



Oracle Backup

Using Bacula Enterprise Edition

This document is intended to provide insight into the considerations and processes required to implement a modern, enterprise-class backup strategy of Oracle® Database with Bacula Enterprise Edition. It also includes a variety of restore scenarios.

Overview

Bacula Enterprise Edition uses a uniquely designed Oracle Database plugin to simplify the backup and restore procedure of your Oracle Database instance. This enables advanced techniques for backup and restore of data and configurations stored in Oracle Database servers 10 and 11g. The plugin provides high-end capabilities such as being able to easily restore your database to any point in time, or to filter out objects during backup or restore operations. It is also designed to backup essential bits of configuration information such as parameters, etc. according to best practices. The plugin is available on Linux platforms 32/64bit supported by Oracle, and supports Oracle Database 10.x, 11.x.

Some other benefits are:

- When using RMAN mode, the plugin provides incremental and differential backups of the database at the block level.
- RMAN's change tracking feature for incremental backups dramatically improves backup performance by recording changed blocks in each data file in a change tracking file.
- Time saving. Backup administrators don't need to learn about the inner details of Oracle Database techniques or write complex Oracle scripts.
- This backup and data recovery plugin is also designed to backup essential bits of configuration information such as parameters, etc. according to best practices.

This document presents various techniques and strategies to backup Oracle® with Bacula Enterprise Edition, using this plugin.

Scope

This paper will present solutions for **Bacula Enterprise Edition** 6.4 and later, which are not applicable to prior versions.

Glossary

The following terms¹ are used in this document:

- **ARC** (Archive Log) is a standard method for ensuring data integrity. Archive Log's central concept is that changes to data files (where tables and indexes reside) will be written only after those changes have been logged, that is, after log records describing the changes have been flushed to permanent storage.
- **PITR** Database point-in-time recovery (PITR) restores the database from backups prior to the target time for recovery, then uses incremental backups and redo to roll the database forward to the target time. DB PITR is sometimes called incomplete recovery because a PITR recovers only to the target time and thus does not use all of the available redo file or completely recover all changes to your database.

¹See docs.oracle.com and www.orafaq.com

- **RMAN** Oracle Recovery Manager (RMAN), a command-line and Oracle Enterprise Manager-based tool, is the Oracle-preferred method for efficiently backing up and recovering an Oracle database. RMAN is designed to work intimately with the server, providing block-level corruption detection during backup and restore. RMAN optimizes performance and space consumption during backup with file multiplexing and backup-set compression.
http://docs.oracle.com/cd/B28359_01/backup.111/b28270/toc.htm
- **EXP/IMP** Oracle's export (exp) import (imp) utilities are used to perform logical database backup and recovery. When exporting, database objects are dumped to a binary file which can then be imported into another Oracle database.
- **Data Pump** Oracle Data Pump is a newer, faster and more flexible alternative to the "exp" and "imp" utilities used in previous Oracle versions. Unfortunately, this new method doesn't support outputting data directly to a FIFO file, so using Data Pump tools requires you to dump data on disk first then read that data with the Bacula Enterprise File Daemon. The current Bacula Enterprise Oracle Plugin doesn't support Data Pump.
- **SBT** By default, RMAN sends all backups to an operating system specific directory on disk. You can also configure RMAN to make backups to media such as tape using SBT module. Bacula will act as Media Manager, and the data will be transferred directly from RMAN to Bacula.
- **libobk** The SBT interface is implemented through libobk library file.
- **Tablespace** A database is divided into logical storage units called tablespaces, which group related logical structures together. For example, tablespaces commonly group together all application objects to simplify some administrative operations.
- **Schema** is a collection of database objects. A schema is owned by a database user and has the same name as that user. Schema objects are the logical structures that directly refer to the database's data. Schema objects include structures like tables, views, and indexes. (There is no relationship between a tablespace and a schema. Objects in the same schema can be in different tablespaces, and a tablespace can hold objects from different schemas.)
- **Instance** An Oracle database server consists of an Oracle database and an Oracle instance. Every time a database is started, a system global area (SGA) is allocated and Oracle background processes are started. The combination of the background processes and memory buffers is called an Oracle instance.
- **SID** The Oracle System ID (SID) is used to uniquely identify a particular database on a system. For this reason, one cannot have more than one database with the same SID on a computer system. Generally the SID is set in the environment variable "ORACLE_SID". Alternatively, you might find it in the first field (before :) of the configuration file `/etc/oratab`.
- **Incarnation** Whenever the database is opened with the command ALTER DATABASE OPEN RESETLOGS

- **SCN** System Change Number (SCN) in Oracle is a number that increments sequentially with every database commit: inserts, updates, and deletes. The SCN is also incremented through linked database interactions.
- **Restore** is the action of getting data back to a prior consistent state from a backup. After a restore the database may need to be recovered to roll it forward to a particular point in time.
- **Recover** a restored datafile is to update it by applying archived redo logs and online redo logs, that is, records of changes made to the database after the backup was taken.
- The **Proxy Copy** feature is a RMAN option that is not supported by the current implementation of the Bacula Enterprise SBT interface.

Convention Used In This Guide

- `<SID>` Anything between `<` and `>` should be adapted by the user, for example, `<SID>` should be replaced by your current `ORACLE_SID`. If your `ORACLE_SID` is `TEST` a file written as `init<SID>.ora` will become `initTEST.ora`.
- `%` means that the command should be run with a normal user such as `oracle`
- `#` means that the command should be run with the root account.
- `RMAN>` means that the command should be run inside a `rman` session.
- `SQL>` means that the command should be run inside a `sqlplus` session

1 Using Oracle Plugin

1.1 Choosing Between Dump and RMAN

The following table might help you to choose between backup techniques supported by the Bacula Enterprise Oracle Plugin. Major functionalities such as being able to restore your database to any point in time, or being able to filter objects during backup or restore should guide you. It is also quite common to combine Dump and RMAN PITR techniques for the same cluster.

RMAN also allows you to use advanced techniques where you can send the data over the Bacula Enterprise SBT interface to tape for example, and at the same time, on disk for fast restore and disaster recovery.

Feature	Dump	RMAN	RMAN SBT
Can restore directly a single object (table, schema...)	Yes	No	No
Can restore directly a single file (index, db, tbs...)	No	Yes	Yes
Backup speed	Low	High	High

This table continues on the following page

Feature	Dump	RMAN	RMAN SBT
Restore speed	Low	High	High*
Backup size	Small	Big	Big
Size on local disk during backup	Nothing	Entire Backup	Nothing
Size on local disk during restore	Nothing	Entire Restore	Objects needed
Can restore to any point in time	No	Yes	Yes
Incremental/Differential support	No	Yes	Yes
Can restore in parallel	Yes	Yes	Yes
Online backup	Yes	Yes	Yes
Consistent	Yes	Yes	Yes
Can restore to previous major version of Oracle	No	No	No

Table 1: Backup techniques features

* When using RMAN SBT interface, the restore speed depends on various elements such as the type of media (tape or disk), the network speed, the availability of the Storage Daemon device, etc... In Bacula Enterprise 6.4 and later, the Storage Daemon device is able to use the same disk volume for multiple concurrent restores, so it is possible to use concurrent jobs to restore and backup the data.

