Web Attacks

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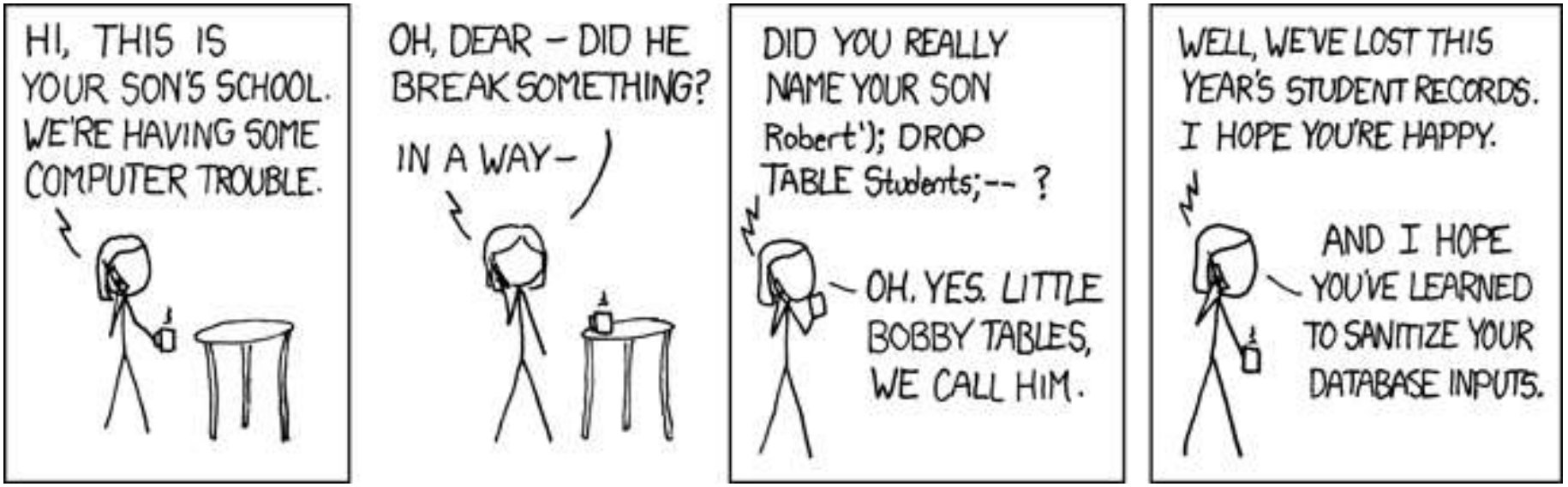
SQL Injection

- Goal: Change or exfiltrate info from *victim.com*'s database
- Main idea: Inject code through the parts of a query that you define

SQL Injection



SQL Injection

- Prerequisites:
  - Victim site uses a database
  - Some user-provided input is used as part of a database query
  - DB-specific characters aren’t (completely) stripped

SQL Injection: How?

- Enter DB logic as part of query you impact
- Back-end query
  - `SELECT * FROM USERS WHERE USER='' AND PASS='';`
- For username & password, attacker gives:
  - `' or '1'='1`
- Straightforward insertion:
  - `SELECT * FROM USERS WHERE USER='' or '1'='1' AND PASS='' or '1'='1';`

SQL Injection: Why Does This Work?

- Database does what you ask in queries!

SQL Injection: Key Mitigations

- Sanitize / escape user input
  - Harder than you think!
  - Different encodings
  - Use libraries to do this!
- Prepared statements from libraries handle escaping for you!
- E.g., mysqli (in place of mysql) for PHP

Cross-Site Scripting (XSS)

- Goal: Run JavaScript on someone else's domain to access that domain's DOM
  - If the JavaScript is inserted into a page on *victim.com* or is an external script loaded by a page on *victim.com*, it follows *victim.com*'s same origin policy
- Main idea: Inject code through either URL parameters or user-created parts of a page

Cross-Site Scripting (XSS)

- Variants:
  - *Reflected XSS*: The JavaScript is there only temporarily (e.g., search query that shows up on the page or text that is echoed)
  - *Stored XSS:* The JavaScript stays there for all other users (e.g., comment section)
- Prerequisites:
  - HTML isn't (completely) stripped
  - *victim.com* echoes text on the page
  - *victim.com* allows comments, profiles, etc.

