eProseed
WE SIMPLIFY COMPLEXITY.

ZDLRA AND MAA INTEGRATION TO REACH ZERO RPO EVERYWHERE

Fernando Simon
Senior DBA Architect – eProseed

- *“The postings on this document are my own and don’t necessarily represent my actual employer positions, strategies or opinions. The information here was edited to be useful for general purpose, specific data and identifications were removed to allow reach the generic audience and to be useful for the community.”*

- About me.
- Availability.
- ZDLRA:
  - Real-Time Redo.
  - Replication.
  - Clones/Tape/Cloud.
- Maximum Availability Architecture – MAA:
  - Goal levels .
  - ZLDRA + MAA
- QA.

ABOUT ME

- Senior DBA at eProseed Luxembourg.
- OCP, OCE RAC, OCI Architect, Autonomous Specialist.
- Co-Founder and Board Member at LuxOUG.

- Oracle ACE, OOW, OOWLA, and User Groups speaker/presentations.

- Contacts:

fernando.simon.br@gmail.com
fernando.simon@eproseed.com

https://www.fernandosimon.com/blog/
https://twitter.com/FSimonDBA
https://www.linkedin.com/in/fernando-simon/

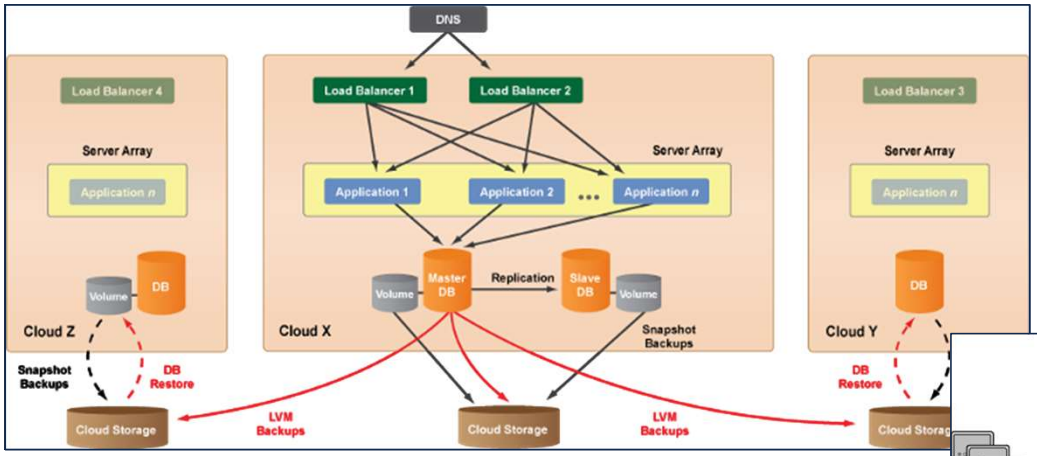
ABOUT ME

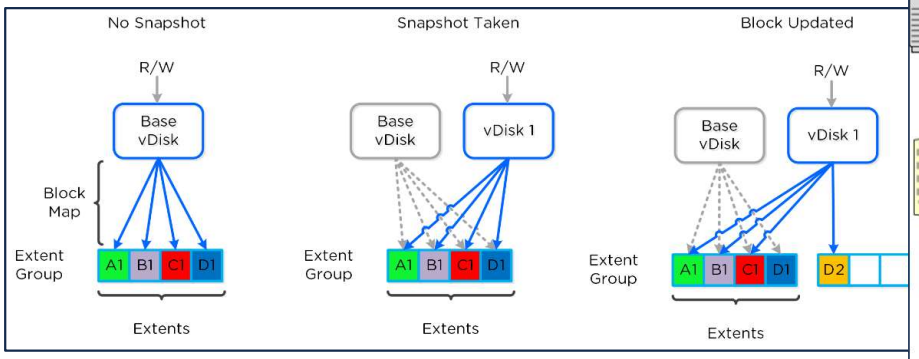
- DBA since 2004:
  - Oracle, PostgreSQL, DB2.
- Head and DBA Team Manager at Court of Justice – 2010/2017:
  - Exadata since 2010:
    - Exadata V2,X2, X4 (Full), X5 (Full EF), and X6.
    - High consolidated environment, IORM, Resource Manager, Instance Caging.
  - ZDLRA since 2014/2015:
    - First ZDLRA in Brazil, one of the first of the world worked replicated.
  - MAA Project, Multi-Site protection, RAC+RAC, DG, ZDLRA:
    - OOW SFO 2015:

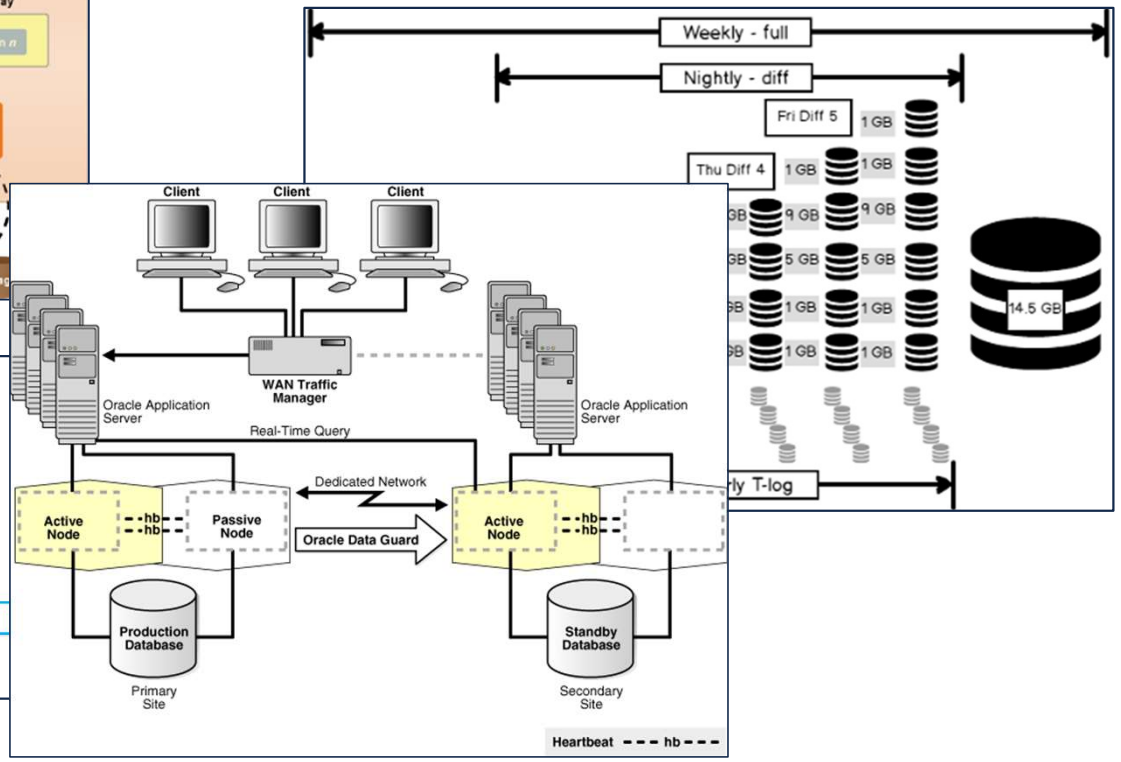
https://www.oracle.com/technetwork/database/availability/con8830-zdlradeepdive-2811109.pdf

- Luxembourg October/2017:
  - eProseed - Senior Database Architect.
- Consulting at European Commission:
  - LCM (Life Cycle Management) to the Oracle Products.
  - Supporting the Production Databases.
- Consulting at Bank Institution:
  - Multi-site environment.
  - DBA Architect: MAA Infrastructure, Exadata and ZDLRA support.
  - 100% allocated at customer.
- LUXOUG Co-Founder and Board Member.

AVAILABILITY







AVAILABILITY

- Principles and goals:
  - Availability of every information.
  - Application Continuity.
  - Low or zero impact over environment.
  - Easy to: operate, control, and verify.
  - Data retention and storage to sustain compliances and requirements.
  - 24x7x365.
  - No Data and Access Loss.

- Two words:
  - **RPO** – Recovery Point Objective:
    - Usually, what/how much you can loose.
  - **RTO** – Recovery Time Objective:
    - Usually, time to put everything running again.

