How Tracking Companies Circumvented Ad Blockers Using WebSockets

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Northeastern University

Presented by Eric Newberry
University of Michigan

Slides (mostly) by Muhammad Ahmad Bashir

Online Tracking

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- Ad networks pour in billions of dollars.
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Ad networks fight back

- E.g Using anti-ad blocking scripts

Google & Safari

- Google evaded Safari's third-party cookie blocking policy (Jonathan Mayer)
- … by submitting a form in an invisible iFrame
- Google fined $22.5M by FTC

This Talk

How **Ad Networks** leveraged a bug in the Chrome API to **bypass Ad Blockers** using **WebSockets**

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How **Ad Networks** leveraged a bug in the Chrome API to **bypass Ad Blockers** using **WebSockets**

1. What caused this?
2. How was this bug leveraged by ad networks?

Web Sockets

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HTTP/S

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- Both client and server can send/receive data
- This is a persistent connection

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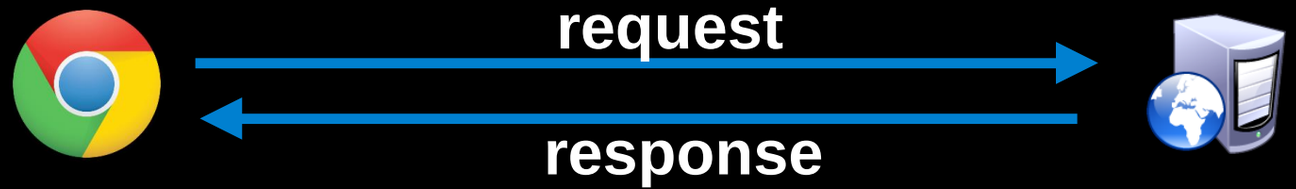

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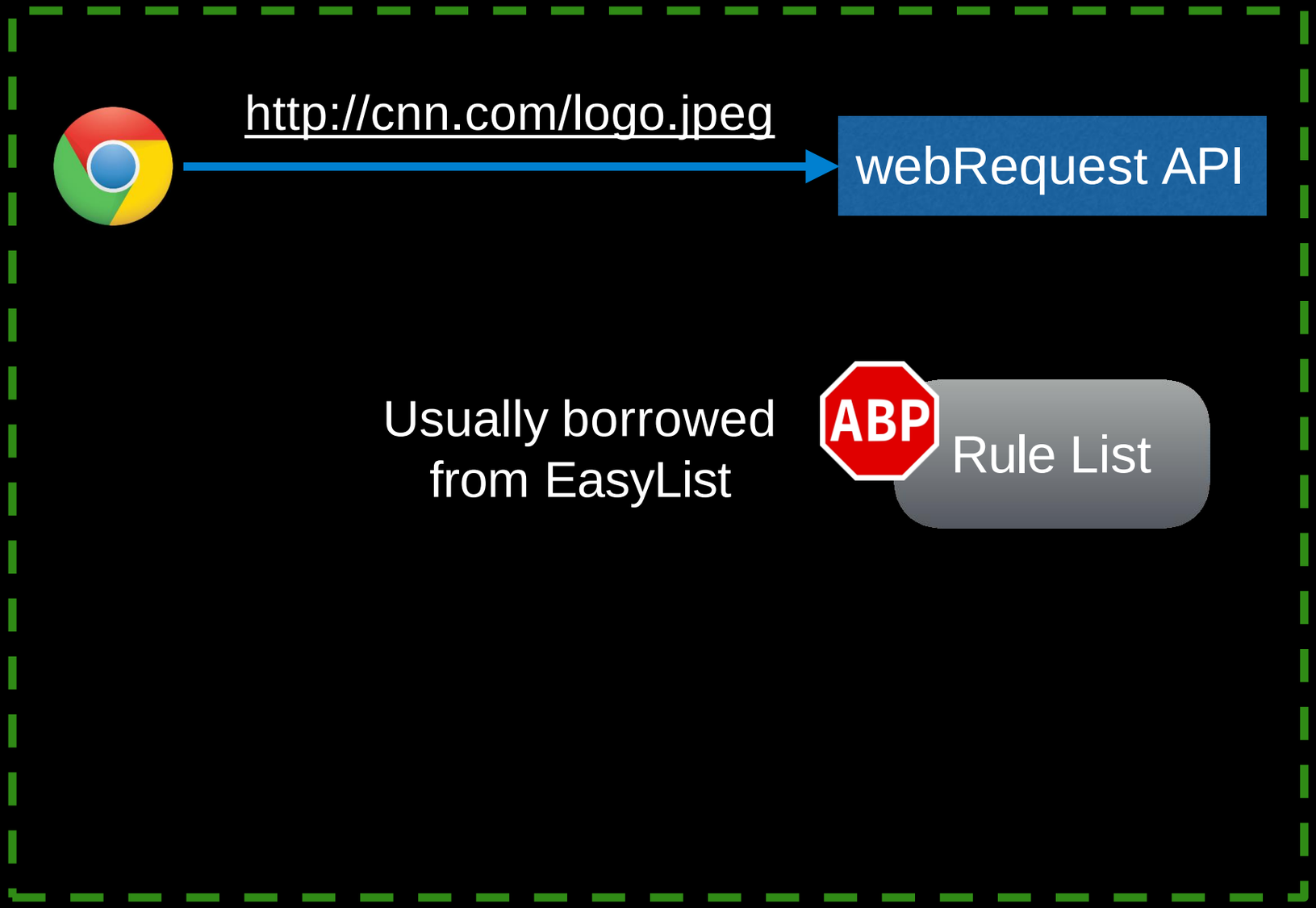

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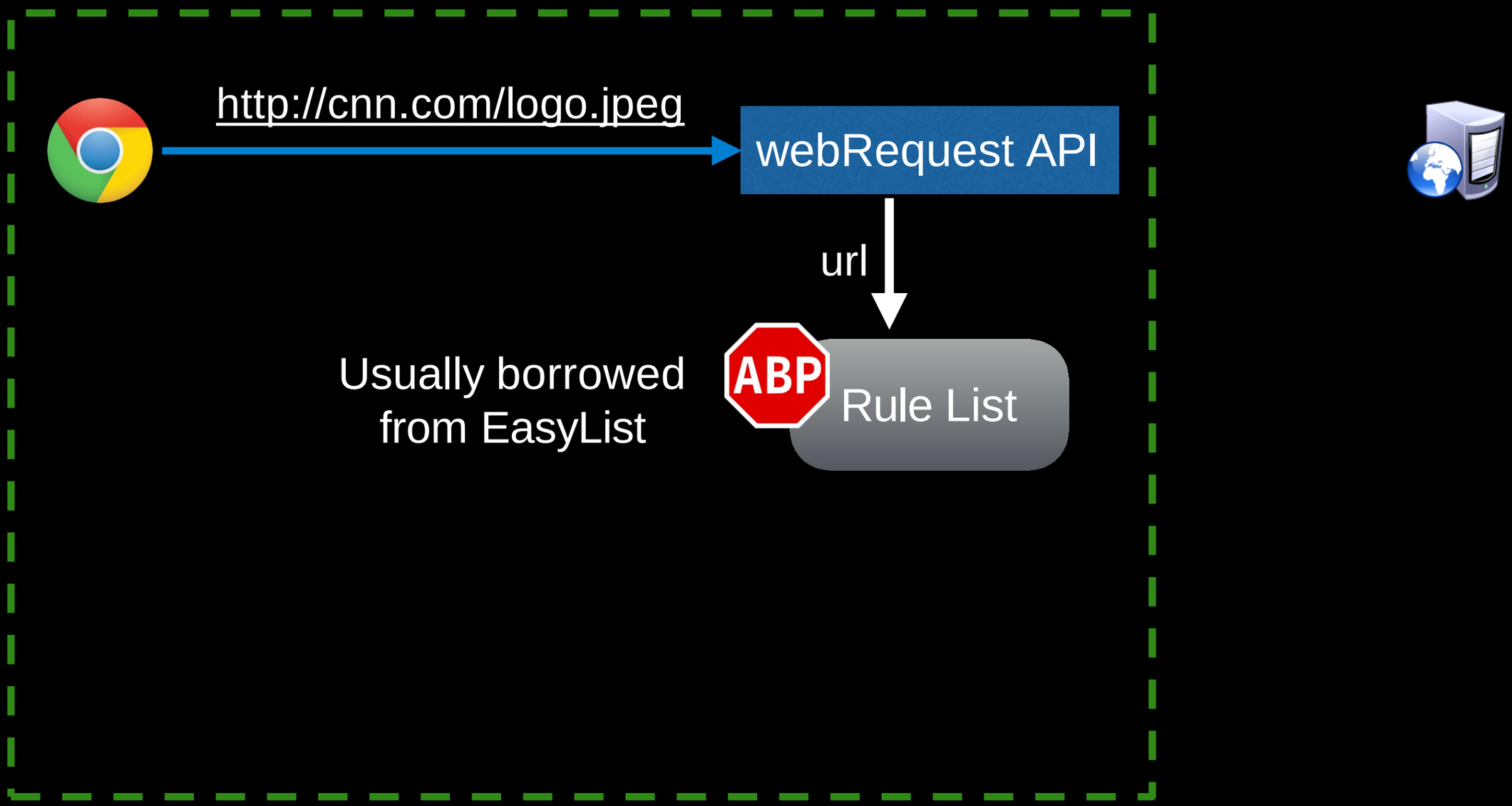

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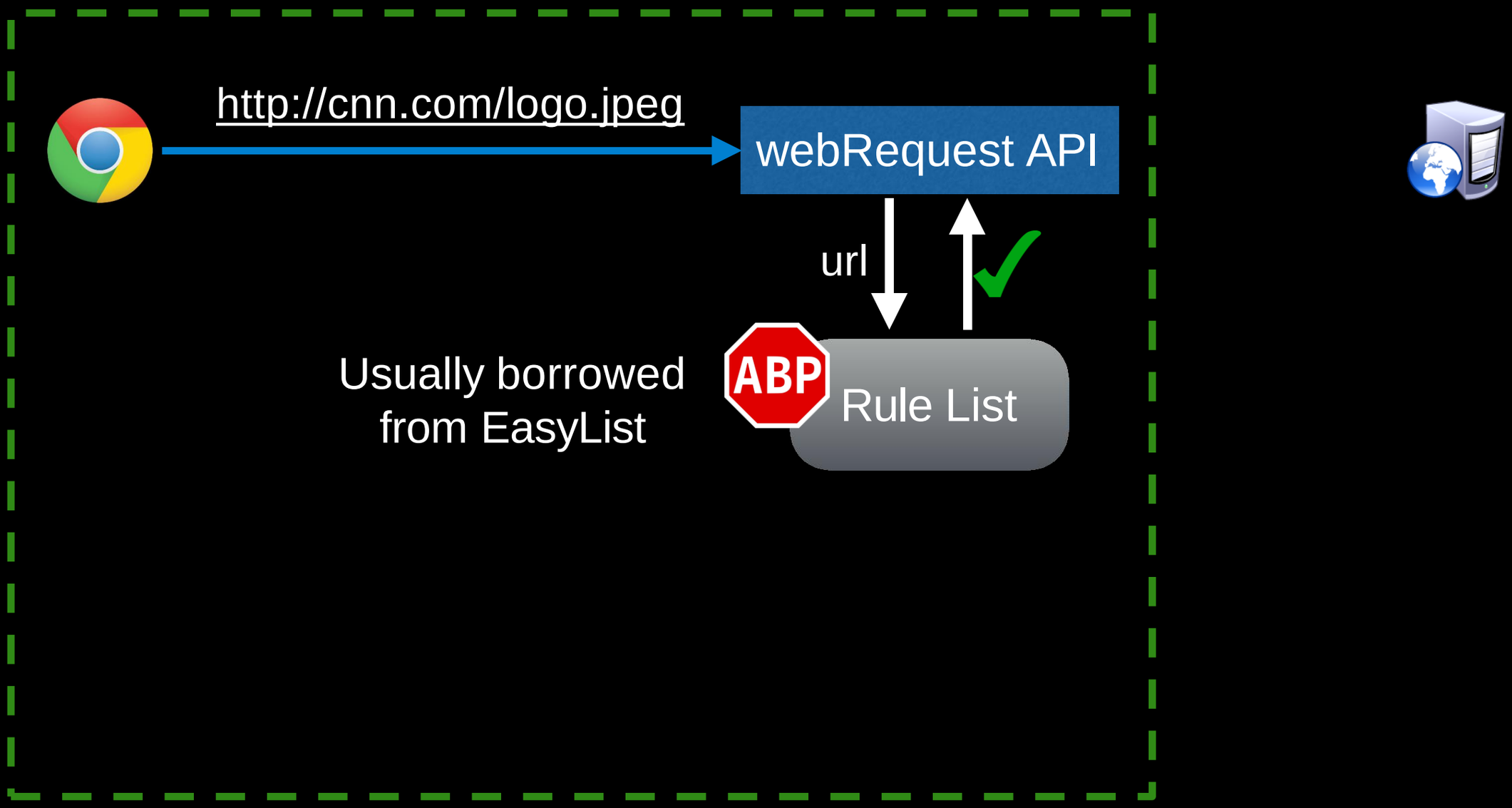

