@fork_while_1

Alternative (ab)uses for HTTP Alternative Services

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Outline

1. Background: HTTP

2. Alt-Svc header

3. Attacks w/ Alt-Svc

4. Mitigations

5. Industry response

6. Conclusion

HTTP

- HTTP/1.0 in 1996
- Simple headers:
  - Hostname
  - Referer
  - User-Agent

[Docs] [txt|pdf] [draft-ietf-http...] [Tracker] [Diff1] [Diff2]

INFORMATIONAL

Network Working Group
Request for Comments: 1945
Category: Informational

T. Berners-Lee
MIT/LCS
R. Fielding
UC Irvine
H. Frystyk
MIT/LCS
May 1996

Hypertext Transfer Protocol -- HTTP/1.0

Status of This Memo

This memo provides information for the Internet community. This memo does not specify an Internet standard of any kind. Distribution of this memo is unlimited.

HTTP

- HTTP expanded:
  - Caching
  - Dynamic content
  - Request multiplexing
- Result = more papers for security researchers 😉

HTTP

- HTTP is as old as me (22 yrs)
- Yet hard to introduce secure protocol updates.

Alternative Services (RFC 7838)

- Yet another HTTP header!!
- Allows website to specify equivalent alternate endpoint

Tired senior who needs to finish thesis

Alternative Services (RFC 7838)

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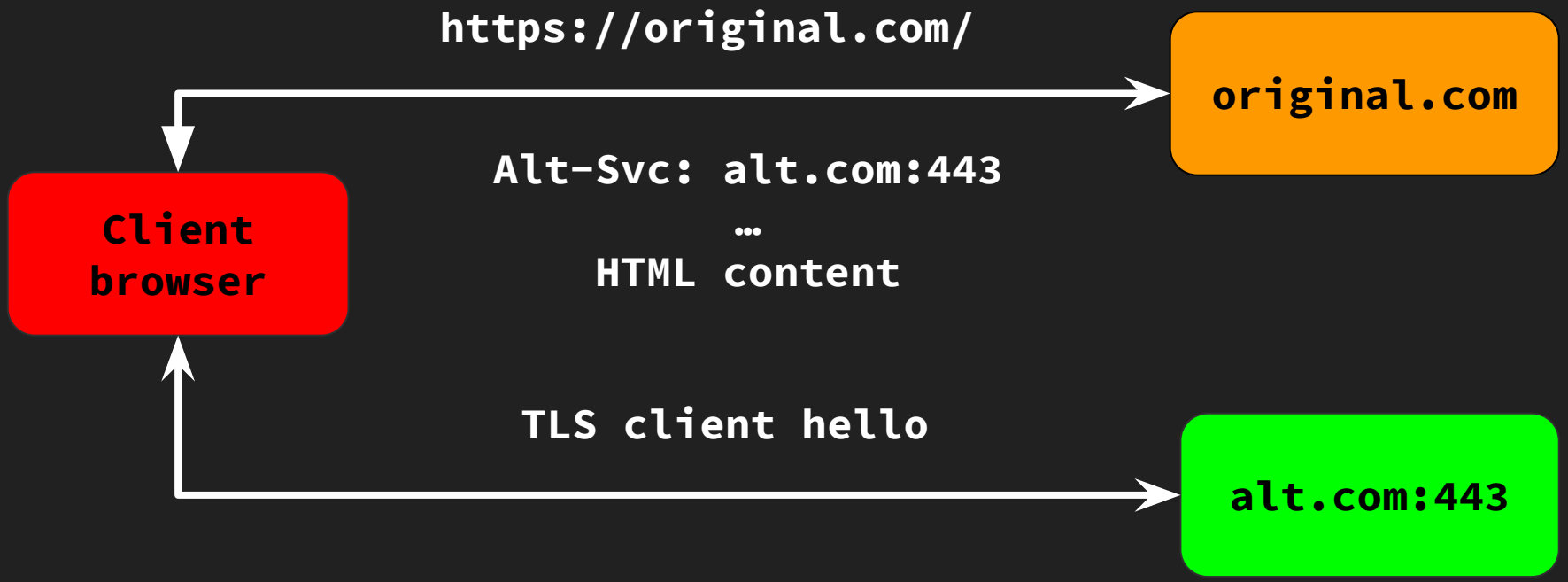
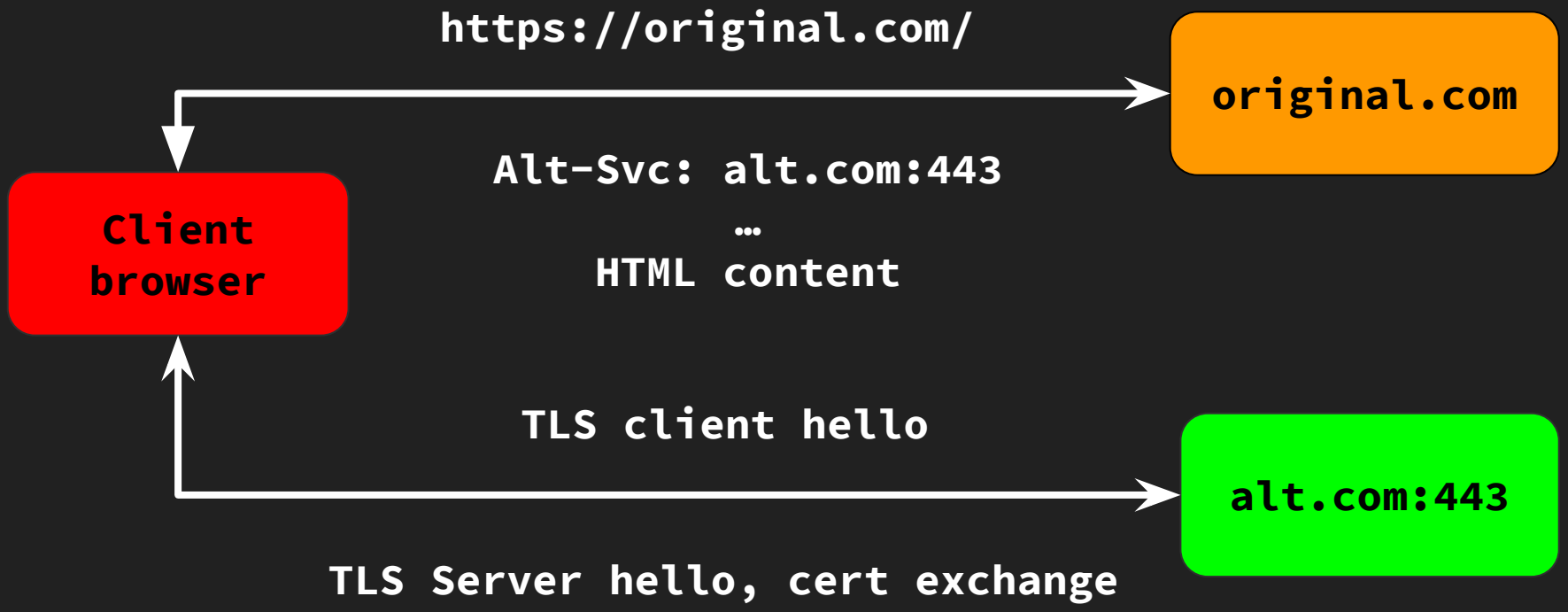
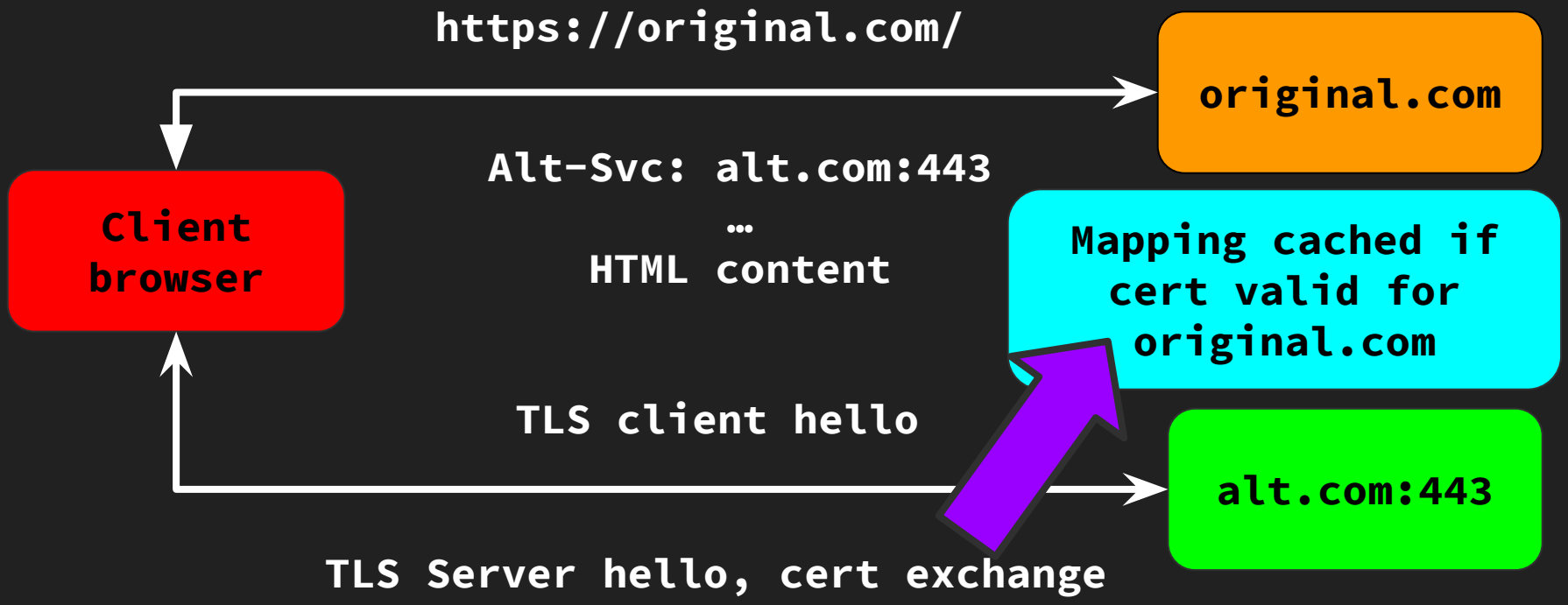
Alternative Services (RFC 7838)



