How to Prevent Business Flaws Vulnerabilities In Web Applications

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Cincinnati Chapter,
January 2011 Meeting

What is OWASP?

OWASP

The Open Web Application Security Project

http://www.owasp.org

Organization Supporters of OWASP's mission

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Agenda For Today's Presentation

1. **General Background on Business Logic Attacks (BLA)**
    1. Problem statement
    2. Business logic exploits
    3. Categorization of business logic flaws
2. **Vulnerability Analysis of Business Logic Flaws**
    1. Threat, vulnerabilities, and attacks
    2. Root causes of vulnerabilities leading to BLA
    3. Categorization of business logic flaws using OWASP T10, SANS-25, WASC
3. **Identification and mitigation of Business Logic Flaws**
    1. Application Threat Modeling
    2. Testing for Business Logic Flaws
    3. Countermeasures
4. **Q & A**

Business Logic Attacks

Business Logic Attacks: The Problem Statement

- **Target specifically the business rules of the application by abusing them for monetary gain and fraud, some examples:**
  - Attacking shopping cart transactions to alter price of an item before checkout
  - Attack shopping cart after checkout to bypass credit card purchase validation before shipping the item
  - Attacking money transfers in an on-line banking transactions by exploiting weaknesses in account validations

- **Take advantage of overlooked flaws in enforcing strict control of business logic at the application layers, for example:**
  - Security design reviews does not focus on designing controls for preventing abuses of business logic
  - Automated vulnerability assessments and code scan do not found business logic flaws

Business Logic Attacks Examples

Macworld crack offers VIP passes, hacker says

INVESTING

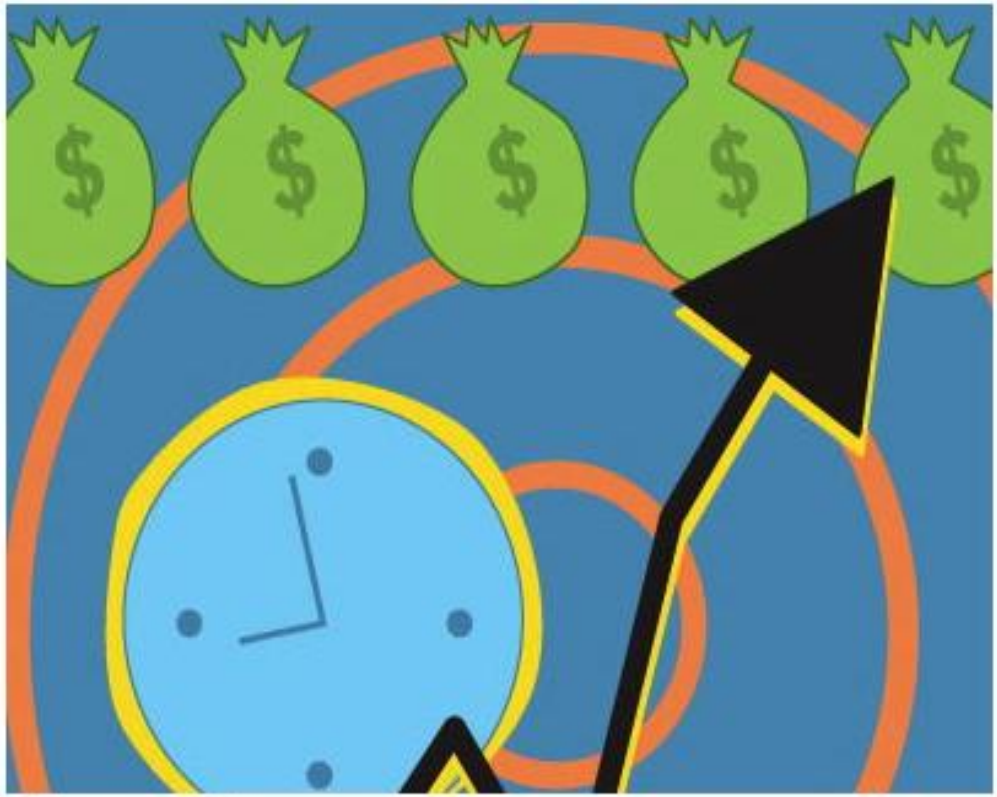
BusinessWeek 1 of 7

How to Game CNBC's Stocks Contest

Contestants in a CNBC stock-picking game may have been able to game the cable channel's trading system in the quest for a $1 million prize

