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October 22–25, 2018
SAN FRANCISCO, CA

#OOW18

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Oracle Recovery Manager

Latest-Generation Features for On-Premises and the Cloud [TRN4219]

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Safe Harbor Statement

The following is intended to outline our general product direction. It is intended for information purposes only, and may not be incorporated into any contract. It is not a commitment to deliver any material, code, or functionality, and should not be relied upon in making purchasing decisions. The development, release, and timing of any features or functionality described for Oracle's products remains at the sole discretion of Oracle.

Program Agenda

1. Oracle Backup and Recovery solutions overview
2. Transparent Data Encryption – Backup Implications
3. Leveraging Backup for Cloud Migrations
4. ZDLRA and RMAN – Exelon Experience

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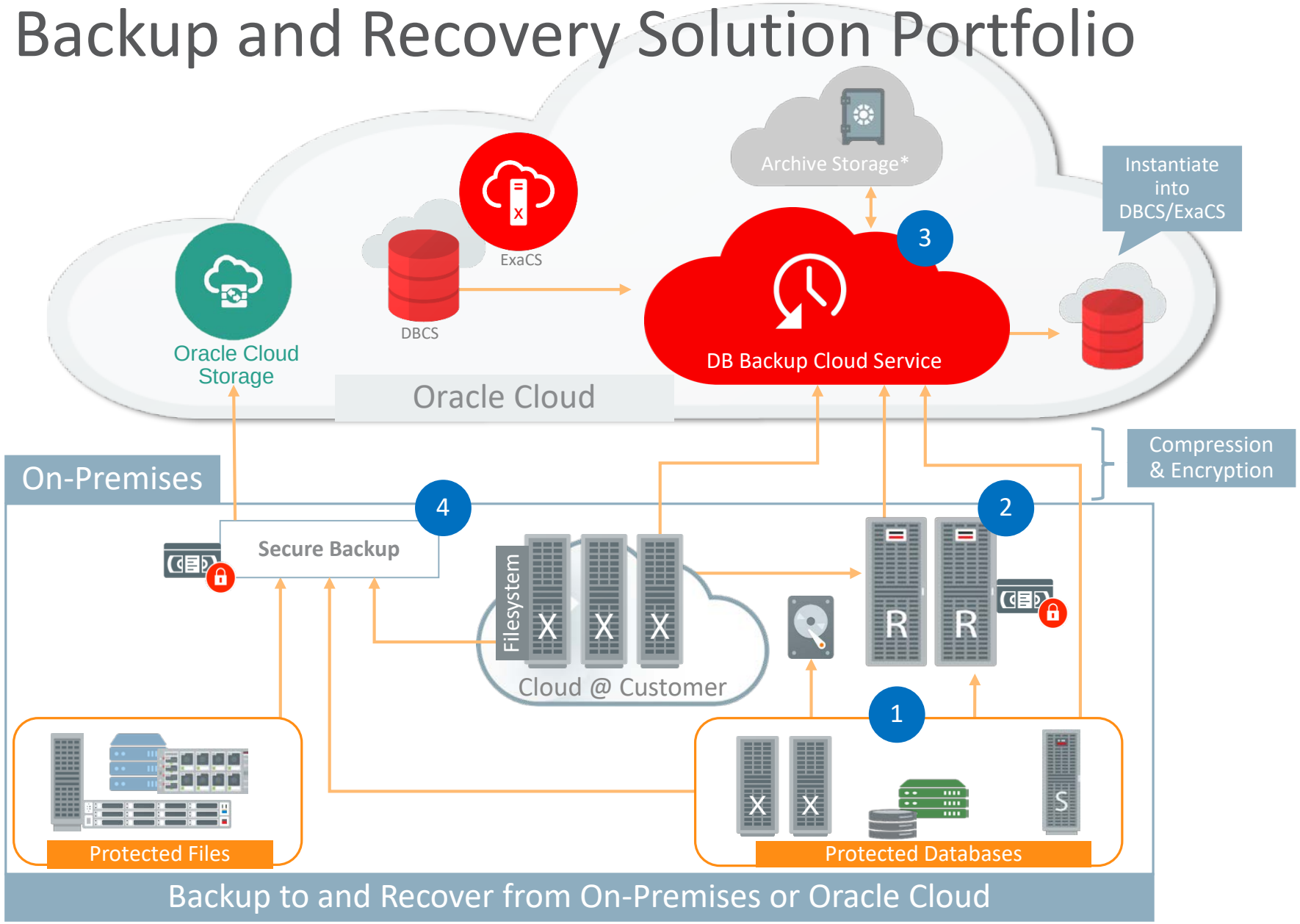
Backup and Recovery Solution Portfolio



1. **RMAN**: Built-in backup & recovery engine for the Oracle database which provides performant, efficient and dependable protection.

