ORACLE

Protect your data efficiently! A Deep dive to Oracle MAA

Disaster and Recovery taken to another level

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, timing, and pricing of any features or functionality described for Oracle's products may change and remains at the sole discretion of Oracle Corporation.

Today's Speaker

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Discovering Oracle MAA

An Oracle reality that ensures your data availability and recoverability

Oracle HA/MAA – The Broader Picture

Designed to Address the Complete Range of Business Requirements

Common Platform – On Premises, Cloud, and Hybrid Cloud

Big Differentiator

Challenges with Disaster Recovery

Reduce Downtime

Application Downtime cause significant financial impact and reputation

Additional Infrastructure

Need to maintain additional data centers for DR purpose

Managing complexity

Complex environments with stringent RTO and RPO

Ensuring compliance

Need to comply with various regulatory guidelines

Revenue, productivity, and lost loyalty

Cost of downtime

53%
Lost revenue

47%
Lost productivity

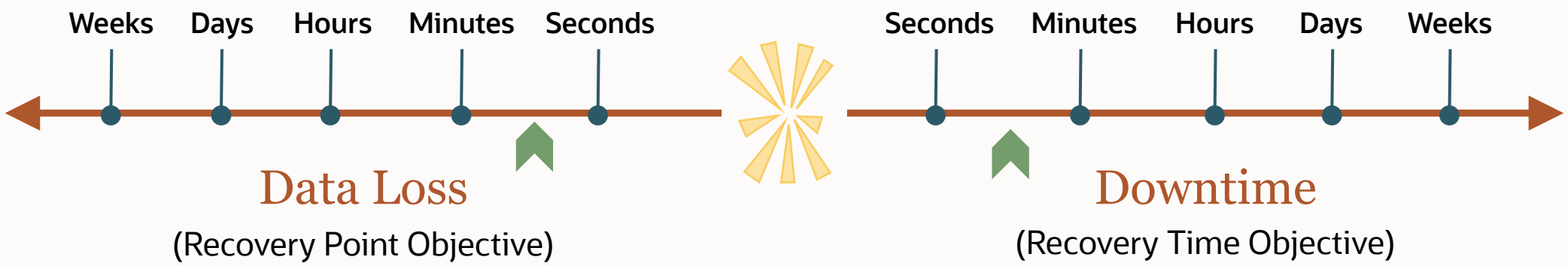
41%
Lost brand equity or trust

Which of the following costs does your organization face due to planned and unplanned downtime?"
Base: 100 IT directors in large US enterprises (Rank top 3)
Source: A commissioned study conducted by Forrester Consulting on behalf of IBM, August 2019

Data Loss? Understanding RPO and RTO

DR protects your RPO

HA protects your RTO



Recovery Point Objective (RPO)

Tolerance for data loss (sec's, hours, days); determines frequency of backups and replication approaches

Possible data loss impact

Recovery Time Objective (RTO)

The shorter the Recovery Time Objective (RTO) the quicker you get back to business

Business availability/continuity impact

Who can afford data loss?

Can your business afford data loss and any business continuity impact?

None of the businesses above can afford data loss or any impact to their business continuity!

Real life business continuity breakdowns

4-hour data center shutdown takes 2% off Wells Fargo share price

- Restoration process interrupted transactions, resulting in missing deposits
- 5500 Wells Fargo branches had to temporarily offer extended hours
- CTO departed a month later

Source: thestreet.com

Ransomware leads to cancellation of 2800 patient procedures

- Attack occurred “before the necessary work on the weakest parts of the system had been completed”
- Halted operations at three Goole NHS Foundation Trust hospitals for five days

Source: Financial Times

California DMV loses two backup systems due to outage

- Simultaneous hard drive failures in both primary and backup systems
- Impacted operations at 100 field offices
- Outage shut down operations for several days

Source: CBS Sacramento

5-hour Delta Airlines outage cost $150M

- Power outage at operations center resulted in 2000+ flight cancellations
- Critical systems failed to switch over to backups
- Many affected customers were given refunds + vouchers for future travel

Source: CNN Business

Landscape for disaster recovery has changed

ZIFF DAVIS MEDIA CIO INSIGHT 2016
Best Practices for IT Business Leaders

"Dissatisfaction with DR Solutions"

- 54% said "too expensive"
- 37% said "too difficult to use"

"After their last downtime incident"

- 55% changed DR strategy

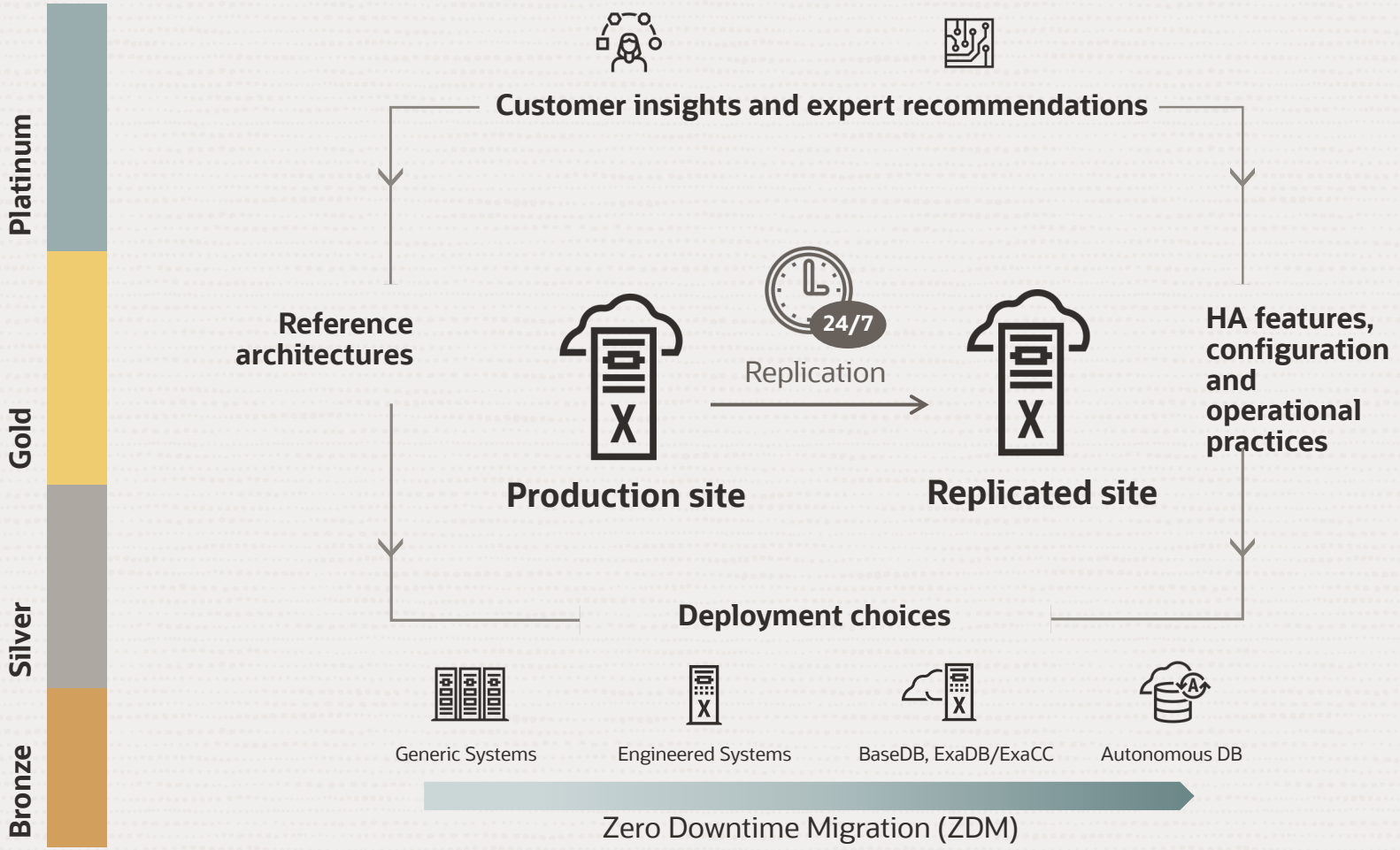
In other words – it didn't work right!

Oracle Cloud today

- Up to 56% less expensive
- Up to 50+% faster to implement
- Less risk, easier to test, scale

Oracle Maximum Availability Architecture (MAA)

Standardized Reference Architectures for Never-Down Deployments



Continuous availability

- Application Continuity
- Online Redefinition
- Edition-based Redefinition

Data protection

- Flashback
- RMAN + ZDLRA

Active replication

- Active Data Guard
- GoldenGate

Scale out & Lifecycle

- RAC
- FPP
- Sharding

MAA reference architectures

Availability service levels

Bronze	Silver	Gold	Platinum
Dev, test, prod	**Prod/departmental**	**Business critical**	**Mission critical**
Single instance DB Restartable Backup/restore	**Bronze +** Database HA with RAC Application continuity Sharding (optional)	**Silver +** DB replication with Active Data Guard	**Gold +** GoldenGate Edition-based redefinition




All tiers exist with on-premises and cloud. However, platinum currently must be configured manually while bronze to gold are covered with some form of cloud automation depending on the desired MAA architecture (i.e., multiple standby databases still must be manually configured in cloud today)

Challenges of deploying highly available systems

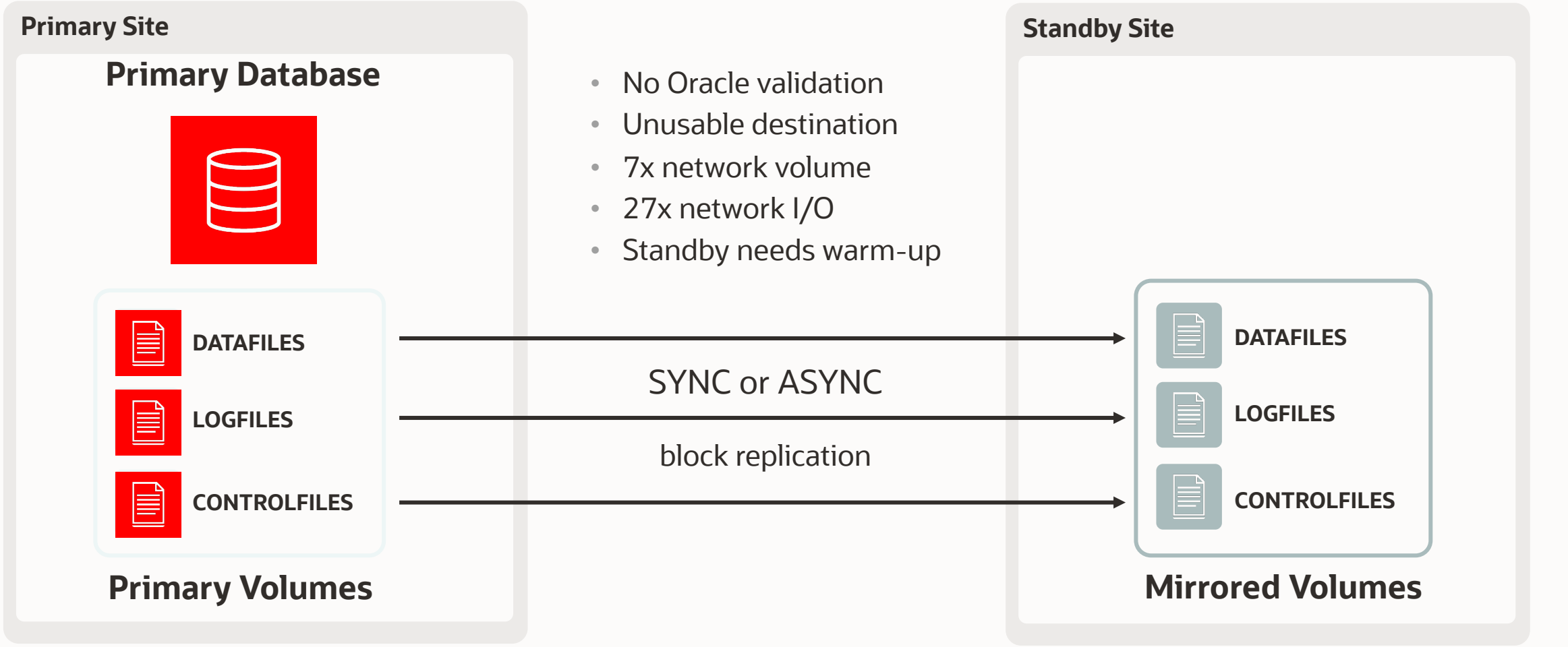
Cost and complexity

Lack of skills

Risk of failure

Storage Remote Mirroring Architecture

Mirrors every write to every file including those that are corrupted or encrypted by ransomware



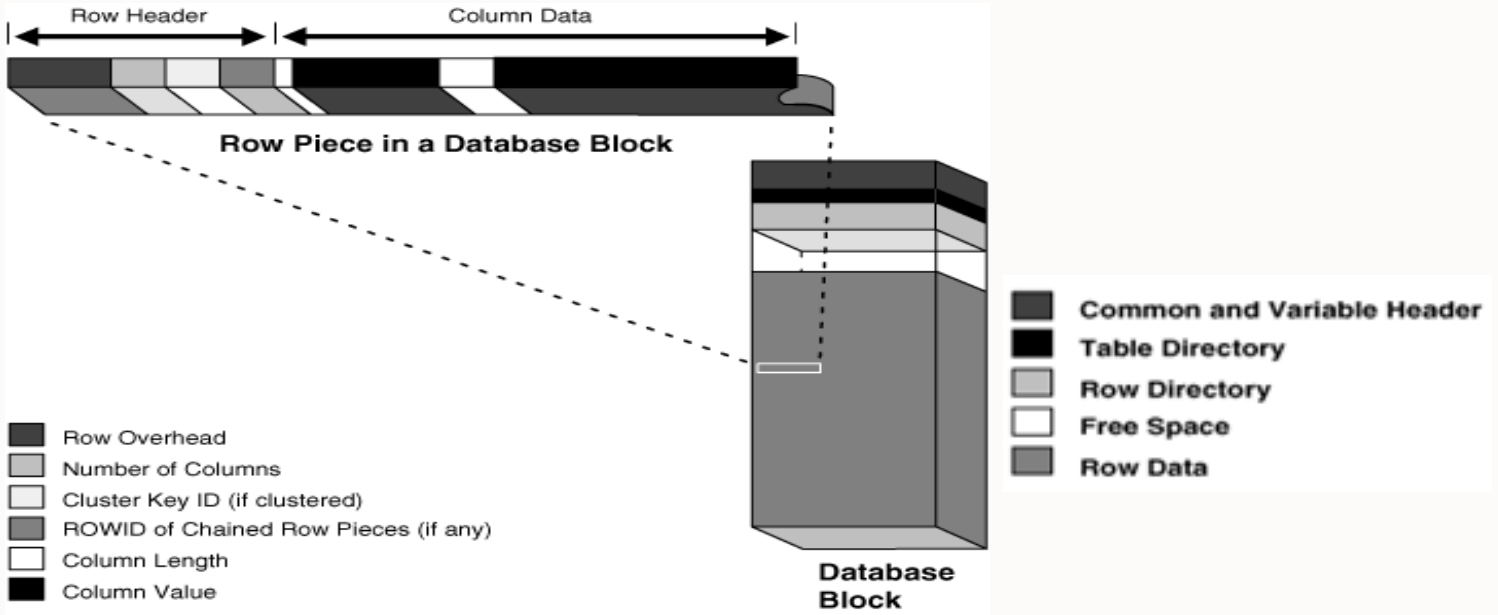
Data Guard Does What Storage Mirroring Can't

Isolate Corruption, Protect Data, Maintain Availability

Storage Remote Mirroring…
blocks are just bits on a disk

```
Block 3941 (0x0f65)
      0  1  2  3  4  5  6  7  8  9  a  b  c  d  e  f
000  20 20 20 54 77 61 73 20 74 68 65 20 6e 69 67 68
010  74 20 62 65 66 6f 72 65 20 73 74 61 72 74 2d 75
020  70 20 61 6e 64 20 61 6c 6c 20 74 68 72 6f 75 67
030  68 20 74 68 65 20 6e 65 74 2c 0a 20 20 20 20 20
040  6e 6f 74 20 61 20 70 61 63 6b 65 74 20 77 61 73
050  20 6d 6f 76 69 6e 67 3b 20 6e 6f 20 62 69 74 20
060  6e 6f 72 20 6f 63 74 65 74 2e 0a 20 20 20 54 68
070  65 20 65 6e 67 69 6e 65 65 72 73 20 72 61 74 74
080  6c 65 64 20 74 68 65 69 72 20 63 61 72 64 73 20
090  69 6e 20 64 65 73 70 61 69 72 2c 0a 20 20 20 20
0a0  20 68 6f 70 69 6e 67 20 61 20 62 61 64 20 63 68
0b0  69 70 20 77 6f 75 6c 64 20 62 6c 6f 77 20 77 69
0c0  74 68 20 61 20 66 6c 61 72 65 2e 0a 20 20 20 54
0d0  68 65 20 73 61 6c 65 73 6d 65 6e 20 77 65 72 65
0e0  20 6e 65 73 74 6c 65 64 20 61 6c 6c 20 73 6e 75
0f0  67 20 69 6e 20 74 68 65 69 72 20 62 65 64 73 2c
100  0a 20 20 20 20 20 77 68 69 6c 65 20 76 69 73 69
110  6f 6e 73 20 6f 66 20 64 61 74 61 20 6e 65 74 73
120  20 64 61 6e 63 65 64 20 69 6e 20 74 68 65 69 72
130  20 68 65 61 64 73 2e 0a 20 20 20 41 6e 64 20 49
140  20 77 69 74 68 20 6d 79 20 64 61 74 61 73 63 6f
150  70 65 20 74 72 61 63 69 6e 67 73 20 61 6e 64 20
160  64 75 6d 70 73 0a 20 20 20 20 20 70 72 65 70 61
170  72 65 64 20 66 6f 72 20 73 6f 6d 65 20 70 72 65
180  74 74 79 20 62 61 64 20 62 72 75 69 73 65 73 20
190  61 6e 64 20 6c 75 6d 70 73 2e 0a 20 20 20 57 68
1a0  65 6e 20 6f 75 74 20 69 6e 20 74 68 65 20 68 61
1b0  6c 6c 20 74 68 65 72 65 20 61 72 6f 73 65 20 73
1c0  75 63 68 20 61 20 63 6c 61 74 74 65 72 2c 0a 20
1d0  20 20 20 49 20 73 70 72 61 6e 67 20 66 72 6f
1e0  6d 20 6d 79 20 64 65 73 6b 20 74 6f 20 73 65 65
1f0  20 77 68 61 74 20 77 61 73 20 74 68 65 20 6d 61
```

Data Guard uses physical and logical
data consistency checks for end to end data integrity

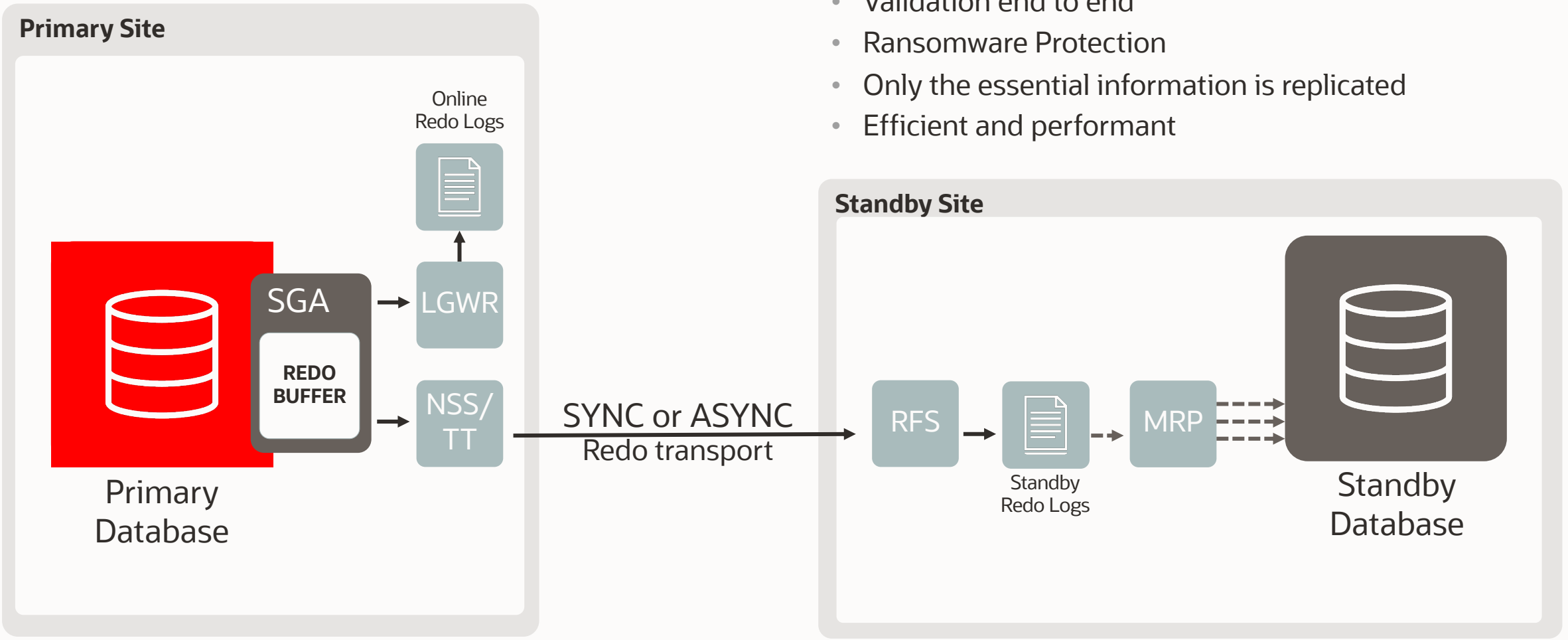


See My Oracle Support Note 1302539.1 for details

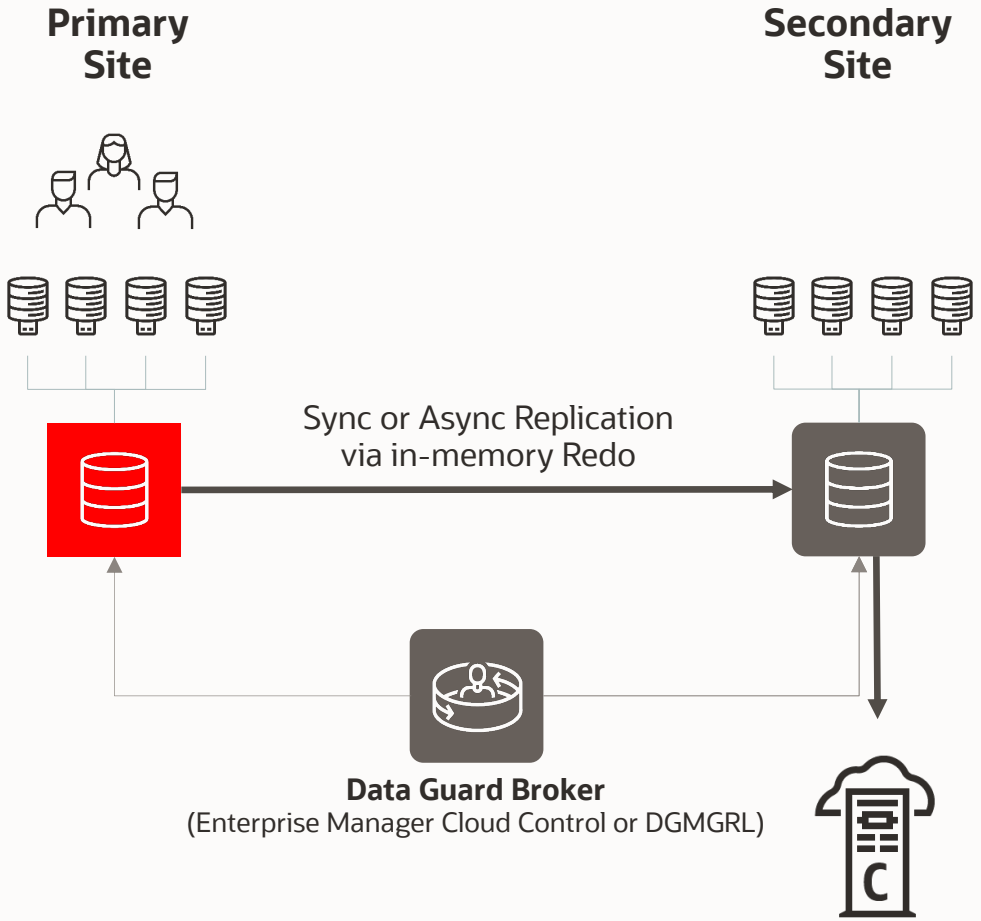
Data Guard is optimized for the database

It efficiently maintains a physical copy of production and guarantees its integrity

- Validation end to end
- Ransomware Protection
- Only the essential information is replicated
- Efficient and performant



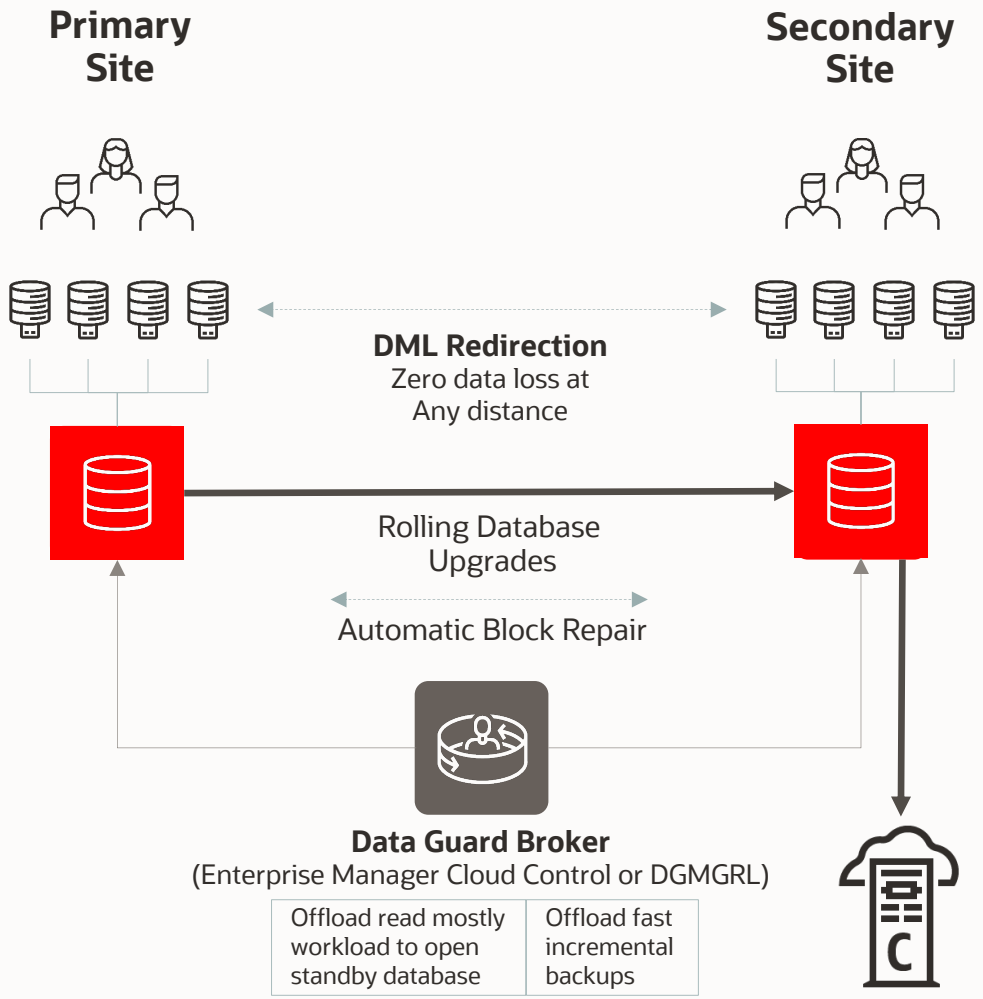
Oracle Data Guard (DG)



- **Basic DR (included with DB EE)**
  - License primary and secondary sites
- **Active-passive**
  - Standby is used only for failovers
- **Automatic failover to Standby site**
- **Zero / near-zero data loss**
- **Continuous data validation**
- **Simple migrations and upgrades**

https://www.oracle.com/database/technologies/high-availability/dataguard-activedataguard-demos.html

Oracle *Active* Data Guard (ADG)

