Oracle Database Links Master Class Part 1

Written and presented
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About Me

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- Application Development and Support 1976 to 1982
- Software Development and Consultancy 1983 to 1986
- IT Training Mainframe Technology 1986 to 1993
- Oracle Support 1994 to 1996
- Oracle University 1997 to Present
- OCP DBA 1997 to Present - Releases 7.3 to 11g
- Oracle 9i OCM DBA from 2002 10g from 2006
- DBA Curriculum Delivery: Basic, Advanced, DSI
- Global DBA Certification Development Team Leader
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Mini-Lesson Objectives

- Database Links Defined
- Globally Unique Object Names
- Database Links Description
- Creating and Managing Database Links
- Global Database Naming
- Database Link Initialisation Parameters
- Dictionary and Dynamic Performance Views
- Statistics, Wait Events and Database Links
- Common Errors Using Database Links
- Remote Access Management
- Location Transparency

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Database Links Defined

A Database Link is:

- A Pointer from one DB to another
- Stored in the Data Dictionary
- Is a “Uni-Directional” Resource Definition
- DB Links between different versions of Oracle must be supported based on the client-server Interoperability matrix. See note 207303.1
- Is Used by Streams,Replication,DB Cloning and Data Guard

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Database Links Categories

Database Links have three main Dimensions:

- Ownership
  - Private
  - Public
  - Global
- Security Context
  - Fixed User
  - Connected User
  - Current User
- Sharing
  - Shared
  - Non-shared

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Database Link Ownership

- Private
- Public
- Global
- They may be used in combination at times

Creating Private Database Links

- Create a private link that will use the connect string 'SALESDW':

```
CREATE DATABASE LINK SALESDW.MYCO.COM
CONNECT TO SH IDENTIFIED BY SH USING
'SALESDW_MYCO';
```

- To use the Link:

```
SELECT * FROM
SH.SALES@SALESDW.MYCO.COM;
```

Private Database Link Usage

- Private Database Links are created in one's own schema
- Are visible in `USER_DB_LINKS` view
- "`OWNER`" column in `DBA_DB_LINKS` and `ALL_DB_LINKS` views will have username
- May be used only by the link owner
- May be used with a Public Link of the same name for maintenance reasons
- The "`USING`" clause and a corresponding `TNSNAMES.ORA` entry are required
- Requires the "`CREATE DATABASE LINK`" system privilege

Creating Public Database Links

```
CREATE PUBLIC DATABASE LINK SALESDW.MYCO.COM
USING 'SALESDW_MYCO';
```

- To use the Link:

```
SELECT * FROM
SH.SALES@SALESDW.MYCO.COM;
```

Public Database Link Usage

- Public Database Links are on the public "schema"
- Are visible in `ALL_DB_LINKS` view
- "`OWNER`" column in `DBA_DB_LINKS` and `ALL_DB_LINKS` views will be "`PUBLIC`"
- May be used by any user
- The "`USING`" clause and a corresponding `TNSNAMES.ORA` entry are optional but often used
- May have same name as a private link to separate the Network details fro the security details easing administration
- Requires the "`CREATE PUBLIC DATABASE LINK`" system privilege

Resolving Database Link Names

```
CREATE PUBLIC DATABASE LINK SALESDW.MYCO.COM
USING 'SALESDW_MYCO';
```

```
CREATE DATABASE LINK SALESDW.MYCO.COM
CONNECT TO SH IDENTIFIED BY SH;
```

- **What happens when the public and private link share the same name?**
- **Eases Administration when many private links connect to same remote database**

Global Database Links

- Are defined with the same attributes as a Private or Public Database Link
- Are used in the same way as Private or Public links
- Name Resolution provided by an OID Name Server or Oracle Name Server in Older releases
- See Net Services Administrators Guide for details on creating entries to act as Global Database Links

Database Link Security Context

- Public and Private Database Links have one of three security contexts:
  - Fixed user
  - Connected user
  - Current user
- Context chosen may depend on:
  - Third Party Package Requirement
  - Home Grown Security needs
  - Security Admin specifications
  - B2B requirements