2. **Recovery Appliance**: Engineered System purpose-built for data center-wide Oracle database protection which ensures zero data loss, verifies backup integrity, and reduces data protection overhead by eliminating repeated full backups.

3. **DB Backup Cloud Service**: Secure & scalable Oracle Cloud Service providing cost effective storage for long-term retention & compliance of RMAN backups.

4. **Secure Backup**: Centralized disk, tape and cloud backup management which provides heterogeneous filesystem protection for the entire data center.

Recovery Manager History

Oracle 8, Oracle 8i, Oracle 9i
Circa 1997-2002

- Parallel Backups
- DUPLICATE
- Block Media Recovery
- Automatic Control File & SPFILE Backup
- CONFIGURE Persistent Settings
- BACKUP BACKUPSET
- And more …

Oracle 10g, Oracle 11g
Circa 2003-2012

- Fast Recovery Area
- Fast Incremental Backups
- Incrementally Updated Backups
- SWITCH TO COPY
- Offload Backups to Standby Database
- And more …

Oracle 12c
2013-2016

- Table Level Recovery
- Cross-Platform Backup & Recovery enhancements
- Fast Active DUPLICATE
- Fast Standby Database Synchronization
- Multitenant Database Backup & Recovery
- RESTORE AS ENCRYPTED

Oracle 18c
2017-2018

- Multi-tenant DB backup history preservation
- Active cross-CDB PDB duplication
- Active Data Guard Sync
- Tiering to Oracle Cloud Archive Object Storage support
- DUPLICATE AS ENCRYPTED

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Oracle Database 19c RMAN new features I

19c

Connect to PDBs as target and Recovery Catalog support

- **Connect to PDB as target with Recovery Catalog support**
  - More control for PDB DBAs to manage their backups
  - The connection to the recovery catalog is created using the recovery catalog owner, rco. The net service name for the recovery catalog database is catdb

```
RMAN> connect target "sys@salespdb as sysbackup"
target database Password:
connected to target database: DBMAIN:SALESPDB (DBID=1661283172)

RMAN> connect catalog rco@catdb
recovery catalog database Password:
connected to recovery catalog database
```

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Oracle Database 19c RMAN new features II

19c

Simplified FRA space management

- **Automatic proactive deletion of unnecessary Flashback logs**
  - Before 19c Flashback logs were deleted only under FRA space pressure
  - When the retention target is reduced, flashback logs that are beyond the retention period are deleted immediately from the FRA
  - Simplifies the management for FRA
  - Load spikes that generate unusual amount logs will have less impact on FRA space consumption as they will be delete immediately when retention expires.

Note: flashback logs cannot be backed up using the RMAN command BACKUP RECOVERY AREA

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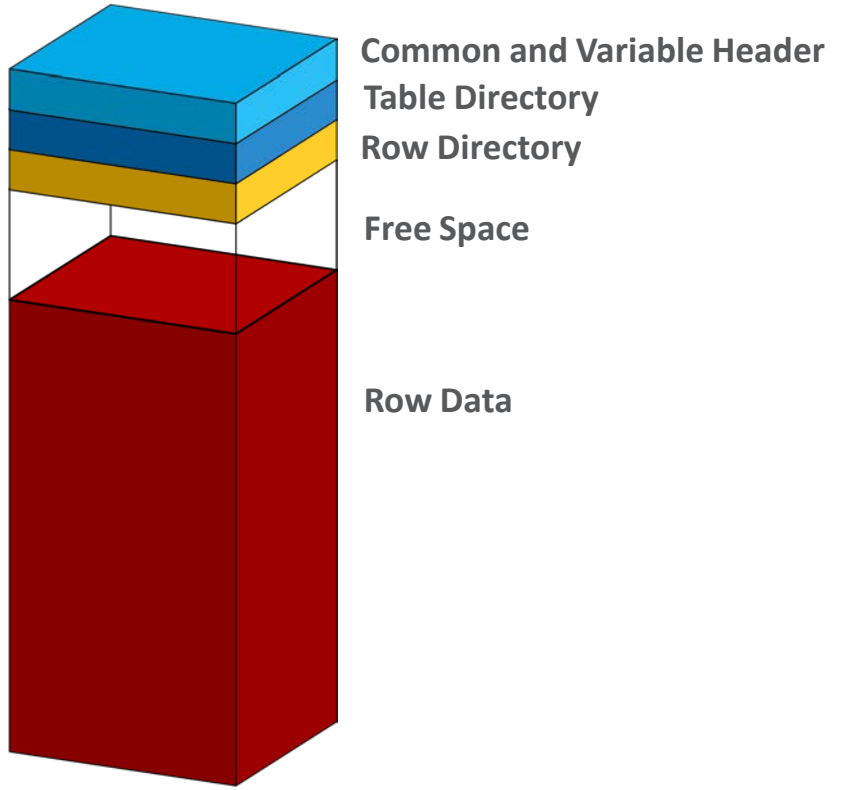
Transparent Data Encryption (TDE)