XSS: How?

- Type <*script*>`EVIL CODE();`</*script*> into form field that is repeated on the page
- Do the same, but as a URL parameter
- Add a comment (or profile page, etc.) that contains the malicious script
- Malicious script accesses sensitive parts of the DOM (financial info, cookies, etc.)
  - Change some values
  - Exfiltrate info (load *attacker.com/?q=SECRET)*

XSS: Why Does This Work?

- All scripts on *victim.com* (or loaded from an external source by *victim.com*) are run with *victim.com* as the origin
  - By the Same Origin Policy, can access DOM

XSS: Key Mitigations

- Sanitize / escape user input
  - Harder than you think!
  - Different encodings
  -
  - Use libraries to do this!
- Define Content Security Policies (CSP)
  - Specify where content (scripts, images, media files, etc.) can be loaded from
  - `Content-Security-Policy: default-src 'self' *.trusted.com`

Cross-Site Request Forgery (CSRF)

- Goal: Make a user perform some action on a website without their knowledge
  - Trick the browser into having them do this
- Main idea: Cause a user who's logged into that website to send a request that has lasting effects

Cross-Site Request Forgery (CSRF)

- Prerequisites:
  - *Victim* is logged into *important.com* in a particular browser
  - *important.com* accepts GET and/or POST requests for important actions
  - *Victim* encounters *attacker's* code in that same browser

CSRF Example

- *Victim* logs into *important.com* and they stay logged in (within some browser)
  - Likely an auth token is stored in a cookie
- *Attacker* causes *victim* to load `https://www.important.com/transfer.php?amount=100000000&recipient=blase`
  - This is a GET request. For POST requests, auto-submit a form using JavaScript
- Transfer money, cast a vote, change a password, change some setting, etc.

CSRF: How?!

- On *blaseur.com* have Cat photos
- Send an HTML-formatted email with <img src="`URL`">
- Have a hidden form on *blaseur.com* with JavaScript that submits it when page loads
- Etc.

CSRF: Why Does This Work?