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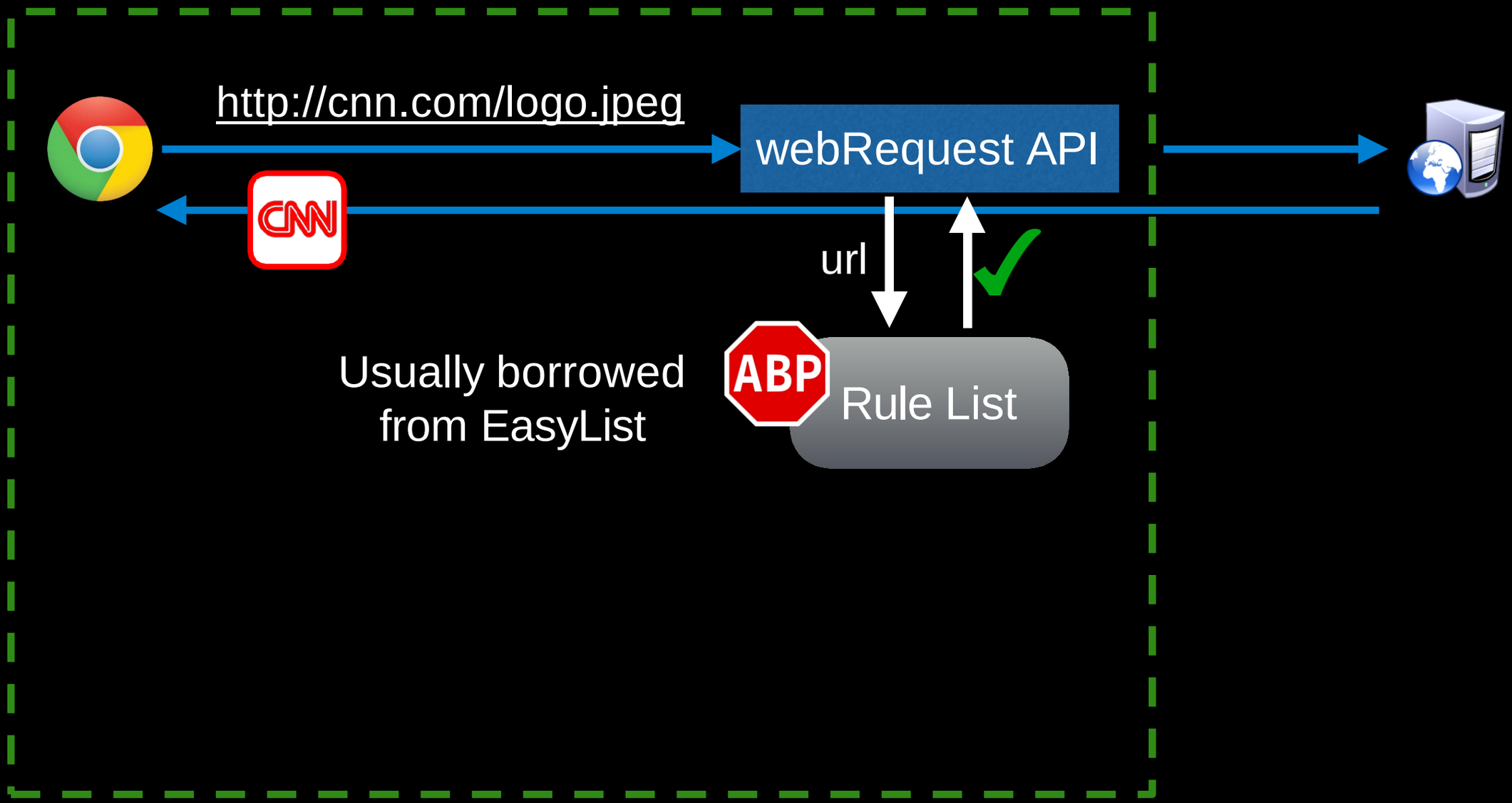

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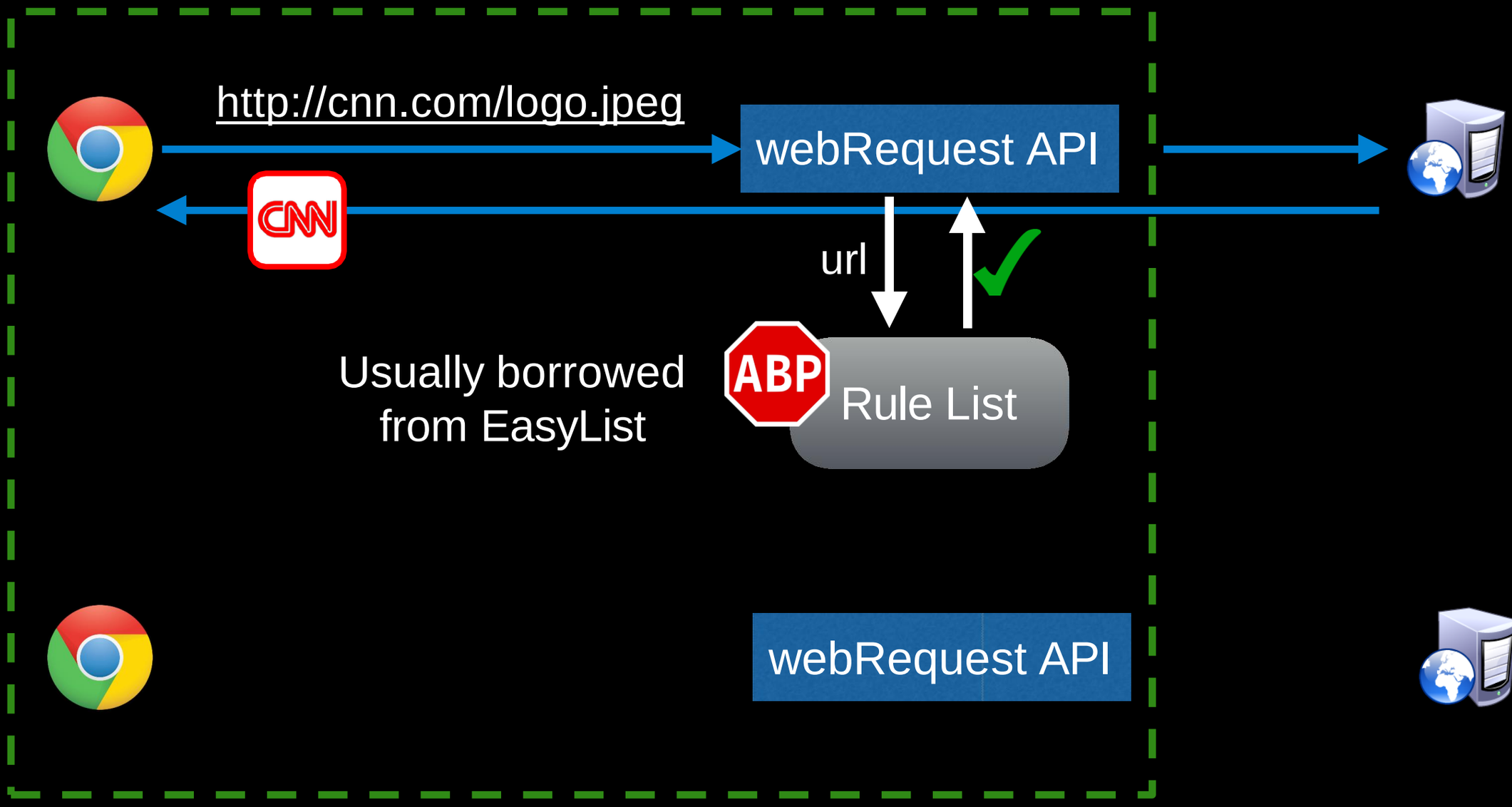

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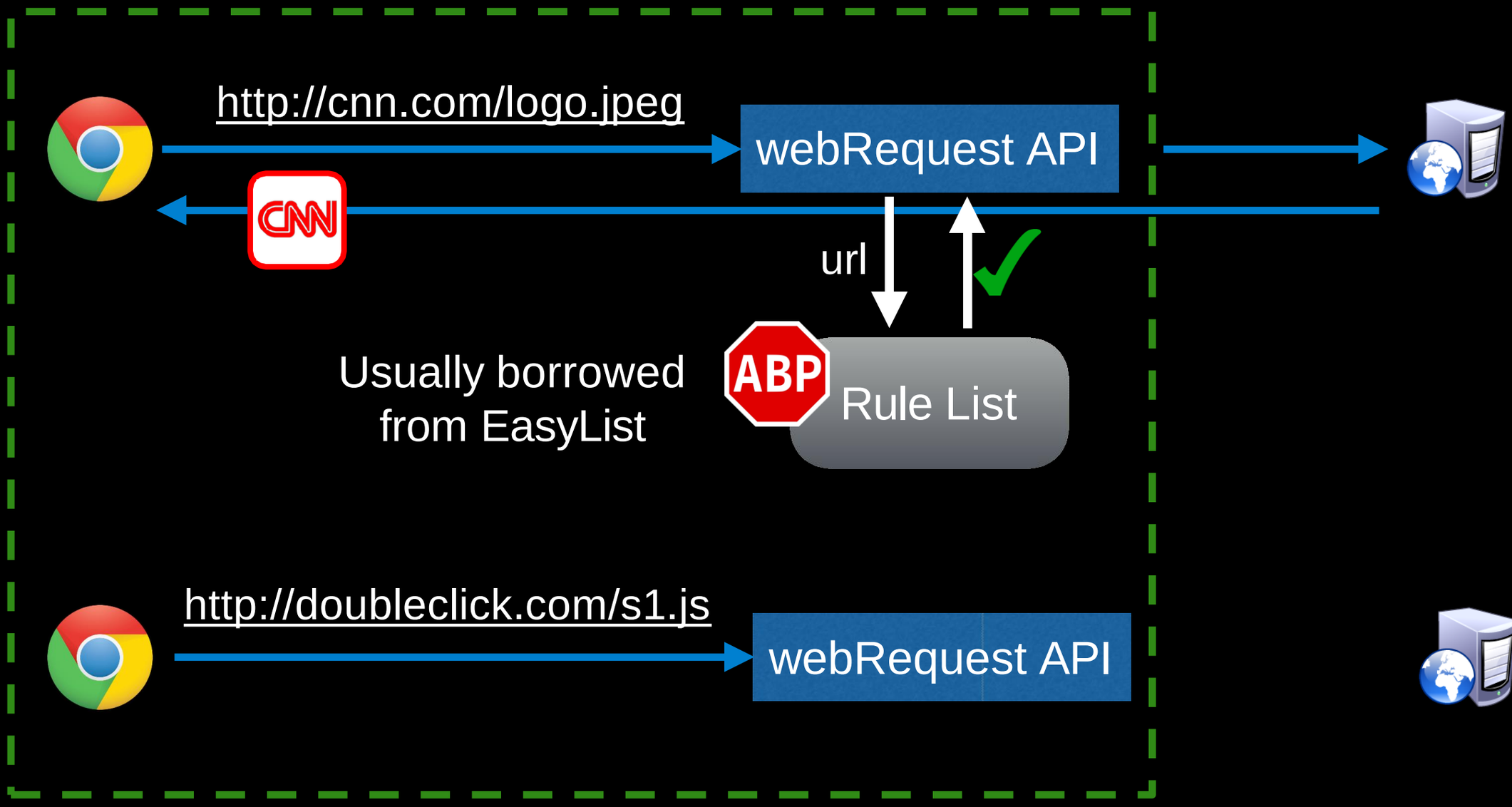

