Oracle Recovery Manager 12*c*

Best Practices

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WORLD

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Safe Harbor Statement

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Program Agenda

1 RMAN 12*c*: List of New Features

2 Efficient & Faster Database Cloning

3 RMAN & Data Guard: Complete Protection

4 Cross Platform Migration Using XTTS

5 Low Cost Offsite Backup Storage to Oracle Public Cloud

6 Eliminate Data Loss using Recovery Appliance

7 Q & A

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Oracle RMAN 12*c*: List of New Features

- Fine grained Recovery
  - ✓ Table / Table partitions

- Support for Multitenant Database
  - ✓ Container and Pluggable Databases Backup and recovery

- Improved Performance
  - ✓ Faster cloning capability
  - ✓ Faster recovery over network
  - ✓ Multi-section support for incremental & image copies

- Simplified Platform Migration
  - ✓ Enhanced Cross-platform process

- Separation of Duty
  - ✓ SYSBACKUP privilege for RMAN

- Storage Snapshot Optimization
  - ✓ Point-in-time recovery from storage snapshots

- SQL interface in RMAN
 - ✓ Directly run SQL commands within RMAN

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RMAN 11*g*: Active DUPLICATE
One-Command Database Cloning

- ACTIVE DUPLICATE introduced in 11g

- Create a clone (or) a standby database from the production DB as of the current time / SCN

- Eliminates need for a backup staging

- Utilizes SOURCE (TARGET) database channels to PUSH data files and archived logs to clone (AUXILIARY) database server

- Data files are copied as image copies

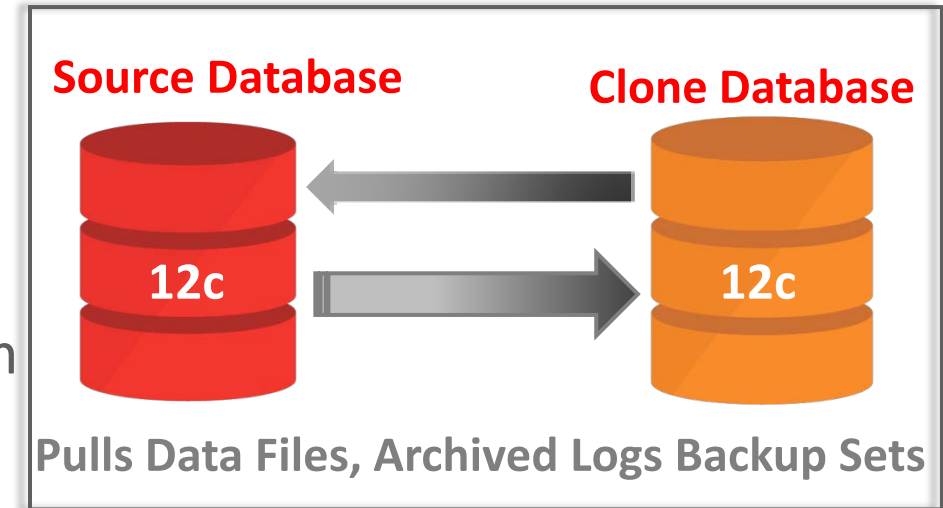DUPLICATE TARGET DATABASE TO cloneDB {FOR STANDBY} FROM ACTIVE DATABASE;

Source Database   **Clone Database**

11g   11g

Push Data Files, Archived Logs
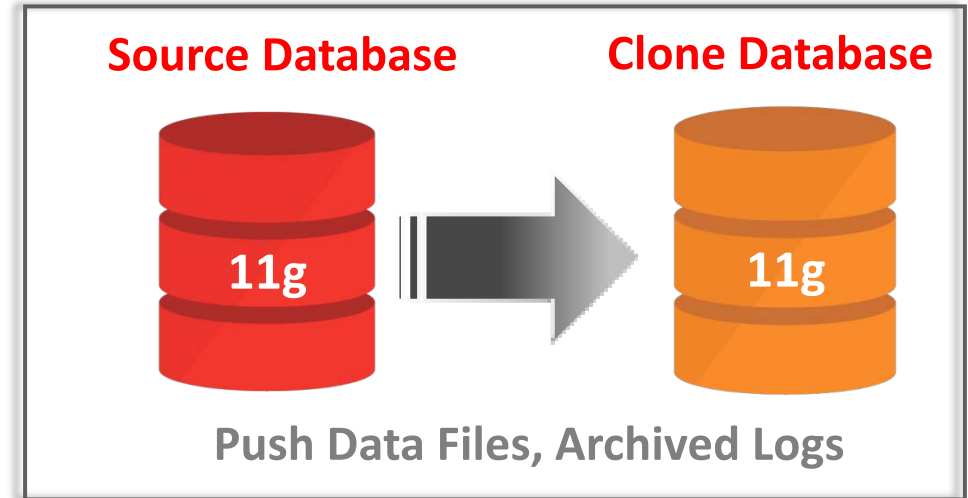
Challenges
- ❑Large transfers due to image copies
- ❑Network could be a bottleneck
- ❑Takes longer to duplicate

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RMAN 12*c*: New RMAN Active DUPLICATE

Network Efficient Duplication

- Create a clone (or) a standby database from the production DB as of the current time / SCN

- Eliminates a need for a backup staging

- Uses Auxiliary Channels (clone side) to PULL data from the source database

- Data files are copied as **backup sets**
  - Unused block compression, multi-channel, compression, encryption

- New keyword not open the clone automatically clone: NOOPEN

Source Database → **Clone Database**

12c ← **12c**

Pulls Data Files, Archived Logs Backup Sets

Benefits

✓ Reduced transfer sizes

✓ Network efficient & secured

✓ Faster to create a clone

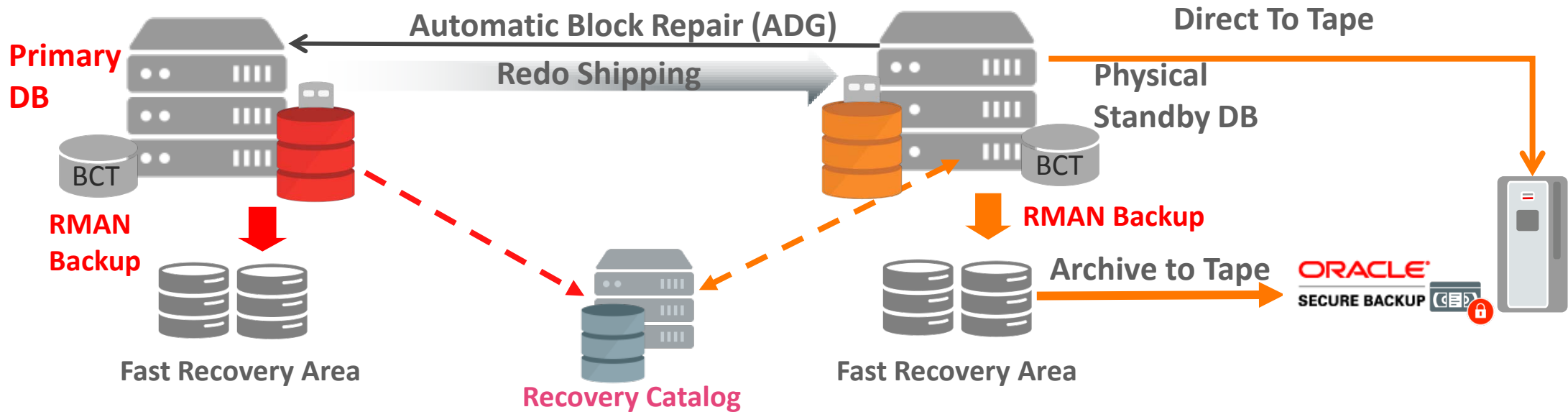DUPLICATE TARGET DATABASE TO cloneDB FROM ACTIVE DATABASE **USING COMPRESSED BACKUPSET SECTION SIZE** 100M **NOOPEN**;