- Uptrend in adoption due to regulations and Cloud
- TDE improves with every version
  - Column encryption introduced in 10.2
  - Tablespace encryption added in 11.1
  - Offline tablespace encryption added in 12.2 and backported to 12.1 & 11.2
  - Online tablespace encryption and RESTORE AS ENCRYPTED added in 12.2

Oracle Data Block Format & RMAN Backups

More Than Simple Bits….

- Oracle Database manages its logical storage in data blocks
  - Minimum unit of I/O
- A well defined structure
  - Block headers, rows, metadata etc.
- RMAN Backups
  - Datafile blocks are logically grouped into backup pieces
  - Ordering of blocks within a backup piece different than within the datafile



TDE Tablespace Encryption

- Master Keys can be stored in local file wallet or on an external Key Manager like Oracle Key Vault
- Wallets are not backed up by RMAN and must be carefully protected
- In Purpose Built Backup Appliances, like ZDLRA, deduplication and compression are two separate processes
- TDE Encryption has a big impact on your appliance compression capabilities and backup space utilization must be carefully planned.

RMAN Backup Encryption

Creates encrypted backup pieces of non-encrypted tablespaces

- RMAN can encrypt backups using TDE Keys
- Same Key Management options are available, Oracle wallet or external Key Manager
- Password based encryption is also possible

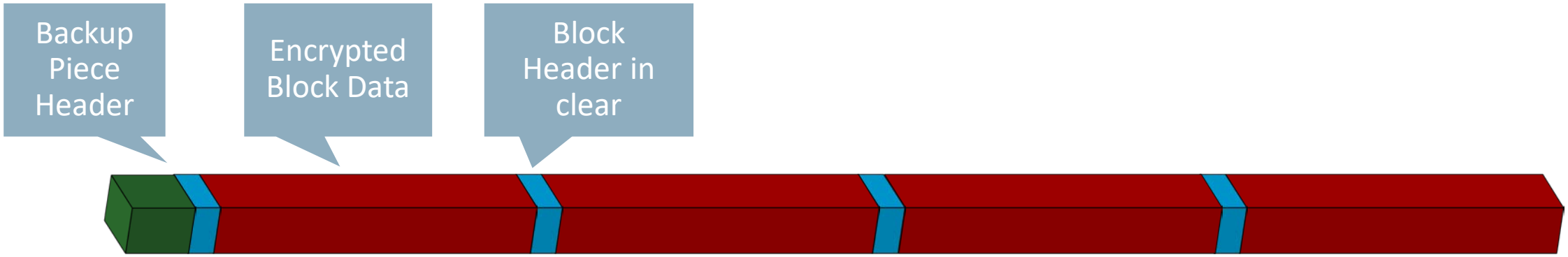
```
RMAN> CONFIGURE ENCRYPTION FOR DATABASE ON
RMAN> CONFIGURE ENCRYPTION ALGORITHM ‘AES256’
```

- RMAN backup encryption negates target-side deduplication or compression savings if the tablespaces are not TDE encrypted

Backing up TDE-Encrypted Tablespaces

Without using RMAN compression

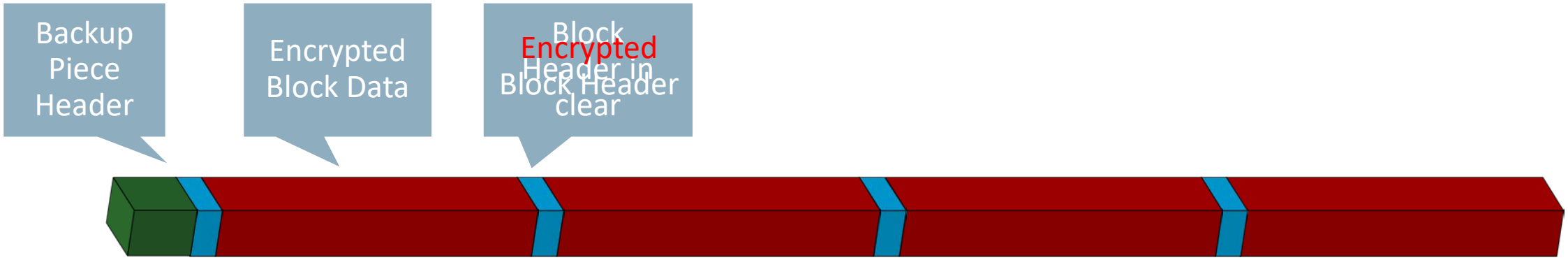
- RMAN does not re-encrypt backups if a tablespace is already TDE-encrypted
- The Oracle block header is stored in clear in the backup piece
- Deduplication-enabled solutions can still provide some benefits, but lose any target-side software compression capability
- If you turn on TDE tablespace encryption expect the backup space consumption to typically double or more depending on the backup compression ratio achieved prior to using TDE



