Secure Your Database in a Single Day

Arup Nanda

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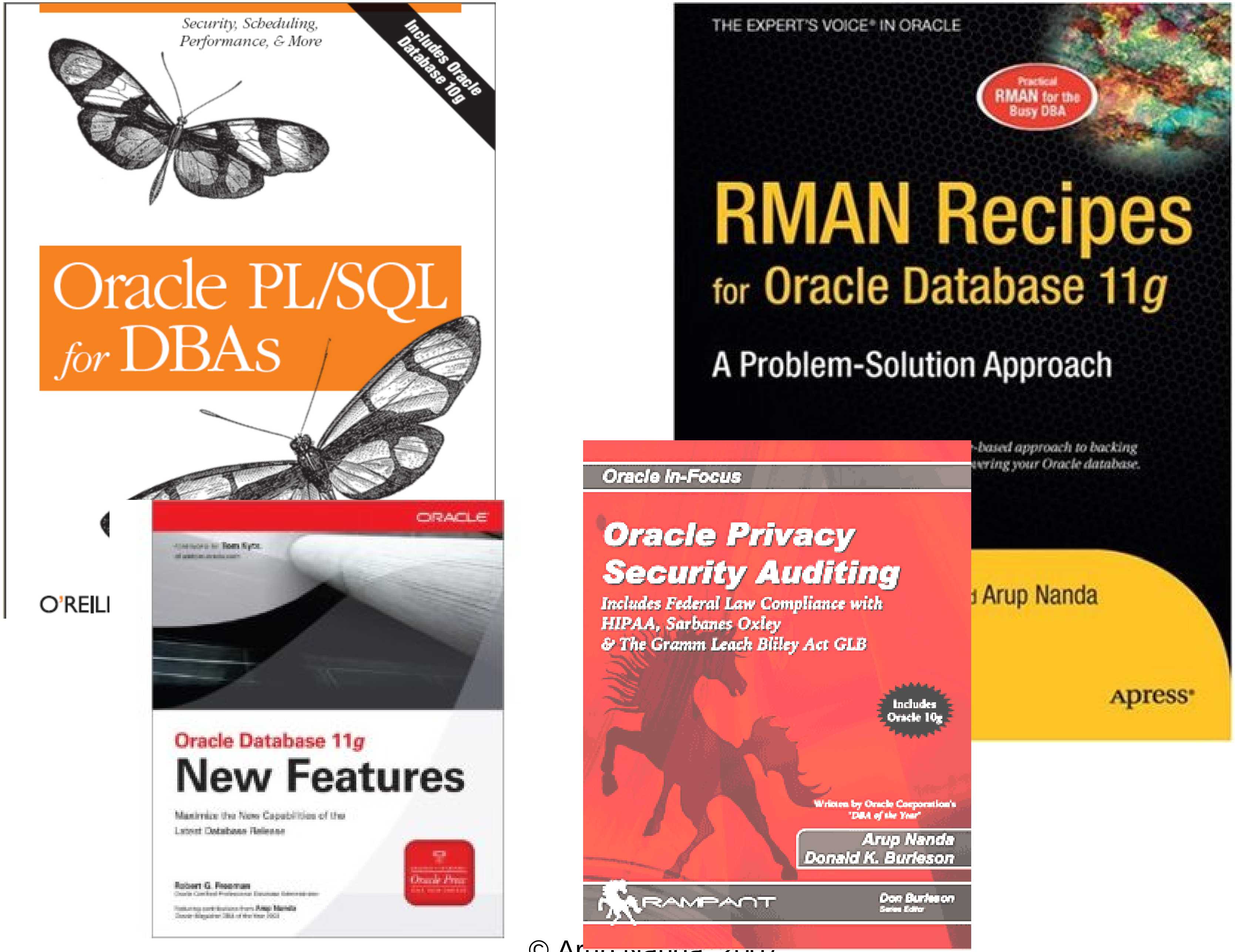
Who I Am

