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Competence Centers for
Excellent Technologies

# Browser History Stealing with Captive Wi-Fi Portals

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bmvit Bundesministerium für Verkehr, Innovation und Technologie

bmwfw Bundesministerium für Wissenschaft, Forschung und Wirtschaft

FFG

wirtschaftsagentur wien Ein Fonds der Stadt Wien

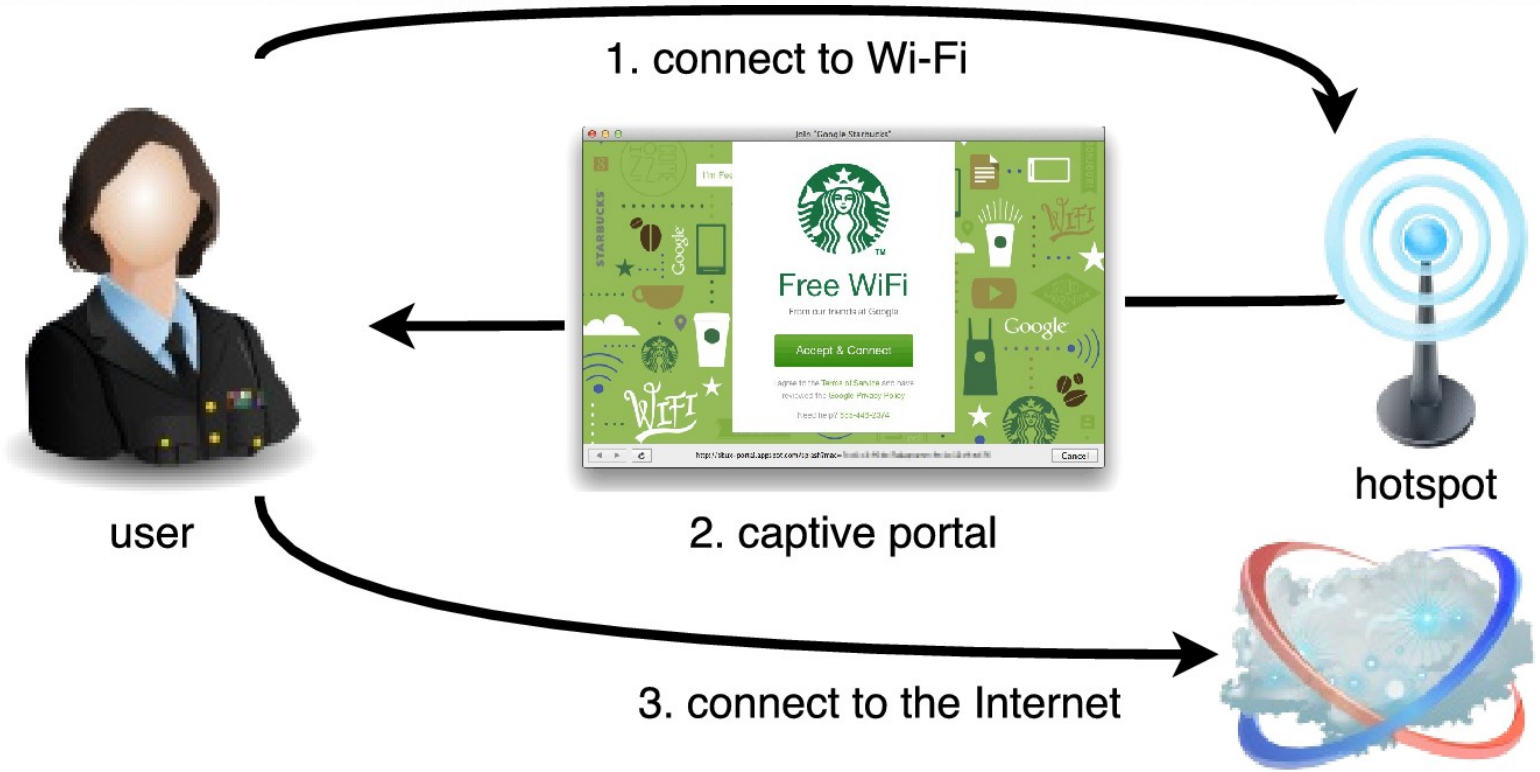
Christian Doppler Forschungsgesellschaft

FWF Der Wissenschaftsfonds.

