Tales of Favicons and Caches: Persistent Tracking in Modern Browsers

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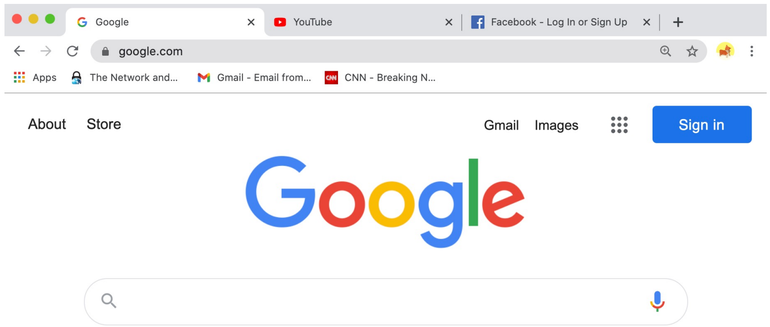
UIC

What is a Favicon?

- Introduced in Internet Explorer 5, 1999
    - ”Favorite website icon” → Favicon
    - Small icon associated with a webpage



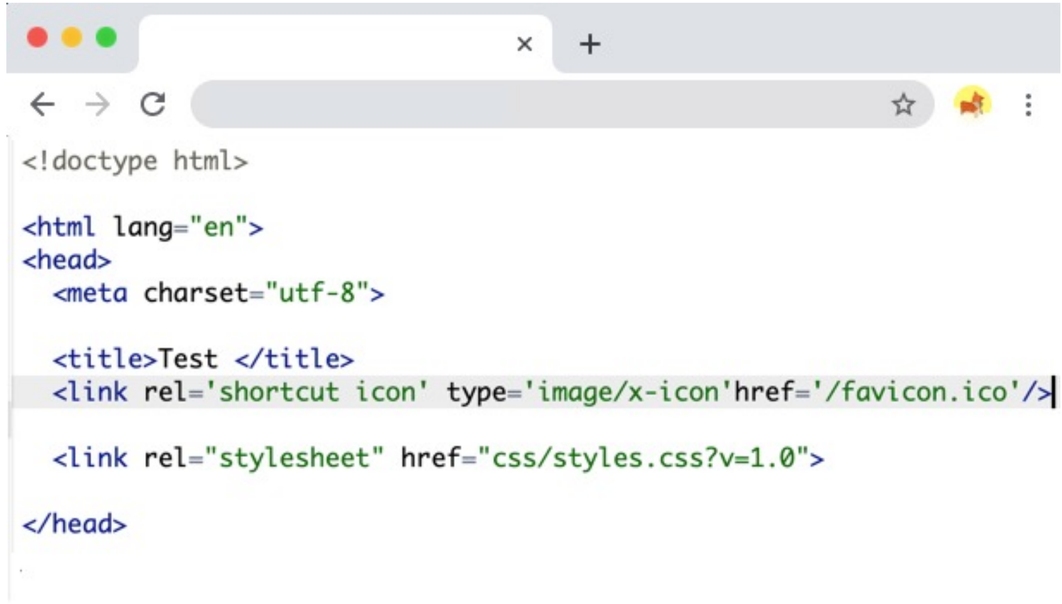
- Different icon formats
- Supported by all browsers and devices
- Part of websites’ branding identity

Favicon Storage & Cache

- Automatically requested and fetched

- **Dedicated Favicon Cache**

  1. Page URL
  2. Favicon ID
  3. Expiration Time (TTL)
  4. Dimensions



Favicon Cache Policies

ID	Page URL	Favicon ID	TTL	Dimensions	Size
1	foo.com	favicon.ico	5000	16x16	120
2	abc.foo.com	icon.png	1000	32x32	240
3	foo.com/path	favicon2.ico	25000	16x16	180

1. Requirements for creating an *entry*
    I. Favicon not already exists
    II. Favicon URL is valid
    III. Icon renders properly

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2. Subdomains and inner paths create different entries

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3. Access Control

- Incognito mode can read and not write

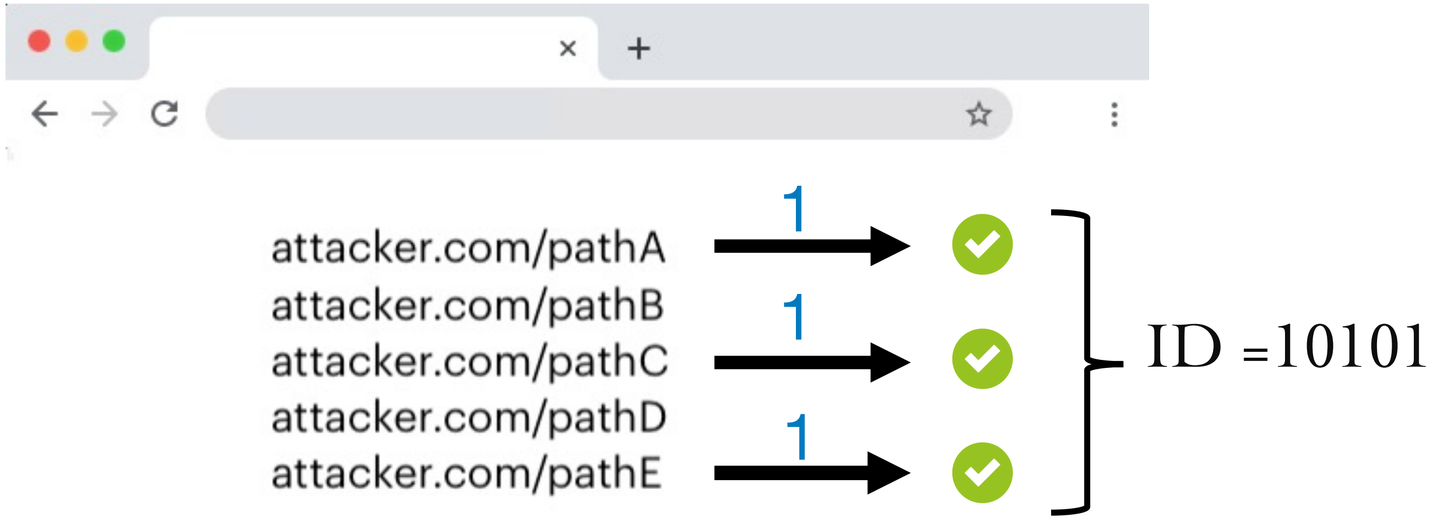
Favicon Supercookie

- Leverage favicons to create **persistent tracking identifier** for user across visits

- Attacker website
  1. Encodes chain of subpaths as a vector : <pathA, pathB, pathC , pathD>
  2. Serves different favicons for each path : <iconA, iconB, iconC, iconD>
  3. Stores browser identifier as favicon cache entries