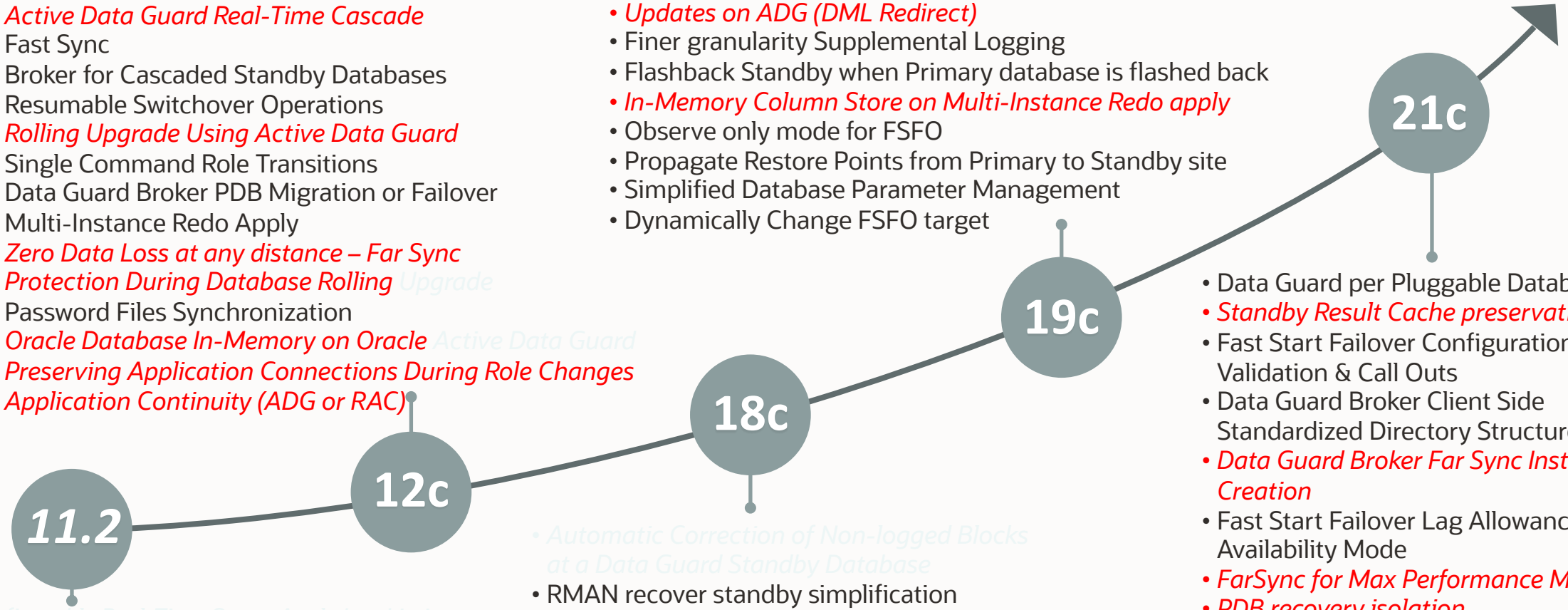


- **Advanced Disaster Recovery**
- **Active-active***
  - Queries, reports, backups
  - Occasional updates (19c)
  - Assurance of knowing system is operational
- **Automatic block repair**
- **Application Continuity**
- **Zero data loss across any distance**
- **Many other features**

https://www.oracle.com/database/technologies/high-availability/dataguard-activedataguard-demos.html

Oracle *Active* Data Guard

Actively protecting data for the future *both* on-premises and in the cloud



- *Configurable Real-Time Query Apply Lag Limit*
- Integrated Support for Application Failover
- *SPA Support for Active Data Guard Environment*
- Support Up to 30 Standby Databases

- *Active Data Guard Real-Time Cascade*
- Fast Sync
- Broker for Cascaded Standby Databases
- Resumable Switchover Operations
- *Rolling Upgrade Using Active Data Guard*
- Single Command Role Transitions
- Data Guard Broker PDB Migration or Failover
- Multi-Instance Redo Apply
- *Zero Data Loss at any distance – Far Sync*
- *Protection During Database Rolling Upgrade*
- Password Files Synchronization
- *Oracle Database In-Memory on Oracle Active Data Guard*
- *Preserving Application Connections During Role Changes*
- *Application Continuity (ADG or RAC)*

- *Automatic Correction of Non-logged Blocks at a Data Guard Standby Database*
- RMAN recover standby simplification
- Shadow Lost Write Protection
- *Transparent Application Continuity*
- *AWR reports for the standby workload*

- *Updates on ADG (DML Redirect)*
- Finer granularity Supplemental Logging
- Flashback Standby when Primary database is flashed back
- *In-Memory Column Store on Multi-Instance Redo apply*
- Observe only mode for FSFO
- Propagate Restore Points from Primary to Standby site
- Simplified Database Parameter Management
- Dynamically Change FSFO target

- Data Guard per Pluggable Database
- *Standby Result Cache preservation*
- Fast Start Failover Configuration Validation & Call Outs
- Data Guard Broker Client Side Standardized Directory Structure
- *Data Guard Broker Far Sync Instance Creation*
- Fast Start Failover Lag Allowance in Max Availability Mode
- *FarSync for Max Performance Mode*
- *PDB recovery isolation*

Oracle Data Guard Redo Transport

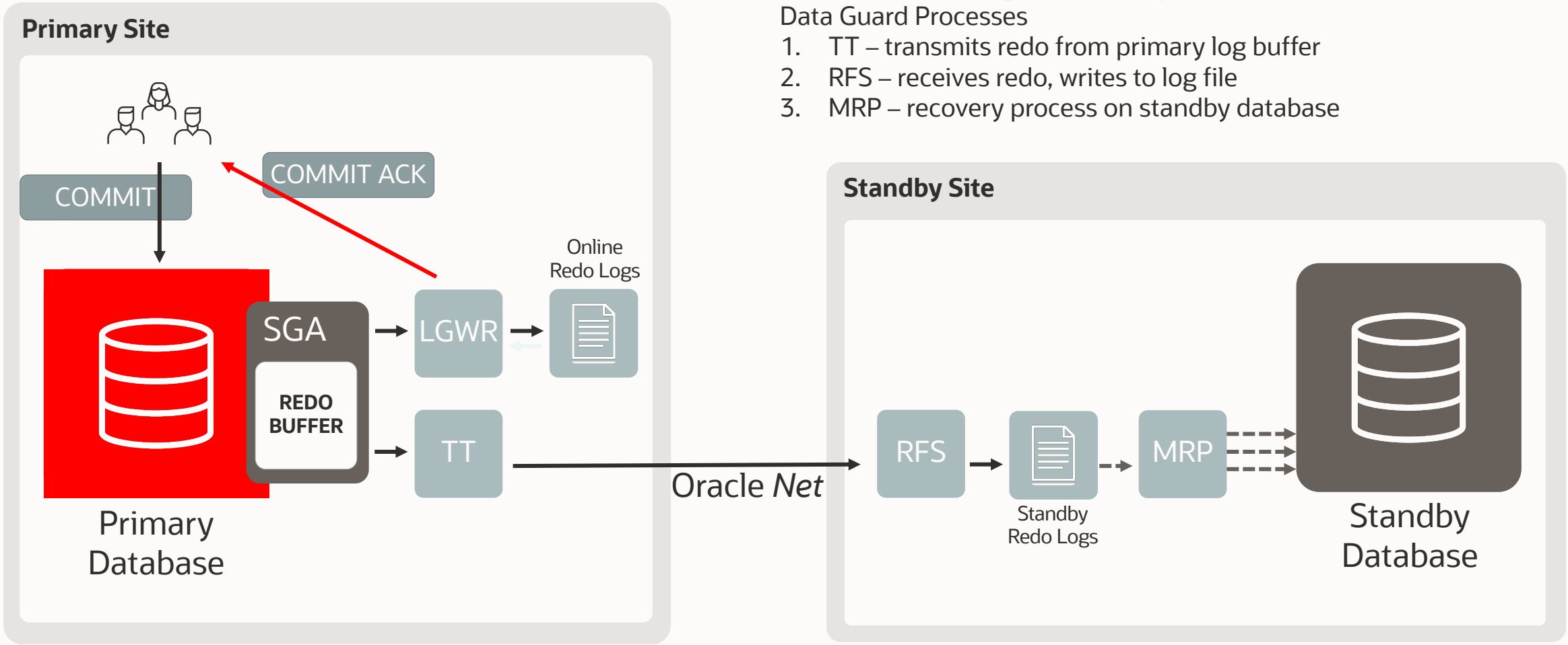
Data Guard Transport for Best Performance

Data Guard ASYNC Process Architecture

Commit Acknowledge is local-only

Data Guard Processes

1. TT – transmits redo from primary log buffer
2. RFS – receives redo, writes to log file
3. MRP – recovery process on standby database

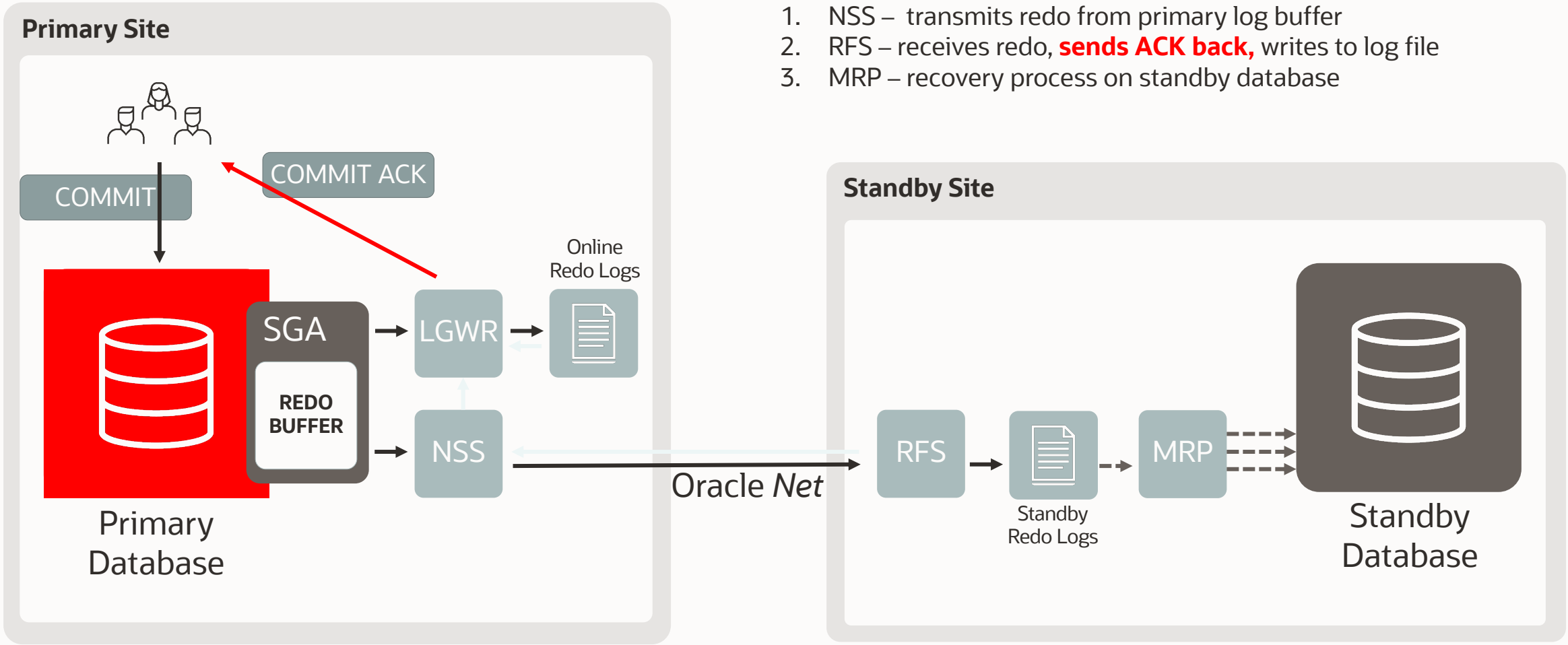


Data Guard Transport for Zero Data Loss

Data Guard FASTSYNC Process Architecture

Data Guard Processes

1. NSS – transmits redo from primary log buffer
2. RFS – receives redo, **sends ACK back,** writes to log file
3. MRP – recovery process on standby database

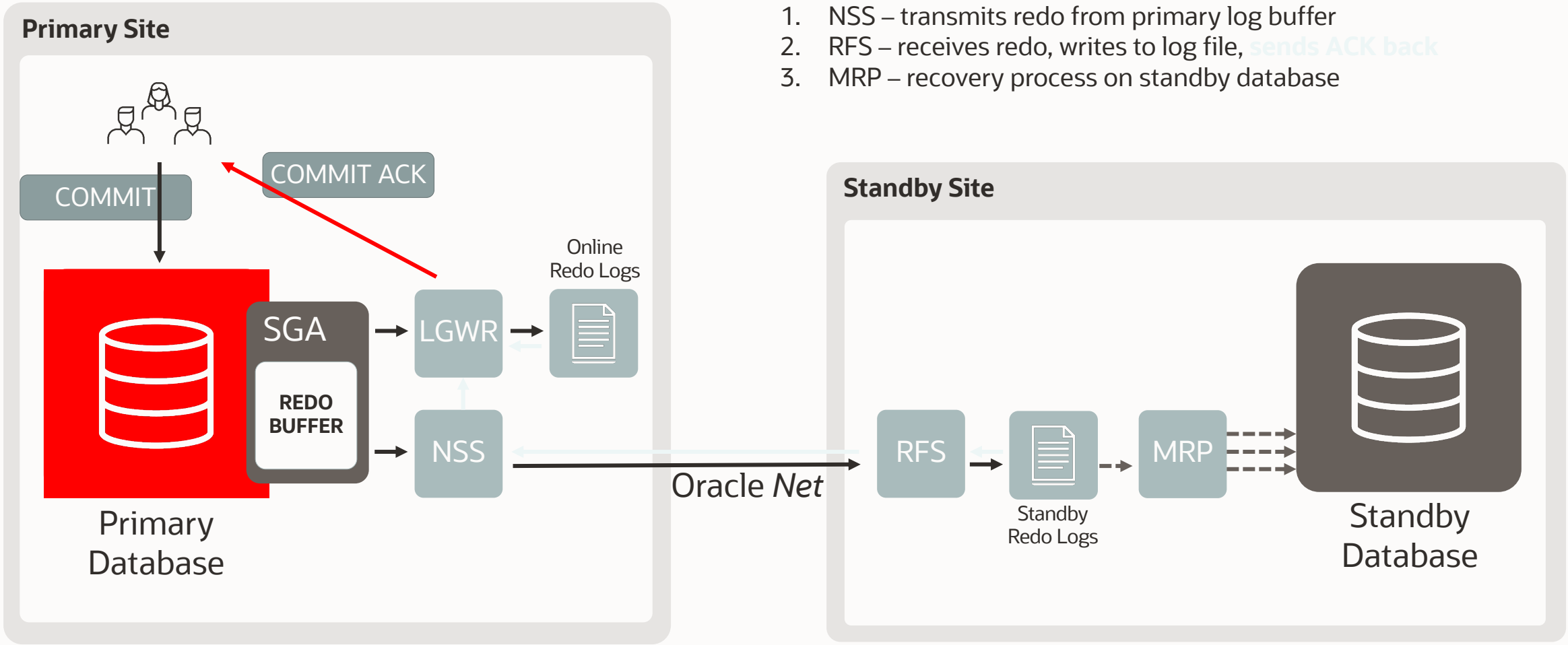


Data Guard Transport for Zero Data Loss

Data Guard SYNC Process Architecture

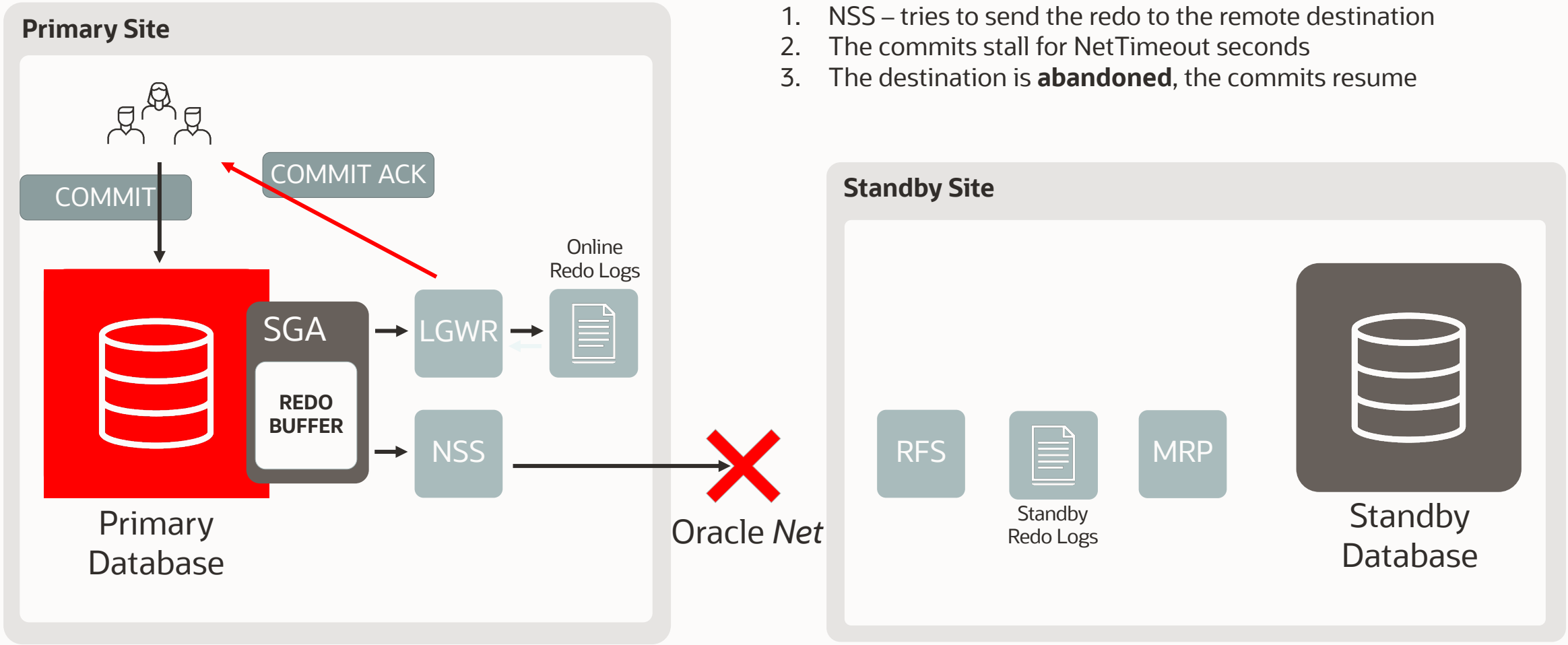
Data Guard Processes

1. NSS – transmits redo from primary log buffer
2. RFS – receives redo, writes to log file, sends ACK back
3. MRP – recovery process on standby database



Stalling Synchronous destinations

Data Guard FASTSYNC/SYNC Process Architecture



Data Guard Processes

1. NSS – tries to send the redo to the remote destination
2. The commits stall for NetTimeout seconds
3. The destination is **abandoned**, the commits resume

The difference between receiving the redo late and not receiving it

DATUM_TIME vs TRANSPORT LAG vs LAST_TIME

Standby **not receiving the redo** from the primary:

```
SQL> select value, datum_time, from v$dataguard_stats where name='transport lag';

VALUE        DATUM_TIME
------------ -------------------
+00 00:00:00 07/11/2022 08:28:46
```

Standby **receiving old redo** from the primary:

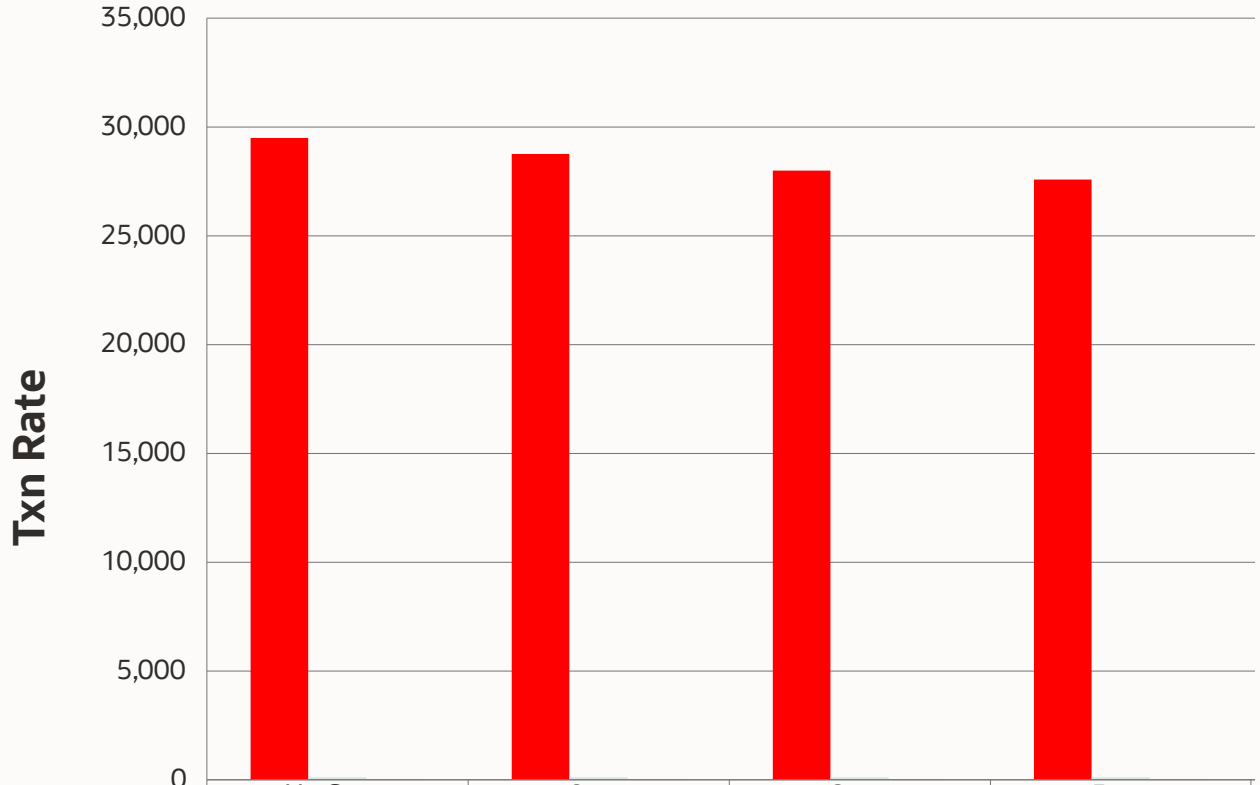
```
SQL> select value, datum_time, from v$dataguard_stats where name='transport lag';

VALUE        DATUM_TIME
------------ -------------------
+01 13:50:54 07/12/2022 21:48:10
```

The last redo written in the standby logs:

```
SQL> select max(last_time) from v$standby_log where status='ACTIVE';

MAX(LAST_TIME)
-------------------
07/11/2022 08:28:46
```

High Performance – Synchronous Redo Transport

Mixed OLTP workload with Metro-Area Network Latency



	No Sync	0ms	2ms	5ms
Txns/s	29,496	28,751	27,995	27,581
Redo Rate (MB/sec)	116	112	109	107
% Workload	100%	97%	95%	94%

Note: 0ms latency on graph represents values <1ms

Workload profile

- Swingbench OLTP plus large inserts
- **112 MB/s redo**

3% impact at < 1ms RTT

5% impact at 2ms RTT

6% impact at 5ms RTT

Use **`oratcptest`** to assess your network bandwidth and latency

Oracle Data Guard Best Practices – Transport and Apply Tuning

Redo Apply Best Practices
https://docs.oracle.com/en/database/oracle/oracle-database/19/haovw/tune-and-troubleshoot-oracle-data-guard.html#GUID-E8C27979-9D37-4899-9306-A5AE2B5CF6C0

Best Practices for Redo Transport Tuning
https://docs.oracle.com/en/database/oracle/oracle-database/19/haovw/tune-and-troubleshoot-oracle-data-guard.html#GUID-A6963335-8C5A-4DD0-AD3F-22F4CBCE3DD0

Assessing Synchronous Redo Transport
https://docs.oracle.com/en/database/oracle/oracle-database/19/haovw/tune-and-troubleshoot-oracle-data-guard.html#GUID-4C3E0CC9-3E54-48C4-8DD6-AB4EC0C51696

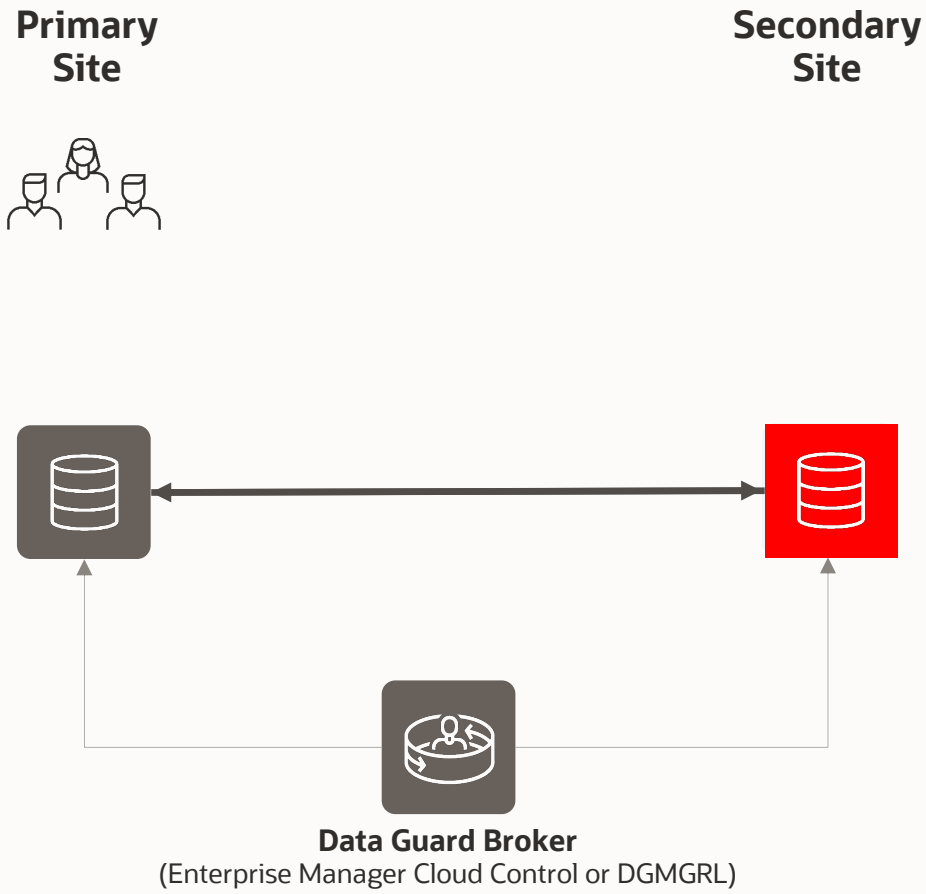
How To Calculate The Required Network Bandwidth Transfer Of Redo In Data Guard (Doc ID 736755.1)
https://support.oracle.com/rs?type=doc&id=736755.1

Assessing and Tuning Network Performance for Data Guard and RMAN (Doc ID 2064368.1)
https://support.oracle.com/rs?type=doc&id=2064368.1

Oracle Data Guard Role Transitions

Oracle Data Guard Planned Role Transition

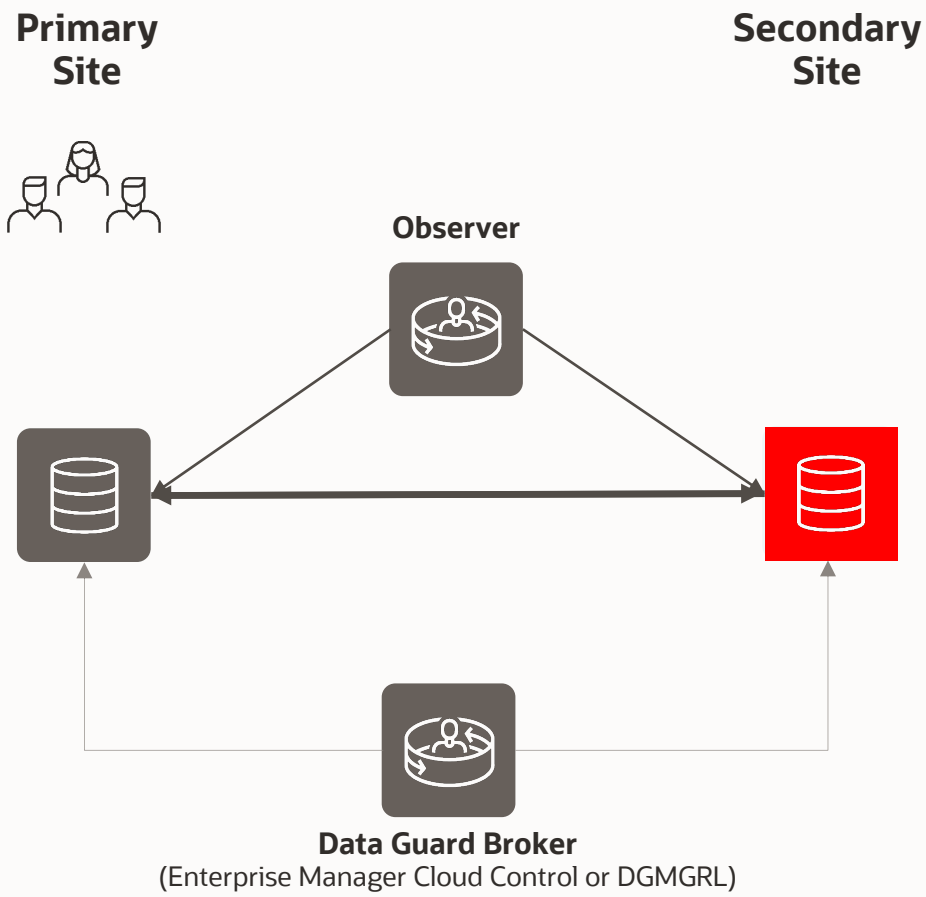
Switchover: Planned role transition with Zero Data Loss



- **Switchover initiated**
- **The primary ends the transactions and stops the services**
- **All the transaction are synced to the standby**
- **The standby is converted to primary and the services are started**
  - The replication starts again
- **The applications reconnect transparently to the new primary**
  - If properly configured, the application experience just a freeze for 1-2 minutes or less

Oracle Data Guard Unplanned Role Transition

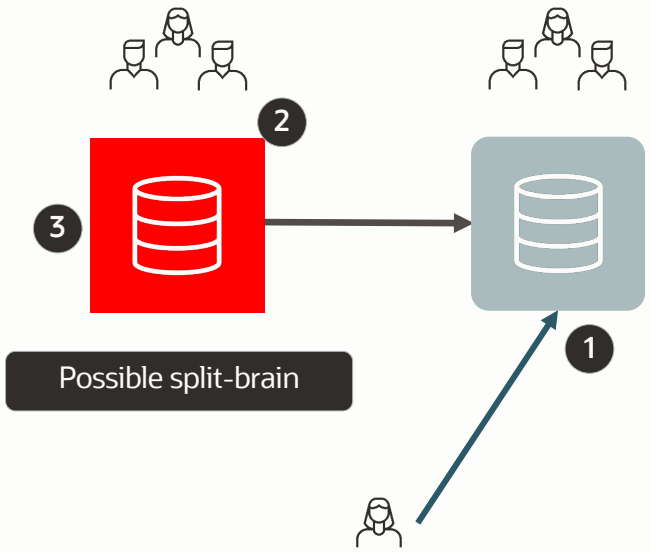
Failover: In case of failure the role transition *can* be without data loss



- **The observer detects the failure of the primary**
  - Depending on the protection mode and situation, the observer initiates the failover after `FastStartFailoverThreshold` seconds
- **The standby is converted to primary and the services are started**
  - Depending on the protection mode and situation, there might be some data loss (the tolerated amount is configurable)
- **The applications reconnect to the new primary**
  - The reinstatement of the primary requires a single broker command
- The **failover** can be initiated also **manually** (DGMGRL) or by the application (DBMS_DG.INITIATE_FS_FAILOVER) . The amount of data loss is customer's responsibility in this case.