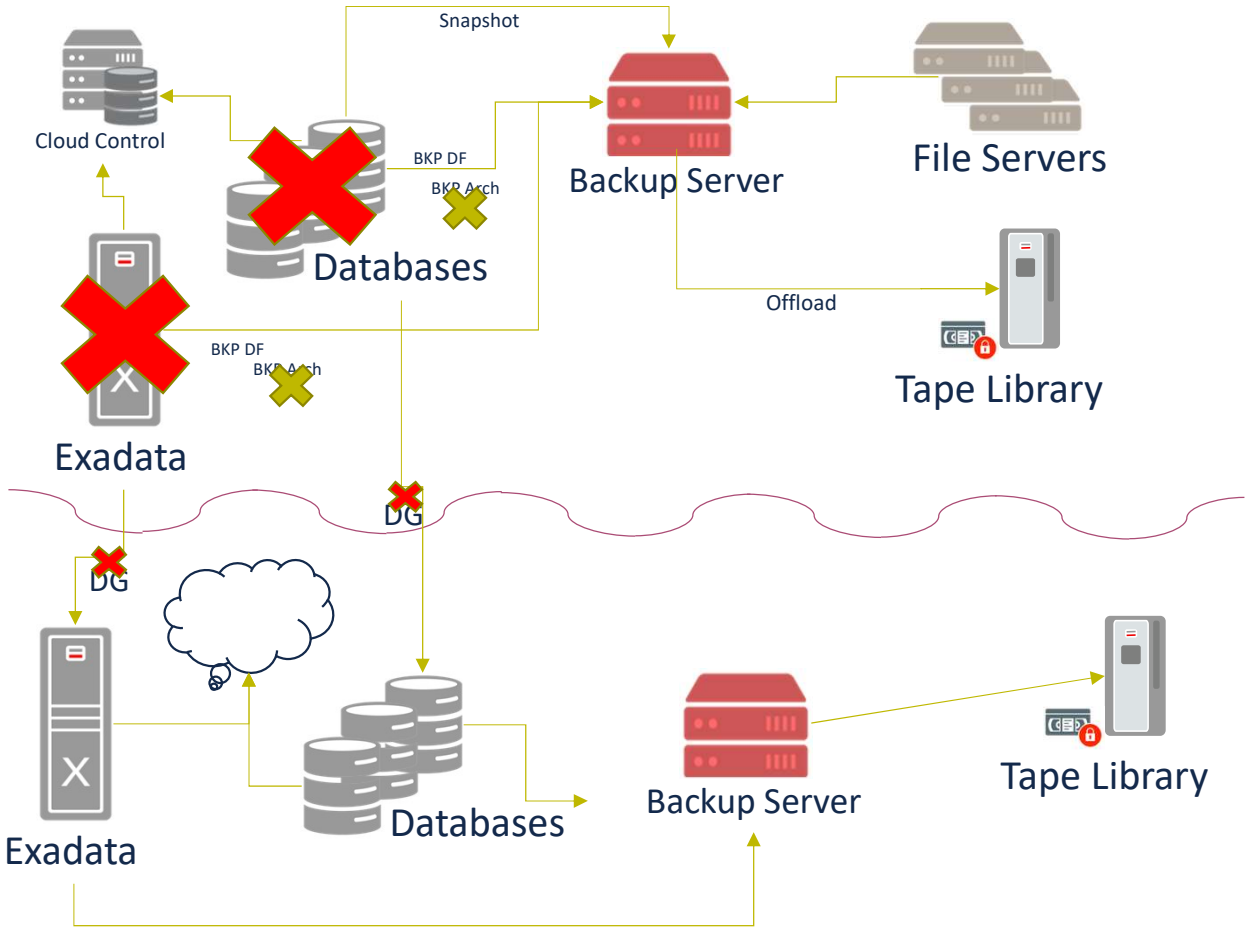
- **The goal is zero RPO and zero RTO.**

AVAILABILITY

- Real Life
  - Mixed environment.
  - Mix of SLA to cover.
  - Uncovered time, lack of synchronization.
  - Data Loss (usually since the last backup).
  - High impact over the environment.
  - A lot of players (Tivoli, EMC, DataProtector, Commvault) and huge complexity.
  - Cloud.
  - Validation, test, validation, test, validation, test….

- And it is worst…

AVAILABILITY



ZDLRA

- **ZERO DATA LOSS RECOVERY APPLIANCE – ZDLRA**
  - Engineered Systems.
  - Exadata based.
  - Hardware + Software:
    - RA Library.
  - MML for tape:
    - SAN.
    - Oracle Secure Backup.
  - Native replication.
  - RMAN Catalog – Integration.
  - EM/CC or CLI.

- **DOES NOT REDUCES RTO, JUST RPO.**

ZDLRA – MAIN FEATURES

- Virtual Full Backup.
- Replication.
- Tape Backups.
- Real-Time Redo.

ZDLRA - WHAT IT IS?

- Oracle Database:
  - Rman catalog + internal RA tables to store the configurations:
    - **Self-Managed RMAN Catalog. Don't need to catalog or crosscheck nothing.**

- Delta Store:
  - **Delta Push** = Virtual Backups + Real Time Redo:
  - Automatic backup index, management, and validation.

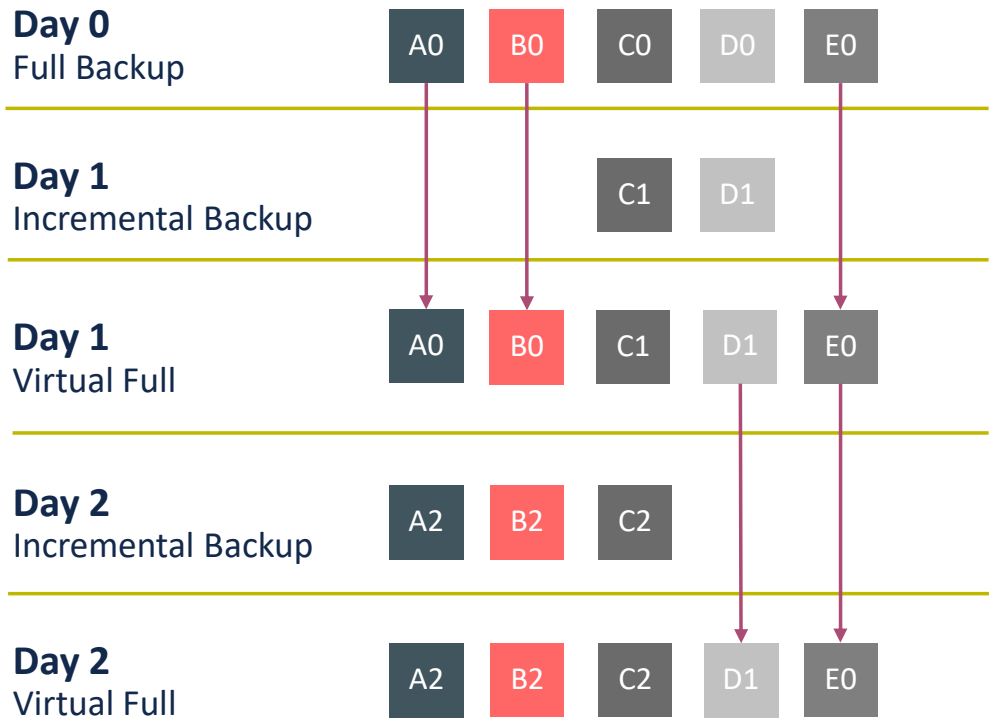
- EM/CC/CLI:
  - DBMS_RA package to manage everything.

- Backup client library installed in every server that sends backup.

ZDLRA – VIRTUAL FULL BACKUP

- Virtual Full Backup:
  - **Incremental Forever Strategy**:
    - ZDLRA merge L0 + L1 to generate a virtual full backup for your datafile.
  - Generate “index” for every datafile backup.
  - Validated against corruption for backup blocks **AND** datafile blocks.
  - Differs from deduplication:
    - Opens the sent RMAN backupset and “see” each datafile blocks. Is not black magic (reverse engineering).
  - Changes noting at RMAN side. Backup and restore commands continue the same.

ZDLRA – VIRTUAL FULL BACKUP



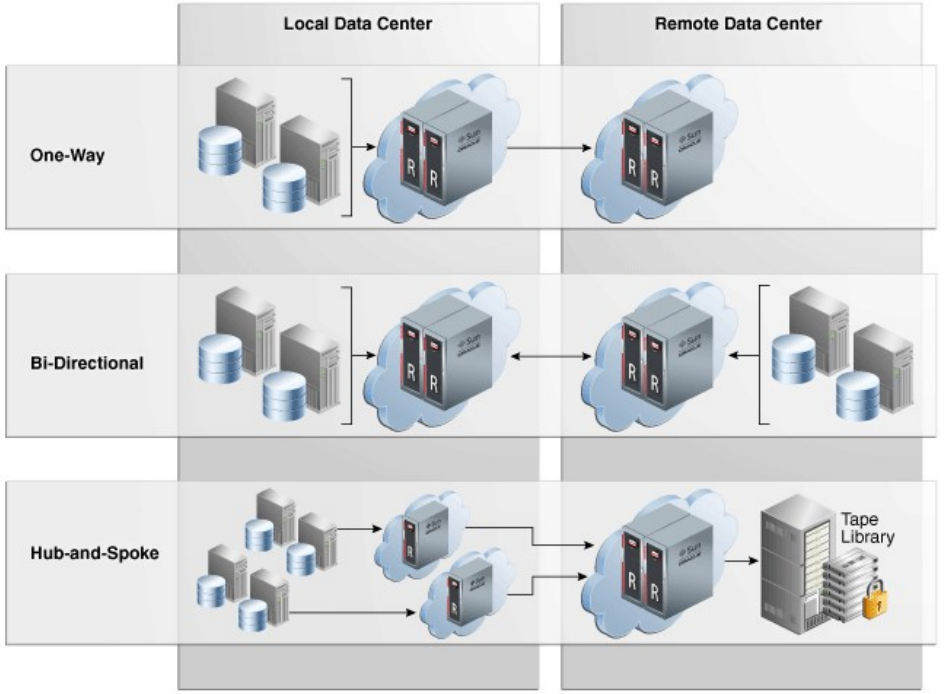
15

```
RMAN> list backup of datafile 1;


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


BS Key  Type LV Size       Device Type Elapsed Time Completion Time
------- ---- -- ---------- ----------- ------------ -------------------
14406   Incr 0  330.29M    SBT_TAPE    00:03:16     05/01/2020 17:40:31
        BP Key: 14407   Status: AVAILABLE  Compressed: YES  Tag: BKP-DB-INC0
        Handle: VB$_1891149551_14397I   Media:
  List of Datafiles in backup set 14406
  File LV Type Ckp SCN    Ckp Time            Abs Fuz SCN Sparse Name
  ---- -- ---- ---------- ------------------- ----------- ------ ----
  1    0  Incr 1885317    05/01/2020 17:37:15             NO     /u01/app/oracle/oradata/ORCL18C/system01.dbf

BS Key  Type LV Size       Device Type Elapsed Time Completion Time
------- ---- -- ---------- ----------- ------------ -------------------
14431   Incr 1  56.00K     SBT_TAPE    00:00:02     05/01/2020 17:44:24
        BP Key: 14432   Status: AVAILABLE  Compressed: YES  Tag: BKP-DB
        Handle: VB$_1891149551_14430I   Media:
  List of Datafiles in backup set 14431
  File LV Type Ckp SCN    Ckp Time            Abs Fuz SCN Sparse Name
  ---- -- ---- ---------- ------------------- ----------- ------ ----
  1    1  Incr 1885774    05/01/2020 17:44:22             NO     /u01/app/oracle/oradata/ORCL18C/system01.dbf

BS Key  Type LV Size       Device Type Elapsed Time Completion Time
------- ---- -- ---------- ----------- ------------ -------------------
14435   Incr 0  329.18M    SBT_TAPE    00:00:02     05/01/2020 17:44:24
        BP Key: 14436   Status: AVAILABLE  Compressed: YES  Tag: BKP-DB
        Handle: VB$_1891149551_14430_1   Media:
  List of Datafiles in backup set 14435
  File LV Type Ckp SCN    Ckp Time            Abs Fuz SCN Sparse Name
  ---- -- ---- ---------- ------------------- ----------- ------ ----
  1    0  Incr 1885774    05/01/2020 17:44:22             NO     /u01/app/oracle/oradata/ORCL18C/system01.dbf

RMAN>
```

MERGED

ZDLRA - REPLICATION

- Replication:
  - One-Way:
    - One master and one destination.
  - Bi-Directional:
    - Both sides replicate each other.
  - Hub/Spoke:
    - One to many.