Backing up TDE-Encrypted Tablespaces

Using RMAN compression

- RMAN de-crypts, compress and re-encrypts the Oracle blocks
- The block header is also encrypted and the Oracle block structure within the backup piece is not accessible
- Deduplication-enabled solutions become ineffective
- If you turn on TDE tablespace encryption and RMAN compression, backups cannot be deduplicated or compressed at the target backup device



TDE Tablespace Encryption Summary

	RMAN Encryption	RMAN Compression
Tablespace Encryption ON	Deduplication, NO Compression	NO Deduplication, Already Compressed
Tablespace Encryption OFF	NO Deduplication, NO Compression	NO Deduplication, Already Compressed

Due to the effect on backup compression when using tablespace encryption, best practice is to use HCC or OLTP compression so that the source data is already compressed and encrypted prior to backup.

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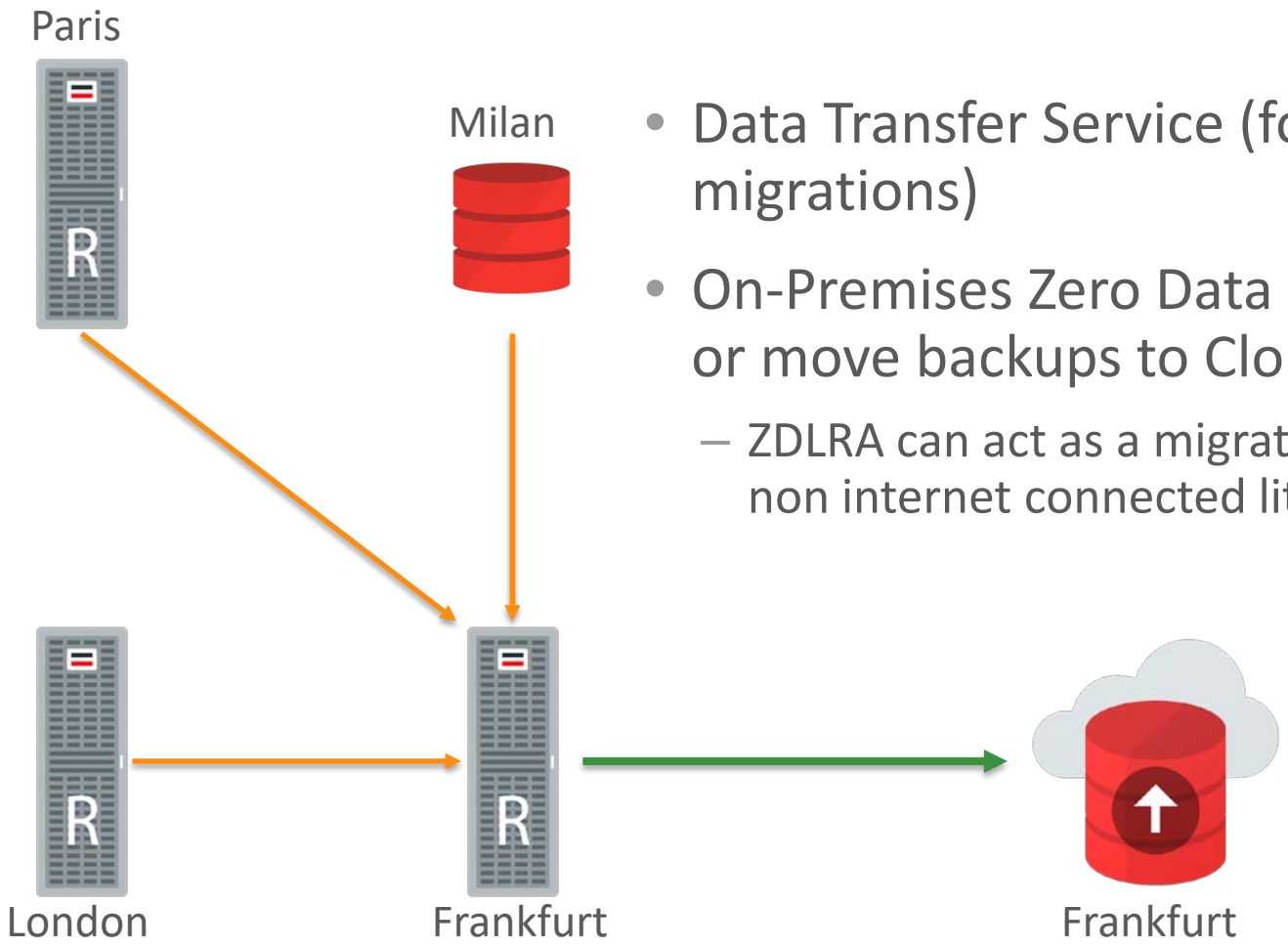
Advantages of Cloud Backups

