

ORACLE WHITEPAPER APRIL 2017

ORACLE DATABASE BACKUP CLOUD SERVICE



Oracle Maximum Availability Architecture

Oracle Database Backup Cloud Service

Best Practices for On-Premise and Cloud Databases

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Table of Contents

Introduction	1
Why Backup to the Cloud?	2
Traditional Database Backup Best Practices	2
Oracle Database Backup Cloud Service: Overview	3
Cloud Backup Module	5
Architecture of Oracle Cloud Backup when used with On-Premise Databases	7
Architecture of Oracle Cloud Backup when used with Cloud Deployed Databas	ses
	7
Oracle Database Backup Cloud Service: Best Practices	8
Backup	8
Recovery	10
Additional Best Practices:	13
Conclusion	14

Introduction

Oracle Database Backup Cloud Service is a secure, scalable, on-demand storage solution for backing up Oracle On-premise or cloud databases to the public cloud. Oracle Database Backup Cloud Service complements your existing backup strategy by providing an off-site storage location in the cloud.

Storage management and data transfer complexities are handled by the service, not by database administrators. Database Administrators use the familiar RMAN (Oracle Recovery Manager) interface to perform backup and restore operations, so there's no need to learn new tools or commands.

If you know how to back up to tape or disk, then you know how to back up to the cloud. Oracle Database Backup Cloud Service is easy to get and use. Your data is always available and always secure, and you can quickly scale up the storage capacity when needed.

Why Backup to the Cloud?

Storing database backups off-site is critical for organizations to be disaster ready. To reduce application downtime, backups must be accessible 24 x 7.

Why business-critical backups must be kept off-site? It's best practice to a have a disaster recovery and data protection plan when your source database or system is irreparable. Off-site backup is typically accomplished by sending backups to tape and shipping the tapes to a secure location. This is a complex procedure endeavor as it requires: Hardware, personnel, and procedures to make sure off-site backups are current, protected, and available at a moment's notice should the unthinkable happen. Many small and medium businesses don't have a tape infrastructure, and end up deploying some form of virtual tape or disks for storing backups and archives.

Oracle Cloud storage provides a great alternative to writing, shipping, and storing tapes at an off-site location which increases performance, redundancy, and security.

Traditional Database Backup Best Practices

The following table summarizes the traditional Database Backup Best Practices.

Local Disk Backups	On-site Tiered Storage	Off-site Storage		
Local disk backups	Storage tier based on data value &	Tapes physically shipped to offsite (Tape		
	retention requirements: Vaulting)			
Short term retention (Ex:7	 Disk-to-Disk (Ex: 30 days) 	Long term retention & Archiving (Ex: 5		
Days)	 Disk-to-Tape (Ex: 90 days) 	yrs)		
Quickest RTO (Image Copy,	 Disk-to-Disk-to-Tape (EX:7- 	Compliance, Regulatory & DR purposes		
Backup Sets)	30-90 days)			

Challenges with Traditional Backup Infrastructure

Traditional backup strategies are facing increasing challenges which affects directly the Backup and Recovery best practices. Some of these challenges are:

On-Demand Capacity Growth:

With explosive data growth, storage capacity planning for the long term retention is a challenge.

No DR/Tape Infrastructure

Not everyone has tape infrastructure or secure and reliable remote (DR) site for taking backups and to store offsite **Accessibility Issues**

Accessibility issues

With Tape-vaulting, offsite data is not immediately accessible which increases RTO

High Cost

Increasing capital expenditures to procure and manage onsite & offsite backup infrastructure and operations.

Oracle Database Backup Cloud Service: Overview

Disaster strikes without warning. With Oracle Database Backup Cloud Service, your backups are always accessible and secure over the Internet and are immediately available for recovery when needed. Data is automatically and transparently replicated across multiple storage nodes in the same geographic region, which protects against hardware failure and data corruption.

Oracle Database Backup Cloud Service protects your data by providing end-to end security. Your data is encrypted at the source, securely transmitted to the cloud, and securely stored in the cloud. You keep the keys at your site, not in the cloud.