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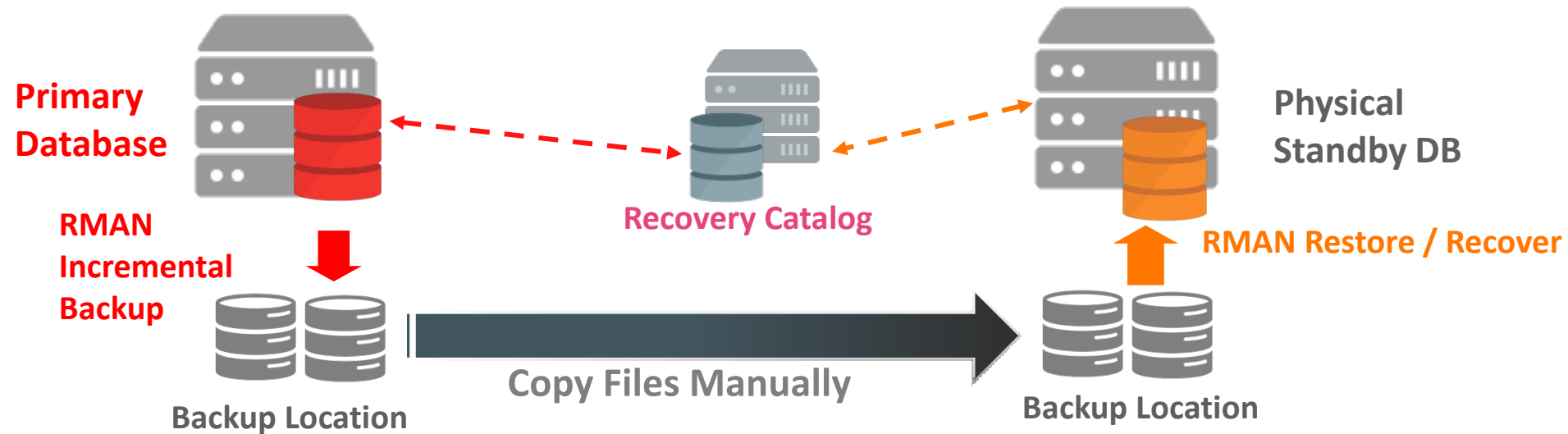
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RMAN & Data Guard: Offloading Backups To Standby
RMAN 12*c* Supports Multi-Tenant CDB/PDB Backup/Recovery

Automatic Block Repair (ADG)

Primary DB

Redo Shipping

Direct To Tape

Physical Standby DB

BCT

BCT

RMAN Backup

RMAN Backup

Archive to Tape

ORACLE® SECURE BACKUP

Fast Recovery Area

Recovery Catalog

Fast Recovery Area

- External Recovery Catalog required when using RMAN in a Data Guard environment
- **Primary**: Enable Block Change Tracking (BCT), Backup sets at local FRA
- **Standby**: Enable BCT, Image copies at local FRA + Daily & Weekly backups from FRA to Tape (or) Direct backup to Tape
- Tape backups made accessible for both Primary an Standby by the catalog by default
- To enable disk backup (NFS) accessible from both: SET BACKUP FILES FOR DEVICE TYPE DISK TO ACCESSIBLE;

RMAN 11g: Standby Synchronization
Manual Process

Primary Database

RMAN Incremental Backup

Backup Location

Copy Files Manually

Recovery Catalog

Physical Standby DB

RMAN Restore / Recover

Backup Location

- Verify the SCN from the standby (V$DATABASE)
  SELECT CURRENT_SCN FROM V$DATABASE;
- On the primary, take incremental backup from that SCN
  BACKUP INCREMENTAL FROM SCN <#> DATABASE …
- Copy the backups to the standby site (or) make the backups accessible by standby)
- Catalog the backups, restore and recover the standby

Challenges
  - ❑ Multi-step manual process
  - ❑ Requires incremental backups, copy, restore

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RMAN 12c: Fast Standby Synchronization
Simplified Standby Sync-Up with Primary Database

Primary Database

Recovery Catalog

Physical Standby DB

Incrementals Applied Automatically
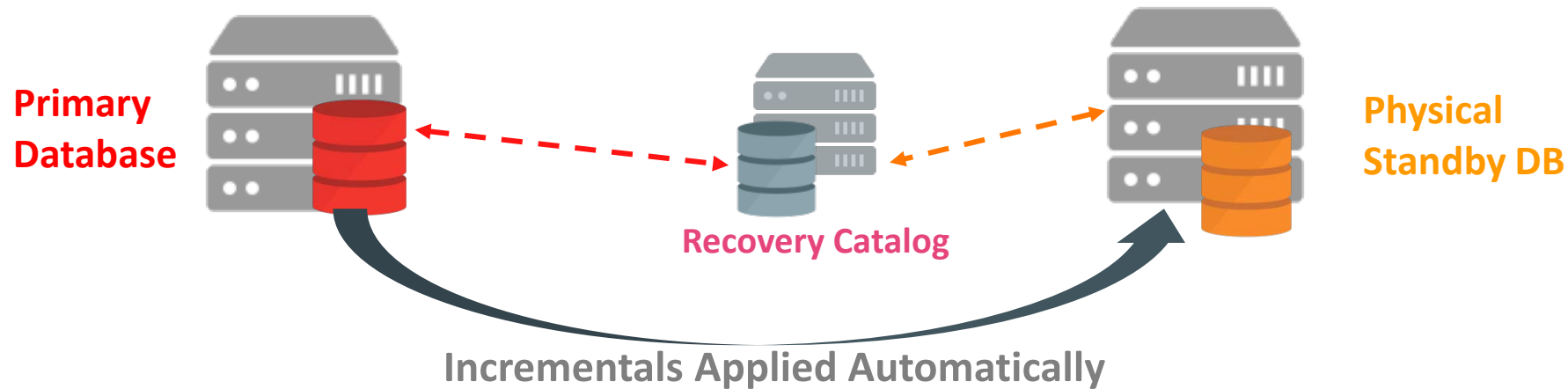
- Connect to Standby as TARGET

- Simply run one command:

  RECOVER DATABASE **FROM SERVICE** <PRIMARY TNS ALIAS> {USING COMPRESSED BACKUPSET};

- Creates incremental backups as of current SCN on Primary, pulls them over the network and applies on the Standby