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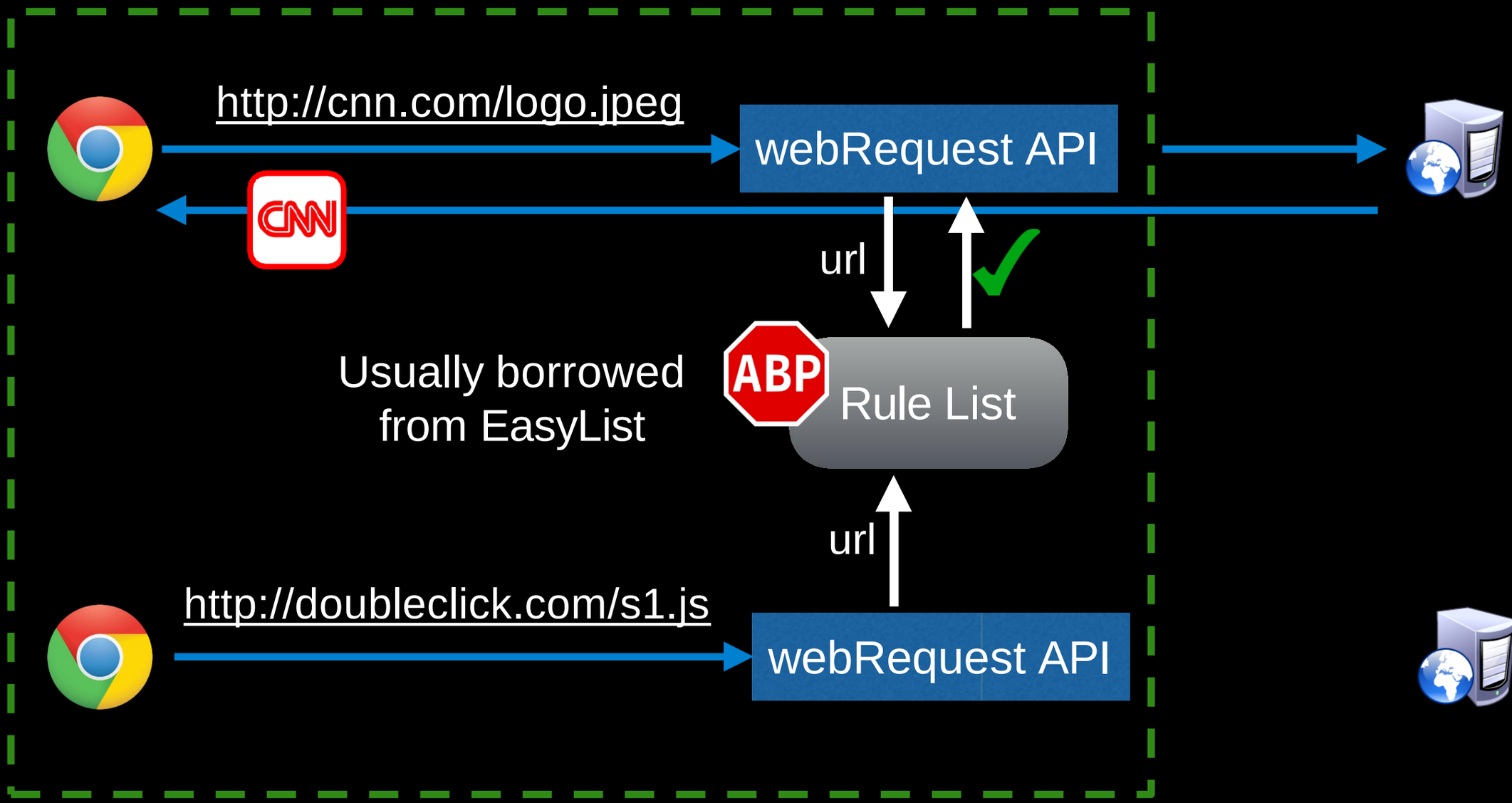

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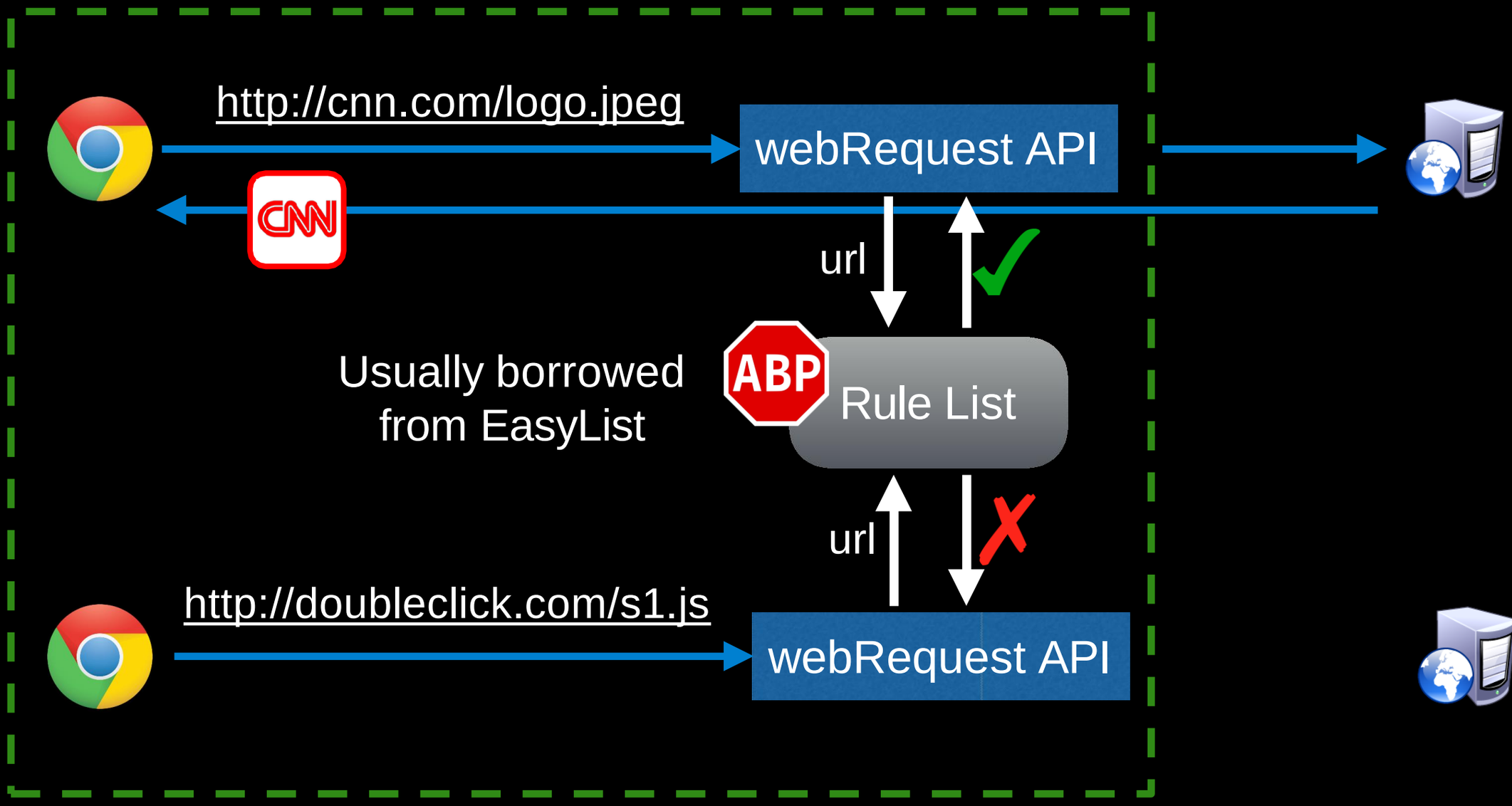

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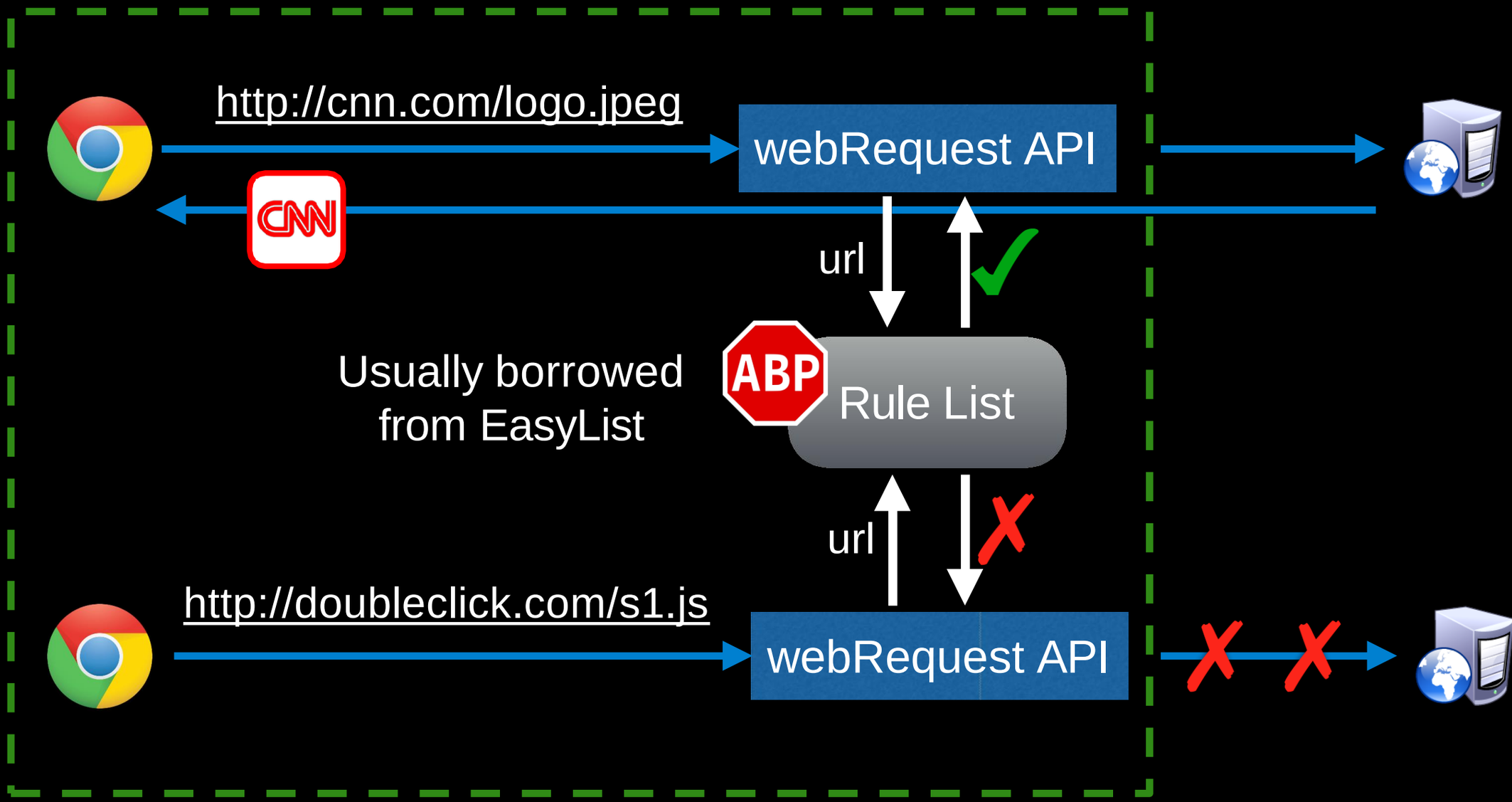

