SQL Star International Limited

Oracle Database 10*g*: Administration Workshop II

Volume II • Student Guide

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Database Security

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Objectives

TDE
DP
RMAN
VPD

After completing this lesson, you should be able to do the following:

- Implement Transparent Data Encryption (TDE)
- Use TDE with encrypted columns
- Describe Data Pump (DP) encryption
- Identify components of Recovery Manager (RMAN)–encrypted backups
- Define basic concepts of a Virtual Private Database (VPD)
- Apply a column-level VPD policy

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Additional Resources

Oracle by Example (OBE) for the Oracle Database 10*g*:
http://www.oracle.com/technology/obe/admin/db10gr2_manage.html

- "Using Transparent Data Encryption"
- "Restricting Data Access using Virtual Private Database"

Documentation:

- *Oracle Database Security Guide*
- *Oracle Database Advanced Security Administrator's Guide*

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Oracle Transparent Data Encryption (TDE): Overview

- Need for secure information
- Automatic encryption of sensitive information:
  - Embedded in the Oracle database
  - No need to change application logic
  - Encrypts data and index values
- Using an encryption key:
  - Master key for the entire database
  - Stored in Oracle Wallet

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Oracle Transparent Data Encryption (TDE): Overview

Need for Secure Information

Oracle Database 10*g* Release 2 Transparent Database Encryption simplifies encryption of sensitive personal information such as credit card numbers and social security numbers. Transparent Data Encryption eliminates the need to embed encryption routines in existing applications and dramatically lowers the cost and complexity of encryption. With a few simple commands, sensitive application data can be encrypted.

Automatic Encryption of Sensitive Information

Most encryption solutions require specific calls to encryption functions within the application code. This is expensive because it typically requires extensive understanding of an application as well as the ability to write and maintain software. In general, most organizations do not have the time or expertise to modify existing applications to make calls to encryption routines. Oracle Transparent Data Encryption addresses the encryption problem by deeply embedding encryption in the Oracle database.

Application logic performed through SQL will continue to work without modification. That is, applications can use the same syntax to insert data into an application table and the Oracle database automatically encrypts the data before writing the information to disk. Subsequent select operations will have the data transparently decrypted so the application will continue to work normally.

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Oracle Transparent Data Encryption (TDE): Overview (continued)

This is important because existing applications generally expect to see application data unencrypted. Displaying encrypted data may, at a minimum, confuse the application user and may even break an existing application.

Encryption typically creates problems for existing application indexes because the index data is not encrypted. Oracle Transparent Data Encryption encrypts the index value associated with a given application table. This means that equality searches within an application will see little to no decrease in performance.

Using an Encryption Key

Oracle Transparent Data Encryption provides the key management infrastructure necessary for implementing encryption. Encryption works by passing clear text data along with a secret, known as the key, into an encryption program. The encryption program encrypts the clear text data using the supplied key and returns the data encrypted. Historically, the burden of creating and maintaining the secret or key has been on the application. Oracle Transparent Data Encryption solves this problem by automatically generating a master key for the entire database. Upon starting up the Oracle database, an administrator must open an object known as an Oracle Wallet with a password separate from the system or DBA password. The wallet uses certificates from a Certificate Authority. The administrator then initializes the database master key. The master key is automatically generated.

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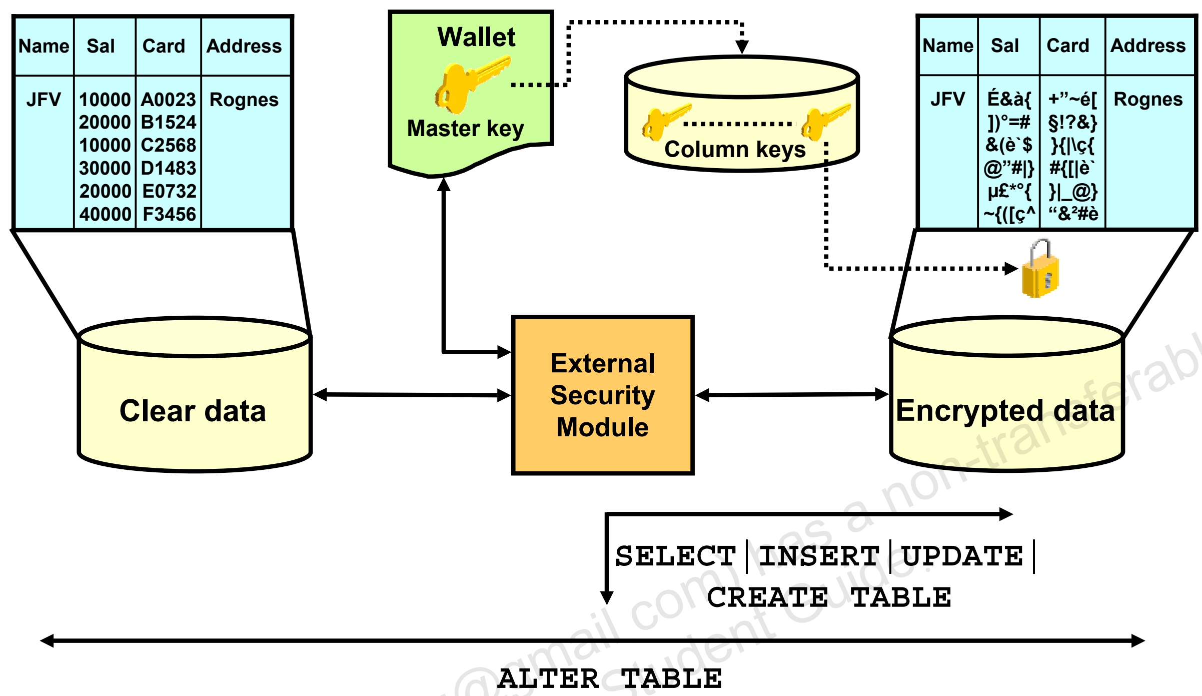
TDE Process



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TDE Process

Although authorization and authentication security mechanisms effectively protect data in the database, they do not prevent access to the operating system files where the data is stored. Transparent Data Encryption enables encryption of sensitive data in database columns as it is placed in, kept in, and retrieved from the operating system files.

TDE uses the External Security Module (ESM) to generate encryption keys, to provide functions for encryption and decryption, and to store encryption keys securely inside and outside the database.

When a table contains encrypted columns, a single column key is used regardless of the number of encrypted columns in that table. The keys for all tables containing encrypted columns are stored in a single column in a dictionary table in the database. That column is encrypted with the database server's master key, preventing any use of those keys through unauthorized access. The master key is stored in a wallet outside the database. The wallet is created using Oracle Wallet Manager, and the master key is generated by the ESM.

The graphic in the slide shows the `EMPLOYEES` table with two columns marked for encryption. The column key for the `EMPLOYEES` table is retrieved from the ESM and is used to encrypt the marked columns. Using this mechanism, you can either encrypt or decrypt columns in your database by using a simple `ALTER TABLE` command. After the columns have been encrypted, you can retrieve the clear text by issuing normal `SELECT` statements. The ESM transparently decrypts the data for you.

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Implementing Transparent Data Encryption

1. **Create a wallet: automatically or by using Oracle Wallet Manager.**

Example `sqlnet.ora` entry:

```
ENCRYPTION_WALLET_LOCATION=
  (SOURCE=(METHOD=FILE)(METHOD_DATA=
  (DIRECTORY=/opt/oracle/product/10.2.0/db_1/)))
```

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Implementing Transparent Data Encryption

Only a few steps are needed to implement and configure this feature:

1. You need to create a wallet. This can be done by either using the Oracle Wallet Manager or by letting the Transparent Data Encryption (TDE) software create it automatically when the directory for that wallet is specified in the `SQLNET.ORA` file. By default, an unencrypted wallet (`cwallet.sso`) is created when the database is installed. However, an encrypted wallet (`ewallet.p12`) is recommended for use with TDE. Here is an example of an entry for your `SQLNET.ORA` file:

```
ENCRYPTION_WALLET_LOCATION=
(SOURCE=(METHOD=FILE)(METHOD_DATA=
(DIRECTORY=/opt/oracle/product/10.2.0/db_1/)))
```

Note: In the `sqlnet.ora` file, you may find two similar-looking entries: The Secure Sockets Layer (SSL) authentication uses the `WALLET_LOCATION` parameter, whereas TDE uses the `ENCRYPTION_WALLET_LOCATION` parameter.

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Implementing Transparent Data Encryption

2. **Set the master key from within your instance:**

```
ALTER SYSTEM SET ENCRYPTION KEY IDENTIFIED BY <password>;
```

3. **Open the wallet from within your instance (future):**

```
ALTER SYSTEM SET ENCRYPTION WALLET OPEN
IDENTIFIED BY <password>;
```

4. **Create tables that contain encrypted columns:**

```
CREATE TABLE emp (
    first_name VARCHAR2(128),
    last_name VARCHAR2(128),
    empID NUMBER ENCRYPT NO SALT,
    salary NUMBER(6) ENCRYPT USING '3DES168',
    comm NUMBER(6) ENCRYPT
);
```

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Implementing Transparent Data Encryption (continued)

2. You need to set the master key inside the wallet. Only if the master key has been compromised is it necessary to regenerate it. Frequent master key regeneration may exhaust all available storage in the wallet. You can set or reset the master key by using the `ALTER SYSTEM` command as shown in the slide. If no encrypted wallet is present in your directory, the command creates an encrypted wallet (`ewallet.p12`), opens the wallet, and creates the master key for TDE.
   If an encrypted wallet is present, the command opens the wallet and creates or re-creates the master key for TDE.
3. For later sessions, you do not want to use the command given in step 2; you need the wallet to be open (it was closed when you shut down your database), but you do not want to create a new master key. So, all you need to do is open the wallet by using the command shown in step 3.

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Implementing Transparent Data Encryption (continued)

4. You can now create tables with encrypted columns. The slide example creates a table called `EMP` that contains three encrypted columns. By default, columns are encrypted with *salt*. Using salt is a way to strengthen the security of encrypted data. Salt is a random string that is added to the data before it is encrypted, making it more difficult for attackers to steal the data by matching patterns of ciphertext to known ciphertext samples. However, if you plan to create indexes on an encrypted column, you must create it with `NO SALT`. In addition, TDE uses the Advanced Encryption Standard with a 192-bit length cipher key (AES192) as its default encryption algorithm. As shown by the example, you can change it to another supported algorithm such as Triple Data Encryption Standard.

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Existing Tables and TDE

- Add encrypted columns:

```
ALTER TABLE emp ADD (ssn VARCHAR2(11) ENCRYPT);
```

- Encrypt unencrypted columns:

```
ALTER TABLE emp MODIFY (first_name ENCRYPT);
```

- Disable column encryption:

```
ALTER TABLE emp MODIFY (first_name DECRYPT);
```

- Add or remove salt:

```
ALTER TABLE emp MODIFY(first_name ENCRYPT [NO] SALT);
```

- Change keys and the encryption algorithm:

```
ALTER TABLE emp REKEY USING '3DES168';
```

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Existing Tables and TDE

- You can add an encrypted column to an existing table by using the `ALTER TABLE ADD` command, specifying the new column with the `ENCRYPT` clause.
- You can also encrypt existing unencrypted columns in tables. To do so, use the `ALTER TABLE MODIFY` command, specifying the unencrypted column with the `ENCRYPT` clause.
- It may be necessary to turn off encryption for reasons of compatibility or performance. Use the `ALTER TABLE MODIFY` command with the `DECRYPT` clause to turn off column encryption.
- By default, the database appends a random string, called "salt," to the cleartext of the column before encrypting it. If you want to use the column as an index or foreign key, you must specify the `NO SALT` option. To add or remove salt from encrypted columns, you again use the `ALTER TABLE MODIFY` command with either the `SALT` (default) or `NO SALT` parameter specified with the `ENCRYPT` clause.
- Each table can have at most one encryption key for its columns. This key can be changed using the original encryption algorithm or using a different algorithm specified by the `REKEY` option.

Note: For more information about the `ALTER TABLE` command and its options, see the *Oracle Database SQL Reference.*

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Transparent Data Encryption: Considerations

- You cannot encrypt tables owned by `SYS`.
- `LONG` and `LOB` data types are not supported.
- The supported encryption algorithms are:
  - 3DES168
  - AES128
  - AES192
  - AES256
- `NO SALT` must be used to encrypt index columns.
- TDE works with indexes for equality searches.
- Encrypted data must be decrypted before expressions evaluation.
- Best practice tip: Back up the wallet.

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Transparent Data Encryption: Considerations

- You cannot encrypt columns belonging to tables owned by `SYS`.
- `LONG` and `LOB` data types are not supported for data encryption.
- Any user allowed to create a table can create one with encrypted columns. The encrypted columns must share the same encryption key and algorithm. AES192 is the default.
- The `NO SALT` option must be used for indexed columns such as a primary key or unique key. In addition, the `NO SALT` option must also be used for foreign key columns.
- Indexes include encrypted data if the corresponding columns are encrypted. Because the encrypted data loses its logical structure, range scans become impossible.
- Encrypted data must be decrypted before expressions evaluation for any query or DML (that is, select list, check constraint expression, where or when conditions).

Note: Good security practices include backing up the wallet before and after you reset the master key.

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Wallet Support for Usernames and Passwords

- Wallets can now hold more than just a certificate:
  - You can store usernames and passwords in a wallet rather than providing them on the command line.
- Batch job processing:
  - Protects exposure of usernames and passwords when listing processes on the OS
- Set up using:
  - `WALLET_LOCATION` in `sqlnet.ora`
  - `mkstore` utility

```
connect /@db_connect_string
```

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Wallet Support for Usernames and Passwords

Password credentials for connecting to databases can now be stored in a client-side Oracle Wallet, a secure software container used to store authentication and signing credentials.

This wallet usage can simplify large-scale deployments that rely on password credentials for connecting to databases. When this feature is configured, application code, batch jobs, and scripts no longer need embedded usernames and passwords. Risk is reduced because such passwords are no longer exposed in the clear, and password management policies are more easily enforced without changing application code whenever usernames or passwords change.

When clients are configured to use the secure external password store, applications can connect to a database with the following `CONNECT` statement syntax, without specifying database login credentials: `connect /@db_connect_string`.

In this case, the database credentials are securely stored in an Oracle Wallet created for this purpose. The autologin feature of this wallet is turned on, so the system does not need a password to open the wallet.

To configure this feature, you need to create the Oracle Wallet on the client side by using the `mkstore` command. Then, add the username and password of the database connection for a specified connect string. This is also done using the `mkstore` utility. Then, make sure that your `sqlnet.ora` file points to the right location of the wallet by using the `WALLET_LOCATION` parameter.

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Data Pump and Transparent Data Encryption

TDE
> DP
RMAN
VPD

- Use your own provided column key during export and import:

```
ENCRYPTION_PASSWORD = <password>
```

- Also true for external tables:

```
CREATE TABLE emp_ext (
   first_name, last_name, empID,
   salary ENCRYPT IDENTIFIED BY "xIcf3T9u" )
ORGANIZATION EXTERNAL
 ( TYPE ORACLE_DATAPUMP
   DEFAULT DIRECTORY "D_DIR"
   LOCATION('emp_ext.dat') )
REJECT LIMIT UNLIMITED
as select * from employees;
```

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Data Pump and Transparent Data Encryption

Two factors are important when exporting tables containing encrypted columns: first, that the sensitive data remain unintelligible during transport, and second, that authorized users can decrypt that data after it is imported at the destination.

Because the key for decryption is local to the server where the tables originally reside, decryption at the destination is possible using the destination's key. Consequently, before exporting, the administrator re-keys the table(s) with a password key, which he or she then securely provides to the destination administrator. Upon import, that receiving administrator specifies the same password. The affected columns being imported are decrypted, enabling the receiving server to immediately reencrypt those columns with a local server key. The columns are then ready for standard authorized use in their new home.

This technique also applies to external tables that use the `ORACLE_DATAPUMP` access driver. If you want certain columns to be encrypted in an external table, you can specify the `ENCRYPT` clause in defining those columns. This specification causes a randomly generated key to be used to encrypt the columns.

However, if you intend to move your external table, that key will not be available in the new location. For such a table, you should specify your own password to encrypt the columns. Then, after you move the data, you can use the same password to regenerate the key so you can access the encrypted columns' data in the new location.

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RMAN Encrypted Backups: Overview

TDE
DP
> RMAN
VPD

Three possible encryption modes for your backups:

- Transparent mode:
  - Requires Oracle Wallet
  - Is best suited for day-to-day backup and restore operations at the same location
  - Is the default encryption mode
- Password mode:
  - Requires you to provide a password
  - Is best suited for backups restored at remote locations
- Dual mode:
  - Can use either Oracle Wallets or passwords
  - Is best suited for backups restored locally and remotely

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RMAN Encrypted Backups: Overview

For improved security, Recovery Manager (RMAN) backups can be encrypted. Encrypted backups cannot be read if they are obtained by unauthorized people.

RMAN offers three encryption modes:

- **Transparent mode:** Transparent encryption can create and restore encrypted backups with no further intervention, as long as the required Oracle key management infrastructure is available. Transparent encryption is best suited for day-to-day backup operations, where backups are restored at the same database that they were backed up from. Transparent encryption is the default mode for RMAN encryption.
- **Password mode:** Password encryption requires that you provide a password when creating and restoring encrypted backups. Restoring a password-encrypted backup requires the same password that was used to create the backup. Password encryption is useful for backups that are restored at remote locations, but that must remain secure in transit. Password encryption cannot be persistently configured. The Oracle Wallet need not be configured if password encryption is to be used exclusively.
- **Dual mode:** Dual mode–encrypted backups can be restored either transparently or by specifying a password. Dual mode–encrypted backups are useful when you create backups that are normally restored on-site using the wallet, but that occasionally need to be restored off-site, where the wallet is not available. When restoring a dual mode–encrypted backup, you can use either the Oracle Wallet or a password for decryption.

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Transparent Mode Setup

1. **Create a wallet: automatically or by using Oracle Wallet Manager.**
2. **Open the wallet from within your instance:**

```
ALTER SYSTEM SET ENCRYPTION WALLET OPEN IDENTIFIED BY <password>;
```

3. **Set the master key from within your instance:**

```
ALTER SYSTEM SET ENCRYPTION KEY IDENTIFIED BY <password>;
```

4. **Configure RMAN to use transparent encryption:**

```
CONFIGURE ENCRYPTION FOR DATABASE ON
```

5. **There are no changes to your backup or recover commands.**
6. **Permanent configuration can be temporarily overwritten:**

```
SET ENCRYPTION OFF
```

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Transparent Mode Setup

If you want to modify your existing backup environment so that all RMAN backups are encrypted using the transparent mode, perform the following steps:

1. Set up the Oracle Wallet as already described in this lesson.
2. Open the wallet by using the `ALTER SYSTEM` command shown in the slide.
3. Issue the following RMAN command: `CONFIGURE ENCRYPTION FOR DATABASE ON`

After these steps, all RMAN backup sets created by your database are encrypted, unless you temporarily override the permanent behavior from your RMAN session with `SET ENCRYPTION OFF`, or change the persistent setting again with the `CONFIGURE ENCRYPTION FOR DATABASE OFF` command. The `BACKUP` command arguments do not change for creating encrypted backups. Encryption is performed on the basis of encryption settings specified with `CONFIGURE ENCRYPTION` or `SET ENCRYPTION`.

RMAN automatically decrypts backup sets when their contents are restored. Transparently encrypted backups require no intervention to restore, as long as the Oracle Wallet is open and available.

Note: If you lose your Oracle Wallet, then you will be unable to restore any transparently encrypted backups.

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Password Mode Setup

1. Set your RMAN session to use password encryption:

```
SET ENCRYPTION ON IDENTIFIED BY password ONLY
```

2. There are no changes to your backup commands.
3. Set your RMAN session to decrypt password-encrypted backups:

```
SET DECRYPTION IDENTIFIED BY password1
{, password2,…, passwordn}
```

4. There are no changes to your recover commands.

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Password Mode Setup

For security reasons, it is not possible to permanently modify your existing backup environment so that all RMAN backups are encrypted using the password mode. Creating password-encrypted backups can be set up only inside your RMAN session by using the `SET ENCRYPTION ON IDENTIFIED BY` *`password`* `ONLY` command in your RMAN scripts. This command is taken into account only for the duration of your RMAN session.

After you set the password by using the `SET ENCRYPTION` command, you can use your regular `BACKUP` commands. All your backup sets are password encrypted.

To restore password-encrypted backups, you must enter the encryption password by using the `SET DECRYPTION IDENTIFIED BY` *`password1`* `{,` *`password2,…, passwordn`*`}` command. If you are restoring from a set of backups that were created with different passwords, then specify all the required passwords on the `SET DECRYPTION` command. RMAN automatically uses the correct password with each backup set.

Note: If you forget, or lose, the password that you used to encrypt a password-encrypted backup, you will be unable to restore that backup.

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Dual Mode Setup

1. Create a wallet: automatically or by using Oracle Wallet Manager.
2. Open the wallet from within your instance:

```
ALTER SYSTEM SET ENCRYPTION WALLET OPEN IDENTIFIED BY <password>;
```

3. Set your RMAN session to use dual encryption:

```
SET ENCRYPTION ON IDENTIFIED BY password
```

4. There are no changes to your backup commands.
5. If necessary, set your RMAN session to decrypt your backups by using the password:

```
SET DECRYPTION IDENTIFIED BY password1 {, password2,…, passwordn}
```

6. There are no changes to your recover commands.

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Dual Mode Setup

To set up the dual mode, you must create the wallet, open it, and use the SET ENCRYPTION command shown in the slide. After this is done, you can start creating backups from the same session that was used to set your password.

Later, when you need to decrypt these types of backups, you can either use the wallet without additional command, or use the correct password after you use the SET DECRYPTION command from your RMAN session.

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RMAN-Encrypted Backups: Considerations

- Image copy backups cannot be encrypted.
- `COMPATIBLE` must be set to at least `10.2.0`.
- `V$RMAN_ENCRYPTION_ALGORITHMS` contains the list of possible encryption algorithms.

```
CONFIGURE ENCRYPTION ALGORITHM 'algorithmname'
```

```
SET ENCRYPTION ALGORITHM 'algorithmname'
```

- Backup encryption is available only with Oracle Database Enterprise Edition.
- One new encryption key is used for each new encrypted backup.
- You can increase disk performance by using multiple channels.
- You can change the master key anytime without affecting your transparent encrypted backups.

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RMAN-Encrypted Backups: Considerations

- Any RMAN backups as backup sets can be encrypted. However, image copy backups cannot be encrypted.
- To use RMAN encryption, the `COMPATIBLE` initialization parameter at the target database must be set to at least `10.2.0`.
- The `V$RMAN_ENCRYPTION_ALGORITHMS` view contains a list of encryption algorithms supported by RMAN. If no encryption algorithm is specified, the default encryption algorithm is 128-bit AES. You can change the algorithm by using the commands shown in the slide.
- Backup encryption is available only in Oracle Database Enterprise Edition.
- The Oracle database uses a new encryption key for every encrypted backup. The backup encryption key is then encrypted with either the password or the database master key, or with both, depending on the chosen encryption mode. Individual backup encryption keys or passwords are never stored in the clear.
- Encryption can have a negative effect on disk backup performance. Because encrypted backups use more CPU resource than nonencrypted backups, you can improve the performance of encrypted backups to disks by using more RMAN channels.
- Because the Oracle key management infrastructure archives all previous master keys in the wallet, changing or resetting the current database master key does not affect your ability to restore encrypted backups performed using an older master key. You may reset the database master key at any time, and RMAN will always be able to restore all encrypted backups that were ever created by this database.

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Need for Data Privacy

TDE
DP
RMAN
> VPD

Examples:

- **Employees: Protect salary and commission percent (used in the remainder of this lesson)**
- **Online banking: Protect access to accounts**
- **Web store: Supply individual shopping baskets**
- **Web host: Allow each customer to see only their own data**
- **Used in Oracle SalesOnline.com and Oracle Portal**

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Need for Data Privacy

Virtual Private Database (VPD) provides row-level access control beyond the capabilities of roles and views. For Internet access, VPD can ensure that online banking customers see only their own accounts. The Web-hosting companies can maintain data of multiple companies in the same Oracle database, while permitting each company to see only its own data.

Security can be built once, in the data server, rather than in each application that accesses data. Security is stronger, because it is enforced by the database, no matter how a user accesses data. Security is no longer bypassed by a user accessing an ad hoc query tool or a new report writer. VPD is a key technology that enables organizations to build hosted, Web-based applications. Indeed, many Oracle applications themselves use VPD to enforce data separation for hosting, including Oracle SalesOnline.com and Oracle Portal.

VPD is enabled by associating one or more security policies with tables or views. Direct or indirect access to a table with an attached security policy causes the database to consult a function that implements the policy. The policy function returns an access condition known as a predicate (a `WHERE` clause), which the database appends to the user's SQL statement, thus dynamically modifying the user's data access.

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Definition and Usage of Terms

- Fine-grained access control (FGAC): Use of functions
- Application context: To preserve user identity and serve as a secure data cache for application attributes and values
- Application attributes: Used by fine-grained access policies

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Definition and Usage of Terms

Fine-grained access control (FGAC) enables you to use functions to implement security policies and to associate those security policies with tables, views, or synonyms.

Application context is a feature that enables application developers to define, set, and access application attributes, and then use these attributes to supply the predicate values for fine-grained access control policies. Used alone, it enables application developers to define, set, and access application attributes by serving as a data cache. Such usage removes the repeated overhead of querying the database each time access to application attributes is needed.

Application attributes, defined inside an application context, are used by fine-grained access policies.

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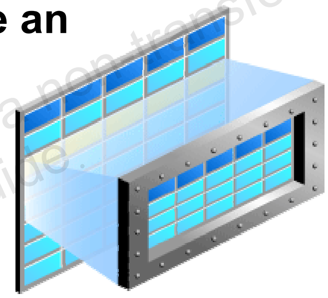
Virtual Private Database: Overview

- Virtual Private Database (VPD) consists of:
  - Fine-grained access control (FGAC)
  - Secure application context
- VPD uses policies to add conditions to SQL statements that protect sensitive data.
- VPD provides row-level access control.
- Application attributes defined inside an application context are used by fine-grained access policies.



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Virtual Private Database: Overview

Virtual Private Database (VPD) is the aggregation of server-enforced, fine-grained access control and secure application context in the Oracle database. It enables you to build applications that enforce your security policies at the row level. When a user directly or indirectly accesses a table, a view, or a synonym associated with a VPD security policy, the server dynamically modifies the user's SQL statement. The modification is based on a `WHERE` clause returned by a function, which implements the security policy. The database modifies the statement dynamically (transparently to the user) by using any condition that can be expressed in, or returned by, a function.

An example of row-level access control is a shopping basket in a Web store, where you see only your items.

Application context is a feature that enables application developers to define, set, and access application attributes, and then use these attributes to supply the predicate values for fine-grained access control policies.

Note: Fine-grained access control and application context can be implemented as stand-alone options. If they are implemented together, they are the basis of VPD.

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Virtual Private Database: Features

- Column-level VPD enforces row-level access control based on accessed security columns.
- With customization, you can define static and nonstatic policies.
- Using shared policies, you can associate one policy with multiple objects.
- Policy type can be `INDEX`.
- Policy predicate text string can be of size 32 KB.

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Virtual Private Database: Features

- Column-level privacy enforces row-level access control only when a command accesses or references security-relevant columns. If you do not specify any relevant columns, then the database applies VPD rewrites to all commands that access or reference the object.
- Customization provides the flexibility for all types of policy implementations to base VPD on the individual requirements of customers' deployments. You can customize VPD to always enforce the same predicate with a static policy, or you can have VPD predicates that change dynamically with a nonstatic policy.
- Shared policies enable you to apply a single VPD policy to multiple objects. This feature reduces administration costs.
- You can now enforce security policies on index maintenance operations performed with the DDL statements `CREATE INDEX` and `ALTER INDEX`. This is important because users need full table access to create table indexes. Consequently, a user who has privileges to maintain an index can see all the row data, although the user does not have full table access under a regular query.
- `DBMS_RLS.ADD_POLICY` has the `LONG_PREDICATE` argument. Its default value is `FALSE` so that the policy function may return up to 4,000 bytes of predicate length. Setting this value to `TRUE` allows the function to return up to 32 KB of predicate text string.

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Column-Level VPD: Example

- **Statements are not always rewritten.**
- **Consider a policy protecting the `SALARY` and `COMMISSION_PCT` columns of the `EMPLOYEES` table. Fine-grained access control is:**
  - **Not needed for this query:**

```
SQL> SELECT last_name FROM employees;
```

  - **Enforced for these queries:**

```
SQL> SELECT last_name, salary
  2  FROM employees;
```

```
SQL> SELECT * FROM employees;
```

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Column-Level VPD: Example

In this example, the business policy, and therefore the imposed VPD policy, is that a manager can access sensitive information in the EMPLOYEES table only for his employees.

The Oracle database does not enforce the VPD policy when you select only the LAST_NAME column from the EMPLOYEES table. Therefore, all employees can access nonsensitive information in the EMPLOYEES table.

However, when you issue queries that access columns considered as security-relevant, VPD applies the fine-grained access control defined by the policy function.

One of the benefits of using column-level VPD is that the statements are rewritten only when they access security-relevant columns. Therefore, the combination of row-level access control and security-relevant columns implies that you can control access down to the element referenced.

Note: Some commands explicitly reference the columns and others reference them implicitly. Depending on how you defined the policy function, it can be applied for DML statements as well.

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Creating a Column-Level Policy

1. Grant the privilege.
2. Create the function.
3. Apply the policy to the object.

```
BEGIN
 dbms_rls.add_policy(object_schema => 'hr',
  object_name => 'employees',
  policy_name => 'hr_policy',
  function_schema =>'hr',
  policy_function => 'hrsec',
  statement_types =>'select,insert',
  sec_relevant_cols=>'salary,commission_pct');
END;
/
```

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Creating a Column-Level Policy

To apply a column-level VPD policy, you must perform the following steps:

1. Grant the appropriate privilege to the user who applies the policy.
   `GRANT EXECUTE ON dbms_rls to admin1;`
2. Create the function that implements the VPD policy. The policy can optionally access an application context or it can be simpler, such as dependent on the time of the day.
3. Apply the policy to the table, view, or synonym by using the `DBMS_RLS` package. In the example, you apply the policy implemented by the `HRSEC` function to the `EMPLOYEES` table. You also set the policy to only apply the VPD predicate for `SELECT` and `INSERT` statements. The two security-relevant columns in the `EMPLOYEES` table are `SALARY` and `COMMISSION_PCT`.

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Summary

In this lesson, you should have learned how to:
- Implement Transparent Data Encryption
- Use TDE with encrypted columns
- Describe Data Pump encryption
- Identify components of RMAN-encrypted backups
- Define basic concepts of a Virtual Private Database
- Apply a column-level VPD policy

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Practice Overview: Using Oracle Database Security

This practice covers the following topics:

- Implementing TDE by creating an encrypted wallet and encryption keys
- Using TDE with encrypted columns

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Using Globalization Support

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Objectives

After completing this lesson, you should be able to:

- Determine a correct database character set that meets your business requirements
- Obtain globalization support configuration information
- Customize language-dependent behavior for the database and individual sessions
- Specify different linguistic sorts for queries
- Retrieve data that matches a search string ignoring case or accent differences

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Objectives

For more information, see the *Oracle Database Globalization Support Guide*.

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What Every DBA Needs to Know

- What is a character set?
- How are character sets used?
- Problems to avoid
- Choosing your character set
- Obtaining character set information
- Specifying language-dependent behavior
- Using linguistic searching and sorting
- Using data conversion

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What Is a Character Set?

The Oracle database supports different classes of character-encoding schemes:

- Single-byte character sets
  - 7-bit
  - 8-bit
- Multibyte character sets, including Unicode

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What Is a Character Set?

When computer systems process characters, they use numeric codes instead of the graphical representation of the character. An *encoded character set* maps numeric codes to characters that a computer or terminal can display and receive. The Oracle database currently supports about 30 encoded character sets, but many more languages and territories (about 100). This is possible because Unicode is a universal character set, which encompasses most major scripts of the modern world.

Different character sets support different character repertoires. Because character sets are typically based on a particular writing script, they can support more than one language. However, script-based character sets are restricted in the sense that they are limited to groups of languages based on similar scripts. Universal character sets encompass most major scripts of the modern world and provide a more useful solution to multilingual support. For information about the Unicode standards, see the Web site at http:www.unicode.org.

The Oracle database provides different classes of encoding schemes:

- Single-byte
- Varying-width multibyte
- Universal

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What Is a Character Set? (continued)

Single-Byte Character Sets

In a single-byte character set, each character occupies one byte. Single-byte 7-bit encoding schemes can define up to 128 (2^7) characters; single-byte 8-bit encoding schemes can define up to 256 (2^8) characters.

Examples of Single-Byte Schemes

7-bit character set:

- American Standard Code for Information Interchange (ASCII) 7-bit American (`US7ASCII`)

8-bit character set:

- International Organization for Standards (ISO) 8859-1 West European (`WE8ISO8859P1`)
- DEC 8-bit West European (`WE8DEC`)
- Extended Binary Coded Decimal Interchange Code (EBCDIC) Code Page 1144 8-bit Italian (`I8EBCDIC1144`)

  Note: ASCII-based character sets are supported only on ASCII-based platforms. Similarly, you can use an EBCDIC-based character set only on EBCDIC-based platforms.

Multibyte Character Sets

A varying-width multibyte character set is represented by one or more bytes per character. Multibyte character sets are commonly used for Asian language support. Some multibyte encoding schemes use the value of the most significant bit to indicate whether a byte represents a single byte or is part of a series of bytes representing a character. However, other character-encoding schemes differentiate single-byte from multibyte characters. A shift-out control code, sent by a device, indicates that any successive bytes are double-byte characters until a shift-in code is encountered. Shift-sensitive encoding schemes are used primarily on IBM platforms.

Examples of Varying-Width Multibyte Schemes

- Shift-JIS 16-bit Japanese (`JA16SJIS`)
- MS Windows Code Page 950 with Hong Kong Supplementary Character Set HKSCS-2001 (`ZHT16HKSCS`)
- Unicode 4.0 UTF-8 Universal character set (`AL32UTF8`)

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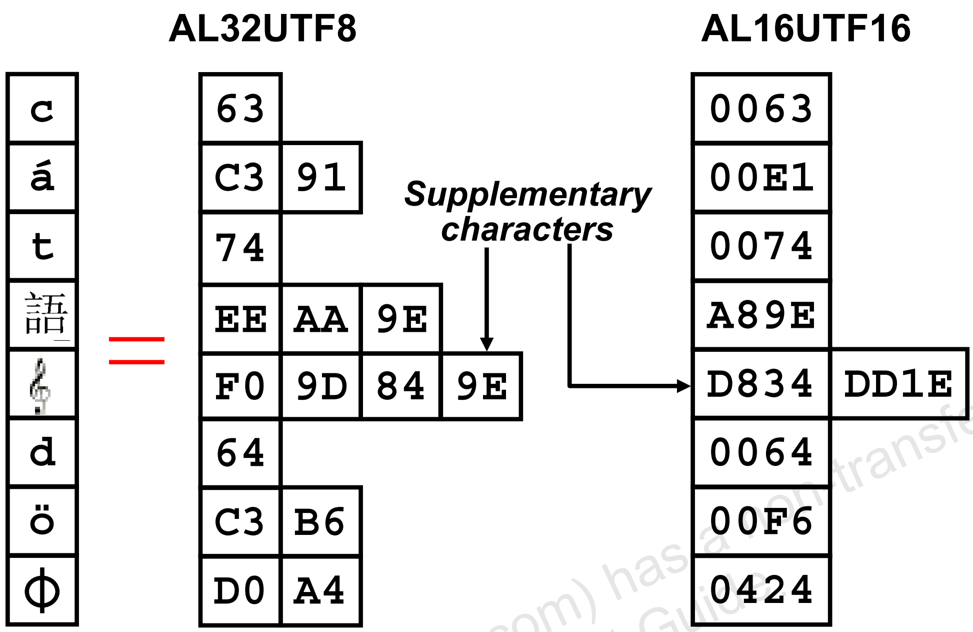
Understanding Unicode



Encoding: Representing characters with byte sequences

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Understanding Unicode

Unicode is a universal encoded character set that enables information from any language to be stored using a single character set. Unicode provides a unique code value for every character, regardless of the platform, program, or language.

The Unicode standard has been adopted by many software and hardware vendors. Many operating systems and browsers now support Unicode. Unicode is required by standards such as XML, Java, JavaScript, LDAP, and WML. It is also synchronized with the ISO/IEC 10646 standard.

AL32UTF8 Encoding

AL32UTF8 encoding is the 8-bit encoding of Unicode. It is a variable-width type of encoding and also a strict superset of ASCII. A strict superset means that each and every character in 7-bit ASCII is available in AL32UTF8 with the same corresponding codepoint value.

One Unicode character can be 1, 2, 3, or 4 bytes in this encoding. Characters from the European scripts are represented in either 1 or 2 bytes; characters from most Asian scripts are represented in 3 bytes, whereas supplementary characters are represented in 4 bytes.

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Understanding Unicode (continued)

AL16UTF16 Encoding

AL16UTF16 encoding is the 16-bit encoding of Unicode.

One Unicode character can be 2 to 4 bytes in this encoding. Characters from both European (including ASCII) and most Asian scripts are represented in 2 bytes. Supplementary characters are represented in 4 bytes. AL16UTF16 is the main Unicode encoding that is used by both Microsoft Windows 2000 and Windows XP.

Supplementary Characters

The initial version of Unicode used the 2-byte encoding format. By using 16 bits for every code point, a total of 65,536 characters can be represented. However, there is a need to support many more characters. For example, the Chinese-speaking community alone uses over 55,000 characters.

For languages such as Chinese, Japanese, and Korean, there are still tens of thousands of ideograms that are not yet encoded. And even though many of these are rarely used characters, they are still present in documents that must be preserved electronically.

To meet this requirement, the Unicode Standard defines *supplementary characters*. By taking two 16-bit code points (also known as *surrogate pairs*) to represent a single character, an additional 1,048,576 characters can be defined.

The first batch of the supplementary characters—44,944 of them—was added in the Unicode standard 3.1 released in March 2001. Together with the 49,194 already existing characters in Unicode 3.0, there are now a grand total of 94,140 encoded characters in Unicode 3.1. This introduces more complexity into the Unicode Standard, but far less than managing a large number of different encodings. Oracle Database 10*g* supports the Unicode 4.0 standard.

Note: Notice above that UTF-16 and UTF-8, with hyphens, refer to the Unicode Standard encodings, whereas UTF8, AL32UTF8, and AL16UTF16, without hyphens, refer to Oracle database character sets based on the Unicode Standard.

Note: For details on Oracle's support for Unicode, see the *Oracle Database Globalization Support Guide 10g Release 2 (10.2)*.

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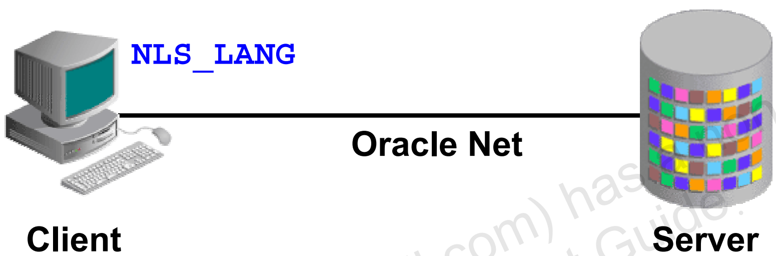
How Are Character Sets Used?

- Oracle Net compares the client `NLS_LANG` setting to the character set on the server.
- If needed, conversion occurs automatically and transparently.



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How Are Character Sets Used?

The `NLS_LANG` parameter defines a client terminal's character-encoding scheme. Different clients can use different encoding schemes. Data passed between the client and the server is converted automatically between the two encoding schemes. The database's encoding scheme should be a superset, or equivalent, of all the clients' encoding schemes. The conversion is transparent to the client application.

When the database character set and the client character set are the same, the database assumes that the data being sent or received is of the same character set, so no validations or conversions are performed.

Character set conversion may be required in a client/server environment, if a client application resides on a different platform than the server and if the platforms do not use the same character encoding schemes. Character data passed between the client and the server must be converted between the two encoding schemes. Character conversion occurs automatically and transparently through Oracle Net.

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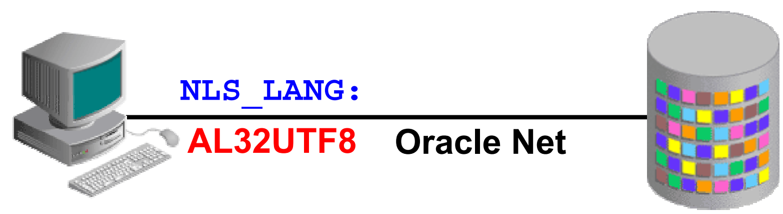
Problems to Avoid

Example:



Client
Windows English
Code page: WE8MSWIN1252

Server
Database character set:
AL32UTF8

No conversion occurs, because it does not seem to be required.

Issue: Invalid data are entered into the database.

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Problems to Avoid

Invalid data usually enters a database when the NLS_LANG parameter is not set properly on the client. The NLS_LANG value should reflect the encoding of the incoming data.

- When the NLS_LANG parameter is set properly, the database can automatically convert incoming data from the client operating system.
- When the NLS_LANG parameter is not set properly, the data entering the database is not converted properly.

For example, suppose that the database character set is AL32UTF8, the client is an English Windows operating system (code page: WE8MSWIN1252), and the NLS_LANG setting on the client is AL32UTF8. Data entering the database is encoded in WE8MSWIN1252 and is not converted to AL32UTF8 data because the NLS_LANG setting on the client matches the database character set. Thus the Oracle database assumes that no conversion is necessary, and invalid data is entered into the database.

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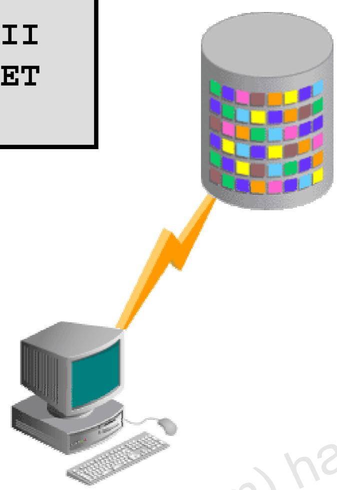
Another Sample Problem

```
CREATE DATABASE ...
CHARACTER SET US7ASCII
NATIONAL CHARACTER SET
UTF8 ...
```



```
% export NLS_LANG= SIMPLIFIED
CHINESE_HONGKONG.US7ASCII
```

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Another Sample Problem

For example, your database character set is US7ASCII and you are using Simplified Chinese Windows as your client terminal. By setting NLS_LANG to SIMPLIFIED CHINESE_HONGKONG.US7ASCII as the client character set, it is possible for you to store multibyte Simplified Chinese characters inside a single-byte database. This means that the database treats these characters as single-byte US7ASCII characters, and therefore, all SQL string manipulation functions such as SUBSTR or LENGTH are based on bytes rather than characters. All of your non-ASCII characters could be lost following an export and import into another database.

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Choosing Your Character Set

- Trade-offs to consider
- Choosing the correct character set that meets your business requirements now and in the future
- Specifying the character set
- Changing the character set after database creation

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Choosing Your Character Set

For best performance, choose a character set that avoids character set conversion and uses the most efficient encoding for the languages desired. Single-byte character sets result in better performance than multibyte character sets, and they also are the most efficient in terms of space requirements. However, single-byte character sets limit how many languages you can support.

To choose your correct database character set, evaluate your current and future business requirements, as well as technical requirements (for example, the XML and Java standards require Unicode). In general, Oracle recommends the use of Unicode for all new databases, because it is the most flexible character set and avoids future conversions.

To specify the character set, use the `CREATE DATABASE` statement with the `CHARACTER SET` and `NATIONAL CHARACTER SET` clauses. If you do not use the `NATIONAL CHARACTER SET` clause, then it defaults to `AL16UTF16`.

You may need to change the character set after database creation, to support unforeseen requirements, for example, to provide support for new data sources (XA, data warehousing, and so on). This can often be a time-consuming and costly process. In most cases, you need to do a full export/import to properly convert all data to the new character set.

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Database Character Sets and National Character Sets

Database Character Sets	National Character Sets
Defined at creation time	Defined at creation time
Cannot be changed without re-creation, few exceptions	Can be exchanged
Store data columns of type `CHAR`, `VARCHAR2`, `CLOB`, `LONG`	Store data columns of type `NCHAR`, `NVARCHAR2`, `NCLOB`
Can store varying-width character sets	Can store Unicode using either `AL16UTF16` or `UTF8`

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Database Character Sets and National Character Sets

Because the database character set is used to identify and to hold SQL and PL/SQL source code, it must have either EBCDIC or 7-bit ASCII as a subset, whichever is native to the platform. Therefore, it is not possible to use a fixed-width, multibyte character set as the database character set; you can use this only as the national character set.

A national character set is an alternate character set that enables you to store Unicode character data in a database that does not have a Unicode database character set. SQL `NCHAR`, `NVARCHAR2`, and `NCLOB` data types support Unicode data only. You can use either the `UTF8` or the `AL16UTF16` character set.

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Obtaining Character Set Information

```
SQL> SELECT parameter, value
 2   FROM nls_database_parameters
 3   WHERE parameter LIKE '%CHARACTERSET%';

PARAMETER                VALUE
----------------------- -------------
NLS_CHARACTERSET         WE8ISO8859P1
NLS_NCHAR_CHARACTERSET   AL16UTF16

2 rows selected.
```

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Obtaining Character Set Information

Use the `NLS_DATABASE_PARAMETERS` view to display the permanent NLS settings for the database, including the database and national character set. This view contains the explicitly set values, as well as the default values used by the database.

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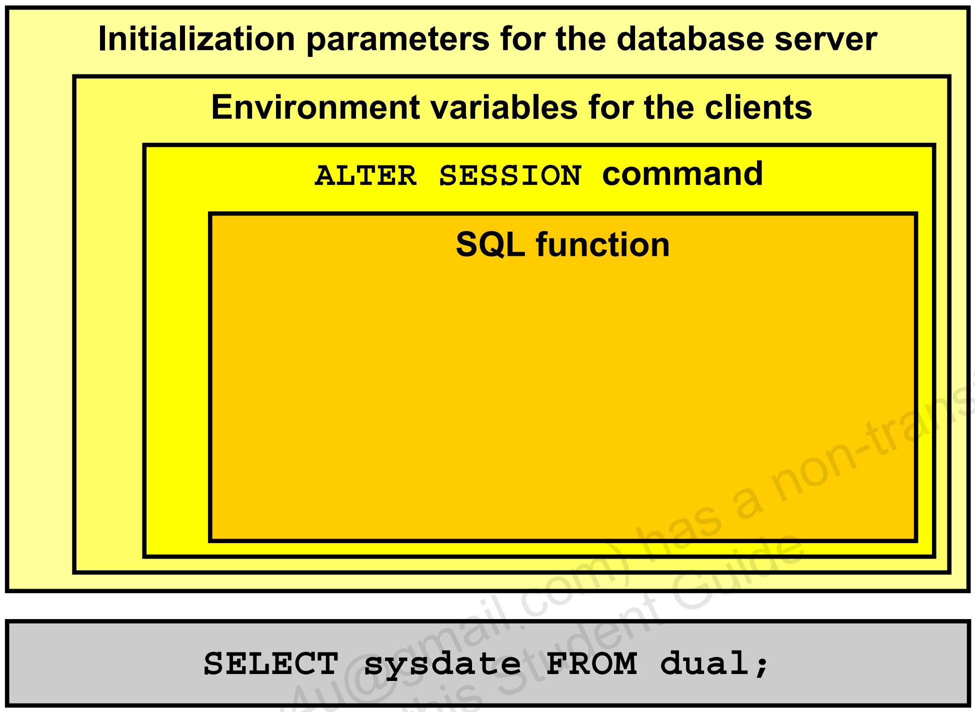
Specifying Language-Dependent Behavior



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Specifying Language-Dependent Behavior

Beyond storing and retrieving data for most contemporary languages in a database, additional support is available for a subset of the languages. The database can display dates by using local date and time formats and can sort text data according to cultural conventions. The database also supports cultural conventions that are specific to geographical locations, or territories, such as numeric and monetary conventions.

NLS parameters determine the locale-specific behavior on both the client and the server. There are four ways to specify national language support (NLS) parameters:

- As initialization parameters on the server side to specify the default server environment. (These default settings have no effect on the client side.)
- As environment variables for the client to specify locale-dependent behavior overriding the defaults set for the server
- Using the `ALTER SESSION` command to override the defaults set for the client and the server
- In SQL functions, to explicitly to hard-code NLS behavior for an application or query overriding the default values that are set for the server and client, as well as any values specified with an `ALTER SESSION` statement

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Specifying Language-Dependent Behavior for the Session

- Specify the locale behavior with the `NLS_LANG` environment variable:
  - Language
  - Territory
  - Character set

```
NLS_LANG=FRENCH_CANADA.WE8ISO8859P1
```

- Set other NLS environment variables to:
  - Override database initialization parameter settings for all sessions
  - Customize the locale behavior
  - Change the default location of the NLS library files

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Specifying Language-Dependent Behavior for the Session

The Environment Variable NLS_LANG

A *locale* is a linguistic and cultural environment in which a system or program is running. Setting the NLS_LANG environment parameter is the simplest way to specify locale behavior for the Oracle database software. It sets the language and territory used by the client application and the database server. It also sets the character set for data entered or displayed by a client program. The value of NLS_LANG overrides any values of the NLS initialization parameters.

Each component controls a subset of NLS features:

```
NLS_LANG=<language>_<territory>.<charset>
```

language is used to override the value of NLS_LANGUAGE. territory overrides the value of NLS_TERRITORY. charset specifies the character-encoding scheme used by client application (usually that of the user's terminal).

All components of the NLS_LANG definition are optional; any item that is not specified uses its default value. If you specify territory or character set, then you *must* include the preceding delimiter [underscore (_) for territory, period (.) for character set]. For example:

```
NLS_LANG = _JAPAN
NLS_LANG = .US7ASCII
```


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Language- and Territory-Dependent Parameters

Parameter	Default Values
NLS_LANGUAGE NLS_DATE_LANGUAGE NLS_SORT	AMERICAN AMERICAN BINARY
NLS_TERRITORY NLS_CURRENCY NLS_DUAL_CURRENCY NLS_ISO_CURRENCY NLS_DATE_FORMAT NLS_NUMERIC_CHARACTERS NLS_TIMESTAMP_FORMAT NLS_TIMESTAMP_TZ_FORMAT	AMERICA $ $ AMERICA DD-MON-RR ., DD-MON-RRHH.MI.SSXFF AM DD-MON-RRHH.MI.SSXFF AM TZR

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Language- and Territory-Dependent Parameters

Setting the NLS_LANGUAGE and NLS_TERRITORY initialization parameters determines the default values that should be used by the Oracle database. You can override these default values by explicitly setting the values for those initialization parameters whose default values depend on the settings of NLS_LANGUAGE and NLS_TERRITORY.

NLS_LANGUAGE Initialization Parameter

The NLS_LANGUAGE initialization parameter determines the default values of the following parameters:

Column	Description
NLS_DATE_LANGUAGE	Determines the language for day and month names and abbreviations and spelled values of other date format elements
NLS_SORT	Changes the linguistic sort sequence that the Oracle database uses to sort character values. (The sort value must be the name of a linguistic sort sequence.)

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Language and Territory Dependent Parameters (continued)

NLS_TERRITORY Initialization Parameter

NLS_TERRITORY determines the default values for the following initialization parameters:

Column	Description
NLS_CURRENCY	Specifies the local currency symbol
NLS_DATE_FORMAT	Specifies the date format. (The value must be a date format model.)
NLS_DUAL_CURRENCY	Defines a secondary currency symbol for a given territory
NLS_ISO_CURRENCY	Indicates the territory whose ISO currency symbol should be used
NLS_NUMERIC_CHARACTERS	Explicitly specifies a new decimal character and group separator
NLS_TIMESTAMP_FORMAT	Defines the default date format for the TIMESTAMP and TIMESTAMP WITH LOCAL TIME ZONE data types. **Must have NLS_LANG set.**
NLS_TIMESTAMP_TZ_FORMAT	Defines the default date format for the TIMESTAMP and TIMESTAMP WITH LOCAL TIME ZONE data types used with the TO_CHAR and TO_TIMESTAMP_TZ functions. **Must have NLS_LANG set.**

These are some of the NLS initialization parameters that are independent of the NLS_LANGUAGE and NLS_TERRITORY values:

Column	Description
NLS_CALENDAR	Specifies which calendar system is used by the Oracle database
NLS_COMP	Can be set to ANSI or BINARY. When NLS_COMP is set to ANSI, SQL operations perform a linguistic comparison based on the value of NLS_SORT.
NLS_LENGTH_SEMANTICS	Enables you to create CHAR, VARCHAR2, and LONG columns by using either byte or character length semantics.

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Specifying Language-Dependent Behavior

```
ALTER SESSION SET
NLS_DATE_FORMAT='DD.MM.YYYY';
```

```
DBMS_SESSION.SET_NLS('NLS_DATE_FORMAT',
'''DD.MM.YYYY''') ;
```

Using NLS parameters in SQL functions

```
SELECT TO_CHAR(hire_date,'DD.Mon.YYYY',
 'NLS_DATE_LANGUAGE=FRENCH')
FROM employees
WHERE hire_date > '01-JAN-2000';
```

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Specifying Language-Dependent Behavior

In addition to explicitly issuing ALTER SESSION commands, you can use the DBMS_SESSION.SET_NLS database procedure, specifying the name of the parameter to change and the new value of the parameter. The second example shown in the slide performs the same action as the first example, but uses the DBMS_SESSION package.

Client utilities such as *i*SQL*Plus, SQL*Plus, or SQL*Loader read the environment variables set on the client and issue the corresponding ALTER SESSION command after they are connected to the database.

The third example shows the use of the NLS_DATE_LANGUAGE NLS parameter in the TO_CHAR SQL function.

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Linguistic Searching and Sorting

Sort order can be affected by:

- **Case sensitivity**
- **Diacritics or accent characters**
- **Combination of characters that is treated as a single character**
- **Phonetics or character appearance**
- **Cultural preferences**

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Linguistic Searching and Sorting

Different languages have different sort orders. In addition, different cultures or countries that use the same alphabets may sort words differently. For example, in Danish, Æ is after Z, whereas Y and Ü are considered to be variants of the same letter. Sort order can:

- Be case sensitive or case insensitive
- Ignore or consider diacritics (a mark near or through a character or combination of characters that indicates a different sound than the sound of the character without the diacritic)
- Be phonetic or it can be based on the appearance of the character (such as the number of strokes in East Asian ideographs)

Another common sorting issue is combining letters into a single character. For example, in traditional Spanish, *ch* is a distinct character that comes after *c*, which means that the correct order is: *cerveza*, *colorado*, *cheremoya*. This means that the letter *c* cannot be sorted until the database has checked whether the next letter is an *h*.

To produce a sort sequence that matches the alphabetic sequence of characters, another sort technique must be used that sorts characters independently of their numeric values in the character-encoding scheme. This technique is called a *linguistic sort*. A linguistic sort operates by replacing characters with numeric values that reflect each character's proper linguistic order.

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Linguistic Searching and Sorting

Three types of sorting:

- Binary sorting
  - Sorted according to the binary values of the encoded characters
- Monolingual linguistic sorting
  - A two-pass sort based on a character's assigned major and minor values
- Multilingual linguistic sorting
  - Based on the ISO standard (ISO 14651), and the Unicode 3.2 Standard for multilingual collation
  - Ordered by the number of strokes, PinYin, or radicals for Chinese characters

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Linguistic Searching and Sorting (continued)

A binary sort is a conventional sorting mechanism by which letters are sorted according to the binary values used to encode the characters. Binary sorts are the fastest type of sort. They produce reasonable results for the English alphabet because the ASCII and EBCDIC standards define the letters A to Z in ascending numeric value. When characters used in other languages are present, a binary sort usually does not produce reasonable results.

For monolingual sorting, the Oracle database uses major and minor values to compare characters. Usually, letters with the same appearance have the same major value. For example, `A`, `a` and `ä`. The Oracle database defines letters with diacritics and case differences as having the same major value but different minor values.

In a monolingual sort, the database makes two passes when comparing strings in monolingual sorts. The first pass is to compare the major value of the entire string from the major table and the second pass is to compare the minor value from the minor table. Although this provides better sorting than binary, it is still limited.

Multilingual sorts enable you to sort data in more than one language in a single sort. This is useful for regions or languages that have complex sorting rules.

Refer to the *Oracle Database Globalization Support Guide* for more information about the supported linguistic sorts.

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Using Linguistic Searching and Sorting

You can specify the type of sort used for character data with the:

- **`NLS_SORT` parameter**
  - **Default value derived from the `NLS_LANG` environment variable, if set**
  - **Can be specified for the session, client, or server**
- **`NLSSORT` function**
  - **Defines the sorting method at the query level**

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Using Linguistic Searching and Sorting

To overcome the limitations of binary sorting, you can specify linguistic sorts by setting the `NLS_SORT` parameter or by using `NLSSORT` in your query.

The `NLS_SORT` Parameter

Consider the following words stored in a database by using the `WE8ISO8859P1` character set:

- `gelée`
- `gelé`
- `gèle`
- `gelez`

If `NLS_SORT` is set to `BINARY`, `gelez` is sorted before `gelé`. This occurs because `e` has a binary value lower than `è` in the `WE8ISO8859P1` character encoding.

If `NLS_SORT` is set to the `FRENCH` monolingual sort, the word `gelé` is sorted before `gelez` and `gèle`, which still does not satisfy all the nuances of the French language. For example, in the French language, letters are sorted from left to right and accents from right to left.

When `NLS_SORT` is set to the `FRENCH_M` multilingual sort, both the characters and the diacritics are sorted properly.

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Using Linguistic Searching and Sorting (continued)

The NLSSORT Function

NLSSORT allows sorting to be defined at the query level. The following example sets NLS_SORT to BINARY at the session level but then changes the sort at the query level.

```
SQL> ALTER SESSION SET NLS_SORT=BINARY;
Session altered.

SQL> SELECT  fr_word
 2   FROM    words
 3   ORDER BY fr_word;

FR_WORD
-------
gelez
gelé
gelée
gèle

SQL> SELECT  fr_word
 2   FROM    words
 3   ORDER BY NLSSORT(fr_word,'NLS_SORT=FRENCH_M');

FR_WORD
--------
gèle
gelé
gelée
gelez
```

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Case- and Accent-Insensitive Search and Sort

- **Specify the linguistic name:**

```
NLS_SORT = <NLS_sort_name>[_AI | _CI]
```

- **Examples:**

```
NLS_SORT = FRENCH_M_AI
```

```
NLS_SORT = XGERMAN_CI
```

- **Specify the sort action for `WHERE` clauses and PL/SQL blocks:**

```
NLS_COMP = BINARY | ANSI | LINGUISTIC
```

- **Useful for migrated databases**

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Case- and Accent-Insensitive Search and Sort

Use the session parameter NLS_SORT to specify the linguistic sort name. The default value is derived from the initialization parameter NLS_LANGUAGE. The _AI and _CI values are suffixed to the sort name to indicate an accent-insensitive sort or a case-insensitive sort. From the example in the slide, the following are determined:

- Accent-insensitive and case-insensitive "French_M" sort
- Accent-sensitive and case-insensitive "Xgerman" sort

Comparisons in the WHERE clause and in PL/SQL blocks are binary unless you use the NLSSORT function. By setting NLS_COMP to ANSI, you indicate that comparisons in the WHERE clause and in PL/SQL blocks should use the linguistic sort specified in the NLS_SORT parameter. You must also define an index on the column for which you want linguistic sorts.

Note: The format of the NLS_SORT parameter applies for both monolingual and multilingual linguistic sorts. In the monolingual sort, only major and minor levels are included. If the NLS_COMP parameter is set to ANSI, the options apply to any SQL or PL/SQL operators that already support collation-based comparisons in previous database releases. The _AI or _CI options are not affected in the INSTR, TRIM, and LIKE SQL functions because these functions compare strings only in binary order.

Note for database migrators: Sybase, SQL Server, and MS Access can use case-insensitive operations. These options can be used to preserve existing application functionality.

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Support in SQL and Functions

- The following SQL clauses support `NLS_SORT` and `NLS_COMP` settings:
  - `WHERE`
  - `ORDER BY`
  - `START WITH`
  - `HAVING`
  - `IN/NOT IN`
  - `BETWEEN`
  - `CASE-WHEN`
- The `NLSSORT()` function supports the case-insensitive and accent-insensitive functionality.

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Support in SQL and Functions

The SQL clauses listed in the slide are affected when the `_AI` or `_CI` options are appended to the `NLS_SORT` parameter.

```
SELECT cust_last_name
FROM customers
WHERE NLSSORT(cust_last_name, 'NLS_SORT = generic_m_ai')
       = NLSSORT('De Niro', 'NLS_SORT=generic_m_ai');

CUST_LAST_NAME
--------------------
de Niro
De Niro
dë Nirõ
```

You typically use the `NLSSORT` function in an `ORDER BY` or `WHERE` clause when the linguistic setting of the session parameter `NLS_SORT` is different from the linguistic setting in the SQL statement. The example (given on this page) searches for all occurrences of “De Niro” regardless of the case and accent. You can get the same result as shown in the example by setting the `NLS_COMP` parameter:

```
ALTER SESSION SET NLS_SORT=generic_m_ai;
ALTER SESSION SET NLS_COMP=ansi;
```


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Linguistic Index Support

- Create an index on linguistically sorted values.
- Rapidly query data without having to specify `ORDER BY` clause and `NLSSORT`:

```
CREATE INDEX list_word ON
 list (NLSSORT(word, 'NLS_SORT=French_M'));

SELECT word FROM list;
```

- Set the `NLS_SORT` parameter to match the linguistic definition that you want to use for the linguistic sort when creating the index.

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Linguistic Index Support

Linguistic sorting is language specific. When data in multiple languages is stored in the database, you may want to sort the data in different ways depending on the language. Creating a linguistic index for columns to be sorted greatly improves the performance of queries requiring linguistic sorting, although it can slow down inserts and updates.

Functional indexes are used to create linguistically sorted indexes. The SQL function `NLSSORT` returns the string of bytes used to sort the first parameter in the given linguistic sorting sequence. In the example shown in the slide, an index is created on `WORD` that is sorted according to the `FRENCH_M` sorting order. This enables you to perform index-based queries on data that is sorted according to the rules of each language.

You can also build a single linguistic index for all languages by using one of the multilingual linguistic sorts such as `GENERIC_M` or `FRENCH_M`. Or, for a small set of languages, use a language column to be used as a parameter of the `NLSSORT` function. The language column contains the `NLS_LANGUAGE` values for the data in the indexed column.

```
CREATE INDEX i2 on list (NLSSORT(word,
'NLS_SORT=GENERIC_M'));
CREATE INDEX word_all_idx ON
  list (NLSSORT(word, 'NLS_SORT=' || LANG_COL));
```

See the *Oracle Database Globalization Support Guide* for details on creating linguistic indexes.

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Customizing Linguistic Searching and Sorting

You can customize linguistic sorting for:

- Ignorable characters
- Contracting or expanding characters
- Special combination letters or special letters
- Expanding characters or special letters
- Special uppercase and lowercase letters
- Context-sensitive characters
- Reverse secondary sorting
- Canonical equivalence

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Customizing Linguistic Searching and Sorting

Linguistic searching and sorting has many features. Many of these features are customizable, so you can retrieve the desired results from your data. For example:

- Now you can also specify a sort or query on the base letters only (accent insensitive) or on the base letter and the accents (case insensitive).
- You can specify that the dash punctuation character should be ignored so that `e-mail` can be treated in the same way as `email`.
- The expanding character `ö` sorts as if it were `oe`, after `od` and before `of`.
- You can properly sort prolonged sound marks in Japanese.
- Making `ä` equivalent to its base letter, `a`, and an umlaut, `¨`, so that `ä` and `a¨` are considered equal.
- You can have a character with a diacritic placed before or after its unmarked variant.
- Whether or not in Thai and Lao, some characters first change places with the following character before sorting.
- You can map lowercase letters to multiple uppercase letters, such as the German `ß` to `SS`, and uppercase letters to multiple lowercase letters, such as the Turkish `I` becoming a small, dotless i: `ı`.

To create custom linguistic sorts, you need to use the Oracle Locale Builder utility.

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Implicit Conversion Between CLOB and NCLOB

Transparent implicit conversion is supported in:

- **SQL IN and OUT bind variables for query and DML**
- **PL/SQL functions and procedure parameter passing**
- **PL/SQL variable assignment**

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Implicit Conversion Between CLOB and NCLOB

Converting data between Unicode and the database national language character set is becoming a more frequent requirement. Explicit conversion between CLOB and NCLOB is already available in SQL and in PL/SQL with the TO_CLOB and TO_NCLOB functions. Oracle Database 10*g* introduces implicit conversion for SQL IN and OUT bind variables in queries and DML operations, as well as for PL/SQL function and procedure parameter passing and PL/SQL variable assignment. For example, conversion is completely transparent in the following scenario:

```
CREATE TABLE my_table (nclob_col NCLOB);
DECLARE
    clob_var CLOB;
    nclob_var NCLOB;
BEGIN
    clob_var := 'clob data'; -- initialize the CLOB
    INSERT INTO my_table VALUES (clob_var);
    -- Bind a CLOB into an NCLOB column
    SELECT nclob_col
      INTO clob_var FROM my_table;
    -- Define an NCLOB column as a CLOB var
END;
```


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NLS Data Conversion with Oracle Utilities

- Multiple data conversions can take place when data is exported from one database and imported into another if the same character sets are not used.
- External tables use the NLS settings on the server for determining the data character set.
- SQL*Loader:
  - Conventional path: Data is converted into the session character set specified by `NLS_LANG`.
  - Direct path: Data is converted using client-side directives.

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NLS Data Conversion with Oracle Utilities

Globalization Support for Export and Import

The Export utility always saves the data, including Unicode data, in the same character sets as the database from which the taken was exported. When exporting data definition language (DDL), Export writes export files using the character set specified in the `NLS_LANG` environment variable for the user session. A character set conversion is performed if the value of `NLS_LANG` differs from the database character set.

When importing user data, if the character sets of the source database (and the export dump file) are different from the character sets of the import database, a single conversion is performed to automatically convert the data to the character sets of the target database.

During the import of DDL, the data is automatically converted from the character set of the export file to the character set of the import user session. Import can perform this conversion only for single-byte character sets. This means that for multibyte character sets, the import file's character set must be identical to the export file's character set. If the character set used by the import user session is different from the target database's character set, a final character set conversion is performed.

Globalization Support for External Tables

The NLS environment variable settings on the **server** determine the character set and date masks for the table.

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NLS Data Conversion with Oracle Utilities (continued)

Globalization Support for SQL*Loader

SQL*Loader supports four character sets:

- Client character set (NLS_LANG of the client SQL*Loader process)
- Data file character set (usually the same as the client character set)
- Database character set
- Database national character set

Performance is optimized if all character sets are the same.

SQL*Loader has the capability to convert data from the data file character set to the database character set. The character set of the data file can be set up by using the NLS_LANG parameter or by specifying the CHARACTERSET parameter in the SQL*Loader control file:

```
LOAD DATA
CHARACTERSET UTF16
INFILE ulcase11.dat
REPLACE …
```

The SQL*Loader control file itself is assumed to be in the character set specified for your session by the NLS_LANG parameter. If the control file character set is different from the data file character set, delimiters and comparison clause values specified in the SQL*Loader control file as character strings are converted from the control file character set to the data file character set before any comparisons are made. To ensure that the specifications are correct, you may prefer to specify hexadecimal strings, rather than character string values.

If the character set specified with the NLS_LANG parameter for your session is different from the character set of the data file, character strings in the control file are converted to the character set of the data file. This is done before SQL*Loader checks for the default record terminator.

The character set specified with the CHARACTERSET parameter does not apply to data in the control file (specified with INFILE). To load data in a character set other than the one specified for your session by the NLS_LANG parameter, you must place the data in a separate data file.

You can use SQL*Loader to load data using one of three methods: conventional path, direct path, or external table. During conventional path data loads, data is converted into the session character set specified by the NLS_LANG parameter for that session.

During a direct path load, data conversion occurs on the client side rather than on the server side. This means that NLS parameters in the initialization parameter file are not used. To override this behavior, you can specify a format mask in the SQL*Loader control file that is equivalent to the setting of the NLS parameter in the initialization parameter file, or set the appropriate environment variable.

If the target character set for the SQL*Loader data is not a superset of the source data file character set, characters that have no equivalent in the target character set are converted to replacement characters, such as a question mark, resulting in loss of data.

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NLS Data Conversion with Data Pump

- Data Pump Export always saves data in the same character set as the database from which the data originates.
- Data Pump Import converts the data to the character set of the target database, if needed.
- The Data Pump log file is written in the language specified by `NLS_LANG` for the session that started Data Pump.

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NLS Data Conversion with Data Pump

The NLS parameter settings used by the session that initiated Data Pump are used within the Data Pump job. Therefore, ensure that the parameters are set correctly before you start any Data Pump job. The client `NLS_LANG` settings are used only for messages returned by the Data Pump utilities, such as `impdp` or `expdp`.

During the execution of a job, a log file is optionally written. The log file summarizes the progress of the job and any errors that were encountered along the way. Data Pump writes the log file by using the `NLS_LANG` setting of the client. For example, setting `NLS_LANG` to `French.WE8DEC` causes all messages for the job to be displayed in French, even if the job is restarted from an `American.WE8DEC` client.

If you use a parameter file (`PARFILE`) with Data Pump, the parameter file is assumed to be in the client's character set. The Data Pump utility translates the text strings in the parameter files into the database character set. If the parameter file is in a different character set than that being currently used by the client, then you must alter the NLS settings of the client to ensure a proper translation.

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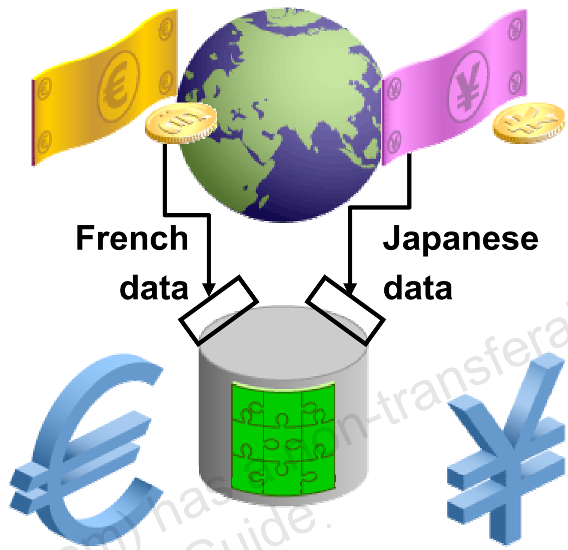
Globalization Support Features

- Language support
- Territory support
- Character set support
- Linguistic sorting
- Message support
- Date and time formats
- Numeric formats
- Monetary formats



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Globalization Support Features

Different countries and geographies dictate different cultural conventions that directly affect data formats. Globalization support ensures that utilities and error messages, sort order, date, time, monetary, numeric, and calendar conventions automatically adapt to the native language. Users can interact, store, process, and retrieve data in their native languages and formats:

- Time zones can be used to support daylight saving time.
- National calendars such as Gregorian, Japanese, Imperial, and Thai Buddha are supported.
- Currency symbols reflect the local economy and ISO conventions. Credit and debit symbols also differ from location to location.

Oracle's globalization support is implemented with Oracle NLS Runtime Library (NLSRTL). NLSRTL provides a comprehensive suite of language-independent functions that allow proper text and character processing and language convention manipulations. The behavior of these functions for a specific language and territory is governed by a set of locale-specific data that is identified and loaded at run time.

You can control the language-dependent operations by using several parameters and environment variables on both the client and the server sides. The server and the client may run in the same or different locations. When the client and the server use different character sets, the Oracle database handles character set conversion automatically.

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Summary

In this lesson, you should have learned how to:

- Determine a correct database character set that meets your business requirements
- Obtain globalization support configuration information
- Customize language-dependent behavior for the database and individual sessions
- Specify different linguistic sorts for queries
- Retrieve data that matches a search string ignoring case or accent differences

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Practice Overview: Using Globalization Support Features

This practice covers the following topics:

- Checking the database and national character set
- Identifying valid NLS values
- Setting NLS parameters

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Practice Overview

Note: For this practice, you will be using *i*SQL*Plus.

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Workshop

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Objectives

After completing this lesson, you should be able to do the following:

- Document a database configuration by using a Database Configuration Worksheet
- Recover data while minimizing down time and data loss
- Use database tools and features to monitor and improve database performance

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Workshop Methodology

- Team-oriented and interactive
- Tools used to keep the database performance at specified levels
- Hands-on diagnosis and problem resolution for a variety of failure scenarios
- Multiple solutions possible for each scenario
- Develop troubleshooting and administration skills

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Workshop Methodology

Group-Oriented and Interactive Structure

The workshop is structured to allow individuals to work in groups to perform database backup, restore, and recovery operations. Each group is encouraged to share its approach to resolving database failures with other groups in the class.

Intensive Hands-On Diagnosis and Problem Resolution

The intent is to provide you with as much hands-on experience as possible to diagnose and work through backup and recovery scenarios. Experience and knowledge gained from the course will play a major role toward successfully completing the objectives of each session.

Using the Right Tools

Enterprise Manager Database Control for Oracle Database 10*g* provides a wealth of information to the DBA. Filtering through the information to identify problems and knowing what tool to use to resolve them can be a challenge. By simulating problems that are not known to you ahead of time, you gain experience in locating problems and resolving them on your own.

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Workshop Methodology (continued)

Variety of Failure Scenarios

During this workshop, you will induce configuration errors by running a series of shell scripts. Your objective is to diagnose the nature of the problem and to make the necessary corrections or perform the appropriate recovery process. The types of failures that you may encounter include:

- Loss of a redo log group
- Media loss
- Data block corruption or incorrect data in application tables
- Loss of control files
- Loss of a table

Recovery Solutions

This workshop simulates a real-world environment in that exact solutions to problems may not be readily available in the event of a database failure. Therefore, only cursory solutions are provided in Appendix A for the workshop scenarios.

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Business Requirements

- Twenty-four hour availability
- Varying peak usage across all time zones
- Daily backups required
- Complete database recovery required

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Business Requirements

The following business requirements should be familiar to you when configuring your database for backup and recovery.

Twenty-four hour availability: The database must be available 24 hours a day, 7 days a week. An eight-hour period for maintenance is scheduled for the first Saturday of each month when the instance can be shut down.

Peak usage varies across available time frame: This database is accessed globally, so it is used throughout the 24-hour period of one day.

Daily backups: Full database backups are required on a daily basis.

Complete database recovery: This is a critical business application database and data loss cannot be tolerated. A high number of transactions occur over the 24-hour time frame.

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Database Configuration

- Archiving is enabled.
- Log files are mirrored and distributed across multiple devices.
- Control files are mirrored and distributed across multiple devices.
- Flashback Database is enabled.
- Full backup of the database exists, including archive log files.

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Database Configuration

The first scenario sets up your environment to meet these requirements. Because of the limitations of the servers used in the classroom, all the critical database files reside on the same disk for this workshop.

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Method for Resolving Database Issues

- Phase I: Diagnose the problem.
- Phase II: Determine the appropriate method to resolve the problem.
- Phase III: Resolve the problem.
- Phase IV: Back up the database, if needed.

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Method for Resolving Database Issues

The workshop is a hands-on exercise. For data failure scenarios, you can choose the restore and recovery operation that you deem appropriate for the situation. Multiple failure and recovery scenarios will be conducted during the workshop.

The instructor will not tell you which failure occurs in each scenario. To complete each task, use the features and techniques learned in this course.

Phase I: Diagnose the Problem

1. The first phase is to research the nature of the problem. Use the EM Database Control Console, data dictionary views, trace and log files, and basic operating system commands to collect information.
2. Determine whether the database instance is available and the database is open.
3. Attempt to start the instance.
4. Shut down the instance if a problem occurs while starting it or when opening the database.
5. Check the Database Alerts region in the Database home page. Also, check the trace files and the alert log file as needed.
6. Check the Job Activity section in the Database home page of the Database Control Console to verify that all application jobs are running without error. Investigate any execution problems.

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Method for Resolving Database Issues (continued)

Phase I: Diagnose the Problem (continued)

7. If recovery is needed, determine the appropriate recovery method:
   - Complete recovery
   - Point-in-time recovery
   - Flashback Database or other flashback operations

Phase II: Decide on a Resolution Plan

Because each scenario can have multiple solutions, you should evaluate your options and decide on the best method for resolving the problem. You can use group discussion to formulate your resolution plan.

If your resolution plan involved data recovery, determine what files to restore and what state the instance and database must be in to perform the recovery. Remember that the objective is to minimize down time and loss of data, so do not restore a file or shut down the database unless you must.

Phase III: Resolve the Problem

Implement your solution. For example, if resolving a data failure, restore the appropriate files and initiate your recovery operation.

After completing the task, note any proactive measures that can be taken to prevent that type of problem in the future.

Phase IV: Back Up the Database

Not all recovery operations require a database backup when they are complete. However, determine whether your database needs to be backed up after performing your chosen recovery method, and if so, perform another backup.

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Summary

- Instructor-facilitated workshop
- Team-oriented
- Hands-on approach
- Use tools and diagnostics to:
  - Monitor database performance
  - Identify problems and potential problems
- Minimize down time and data loss

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Summary

Instructor-Facilitated Workshop

The instructor will facilitate the workshop by providing guidance and additional information as appropriate.

Group-Oriented Emphasis

A strong emphasis is placed on teaming with other students in the workshop for purposes of diagnosing and resolving failures. The ability to complete each scenario successfully is based on the cumulative knowledge and problem resolution skills of each group.

Hands-On Approach

This is meant to be a hands-on workshop, providing you with the maximum allowable time to be involved in a lab situation.

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Practice Overview: Workshop Setup

This practice covers the following topics:

- Restoring the database to a previous point in time
- Performing a physical investigation of the database:
  - Using the Enterprise Manager Database Control Console
  - Using views and tools
  - Viewing command output and log files
  - Viewing trace files and the alert log
- Modifying the database configuration to meet business requirements
- Resolving typical database administrative issues

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Practice Overview: Workshop Setup

For the practice exercise, you will restore the backup of the database taken in the first practice exercise of this course. After the database is restored, you will investigate the database, alter its configuration to meet business requirements, and work through various scenarios to simulate typical database administrator tasks.

Physical Investigation

Use the features of Oracle Database 10*g*, such as Enterprise Manager, SQL*Plus, the `V$` views and other data dictionary views, to derive information about your database environment. Keep the business requirements in mind and note any deficiencies that you feel will need to be corrected to support these requirements.

Database Configuration

Physically modify the database configuration to ensure that the business requirements can be met.

Database Administration

Work through the scenarios, in any order, to gain experience in resolving typical database administrative tasks and procedures.

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Workshop: Database Configuration Checklist

Use Enterprise Manager Database Control to determine and record your database's current settings for the following.

Tablespace and Data File Information

Navigation aid: Administration > Datafiles

Tablespace Name	Data File Name (full path)

Online Redo Log File Information

Navigation aid: Administration > Redo Log Groups

Group #	Redo Log File Name (full path)	Size	Status

Control File Information

Navigation aid: Administration > Control Files

Control File Name (full path)

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Workshop: Database Configuration Checklist (continued)

Initialization Parameters

Navigation aid: Administration > All Initialization Parameters

Parameter Name	Value
BACKGROUND_DUMP_DEST	
CORE_DUMP_DEST	
DB_BLOCK_CHECKING	
DB_BLOCK_SIZE	
DB_CACHE_SIZE	
DB_FILES	
DB_NAME	
DB_RECOVERY_FILE_DEST	
DB_RECOVERY_FILE_DEST_SIZE	
LOG_ARCHIVE_DEST_*n*	
LOG_ARCHIVE_DEST_*n*_STATE	
LOG_ARCHIVE_FORMAT	
SGA_MAX_SIZE	
SGA_TARGET	
USE_RECOVER_FILE_DEST	
USER_DUMP_DEST	

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Appendix A
Practices

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Practice 2: Configuring Recovery Manager

Background: You need to configure backup and recovery settings. Some of this you do with RMAN, and some with Enterprise Manager. These settings will, unless overridden later, provide the configuration for the backup and recovery activity you do later. These configurations include defining retention policy, control-file autobackup, and excluded tablespaces.

Important Note: As preparation for the workshop at the end of this course, before doing anything else, run the following script in an XTerm command shell to prepare a copy of your database files:

```
$ $HOME/labs/lab_02_copy.sh
```

1. Set the `NLS_DATE_FORMAT` environment variable to `"yyyy-mm-dd hh24:mi:ss"` in your XTerm window, and then connect to your database as the target database in the default `NOCATALOG` mode as the `SYS` user.

2. Use the RMAN `SHOW ALL` command to generate a listing of the RMAN configuration settings.

3. Configure RMAN to automatically back up the control file and SPFILE whenever a backup of the database or data files is taken. Leave the RMAN session connected. You will need it again.

4. Use the Enterprise Manager (EM) Database Control Console to set the backup retention policy to a recovery window of 2 days. Log in to the Database Control Console as the `SYS` user (with password `oracle`, connect as `SYSDBA`). If this is the first time you are logging in to EM as the `SYS` user, you will need to click "I agree" on the License Agreement screen. The URL is of this format:

   `http://<machine_name>.us.oracle.com:1158/em`

   Your machine name appears in the upper-left corner of the Xterm window you started. You can also look in the `$ORACLE_HOME/install/readme.txt` file and find the URL under the "Enterprise Manager 10*g* Database Control URL" heading.

5. Verify the backup retention policy setting using the RMAN utility and the `SHOW` command.

6. Application development tells you that there will be a daily loading of data from an external source, and there needs to be a staging area set up for that data. Run the `lab_02_06.sql` script to create the `STAGING` tablespace, to hold this data. Then configure RMAN to exclude this tablespace from backup tasks. You can do this because, if you ever lose this data, you do not need to recover it; you can simply reload the data from the external source. Then verify that the tablespace is excluded.

7. Exit RMAN.

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Practice 3: Using Recovery Manager

Background: In this exercise, you become familiar with using RMAN to perform and manage backups. You need to put your database into `ARCHIVELOG` mode, and take a full backup of your database.

1. Using SQL*Plus or the EM Database Control Console, verify that the database is in `ARCHIVELOG` mode. If not, alter the database to enable archiving of the online redo logs. Note that the database must be in the `MOUNT` state in order to change the archive log mode. Ensure that the database is open after this step.

   Note: If you see the following error, click OK, and continue to click Refresh. This error will go away eventually.

2. Connect to your database using RMAN in the `NOCATALOG` mode. You cannot use an existing RMAN session because the database has been restarted. First, ensure that your XTerm shell has the `NLS_LANG` environment variable set as indicated in Practice 2.

3. Use the RMAN `REPORT` command to generate a listing of your database structure.

4. Obtain a listing of all database backup sets that currently exist. There should be none.

5. Use RMAN to back up the data files belonging to the `EXAMPLE` and `USERS` tablespaces. Verify that:
   - The current control file and the server parameter file are backed up with this backup
   - Your backups are placed in the flash recovery area
   - The format of the backup is a backup set

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Practice 3: Using Recovery Manager (continued)

6. Create an image copy of two data files. Use the following information:
   - Make an image copy of the `SYSTEM` tablespace in the flash recovery area, with a tag of `SYSTEM01`.
   - Make an image copy of the `SYSAUX` tablespace in the `ORACLE_HOME` directory, and name the copy `sysaux01.cpy` with a tag of `SYSAUX01`.

   What are the locations of each of the two backup files?

   ____

   ____

   The output file for this backup file is highlighted above. Yours should match this exactly.

7. Obtain a listing of all the database files that have not been backed up. Note that the STAGING tablespace is still excluded from backup.

8. Take a full backup of the database, including archived logs. Use as little space as possible to store the backup. Also be sure to include the excluded tablespace, just for this backup. Afterward, list the files that need to be backed up, and list the database backups.

9. Configure RMAN to include the STAGING tablespace in all future backups.

   Note: *If you put STAGING in quotes in the command to exclude it from backups in Practice 2, then you must do so again for these steps, and you must also match the case that you used in Practice 2.*

10. Exit RMAN.

11. Now that you have a full database backup, remove the image copy backups that were made of the `system01.dbf` and the `sysaux01.dbf` data files. This will save some disk space. Use Enterprise Manager to do this.

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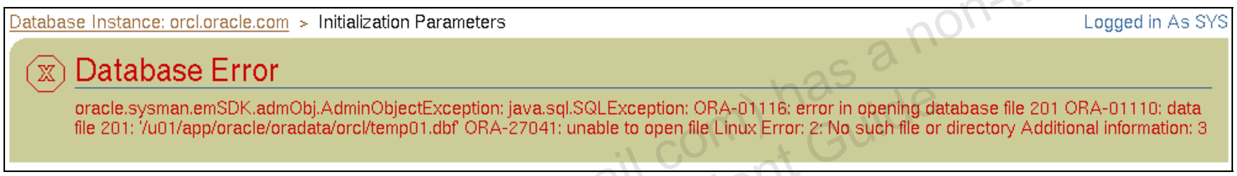
Practice 4: Recovering from Noncritical Losses

Background: The default `TEMP` tablespace is defined for a database. It is where sorts and other memory-hungry operations are performed when they cannot fit into memory. If the data files of the `TEMP` tablespace are lost or damaged, you need only to add a new file to the `TEMP` tablespace and drop the old one. Also, only a redo log member needs to be re-created if it is lost or damaged. In the following exercises, you encounter and deal with a lost tempfile belonging to the `TEMP` tablespace, and a lost online redo log member. Note that the password for the `HR` user is `hr`.

1. Use Enterprise Manager to view all the initialization parameters.

2. Run the `lab_04_02.sh` script to remove the tempfile in the TEMP tablespace.

3. In Enterprise Manager, again, attempt to view all the initialization parameters. You should get an error regarding the missing `temp01.dbf` file.



Note: *If you do not see the error, log out of Enterprise Manager and log in again.*

4. Recover from the missing tempfile error by creating a new tempfile in the `TEMP` tablespace and dropping the missing one. The new tempfile should be of size 25 MB, and should be allowed to extend to a size of 100 MB. Then try again to view the initialization parameters as described in step 3.

5. Recover from a missing online redo log file. First, run the `lab_04_05_a.sql` script that creates a second redo log file for each redo log group. Then run the `lab_04_05_b.sh` script that removes one of the online redo log files. Run the `lab_04_05_c.sql` script to elicit the error. Recover from the missing file.

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Practice 5: Database Recovery

Background: As the DBA, you get a call from some users stating that there is incorrect data in the HR application. Payroll states that the sum of all salaries is supposed to be $691,400. It is now $679,050. Also, there should be no department changes within the last 60 days, but the `JOB_HISTORY` table shows changes from today. You realize that the personnel reorganization batch job must have run earlier than it should have, so you need to undo those far-reaching and multitable changes, including some made by triggers. Note that the password for the HR user is `hr`.

1. In order to simulate the incorrectly run batch job, run the `lab_05_01.sql` script.

2. Verify that the information about the salary sum and the job history is as reported to you by the users.

3. You realize that undoing all these changes manually is too complex and error prone because of the tables and triggers involved. So, you decide to restore the entire database to a previous point in time. You know that the first modifications done in the reorganization batch job are the department changes. So, you look at the time of the first change in the `JOB_HISTORY` table, and decide to restore the database to a time that is one minute before then. Perform the restore.

   Note the date and time. ________________________________

4. Verify that the database is restored to a point where the HR data does not have the reorganization changes.

5. Exit SQL*Plus.

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Practice 6: Flashback

Background: The same scenario is executed here that was done in the practice titled "Database Recovery." The HR reorganization job runs prematurely, and you must undo its changes. The changes are such that you are not sure what tables are involved, so you decide, now that flashback logging has been enabled, to use Flashback Database instead of performing a recovery. Unless specified otherwise, you should log in as the `SYS` user as `SYSDBA` through either SQL*Plus or Database Control.

1. Using Enterprise Manager, turn on flashback logging for your database (enable Flashback Database).

2. After the database has been restarted with flashback logging enabled, note the current SCN of the database by querying the `V$DATABASE` view.

   Note: *You will need this later.*

   Current SCN: ________________

3. Note the sum of the salaries in the `HR.EMPLOYEES` table, and the count of the rows in the `JOB_HISTORY` table.

   Salary sum: ____________________

   Row count: ____________________

4. Run the `lab_06_04.sql` script to perform the same HR reorganization updates as was run in the practice for the lesson titled "Database Recovery."

5. Note the current SCN in the database again, and also the salary sum and the `JOB_HISTORY` row count. If you are not connected as the SYS user, do that first. Note that these values are different from what was queried in steps 2 and 3.

6. Use the `FLASHBACK DATABASE` command of RMAN to flash back the database to the first SCN value noted in step 2.

7. Before opening the database for read/write verify that the database was flashed back to the correct SCN by looking at the contents of the tables and seeing that they are back to what was noted in step 3.