By Tim Catts

Cable business news channel CNBC attracted some 375,000 players to its recent "Million Dollar Portfolio Challenge," which ended May 25, as players put their stock-picking skills to the test. But now New Jersey-based CNBC says it is investigating "unusual trading in violation of contest rules among some of the 20 finalists" after contestants alerted the network that some of their rivals may have been gaming the trading system.



Bypassing Security Controls ?

Business Logic Flaws Categorized in 2 Groups

Group 1: Exploit flaws in enforcement of business logic for transactions and the data , examples include:

Weak enforcement of business logic such as workflows and steps required by transactions (e.g. A, B, C not A to C directly)

Insufficient parameters validation (e.g. priceID, roleIDs, userIDs),

Committing to transactions without doing all checks required first

Group 2: Exploit weaknesses in security controls whose function is protect the business rules examples include:

Mis-configurations of Role Base Access Controls (RBAC) policy rules,

Password reset flaws, username recovery flaws,

Security controls failing insecurely,

Insufficient anti-automation attacks defenses

Vulnerability Analysis of Business Logic Flaws

BLA From Risk Analysis Perspective

- **Threats**
  - **Some threat agent (human, non-human) and/or adverse condition** that target the application logic to cause a negative impact to the business and the customers
- **Attacks**
  - **Realize the threat to business logic cause a negative impact**, includes different ways for an attacker to conduct business logic attacks by exploiting one or more vulnerabilities and logic flaws
- **Application vulnerabilities**
  - **Are weaknesses in the application** that can be exploited by a threat and cause a negative impact to the application.

Root Causes Of Business Logic Flaws

- **Security Design Flaws**
  - **Caused by lack of security requirements, poor knowledge, lack of security architecture design reviews**
  - **Cannot be identified by security tools alone** since are logical vulnerabilities and require manual threat analysis/ threat modeling
- **Security Coding Errors**
  - **Coding bugs that result in vulnerabilities**
  - **Can be identified with source code analysis tools and manual code reviews**
- **Security Mis-configurations**
  - **Mis-configuration for application security policies and business rules**
  - **Can be identified through change control processes**

Business Logic Attack, Mostly Exploit Security Flaws in Design and Security Mis-Configurations

Vulnerabilities Potentially Exploited By BLAs

WASC Threat Classification v2	OWASP Top Ten 2010 RC1
WASC-19 SQL Injection	A1 - Injection
WASC-23 XML Injection	
WASC-28 Null Byte Injection	
WASC-29 LDAP Injection	
WASC-30 Mail Command Inject	
WASC-31 OS Commanding	
WASC-39 XPath Injection	
WASC-46 XQuery Injection	
WASC-08 Cross-Site Scripting	
WASC-01 Insufficient Authentic	
WASC-37 Session Fixation	
WASC-47 Insufficient Session E	
WASC-01 Insufficient Authentic	
WASC-33 Path Traversal	
WASC-09 Cross-site Request F	
WASC-14 Server Misconfigurati	
WASC-02 Insufficient Authoriza	
WASC-10 Denial of Service	
WASC-11 Brute Force	
WASC-21 Insufficient Anti-auto	
WASC-34 Predictable Resource	
WASC-38 URL Redirector Abus	
WASC-50 Insufficient Data Protection	A9 - Insecure Cryptographic Storage
WASC-04 Insufficient Transport Layer Protection	A10 -Insufficient Transport Layer Protection

OWASP Top Ten 2010 RC1	2010 Top 25
A1 - Injection	CWE-89 (SQL injection), CWE-78 (OS Command injection)
A2 - Cross Site Scripting (XSS)	CWE-79 (Cross-site scripting)