Oracle Database Backup Cloud Service is simple to deploy and easy to use. Subscribe to the service, install the cloud backup module, configure a few settings, and you're ready to back up to the cloud using familiar commands and tools. It's that simple

Certification Matrix and Supportability

Oracle Database Backup Cloud Service supports the Certification Matrix below.

Database / Features	Supported Versions / Options
Oracle Database – Enterprise Edition*	10.2.0.5, 11.1,11.2, 12c (64 bits)
Oracle Database – SE/SE1/SE2*	10.2.0.5, 11.1.0.7, 11.2.0.3, and versions 11.2.0.4 and above
Platforms (64 bits)	Linux, Solaris, SPARC, Windows, HP-UX, AIX, zLinux
RMAN Compression (Included)	HIGH, MEDIUM, BASIC, LOW (depends on DB version)
RMAN Encryption (Included)	Password, TDE, Dual-mode

* Older Database versions no longer supported by Oracle are in deprecated mode

Oracle Database Backup Cloud Service supports the following RMAN operations :

Database (Backupset)	Backups From Fast Recovery Area	Restore from Cloud	Maintenance
BACKUPSET Backups	Image Copies	Full Database	Retention Period
Full Database	Archived logs	Tablespace	Crosscheck
Selected	Compressed	Datafile	Obsolete
Tablespace(s)	Encrypted backup sets	Table Recovery (12c)	Delete Obsolete
Selected Data Files		Block Recovery	Delete Backups
Incremental – Differential		,	
Incremental – Cumulative			
Compressed			
Encrypted			

RMAN Compression and Encryption:

RMAN Compression (Optional)	RMAN Encryption (Mandatory)
– 10g: BASIC	 Password, Transparent Data Encryption (TDE),
 11g and above: HIGH, BASIC, MEDIUM,LOW 	Dual-Mode
 MEDIUM recommended 	 <u>No ASO licensing required</u>
 <u>No ACO licensing required</u> 	 Keys are kept local (not in the storage cloud)
CONFIGURE COMPRESSION ALGORITHM 'MEDIUM';	 If TDE is used (preferred), then simply use SET ENCRYPTION ON before backups and restores
BACKUP AS COMPRESSED BACKUPSET DATABASE PLUS ARCHIVELOG;	 For password encryption:
	SET ENCRYPTION ON IDENTIFIED BY ' <password>'</password>
	ONLY;
	 Before doing restore,
	SET DECRYPTION IDENTIFIED BY ' <password>';</password>

Setting up Oracle Database Backup Cloud Service in simple 4 steps.

1. Subscribe for the Oracle Database Backup Cloud Service. You can do that from <u>shop.oracle.com</u> (or) work with your Oracle representative. Alternatively, you can choose to give it a try using Database Cloud Service trial. For more information, refer to cloud.oracle.com/database_backup.

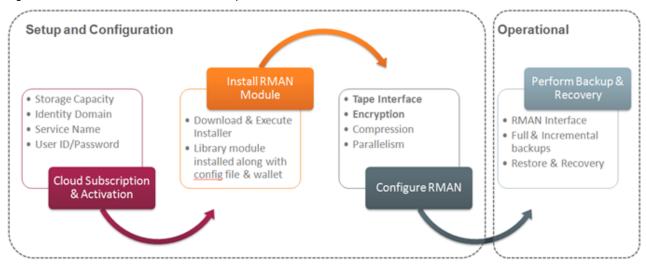
2. Download and install the Oracle Database Cloud Backup Module from <u>Oracle Technology Network</u> (OTN). The module is what makes it possible to perform secure cloud backups and restores. You'll install the module on the system where your Oracle database is running. Multiple database versions and operating systems are supported.

3. After you install the backup module, you'll configure a few RMAN settings.

4. Then you're ready to perform backup & recovery operations to the cloud using familiar RMAN commands.

You'll use the online dashboard to monitor your service and see how much storage capacity you're using for your backups..

High Level Architecture of Oracle Cloud Backup



Cloud Backup Module

The module is a system backup to tape (SBT) interface that's tightly integrated with Recovery Manager (RMAN), which means you don't need to learn new tools or commands.