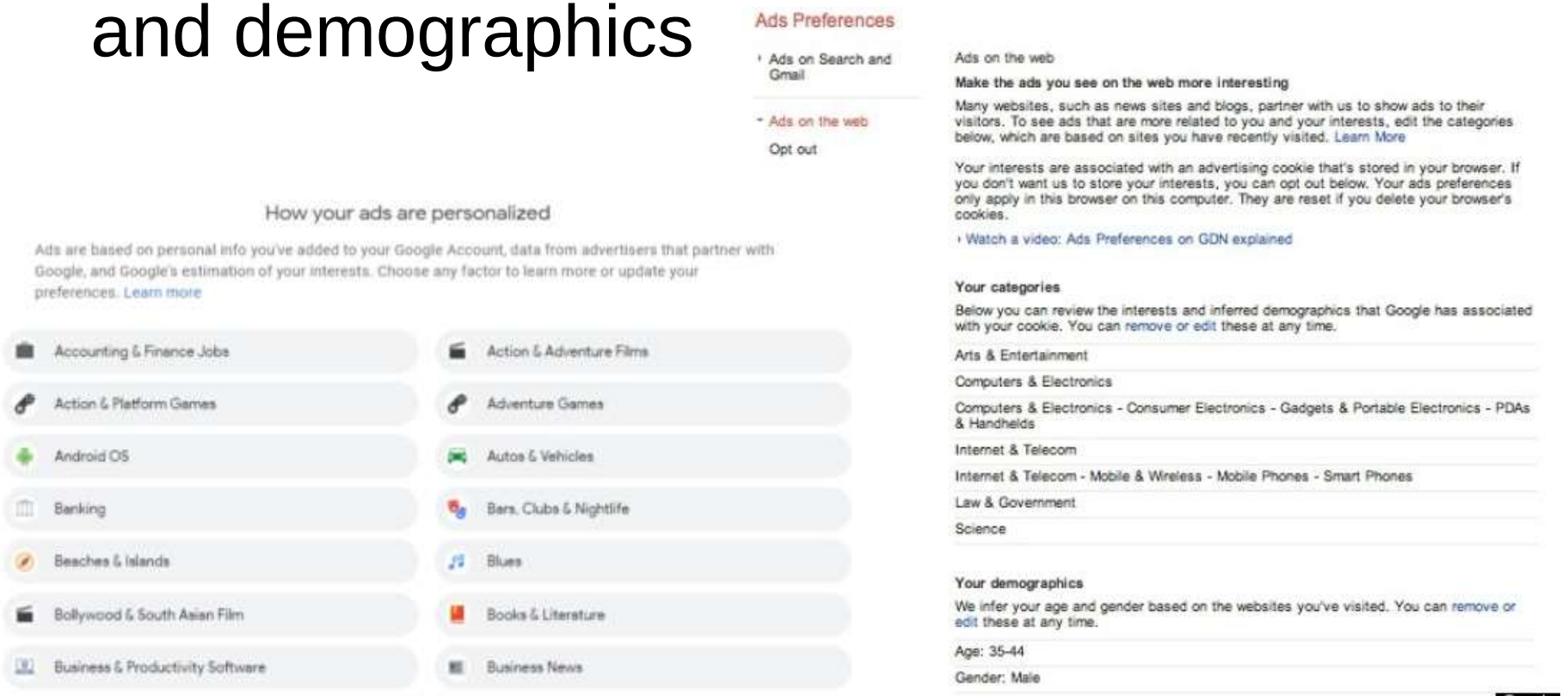
- Recall: Cookies for *important.com* are automatically sent as HTTP headers with every HTTP request to *important.com*
- *Victim* doesn't need to visit the site explicitly, but their browser just needs to send an HTTP request
- Basically, the browser is confused
  - "Confused deputy" attack

CSRF: Key Mitigations

- Check HTTP referer
  - But this can sometimes be forged
- CSRF token
  - "Randomized" value known to *important.com* and inserted as a hidden field into forms
  - Key: not sent as a cookie, but sent as part of the request (HTTP header, form field, etc.)