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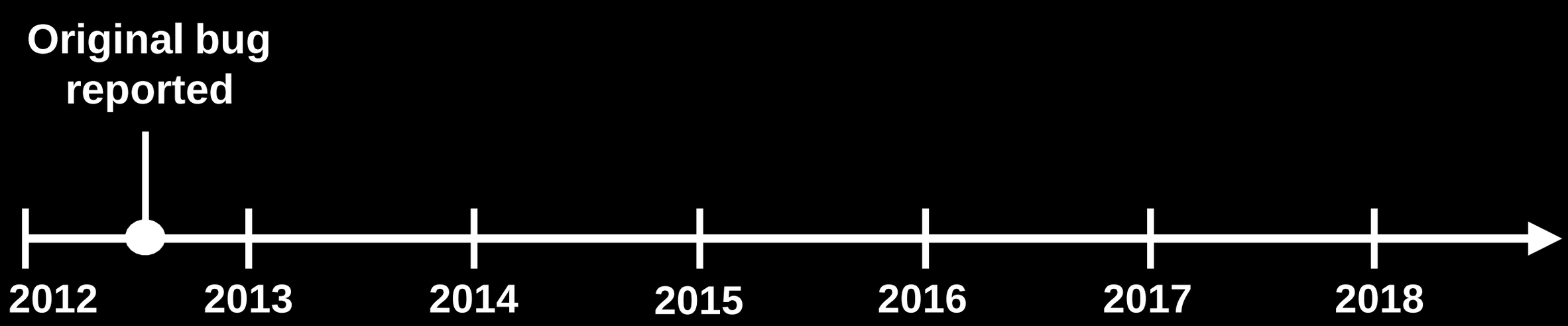

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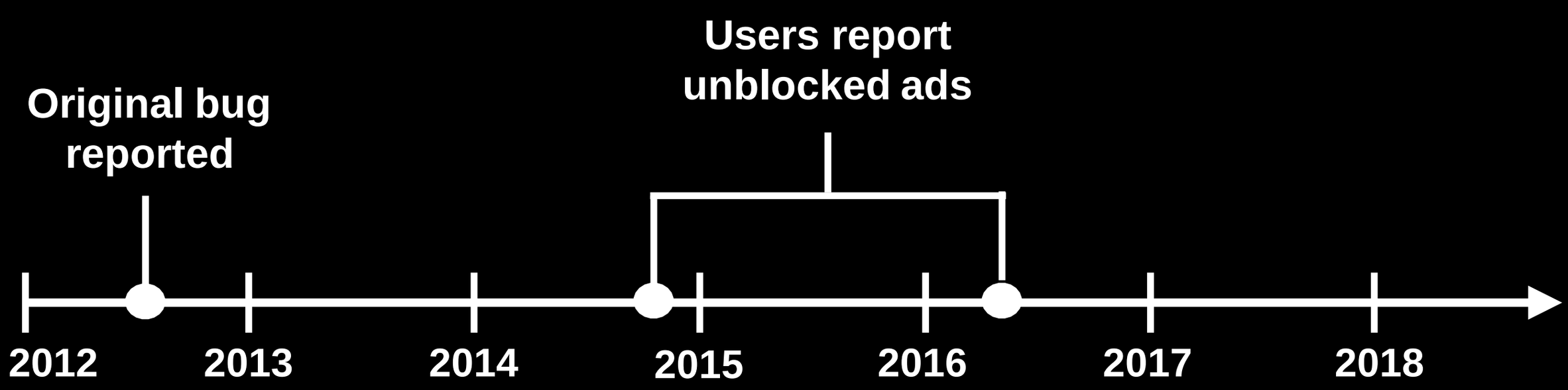

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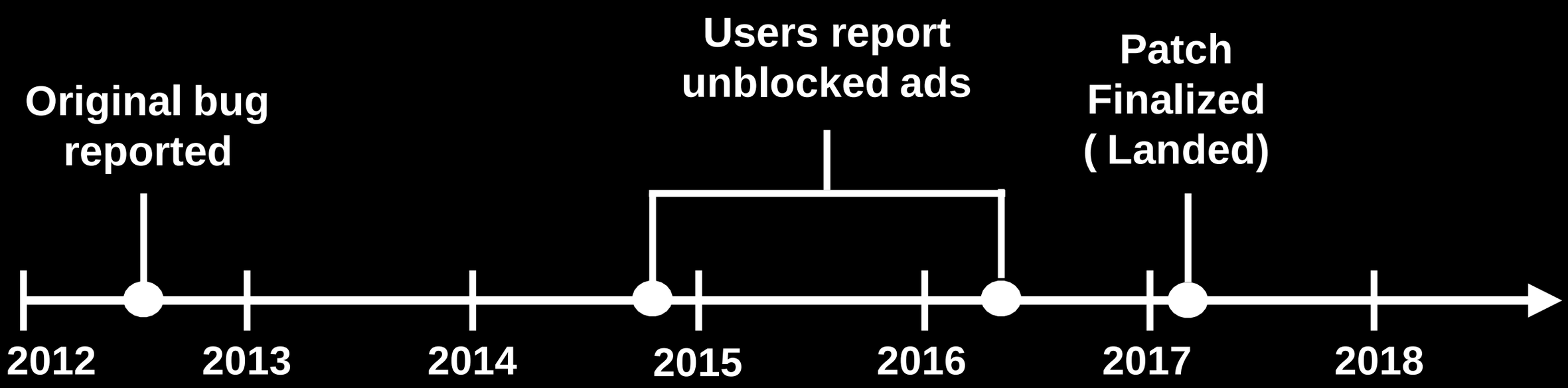

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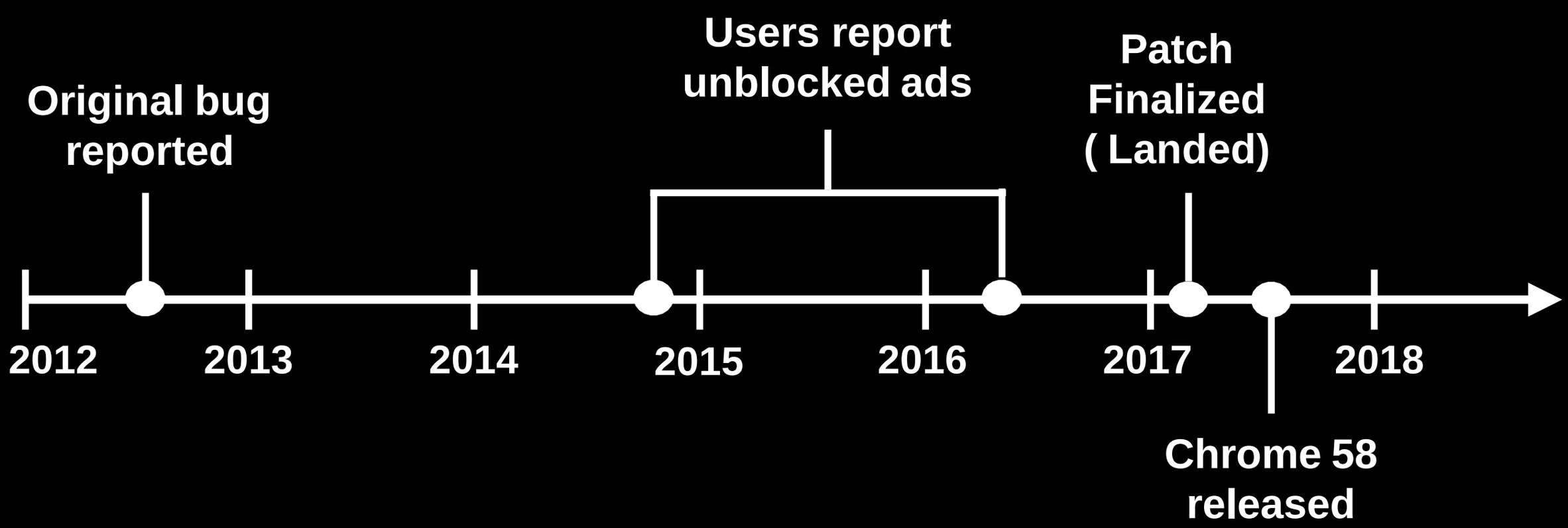

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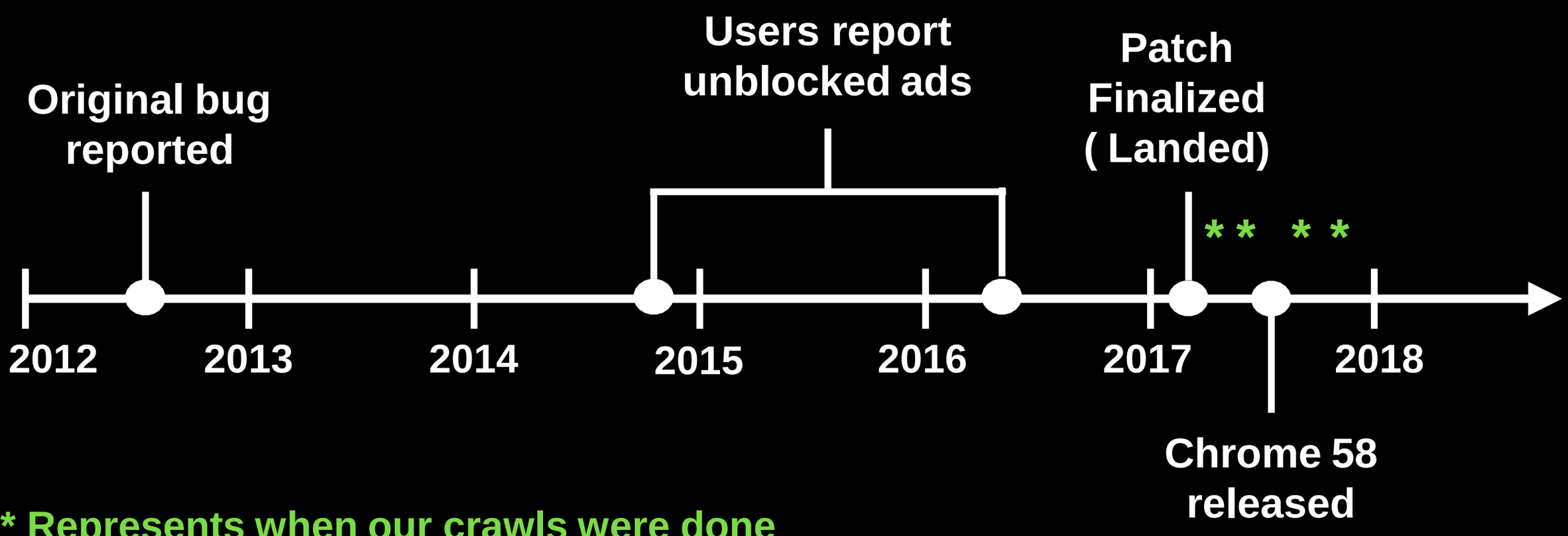

*** Represents when our crawls were done**

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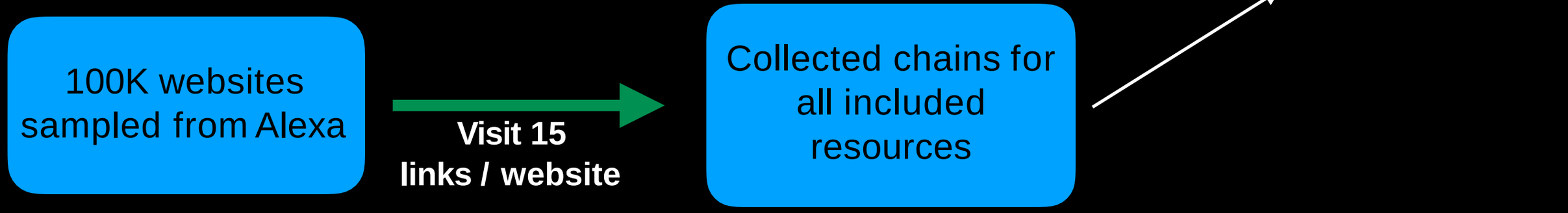