1.2 RMAN SBT Configuration

This part of the user's guide will describe how to install and configure properly the Bacula Enterprise SBT interface with Oracle and RMAN.

When running a backup or a restore from RMAN, RMAN will need to contact the Bacula Enterprise Director to get information about files and volumes, or run backup and restore jobs. This communication involves shared FIFO command files, and the `bconsole` program.

When using the `oracle-sbt-fd` plugin, the Director will not be able to start a backup from `Bconsole` or from a `Schedule`. Only RMAN will be able to initiate the session and start a Backup. Note that you can still run a regular system backup of your Oracle server, and then, use a `RunScript` to call RMAN automatically.

Bacula Configuration When using the SBT interface, Bacula console `bconsole` should be installed, and the console should be able to connect to your Director and have access to the local Client, the backup Job and other Pool specifications.

To use a restricted console, you may use the following Console definition:

```
Client {
  Name = oracle-fd
  Maximum Concurrent Jobs = 10
  ...
}
```

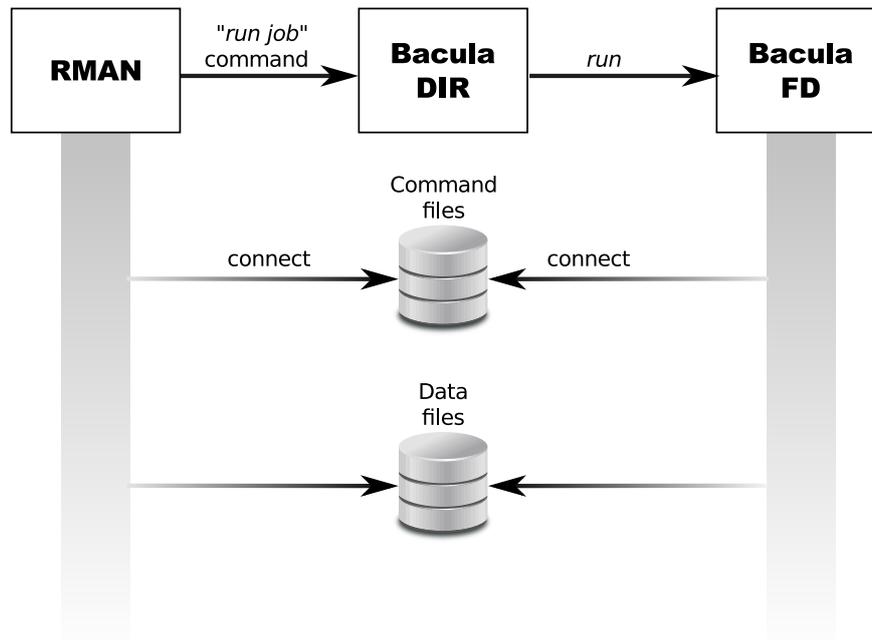


Figure 1: Interaction between RMAN and Bacula

```

}
Console {
  Name = oracle-fd
  Password = "pass"

  CommandACL = .bvfs_lsfiles, .bvfs_get_volumes, use, .bvfs_get_jobids, wait
  CommandACL = .bvfs_restore, .bvfs_cleanup, restore, run, gui, .jobs, quit

  # These commands are used only by the install-sbt-libobk.sh test
  # procedure and can be commented out after the installation
  CommandACL = show, status

  ClientACL = oracle-fd
  JobACL = SBT-Backup, RestoreJob

  CatalogACL = *all*
  StorageACL = *all*
  FileSetACL = *all*
  PoolACL = *all*
  WhereACL = /
}

Job {
  Name = SBT-Backup
  FileSet = SBT-FileSet
  Client = oracle-fd
  Maximum Concurrent Jobs = 10

  # Adapt the following resources
  # to your settings
  Messages = Standard
  
```

```
Pool      = Default
Storage   = File
}
FileSet {
  Name = SBT-FileSet
  Include {
    Options {
      Signature = MD5
    }
    Plugin = oracle-sbt
  }
}
```

The unix “oracle” user should be able to execute `bconsole` and read the associated configuration file `bconsole.conf`, which is **not the default configuration**. You can copy the binary and the configuration file to the `/opt/bacula/oracle` directory with the following unix commands:

```
cp /opt/bacula/bin/bconsole /opt/bacula/oracle
cp /opt/bacula/etc/bconsole.conf /opt/bacula/oracle
chown oracle:dba /opt/bacula/oracle/bconsole*
chmod go-rwx /opt/bacula/oracle/bconsole*
```

Important, the copy of the `bconsole` binary will be probably necessary after each upgrade of the Bacula Enterprise package.

1.2.1 Running Parallel Jobs

In order to run Backup or Restore using multiple channels, you need to ensure that all required resources in Bacula are properly configured using `Maximum Concurrent Jobs` directive to allow concurrent jobs.

- Director: Director (ex: 100)
- Director: Client (ex: 10)
- Director: Job (ex: 10)
- Director: Storage (ex: 10)
- Storage: Storage (ex: 100)
- Storage: Device (ex: 10 or 10 devices grouped in a Virtual Changer)
- Client: FileDaemon (ex: 10)

To allow concurrent Backup and Restore jobs using the same Director Storage resource, the configuration must use a Virtual Changer disk device. See *Disk Backup* whitepaper about this specific configuration.

1.2.2 Storage Consideration

Oracle imposes to the Media Manager, Bacula Enterprise, to not multiplex data streams from two concurrent API sessions onto the same sequential device. It means that if you are using tape based storage for your Oracle backup, you must use different tape devices for each concurrent backup jobs. This restriction doesn't apply to disk based storage. This limitation implies specially longer restore time.



1.2.3 Bacula SBT Configuration

The libobk can be configured with `/opt/bacula/oracle/sbt.conf` or the `/opt/bacula/etc/sbt.conf` file, or using the RMAN SEND command. The keywords presented Table 2 on the following page are accepted.

Option	Comment	Example
client	Bacula Client name	client=oracle-fd
restoreclient	Bacula Client name used for restore	restoreclient=oracle-fd
job	Bacula Backup Job name	job=SBT-Backup
bconsole	Bconsole command with arguments	bconsole="/tmp/bconsole -n"
restorejob	Bacula Restore Job name. If multiple restore jobs are defined in your configuration and this option is not used, the SBT plugin will choose automatically the first restore Job defined.	restorejob=RestoreFiles
waitjobcompletion	Wait for Job completion at the end of the SBT session. The default is to finish the SBT session as soon as possible. Note that this option can be used only when starting the Backup from RMAN.	waitjobcompletion

This table continues on the following page

Option	Comment	Example
update	Type of update (local/catalog). When the filename is present in the local catalog, the Plugin will reply directly to RMAN without contacting Bacula Director. Use update=force to force Bacula Director check.	update=force
jobopt	Extra Job options	jobopt="spooldata=no"
backupdir	Directory for the local catalog	backupdir=/opt/bacula/oracle
ctrlfile	Base path of control files	ctrlfile=/tmp/oracle
ctrltimeout	Timeout when connecting with Bacula	ctrltimeout=300
retry	Number of retry when connecting to Bacula	retry=30
localdir	Local data file directory where the SBT plugin will check first before calling a Bacula restore.	localdir=/tmp/@ORACLE/sbt
catalog	Bacula Catalog name.	catalog="MyCatalog 2"
trace	Path to the trace file.	trace=/tmp/log.txt
debug	Debug level.	debug=50