# Public Wi-Fi Hotspots

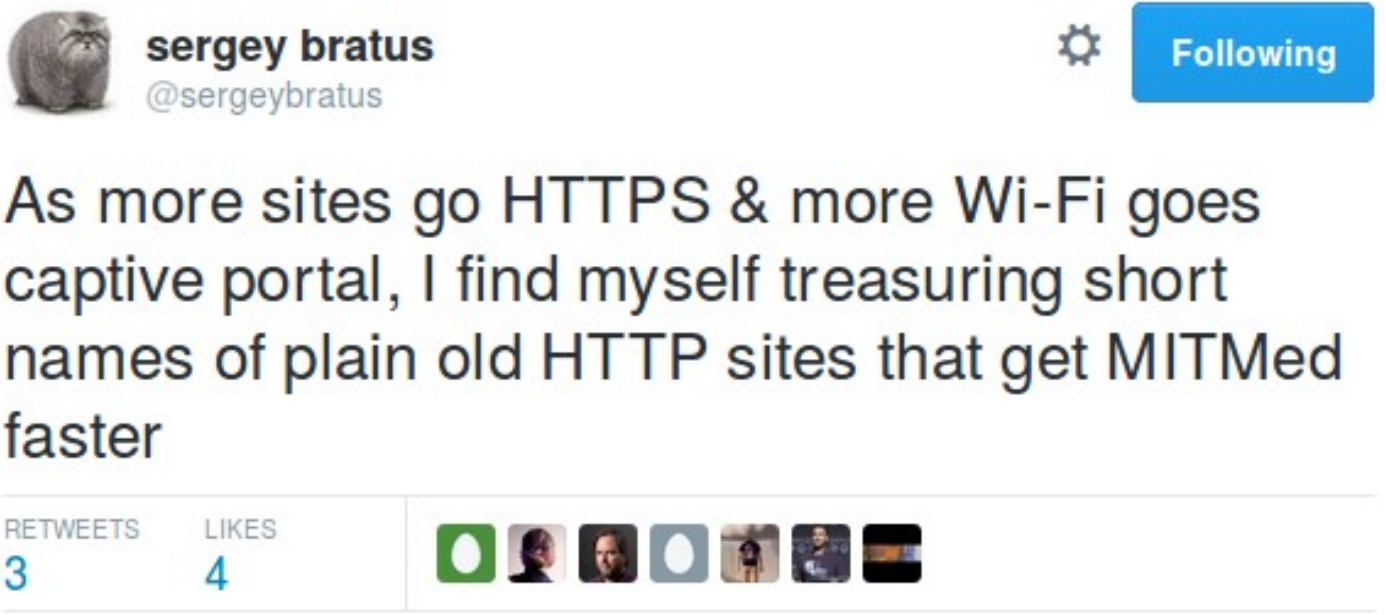

- Like a well in a village
- We gather there, pull up a bucket or two of “Internet”
- Look at the sign from the sponsor
- … and move on.

# What is a “Captive Portal”?



# Why Captive Portal

- Omnipresent in Wi-Fi Hotspots
  - Used by you probably right now (in this very hotel)
- Has an elevated position on the network
- Man-in-the-Middle by design
  - Sponsors of a Wi-Fi want us to see their messages (and accept the disclaimer)
  - There is no standard for that
  - Let's inject it into your traffic…



# Browser History Stealing, again?

- Baron, 2002
  - :visited link color
- Ruderman, 2000
  - :visited can load images
- Jang, 2010
  - Sites are actively trying to steal history

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# History, so what?

- Culture & Language
  - Amazon.fr, Amazon.jp
- Sexual orientation
  - grindr.com, transblog.de
- Partnership status
  - Okcupid.com, parship.com
- Employer
  - intranet.ibm.com

- Other websites that give interesting insights
  - Medical conditions
  - Political campaigns
  - Religious communities

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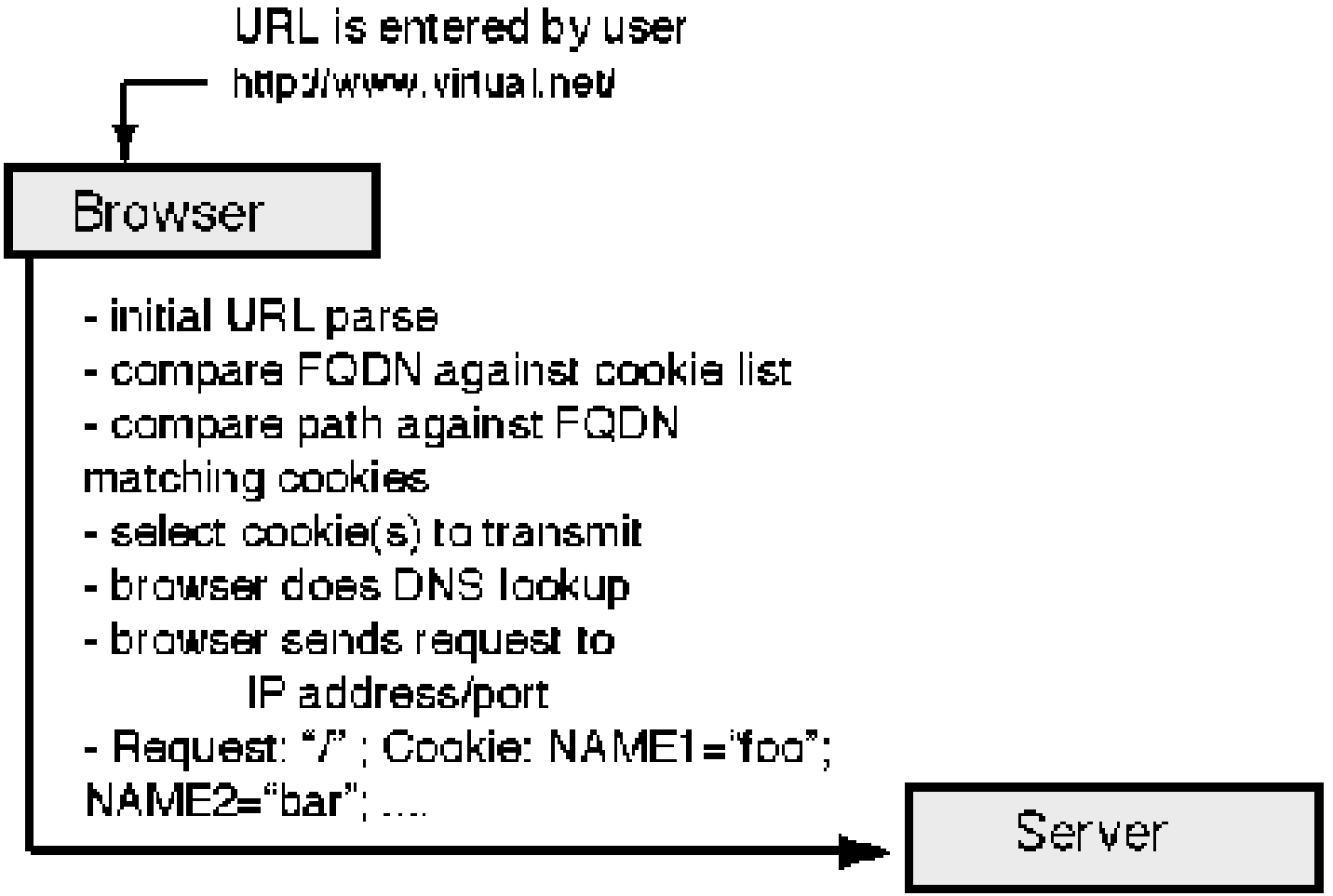
# HTTP Request w/Cookie




