Cookie and Session

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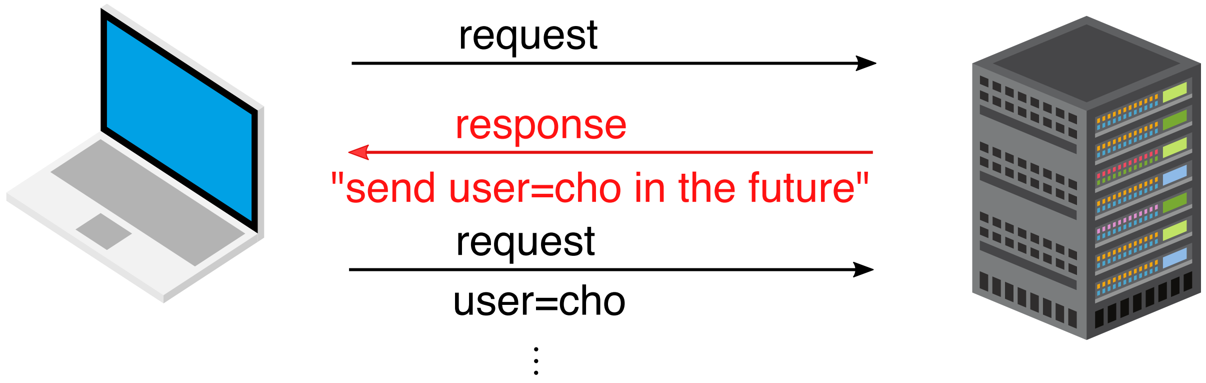
HTTP: Stateless

- HTTP is a stateless protocol
  - Every request can be handled independently of others
- Q: How does a Web site “remember” a user and customize its
  - Q: How do they know that two requests are from the same user?
- Idea: “Embed” a unique identifier in every request from a use

Cookie: Key Idea

- *Cookies* allow a server to ask a client to remember `"name=va` and send them back in all future requests



Setting Cookie

```
Set-Cookie: username=john; expires=Wed, 21 Oct 2031 07:28:00 GMT;
```

- Ask client to "set" the cookie `username=john`
- `expires`: expiration time
  - By default, cookie becomes "transient" (= session cookie) and is sent during current browsing session
  - `expires` makes cookie "persistent" until expiration
  - Setting `expires` to past "erases" the cookie
- `path` and `domain`
  - By default, cookie is sent in all requests to the same server
  - This can be adjusted by setting to a specific path and/or domain
  - Example: `path=/cs144/; domain=ucla.edu;`

Sending Cookie Back

```
Cookie: username=john
```

- In all future requests to the specified domain and path, clien
  `Cookie` header:
  - From the cookie, server knows the requests are all from the same cli

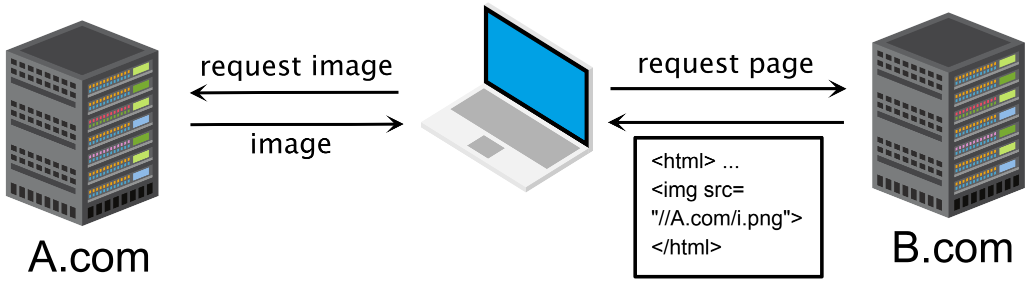
Same-Origin Policy

- Client sends the cookie only to the domain from which it wa
  - No cross-domain cookie exchange is allowed
- Q: Why same-origin policy?
- Q: Can we use cookie(s) to identify a user across multiple doı

Tracking Users Across Domains

- Q: Given same-origin policy, is it possible to track a user's rec across multiple domains?
- Q: But Google/facebook/Amazon… does it. How?