8. Open the database for read/write use. You will have to use the RESETLOGS keyword.

9. At this point, you can familiarize yourself with the flashback-related dynamic views. In preparation for seeing the time values, alter your session to display hours, minutes, and seconds with any date values.

10. Query the `V$FLASHBACK_DATABASE_LOG` view and determine the lowest SCN that the database can be flashed back to. Record your answer here: _____________

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Practice 6: Flashback (continued)

11. View the overhead associated with flashback logging and related operations by querying `V$FLASHBACK_DATABASE_STAT`. What is the average number of bytes of flashback data written per minute during this time interval?

    ____

12. Determine the current size of stored flashback data by querying `V$FLASHBACK_DATABASE_LOG`. Record your answer here: _____________.

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Practice 7: Dealing with Database Corruption

Background: In the practice, a data file is deliberately corrupted, and you see the results of it as you query the affected table. You need to determine the location of the corruption and correct the problem.

1. In order to introduce corruption into the `DEPARTMENTS` table, you need to find out the OS file name in which its data is stored, and also an OS file block ID that is in the `DEPARTMENTS` table portion of the file. Query the `DBA_SEGMENTS` view to find the file ID and block ID for the `DEPARTMENTS` segment. Then determine the name of the associated OS file by querying the `DBA_DATA_FILES` view.

   Record these values here:

   File ID: _____________

   Block ID: _____________

2. Run the `lab_07_02.sh` script to introduce corruption into the `example01.dbf` data file in the block number reported above. The order of the parameters to the script are the fully qualified file name, then the block number, and then the block size. The block size is `8192`. This script writes the characters `CORRUPT` into the given block number.

3. Flush the buffer cache so that any queries against the `DEPARTMENTS` table are forced to go to the data file on disk. Then select all the columns of the `DEPARTMENTS` table and note the error. Use the following command to flush the buffer cache:

```
SQL> ALTER SYSTEM FLUSH BUFFER_CACHE;
```

4. Run the `dbv` utility to report all corruption in the `example01.dbf` file.

5. View the alert log to see the details of the corruption.

6. Perform block media recovery using the `BLOCKRECOVER DATAFILE` command of RMAN. Use the `DBVERIFY` output from the previous step to determine the blocks that need to be recovered.

7. Verify that the block recover operation was successful by again flushing the buffer cache and querying the `DEPARTMENTS` table.

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Practice 8: Monitoring and Managing Memory

Background: This exercise puts your database in a mode where it is not running as efficiently and flexibly as possible. New objects are then introduced, and the database is unable to adjust. You must determine the cause of the problem and reconfigure the database so that it is able to accommodate the new objects dynamically. Unless specified otherwise, you should be logging in as `SYSDBA` either through Database Control Console or SQL*Plus.

1. Make sure you are in the `labs` directory under the `oracle` user home. Use SQL*Plus to shut down your instance, and start it up again using the `init_sgalab.ora` initialization parameter file located in your `labs` directory. You need to use the `PFILE` parameter with the `STARTUP` command.

2. Execute the `lab_08_02.sql` script. This script attempts to create many Java stored procedures.

   Question: What appears to be the cause of the error?

   ____

3. Use Database Control Console to check the size of the various SGA buffers of your instance.

   Question 1: Is Automatic Shared Memory Management enabled?

   ____

   Question 2: What is the size of the Java Pool?

   ____

4. Run the `lab_08_04.sql` script as the `SYS` user to see the current memory settings. Are there any SGA dynamic components that have a `CURRENT_SIZE` different from `MIN_SIZE`? Explain your answer.

   ____

   ____

5. Use Automatic Shared Memory Management to correct the problem so that the Java stored procedures can be created, but do not reattempt the stored procedure creation script yet.

6. Run the `lab_08_04.sql` script again to see memory-related information. Be sure to run the script as the `SYS` user `AS SYSDBA`. Then answer the following questions:

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Practice 8: Monitoring and Managing Memory (continued)

Question 1: What value do you expect to see now for the `SGA_TARGET` initialization parameter? You can verify your answer by looking at the output of the `lab_08_04.sql` script.

Note: *There may be some rounding based on the granule size.*

____

Question 2: View the last 20 lines of the alert log to see the commands that were issued as a result of enabling ASMM. Why are the automatically managed pools set to a size of zero?

____

Question 3: Why is the `DB_CACHE_SIZE` set to a nonzero value?

____

Question 4: Why do you think the Java stored procedures could not be created?

____

7. Rerun the `lab_08_02.sql` script to create the Java stored procedures. How much memory has been added to the Java Pool as a result of this script completing?

   ____

8. Run the `lab_08_drop_javas.sql` script to drop the Java objects.

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Practice 9: Automatic Performance Management

Background: Run a script that generates load on the database. Then use Automatic Database Diagnostic Monitor to determine the problem. You need to evaluate a few different candidate causes of the problem until you find the real cause. Unless specified otherwise, you should be logging in as SYSDBA either through Database Control Console or SQL*Plus.

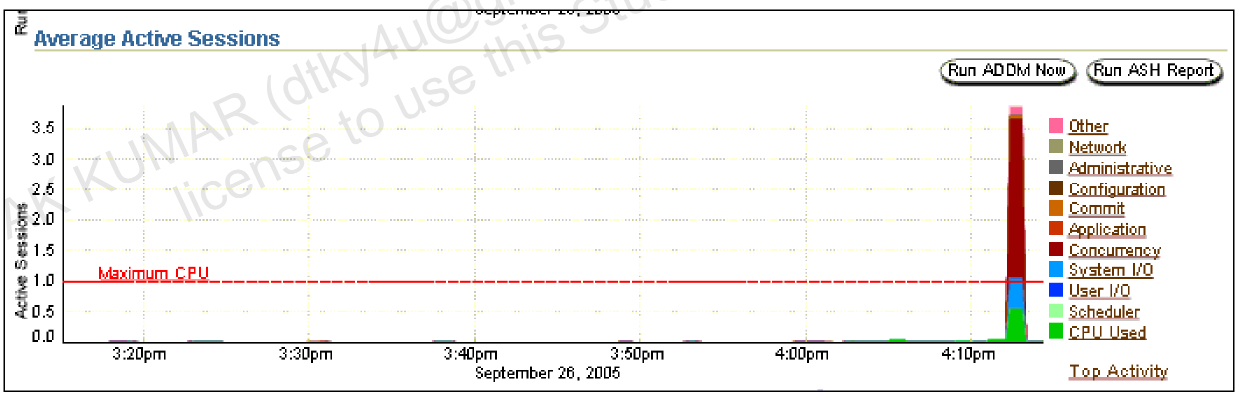
1. Run the `lab_09_01.sql` script to create the `TBSADDM` tablespace and create the `ADDM` user, which has the password **addm**.

2. Run the `lab_09_02.sql` script to create a table in the new tablespace.

3. As the `oracle` Linux user, execute the `lab_09_03.sh` script from your labs directory. Wait for the eight stored procedures to complete.

4. On the Database Control Console home page, click the Performance tabbed page. On the Performance page, make sure that the View Data field is set to “Real Time: 15 Seconds Refresh.” After two minutes, you should see a spike on the Average Active Sessions graph.

   Note: If you see a pop-up screen asking you to accept or decline the SVG Viewer agreement, type [A] to accept. Using the SVG Viewer enhances the graphical displays of Enterprise Manager. The screenshots shown below do not use the SVG Viewer.



5. After the spike is finished, execute the `lab_09_05.sql` script as the `ADDM` user. This script forces the creation of a new snapshot. Looking at the graph, you can already determine that this instance is suffering concurrency problems.

6. Return to the Database Home page. The latest ADDM result might not yet be displayed in the Diagnostic Summary region. To avoid waiting for the next refresh interval, retrieve the latest ADDM findings from the Advisor Central, and determine the cause of the problem by looking into the top two highest impact findings.

   Note: *Because of the variations in environments, this load may not have generated any findings. If that is the case, perform the above steps 3 through 5 again, to generate another load.*

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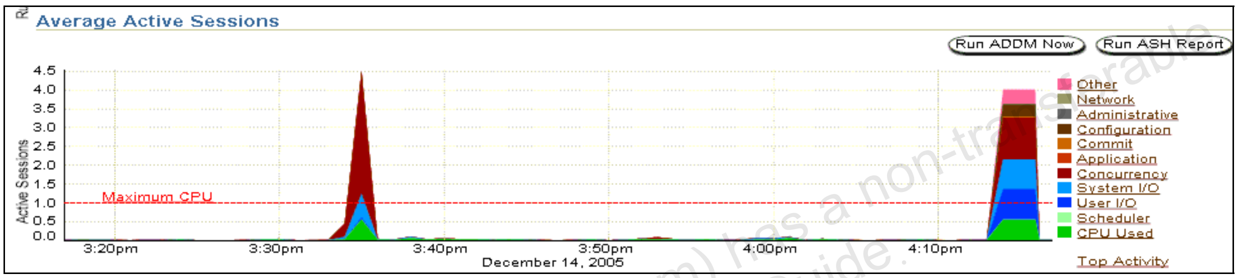
Practice 9: Automatic Performance Management (continued)

7. To implement the recommendation, you must re-create the objects. Create a new tablespace called `TBSADDM2` that uses the Automatic Space Management feature.

8. Execute the `lab_09_08.sql` script from your labs directory to drop the `ADDM` table and re-create it in the new tablespace. This script also gathers statistics on the table and takes a new snapshot.

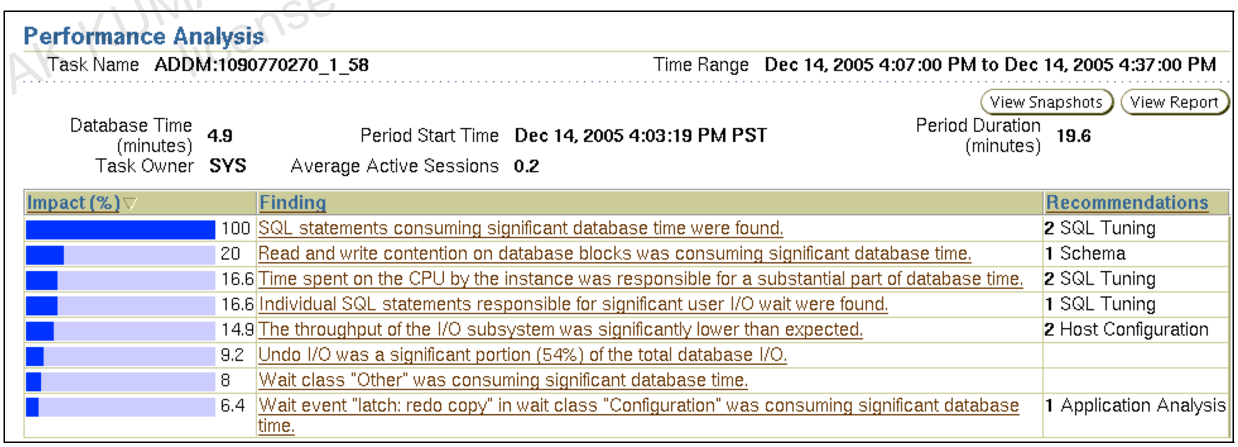
9. Rerun the `lab_09_03.sh` script.

10. View the load spike using Enterprise Manager.



11. When the spike is finished, connect to the database as the `ADDM` user using SQL*Plus and execute the `lab_09_11.sql` script. This script forces the creation of a new snapshot.

12. From the Database Control Console home page, go to Advisor Central and look at the latest snapshot. Has the situation improved?



Performance Analysis

Task Name **ADDM:1090770270_1_58** Time Range **Dec 14, 2005 4:07:00 PM to Dec 14, 2005 4:37:00 PM**

View Snapshots | View Report

Database Time (minutes) **4.9** Period Start Time **Dec 14, 2005 4:03:19 PM PST** Period Duration (minutes) **19.6**

Task Owner **SYS** Average Active Sessions **0.2**

Impact (%)	Finding	Recommendations
100	SQL statements consuming significant database time were found.	2 SQL Tuning
20	Read and write contention on database blocks was consuming significant database time.	1 Schema
16.6	Time spent on the CPU by the instance was responsible for a substantial part of database time.	2 SQL Tuning
16.6	Individual SQL statements responsible for significant user I/O wait were found.	1 SQL Tuning
14.9	The throughput of the I/O subsystem was significantly lower than expected.	2 Host Configuration
9.2	Undo I/O was a significant portion (54%) of the total database I/O.	
8	Wait class "Other" was consuming significant database time.	
6.4	Wait event "latch: redo copy" in wait class "Configuration" was consuming significant database time.	1 Application Analysis

13. To clean up your environment, execute the `lab_09_cleanup.sql` script.

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Practice 10: Managing Schema Objects

Background: Your company is going through a merging process. As a result, you expect some dramatic growth in a few tables of the databases for which you are responsible. To proactively monitor table and index space usage, you create a test case and perform the tasks, which you expect for your production system.

Log in as the `SYS` user (with `oracle` password, connect as `SYSDBA`) and perform the necessary tasks either through Enterprise Manager Database Control or through SQL*Plus. All scripts for this practice are in the `/home/oracle/labs` directory.

1. Run the `lab_10_01.sh` script to create the `TEST_REGIONS` table.

   Question 1: What does `PCTFREE 10` mean?

   ____

2. Populate the `TEST_REGIONS` table by running the `lab_10_02.sh` script.

   Question 2: On the Tables page, what is the number of rows for the `TEST_REGIONS` table, and why?

   ____

3. Best practices recommend that you gather new statistics after major DML activities, such as populating a new table. Do so for the `HR.TEST_REGIONS` table.

4. View the segment information for the `HR.TEST_REGIONS` table, which you can access on the Edit Table Segments page.

   While you look at the segment information for the `HR.TEST_REGIONS` table, you notice that the table segment has a "Wasted Space (%)" of over 20%. You decide to reorganize the tablespace usage. After doing that, confirm that your job succeeded and view the current space usage again. Did it increase or decrease?

   Question 3: What is the cause of the wasted space?

   ____

5. Delete the `HR.TEST_REGIONS` table by running the `lab_10_05.sh` script. (This ensures that other practice sessions are not affected by this extra table.)

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Practice 11: Managing Storage

Background: As preparation for the upcoming merger, you want to set the warning and critical thresholds to a lower value than the default. Ensure that you receive early warnings, to give you more time to react. When you have finished with your test case, drop the tablespace, which you used.

Log in as the SYS user (with oracle password, connect as SYSDBA) and perform the necessary tasks either through Enterprise Manager Database Control or through SQL*Plus. All scripts for this practice are in the /home/oracle/labs directory.

1. Using the DBMS_SERVER_ALERT.SET_THRESHOLD procedure, reset the databasewide threshold values for the Tablespace Space Usage metric. You can use the lab_11_01.sh script.

2. In SQL*Plus, check the databasewide threshold values for the Tablespace Space Usage metric by using the following command:

```
SELECT warning_value,critical_value
FROM   dba_thresholds
WHERE  metrics_name='Tablespace Space Usage'
AND    object_name IS NULL;
```

3. Create a new tablespace called TBSALERT with a 120 MB file called alert1.dbf. Make sure that this tablespace is locally managed and uses Automatic Segment Space Management. Do **not** make it autoextensible, and do **not** specify any thresholds for this tablespace. Use Enterprise Manager Database Control to create it. If this tablespace already exists in your database, drop it first, including its files.

4. In Enterprise Manager, change the Tablespace Space Usage thresholds of the TBSALERT tablespace. Set its warning level to 55 percent and its critical level to 70 percent.

5. Using SQL*Plus, check the new threshold values for the TBSALERT tablespace.

6. Select the reason and resolution columns from DBA_ALERT_HISTORY for the TBSALERT tablespace.

7. Execute the lab_11_07.sh script that creates and populates new tables in the TBSALERT tablespace.

8. Check the fullness level of the TBSALERT tablespace by using either Database Control or SQL*Plus. The current level should be around 60%. Wait for approximately 10 minutes, and check whether the warning level is reached for the TBSALERT tablespace.

9. Execute the lab_11_09_a.sh script to add data to TBSALERT. Wait for 10 minutes and view the critical level in both the database and Database Control. Verify that the TBSALERT fullness is around 75%.

10. Execute the lab_11_10.sh script. This script deletes rows from tables in TBSALERT.

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Practice 11: Managing Storage (continued)

11. Now, run the Segment Advisor for the TBSALERT tablespace by using Database Control. Make sure that you run the Advisor in Comprehensive mode without time limitation. Accept and implement its recommendations. After the recommendations have been implemented, check whether the fullness level of TBSALERT is below 55%.

12. Wait for approximately 10 more minutes, and check that there are no longer any outstanding alerts for the TBSALERT tablespace.

13. Retrieve the history of the TBSALERT "Tablespace Space Usage" metric for the last 24 hours.

14. Reset the databasewide default thresholds from the Tablespace Space Usage metric for the TBSALERT tablespace.

15. Because you have finished with your test case, execute the `lab_11_15.sh` script to drop your TBSALERT tablespace.

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Practice 12-1: Automatic Storage Management

Exercise 1: Creating and Configuring an ASM Instance

Background: Currently there is no ASM instance running on your database server. You need to create one and start it, pointing it to the already configured raw disk partitions. Then create a tablespace on that disk group. Also, you are going to create a tablespace on conventional storage, and then migrate it to ASM storage.

Unless specified otherwise, you should log in as the SYS user, as SYSDBA through either Database Control or SQL*Plus.

In this practice, you create an ASM instance, configure the ASM initialization parameters, create disk groups, and create a tablespace that uses ASM storage.

1. Use DBCA to create the ASM instance on your machine. Implement the following configuration within DBCA:

   Change the default values for the ASM initialization parameter disk discovery string to "/dev/raw/raw*" (without quotation marks).

   Create one disk group called DGROUP1 that uses the following four ASM disks:

   /dev/raw/raw1

   /dev/raw/raw2

   /dev/raw/raw3

   /dev/raw/raw4

   Specify that DGROUP1 is using normal redundancy.

   When needed, enter oracle as the password for root.

2. Leave the Linux command window open for later use.

3. Connect to your ASM instance as oracle in your OS command shell. List the processes associated with it. You must set ORACLE_SID to +ASM before starting your ASM instance.

4. Review the ASM processes at the operating-system level, and query V$ASM_DISKGROUP to view the disk group characteristics.

5. Connect to the orcl instance, and create a new tablespace called TBSASM that is stored inside the ASM disk group DGROUP1. The tablespace should have one 5 MB data file. Before starting SQL*Plus, exit from your current shell and log back in as oracle. This resets the ORACLE_SID environment variable overwritten earlier for your ASM instance.

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Practice 12-2: Automatic Storage Management (continued)

Exercise 2: Migrating Tablespaces to ASM Storage

In this practice, you migrate a tablespace to use ASM storage.

1. Using SQL*Plus, connect to your database instance as a `SYSDBA` user and create a new tablespace called `TBSASMMIG.` This tablespace should contain only one 10 MB file stored in your file system (not using ASM). Make sure that you are connecting to the `orcl` instance and not the ASM instance.

2. Create a table called `T2` stored in the new tablespace `TBSASMMIG`. Insert one row inside `T2.` Commit your work.

3. Migrate `TBSASMMIG` to ASM storage. When done, check whether the migration is successful and the table within the tablespace is intact.

4. Clean up your environment by dropping tablespace `TBSASMMIG`, including its contents and data file. Also, remove the standard file system file that was created in step 1 to store the `TBSASMMIG` tablespace.

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Practice 13: Managing Resources

Background: You received complaints that certain batch jobs are using too many system resources and that a specific user is known to start data warehouse processes during regular business hours. You decide to use the Database Resource Manager for better system resource utilization and control.

Your first effort to balance the situation includes creating an APPUSER consumer group and assigning it to the default SYSTEM_PLAN resource plan. Then, you map a couple of Oracle users and your major OS user to resource groups. Activate the resource plan and test your assignments. Regularly, click Show SQL to review all statements that are new to you.

Log in as the SYS user (with oracle password, connect as SYSDBA) and perform the necessary tasks either through Enterprise Manager Database Control or through SQL*Plus. All scripts for this practice are in the /home/oracle/labs directory.

1. Using Enterprise Manager Database Control, create a resource group called APPUSER. At this point, do not add users to the group. View the generated SQL.

   Question 1: What does the ROUND-ROBIN parameter value mean?

   ____

2. Add the APPUSER consumer group to the SYSTEM_PLAN resource plan. Change the level 3 CPU resource allocation percentages: 60% for the APPUSER consumer group and 40% for the LOW_GROUP consumer group.

3. Configure Consumer Group Mappings, so that the HR Oracle user belongs to the APPUSER consumer group, and the SCOTT Oracle user to the LOW_GROUP consumer group. Confirm that the ORACLE_USER attribute has a higher priority than the CLIENT_OS_USER attribute.

4. Configure Consumer Group Mappings, so that the oracle OS user belongs to the SYS_GROUP consumer group.

5. Assign the PM Oracle user to the following consumer groups: APPUSER, LOW_GROUP, and SYS_GROUP.

6. Execute the lab_13_06.sh script to unlock the HR, SCOTT, OE, and PM Oracle user accounts. Set the password to match the username.

7. Activate the SYSTEM_PLAN resource plan.

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Practice 13: Managing Resources (continued)

8. Test the consumer group mappings. Start two SQL*Plus sessions, the first with the `system/oracle@orcl` connect string and the second with the `scott/scott@orcl` connect string.

   a. In a terminal window, enter:

```
cd /home/oracle/labs
sqlplus system/oracle@orcl
```

   b. In your SQL*Plus session, enter:

```
SET SQLPROMPT "FIRST>"
```

   c. In a second terminal window, enter:

```
cd /home/oracle/labs
sqlplus scott/scott@orcl
```

   d. In your second SQL*Plus session, enter:

```
SET SQLPROMPT "SECOND>"
```

   e. In your `FIRST` SQL*Plus session, enter:

```
@lab_13_08_e.sql
```

   f. ***Question:*** To which consumer group does the `SCOTT` user belong?

   ____

   g. In the `SECOND` terminal window, enter:

```
connect pm/pm@orcl
```

   h. In your `FIRST` SQL*Plus session, enter / (a slash) to execute the previous SQL statement again.

   i. ***Question:*** To which consumer group does the `PM` user belong?

   ____

   j. In the `SECOND` terminal window, enter:

```
connect oe/oe@orcl
```

   k. In your `FIRST` SQL*Plus session, enter / (a slash) to execute the previous SQL statement again.

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Practice 13: Managing Resources (continued)

l. *Question:* When testing your OE Oracle user, you notice that OE is in the OTHER_GROUPS consumer group. Why is that?

9. Deactivate the SYSTEM_PLAN resource plan.

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Practice 14-1: Monitoring the Scheduler

Background: Because your job tasks are regularly increasing, you decide to automate routine tasks. First, you monitor existing scheduler elements, and then you create scheduler components and test them.

In this practice, you use Enterprise Manager Database Control to define and monitor the Scheduler and automate tasks. Regularly, click Show SQL to review all statements that are new to you.

Log in as the `SYS` user (with `oracle` password, connect as `SYSDBA`) or as `HR` user (with `HR` password, connect as `Normal`), as indicated. Perform the necessary tasks either through Enterprise Manager Database Control or through SQL*Plus. All scripts for this practice are in the `/home/oracle/labs` directory.

1. Log in to Enterprise Manager Database Control as the `SYS` user, and grant the following roles to the `HR` user:
   - `CONNECT` role
   - `RESOURCE` role
   - `DBA` role

   Because you are going to use the `HR` user to administer jobs through Database Control, you need to make sure that `HR` is registered as a possible administrator.

2. Log in to Enterprise Manager Database Control as the `HR` user. On the Administration tabbed page, click the Jobs link in the Database Scheduler region.

   Question: Are there any jobs?

   ____

3. Review the Programs page in Enterprise Manager. (**Hint:** Use the browser's **Back** button.)

   Question: Are there any existing programs?

   ____

4. Review the Scheduler Schedules page in Enterprise Manager.

   Question: Are there any existing schedules?

   ____

5. Review the Scheduler Windows page in Enterprise Manager. Are there any existing windows? Which resource plan is associated with each window?

   Question 1: Are there any existing windows? What are their names?

   ____

   ____

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Practice 14-1: Monitoring the Scheduler (continued)

Question 2: Which resource plan is associated with the `WEEKNIGHT_WINDOW` window?

____

Question 3: Which resource plan is associated with the `WEEKEND_WINDOW` window?

____

6. Review the Scheduler Job Classes page in Enterprise Manager. Are there any existing job classes? If so, which resource consumer group is associated with each job class?

   Question 1: Are there any existing job classes?

   ____

   Question 2: Which resource consumer group is associated with the `DEFAULT_JOB_CLASS` job class?

   ____

   Question 3: Which resource consumer group is associated with the `AUTO_TASKS_JOB_CLASS` job class?

   ____

   ____

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Practice 14-2: Creating Scheduler Components

In this practice, you use Enterprise Manager Database Control to create Scheduler objects and automate tasks.

Prerequisite: Ensure that you completed the previous step 1, which gives the HR user administrative privileges.

1. While logged in to the database as the HR user in Database Control, create a simple job that runs a SQL script:
   - General:
     Name: CREATE_LOG_TABLE_JOB
     Owner: HR
     Description: Create the SESSION_HISTORY table for the next part of this practice
     Logging level: RUNS
     Command type: PL/SQL
     PL/SQL block: `BEGIN execute immediate('create table session_history(snap_time TIMESTAMP WITH LOCAL TIME ZONE, num_sessions NUMBER)'); END;`
     (*You can find this block in your* `lab_14_02_01.sql` *file.)*
   - Schedule:
     Repeating: Do not Repeat
     Start: Immediately
   - Options:
     No special options

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2. Create a program called LOG_SESS_COUNT_PRGM that logs the current number of database sessions into a table. Use the following code, which is also provided in the `lab_14_02_02.sql` script:

```
DECLARE
sess_count   NUMBER;
BEGIN
SELECT COUNT(*) INTO sess_count FROM V$SESSION;
INSERT INTO session_history VALUES (systimestamp,
sess_count);
COMMIT;
END;
```

3. Create a schedule named SESS_UPDATE_SCHED owned by HR that executes every three seconds. Use SQL*Plus and the DBMS_SCHEDULER.CREATE_SCHEDULE procedure to create the schedule.

```
BEGIN
  DBMS_SCHEDULER.CREATE_SCHEDULE (
   schedule_name => 'SESS_UPDATE_SCHED',
   start_date => SYSTIMESTAMP,
   repeat_interval => 'FREQ=SECONDLY;INTERVAL=3',
   comments => 'Every three seconds');
END;
/
```


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Practice 14-2: Creating Scheduler Components (continued)

Return to Enterprise Manager Database Control, and verify that the SESS_UPDATE_SCHED schedule is created.

Hint: You may have to refresh the page for the Schedule to appear.

4. Using Enterprise Manager Database Control, create a job named LOG_SESSIONS_JOB that uses the LOG_SESS_COUNT_PRGM program and the SESS_UPDATE_SCHED schedule. Make sure that the job uses FULL logging.

5. In your SQL*Plus session, check the HR.SESSION_HISTORY table for rows.

   Question: If there are rows in the table, are the time stamps three seconds apart?

   ____

6. Use Enterprise Manager Database Control to alter the SESS_UPDATE_SCHED schedule from every three seconds to every three minutes. Then use SQL*Plus to verify that the rows are now being added every three minutes: query the HR.SESSION_HISTORY table, ordered by the SNAP_TIME column.

7. **This is your mandatory cleanup task.** Use Enterprise Manager to drop the LOG_SESSIONS_JOB and CREATE_LOG_TABLE_JOB jobs, the LOG_SESS_COUNT_PRGM program, and the SESS_UPDATE_SCHED schedule. Use SQL*Plus to drop the SESSION_HISTORY table, and exit from your session.

   Note: ***Make sure that you do not delete the wrong schedule.***

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Practice 15: Database Security

Background: Your organization has an increased need for database security. You have been asked to prepare a demonstration for your technical colleagues on how transparent data encryption works. First, you create a new encrypted wallet using Oracle Wallet Manager. Then (as SYSDBA), you open the wallet, set an encryption key, and create the TDE_DBA user. As the TDE_DBA user, create the TDE tablespace with the EMP_ENC table containing one row. On the basis of questions from your audience, you show various details, including DBA_ENCRYPTED_COLUMNS and what happens when you query with a closed wallet and an open wallet. Finally, you clean up your demonstration objects.

1. From your desktop, use the Oracle Wallet Manager graphical tool to create a new wallet stored in your `/home/oracle/labs` directory. Make sure that you use the `ora1cle2` password for your wallet.

2. Make sure that you add the following entry to your `sqlnet.ora` file. In class, it is in the `walletlocation.ora` file.

```
WALLET_LOCATION=
(SOURCE=
  (METHOD=file)
  (METHOD_DATA=
     (DIRECTORY=/home/oracle/labs)))
```

3. Start a SQL*Plus session as SYSDBA to open your wallet from within your instance. Use the command:

```
ALTER SYSTEM SET ENCRYPTION WALLET OPEN IDENTIFIED BY "ora1cle2";
```

4. In your SQL*Plus session (as SYSDBA), set the master key from within your instance. You will have to use the `ALTER SYSTEM SET ENCRYPTION KEY` command.

5. From your terminal emulator session, execute the `lab_15_05.sh` script. This script creates a new user called TDE_DBA identified by the password TDE_DBA. It also creates a new tablespace called TDE stored outside ASM. Then, the script creates a new table called EMP_ENC stored in the TDE tablespace and owned by TDE_DBA. This table contains two encrypted columns, SALARY and JOB. The scripts then inserts one row in the new table.

6. In your SQL*Plus session (as SYSDBA), determine the list of encrypted columns in your database. Then, select all the rows and columns of the EMP_ENC table.

7. In your SQL*Plus session (as SYSDBA), make sure that the file containing your EMP_ENC table contains encrypted column values. Take the TDE tablespace offline, then use OS commands to view the file content, and alter the tablespace to be online again.

   Linux syntax: `strings <directory>/<file_name> | more`

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Practice 15: Database Security (continued)

8. In your SQL*Plus session (as SYSDBA), close your wallet from within your instance, and try to select the data contained in the TDE_DBA.EMP_ENC table. What do you observe?

   ____

   Now, open the wallet and query the TDE_DBA.EMP_ENC table again.

9. To clean up your environment, execute the lab_15_09.sh script from your terminal emulator session. It closes the wallet and drops the TDE tablespace and the TDE_DBA user. If your Oracle Wallet Manager is still open, exit from it.

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Practice 16: Using Globalization Support

Background: Your company has bought another company that has a large user community speaking French. In general, you are not supposed to change the database itself, but you are supposed to use a lower granularity to accommodate their needs. So you decide to use primarily session-specific settings for changing the language, date, and time formats, and for addressing a sorting issue. Use `system/oracle@orcl` as your database login and `/home/oracle/labs` as your working directory.

1. Start *i*SQL*Plus by opening your browser and entering the following URL: `http://<hostname>:5560/isqlplus` or navigate to Enterprise Manager > Database home page > Related Links > iSQL*Plus. Log in as the `system` user with the `oracle` password and the `orcl` connect identifier.

2. Determine the database and the national character set by querying the `NLS_DATABASE_PARAMETERS` view.

   ____

   ____

3. Familiarize yourself with NLS settings and modify the current date format.

   a. Select the current date.

   b. The year is not displayed using a four-digit year. Change your session to display a four-digit year and the current time (including seconds).

   c. Let your session speak French. Then, display the current system date and time.

4. Import the `WORDS` table (which is in the `lab_16_04_a.dmp` file). The `lab_16_04_a.sh` script can assist you.

   The script creates a table, called `WORDS`, with four rows.

5. Display the content of the `WORDS` table.

6. Set `NLS_SORT` to `BINARY` for your session. Select the table contents and order the results by the `FR_WORD` column. In what order are the numbers in the `NUM` column displayed?

   ____

7. Next, set `NLS_SORT` to `FRENCH`. Select the table contents and order the results by the `FR_WORD` column. In what order are the numbers in the `NUM` column displayed?

   ____

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Practice 16: Using Globalization Support (continued)

8. Set `NLS_SORT` to `FRENCH_M`. Select the table contents and order the results by the `FR_WORD` column. In what order are the numbers in the `NUM` column displayed?

    ____

9. Set `NLS_SORT` to `BINARY`. Now retrieve the table contents in the same order as the last query, without using another `ALTER SESSION` command.

10. Drop the table and also remove it from the recycle bin.

11. Shut down the *i*SQL*Plus instance by closing the window.

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Workshop Scenario 1

Background: In order to provide a consistent baseline for starting the workshop exercises, you need to copy in a backup of the database that you made at the very beginning of this course. There is a script to do that and to perform some other tasks for resetting the state of the database. The main difference at this point, though, is the fact that the ASM instance is still available.

1. Change to the `$HOME/workshops` directory and then run the `ws_prep.sh` script to reset the database to the beginning of the course.

2. Shut down and start up the Database Control console in Enterprise Manager. Use the `emctl stop` and `start` directives to do this.

3. Log in to Enterprise Manager as `SYS` user as `SYSDBA`, put your database in `ARCHIVELOG MODE`, and enable Flashback Logging.

4. Use RMAN to configure `AUTOBACKUP` for your control file and `SPFILE`.

5. Take a full backup of the database, including archived logs. Use as little space as possible to store the backup.

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Workshop Scenario 2

Background: This workshop scenario concerns the loss of data. To introduce the problem, first log out of Enterprise Manager. Then, change directory to `$HOME/workshops` and use SQL*Plus to run the `wlab_02.sql` script as the `SYSTEM` user.

Start your investigation by going to the Enterprise Manager console and viewing the Database page. Record the results of your investigation under "Observations." After you have determined the problem, formulate a plan to correct the problem. It is possible that there may be more than one viable solution. Record all possible methods that will address the problem under "Methodology."

It is your job to pick the best solution to solve your database problem. After applying your solution, verify that the problem has been corrected. Record your results under "Results."

Observations: After executing the `wlab_02.sql` script, you will notice that the database is shut down. Attempting to restart the instance results in the following errors:

```
ORA-01157: cannot identify/lock data file 1 - see DBWR trace file
ORA-01110: data file 1: '/u01/app/oracle/oradata/orcl/system01.dbf'
```

Attempting to connect to the database via Enterprise Manager displays an informational screen indicating "The database status is currently unavailable." You have the option of starting the database or performing recovery.

An examination of the `$ORACLE_BASE/oradata/orcl` directory reveals that the `SYSTEM` tablespace data file is missing.

Methodology

Because you have a recent backup and are archiving, the best solution is to use complete recovery to recover the missing data file. Using Enterprise Manager, click Startup in order to attempt to start up the database. Then startup fails, putting the database into the `MOUNT` state. Use Object Level Recovery to recover the `SYSTEM` data file to the current time.

Results

- The database is now open and available for users. SQL*Plus and EM connections are now allowed.
- There are no alerts listed in the Database home page.
- The only way to prevent this problem from occurring is to determine why the data file went missing in the first place, and prevent the situation from occurring again.

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Workshop Scenario 3

Background: Investigate the ASM storage configuration, disks, and disk groups. Add a disk to the existing disk group, and observe the rebalance operation as it happens.

Unless specified otherwise, you must log in as `SYSDBA` either through Database Control or through SQL*Plus.

1. Create a tablespace called `TBSASM` that uses ASM storage. It should use the ASM disk group named `+DGROUP1` and be 200 MB in size.

2. Navigate to the Database home page and see the links that are available in the General region in the upper-left area. Note that there is no link for the ASM instance.

3. Configure Enterprise Manager to have the ASM link on the Database home page.

   Note: *It is necessary that there be ASM storage associated with the* `ORCL` *instance when this step is done. That is why the* `TBSASM` *tablespace must be created before this step.*

   At the OS command prompt, enter the following series of commands. The commands and the responses to the prompts are in bold face, so that you can easily follow them.

```
$ emca -deconfig dbcontrol db

STARTED EMCA at Oct 13, 2005 12:41:40 AM
EM Configuration Assistant, Version 10.2.0.1.0 Production
Copyright (c) 2003, 2005, Oracle.  All rights reserved.

Enter the following information:
Database SID: orcl

Do you wish to continue? [yes(Y)/no(N)]: Y
Oct 13, 2005 12:41:54 AM oracle.sysman.emcp.EMConfig perform
INFO: This operation is being logged at
/u01/app/oracle/product/10.2.0/db_1/cfgtoollogs/emca/orcl/emca_2005-10-13_12-
41-40-AM.log.
Oct 13, 2005 12:41:55 AM oracle.sysman.emcp.util.DBControlUtil stopOMSINFO:
Stopping Database Control (this may take a while) ...
Enterprise Manager configuration completed successfully
FINISHED EMCA at Oct 13, 2005 12:42:02 AM
```

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Workshop Scenario 3 (continued)

```
$ emca -config dbcontrol db

STARTED EMCA at Oct 13, 2005 12:42:52 AM
EM Configuration Assistant, Version 10.2.0.1.0 Production
Copyright (c) 2003, 2005, Oracle.  All rights reserved.

Enter the following information:
Database SID: orcl
Listener port number: 1521
Password for SYS user: oracle
Password for DBSNMP user: oracle
Password for SYSMAN user: oracle
Email address for notifications (optional): <just press enter>
Outgoing Mail (SMTP) server for notifications (optional): <just press enter>
ASM ORACLE_HOME [ /u01/app/oracle/product/10.2.0/db_1 ]: <just press enter>
ASM SID [ +ASM ]: <just press enter>
ASM port [ 1521 ]: <just press enter>
ASM user role [ SYSDBA ]: <just press enter>
ASM username [ SYS ]: <just press enter>
ASM user password: oracle
-----------------------------------------------------------------

You have specified the following settings

Database ORACLE_HOME ................ /u01/app/oracle/product/10.2.0/db_1

Database hostname ................ edbsr5p0.us.oracle.com
Listener port number ................ 1521
Database SID ................ orcl
Email address for notifications ...............
Outgoing Mail (SMTP) server for notifications ...............
ASM ORACLE_HOME ................ /u01/app/oracle/product/10.2.0/db_1
ASM SID ................ +ASM
ASM port ................ 1521
ASM user role ................ SYSDBA
ASM username ................ SYS

-----------------------------------------------------------------
Do you wish to continue? [yes(Y)/no(N)]: Y
Oct 13, 2005 12:43:42 AM oracle.sysman.emcp.EMConfig perform
INFO: This operation is being logged at
/u01/app/oracle/product/10.2.0/db_1/cfgtoollogs/emca/orcl/emca_2005-10-13_12-
42-52-AM.log.
Oct 13, 2005 12:43:58 AM oracle.sysman.emcp.util.DBControlUtil startOMS
INFO: Starting Database Control (this may take a while) ...
Oct 13, 2005 12:45:45 AM oracle.sysman.emcp.EMDBPostConfig performConfiguration
INFO: Database Control started successfully
Oct 13, 2005 12:45:45 AM oracle.sysman.emcp.EMDBPostConfig performConfiguration
INFO: >>>>>>>>>>> The Database Control URL is
http://edbsr5p0.us.oracle.com:1158/em <<<<<<<<<<<
Enterprise Manager configuration completed successfully
FINISHED EMCA at Oct 13, 2005 12:45:45 AM
[oracle@edbsr5p0 oracle]$
```


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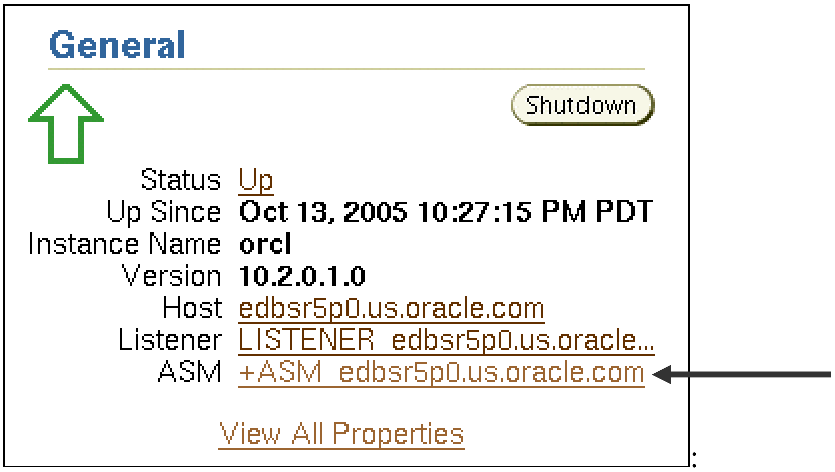
Workshop Scenario 3 (continued)

4. Click the link for the ASM instance on the Database home page.



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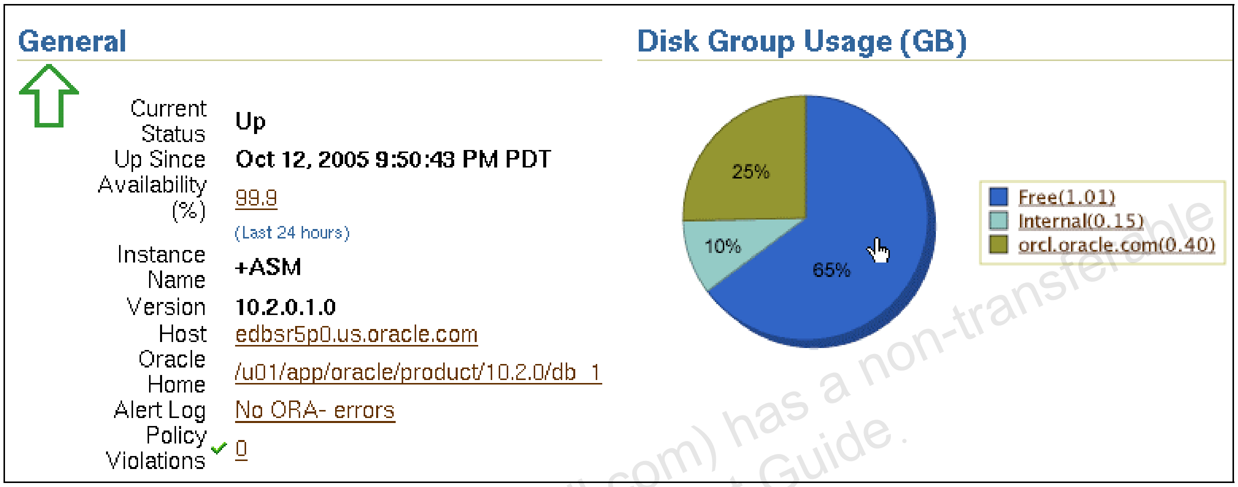
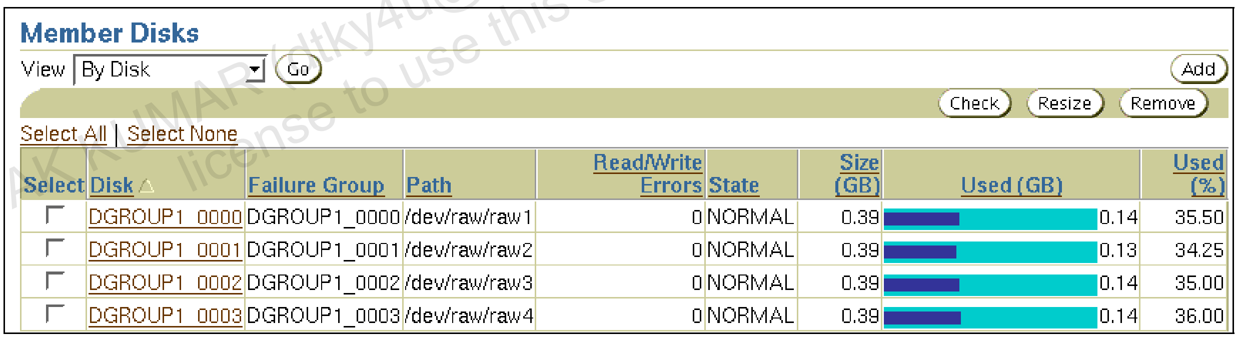
Workshop Scenario 3 (continued)

5. Click the pie chart to see the Disk Group information. You are prompted for the login credentials for the ASM instance, which are `SYS` and `oracle`, for username and password, respectively. Enter those, and click Login.

   Note: *It may take several minutes for the pie chart to appear.*



6. Note the percentage used for each disk in the disk group.



Member Disks

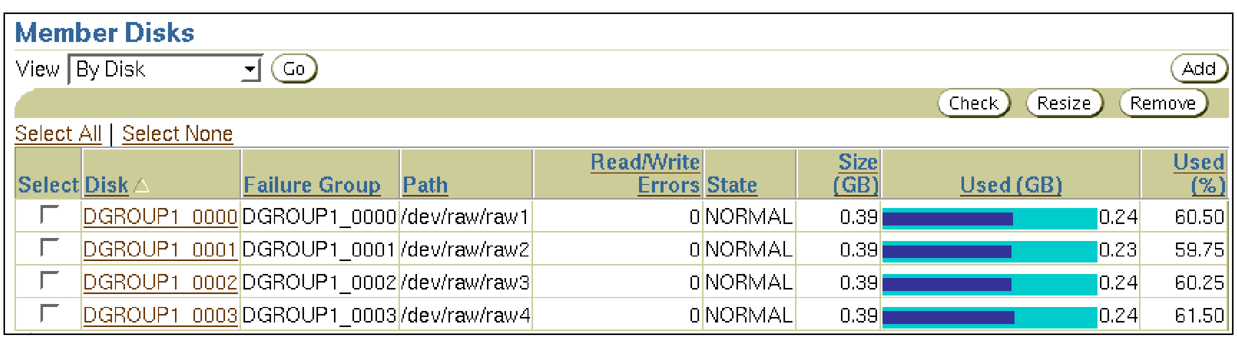
View By Disk Go | Add | Check | Resize | Remove

Select All | Select None

Select	Disk	Failure Group	Path	Read/Write Errors	State	Size (GB)	Used (GB)	Used (%)
	DGROUP1_0000	DGROUP1_0000	/dev/raw/raw1	0	NORMAL	0.39	0.14	35.50
	DGROUP1_0001	DGROUP1_0001	/dev/raw/raw2	0	NORMAL	0.39	0.13	34.25
	DGROUP1_0002	DGROUP1_0002	/dev/raw/raw3	0	NORMAL	0.39	0.14	35.00
	DGROUP1_0003	DGROUP1_0003	/dev/raw/raw4	0	NORMAL	0.39	0.14	36.00

7. Add another data file of size 200 MB to the `TBSASM` tablespace.

8. Go back to the disk group list and note the change in used space on each disk.



Member Disks

View By Disk Go | Add | Check | Resize | Remove

Select All | Select None

Select	Disk	Failure Group	Path	Read/Write Errors	State	Size (GB)	Used (GB)	Used (%)
	DGROUP1_0000	DGROUP1_0000	/dev/raw/raw1	0	NORMAL	0.39	0.24	60.50
	DGROUP1_0001	DGROUP1_0001	/dev/raw/raw2	0	NORMAL	0.39	0.23	59.75
	DGROUP1_0002	DGROUP1_0002	/dev/raw/raw3	0	NORMAL	0.39	0.24	60.25
	DGROUP1_0003	DGROUP1_0003	/dev/raw/raw4	0	NORMAL	0.39	0.24	61.50

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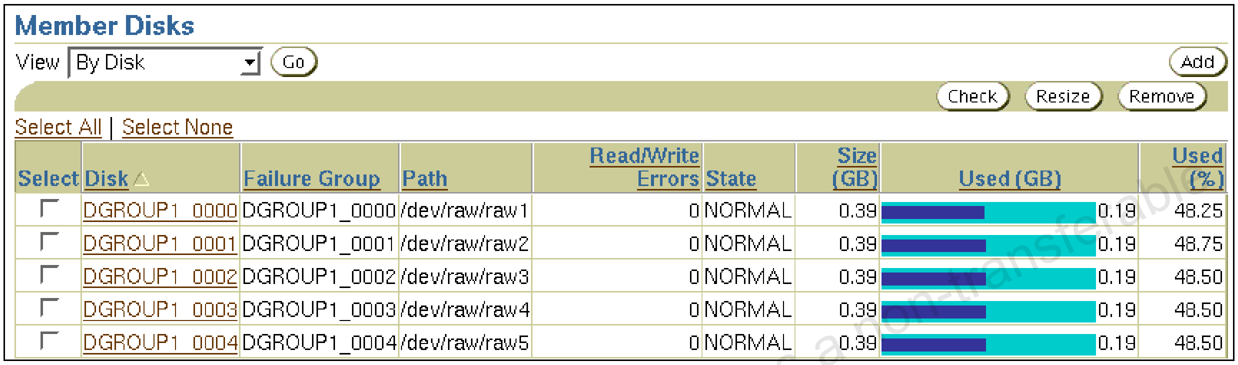
Workshop Scenario 3 (continued)

9. Add another disk of size 400 MB to the group by clicking Add on this page. Name the disk `DGROUP1_0004`.

10. Return to the disk member list, and continue to click the browser's Reload button until the disks are balanced. Note that the new disk starts off empty, but eventually contains about the same amount of data as the other four disks.



Member Disks

View By Disk Go | Add

Check Resize Remove

Select All | Select None

Select	Disk △	Failure Group	Path	Read/Write Errors	State	Size (GB)	Used (GB)	Used (%)
☐	DGROUP1_0000	DGROUP1_0000	/dev/raw/raw1	0	NORMAL	0.39	0.19	48.25
☐	DGROUP1_0001	DGROUP1_0001	/dev/raw/raw2	0	NORMAL	0.39	0.19	48.75
☐	DGROUP1_0002	DGROUP1_0002	/dev/raw/raw3	0	NORMAL	0.39	0.19	48.50
☐	DGROUP1_0003	DGROUP1_0003	/dev/raw/raw4	0	NORMAL	0.39	0.19	48.50
☐	DGROUP1_0004	DGROUP1_0004	/dev/raw/raw5	0	NORMAL	0.39	0.19	48.50

11. After the rebalance has completed, remove the `DGROUP1_0001` and `DGROUP1_0003` disks from the disk group, and view the rebalance operation in the same way.

12. Drop the tablespace by entering the following at the SQL prompt:

```
SQL> DROP TABLESPACE TBSASM INCLUDING CONTENTS AND DATAFILES;
```

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Workshop Scenario 4

Background: This workshop scenario simulates loss of data. To introduce the problem, change directory to `$HOME/workshops` and run the `wlab_04.sql` script as the `SYS` user as shown below:

```
SQL> @wlab_04.sql
```

Start your investigation by going to the Enterprise Manager console and viewing the Database page. Record the results of your investigation under "Observations." After you have determined the problem, formulate a plan to correct the problem. It is possible that there may be more than one viable solution. After applying your solution, verify that the problem has been corrected.

1. Run the `wlab_04.sql` script as the `SYS` user to simulate the problem. You note that the `HR.DEPARTMENTS` table is reported as missing.

2. Query the recycle bin to determine whether there are any relevant tables in it.

3. Test the `HR.DEPARTMENTS` table by querying it.

4. Flash back the `HR.DEPARTMENTS` table from the recycle bin.

5. Perform a select operation against the `DEPARTMENTS` table to confirm the success of the Flashback Table operation.

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Workshop Scenario 5

Background: This workshop scenario pertains to database availability. To introduce the problem, first log out of Enterprise Manager. Then, change directory to `$HOME/workshops` and run the `wlab_05.sql` script as the `SYS` user as shown below:

```
SQL> @wlab_05.sql
```

Start your investigation by going to the Enterprise Manager console and viewing the Database page. Record the results of your investigation under "Observations." After you have determined the problem, formulate a plan to correct the problem. It is possible that there may be more than one viable solution. Record all possible methods that will address the problem under "Methodology."

It is your job to pick the best solution to solve your database problem. After applying your solution, verify that the problem has been corrected. Record your results under "Results."

Observations: After executing the `wlab_05.sql` script, you will notice the database is shut down. Attempting to restart the instance results in the following errors:

```
ORA-01157: cannot identify/lock data file 4 - see DBWR trace file
ORA-01110: data file 4: '/u01/app/oracle/oradata/orcl/users01.dbf'
```

Attempting to connect to the database via Enterprise Manager displays an informational screen indicating "The database status is currently unavailable." You have the option of starting the database or performing recovery.

Methodology

Because you have a recent backup and are archiving, the best solution is to use complete recovery to recover the missing data file.

1. Use RMAN to recover the missing data file. Start an RMAN session and issue the `run` command.

2. The recovery operation fails. Review the RMAN output to determine the cause of the failure. You find the following type of errors in the output:

   ```
   ORA-00283: recovery session canceled due to errors
   ORA-00313: open failed for members of log group 2 of thread 1
   ORA-00312: online log 2 thread 1:
   '/u01/app/oracle/oradata/orcl/redo02b.log'
   ORA-27037: unable to obtain file status
   Linux Error: 2: No such file or directory
   ```

   You check the data file directory, and see that all the online redo logs are missing.

3. Because you do not back up online redo logs, there is no way to recover them. You must use incomplete recovery to open the database. Determine the sequence number of the last archived redo log by querying the `v$archived_log` view. Record that sequence number here:

   ____

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Workshop Scenario 5 (continued)

4. To perform incomplete recovery, you must restore *all* the data files, not just the missing one (`users01.dbf`). Issue an RMAN `run` command to restore up to and including log sequence number that you recorded in step 3. Specify this number plus one as the sequence number in the RMAN command.
5. Review the RMAN output, which indicates a successful recovery.
6. Log back in to Enterprise Manager to verify that the database has been recovered. If the console indicates that the database is still not started, click the Administration tab, and then click Tablespaces. Verify that all the tablespaces are listed and are online. Then, click the Database tab to return to the Database home page, which should be displayed correctly now.

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Appendix B
Solutions

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Solutions for Practice 2: Configuring Recovery Manager

Background: You need to configure backup and recovery settings. Some of this you do with RMAN, and some with Enterprise Manager. These settings will, unless overridden later, provide the configuration for backup and recovery activity you do later. These configurations include defining retention policy, controlfile autobackup, and excluded tablespaces.

Important Note: As preparation for the workshop at the end of this course, before doing anything else, run the following script in an XTerm command shell to prepare a copy of your database files:

```
$ $HOME/labs/lab_02_copy.sh
```

1. Set the `NLS_DATE_FORMAT` environment variable to `"yyyy-mm-dd hh24:mi:ss"` in your XTerm window, and then connect to your database as the target database in the default `NOCATALOG` mode as the `SYS` user.

   a. Double-click the XTerm icon on the desktop.

   b. Enter the following in the XTerm window:

```
$ export NLS_DATE_FORMAT="yyyy-mm-dd hh24:mi:ss"
$ rman target / nocatalog

Recovery Manager: Release 10.2.0.1.0 - Production on Tue Dec 13 13:43:48
2005

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connected to target database: ORCL (DBID=1090770270)
using target database control file instead of recovery catalog

RMAN>
```

2. Use the RMAN `SHOW ALL` command to generate a listing of the RMAN configuration settings.

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Solutions for Practice 2: Configuring Recovery Manager (continued)

a. Enter the following at the RMAN prompt:

```
RMAN> show all;

RMAN configuration parameters are:
CONFIGURE RETENTION POLICY TO REDUNDANCY 1; # default
CONFIGURE BACKUP OPTIMIZATION OFF; # default
CONFIGURE DEFAULT DEVICE TYPE TO DISK; # default
CONFIGURE CONTROLFILE AUTOBACKUP OFF; # default
CONFIGURE CONTROLFILE AUTOBACKUP FORMAT FOR DEVICE TYPE DISK TO '%F'; #
default
CONFIGURE DEVICE TYPE DISK PARALLELISM 1 BACKUP TYPE TO BACKUPSET; #
default
CONFIGURE DATAFILE BACKUP COPIES FOR DEVICE TYPE DISK TO 1; # default
CONFIGURE ARCHIVELOG BACKUP COPIES FOR DEVICE TYPE DISK TO 1; # default
CONFIGURE MAXSETSIZE TO UNLIMITED; # default
CONFIGURE ENCRYPTION FOR DATABASE OFF; # default
CONFIGURE ENCRYPTION ALGORITHM 'AES128'; # default
CONFIGURE ARCHIVELOG DELETION POLICY TO NONE; # default
CONFIGURE SNAPSHOT CONTROLFILE NAME TO
'/u01/app/oracle/product/10.2.0/db_1/dbs/snapcf_orcl.f'; # default
```

3. Configure RMAN to automatically back up the control file and SPFILE whenever a backup of the database or data files is taken.

   a. Enter the following in the RMAN session:

```
RMAN> configure controlfile autobackup on;

new RMAN configuration parameters:
CONFIGURE CONTROLFILE AUTOBACKUP ON;
new RMAN configuration parameters are successfully stored

RMAN>
```

   b. Leave the RMAN session connected. You will need it again.

4. Use the Enterprise Manager Database Control Console to set the backup retention policy to a recovery window of two days. Log in to the Database Control Console as the SYS user, as SYSDBA. If this is the first time you are logging in to EM as the SYS user, you will need to click “I agree” on the License Agreement screen.

   a. Double-click the Mozilla icon on the machine desktop.

   b. When prompted with the Select User Profile window, highlight **oracle**, and then click Start Mozilla.

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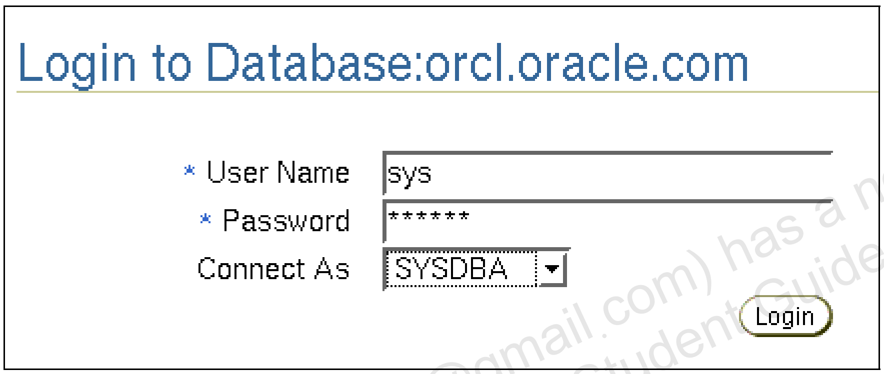
Solutions for Practice 2: Configuring Recovery Manager (continued)

c. Navigate to the URL for Database Control. The URL is of this format:

http://<*machine_name*>.us.oracle.com:1158/em

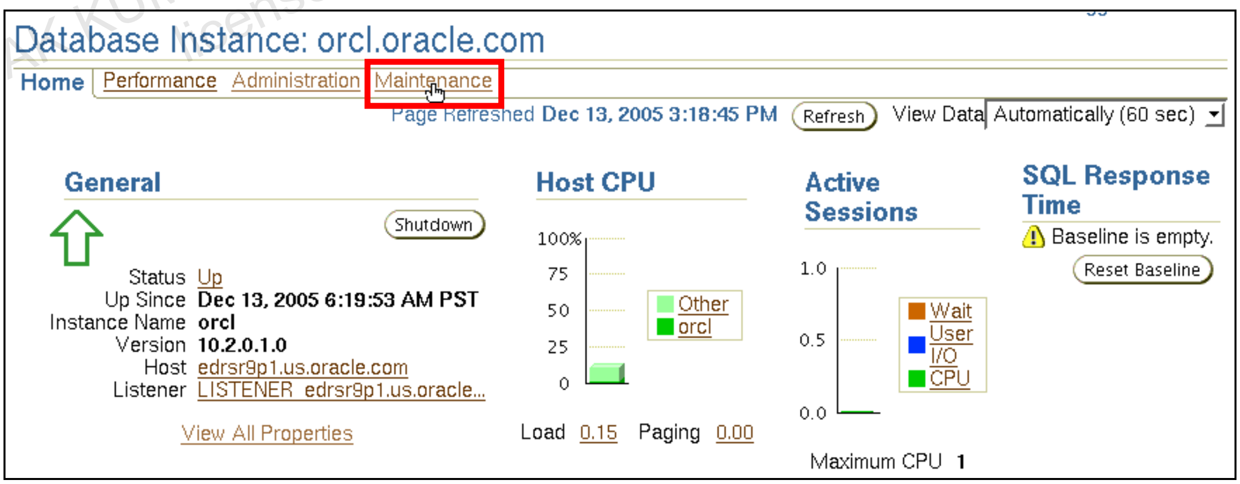
Your machine name appears in the upper-left corner of the Xterm window you started. You can also look in the `$ORACLE_HOME/install/readme.txt` file and find the URL under the Enterprise Manager 10*g* Database Control URL heading.

d. Enter `SYS` as the username, `oracle` as the password, and select `SYSDBA` for the Connect As setting.



e. If the License Agreement page appears, click "I agree" at the bottom of the page.

f. Click the Maintenance tabbed page.



g. Click Backup Settings link in the Backup/Recovery Settings region.

h. Click the Policy tab.

i. Scroll down to the Retention Policy region.

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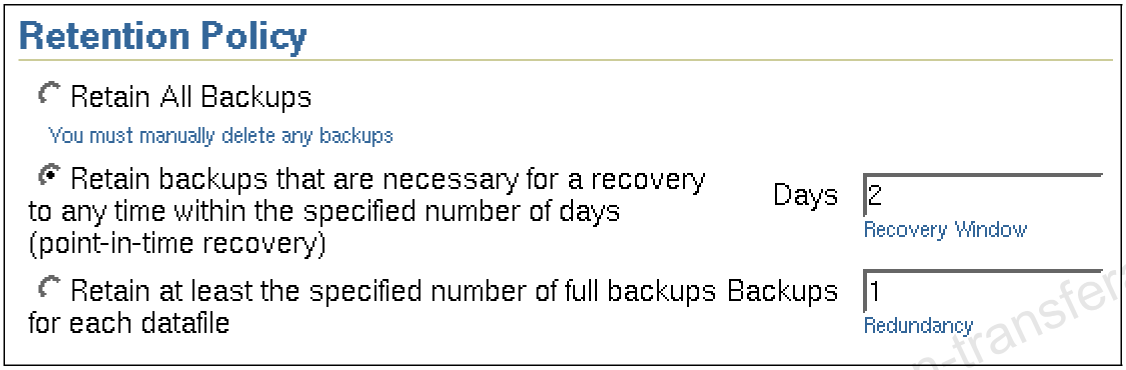
Solutions for Practice 2: Configuring Recovery Manager (continued)

j. Choose "Retain backups that are necessary for a recovery to any time within the specified number of days…" and specify a value of `2`. To save the modified details of Retention Policy, enter the Host Credentials of `oracle/oracle`, select "Save as Preferred Credential," and click OK.



5. Verify the backup retention policy setting using the RMAN utility and the `SHOW` command.

   a. Use the RMAN session you left connected in step 3, and enter the following:

```
RMAN> show retention policy;

RMAN configuration parameters are:
CONFIGURE RETENTION POLICY TO RECOVERY WINDOW OF 2 DAYS;

RMAN>
```

6. Application development indicates to you that there will be a daily loading of data from an external source, and there needs to be a staging area set up for that data. Run the `lab_02_06.sql` script to create the `STAGING` tablespace, to hold this data. Then configure RMAN to exclude this tablespace from backup tasks. You can do this because, if you ever lose this data, you do not need to recover it; you can simply reload the data from the external source. Then verify that the tablespace is excluded.

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Solutions for Practice 2: Configuring Recovery Manager (continued)

a. Start a new XTerm window by double-clicking the XTerm icon, and enter the following to run the `lab_02_06.sql` script:

```
$ cd $HOME/labs
$ sqlplus system/oracle @lab_02_06.sql

SQL>
SQL> CREATE SMALLFILE TABLESPACE "STAGING" DATAFILE
'/u01/app/oracle/oradata/orcl/staging01.dbf' SIZE 3M REUSE NOLOGGING
EXTENT MANAGEMENT LOCAL SEGMENT SPACE MANAGEMENT AUTO
  2  /

Tablespace created.

SQL> create table hr.staging_tab tablespace staging as select * from
all_objects where rownum < 11
  2  /

Table created.

SQL> set echo off

STAGING tablespace created and populated with one table.

SQL> quit
Disconnected from Oracle Database 10g Enterprise Edition Release
10.2.0.1.0 - Production
With the Partitioning, OLAP and Data Mining options
$
```

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b. Return to the RMAN session, and enter this command:

```
RMAN> CONFIGURE EXCLUDE FOR TABLESPACE STAGING;

tablespace STAGING will be excluded from future whole database backups
new RMAN configuration parameters are successfully stored

RMAN>
```

c. Enter the following command at the RMAN prompt:

```
RMAN> show exclude;

RMAN configuration parameters are:
CONFIGURE EXCLUDE FOR TABLESPACE 'STAGING';

RMAN>
```

7. Exit RMAN.

```
RMAN> exit
```


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Solutions for Practice 3: Using Recovery Manager

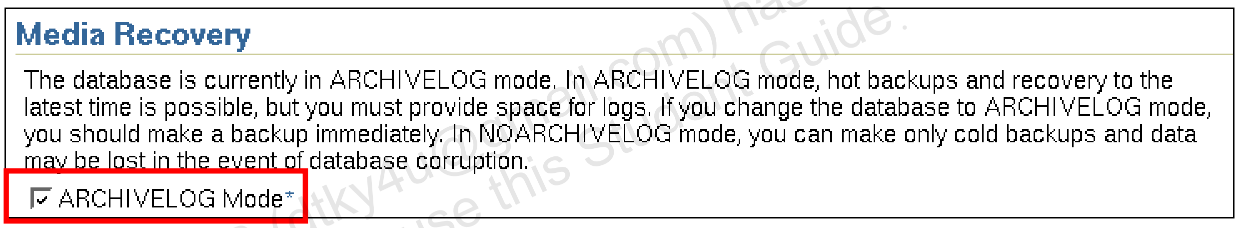
Background: In this exercise, you become familiar with using RMAN to perform and manage backups. You need to put your database into `ARCHIVELOG` mode, and take a full backup of your database.

1. Using SQL*Plus or the EM Database Control Console, verify that the database is in `ARCHIVELOG` mode. If not, alter the database to enable archiving of the online redo logs. Note that the database must be in the `MOUNT` state in order to change the archive log mode.

   Note: Steps (a) through (f) are related to using Enterprise Manager. Steps (g) through (k) are related to using SQL*Plus. You can do either.

   a. To select using EM, make sure you are still logged in as the SYS user, and go to the Maintenance page of EM. Click Recovery Settings under the Backup/Recovery Settings region.

   b. See if ARCHIVELOG Mode is selected in the Media Recovery region. If it is not, select it, and click Apply.

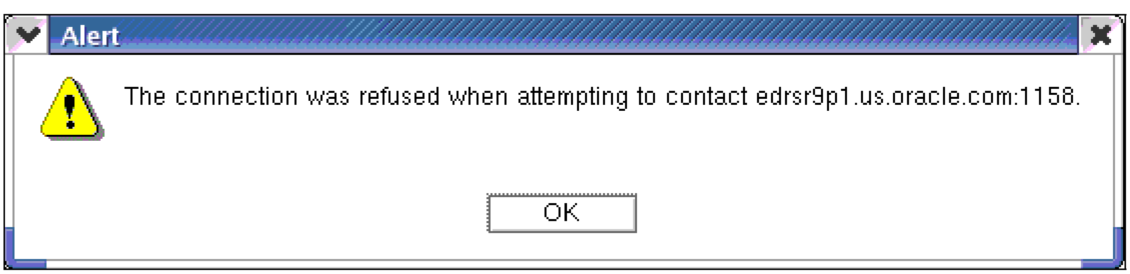


   c. Click Yes on the Confirmation page to acknowledge that the database will be restarted now.

   d. On the Credentials page, enter Host Credentials of `oracle` and `oracle` for the Username and Password, respectively. If you have selected to save this as the preferred credentials earlier, this will already be filled in for you. Then click OK.

   e. Click Yes on the "Restart Database:Confirmation" page. Then click Refresh until the EM Login page appears. This may take one or two minutes.

   Note: If you see the following error, click OK, and continue to click Refresh. This error will go away eventually.



   f. On the Login page, log in as `SYS` (with password `oracle`, connect as `SYSDBA`).

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Solutions for Practice 3: Using Recovery Manager (continued)

g. Alternatively, to use SQL*Plus, enter the following command to log in:

```
$ sqlplus / as sysdba
```

h. Enter the following command to determine the current archive mode of the database:

```
SQL> ARCHIVE LOG LIST
```

```
SQL> ARCHIVE LOG LIST
Database log mode              No Archive Mode
Automatic archival             Disabled
Archive destination            USE_DB_RECOVERY_FILE_DEST
Oldest online log sequence     30
Current log sequence           32
SQL>
```

i. Note that the database is currently not archiving. Enter the following command to shut down the database in preparation for changing the archive log mode:

```
SQL> SHUTDOWN IMMEDIATE
```

j. Mount the database by entering the following command:

```
SQL> STARTUP MOUNT
```

```
SQL> STARTUP MOUNT
ORACLE instance started.

Total System Global Area  285212672 bytes
Fixed Size                  1218992 bytes
Variable Size             117442128 bytes
Database Buffers          163577856 bytes
Redo Buffers                2973696 bytes
Database mounted.
SQL>
```

k. Put the database into `ARCHIVELOG` mode by entering the following command:

```
SQL> ALTER DATABASE ARCHIVELOG;
```

l. Verify the archive log mode by entering the following command:

```
SQL> ARCHIVE LOG LIST
```

```
SQL> ARCHIVE LOG LIST
Database log mode              Archive Mode
Automatic archival             Enabled
Archive destination            USE_DB_RECOVERY_FILE_DEST
Oldest online log sequence     30
Next log sequence to archive   32
Current log sequence           32
SQL>
```

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Solutions for Practice 3: Using Recovery Manager (continued)

m. Open the database by entering the following command:

```
SQL> ALTER DATABASE OPEN;
```

2. Connect to your database using RMAN in the NOCATALOG mode. You cannot use an existing RMAN session because the database has been restarted. First, ensure that your XTerm shell has the NLS_LANG environment variable set as indicated in Practice 2.

   a. Enter the following command at the XTerm prompt:

```
$ export NLS_DATE_FORMAT="yyyy-mm-dd hh24:mi:ss"
$ rman target / NOCATALOG
```

3. Use the RMAN REPORT command to generate a listing of your database structure.

   a. Enter the following at the RMAN prompt:

```
RMAN> REPORT SCHEMA;

Report of database schema

List of Permanent Datafiles
===========================
File Size(MB) Tablespace RB segs Datafile Name
---- -------- ---------- ------- ------------------------
1    490      SYSTEM     ***     /u01/app/oracle/oradata/orcl/system01.dbf
2    50       UNDOTBS1   ***     /u01/app/oracle/oradata/orcl/undotbs01.dbf
3    270      SYSAUX     ***     /u01/app/oracle/oradata/orcl/sysaux01.dbf
4    5        USERS      ***     /u01/app/oracle/oradata/orcl/users01.dbf
5    100      EXAMPLE    ***     /u01/app/oracle/oradata/orcl/example01.dbf
6    3        STAGING    ***     /u01/app/oracle/oradata/orcl/staging01.dbf

List of Temporary Files
=======================
File Size(MB) Tablespace Maxsize(MB) Tempfile Name
---- -------- ---------- ----------- --------------------
1    25       TEMP       32767       /u01/app/oracle/oradata/orcl/temp01.dbf

RMAN>
```

4. Obtain a listing of all database backup sets that currently exist. There should be none.

   a. Enter the following command at the RMAN prompt:

```
RMAN> LIST BACKUP OF DATABASE;

RMAN>
```

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Solutions for Practice 3: Using Recovery Manager (continued)

5. Use RMAN to back up the data files belonging to the `EXAMPLE` and `USERS` tablespaces. Verify that:
   - The current control file and server parameter file are backed up with this backup
   - Your backups are placed in the flash recovery area
   - The format of the backup is a backup set

   a. Enter the following at the RMAN prompt:

```
RMAN> BACKUP AS BACKUPSET TABLESPACE users, example;
```

Following is the output of this command:

```
RMAN> BACKUP AS BACKUPSET TABLESPACE users, example;

Starting backup at 2005-12-14 05:16:03
allocated channel: ORA_DISK_1
channel ORA_DISK_1: sid=132 devtype=DISK
channel ORA_DISK_1: starting full datafile backupset
channel ORA_DISK_1: specifying datafile(s) in backupset
input datafile fno=00005 name=/u01/app/oracle/oradata/orcl/example01.dbf
input datafile fno=00004 name=/u01/app/oracle/oradata/orcl/users01.dbf
channel ORA_DISK_1: starting piece 1 at 2005-12-14 05:16:05
channel ORA_DISK_1: finished piece 1 at 2005-12-14 05:16:12
piece
handle=/u01/app/oracle/flash_recovery_area/ORCL/backupset/2005_12_14/o1_
mf_nnndf_TAG20051214T051604_1t06ro3k_.bkp tag=TAG20051214T051604
comment=NONE
channel ORA_DISK_1: backup set complete, elapsed time: 00:00:08
Finished backup at 2005-12-14 05:16:12

Starting Control File and SPFILE Autobackup at 2005-12-14 05:16:12
piece
handle=/u01/app/oracle/flash_recovery_area/ORCL/autobackup/2005_12_14/o1
_mf_s_576998172_1t06rwqq_.bkp comment=NONE
Finished Control File and SPFILE Autobackup at 2005-12-14 05:16:15

RMAN>
```

   b. Note the autobackup of the controlfile and spfile in the output. Also note that the backup set is written to the flash recovery area.

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Solutions for Practice 3: Using Recovery Manager (continued)

6. Create an image copy of two data files. Use the following information:
   - Make an image copy of the `SYSTEM` tablespace in the flash recovery area, with a tag of `SYSTEM01`.
   - Make an image copy of the `SYSAUX` tablespace in the `ORACLE_HOME` directory, and name the copy `sysaux01.cpy` with a tag of `SYSAUX01`.

   What are the locations of each of the two backup files?

   a. Enter the following at the RMAN prompt. Without the FORMAT keyword, the file will automatically go to the flash recovery area.

```
RMAN> BACKUP AS COPY TABLESPACE SYSTEM TAG=SYSTEM01;
```

Following is the output of this command:

```
RMAN> BACKUP AS COPY TABLESPACE SYSTEM TAG=SYSTEM01;

Starting backup at 2005-12-14 05:27:35
using channel ORA_DISK_1
channel ORA_DISK_1: starting datafile copy
input datafile fno=00001 name=/u01/app/oracle/oradata/orcl/system01.dbf
output
filename=/u01/app/oracle/flash_recovery_area/ORCL/datafile/o1_mf_system_
1t07g7kj_.dbf tag=SYSTEM01 recid=2 stamp=576998914
channel ORA_DISK_1: datafile copy complete, elapsed time: 00:01:06
Finished backup at 2005-12-14 05:28:41

Starting Control File and SPFILE Autobackup at 2005-12-14 05:28:42
piece
handle=/u01/app/oracle/flash_recovery_area/ORCL/autobackup/2005_12_14/o1
_mf_s_576998922_1t07jcsf_.bkp comment=NONE
Finished Control File and SPFILE Autobackup at 2005-12-14 05:28:45

RMAN>
```

The output file for this backup file is highlighted above. Yours will likely be different.

   b. Enter the following at the RMAN prompt. With the FORMAT keyword specifying only the file name, the file will automatically go to the `$ORACLE_HOME/dbs` directory.

```
RMAN> BACKUP AS COPY
2> FORMAT 'sysaux01.cpy'
3> TABLESPACE SYSAUX
4> TAG=SYSAUX01;
```


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Solutions for Practice 3: Using Recovery Manager (continued)

Following is the output of this command:

```
RMAN> BACKUP AS COPY FORMAT 'sysaux01.cpy' TABLESPACE SYSAUX
TAG=SYSAUX01;

Starting backup at 2005-12-14 05:34:47
using channel ORA_DISK_1
channel ORA_DISK_1: starting datafile copy
input datafile fno=00003 name=/u01/app/oracle/oradata/orcl/sysaux01.dbf
output filename=/u01/app/oracle/product/10.2.0/db_1/dbs/sysaux01.cpy
tag=SYSAUX01 recid=3 stamp=576999322
channel ORA_DISK_1: datafile copy complete, elapsed time: 00:00:35
Finished backup at 2005-12-14 05:35:23

Starting Control File and SPFILE Autobackup at 2005-12-14 05:35:23
piece
handle=/u01/app/oracle/flash_recovery_area/ORCL/autobackup/2005_12_14/o1
_mf_s_576999323_1t07wwt5_.bkp comment=NONE
Finished Control File and SPFILE Autobackup at 2005-12-14 05:35:26

RMAN>
```

The output file for this backup file is highlighted above. Yours should match this exactly.

7. Obtain a listing of all database files that have not been backed up. Note that the STAGING tablespace is still excluded from backup.

   a. Enter the following at the RMAN prompt:

```
RMAN> REPORT NEED BACKUP;

RMAN retention policy will be applied to the command
RMAN retention policy is set to recovery window of 2 days
Report of files that must be backed up to satisfy 2 days recovery window
File Days  Name
---- ----- -----------------------------------------------------
2    167   /u01/app/oracle/oradata/orcl/undotbs01.dbf
file 6 is excluded from whole database backup

RMAN>
```

8. Take a full backup of the database, including archived logs. Use as little space as possible to store the backup. Also be sure to include the excluded tablespace, just for this backup. Afterward, list the files that need to be backed up, and list the database backups.

   a. Enter the following command at the RMAN prompt:

```
RMAN> BACKUP NOEXCLUDE AS COMPRESSED BACKUPSET DATABASE PLUS ARCHIVELOG;
```

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Solutions for Practice 3: Using Recovery Manager (continued)

Following is the output of this command:

```
RMAN> BACKUP NOEXCLUDE AS COMPRESSED BACKUPSET DATABASE PLUS ARCHIVELOG;


Starting backup at 2005-12-14 06:06:54
current log archived
using channel ORA_DISK_1
channel ORA_DISK_1: starting compressed archive log backupset
channel ORA_DISK_1: specifying archive log(s) in backup set
input archive log thread=1 sequence=12 recid=1 stamp=577001221
channel ORA_DISK_1: starting piece 1 at 2005-12-14 06:07:03
channel ORA_DISK_1: finished piece 1 at 2005-12-14 06:07:10
piece
handle=/u01/app/oracle/flash_recovery_area/ORCL/backupset/2005_12_14/o1_
mf_annnn_TAG20051214T060701_1t09r7kk_.bkp tag=TAG20051214T060701
comment=NONE
channel ORA_DISK_1: backup set complete, elapsed time: 00:00:08
Finished backup at 2005-12-14 06:07:10

Starting backup at 2005-12-14 06:07:10
using channel ORA_DISK_1
channel ORA_DISK_1: starting compressed full datafile backupset
channel ORA_DISK_1: specifying datafile(s) in backupset
input datafile fno=00001 name=/u01/app/oracle/oradata/orcl/system01.dbf
input datafile fno=00003 name=/u01/app/oracle/oradata/orcl/sysaux01.dbf
input datafile fno=00005 name=/u01/app/oracle/oradata/orcl/example01.dbf
input datafile fno=00002 name=/u01/app/oracle/oradata/orcl/undotbs01.dbf
input datafile fno=00004 name=/u01/app/oracle/oradata/orcl/users01.dbf
input datafile fno=00006 name=/u01/app/oracle/oradata/orcl/staging01.dbf
channel ORA_DISK_1: starting piece 1 at 2005-12-14 06:07:11
channel ORA_DISK_1: finished piece 1 at 2005-12-14 06:09:27
piece
handle=/u01/app/oracle/flash_recovery_area/ORCL/backupset/2005_12_14/o1_
mf_nnndf_TAG20051214T060710_1t09rj5m_.bkp tag=TAG20051214T060710
comment=NONE
channel ORA_DISK_1: backup set complete, elapsed time: 00:02:16
Finished backup at 2005-12-14 06:09:28

Starting backup at 2005-12-14 06:09:28
current log archived
using channel ORA_DISK_1
channel ORA_DISK_1: starting compressed archive log backupset
channel ORA_DISK_1: specifying archive log(s) in backup set
input archive log thread=1 sequence=13 recid=2 stamp=577001370
channel ORA_DISK_1: starting piece 1 at 2005-12-14 06:09:33
channel ORA_DISK_1: finished piece 1 at 2005-12-14 06:09:34
piece
handle=/u01/app/oracle/flash_recovery_area/ORCL/backupset/2005_12_14/o1_
mf_annnn_TAG20051214T060932_1t09wxy0_.bkp tag=TAG20051214T060932
comment=NONE
```

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Solutions for Practice 3: Using Recovery Manager (continued)

```
channel ORA_DISK_1: backup set complete, elapsed time: 00:00:02
Finished backup at 2005-12-14 06:09:34

Starting Control File and SPFILE Autobackup at 2005-12-14 06:09:35
piece
handle=/u01/app/oracle/flash_recovery_area/ORCL/autobackup/2005_12_14/o1
_mf_s_577001376_1t09x2qc_.bkp comment=NONE
Finished Control File and SPFILE Autobackup at 2005-12-14 06:09:43
```

b. Enter the following command at the RMAN prompt:

```
RMAN> REPORT NEED BACKUP;
```

Following is the output of this command:

```
RMAN> REPORT NEED BACKUP;

RMAN retention policy will be applied to the command
RMAN retention policy is set to recovery window of 2 days
Report of files that must be backed up to satisfy 2 days recovery window
File Days  Name
---- ----- -----------------------------------------------------
file 6 is excluded from whole database backup

RMAN>
```

c. Enter the following command at the RMAN prompt:

```
RMAN> LIST BACKUP OF DATABASE;
```

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Solutions for Practice 3: Using Recovery Manager (continued)

Following is the output of that command:

```
RMAN> LIST BACKUP OF DATABASE;


List of Backup Sets
===================

BS Key  Type LV Size       Device Type Elapsed Time Completion Time
------- ---- -- ---------- ----------- ------------ -------------------
3       Full    60.12M     DISK        00:00:07     2005-12-14 05:16:11
        BP Key: 3   Status: AVAILABLE  Compressed: NO  Tag:
TAG20051214T051604
        Piece Name:
/u01/app/oracle/flash_recovery_area/ORCL/backupset/2005_12_14/o1_mf_nnnd
f_TAG20051214T051604_1t06ro3k_.bkp
  List of Datafiles in backup set 3
  File LV Type Ckp SCN    Ckp Time            Name
  ---- -- ---- ---------- ------------------- ----
  4       Full 697766     2005-12-14 05:16:05
/u01/app/oracle/oradata/orcl/users01.dbf
  5       Full 697766     2005-12-14 05:16:05
/u01/app/oracle/oradata/orcl/example01.dbf

BS Key  Type LV Size       Device Type Elapsed Time Completion Time
------- ---- -- ---------- ----------- ------------ -------------------
8       Full    122.48M    DISK        00:02:05     2005-12-14 06:09:16
        BP Key: 8   Status: AVAILABLE  Compressed: YES  Tag:
TAG20051214T060710
        Piece Name:
/u01/app/oracle/flash_recovery_area/ORCL/backupset/2005_12_14/o1_mf_nnnd
f_TAG20051214T060710_1t09rj5m_.bkp
  List of Datafiles in backup set 8
  File LV Type Ckp SCN    Ckp Time            Name
  ---- -- ---- ---------- ------------------- ----
  1       Full 700545     2005-12-14 06:07:11
/u01/app/oracle/oradata/orcl/system01.dbf
  2       Full 700545     2005-12-14 06:07:11
/u01/app/oracle/oradata/orcl/undotbs01.dbf
  3       Full 700545     2005-12-14 06:07:11
/u01/app/oracle/oradata/orcl/sysaux01.dbf
  4       Full 700545     2005-12-14 06:07:11
/u01/app/oracle/oradata/orcl/users01.dbf
  5       Full 700545     2005-12-14 06:07:11
/u01/app/oracle/oradata/orcl/example01.dbf
  6       Full 700545     2005-12-14 06:07:11
/u01/app/oracle/oradata/orcl/staging01.dbf

RMAN>
```

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Solutions for Practice 3: Using Recovery Manager (continued)

9. Configure RMAN to include the STAGING tablespace in all future backups.

   a. Enter the following at the RMAN prompt:

```
RMAN> CONFIGURE EXCLUDE FOR TABLESPACE STAGING CLEAR;

tablespace STAGING will be included in future whole database backups
old RMAN configuration parameters are successfully deleted

RMAN>
```

   Note: *If you put STAGING within quotation marks in the command to exclude it from backups in Practice 2, then you must do so again for this command, and you must also match the case that you used in Practice 2.*

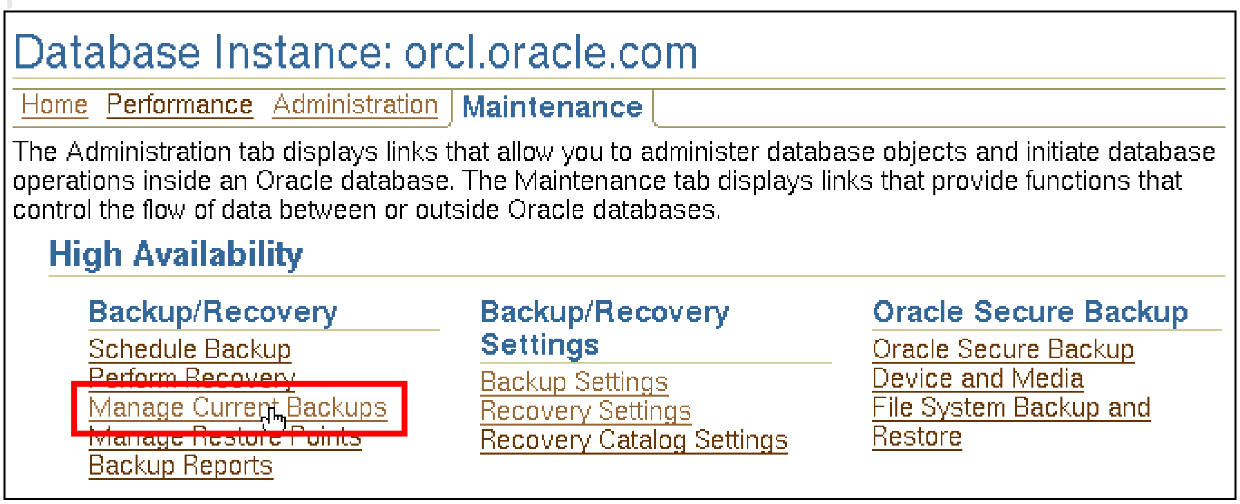
10. Exit RMAN.

    a. Enter the following at the RMAN prompt:

```
RMAN> exit
```

11. Now that you have a full database backup, remove the image copy backups that were made of the `system01.dbf` and the `sysaux01.dbf` data files. This will save some disk space. Use Enterprise Manager to do this.

    a. While logged in to Enterprise Manager as the `SYS` user with password `oracle`, and connect as `SYSDBA`, click the Maintenance tabbed page on the Database page. Then click Manage Current Backups in the Backup/Recovery region.



    b. Click the Image Copies tab.

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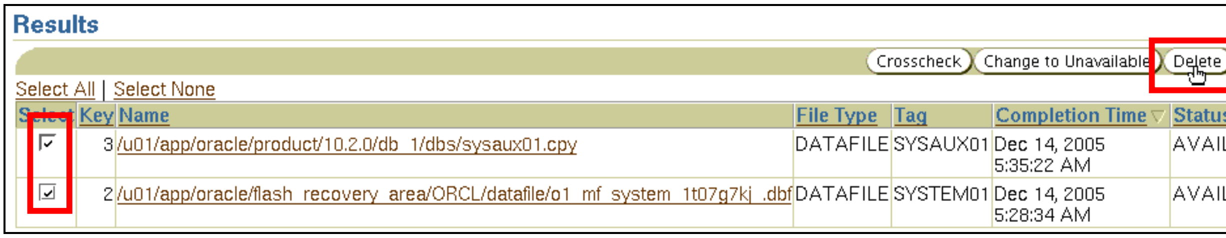
Solutions for Practice 3: Using Recovery Manager (continued)

c. Select the two image copies with tags `SYSAUX01` and `SYSTEM01`, and click Delete.



d. Click Yes on the Confirmation page. Then wait for the successful completion message.

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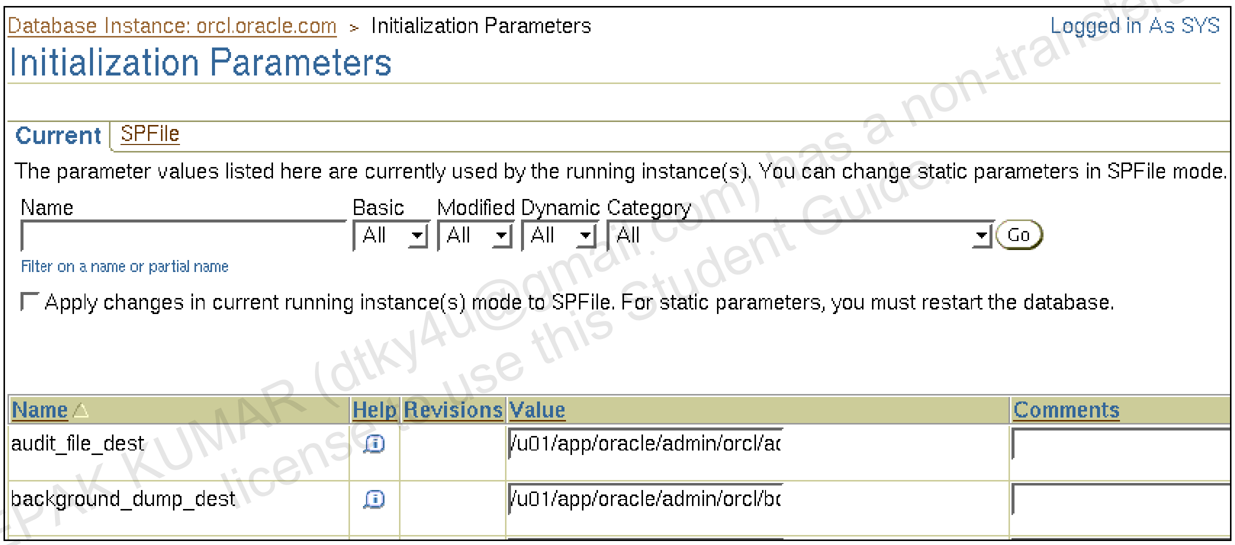
Solutions for Practice 4: Recovering from Noncritical Losses

Background: The default `TEMP` tablespace is defined for a database. It is where sorts and other memory-hungry operations are performed when they cannot fit into memory. If the data files of the `TEMP` tablespace are lost or damaged, you need only to add a new file to the `TEMP` tablespace and drop the old one. Also, only a redo log member needs to be re-created if it is lost or damaged. In the following exercises, you encounter and deal with a lost tempfile belonging to the `TEMP` tablespace, and a lost online redo log member. Note that the password for the `HR` user is `hr`.