Source: MindSource April 1996 BOF;
Client State Tracking with Netscape Cookies;
M. Strata Rose; strata@virtual.net

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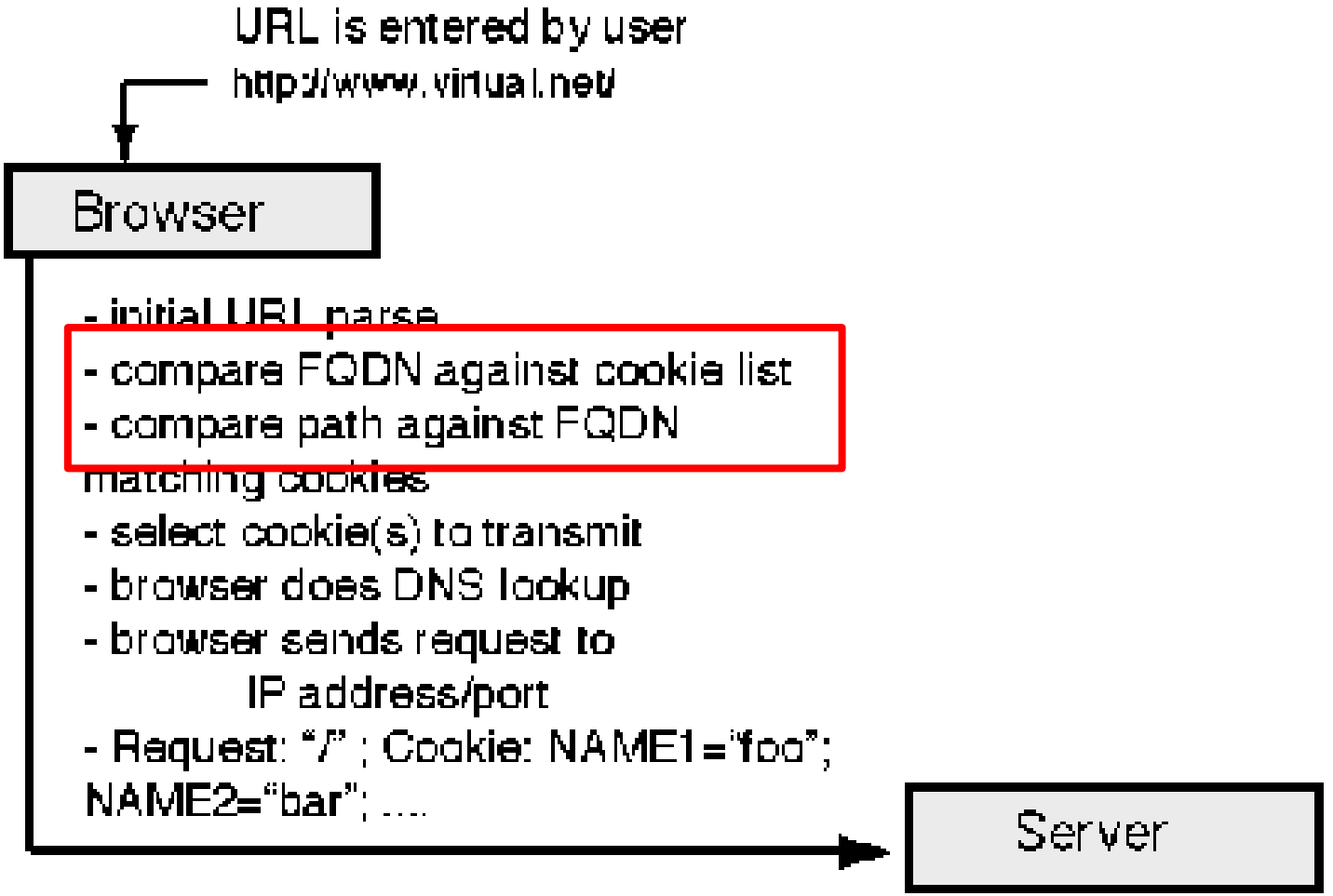