Benefits

✓ Single step process

✓ Over the network transfer

✓ Faster and easier

✓ No need for backup staging, copying

RMAN 11g: Primary Database Recovery
Data File Recovery

Primary Database

Restore/Recover from Backup (or) SWITCH COPY

Recovery Catalog

Physical Standby DB

RMAN Backup / Image Copy

Copy Files Manually

Backup Location

Backup Location
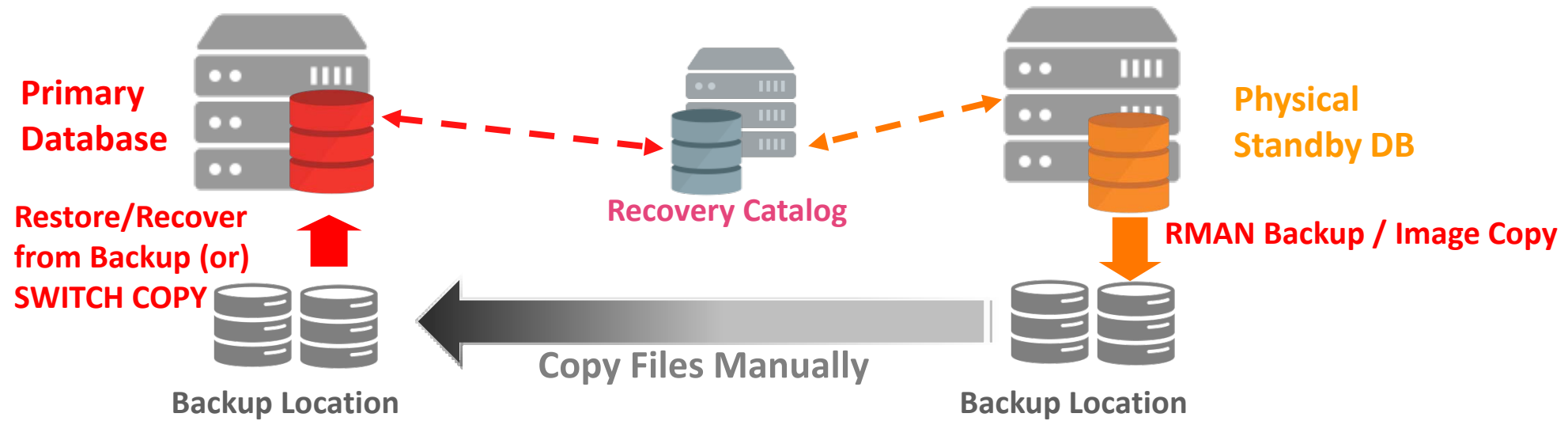
- To recover in the primary site
  - Option #1 to use the local backup
  - Option #2 is get backup from Standby
    - Copy backups from standby and restore/recover
    - Copy image copies from standby and perform SWITCH TO COPY

Challenges

☐ Multi-step manual process

☐ Requires recent backup from standby

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RMAN 12c: Fast Primary Database Recovery

Simplified Primary Restore/Recovery From Standby

Primary Database

Recovery Catalog

Physical Standby DB

Incrementals Applied Automatically
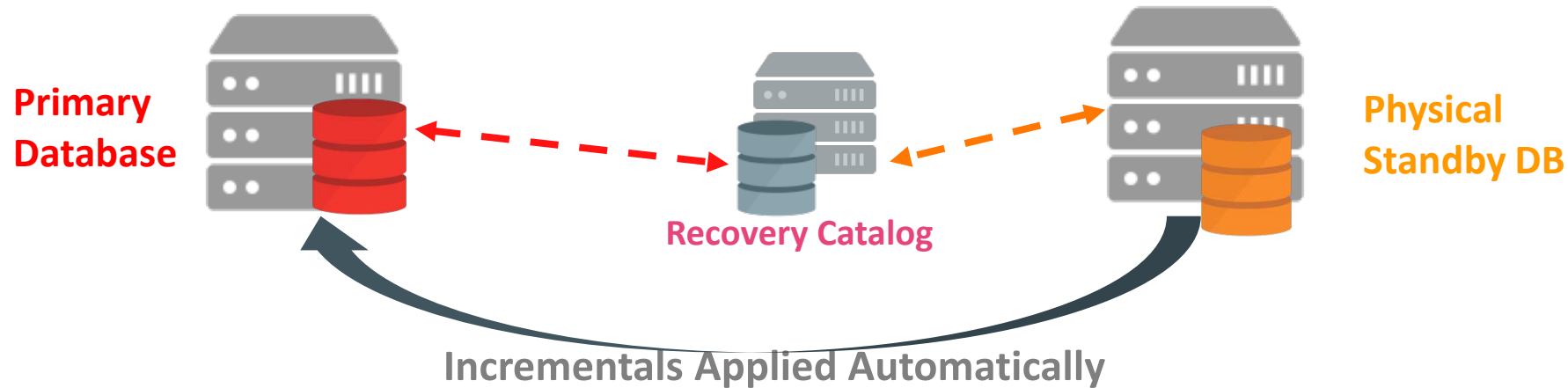
- Connect to Primary as TARGET

- Simple one command to restore
  - RESTORE DATAFILE <File No> **FROM SERVICE** <STANDBY TNS ALIAS> {SECTION SIZE <#> COMPRESSED BACKUPSET};

- Creates full backup of the datafile from Standby, pulls them over the network and restores on the Primary

- Proceed with normal recovery

Benefits

✓ Reduces longer RTO for complete recovery

✓ Files copied using backup sets over the network transfer

✓ Faster and easier

✓ No need for an additional backup at Standby

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RMAN 11g: Cross-Platform Transportable Tablespace (XTTS)

Regular XTTS: Steps Overview to Migrate USER_TBS
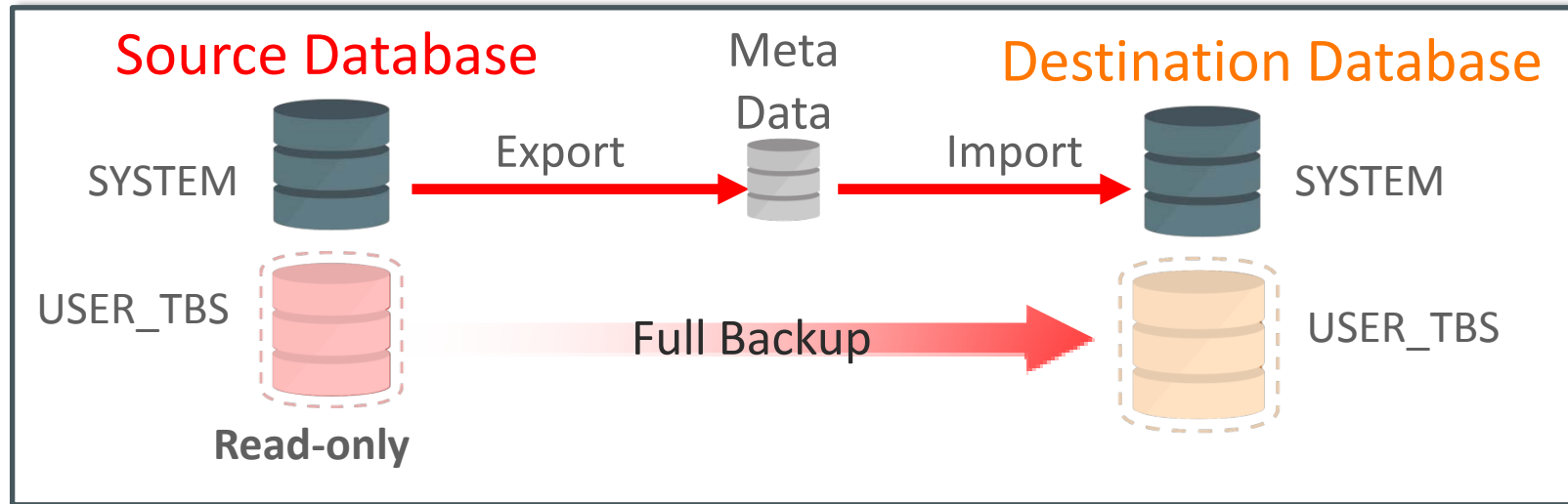
- Tablespace(s) are in read-only mode during the process