1. Use Enterprise Manager to view all the initialization parameters.

   a. In EM, click All Initialization Parameters on the Administration tabbed page. Note that the parameters are viewable.



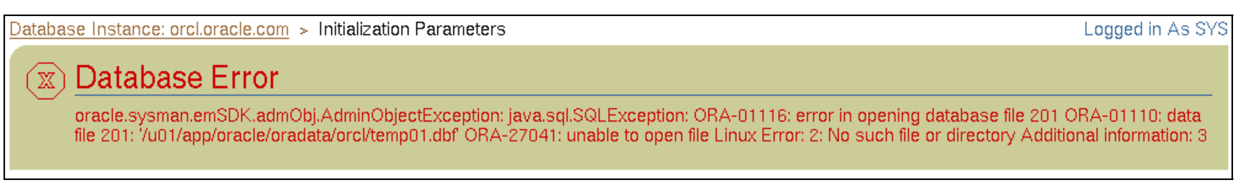
2. Run the `lab_04_02.sh` script to remove the tempfile in the `TEMP` tablespace.

   a. Enter the following in an XTerm window, at the Linux prompt.

```
$ cd $HOME/labs
$ ./lab_04_02.sh
```

3. In Enterprise Manager, again, attempt to view all the initialization parameters. You should get an error regarding the missing `temp01.dbf` file.

   a. In EM, click All Initialization Parameters on the Administration tabbed page. You should see this error:



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Solutions for Practice 4: Recovering from Noncritical Losses (continued)

Note: *If you do not see the error, log out of Enterprise Manager and log in again. Do this by clicking Logout in the upper-right corner of the page. Then log in as described in step 2-4 (d). Then reattempt the above step.*

4. Recover from the missing tempfile error by creating a new tempfile in the `TEMP` tablespace and dropping the missing one. The new tempfile should be of size 25 MB, and should be allowed to extend to a size of 100 MB. Then try again to view the initialization parameters as described in step 3.

   a. Log in to SQL*Plus as the SYS user.

```
$ sqlplus / as sysdba
```

   b. Create a new tempfile in the TEMP tablespace and call it `'u01/app/oracle/oradata/orcl/temp02.dbf'`. Do that by entering the following at the SQL prompt:

```
SQL> ALTER TABLESPACE "TEMP" ADD TEMPFILE
'/u01/app/oracle/oradata/orcl/temp02.dbf' SIZE 25M AUTOEXTEND ON NEXT 5M
MAXSIZE 100M;

Tablespace altered.
```

   c. Drop the tempfile that is missing by entering the following:

```
SQL> ALTER TABLESPACE TEMP DROP TEMPFILE
'/u01/app/oracle/oradata/orcl/temp01.dbf';

Tablespace altered.
```

   d. Verify that the TEMP tablespace is recovered by again attempting to view the initialization parameters using Enterprise Manager. See step 3. It should succeed this time.

5. Recover from a missing online redo log file. First, run the `lab_04_05_a.sql` script that creates a second redo log file for each redo log group. Then run the `lab_04_05_b.sh` script that removes one of the online redo log files. Run the `lab_04_05_c.sql` script to elicit the error. Recover from the missing file.

   a. Enter the following at the Linux prompt:

```
$ sqlplus / as sysdba @lab_04_05_a.sql
```

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Solutions for Practice 4: Recovering from Noncritical Losses (continued)

Following is the output of this command:

```
$ sqlplus / as sysdba @lab_04_05_a.sql

SQL>
SQL> ALTER DATABASE ADD LOGFILE MEMBER
  2  '/u01/app/oracle/oradata/orcl/redo01b.log'
  3  TO GROUP 1;

Database altered.

SQL>
SQL> ALTER DATABASE ADD LOGFILE MEMBER
  2  '/u01/app/oracle/oradata/orcl/redo02b.log'
  3  TO GROUP 2;

Database altered.

SQL>
SQL> ALTER DATABASE ADD LOGFILE MEMBER
  2  '/u01/app/oracle/oradata/orcl/redo03b.log'
  3  TO GROUP 3;

Database altered.

SQL>
```

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b. To delete one of the online redo log files, run the `lab_04_05_b.sh` script by entering the following at the Linux prompt:

```
$ ./lab_04_05_b.sh
```

Following is the output of this command:

```
$ ./lab_04_05_b.sh
rm '/u01/app/oracle/oradata/orcl/redo02b.log'

redo file deleted.
```

c. Elicit the error by entering the following at the Linux prompt:

```
$ sqlplus /  as sysdba @lab_04_05_c.sql
```


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Solutions for Practice 4: Recovering from Noncritical Losses (continued)

Following is the output of that command. Note the error in the alert log:

```
$ sqlplus / as sysdba @lab_04_05_c.sql

SQL> alter system switch logfile;

System altered.

SQL> alter system switch logfile;

System altered.

SQL> alter system switch logfile;

System altered.

SQL> host tail -60 $ORACLE_BASE/admin/orcl/bdump/alert_orcl.log
'/u01/app/oracle/oradata/orcl/redo03b.log'
TO GROUP 3
Wed Dec 14 08:19:04 2005
Thread 1 cannot allocate new log, sequence 15
Private strand flush not complete
  Current log# 1 seq# 14 mem# 0: /u01/app/oracle/oradata/orcl/redo01.log
Wed Dec 14 08:19:09 2005
Errors in file /u01/app/oracle/admin/orcl/bdump/orcl_lgwr_20401.trc:
ORA-00313: open failed for members of log group 2 of thread 1
ORA-00312: online log 2 thread 1:
'/u01/app/oracle/oradata/orcl/redo02b.log'
ORA-27037: unable to obtain file status
Linux Error: 2: No such file or directory
.
.
.
```

d. Re-create the redo log member by entering the following in SQL*Plus session, still logged in as the SYS user from the previous steps' session:

```
SQL> ALTER DATABASE DROP LOGFILE MEMBER
   > '/u01/app/oracle/oradata/orcl/redo02b.log';
SQL> ALTER DATABASE ADD LOGFILE MEMBER
   > '/u01/app/oracle/oradata/orcl/redo02b.log'
   > TO GROUP 2;
```

e. Rerun the `lab_04_05_c.sql` script to verify that the redo log error does not appear in the alert log again.

```
$ sqlplus / as sysdba @lab_04_05_c.sql
```

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Solutions for Practice 4: Recovering from Noncritical Losses (continued)

Following is the output of that command. Note that the redo log switches occur without error this time:

```
.
.
.
  Current log# 1 seq# 17 mem# 0: /u01/app/oracle/oradata/orcl/redo01.log
  Current log# 1 seq# 17 mem# 1:
/u01/app/oracle/oradata/orcl/redo01b.log
Thread 1 advanced to log sequence 18
  Current log# 2 seq# 18 mem# 0: /u01/app/oracle/oradata/orcl/redo02.log
  Current log# 2 seq# 18 mem# 1:
/u01/app/oracle/oradata/orcl/redo02b.log
Thread 1 advanced to log sequence 19
  Current log# 3 seq# 19 mem# 0: /u01/app/oracle/oradata/orcl/redo03.log
  Current log# 3 seq# 19 mem# 1:
/u01/app/oracle/oradata/orcl/redo03b.log
Thread 1 cannot allocate new log, sequence 20
Checkpoint not complete
  Current log# 3 seq# 19 mem# 0: /u01/app/oracle/oradata/orcl/redo03.log
  Current log# 3 seq# 19 mem# 1:
/u01/app/oracle/oradata/orcl/redo03b.log
Thread 1 advanced to log sequence 20
  Current log# 1 seq# 20 mem# 0: /u01/app/oracle/oradata/orcl/redo01.log
  Current log# 1 seq# 20 mem# 1:
/u01/app/oracle/oradata/orcl/redo01b.log

SQL>
```

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Solutions for Practice 5: Database Recovery

Background: As the DBA, you get a call from some users stating that there is incorrect data in the HR application. Payroll states that the sum of all salaries is supposed to be $691,400. It is now $679,050. Also, there should be no department changes within the last 60 days, but the `JOB_HISTORY` table shows changes from today. You realize that the personnel reorganization batch job must have run earlier than it should have, so you need to undo those far-reaching and multitable changes, including some made by triggers. Note that the password for the HR user is `hr`.

1. In order to simulate the incorrectly run batch job, run the `lab_05_01.sql` script.

   a. Enter the following at the Linux prompt:

```
$ sqlplus hr/hr @lab_05_01.sql
```

Following is the output of that command:

```
$ sqlplus hr/hr @lab_05_01.sql

SQL>
SQL> update employees set department_id = 90 where job_id = 'IT_PROG';

5 rows updated.

SQL>
SQL> update employees e set salary = least(e.salary,(select (min_salary
+ max_salary)/2 * 1.10 from jobs j where j.job_id = e.job_id)) where
job_id not like 'AD_%';

103 rows updated.

SQL>
SQL> commit;

Commit complete.

SQL>
```

2. Verify that the information about the salary sum and the job history is as reported to you by the users.

   a. Enter the following at the SQL*Plus prompt, while logged in as the HR user.

```
SQL> select sum(salary) from employees;
```


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Solutions for Practice 5: Database Recovery (continued)

Following is the output of that statement:

```
SQL> select sum(salary) from employees;

SUM(SALARY)
-----------
     679050
```

Note that the salary total is `679050` instead of `691400`.

b. Enter the following at the SQL prompt:

```
SQL> select count(*) from job_history where end_date > sysdate - 60;
```

Following is the output of that statement:

```
SQL> select count(*) from job_history where end_date > sysdate - 60;

  COUNT(*)
----------
         5
```

Note that there have been some department changes within the last 60 days, confirming the users' complaints.

3. You realize that undoing all these changes manually is too complex and error prone because of the tables and triggers involved. So, you decide to restore the entire database to a previous point in time. You know that the first modifications done in the reorganization batch job are the department changes. So, you look at the time of the first change in the `JOB_HISTORY` table, and decide to restore the database to a time that is one minute before then. Perform the restore.

a. To find the time of the first update, enter the following at the SQL prompt:

```
SQL> alter session set nls_date_format = "yyyy-mm-dd hh24:mi:ss";
SQL> select min(end_date) from job_history
  2  where end_date > sysdate - 60;
```

Note the date and time. ________________________________

For this example, the date and time is `2005-12-14 10:30:12`.

b. Connect as `AS SYSDBA` and shut down the instance, and bring the database to a MOUNT state in preparation for the RMAN restore operation.

```
SQL> connect / as sysdba
SQL> SHUTDOWN IMMEDIATE
SQL> STARTUP MOUNT
```

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Solutions for Practice 5: Database Recovery (continued)

c. Wait for the database to mount. Then, in a separate XTerm window, enter these commands at the Linux command-line prompt to prepare for the RMAN session, and then invoke RMAN.

Note: These environment variables must be in uppercase.

```
$ export NLS_DATE_FORMAT="yyyy-mm-dd hh24:mi:ss"
$ export NLS_LANG=american_america.we8iso8859p15
$ rman target / NOCATALOG
```

d. At the RMAN prompt, enter the following to restore the database to a time one minute before the batch job ran. Change the time below to the time noted in step 3-a above, less one minute.

```
RMAN> run {
2> set UNTIL TIME = '2005-12-14 10:29:12';
3> RESTORE DATABASE;
4> RECOVER DATABASE;
5> ALTER DATABASE OPEN RESETLOGS;
6> }
```

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Solutions for Practice 5: Database Recovery (continued)

Following is the output of this command:

```
RMAN> run {
2> set UNTIL TIME = '2005-12-14 10:29:12';
3> RESTORE DATABASE;
4> RECOVER DATABASE;
5> ALTER DATABASE OPEN RESETLOGS;
6> }

executing command: SET until clause

Starting restore at 2005-12-14 10:40:07
allocated channel: ORA_DISK_1
channel ORA_DISK_1: sid=155 devtype=DISK

channel ORA_DISK_1: starting datafile backupset restore
channel ORA_DISK_1: specifying datafile(s) to restore from backup set
restoring datafile 00001 to /u01/app/oracle/oradata/orcl/system01.dbf
restoring datafile 00002 to /u01/app/oracle/oradata/orcl/undotbs01.dbf
restoring datafile 00003 to /u01/app/oracle/oradata/orcl/sysaux01.dbf
restoring datafile 00004 to /u01/app/oracle/oradata/orcl/users01.dbf
restoring datafile 00005 to /u01/app/oracle/oradata/orcl/example01.dbf
restoring datafile 00006 to /u01/app/oracle/oradata/orcl/staging01.dbf
channel ORA_DISK_1: reading from backup piece
/u01/app/oracle/flash_recovery_area/ORCL/backupset/2005_12_14/o1_mf_nnnd
f_TAG20051214T060710_1t09rj5m_.bkp
channel ORA_DISK_1: restored backup piece 1
piece
handle=/u01/app/oracle/flash_recovery_area/ORCL/backupset/2005_12_14/o1_
mf_nnndf_TAG20051214T060710_1t09rj5m_.bkp tag=TAG20051214T060710
channel ORA_DISK_1: restore complete, elapsed time: 00:02:07
Finished restore at 2005-12-14 10:42:17

Starting recover at 2005-12-14 10:42:17
using channel ORA_DISK_1

starting media recovery

archive log thread 1 sequence 13 is already on disk as file
/u01/app/oracle/flash_recovery_area/ORCL/archivelog/2005_12_14/o1_mf_1_1
3_1t09wtrj_.arc
archive log thread 1 sequence 14 is already on disk as file
/u01/app/oracle/flash_recovery_area/ORCL/archivelog/2005_12_14/o1_mf_1_1
4_1t0khy2v_.arc
.
.
.
archive log thread 1 sequence 20 is already on disk as file
/u01/app/oracle/flash_recovery_area/ORCL/archivelog/2005_12_14/o1_mf_1_2
0_1t0qnwjp_.arc
```

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Solutions for Practice 5: Database Recovery (continued)

```
archive log
filename=/u01/app/oracle/flash_recovery_area/ORCL/archivelog/2005_12_14/
o1_mf_1_13_1t09wtrj_.arc thread=1 sequence=13
archive log
filename=/u01/app/oracle/flash_recovery_area/ORCL/archivelog/2005_12_14/
o1_mf_1_14_1t0khy2v_.arc thread=1 sequence=14
.
.
.
archive log
filename=/u01/app/oracle/flash_recovery_area/ORCL/archivelog/2005_12_14/
o1_mf_1_20_1t0qnwjp_.arc thread=1 sequence=20
media recovery complete, elapsed time: 00:00:14
Finished recover at 2005-12-14 10:42:33

database opened

RMAN>
```

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4. Verify that the database is restored to a point where the HR data does not have the reorganization changes.

   a. To see when the most recent `JOB_HISTORY` entry was, enter the following at the SQL prompt:

```
SQL> SELECT MAX(end_date) FROM hr.job_history;
```

It should be years in the past (not today). The output should be something like this, but not necessarily this exact date:

```
SQL> SELECT MAX(end_date) FROM hr.job_history;

MAX(END_D
---------
31-DEC-99
```

5. Exit SQL*Plus.

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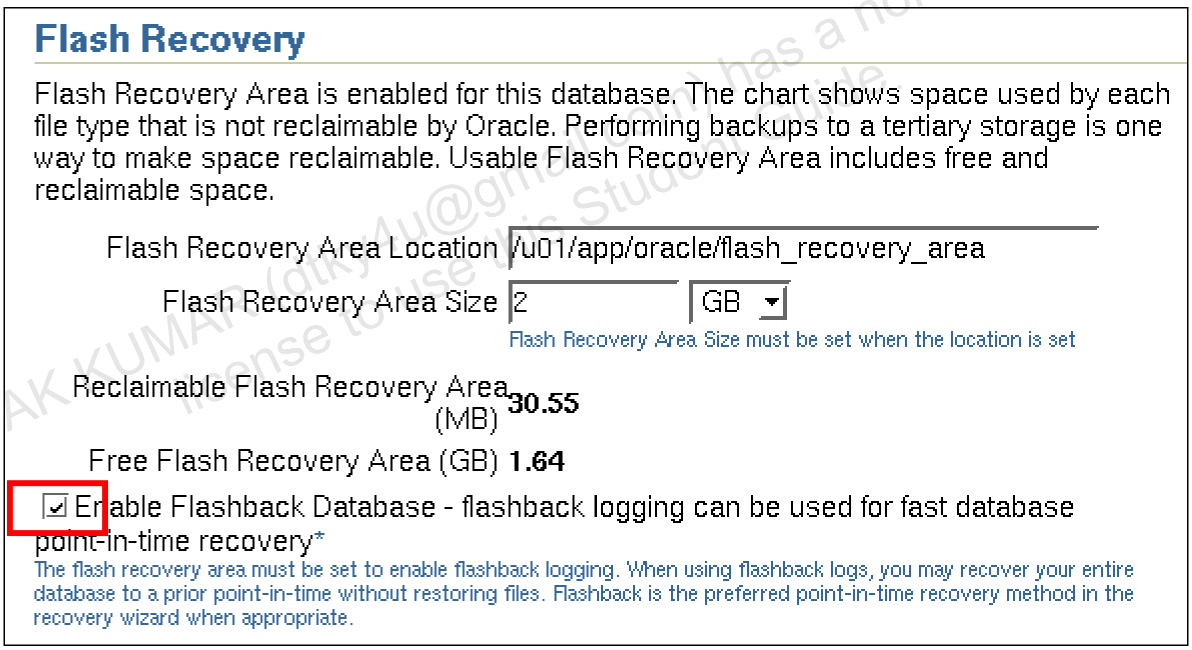
Solutions for Practice 6: Flashback

Background: The same scenario is executed here that was done in the practice titled "Database Recovery." The HR reorganization job runs prematurely, and you must undo its changes. The changes are such that you are not sure what tables are involved, so you decide, now that flashback logging has been enabled, you can use Flashback Database instead of performing a recovery. Unless specified otherwise, you should log in as the SYS user as SYSDBA through either SQL*Plus or Database Control.

1. Using Enterprise Manager, turn on flashback logging for your database (enable Flashback Database).

   a. In Database Control, click the Maintenance tabbed page, and then the Recovery Settings link in the Backup/Recovery Settings region.

   b. Scroll down and select the Enable Flashback Database check box. Click Apply. On the Confirmation page, click Yes to proceed with the database shutdown.



   c. Enter the host credentials using `oracle/oracle` and click OK.

   d. Click Yes on the Restart Database:Confirmation page.

   e. Click Refresh and wait a few moments for the database to restart. You may need to click Refresh several times.

   f. When the Login screen appears, log in as SYS AS SYSDBA.

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Solutions for Practice 6: Flashback (continued)

2. After the database has been restarted with flashback logging enabled, note the current SCN of the database by querying the V$DATABASE view.

   Note: *You will need this later.*

   Current SCN: _______________

   a. Enter the following:

```
$ cd $HOME/labs
$ sqlplus / as sysdba
SQL> SELECT current_scn FROM v$database;

CURRENT_SCN
-----------
     722521
```

3. Note the sum of the salaries in the HR.EMPLOYEES table, and the count of the rows in the JOB_HISTORY table.

```
SQL> SELECT SUM(salary) FROM hr.employees;

SUM(SALARY)
-----------
     691400
SQL> SELECT COUNT(*) FROM hr.job_history;

  COUNT(*)
----------
        10
```

4. Run the lab_06_04.sql script to perform the same HR reorganization updates as was run in the practice for the lesson titled "Database Recovery."

   a. Enter the following at the SQL prompt:

```
SQL> @lab_06_04.sql
```

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Solutions for Practice 6: Flashback (continued)

Following is the output of that command:

```
SQL> @lab_06_04.sql
SQL>
SQL> update employees set department_id = 90 where job_id = 'IT_PROG';

5 rows updated.

SQL>
SQL> update employees e set salary = least(e.salary,(select (min_salary
+ max_salary)/2 * 1.10 from jobs j where j.job_id = e.job_id)) where
job_id not like 'AD_%';

103 rows updated.

SQL>
SQL> commit;

Commit complete.

SQL>
```

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5. Note the current SCN in the database again, and also the salary sum and the JOB_HISTORY row count. If you are not connected as the SYS user, do that first. Note that these values are different from what was queried in steps 2 and 3.

```
SQL> show user
USER is "HR"
SQL> connect / as sysdba
Connected.
SQL> SELECT current_scn FROM v$database;

CURRENT_SCN
-----------
     722801

SQL> SELECT SUM(salary) FROM hr.employees;

SUM(SALARY)
-----------
     679050

SQL> SELECT COUNT(*) FROM hr.job_history;

  COUNT(*)
----------
        15

SQL>
```


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Solutions for Practice 6: Flashback (continued)

6. Using RMAN, flash back the database to the first SCN value noted in step 2.

   a. Shut down and then mount the database by entering the following:

```
SQL> SHUTDOWN IMMEDIATE
SQL> STARTUP MOUNT
```

   b. Go to the RMAN session in another XTerm window, and exit the current RMAN session there. Then log in to RMAN again.

```
$ rman target / NOCATALOG
```

   c. At the RMAN prompt, enter the `FLASHBACK DATABASE` command, and supply the SCN number recorded in step 2:

```
RMAN> FLASHBACK DATABASE TO SCN=632176;
```

Following is the output of this command:

```
RMAN> FLASHBACK DATABASE TO SCN=722521;

Starting flashback at 2005-12-14 11:24:04
allocated channel: ORA_DISK_1
channel ORA_DISK_1: sid=154 devtype=DISK


starting media recovery
media recovery complete, elapsed time: 00:00:07

Finished flashback at 2005-12-14 11:24:14

RMAN>
```

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7. Before opening the database for read/write, verify that the database was flashed back to the correct SCN by looking at the contents of the tables and seeing that they are back to what was noted in step 3.

   a. Enter the following at the SQL prompt to open the database in read-only mode:

```
SQL> alter database open read only;
```

   b. Enter the following at the SQL prompt to determine the row count for the `JOB_HISTORY` table.

```
SQL> SELECT SUM(salary) FROM hr.employees;

SUM(SALARY)
-----------
     691400
```


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Solutions for Practice 6: Flashback (continued)

8. Open the database for read/write use. You will have to use the RESETLOGS keyword.

   a. Shut down the database by entering the following at the SQL prompt:

```
SQL> shutdown immediate
Database closed.
Database dismounted.
ORACLE instance shut down.
```

   b. Enter the following at the SQL prompt to start up the database in the MOUNT state.

```
SQL> startup mount
ORACLE instance started.

Total System Global Area  285212672 bytes
Fixed Size                  1218992 bytes
Variable Size             121636432 bytes
Database Buffers          159383552 bytes
Redo Buffers                2973696 bytes
Database mounted.
```

   c. Enter the following at the SQL prompt to open the database in read-write mode:

```
SQL> alter database open resetlogs;

Database altered.
```

9. At this point you can familiarize yourself with the flashback-related dynamic views. In preparation for seeing the time values, alter your session to display hours, minutes, and seconds with any date values.

```
SQL> ALTER SESSION SET NLS_DATE_FORMAT="yyyy-mm-dd hh24:mi:ss";
```

10. Query the `V$FLASHBACK_DATABASE_LOG` view and determine the lowest SCN that the database can be flashed back to. Record your answer here: _____________

```
SQL> set wrap off
SQL> select * from v$FLASHBACK_DATABASE_LOG;
truncating (as requested) before column ESTIMATED_FLASHBACK_SIZE


OLDEST_FLASHBACK_SCN OLDEST_FLASHBACK_TI RETENTION_TARGET FLASHBACK_SIZE
-------------------- ------------------- ---------------- --------------
              720683 2005-12-14 11:01:52             1440        8192000
```


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Solutions for Practice 6: Flashback (continued)

11. View the overhead associated with flashback logging and related operations by querying V$FLASHBACK_DATABASE_STAT. What is the average number of bytes of flashback data written per minute during this time interval?

```
SQL> select * from V$FLASHBACK_DATABASE_STAT;
truncating (as requested) before column ESTIMATED_FLASHBACK_SIZE

BEGIN_TIME          END_TIME            FLASHBACK_DATA    DB_DATA
REDO_DATA
------------------- ------------------- -------------- ---------- ------
----
2005-12-14 11:29:00 2005-12-14 11:36:27        2686976    2424832
752640

SQL>
```

In the example above, the answer is `2686976/(11:36 - 11:29)`, which is `383854` bytes per minute.

12. Determine the current size of stored flashback data by querying V$FLASHBACK_DATABASE_LOG. Record your answer here: _____________ .

```
SQL> SELECT flashback_size FROM V$FLASHBACK_DATABASE_LOG;

FLASHBACK_SIZE
--------------
       8192000
```

Note: Your results will probably vary from those shown here.

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Solutions for Practice 7: Dealing with Database Corruption

Background: In the practice, a data file is deliberately corrupted, and you see the results of it as you query the affected table. You need to determine the location of the corruption and correct the problem.

1. In order to introduce corruption into the `DEPARTMENTS` table, you need to find out the OS file name in which its data is stored, and also an OS file block ID that is in the `DEPARTMENTS` table portion of the file. Query the `DBA_SEGMENTS` view to find the file ID and block ID for the `DEPARTMENTS` segment. Then determine the name of the associated OS file by querying the `DBA_DATA_FILES` view.

   Record these values here:

   File ID: _____________

   Block ID: _____________

   a. Be sure you are at the labs directory, and log in to SQL*Plus as the `SYS` user with the password `oracle`, and as `SYSDBA`.

```
$ cd $HOME/labs
$ sqlplus / as sysdba
```

   b. Enter the following at the SQL prompt:

```
SQL> select file_id, block_id from dba_extents
  2  where segment_name = 'DEPARTMENTS';
```

   Following is the output of that statement:

```
SQL> select file_id, block_id from dba_extents
  2  where segment_name = 'DEPARTMENTS';

   FILE_ID   BLOCK_ID
---------- ----------
         5         49
```

   c. There is only one extent returned in the above query. Determine the file name associated with `FILE_ID 5` by doing the following query. This gives you the name of the file that is to be corrupted. Enter the following at the SQL prompt:

```
SQL> select file_name from dba_data_files where file_id = 5;
```

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Solutions for Practice 7: Dealing with Database Corruption (continued)

Following is the output of that statement:

```
SQL> select file_name from dba_data_files where file_id = 5;

FILE_NAME
--------------------------------------------------------------------------------
/u01/app/oracle/oradata/orcl/example01.dbf
```

2. Run the `lab_07_02.sh` script to introduce corruption into the `example01.dbf` data file in the block number reported above. The order of the parameters to the script are the fully qualified file name, then the block number, and then the block size. The block size is `8192`. This script writes the characters `CORRUPT` into the given block number.

   a. Go to a separate XTerm window, and enter the following at the Linux command prompt:

```
$ ./lab_07_02.sh /u01/app/oracle/oradata/orcl/example01.dbf 49 8192
```

Following is the output of that command:

```
$ ./lab_07_02.sh /u01/app/oracle/oradata/orcl/example01.dbf 49 8192
0+1 records in
0+1 records out
0+1 records in
0+1 records out
0+1 records in
0+1 records out
0+1 records in
0+1 records out
$
```

3. Flush the buffer cache so that any queries against the `DEPARTMENTS` table are forced to go to the data file on disk. Then select all the columns of the `DEPARTMENTS` table and note the error.

   a. Enter the following at the SQL prompt to flush the buffer cache:

```
SQL> ALTER SYSTEM FLUSH BUFFER_CACHE;
```

   b. Enter the following at the SQL prompt to see whether the `DEPARTMENTS` table can be accessed:

```
SQL> SELECT * FROM hr.departments;
```

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Solutions for Practice 7: Dealing with Database Corruption (continued)

Following is the output of that statement. Note the error.

```
SQL> SELECT * FROM hr.departments;
select * from hr.departments
                 *
ERROR at line 1:
ORA-01578: ORACLE data block corrupted (file # 5, block # 51)
ORA-01110: data file 5: '/u01/app/oracle/oradata/orcl/example01.dbf'
```

4. Run the dbv utility to report all corruption in the example01.dbf file.

   a. Enter the following at the OS command prompt to invoke DBVERIFY:

```
$ dbv file=/u01/app/oracle/oradata/orcl/example01.dbf blocksize=8192
```

Following is the output of that command:

```
$ dbv file=/u01/app/oracle/oradata/orcl/example01.dbf blocksize=8192

DBVERIFY: Release 10.2.0.1.0 - Production on Fri Sep 9 11:51:05 2005

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DBVERIFY - Verification starting : FILE =
/u01/app/oracle/oradata/orcl/example01.dbf
Page 49 is marked corrupt
Corrupt block relative dba: 0x01400031 (file 5, block 49)
Bad header found during dbv:
Data in bad block:
 type: 67 format: 7 rdba: 0x0a545055
 last change scn: 0x0000.0006d161 seq: 0x2 flg: 0x04
 spare1: 0x52 spare2: 0x52 spare3: 0x0
 consistency value in tail: 0xd1612002
 check value in block header: 0xe5e
 computed block checksum: 0xe441

Page 50 is marked corrupt
Corrupt block relative dba: 0x01400032 (file 5, block 50)
Bad header found during dbv:
Data in bad block:
 type: 67 format: 7 rdba: 0x0a545055
 last change scn: 0x0000.0006d085 seq: 0x1 flg: 0x04
 spare1: 0x52 spare2: 0x52 spare3: 0x0
 consistency value in tail: 0xd0852101
 check value in block header: 0x4e60
 computed block checksum: 0xe443

Page 51 is marked corrupt
Corrupt block relative dba: 0x01400033 (file 5, block 51)
Bad header found during dbv:
Data in bad block:
```


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Solutions for Practice 7: Dealing with Database Corruption (continued)

```
type: 67 format: 7 rdba: 0x0a545055
 last change scn: 0x0000.0006d161 seq: 0x2 flg: 0x04
 spare1: 0x52 spare2: 0x52 spare3: 0x0
 consistency value in tail: 0xd1612302
 check value in block header: 0x63bb
 computed block checksum: 0xe440

Page 52 is marked corrupt
Corrupt block relative dba: 0x01400034 (file 5, block 52)
Bad header found during dbv:
Data in bad block:
 type: 67 format: 7 rdba: 0x0a545055
 last change scn: 0x0000.0006d161 seq: 0x2 flg: 0x04
 spare1: 0x52 spare2: 0x52 spare3: 0x0
 consistency value in tail: 0xd1610602
 check value in block header: 0x59cc
 computed block checksum: 0xe462



DBVERIFY - Verification complete

Total Pages Examined         : 12800
Total Pages Processed (Data) : 4408
Total Pages Failing   (Data) : 0
Total Pages Processed (Index): 1264
Total Pages Failing   (Index): 0
Total Pages Processed (Other): 1536
Total Pages Processed (Seg)  : 0
Total Pages Failing   (Seg)  : 0
Total Pages Empty            : 5588
Total Pages Marked Corrupt   : 4
Total Pages Influx           : 0
Highest block SCN            : 654836 (0.654836)
$
```

5. View the alert log to see the details of the corruption.

   a. Enter the following at the OS command prompt:

```
$ tail -50 $ORACLE_BASE/admin/orcl/bdump/alert_orcl.log
```

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Solutions for Practice 7: Dealing with Database Corruption (continued)

Following is the relevant output from that command:

```
Hex dump of (file 5, block 51) in trace file
/u01/app/oracle/admin/orcl/udump/orcl_ora_4287.trc
Corrupt block relative dba: 0x01400033 (file 5, block 51)
Bad header found during buffer read
Data in bad block:
 type: 67 format: 7 rdba: 0x0a545055
 last change scn: 0x0000.0006d161 seq: 0x2 flg: 0x04
 spare1: 0x52 spare2: 0x52 spare3: 0x0
 consistency value in tail: 0xd1612302
 check value in block header: 0x63bb
 computed block checksum: 0xe440
Reread of rdba: 0x01400033 (file 5, block 51) found same corrupted data
Wed Dec 14 12:32:19 2005
Corrupt Block Found
         TSN = 6, TSNAME = EXAMPLE
         RFN = 5, BLK = 51, RDBA = 20971571
         OBJN = 51852, OBJD = 51250, OBJECT = , SUBOBJECT =
         SEGMENT OWNER = , SEGMENT TYPE =
```

6. Perform block media recovery using RMAN. Use the DBVERIFY output from the previous step to determine the blocks that need to be recovered.

   a. Go to an XTerm window and connect to RMAN as the SYS user:

```
$ rman target / NOCATALOG
```

   b. At the RMAN prompt, enter the following to perform the block recovery:

```
RMAN> BLOCKRECOVER DATAFILE 5 BLOCK 49, 50, 51, 52;
```

Following is the output of this command:

```
RMAN> BLOCKRECOVER DATAFILE 5 BLOCK 49, 50, 51, 52;

Starting blockrecover at 2005-12-14 12:40:26
allocated channel: ORA_DISK_1
channel ORA_DISK_1: sid=142 devtype=DISK

channel ORA_DISK_1: restoring block(s)
channel ORA_DISK_1: specifying block(s) to restore from backup set
restoring blocks of datafile 00005
channel ORA_DISK_1: reading from backup piece
/u01/app/oracle/flash_recovery_area/ORCL/backupset/2005_12_14/o1_mf_nnnd
f_TAG20051214T060710_1t09rj5m_.bkp
channel ORA_DISK_1: restored block(s) from backup piece 1
piece
handle=/u01/app/oracle/flash_recovery_area/ORCL/backupset/2005_12_14/o1_
mf_nnndf_TAG20051214T060710_1t09rj5m_.bkp tag=TAG20051214T060710
channel ORA_DISK_1: block restore complete, elapsed time: 00:00:36
```


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Solutions for Practice 7: Dealing with Database Corruption (continued)

```
starting media recovery
archive log thread 1 sequence 13 is already on disk as file
/u01/app/oracle/flash_recovery_area/ORCL/archivelog/2005_12_14/o1_mf_1_1
3_1t09wtrj_.arc
archive log thread 1 sequence 14 is already on disk as file
/u01/app/oracle/flash_recovery_area/ORCL/archivelog/2005_12_14/o1_mf_1_1
4_1t0khy2v_.arc
archive log thread 1 sequence 15 is already on disk as file
/u01/app/oracle/flash_recovery_area/ORCL/archivelog/2005_12_14/o1_mf_1_1
5_1t0khydx_.arc
.
.
.
archive log thread 1 sequence 1 is already on disk as file
/u01/app/oracle/flash_recovery_area/ORCL/archivelog/2005_12_14/o1_mf_1_1
_1t0wnx22_.arc
media recovery complete, elapsed time: 00:00:08
Finished blockrecover at 2005-12-14 12:41:15

RMAN>
```

7. Verify that the block recover operation was successful by again flushing the buffer cache and querying the DEPARTMENTS table.

   a. Enter the following at the SQL prompt to flush the buffer cache:

```
SQL> ALTER SYSTEM FLUSH BUFFER_CACHE;
```

   b. Enter the following at the SQL prompt to query the table:

```
SQL> SELECT * FROM hr.departments;
```

Following is the output of that statement:

```
SQL> select * from hr.departments;

DEPARTMENT_ID DEPARTMENT_NAME                MANAGER_ID LOCATION_ID
------------- ------------------------------ ---------- -----------
           10 Administration                        200        1700
           20 Marketing                             201        1800
   .
   .
   .
```

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Solutions for Practice 8: Monitoring and Managing Memory

Background: This exercise puts your database in a mode where it is not running as efficiently and flexibly as possible. New objects are then introduced, and the database is unable to adjust. You must determine the cause of the problem and reconfigure the database so that it is able to accommodate the new objects dynamically. Unless specified otherwise, you should be logging in as SYSDBA either through Database Control Console or SQL*Plus.

1. Make sure you are in the labs directory under the oracle user home. Use SQL*Plus to shut down your instance, and start it up again using the init_sgalab.ora initialization parameter file located in your labs directory. You need to use the PFILE parameter with the STARTUP command.

   a. Perform an immediate shutdown on the database by entering the following at the SQL*Plus command line:

```
$ cd $HOME/labs
$ sqlplus / as sysdba
SQL> shutdown immediate
```

   b. Start up the database using the init_sgalab.ora parameter file that is in the labs directory. Do that by entering the following at the SQL*Plus command line:

```
SQL> startup pfile=init_sgalab.ora
```

2. Execute the lab_08_02.sql script. This script attempts to create many Java stored procedures.

   a. Enter the following at the SQL prompt to run the script to generate the Java stored procedures:

```
SQL> @lab_08_02.sql
```

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Solutions for Practice 8: Monitoring and Managing Memory (continued)

Following is the output of this command:

```
SQL> @lab_08_02.sql
Connected.
SQL>
SQL> DECLARE
  2  i NUMBER;
  3  v_sql VARCHAR2(200);
  4  BEGIN
  5    FOR i IN 1..200 LOOP
  6      -- Build up a dynamic statement to create a uniquely named java
stored proc.
  7      -- The "chr(10)" is there to put a CR/LF in the source code.
  8      v_sql := 'create or replace and compile' || chr(10) ||
  9               'java source named "SmallJavaProc' || i || '"' ||
chr(10) ||
 10               'as' || chr(10) ||
 11               'import java.lang.*;' || chr(10) ||
 12               'public class Util' || i || ' extends Object' ||
chr(10) ||
 13               '{ int v1=1;int v2=2;int v3=3;int v4=4;int v5=5;int
v6=6;int v7=7; }';
 14      EXECUTE IMMEDIATE v_sql;
 15    END LOOP;
 16  END;
 17  /
DECLARE
*
ERROR at line 1:
ORA-04031: unable to allocate 4096 bytes of shared memory ("java
pool","java/lang/ref/ReferenceQueueSYS","joxlod exec hp","SGAClass")
ORA-06512: at line 14
```

Question: What appears to be the cause of the error?

Answer: The Java Pool is too small.

3. Use Database Control Console to check the size of the various SGA buffers of your instance.

   Question 1: Is Automatic Shared Memory Management enabled?

   Question 2: What is the size of the Java Pool?

   a. On the Administration tabbed page, click Memory Parameters in the Database Configuration region.

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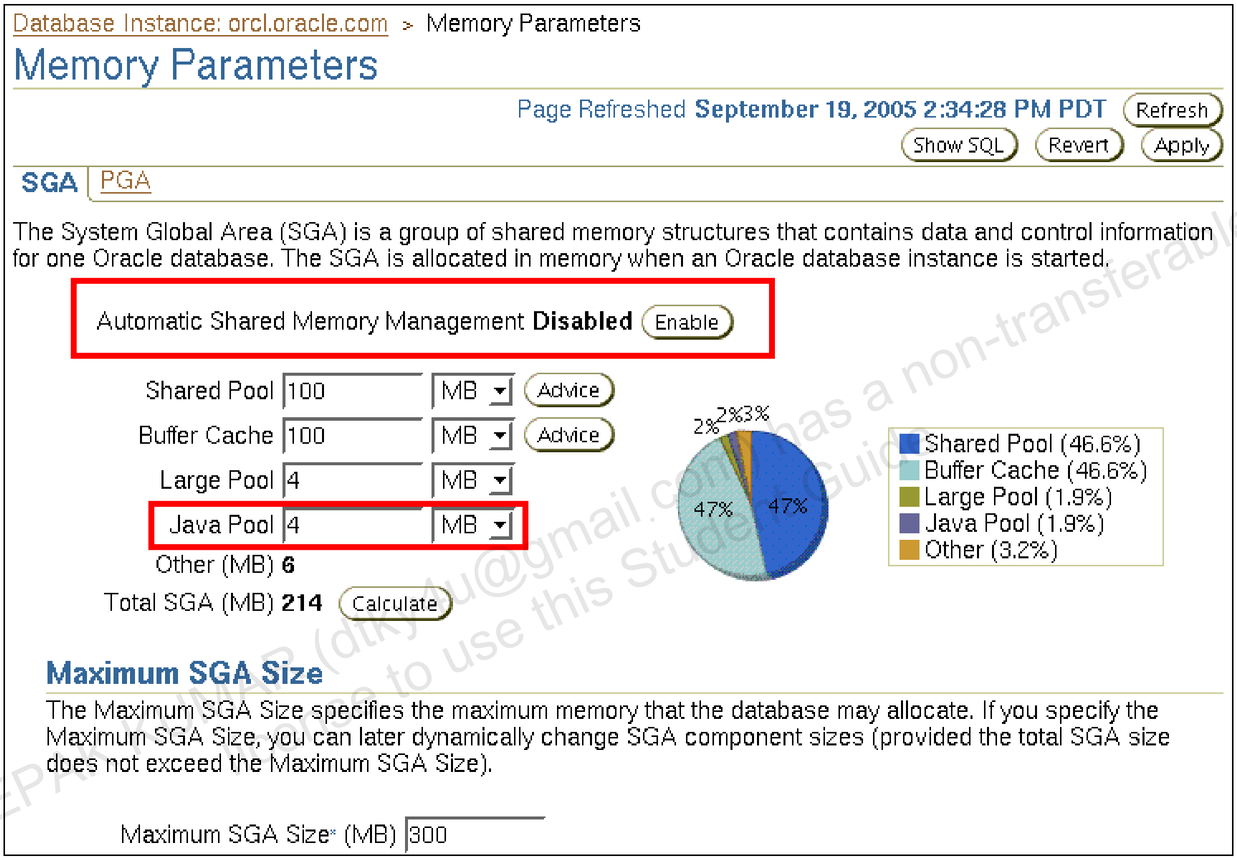
Solutions for Practice 8: Monitoring and Managing Memory (continued)

b. Note that Automatic Shared Memory Management is disabled.

Answer 1: No, ASMM is not enabled.

Answer 2: The Java Pool is 4 MB in size.



4. Run the `lab_08_04.sql` script as the `SYS` user to see the current memory settings. Are there any SGA dynamic components that have a `CURRENT_SIZE` different from `MIN_SIZE`? Explain your answer.

   Answer: No. The reason is because Automatic Shared Memory Management is not enabled, any specified size will be taken as the literal size that component should be set to, and the size will not change automatically. So, the minimum size is also the current size.

   a. Enter the following at the SQL prompt to see the memory settings:

```
SQL> connect / as sysdba
SQL> @lab_08_04.sql
```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Solutions for Practice 8: Monitoring and Managing Memory (continued)

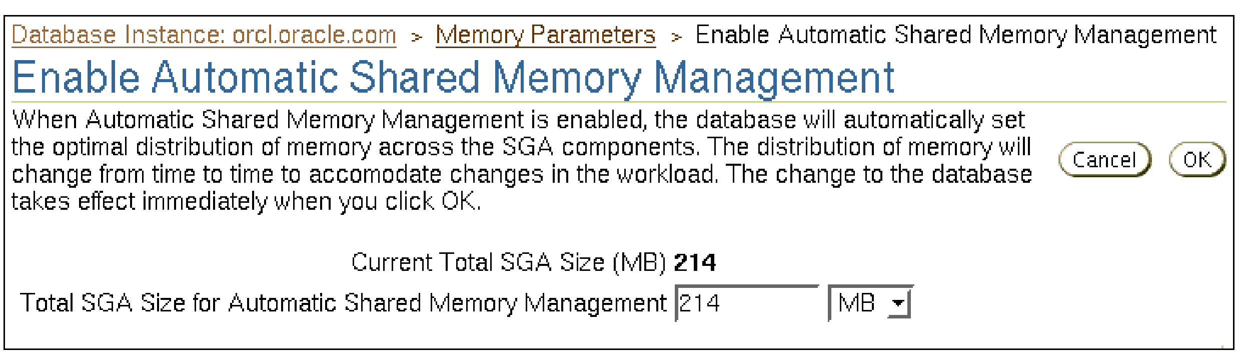
Following is the output of that command:

```
SQL> @lab_08_04.sql
*** Current parameter settings ***

NAME                                 TYPE        VALUE
------------------------------------ ----------- ------------------------------
sga_max_size                         big integer 300M
sga_target                           big integer 0

*** SGA Dynamic Component Size Information***

COMPONENT                 CURRENT_SIZE    MIN_SIZE
------------------------- --------------- ---------------
shared pool               100M            100M
large pool                4M              4M
java pool                 4M              4M
DEFAULT buffer cache      100M            100M

*** Current parameter settings in V$PARAMETER ***

NAME                 VALUE                ISDEFAULT
-------------------- -------------------- ---------
shared_pool_size     104857600            FALSE
large_pool_size      4194304              FALSE
java_pool_size       4194304              FALSE
db_cache_size        104857600            FALSE
```

5. Use Automatic Shared Memory Management to correct the problem so that the Java stored procedures can be created, but do not reattempt the stored procedure creation script yet.

   a. On the Memory Parameters page, click Enable to enable Automatic Shared Memory Management.

   b. On the Enable Automatic Shared Memory Management page, make sure that the "Total SGA Size for Automatic Shared Memory Management" field is set to the same value as the "Current Total SGA Size (MB)" field. Your value may be different from what is shown below. Then click OK.



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Solutions for Practice 8: Monitoring and Managing Memory (continued)

c. If a license agreement window appears at this point, press the [A] key to accept the agreement and continue.

6. Run the `lab_08_04.sql` script again to see the memory-related information. Be sure to run the script as the `SYS` user `AS SYSDBA`. Then answer the following questions:

Question 1: What value do you expect to see now for the `SGA_TARGET` initialization parameter? You can verify your answer by looking at the output of the `lab_08_04.sql` script.

Note: *There may be some rounding based on the granule size.*

Question 2: View the last 20 lines of the alert log to see the commands that were issued as a result of enabling ASMM. Why are the automatically managed pools set to a size of zero?

Question 3: Why is the `DB_CACHE_SIZE` set to a nonzero value?

Question 4: Why do you think the Java stored procedures could not be created?

Answer 1: A value (in this case 214 MB) that is very close to the value specified for “Total SGA Size for Automatic Shared Memory Management” (which in this case is 214 MB) when enabling ASMM.

```
SQL> connect / as sysdba
Connected.
SQL> @lab_08_04.sql
*** Current parameter settings ***

NAME                          TYPE        VALUE
----------------------------- ----------- ------------------------------
sga_max_size                  big integer 300M
sga_target                    big integer 216M
   .
   .
   .
```

a. View the alert log by entering the following command at the OS command prompt:

```
$ tail -20 $ORACLE_BASE/admin/orcl/bdump/alert_orcl.log
```

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Solutions for Practice 8: Monitoring and Managing Memory (continued)

Following is a sample output of this command:

```
$ tail -20 $ORACLE_BASE/admin/orcl/bdump/alert_orcl.log
Tue Sep 20 07:57:13 2005
MMAN: Can't zero buffer pool DEFAULT for blocksize 8192
Tue Sep 20 07:57:13 2005
ALTER SYSTEM SET sga_target='224395264' SCOPE=MEMORY;
Tue Sep 20 07:57:13 2005
ALTER SYSTEM SET db_cache_size='4194304' SCOPE=MEMORY;
Tue Sep 20 07:57:13 2005
ALTER SYSTEM SET java_pool_size='0' SCOPE=MEMORY;
Tue Sep 20 07:57:13 2005
ALTER SYSTEM SET large_pool_size='0' SCOPE=MEMORY;
Tue Sep 20 07:57:13 2005
ALTER SYSTEM SET shared_pool_size='0' SCOPE=MEMORY;
```

Answer 2: The automatically managed pools are set to a size of zero because they are now automatically managed, so any setting for these variables would mean that is the minimum size for that pool, now that ASMM is enabled. So, they are set to zero to indicate that there is no minimum, which is recommended for ASMM.

Answer 3: `DB_CACHE_SIZE` is set to a nonzero value because there is indeed a minimum for this: a value such that enough of the `SYSTEM` tablespace can be loaded to start up the database.

Answer 4: The Java stored procedures could not be created because, based on the reported error, there was not enough memory allocated to the Java Pool. Because ASMM was not yet enabled, there was no automatic adjustment made.

7. Rerun the `lab_08_02.sql` script to create the Java stored procedures. How much memory has been added to the Java Pool as a result of this script completing?

   a. Enter the following at the SQL prompt to rerun the script that generates the Java objects:

```
SQL> @lab_08_02.sql
```

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Solutions for Practice 8: Monitoring and Managing Memory (continued)

Following is the output of that command. Note that it succeeds this time.

```
SQL> @lab_08_02.sql
Connected.
SQL>
SQL> DECLARE
  2  i NUMBER;
  3  v_sql VARCHAR2(200);
  4  BEGIN
  5    FOR i IN 1..200 LOOP
  6      -- Build up a dynamic statement to create a uniquely named java
stored proc.
  7      -- The "chr(10)" is there to put a CR/LF in the source code.
  8      v_sql := 'create or replace and compile' || chr(10) ||
  9               'java source named "SmallJavaProc' || i || '"' ||
chr(10) ||
 10               'as' || chr(10) ||
 11               'import java.lang.*;' || chr(10) ||
 12               'public class Util' || i || ' extends Object' ||
chr(10) ||
 13               '{ int v1=1;int v2=2;int v3=3;int v4=4;int v5=5;int
v6=6;int v7=7; }';
 14      EXECUTE IMMEDIATE v_sql;
 15    END LOOP;
 16  END;
 17  /

PL/SQL procedure successfully completed.

SQL>
```

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b. Reconnect as the SYS user by entering the following at the SQL prompt:

```
SQL> connect / as sysdba
```

c. See the memory settings again by entering the following at the SQL prompt:

```
SQL> @lab_08_04.sql
```

Following is the relevant output of this command:

```
COMPONENT                CURRENT_SIZE    MIN_SIZE
----------------------  --------------- ---------------
shared pool              100M            100M
large pool               4M              4M
java pool                16M             4M
DEFAULT buffer cache     92M             92M
```

Answer: The Java Pool is now 16 MB, and it used to be 4 MB, so 12 MB has been added.

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Solutions for Practice 8: Monitoring and Managing Memory (continued)

8. Run the `lab_08_drop_javas.sql` script to drop the Java objects.

   a. Enter the following at the SQL prompt to run the script:

```
SQL> @lab_08_drop_javas.sql
```

Following is the output from that command:

```
SQL> @lab_08_drop_javas.sql
Connected.
SQL> DECLARE
     i NUMBER;
     v_sql VARCHAR2(200);
     BEGIN
       FOR i IN 1..200 LOOP
         v_sql := 'drop java source"SmallJavaProc' || i || '"';
         EXECUTE immediate v_sql;
       end loop;
     end;
     /

PL/SQL procedure successfully completed.

SQL>
```

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Solutions for Practice 9: Automatic Performance Management

Background: Run a script that generates load on the database. Then use Automatic Database Diagnostic Monitor to determine the problem. You need to evaluate a few different candidate causes of the problem until you find the real cause. Unless specified otherwise, you should be logging in as SYSDBA either through Database Control Console or SQL*Plus.

1. Run the `lab_09_01.sql` script to create the `TBSADDM` tablespace and create the `ADDM` user, which has the password **addm**.

   a. Enter the following command at the OS command prompt to create the `ADDM` user:

```
$ sqlplus / as sysdba @lab_09_01.sql
```

   Following is the output from that command:

```
$ sqlplus / as sysdba @lab_09_01.sql

SQL> CREATE SMALLFILE TABLESPACE "TBSADDM" DATAFILE
'/u01/app/oracle/oradata/orcl/tbsaddm.dbf' SIZE 50M LOGGING EXTENT
MANAGEMENT LOCAL SEGMENT SPACE MANAGEMENT MANUAL;
Tablespace created.

SQL>
SQL> CREATE USER "ADDM" PROFILE "DEFAULT" IDENTIFIED BY addm DEFAULT
TABLESPACE "TBSADDM" TEMPORARY TABLESPACE "TEMP" ACCOUNT UNLOCK;

User created.

SQL> GRANT CREATE SESSION TO "ADDM";

Grant succeeded.

SQL> GRANT "DBA" TO "ADDM";

Grant succeeded.

SQL> GRANT "RESOURCE" TO "ADDM";

Grant succeeded.

SQL>
```

2. Run the `lab_09_02.sql` script to create a table in the new tablespace.

   a. Enter the following at the SQL prompt to run the `lab_09_02.sql` script that creates a table in the new tablespace and gathers statistics for it:

```
SQL> @lab_09_02.sql
```

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Solutions for Practice 9: Automatic Performance Management (continued)

Following is the output of that command:

```
SQL> @lab_09_02.sql
SQL>
SQL> CONNECT / as sysdba
Connected.
SQL>
SQL> EXEC
dbms_advisor.set_default_task_parameter('ADDM','DB_ACTIVITY_MIN',30);

PL/SQL procedure successfully completed.

SQL>
SQL> CONNECT addm/addm
Connected.
SQL>
SQL> DROP TABLE addm PURGE;
DROP TABLE addm PURGE
           *
ERROR at line 1:
ORA-00942: table or view does not exist


SQL> CREATE TABLE addm(id NUMBER, name VARCHAR2(2000));

Table created.

SQL>
SQL> EXEC DBMS_STATS.GATHER_TABLE_STATS(-
> ownname=>'ADDM', tabname=>'ADDM',-
> estimate_percent=>DBMS_STATS.AUTO_SAMPLE_SIZE);

PL/SQL procedure successfully completed.

SQL>
SQL> exit
Disconnected from Oracle Database 10g Enterprise Edition Release
10.2.0.1.0 - Production
With the Partitioning, OLAP and Data Mining options
$
```

3. As the `oracle` Linux user, execute the `lab_09_03.sh` script from your labs directory. Wait for the eight stored procedures to complete.

   a. At the OS command prompt, enter the following to generate the load:

```
$ ./lab_09_03.sh
```

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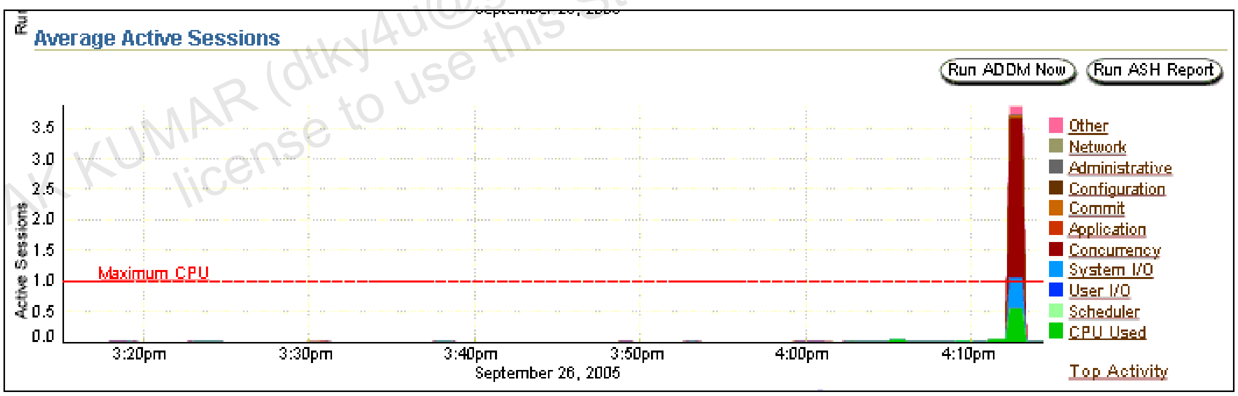
Solutions for Practice 9: Automatic Performance Management (continued)

Following is the output of this command:

```
$ ./lab_09_03.sh
Wait for 8 stored procedures to complete...

PL/SQL procedure successfully completed.

PL/SQL procedure successfully completed.

. . . <repeats 5 more times>

PL/SQL procedure successfully completed.

$
```

4. From the Database Control Console home page, click the Performance tabbed page. On the Performance page, make sure that the View Data field is set to “Real Time: 15 Seconds Refresh.” After two minutes, you should see a spike on the Average Active Sessions graph.

   Note: If you see a pop-up screen asking you to accept or decline the SVG Viewer agreement, type [A] to accept. Using the SVG Viewer enhances the graphical displays of Enterprise Manager. The screenshots shown below do not use the SVG Viewer.



5. After the spike is finished, execute the `lab_09_05.sql` script as the `ADDM` user. This script forces the creation of a new snapshot. Looking at the graph, you can already determine that this instance is suffering concurrency problems.

```
$ sqlplus addm/addm @lab_09_05.sql

PL/SQL procedure successfully completed.
PL/SQL procedure successfully completed.
```

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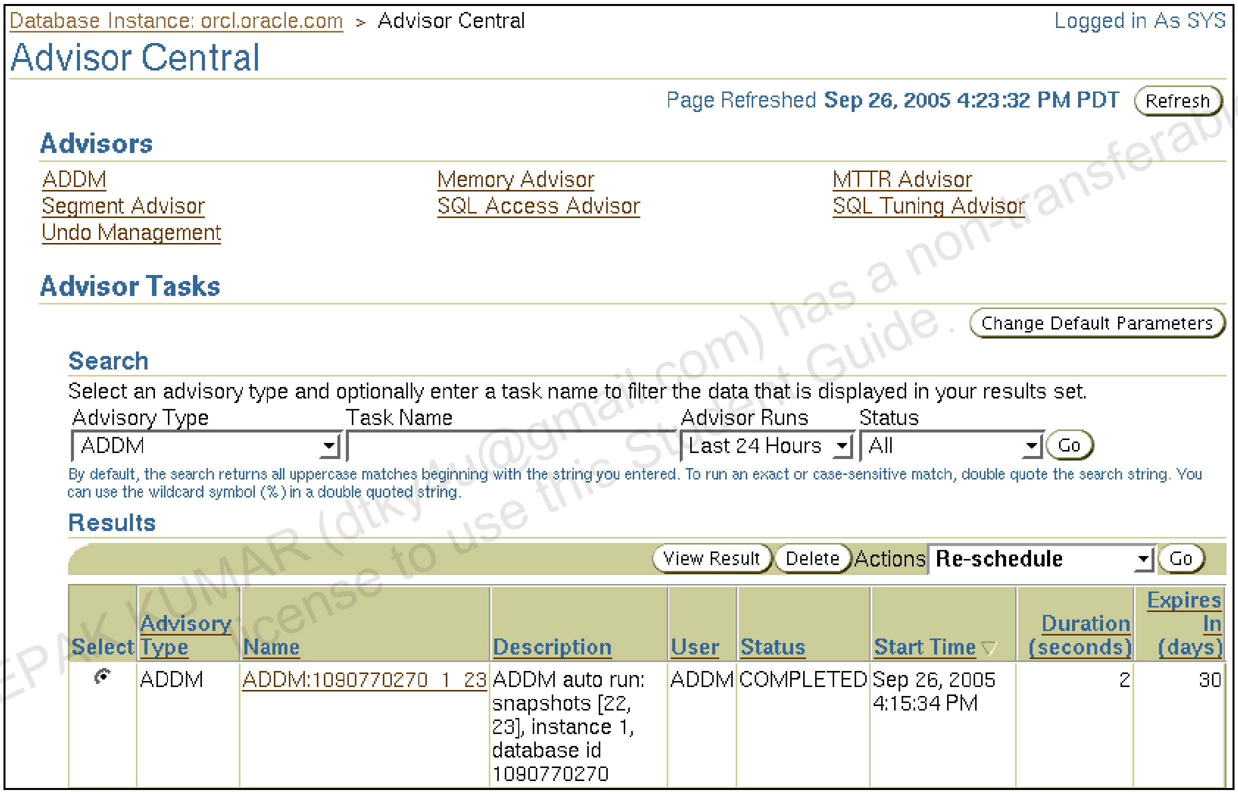
Solutions for Practice 9: Automatic Performance Management (continued)

6. Return to the Database Home page. The latest ADDM result might not yet be displayed in the Diagnostic Summary region. To avoid waiting for the next refresh interval, retrieve the latest ADDM findings from the Advisor Central, and determine the cause of the problem.

    a. On the Database home page, click the Advisor Central link. On the Advisor Central page, in the Advisor Tasks region, select ADDM in the Advisory Type drop-down list, and select Last 24 Hours in the Advisor Runs drop-down list. Then click Go. Then click the name of the latest successful advisor task that was run by the `ADDM` user.



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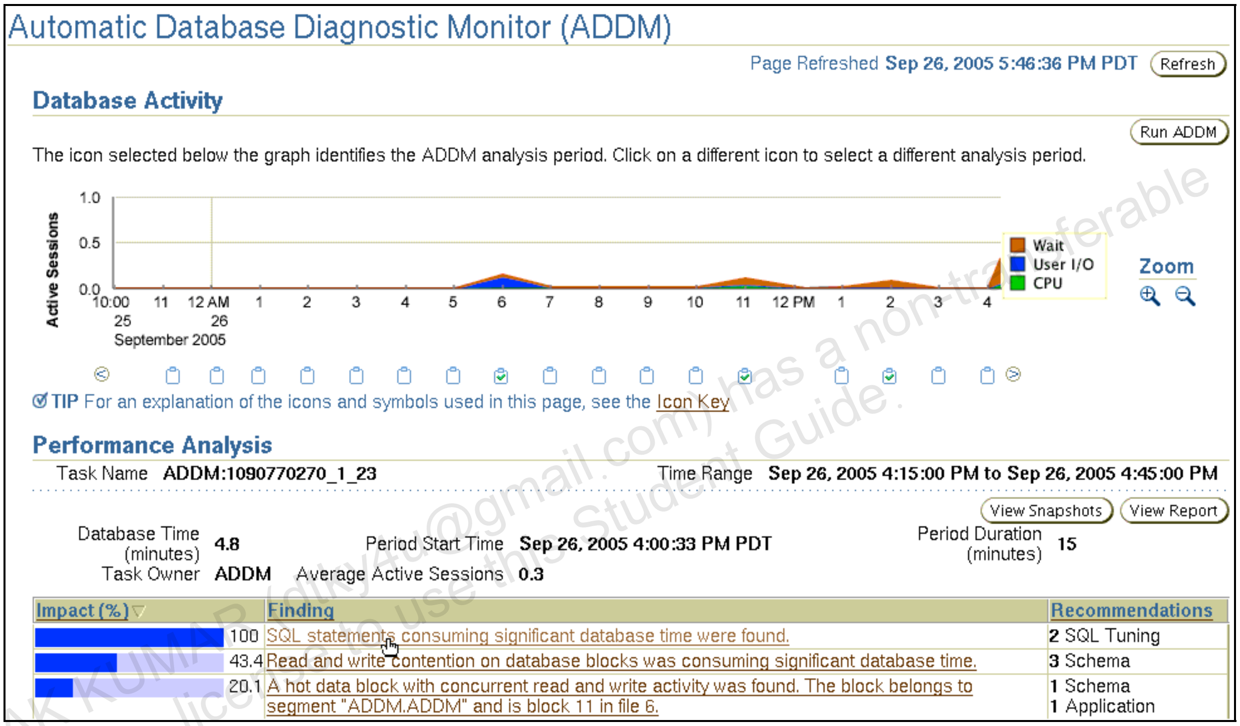
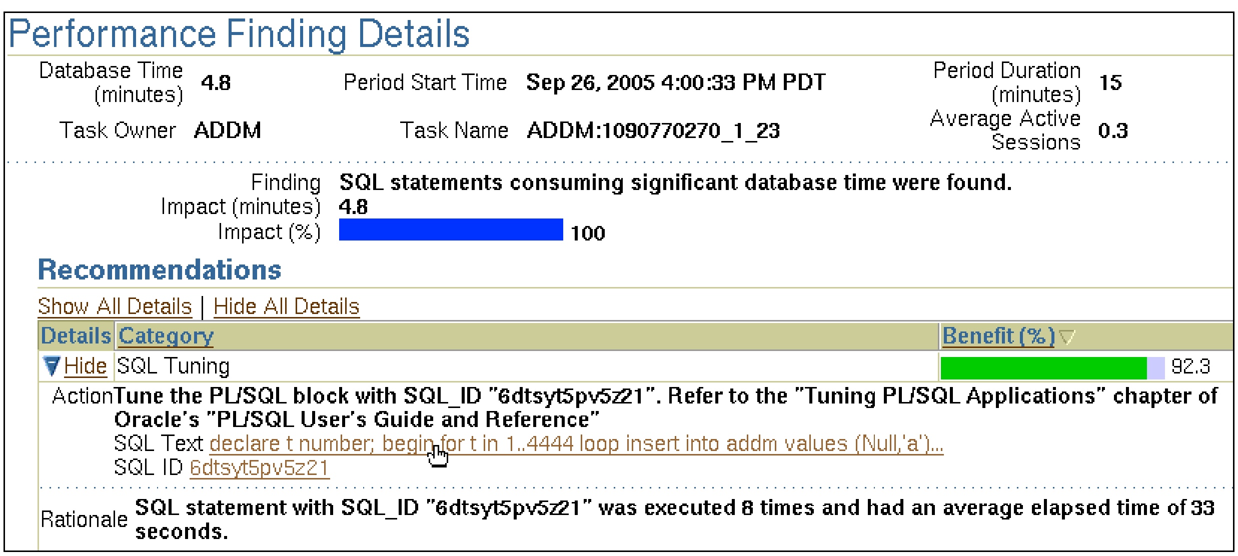
Solutions for Practice 9: Automatic Performance Management (continued)

b. Click the text in the Finding column that has the highest impact. This is naturally the first place to look because it has the highest impact.

Note: *Because of the variations in environments, this load may not have generated any findings. If that is the case, perform the above steps 3 through 5 again to generate another load.*



c. This takes you to the Performance Finding Details page. Click either the SQL Text link or the SQL ID link to drill down into the suspect SQL details.



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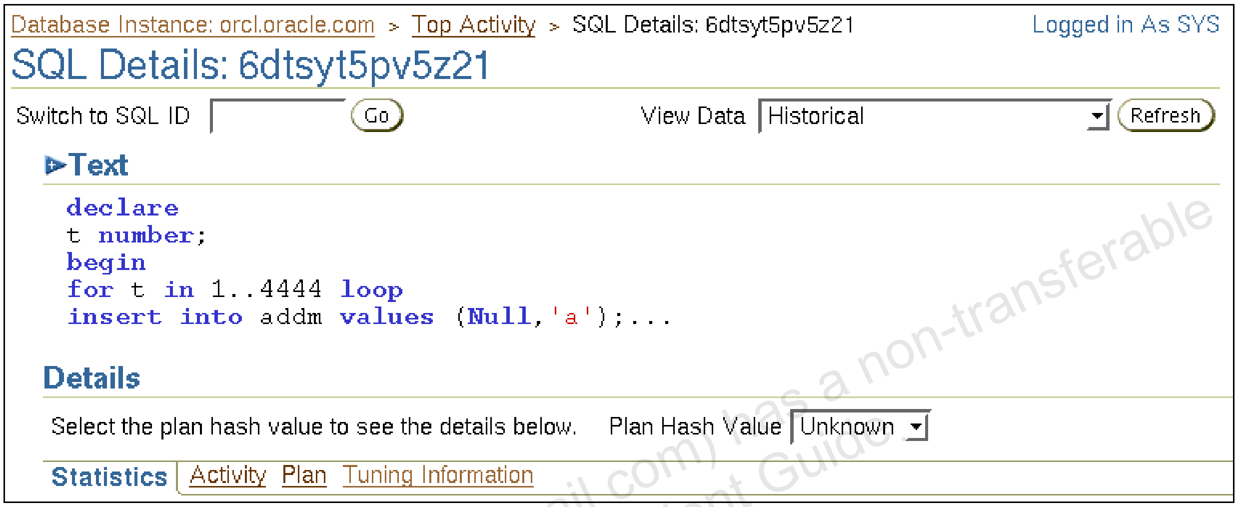
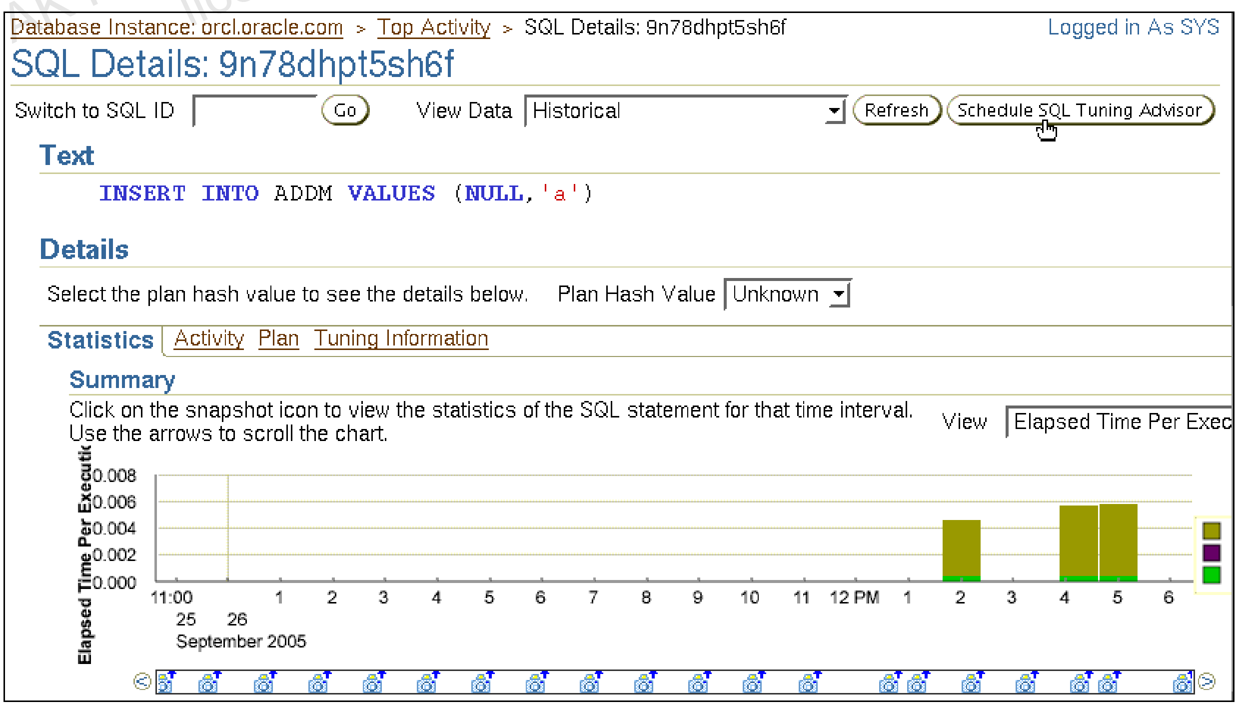
Solutions for Practice 9: Automatic Performance Management (continued)

d. This takes you to the SQL Details page. You want to run the SQL Tuning Advisor on this SQL, but you see no button for invoking it on this screen. That is because this is actually an anonymous SQL block, which cannot be tuned using the SQL Tuning Advisor. The SQL that is in that block is what should be tuned. So, you click the browser's Back button once to view the other findings.



e. Click "Show All Details" and then click the INSERT statement link.

f. Based on the pie chart, you see there are a lot of concurrency issues with this INSERT statement. You decide to run the SQL Tuning Advisor by clicking on the "Schedule SQL Tuning Advisor" button on the upper-right corner of the page.



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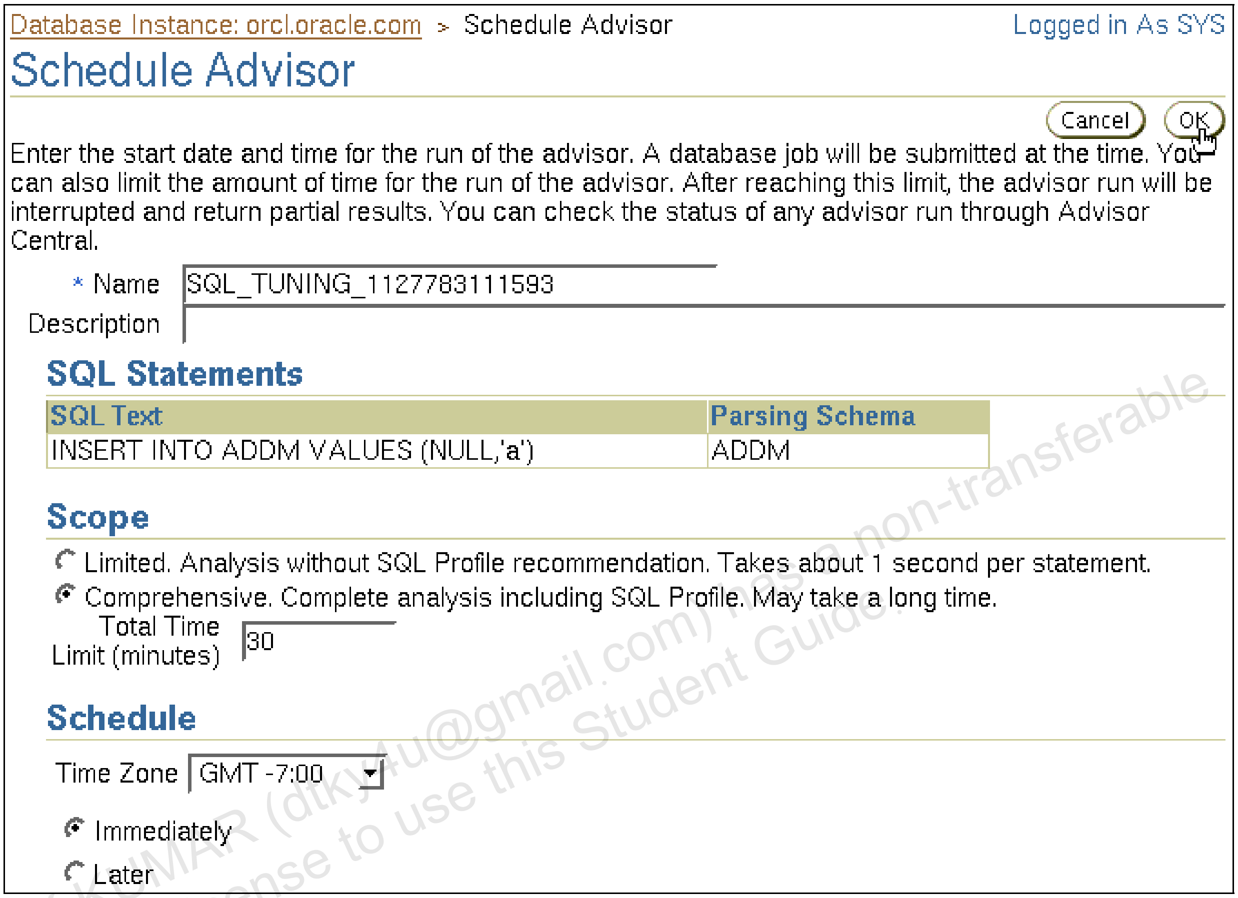
Solutions for Practice 9: Automatic Performance Management (continued)

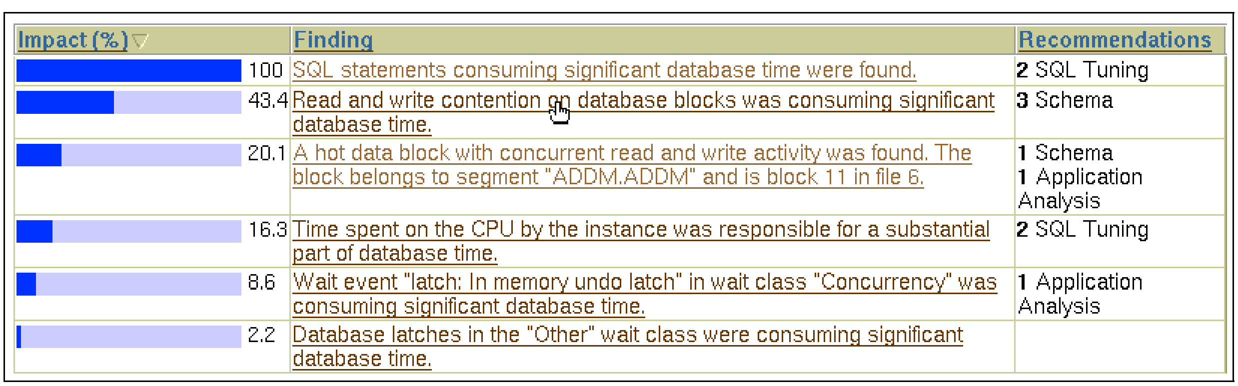
g. Keep all the defaults for the scheduled task, and click OK.



h. As soon as the advisor is finished, you are taken to the recommendations page. Unfortunately, there are no recommendations for the `INSERT` statement.

i. Go back to the findings page again, and click the next finding down in the list labeled “Read and write contention on database blocks was consuming significant database time.”

Note: *You may need to navigate to the ADDM Advisor task again as specified in step 6 (a) if the browser Back button functionality does not retain the state.*



Impact (%)	Finding	Recommendations
100	SQL statements consuming significant database time were found.	2 SQL Tuning
43.4	Read and write contention on database blocks was consuming significant database time.	3 Schema
20.1	A hot data block with concurrent read and write activity was found. The block belongs to segment "ADDM.ADDM" and is block 11 in file 6.	1 Schema 1 Application Analysis
16.3	Time spent on the CPU by the instance was responsible for a substantial part of database time.	2 SQL Tuning
8.6	Wait event "latch: In memory undo latch" in wait class "Concurrency" was consuming significant database time.	1 Application Analysis
2.2	Database latches in the "Other" wait class were consuming significant database time.	

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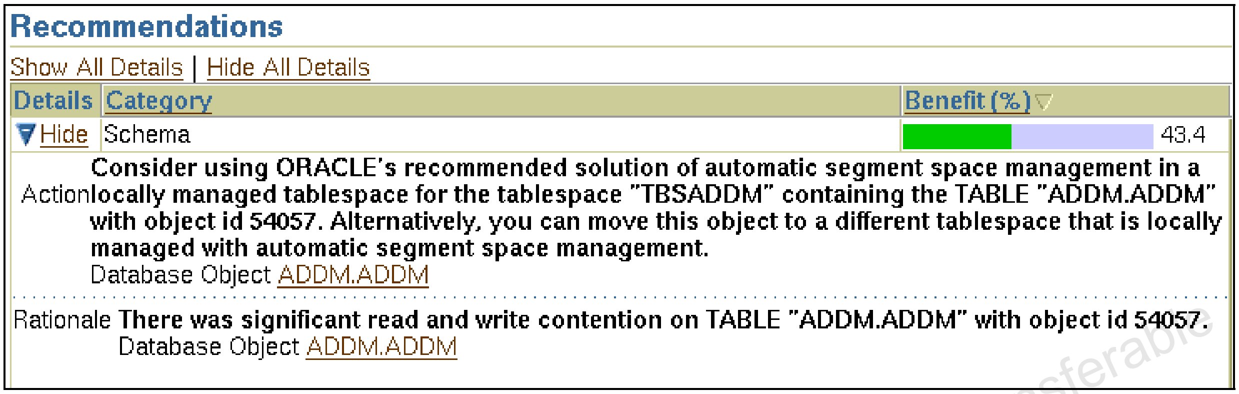
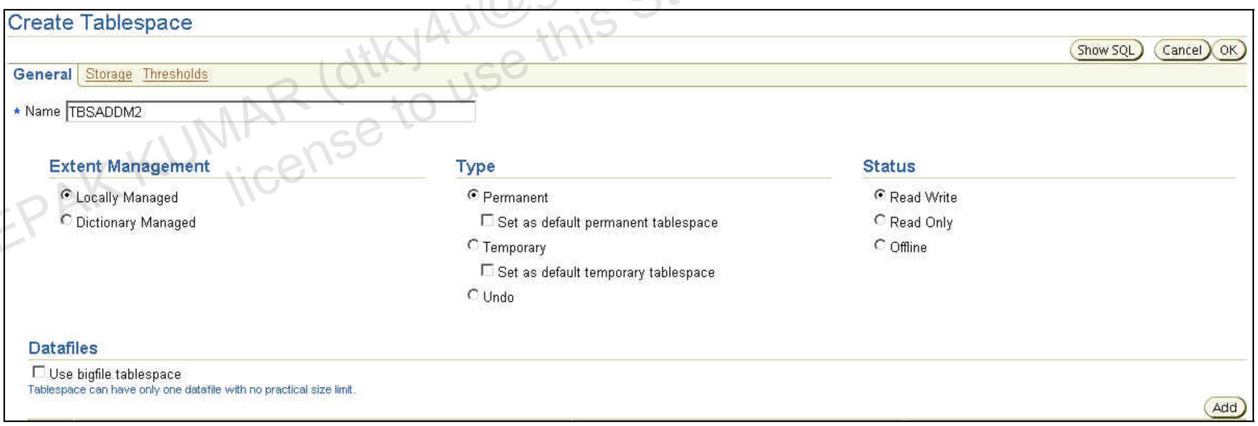
Solutions for Practice 9: Automatic Performance Management (continued)

j. This time you immediately see a recommendation to implement automatic segment space management on the TBSADDM tablespace.



7. To implement the recommendation, you must re-create the objects. First, you need to create a new tablespace called TBSADDM2 that uses the Automatic Space Management feature.

a. On the Database Administration page, click the Tablespaces link, and then click Create. Specify the name of the new tablespace in the Name field. You can call this new tablespace TBSADDM2. Click Add to add a file to this tablespace.



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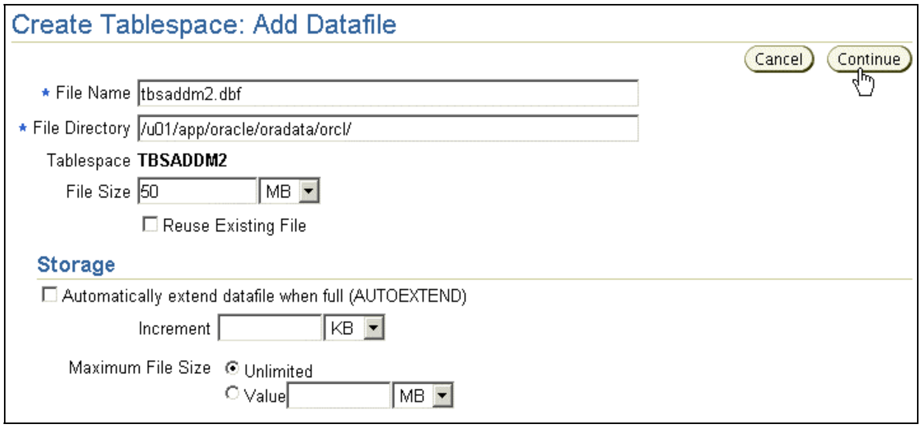
Solutions for Practice 9: Automatic Performance Management (continued)

b. On the Create Tablespace: Add Datafile page, specify `tbsaddm2.dbf` as the name of the new file, and set its size to 50 MB. When done, click Continue.



c. When returned to the Create Tablespace page, click the Storage tab, and make sure that Automatic is set in the Segment Space Management region. Then click the OK button to create the new tablespace.

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8. Execute the `lab_09_08.sql` script from your labs directory to drop the `ADDM` table and re-create it in the new tablespace. This script also gathers statistics on the table and takes a new snapshot.

a. Enter the following at the OS command prompt to move the `ADDM` table to the new tablespace:

```
$ sqlplus addm/addm @lab_09_08.sql
```


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Solutions for Practice 9: Automatic Performance Management (continued)

Following is the output of that command:

```
$ sqlplus addm/addm @lab_09_08.sql

Connected.
SQL> drop table addm purge;

Table dropped.

SQL> create table addm(id number, name varchar2(2000)) tablespace
TBSADDM2;

Table created.

SQL>
SQL> exec DBMS_STATS.GATHER_TABLE_STATS(-
> ownname=>'ADDM', tabname=>'ADDM',-
> estimate_percent=>DBMS_STATS.AUTO_SAMPLE_SIZE);

PL/SQL procedure successfully completed.

SQL>
SQL> exec DBMS_WORKLOAD_REPOSITORY.CREATE_SNAPSHOT();

PL/SQL procedure successfully completed.

SQL>
```

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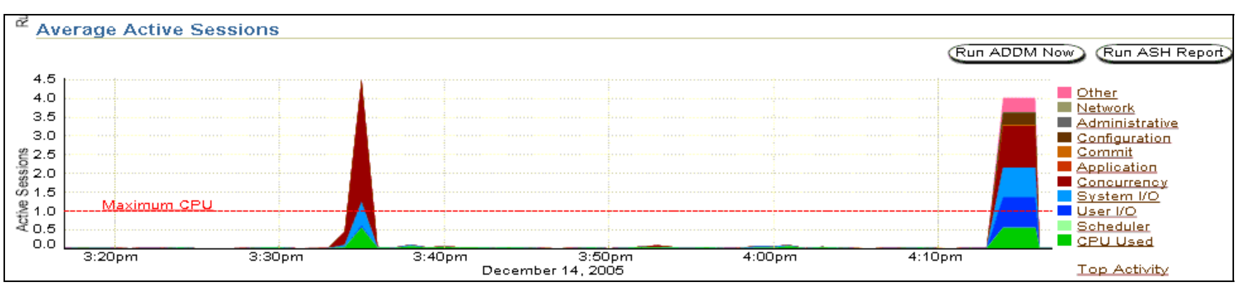
9. Rerun the `lab_09_03.sh` script.

   a. At the OS command prompt, enter the following to regenerate the load on the database:

```
$ ./lab_09_03.sh
```

10. View the load spike using Enterprise Manager.

    a. From the Database Control Console home page, go to the Performance page and make sure that the View Data field is set to "Real Time: 15 Seconds Refresh." After two minutes, you should see a spike on the "Average Active Sessions" graph.



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Solutions for Practice 9: Automatic Performance Management (continued)

11. When the spike is finished, connect to the database as the `ADDM` user using SQL*Plus and execute the `lab_09_11.sql` script. This script forces the creation of a new snapshot.

    a. Enter the following at the SQL prompt to take another snapshot:

```
SQL> @lab_09_11.sql
```

Following is the output of this command:

```
SQL> @lab_09_11.sql
SQL> connect / as sysdba
Connected.
SQL>
SQL> exec DBMS_STATS.GATHER_TABLE_STATS(-
> ownname=>'ADDM', tabname=>'ADDM',-
> estimate_percent=>DBMS_STATS.AUTO_SAMPLE_SIZE);

PL/SQL procedure successfully completed.

SQL>
SQL> exec DBMS_WORKLOAD_REPOSITORY.CREATE_SNAPSHOT();

PL/SQL procedure successfully completed.

SQL>
```

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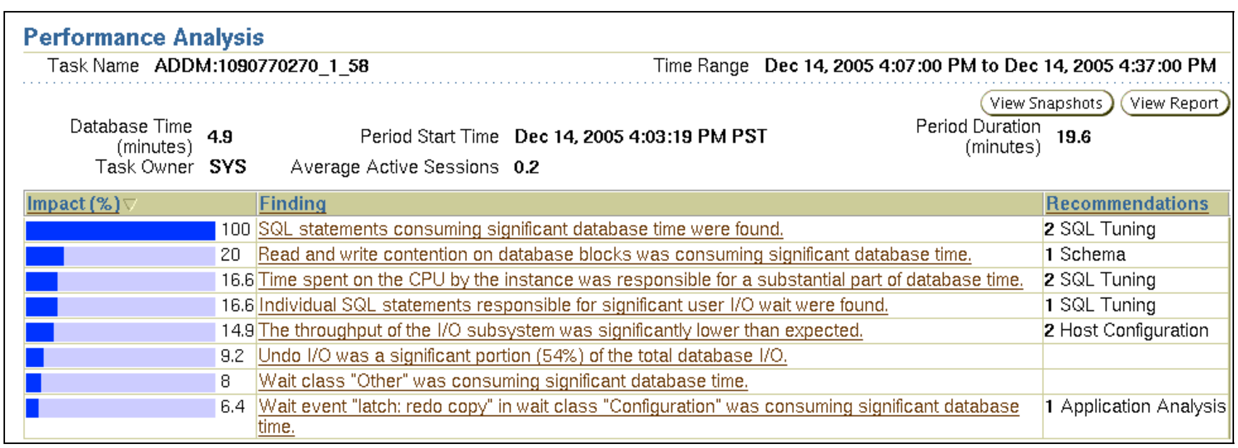
12. From the Database Control Console home page, go to Advisor Central and look at the latest snapshot. Has the situation improved?

    a. In Enterprise Manager, click the Administration tabbed page, and then click the Advisor Central link in the Related Links region.

    b. Click the name of the most recent ADDM advisor task.



    c. Looking at the graph, you can already determine that this instance is not having the same concurrency issues encountered earlier.

