-------------+-----------------------------------------------+
|R|                  Promised Stream ID (31)                      |
+-+-----------------------------+-------------------------------+
|                   Header Block Fragment (*)                     ...
+---------------------------------------------------------------+
|                           Padding (*)                           ...
+---------------------------------------------------------------+
```

FLOW CONTROL

WEIGHTED DEPENDENCIES

PRIORITY TREE

from "Understanding HTTP/2 prioritization" by Moto Ishizawa
https://speakerdeck.com/summerwind/2-prioritization



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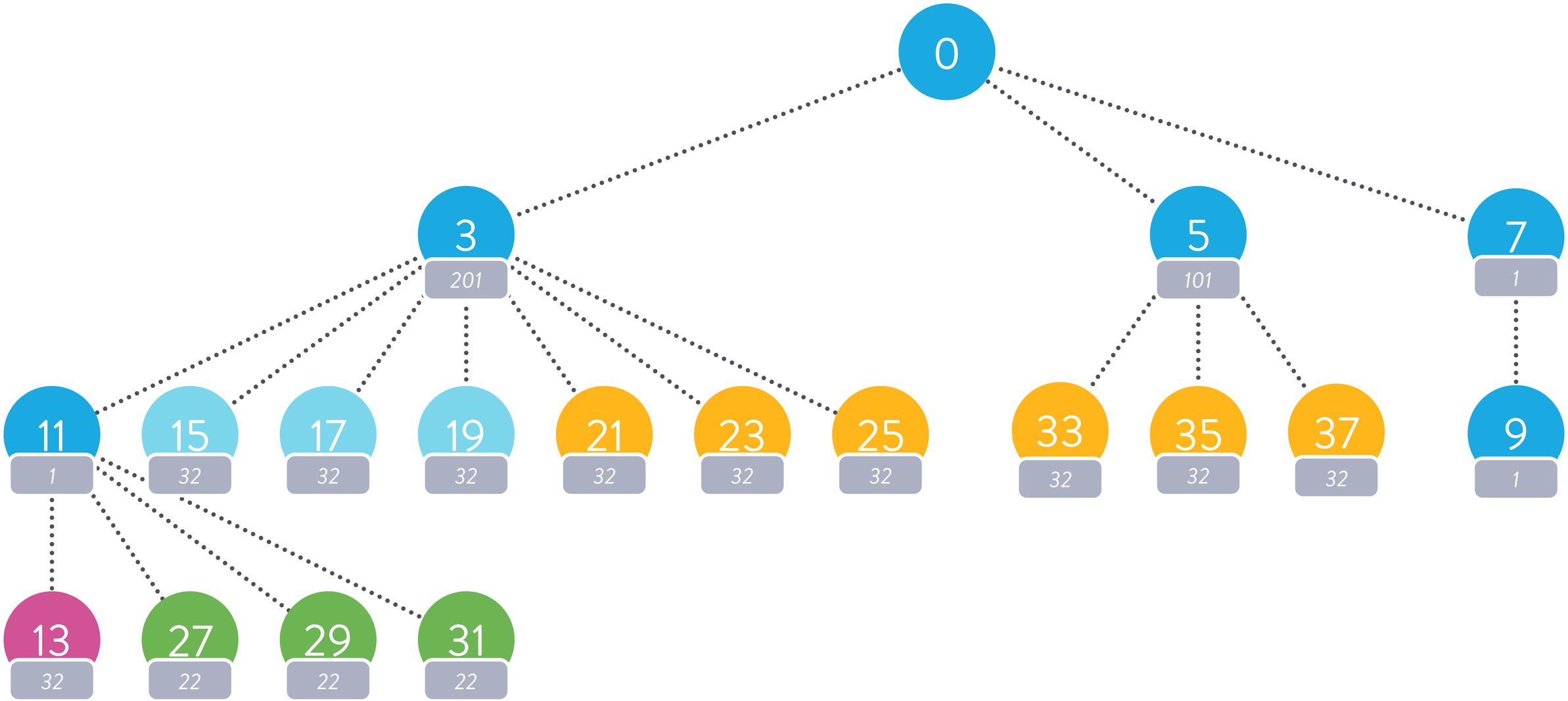
FIREFOX DEPENDENCY TREE



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COMPRESSED HEADERS

HEADERS 0x1

```
+---------------+
|Pad Length? (8)|
+-+-------------+-----------------------------------------------+
|E|                 Stream Dependency? (31)                     |
+-+-------------+-----------------------------------------------+
|  Weight? (8)  |
+-+-------------+-----------------------------------------------+
|                   Header Block Fragment (*)                 ...
