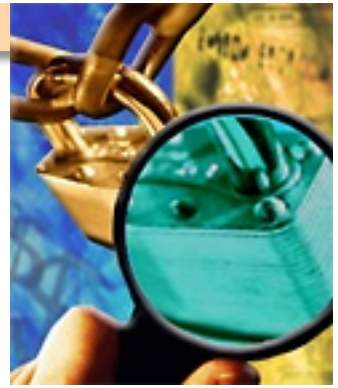

Database Assessment

Vulnerability Assessment Course

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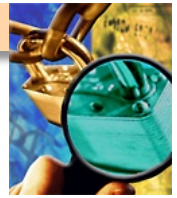

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Agenda

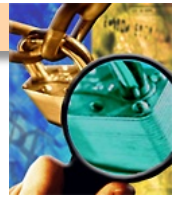
- Introduction
- Configuration Guidance
- Operating System Configuration
- Database Installation
- Default Database Configurations
- Identification and Authentication
- Auditing and Monitoring
- Overview of Oracle Testing
- Overview of SQL Server Testing

Introduction

- Database Security focuses on the use of database management systems to protect systems and data from unauthorized:
  - Access
  - Creates
  - Reads
  - Updates
  - Deletes

Relational Database Management Systems

- Sublanguages
  - Data Definition Language (DDL) defines structure
  - Data Control Language (DCL) defines security/access controls
  - Data Manipulation Language (DML) for data query/updates
- Interface drivers – code libraries for prepare statements, execute statements, and fetch results
  - SQL*Net/Net8
  - Open Database Connectivity (ODBC)
  - Java Database Connectivity (JDBC)
- SQL Engine interprets/executes DDL, DCL, and DML
- Other Engines
  - Transaction – statements either succeed or fail as a group
  - Relational – integrity constraints
  - Storage – data modification, commit/rollback, and backup/recovery



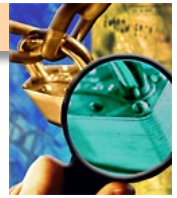
Breadth of Technology

- **Examples of Databases**
  - Oracle
  - Microsoft SQL
  - MySQL
  - DB2
  - Informix
  - TeraData
  - Sybase
- **Examples of Database Applications**
  - Oracle Financials
  - SAP
  - SAS

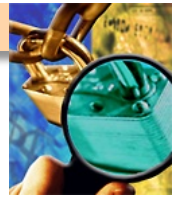
Considerations

- Majority of tests performed on live production systems
  - Limit to non-destructive testing
  - Penetration testing vs. Vulnerability Assessment/Compliance
- Database similarities allow for similar tests
  - Different products use different commands/procedures
  - Features are similar yet different between products
- Must be very familiar with the product and add-ons to
  - Eliminate false positives
  - Be taken seriously by administrators
  - Know most important product add-ons
  - Where is the database within the system architecture
  - Understand the database purpose

Security Configuration Guidance

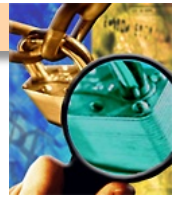


- DISA Guidance – Secure Technical Implementation Guides (STIGS) and Checklists
- NSA Security Configuration Guidance
- NIST Security Configuration Checklists
- Center for Internet Security (CIS) Benchmarks
- Vendor Database Security Guidance



What is a STIG?

- What is a Database STIG?
  - Guidance on technical security policy, requirements, and implementation details
  - Covers major vendors' database product
  - Provides classification guidance for weaknesses found
- What it is not?
  - Step by step implementation guide
  - Guidance to be taken literally
  - Always consistent and up to date
  - Always applicable to commercial or non-DoD environments



What Else Is It Not?

