

# BENCHMARK

## SEARCH & DIGITAL CONFERENCE

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# BENCHMARK

## SEARCH & DIGITAL CONFERENCE

# Roxana Stingu

Alamy

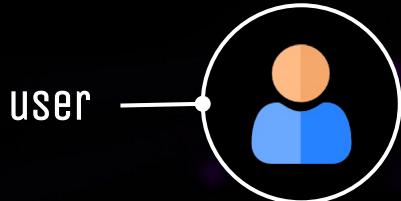
“The **internet** is the first thing that humanity has built that humanity doesn't understand.”

– Eric Schmidt, Some guy working at **GOOGLE**

# HOW I THINK OF THE INTERNET

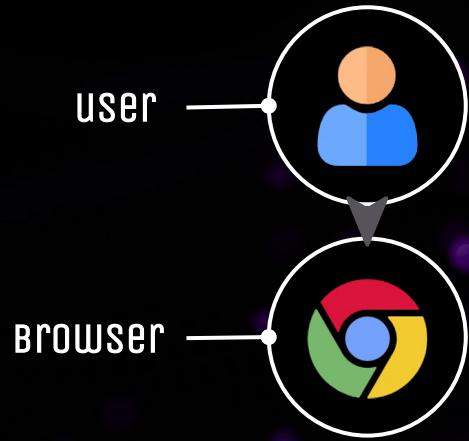


# IT ALL STARTS WITH THE USER

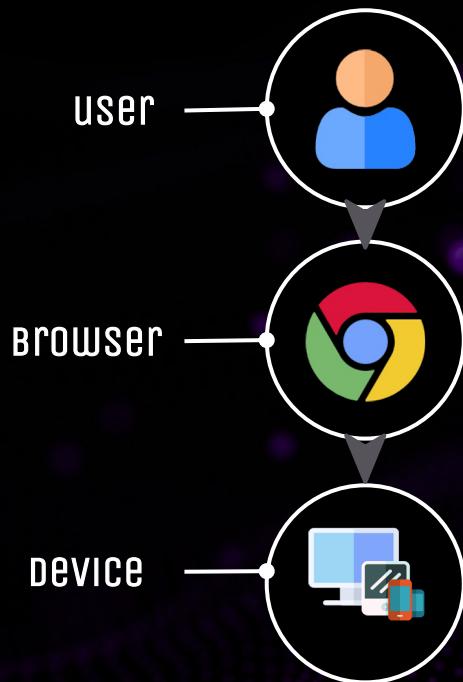


user

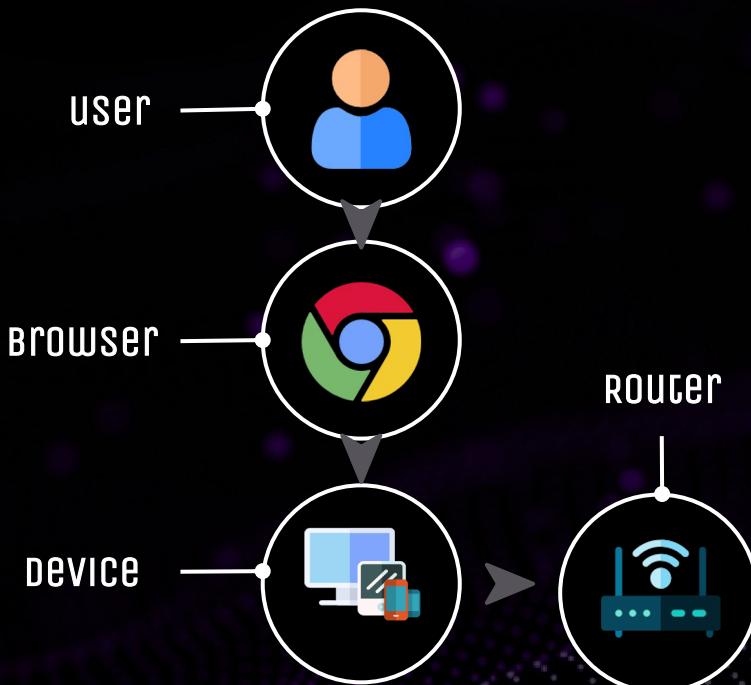
# USER USES A BROWSER



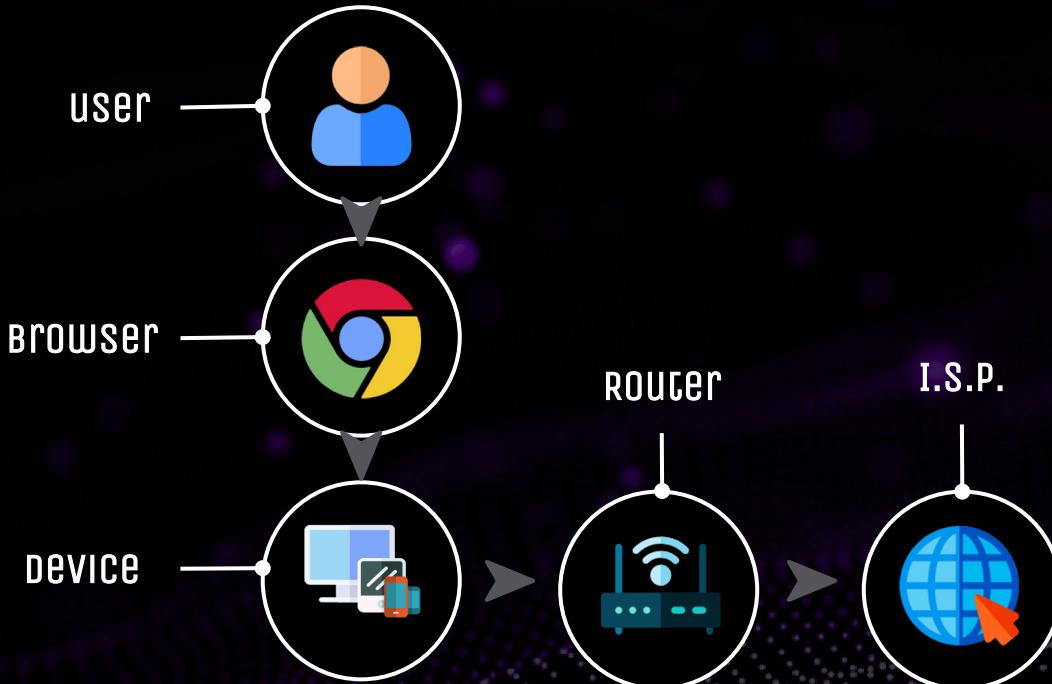
# THE BROWSER IS FOUND ON A DEVICE



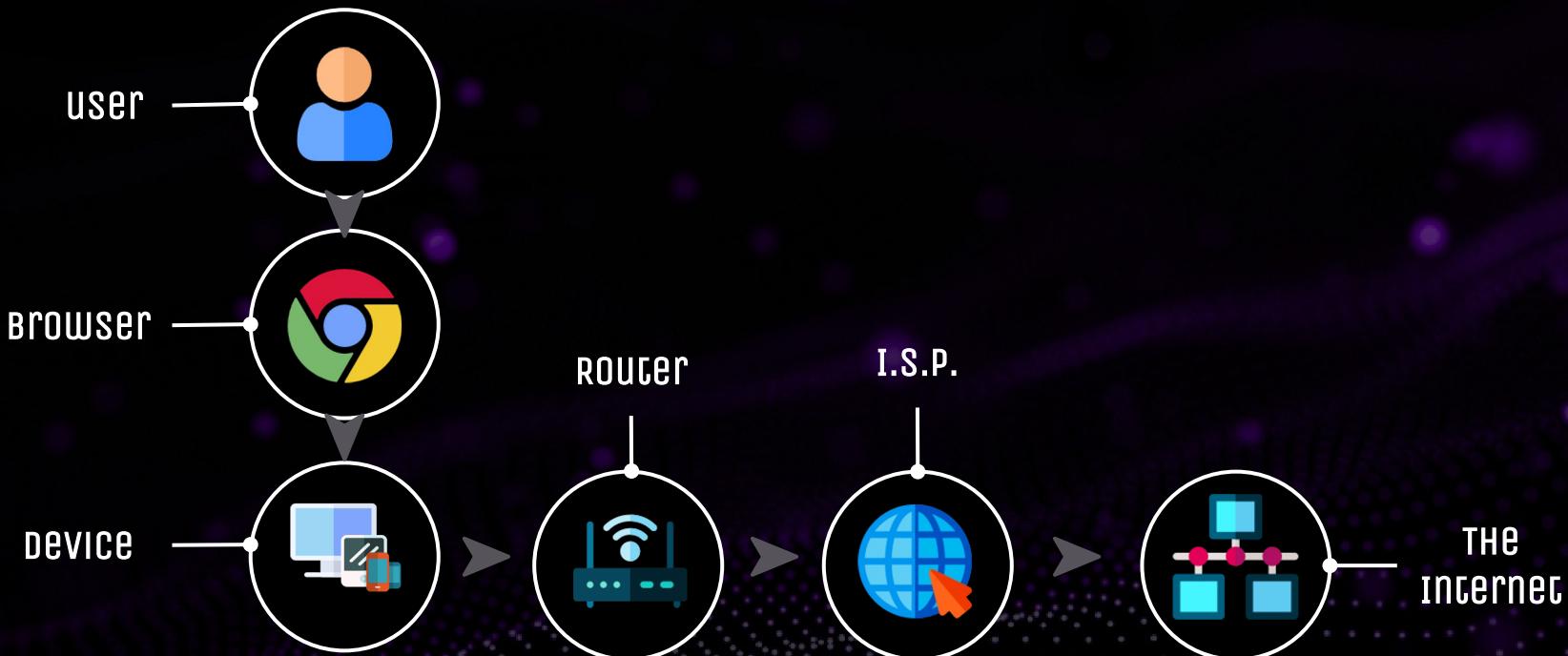
# A DEVICE IS CONNECTED TO A ROUTER



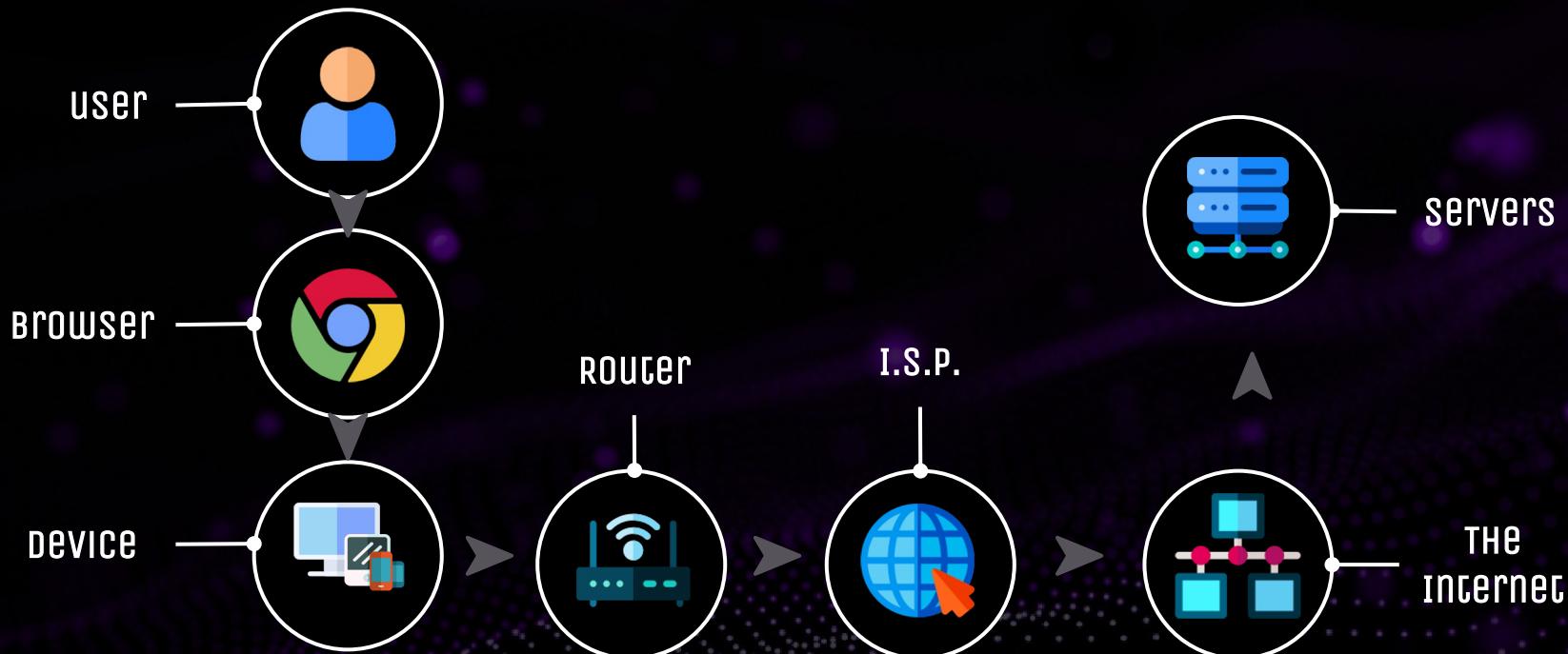
