Web Security: Session management

CS 161: Computer Security

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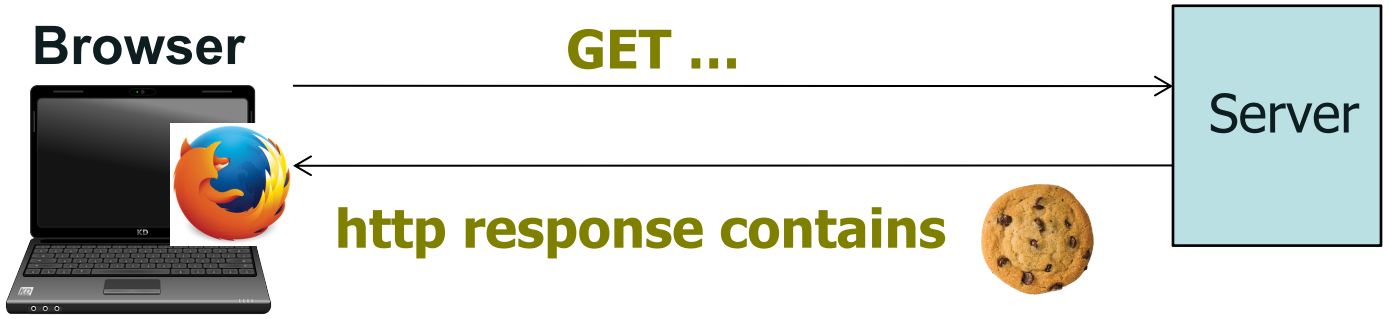
Some content adapted from materials by David Wagner or Dan Boneh

Announcements

- Starting recording
- Project 3 part 1 due Tuesday, April 14 at 11:59pm

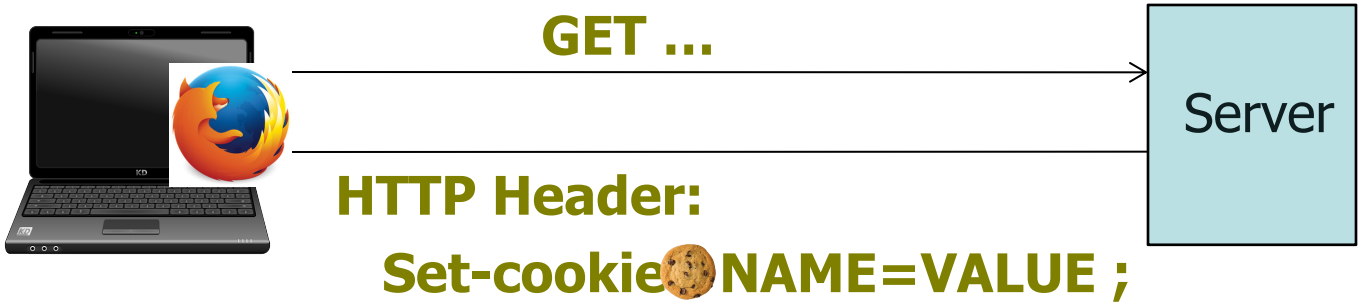
Cookies

A way of maintaining state in the browser



Browser maintains cookie jar with all cookies it receives

Setting/deleting cookies by server



- The first time a browser connects to a particular web server, it has no cookies for that web server
- When the web server responds, it includes a **Set-Cookie:** header that defines a cookie
- Each cookie is just a name-value pair (with some extra metadata)