- An Oracle DBA for 14 years
- Lead DBA at Starwood Hotels
- Written some papers, speaks at conferences, three books
- Services – Security Audits, Security Preparedness, Backup Planning, RAC Setup, etc.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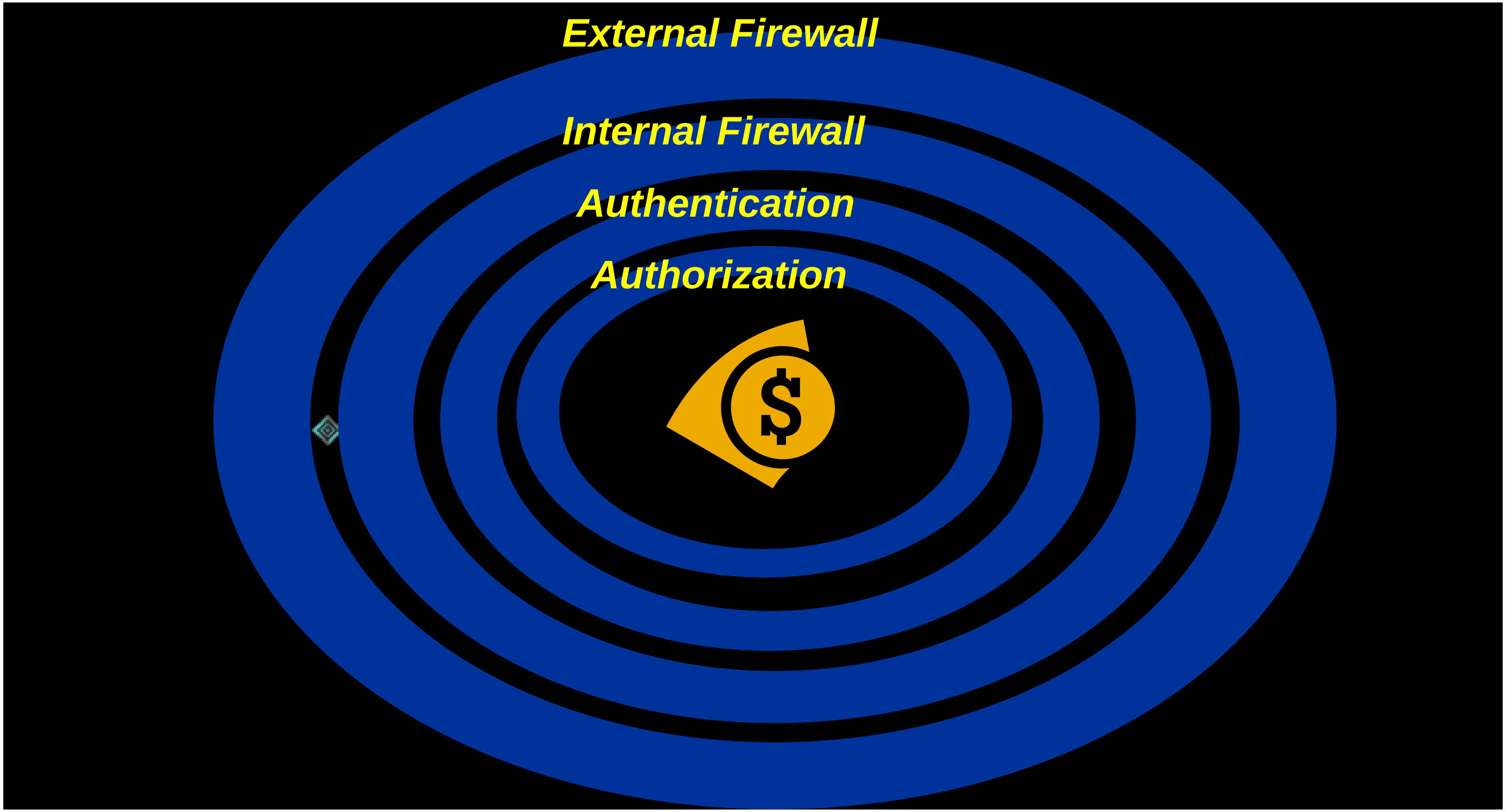
Why This Session

- Security is a often misunderstood area with a lot of "myths"
- Some examples:
  - Encryption is absolutely necessary
  - You should not use port 1521 for listener
  - Listener name should not be "LISTENER"
  - Database server must be behind a firewall
  - If you have a firewall, you don't need to worry
  - Any decent security implementation takes a long time and lot of effort (and money)