- Backups are done as image copies

- CONVERT TABLESPACE @ source (or) CONVERT DATAFILE @destination

- Separate Data Pump process to export metadata

- More suitable for smaller databases / low transaction rate applications

RMAN 11.2.0.4: XTTS Using Incremental Backup Method
Reduced Down Time For Large Databases: Process Overview

Source Database — Meta Data — Destination Database

SYSTEM → Export → SYSTEM

USER_TBS — Day n: Final Incremental → USER_TBS
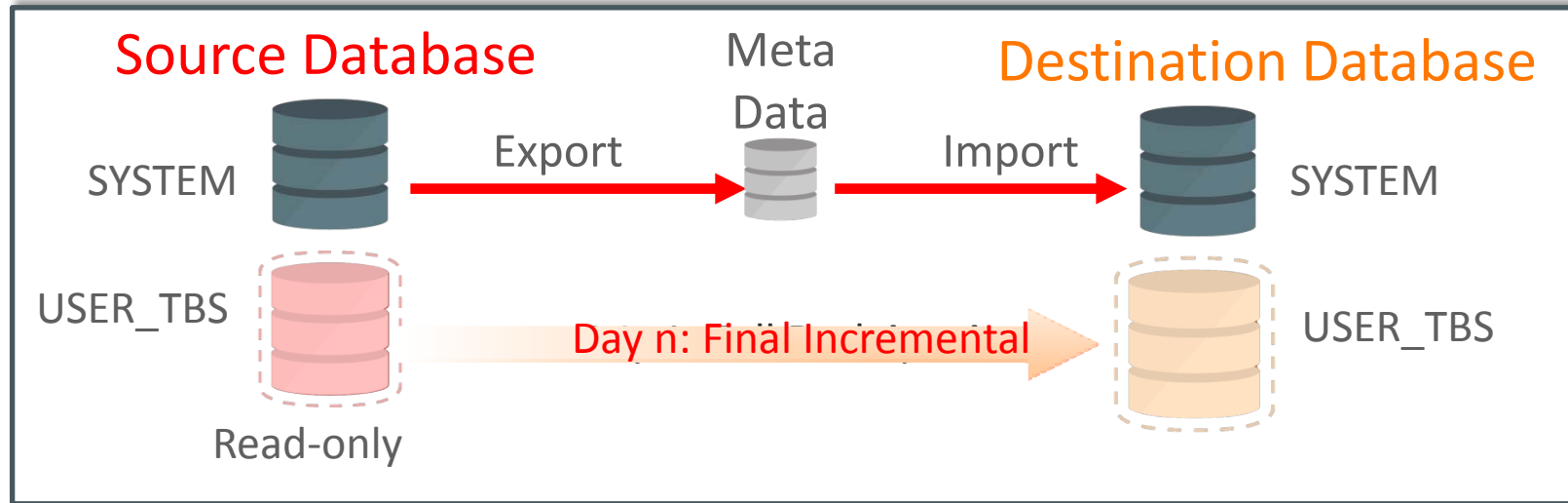
Read-only

- Reduced downtime – as the tablespace is made read-only only <u>at the end</u>
- Image copy transfers
- Either CONVERT TABLESPACE @ source (or) CONVERT DATAFILE @destination
- Separate Data Pump process to export metadata
- Manual process, but made easy with MOS Note 1398952.1

RMAN 12c: XTTS Overall Improvements
Applicable to Both Regular XTTS and Using Incremental Backups

- Now supports **backup sets**
  - Unused block compression, smaller transport size, multi-section

- New Keyword: FOR TRANSPORT

- New Keywords: TO PLATFORM (at source) and FROM PLATFORM (destination)
  - No longer require CONVERT TABLESPACE or CONVERT DATAFILE
  - Can include tablespace metadata if that tablespace is read-only (final step)
  - Preferred to perform the conversion at the destination using FROM PLATFORM

- New Keyword: ALLOW INCONSISTENT to create inconsistent backups of tablespace (during incremental backups)

- XTTS with incremental backups reduces downtime up to **8X**

- Backups from 10g, 11g can be restored to a 12c destination

RMAN 12c: XTTS with Read-Only

Example: Transport USER_TBS from AIX to Linux

Source (AIX)

1. Place the user tablespaces in read-only mode

   ALTER TABLESPACE USER_TBS READ ONLY;

2. Check the tablespaces are self contained:

   EXECUTE
   DBMS_TTS.TRANSPORT_SET_CHECK(USER_TBS,
   TRUE);
   SELECT * FROM TRANSPORT_SET_VIOLATIONS;

3. Backup using FOR TRANSPORT syntax:

   BACKUP **FOR TRANSPORT**
   FORMAT '/tmp/xplat_backups/trans_ts.bck'
   DATAPUMP FORMAT
   '/tmp/xplat_backups/trans_ts_dmp.bck'
   TABLESPACE USER_TBS;

4. Copy the backup to the Linux Server

Destination (Linux)

1. Create a 'shell' database (SYSTEM, SYSAUX, UNDO) & tablespace users

2. Perform Restore operation:

   RESTORE **FROM PLATFORM** 'AIX-Based Systems (64-bit)'
   FOREIGN TABLESPACE USER_TBS TO NEW
   FROM BACKUPSET '/tmp/xplat_restores/trans_ts.bck'
   DUMP FILE FROM BACKUPSET
   '/tmp/xplat_restores/trans_ts_dmp.bck';

3. Data file blocks automatically endian-converted during restore

4. Data Pump metadata dump file automatically imported to plug in user tablespaces

5. Make the tablespace read writable

   ALTER TABLESPACE USER_TBS READ WRITE;

RMAN 12c: XTTS with Incremental Backups
Example: Transport USER_TBS from AIX to Linux Using Incremental Backups

Source tablespace(s) are in Read/Write mode

- On destination Linux, create a shell destination database(SYSTEM, SYSAUX, UNDO)

- On source AIX database
  - Check self-contained using DBMS_TTS.TRANSPORT_SET_CHECK
  - Perform initial Level 0 and subsequent Level 1 backups using FOR TRANSPORT and ALLOW INCONSISTENT
  - Copy backups to the destination server

- On destination Linux
  - Using Level 0 backup, restore and convert the blocks using RESTORE FROM PLATFORM
  - Subsequently, perform recovery using Level 1 backups using RECOVER FROM PLATFORM

Source tablespace(s) in Read-Only Mode

- On source AIX database,
  - Place the tablespace(s) in READ-ONLY mode
  - Perform a last incremental and metadata export using FOR TRANSPORT and DATAPUMP entries
  - Copy the backup files to the destination Linux system