Hackers

- highly-skilled, but few in numbers, break mostly into "challenging" systems, publish/trade weaknesses

➢Hackers look for new security weaknesses

Not Addressed

Script Kiddies

- low-skilled, but numerous, use other peoples' tools to break into systems
- goal is to "OWN" as many machines as possible

➢Script Kiddies look for systems vulnerable to known exploits

Addressed

Social Engineers

- very good technical as well as social skills
- attacks are primarily directed against humans ('wetware')

➢Social Engineers look for clues on which they can base their attacks.

Partially Addressed

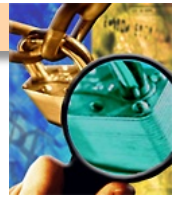
(Disgruntled) Employees

- use insider knowledge to gain system access
- motivated by curiosity or anger
- Disgruntled employees will try to damage the IT infrastructure

➢Employees usually look for HR information (e.g. salary) or want to enrich themselves

Partially Addressed

Common Pitfalls

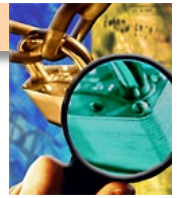


- Guidance can be out-of-date
  - Covers only the “core” product
  - What about add-on options?
  - Some add-on options are not so optional
  - Infrastructure and system architecture in which the DB operates not taken into account
- Familiarity with a variety of vendor add-on products or 3rd party tools used to
  - Manage the database
  - Monitor the database
  - Backup the database
  - Perform ETL operations on the database
  - Authentication constraints imposed by tools
  - Permissions required to run tools
  - Constraints imposed by application using DB

Operating System Configuration

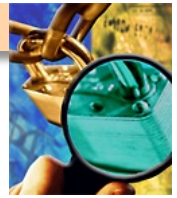
- Permissions on the OS directories and on the binary files
  - Why bother to break into the database if you can just take the database files
- Permissions of critical configuration files
- Permissions of installation, log, trace, and files

Database Installation



- Root of many problems
  - "All or nothing" option when installing some products
- Removal of options difficult if not impossible
  - If at all possible, vendor technical services needed in some cases
- Demonstration code in the database and on the binary install base
- Java Virtual Machines (JVM) and Java Runtime Environments (JRE) inside the database and in the binary install base
- Fully functioning, unsecured J2EE containers
- DBMS version maintenance
- Updated patch and fix installation

When Your Database Looks Like The Web



Methods for HttpSoap11 - Microsoft Internet Explorer provided by MITRE

File Edit View Favorites Tools Help

Back Search Favorites

Address http://sternschnuppe:8888/javacallout/javacallout?HelloServiceEJBHttpSoap11stub.html

Google Go Bookmarks 195 blocked Check AutoLink AutoFill Send to Settings

Method Summary

HttpSoap11_getProperties ()
Synchronous invocation of operation: getProperties

HttpSoap11_getProperty ()
Synchronous invocation of operation: getProperty

HttpSoap11_propertyNames ()
Synchronous invocation of operation: propertyNames

HttpSoap11_sayHello ()
Synchronous invocation of operation: sayHello

HttpSoap11_getPropertiesAsync ()
Asynchronous invocation of Operation: getProperties

HttpSoap11_getPropertyAsync ()
Asynchronous invocation of Operation: getProperty

HttpSoap11_propertyNamesAsync ()
Asynchronous invocation of Operation: propertyNames

HttpSoap11_sayHelloAsync ()
Asynchronous invocation of Operation: sayHello

HttpSoap11_getProperties

```
string[] HttpSoap11_getProperties (string[] arrayOfString_1);
```

HttpSoap11_getProperty

```
string HttpSoap11_getProperty (string String_1);
```

HttpSoap11_propertyNames

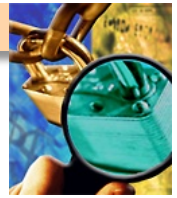
```
string[] HttpSoap11_propertyNames ();
```