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Solutions for Practice 9: Automatic Performance Management (continued)

13. To clean up your environment, execute the `lab_09_cleanup.sql` script.

    a. Disconnect from all of your SQL*Plus sessions that are connected as the `ADDM` user.

    b. Enter the following at the OS prompt to clean up your environment:

```
$ sqlplus / as sysdba @lab_09_cleanup.sql
```

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Solution for Practice 10: Managing Schema Objects

Background: Your company is going through a merging process. As a result, you expect some dramatic growth in a few tables of the databases for which you are responsible. To proactively monitor table and index space usage, you create a test case and perform the tasks, which you expect for your production system.
Log in as the `SYS` user (with `oracle` password, connect as `SYSDBA`) and perform the necessary tasks either through Enterprise Manager Database Control or through SQL*Plus. All scripts for this practice are in the `/home/oracle/labs` directory.

1. Run the `lab_10_01.sh` script to create the `TEST_REGIONS` table.

    a. Enter the following at the OS command prompt:

```
$ ./lab_10_01.sh
```

Following is the output of this command:

```
$ ./lab_10_01.sh

Connected to:
Oracle Database 10g Enterprise Edition Release 10.2.0.1.0 - Production
With the Partitioning, OLAP and Data Mining options

SQL> SQL> SQL> DROP TABLE hr.test_regions CASCADE CONSTRAINTS PURGE
              *
ERROR at line 1:
ORA-00942: table or view does not exist


SQL> SQL>   2    3    4    5    6    7    8
Table created.

SQL> SQL>   1  CREATE TABLE hr.test_regions
  2  ( REGION_ID        NUMBER
  3  , REGION_NAME      VARCHAR2(25)
  4  )
  5  TABLESPACE example PCTFREE 10 INITRANS 1 MAXTRANS 255
  6  STORAGE (INITIAL 64K BUFFER_POOL DEFAULT)
  7* NOLOGGING
SQL> SQL> Disconnected from Oracle Database 10g Enterprise Edition
Release 10.2.0.1.0 - Production
With the Partitioning, OLAP and Data Mining options
$
```

Question 1: What does `PCTFREE 10` mean?

Possible Answer: When inserting rows for this table, the Oracle database will keep 10% of the block free for future updates.

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Solution for Practice 10: Managing Schema Objects (continued)

2. Populate the `TEST_REGIONS` table by running the `lab_10_02.sh` script.

   a. Enter the following at the OS command prompt:

```
$ ./lab_10_02.sh
```

Following is the output of this command:

```
$ ./lab_10_02.sh

Connected to:
Oracle Database 10g Enterprise Edition Release 10.2.0.1.0 - Production
With the Partitioning, OLAP and Data Mining options

SQL> SQL> drop sequence test_seq
             *
ERROR at line 1:
ORA-02289: sequence does not exist

SQL> SQL>
Sequence created.

SQL> SQL>   2    3    4    5    6    7    8    9   10   11   12   13
14   15   16   17   18   19   20   21   22   23   24   25   26
PL/SQL procedure successfully completed.

SQL>   1  BEGIN
  2   FOR i in 1..1000 LOOP
  3     insert into hr.test_regions values (test_seq.nextval, 'Test
region '||'10');
  4     insert into hr.test_regions values (test_seq.nextval, 'Test
region '||'20');
  5     insert into hr.test_regions values (test_seq.nextval, 'Test
region '||'30');
  6     insert into hr.test_regions values (test_seq.nextval, 'Test
region '||'40');
  7     insert into hr.test_regions values (test_seq.nextval, 'Test
region '||'50');
  8     insert into hr.test_regions values (test_seq.nextval, 'Test
region '||'60');
  9     insert into hr.test_regions values (test_seq.nextval, 'Test
region '||'70');
 10     insert into hr.test_regions values (test_seq.nextval, 'Test
region '||'80');
 11     insert into hr.test_regions values (test_seq.nextval, 'Test
region '||'90');
 12     insert into hr.test_regions values (test_seq.nextval, 'Test
region '||'00');
 13     insert into hr.test_regions values (test_seq.nextval, 'Test
region '||'11');
```

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Solution for Practice 10: Managing Schema Objects (continued)

```
 14     insert into hr.test_regions values (test_seq.nextval, 'Test
region '||'21');
 15     insert into hr.test_regions values (test_seq.nextval, 'Test
region '||'31');
 16     insert into hr.test_regions values (test_seq.nextval, 'Test
region '||'41');
 17     insert into hr.test_regions values (test_seq.nextval, 'Test
region '||'51');
 18     insert into hr.test_regions values (test_seq.nextval, 'Test
region '||'61');
 19     insert into hr.test_regions values (test_seq.nextval, 'Test
region '||'71');
 20     insert into hr.test_regions values (test_seq.nextval, 'Test
region '||'81');
 21     insert into hr.test_regions values (test_seq.nextval, 'Test
region '||'91');
 22     insert into hr.test_regions values (test_seq.nextval, 'Test
region '||'01');
 23     commit;
 24   END LOOP;
 25* END;
SQL>
  COUNT(*)
----------
     20000

SQL> SQL>   2
1000 rows deleted.

SQL>   1  delete from hr.test_regions
  2* where region_name like '%20'
SQL>   2
1000 rows deleted.

SQL>   1  delete from hr.test_regions
  2* where region_name like '%41'
SQL>   2
1000 rows deleted.

SQL>   1  delete from hr.test_regions
  2* where region_name like '%60'
SQL>
Commit complete.

SQL> SQL> Disconnected from Oracle Database 10g Enterprise Edition
Release 10.2.0.1.0 - Production
With the Partitioning, OLAP and Data Mining options
$
```

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Solution for Practice 10: Managing Schema Objects (continued)

b. Go to the Tables page on the Administration tabbed page.

c. Enter HR as the Schema, and click Go.

Question 2: On the Tables page, what is the number of rows for the `TEST_REGIONS` table, and why?

Answer: The number of rows is empty because the table has not been recently analyzed.

3. Best practices recommend that you gather new statistics after major DML activities, such as populating a new table. Do so for the `HR.TEST_REGIONS` table.

a. On the Tables page, select the `TEST_REGIONS` table, then select Manage Optimizer Statistics from the Actions drop-down list and click Go.

b. The Manage Optimizer Statistics page appears. Review the information and click Gather Optimizer Statistics.

c. On the following pages, review the information and click Next. On the Review page, click Submit.

d. Click the Job Name link (which most likely has a different name).

e. If you are fast, you will see the job running. Click Refresh until you do not see the job anymore.

f. Click the History tabbed page, and click the name of your job. Confirm that it succeeded.

g. Return to the HR Tables page and view the number of rows in the `TEST_REGIONS` table.

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Solution for Practice 10: Managing Schema Objects (continued)

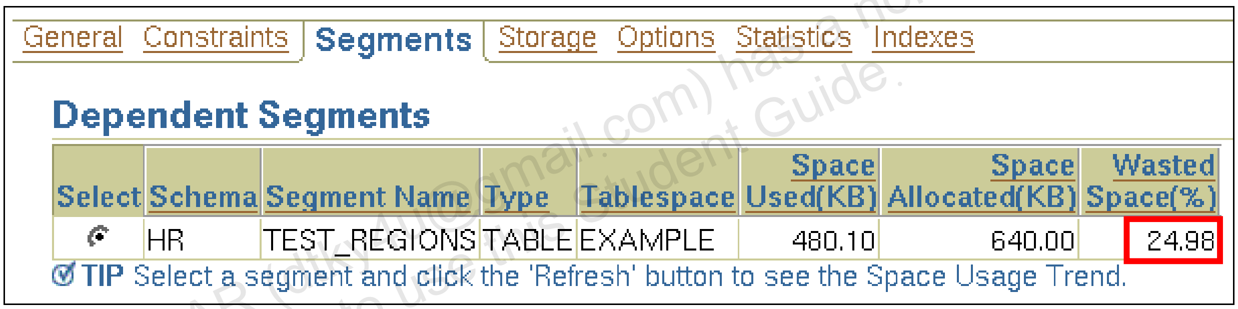
h. The number has been updated by the Optimizer Statistics. It now shows 17000 as the row count.

4. View the segment information for the `HR.TEST_REGIONS` table, which you can access on the Edit Table Segments page.

While you look at the segment information for the `HR.TEST_REGIONS` table, you notice that the table segment has a "Wasted Space (%)" of over 20%. You decide to reorganize the tablespace usage. After doing that, confirm that your job succeeded and view the current space usage again. Did it increase or decrease?

a. In Enterprise Manager, select Administration > Tables. Select the `TEST_REGIONS` table and click Edit.

b. Click the Segments tabbed page and review the table's segment information.

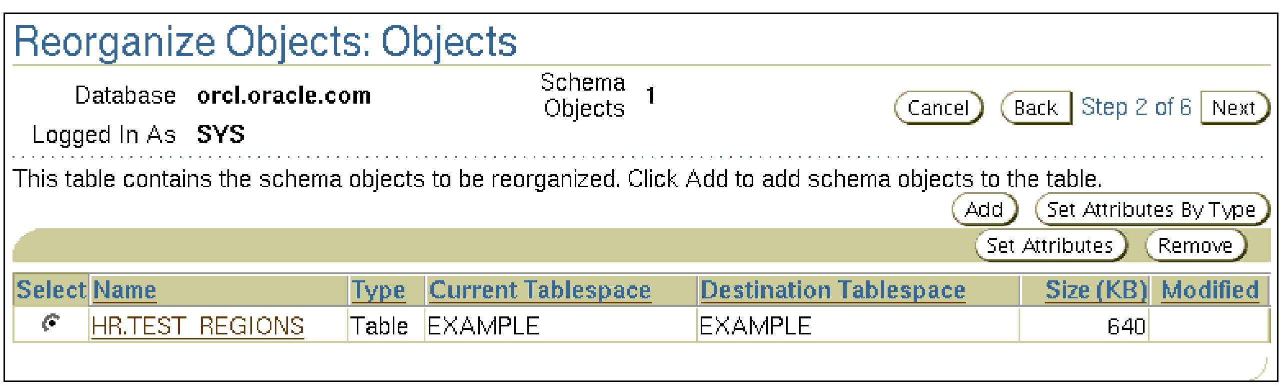


c. Notice the Wasted Space (%). *Your values may differ from those shown here.*

Question 3: What is the cause of the wasted space?

Answer: The script that populated the table first inserted many rows, and then there were several deletes that removed rows that were not adjacent, according to their order of insert. That means there is free space scattered among the data blocks, which is considered wasted space.

d. Select Reorganize from the Actions drop-down list and click Go.



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Solution for Practice 10: Managing Schema Objects (continued)

e. Accept the defaults on the following pages and click Next. On the Schedule page, enter `oracle` as Username and Password for Host Credentials.

f. On the Review page, click Submit Job.

g. If you see the job running, click Refresh or Reload in your browser window until it is completed and disappears from the Results list.

h. Then click the job name link in the Confirmation window. The status of the job run should be "Succeeded."

i. Return to the Tables page for the `HR` schema. Select the `TEST_REGIONS` table, click edit and view the Wasted Space (%) on the Segments tab. The value should be significantly lower than the previous value.

Dependent Segments

Select	Schema	Segment Name	Type	Tablespace	Space Used(KB)	Space Allocated(KB)	Wasted Space(%)
◉	HR	TEST_REGIONS	TABLE	EXAMPLE	461.39	512.00	9.88

TIP Select a segment and click the 'Refresh' button to see the Space Usage Trend.

5. Delete the `HR.TEST_REGIONS` table by running the `lab_10_05.sh` script. (This ensures that other practice sessions are not affected by this extra table.)

```
DROP SEQUENCE test_seq;
DROP TABLE hr.test_regions CASCADE CONSTRAINTS PURGE;
```

a. In a terminal window, in the `/home/oracle/labs` directory, enter:

```
./lab_10_05.sh
```


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Solution for Practice 11: Managing Storage

Background: As preparation for the upcoming merger, you want to set the warning and critical thresholds to a lower value than the default. Ensure that you receive early warnings to give you more time to react. When you have finished with your test case, drop the tablespace, which you used.

Log in as the SYS user (with oracle password, connect as SYSDBA) and perform the necessary tasks either through Enterprise Manager Database Control or through SQL*Plus. All scripts for this practice are in the /home/oracle/labs directory.

1. Using the DBMS_SERVER_ALERT.SET_THRESHOLD procedure, reset the databasewide threshold values for the Tablespace Space Usage metric. You can use the lab_11_01.sh script.

```
exec DBMS_SERVER_ALERT.SET_THRESHOLD(-
dbms_server_alert.tablespace_pct_full,-
NULL,NULL,NULL,NULL,1,1,NULL,-
dbms_server_alert.object_type_tablespace,NULL);
```

   a. Enter the following commands in a terminal window:

```
cd /home/oracle/labs
./lab_11_01.sh
```

2. In SQL*Plus, check the databasewide threshold values for the Tablespace Space Usage metric by using the following command:

```
SELECT warning_value,critical_value
FROM   dba_thresholds
WHERE  metrics_name='Tablespace Space Usage'
AND    object_name IS NULL;
```

   a. Log in to SQL*Plus:

```
sqlplus / as sysdba
```

   b. Enter the command from step 2. You should get this result:

```
WARNING_VALUE
--------------------------------------------------------------
CRITICAL_VALUE
--------------------------------------------------------------
85
97
```

3. Create a new tablespace called TBSALERT with a 120 MB file called alert1.dbf. Make sure that this tablespace is locally managed and uses Automatic Segment Space Management. Do **not** make it autoextensible, and do **not** specify any thresholds for this tablespace. Use Enterprise Manager Database Control to create it. If this tablespace already exists in your database, drop it first, including its files.

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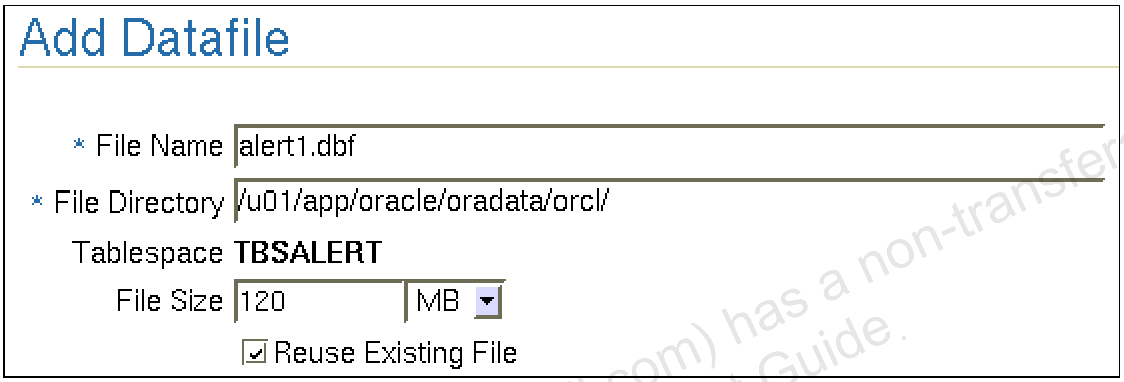
Solution for Practice 11: Managing Storage (continued)

a. In Enterprise Manager, select Administration > Tablespaces.

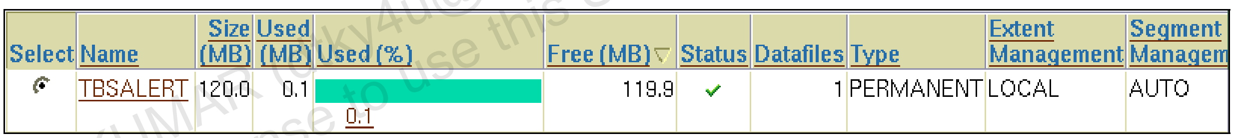
b. Click the Create button.

c. Enter `TBSALERT` as Name, and click the Add button in the Datafiles region.

d. Enter `alert1.dbf` as File Name and `120 MB` as File Size, and select Reuse Exisiting File.



e. Click Continue, and then click OK to create the tablespace.



Select	Name	Size (MB)	Used (MB)	Used (%)	Free (MB)	Status	Datafiles	Type	Extent Management	Segment Managem
◉	TBSALERT	120.0	0.1	0.1	119.9	✓	1	PERMANENT	LOCAL	AUTO

4. In Enterprise Manager, change the Tablespace Space Usage thresholds of the `TBSALERT` tablespace. Set its warning level to 55 percent and its critical level to 70 percent.

   a. On the Tablespaces page, select `TBSALERT`, click Edit, and then click Thresholds.

   b. Select Specify Thresholds, and enter `55` as Warning (%) and `70` as Critical (%).

   c. Optionally, click Show SQL, review the statement, and click Return.

   d. Click Apply to modify the threshold values.

5. Using SQL*Plus, check the new threshold values for the `TBSALERT` tablespace.

   a. In your SQL*Plus session, enter:

```
select warning_value,critical_value
from dba_thresholds
where metrics_name='Tablespace Space Usage' and
object_name='TBSALERT';
```

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Solution for Practice 11: Managing Storage (continued)

The result should be:

```
WARNING_VALUE
--------------------------------------------------------------------
CRITICAL_VALUE
--------------------------------------------------------------------
55
70
```

6. Select the `reason` and `resolution` columns from `DBA_ALERT_HISTORY` for the `TBSALERT` tablespace.

   a. In your SQL*Plus session, enter:

```
select reason,resolution
from dba_alert_history
where object_name='TBSALERT';
```

The result should be (if you are repeating this practice, look at the last row):

```
REASON                                                 RESOLUT
-----------------------------------------------------  -------
Threshold is updated on metrics "Tablespace Space Usage"  cleared
```

7. Execute the `lab_11_07.sh` script that creates and populates new tables in the `TBSALERT` tablespace. The output is shown here:

```
create table employees1 tablespace tbsalert as select * from
hr.employees;
create table employees2 tablespace tbsalert as select * from
hr.employees;
create table employees3 tablespace tbsalert as select * from
hr.employees;
create table employees4 tablespace tbsalert as select * from
hr.employees;
create table employees5 tablespace tbsalert as select * from
hr.employees;

alter table employees1 enable row movement;
alter table employees2 enable row movement;
alter table employees3 enable row movement;

BEGIN
 FOR i in 1..10 LOOP
   insert into employees1 select * from employees1;
   insert into employees2 select * from employees2;
   insert into employees3 select * from employees3;
   insert into employees4 select * from employees4;
   insert into employees5 select * from employees5;
   commit;
 END LOOP;
END;
/
```


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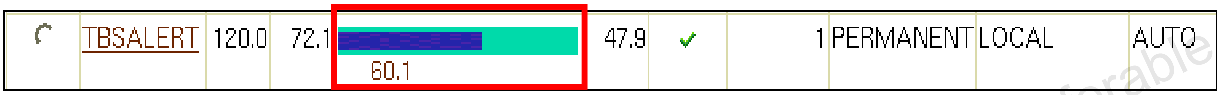
Solution for Practice 11: Managing Storage (continued)

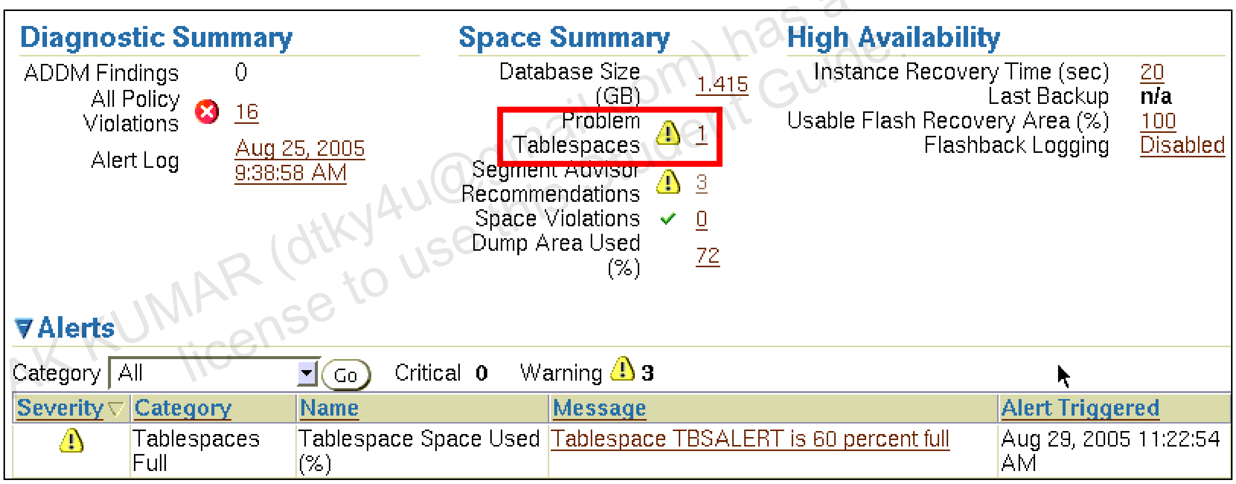
```
insert into employees1 select * from employees1;
insert into employees2 select * from employees2;
insert into employees3 select * from employees3;
commit;
```

8. Check the fullness level of the `TBSALERT` tablespace by using either Database Control or SQL*Plus. The current level should be around 60%. Wait for approximately 10 minutes, and check that the warning level is reached for the `TBSALERT` tablespace.

   a. In Enterprise Manager on the Tablespaces page, see Used (%).



   b. Navigate to the Database home page. You should see the new alert in the Space Summary section.



   c. In SQL*Plus, enter:

```
select sum(bytes) *100 /125829120
        from dba_extents
        where tablespace_name='TBSALERT';
```

   The result should be:

```
SUM(BYTES)*100/125829120
------------------------
                      60
```

   d. Enter the following command:

```
select reason
from dba_outstanding_alerts
where object_name='TBSALERT';
```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Solution for Practice 11: Managing Storage (continued)

The result should be:

```
REASON
--------------------------------------------------------------------------
--
Tablespace [TBSALERT] is [60 percent] full
```

9. Execute the `lab_11_09_a.sh` script to add data to `TBSALERT`. Wait for 10 minutes and view the critical level in both the database and Database Control. Verify that `TBSALERT` fullness is around 75%.

```
insert into employees4 select * from employees4;
commit;
insert into employees5 select * from employees5;
commit;
```

a. Enter the following command in a terminal window:

```
./lab_11_09_a.sh
```

b. Wait for 10 minutes and view the critical level in both the database and Database Control. Verify that `TBSALERT` fullness is around 75%. In SQL*Plus, enter:

```
select sum(bytes) *100 /125829120
from dba_extents
where tablespace_name='TBSALERT';
```

```
SUM(BYTES)*100/125829120
------------------------
                      75
```

c. In SQL*Plus, enter:

```
select reason, message_level
from dba_outstanding_alerts
where object_name='TBSALERT';
```

```
REASON
--------------------------------------------------------------------------
--
MESSAGE_LEVEL
-------------
Tablespace [TBSALERT] is [75 percent] full
            1
```

d. In Enterprise Manager, on the Tablespaces page, see Used (%).

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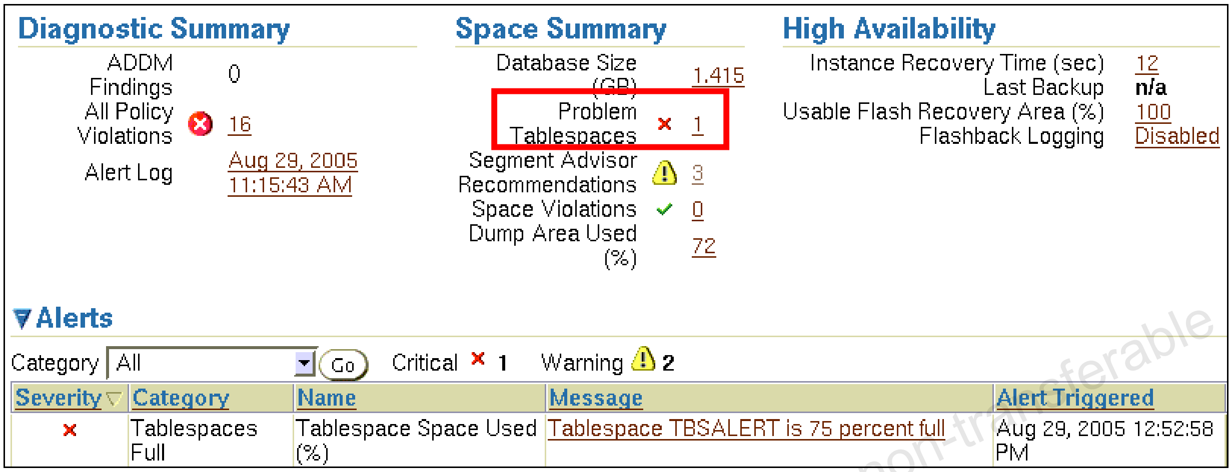
Solution for Practice 11: Managing Storage (continued)

e. Navigate to the Database home page. You should see the new alert in the Space Summary region. Notice the red flag instead of the yellow one.



10. Execute the `lab_11_10.sh` script. This script deletes rows from tables in `TBSALERT`.

```
delete employees1 where department_id=50;
commit;
delete employees2 where department_id=50;
commit;
delete employees3 where department_id=50;
commit;
```

a. Enter the following command in a terminal window:

```
./lab_11_10.sh
```

11. Now, run the Segment Advisor for the `TBSALERT` tablespace by using Database Control. Make sure that you run the Advisor in Comprehensive mode without time limitation. Accept and implement its recommendations. After the recommendations have been implemented, check whether the fullness level of `TBSALERT` is below 55%.

a. In Enterprise Manager, select Administration > Tablespaces.

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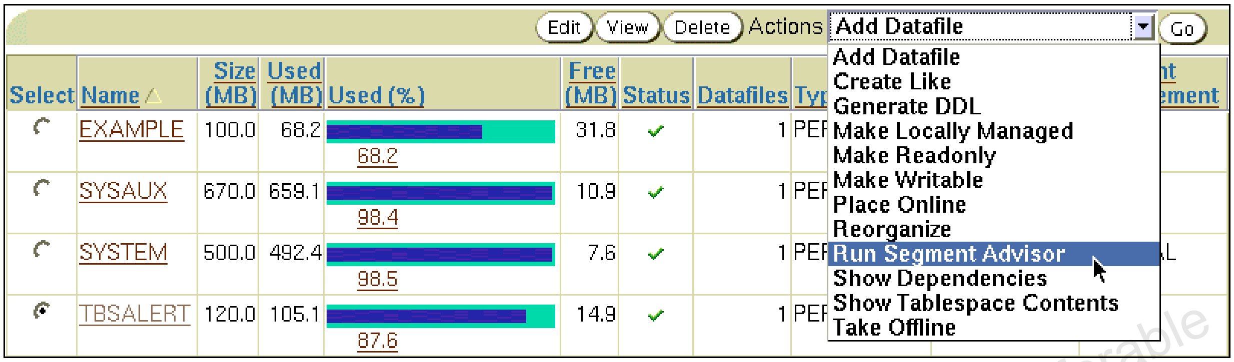
Solution for Practice 11: Managing Storage (continued)

b. Select TBSALERT, and then select Run Segment Advisor from the Actions drop-down list.



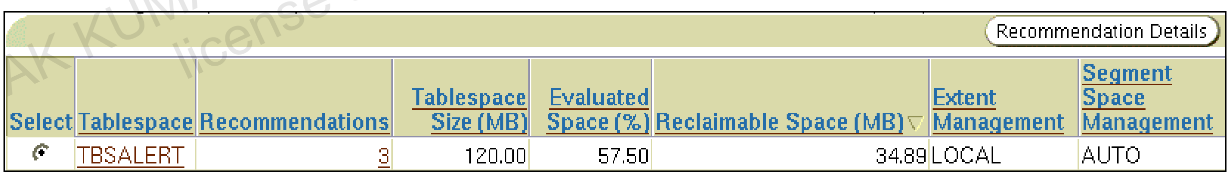
c. Click Go, review the objects, and click Next.

d. On the Segment Advisor: Schedule page, make sure that Schedule Type is “Standard” and Start is “Immediately.” Click Next.

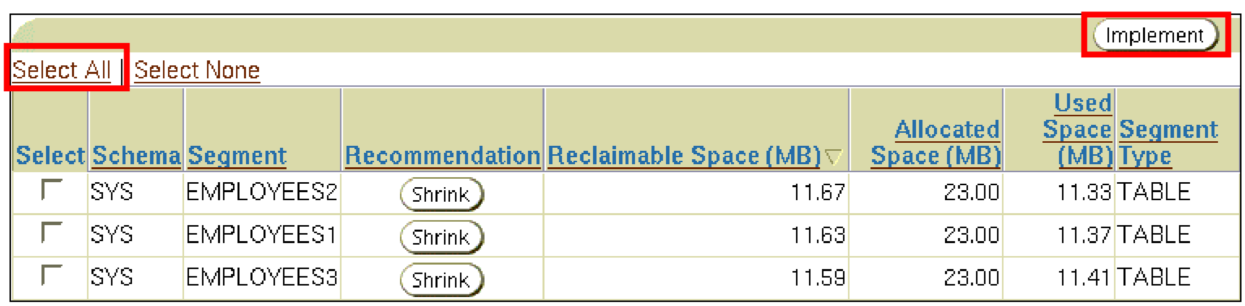
e. On the Segment Advisor: Review page, click the Submit button.

f. This takes you back to the Advisor Central page, where you can see the evolution of your task. Click the Refresh button until your shrink task is *completed*.

g. Select your Segment Advisor task, and click the View Result button.



h. On the Segment Advisor Task page, click the Recommendation Details button.



i. Click the Select All link, and then click the Implement button.

j. On the Shrink Segment: Options page, make sure that the “Compact Segments and Release Space” option is selected.

k. Optionally, click Show SQL, review the statements, and click Return.

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Solution for Practice 11: Managing Storage (continued)

l. Click Implement.

m. On the Shrink Sement: Schedule page, click the Submit button.

n. On the Scheduler Jobs page, click Refresh until you see your job in the Running table. Continue to click Refresh until you no longer see your job in the Running table. It should take approximately two minutes to complete.

o. Navigate to the Tablespaces page and verify that the TBSALERT tablespace fullness is now below 55%.

Select	Name	Size (MB)	Used (MB)	Used (%)	Free (MB)	Status	Datafiles	Type	Extent Management	Segment Management
◉	EXAMPLE	100.0	68.2	68.2	31.8	✓	1	PERMANENT	LOCAL	AUTO
○	SYSAUX	670.0	659.4	98.4	10.6	✓	1	PERMANENT	LOCAL	AUTO
○	SYSTEM	500.0	492.4	98.5	7.6	✓	1	PERMANENT	LOCAL	MANUAL
○	TBSALERT	120.0	64.6	53.8	55.4	✓	1	PERMANENT	LOCAL	AUTO

12. Wait for approximately 10 more minutes, and check that there are no longer any outstanding alerts for the TBSALERT tablespace.

a. Navigate to the Database home page. You should see Problem Tablespaces **0**.

Space Summary

Database Size (GB)	1.415
Problem Tablespaces	0
Segment Advisor Recommendations	⚠ 3
Space Violations	✓ 0
Dump Area Used (%)	72

13. Retrieve the history of the TBSALERT Tablespace Space Usage metric for the last 24 hours.

a. On the Database home page, select All Metrics in the Related Links region.

b. Expand the “Tablespaces Full” category, and click the “Tablespace Space Used (%)” link.

c. Make sure that you select “Real Time: Manual Refresh” from the View Data drop-down list. Then, click the TBSALERT link.

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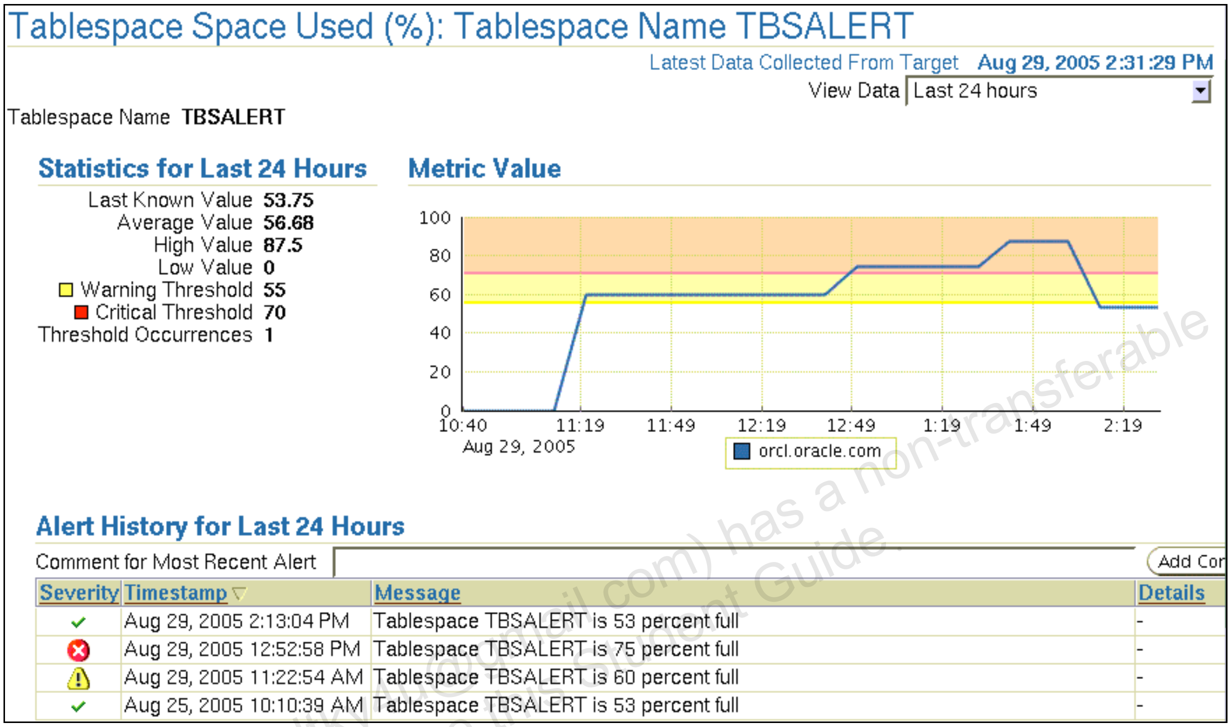
Solution for Practice 11: Managing Storage (continued)

d. This takes you to the “Tablespace Space Used (%): Tablespace Name TBSALERT” page. Select “Last 24 hours” from the View Data drop-down list.



14. Reset the databasewide default thresholds from the Tablespace Space Usage metric for the `TBSALERT` tablespace.

    a. From the context of the “Tablespace Space Used (%): Tablespace Name TBSALERT” page, click the Edit Tablespace link at the bottom of the page.

    b. This opens the Edit Tablespace: TBSALERT page. Click the Thresholds tab.

    c. Select the Use Database Default Thresholds option in the Space Used (%) section. Click the Apply button.

15. Because you have finished with your test case, execute the `lab_11_15.sh` script to drop your `TBSALERT` tablespace.

```
drop tablespace tbsalert including contents and datafiles;
```

    a. Enter the following command in a terminal window:

```
./lab_11_15.sh
```

You should see:

```
Tablespace dropped.
```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Solutions for Practice 12-1: Automatic Storage Management

Exercise 1: Creating and Configuring an ASM Instance

Background: Currently there is no ASM instance running on your database server. You need to create one and start it, pointing it to the already configured raw disk partitions. Then create a tablespace on that disk group. Also, you are going to create a tablespace on conventional storage, and then migrate it to ASM storage.

Unless specified otherwise, you should log in as the SYS user, as SYSDBA through either Database Control or SQL*Plus.

In this practice, you create an ASM instance, configure the ASM initialization parameters, create disk groups, and create a tablespace that uses ASM storage.

1. Use DBCA to create the ASM instance on your machine. Implement the following configuration within DBCA:

   Change the default values for the ASM initialization parameter disk discovery string to "/dev/raw/raw*" (without quotation marks).

   Create one disk group called DGROUP1 that uses the following four ASM disks:

   /dev/raw/raw1

   /dev/raw/raw2

   /dev/raw/raw3

   /dev/raw/raw4

   Specify that DGROUP1 is using normal redundancy.

   a. Start dbca as the oracle user from an OS command-line window.

```
$ whoami
oracle
$ dbca
```

   b. On the DBCA Welcome page, click Next to continue.

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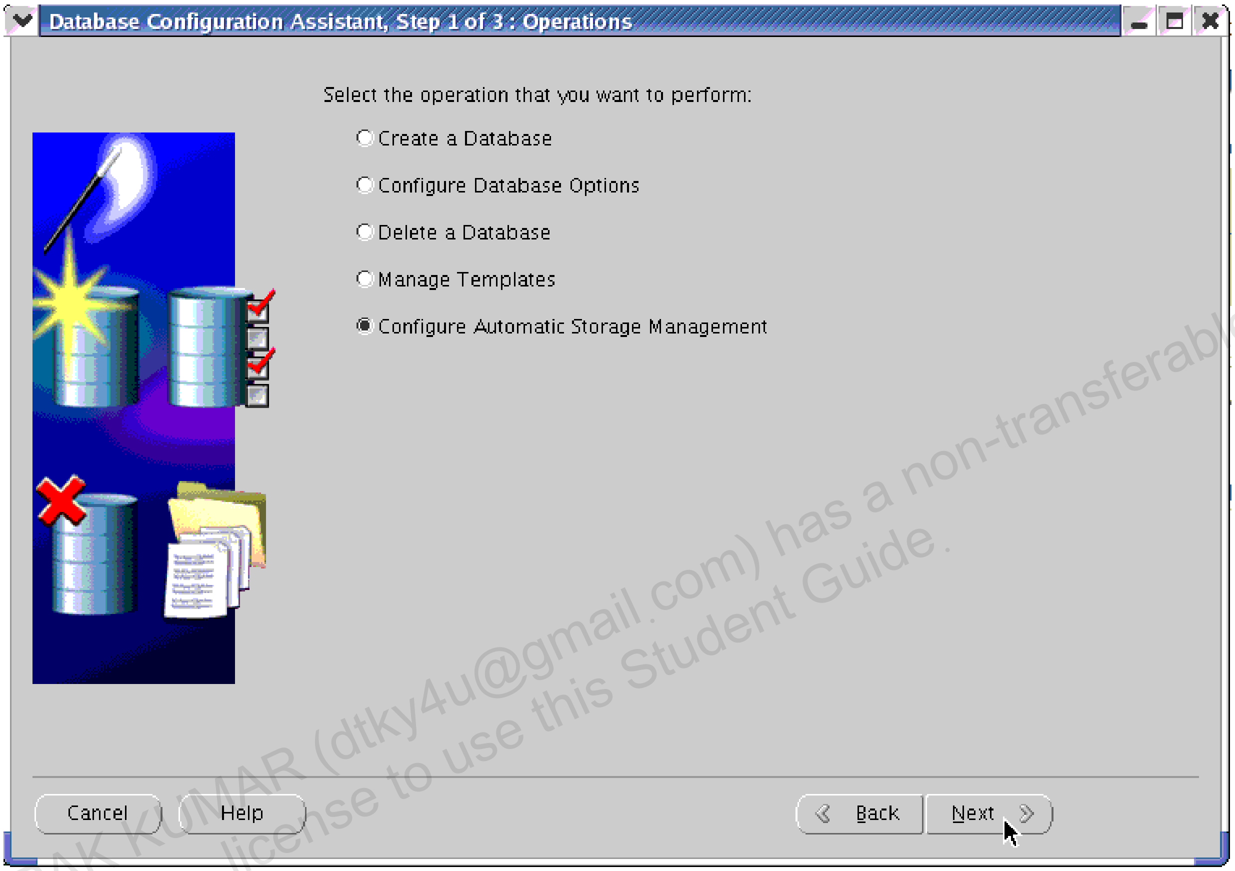
Solutions for Practice 12: Automatic Storage Management (continued)

c. On the Operations page, select the Configure Automatic Storage Management option, and click Next to proceed.



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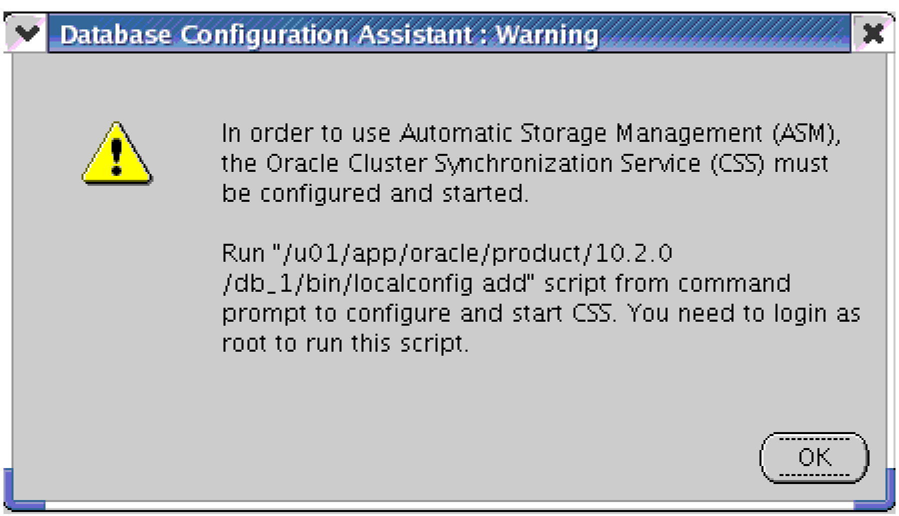

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Solutions for Practice 12: Automatic Storage Management (continued)

d. After clicking Next, a warning window appears, indicating that you need to run a script. Log in as `root` by entering the `su –` command. Then, run the command as specified in the warning window. Log out of the `root` user session when you have finished.

```
$ su -
Password:
# /u01/app/oracle/product/10.2.0/db_1/bin/localconfig add
/etc/oracle does not exist. Creating it now.
Successfully accumulated necessary OCR keys.
Creating OCR keys for user 'root', privgrp 'root'..
Operation successful.
Configuration for local CSS has been initialized

Adding to inittab
Startup will be queued to init within 90 seconds.
Checking the status of new Oracle init process...
Expecting the CRS daemons to be up within 600 seconds.
CSS is active on these nodes.
        edrsr9p1
CSS is active on all nodes.
Oracle CSS service is installed and running under init(1M)
```

Note: *Be sure to log out of the* `root` *user session by entering this:*

```
# exit
```

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e. Wait for the script to complete; it takes about two minutes. Then return to the warning window and click OK, and then click Next in the Operations window.

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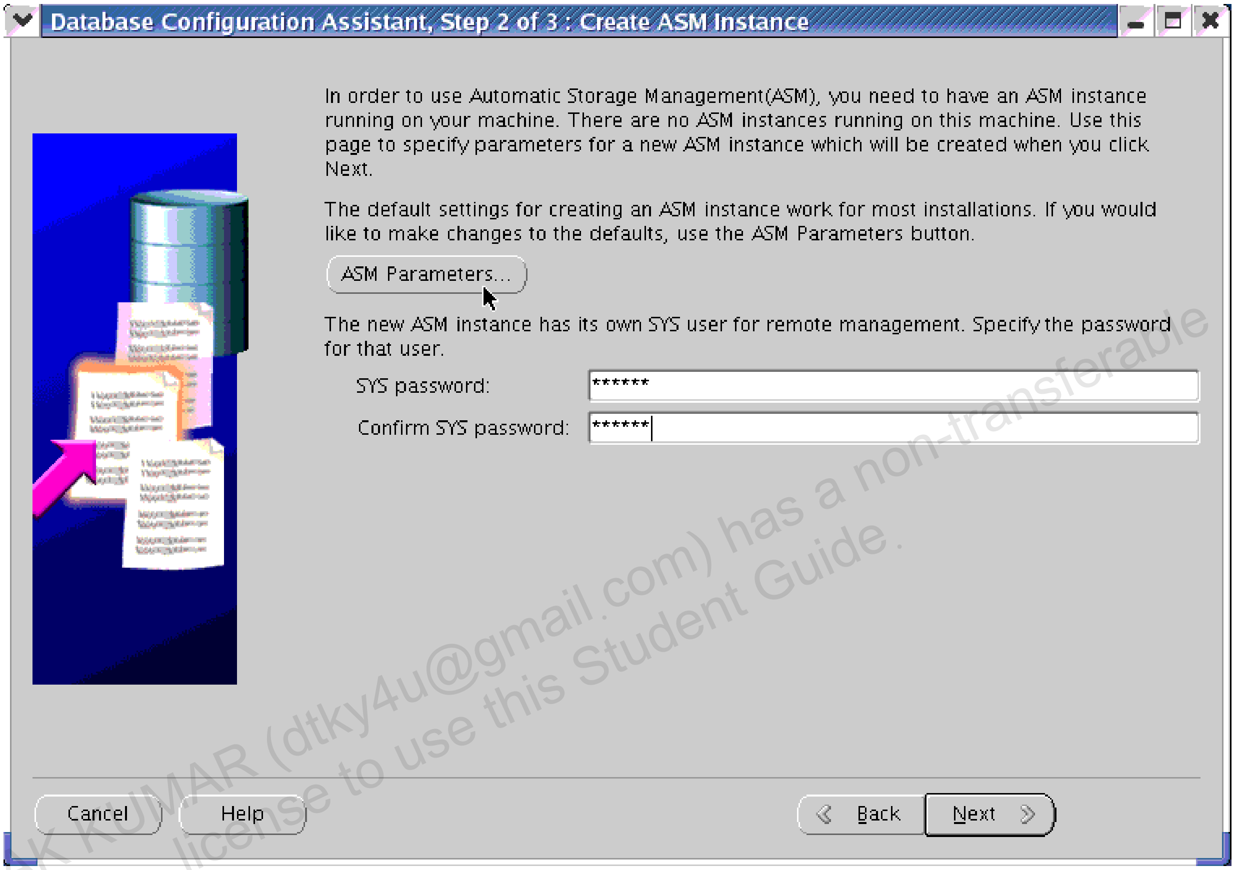
Solutions for Practice 12: Automatic Storage Management (continued)

f. Enter `oracle` for the ASM instance password for the `SYS` user, and also enter it in the confirm field. Then click ASM Parameters.



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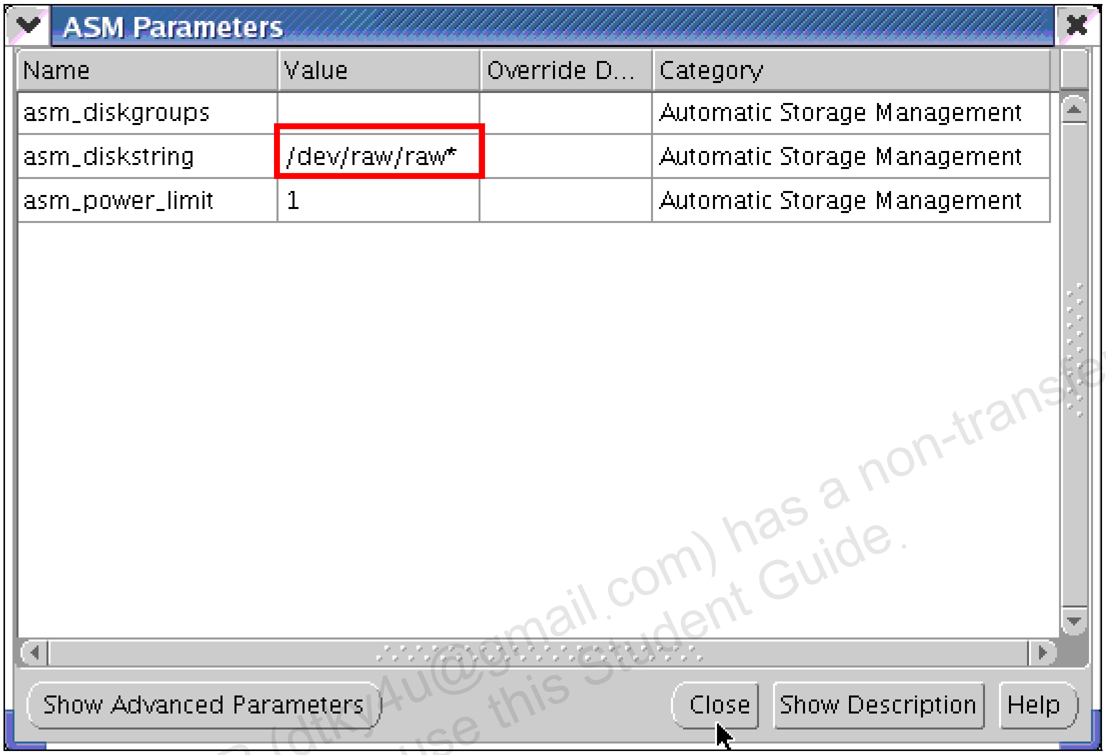
Solutions for Practice 12: Automatic Storage Management (continued)

g. On the **ASM Parameters** page, enter `/dev/raw/raw*` in the **asm_diskstring** field. When done, click **Close**.



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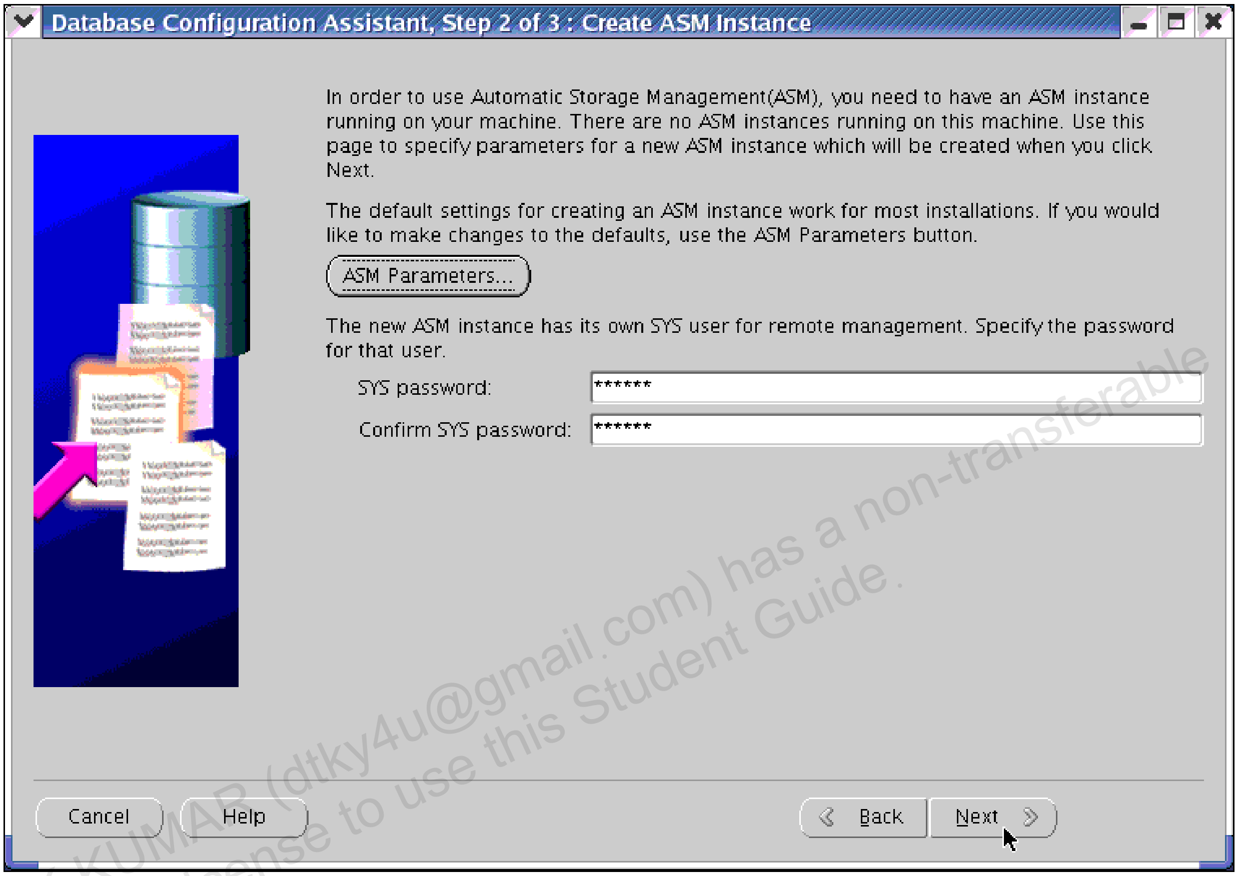
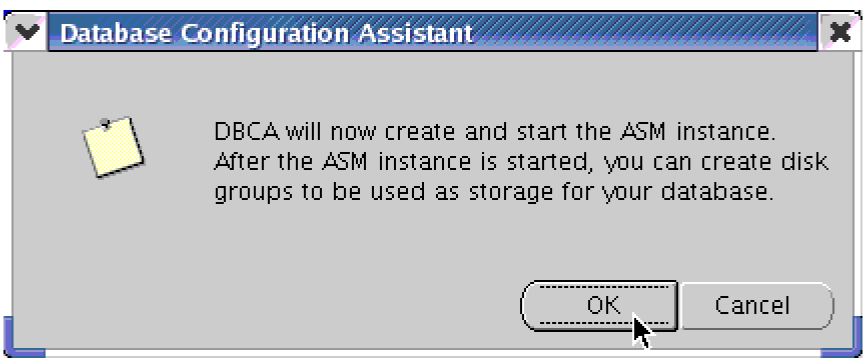
Solutions for Practice 12: Automatic Storage Management (continued)

h. Back on the **Create ASM Instance** page, click the **Next** button.



i. When the confirmation window appears, click OK.



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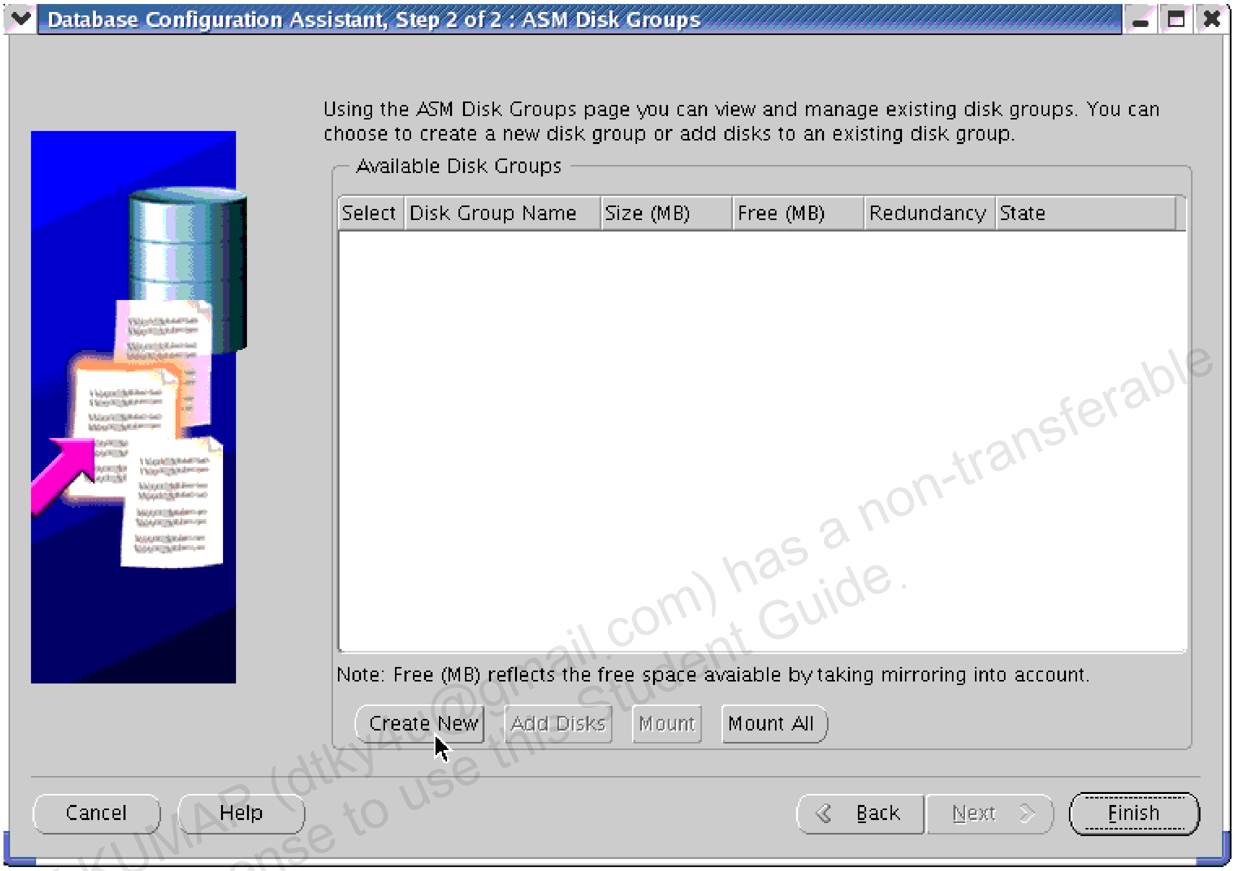
Solutions for Practice 12: Automatic Storage Management (continued)

j. When the ASM Disk Groups window appears, click Create New to create a disk group.



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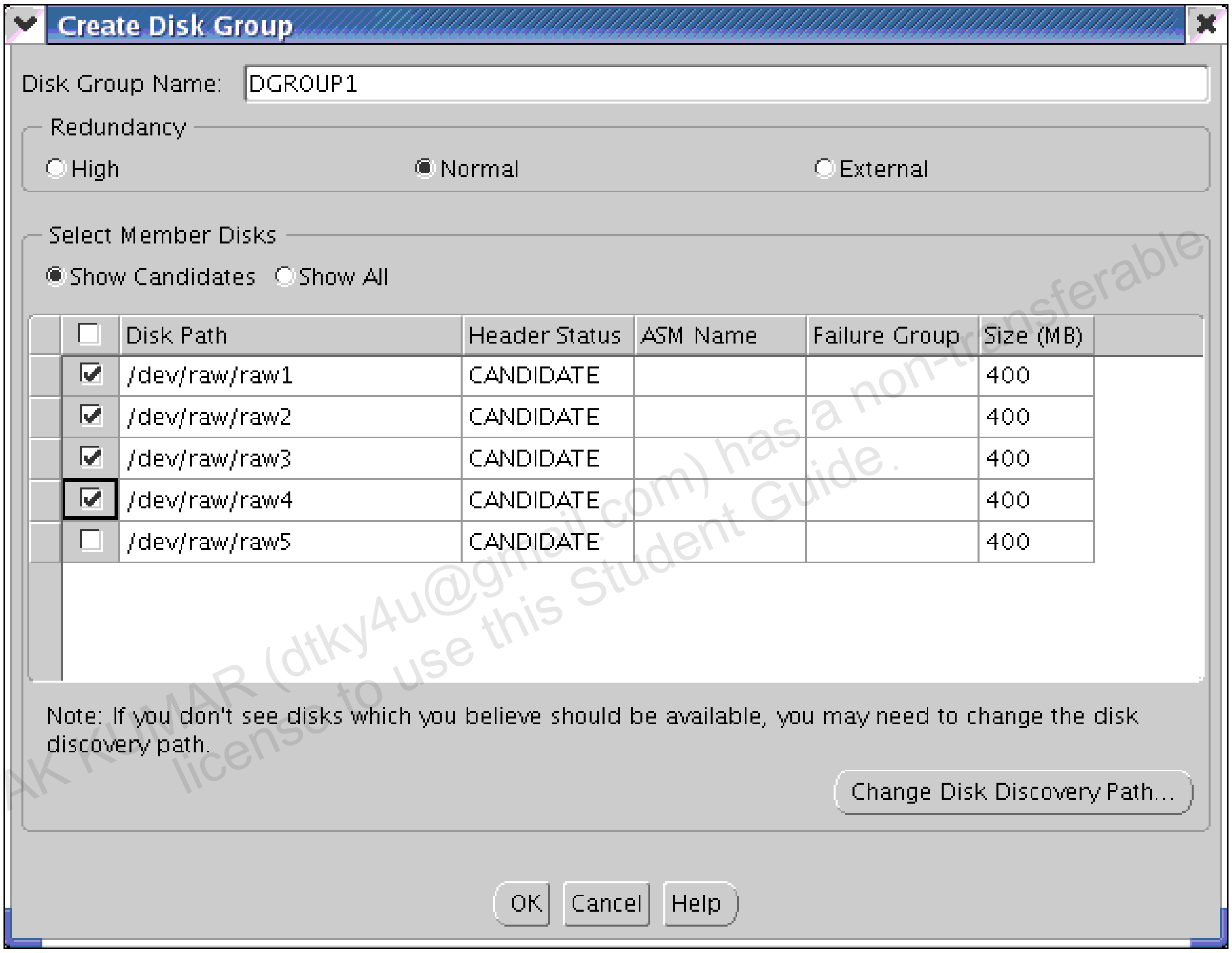
Solutions for Practice 12: Automatic Storage Management (continued)

k. In the Create Disk Group dialog box, specify `DGROUP1` in the Disk Group Name field. Make sure **Normal** is selected. Select only the first four CANDIDATE disks from the Select Member Disks list to add them to the disk group, and then click **OK** to create the disk group. Do *not* select disk path `/dev/raw/raw5`.



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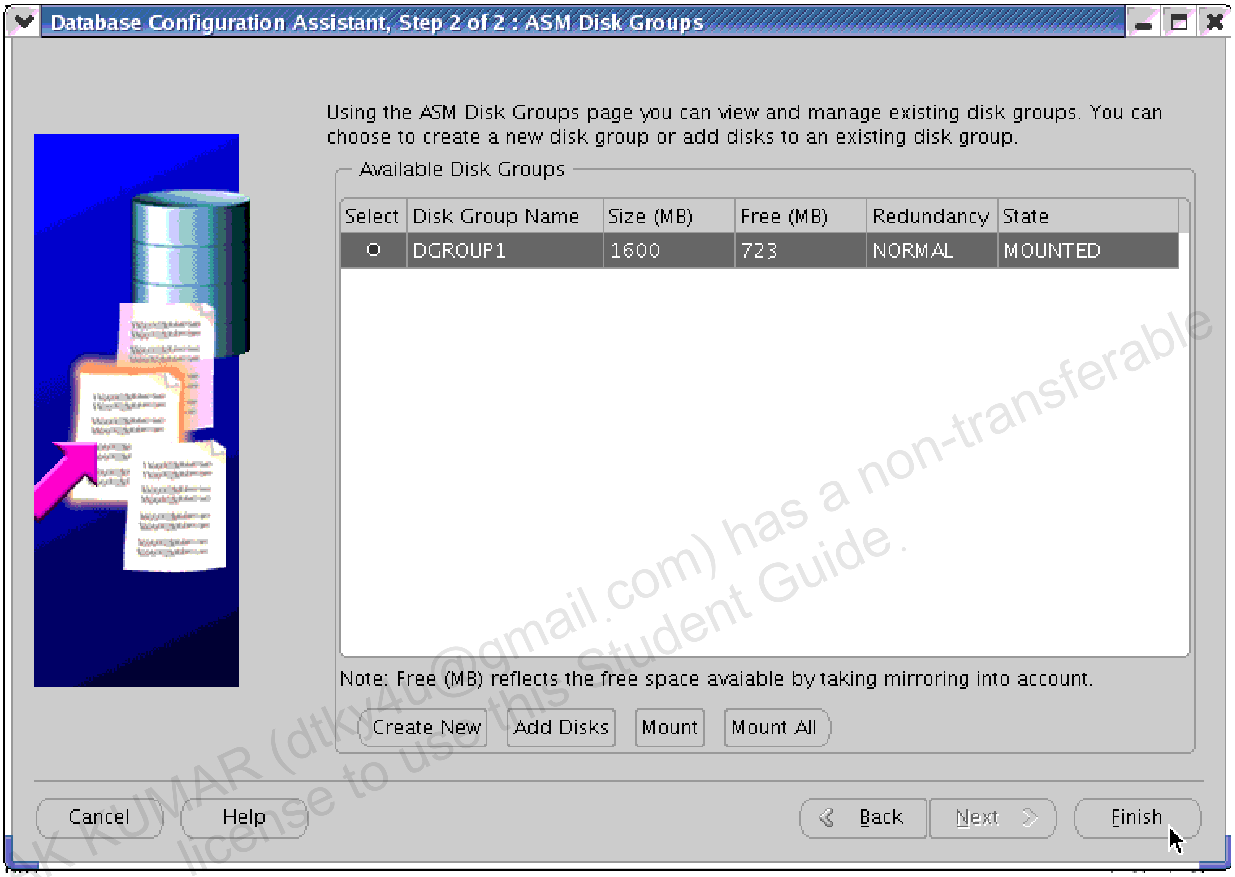
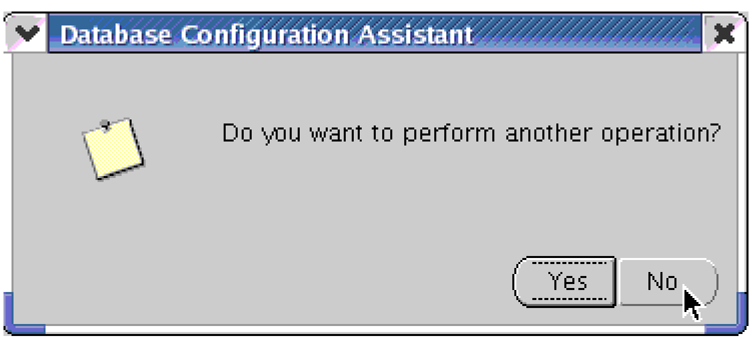
Solutions for Practice 12: Automatic Storage Management (continued)

l. When the ASM Disk Groups window appears, showing the DGROUP1 disk group, click Finish.



m. Click No to answer the question about performing another operation. DBCA then exits.



2. Leave the Linux command window open for later use.

3. Connect to your ASM instance as `oracle` in your OS command shell. List the processes associated with it. You must set ORACLE_SID to +ASM before starting your ASM instance.

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Solutions for Practice 12: Automatic Storage Management (continued)

a. Enter these commands to connect to the ASM instance:

```
$ export ORACLE_SID=+ASM
$ sqlplus / as sysdba
```

Following is the output of those commands:

```
$ export ORACLE_SID=+ASM
$ sqlplus / as sysdba

SQL*Plus: Release 10.2.0.1.0 - Production on Wed Oct 12 20:21:17 2005

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Connected to:
Oracle Database 10g Enterprise Edition Release 10.2.0.1.0 - Production
With the Partitioning, OLAP and Data Mining options
```

b. List the processes by entering this command:

```
SQL> !ps -ef | grep ASM
oracle   20417     1  0 15:26 ?        00:00:00 asm_pmon_+ASM
oracle   20419     1  0 15:26 ?        00:00:00 asm_psp0_+ASM
oracle   20421     1  0 15:26 ?        00:00:00 asm_mman_+ASM
oracle   20423     1  0 15:26 ?        00:00:00 asm_dbw0_+ASM
oracle   20425     1  0 15:26 ?        00:00:00 asm_lgwr_+ASM
oracle   20427     1  0 15:26 ?        00:00:00 asm_ckpt_+ASM
oracle   20429     1  0 15:26 ?        00:00:00 asm_smon_+ASM
oracle   20431     1  1 15:26 ?        00:00:00 asm_rbal_+ASM
oracle   20433     1  0 15:26 ?        00:00:00 asm_gmon_+ASM
oracle   20445 20414  0 15:26 ?        00:00:00 oracle+ASM
(DESCRIPTION=(LOCAL=YES)(ADDRESS=(PROTOCOL=beq)))
oracle   20449 20414  0 15:26 pts/1    00:00:00 /bin/bash -c ps -ef |
grep ASM
oracle   20451 20449  0 15:26 pts/1    00:00:00 grep ASM
```

4. Review the ASM processes at the operating-system level, and query `V$ASM_DISKGROUP` to view the disk group characteristics.

```
SQL> SELECT name, state, type, total_mb, free_mb FROM V$ASM_DISKGROUP;

NAME                           STATE       TYPE     TOTAL_MB    FREE_MB
------------------------------ ----------- ------ ---------- ----------
DGROUP1                        MOUNTED     NORMAL       1600       1445
```

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Solutions for Practice 12: Automatic Storage Management (continued)

5. Connect to the `orcl` instance and create a new tablespace called `TBSASM` that is stored inside the ASM disk group DGROUP1. The tablespace should have one 5 MB data file. Before starting SQL*Plus, exit from your current shell and log back in as `oracle`. This resets the `ORACLE_SID` environment variable overwritten earlier for your ASM instance. Alternatively, use the command shown below to set the `ORACLE_SID` to `orcl`.

   a. Enter these commands to connect to the `ORCL` instance:

```
$ export ORACLE_SID=orcl
$ sqlplus / as sysdba
```

   b. At the SQL prompt, enter this command to verify that you can create a data file in the ASM storage:

```
SQL> CREATE TABLESPACE tbsasm DATAFILE '+DGROUP1' SIZE 5M;
```

   c. Enter the following to drop the tablespace:

```
SQL> DROP TABLESPACE tbsasm including contents and datafiles;
```

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Solution for Practice 12-2: Automatic Storage Management (continued)

Exercise 2: Migrating Tablespaces to ASM Storage

In this practice, you migrate a tablespace to use ASM storage.

1. Using SQL*Plus, connect to your database instance as a `SYSDBA` user and create a new tablespace called `TBSASMMIG.` This tablespace should contain only one 10 MB file stored in your file system (not using ASM). Make sure that you are connecting to the `orcl` instance and not the ASM instance.

```
$ echo $ORACLE_SID
orcl
$ sqlplus / as sysdba

SQL*Plus: Release 10.2.0.1.0 - Production on Sun Sep 25 16:38:21 2005

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Connected to:
Oracle Database 10g Enterprise Edition Release 10.2.0.1.0 - Production
With the Partitioning, OLAP and Data Mining options

SQL> CREATE TABLESPACE tbsasmmig DATAFILE 'asmmig1.dbf' SIZE 10M;

Tablespace created.
```

2. Create a table called `T2` stored in the new tablespace `TBSASMMIG`. Insert one row inside `T2`. Commit your work.

```
SQL> create table t2(c number) tablespace tbsasmmig;

Table created.

SQL> insert into t2 values(1);

1 row created.

SQL> commit;

Commit complete.
```

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Solution for Practice 12-2: Automatic Storage Management (continued)

3. Migrate TBSASMMIG to ASM storage. When done, check whether the migration is successful and the table within the tablespace is intact.

```
SQL> host rman target / nocatalog

Recovery Manager: Release 10.2.0.1.0 - Production on Sun Sep 25 16:43:31
2005

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connected to target database: ORCL (DBID=1090770270)
using target database control file instead of recovery catalog

RMAN> SQL "ALTER TABLESPACE tbsasmmig OFFLINE";

sql statement: ALTER TABLESPACE tbsasmmig OFFLINE

RMAN> BACKUP AS COPY TABLESPACE tbsasmmig FORMAT '+DGROUP1';

Starting backup at 25-SEP-05
allocated channel: ORA_DISK_1
channel ORA_DISK_1: sid=123 devtype=DISK
channel ORA_DISK_1: starting datafile copy
input datafile fno=00009
name=/u01/app/oracle/product/10.2.0/db_1/dbs/asmmig1.db f
output filename=+DGROUP1/orcl/datafile/tbsasmmig.256.569954653
tag=TAG20050925T1 64407 recid=7 stamp=569954661
channel ORA_DISK_1: datafile copy complete, elapsed time: 00:00:16
Finished backup at 25-SEP-05

Starting Control File and SPFILE Autobackup at 25-SEP-05
piece
handle=/u01/app/oracle/flash_recovery_area/ORCL/autobackup/2005_09_25/o1
_m f_s_569954663_1mgflrnn_.bkp comment=NONE
Finished Control File and SPFILE Autobackup at 25-SEP-05
RMAN> SWITCH TABLESPACE tbsasmmig TO COPY;

datafile 9 switched to datafile copy
"+DGROUP1/orcl/datafile/tbsasmmig.256.56995 4653"

RMAN> SQL "ALTER TABLESPACE tbsasmmig ONLINE";

sql statement: ALTER TABLESPACE tbsasmmig ONLINE

RMAN> exit

Recovery Manager complete.
SQL> column file_name format a48

SQL> select tablespace_name, file_name from dba_data_files;
```


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Solution for Practice 12-2: Automatic Storage Management (continued)

```
TABLESPACE_NAME                 FILE_NAME
------------------------ ------------------------------------------------
USERS                    /u01/app/oracle/oradata/orcl/users01.dbf
SYSAUX                   /u01/app/oracle/oradata/orcl/sysaux01.dbf
UNDOTBS1                 /u01/app/oracle/oradata/orcl/undotbs01.dbf
SYSTEM                   /u01/app/oracle/oradata/orcl/system01.dbf
EXAMPLE                  /u01/app/oracle/oradata/orcl/example01.dbf
STAGING                  /u01/app/oracle/oradata/orcl/staging01.dbf
TBSASMMIG                +DGROUP1/orcl/datafile/tbsasmmig.257.570022789

7 rows selected.

SQL> SELECT * FROM t2;

         C
----------
         1
```

4. Clean up your environment by dropping tablespace TBSASMMIG including its contents and data file. Also, remove the standard file system file that was created in step 1 to store the TBSASMMIG tablespace.

```
SQL> DROP TABLESPACE tbsasmmig INCLUDING CONTENTS AND DATAFILES;

Tablespace dropped.

SQL> host rm $ORACLE_HOME/dbs/asmmig1.dbf
```

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Solutions for Practice 13: Managing Resources

Background: You received complaints that certain batch jobs are using too many system resources and that a specific user is known to start data warehouse processes during regular business hours. You decide to use the Database Resource Manager for better system-resource utilization and control.

Your first effort to balance the situation includes creating an `APPUSER` consumer group and assigning it to the default `SYSTEM_PLAN` resource plan. Then, you map a couple of Oracle users and your major OS user to resource groups. Activate the resource plan and test your assignments. Regularly, click "Show SQL" to review all statements that are new to you.

Log in as the `SYS` user (with `oracle` password, connect as `SYSDBA`) and perform the necessary tasks either through Enterprise Manager Database Control or through SQL*Plus. All scripts for this practice are in the `/home/oracle/labs` directory.

1. Using Enterprise Manager Database Control, create a resource group called `APPUSER`. At this point, do not add users to the group.

   a. In Enterprise Manager, select Administration > Consumer Groups.

   b. On the Resource Consumer Groups page, click the Create button.

   c. Enter `APPUSER` as Consumer Group, and click Show SQL.

Database Instance: orcl.oracle.com > Resource Consumer Groups > Create Resource Consumer Group Logged in As SYS

Show SQL

Return

```
BEGIN
dbms_resource_manager.clear_pending_area();
dbms_resource_manager.create_pending_area();
dbms_resource_manager.create_consumer_group(consumer_group => 'APPUSER',
comment => '', cpu_mth => 'ROUND-ROBIN');
dbms_resource_manager.submit_pending_area();
END;
```

   d. Review the statements.

Question 1: What does the `ROUND-ROBIN` parameter value mean?

Possible Answer: `ROUND-ROBIN` indicates that CPU resources will be fairly allocated to the `APPUSER` consumer group, according to the active resource plan directives.

   e. Click Return, and then click OK to create the consumer group.

Select	Consumer Group △	Mandatory	Description
◉	APPUSER	NO	
○	AUTO_TASK_CONSUMER_GROUP	NO	System maintenance task consumer group
○	DEFAULT_CONSUMER_GROUP	YES	consumer group for users not assigned to any group
○	LOW_GROUP	NO	Group of low priority sessions
○	SYS_GROUP	YES	Group of system sessions

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Solutions for Practice 13: Managing Resources (continued)

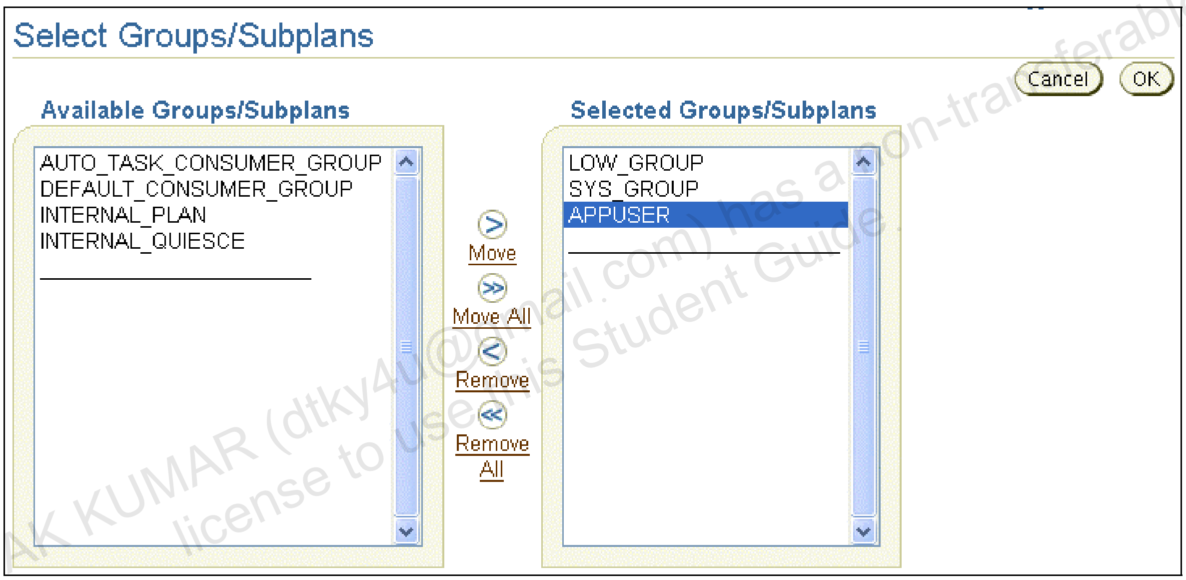
2. Add the APPUSER consumer group to the SYSTEM_PLAN resource plan. Change the level 3 CPU resource allocation percentages: 60% for the APPUSER consumer group and 40% for the LOW_GROUP consumer group.

   a. In Enterprise Manager, select Administration > Plans.

   b. On the Resource Plans page, select SYSTEM_PLAN and click the Edit button.

   c. Click Modify.

   d. Select APPUSER and move it to the "Selected Groups/Subplans."



   e. Click OK.

   f. Enter 60 for APPUSER Level 3 and 40 for LOW_GROUP Level 3.

   g. Click Show SQL, review the statements, and click Return.

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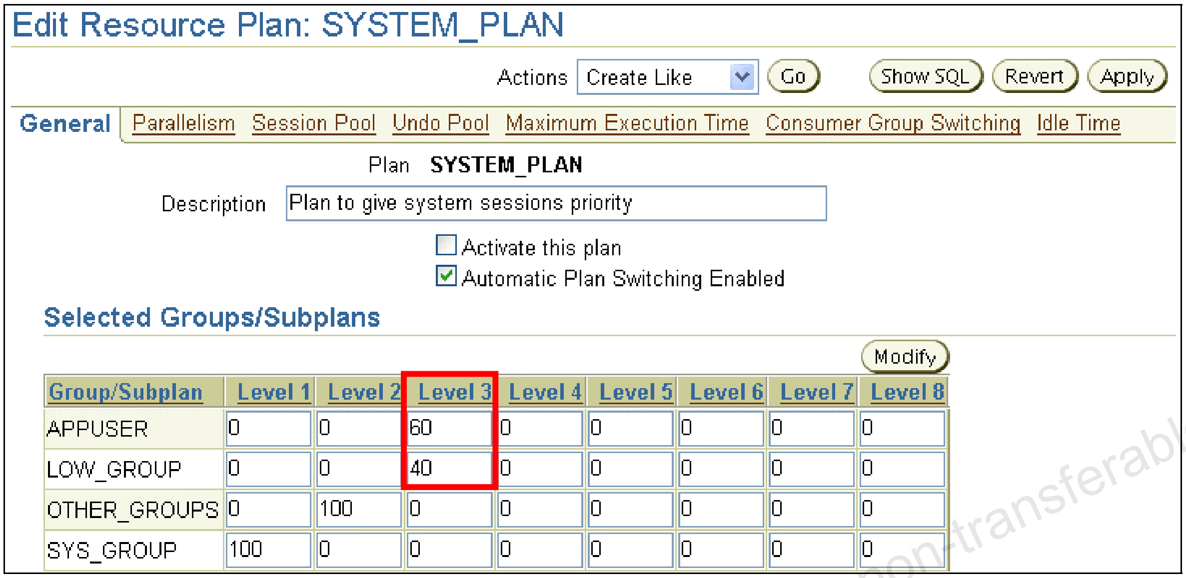
Solutions for Practice 13: Managing Resources (continued)



Group/Subplan	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7	Level 8
APPUSER	0	0	60	0	0	0	0	0
LOW_GROUP	0	0	40	0	0	0	0	0
OTHER_GROUPS	0	100	0	0	0	0	0	0
SYS_GROUP	100	0	0	0	0	0	0	0

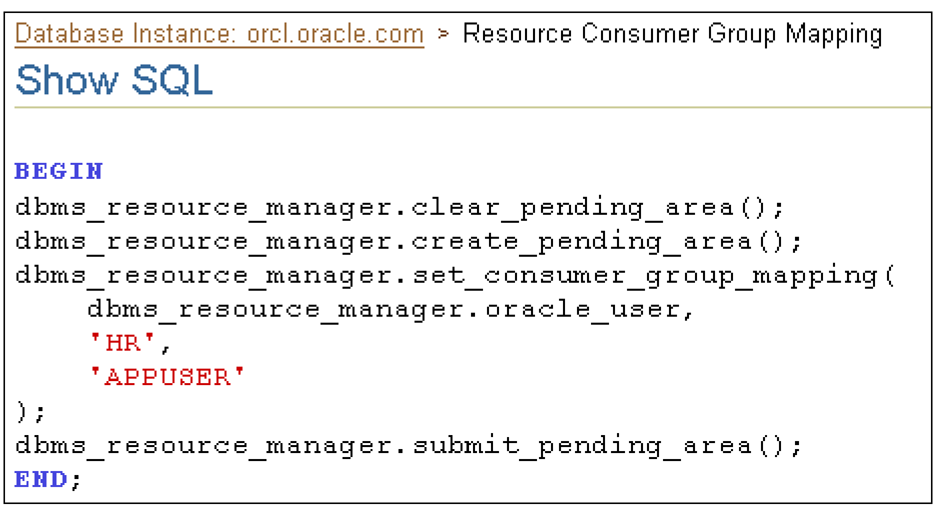
h. Click Apply to assign the APPUSER consumer group to the SYSTEM_PLAN resource plan. (You will activate this plan later.)

3. Configure Consumer Group Mappings, so that the HR Oracle user belongs to the APPUSER consumer group, and the SCOTT Oracle user to the LOW_GROUP consumer group. Confirm that the ORACLE_USER attribute has a higher priority than the CLIENT_OS_USER attribute.

   a. In Enterprise Manager, select Administration > Consumer Group Mappings.

   b. In the "Oracle User Map" region, click "Add Another Row."

   c. Select APPUSER from the Consumer Group drop-down list, and enter HR as Oracle User, and then click Show SQL.




```
BEGIN
dbms_resource_manager.clear_pending_area();
dbms_resource_manager.create_pending_area();
dbms_resource_manager.set_consumer_group_mapping(
    dbms_resource_manager.oracle_user,
    'HR',
    'APPUSER'
);
dbms_resource_manager.submit_pending_area();
END;
```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Solutions for Practice 13: Managing Resources (continued)

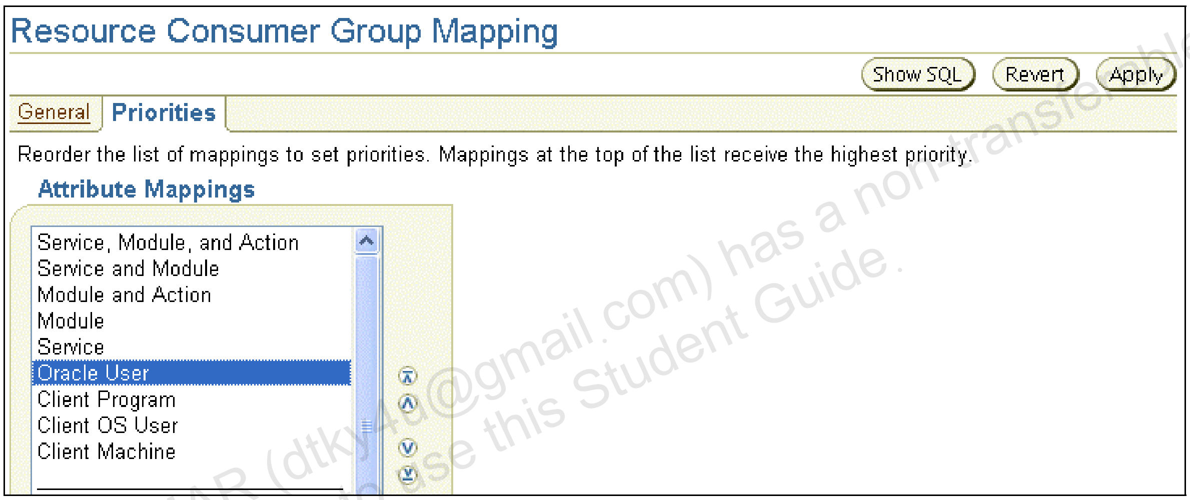
d. Review the statements and click Return.

e. Click Apply to assign the HR user to the APPUSER consumer group.

f. In the "Oracle User Map" region, click "Add Another Row".

g. Select LOW_GROUP from the Consumer Group drop-down list, and enter SCOTT as Oracle User.

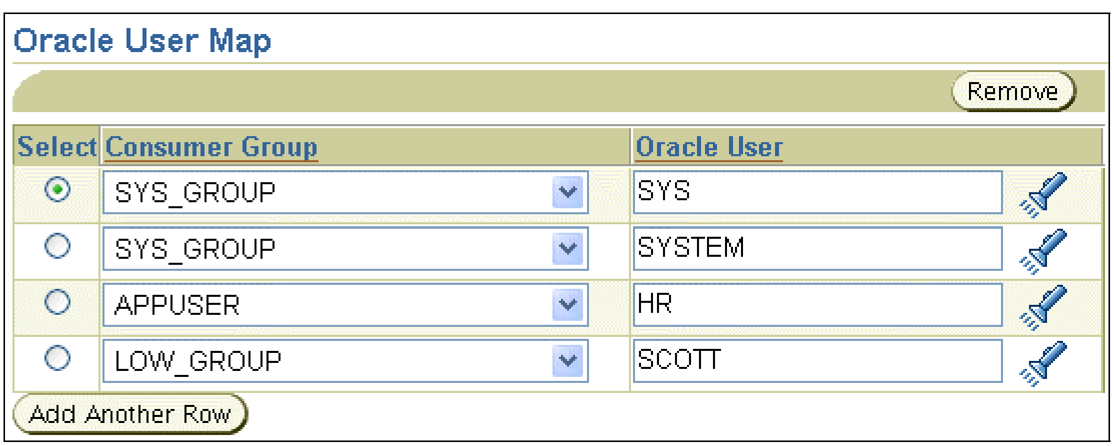
h. Click the Priorities tab.



i. Confirm that "Oracle User" has a higher priority than "Client OS User."

j. Click Apply to assign the SCOTT user to the LOW_GROUP consumer group.

k. Click the General tab.



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Solutions for Practice 13: Managing Resources (continued)

4. Configure Consumer Group Mappings so that the `oracle` OS user belongs to the `SYS_GROUP` consumer group.

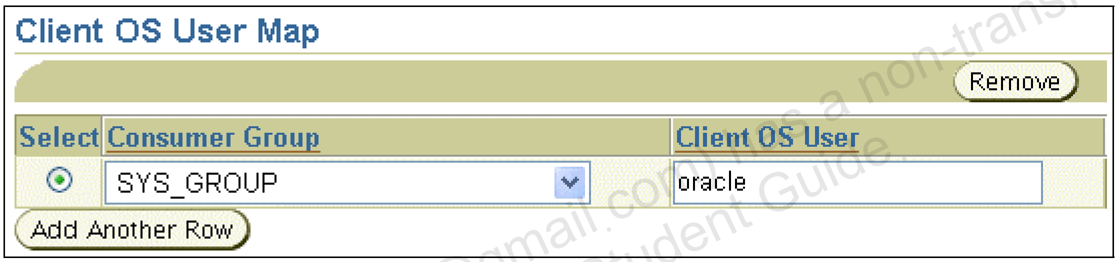
   a. In Enterprise Manager, select Administration > Consumer Group Mappings.

   b. In the "Client OS User Map" region, click "Add Another Row."

   c. Select `SYS_GROUP` from the Consumer Group drop-down list, and enter `oracle` as Client OS User.

   d. Optionally, click Show SQL, review the statements, and click Return.

   e. Click Apply to assign the `oracle` OS user to the `SYS_GROUP` consumer group.



5. Assign the `PM` Oracle user to the following consumer groups: `APPUSER`, `LOW_GROUP`, and `SYS_GROUP`.

   a. In Enterprise Manager, select Administration > Users.

   b. Select the `PM` user and click the Edit button.

   c. Click the "Consumer Groups Switching Privileges" tab.

   d. Click the "Edit List" button.

   e. Move the `APPUSER`, `LOW_GROUP`, and `SYS_GROUP` consumer groups to "Selected Consumer Groups."