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Fixed User Database Links

- To create a link for a fixed user, include the username and password in the link.
- Private DB Links are often Fixed-User Links
- The "`USING`" clause may be omitted if a Public Database Link with the same name exists

```
CREATE DATABASE LINK SALESDW.MYCO.COM
CONNECT TO SH IDENTIFIED BY
SH USING 'SALESDW_MYCO';
```

Connected User Database Links

- User SH connects to a local database:

```
SQL> CONNECT SH/SH
```

- SH invokes an application which uses a public or private dblink without the "CONNECT TO" clause to connect to a remote database:

```
CREATE DATABASE LINK SALESDW.MYCO.COM USING
'SALESDW_MYCO';
```

```
SQL> SELECT * FROM SALES@SALESDW.MYCO.COM;
```

Current User Database Links

- User SH connects to a local database:

```
SQL> CONNECT SH/SH
```

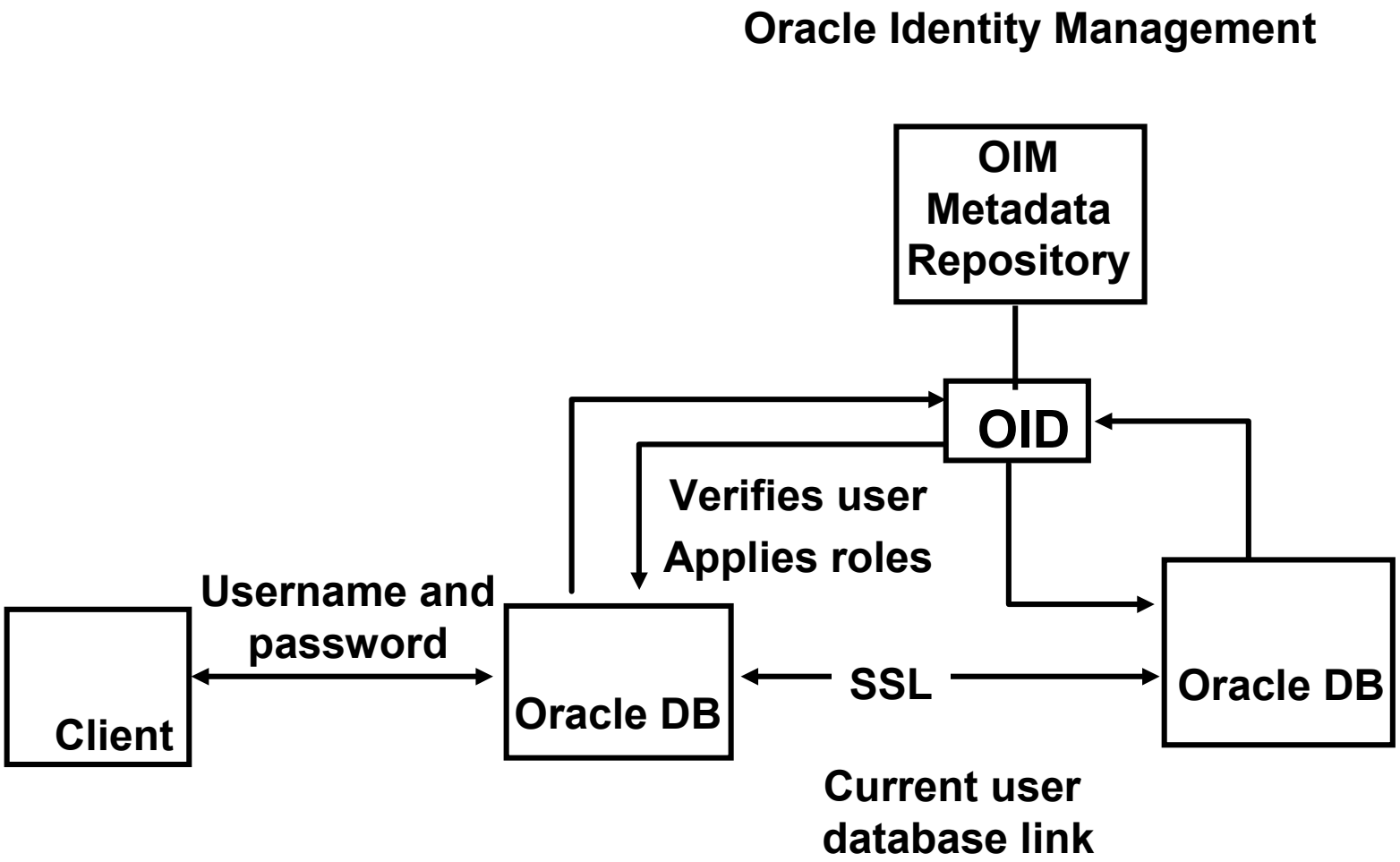
- SH invokes an application which uses a public or private dblink with the "`CONNECT TO CURRENT USER`" clause to execute a procedure on the remote database instance:

```
CREATE DATABASE LINK SALESDW.MYCO.COM CONNECT
TO CURRENT_USER USING 'SALESDW_MYCO';
```

```
SQL> EXECUTE HR.HIRE_EMP@SALESDW.MYCO.COM;
```