View a cookie

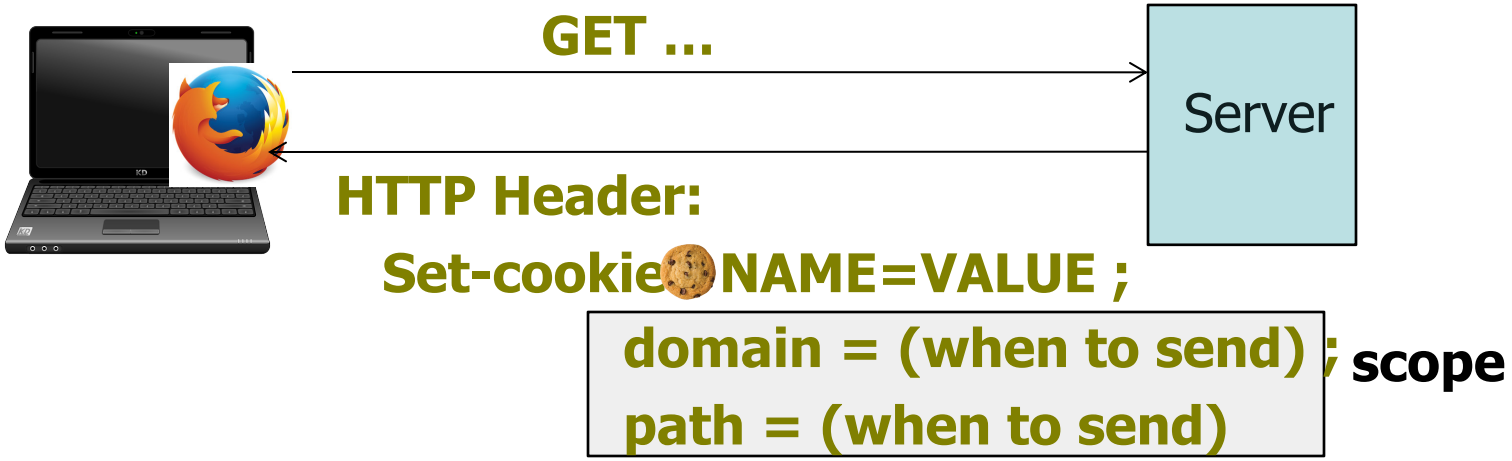
In a web console (firefox, tool->web developer->web console), type

document.cookie

to see the cookie for that site

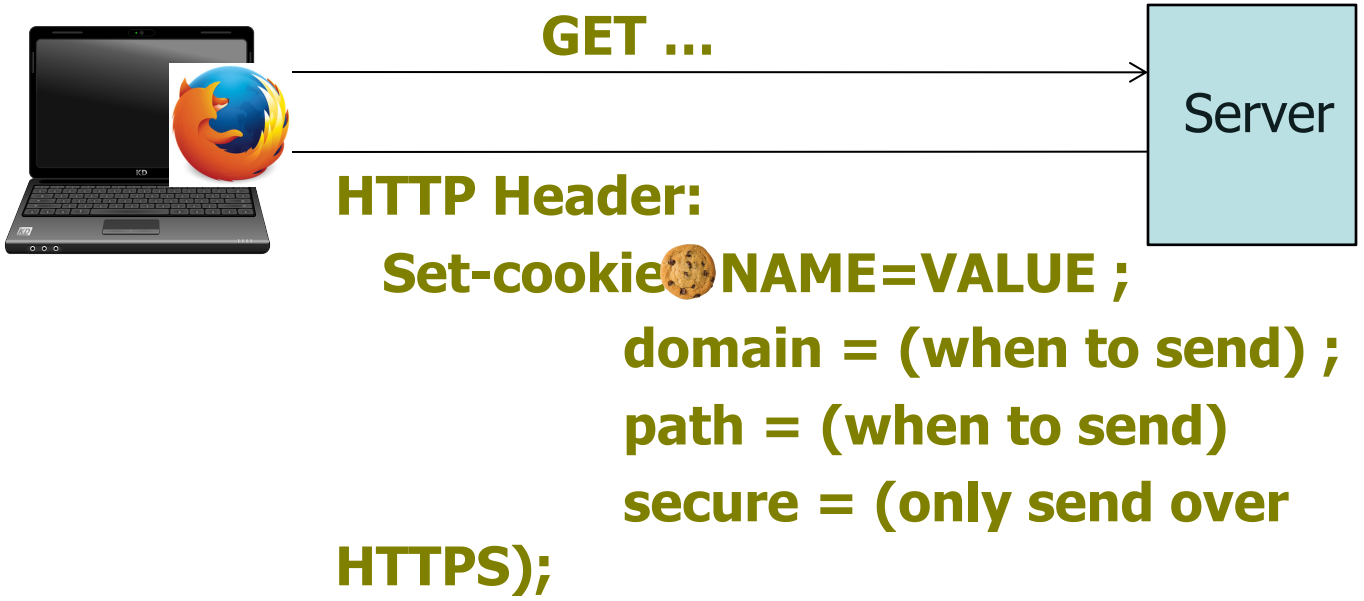
Each name=value is one cookie.
document.cookie lists all cookies in scope for document