5 **CWE-285: Improper Access Control (Authorization)**

Summary

Weakness Prevalence	High	Consequences	Security bypass
Remediation Cost	Low to Medium	Ease of Detection	Moderate
Attack Frequency	Often	Attacker Awareness	High

Discussion

Suppose you're hosting a house party for a few close friends and their guests. You invite everyone into your living room, but while you're catching up with one of your friends, one of the guests raids your fridge, peeks into your medicine cabinet, and ponders what you've hidden in the nightstand next to your bed. Software faces similar authorization problems that could lead to more dire consequences. If you don't ensure that your software's users are only doing what they're allowed to, then attackers will try to exploit your improper authorization and exercise unauthorized functionality that you only intended for restricted users.

1: BLAs Exploiting Authorization Flaws

- **BUSINESS LOGIC ATTACKS:**
  - **Attackers access web resources not restricted by role,** simply changes the workflow/URL to a privileged page using forceful browsing
  - **Attackers change the parameters of a business transaction** such as the price of goods purchased to be charged a cheaper price
- **FLAWS:**
  - **INSUFFICIENT AUTHORIZATION (WASC-02),**
  - **FAILURE TO RESTRICT URL ACCESS (OWASP A7),**
  - **IMPROPER ACCESS CONTROL (SANS-CWE-285)**
- **ROOT CAUSES:**
  - **Lack of granular enforcement of authorization rules** through policy such as Role Base Access Controls (RBAC)
  - **Business rules enforced using client side parameters** instead of server side logic

2: BLAs Exploiting Authentication Flaws

- **BUSINESS LOGIC ATTACKS:**
  - **Attackers guess questions in challenge/question authentication** (e.g. account creation, change password, recover password, this includes KBA , Knowledge Based Authentication)
  - **Attackers replay the session** such as a valid sessionID to logon in the application after previous logout
- **FLAWS:**
  - **INSUFFICIENT AUTHENTICATION (WASC-01),**
  - **BROKEN AUTHENTICATION AND SESSION MANAGEMENT (OWASP A3),**
  - **MISSING AUTHENTICATION FOR CRITICAL FUNCTION (CWE 306)**
- **ROOT CAUSES:**
  - **Design flaws for password reset transactions**
  - **Easily guessable questions**
  - **Session management issues** such as lack of single logout across applications-tiers

3: BLAs Exploiting Mis-Configurations

- **BUSINESS LOGIC ATTACKS:**
  - **Attackers exploit mis-configuration of access control policy** to exploit fail open-insecure conditions, unauthorized access to resources, bypass of authentication and RBAC, information disclosure through errors
  - **Attackers bypass detection since transaction and security events are not logged** so the attack cannot be audited/investigated
- **FLAWS:**
  - **SERVER MISCONFIGURATION (WASC-14),**
  - **SECURITY MISCONFIGURATION (OWASP A6)**
- **ROOT CAUSES:**
  - **Configuration management changes not tested** for enforcement of roles and permissions
  - **Logging does not cover validations x transaction x user**

4: BLAs Exploiting Insufficient Anti-Automation

- **BUSINESS LOGIC ATTACKS:**
  - **Automatic injection of web pages** (e.g. forms/Frames) in application workflows to collect PII (e.g. Zeus Trojans) to commit fraud
  - **Automated validation of credit card data** through the application exploiting error and exception handling flaws
  - **Spam of account registrations** to flood back-office processes
  - **Denial of services to customers by locking accounts by failing logins** through automation locking and by flooding of call center for unlocking requests
- **FLAWS:**
  - **INSUFFICIENT ANTI-AUTOMATION (WASC-21)**
- **ROOT CAUSES:**
  - **Lack of detective control for automation (e.g. CAPTCHA, automated intrusion detection) to protect transactions**