- On destination Linux system
  - Recover the datafile from the incremental using RECOVER FROM PLATFORM
  - Extract the datapump data from the backupset using RESTORE FROM PLATFORM, DUMP FILE and DATA PUMP DESTINATION
  - Plug-in the tablespace into the metadata using IMPDP command and TRANSPORT DATAFILE entries.
  - Make the tablespace read/writable

Additional RMAN 12c Features

Overview

RMAN 12c: Table & Table Partition Recovery

Primary Instance

12c

Data Pump Import

Auxiliary Instance

RMAN Backups
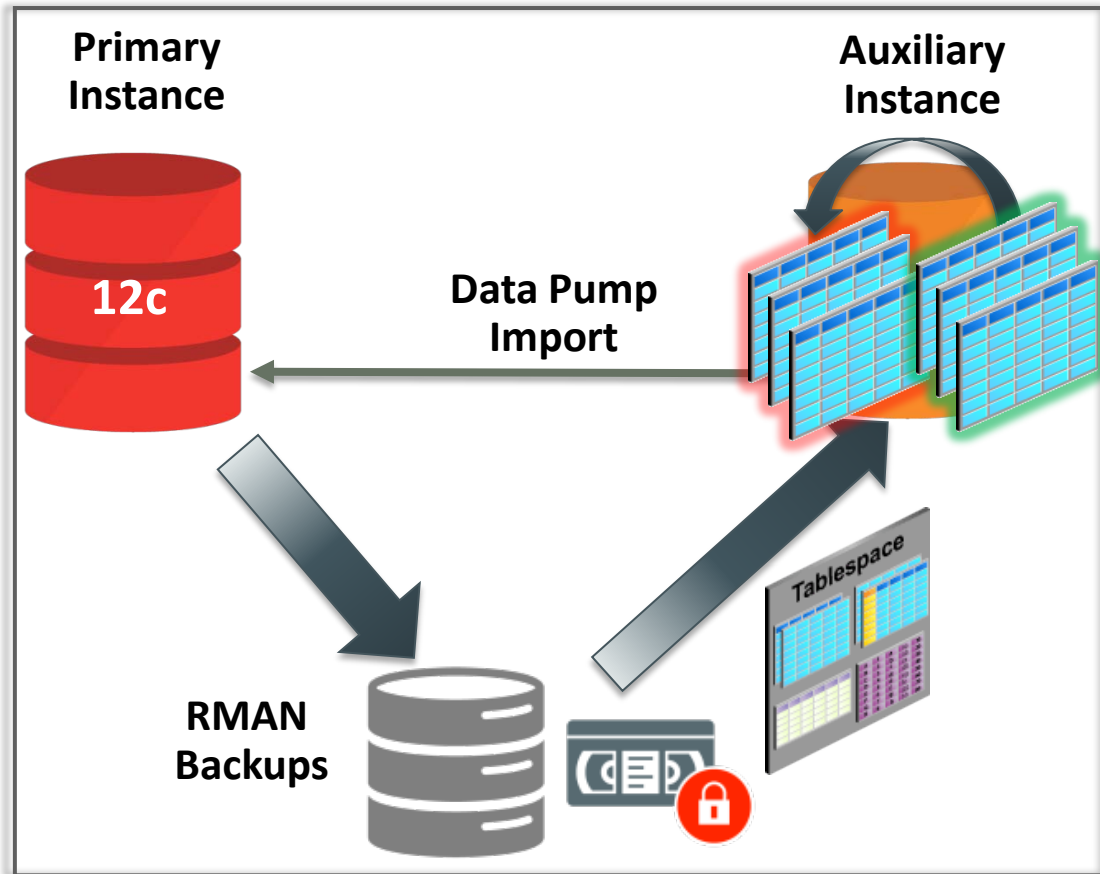
Tablespace

RECOVER TABLE SCOTT.EMP UNTIL SCN 123456
AUXILIARY DESTINATION '/tmp/oracle/recover';

- Simple **RECOVER TABLE** command to recover one or more tables/partitions (most recent or older version) from an RMAN backup

- Eliminates time and complexity associated with the following manual steps:

  1. Regular RMAN backups are taken using **DISK** and/or **SBT** channels.

  2. Upon **RECOVER TABLE**, an auxiliary instance is started using the primary control file,**SYSTEM,SYSAUX,UNDO**, and user tablespaces containing the table(s).

  3. Auxiliary instance is recovered to the desired time/SCN.

  4. Tables are imported by primary instance via SQL*Net.

RMAN 12c: Recovery Using Snapshot Copy

Point-in-time Recovery Using Storage Snapshots

Prod Server   **Test Server**

- Addresses 2 requirements
  1. Snapshots can be taken without HOT BACKUP
  2. Point-in-time recovery without scanning the whole data file using new SNAPSHOT TIME keyword

- Storage subsystem should adhere to
  - ✓ Database crash consistency
  - ✓ Write ordering
  - ✓ Registering snapshot time

Prod Storage Volume(s)

Read/Writable Snapshot

- Recovery using Snapshot Copy
  - **Compete Recovery**: Use RECOVER DATABASE;
  - **Point-in-time Recovery**: Use SNAPSHOT TIME UNTIL {SCN | TIMESTAMP};
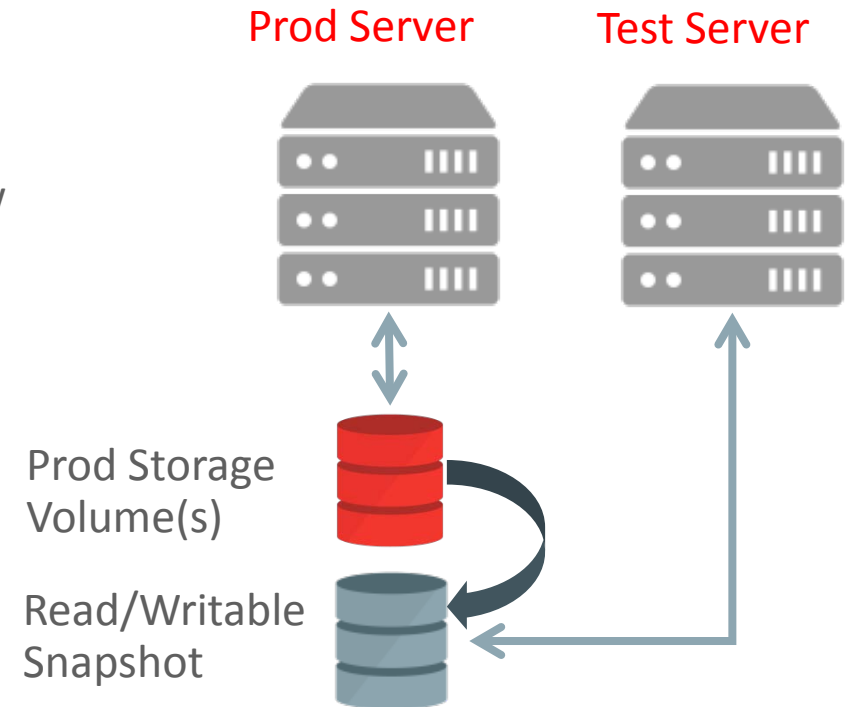
```
RECOVER DATABASE UNTIL TIME "to_date('14-JUL-14 15.16.21','DD-MON-RR HH24:MI:SS')"
SNAPSHOT TIME "to_date('14-JUL-14 15.15.27','DD-MON-RR HH24:MI:SS')";
```