Alternative Services (RFC 7838)



Alternative Services (RFC 7838)



Alt-Svc format

```
Alt-Svc: ‘h2=“www.google.com:123”; ma=123456’
```

Alt-Svc format

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Protocol (http/1.1, quic, h2c, ftp, etc.)

Alt-Svc format

Domain/IP

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Protocol (http/1.1, quic, h2c, ftp, etc.)

Alt-Svc format

Domain/IP

Port

Alt-Svc: ‘h2=“www.google.com:123”; ma=123456’

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Alt-Svc format

Domain/IP

Port

Alt-Svc: ‘h2=“www.google.com:123”; ma=123456’

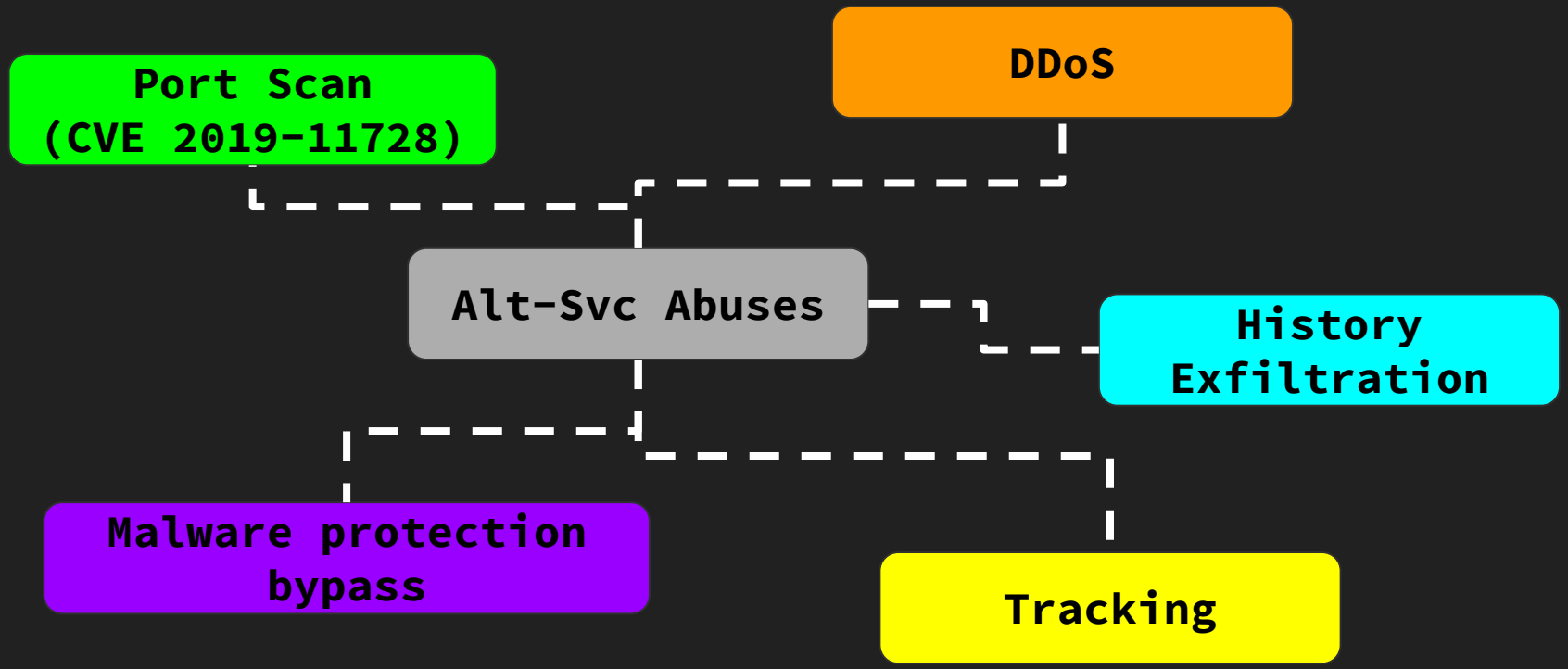
Protocol (http/1.1, quic, h2c, ftp, etc.)

Max age (s)

Alt-Svc Uses

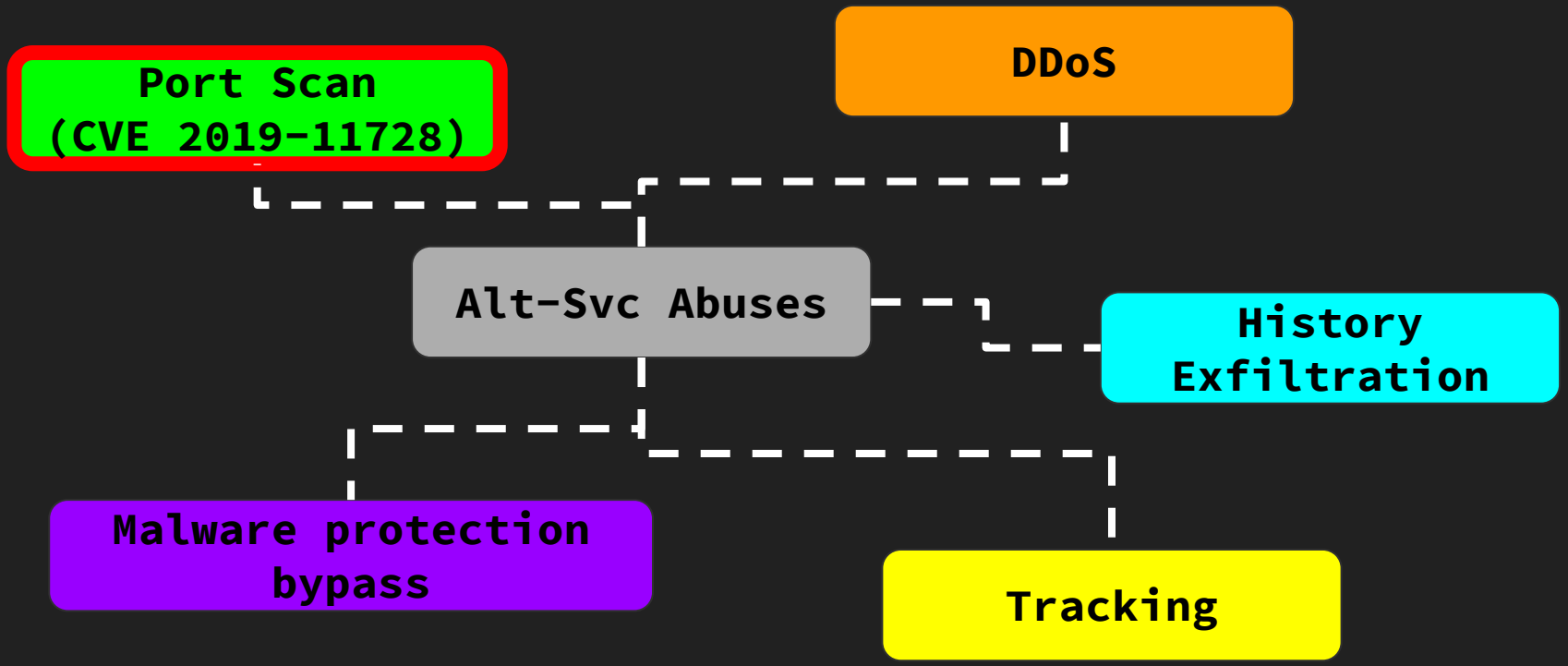
- Load balancing
- Client segmentation
- Advertising endpoints with new protocols

Overview of abuse



Threat model

- **Case #1:**
  - Attacker controls website(s)
- **Case #2:**
  - Attacker controls website(s)
  - Monitors victim network traffic
    - E.g. Cafe/Airport WiFi


Port Scan
(CVE 2019-11728)
DDoS
Alt-Svc Abuses
History
Exfiltration
Malware protection
bypass
Tracking

Port-Scan (CVE-2019-11728)

- (Distributed) port scanning (from browser context).

```
http://evil.com/p1
Alt-Svc: “h2=localhost:25”
```

Port-Scan (CVE-2019-11728)

