Web Security: Session management and CSRF

CS 161: Computer Security

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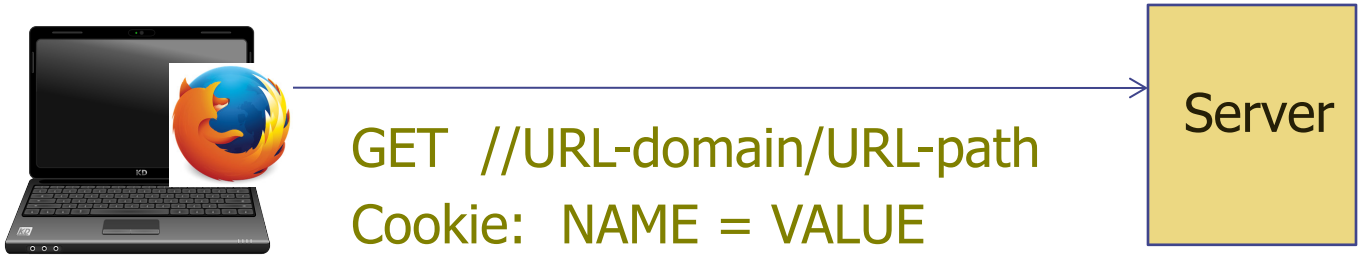
Credit: this deck is a combination of my slides and slide adaptations from previous offerings of this course and from CS 241 of Prof. Dan Boneh

Cookie policy versus same-origin policy

Cookie policy: when browser sends cookie



A cookie with

domain = example.com, and

path = /some/path/

will be included on a request to

http://foo.example.com/some/path/subdirectory/hello.txt

Cookie policy versus same-origin policy

- Consider Javascript on a page loaded from a URL U
- If a cookie is in scope for a URL U, it can be accessed by Javascript loaded on the page with URL U,

  unless the cookie has the httpOnly flag set.

Examples

cookie 1
name = **userid**
value = u1
domain = **login.site.com**
path = **/**
non-secure

cookie 2
name = **userid**
value = u2
domain = **.site.com**
path = **/**
non-secure

http://checkout.site.com/	cookie: userid=u2
http://login.site.com/	cookie: userid=u1, userid=u2
http://othersite.com/	cookie: none

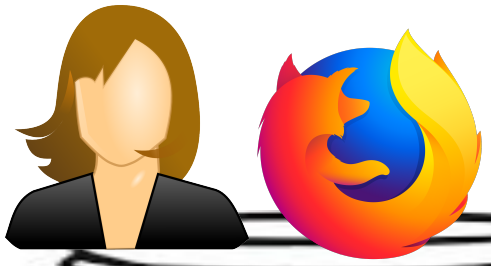
JS on each of these URLs can access all cookies that would be sent for that URL if the httpOnly flag is not set

Indirectly bypassing same-origin policy using cookie policy

- Since the cookie policy and the same-origin policy are different, there are corner cases when one can use cookie policy to bypass same-origin policy
- Ideas how?