Cookie scope



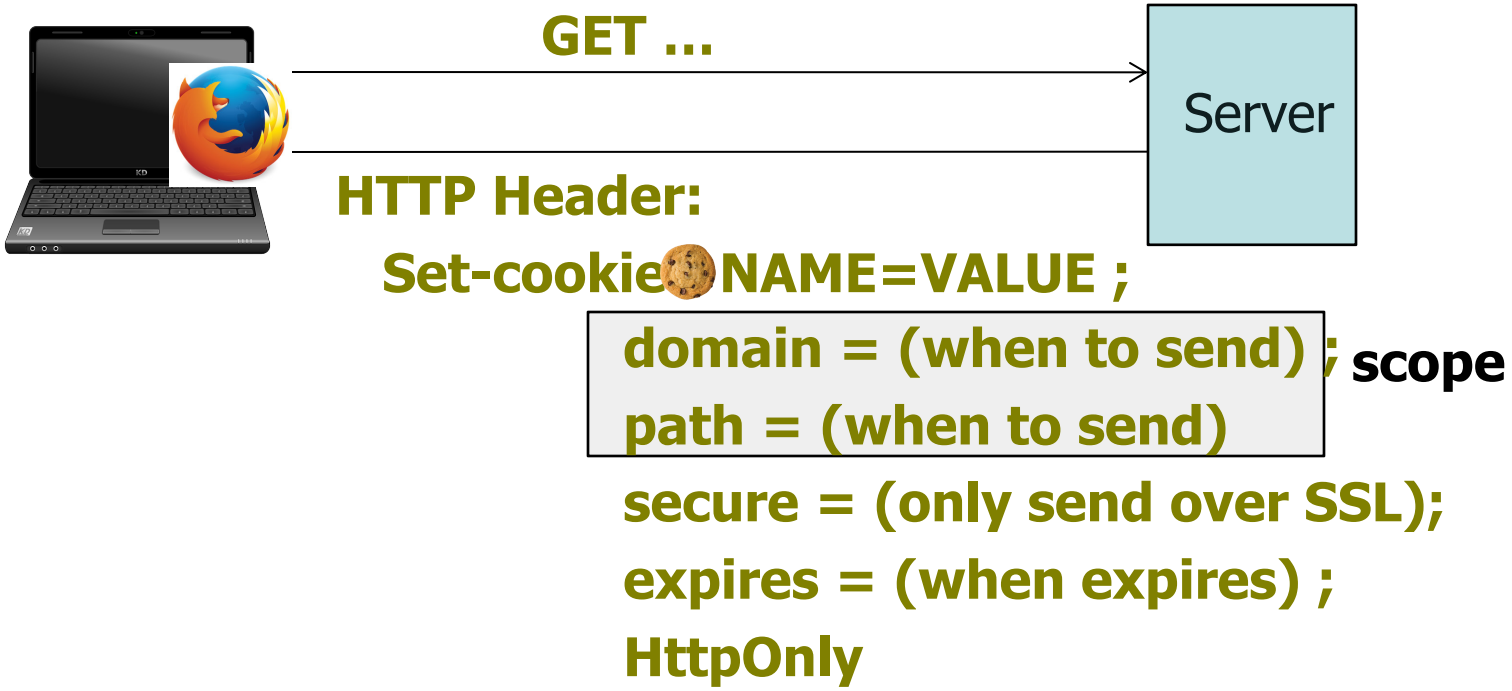
- When the browser connects to the same server later, it automatically attaches the cookies in scope: header containing the name and value, which the server can use to connect related requests.
- Domain and path inform the browser about which sites to send this cookie to

Cookie scope



- **Secure: sent over https only**
  - **https provides secure communication using TLS (privacy and integrity)**

Cookie scope



- **Expires is expiration date**
  - Delete cookie by setting “expires” to date in past
- **HttpOnly:** cookie cannot be accessed by Javascript, but only sent by browser (defense in depth, but does not prevent XSS)

Cookie policy

The cookie policy has two parts:

1. What scopes a URL-host name web server is allowed to set on a cookie
2. When the browser sends a cookie to a URL

Cookie scope

- Scope of cookie might not be the same as the URL-host name of the web server setting it

What scope a server may set for a cookie

The browser checks if the web server may set the cookie, and if not, it will not accept the cookie.

domain: any domain-suffix of URL-hostname, except TLD

example: host = "login.site.com"

[top-level domains, e.g. '.com']

allowed domains	disallowed domains
login.site.com	user.site.com
.site.com	othersite.com
	.com

⇒ **login.site.com** can set cookies for all of **.site.com**
but not for another site or TLD

Problematic for sites like .berkeley.edu

path: can be set to anything

Examples

Web server at **foo.example.com** wants to set cookie with domain:

domain	Whether it will be set
(value omitted)	*foo.example.com* (exact)
bar.foo.example.com	
foo.example.com	
baz.example.com	
example.com	yes
ample.com	
.com	

When browser sends cookie

Goal: server only sees cookies in its scope

Browser sends all cookies in URL scope:

- cookie-domain is domain-suffix of URL-domain, and
- cookie-path is prefix of URL-path, and
- [protocol=HTTPS if cookie is “secure”]

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

Examples: Which cookie will be sent?