ZDLRA - REPLICATION

- Replication:
  - Replicated copies of your backupsets.
  - Upstream (source) and Downstream (destination).
  - **Every ZDLRA can have different policies and recovery windows.**
  - **Just replicate archivelogs and incremental backups:**
    - Each sides generate the virtual full.
  - The rman restore/recover can use any side:
    - Since can exists different recovery windows, backupset can exist in just one side.
    - The database can connect on both sides.

```
RMAN> list backup of datafile 1;


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


BS Key  Type LV Size
------- ---- -- ----------
9265    Incr 1  88.00K
  List of Datafiles in backup set 9265
  File LV Type Ckp SCN    Ckp Time            Abs Fuz SCN Sparse Name
  ---- -- ---- ---------- ------------------- ----------- ------ ----
  1    1  Incr 2066326    22/12/2019 22:08:46              NO     /u01/app/oracle/oradata/ORCL19/system01.dbf

  Backup Set Copy #1 of backup set 9265
  Device Type Elapsed Time Completion Time     Compressed Tag
  ----------- ------------ ------------------- ---------- ---
  SBT_TAPE    00:00:42     22/12/2019 22:08:49 YES        BKP-DB

    List of Backup Pieces for backup set 9265 Copy #1
    BP Key  Pc# Status      Media                    Piece Name
    ------- --- ----------- ------------------------ ----------
    9266    1   AVAILABLE                            VB$_1891149551_9264I

  Backup Set Copy #2 of backup set 9265
  Device Type Elapsed Time Completion Time     Compressed Tag
  ----------- ------------ ------------------- ---------- ---
  SBT_TAPE    00:00:42     22/12/2019 22:09:28 YES        BKP-DB

    List of Backup Pieces for backup set 9265 Copy #2
    BP Key  Pc# Status      Media                    Piece Name
    ------- --- ----------- ------------------------ ----------
    9676    1   AVAILABLE   ZDLRAS2_REP              VB$_2127575003_7641I

BS Key  Type LV Size
------- ---- -- ----------
9269    Incr 0  320.50M
...
```

```
...
BS Key  Type LV Size
------- ---- -- ----------
9269    Incr 0  320.50M
  List of Datafiles in backup set 9269
  File LV Type Ckp SCN    Ckp Time            Abs Fuz SCN Sparse Name
  ---- -- ---- ---------- ------------------- ----------- ------ ----
  1    0  Incr 2066326    22/12/2019 22:08:46              NO     /.../system01.dbf

  Backup Set Copy #1 of backup set 9269
  Device Type Elapsed Time Completion Time     Compressed Tag
  ----------- ------------ ------------------- ---------- ---
  SBT_TAPE    00:00:42     22/12/2019 22:08:49 YES        BKP-DB

    List of Backup Pieces for backup set 9269 Copy #1
    BP Key  Pc# Status      Media                    Piece Name
    ------- --- ----------- ------------------------ ----------
    9270    1   AVAILABLE                            VB$_1891149551_9264_1

  Backup Set Copy #2 of backup set 9269
  Device Type Elapsed Time Completion Time     Compressed Tag
  ----------- ------------ ------------------- ---------- ---
  SBT_TAPE    00:00:42     22/12/2019 22:09:28 YES        BKP-DB

    List of Backup Pieces for backup set 9269 Copy #2
    BP Key  Pc# Status      Media                    Piece Name
    ------- --- ----------- ------------------------ ----------
    9690    1   AVAILABLE   ZDLRAS2_REP              VB$_2127575003_7641_1

RMAN>
```

```
RMAN> list backup of archivelog all;


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


BS Key  Size
------- ----------
9315    91.00K

  List of Archived Logs in backup set 9315
  Thrd Seq     Low SCN    Low Time            Next SCN   Next Time
  ---- ------- ---------- ------------------- ---------- ---------
  1    7       2074788    22-12-2019_23:06:16 2075182    22-12-2019_23:09:09

  Backup Set Copy #1 of backup set 9315
  Device Type Elapsed Time Completion Time     Compressed Tag
  ----------- ------------ ------------------- ---------- ---
  SBT_TAPE    00:57:30     22-12-2019_23:09:40 YES        TAG20191222T230939

    List of Backup Pieces for backup set 9315 Copy #1
    BP Key  Pc# Status      Media                   Piece Name
    ------- --- ----------- ----------------------- ----------
    9316    1   AVAILABLE                           $RSCN_2029050_RTIM_1021856938_THRD_1_SEQ_7_CTKEY_9313_BACKUP

  Backup Set Copy #2 of backup set 9315
  Device Type Elapsed Time Completion Time     Compressed Tag
  ----------- ------------ ------------------- ---------- ---
  SBT_TAPE    00:57:30     22-12-2019_22:12:09 YES        TAG20191222T230939

    List of Backup Pieces for backup set 9315 Copy #2
    BP Key  Pc# Status      Media                   Piece Name
    ------- --- ----------- ----------------------- ----------
    9319    1   AVAILABLE   Recovery Appliance (ZDLRAS2) RA_SBT_ORCL19_323177095_9191_8iuk3llj_1_2_9315

RMAN>
```

ZDLRA – CLONE TO TAPE

- Tape and Cloud:
  - Can copy to tapes directly, is MML:
    - It can be by OSB or Third Part (since it is compatible with rman).
    - Natively uses Oracle Secure Backup (OSB) with SAN.
  - Can copy backups to Oracle Cloud, Object Store:
    - Uses Key Vault.
  - Offload/copy backupsets.
  - **Requires schedule**. Based at dbms_scheduler to call clone job.

```
RMAN> list backupset 12631;


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


BS Key  Type LV Size
------- ---- -- ----------
12631   Incr 0  336.35M
  List of Datafiles in backup set 12631
  File LV Type Ckp SCN    Ckp Time            Abs Fuz SCN Sparse Name
  ---- -- ---- ---------- ------------------- ----------- ------ ----
  1    0  Incr 2452316    01/01/2020 20:25:20              NO    +DATA/OR19DG/DATAFILE/system.265.1028557261

  Backup Set Copy #1 of backup set 12631
  Device Type Elapsed Time Completion Time     Compressed Tag
  ----------- ------------ ------------------- ---------- ---
  SBT_TAPE    01:50:05     01/01/2020 20:25:23 YES        BKP-DB

    List of Backup Pieces for backup set 12631 Copy #1
    BP Key  Pc# Status      Media                     Piece Name
    ------- --- ----------- ------------------------- ----------
    12632   1   AVAILABLE                             VB$_1891149551_12626_1

  Backup Set Copy #2 of backup set 12631
  Device Type Elapsed Time Completion Time     Compressed Tag
  ----------- ------------ ------------------- ---------- ---
  SBT_TAPE    01:50:05     01/01/2020 22:15:25 NO         BKP-DB

    List of Backup Pieces for backup set 12631 Copy #2
    BP Key  Pc# Status      Media                     Piece Name
    ------- --- ----------- ------------------------- ----------
    13361   1   AVAILABLE   zdlras1-osbmf-000001    RA_SBT_OR19DG_41954437_13318_qsuktnpg_1_2_12631

RMAN>
```