5: BLAs Exploiting Insufficient Process Controls

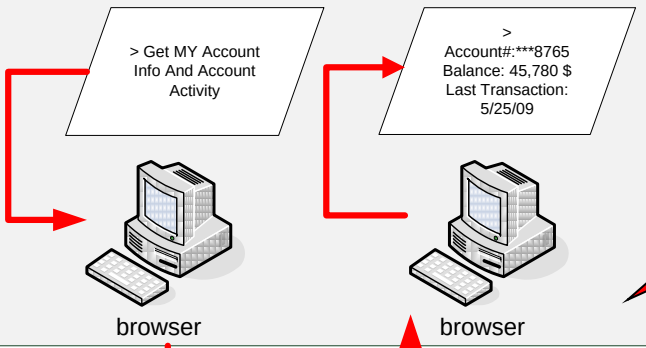
- **BUSINESS LOGIC ATTACKS:**
  - **Fraudster bypasses validations checks** for performing transactions such as by altering the flow (e.g. shipping for goods not being purchased)
  - **Attacker learns to exploit business logic from client code** (e.g. Web 2.0 applications)
  - **Attacker learns how to game the system from the way the system responds to input data**
- **VULNERABILITY**
  - **INSUFFICIENT PROCESS CONTROLS (UNCLASSIFIED)**
- **ROOT CAUSES:**
  - **Insufficient enforcement of transaction validations performed** at different stages of the business transaction before committing to it
  - **Lack of data validations at different tiers of the application architecture (e.g. application and messaging)**
  - **Lack of Out of Band (OOB) validations and call backs**
  - **Business logic exposed to clients**

Identification and Mitigation of Business Logic Flaws

Business Logic In Web Application Architectures

Presentation Tier

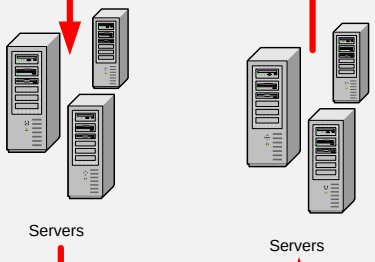
Represents the top most level
of the application.
The purpose of this tier is to translate
commands from the user interface
into data for processing to other tiers and
present back the processed data



Beware of Web 2.0 Apps that include business logic client side (e.g. AJAX, Widgets, Mashups

Logic Tier

This layer processes commands and
makes decisions based upon
the application business logic
It also moves and processes data
between the presentation and the data tier

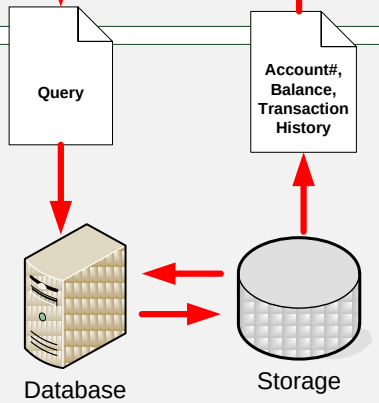


Not All Business Logic Resides on the Application Server !

Beware of Flaws in Integration of Business Logic with Server Components

Data Tier

Is the layer responsible for data storage and
retrieval from a database or file system
Query commands or messages are processed
by the DB server, retrieved from the datasource
and passed back to the lo the logical tier for
processing before being presented to the user