Table 2: SBT libobk Configuration

The minimal configuration file will require the `client`, `job` and `bconsole` options to be set. Note that if the configuration item contains spaces (such as `bconsole`), you need to use double quotes to enclose it.

```
# cat /opt/bacula/etc/sbt.conf
client=oracle-fd
job=OracleBackup
bconsole="/opt/bacula/oracle/bconsole -n -c /opt/bacula/oracle/bconsole.conf"
```

It is possible to overwrite these settings using the RMAN SEND command.

```

RUN {
  ALLOCATE CHANNEL c1 DEVICE TYPE sbt;

  SEND 'job=OtherBackup jobopt="spooldata=yes storage=File1"';
  SEND 'retry=10';
}

```

The SEND command is limited to 512 bytes, so this is possible to use multiple SEND commands to set all options. In general, this is a good idea to avoid long path names when using the SBT interface.

1.2.4 FileSet Configuration

The Oracle SBT plugin (oracle-sbt) is accepting parameters in the Job FileSet described in Table 3.

Option	Default	Comment	Example
unix_user	oracle	Unix user to use for Oracle commands	unix_user=rob
ctrlfile	<code>/opt/bacula/oracle</code>	Path to the control file shared between the Plugin and RMAN.	ctrlfile= <code>/tmp/base</code>

Table 3: Oracle SBT Plugin Options

1.2.5 Testing sbt.conf Configuration

To test the Bacula Enterprise Oracle SBT Plugin configuration, the following command can be used as root user:

```

oracle# /opt/bacula/scripts/install-sbt-libobk.sh test
1000 OK: oracle11-dir Version: 6.4.1 (24 May 2013)
INFO: Connection to the Director OK
INFO: Connection from the Director to the Client OK
INFO: Plugin installed correctly
INFO: Job found on the Director
INFO: FileSet configured on the Director

```

If a connection error is detected, a message will be displayed. It is useless to run any RMAN backup until the connection is properly configured.

1.2.6 Internal Bacula SBT Catalog

The Bacula Enterprise libobk will use a local catalog to store information about all files. These information may be outdated, so you can use the `update=force` in the `sbt.conf` file or in the SEND command, to force lookup Bacula catalog.

```

RUN {
  ALLOCATE CHANNEL c1 DEVICE TYPE sbt;
  ALLOCATE CHANNEL c2 DEVICE TYPE disk;
  SEND 'update=force client=oracle-fd';
}

```

```
CROSSCHECK ARCHIVELOG ALL;  
DELETE EXPIRED ARCHIVELOG ALL;  
CROSSCHECK BACKUP;  
DELETE NOPROMPT FORCE OBSOLETE;  
}
```

The catalog is stored by default in `/opt/bacula/oracle/bacula-sbt.cat` and can be a part of the regular system backup.

1.2.7 RMAN Backup Retention

When using RMAN SBT plugin of the Bacula Enterprise, the backup retention defined in RMAN should match the Bacula volume or job retention. When RMAN will send commands to delete backup files, Bacula will not try to purge or delete anything.

1.2.8 Backup Examples

The following example will start 3 Bacula backup jobs in parallel and RMAN will send data into them using a kind of round robin. If RMAN is not able to contact Bacula for one or more channel, RMAN will automatically send the data to the available channel. It means that if your Storage or the Director is busy (limited by the number of devices or the Maximum Concurrent Jobs setting), RMAN will manage the situation automatically.

```
RUN {  
  ALLOCATE CHANNEL c1 DEVICE TYPE sbt;  
  ALLOCATE CHANNEL c2 DEVICE TYPE sbt;  
  ALLOCATE CHANNEL c3 DEVICE TYPE sbt;  
  BACKUP INCREMENTAL LEVEL 0 DATABASE plus archivelog;  
}
```

In this example, RMAN will use 3 Bacula backup jobs to backup 3 datafiles.

```
RUN {  
  ALLOCATE CHANNEL c1 DEVICE TYPE sbt;  
  ALLOCATE CHANNEL c2 DEVICE TYPE sbt;  
  ALLOCATE CHANNEL c3 DEVICE TYPE sbt;  
  BACKUP DATAFILE 1,2,3;  
}
```

1.3 RMAN Mode Configuration

This part of the user's guide will describe how to configure RMAN to work properly with the non-SBT part of the Bacula Enterprise Oracle Plugin.

The current version of the Bacula Enterprise Oracle Plugin currently supports only databases running with ARCHIVELOG mode enabled.

1.3.1 ARCHIVELOG Oracle Configuration

In order to use the RMAN backup mode, the database must be in ARCHIVELOG mode. To verify how your database is configured you can use the following SQL command.

```
SQL> SELECT LOG_MODE FROM SYS.V$DATABASE;  
  
LOG_MODE  
-----  
ARCHIVELOG
```

To activate the archive mode of your database, you can use the ALTER DATABASE ARCHIVELOG command on a non-open state as SYSDBA.

- Stop the database with SHUTDOWN
- Backup the database
- Edit your init<SID>.ora file to configure the archive log destination
- Start your database without opening it with STARTUP MOUNT
- Change the archive mode with ALTER DATABASE ARCHIVELOG; and open it with ALTER DATABASE OPEN;
- Stop the database with SHUTDOWN IMMEDIATE
- Backup the database again, because changing the ARCHIVELOG will update control files and will make old backups unusable.

Bacula Enterprise Oracle Plugin will create RMAN backup set into a sub directory of the archive log destination defined in the init<SID>.ora file.

1.3.2 Optimize Incremental Backup

RMAN's change tracking feature for incremental backups improves incremental backup performance by recording changed blocks in each data file in a change tracking file. If change tracking is enabled, RMAN uses the change tracking file to identify changed blocks for incremental backup, thus avoiding the need to scan every block in the data file.

After enabling change tracking, the first Full backup still has to scan the entire data file, as the change tracking file does not yet reflect the status of the blocks. Any subsequent incremental backups that use this Full backup as parent will take advantage of the change tracking file.