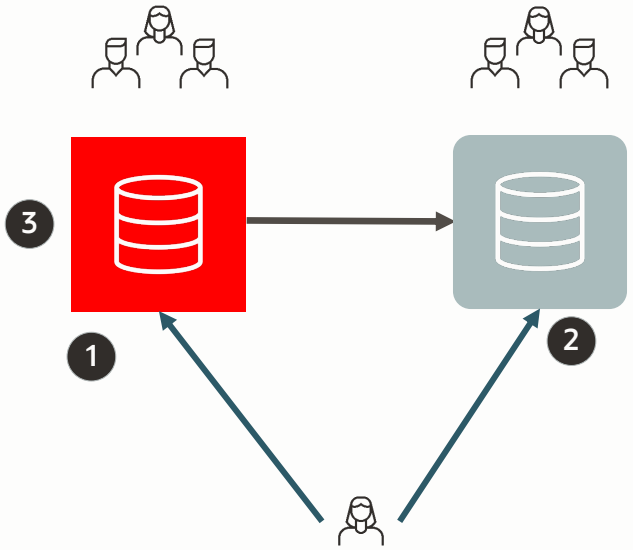
"FAILOVER TO" vs "DBMS_DG.INITIATE_FS_FAILOVER"

FAILOVER TO stdby



1. The standby database becomes the new primary
2. The former primary shuts down after **`FastStartFailoverThreshold`**
3. The former primary is reinstated automatically

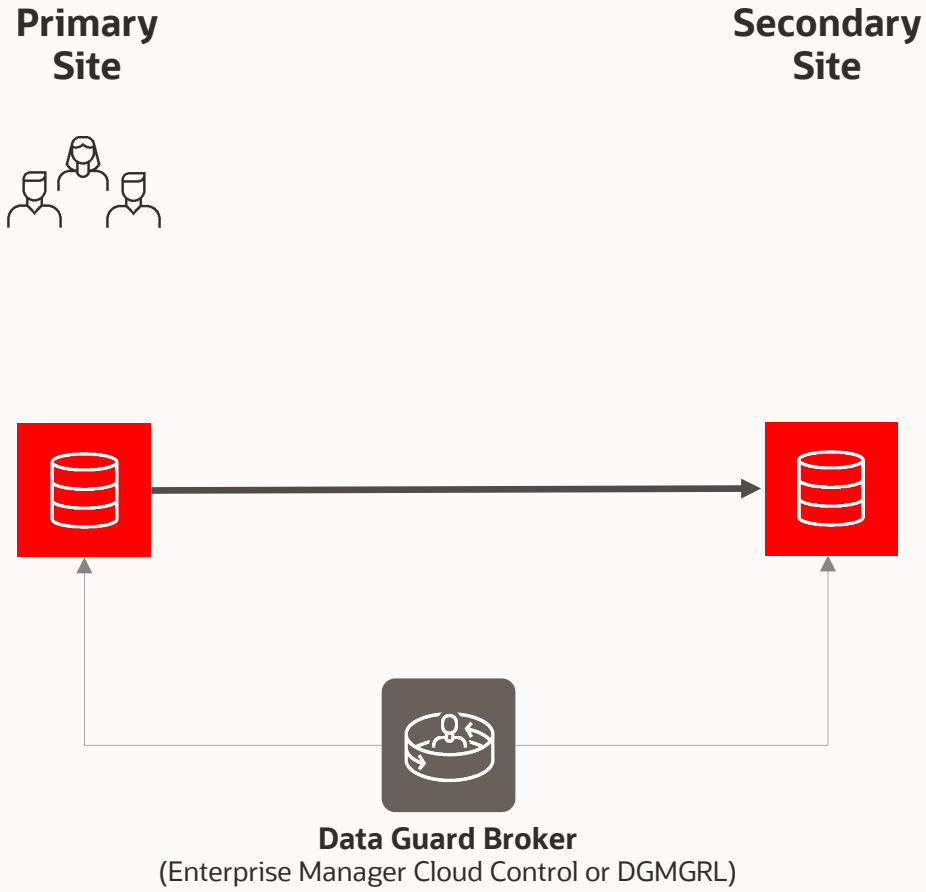
DBMS_DG.INITIATE_FS_FAILOVER



1. The procedure shuts down the primary first
2. The standby database becomes the new primary
3. The former primary is not reinstated

Data Guard Snapshot Standby

Standby database temporarily in Read Write



- **The standby is converted to Snapshot Standby**
  - Standby open read write
- **Users and DBAs perform tests (Upgrade, Performance, etc)**
  - The primary is still protected by the redo transfer
- **When the tests are over, the standby is flashed back and converted to physical standby again**
- Note: the snapshot standby cannot relay the redo to a cascaded standby

Oracle Data Guard Role Transitions – Read More

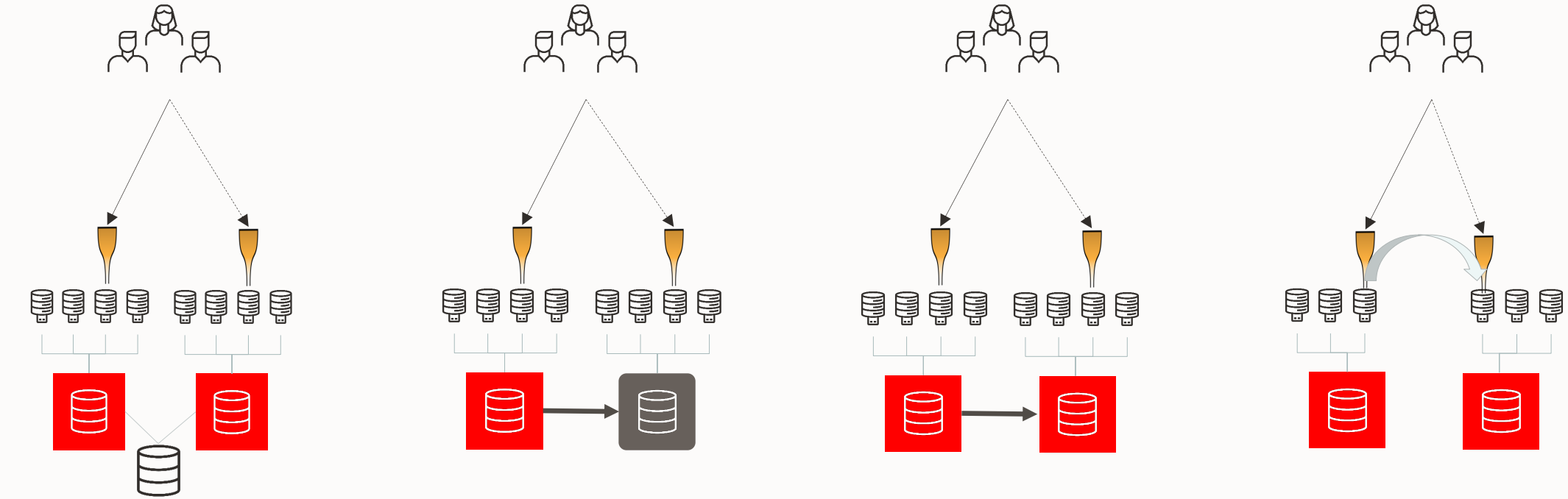
Role Transition Assessment and Tuning
https://docs.oracle.com/en/database/oracle/oracle-database/19/haovw/tune-and-troubleshoot-oracle-data-guard.html#GUID-CBA9FC61-9894-4D62-9569-EFBD7960267F

Client Failover and Application Continuity

Services for Location Transparency and High Availability

Services provide a “dial in number” for your application

- Use Custom services with FAN notifications and Application Continuity
- Regardless of location, application keeps the name!
- Client failover best practices across the Oracle technology stack



Real Application Clusters | Active Data Guard | GoldenGate | PDB Relocation

Connections Appear Continuous

Standard for All Drivers from 12.2

Automatic retries until the service is available

```
HR = (DESCRIPTION =
  (CONNECT_TIMEOUT=120)(RETRY_COUNT=50)(RETRY_DELAY=3)
  (TRANSPORT_CONNECT_TIMEOUT=3)
  (ADDRESS_LIST =
    (LOAD_BALANCE=on)
    (ADDRESS=(PROTOCOL=TCP)(HOST=cluster1-scan)(PORT=1521)))
  (ADDRESS_LIST =
    (LOAD_BALANCE=on)
    (ADDRESS=(PROTOCOL=TCP)(HOST=cluster2-scan)(PORT=1521)))
  (CONNECT_DATA=(SERVICE_NAME = HR.oracle.com)))
```

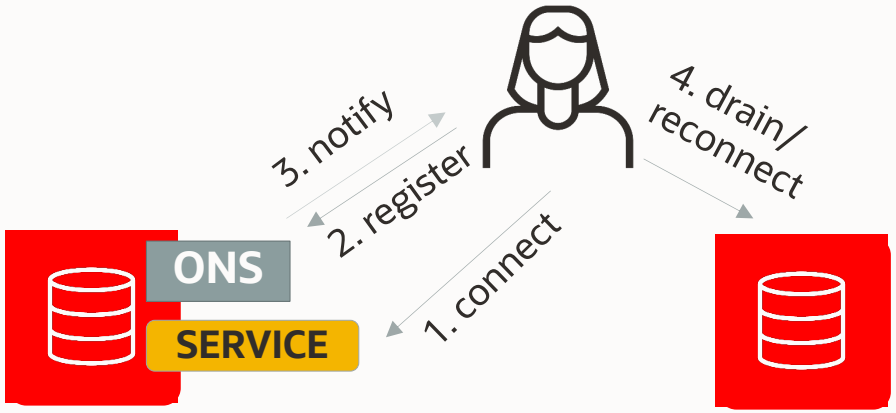
Always use a custom service!
Do NOT use PDB or DB Name

Client-side required technologies

Client draining/failover is a crucial part of high availability for applications connecting to the database.

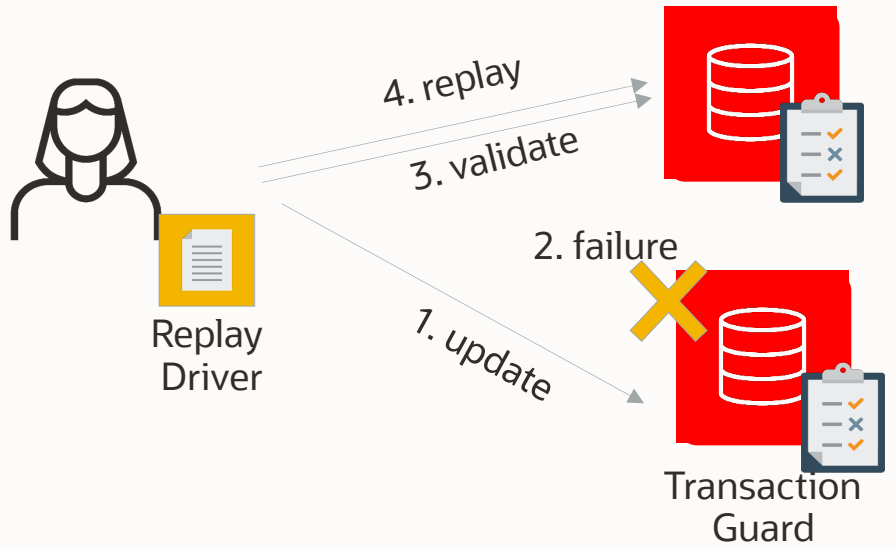
PLANNED MAINTENANCE

Fast Application Notification
(Session Draining)



UNPLANNED MAINTENANCE

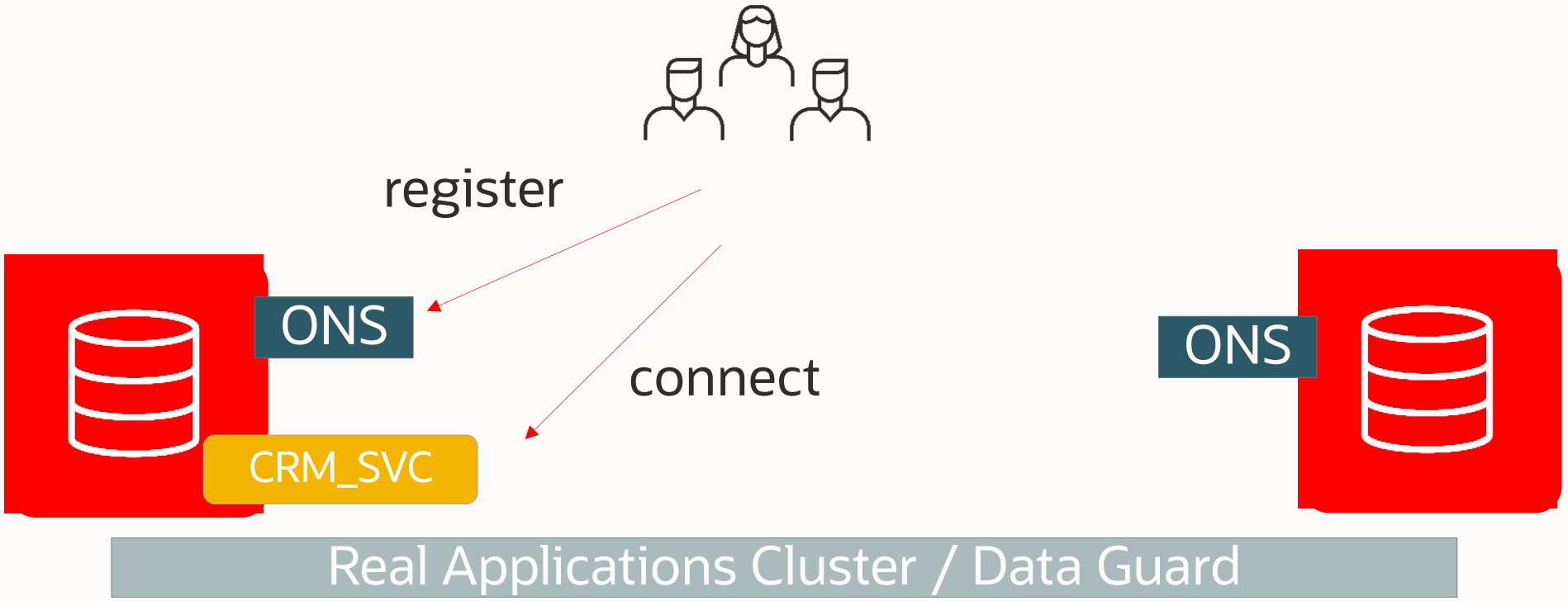
Application Continuity [1]
(Transaction Replay)



[1] Application Checklist for Continuous Service for MAA Solutions
https://www.oracle.com/technetwork/database/clustering/checklist-ac-6676160.pdf

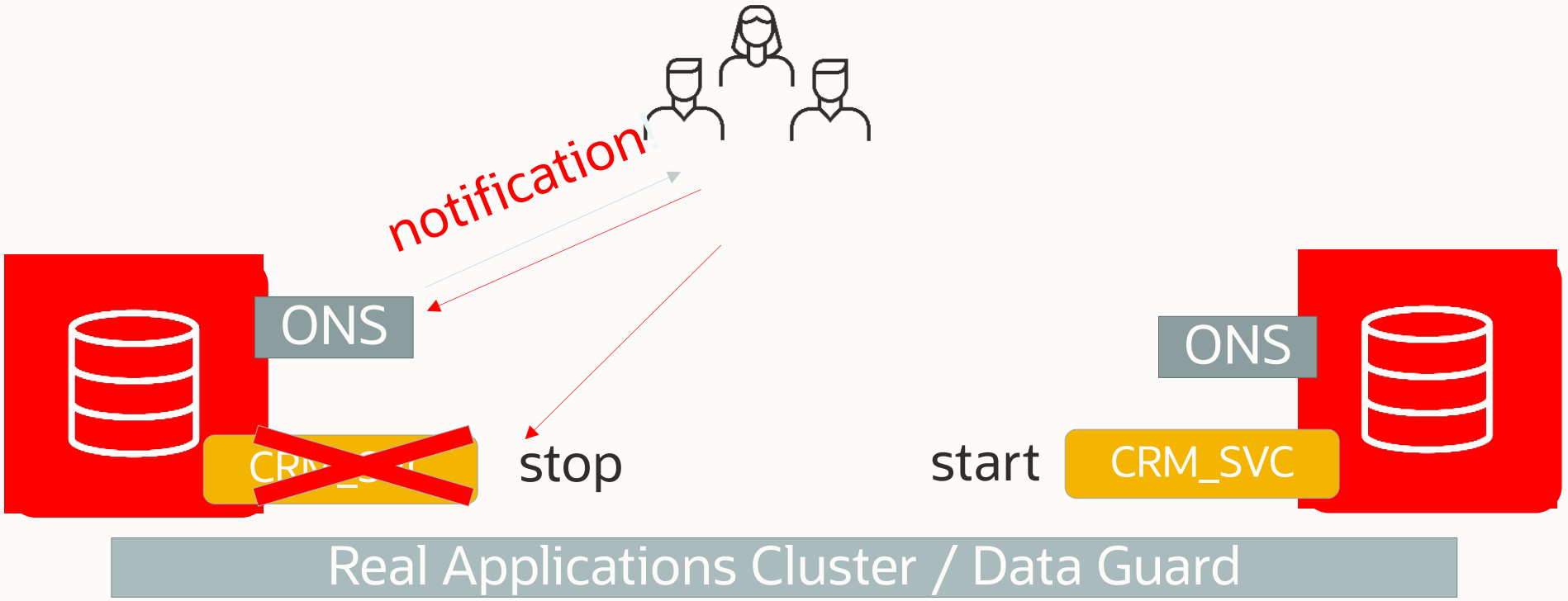
Fast Application Notification

Session Draining for planned maintenance



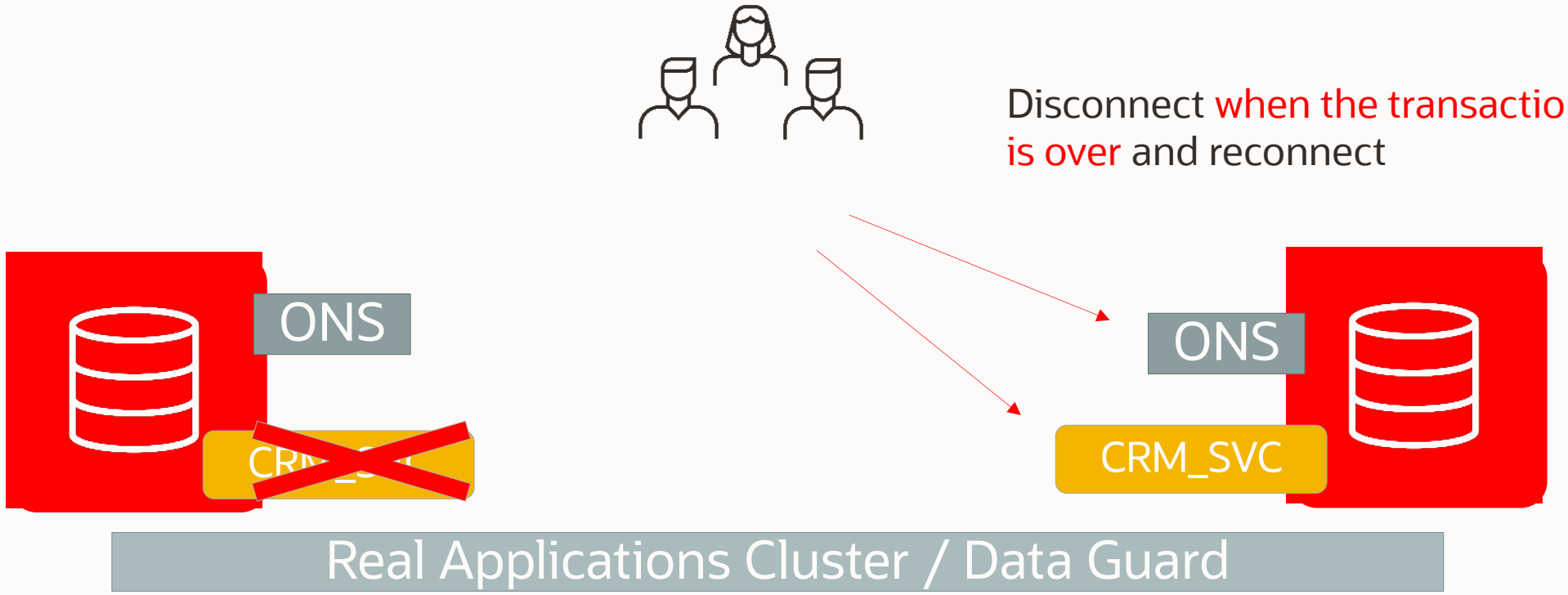
Fast Application Notification

Session Draining for planned maintenance



Fast Application Notification

Session Draining for planned maintenance



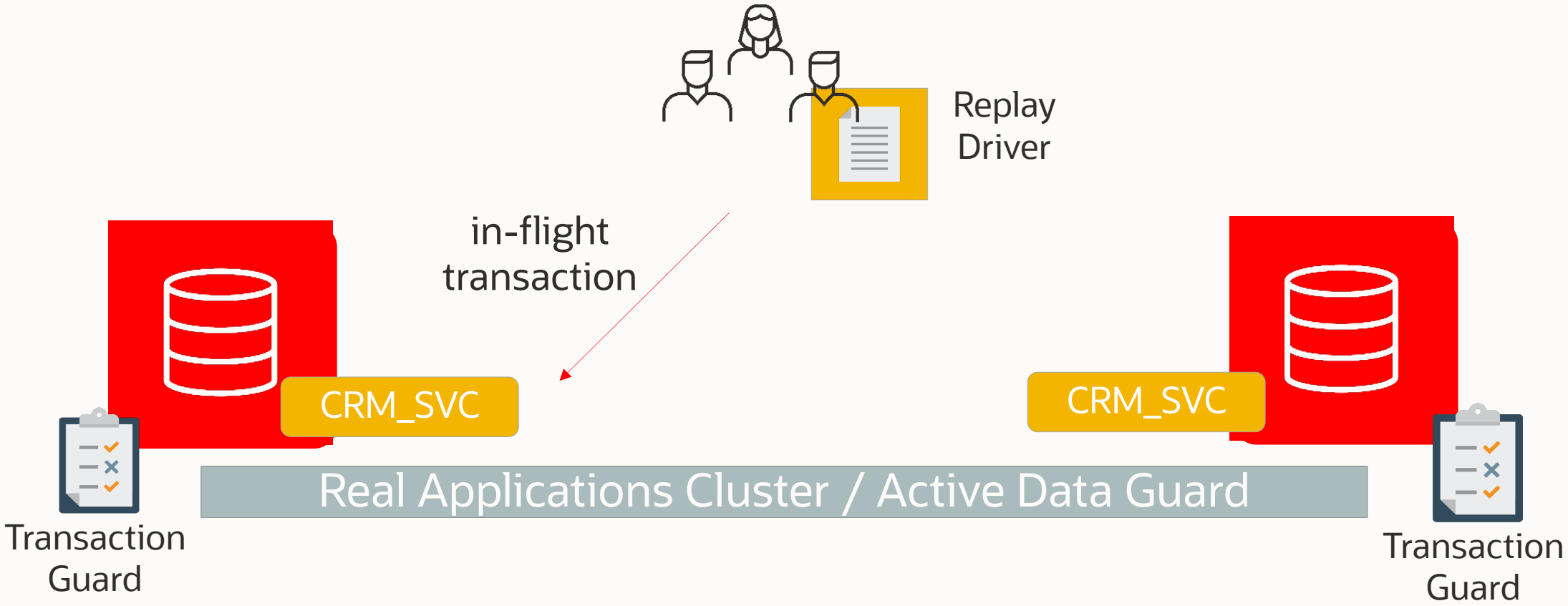
Fast Connection Failover (FCF)

FAN integrated in connection pools

- Pre-configured FAN integration
- Uses connection pools
- The application must be pool aware
  - (borrow/release)
- The connection pool leverages FAN events to:
  - Remove quickly dead connections on a DOWN event
  - (opt.) Rebalance the load on a UP event

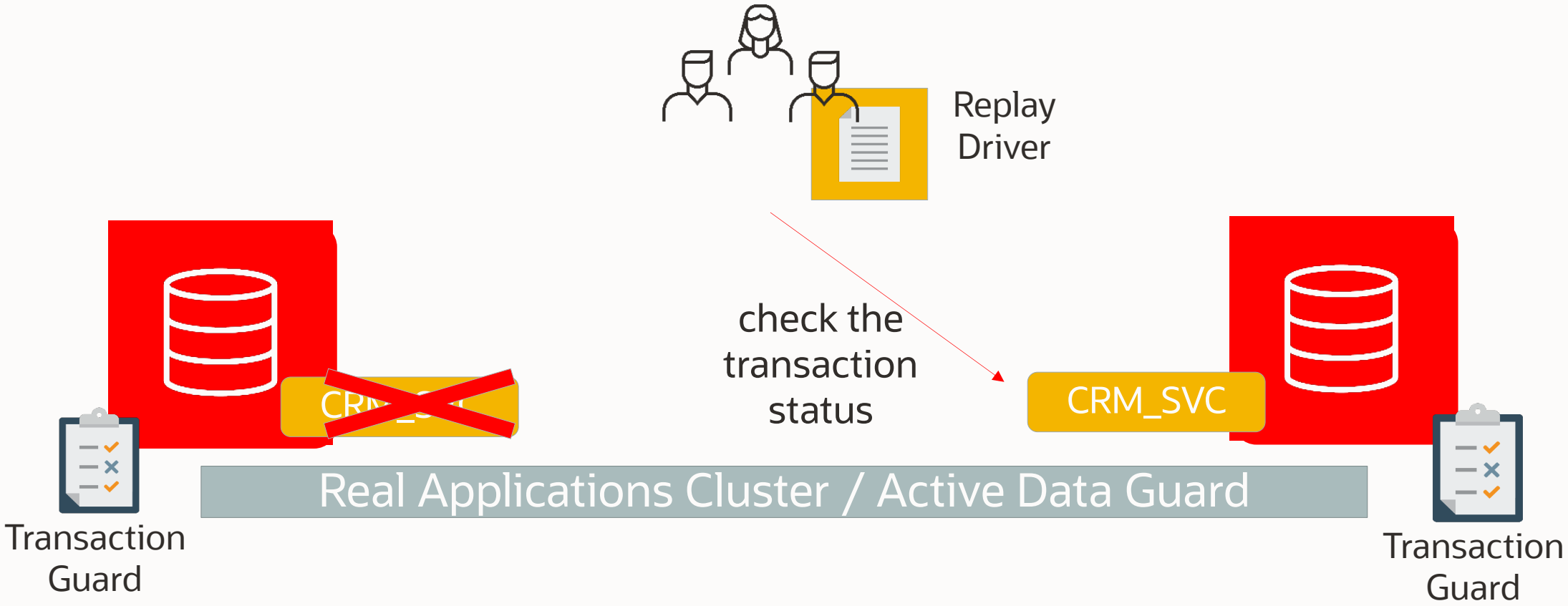
Application Continuity (AC)

