CSE 484 / CSE M 584: Computer Security and Privacy

Web Security: Web Application Security [continued]

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Reminder: Friday is a holiday
- No class or office hours

Lab 2
- Sign up if you haven’t!
- Check forum post for whether you should have access (let us know if having trouble)
- FYI: Running your sites on homes.cs.washington.edu is not a web security things but a restriction of the lab itself
OWASP Top 10 Web Vulnerabilities

1. Injection
2. Broken Authentication & Session Management
3. Cross-Site Scripting
4. Insecure Direct Object References
5. Security Misconfiguration
6. Sensitive Data Exposure
7. Missing Function Level Access Control
8. Cross-Site Request Forgery
9. Using Known Vulnerable Components
10. Unvalidated Redirects and Forwards

http://www.owasp.org
Cross-Site Request Forgery (CSRF/XSRF)
Cookie-Based Authentication Redux

Browser

POST/login.cgi

Set-cookie: authenticator

GET...
Cookie: authenticator

response

Server
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
Sending a Cross-Domain POST

<form method="POST" action=http://othersite.com/action >
  ...
</form>

<script>document.forms[0].submit()</script>

submit post

• Hidden iframe can do this in the background
• User visits a malicious page, browser submits form on behalf of the user
  – Hijack any ongoing session (if no protection)
    • Netflix: change account settings, Gmail: steal contacts, Amazon: one-click purchase
  – Reprogram the user’s home router
  – Many other attacks possible
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?
XSRF True Story [Alex Stamos]

Internet Explorer

GET news.html

HTML and JS

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

CyberVillians.com

StockBroker.com

www.cybervillians.com/news.html

Bernanke Really an Alien?

script

ticker.stockbroker.com

Java
Broader View of XSRF

• Abuse of cross-site data export
  – SOP does not control data export
  – Malicious webpage can initiates 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)
Login XSRF: Attacker logs you in as them!

User logged in as attacker

Attacker’s account reflects user’s behavior
XSRF Defenses

• Secret validation token

  <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

<input type=hidden value=23a3af01b>
Referer Validation

- Lenient referer checking – header is optional
- Strict referer checking – header is required
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
Web Session Management
Primitive Browser Session

- View catalog: www.e_buy.com
- Select item: www.e_buy.com/shopping.cfm?pID=269
- Check out: www.e_buy.com/checkout.cfm?pID=269&item1=102030405

Store session information in URL; easily read on network
Bad Idea: Encoding State in URL

• Unstable, frequently changing URLs
• Vulnerable to eavesdropping and modification
• There is no guarantee that URL is private
FatBrain.com circa 1999

• User logs into website with his password, authenticator is generated, user is given special URL containing the authenticator
  
  https://www.fatbrain.com/HelpAccount.asp?t=0&p1=me@me.com&p2=540555758
  
  – With special URL, user doesn’t need to re-authenticate
    • Reasoning: user could not have not known the special URL without authenticating first. That’s true, BUT...

• Authenticators are global sequence numbers
  
  – It’s easy to guess sequence number for another user
    https://www.fatbrain.com/HelpAccount.asp?t=0&p1=SomeoneElse&p2=540555752
  
  – Partial fix: use random authenticators
Typical Solution: Web Authentication via Cookies

• Servers can use cookies to store state on client
  – When session starts, server computes an authenticator and gives it back to browser in the form of a cookie
    • Authenticators must be unforgeable and tamper-proof
      – Malicious client shouldn’t be able to compute his own or modify an existing authenticator
    • Example: \text{MAC}(server’s secret key, session id)
  – With each request, browser presents the cookie
  – Server recomputes and verifies the authenticator
    • Server does not need to remember the authenticator
Storing State in Hidden Forms

• Dansie Shopping Cart (2006)
  – “A premium, comprehensive, Perl shopping cart. Increase your web sales by making it easier for your web store customers to order.”

```html
<FORM METHOD=POST
ACTION="http://www.dansie.net/cgi-bin/scripts/cart.pl">
  Black Leather purse with leather straps
  <INPUT TYPE=HIDDEN NAME=name VALUE="Black leather purse">
  <INPUT TYPE=HIDDEN NAME=price VALUE="20.00">
  <INPUT TYPE=HIDDEN NAME=sh VALUE="1">
  <INPUT TYPE=HIDDEN NAME=img VALUE="purse.jpg">
  <INPUT TYPE=HIDDEN NAME=custom1 VALUE="Black leather purse with leather straps">
  <INPUT TYPE=SUBMIT NAME="add" VALUE="Put in Shopping Cart">
</FORM>
```

Fix: MAC client-side data, or, more likely, keep on server.

Change this to 2.00

Bargain shopping!
Top Web Vulnerabilities: Summary

- **XSS (CSS)** – cross-site scripting
  - Malicious code injected into a trusted context
    (e.g., malicious data presented by an honest website interpreted as code by the user’s browser)

- **SQL injection**
  - Malicious data sent to a website is interpreted as code in a query to the website’s back-end database

- **XSRF (CSRF)** – cross-site request forgery
  - Bad website forces the user’s browser to send a request to a good website

- **Broken authentication and session management**