Threat Model

Victim visits website and the identifier is automatically stored

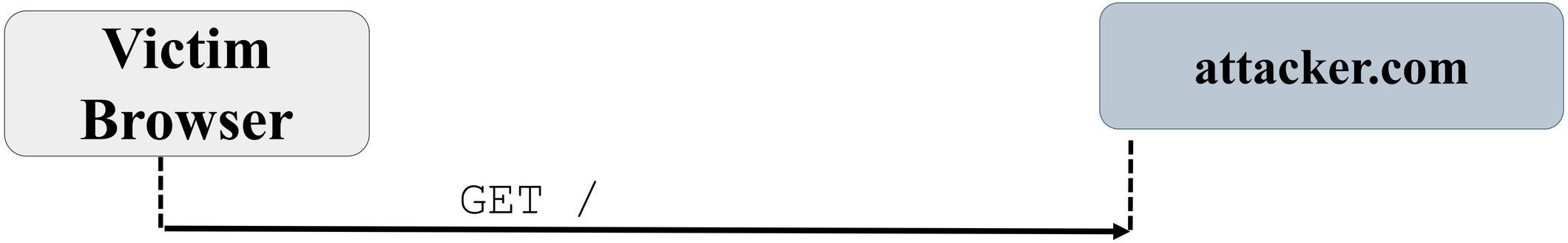


Write Identifier

Victim Browser

attacker.com

Write Identifier



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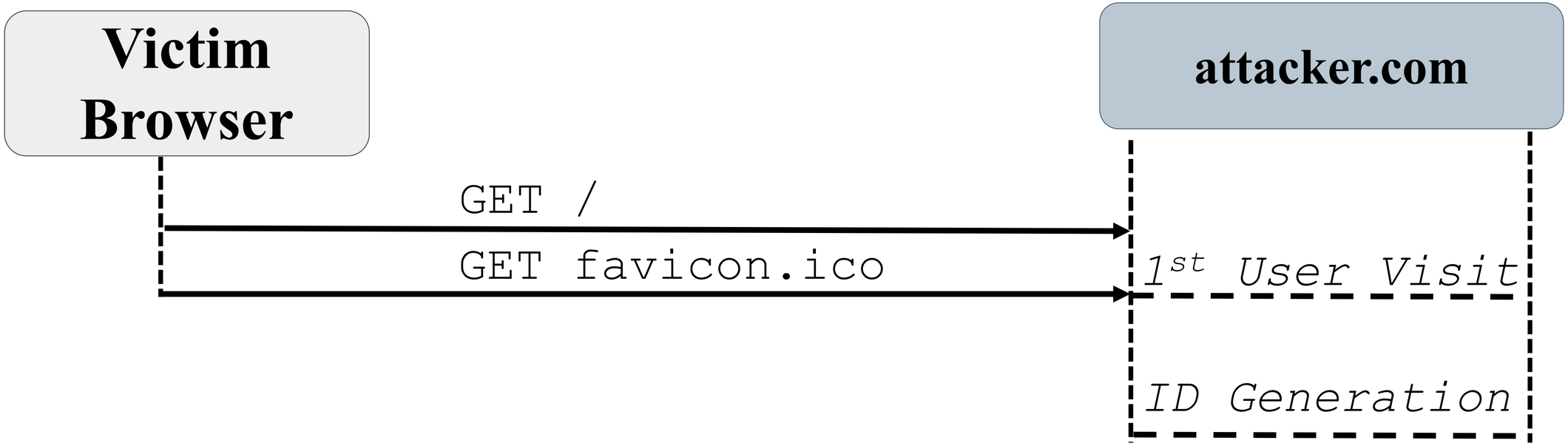

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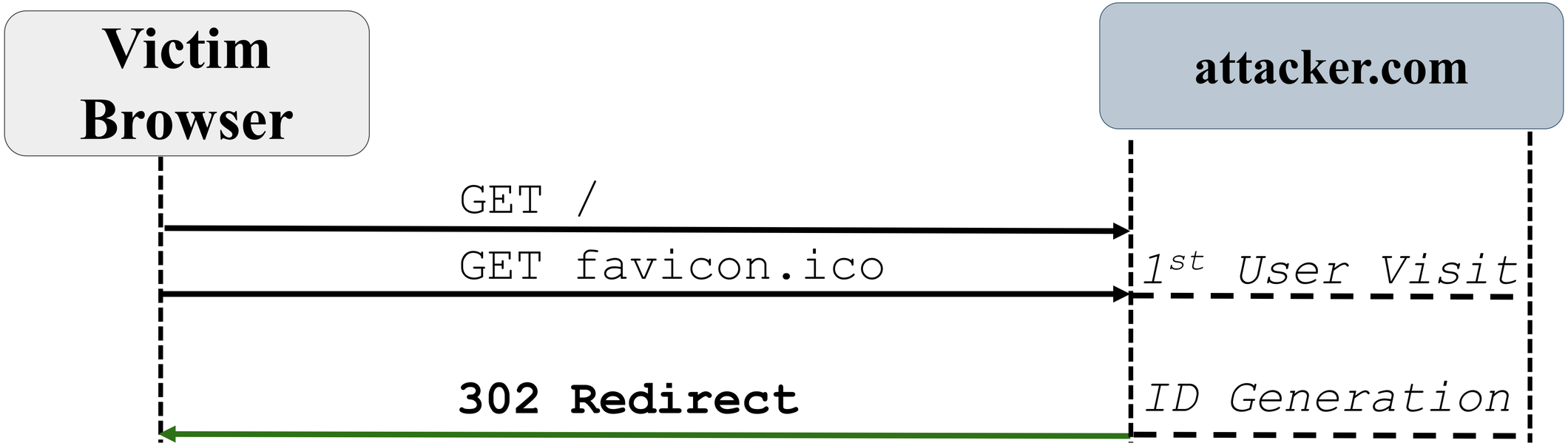

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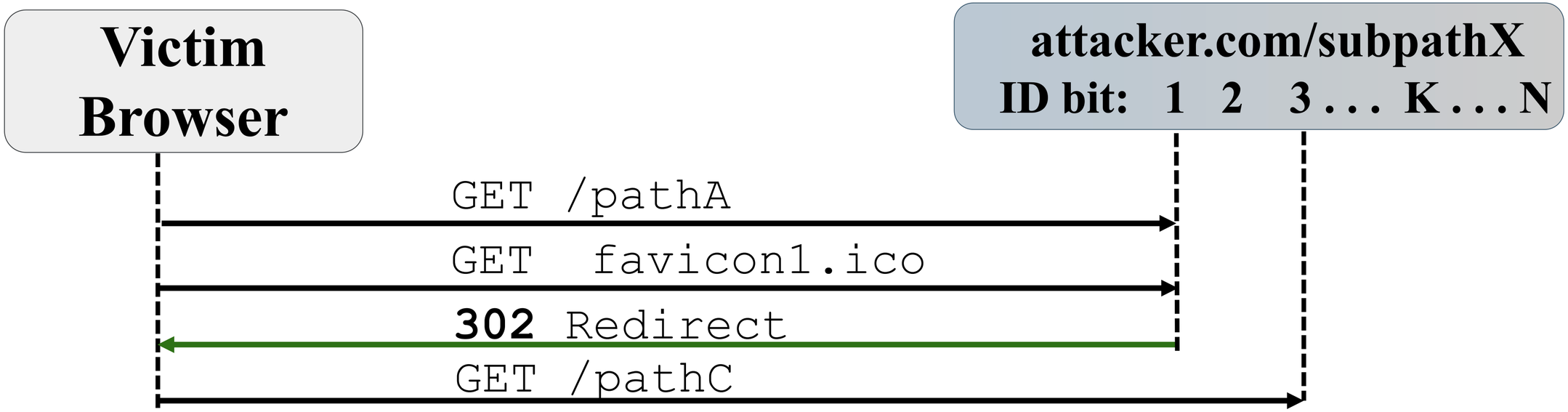

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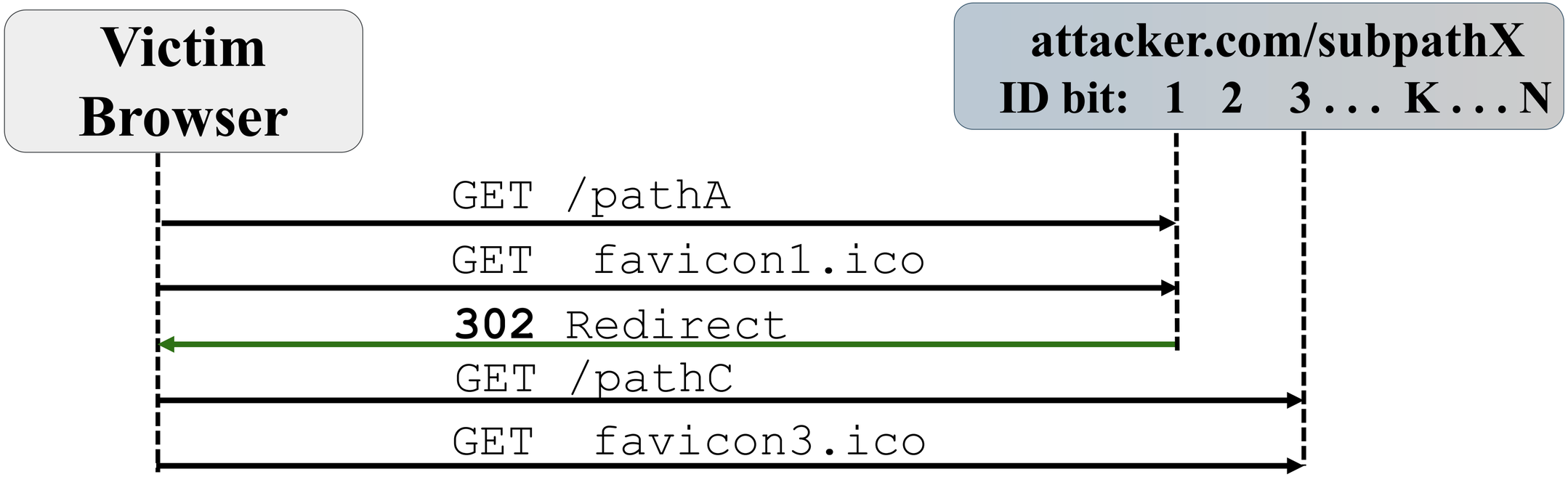