+---------------------------------------------------------------+
|                           Padding (*)                       ...
+---------------------------------------------------------------+
```

HPACK

RFC 7541

HEADER COMPRESSION TABLE

request headers

:method	GET
:scheme	https
:host	jimdo.com
:path	/resource
user-agent	Mozilla/5.0
custom-hdr	some-value

static table

1	:authority	
2	:method	GET
...	...	...
51	referer	
...	...	...
62	user-agent	Mozilla/5.0
63	:host	jimdo.com
...	...	...

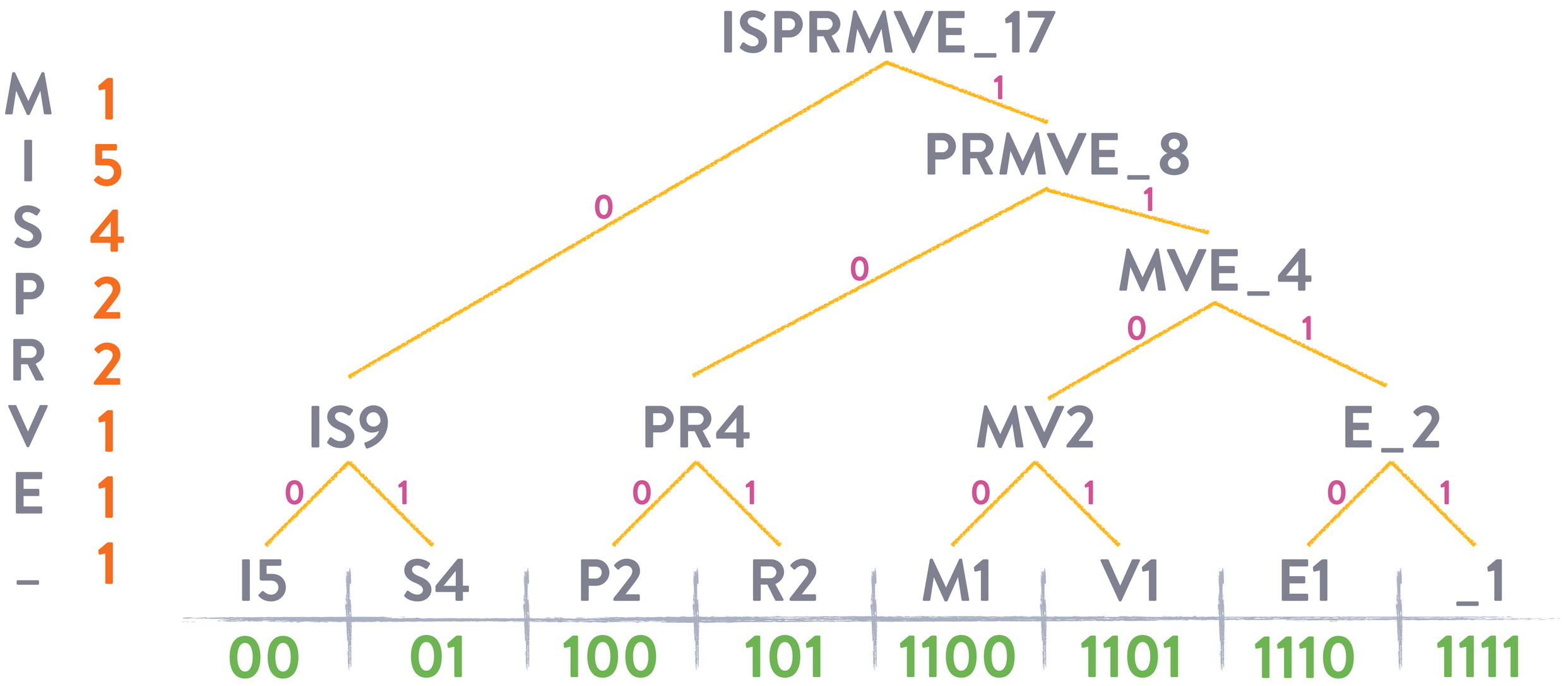
dynamic table

encoded headers

2	
7	
63	
19	huffman('/resource')
62	
huffman('custom-hdr')	
huffman('some-value')	

HUFFMAN IN 1 MINUTE

Mississippi River = 17 chars * 8 bit = 136 bits



https://www.youtube.com/watch?v=ZdooBTdW5bM

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COMPRESSION TABLE

I5	S4	P2	R2	M1	V1	E1	_1
00	01	100	101	1100	1101	1110	1111

HTTP/2 IN THE REAL WORLD

IT'S HERE ALREADY

demo time

```