You can continue to use standard RMAN commands for all backup, restore, recovery, and maintenance operations

You'll download the backup module from Oracle Technology Network (OTN) and install it on your database server. Multiple database versions and operating systems are supported. For more information about the module, see Installing the Oracle Database Cloud Backup Module.

Workflow:

- 1. RMAN streams backup data to the cloud via RMAN cloud module
- 2. Cloud module breaks backup pieces into 100MB chunks (Default) and ships to the cloud
 - a. Failed transmissions are retried automatically.
 - b. Multiple buffers (RMAN Channels) can be used for parallelism and to increase backup throughput if there is sufficient network bandwidth.
- Each chunk is stored as an object inside the Oracle clouduser container. The container can either be user pre-created (or) automatically created by the RMAN cloud module.Default container name : "oracle-data-[first 8 chars of service & domain]
- 4. Uses REST API calls PUT,GET, POST, HEAD & DELETE over HTTPS
- 5. Typical URL formation for every object
 - a. http://<identitydomain>.storage.oraclecloud.com/v1/<service>-<domain>/<container>/<piece name>/<unique ID>/0000001, 0000002 ..
 - b. Creates and maintains metadata XML files in the cloud which acts as manifest files and used by the RMAN module.

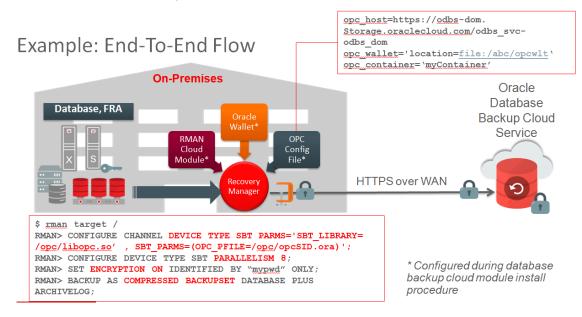
Required Configuration Files for Cloud Backups

File name	Location / Creation	Purpose
libopc.so(or) oraopc.dll	User specified library location. Downloaded by the installer.	SBT library which enables backup to Oracle Cloud
opc <sid>.ora</sid>	Configured by the installer under \$ORACLE_HOME/dbs	Contains ODBS container URL location for the user and also the ODBS credential wallet location
cwallet.sso	User specified wallet location during the RMAN module installation.	Oracle wallet which securely stores backup service credentials. This is used during RMAN backups and restore operations.
Wallet for encryption (optional –only needed for TDE)	Either \$ORACLE_BASE /admin/\$ORCLE_SID /wallet (or) defined in sqlnet.ora / Existing wallet	Used for backup encryption. Existing Oracle wallet can be used (or) new Oracle wallet can be created.

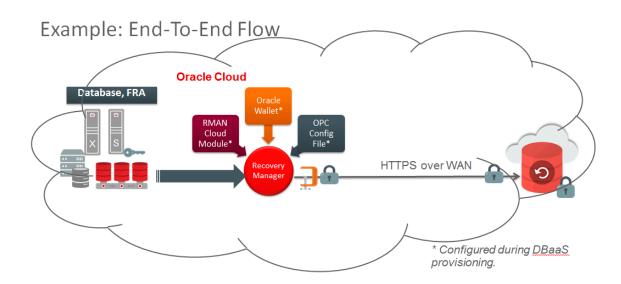
Content of the OPC Configuration File - Run time configurations (located under \$ORACLE_HOME/opc<sid>.ora)

Parameter Name	Description
OPC_HOST	REST destination URL
	Ex: https://mydomain.storage.orclecloud.com/v1/myservice- mydomain
OPC_WALLET	OPC credential wallet location
	Ex: 'LOCATION=file:/home/oracle/OPC/wallet CREDENTIAL_ALIAS=odbs_opc'
OPC_CONTAINER	User specified container name Ex:PAYROLL_DB
	(Customer need to create that using tools like cloudberry until Oracle Cloud has GUI)
OPC_CHUNK_SIZE	Specified in bytes. By default, 100MB. Not recommended to change.
_OPC_TRACE_LEVEL	For debug purposes only. Set this parameter to – say 100 which generates more trace information in sbtio.log.