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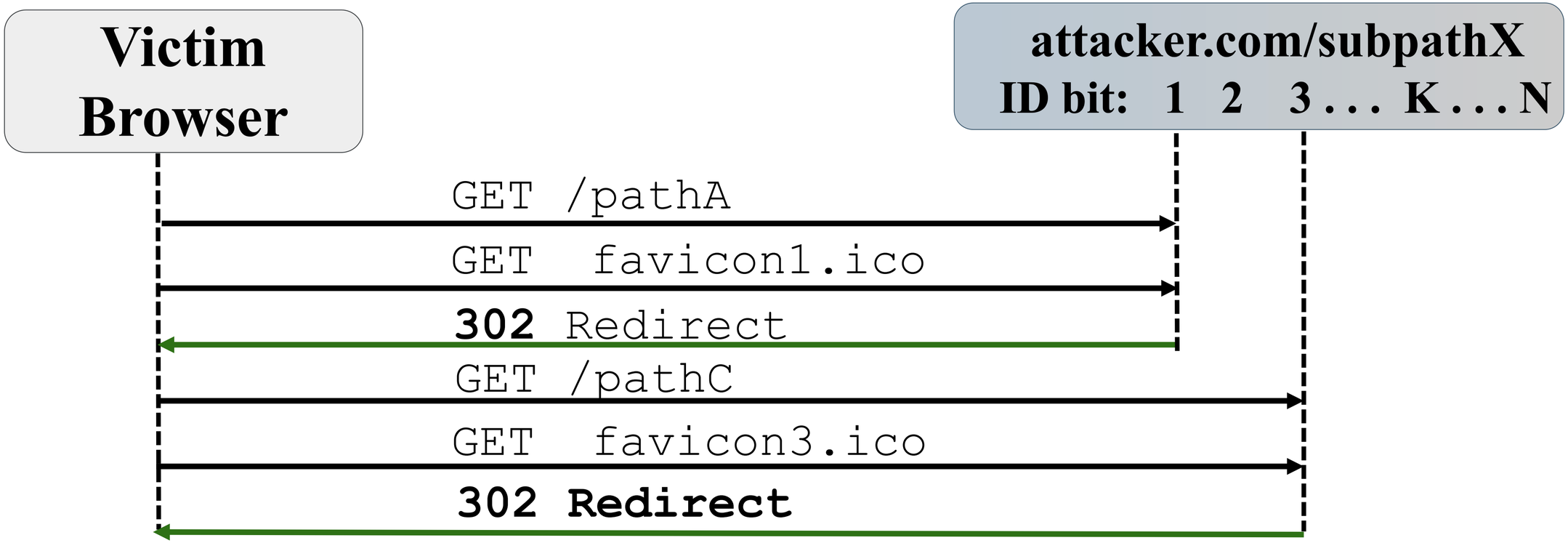

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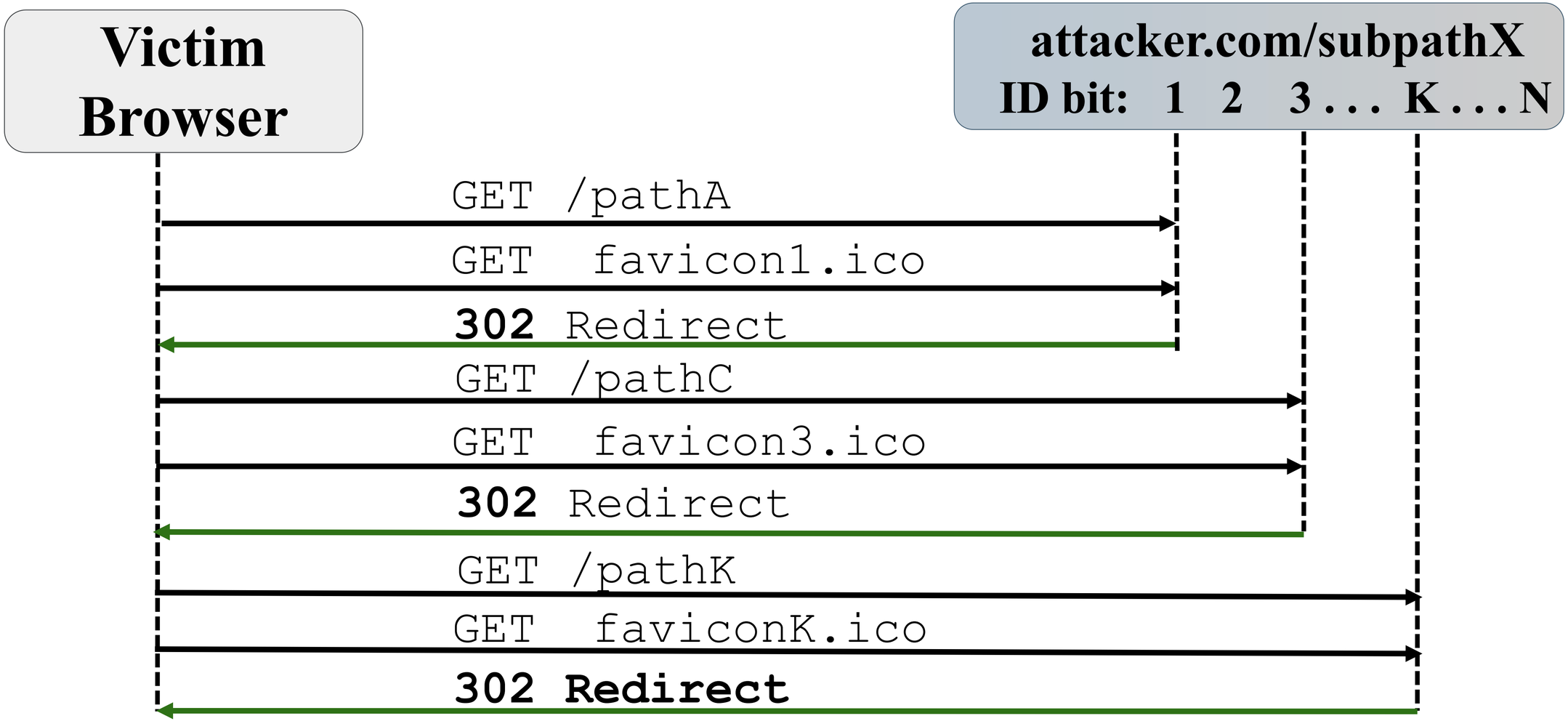