The following SQL command, run as sysdba, permits activating the change tracking feature and use the file `"/path/to/file"` as destination of the activity log. (Note that the file must be in a valid directory where the Oracle user can write)

```
SQL> SHUTDOWN IMMEDIATE;
SQL> STARTUP MOUNT;
SQL> ALTER DATABASE ENABLE BLOCK CHANGE TRACKING USING FILE '/path/to/file';
SQL> ALTER DATABASE OPEN;
```

1.3.3 RMAN Backup Retention

When using RMAN mode of the Bacula Enterprise Oracle Plugin, each Bacula job will execute RMAN to generate a backup set. We advise you to configure RMAN in order to delete old files after some time period. Although this can be done just after the end of the backup, we advise you to keep data on disk a bit longer to avoid any gaps in your point-in-time recovery capability. The following command will configure the Oracle retention period of 7 days, which should be sufficient providing you do some sort of backup at least once every 7 days.

```
RMAN> CONFIGURE RETENTION POLICY TO RECOVERY WINDOW OF 7 DAYS;
```

See the Oracle RMAN manual for more information

docs.oracle.com/cd/B28359_01/backup.111/b28270/rcmconfb.htm#i1019318

1.3.4 Oracle Plugin Configuration for RMAN

With the RMAN point-in-time recovery (PITR) option, the Bacula Oracle plugin requires Accurate mode information to correctly handle incremental and differential backups, thus you must enable the Accurate option in your Job resource. Note that when combined with the plugin, the Accurate option is used to ensure that all new files are saved by Bacula, but will not mark old files as deleted from previous backups as they most likely will still be useful.

```
Job {
  Name = "Oracle-RMAN"
  Client = laptop1-fd
  FileSet = FS_oracle
  Accurate = yes
  ...
}

FileSet {
  Name = FS_oracle
  Include {
    Options {
      Signature = MD5
    }
    Plugin = "oracle: mode=rman"
  }
}
```

In the RMAN mode, the Oracle plugin also accepts additional options on the Plugin command line listed in table 4 below.

Option	Comment	Default	Example
mode	Needed to enable RMAN PITR backup	dump	mode=rman

This table continues on the following page

Option	Comment	Default	Example
oracle_user	Oracle Unix super user	oracle	oracle_user=oracle10
sid	Oracle SID		sid=XE
ORACLE_SID	Oracle SID		ORACLE_SID=XE
ORACLE_HOME	Oracle HOME		ORACLE_HOME=/opt/oracle/...
verbose	Display RMAN output in the Job	0	verbose=1
sbt ²	Use SBT in RMAN script		sbt
ctrlfile	Base path of control files when using SBT		ctrlfile=/tmp/oracle

Table 4: Oracle Plugin Options in RMAN Mode

1.3.5 Schedule Consideration for RMAN

If you wish to be able to restore to any point in time between the last Incremental and the next Full or Differential backup you must arrange your backups carefully so as not to leave a gap. One way is to schedule an Incremental backup immediately before your next Full or Differential.

Another way is to configure the RMAN Retention Policy to include previous archivelogs. For example:

```
RMAN> CONFIGURE RETENTION POLICY TO RECOVERY WINDOW OF 7 DAYS;
or
RMAN> CONFIGURE ARCHIVELOG BACKUP COPIES FOR DEVICE TYPE DISK TO 2;
```

With either of the above options, the Full backup will contain previous archivelog files required to restore to a point between the last Incremental and the Full backup. To restore to a point between both jobs, you need to restore files from both groups of backup. Note, if you have implemented the above policy, there is no need to do an Incremental backup immediately before your Full since the Full will find the old logs and save them.

1.3.6 Customize RMAN Scripts

The Bacula Enterprise Oracle Plugin allows you to customize the RMAN backup script by creating special files in `/opt/bacula/etc`:

- `oracle_before_full_backup.rman`
- `oracle_before_incr_backup.rman`
- `oracle_before_diff_backup.rman`

²The SBT option is available with Bacula Enterprise 6.4.3 and later

You may want to add special actions to these files such as:

```
% cat /opt/bacula/etc/oracle_before_full_backup.rman
BACKUP ARCHIVELOG FROM TIME 'SYSDATE-2';
```

In this example, the Bacula Enterprise Oracle Plugin will include a backup of all ArchiveLogs generated for the last two days. It will allow you to cover the gap between the last Incremental backup and the current Full backup as described in 1.3.5. Note that if you configure the Retention Policy the Full backup will automatically include ArchiveLogs generated between the two backups that have not been backed up.

If you want to exclude tablespaces from the backup, you can use the following RMAN script.

```
% cat /opt/bacula/etc/oracle_before_full_backup.rman
CONFIGURE EXCLUDE FOR TABLESPACE cwmlite;
CONFIGURE EXCLUDE FOR TABLESPACE example;
```

In this example, the RMAN backup will exclude the two tablespaces “cwmlite” and “example”³. Note that this setting is saved in RMAN configuration and will stay across RMAN sessions.

Important, you can't change the configuration of the disk device or it will reset the previous configuration made by Bacula and break the job.

1.4 Dump Configuration

With the Dump option, Bacula cannot perform Incremental or Differential backups, but the procedure to backup and restore is very simple, and this method is suitable for small/medium databases that don't need the Point-In-Time recovery feature.

```
Job {
  Name = "Oracle-dump"
  Client = laptop1-fd
  FileSet = FS_oracle_dump
  ...
}

FileSet {
  Name = FS_oracle_dump
  Include {
    Options {
      Signature = MD5
      Compression = GZIP
    }
    Plugin = oracle
  }
}
```

In this example, the plugin will detect and backup all databases on your server. Instances will be detected using information in `/etc/oratab`. You can also specify `ORACLE_HOME` and `ORACLE_SID` in Plugin command line.

³Use `CONFIGURE EXCLUDE FOR TABLESPACE cwmlite CLEAR;` remove this exception

```

FileSet {
  Name = FS_oracle
  Include {
    Options {
      Signature = MD5
      Compression = GZIP
    }
    Plugin = "oracle: schema=bacula"
    Plugin = "oracle: schema=master"
  }
}

```

In this example, the plugin will backup databases bacula and master.

In the Dump mode, the Oracle plugin also accepts additional options on the Plugin command line listed in table 5.

Option	Default	Comment	Example
mode	dump	Configure the Plugin backup method	mode=dump
dump_opt	CONSISTENT=Y GRANTS=y	This string will be passed to the exp command	dump_opt=""
unix_user	oracle	Unix user to use for Oracle commands	unix_user=rob
oracle_user	/ as sysdba	Oracle user to use for Oracle commands	oracle_user="scott/tiger"
use_sudo		Use sudo instead to run Oracle commands (when not root)	use_sudo
compress	Y	Use exp compression. Y/N	compress=N
schema		Will backup schema matching this string	schema=PROD*
instance		Will backup instances (SID) matching this string	instance=PROD*
sid		Instance (SID) to backup	sid=PROD
ORACLE_HOME		ORACLE_HOME to use with sid	ORACLE_HOME=/ora

Table 5: Oracle Plugin Options in Dump Mode

```

FileSet {
  Name = FS_oracle_dump
  Include {
    Options {
      Signature = MD5
    }
  }
}

```

```

    }
    Plugin = "oracle: unix_user=rob dump_opt=\"TABLES=temp\""
  }
}

```

In this example, the Oracle plugin will use Unix account “rob” to perform a dump backup of table named “temp”. The Oracle Plugin expects the “rob” account to be a member of the dba Unix group in order to directly access Oracle using “/ as sydba”.