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Visit 15 links / website

Collected chains for all included resources

This means we know which resource included which other resource

Filter WebSockets

Filter all resources which end in web sockets

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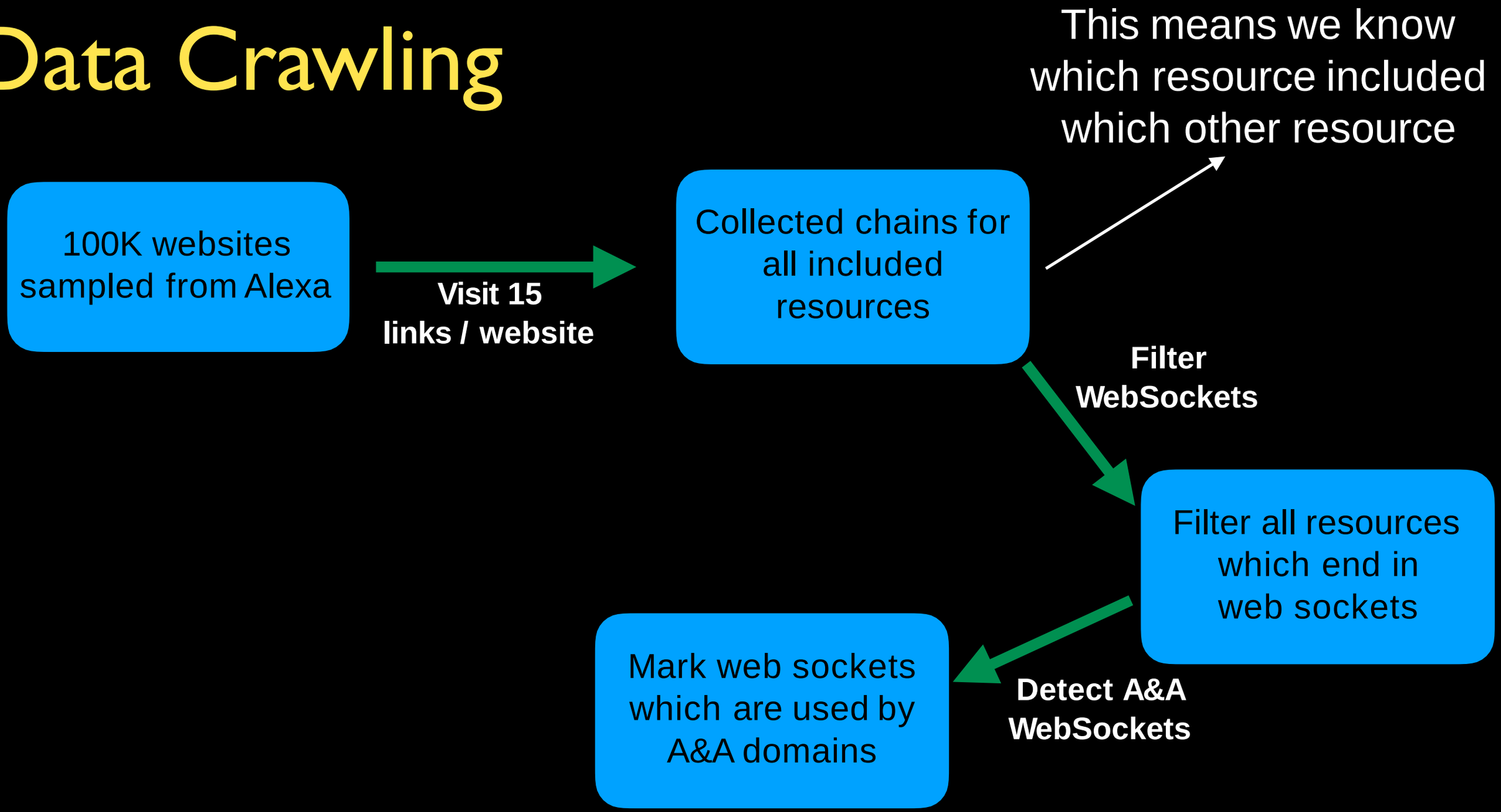

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Mark web sockets which are used by A&A domains

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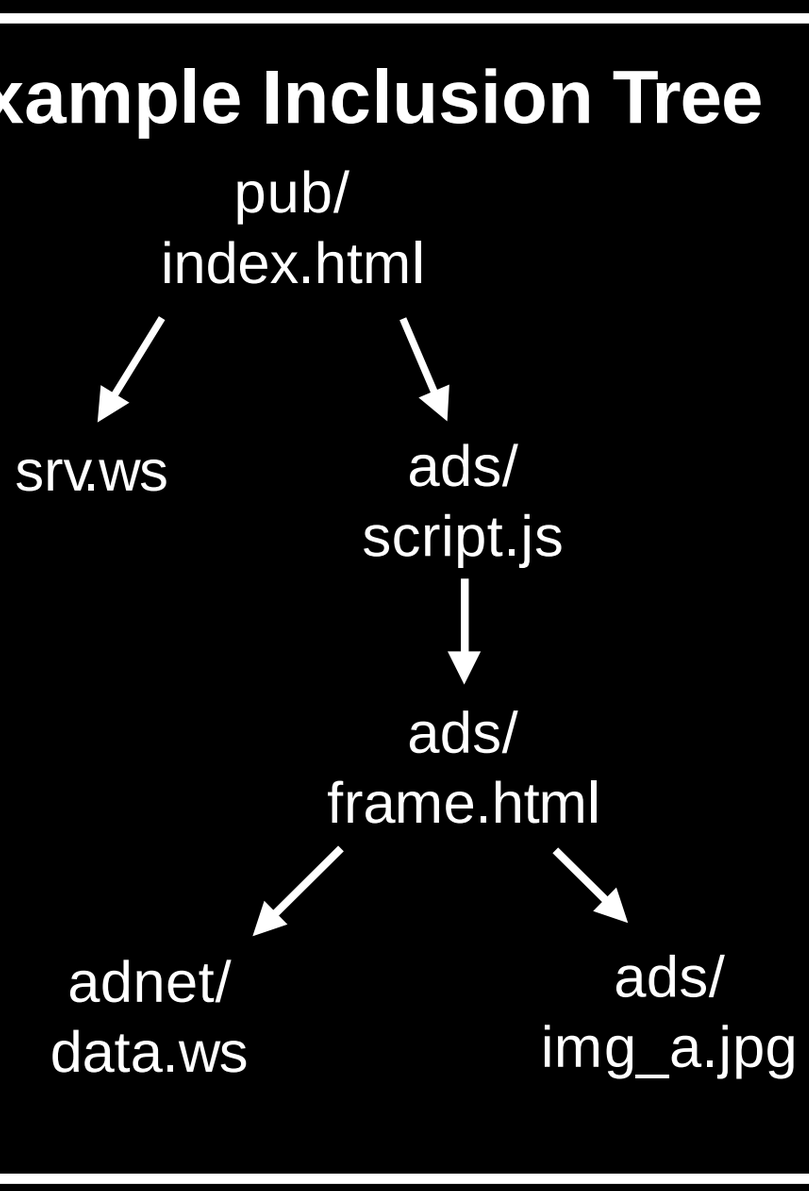

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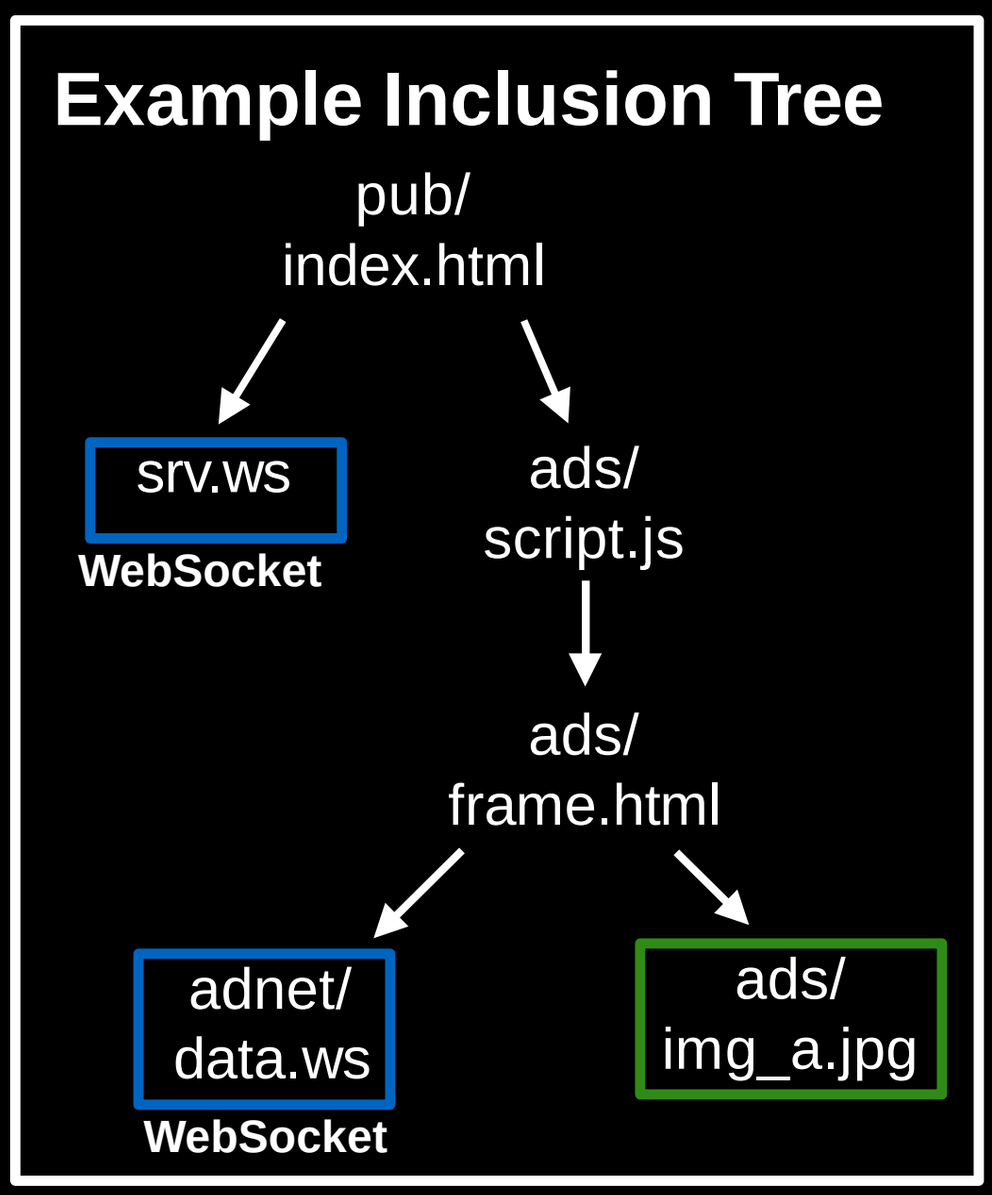