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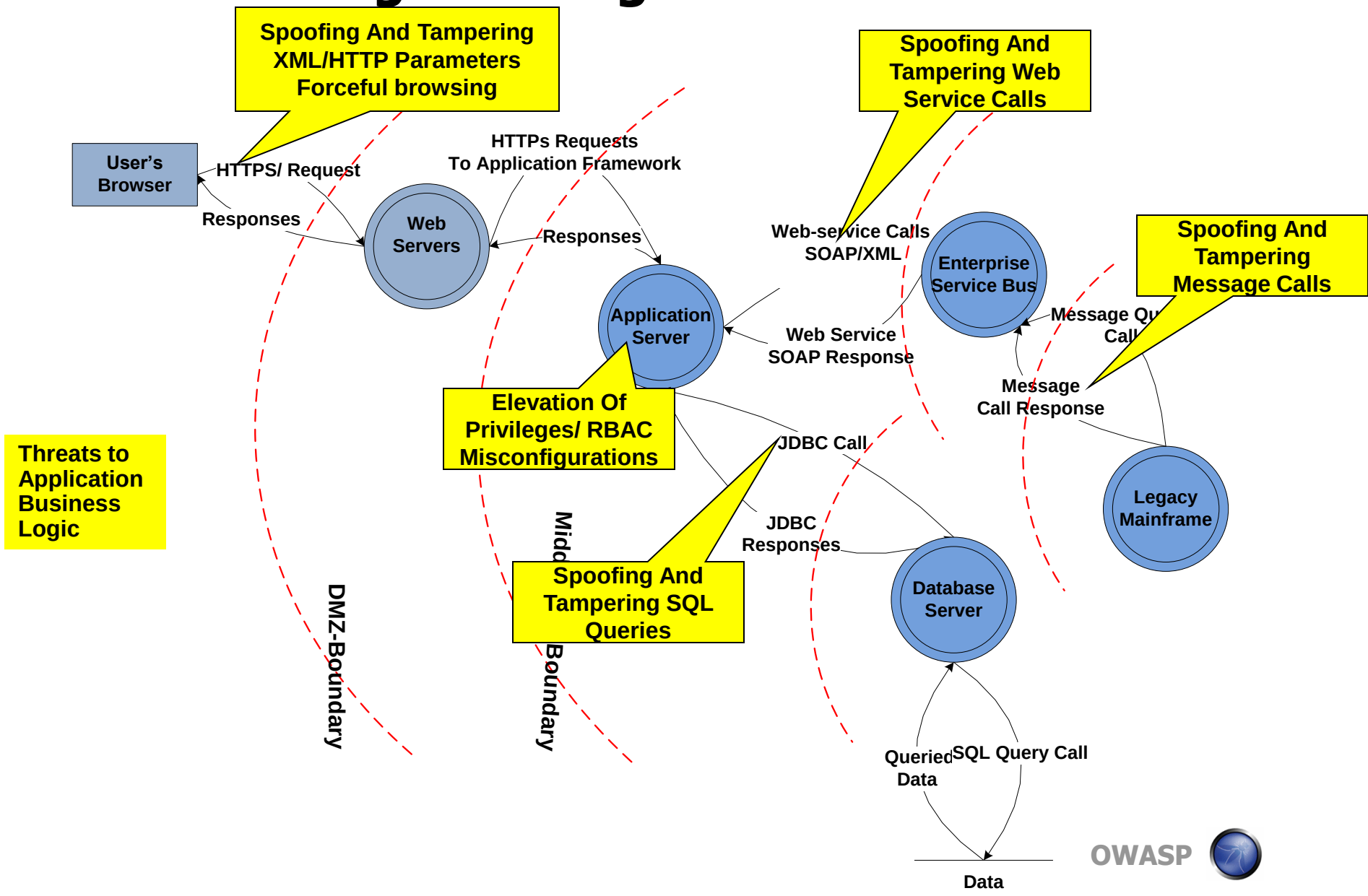
Security Process for Preventing Business Logic Flaws in Applications

1. **Require every application to document business logic** with data flows for transactions and the access control matrix used
2. **Design the application as business logic abuse resistant**, including process validations and controls assuming that the application business logic can be abused
3. **Use application threat modeling** to identify design flaws in business logic. Analyze abuse of business logic and security controls with use misuse cases and transaction analysis
4. **Security test (manually) for business logic flaws/vulnerabilities such as** OWASP 3,4,8, WASC 1,2,14,21 and SANS-25-CWE 285,306
5. **Create specific security tests for abuse of business logic** by deriving them from the use-abuse cases and transaction/data flow analysis performed during threat modeling
6. **Analyze risks and apply countermeasures** to mitigate likelihood and impact of business logic attacks