Protects the in-flight transaction from failures and disconnections



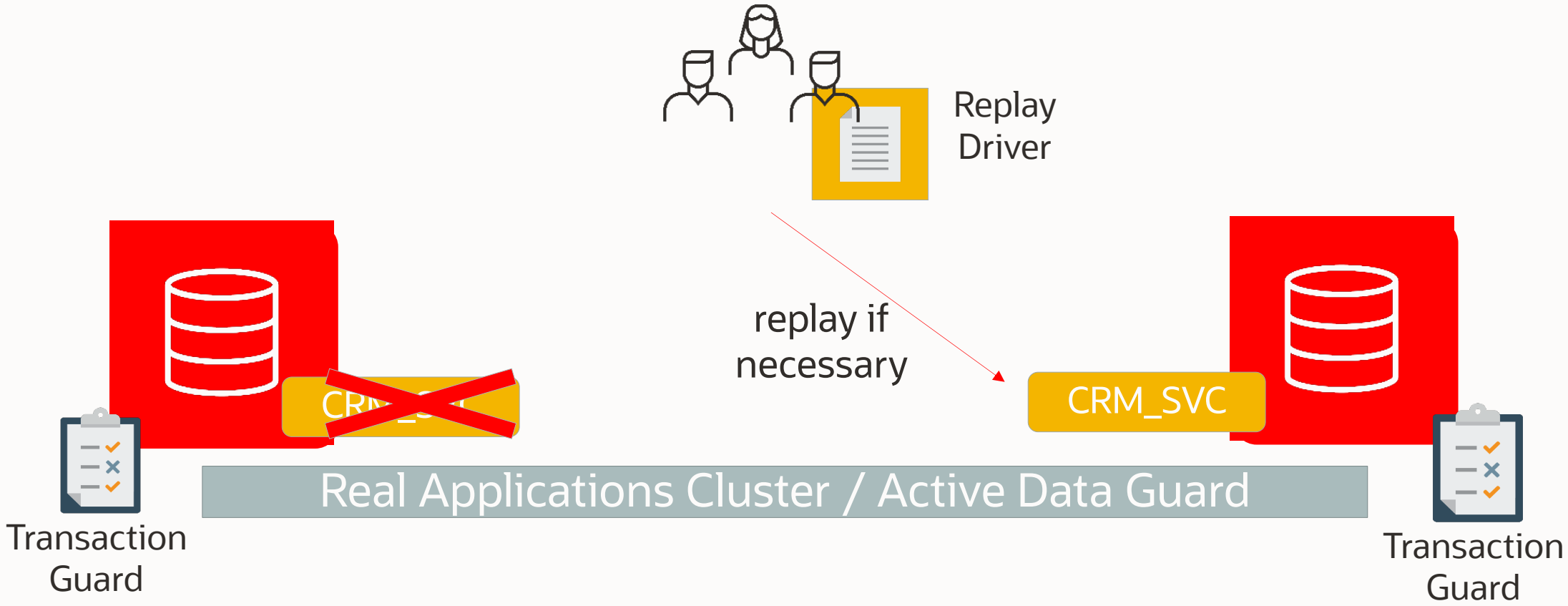
Application Continuity (AC)

Protects the in-flight transaction from failures and disconnections



Application Continuity (AC)

Protects the in-flight transaction from failures and disconnections



Application Continuity (AC)

Protects the in-flight transaction from failures and disconnections

- AC with UCP: no code change

```
PoolDataSource  pds = PoolDataSourceFactory.getPoolDataSource();
pds.setConnectionFactoryClassName("oracle.jdbc.replay.OracleDataSourceImpl");
...
conn = pds.getConnection();                    // Implicit database request begin
  // calls protected by Application Continuity
conn.close();                                  // Implicit database request end
```

- AC without connection pool: code change

```
OracleDataSourceImpl ods = new OracleDataSourceImpl();
conn = ods.getConnection();
...
((ReplayableConnection)conn).beginRequest(); // Explicit database request begin
  // calls protected by Application Continuity
 ReplayableConnection)conn).endRequest();   // Explicit database request end
```

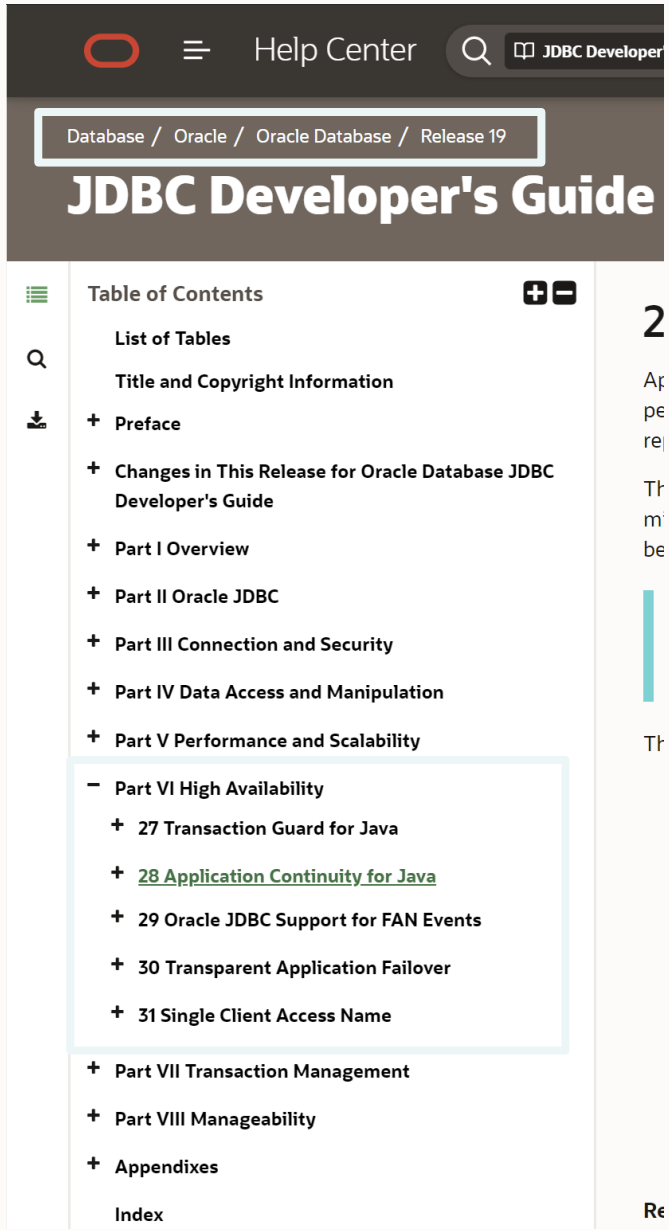
Transparent Application Continuity (TAC)

Application Continuity for every connection and application type

- Introduced in 18c for JDBC thin, 19c for OCI (Oracle Call Interface)
- Records session and transaction state server-side
- No application change
- Replayable transactions are replayed
- Non-replayable transactions raise exception
- Good driver coverage but check the doc!
- Side effects are never replayed

Key Differences between FAN, AC, and TAC

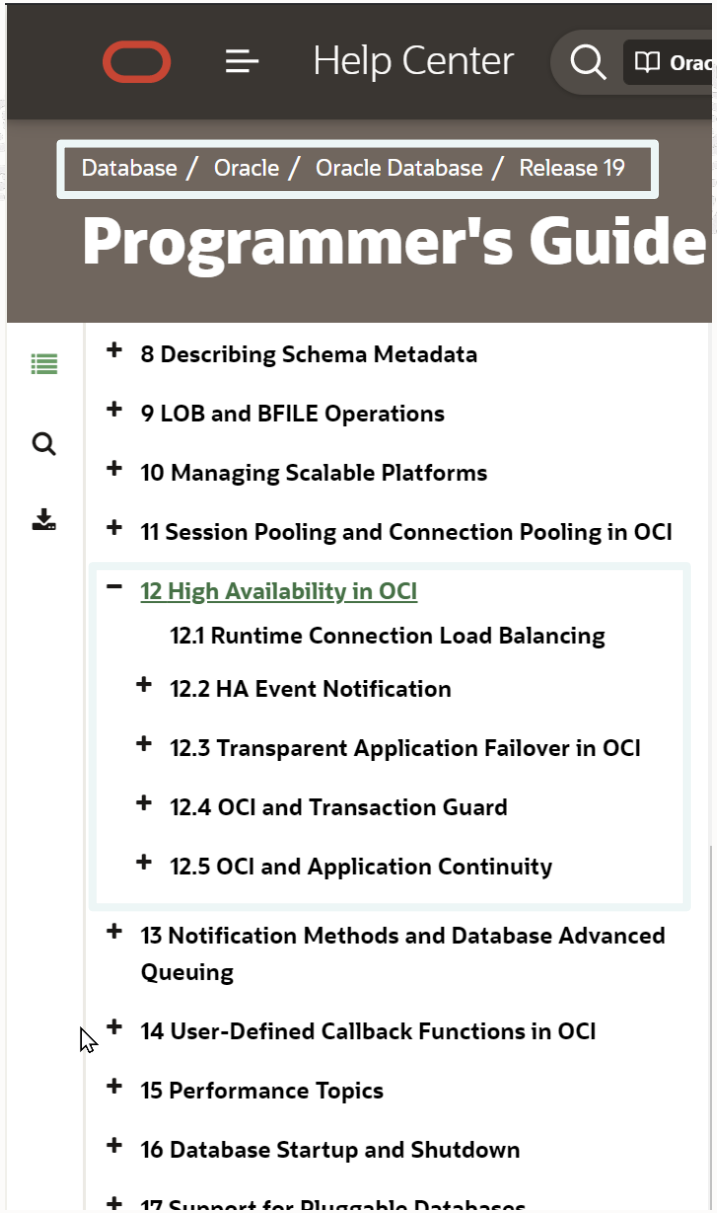
	Best for	Since Version	Application Changes	Requires Connection Pool	Replay Side Effects	JDBC/OCI
FAN	Planned Maintenance	10g	Catch FAN events (or use UCP)	No but recommended (FCF)	N/A	Both
AC	Unplanned Maintenance	12c	Use explicit boundaries (or use UCP)	Yes	Yes (Choose)	Both
TAC (Recommended)	Unplanned Maintenance	19c	No	No	Never	Both



Documentation!

JDBC

OCI



Fast-Start Failover: Oracle Data Guard Observer

Network partitioning

When did the primary disconnect?

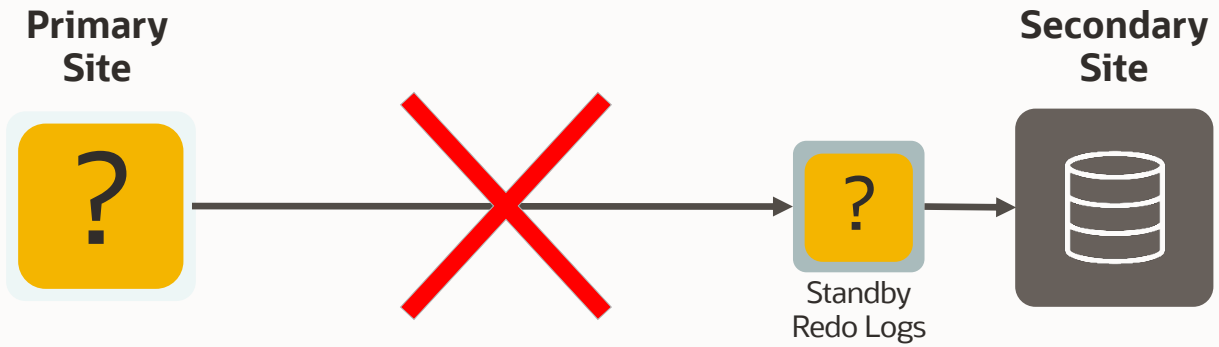

```
-- THE LAST TIME THE STANDBY HEARD FROM THE PRIMARY (1 second tolerance)
SQL> select datum_time, (sysdate-to_date(datum_time,'MM/DD/YYYY HH24:MI:SS'))*86400 secs_ago
2>   from v$dataguard_stats where name='transport lag';

DATUM_TIME                          SECS_AGO
------------------------------ ----------
07/11/2022 08:28:46                  90361
```

⚠ The columns might be null in some cases

⚠ Do not rely on the transport lag value

Network partitioning

Up to which point can the standby recover?

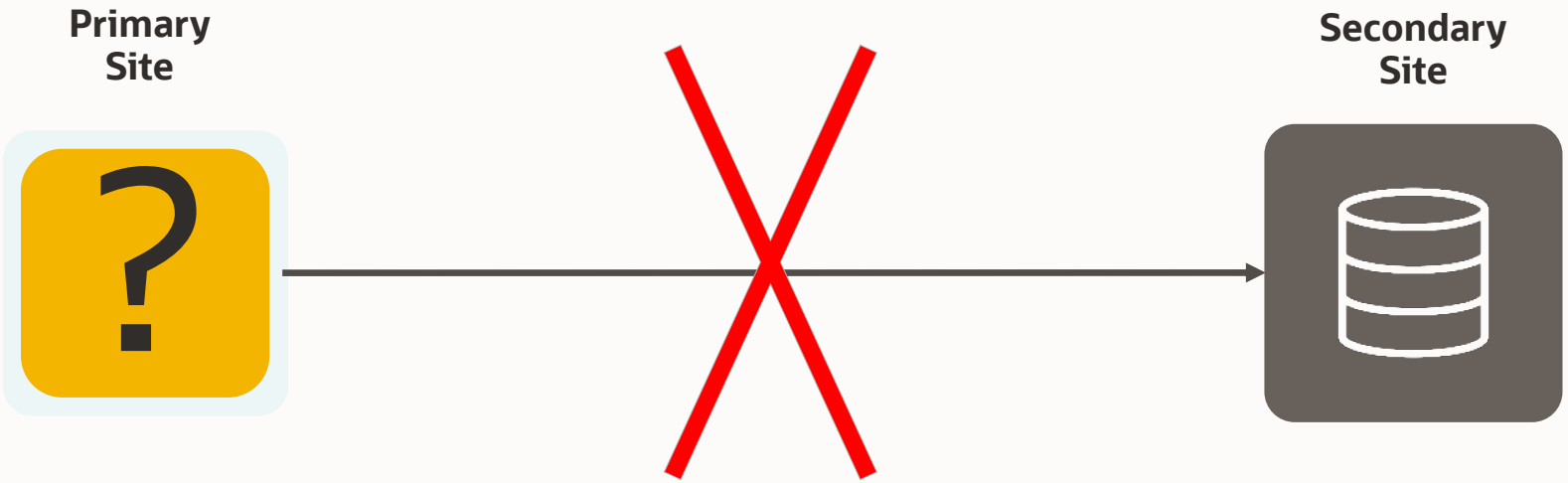



```
-- THE TIMESTAMP OF THE LAST REDO ENTRY RECEIVED FROM THE PRIMARY
SQL> alter session set nls_date_format='MM/DD/YYYY HH24:MI:SS';
SQL> select coalesce(max(s.last_time), max(a.next_time)) as last_redo_from_prim,
2>   (sysdate-coalesce(max(s.last_time), max(a.next_time)))*86400 as secs_ago
3>   from v$standby_log s , v$archived_log a ;

LAST_REDO_FROM_PRIM   SECS_AGO
-------------------- ----------
07/11/2022 08:28:46      91061
```

? Is it a reliable way to calculate data loss?

Network partitioning

Is there a way to calculate the data loss upon failover?



DID IT CRASH?

DID IT STALL?

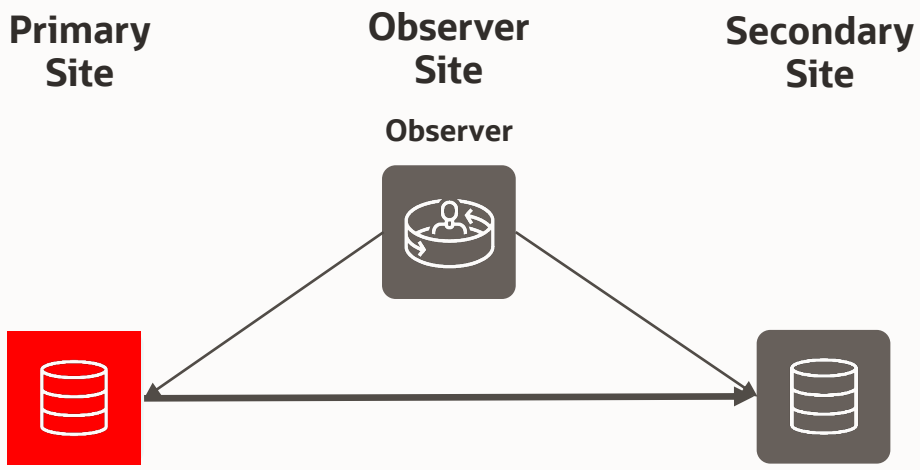
DID IT KEEP COMMITTING?

WHAT IS THE PRIMARY DOING?

- Primary still committing
  - DATA LOSS and possible split brain
- Primary crashed
  - *Maybe* no data loss

Oracle Data Guard Observer acts as a quorum

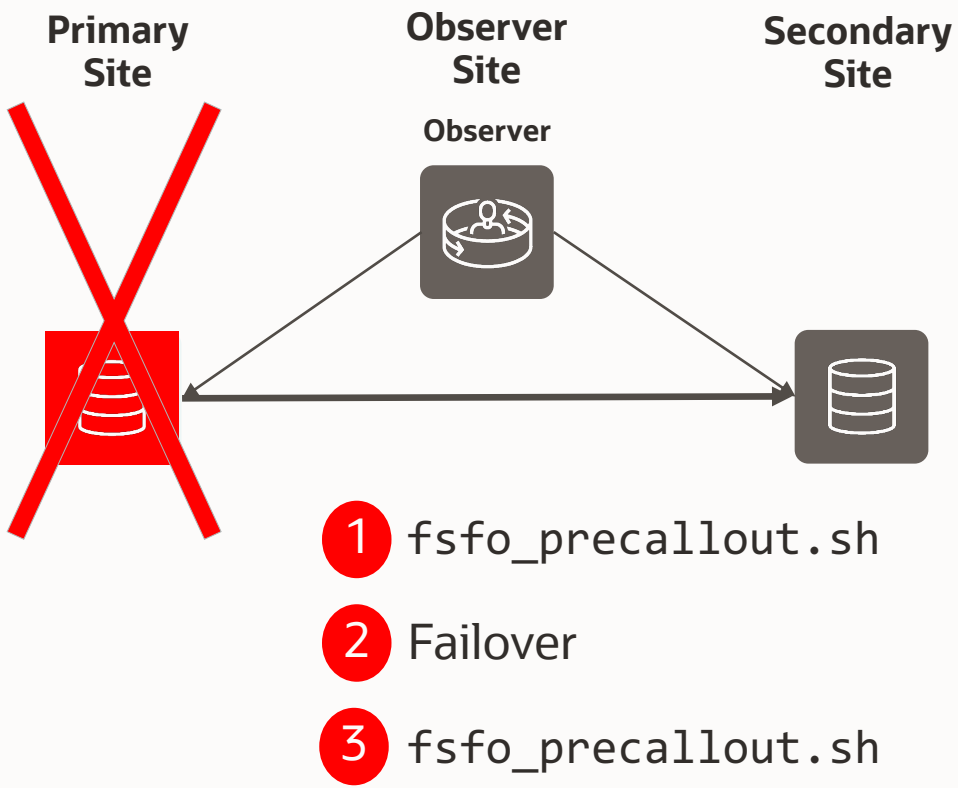
Automatic failover when the Primary Database is unavailable



- **The observer monitors both primary and standby**
- **Standby isolated:**
  - The primary keeps writing
- **The Observer Isolated:**
  - The configuration keeps working unobserved
- **Primary Isolated:**
  - Failover!
    The primary loses the quorum and stops committing
- The observer can work in "**OBSERVE ONLY**" mode
  - Reports a failure without failing over

Fast-Start Failover callouts

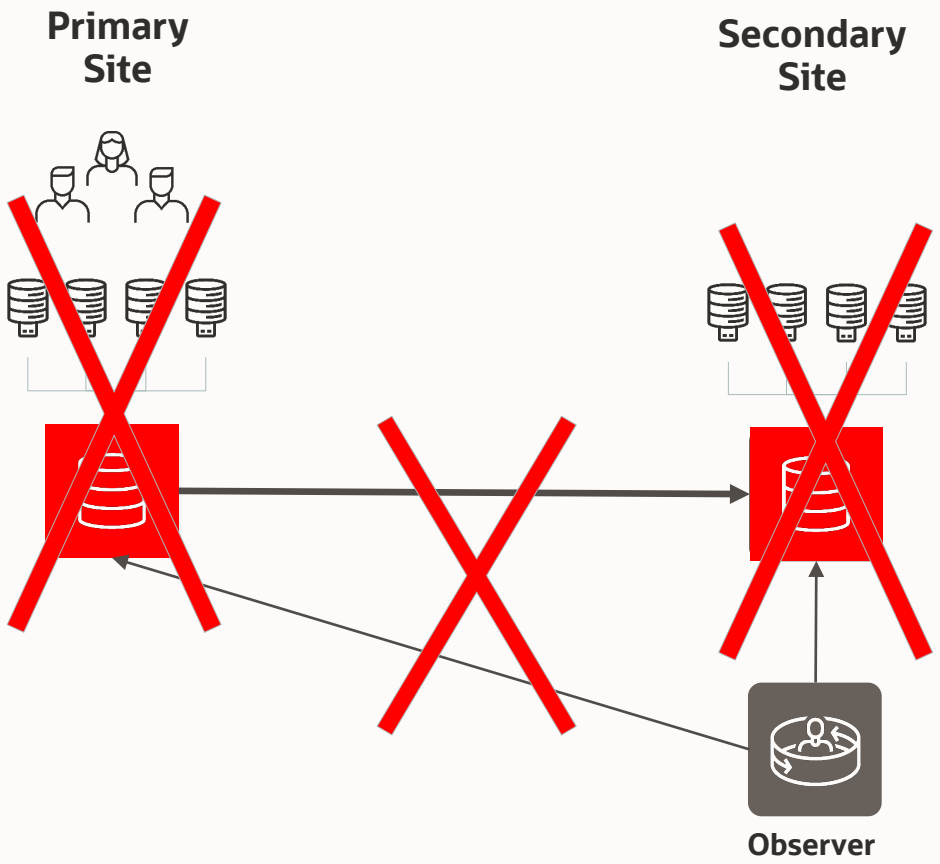
Execute custom actions before and after the automatic failover occurs




```
$ cat $DG_ADMIN/config_ConfigName/callout/fsfocallout.ora

# The pre-callout script is run before failover
FastStartFailoverPreCallout=fsfo_precallout.sh
FastStartFailoverPreCalloutTimeout=1200
FastStartFailoverPreCalloutSucFileName=fsfo_precallout.suc
FastStartFailoverPreCalloutErrorFileName=precallout.err
FastStartFailoverActionOnPreCalloutFailure=STOP

# The post-callout script is run after failover succeeds
FastStartFailoverPostCallout=fsfo_postcallout.sh
$
```

Oracle Data Guard Observer Placement

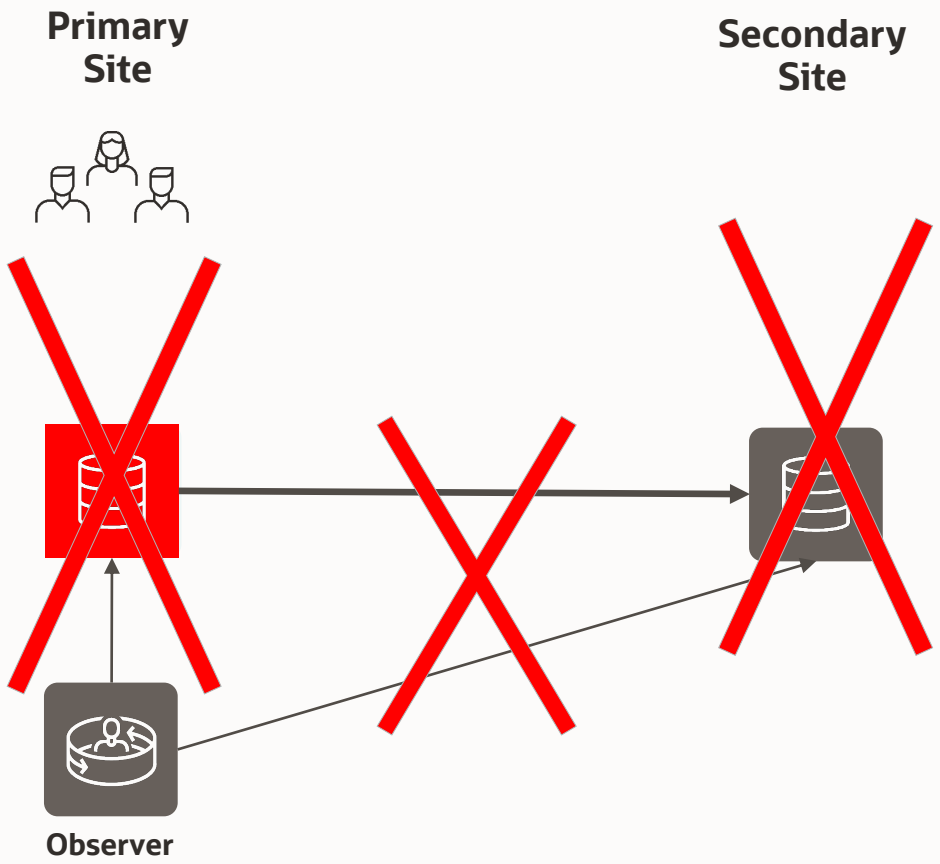
Observer at the standby site



- **Observer at the standby site: BAD**
- Primary/Standby network failure
  - **Failover despite healthy primary!**
- Primary site failure
  - Failover
- Standby site failure
  - Primary shuts down assuming failover

Oracle Data Guard Observer Placement

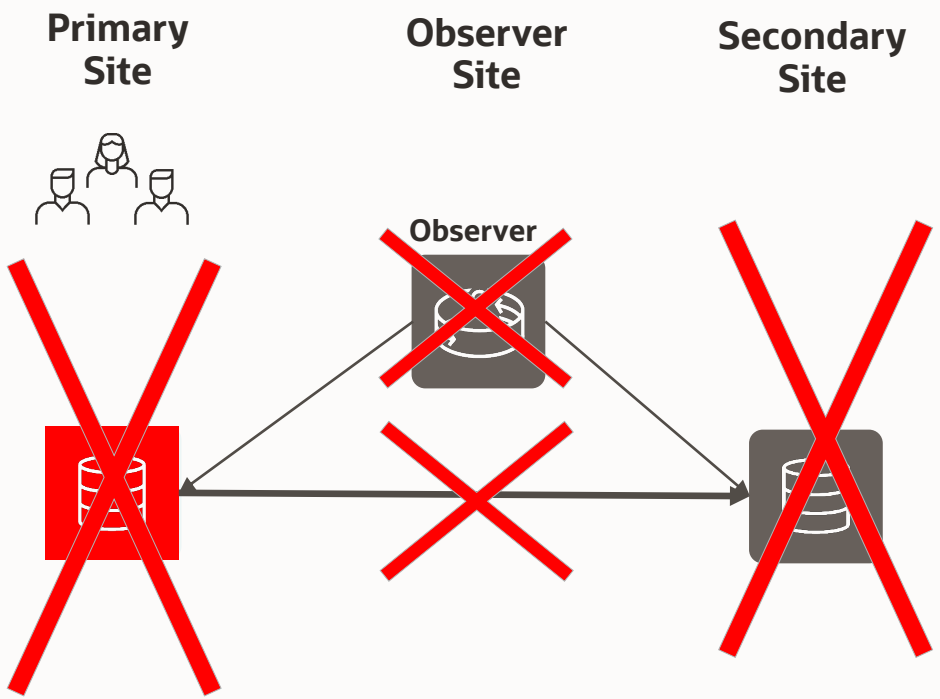
Observer at the primary site



- **Observer at the primary site: BETTER**
- Primary/Standby network failure
  - Nothing happens
- Primary site failure
  - No automatic failover (manual still possible)
- Standby site failure
  - Nothing happens