HttpSoap11_sayHello

```
string HttpSoap11_sayHello (string String_1);
```

Local intranet

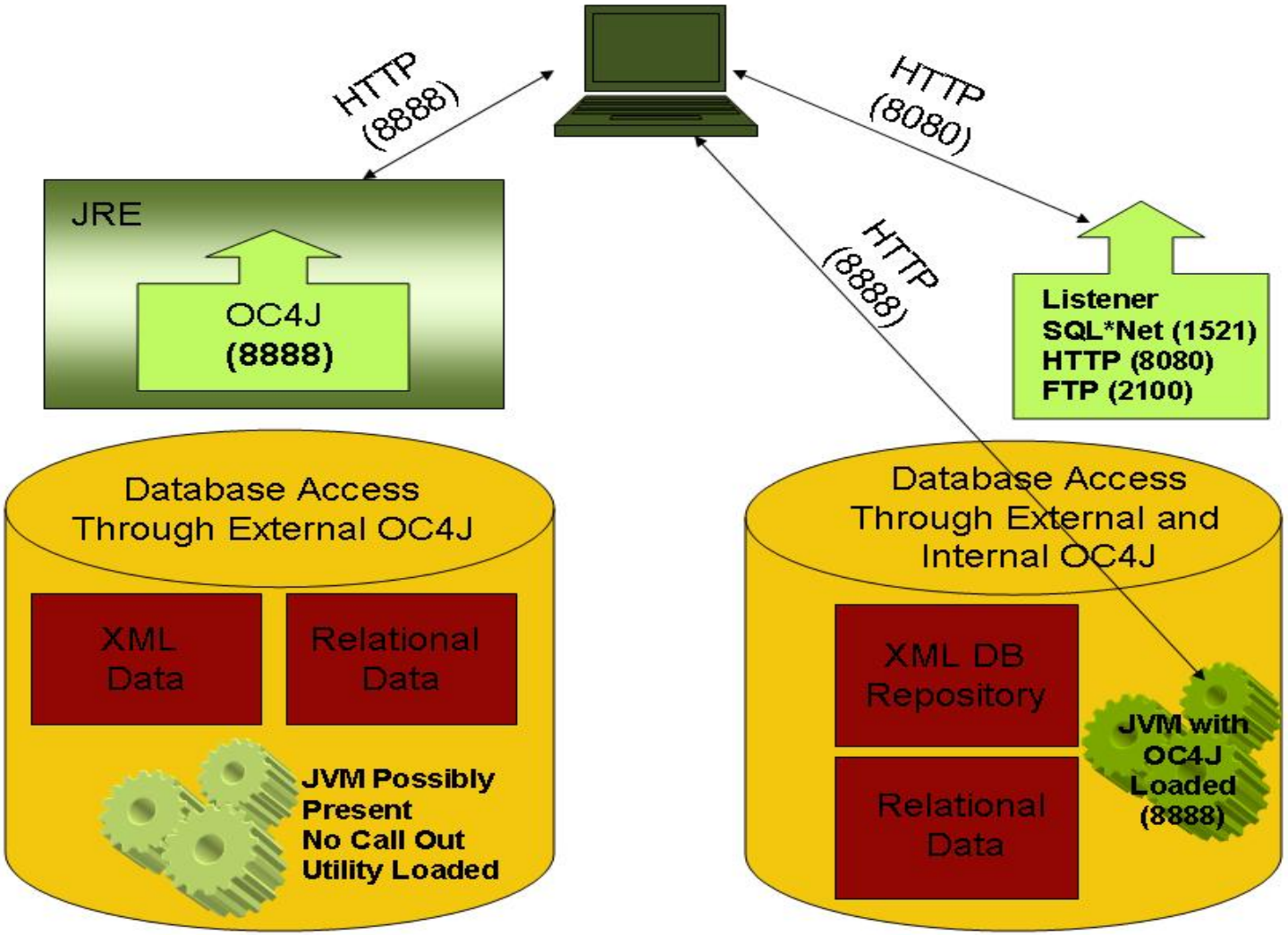
Default Oracle LISTENER Configuration 10g