Architecture of Oracle Cloud Backup when used with On-Premise Databases



Architecture of Oracle Cloud Backup when used with Cloud Deployed Databases



Oracle Database Backup Cloud Service: Best Practices

In this section we will discuss the best practices when backing-up or recovering to or from the Oracle Cloud Backup Service. These best practices are based on native RMAN commands.

Before you start, ensure you have installed the Oracle Cloud Backup module from OTN and you configure your RMAN environment properly.

RMAN>CONFIGURE CHANNEL DEVICE TYPE 'SBT_TAPE' PARMS 'SBT_LIBRARY=/home/oracle/OPC/lib/libopc.so, ENV=(OPC_PFILE=/u01/products/db/12.1/dbs/opcodbs.ora)';

Backup

RMAN encryption for backups is enforced (mandatory for On-Premise Databases)

- Use the RMAN set encryption clause in your RMAN run block.

RMAN> SET ENCRYPTION ON IDENTIFIED BY 'abc123' ONLY;

Keys are managed by the customer (password, TDE, dual-mode)

Data securely transmitted to the cloud over HTTPS

- To optimize data transfer when network bandwidth is limited and CPU resources are available
 - Use RMAN compression (HIGH, MEDIUM, LOW, BASIC)

RMAN> CONFIGURE COMPRESSION ALGORITHM 'MEDIUM';

RMAN>BACKUP DEVICE TYPE SBT AS COMPRESSED BACKUPSET DATABASE PLUS ARCHIVELOG FORMAT '%d_%U';

 Increase PARALLELISM (until you reach acceptable network throughput or hit max throughput capable with the existing network)

RMAN> CONFIGURE DEVICE TYPE 'SBT_TAPE' PARALLELISM 4 BACKUP TYPE TO BACKUPSET;

To determine network throughput for a specific time period, use RMAN network analyzer, see MOS note **2022086.1**

To diagnose Oracle Cloud Backup Performance, see MOS note 2078576.1.

Use MULTISECTION backups

The purpose of multisection backups (available starting Oracle 11g) is to enable RMAN channels to back up a single large file in parallel. RMAN divides the work among multiple channels, with each channel backing up one file section in a file. Backing up a file in separate sections can improve the performance of backups of large data files. For example, suppose that the users tablespace contains a single datafile of 800 MB and assume that four SBT channels are configured, with the parallelism setting for the SBT device set to 4. You can break up the datafile in this tablespace into file sections as shown below.

RMAN> BACKUP SECTION SIZE 200M TABLESPACE USERS;

Use "weekly full and daily incremental" strategy

The goal of an incremental backup is to back up only those data blocks that have changed since a previous backup. This has a lot of benefits but prior to moving toward this standard approach, you should evaluate if your RTO requirements can still be met.

The advantages of this strategy are:

- Reduce the amount of time needed for daily backups. Since backup times are shorter, you have an option to backup more frequently as well to reduce RPO.
- Reduce network usage and network bandwidth requirements when backing up over a network.
- Reduce backup overhead and read I/Os.

The trade off is that restore and recovery time is longer since you have to restore the previous cumulative backup and subsequent incremental plus redo to recover the database.

Below is an example of a Weekly full/daily incremental strategy.

 Sunday An incremental level 0 backup backs up all blocks that have ever been in use in this database.

RMAN> BACKUP INCREMENTAL LEVEL Ø DATABASE PLUS ARCHIVELOG NOT BACKED UP DELETE INPUT;

Monday - Saturday

On each day from Monday through Saturday, a differential incremental level 1 backup backs up all blocks that have changed since the most recent incremental backup at level 1 or 0. So, the Monday backup copies blocks changed since Sunday level 0 backup, the Tuesday backup copies blocks changed since the Monday level 1 backup, and so forth.

RMAN> BACKUP INCREMENTAL LEVEL 1 DATABASE PLUS ARCHIVELOG NOT BACKED UP DELETE INPUT;

RMAN's change tracking feature for incremental backups improves incremental backup performance by recording changed blocks in each datafile 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 datafile.