1.4.1 Testing Database Access

You can use the estimate command to verify that the Oracle plugin is correctly configured.

```

* estimate listing job=oracle-test
Connecting to Client 127.0.0.1-fd at 127.0.0.1:8102
-rw-r--r-- 1 oracle dba 1949 2012-06-06 21:55:20 /@ORACLE/XE/users.sql
-rw-r--r-- 1 oracle dba 5240 2012-06-06 21:55:22 /@ORACLE/XE/FLOWS/user.sql
-rw-r----- 1 oracle dba -1 2012-06-06 21:55:22 /@ORACLE/XE/FLOWS/data.dmp
drwxr-x--- 2 oracle dba 4096 2012-06-06 21:55:22 /@ORACLE/XE/FLOWS
-rw-r--r-- 1 oracle dba 1028 2012-06-06 21:55:23 /@ORACLE/XE/HR/user.sql
-rw-r----- 1 oracle dba -1 2012-06-06 21:55:23 /@ORACLE/XE/HR/data.dmp
drwxr-x--- 2 oracle dba 4096 2012-06-06 21:55:23 /@ORACLE/XE/HR
-rw-r--r-- 1 oracle dba 360 2012-06-06 21:55:23 /@ORACLE/XE/OUTLN/user.sql
-rw-r----- 1 oracle dba -1 2012-06-06 21:55:23 /@ORACLE/XE/OUTLN/data.dmp
drwxr-x--- 2 oracle dba 4096 2012-06-06 21:55:23 /@ORACLE/XE/OUTLN
-rw-r--r-- 1 oracle dba 2941 2012-06-06 21:55:24 /@ORACLE/XE/SYS/user.sql
-rw-r----- 1 oracle dba -1 2012-06-06 21:55:24 /@ORACLE/XE/SYS/data.dmp
drwxr-x--- 2 oracle dba 4096 2012-06-06 21:55:24 /@ORACLE/XE/SYS
-rw-r--r-- 1 oracle dba 2857 2012-06-06 21:55:24 /@ORACLE/XE/SYSTEM/user.sql
-rw-r----- 1 oracle dba -1 2012-06-06 21:55:24 /@ORACLE/XE/SYSTEM/data.dmp
drwxr-x--- 2 oracle dba 4096 2012-06-06 21:55:24 /@ORACLE/XE/SYSTEM
-rw-r--r-- 1 oracle dba 233 2012-06-06 21:55:25 /@ORACLE/XE/TSMYSYS/user.sql
-rw-r----- 1 oracle dba -1 2012-06-06 21:55:25 /@ORACLE/XE/TSMYSYS/data.dmp
drwxr-x--- 2 oracle dba 4096 2012-06-06 21:55:25 /@ORACLE/XE/TSMYSYS
2000 OK estimate files=25 bytes=36,643

```

Notice that all the files backed up by the Bacula Oracle plugin are under a pseudo-directory named `/@ORACLE/`.

In order to use the sudo wrapper, you need to comment out:

```

| Defaults requiretty

```

by putting a pound sign (#) in front of it in the `/etc/sudoers` file.

1.5 Estimate Information

The estimate command will display all discovered information by the Oracle plugin. Note that with the dump mode, Bacula can't compute dump size for databases and will display -1 instead. On RMAN PITR mode, Bacula will not use RMAN to generate backup set, so it will display only system files and the flash recovery area.

1.6 Backup Files in RMAN Mode

In RMAN mode, Bacula Enterprise Oracle Plugin will not be cataloged under the pseudo-directory named `/@ORACLE/` but will be under their original location. For example:

```

/etc/oratab
/ora10/flash_recovery_area/<Jobname>/<SID>/last_control_file
/ora10/flash_recovery_area/<Jobname>/<SID>/restore_query_file.txt
/ora10/product/10.2.0/server/network/admin/tnsnames.ora
/ora10/product/10.2.0/server/network/admin/listener.ora
/ora10/product/10.2.0/server/dbs/orapw<SID>

```

The Plugin will also generate some extra files in order to help you in case of a disaster situation, such as `datafiles.txt` or `logfiles.txt` as shown in Table 6.

File	Comment
<code>dbid.txt</code>	DBID of the current instance
<code>tnsname.ora</code>	Backup of <code>ORACLE_HOME/network/admin/tnsname.ora</code>
<code>control<SID>.txt</code>	Last control file generated after the backup
<code>init<SID>.ora</code>	Parameter file for the current instance
<code>last_control_file</code>	File that contains the name of the last control file backup
<code>datafiles.txt</code>	List of all data files
<code>logfiles.txt</code>	List of all log files
<code>tempfiles.txt</code>	List of all temp files
<code>restore_query_file.txt</code>	Special file needed for automatic restore
<code>orpw<SID></code>	Password file for this instance
<code>c-0000-YYYYMMDD-00</code>	Control file
<code>9tnclu2b_1_1</code>	Backup Set

Table 6: Files Generated During RMAN Backup

1.6.1 RMAN Backup Level

In Bacula Enterprise terminology, jobs may have the following **Level**

- **Full** A backup that includes all files, it corresponds to the `INCREMENTAL LEVEL 0` RMAN level. This level will allow RMAN to do subsequent incremental backups.
- **Incremental** A backup that includes all files changed since the last Full, Differential, or Incremental backup started. It corresponds to the `INCREMENTAL LEVEL 1` or `INCREMENTAL FROM SCN` RMAN level. Depending on the current state of the RMAN catalog, Bacula will choose one level or the other, depending on the SCN sequence.
- **Differential** A backup that includes all files changed since the last Full save started. It corresponds to the `INCREMENTAL LEVEL 1 CUMULATIVE` RMAN level.