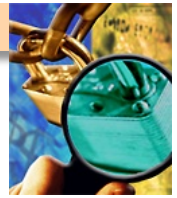
Telnet

```
$ lsnrctl status

LSNRCTL for Solaris: Version 10.2.0.1.0 - Production on 01-MAR-2007 11:45:56

Copyright (c) 1991, 2005, Oracle.  All rights reserved.

Connecting to (DESCRIPTION=(ADDRESS=(PROTOCOL=IPC)(KEY=EXTPROC2)))
STATUS of the LISTENER
------------------------
Alias                     LISTENER
Version                   TNSLSNR for Solaris: Version 10.2.0.1.0 - Production
Start Date                01-MAR-2007 11:05:35
Uptime                    0 days 0 hr. 40 min. 21 sec
Trace Level               off
Security                  ON: Local OS Authentication
SNMP                      OFF
Listener Parameter File   /export/oracle/10g/network/admin/listener.ora
Listener Log File         /export/oracle/10g/network/log/listener.log
Listening Endpoints Summary...
  (DESCRIPTION=(ADDRESS=(PROTOCOL=ipc)(KEY=EXTPROC2)))
  (DESCRIPTION=(ADDRESS=(PROTOCOL=tcp)(HOST=s[illegible])(PORT=1522)))
  (DESCRIPTION=(ADDRESS=(PROTOCOL=tcp)(HOST=[illegible])(PORT=8080))(Presentat
ion=HTTP)(Session=RAW))
  (DESCRIPTION=(ADDRESS=(PROTOCOL=tcp)(HOST=[illegible])(PORT=2100))(Presentat
ion=FTP)(Session=RAW))
Services Summary...
Service "PLSExtProc" has 1 instance(s).
  Instance "PLSExtProc", status UNKNOWN, has 1 handler(s) for this service...
Service "V880" has 1 instance(s).
  Instance "V880", status READY, has 1 handler(s) for this service...
Service "V880XDB" has 1 instance(s).
  Instance "V880", status READY, has 1 handler(s) for this service...
Service "V880_XPT" has 1 instance(s).
  Instance "V880", status READY, has 1 handler(s) for this service...
The command completed successfully
$
```

