ORACLE

Oracle (Active) Data Guard

Master Slide Deck - Updated 2024.09.02

Ludovico Caldara

Senior Principal Product Manager

Oracle Database High Availability (HA), Scalability and Maximum Availability Architecture (MAA) Team

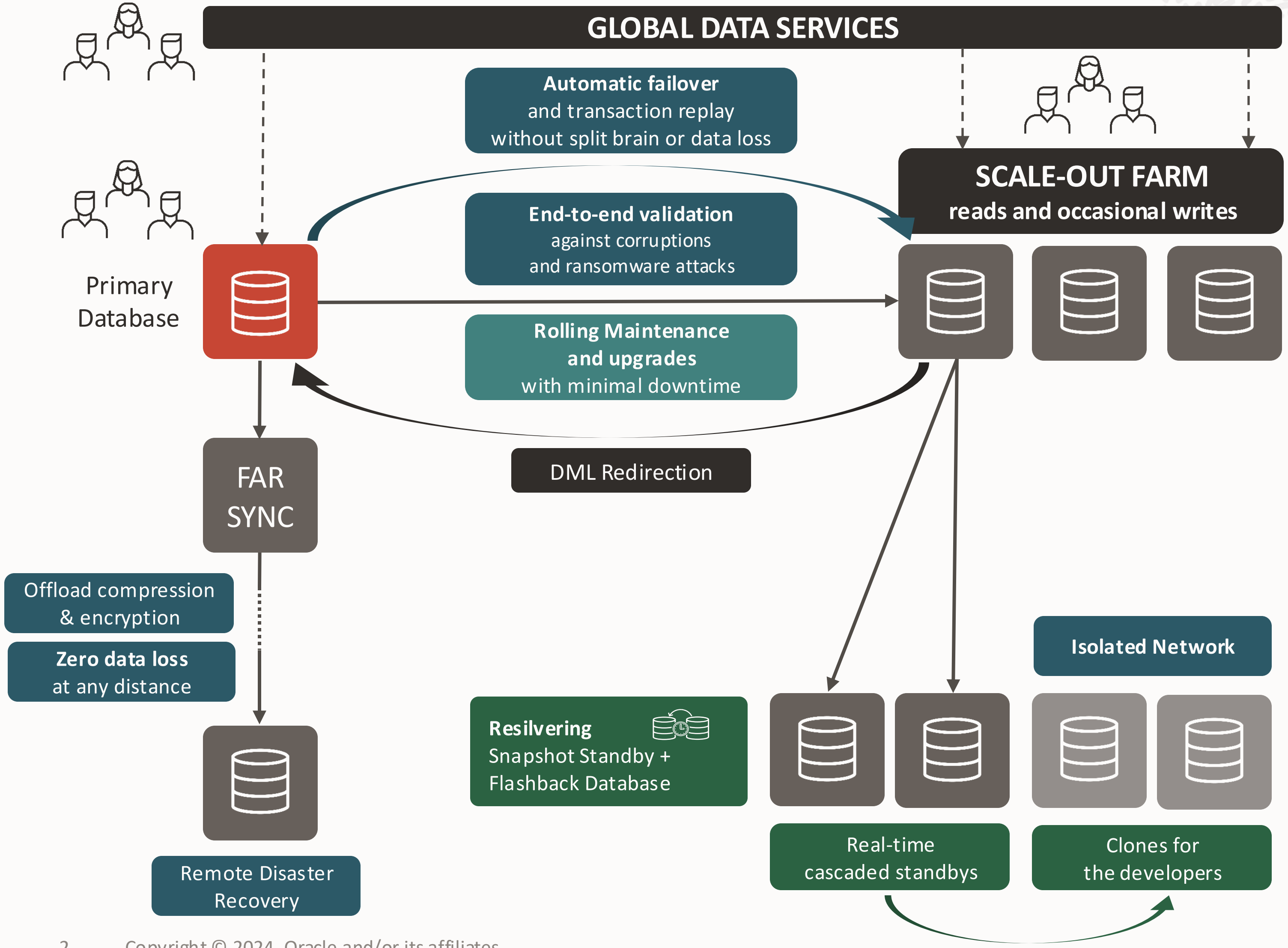
@ludodba

in http://www.linkedin.com/in/ludovicocaldara

www.ludovicocaldara.net

Oracle Active Data Guard

Come for the data protection, stay for the data management



GLOBAL DATA SERVICES

Automatic failover and transaction replay without split brain or data loss

End-to-end validation against corruptions and ransomware attacks

Rolling Maintenance and upgrades with minimal downtime

DML Redirection

SCALE-OUT FARM reads and occasional writes

Primary Database

FAR SYNC

Offload compression & encryption

Zero data loss at any distance

Remote Disaster Recovery

Resilvering Snapshot Standby + Flashback Database

Isolated Network

Real-time cascaded standbys

Clones for the developers

UNMATCHED DATA PROTECTION

OPERATIONAL CONTINUITY

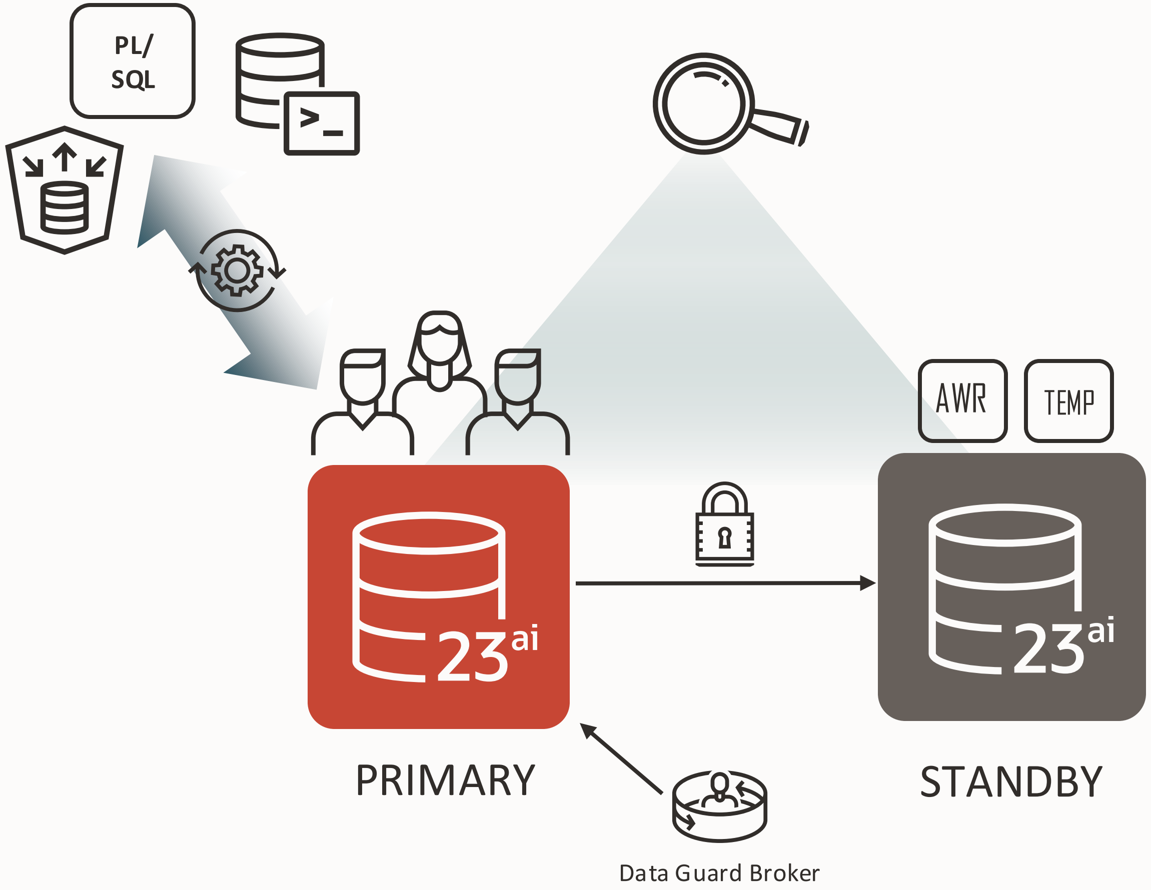
MODERN DEVELOPMENT PLATFORM

SCALE AS YOU GROW

New In 23ai

Active Data Guard 23ai furtherly enhances the experience

Enhanced performance, observability, and manageability



- Automatic preparation of the primary
- PL/SQL APIs for better automation
- SQLcl command-line integration
- REST APIs for easier DevOps integration
- 4 new SQL views to monitor Data Guard
- Support for mixed Transparent Data Encryption
- Automatic temp file creation on the standby
- Simplified AWR snapshots on the standby DB

Oracle (Active) Data Guard & MAA

Challenges of deploying highly available systems

Cost and complexity

Lack of skills

Risk of failure

Impact of database downtime

$350K

average cost of downtime per hour

$10M

average cost of unplanned data center outage or disaster

87 hours

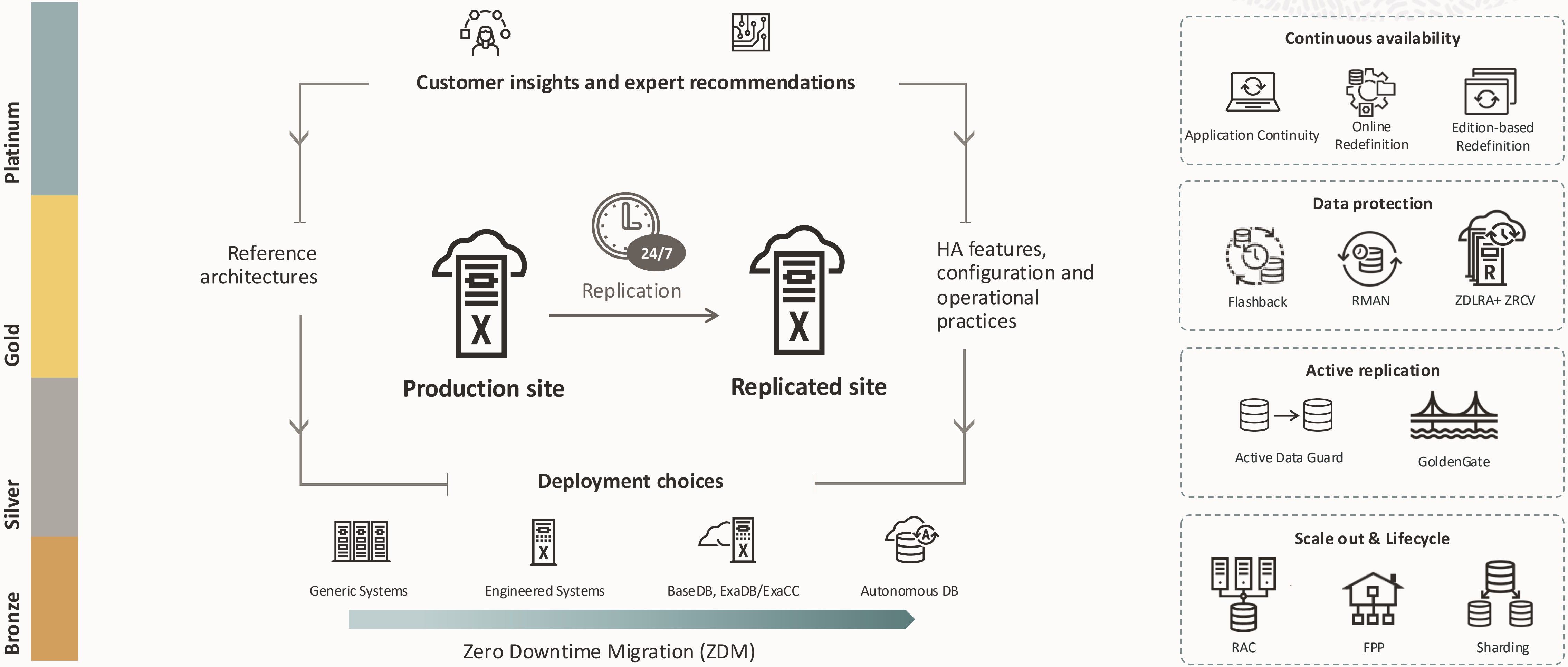
average amount of downtime per year

91%

percentage of companies that have experienced an unplanned data center outage in the last 24 months

Oracle Maximum Availability Architecture (MAA)

Standardized Reference Architectures for Never-Down Deployments



Platinum

Gold

Silver

Bronze

Customer insights and expert recommendations

Reference architectures

24/7

Replication

Production site

Replicated site

HA features, configuration and operational practices

Deployment choices

Generic Systems

Engineered Systems

BaseDB, ExaDB/ExaCC

Autonomous DB

Zero Downtime Migration (ZDM)

Continuous availability

Application Continuity

Online Redefinition

Edition-based Redefinition

Data protection

Flashback

RMAN

ZDLRA+ ZRCV

Active replication

Active Data Guard

GoldenGate

Scale out & Lifecycle

RAC

FPP

Sharding

MAA reference architectures

Availability service levels

Bronze

Dev, test, prod

Single instance DB

Restartable

Backup/restore

Silver

Prod/departmental

Bronze +

Database HA with RAC

Application continuity

Sharding (optional)

Gold

Business critical

Silver +

DB replication with Active Data Guard

Platinum

Mission critical

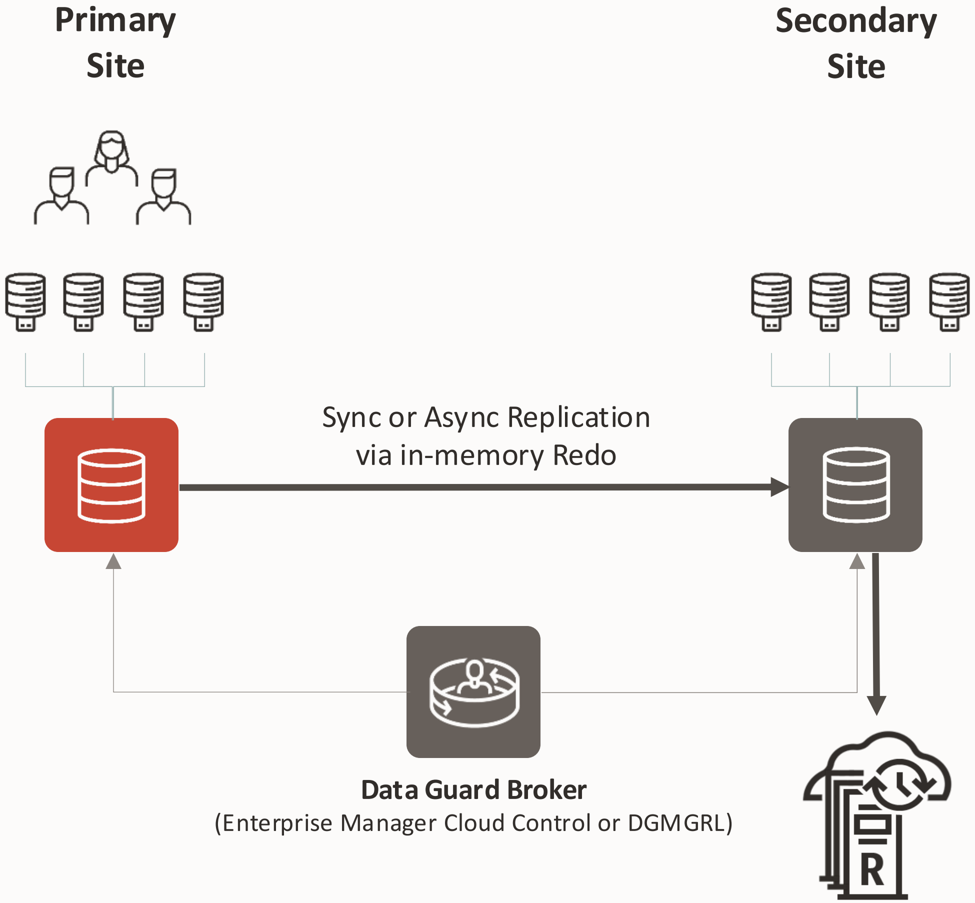
Gold +

GoldenGate

Edition-based redefinition

Oracle Data Guard Overview

Oracle Data Guard


Primary Site
Secondary Site
Sync or Async Replication via in-memory Redo
Data Guard Broker
(Enterprise Manager Cloud Control or DGMGRL)
R

- **Disaster Recovery (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

Data Guard

Capabilities Included with Oracle Database Enterprise Edition (EE)

Data Protection

- Zero or sub-second data loss protection
- Strong isolation using continuous Oracle validation
- Lost-write detection
- Universal support – all data types and applications
- Comprehensive monitoring with Enterprise Manager

High Availability

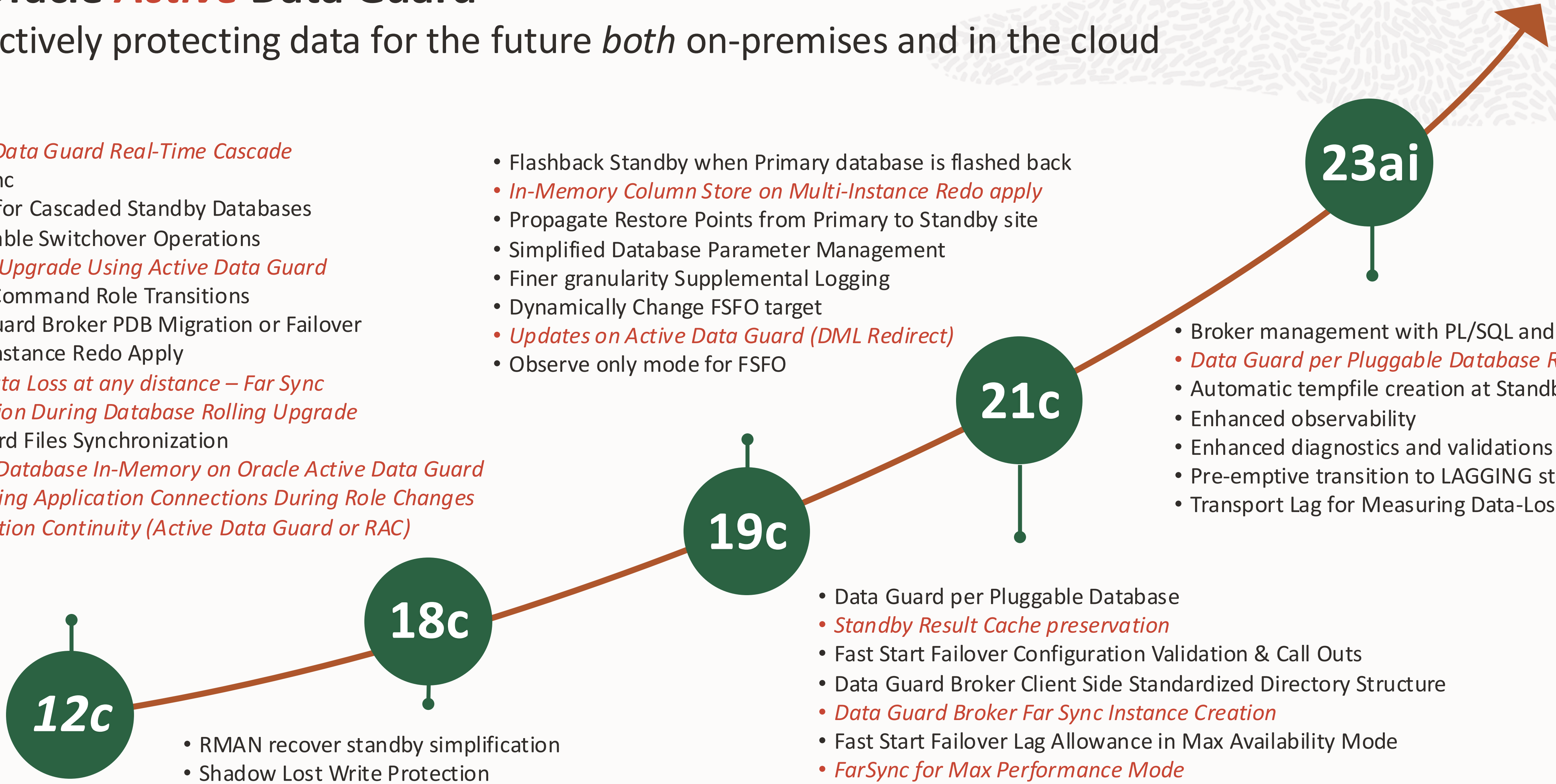
- Automatic database failover
- Automatic client failover
- Standby-first patch apply
- Database rolling maintenance
- Select platform migrations

Performance and ROI

- Extreme throughput - supports all workloads
- Dual-purpose standby for development and test
- Integrated management

Oracle *Active* Data Guard

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



12c

- *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 (Active Data Guard or RAC)*

18c

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

19c

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

21c

- 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*

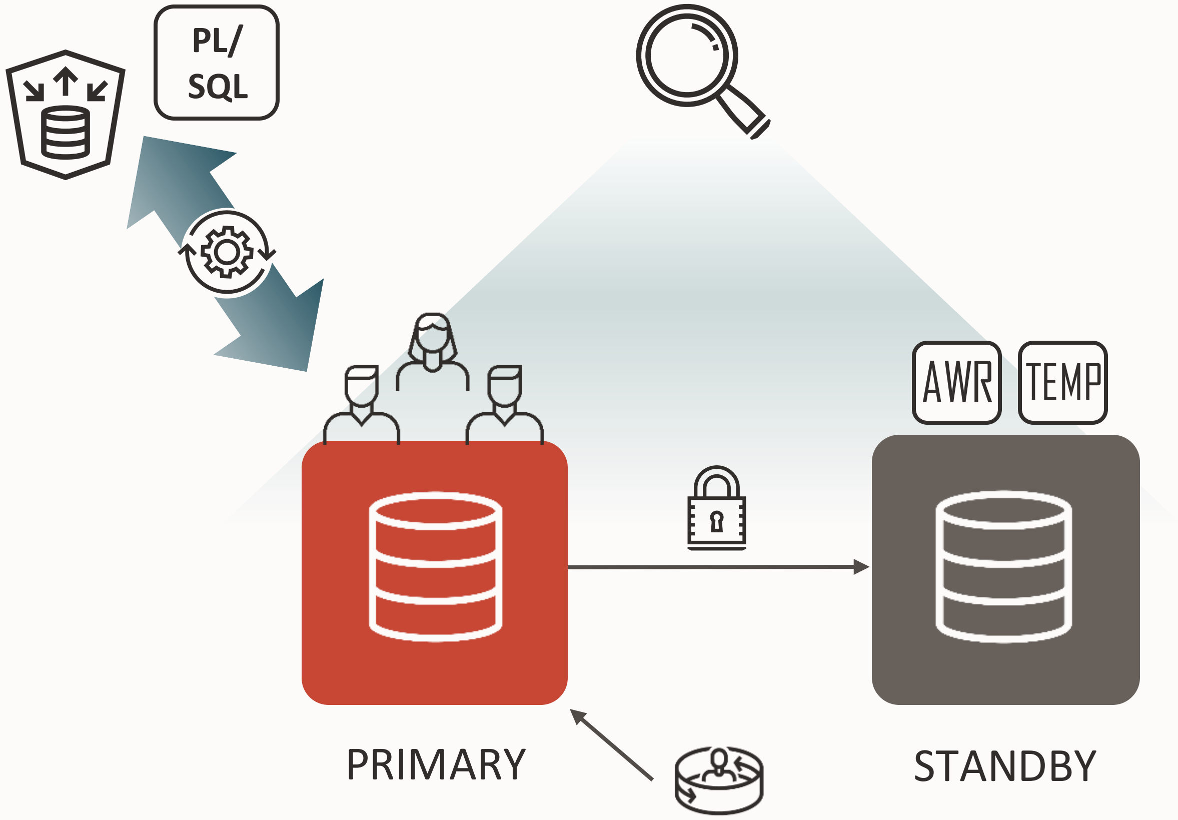
23ai

- Broker management with PL/SQL and REST APIs
- *Data Guard per Pluggable Database Real-Time Query*
- Automatic tempfile creation at Standby Database
- Enhanced observability
- Enhanced diagnostics and validations
- Pre-emptive transition to LAGGING state
- Transport Lag for Measuring Data-Loss

New In 23ai

Oracle Data Guard 23ai is Simple

Enhanced manageability and observability for CI/CD, DevOps, and traditional operations



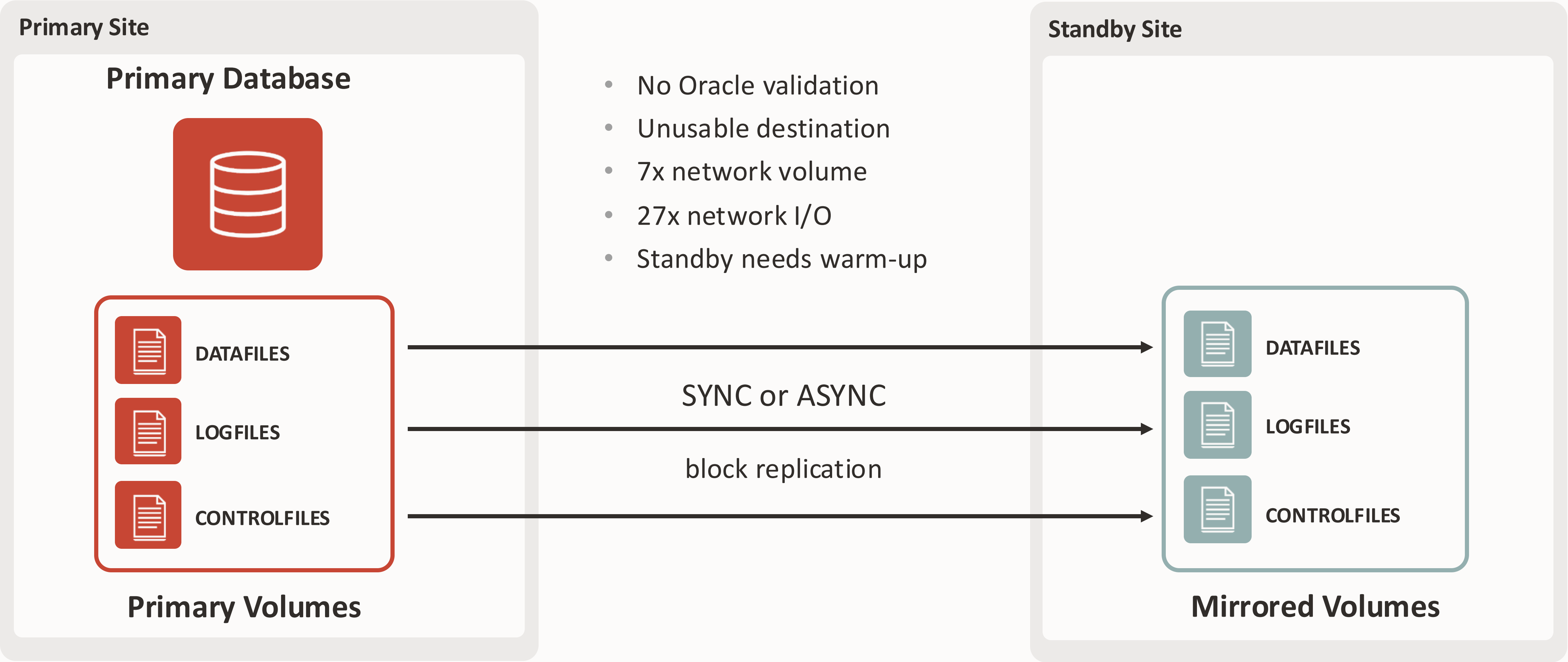
- Automatic preparation of the primary
- PL/SQL APIs for better automation
- REST APIs for easier DevOps integration
- 6 new SQL views to monitor Data Guard
- Support for mixed Transparent Data Encryption
- Automatic temp file creation on the standby
- Simplified AWR snapshots on the standby DB*

* It requires the Active Data Guard option

Oracle Data Guard vs Storage Replication

Storage Remote Mirroring Architecture

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

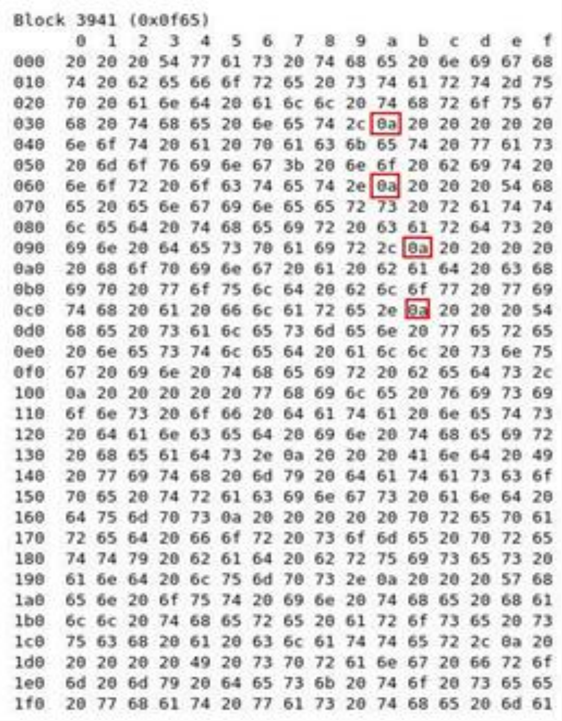


- No Oracle validation
- Unusable destination
- 7x network volume
- 27x network I/O
- Standby needs warm-up

Data Guard Does What Storage Mirroring Can’t

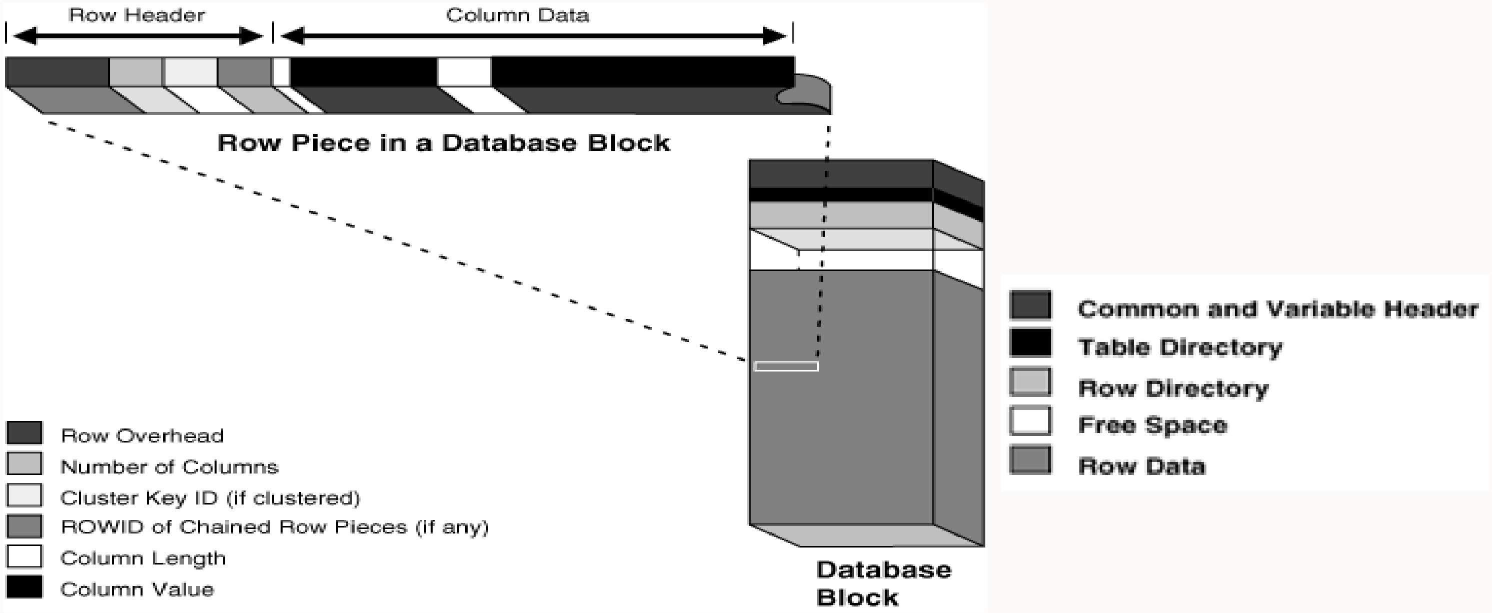
Isolate Corruption, Protect Data, Maintain Availability

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 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

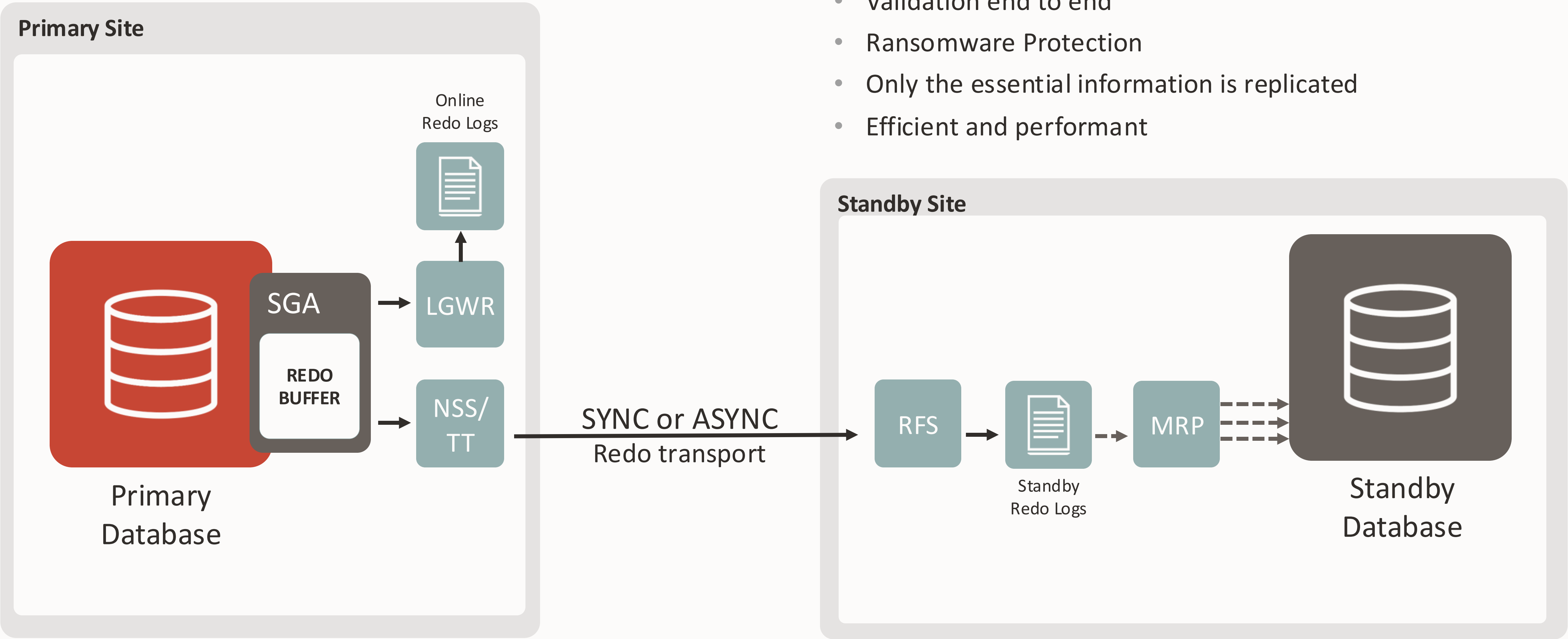


See My Oracle Support Note 1302539.1 for details

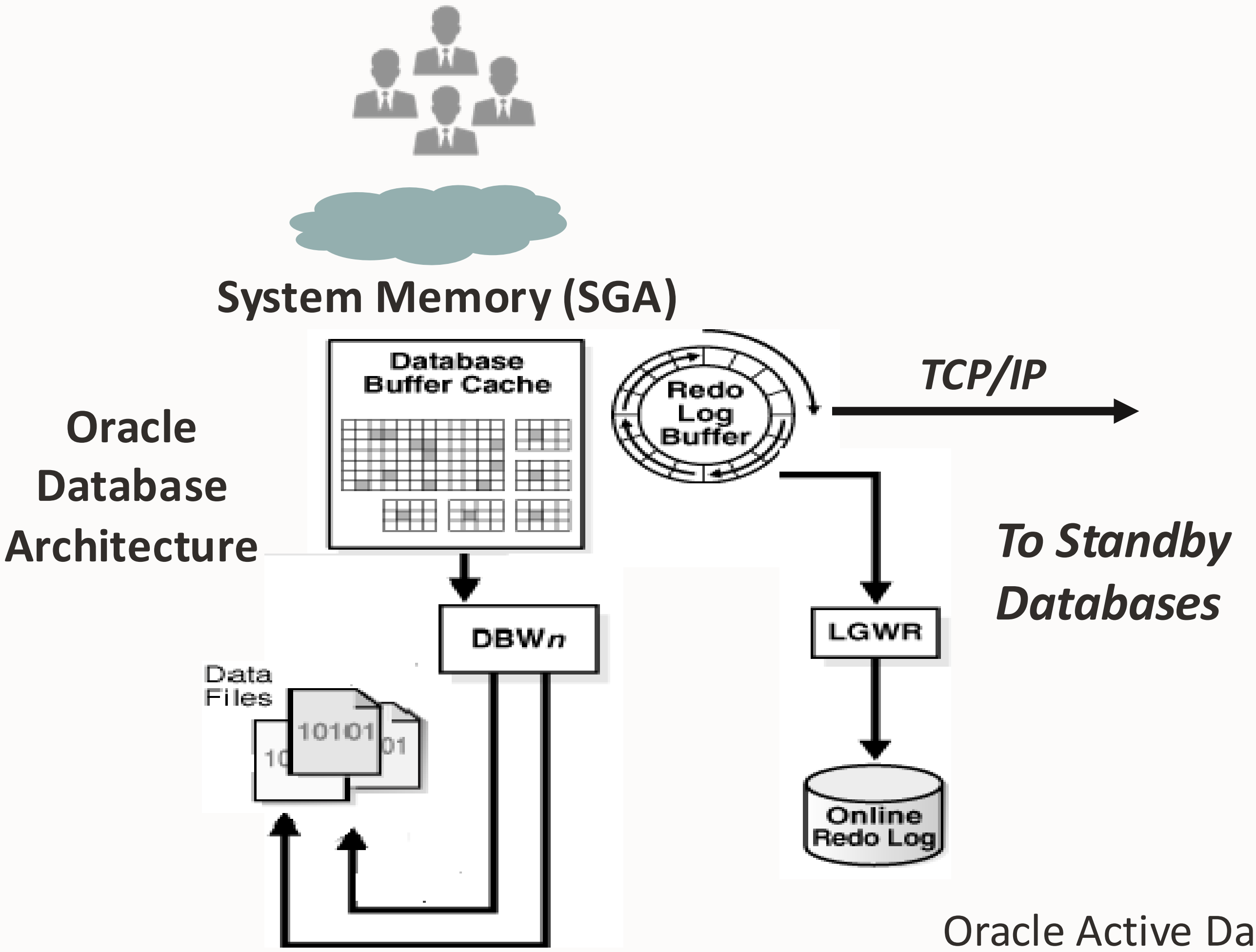
Data Guard is optimized for the database

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



Data Guard Provides Strongest Fault Isolation and Best Performance



System Memory (SGA)

Oracle Database Architecture

Database Buffer Cache

Redo Log Buffer

TCP/IP

To Standby Databases

DBWn

LGWR

Data Files

Online Redo Log

Data Guard transmits redo blocks directly from SGA: like a *memcpy* over the network

Redo received / applied by running Oracle instance: continuous Oracle-integrated data validation

- Best isolation from lower layer faults
- Best performance since no disk I/O
- Best network utilization: only redo sent
- Transactional consistency: always
- Corrupted blocks auto-repaired *
- Database-integrated application failover

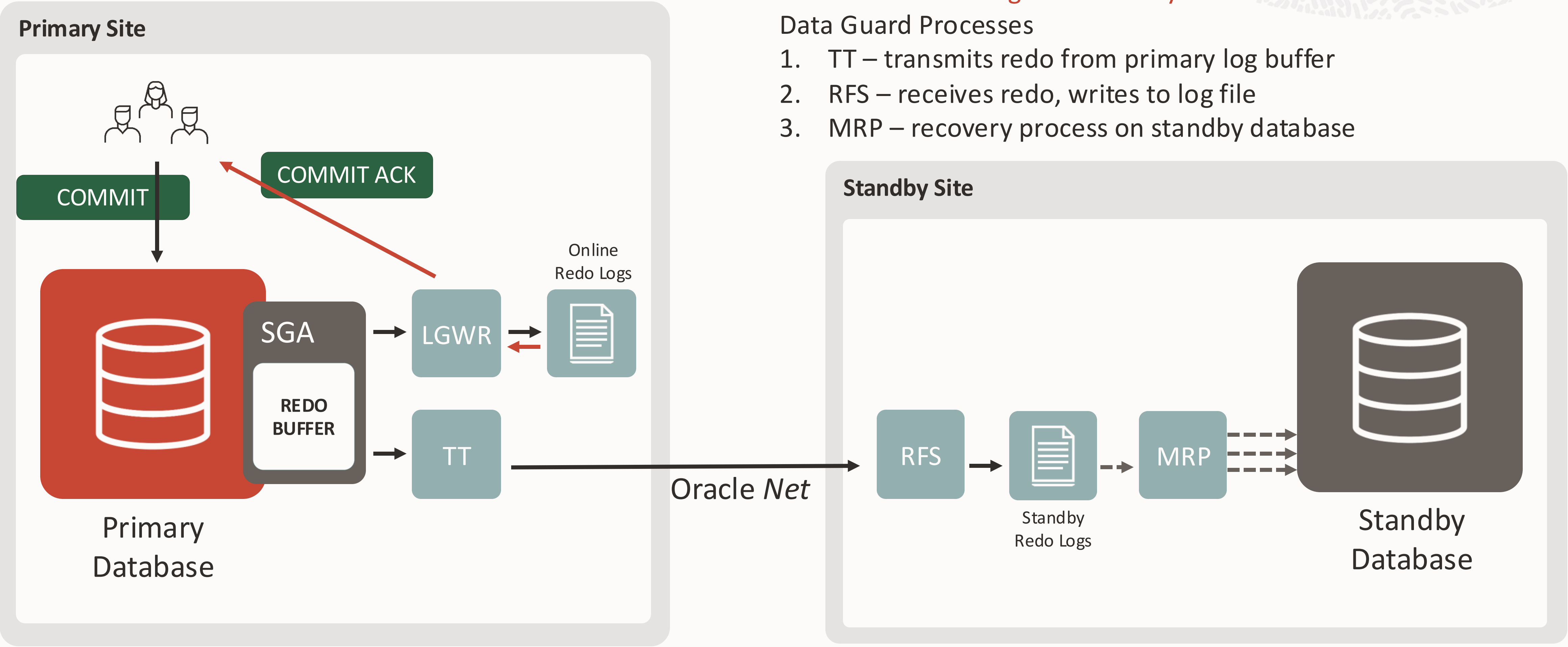
* Requires Active Data Guard License

Oracle Active Data Guard Compared to Storage Remote Mirroring
https://www.oracle.com/a/tech/docs/adg-vs-storage-mirroring.pdf
Oracle Replication done right
https://blogs.oracle.com/maa/replication-done-right

Oracle Data Guard Redo Transport

Data Guard Transport for Best Performance

Data Guard ASYNC Process Architecture



Commit Acknowledge is local-only

Data Guard Processes

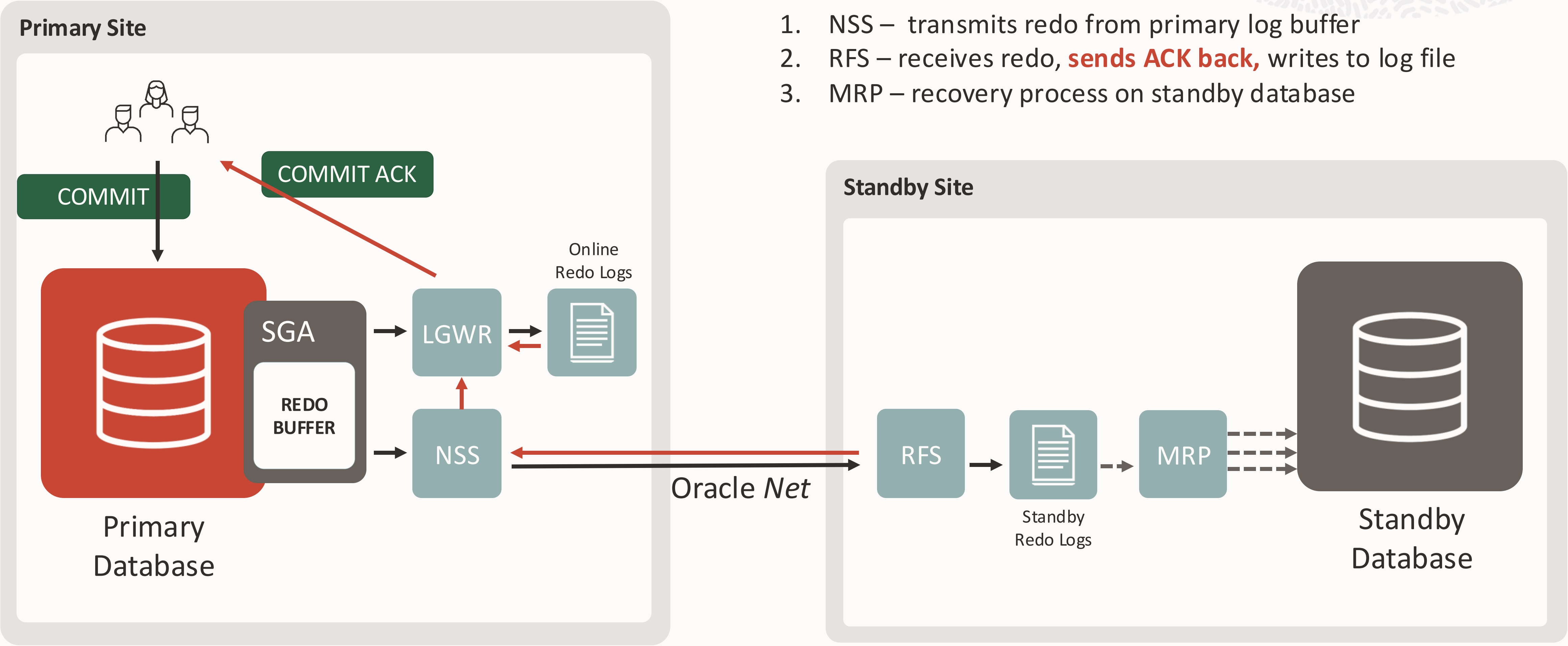
1. TT – transmits redo from primary log buffer
2. RFS – receives redo, writes to log file
3. MRP – recovery process on standby database

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

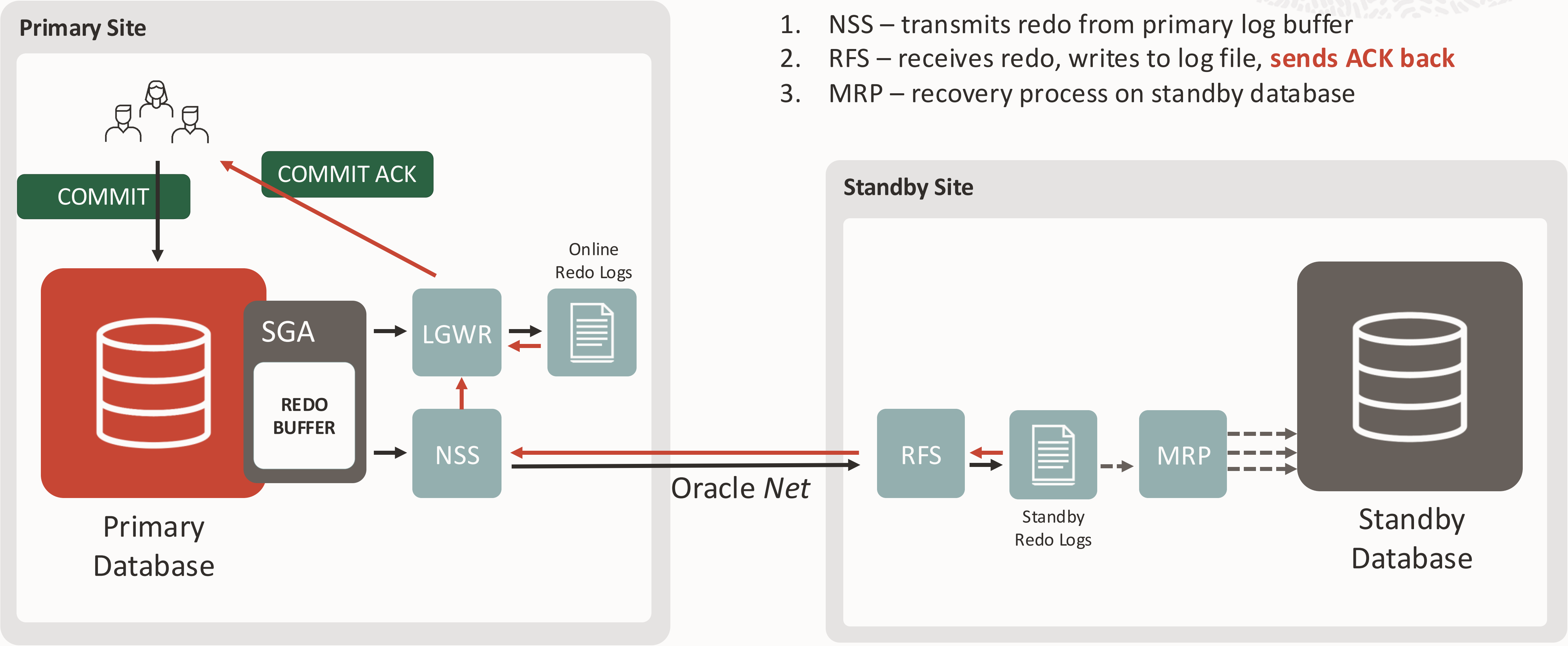


Data Guard Transport for Zero Data Loss

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

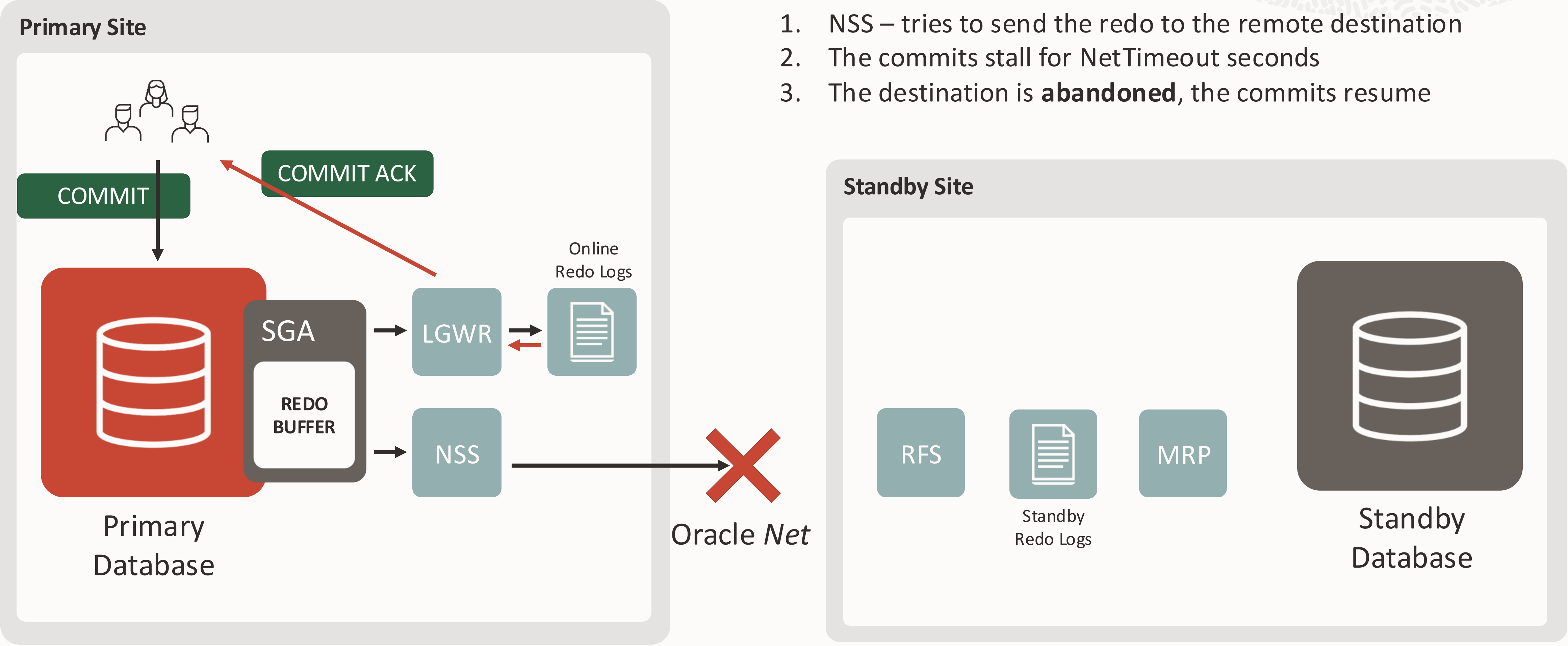


Stalling Synchronous destinations

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
```

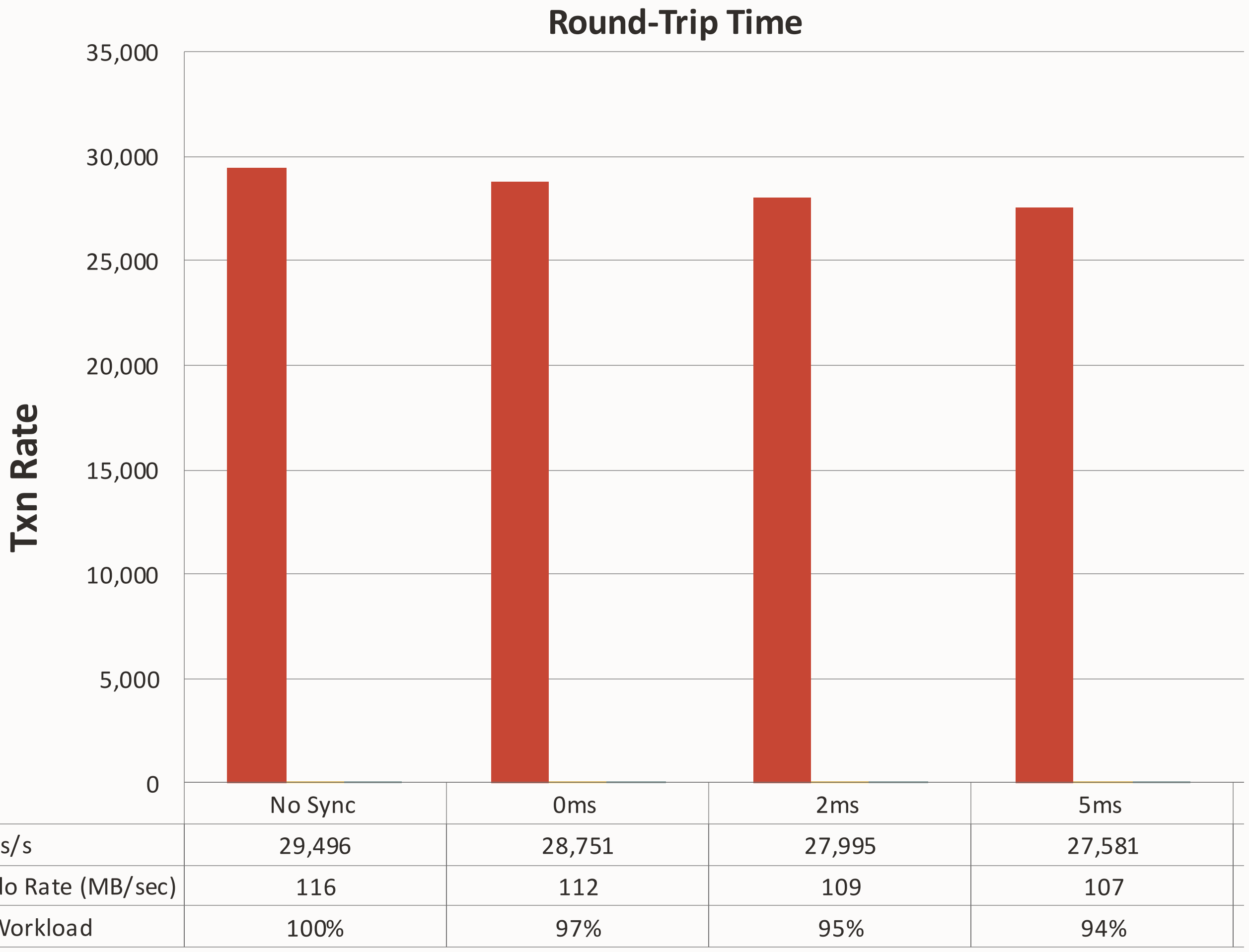
The last redo written in the standby logs:

```
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

- Simulated OLTP with 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 and Database Nologging

Enabling the FORCE LOGGING mode is a must for non-Engineered Systems.

On Exadata and Oracle Cloud Infrastructure, two modes are alternative to the FORCE LOGGING mode:

1. Standby Nologging for Load Performance
   - Ensures that standbys will receive the non-logged data changes with minimum impact on the speed of loading at the primary.
   - The standby can transiently have non-logged blocks. These non-logged blocks will be automatically resolved by managed standby recovery.
2. Standby Nologging for Data availability
   - Ensures that all standbys have the data when the primary load commits, but at the cost of throttling the speed of loading data at the primary.
   - The standbys will never have any non-logged blocks.

- These new modes cause Multi-Instance Redo Apply to return an error
  - Single Instance Redo apply must be manually enabled to proceed past the nologging operation.