ZDLRA – REAL-TIME REDO

- Real-Time Redo:
  - **Is the "zero data loss" - guarantee the zero RPO:**
    - **Reduces RPO from the last backup to zero/sub-seconds.**
  - ZDLRA it is a log_archive_dest destination:
    - Can be SYNC or ASYNC.
    - Uses same procedure than DG. ZDLRA operates with RFS to receive redo buffers.
  - Differ from FARSYNC, just need to config the archive dest at database side.
  - If protected database crash, ZDLRA creates 'partial archived log backup' with last sent redo info.
  - 100% integrated and compatible with MAA.
  - **DOES NOT REQUIRE DG LICENSE! INDEPENDETELY OF ORACLE EDITION THAT YOU USE!**

```
RMAN> list copy of archivelog all;

List of Archived Log Copies for database with db_unique_name OR19DG
=====================================================================

Key     Thrd Seq     S Low Time
------- ---- ------- - -------------------
13295   1    90      A 01/01/2020 22:28:18
        Name: +RECO/OR19DG/ARCHIVELOG/2020_01_01/thread_1_seq_90.446.1028586681


RMAN> alter system archive log current;

Statement processed

RMAN> list backup of archivelog sequence 91;


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


BS Key  Size       Device Type Elapsed Time Completion Time
------- ---------- ----------- ------------ -------------------
13314   21.50K     SBT_TAPE    00:00:01     01/01/2020 22:32:09
        BP Key: 13315   Status: AVAILABLE  Compressed: YES  Tag: TAG20200101T223208
        Handle: $RSCN_1920977_RTIM_1028557385_THRD_1_SEQ_91_CTKEY_13291_BACKUP   Media:

  List of Archived Logs in backup set 13314
  Thrd Seq     Low SCN    Low Time            Next SCN   Next Time
  ---- ------- ---------- ------------------- ---------- ---------
  1    91      2519988    01/01/2020 22:31:20 2520099    01/01/2020 22:31:51

RMAN>
```

```
RMAN> list backup of archivelog sequence 32;

specification does not match any backup in the repository

RMAN>
```

```
[oracle@exac1vm01-ORAD18]$ ps -ef |grep pmon_ORAD18
oracle    31646      1  0 22:27 ?        00:00:00 ora_pmon_ORAD18
[oracle@exac1vm01-ORAD18]$ ps -ef |grep smon_ORAD18
oracle    31731      1  0 22:27 ?        00:00:00 ora_smon_ORAD18
[oracle@exac1vm01-ORAD18]$ ps -ef |grep lgwr_ORAD18
oracle    31724      1  0 22:27 ?        00:00:00 ora_lgwr_ORAD18
[oracle@exac1vm01-ORAD18]$ ps -ef |grep dbw0_ORAD18
oracle    31722      1  0 22:27 ?        00:00:00 ora_dbw0_ORAD18
[oracle@exac1vm01-ORAD18]$ ps -ef |grep arc* |grep ORAD18
oracle    31805      1  0 22:27 ?        00:00:00 ora_mark_ORAD18
oracle    32021      1  0 22:27 ?        00:00:00 ora_arc0_ORAD18
oracle    32042      1  0 22:27 ?        00:00:00 ora_arc1_ORAD18
oracle    32050      1  0 22:27 ?        00:00:00 ora_arc2_ORAD18
oracle    32057      1  0 22:27 ?        00:00:00 ora_arc3_ORAD18
[oracle@exac1vm01-ORAD18]$
[oracle@exac1vm01-ORAD18]$ kill -9 31646 31731 31724 31722 32021 32042 32050
32057
[oracle@exac1vm01-ORAD18]$
```

```
#####
At alertlog:
    2019-10-18T22:30:33.160912+02:00
    RMS0 (ospid: 31718): terminating the instance due to ORA error 472
    Cause - 'Instance is being terminated due to fatal process PMON being dead.'
    2019-10-18T22:30:33.290189+02:00
    System state dump requested by (instance=1, osid=31718 (RMS0)),
summary=[abnormal instance termination]. error - 'Instance is terminating.
    '
```

```
RMAN> list backup of archivelog sequence 32;


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


BS Key  Size       Device Type Elapsed Time Completion Time
------- ---------- ----------- ------------ -------------------
50958220 72.50K     SBT_TAPE    00:00:00     2019-10-18_22-30-42
        BP Key: 50958221   Status: AVAILABLE  Compressed: YES  Tag: TAG20191018T223042
        Handle: $RSCN_1_RTIM_1022003674_THRD_1_SEQ_32_CTKEY_50958156_BACKUP   Media:

  List of Archived Logs in backup set 50958220
  Thrd Seq     Low SCN    Low Time            Next SCN   Next Time
  ---- ------- ---------- ------------------- ---------- ---------
  1    32      1025761    2019-10-18_22-28-20 1026104    2019-10-18_22-30-32

RMAN>
```

```
[oracle@exac1vm01-ORAD18]$ for i in {1..100000}
> do
> echo "Insert Data $i - date +%d-%m-%Y-%H%M%S"
> sqlplus -s / as sysdba<<EOF
> set heading on feedback on;
> insert into testIns(c1, c2, c3) values ($i, sysdate, 'Loop');
> commit;
> EOF
> done
Insert Data 1 - 18-10-2019-230723

1 row created.


Commit complete.
...

...
Insert Data 1016 - 18-10-2019-230944

1 row created.


Commit complete.

Insert Data 1017 - 18-10-2019-230944

1 row created.

commit
     *
ERROR at line 1:
ORA-03113: end-of-file on communication channel
Process ID: 142277
Session ID: 53 Serial number: 30197
```

KILL -9 ALL!!!

```
[oracle@exac1vm01-ORAD18]$ for i in {1..100000}
> do
> echo "Insert Data $i - date +%d-%m-%Y-%H%M%S"
> sqlplus -s / as sysdba<<EOF
> set heading on feedback on;
> insert into testIns(c1, c2, c3) values ($i, sysdate, 'Loop2');
> commit;
> EOF
> done
Insert Data 1 - 18-10-2019-230816

1 row created.


Commit complete.


Insert Data 646 - 18-10-2019-230944

1 row created.


Commit complete.

Insert Data 647 - 18-10-2019-230944

1 row created.

commit
     *
ERROR at line 1:
ORA-03113: end-of-file on communication channel
Process ID: 142274
Session ID: 41 Serial number: 3186
```

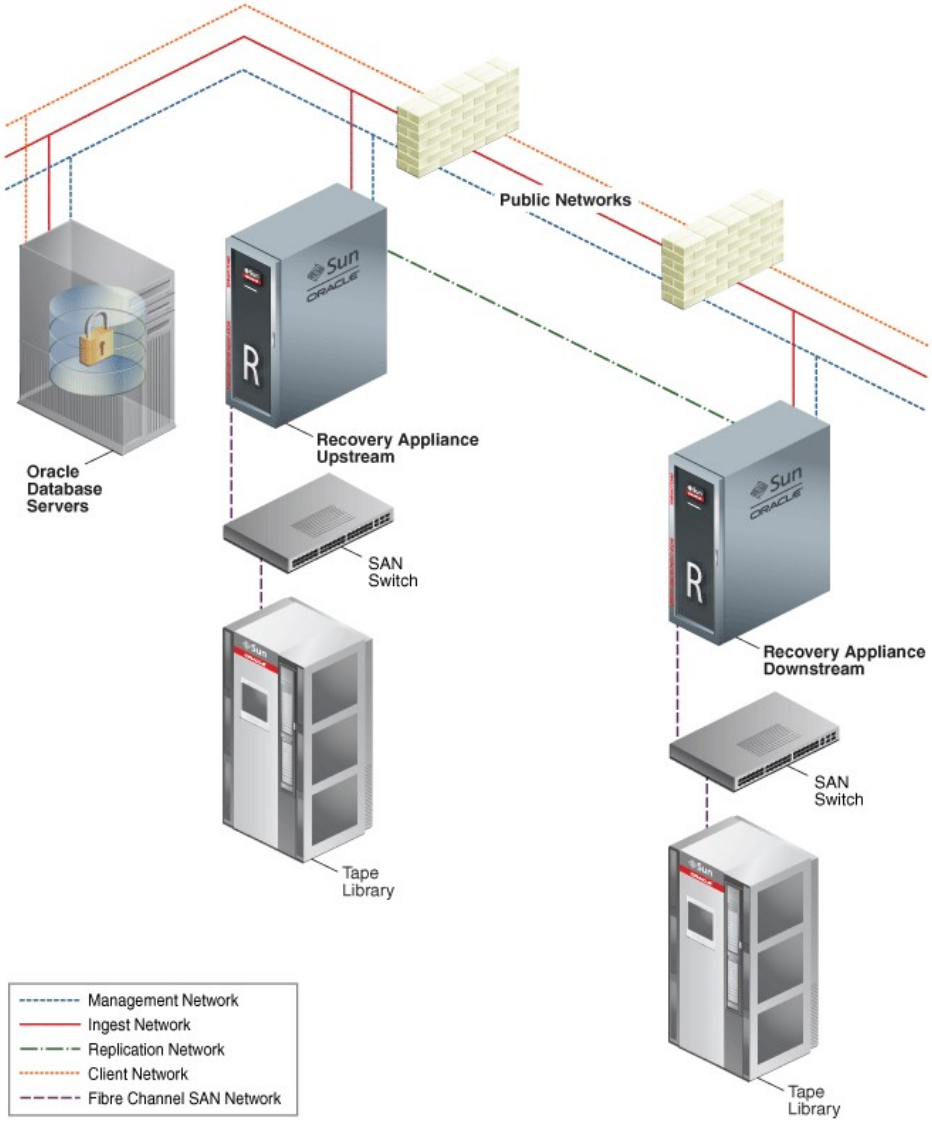
```
ASMCMD> cd +DATAC1/ORAD18/
ASMCMD> rm -rf CONTROLFILE/
ASMCMD> rm -rf DATAFILE/
ASMCMD> rm -rf ONLINELOG/
ASMCMD> rm -rf TEMPFILE/
ASMCMD>
ASMCMD> cd +RECOC1/ORAD18/
ASMCMD> rm -rf ARCHIVELOG/
ASMCMD> rm -rf AUTOBACKUP/
ASMCMD> rm -rf CONTROLFILE/
ASMCMD> rm -rf ONLINELOG/
ASMCMD>
```

```
RMAN> list backup of archivelog all completed after "sysdate - 15/1440";
...
...
BS Key  Size       Device Type Elapsed Time Completion Time
------- ---------- ----------- ------------ -------------------
50958809 2.05M      SBT_TAPE    00:00:00     2019-10-18_23-10-12
        BP Key: 50958810   Status: AVAILABLE  Compressed: YES  Tag: TAG20191018T231012
        Handle: $RSCN_1129803_RTIM_1022011106_THRD_1_SEQ_5_CTKEY_50958757_BACKUP   Media:

  List of Archived Logs in backup set 50958809
  Thrd Seq     Low SCN    Low Time            Next SCN   Next Time
  ---- ------- ---------- ------------------- ---------- ---------
  1    5       1131667    2019-10-18_23-05-09 1135762    2019-10-18_23-09-44

RMAN>



RMAN> run{
2> set until scn 1135762;
3> restore database;
4> recover database;
5> }
```

```
SQL> select count(*) from testIns group by c3;

  COUNT(*)
----------
       646
      1016

SQL>
```

ZDLRA

- **Real-Time Redo**
  - Guarantee the zero RPO.
  - Don’t need to pay DG license to use.
  - Can be used from SI to DG.
- **Replication**
  - Based in policies.
  - Based in backupsets, will not be zero RPO between replicated ZDLRA’s.
  - Not based in dbms_schedule, tends to replicate ASAP.
  - Replicate just incremental backups.
- **Clones**
  - It is not online, it is scheduled.
  - Can have multiple schedules, backupsets, archivelogs, incrementals.
  - By default, clones the last backup but can you TAG’s to control what will be a clone.