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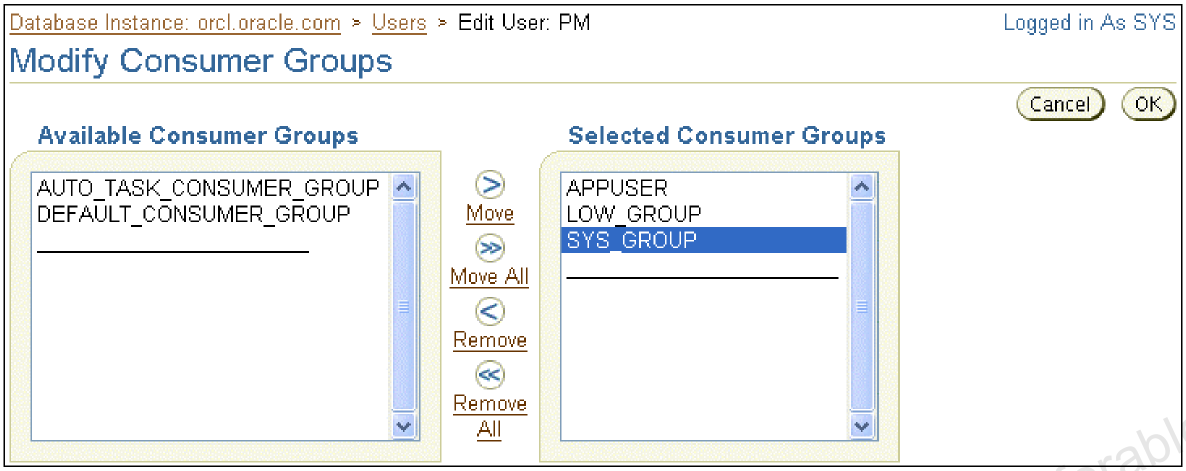
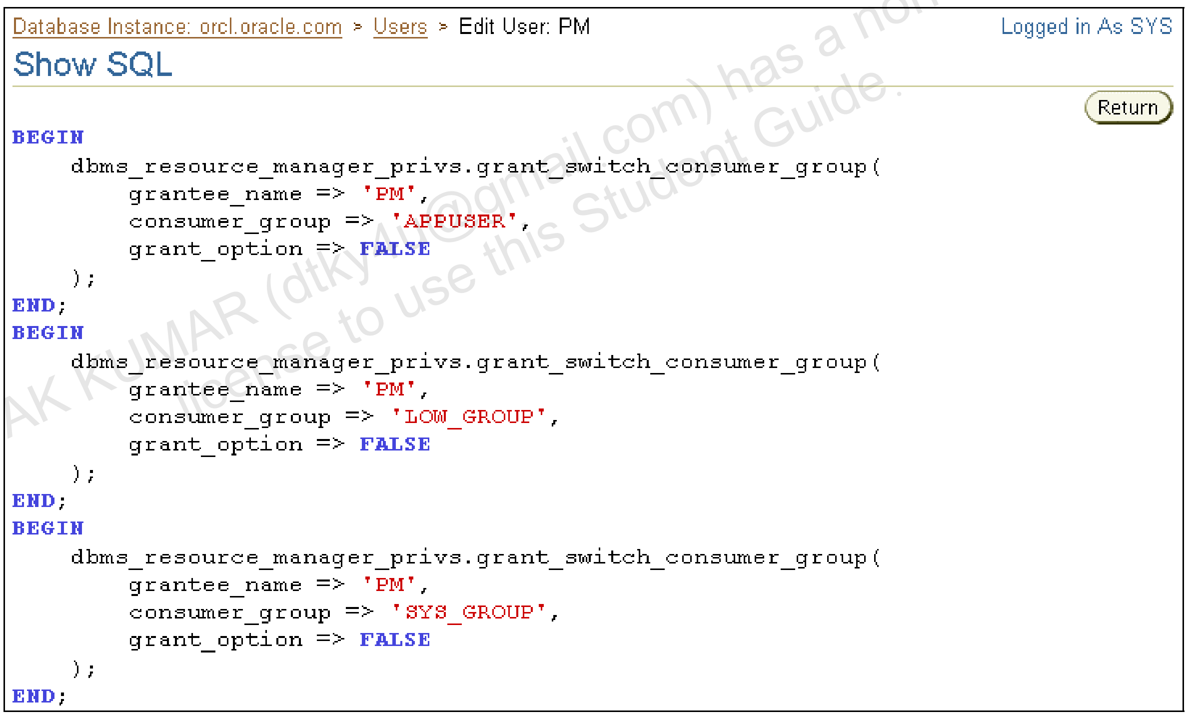
Solutions for Practice 13: Managing Resources (continued)



f. Click OK, and then click Show SQL.



g. Review the statements and click Return.

h. Click Apply to assign the PM user to these consumer groups.

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Solutions for Practice 13: Managing Resources (continued)

6. Execute the `lab_13_06.sh` script to unlock the `HR`, `SCOTT`, `OE`, and `PM` Oracle user accounts. Set the password to match the username.

   a. In a terminal window, enter:

```
cd /home/oracle/labs
./lab_13_06.sh
```

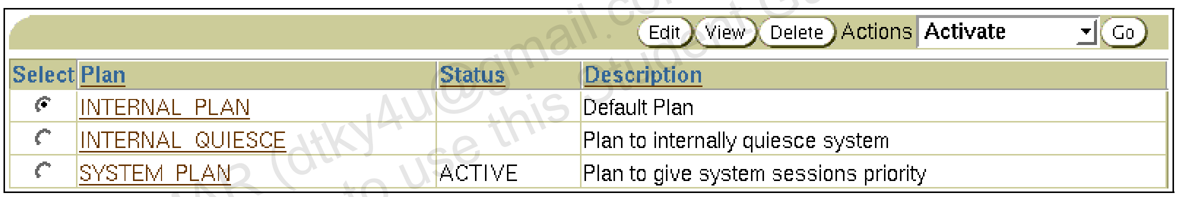
   You should see that the four users have been altered. If not, resolve any problems that might have occurred.

7. Activate the `SYSTEM_PLAN` resource plan.

   a. In Enterprise Manager, select Administration > Plans.

   b. On the Resource Plans page, select the `SYSTEM_PLAN`, select Activate from the Actions drop-down list, and click Go.

   c. Click Yes to confirm your activation.



8. Test the consumer group mappings. Start two SQL*Plus sessions: the first with the `system/oracle@orcl` connect string and the second with the `scott/scott@orcl` connect string.

   a. In a terminal window, enter:

```
cd /home/oracle/labs
sqlplus system/oracle@orcl
```

   b. In your SQL*Plus session, enter:

```
SET SQLPROMPT “FIRST>”
```

   c. In a second terminal window, enter:

```
cd /home/oracle/labs
sqlplus scott/scott@orcl
```

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Solutions for Practice 13: Managing Resources (continued)

d. In your second SQL*Plus session, enter:

```
SET SQLPROMPT "SECOND>"
```

e. In your FIRST SQL*Plus session, enter:

```
@lab_13_08_e.sql
```

f. ***Question:*** To which consumer group does the SCOTT user belong?

   Answer: SCOTT is in the LOW_GROUP consumer group.

g. In the SECOND terminal window, enter:

```
connect pm/pm@orcl
```

h. In your FIRST SQL*Plus session, enter / (a slash) to execute the previous SQL statement again.

i. ***Question:*** To which consumer group does the PM user belong?

   Answer: PM is in the SYS_GROUP consumer group.

j. In the SECOND terminal window, enter:

```
connect oe/oe@orcl
```

k. In your FIRST SQL*Plus session, enter / (a slash) to execute the previous SQL statement again.

l. *Question:* When testing your OE Oracle user, you notice that OE is in the OTHER_GROUPS consumer group. Why is that?

   Possible Answer: The OE user is not explicitly assigned to another consumer resource group.

9. Deactivate the SYSTEM_PLAN resource plan.

   a. In Enterprise Manager, select Administration > Plans.

   b. On the Resource Plans page, select SYSTEM_PLAN, select Deactivate from the Actions drop-down list, and click Go.

   c. Click Yes to confirm your deactivation.

   d. Exit all SQL sessions and close the terminal windows.

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Solution for Practice 14-1: Monitoring the Scheduler

Background: Because your job tasks are regularly increasing, you decide to automate routine tasks. First, you monitor existing scheduler elements, and then you create scheduler components and test them.

In this practice, you use Enterprise Manager Database Control to define and monitor the Scheduler and automate tasks. Regularly, click "Show SQL" to review all statements that are new to you.

Log in as the `SYS` user (with `oracle` password, connect as `SYSDBA`) or as `HR` user (with `HR` password, connect as `Normal`), as indicated. Perform the necessary tasks either through Enterprise Manager Database Control or through SQL*Plus. All scripts for this practice are in the `/home/oracle/labs` directory.

1. Log in to Enterprise Manager Database Control as the `SYS` user and grant the following roles to the `HR` user:
   - `CONNECT` role
   - `RESOURCE` role
   - `DBA` role

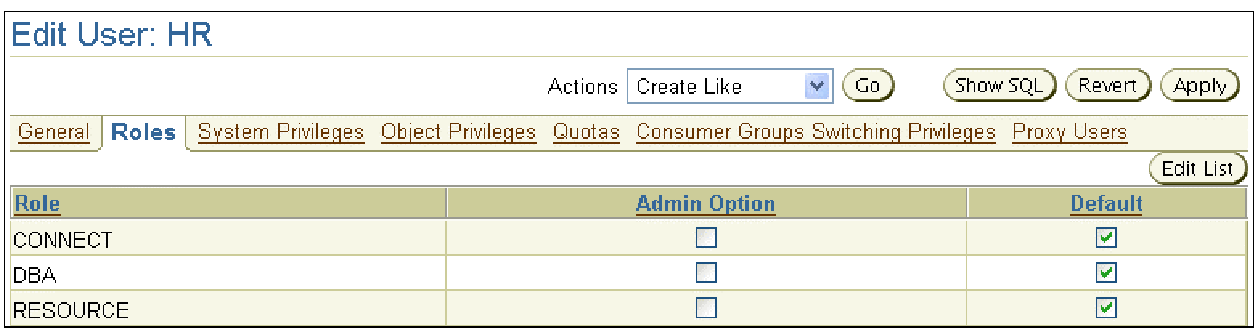
   Because you are going to use the `HR` user to administer jobs through Database Control, you need to make sure that `HR` is registered as a possible administrator.

   a. In Enterprise Manager, select Administration > Users.

   b. On the Users page, select the `HR` user and click Edit.

   c. On the Edit User page, click the Roles tab. Then, click the Edit List button on the right side of the page.

   d. On the Modify Roles page, click the `DBA` role, and then click the Move button to grant this role to the `HR` user. Repeat this step for the `CONNECT` role. Then, click the OK button.



   e. Optionally, click Show SQL, review the statements, and click Return.

   f. On the Edit User page, click Apply.

   g. Click the Setup link on the upper-right region of the page.

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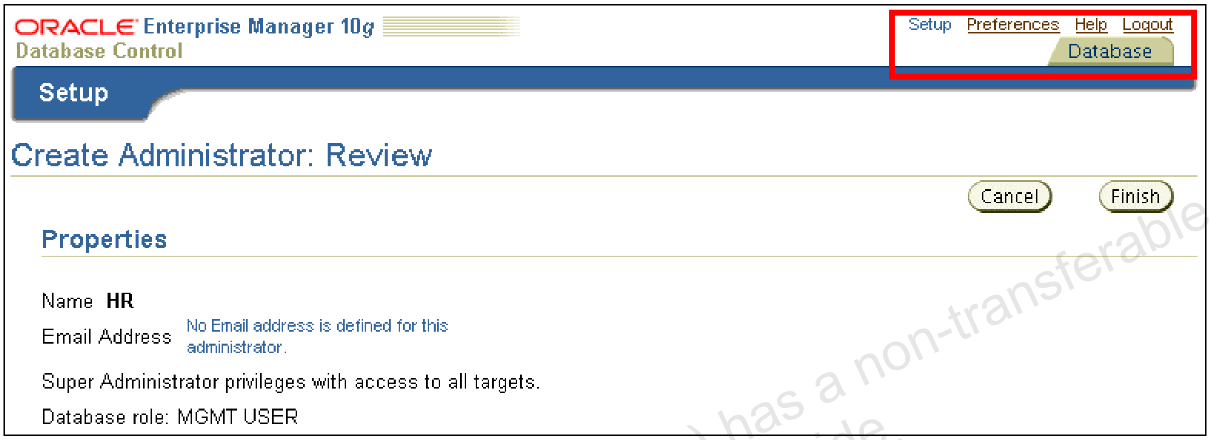
Solution for Practice 14-1: Monitoring the Scheduler (continued)

h. On the Administrators page, click the Create button.

i. On the “Create Administrators: Properties” page, enter HR in the Name, Password, and Confirm Password fields.

j. Click the Finish button.



k. On the “Create Administrator: Review” page, click the Finish button.

l. Click the Logout link on the upper-right corner of the page.

2. Log in to Enterprise Manager Database Control as the HR user. On the Administration tabbed page, click the Jobs link in the Database Scheduler region. Are there any jobs?

a. Click the Login button to log in as the HR user.

b. For the username and password, enter HR, accept Connect As `Normal`, and click Login.

c. On the “Oracle Database 10*g* Licensing Information” page, click the “I agree” button.

d. In Enterprise Manager, select Administration > Jobs in the Database Scheduler region.

Question: Are there any jobs?

Answer: There are some jobs.

3. Review the Programs page in Enterprise Manager. Are there any existing programs? (**Hint:** Use the browser’s **Back** button).

a. In Enterprise Manager, select Administration > Programs in the Database Scheduler region.

Question: Are there any existing programs?

Answer: There are some existing programs.

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Solution for Practice 14-1: Monitoring the Scheduler (continued)

4. Review the Scheduler Schedules page in Enterprise Manager. Are there any existing schedules?

   a. In Enterprise Manager, select Administration > Schedules.

   Question: Are there any existing schedules?

   Answer: There is one schedule called `DAILY_PURGE_SCHEDULE`.

5. Review the Scheduler Windows page in Enterprise Manager. Are there any existing windows? Which resource plan is associated with each window?

   a. In Enterprise Manager, select Administration > Windows.

   Question 1: Are there any existing windows? What are their names?

   Answer: There are two windows called WEEKNIGHT_WINDOW and WEEKEND_WINDOW.

   b. Click the `WEEKNIGHT_WINDOW` link.

   Question 2: Which resource plan is associated with this window?

   Answer: None.

   c. Click OK, and then click the `WEEKEND_WINDOW` link.

   Question 3: Which resource plan is associated with this window?

   Answer: None.

6. Review the Scheduler Job Classes page in Enterprise Manager. Are there any existing job classes? If so, which resource consumer group is associated with each job class?

   a. In Enterprise Manager, select Administration > Job Classes.

   Question 1: Are there any existing job classes?

   Answer: There are two job classes called `DEFAULT_JOB_CLASS` and `AUTO_TASKS_JOB_CLASS`.

   b. Click the `DEFAULT_JOB_CLASS` link.

   Question 2: Which resource consumer group is associated with the job class?

   Answer: None.

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Solution for Practice 14-1: Monitoring the Scheduler (continued)

c. Click OK, and then click the AUTO_TASKS_JOB_CLASS link.

Question 3: Which resource consumer group is associated with the job class?

Answer: AUTO_TASKS_JOB_CLASS is associated with AUTO_TASK_CONSUMER_GROUP.

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Solution for Practice 14-2: Creating Scheduler Components

In this practice, you use Enterprise Manager Database Control to create Scheduler objects and automate tasks.

Prerequisite: Ensure that you completed the previous step 1, which gives the HR user administrative privileges.

1. While logged in to the database as the HR user in Database Control, create a simple job that runs a SQL script:
   - General:
     Name: CREATE_LOG_TABLE_JOB
     Owner: HR
     Description: Create the SESSION_HISTORY table for the next part of this practice
     Logging level: RUNS
     Command type: PL/SQL
     PL/SQL block: BEGIN execute immediate('create table session_history(snap_time TIMESTAMP WITH LOCAL TIME ZONE, num_sessions NUMBER)'); END;
     (You can find this block in your lab_14_02_01.sql file.)
   - Schedule:
     Repeating: Do not Repeat
     Start: Immediately
   - Options:
     No special options

   a. Log in to Enterprise Manager Database Control as the HR user.

   b. In Enterprise Manager, select Administration > Jobs in the Database Scheduler region.

   c. On the Scheduler Jobs page, click the Create button.

   d. On the Create Job - General page, enter and confirm the following values:

      Name: CREATE_LOG_TABLE_JOB
      Owner: HR
      Description: Create the SESSION_HISTORY table
      Logging level: RUNS
      Command type: PL/SQL
      PL/SQL block:

```
BEGIN
   execute immediate
   ('create table session_history(
     snap_time TIMESTAMP WITH LOCAL TIME ZONE,
     num_sessions NUMBER)');
END;
```

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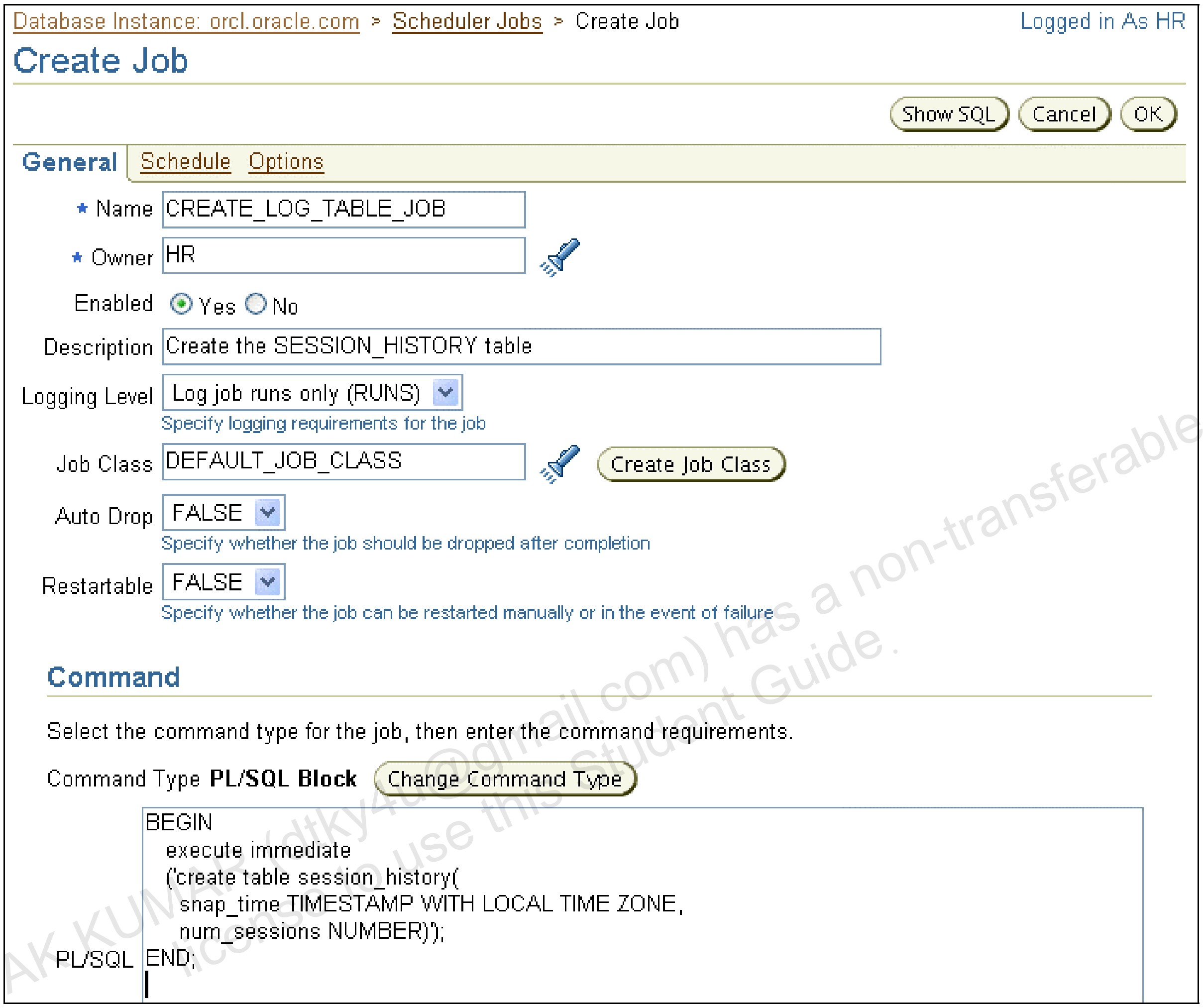
Solution for Practice 14-2: Creating Scheduler Components (continued)



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e. On the Create Job - Schedule page, enter and confirm the following values:

    Repeating: Do not Repeat
    Start: Immediately

f. Click Show SQL.

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Solution for Practice 14-2: Creating Scheduler Components (continued)


```
BEGIN
sys.dbms_scheduler.create_job(
job_name => '"HR"."CREATE_LOG_TABLE_JOB"',
job_type => 'PLSQL_BLOCK',
job_action => 'BEGIN
   execute immediate
   (''create table session_history(
     snap_time TIMESTAMP WITH LOCAL TIME ZONE,
     num_sessions NUMBER)'');
END;
',
start_date => systimestamp at time zone 'America/New_York',
job_class => 'DEFAULT_JOB_CLASS',
comments => 'Create the SESSION_HISTORY table',
auto_drop => FALSE,
enabled => TRUE);
END;
```

g. Review the statements and click Return.

h. Click OK to create the job.

i. If the job does not appear on the Scheduler Jobs page, click the Refresh button until it succeeds.

2. Create a program called `LOG_SESS_COUNT_PRGM` that logs the current number of database sessions into a table. Use the following code, which is also provided in the `lab_14_02_02.sql` script:

```
DECLARE
sess_count   NUMBER;
BEGIN
SELECT COUNT(*) INTO sess_count FROM V$SESSION;
INSERT INTO session_history VALUES (systimestamp,
sess_count);
COMMIT;
END;
```

a. In Enterprise Manager, select Administration > Programs.

b. On the Scheduler Programs page, click the Create button.

c. On the Create Program page, enter and confirm the following values:

Name: `LOG_SESS_COUNT_PRGM`
Schema: `HR`
Enabled: Yes
Type: `PLSQL_BLOCK`
Source:

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Solution for Practice 14-2: Creating Scheduler Components (continued)

```
DECLARE
sess_count    NUMBER;
BEGIN
SELECT COUNT(*) INTO sess_count FROM V$SESSION;
INSERT INTO session_history VALUES (systimestamp, sess_count);
COMMIT;
END;
```

d. Click Show SQL.

Database Instance: orcl.oracle.com > Scheduler Programs > Create Program   Logged in As HR

Show SQL

Return

```
BEGIN
DBMS_SCHEDULER.CREATE_PROGRAM(
program_name=>'HR.LOG_SESS_COUNT_PRGM ',
program_action=>'DECLARE
sess_count    NUMBER;
BEGIN
SELECT COUNT(*) INTO sess_count FROM V$SESSION;
INSERT INTO session_history VALUES (systimestamp, sess_count);
COMMIT;
END;
',
program_type=>'PLSQL_BLOCK',
number_of_arguments=>0,
comments=>'',
enabled=>TRUE);
END;
```

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e. Review the statements, and then click Return.

f. Click OK to create the program.

3. Create a schedule named `SESS_UPDATE_SCHED` owned by `HR` that executes every three seconds. Use SQL*Plus and the `DBMS_SCHEDULER.CREATE_SCHEDULE` procedure to create the schedule.

```
BEGIN
  DBMS_SCHEDULER.CREATE_SCHEDULE (
   schedule_name => 'SESS_UPDATE_SCHED',
   start_date => SYSTIMESTAMP,
   repeat_interval => 'FREQ=SECONDLY;INTERVAL=3',
   comments => 'Every three seconds');
END;
/
```

Return to Enterprise Manager Database Control, and verify that the `SESS_UPDATE_SCHED` schedule was created.

Hint: You may have to refresh the page for the Schedule to appear.

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Solution for Practice 14-2: Creating Scheduler Components (continued)

a. In a terminal window, enter:

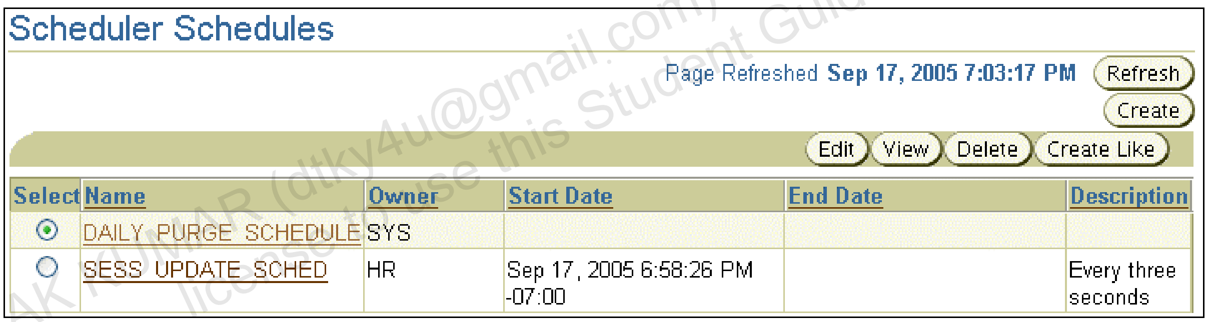
```
sqlplus hr/hr
```

b. In your SQL*Plus session, enter:

```
BEGIN
  DBMS_SCHEDULER.CREATE_SCHEDULE (
   schedule_name => 'SESS_UPDATE_SCHED',
   start_date => SYSTIMESTAMP,
   repeat_interval => 'FREQ=SECONDLY;INTERVAL=3',
   comments => 'Every three seconds');
END;
/
```

c. In Enterprise Manager, select Administration > Schedules.

d. Verify that the SESS_UPDATE_SCHED schedule has been created. (You may have to refresh the page for the Schedule to appear.)



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4. Using Enterprise Manager Database Control, create a job named LOG_SESSIONS_JOB that uses the LOG_SESS_COUNT_PRGM program and the SESS_UPDATE_SCHED schedule. Make sure that the job uses FULL logging.

   a. In Enterprise Manager, select Administration > Jobs, and then click Create.

   b. On the Create Job page, enter and confirm the following values:

      Name: LOG_SESSIONS_JOB
      Owner: HR
      Description: Count sessions with HR.LOG_SESS_COUNT_PRGM
      Logging level: FULL

   c. Click "Change Command Type," and on the Select Command Option page, select Program Name, and enter HR.LOG_SESS_COUNT_PRGM in the field next to it, or use the Lookup icon to select the program. Click OK.

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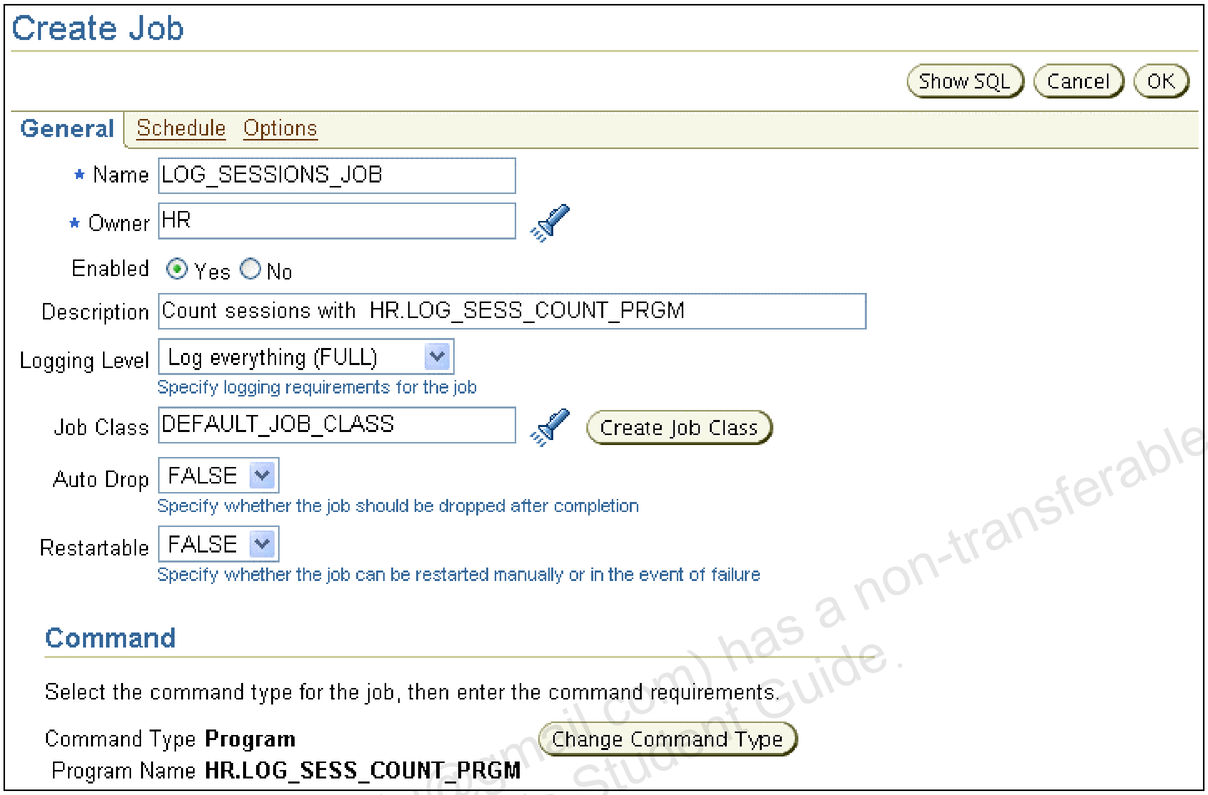
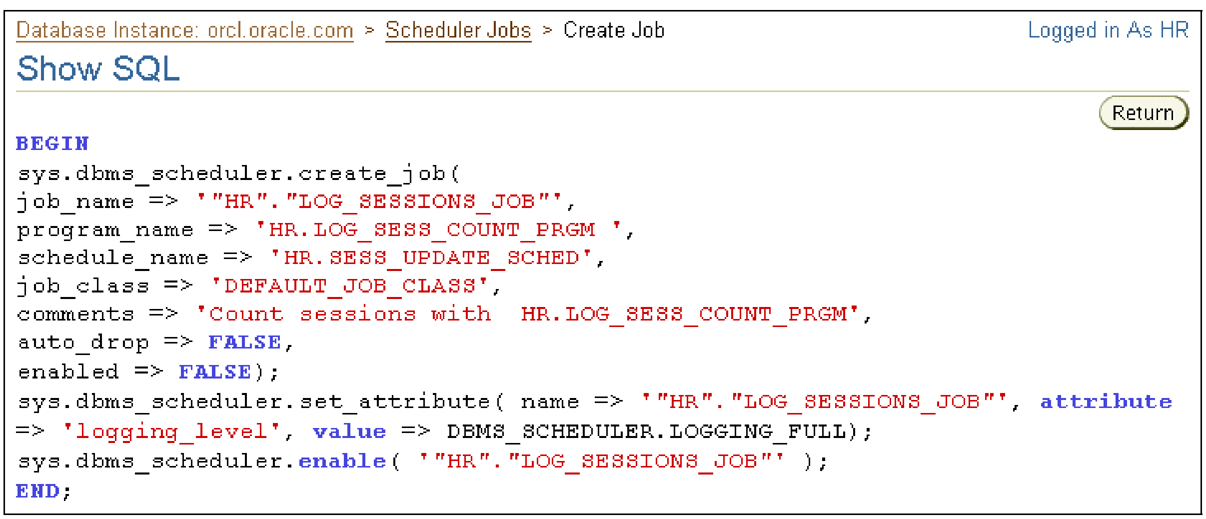
Solution for Practice 14-2: Creating Scheduler Components (continued)



d. Click the Schedule tab.

e. Change the Schedule Type to "Use Pre-Defined Schedule," and select the `HR.SESS_UPDATE_SCHED` schedule by using the Lookup icon.

f. Click Show SQL.




```
BEGIN
sys.dbms_scheduler.create_job(
job_name => '"HR"."LOG_SESSIONS_JOB"',
program_name => 'HR.LOG_SESS_COUNT_PRGM ',
schedule_name => 'HR.SESS_UPDATE_SCHED',
job_class => 'DEFAULT_JOB_CLASS',
comments => 'Count sessions with  HR.LOG_SESS_COUNT_PRGM',
auto_drop => FALSE,
enabled => FALSE);
sys.dbms_scheduler.set_attribute( name => '"HR"."LOG_SESSIONS_JOB"', attribute
=> 'logging_level', value => DBMS_SCHEDULER.LOGGING_FULL);
sys.dbms_scheduler.enable( '"HR"."LOG_SESSIONS_JOB"' );
END;
```

g. Review the statements, and then click Return.

h. Click OK to create the job.

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Solution for Practice 14-2: Creating Scheduler Components (continued)

5. In your SQL*Plus session, check the HR.SESSION_HISTORY table for rows.

   a. Enter:

```
SELECT * FROM SESSION_HISTORY
ORDER BY snap_time;
```

   Your result will look different but the second values should be three seconds apart:

```
SNAP_TIME
-----------------------------------------------------------------
-
NUM_SESSIONS
------------
17-SEP-05 07.24.35.113274 PM
          24
17-SEP-05 07.24.38.112987 PM
          24
```

   Question: If there are rows in the table, are the time stamps three seconds apart?

   Answer: Yes, there are rows, and yes, the time stamps are three seconds apart.

6. Use Enterprise Manager Database Control to alter the SESS_UPDATE_SCHED schedule from every three seconds to every three minutes. Then use SQL*Plus to verify that the rows are now being added every three minutes: query the HR.SESSION_HISTORY table, ordered by the SNAP_TIME column.

   a. In Enterprise Manager, select Administration > Schedules.

   b. Click the SESS_UPDATE_SCHED link.

   c. On the View Schedule page, click Edit.

   d. Change the description to “Every three minutes.”

   e. Change the value in the “Repeat” drop-down list from “By Seconds” to “By Minutes.”

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Solution for Practice 14-2: Creating Scheduler Components (continued)

f. Ensure that the interval is 3 and click Show SQL.

Show SQL

Return

```
BEGIN
sys.dbms_scheduler.set_attribute( name => '"HR"."SESS_UPDATE_SCHED"', attribute
=> 'repeat_interval', value => 'FREQ=MINUTELY;INTERVAL=3');
sys.dbms_scheduler.set_attribute( name => '"HR"."SESS_UPDATE_SCHED"', attribute
=> 'start_date', value => to_timestamp_tz('2005-09-17 18:58:00 -7:00',
'YYYY-MM-DD HH24:MI:SS TZH:TZM'));
sys.dbms_scheduler.set_attribute( name => '"HR"."SESS_UPDATE_SCHED"', attribute
=> 'comments', value => 'Every three minutes');
END;
```

g. Review the statements, click Return, and then click Apply.

h. In your SQL*Plus session, query the HR.SESSION_HISTORY table, ordered by the SNAP_TIME column. (Wait for three minutes after you update the schedule.) Enter:

```
SELECT * FROM HR.SESSION_HISTORY
ORDER BY snap_time;
```

Your result will look different (but the minute values should be 3 minutes apart):

```
SNAP_TIME
---------------------------------------------------------------
NUM_SESSIONS
------------
17-SEP-05 08.29.32.024307 PM
          23
17-SEP-05 08.32.00.113159 PM
          23
```

7. **This is your mandatory cleanup task.** Use Enterprise Manager to drop the LOG_SESSIONS_JOB and CREATE_LOG_TABLE_JOB jobs, the LOG_SESS_COUNT_PRGM program, and the SESS_UPDATE_SCHED schedule. Use SQL*Plus to drop the SESSION_HISTORY table, and exit from your session.

   Note: ***Make sure that you do not delete the wrong schedule.***

   a. In Enterprise Manager, select Administration > Jobs.

   b. With the LOG_SESSIONS_JOB job selected, click the Delete button. Select "Drop the job and stop any running instance," and then click Yes.

   c. Go back to the Scheduler Jobs page, select CREATE_LOG_TABLE_JOB, and click Delete.

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Solution for Practice 14-2: Creating Scheduler Components (continued)

d. Select "If there are dependent objects, it will not be dropped" and then click Yes on the Confirmation page.

e. Click the Database Instance breadcrumb on the upper-left corner of the page to return to the Administration page. Then, click Programs.

f. With the `LOG_SESS_COUNT_PRGM` program selected, click the Delete button. Click Yes to confirm.

g. Click the Database Instance breadcrumb on the upper-left corner of the page to return to the Administration page. Click Schedules.

h. With the `SESS_UPDATE_SCHED` schedule selected, click the Delete button. *Make sure that you do not delete the wrong schedule.*

i. Select "If there are dependent objects, it will not be dropped," and then click Yes to confirm.

j. In your SQL*Plus session as the `HR` user, delete the `SESSION_HISTORY` table, and then exit the session. Enter:

```
DROP TABLE session_history PURGE;
EXIT
```

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Solutions for Practice 15: Database Security

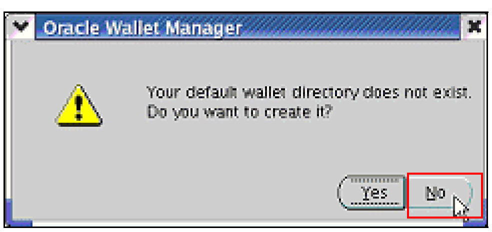
Background: Your organization has an increased need for database security. You have been asked to prepare a demonstration for your technical colleagues on how transparent data encryption works. First, you create a new encrypted wallet using Oracle Wallet Manager. Then (as `SYSDBA`), you open the wallet, set an encryption key and create the `TDE_DBA` user. As the `TDE_DBA` user, create the `TDE` tablespace with the `EMP_ENC` table containing one row. On the basis of questions from your audience, you show various details, including `DBA_ENCRYPTED_COLUMNS` and what happens when you query with a closed wallet and an open wallet. Finally, you clean up your demonstration objects.

1. From your desktop, use the Oracle Wallet Manager graphical tool to create a new wallet stored in your `/home/oracle/labs` directory. Make sure that you use the `ora1cle2` password for your wallet.

   a. In a terminal window, enter:

```
owm
```

   b. Click Wallet from the menu bar, and then click New.



   c. A warning window appears on your screen asking you to create a default wallet directory. Click No.

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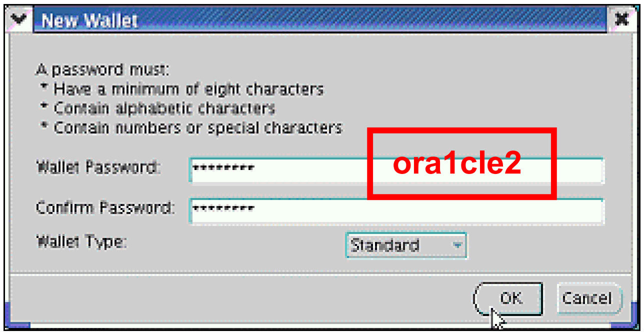
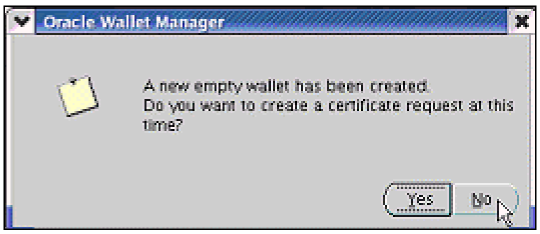
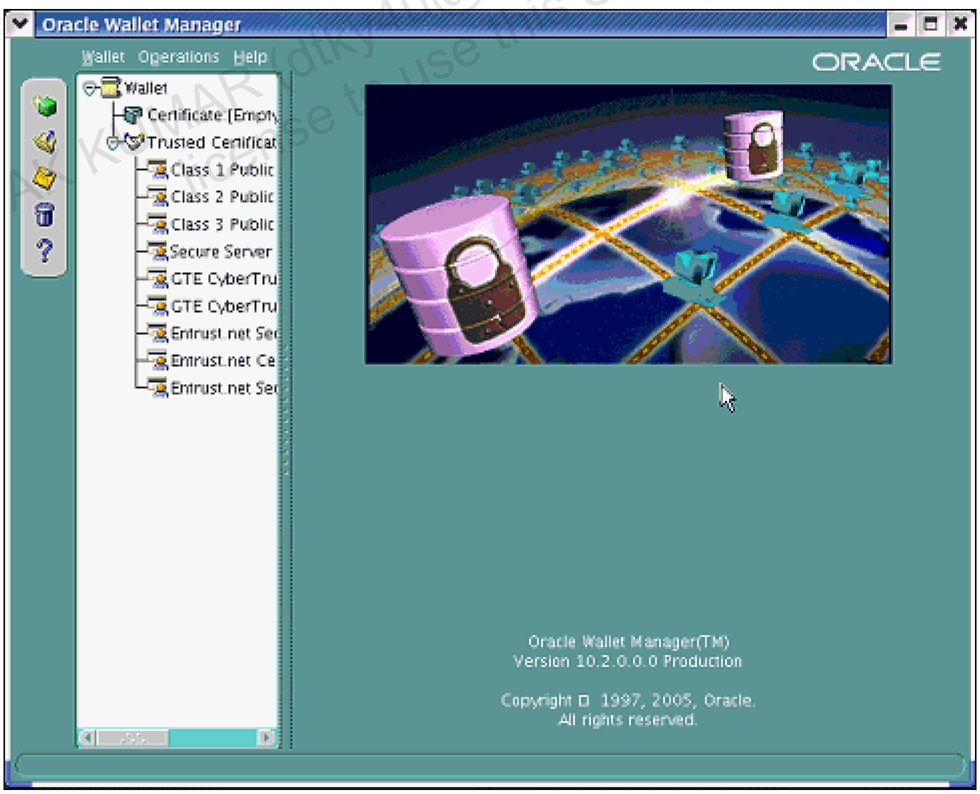
Solutions for Practice 15: Database Security (continued)



d. On the New Wallet window, enter `ora1cle2` in the Wallet Password and the Confirm Password field. Click OK.



e. Click No. Do not create a certificate at this time.



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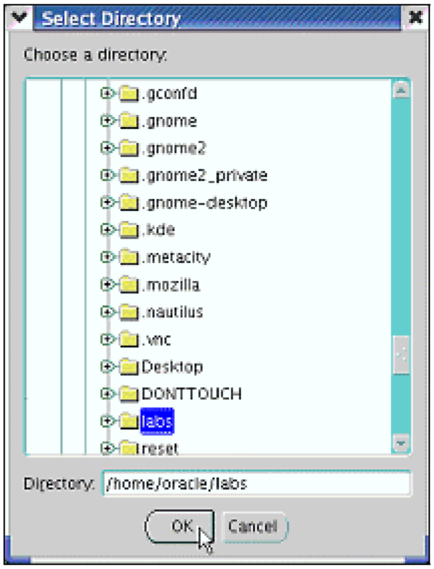
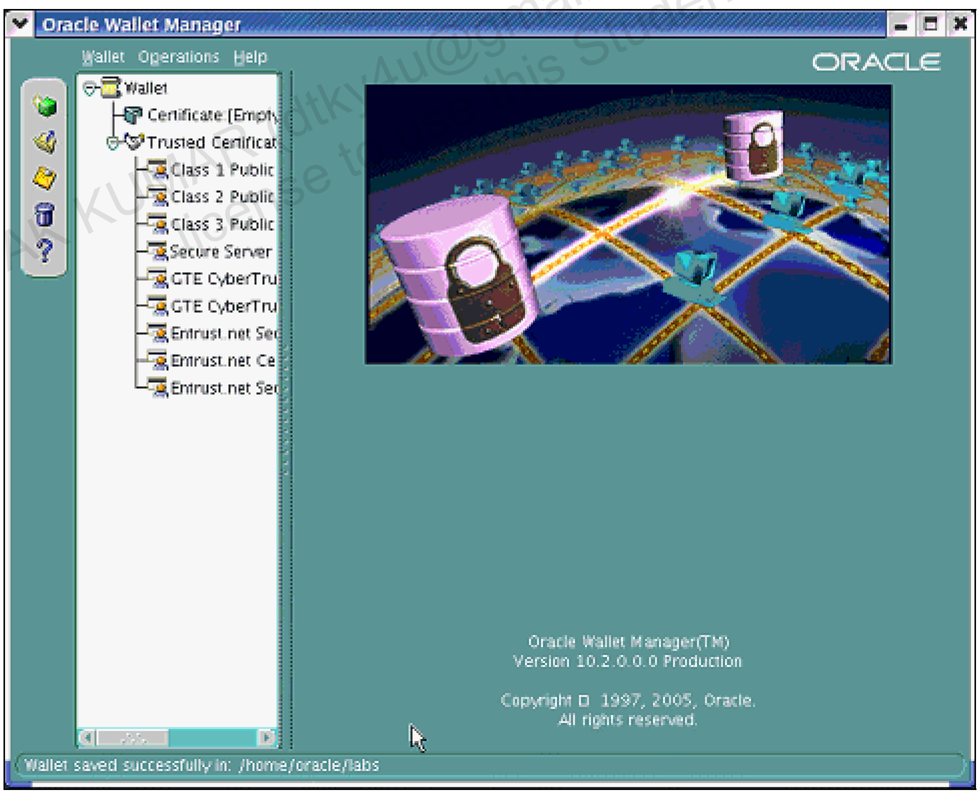
Solutions for Practice 15: Database Security (continued)

f. Select Wallet from the menu bar again, and then click Save As.



g. On the Select Directory window, select `/home/oracle/labs`, and click OK.



You have now created a new wallet called `ewallet.p12` in your `/home/oracle/labs` directory.

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Solutions for Practice 15: Database Security (continued)

2. Make sure that you add the following entry to your `sqlnet.ora` file. In class, it is in the `walletlocation.ora` file.

```
  WALLET_LOCATION=
  (SOURCE=
    (METHOD=file)
    (METHOD_DATA=
       (DIRECTORY=/home/oracle/labs)))
```

   a. Enter the following commands in a terminal window:

```
cd $HOME/labs

cp $ORACLE_HOME/network/admin/sqlnet.ora old_sqlnet.ora

cat walletlocation.ora >> $ORACLE_HOME/network/admin/sqlnet.ora
```

3. Start a SQL*Plus session as `SYSDBA` to open your wallet from within your instance.

   a. In a terminal window, enter:

```
sqlplus / as sysdba
```

   b. In your SQL*Plus session, enter:

```
ALTER SYSTEM SET ENCRYPTION WALLET OPEN IDENTIFIED BY "ora1cle2";
```

   You should receive a message that the system is altered.

4. In your SQL*Plus session (as `SYSDBA`), set the master key from within your instance.

   a. Enter:

```
ALTER SYSTEM SET ENCRYPTION KEY IDENTIFIED BY "ora1cle2";
```

   Again, you should receive a message that the system is altered.

5. From your terminal emulator session, execute the `lab_15_05.sh` script. This script creates a new user called `TDE_DBA` identified by the password `TDE_DBA`. It also creates a new tablespace called `TDE` stored outside ASM. Then, the script creates a new table called `EMP_ENC` stored in the `TDE` tablespace and owned by `TDE_DBA`. This table contains two encrypted columns: `SALARY` and `JOB`. The script then inserts one row in the new table.

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Solutions for Practice 15: Database Security (continued)

```
sqlplus / as sysdba << EOF

set echo on

create user TDE_DBA identified by TDE_DBA
default tablespace users
temporary tablespace temp;

grant connect, resource, dba to TDE_DBA;

connect TDE_DBA/TDE_DBA

CREATE SMALLFILE TABLESPACE "TDE"
DATAFILE 'tde1.dbf' SIZE 500K
LOGGING
EXTENT MANAGEMENT LOCAL
SEGMENT SPACE MANAGEMENT AUTO;

drop table emp_enc purge;

CREATE TABLE emp_enc (
     first_name VARCHAR2(20),
     last_name VARCHAR2(20),
     empID NUMBER,
     salary NUMBER(6) ENCRYPT,
     job_nonenc varchar2(20),
     job varchar2(20) ENCRYPT
) tablespace tde;

insert into emp_enc
values('John','Wild',1,'10000','CurriculumA','CurriculumB');
commit;

exit;
EOF
```

a) In a terminal window, enter:

```
./lab_15_05.sh
```

6. In your SQL*Plus session (as SYSDBA), determine the list of encrypted columns in your database. Then, select all the rows and columns of the EMP_ENC table.

   a. Enter:

```
select table_name,column_name from dba_encrypted_columns;
```

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Solutions for Practice 15: Database Security (continued)

Following is the output of this command:

```
TABLE_NAME                        COLUMN_NAME
------------------------------    ------------------------------
EMP_ENC                           SALARY
EMP_ENC                           JOB
```

b. Now enter:

```
SQL> select * from TDE_DBA.emp_enc;
```

Your result should look like this:

```
FIRST_NAME           LAST_NAME                 EMPID     SALARY
-------------------- -------------------- ---------- ----------
JOB_NONENC           JOB
-------------------- --------------------
John                 Wild                          1      10000
CurriculumA          CurriculumB
```

7. In your SQL*Plus session (as SYSDBA), make sure that the file containing your EMP_ENC table contains encrypted column values. Take the TDE tablespace offline, then use OS commands to view the file content, and alter the tablespace to be online again.

   Possible Linux syntax: `strings <directory>/<file_name> | more`

   a. Enter:

```
alter tablespace tde offline;
```

   b. Enter:

```
host strings /u01/app/oracle/product/10.2.0/db_1/dbs/tde1.dbf |
more
```

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Solutions for Practice 15: Database Security (continued)

Portions of your result should look similar to this:

```
}|{z
@ORCL
        u       >
STATUS
STATUS#
NAME
TYPE#

…

DEFLOGGING
        DEFGROUPS
&---------------------------------------
&---------------------------------------
&---------------------------------------
&---------------------------------------
&---------------------------------------
        John
Wild
`Eo4
CurriculumA4
$#t
zqm     VS
DEGREE
SAMPLESIZE

…
```

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c. Enter:

```
alter tablespace tde online;
```

8. In your SQL*Plus session (as SYSDBA), close your wallet from within your instance, and try to select the data contained in the TDE_DBA.EMP_ENC table. What do you observe?

a. In your SQL*Plus session, enter:

```
ALTER SYSTEM SET ENCRYPTION WALLET CLOSE;
```

b. Query the TDE_DBA.EMP_ENC table. Enter:

```
SQL> select * from TDE_DBA.emp_enc;
select * from TDE_DBA.emp_enc
*
ERROR at line 1:
ORA-28365: wallet is not open
```


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Solutions for Practice 15: Database Security (continued)

Question: What do you observe?

Possible Answer: Because your wallet is closed, it is no longer possible to access EMP_ENC.

c. Now open the wallet and query the TDE_DBA.EMP_ENC table again:

```
SQL> ALTER SYSTEM SET ENCRYPTION WALLET OPEN IDENTIFIED BY
"ora1cle2";

System altered.

SQL> select * from TDE_DBA.emp_enc;

FIRST_NAME           LAST_NAME                 EMPID     SALARY
-------------------- -------------------- ---------- ----------
JOB_NONENC           JOB
-------------------- --------------------
John                 Wild                          1      10000
CurriculumA          CurriculumB
```

d) Exit your SQL*Plus session:

```
SQL> exit;
Disconnected from Oracle Database 10g Enterprise Edition Release
10.2.0.1.0 - Production
With the Partitioning, OLAP and Data Mining options
$
```

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9. To clean up your environment, execute the `lab_15_09.sh` script from your terminal emulator session. It closes the wallet, and drops the TDE tablespace and the TDE_DBA user.

   a. In a terminal window, enter:

```
./lab_15_09.sh
```


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Solutions for Practice 15: Database Security (continued)

Following is the result of this command:

```
$ sqlplus / as sysdba

SQL*Plus: Release 10.2.0.1.0 - Production on Mon May 16 03:41:34
2005

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Connected to:
Oracle Database 10g Enterprise Edition Release 10.2.0.1.0 -
Production
With the Partitioning, OLAP and Data Mining options

SQL> ALTER SYSTEM SET ENCRYPTION WALLET CLOSE;

System altered.

SQL> drop tablespace tde including contents and datafiles;

Tablespace dropped.

SQL> drop user TDE_DBA cascade;

User dropped.

SQL> exit;
Disconnected from Oracle Database 10g Enterprise Edition Release
10.2.0.1.0 - Production
With the Partitioning, OLAP and Data Mining options
$
```

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b. If your Oracle Wallet Manager is still open, select Wallet > Exit to exit from it.

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Solution for Practice 16: Using Globalization Support

Background: Your company has bought another company that has a large user community speaking French. In general, you are not supposed to change the database itself, but you are supposed to use a lower granularity to accommodate their needs. So you decide to use primarily session-specific settings for changing the language, date and time formats, and for addressing a sorting issue. Use `system/oracle@orcl` as your database login and `/home/oracle/labs` as your working directory.

1. Start *i*SQL*Plus by opening your browser and entering the following URL: `http://<hostname>:5560/isqlplus` or navigate to Enterprise Manager > Database home page > Related Links > iSQL*Plus. Log in as the `system` user with the `oracle` password and the `orcl` connect identifier.

2. Determine the database and the national character set.

```
SELECT * FROM NLS_DATABASE_PARAMETERS
WHERE parameter LIKE '%CHARACTER%';
```

PARAMETER	VALUE
NLS_NUMERIC_CHARACTERS	.,
NLS_CHARACTERSET	AL32UTF8
NLS_NCHAR_CHARACTERSET	AL16UTF16

3. Familiarize yourself with NLS settings and modify the current date format.

   a. Select the current date.

```
SELECT SYSDATE FROM dual;
```

SYSDATE
16-AUG-05

   b. The year is not displayed using a four-digit year. Change your session to display a four-digit year and the current time (including seconds).

```
ALTER SESSION SET NLS_DATE_FORMAT='DD-MON-YYYY HH:MI:SS';
SELECT SYSDATE FROM dual;
```

SYSDATE
16-AUG-2005 09:10:00

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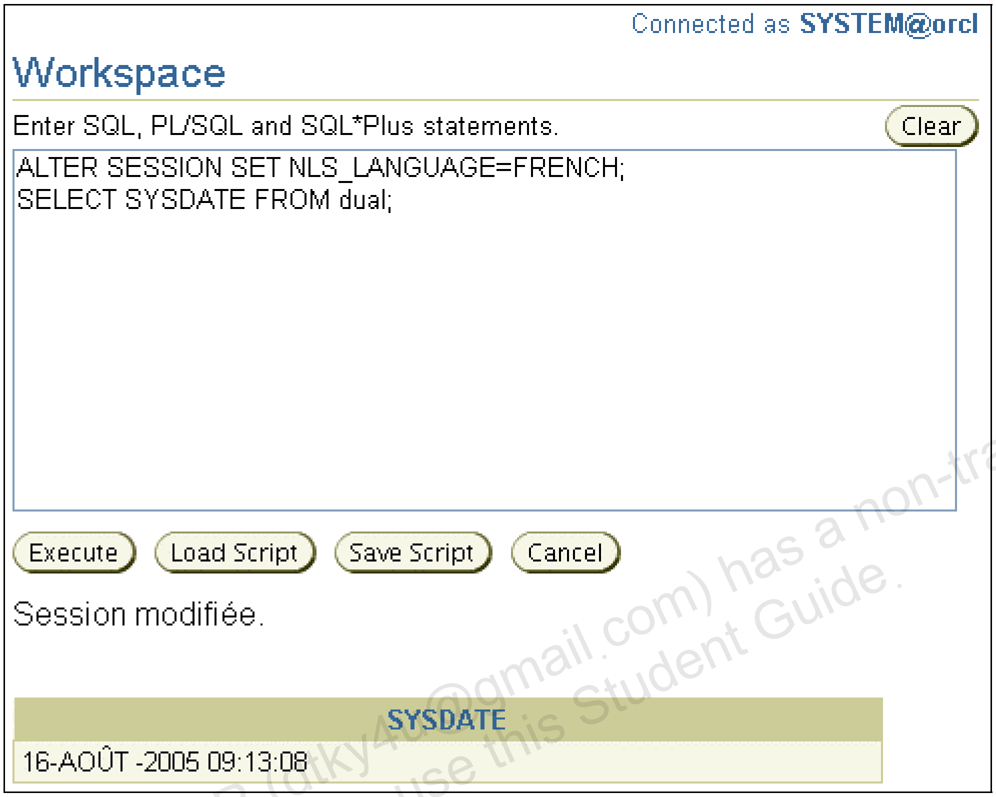
Solution for Practice 16: Using Globalization Support (continued)

c. Let your session speak French. Display the current system date and time.



4. Import the `WORDS` table (which is in the `lab_16_04_a.dmp` file). The `lab_16_04_a.sh` script can assist you.

   a. Navigate to your working directory and execute the script:

```
cd $HOME/labs
./lab_16_04_a.sh
```

The script creates a table, called `WORDS`, with four rows.

   b. Resolve any errors that may have occurred.

5. Display the content of the `WORDS` table.

```
SELECT * FROM words;
```

NUM	FR_WORD	EN_WORD
1	gelée	frost
2	gelé	frozen
3	gèle	freezes
4	gelez	freeze

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Solution for Practice 16: Using Globalization Support (continued)

6. Set NLS_SORT to BINARY for your session. Select the table contents and order the results by the FR_WORD column. In what order are the numbers in the NUM column displayed?

```
ALTER SESSION SET NLS_SORT=BINARY;

SELECT * FROM words
ORDER BY fr_word;
```

NUM	FR_WORD	EN_WORD
4	gelez	freeze
2	gelé	frozen
1	gelée	frost
3	gèle	freezes

7. Next, set NLS_SORT to FRENCH. Select the table contents and order the results by the FR_WORD column. In what order are the numbers in the NUM column displayed?

```
ALTER SESSION SET NLS_SORT=FRENCH;

SELECT * FROM words
ORDER BY fr_word;
```

NUM	FR_WORD	EN_WORD
2	gelé	frozen
3	gèle	freezes
1	gelée	frost
4	gelez	freeze

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8. Set NLS_SORT to FRENCH_M. Select the table contents and order the results by the FR_WORD column. In what order are the numbers in the NUM column displayed?

```
ALTER SESSION SET NLS_SORT=FRENCH_M;

SELECT * FROM words
ORDER BY fr_word;
```

NUM	FR_WORD	EN_WORD
3	gèle	freezes
2	gelé	frozen
1	gelée	frost
4	gelez	freeze

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Solution for Practice 16: Using Globalization Support (continued)

9. Set NLS_SORT to BINARY. Now retrieve the table contents in the same order as the last query, without using another ALTER SESSION command.

```
ALTER SESSION SET NLS_SORT=BINARY;

SELECT * FROM words
ORDER BY NLSSORT(fr_word,'NLS_SORT=FRENCH_M');
```

NUM	FR_WORD	EN_WORD
3	gèle	freezes
2	gelé	frozen
1	gelée	frost
4	gelez	freeze

10. Drop the table and also remove it from the recycle bin.

```
DROP TABLE words PURGE;
```

11. Shut down the *i*SQL*Plus instance by closing the window.

    Click X (the Close icon) on the upper-right corner of the window frame.

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Solution for Workshop Scenario 1

Background: In order to provide a consistent baseline for starting the workshop exercises, you need to copy in a backup of the database that you made at the very beginning of this course. There is a script to do that, and to perform some other tasks for resetting the state of the database. The main difference at this point, though, is the fact that the ASM instance is still available.

1. Change to the `$HOME/workshops` directory and then run the `ws_prep.sh` script to reset the database to the beginning of the course.

   a. Enter the following at the OS command prompt:

```
$ cd $HOME/workshops
$ ./ws_prep.sh
```

Following is the output of that script:

```
$ ./ws_prep.sh
Shutting down the database...

SQL> Database closed.
Database dismounted.
ORACLE instance shut down.
SQL> Disconnected from Oracle Database 10g Enterprise Edition Release
10.2.0.1.0 - Production
With the Partitioning, OLAP and Data Mining options
Cleaning out the Flash Recovery Area...
Moving the current datafiles out...
Copying baseline datafiles in...
Starting the instance...

Connected to an idle instance.

SQL> ORACLE instance started.

Total System Global Area  285212672 bytes
Fixed Size                  1218992 bytes
Variable Size             113247824 bytes
Database Buffers          167772160 bytes
Redo Buffers                2973696 bytes
Database mounted.
Database opened.
SQL> Disconnected from Oracle Database 10g Enterprise Edition Release
10.2.0.1.0 - Production
With the Partitioning, OLAP and Data Mining options
Finished.
$
```

2. Shut down and start up the Database Control console in Enterprise Manager. Use the `emctl stop` and `start` directives to do this.

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Solution for Workshop Scenario 1 (continued)

a. Enter the following at the OS command prompt to stop the Database Control:

```
$ emctl stop dbconsole
```

b. Enter the following at the OS command prompt to restart the Database Control:

```
$ emctl start dbconsole
```

3. Log in to Enterprise Manager as `SYS` user as `SYSDBA` and put your database into `ARCHIVELOG` mode, and enable Flashback Logging.

   a. Navigate to Maintenance > Recovery Settings.

   b. Select the ARCHIVELOG Mode check box.

   c. Select the Enable Flashback Database check box.

   d. Click Apply.

   e. Click Yes to confirm the restart of the database.

   f. Enter the host credentials of `oracle/oracle` and click OK to restart the database.

   g. Click Yes to confirm going ahead with the restart.

   h. Click Refresh until the login screen appears, at which time, log in again as `SYS` as `SYSDBA`.

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4. Use RMAN to configure `AUTOBACKUP` for your control file and `SPFILE`.

   a. Start RMAN by entering the following at the OS command prompt:

```
$ rman target / NOCATALOG
```

   b. Enter the following RMAN command:

```
RMAN> configure controlfile autobackup on;
```

5. Take a full backup of the database, including archived logs. Use as little space as possible to store the backup.

   a. Enter the following RMAN command:

```
RMAN> BACKUP AS COMPRESSED BACKUPSET DATABASE PLUS ARCHIVELOG;
```


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Solution for Workshop Scenario 1 (continued)

Following is the output of that command:

```
RMAN> BACKUP AS COMPRESSED BACKUPSET DATABASE PLUS ARCHIVELOG;

Starting backup at 2005-12-14 23:01:11
current log archived
allocated channel: ORA_DISK_1
channel ORA_DISK_1: sid=126 devtype=DISK
channel ORA_DISK_1: starting compressed archive log backupset
channel ORA_DISK_1: specifying archive log(s) in backup set
input archive log thread=1 sequence=8 recid=1 stamp=577062077
channel ORA_DISK_1: starting piece 1 at 2005-12-14 23:01:20
channel ORA_DISK_1: finished piece 1 at 2005-12-14 23:01:35
piece
handle=/u01/app/oracle/flash_recovery_area/ORCL/backupset/2005_12_14/o1_
mf_annnn_TAG20051214T230119_1t2560so_.bkp tag=TAG20051214T230119
comment=NONE
channel ORA_DISK_1: backup set complete, elapsed time: 00:00:16
Finished backup at 2005-12-14 23:01:35

Starting backup at 2005-12-14 23:01:36
using channel ORA_DISK_1
channel ORA_DISK_1: starting compressed full datafile backupset
channel ORA_DISK_1: specifying datafile(s) in backupset
input datafile fno=00001 name=/u01/app/oracle/oradata/orcl/system01.dbf
input datafile fno=00003 name=/u01/app/oracle/oradata/orcl/sysaux01.dbf
input datafile fno=00005 name=/u01/app/oracle/oradata/orcl/example01.dbf
input datafile fno=00002 name=/u01/app/oracle/oradata/orcl/undotbs01.dbf
input datafile fno=00004 name=/u01/app/oracle/oradata/orcl/users01.dbf
channel ORA_DISK_1: starting piece 1 at 2005-12-14 23:01:36
channel ORA_DISK_1: finished piece 1 at 2005-12-14 23:04:03
piece
handle=/u01/app/oracle/flash_recovery_area/ORCL/backupset/2005_12_14/o1_
mf_nnndf_TAG20051214T230136_1t256l6p_.bkp tag=TAG20051214T230136
comment=NONE
channel ORA_DISK_1: backup set complete, elapsed time: 00:02:27
Finished backup at 2005-12-14 23:04:04

Starting backup at 2005-12-14 23:04:04
current log archived
using channel ORA_DISK_1
channel ORA_DISK_1: starting compressed archive log backupset
channel ORA_DISK_1: specifying archive log(s) in backup set
input archive log thread=1 sequence=9 recid=2 stamp=577062246
channel ORA_DISK_1: starting piece 1 at 2005-12-14 23:04:09
channel ORA_DISK_1: finished piece 1 at 2005-12-14 23:04:10
piece
handle=/u01/app/oracle/flash_recovery_area/ORCL/backupset/2005_12_14/o1_
mf_annnn_TAG20051214T230407_1t25c9kx_.bkp tag=TAG20051214T230407
comment=NONE
channel ORA_DISK_1: backup set complete, elapsed time: 00:00:02
```

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Solution for Workshop Scenario 1 (continued)

```
Finished backup at 2005-12-14 23:04:10

Starting Control File and SPFILE Autobackup at 2005-12-14 23:04:10
piece
handle=/u01/app/oracle/flash_recovery_area/ORCL/autobackup/2005_12_14/o1
_mf_s_577062250_1t25cd94_.bkp comment=NONE
Finished Control File and SPFILE Autobackup at 2005-12-14 23:04:13

RMAN>
```

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Solution for Workshop Scenario 2

Background: This workshop scenario concerns the loss of data. To introduce the problem, first log out of Enterprise Manager. Then, change directory to `$HOME/workshops` and use SQL*Plus to run the `wlab_02.sql` script as the `SYSTEM` user as shown below:

```
$ cd $HOME/workshops
$ sqlplus system/oracle @wlab_02.sql
```

Start your investigation by going to the Enterprise Manager console and viewing the Database page. Record the results of your investigation under "Observations." After you have determined the problem, formulate a plan to correct the problem. It is possible that there may be more than one viable solution. Record all possible methods that will address the problem under "Methodology."

It is your job to pick the best solution to solve your database problem. After applying your solution, verify that the problem has been corrected. Record your results under "Results."

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Observations: After executing the `wlab_02.sql` script, you will notice that the database is shut down. Attempting to restart the instance results in the following errors:

```
ORA-01157: cannot identify/lock data file 1 - see DBWR trace file
ORA-01110: data file 1: '/u01/app/oracle/oradata/orcl/system01.dbf'
```

Attempting to connect to the database via Enterprise Manager displays an informational screen indicating "The database status is currently unavailable." You have the option of starting the database or performing recovery.

An examination of the `$ORACLE_BASE/oradata/orcl` directory reveals that the `SYSTEM` tablespace data file is missing.

Methodology

Because you have a recent backup and are archiving, the best solution is to use complete recovery to recover the missing data file.

1. Using Enterprise Manager, click Startup in order to attempt to start up the database. Startup fails, putting the database into the `MOUNT` state.
2. Click the **Perform Recovery** button on the page displayed after you attempted to log in.
3. Supply the host credentials of `oracle/oracle` and the database credentials of `sys/oracle`.
4. Select Datafiles as the Object Type in the Object Level Recovery region. Select "Recover to current time" and click "Perform Object Level Recovery."
5. Select the `system01.dbf` data file by selecting the check box in front of the file name, and then click **Next**.
6. Indicate that the files should be restored to the default location, and then click **Next**.
7. Click **Submit** to start the recovery.
8. Review the RMAN output, and then click Open Database.

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Solution for Workshop Scenario 2 (continued)

9. After the database has opened, click OK and log in to Enterprise Manager as `SYS` again. Verify that the database is running by viewing the Database home page.

Results

- The database is now open and available for users. SQL*Plus and EM connections are now allowed.
- There are no alerts listed on the Database home page.
- The only way to prevent this problem from occurring is to determine why the data file went missing in the first place, and prevent the situation from occurring again.

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Solution for Workshop Scenario 3

Background: Investigate the ASM storage configuration, disks, and disk groups. Add a disk to the existing disk group, and observe the rebalance operation as it happens.

Unless specified otherwise, you must log in as SYSDBA either through Database Control or through SQL*Plus.

1. Create a tablespace called TBSASM that uses ASM storage. It should use the ASM disk group named "+DGROUP1" and be 200 MB in size.

   a. Log in to SQL*Plus as SYS, and enter the following command:

```
SQL> CREATE TABLESPACE tbsasm DATAFILE '+DGROUP1' SIZE 200M;
```

2. Navigate to the Database home page and see the links that are available in the General region in the upper-left area. Note that there is no link for the ASM instance.

3. Configure Enterprise Manager to have the ASM link on the Database home page.

   Note: *It is necessary that there be ASM storage associated with the ORCL instance when this step is done. That is why the TBSASM tablespace must be created before this step.*

   At the OS command prompt, enter the following series of commands. The commands and the responses to the prompts are in bold so that you can easily follow them.

```
$ emca -deconfig dbcontrol db

STARTED EMCA at Oct 13, 2005 12:41:40 AM
EM Configuration Assistant, Version 10.2.0.1.0 Production
Copyright (c) 2003, 2005, Oracle.  All rights reserved.

Enter the following information:
Database SID: orcl

Do you wish to continue? [yes(Y)/no(N)]: Y
Oct 13, 2005 12:41:54 AM oracle.sysman.emcp.EMConfig perform
INFO: This operation is being logged at
/u01/app/oracle/product/10.2.0/db_1/cfgtoollogs/emca/orcl/emca_2005-10-13_12-
41-40-AM.log.
Oct 13, 2005 12:41:55 AM oracle.sysman.emcp.util.DBControlUtil stopOMSINFO:
Stopping Database Control (this may take a while) ...
Enterprise Manager configuration completed successfully
FINISHED EMCA at Oct 13, 2005 12:42:02 AM
```

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Solution for Workshop Scenario 3 (continued)

```
$ emca -config dbcontrol db

STARTED EMCA at Oct 13, 2005 12:42:52 AM
EM Configuration Assistant, Version 10.2.0.1.0 Production
Copyright (c) 2003, 2005, Oracle.  All rights reserved.

Enter the following information:
Database SID: orcl
Listener port number: 1521
Password for SYS user: oracle
Password for DBSNMP user: oracle
Password for SYSMAN user: oracle
Email address for notifications (optional): <just press enter>
Outgoing Mail (SMTP) server for notifications (optional): <just press enter>
ASM ORACLE_HOME [ /u01/app/oracle/product/10.2.0/db_1 ]: <just press enter>
ASM SID [ +ASM ]: <just press enter>
ASM port [ 1521 ]: <just press enter>
ASM user role [ SYSDBA ]: <just press enter>
ASM username [ SYS ]: <just press enter>
ASM user password: oracle
-----------------------------------------------------------------

You have specified the following settings

Database ORACLE_HOME ................ /u01/app/oracle/product/10.2.0/db_1

Database hostname ................ edbsr5p0.us.oracle.com
Listener port number ................ 1521
Database SID ................ orcl
Email address for notifications ...............
Outgoing Mail (SMTP) server for notifications ...............
ASM ORACLE_HOME ................ /u01/app/oracle/product/10.2.0/db_1
ASM SID ................ +ASM
ASM port ................ 1521
ASM user role ................ SYSDBA
ASM username ................ SYS

-----------------------------------------------------------------
Do you wish to continue? [yes(Y)/no(N)]: Y
Oct 13, 2005 12:43:42 AM oracle.sysman.emcp.EMConfig perform
INFO: This operation is being logged at
/u01/app/oracle/product/10.2.0/db_1/cfgtoollogs/emca/orcl/emca_2005-10-13_12-
42-52-AM.log.
Oct 13, 2005 12:43:58 AM oracle.sysman.emcp.util.DBControlUtil startOMS
INFO: Starting Database Control (this may take a while) ...
Oct 13, 2005 12:45:45 AM oracle.sysman.emcp.EMDBPostConfig performConfiguration
INFO: Database Control started successfully
Oct 13, 2005 12:45:45 AM oracle.sysman.emcp.EMDBPostConfig performConfiguration
INFO: >>>>>>>>>>> The Database Control URL is
http://edbsr5p0.us.oracle.com:1158/em <<<<<<<<<<<
Enterprise Manager configuration completed successfully
FINISHED EMCA at Oct 13, 2005 12:45:45 AM
[oracle@edbsr5p0 oracle]$
```

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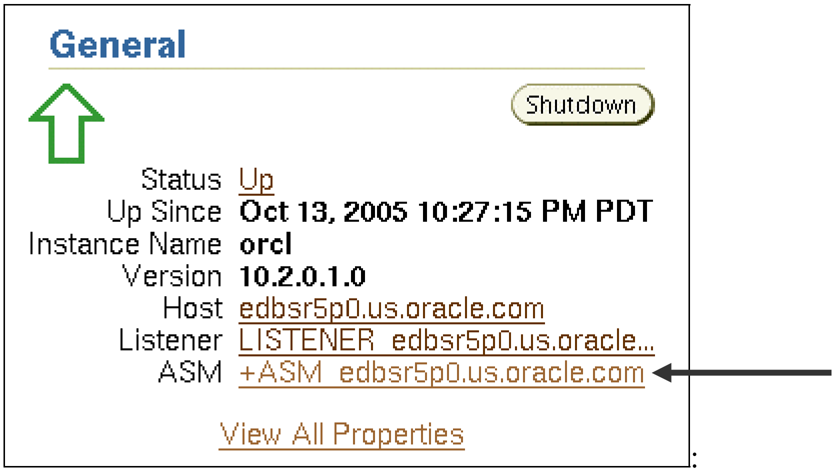
Solution for Workshop Scenario 3 (continued)

4. Click the link for the ASM instance on the Database home page.



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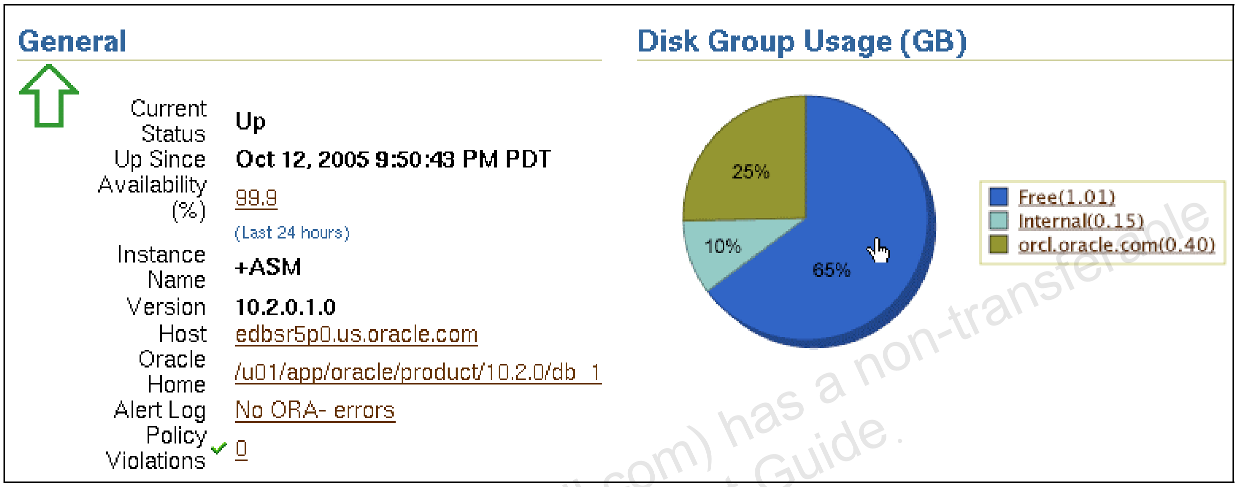
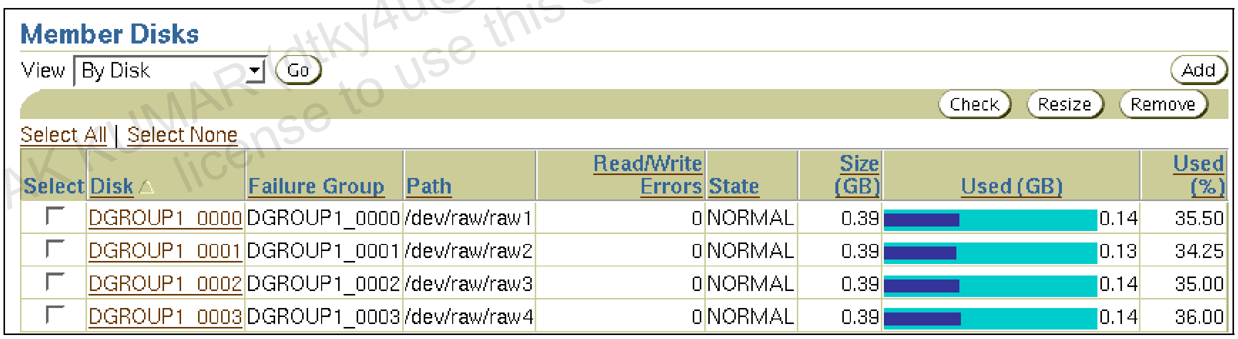
Solution for Workshop Scenario 3 (continued)

5. Click the pie chart to see the Disk Group information. You will be prompted for the login credentials for the ASM instance, which are `SYS` and `oracle`, for username and password, respectively. Enter those, and click Login.

   Note: *It may take several minutes for the pie chart to appear.*



6. Note the percentage used for each disk in the disk group.



Select	Disk	Failure Group	Path	Read/Write Errors	State	Size (GB)	Used (GB)	Used (%)
	DGROUP1_0000	DGROUP1_0000	/dev/raw/raw1	0	NORMAL	0.39	0.14	35.50
	DGROUP1_0001	DGROUP1_0001	/dev/raw/raw2	0	NORMAL	0.39	0.13	34.25
	DGROUP1_0002	DGROUP1_0002	/dev/raw/raw3	0	NORMAL	0.39	0.14	35.00
	DGROUP1_0003	DGROUP1_0003	/dev/raw/raw4	0	NORMAL	0.39	0.14	36.00

7. Add another data file of size 200 MB to the `TBSASM` tablespace.

   a. Enter the following command at a SQL*Plus prompt, logged in to the `ORCL` instance as the `SYS` user:

```
SQL> ALTER TABLESPACE TBSASM ADD DATAFILE '+DGROUP1' SIZE 200M;
```

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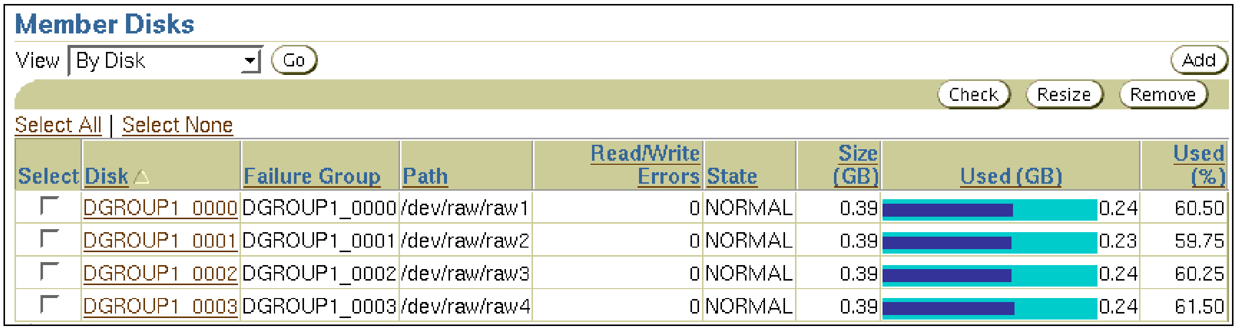
Solution for Workshop Scenario 3 (continued)

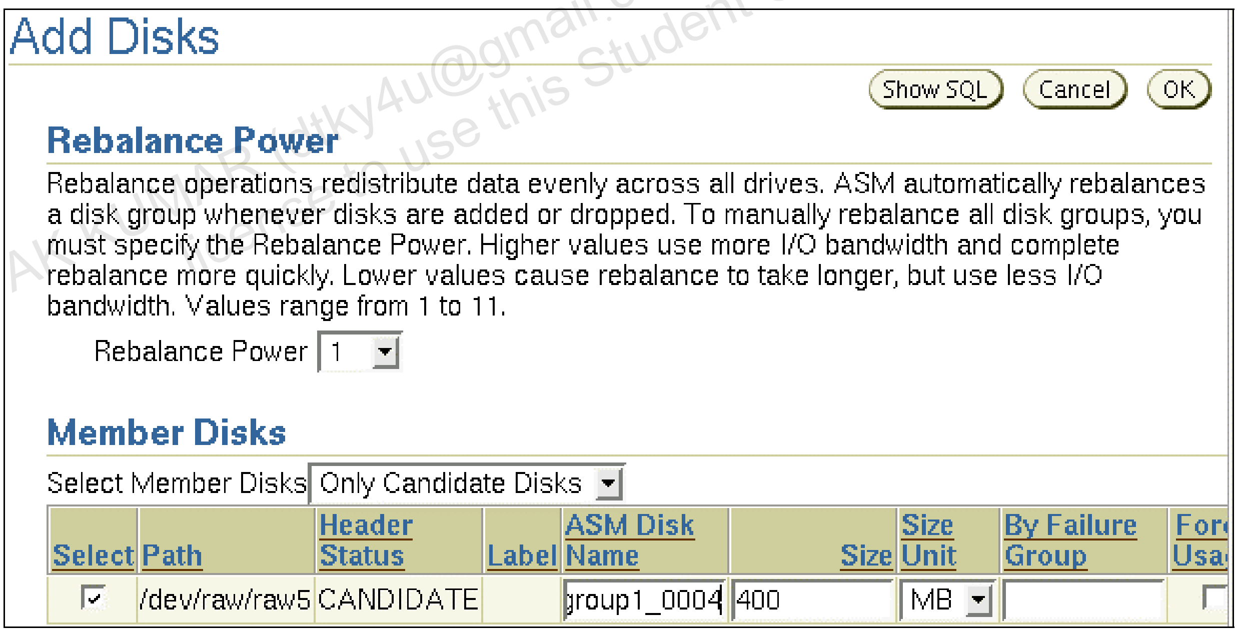
8. Go back to the disk group list and note the change in used space in each disk.



9. Add another disk to the group by clicking Add on this page. Name the disk `DGROUP1_0004`.

   a. Click Add to add the disk to the disk group.

   b. Select the row for `/dev/raw/raw5`, and enter `DGROUP1_0004` for the ASM Disk Name, and `400 MB` for Size.



   c. Click OK.

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Solution for Workshop Scenario 3 (continued)

10. Return to the disk member list, and continue to click the browser's Reload button until the disks are balanced. Note that the new disk starts off empty, but eventually contains about the same amount of data as the other four disks.

Member Disks

View By Disk Go Add

Check Resize Remove

Select All | Select None

Select	Disk	Failure Group	Path	Read/Write Errors	State	Size (GB)	Used (GB)	Used (%)
	DGROUP1_0000	DGROUP1_0000	/dev/raw/raw1	0	NORMAL	0.39	0.19	48.25
	DGROUP1_0001	DGROUP1_0001	/dev/raw/raw2	0	NORMAL	0.39	0.19	48.75
	DGROUP1_0002	DGROUP1_0002	/dev/raw/raw3	0	NORMAL	0.39	0.19	48.50
	DGROUP1_0003	DGROUP1_0003	/dev/raw/raw4	0	NORMAL	0.39	0.19	48.50
	DGROUP1_0004	DGROUP1_0004	/dev/raw/raw5	0	NORMAL	0.39	0.19	48.50

11. After the rebalance has completed, remove the `DGROUP1_0001` and `DGROUP1_0003` disks from the disk group, and view the rebalance operation in the same way.

    a. Select the `DGROUP1_0001` and `DGROUP1_0003` disks, and then click Remove.

    b. Optionally, click Show SQL. Click Yes on the Confirmation page.

12. Drop the tablespace by entering the following at the SQL prompt:

```
SQL> DROP TABLESPACE TBSASM INCLUDING CONTENTS AND DATAFILES;
```

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Solution for Workshop Scenario 4

Background: This workshop scenario simulates loss of data. To introduce the problem, change directory to `$HOME/workshops` and run the `wlab_04.sql` script as the `SYS` user as shown below:

```
SQL> @wlab_04.sql
```

Start your investigation by going to the Enterprise Manager console and viewing the Database page. Record the results of your investigation under "Observations." After you have determined the problem, formulate a plan to correct the problem. It is possible that there may be more than one viable solution. Record all possible methods that will address the problem under "Methodology."

It is your job to pick the best solution to solve your database problem. After applying your solution, verify that the problem has been corrected.

Observations: After executing the `wlab_04.sql` script, you observe that queries to the `HR.DEPARTMENTS` table are failing. To help determine the best method of recovery from this problem, you query the `DBA_RECYCLE_BIN` view.

```
SQL> SELECT owner, original_name, droptime FROM dba_recyclebin;

OWNER                     ORIGINAL_NAME            DROPTIME
------------------------- --------------------     ------------------
HR                        DEPT_LOCATION_IX         2004-03-04:09:39:36
HR                        DEPT_ID_PK               2004-03-04:09:39:36
HR                        DEPARTMENTS              2004-03-04:09:39:36
```

You deduce that the `DEPARTMENTS` table has been dropped. You must take immediate steps to restore this table.

Methodology: There are several methods that will work in this situation. Flashback Table is probably the most straightforward choice. You can use Flashback Table through Enterprise Manager or through SQL*Plus. The SQL*Plus approach is shown here because of its simplicity.

```
SQL> FLASHBACK TABLE hr.departments TO BEFORE DROP;

Flashback complete.
```

The solution steps for this exercise are shown here:

1. Run the `wlab_04.sql` script as the `SYS` user to simulate the problem.

   a. Enter the following at the OS command prompt:

```
$ sqlplus / as sysdba
SQL> @wlab_04.sql
```

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Solution for Workshop Scenario 4 (continued)

2. Query the recycle bin to see whether there are any relevant tables in there.

   a. Enter the following at the SQL prompt:

```
SQL> SELECT owner, original_name, droptime FROM dba_recyclebin;
```

3. Test the `HR.DEPARTMENTS` table by querying it.

   a. Enter the following at the SQL prompt:

```
SQL> SELECT * FROM hr.departments;
```

4. Flash back the `HR.DEPARTMENTS` table from the recycle bin.

   a. Enter the following at the SQL prompt:

```
SQL> FLASHBACK TABLE hr.departments TO BEFORE DROP;
```

5. Perform a select operation against the `DEPARTMENTS` table to confirm the success of the Flashback Table operation.

   a. Enter the following at the SQL prompt:

```
SQL> SELECT department_name FROM hr.departments;

DEPARTMENT_NAME
------------------------------
Administration
Marketing
Purchasing
Human Resources
. . .
```

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Solution for Workshop Scenario 5

Background: This workshop scenario pertains to database availability. To introduce the problem, first log out of Enterprise Manager. Then, change directory to `$HOME/workshops` and run the `wlab_05.sql` script as the `SYS` user as shown below:

```
SQL> @wlab_05.sql
```

Start your investigation by going to the Enterprise Manager console and viewing the Database page. Record the results of your investigation under "Observations." After you have determined the problem, formulate a plan to correct the problem. It is possible that there may be more than one viable solution. Record all possible methods that will address the problem under "Methodology."

It is your job to pick the best solution to solve your database problem. After applying your solution, verify that the problem has been corrected. Record your results under "Results."

Observations: After executing the `wlab_05.sql` script, you will notice the database is shut down. Attempting to restart the instance results in the following errors:

```
ORA-01157: cannot identify/lock data file 4 - see DBWR trace file
ORA-01110: data file 4: '/u01/app/oracle/oradata/orcl/users01.dbf'
```

Attemtping to connect to the database via Enterprise Manager displays an informational screen indicating "The database status is currently unavailable." You have the option of starting the database or performing recovery.

Methodology

Because you have a recent backup and are archiving, the best solution is to use complete recovery to recover the missing data file. Be sure to run the `wlab_05.sql` script before continuing with step 1.

1. Use RMAN to recover the missing data file. Start an RMAN session and issue the `run` command:

```
RMAN> run {
2> sql 'alter database datafile 4 offline';
3> restore datafile 4;
4> recover datafile 4;
5> sql 'alter database datafile 4 online';
6> }
```

2. The recovery operation fails. Review the RMAN output to determine the cause of the failure. You find the following type of errors in the output.

```
ORA-00283: recovery session canceled due to errors
ORA-00313: open failed for members of log group 2 of thread 1
ORA-00312: online log 2 thread 1:
'/u01/app/oracle/oradata/orcl/redo02b.log'
ORA-27037: unable to obtain file status
Linux Error: 2: No such file or directory
```

You check the data file directory, and see that all the online redo logs are missing.