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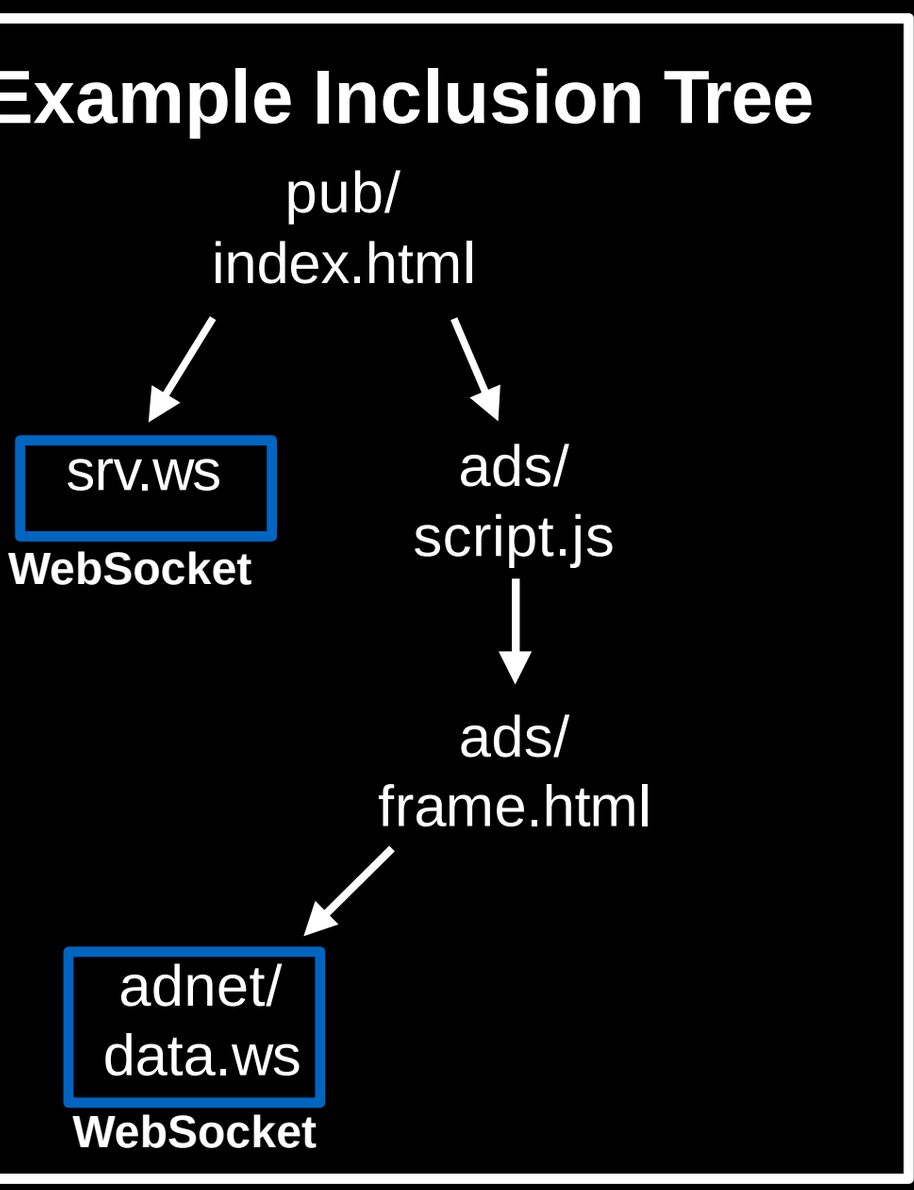

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pub/
index.html

ads/
script.js

ads/
frame.html

adnet/
data.ws

WebSocket

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- # Initiators drop after Chrome 58 release.
- Small but persistent A&A receivers.

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google	11
doubleclick	9
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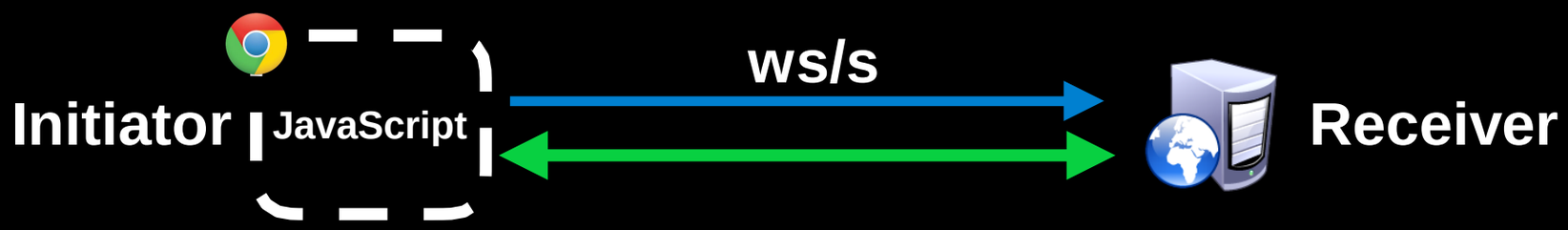

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- **33across** & **Lockerdome** are advertising platforms.
- **Inspectlet** & **Hotjar** are session replay services.

Sent Items Over Web Sockets

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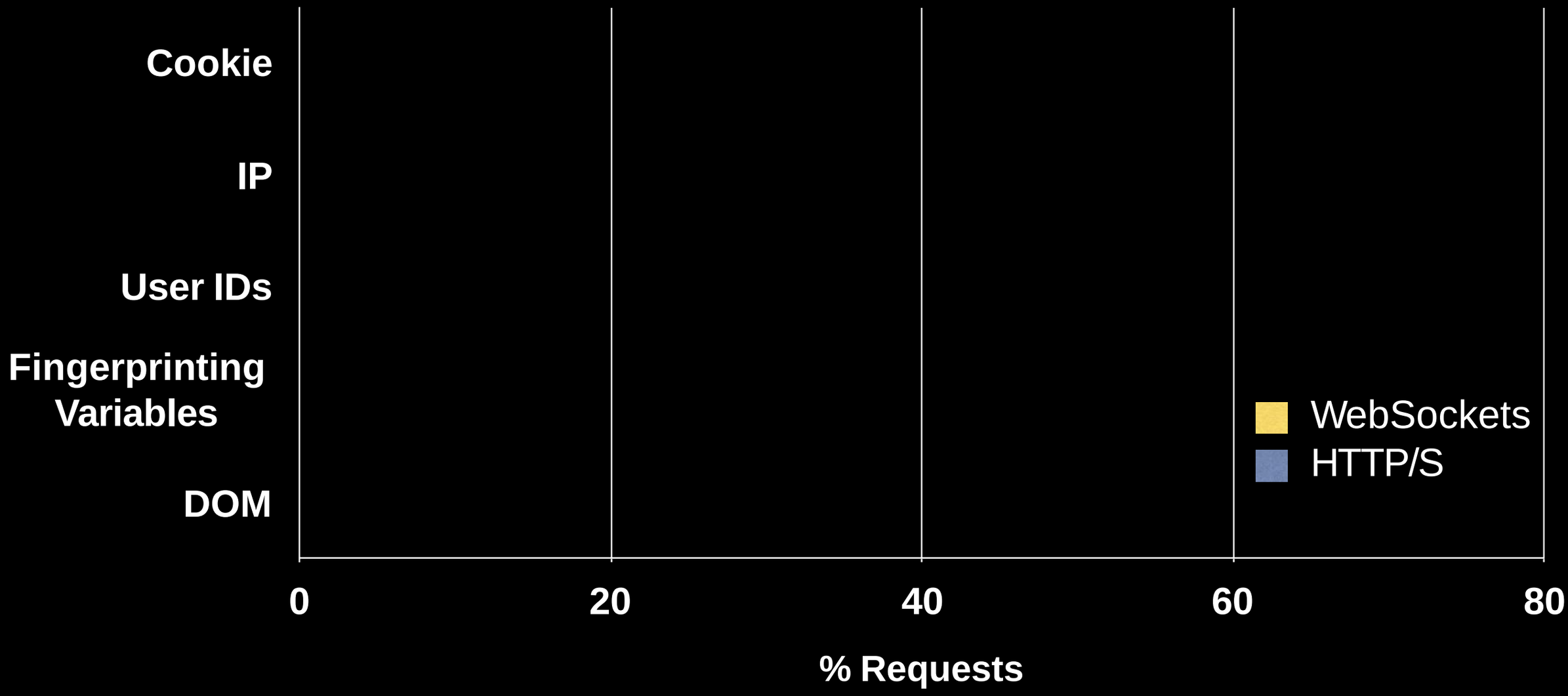

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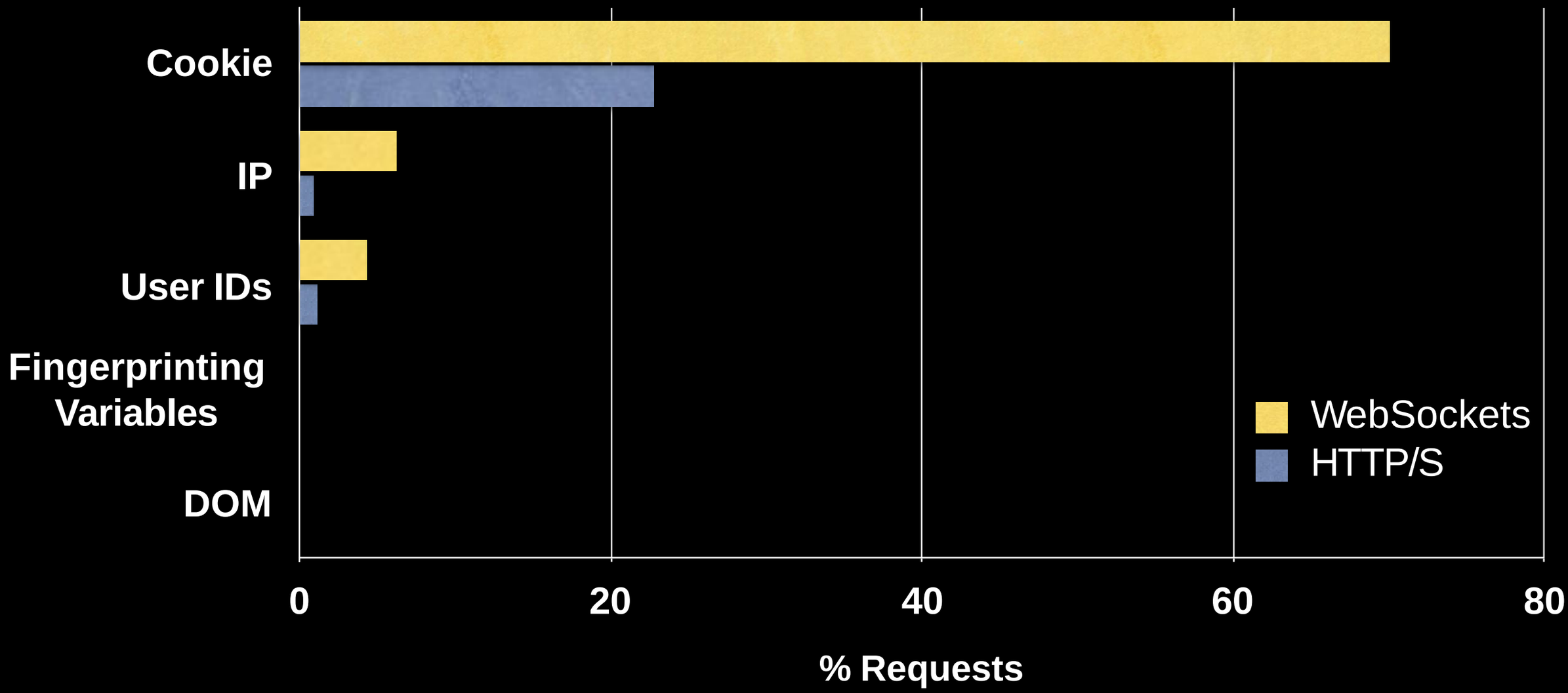
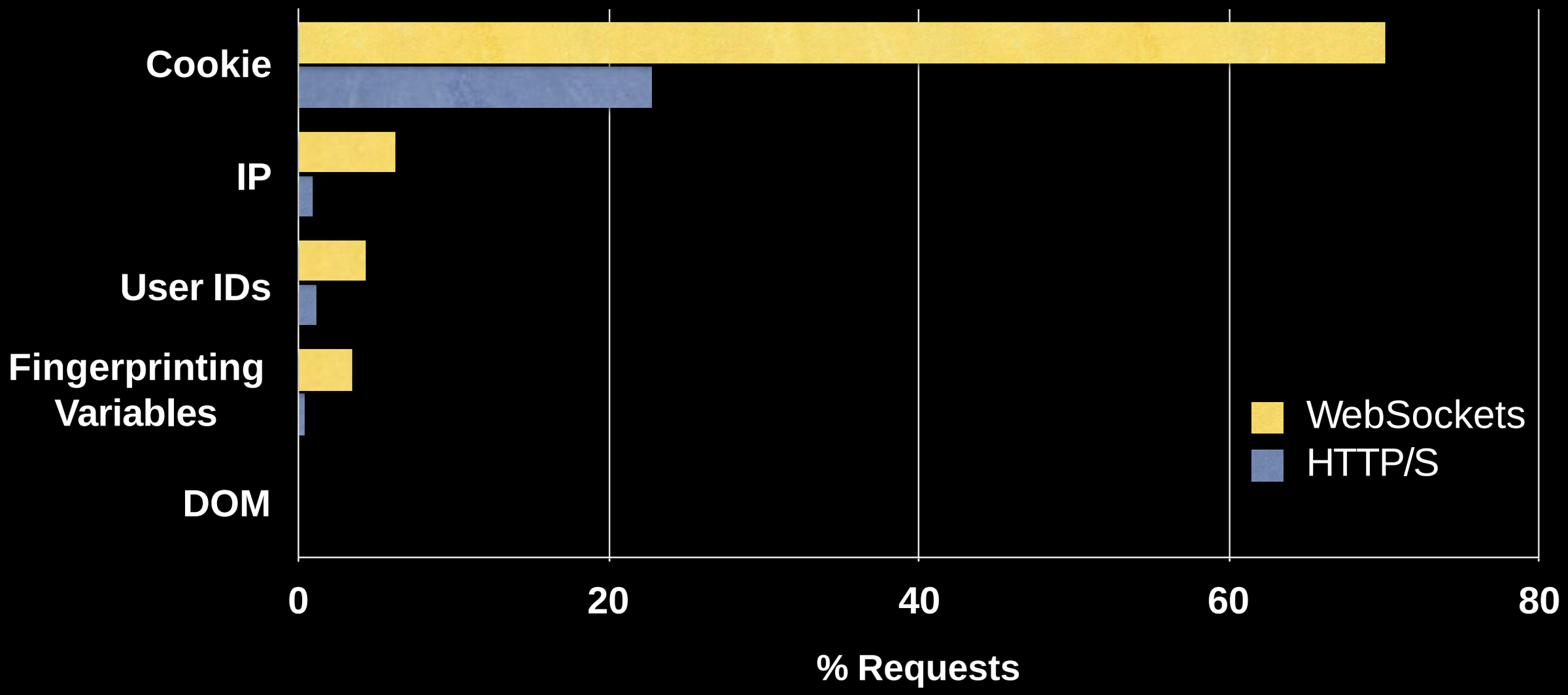