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

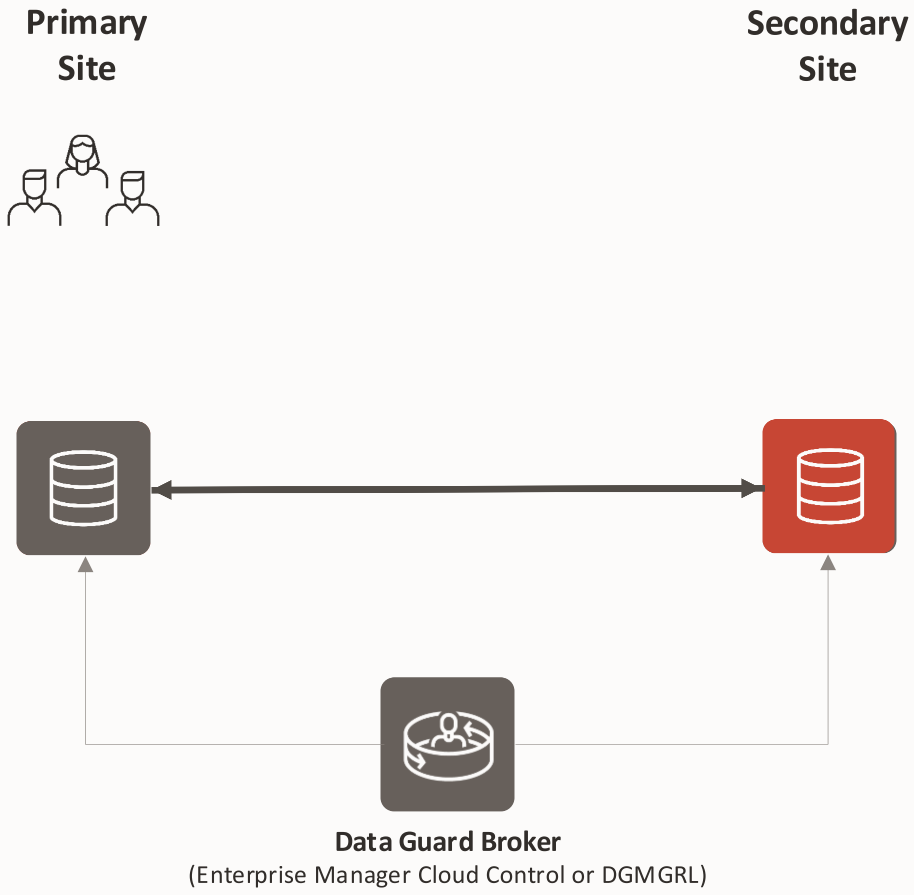
How To Calculate The Required Network Bandwidth Transfer Of Redo In Data Guard (Doc ID 736755.1)
https://support.oracle.com/rs?type=doc&id=736755.1

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

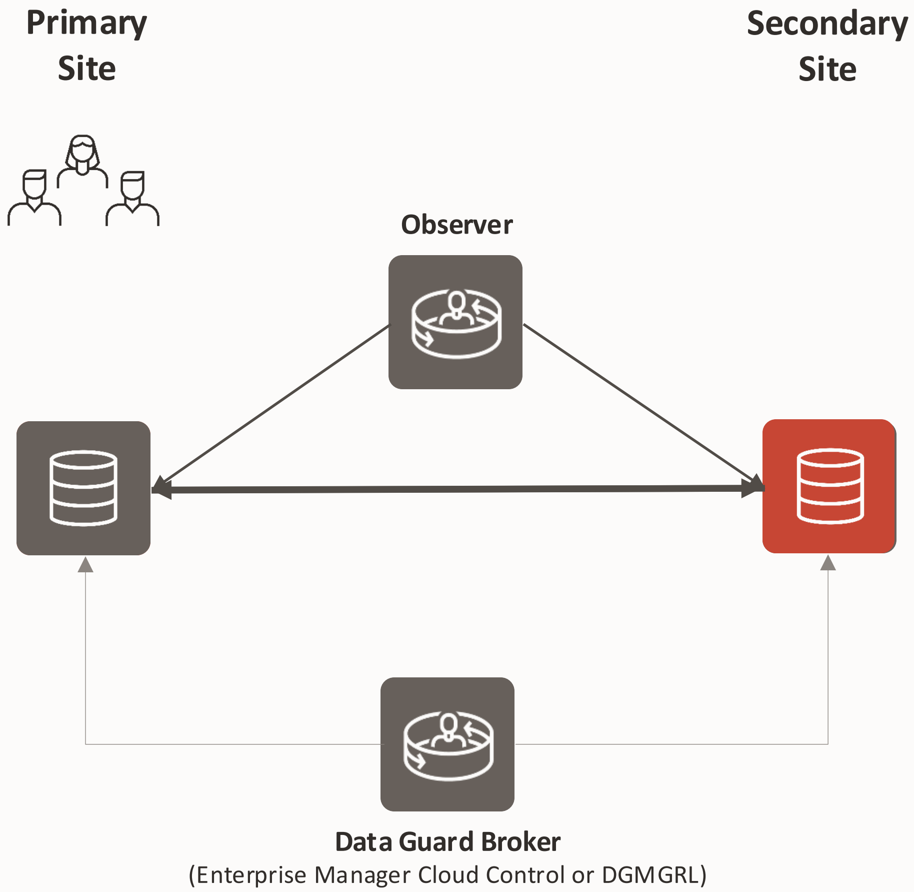


Data Guard Broker
(Enterprise Manager Cloud Control or DGMGRL)

- **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

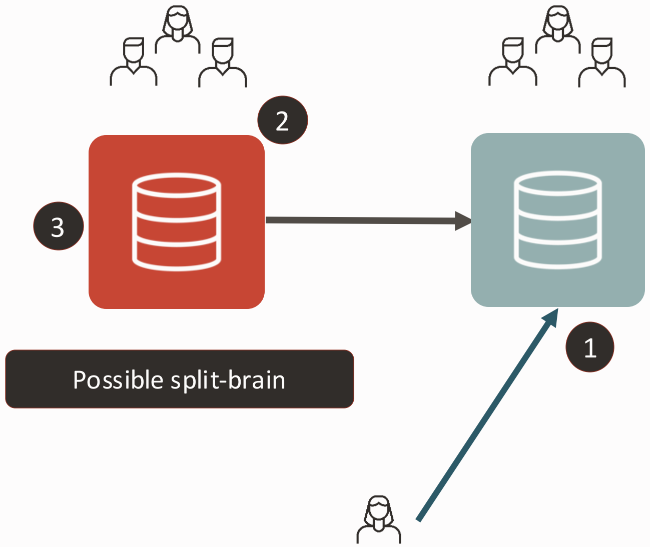
Failover: In case of failure the role transition *can* be without data loss



- **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.

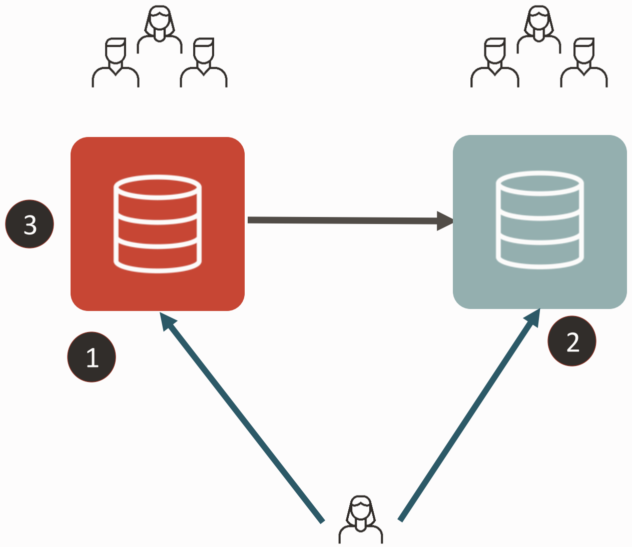
"FAILOVER TO" vs "DBMS_DG.INITIATE_FS_FAILOVER"

FAILOVER TO stdby



1. The standby database becomes the new primary
2. The former primary shuts down if FSFO is in place
3. The former primary is automatically reinstated

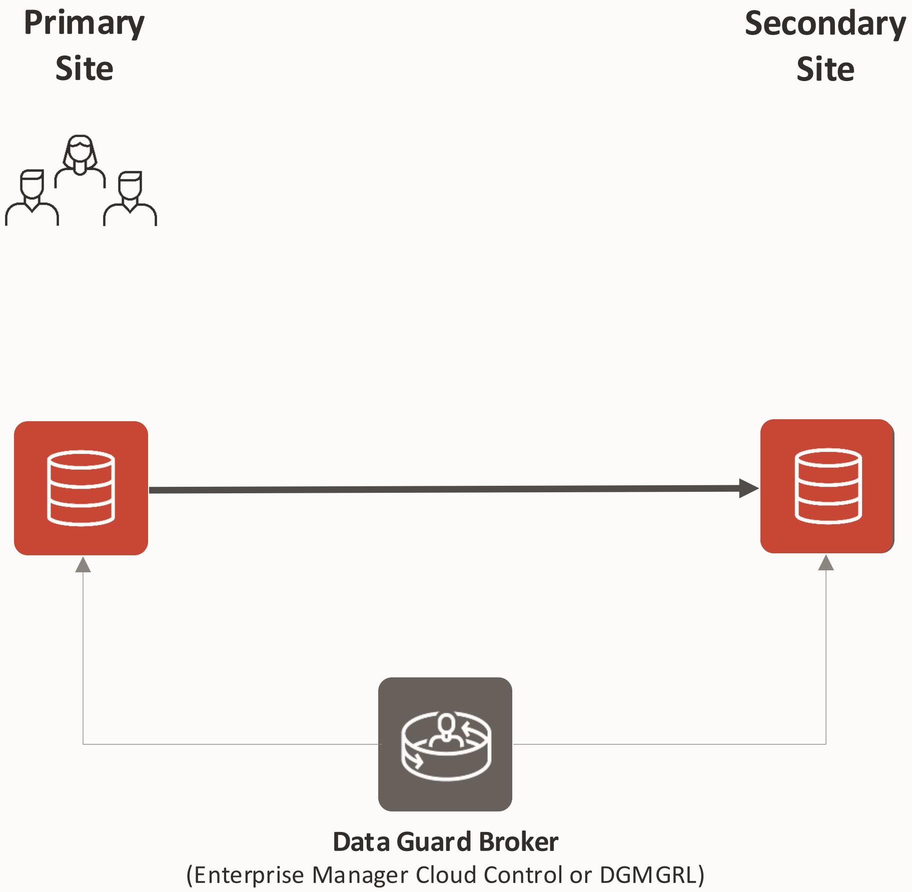
DBMS_DG.INITIATE_FS_FAILOVER



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

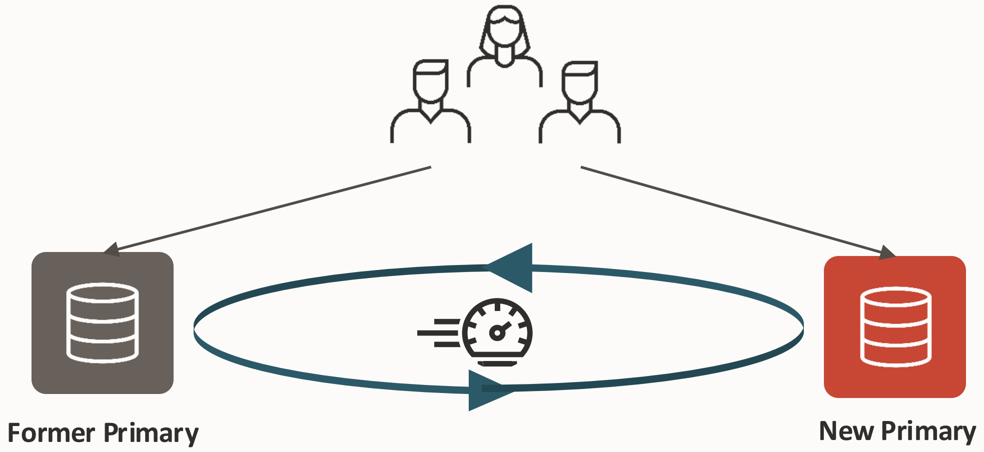
Data Guard Snapshot Standby

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

Tune the Switchover and Failover Operations



DEVELOPMENT

- Use Oracle Connection Pools
- Make your transactions as light as possible
- Use FAN notifications
- Implement session draining
- Use the recommended connection strings

ADMINISTRATION

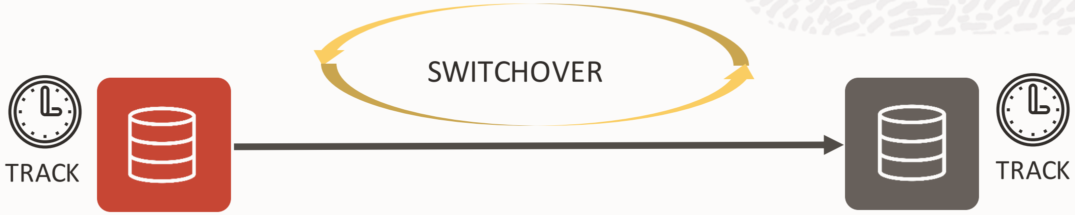
- Stop any long running operations before switchover
- Reduce `FAST_START_MTTR_TARGET`
- Switchover to a `MOUNTED` database whenever possible

IMPLEMENTATION

- Reduce the number of data files
- Reduce the workload on the database
- Don't over-consolidate PDBs

New In 23ai

Easier tracking of role transitions



The new fixed view **V$DG_BROKER_ROLE_CHANGE** tracks the last 10 role transitions

```
SQL> select * from V$DG_BROKER_ROLE_CHANGE;

EVENT               STANDBY_TYPE OLD_PRIMARY NEW_PRIMARY FS_FAILOVER_REASON   BEGIN_TIME           END_TIME
------------------- ------------ ----------- ----------- -------------------- -------------------- --------------------
Failover            Physical     mydb1       mydb1b      Manual Failover      30-SEP-2022 19:01:14 30-SEP-2022 19:01:35
Switchover          Physical     mydb1b      mydb1                            30-SEP-2022 19:04:53 30-SEP-2022 19:05:15
Switchover          Physical     mydb1       mydb1b                           30-SEP-2022 20:51:38 30-SEP-2022 20:52:03
Failover            Physical     mydb1b      mydb1       Manual Failover      30-SEP-2022 20:52:46 30-SEP-2022 20:53:04
Switchover          Physical     mydb1       mydb1c                           30-SEP-2022 19:53:14 30-SEP-2022 19:54:14
Switchover          Physical     mydb1c      mydb1                            30-SEP-2022 20:03:14 30-SEP-2022 20:04:04
Switchover          Logical      mydb1       mydb1d                           30-SEP-2022 20:24:46 30-SEP-2022 20:26:32
Switchover          Logical      mydb1d      mydb1                            30-SEP-2022 20:35:27 30-SEP-2022 20:35:48
Fast-Start Failover Physical     mydb1       mydb1b      Primary Disconnected 30-SEP-2022 20:13:51 30-SEP-2022 20:14:53
```

New In 23ai

Strict validation of switchover readiness

New command VALIDATE DATABASE STRICT

```
DGMGRL> VALIDATE DATABASE mydb_site2

  Database Role:     Physical standby database
  Primary Database:  mydb_site1

  Ready for Switchover:  Yes
  Ready for Failover:    Yes (Primary Running)

  Flashback Database Status:
    Database       Status            Retention Target
    mydb_site1     Off               1440
    mydb_site2     Off               1440

...
```

No strict validation

The DB shows as `Ready for Switchover` if no conditions would prevent the switchover from working.

```
DGMGRL> VALIDATE DATABASE mydb_site2 STRICT ALL

  Database Role:     Physical standby database
  Primary Database:  mydb_site1

  Ready for Switchover:  No
  Ready for Failover:    Yes (Primary Running)

 Flashback Database Status:
    Database       Status            Retention Target
    mydb_site1     Off               1440
    mydb_site2     Off               1440

...
```

Strict validation

No conditions would prevent the switchover from working, but the new primary would miss some important configurations.

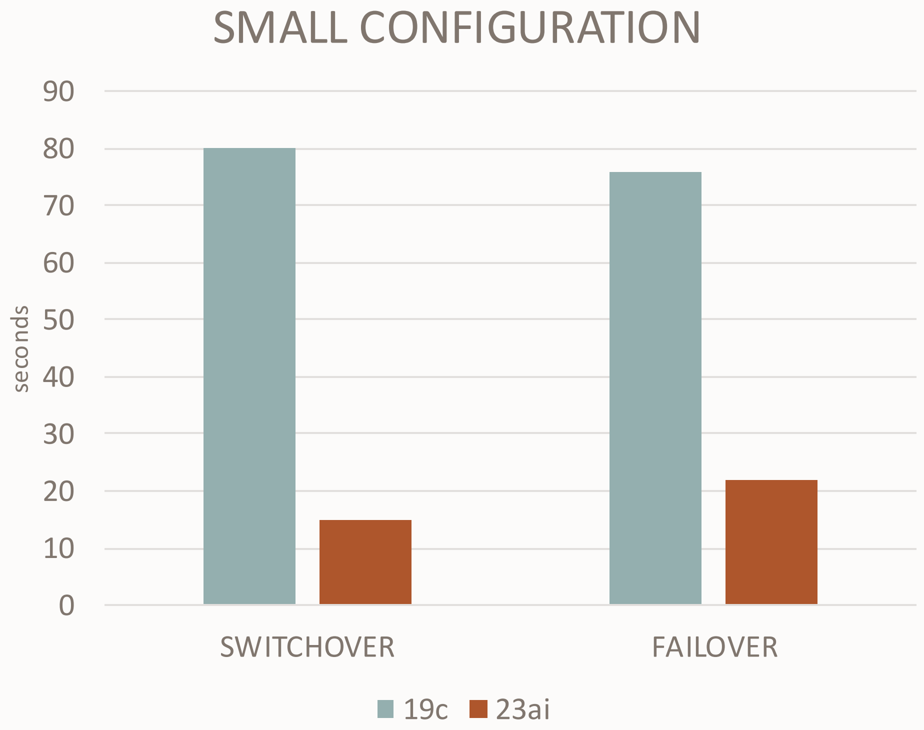
Syntax:

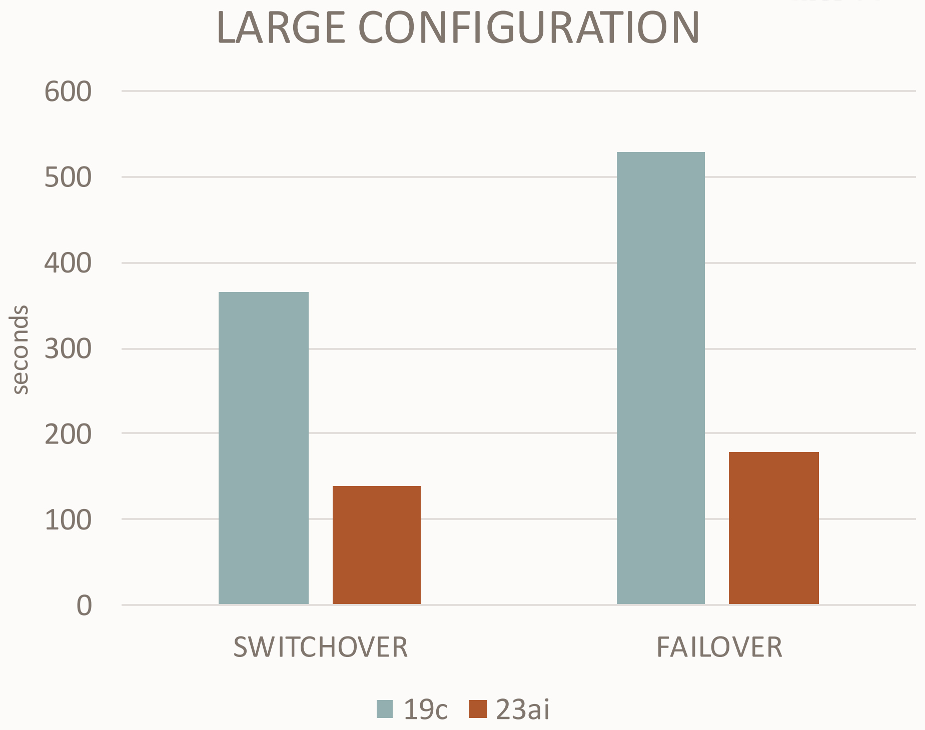
```
VALIDATE DATABASE [VERBOSE] <database> STRICT
{TEMP_FILES | FLASHBACK | LOG_FILES_CLEARED | LOG_FILE_CONFIGURATION | APPLY_PROPERTY | TRANSPORT_PROPERTY | ALL}
```

New In 23ai

Faster Role Transitions in Oracle Data Guard 23.5

Between 50% and 85% faster role transition in Oracle Data Guard 23ai





2-node Exadata RAC
5 PDBs
50 data files

10 services

60MB redo/sec

4-node Exadata RAC
100 PDBs
10k data files

1200 services

100MB redo/sec

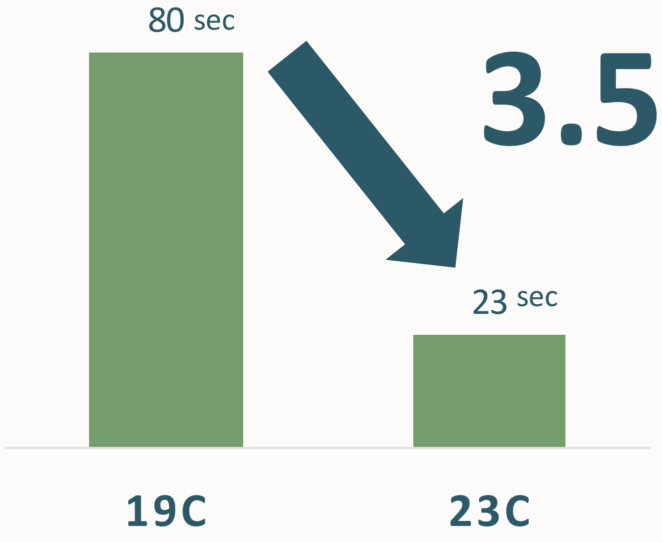
New In 23ai

Oracle Data Guard 23ai Provides Lower RTO

Faster role transitions. Pre-emptive actions to prevent stalls.

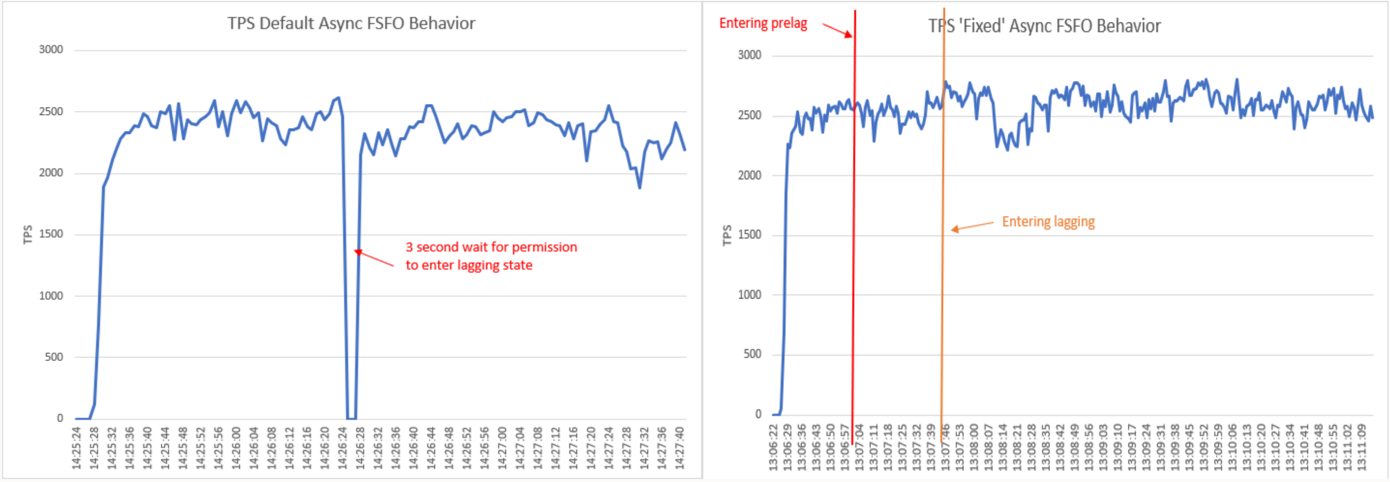
UP TO

3.5x



Faster role transitions compared to 19c*

Up to 3 seconds faster observer acknowledgment



19c

23ai

in Fast-Start Failover Max Performance

* Figures vary with the workload and the environment

Oracle Data Guard Role Transitions – Read More

Role Transition Assessment and Tuning

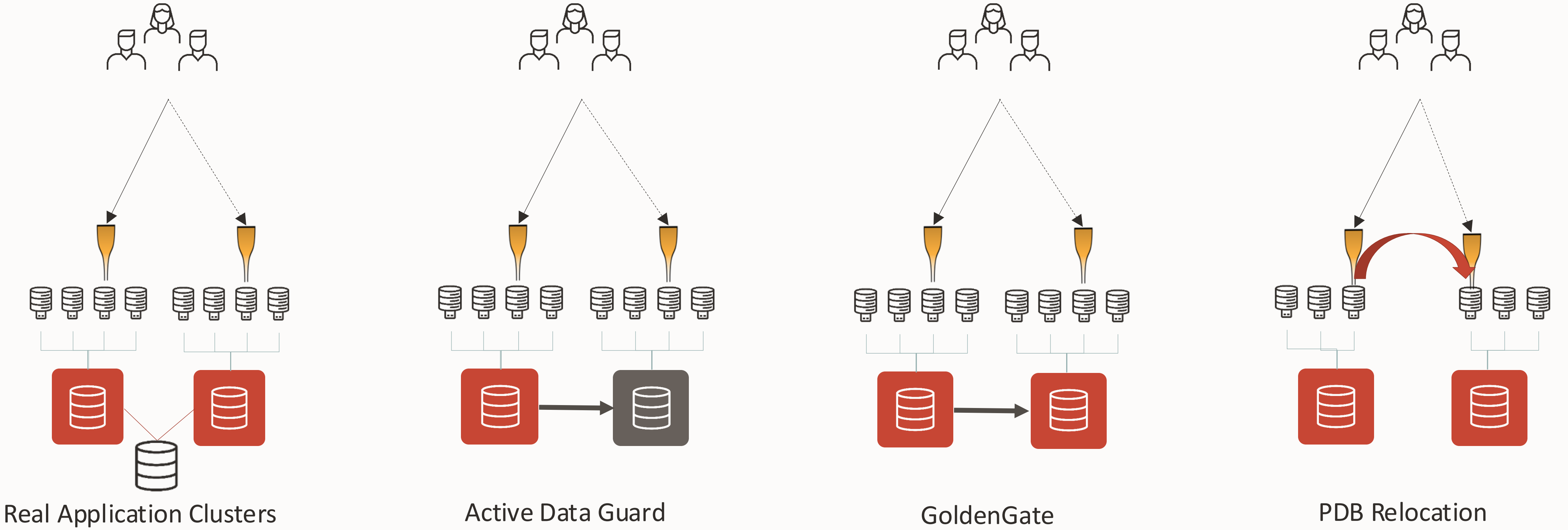
https://docs.oracle.com/en/database/oracle/oracle-database/19/haovw/tune-and-troubleshoot-oracle-data-guard.html#GUID-CBA9FC61-9894-4D62-9569-EFBD7960267F

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



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

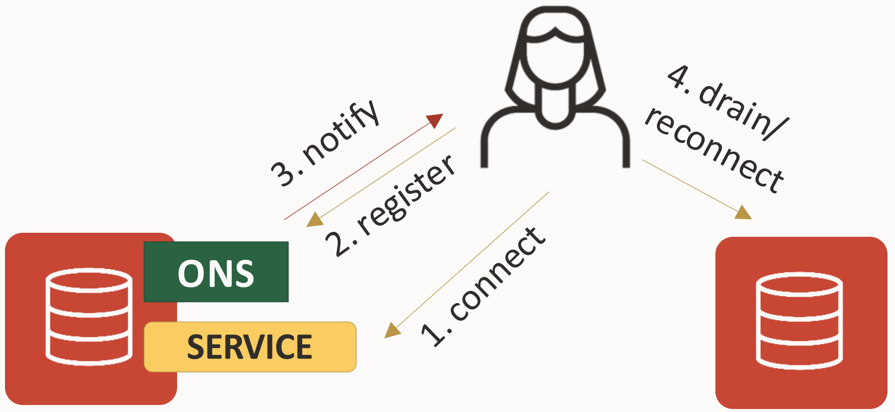
Client-side required technologies

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

PLANNED MAINTENANCE

Fast Application Notification

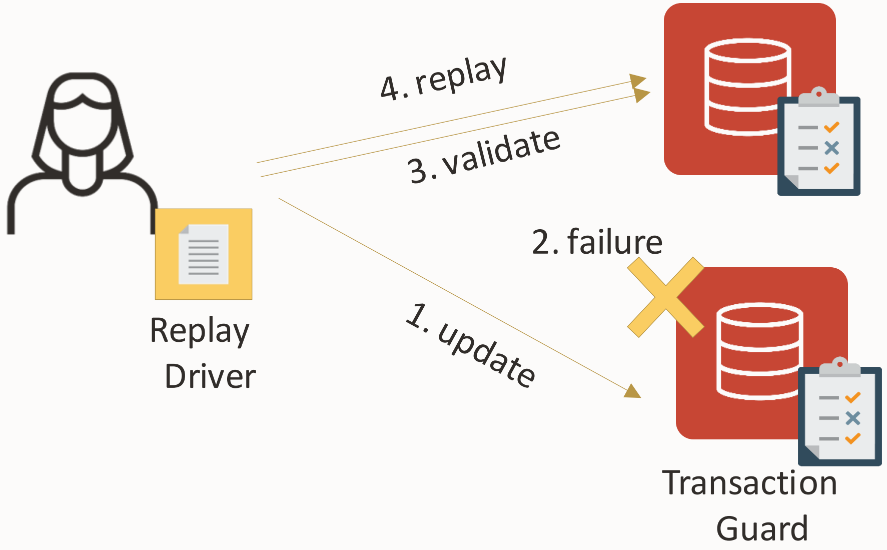
(Session Draining)



UNPLANNED OUTAGE

Application Continuity [1]

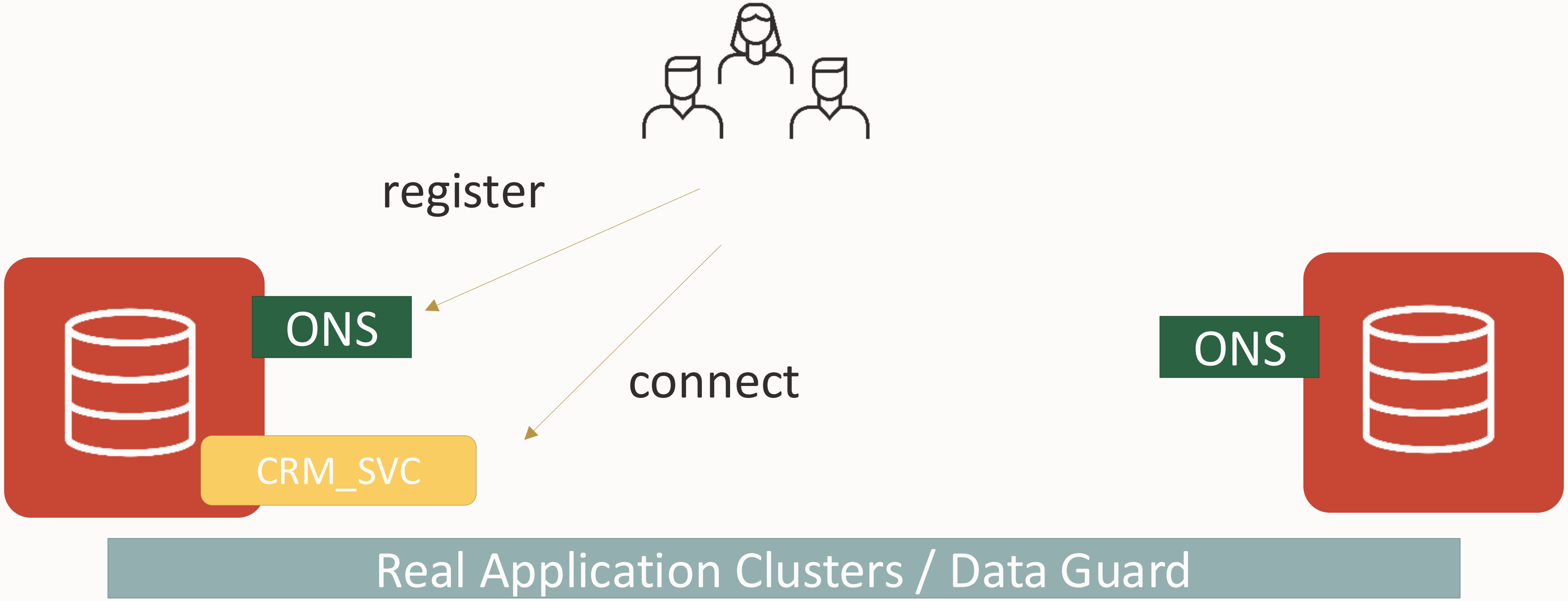
(Transaction Replay)



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

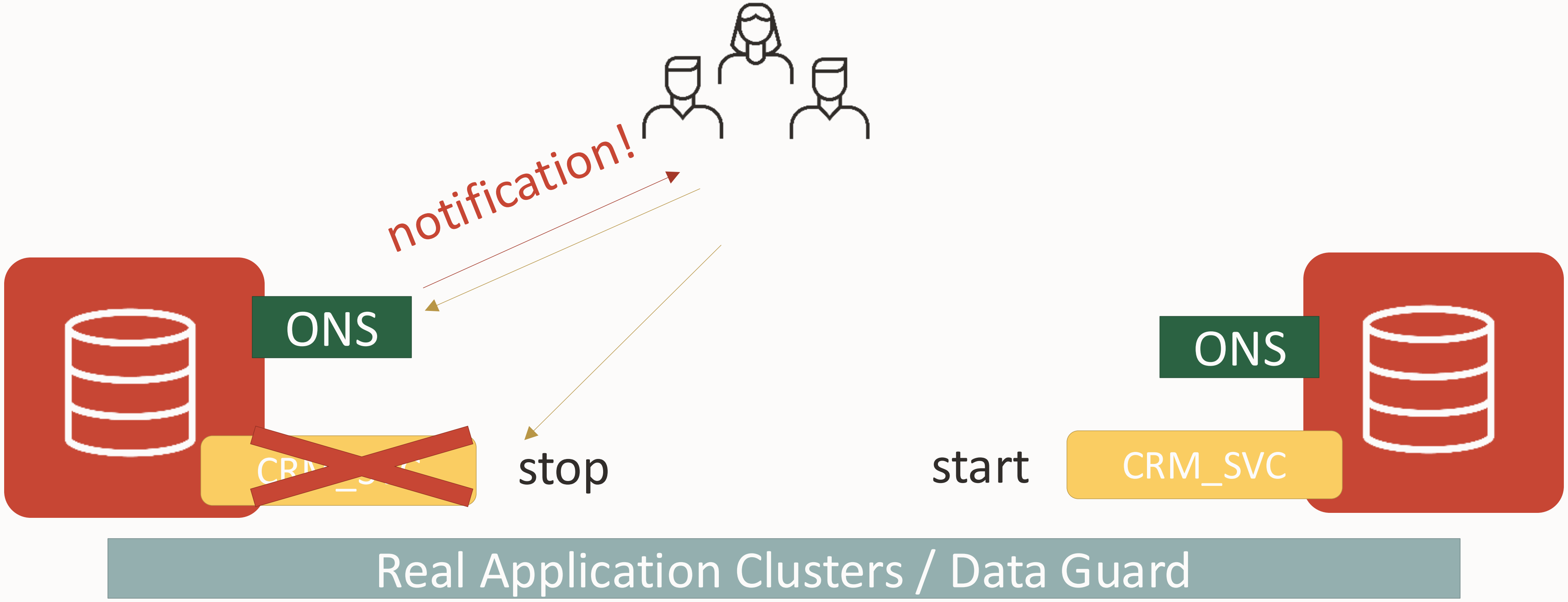
Fast Application Notification

Session Draining for planned maintenance



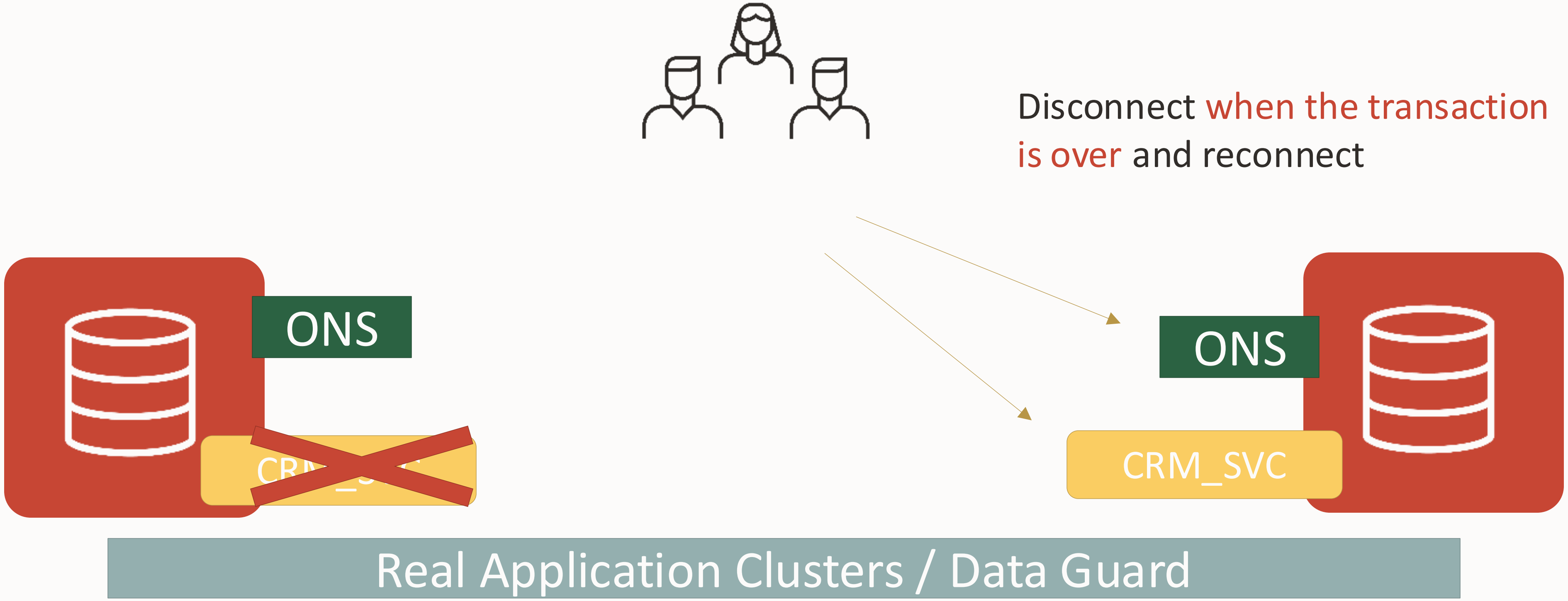
Fast Application Notification

Session Draining for planned maintenance



Fast Application Notification

Session Draining for planned maintenance



Disconnect when the transaction is over and reconnect

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

Fast Connection Failover (FCF)

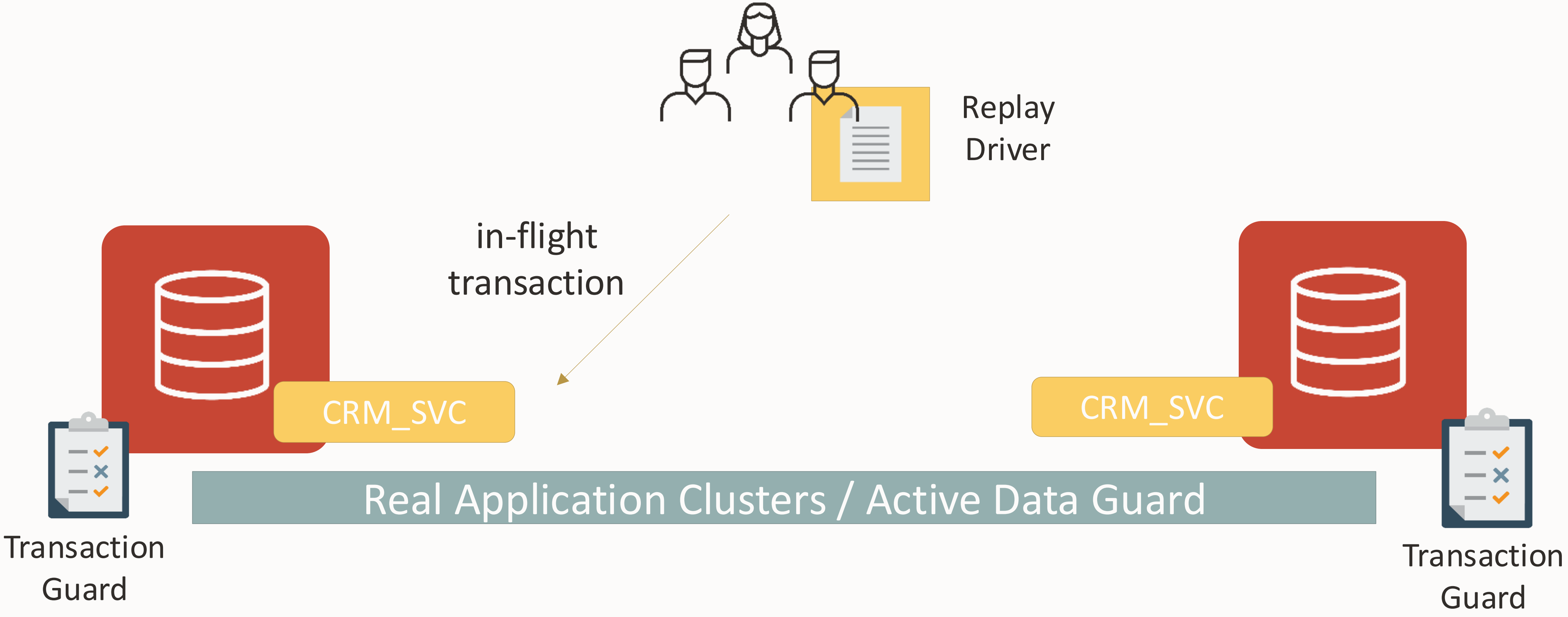
FAN integrated in connection pools

- UCP (Universal Connection Pool, ucp.jar) and WebLogic Active GridLink handle FAN out of the box.
  No code changes! Just enable `FastConnectionFailoverEnabled`

- Third-party connection pools can implement FCF
  - If JDBC driver version >= 12.2
  - simplefan.jar and ons.jar in CLASSPATH
  - Connection validation options are set in pool properties
  - Connection pool can plug `javax.sql.ConnectionPoolDataSource`
  - Connection pool checks connections at borrow/release

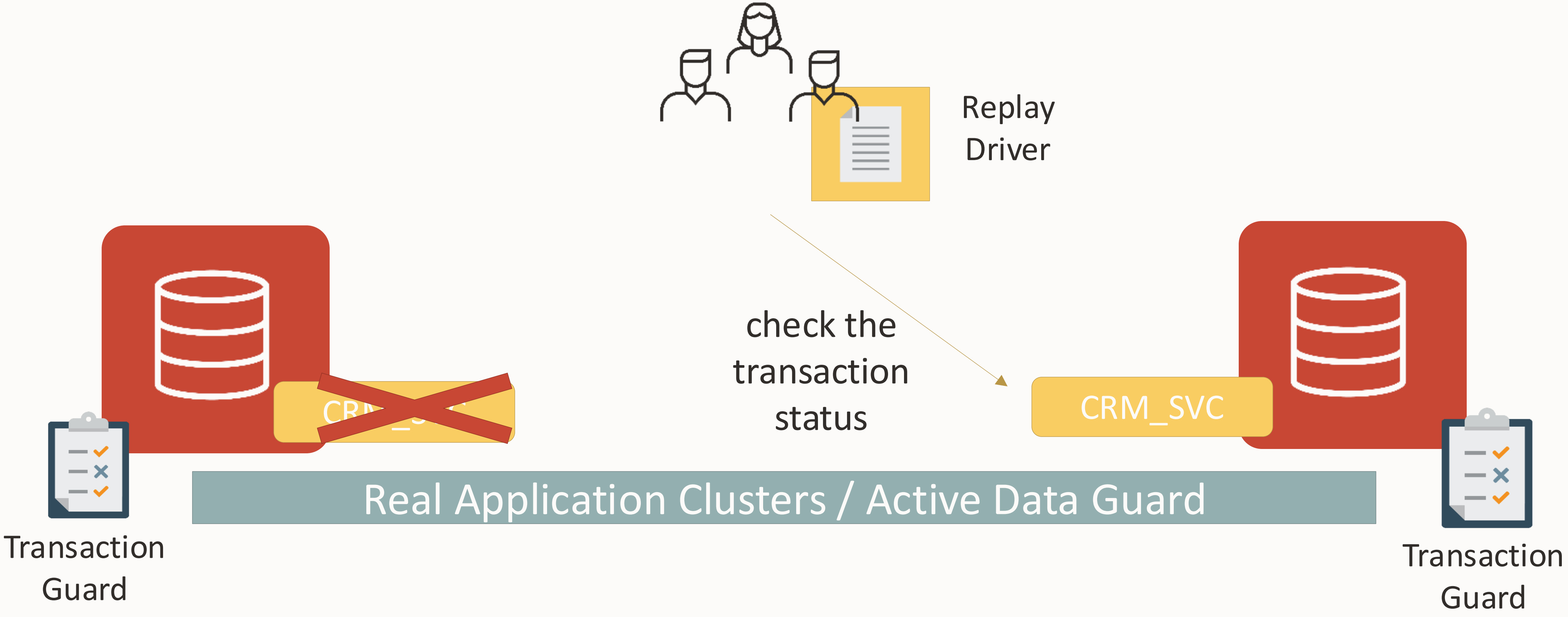
Application Continuity (AC)

Protects the in-flight transaction from failures and disconnections



Application Continuity (AC)

Protects the in-flight transaction from failures and disconnections



Replay Driver

check the transaction status

CRM_SVC

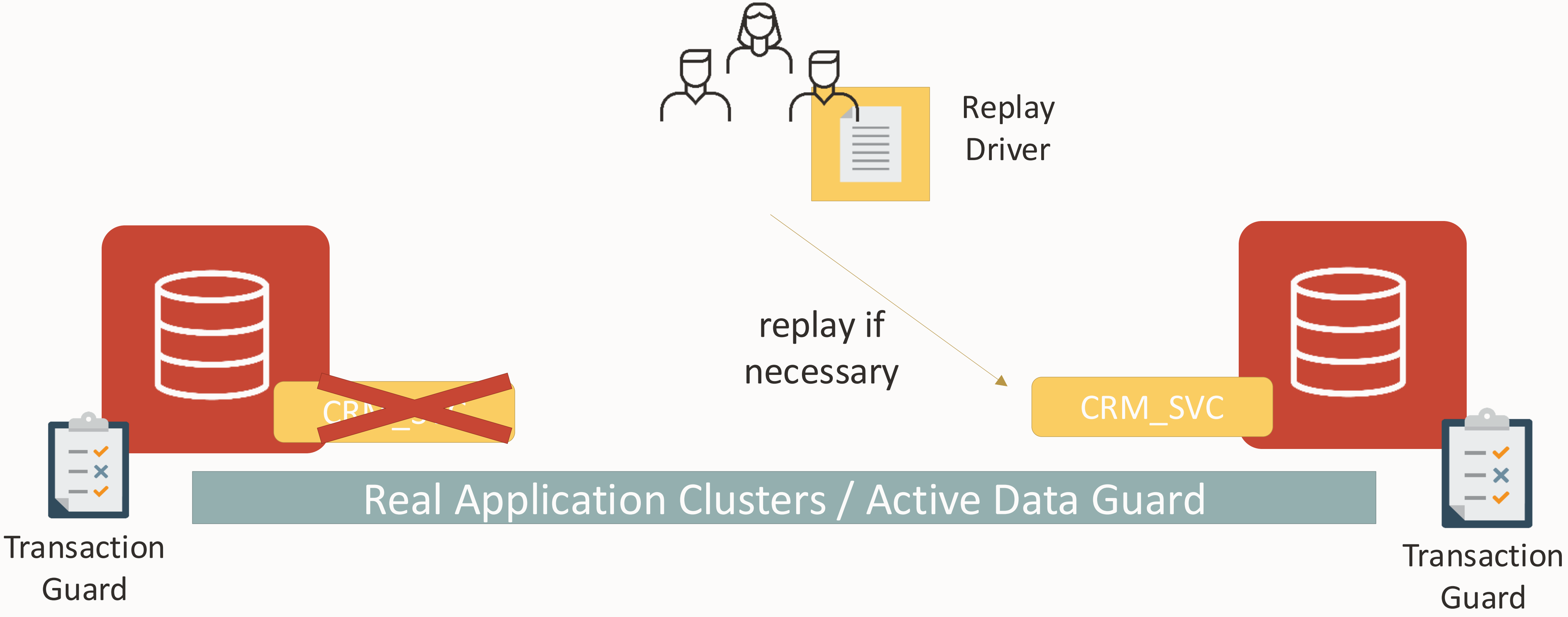
Real Application Clusters / Active Data Guard

Transaction Guard

Transaction Guard

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)

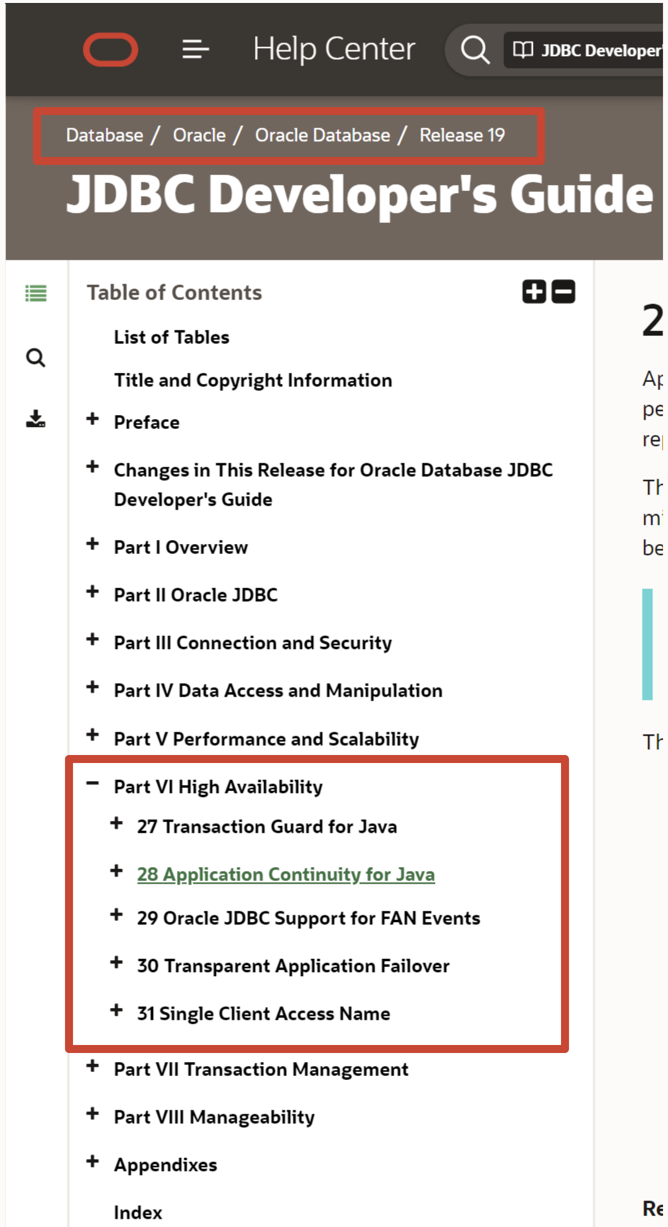
Application Continuity for every connection and application type

- Introduced in 18c for JDBC thin, 19c for OCI (Oracle Call Interface)
- Records session and transaction state server-side
- No application change
- Works without connection pools (although they are still recommended)
- 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 Outage	12c	Use explicit boundaries (or use UCP)	Yes	Yes (Choose)	Both
TAC (Recommended)	Unplanned Outage	19c	No	No, but recommended	Never	Both

Documentation!



Help Center

JDBC Developer

Database / Oracle / Oracle Database / Release 19

JDBC Developer's Guide

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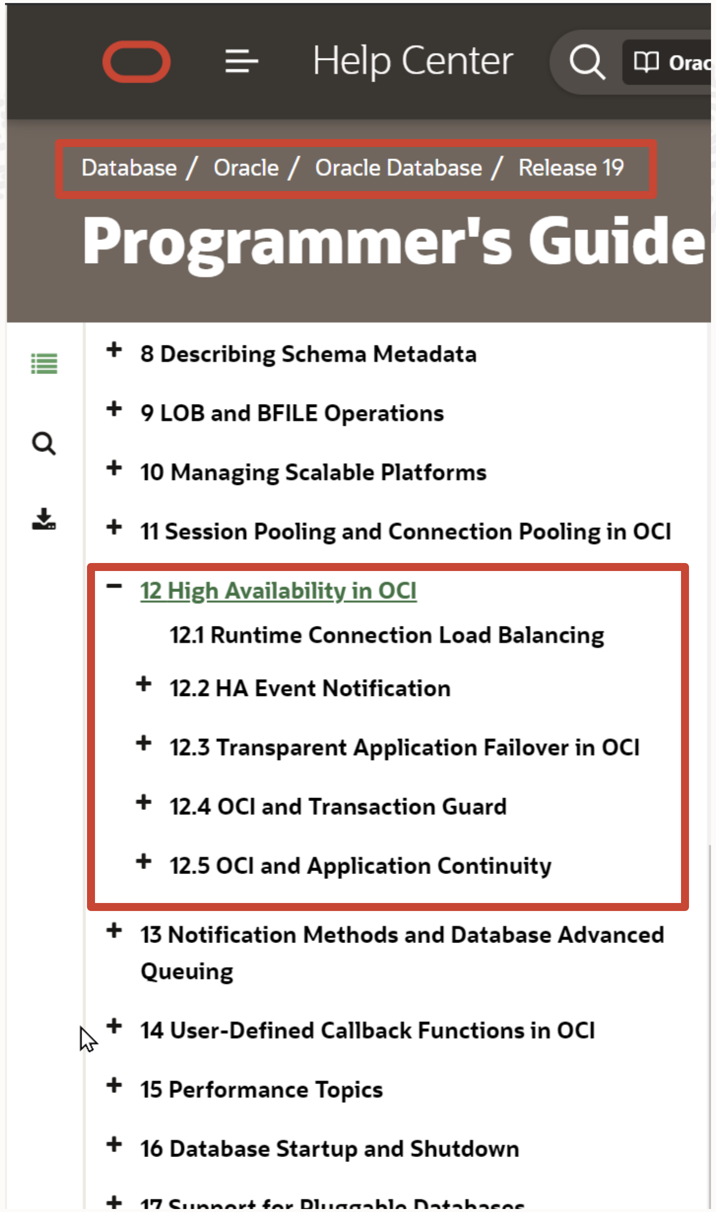
JDBC

OCI



Help Center

Orac

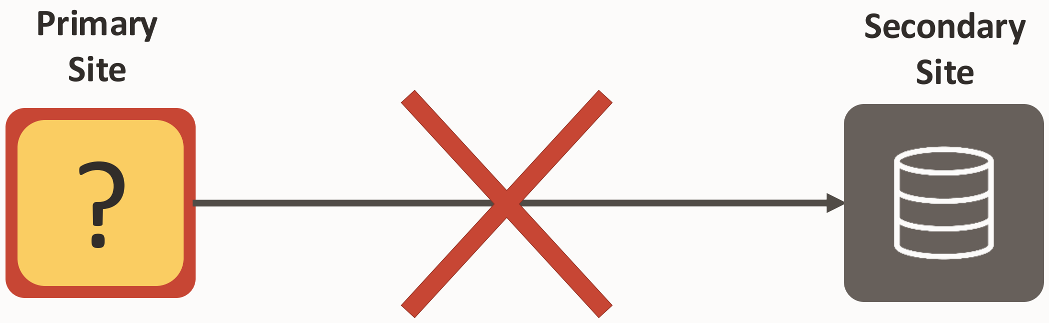
Database / Oracle / Oracle Database / Release 19

Programmer's Guide

Fast-Start Failover: an overview

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';

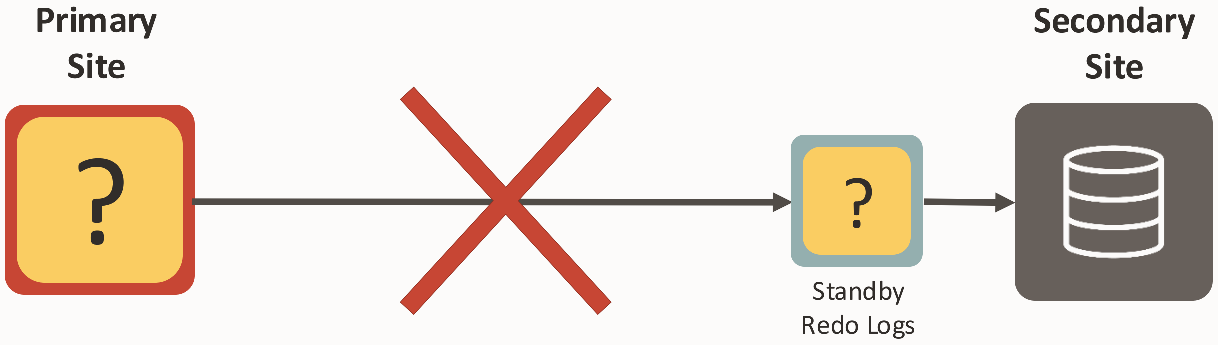
DATUM_TIME                            SECS_AGO
------------------------------ ----------
07/11/2022 08:28:46                      90361
```

⚠ 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?



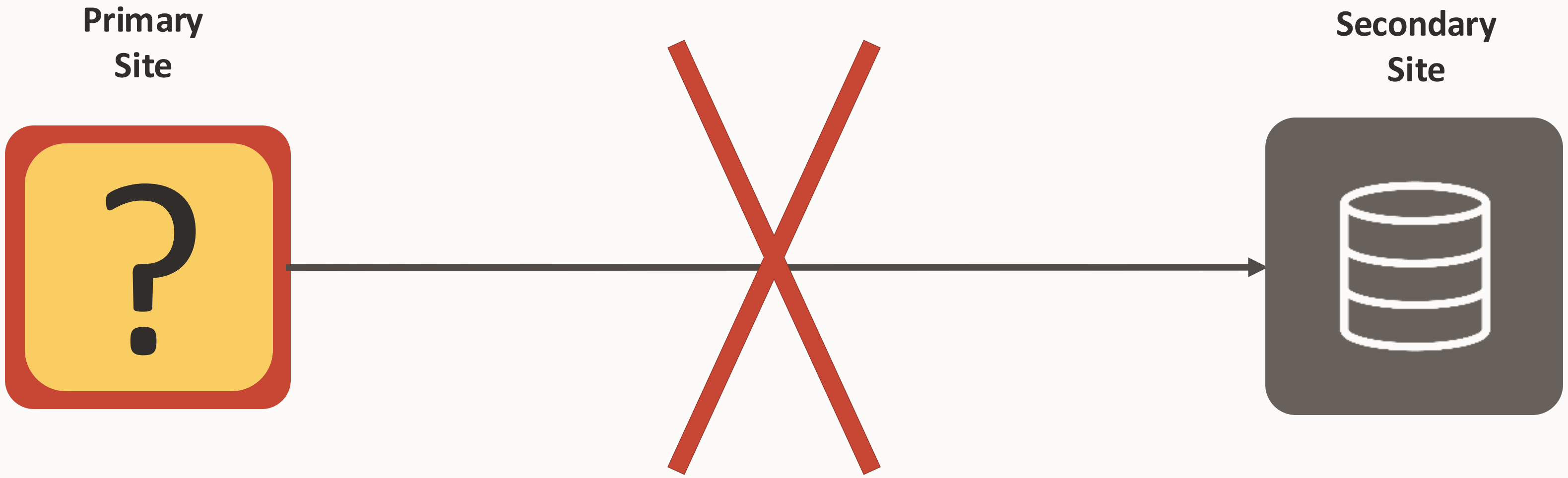
```
-- THE TIMESTAMP OF THE LAST REDO ENTRY RECEIVED FROM THE PRIMARY
SQL> alter session set nls_date_format='MM/DD/YYYY HH24:MI:SS';
SQL> select coalesce(max(s.last_time), max(a.next_time)) as last_redo_from_prim,
2>   (sysdate-coalesce(max(s.last_time), max(a.next_time)))*86400 as secs_ago
3>   from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

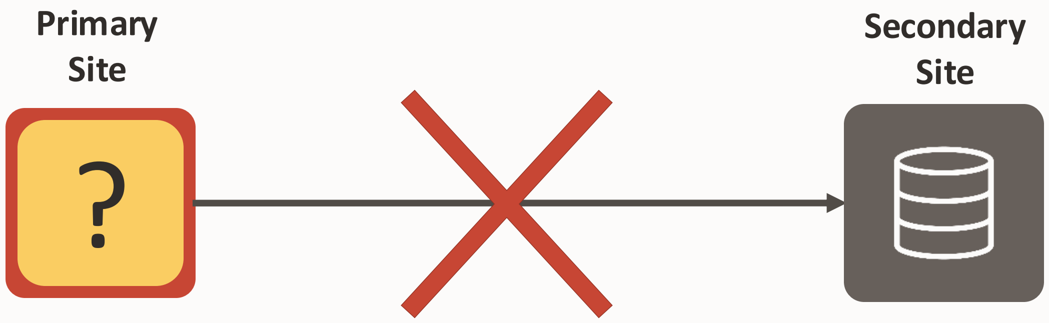
DID IT KEEP COMMITTING?