Security Must be Layered



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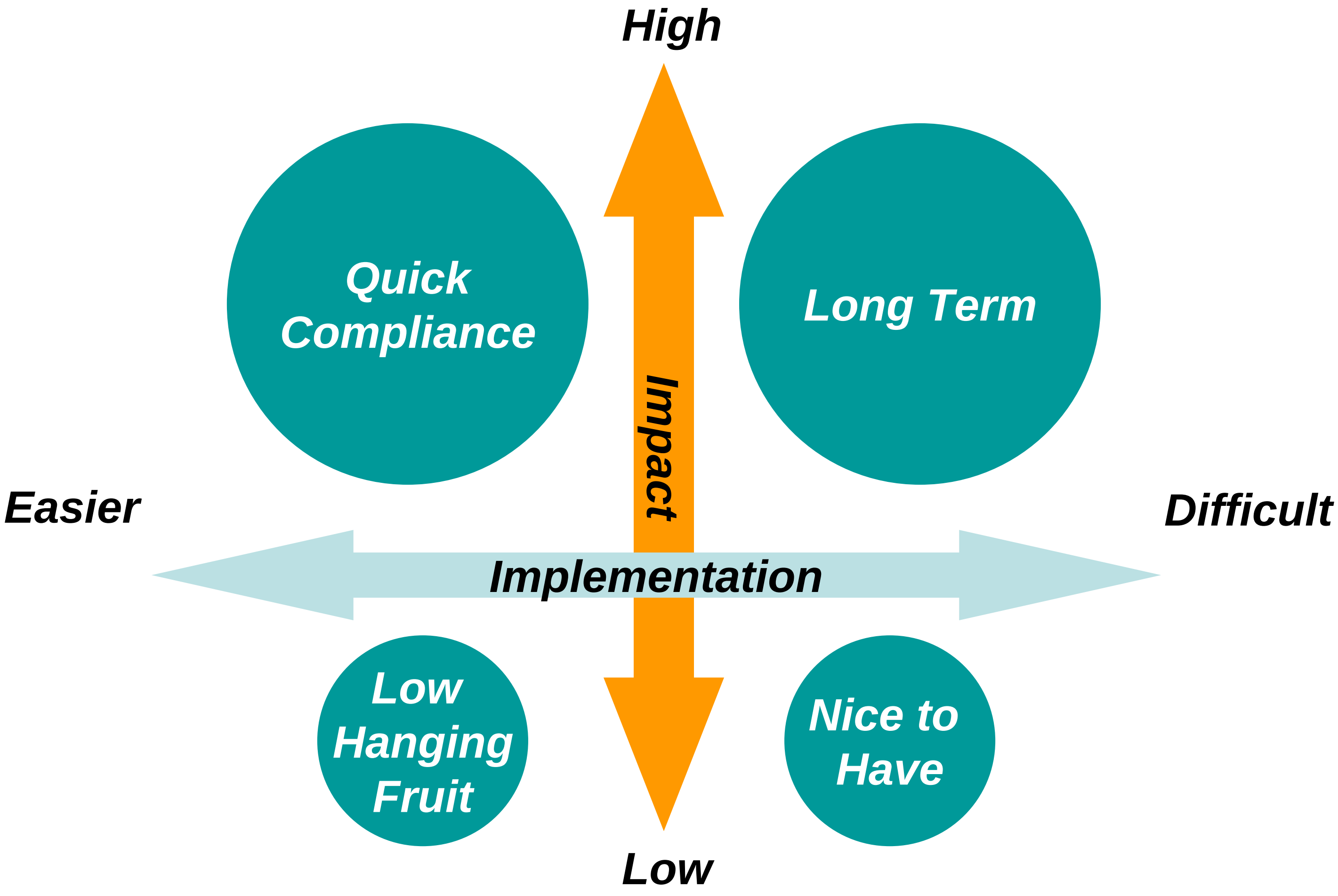
Plan of Attack



What You’ll Learn

- What you can do, in a single day
- 30 Carefully planned actions
- Addresses three Areas:
  - Identify and Seal Vulnerabilities
    - OS
    - Database
  - Build a Monitoring System
  - Enforce Change Control
- It will accomplish 60% of the compliance
- Each recommendation has – pros, cons and impact
- Take away scripts (please see the scripts.txt file or download from www.proligence.com)

Prelims

- Physical Security
  - Access control to the server
  - Authentication (unix userid password, etc.)
  - Surveillance and Auditing
  - OS Level Security – patches, unknown users, etc.
- Oracle specific
  - OS Vulnerabilities, including Listener
  - Database Vulnerabilities

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Protecting the Oracle Account

- Institute an indirect login policy
- All users directly logging in can be mapped to real persons
- `su – oracle`
- This leaves an audit trail of account logins

Listener Information

- Information from Listener

```
SERVICES
RAWMODE
```

- Remote Listener
  - – Place an entry in LISTENER.ORA

```
LSNRCTL> set current_listener ip_address
LSNRCTL> set RAWMODE on
LSNRCTL> services
```

Listener Denial of Service

- Stopping the Listener Maliciously
  - `LSNRCTL> stop`
  - `LSNRCTL> set startup_waittime 20`
    - This will prevent from accepting connections up to 20 seconds, enough time for the adversary to stop it.
- An attacker can loop through this logic to stop the listener forever.

Listener as a Launchpad

- Vandalism in redo log files
  - `LSNRCTL> set log_file dumb`
  - This command creates a file named `dumb.log`
  - `LSNRCTL> set log_directory ‘/tmp’`
- Hacker can use it to replace online redo log files by specifying the redo log directory and name.
- Best Practice: Do not use “log” as extension for Online Redo Logs; use “redo”, e.g. redo1.redo

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Prevention

- Disable Online Modification
  - ADMIN_RESTRICTIONS_<***ListenerName***> = ON
  - This will force values to be changed in LISTENER.ORA and then listener reloaded.
- Set a password

```
LSNRCTL> change_password
LSNRCTL> save_config
```

Oracle 10g Issues

- Listener Protection is in 2 ways:
  - OS Authentication
  - Password
- Disable OS Authentication
  - Undocumented parameter in listener.ora
  - `LOCAL_OS_AUTHENTICATION_`*<ListenerName>* `= OFF`

Ramifications

- Password required for all key listener operations but not to startup
- Enterprise Manager Grid Control will fail to identify the Listener. Solution: create the listener using GC.
- Oracle Real Application Cluster (RAC) CRS does not know the password. So it will report the listener as offline.