- (Distributed) port scanning (from browser context).

```
http://evil.com/p1
Alt-Svc: “h2=localhost:25”
```

Browser validates Alt-Svc

Port-Scan (CVE-2019-11728)

Closed Port	Open Port

Time

Port-Scan (CVE-2019-11728)

Closed Port	Open Port
RST	

Time

Port-Scan (CVE-2019-11728)

Closed Port	Open Port
RST	PKT

Time

Port-Scan (CVE-2019-11728)

Closed Port	Open Port
RST	PKT
	PKT

Time

Port-Scan (CVE-2019-11728)

Closed Port	Open Port
RST	PKT
	PKT
	PKT

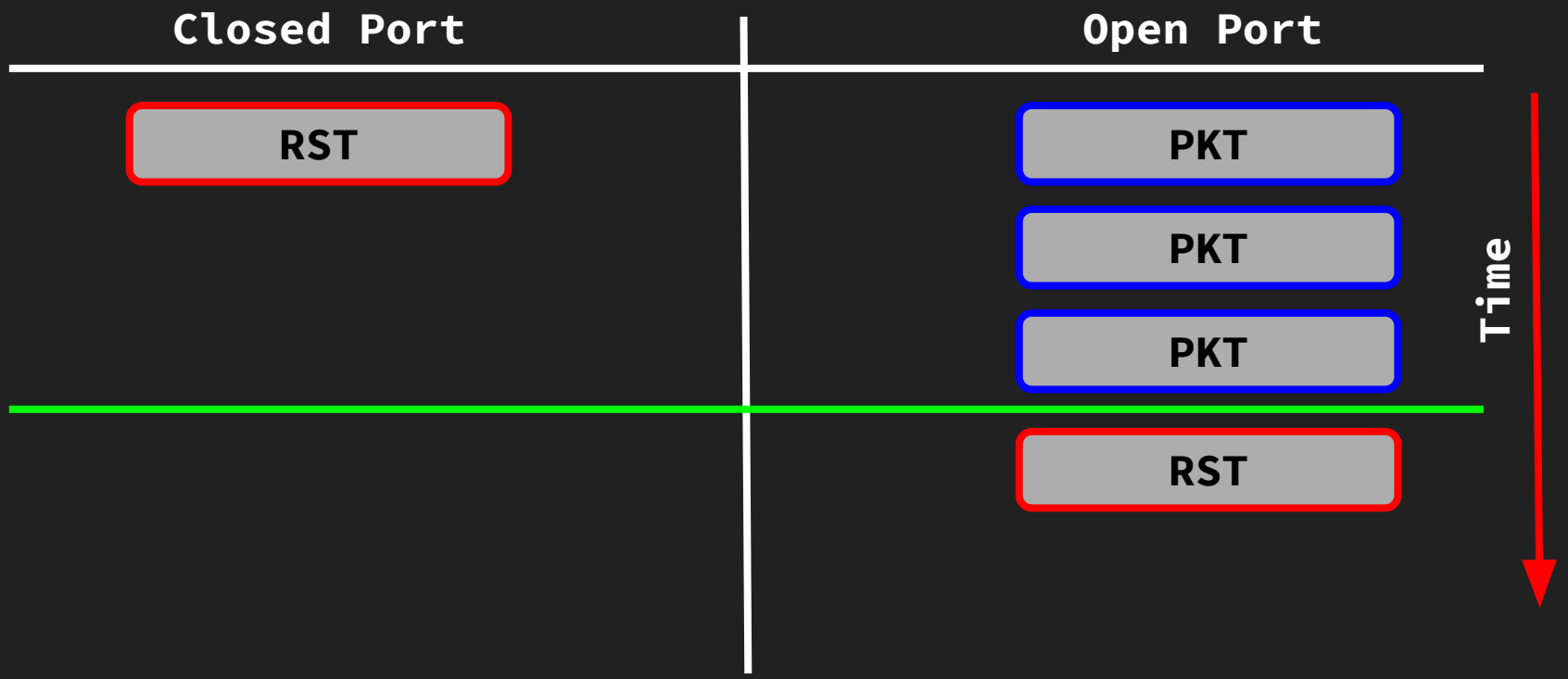
Time

Port-Scan (CVE-2019-11728)

Closed Port	Open Port
RST	PKT
	PKT
	PKT
	RST

Time

Port-Scan (CVE-2019-11728)



Port-Scan (CVE-2019-11728)

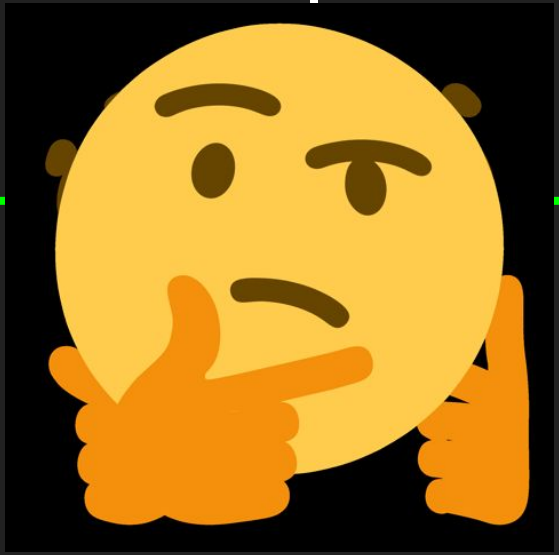
Closed Port	Open Port
RST	PKT PKT PKT
⊘	?

Time

Port-Scan (CVE-2019-11728)

Closed Port	Open Port
RST	PKT
	PKT
	PKT

Time



Port-Scan (CVE-2019-11728)

Closed Port	Open Port
RST	PKT
Redirect: http://evil.com/p2 Alt-Svc: “h2=evil2.com:443”	PKT
	PKT

Time

Port-Scan (CVE-2019-11728)

Closed Port	Open Port
RST	PKT
Redirect: http://evil.com/p2 Alt-Svc: “h2=evil2.com:443”	PKT
	PKT
Browser connects to new Alt-Svc	

Time

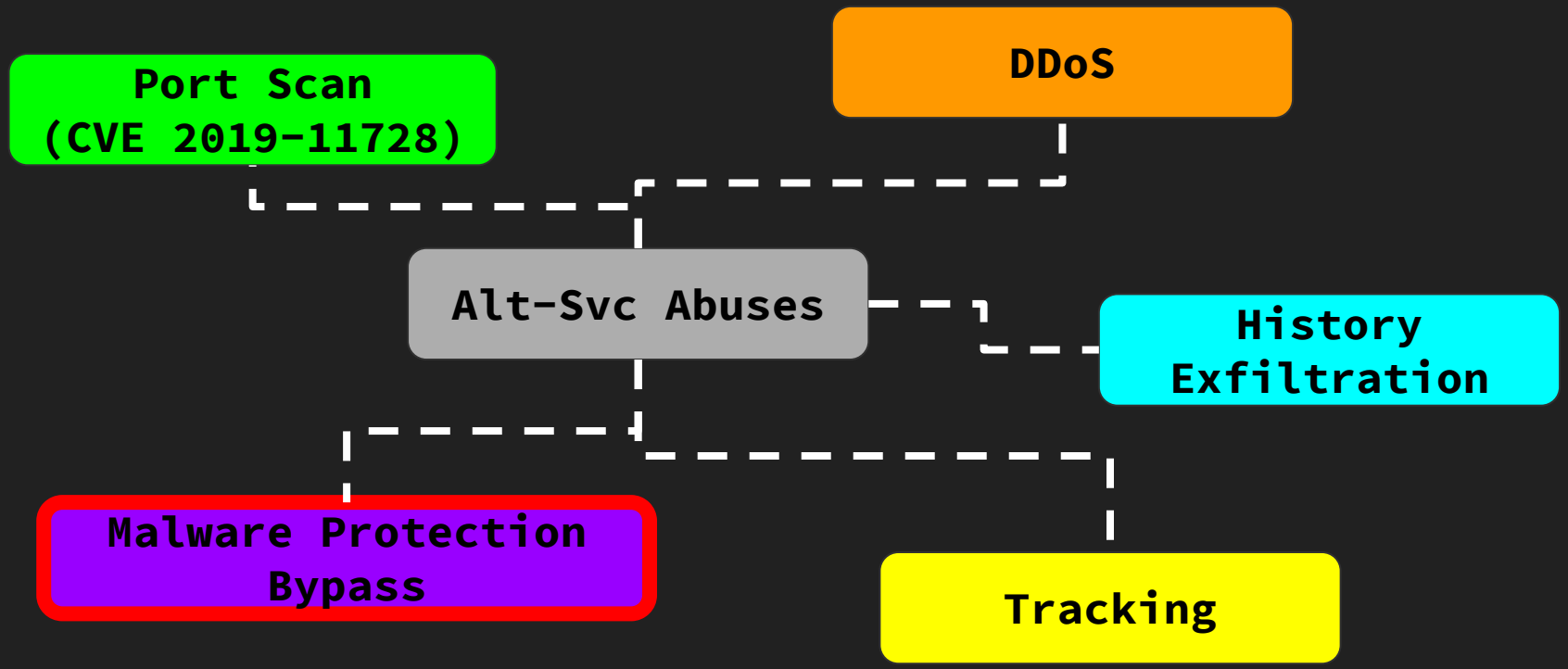
Port-Scan (CVE-2019-11728)

Closed Port	Open Port
RST	PKT
Redirect: http://evil.com/p2 Alt-Svc: “h2=evil2.com:443”	PKT
	PKT
Browser connects to new Alt-Svc	Browser DOES NOT connect to new Alt-Svc

Time

Port-Scan consequences

- Distributed port scanning
- Localhost, private networks (behind firewall/NAT)
- TCP ports, some UDP ports
- Attacker identity is not revealed!