- Oracle Database Backup Cloud Module enables on-premises Databases to be backed up to Oracle Cloud Infrastructure Object Storage (Standard and Archive)
- Secure offsite storage location, virtually unlimited scalability.
- Restore can be performed directly into a DB Cloud Service, ExaCS or customized DB created in a Compute Instance
- Simple DR solution or use the cloud for Test/Dev
- Facilitate Workload Migration to Cloud

Other paths to Cloud Storage



- Data Transfer Service (for hundreds of TB or PB scale migrations)
- On-Premises Zero Data Loss Recovery Appliance can copy or move backups to Cloud Storage in native RMAN format
  - ZDLRA can act as a migration engine centralizing backups from non internet connected little-endian DBs

Planning for a Migration to Cloud Database Instances

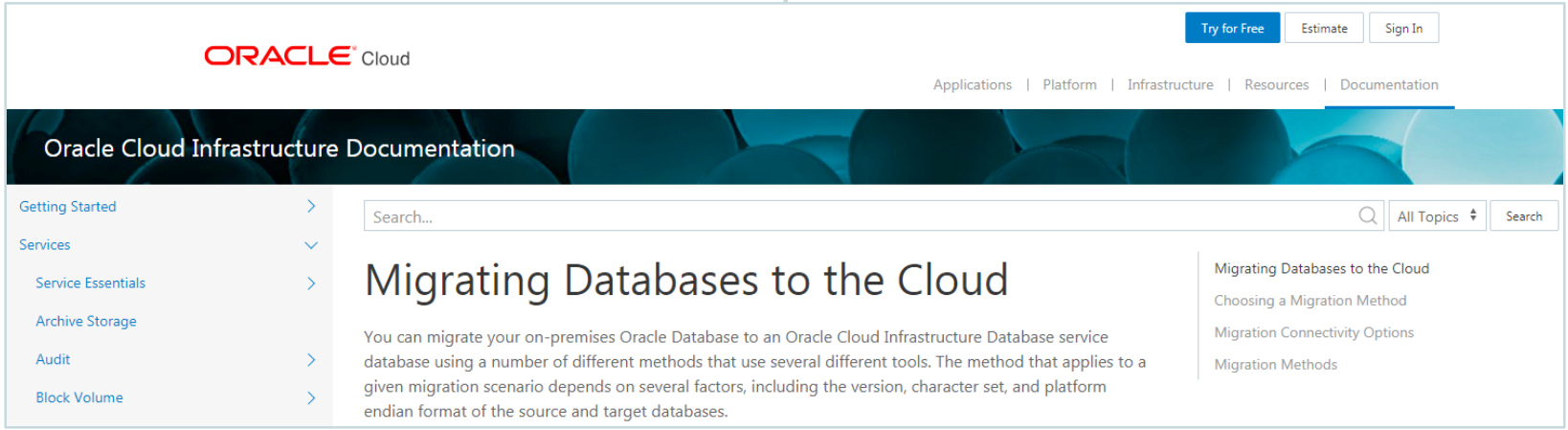
Database Cloud Service, Exadata Cloud Service

- On-premises database version
- On-premises host operating system and version
- On-premises database character set
- On-premises multi tenant or non-multi tenant DB

- Database service database version
- Amount of data, including indexes
- Storage for data staging, if needed
- Acceptable length of system outage
- Network bandwidth

Migrating to ExaCS or DBCS instances

- RMAN Cross-Platform Transportable PDB
- RMAN Cross-Platform Transportable Tablespace Backup Sets
- RMAN CONVERT Transportable Tablespace with Data Pump
- RMAN DUPLICATE from an Active Database
- Data Pump
- Remote Cloning
- RMAN Transportable Tablespace with Data Pump
- Unplugging/Plugging a PDB
- Unplugging/Plugging Non-CDB
- SQL Developer