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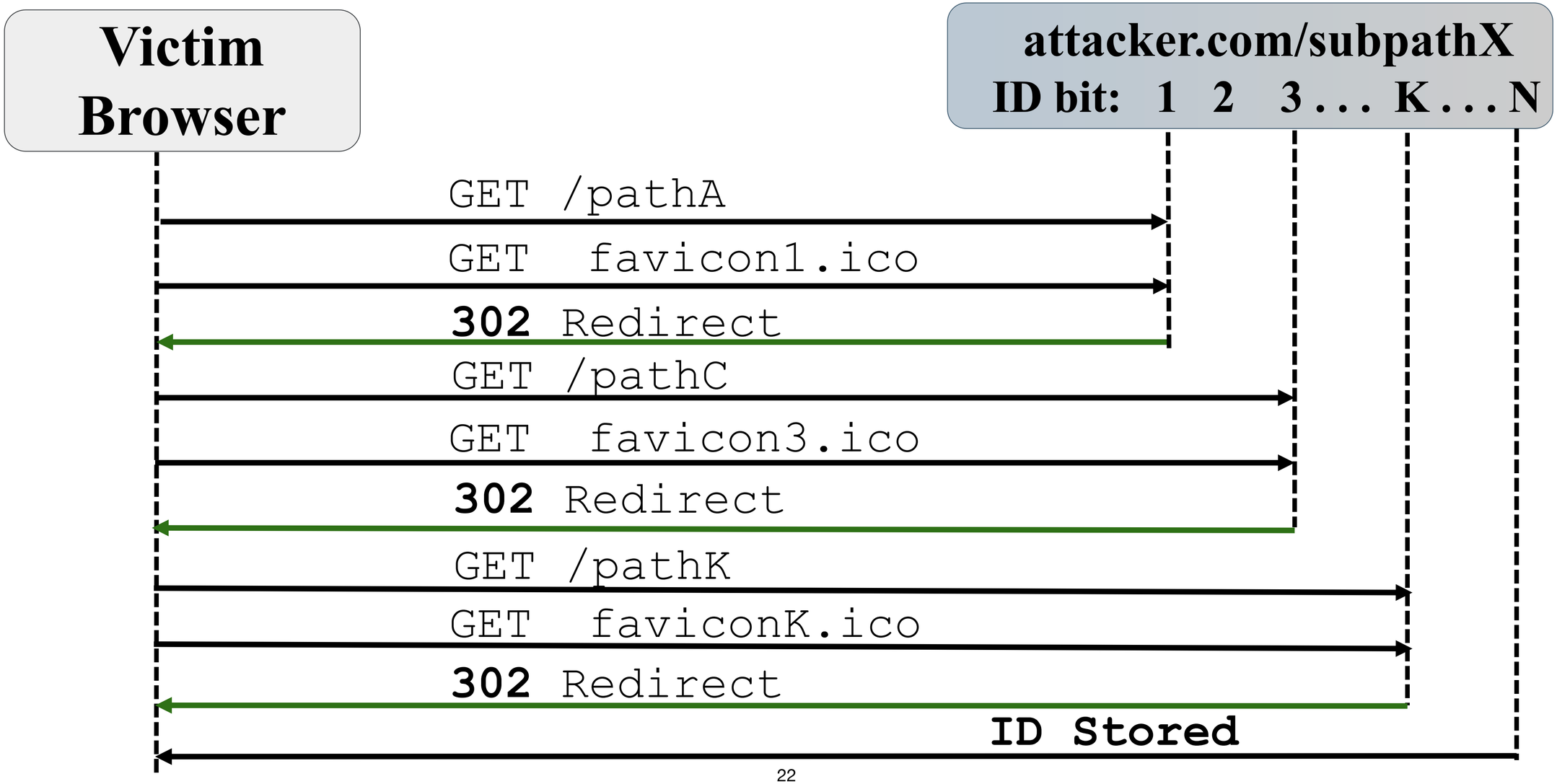

Read Identifier

Victim Browser

attacker.com

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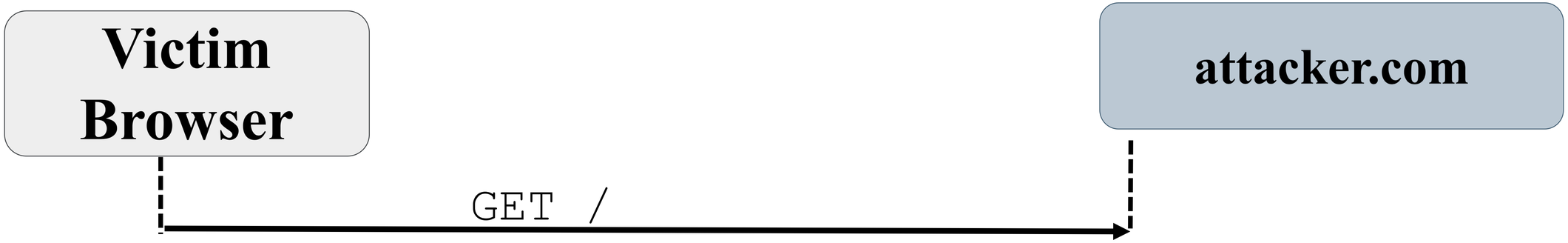

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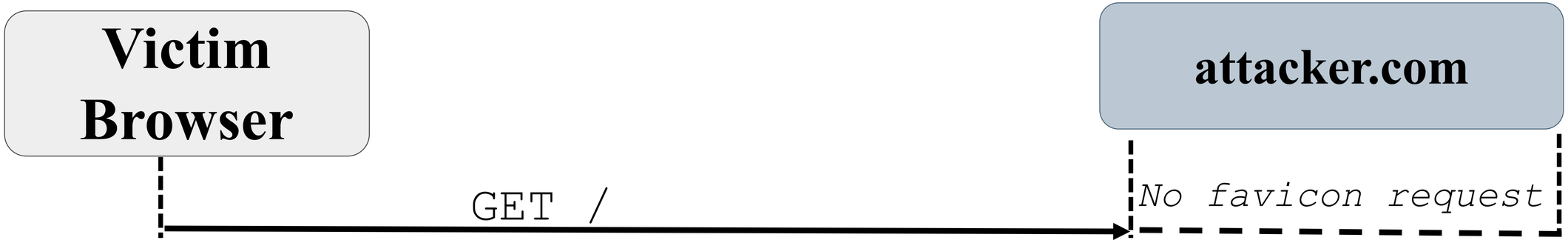

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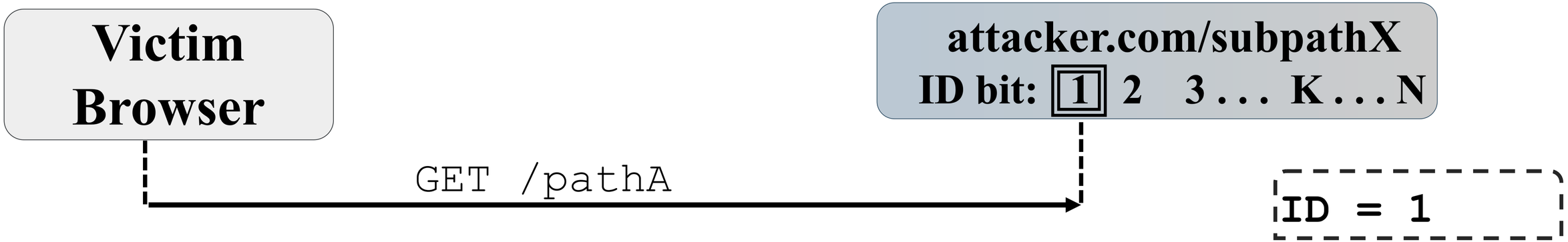

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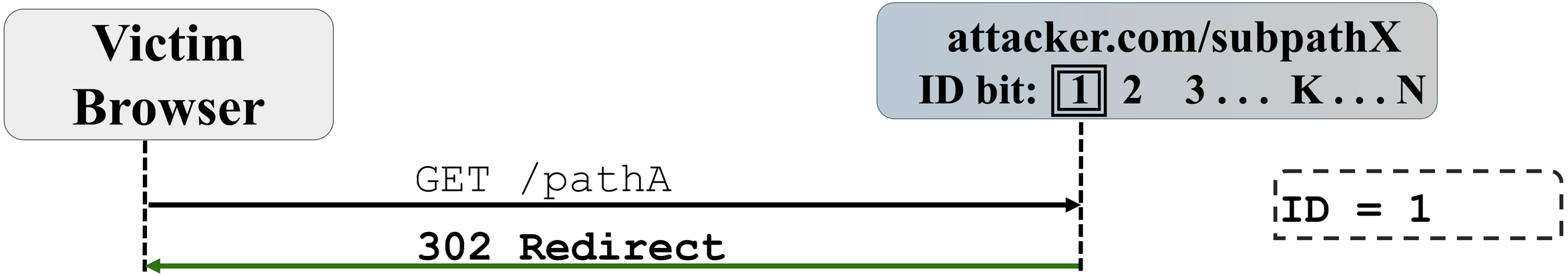