Port Scan
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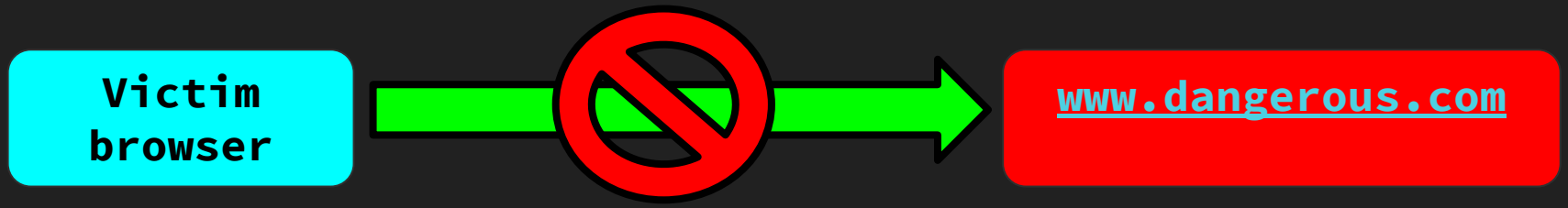
Malware protection bypass

Victim browser

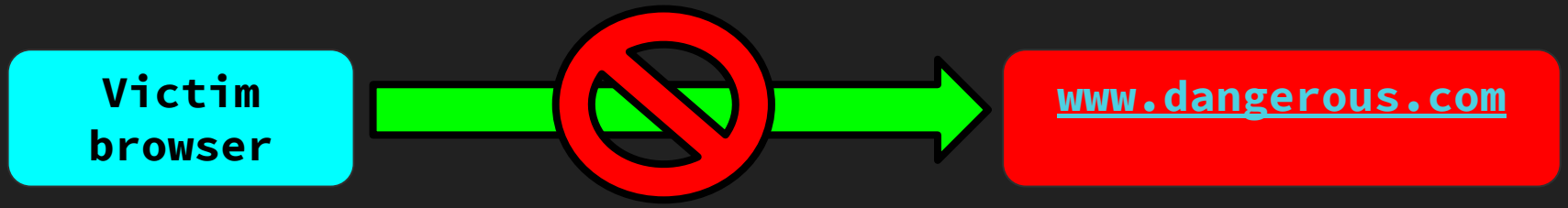
www.dangerous.com

Malware protection bypass



Safe browsing

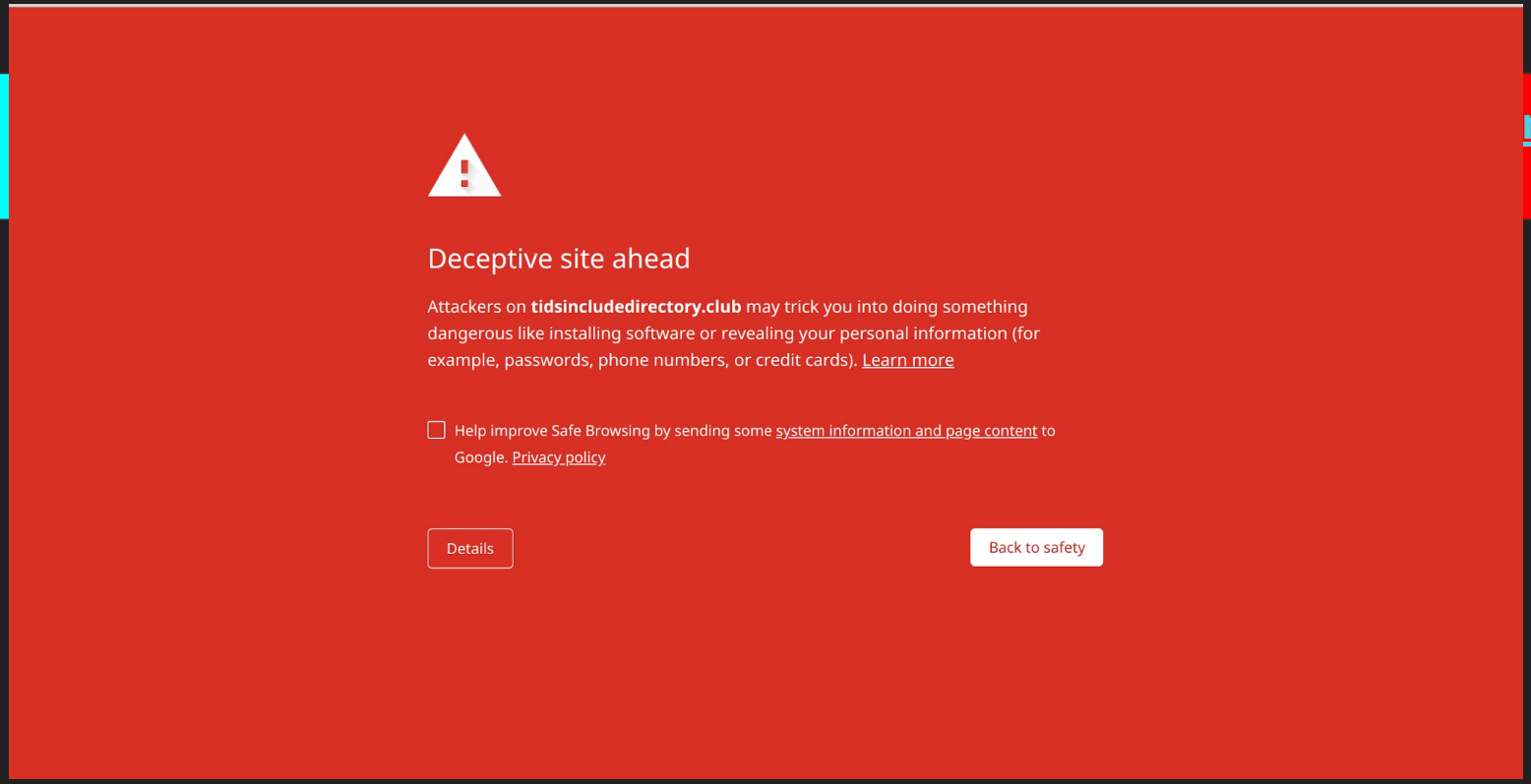
Malware protection bypass



Safe browsing

- Blocks first and third party:
  - www.dangerous.com in URL bar
  - <img src=www.dangerous.com> in www.example.com

Malware protection bypass



Malware protection bypass

- www.example.com specifies www.dangerous.com as it’s Alt-Svc.
- Browser allows content loading from www.dangerous.com!

Malware protection bypass

- www.exam com as it's Alt-Svc.
- Browser dangerous.com!

Malware protection bypass

- www.example.com specifies any dangerous.com as it's Alt-Svc.
- Browser [illegible] dangerous.com!