# ROUTER COMMUNICATES WITH ISP



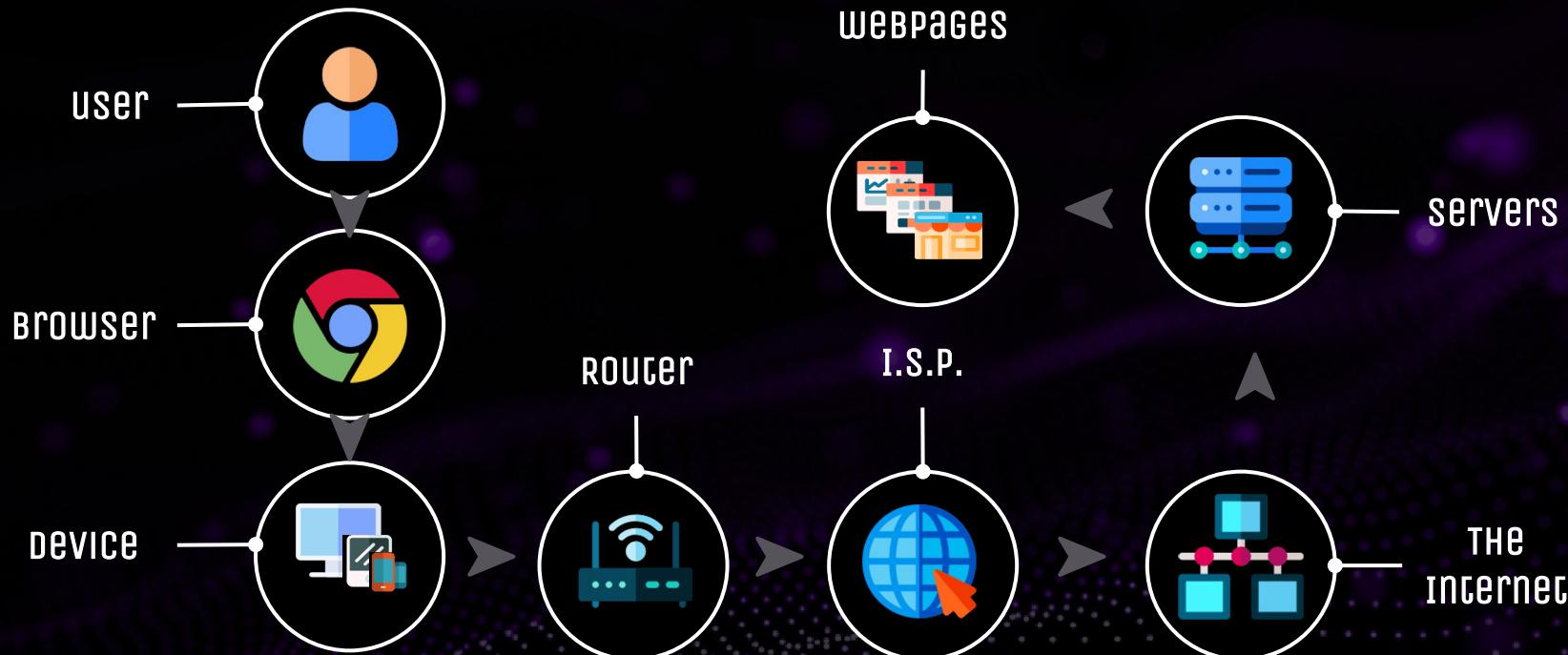
# ISP ENABLES ACCESS TO THE INTERNET



# INTERNET CONNECTS TO WEB SERVERS

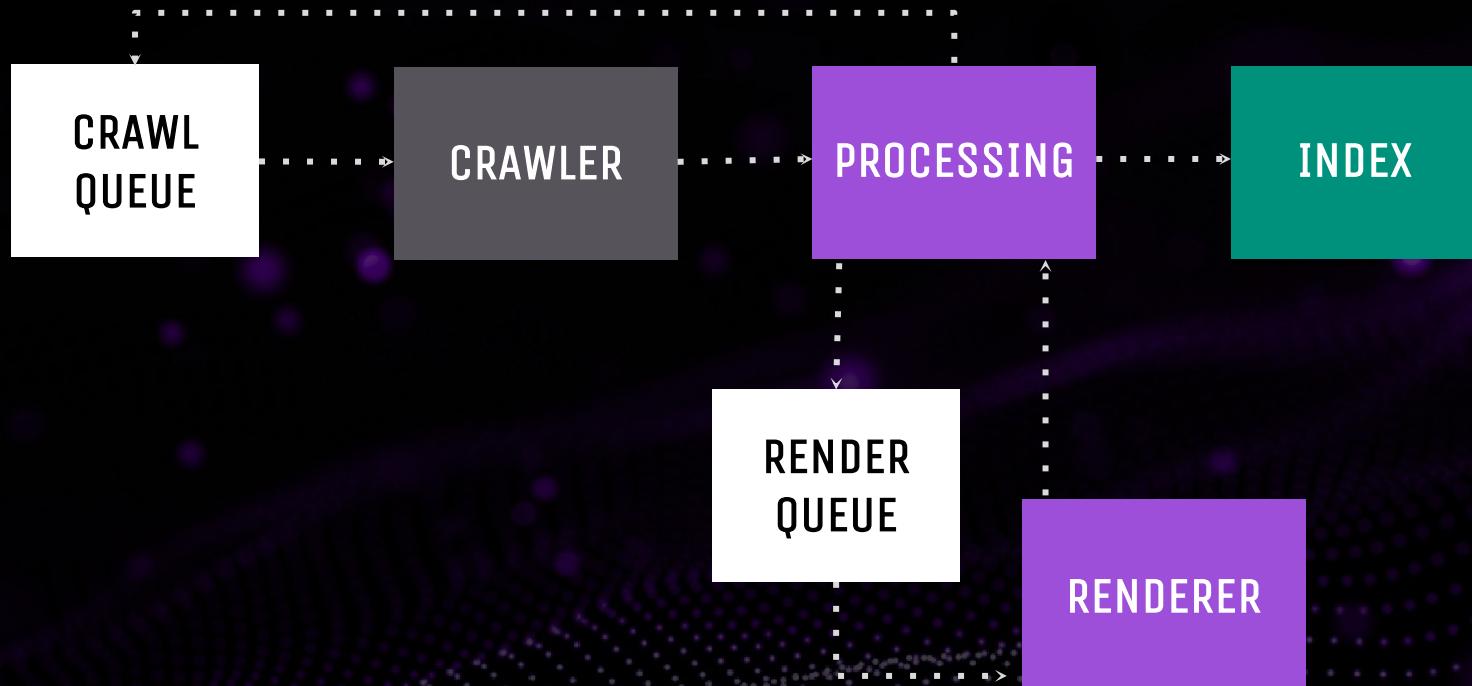


# WEBSERVER HOSTS WEBPAGES

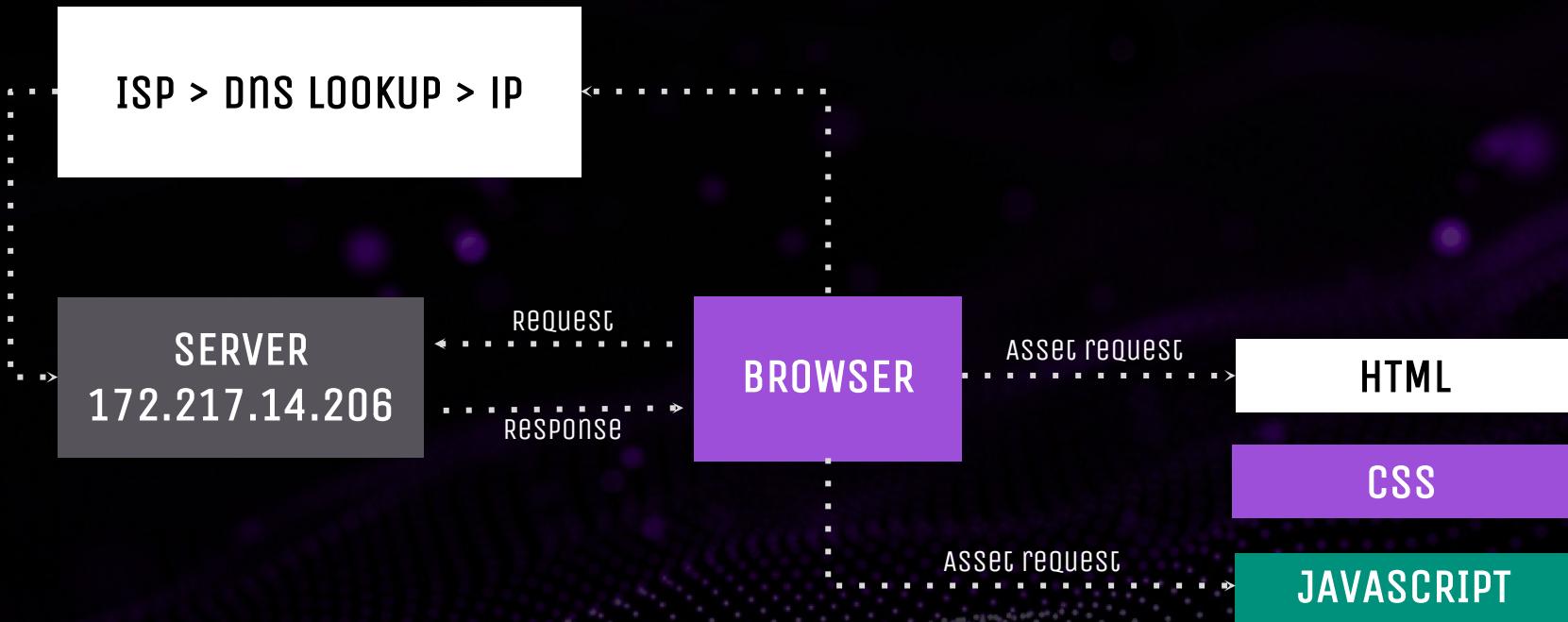


# WHY AM I DOING THIS TALK?

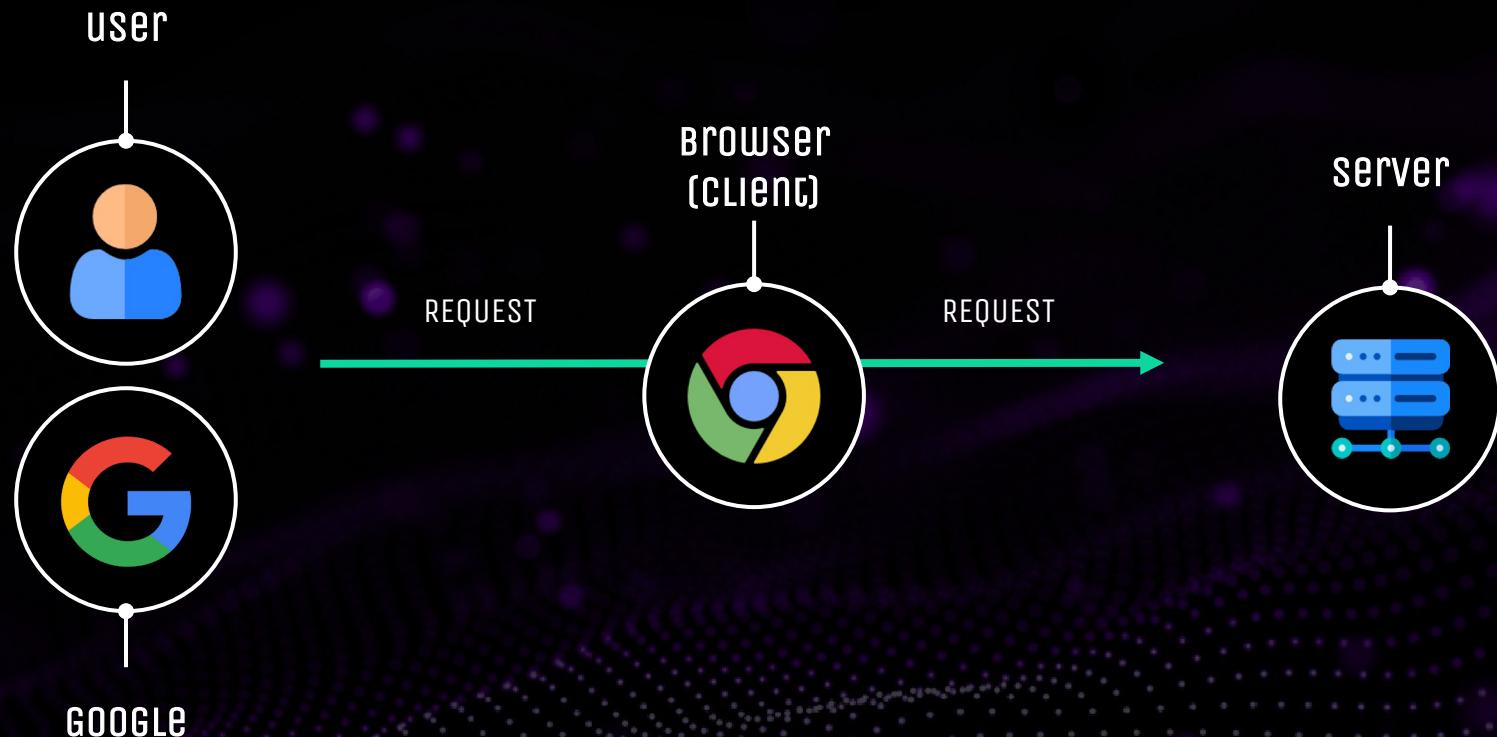
# THE SEO PERSPECTIVE



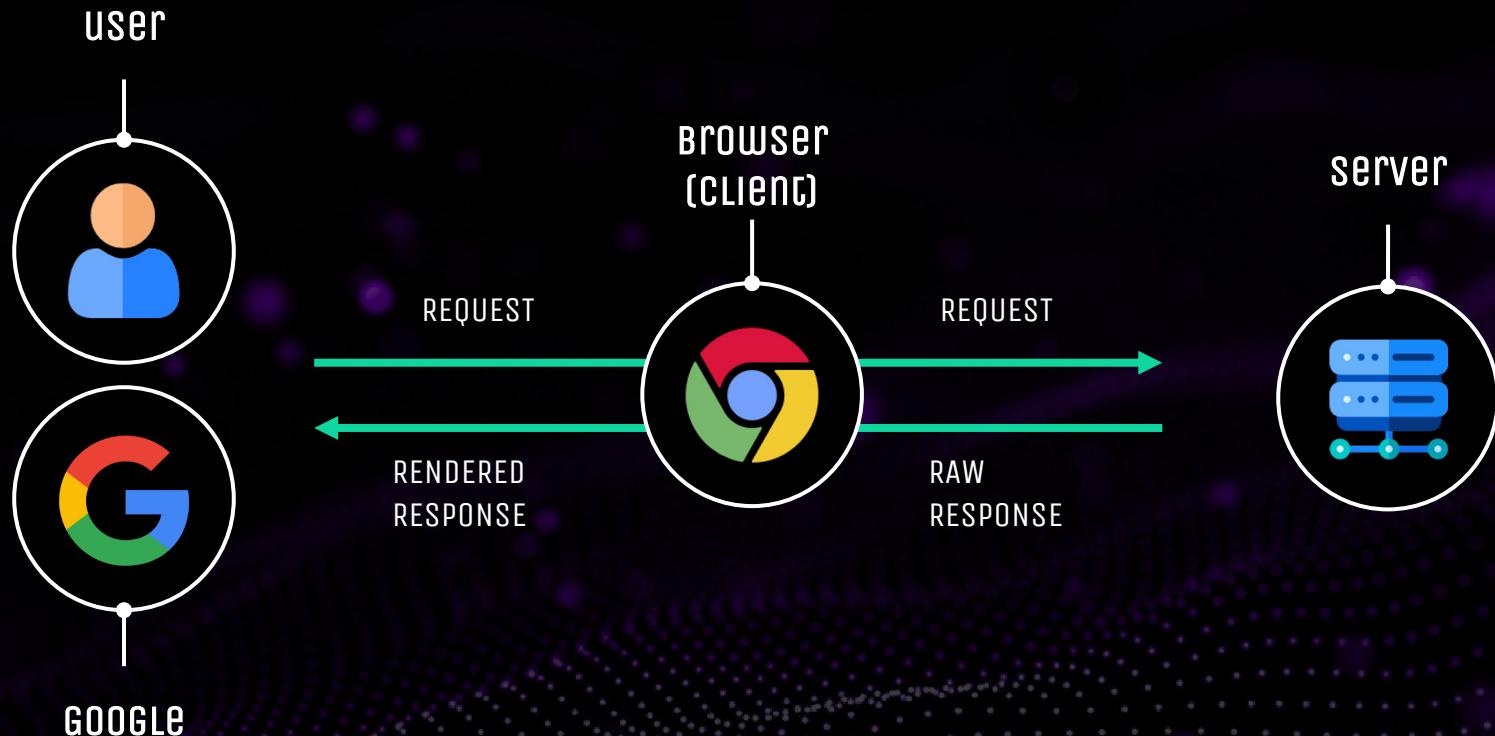
# THE DEV PERSPECTIVE



# SAME THING UNDER THE HOOD



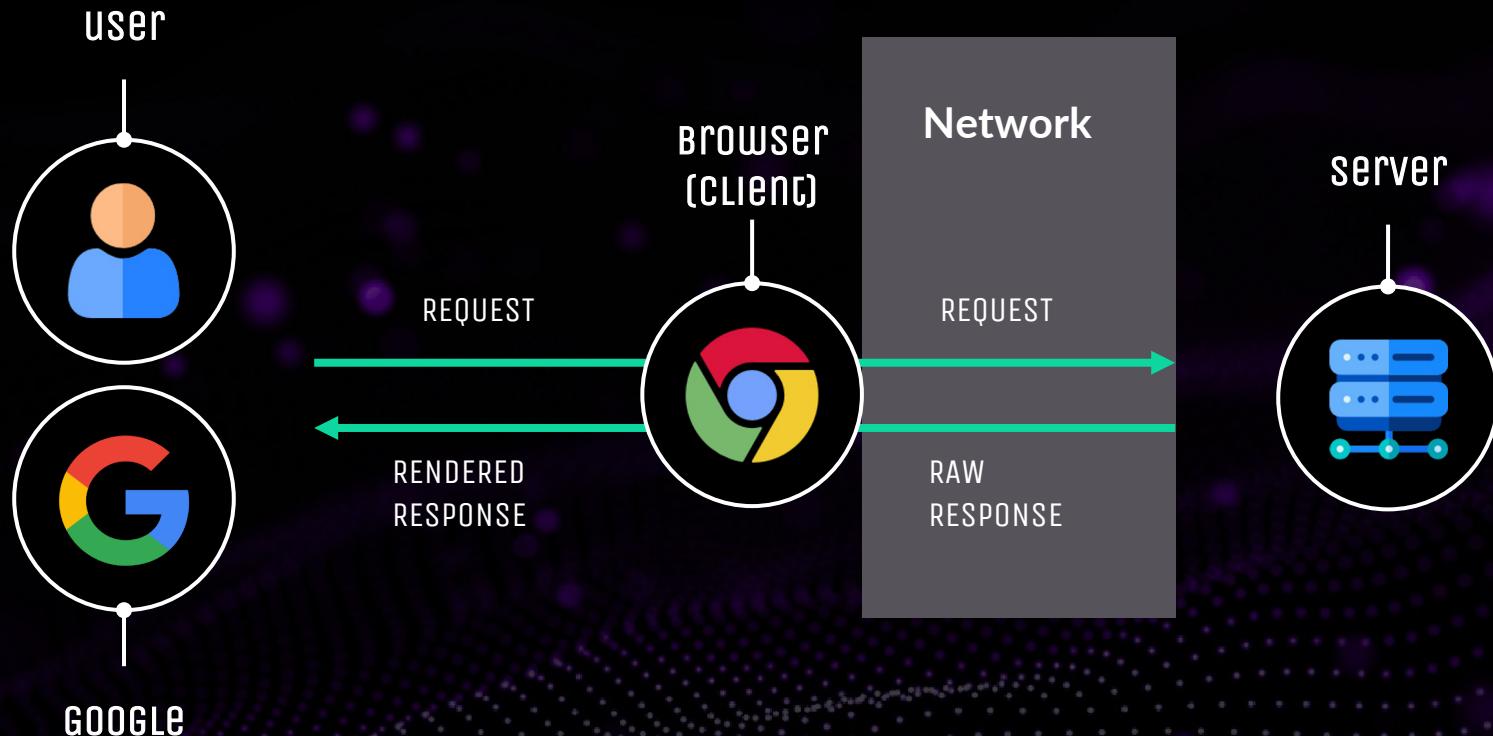
# SAME THING UNDER THE HOOD



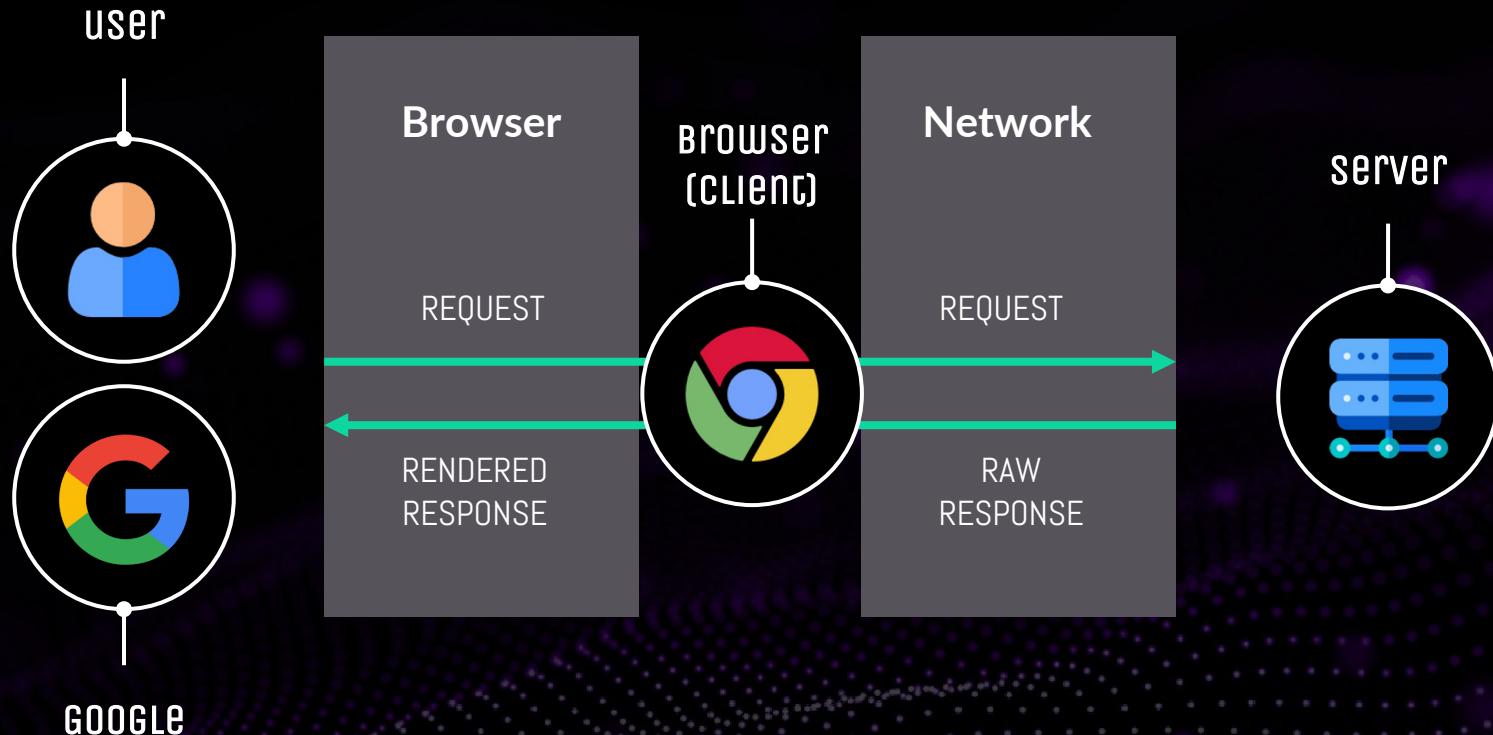
GOOGLE

BENCHM<sup>A</sup>RK

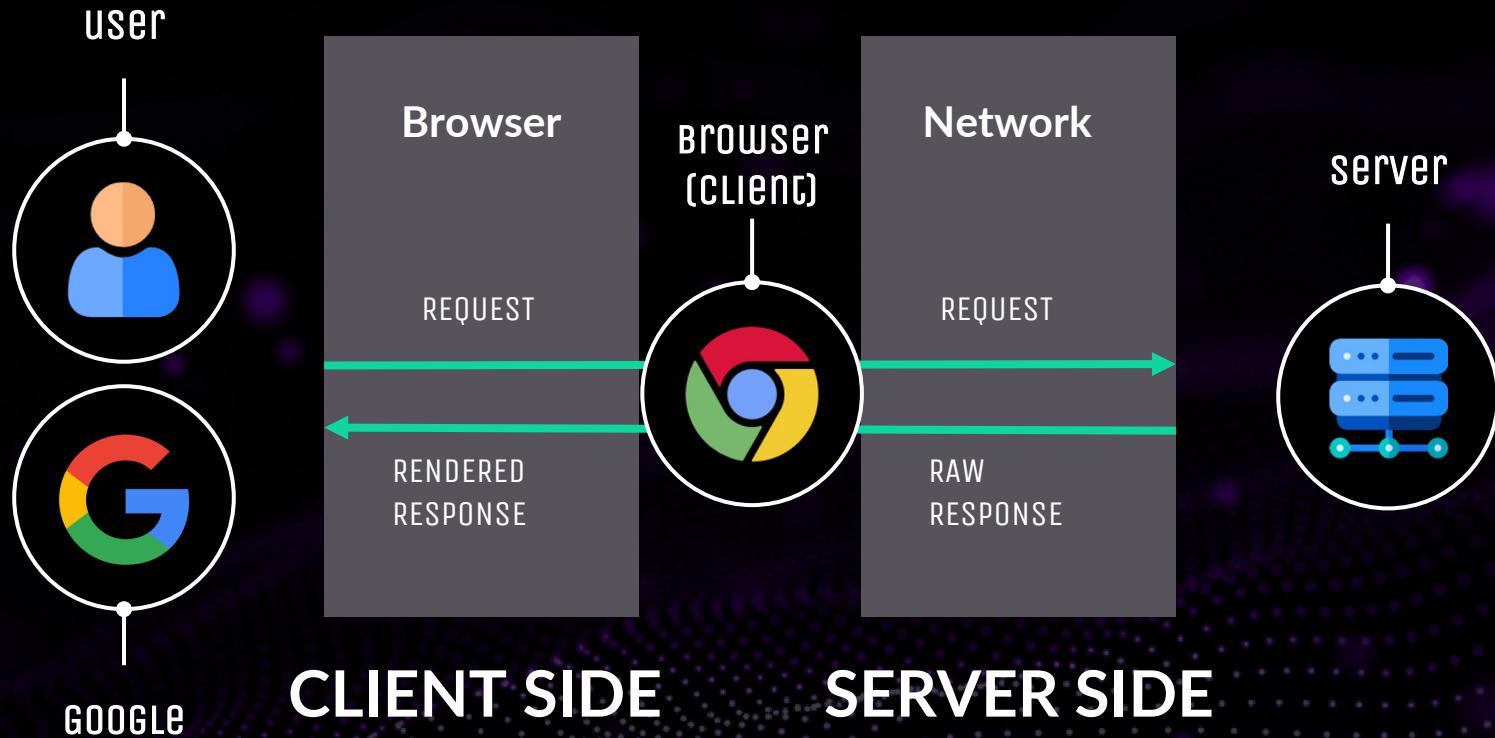
# NETWORK ACTIVITY



# BROWSER ACTIVITY

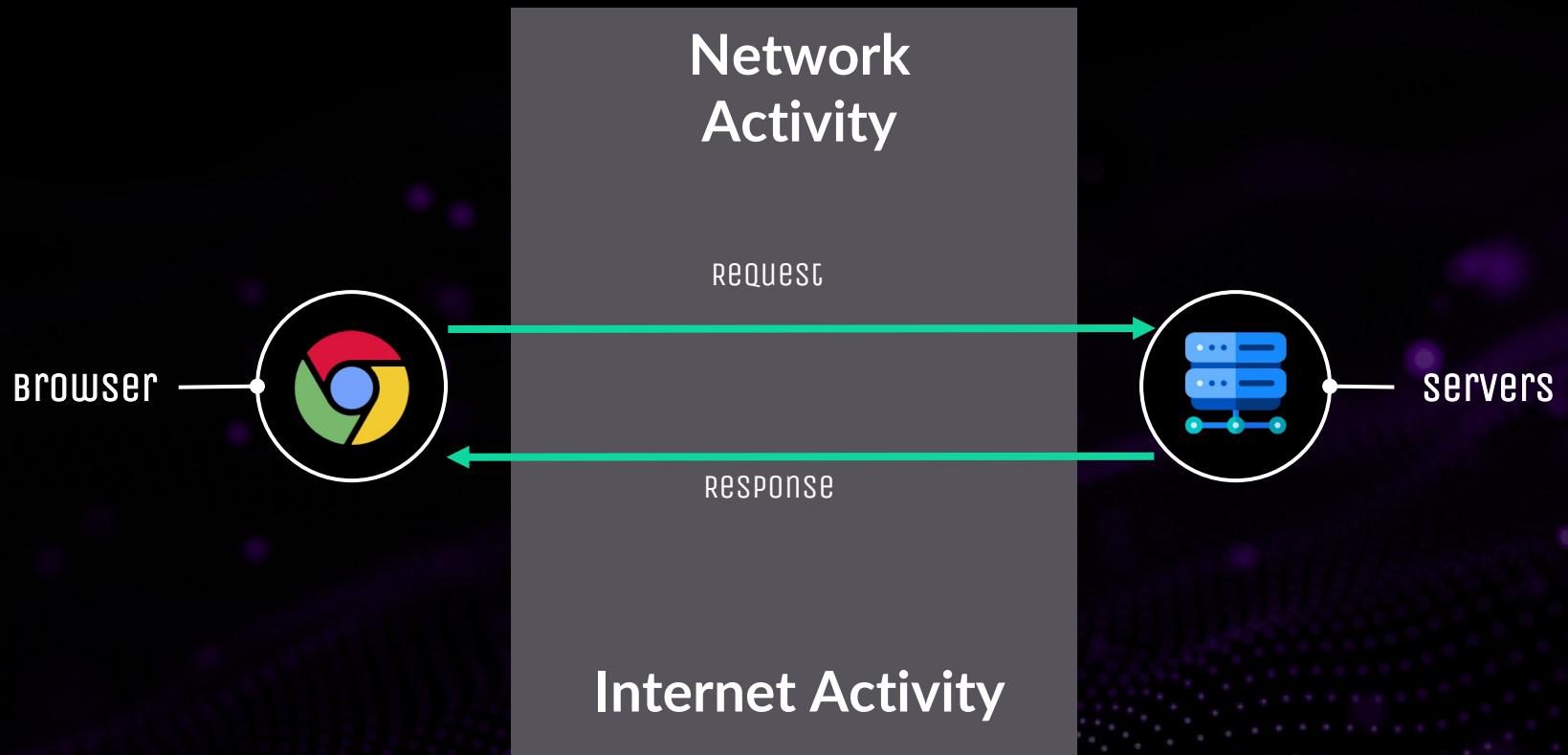


# CLIENT-SIDE v. SERVER-SIDE

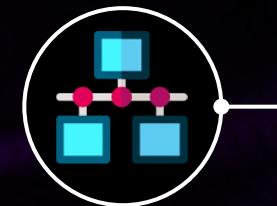
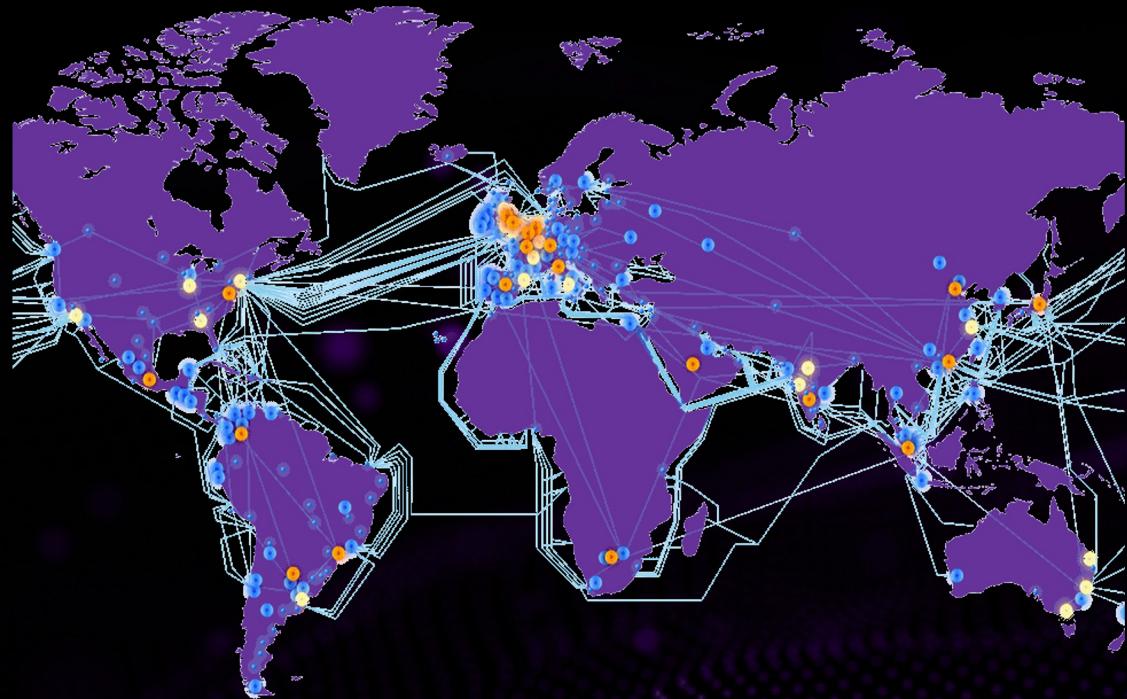