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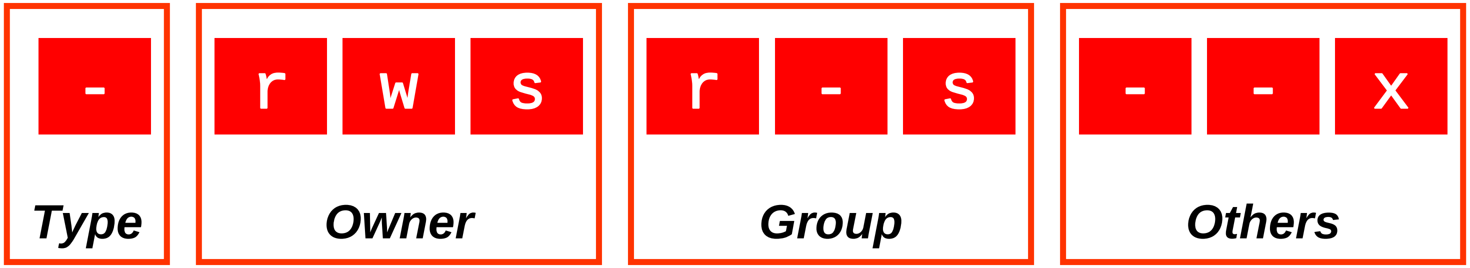
Permissions Issues

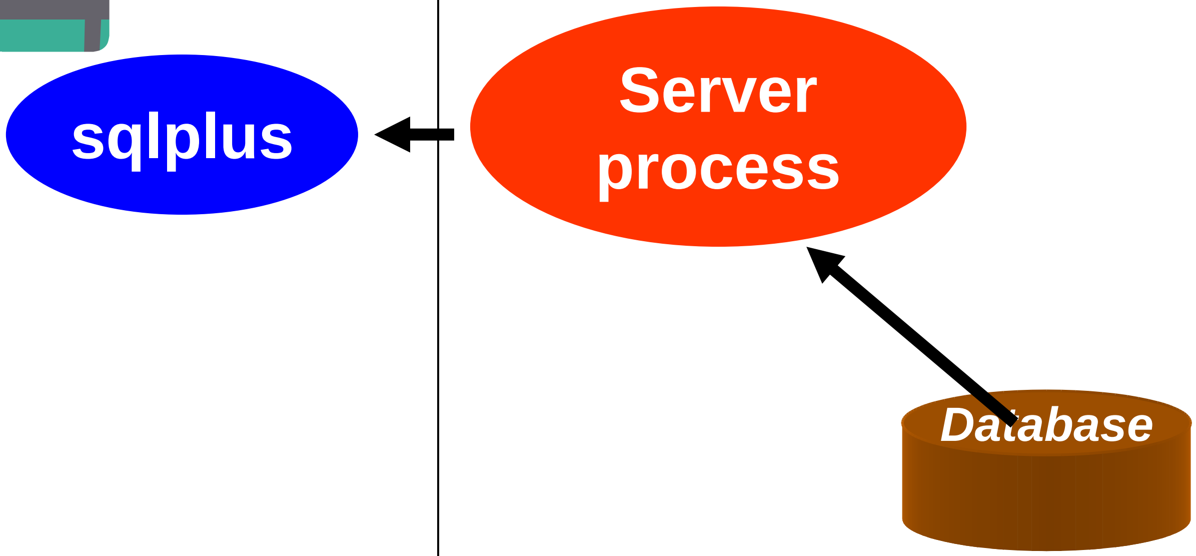
- The “oracle” executable

```
$ ls -l oracle
-rwsr-s--x 1 oracle oinstall 69344968 Jun 10 14:05 oracle
```



ananda: `sqlplus scott/tiger`

Two Task Architecture



Running under ANANDA

Running under ORACLE

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Server Process

```
$ sqlplus scott/tiger
$ ps -aef|grep sqlplus
ananda  6339  6185  0 13:06 pts/0     00:00:00
   sqlplus
$ ps -aef|grep 6339
ananda  6339  6185  0 13:06 pts/0     00:00:00
   sqlplus
oracle    6340  6339  0 13:06 ?         00:00:00
   oraclePRODB1
   (DESCRIPTION=(LOCAL=YES)(ADDRESS=(PROTOCOL=beq)))
```

Client Process

Server Process

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Change Permission

- Remove SUID

```
$ chmod 0700 $ORACLE_HOME/bin/oracle
```

- New Permissions

```
-rwx------   1 oracle    oinstall   248754168 Oct
  8 07:11 oracle
```

- Test

```
$ sqlplus scott/tiger
```

The user will immediately get an error.

```
ERROR:
ORA-12546: TNS:permission denied
```

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Fix

- Add in TNSNAMES.ORA

```
PRODB2 =
  (DESCRIPTION =
    (ADDRESS_LIST =
      (ADDRESS = (PROTOCOL = TCP)
      (HOST = prolin2)(PORT = 1521))
    )
    (CONNECT_DATA =(SERVICE_NAME = PRODB2))
  )
```

- `$ sqlplus scott/tiger@prodb2`

- Install a new Oracle Home for the clients and let then use the SQLPLUS there. This OH is owned by apps group.