nghttp -vnu https://http2.golang.org/reqinfo
https://http2.golang.org/
https://http2.akamai.com/demo
```

IMPLEMENTATIONS

BROWSER

HTTP/2 protocol - OTHER

Global	70.13%	+ 5.95%	=	76.08%
Germany	78.01%	+ 11.24%	=	89.25%

Networking protocol for low-latency transport of content over the web. Originally started out from the SPDY protocol, now standardized as HTTP version 2.

Current aligned | Usage relative | Show all

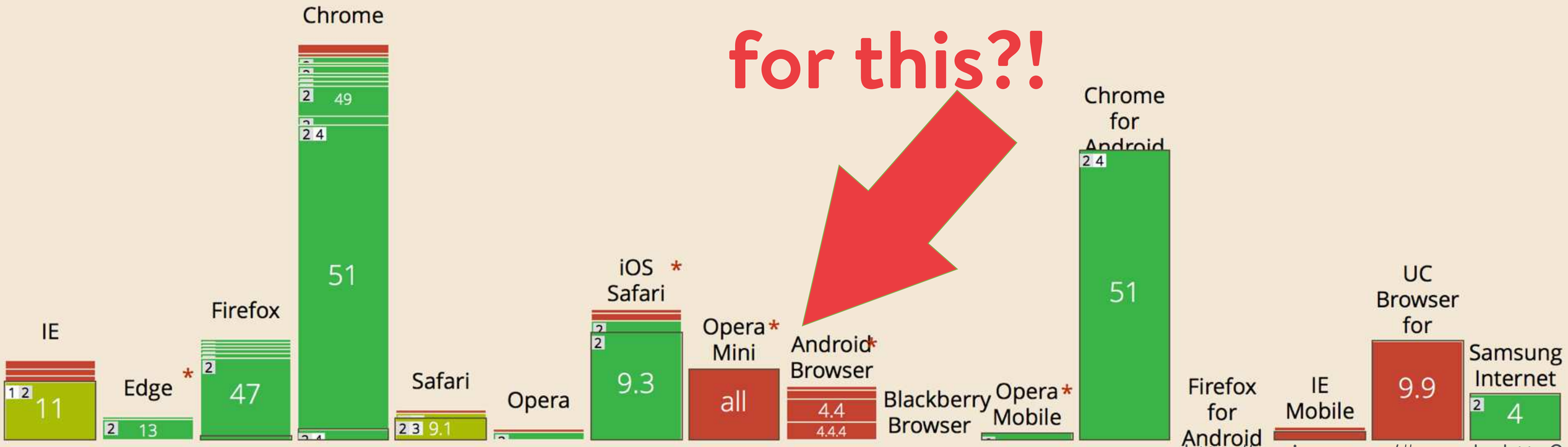
IE	Edge *	Firefox	Chrome	Safari	Opera	iOS Safari *	Opera Mini *	Android Browser *	Chrome for Android
			29						
			[2] 49					4.3	
			[2] 50					4.4	
8	[2] 13	[2] 47	[2 4] 51			[2] 9.2		4.4.4	
[1 2] 11	[2] 14	[2] 48	[2 4] 52	[2 3] 9.1	[2] 39	[2] 9.3	all	[2] 51	[2 4] 51
		[2] 49	[2 4] 53	[2 3] 10	[2] 40				
		[2] 50	[2 4] 54	[2 3] TP	[2] 41				
		[2] 51	[2 4] 55						

HTTP/2 protocol - OTHER

Networking protocol for low-latency transport of content over the web. Originally started out from the SPDY protocol, now standardized as HTTP version 2.