RMAN 12c: Consolidate and Protect Data
Container Level (CDB) or Pluggable Database Level (PDB)

RMAN Backup - PDB
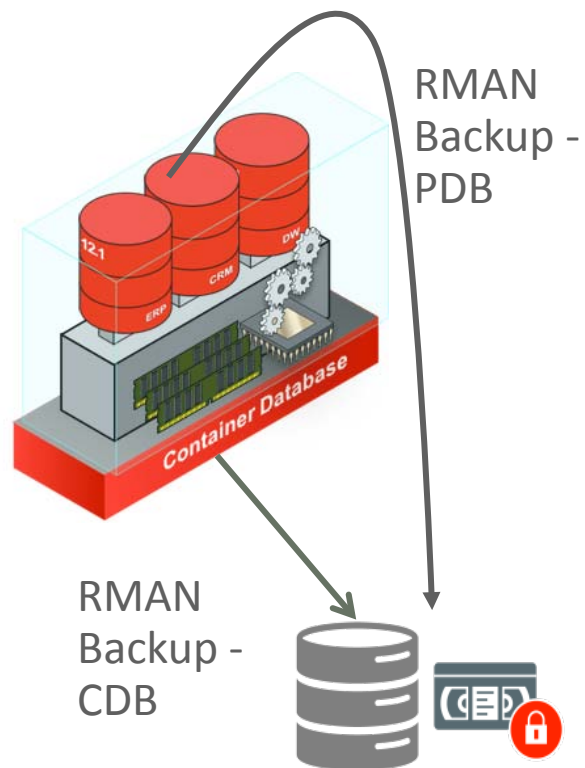
RMAN Backup - CDB

- New **PLUGGABLE DATABASE** and **ROOT** keywords
- Connect in RMAN as:
  - ROOT common user: Backup, Restore, Recover CDB or selected PDBs
  - PDB local user: Backup & Restore PDB (excludes archived logs)
- **Backup** commands as ROOT user:
  BACKUP DATABASE; -- Backup CDB, including all PDBs
  BACKUP (PLUGGABLE DATABASE <PDB1>, <PDB2>);
  BACKUP TABLESPACE <PDB1>:<TBS1>, <PDB2>:<TBS1>;
- **Restore** commands as ROOT user:
  RESTORE DATABASE; -- Restore CDB, including all PDBs
  RESTORE PLUGGABLE DATABASE <PDB1>;
  RESTORE TABLESPACE <PDB2>:<TBS1>;
- **Recovery** of CDB & PDB:
  - Full: RECOVER {PLUGGABLE} DATABASE;
  - PIT Recovery (PITR): RECOVER {PLUGGABLE} DATABASE <PDB/CDB> UNTIL …
  - Open after PITR: ALTER {PLUGGABLE} DATABASE <PDB/CDB> OPEN RESETLOGS;

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Oracle Database Backup-as-a-Service

Database Backup

Offsite Backups with Simple and Low Cost Cloud Backup

DBaaS
(Oracle Public Cloud)

▪ Backup on-premise or Cloud Databases to Oracle Database Backup Service hosted in Oracle Public Cloud

Data Center

▪ Cost effective, scalable cloud storage for database backups (*10.2 and above*)

▪ End-to-end enterprise-grade data encryption, compression and protection

Oracle Public Cloud

- Clients: Data is always encrypted with keys kept locally at client, optionally compressed, and securely transmitted

- Cloud: Encrypted data is protected with 3-way mirroring on every write
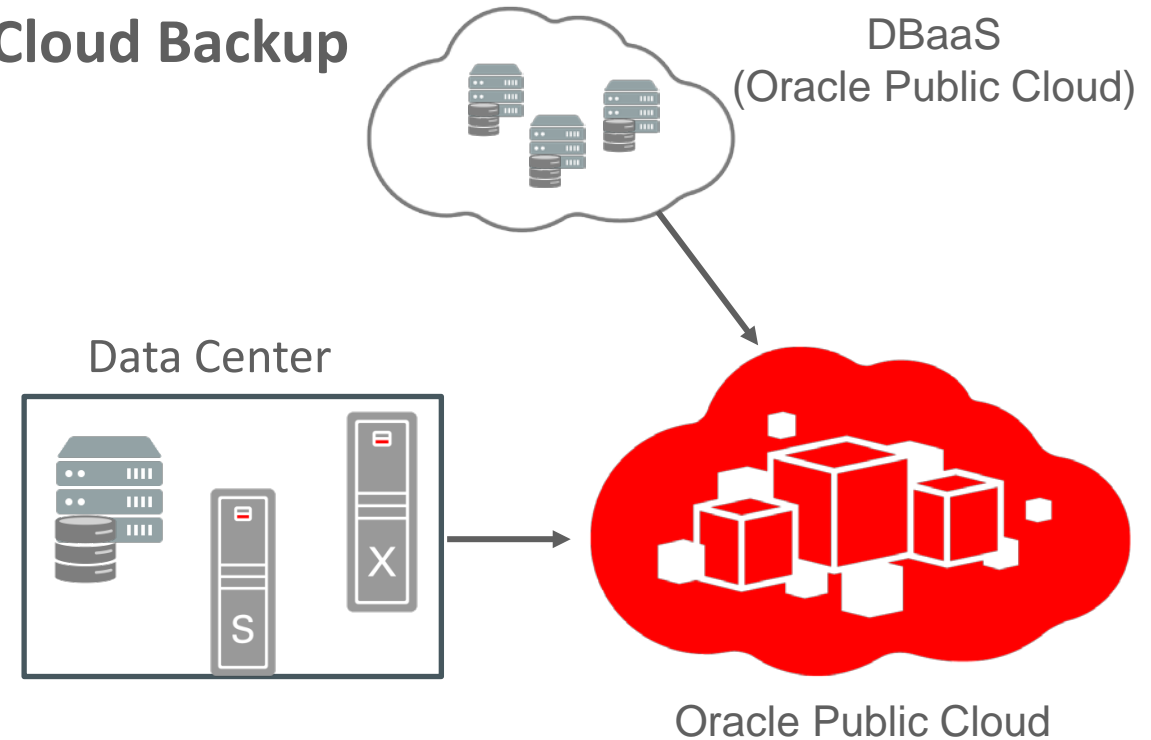
Try it today: http://cloud.oracle.com/database_backup

Oracle Database Backup To Oracle Public Cloud

End-to-End Flow

1. Subscribe for Oracle Database Backup Service (or) Trial – https://cloud.oracle.com/database_backup

2. Download and install the RMAN SBT (Tape) module from OTN

3. RMAN uses this module (libopc.so) to backup to Oracle Database Backup Service

4. Configure RMAN to use this library
   - RMAN> configure channel device type sbt parms='SBT_LIBRARY=libopc.so, SBT_PARMS=(OPC_PFILE=opc*SID*.ora)';

5. Perform backup, restore and recovery process using RMAN

6. <u>RMAN encryption for backups enforced</u> - keys kept locally on client (Password, TDE, Dual-mode)

7. Data securely transmitted to the cloud over HTTPS

Database, FRA

RMAN

Encryption & Optional Compression

Oracle Database Cloud Backup Module (libopc.so)

WAN(HTTPS)