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Other Executables

- Find them:

```
find . -type f \( -perm -2000 -o -perm -4000 \) -exec ls -l {} \;
```

  - oracle0. chown 0000
  - oradism
  - emtgtctl2 – EM Agent. chown 0700
  - nmb – Grid Control Agent
  - nmo - Grid Control Agent
  - extjob and extjob0 – 0700

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Other Executables

- **DBSNMP**

  ```
  -rwsr-s---   1 root  dba 2986836 Jan 26  2005 dbsnmp
  ```

  – Change it.

  ```
  chown oracle:dba dbsnmp
  chmod 0700 dbsnmp
  ```

- lsnrctl and (lsnrctl0) and tnslsnr (and tnslsnr0)

  $ ls -l *lsnr*

  ```
  -rwxr-x--x 1 oracle oinstall 214720 Oct 25 01:23
    lsnrctl
  -rwxr-x--x 1 oracle oinstall 1118816 Oct 25 01:23
    tnslsnr
  ```

- Change them:

  ```
  $ chmod 700 lsnrctl tnslsnr
  $ chmod 000 lsnrctl0 tnslsnr0
  ```

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Configuration File Perms

- No Oracle Configuration file should have any privilege to others

```
-rwxr-xr-x   1 orandsp    oinstall       779 Jun 16
  03:59 listener.ora
```

- No need to have read and execute permissions to `listener.ora`. Password can be made visible.
- Change permissions of listener.ora, init.ora
- Do not change: `sqlnet.ora` and `tnsnames.ora`

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External Procedure

- Entry in listener.ora

```
 (ADDRESS_LIST =
    (ADDRESS = (PROTOCOL = IPC)
               (KEY = EXTPROC))
```

- The user executes a program ***as the user oracle!***
  - Can delete data files, steals data, and so on
- Solutions:
  - Remove the lines
  - Move it to a different listener
  - Separate it to different listener.ora file

Separate Listener

```
LISTENER =
  (DESCRIPTION_LIST =
    (DESCRIPTION =
      (ADDRESS_LIST =
        (ADDRESS = (PROTOCOL = IPC)(KEY =
    EXTPROC))
      )
      (ADDRESS_LIST =
        (ADDRESS = (PROTOCOL = TCP)(HOST =
    ANANDA)(
                   PORT = 1521))
      )
      (ADDRESS_LIST =
        (ADDRESS = (PROTOCOL = IPC)(KEY=ANANDA))
      )
    )
  )
SID_LIST_LISTENER =
  (SID_LIST =
    (SID_DESC =
      (SID_NAME = PLSExtProc)
      (ORACLE_HOME = d:\ora9)
      (PROGRAM = extproc)
    )
    (SID_DESC =
      (GLOBAL_DBNAME = ANANDA)
      (ORACLE_HOME = d:\ora9)
      (SID_NAME = ANANDA)
    )
  )
```

```
LISTENER =
  (DESCRIPTION_LIST =
    (DESCRIPTION =
      (ADDRESS_LIST =
        (ADDRESS = (PROTOCOL = TCP)(HOST =
ANANDA)(PORT = 1521))
      )
      (ADDRESS_LIST =
        (ADDRESS = (PROTOCOL = IPC)(KEY=ANANDA))
      )
    )
  )
LISTENER_EXTPROC =
  (DESCRIPTION_LIST =
    (DESCRIPTION =
      (ADDRESS_LIST =
        (ADDRESS = (PROTOCOL =
IPC)(KEY=EXTPROC))
      )
    )
  )
SID_LIST_LISTENER =
   (SID_LIST =
      (SID_DESC =
         (GLOBAL_DBNAME = ANANDA)
         (ORACLE_HOME = d:\ora9)
         (SID_NAME = ANANDA)
      )
   )
SID_LIST_LISTENER_EXTPROC =
   (SID_LIST =
      (SID_DESC =
         (SID_NAME = PLSExtProc)
         (ORACLE_HOME = d:\ora9)
         (PROGRAM = extproc)
      )
      )
```

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Hiding Passwords

- `sqlplus scott/tiger @myscript`
- `sqlplus scott/$SCOTTPASS @myscript`
- Option 1:
  - `sqlplus /nolog @myscript`
  - *(Inside myscript)* `connect scott/tiger`
- Option 2:

```
sqlplus /nolog << EOF
connect scott/tiger
EOF
```