- Requires ASO

Current User Database Links



ASO and Current User Database Links

- Local and remote databases must have global schemas
  - Local Schema must be exclusive
  - Remote schema may be exclusive or shared
- Enterprise users must be mapped to the global schemas
- Secure Connection required between the Databases
- See Details in Note 264872.1

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Database Link Sharing

- Non-Shared Database Links
- Shared Database Links
- Network Connections

Non-shared Database Links

- Use Private links in single-user situations
- Prevents many or all shared server sessions creating connections to the remote server on behalf of the same user

```
CREATE DATABASE LINK
SALESDW.MYCO.COM
CONNECT TO SH IDENTIFIED BY SH
USING 'SALESDW_MYCO';
```

Shared Database Links

- Reduces Number of network connections
- Works with Dedicated and Shared Server
- "`AUTHENTICATED BY`" user must be defined on remote database and have `CREATE SESSSION` privs
- Link may be public or private

```
CREATE SHARED [PUBLIC] DATABASE LINK

SALESDW.MYCO.COM

[CONNECT TO [SH IDENTIFIED BY SH] |
[CURRENT_USER]]

AUTHENTICATED BY SHARED_GUEST

IDENTIFIED BY JOEL

[USING 'SALESDW_MYCO'];
```

Effect of Shared Database Links

- Using Non-Shared Database Links
  - 100 local sessions for any users each connecting to a remote database requires 100 connections to the remote database for the open dblinks. Local connections may be Dedicated or Shared Server.
- Using Shared Database Links
  - With Shared Server – If 10 local Shared Server processes exist and 100 local sessions login, each connecting to a remote database, then only 10 direct network connections are needed locally and 10 to the remote database for the open links.
  - With Dedicated Server -If 10 local clients connect 10 times each to local Dedicated Servers thereby creating 100 local sessions, and each session references the same remote database, then only 10 connections are needed to the remote database for the open links.

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Guidelines for Shared Database Links

- Shared dblinks use more network connections when many or all local logins use the same username
- Use shared dblinks when many local users need to use the same link or when the number of local users accessing a database link is expected to be much *larger* than the number of shared servers in the local database
- Often shared db links are used for public database links, but may also be used for private database links when many clients access the same local schema and therefore the same private dblink
- The "`AUTHENTICATED BY`" user must exist in the remote database and be granted `CREATE SESSION` privilege. This protects the remote shared server process which keeps the original "connected user" session open until another local user reuses the shared link. The authenticated user remains the same throughout providing guaranteed authentication to use the link.

Multiple Database Links with Connection Qualifiers

- Use Qualifiers for specific RAC Instances for Streams
- Use also for different protocols

```
CREATE PUBLIC DATABASE LINK
SALESDW.MYCO.COM@INST1
USING 'SALESDW_MYCO_I1';
```

```
CREATE PUBLIC DATABASE LINK
SALESDW.MYCO.COM@INST2
USING 'SALESDW_MYCO_I2';
```

Database Links and Global Naming

SELECT * FROM SALES_HST@SALESDW????