MAXIMUM AVAILABILITY ARCHITECTURE - MAA

- Reduce planned and unplanned downtime for databases:
  - Protect from outages (planed and unplanned).

- **Application continuity**, data protection, scalable.

- **ZERO RPO and ZERO RTO.**

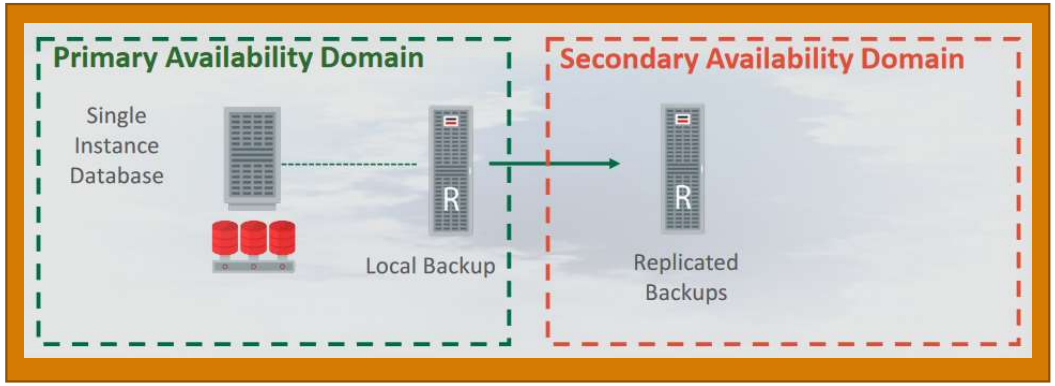
- Reference architecture for On-Premises:
  - Four architectures (Bronze, Silver, Gold, Platinum), from single instances to multi-site DG.
  - https://www.oracle.com/a/tech/docs/maa-overview-onpremise-2019.pdf
  - https://www.oracle.com/technetwork/database/availability/maa-reference-architectures-2244929.pdf

MAA

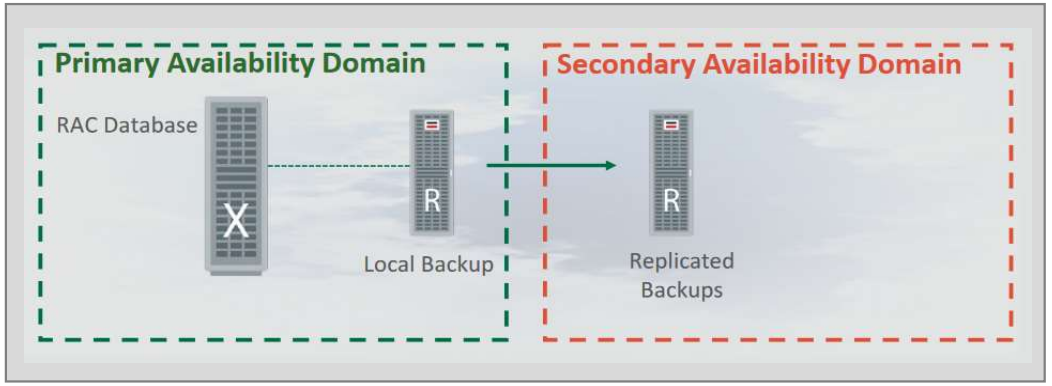
- MAA + ZDLRA:
  - Increase even more the the reliability of the environment.
  - Allows reduces RPO to zero in all architectures.
  - Protects for simultaneous failures/outages. Including at multiple sites at same time.
  - **Think BIG**.
  - **Today there is no MAA without ZDLRA.**

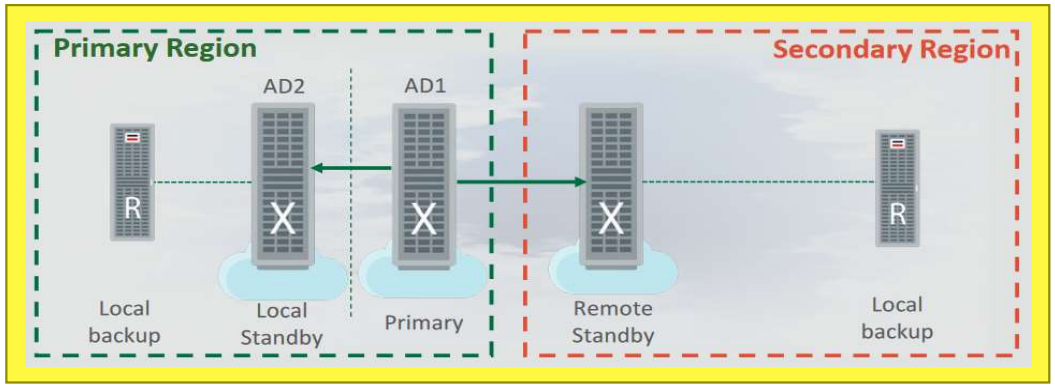
ZDLRA + MAA

Bronze

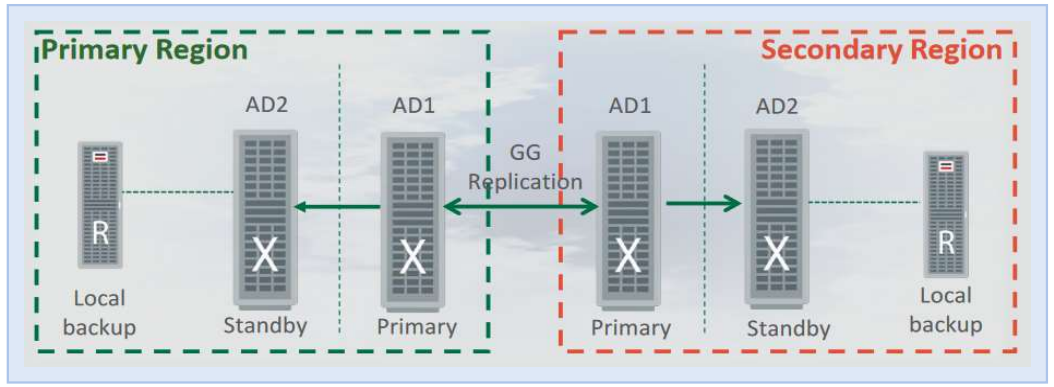


Silver





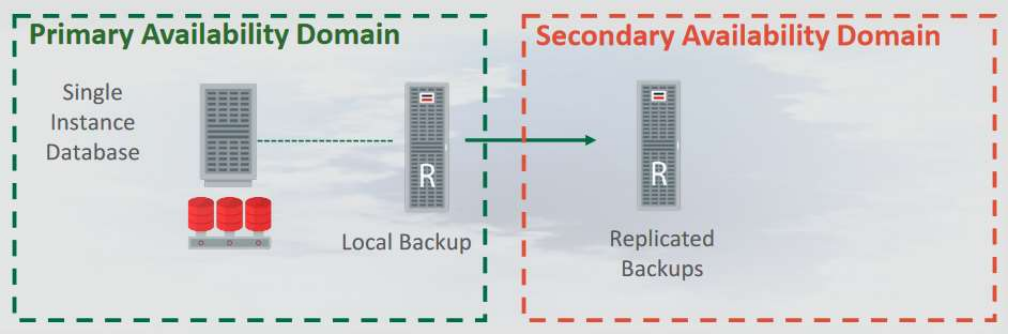
Golden



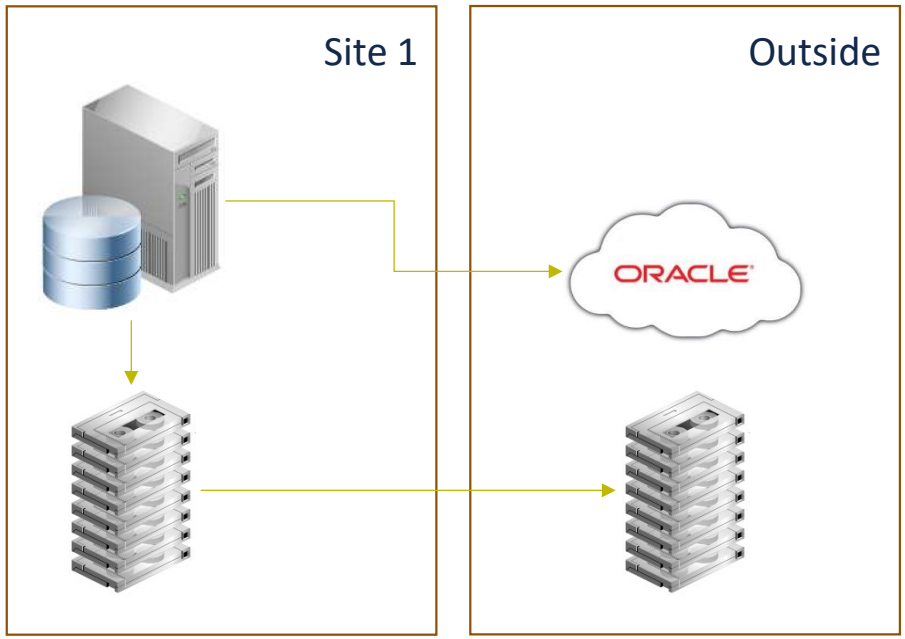
Platinum

MAA – BRONZE ARCHITECTURE

- BRONZE:
  - Where/When the restore from the last backup is enough.
  - Single instances.
  - Traditional environment:
    - Not Engineering systems. **DB + Storage.**
    - It can be more susceptible to HW errors.
  - RTO and RPO will not be Zero:
    - RPO can be zero with ZDLRA:
      - Not from a complete site outage (like fire/water).
  - **With ZDLRA you can have ZERO RPO and multi-site protection for a Standard Edition.**