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Solution for Workshop Scenario 5 (continued)

3. Because you do not back up online redo logs, there is no way to recover them. You must use incomplete recovery to open the database. Determine the sequence number of the last archived redo log by querying the `v$archived_log` view. Record that sequence number here: ________________

```
SQL> SELECT MAX(sequence#) FROM v$archived_log;

MAX(SEQUENCE#)
--------------
            14
```

4. To perform incomplete recovery, you must restore *all* the data files, not just the missing one (`users01.dbf`). Issue an RMAN `run` command to restore up to and including log sequence number that you recorded in step 3 above. Specify this number plus one as the sequence number in the RMAN command.

```
RMAN> run {
2> SET UNTIL SEQUENCE 15 thread 1;
3> RESTORE DATABASE;
4> RECOVER DATABASE;
5> ALTER DATABASE OPEN RESETLOGS;
6> }
```

Following is the output of that command:

```
RMAN> run {
2> SET UNTIL SEQUENCE 15 thread 1;
3> RESTORE DATABASE;
4> RECOVER DATABASE;
5> ALTER DATABASE OPEN RESETLOGS;
6> }

executing command: SET until clause

Starting restore at 15-DEC-05
using channel ORA_DISK_1

creating datafile fno=6 name=+DGROUP1/orcl/datafile/tbsasm.256.577065581
creating datafile fno=7 name=+DGROUP1/orcl/datafile/tbsasm.257.577067627
channel ORA_DISK_1: starting datafile backupset restore
channel ORA_DISK_1: specifying datafile(s) to restore from backup set
restoring datafile 00001 to /u01/app/oracle/oradata/orcl/system01.dbf
restoring datafile 00002 to /u01/app/oracle/oradata/orcl/undotbs01.dbf
restoring datafile 00003 to /u01/app/oracle/oradata/orcl/sysaux01.dbf
restoring datafile 00004 to /u01/app/oracle/oradata/orcl/users01.dbf
restoring datafile 00005 to /u01/app/oracle/oradata/orcl/example01.dbf
channel ORA_DISK_1: reading from backup piece
/u01/app/oracle/flash_recovery_area/ORCL/backupset/2005_12_14/o1_mf_nnnd
f_TAG20051214T230136_1t256l6p_.bkp
channel ORA_DISK_1: restored backup piece 1
```

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Solution for Workshop Scenario 5 (continued)

```
piece
handle=/u01/app/oracle/flash_recovery_area/ORCL/backupset/2005_12_14/o1_
mf_nnndf_TAG20051214T230136_1t256l6p_.bkp tag=TAG20051214T230136

channel ORA_DISK_1: restore complete, elapsed time: 00:02:17
Finished restore at 15-DEC-05

Starting recover at 15-DEC-05
using channel ORA_DISK_1

starting media recovery

archive log thread 1 sequence 9 is already on disk as file
/u01/app/oracle/flash_recovery_area/ORCL/archivelog/2005_12_14/o1_mf_1_9
_1t25c5p2_.arc
archive log thread 1 sequence 10 is already on disk as file
/u01/app/oracle/flash_recovery_area/ORCL/archivelog/2005_12_15/o1_mf_1_1
0_1t28wqpj_.arc
archive log thread 1 sequence 11 is already on disk as file
/u01/app/oracle/flash_recovery_area/ORCL/archivelog/2005_12_15/o1_mf_1_1
1_1t290wo5_.arc
archive log thread 1 sequence 12 is already on disk as file
/u01/app/oracle/flash_recovery_area/ORCL/archivelog/2005_12_15/o1_mf_1_1
2_1t2959py_.arc
archive log thread 1 sequence 13 is already on disk as file
/u01/app/oracle/flash_recovery_area/ORCL/archivelog/2005_12_15/o1_mf_1_1
3_1t2d6tth_.arc
archive log thread 1 sequence 14 is already on disk as file
/u01/app/oracle/flash_recovery_area/ORCL/archivelog/2005_12_15/o1_mf_1_1
4_1t2dhbpr_.arc
archive log
filename=/u01/app/oracle/flash_recovery_area/ORCL/archivelog/2005_12_14/
o1_mf_1_9_1t25c5p2_.arc thread=1 sequence=9
archive log
filename=/u01/app/oracle/flash_recovery_area/ORCL/archivelog/2005_12_15/
o1_mf_1_10_1t28wqpj_.arc thread=1 sequence=10
archive log
filename=/u01/app/oracle/flash_recovery_area/ORCL/archivelog/2005_12_15/
o1_mf_1_11_1t290wo5_.arc thread=1 sequence=11
archive log
filename=/u01/app/oracle/flash_recovery_area/ORCL/archivelog/2005_12_15/
o1_mf_1_12_1t2959py_.arc thread=1 sequence=12
archive log
filename=/u01/app/oracle/flash_recovery_area/ORCL/archivelog/2005_12_15/
o1_mf_1_13_1t2d6tth_.arc thread=1 sequence=13
archive log
filename=/u01/app/oracle/flash_recovery_area/ORCL/archivelog/2005_12_15/
o1_mf_1_14_1t2dhbpr_.arc thread=1 sequence=14
media recovery complete, elapsed time: 00:05:22
Finished recover at 15-DEC-05

database opened
RMAN>
```

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Solution for Workshop Scenario 5 (continued)

5. Review the RMAN output, which indicates a successful recovery.
6. Log back in to Enterprise Manager to verify that the database has been recovered. If the console indicates that the database is still not started, click the Administration tab, and then click Tablespaces. Verify that all the tablespaces are listed and are online. Then, click the Database tab to return to the Database home page, which should be displayed correctly now.

Results

- The database is now open and available for users. SQL*Plus and EM connections are now allowed.
- The `USERS` tablespace is online.
- There are no alerts listed on the Database home page.
- The only way to prevent this problem from occurring is to determine why the database files went missing in the first place, and prevent the situation from occurring again.

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Appendix C
Basic Linux and *vi* Commands

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vi Commands

The Visual Interpreter/Editor (*vi*) is the most widely used text editor available for the UNIX environment. While almost everybody curses its unwieldy command syntax, it is still the only editor almost certain to be included with every version of the UNIX and Linux operating systems. The following are a partial list of available *vi* commands.

vi has two modes: command line (where anything typed is taken as an editing command) and input mode (where everything typed is treated as part of the file being edited). To enter the input mode, type a, A, i, I, o, O, c, C, s, S, r, or R. To return to the command-line mode, use the Esc key. To access the *vi* editor from SQL Plus, enter the following command:

```
SQL>define _editor=vi
```

To edit a file from SQL Plus prompt, enter the following:
`edit` *<filename>* (press enter)

To edit a file from the Linux command prompt, enter the following:
`vi` *<filename>* (press enter)

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To MOVE the cursor

h - move left   j - move down   k - move up   l - move right
w - move one word forward   b - move one word backward
e - move to the end of current word

W, B, or E - same as lowercase but ignores punctuation

0 (zero) - move to the beginning of current line $ - move to the end of current line

G - go to the last line of file   H - go to the top line on screen

L - go to the last line on screen   M - go to the middle line on screen

/<string> - search forward to the next occurrence of <string>

?<string> - search backward to the next occurrence of <string>

n - repeat previous search   N - repeat previous search in opposite direction

<ctrl> f - scroll forward one page   <ctrl> b - scroll backward one page

To UNDO previous changes

u - undo the most recent change   U - undo the most recently deleted text

:e! - re-edit current file without saving any changes made since last change

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To ENTER NEW text

a - append text after the current cursor position

A - append text to the end of a line (jumps to end of line and begins appending)

c - change object C - change from current cursor position to the end of line

i - insert text before the current cursor position I - insert text at the beginning of a line
o - insert a blank line BELOW the current cursor position

O - insert a blank line ABOVE the current cursor position

r - replace character at current cursor position
R - replace all characters until [Esc] is pressed

s - substitute text for character under cursor

:s/A/B/opt - substitutes string B for string A. %s/A/B/opt is global replace.

Options include:
g - change all occurences on current line c - confirm prior to each change

p - print changed lines S - substitute entire line to the end

. <period> - repeat last change *n*. <integer><period> - repeat last change *n* times

To leave input mode, press [Esc].

To DELETE existing text

x - delete the character directly under the current cursor location

dd - delete the entire line where the cursor is located

d*n*d (where *n* is some integer) - delete *n* lines from the current cursor position

dw - delete current word D - delete to the end of current line

J - delete return at the end of current line. Join this line and the next.

<int> J - join the next <int> lines

COPY, CUT, and PASTE: *vi* uses a single buffer, where the last changed or deleted text is stored. This text may be manipulated with the following commands:

Y - yank a copy of the current line y <integer> - yank a copy of the next <int> lines

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yw - yank a copy of the current word

yb - yank a copy of the previous word

p - put buffer contents after cursor

P - put buffer contents before cursor

Also, see the s and S commands under the input section.

To SAVE edited changes to an operating-system file

zz - terminate edit mode

:w filename - save changes to the file name specified

:wq - write all changes and quit edit mode

To QUIT without saving changes

ZZ - terminate edit mode

:q! - terminate the file without saving changes

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Basic Linux Commands

This appendix is meant to serve only as a quick reference while you are in class. For more details about these commands, consult the man pages, your Linux documentation, or other Linux command reference books.

Files and Directories	Linux Commands	Description/Comments

Command manual	`man <command>`
	`man –k <string>`
	`man man`
		Find the manual entry for this <command>.
		Show all the manual entries that contain this <string>.
		Display the manual page for `man`.

Command information	`info <command>`	Show the information system entry for this command. Using `info info` shows a tutorial of the `info` documentation system.
Print to standard out	`cat <file>`	Concatenate and print (Print the named file to the terminal screen.)
List users	`cat /etc/password`	
Change working directory	`cd <directory>`	Change working directory to specified directory. cd with no parameters changes to `$HOME`.
Copy a file	`cp <source_file> <destination_file>`	Copy a source file to a destination file.
View a file	`less <file>`	View a file one page at a time. This is a GNU version of `more` or `pg`.
View a file	`more <file>`	View a file one page at a time. BSD version.
List directory	`ls <directory>`	Options include –l (long listing), -R (recursive), -a (show hidden files), -t (sort by time), and -r (reverse sort). Default directory is the current working directory.
Create a directory	`mkdir <directory>`	Make a directory; it defaults into the current working directory. The full path may be specified.
Move or rename a file	`mv <old_file> <new_file>`	Move changes the name of a file or moves it to a different directory.

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Process List	ps ps -ef	Show the processes report; show all processes on the system with a full listing. Many options exist. See the man page for details.
Print working directory	pwd	Print to stdout the current working directory.
Remove or erase a file	rm <file>	Removing a file on Linux is permanent. Options include –r (recursive) and –f (force) (including subdirectories) are *very dangerous*. Often the rm command is aliased with rm –i The option –i asks “Are you sure?”
Create an empty file	touch <file>	Create a file.
Name of the machine	hostname	Show the name of the machine.
The IP address of the machine	host <machine_name>	Query the Domain Name Server, and return the IP address of the machine name.
Remote shell	rsh <host> <command>	Execute a <command> on <host>. Rsh is not secure; use ssh instead.
Remote shell	ssh <host>	Secure shell; it has features to replace rsh, rcp, ftp, and telnet.
Remote shell	telnet <host>	Start a terminal session on <host>. Telnet is not secure; use ssh instead.
Search a file for a pattern	grep <option> <pattern> <file>	Search a <file> or stream for a regular expression defined by <pattern> and show the line that contains that pattern. A common option is –i for case-insensitive. grep can accept input from a file or stdin through a pipe as in: netstat –a| grep ESTABLISHED
Source a script	. <script_file>	In the bash shell, this command “.” forces the script to run in the shell. Normal behavior is for the script to run in a child shell.

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An interpreter	awk	A macrolanguage for reformatting or interpreting input. For each line of input, a variety of actions can be taken. This may be referred to as nawk – for “new awk.”
Sort a file	sort	Sort a file takes input from stdin or a file name argument. There are many options to sort by a particular column, field, and so on. See man page.
Command-line editor	sed	Sed is a command-line editor with many possible commands and options that are very good for editing from a shell script.
Visual editor	vi <file>	Terminal-based editor available on every UNIX system. Linux provides vim (an improved vi, that is a superset of vi).
GNU editor	emacs <file>	This is a GPL editor with extensive customizable features available on most UNIX and Linux distributions.
WSIWIG editor	gedit <file>	A full-screen editor, requiring X. It is available under Gnome.
WSIWIG	kate <file>	A full-screen editor, requiring X. It is available under KDE.
Terminal output	stdout	Standard out (stdout) is not a command but a concept. Most Linux commands write to stdout by default, unless redirected.
Terminal input (keyboard)	stdin	Standard in (stdin) is not a command but a concept. Most Linux commands read from stdin by default, unless redirected.
Alias	alias <command> <alias>	Make a substitution when a user types <command> substitute and execute <alias>; common alias is alias ‘rm’ ‘rm –i’. These aliases are set in the .bashrc file.
Show shell variables	set	Prints all of the variables that are currently defined in the shell.

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Show environment variables	`printenv or env`	Prints all the environment variables; an environment variable has been "exported" so that it will be inherited by child processes.
File Creation mask	`umask –S u=rwx,g=rx,o=rx`	Set the default permissions for all files created by this shell or its children. The –S option uses the symbolic notation; the numeric notation is obsolete.
Clock	`xclock`	An Xclient that shows a clock on the screen. It is often used to test the X windows system.
X access control	`xhost` `xhost +<Xclient>`	Show the current access control in place. Add an Xclient that is allowed to access the local DISPLAY; if no <Xclient> is given, all are allowed.

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System Administration	Linux Commands	Description/Comments
Root file system	`/`	The root directory for the system directory tree
Home Directory	`/home`	Typically, the directory in which all user home directories are placed—for example, `/home/oracle`.
Tmp directory	`/tmp`	A temporary storage area. Do not put anything that you want to keep, here. SA often has a cron job to remove everything periodically.
Boot directory	`/boot`	A small partition to hold the kernel images and boot loader instructions
Log directory	`/var/log`	The location of most system log files
Sample configuration files	`/etc/inittab`	Configuration files are located per the application. Any configuration file that you change after installation should be included in the backup.
Password files	`/etc/passwd` `/etc/shadow`	The `/etc/passwd` file holds user information and must be readable by others; even with encrypted passwords, this can be a security hole. The `/etc/shadow` file holds the encrypted passwords and is readable only by root.
Groups file	`/etc/group`	The `/etc/groups` file defines the groups on a server and the users that are members of the group; primary group for a user is defined in the `/etc/passwd` file.
X configuration file	`/etc/X11/XF86Config`	The file that sets the X server settings for your video card, monitor, mouse, and keyboard. It is usually set up with a vendor-supplied tool, such as `sax2`.

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Schedule a command to run at a regularly scheduled time	crontab -e	Use this command to edit the crontab file to create the specification for the cron daemon to use.
Schedule a script to run at a particular frequency	/etc/anacrontab	Edit the file to specify a script to run at a particular frequency. (See man anacrontab for details).
Schedule a command to run at a single specified time	at <options> TIME	Run a job specified by <options> at a specified TIME parameter.
Schedule a command	batch <options> <TIME>	Run a command when the load average drops below .8, optionally after a set TIME.
Mount a file system	mount <opt> <dev> <mount_point>	Mount a file system on device <dev> at <mount_point> with the options specified by <dev>.
Unmount a file system	umount <dev> umount <mount_point>	Unmount the file system or device.
Maximum # of user ID	65535	
Recover root password	{lilo} control-x linux S passwd root {grub} c kernel vmlinuz-2.4.9-13 **single** ro root=/dev/hda8 initrd /initrd-2.4.9-13.img boot passwd root	This is a procedure to recover the root password if it is lost. This requires physical access to the machine and system console. You start by rebooting the machine, and then during the LILO boot, press and hold [Ctrl] + [x] to get a prompt and command LILO to boot Linux to runlevel S. The second procedure uses the grub boot loader.
Create new user	useradd	The –D option alone shows the defaults. –D with other options changes the defaults options; without –D override, the default (for example, –g) sets a primary group.

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Delete user	`userdel`	Remove a user and optionally all files belonging to the user.
Modify user account	`usermod`	Change `/etc/password` information.
Create new group	`groupadd`	–g sets the group ID. Default is the first free value above 500.
Delete group	`groupdel`	Remove a group from the system. It may not remove a group that is a primary group for a user. Files owned by deleted group must be manually changed with chown.
Change run levels	init <runlevel>	The `init` command causes the rcN.d scripts to be evaluated for the change in run level. `init 6` forces a reboot.
Synchronize the disks	`sync`	Force the buffer cache and page cache to write all dirty buffers to disk. It is used just before a reboot to prevent disk corruption.
Shut down the Linux system	shutdown <mode> <delay>	Do a graceful shutdown of the system, shut down processes, run all shutdown scripts, and sync disks. The modes are –r (reboot) and –h (halt). The delay is a required parameter, which is a number in seconds or “now.” Option shutdown warning message may be sent as well.
Error logs	`dmesg`	View boot messages. This log is circular, and limited system errors could overwrite boot information after a time.
Network IP configuration	`/etc/sysconfig/network-scripts/`	This directory holds scripts executed as part of the boot up sequence by `rc.sysinit`.
Hosts IP addresses	`/etc/hosts`	A list of hosts that your machine knows about. It must at minimum include the name of the local machine and loopback IP.
Name service switch	`/etc/nsswitch.conf`	

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Network parameters	sysctl -a | grep net	View all net parameters that are set for the kernel.
Routing daemon	routed	
NIC Configurations	ifconfig -a	Show all the network devices currently configured.
Secondary IP Address	modprobe ip_alias	
	ifconfig eth0:1 IP	
Login prompt	/etc/issue	Banner message that the user sees when issued the login prompt
YP/NIS service binder	/sbin/ypbind	Find and attach to an NIS server for name resolution and other services.
Module information	modinfo <options> <module>	Display information about kernel modules: –l (license), –p (parameters), –d (description).
List modules	lsmod	Show currently loaded modules.
Load module	insmod	Load a loadable module.
Unload module	rmmod	Unload a loadable module.
Install Software	rpm -ivh package	–i (install), –v (verbose), –h (with progress hash marks)
Uninstall software	rpm -e package	Erase package. It will not uninstall if dependencies exist.
List installed software	rpm -qa	–q (query), –a (all). It lists all installed packages.
Verify installed software	rpm -V package	Compare installed files with the rpm database information.
List all files	rpm -ql package	List all the files that are part of a package.
Package owner	rpm -qf file	List the package when given the full file name.
Machine model	uname -m	Show CPU level (for example, i686)
OS Level	uname -r	Show kernel version.
Run Level	runlevel	Show previous and current runlevel.
Kernel Parameters	sysctl -a	Show settings of all settable kernel parameters.

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Max # File Descriptors	`sysctl fs.file-max`	Show the value of maximum number of file descriptors per process.
Kernel parameter settings	`/etc/sysctl.conf`	Compiled in kernel parameters. It may be reset at bootup by setting them in this file.
Change Kernel Parameter	`echo <value> > </proc/<file>`	Write the new value of a kernel parameter into the `/proc` file system.
	`echo 2147483648 >/proc/sys/kernel/shmmax`	Set the value of the maximum size of a shared memory segment.
Shared Memory	`sysctl kernel.shmmax`	Show the `shmmax` parameter.
Change Kernel Parameter	`sysctl –w <parameter>=<value>`	Change a kernel parameter; the –p option reads the setting from a file and sets them. The default file is `/etc/sysctl.conf`.
Set Process limits	`ulimit <option> <value>`	Set limits on a shell and processes started by the shell. Users can make limits more restrictive; generally; only root can make limit less restrictive. Some options require root privilege. Options include –u (sets number of processes), –n (number of file handles), and so on (see `man bash`).
Show process limits	`ulimit`	Without options ulimit, show the current limit settings.
Interprocess Communication (Shared Memory and Semaphores)	`ipcs <option>`	Options include –m (the current usage of shared memory), –s (usage of semaphores), and –a (shows all).
Remove a shared memory segment	`ipcrm shm <shmid>`	Release the shared memory segment identified by `<shmid>`. *This is very dangerous*. You can corrupt a database that is using the segment that is released.

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System Performance	Linux Commands	Description/Comments
Performance monitor	top	View real-time OS and process statistics.
System activity reporter	sar –<options> <interval> <count>	Options include –q (shows CPU queue), –u (CPU utilization), –d (device activity), –n DEV (network device activity), and so on (see man page). Interval is in seconds.
Virtual Memory statistics	vmstat <interval> < count>	Interval is in seconds.
Virtual Memory statistics	cat /proc/meminfo	Show instantaneous virtual memory usage.
Kernel Cache statistics	cat /proc/slabinfo	Kernel slab allocator statistics: frequently allocated cache objects such as inode, dentries, and asynchronous IO buffers.
I/O statistics	iostat <option> <interval> <count>	Options include –d (device activity), –c (CPU activity), and –x (extended disk activity statistics). The interval is in seconds.
Multiprocessor Statistics	mpstat -P <cpu> <count> <interval>	Return CPU statistics for a particular processor or *all* CPUs in an smp system.
Physical RAM	64 GB(Theoretical)	Maximum physical RAM requires enterprise kernel (Red Hat Enterprise Linux AS 21 only supports up to 16 GB).
Swap device	swapon -s	Show devices currently in use for swap. The swap device is arbitrarily designated at installation. It may be changed or added to. Multiple swap devices may be created; swap size should be at least as large as the physical memory.

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Display swap size	`free`	Show the current memory and swap usage.
Activate Swap	`swapon -a`	Turn on swap.
Free disk blocks	`df -k`	Measured in KB; use –m for MB units.
Device listing	`cat /proc/devices`	List devices known to the system by major and minor number.

Disk information	`cat /proc/scsi/scsi0/sda/model`
	
	`cat /proc/ide/ide0/hda/model`
		View SCSI disk information.
		
		View IDE disk information.

Print network statistics	`netstat <options>`	Print a wide variety of network statistics (see `man netstat`).
Graphical system statistics viewer	`xosview`	An X-based display of recent OS statistics

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Misc System Information	Linux Commands	Description/Comments
NFS exported	/etc/exports	Database files are not supported on simple NFS.
NFS Client mounted directories	/var/lib/nfs/xtab	
Max File System	2 TB with 4KB block size (on 32 kernel)	With ext3 and ext2, others vary.
Max File Size File size cannot exceed file system	2 GB {512B block size} 2 TB {4KB block size}	The Oracle database can create files up to 64 GB with a 16-KB database block size. The 32-bit kernel limits file and block devices to 2 TB.
File System Block size	dumpe2fs <device>	Dump the file system properties to `stdout`.
Filesystem table	/etc/fstab	Mount these file systems at bootup
Journal Filesystem types	ext3 reiserfs	
Disk Label	fdisk -l	`fdisk` is not available on all distributions.
Extend File system	resize2fs resize_reiserfs	Extending a file system is applicable to only some file system types.
Backup	tar cvf /dev/rst0 /	Create a backup of the root / file system.
Restore	tar xvf /dev/rst0	Restore the root / file system.
Prepare boot volumes	/sbin/lilo	It must be run after changing `/etc/lilo.conf` to push changes to boot loader.
Startup script	/etc/rc.d/rc	
Kernel	/boot/vmlinuz	
Kernel Bits	getconf WORD_BIT	POSIX call to get kernel information. There are many other variables besides `WORD_BIT`.

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Boot single user	{lilo} control-x linux S {grub} c kernel vmlinuz-2.4.9-13 **single** ro root=/dev/hda8 initrd /initrd-2.4.9-13.img boot	Use LILO facility. Use GRUB Boot Loader.
Time zone Management	/etc/sysconfig/clock	
SW Directory	/var/lib/rpm	This directory holds rpm databases.
Devices	/dev	This directory holds all the device files.
CPU	cat /proc/cpuinfo	Show CPU static information.
Whole Disk	/dev/sda	Device name
CDROM	/dev/cdrom	Usually mounted at /mnt/cdrom
CDROM file type	iso9660	
Floppy drive	/dev/fd0	Usually mounted at /mnt/floppy
System information	/proc	The /proc file system is a memory-based file system that allows access to process and kernel settings and statistics.
Compile and link a executable	make –f <file> <command>	Use a make file <file> to determine which parts of a large program need to be recompiled, and issue the commands required to compile, link, and prepare the executable for use.

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LVM	Linux (UnitedLinux)	Description/Comments
LVM	`Logical Volume Manager`	This package is not provided by Red Hat Enterprise Linux AS 2.1 and may not be added without tainting the kernel. Kernel support is provided in United Linux.
LVM Concepts	`logical extents`	A logical volume is made up of logical extents.
	`logical volume`	A set of logical extents taken from a volume group and presented to the OS as a disk volume. These extents may be striped across multiple disks.
	`volume group`	A set of physical disk partitions created by `fdisk` or the like, initialized with `pvcreate`, and then grouped into a physical volume with `vgcreate`.
Display volume group	`vgdisplay -v`	
Modify physical volume	`pvchange`	
Prepare physical disk	`pvcreate`	
List physical volume	`pvdisplay`	
Remove disk from volume group	`vgreduce`	
Move logical volumes to another physical volumes	`pvmove`	
Create volume group	`vgcreate`	
Remove volume group	`vgremove`	
Volume group availability	`vgchange`	
Restore volume group	`vgcfgrestore`	

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Exports volume group	`vgexport`	
Imports volume group	`vgimport`	
Volume group listing	`vgscan`	
Change logical volume characteristics	`lvchange`	
List logical volume	`lvdisplay`	
Make logical volume	`lvcreate`	
Extend logical volume	`lvextend`	
Reduce logical volume	`lvreduce`	
Remove logical volume	`lvremove`	
Create striped volumes	`lvcreate -i 3 -I 64`	

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Appendix D

Acronyms and Terms

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Term	Definition
Active session pool	Number of current active sessions allowed for a resource group or subplan
ADDM	Automatic Database Diagnostic Management
ADT	Abstract Data Type
ASCII	American Standard Code for Information Interchange
`US7ASCII`	7-bit American ASCII single-byte encoding scheme
ASM	Automatic Storage Management
ASM	Automatic Summary Management
ASMM	Automatic Shared Memory Management
ASSM	Automatic Segment Space Management
ATO	Automatic Tuning Optimizer
Automatic PGA Memory Management	A feature of the Oracle database that simplifies and improves the way PGA memory is allocated
Automatic Shared Memory Management	A feature of the Oracle database that automates the management of the most important shared memory structures used by an Oracle database instance
Automated Storage Management	Provides a vertical integration of the file system and the volume manager specifically built for the Oracle database files
Automatic Database Diagnostic Management	A utility that performs a top-down instance analysis, identifies problems and potential causes, and makes recommendations for fixing the problems
Automatic Tuning Optimizer	A database feature that performs various analyses of SQL performance within the database
Automatic Workload Repository	Collects, processes, and maintains performance statistics for problem detection and self-tuning purposes
Auxiliary database	Used when creating a duplicate database or performing tablespace point-in-time recovery
AWR	Automatic Workload Repository
Backup piece	An individual file that is part of a backup set
Backup set	A copy of one or more data or archived log files. It differs from image copies in that empty blocks are not stored.
BFT	Bigfile tablespace: a single data file can contain up to 4 billion blocks; maximum file size 8–128 TB (depending on Oracle data block size)
Block change tracking	Uses the change tracking writer (CTWR) background process to record the physical location of all database changes in a separate file
Block corruption	A corrupted data block is a block that is not in a recognized Oracle format, or whose contents are not internally consistent.
Block Media Recovery	A recovery method that reduces the smallest recoverable unit of media recovery from a data file to a block
BMR	Block Media Recovery
Buffer cache	A region of memory that caches blocks of data retrieved from the

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Term	Definition
	database
CFS	Cluster File Storage
Change tracking file	File used to store the physical location of database changes made since the last backup
Channel	A link or connection to a target database
CLI	Command-line interpreter
Cluster	A group of one or more tables that share the same data blocks
CMAN	Oracle Connection Manager; functions as a net traffic firewall and proxy server
Control file	Contains information about the physical structure of the database, including the locations of all data and redo log files
CRS	Cluster ready services
Data block	The smallest unit of physical storage within the database. Data blocks contain rows of data, index information, and so on.
Data dictionary cache	An area of memory within the shared pool that holds the definitions of dictionary objects in memory
Data file	Contains data for the database
Database Character Set Scanner	A utility that assesses the feasibility of migrating an Oracle database to a new database character set
DBA	Database administrator
DBA	Data block address, used to uniquely identify a data block within the database
DBCA	Database Configuration Assistant
DBVERIFY	An external command-line utility that performs a physical data structure integrity check on an offline database
DDL	Data definition language; the class of SQL statements that define and manipulate database objects
DML	Data Manipulation Language; the class of SQL statements that query and manipulate data
EBCDIC	Extended Binary Coded Decimal Interchange Code
EM	Enterprise Manager
`emctl`	Enterprise Manager Control. A utility for starting, stopping, and checking the status of Database Control, the Oracle Agent, and Oracle Management servers
Encoded character set	Maps numeric codes to characters that a computer or terminal can display and receive
Enterprise Manager Database Control Console	A graphical interface used to manage the database
ETL	Extraction, transformation, and loading
exabyte	1 EB = 1,024 PB = 1,048,576 TB = 2^{60} bytes
EXTPROC	External code libraries
FGA	Fine-grained auditing
FGAC	Fine-Grained Access Control enables you to use functions to implement security policies and to associate those security policies

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Term	Definition
	with tables, views, or synonyms. The database server automatically enforces your security policies, no matter how the data is accessed, including, for example, through an application by ad hoc queries.
Flash recovery area	A unified storage location for all recovery-related files and activities in an Oracle database
Flashback buffer	An area in memory that stores Flashback Database data
Flashback Database	A new recovery method that uses undo data, instead of redo data, to recover the database
Flashback Drop	A feature that enables you to undo the effects of a `DROP TABLE` statement without resorting to traditional point-in-time recovery
Flashback Table	A command that enables you to recover a table and all of its dependent objects from the recycle bin
Flashback Transaction Query	A diagnostic tool that you can use to view changes made to the database at the transaction level
Flashback Versions Query	Provides a history of changes made to a row along with the corresponding identifier of the transaction that made the change
Format mask elements	A character literal that describes the format of datetime or numeric data stored in a character string
Growth trend report	Analysis of the growth of database segments
Globalization support	Ensures that utilities and error messages, sort order, alphabet, calendar, date, time, money, and numbers automatically adapt to the native language
Image copy	A bit-for-bit identical copy of a database file
Incarnation	A separate version of a physical database. The incarnation of the database changes when you open it with the `RESETLOGS` option, but you can recover backups from a previous incarnation so long as the necessary redo is available.
Index-organized tables	A database structure that has the appearance of a table but stores its data in a B*Tree structure
`init.ora` or `init<sid>.ora`	Also known as “parameter file”
Instance	The collection of shared memory and processes used to access the Oracle database
IPC	Internal Process Communication
ISO	International Organization for Standards
`isqlplusctl`	Control utility for starting and stopping *i*SQL*Plus listener processes
ISV	Independent software vendor
Java pool	A region of memory in the SGA that is used for all session-specific Java code and data within the Java Virtual Machine (JVM)
JDBC	Java Database Connectivity
`j`*nnn*	Job Queue Processes. Execute scheduled jobs.
Keep buffer cache	An area of memory in the SGA used to cache data in the buffer cache for longer periods of time.

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Term	Definition
Language and Character Set File Scanner	A statistic-based utility for determining the language and character set for unknown file text
Large pool	An optional memory storage area used for buffering large I/O requests
LCSSCAN	Language and Character Set File Scanner
LEGATO® NetWorker, Single-Server Version	Software included with Oracle Database 10*g* that enables the Recovery Manager utility to write to tape drives
Library cache	An area of memory within the shared pool that contains the fully parsed or compiled representations of PL/SQL blocks and SQL statements
Linguistic sort	Produces a sort sequence that matches the alphabetic sequence of characters, and not their numeric values in the character-encoding scheme
Listener	The gateway to the Oracle instance for all nonlocal user connections
Locale	A collection of information about the linguistic and cultural preferences from a particular region
Locale variants	A language-dependent territory definition
LSSV	LEGATO® NetWorker, Single-Server Version
Media management library	Used by RMAN when writing to or reading from tapes
Memory Advisor	A feature of Enterprise Manager that helps you tune the size of your memory structures
Memory Manager (MMAN)	A database background process that serves as the SGA memory broker and coordinates the sizing of memory components
Metric	A measurement of some database or instance characteristic
MML	Media Management Library is used by RMAN when writing to or reading from tapes.
MMON	Management Monitor Process. It issues alerts whenever a metric violates its threshold value. It captures statistics for SQL objects that have been recently modified.
National language support	Parameters and files that determine the locale-specific behavior of the database client and the database server
*n*K block size buffer	A region of memory in the SGA, which caches data blocks that are of a different size than the default database block size; used to support transportable tablespaces
NLS	National language support
NLS Runtime Library	A comprehensive suite of language-independent functions that allow proper text and character processing and language-convention manipulations
NLS_LANG	An environment variable used to specify the language, territory, and character set used by a database
NLSRTL	National Language Support Runtime Library
NMP	Named Pipes
OC4J	Oracle Application Server Containers for J2EE

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Term	Definition
OMF	Oracle Managed Files
Optimizer statistics	Statistics that describe the database and the objects in the database and are used by the query optimizer to choose the best execution plan for each SQL statement
OUI	Oracle Universal Installer
Oracle Locale Builder	Provides a graphical user interface through which you can easily view, modify, and define locale-specific data
Oracle Managed Files	A feature of the Oracle database, which manages the creation, naming, and deletion of Oracle database files within dedicated areas of the disk
Oracle Net	Enables network connections between Oracle Database 10*g* and client- or middle-tier applications
Oracle Shared Server	A database server configuration that allows many user processes to share a small number of server processes, minimizing the number of server processes and maximizing the use of available system resources
`ORACLE_BASE`	Environment variable used to point to the base of the OFA structure
`ORACLE_HOME`	Environment variable used to identify a directory containing the Oracle software
`ORACLE_SID`	Environment variable used to specify the default database instance name
Package	A collection of procedures and function definitions that are logically related. The procedures and functions are implemented by the package body.
Parallelization	Allocating multiple channels for RMAN backup and recovery operations
PGA	Program Global Area
PGA Advisor	A feature of Enterprise Manager that gives detailed statistics for the work areas and provides recommendations about optimal usage of Program Global Area (PGA) memory on the basis of workload characteristics
Pipe	An area of memory used by one process to pass information to another
Private SQL area	An area of memory in the PGA that contains data such as bind information and run-time memory structures
Privilege	The right to execute a particular type of SQL statement. There are two basic forms of privileges: object and system.
Proactive Tablespace Monitoring	A feature of Oracle Database 10*g* that manages tablespace disk space usage
Program Global Area	Private memory area for use by a process
Recovery catalog	A separate database that keeps historical data concerning backup activities
Recovery Manager	The Oracle utility used to back up and restore database files
Recycle bin	A data dictionary table that maintains the relationships between the

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Term	Definition
	original names of dropped objects and their system-generated names
Recycle buffer cache	A region of memory in the SGA, which holds data that is quickly aged out of the buffer cache
Redo log buffer	A region of memory that caches redo information until it can be written to the disk
Redo Log File Sizing Advisor	A feature of Enterprise Manager that offers redo log file–sizing advice
Resource Manager	A feature of the Oracle database that gives the Oracle database server more control over resource management decisions, thus circumventing problems resulting from inefficient operating system–management
Resumable space allocation	A means for suspending, and later resuming, the execution of large database operations in the event of space allocation failures
RMAN	Recovery Manager
RMAN Repository	A storage structure that maintains metadata about a database's backup and recovery operations
Scheduler	A new database feature that enables database administrators and application developers to control when and where various tasks take place in the database environment
SCN	System Change Number
Segment Advisor	Monitors object space issues and analyzes growth trends
Segment Resource Estimator	The new segment resource estimation feature enables you to estimate the amount of resources that the creation of a new segment would require.
Server sessions	The server processes (UNIX) or threads (Windows NT/2000) invoked by a client utility to connect to the target database
Service	Exists on many levels of the database (Part of RAC functionality for workload management: A service renders the machine on which an application is running transparent to the application itself.)
Session memory	Memory in the PGA that is allocated to hold session variables and other information related to the session
SGA	System Global Area; Memory area shared by all server and background processes
SGA Advisor	Makes recommendations for SGA parameter settings
Shared pool	A region of memory that caches various constructs that can be shared among users
Shrink Advisor	See the Segment Advisor.
SID	System Identifier. It defaults to the database name and uniquely identifies the instance on a given server.
SQL	Structured query language
SQL Access Advisor	Determines optimal data access path (for example, the use of indexes and materialized views)
SQL Tuning Advisor	Provides tuning advice for SQL statements

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Term	Definition
Statspack	A set of SQL, PL/SQL, and SQL*Plus scripts that allow the collection, automation, storage, and viewing of performance data. This feature has been replaced by the Automatic Workload Repository.
Streams pool	An optional region of memory in the SGA that is used by Oracle Streams
System statistics	Statistics that describe the system's hardware characteristics, such as I/O and CPU performance and utilization, to the query optimizer
Tablespace	A logical grouping of data files
Target database	The database that you are attempting to connect to
Threshold	A boundary value against which metric values are compared
TSPITR	Tablespace point-in-time recovery uses an auxiliary database that can reside on the same or a different host than the target database.
Undo Advisor	A feature of Enterprise Manager that suggests parameter values and the amount of additional space that is needed to support flashback for a specified time
Undo data	A copy of original data stored whenever a DML transaction changes data. Undo data is used to roll back a transaction and to provide read-consistent views of changing data.
User Global Area	An area of memory within the shared pool or large pool that contains the session information for the Oracle shared server sessions
UTC	Universal Time Coordinates, a global time stamp in the Uniform Audit Trail
VPD	Virtual Private Database
Wait event	Statistics that are incremented by a server process or thread to indicate that the process had to wait for an event to complete before being able to continue processing
Work area	A private allocation of memory in the PGA, used for sorts, hash joins, and other operations that are memory intensive
Workload repository	See AWR.

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E

Oracle Shared Servers

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Objectives

After completing this lesson, you should be able to do the following:

- Identify when to use Oracle Shared Servers
- Configure Oracle Shared Servers
- Monitor shared servers

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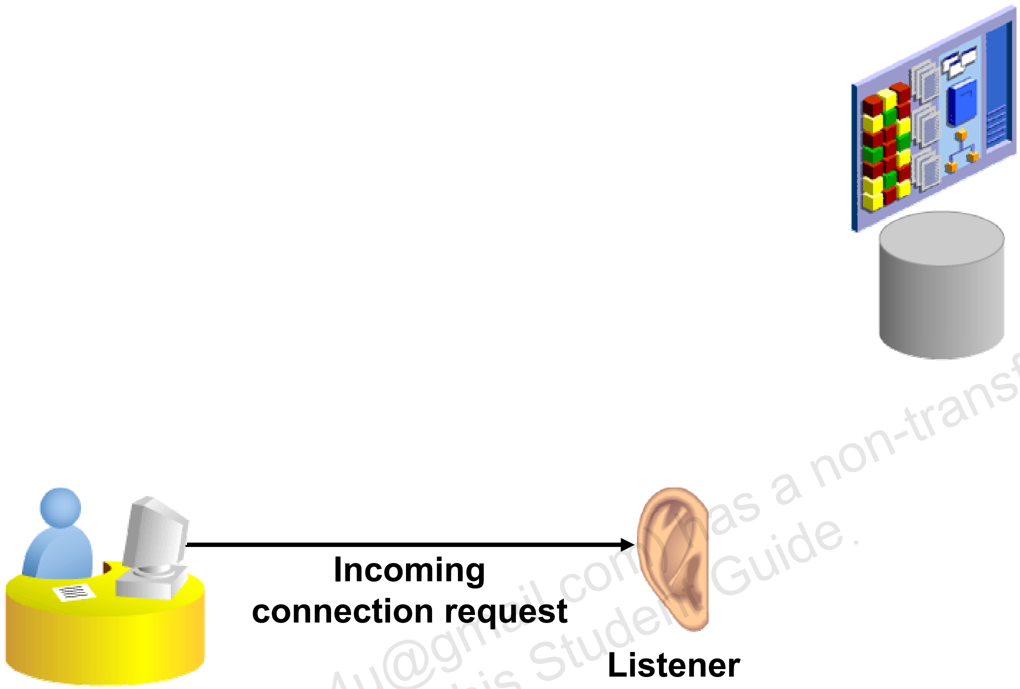
Establishing a Connection



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Establishing a Connection

After Oracle Net names resolution is complete, a connection request is passed from the user or middle-tier application (referred to as the user process from here on) to the Oracle Net Listener. The listener receives a `CONNECT` packet and checks to see whether that `CONNECT` packet is requesting a valid Oracle Net service name.

If the service name is not requested (as in the case of a `TNSPING` request), the listener acknowledges the connect request and does nothing else. If an invalid service name is requested, the listener transmits an error code to the user process.

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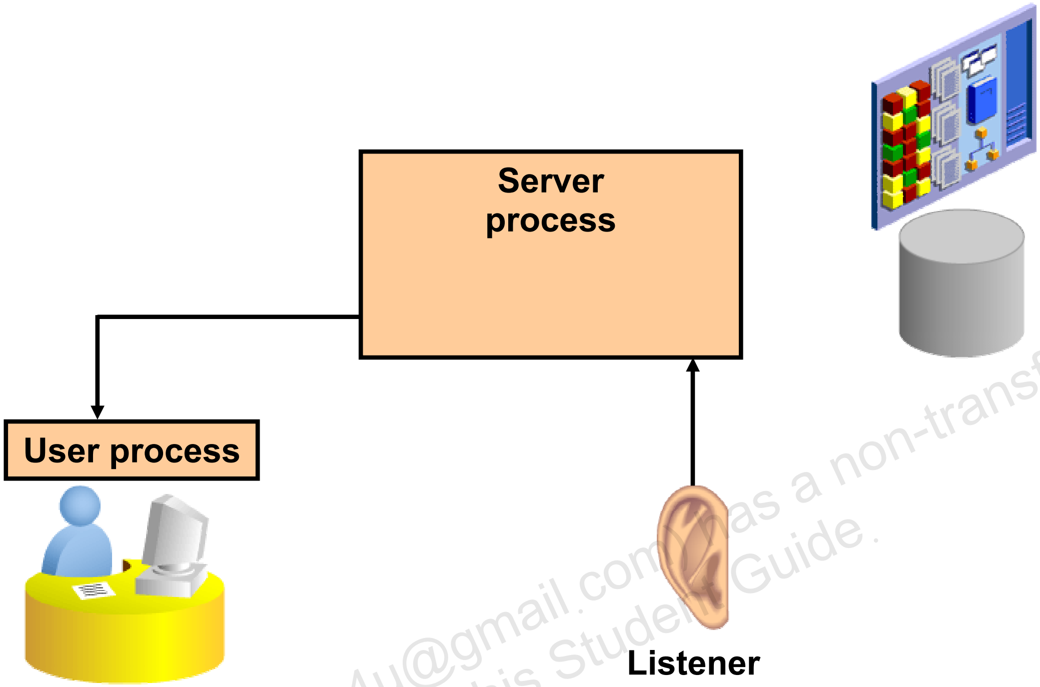
Dedicated Server Process



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Dedicated Server Process

If the CONNECT packet requests a valid service name, the listener spawns a new process to deal with the connection. This new process is known as the "server process" and is sometimes also referred to as the "shadow process." After the process has been spawned, the listener connects to the process and passes it initialization information, including the address information for the user process. At this point, the listener no longer deals with the connection and all work is handed off to the server process.

The server process now transmits a RESEND packet back to the user process.

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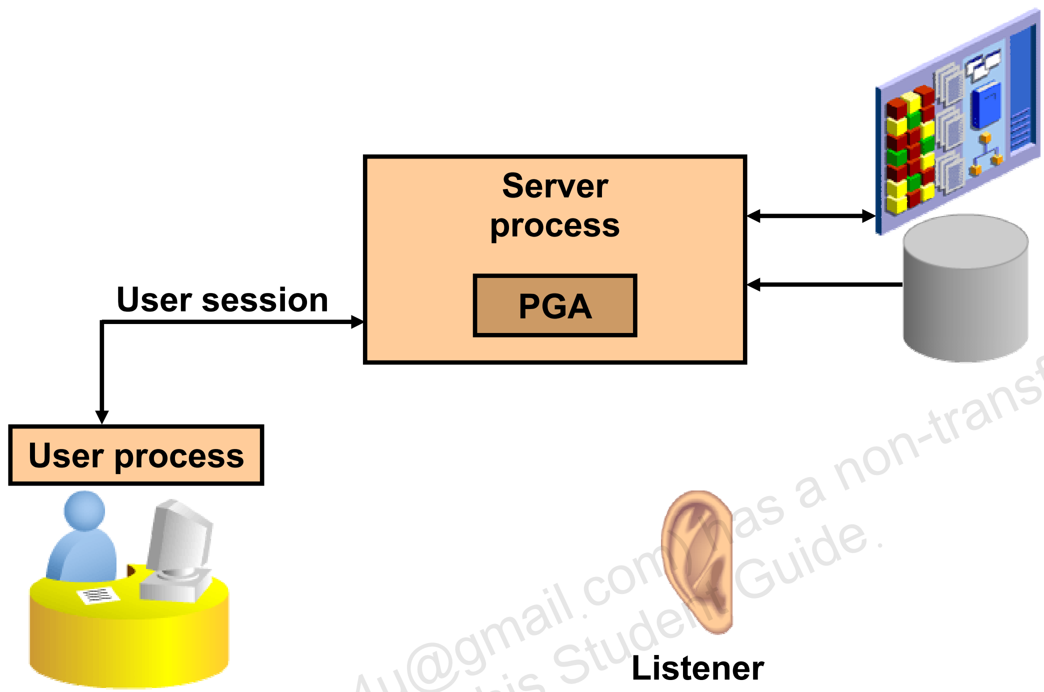
User Sessions



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User Sessions

After the user process receives the RESEND packet, it retransmits the CONNECT packet. The server process checks the user's authentication credentials (usually a password) and if the credentials are valid, a user session is created.

Dedicated server process: With the session established, the server process now acts as the user's agent on the server. The server process is responsible for:

- Parsing and running any SQL statements issued through the application
- Checking the database buffer cache for data blocks required to perform SQL statements
- Reading necessary data blocks from data files on disk into the database buffer cache portion of the SGA, if the blocks are not already present in the SGA
- Managing all sort activity. A portion of the server process called the Program Global Area (PGA) contains a memory area known as the Sort Area that is used to work with sorting.
- Returning results to the user process in such a way that the application can process the information

Server processes also reserve memory for specialized work such as bitmap and hash joins. The amount of memory consumed by the dedicated server process depends on several initialization parameter settings. It can be automatically controlled through the use of `PGA_AGGREGATE_TARGET` and `WORKAREA_SIZE_POLICY` or fined-tuned if needed for advanced use.

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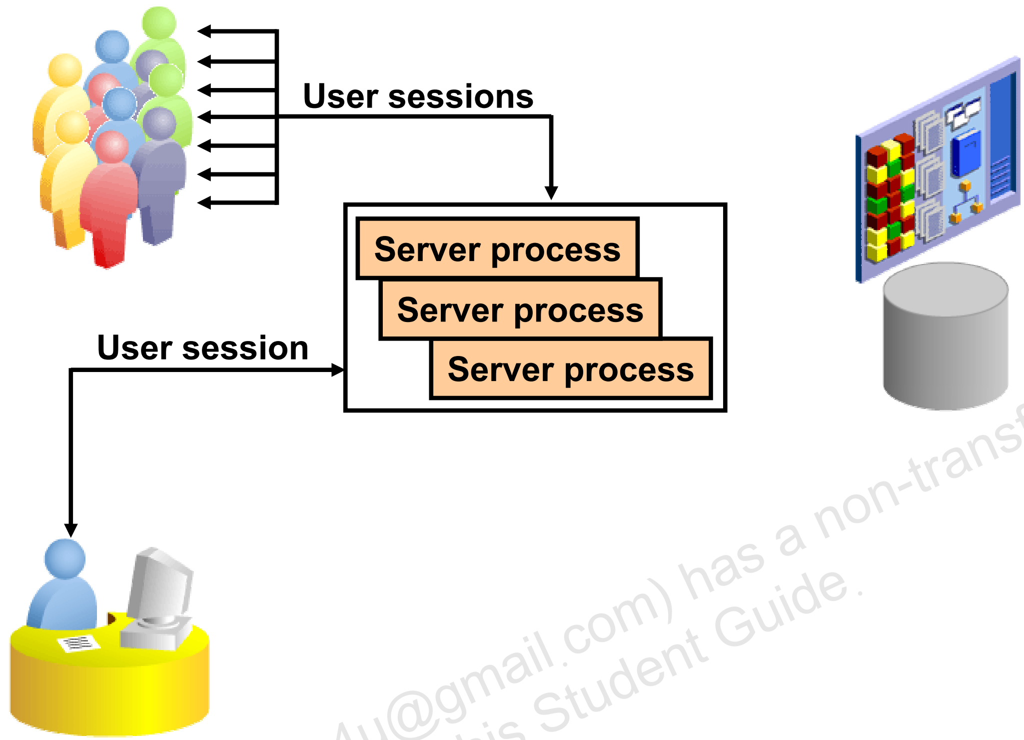
User Sessions: Dedicated Server



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User Sessions: Dedicated Server

With dedicated server processes, there is a one-to-one ratio between server processes and user processes. Each server process consumes system resources including CPU cycles and memory.

In a heavily loaded system, the memory and CPU resources consumed by dedicated server processes can be prohibitive and negatively affect the system's scalability. If your system is being negatively impacted by the resource demands of the dedicated server architecture, you have two options:

- Increase system resources by adding more memory and additional CPU capability.
- Use the Oracle Shared Server architecture.

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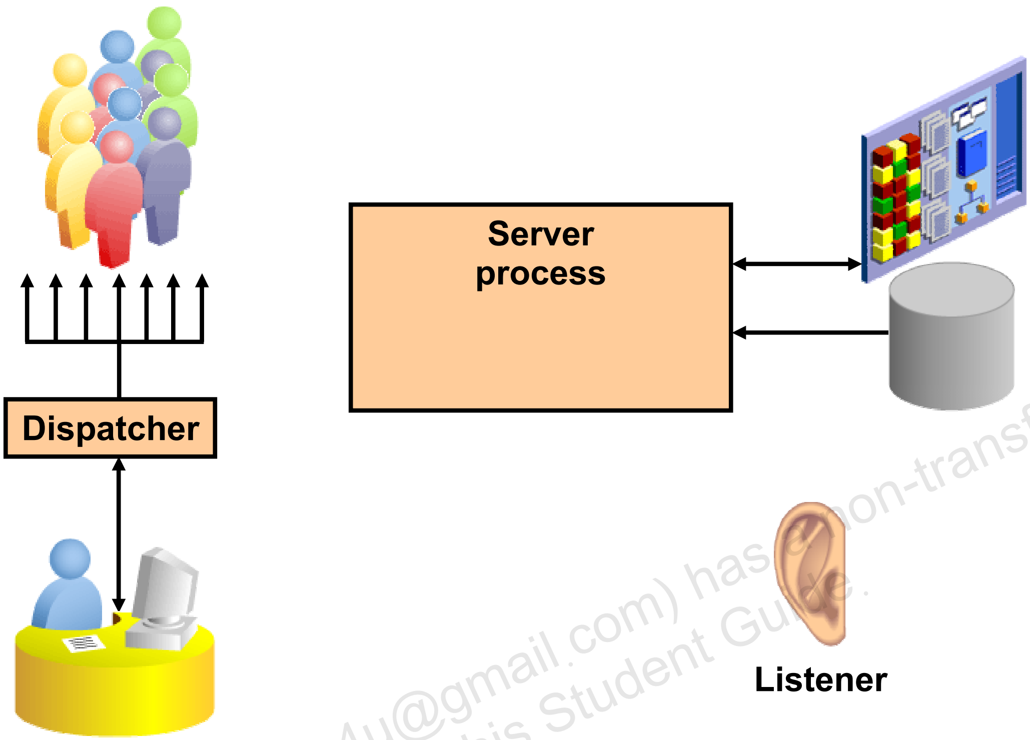
User Sessions: Shared Server



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User Sessions: Shared Server

Each service that participates in the shared server architecture has at least one (and usually more) dispatcher process. When a connection request arrives, the listener does not spawn a dedicated server process. Instead, the listener maintains a list of dispatchers available for each service name, along with the connection load (number of concurrent connections) for each dispatcher.

Connection requests are routed to the lightest loaded dispatcher that is servicing a given service name. Users remain connected to the same dispatcher for the duration of a session.

Unlike dedicated server processes, a single dispatcher can manage hundreds of user sessions.

Dispatchers do not actually handle the work of user requests. Instead they pass user requests to a common queue located in the shared pool portion of the SGA.

Shared server processes take over most of the work of dedicated server processes, pulling requests from the queue and processing them until complete.

Because a single user session may have requests processed by multiple shared server processes, most of the memory structures usually stored in the Program Global Area (PGA) must be in a shared memory location. In a shared server architecture, most of these memory areas are stored in the large pool portion of the SGA.

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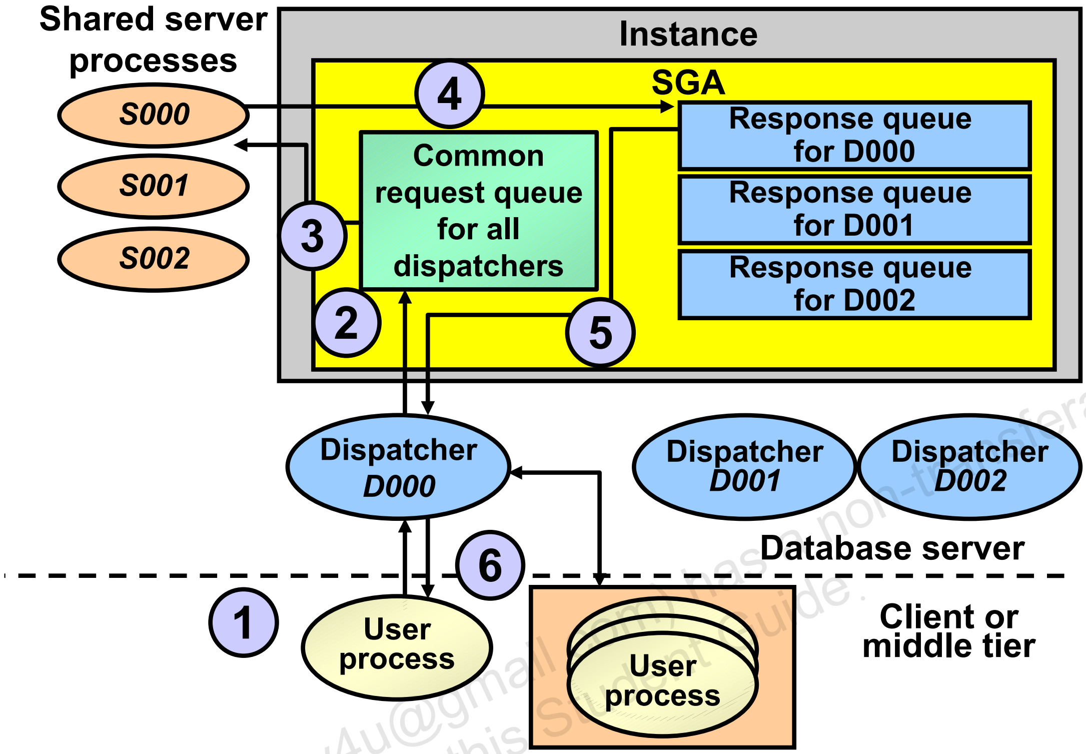
Processing a Request



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Processing a Request

When a user connects through the shared server architecture and submits a database request, the following take place:

1. The user process forwards the request to its dispatcher.
2. The dispatcher places the request into the common request queue in the SGA.
3. The next available shared server picks up the request from the request queue and processes the request.
4. The shared server places the response on the calling dispatcher's response queue. Each dispatcher has its own response queue.
5. The dispatcher retrieves the response from its response queue.
6. The dispatcher returns the response to the user.

After the user call has been completed, the shared server process is released and is available to service another user call in the request queue.

Request Queue

- One request queue is shared by all dispatchers.
- Shared servers monitor the request queue for new requests.
- Requests are processed on a first-in, first-out (FIFO) basis. There is no priority setting.

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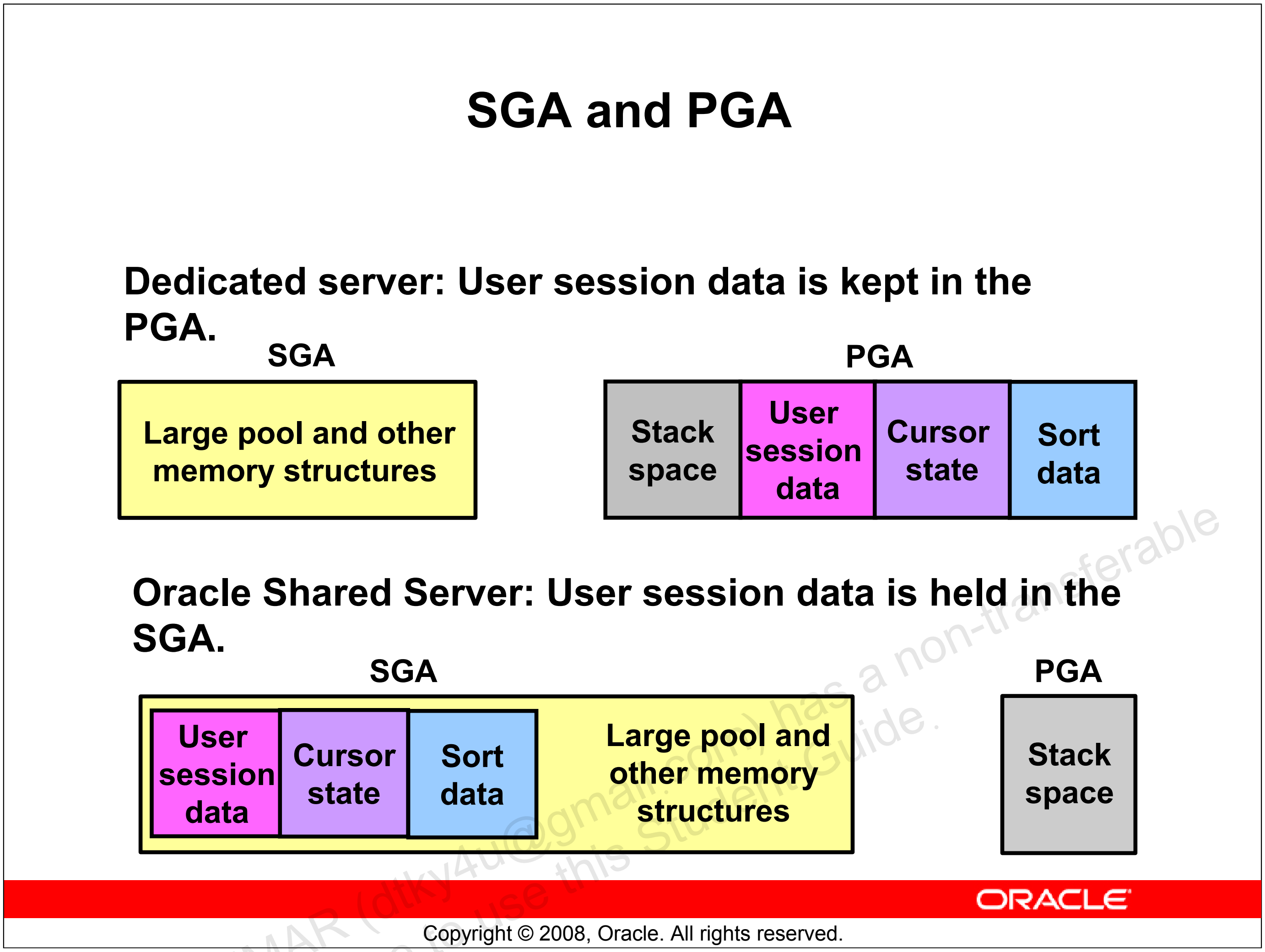
SGA and PGA



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SGA and PGA

The contents of the SGA and the PGA differ when dedicated servers or shared servers are used:

- Text and parsed forms of all SQL statements are stored in the SGA.
- The cursor state contains run-time memory values for the SQL statement, such as rows retrieved.
- User-session data includes security and resource usage information.
- The stack space contains local variables for the process.

Technical Note

The change in the SGA and the PGA is transparent to the user; however, if you are supporting multiple users, you need to increase the `LARGE_POOL_SIZE` initialization parameter. Each shared server process must access the data spaces of all sessions so that any server can handle requests from any session. Space is allocated in the SGA for each session's data space. You can limit the amount of space that a session can allocate by setting the `PRIVATE_SGA` resource limit in the Database Services region of the General page of the user's profile.

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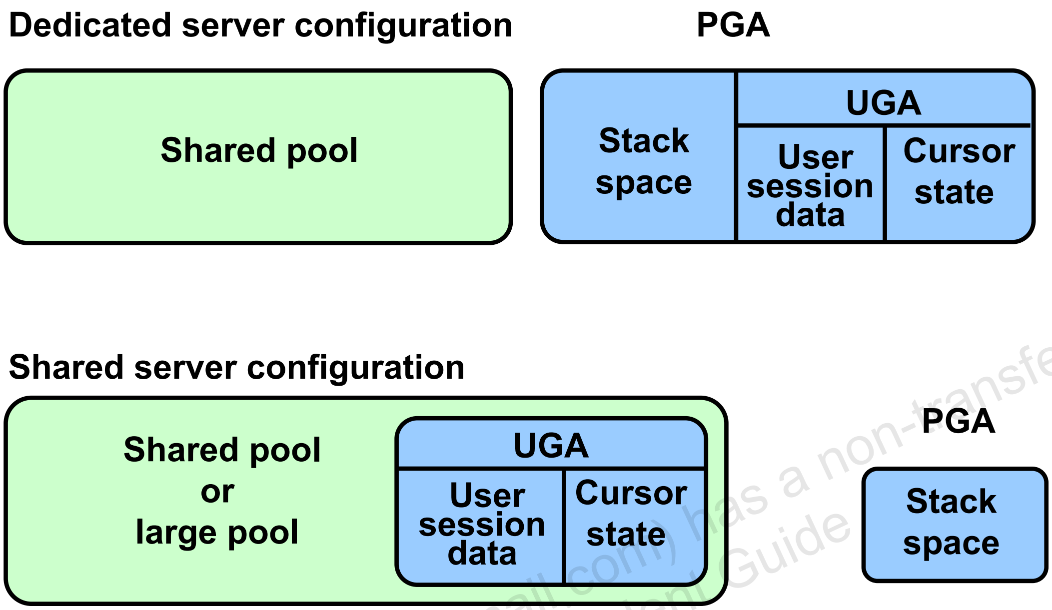
UGA and Oracle Shared Server



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UGA and Oracle Shared Server

When you use a dedicated server configuration, the User Global Area (UGA) does not use any memory within the SGA. If you use Oracle Shared Server, then the UGA (which includes the user session and cursor state information) is stored in the shared pool instead of in private user memory. If a large pool has not been configured, then the UGA is stored in the shared pool. Sort areas and private SQL areas are included in the session information. This is because shared servers work on a per-call basis, so any server process may need access to any user's information.

The total memory requirement for Oracle Shared Server is no larger than if you use dedicated servers. You may need to increase the `SHARED_POOL_SIZE` parameter but your private user memory is lower.

If you are using shared servers, configure the large pool for better shared pool performance.

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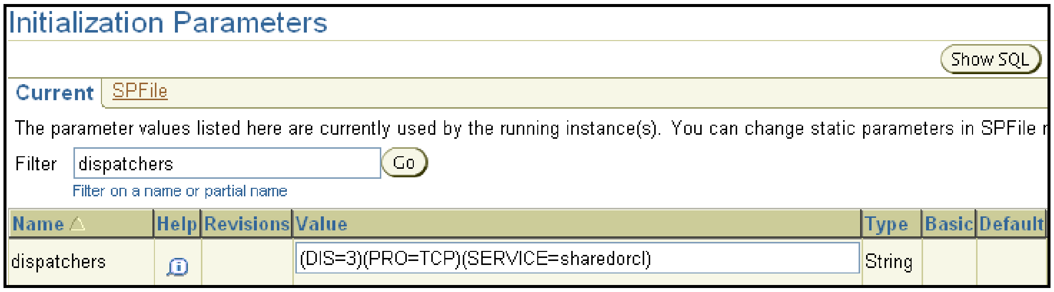
Configuring Oracle Shared Server



Required parameter

- **DISPATCHERS**

Optional parameters

- **SHARED_SERVERS**
- **MAX_SHARED_SERVERS**
- **CIRCUITS**
- **SHARED_SERVER_SESSIONS**

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Configuring Oracle Shared Server

To configure Oracle Shared Server, you must edit the initialization parameters for your instance. Most of the optional parameters have sensible defaults. On many systems, the only parameter that must be configured is `DISPATCHERS`.

Depending on the options selected when you created your database, the `DISPATCHERS` parameter may already be configured to start one dispatcher to service the XML database. The `DISPATCHERS` parameter accepts multiple sets of values in the format:

```
'<parameters for first set>','<parameters for second set>'
```


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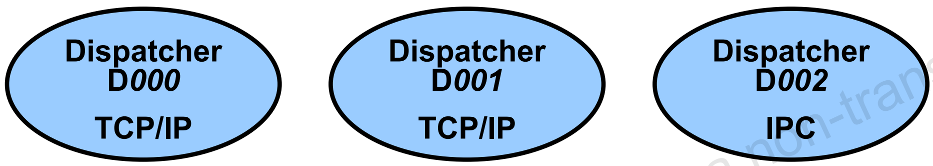
DISPATCHERS

Specifies the number of dispatchers that are initially started for a given protocol:

```
DISPATCHERS = "(PROTOCOL=TCP)(DISPATCHERS=2)\
                (PROTOCOL=IPC)(DISPATCHERS=1)"
```



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DISPATCHERS

The `DISPATCHERS` parameter enables various attributes for each dispatcher.

Oracle Database10*g* supports a name-value syntax (similar to the syntax used by Oracle Net Services) to enable the specification of existing and additional attributes in a position-independent, non-case-sensitive manner.

For example: `DISPATCHERS = '(PROTOCOL=TCP)(DISPATCHERS=3)'`

Parameter type	String (specify as a quoted string)
Parameter class:	Dynamic
Default value:	Null (no dispatchers will be started)

Although the number of connections a dispatcher can handle varies greatly depending on the type of workload, a good measure to use is to allow one dispatcher per every fifty concurrent database connections that use the shared server architecture.

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DISPATCHERS (continued)

The only required dispatcher attribute is PROTCOL. All others are optional. A few of the possible arguments for the DISPATCHERS parameter are described below. Notice that arguments use a three-letter abbreviation instead of the full argument name.

Attribute	Description
PROTOCOL (PRO or PROT)	Specifies the network protocol for which the dispatcher generates a listening endpoint (usually TCP)
DISPATCHERS (DIS or DISP)	The initial number of dispatchers to start (default is 1)
SERVICE (SER or SERV)	The Oracle Net Service name the dispatcher registers with the listener. If not given, the dispatcher registers the values in SERVICE_NAMES.
LISTENER (LIS or LIST)	Specifies an alias name for the listeners with which the PMON process registers dispatcher information. Set the alias to a name which is resolved through a naming method. This attribute need be specified only if the listener is a local listener that uses a nondefault port (not 1521) and is not specified with the LOCAL_LISTENER parameter *or* the listener is on another node.
SESSIONS (SES or SESS)	The maximum number of network sessions for each dispatcher. The default is operating system specific. Most operating systems have a default of 16 K.
CONNECTIONS (CON or CONN)	Specifies the maximum number of network connections to allow for each dispatcher. The default is operating system specific. For example, 1024 is the default for Sun Solaris and Windows.

Note: There are many more possible attributes for the DISPATCHERS parameter. Further details on the DISPATCHERS parameter can be found in the "Initialization Parameters" section in the *Oracle Database Reference Manual*.

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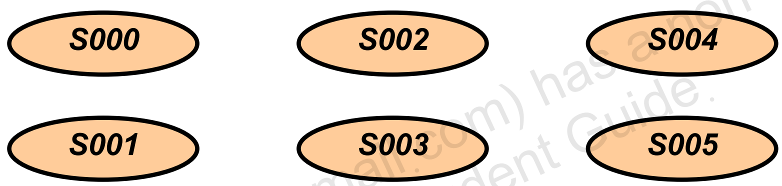
SHARED_SERVERS

Specifies the number of shared server processes created when an instance is started up, and retained during instance operation

```
SHARED_SERVERS = 6
```



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SHARED_SERVERS

SHARED_SERVERS specifies the minimum number of server processes that will be retained. Setting this parameter is not usually critical because the instance monitors the Common Request Queue and will start additional shared servers as needed to serve the queue, and then dispose of them when no longer needed.

Parameter type	Integer
Parameter class	Dynamic
Default value	0 if DISPATCHERS is NULL, 1 if DISPATCHERS is set
Range of values	Operating system dependent

A good measure to use is to retain one shared server for every twenty-five concurrent database connections using the shared server architecture.

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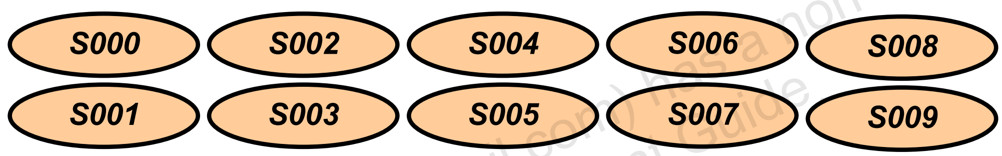
MAX_SHARED_SERVERS

- Specifies the maximum number of shared servers that can be started
- Allows shared servers to be allocated dynamically on the basis of the length of the request queue

```
MAX_SHARED_SERVERS = 10
```



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MAX_SHARED_SERVERS

MAX_SHARED_SERVERS specifies the maximum number of shared server processes that will be allowed to run simultaneously. The setting is important because the instance automatically creates additional shared server processes as needed to service the common request queue.

Parameter type	Integer
Parameter class	Dynamic
Default value	None (unlimited)
Range of values	Operating system dependent

Estimating the Maximum Number of Shared Servers

In general, set this parameter for an appropriate number of shared server processes at times of highest activity. Experiment with this limit, and monitor shared servers to determine an ideal setting for this parameter. To find the maximum numbers of servers started (high-water mark), query the V$SHARED_SERVER_MONITOR data dictionary view.

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CIRCUITS

- **Specifies the total number of virtual circuits that are available for inbound and outbound network sessions**
- **Contributes to total SGA size**

```
CIRCUITS = 100
```

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CIRCUITS

Virtual circuits are user connections to the database through dispatchers and servers. The `CIRCUITS` parameter specifies the total number of virtual circuits that are available for inbound and outbound network sessions.

Parameter type	Integer
Parameter class	Dynamic
Default value	If Oracle Shared Server is configured, then the value of `CIRCUITS` matches that of `SESSIONS`. Otherwise, the value is 0.

Set this parameter only if you want to limit the total number of connections that users can make via the shared server architecture. This parameter is of interest because it is one of several parameters that contribute to the total SGA requirements of an instance.

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SHARED_SERVER_SESSIONS

- Specifies the total number of Oracle Shared Server user sessions to allow
- Enables you to reserve user sessions for dedicated servers

```
SHARED_SERVER_SESSIONS = 100
```

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SHARED_SERVER_SESSIONS

This parameter controls the total number of shared server sessions open concurrently at any point in time. The use of this parameter allows resources for dedicated user sessions to be reserved.

Parameter type	Integer
Parameter class	Dynamic
Default value	None (unlimited)

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Related Parameters

Other initialization parameters affected by Oracle Shared Server that may require adjustment:

- `LARGE_POOL_SIZE`
- `SESSIONS`
- `PROCESSES`
- `LOCAL_LISTENER`

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Related Parameters

Other parameters affected by Oracle Shared Server that may require adjustment:

- `LARGE_POOL_SIZE` specifies the size in bytes of the large pool. Oracle Shared Server uses the large pool to store session information that usually resides in the PGA in a dedicate server session.
- `SESSIONS` specifies the maximum number of sessions that can be created in the system. This may need to be adjusted for Oracle Shared Server because your system can now service more sessions.
- `PROCESSES` controls the number of server-side processes.
- `LOCAL_LISTENER` defines the port and protocol used by the listeners. If your listener is not using TCP/IP on port 1521, or if you have multiple listeners, you must configure `LOCAL_LISTENER` so the dispatchers can register with the listeners.

If you do not set a value for `LARGE_POOL_SIZE`, then the Oracle database uses the shared pool for Oracle Shared Server user session memory. This can negatively impact the performance of PL/SQL, SQL, and other services that rely on the shared pool.

The Oracle database allocates some fixed amount of memory (about 10 KB) per configured session from the shared pool, even if you have configured the large pool.

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Verifying Shared Server Setup

- Verify that the dispatcher has registered with the listener when the database is started by issuing:

```
$ lsnrctl SERVICES
```

- Verify that you are connected using shared servers by making a connection and then query the `V$CIRCUIT` view to show one entry per shared server connection.

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Verifying Shared Server Setup

When using Oracle Shared Server, you should first start the listener and then the database so that the dispatchers can immediately register with the listener. If you later restart the listener, allow one minute for services to reregister. To verify that registration has taken place, issue the following command:

```
$ lsnrctl services
Service "TEST" has 1 instance(s).
Instance "TEST", status READY, has 3 handler(s) for this service.
 Handler(s):
"DISPATCHER" established:1 refused:0 curr:0 max:1022 state:ready
   D001 <machine: db.us.oracle.com, pid: 8705>
   (ADDRESS=(PROTOCOL=tcp)(HOST=db.us.oracle.com)(PORT=35230))
"DISPATCHER" established:1 refused:0 curr:0 max:1022 state:ready
   D000 <machine: db.us.oracle.com, pid: 8703>
   (ADDRESS=(PROTOCOL=tcp)(HOST=db.us.oracle.com)(PORT=35229))
"DEDICATED" established:0 refused:0
```


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Verifying Shared Server Setup (continued)

Verify that your connections are using shared servers by making connections, and then query the `V$CIRCUIT` view to show one entry per shared server connection. This also verifies that the listener is performing load-balancing for incoming connections.

```
SQL>select dispatcher, circuit, server, status from v$circuit;

DISPATCH CIRCUIT  SERVER   STATUS
-------- -------- -------- ----------------
82890064 8257BA64 8288F6A4 NORMAL
8288F9E4 8257BBB0 00       NORMAL
8288FD24 8257BCFC 00       NORMAL
```

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Data Dictionary Views

- **V$CIRCUIT**
- **V$SHARED_SERVER**
- **V$DISPATCHER**
- **V$SHARED_SERVER_MONITOR**
- **V$QUEUE**
- **V$SESSION**

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Data Dictionary Views

`V$CIRCUIT`	This view contains information about virtual circuits, which are user connections to the database through dispatchers and servers. Any shared server connection creates an entry in `V$CIRCUIT`.
`V$SHARED_SERVER`	This view contains information about the shared server processes.
`V$DISPATCHER`	This view provides information about the dispatcher processes.
`V$SHARED_SERVER_MONITOR`	This view contains information for tuning the shared server processes.
`V$QUEUE`	This view contains information about request and response queues.
`V$SESSION`	This view lists session information for each current session.

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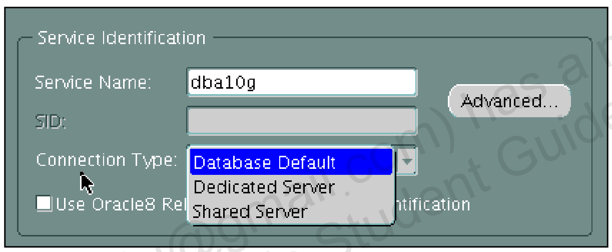
Choosing a Connection Type

Unless otherwise configured, Oracle Net connections use:

- **Shared server if one is available**
- **Dedicated server if a shared server connection is not available**

Using local or directory naming, the connection type can be specified as part of the Net service alias.



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Choosing a Connection Type

Oracle Net's default connection type is the shared server connection. If the instance has been configured for a shared server and a connect request does not specifically ask for a dedicated server, then the connection type is shared.

The Oracle Net Manager allows the connection type to be specified for both local naming and directory naming. Select the desired `Connection Type` from the drop-down list.

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When Not to Use Shared Server

Certain types of database work should not be performed using shared servers:

- **Database administration**
- **Backup and recovery operations**
- **Batch processing and bulk load operations**
- **Data warehouse operations**

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When Not to Use Shared Server

The Oracle Shared Server architecture is an efficient process and memory use model, but is not appropriate for all connections. Because of the common request queue, and the fact that many users may share a dispatcher response queue, shared servers do not perform well with operations that must deal with large sets of data such as warehouse queries or batch processing.

Backup and recovery sessions using Oracle Recovery Manager (discussed in later chapters) also deal with very large data sets and should make use of dedicated connections.

Many administration tasks cannot or should not be performed using shared server connections. These include startup and shutdown of the instance, creating tablespaces or data files, index and table maintenance, analyzing statistics, and many other tasks commonly performed by the DBA. All DBA sessions should choose dedicated servers.

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Summary

In this lesson, you should have learned how to:
- Identify when to use Oracle Shared Servers
- Configure Oracle Shared Servers
- Monitor shared servers

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F

Oracle Secure Backup

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Objectives

After completing this lesson, you should be able to do the following:

- Describe the Oracle Secure Backup architecture and how it benefits your environment
- Discuss the basic Oracle Secure Backup media management concepts
- Install and configure Oracle Secure Backup
- Use RMAN and Oracle Secure Backup to back up and restore the Oracle database
- Use Oracle Secure Backup to back up and restore file system files

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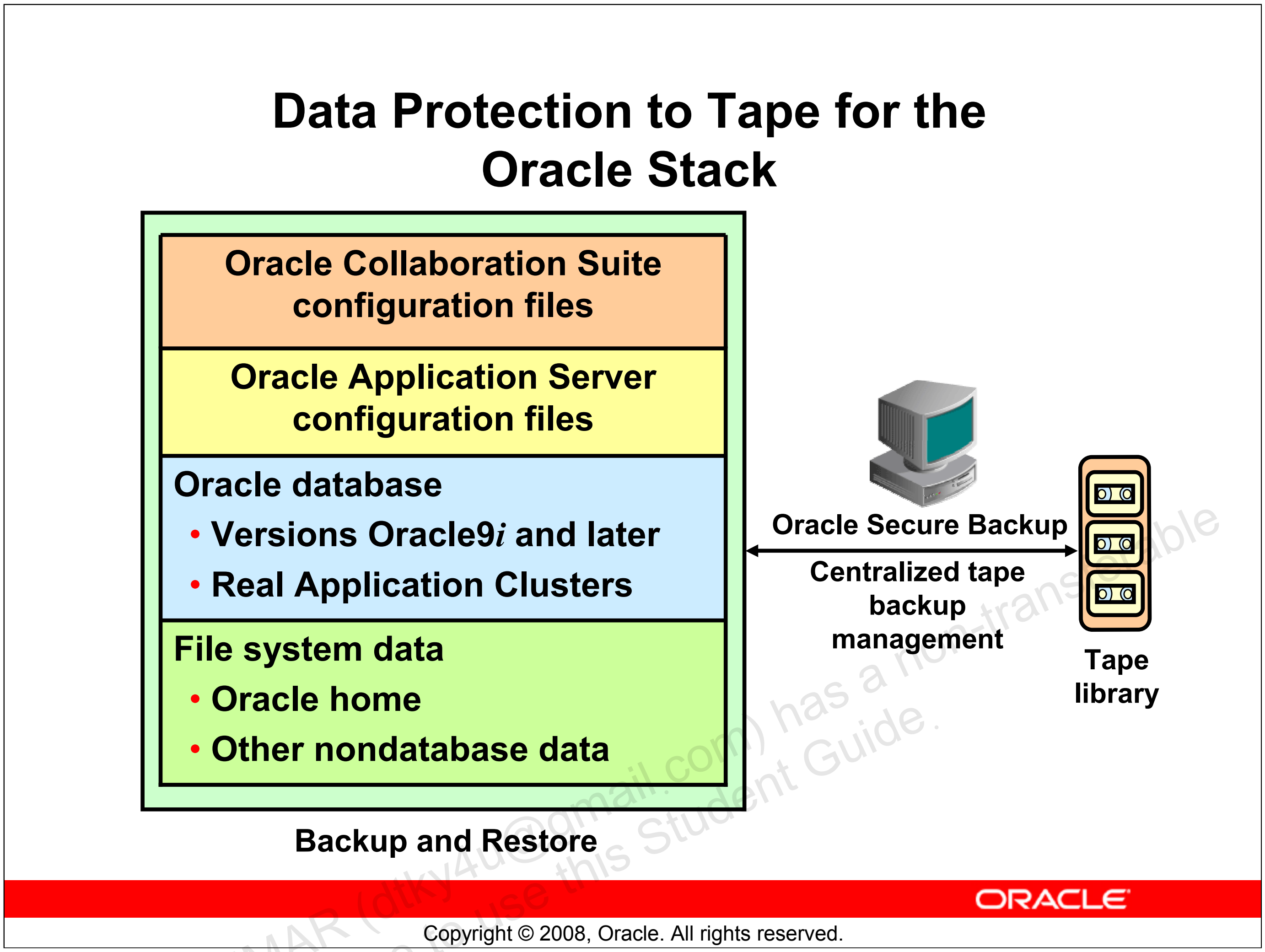

Data Protection to Tape for the Oracle Stack

Some of the options available for protecting your Oracle data are: backing up solely to disk, backing up to disk as a staging area for tape backups, or backing up directly to tape. Disk backup and restore operations are generally faster than those of tape. However, tape backups provide some advantages for long-term backup requirements, off-site storage, and portability to move backups from one data center to another.

Oracle Secure Backup provides tape backup management for the Oracle ecosystem, which includes:

- Oracle database protection to tape through integration with Recovery Manager
- Seamless support of Oracle Real Application Clusters (RAC)
- Central administration of distributed clients and media servers including:
  - Oracle Application Servers
  - Oracle Collaboration Suites
  - Oracle home and binaries

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The Customer Advantage: Complete Oracle Solution

- Oracle Secure Backup and RMAN provide an end-to-end backup solution for Oracle environments
  - Centralized backup management to tape for file system data and the Oracle database
  - Most well-integrated media management layer for RMAN backups
  - Backup of any data anywhere on the network
- A single technical support resource for the entire backup solution expedites problem resolution.
- This ensures reliable data protection at a lower cost and complexity.

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The Customer Advantage: Complete Oracle Solution

Oracle's current backup and recovery product for the database is Recovery Manager (RMAN), a utility that has been part of the Oracle server since Oracle 8.0. Oracle Secure Backup complements the existing functionality in the following ways:

- **Complete backup solution:** Oracle Secure Backup provides data protection for the database and nondatabase data to protect the whole Oracle environment.
- **Media management:** Oracle Secure Backup provides the media management layer for RMAN database backups to tape. Before Oracle Secure Backup, customers had to purchase expensive third-party media management products offering integration with RMAN tape backups.
- **Anywhere on the network:** Oracle Secure Backup backs up data from multiple network-attached computer systems to tertiary storage resources on the network. Oracle Secure Backup supports diverse configurations of servers, clients, Network Attached Storage (NAS) servers, and tertiary storage devices and protects network storage environments.

The combination of RMAN and Oracle Secure Backup provides an end-to-end backup solution, entirely within the Oracle product stack. This allows for better customer support because Oracle Corporation is responsible for the entire backup solution.

Oracle Corporation provides customers with the highest levels of data protection at the lowest possible cost.

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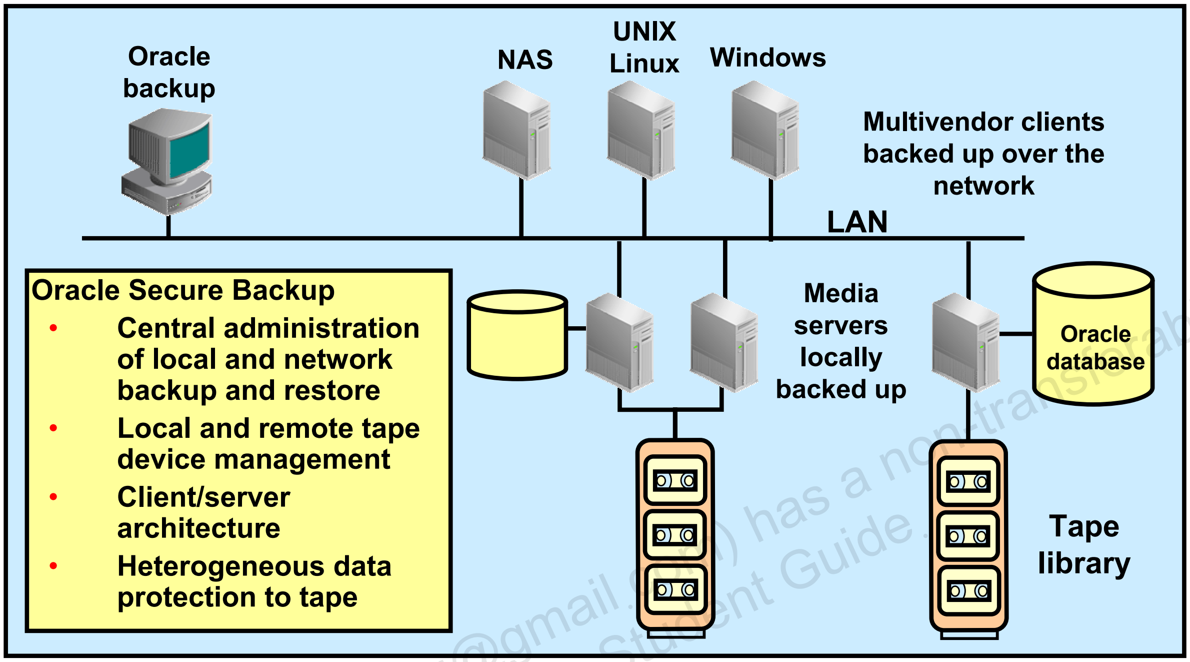
Oracle Secure Backup for Centralized Tape Backup Management



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Oracle Secure Backup for Centralized Tape Backup Management

The Oracle Secure Backup software offers centralized backup management of heterogeneous clients and servers through a single point of administration called the Oracle Secure Backup Administrative Server. Through a central console that uses a consolidated backup catalog, you can easily manage backup policies, schedule backups for multiple platforms, and manage local and remote tape devices. The configured machines and devices managed by an administrative server make up the Oracle Secure Backup Administrative Domain as shown in the slide.

The Oracle Secure Backup tape management system minimizes the complexity of managing diverse architectures and provides:

- Unified heterogeneous data protection for multiple platforms including UNIX (HP-UX, Tru64, AIX, and Solaris), Linux (Red Hat, SuSE), Windows (2000, XP, 2003), and NAS servers
- Flexible tape device configuration with options for single and multihosted libraries or Storage Area Networks (SANs) offering dynamic drive sharing for optimal resource utilization
- Support for major tape libraries and drives in SAN, GbE, and SCSI environments
- Client or server architecture providing centralized administration of distributed media servers over a local area network (LAN) or wide area network (WAN)

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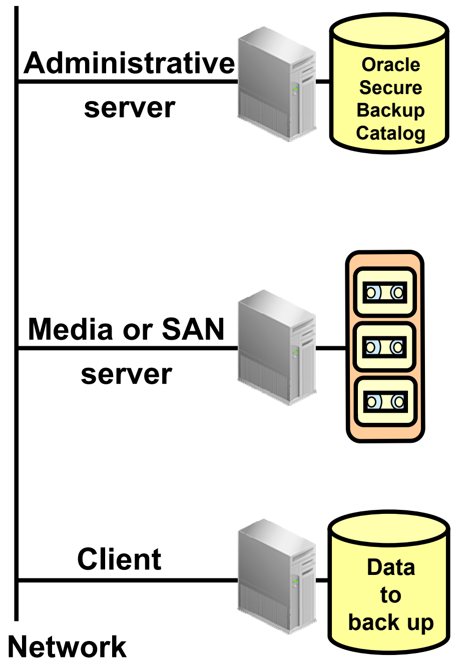
Oracle Secure Backup Administrative Domain



- Administrative server:
  - Maintains Oracle Secure Backup catalog files containing configuration settings and backup history
  - Has standard access mode only
- Media or SAN server:
  - Transfers data to or from attached devices
  - Has standard or NDMP access modes
- Client:
  - Is a server backed up by Oracle Secure Backup
  - Has standard or NDMP access modes

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Oracle Secure Backup Administrative Domain

An administrative domain has one administrative server, one or more clients, and one or more media servers.

- An *administrative server* is a machine in your administrative domain that contains a copy of the Oracle Secure Backup software and the catalog files that contain configuration settings and store backup history. The administrative server runs the Scheduler, which starts and monitors jobs within the administrative domain.
- A *media server* or SAN server is a machine that has one or more secondary storage devices, such as a tape library, connected to it. A media server transfers data to or from attached devices.
- A *client* is a machine whose locally accessed data is backed up by Oracle Secure Backup.

Each configured machine is characterized by the following access modes:

- **Standard:** A standard, configured machine runs the Oracle Secure Backup daemons that manage the client or server from a backup and restore perspective.
- **NDMP:** A Network Data Management Protocol (NDMP) host is a storage appliance from a third-party vendor such as Network Appliance, Mirapoint, or DinoStor. An NDMP host employs NDMP daemons to back up and restore file systems.

Note: Any machine in your network can serve in any of these roles or in any combination of these roles.

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Oracle Secure Backup: Backup Management Overview

- Centralized management of the administrative domain
  - Consolidated catalog
  - Users and privileges
- Ease of administration with multiple interface options, backup policies, and much more
- Backing up and restoring data
  - File system and Oracle database
  - Management through policies
- Media management (tapes)
- Automated tape device management
- Flexible configuration options

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Oracle Secure Backup: Backup Management Overview

Oracle Secure Backup provides data protection to tape for the Oracle database and file system data. Addressing the needs of DBAs and system administrators, Oracle Secure Backup delivers reliability, scalability, and ease of use ideally suited for workgroups and Oracle ecosystems.