Defining Global Names

Global database names:

- If `global_names = TRUE` on the local database, then the database link name must match the `global_name` of the remote database thereby enforcing unique dblink names otherwise:
  - `ORA-02085: database link <name> connects to <database name>`
- To view a database's global name, query the data dictionary view `GLOBAL_NAME`
- Set `GLOBAL_NAME` as follows:

```
SQL> Alter database rename global_name
        to "salesdw.uk.com";
```

- Uses Hierarchical domain naming model based on `DB_NAME` and `DB_DOMAIN` Parameters

Globally Unique Object Names

- Unique object names comprise a:
  - Schema name
  - Object name
  - Global Database Name
- Reference to a Globally unique object may be explicit or use a public or private synonym.
- Synonyms provide Location transparency

Using Synonyms and DB Links

- Synonyms may be used for
  - Tables, Views and Mviews
  - Procedures, Functions and Packages
  - Sequences and Operators
  - Object Types and Java Class Objects
  - Other Synonyms
- Synonyms for remote functions or procedures must specify the “schema owner” in the “for clause”
- Synonyms for other objects may omit the “schema owner” in which case it defaults to the schema of the session on the remote instance.

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Closing Database Links

- Close Database links for a session when:
  - The user session must be terminated
  - The network connection established by the link is used infrequently in the application or no longer required
- Max open links per session is controlled by:
  - `OPEN_LINKS`
  - `OPEN_LINKS_PER_INSTANCE`
- Session's Open Links seen in `V$DBLINK`
- Close Open Links with idle time in profile or:

```
ALTER SESSION CLOSE DATABASE LINK "name";
```

```
DBMS_SESSION.CLOSE_DATABASE_LINK(<name>);
```

Closing Database Links

- Closing Links may not be done in mid transaction
  - Results in "ORA-02080 database link is in use"
- Queries will open transactions and are visible in
  - `V$GLOBAL_TRANSACTION`
  - `V$TRANSACTION`
- Use `COMMIT` to close transactions when updates have been done
- Use `ROLLBACK` or `COMMIT` for Queries
- If not done may cause Undo Segment problems

Dropping Database Links

- Drop a Database Link when the application no longer requires it.
- Redefine a link when:
  - Security breaches demand it
  - Physical databases must be moved
  - Network protocols change
  - Node names change

```
DROP DATABASE LINK "linkname";
```

```
DROP PUBLIC DATABASE LINK linkname;
```

Database Link Parameters

- **GLOBAL_NAMES**
- **OPEN_LINKS**

GLOBAL_NAMES Parameter

- Specifies if a DB link must have the same name as the database to which it connects
- Value may be TRUE or FALSE
- If set to TRUE on the Local Database Instance then a Database Link name used must match the Global Name of the Remote Database at the time the link is used.
- May require DB Link Qualifiers to avoid duplicate names
- Permits consistent naming conventions for databases and links in your Oracle network
- Is Session and System Modifiable

`OPEN_LINKS` Parameter

- Specifies the maximum number of concurrent open connections to remote databases from one session in a instance.
- Includes
  - External Callouts
  - Cartridges
- Value is numeric from 0 to 255
- Is not Modifiable
- Connection closes when:
  - Session Ends
  - Explicitly closed using "`ALTER SESSION CLOSE DATABASE LINK`"

Database Link Views

- DBA_DB_LINKS
- USER_DB_LINKS
- ALL_DB_LINKS
- DBA_SYNONYMS
- USER_SYNONYMS
- ALL_SYNONYMS
- V$DBLINK
- GV$DBLINK

Data Dictionary Views

- DBA_DB_LINKS - All Links in the Database
- ALL_DB_LINKS – DB Links accessible to current user

Columns	Description
OWNER	Owner of the database link
DB_LINK	Link Name
USERNAME	User logging into remote db
HOST	Oracle Net Connect String
CREATED	Date Created