Global	70.13%	+ 5.95%	=	76.08%
Germany	78.01%	+ 11.24%	=	89.25%

Current aligned | Usage relative | Showing all

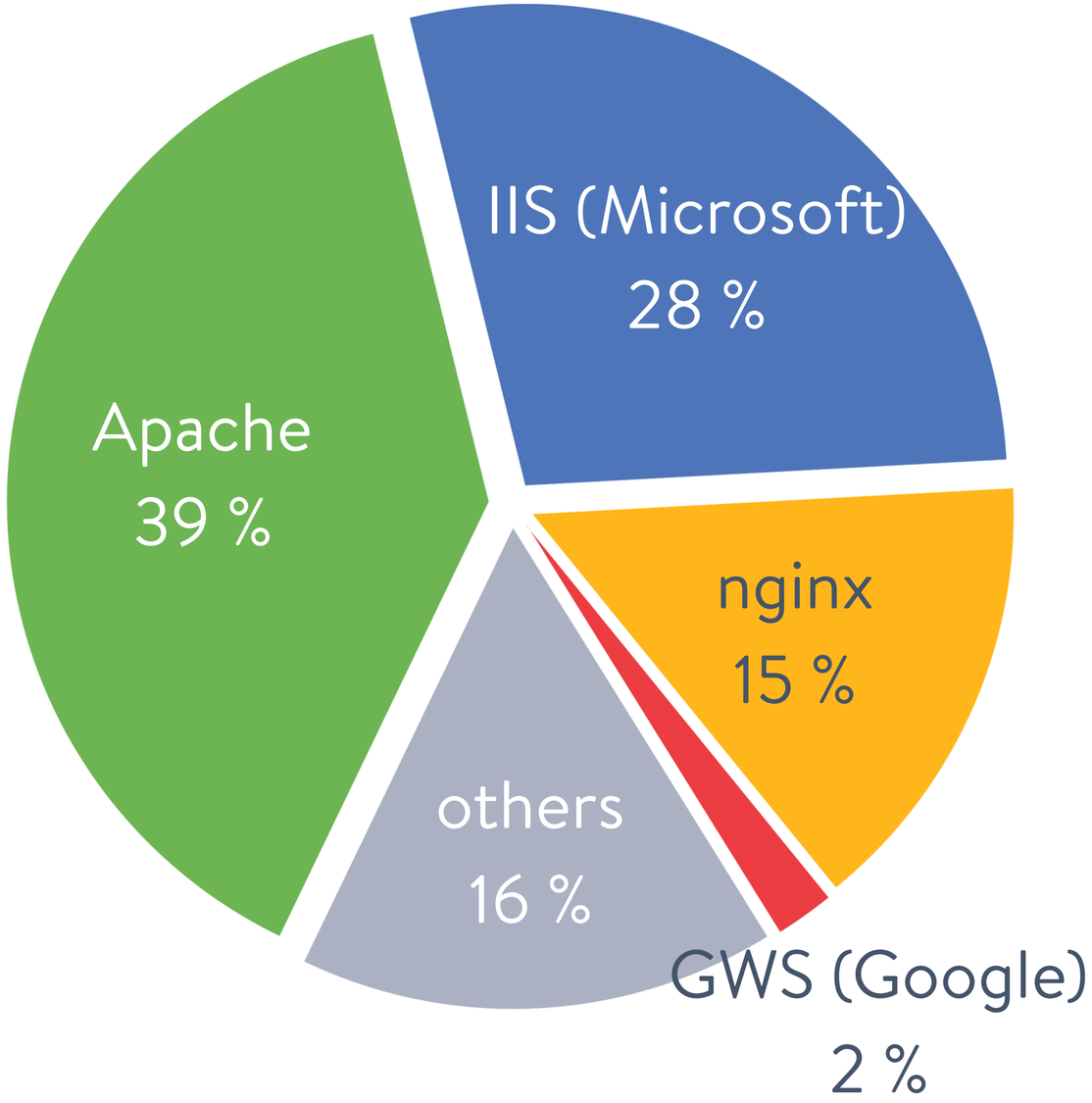


Why are you optimising for this?!

http://caniuse.com/#search=http2

SERVER

MARKET SHARE & HTTP/2 SUPPORT



GWS

unknown — Chrome

dropped SPDY in Feb 2015

Apache

since 2.4.12 — Jul 2015

nginx

since 1.9.5 — 22 Sep 2015

IIS

Win 10 / Server 2016

http://netcraft.com/

It is super easy!

Apache

```
# this needs to be somewhere
LoadModule http2_module modules/mod_http2.so

# this is already optional
<IfModule http2_module>
    LogLevel http2:info
</IfModule>
```

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NGINX

```
server {
    listen 443 ssl http2 default_server;

    ssl_certificate     server.crt;
    ssl_certificate_key server.key;
    ...
}
```

3rd Party

The Future

Cache digests

QUIC*

**TCP/2*

YOU ARE HOLDING IT WRONG

STOP

STOP

CONCATENATING

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STOP

SPRITING

STOP

DOMAIN SHARDING

TRASH

THE ASSET PIPELINE

START USING HTTP/2

OLE MICHAELIS

CodeStars

nesQuick

codestars.eu

THANKYOU