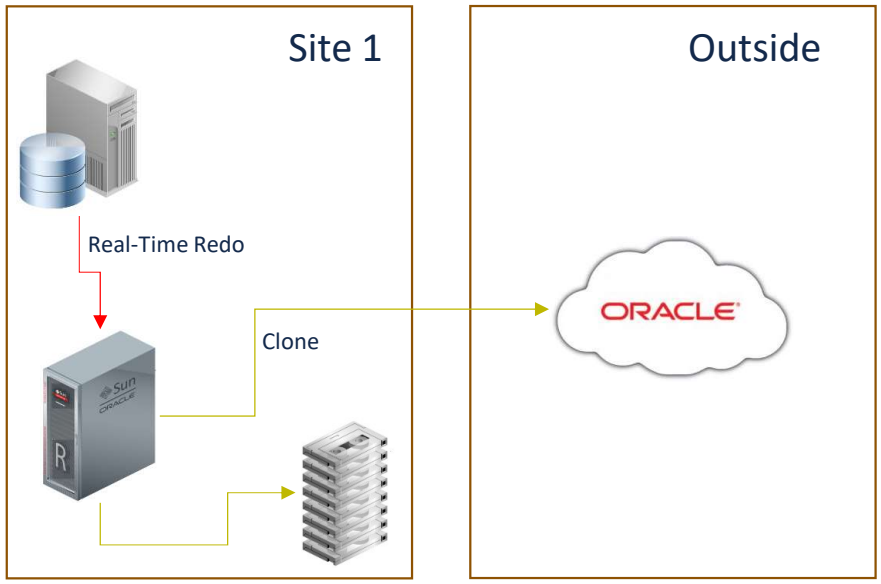


MAA – BRONZE ARCHITECTURE

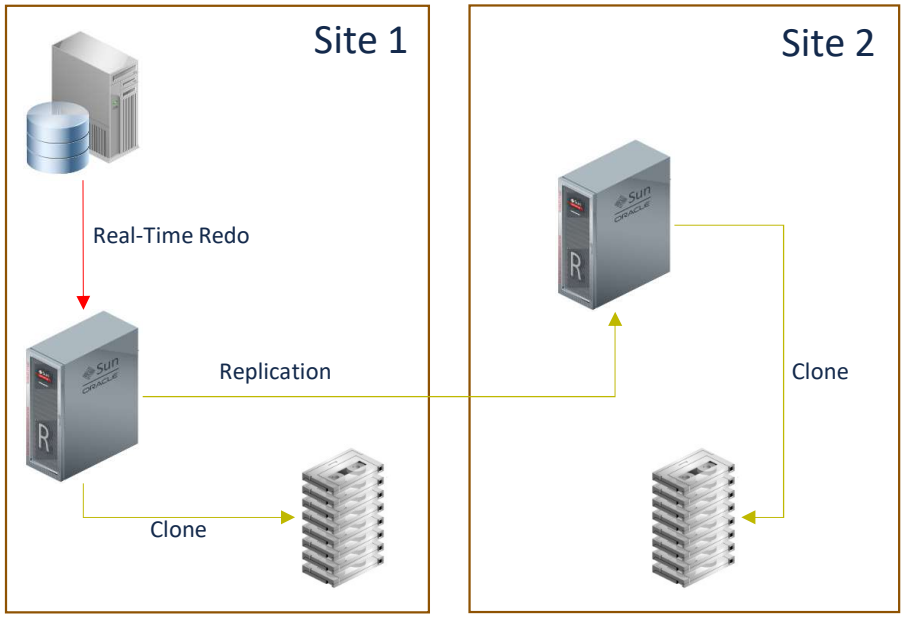


Event	RPO	RTO
Hardware error	> Zero	> Zero
Database Error (SW)	Zero	> Zero
Data Corruption	Since last backup	> Zero
Site Outage	Can be > then Zero	> Zero

MAA – BRONZE ARCHITECTURE + ZDLRA

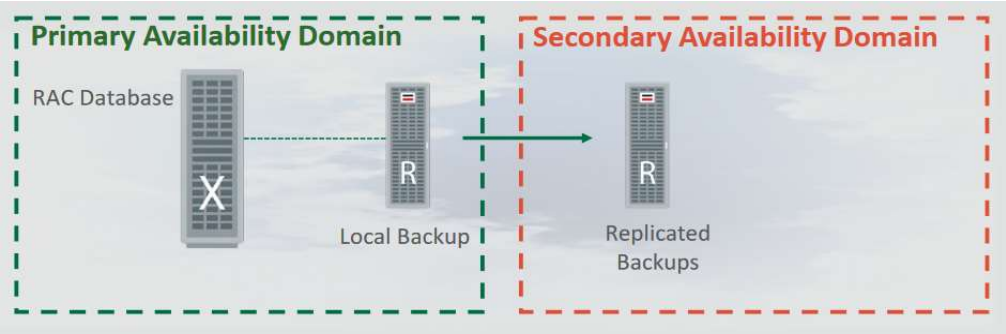


Event	RPO	RTO
Hardware error	**Zero**	> Zero
Database Error (SW)	Zero	> Zero
Data Corruption	**Zero**	> Zero
Site Outage	**Can be Zero**	> Zero

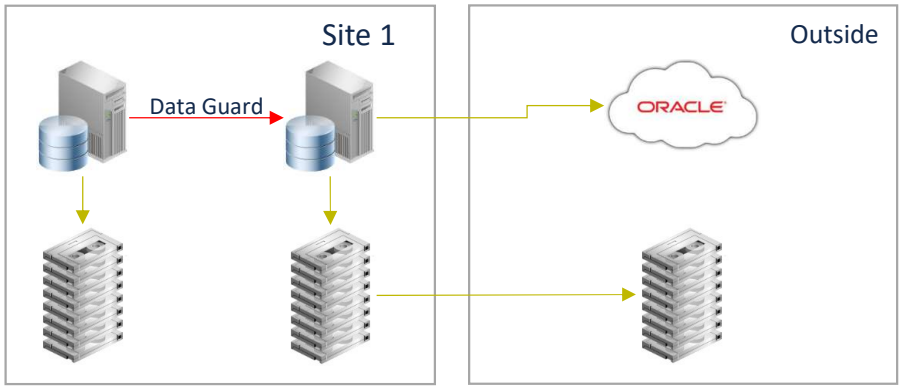


MAA – SILVER ARCHITECTURE

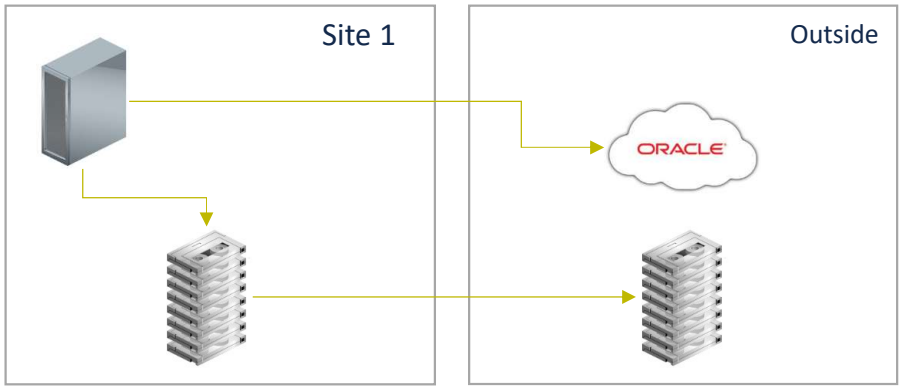
- SILVER:
  - **Start focus on Application Continuity.**
  - RAC or Single instance (With DG).
  - Two patterns for HA:
    - Traditional environment, but with DG:
      - Not Engineer systems.
      - Can be more susceptible to HW errors.
    - Engineer systems, RAC.
  - RTO can reach zero and RPO will not be Zero:
    - RPO can be zero with ZDLRA.



MAA – SILVER ARCHITECTURE

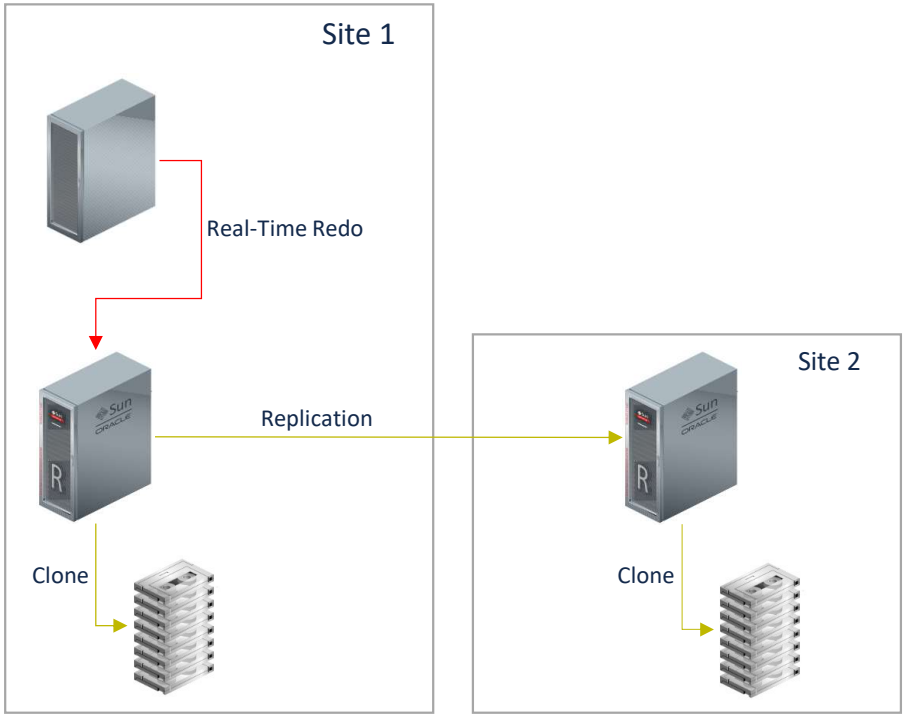


Event	RPO	RTO
Hardware error	Zero	Zero
Database Error (SW)	Zero	Can be Zero
Data Corruption	Zero	Zero
Site Outage	Can be > then Zero	> Zero