Online Tracking

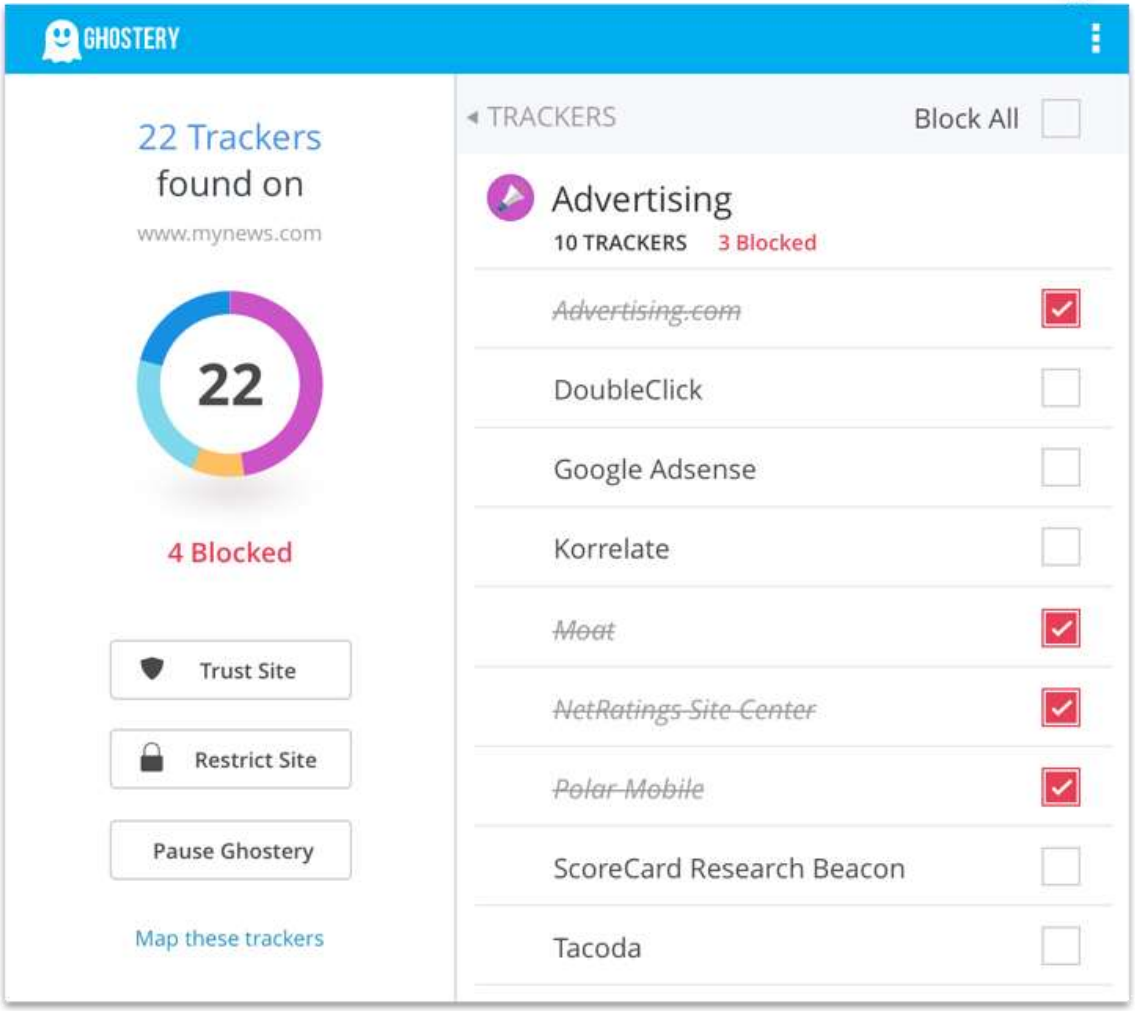
- Advertisers want to show you advertisements targeted to your interests and demographics