Example

Victim user browser



financial.example.com
web server

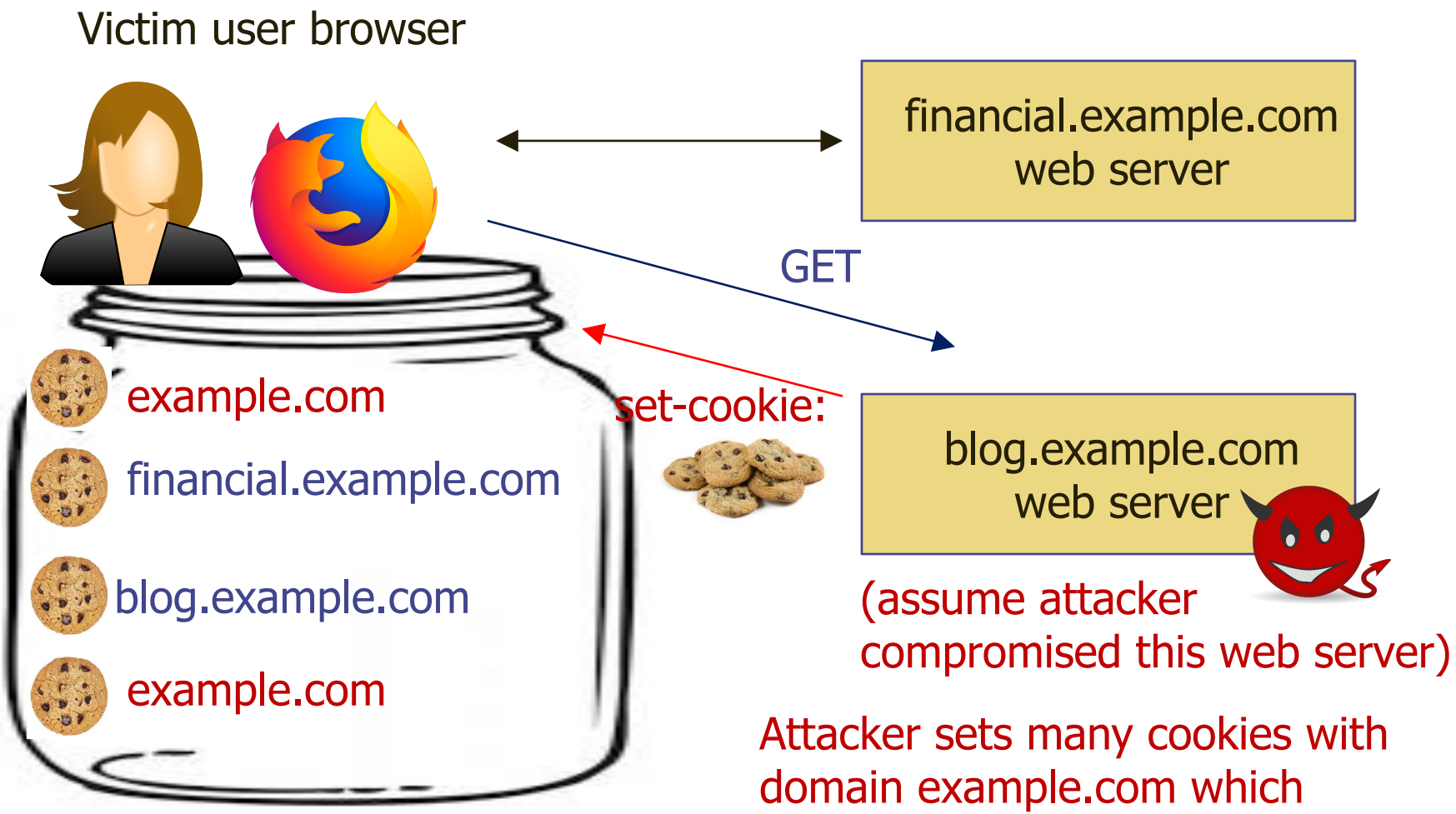
blog.example.com
web server

(assume attacker compromised this web server)

cookie jar for *.example.com

Browsers maintain a separate cookie jar per domain group, such as one jar for *.example.com to avoid one domain filling up the jar and affecting another domain. Each browser decides at what granularity to group domains.

Example

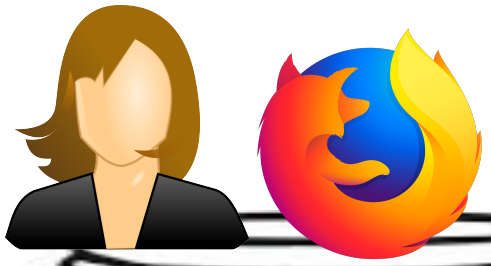


cookie jar for *.example.com

Attacker sets many cookies with domain example.com which overflows the cookie jar for domain *.example.com and overwrites cookies from financial.example.com

Example

Victim user browser



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(assume attacker compromised this web server)

cookie jar for *.example.com

Attacker sets many cookies with domain example.com which overflows the cookie jar for domain *.example.com and overwrites cookies from financial.example.com

Example

Victim user browser

cookie jar for *.example.com

GET

financial.example.com
web server

When Alice visits financial.example.com, the browser automatically attaches the attacker's cookies due to cookie policy (the scope of the cookies is a domain suffix of financial.example.com)

Why is this a problem?

Indirectly bypassing same-origin policy using cookie policy

- Victim thus can login into attackers account at financial.example.com
- This is a problem because the victim might think its their account and might provide sensitive information
- This bypassed same-origin policy (indirectly) because blog.example.com influenced financial.example.com

RFC6265

- For further details on cookies, checkout the standard RFC6265 “HTTP State Management Mechanism”

https://tools.ietf.org/html/rfc6265

- Browsers are expected to implement this reference, and any differences are browser specific

Session management

Sessions

- A sequence of requests and responses from one browser to one (or more) sites
  - Session can be long (Gmail - two weeks)
    or short
  - without session mgmt:

    users would have to constantly re-authenticate

- Session mgmt:
  - Authorize user once;
  - All subsequent requests are tied to user