RMAN for Cloud Migrations

RMAN cross platform transportable PDB

- SQL> ALTER PLUGGABLE DATABASE UNPLUG for CDB or exec DBMS_PDB.DESCRIBE for non-CDB (generates XML)
- RMAN> BACKUP DEVICE TYPE SBT FOR TRANSPORT PLUGGABLE DATABASE

scp XML file and encryption wallet

- RMAN> CATALOG DEVICE TYPE SBT BACKUPPIECE
- RMAN> RESTORE ALL FOREIGN DATAFILES
- SQL> CREATE PLUGGABLE DATABASE
- Run the noncdb_to_pdb.sql script to delete unnecessary metadata from the SYSTEM tablespace of the new PDB
- SQL> ALTER PLUGGABLE DATABASE OPEN

Must be little endian and compatible character set

RMAN for Cloud Migrations II

RMAN Cross-Platform Transportable Tablespace Backup Sets

- SQL> CREATE DIRECTORY dp_for_cloud AS '/u01/app/oracle/admin/orcl/dpdump/for_cloud';
- SQL> ALTER TABLESPACE … READONLY;
- RMAN> BACKUP DEVICE TYPE SBT FOR TRANSPORT TABLESPACE … DATAPUMP FORMAT '/u01/app/oracle/admin/orcl/dpdump/for_cloud‘;

Must be little endian and compatible character set

scp DP files and encryption wallet

- prepare the database by creating the required schemas and users.
- RMAN> CATALOG DEVICE TYPE SBT BACKUPPIECE …;
- RMAN> RESTORE DEVICE TYPE SBT TABLESPACE … TO NEW DUMP FILE DATAPUMP DESTINATION ‘……';

RMAN for Cloud Migrations III

RMAN Convert Cross-Platform Transportable Tablespace Backup Sets

- SQL> CREATE DIRECTORY dp_for_cloud AS '/u01/app/oracle/admin/orcl/dpdump/for_cloud';
- SQL> ALTER TABLESPACE … READONLY;
- RMAN> BACKUP DEVICE TYPE SBT FOR TRANSPORT TABLESPACE … DATAPUMP FORMAT '/u01/app/oracle/admin/orcl/dpdump/for_cloud‘;

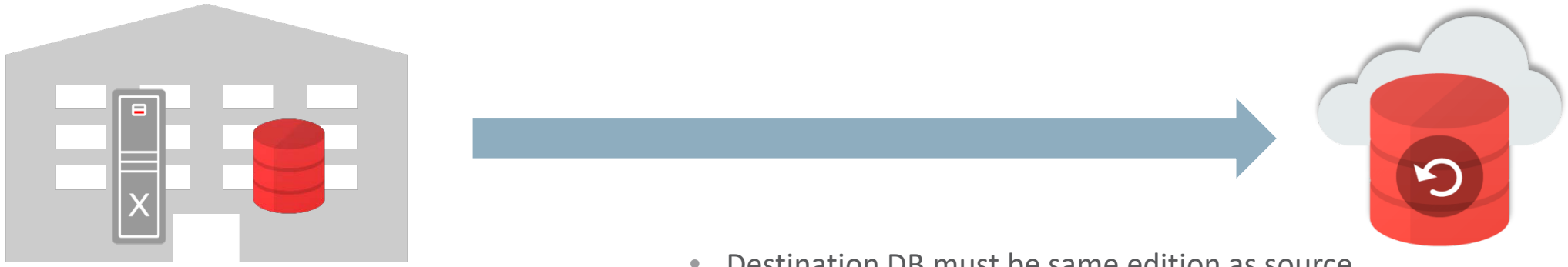
scp DP files and encryption wallet

- RMAN>RESTORE DEVICE TYPE SBT FROM PLATFORM 'Solaris[tm] OE (64-bit)' foreign datafile .. FORMAT '/…../DBSOL11.26_SOE_INDX_02.1539554166.dbf‘ FROM BACKUPSET …;