1.6.2 Example of Job Output

The Bacula Enterprise Oracle Plugin will display in the Job output the full result of the RMAN command executed.

```
dir: Start Backup JobId 7, Job=Oracle.2012-06-11_20.00.07_10
dir: Using Device "FileStorage"
sd: Recycled volume "TestVolume001" on device "FileStorage" (/storage), all previous data lost.
fd: Calling RMAN for orcl
fd: connected to target database: ORCL (DBID=1229390655)
fd: using target database control file instead of recovery catalog
fd: RMAN> RUN {
fd: 2> CROSSCHECK ARCHIVELOG ALL;
fd: 3> DELETE EXPIRED ARCHIVELOG ALL;
fd: 4> CROSSCHECK BACKUP;
fd: 5> DELETE NOPROMPT FORCE OBSOLETE;
fd: 6> CONFIGURE CONTROLFILE AUTOBACKUP FORMAT FOR DEVICE TYPE DISK
      TO '/app/oracle/flash_area/Oracle.2012-06-11_20.00.07_10/orcl/%F';
fd: 7> CONFIGURE CONTROLFILE AUTOBACKUP ON;
fd: 8> CONFIGURE BACKUP OPTIMIZATION OFF;
fd: 9> CONFIGURE CHANNEL DEVICE TYPE DISK MAXPIECESIZE 2G
      FORMAT '/app/oracle/flash_area/Oracle.2012-06-11_20.00.07_10/orcl/%U';
fd: 10> # @/tmp/oracle_before_full_backup.rman
fd: 11> BACKUP INCREMENTAL LEVEL 0 DATABASE PLUS ARCHIVELOG;
fd: 12> SQL "ALTER DATABASE BACKUP CONTROLFILE TO TRACE
      AS '/app/oracle/flash_area/Oracle.2012-06-11_20.00.07_10/orcl/controlorcl.txt' REUSE";
fd: 13> SQL "CREATE pfile='/app/oracle/flash_area/Oracle.2012-06-11_20.00.07_10/orcl/initorcl.ora'
      FROM spfile";
fd: 14> }
fd: 15>
fd: allocated channel: ORA_DISK_1
fd: channel ORA_DISK_1: SID=33 device type=DISK
fd: validation succeeded for archived log
fd: Crosschecked 28 objects
fd: released channel: ORA_DISK_1
fd: allocated channel: ORA_DISK_1
fd: channel ORA_DISK_1: SID=33 device type=DISK
fd: specification does not match any archived log in the repository
fd: using channel ORA_DISK_1
fd: crosschecked backup piece: found to be 'AVAILABLE'
fd: backup piece handle=/app/oracle/flash_area/Oracle2.2012-06-08_15.33.06_28/orcl/1pnd0fqi_1_1 RECID=96 STA
...
fd: Crosschecked 3 objects
fd: RMAN retention policy will be applied to the command
fd: RMAN retention policy is set to redundancy 1
fd: using channel ORA_DISK_1
fd: no obsolete backups found
fd: CONFIGURE BACKUP OPTIMIZATION OFF;
fd: released channel: ORA_DISK_1
fd: Starting backup at 2012-06-11_11:00:22
fd: current log archived
fd: allocated channel: ORA_DISK_1
fd: channel ORA_DISK_1: SID=33 device type=DISK
fd: channel ORA_DISK_1: starting archived log backup set
fd: channel ORA_DISK_1: specifying archived log(s) in backup set
fd: input archived log thread=1 sequence=556 RECID=6 STAMP=785300484
...
fd: channel ORA_DISK_1: starting piece 1 at 2012-06-11_11:00:23
fd: channel ORA_DISK_1: finished piece 1 at 2012-06-11_11:00:24
fd: piece handle=/app/oracle/flash_area/Oracle.2012-06-11_20.00.07_10/orcl/1rnd8si7_1_1 tag=TAG20120611T1100
fd: channel ORA_DISK_1: backup set complete, elapsed time: 00:00:01
fd: Finished backup at 2012-06-11_11:00:24
fd: Starting backup at 2012-06-11_11:00:24
```

```
fd: using channel ORA_DISK_1
fd: channel ORA_DISK_1: starting incremental level 0 datafile backup set
fd: channel ORA_DISK_1: specifying datafile(s) in backup set
fd: input datafile file number=00002 name=/app/oracle/oradata/orcl/sysaux01.dbf
...
fd: channel ORA_DISK_1: starting piece 1 at 2012-06-11_11:00:24
fd: channel ORA_DISK_1: finished piece 1 at 2012-06-11_11:01:19
fd: piece handle=/app/oracle/flash_area/Oracle.2012-06-11_20.00.07_10/orcl/1snd8si8_1_1 tag=TAG20120611T1100
fd: channel ORA_DISK_1: backup set complete, elapsed time: 00:00:55
fd: Finished backup at 2012-06-11_11:01:19
fd: Starting backup at 2012-06-11_11:01:19
fd: current log archived
fd: using channel ORA_DISK_1
fd: channel ORA_DISK_1: starting archived log backup set
fd: channel ORA_DISK_1: specifying archived log(s) in backup set
fd: input archived log thread=1 sequence=585 RECID=35 STAMP=785674879
fd: channel ORA_DISK_1: starting piece 1 at 2012-06-11_11:01:19
fd: channel ORA_DISK_1: finished piece 1 at 2012-06-11_11:01:20
fd: piece handle=/app/oracle/flash_area/Oracle.2012-06-11_20.00.07_10/orcl/1tnd8sjv_1_1 tag=TAG20120611T1101
fd: channel ORA_DISK_1: backup set complete, elapsed time: 00:00:01
fd: Finished backup at 2012-06-11_11:01:20
fd: Starting Control File and SPFILE Autobackup at 2012-06-11_11:01:20
fd: piece handle=/app/oracle/flash_area/Oracle.2012-06-11_20.00.07_10/orcl/c-1229390655-20120611-00
fd: Finished Control File and SPFILE Autobackup at 2012-06-11_11:01:21
fd: sql statement: ALTER DATABASE BACKUP CONTROLFILE TO TRACE AS
    '/app/oracle/flash_area/Oracle.2012-06-11_20.00.07_10/orcl/controlorcl.txt' REUSE
fd: sql statement: CREATE pfile='/app/oracle/flash_area/Oracle.2012-06-11_20.00.07_10/orcl/initorcl.ora'
    FROM spfile
fd: Recovery Manager complete.
sd: Job write elapsed time = 00:02:29, Transfer rate = 5.577 M Bytes/second
sd: Sending spooled attrs to the Director. Despooling 7,972 bytes ...
dir: Bacula dir 6.0.2 (01May12):
  Build OS:          i686-pc-linux-gnu redhat
  JobId:             7
  Job:               Oracle.2012-06-11_20.00.07_10
  Backup Level:     Full (upgraded from Incremental)
  Client:           "127.0.0.2-fd" 6.0.2 (01May12) i686-pc-linux-gnu,redhat,
  FileSet:          "OracleSQLRMAN" 2012-06-11 14:26:50
  Pool:             "Default" (From Job resource)
  Catalog:          "MyCatalog" (From Client resource)
  Storage:          "File" (From Job resource)
  Scheduled time:   11-juin-2012 20:00:07
  Start time:       11-juin-2012 20:00:09
  End time:         11-juin-2012 20:02:41
  Elapsed time:    2 mins 32 secs
  Priority:         10
  FD Files Written: 25
  SD Files Written: 25
  FD Bytes Written: 831,041,382 (831.0 MB)
  SD Bytes Written: 831,045,562 (831.0 MB)
  Rate:             5467.4 KB/s
  Software Compression: 60.4 %
  VSS:              no
  Encryption:       no
  Accurate:         yes
  Volume name(s):   TestVolume001
  Volume Session Id: 1
  Volume Session Time: 1339432273
  Last Volume Bytes: 831,895,725 (831.8 MB)
  Non-fatal FD errors: 0
  SD Errors:        0
  FD termination status: OK
```

```
SD termination status: OK
Termination:           Backup OK
```

1.7 Backup Information in Dump Mode

The Oracle plugin will generate the following files for a MAIN instance having a single database "test".

```
/@ORACLE/MAIN/TEST/user.sql
/@ORACLE/MAIN/TEST/tables.sql
/@ORACLE/MAIN/TEST/data.dmp

/@ORACLE/MAIN/users.sql
/@ORACLE/MAIN/tnsnames.ora
/@ORACLE/MAIN/listener.ora
/@ORACLE/MAIN/orapwMAIN
/@ORACLE/MAIN/datafiles.txt
/@ORACLE/MAIN/logfiles.txt
/@ORACLE/MAIN/init.ora

/@ORACLE/oratab
```

File	Context	Comment
users.sql	global	List of all users, their password and specific options
datafiles.txt	global	List of all data files, for information only
tempfiles.txt	global	List of all temp files, for information only
logfiles.txt	global	List of all log files, for information only
tnsnames.ora	global	Content of the tnsnames.ora
listener.ora	global	Content of the listener configuration file
orapw<SID>	global	Password file of the current instance
init.ora	global	Oracle configuration file
user.sql	schema	Schema definition with all information about GRANT, PASSWORD, ...
data.dmp	schema	Database data in exp format, contains everything needed to restore
tables.sql	schema	Tables and indexes definition in SQL format

Table 7: Files Generated During Dump Backup

1.8 Restore Scenarios

Before starting a restore or recovery procedure, we strongly advise you to run a backup of your database.