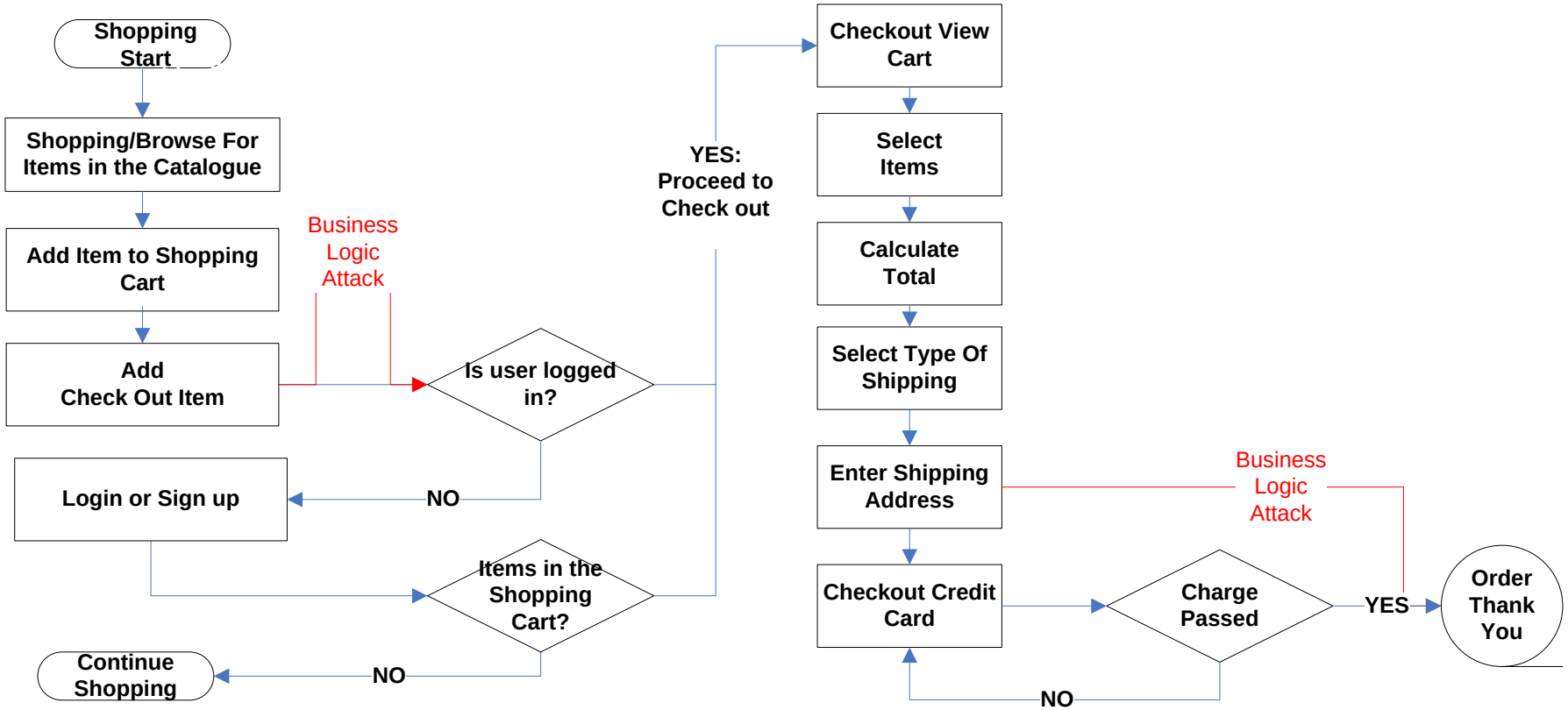
Identification Of Security Flaws: Application Threat Modeling Process