Must be compatible character set

RMAN for Cloud Migrations IV

RMAN Duplicate from Active Database



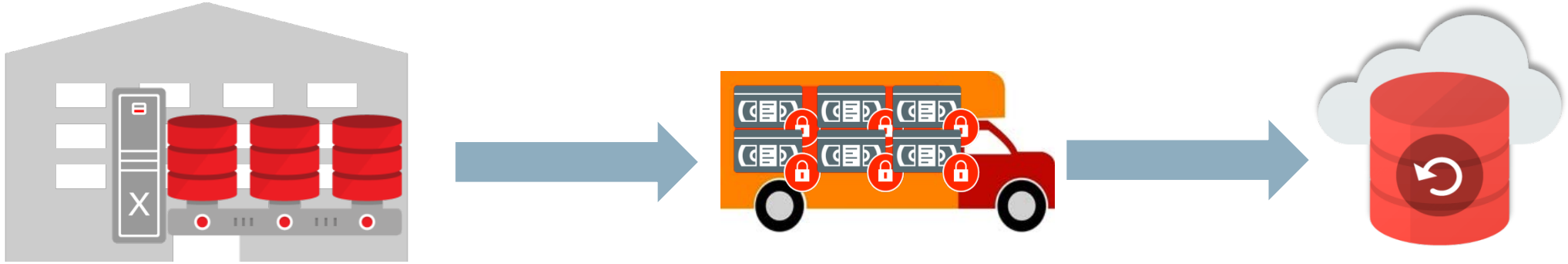
- Patch source DB to the same level of destination DB

scp encryption wallet if source DB is TDE encrypted

- Destination DB must be same edition as source
- DB created when instance is provisioned can be deleted
- Prepare the target instance (listener, wallet, storage)
- Make sure source DB is reachable on port 1521
- Start listener and instance in nomount mode
- RMAN>rman target sys/sourcePassword@sourceNode:1521/SourceDb auxiliary sys/auxSysPassword@destNode:destListenerPort/auxService
- RMAN>duplicate target database to destDb as encrypted from active database
- password file spfile
- <spfile params>
- nofilenamecheck

RMAN for Cloud Migrations V

Using OCI Data Transfer Service



- Use external disk drives or a storage appliance to perform a RMAN backup to disk
- Ship media to Oracle

scp encryption wallet

"convert" the disk backup format to cloud backup

RMAN> SEND CHANNEL t1 '

2> export backuppiece /import/o1_mf_nnn.bkp,

3> export backuppiece /import/c-40712312-01';

Perform restore as in previous examples

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RMAN with ZDLRA at Exelon

Exelon

Who am I?

- Been a DBA since 1992 – Oracle 6.0.7
- Various development and Unix System Administration
- From Denmark. Immigrated to the US in 1996.
  Became a US Citizen in 2015
- Worked in a variety of industries like travel, TV,
  online gambling and energy
- Currently a DBA Engineer for Exelon Corp. since 2007

Who We Are

Generation	Competitive Energy Sales	Transmission and Delivery
One of the largest U.S. competitive power generators 32,000 MW of owned capacity Largest U.S. nuclear fleet Renewables - wind and solar	Retail and wholesale sales through Constellation Approximately 2.5 million residential, public sector and business customers	Three utilities delivering electricity and natural gas to more than 7.8 million customers: •BGE in Maryland •ComEd in Illinois •PECO in Pennsylvania

Exelon

Oracle at Exelon

- 2000+ databases total. 320+ production
- DB size ranging from 5GB to 170TB
- Backups to 10 ZDLRA's
  - 4 are project specific
  - 2 are for non-prod
- Replication of all database backups to alternate data center for protection

ZDLRA migration reasons

- Old backup hardware was ready for retirement
- Dollar per protected GB was competitive with other solutions
- Need to minimize Data Loss in protected databases
- Weekly backup sizes are smaller and have much less impact on databases

ZDLRA – Reduction in volume

- ZDLRA only does 1 full backup and then incremental backups for life.
- On average Exelon's incremental backups are 2% of the total database size
  - Huge reduction in IO on local database server
  - Huge reduction in network traffic
  - Huge space savings from only storing 1 full backup
  - No CPU overhead on the local database server from compression. ZDLRA takes care of that.

RMAN Parameter configuration with ZDLRA

```
RMAN> CONFIGURE DEFAULT DEVICE TYPE TO 'SBT_TAPE';

RMAN> CONFIGURE DEVICE TYPE 'SBT_TAPE' PARALLELISM 8 BACKUP TYPE
TO BACKUPSET;

RMAN> CONFIGURE CHANNEL DEVICE TYPE 'SBT_TAPE' FORMAT '%d_%U'
PARMS  "SBT_LIBRARY=$ORACLE_HOME/dbs/libra/libra.so,
ENV=(RA_WALLET='location=file:$ORACLE_HOME/network/admin
credential_alias=baltimore-ingest-
scan:1521/baltimore:dedicated')";

RMAN> CONFIGURE ARCHIVELOG DELETION POLICY TO SHIPPED TO ALL
STANDBY BACKED UP 1 TIMES TO 'SBT_TAPE';
```