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**

Examples

Web server at foo.example.com wants to set cookie with domain:

domain	Whether it will be set, and if so, where it will be sent to
(value omitted)	*foo.example.com* (exact)
bar.foo.example.com	Cookie not set: domain more specific than origin
foo.example.com	
baz.example.com	Cookie not set: domain mismatch
example.com	
ample.com	Cookie not set: domain mismatch
.com	Cookie not set: domain too broad, security risk

Credits: The Tangled Web: A Guide to Securing Modern Web Applications, by Michał Zalewski

Examples

Web server at foo.example.com wants to set cookie with domain:

domain	Whether it will be set, and if so, where it will be sent to	
(value omitted)	*foo.example.com* (exact)	**.foo.example.com*
bar.foo.example.com	Cookie not set: domain more specific than origin	
foo.example.com	**.foo.example.com*	
baz.example.com	Cookie not set: domain mismatch	
example.com	**.example.com*	
ample.com	Cookie not set: domain mismatch	
.com	Cookie not set: domain too broad, security risk	

Examples

cookie 1
name = userid
value = u1
domain = login.site.com
path = /
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=u2**

https://login.site.com/ **cookie: userid=u1; userid=u2**

(arbitrary order)

Client side read/write: document.cookie

- Setting a cookie in Javascript:

  document.cookie = “name=value; expires=…; ”

- Reading a cookie: alert(document.cookie)

  prints string containing all cookies available for document (based on [protocol], domain, path)

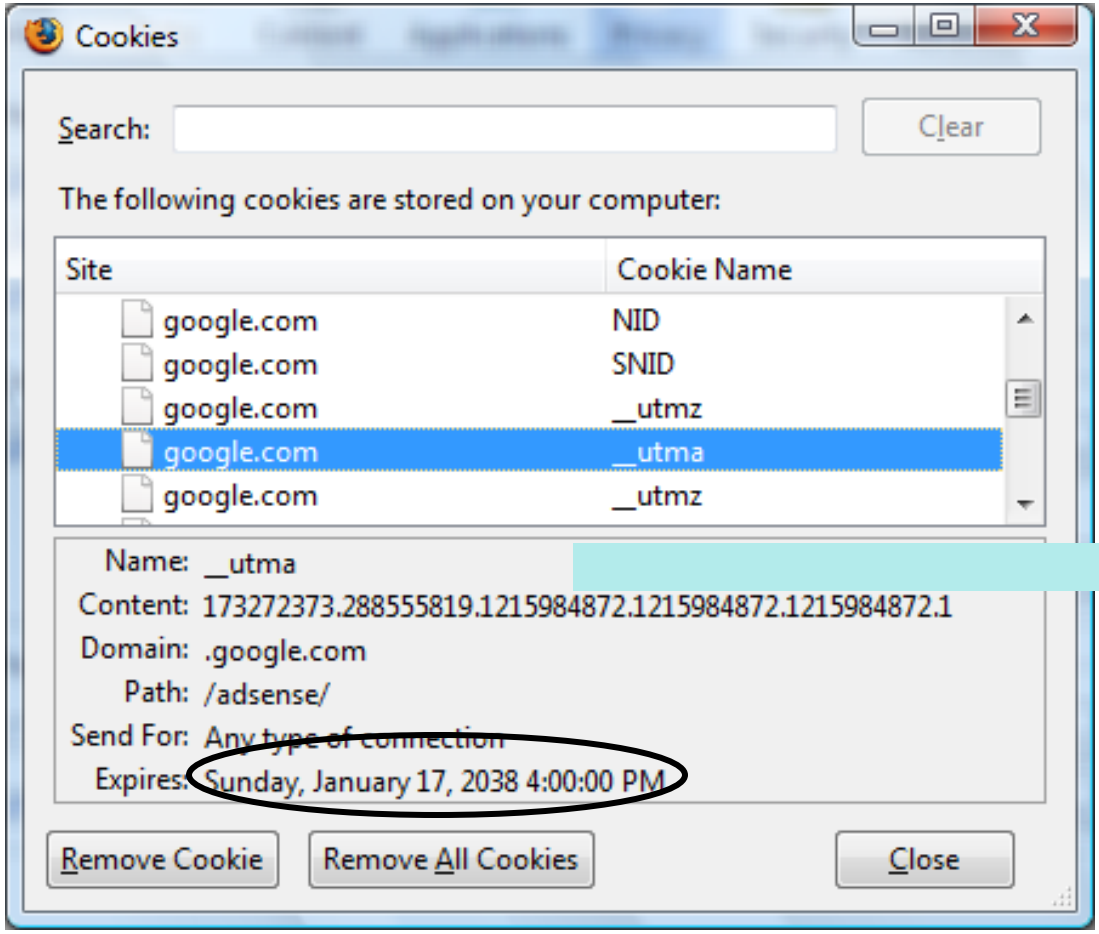
- Deleting a cookie:

  document.cookie = “name=; expires= Thu, 01-Jan-00”

document.cookie often used to customize page in Javascript

Viewing/deleting cookies in Browser UI

Firefox: Tools -> page info -> security -> view cookies



Cookie policy versus same-origin policy

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.

So there isn't exact domain match as in same-origin policy, but cookie policy instead.

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

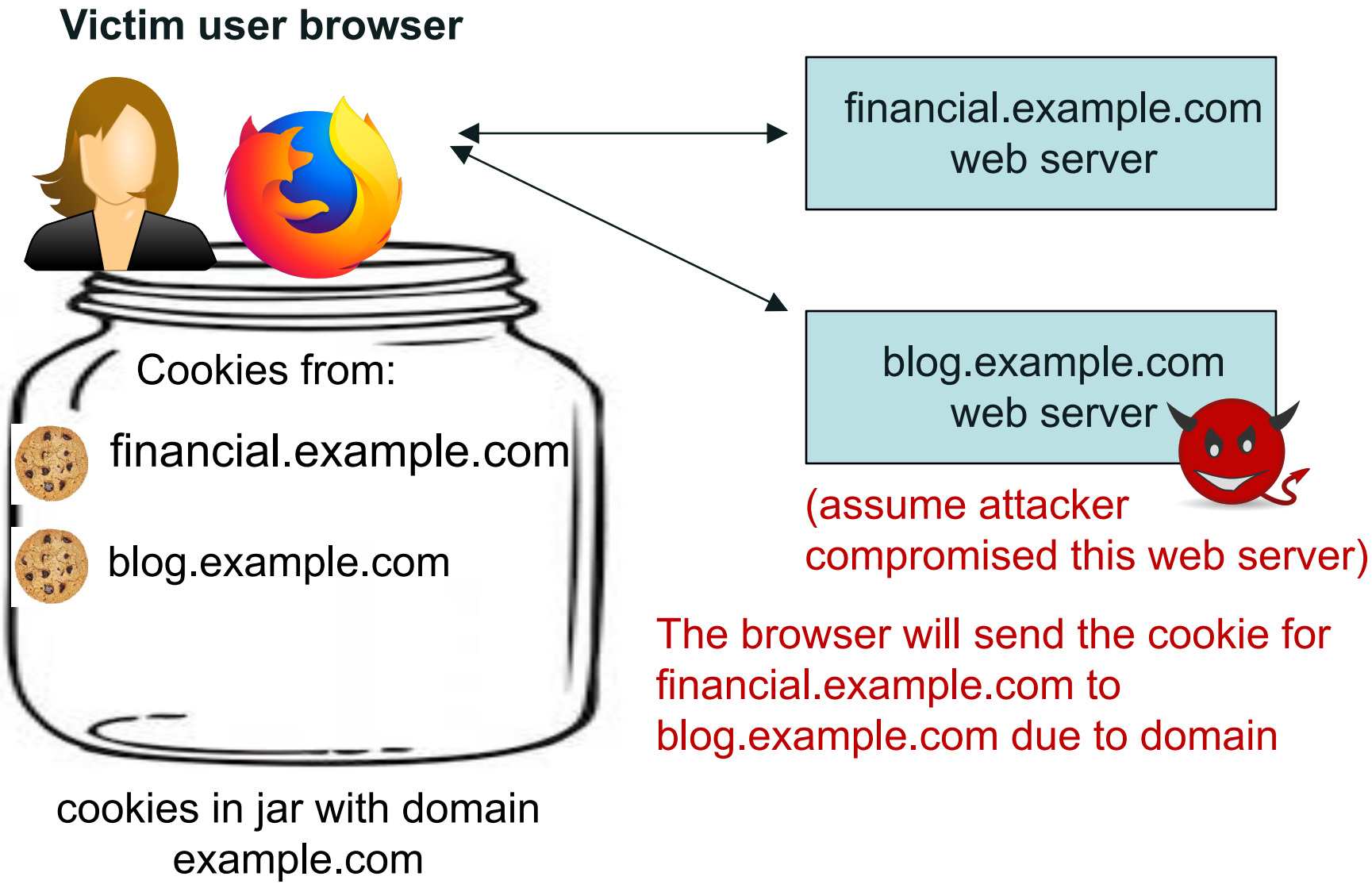
http://checkout.site.com/	**cookie: userid=u2**
http://login.site.com/	**cookie: userid=u1, userid=u2**
http://othersite.com/	**cookie: none**