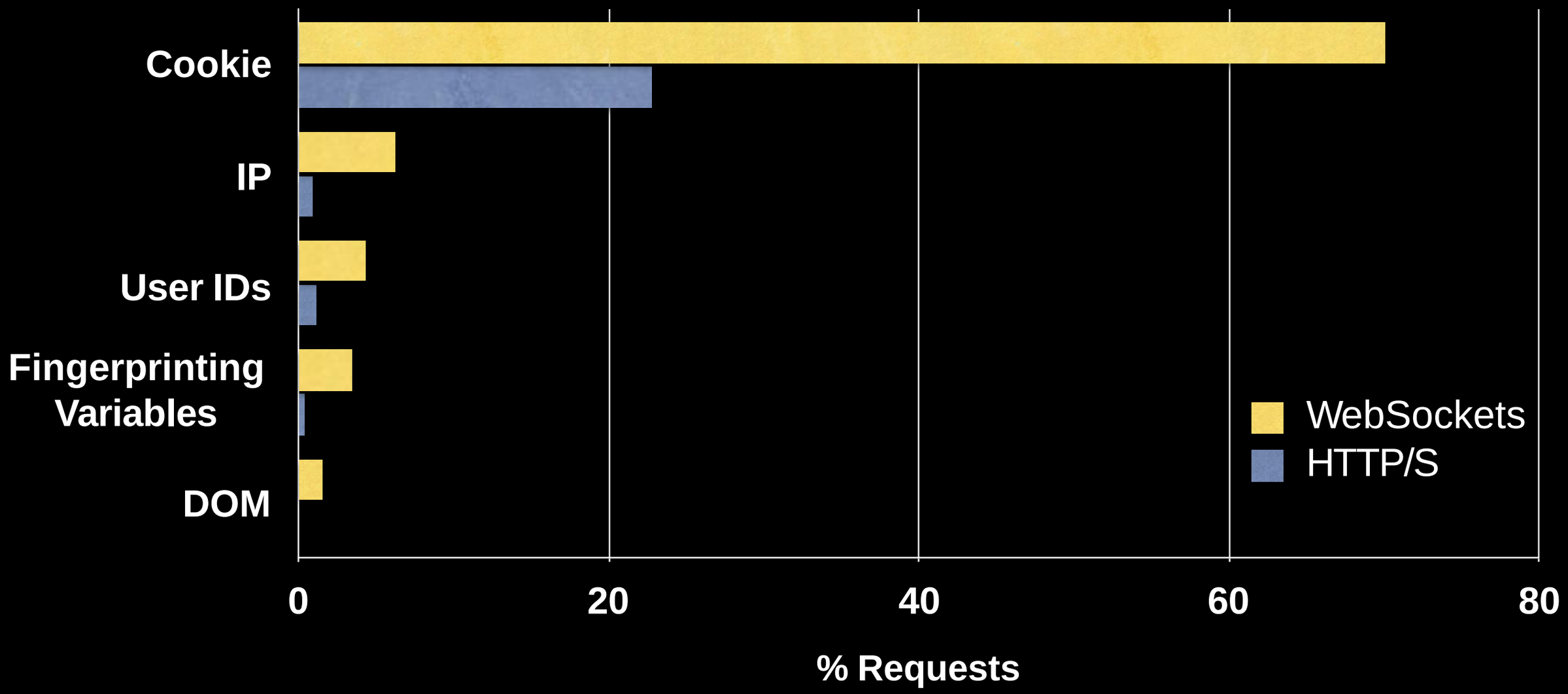
- Stateful Identifiers like Cookies and User IDs

Sent Items Over Web Sockets



- Stateful Identifiers like Cookies and User IDs
- Fingerprinting data in ~3.4% WebSockets.
  97% is **33across**