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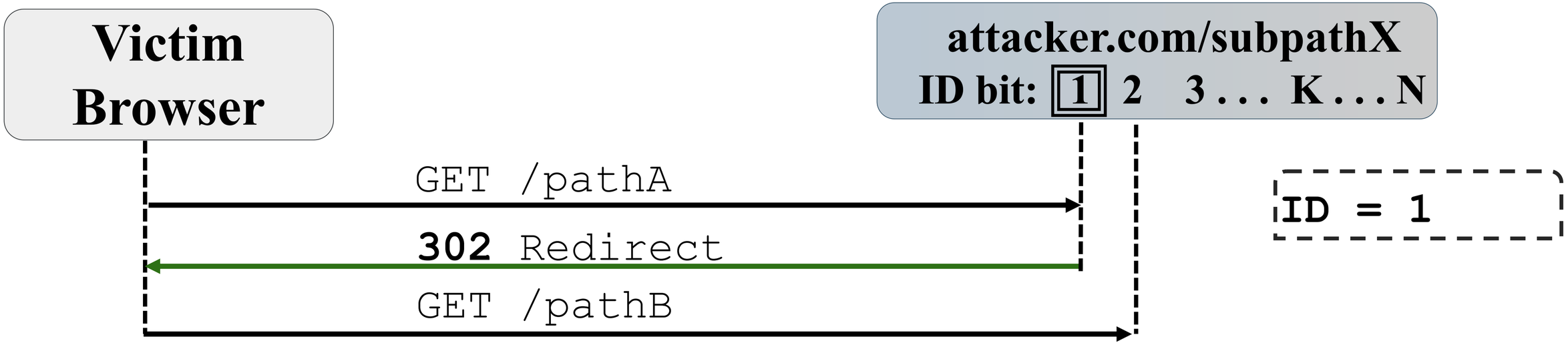

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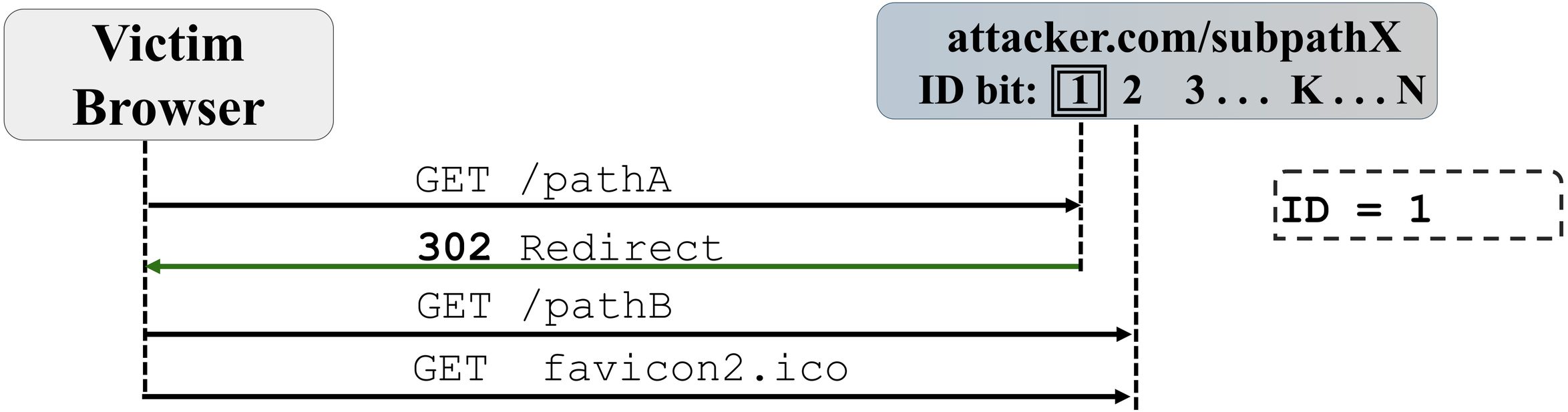

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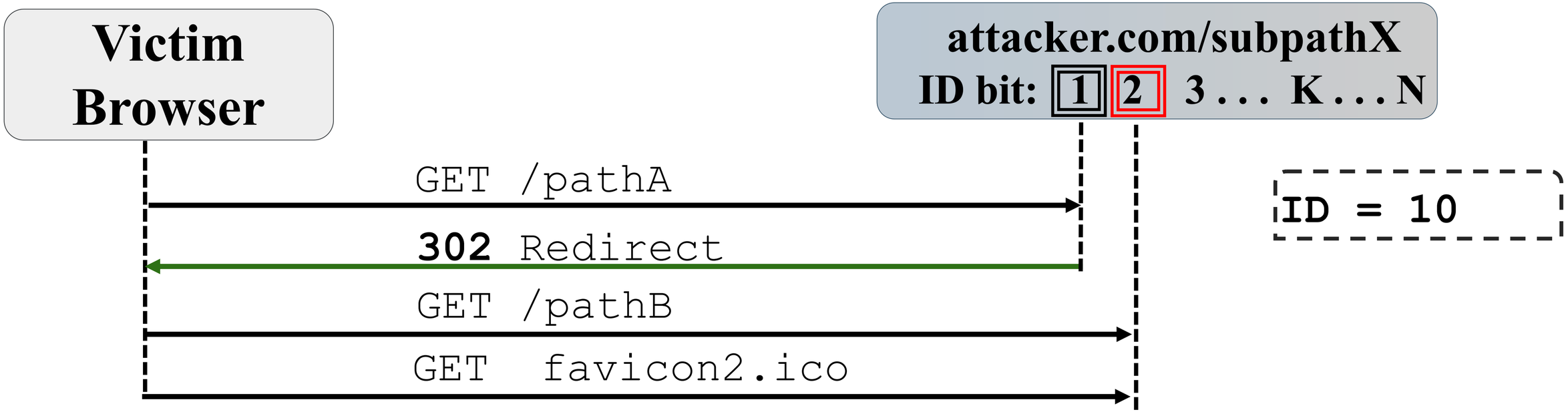

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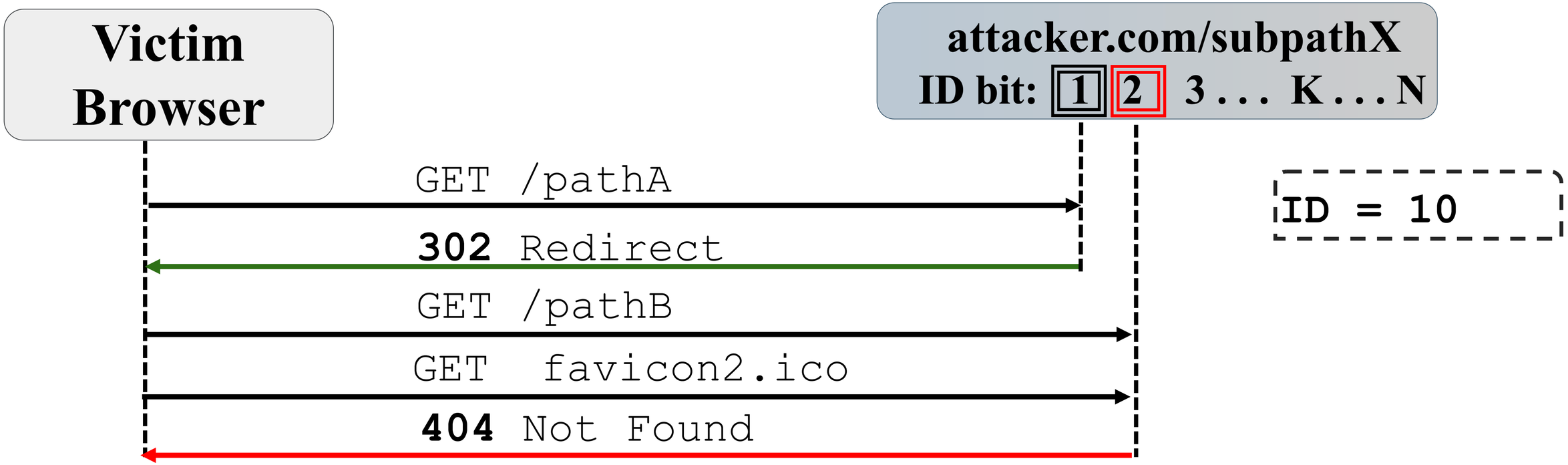