- Typical IT environments are heterogeneous and need the same level of protection to tape. Oracle Secure Backup minimizes the complexity of managing those diverse architectures from a central administrative server.
- Providing maximum flexibility and ease of use, Oracle Secure Backup is integrated with Oracle Enterprise Manager (EM) for database backups and most administrative tasks. File system backups are effectively managed using an intuitive Web tool or a uniform command interface, or both.
- Security to control unauthorized access to backups is key in protecting the data. Oracle Secure Backup provides password protection and user classes to govern backup and recovery operation permissions. Oracle Secure Backup is hardened against buffer overflow attacks.
- Tightly integrated with RMAN, Oracle Secure Backup provides performant database backup and recovery through familiar Oracle Enterprise Manager or RMAN interfaces, or both.
- With configurable management policies and flexible device configuration and scheduling options, Oracle Secure Backup delivers a cohesive data protection tape management tool.

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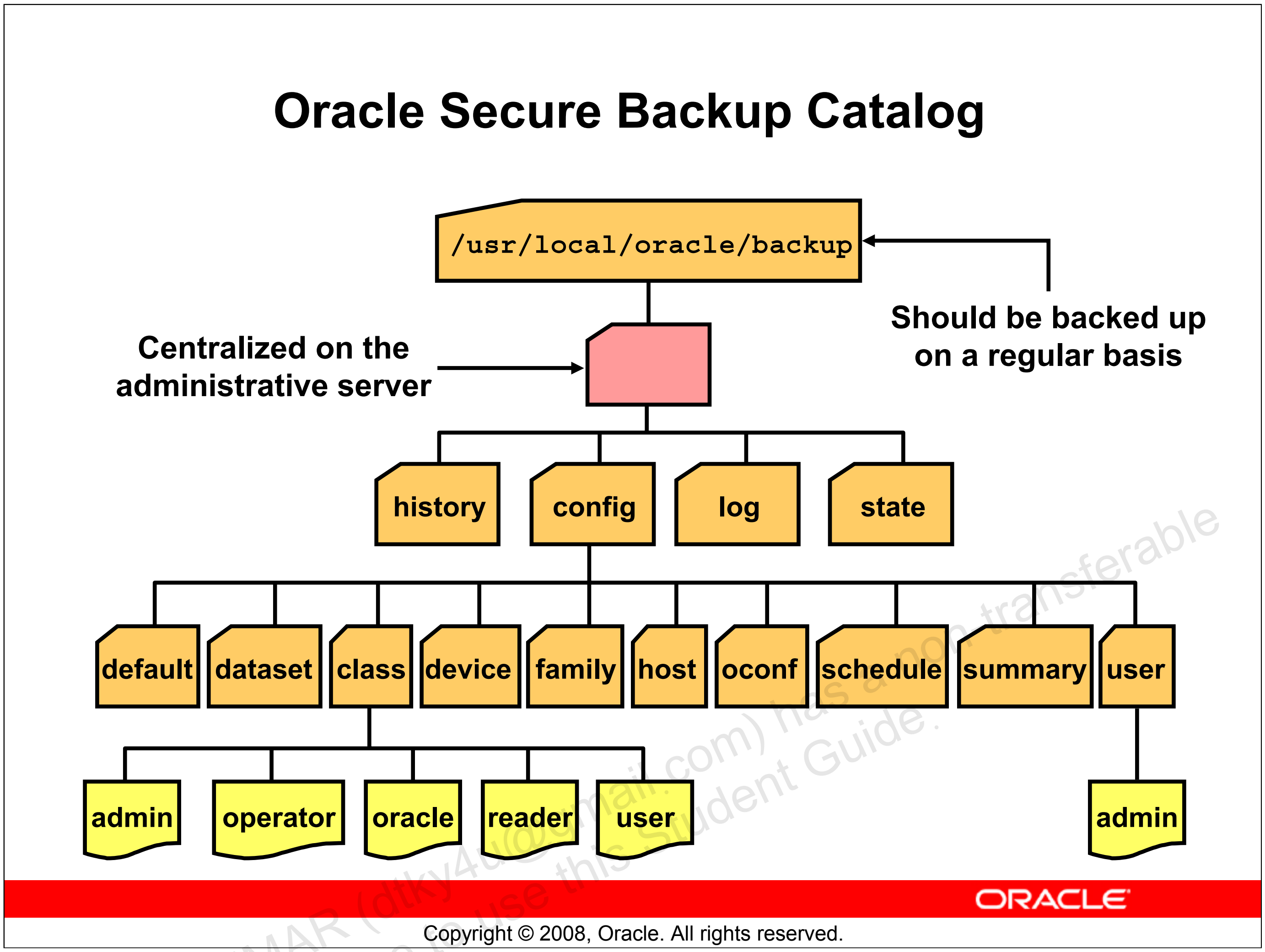

Oracle Secure Backup Catalog

Oracle Secure Backup maintains its own centralized catalog on the administrative server. The Oracle Secure Backup catalog contains all the information used to define your configuration. It also includes metadata relating to your backup and restore operations. The slide shows you the tree structure of directories installed by Oracle Secure Backup on an administrative server. Oracle Secure Backup organizes its catalog in a hierarchical manner. The `admin` directory contains the administrative domain catalogs. As shown in the slide, the `config` directory contains many subdirectories representing objects that Oracle Secure Backup maintains. In each of these directories, Oracle Secure Backup maintains files containing the characteristics of the corresponding objects.

As shown in the slide, it is recommended to back up the Oracle Secure Backup installation tree on your administrative server on a regular basis. That way, your Oracle Secure Backup data will not be lost in case your administrative server fails.

Note: For formatting reasons, the slide does not represent the complete set of directories used by Oracle Secure Backup. The administrative server also contains a set of executables. For more information about the entire tree structure, refer to the *Oracle Secure Backup Installation* guide. Also, the default Windows installation directory is `C:\Program Files\Oracle\Backup`, and the directory structure under the installation directory is the same for both Windows and UNIX systems.

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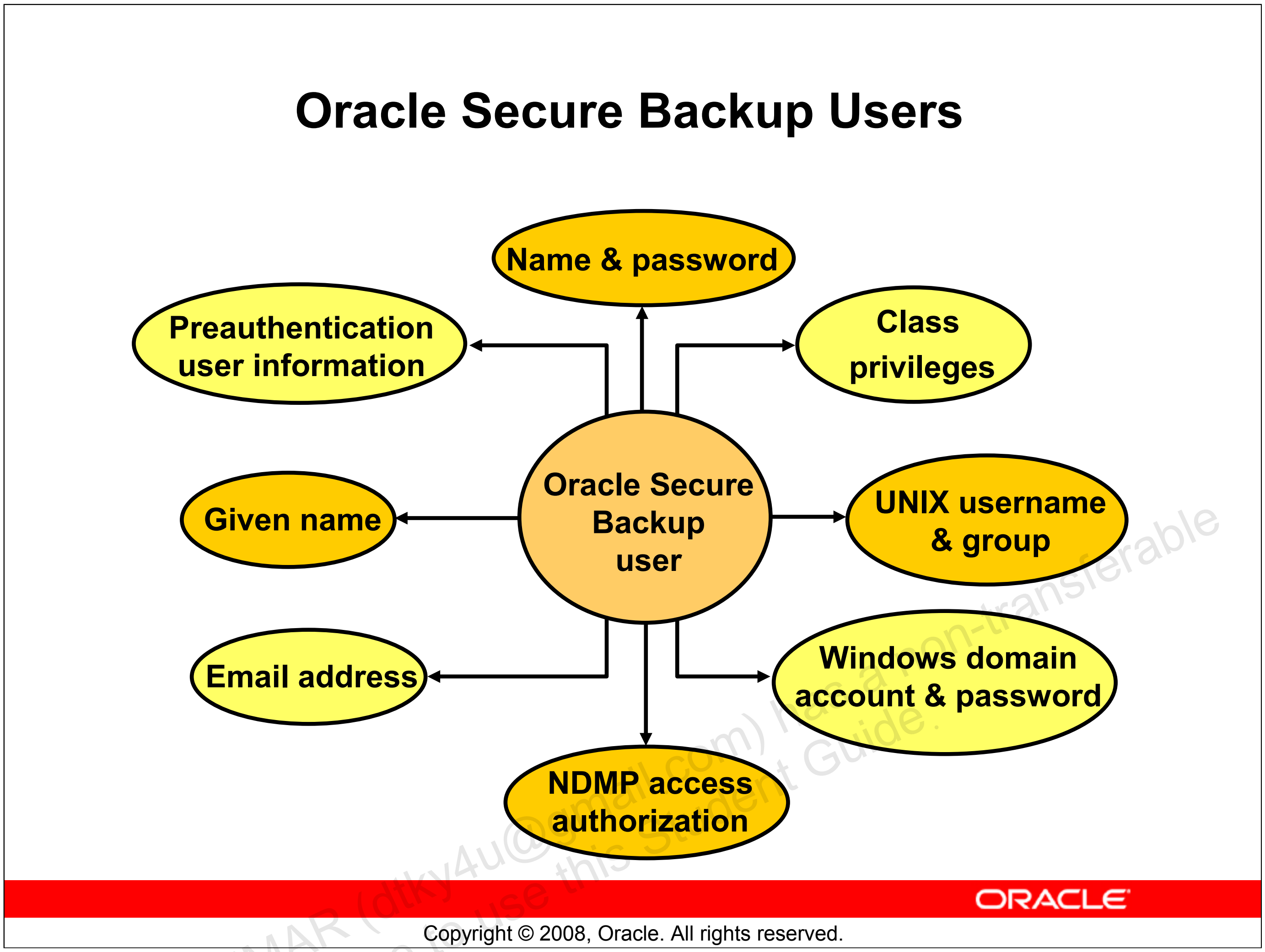

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Oracle Secure Backup Users

Oracle Secure Backup manages its own catalog of users and their corresponding rights to maintain a consistent user identity across the various hosts (UNIX, Linux, and Windows) of your administrative domain. Although you can assign usernames and passwords that are identical to those of existing OS users, the namespace for Oracle Secure Backup users is distinct from the namespaces of existing OS users. The following is a description of the parameters that must be specified when creating Oracle Secure Backup users:

- The name of the Oracle Secure Backup user as well as its password
- The Oracle Secure Backup class associated to this user
- A UNIX or Windows username and the corresponding information. This username is used by Oracle Secure Backup's unprivileged operations to access file system data on your clients. An unprivileged operation is constrained by the rights of the UNIX user or Windows account having that identity.
- Whether the Oracle Secure Backup user is permitted to log in to an NDMP server. This login is done using an external client program.
- An e-mail address used to send Oracle Secure Backup operation notifications and reports

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Oracle Secure Backup Users (continued)

- A given name. This is more like a comment.
- The possibility to specify preauthorized user information. This allows the use of Oracle Secure Backup without going through the normal Oracle Secure Backup login requirements.

Note: Configuring users is best accomplished using the Web tool or command-line interface.

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Predefined Classes

Rights	ADMIN	OPERATOR	USER	ORACLE	READER
Browse backup catalogs with this access	privileged	not denied	permitted	permitted	named
Display administrative domain's configuration	✓	✓	✓	✓	
Modify own username and password	✓	✓	✓	✓	✓
Modify administrative domain's configuration	✓				
Perform backups as self	✓	✓		✓	
Perform backups as privileged user	✓	✓			
List any jobs, owned by user	✓	✓	✓	✓	
Modify any jobs, owned by user	✓	✓	✓	✓	
Perform restores as self	✓	✓	✓	✓	
Perform restores as privileged user	✓	✓			
Receive e-mail requesting operator assistance	✓	✓		✓	
Receive e-mail describing internal errors	✓	✓		✓	
Query and display information about devices	✓	✓	✓	✓	
Manage devices and change device state	✓	✓		✓	
List any job, regardless of its owner	✓	✓			
Modify any job, regardless of its owner	✓	✓			
Access Oracle Secure Backups (database)	all	owner	owner	owner	none
User can perform Oracle database backups and restores	✓			✓	

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Predefined Classes

A class defines a set of rights or access privileges. A class may be assigned to multiple users but each user is a member of exactly one class. The following classes are key to understanding user access privileges in Oracle Secure Backup:

- **Admin:** Class used for overall administration of a domain. The admin class has all the rights and privileges needed to modify domain configurations and perform backup and restore operations.
- **Operator:** Class used for standard, day-to-day operations. The operator class lacks configuration privileges but has all the rights needed for backup and restore operations as well as device management browsing capabilities.
- **User:** Class assigned to specific users giving them permission to interact in a limited way with their domains. This class is reserved for users who need to browse their own data within an index and perform user-based restores.
- **Oracle:** Similar to the operator class with specific privileges to modify Oracle database configuration settings as well as to perform Oracle database backups
- **Reader:** Class assigned that enables users to view index information. Readers are permitted to perform no operation other than modifying their usernames and passwords.

Configuring classes is best accomplished using the Web tool or command-line interface.

Note: For more information about individual rights, refer to the *Oracle Secure Backup Administrator's Guide*.

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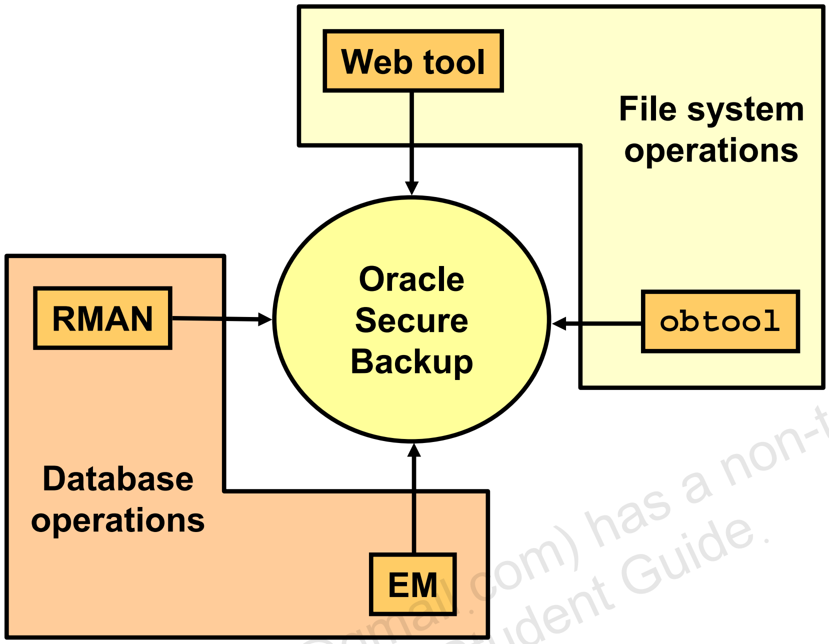
Oracle Secure Backup Interface Options



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Oracle Secure Backup Interface Options

As shown in the slide, you can access Oracle Secure Backup in four different ways depending on what you want to do.

- Management operations for administering the domain, such as adding or managing devices, is best accomplished using Enterprise Manager. The Oracle Secure Backup Web tool or command line is also available for administrative management tasks, including adding clients and configuring users and classes.
- Oracle database backup and restore operations are managed using the Oracle Enterprise Manager or RMAN interface.
- File system backup and restore operation are managed using the Oracle Secure Backup Web tool or the command-line interface.

Note: In terms of backup and recovery operations, the difference between the Oracle Secure Backup Web interface and `obtool` is the same as the difference between the EM interface and RMAN.

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Managing Data to Be Protected

	Oracle Database	File System Data
Defining what data to back up	RMAN backup sets	Oracle Secure Backup data sets: User defined
Backup options	Use RMAN backup levels: Full and incremental	Multilevel backups: Full, incremental, or off-site
Frequency of backups	Intuitive Enterprise Manager scheduling interface	Flexible date/time calendar–based scheduling On-demand backups

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Managing Data to Be Protected

Managing the backup infrastructure of file system data and Oracle database data is easily administered with Oracle Secure Backup and RMAN. Defining what data to back up is conceptually similar for file system and database data. Both require that you, the user, define what to include in the backup. For the database, you use the RMAN backups sets created using RMAN or Enterprise Manager. For file systems, Oracle Secure Backup uses data sets. Defining file system data sets is easily accomplished using the Oracle Secure Backup Web tool.

After defining what data to back up, you must determine what type of backups are most appropriate to meet your backup and restore requirements. Oracle Secure Backup offers multiple backup levels for file system backups including full backup levels, multiple incremental levels, and an off-site backup level. The off-site level is actually a full backup performed without interfering with any incremental backup strategies. Oracle Secure Backup also provides flexible scheduling options enabling you to determine ongoing backup schedules based on the day and time granularity. For the Oracle database, RMAN offers full and incremental backup levels that are backed up to tape by Oracle Secure Backup.

After you have defined what to back up, how to back it up, and how often to back up the data through scheduling, Oracle Secure Backup can automatically implement your backup schedules only requiring manual intervention for hardware errors or media needs.

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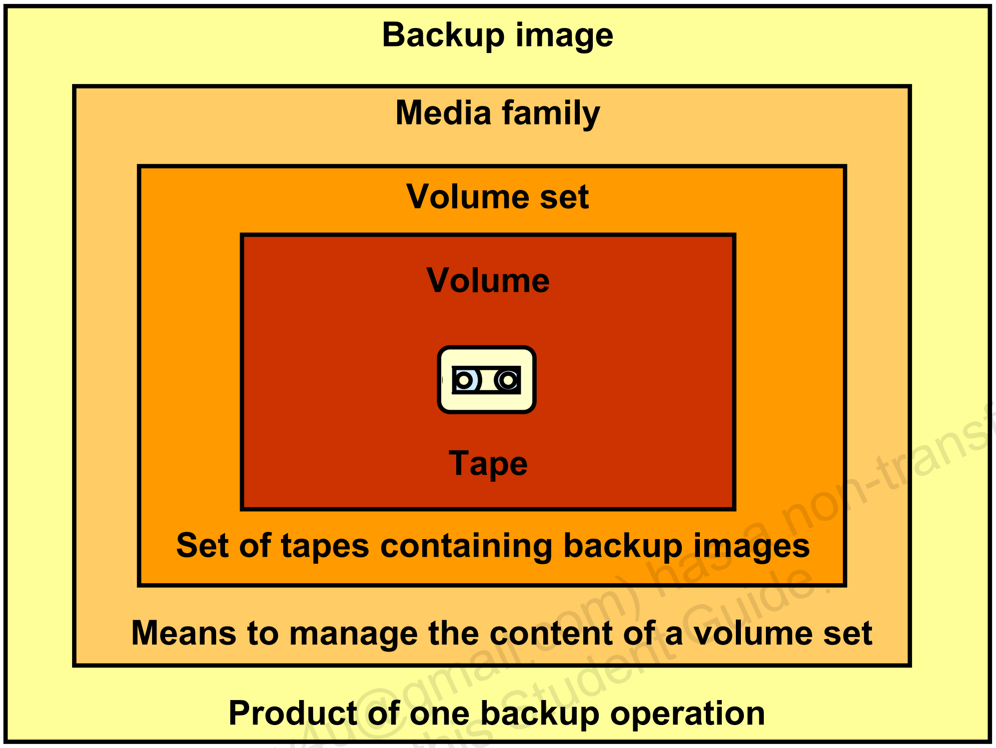
Oracle Secure Backup Media Concepts



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Oracle Secure Backup Media Concepts

Oracle Secure Backup organizes backups that it creates in a simple hierarchy that comprises the following concepts:

- A backup image (archive) is the product of a backup operation. Basically, it can be seen as the list of files that are backed up in one operation.
- A volume is a single unit of media, such as an 8-mm tape.
- A volume set is a group of volumes that a backup image spans.
- A media family is a named classification of volumes that share some common attributes, such as the way volumes are named, and the policies used to write and keep data stored in the media family volumes.

So, when you back up files by using Oracle Secure Backup, you generate a volume set that has some common characteristics defined by the corresponding media family that you have associated with your backup operation.

Note: The graphic in the slide illustrates these concepts from the most logical one to the most physical one.

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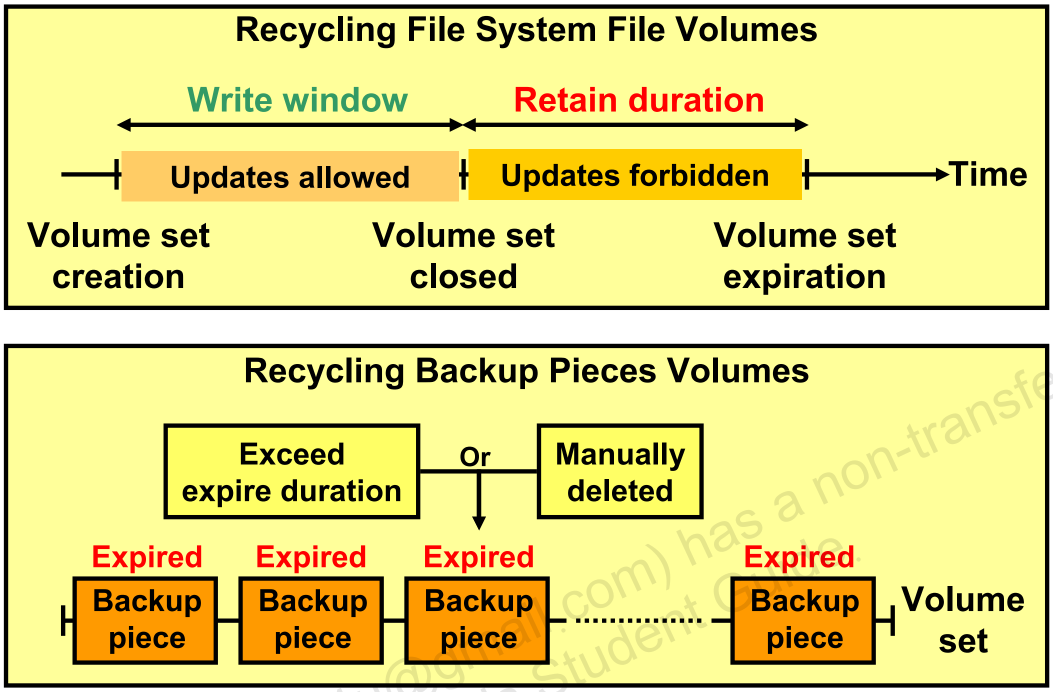
Volume Set Recycling



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Volume Set Recycling

Oracle Secure Backup has two volume-recycling concepts:

- **Recycling volumes containing file system file backups:** The retention period for file system backups is managed at the volume level in that a volume (tape) or volume set containing one or more file system backups may not be overwritten until the retention period for the volume has expired. Oracle Secure Backup continues to append backups to the volume set until its write window period has expired, at which time it considers the volume set closed to further updates. After the volume set is closed, its data are kept for the retention duration, then expired and automatically available to be overwritten. The retention period is the total time of the user-defined write window plus retain duration.

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Volume Set Recycling (continued)

- **Recycling volumes containing backup pieces:** Oracle Secure Backup uses content-managed volume recycling for Oracle database backups, where each backup piece is managed discretely, not at the volume level. There are two ways in which backup pieces may expire:
  1. A backup administrator manually deletes the piece from the backup catalog.
  2. The life of the piece exceeds its expiration date. This expiration date is determined when the backup piece is created, and corresponds to its creation time plus its expire duration. The expire duration is set in the corresponding Oracle Secure Backup Configuration object. If either of these conditions is satisfied, the piece is considered expired. When *all* backup pieces written to a volume have expired, the volume may be overwritten.

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Automated Device Management

- Oracle Secure Backup automates the control of tape libraries.
  - Accepts SCSI commands from the library to:
    - Manage the tapes inventory
    - Move tapes to or from storage elements and drives
  - Automates tape drive cleaning
  - Supports bar code readers and media verification
- Automated device discovery and configuration for NDMP v3 and v4 capable servers

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Automated Device Management

Oracle Secure Backup automates the management of tape libraries, enabling efficient and reliable use of its capabilities (including bar code readers). Oracle Secure Backup communicates with a tape library controlling the robotics to facilitate the management of tapes within the library. A tape library is often referred to as a robotic tape device, autochanger, or medium changer. A list of supported tape drives and libraries is available on OTN.

A library accepts small computer system interface (SCSI) commands to move media between storage locations and drives. Oracle Secure Backup uses the following SCSI terms to describe basic components of libraries:

- A storage element (se) contains a volume when it is not in use.
- An import-export element (iee) or mail slot is used to move volumes into and out of the library without opening the door. Availability of an iee is dependent on the library. Some offer a media access port, whereas some require manual action by the operator to open the door, and remove a tape from a slot in the library.
- A medium transport element (mte) moves a volume from a storage element to another element, such as a drive.
- A data transfer element (dte) is, for Oracle Secure Backup's purposes, a tape drive.

Each element has a user-defined name that Oracle Secure Backup uses to identify it. The first storage element, for example, is usually called se1, and the first tape drive is dte1.

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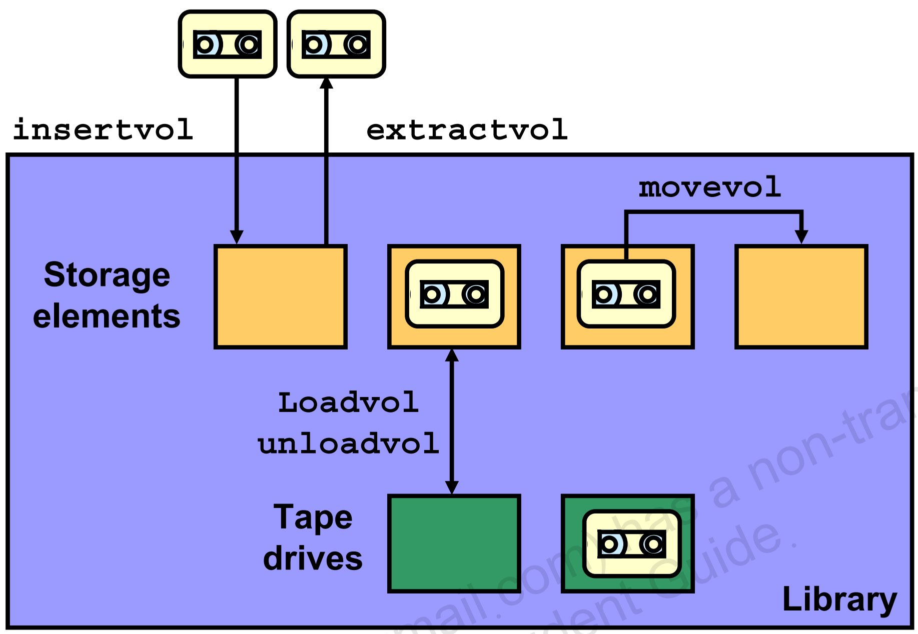
Library Management Operations



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Library Management Operations

The illustration in the slide shows you a library with its storage elements and drives. The following are some basic operations that you can perform on the components of a library.

- You can express that you have inserted one or more volumes into the library's storage elements.
- Similarly, you can extract one or more volumes from a tape library's storage elements. This command notifies Oracle Secure Backup that you are removing a volume manually from the library.
- You can also load a volume from a storage element into a drive, to be ready to start backup operations.
- Similarly, you can unload a volume from a drive to a particular storage element.
- You can also move one volume from one storage element to another.

Note: For more information about the possible library commands, refer to the *Oracle Secure Backup Reference* guide.

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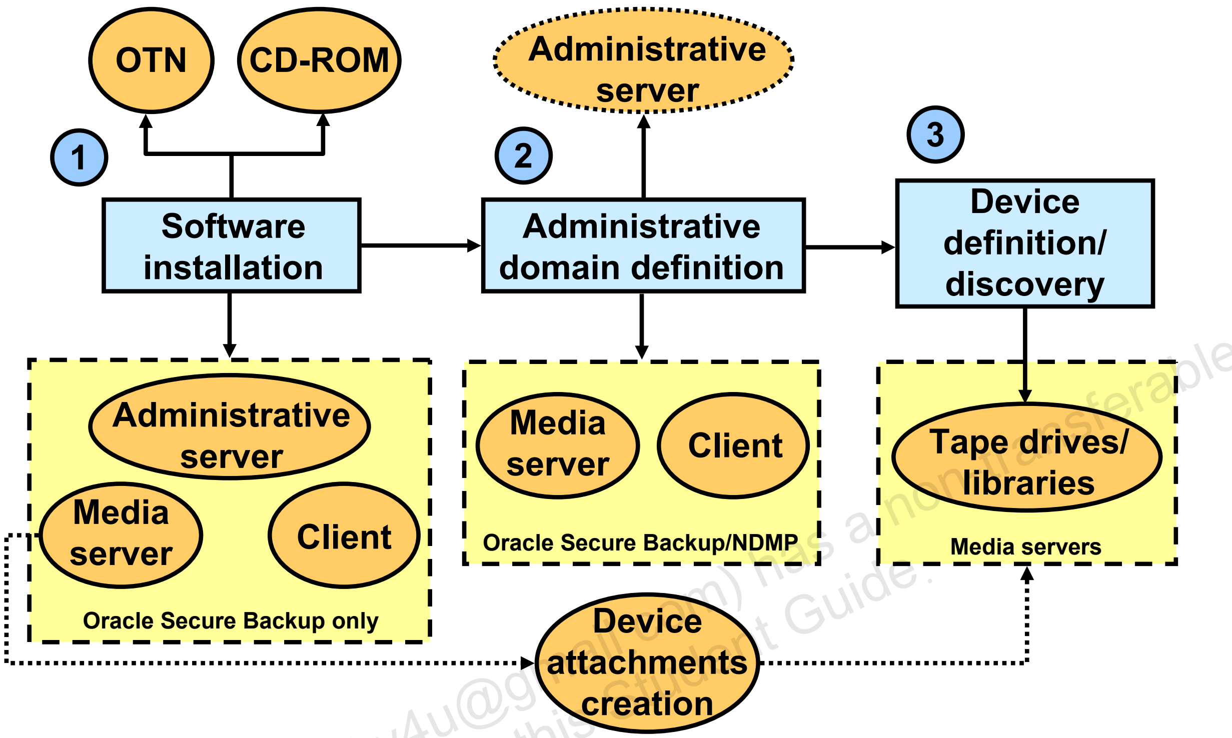
Oracle Secure Backup: Installation



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Oracle Secure Backup: Installation

The installation and configuration of your administrative domain is generally done in three steps:

1. Install the Oracle Secure Backup software on each of your hosts except the ones on which NDMP daemons are already running. This can be done either by using a CD-ROM or by downloading the software from OTN.
2. Make sure that your complete administrative domain is defined on the administrative server. This involves defining all media servers, client servers, and Network Attached Storage (NAS) filers. You do this directly from the administrative server, which is defined during the software installation process.
3. Make the administrative server aware of the tape devices that exist in your administrative domain. This third step is reserved for media servers only, and it allows you to configure the SCSI and Fiber Channel devices (libraries and tape drives) directly attached to an Oracle Secure Backup host in your administrative domain, or it allows you to discover the libraries and tape drives attached to an NAS Filer so that the filer can communicate with Oracle Secure Backup.

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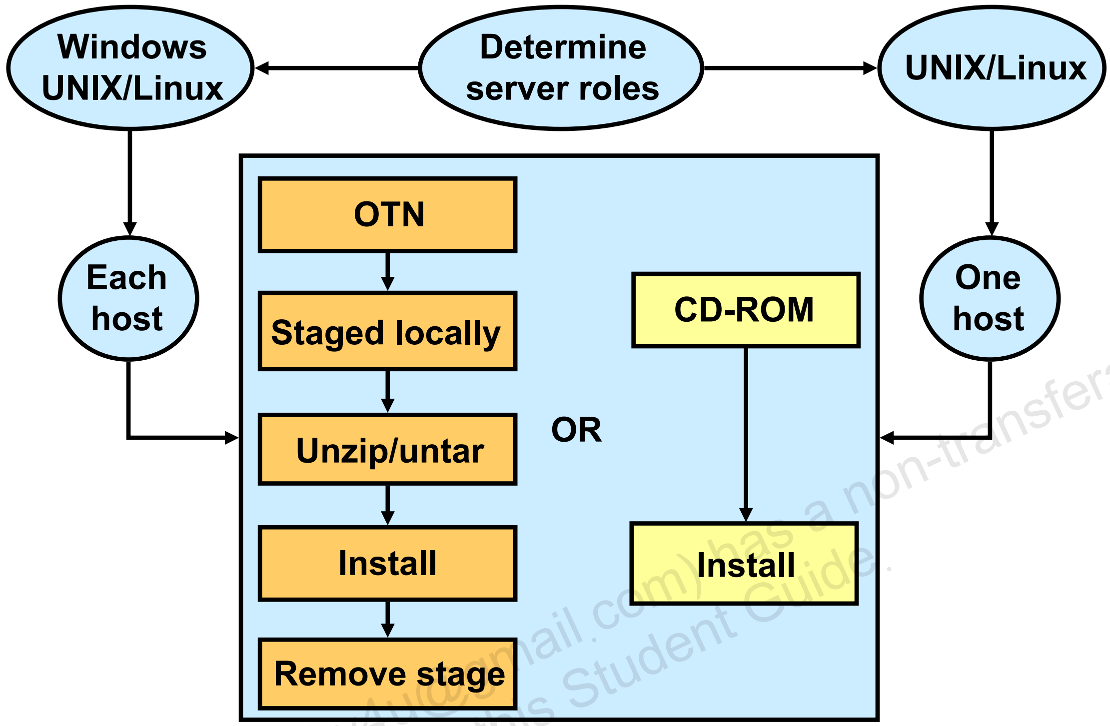
Installing Oracle Secure Backup Software



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Installing Oracle Secure Backup Software

Before you start the Oracle Secure Backup software installation on a particular host, you need to determine its Oracle Secure Backup role (administrative, media, or client).

Whatever the platform you are using (Windows, UNIX/Linux), you can select to install the Oracle Secure Backup software in one of the following ways:

- Install Oracle Secure Backup on each host from the supplied CD-ROM.
- Download Oracle Secure Backup on each host from OTN, and install it from your local staged directory.

However, with UNIX/Linux platforms it is also possible to distribute the Oracle Secure Backup software remotely to other UNIX/Linux hosts on the network, after the software has been downloaded through OTN or the CD-ROM to one machine. This distribution method requires you to be able to issue the `rsh` command as `root` to push the software across the network.

A complete domain installation is possible only for UNIX-like systems. Windows systems require separate installation on each system in the administrative domain.

Note: On UNIX-like systems, an Oracle Secure Backup installation can be done interactively, but also in batch mode by using network description files.

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Administrative Server Installation: Example

```
[root@EDRSR14P1 stage]# mkdir -p /usr/local/oracle/backup
[root@EDRSR14P1 stage]# cd /usr/local/oracle/backup
[root@EDRSR14P1 backup]# /stage/ob-4.1cdrom040914/setup
Welcome to Oracle's setup program for Oracle Secure Backup. This
program loads Oracle Secure Backup software from the CD-ROM to a
filesystem directory of your choosing.
This CD-ROM contains Oracle Secure Backup version 10.2.
Please wait a moment while I learn about this host... done.
-  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
You may load any of the following Oracle Secure Backup packages:
1. solaris (Solaris 32, SPARC) administrative server, media
server, client
2. linux32 (RH 2.1, RHEL 3, RHEL 4, SuSE 8, SuSE 9)
administrative server, media server, client
3. solaris64 (Solaris 2.8 and later, SPARC) administrative
server, media server, client

Enter a space-separated list of packages you'd like to load. To
load all packages, enter 'all' [2]:  2
```

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Administrative Server Installation: Example

Although not mandatory, most of the time, the installation directory that is used to install the Oracle Secure Backup software is `/usr/local/oracle/backup`.

After your installation directory is created, change your current directory to the installation directory, and execute the setup program from either your CD-ROM or your staging area. In the slide example, a stage directory is used instead of a CD-ROM.

As you can see, several numeric choices are displayed for various platforms, including Solaris, and several flavors of Linux. Select the number that corresponds to the installation package for the UNIX platform you are running. The example uses Linux.

You have the option of selecting multiple machines on which to install Oracle Secure Backup. Simply list all package numbers, separated by spaces, on the same line. For example, to install Oracle Secure Backup software on Solaris and Linux machines, enter: `1 2`.

For the following steps, it is recommended that you accept the default option provided. The `obparameters` file has been preconfigured for use during the installation process. Alternatively, open a text editor and inspect `/usr/local/oracle/backup/install/obparameters`. Various parameters are defined that you may customize to suit the needs of your Oracle Secure Backup installation. For example, you can ask Oracle Secure Backup to automatically create an Oracle Secure Backup user that is assigned the `oracle` class, and is preauthenticated to use with RMAN.

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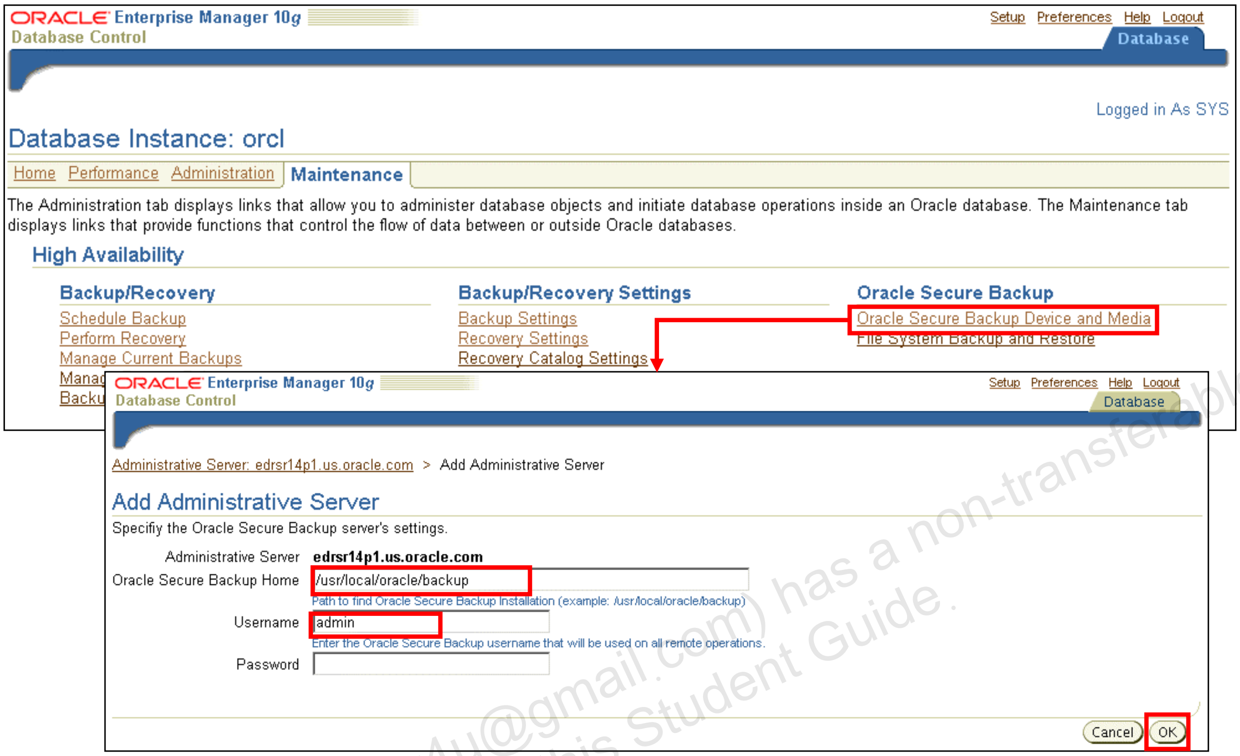
Defining Your Administrative Server in EM



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Defining Your Administrative Server in EM

After you have completed the Oracle Secure Backup software installation, you need to define your administrative domain.

On the Database Control Maintenance page, you need to click the Oracle Secure Backup Device and Media link in the Oracle Secure Backup section.

This displays the Add Administrative Server page if this is the first time you are trying to access Oracle Secure Backup from Database Control.

On the Add Administrative Server page, you must specify the Oracle Secure Backup Home directory used during the installation process. It is assumed that your host is also an Oracle Secure Backup administrative server. Then, you need to specify the Oracle Secure Backup Username that will be used for all remote operations.

After this is done, click OK.

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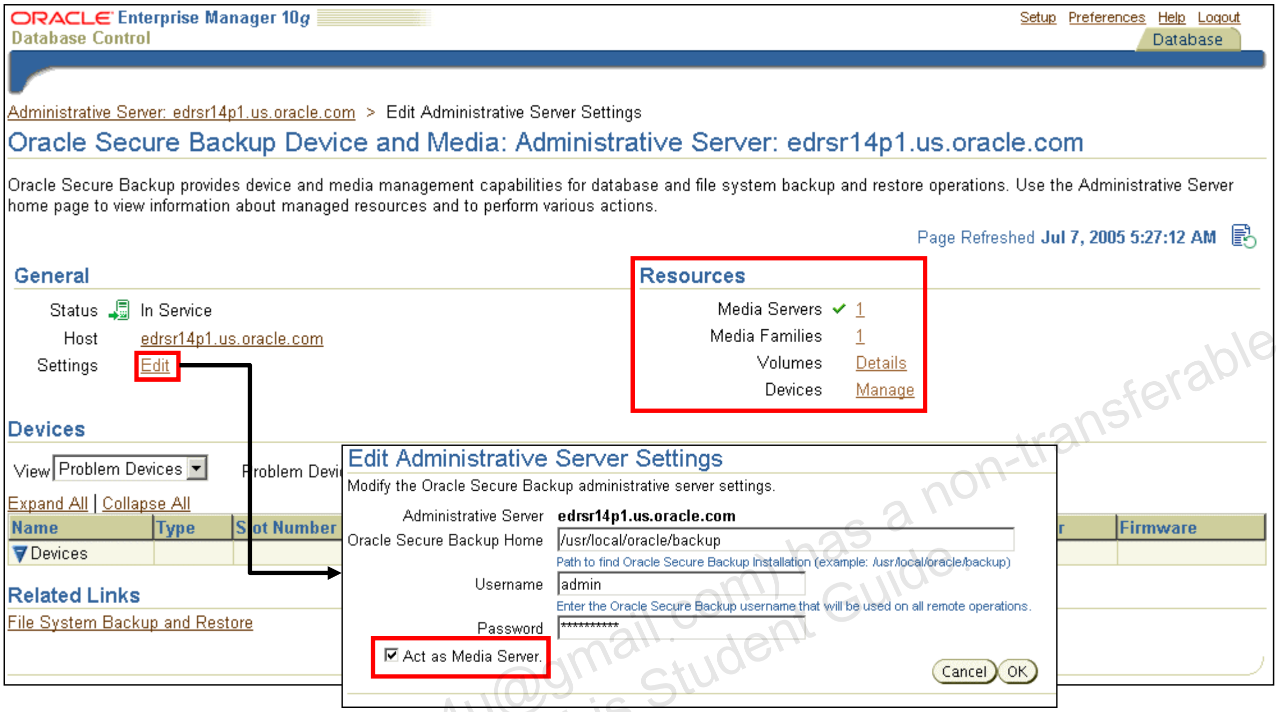
The Oracle Secure Backup Device and Media Page



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The Oracle Secure Backup Device and Media Page

On the Oracle Secure Backup Device and Media Page, you can manage your administrative domain by using the links available in the Resources section. Using this section, you can manage:

- Devices
- Media servers
- Media families
- Volumes

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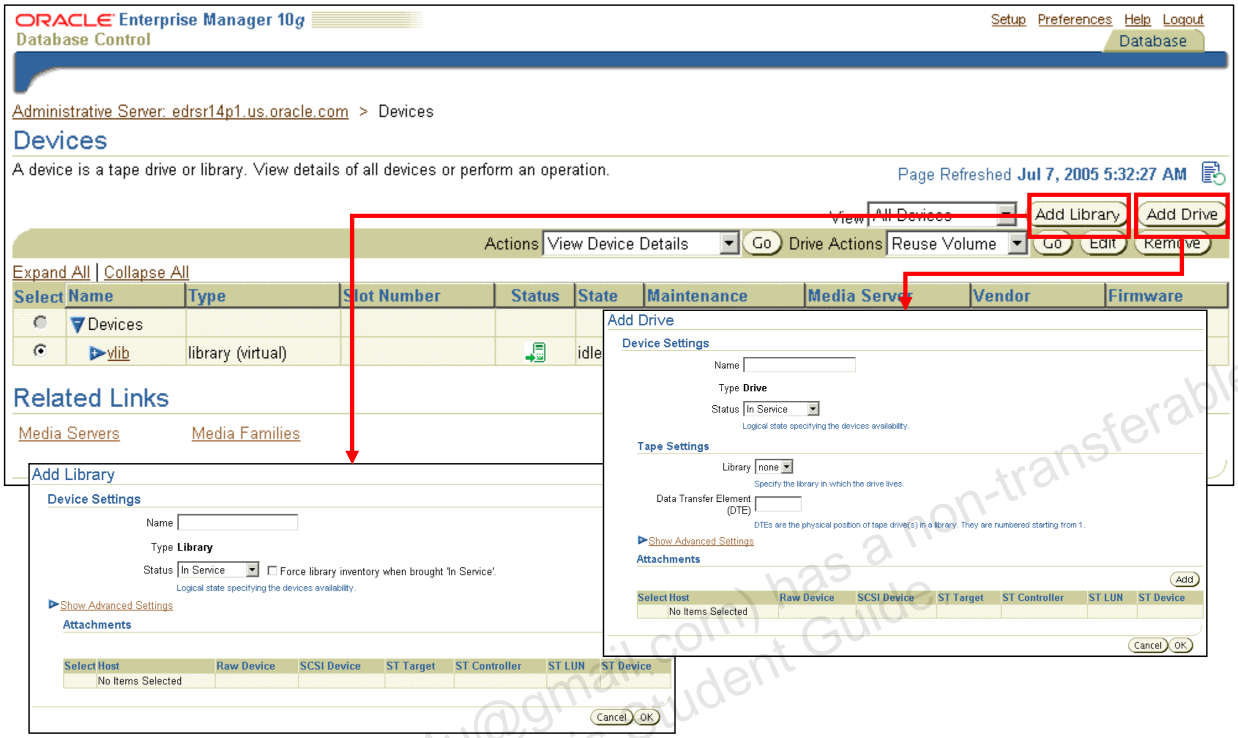
Adding Devices



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Adding Devices

After your administrative domain has been established, you can proceed to configure libraries and tape drives for use with Oracle Secure Backup. Oracle Secure Backup supports SCSI and Fiber Channel devices.

You can add new devices in one of two ways:

- By automatically discovering them. Oracle Secure Backup can automatically discover and configure secondary storage devices connected to certain types of NDMP servers, such as Network Appliance filers.
- By configuring them through Enterprise Manager, the Web tool, or command-line interface.

On the Devices page, click either Add Library or Add Drive to add a new device to your configuration.

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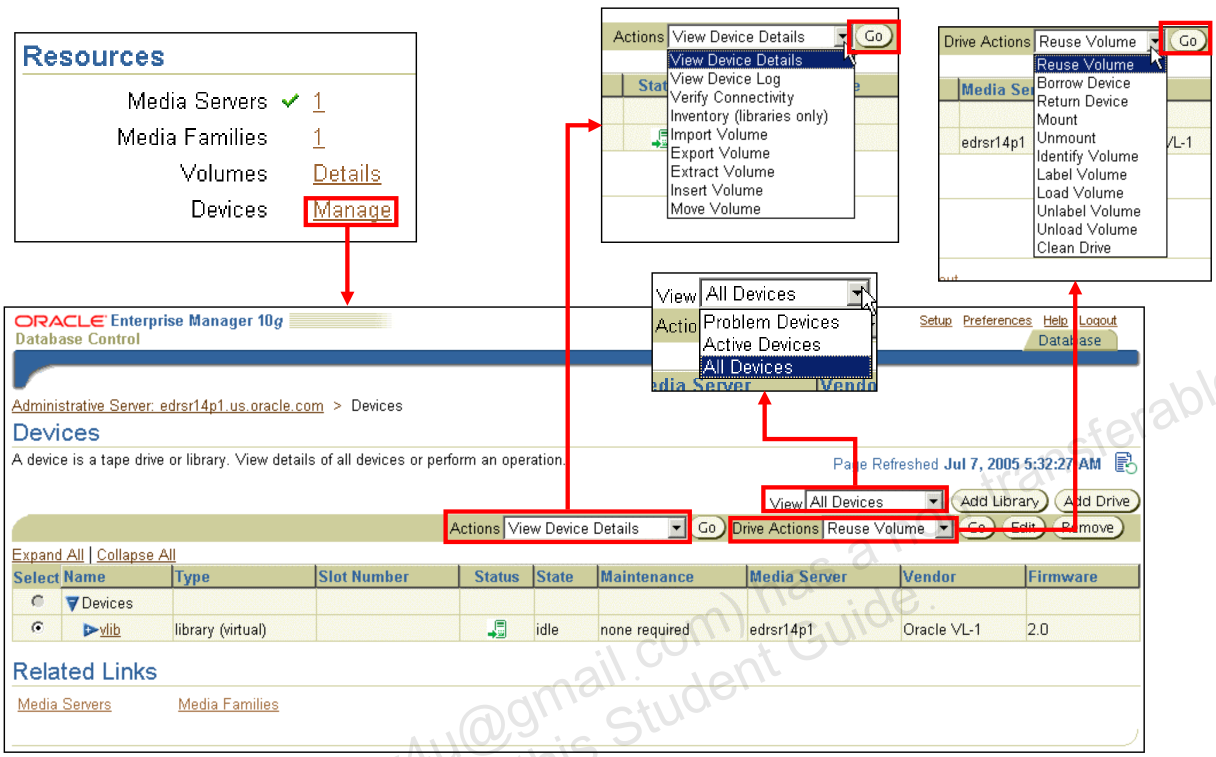
Managing Devices by Using EM



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Managing Devices by Using EM

On the EM Administrative Server page, you can click the Manage link corresponding to the Devices line.

This displays the Devices page; here, you can Add Library and Add Drive. You can also select an existing device, and edit or remove that device by using the Edit and Remove buttons, respectively.

As you can see, after a device has been created, you can select that device, and apply certain actions to that device, such as Mount, Load Volume, and so on, using the Actions and Drive Actions list. Then, click Go.

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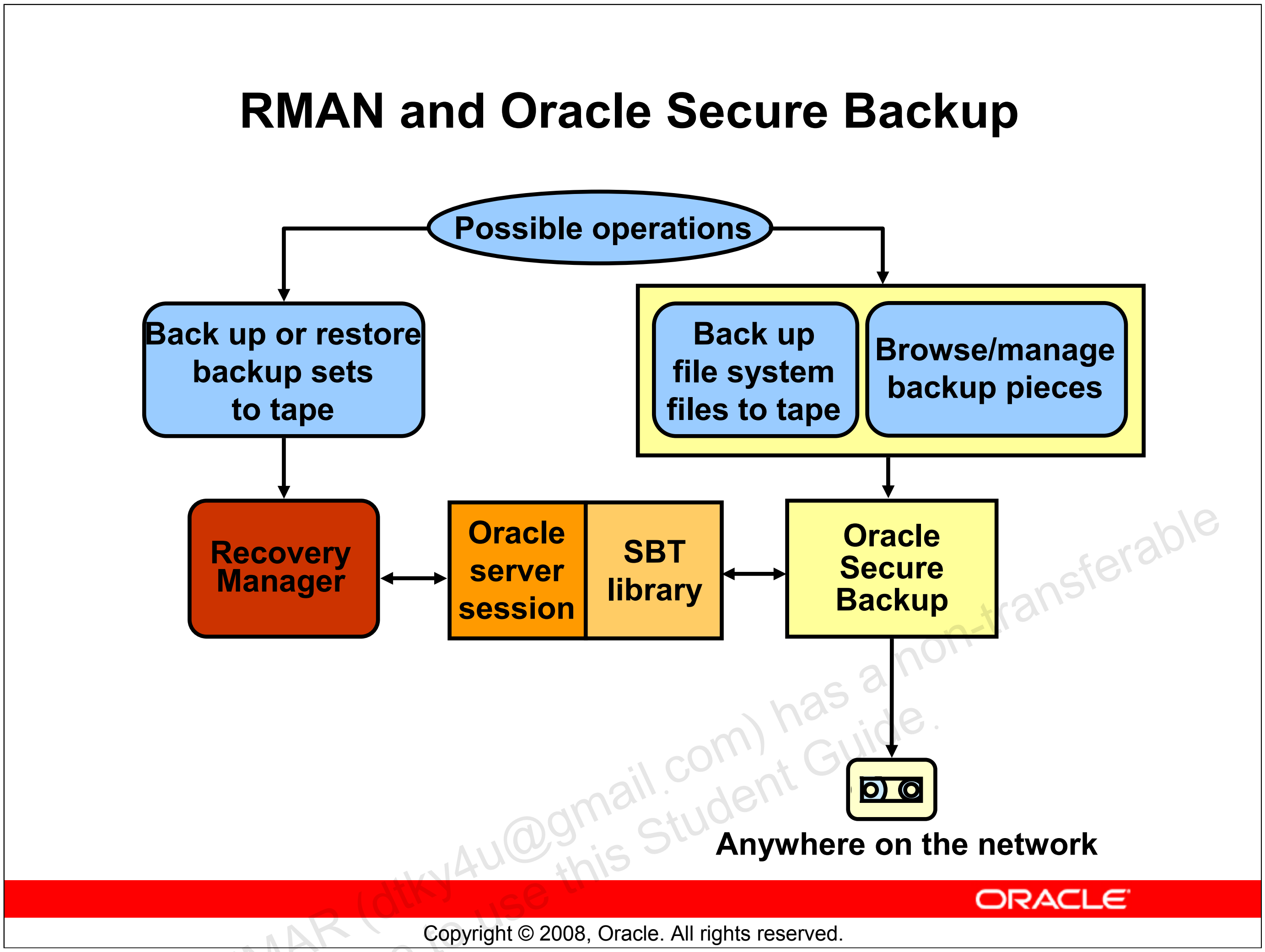

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RMAN and Oracle Secure Backup

Oracle Secure Backup provides the ability to back up and restore UNIX, Linux, Windows, and NAS file systems. In addition, Oracle Secure Backup also implements the RMAN media management interface, allowing it to provide seamless database backups via RMAN.

Oracle Secure Backup thus performs two separate functions: the backup of Oracle databases and the backup of other file system objects. For the backup of Oracle databases, Oracle Secure Backup is accessed via the RMAN or the EM interface. For the backup of other file system data, Oracle Secure Backup is accessed via its `obtool` command-line interface, or its Web tool.

Oracle Secure Backup can browse backup pieces and manage them individually. This is important when a backup piece becomes orphaned. An *orphan* is a backup piece that exists in the Oracle Secure Backup catalog but not in the RMAN catalog. Oracle Secure Backup stores and reports Oracle-specific metadata about the contents of each backup piece type.

Backup sets are the only form in which RMAN can write backups to media manager devices such as tape libraries. Each RMAN backup piece is created as one Oracle Secure Backup backup image when using Oracle Secure Backup to store your backups on tapes.

Note: SBT stands for System Backup to Tape.

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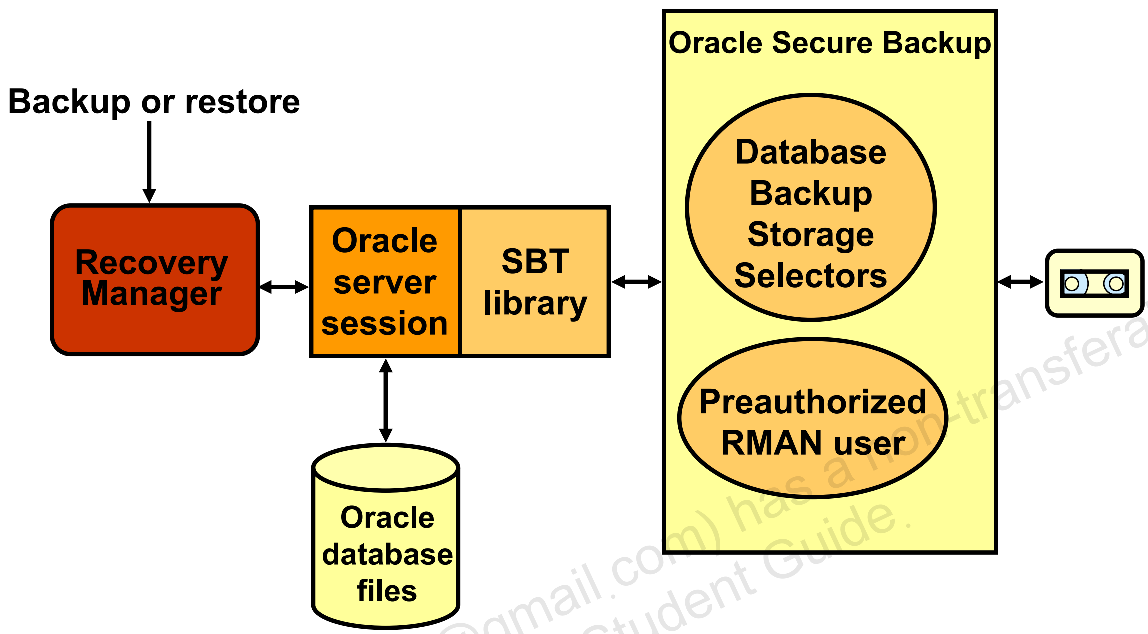
Accessing Oracle Secure Backup from RMAN



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Accessing Oracle Secure Backup from RMAN

When you access Oracle Secure Backup from RMAN, all you need to do is allocate a channel of the `SBT_TAPE` type, and then run RMAN commands to back up or restore your database. On the Oracle Secure Backup side, you must predefine two important Oracle Secure Backup objects:

- **Database Backup Storage Selectors:** These objects are configured to represent backup and restore parameters that describe an Oracle database. They act as a *glue layer* between RMAN, which accesses the database, and the Oracle Secure Backup software, which manages the underlying media.
- **Preauthorized RMAN user:** RMAN preauthorization is used to determine the Oracle Secure Backup user under which a specific RMAN operation, such as backup or restore, is performed.

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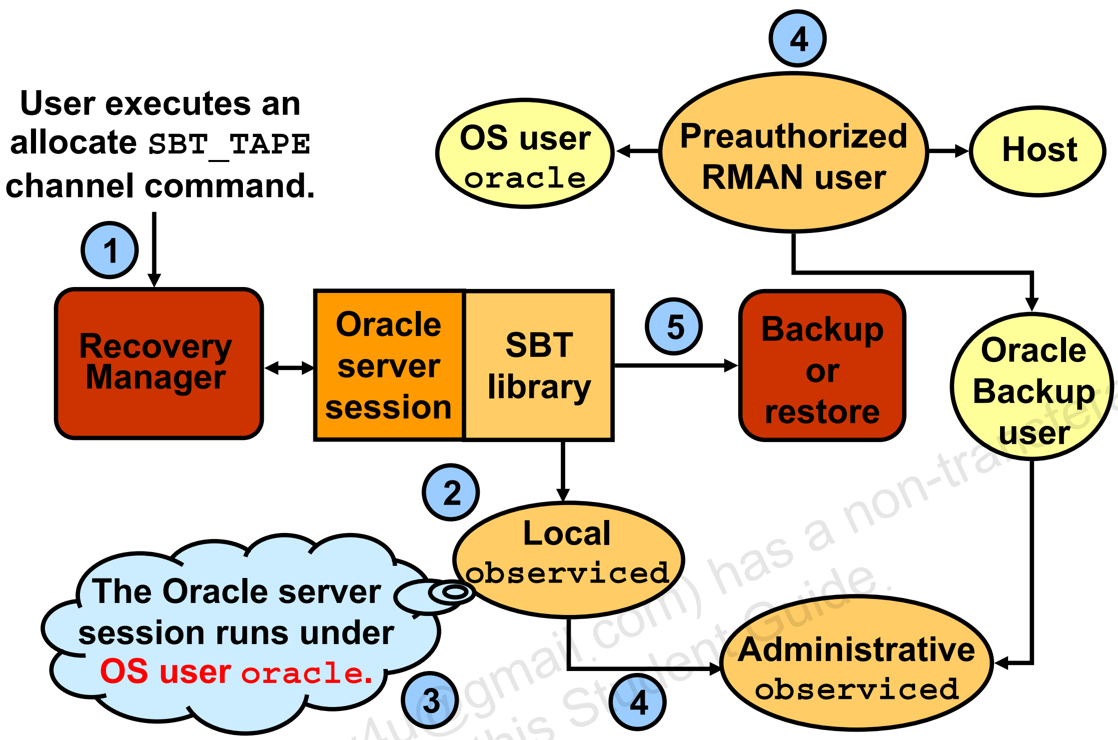
User Preauthorization



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User Preauthorization

It is possible to preauthorize an OS user for RMAN access to Oracle Secure Backup when logged in to a given host. This allows for the use of Oracle Secure Backup without going through the normal Oracle Secure Backup login requirements. Preauthorization is used to determine the Oracle Secure Backup user under which a specific RMAN operation, such as backup or restore, is performed. The slide shows you an example for the RMAN case:

1. When you start RMAN and allocate an SBT channel, the Oracle database spawns an Oracle foreground process to actually perform operations.
2. The Oracle process connects to the Oracle Secure Backup service daemon running locally on its host.
3. The service daemon determines the OS user and host under which the Oracle process runs.
4. The local service daemon checks the user information in the administrative service daemon. If there is an Oracle Secure Backup user that supports preauthentication for this host and OS user, the login is successful.
5. The Oracle foreground process uses the preauthenticated Oracle Secure Backup user to perform its Oracle Secure Backup operations. Note that Oracle Secure Backup operations submitted through the SBT interface use the OS user defined by the Oracle Secure Backup user to access the host.

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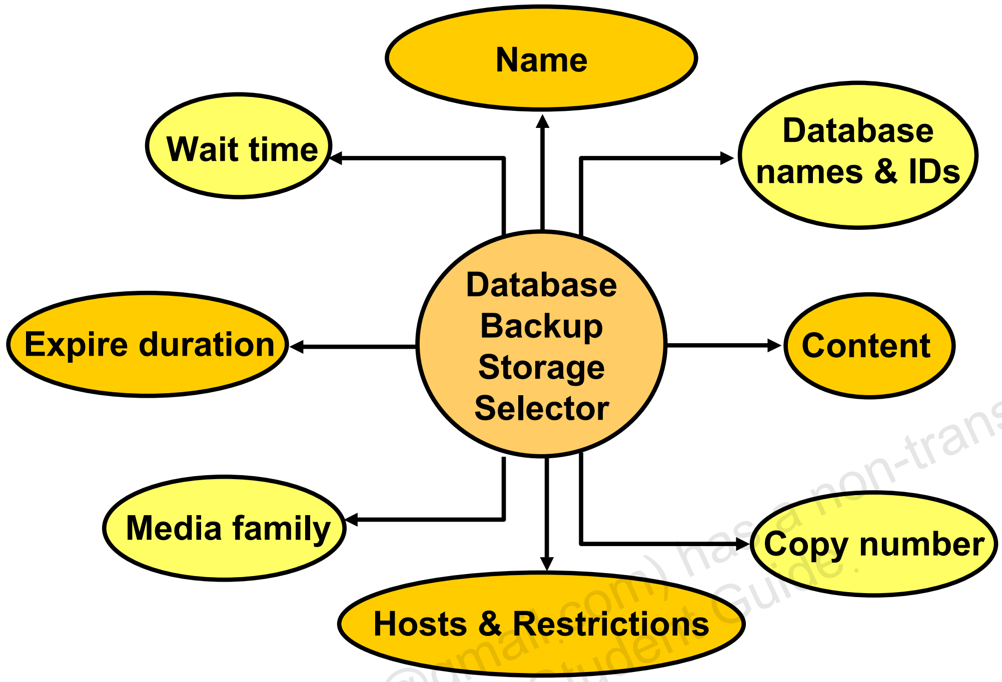
Database Backup Storage Selector



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Database Backup Storage Selector

Using Database Backup Storage Selectors, you can exercise fine-grained control over database backup and restore operations. Oracle Secure Backup uses the information encapsulated in Database Backup Storage Selectors when interacting with RMAN. A Database Backup Storage Selector contains the following information:

- The name of the storage selector itself
- The names of the databases to which this selector applies
- The IDs of the databases to which this selector applies
- The names of the hosts to which this selector applies
- The backup piece contents to which this selector applies: archivelogs, full, incremental, and autobackup. A combination of these values is also possible.
- The RMAN copy number to which this selector applies. This is configured generally using the RMAN commands `BACKUP … COPIES` or `CONFIGURE BACKUP COPIES` to duplex backup sets to protect against disaster, media damage, or human error.
- The name of the media family to use
- The names of devices to which operations are restricted
- The expiration time (duration) of backup pieces
- How long to wait (duration) for resource availability

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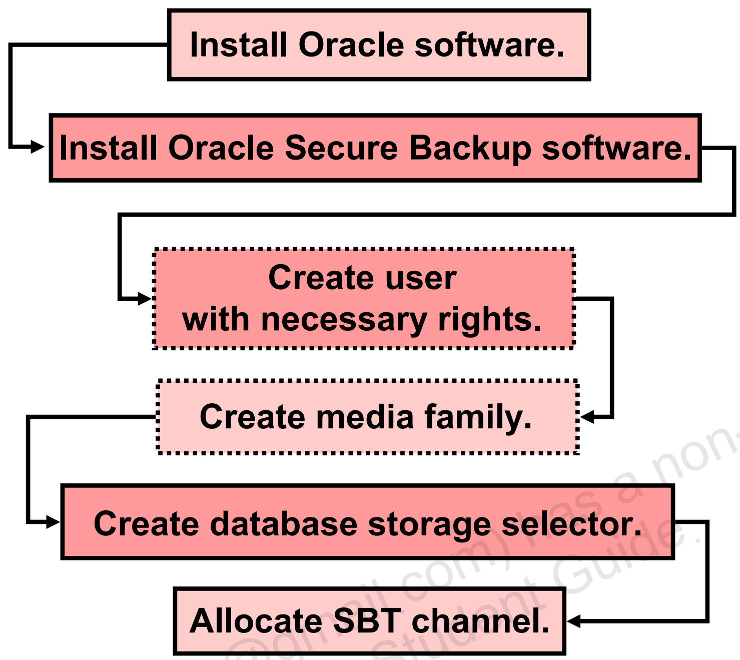
RMAN and Oracle Secure Backup: Usage Model



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RMAN and Oracle Secure Backup: Usage Model

Oracle Secure Backup functions in exactly the same way as any other backup product that provides an SBT implementation. Before using RMAN with Oracle Secure Backup, perform the following steps:

1. Install the Oracle software as well as the Oracle Secure Backup software.
2. Create an Oracle Secure Backup user assigned to the “oracle” class, and with RMAN preauthorization. To create such a user during the Oracle Secure Backup installation, simply change the value of the `create pre-authorized oracle user` parameter to `yes` in the `obparameters` file before installation.
3. Create media families. For example, you could create different media families depending on the type of backup set created: archived logs and data files. By default, Oracle Secure Backup creates the `RMAN-DEFAULT` media family to be used with RMAN.
4. Create Oracle Secure Backup Database Backup Storage Selectors. You could, for example, create one selector for each database.
5. Before submitting RMAN commands to generate backups, or to restore databases, allocate channels of the `SBT_TAPE` type.

Note: When installing the Oracle Secure Backup software, the installer automatically copies the `libobk.so` file to the `/lib` directory. Therefore, by default, you automatically use Oracle Secure Backup each time you allocate an `SBT_TAPE` channel.

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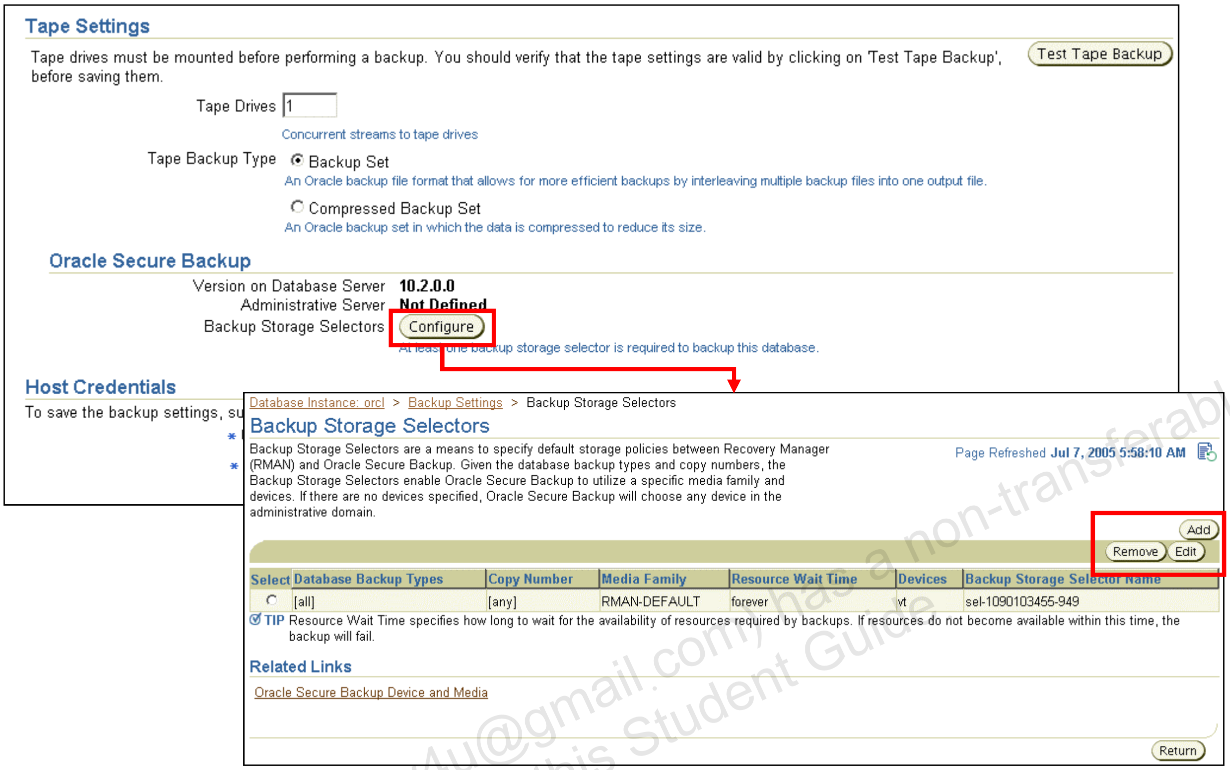
Defining Database Storage Selector



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Defining Database Storage Selector

After you define the administrative server, you need to configure a Database Backup Storage Selector so that you can start creating backups using Oracle Secure Backup through RMAN and Enterprise Manager.

To create a storage selector, perform the following steps:

1. On the Database Control home page, click the Maintenance tab.
2. On the Maintenance page, click the Configure Backup Settings link.
3. On the Configure Backup Settings page, click Configure in the Oracle Secure Backup section. The Backup Storage Selectors page opens. Using this page, you can manage your backup storage selectors. After creating the selector, click Return.

You can also use the following example to create a database storage selector by using the `obtool` command-line interface:

```
mkssel -c * -d * -i * -h EDRSR14P1 -r vt1 ssel1
```

This example creates a Database Backup Storage Selector that is valid for any Oracle database located on the `EDRSR14P1` host. This object is called `ssel1`, and uses the `vt1` tape drive for backing up data.

Note: For more information about how to manage Database Backup Storage Selectors, refer to the *Oracle Secure Backup Administrator's Guide*.

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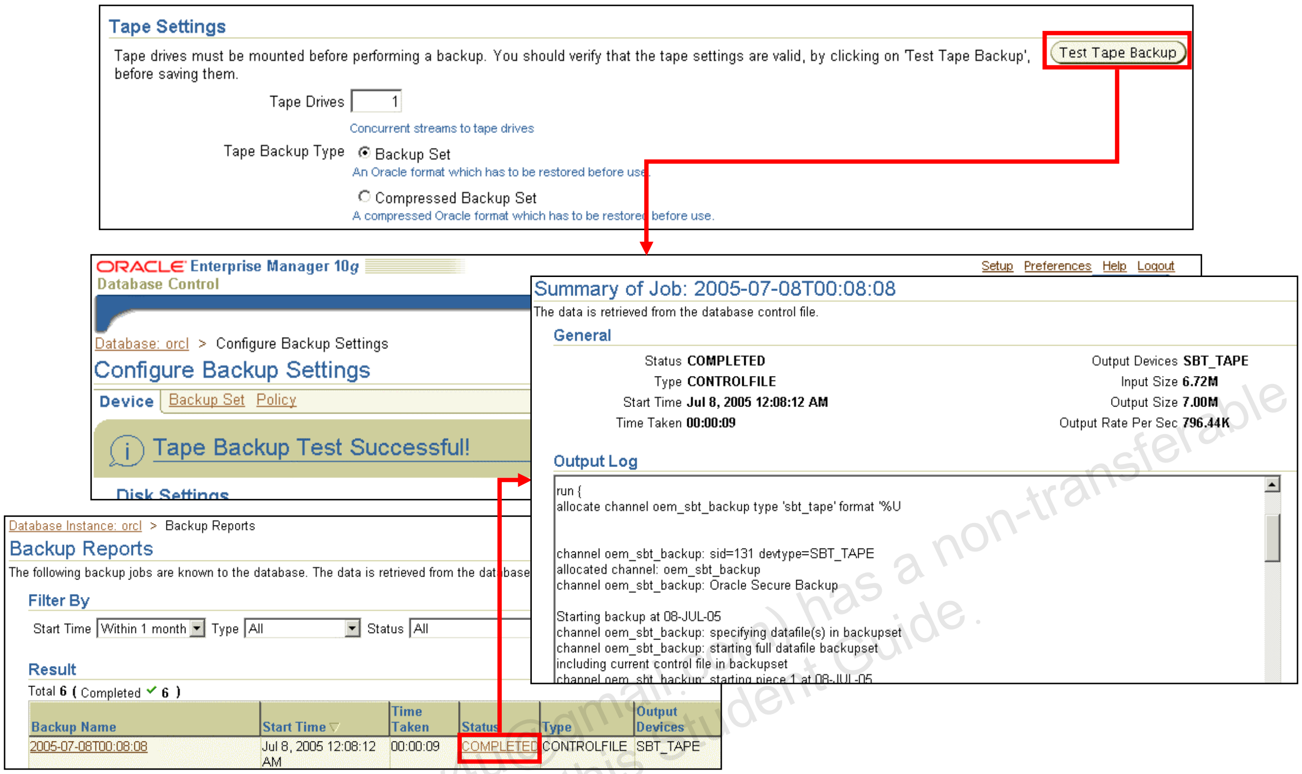
Testing Your Tape Drives



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Testing Your Tape Drives

After you register Oracle Secure Backup to be used by RMAN through EM, you can open the Configure Backup Settings page to test that everything is set up correctly. In the Tape Settings section, click Test Tape Backup. This creates a backup of the control file, issues the `RESTORE VALIDATE CONTROLFILE` RMAN command, and deletes the control file copy from tape.

After this is done, you are taken back to the Configure Backup Settings page, where you can see the Tape Backup Test Successful message.

You can then look at the backup report. On the Maintenance page, click the Backup Report link in the Backup/Recovery section. Then, on the Backup Report page, locate the corresponding report, and click its corresponding Status. You are directed to the Summary page, where you can see the detail log information.

Note: The following is a script example that is automatically executed by RMAN to test your tape drive.

```
run { allocate channel oem_sbt_backup type 'sbt_tape' format '%U';
backup as BACKUPSET current controlfile tag '12152004064001';
restore controlfile validate from tag '12152004064001';
release channel oem_sbt_backup;}
allocate channel for maintenance type 'sbt_tape' ;
delete noprompt backuppiece tag '12152004064001';
```

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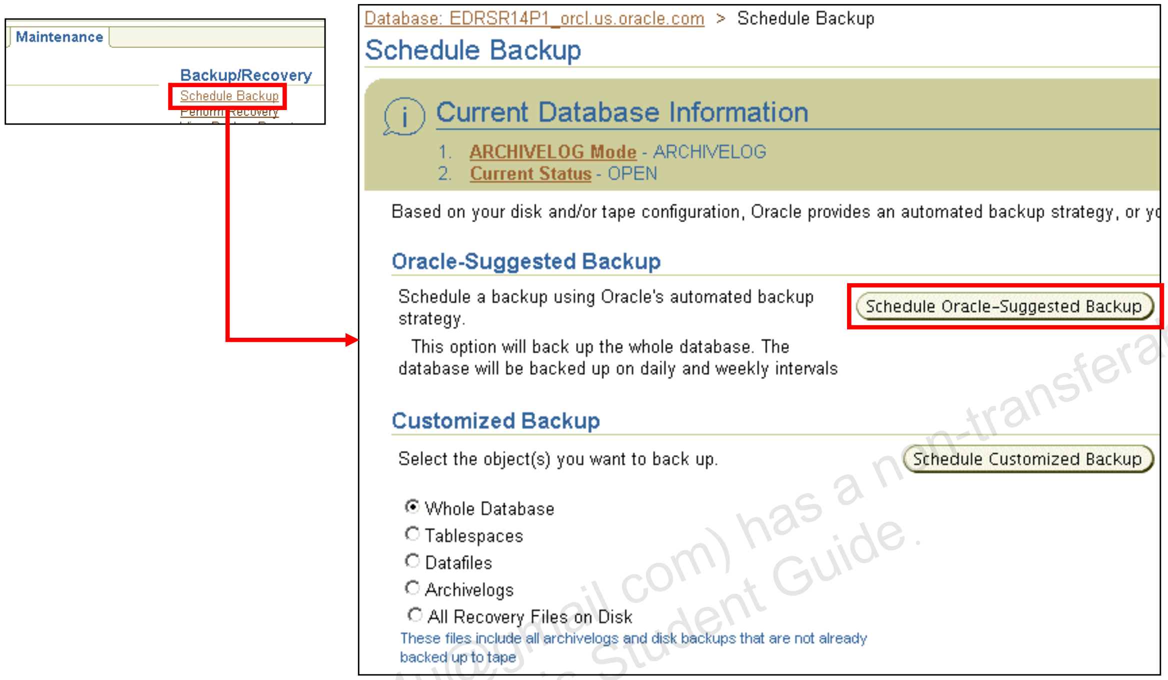
Scheduling Backups by Using EM Database Control



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Scheduling Backups by Using EM Database Control

Using EM Database Control, you can schedule backups to either disks or tapes, or to both.

To schedule a backup, click the Schedule Backup link on the Maintenance tabbed page.

On the Schedule Backup page, you can choose either the Oracle-Suggested Backup strategy or Customized Backup.

In the slide example, the Oracle-suggested strategy is used by clicking Schedule Oracle-Suggested Backup.

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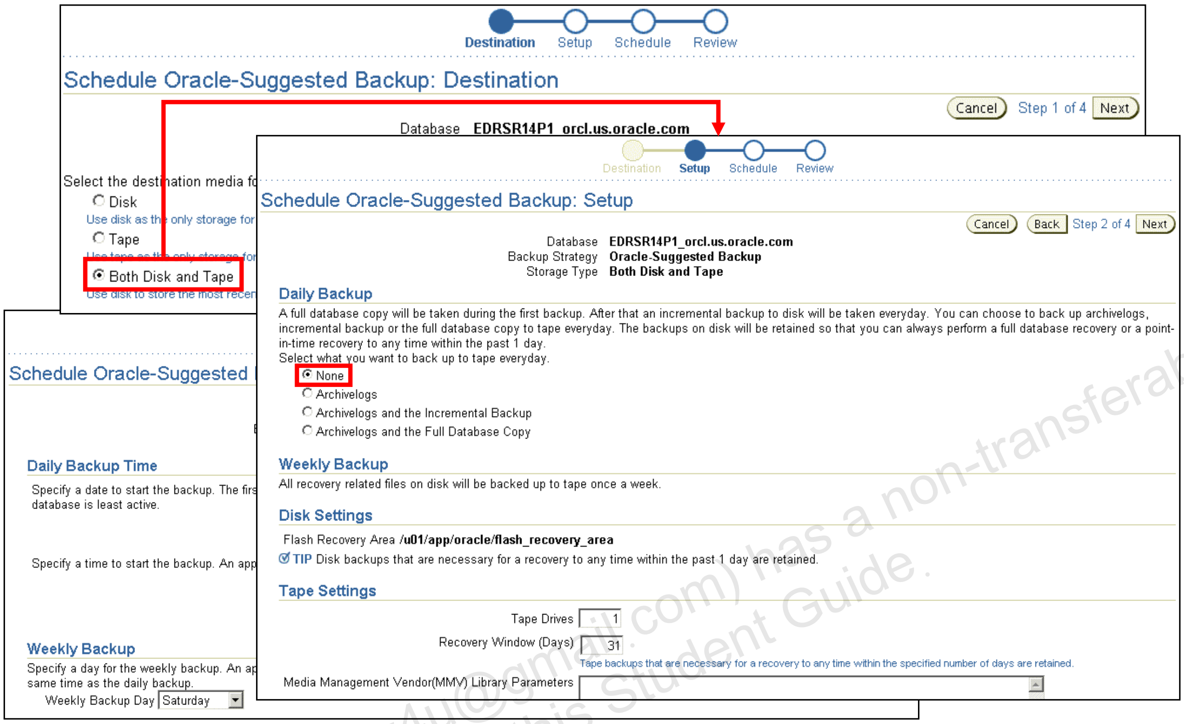
Oracle-Suggested Strategy for Backups



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Oracle-Suggested Strategy for Backups

On the Schedule Oracle-Suggested Backup: Destination page, you can select the destination media for your backup. In the slide example, Both Disk and Tape is selected. The idea is to generate a daily backup of the database to disk, and once a week to back up the flash recovery area to tape. The default Oracle-suggested strategy is to use incremental RMAN backups daily to disk.

Click Next to display the Schedule Oracle-Suggested Backup: Setup page, where you can determine what needs to be backed up to tape daily. In the example, you indicate that you do not want to back up data to tape daily by selecting None in the Daily Backup section.

As shown in the example, “all recovery-related files on disk will be backed up to tape once a week,” and “disk backups that are necessary for a recovery to any time within the past 1 day are retained.”

In addition, you can specify your tape settings, such as the Recovery Window, the number of Tape Drives, and the Library Parameters.

Click Next to access the Schedule Oracle-Suggested Backup: Schedule page. On this page, you can define the Daily Backup Time as well as the Weekly Backup Time. Click Next to review your job and then click Submit Job to submit your job.

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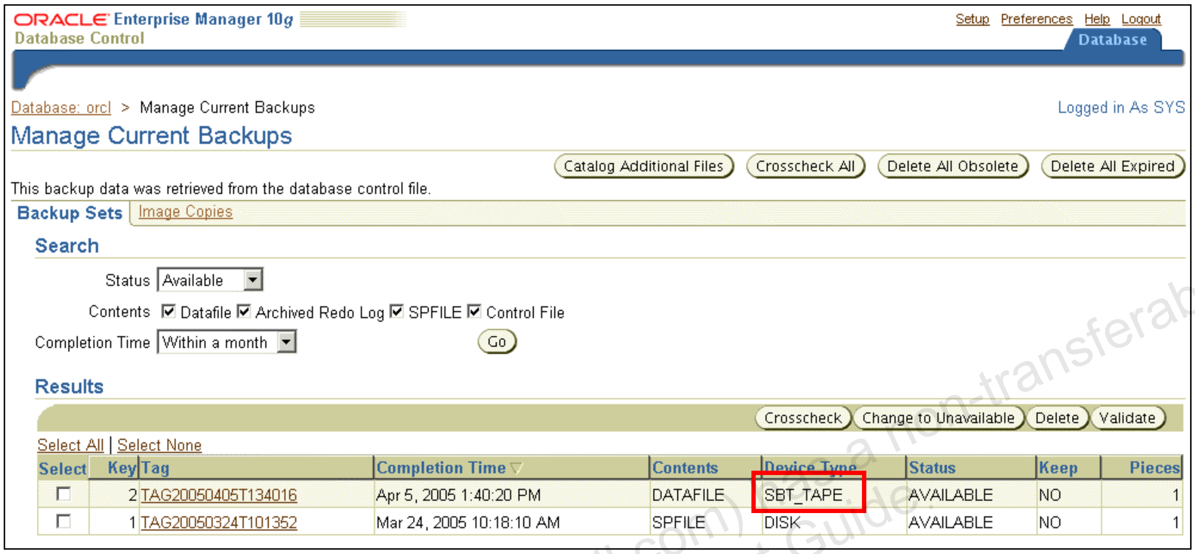
Managing Tape Backups



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Managing Tape Backups

Use the Manage Current Backups page to search for and display a list of backup sets or backup copies and to perform management operations on selected copies, sets, or files. You can access this page from the Maintenance tabbed page.

As you can see in the slide, this page shows you both disk backups and tape backups.

Use the Search section to find backup sets or copies by using Status filters to isolate specific objects. You can then use the available functions on the Manage Current Backups page to manage the files or sets displayed in the Results table.

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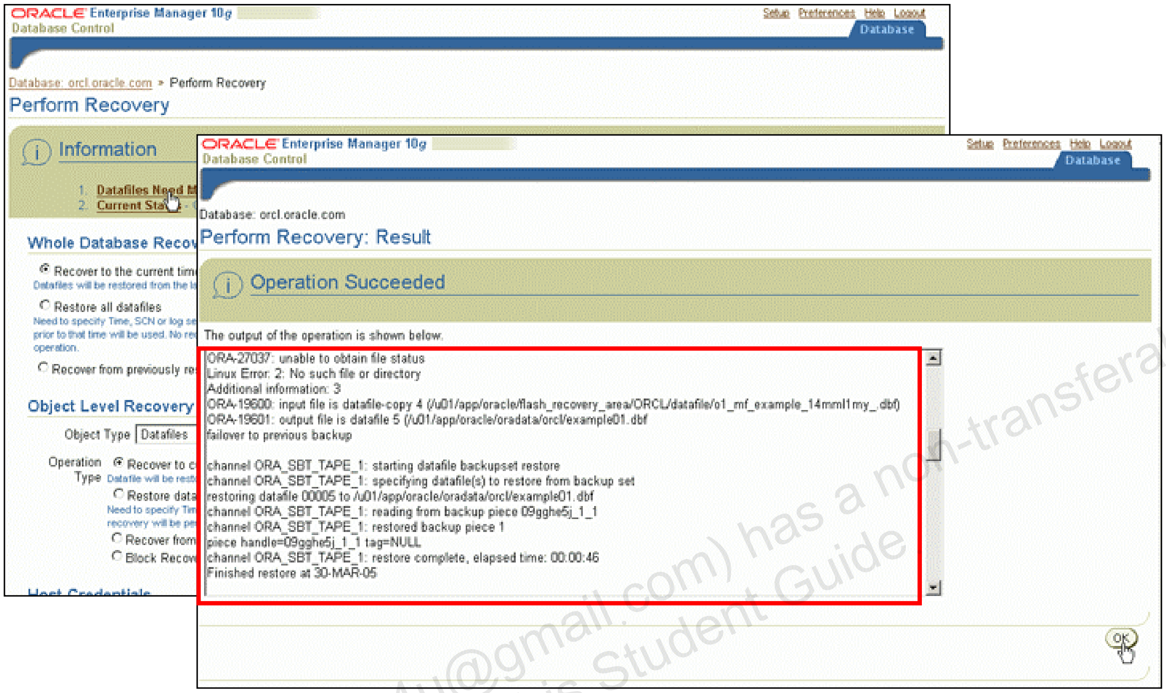
Performing Database Recovery by Using Tape Backups



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Performing Database Recovery by Using Tape Backups

You can access the Perform Recovery page from the Maintenance tabbed page. Using the Perform Recovery page, you can perform various kinds of database recovery. You can recover the whole database, a particular data file, or a tablespace.

In the background, RMAN requests the necessary files from previous backups. If those files are stored on tape, Oracle Secure Backup automatically determines which tape to use. If those tapes are not immediately available (off-site), RMAN waits for the resources. This wait time is defined by the resource wait time parameter of your backup storage selector that defaults to one hour.

When you need to perform recovery of your database, following a data file incident, RMAN automatically selects the most appropriate backup to restore. This means that RMAN may decide to fall back to a tape backup created by Oracle Secure Backup. This operation is totally transparent and is automatically done by RMAN.

The screenshot (given in the slide) illustrates this situation where the needed data file to be restored was inadvertently deleted from the flash recovery area. As you can see, RMAN automatically switches from a previous backup that was generated by Oracle Secure Backup.

Note: RMAN recovers the data file or database, whereas Oracle Secure Backup just restores the necessary files if they are located on tape.

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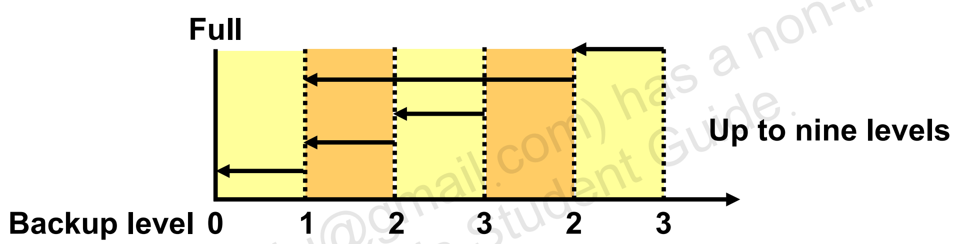
Backing Up File System Files with Oracle Secure Backup

- Two ways of backing up data
  - On-demand backups
  - Scheduled backups
- Two types of backup
  - Full: All specified files
  - Incremental: Only files that have changed since the last lower backup



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Backing Up File System Files with Oracle Secure Backup

You can back up file system files in two different ways:

- By creating on-demand (ad hoc or one-time only) backup jobs, and submitting them to the Oracle Secure Backup scheduler
- By scheduling backup jobs to run at predetermined times. The Oracle Secure Backup scheduler automatically initiates such jobs upon a day and time that you specify.

