CSE 484 : Computer Security and Privacy

Web Security
[Web Application Security]

Winter 2021

David Kohlbrenner
dkohlbre@cs.washington.edu

Thanks to Franzi Roesner, Dan Boneh, Dieter Gollmann, Dan Halperin, Yoshi Kohno, Ada Lerner, John Manferdelli, John Mitchell, Vitaly Shmatikov, Bennet Yee, and many others for sample slides and materials ...
Admin

• Lab 2
  • Granting access on a regular basis
  • Please sign up if you haven’t already

• Final project
  • First checkpoint deadline TODAY!
SQL Injection
SQL Injection: Basic Idea

1. Post malicious form
2. Unintended query
3. Receive data from DB

- This is an **input validation vulnerability**
  - Unsanitized user input in SQL query to back-end database changes the meaning of query
- Special case of command injection
Authentication with Backend DB

User supplies username and password, this SQL query checks if user/password combination is in the database

```
set UserFound = execute(
    "SELECT * FROM UserTable WHERE
    username= ' ' & form("user") & ' AND
    password= ' ' & form("pwd") & ' ');
```

If not UserFound.EOF
   Authentication correct
else Fail

Only true if the result of SQL query is not empty, i.e., user/pwd is in the database
Cross-Site Request Forgery (CSRF/XSRF)
Cookie-Based Authentication Redux

HTTP
GET
POST

Browser

Server

u/pw
POST/login.cgi

Set-cookie: authenticator

GET...
Cookie: authenticator

response
Browser Sandbox Redux

- Based on the same origin policy (SOP)
- Active content (scripts) can send anywhere!
  - For example, can submit a POST request
  - Some ports inaccessible -- e.g., SMTP (email)
- Can only read response from the same origin
  - ... but you can do a lot with just sending!
Cross-Site Request Forgery

• Users logs into bank.com, forgets to sign off
  • Session cookie remains in browser state
• User then visits a malicious website containing
  
  <form name=BillPayForm
  action=http://bank.com/BillPay.php>
  <input name=recipient value=badguy> ...
  
  <script> document.BillPayForm.submit(); </script>

• Browser sends cookie, payment request fulfilled!

• Lesson: cookie authentication is not sufficient when side effects can happen
Cookies in Forged Requests

User credentials automatically sent by browser
Impact

• Hijack any ongoing session (if no protection)
  • Netflix: change account settings, Gmail: steal contacts, Amazon: one-click purchase

• Reprogram the user’s home router

• Login to the attacker’s account
  • Why?
XSRF True Story

Internet Explorer

www.cybervillians.com/news.html

Bernanke Really an Alien?

script

ticker.stockbroker.com

Java

Hidden iframes submitted forms that...
- Changed user’s email notification settings
- Linked a new checking account
- Transferred out $5,000
- Unlinked the account
- Restored email notifications
XSRF (aka CSRF): Summary

1. Establish session
2. Visit server
3. Receive malicious page
4. Send forged request

Q: how long do you stay logged on to Gmail? Financial sites?
Broader View of XSRF

• Abuse of cross-site data export
  • SOP does not control data export
  • Malicious webpage can initiate requests from the user’s browser to an honest server
  • Server thinks requests are part of the established session between the browser and the server (automatically sends cookies)
XSRF Defenses

• Secret validation token

\[
\text{<input type=hidden value=23a3af01b>}
\]

• Referer validation

Referer:
http://www.facebook.com/home.php
Add Secret Token to Forms

• “Synchronizer Token Pattern”

• Include a secret challenge token as a hidden input in forms
  • Token often based on user’s session ID
  • Server must verify correctness of token before executing sensitive operations

• Why does this work?
  • Same-origin policy: attacker can’t read token out of legitimate forms loaded in user’s browser, so can’t create fake forms with correct token
Referer Validation

- **Lenient** referer checking – header is optional
- **Strict** referer checking – header is required

• Referer: http://www.facebook.com/home.php
• Referer: http://www.evil.com/attack.html
• Referer:
Why Not Always Strict Checking?

• Why might the referer header be suppressed?
  • Stripped by the organization’s network filter
  • Stripped by the local machine
  • Stripped by the browser for HTTPS → HTTP transitions
  • User preference in browser
  • Buggy browser

• Web applications can’t afford to block these users

• Many web application frameworks include CSRF defenses today
Bonus topic:
Consider the network
Where Does the Attacker Live?

Mitigation: SSL/TLS (not covered further)
Network attacker

• Lives between you and your destination server
  • Person-in-the-middle

• Person-on-the-side

• Passive/active

• Physical/remote
TREVOR PAGLEN

185.jpg

NSA-Tapped Undersea Cables, North Pacific Ocean, 2016
What might they be interested in?

• Eavesdropping

• Making us talk to the wrong server

• Denial-of-service

• Corrupting our conversation with a real server
Background: DNS

Who is www.google.com?

Who is .com?

Who is google.com?

HTTP Start!

172.217.14.228

Google Land
DNS is *unauthenticated* and over UDP

- 16-bit ‘request ID’
  * Used to be *sequential*
  * Now random

- Reply is cleartext and ‘simple’
DNS Hijacking

Who is www.google.com?
Request-id: 3

HTTP Start!
www.google.com cookies

172.217.14.228

Google Land
Throwback: Birthday Paradox

- Are there two people in the first 1/8 of this class that have the same birthday?
  - 365 days in a year (366 some years)
    - Pick one person. To find another person with same birthday would take on the order of 365/2 = 182.5 people
    - Expect birthday “collision” with a room of only 23 people.
    - For simplicity, approximate when we expect a collision as $\sqrt{365}$.

- Why is this important for cryptography?
  - $2^{128}$ different 128-bit values
    - Pick one value at random. To exhaustively search for this value requires trying on average $2^{127}$ values.
    - Expect “collision” after selecting approximately $2^{64}$ random values.
  - 64 bits of security against collision attacks, not 128 bits.
DNS Hijacking Continued

• 16-bit ID: $2^8$ for collision (256!)

• How do we get the victim to ask for www.google.com?
  • How about “notreal.google.com” instead?
DNS Hijacking

Who is notreal.google.com?
Request-id: 3

Reply-id: 1, 2, 3, 4...
555.555.555.555

HTTP Start!
*.google.com cookies

555.555.555.555
The state of DNS

• Randomize:
  • Request ID
  • Port number

• ... hope!
Network security

• All our protocols weren’t built for security 😞

• DNS
• BGP
• DHCP
• ... ARP

DNSSEC
IP
IPSEC?