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RESSOURCES

@bagder @igrigorik @tatsuhiro_t @mnot
https://http2.github.io/http2-spec/
http://daniel.haxx.se/http2/
http://daniel.haxx.se/blog/2015/05/07/http2-for-tcpip-geeks/
http://www.slideshare.net/peychevi/http2-and-quick-protocols-optimizing-the-web-stack
https://ma.ttias.be/architecting-websites-http2-era/
https://benramsey.com/talks/2015/05/phptek-http2/
https://speakerdeck.com/summerwind/2-prioritization
http://chimera.labs.oreilly.com/books/1230000000545/ch12.html#HTTP2_HEADER_COMPRESSION
http://tools.ietf.org/html/rfc6585
http://httparchive.org
https://http2.golang.org/
https://github.com/igrigorik/http-2
https://aprescott.com/posts/spdy-colon-headers
https://tools.ietf.org/html/draft-ietf-httpbis-header-compression-12
https://www.youtube.com/watch?v=ZdooBTdW5bM
https://github.com/supertinou/huffman
http://daniel.haxx.se/blog/2015/03/06/tls-in-http2/
http://news.netcraft.com/archives/2015/06/25/june-2015-web-server-survey.html
http://isthewebhttp2yet.com/

Thanks to all the people who helped me with this deck!

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