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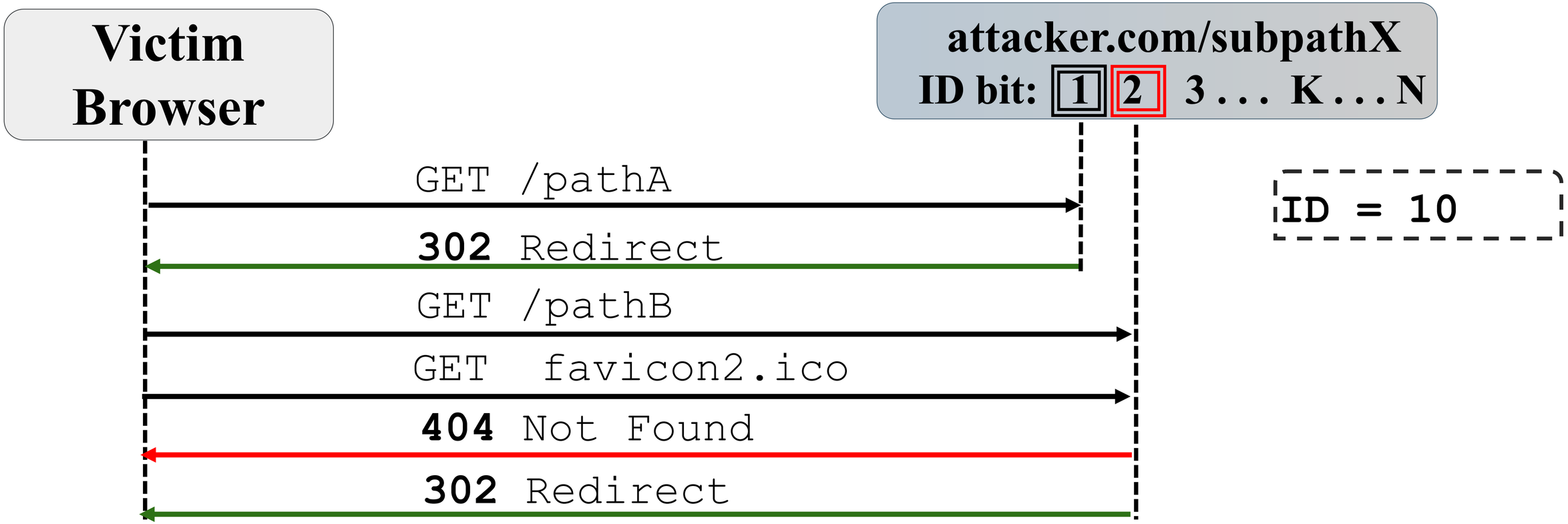

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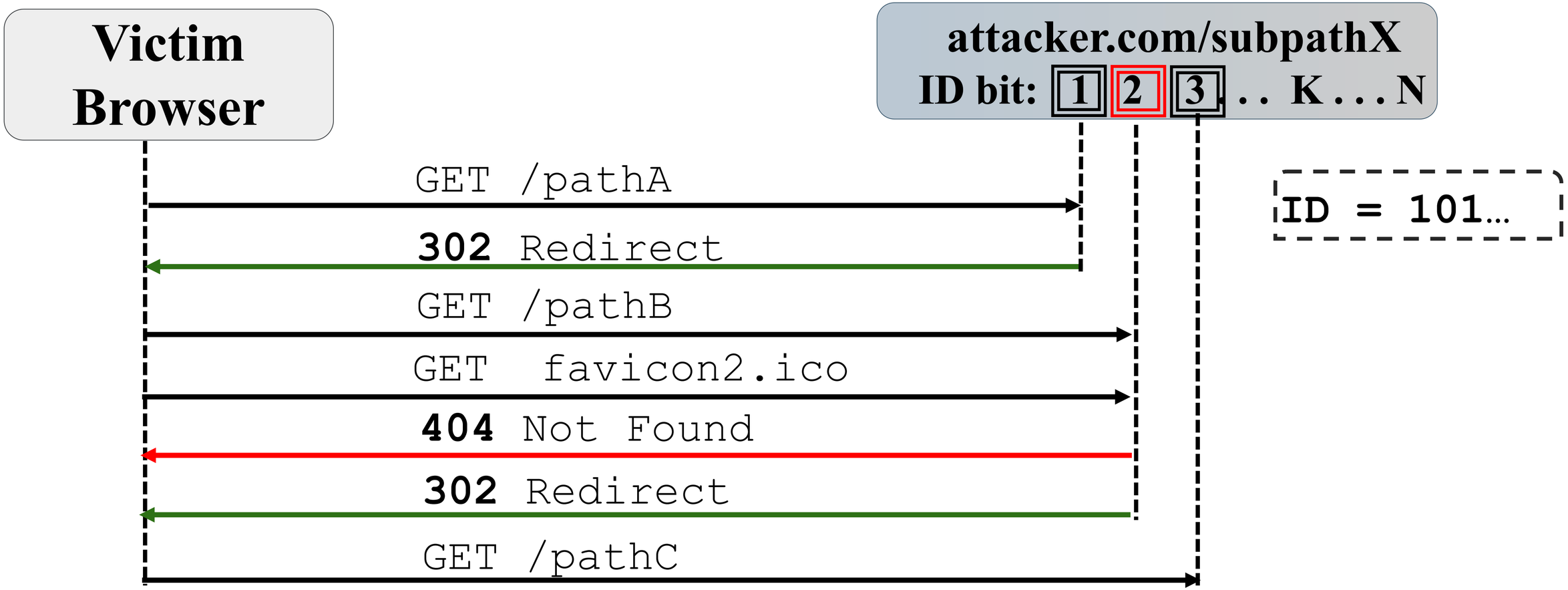