Database Redo Real Time Transport to ZDLRA

- Database sends redo stream to ZDLRA as a log archive destination.
- Database Uses Oracle Wallet to store credentials for connecting to ZDLRA

```
RMAN> log_archive_dest_5='SERVICE="baltimore-ingest-
scan:1521/baltimore:dedicated",  VALID_FOR=(ALL_LOGFILES,
ALL_ROLES) ASYNC DB_UNIQUE_NAME=baltimore'
```

Oracle Wallet Setup to ZDLRA

```
sqlnet.ora:

SQLNET.WALLET_OVERRIDE = true
WALLET_LOCATION = (SOURCE = (METHOD = FILE) (METHOD_DATA =
(DIRECTORY =$ORACLE_HOME/network/admin ) ) )
```

```
Wallet content:

$ mkstore -wrl =$ORACLE_HOME/network/admin -listCredential
Oracle Secret Store Tool : Version 12.1.0.2
Copyright (c) 2004, 2014, Oracle and/or its affiliates. All
rights reserved.
```

```
List credential (index: connect_string username)

1: baltimore-ingest-scan:1521/baltimore:dedicated ravpc1
```

RMAN Sample backup script to ZDLRA

```
RMAN> connect target /

RMAN> connect catalog /@ baltimore-ingest-
scan:1521/baltimore:dedicated

RMAN> backup incremental level 1 cumulative section size 64g
filesperset=1 database;
```

Archivelogs should already be backed up via Real Time Transport but otherwise a simple script can handle that:

```
RMAN> backup archivelog all delete all input;
```

RMAN Sample restore script from ZDLRA

```
RMAN> connect target /

RMAN> connect catalog /@ baltimore-ingest-
scan:1521/baltimore:dedicated

RMAN> restore database;

RMAN> recover database;
```

RMAN Sample database clone build script from ZDLRA

```
RMAN> connect target sys/change_on_install@PROD

RMAN> connect auxiliary /

RMAN> connect catalog /@ baltimore-ingest-
scan:1521/baltimore:dedicated

RMAN> run {
ALLOCATE AUXILIARY CHANNEL c1 DEVICE TYPE sbt_tape
PARMS='SBT_LIBRARY=$ORACLE_HOME/dbs/libra/libra.so,ENV=(RA_WALLET='
location=file:$ORACLE_HOME/network/admin
credential_alias=baltimore-ingest-scan:1521/baltimore:dedicated')'
FORMAT'%U_%d';

set until time "to_date('10/01/2018','MM/DD/YYYY')";
DUPLICATE TARGET DATABASE TO 'TEST';
}
```

RMAN Sample standby database build script from ZDLRA

```
RMAN> connect auxiliary /

RMAN> connect catalog /@ baltimore-ingest-
scan:1521/baltimore:dedicated

RMAN> run {

set DBID 123456789

ALLOCATE AUXILIARY CHANNEL c1 DEVICE TYPE sbt_tape
PARMS='SBT_LIBRARY=$ORACLE_HOME/dbs/libra/libra.so,
ENV=(RA_WALLET='location=file:$ORACLE_HOME/network/admin
credential_alias=baltimore-ingest-scan:1521/baltimore:dedicated')'
FORMAT'%U_%d';

DUPLICATE DATABASE PROD FOR STANDBY DORECOVER NOFILENAMECHECK;

}
```

Summary

- ZDLRA and RMAN makes backups and restores very easy

- In Exelon's case (35 day retention)
  - IO and CPU savings by not reading and compressing 360TB/week of database files for full backups
  - Network traffic savings of 55TB/week from not performing full backups (62TB compressed backup vs. 7TB incremental)
  - Backup media savings of 244TB from only storing 1 full backup

Wrap up

RMAN continues to evolve after 20 years

- Consider the challenges of encryption
- RMAN is a powerful tool for on-premises or cloud migrations
- In combination with ZDLRA can provide additional benefits (attend Wednesday's sessions!)
  - Zero Data Loss Recovery Appliance: Leveraging Integration with Oracle Cloud [PRO4217]
    - Wednesday, Oct 24th, 12:30 p.m. | Moscone West - Room 3007
  - Zero Data Loss Recovery Appliance: Insider's Guide to Architecture and Practices [TIP4218]
    - Wednesday, Oct 24th, 4:45 p.m. | Moscone West - Room 3007
- More on cloud migrations
  - Oracle Database Cloud Migration: Fast, Simple, Universal [TRN4033]
    - Thursday, Oct 25, 09:00 AM - 09:45 AM | Moscone West - Room 3004

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Thursday, Oct 25, 09:00 AM - 09:45 AM | Moscone West - Room 3004

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