Data Flow Diagramming

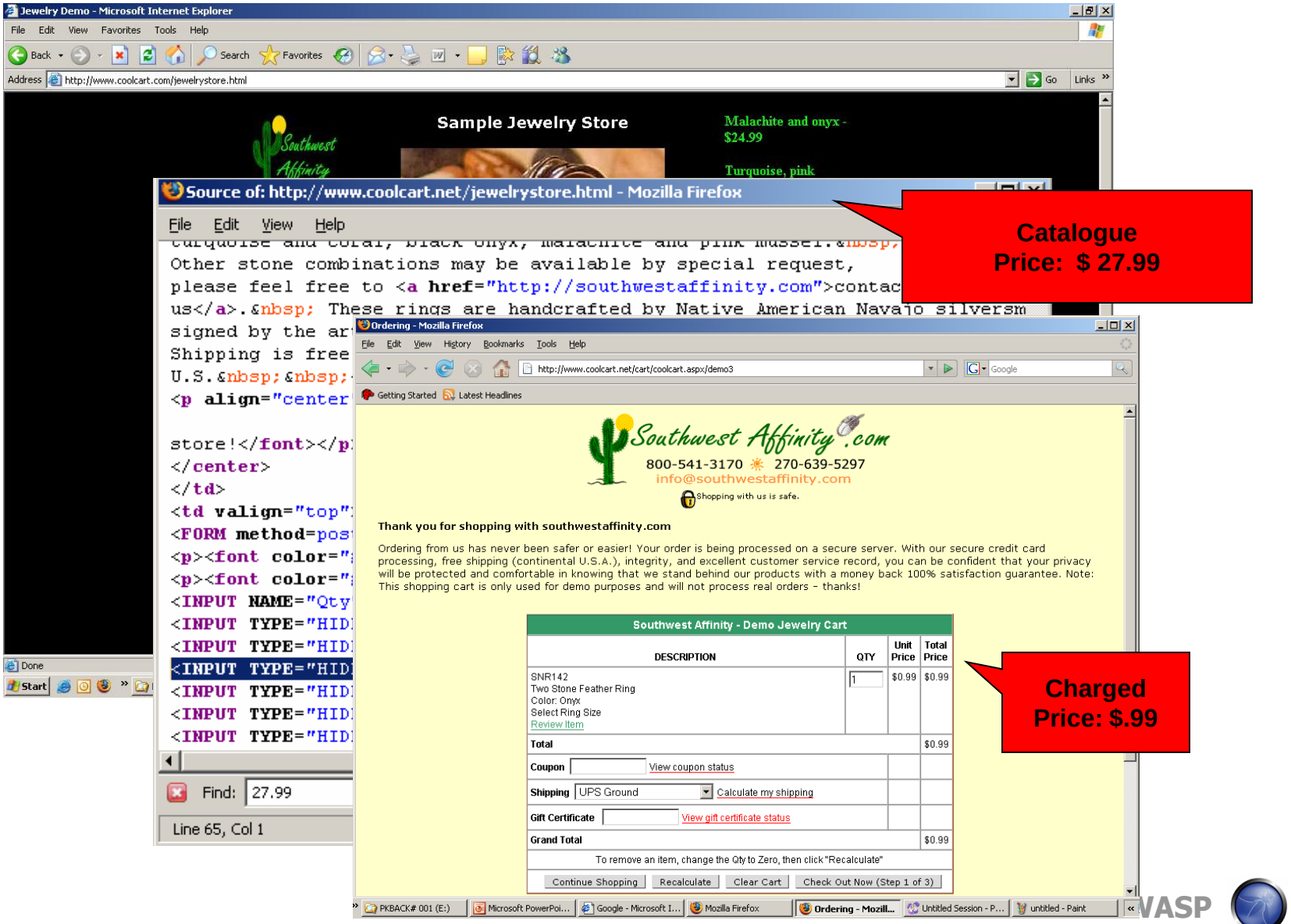


Security Flaws Identification With Use And Abuse Cases: Password Reset

Identification of Business Logic Flaws Using Transaction Analysis: Shopping Cart



Shopping Cart BLA Example



Testing For Occurrence of Business Logic Flaws

- **Main objective is to test that the application business rules cannot be altered by business logic attacks**
- **Require testers to write NEGATIVE test cases and scripts to identify potential exploits of business logic flaws during Q/A test validation cycles. Examples include**:
  1. Trying to bypass of user validations and prerequisite checks for a transaction,
  2. Trying to bypass multi factor authentication in a transaction,
  3. Trying to force a transaction and access high privileged resources logging as low privilege user,
  4. Tampering with business logic parameters during a request to try to access resources,
  5. Replaying session tokens after logouts to try to log back to the application,
  6. Trying to force the application to fail in unsecure conditions such as fail open or as un-handled exceptions
  7. Trying to alter price of items and validate if they can be added,
  8. Trying to abuse registration, account openings/applications with automation scripts

Checking Configuration of Security And Business Rules

	Role1	Role2	Role3
Resource1	Deny	Grant	SpecialCaseAccessControlRule
Resource2	Grant	Deny	Deny

```
<?xml version="1.0" encoding="ISO-8859-1" ?>
<AccessControlPolicy>
     <AccessControlRules>
          <AccessControlRule
               name="Grant"
               description="Access is always granted"
               class="org.owasp.esapi.accesscontrol.AlwaysTrueACR">
          </AccessControlRule>
          <AccessControlRule
               name="Deny"
               description="Access is always denied"
               class="org.owasp.esapi.accesscontrol.AlwaysFalseACR">
          </AccessControlRule>
          <AccessControlRule
               name="SpecialCaseAccessControlRule"
               description="Access depends on the value of the policy parameter: isTrue"
               class="org.owasp.esapi.accesscontrol.policy.EchoDynaBeanPolicyParameterACR">