# THE NETWORK

# BENCHMARK

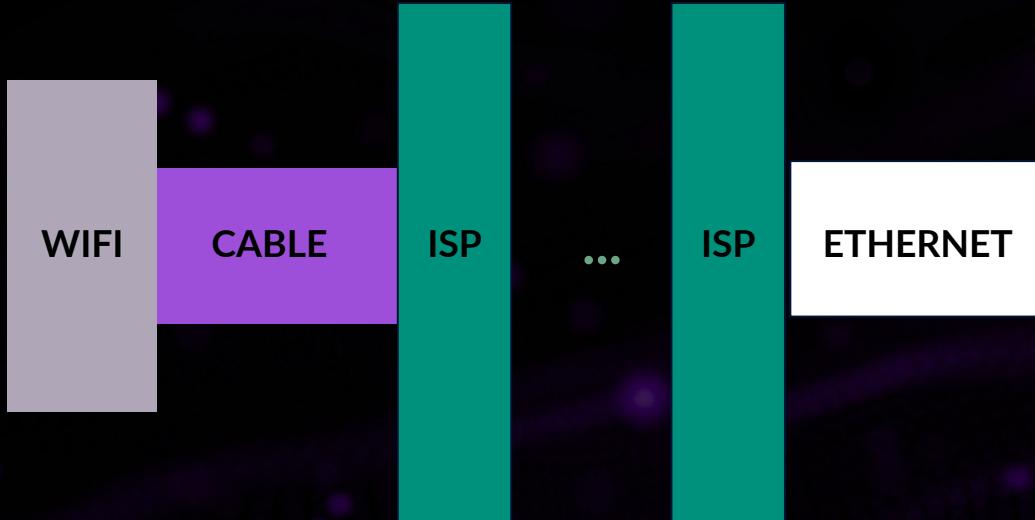


# INTERNET HARDWARE



THE  
Internet

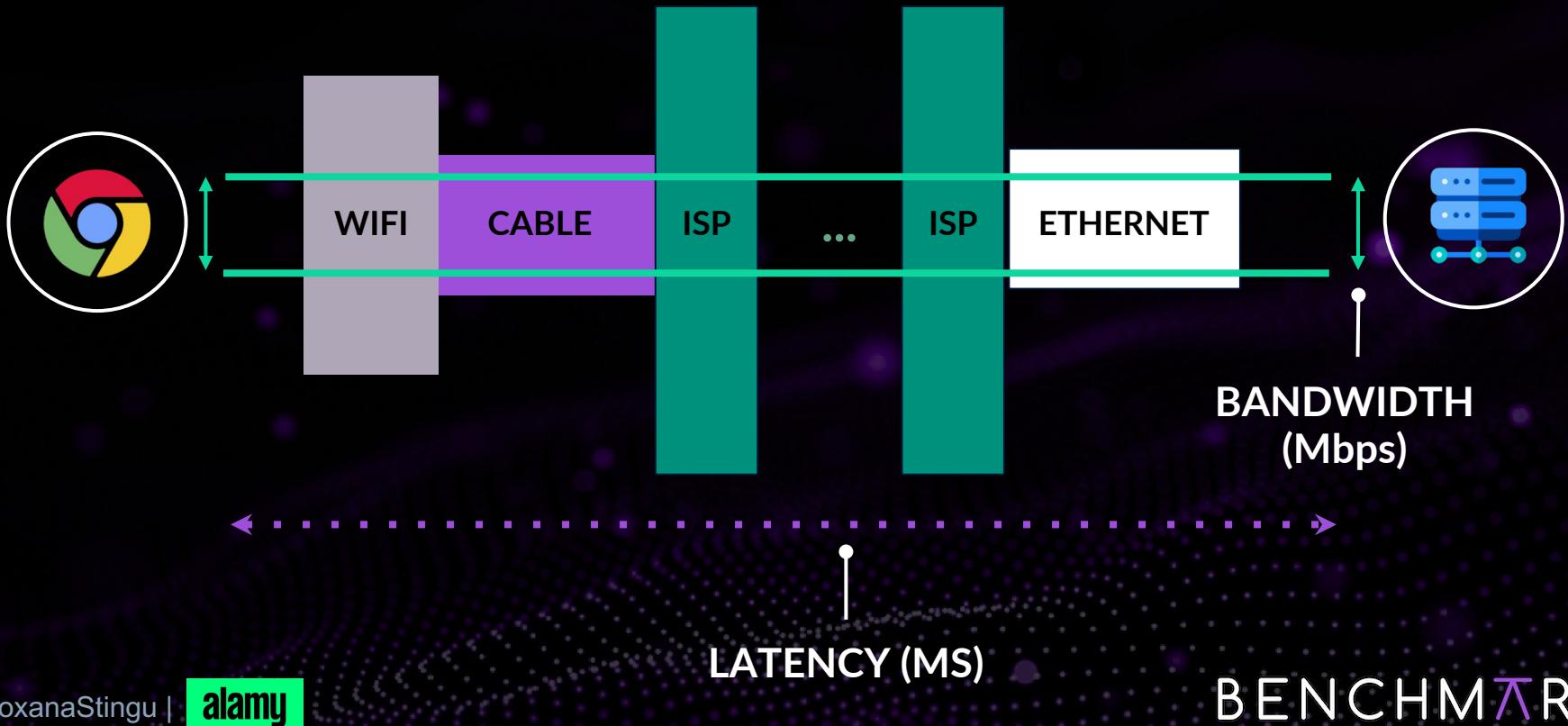
# BANDWIDTH AND LATENCY



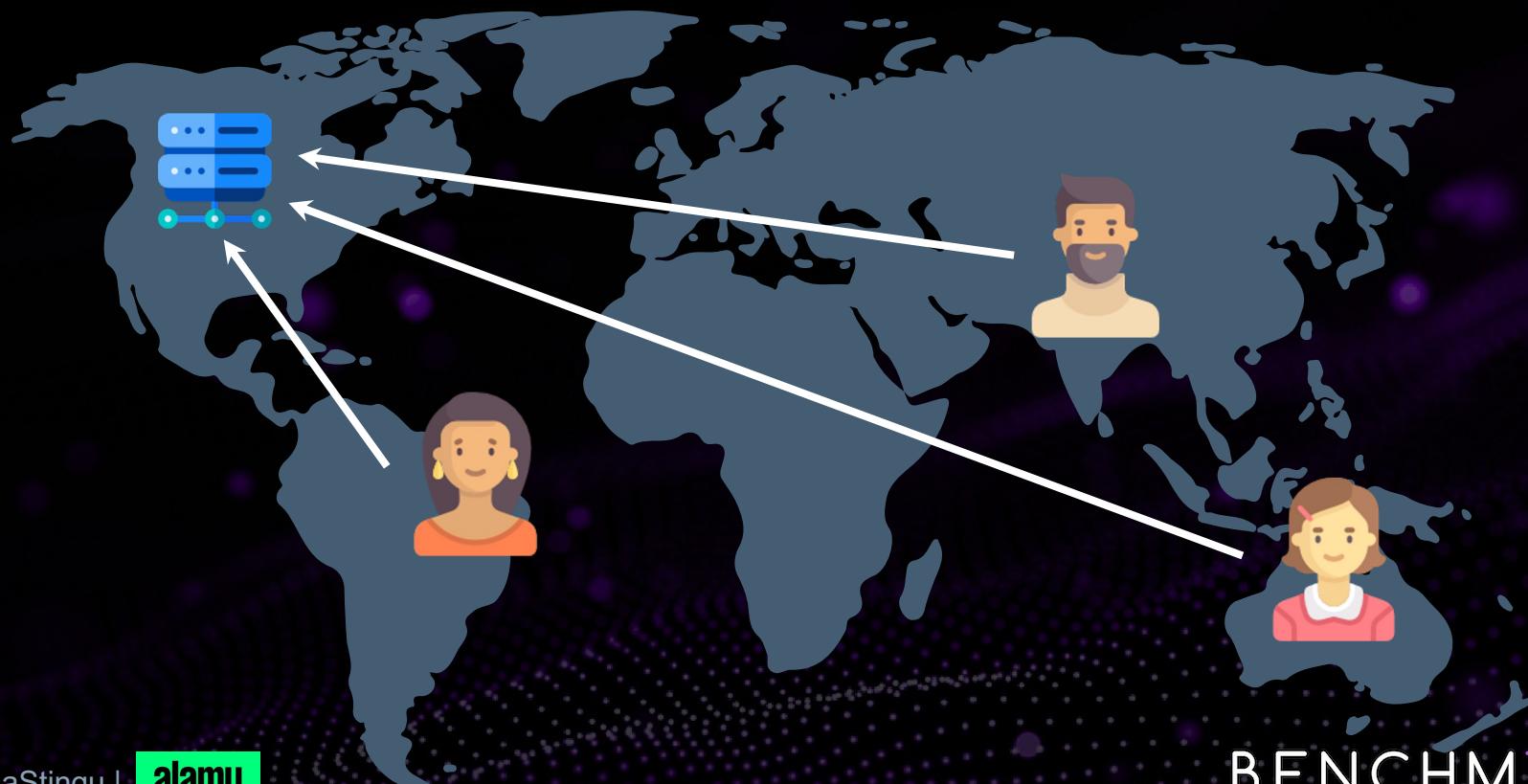
# BANDWIDTH AND LATENCY



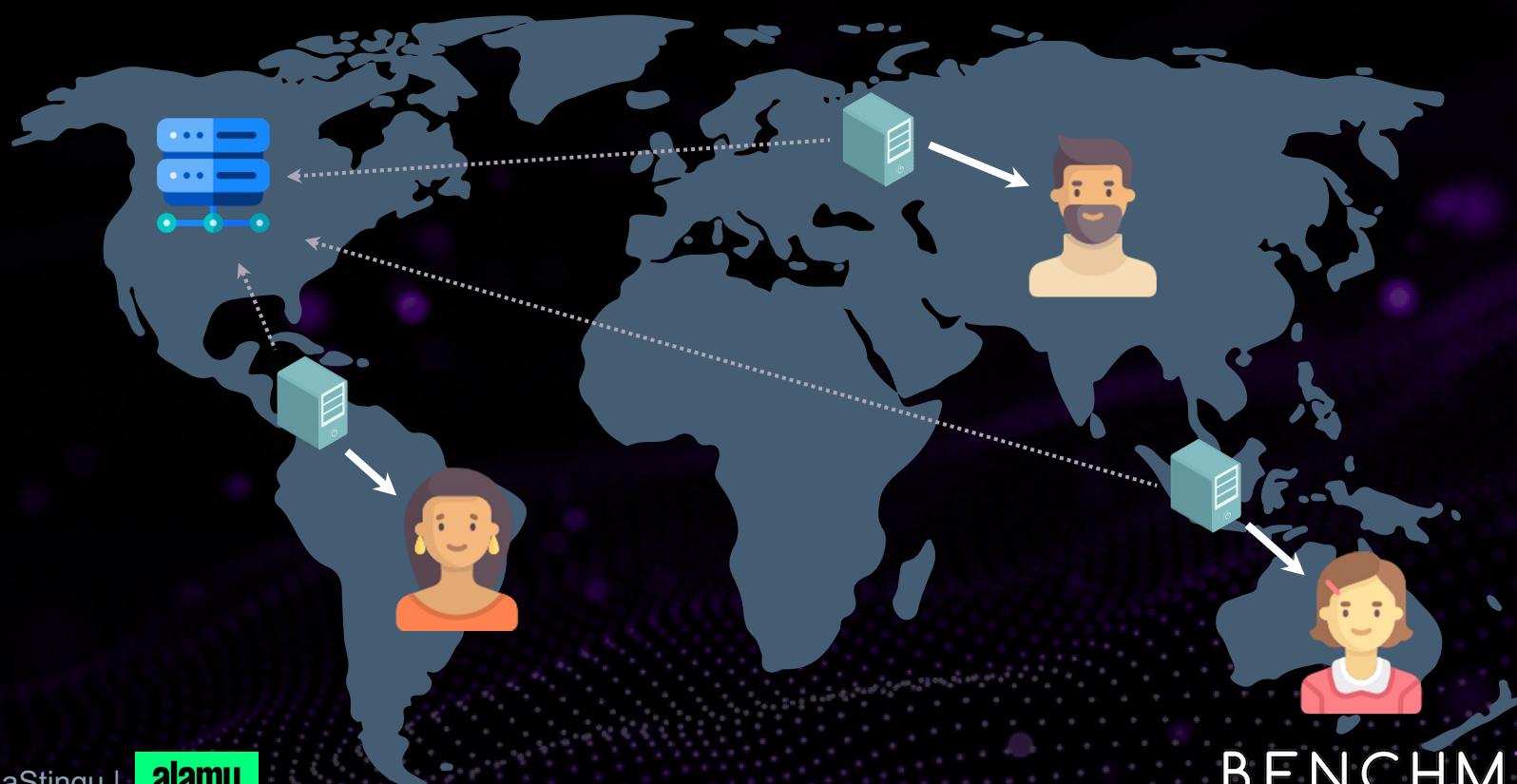
# BANDWIDTH AND LATENCY



# HOW LATENCY HAPPENS

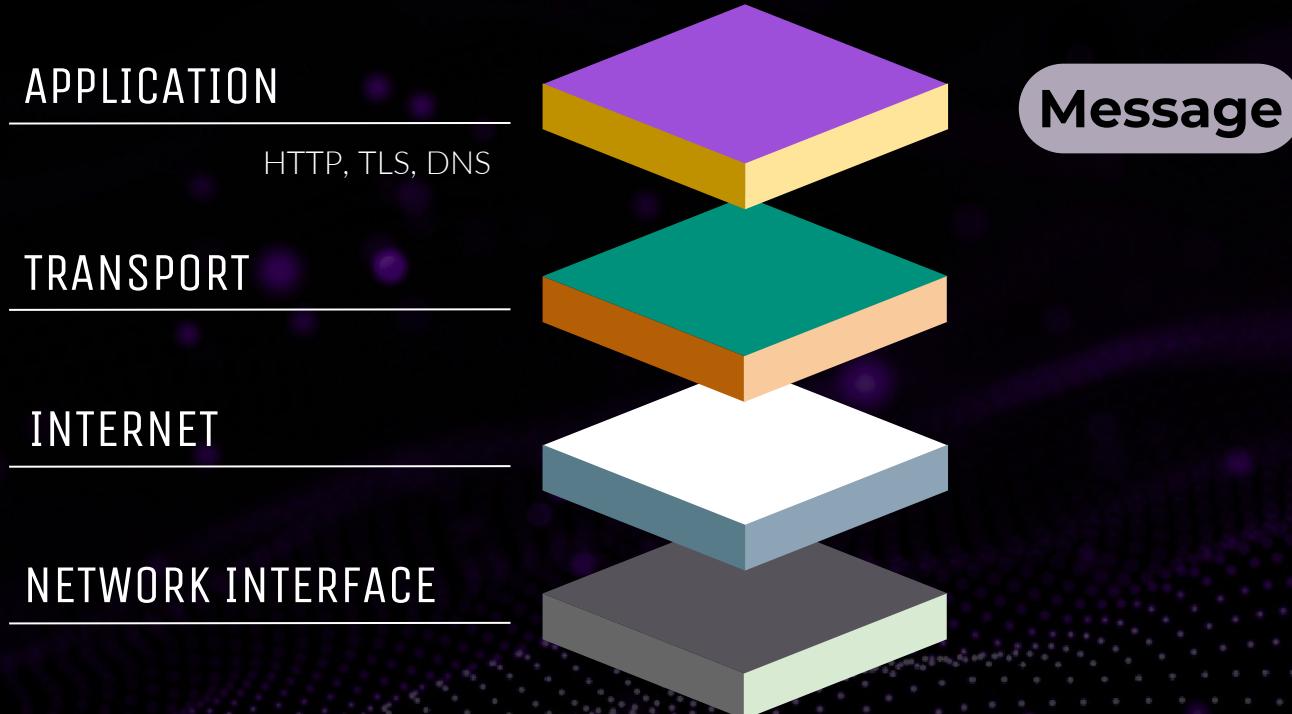


# LATENCY CAN BE REDUCED WITH A CDN

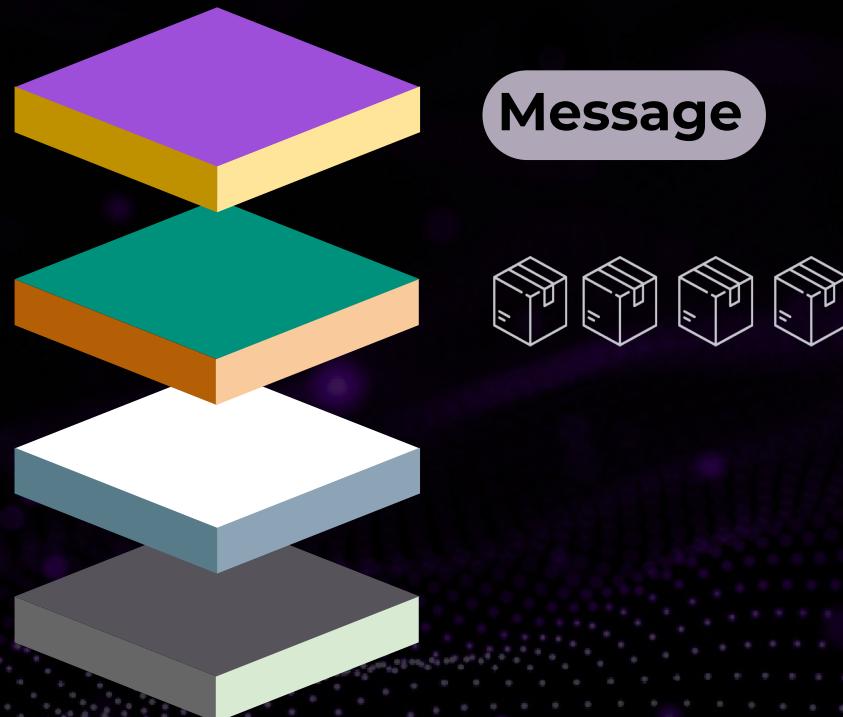
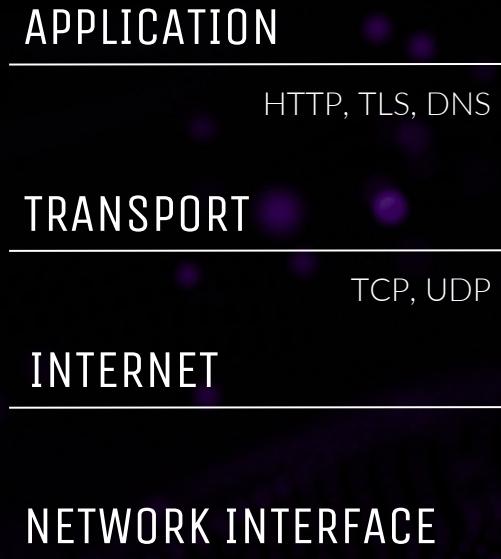


# INTERNET SOFTWARE

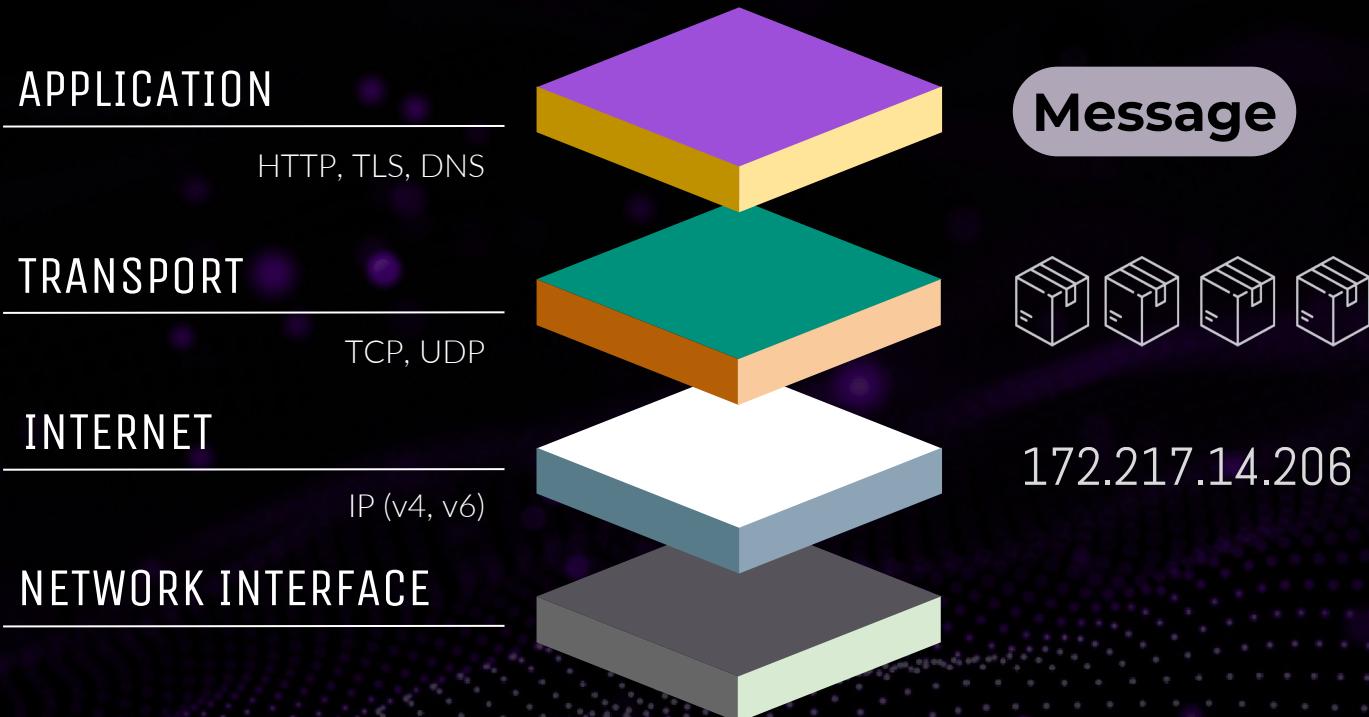
# THE TCP/IP MODEL



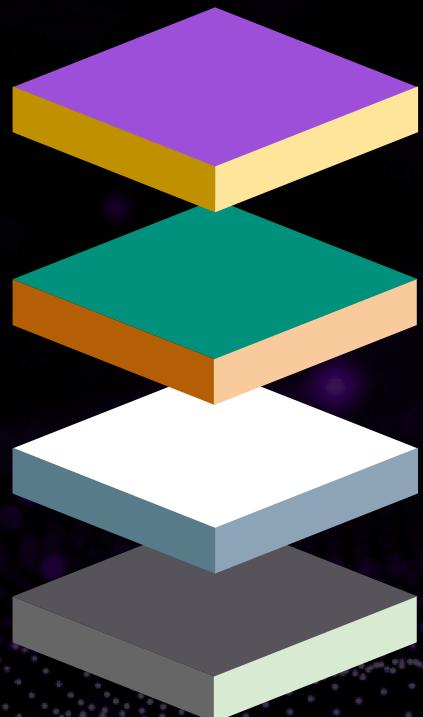