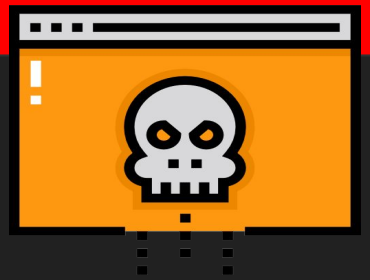
Two-faced content

Original

www.example.com

Alt-Svc

www.dangerous.com



Two-faced content

Original
www.example.com

Automated scanners check

Alt-Svc
www.dangerous.com

User browser loads

Two-faced content

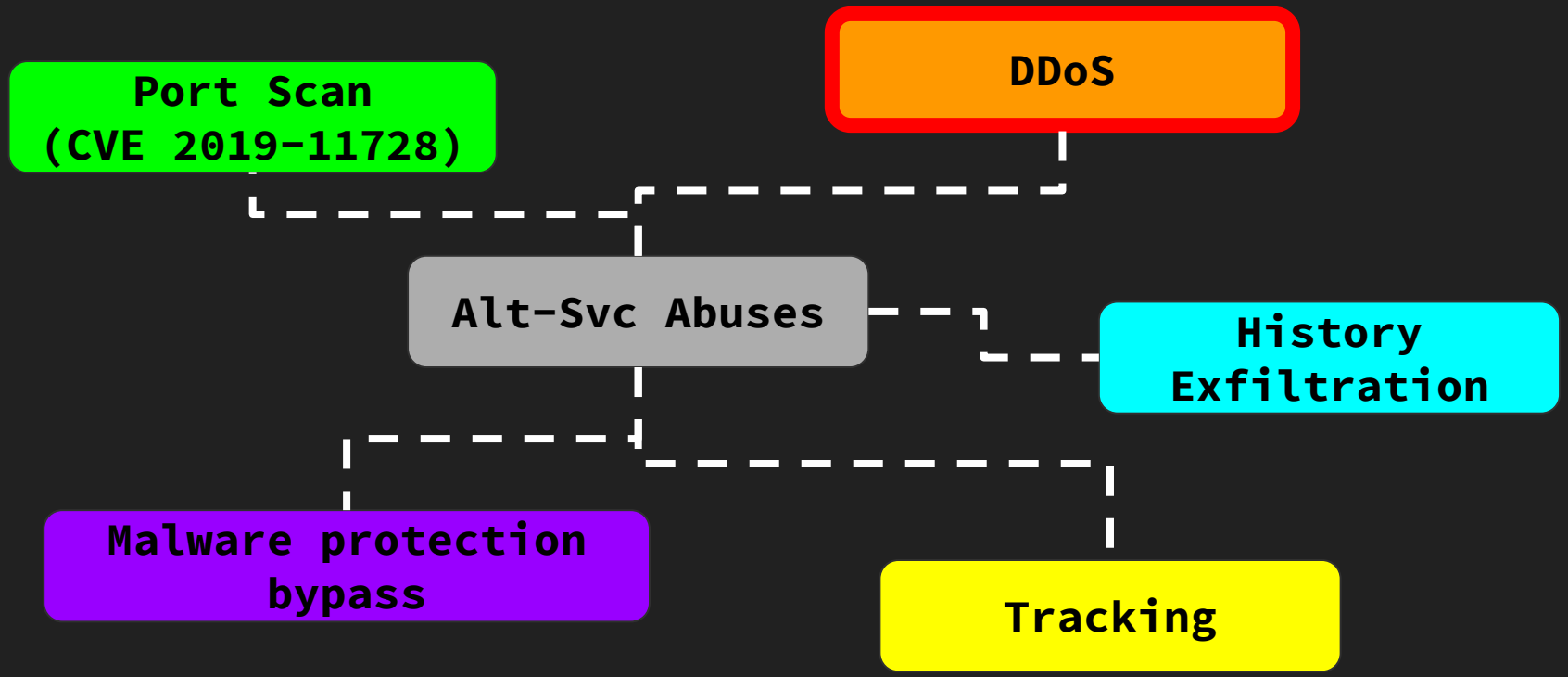
Original
www.example.com

Automated scanners check

Alt-Svc
www.dangerous.com

User browser loads

Vulnerable: URLVoid, VirusTotal, Sucuri, IPVoid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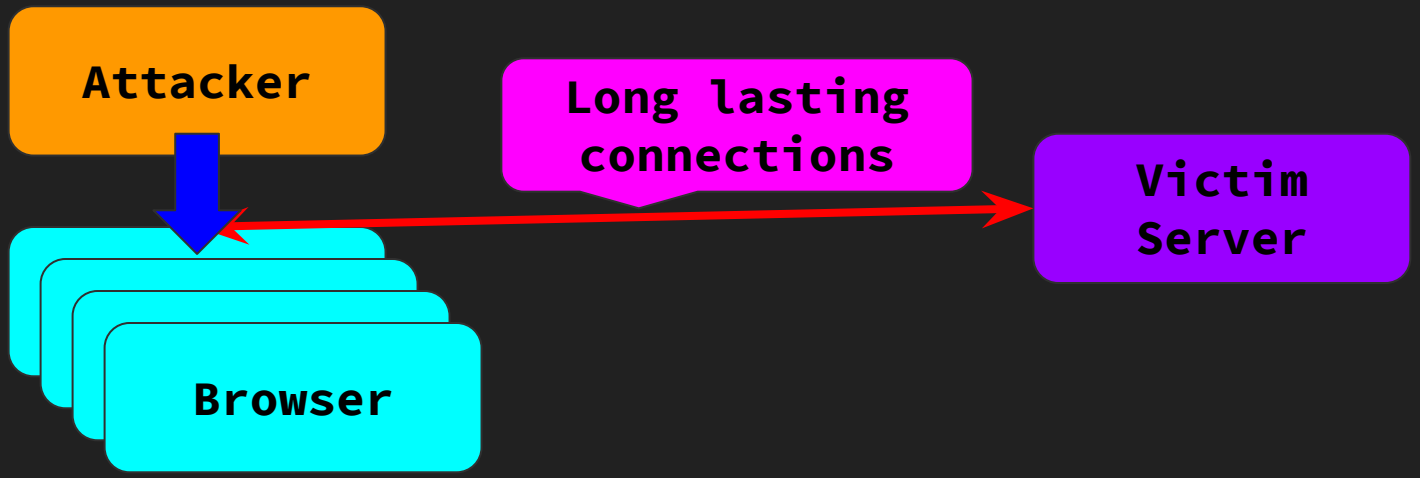
DDoS

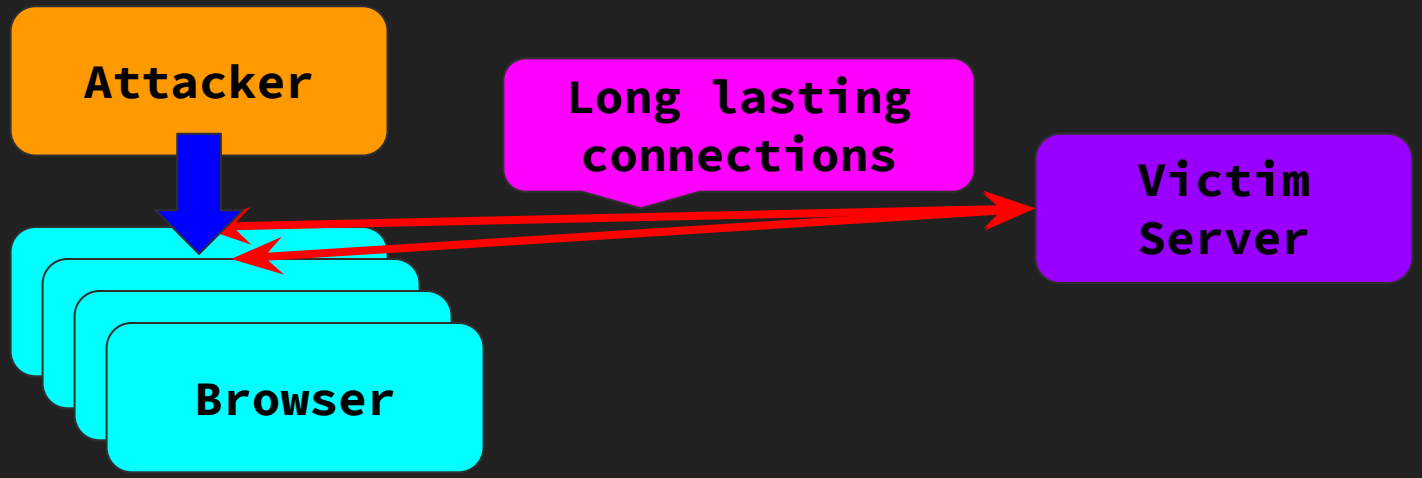
- Many clients connect to victim Alt-Svc endpoint: DDoS!
  - Long timeouts
  - Bandwidth Exhaustion