To enable or disable block change tracking refer to the example below. Additional information can also be found here

SQL>ALTER DATABASE ENABLE BLOCK CHANGE TRACKING; SQL>ALTER DATABASE DISABLE BLOCK CHANGE TRACKING;

In summary, your RMAN configuration should contain similar settings to the below:

```
CONFIGURE CHANNEL DEVICE TYPE 'SBT_TAPE' PARMS

'SBT_LIBRARY=/home/oracle/OPC/lib/libopc.so,

ENV=(OPC_PFILE=/u01/products/db/12.1/dbs/opcodbs.ora)'

CONFIGURE COMPRESSION ALGORITHM 'MEDIUM'

CONFIGURE CONTROLFILE AUTOBACKUP ON

CONFIGURE DEVICE TYPE 'SBT_TAPE' PARALLELISM 4 BACKUP TYPE TO BACKUPSET

CONFIGURE BACKUP OPTIMIZATION ON
```

You can always list your backups by using the RMAN list command, note the Media attribute name that refers to your storage domain the Oracle Cloud Service.

Recovery

Because accidents can happen and often without warning, you need to ensure that your backups are available when you need them. Oracle Cloud Backup offers you performance, redundancy, and security, which in turn provide peace of mind. Nevertheless, testing your restore procedures and your backups is still an important activity and should be performed regularly.

Some of the important reasons that require recovery from your backups are below:

- 1. Storage Failure
- 2. Block Corruption
- 3. User/Logical Error
- 4. Database Failure
- 5. Site failure or disaster

Pro-actively testing your backups is the key of successful recovery. Below are some important items to consider.

Follow generic Database MAA best practices to detect, prevent and repair from data corruptions.

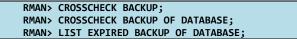
Preventing, Detecting, and Repairing Block Corruption - Oracle Database 12c Preventing, Detecting, and Repairing Block Corruption: Oracle Database 11g

Crosscheck your backups

Crosschecking your backups is important and it should be done before a delete obsolete. If a backup set, or piece, has gone missing we want to delete it. Crosschecking only marks the missing backup set/piece as expired and does not delete or remove anything. Backup set/pieces marked as expired will not count toward the retention policy of the delete obsolete command.

Following any crosscheck command, it's a good idea to do a corresponding report expired. The delete expired will remove the entries flagged as expired from the RMAN repository.

Use RMAN Crosscheck to check that files are accessible and ready for a restore operation.



Validate your backups

Because media can get corrupted - for several reasons - RMAN provide mechanisms to check for physical and logical corruption for backup residing on a particular media. RMAN *restore validate* command does a block level check of the backups and ensures that a restore could be performed, by confirming that all database files exist and are free of physical and logical corruptions. It is recommended to validate your backup on a regular basis.

RMAN> RESTORE DATABASE VALIDATE CHECK LOGICAL;

Note: The RMAN *restore validate* reads the backup sets and check them for corruption. *RMAN restore validate* will consume minimal CPU, memory and network resources to read the backups and analyze them – Restore validate command acts as a normal restore operation but without the overhead of writing any data to storage. The data is streamed from the cloud to your on-premises database for validation purposes and gets discarded after the validation. You may incur in network traffic charges for data leaving the Oracle Cloud (metered service only).

If you have a large backup set, your restore validate command will take longer to complete. For a very quick validation to ensure the backup files are available you can leverage the restore validate in conjunction with the HEADER clause, this will validate if the backups are present but will not validate their content.

*- This is not recommended as the only mean of backup validation. RMAN>RESTORE DATABASE VALIDATE HEADER;

You should also use the backup validate after a backup completion to perform a database validation. The validate command will check for physical corruption in the used blocks only, to extend the check for logical corruptions, you should use check logical in conjunction with the validate command.

RMAN>BACKUPVALIDATE CHECK LOGICAL DATABASE ARCHIVELOG ALL;

In summary:

- » Crosscheck: Ensures that the backup pieces are available on the cloud object store. It will compare the backup metadata (either in the controlfile or catalog) against the physical backup pieces to check if it matches.
- » Backup validate: Checks the database datafiles for physical corruptions and with the check logical option, the command checks for logical corruptions as well.
- » Restore validate: Checks if the backup is restorable and if it contains any physical corruptions and with the check logical option, the command checks for logical corruptions as well.