WHAT IS THE PRIMARY DOING?

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

Network partitioning

When did the primary disconnect?



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------------------------------ ----------
07/11/2022 08:28:46                  90361
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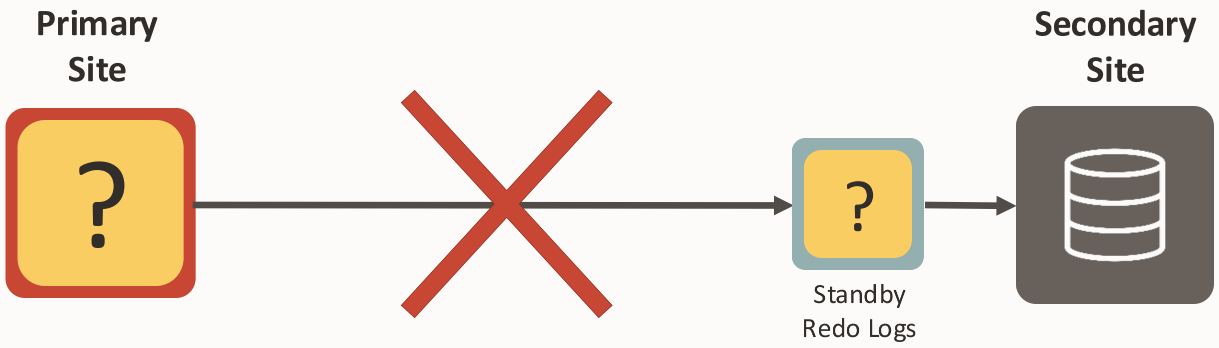

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3>   from v$standby_log s , v$archived_log a ;

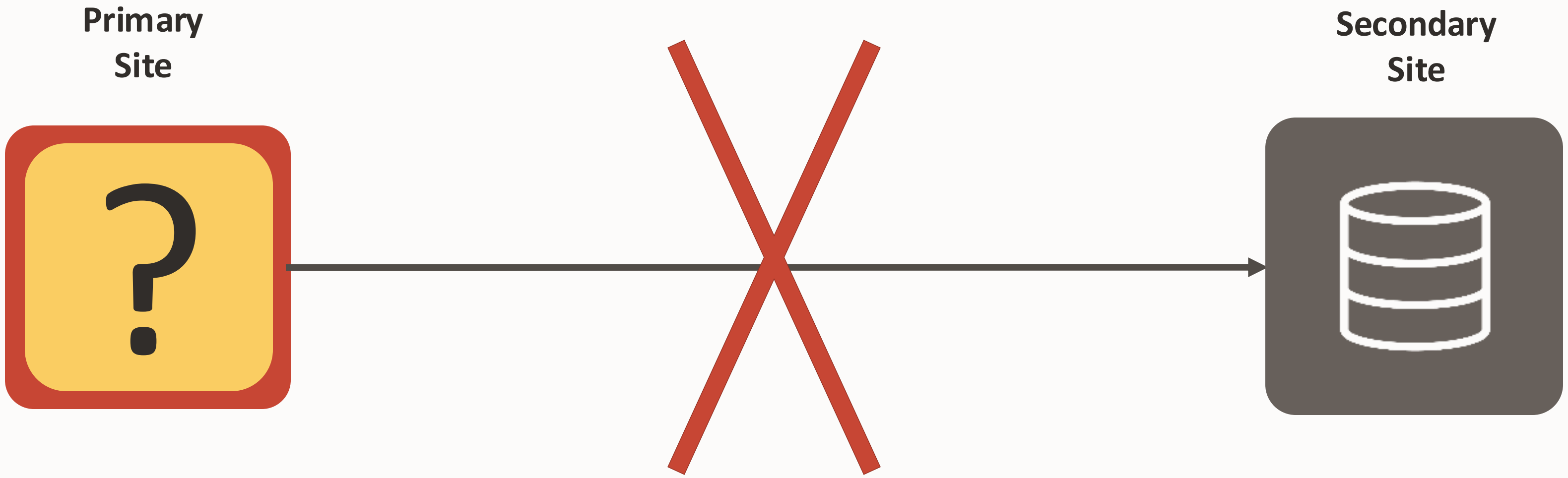
LAST_REDO_FROM_PRIM   SECS_AGO
------------------- ----------
07/11/2022 08:28:46      91061
```

? Is it a reliable way to calculate data loss?

Network partitioning

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

Can I safely fail over to the standby site?



DID IT CRASH?

DID IT STALL?

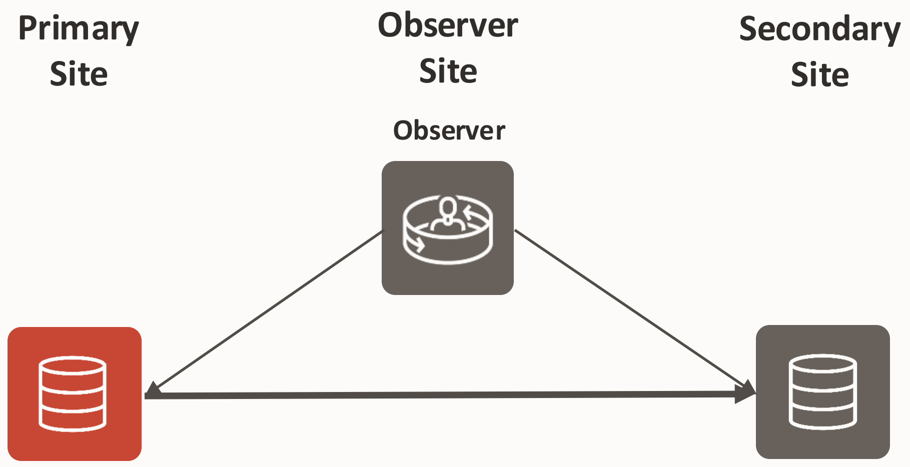
DID IT KEEP COMMITTING?

WHAT IS THE PRIMARY DOING?

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

Oracle Fast-Start Failover introduces a quorum

Automatic failover when the Primary Database is unavailable



- **The observer monitors both primary and standby**

- **Primary has the quorum** (standby is isolated)**:**
  - The primary keeps writing
- **Primary and standby have the quorum** (observer is isolated)**:**
  - The configuration keeps working unobserved
- **Standby has the quorum** (primary is 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 automates the failover and solves important problems

Recovery Point Objective is honored

No automatic failover if the data loss breaches your RPO.

RPO can be set to ZERO (no data loss).

Recovery Time Objective improves

Automatic failover begins immediately after the primary is not reachable for more than a specified threshold.

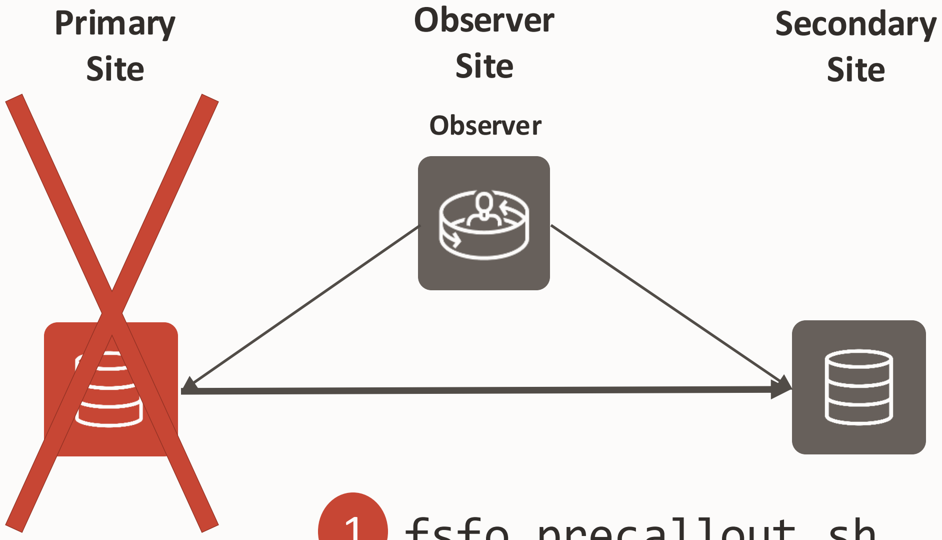
Split-brain protection

The quorum mechanism intrinsically prevents having two primary databases after an automatic failover.

Fast-Start Failover callouts

NEW IN 21c

Execute custom actions before and after the automatic failover occurs



1 `fsfo_precallout.sh`

2 Failover

3 `fsfo_precallout.sh`

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

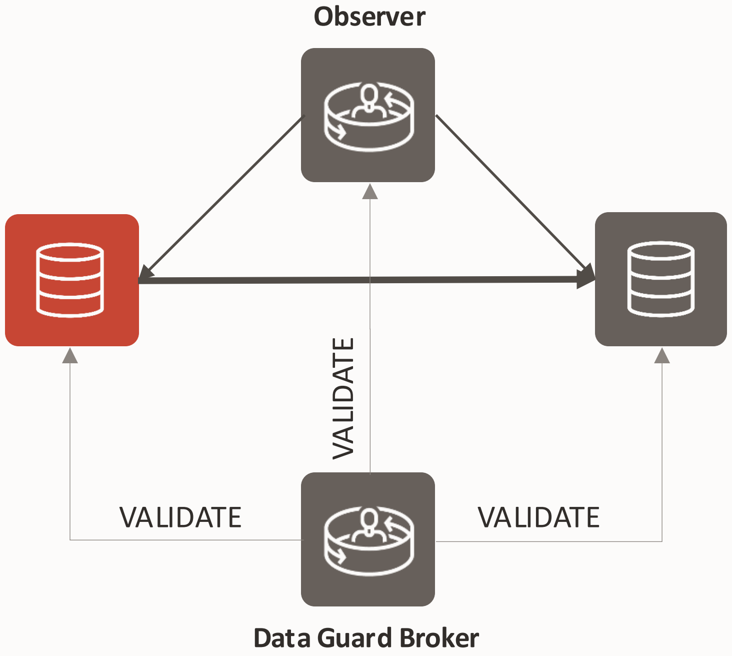
# The pre-callout script is run before failover
FastStartFailoverPreCallout=fsfo_precallout.sh
FastStartFailoverPreCalloutTimeout=1200
FastStartFailoverPreCalloutSucFileName=fsfo_precallout.suc
FastStartFailoverPreCalloutErrorFileName=precallout.err
FastStartFailoverActionOnPreCalloutFailure=STOP

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

NEW IN
21c

Fast Start Failover Configuration Validation

Ensure everything is configured properly for the automatic failover



```
DGMGRL> VALIDATE FAST_START FAILOVER;
  Fast-Start Failover:  Enabled in Potential Data Loss Mode
  Protection Mode:     MaxPerformance
  Primary:                   North_Sales
  Active Target:          South_Sales

Fast-Start Failover Not Possible:
  Fast-Start Failover observer not started

Post Fast-Start Failover Issues:
  Flashback database disabled for database ‘dgv1’

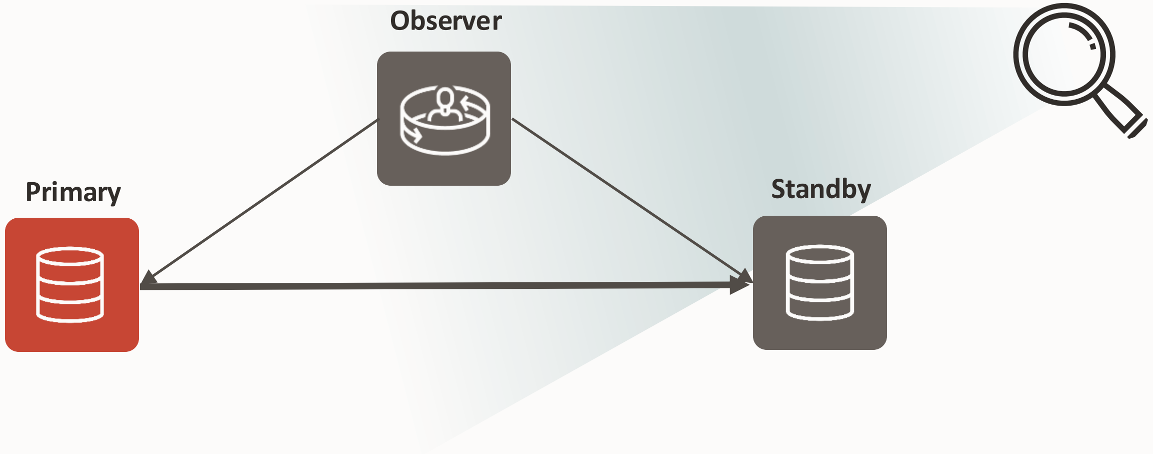
Other issues:
  FastStartFailoverThreshold may be too low for RAC databases.

Fast-start failover callout configuration file "fsfocallout.ora" has
the following issues:
  Invalid lines
    foo=foo
  The specified file "./precallout" contains a path.
```

New In 23ai

Easier checking of Fast-Start Failover configurations

The new fixed view **V$FAST_START_FAILOVER_CONFIG** shows the Fast-Start Failover settings and status



```
SQL> desc V$FAST_START_FAILOVER_CONFIG;
 Name                       Null?    Type
 -------------------------- -------- ------------------
 FSFO_MODE                           VARCHAR2(19)
 STATUS                              VARCHAR2(22)
 CURRENT_TARGET                      VARCHAR2(30)
 THRESHOLD                           NUMBER
 OBSERVER_PRESENT                    VARCHAR2(7)
 OBSERVER_HOST                       VARCHAR2(512)
 PING_INTERVAL                       NUMBER
 PING_RETRY                          NUMBER
 PROTECTION_MODE                     VARCHAR2(30)
 LAG_LIMIT                           NUMBER
 AUTO_REINSTATE                      VARCHAR2(5)
 OBSERVER_RECONNECT                  NUMBER
 OBSERVER_OVERRIDE                   VARCHAR2(5)
 SHUTDOWN_PRIMARY                    VARCHAR2(5)
 CON_ID                              NUMBER
```

```
SQL> SELECT fsfo_mode, status, current_target, threshold, observer_present, observer_host,
 2> protection_mode, lag_limit, auto_reinstate, observer_override, shutdown_primary FROM V$FAST_START_FAILOVER_CONFIG;

FSFO_MODE           STATUS                 CURRENT_TARGET THRESHOLD OBSERVE OBSERVER_HOST PROTECTION_MODE  LAG_LIMIT AUTO_ OBSER SHUTD
------------------- ---------------------- -------------- --------- ------- ------------- ---------------- --------- ----- ----- -----
POTENTIAL DATA LOSS TARGET UNDER LAG LIMIT mydb_site2           180 YES     mydb-obs      MaxPerformance         300 TRUE  FALSE TRUE
```

Note: V$DATABASE columns starting with FS_FAILOVER_ are therefore deprecated.

New In
23ai

Fast-Start Failover Lag Histogram

The view **V$FS_LAG_HISTOGRAM** displays the frequency of Fast-Start Failover lags.

```
SQL> select * from v$fs_lag_histogram;

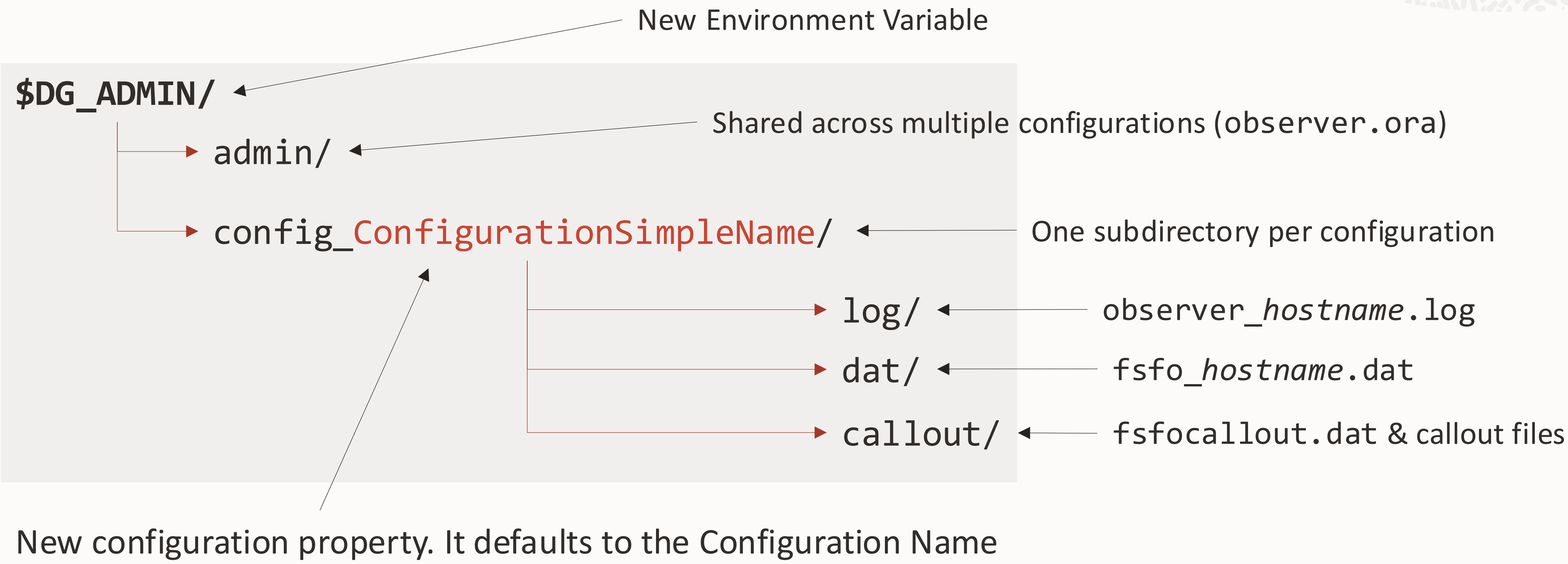
   THREAD# LAG_TYPE      LAG_TIME  LAG_COUNT LAST_UPDATE_TIME         CON_ID
---------- ----------- ---------- ---------- -------------------- ----------
         1 APPLY                5        122 01/23/2023 10:46:07           0
         1 APPLY               10          5 01/02/2023 16:12:42           0
         1 APPLY               15          2 12/25/2022 12:01:23           0
         1 APPLY               30          0                               0
         1 APPLY               60          0                               0
         1 APPLY              120          0                               0
         1 APPLY              180          0                               0
         1 APPLY              300          0                               0
         1 APPLY            65535          0                               0
```

- Useful to calculate the optimal **FastStartFailoverLagTime** property.
- It shows also the most recent occurrence for each bucket.
- **LAG_TIME** is the upper bound of the bucket:
  - 5 -> between 0 and 5 seconds
  - 10 -> between 5 and 10 seconds
  - etc.
- It's calculated every minute, only when Fast-Start Failover is enabled (also in observe-only mode)

NEW IN 21c

Data Guard Broker Client Side Standardized Directory Structure

A single environment variable to define all the locations



New Environment Variable

$DG_ADMIN/

admin/

Shared across multiple configurations (observer.ora)

config_ConfigurationSimpleName/

One subdirectory per configuration

log/

observer_*hostname*.log

dat/

fsfo_*hostname*.dat

callout/

fsfocallout.dat & callout files

New configuration property. It defaults to the Configuration Name

Location of Client-side Broker Files
https://docs.oracle.com/en/database/oracle/oracle-database/21/dgbkr/using-data-guard-broker-to-manage-switchovers-failovers.html#GUID-0C8473F6-33B5-479F-9208-9CA651F1B483

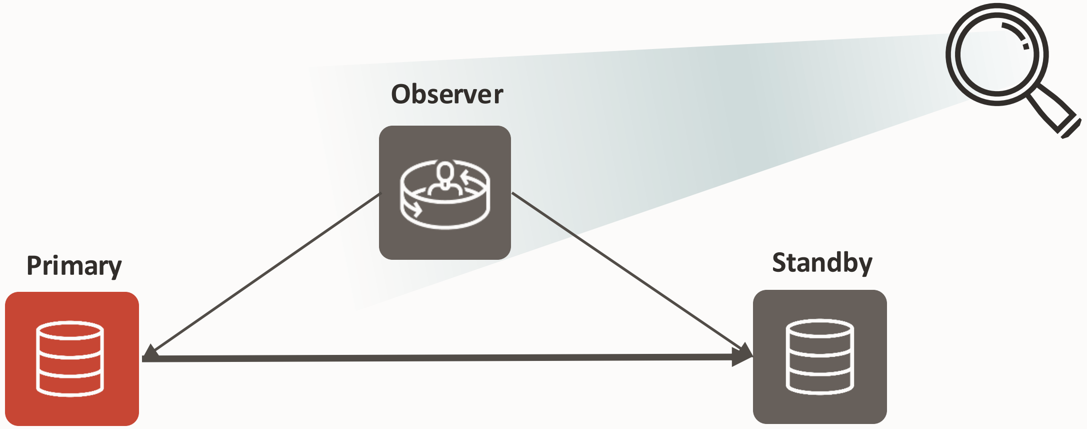
New In 23ai

Enhanced observer diagnostic

New columns in V$FS_FAILOVER_OBSERVERS with additional details

New columns:

LAST_PING_PRIMARY
LAST_PING_TARGET
LOG_FILE
STATE_FILE
CURRENT_TIME



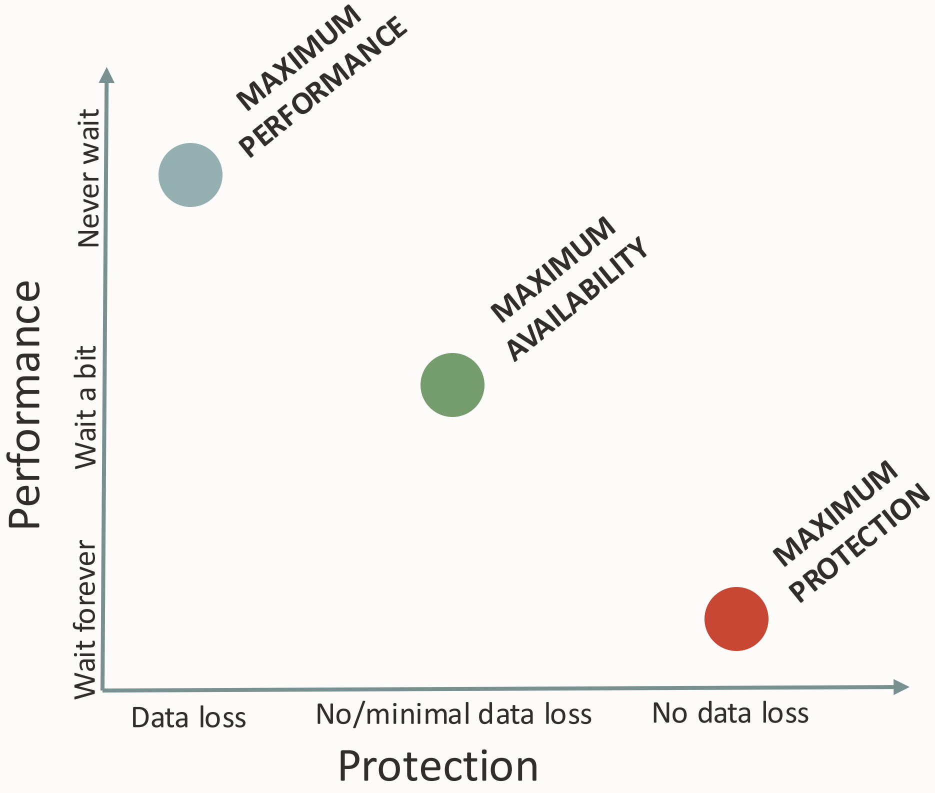
```
SQL> select name, registered, host, ismaster, pinging_primary, pinging_target ,
  2> last_ping_primary, last_ping_target, log_file, state_file, current_time
  3> from V$FS_FAILOVER_OBSERVERS where host is not null;