DDoS: Long timeouts

DDoS: Long timeouts



DDoS: Long timeouts



DDoS: Long timeouts

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DDoS: Long timeouts

- FTP, SMTP, etc. servers

DDoS: Bandwidth exhaustion

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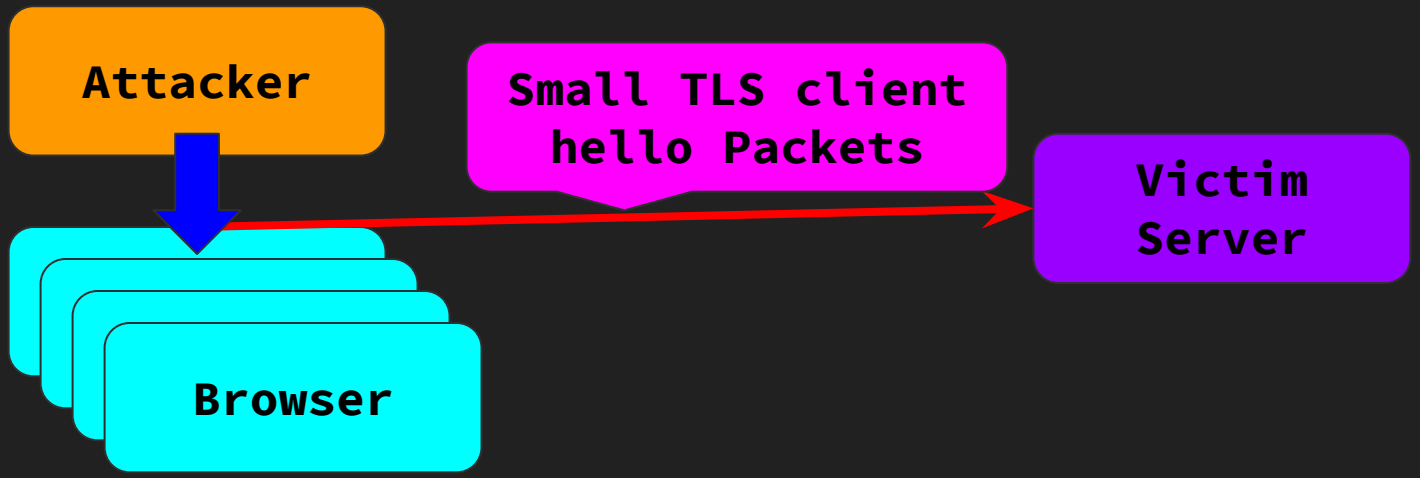
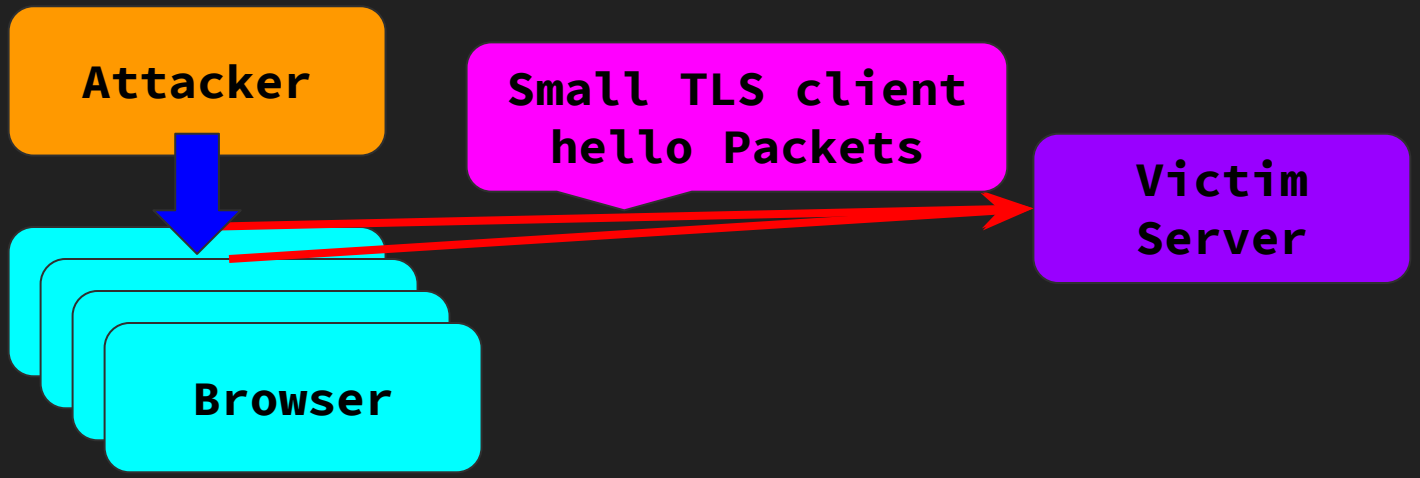
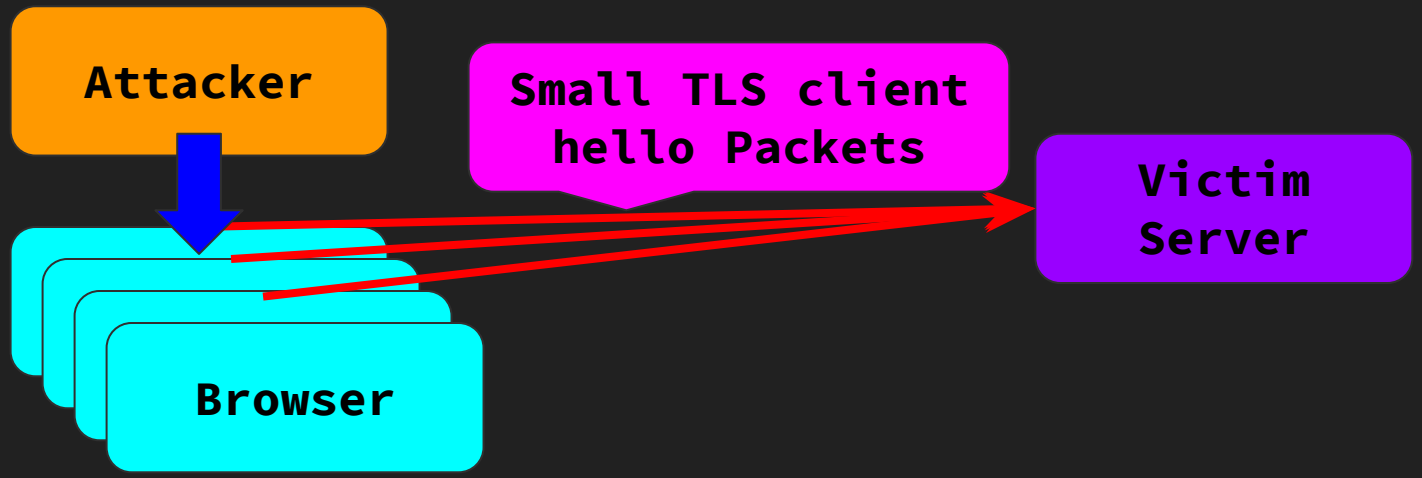


DDoS: Bandwidth exhaustion



DDoS: Bandwidth exhaustion



DDoS: Bandwidth exhaustion

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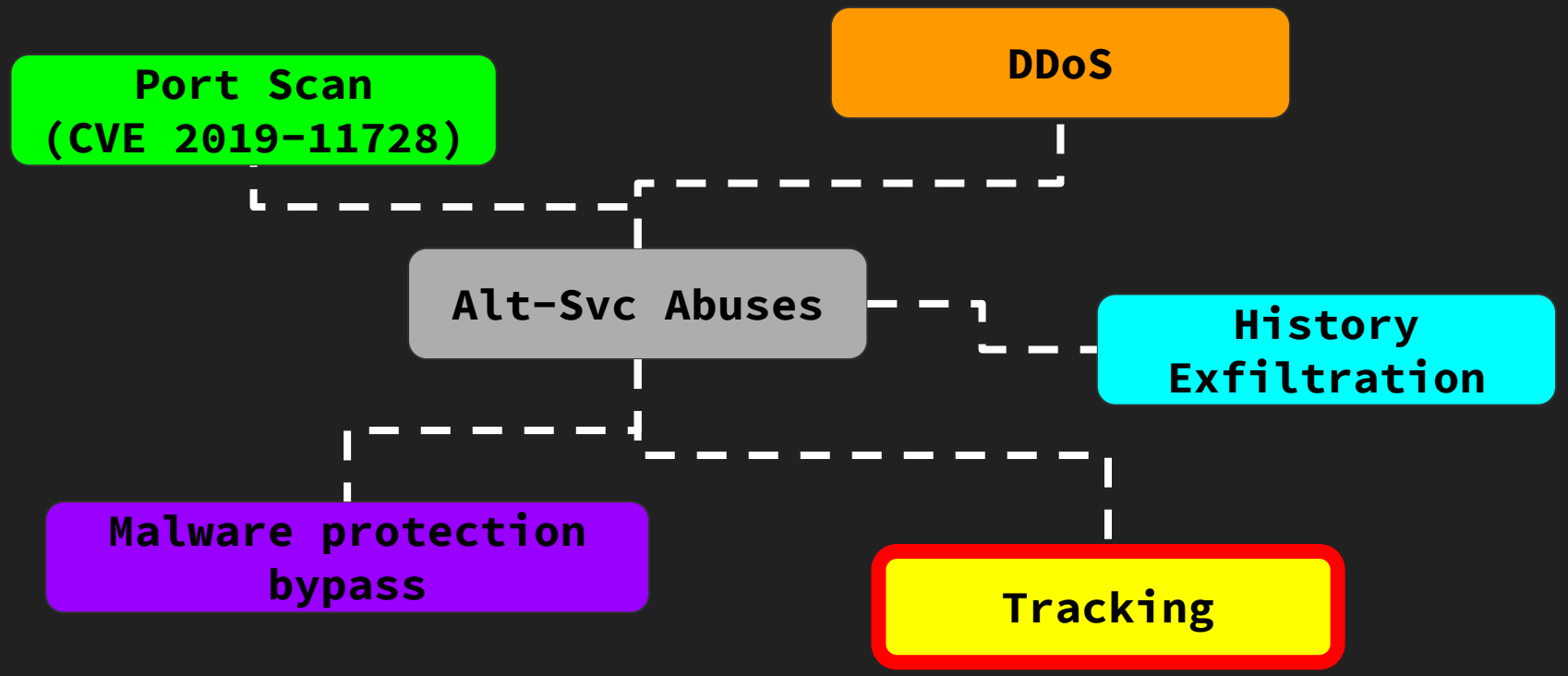
DDoS: Bandwidth exhaustion