Data Dictionary Views

- USER_DB_LINKS – Links owned by current user

Columns	Description
DB_LINK	Link Name
USERNAME	User logging into remote db
PASSWORD	Null (backward compatibility)
HOST	Oracle Net Connect String
CREATED	Date Created

Querying Database Links

```
SQL> SELECT
  2     db_link,
  3     owner,
  4     nvl(username, '**********') username,
  5     host,
  6     TO_CHAR(created, 'DD-Mon-YYYY HH24:MI:SS') created
  7  FROM
  8     dba_db_links
  9  ORDER BY
 10     host, owner, db_link;
```

```
DB Link            Owner    User     Host               Created
----------------- -------- -------- ----------------- --------------------
db1.UK.ORACLE.COM PUBLIC   ******** db1.UK.oracle.com 03-Jan-2009 09:49:30
db3.UK.ORACLE.COM PUBLIC   ******** db3.UK.oracle.com 10-Jan-2009 09:52:18
db2.UK.ORACLE.COM PUBLIC   ******** db2.UK.oracle.com 06-Jan-2009 16:24:09
db1.UK.ORACLE.COM ADMINDBS ADMINDBS                   10-Jan-2009 10:00:16
db3.UK.ORACLE.COM ADMINDBS ADMINDBS                   10-Jan-2009 09:54:16
db2.UK.ORACLE.COM ADMINDBS ADMINDBS                   10-Jan-2009 10:00:06
db1.UK.ORACLE.COM ADMINDB1 ADMINDB1                   03-Jan-2009 09:50:26
db3.UK.ORACLE.COM ADMINDB1 ADMINDB1                   03-Jan-2009 09:53:31
db2.UK.ORACLE.COM ADMINDB1 ADMINDB1                   10-Jan-2009 16:22:16
db1.UK.ORACLE.COM HR       HR                         05-Jan-2009 11:42:58

10 rows selected.
```

Data Dictionary Views

- DBA_SYNONYMS – All Synonyms in the Database
- ALL_SYNONYMS – Synonyms accessible to current user

Columns	Description
OWNER	Owner of the database link
SYNONYM_NAME	Synonym Name
TABLE_OWNER	Object owner of Synonym target
TABLE_NAME	Object name of Synonym target
DB_LINK	DB Link used – if any

Data Dictionary Views

- **USER_SYNONYMS – Synonyms owned by current user**

Columns	Description
SYNONYM_NAME	Synonym Name
TABLE_OWNER	Object owner of Synonym target
TABLE_NAME	Object name of Synonym target
DB_LINK	DB Link used – if any

Querying Synonyms

```
SQL> select owner,synonym_name,table_owner as
object_owner,table_name as object_name,db_link
from dba_synonyms where db_link not null order by
1,2,3,4;
```

```
OWNER      SYNONYM_NAME     OBJECT_OWN OBJECT_NAME      DB_LINK
---------- ---------------- ---------- ---------------- -------------
SYSTEM     SIDFUNC_ANGEL1   SYSTEM     SIDFUNC          ANGEL@ANGEL1
SYSTEM     SIDFUNC_ANGEL2   SYSTEM     SIDFUNC          ANGEL@ANGEL2
```

Dynamic Performance Views

- V$DBLINK - Open DB Links for current session
- GV$DBLINK – Has extra column `INST_ID`

Columns	Description
DB_LINK	link name
OWNER_ID	Owner of the database link UID
LOGGED_ON	Is database link currently logged on
HETEROGENEOUS	Is it heterogeneous
PROTOCOL	Protocol used by the database link
OPEN_CURSORS	open cursors for the database link
IN_TRANSACTION	Is database link in a transaction
UPDATE_SENT	have updates occurred
COMMIT_POINT_STRENGTH	TXN Commit point strength

Statistics and Database Links

- **Database Link Statistics**
  - **SQL*Net roundtrips to/from dblink**
  - **bytes received via SQL*Net from dblink**
  - **bytes sent via SQL*Net to dblink**
  - **bytes via SQL*Net vector from dblink**
  - **bytes via SQL*Net vector to dblink**