Event	RPO	RTO
Hardware error	Zero*	Can be Zero
Database Error (SW)	Zero	Can be Zero
Data Corruption	Since last backup	> Zero
Site Outage	Can be > then Zero	> Zero

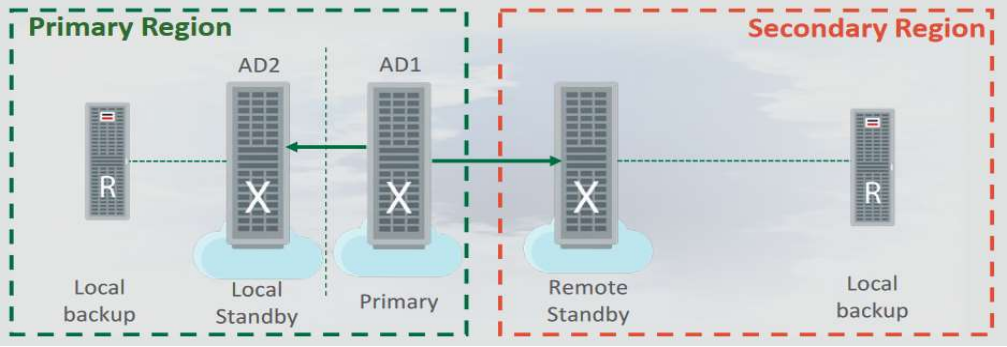
MAA – SILVER ARCHITECTURE + ZDLRA

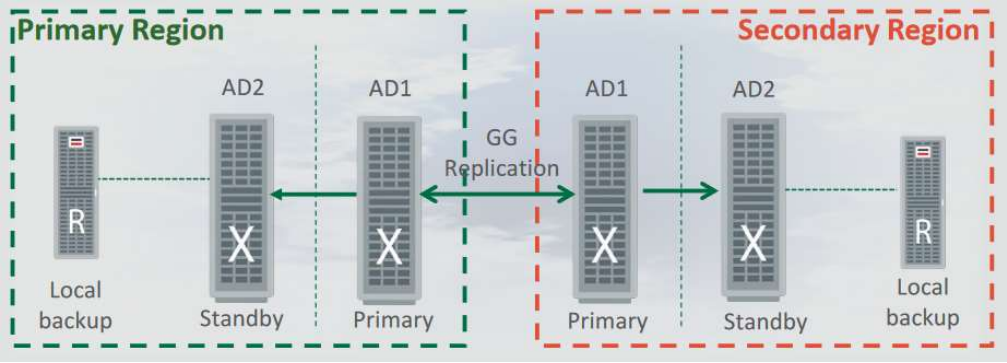


Event	RPO	RTO
Hardware error	**Zero**	Zero
Database Error (SW)	Zero	Can be Zero
Data Corruption	**Zero**	> Zero
Site Outage	**Can be Zero***	> Zero

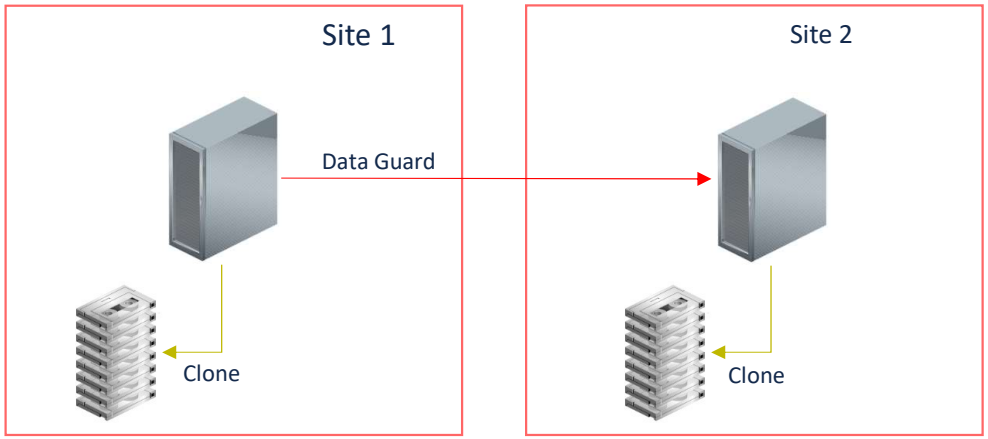
MAA – GOLD AND PLATINUM

- GOLD and PLATINUM:
  - Focus in Application Continuity.
  - Multi Site, Data Guard, and Engineered systems.
  - Golden not protect for simultaneous outages.
  - Platinum adds replication intra and multi-region replication:
    - Golden Gate to reach zero RTO even for binary version upgrade.
  - RTO and RPO zero:
    - Replication is done by DG, not by ZDLRA.
    - **RPO zero depends on the DG protection.**



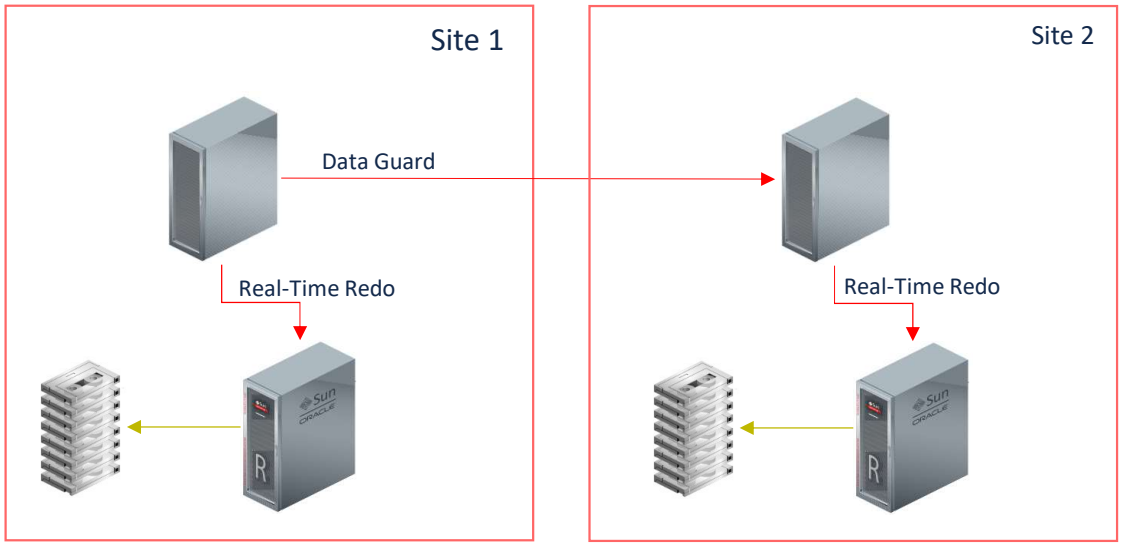


MAA - GOLD



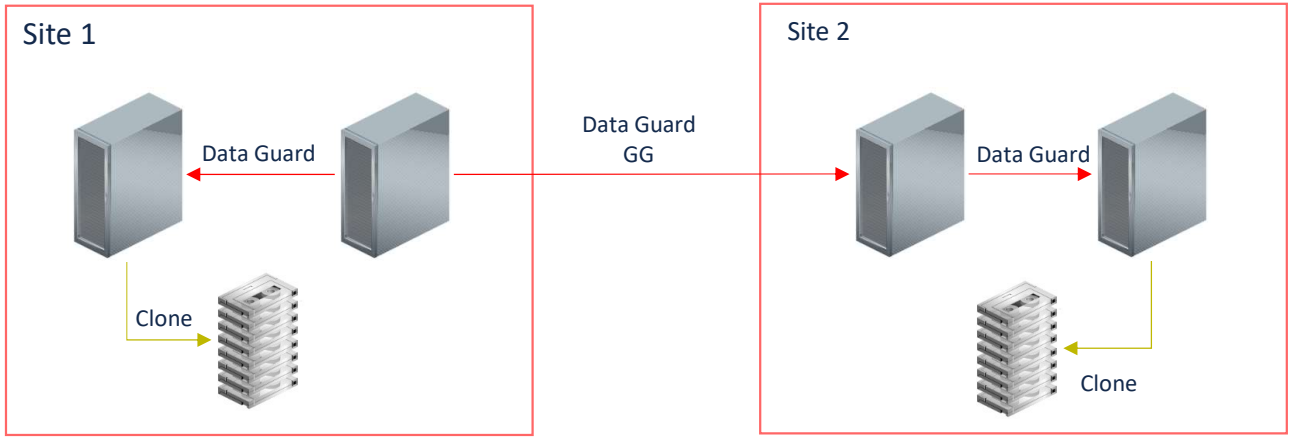
Event	RPO	RTO
Hardware error	Zero*	Zero
Database Error (SW)	Zero	Zero
Data Corruption	Zero	Zero
Site Outage	Zero	Zero

MAA – GOLD ARCHITECTURE + ZDLRA



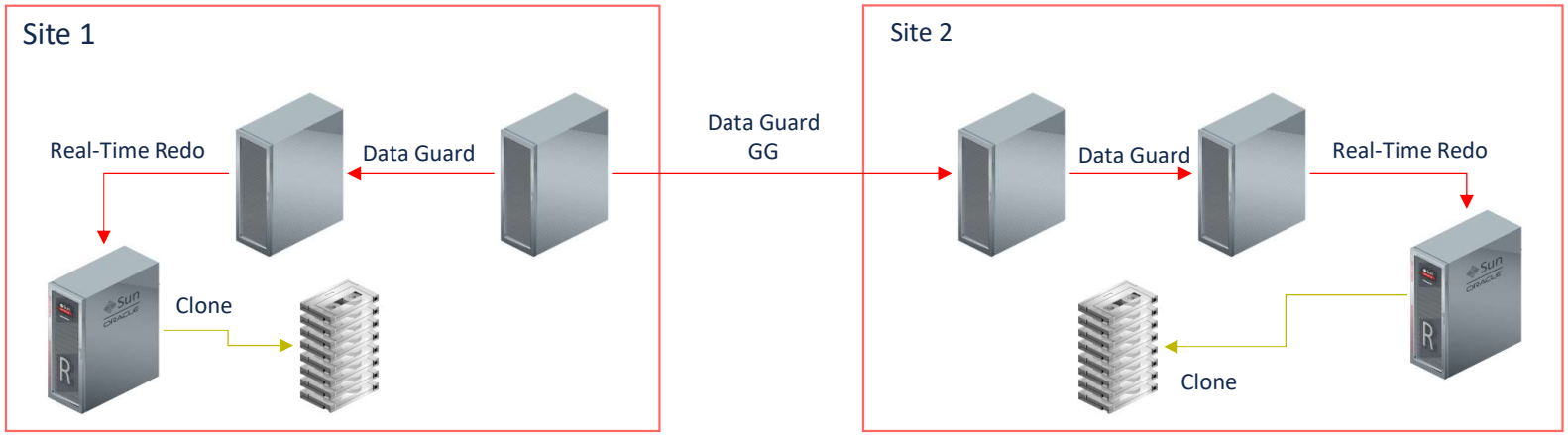
Event	RPO	RTO
Hardware error	Zero	Zero
Database Error (SW)	Zero	Zero
Data Corruption	Zero	Zero
Site Outage	Zero	Zero