- SMTP, HTTPS, etc. (any TLS speaking servers).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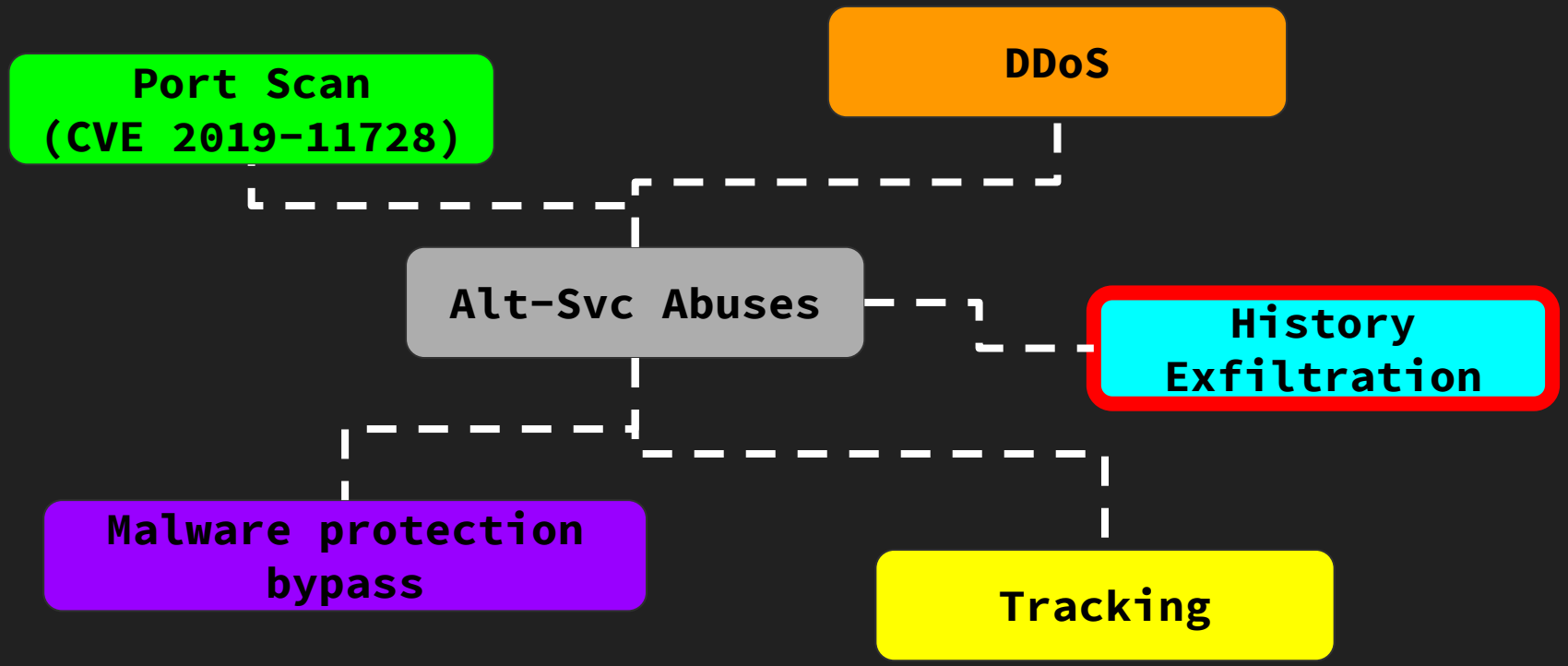
Tracking

- Alt-Svc mapping is cached by browser.
- Specify unique value for each user to track.
- Works 1st and 3rd party, bypassing known tracking blockers.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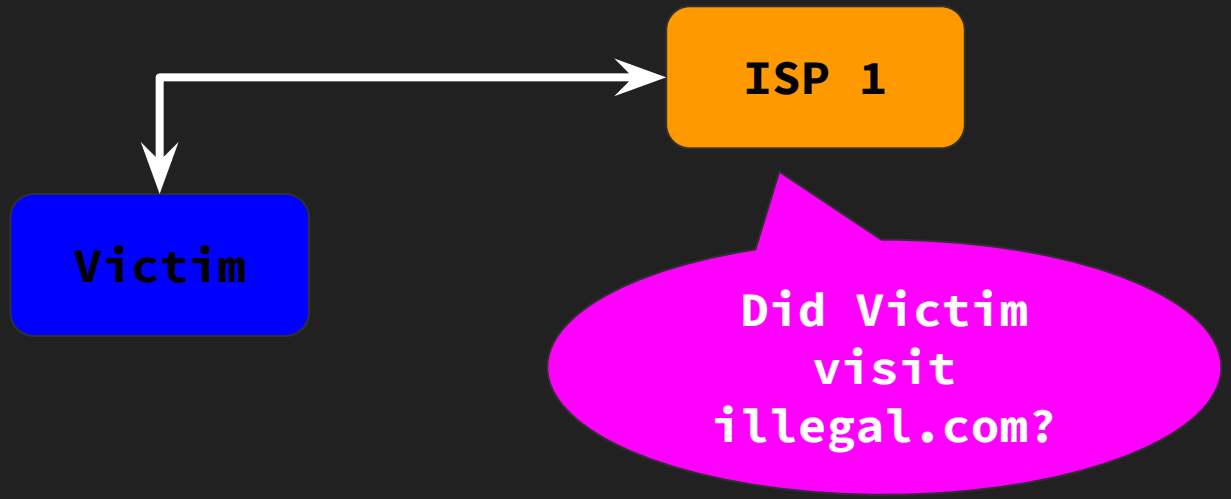
History exfiltration

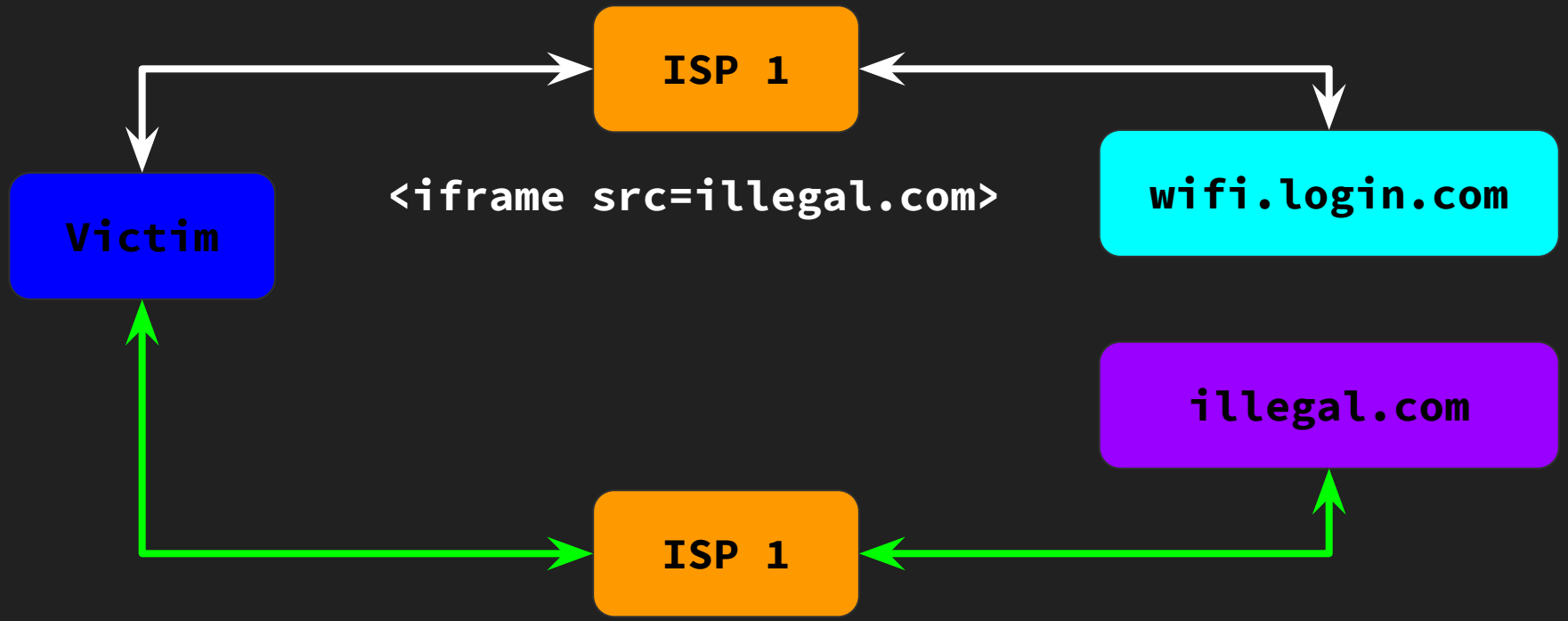
- Captive WiFi Portal
- Restaurants, coffee shops, hotels