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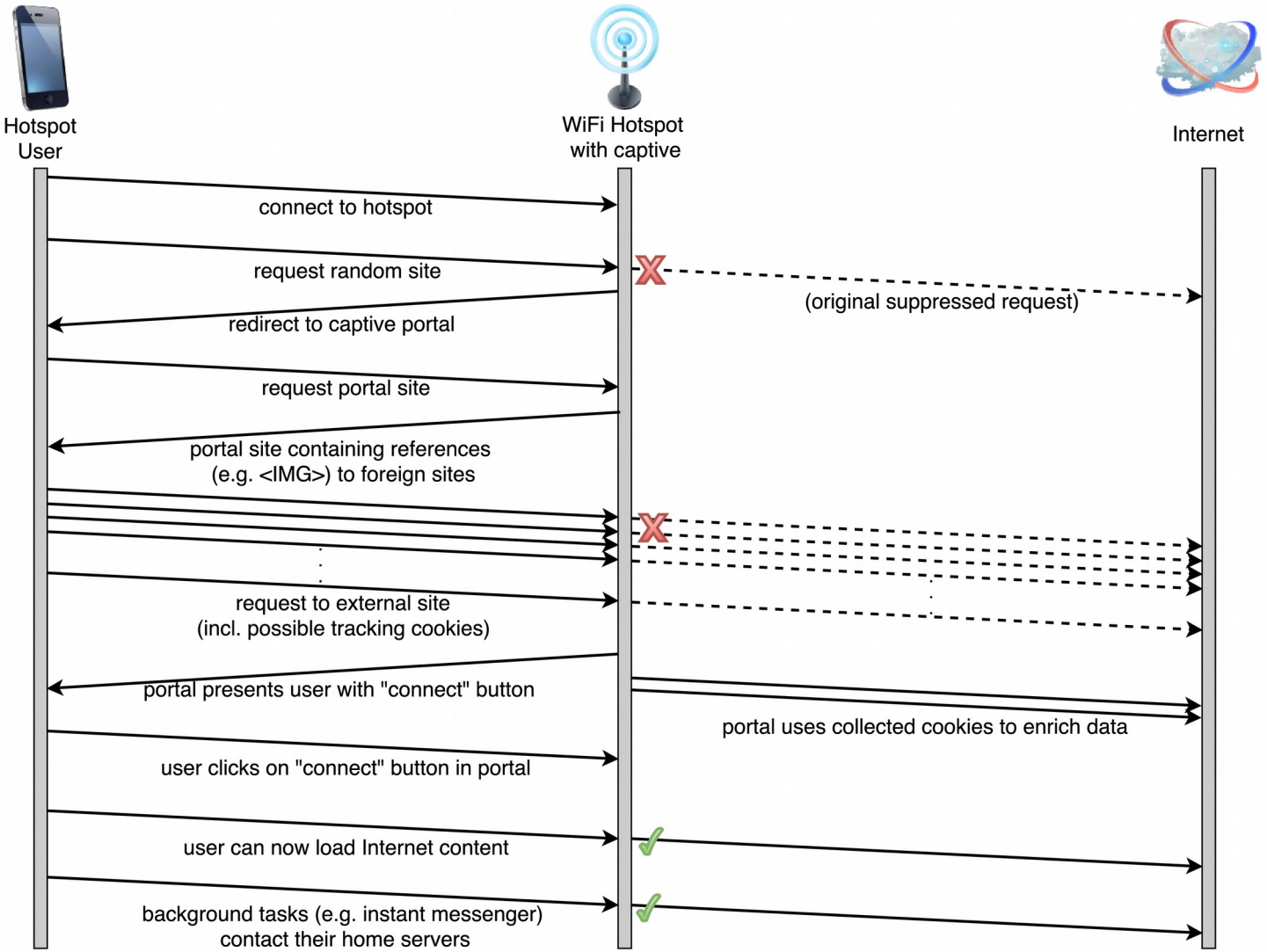