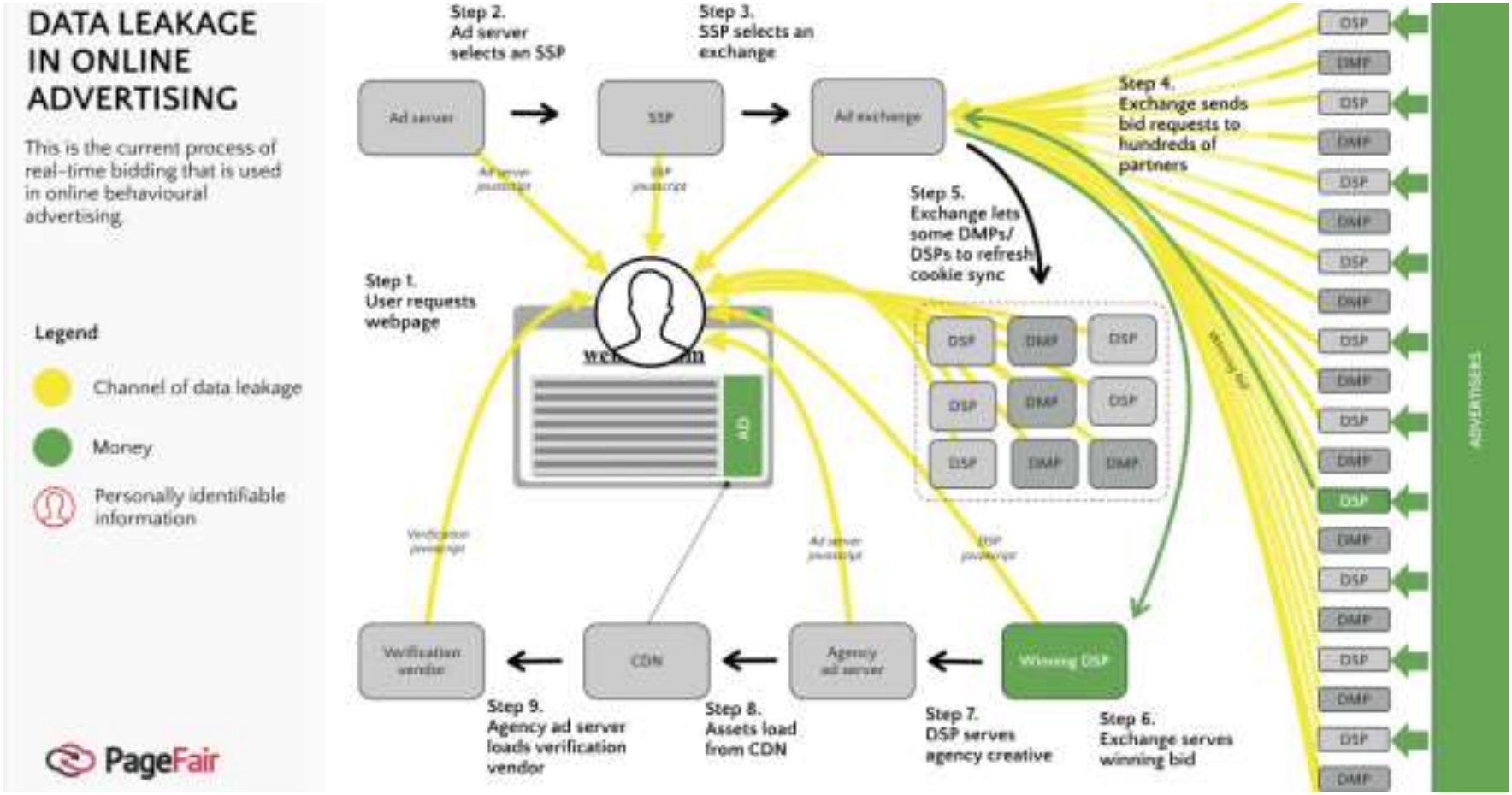
Online Tracking

- JavaScript / images from advertising networks loaded as part of your page
  - In iframes
  - Or sometimes not
  - Why does this matter?

Ubiquity of Online Tracking



Ad Bidding Marketplaces

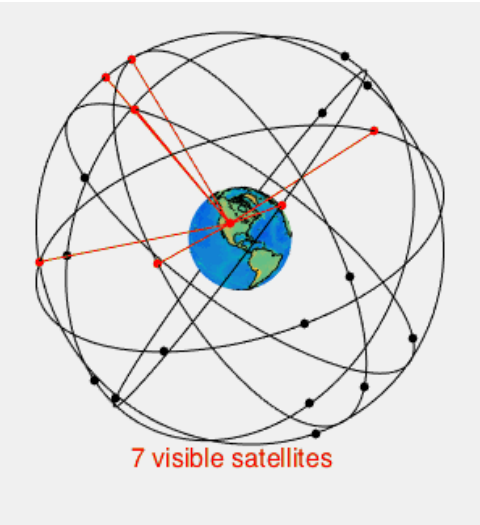


Device Fingerprinting

- Use unique(-ish) combination of device features as an identifier
- https://panopticlick.eff.org/

Location Tracking

- IP Geolocation
  - Hierarchy of IP addresses
- GPS (Global Positioning System)
  - ~31 satellites in semi-synchronous orbit in OUTER SPACE with atomic clocks
  - Always ~6 satellites in line of sight
  - Multilateration



What Does HTTPS Hide?

