WaveFront Consulting Group

BLIND SQL INJECTION
(UBC)

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WHO AM I

- Rui (Roy) Pereira
- Over 25 years in Information Technology industry
- Last 13 years specializing in Information Security and Audit
- CISSP and CISA certified, CIPS ISP, CWNA, CPTS/CPTE
- Independent consultant
- Specializing in…
  - Threat-Risk Assessments, Investigations, DRP/BCP
  - Penetration Testing and Vulnerability Assessments
  - Policy Development, Security Awareness and Education
  - Applications Security, PCI/SOX Compliance
  - Security Architecture Design and Implementation
  - Wireless and Telecommunications Security
- Customers include BC and Alberta Governments, E-Comm, ICBC, LDB, Citadel Commerce, Top Producer, etc.
- Teach various courses at BCIT and UBC, including Intro to Computer Crime and Wireless Network Security

AGENDA

- Database Attacks
- Verbose SQL Injection
- Blind SQL Injection
- An Example
- Finding Blind SQL Injection
  - W3AF, Samurai, SQLMap
- Fixing SQL Injection

DATABASE ATTACKS

- Listed as one of SANS Top 20 Security Risks for 2007
  - http://www.sans.org/top20/#s7
- Indirect Attacks
  - Attack the application which uses the database
  - SQL Injection (Verbose and Blind)
- Direct Attacks
  - Exploit vulnerabilities in database system and underlying OS
  - Buffer overflows, weak passwords or access control, lack of auditing, vulnerable services, etc.
  - Includes password guessing, cracking, stealing
  - Includes bypassing database and accessing underlying disk file/storage structures

DIRECT DATABASE ATTACKS

- SQL Slammer/Saphire Worm hit in January 2003
  - Exploited a buffer overflow vulnerability in Microsoft's SQL Server and MSDE 2000
  - Infected more than 90% of vulnerable hosts in 10 mins
  - www.caida.org/publications/papers/2003/sapphire/sapphire.html
  - www.microsoft.com/technet/security/bulletin/MS02-039.mspx
  - Exploit in Metasploit Framework 3 exploits/windows/mssql/ms02_039_slammer.rb (also is MSF2)
- Other exploits exist in MSF2&3, and elsewhere
  - SQL 2K HELO Overflow, www.securityfocus.com/bid/5411
  - SQL 2K5 sqldmo.dll ActiveX Buffer Overflow, http://www.securityfocus.com/bid/25594

SQL SERVER

- If trusted connections are used, then OS access may be sufficient for database access
  - Trusted connections use Windows accounts to access the database
- Blank sa admin accounts are a problem
  - With Oracle problem is huge number of seeded accounts
- If xp_cmdshell and similar procedures are available, can access OS functionality
  - Even if xp_cmdshell is not available, can be re-enabled with sp_configure
- Can enter multiple SQL commands together on same line

DATABASE COUNTERMEASURES

- Enforce strong password policies
  - Change default account passwords
  - Oracle has over 600 of these, SQL Server has sa
- Patch database and underlying OS
  - Setup ongoing patch management process
- Harden (secure) database and OS installs
  - Remove dangerous xp_ and sp_ procedures, or restrict access to them (SQL Server)
- Code applications securely to reduce risk of SQL Injection
  - Architect web applications to reduce risk of compromise, impact should compromise occur
- Restrict access to database ports via internal and external network and host-based firewalls

SQL INJECTION

- Attacking the application which uses the database
  - Attacker includes SQL statements or fragments as input to the application
  - Application accepts this input and passes it, as is, to the backend database for processing
  - Application does not validate client input
  - Allows authentication bypass, unauthorized access to data (crud), access to OS system commands
  - Example: http://www.testfire.net/bank/login.aspx
  - Finding potentially vulnerable sites using Google
    - inurl:"id=10“ (Michael Sutton’s Blog)

SQL INJECTION

Normal Query

```
SELECT COUNT (*) FROM User.tbl
WHERE UserName='Rui'
AND Password='IamaWalrus'
```

Malicious Query

```
SELECT COUNT (*) FROM User.tbl
WHERE UserName='' OR 1=1--
AND Password=''
```

“OR 1=1" is always true, matches every record in table

"--" comments out rest of query

WHAT CAN AN ATTACKER DO?