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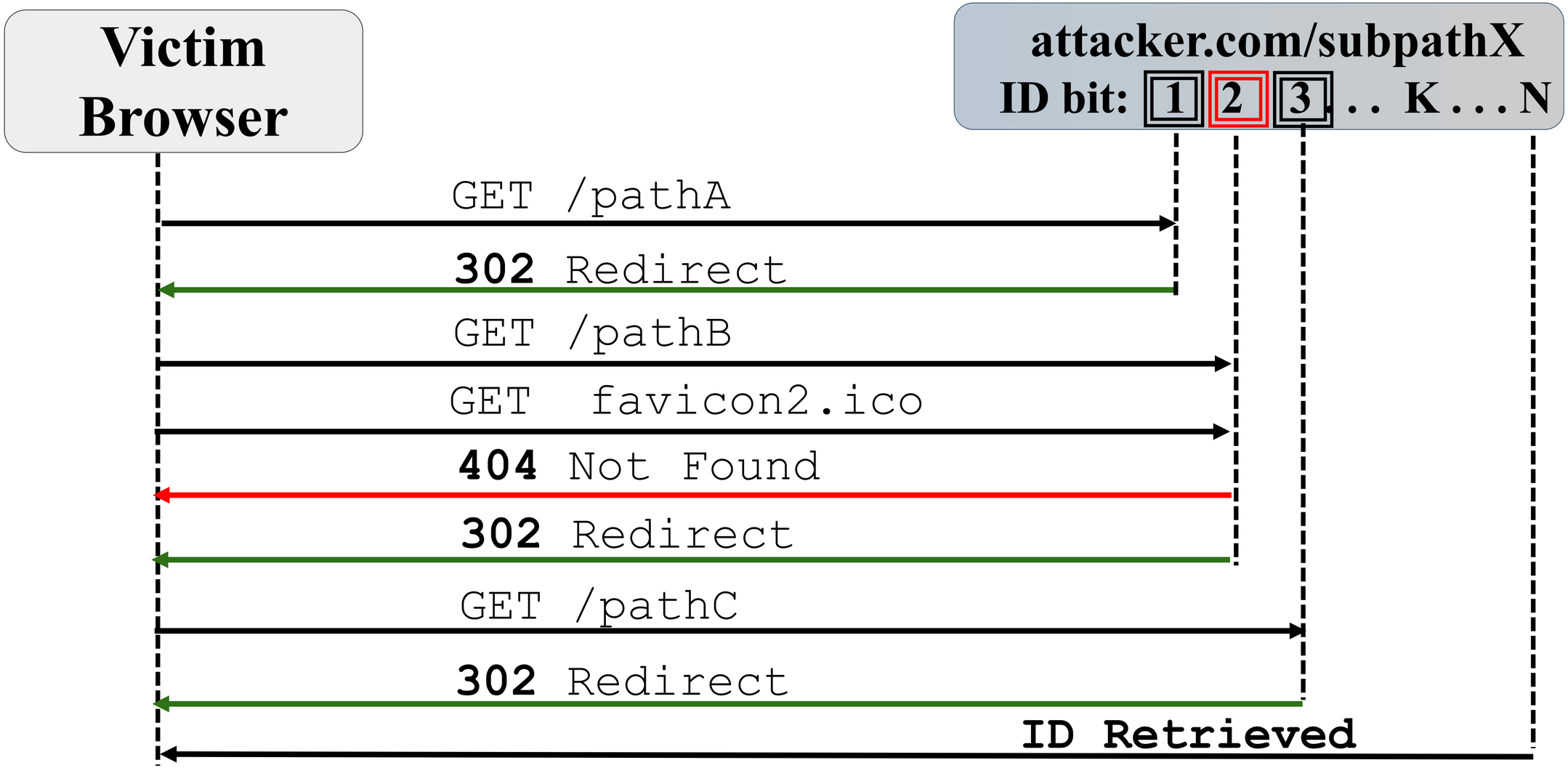
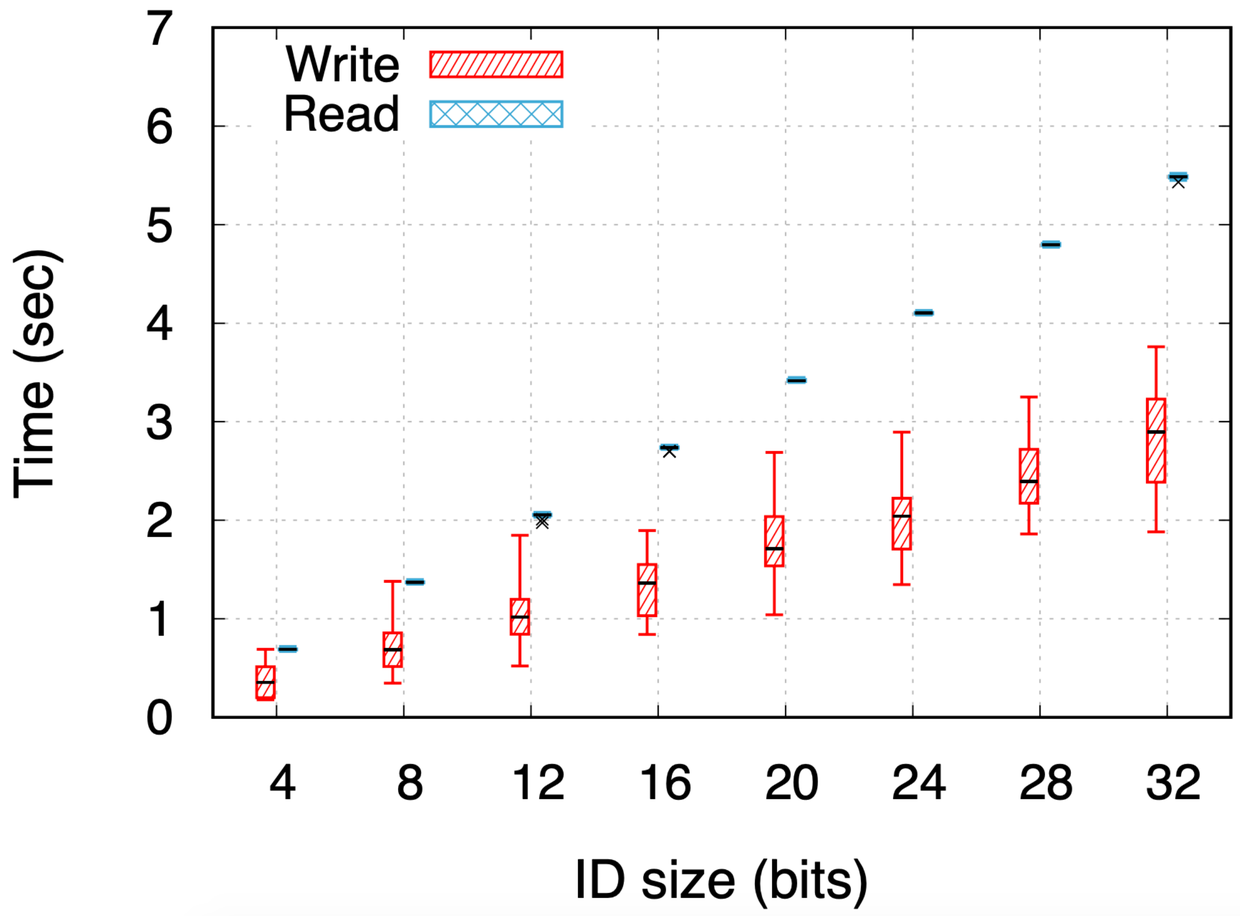


Affected Browsers and Modes

	Incognito	Clear Browser Data	Anti-Tracking Extensions	VPN
Chrome	✓	✓	✓	✓
Safari	✓	✓	✓	✓
Edge	✓	✓	✓	✓
Brave	✓	✓	✓	✓