Oracle Data Guard Observer Placement

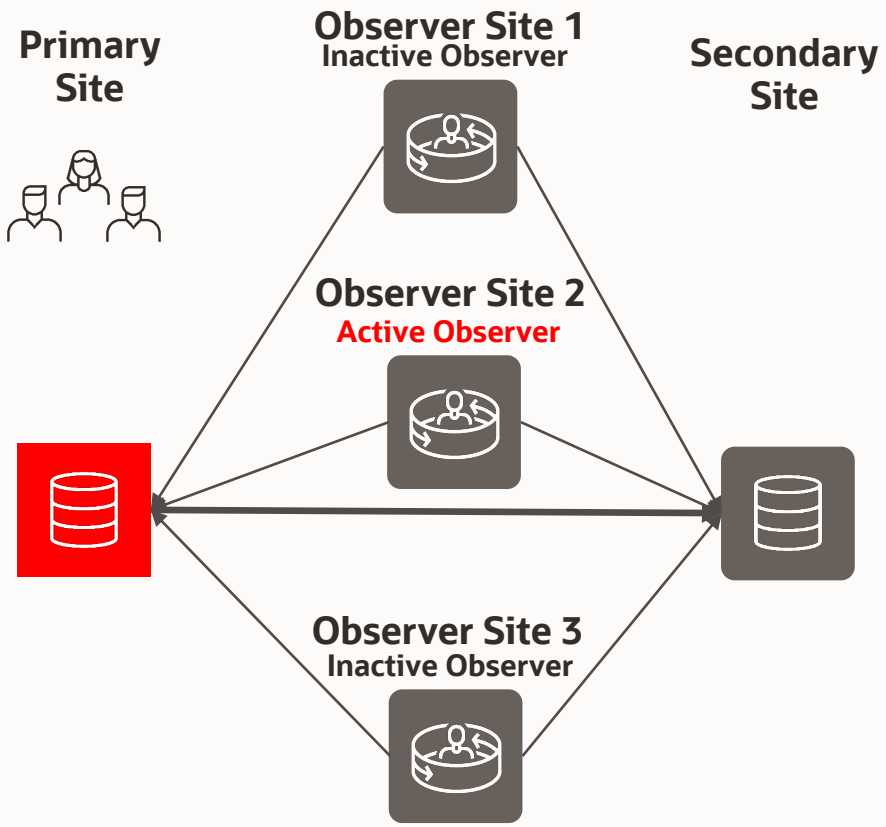
Observer at external site with different network paths



- **Observer at external site: BEST**
- Primary/Standby network failure
  - Nothing happens
- Primary site failure
  - Failover
- Standby site failure
  - Nothing happens
- Observer site failure
  - Nothing happens

Oracle Data Guard Observer High Availability

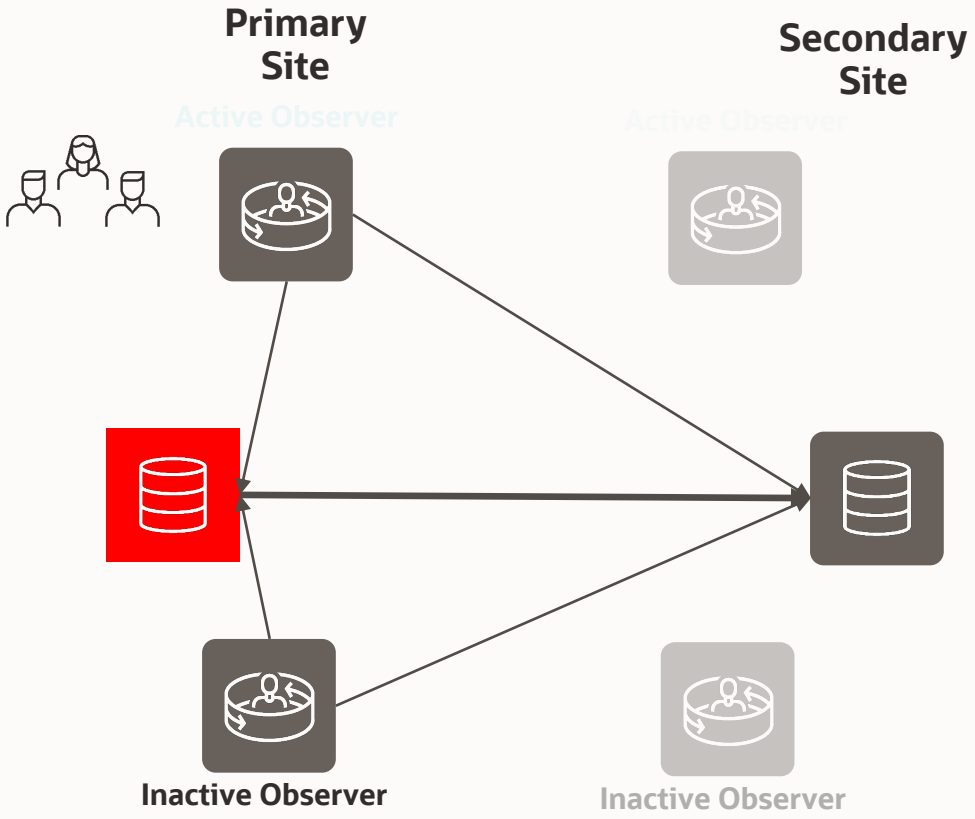
Up to three observers configured (one active at a time)



- **Optimal: 2 or 3 different Regions/Data Centers/Ads**
  - Ensure there are no SPOFs (network, power…)
- If one observer fails, another is promoted

Oracle Data Guard Observer High Availability

Up to three observers configured (one active at a time)



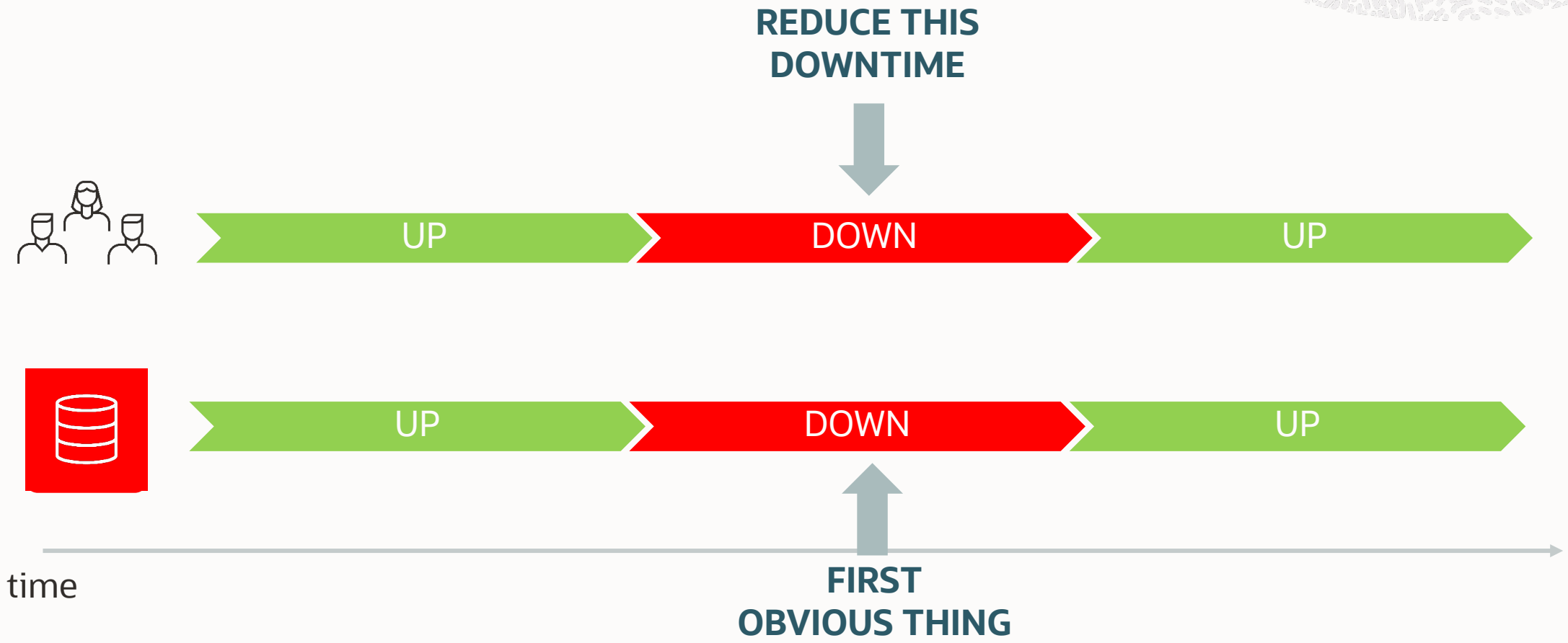
- **No external site?**
  - Configure HA observers at the primary site
  - Ideally, at least one in the application network
  - When role change occurs, have two observers ready at the secondary site

TIME FOR A BREAK!

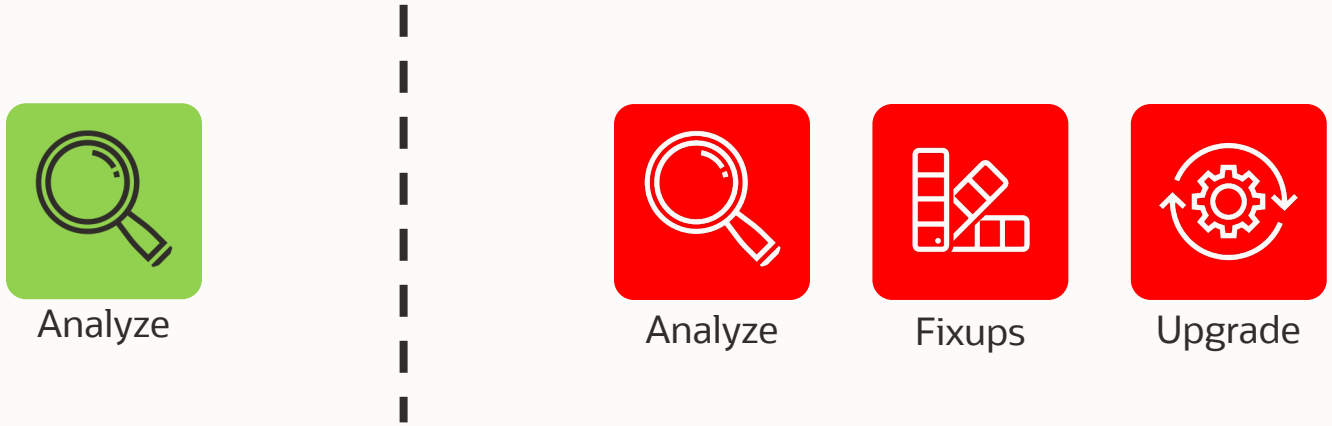
Our mission is to help people see data in new ways, discover insights, unlock endless possibilities.

ROLLING UPGRADES

Database Downtime and Application Downtime

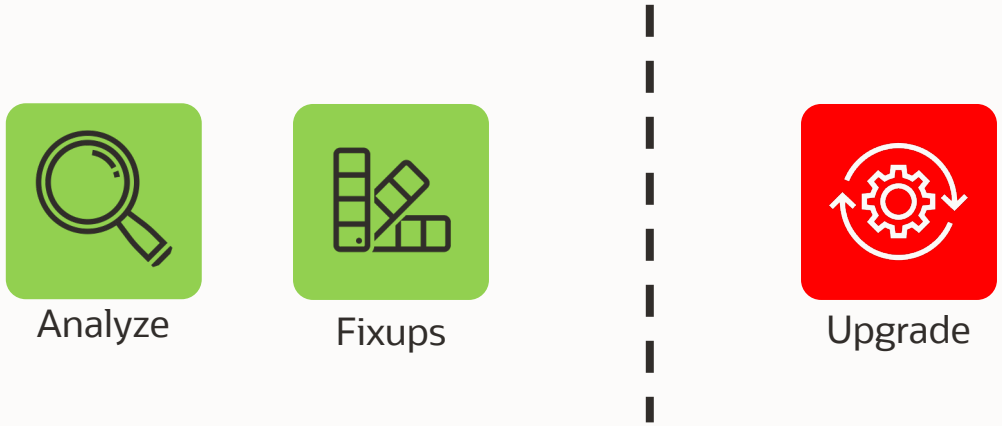


Fixups | Traditional



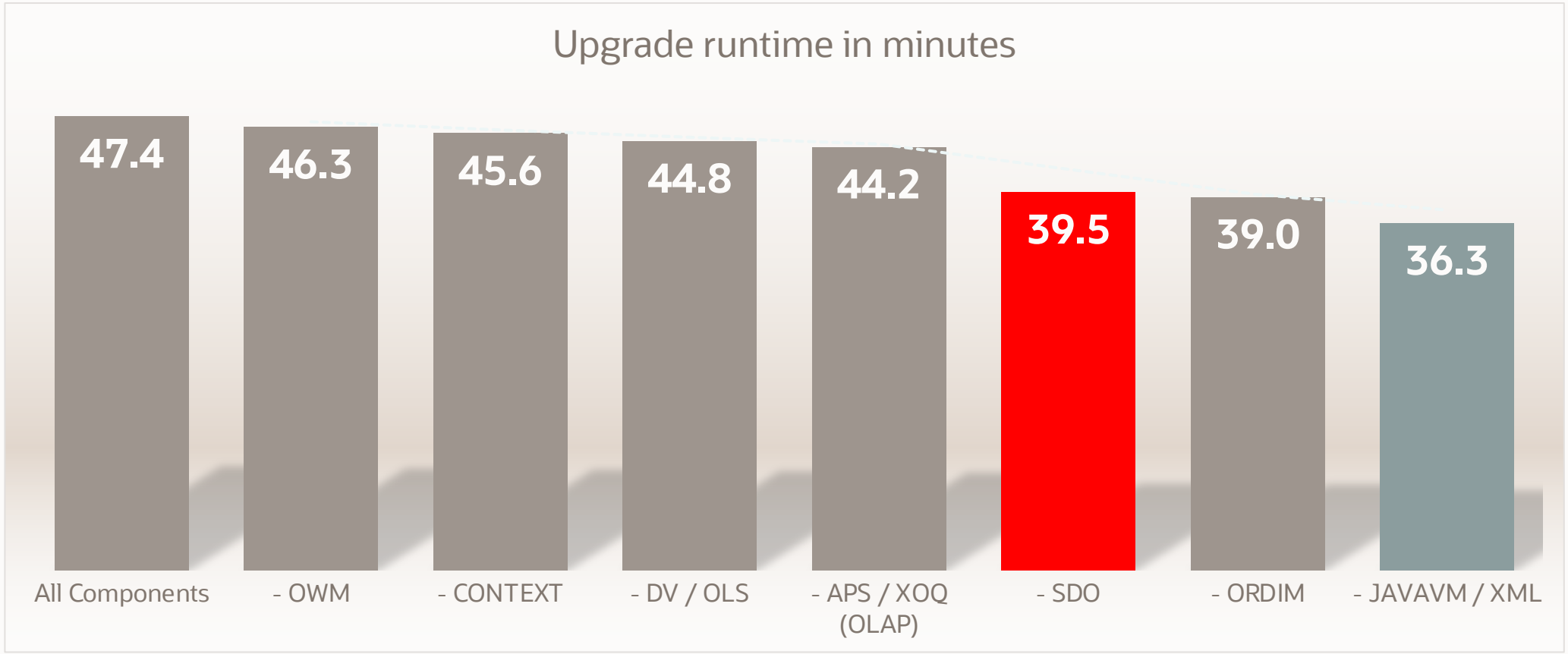

```
$ java -jar autoupgrade.jar -mode analyze

$ java -jar autoupgrade.jar -mode deploy
```

Fixups | Fast Deploy



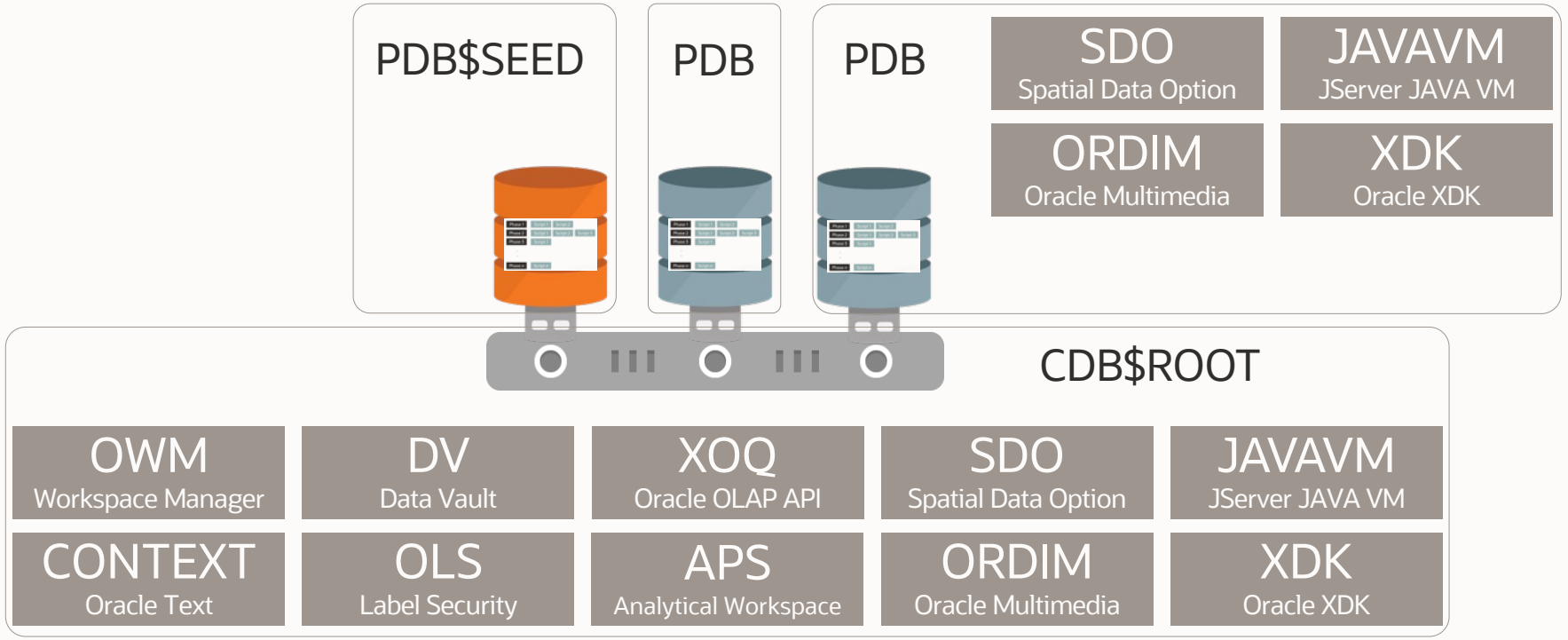

```
$ java -jar autoupgrade.jar -mode analyze
$ java -jar autoupgrade.jar -mode fixups

$ java -jar autoupgrade.jar -mode upgrade
```

Components | Impact

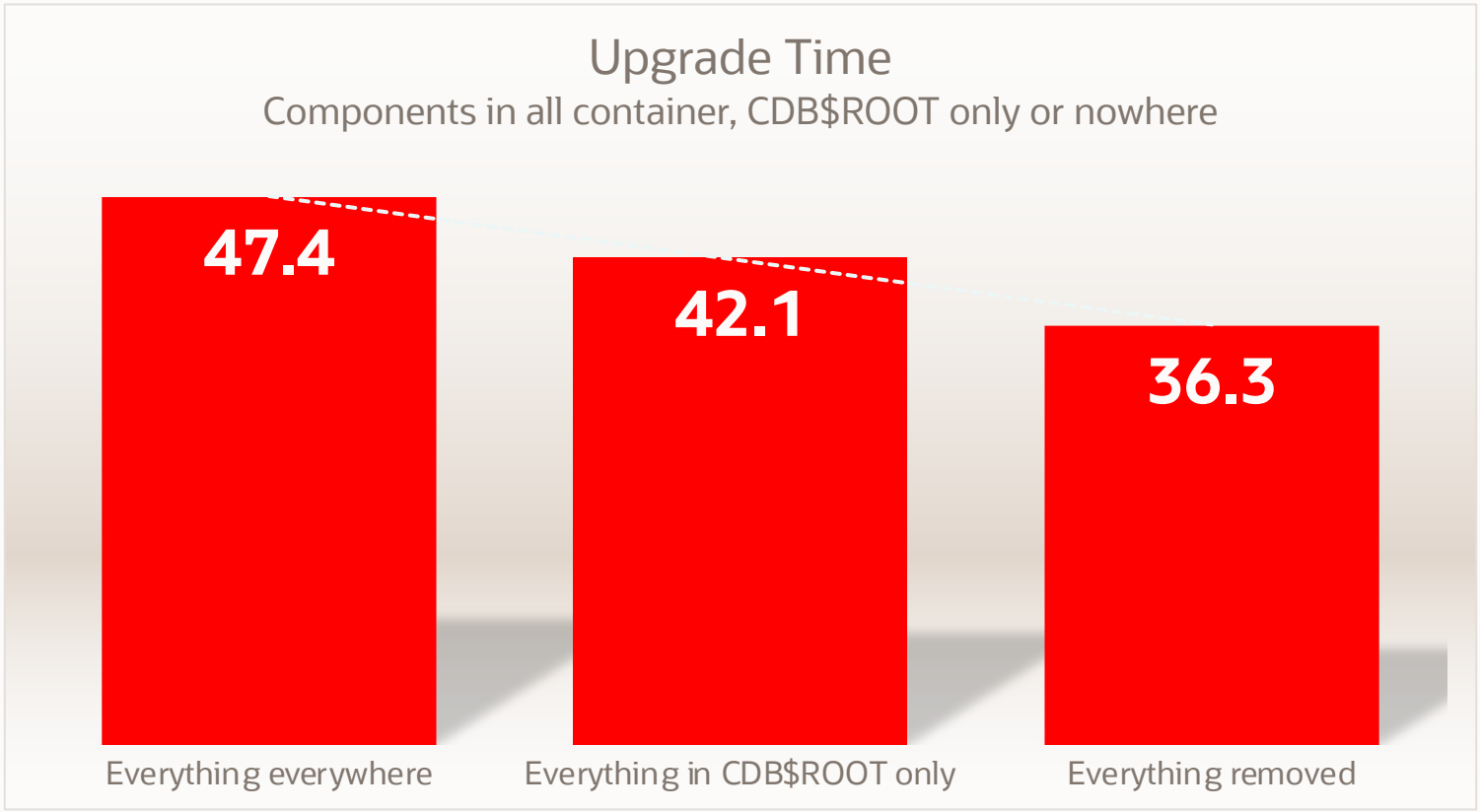


Components | CDB$ROOT vs PDB

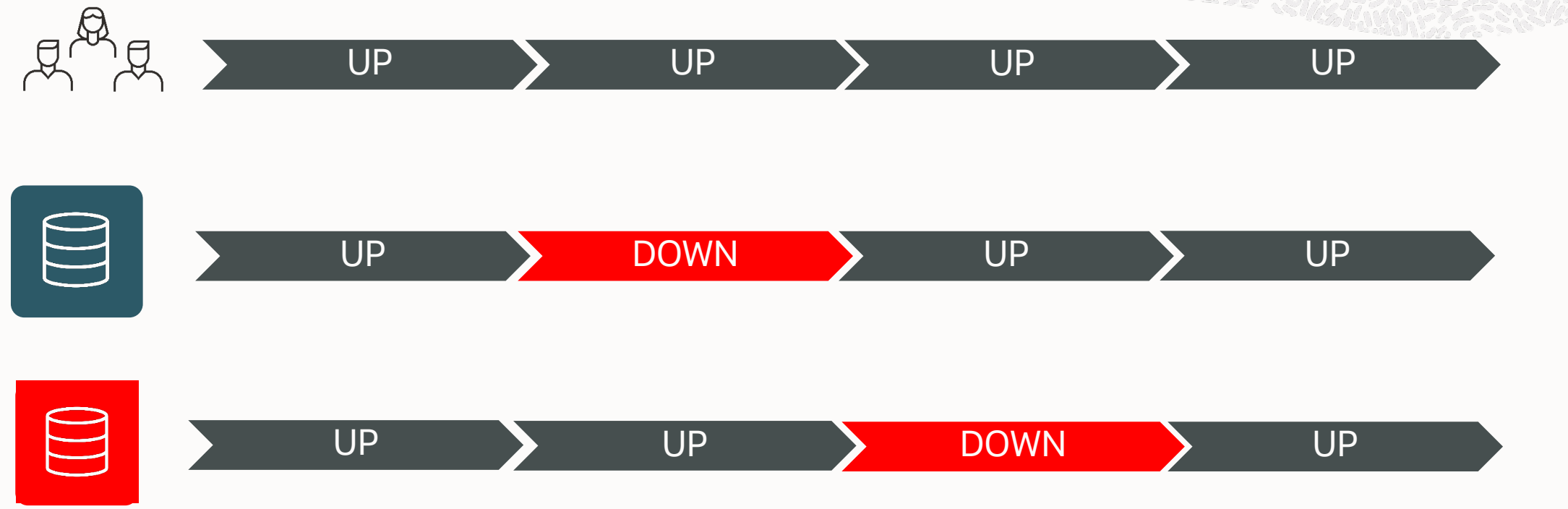
This may be a solution



Components | Compromise



Rolling Upgrade and Application Downtime



Solutions for Database Rolling Maintenance and Upgrades

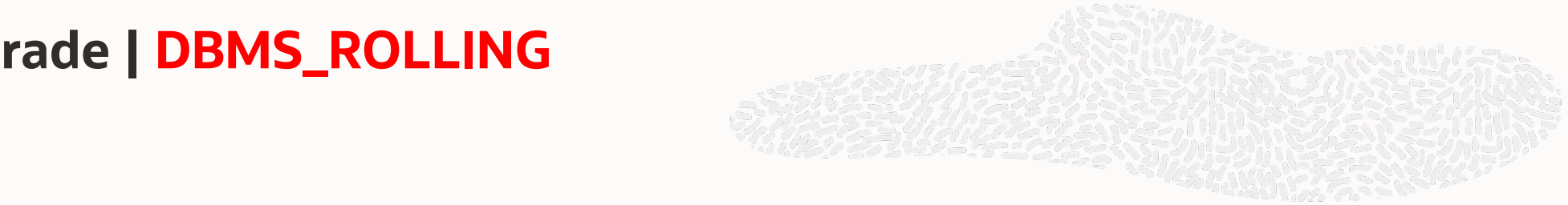
Manual	DBMS_ROLLING	GoldenGate
Part of Enterprise Edition	Requires Active Data Guard	Requires GoldenGate
Source >= 11.1.0.7	Source >= 12.1.0.2	Source >= 11.2.0.4 (for OCI GG)
Manual approach	Automated	Manual approach
Limited feature support	Comprehensive feature support	Best feature support
		Fallback mechanism

Using SQL Apply to Upgrade the Oracle Database
https://docs.oracle.com/en/database/oracle/oracle-database/19/sbydb/using-sql-apply-to-perform-rolling-upgrade.html

Using DBMS_ROLLING to Perform a Rolling Upgrade
https://docs.oracle.com/en/database/oracle/oracle-database/19/sbydb/using-DBMS_ROLLING-to-perform-rolling-upgrade.html

Overview of Steps for Upgrading Oracle Database Using Oracle GoldenGate
https://docs.oracle.com/en/database/oracle/oracle-database/19/upgrd/converting-databases-upgrades.html#GUID-8E029631-8265-497C-983B-B8A4ACD47B98

Rolling Upgrade | DBMS_ROLLING



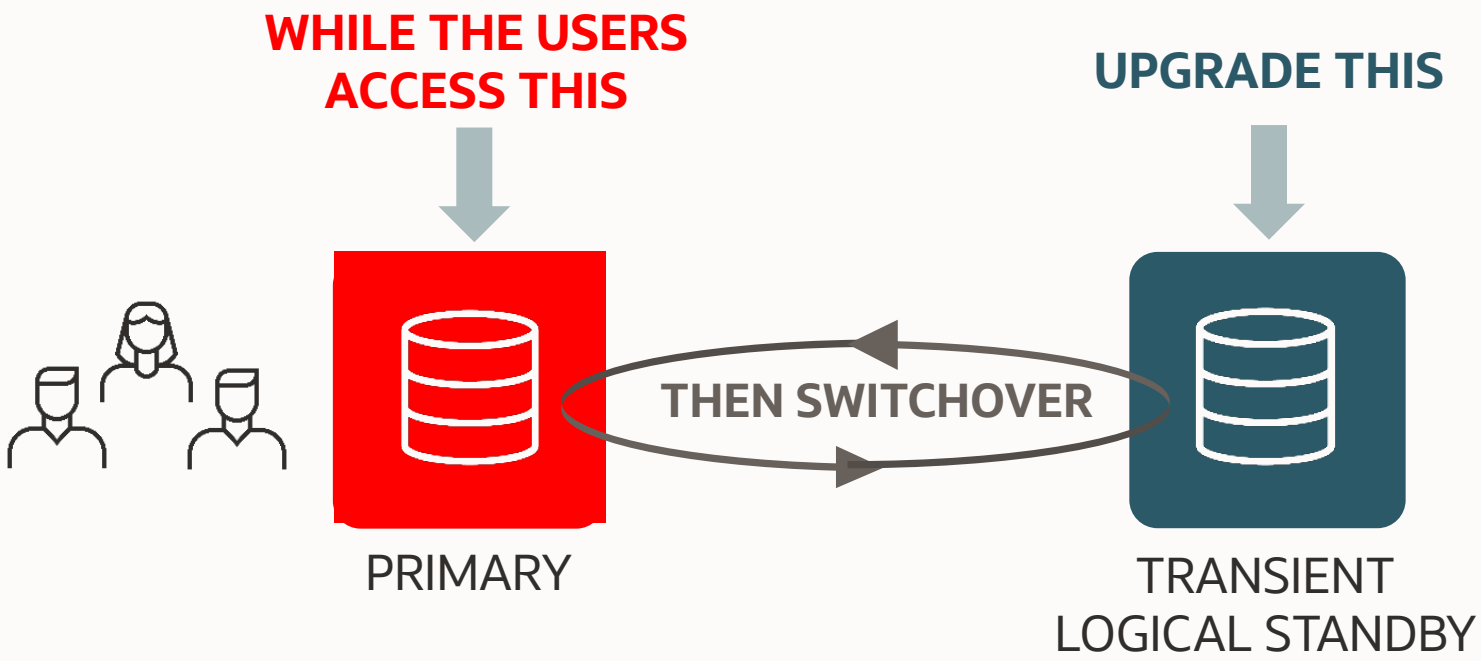
Use a logical standby database to upgrade with very little downtime.