- Bypass authentication and access controls
- Determine structure of backend database
  - Database enumeration
- Unauthorized access to data
  - Including passwords and credit card numbers if stored in plaintext
- Unauthorized changes to data
  - Including deletion of records and tables, insertion of records
- Able to run Operating System commands

SQL INJECTION

- Verbose (Normal) SQL Injection
  - Attacker relies on SQL error messages to piece together the SQL code being executed, enumerate backend database tables, columns, etc.
- Blind SQL Injection
  - Application does not return SQL error messages
  - Its behavior when subjected to erroneous input is used to detect SQL Injection possibilities
  - We ask the server a series of true/false questions and build up our results from the answers

VERBOSE SQL INJECTION

- Error message
  - The close brackets “)” were provided on input

```
Microsoft OLE DB Provider for ODBC Drivers error ‘80040e14’
([Microsoft][ODBC Microsoft Access Driver]

Extra ) In query expression ‘Username=’’’ AND Password =’’

/_employees/login3.asp, line 49
```


BLIND SQL INJECTION

- These statements don’t generate errors, give same result:

  http://www.acme.com/pressRels.jsp?pressRelID=5 AND 1=1
  http://www.acme.com/pressRels.jsp?pressRelID=4+1

- These don’t generate errors (or return nothing):

  http://www.acme.com/pressRels.jsp?pressRelID=5 AND 1=2
  http://www.acme.com/pressRels.jsp?pressRelID=5 AND USER_NAME() = ‘dbo’

- But this statement returns press release #5:

  http://www.acme.com/pressRels.jsp?pressRelID=5 AND USER_NAME() = ‘sa’

  - So we know the current user name is sa!

BLIND SQL INJECTION

- In practice tests are done character by character
  - A binary search is used to speed things up
- http://.../...jsp?pressRelID=5 AND ascii(lower(substring((SELECT TOP 1 name FROM sysobjects WHERE xtype='U'), 1, 1))) > 109
  - If the fifth press release is returned, then first letter comes after ‘m’
- http://.../...jsp?pressRelID=5 AND ascii(lower(substring((SELECT TOP 1 name FROM sysobjects WHERE xtype='U'), 1, 1))) > 116
  - If the fifth press release is not returned, then letter is greater than ASCII 109 (‘n’) and less than 116 (‘t’)
  - And so on...

BLIND SQL INJECTION

- A secure application would reject such requests because it treats the user’s input as a value
  - The value “5 AND 1=2” would cause a type mismatch error (if passed to a stored procedure)
  - The server would not display a press release (may display generic or custom error message)
  - Simply disabling the display of database error messages does not offer sufficient protection against SQL injection attacks

TYPES OF BLIND SQL INJECTION

- Conditional Response
  - SELECT field FROM table WHERE otherfield='value' AND 1=1 produces normal page
  - SELECT field FROM table WHERE otherfield='value' AND 1=2 produces different page
- Conditional Error
  - SELECT 1/0 FROM table WHERE field='value' will generate error if field='value'
- Time Delays
  - SQL engine executes a long running query or a time delay statement depending on the logic injected
  - Attacker can measure how long page takes to load to see if injected statement is true

BLIND SQL EXAMPLE

- WordPress is Open Source Blogging software
  - Blind SQL Injection in WordPress 2.1.3
  - Advisory at http://www.waraxe.us/advisory-50.html
  - Exploit at http://www.waraxe.us/ftopict-1776.html
  - Uses time delays to get hash of WordPress password one character at a time
  - Can then brute force hash (no salt), or create valid session cookie from hash

FINDING SQL INJECTION

- Manual Tests
- Automated Scanners
  - HP WebInspect
  - IBM Rational Appscan
  - Cenzic Hailstorm
  - Syhunt Sandcat
  - Paros Proxy
  - W3AF
  - etc...
- SQL Injection Tools
  - SQLMap
  - SQL Ninja (SQL Server)
  - SQLIx
  - etc…

FIXING SQL INJECTION

- Validate all user input to ensure it is appropriate for the particular information the field represents
  - User names do not usually contain semicolons (;), tildes (~) or ampersands (&)
  - May contain single quotes though (O'Brien)
  - In general, limit all client-supplied data to alpha-numeric characters whenever possible
- Filter out potentially dangerous characters
  - Major culprits are the single quote (‘), double dash (--), and semicolon (;)
    - Remove these entirely
    - Replace them with ‘safe’ equivalents
    - Use HTML encoding like &code; or &#number;
  - Other characters that can be used for SQL Injection include " , / \ * & ( ) $ % ^ @ ~ ?