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Password File

- Create a passwords file “.passwords”

```
scott tiger
arup aruppass
```

- Create a shell script “.getpass.sh”

```
fgrep $1 $HOME/tools/.passwords | cut -d
  " " -f2
```

- Use it in scripts

```
.getpass.sh scott | sqlplus –s scott
  @script.sql
```

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Other Options

- Use DBMS_JOB or DBMS_SCHEDULER
  - No password is ever entered or displayed
  - Jobs start only when the database is up
- Use OPS$ Accounts

```
SQL> create user OPS$SCOTT identified externally;
$ su – scott
$ sqlplus /
```

- In RMAN scripts

```
Old:  rman target=/ rcvcat=u/p@catdb
New:  rman target=/
      connect catalog u/p@catdb
```

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Users with Default Passwords

- About Oracle Passwords
  - PASSWORD in DBA_USERS is a hash value of the combined value of USERID and PASSWORD.
  - So even if two users have the same password, the hash value will be different.

UserID	***Password***	***Password Hash***
ABC	DEF	016811C1486D026B
ABCD	EF	016811C1486D026B

In Oracle 11g, a new view DBA_USERS_WITH_DEFPWD shows users with default passwords.

Identify Default Passwords

Create a table to hold the passwords. Script: cr_osp_acounts.sql

```
CREATE TABLE OSP_ACCOUNTS
(
   product         VARCHAR2(30),
   security_level  NUMBER(1),
   username        VARCHAR2(30),
   password        VARCHAR2(30),
   hash_value      VARCHAR2(30),
   commentary      VARCHAR2(200)
);
```

Download the scripts from http://www.petefinnigan.com/default/osp_accounts_public.zip

Script: osp_install_data.sql

Then execute script get_def_pwd.sql

```
col password format a20
col account_status format a20
col username format a15
select o.username, o.password, d.account_status
from dba_users d, osp_accounts o
where o.hash_value = d.password;
```

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Trim Privileges

- “Sweeping” Privileges
- “ANY” privileges,
  - `CREATE ANY TABLE/PROCEDURE/INDEX, etc.`
  - `RESTRICTED SESSION`
  - `SELECT ANY TABLE`
  - `SELECT ANY DICTIONARY`
  - `UNLIMITED TABLESPACE`
  - Script sweeping.sql

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Seemingly Innocuous Privileges

- SCOTT needs to use these statements in a regular day’s work:
  - alter session set query_rewrite_enabled = true
  - alter session set optimizer_mode = …
  - alter session set sort_area_size = …
- Does SCOTT need ALTER SESSION privilege?
- NO! Alter Session System Privilege
  - is ***not*** required to change session params
  - Only required for I/O operations, e.g. trace file
  - Script – alter_sess_grantees.sql

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Other Dangerous Privs

- Create ANY Directory
  - can create a directory on any directory owned by Oracle user, incl. datafiles.
- Create ANY Trigger
  - can create triggers on any schema to capture sensitive data during insert/update
- Create Database Link

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Dangerous Supplied Packages

- UTL_TCP
  - Main attack vehicle for the “Voyager” worm!
- DBMS_SCHEDULER
  - Can cause DoS attacks by calling the executables
- DBMS_JAVA
  - Can cause system hijacking by calling java programs to execute with oracle’s OS privs
- UTL_FILE
  - Can open/close files, even if controlled.
- DBMS_ASSERT
  - Can be used by hackers to make a user the DBA

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UTL_FILE_DIR

- Is it set to “*”?
  - Then someone can write a PL/SQL program to read (and *WRITE*!) ***any*** file owned by oracle, including data files, archived log files, etc.
- Use DIRECTORY objects, instead.

```
SQL> create directory MYDIR as ‘/u10/mydir’;
utl_file.fopen (‘MYDIR','myfile.txt','W')
```

- Revoke CREATE ANY DIRECTORY from PUBLIC
- Log Miner Dictionary File creation still needs this!

```
utl_file_dir = ‘/tmp’
```

- Database restart required.

OS Authentication

- OS Authenticated Users

  ```
  create user OPS$JOHNUNIX
  identified externally;
  $ sqlplus /
  ```