Third-Party Cookie



- A wants to track users across its partner sites B's
- Ask partner B to include a (tiny) image from A in their pages
  - When browser access a page from B, it also sends a request to A (to
    the image)
  - The request to A contains `Referrer` header (with B's URL) and cooki
    - *Third-party cookies*
- A knows all URLs that users visited on partner site B

Cookie is Unsafe

- Cookies can be stolen (*cookie theft*)
- Cookies can be tempered with by the client (*cookie poisonin*
- Be ***very careful*** about what we store in cookie

Securing Cookies

- `secure;` attribute
  - With `secure;` attribute set, the cookie is sent back *only over https*
  - Protects against cookie theft
- *Signed cookie*
  - Secret-key encrypted *signature* added to the main cookie data
- Attaching expiration date
  - Make sure cookie expires after a while
  - Even if the cookie is stolen, it will be no longer valid after a while

JSON Web Token (JWT)

- Web standard to encode and exchange client-managed stat tempering protection
- Format: `header.payload.signature`
  - `header`: information on the token
  - `payload`: “main body” of the token
  - `signature`: encrypted hash value for tempering detection

JWT Header

- JSON data (encoded into Base64 string)
- Typically has two fields
  - `alg` (hashing algorithm)
  - `typ` (token type)
- Example

```
{
    "alg": "HS256",
    "typ": "JWT"
}
```

$\longrightarrow$ eyJ0eXAiOiJKV1QiLCJhbGciOiJIUzI1NiJ9

Payload

- JSON data (encoded to Base64)
- Contains main information
- Example

```
{
    "iss": "http://oak.cs.ucla.edu",
    "jti": "3gxhylhd",
    "exp": 11253352,
    "user": "junghoo"
}
```

→ `eyJrZXkiOiJ2YWwiLCJpYXQiOjE0MjI2MDU0NDV9`

  - “Registered claims (=fields)”
    - `iss` (issuer), `jti` (JWT ID), `iat` (issued at, # seconds since 1970-01-01T00:00:00Z (expires at), `sub` (subject), `aud` (audience), …
  - No claim is required. “Unregistered claims” can be used

Signature

- Secret-key encrypted hash of `header.payload` (encoded int
- Example

```
HMACSHA256(header.payload,"secret password")
→ eUiabuiKv-8PYk2AkGY4Fb5KMZeorYBLw261JPQD5lM
```

- When the JWT is tempered, a hacker cannot generate a corr signature without knowing the correct password
- The creator of JWT can check tempering by comparing attac signature with the computed hash value

Final JWT

```
eyJ0eXAiOiJKV1QiLCJhbGciOiJIUzI1NiJ9          // header
.eyJrZXkiOiJ2YWwiLCJpYXQiOjE0MjI2MDU0NDV9     // payload
.eUiabuiKv-8PYk2AkGY4Fb5KMZeorYBLw261JPQD5lM   // signature
```

```
{
    "alg": "HS256",
    "typ": "JWT"
}.{
    "iss": "http://oak.cs.ucla.edu",
    "jti": "3gxhylhd",
    "exp": 11253352,
    "user": "junghoo"
}.signature
```

- JWT is sent to the browser
  - Browser sends it back in future requests

User Authentication

- Q: How does server authenticate the identity of a user?
- Q: How can we let a user authenticate once, without asking f authentication for every request?
- Q: After authentication, what should we store in the cookie?
- A: Two choices
  - Username
  - “Session ID”

Session

- When user logs in, the server creates a “session”
    - All session-related “states” reside on the server
    - A unique session ID is associated with a session and set as a cookie
    - Given a session ID in a request, the server obtains session related “st
      local “session data store”
- Q: What are the pros and cons of using session ID vs usernan

What We Learned

- Stateless HTTP protocol
- Cookie
- Same-origin policy
- Cookie theft, cookie poisoning, secure cookie
- JSON Web token (JWT)
- User authentication and session management

References

- Cookie: RFC 6265
- JSON Web Token