Using Oracle Secure Backup, you create two types of backup:

- **Full backups:** A full backup backs up all specified files, regardless of when they were last backed up. This option is the same as backup level 0. You can also perform full backups in such a manner that it does not affect the full or incremental backup schedule. This is useful when you want to create an archive for off-site storage without disturbing your schedule of incremental backups.
- **Incremental backups:** There are nine different incremental backup levels. In each level, Oracle Secure Backup backs up only those files that have changed since the last backup at a lower (numerical) backup level. You can also ask Oracle Secure Backup to back up only those files that have been modified since the last backup, regardless of its backup level. This option is the same as backup level 10, and is called “incr.”

Note: Oracle Secure Backup does not support the incr backup level in conjunction with some platforms, including certain NAS devices. Notably, this includes Network Appliance filers.

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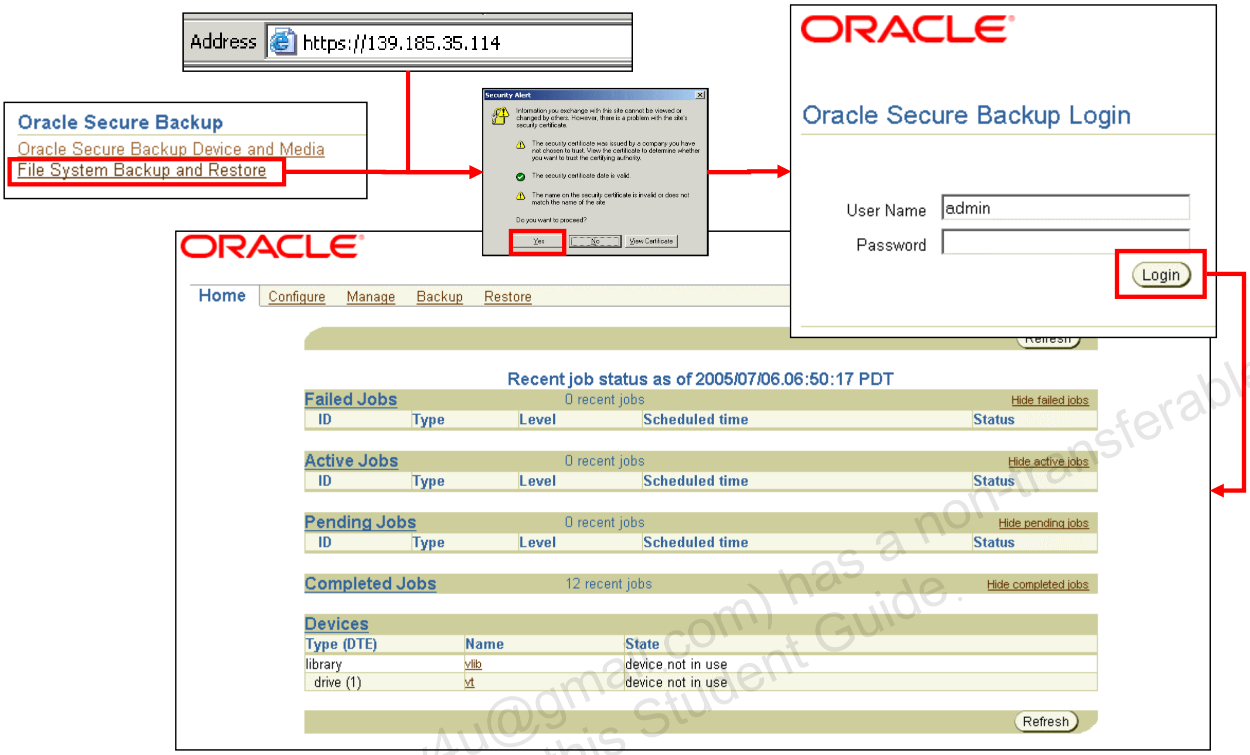
Oracle Secure Backup Web Tool



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Oracle Secure Backup Web Tool

Oracle Secure Backup invokes Apache to start the GUI tool. The Apache Web server is started in the background during the installation process.

To start Oracle Secure Backup by using a Web browser:

- Ensure that:
  - Service daemon `observiced` is running on the machine
  - Oracle Secure Backup Web server `obhttpd` is running
- Invoke a Web browser on any machine that can connect to the secure HTTPS port (usually port 443) on your administrative server
- In the browser's URL or Location field, enter: `https://`*`administrative-server-name`*

You can also access the Web tool directly from the EM Maintenance page. When the Security Alert box appears, click Yes.

When the Oracle Secure Backup login page appears, enter `admin` in the User Name field. This is the default username created during installation. Leave the Password field empty, and click Login.

The Oracle Secure Backup Web tool is best to handle the following operations:

- If you want to add client hosts to your Oracle Secure Backup configuration
- To manage Oracle Secure Backup daemons
- To manage additional Oracle Secure Backup users along with their class names and e-mail addresses

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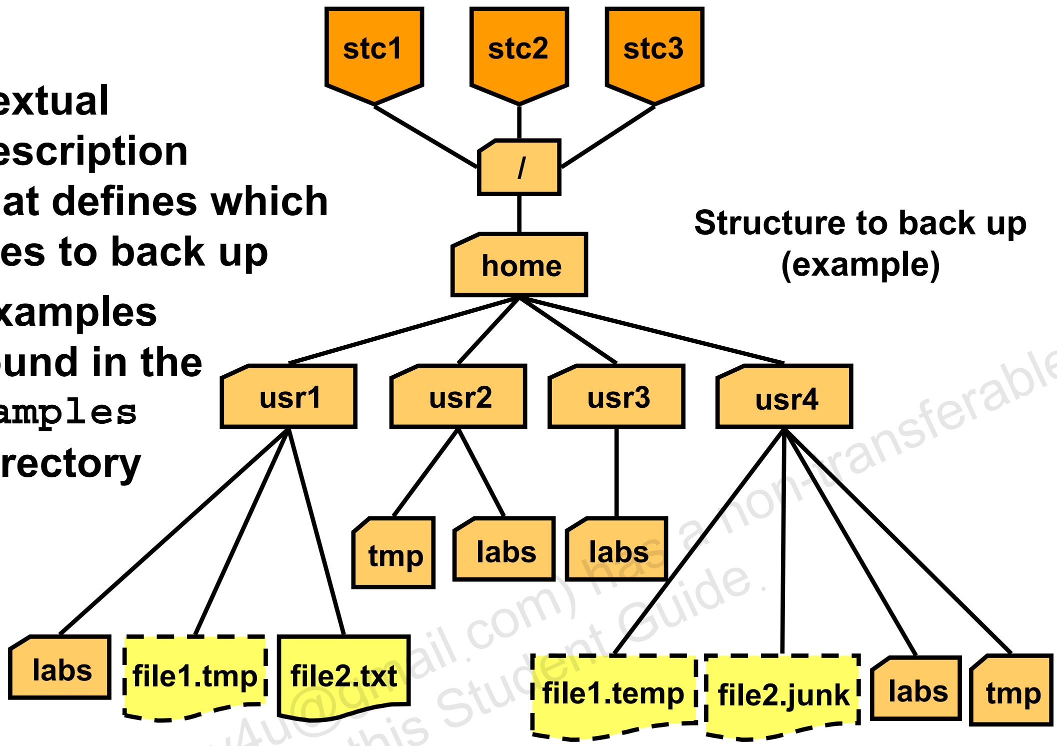
Oracle Secure Backup Data Set Scripts

- **Textual description that defines which files to back up**
- **Examples found in the `samples` directory**



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Oracle Secure Backup Data Set Scripts

With Oracle Secure Backup, you need to define data sets to describe the list of files that you want to back up.

A data set is a textual description that indicates to Oracle Secure Backup what files to back up.

To enable this, data sets employ a lightweight language. With it, Oracle Secure Backup provides you great flexibility in how you build and organize the definitions of the files you want to protect.

The graphic in the slide illustrates the files that you can find on three different hosts. Using the data set script defined in the next slide, you can back up the files (shown in this slide), except the ones corresponding to the dashed boxes.

To familiarize yourself with the data set language, you can find data set file examples in the `/usr/local/oracle/backup/samples` directory.

Note: Never back up files or directories matching `*.backup` and `*~`.

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Data Set Script: Examples

```
# Dataset "common-exclusions":
exclude name tmp
exclude name *.tmp
exclude name *.temp
```

```
exclude name *~
include path /home/usr1
include path /home/usr2
include host stc1
include host stc2
include host stc3 {
 include dataset common-exclusions
 include path /home/usr3
  before backup optional "/etc/local/nfy '/usr3 begin'"
  after backup optional "/etc/local/nfy '/usr3 end'"
 include path /home/usr4 {
  exclude name *.junk
 }
}
```

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Data Set Script: Examples

The slide shows you two data set description files that can be used to back up the data shown in the previous slide.

The first script is used to exclude directories and files starting with `tmp`, `*.tmp`, and `*.temp`.

The second script is used to back up the following data on hosts `stc1`, `stc2`, and `stc3`:

- On `stc1` and `stc2`: `/home/usr1` and `/home/usr2`, except files starting with `*~`
- On `stc3`: `/home/usr1`, `/home/usr2`, `/home/usr3`, and `/home/usr4`, except files starting with `*~`, `tmp`, `*.tmp`, `*.temp`, and `*.junc` only for `/home/usr4`

When Oracle Secure Backup starts backing up data in `/home/usr3` on `stc3`, it also executes the `/etc/local/nfy` executable. The same executable is also executed when Oracle Secure Backup finishes its backup of `/home/usr3`.

When performing a normal (nondatabase) backup, you may want to skip files that would be included in a database backup. Examples of such files include the database files themselves, control files, redo logs, flashback logs, and so on. To exclude these files, specify the `exclude oracle files` directive in your data set.

Note: For more information about the data set language, refer to the *Oracle Secure Backup Administrator's Guide*.

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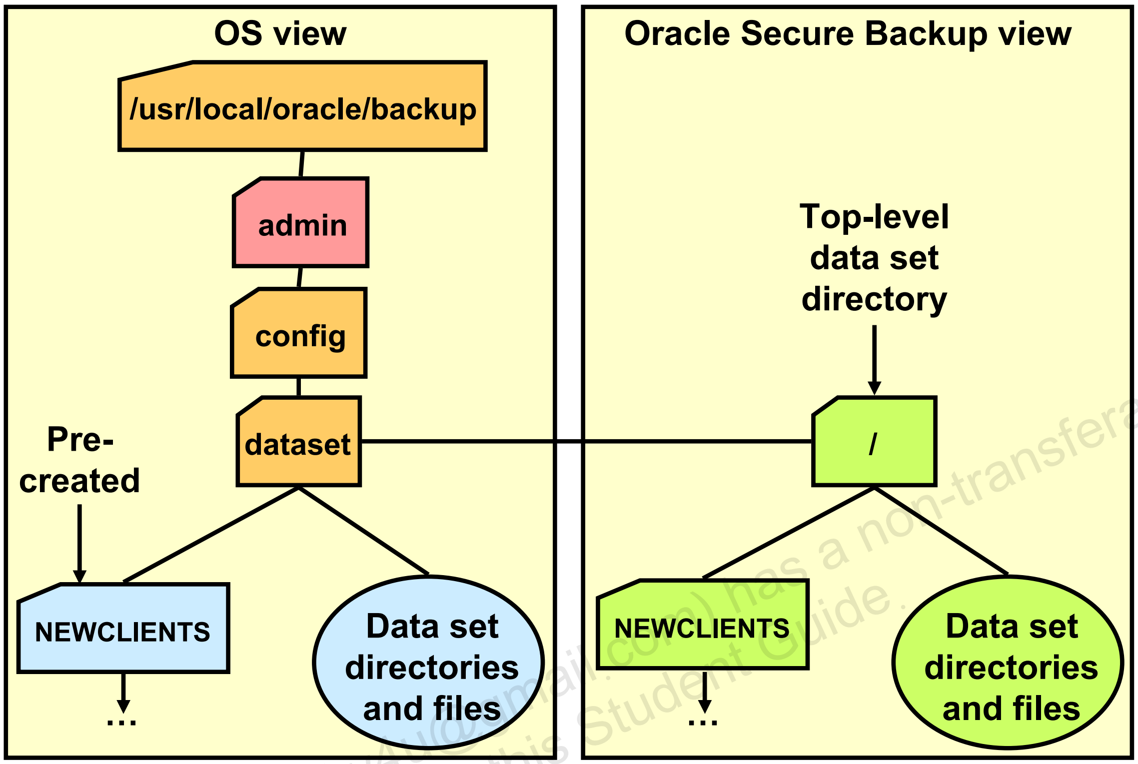
Data Set Organization



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Data Set Organization

As shown in the slide, data set description files are hierarchically organized into a directory structure.

From the administrative server point of view, the data set description files and directories are stored in the `/usr/local/oracle/admin/config/dataset` file system directory. As shown on the left part of the illustration, the `NEWCLIENTS` directory is automatically created during installation. This directory can be used to store your future data set description files.

Using either `obtool` or the Oracle Secure Backup Web interface, you have access to special commands that enable you to manage data set description files and directories. Therefore, from an Oracle Secure Backup perspective, you can create your own data set directories and description files, and organize them into a tree-like structure. This is shown on the right part of the illustration.

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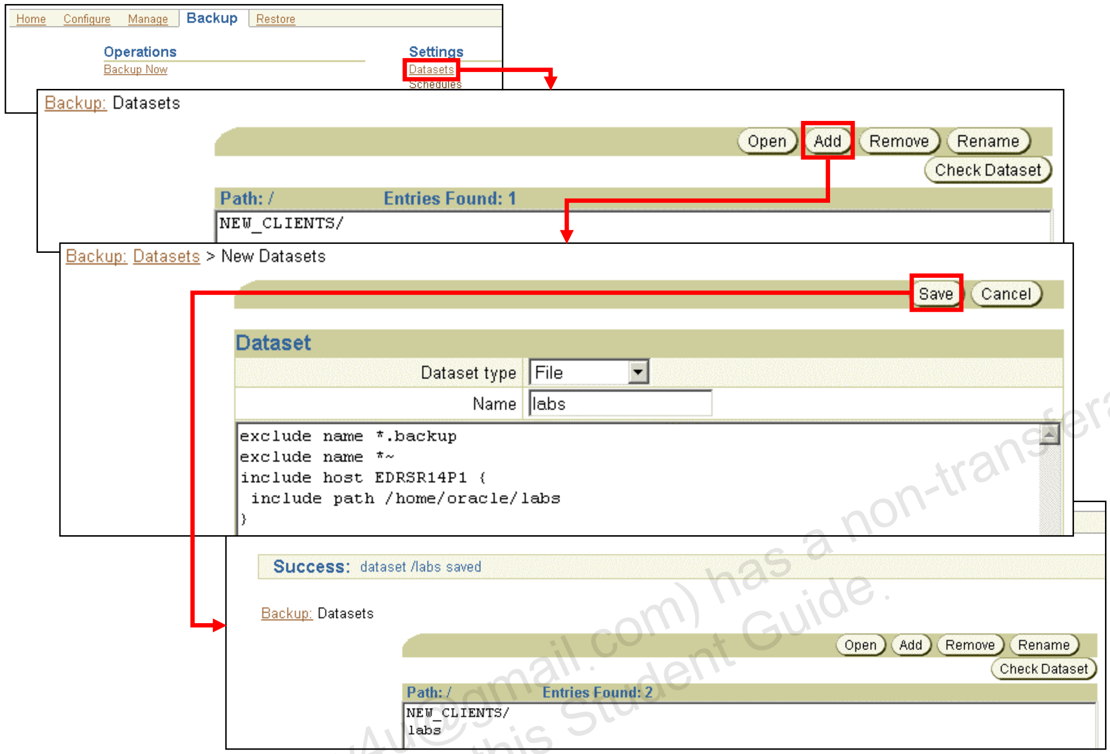
Creating Data Sets Using the Web Interface



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Creating Data Sets by Using the Web Interface

Use the Oracle Secure Backup Web interface to create a data set by performing the following steps:

1. On the home page, click the Backup tab in the menu bar.
2. From the Backup menu, click Datasets in the submenu under Settings. The Datasets page appears. Data set directories appear in the Path box with a slash as the last character in the name.
3. Click the Add button to create a new data set. When you create a new data set description, the initial contents of the data set is defined by a data set template.
4. Select File or Directory from the “Dataset type” list. You can create data set directories to organize your data definitions. By default, a data set file is created in the `/usr/local/oracle/backup/admin/dataset/NEW_CLIENTS` directory.
5. In the Name field, enter a name for the data set.
6. Update the data set statements displayed in the template file to define your backup data. See the “Data Set Script: Examples” section for more information.
7. Click the Save button to accept your entries and return to the Datasets page.

If your data set has errors, a message appears in the Status section. As you can see in the slide, you can check, edit, rename, and remove data sets.

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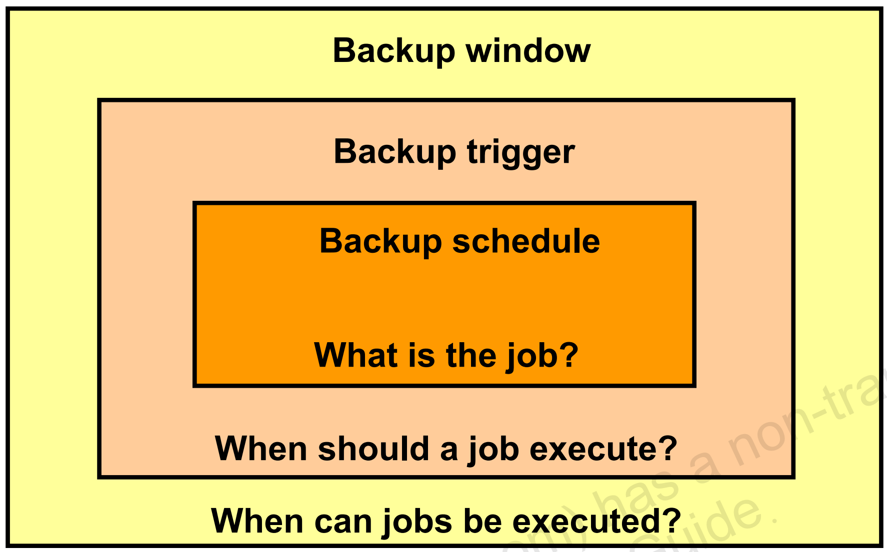
File System Files: Backup Concepts



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File System Files: Backup Concepts

The slide illustrates the important concepts relating to backing up file system files by using Oracle Secure Backup:

- A backup window defines a time range within which Oracle Secure Backup performs scheduled backup jobs. You must have at least one backup window in order for scheduled backup jobs to run. However, a backup window is not associated with any particular scheduled backup jobs. A default backup window is always created, and is identified as `daily 00:00-24:00`.
- A backup trigger is a calendar-based time at which a particular scheduled backup becomes eligible to run. One particular scheduled backup can be associated with more than one backup trigger.
- A backup schedule basically tells Oracle Secure Backup what data to back up, and how to back up that data.

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Oracle Secure Backup Jobs

- Backups using data sets:
  - Data set jobs: One for each data set request
  - Backup jobs: One for each impacted host for each data set job
- File system file restores:
  - Restore jobs: One for each needed backup image
- RMAN jobs
- For each job, Oracle Secure Backup maintains:
  - A log
  - A running transcript

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Oracle Secure Backup Jobs

Oracle Secure Backup creates jobs in response to the work that you ask it to do. It assigns each job a name, called a job identifier, that is unique among all jobs within the administrative domain. Several events cause Oracle Secure Backup to create new jobs:

- Oracle Secure Backup creates a *data set job* for each scheduled backup request, or each time you explicitly request a backup using a data set. An example of such a job identifier is `admin/233`.
- At the scheduled start time for a data set job, Oracle Secure Backup creates one subordinate *backup job* for each host it includes. An example of such a job identifier is `admin/233.1`.
- Each time you explicitly request that Oracle Secure Backup restore data, Oracle Secure Backup creates a *restore job* for each backup image that must be read to effect the restore.
- RMAN creates an Oracle Secure Backup job with the `Oracle Secure Backup` type, instead of the `dataset` type. Rather than using the data set name, the RMAN job type contains the database name.

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Oracle Secure Backup Jobs (continued)

Oracle Secure Backup keeps a log for each job. This log describes high-level events, such as the creation, dispatch, and completion times of the job.

Oracle Secure Backup also maintains a running transcript for each job. The transcript describes the details of the job's operation. Oracle Secure Backup creates this transcript when dispatching the job for the first time, and updates it as the job progresses. When a job requires operator assistance, Oracle Secure Backup prompts for assistance using the transcript.

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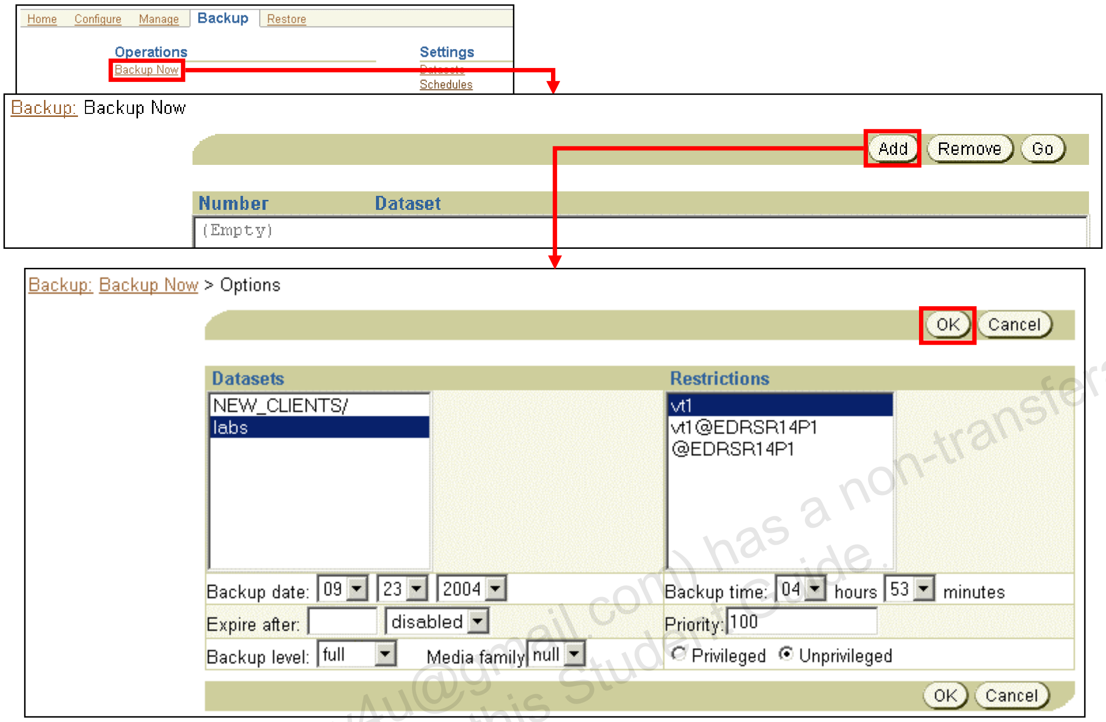
Creating On-Demand Backup Requests



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Creating On-Demand Backup Requests

To create an on-demand backup request with the Web interface, perform the following steps:

1. On the Backup tabbed page, click Backup Now. The Backup Now page appears.
2. To create a new backup, click the Add button. The Options page appears.
3. Select one or more data sets from the Datasets box.
4. Optionally, select a future date and time for the backup to run from the “Backup date” and “Backup time” drop-down lists. If you leave these fields unchanged, Oracle Secure Backup considers your backup job immediately “runnable.”
5. Optionally, enter an expiration time in the “Expire after” field.
6. Select a backup level from the “Backup level” drop-down list. Your choices are: full (default), 1 to 9, incr, and offsite.
7. From the “Media family” drop-down list, select a media family to which the data of this backup should be assigned.
8. Optionally, select one or more device restrictions from the Restrictions box.
9. Optionally, change the priority (1–100) of the backup job in the Priority field. The lower this value, the greater the priority assigned to the job by the scheduler.
10. Click OK to accept your selections.

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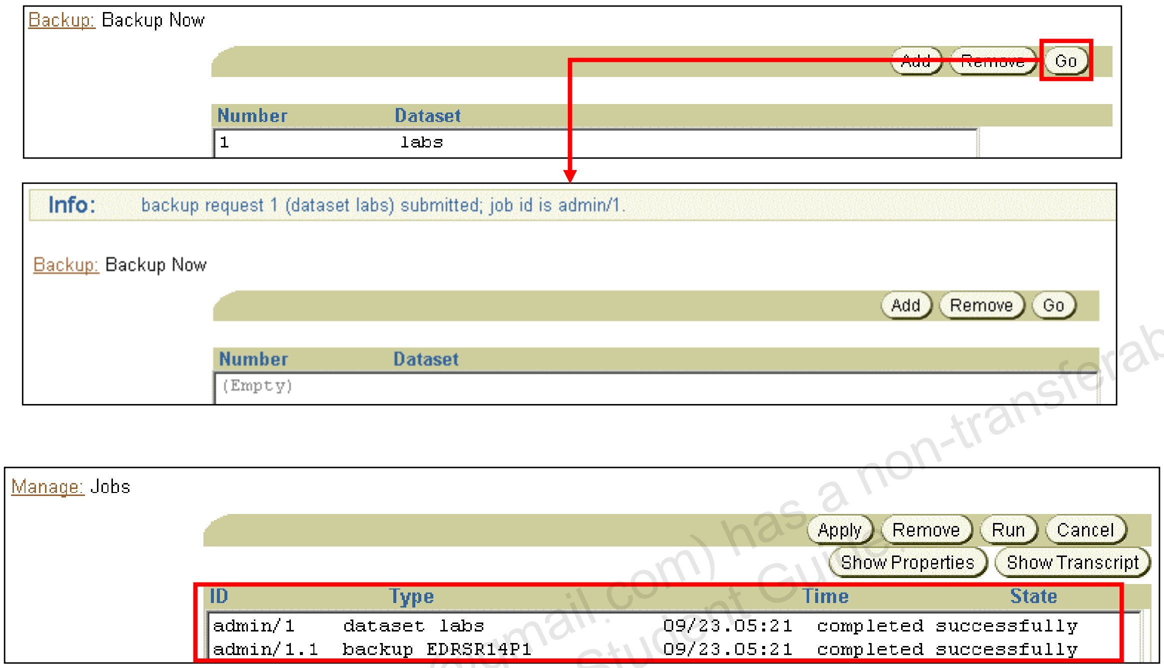
Sending Backup Requests to the Scheduler



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Sending Backup Requests to the Scheduler

To send backup requests to the scheduler by using the Oracle Secure Backup Web interface, perform the following steps:

1. On the Backup menu, click Backup Now in the submenu under Operations. The Backup Now page appears.
2. Click the Go button. Oracle Secure Backup sends each backup request that appears in the Number/Dataset central panel to the scheduler. A message appears in the status section for each request acknowledged by the scheduler.
   Oracle Secure Backup deletes each backup request upon its acceptance by the scheduler. As a result, the Number/Dataset central panel is empty upon completion of the Go operation.
3. To view the status of your job, access the Manage page, and click the Jobs link. On the Jobs page, you can see the output of your job as illustrated in the slide.

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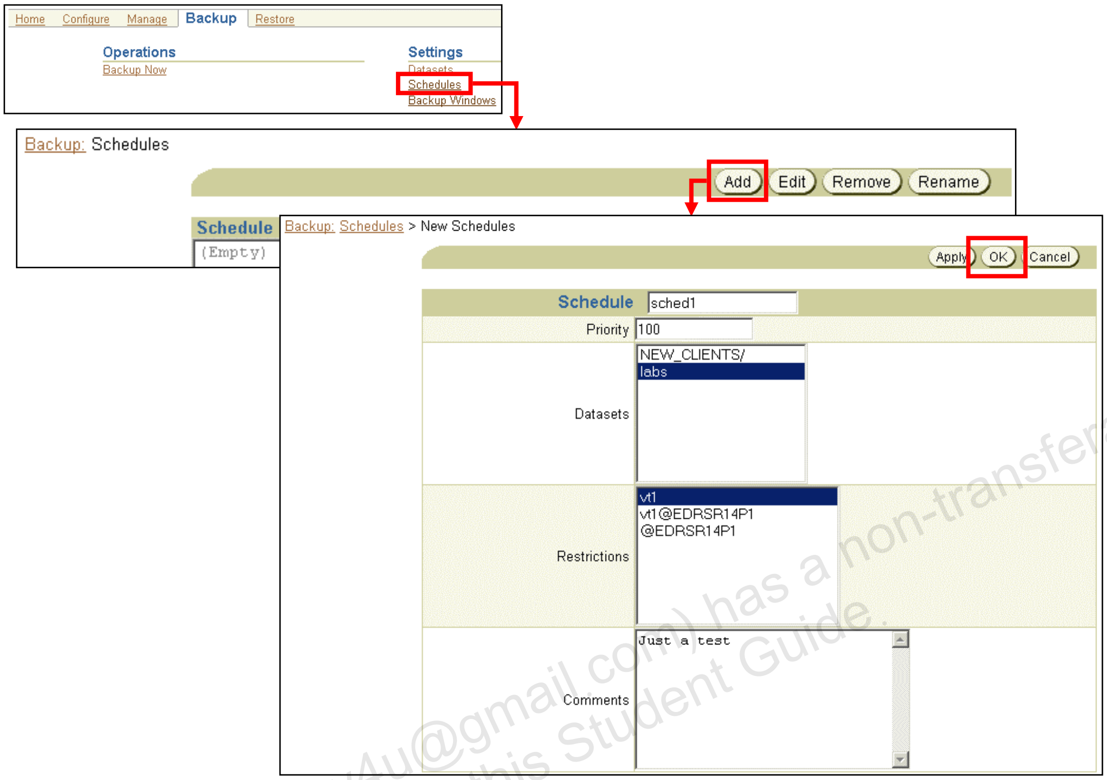
Creating Backup Schedules



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Creating Backup Schedules

A backup schedule tells Oracle Secure Backup what data to back up, and how to back up the data. Perform the following steps to create a schedule by using the Oracle Secure Backup Web interface:

1. On the Backup menu, click Schedules in the submenu under Settings. The Schedules page appears. Backup schedules appear in the “Schedule name” box in the central panel.
2. Click the Add button to add a new schedule. The New Schedules page appears.
3. Enter a name for the schedule in the Schedule field.
4. Enter a priority number for the backup job in the Priority field.
5. In the Datasets box, select one or more data sets that you want to include in the backup job.
6. Optionally, select a restriction in the Restrictions box. You can restrict scheduled backups to specific devices.
7. Optionally, enter any information that you want to store with the backup schedule in the Comments field.
8. Click OK to save your changes and return to the Schedules page.

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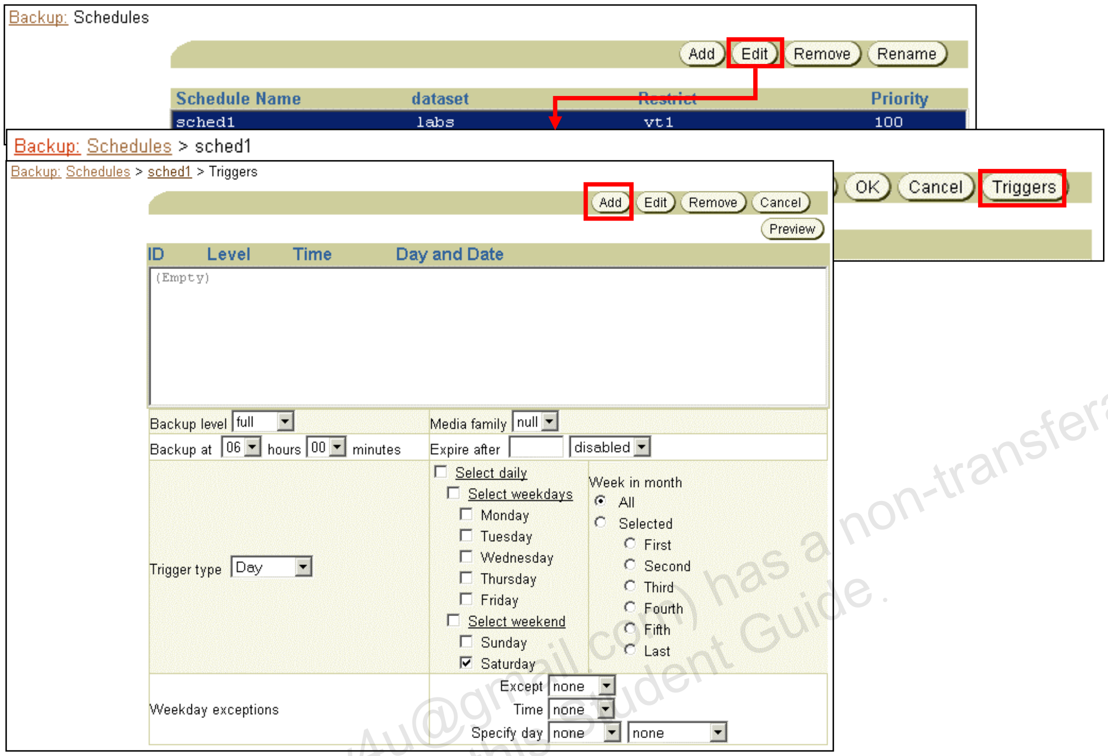
Creating Backup Triggers



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Creating Backup Triggers

A trigger is a calendar-based time at which a scheduled backup becomes eligible to run. Perform the following steps to create triggers by using the Oracle Secure Backup Web interface:

1. Go to the Backup Schedules page and select the schedule for which you want to add a trigger. Click Edit.
2. On the corresponding schedule page, click Triggers. The Triggers page appears with the default Day in the “Trigger type” field.
3. Using the “Trigger type” field, select a time representation that you want to use to define when to perform the backup job.
4. After this is done, complete the needed information, and click Add to accept your entries and add the trigger.

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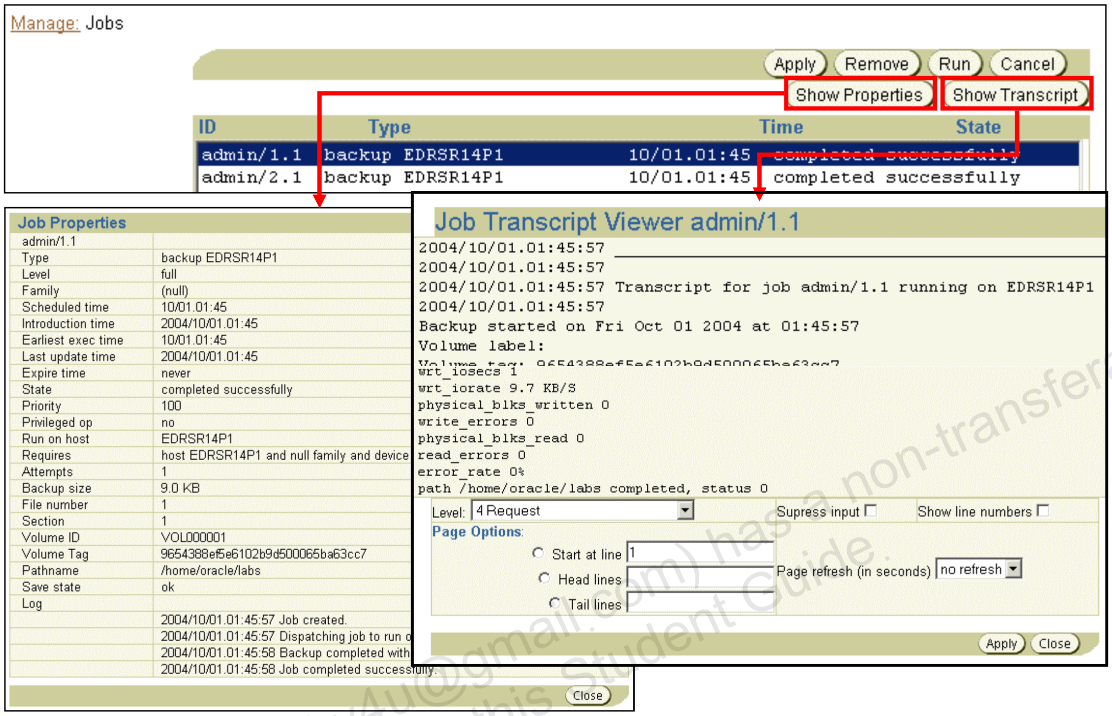
Viewing Job Properties and Transcripts



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Viewing Job Properties and Transcripts

Perform the following steps to view a job's properties by using the Oracle Secure Backup Web interface:

1. On the Manage page, click the Jobs link in the Maintenance section. You are directed to the Jobs page. Select a job ID from the central panel of the Jobs page.
2. Click the Show Properties button. The Job Properties page appears showing the characteristics of the selected job.

Perform the following steps to view a job's transcript by using the Oracle Secure Backup Web interface:

1. Select a job from the job management table in the central panel of the Jobs page.
2. Click Show Transcripts. A transcript page appears.
3. Scroll down the page to view more information. At the end of the page, you can modify the transcript-viewing criteria.
4. Optionally, click the "Start at line" box and enter a line number at which you want the transcript view messages to start.
5. Optionally, select the "Suppress input" check box to suppress input requests. When a request for input is recognized, Oracle Secure Backup prompts for a response.
6. Click Apply to accept your changes, if any, and redisplay the transcript.

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Restoring File System Files with Oracle Secure Backup

Two ways for restoring data

- Catalog-based restore: Based on catalog backups history
- Raw restore: Based on your memory

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Restoring File System Files with Oracle Secure Backup

With Oracle Secure Backup, you can restore data in two different ways:

- By browsing backup catalogs for the file system objects of interest. After you have located their names and selected the instances to restore, you may direct Oracle Secure Backup to perform the restore. This is called catalog-based restore.
- By knowing the names of the file system objects of interest and the secondary storage location (volume ID and archive file number) in which they are stored. This is called raw restore.

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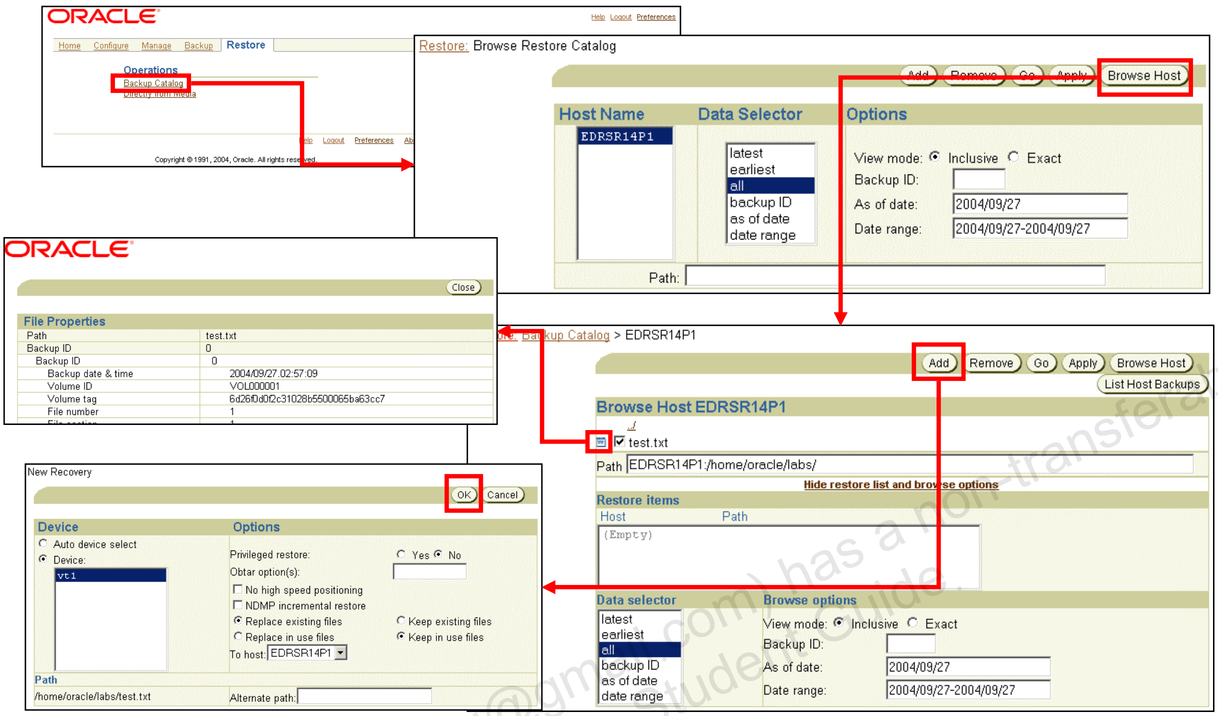
Creating a Catalog-Based Restore Request



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Creating a Catalog-Based Restore Request

To browse a backup catalog for data restore, perform the following steps:

1. On the home page, click the Restore tab. The Restore tabbed page appears.
2. On the Restore tabbed page, click the Backup Catalog link in the Operations section.
3. On the Browse Restore Catalog page that appears, select the client from which the data was originally saved in the Host Name list.
4. Select one or more data selectors from the Data Selector list.
5. Click Browse Host. The Browse Host page appears, with the selected directory displayed.
6. Click a directory name to make it your current directory and view its contents. You can repeat this operation many times to find the data you want to restore.
7. Select the check box next to the name of each file system file you want to restore. Doing so requests that Oracle Secure Backup restore each instance of the file identified by the data selector. To learn the identity of those instances, view the object's properties page by clicking the adjacent Properties button.
8. Click the Add button. The New Recovery page appears.

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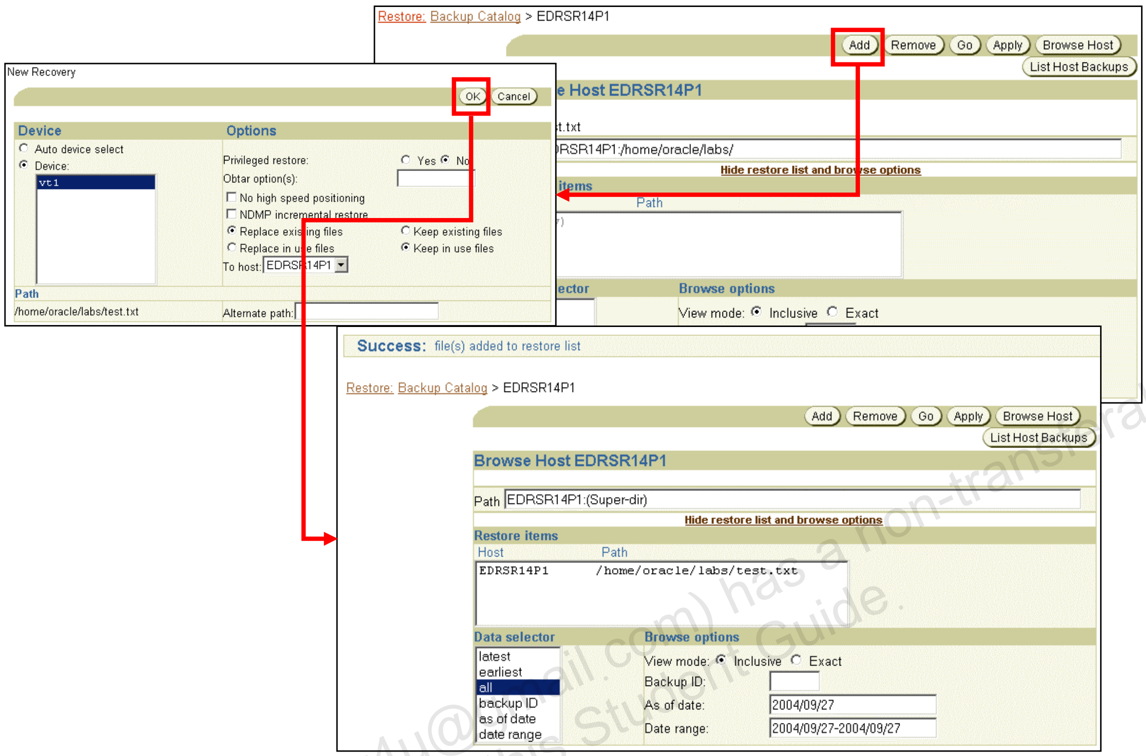
Creating a Catalog-Based Restore Request



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Creating a Catalog-Based Restore Request (continued)

9. Optionally, enter an alternate path name for each file or directory to restore. The original path name of each object you previously selected appears in the lower-left portion of this page. To its right is a text box in which you may enter the alternate path name. If you leave this blank, Oracle Secure Backup restores the data using its original name.
10. Optionally, click the Device option button and select a tape drive to use to perform the restore. By default, Oracle Secure Backup automatically selects the best drive to use.
11. Select "NDMP incremental restore" to direct certain NAS data servers to apply incremental restore rules. Normally, recoveries are additive: each file and directory restored from a full or an incremental backup is added to its destination directory. When you select NDMP incremental restore, NAS data servers that implement this feature restore each directory to its exact state as of the last incremental backup image applied during the restore job. Files that were deleted before the last incremental backup are deleted by the NAS data service upon restore of that incremental backup.

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Creating a Catalog-Based Restore Request (continued)

12. Select "Replace existing files" to overwrite any existing files with those restored from the backup image. Alternatively, select "Keep existing files" to keep any existing files instead of overwriting them with files from the backup image.
13. Click OK. Oracle Secure Backup displays the Browse Host page. The restore request you just made appears in the "Restore items" list.

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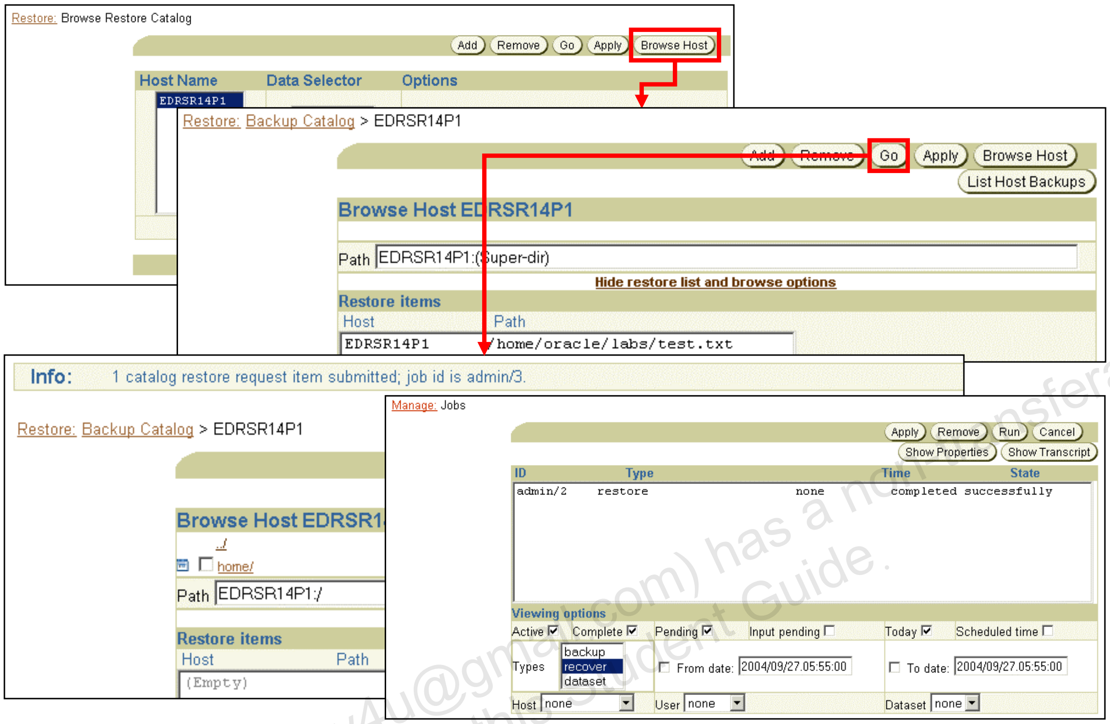
Sending Catalog-Based Restore Requests to the Scheduler



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Sending Catalog-Based Restore Requests to the Scheduler

Perform the following steps to send catalog-based restore requests to the scheduler by using the Oracle Secure Backup Web interface:

1. On the Browse Restore Catalog page, select any host from the Host Name list.
2. Click Browse Host. Oracle Secure Backup displays the Browse Host page.
3. Click Go. The Web tool sends each restore request that appears in the “Restore items” list to the scheduler. A message appears in the status area for each request acknowledged by the scheduler. It might say, for example, `2 catalog restore request items submitted; job id is admin/2`. Oracle Secure Backup deletes each restore request upon its acceptance by the scheduler. As a result, the “Restore items” list box is empty upon completion of the Go operation.
4. To view the status of your job, go to the Manage page, and click the Jobs link. On the Jobs page, select “recover” in the Types field, and click Apply. You can see the output of your job.

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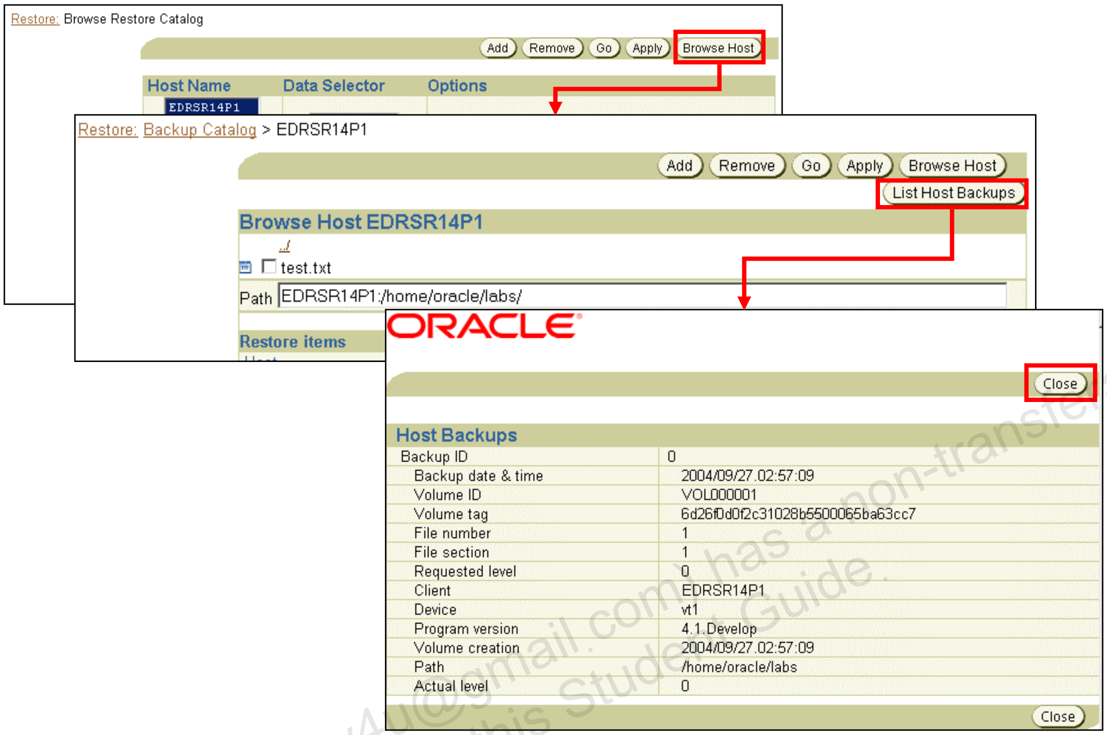
Listing All Backups of a Client



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Listing All Backups of a Client

Perform the following steps to list all backups of a client by using the Oracle Secure Backup Web interface:

1. On the Browse Restore Catalog page, select any host from the Host Name list.
2. Click Browse Host. Oracle Secure Backup displays the Browse Host page.
3. Click the List Host Backups button. A properties page appears. Click the Close button when you have finished viewing this window.

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Summary

In this lesson, you should have learned how to:

- Describe the Oracle Secure Backup architecture and how it benefits your environment
- Discuss basic Oracle Secure Backup media management concepts
- Install and configure Oracle Secure Backup
- Use RMAN and Oracle Secure Backup to back up and restore the Oracle database
- Use Oracle Secure Backup to back up and restore file system files

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Miscellaneous Topics

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Appendix Overview

BFT
ROWID
TTG

This appendix assists you to:

- Use bigfile tablespaces for very large databases (VLDB)
- Describe the row IDs for bigfile tablespaces
- Use temporary tablespace groups (TTG) for VLDB

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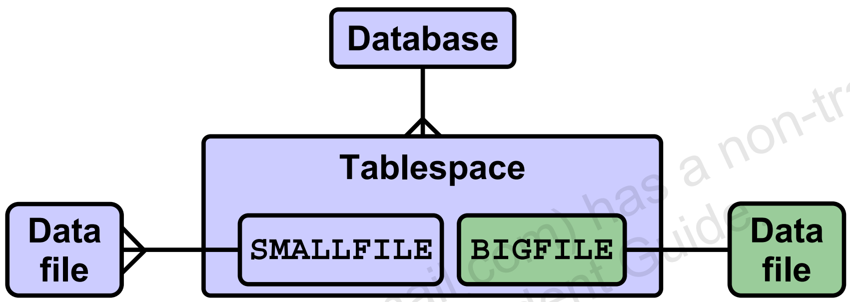
Bigfile Tablespaces: Overview

- A bigfile tablespace contains a single file.
- The maximum file size ranges from 8 TB through 128 TB.
- Tablespaces are logically equivalent to data files.



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Bigfile Tablespaces: Overview

A bigfile tablespace (BFT) is a tablespace containing a single file that has a very large size. The addressing scheme allows up to four billon blocks in a single data file, and the maximum file size can be 8 TB–128 TB depending on the Oracle block size.

To distinguish a BFT from the traditional tablespace that can contain multiple, relatively small files, the traditional tablespace is referred to as a "smallfile" tablespace. An Oracle database can contain both bigfile and smallfile tablespaces.

The BFT concept eliminates the need for adding new data files to a tablespace. This simplifies manual or automatic management of the disk space (using Oracle Managed Files (OMF) or Automated Storage Management (ASM)) and provides data file transparency. The graphic in the slide shows the entity-relationship diagram of the Oracle database space management architecture. The one-to-many relationship between tablespaces and data files complicates the architecture and can create difficulties in managing disk space utilization whenever one tablespace is associated with hundreds of data files.

The BFT concept makes the notion of tablespaces logically equivalent to data files. **All operations traditionally performed on data files can be performed on tablespaces.**

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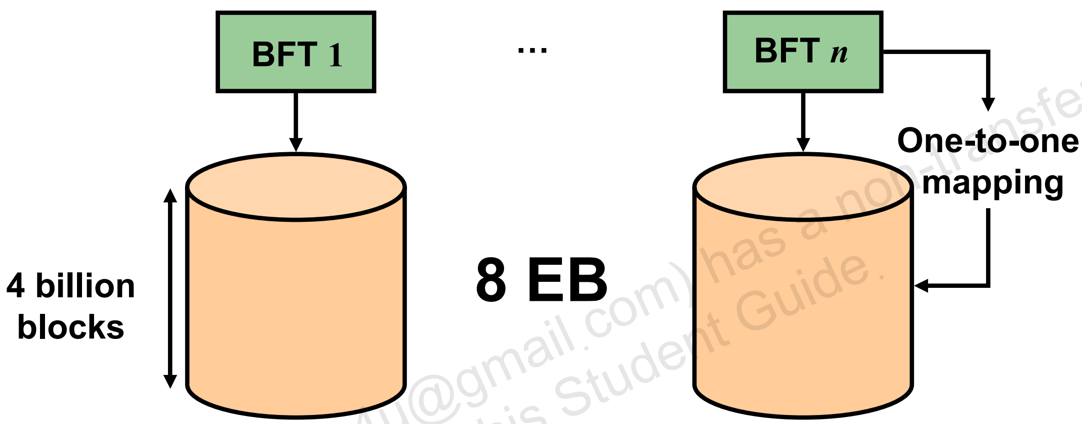
Benefits of Bigfile Tablespaces

- **Significantly increase the storage capacity**
- **Simplify data file management for large databases by making tablespaces the main units of disk space administration**



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Benefits of Bigfile Tablespaces

The purpose of using BFTs is to significantly increase the storage capacity of Oracle databases and, at the same time, simplify management of data files in large databases. This feature enables an Oracle database to contain up to eight exabytes (8,000,000 TB) of data. This allows you to store data in much larger files and, by doing so, to decrease the number of files in large databases. It also simplifies database management by providing data file transparency and making tablespaces the main units of disk space administration and backup and recovery. Calculate the maximum amount of data "`M`" that can be stored in the Oracle database by using the formula: `M = D * F * B`, where "`D`" is the maximum number of data files in the database, "`F`" is the maximum number of blocks per data file, and "`B`" is the maximum block size.

Availability of 64-bit operating systems that can handle much larger files and technologies that result in 500-GB hard drives within five years are good reasons to use BFTs.

Note: 1 PB = 1,024 TB ; 1 EB = 1,024 PB = 1,048,576 TB = 2^{60} bytes

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Bigfile Tablespace: Usage Model

- BFTs are supported only for locally managed tablespaces using Automatic Segment Space Management.
- Use BFTs with logical volume managers or Automatic Storage Management.
- OMF provides complete data file transparency.

Database Block Size	Recommended Maximum Number of Extents
2 KB	100,000
4 KB	200,000
8 KB	400,000
16 KB	800,000

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Bigfile Tablespace: Usage Model

BFTs are supported only for locally managed tablespaces with bitmapped segments, as well as locally managed `UNDO` and `TEMPORARY` tablespaces. (This is mainly because dictionary-managed tablespaces cannot address operations involving high space management activity as well as locally managed tablespaces.) Use BFTs with a logical volume manager or Automated Storage Management that supports striping, mirroring, and dynamically extensible logical volumes. You should avoid creating a BFT on a system that does not support striping because of negative implications for parallel executions.

Using BFTs with OMF provides more benefits because of the higher degree of data file transparency. When using bigfile tablespaces, you should think about the extent size before creating such a tablespace. Although the default allocation policy is `AUTOALLOCATE`, you may want to change that default to `UNIFORM` with a large extent size when the file has a size in terabytes. Otherwise, `AUTOALLOCATE` is probably the best choice. The table in the slide gives you recommendations regarding the maximum number of extents depending on the block size.

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Bigfile Tablespace: Usage Model (continued)

These figures are not a hard limit, but if more extents are created, there may be a performance penalty under high concurrency and during DDL operations involving high space management activity.

Note: Using BFTs on platforms that do not support large files can dramatically limit the tablespace's capacity.

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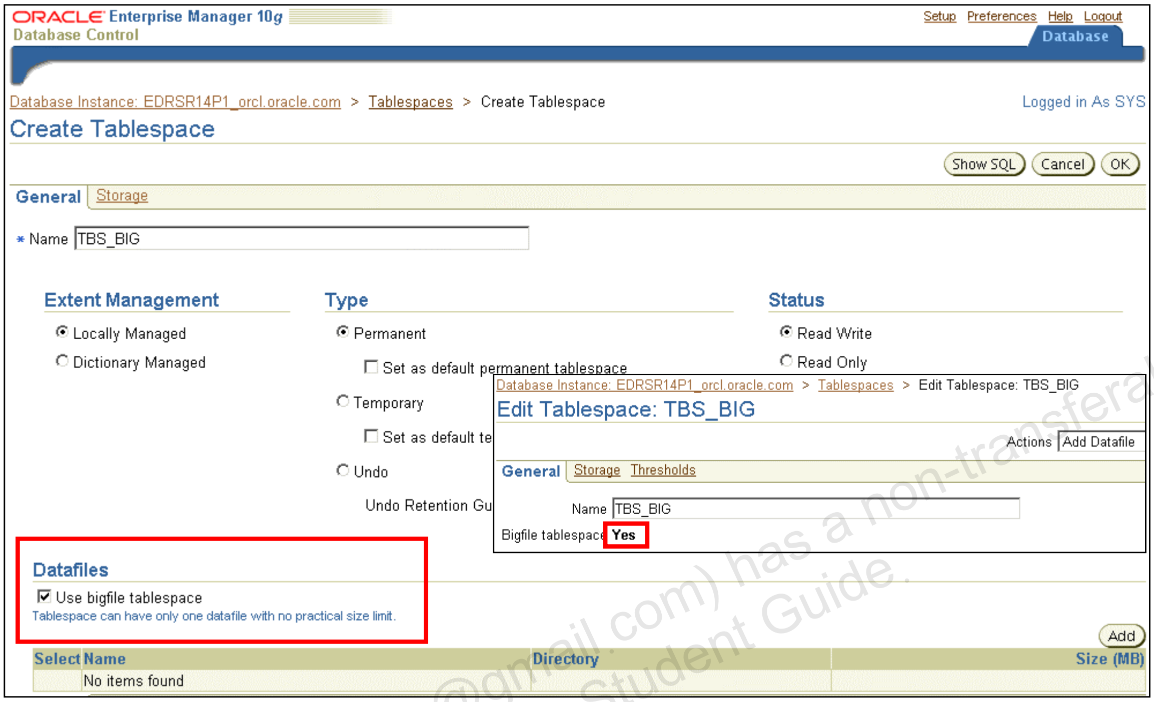
Creating Bigfile Tablespaces



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Creating Bigfile Tablespaces

You can use Database Control to create bigfile tablespaces. In Enterprise Manager, select Administration > Tablespaces. Click Create. On the Create Tablespace page, specify the tablespace name, and select the “Use bigfile tablespace” option in the Datafiles section.

Note: You can also determine whether a particular tablespace is a bigfile tablespace by looking at its corresponding Edit Tablespace page. On the General tabbed page, there is the “Bigfile tablespace” flag.

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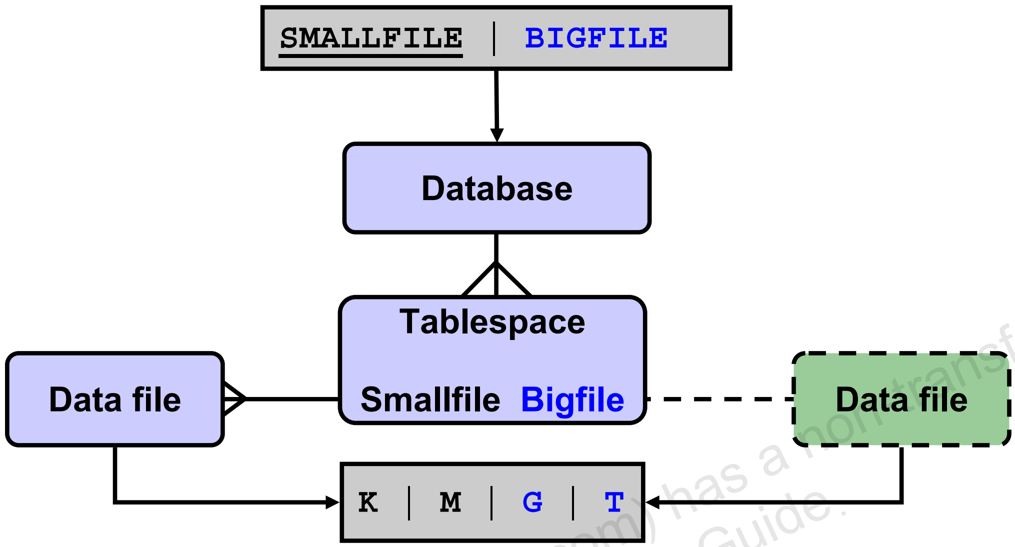
SQL Statement Clauses



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SQL Statement Clauses

It is expected that, in most cases, you do not have to explicitly specify the tablespace type, and a default setting is used. The default tablespace type is a persistent database property stored in the data dictionary. You can set it by using the `CREATE DATABASE` command and change it by using the `ALTER DATABASE` command. If the parameter is not set by one of these commands, the default tablespace type for Oracle Database 10*g* is `SMALLFILE`. The default tablespace type setting is applied to all tablespaces being created unless it is explicitly overridden. Two keywords, `BIGFILE` and `SMALLFILE`, are used to override the default tablespace type, when creating a particular tablespace. These keywords can be used in the `DATAFILE` clause of all commands that create tablespaces.

In the `SIZE`, `MAXSIZE`, and `AUTOEXTEND` clauses, you can specify size in kilobytes “K,” megabytes “M,” gigabytes “G,” and terabytes “ T.”

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BFTs and SQL Statements: Examples

```
CREATE DATABASE
SET DEFAULT BIGFILE TABLESPACE
DATAFILE '/u0/data/system.dbf' SIZE 200M
SYSAUX DATAFILE '/u0/data/sysaux.dbf' SIZE 300M
SMALLFILE DEFAULT TEMPORARY TABLESPACE stemp_tbs
TEMPFILE '/u3/data/stemp_tbs1.dbf' SIZE 60M
SMALLFILE UNDO TABLESPACE sundo_tbs
DATAFILE '/u2/data/sundo_tbs1.dbf' SIZE 100M;
```
1

```
ALTER DATABASE SET DEFAULT BIGFILE TABLESPACE;
```
2

```
CREATE BIGFILE UNDO TABLESPACE bundo_tbs
DATAFILE '/u1/data/bundo_tbs.dbf' SIZE 1G;
```
3

```
ALTER TABLESPACE users RESIZE 2G;
```
4

```
ALTER TABLESPACE users AUTOEXTEND ON ;
```
5

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BFTs and SQL Statements: Examples

- The tablespace type for SYSTEM and SYSAUX tablespaces is always the same as the default tablespace type at the time of creation of the database. The first statement creates a new database and sets the default tablespace type to BIGFILE. Then the statement uses the SMALLFILE keyword to override the database's default setting for the UNDO and DEFAULT TEMPORARY tablespaces.
- The second statement is used to dynamically change the default tablespace type. The new setting takes effect immediately after the statement gets executed. The setting defines the default type of the new tablespace being created but has no effect on existing tablespaces. In the example, the new default is set to BIGFILE.
- The third statement creates an UNDO tablespace as a BIGFILE tablespace.
- You can use the fourth statement to resize the unique data file contained inside the BIGFILE USERS tablespace.
- The last statement can be used to enable automatic file extension at the tablespace level. This is possible only for BIGFILE tablespaces.

Note: For more syntax information, see the *Oracle Database SQL Reference* guide.

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Data Dictionary Additions To Support VLDB

```
SELECT property_value
FROM database_properties
WHERE property_name='DEFAULT_TBS_TYPE';
```

```
SELECT tablespace_name, bigfile
FROM DBA_TABLESPACES;
```

```
SELECT name, bigfile FROM V$TABLESPACE;
```

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Data Dictionary Additions to Support VLDB

- DATABASE_PROPERTIES is a dictionary view that contains different database properties. A new row is added to this table to specify the default tablespace type for the database: BIGFILE or SMALLFILE.
- DBA_TABLESPACES displays information about all tablespaces in the database. A new column is added to this view to indicate whether a particular tablespace is bigfile (YES) or smallfile (NO). The same column is also added to USER_TABLESPACES.
- V$TABLESPACE contains information from the control file about all tablespaces in the database. A new column is added to this view to indicate whether a particular tablespace is bigfile (YES) or smallfile (NO).

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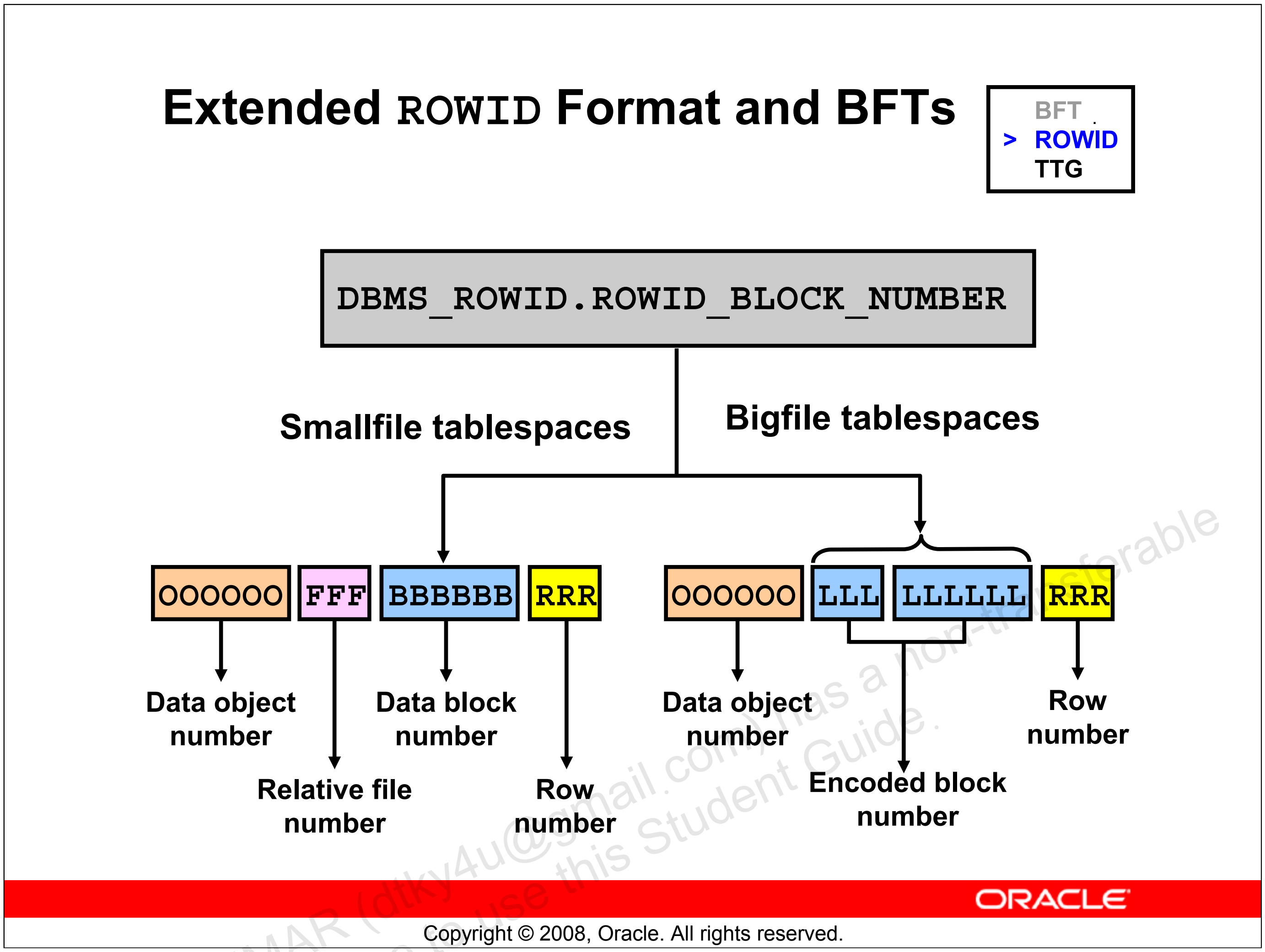

Extended ROWID Format and BFTs

The description of the extended ROWID format, for both previous releases and smallfile tablespaces, has a four-piece format, OOOOOOFFFBBBBBBRRR:

- OOOOOO is the data object number that identifies the database segment.
- FFF is the tablespace-relative data file number of the data file that contains the row.
- BBBBBB is the data block that contains the row. In smallfile tablespaces, block numbers are relative to their data file rather than their tablespace. Therefore, two rows with identical block numbers could reside in two different data files of the same tablespace.
- RRR is the slot number identifying the row inside a particular block.

In a bigfile tablespace, there is only one file that always has a relative file number equal to 1024. Therefore, there is no need to include the file number in row IDs, and both FFF and BBBBBB pieces are used to denote the block number. The concatenation of these two fields represents the "encoded block number," which can be much bigger compared to row IDs from traditional smallfile tablespaces. For BFTs, block numbers are relative to their tablespaces and are unique within a tablespace.

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Extended ROWID Format and BFTs (continued)

With BFTs, the only supported way of getting components of extended row IDs is to use the DBMS_ROWID package. It is not recommended that you use any other means of extracting ROWID components. This implies that, in previous releases, user applications that do not use the DBMS_ROWID package to extract ROWID components are not able to recognize and correctly interpret row IDs from BFTs.

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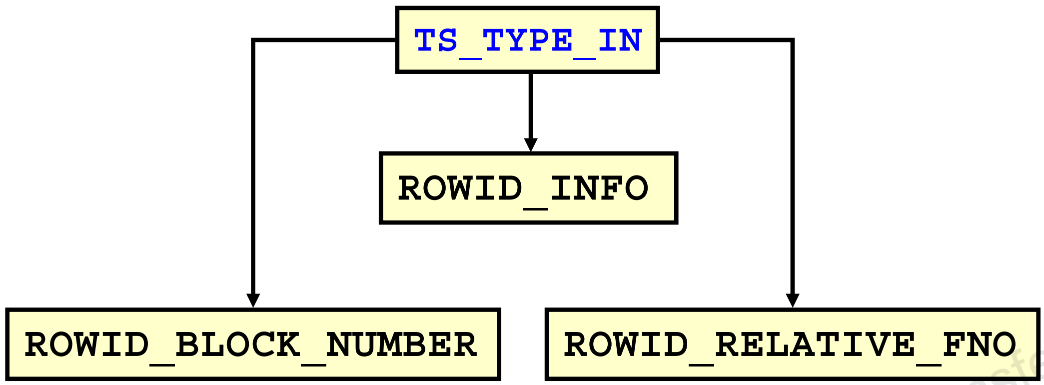
VLDB Support: DBMS_ROWID Package




```
SELECT DBMS_ROWID.ROWID_RELATIVE_FNO(ROWID,'BIGFILE')
FROM employees;
```

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VLDB Support: DBMS_ROWID Package

Using the DBMS_ROWID package, you can create row IDs and get components of existing row IDs. Because row IDs have different formats for bigfile and smallfile tablespaces, some functions and procedures of this package are changed to take into account the tablespace type when interpreting row IDs. The TS_TYPE_IN input parameter describes the type of tablespace to which a particular row belongs. The permissible values for this parameter are BIGFILE and SMALLFILE.

As shown, this parameter is added to the following procedures: ROWID_INFO, ROWID_BLOCK_NUMBER, and ROWID_RELATIVE_FNO.

Note: The only supported way of constructing an external or internal ROWID string corresponding to a BFT row is to use the ROWID_CREATE function with the RELATIVE_FNO argument set to 1024.

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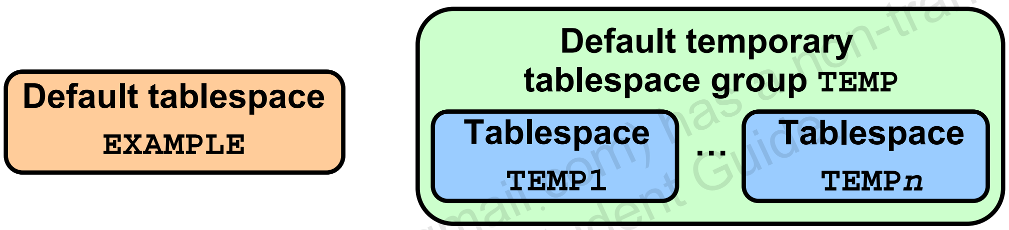
Temporary Tablespace Group (TTG): Overview

BFT
ROWID
> TTG

- Groups multiple temporary tablespaces
- Characteristics:
  - At least one temporary tablespace
  - Same namespace as tablespaces
  - Created implicitly on first assignment
  - No explicit deletion



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Temporary Tablespace Group (TTG): Overview

You can think of a temporary tablespace group as a shortcut for a list of temporary tablespaces. A temporary tablespace group consists of only temporary tablespaces and has the following properties:

- It contains at least one temporary tablespace. There is no explicit limit on how many tablespaces are contained in a group.
- It has the same namespace as tablespaces. It is not possible for a tablespace and a temporary tablespace group to have the same name.
- A temporary tablespace group name can appear wherever a temporary tablespace name appears (for example, while assigning a default temporary tablespace for the database, or assigning a temporary tablespace for a user).
- It is not explicitly created. It is created implicitly when the first temporary tablespace is assigned to it, and it is deleted when the last temporary tablespace is removed from the group.

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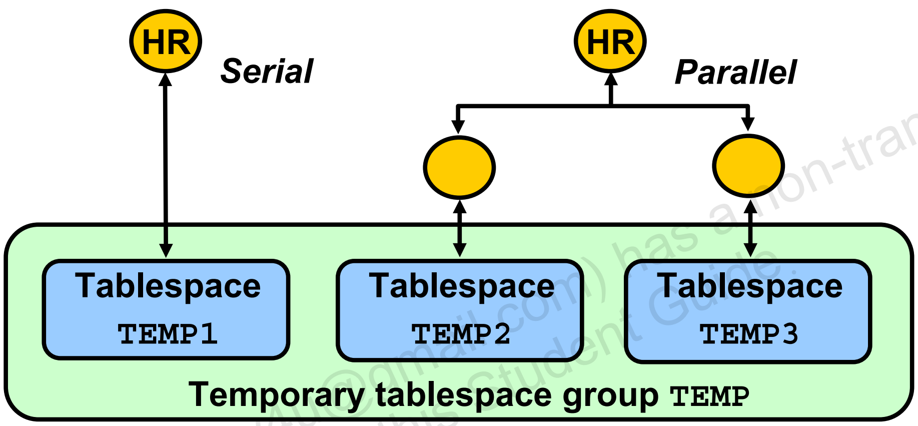
Temporary Tablespace Group: Benefits

Enables the use of multiple temporary tablespaces:
- For the same user in multiple sessions
- For slave processes in one parallel operation
- For configuration at database level



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Temporary Tablespace Group: Benefits

This feature has the following benefits:

- Enables one particular user to use multiple temporary tablespaces in different sessions at the same time
- Enables the slave processes in a single parallel operation to use multiple temporary tablespaces
- Enables multiple default temporary tablespaces to be specified at the database level

Therefore, you can now define more than one default temporary tablespace, and a single SQL operation can use more than one temporary tablespace for sorting. This prevents large tablespace operations from running out of temporary space. This is especially relevant with the introduction of bigfile tablespaces.

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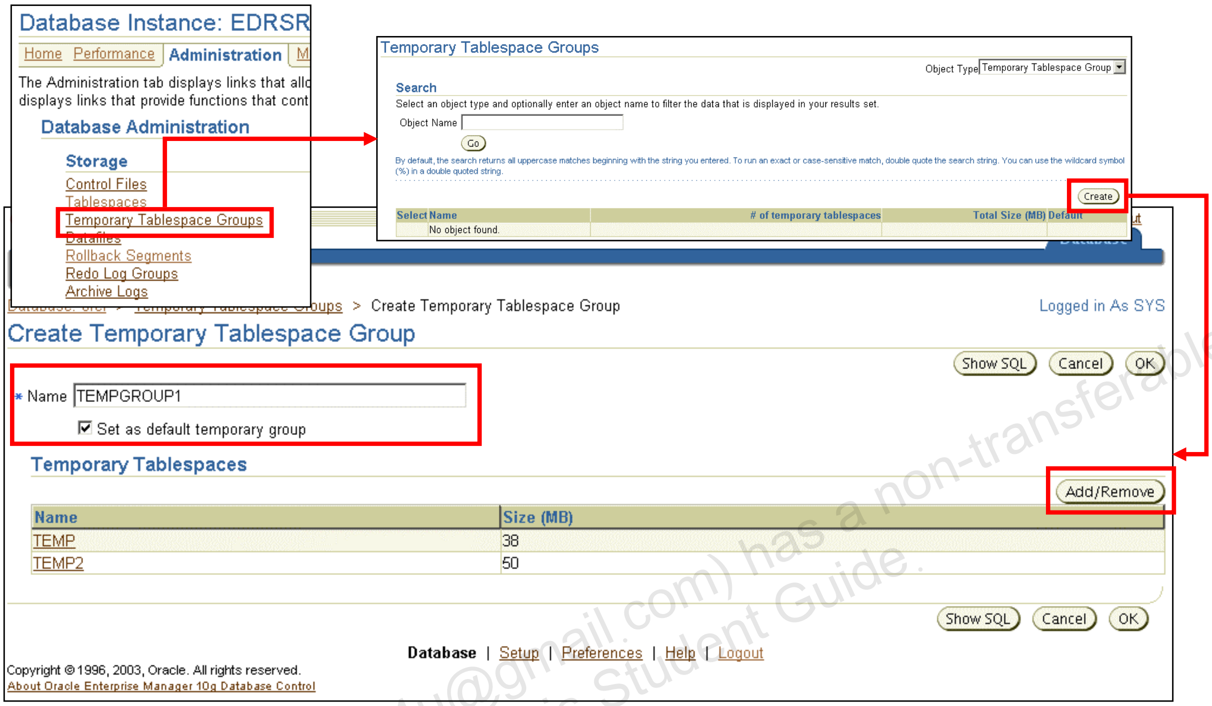
Creating and Maintaining Temporary Tablespace Groups



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Creating and Maintaining Temporary Tablespace Groups

You can create and maintain temporary tablespace groups by using Database Control. Select Administration > Temporary Tablespace Groups. This displays the Temporary Tablespace Groups page, where you can see a list of existing tablespace groups. On this page, you can view and edit existing tablespace groups.

When you click the Create button, the Create Temporary Tablespace Group page is displayed. Enter the name and specify whether or not you want this group to be set as the default temporary group. You can do this by selecting the “Set as default temporary group” option. After selecting this option, you need to add existing temporary tablespaces to the group. Click the Add/Remove button, and select the temporary tablespaces that belong to the group. Then, click the OK button to create the TTG.

When you edit a TTG, also use the Add/Remove button, and then click Apply.

Note: If you remove all temporary tablespaces from a temporary tablespace group, then the group is also removed implicitly.

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Temporary Tablespace Group: SQL Examples

```
CREATE TEMPORARY TABLESPACE temp1 TEMPFILE 'tmp1.f'
SIZE 100M TABLESPACE GROUP group1;
```
1

```
CREATE TEMPORARY TABLESPACE temp2 TEMPFILE 'tmp2.f'
SIZE 200M TABLESPACE GROUP group2;
```
2

```
CREATE TEMPORARY TABLESPACE temp3 TEMPFILE 'tmp3.f'
SIZE 50M TABLESPACE GROUP '';
```
3

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Temporary Tablespace Group: SQL Examples

The first and the second SQL statements shown in the slide implicitly result in the creation of two temporary tablespace groups (GROUP1 and GROUP2) that contain one temporary tablespace each: TEMP1 and TEMP2, respectively.

The third statement creates the temporary tablespace TEMP3. This tablespace does not belong to any group.

Note: The use of '' indicates the lack of a group. This is exactly equivalent to the following statement:

```
CREATE TEMPORARY TABLESPACE temp3 TEMPFILE 'tmp3.f' SIZE
50M;
```


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Temporary Tablespace Group: SQL Examples

```
ALTER TABLESPACE temp3 TABLESPACE GROUP group2;
```
1

```
ALTER TABLESPACE temp2 TABLESPACE GROUP '';
```
2

```
ALTER TABLESPACE temp1 TABLESPACE GROUP group2;
```
3

```
ALTER DATABASE DEFAULT TEMPORARY TABLESPACE group2;
```
4

```
CREATE USER hr IDENTIFIED BY hr DEFAULT
TABLESPACE TS1 TEMPORARY TABLESPACE group2;
```
5

```
ALTER USER hr TEMPORARY TABLESPACE group2;
```
6

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Temporary Tablespace Group: SQL Examples (continued)

These examples give you an idea of the various uses of temporary tablespace groups. They are described in order:

- The first statement adds the `TEMP3` tablespace to the `GROUP2` group, which now has the `TEMP2` (from the previous example) and `TEMP3` tablespaces. If `GROUP2` does not exist, then it is created.
- The second statement removes the `TEMP2` tablespace from the `GROUP2` group, which now contains only the `TEMP3` tablespace.
- The third statement moves the `TEMP1` tablespace from `GROUP1` to `GROUP2`. `GROUP1` is implicitly deleted because `TEMP1` was the only tablespace in it.
- The fourth statement sets all the tablespaces in the `GROUP2` tablespace group as the default temporary tablespaces for the database. All database users that do not have temporary tablespaces specified can create temporary segments in either `TEMP1` or `TEMP3`.
- The fifth statement creates the `HR` user with the temporary tablespace group `GROUP2`.
- The last statement alters the `HR` user to use the `GROUP2` tablespace group.

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Temporary Tablespace Group: SQL Examples (continued)

Note: An implication of a tablespace being listed as a default temporary tablespace is that it cannot be dropped unless it is first excluded from the list of default temporary tablespaces. Extending this concept, if a tablespace group is specified as the default temporary tablespace for the database, none of the tablespaces in that group can be dropped.

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Summary

BFT
ROWID
TTG

In this appendix, you should have learned how to:

- **Use bigfile tablespaces for very large databases (VLDB)**
- **Describe the row IDs for bigfile tablespaces**
- **Use temporary tablespace groups (TTG) for VLDB**

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H

Next Steps:
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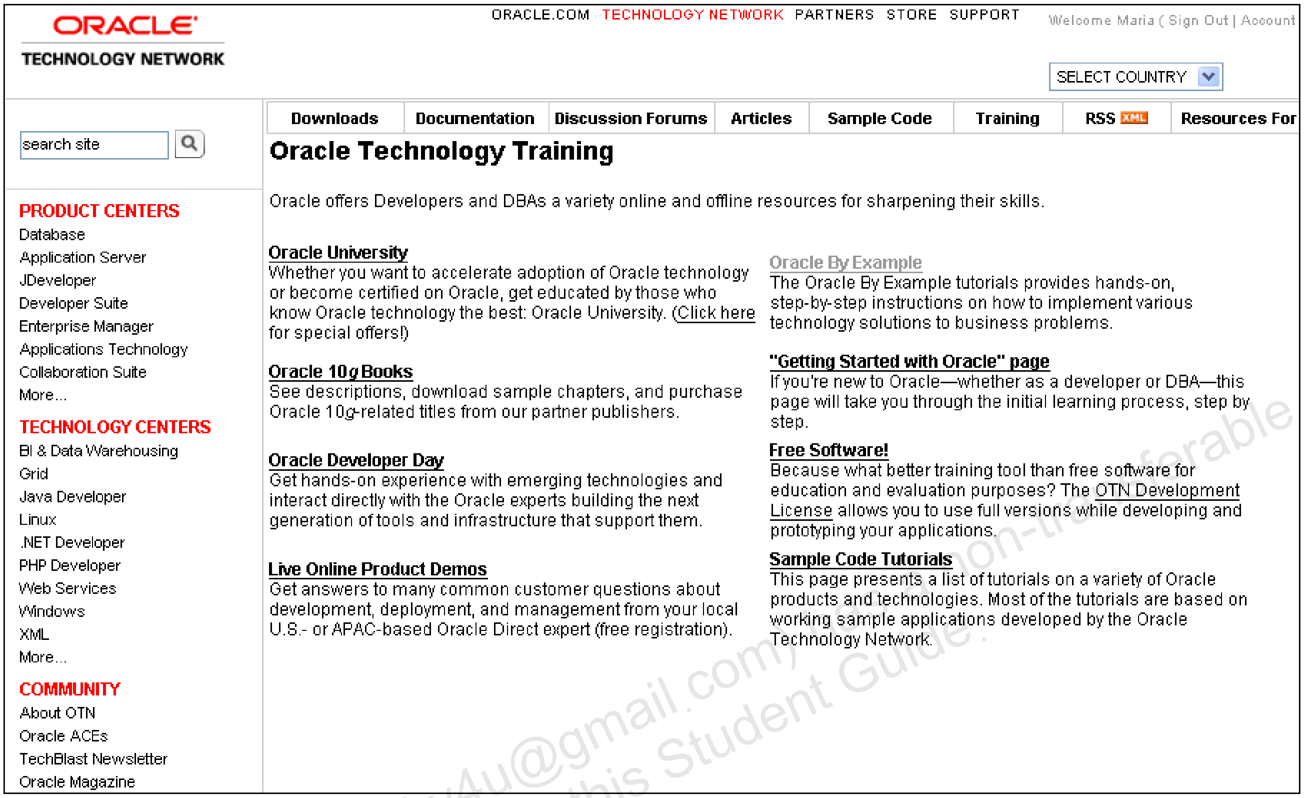

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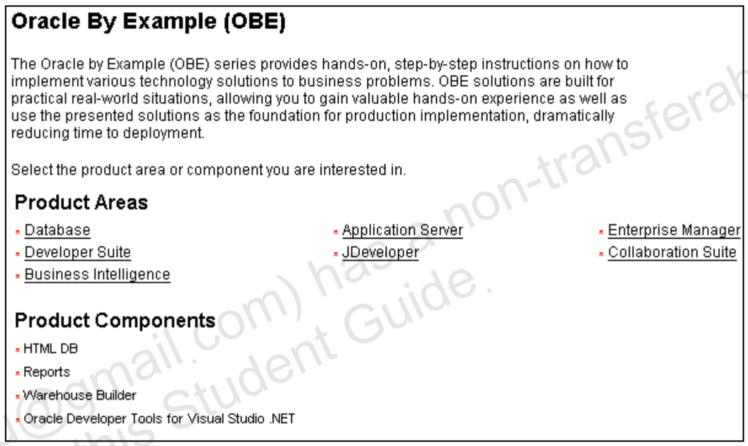
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