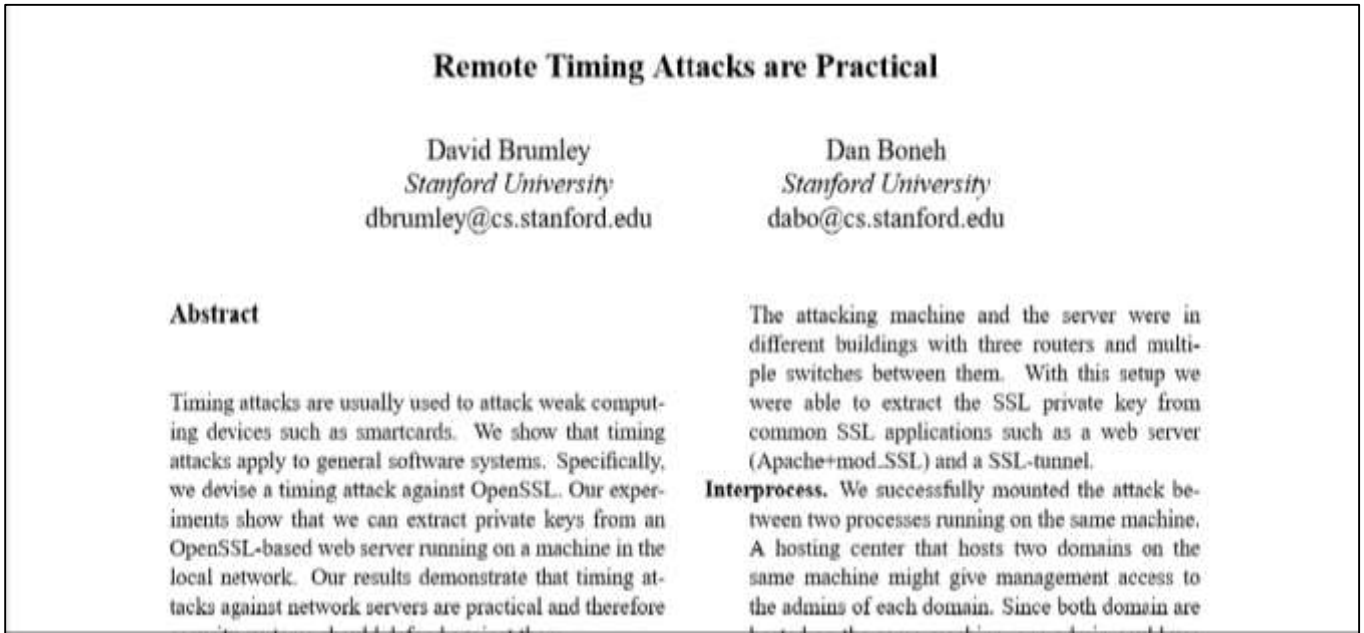
- Body of the HTTP request / response is hidden
- …So what's left to be seen / inferred?

Side Channels

- Using metadata or outside observations to make inferences about the data

Web Side Channels Include:

- Size of packets
  - How can this reveal what pages you are visiting?
- Timing



Remote Timing Attacks are Practical

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Abstract

Timing attacks are usually used to attack weak computing devices such as smartcards. We show that timing attacks apply to general software systems. Specifically, we devise a timing attack against OpenSSL. Our experiments show that we can extract private keys from an OpenSSL-based web server running on a machine in the local network. Our results demonstrate that timing attacks against network servers are practical and therefore

The attacking machine and the server were in different buildings with three routers and multiple switches between them. With this setup we were able to extract the SSL private key from common SSL applications such as a web server (Apache+mod_SSL) and a SSL-tunnel.

Interprocess. We successfully mounted the attack between two processes running on the same machine. A hosting center that hosts two domains on the same machine might give management access to the admins of each domain. Since both domain are