CSE 484 / CSE M 584: Computer Security and Privacy

Web Security
[Web Application Security]

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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
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
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
Login XSRF: Attacker logs you in as them!

User logged in as attacker

Attacker’s account reflects user’s behavior
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 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)
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

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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
Web Session Management
Primitive Browser Session

View catalog

Select item

Check out

www.e_buy.com

www.e_buy.com/shopping.cfm?pID=269

www.e_buy.com/shopping.cfm?pID=269&item1=102030405

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: 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.
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