CSE 484 : Computer Security and Privacy

Web Security
[Web Application Security]

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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

- 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

set UserFound = execute(

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

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

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

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

GET /blog HTTP/1.1

POST /transfer HTTP/1.1
Referer: http://www.attacker.com/blog
Recipient=attacker&amount=$100
Cookie: SessionID=523FA4cd2E

HTTP/1.1 200 OK
Transfer complete!
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

[Alex Stamos]

CyberVillians.com

Internet Explorer

www.cybervillians.com/news.html

Bernanke Really an Alien?

script

HTML Form POSTs

GET news.html

HTML and JS

GET news.html

StockBroker.com

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 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

• 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.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?

Who is www.google.com?
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

555.555.555.555
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 the 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
• ...

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