1.8.1 Restoring using RMAN SBT Interface

Like when doing a Backup job, to restore objects with RMAN, the connection between RMAN and Bacula should be functional. If resources are available, everything will be managed by RMAN automatically.

```
SHUTDOWN IMMEDIATE;
STARTUP MOUNT;

RUN {
  ALLOCATE CHANNEL c1 DEVICE TYPE sbt;
  ALLOCATE CHANNEL c2 DEVICE TYPE sbt;
  SET UNTIL TIME "to_date('2013-05-31_10:20:00','YYYY-MM-DD_HH24:MI:SS')";
  RESTORE DATABASE;
  RECOVER DATABASE;
}
ALTER DATABASE OPEN RESETLOGS;
```

In this example, RMAN will restore the database at a certain point in time defined by the UNTIL command. More information can be found on Oracle RMAN documentation.

docs.oracle.com/cd/B28359_01/server.111/b28294/rman.htm#i1024051

If you restore RMAN files into a local directory and the `localdir` option is defined in `sbt.conf`, the RMAN plugin will look the `localdir` before starting a Bacula restore session. If the requested file is present, the RMAN Plugin will use it directly.

1.8.2 Restoring using RMAN with `bs_oracle_restore.pl`

Once you have restored the contents of the RMAN backup to your system (Fig 2) with the `bconsole` restore command or with `BAT/BWeb`, the Bacula Enterprise Oracle Plugin allows you to automate some RMAN operations through a wrapper called `bs_oracle_restore.pl`. This script is menu driven and allows you to:

- Restore the original database to a certain Point-In-Time
- Clone your database whether or not it is still available (currently in beta testing)

Once you have restored the contents of the backup to a given point in time, you should run the `bs_oracle_restore.pl` script with `restore_query_file.txt` file as argument.

Note that you only need to restore files that are not on your system, RMAN will use files that are still in the flash recovery area to perform the restore.

In the next example, you will find the file named `restore_query_file.txt` in the directory where you restored the files with Bacula. If your backup was in `/u01/flash/Test.2012-06-06_12-00-00`, and you restored it using `where=/tmp`, the `restore_query_file.txt` should be in `/tmp/u01/flash/Test.2012-06-06_12-00-00/restore_query_file.txt`

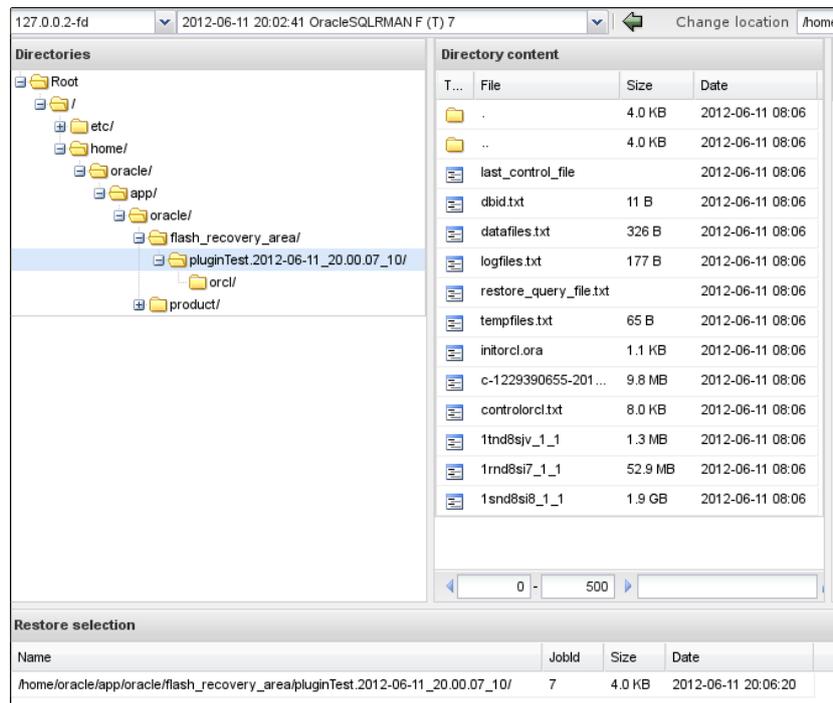


Figure 2: RMAN file selection when restoring using BWeb

```
# /opt/bacula/bin/bs_oracle_restore.pl /path/to/restore_query_file.txt
Bacula Enterprise Oracle Restore Tool 0.9
```

```
Do you want to:
1- restore the original database
```

The Bacula Enterprise Oracle restore script can be called with the `-testing` option to have access to restore procedures that are currently in testing phase by Bacula Systems.

```
# /opt/bacula/bin/bs_oracle_restore.pl --testing /path/to/restore_query_file.txt
Bacula Enterprise Oracle Restore Tool 0.9
```

```
Do you want to:
1- restore the original database
```

```
The following restore modes are available but still being beta tested
2- restore the database into a clone
3- restore the database to a different location
```

Performing Database Point-In-Time Recovery RMAN can perform recovery of the whole database to a specified past time, SCN, or log sequence number. This type of recovery is sometimes called incomplete recovery because it does not completely use all of the available redo information.

The restore wrapper `bs_oracle_restore.pl` will detect from files restored with Bacula Enterprise parameters that you can use during the restore.

```
Do you want to:
1- restore to a certain point-in-time
```

```

                2- restore to a certain scn

Choose restore mode (1-2): 1

Getting the range of recoverable backups
Please input the time to which you want to restore
between 2012-06-05_15:17:16 and 2012-06-05_15:36:09

(YYYY-MM-DD_HH24:MI:SS): 2012-06-05_15:35:00

INFO: Mounting database in mount state
The database is in open state,
do you really want to shutdown the database now (y/N): y
INFO: Call RMAN to restore the database
Opening database

BE CAREFUL, we are about to open the database in RESETLOGS mode.

Do you want to continue ? (no will exit) (y/N): y
Opening database resetlogs

```

The `bs_oracle_restore.pl` will scan the backup directory, then detect the right Incarnation in order to restore files as expected.

At the end of the restore process, the database should be in "OPEN" state. The `bs_oracle_restore.pl` will perform all the step necessary to recover the database. If you are familiar with RMAN, you may want to do these steps manually.

Using `bs_oracle_restore.pl` Script Without Restoring First In some case, if RMAN backup sets are still present on disk, you may want to skip the Bacula restore and run directly the `bs_oracle_restore.pl` script. For that, just use the `-D` option and point to the flash back recovery area where are located files generated during the last backup.

```
| # /opt/bacula/bin/bs_oracle_restore.pl -D /path/to/flash/job/SID
```

1.8.3 Restoring Directly with RMAN

Once you restored your files with Bacula, you need to scan the backup directory to include files in the RMAN catalog.

```
| RMAN> CATALOG START WITH '/path/to/restore' NOPROMPT;
```

Then, you should have all backups registered and you can list them with:

```

RMAN> LIST BACKUP SUMMARY;

List of Backups
=====
Key      TY LV S Device Type Completion Time #Pieces #Copies Compressed Tag
-----
458     B  0  A DISK      12-JUN-12         1         1       YES   TAG20120612
459     B  A  A DISK      13-JUN-12         1         1       YES   TAG20120613
461     B  A  A DISK      14-JUN-12         1         1       YES   TAG20120614
462     B  1  A DISK      15-JUN-12         1         1       YES   TAG20120615
...