Wait Events and Database Links

- **Database Link Wait Events**
  - **SQL*Net break/reset to dblink**
  - **SQL*Net message from dblink**
  - **SQL*Net message to dblink**
  - **SQL*Net more data from dblink**
  - **SQL*Net more data to dblink**
  - **SQL*Net vector data from dblink**
  - **SQL*Net vector data to dblink**
- **P1 is Driver ID for all Events**
- **P2 is number of bytes for all but break/reset where it is break?**

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Common Errors Using Database Links

- ORA-12154 "TNS:could not resolve service name"
- ORA-12224 "TNS:no listener"
- ORA-12305 "TNS:listener could not resolve SID given in connect descriptor"
- ORA-01004: Default username feature not supported; logon denied
- ORA-25426: Remote instance does not support shared DBLINKs
- ORA-02085: Database link *name* connects to *name*

Remote Access Management

- Unsynchronised User Accounts
- Synchronised User Accounts
- Single Shared Accounts
- Location Transparency
  - Synonyms
  - Views
  - Procedural Code
- Password Management
- Auditing

Unsynchronised User Accounts

- Create one public Database Link for each remote database to be accessed.
  - A `CONNECT TO` clause is explicitly specified in all private links thereby using Fixed User Database Links
  - If `USING` clause is omitted, all private links inherit the public link definition that shares the same name
- Implications
  - Users must change their own passwords
  - Private links must be recreated each time a remote password changes
  - Users must have privilege to manage private links
  - Private links may be defined incorrectly, thus resulting in errors
  - Administrators need only give the remote account minimal privilege

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Synchronised User Accounts

- Create one public database link for each remote database to be accessed.
  - The `CONNECT TO` and `IDENTIFIED BY` clauses are not specified or specify `CURRENT_USER`
  - No private links are necessary thereby using Connected User or Current User Database Links
- Implications
  - Users do not need to create private links.
  - Users do not need to administer passwords
  - DBA must synchronise passwords for all users at all sites which means every username and password must be the same at all sites
  - Having the same passwords on multiple sites may not be acceptable for security reasons.
  - Administrators need only give the remote account minimal privileges.

Single Shared Accounts

- Create one public database link for each remote database to be accessed.
  - No private links are necessary `CONNECT TO` and `IDENTIFIED BY` clauses are specified thereby using Fixed User Database Links
- Implications
  - Users do not need to create private links.
  - Users do not need to administer passwords
  - DBAs must recreate a public link when a remote account password changes on database pointed to by that link
  - Remote accounts must have privileges granted.
  - If local user password is disclosed, all sites are vulnerable.
  - Auditing sessions `BY USER` on remote database not useful when different local users connect to the remote database using the shared account link

Location Transparency

- Create a private Database Link owned by a local privileged user account
  - Use Synonyms to hide the Globally Unique Name of the object
  - Create Local Views that access remote objects
  - Embed references to remote objects in local code
- Implications:
  - Direct access to remote sites not required by local users also improving security and reducing account maintenance
  - Administrators control security from one local site
  - Remote object locations are unknown to application providing better security
  - Objects can be moved without any changes being made to application code, thereby reducing programming maintenance
  - Links must be recreated if the location changes

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Database Links and Passwords

- Good practice requires passwords to change.
- Cascade password changes to database links.
  - Fixed links: Find links to be changed by username.
  - Connected user links: Find links to be changed by username.
  - Current user links: User credentials are in the directory.

Database Links and Auditing

- Auditing must be done locally
- Local auditing will not catch access to remote objects but auditing in the remote database may be used.
- Remote database does not distinguish between local connections and connections from a remote database
- The user audited on the remote database is the one associated with the DB Link session. This depends on whether the link is a Fixed User, Connected User or Current User DB Link

Summary

- Database Links Defined
- Globally Unique Object Names
- Database Links Description
- Creating and Managing Database Links
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- Statistics, Wait Events and Database Links
- Common Errors Using Database Links
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