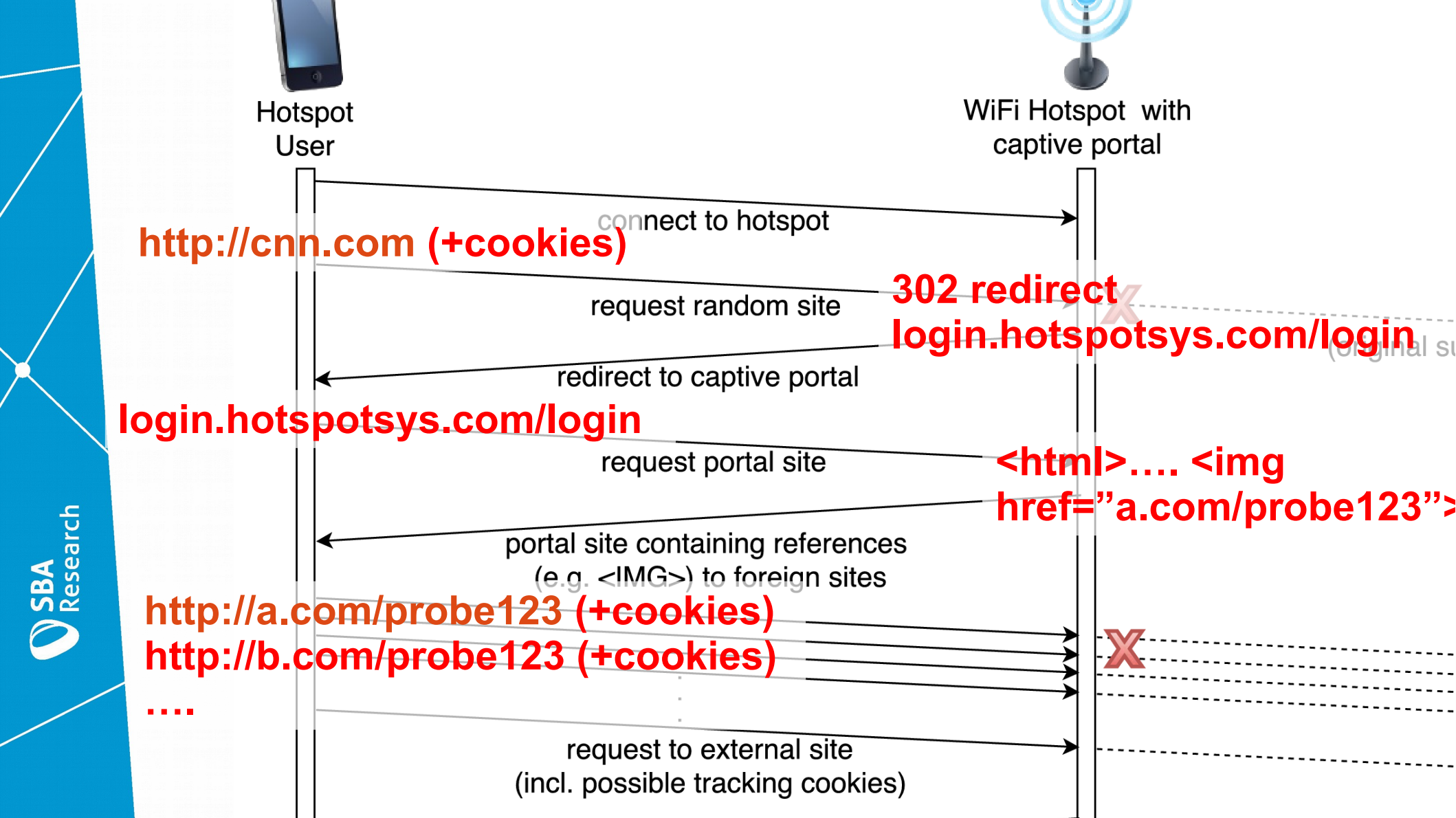
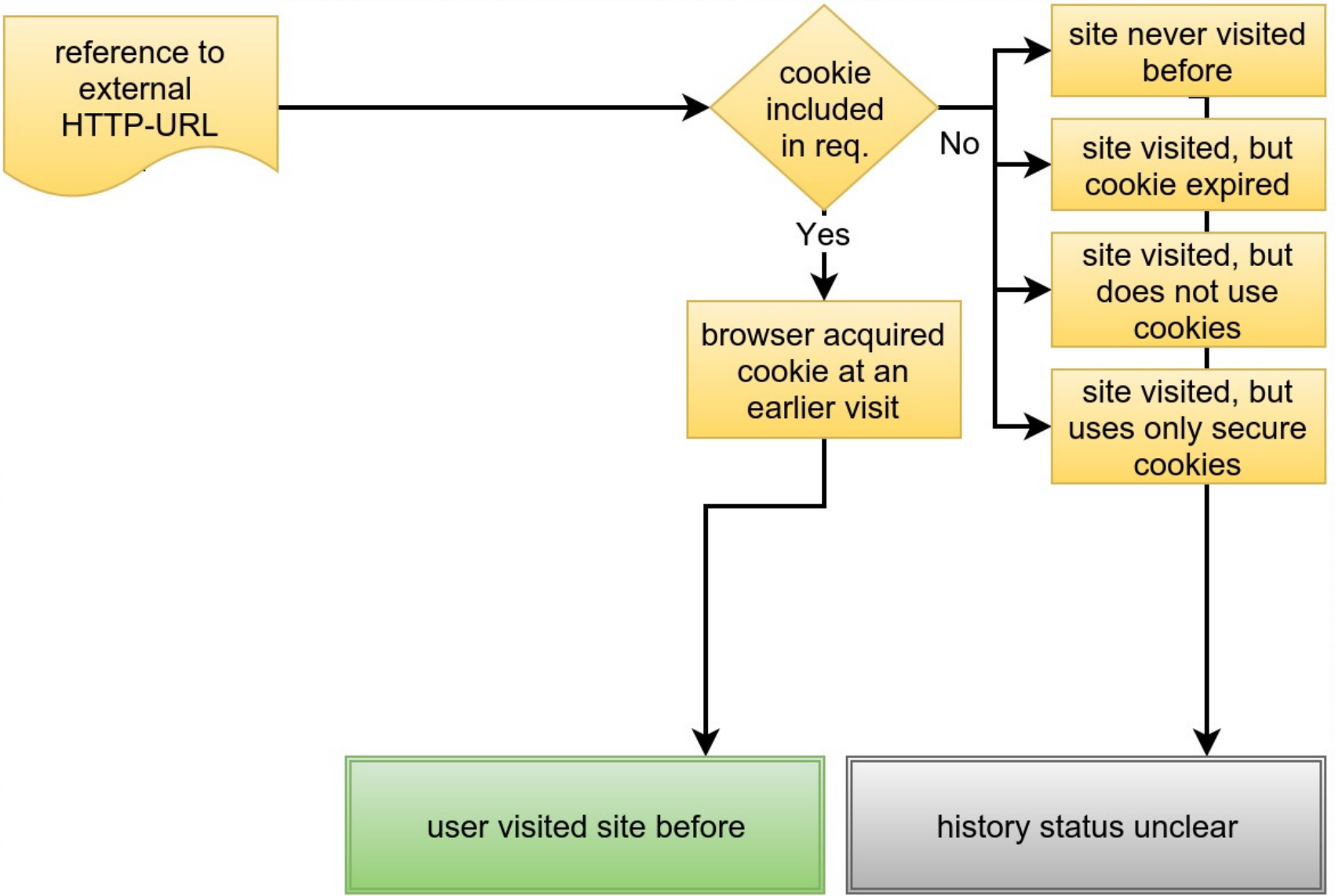
# Cookies (or not enough state for HTTP)