Default Oracle 11g Database Access

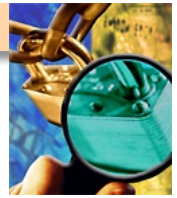


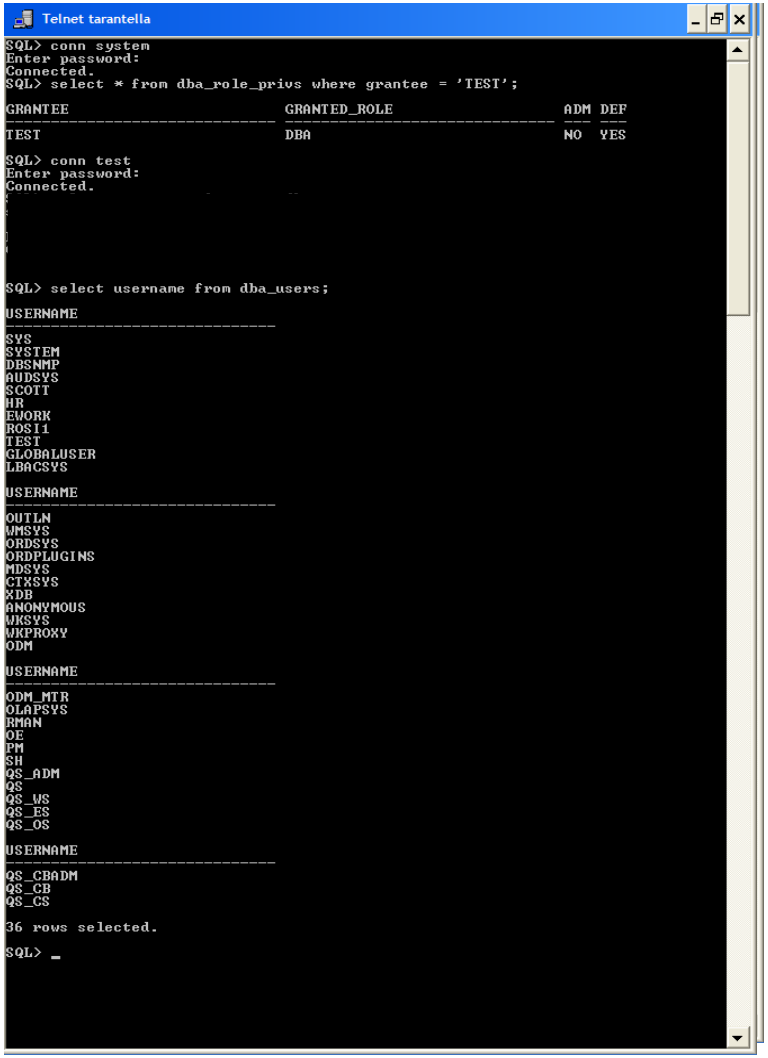
More Exploits, No Checklists



- Previous examples showed default installation issues
  - Database is no longer accessible with SQL*Net only
  - JRE installed as an external component to the database
  - Internal JVM is another potential vulnerability
- Next example demonstrates
  - Behavior of invoker vs. definer rights
  - PUBLIC assignment of privileges
  - Exploit using both to elevate user privileges from next to none to DBA
- What you should take away from these examples
  - Some guidance does not always address vulnerabilities
  - Gap needs to be addressed by manual testing and ad-hoc probing
  - There are no checklists for this!

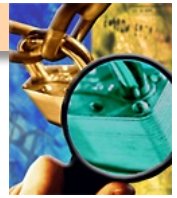
Escalation of privileges





- Unpatched Oracle 9i
- Create user (TEST)
- Minimal privilege (CREATE SESSION and PUBLIC privileges)
- TEST user executes CTXSYS package with rogue command
- TEST user has DBA privileges

DBA Role

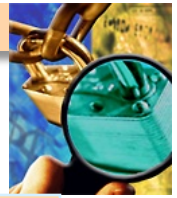


- DBA role is very powerful and access to it should be restricted
- Verify that any database account granted the DBA role is explicitly authorized
- Individual DBA accounts should be created for each DBA
- DBA accounts used only for DBA functions

Identification and Authentication

- OS-based authentication mode
  - Different databases, different modes
    - MS SQL Server – Windows or server authentication
    - Oracle – OS authentication or remote authentication
- Default or blank passwords
  - Oracle accounts…too many!!!
    - 483 unique default accounts
    - 46 accounts have multiple default passwords, depending on version
    - 597 total default password possibilities
- Oracle LISTENER security
  - Local OS authentication is used for listener security in Oracle 10g and higher version
  - Prior to 10g, password did not follow best practices
    - Age, strength, history, and lockout

Oracle Connection Security



- listener.ora file
  - Program = extproc

```
# listener.ora Network Configuration File: C:\oracle\product\10.1.0\db_
1\NETWORK\ADMIN\listener.ora
# Generated by Oracle configuration tools.

SID_LIST_LISTENER =
  (SID_LIST =
    (SID_DESC =
      (SID_NAME = PLSExtProc)
      (ORACLE_HOME = C:\oracle\product\10.1.0\db_1)
      (PROGRAM = extproc)
    )
  )

LISTENER =
  (DESCRIPTION_LIST =
    (DESCRIPTION =
      (ADDRESS = (PROTOCOL = IPC)(KEY = EXTPROC))
    )
    (DESCRIPTION =
      (ADDRESS = (PROTOCOL = TCP)(HOST = IOWACSVRSTLDB)(PORT = 1521))
    )
  )
```