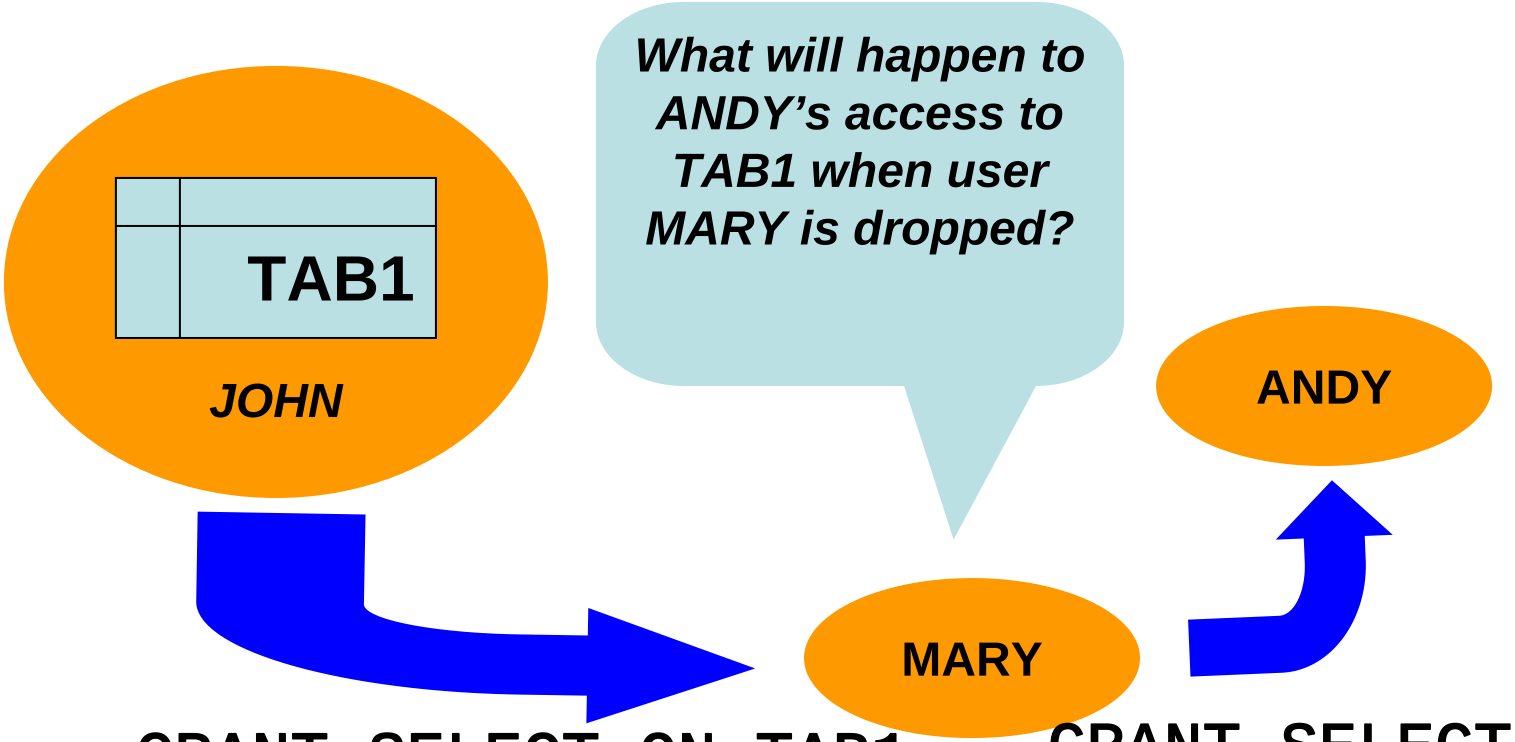
- Initialization Parameter Controls the Prefix

  ```
  os_authent_prefix = ‘OPS$’
  ```

- Dual Authentication

  ```
  create user OPS$JOHNUNIX identified by
    JOHNPASS;
  $ sqlplus ops$johnunix/johnpass -> not johnunix
  $ sqlplus / -> johnunix
  ```

Indirect Grants



TAB1

JOHN

What will happen to ANDY's access to TAB1 when user MARY is dropped?

ANDY

MARY

```
GRANT SELECT ON TAB1
TO MARY
WITH GRANT OPTION;
```

```
GRANT SELECT ON
JOHN.TAB1
TO ANDY;
```

script ind_demo.sql

Effect of Indirect Grants

- Different Syntax for Different Privileges
  - System Privileges

    ```
    grant create trigger to mary with
      admin option;
    ```

  - Object Privlileges

    ```
    grant select on tab1 to mary with
      grant option;
    ```

- If mary grants these two privileges to andy, and then mary is dropped, andy will:
  - Lose the object privileges
  - Retain the system privilege

Identify Indirect Grants

- Use script indirect_grants.sql

```
select grantee, privilege, owner,
  table_name
from dba_tab_privs
where grantor != owner;
```

Identifying Grantable Grants

Script grantable_privs_obj.sql

```
select grantee, owner, table_name,
  privilege, grantor
from dba_tab_privs
where grantable = 'YES'
and grantee != 'SYS‘;
```

Script grantable_privs_sys.sql

```
select grantee, privilege
from dba_sys_privs
where admin_option = 'YES'
and grantee not in ('SYS','DBA')
order by 1,2;
```

Simple Audit

- As a best practice, always set the database parameter AUDIT_TRAIL to DB_EXTENDED or at least DB, even if you do not want to audit anything yet.
- Oracle 11g already has it
- Objective:
  - Which user connected, OS User
  - Other details – terminal, (dis)connection time, etc.
- Auditing is expensive; so start small: `audit session`