JS on each of these URLs can access the corresponding cookies even if the domains are not the same

Indirectly bypassing same-origin policy using cookie policy

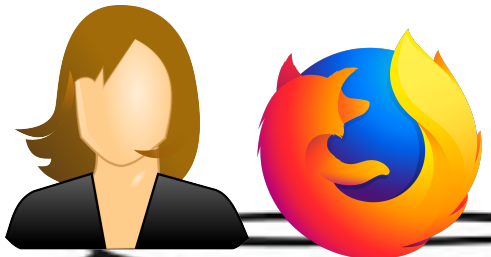
- Since the cookie policy and the same-origin policy are different, there are corner cases when one can use cookie policy to bypass same-origin policy
- Ideas how?

Example


Victim user browser
financial.example.com
web server
blog.example.com
web server
Cookies from:
financial.example.com
blog.example.com
(assume attacker
compromised this web server)
The browser will send the cookie for
financial.example.com to
blog.example.com due to domain
cookies in jar with domain
example.com

Example

Victim user browser



financial.example.com
web server

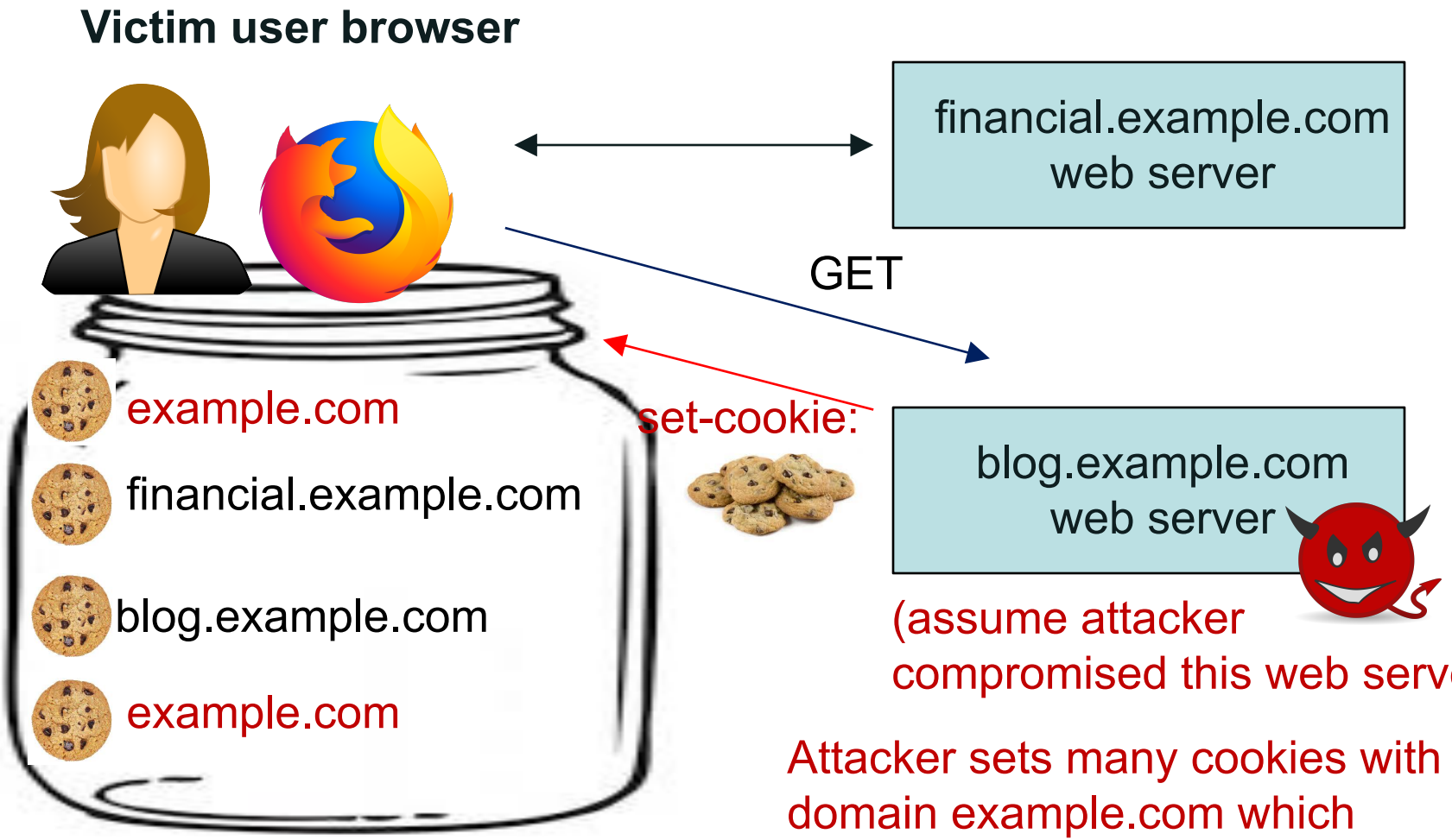
blog.example.com
web server

(assume attacker compromised this web server)

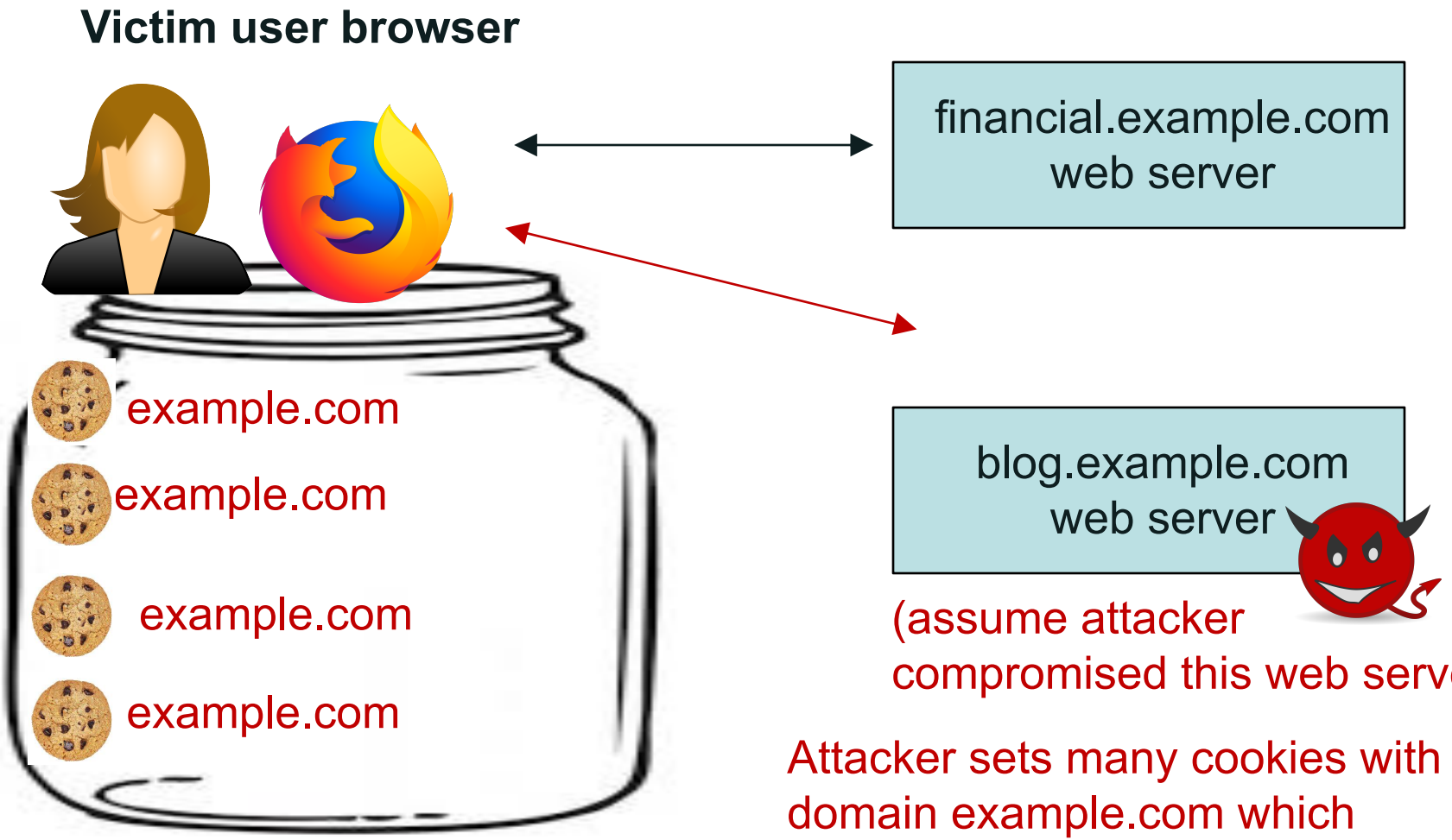
cookie jar

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 hold group domains.