The only downtime is as little as it takes to perform a switchover.

Pro tip: Also useful for other maintenance activities

Active Data Guard Rolling Maintenance and Upgrades

Using DBMS_ROLLING package



- Use a transient logical standby database to upgrade with very little downtime.
- The only downtime is as little as it takes to perform a switchover.

DBMS_ROLLING points of attention

Do not create the logical standby on the same server as the primary database

Supplemental logging is enabled automatically which introduces an overhead and increases the amount of redo generated

When supplemental logging is enabled all DML cursors are invalidated

Not all data types and partitioning types are supported

For optimal performance all tables should have primary keys or unique keys

Important DBMS_ROLLING milestones

The driver is the SOURCE database!

ADG

SOURCE VERSION

12.1

- First version of DBMS_ROLLING for upgrades from 12.1 to higher versions

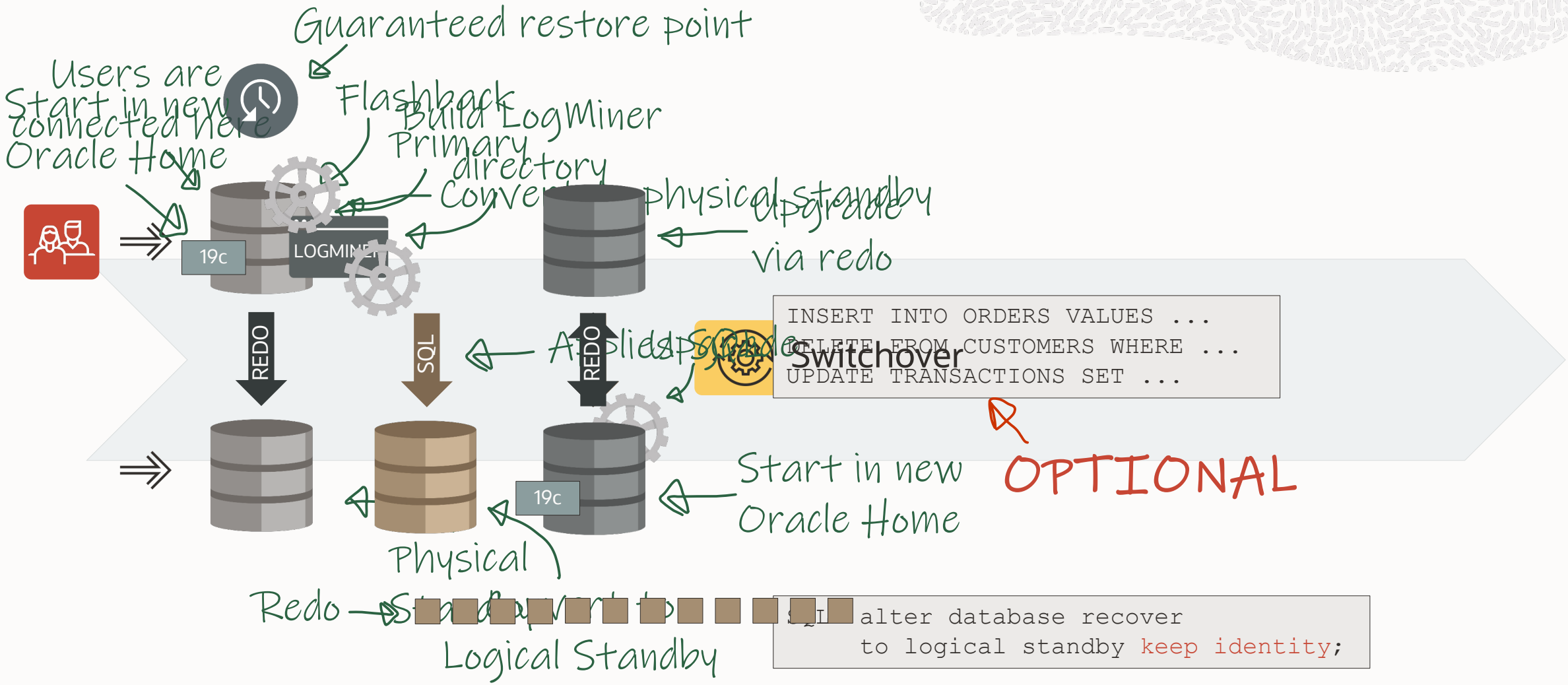
12.2

- Integration with the Data Guard broker
- Services, roles changes, and instances are managed automatically by Clusterware
- FAN events for Clusterware-backed databases
- Support for Identity columns

21c

- FAN events without Clusterware
- Support for JSON datatype

Rolling Upgrade | Concept



MORE FROM MAA

Edition-Based Redefinition

Online Application Upgrade

- Enables application upgrades to be performed online
- Code changes installed in the privacy of a **new edition**
- Data changes are made safely by writing only to new columns or new tables not seen by the old edition
- An editioning view exposes a different projection of a table into each edition to allow each to see just its own columns
- A cross-edition trigger propagates data changes made by the old edition into the new edition's columns, or (in hot-rollover) vice-versa

Full Stack Disaster Recovery (FSDR)

DR for the entire application stack

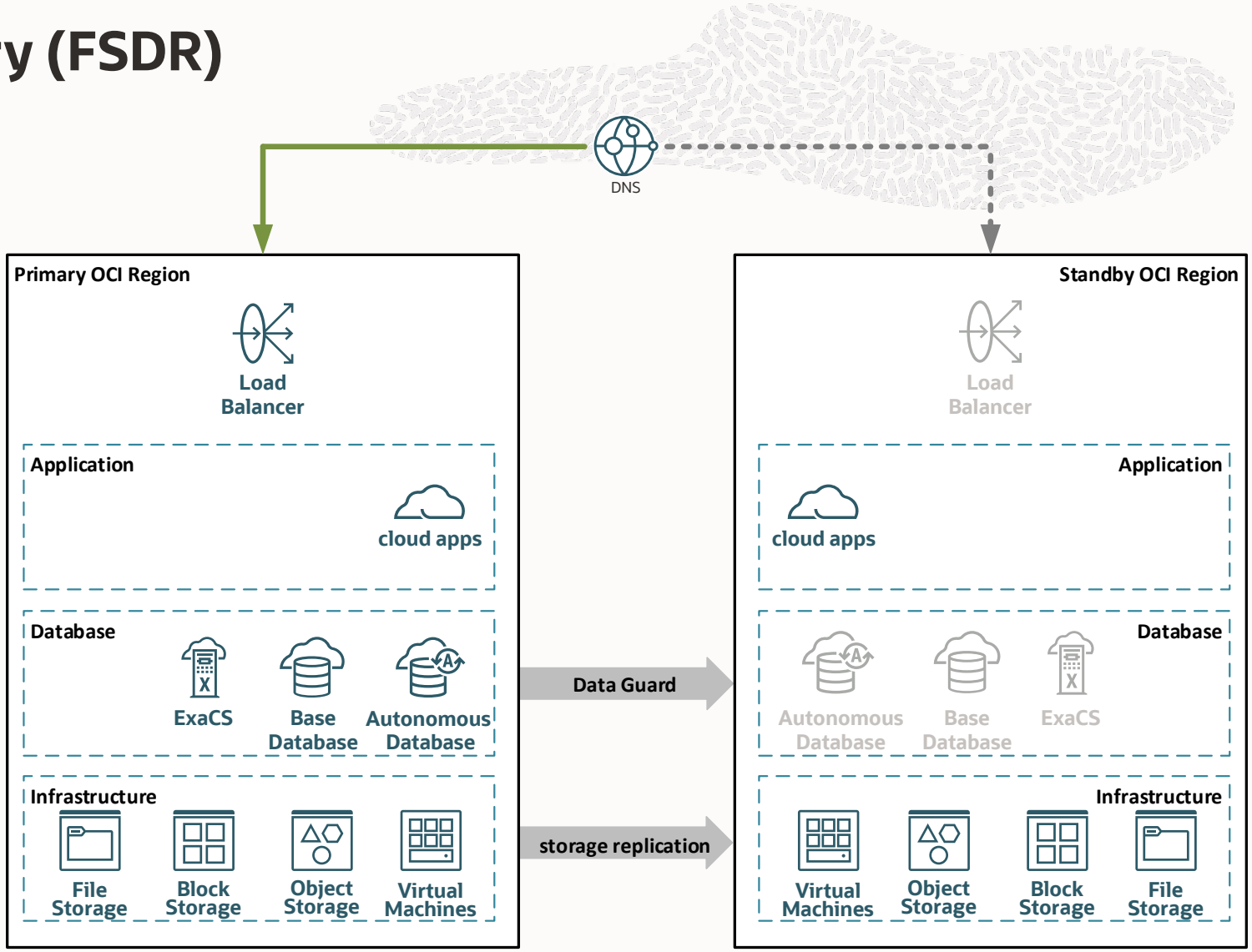
Orchestrated single-click DR for infrastructure, databases & applications

Automated discovery

Integrated discovery to automate the creation and customization of a DR plan

Single pane of glass

Validated and monitored execution of a DR plan using a single pane of glass



Large Multinational Insurance Company in Europe

Improve Disaster Recovery runtime operation

Industry: *Banking and Financial Services*
Headquarters: *Spain*

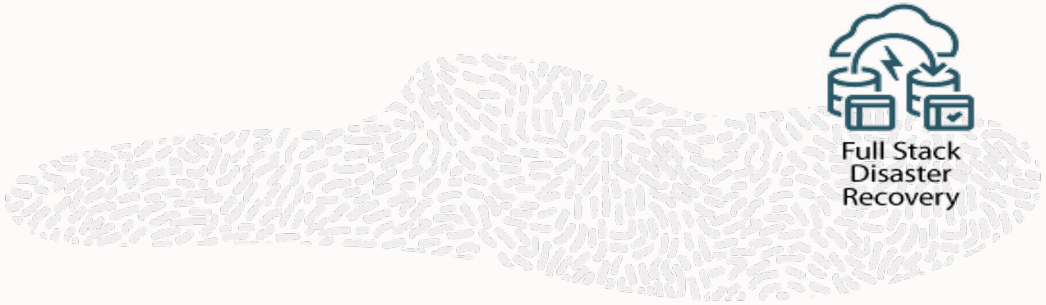
Objectives

- Reduce RTO and achieve RPO = 0
- Orchestrate switchover/failover of all infrastructure components
- Implement DR plans according to our business requirements
- Reduce or eliminate any possible manual intervention

Results

- Compliance with security and business continuity normative
- Business-approved (acceptance) RTO / RPO
- Able to utilize the main business service (Insurance ERP) in the DR environment successfully
- Full validation of all Java APIs for WebLogic in use at the DR environment by end users

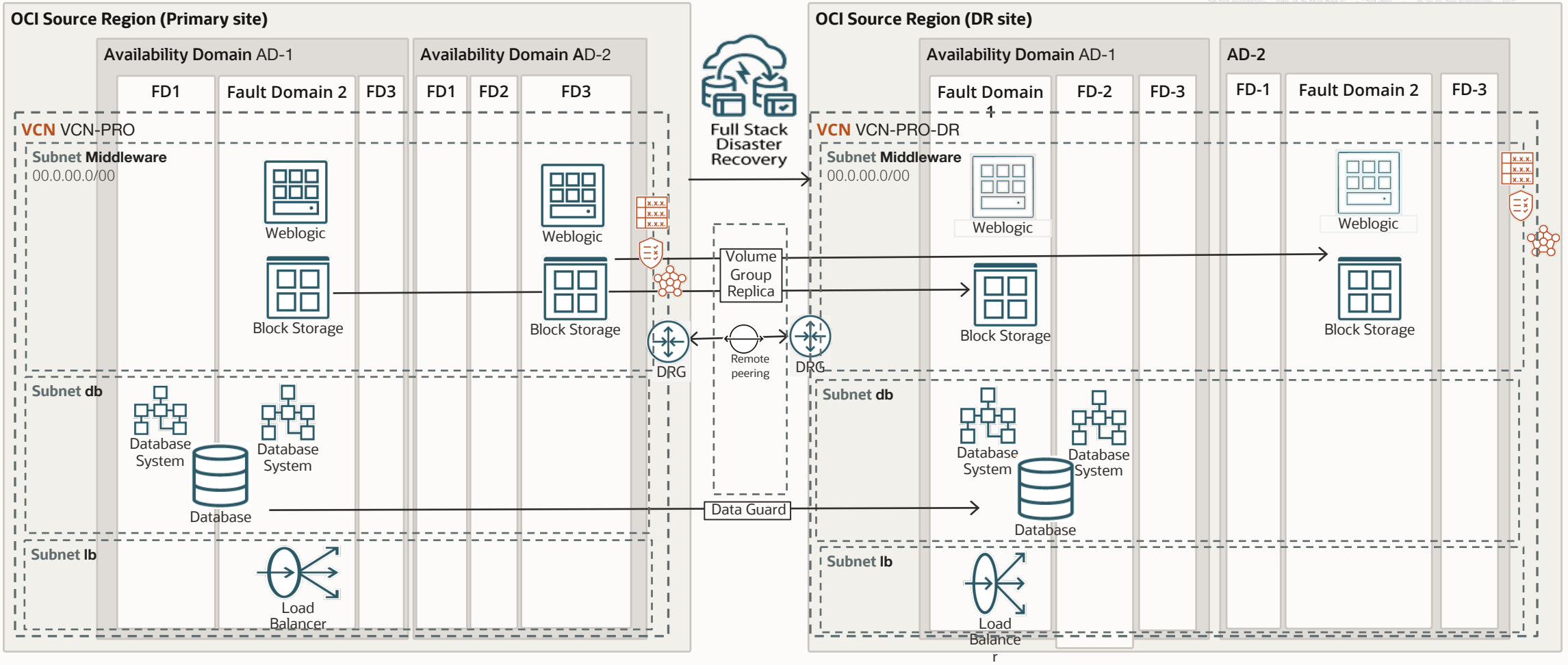
Why Full Stack DR



- Make the best use of having cross-region capabilities by using Volume Group Replica
- Achieve consistency within the whole infrastructure in use
- Capable of follow-up all DR Executions Plans
- Fulfil user-specific user requirements by creating User Defined Steps within the DR plan
- The capability of adding other servers on top of WebLogic to the process
- Avoid manual intervention within any critical process (DR site)

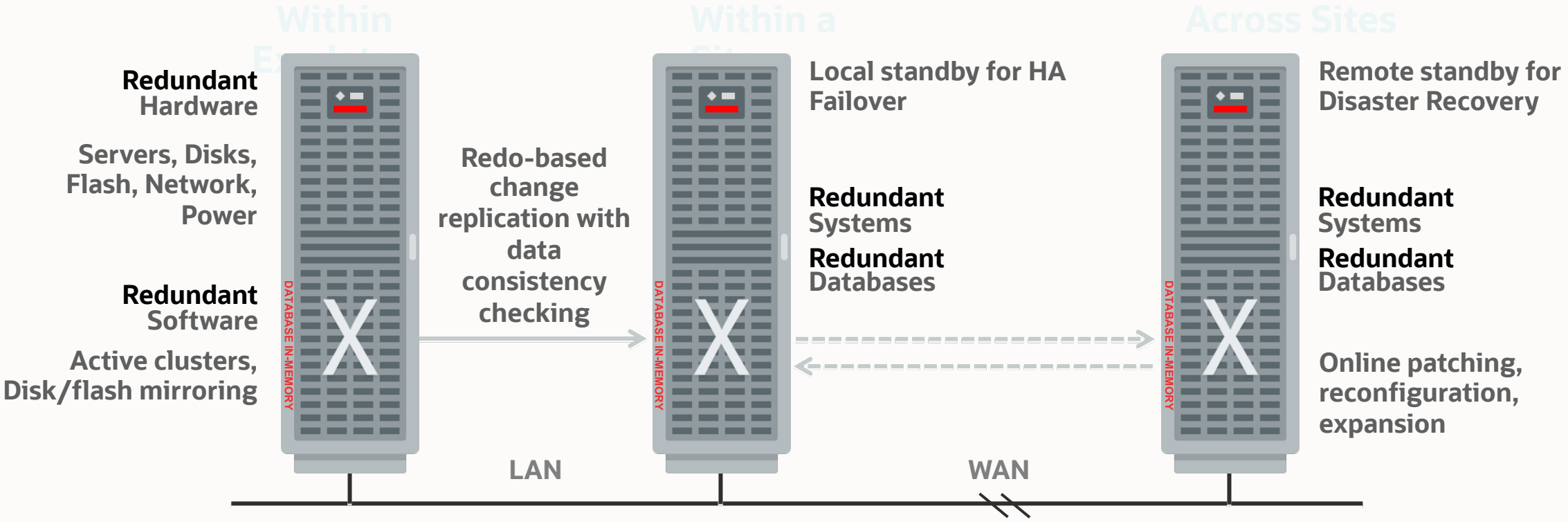
WebLogic ERP with Oracle Base DB

Full Stack DR with Cold Standby setup



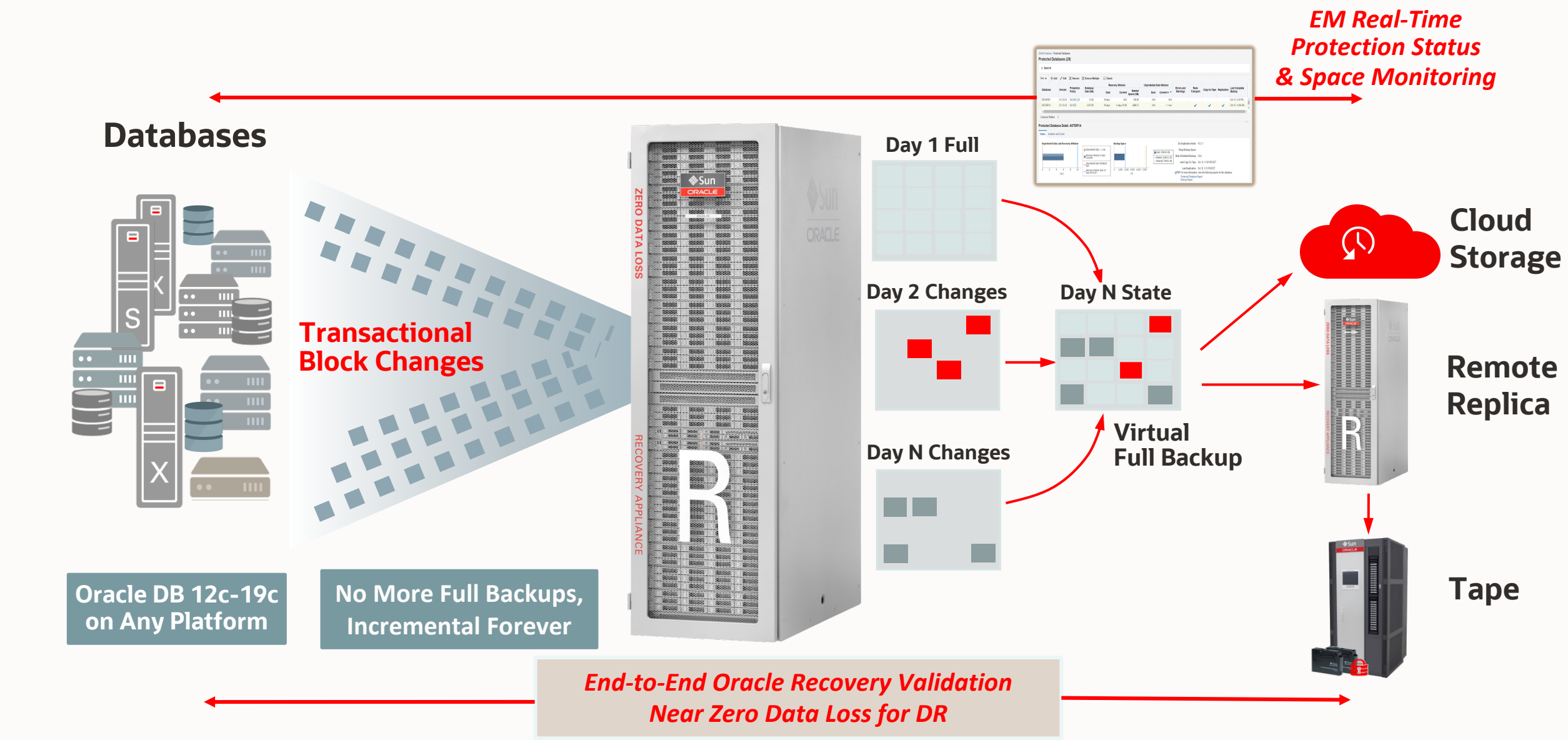
Exadata Maximum Availability Architecture

Designed and Tested to Handle All Failure Scenarios



Best MAA Database Platform | Fastest RAC Instance and Node Failure Recovery | Fastest Backup - RMAN Offload to Storage
Deep ASM Mirroring Integration | Fastest Data Guard Redo Apply | Complete Failure Testing with Lowest Brownouts
Frequently Updated Health Checks

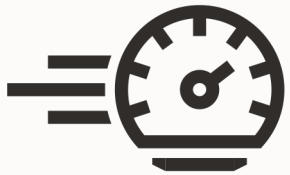
Recovery Appliance Recommended



Zero Data Loss Autonomous Recovery Service

Ransomware resiliency

- Automated and mandatory encryption to help prevent data theft
- Safeguards backups with enforced 14-day minimum retention
- Optimizes backups in background for fast recovery with zero data loss



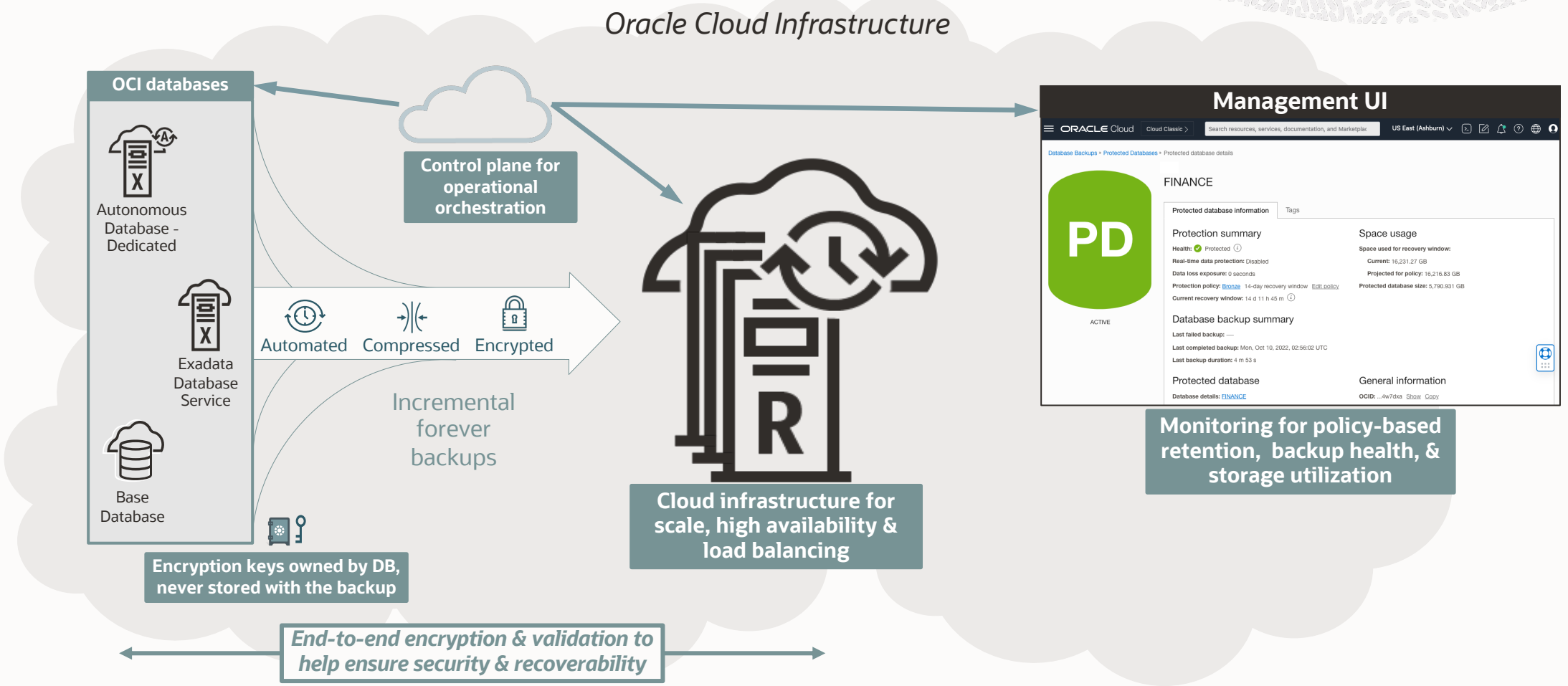
Operational efficiency

- No more weekly full backups – eliminates production database overhead
- Shorter backup windows with incremental forever strategy
- Zero-impact database recovery validation for every backup

Cloud simplicity

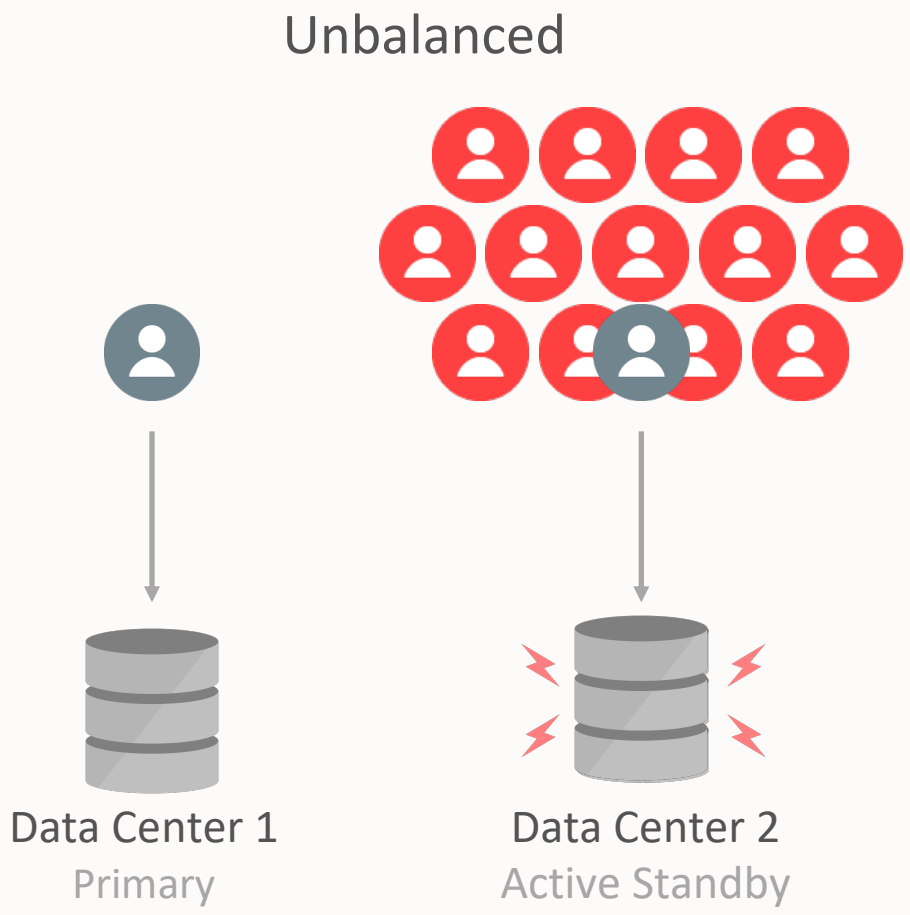
- Quickly configure database protection at scale with zero data loss
- Control costs with database-specific backup consumption metrics
- Gain deep data protection insights with granular recovery health dashboard