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Reporting

- Use this for reporting

```
select
    to_char(timestamp,'mm/dd/yy hh24:mi:ss') li,
    username,
    os_username,
    userhost,
    terminal,
    to_char(logoff_time,'mm/dd/yy hh24:mi:ss') lo
from dba_audit_trail
where logoff_time is not null;
```

- Shows who, OS user, terminal, time of login and logout

Simple_audit.sql

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Use of Simple Auditing

- Build a profile of database access
  - Which users connect, how often
  - Where they connect from, how frequently
  - How many app servers are present
  - Who is a heavy-hitter
- Prepare a Baseline
- Check regularly against the baseline to see patterns

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Identify Access Violations

- Who tried but was not successful

```
select username, os_username, terminal,
  userhost,
to_char(timestamp,'mm/dd/yy hh24:mi:ss')
  logon_ts
from dba_audit_trail
where returncode = 1017;
```

Unsucc.sql

- Was someone trying to "guess" userids?

```
select username from dba_audit_trail
where returncode = 1017
minus
select username from dba_users;
```

Wrong.sql

Fringe Benefits

- CPU and IO Usage
  - Useful for Resource Manager/Profiles
  - Diagnosis of past performance issues
  - Capacity Planning

```
select username, to_char(logoff_time,'mm/dd') ts,
   count(1) cnt,
   sum(session_cpu) sum_cpu,
   avg(session_cpu) avg_cpu,
   min(session_cpu) min_cpu,
   max(session_cpu) max_cpu
from dba_audit_trail
group by username, to_char(logoff_time,'mm/dd')
order by username, to_char(logoff_time,'mm/dd')
```

Audcpu.sql

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Auditing on Objects

- By Access
  - `audit select on ccmaster.credit_cards by access;`
  - One record per access
- By Session
  - `audit select on ccmaster.credit_cards by session;`
  - One record per session

Object Audit by Session

```
select username, timestamp, ses_actions
from dba_audit_trail
where obj_name = 'CREDIT_CARDS'
and action_name = 'SESSION REC';

USERNAME                TIMESTAMP SES_ACTIONS
----------------------- --------- ----------------
ARUP                    16-JAN-06 ---------S------
```

sessaud.sql

SES_ACTIONS

Position	***Action***
1	**Alter**
2	**Audit**
3	**Comment**
4	**Delete**
5	**Grant**
6	**Index**
7	**Insert**
8	**Lock**
9	**Rename**
10	**Select**
11	**Update**
12	**References**
13	**Execute**
14	**Not used**
15	**Not used**
16	**Not used**

S – *for Success*; F – *for Failure* and B – *for Both*

Object Auditing by Access

```
select to_char(timestamp,’mm/dd/yy hh24:mi:ss’) ts,
       username, userhost, action_name
from dba_audit_trail
where owner = 'CCMASTER'
and obj_name = 'CREDIT_CARDS';

TS                 USERNAME   USERHOST    ACTION_NAM
----------------- ---------- ----------- ----------
01/16/06 00:27:44 ARUP       prolin1         SELECT
01/16/06 11:03:24 ARUP       prolin1         UPDATE
01/16/06 12:34:00 ARUP       prolin1         SELECT
```

accaud.sql

Thoughts on Auditing Use

- Set the initialization parameter `audit_trail = db` or `db_extended`
- Start with BY SESSION, dig deeper into BY ACCESS later
- Find attempted break-ins by auditing for unsuccessful attempts:
  - `audit select on CCMASTER.CREDIT_CARDS by session whenever not successful;`

Control Schema Changes

- Problem:
  - ACCMAN; main schema. password known to the application group
  - ACCAPP: the user that connects to the database.
  - How do you ensure that the DDL changes are in tune with the Change Management Process?
- Solution:
  - Release Manager: Unlocks “something”
  - App DBA/Developer: Makes the DDL change
  - Release Manager: Locks “it”; no DDL allowed

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Release Management

DDL Triggers lock_alter.sql

```
create or replace trigger lock_alter
before ddl
on accman.schema
begin
   if (
      ora_dict_obj_name = 'IMPORTANT_PROC'
      and
      ora_sysevent = 'CREATE'
   )
   then
      raise_application_error
         (-20001,'Can''t Alter '||ora_dict_obj_name);
   end if;
end;
```

“Unlock” `: alter trigger lock_alter disable;`

alter_imp_proc.sql

Listener Log Monitoring

- Listener Log records the connections from
- For a complete description, including code and examples, see:

  http://www.dbazine.com/oracle/or-articles/nanda14

Plan

- Make listener changes
- Reload listener to take effect
- Make all nonrequired binary changes
- Make all binary permission changes
- Make the changes to the INIT.ORA params
- Recycle the database
- Remove Sweeping Privileges
- Remove Execute Privileges from PUBLIC

Thank You!

Download Scripts, Presentations from

http://www.proligence.com

Questions?