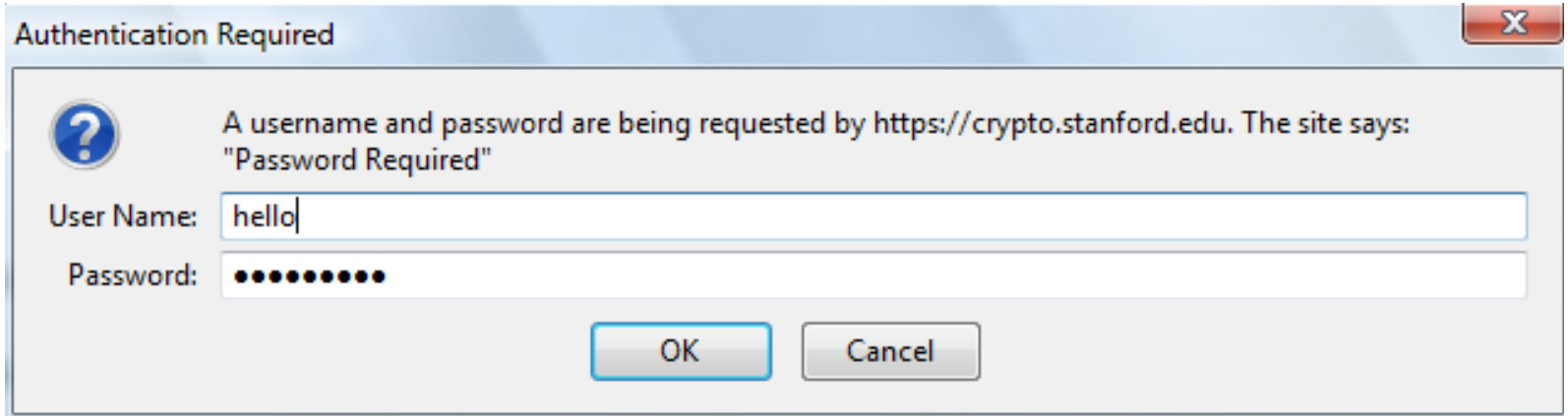
Pre-history: HTTP auth

One username and password for a group of users

HTTP request: GET /index.html

HTTP response contains:

WWW-Authenticate: Basic realm="Password Required"



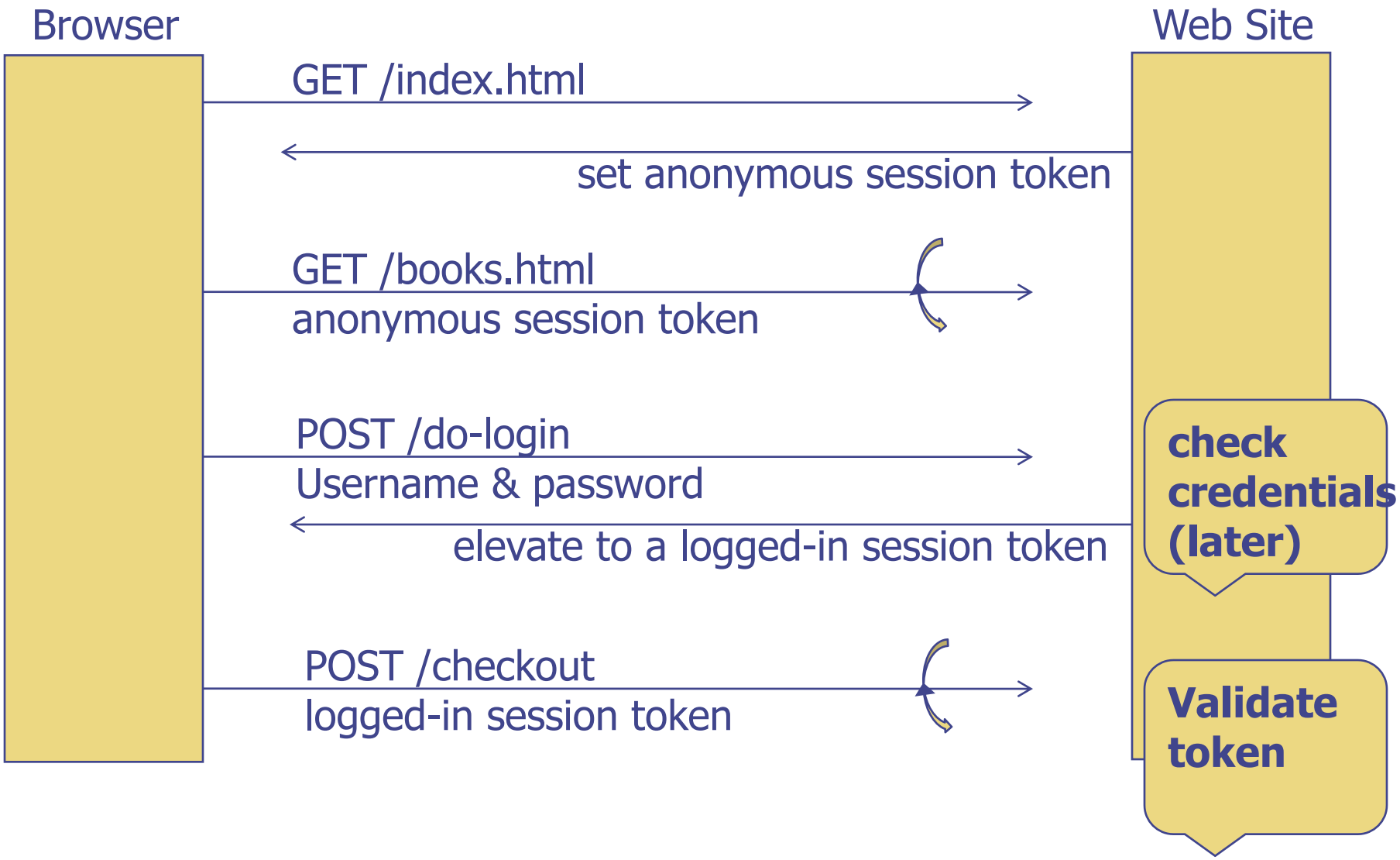
Browsers sends hashed password on all subsequent HTTP requests:

Authorization: Basic ZGFddfibzsdfgkjheczI1NXRleHQ=

HTTP auth problems

- Hardly used in commercial sites
  - User cannot log out other than by closing browser
    - What if user has multiple accounts?
    - What if multiple users on same computer?
  - Site cannot customize password dialog
  - Confusing dialog to users
  - Easily spoofed

Session tokens



Storing session tokens:

Lots of options (but none are perfect)

- Browser cookie:

  Set-Cookie: SessionToken=fduhye63sfdb

- Embedd in all URL links:

  https://site.com/checkout ? SessionToken=kh7y3b

- In a hidden form field:

  <input type="hidden" name="sessionid" value="kh7y3b">

Storing session tokens: problems

- Browser cookie:

  browser sends cookie with every request, even when it should not (CSRF)

- Embed in all URL links:

  token leaks via HTTP Referer header

  users might share URLs

- In a hidden form field: short sessions only

Better answer: a combination of all of the above (e.g., browser cookie with CSRF protection using form secret tokens)

Cross Site Request Forgery

Top web vulnerabilities

OWASP Top 10 – 2010 (Previous)	OWASP Top 10 – 2013 (New)
A1 – Injection	A1 – Injection
A3 – Broken Authentication and Session Management	A2 – Broken Authentication and Session Management
A2 – Cross-Site Scripting (XSS)	A3 – Cross-Site Scripting (XSS)
A4 – Insecure Direct Object References	A4 – Insecure Direct Object References
A6 – Security Misconfiguration	A5 – Security Misconfiguration
A7 – Insecure Cryptographic Storage – Merged with A9 →	A6 – Sensitive Data Exposure
A8 – Failure to Restrict URL Access – Broadened into →	A7 – Missing Function Level Access Control
A5 – Cross-Site Request Forgery (CSRF)	A8 – Cross-Site Request Forgery (CSRF)
<buried in A6: Security Misconfiguration>	A9 – Using Known Vulnerable Components

HTML Forms

- Allow a user to provide some data which gets sent with an HTTP POST request to a server

```
<form action="bank.com/action.php">

First name:  <input type="text" name="firstname">

Last name:<input type="text" name="lastname">

<input type="submit" value="Submit"></form>
```

First name:

Last name:

Submit

When filling in Alice and Smith, and clicking submit, the browser issues

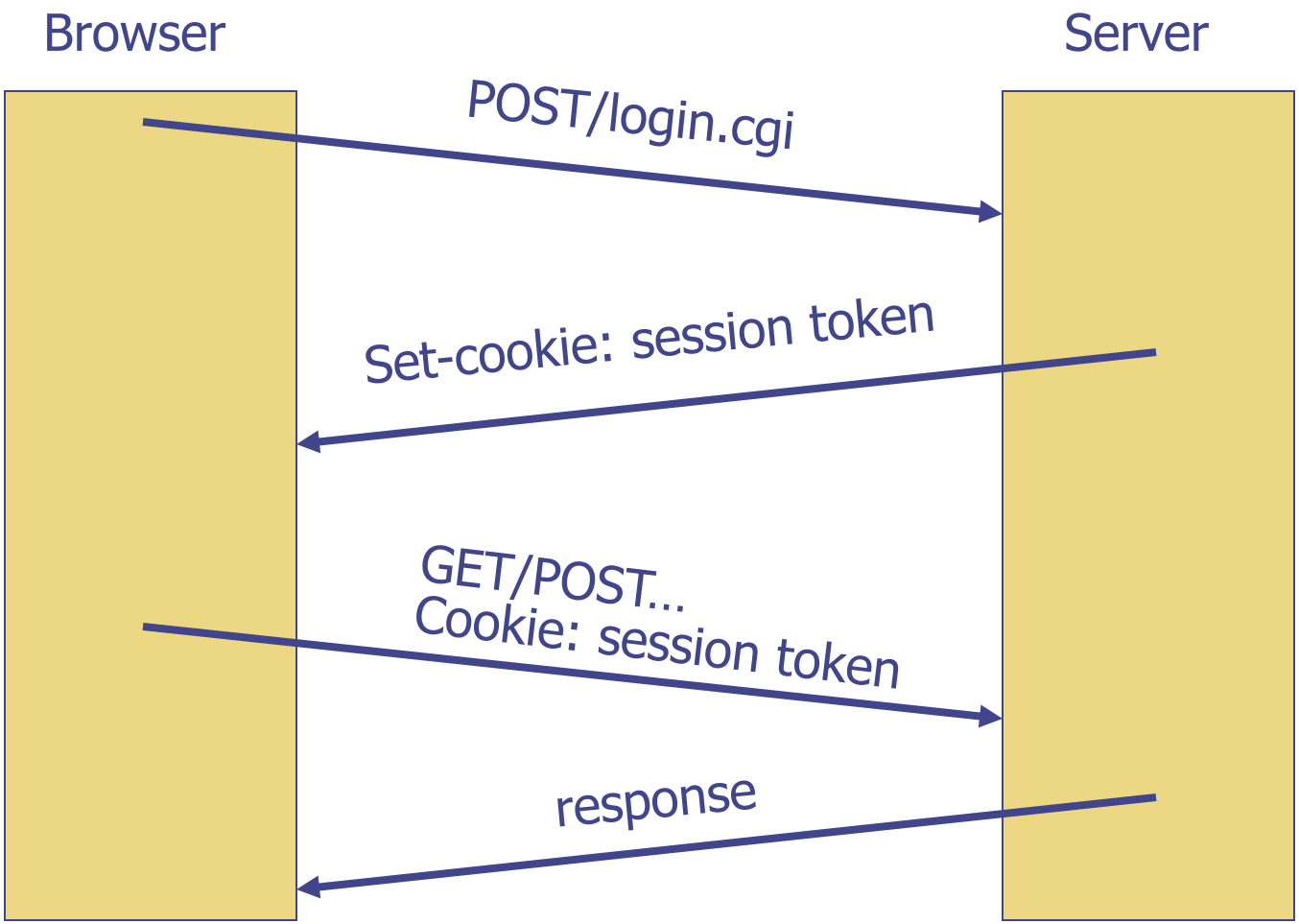
HTTP POST request bank.com/action.php?firstname=Alice&lastname=Smith

As always, the browser attaches relevant cookies

Consider cookie storing session token

- Server assigns a session token to each user after they logged in, places it in the cookie
- The server keeps a table of username to current session token, so when it sees the session token it knows which user

Session using cookies



Basic picture

Server Victim bank.com

1 establish session

4 send forged request (w/ cookie)

User Victim

2 visit server

3 receive malicious page

cookie for bank.com with session token

Attack Server

What can go bad?