Example Plan:

- » Crosscheck daily
- » Restore "check logical" Validate Weekly

The calendar below shows a sample backup schedule with validation activities - This is applicable for on premise and Cloud deployments*.

The following validation procedure is recommended:

- 1. Daily Crosscheck: To ensure that backup pieces are available for restore.
- 2. Weekly Restore Validate: To confirm that a restore can be performed in the event of a disaster.
- 3. Bi-Weekly Backup Validate: Executing with check logical will ensure to validate all the used database blocks for physical and logical corruptions.
- 4. Quarterly Full Restore To test the DR strategy.

July 16						
Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
June 27	28	29	30	July 1	2	3
 Level 1 Backup Crosscheck Delete Expired 	Level 1 Backup Crosscheck Delete Expired	 Level 1 Backup Crosscheck Delete Expired Restore Validate Check Logical 	Level 1 Backup Crosscheck Delete Expired			
4	5	6	7	8	9	10
 Level 1 Backup Crosscheck Delete Expired 	 Level 1 Backup Crosscheck Delete Expired 	 Level 1 Backup Crosscheck Delete Expired Restore Validate Check Logical 	 Level 1 Backup Crosscheck Delete Expired 	 Level 1 Backup Crosscheck Delete Expired 	 Level 1 Backup Crosscheck Delete Expired 	 Level 1 Backup Crosscheck Delete Expired Backup Database Check Logical
11	12	13	14	15	16	17
 Level 1 Backup Crosscheck Delete Expired 	 Level 1 Backup Crosscheck Delete Expired 	 Level 1 Backup Crosscheck Delete Expired Restore Validate Check Logical 	 Level 1 Backup Crosscheck Delete Expired 	 Level 1 Backup Crosscheck Delete Expired 	 Level 1 Backup Crosscheck Delete Expired 	 Level 1 Backup Crosscheck Delete Expired
18	19	20	21	22	23	24
 Level 1 Backup Crosscheck Delete Expired 	 Level 1 Backup Crosscheck Delete Expired 	 Level 1 Backup Crosscheck Delete Expired Restore Validate Check Logical 	 Level 1 Backup Crosscheck Delete Expired 	 Level 1 Backup Crosscheck Delete Expired 	 Level 1 Backup Crosscheck Delete Expired 	 Level 1 Backup Crosscheck Delete Expired Backup Database Check Logical
25	26	27	28	29	30	31
 Level 1 Backup Crosscheck Delete Expired 	 Level 1 Backup Crosscheck Delete Expired 	 Level 1 Backup Crosscheck Delete Expired Restore Validate Check Logical 	 Level 1 Backup Crosscheck Delete Expired 	 Level 1 Backup Crosscheck Delete Expired 	 Level 1 Backup Crosscheck Delete Expired 	 Level 1 Backup Crosscheck Delete Expired

Additional Best Practices:

- » Use RMAN compression (HIGH, MEDIUM, LOW, BASIC) for optimal data transfers.
- » Increase PARALLELISM (until you reach maximum network throughput)
- » Refer to MOS Note 2078576.1 for performance investigation of your backups.
- » If public network throughput is not sufficient, choose Oracle Fast Connect (Standard, Partner Edition, MPLS). Refer to cloud.oracle.com/network
- » Choose cloud storage as appropriate storage tier based on RTO/RPO
- » Perform traditional weekly full and daily incremental backups.
- » You may schedule backing up archived logs frequently to reduce RPO
- » Run Installer once each two months to pick up latest RMAN SBT module
- » Run Installer with new credentials after changing Oracle Cloud password
- » Use Global Namespace to access REST endpoint instead of hard-coding to datacenter specific URLs.
- » Copy opc<SID>.ora file to other SIDs if same ORACLE_HOME is used by multiple databases
- » Configure CONTROLFILE AUTOBACKUP ON. This will enable complete restore of a database into a different host.

Conclusion

Oracle Cloud Database backup service is an effective and low cost solution to protect your Oracle databases. By leveraging the MAA configuration and operational practices, you have additional guarantees that your restore and recovery operations from Oracle Cloud object store will be successful.



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Integrated Cloud Applications & Platform Services

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