- Two kinds
  - Session cookies: usually forgotten when browser closed
  - Persistent cookies: stored on disk with expiry date
- Only depend on the FQDN and Protocol
  - XSS
  - XSRF
  - HTTP set cookie also used for HTTPS
    - Insecure set cookies mixed into the cookies over HTTPS


Hotspot User
WiFi Hotspot with captive
Internet
connect to hotspot
request random site
(original suppressed request)
redirect to captive portal
request portal site
portal site containing references (e.g. <IMG>) to foreign sites
request to external site (incl. possible tracking cookies)
portal presents user with "connect" button
portal uses collected cookies to enrich data
user clicks on "connect" button in portal
user can now load Internet content
background tasks (e.g. instant messenger) contact their home servers


Hotspot User
WiFi Hotspot with captive portal
connect to hotspot
http://cnn.com (+cookies)
request random site
302 redirect
login.hotspotsys.com/login
redirect to captive portal
login.hotspotsys.com/login
request portal site
<html>…. <img
href=”a.com/probe123”>
portal site containing references
(e.g. <IMG>) to foreign sites
http://a.com/probe123 (+cookies)
http://b.com/probe123 (+cookies)
….
request to external site
(incl. possible tracking cookies)


reference to external HTTP-URL
cookie included in req.
No
Yes
site never visited before
site visited, but cookie expired
site visited, but does not use cookies
site visited, but uses only secure cookies
browser acquired cookie at an earlier visit
user visited site before
history status unclear

# Sure, crypto will save us!

- HTTPS hides content (and therefore cookies)
  - But is not used by default
    (e.g., when URL entered in location bar)
- HTTP Strict Transport Security (HSTS)
  - Site announces availability of HTTPS with same content as via HTTP
  - Client caches this
  - Uses HTTPS by default next time for this site