Zero Data Loss Autonomous Recovery Service



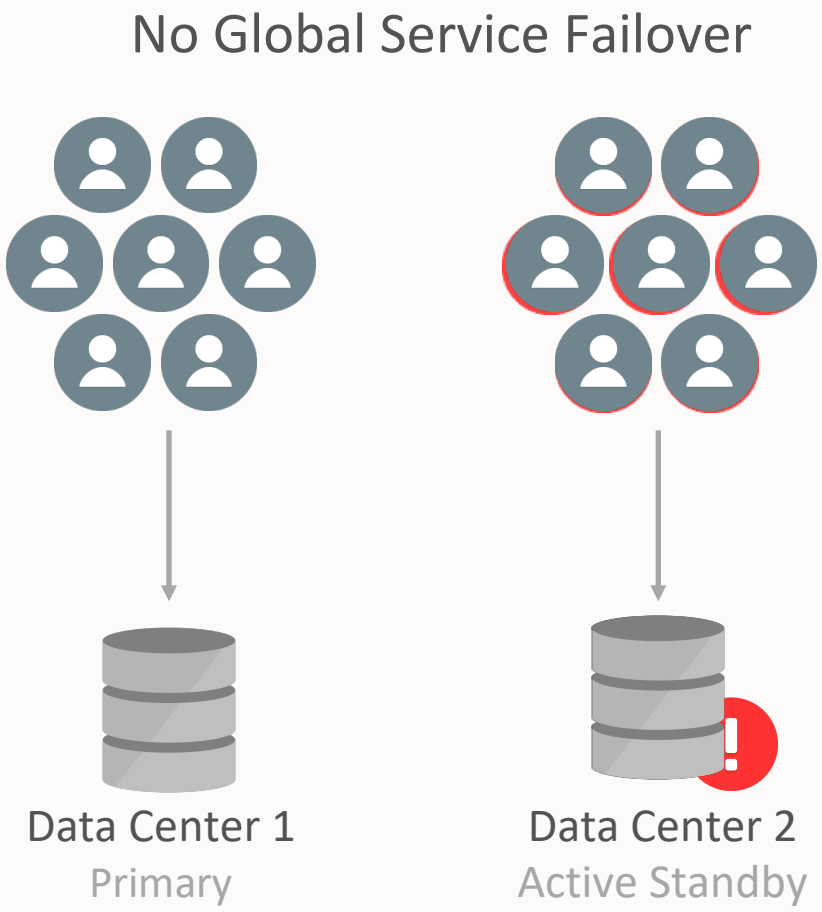
EVEN MORE FROM MAA (GDS)

Challenges of Replicas – Workload Balance



- No automated load balancing
- Sub-optimal resource utilization

Challenges of Replicas – Service Failover



- App outages when replicas fail
- No Service HA

Oracle Global Data Services (GDS)

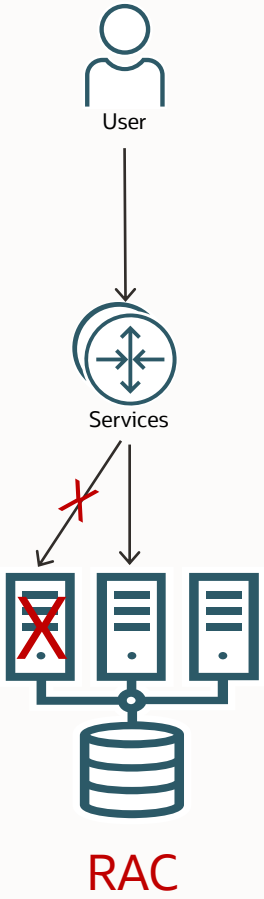
- Automatic and transparent client workload management across replicas
- Extends the concept of services to replicas

Capabilities

- Workload routing based on load, locality or lag
- Service failover across replicas

Benefits

- Maximize application performance
- Mitigate downtime during planned and unplanned outages
- Manage resources of replicas with one interface



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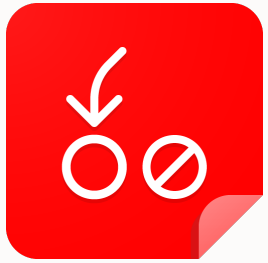
- Maximize application performance
- Mitigate downtime during planned and unplanned outages
- Manage resources of replicas with one interface

Workload Management for Database Replicas with GDS

Centralized service management

Workload routing
(region-based & lag-based)

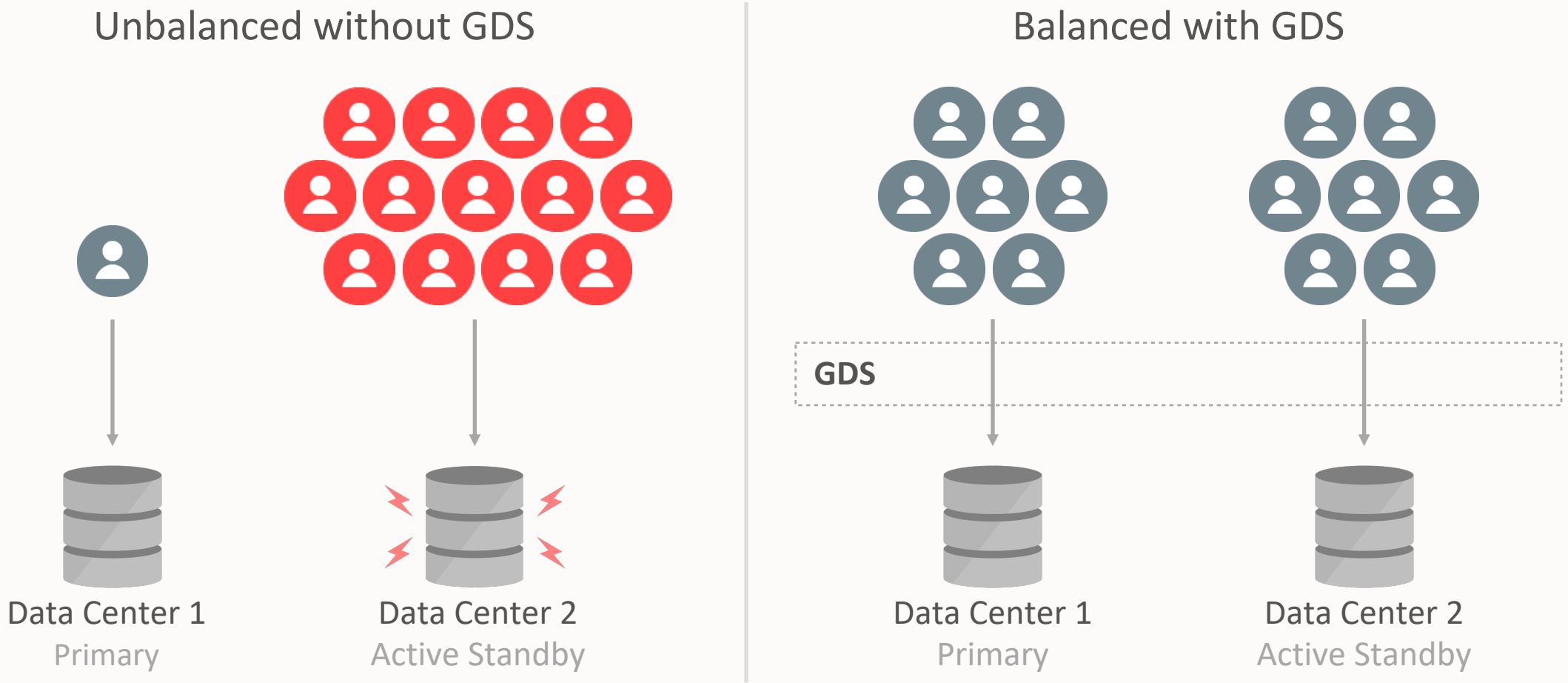


Inter-database service failover

Role based global services

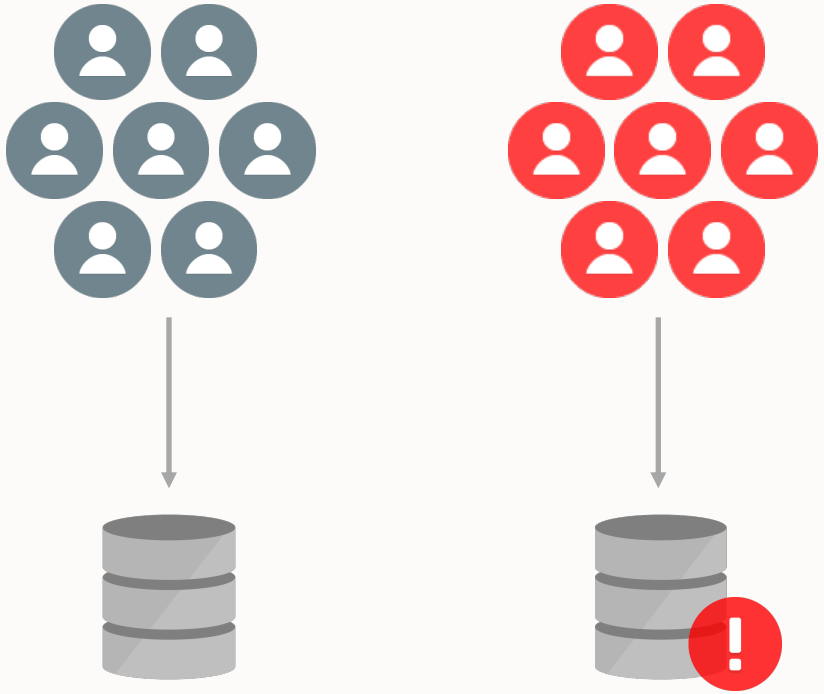
Load balancing
(connect-time & run-time)

Workload Balance – Maximize Application Performance

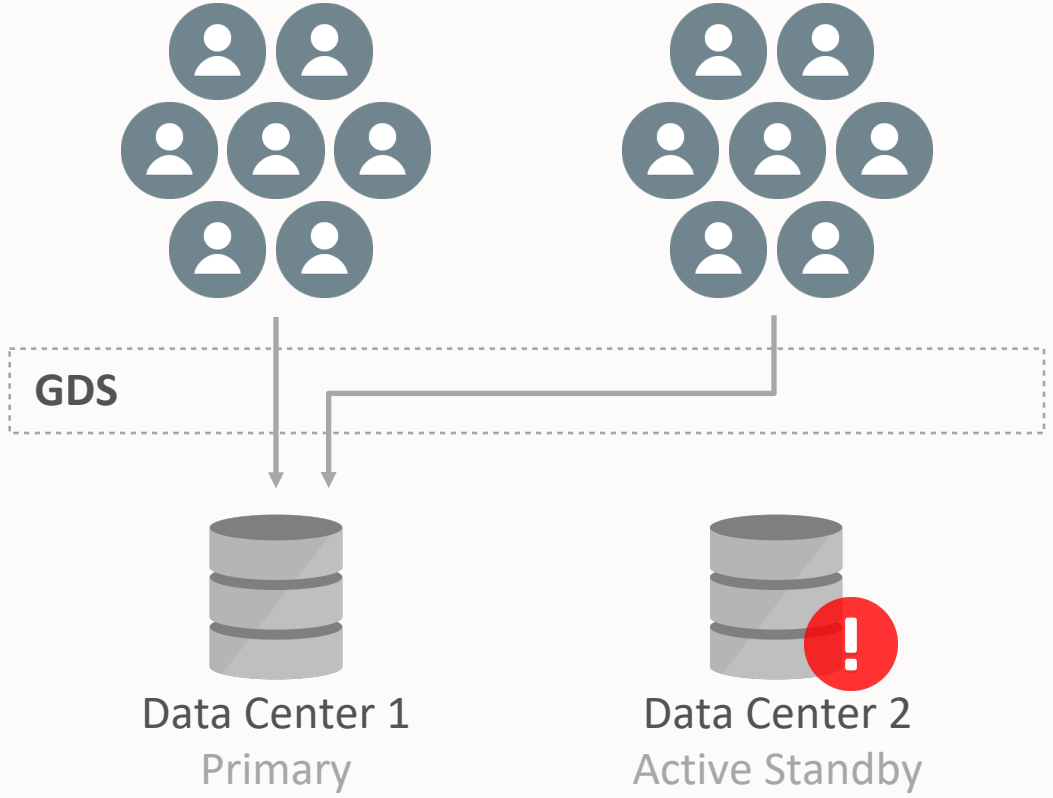


Global Service Failover – Maximize Application Availability

No Global Service Failover without GDS

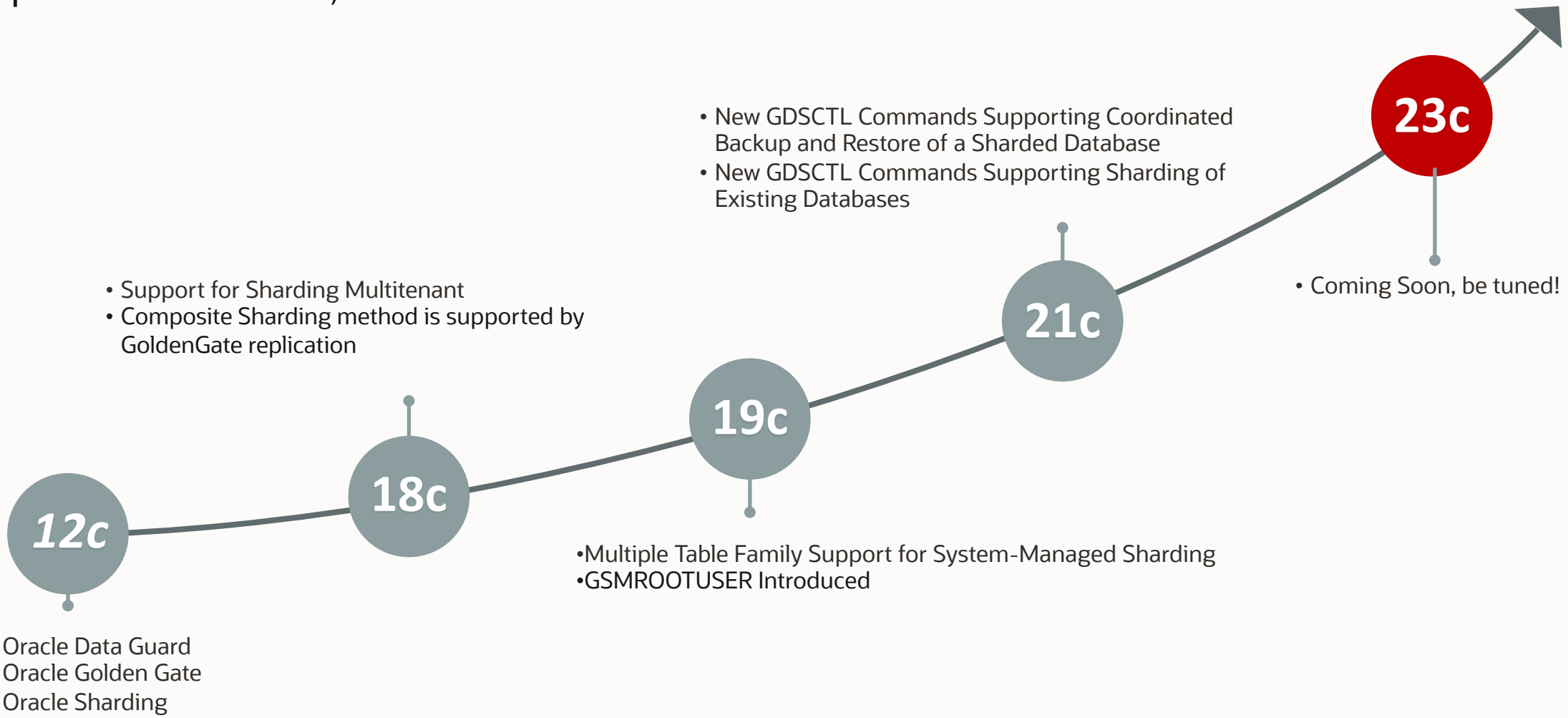


Global Service Failover with GDS

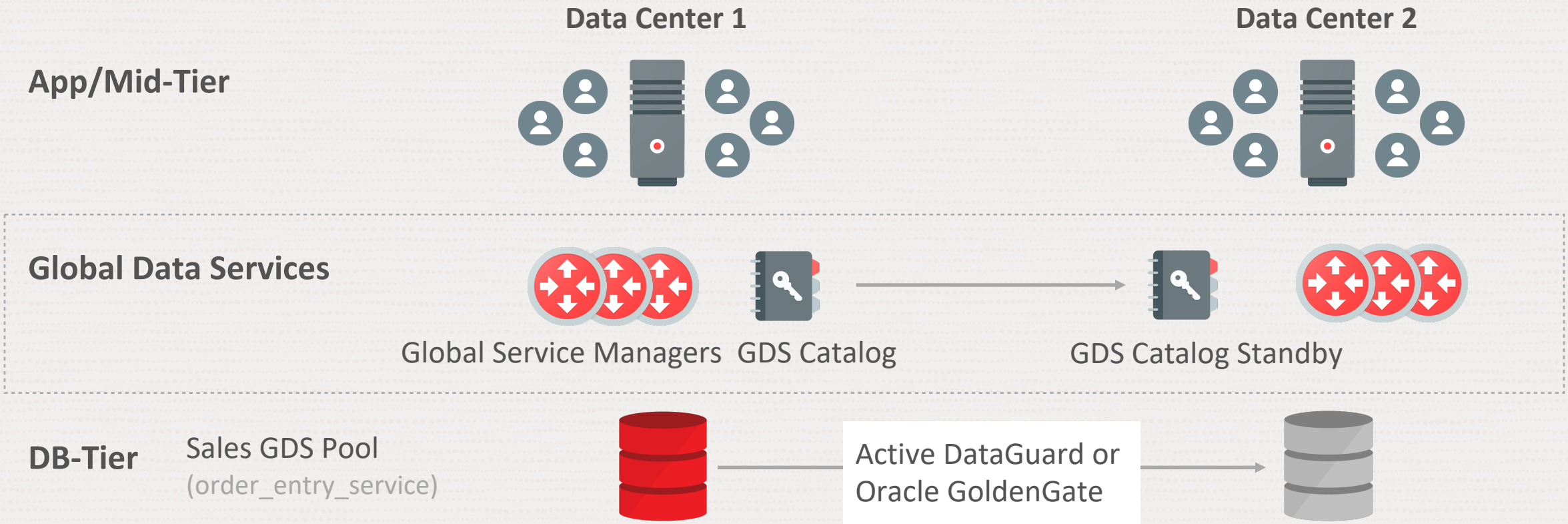


Oracle Global Data Services

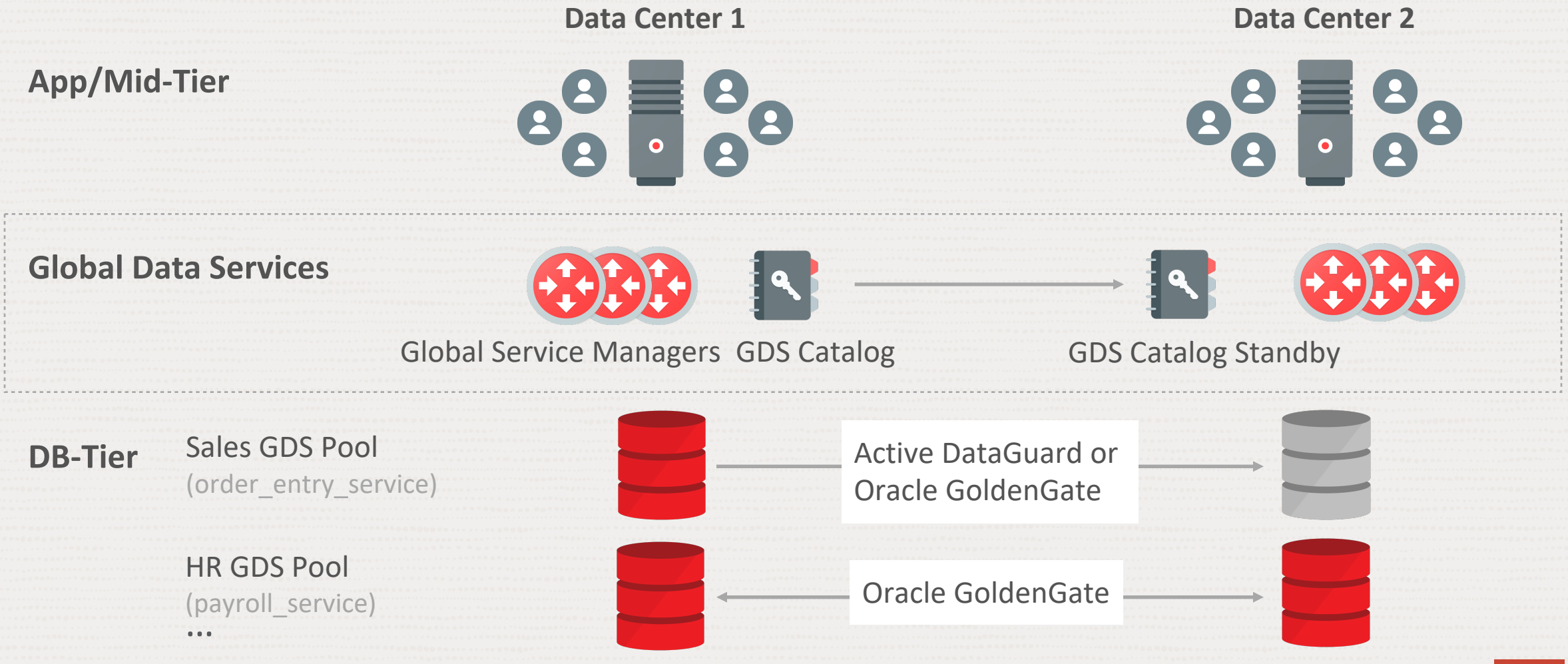
GDS is a highly effective solution for automatic workload management across a set of replicated databases,



GDS Architecture



One GDS Infrastructure For Many Replicated Configurations



GDS Components

Global Service Manager (GSM):

- Regional listener to the incoming database connections
- Performs Connect-time load balancing
- Publishes FAN events (via ONS) for service failovers and run-time load balancing advisory
- Inter-database Service failover & management

GDS Catalog: stores GDS configuration metadata

GDS Region: Group of databases and clients in close network proximity, e.g., East, West

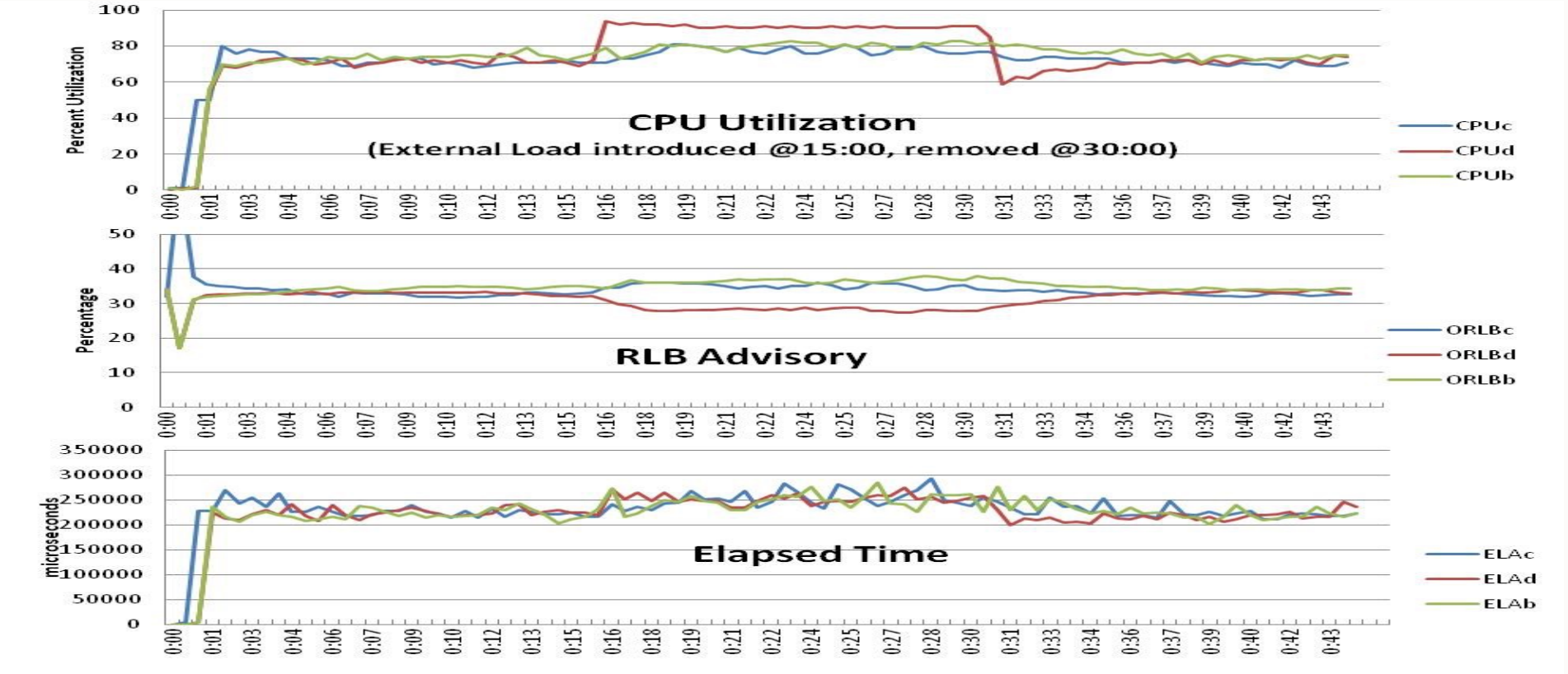
GDS Pool: Databases that offer a common set of global services, e.g., HR, Sales

Global Service: Database Service provided by multiple databases with replicated data

- Local service + {Locality, replication lag, role, database cardinality, load balancing goals}
- Establish workload management policies via Service attributes

Run-time Load Balancing with GDS

Standalone Identical Database Servers with External Load

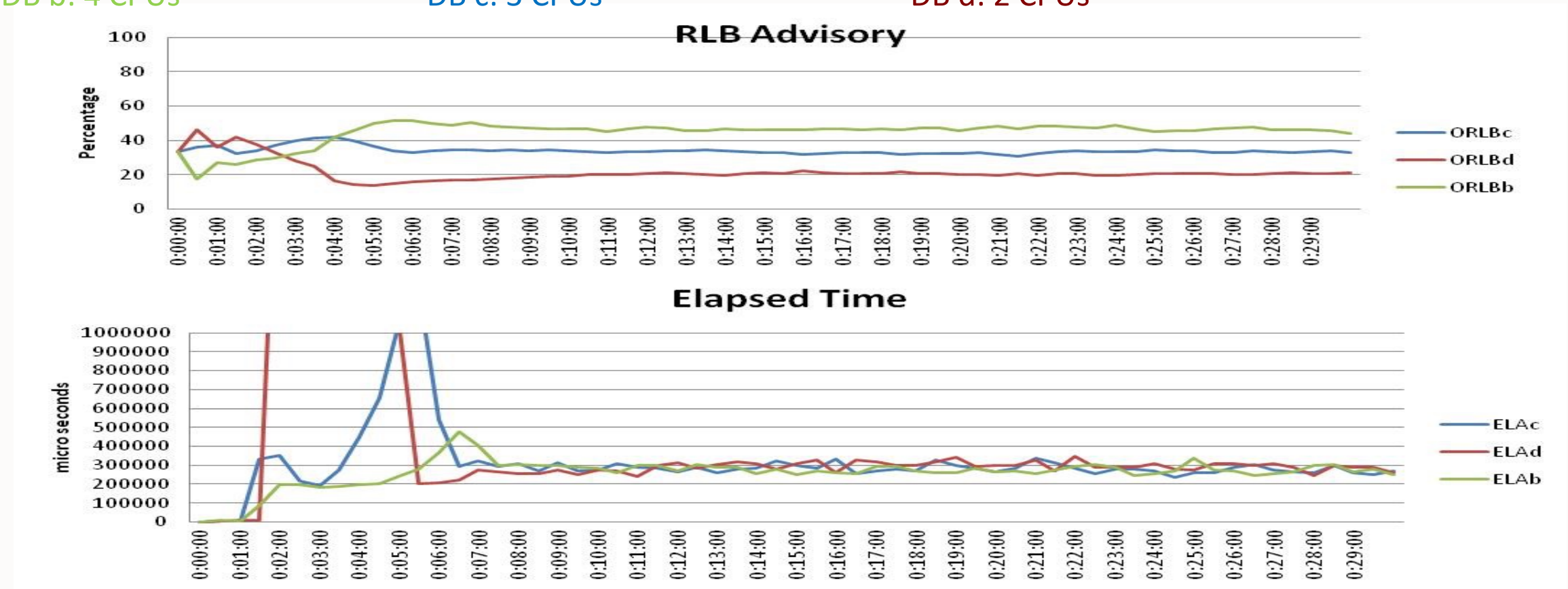


Routing responds gracefully to changing system conditions

Run-time Load Balancing with GDS

Standalone Asymmetrical Database Servers

DB b: 4 CPUs DB c: 3 CPUs DB d: 2 CPUs



GDS does intelligent load balancing even across asymmetrical database servers

GDS – A shared infrastructure

A Single GDS manages

- 20 GDS Pools
- 10 GDS Regions
- 5 GSMs per Region
- 300 Database instances
- 1000 Global Services
- 1000 Mid-tier connection pools

GDS Databases

- Must be Oracle Database EE 12.1+
- Can be a Single Instance or RAC
- Can be CDB or Non-CDB
- Can run on commodity or Engineered systems (Oracle Exadata, ODA)
- Managed with GDSCTL CLI or Enterprise Manager DB Plug-in
- Must be licensed for Active Data Guard or Oracle GoldenGate