Oracle Database Backup Service
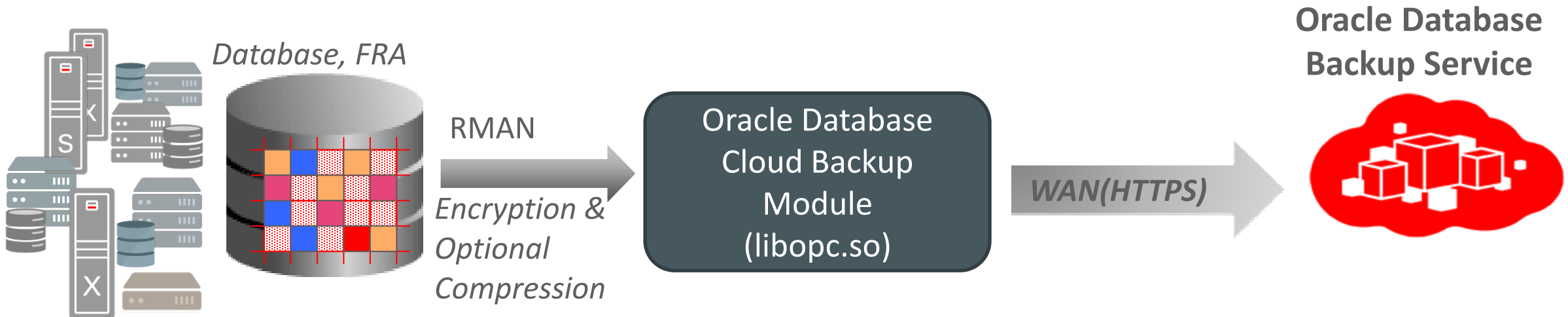
Use of RMAN Compression and Encryption

- RMAN Compression

  - **Optional**
    - 10g: BASIC
    - 11g and above: HIGH, BASIC, MEDIUM, LOW
  - MEDIUM recommended
  - No ACO licensing required

  CONFIGURE COMPRESSION ALGORITHM 'MEDIUM';

  BACKUP AS COMPRESSED BACKUPSET DATABASE PLUS ARCHIVELOG;

- RMAN Encryption

  - **Mandatory**
  - Password, Transparent Data Encryption (TDE), Dual-Mode
  - No ASO licensing required
  - Keys are to be kept local
  - If TDE is used (preferred), then simply use SET ENCRYPTION ON before backups and restores
  - For password encryption:

    SET ENCRYPTION ON IDENTIFIED BY 'abc123' ONLY;

  - Before doing restore,

    SET DECRYPTION IDENTIFIED BY 'abc123';

DEMO

Example: Performing Backup & Recovery

BACKUP

```
RMAN> configure device type sbt parallelism 4;

using target database control file instead of recovery catalog
old RMAN configuration parameters:
CONFIGURE DEVICE TYPE 'SBT_TAPE' PARALLELISM 4 BACKUP TYPE TO BACKUPSET;
new RMAN configuration parameters:
CONFIGURE DEVICE TYPE 'SBT_TAPE' PARALLELISM 4 BACKUP TYPE TO BACKUPSET;
new RMAN configuration parameters are successfully stored

RMAN> set encryption on identified by "abc123" only;

executing command: SET encryption

RMAN> backup device type sbt datafile 4;

Starting backup at 25-APR-14
allocated channel: ORA_SBT_TAPE_1
channel ORA_SBT_TAPE_1: SID=16 device type=SBT_TAPE
channel ORA_SBT_TAPE_1: Oracle Database Backup Service Library VER=3.14.3.21
allocated channel: ORA_SBT_TAPE_2
channel ORA_SBT_TAPE_2: SID=252 device type=SBT_TAPE
channel ORA_SBT_TAPE_2: Oracle Database Backup Service Library VER=3.14.3.21
allocated channel: ORA_SBT_TAPE_3
channel ORA_SBT_TAPE_3: SID=254 device type=SBT_TAPE
channel ORA_SBT_TAPE_3: Oracle Database Backup Service Library VER=3.14.3.21
allocated channel: ORA_SBT_TAPE_4
channel ORA_SBT_TAPE_4: SID=18 device type=SBT_TAPE
channel ORA_SBT_TAPE_4: Oracle Database Backup Service Library VER=3.14.3.21
channel ORA_SBT_TAPE_1: starting full datafile backup set
channel ORA_SBT_TAPE_1: specifying datafile(s) in backup set
input datafile file number=00004 name=/u01/OracleHomes/db/oradata/emrepus/users0
channel ORA_SBT_TAPE_1: starting piece 1 at 25-APR-14
channel ORA_SBT_TAPE_1: finished piece 1 at 25-APR-14
piece handle=5sp6kse0_1_1 tag=TAG20140425T183856 comment=API Version 2.0,MMS Ver
1
channel ORA_SBT_TAPE_1: backup set complete, elapsed time: 00:00:15
Finished backup at 25-APR-14
```

RESTORE/RECOVERY

```
RMAN> set decryption identified by "abc123";

executing command: SET decryption

RMAN> restore datafile 4;

Starting restore at 27-APR-14
allocated channel: ORA_SBT_TAPE_1
channel ORA_SBT_TAPE_1: SID=245 device type=SBT_TAPE
channel ORA_SBT_TAPE_1: Oracle Database Backup Service Library VER=3.14.3.21
allocated channel: ORA_SBT_TAPE_2
channel ORA_SBT_TAPE_2: SID=10 device type=SBT_TAPE
channel ORA_SBT_TAPE_2: Oracle Database Backup Service Library VER=3.14.3.21
allocated channel: ORA_DISK_1
channel ORA_DISK_1: SID=246 device type=DISK

channel ORA_SBT_TAPE_1: starting datafile backup set restore
channel ORA_SBT_TAPE_1: specifying datafile(s) to restore from backup set
channel ORA_SBT_TAPE_1: restoring datafile 00004 to /u01/OracleHomes/db/oradata/emrepus/users01
.dbf
channel ORA_SBT_TAPE_1: reading from backup piece 5sp6kse0_1_1
channel ORA_SBT_TAPE_1: piece handle=5sp6kse0_1_1 tag=TAG20140425T183856
channel ORA_SBT_TAPE_1: restored backup piece 1
channel ORA_SBT_TAPE_1: restore complete, elapsed time: 00:00:07
Finished restore at 27-APR-14

RMAN> recover datafile 4;

Starting recover at 27-APR-14
using channel ORA_SBT_TAPE_1
using channel ORA_SBT_TAPE_2
using channel ORA_DISK_1

starting media recovery
media recovery complete, elapsed time: 00:00:00

Finished recover at 27-APR-14
```

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Zero Data Loss Recovery Appliance
RMAN based Backup & Recovery

Protected Databases

ZDLRA

Oracle Public Cloud

Offloads Tape Backup
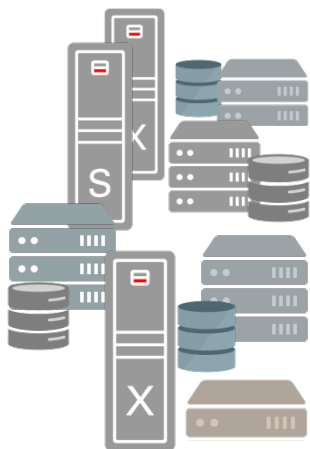
RMAN Delta Push

- DBs access and send only changes
  - Minimal impact on production
- Data Guard-like real-time redo ship instantly protects new transactions