History exfiltration

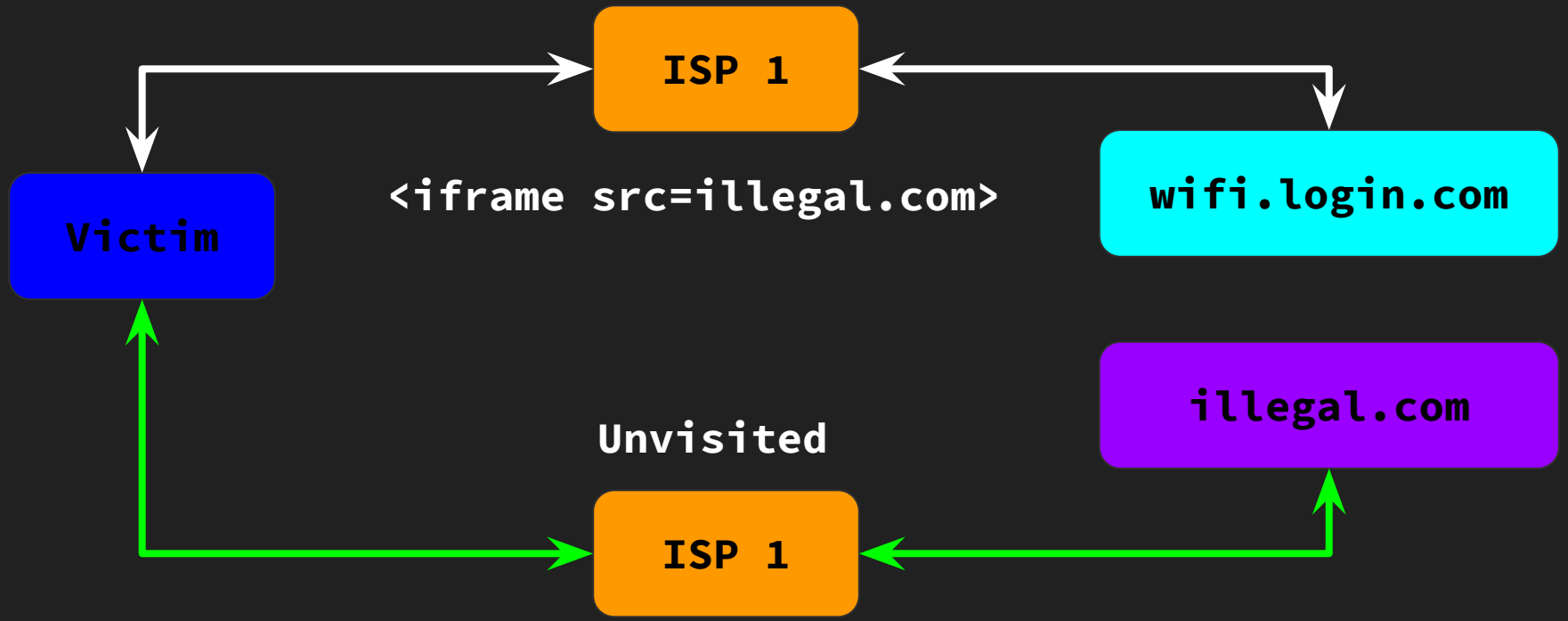


History exfiltration

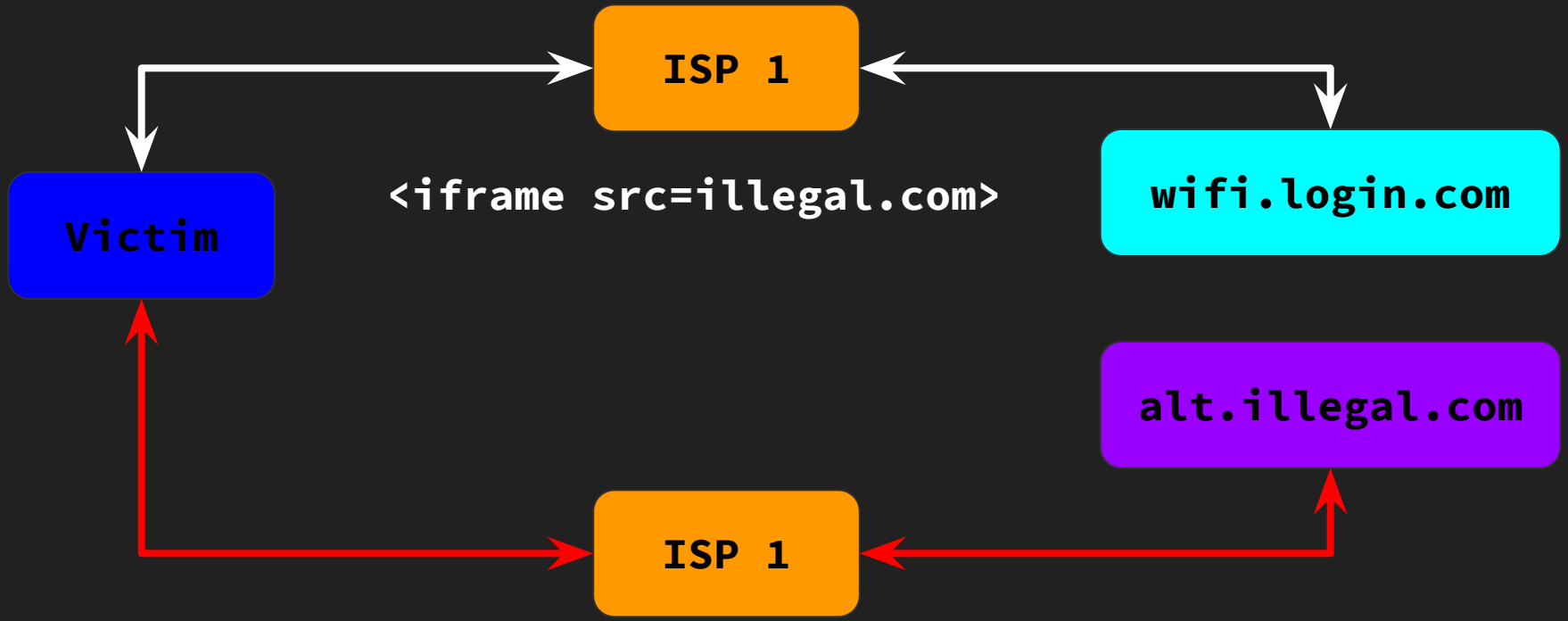
History exfiltration



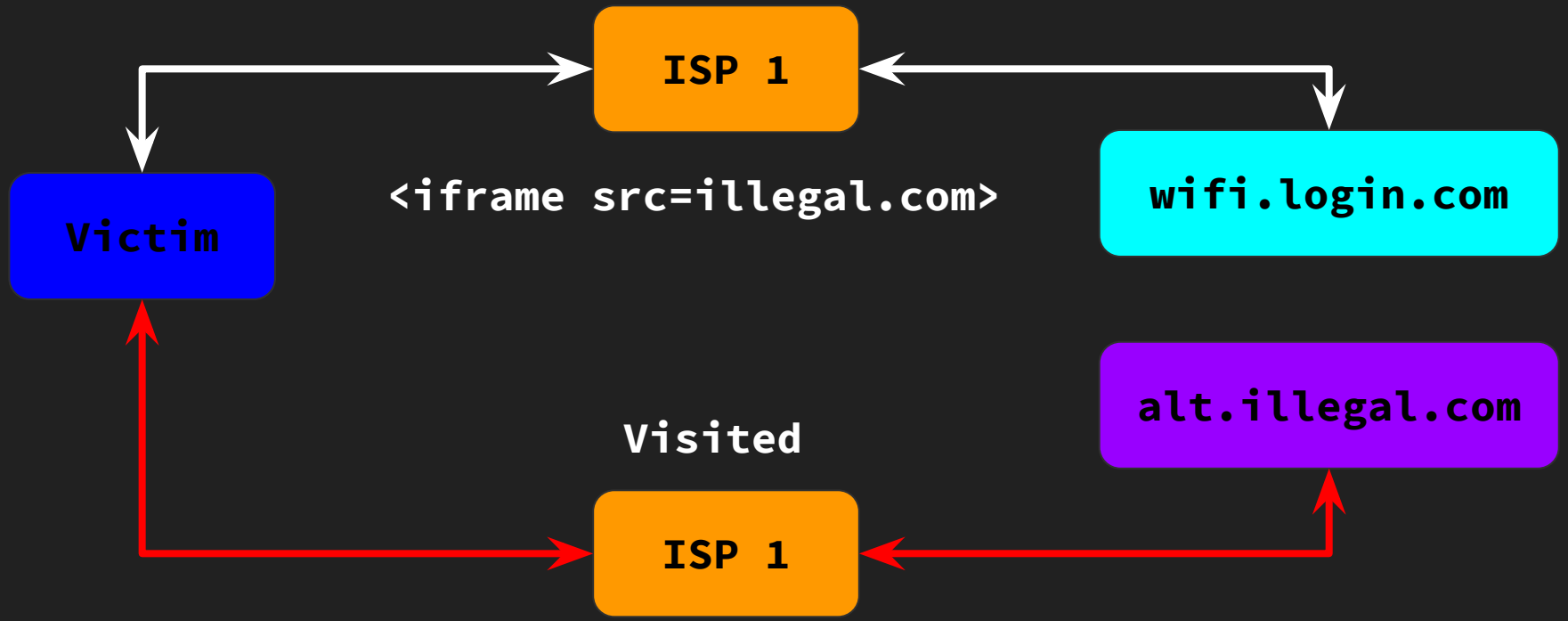
History exfiltration



History exfiltration



History exfiltration



Mitigations

- **Port-Scan, DDoS:**
  Block sensitive ports

- **Safe Browsing:**
  Alt-Svc domain check

- **Tracking, History Exfiltration:**
  Isolate Alt-Svc cache

Industry response

	Firefox	TOR	Chrome	Brave
Port-Scan				
DDoS				
Malware protection bypass				
Tracking				
History exfiltration				

Fixed	In process	Unpatched	Unaffected

Conclusion

- New but widely adopted Alt-Svc is vulnerable
- 5 attacks(!), despite:
  - Maturity of HTTP
  - Highly competent browser developers
- Securing is not easy!

References

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Questions?