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**side channel**

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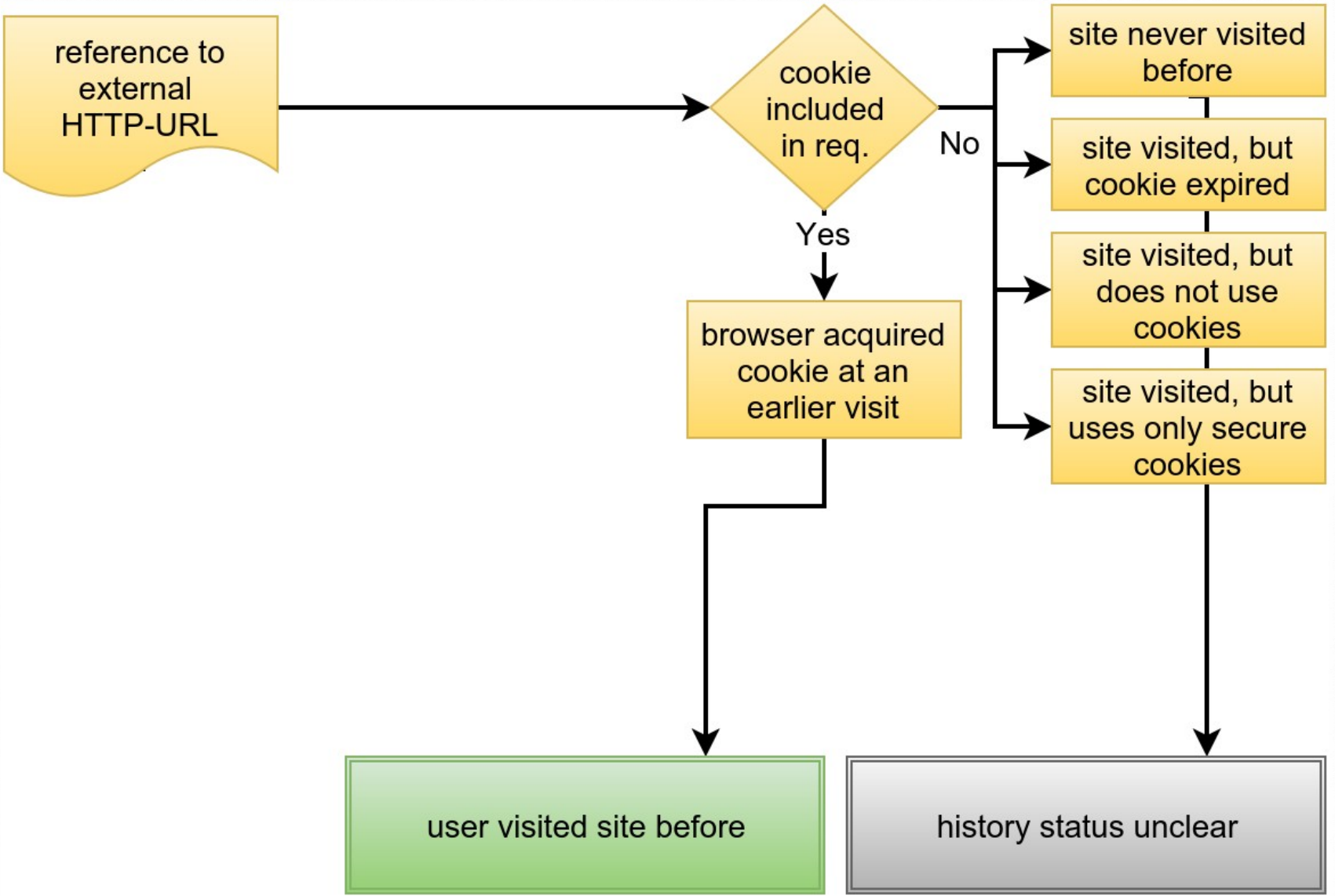
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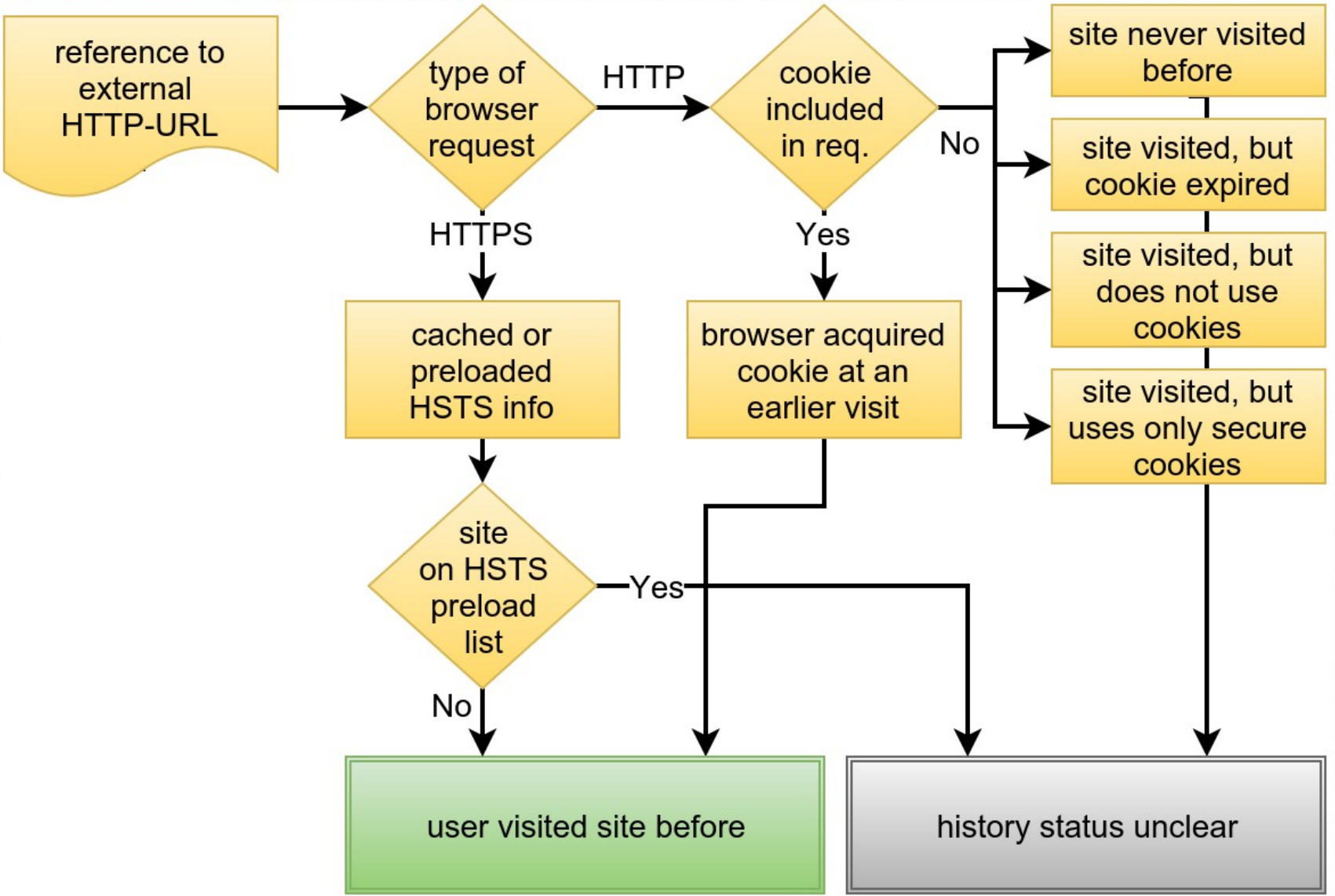

reference to external HTTP-URL
type of browser request
HTTP
HTTPS
cookie included in req.
No
Yes
site never visited before
site visited, but cookie expired
site visited, but does not use cookies
site visited, but uses only secure cookies
cached or preloaded HSTS info
browser acquired cookie at an earlier visit
site on HSTS preload list
Yes
No
user visited site before
history status unclear