FIXING SQL INJECTION

- Filtering and validation should be part of a global facility called when any page is loaded / submitted
  - It should be done on all pages and fields
  - But see subsequent section on data validation and on black vs. white listing
- Use language platform tools to handle potentially dangerous characters
  - Such as cfqueryparam in ColdFusion
- Do not create dynamic SQL queries using simple string concatenation
- Replace individual single quotes in string data with two single quotes
- Ensure numeric variables contain numeric data

FIXING SQL INJECTION

- Run the database and web server under low privilege accounts
  - Do not access database from Web server using dba or database owner accounts
  - Do not run database under privileged system account
  - Do not run Web Server as root or administrator
  - Do not allow database server to initiate outbound access (use internal firewalls)
- This does not prevent SQL Injection, but reduces the impact of such attacks

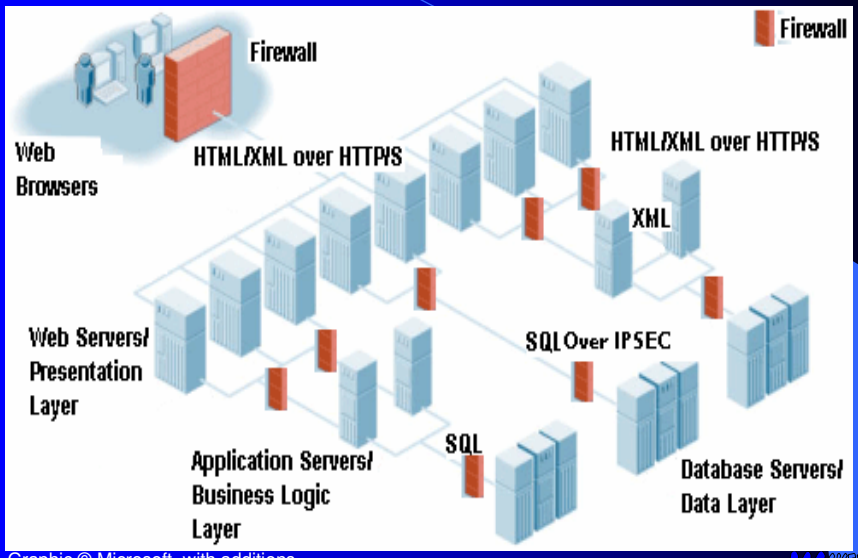
FIXING SQL INJECTION

- Use parameterized queries (.NET), prepared statements (Java)
  - Use strongly typed parameters
- Use stored procedures to abstract data access, so users do not directly access tables and views
  - Access control can then be applied to stored procedures instead of the underlying tables and views
  - NEVER take input from client and add it verbatim to SQL statements
  - Do not pass SQL statements, or fragments of SQL statements, as parameters to stored procedures
  - Stored procedures (should) prevent attacker from providing SQL code to be executed
  - Parameters are treated as literal values, not as executable code

FIXING SQL INJECTION

- Turn off verbose SQL error messages
  - Can still use Blind SQL Injection
- Improve application level filters to better detect these kinds of attacks
  - mod_security on Linux Apache Web Servers
  - Can be deployed as a separate server for Windows IIS shops
- Use web application firewalls and Intrusion Detection / Prevention Systems (IDS/IPS)

WEB APPLICATION ARCHITECTURE



Graphic © Microsoft, with additions

DATABASE SCANNERS

- Work with various database systems
  - Oracle, SQL Server, MySQL, DB2, Sybase
  - Look for configuration issues, as well as vulnerabilities
- AppDetectivePro
  - www.appsecinc.com/products/appdetective
  - Audit and pen-test components
- Integrigy AppSentry
  - www.integrigy.com/products/appsentry
  - Tests Oracle e-Business Suite, Web Application Server
- SCUBA (free)
  - www.imperva.com/products/scuba.html
  - More of an audit tool
- Nessus has several Oracle and SQL Server checks

SQL INJECTION REFERENCES

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- SQL Injection Attacks by Example, http://www.unixwiz.net/techtips/sql-injection.html
- SQL Injection Whitepaper, http://www.spidynamics.com/papers/SQLInjectionWhitePaper.pdf
- SQL Injection: Finding and Fixing It, http://www.acunetix.com/websitesecurity/sql-injection.htm
- Blind SQL Injection, http://www.spidynamics.com/whitepapers/Blind_SQLInjection.pdf and www.imperva.com/resources/adc/blind_sql_server_injection.html
- SQL Security Website, http://www.sqlsecurity.com/

SQL INJECTION REFERENCES

- The Database Hacker's Handbook: Defending Database Servers, David Litchfield / Chris Anley / John Heasman / Bill Grindlay, Wiley, 2005
- How Prevalent Are SQL Injection Vulnerabilities?, http://portal.spidynamics.com/blogs/msutton/archive/2006/09/26/How-Prevalent-Are-SQL-Injection-Vulnerabilities_3F00_.aspx
- SQL Injection Cheat Sheet, http://ferruh.mavituna.com/makale/sql-injection-cheatsheet/
- MS-SQL Injection Cheat Sheet (and others), http://pentestmonkey.net/blog/mssql-sql-injection-cheat-sheet/

Thank You

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