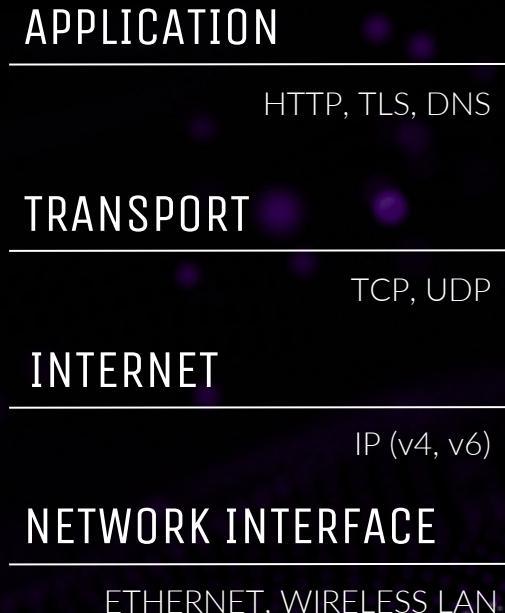
# THE TCP/IP MODEL



# THE TCP/IP MODEL



# THE TCP/IP MODEL



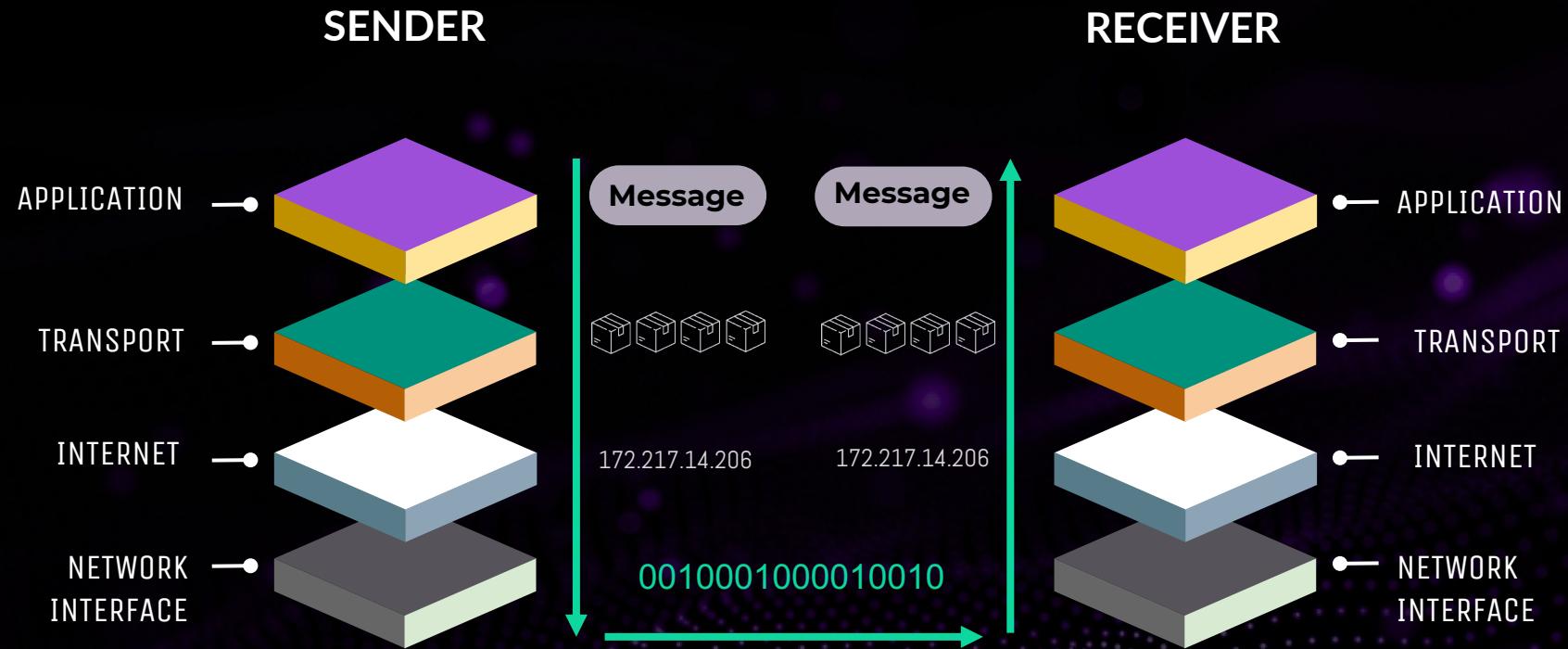
**Message**



172.217.14.206

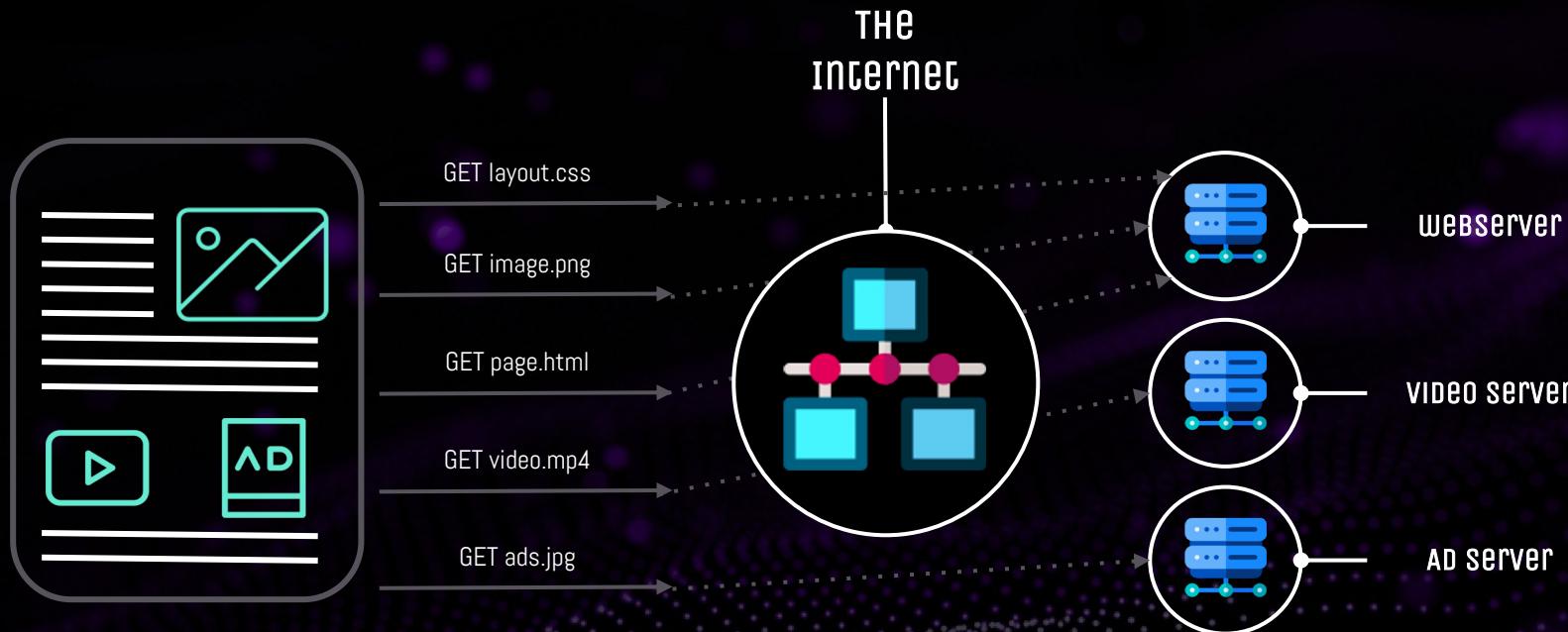


# THE TCP/IP MODEL



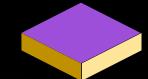
# THE HTTP PROTOCOL

APPLICATION

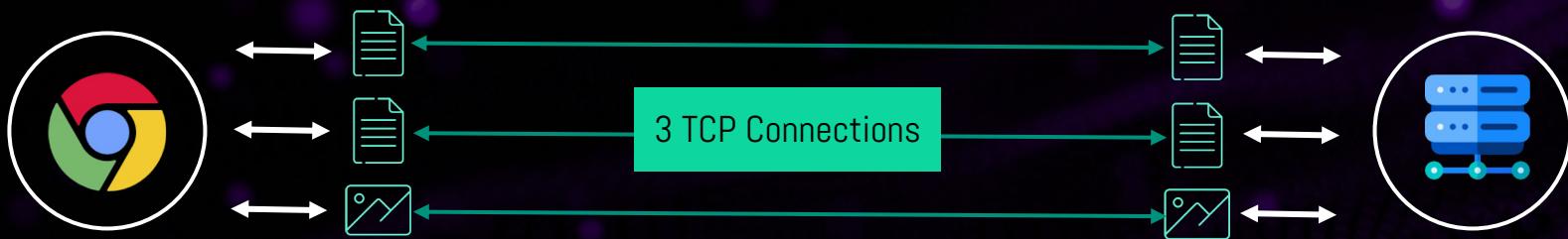


# HTTP PROTOCOL VERSION 1

APPLICATION

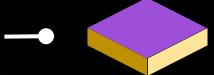


HTTP 1.1

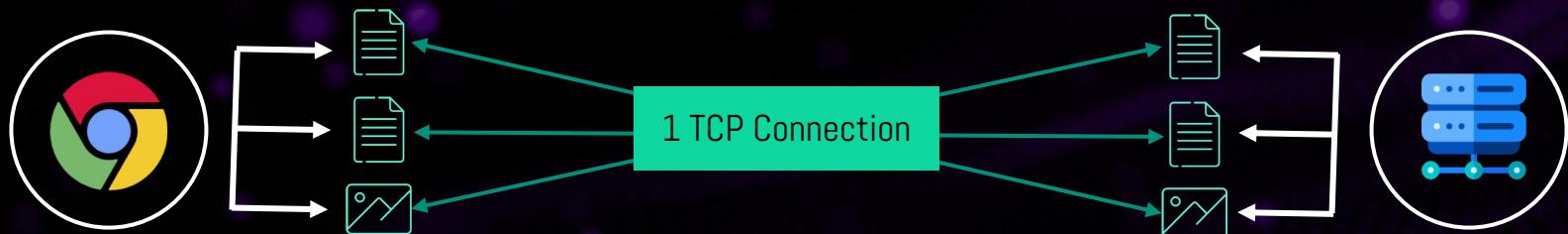


# HTTP PROTOCOL VERSION 2

APPLICATION



HTTP/2



# IP (v4, v6)



## IPv4

Example:

**192.168.2.33**

No. of octets:

4

No. of addresses:

~4,294,967,296

## IPv6

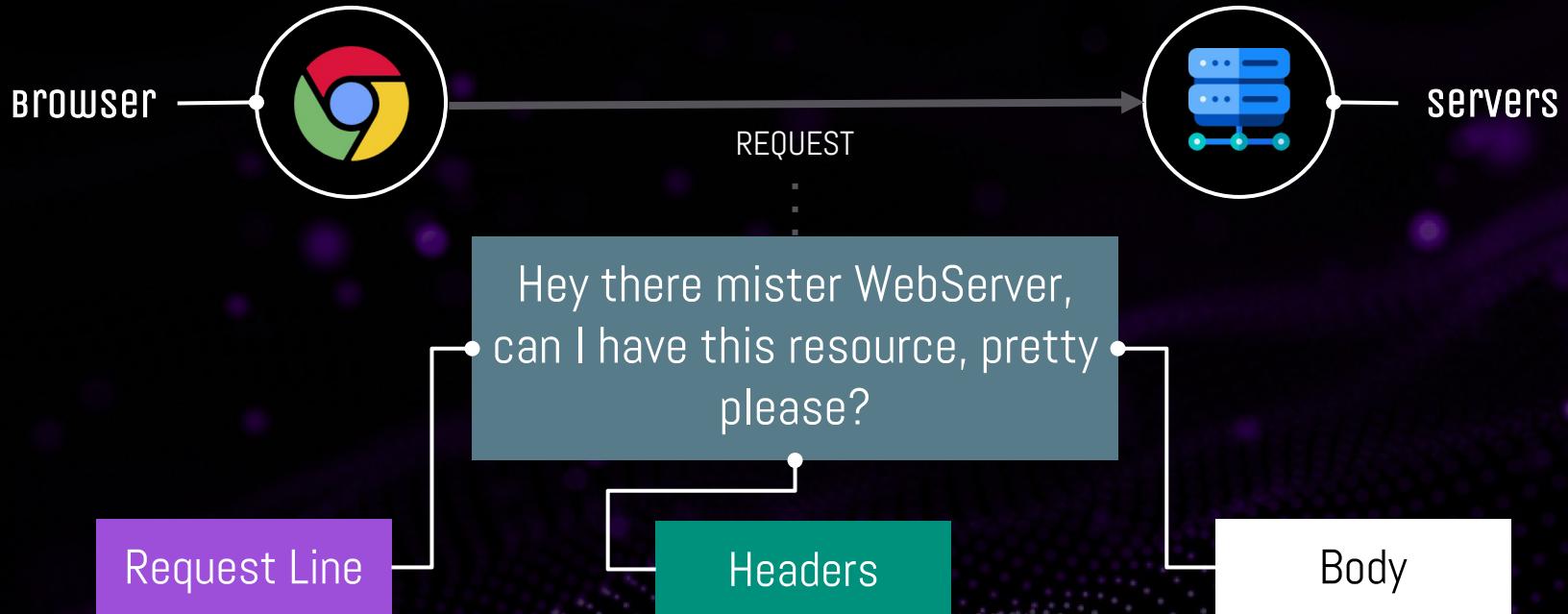
Example: **FDEC:BA98:7654:3210:ADFC:BDFF:2990:FFFF**

No. of octets: 16

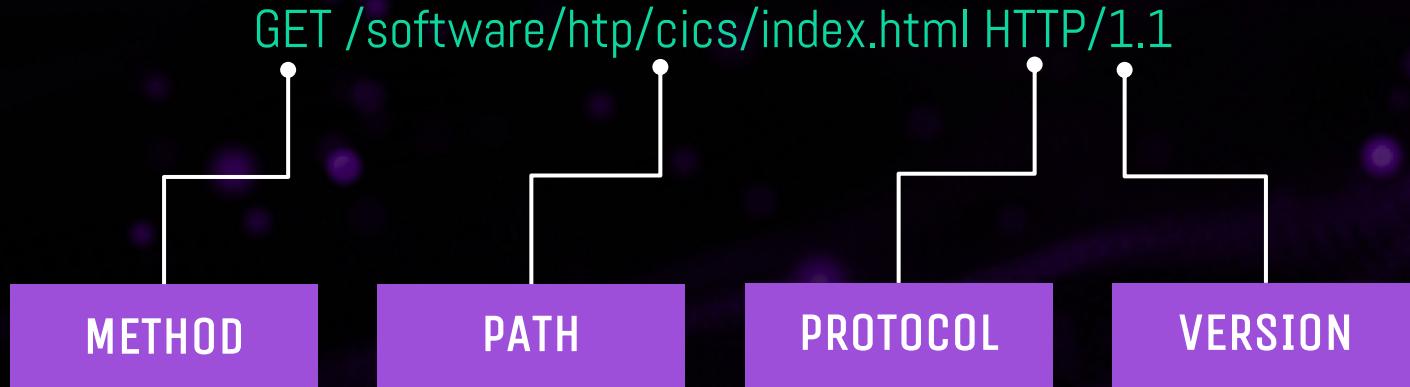
No. of addresses: ~340,282,366,920,938,463,463,374,607,431,768,211,456

# CLIENT TO SERVER COMMUNICATION

# WHAT IS A REQUEST?



# THE REQUEST LINE



# DIFFERENT TYPES OF METHODS

GET

POST

PUT

DELETE

TRACE

OPTIONS

CONNECT

PATCH

# THE HEADERS

# HOW TO QUICKLY CHECK HEADERS

The screenshot shows the Google homepage on the left and the Network tab of the browser developer tools on the right. A large blue box labeled "ANY RESOURCE" is overlaid on the developer tools interface.

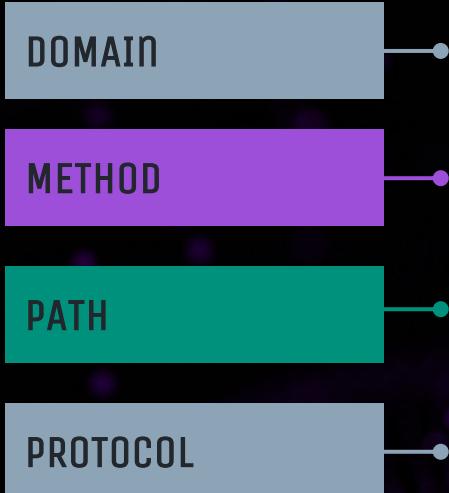
**Google Page Content:**

- About Store
- Gmail Images
- User profile icon
- Google logo
- Search bar
- Google Search I'm Feeling Lucky buttons
- United Kingdom
- Carbon neutral since 2007
- Advertising Business How Search works

**Developer Tools Network Tab:**

- Filter:** All, Fetch/XHR, JS, CSS, Img, Media, Font, Doc, WS, Wasm, Manifest, Other, 3rd-party requests.
- Headers Section:** General, Response Headers.
- General:**
  - Request URL: https://www.google.com/
  - Request Method: GET
  - Status Code: 200
  - Remote Address: 142.250.179.228:443
  - Referrer Policy: strict-origin-when-cross-origin
- Response Headers:**
  - accept-ch: Sec-CH-UA-Platform-Version
  - accept-ch: Sec-CH-UA-Full-Version
  - accept-ch: Sec-CH-UA-Arch
  - accept-ch: Sec-CH-UA-Model
  - accept-ch: Sec-CH-UA-Bitness

# THE REQUEST HEADERS



Screenshot of the Network tab in the Chrome DevTools, showing the request headers for the URL `https://en.wikipedia.org/wiki/Main_Page`.

**General** (Request Headers):

- Request URL: `https://en.wikipedia.org/wiki/Main_Page`
- Request Method: GET
- Status Code: 200
- Remote Address: 91.198.174.192:443
- Referrer Policy: origin

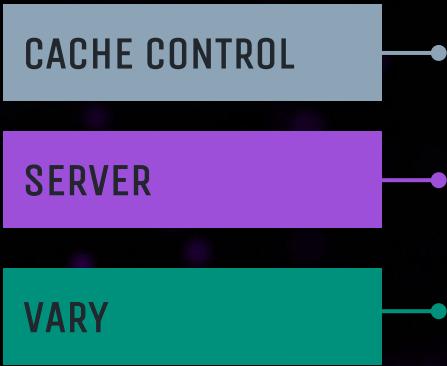
**Response Headers** (21):

- `:authority: en.wikipedia.org`
- `:method: GET`
- `:path: /wiki/Main_Page`
- `:scheme: https`

**Request Headers**:

```
accept: text/html,application/xhtml+xml,application/xml;q=0.9,image/avif,image/webp,image/apng,*/*;q=0.8,application/signed-exchange;v=b3;q=0.9
accept-encoding: gzip, deflate, br
accept-language: en-US,en;q=0.9,ro;q=0.8,fr;q=0.7,de;q=0.6
cache-control: max-age=0
cookie: GeoIP=GB;ENG;Reading:51.46;-1.04:v4; enwikimwuser-sessionId=662882135a49144a4438; enwikis8-UserName=Rstingu; enwikimwuserSession=gaaitej5p0hie4kb1soip0ibfi0r9kd1; enwikiSession=gaaitej5p0hie4kb1soip0ibfi0r9kd1; WMF-Last-Access=4kb1soip0ibfi0r9kd1; enwikiSession=gaaitej5p0hie4kb1soip0ibfi0r9kd1; WMF-Last-Access=11-Sep-2022; WMF-Last-Access-Global=11-Sep-2022; enwikimwE-sessionTickLastTickTime=1662904063867; enwikimwE-sessionTickCount=1
referer: https://www.google.com/
sec-ch-ua: "Google Chrome";v="105", "Not)A;Brand";v="8", "Chromium";v="105"
```

# THE RESPONSE HEADERS



The screenshot shows the Network tab of a browser developer tools interface. A request for the URL `https://en.wikipedia.org/wiki/Main_Page` is selected. The Headers section displays the following response headers:

```
accept-ch: Sec-CH-UA-Arch,Sec-CH-UA-Bitness,Sec-CH-UA-Full-Version-List,Sec-CH-UA-Mode  
1,Sec-CH-UA-Platform-Version  
age: 0  
cache-control: private, s-maxage=0, max-age=0, must-revalidate  
date: Sun, 11 Sep 2022 13:57:24 GMT  
expires: Thu, 01 Jan 1970 00:00:00 GMT  
nel: { "report_to": "wm_nel", "max_age": 86400, "failure_fraction": 0.05, "success_fraction": 0.0 }  
permissions-policy: interest-cohort=(),ch-ua-arch=(self "intake-analytics.wikimedia.org"),ch-ua-bitness=(self "intake-analytics.wikimedia.org"),ch-ua-full-version-list=(self "intake-analytics.wikimedia.org"),ch-ua-model=(self "intake-analytics.wikimedia.org"),ch-ua-platform-version=(self "intake-analytics.wikimedia.org")  
report-to: { "group": "wm_nel", "max_age": 86400, "endpoints": [ { "url": "https://intake-logging.wikimedia.org/v1/events?stream=w3c.reportingapi.network_error&schema_uri=/w3c/reportingapi/network_error/1.0.0" } ] }  
server: ATS/8.0.8  
server-timing: cache;desc="pass", host;desc="cp3064"  
strict-transport-security: max-age=106384710; includeSubDomains; preload  
vary: Accept-Encoding,Cookie,Authorization
```

# HTTP HEADERS: CANONICALISATION

**Link:** <http://www.example.com/downloads/white-paper.pdf>; rel="canonical"

# HTTP HEADERS: HREFLANG

**Link:**

```
<http://example.com/file.pdf>; rel="alternate";  
hreflang="en",  
<http://de-ch.example.com/file.pdf>;  
rel="alternate"; hreflang="de-ch",  
<http://de.example.com/file.pdf>; rel="alternate";  
hreflang="de"
```

# HTTP HEADERS: ROBOTS

**X-Robots-Tag:** noarchive

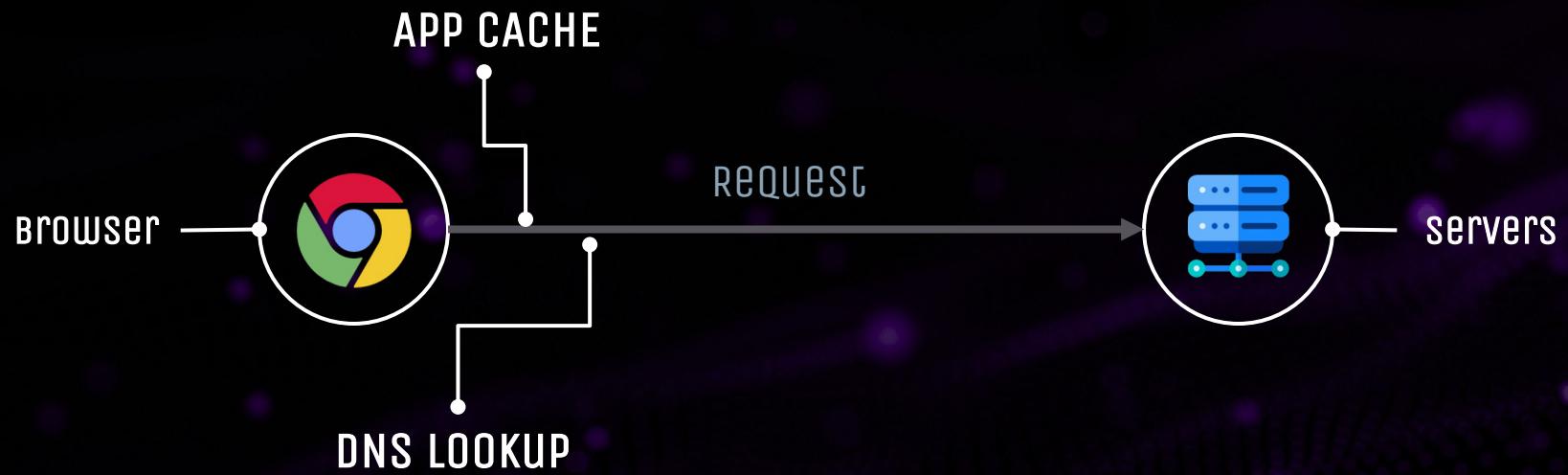
**X-Robots-Tag:** unavailable\_after: 25 Jun 2021  
15:00:00 PST

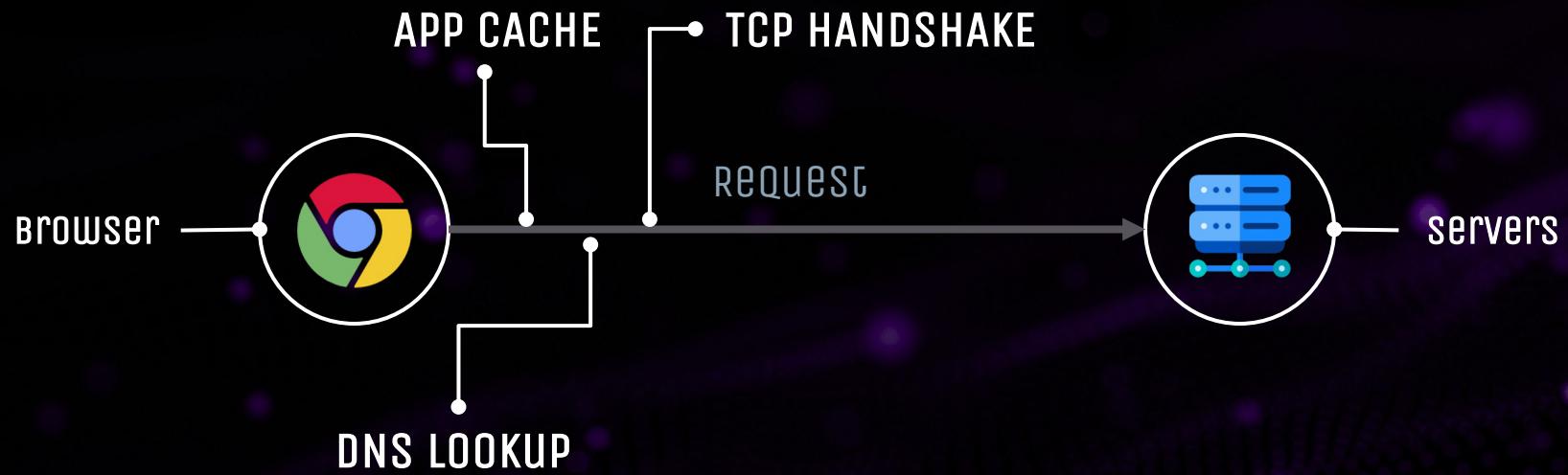
**X-Robots-Tag:** googlebot:nofollow

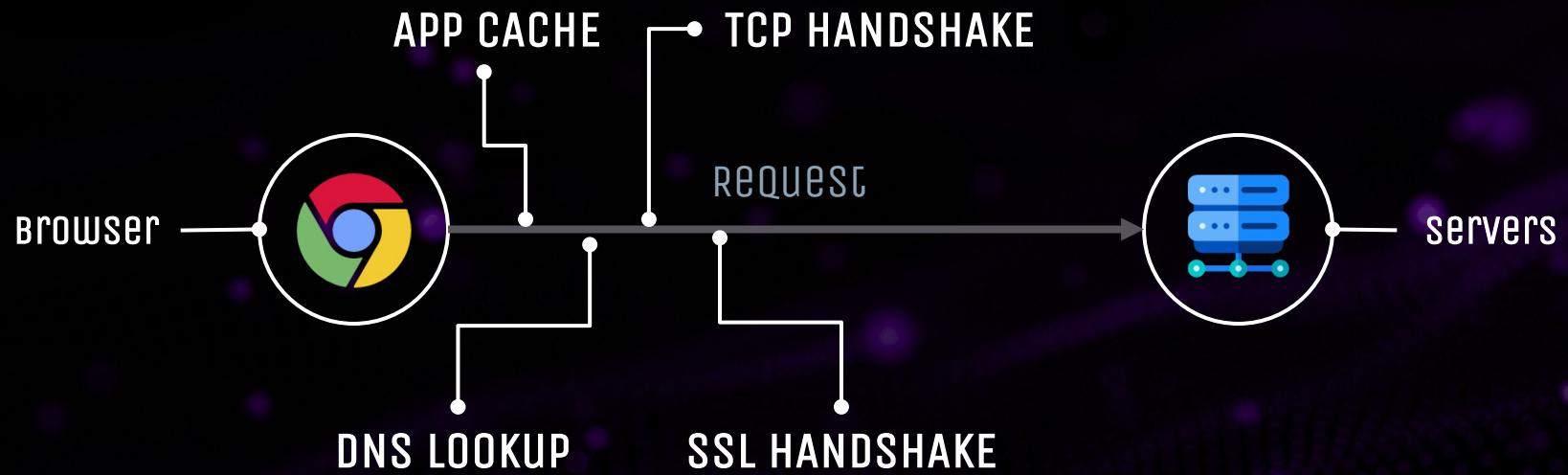
**X-Robots-Tag:** otherbot: noindex, nofollow