GDS Deployment

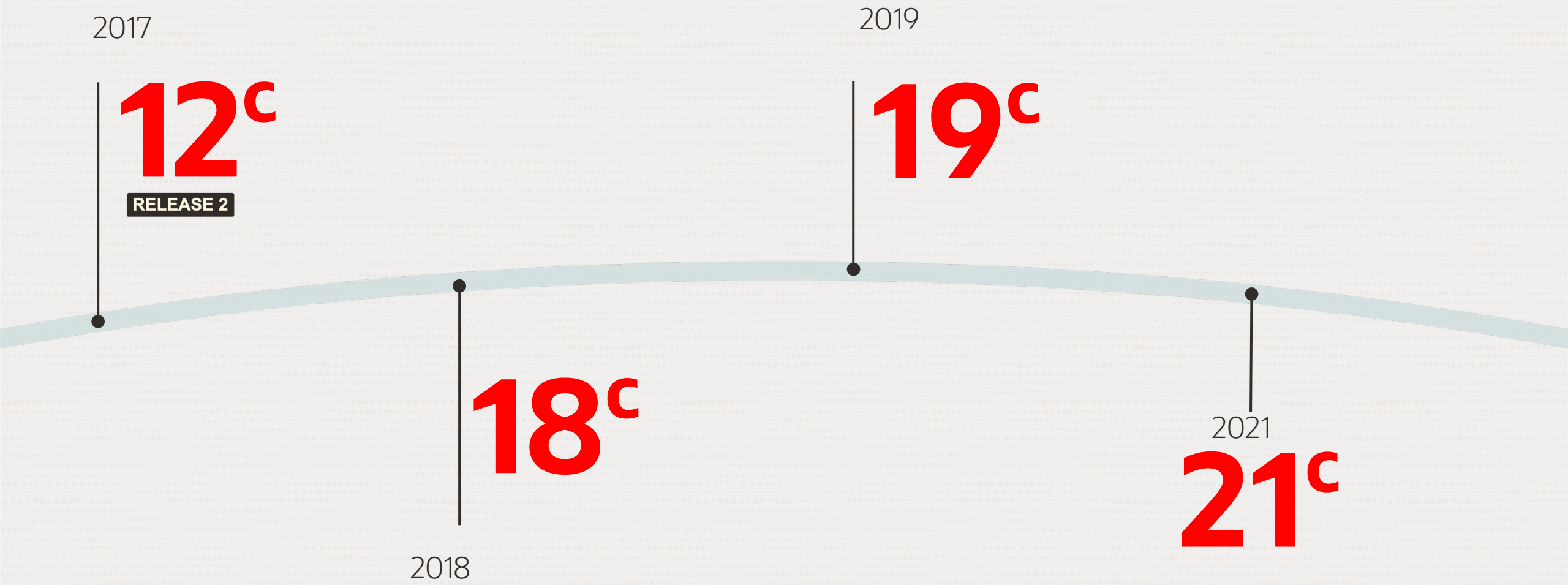
High Level Steps

1. Install GSM software on GSM servers
   - Min of 1 GSM per region
   - Recommended 3 GSMs/region
2. Pre-create the GDS catalog database
3. Setup GDS Administrator accounts & privileges
4. Configure GDS
   - Create GDS Catalog and Standby
   - Add GSMs, Regions, Pools, Databases, and Global Services
5. Setup client connectivity

Key points from Oracle Could World 2022

Making your data the center of attention

Continual improvements in each release…



Continual improvements in each release…

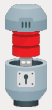
2017

12c

RELEASE 2

2019

Sharding



Online Encryption

Multitenant, Online Clone and Relocate

New In-Memory Features

Autonomous Health Framework

Real Time Analytics

18c

2018

2021

21c

Continual improvements in each release…

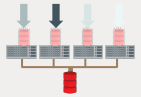
2017

12c

RELEASE 2

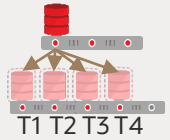
Active Directory Integration

Private Temporary Tables



Sharded RAC

Mem-Optimized Row Store



Multitenant Snapshot Carousel

In-Mem for External Tables

18c

2018

2021

21c

Continual improvements in each release…

2017

High Speed Data Ingestion

Active Data Guard DML Redirect

Automatic Indexing

Hybrid Partition Tables

JSON Improvements

Security Enhancements

2018

18c

2019

19c

Final release that supports non-container database (non-CDB) architecture

2021

21c

Continual improvements in each release…

2017

12c

RELEASE 2

2018

2019

19c

- Native Blockchain Tables
- Native JSON Type
- AutoML
- SQL Macros
- Per-PDB Data Guard
- JavaScript Stored Logic

2021

21c

23c

App Simple

Introducing:

The next long term support release of Oracle Database

Oracle Database 23c accelerates Oracle's mission to make it **simple** to develop and run all data-driven apps

BETA available now on-premises and in Oracle Cloud

https://tinyurl.com/OracleBeta

Oracle 23c is the sum of…

21c + 23c

All the features from Oracle 21c Innovation Release

300+ New Features and Enhancements

Key focus areas:
JSON, Graph, Microservices, Developer Productivity

A Better Document Database Than MongoDB

Blockchain JSON Tables

JSON Data Guide

Oracle Database 23c

App Simple

In-Memory Document Analytics

SQL

Full SQL Support

New In 23c

2X Faster Operational Workloads than MongoDB

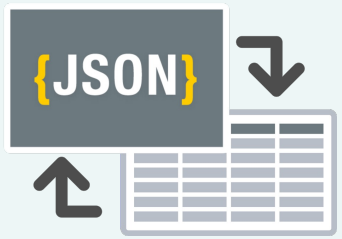
New In 23c

JSON Schema

MongoDB API

New In 23c

JSON / Relational Duality



Native JSON Datatype

Best in Class Security

New In 23c

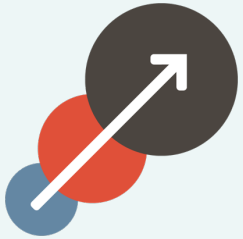
JS

JS Stored Procedures

New In 23c

Graph Analytics

New In 23c

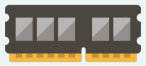


10X faster Analytics

A Better Operational Graph Database

High Speed Ingest

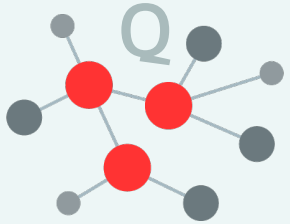
In-Memory Analytics



Graph Studio

New In 23c

SQL/PG Q



Oracle Database 23c

App Simple

50+ Graph Analysis Algorithms

New In 23c

JSON or Row based Graph Models

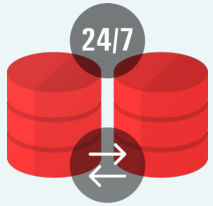
Flashback Queries

Comprehensive Enterprise Capabilities

Full SQL Support

New In 23c

Unrivaled High Availability



Average of 26X Faster

Low-Cost Secondary Indexes

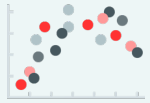
Best in Class Security

Better SQL Than Anyone Else

Approximate Functions

Automatic
Indexing, Partitioning, Materialized Views

Window Functions



Real Time Materialized Views

Polymorphic Tables

SQL Model Clause

SQL Macros

SQL Pattern Matching

External Tables

Oracle Database

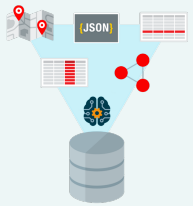
23c

App Simple

Readers don't block Writers

Parallel Query

Multi Model



Flashback Query

Results Cache

PL/SQL

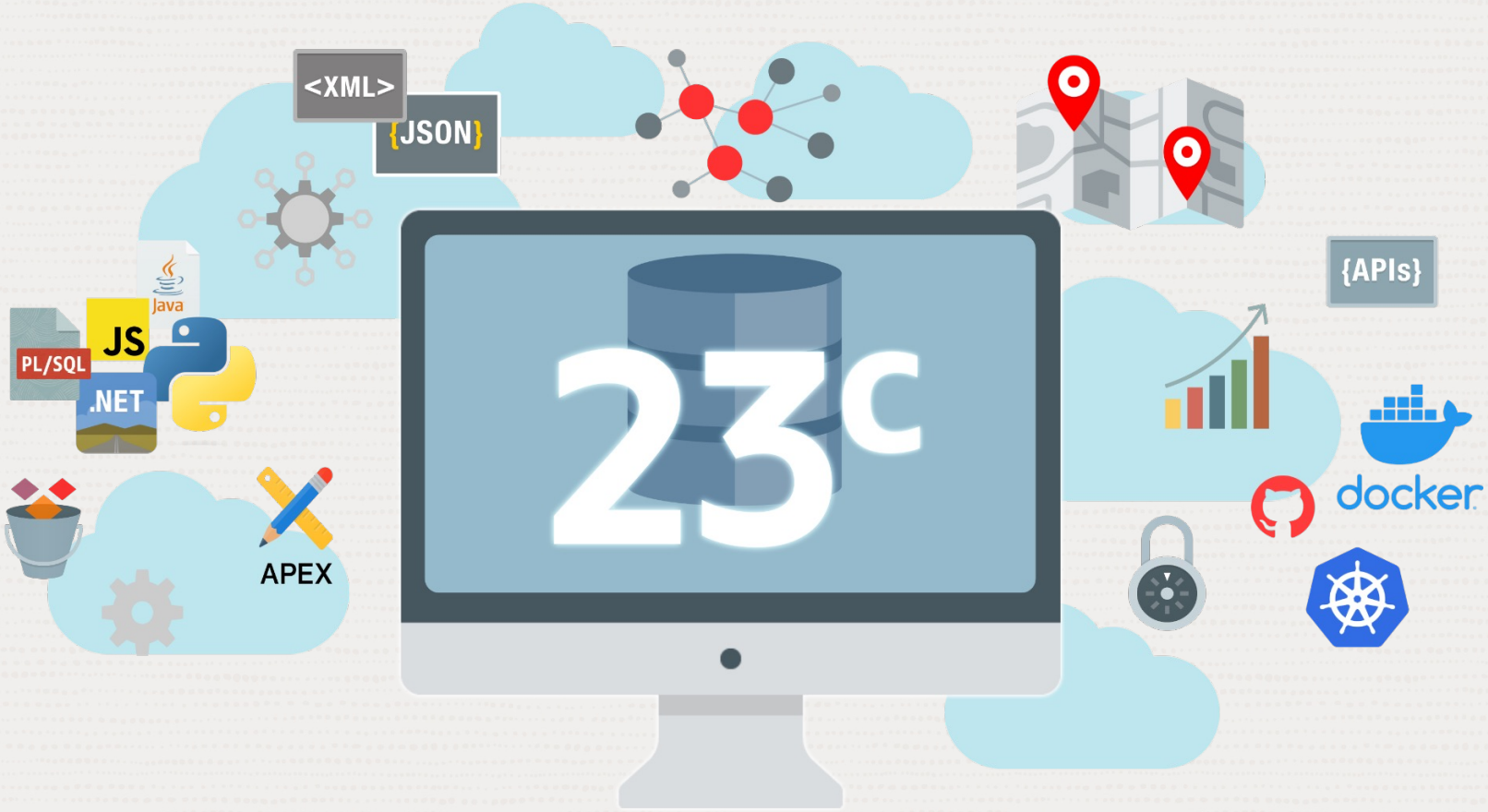
SQL/PGQ

New In 23c

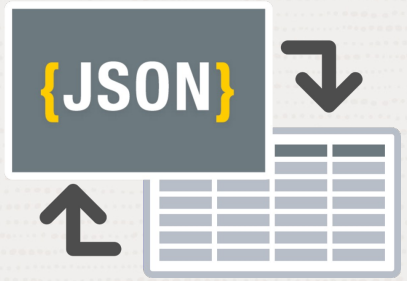
SQL For JSON

Analytical Views

Oracle Database 23c, Simple and Complete



Making 23c Simpler



JSON Relational Duality

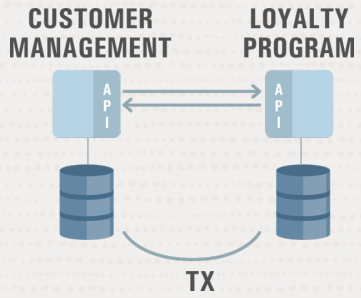
Data can be transparently accessed and updated as either JSON documents or Relational Tables

Developers benefit from the strengths of both

Simpler and more powerful than Object Relational Mapping (ORM)

Operational Property Graph

Developers can now build real-time graph analysis applications against operational data directly in the Oracle Database, utilizing its industry leading security, high availability and performance capabilities.



Microservice Support

Alongside Oracle's already comprehensive support for microservices, new functionality makes it simpler to implement cross service transactions.

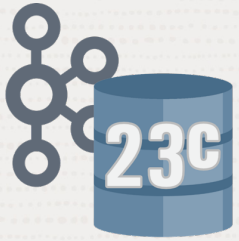
Many Datatype and SQL Enhancements

- Boolean Datatype
- Direct Joins for Update
- SELECT without FROM
- Group By Alias
- Unicode-14 Support

Making 23c Complete

SQL Firewall

Embedded inside the database, SQL Firewall provides real-time protection against common database attacks by monitoring and blocking unauthorized SQL and SQL injection attacks, no matter the SQL execution path.

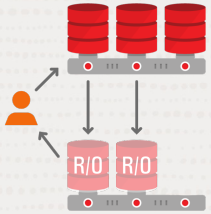


OKafka

Kafka applications can now run directly against the Oracle Database with minimal code changes leveraging high performance Transaction Even Queues (TxEventQ).

JavaScript Stored Procedures

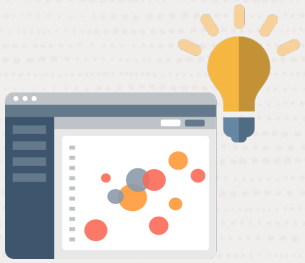
Allows developers to create stored procedures using JavaScript in the database. This functionality also allows developers to leverage the huge number of JavaScript libraries.



Read-Only Per-PDB Standbys

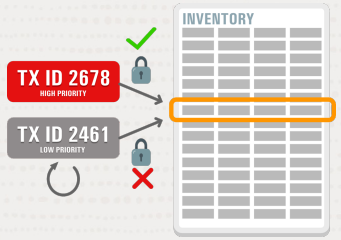
Per-PDB Data Guard now supports the PDBs being opened Read-Only. This further increases the flexibility of solution supporting the offloading of reporting on the standby.

Making 23c Complete



Improved ML Algorithms

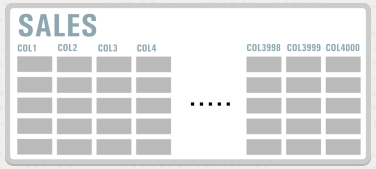
New improvements to Oracle In-Database Machine Learning algorithms make it simpler to categorize text and data whilst offering better performance and flexibility.



Priority Transactions

Low priority transactions that block high priority transactions can be automatically aborted.

This reduces the admin burden on the DBA whilst maintaining high transaction throughput.



Up to 4096 Columns per Table

Tables now support up to 4096 columns.

This simplifies the development of applications needing large numbers of attributes such as ML and IoT

Azure AD Oauth2 Integration

New functionality enables single sign-on to Oracle Database service instances from Microsoft Azure Cloud.

Plus Over 300 Additional New Features

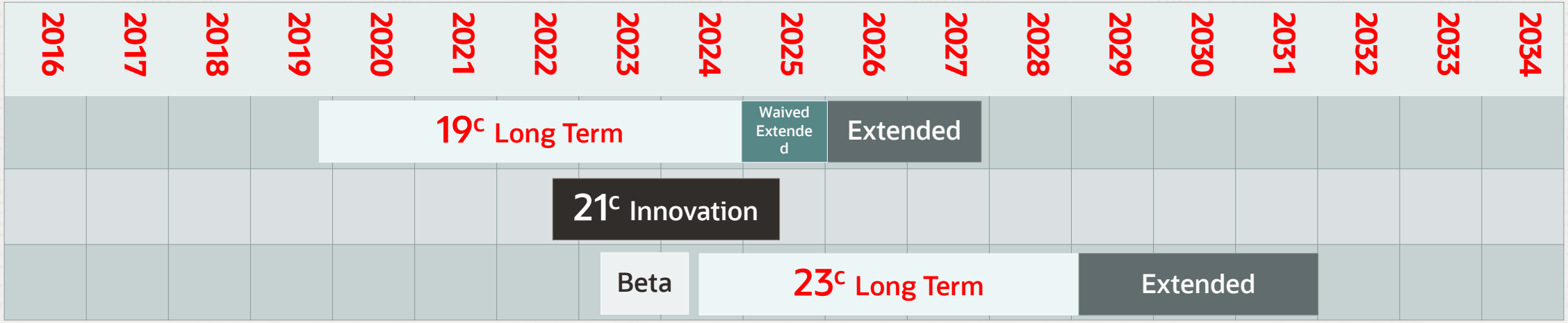
Announcing One Year of Waived Extended Support for Oracle 19c

Premier Support Ends April 30th 2024

Waived Extended Support Ends April 30th 2025

Extended Support Ends April 30th 2027

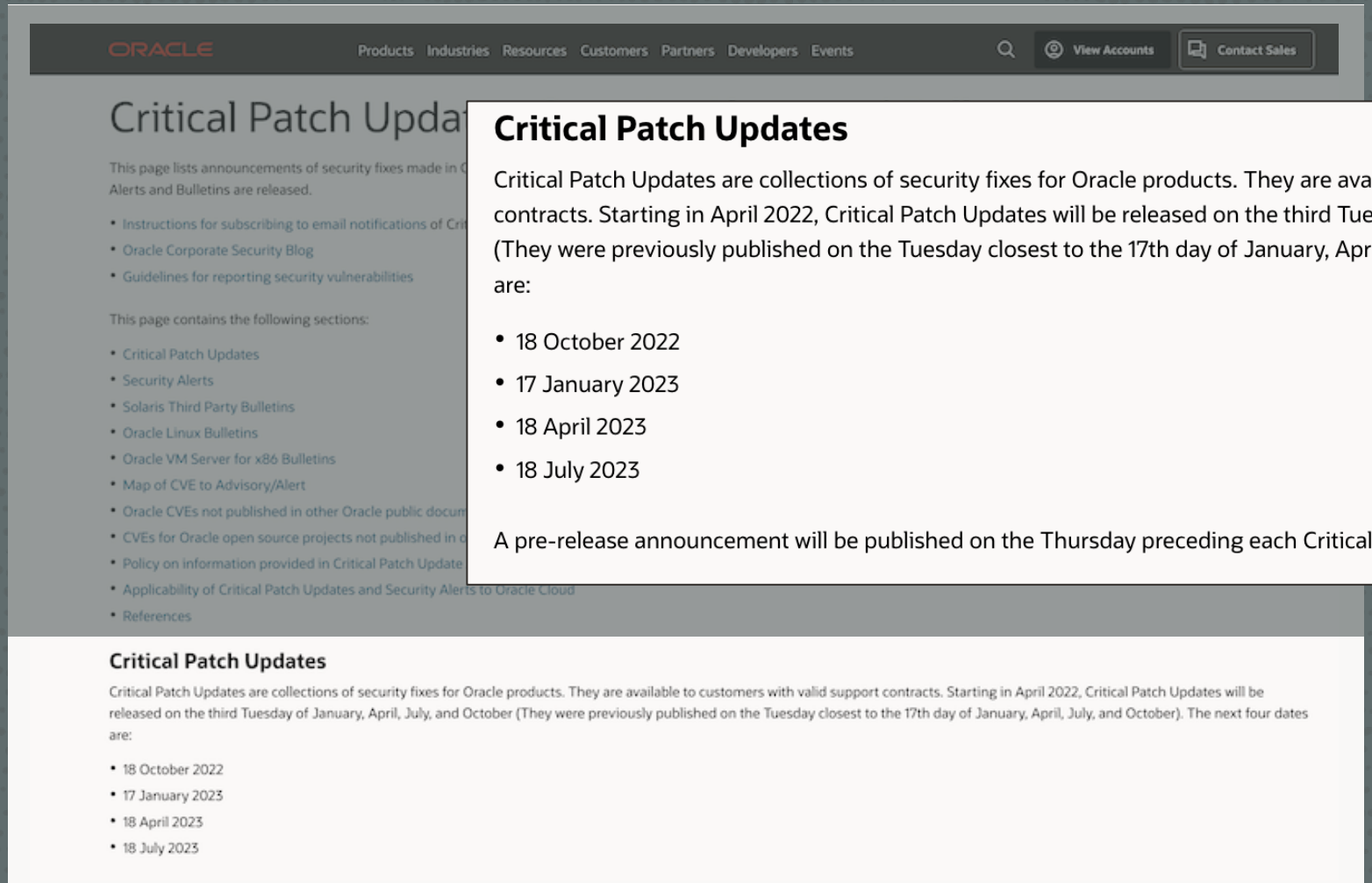
Projected Database Release and Support Timeline



- Innovation Release - 2 years of Premier Support, and no Extended Support
- Long Term Release - 5 years of Premier Support, and 3 years of Extended Support
- Always refer to MOS Note: Release Schedule of Current Database Releases (Doc ID 742060.1)

Finding the Right Patches | Quarterly

https://www.oracle.com/security-alerts/



Critical Patch Updates

Critical Patch Updates are collections of security fixes for Oracle products. They are available to customers with valid support contracts. Starting in April 2022, Critical Patch Updates will be released on the third Tuesday of January, April, July, and October (They were previously published on the Tuesday closest to the 17th day of January, April, July, and October). The next four dates are:

- 18 October 2022
- 17 January 2023
- 18 April 2023
- 18 July 2023

A pre-release announcement will be published on the Thursday preceding each Critical Patch Update release.

Announcing Monthly Recommended Patches

- For each new Release Update (RU)
  - Each MRP contains the current set of recommended one-off patches for the RU plus the prior MRPs
  - As documented in MOS note 555.1

- Customers get access to recommended, one-off patches
  - Without having to request a patch bundle after an RU release

- Starting with 19.17 in October, Oracle will ship six MRPs for each RU
  - Release Update Revisions (RURs) will be sunsetted after 19.16.2 (January, 2023)
  - MRPs are available on Linux x86-64 only
  - RUs continue to be available on all supported platforms

Timeline | Release Update

	2021				2022				2023				2024		
	January	**April**	**July**	**October**	**January**	**April**	**July**	**October**	**January**	**April**	**July**	**October**	**January**	**April**	**July**
19c	19.10.0	19.11.0	19.12.0	19.13.0	19.14.0	19.15.0	19.16.0	19.17.0	19.18.0	19.19.0	19.20.0	19.21.0	19.22.0	19.23.0	19.24.0
21c		21.3.0	21.4.0	21.5.0	21.6.0	21.7.0	21.8.0	21.9.0	21.10.0	21.11.0	21.12.0	21.13.0	21.14.0	21.15.0	

Timeline | Monthly Recommended Patches

	2022			2023									
	October	November	December	January	February	March	April	May	June	July	August	September	October	November
19.17.0	19.17.0	MRP1	MRP2	MRP3	MRP4	MRP5	MRP6							
19.18.0				19.18.0	MRP1	MRP2	MRP3	MRP4	MRP5	MRP6				
19.19.0							19.19.0	MRP1	MRP2	MRP3	MRP4	MRP5	MRP6	
19.20.0										19.20.0	MRP1	MRP2	MRP3	MRP4
19.21.0													19.21.0	MRP1

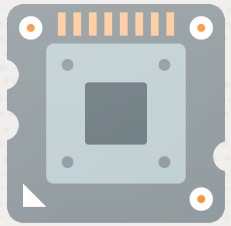
Other Announcements

APEX 22.2

Golden Gate Free

ORACLE | GoldenGate

Arm Support



MongoDB Compatible API

mongoDB®

Wrapping-up

Let’s review everything

MAA reference architectures

Availability service levels

Bronze	Silver	Gold	Platinum
Dev, test, prod	**Prod/departmental**	**Business critical**	**Mission critical**
Single instance DB	**Bronze +**	**Silver +**	**Gold +**
Restartable	Database HA with RAC	DB replication with Active Data Guard	GoldenGate
Backup/restore	Application continuity		Edition-based redefinition
	Sharding (optional)		

All tiers exist with on-premises and cloud. However, platinum currently must be configured manually while bronze to gold are covered with some form of cloud automation depending on the desired MAA architecture (i.e., multiple standby databases still must be manually configured in cloud today)

Why Oracle Database instead of others?

1

Architectured for all Maximum Availability requirements your data could require to achieve your business SLA's.

2

Continuous Innovation in a pace Open Source Databases can only dream about.

3

Converged database to store all your data in one place and cover all your applications needs in one place – Lower TCO and higher ROI in the market.

Business Reasons

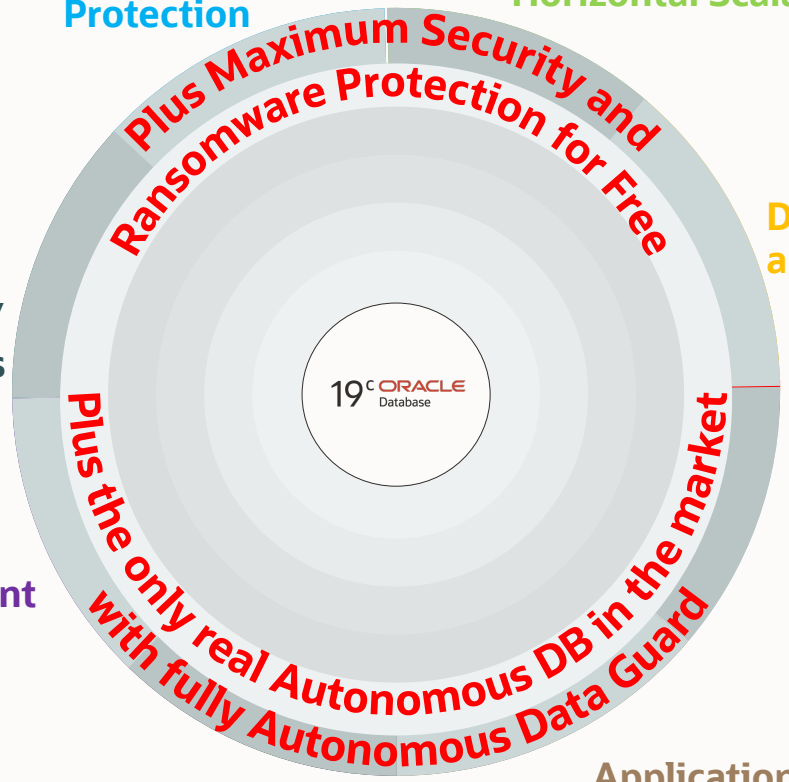
Why Oracle Database instead of others?

1. Reads do not block Writers – Use all your resources without being afraid of impacting your data availability
2. Data Replication the right way – protecting data integrity, recoverability and against Ransomware
3. **Application Continuity and transparent Applications upgrades/deployments**
4. Real Zero Downtime Patching and Migrations, plus near Zero Downtime Upgrade
5. High Availability and Disaster and Recover with Zero Data Loss at any distance, whatever your data is
6. **The most efficient time machine for your data, at transaction, query, query version, and database level**

Technical Reasons

Need more reasons to why Oracle is the best for your data?

Oracle Database – all-inclusive, converged by design and protected by MAA



Data Corruption Protection

Automatic Block Media Recovery
RMAN – Block Media Recovery
Zero Data Loss Recovery Appliance (ZDLRA)

High Availability & Horizontal Scalability

Oracle Real Application Clusters
Oracle Sharding
Oracle GoldenGate

Zero Downtime Patches/ Upgrades/ Migrations

Oracle Real Application Clusters
Oracle GoldenGate
Edition Base Redefinition
Rolling Upgrade
Oracle Fleet Patching and Provisioning (FPP)
Zero Downtime Migration (ZDM)

Disaster and Recovery

Oracle Data Guard
Oracle Active Data Guard
Oracle GoldenGate
Oracle Flashback
Zero Data Loss Recovery Appliance (ZDLRA)
Oracle Database Zero Data Loss Autonomous Recovery Service

Storage Management

Oracle Automatic Storage Management

Multi-Master Capabilities

Oracle Real Application Clusters
Oracle GoldenGate
Oracle Active Data Guard (DML Redirection)

Automation

Full Stack DR
Fast-Start Failover (FSFO)
Oracle Fleet Patching and Provisioning (FPP)
Global Data Services

Application Continuity

Oracle Real Application Clusters
Global Data Services
Oracle Application Continuity
Transparent Application Continuity
Edition Base Redefinition
Oracle GoldenGate

Oracle LiveLabs

Showcasing how Oracle's solutions solve your business problems

500+

free workshops, available or in development

2 million

people have already visited LiveLabs

600+

events run using LiveLabs workshops

developer.oracle.com/livelabs

learn something new …at your pace!

Oracle ACE Program

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The **Oracle ACE Program** recognizes & rewards individuals for their technical & community contributions to the Oracle community

3 membership tiers

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- Oracle ACE Associate

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Oracle ACE

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yourself or a candidate:

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Where to get more information
(Including Demos and Livelab links)

- Discovering Oracle MAA
- Oracle MAA Page and Feature Details
- Oracle MAA Webcast Series
- Oracle MAA Datasheet
- Demos – Oracle Active Data Guard
- Demo – RMAN and ZDLRA
- Demo – Oracle GoldeGate
- Demos – Oracle Data Guard and Sharding
- Free Training – Active Data Guard
- Free Training – Oracle GoldeGate
- Free Training – Application Continuity
- Free Training – Oracle RAC
- Full Stack DR Page – https://bit.ly/3WkAx5R
- Full Stack DR Documentation – https://bit.ly/3h6wjOQ
- Lab Step-by-Step Tutorial Part I – https://bit.ly/3SWP1FW
- Lab Step-by-Step Tutorial Part II - https://bit.ly/3FK2YEa

Q&A

Any Questions


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