NAME     REGI HOST     ISMA PING PING LAST_PING_PRIMARY LAST_PING_TARGET LOG_FILE           STATE_FILE        CURRENT_TIME
-------- ---- -------- ---- ---- ---- ----------------- ---------------- ------------------ ----------------- -------------------------------
host-obs YES  host-obs YES  YES  YES                  0                2 /.../observer.lst  /.../observer.dat 06-OCT-22 06.38.14.000000000 AM
```

Fast-Start Failover:
Oracle Data Guard Protection Modes

Data Guard Fast-Start Failover Protection Modes

Balance Data Protection with Performance and Availability



What does the primary do if the standby does not acknowledge the transaction?

MAXIMUM PERFORMANCE

Never waits for acknowledge (**ASYNC**).
Some transactions might get lost when primary fails.

MAXIMUM AVAILABILITY

Waits until *NetTimeout* seconds (**SYNC** or **FASTSYNC**), then continue without standby. Data loss possible with manual failover *or within specified limit (21c)*.

MAXIMUM PROTECTION

Waits until the standby is available again (**SYNC only**).
No transactions are lost, ever.

Fast-Start Failover: Maximum Performance

Max Performance without Fast-Start Failover

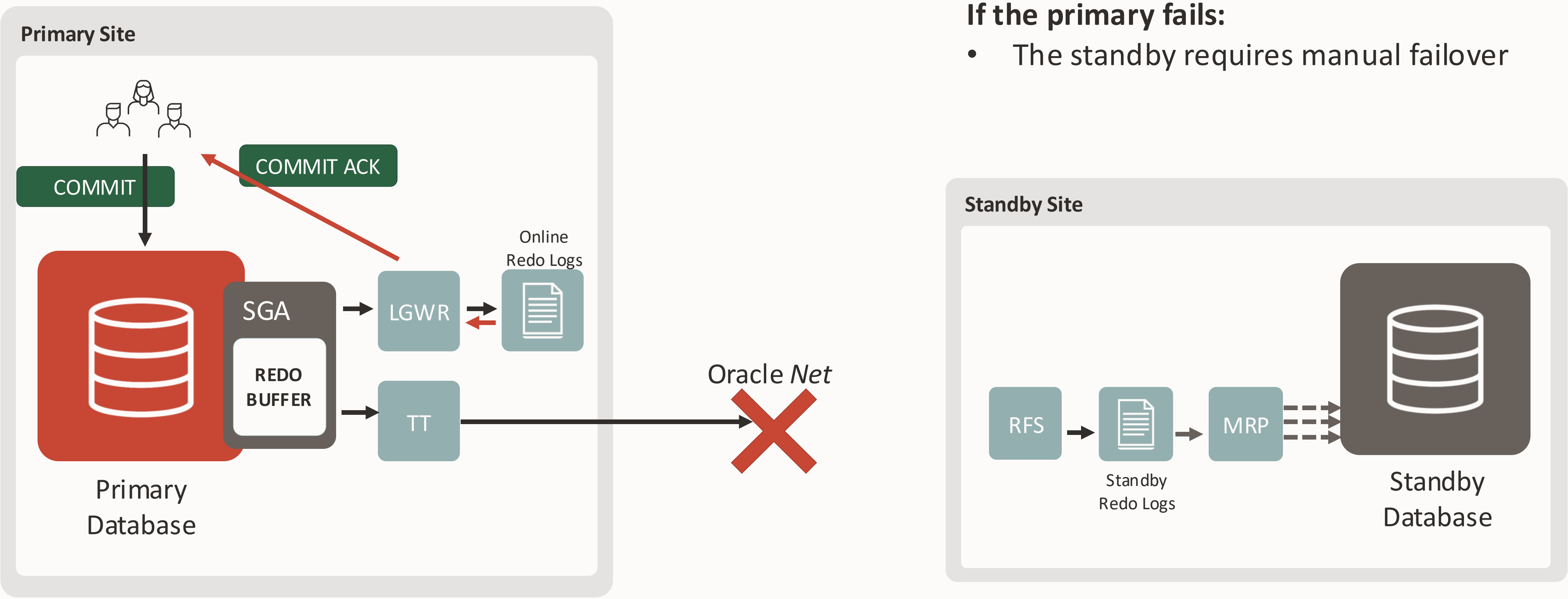
Data Guard ASYNC redo transport

If the standby is not reachable or is slow:

- The primary keeps writing at its pace
- The lag (data loss exposure) increases

If the primary fails:

- The standby requires manual failover

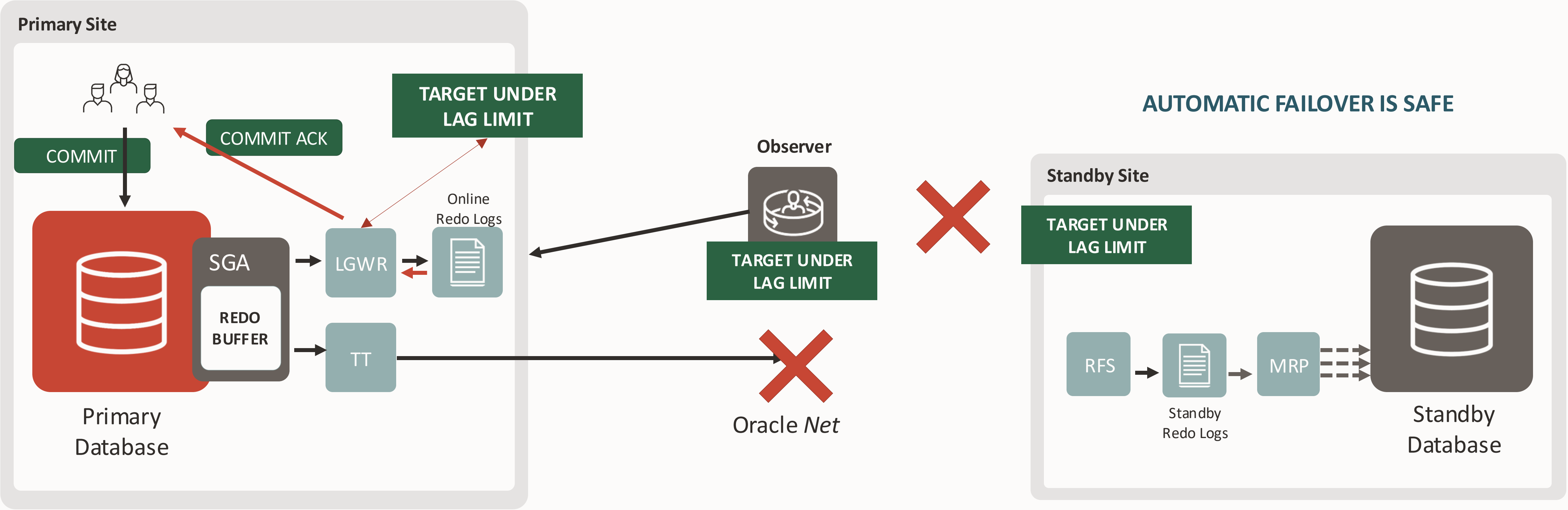


Max Performance with Fast-Start Failover

The primary continuously computes the lag with the Fast-Start Failover Target

If the standby is not reachable or is slow:

- The primary keeps committing until reaching the lag limit

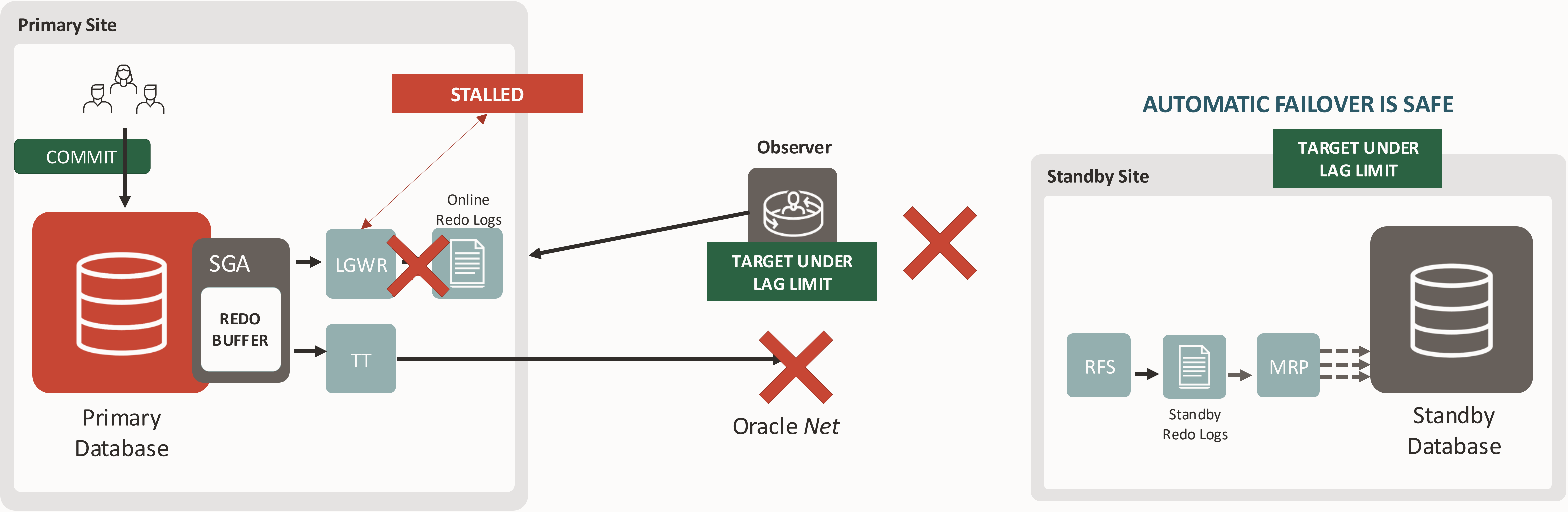


Max Performance with Fast-Start Failover

The primary continuously computes the lag with the Fast-Start Failover Target

If the standby is not reachable or is slow:

- The primary keeps committing until reaching the lag limit
- Then it goes to STALLED mode (no commits possible)

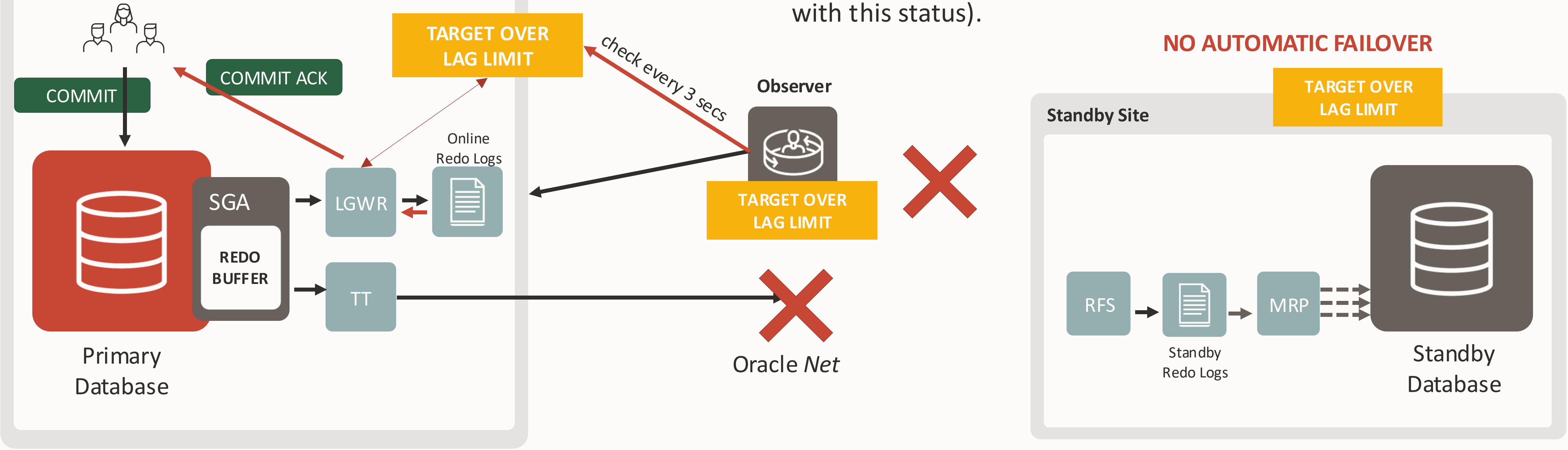


Max Performance with Fast-Start Failover

The primary continuously computes the lag with the Fast-Start Failover Target

If the standby is not reachable or is slow:

- The primary keeps committing until reaching the lag limit
- Then it goes to STALLED mode (no commits possible)
- The observer sees the primary stalling (quorum with primary) and resumes its activity OVER LAG LIMIT (no failover possible with this status).

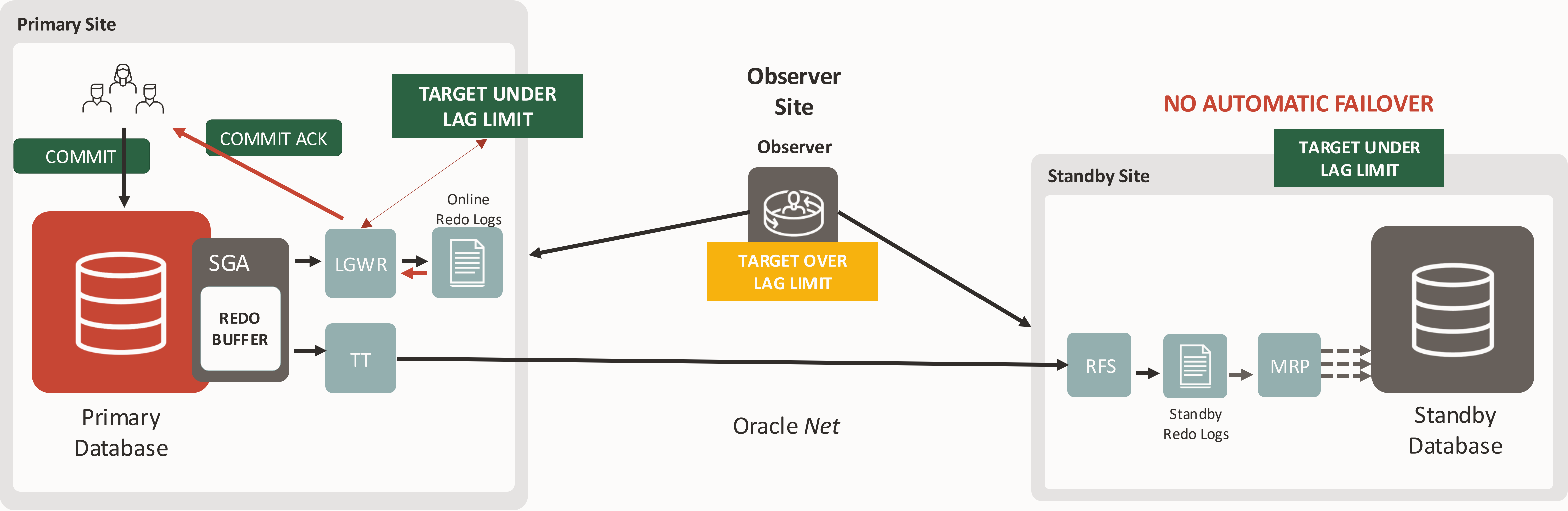


Max Performance with Fast-Start Failover

The primary continuously computes the lag with the Fast-Start Failover Target

When the standby catches up with the primary

- The primary goes autonomously under lag limit

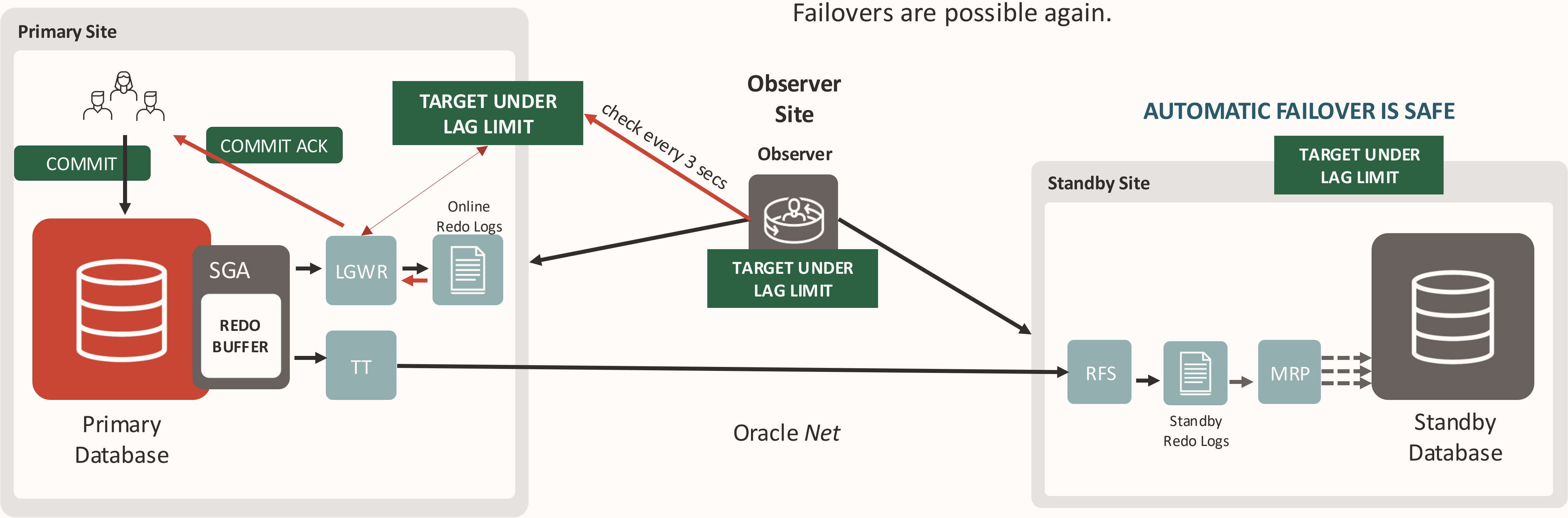


Max Performance with Fast-Start Failover

The primary continuously computes the lag with the Fast-Start Failover Target

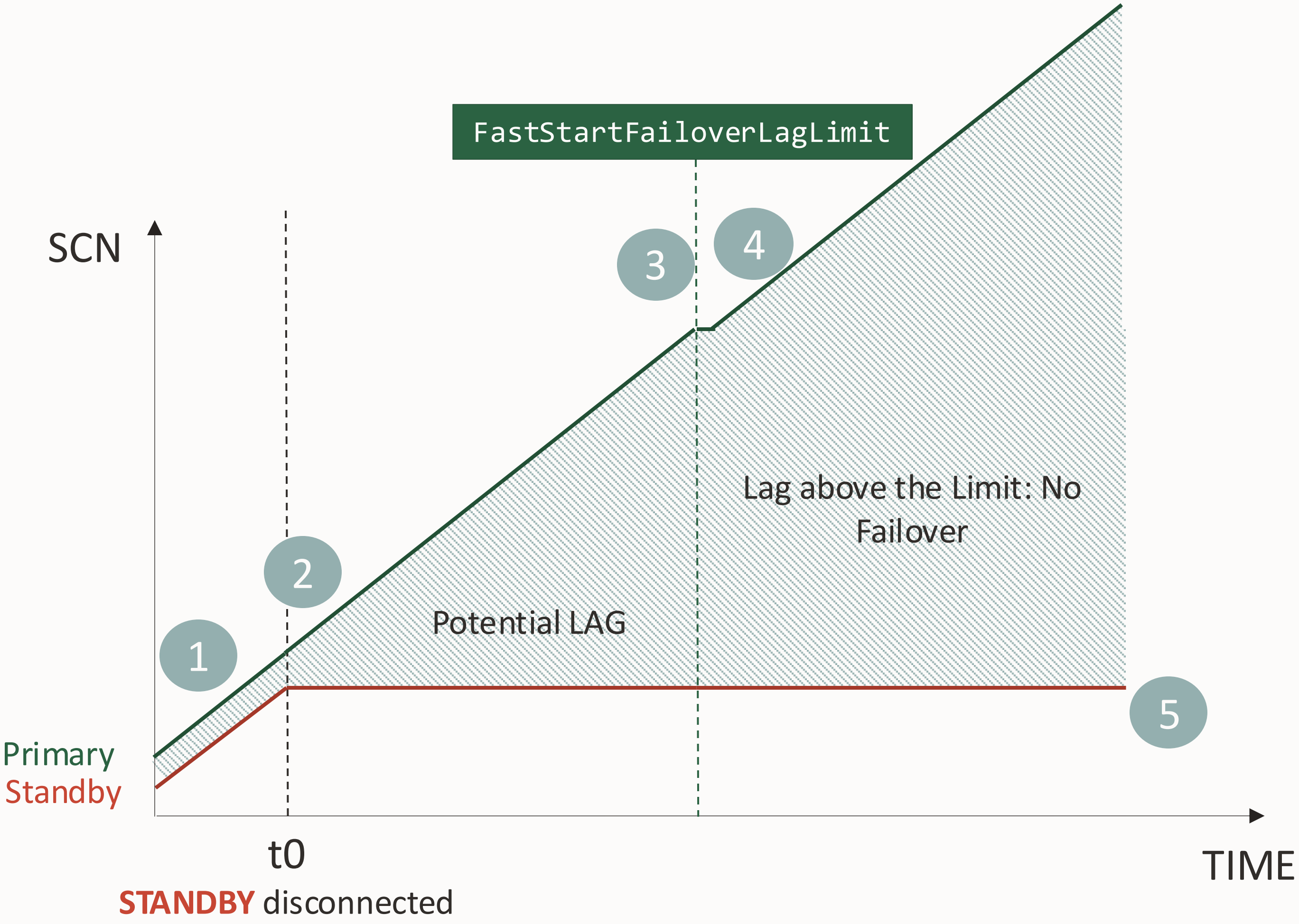
When the standby catches up with the primary

- The primary goes autonomously under lag limit
- At the next check, the observer acknowledges the change. Failovers are possible again.



Automatic Failover with MaxPerformance

Choose how much data loss you can tolerate



1 ASYNC Transport. The Standby has a residual lag

Status: TARGET UNDER LAG LIMIT

2 At `t0` + ping time, the primary cannot contact the standby. The Primary keeps committing, the Standby lag increases.

Status: TARGET UNDER LAG LIMIT

3 The primary reaches `FastStartFailoverLagLimit`. It temporarily stalls (~3 seconds) until it gets permission from the observer to continue.
Status: STALLED

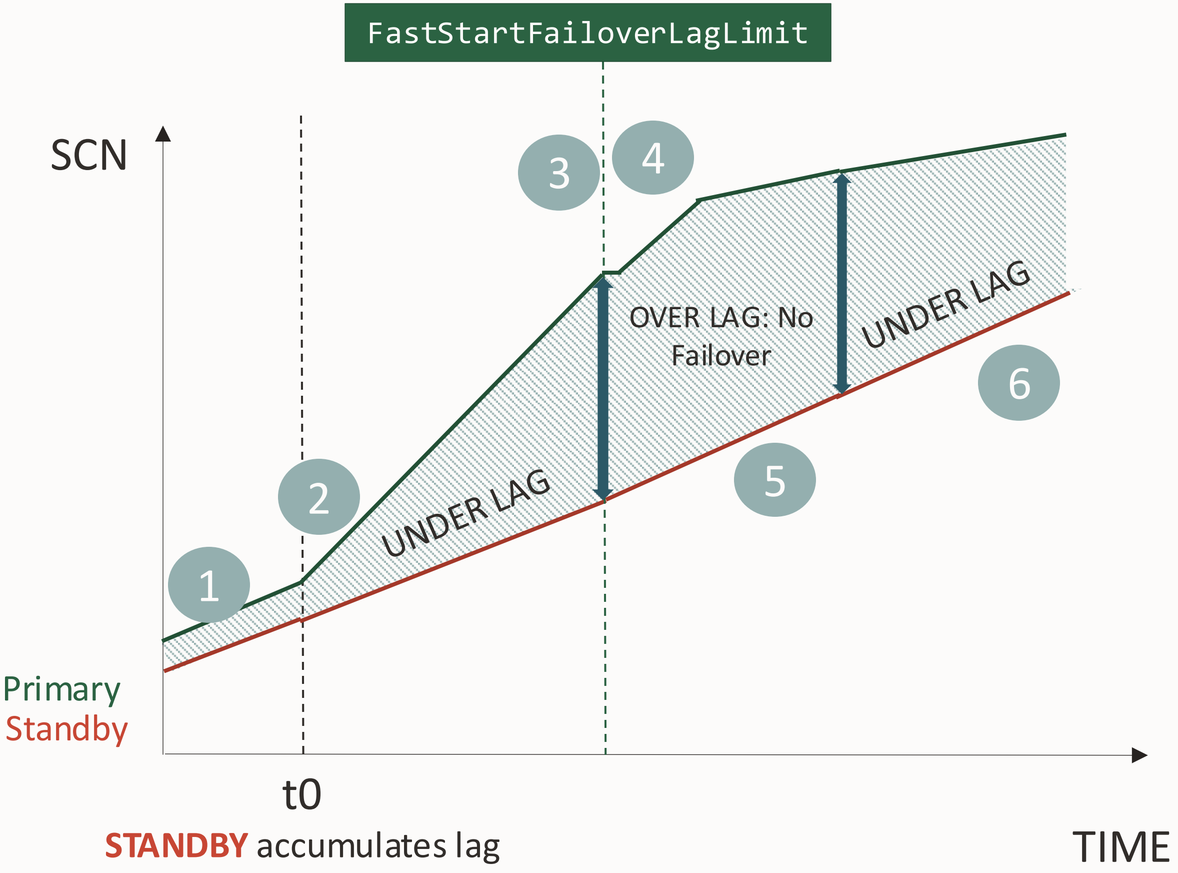
4 After the observer pings the primary and gives permission to continue, the primary resumes the commit activity. Status: TARGET OVER LAG LIMIT

5 The observer acknowledges that the lag is above the limit and will not permit a failover in case it loses connectivity with the primary. The standby is declared out of sync.

Status: TARGET OVER LAG LIMIT

Automatic Failover with MaxPerformance

Choose how much data loss you can tolerate



STANDBY accumulates lag

1 ASYNC Transport. The Standby has a residual lag

Status: TARGET UNDER LAG LIMIT

2 At `t0` the primary increases the activity rate. The Standby lag increases.

Status: TARGET UNDER LAG LIMIT

3 The primary reaches `FastStartFailoverLagLimit`. It temporarily stalls (~3 seconds) until it gets permission from the observer to continue.

Status: STALLED

4 After the observer pings the primary and gives permission to continue, the primary resumes the commit activity. Status: TARGET OVER LAG LIMIT

5 The observer acknowledges that the lag is above the limit and will not permit a failover in case it loses connectivity with the primary. The standby is declared out of sync.

Status: TARGET OVER LAG LIMIT

6 The standby catches up with the primary and the lag goes under the limit. The observer can now failover if the primary fails.

Status: TARGET UNDER LAG LIMIT

New In 23ai

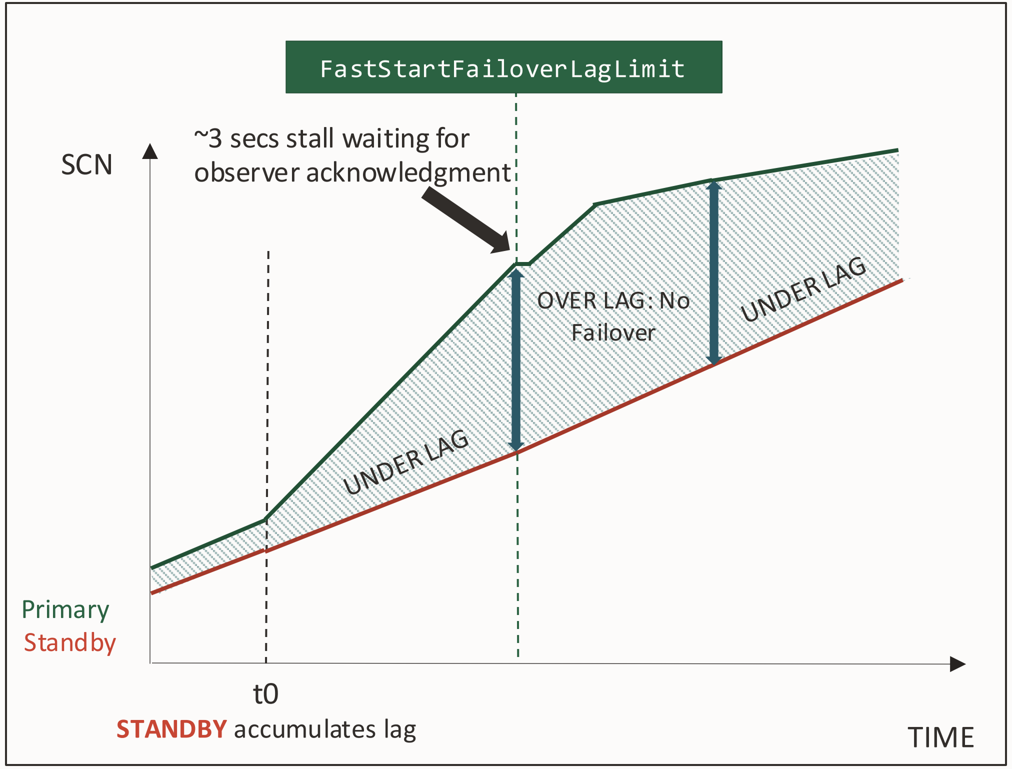
Minimized Stall in Fast-Start Failover Maximum Performance

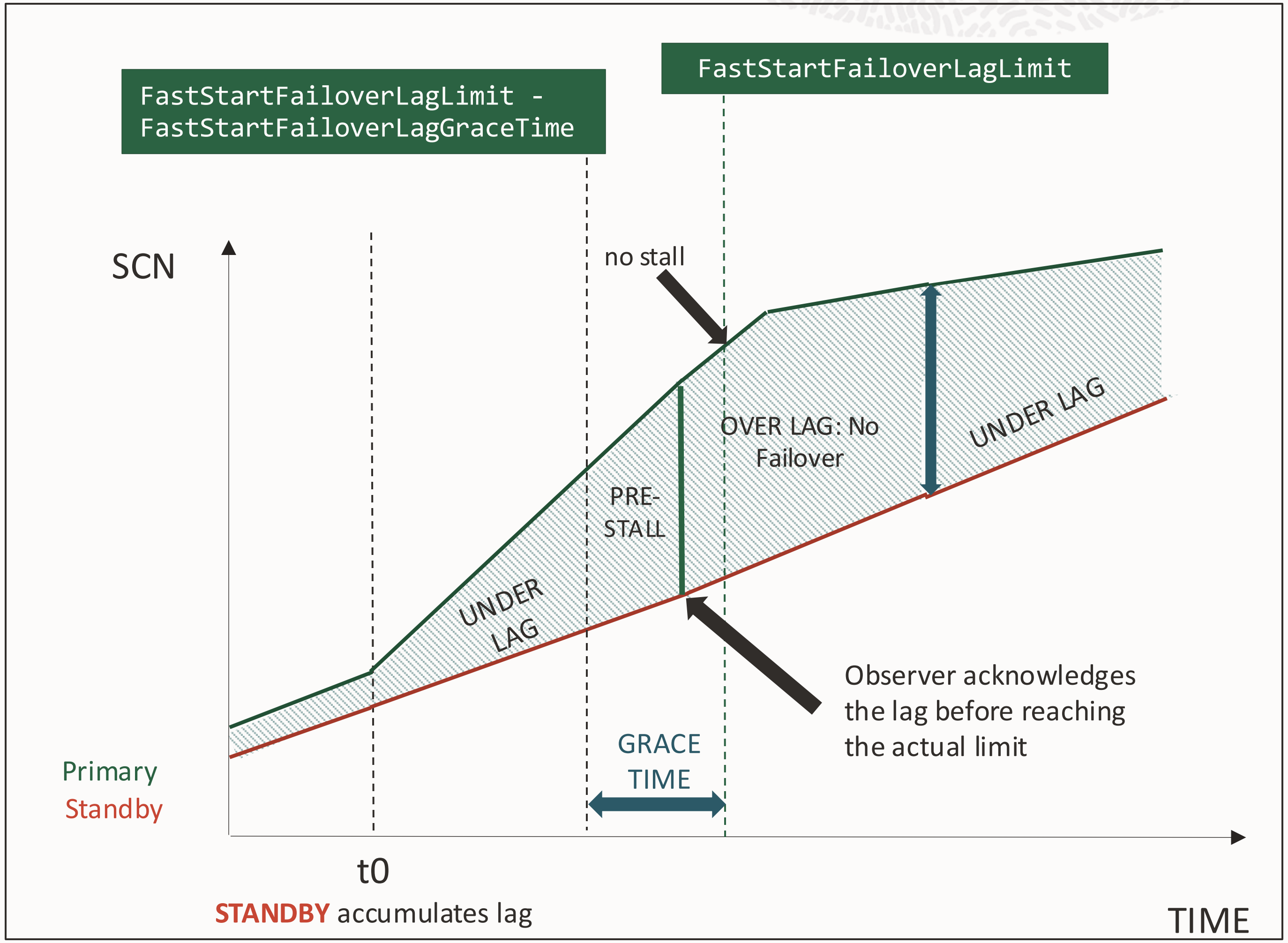
Reduce/avoid delays during FSFO state transition to "OVER LAG LIMIT"

FastStartFailoverLagGraceTime

BEFORE 23ai

STARTING WITH 23ai



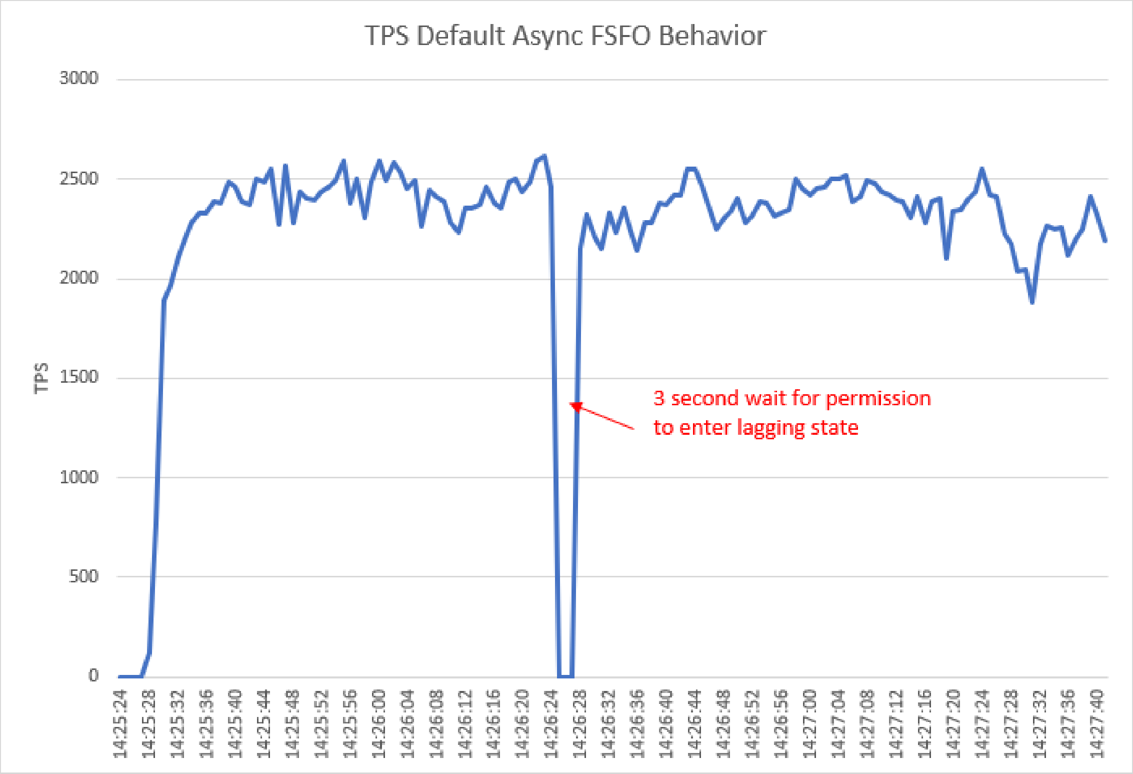

FastStartFailoverLagLimit - FastStartFailoverLagGraceTime
FastStartFailoverLagLimit
SCN
no stall
OVER LAG: No Failover
UNDER LAG
PRE-STALL
UNDER LAG
Observer acknowledges the lag before reaching the actual limit
GRACE TIME
Primary
Standby
t0
STANDBY accumulates lag
TIME

* or 19c Patch 34995066: MINIMIZE STALL IN DATA-LOSS FAST-START FAILOVER

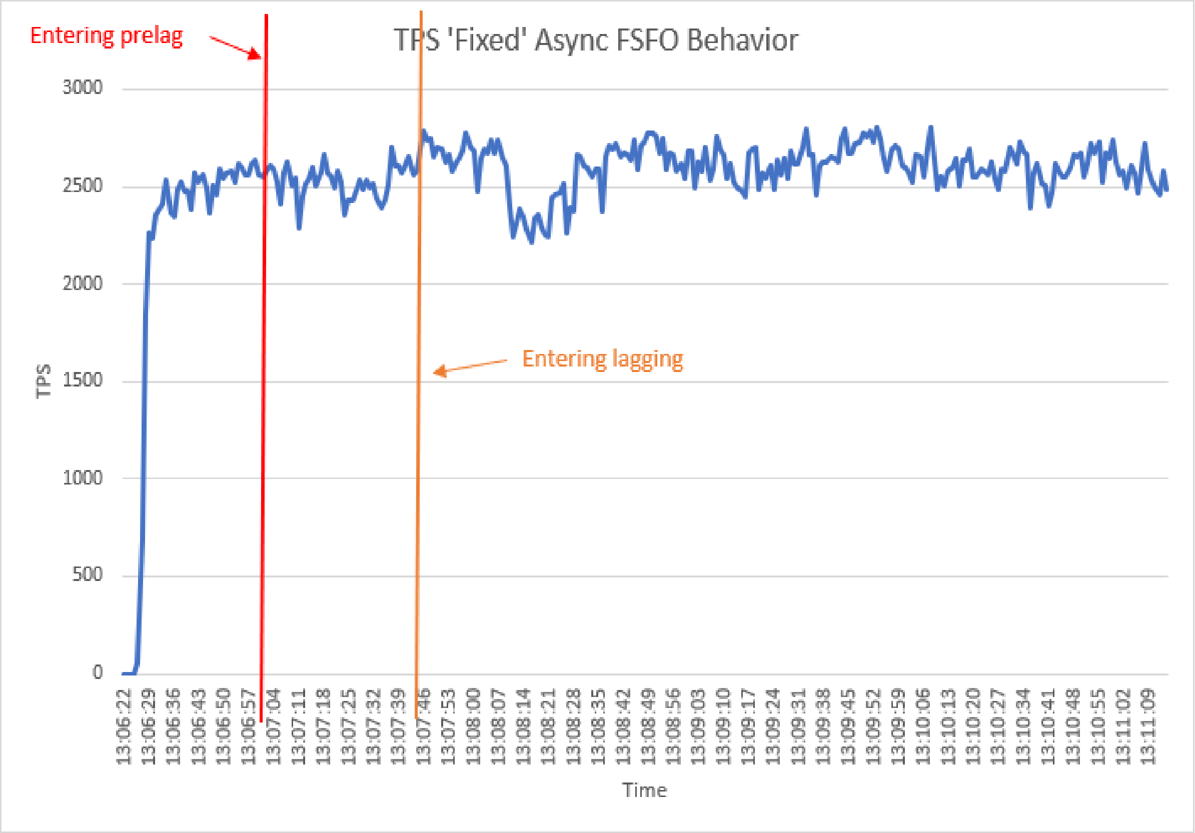
New In 23^{ai}

Minimized Stall in Fast-Start Failover Maximum Performance

Reduce/avoid delays during FSFO state transition to "OVER LAG LIMIT"



3 second wait for permission to enter lagging state



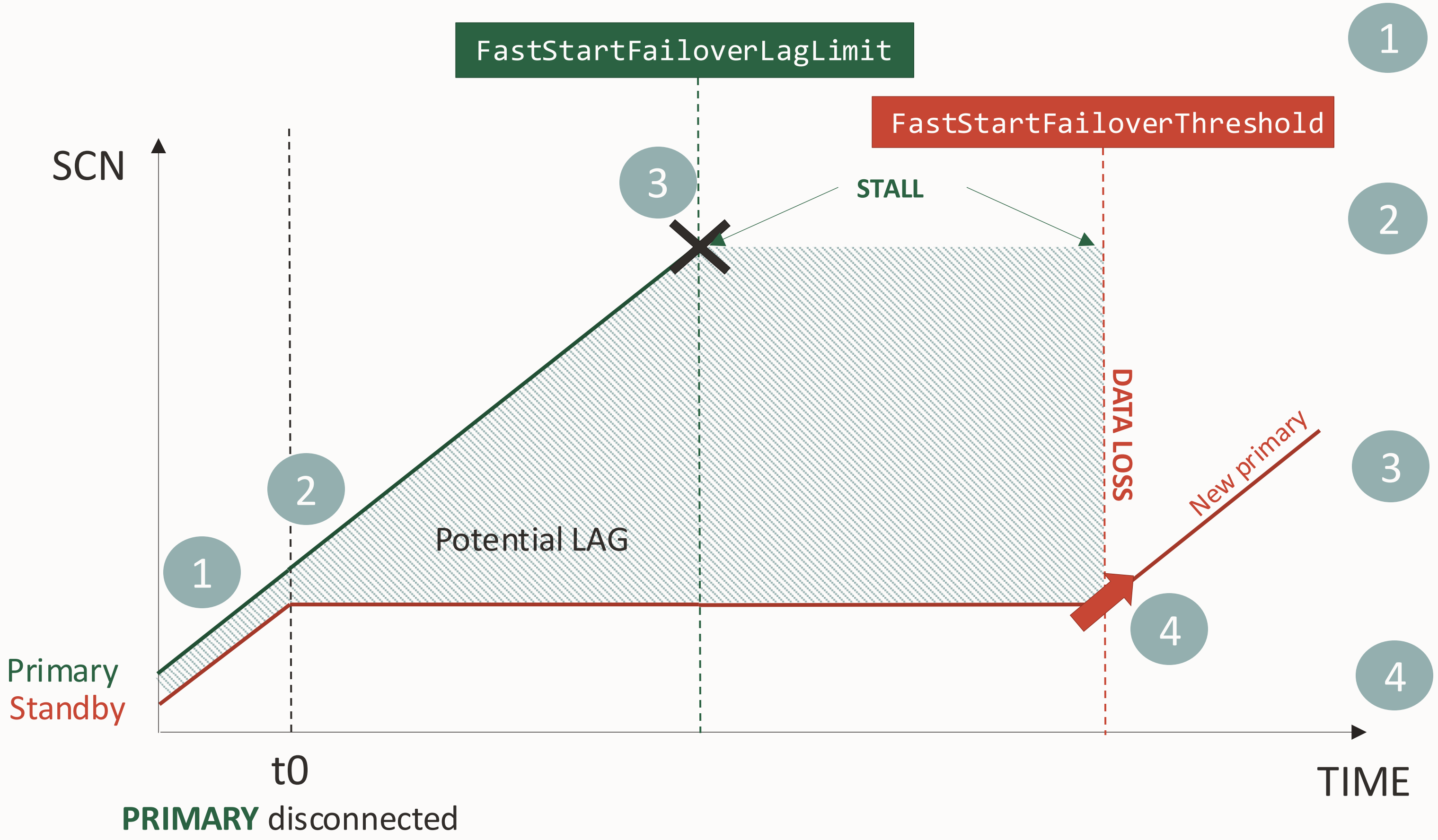
Entering prelag

Entering lagging

Automatic Failover with MaxPerformance

Choose how much data loss you can tolerate

`FastStartFailoverLagLimit` ≤ `FastStartFailoverThreshold`



1 ASYNC Transport. The Standby has a residual lag

Status: TARGET UNDER LAG LIMIT

2 At `t0` + ping time, the observer cannot contact the primary and starts a timer for `FastStartFailoverThreshold` seconds. The Primary keeps committing, the Standby lag increases.

Status: TARGET UNDER LAG LIMIT

3 The primary reaches `FastStartFailoverLagLimit`. It cannot obtain permission from the observer to continue. It stalls or shuts down depending on `FastStartFailoverPmyShutdown`

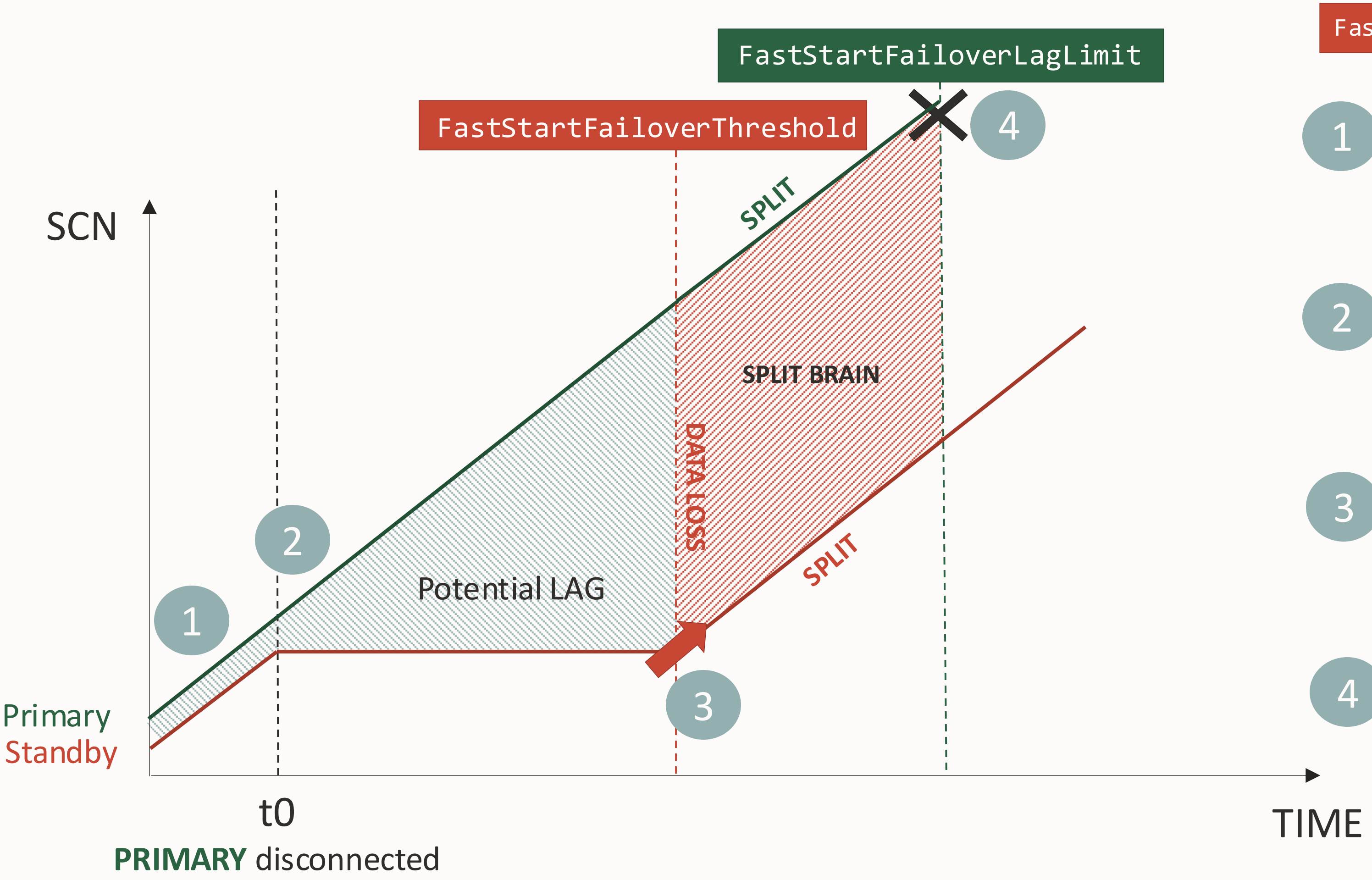
Status: STALLED

4 The observer timer reaches `FastStartFailoverThreshold`. Still no connection with the primary: it initiates the Failover

Status: REINSTATE REQUIRED

Automatic Failover with MaxPerformance

Set the FastStartFailoverLagLimit wisely to avoid split-brain conditions



FastStartFailoverThreshold < FastStartFailoverLagLimit

1 ASYNC Transport. The Standby has a residual lag
Status: TARGET UNDER LAG LIMIT

2 At `t0` + ping time, the observer cannot contact the primary and starts a timer for `FastStartFailoverThreshold` seconds. The Primary keeps committing, the Standby lag increases.
Status: TARGET UNDER LAG LIMIT

3 The observer timer reaches `FastStartFailoverThreshold`. Still no connection with the primary: it initiates the Failover
Primary status: TARGET UNDER LAG LIMIT
Standby status: REINSTATE REQUIRED

4 The Primary keeps committing until it reaches `FastStartFailoverLagLimit`, then stalls or shuts down. A Split-Brain condition may occur depending on timings and parameter values.
Primary status: STALLED or REINSTATE REQUIRED
Standby status: REINSTATE REQUIRED

New In 23ai

Choose the Lag Type for Maximum Performance Mode

New Property FastStartFailoverLagType

The broker can now use the standby's transport lag to determine whether a data loss situation exists.
The amount of tolerated data loss is still set with `FastStartFailoverLagLimit`.

Before 23ai	Starting with 23ai
Only the **APPLY lag** is used to determine the data loss exposure.	The new property **`FastStartFailoverLagType`** property can be used to choose which type of lag should be used. It can be **TRANSPORT** or **APPLY**. **APPLY** is the default to keep the old behavior.

* or 19c Patch 34995066: MINIMIZE STALL IN DATA-LOSS FAST-START FAILOVER

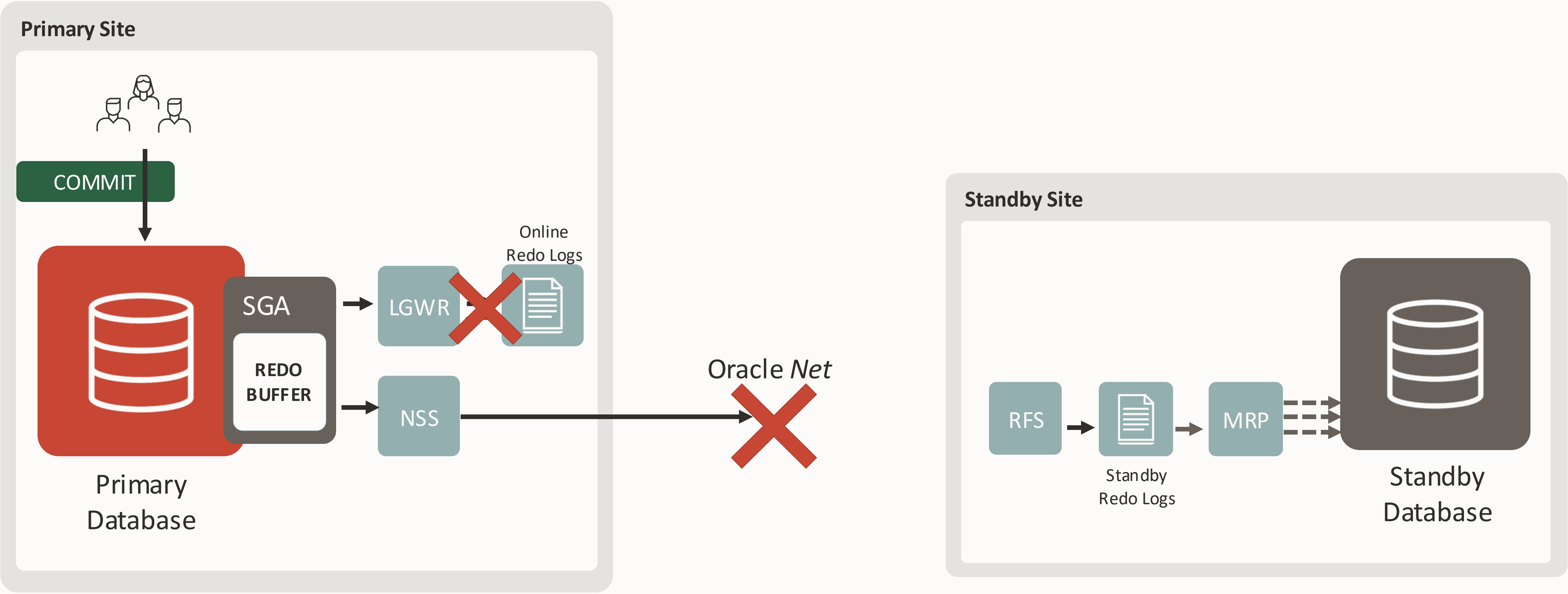
Fast-Start Failover: Maximum Availability

Max Availability without Fast-Start Failover

Data Guard SYNC redo transport

If the standby is not reachable:

- The primary stalls waiting for the SYNC destination (no commits possible)

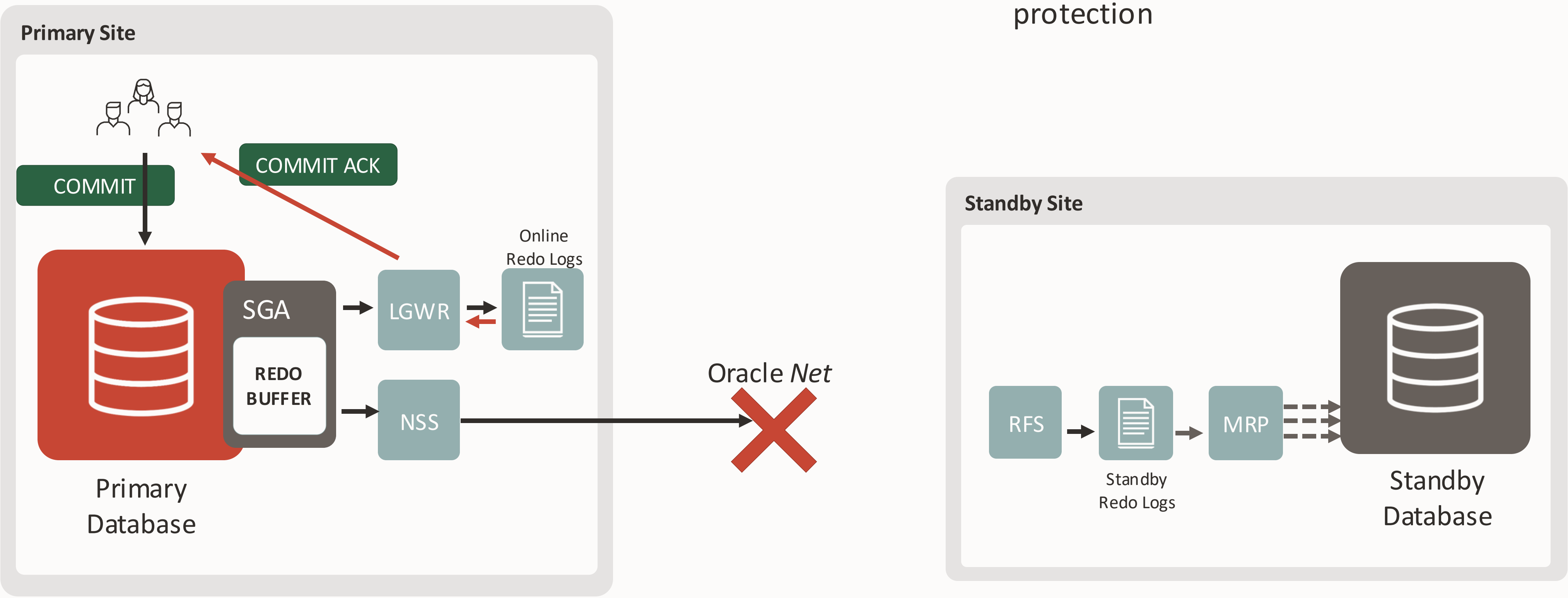


Max Availability without Fast-Start Failover

Data Guard SYNC redo transport

If the standby is not reachable:

- The primary stalls waiting for the SYNC destination (no commits possible)
- After NetTimeout seconds, it resumes the activity without protection

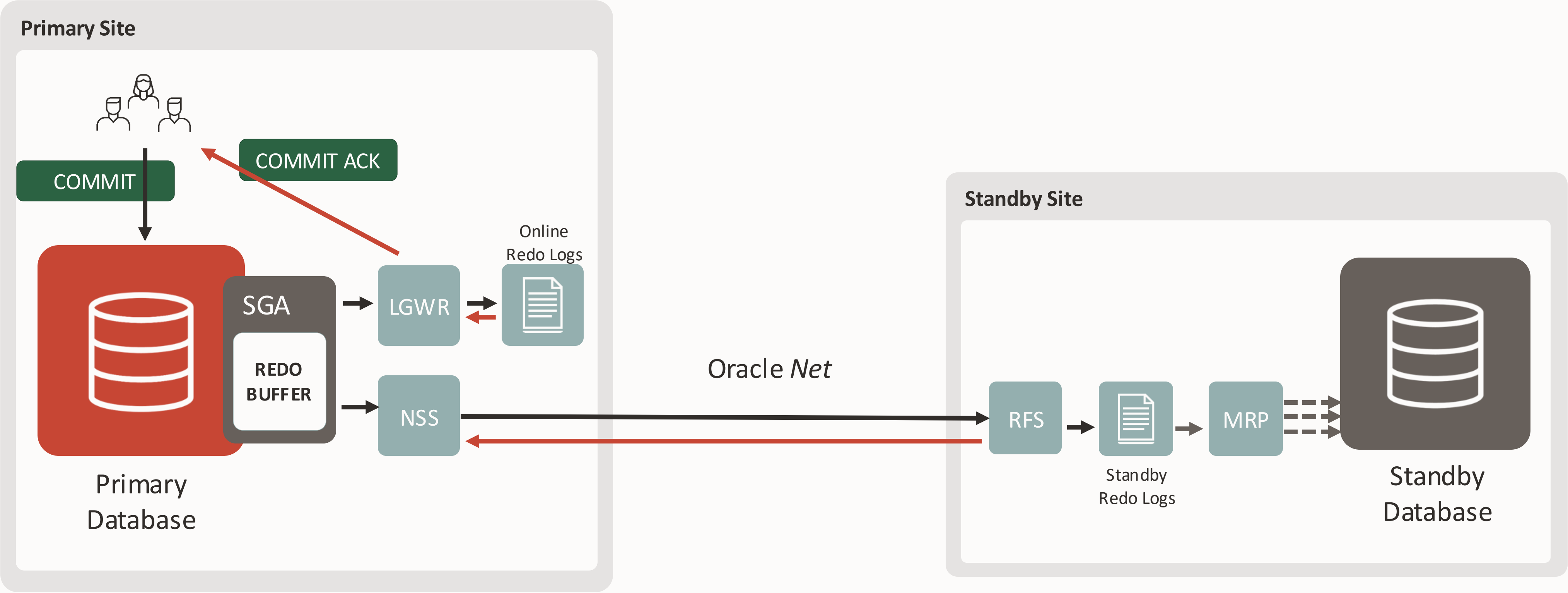


Max Availability without Fast-Start Failover

Data Guard SYNC redo transport

If the standby is slow:

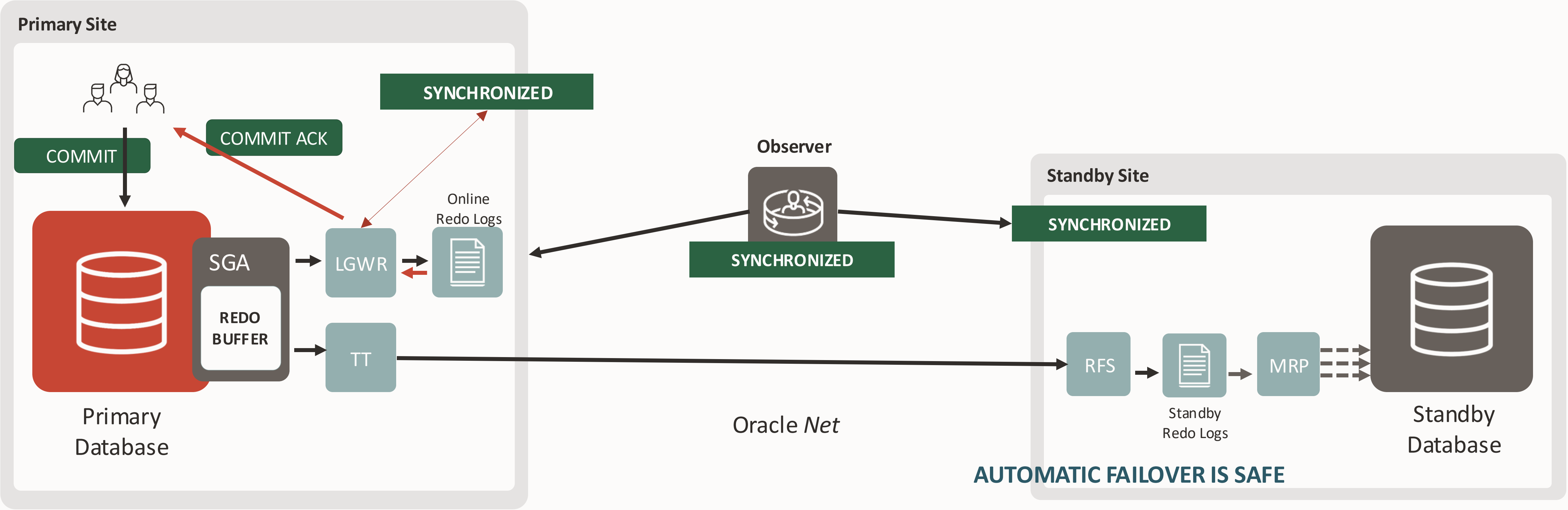
- The commits will take longer, decreasing the primary database performance
- Latencies (disk and/or network) have a crucial role



Max Availability with Fast-Start Failover

The primary never commits without the observer quorum

In a normal situation, the status is SYNCHRONIZED

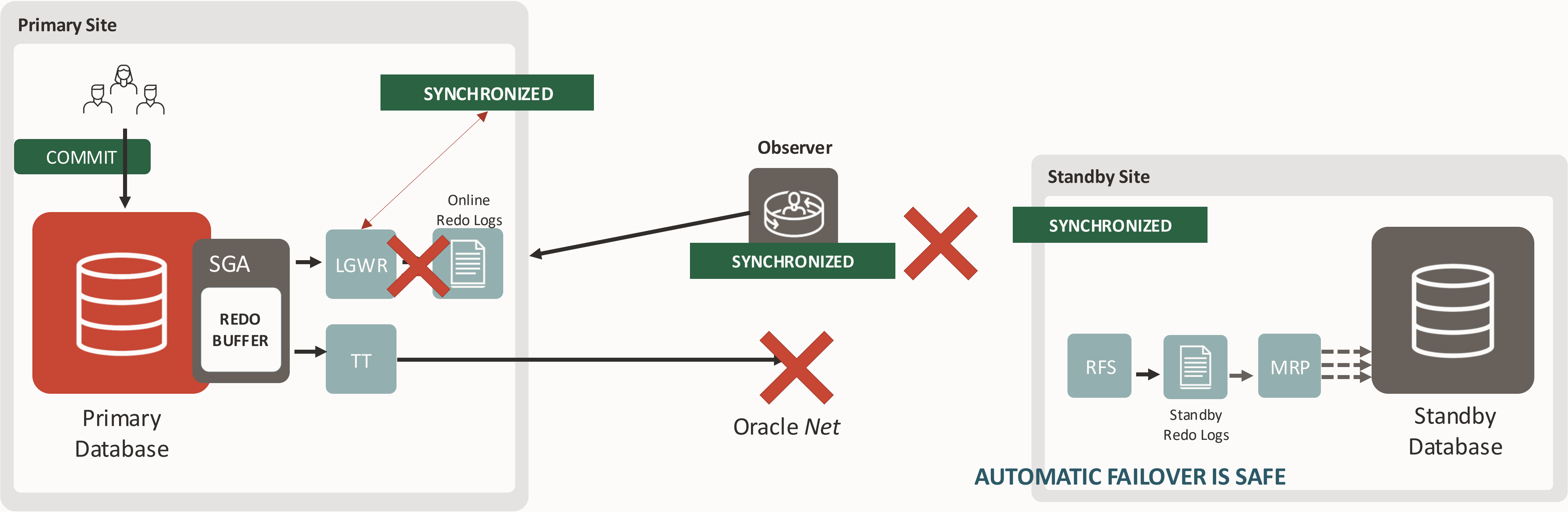


Max Availability with Fast-Start Failover

The primary never commits without the observer quorum

If the standby is not reachable:

- The primary waits for the SYNC destination (no commits possible) but keeps the status synchronized



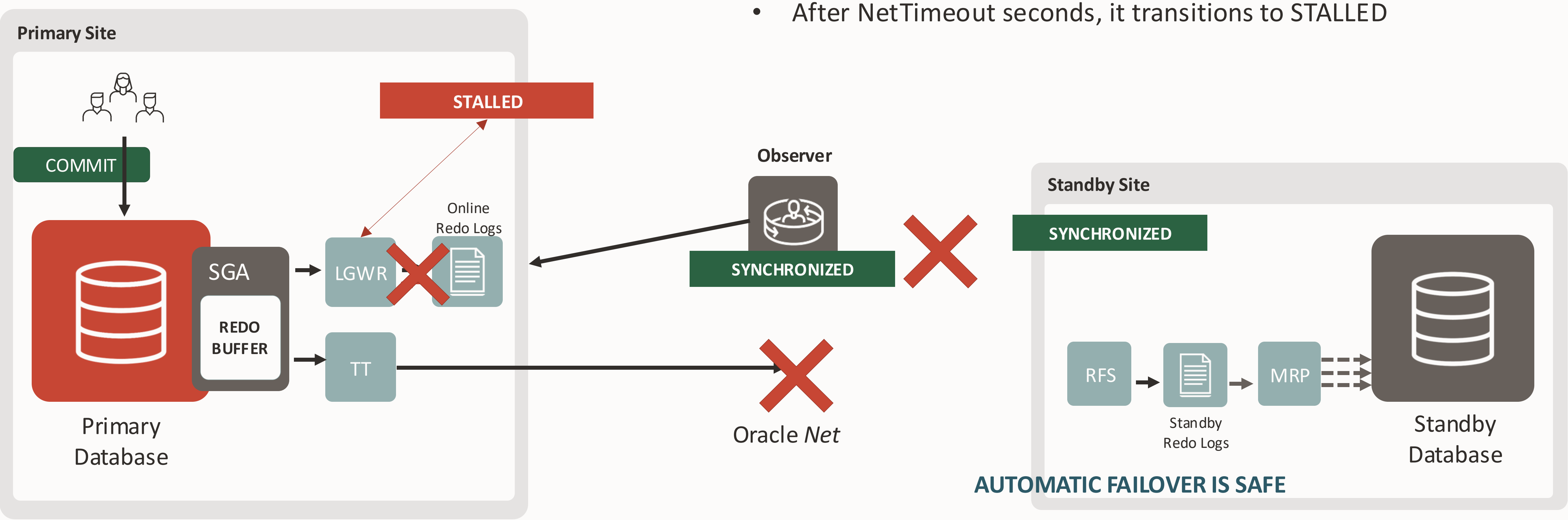
AUTOMATIC FAILOVER IS SAFE

Max Availability with Fast-Start Failover

The primary never commits without the observer quorum

If the standby is not reachable:

- The primary waits for the SYNC destination (no commits possible) but keeps the status synchronized
- After NetTimeout seconds, it transitions to STALLED



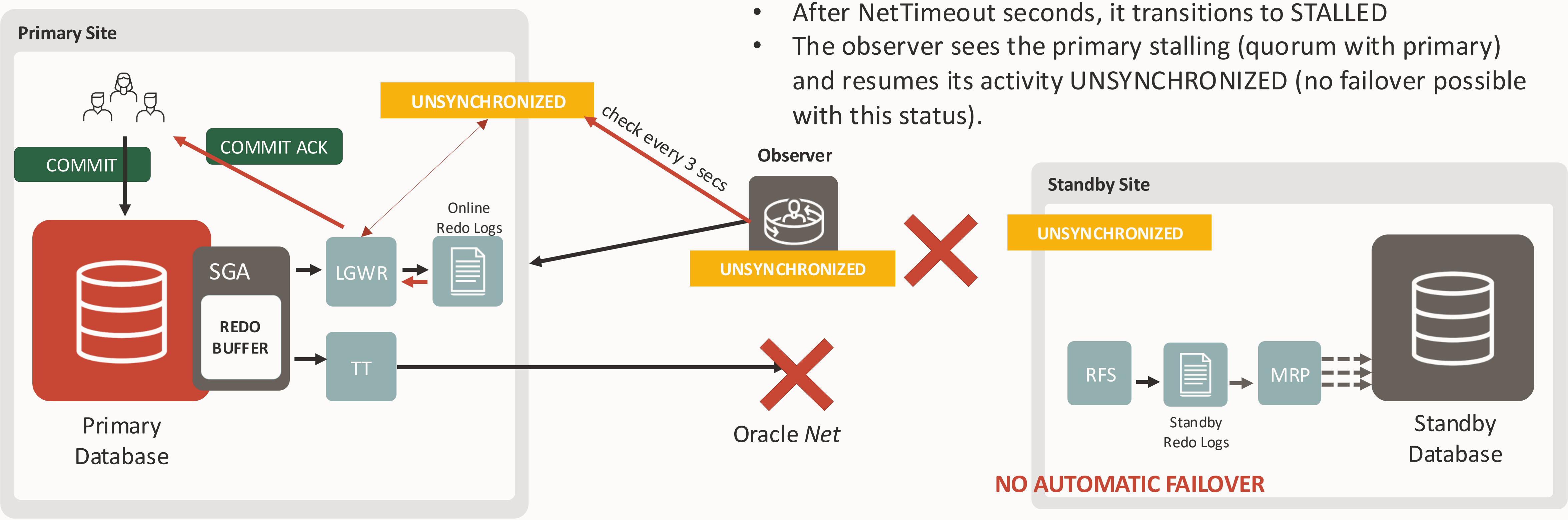
AUTOMATIC FAILOVER IS SAFE

Max Availability with Fast-Start Failover

The primary never commits without the observer quorum

If the standby is not reachable:

- The primary waits for the SYNC destination (no commits possible) but keeps the status synchronized
- After NetTimeout seconds, it transitions to STALLED
- The observer sees the primary stalling (quorum with primary) and resumes its activity UNSYNCHRONIZED (no failover possible with this status).

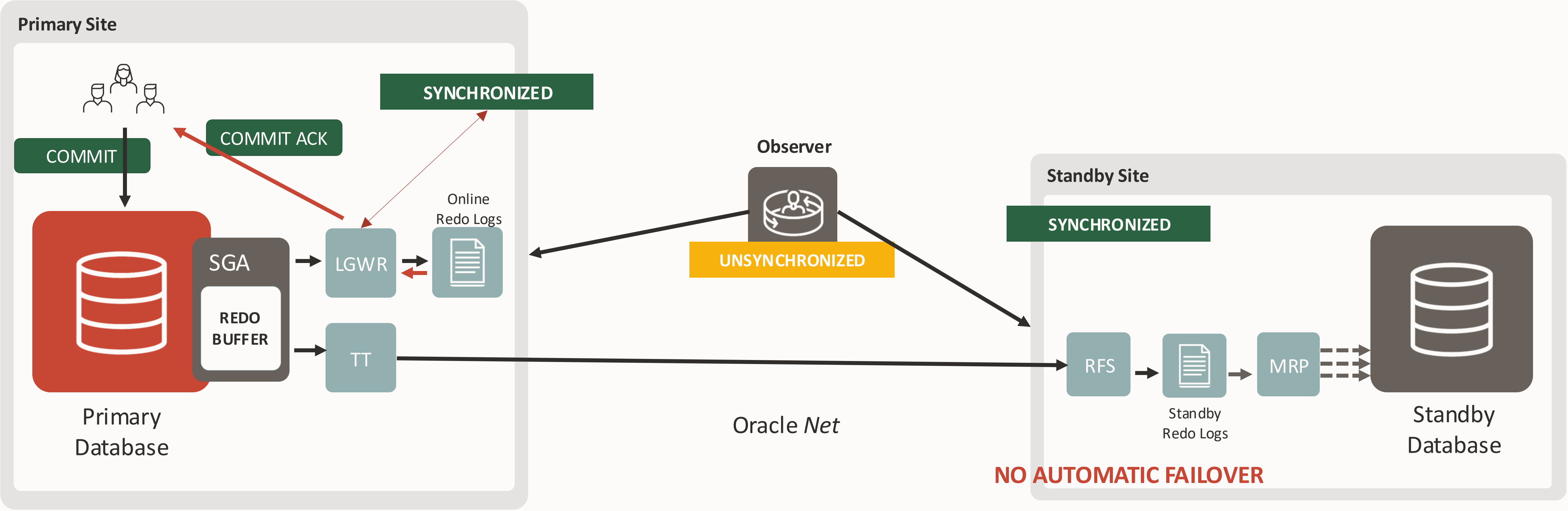


Max Availability with Fast-Start Failover

The primary never commits without the observer quorum

When the standby is in SYNC again

- The primary autonomously change the status to SYNCHRONIZED

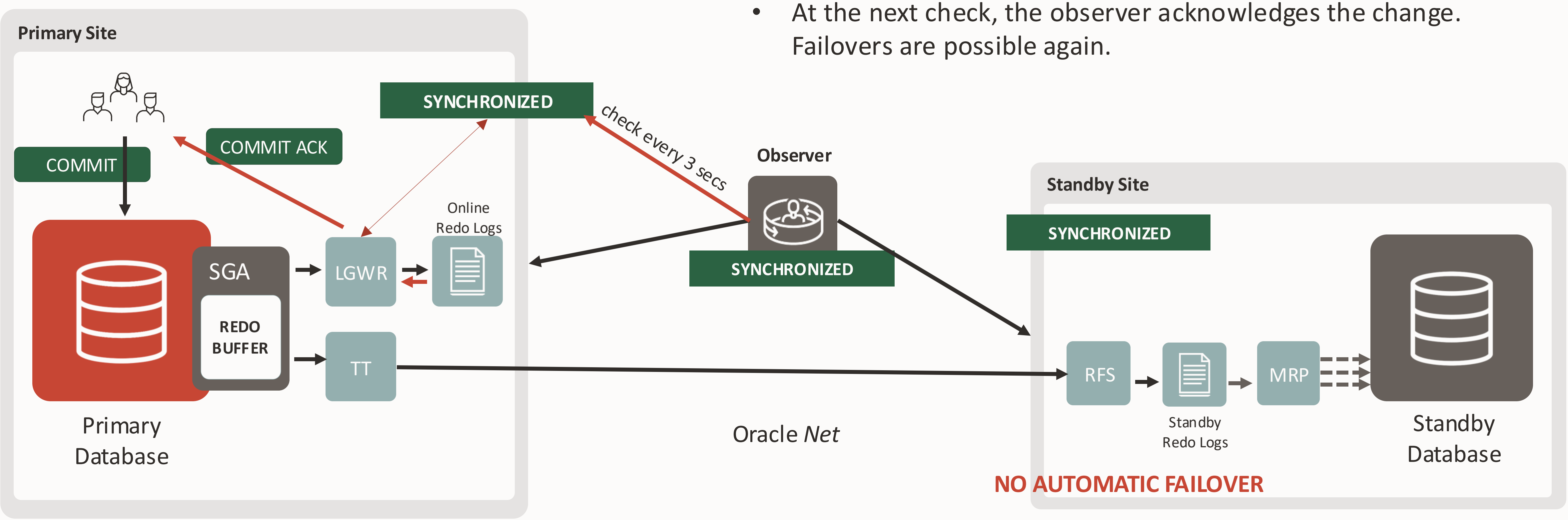


Max Availability with Fast-Start Failover

The primary never commits without the observer quorum

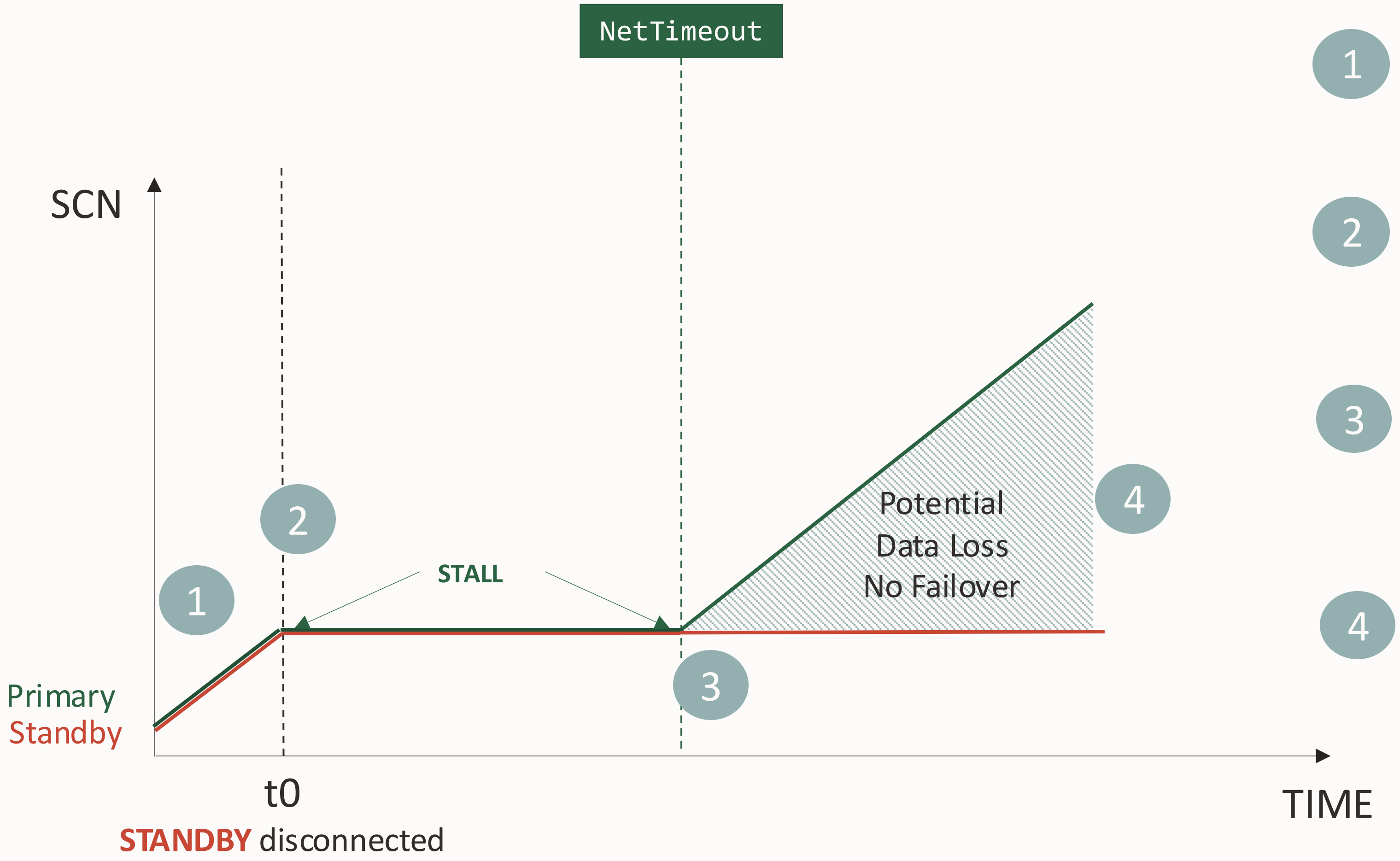
When the standby is in SYNC again

- The primary autonomously change the status to SYNCHRONIZED
- At the next check, the observer acknowledges the change. Failovers are possible again.