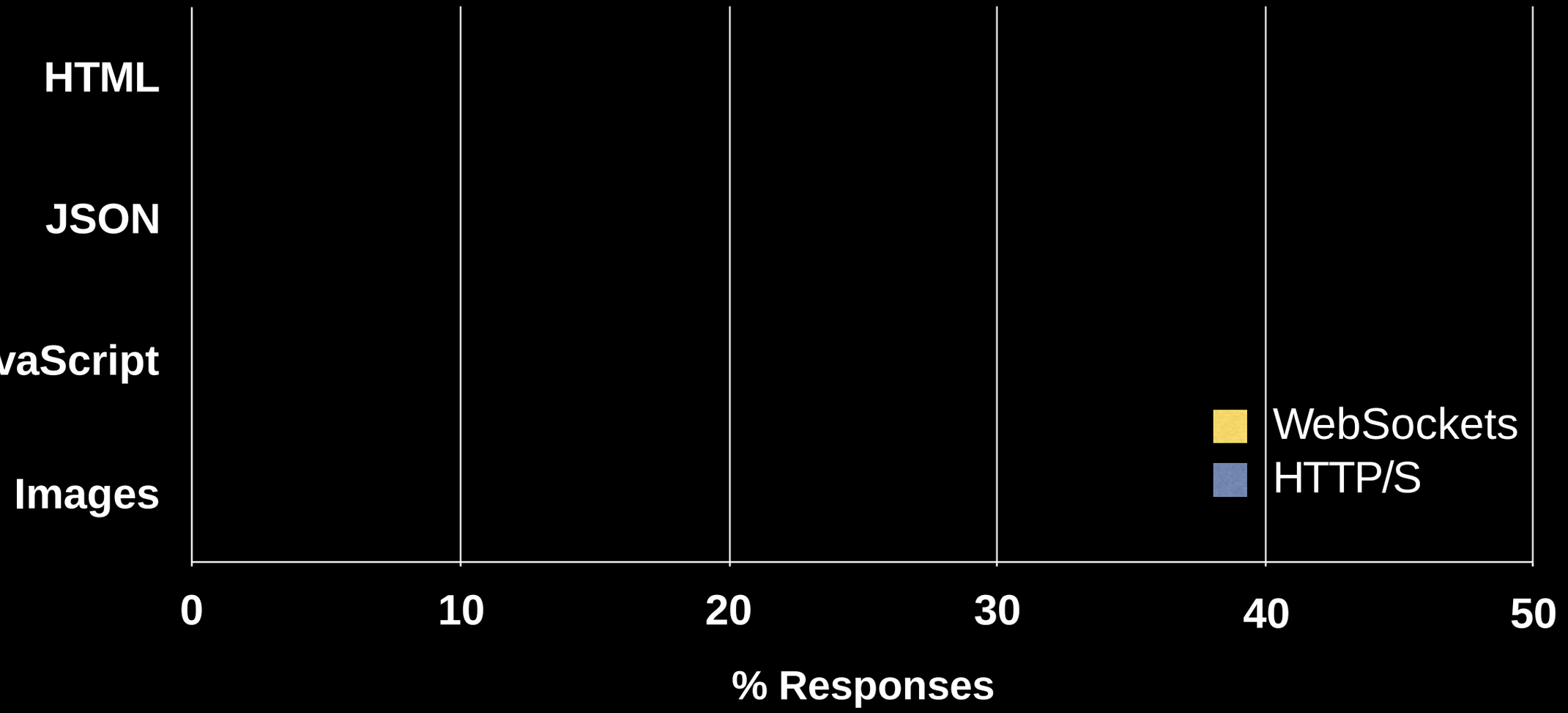
Sent Items Over Web Sockets



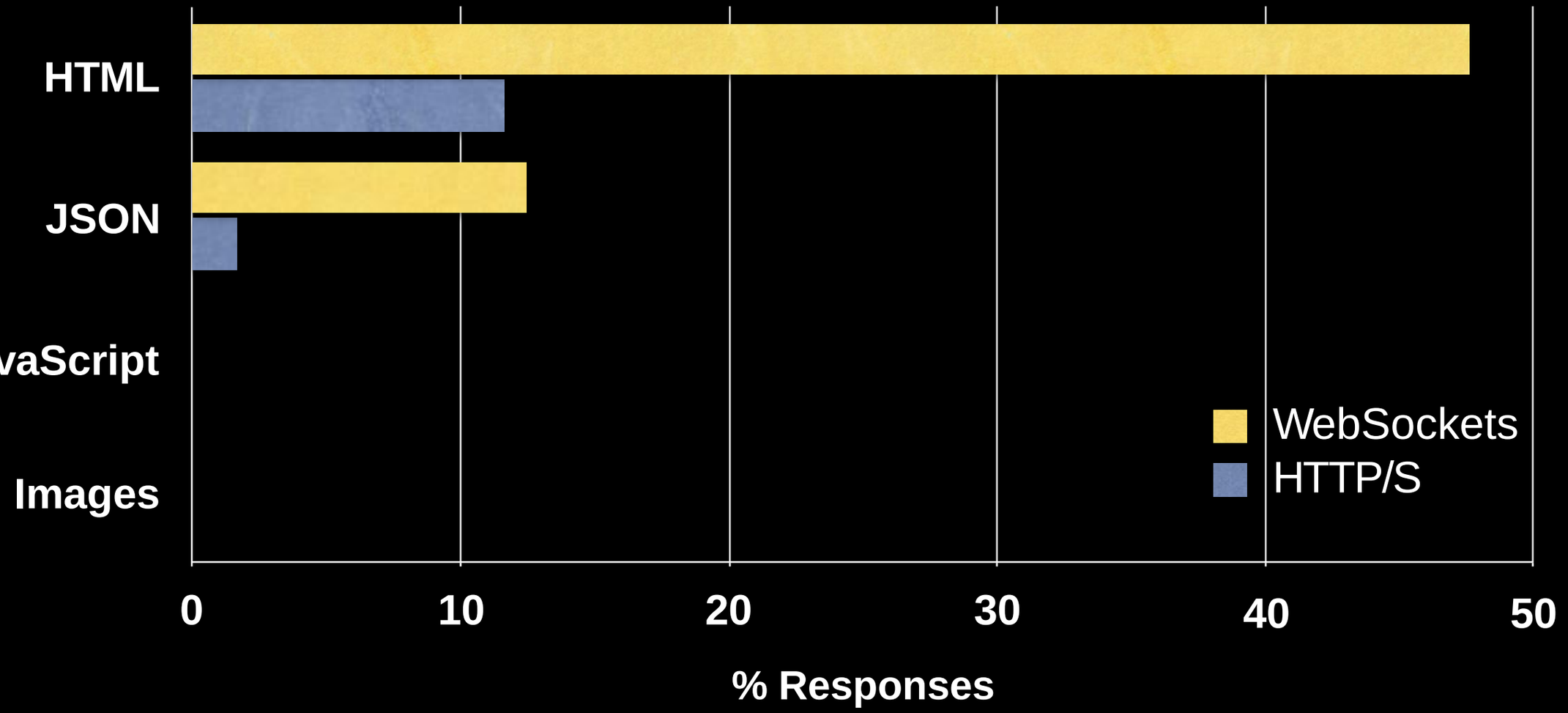
- Stateful Identifiers like Cookies and User IDs
- Fingerprinting data in ~3.4% WebSockets.
  97% is **33across**
- ~1.6% WebSockets sends the entire DOM to
  Hotjar, LuckyOrange, TruConversion

Received Items Over Web Sockets

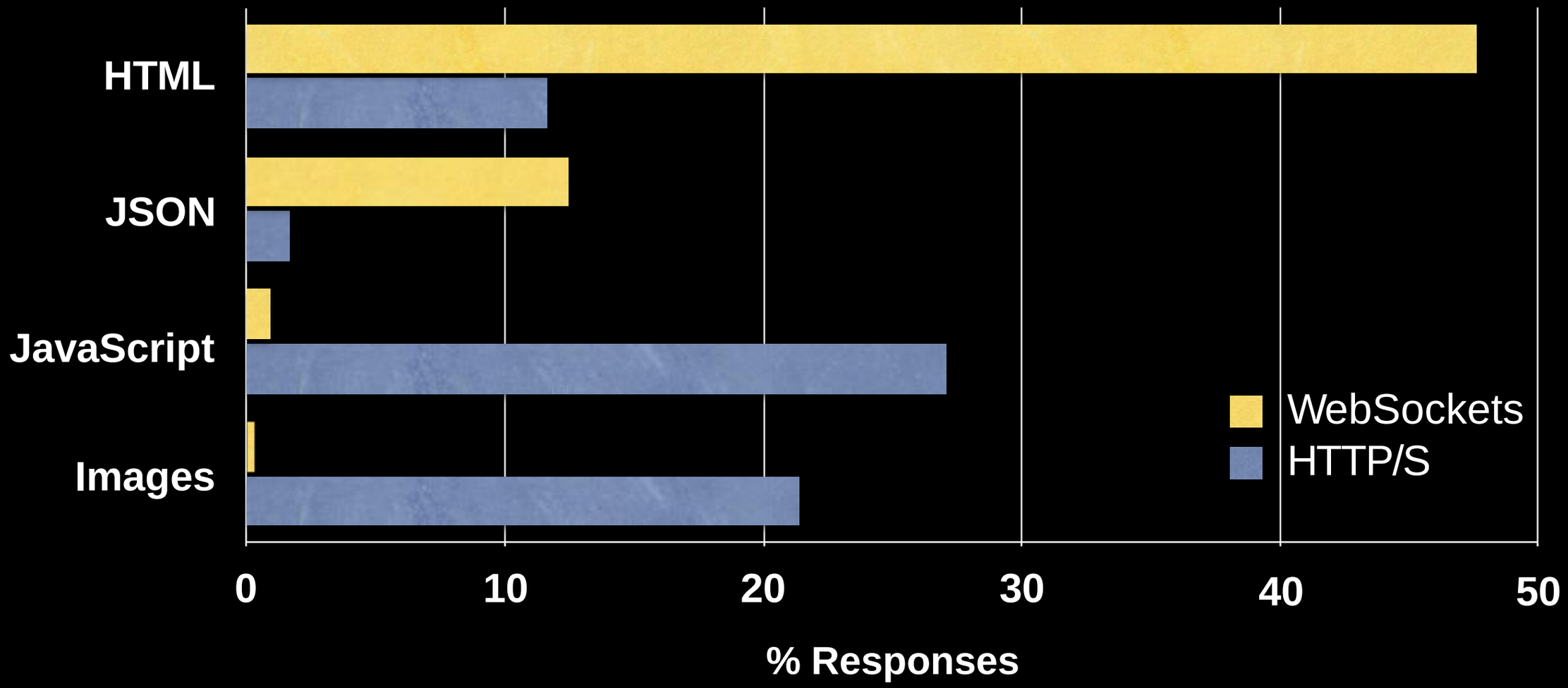
Received Items Over Web Sockets



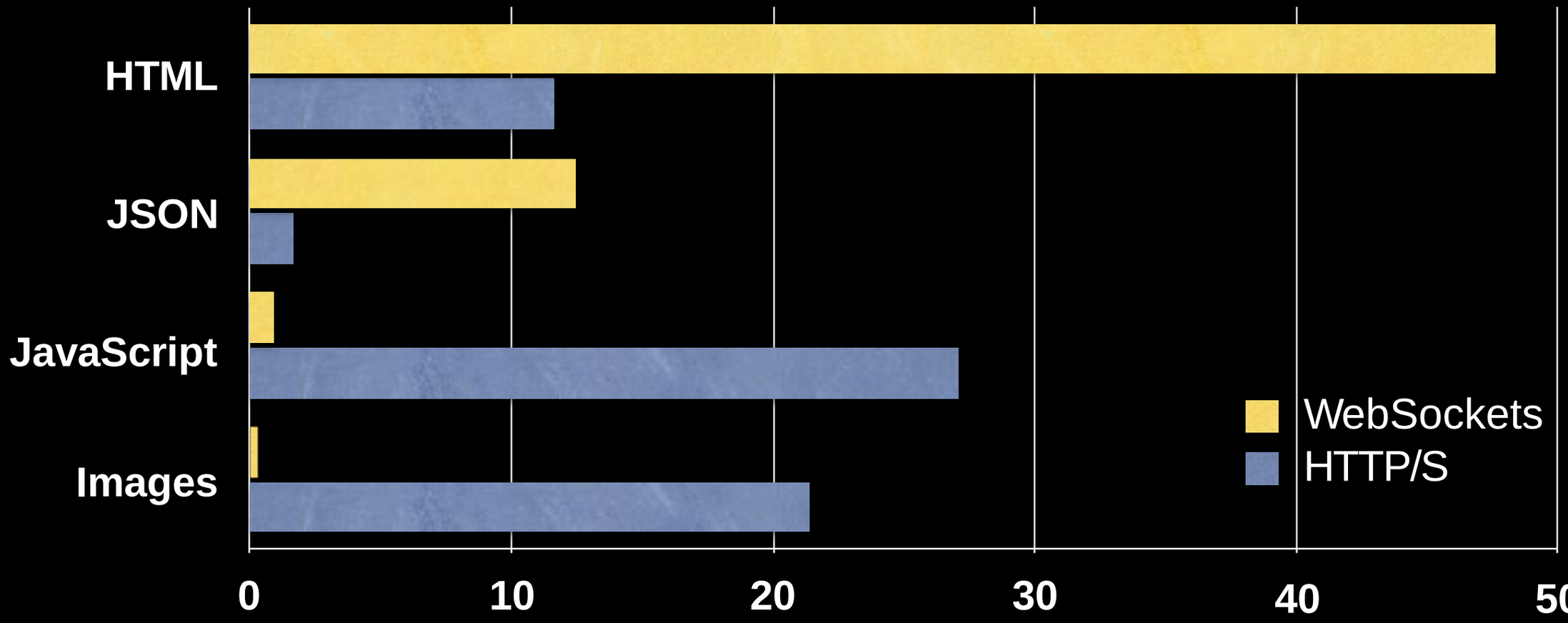
Received Items Over Web Sockets



Received Items Over Web Sockets



Received Items Over Web Sockets



Ads served from **Lockerdome**

Summary

- ~67% of socket connections are initiated or received by A&A domains.
- Major companies like Google, Facebook, Addthis adopted WebSockets. Abandoned after Chrome 58 was released.
- The culprits:
  - **33across** was harvesting fingerprinting data.
  - DOM exfiltration by **HotJar, LuckyOrange, TruConversion**
  - **Lockerdome** downloaded URLs to serve ads.
- We need to keep up with the current practices of A&A companies.

Implications

- How can we stop A&A networks from doing shady things?
- Mechanisms to help prevent tracking
  - Papaodyssefs et al (2015): private cookies to prevent tracking
  - Nikiforakis et al (2015): browser entropy to prevent fingerprinting
- However, ad blocking extensions are not always effective
  - Snyder et al (2016): extensions only blocked 65% of A&A WS connections
  - Franken et al (2018): developer mistakes affecting filters

Eric's Thoughts

- Interesting evaluation, particularly implications on A&A tactics
  - Some willing to exploit browser (security) loopholes to serve ads
  - However, most still did not do this
- Why did this loophole take so long to close (5 years)?
- Authors stated not obvious why stopped using WS after patch released
  - Correlation != causation, but…
  - Obvious educated guess: No more loophole → no more reason to use WS
- Weakness in evaluation: A&A domain matching had issues

Your Thoughts

- Measurement researchers liked it, others not so much
  - Reethika and Ram both rated it “Accept”
  - Jiacheng didn’t like it (“Weak Reject”)
  - Ben really didn’t like it (“Reject”)
  - I liked it (“Accept”)
  - Average score was 3.25 (as of earlier this afternoon)
- Jiacheng: Good that authors named A&A companies
  - Agreed! It was quite nice vs other papers that say “Company A”
- Ben: Conclusion was obvious, no suggestions on how to fix problem
  - I disagree somewhat. They were seeking to gather data about prevalence of well-known issue
  - Issue was already patched by Google as of publication
- Ed and Junpeng: Needs discussion of why WS usage ceased after patch
  - Agreed! I thought this as well during my reading
- Reethika: Alexa isn’t a good source of domains for experiments
  - This list can change rapidly (Reethika cited another IMC ‘18 paper stating this)

Your Thoughts

- Can and Ram: Why did it take Google (also does A&A) five years to fix this bug?
  - Very valid question
- Steve: They didn't need to build their own inclusion tree analysis tools
  - Steve: Two tools already exist that have been used in prior research
- Can: Authors state that many companies have legitimate uses for WS
  - Some need them for legitimate purposes, but others used them to work around user preferences
- Kevin: Observational, not empirical study → can't draw conclusions

Backup Slides

Inclusion Chain

DOM Tree

```
<html>
  <body>
    <script src="tracker/script.js" </script>
    <img src="tracker/img.jpg"> </img>

    <script src="ads/script.js"> </script>
    <iframe src="frame.html">
        <html> <body>
          <script src="script_12.js"> </script>
          <img src="img_a.jpg"> </img>
        </body> </html>
      </iframe>
    </body>
  </html>
```

Source code for ads/script_12.js

```
let ws =
  new WebSocket("ws://adnet/data.ws", …);
  ws.onopen = function (e) {ws.send("…");}
```

Inclusion Tree