```

Note that the `LIST BACKUP` can display information about specific objects such as:

- Archivelogs

- Datafiles
- Controlfile
- ...

To start the restore process, the database should not be in open state.

```
RMAN> shutdown immediate;
RMAN> startup mount;
```

Then, you can set a UNTIL clause and start your recovery

```
RMAN> RUN {
2> RESTORE DATAFILE 1;
3> RECOVER DATAFILE 1;
3> }

Starting restore at 15-JUN-12
using channel ORA_DISK_1
...
```

RMAN is a very powerful tool with many options, for more information, see the RMAN documentation available on docs.oracle.com

1.8.4 Restoring using Dump

Restoring Users To restore users/schema to your Oracle instance, you just select the `users.sql` file located in `/@ORACLE/<SID>/users.sql`. Then, using `where=/` or `where=` the plugin will load this SQL file to your database. If some roles already exist, errors will be printed in the Job log. It is also possible to restore the `users.sql` file to a local directory, edit the file and load it with `sqlplus` to restore any selected part of the file.

```
% sqlplus / as sysdba @users.sql
```

Restoring a Single Database To restore a single schema with the Bacula Enterprise Oracle plugin, you must select the schema directory during the restore command, the selection should contain the data file (`data.dmp`) and the schema creation script (`user.sql`).

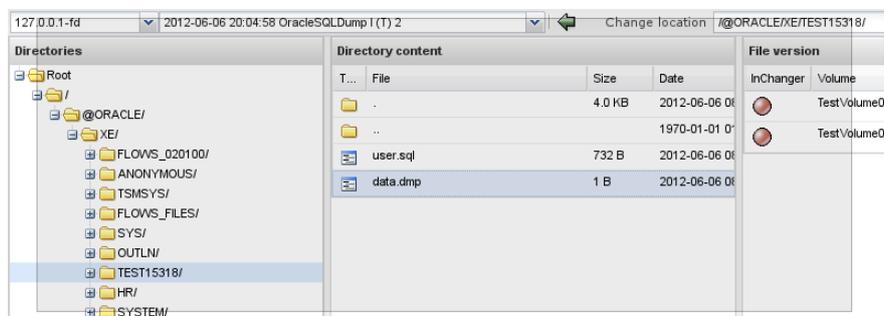


Figure 3: Database content with dumps with BWeb

When the database directory is selected, you can use the `where` parameter to restore the schema to a new schema, with a different name. In order to create a new schema name, you must set `where` to a single word that contains only A..Z, 0-9, and `_`. Bacula will then create the specified schema and restore data into it.

```
| * restore where=BACULAOLD
```

We advise you to always use schema names in capital letters. Bacula Enterprise Oracle Plugin will recreate the new schema using exactly the same name that you provided in the `where=` parameter. If you mix upper and lowercase characters in the name, it can lead to a situation where you will need to enclose the schema name with quotes to access it.

Once restored, you may need to reset the password of the schema that you just created using the same parameters as the original schema. To do so, use:

```
| SQL> ALTER USER BACULAOLD IDENTIFIED BY APASSWORD;
```

If you set the `replace` parameter to `never`, Bacula will check the schema list, and will abort the Job if the schema currently restored already exists.

Using `replace=always` is not recommended, because it can overwrite existing files. If the `where` parameter is a directory (containing `/`), Bacula will restore all files into this directory. Doing so, you will be able to use `imp` directly and restore only triggers, tables, indexes, etc...

Restoring a Single Table To restore a single object such as a table from your dump, you must first restore the dump file to a local directory, then use the `imp` tool to import the needed object. See the Oracle `imp` documentation for more information.

Restoring Dump Files to a Directory To restore SQL dumps to a directory, you can set the `where` parameter to any valid directory.

```
| * restore where=/tmp
```

The Bacula restore process will create the following directories when restoring the schema `SYS` in the Oracle `SID XE`, and will restore selected files into it.

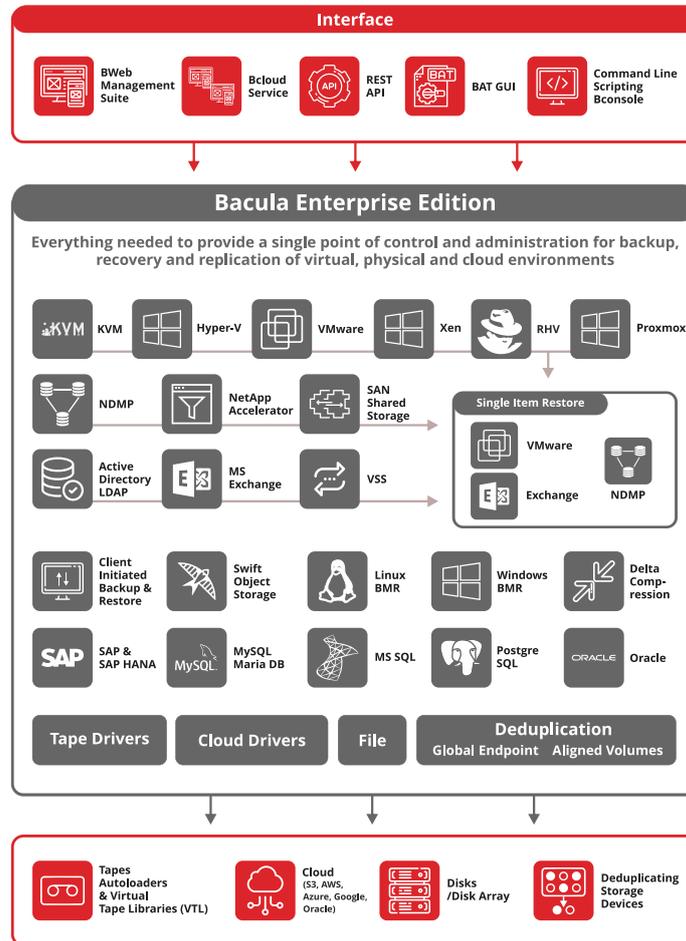
```
| /tmp/@ORACLE/MAIN/XE
```

Restoring the Entire Database To restore the all databases and the database configuration, just all files located in `/@ORACLE/<service>`, use `replace=always` and `where=.`

1.9 Limitation

- Plugins are not compatible with Copy/Migration/VirtualFull jobs by default. Please contact Bacula Systems support team to confirm your strategy is compatible with your setup.

Bacula Enterprise has an especially wide range of capabilities that go far beyond its Delta abilities. The diagram below shows an overview of Bacula Enterprise's broad feature set.





For More Information

For more information on Bacula Enterprise Edition, or any part of the broad Bacula Systems services portfolio, visit www.baculasystems.com.

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