Automatic Failover with MaxAvailability

Failover only if Zero Data Loss is guaranteed



1 SYNC Transport. The Standby is synched.
Status: SYNCHRONIZED

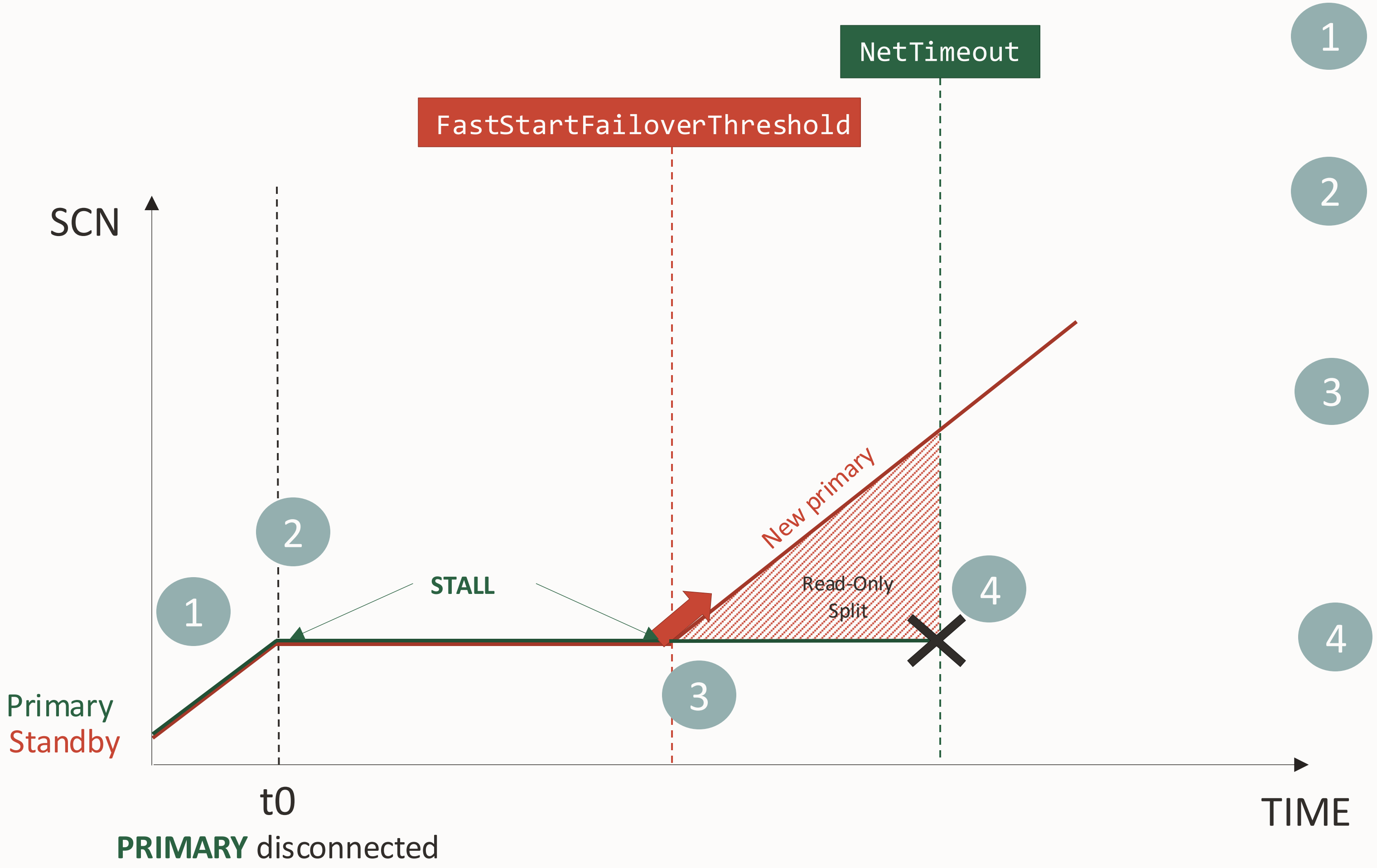
2 At `t0` + ping time, the primary and observer cannot contact the standby. The primary stalls and keeps retrying for `NetTimeout` seconds.
Status: STALLED

3 At NetTimeout seconds, the primary asks and obtain permission from the observer to stop the redo transport to the destination. The standby is declared unsynchronized.
Status: UNSYNCHRONIZED

4 The Observer knows that the standby is out of sync. If later the connection with the primary is lost, and the standby is back, the observer will not initiate a failover because of the unsynched status, unless `FastStartFailoverLagLimit` is set.
Status: UNSYNCHRONIZED

Automatic Failover with MaxAvailability

Failover only if Zero Data Loss is guaranteed



1 SYNC Transport. The Standby is synched.
Status: SYNCHRONIZED

2 At `t0` + ping time, the observer cannot contact the primary and starts a timer for `FastStartFailoverThreshold` seconds. The Primary stalls and keeps retrying for `NetTimeout` Seconds.
Status: STALLED

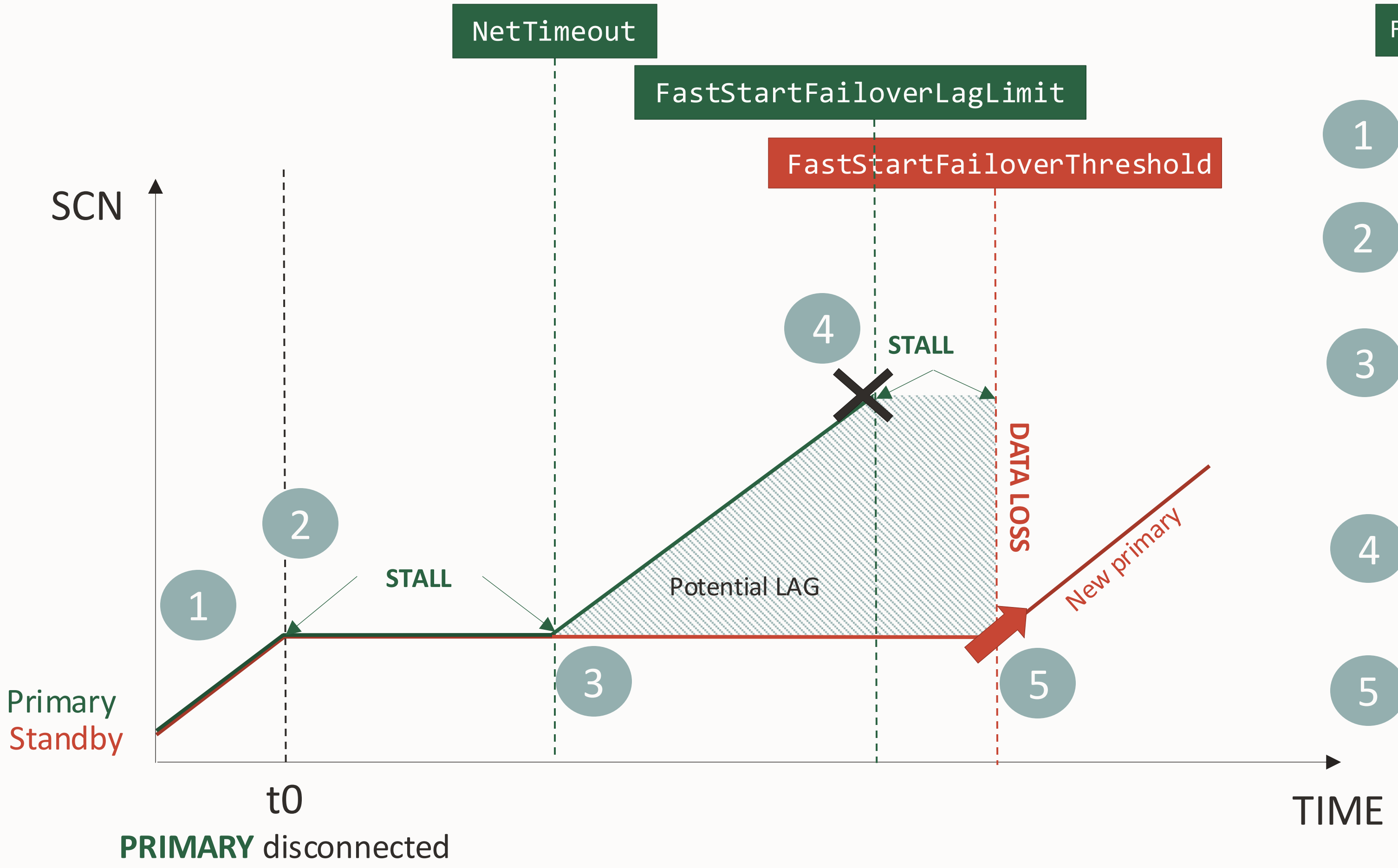
3 The observer timer reaches `FastStartFailoverThreshold`. Still no connection with the primary: it initiates the Failover. If `NetTimeout` is higher than the threshold, the Primary is reachable but not committing (read-only split).
Primary status: STALLED
Standby status: REINSTATE REQUIRED

4 The Primary keeps stalling or shuts down after `NetTimeout` because it cannot get the permission from the observer to abandon the destination. A lower `NetTimeout` reduces the potential of read-only split.
Status: REINSTATE REQUIRED

NEW IN 21c

Automatic Failover with MaxAvailability

Optionally choose a limit to have an automatic failover with potential data loss



`FastStartFailoverLagLimit` ≤ `FastStartFailoverThreshold`

1. SYNC Transport. The Standby is synched.

2. At `t0` + ping time, the primary cannot contact the standby. The primary stalls and keeps retrying for `NetTimeout` seconds. The observer starts the timer.

3. At NetTimeout seconds, the primary stops shipping the redo <u>without asking permission to the observer</u>, because `FastStartFailoverLagLimit` is set. The observer does not acknowledge the unsynched status.

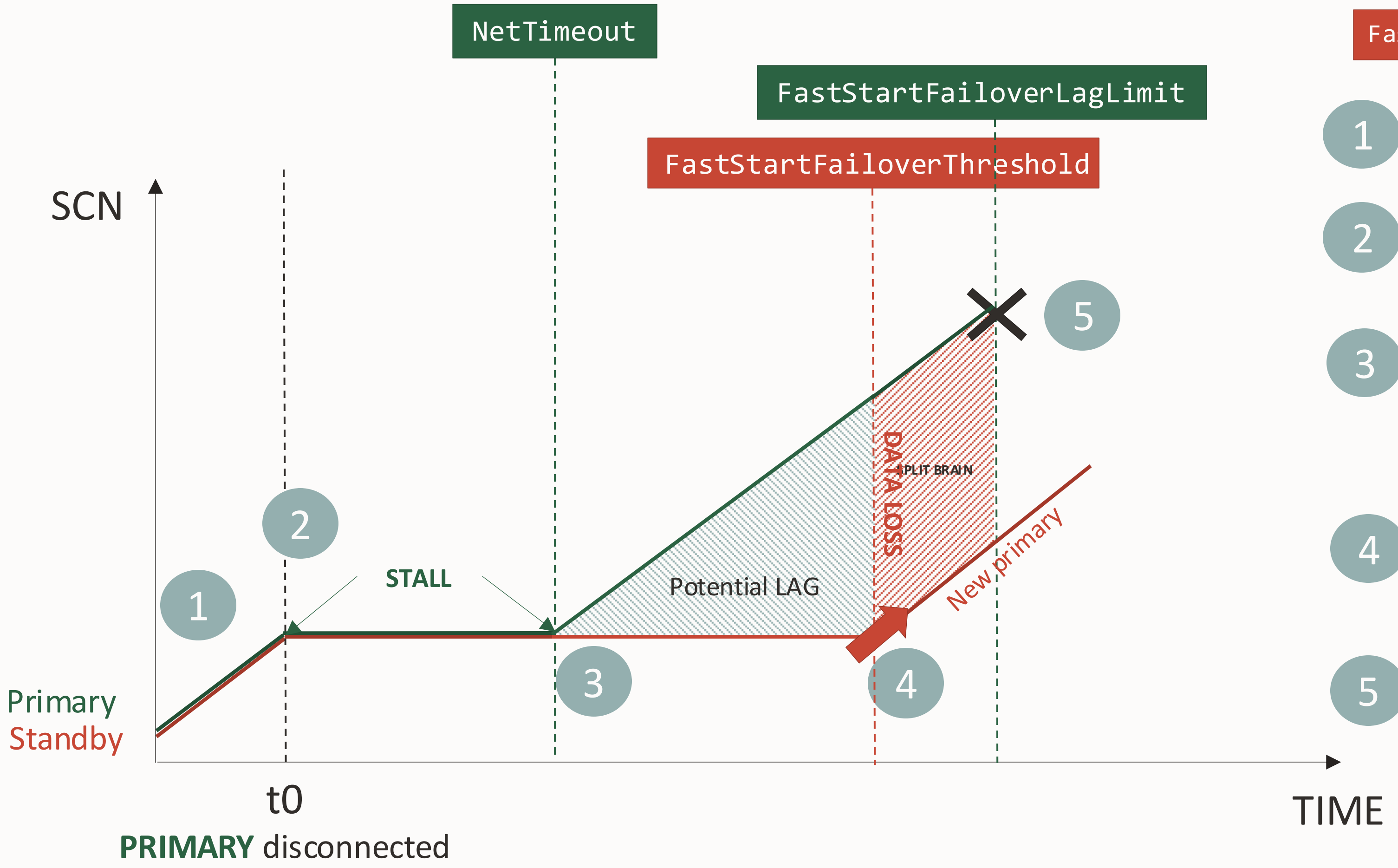
4. The primary reaches `FastStartFailoverLagLimit`. <u>It cannot obtain permission from the observer to continue</u>. It stalls or shuts down depending on `FastStartFailoverPmyShutdown`

5. The observer timer reaches `FastStartFailoverThreshold`. Still no connection with the primary: it initiates the Failover.

NEW IN 21c

Automatic Failover with MaxAvailability

Set the FastStartFailoverLagLimit wisely to avoid split-brain conditions



`FastStartFailoverThreshold` < `FastStartFailoverLagLimit`

1. SYNC Transport. The Standby is synched.

2. At `t0` + ping time, the primary cannot contact the standby. The primary stalls and keeps retrying for `NetTimeout` seconds. The observer starts the timer.

3. At NetTimeout seconds, the primary switches to ASYNC redo transport without requiring permission to the observer, because `FastStartFailoverLagLimit` is set. The observer does not acknowledge the unsynched status.

4. The observer timer reaches `FastStartFailoverThreshold`. Still no connection with the primary: it initiates the Failover

5. The Primary keeps committing until it reaches `FastStartFailoverLagLimit`, then stalls or shuts down. A Split-Brain condition may occur depending on timings and parameter values.

Fast-Start Failover: Maximum Protection

Max Protection without Fast-Start Failover

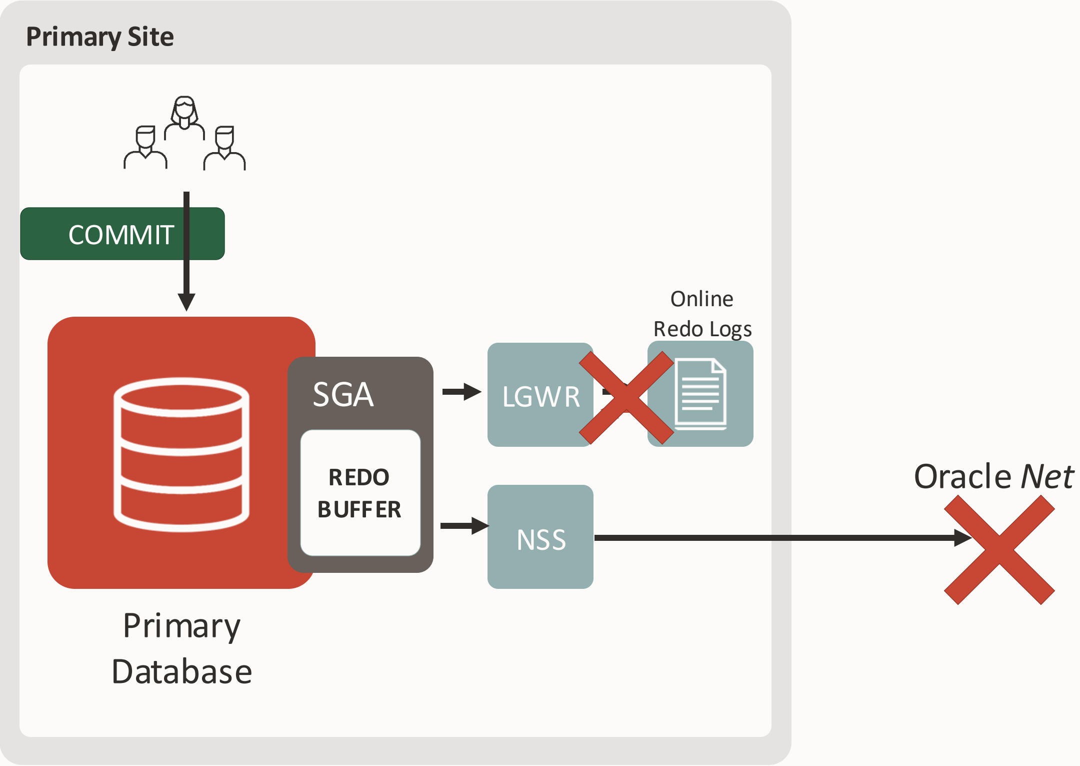
Data Guard SYNC redo transport

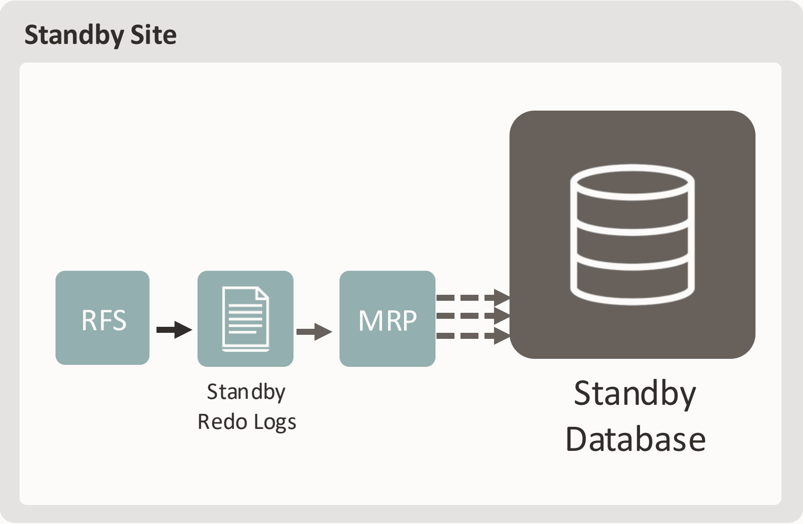
If the standby is not reachable:

- The primary stalls waiting for the SYNC destination (no commits possible)
- Even after NetTimeout, the commits cannot happen

If the primary is not reachable:

- Failovers, even manual, are safe <u>if no other standbys are protecting the primary</u>

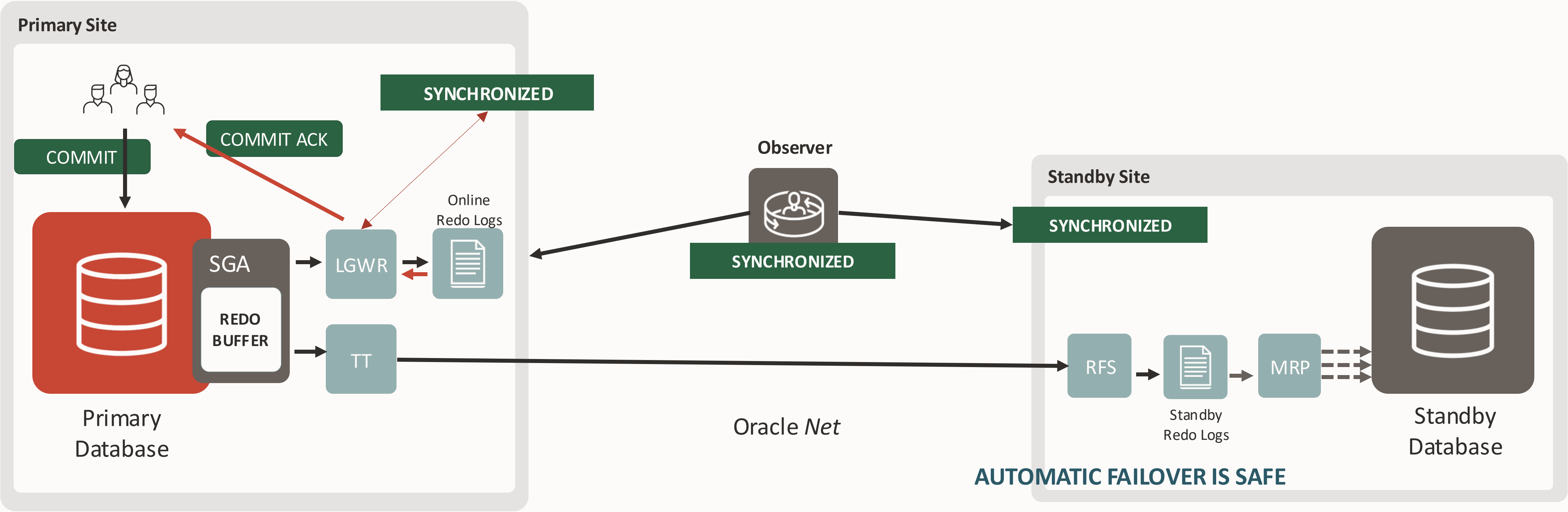




Max Protection with Fast-Start Failover

The primary never commits without the observer quorum

In a normal situation, the status is SYNCHRONIZED



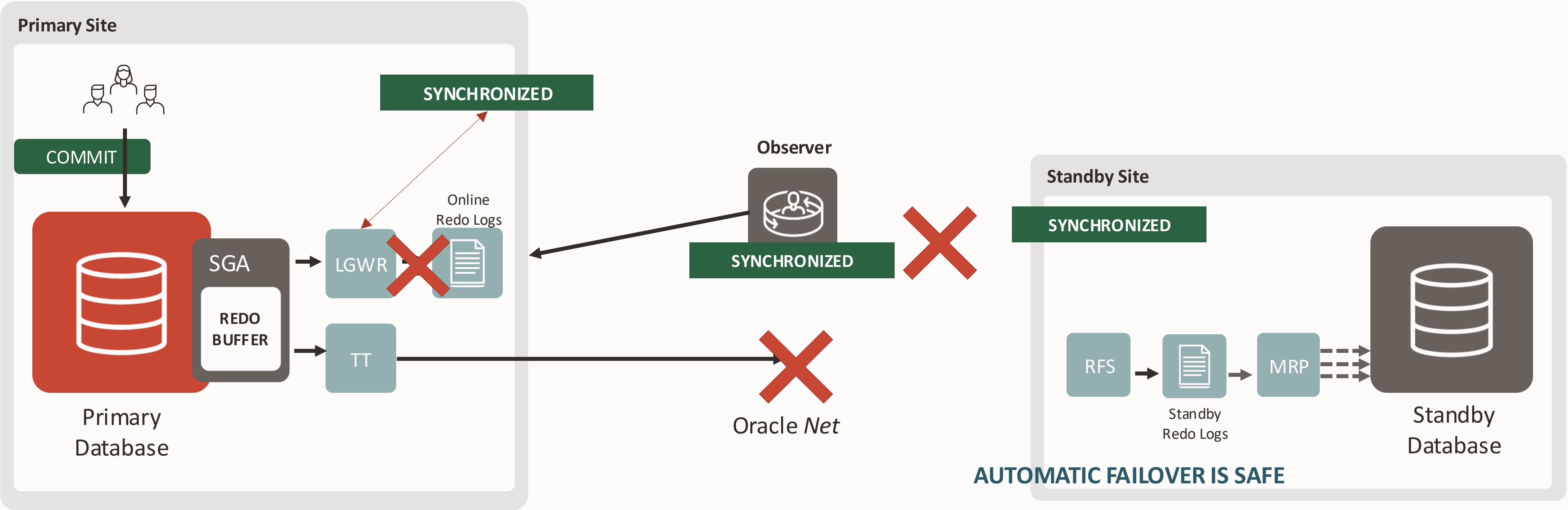
AUTOMATIC FAILOVER IS SAFE

Max Protection with Fast-Start Failover

The primary never commits without the observer quorum

If the standby is not reachable:

- The primary waits for the SYNC destination (no commits possible) but keeps the status synchronized

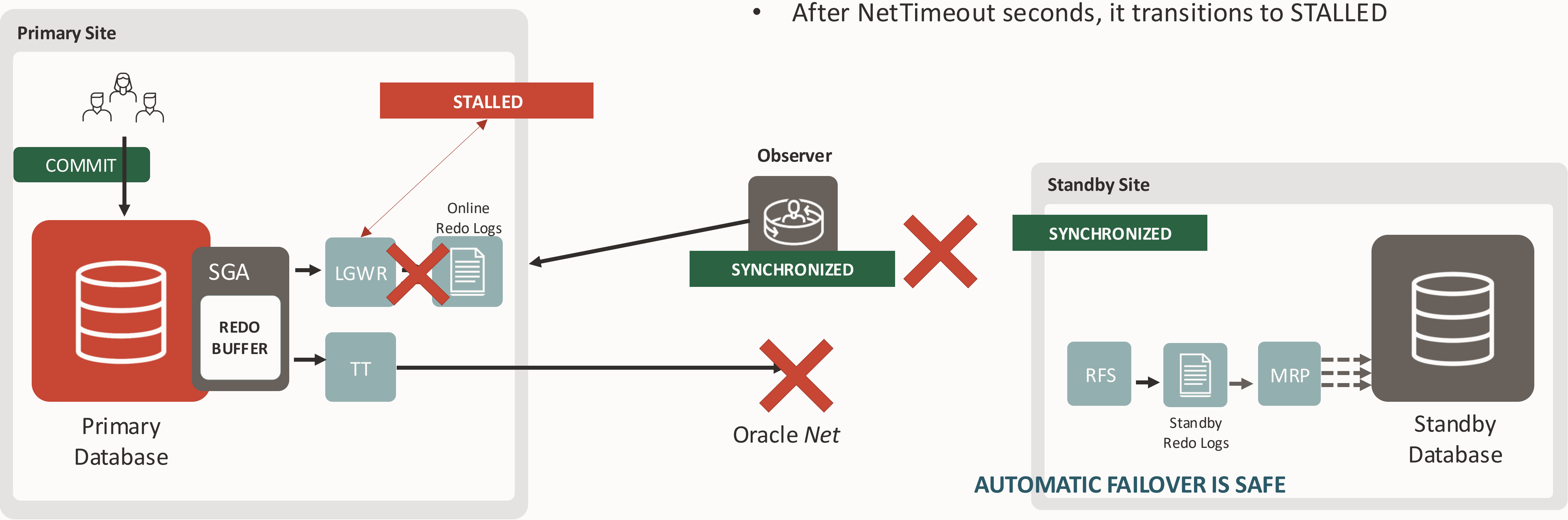


Max Protection with Fast-Start Failover

The primary never commits without the observer quorum

If the standby is not reachable:

- The primary waits for the SYNC destination (no commits possible) but keeps the status synchronized
- After NetTimeout seconds, it transitions to STALLED



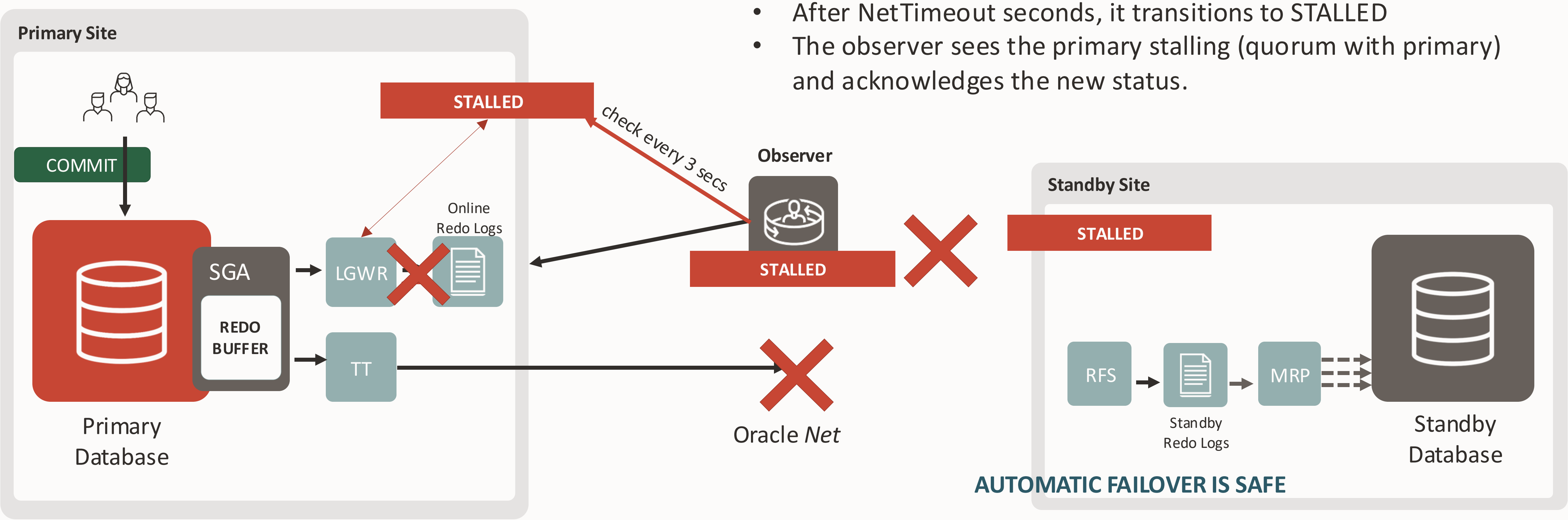
AUTOMATIC FAILOVER IS SAFE

Max Protection with Fast-Start Failover

The primary never commits without the observer quorum

If the standby is not reachable:

- The primary waits for the SYNC destination (no commits possible) but keeps the status synchronized
- After NetTimeout seconds, it transitions to STALLED
- The observer sees the primary stalling (quorum with primary) and acknowledges the new status.

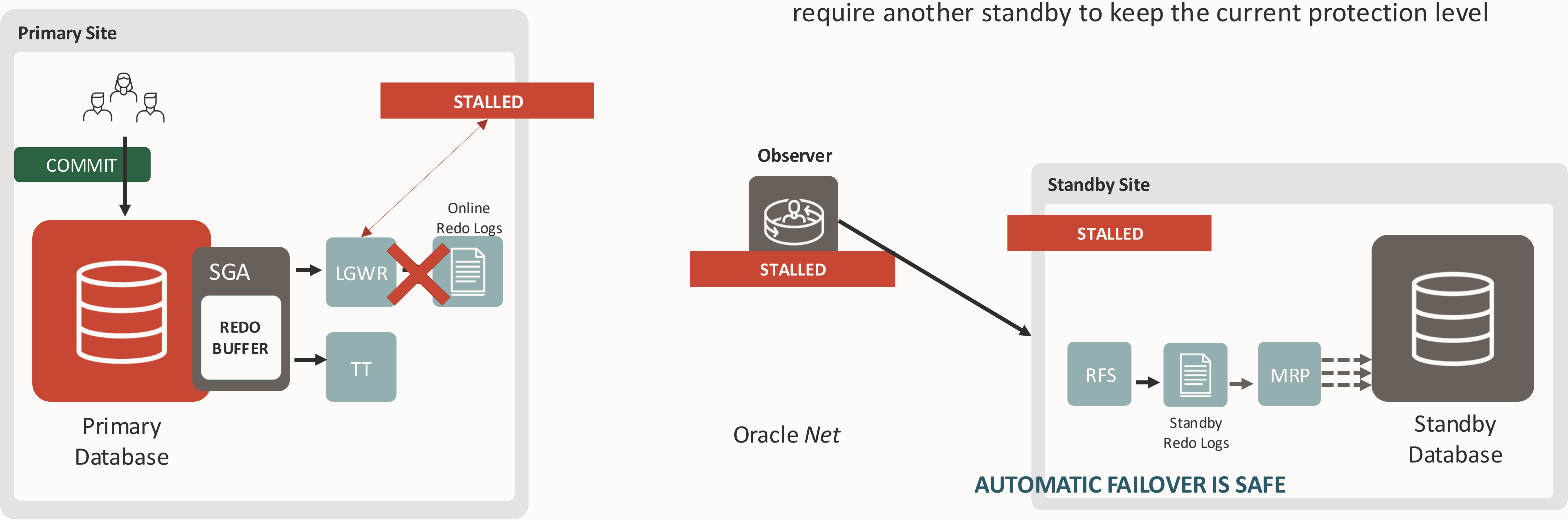


Max Protection with Fast-Start Failover

The primary never commits without the observer quorum

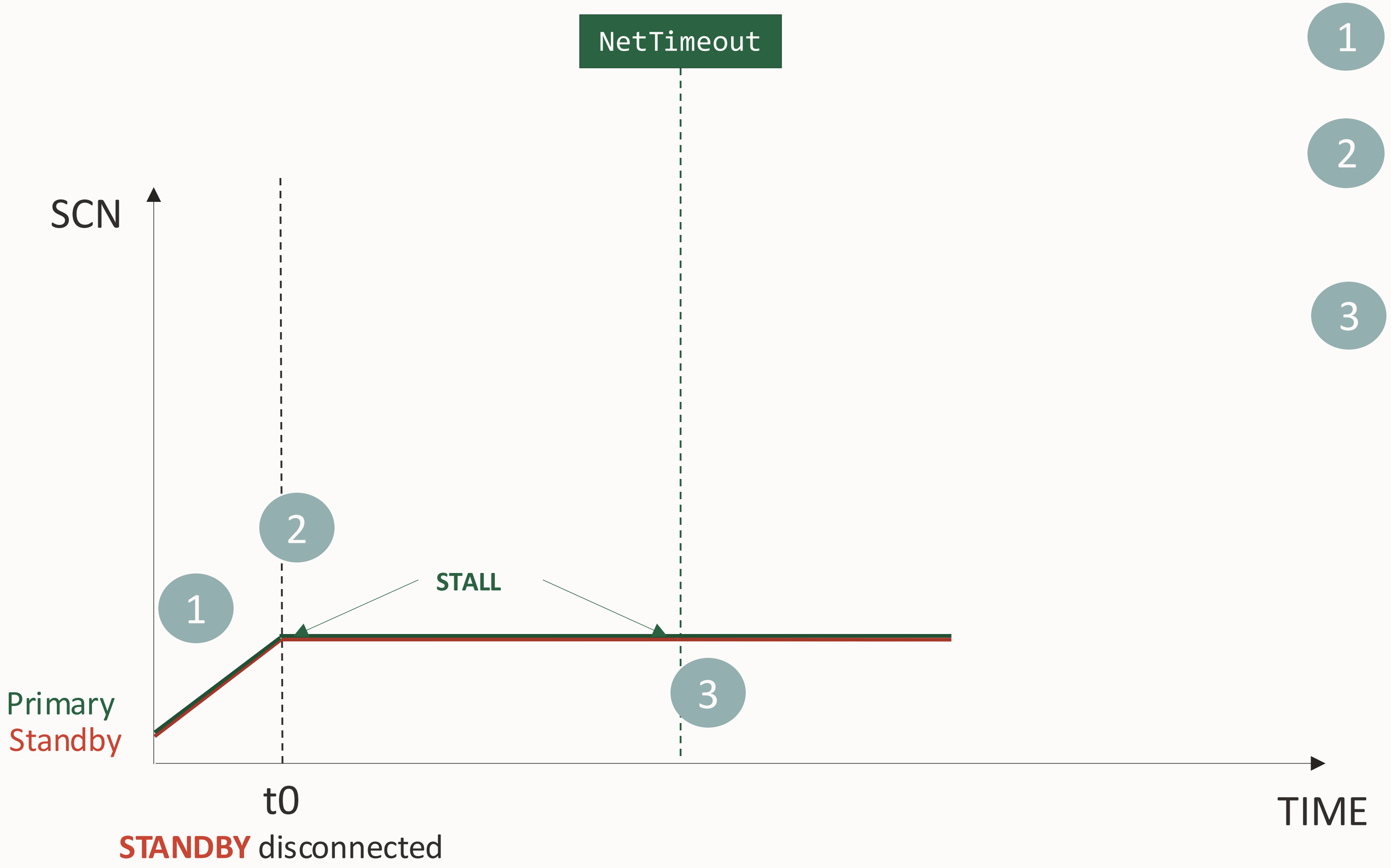
If the primary is not reachable:

- The primary never committed without a SYNC standby
- The automatic failover is always safe, but the new primary will require another standby to keep the current protection level



Automatic Failover with MaxProtection

Zero Data Loss in any condition



STANDBY disconnected

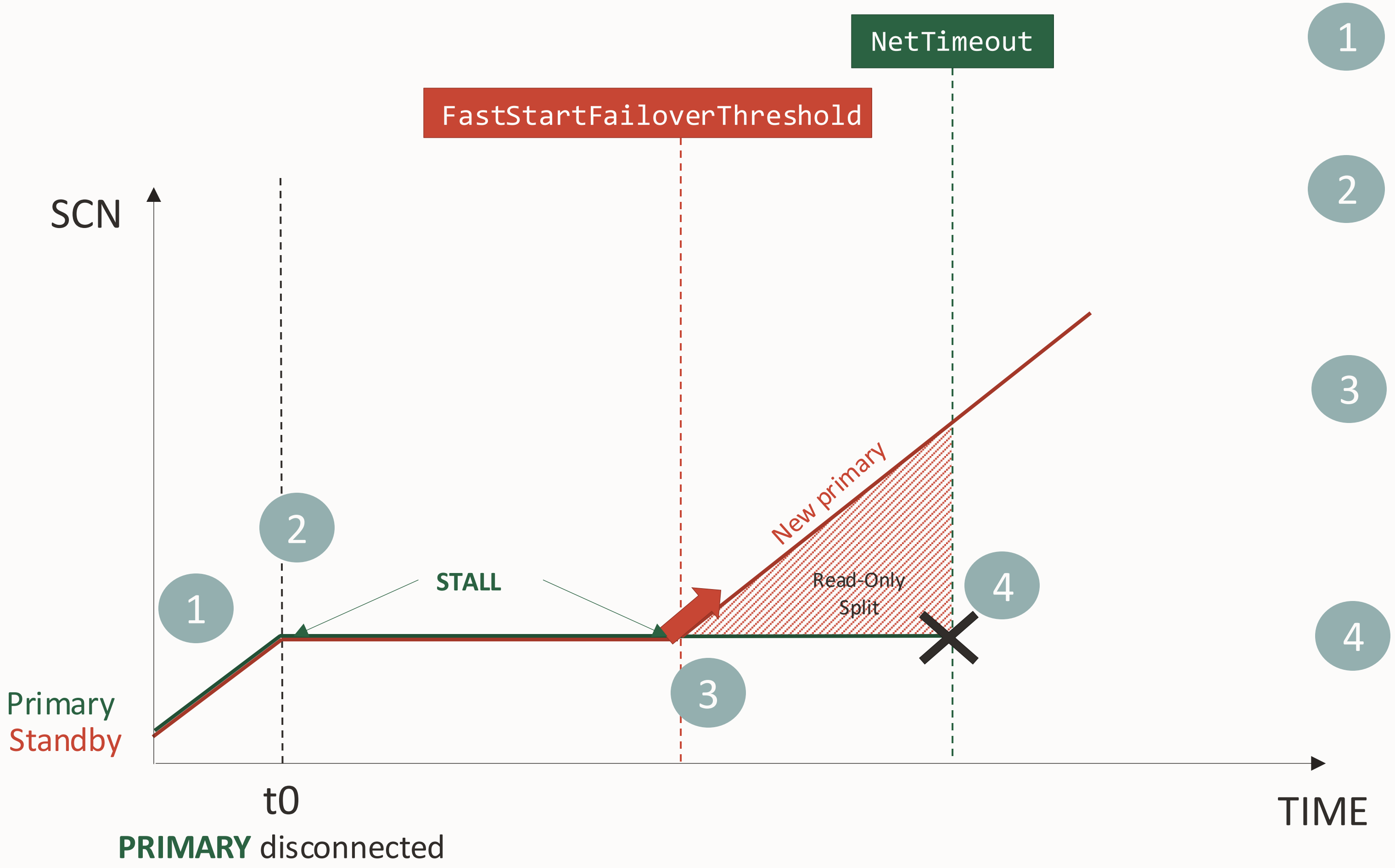
1. SYNC Transport. The Standby is synched.
   Status: SYNCHRONIZED

2. At `t0` + ping time, the primary cannot contact the standby and keeps retrying for `NetTimeout` Seconds.
   Status: STALLED

3. After NetTimeout, the primary still has connectivity with the observer. Knowing that a failover did not occur, it keeps trying forever.
   Status: STALLED

Automatic Failover with MaxProtection

Zero Data Loss in any condition



1 SYNC Transport. The Standby is synched.
Status: SYNCHRONIZED

2 At t0 + ping time, the observer cannot contact the primary and starts a timer for FastStartFailoverThreshold seconds. The Primary stalls and keeps retrying for NetTimeout Seconds.
Status: STALLED

3 The observer timer reaches FastStartFailoverThreshold. Still no connection with the primary: it initiates the Failover. If NetTimeout is higher than the threshold, the Primary is reachable but not committing (read-only split).
Former Primary Status: STALLED
New Primary Status: REINSTATE_REQUIRED

4 The primary keeps stalling or shuts down after NetTimeout depending on FastStartFailoverPmyShutdown. A lower NetTimeout reduces the potential of read-only split.
Former Primary Status: STALLED or REINSTATE_REQUIRED
New Primary Status: REINSTATE_REQUIRED

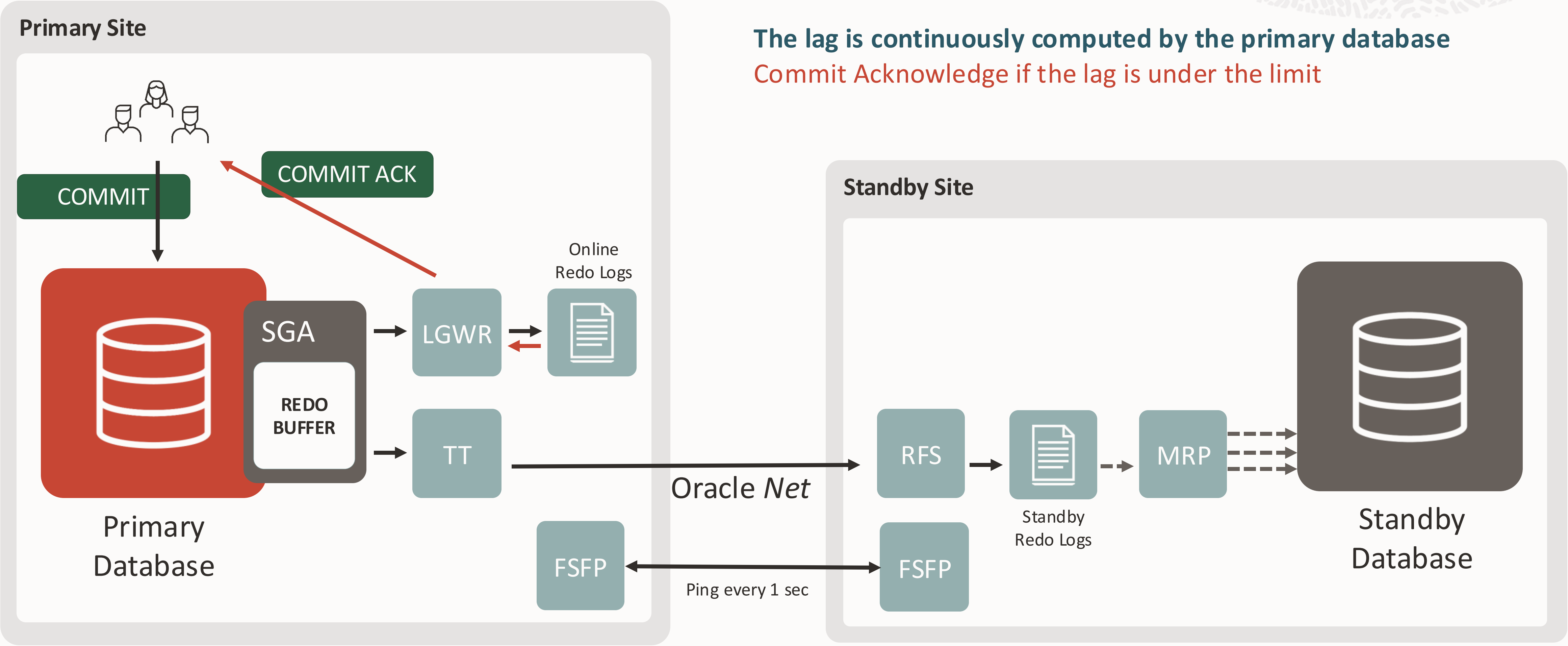
Fast-Start Failover:
Oracle Data Guard Observer

How Fast-Start Failover limits data loss

Data Guard ASYNC Process Architecture (Possible Data Loss)

The lag is continuously computed by the primary database

Commit Acknowledge if the lag is under the limit

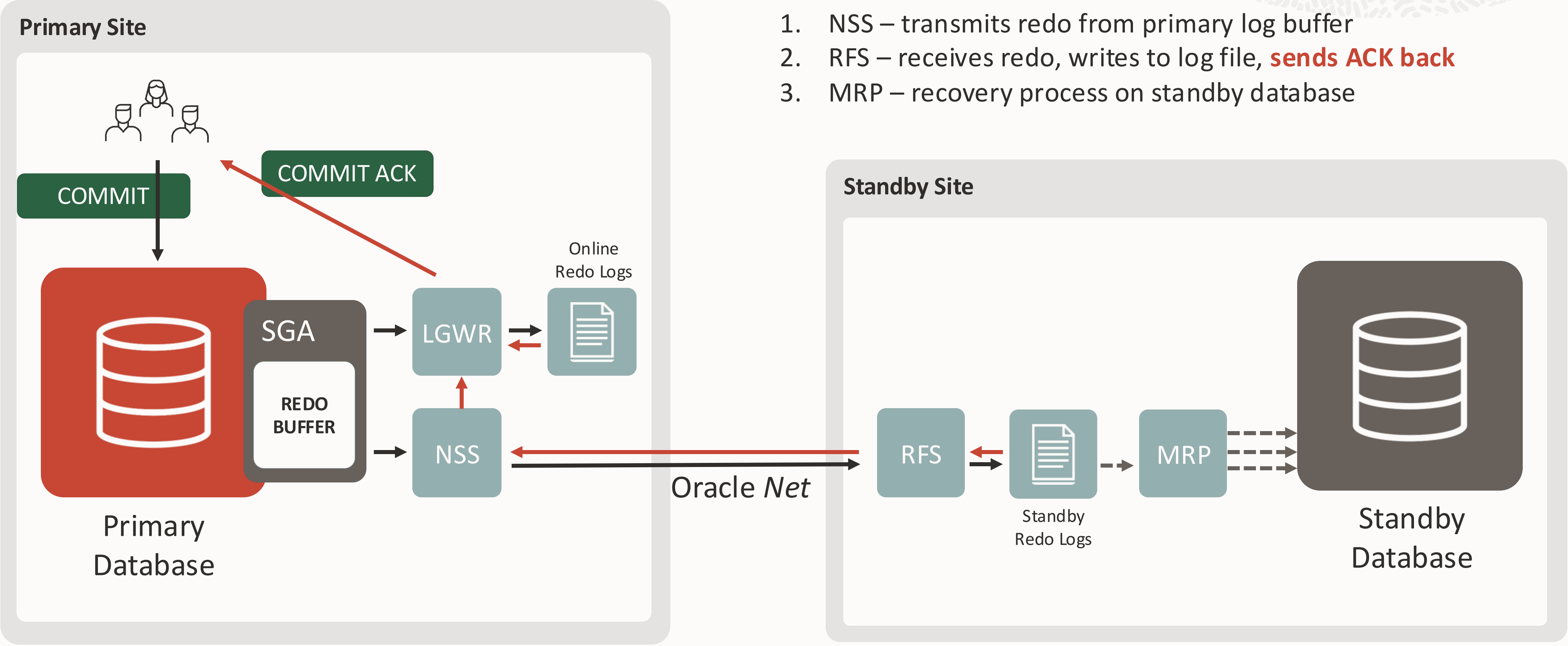


Data Guard Transport for Zero Data Loss

Data Guard SYNC Process Architecture

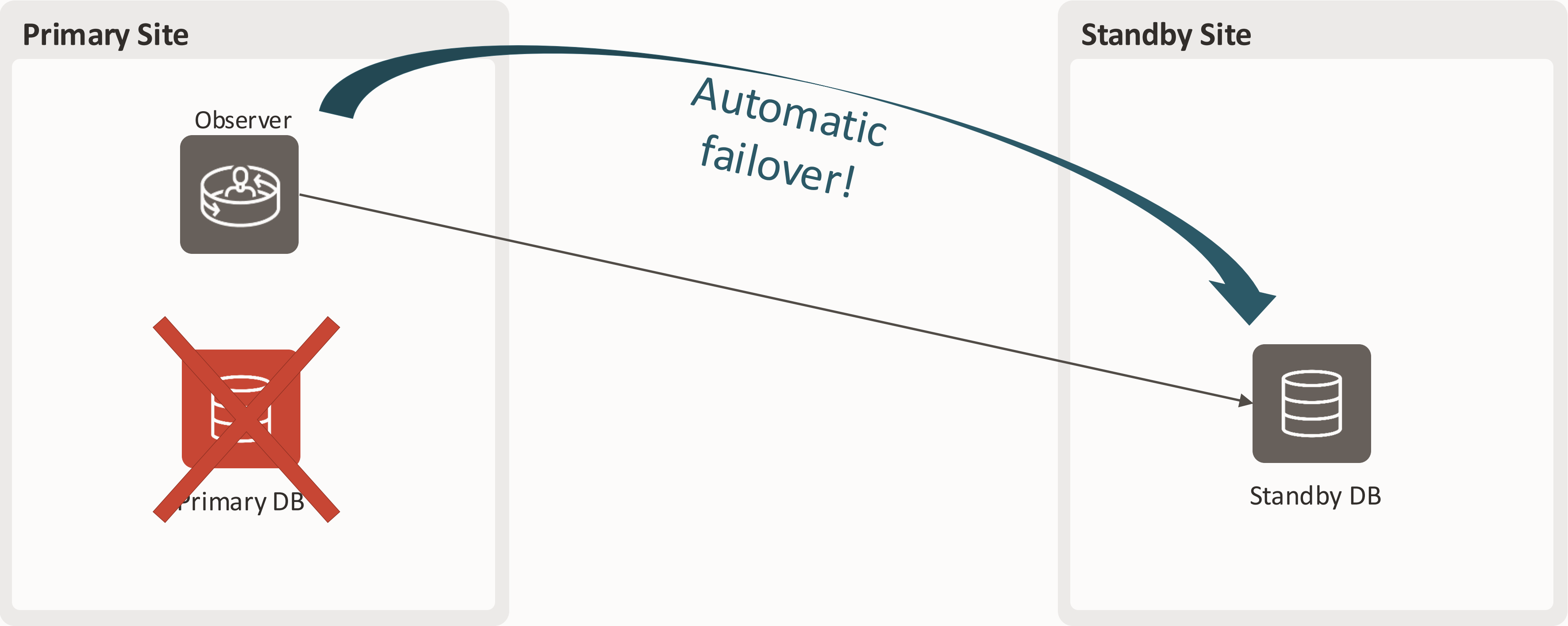
Data Guard Processes

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



Oracle Data Guard Observer Placement

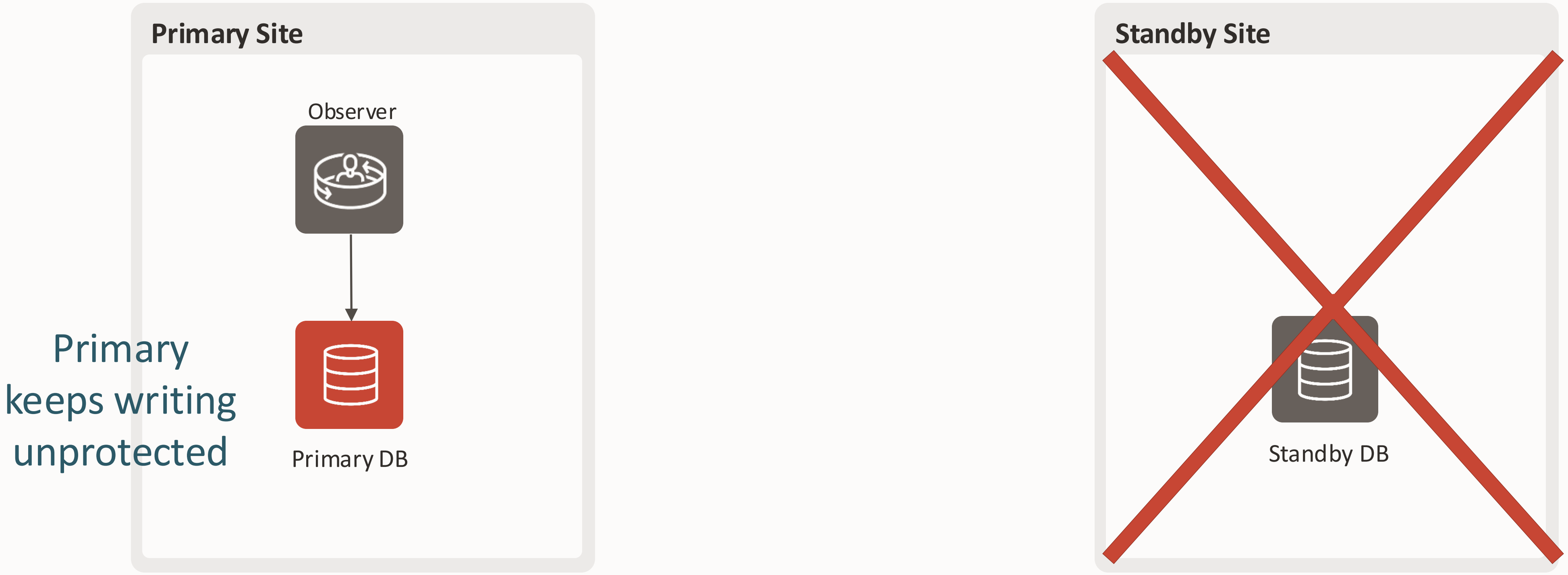
Observer at the primary site



Failure:	Primary DB	Standby DB	Network	Primary Site	Standby Site	Observer
	✓	✓	✓	✗	✓	✓

Oracle Data Guard Observer Placement

Observer at the primary site

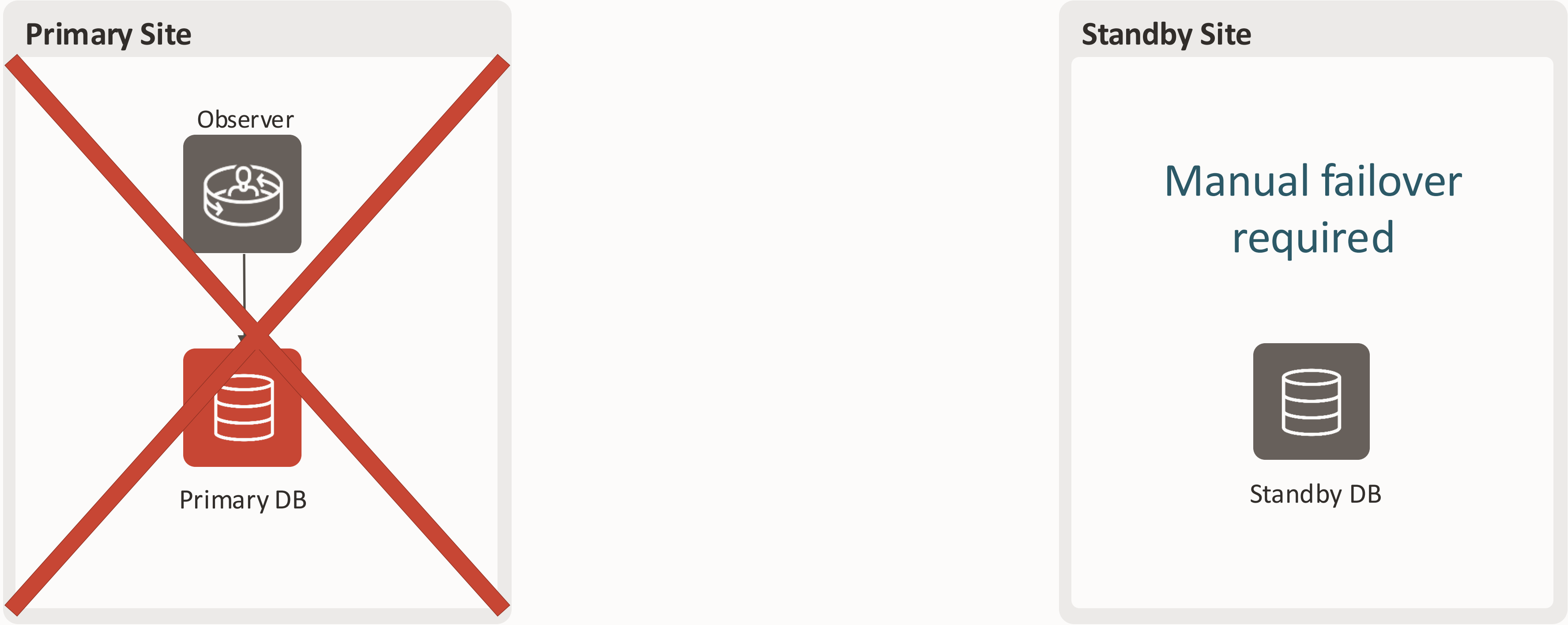


Primary keeps writing unprotected

Failure:	Primary DB	Standby DB	Network	Primary Site	Standby Site	Observer
	✓	✓	✓	✗	✓	✓

Oracle Data Guard Observer Placement

Observer at the primary site

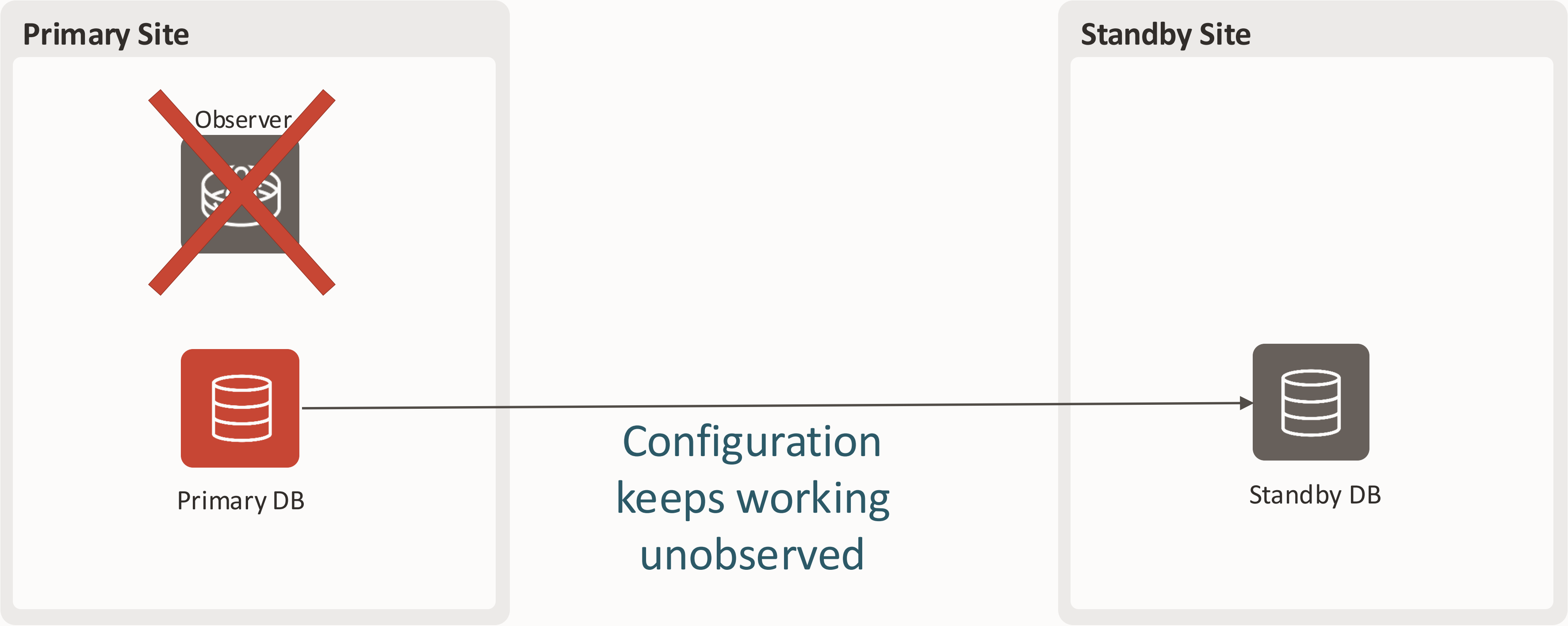


Manual failover required

Failure:	Primary DB	Standby DB	Network	Primary Site	Standby Site	Observer
	✓	✓	✓	✗	✓	✓

Oracle Data Guard Observer Placement

Observer at the primary site

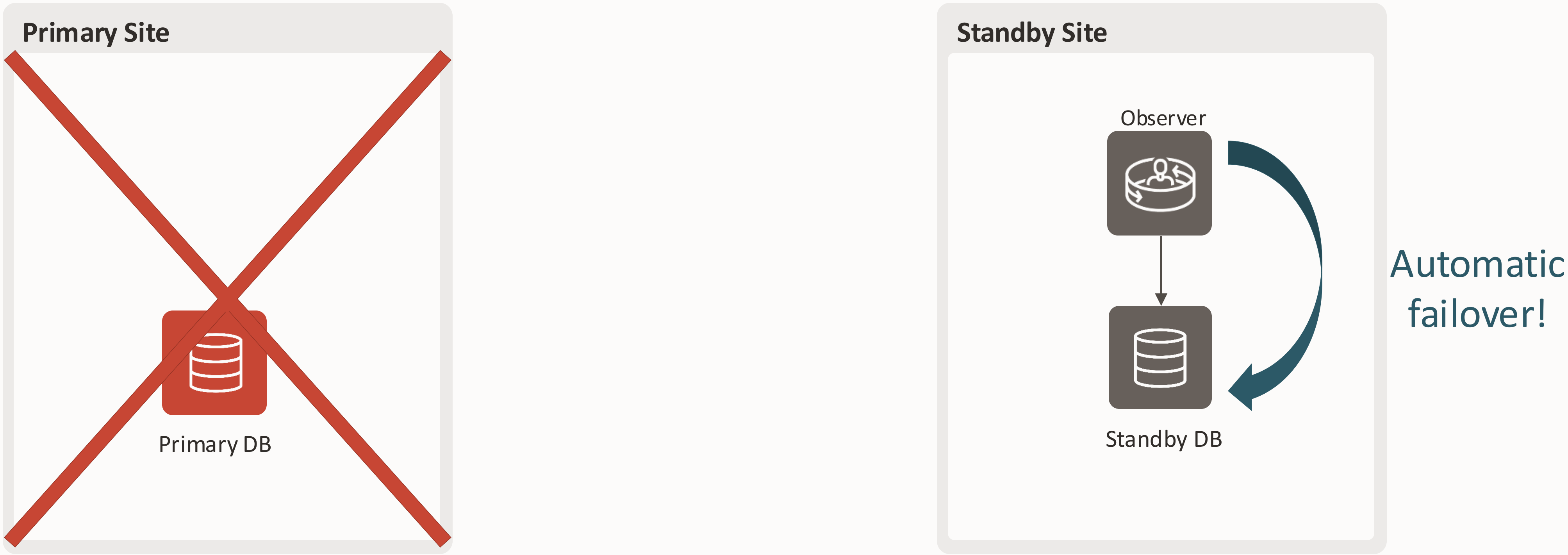


Configuration keeps working unobserved

Failure:	Primary DB	Standby DB	Network	Primary Site	Standby Site	Observer
	✓	✓	✓	✗	✓	✓

Oracle Data Guard Observer Placement

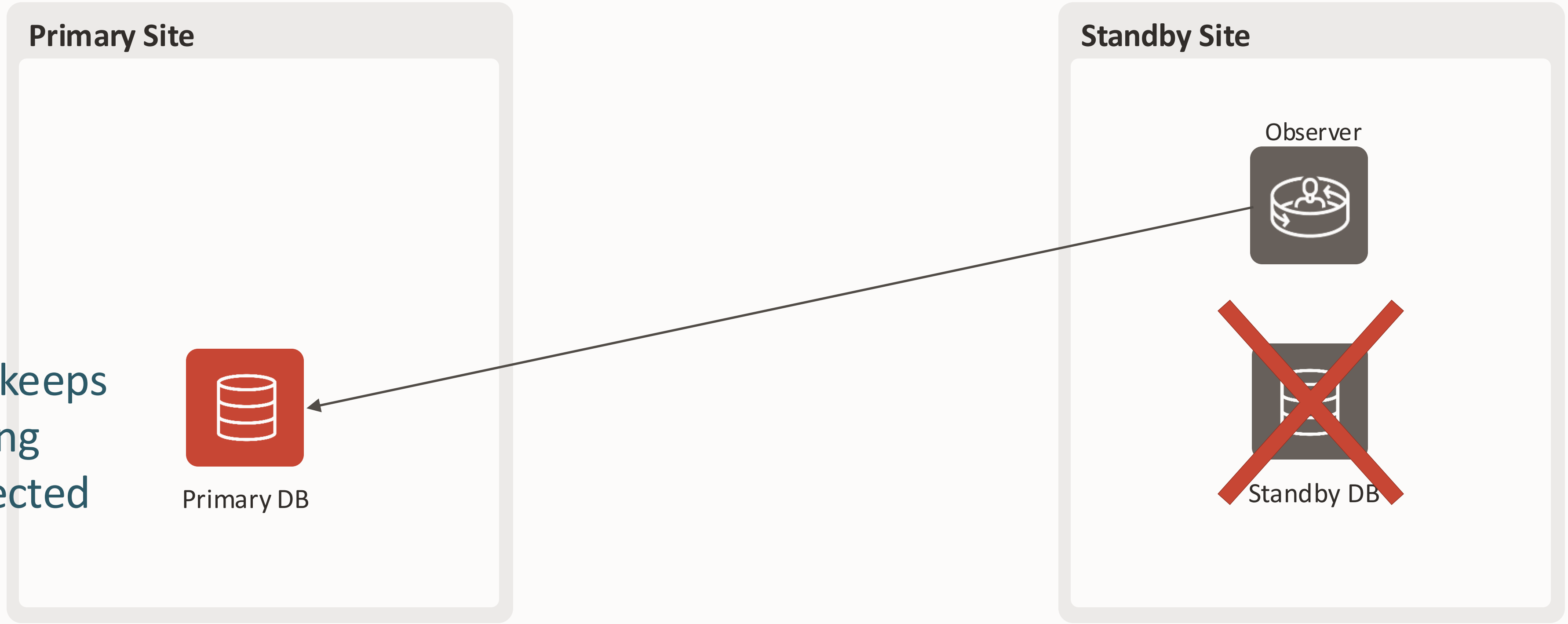
Observer at the standby site



Failure:	Primary DB	Standby DB	Network	Primary Site	Standby Site	Observer
	✓	✓	✗	✓	✗	✓

Oracle Data Guard Observer Placement

Observer at the standby site

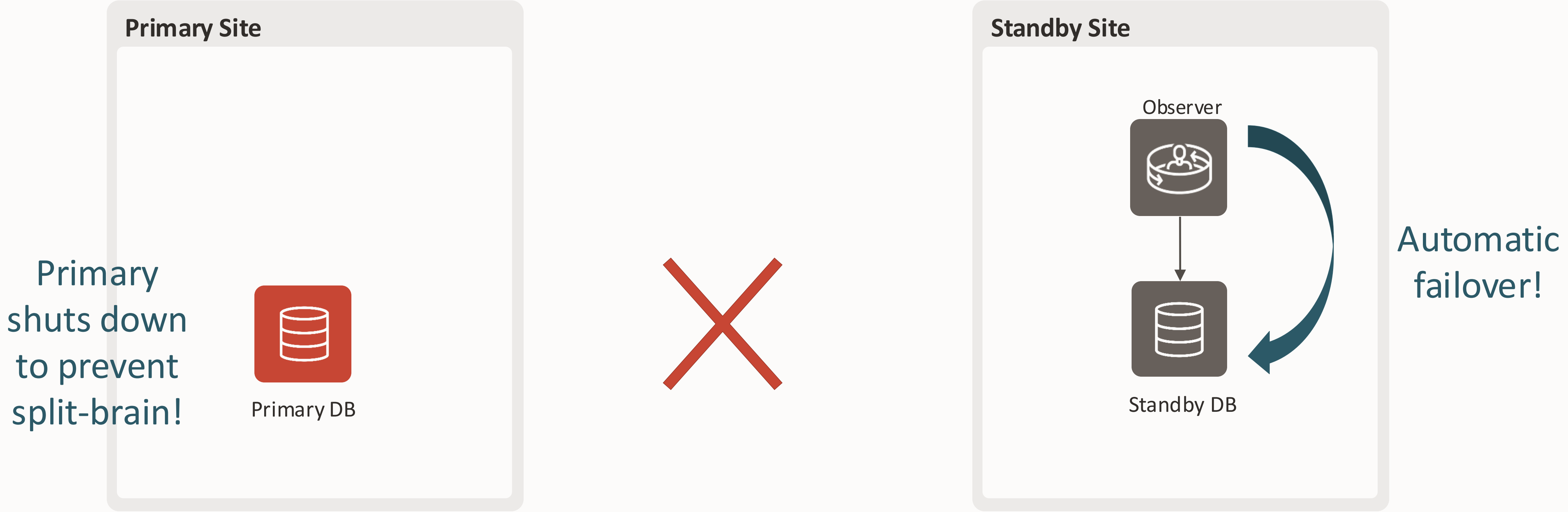


Primary keeps writing unprotected

Failure:	Primary DB	Standby DB	Network	Primary Site	Standby Site	Observer
	✓	✓	✗	✓	✗	✓

Oracle Data Guard Observer Placement

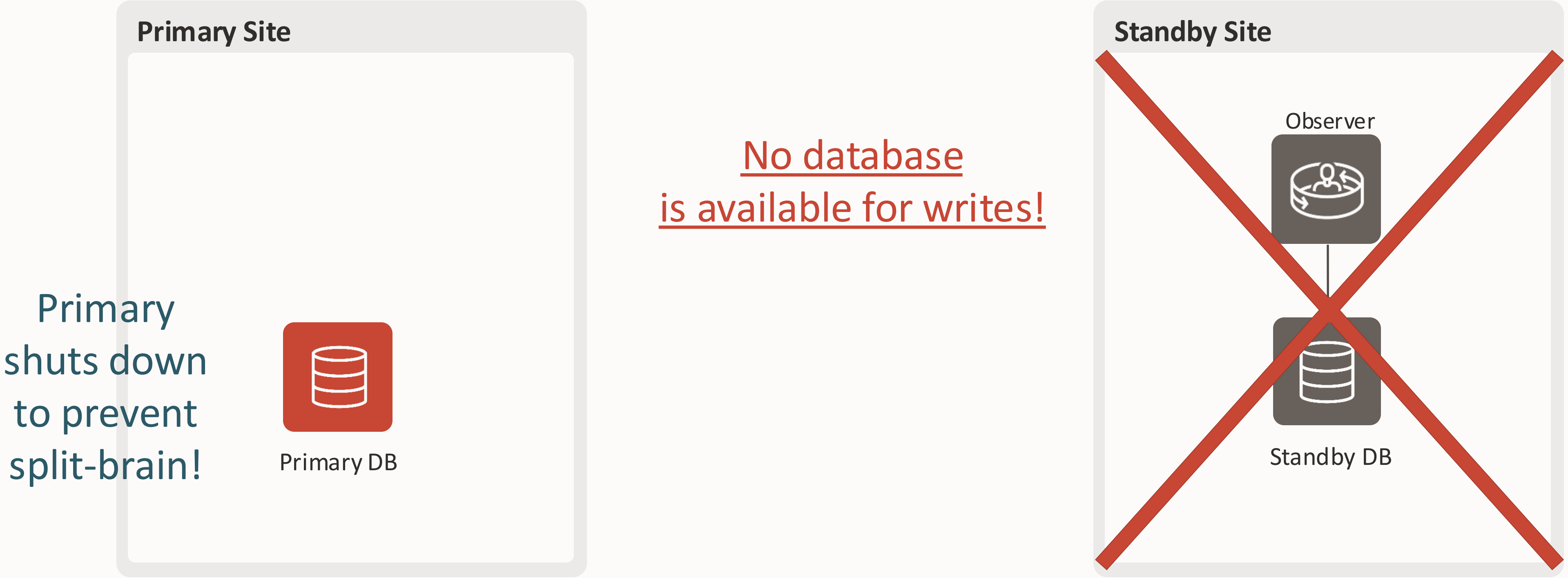
Observer at the standby site



Failure:	Primary DB	Standby DB	Network	Primary Site	Standby Site	Observer
	✓	✓	✗	✓	✗	✓

Oracle Data Guard Observer Placement

Observer at the standby site



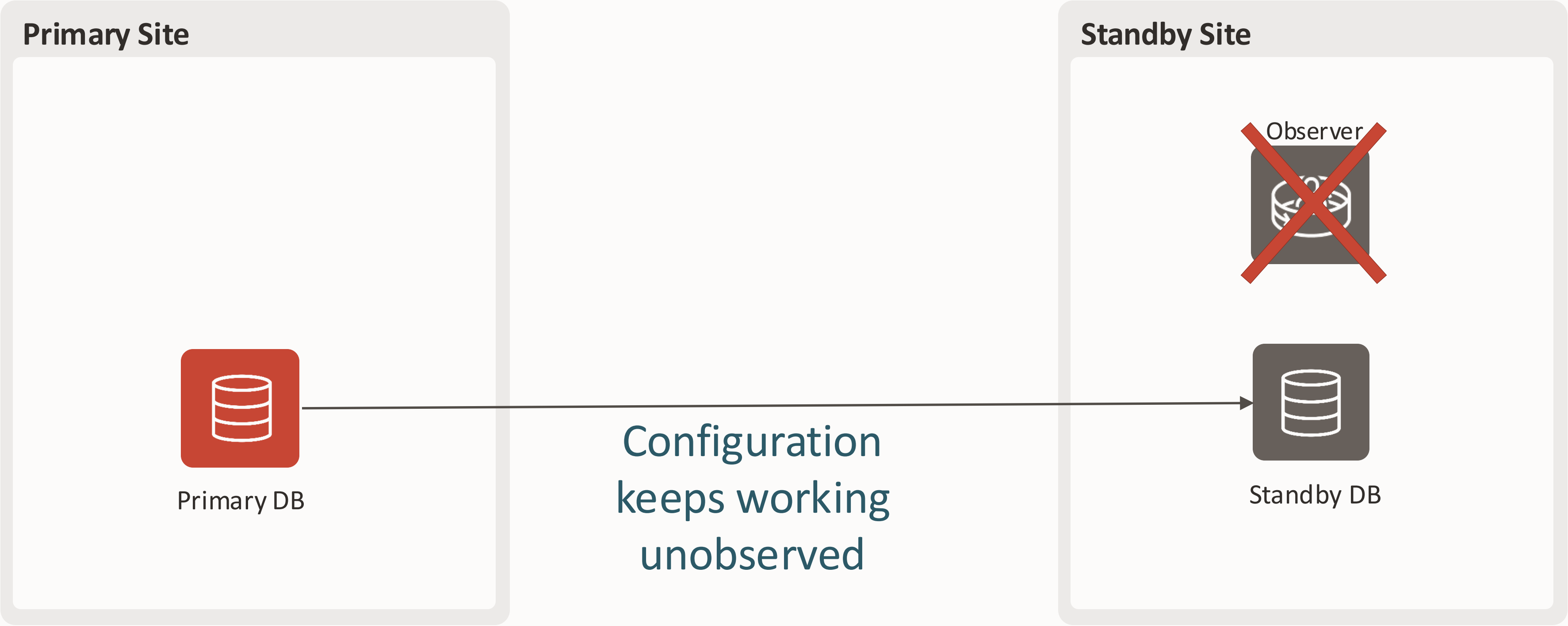
No database is available for writes!

Primary shuts down to prevent split-brain!

Failure:	Primary DB	Standby DB	Network	Primary Site	Standby Site	Observer
	✓	✓	✗	✓	✗	✓

Oracle Data Guard Observer Placement

Observer at the standby site

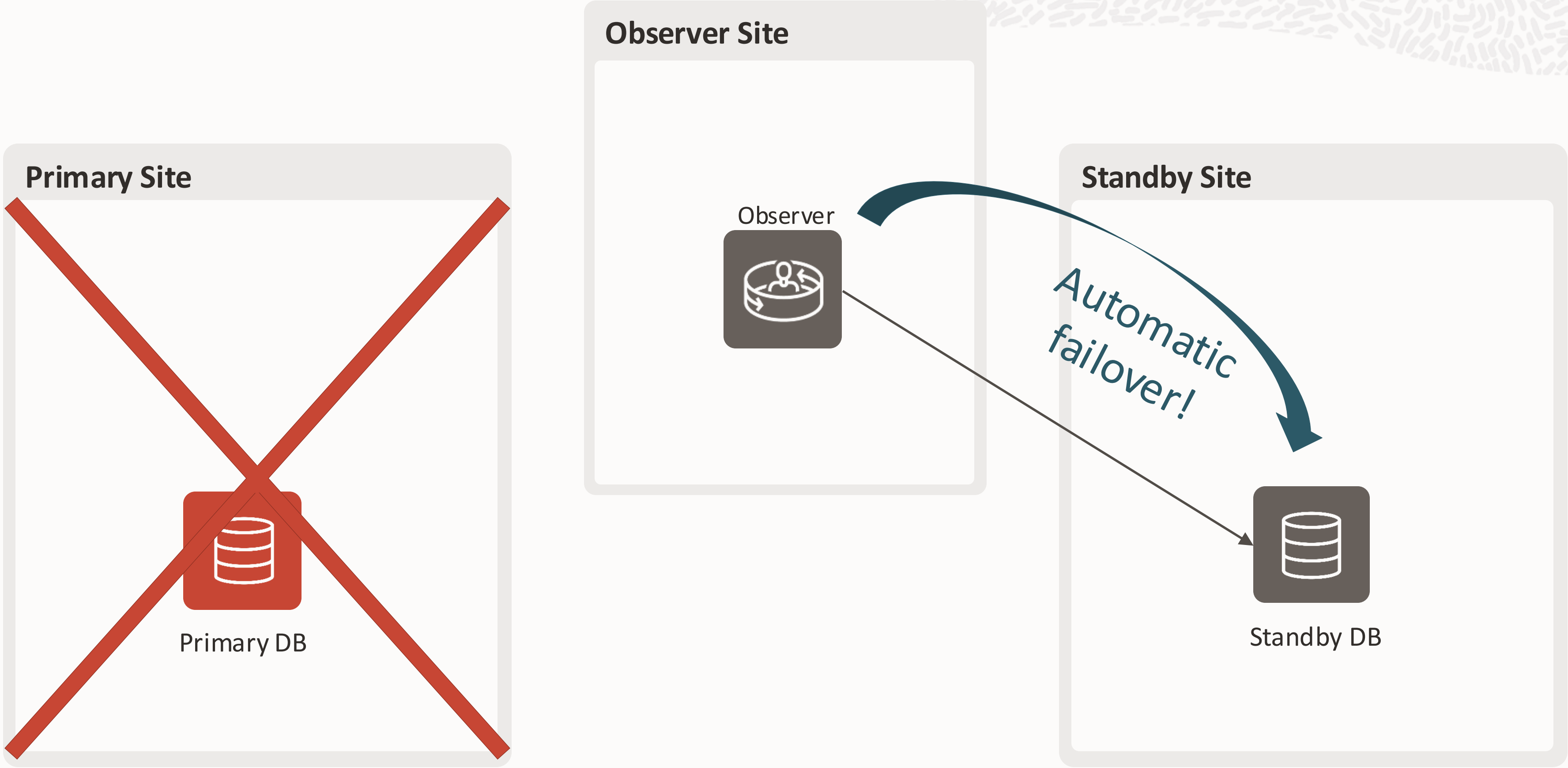


Configuration keeps working unobserved

Failure:	Primary DB	Standby DB	Network	Primary Site	Standby Site	Observer
	✓	✓	✗	✓	✗	✓

Oracle Data Guard Observer Placement

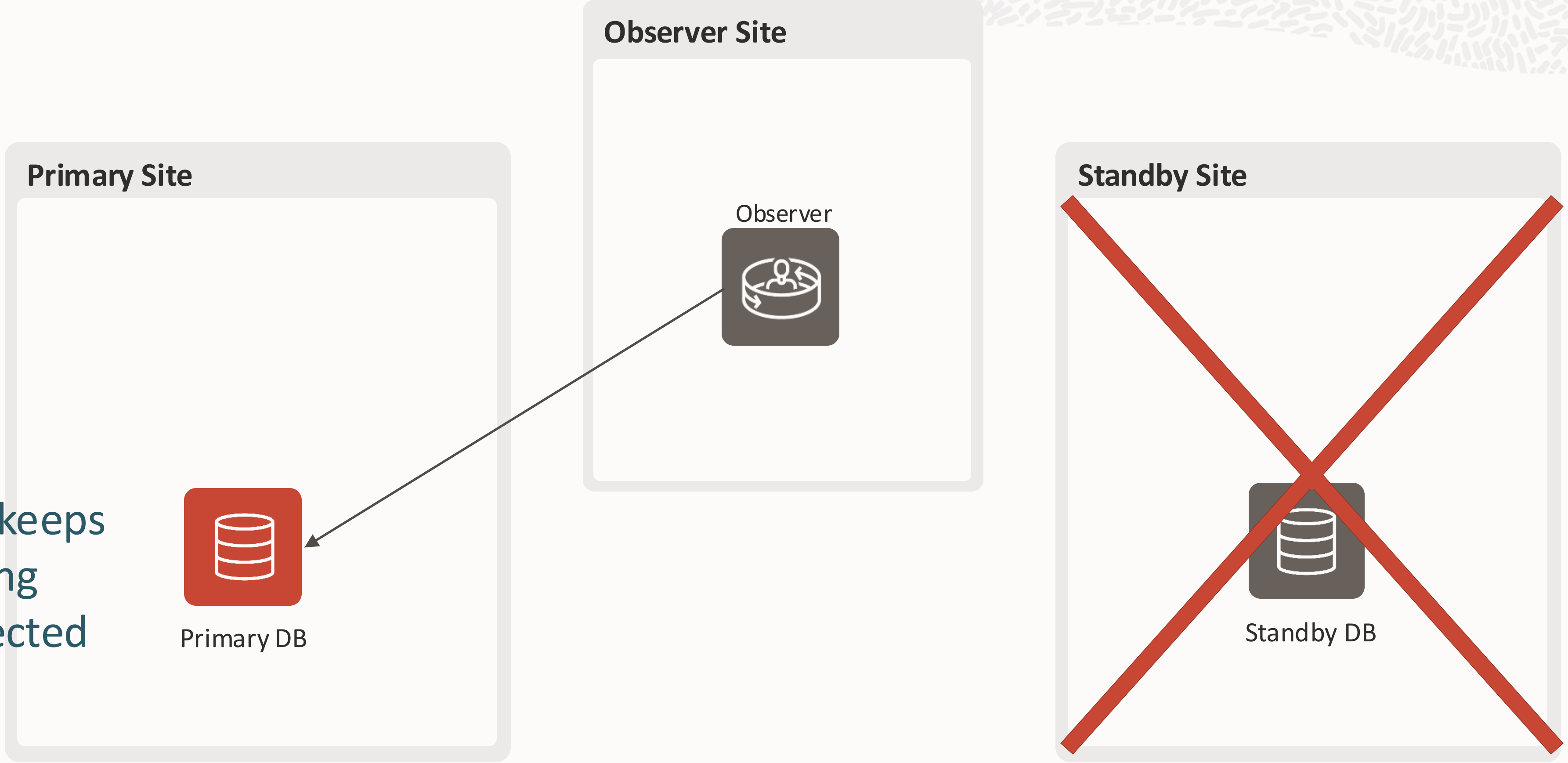
Observer at an external size



Failure:	Primary DB	Standby DB	Network	Primary Site	Standby Site	Observer
	✓	✓	✓	✓	✓	✓

Oracle Data Guard Observer Placement

Observer at an external size

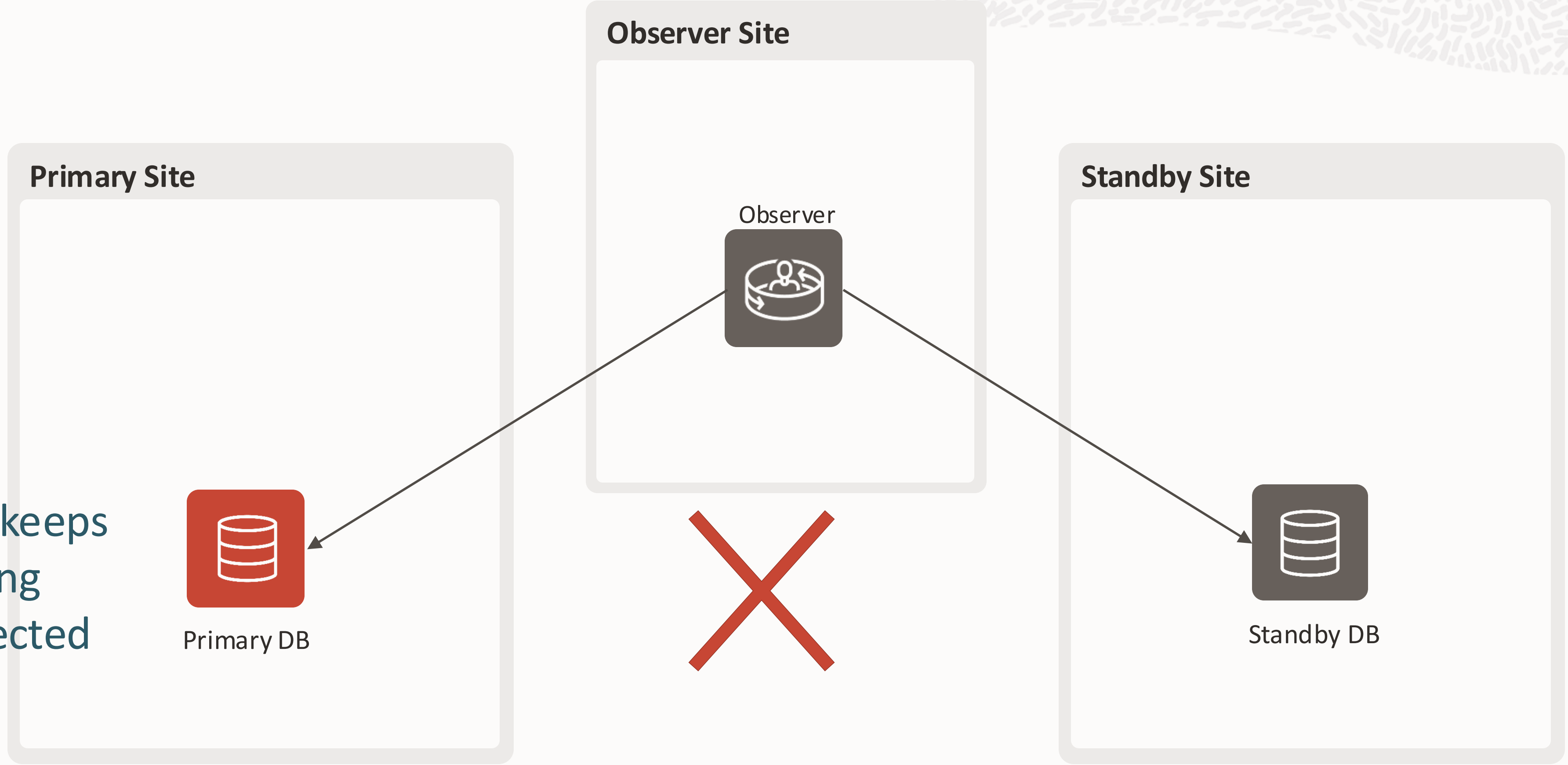


Primary keeps writing unprotected

Failure:	Primary DB	Standby DB	Network	Primary Site	Standby Site	Observer
	✓	✓	✓	✓	✓	✓

Oracle Data Guard Observer Placement

Observer at an external size

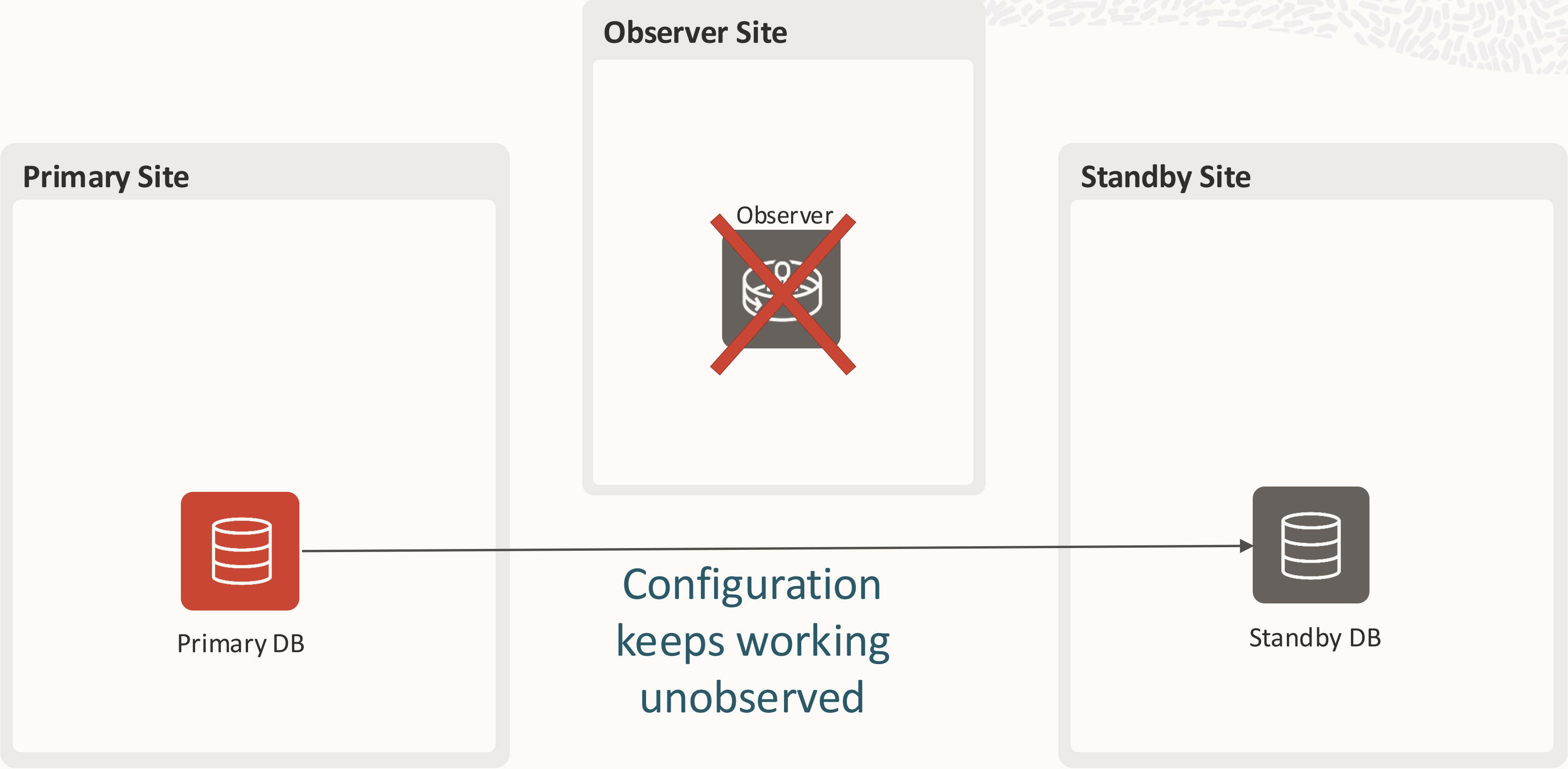


Primary keeps writing unprotected

Failure:	Primary DB	Standby DB	Network	Primary Site	Standby Site	Observer
	✓	✓	✓	✓	✓	✓

Oracle Data Guard Observer Placement

Observer at an external size

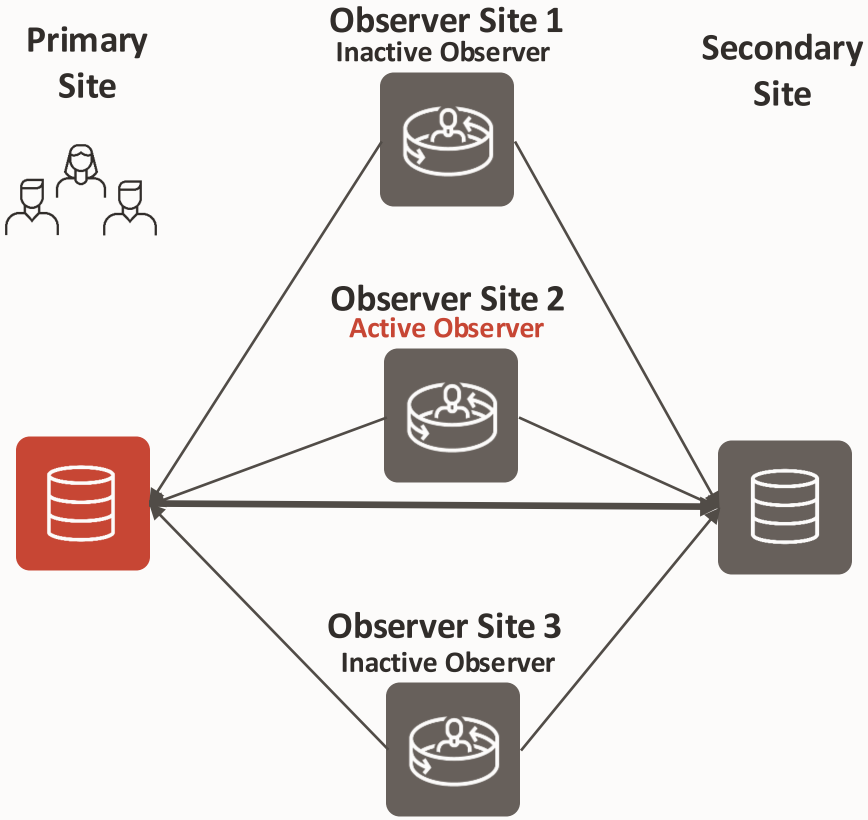


Configuration keeps working unobserved

Failure:	Primary DB	Standby DB	Network	Primary Site	Standby Site	Observer
	✓	✓	✓	✓	✓	✓

Oracle Data Guard Observer High Availability

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

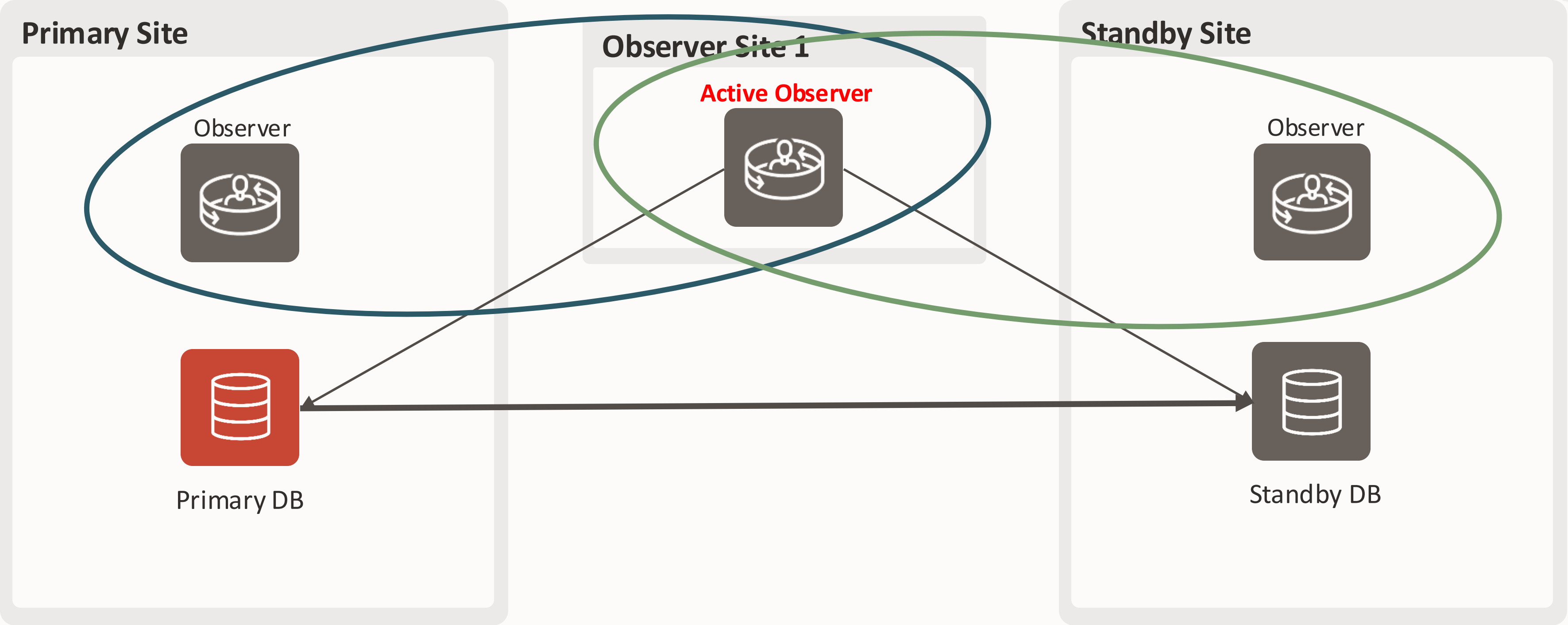


- **Optimal: 2 or 3 different Regions/Data Centers/Ads**
  - Ensure there are no SPOFs (network, power…)
- If one observer fails, another is promoted

* Four starting with 21c

Oracle Data Guard Observer High Availability

Tolerate observer site failure

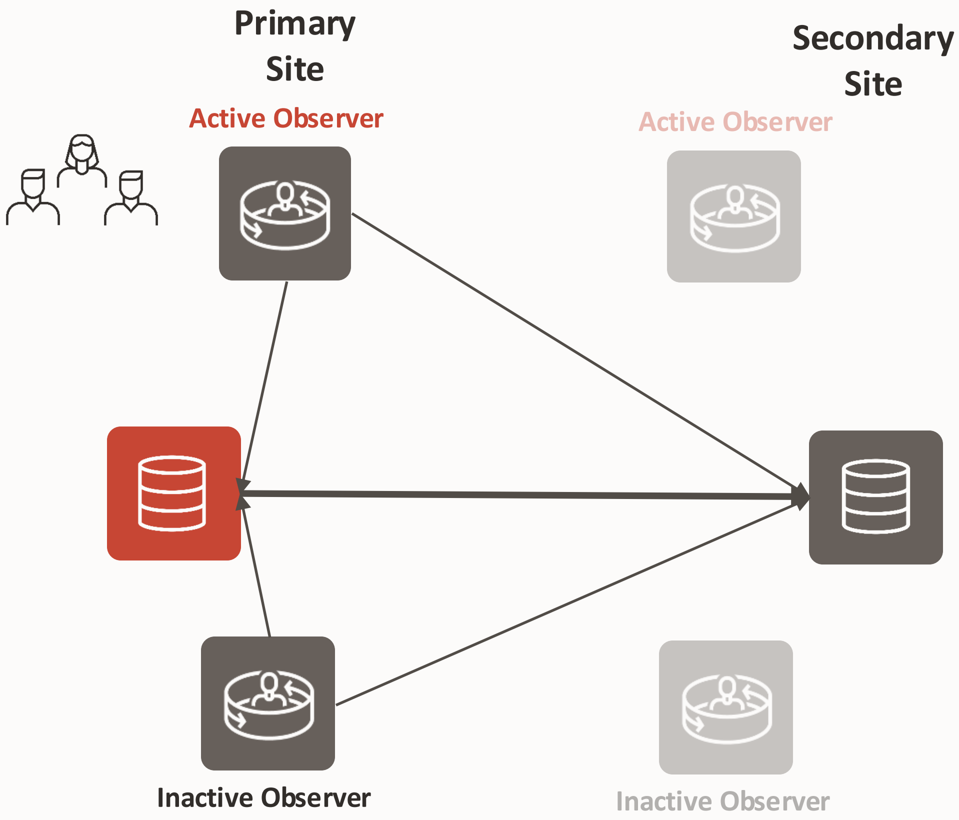