R
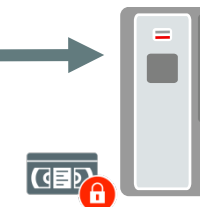
Replicates to Remote ZDLRA

Protects all DBs in Data Center

- Petabytes of data, 10.2.0.4 and above
- No expensive DB backup agents

ZDLRA Delta Store – massive DB of changes

- Stores validated, compressed DB changes on disk
- Fast restores to any point-in-time using deltas
- Built on Exadata scaling and resilience
- Enterprise Manager end-to-end control

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Oracle Database Backup To Zero Data Loss Recovery Appliance
RMAN Configuration

ZDLRA

Database, FRA

RMAN

ZDLRA Backup
Module
(libra.so)

10GbE / IB

R
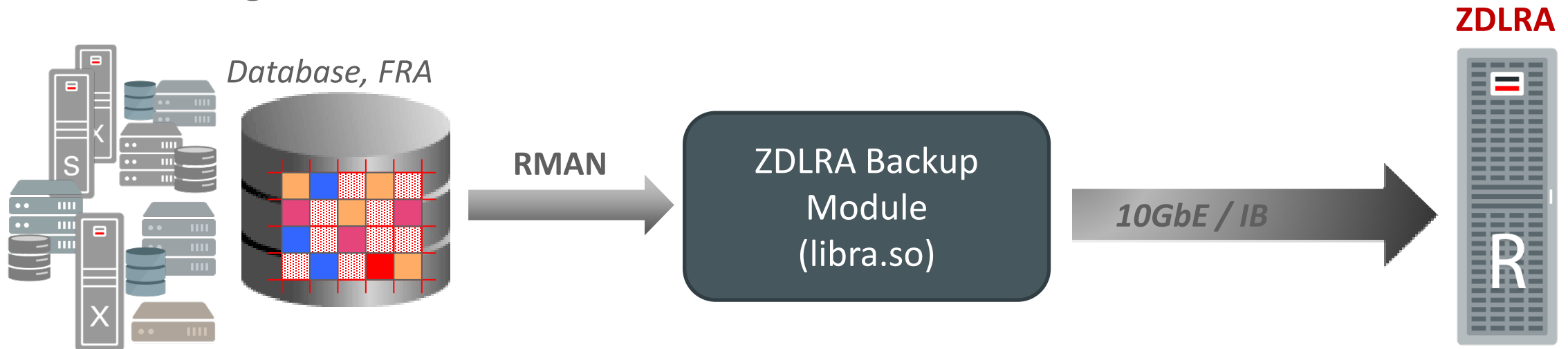
1. Download and install the RMAN SBT (Tape) module from OTN or from the Recovery Appliance

2. RMAN uses this module (libra.so) as an interface to the Recovery Appliance

3. Configure RMAN to use this library (for example)

   CONFIGURE CHANNEL DEVICE TYPE SBT PARMS='SBT_LIBRARY=libra.so,
   SBT_PARMS=(RA_CLIENT_CONFIG_FILE=/orclhome/dbs/raSID.ora)';

4. Connect to ZDLRA as the catalog and perform backups

Dashboard

Protection Policy

Recovery Appliance ▾

ZDLRA London > Protection Policies

Protection Policies

A protection policy contains Recovery Appliance properties for multiple protected databases in a single object.

- Protection policy attributes include:
  - Recovery window goal: The interval of time within which point-in-time recovery will be possible for all databases using the policy.
  - Storage location: The storage location where backups from databases using the policy will be stored.
  - Polling location: A location that will be polled for backups by the Recovery Appliance.
- Backups for all databases using a protection policy can be:
  - Replicated by assigning the policy to a replication server.
  - Copied to tape by setting up a copy-to-tape job for the policy.

✅ **TIP** To enroll protected databases and assign them to protection policies, go to Protected Databases.

Create   Edit   Delete
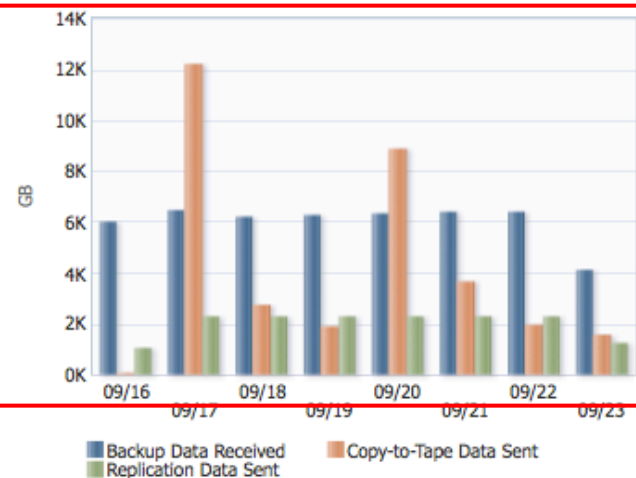
Name	Disk Recovery Window Goal (days)	Unprotected Data Window Threshold	Media Manager Recovery Window Policy (days)	Maximum Disk Backup Retention (days)	Storage Location	Backup Polling Location	Frequency (days)	Delete Backups After Copy	Guaranteed Backup Copy	Copy-to-Tape	Replication
BRONZE	2.0	24.0 hrs	10.0	5.0	DELTA					✔	
BRONZE_REP...	2.0	24.0 hrs	10.0	5.0	DELTA					✔	✔
CHAMPIONS	7.0	5.0 hrs	30.0	10.0	DELTA						
GOLD	7.0	5.0 min	28.0	14.0	DELTA						
GOLD_REP_T...	2.0	5.0 min		5.0	DELTA						✔
MOSCOW	2.0				DELTA						
RWG_IS_MDBR	1.0			1.0	DELTA						
SILVER_C2T_...	5.0	24.0 hrs	14.0	10.0	DELTA					✔	
SILVER_REP...	5.0	5.0 min		6.0	DELTA						✔

Protected Databases Using Protection Policy BRONZE

Database	Target Name	Host
STORE35	store35	scam06adm11.us.oracle.com
STORE32	store32	scam06adm12.us.oracle.com
STORE33	store33	scam06adm09.us.oracle.com

Protected Databases

RMAN - Summary

Continuing the innovation

- We keep improving by adding new and enhancing existing features:
  - ✓ Ease of use
  - ✓ Reducing downtime
  - ✓ Improved performance
- Address new ways to solve backup storage requirement
  - ✓ Enabling cloud backups
- Shift the focus to **RECOVERABILITY** for the entire data center
  - ✓ Recovery Appliance – built by RMAN development

Reference

- http://www.oracle.com/goto/rman

- http://www.oracle.com/goto/ha

- http://www.oracle.com/goto/maa

- https://cloud.oracle.com/database_backup

- Master RMAN Note (**Doc ID 1116484.1**)

Social

- http://blog.oracle.com/maa
- Follow us @OracleMAA

Program Agenda

1 RMAN 12c New Features

2 Efficient & Faster Database Cloning

3 RMAN & Data Guard: Complete Protection

4 Cross Platform Migration Using XTTS

5 Low Cost Offsite Backup Storage to Oracle Public Cloud

6 Eliminate Data Loss using Recovery Appliance

7 Q & A