# Which users are affected?

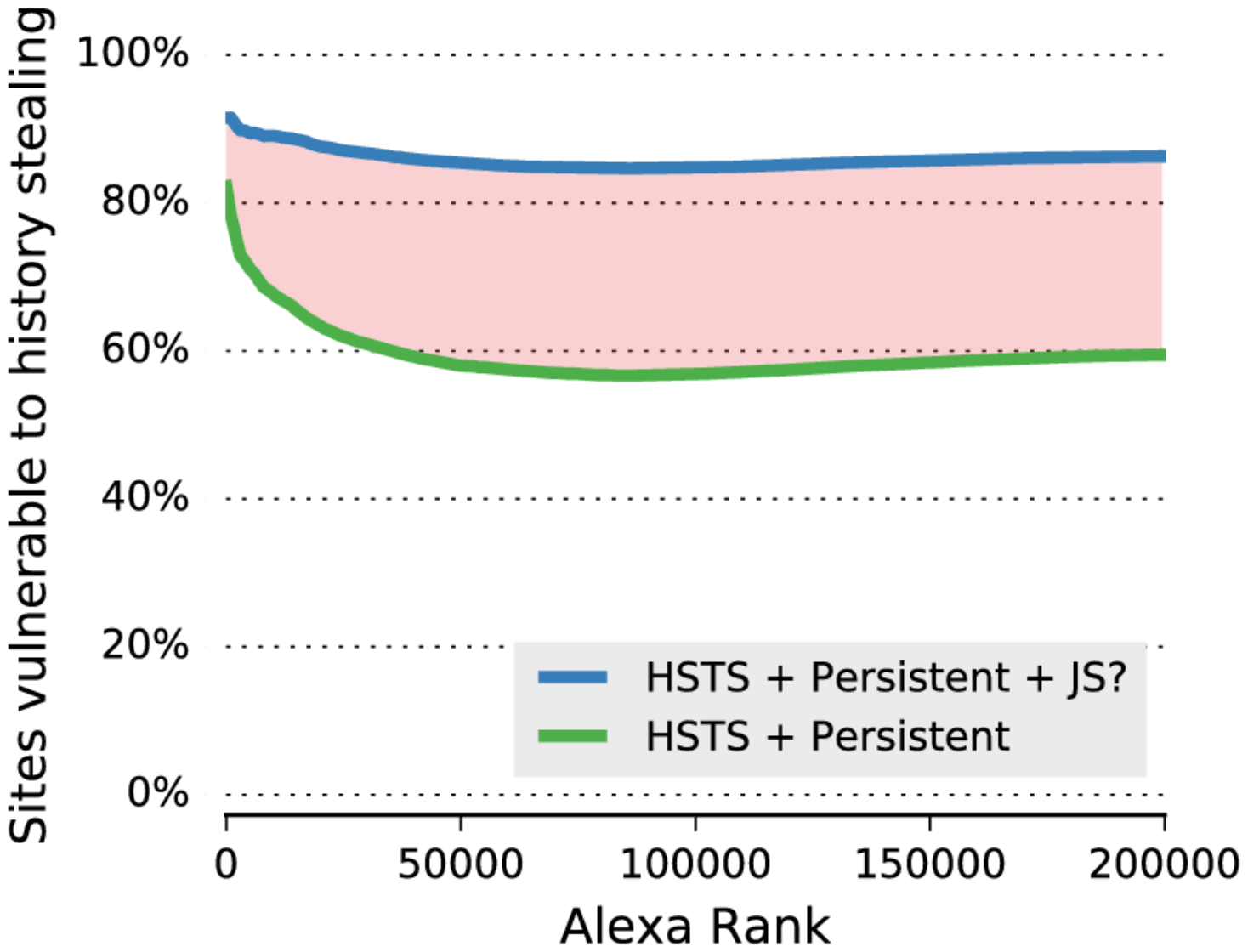
- Everyone who uses the standard browser to login into the captivce portal (mobile, notebook, ...)
  - Even VPN users
- Android and iOS introduced captive portal detectors
  - Primarily for convenience – starts stripped down browser
  - The online test is very easy to fool, since based on HTTP
  - User will use main browser to login, exposing their history

# Captive Portal Detection

- A convenience feature
  - iOS since Version 4
  - Android since 4.2 – used default browser
  - Android since 5 – uses captive portal browser
- Test is easy to circumvent – HTTP!
  - http://clients3.google.com/generate_204
  - http://captive.apple.com/hotspot-detect.html

# Which sites affected?

- Uses long-term (persistent) cookie
  - e.g., for session, tracking, or configuration
  - Can be set via
    - HTTP Header
    - Javascript
- Uses HSTS header




Top 1K
82-92%

Top 200K
59-86%

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# Implementation

- POC implementation
  - Speed up by…
  - Marking probe request with a special string
  - Returning 1x1 pixel or killing connections
  - Caching DNS
    - Still one DNS request for each probed site
- Added de-anonymization
  - e.g., via amazon.com


# Solutions & Countermeasures?

Transmission

Hotspot Eco-System

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# Hotspot Ecosystem


There is no standard for hotspot splash screen display

- Choose to present message in-band
- By redirecting/tampering with traffic
- Some do this also for SSL traffic
- e.g., via DNS _portal.local

# Countermeasures

On the Client

- Better captive portal detection
  - Private browsing mode for portal
- Same-Site Cookies
  - Circumvention with one more fake indirection step
- Hotspot 2.0
  - Not widely supported
  - Solution for seamless roaming, not for showing banners and ads to the customer

On the Server

- HTTPS-only cookies
  - Google is changing an increasing number of Client-APIs to require HTTPS connections

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# Conclusion

- Captive Portals (& MITM) can learn about the
  - current session
  - past browsing sessions
  - Even for VPN users
- Side channels
  - Cookies
  - HSTS

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