```
edit database db_site1 set property PreferredObserverHosts='obs_ext:1,obs_site1:2';
```

```
edit database db_site2 set property PreferredObserverHosts='obs_ext:1,obs_site2:2';
```

Oracle Data Guard Observer High Availability

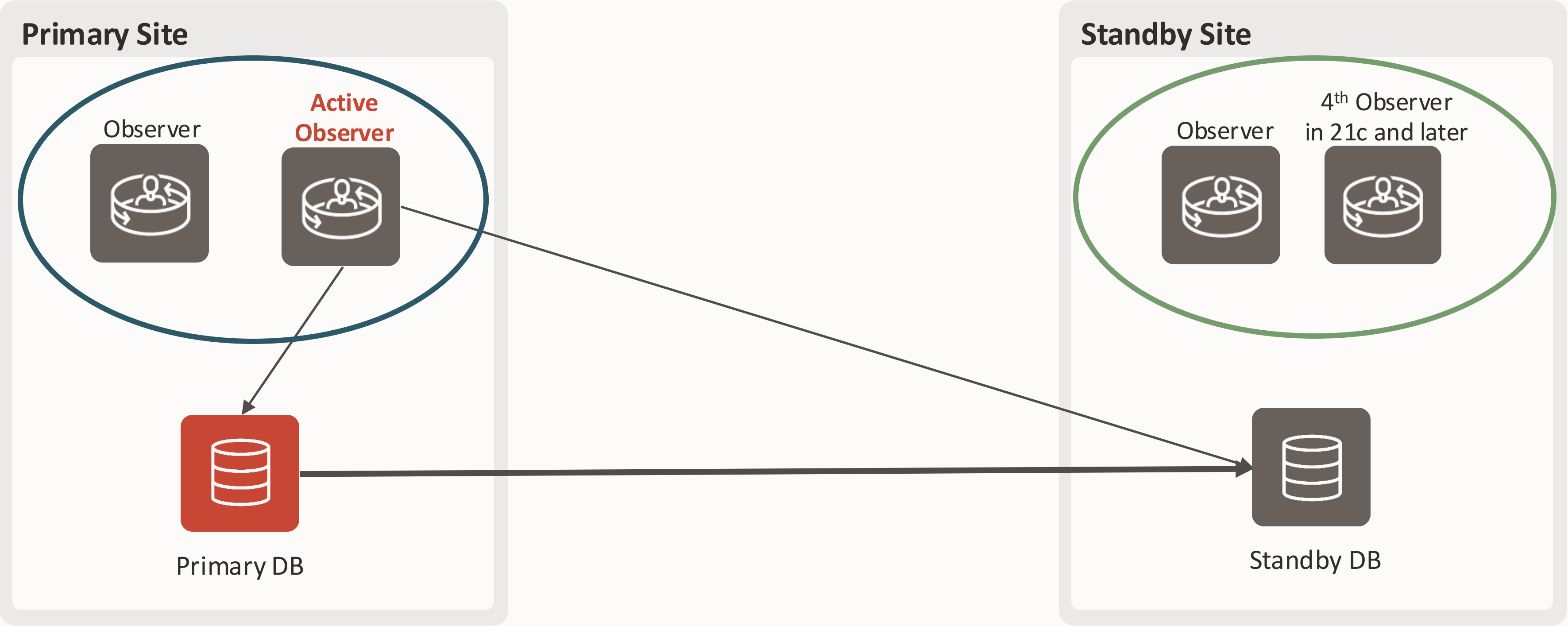
Up to four observers configured (one active at a time)



- **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

Oracle Data Guard Observer High Availability

Optimal configuration with two sites

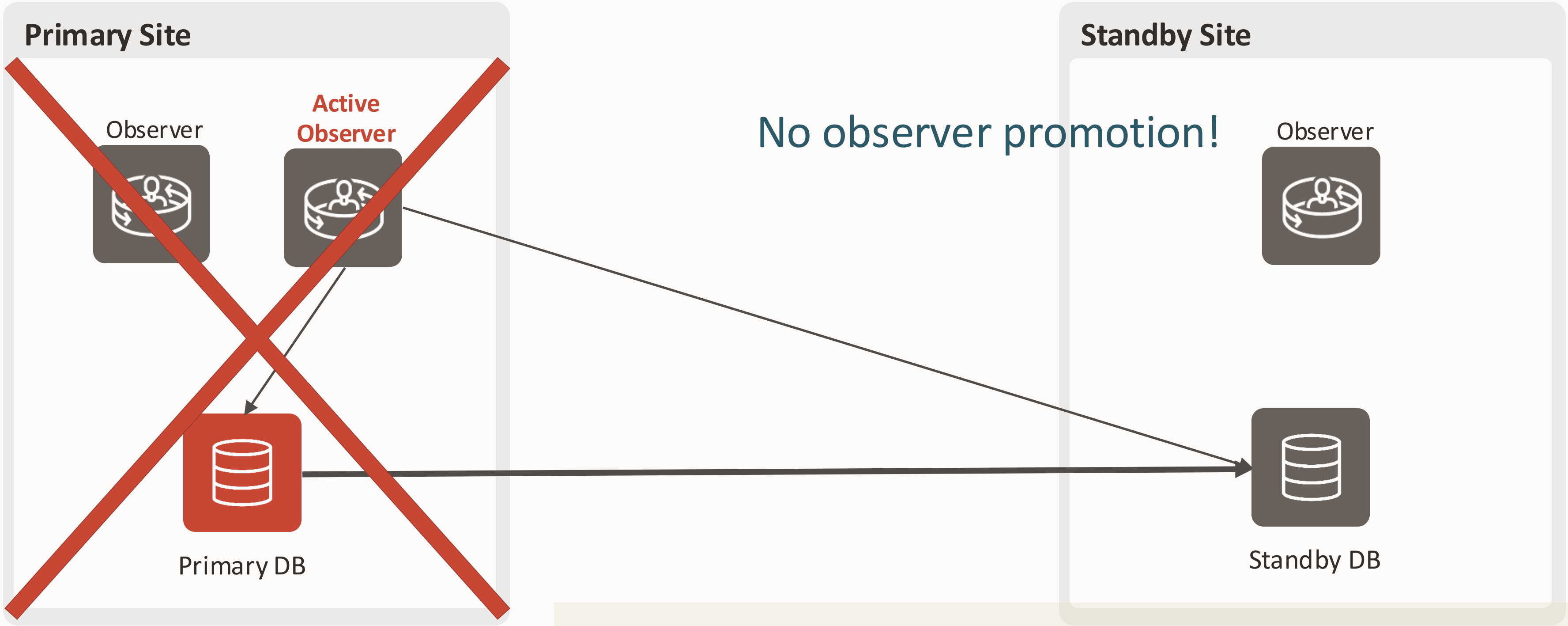


```
edit database db_site1 set property PreferredObserverHosts='obs1_site1,obs2_site1';
```

```
edit database db_site2 set property PreferredObserverHosts='obs1_site2,obs2_site2';
```

Oracle Data Guard Observer High Availability

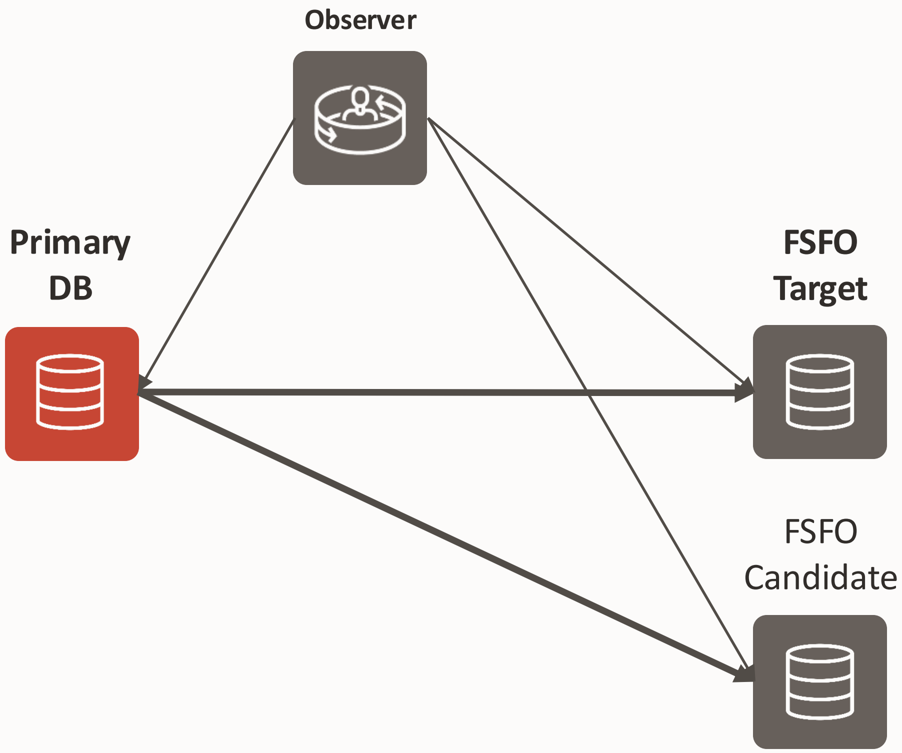
Observer promotion requires both primary and standby databases



- The surviving observer cannot tell if the configuration isn't working on the primary site: a promotion and failover might cause a split-brain

Multiple Fast-Start Failover Targets

Don’t let a database failure compromise your protection



```
DGMGRL> edit database BOSTON set property
  FastStartFailoverTarget='NASHUA,NEWYORK';

DGMGRL> edit database NASHUA set property
  FastStartFailoverTarget='BOSTON,NEWYORK';

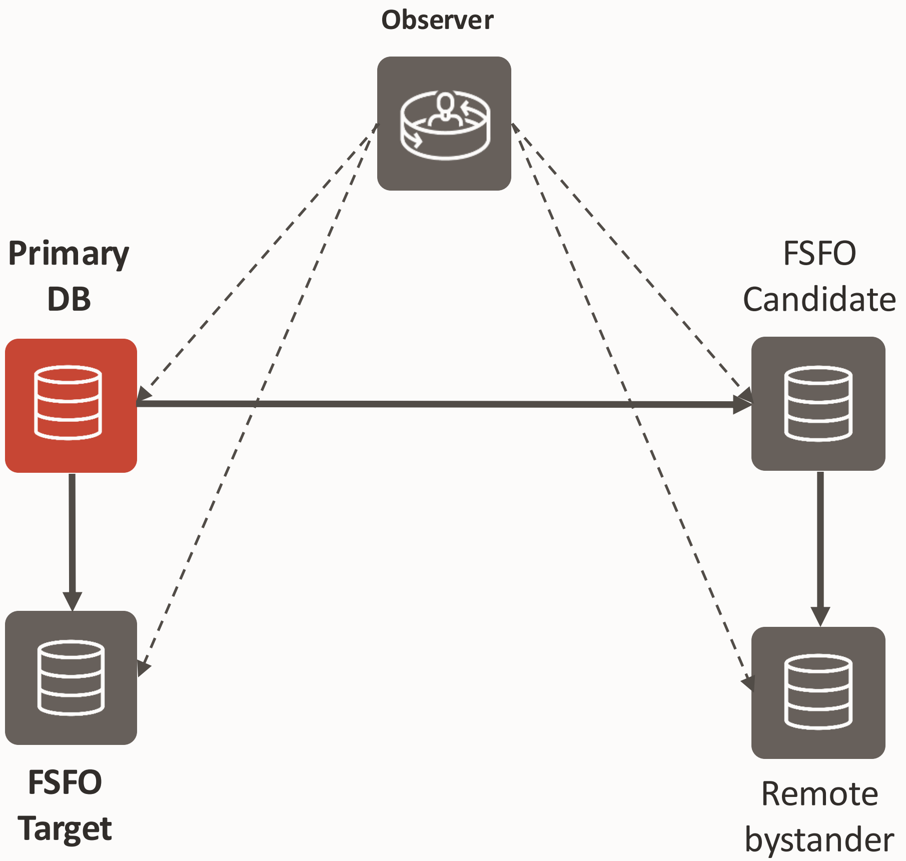
DGMGRL> edit database NEWYORK set property
  FastStartFailoverTarget='BOSTON,NASHUA';


DGMGRL> show fast_start failover;
...
  Active Target: NASHUA
  Potential Targets: NEWYORK
    NEWYORK    valid
  ...
```

Always use at least two standbys in Max Protection!

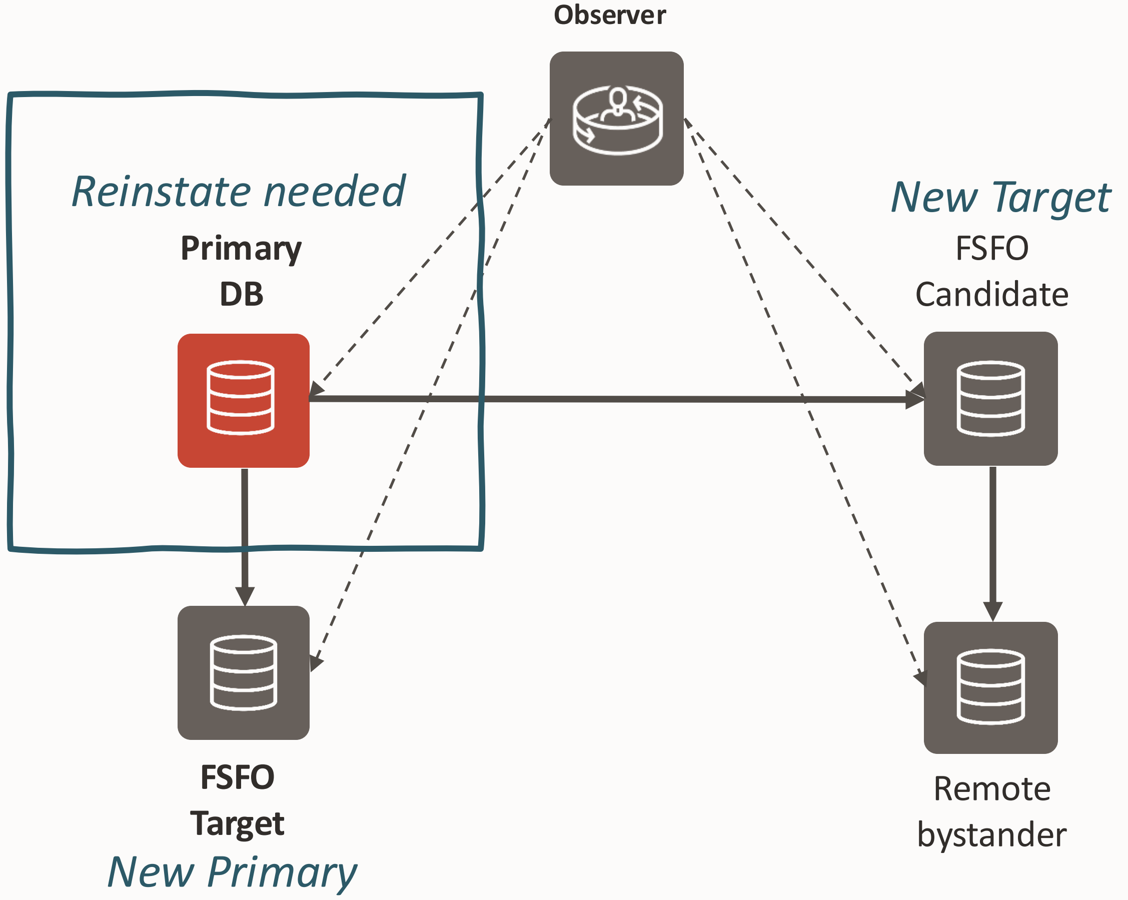
Network partitions and consistency

Multiple Fast-Start Failover Targets



Network partitions and consistency

Multiple Fast-Start Failover Targets



Primary Isolated

- The observer can still contact the FSFO target.

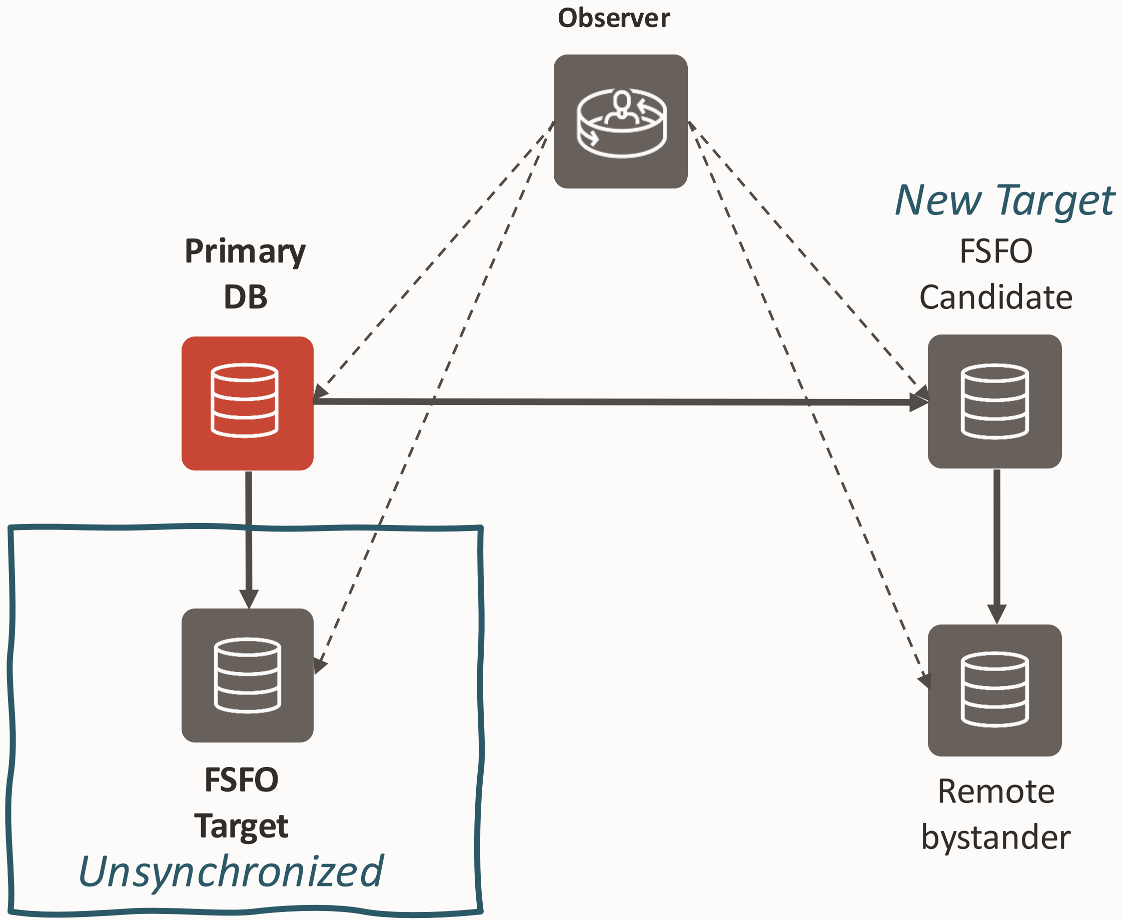
What happens:

1. The primary is STALLED.
2. The observer initiates the failover to FSFO Target.
3. The FSFO Target becomes primary.
4. The new primary and the observer agree to a new FSFO Target.
5. The former Primary DB will require a reinstate.

Execution of Fast Start Failover

Network partitions and consistency

Multiple Fast-Start Failover Targets



FSFO Target Isolated

- The observer can still contact the primary.

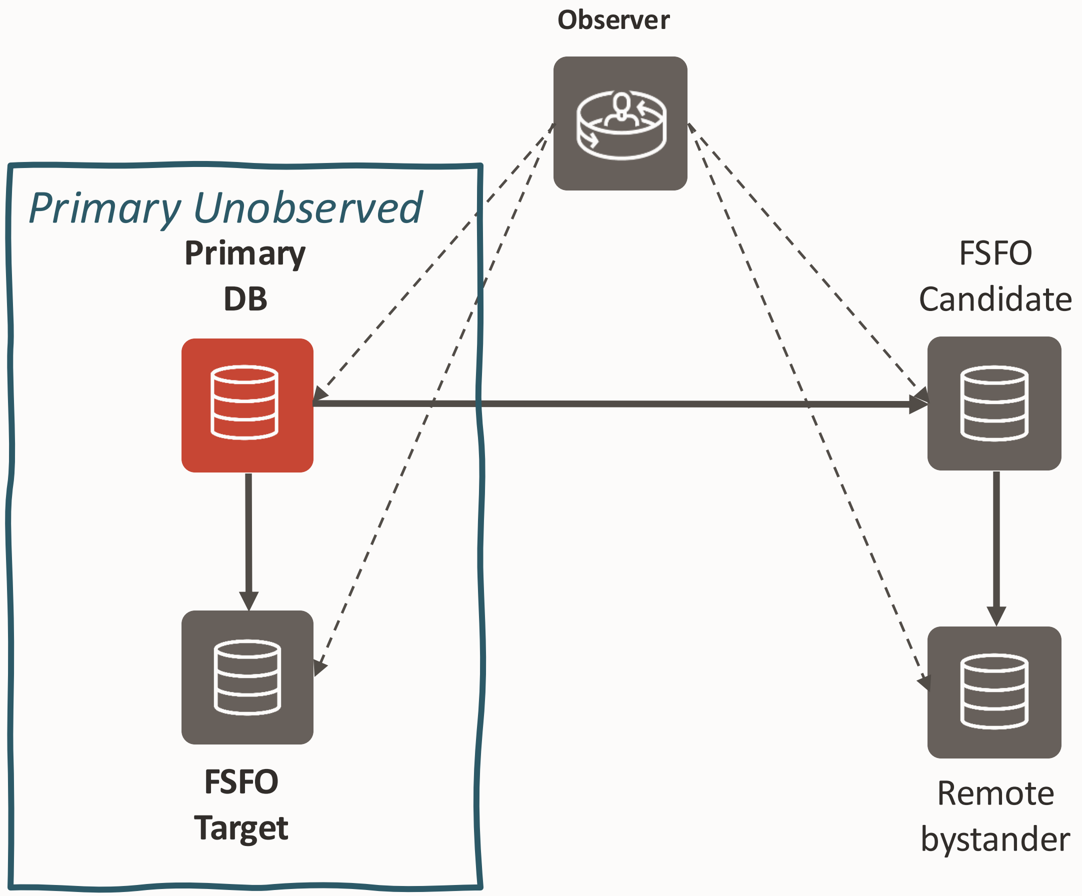
What happens:

1. The primary goes temporarily UNSYNCHRONIZED (no FSFO, unless Max Protection).
2. The new primary and the observer agree to a new FSFO Target.
3. As soon as the new FSFO target is ready, FSFO is possible again.

Fast Start Failover not possible for the time of target switch, then possible again

Network partitions and consistency

Multiple Fast-Start Failover Targets



Primary and FSFO Target Isolated

- The observer cannot contact the primary nor the FSFO target

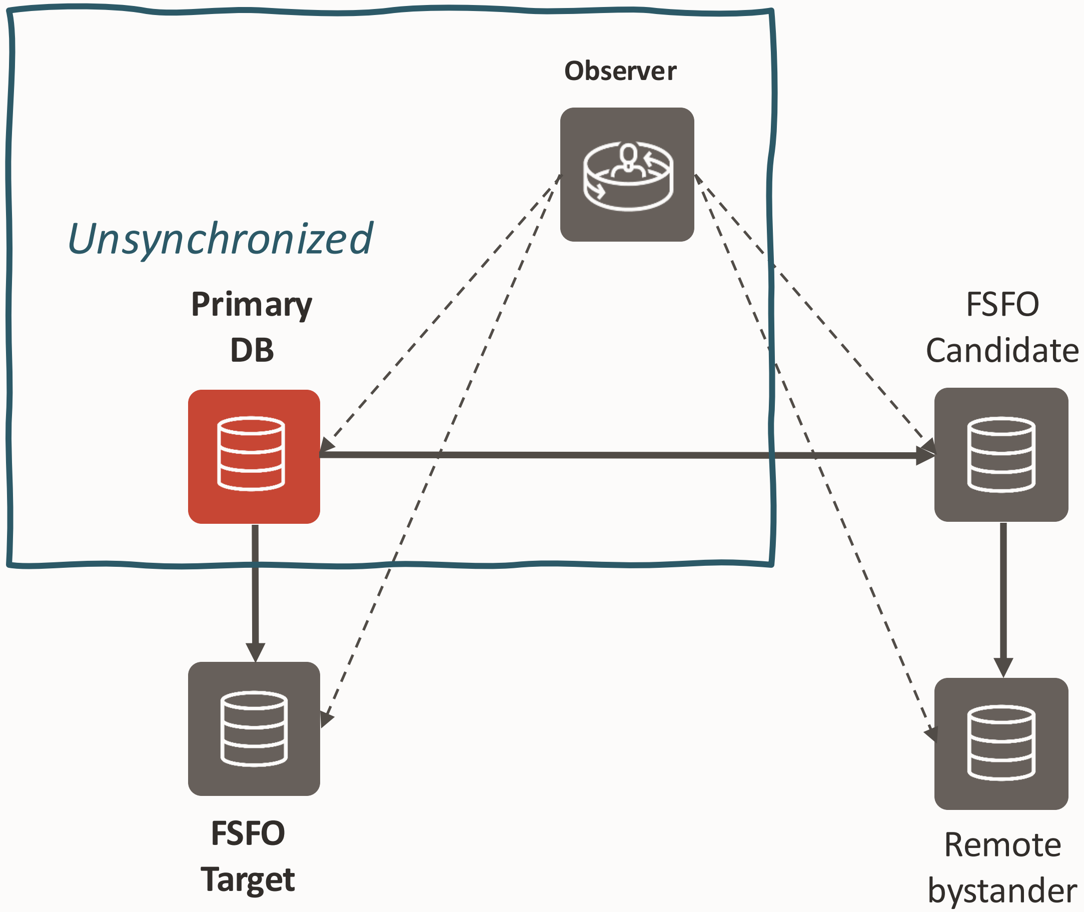
What happens:

1. The observer cannot tell if the network is unreachable, or the whole site is down. The primary might still write to the standby (valid LAD destination).
2. The primary and FSFO targets keep working, the configuration is UNOBSERVED.
3. The observer cannot initiate a failover, as it would lead to split-brain and data loss.

Fast Start Failover not possible ⚠

Network partitions and consistency

Multiple Fast-Start Failover Targets



Primary and Observer Isolated

- No FSFO target or candidates can be contacted.

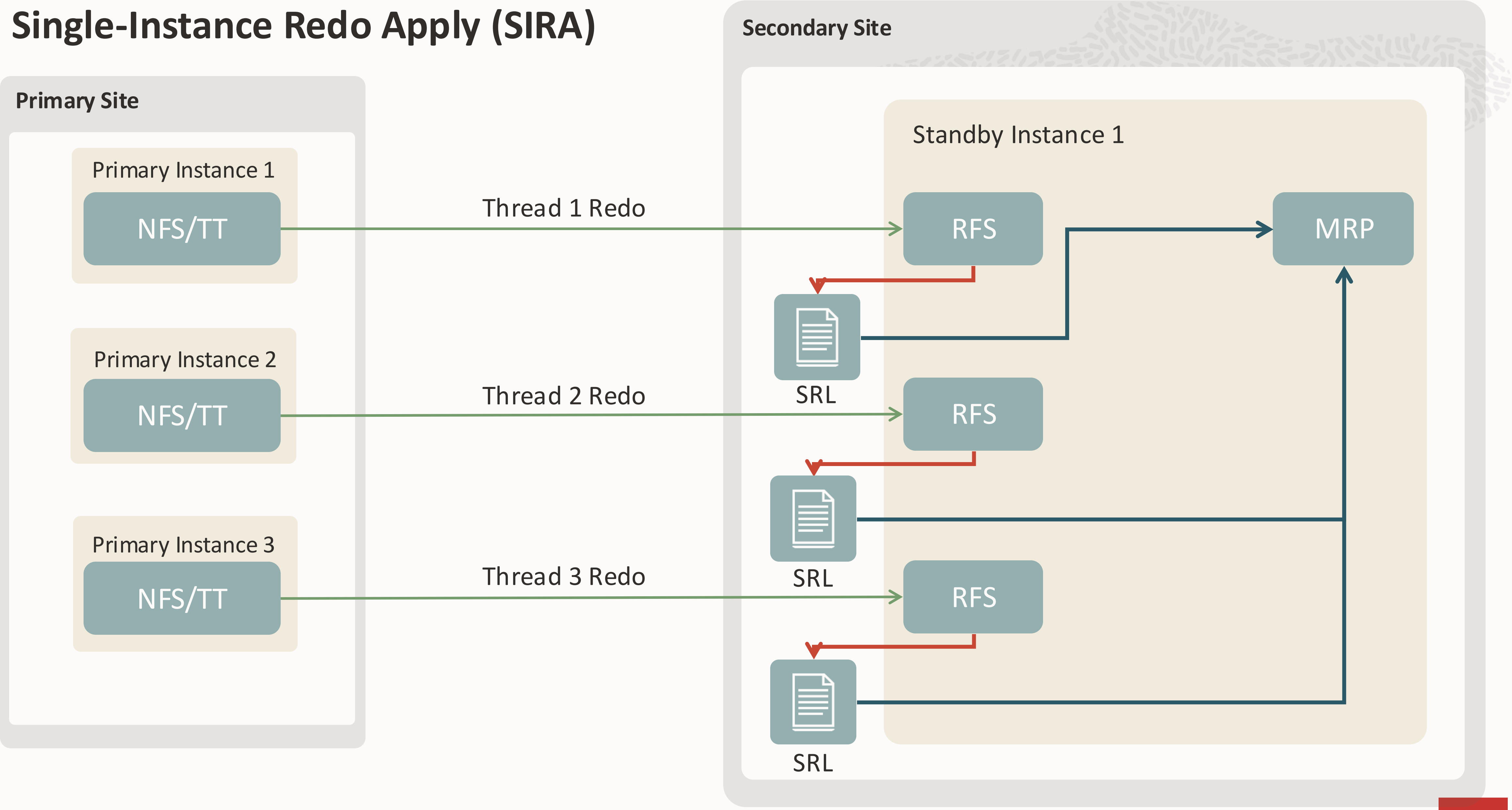
What happens:

1. The primary keeps working without protection (unless Max Protection).

Fast Start Failover not possible ⚠

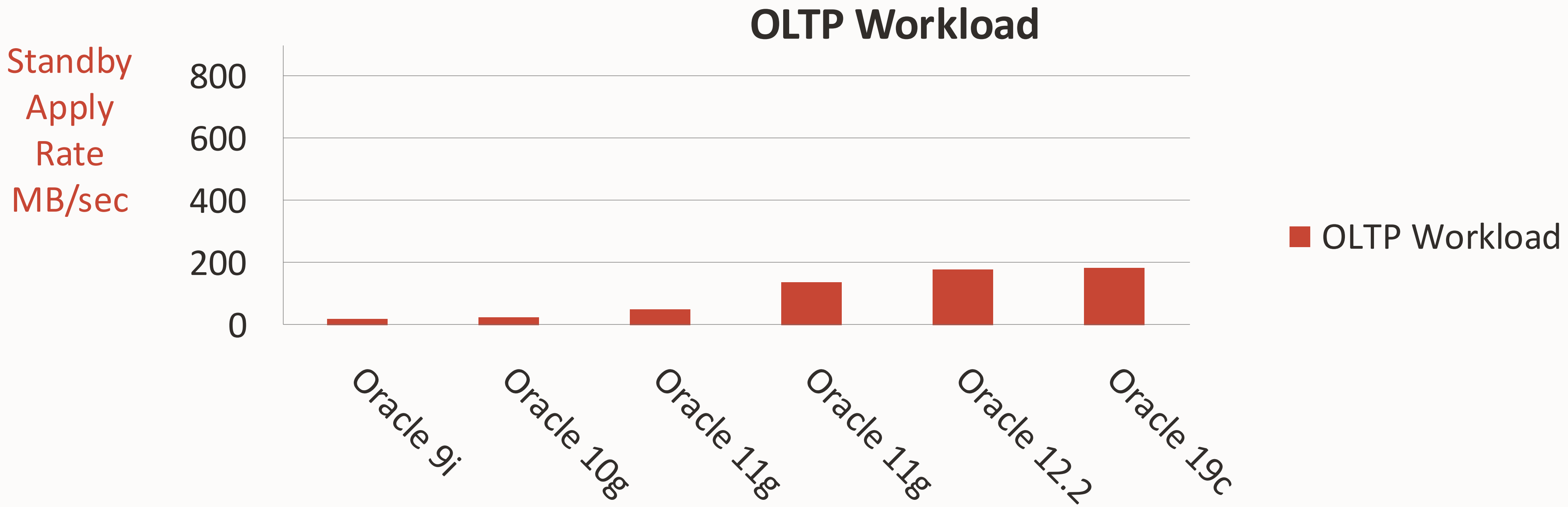
Multi-Instance Redo Apply (MIRA)

Single-Instance Redo Apply (SIRA)

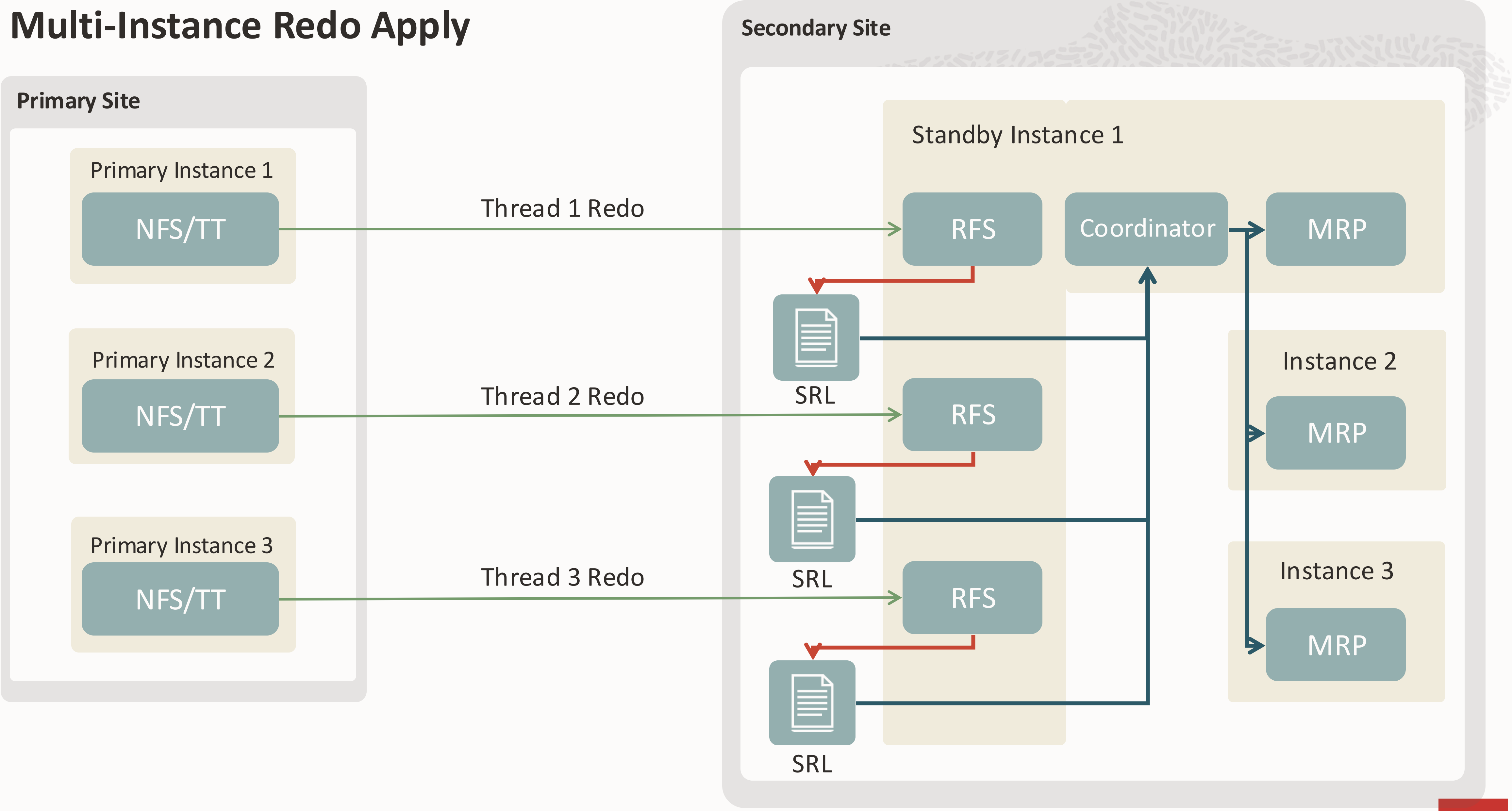


Single-Instance Redo Apply (SIRA)

- The MRP and its redo apply servers run on one node of a Physical Standby RAC.
- Single-Instance Redo apply performance generally meets all use cases.
- Before considering Multi-Instance apply, make sure you apply the best practices for Redo Apply

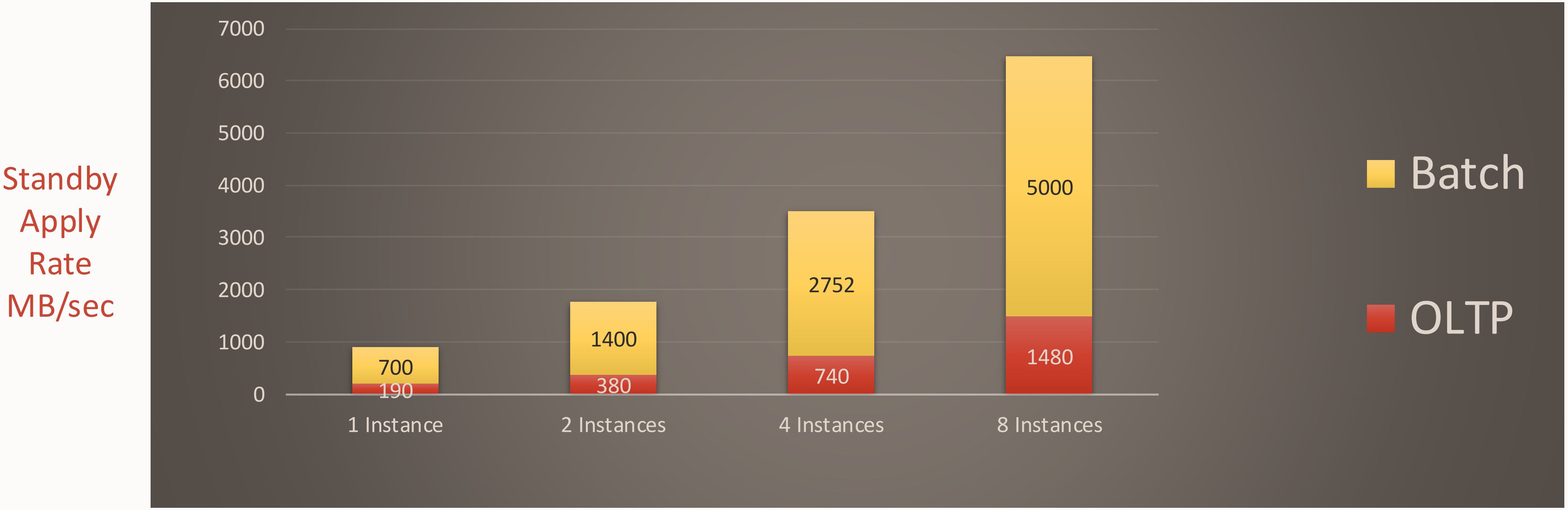


Multi-Instance Redo Apply



Multi-Instance Redo Apply

- Utilizes all RAC nodes on the Standby database to parallelize recovery
- OLTP workloads on Exadata show great scalability
- Generally 30% improvement or more, depending on the workload



When to consider Multi-Instance Redo Apply

- IO bottlenecks and database wait events affecting SIRA, will affect MIRA as well!
- Consider MIRA only if SIRA *is* the bottleneck and cannot meet the SLA
- We recommend Oracle Database 19.17 or higher (it includes critical fixes for MIRA)
- CPU-bounded apply coordinator or worker are the best indicators that MIRA is needed
- **Oracle Data Guard Configuration Best Practices**

  https://docs.oracle.com/en/database/oracle/oracle-database/19/haovw/configure-and-deploy-oracle-data-guard.html#GUID-97769612-4980-42C2-A28C-4C5E49FE2824
- **Redo Apply Troubleshooting and Tuning**

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

How to Enable Multi-Instance Redo Apply

With the Data Guard Broker:

```
DGMGRL> edit database <standby> set property ApplyInstances=<#|ALL>;
```

From SQL*Plus:

```
SQL> alter database recover managed standby database disconnect from session instances <#|ALL>;
```

Entries in the alert log:

```
ALTER DATABASE RECOVER MANAGED STANDBY DATABASE DISCONNECT FROM SESSION INSTANCES ALL
2018-05-23T11:37:09.937690+01:00
Attempt to start background Managed Standby Recovery process (<db_unique_name>)
…
2018-05-23T11:37:15.111518+01:00
Started logmerger process on instance id 1
Started logmerger process on instance id 2
Starting Multi Instance Redo Apply (MIRA) on 2 instances
…
2018-05-23T11:37:16.027775+01:00
Started 24 apply slaves on instance id 1
2018-05-23T11:37:16.545221+01:00
Started 24 apply slaves on instance id 2
```

Multi-Instance Redo Apply on Exadata

- Exadata prerequisites to enable MIRA

Exadata Systems	RDBMS version	Steps
With PMEM	19.13 and higher	No additional steps
Without PMEM	19.13 and higher	Set dynamic parameter on all instances: `"_cache_fusion_pipelined_updates_enable"=FALSE` (*)
Any Exadata System	19.12 and lower	Apply Patch 31962730 and set dynamic parameter on all instances: `"_cache_fusion_pipelined_updates_enable"=FALSE` (*)

(*) MIRA can recover only redo generated with the “_cache_fusion_pipelined_updates_enable” set to FALSE

- Using ExaWatcher Charts to Monitor Exadata Database Machine Performance
  https://docs.oracle.com/en/engineered-systems/exadata-database-machine/dbmmn/exadata-general-maintenance.html#GUID-5AEB3139-333D-453F-91D6-8EB09CB6E6EB

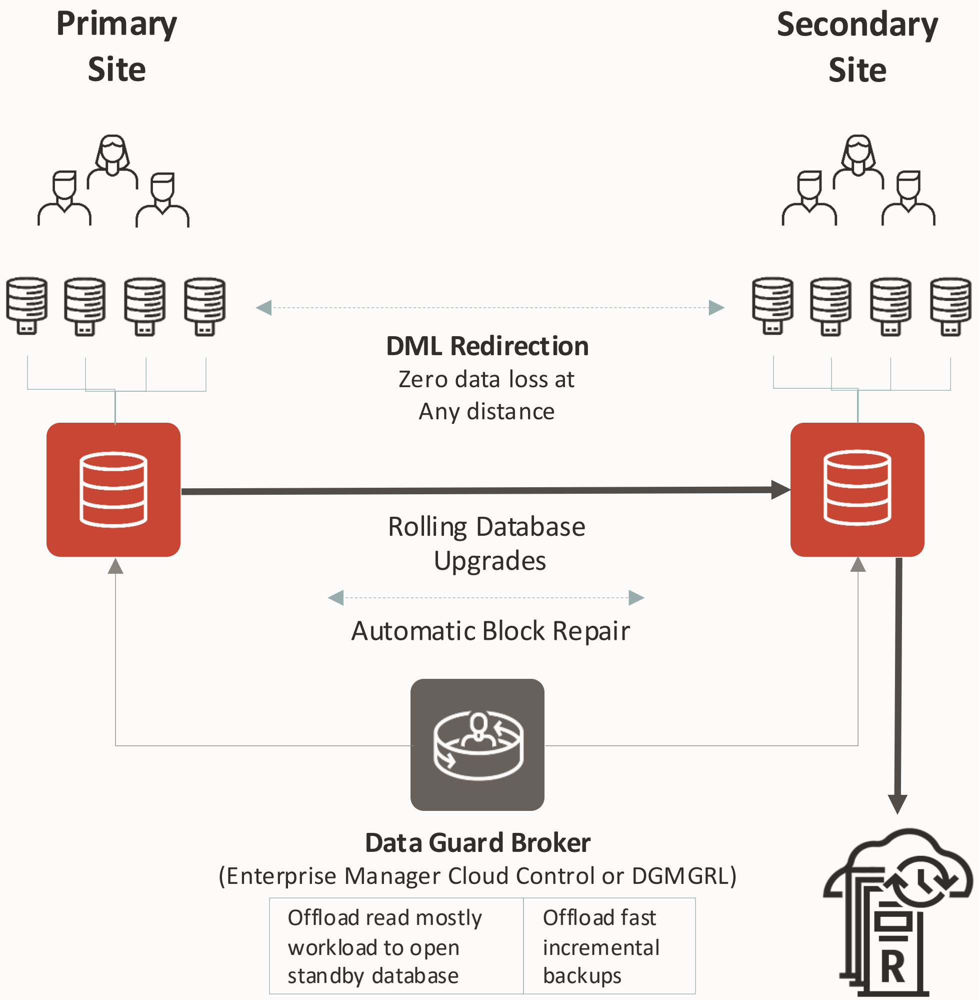
Tuning Multi-Instance Redo Apply

- Tune Redo Apply by evaluating Database wait events
- If `recovery apply pending` and/or `recovery receive buffer free` are among the top wait events:
  - Incrementally increase `_mira_num_receive_buffers` and `_mira_num_local_buffers` by 100
  - Additionally set “`_mira_rcv_max_buffers`”`=10000`
  - The additional memory requirements for each participating MIRA RAC instance:
    `(_mira_num_receive_buffers + _mira_num_local_buffers) * (#instances * 2MB)`

- If `parallel recovery change buffer free` is among the top wait events:
  - Increase `_change_vector_buffers` to 2 or 4.

Oracle Active Data Guard Overview

Oracle *Active* Data Guard



Oracle Data Guard features, plus:

- **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**
- **Rolling Upgrades and Maintenance**
- **Real-time cascaded standbys**
- **Global Data Services**

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

Active Data Guard

Option of Oracle Database for Advanced Capabilities and Protection

Data Protection

- Zero data loss at any distance
- Real-time cascade
- Automatic Block Repair

High Availability

- Automatic block repair
- Automated rolling database maintenance
- Application continuity
- Service management for replicated databases
- Rolling Upgrade

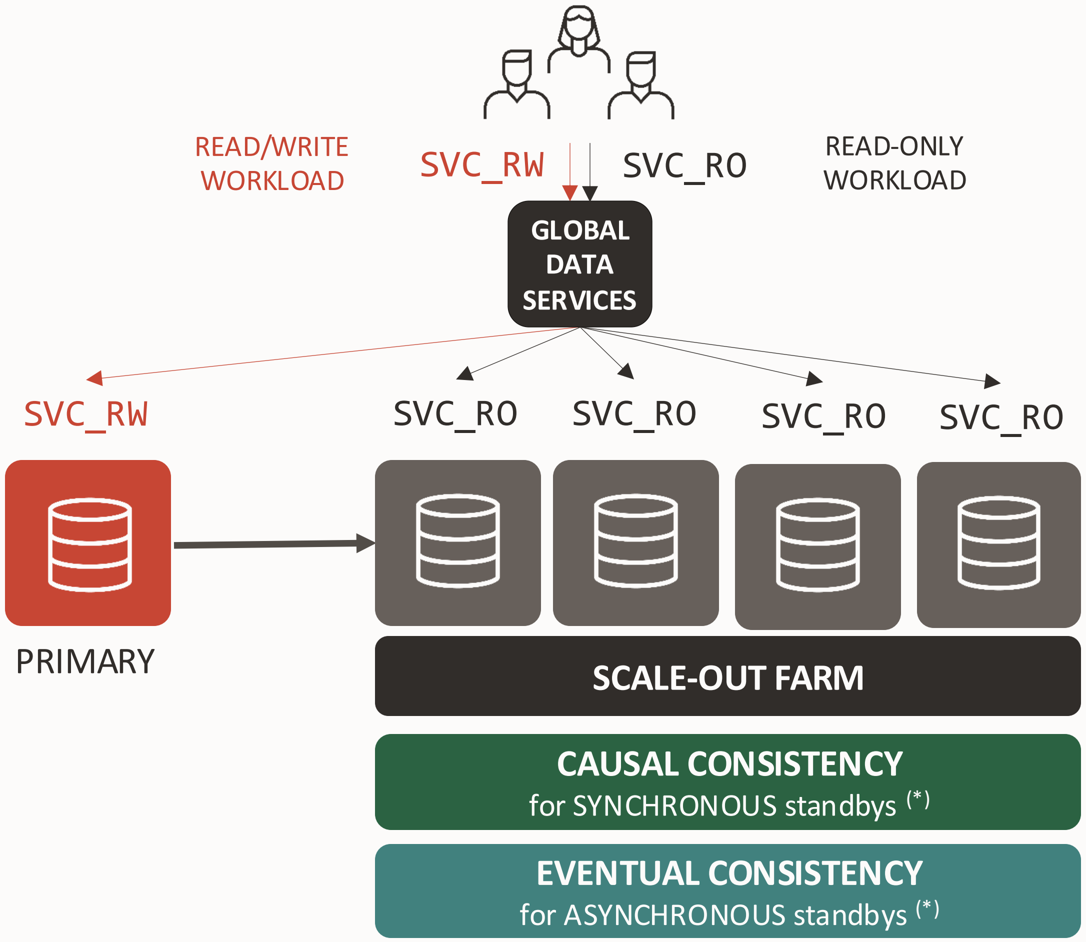
Performance and ROI

- Extreme throughput - supports all workloads
- Dual-purpose standby for development and test
- Integrated management
- Offload network compression
- Intelligent load balancing for replicated databases
- Active Standby DML redirection

Oracle Active Data Guard Real-Time Query

Scale and Improve ROI of your Active Data Guard Environments

Scale linearly by opening standbys read-only for additional processing power



Benefits of offloading read-only workload:

- Linear scalability of read-only (RO) workloads
- Isolation of primary from heavy queries
- RO sessions uninterrupted during role changes
- Reports and data extractions off the primary
- Fast incremental backups on the standby databases

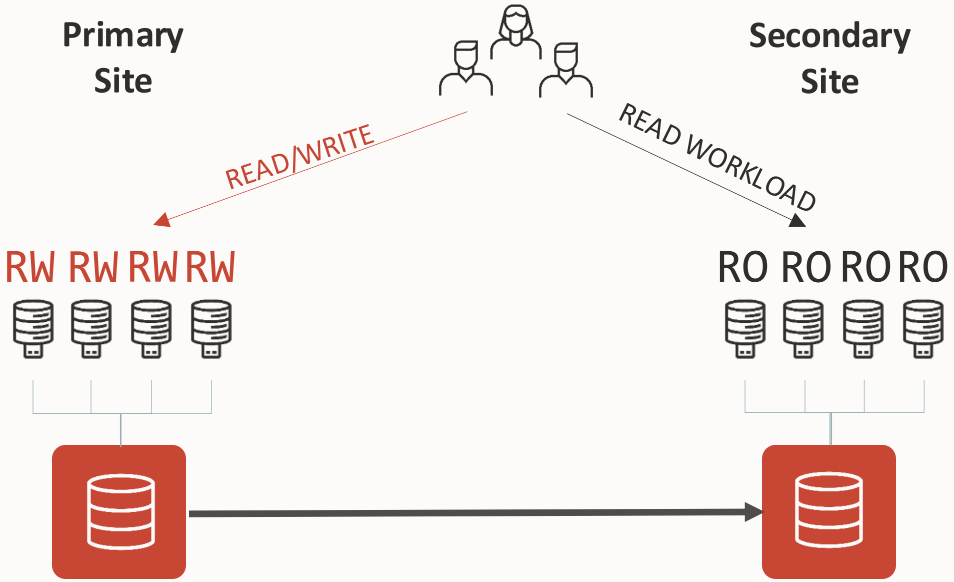
Global Data Service (optional):

- Simplifies the application configuration with a single, highly-available endpoint
- Sessions are redirected to the best standby based on locality and load
- Problematic or lagging standbys are excluded automatically

(*) Sessions can individually set the lag tolerance. For synchronous standby it can be zero.

Active Data Guard Real-Time Query

Read-only Standby while Recovery is Active



Activation

With Data Guard Broker:

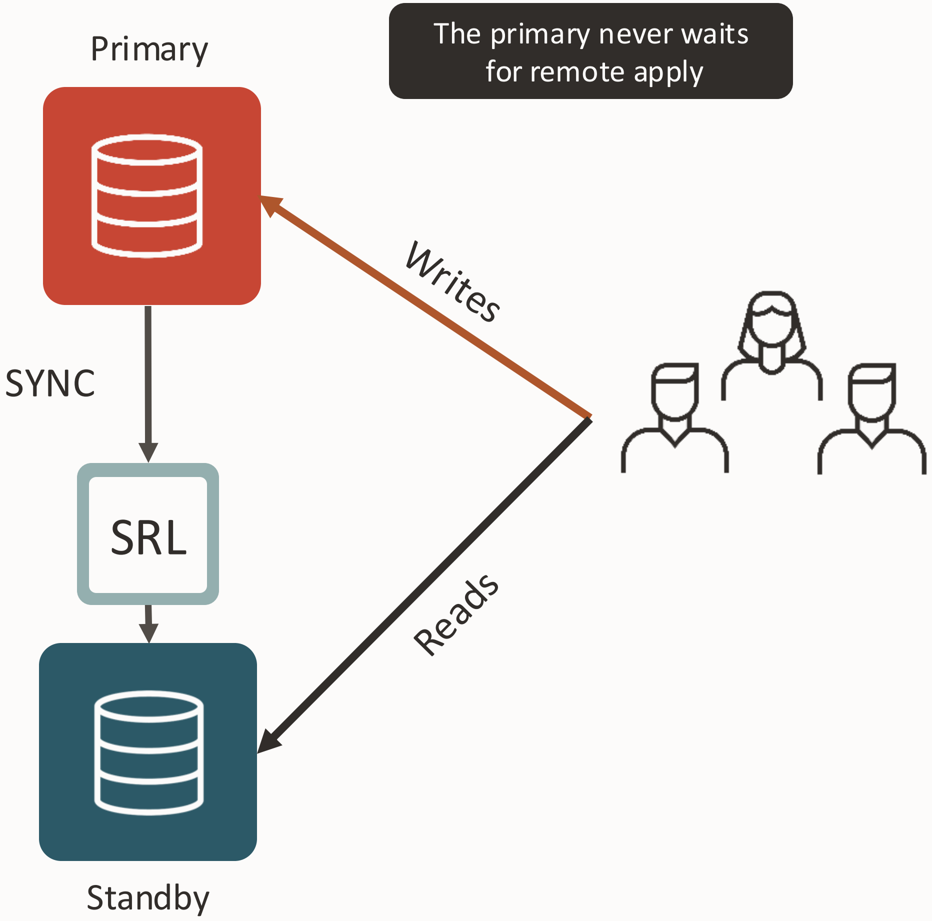
```
SQL> ALTER DATABASE OPEN;
```

Without Data Guard Broker:

```
ALTER DATABASE RECOVER MANAGED STANDBY DATABASE CANCEL;
ALTER DATABASE OPEN;
ALTER DATABASE RECOVER MANAGED STANDBY DATABASE DISCONNECT;
```

Real-Time Query Apply Lag Limit

Full read consistency at the session level



The primary never waits for remote apply

```
-- log transport to the standby must be synchronous
DGMGRL> edit database prim
 set property LogXptMode='SYNC';

-- write on the primary
insert into emp values (...);
commit;

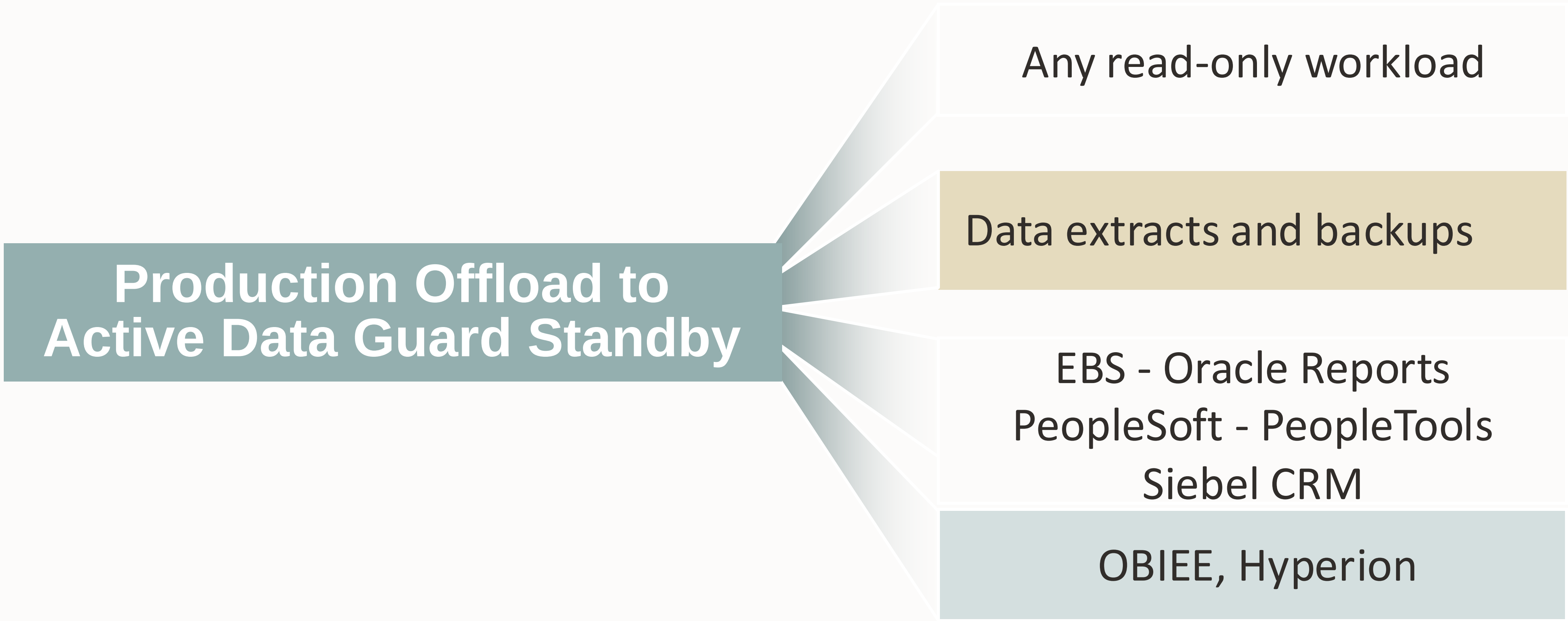
-- read on the standby
-- wait once until current SCN is applied
alter session sync with primary;

-- or always have READ COMMITTED in the session
alter session set standby_max_data_delay=0;

select first_name from emp where ...;
```

Offload Read-Only Workloads

Increase Performance and ROI – Standby is a Production System



Production Offload to Active Data Guard Standby

Any read-only workload

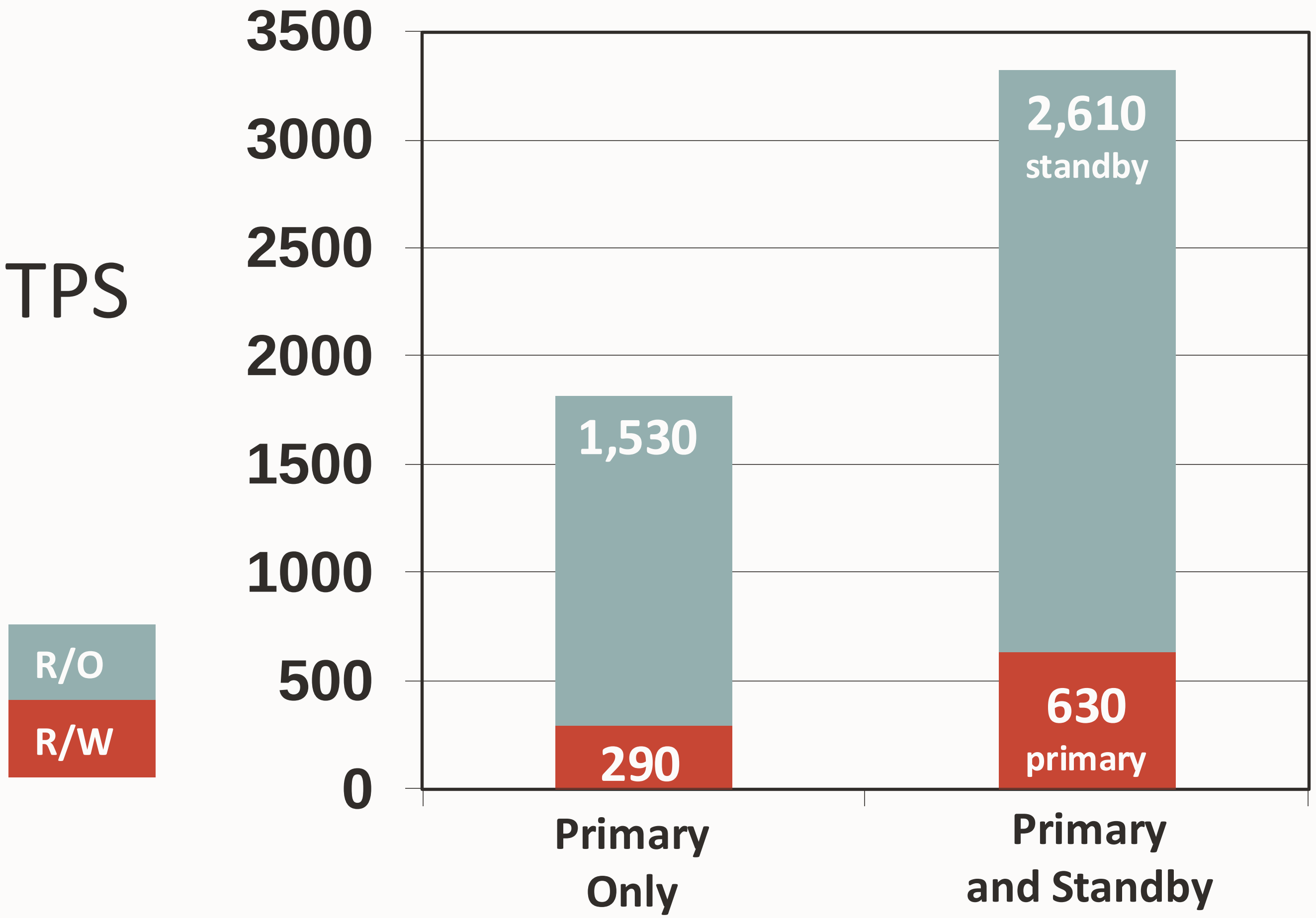
Data extracts and backups

EBS - Oracle Reports
PeopleSoft - PeopleTools
Siebel CRM

OBIEE, Hyperion

Standby Offload Increases Performance for all Workloads

Bring Idle Capacity Online



Double read-write throughput

Increase read-only throughput by 70%

Eliminate contention between read-write and read-only workloads

Real-Time Query

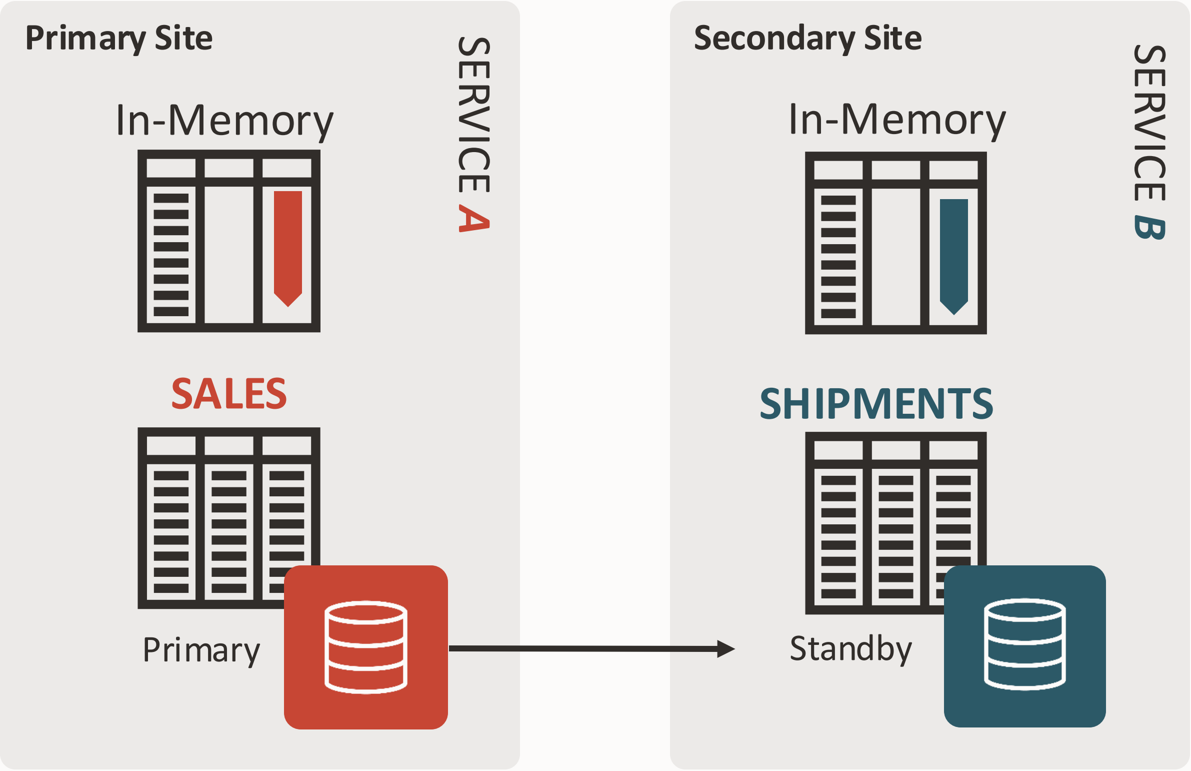
Not just Selects for your Application Workloads!

- SQL Performance Analyzer
- Oracle Database In-Memory *
- Global Temporary Tables
- R/O Connections Preserved

- Sequences
- Updates on Active Data Guard
- Standby Result Cache preservation — NEW in 21c
- Simplified AWR snapshots — NEW in 23ai

* Only on Engineered Systems or Oracle Cloud Infrastructure

Active Data Guard and Database In-Memory

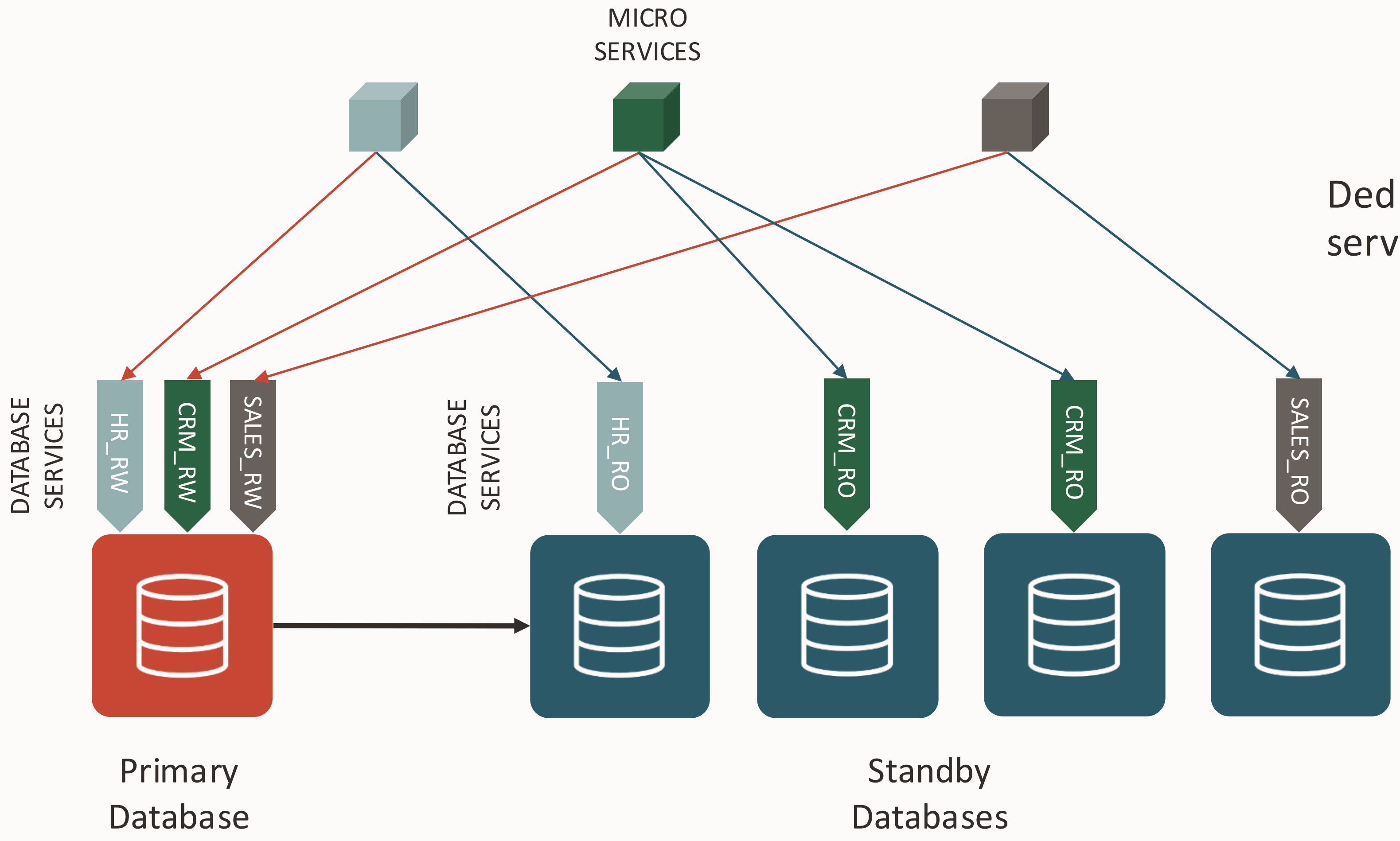


```
ALTER TABLE
SALES INMEMORY
DISTRIBUTE
FOR SERVICE A
```

```
ALTER TABLE
SHIPMENTS INMEMORY
DISTRIBUTE
FOR SERVICE B
```

- In-Memory queries run on standby
  - No impact on the primary database
  - Full use of standby database resources
- Standby can have different in-memory contents from Primary
  - **DISTRIBUTE FOR SERVICE** subclause used to determine data placement
  - Increases total effective in-memory columnar capacity
  - Increases column store availability:
    - Reporting workload on standby unaffected by primary site outage

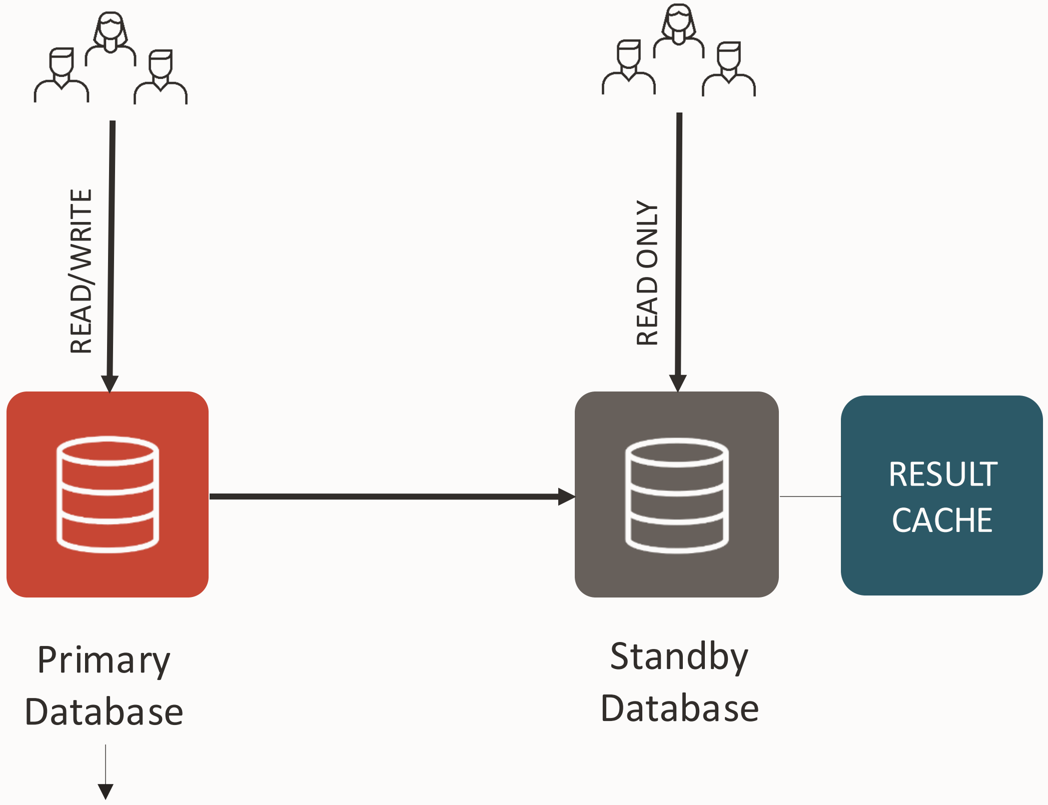
Service Distribution to Optimize the Buffer Cache



Dedicate standby instances to specific services to maximize the cache hits

Standby Result Cache preservation

Keep the Result Cache warm after a role transition



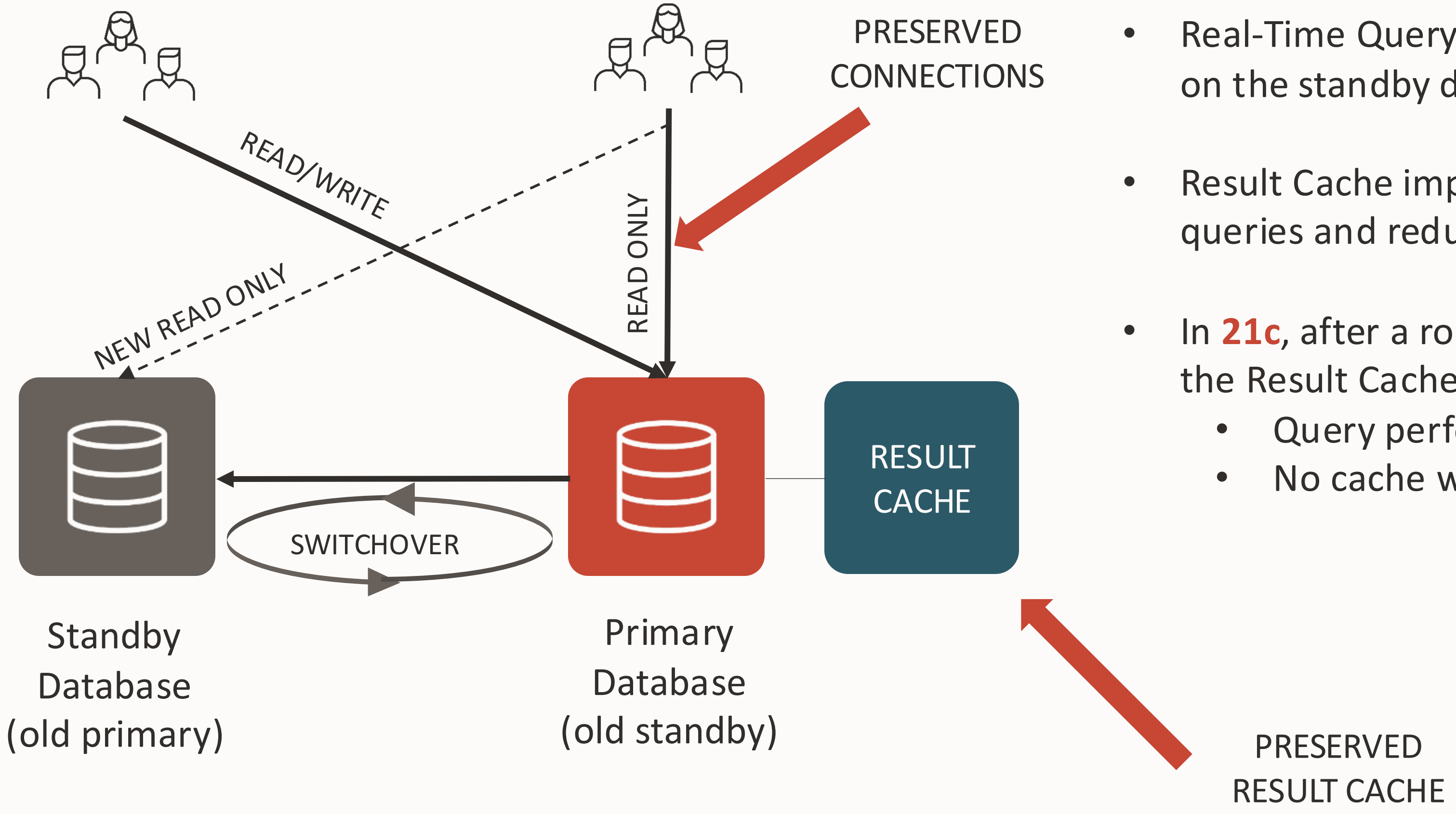
```
ALTER TABLE employee RESULT_CACHE (STANDBY ENABLE)
```

- Real-Time Query supports the Result Cache for queries run on the standby database (tables only)
- Result Cache improves query performance for recurring queries and reduces resource usage (CPU, I/O)

NEW IN 21c

Standby Result Cache preservation

Keep the Result Cache warm after a role transition



- Real-Time Query supports the Result Cache for queries run on the standby database (tables only)
- Result Cache improves query performance for recurring queries and reduces resource usage (CPU, I/O)
- In **21c**, after a role transition (switchover or failover), the Result Cache is preserved
  - Query performance not impacted
  - No cache warm-up required

New In 23ai

Simplified AWR snapshots on Active Data Guard

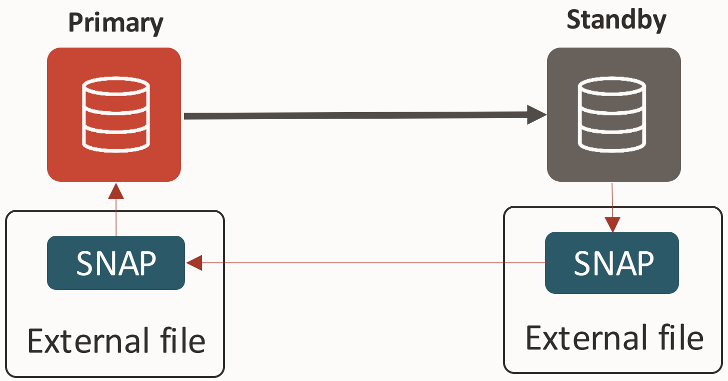
Just create the snapshot on the standby, and you are ready to go.

```
-- at the PDB or CDB level
alter session set container = PDB1;

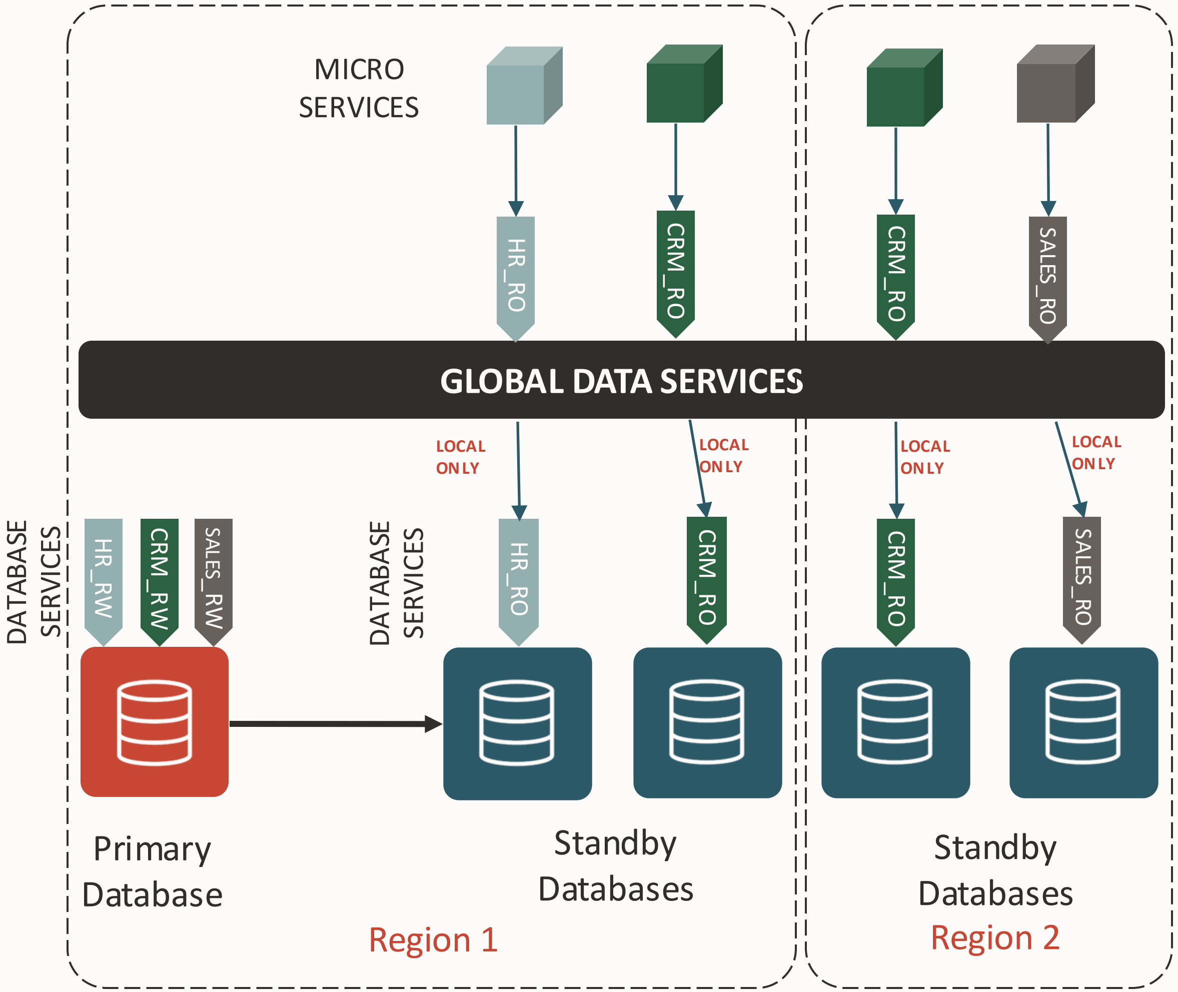
-- the snapshot can be created without additional configuration
select dbms_workload_repository.create_snapshot from dual;

-- create the report at the PDB or CDB level
@?/rdbms/admin/awrrpti
```

```
-- databases already using SYS$UMF can set this
-- to use the new framework instead:
alter system set "_umf_remote_enabled"=FALSE;
```

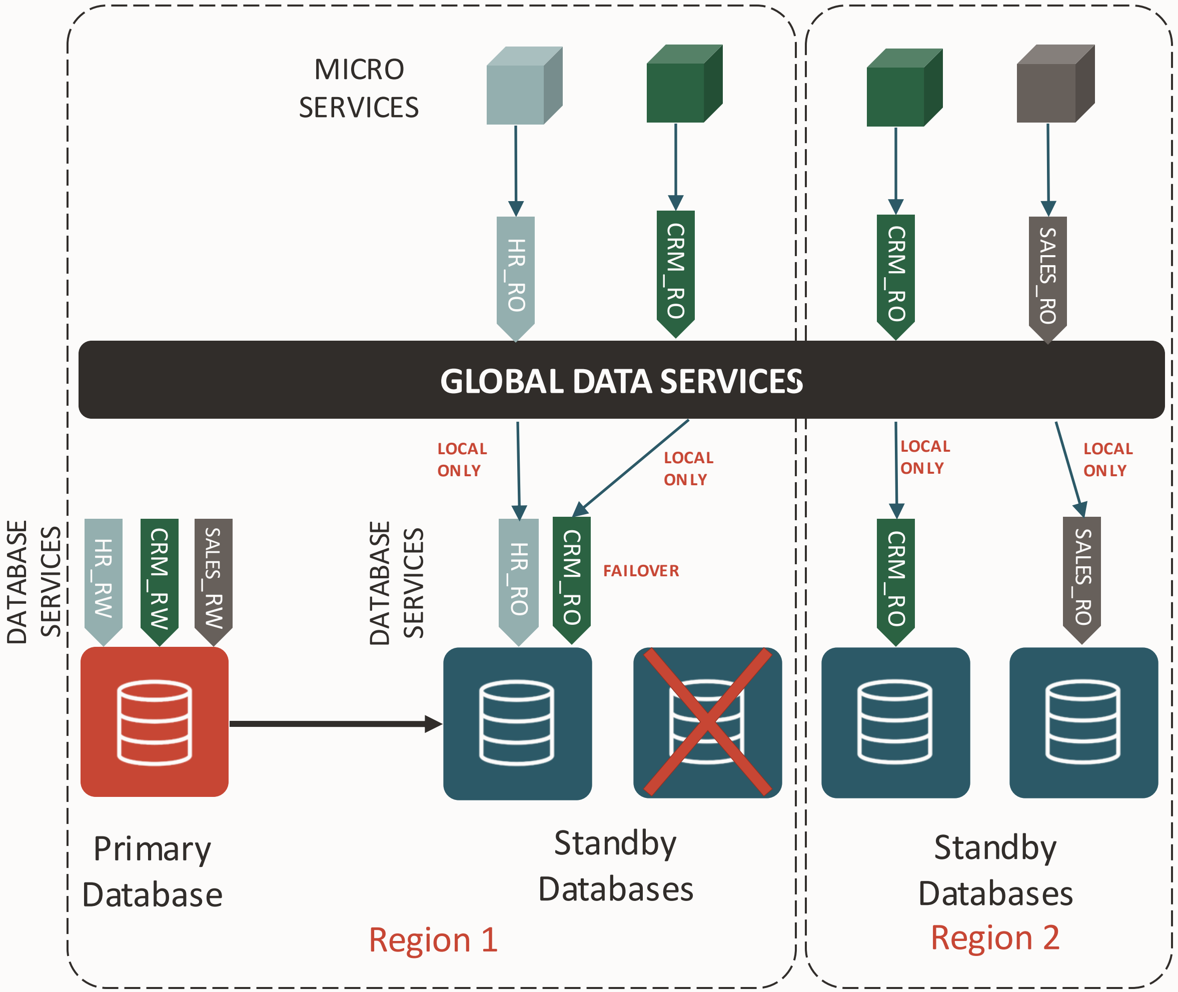


Oracle Global Data Services (GDS)



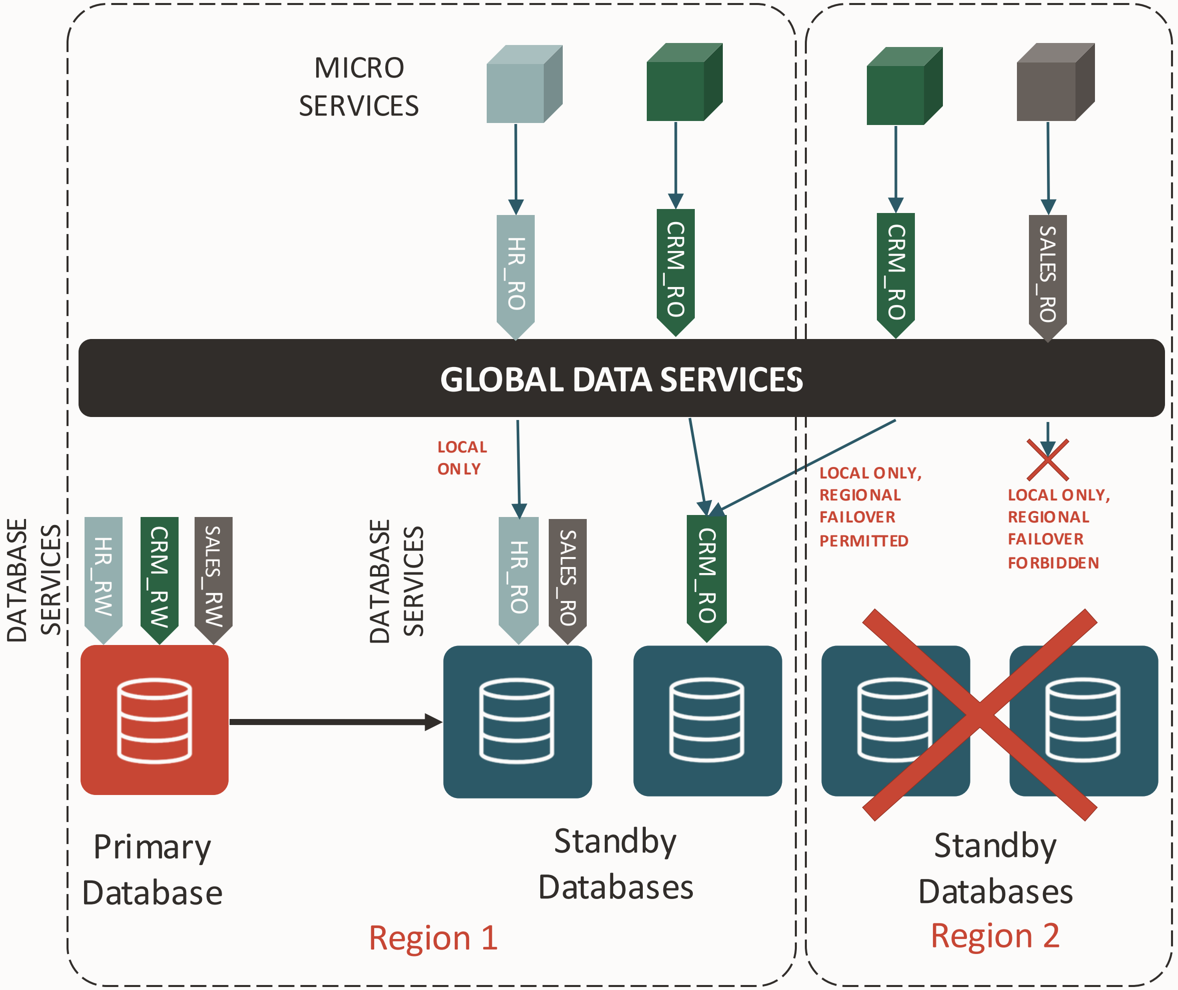
- Automatic and transparent client workload management across replicas
- Extends the concept of services across clusters
- Capabilities
  - Workload routing based on standby load, locality, or lag
  - Service failover across replicas
- Benefits
  - Maximize application performance
  - Mitigate downtime during planned and unplanned outages
  - Centrally manage services and resources of replicas

Oracle Global Data Services (GDS)



- Inter-database service failover
  - If a cluster fails, the service is restarted automatically on another cluster
  - Clients reconnect automatically where the service is available
- Workload routing (region-based and lag-based)
- Load balancing (connect-time & run-time)

Oracle Global Data Services (GDS)



- Region-based services can be configured to accept (fail over) deny requests from remote clients should a region become unavailable

Oracle Active Data Guard DML Redirection

Bigger Footprint of ADG Applications

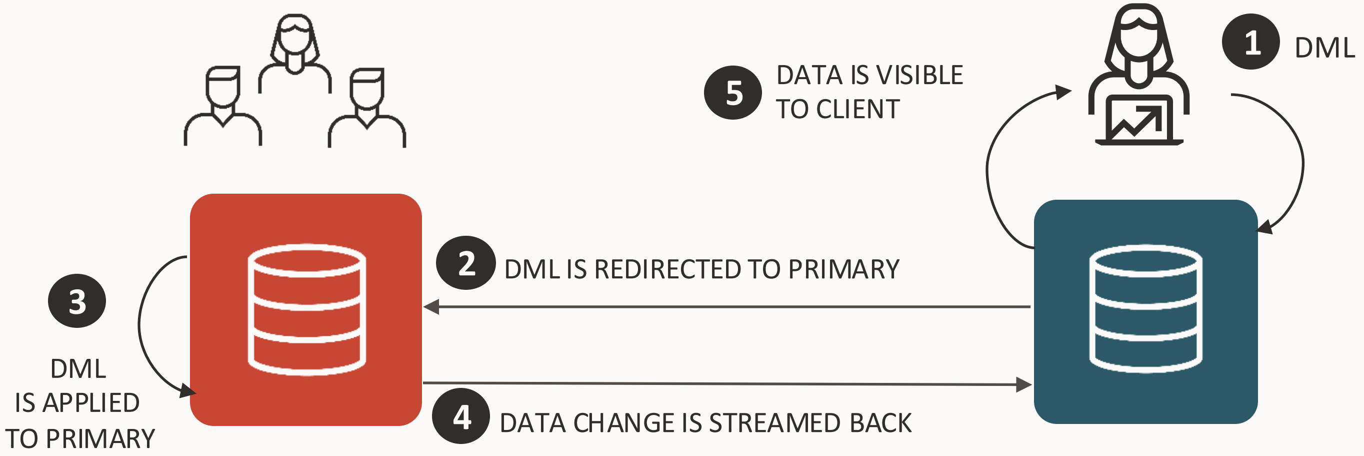
DML on Active Data Guard

DML Re-direction is automatically performed from
an Active Data Guard standby to the primary without compromising ACID compliance

- New documented parameter `ADG_REDIRECT_DML` controls DML Redirection
- New `alter system set ADG_REDIRECT_DML | alter session enable ADG_REDIRECT_DML`
- New `ADG_REDIRECT_PLSQL` commands

Supported with Oracle Database 19c

Targeted for "Read-Mostly,
Occasional Updates" applications


1 DML
2 DML IS REDIRECTED TO PRIMARY
3 DML IS APPLIED TO PRIMARY
4 DATA CHANGE IS STREAMED BACK
5 DATA IS VISIBLE TO CLIENT

Active Data Guard DML Replication

Easy and ready to use

By default DMLs are not possible on the standby