URL contains transaction action

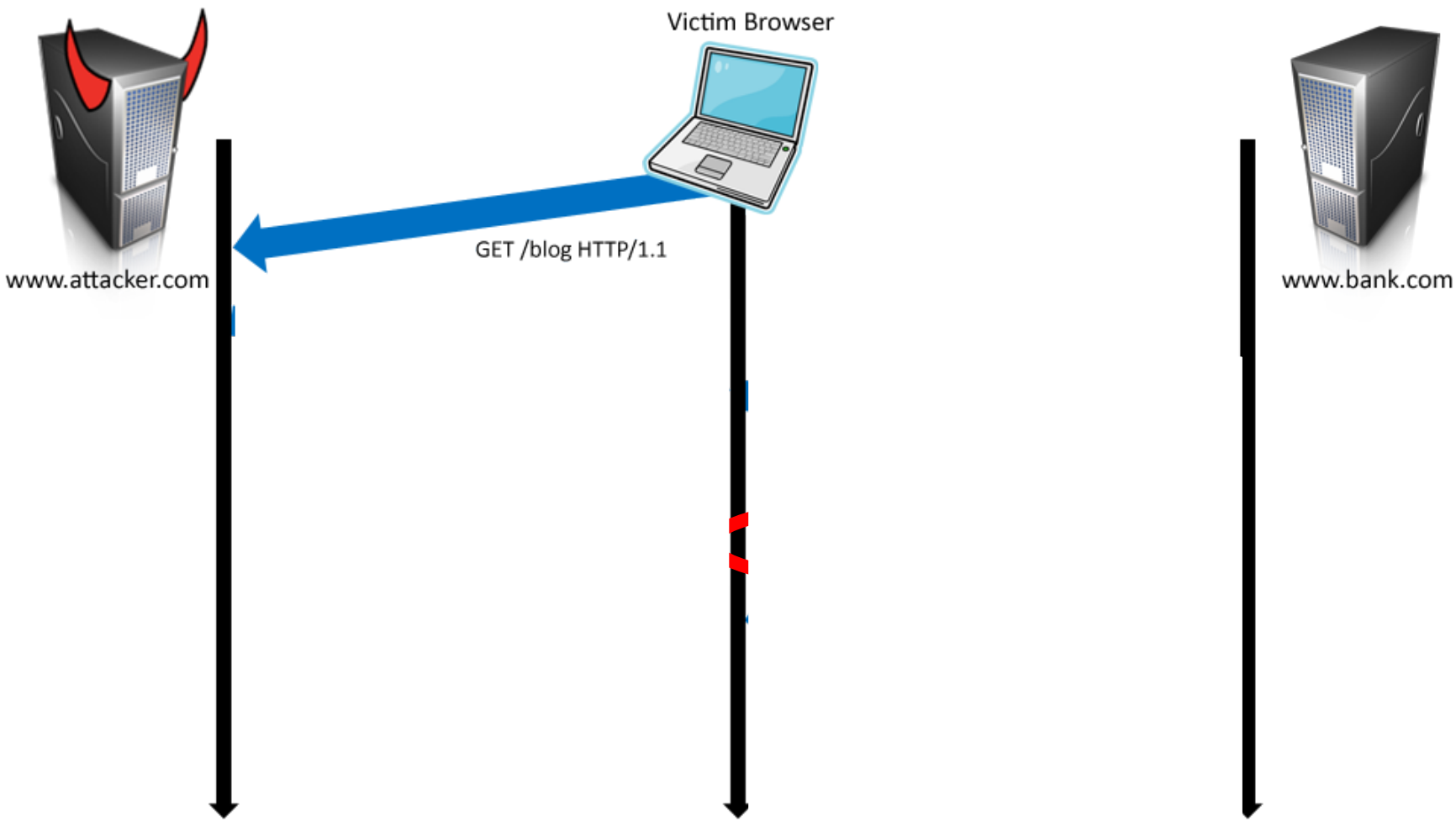
Cross Site Request Forgery (CSRF)

- Example:
  - User logs in to bank.com
    - Session cookie remains in browser state
  - User visits malicious site containing:

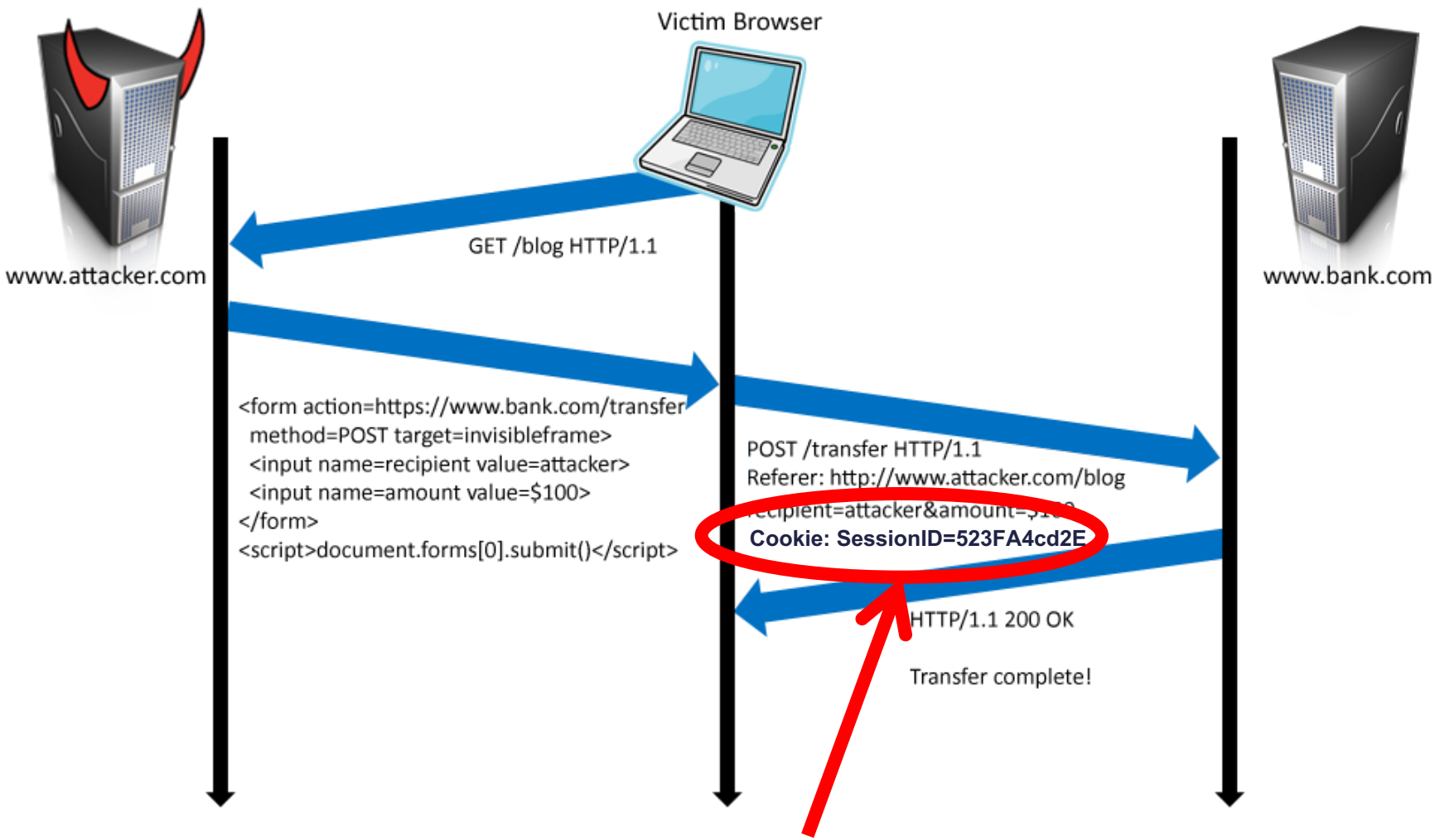
```
<form name=F action=http://bank.com/BillPay.php>
<input name=recipient value=badguy> …
<script> document.F.submit(); </script>
```

  - Browser sends user auth cookie with request
    - Transaction will be fulfilled
- Problem:
  - cookie auth is insufficient when side effects occur

Form post with cookie



Form post with cookie



User credentials

Squigler demo

YouTube 2008 CSRF attack

An attacker could

- add videos to a user's "Favorites,"
- add himself to a user's "Friend" or "Family" list,
- send arbitrary messages on the user's behalf,
- flagged videos as inappropriate,
- automatically shared a video with a user's contacts, subscribed a user to a "channel" (a set of videos published by one person or group), and
- added videos to a user's "QuickList" (a list of videos a user intends to watch at a later point).

Home → Security → Facebook Hit by Cross-Site Request Forgery Attack

Facebook Hit by Cross-Site Request Forgery Attack

By Sean Michael Kerner | August 20, 2009

Angela Moscaritolo

September 30, 2008

Popular websites fall victim to CSRF exploits

Defenses

ideas?

CSRF Defenses

- CSRF token


```
<input type=hidden value=23a3af01b>
```

- Referer Validation


```
Referer: http://www.facebook.com/home.php
```

- Others (e.g., custom HTTP Header) we won’t go into

CSRF token

1. goodsite.com server wants to protect itself, so it includes a secret token into the webpage (e.g., in forms as a hidden field)
2. Requests to goodsite.com include the secret
3. goodsite.com server checks that the token embedded in the webpage is the expected one; reject request if not

Can the token be?