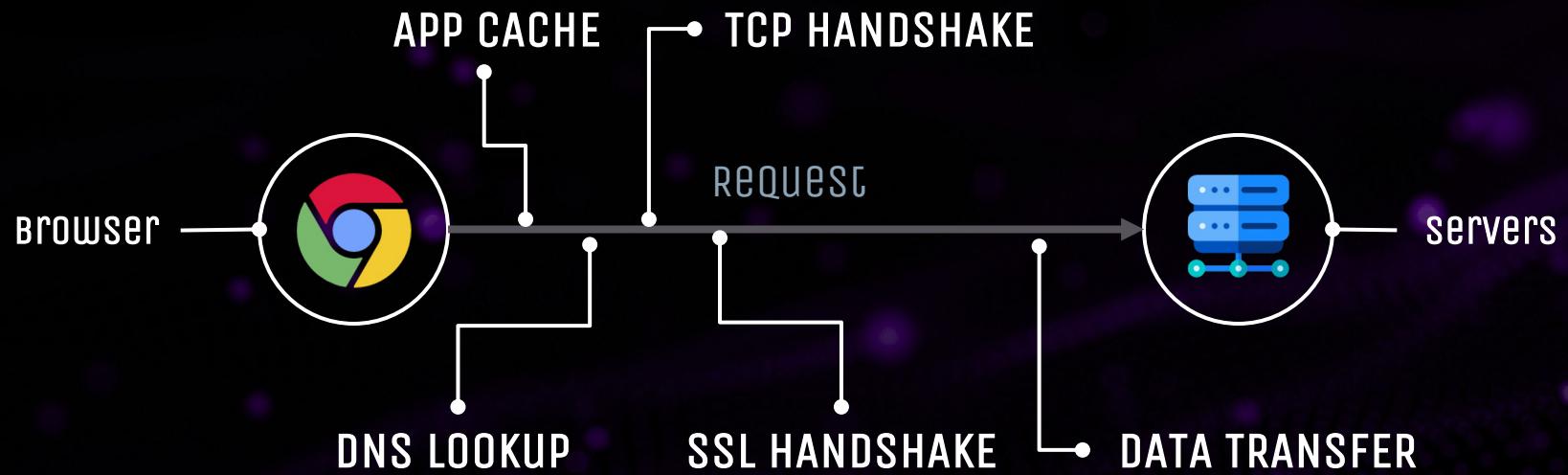
# REQUEST TIMINGS



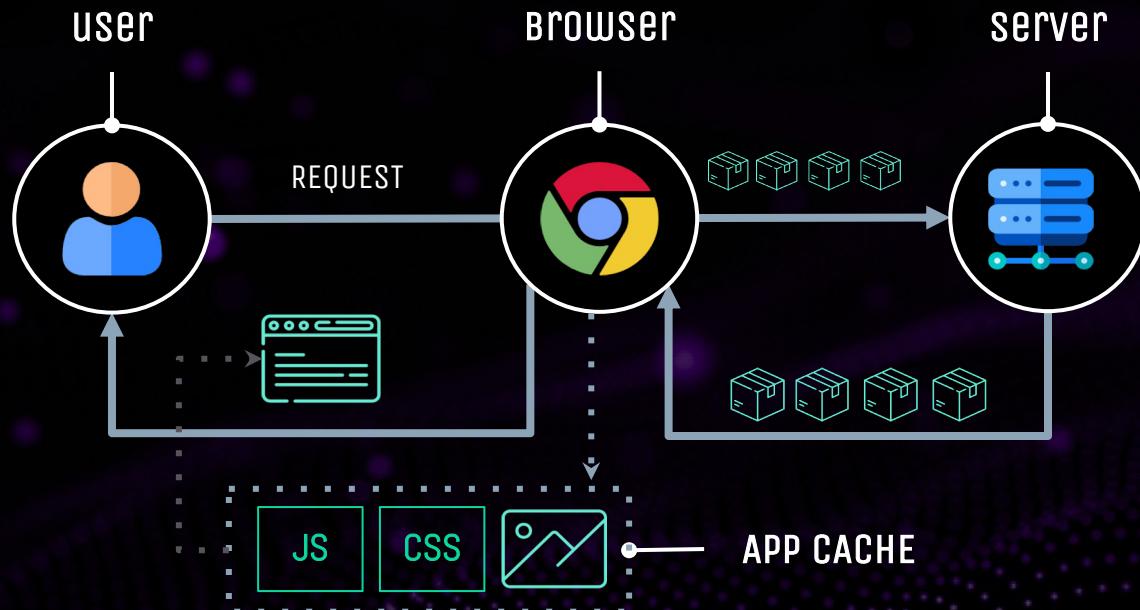




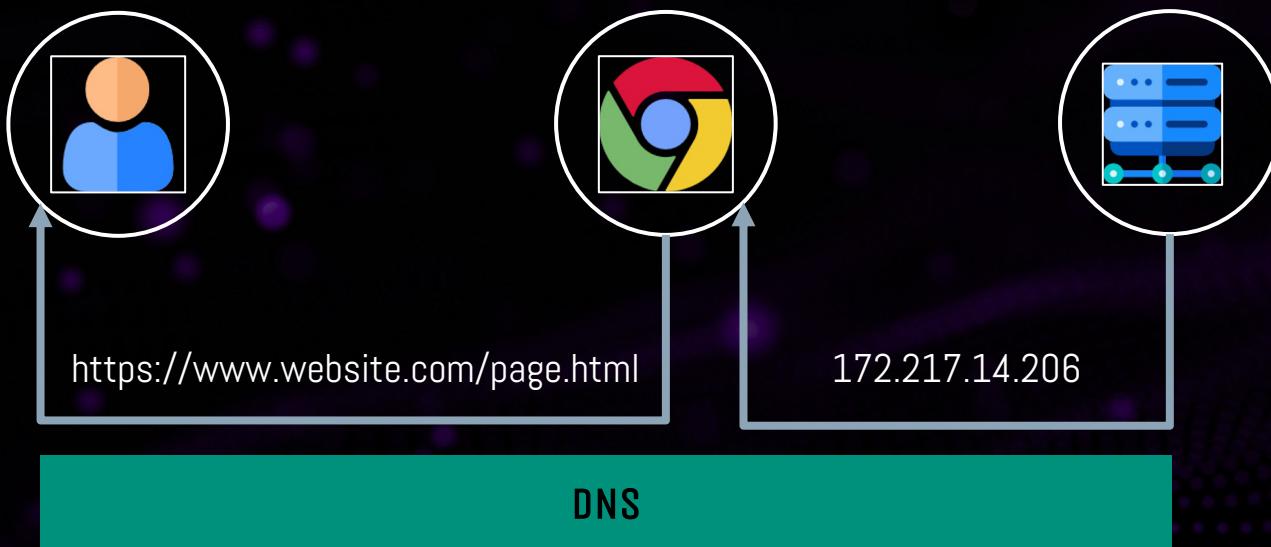




# APP CACHE



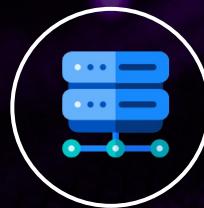
# DOMAIN NAME SYSTEM (DNS)



# TCP HANDSHAKE



SYN (synchronization) = X



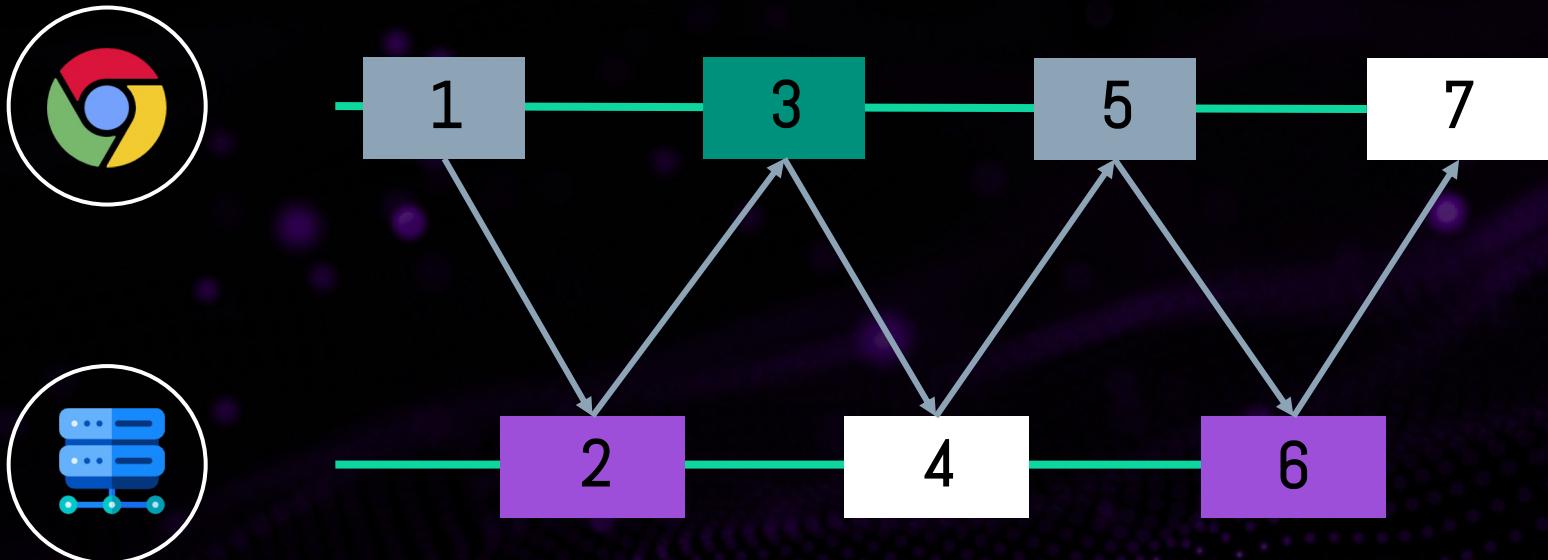
SYN-ACK (synchronization - acknowledgment) = Y ; X+1



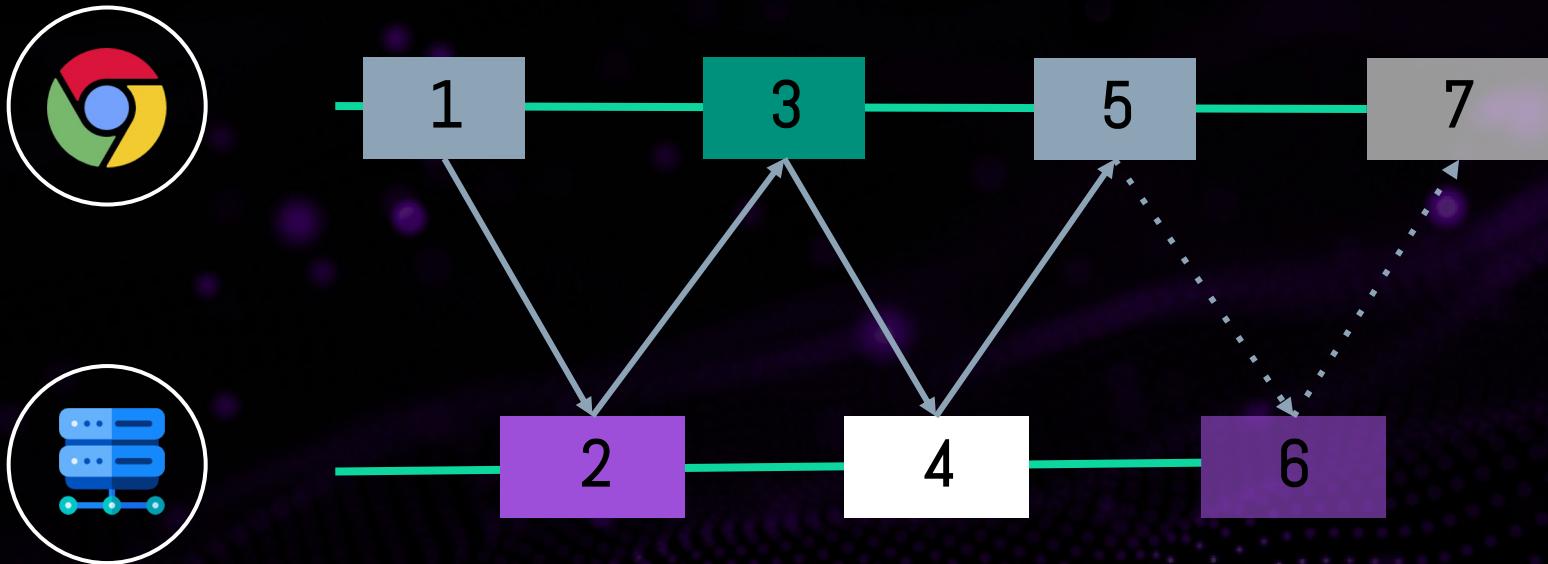
ACK(acknowledgment) = Y+1



# SSL HANDSHAKE - TLS 1.2



# SSL HANDSHAKE - TLS 1.3



# REQUEST TIMINGS IN DEV TOOLS

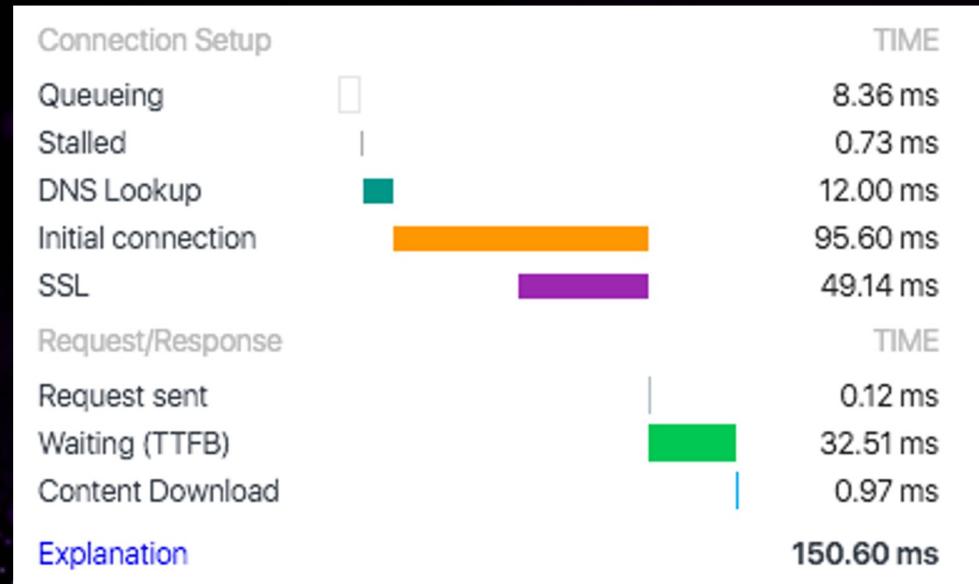
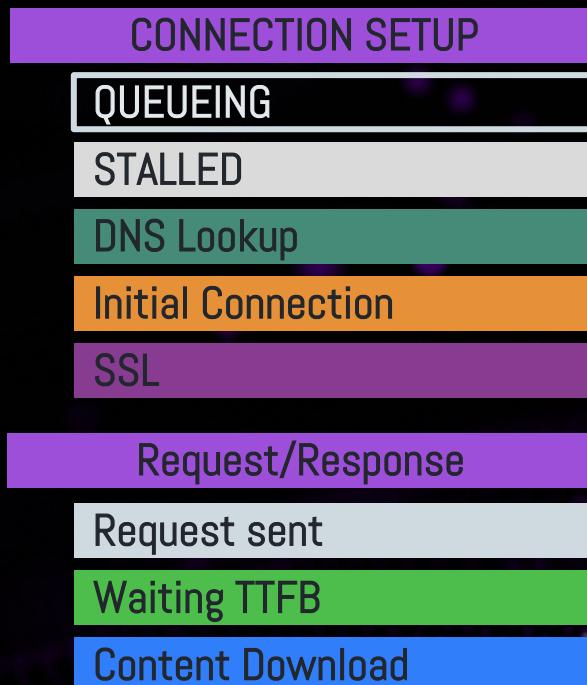
The screenshot shows the Google homepage with the DevTools Network tab open. A large green callout box labeled "ANY RESOURCE" points to the "google.com" entry in the list. Another green callout box labeled "TIMING" points to the detailed timeline for the google.com request.

**ANY RESOURCE**

**TIMING**

| Event                       | DURATION |
|-----------------------------|----------|
| Queued at 0                 |          |
| Started at 5.25 ms          | 5.25 ms  |
| Resource Scheduling         |          |
| Queueing                    |          |
| Connection Start            |          |
| Stalled                     | 0.42 ms  |
| Request/Response            |          |
| Request sent                | 0        |
| Waiting (TTFB)              | 1.86 ms  |
| Content Download            | 1.51 ms  |
| <a href="#">Explanation</a> | 9.03 ms  |

# REQUEST TIMINGS IN DEV TOOLS

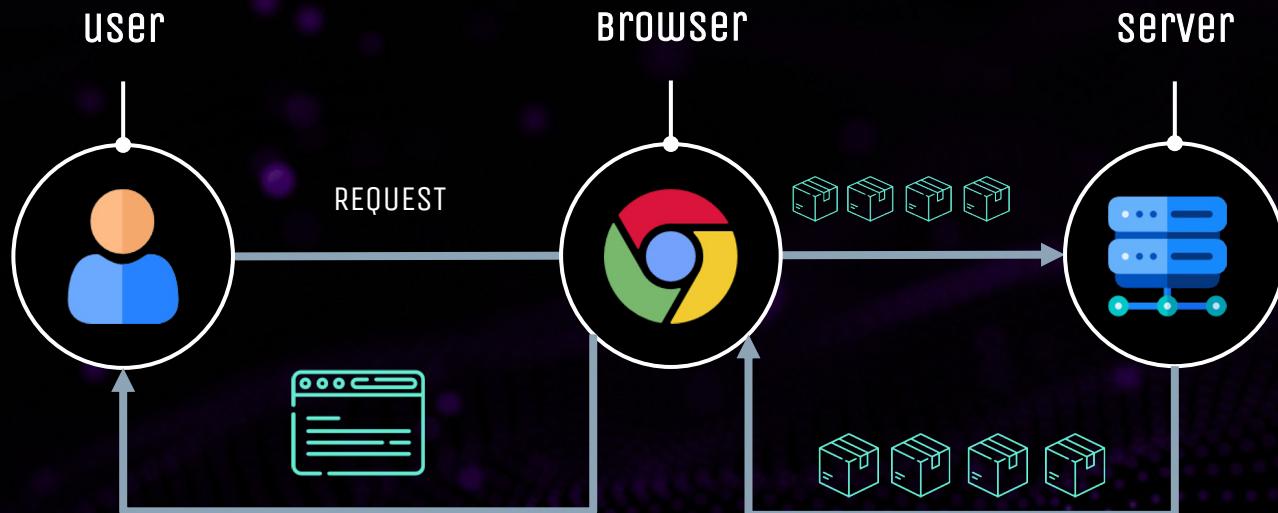


# THE BROWSER

UI DOM CSSOM JS CRP FCP LCP FID TTI TBT CLS UI DOM CSSOM JS CRP FCP LCP FID TTI TBT  
CLS UI DOM CSSOM JS CRP FCP LCP FID TTI TBT CLS UI DOM CSSOM JS CRP FCP LCP FID TTI  
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CSS JI  
DOM CLS  
UI BT

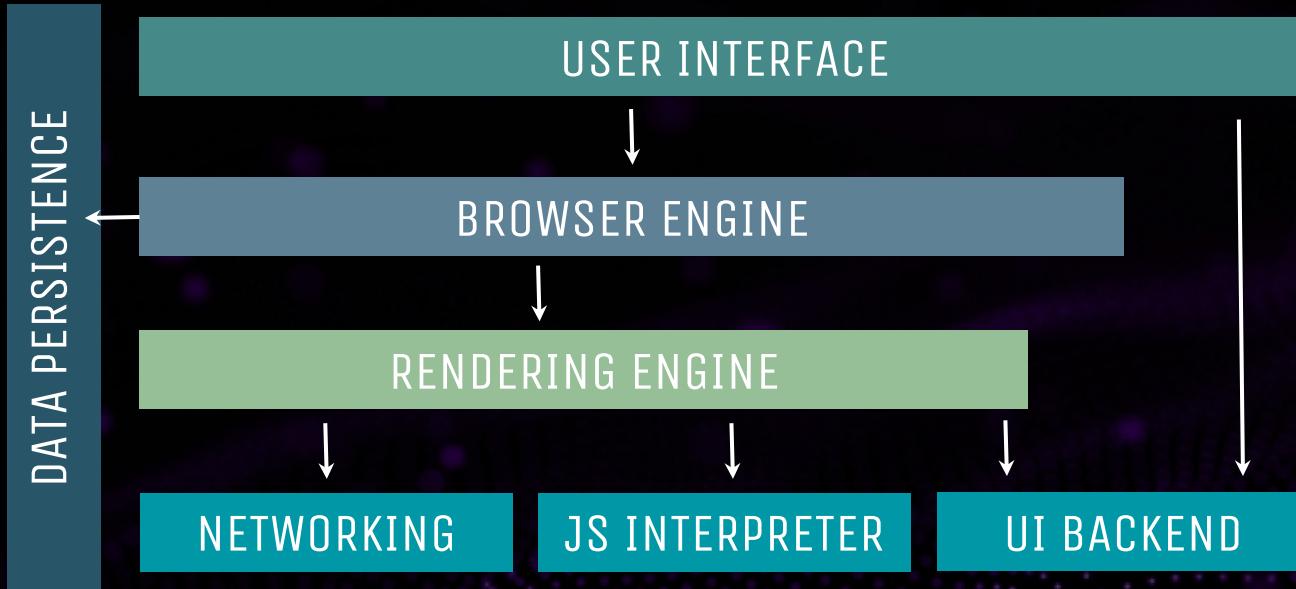
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# HOW THE TCP/IP MODEL WORKS