               <Parameters>
                    <Parameter name="isTrue" type="Boolean" value="true"/>
               </Parameters>
          </AccessControlRule>
     </AccessControlRules>
</AccessControlPolicy>
```

Possible Countermeasures Against BLAs

- **Deterrent controls**
  - Anti-automation (e.g. CAPTCHA, logic puzzles)
- **Preventive controls**
  - Strong authentication and authorization of transactions (e.g. ESAPI)
  - Secure password reset and userID reminder processes
  - Strong business process validation/checks for transactions (e.g. use Out Of Band)
  - Data validation/filtering of transaction parameters (e.g. ESAPI)
  - Secure session management such as the SessionIDs used in business transactions
- **Detective controls**
  - Application layer detection rules for BLA patterns (e.g. ESAPI IDS)
  - Web Application Firewall (WAF) rules (e.g. ESAPI WAF)
  - Fraud monitoring and detection rules (e.g. Fraud Detection)
  - Logging and alerts of business transaction events as well as related security events

QUESTIONS ANSWERS

Thanks for listening, further references

- Designing a Framework Method for Secure Business Application Logic Integrity in e-Commerce Systems
  - http://ijns.femto.com.tw/contents/ijns-v12-n1/ijns-2011-v12-n1-p29-41.pdf
- Seven Business Logic Flaws That Put Your Website At Risk
  - http://www.whitehatsec.com/home/assets/WP_bizlogic092407.pdf
- Testing for business logic (OWASP-BL-001)
  - http://www.owasp.org/index.php/Testing_for_business_logic_(OWASP-BL-001)
- Get rich or die trying, "Making money on the web, the black hat way"
  - http://www.whitehatsec.com/home/assets/presentations/PPT_BlackHat080708.pdf

Further references con't

- OWASP Top Ten Project
  - http://www.owasp.org/index.php/Category:OWASP_Top_Ten_Project
- The WASC Threat Classification v2.0
  - http://projects.webappsec.org/Threat-Classification
- CWE/SANS TOP 25 Most Dangerous Coding Errors
  - http://www.sans.org/top25-software-errors/
- OWASP Application Threat Modeling
  - http://www.owasp.org/index.php/Application_Threat_Modeling
- OWASP EASPI
  - http://www.owasp.org/index.php/ESAPI_Access_Control
- OWASP Testing Project
  - http://www.owasp.org/index.php/Category:OWASP_Testing_Project