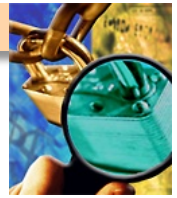
- sqlnet.ora file
  - TCP.VALIDNODE_CHECKING = yes
  - TCP.INVITED_NODES = list of accepted TCP/IP addresses
  - TCP.EXCLUDED_NODES = list of unallowed TCP/IP addresses

```
# sqlnet.ora Network Configuration File: C:\oracle\product\10.1.0\db_1
\NETWORK\ADMIN\sqlnet.ora
# Generated by Oracle configuration tools.

SQLNET.AUTHENTICATION_SERVICES= (NTS)

NAMES.DIRECTORY_PATH= (TNSNAMES, EZCONNECT)
```

Database Links and Remote Connections

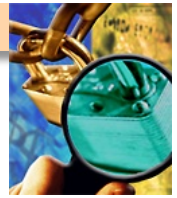
- Available for almost all databases
- Are they required for this database to operate?
- Ensure that the database object containing the link and password information is not accessible

Data Confidentiality



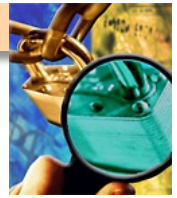
- Data in transit
  - Per default, database connections are not encrypted
  - Some vendors' encryption capabilities are add-on purchases and expensive
  - Consider encrypting JDBC connections
- Data at rest
  - Encryption of Personally Identifiable Information (PII) data in the database
  - Encryption of database data means
    - Examine any custom code used to encrypt data
    - Examine the encryption algorithms used and the implementation details
    - Some use Vormetric or Decru…issues with key management
  - Newer versions of Oracle and SQL Server offer data encryption

Data Integrity



- Assurance that data is consistent throughout various data operations
- Most guidance does not cover this aspect
- Application and business process dependent
- Highest levels of data integrity are in databases with rigid business process frameworks like Oracle Financials and SAP
- Both Oracle and SQL Server allow developers to wrap custom code
  - SQL Server – Encrypted Stored Procedures
  - Oracle – Database Source Code Object Encryption/Encoding

Auditing and Monitoring – A Sore Subject



- Auditing and Monitoring is resource intensive
  - Human resources
  - Computing resources
- Different audit settings for different databases
  - Audit the privileged and database users
  - Various level of audit settings
  - Location of audit data
    - Choice of OS, DB, extended, XML (Oracle)
    - Set audit destination (SQL Server)
  - Permissions on audit data files
- Most guidance is excessive – balance it with resources
- Frequently no auditing is performed at all
- Fine-grained auditing installed 90%, but only used 10% of time

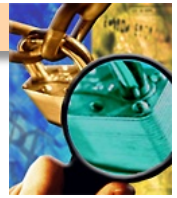
Backup and Recovery

- Main focus is on backup procedures
  - Poor OS permissions
  - “Cold” backup files – entire database at a point in time
  - “Hot” backup or archive log files – incremental data changes written to the redo logs
- Backup can also mean a quick export file, which may have World OS permissions
- Backup procedure usually involves
  - Oracle Recovery Manager (RMAN)
  - SQL Server Management Studio
  - Third-party backup tool

Overview of Oracle Testing

- Built-in users installed with excess privileges
- Default passwords and roles assigned to users
- Demo and sample schemas; well known passwords
- All or most users assigned to default tablespaces
- Users have SYSTEM tablespace assigned
- Every DBA uses SYSTEM or SYS account to manage database
- Database was not patched after installation
- Specific parameters left at default setting
- Default profiles used
- No or inadequate password management
- LISTENER has default port, name, and no security settings
- Audit not enabled

Overview of SQL Server Testing



- Big differences between SQL Server 2000, 2005, and 2008
- Built-in user account name left unchanged
- Guest User account enabled in database
- SA account password left null
- SYSADMIN fixed server role assigned to BUILTIN/ Administrators
- Fixed server and database roles used instead of custom roles
- Xp_cmdshell not removed
- Demo databases installed on the server
- DBMS object permissions granted to PUBLIC role
- SQL Server vs. Windows authentication
- Audit not enabled; audit flags not set

Questions