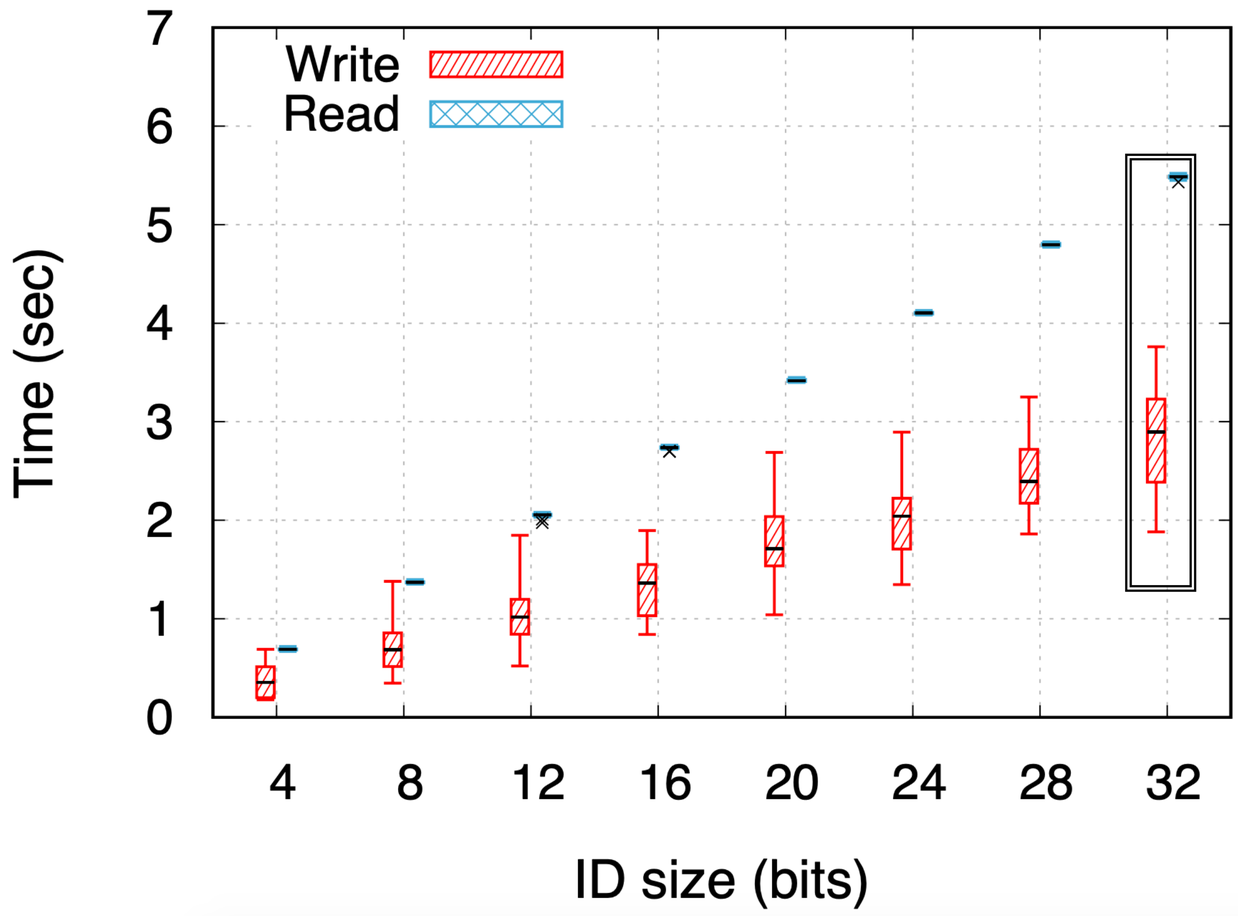
Baseline Attack Performance



- Write Identifier ≤ 2.5 sec
- Read Identifier ≤ 5.5 sec
- Average tracker overhead ≥ 10 sec [M. Hanson et al.,Tech.Rep.18’]

➢ **Can we do better?**

Baseline Attack Performance



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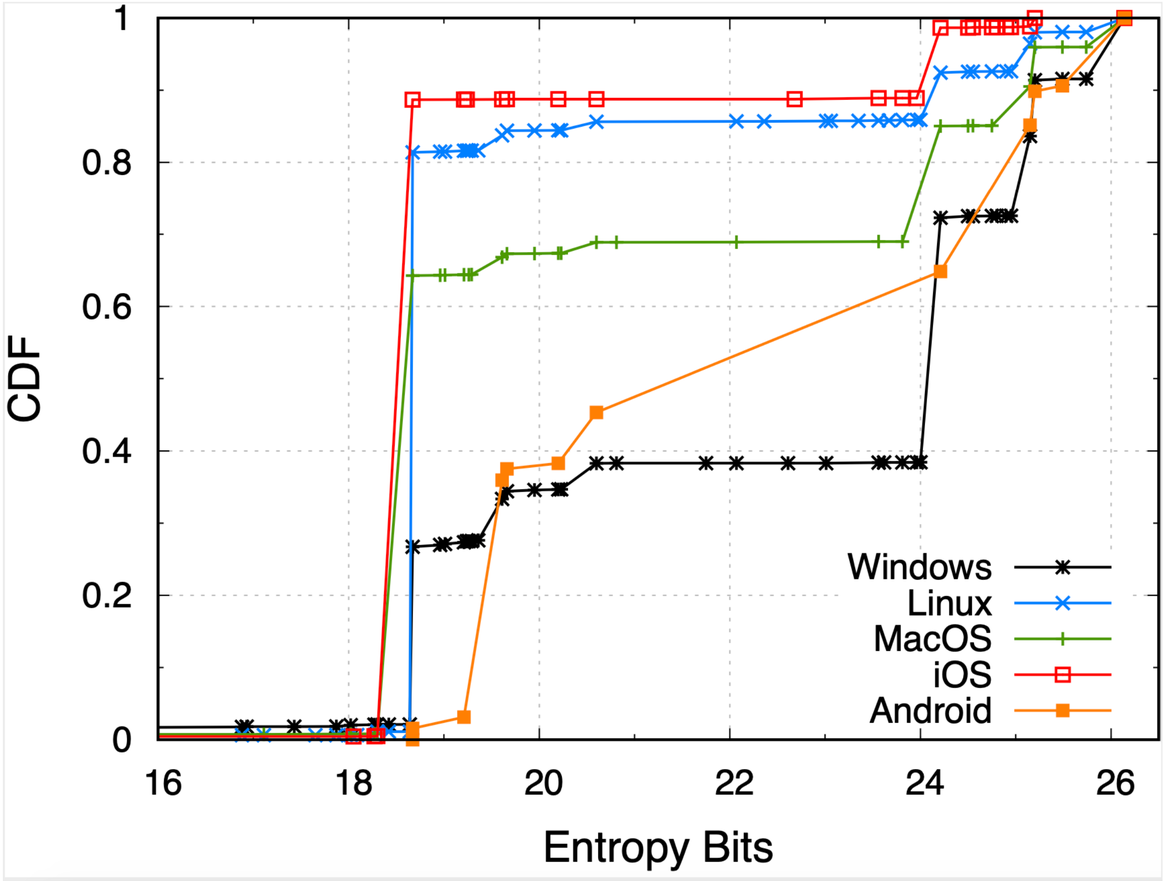
➢ **Can we do better?**

Optimization: Fingerprints and Favicons

- Browser attributes that are immutable over time [Vastel et al., S&P 18’]
  - `Cookies Enabled, Local Storage, DNT, Ad Block, Platform, Encoding, Language, WebGL ,Canvas`
- Browser Fingerprint dataset `amiunique.org` [Lapperdrix et al.,S&P 16’]
  - Calculated Fingerprint Entropy of the available attributes

Optimization: Fingerprints and Favicons



- Lower: **16 bits**
- Higher: **26 bits**
- 50% desktop devices: **19-24 bits**

➢ **Combine Browser Fingerprint with Favicon Identifier**

Optimization: Fingerprints and Favicons

- Fingerprint generation overhead **≤ 200** ms
    - Cookies, Local Storage, DNT ≤ 2 ms
    - Canvas, WebGL ≤ 100 ms
- Reconstruct 32-bit ID with less redirections
    - **20 bits** Browser FP + **12 bits** Favicon ID ≈ **2 sec**
- Anti-Fingerprint tools
    - Randomize WebGL- Canvas: **18** bits
    - Brave defense: **12** bits → Full ID reconstruct ≈ **3 sec**

Network Effects

- Web server and client located in the same city
    - **27%** faster ID Generation
    - **35%** decreased read-ID time
- **Optimal** attack time with redirection overhead
    - Write ≈ **1.5 sec** – Read ≈ **3 sec**

➢ Large-Scale attack: dedicated CDNs and servers across locations

Proposed Countermeasures

1. Incognito mode should use an isolated cache instance
2. Default “Clear browsing data” should also clear Favicon Cache

- Notified vulnerable browsers
  - Confirmed and acknowledged
  - Brave deployed countermeasure

Summary

- Demonstrated novel persistent favicon tracking technique
  - Breaks incognito mode
  - Robust against anti-tracking defenses
  - Long-term identifier
- Browser FPs a powerful optimization mechanism for augmenting other tracking vectors
- Extensive experimental evaluation under different network/device/browser conditions
- Mitigation needs redesign of policies and browser architecture. Remediation under way.

Thank you!

Feel free to reach out with any questions:

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