# BROWSER “HARDWARE”

# WHAT IS A BROWSER?



# THE USER INTERFACE (UI)



# BROWSER ENGINE

WebKit

Apple - Safari

Blink

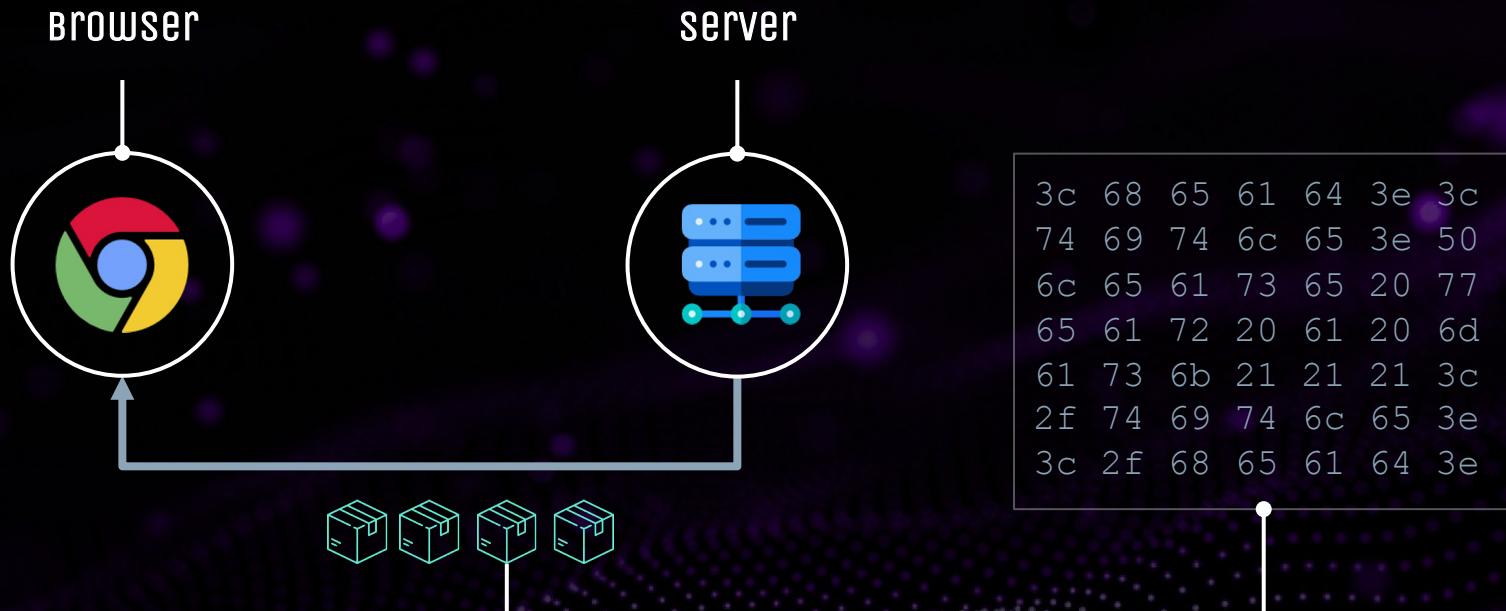
Google - Chrome, Microsoft Edge, Opera

Gecko

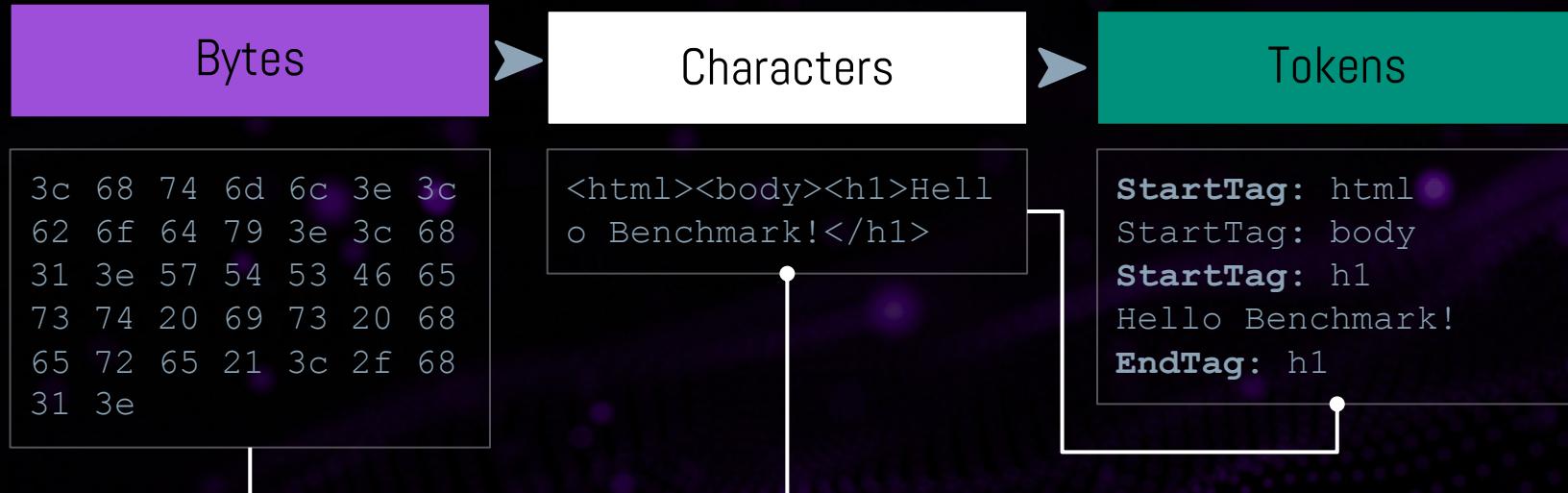
Mozilla - Firefox, Thunderbird

# THE RENDERING ENGINE

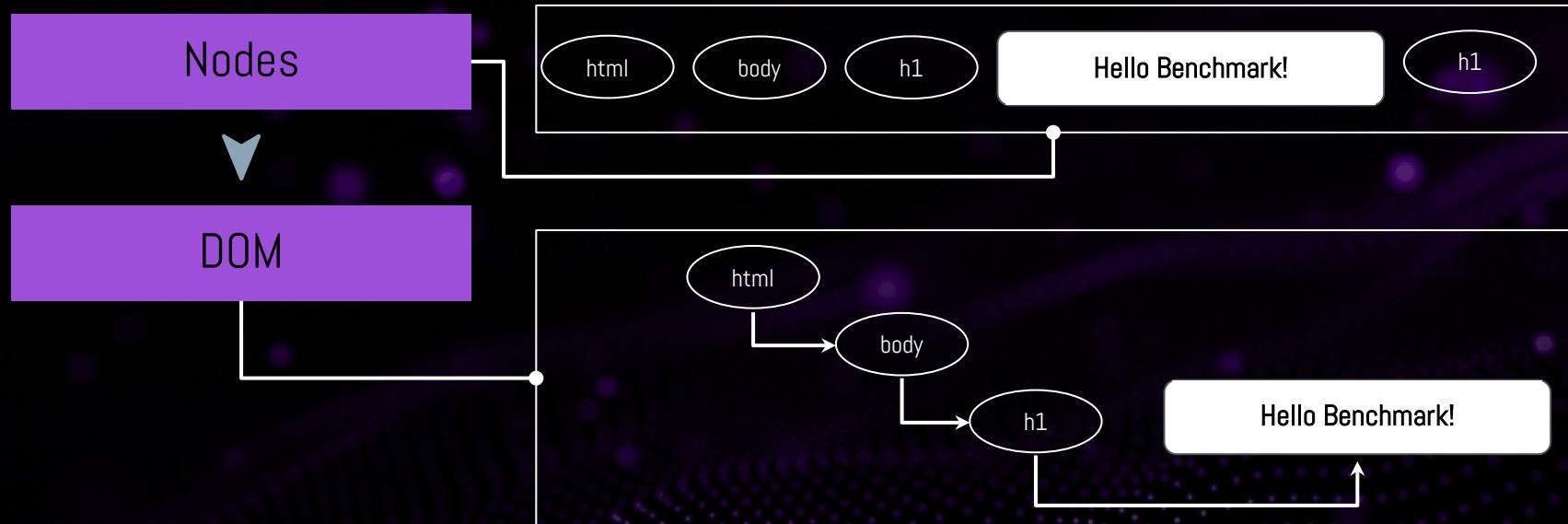
# THE RENDERING ENGINE



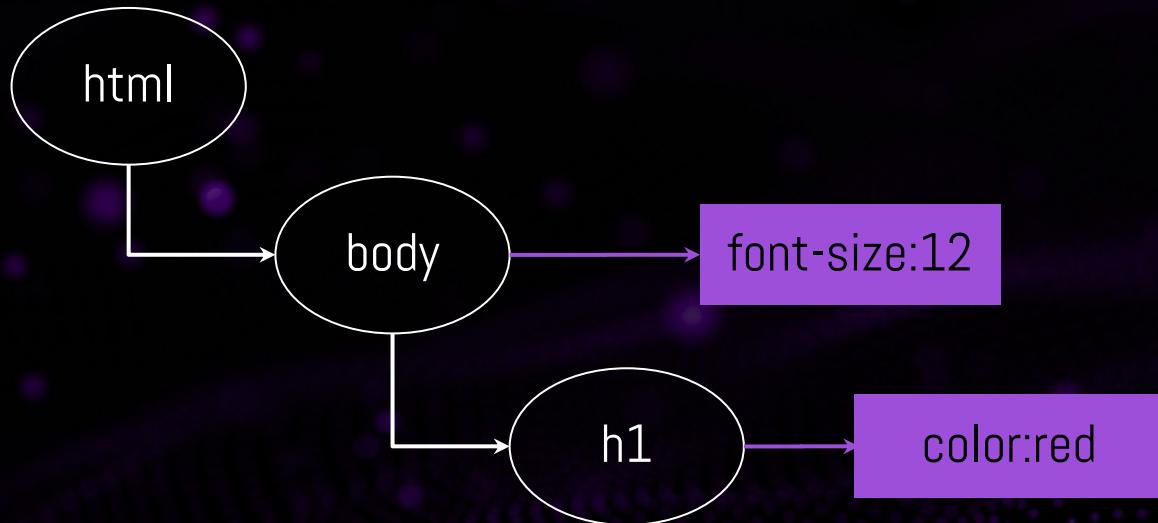
# FROM BYTES OF HTML TO DOM



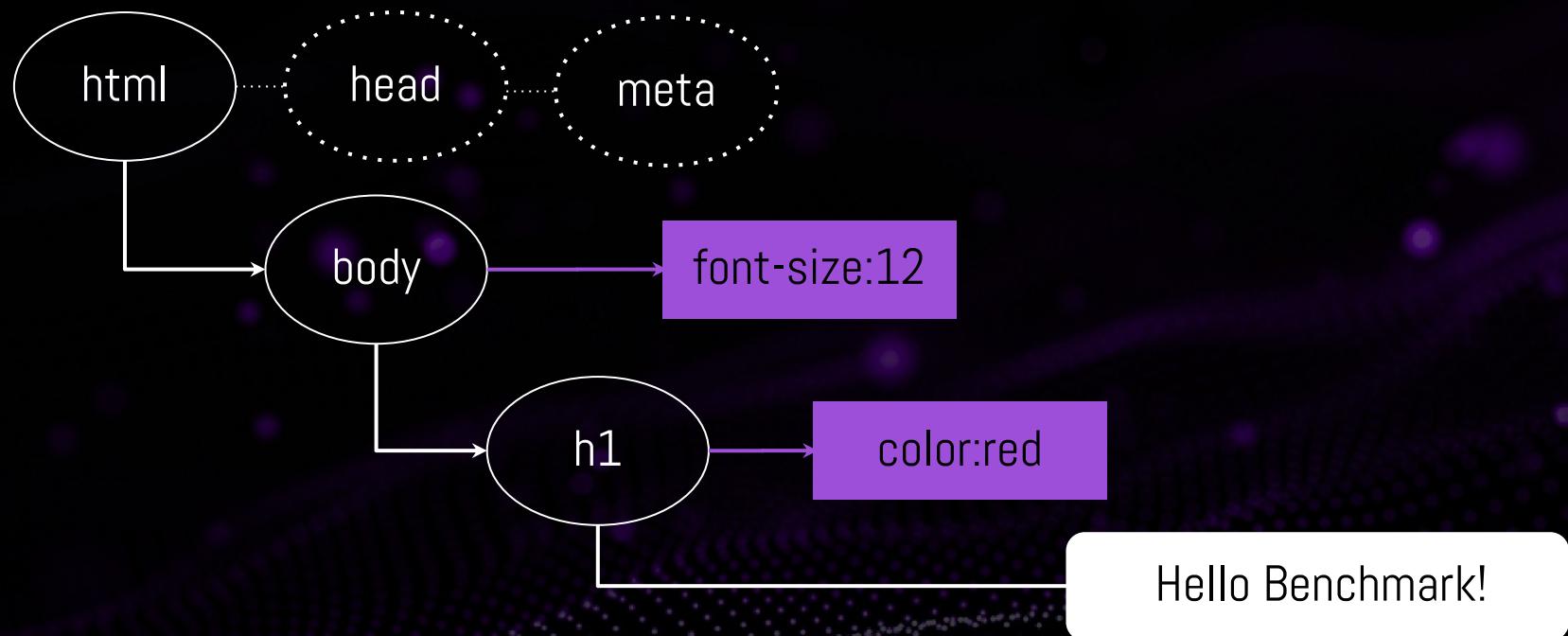
# THE TREE BUILDER



# THE CSSOM

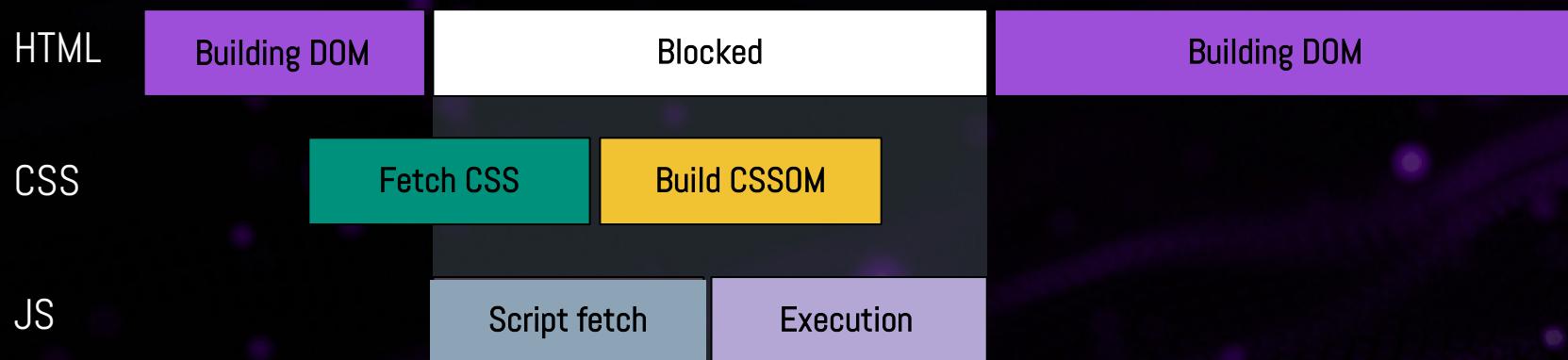


# DOM + CSSOM = RENDER TREE



# THE JS INTERPRETER

# RESOURCE LOADING PRIORITY



# ASYNC JS LOADING



# DEFERRED JS LOADING

HTML

Building DOM

CSS

Fetch CSS

Build CSSOM

JS

Script fetch

Execution

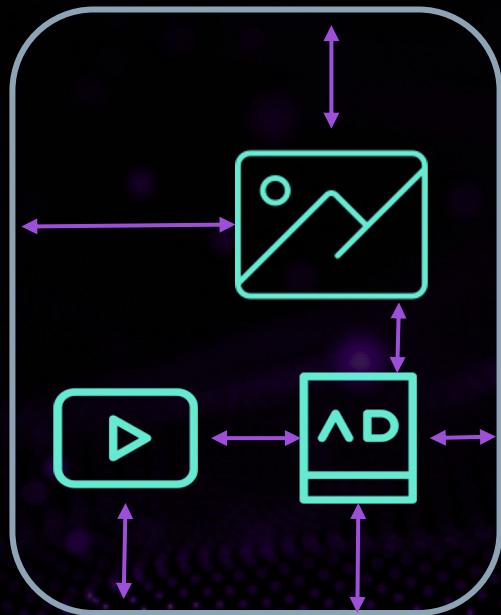
# HOW TO SPOT ASYNC AND DEFER

```
<script src="https://website.com/resource.js"></script>
```

```
<!-- Google Analytics is usually added like this -->
<script async src="https://google-
analytics.com/analytics.js"></script>
```

```
<script defer
src="https://website.com/resource.js"></script>
```

# LAYOUT



# HOW TO DEBUG LAYOUT SHIFTS

The screenshot shows the Google homepage with the developer tools Network tab open. The Network tab displays a timeline of requests and their execution times. A green box highlights the "Rendering" section in the "MORE TOOLS" dropdown menu, which contains various options for debugging layout shifts.

**MORE TOOLS**

- Shortcuts
- Help

**Rendering**

Layout Shift Regions

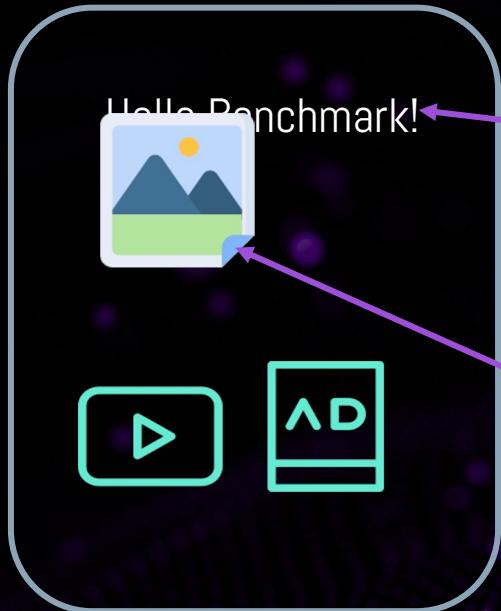
Highlights areas of the page (blue) that were shifted. May not be suitable for people prone to photosensitive epilepsy.

Layer borders  
Shows layer borders (orange/olive) and tiles (cyan).

Frame Rendering Stats  
Plots frame throughput, dropped frames distribution, and GPU memory.