- 123456
- Dateofbirth

CSRF token must be hard to guess by the attacker

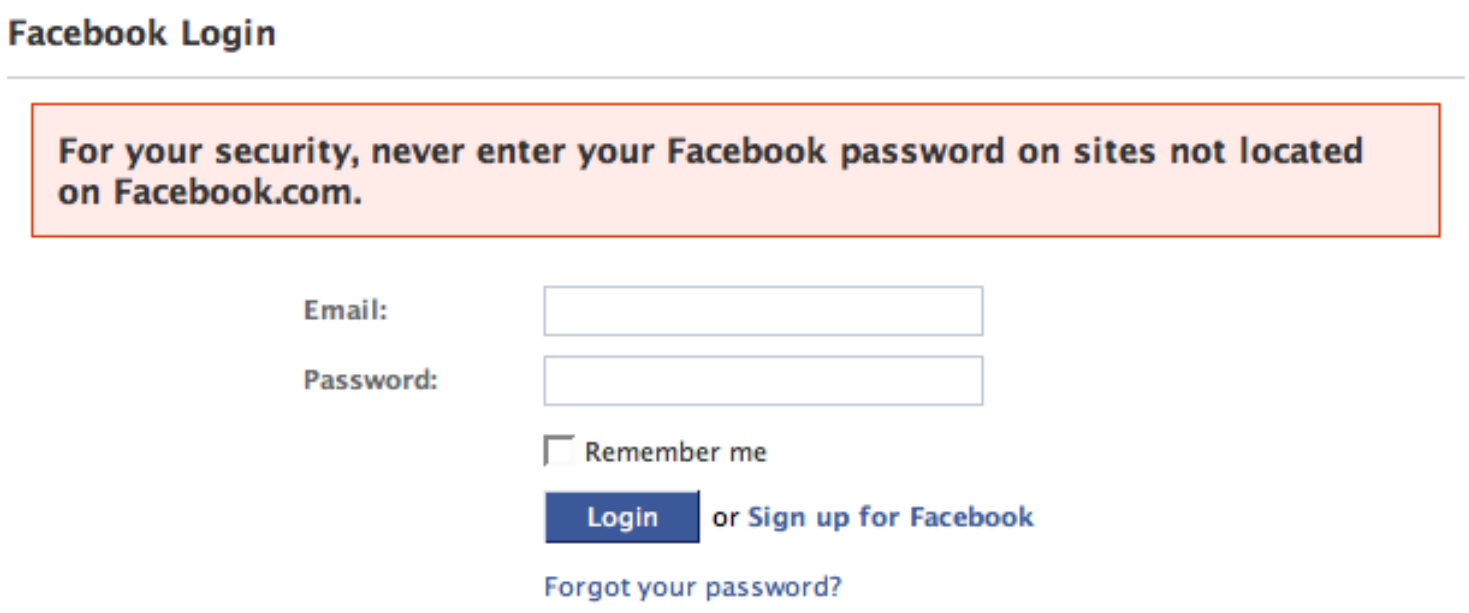
How token is used

- The server stores state that binds the user's CSRF token to the user's session id
- Embeds CSRF token in every form
- On every request the server validates that the supplied CSRF token is associated with the user's session id
- Disadvantage is that the server needs to maintain a large state table to validate the tokens.

Other CRSF protection: Referer Validation

- When the browser issues an HTTP request, it includes a referer header that indicates which URL initiated the request
- This information in the Referer header could be used to distinguish between same site request and cross site request

Referer Validation



Referer Validation Defense

- HTTP Referer header
  - Referer: http://www.facebook.com/
  - Referer: http://www.attacker.com/evil.html
  - Referer:
    - Strict policy disallows (secure, less usable)
    - Lenient policy allows (less secure, more usable)

Privacy Issues with Referer header

- The referer contains sensitive information that impinges on the privacy
- The referer header reveals contents of the search query that lead to visit a website.
- Some organizations are concerned that confidential information about their corporate intranet might leak to external websites via Referer header

Referer Privacy Problems

- Referer may leak privacy-sensitive information

  `http://intranet.corp.apple.com/projects/iphone/competitors.html`

- Common sources of blocking:
  - Network stripping by the organization
  - Network stripping by local machine
  - Stripped by browser for HTTPS -> HTTP transitions
  - User preference in browser

Summary: sessions and CSRF

- Cookies add state to HTTP
  - Cookies are used for session management
  - They are attached by the browser automatically to HTTP requests
- CSRF attacks execute request on benign site because cookie is sent automatically
- Defenses for CSRF:
  - embed unpredicatable token and check it later
  - check referer header