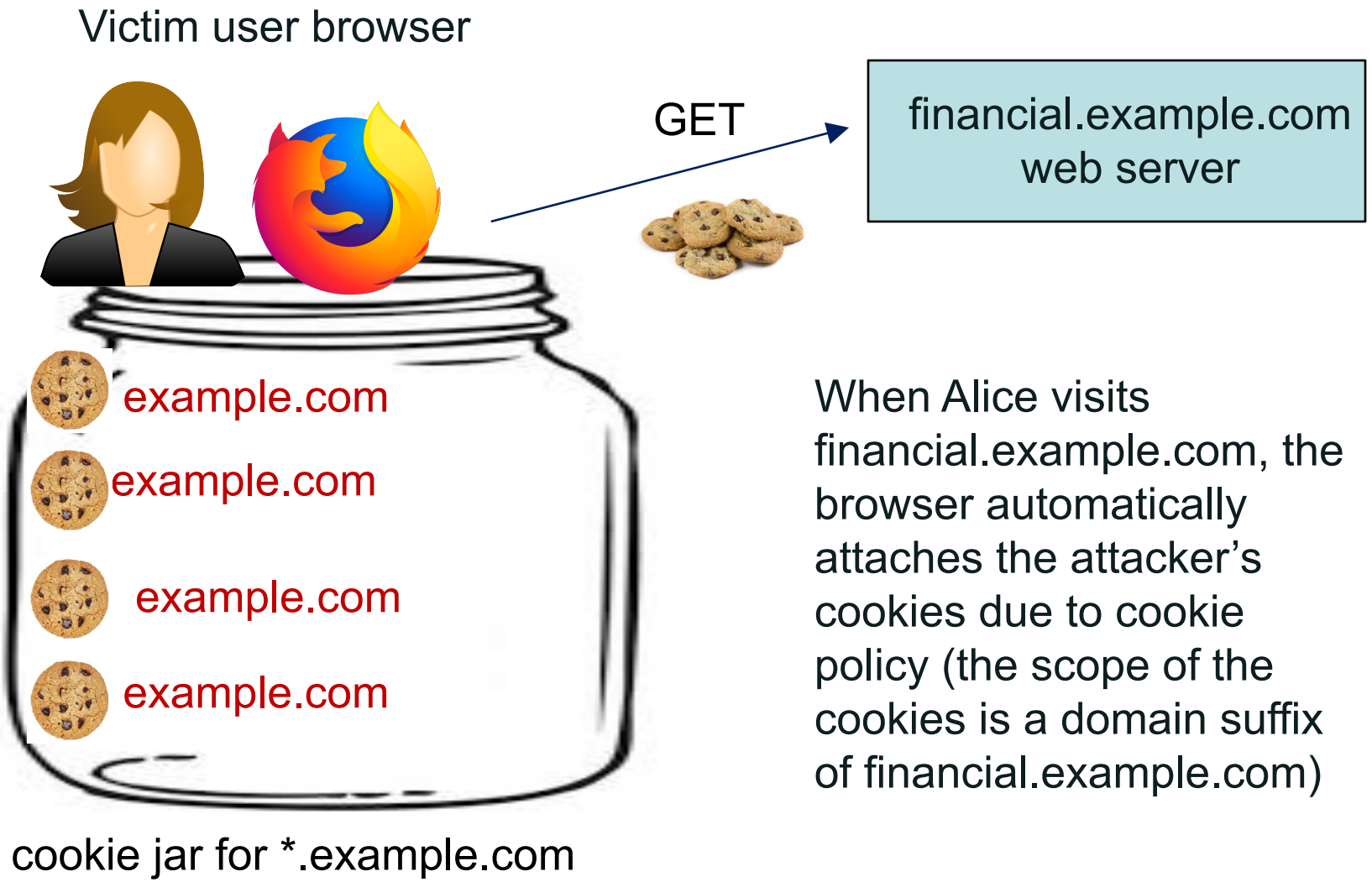
Example


Victim user browser
financial.example.com
web server
GET
example.com
financial.example.com
blog.example.com
example.com
set-cookie:
blog.example.com
web server
(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
financial.example.com
web server
example.com
example.com
example.com
example.com
blog.example.com
web server
(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



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 also 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