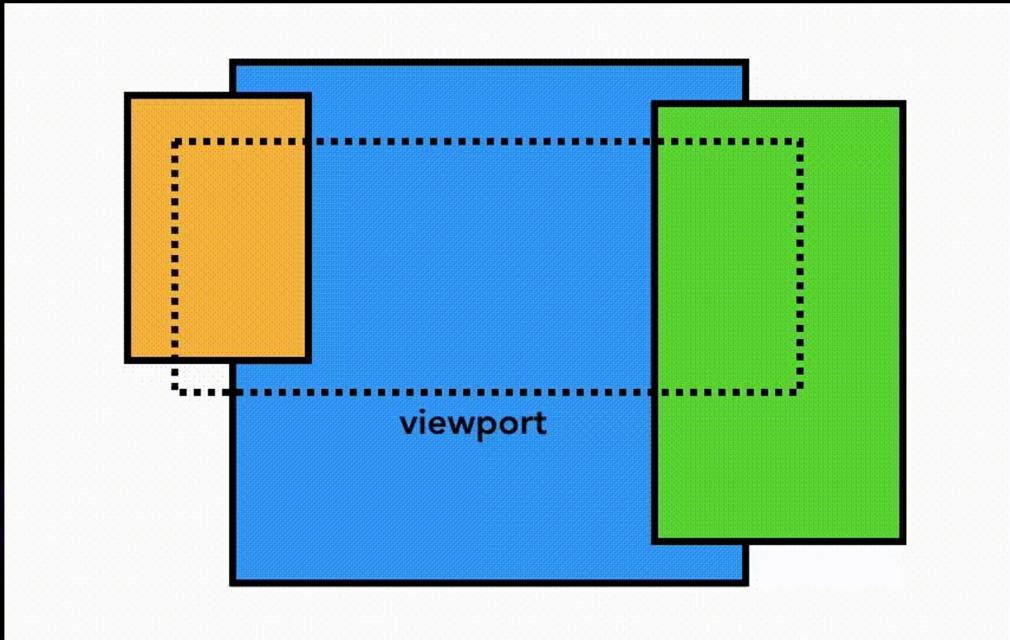
Scrolling performance issues  
Highlights elements (teal) that can slow down scrolling, including touch & wheel event handlers and other

# PAINT

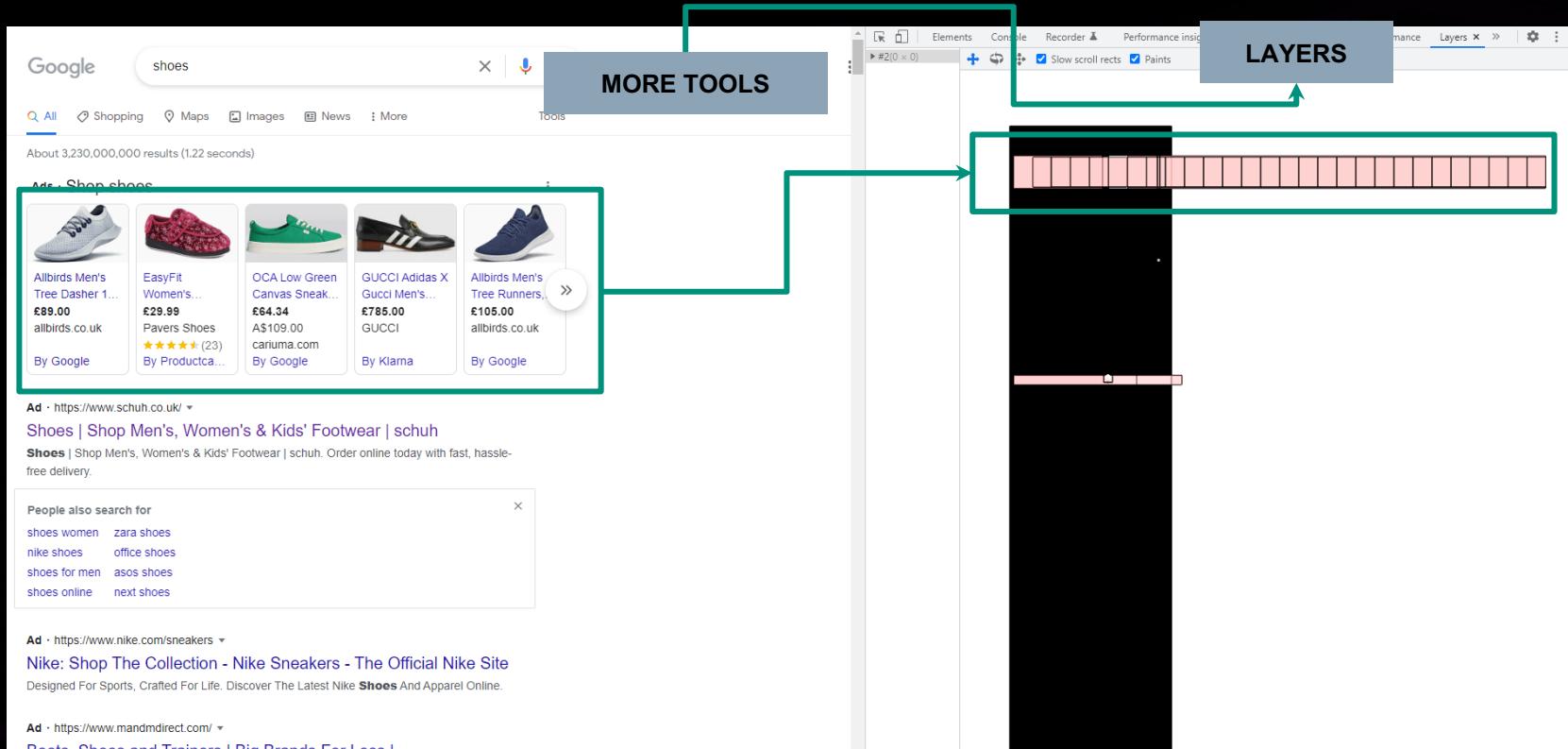


```
H1 {  
    z-index: 1;  
    position:  
    absolute;  
}  
  
Div{  
    z-index: 0;  
}
```

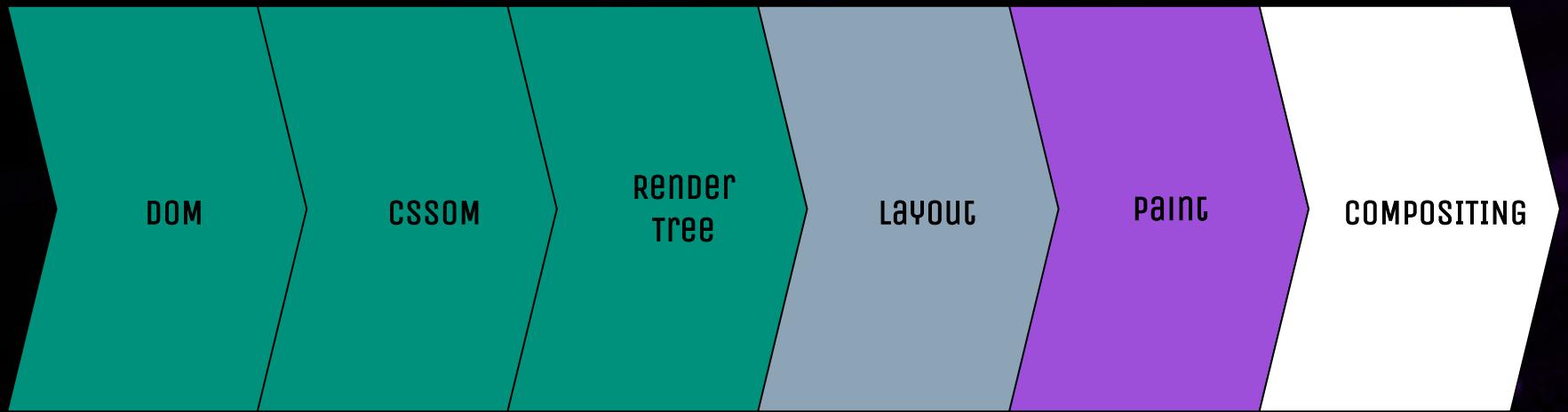
# COMPOSITING



# HOW TO TROUBLESHOOT COMPOSITING



# THE CRITICAL RENDERING PATH (CRP)



# HOW To SEE THE CRP

The screenshot shows the Chrome DevTools Performance tab for the URL [www.youtube.com](http://www.youtube.com/). The top section displays the Critical Rendering Path (CRP) timeline, which highlights the sequence of events from the first paint to the main content becoming fully visible. The timeline is annotated with green boxes and arrows indicating specific events:

- A green box labeled "CRITICAL RENDERING PATH" covers the initial loading phase, starting with "Parse HTML" and "Evaluate Script" tasks.
- An arrow points from this box to the "Web Vitals" section below, which shows a green dot representing the first input render (FIR).
- Another arrow points from the CRP timeline to the "LONG TASKS" section, highlighting a long script execution labeled "Evaluate Script" and "Compile Script".

The "LONG TASKS" section provides a detailed view of the tasks that took longer than 100ms. It lists various tasks such as "Parse HTML", "Evaluate Script", "Compile Script", and numerous anonymous functions and event listeners. The tasks are color-coded by their type and source.

On the left side of the interface, there are several smaller images and icons:

- A search bar at the top left with the query "women in tech sX".
- A "FILTERS" section with a dropdown menu.
- A small thumbnail image of a person using a laptop.
- A red circular icon containing a white female gender symbol.
- A portrait photo of a woman.
- The word "BENCHM" partially visible at the bottom right.

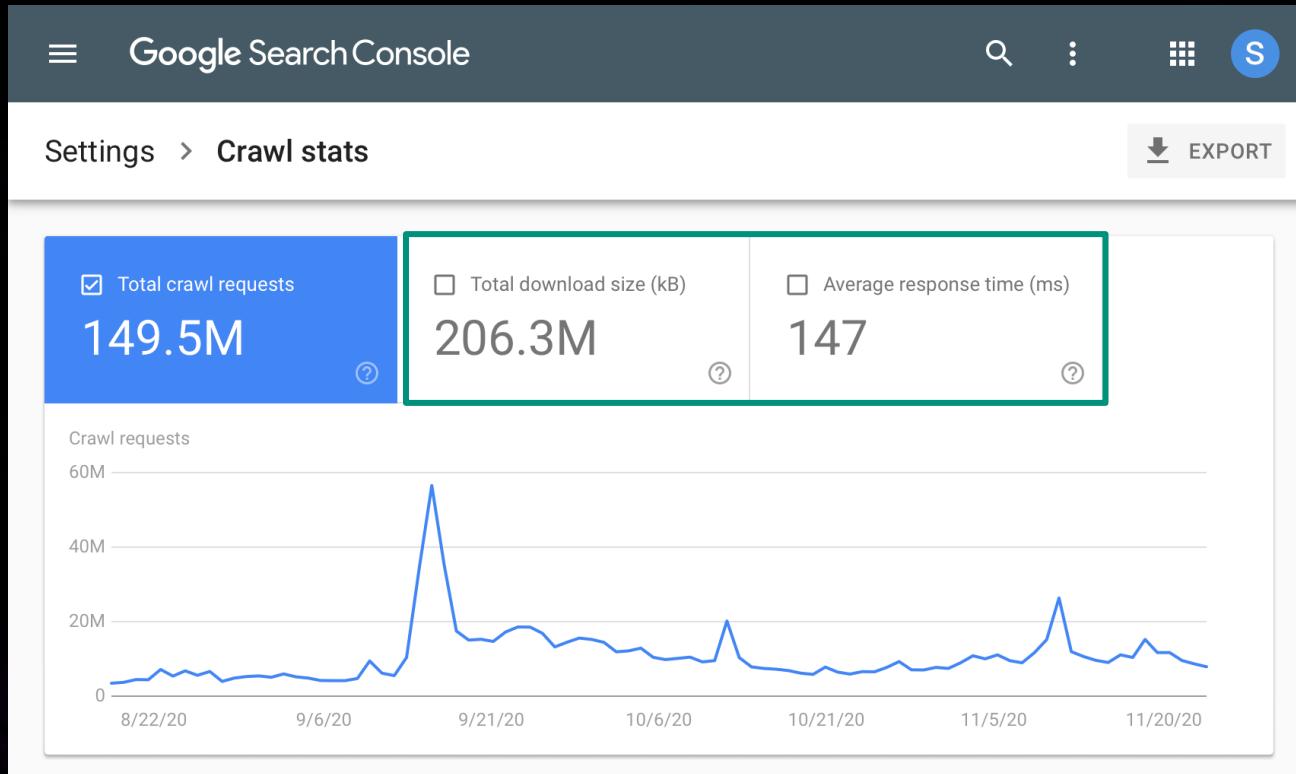
# HOW IT ALL FITS IN

@RoxanaStingu |

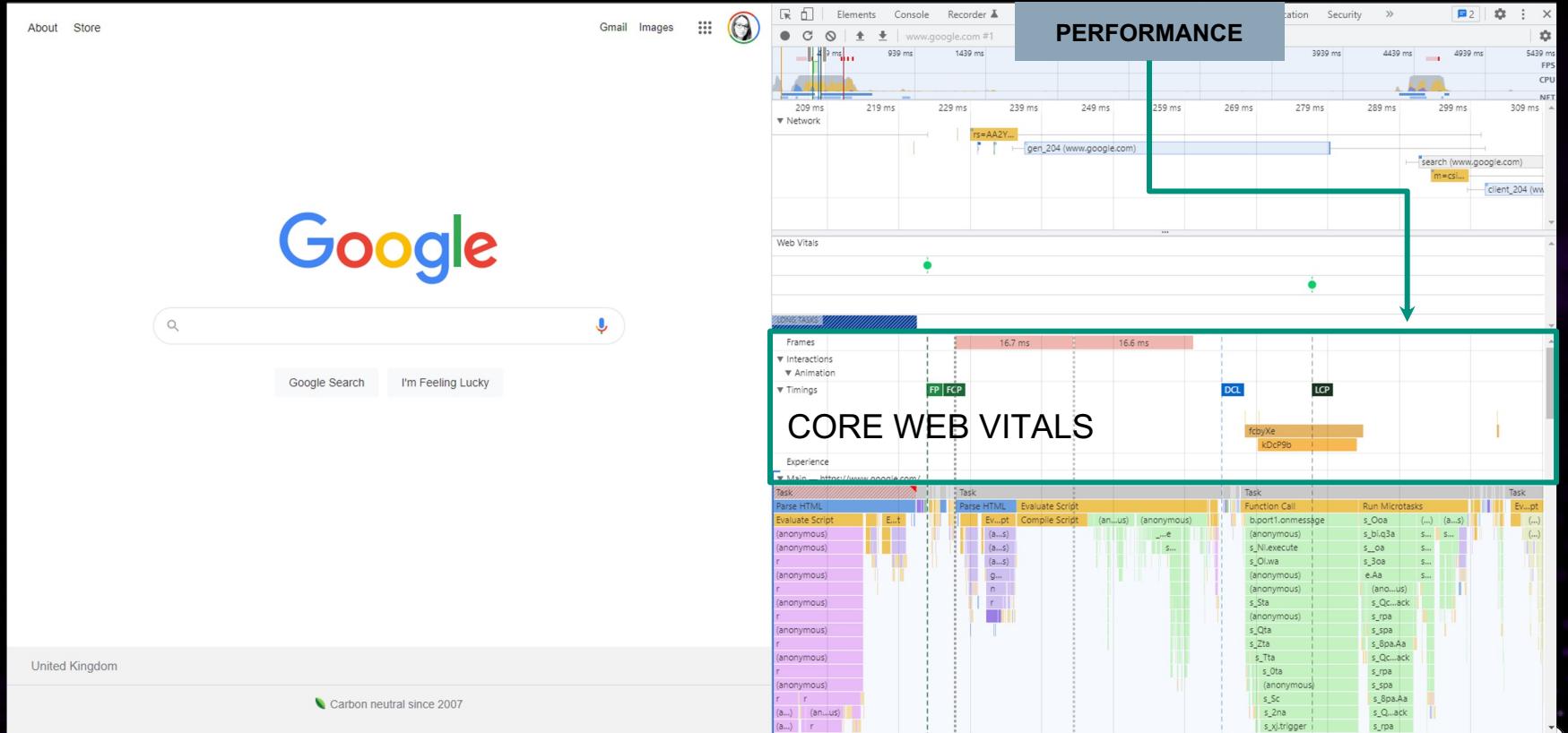


BENCHMARK

# CRAWL BUDGET OPTIMISATION



# CORE WEB VITALS TROUBLESHOOTING



# CONDUCT BETTER AUDITS

| Header Name     | Header Value  | Header Name               | Header Value  |
|-----------------|---|---------------------------|---|
| Cache-Control   | no-cache  | Status                    | OK  |
| Accept          | text/html,application/xhtml+xml,application/xml;q=0.9,*/*;q=1 | Status Code               | 200   |
| User-Agent      | Screaming Frog SEO Spider/17.1                                | accept-ch                 | Sec-CH-UA-Arch,Sec-CH-UA-Bitness,Sec-CH-UA-Full-Version-List,Sec-CH...  |
| Pragma          | no-cache  | accept-ranges             | bytes   |
| Accept-Encoding | gzip  | age                       | 37676   |
|                 |   | cache-control             | s-maxage=86400, must-revalidate, max-age=3600   |
|                 |   | content-encoding          | gzip  |
|                 |   | content-length            | 18013   |
|                 |   | content-type              | text/html   |
|                 |   | date                      | Sun, 11 Sep 2022 05:16:59 GMT   |
|                 |   | etag                      | W/"125b5-5e6725e59beb1"   |
|                 |   | last-modified             | Wed, 17 Aug 2022 16:29:27 GMT   |
|                 |   | nel                       | {"report_to": "wm_nel", "max_age": 86400, "failure_fraction": 0.05, "success_fraction": 0.95, "group": "wm_nel", "min_report_time": 1663123200000, "max_report_time": 1663123200000, "min_percentile": 0, "max_percentile": 100}, {"group": "wm_nel", "max_age": 86400, "endpoints": [{"url": "https://intake-analytics.wikimedia.org"}, {"url": "https://intake-wm-nel.wikimedia.org"}], "interest-cohort": "ch-ua-arch=(self \"intake-analytics.wikimedia.org\"),ch-ua-device=mobile,interest-cohort=(,),ch-ua-platform=mobile"}, {"group": "wm_nel", "max_age": 86400, "endpoints": [{"url": "https://intake-wm-nel.wikimedia.org"}], "interest-cohort": "ch-ua-arch=(self \"intake-wm-nel.wikimedia.org\"),ch-ua-device=mobile,interest-cohort=(,),ch-ua-platform=mobile"}] |
|                 |   | permissions-policy        |   |
|                 |   | report-to                 |   |
|                 |   | server                    | ATS/8.0.8   |
|                 |   | server-timing             | cache;desc="hit-front", host;desc="cp3064"  |
|                 |   | set-cookie                | GeoIP=GB;ENG;Reading;51.45;-1.01;v4; Path=/; secure; Domain=.wikipedia.org;HttpOnly;Max-Age=86400; SameSite=None  |
|                 |   | set-cookie                | WMF-Last-Access-Global=11-Sep-2022;Path=/;Domain=.wikipedia.org;HttpOnly;Secure;Expires=Thu, 11-Sep-2022 16:29:27 GMT; Max-Age=86400; SameSite=None   |
|                 |   | set-cookie                | WMF-Last-Access=11-Sep-2022;Path=/;HttpOnly;secure;Expires=Thu, 11-Sep-2022 16:29:27 GMT; max-age=106384710; includeSubDomains; preload   |
|                 |   | strict-transport-security | Accept-Encoding   |
|                 |   | vary                      | cp3062 hit, cp3064 hit/760471   |
|                 |   | x-cache                   | hit-front   |
|                 |   | x-cache-status            |   |
|                 |   | x-client-ip               | 143.159.179.26  |



# **DEVELOPER, DEAR SEO**

# **DO YOU SPEAK IT?**

[memegenerator.net](http://memegenerator.net)

# RESOURCES



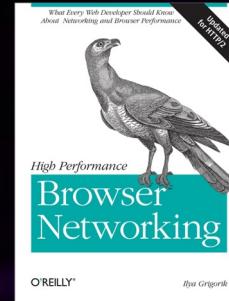
[Developer.mozilla.org  
Web Performance](https://developer.mozilla.org/en-US/docs/Web/Performance)



[Developers.google.com  
Inside look at modern  
web browser](https://developers.google.com/web/inside-the-browser)



[Web.dev  
Measuring performance  
and user experience](https://web.dev/measuring/)



High performance  
browser networking

by Ilya Grigorik

# THANK YOU