MAA – PLATINUM ARCHITECTURE



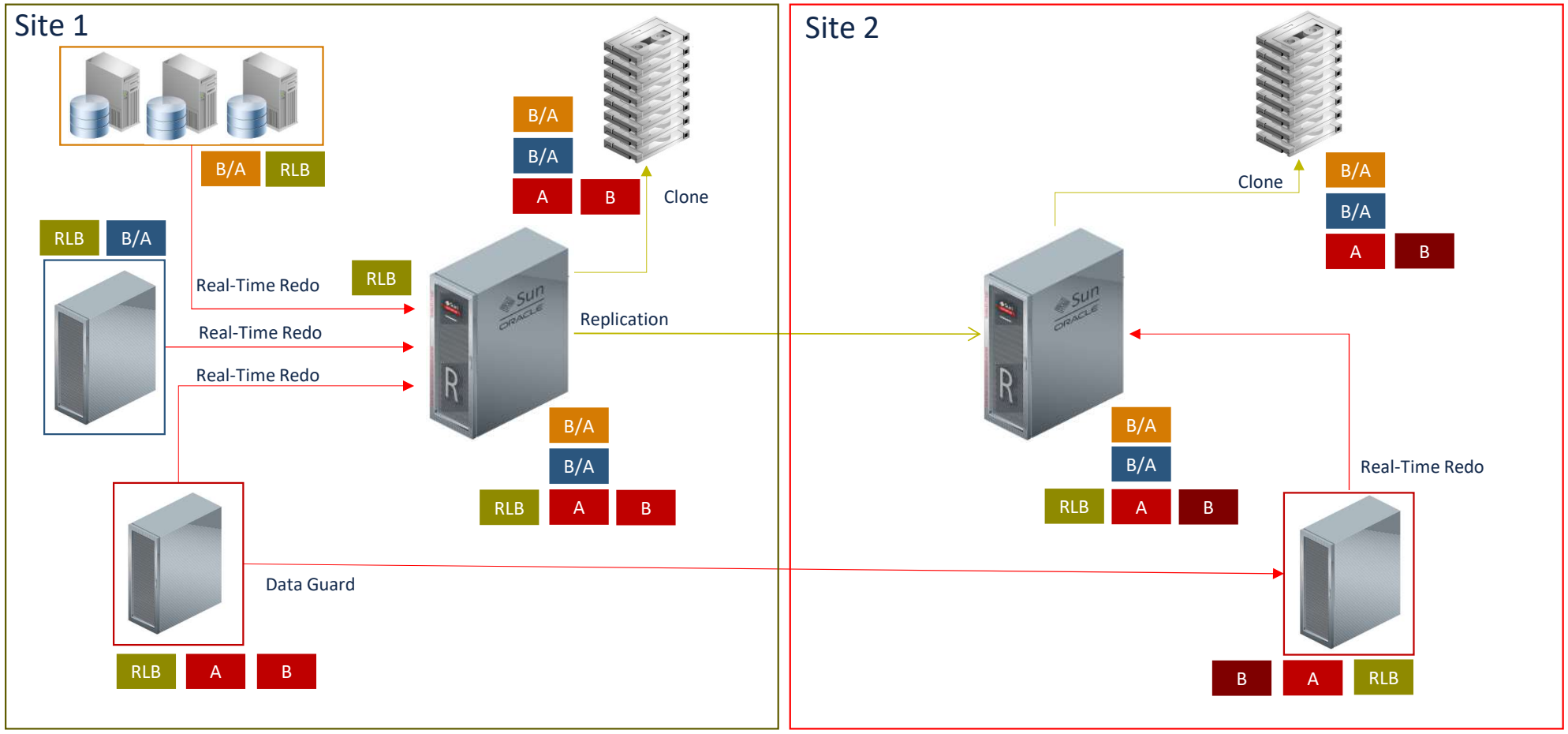
Event	RPO	RTO
Hardware error	Zero	Zero
Database Error (SW)	Zero	Zero
Data Corruption	Zero	Zero
Site Outage	Zero	Zero

MAA – PLATINUM ARCHITECTURE + ZDLRA

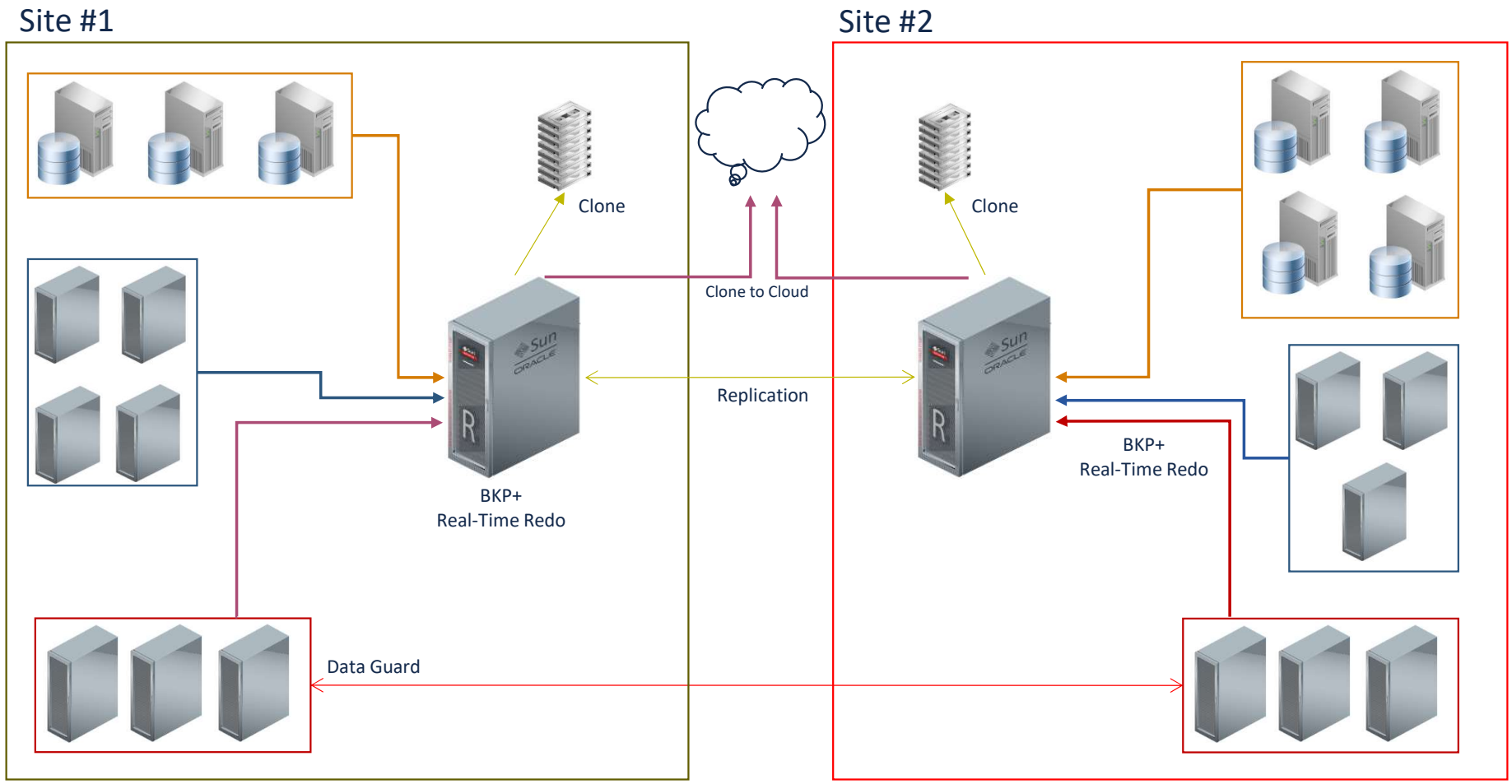


Event	RPO	RTO
Hardware error	Zero	Zero
Database Error (SW)	Zero	Zero
Data Corruption	Zero	Zero
Site Outage	Zero	Zero

MAA – BASE ARCHITECTURE + ZDLRA



MAA – EVERYTHING INTEGRATED



MAA – IS MORE THAN THIS

- If I don’t have ZDLRA?
  - Multiple Storage?
    - Multiple storage vendors?
      - Susceptive to software error?
  - DC levels:
    - T1, T2, T3, T3
  - Compliances:
    - SOC1, SOC2, SOC3, HIPAA.
  - Connection/Transaction Drain.
  - Application continuity.
  - TAF, FCF, GNS, ONS.

- Check more details at my blog:
  - ZDLRA, How to enroll a database
  - ZDLRA, Virtual Full Backup and Incremental Forever
  - ZDLRA Internals, INDEX BACKUP task in details
  - ZDLRA Internals, Virtual Full Backup
  - ZDLRA, Real-Time Redo and Zero RPO
  - ZDLRA, Multi-site protection – ZERO RPO for Primary and Standby

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