```
SQL> update hr.employee set salary=salary+100 where employee_id=1;
ERROR at line 1:
ORA-16000: database or pluggable database open for read-only access
```

Enable DML redirection

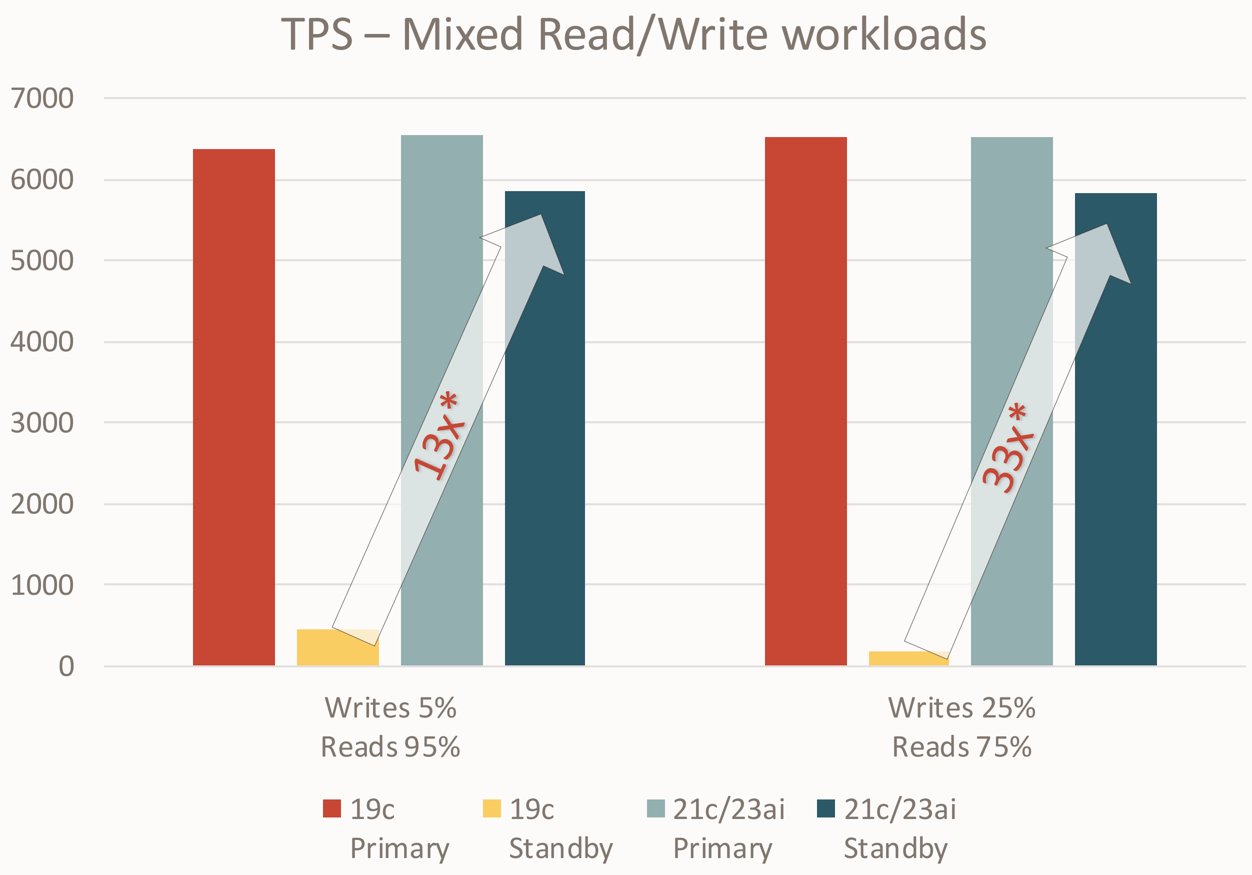
```
SQL> alter session enable ADG_REDIRECT_DML;
```

DMLs work seamlessly

```
SQL> update hr.employee set salary=salary+100 where employee_id=1;
1 row updated.
SQL> commit;
Commit complete.
```

New In 23ai

Improved Performance of Redirected Transactions



- 19c redirected statements wait for the DML to be applied on the standby before returning to the application.
  - Wait event: `"standby query scn advance"`
- From **21c** onwards, the statement returns as soon as it's executed on the primary.
  - The session waits only at commits or when the modified data is needed for consistent reads.
  - The non-documented parameter: `"_alter_adg_redirect_behavior"` can be set to `"sync_each_dml"` to restore the previous behavior.

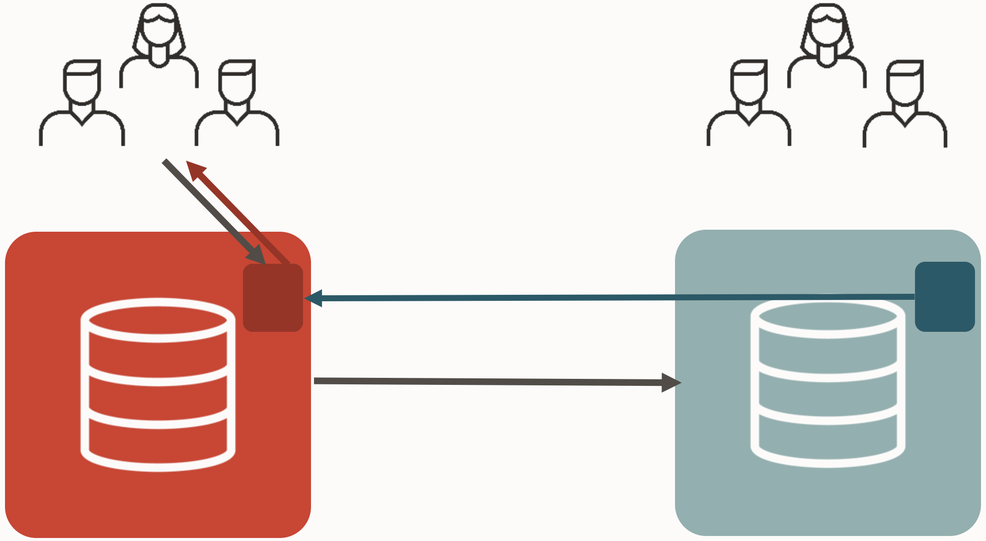
* 16 concurrent Order Entry sessions simulated with Swingbench with mixed 'NewCustomerProcess' and 'BrowseProducts' transactions.

Oracle Active Data Guard Automatic Block Repair

Oracle Active Data Guard Automatic Block Repair

Transparently repairs corrupted blocks

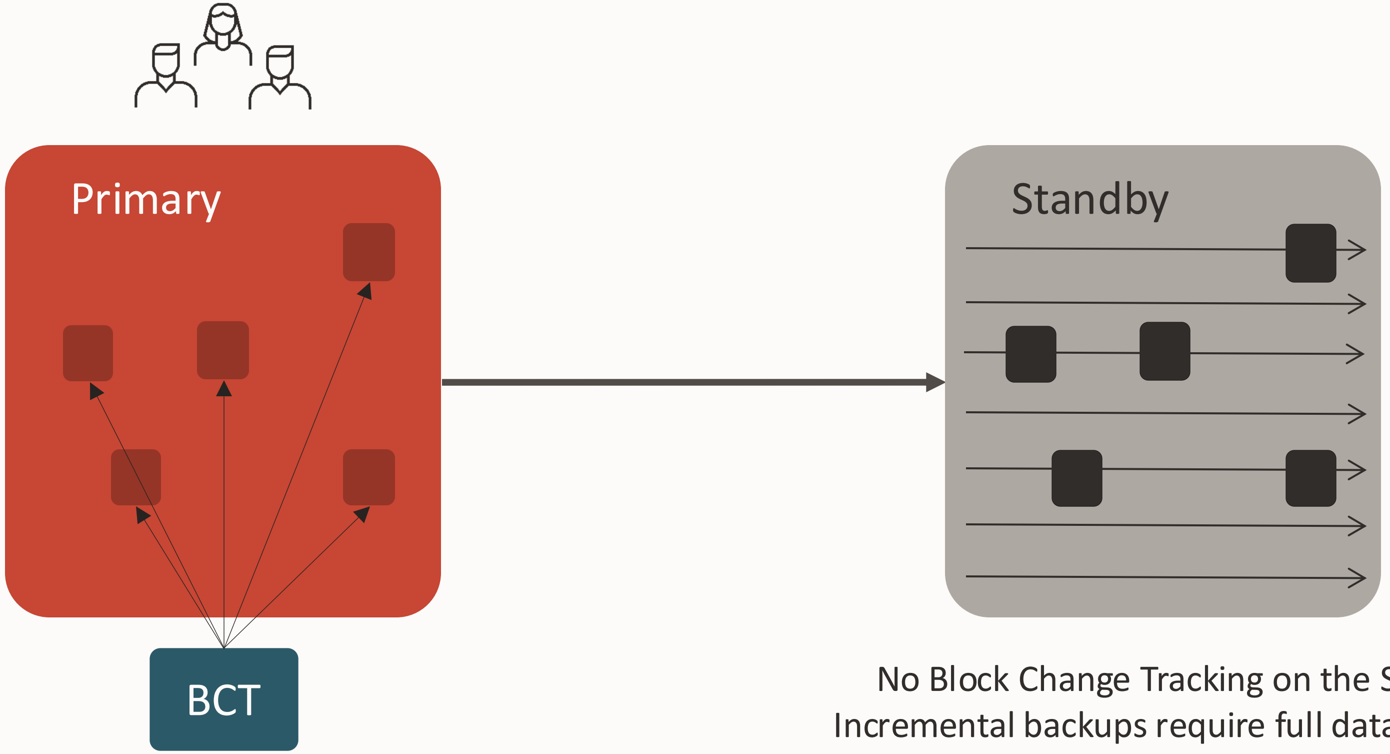
- Oracle detects if a block is corrupted when reading it
- The corruption is automatically repaired using a good copy
  - From the standby when the corruption is on the primary
  - From the primary when the corruption is on the standby



Oracle Active Data Guard
Fast Incremental Backup on Physical Standby

Fast Incremental Backup on Physical Standby

Enable the Block Change Tracking to speed up backups and avoid unnecessary I/O

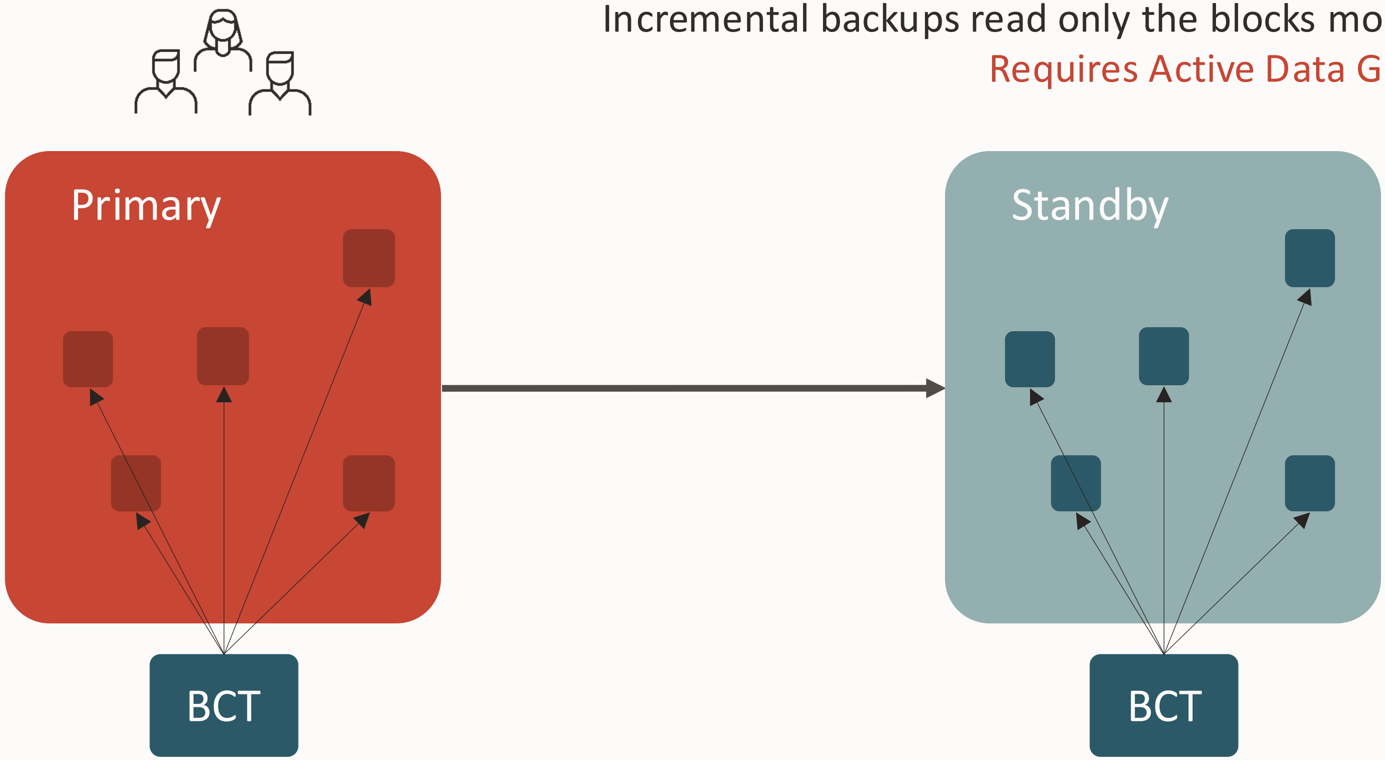


No Block Change Tracking on the Standby
Incremental backups require full data file reads

Fast Incremental Backup on Physical Standby

Enable the Block Change Tracking to speed up backups and avoid unnecessary I/O

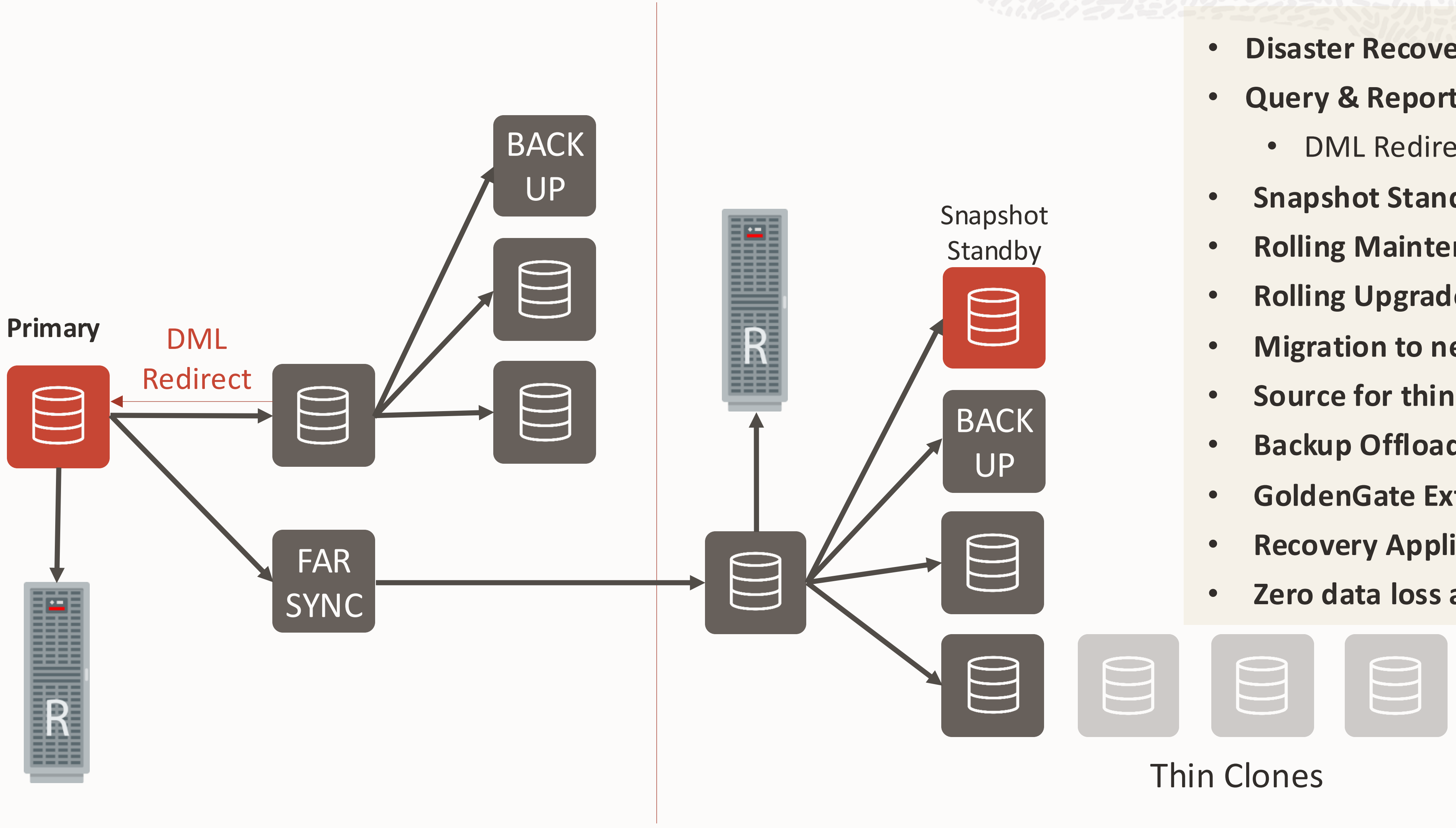
Block Change Tracking on the Standby:
Incremental backups read only the blocks modified since the last Level 0
Requires Active Data Guard



Oracle Active Data Guard Real-Time Cascade Standbys

Active Data Guard: up to 30 direct standbys and 253 total members

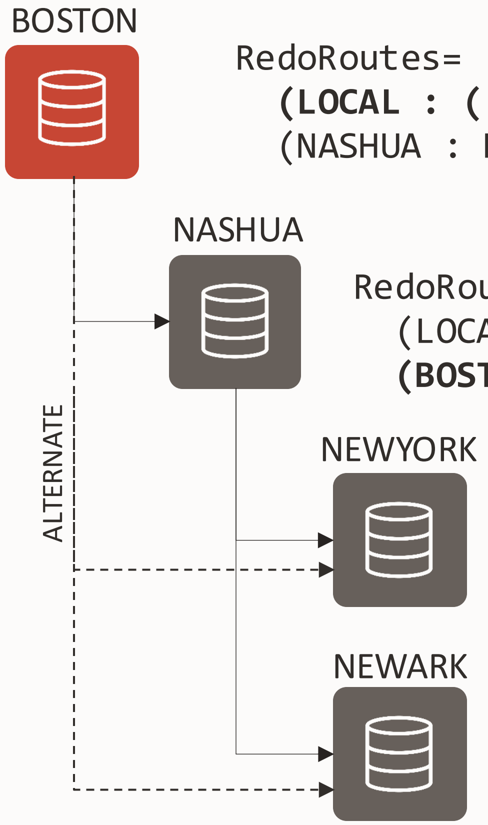
Far Sync and Cascading Standby open endless possibilities



- Disaster Recovery
- Query & Reporting Offload
  - DML Redirection
- Snapshot Standby for tests
- Rolling Maintenance
- Rolling Upgrade
- Migration to new Hardware
- Source for thin clones
- Backup Offload
- GoldenGate Extract Offload
- Recovery Appliance
- Zero data loss at any distance

Active Data Guard Real-Time Cascade Standby

Offload multiple redo transports to a first-level standby



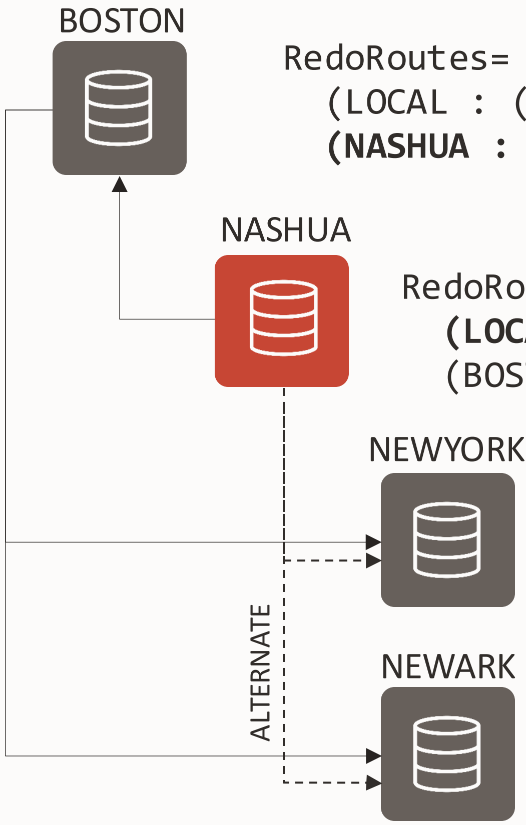
```
RedoRoutes=
  (LOCAL : ( NASHUA SYNC PRIORITY=1, NEWYORK ASYNC PRIORITY=8, NEWARK ASYNC PRIORITY=8 ))
  (NASHUA : NEWYORK ASYNC, NEWARK ASYNC ))
```

```
RedoRoutes=
  (LOCAL : ( BOSTON SYNC PRIORITY=1, NEWYORK ASYNC PRIORITY=8, NEWARK ASYNC PRIORITY=8 ))
  (BOSTON : NEWYORK ASYNC, NEWARK ASYNC ))
```

- Explicit “ASYNC” in the cascading member means “Real-Time Cascade”. Such configuration requires Active Data Guard.
- If not specified, the redo is shipped at log switch.

Active Data Guard Real-Time Cascade Standby

Offload multiple redo transports to a first-level standby



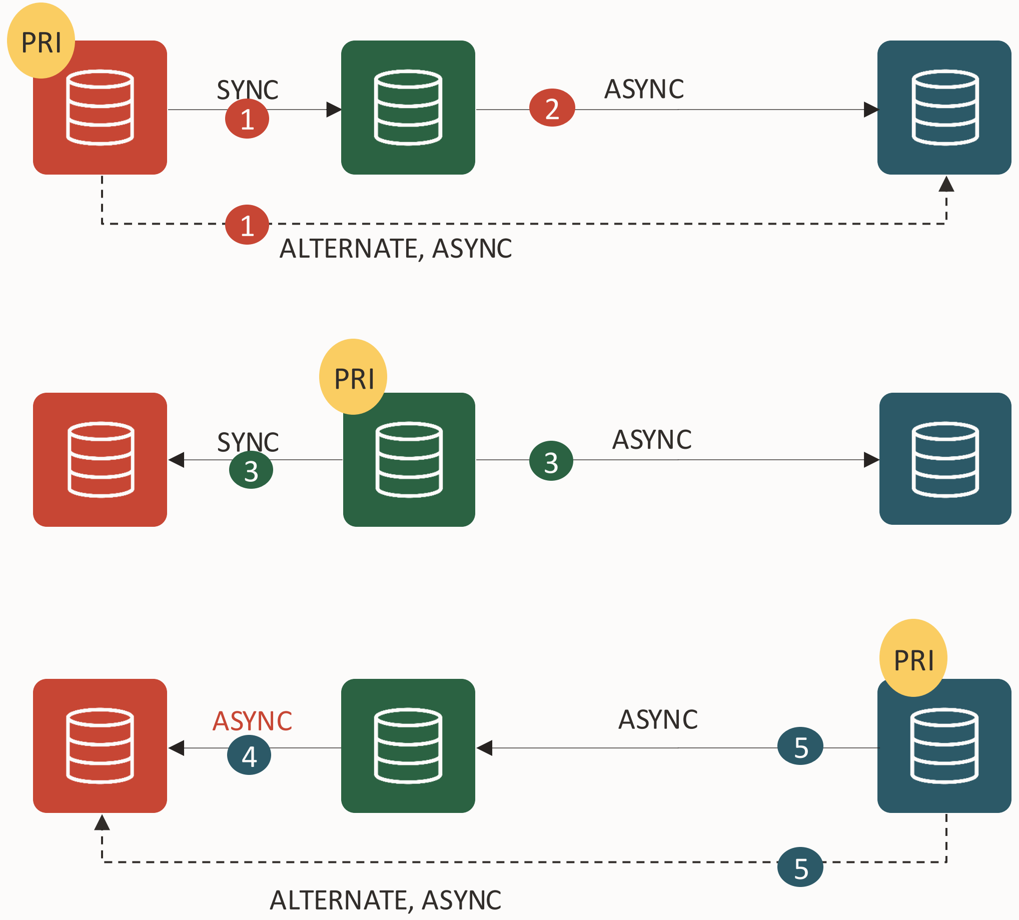
```
RedoRoutes=
  (LOCAL : ( NASHUA SYNC PRIORITY=1, NEWYORK ASYNC PRIORITY=8, NEWARK ASYNC PRIORITY=8 ))
  (NASHUA : NEWYORK ASYNC, NEWARK ASYNC ))
```

```
RedoRoutes=
  (LOCAL : ( BOSTON SYNC PRIORITY=1, NEWYORK ASYNC PRIORITY=8, NEWARK ASYNC PRIORITY=8 ))
  (BOSTON : NEWYORK ASYNC, NEWARK ASYNC ))
```

- **RedoRoutes** is an efficient way to route the redo properly in any situation.
- The Broker takes care of all the complex LOG_ARCHIVE_DEST_n modifications.

Understanding RedoRoutes

Start by drawing all the permutations and describe what you want



Where does RED send the redo?

1 When RED is primary:
- to GREEN (SYNC)
  or BLUE (ASYNC) if GREEN is not available

Where does GREEN send the redo?

2 When RED is primary:
- to BLUE (ASYNC) (real-time cascade)

3 When GREEN is primary:
- to RED (SYNC)
  and to BLUE (ASYNC)

4 When BLUE is primary:
- to RED (ASYNC) (real-time cascade)

Where does BLUE send the redo?

5 When BLUE is primary:
- to GREEN (ASYNC)
  or RED (ASYNC) if GREEN is not available

RedoRoutes

Understanding RedoRoutes

RedoRoutes tells where a DB (or Far Sync) should send the redo, depending on the primary

```
EDIT DATABASE RED SET PROPERTY RedoRoutes =
1 (RED: ( GREEN SYNC PRIORITY=1, BLUE ASYNC PRIORITY=2 ))
```

Where does RED send the redo?

1 When RED is primary:

- to GREEN (SYNC)
  or BLUE (ASYNC) if GREEN is not available

```
EDIT DATABASE GREEN SET PROPERTY RedoRoutes =
2 (RED: BLUE ASYNC)
3 (GREEN: RED SYNC, BLUE ASYNC)
4 (BLUE: RED ASYNC)
```

Where does GREEN send the redo?

2 When RED is primary:

- to BLUE (ASYNC) (real-time cascade)

3 When GREEN is primary:

- to RED (SYNC)
  and to BLUE (ASYNC)

4 When BLUE is primary:

- to RED (ASYNC) (real-time cascade)

```
EDIT DATABASE BLUE SET PROPERTY RedoRoutes =
5 (BLUE: ( GREEN ASYNC PRIORITY=1, RED ASYNC PRIORITY=2 ))
```

Where does BLUE send the redo?

5 When BLUE is primary:

- to GREEN (ASYNC)
  or RED (ASYNC) if GREEN is not available

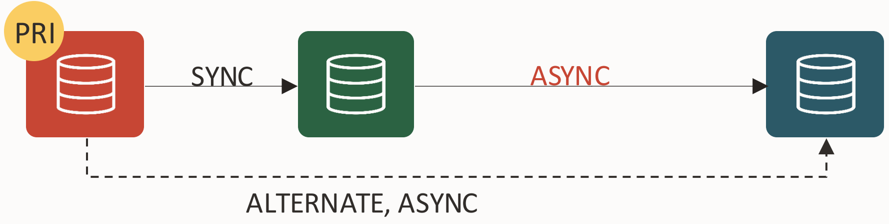
Verifying the RedoRoutes configuration

```
EDIT DATABASE RED   SET PROPERTY RedoRoutes ='(RED: ( GREEN SYNC PRIORITY=1, BLUE ASYNC PRIORITY=2 ))';
EDIT DATABASE GREEN SET PROPERTY RedoRoutes ='(RED:BLUE ASYNC)(GREEN:RED SYNC,BLUE ASYNC)(BLUE:RED ASYNC)';
EDIT DATABASE BLUE  SET PROPERTY RedoRoutes ='(BLUE: ( GREEN ASYNC PRIORITY=1, RED ASYNC PRIORITY=2 ))';
```

```
DGMGRL> show configuration when primary is red ;

Configuration when red is primary - redoroutes_demo

  Members:
  red    - Primary database
    green - Physical standby database
      blue   - Physical standby database (receiving current redo)
    blue   - Physical standby database (alternate of green)
```



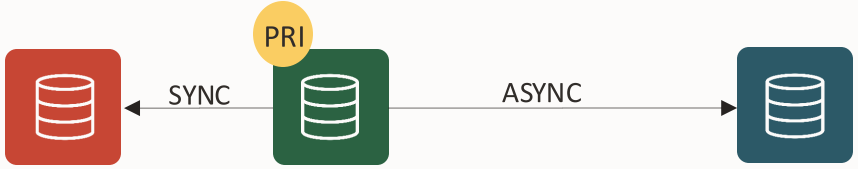
Verifying the RedoRoutes configuration

```
EDIT DATABASE RED   SET PROPERTY RedoRoutes ='(RED: ( GREEN SYNC PRIORITY=1, BLUE ASYNC PRIORITY=2 ))';
EDIT DATABASE GREEN SET PROPERTY RedoRoutes ='(RED:BLUE ASYNC)(GREEN:RED SYNC,BLUE ASYNC)(BLUE:RED ASYNC)';
EDIT DATABASE BLUE  SET PROPERTY RedoRoutes ='(BLUE: ( GREEN ASYNC PRIORITY=1, RED ASYNC PRIORITY=2 ))';
```

```
DGMGRL> show configuration when primary is green ;

Configuration when green is primary - redoroutes_demo

  Members:
  green - Primary database
    red   - Physical standby database
    blue  - Physical standby database
```



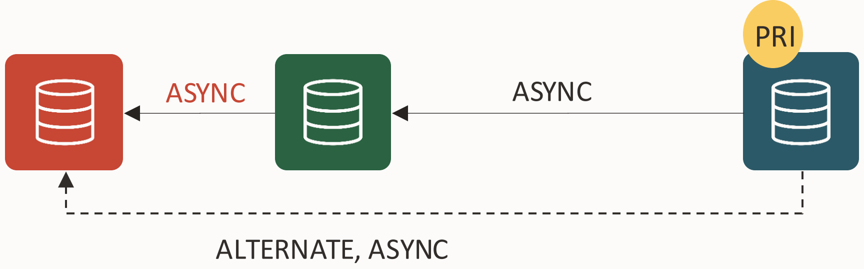
Verifying the RedoRoutes configuration

```
EDIT DATABASE RED   SET PROPERTY RedoRoutes ='(RED: ( GREEN SYNC PRIORITY=1, BLUE ASYNC PRIORITY=2 ))';
EDIT DATABASE GREEN SET PROPERTY RedoRoutes ='(RED:BLUE ASYNC)(GREEN:RED SYNC,BLUE ASYNC)(BLUE:RED ASYNC)';
EDIT DATABASE BLUE  SET PROPERTY RedoRoutes ='(BLUE: ( GREEN ASYNC PRIORITY=1, RED ASYNC PRIORITY=2 ))';
```

```
DGMGRL> show configuration when primary is blue ;

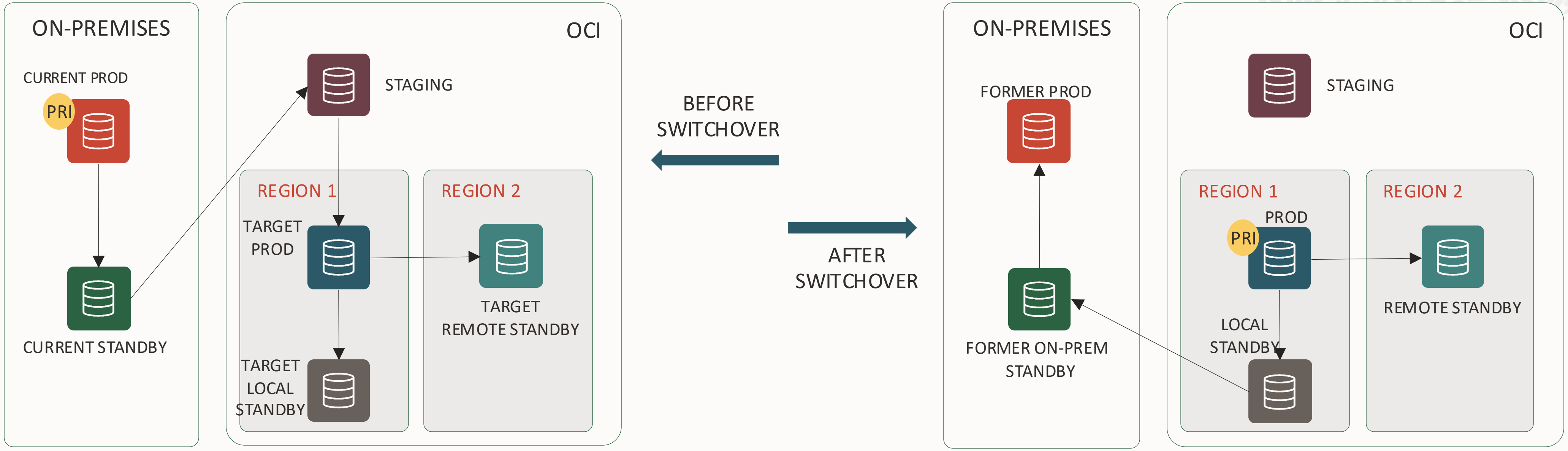
Configuration when blue is primary - redoroutes_demo

  Members:
  blue  - Primary database
    green - Physical standby database
      red   - Physical standby database (receiving current redo)
    red   - Physical standby database (alternate of green)
```



Real Life Use Case #1

Highly available migration to the Oracle Cloud Infrastructure



```
DGMGRL> show configuration when primary is red;

Configuration when blue is primary - redoroutes_demo

  Members:
  red       - Primary database
    green     - Physical standby database
      purple    - Physical standby database (receiving current redo)
        blue      - Physical standby database (receiving current redo)
          gray      - Physical standby database (receiving current redo)
          turquoise - Physical standby database (receiving current redo)
```

```
DGMGRL> show configuration when primary is blue ;

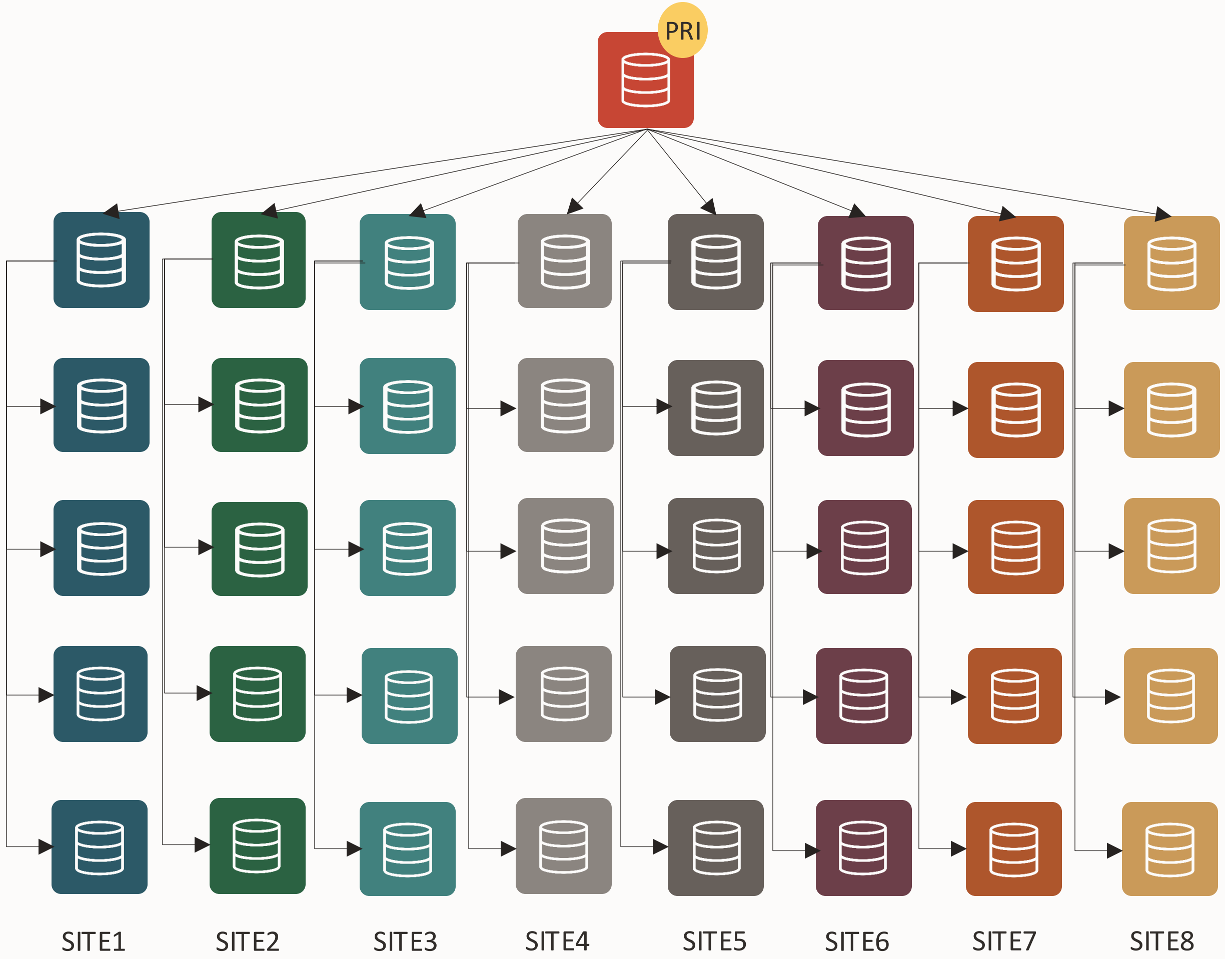
Configuration when blue is primary - redoroutes_demo

  Members:
  blue      - Primary database
    turquoise - Physical standby database
    gray      - Physical standby database
      green     - Physical standby database  (receiving current redo)
        red       - Physical standby database (receiving current redo)

  Members Not Receiving Redo:
  purple  - Physical standby database
```

Real Life Use Case #2

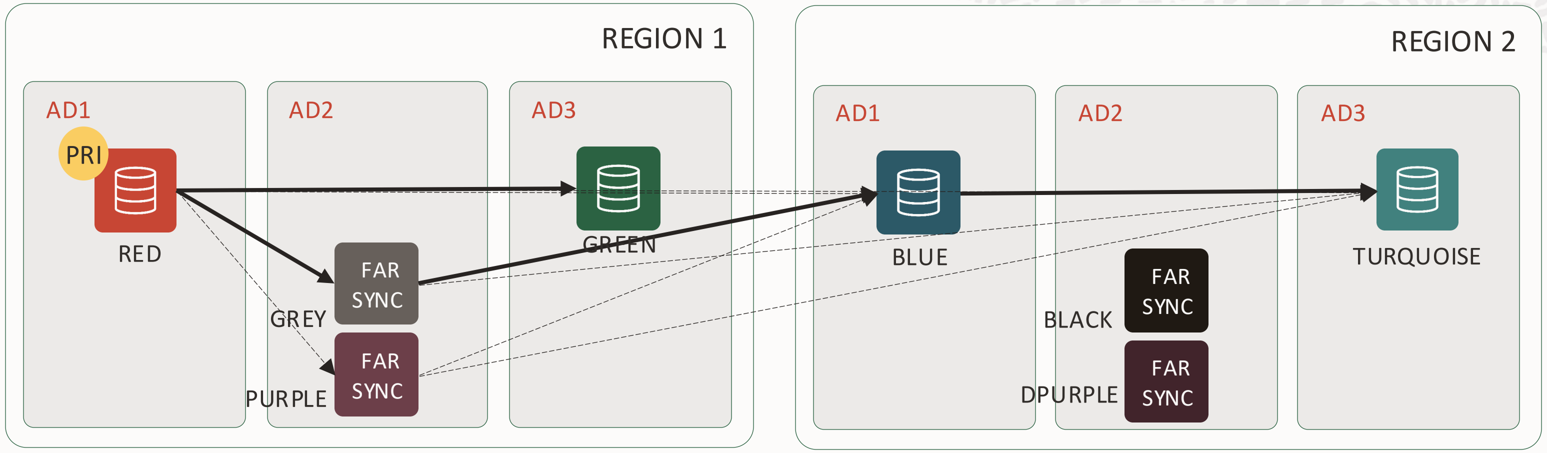
Read-only farm for intensive, latency-sensitive workloads



```
Members:
prod - Primary database
  site1 - Physical standby database
    site101 - Physical standby database (receiving current redo)
    site102 - Physical standby database (receiving current redo)
    site103 - Physical standby database (receiving current redo)
    site104 - Physical standby database (receiving current redo)
  site2 - Physical standby database
    site201 - Physical standby database (receiving current redo)
    site202 - Physical standby database (receiving current redo)
    site203 - Physical standby database (receiving current redo)
    site204 - Physical standby database (receiving current redo)
  site3 - Physical standby database
    site301 - Physical standby database (receiving current redo)
    site302 - Physical standby database (receiving current redo)
    site303 - Physical standby database (receiving current redo)
    site304 - Physical standby database (receiving current redo)
  site4 - Physical standby database
    site401 - Physical standby database (receiving current redo)
    site402 - Physical standby database (receiving current redo)
    site403 - Physical standby database (receiving current redo)
    site404 - Physical standby database (receiving current redo)
  site5 - Physical standby database
    site501 - Physical standby database (receiving current redo)
    site502 - Physical standby database (receiving current redo)
    site503 - Physical standby database (receiving current redo)
    site504 - Physical standby database (receiving current redo)
  site6 - Physical standby database
    site601 - Physical standby database (receiving current redo)
    site602 - Physical standby database (receiving current redo)
    site603 - Physical standby database (receiving current redo)
    site604 - Physical standby database (receiving current redo)
  site7 - Physical standby database
    site701 - Physical standby database (receiving current redo)
    site702 - Physical standby database (receiving current redo)
    site703 - Physical standby database (receiving current redo)
    site704 - Physical standby database (receiving current redo)
  site8 - Physical standby database
    site801 - Physical standby database (receiving current redo)
    site802 - Physical standby database (receiving current redo)
    site803 - Physical standby database (receiving current redo)
    site804 - Physical standby database (receiving current redo)
```

Real Life Use Case #3

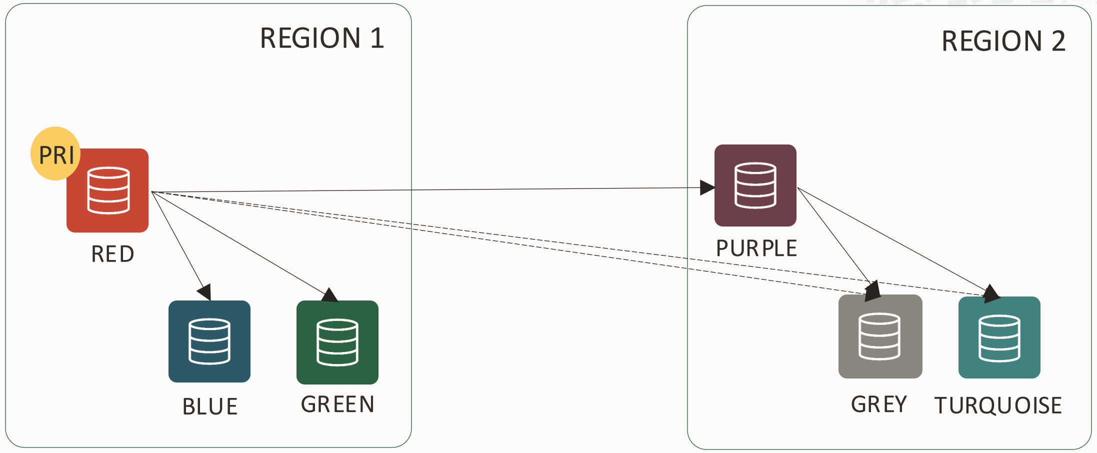
Highly available cloud blueprint for multi-AD regions



```
DGMGRL> show configuration when primary is RED;
Configuration - HADB
  Protection Mode: MaxAvailability
  Members:
  RED     - Primary database
    GREEN - Physical standby database
    GREY - Far sync instance
      BLUE - Physical standby database
        TURQUOISE - Physical standby database (receiving current redo)
      TURQUOISE - Physical standby database (alternate of BLUE)
    PURPLE - Far sync instance (alternate of GREY)
      BLUE - Physical standby database
        TURQUOISE - Physical standby database (receiving current redo)
      TURQUOISE - Physical standby database (alternate of BLUE)
    BLUE - Physical standby database (alternate of GREY)
      TURQUOISE - Physical standby database (receiving current redo)
    TURQUOISE - Physical standby database (alternate of BLUE)
  Members Not Receiving Redo:
  BLACK - Far sync instance
  DPURPLE - Far sync instance
```

Real Life Use Case #4

Two local Active Data Guard standbys and a symmetric region for DR



```
DGMGRL> show configuration

Configuration - HADB

 Protection Mode: MaxPerformance
 Members:
 RED  - Primary database
   GREEN  - (*) Physical standby database
   BLUE  - Physical standby database
   PURPLE - Physical standby database
     TURQUOISE - Physical standby database (receiving current redo)
     GREY - Physical standby database (receiving current redo)

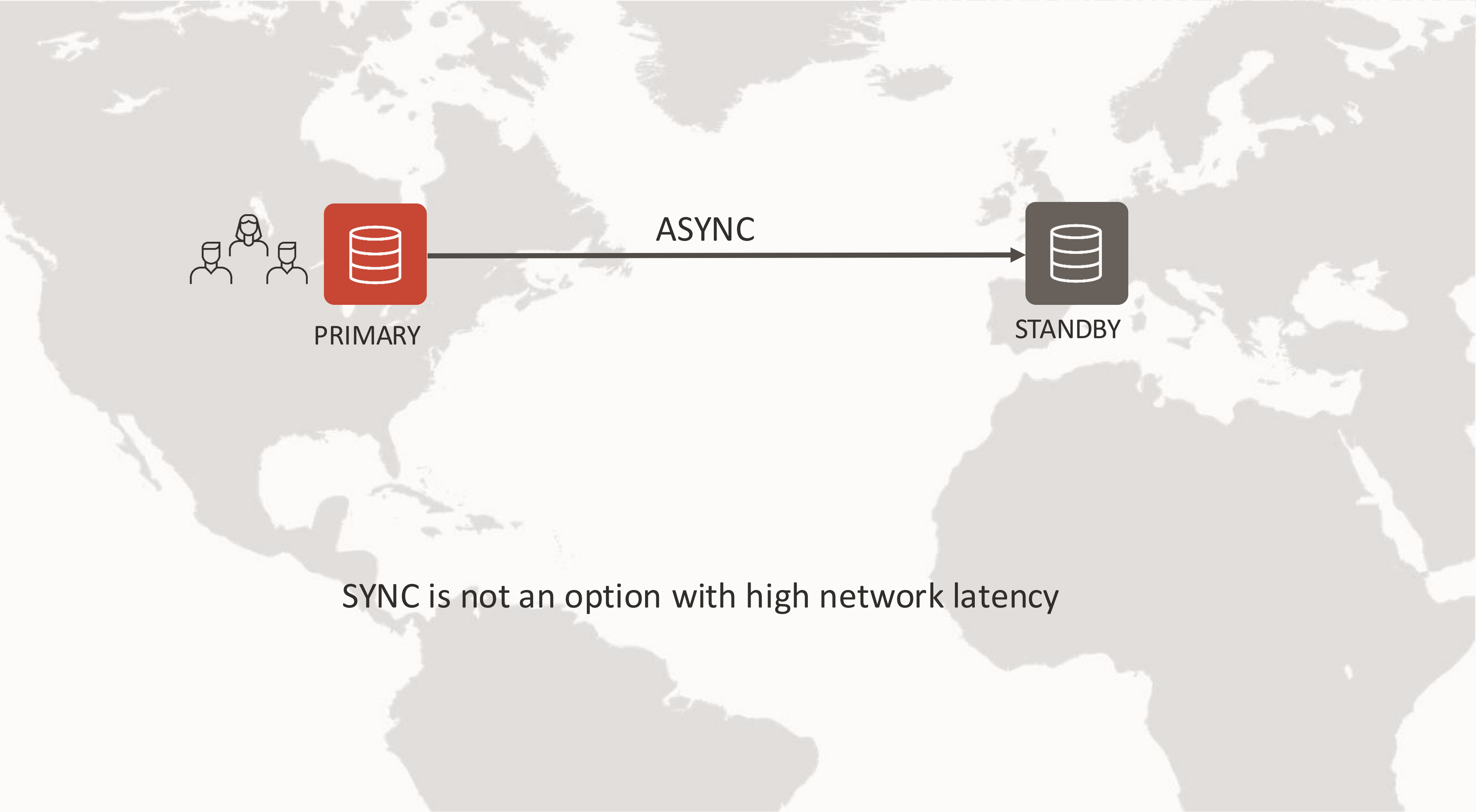
Fast-Start Failover: Enabled in Potential Data Loss Mode

Configuration Status:
SUCCESS (status updated 29 seconds ago)
```

Oracle Active Data Guard Far Sync

The Zero Data Loss Challenge

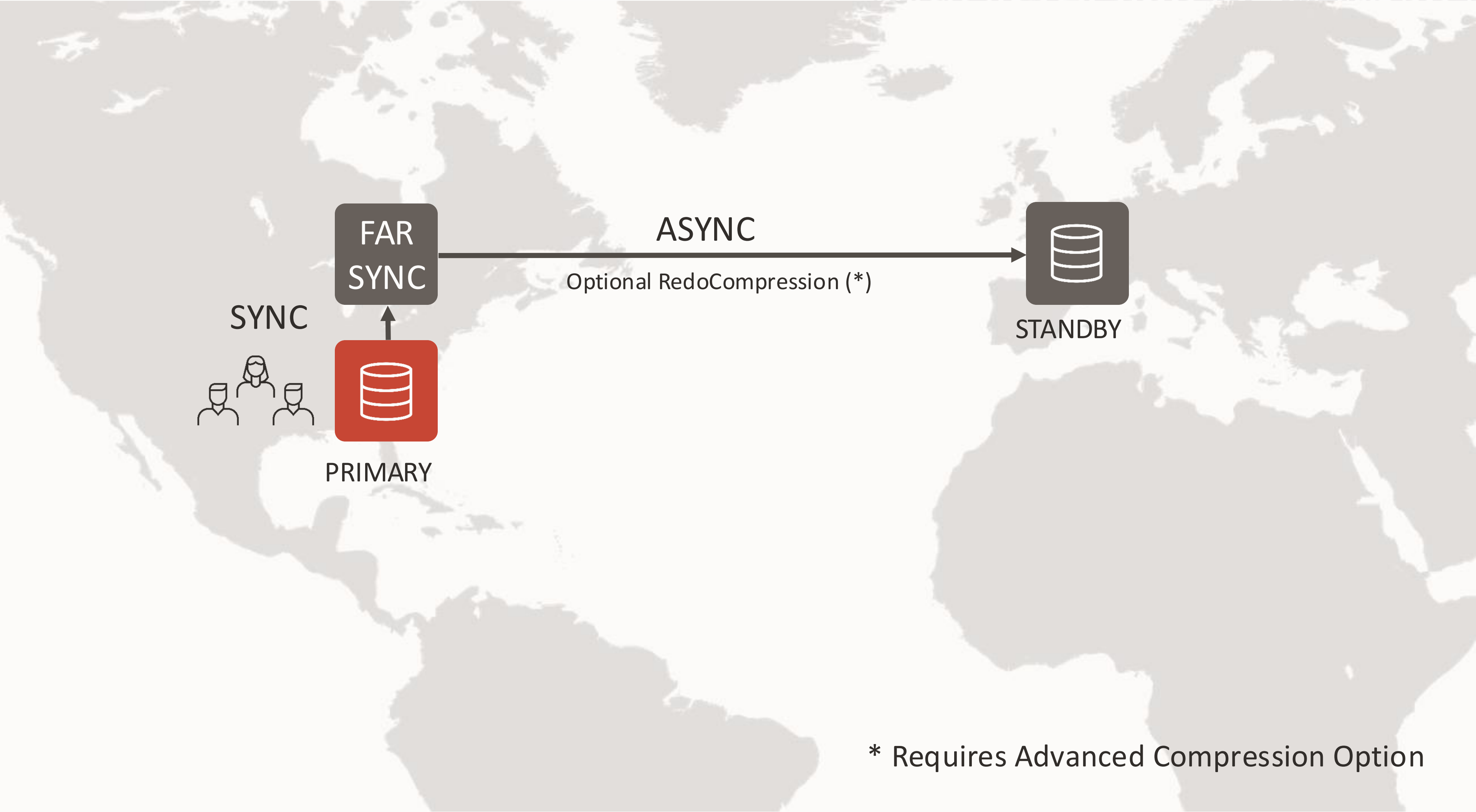
Trade-off Performance for Protection



SYNC is not an option with high network latency

Active Data Guard Far Sync

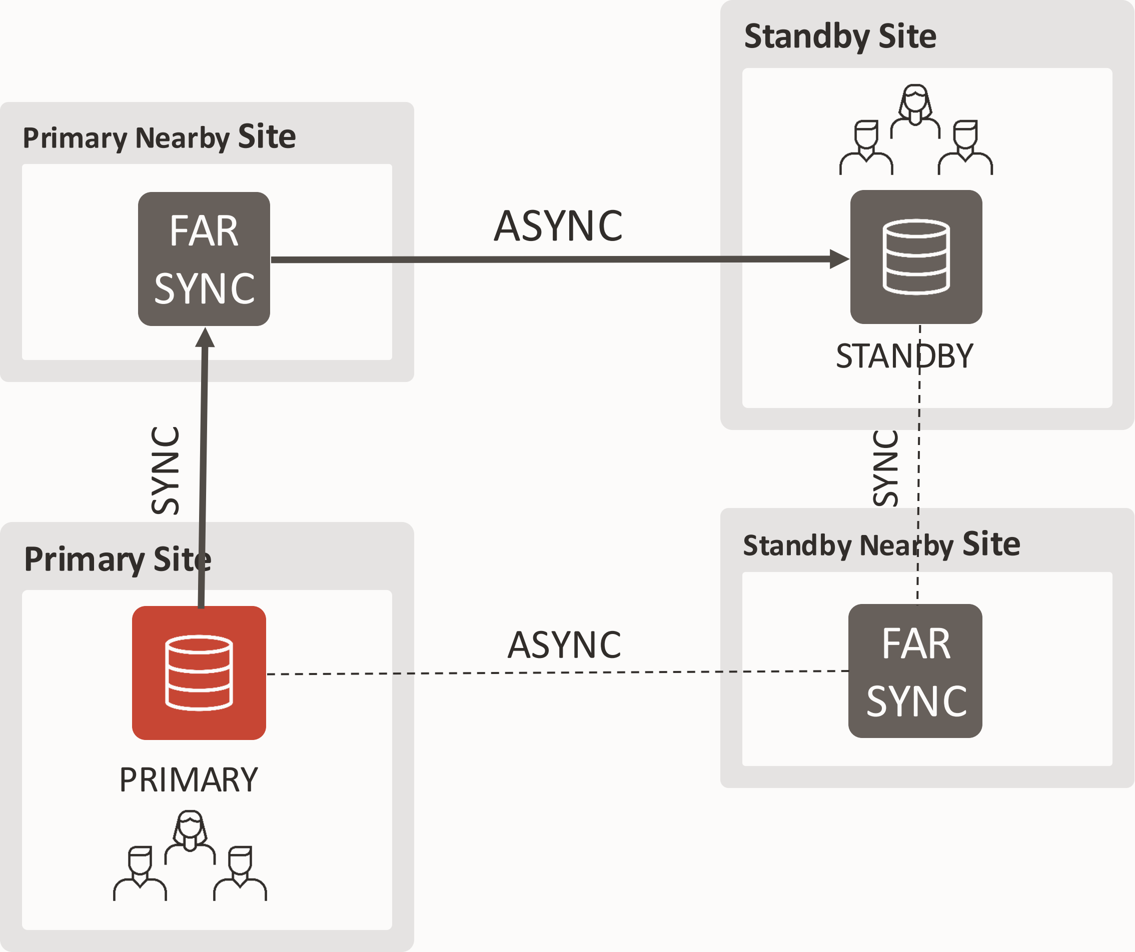
Zero Data Loss Protection at Any Distance



* Requires Advanced Compression Option

Active Data Guard Far Sync

Do not Trade-off Protection for Performance



Far Sync

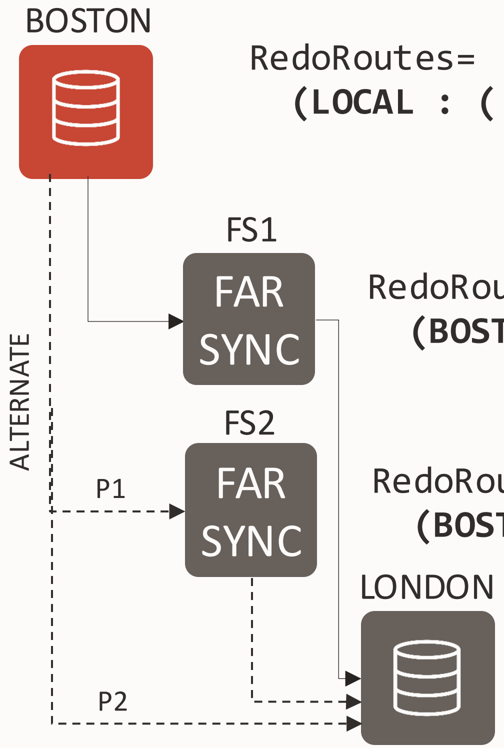
- Special instance:
  - No datafiles
  - No Media Recovery
  - Only control files, archives and standby logs
- Up to 30 direct destinations
- Offload transport compression (Advanced Compression)
- Supports FSFO in MaxAvailavility
- Supports FSFO in MaxPerformance (**new in *21c***)

Use different Datacenters or Availability Domains!

- Upon failover, the standby will fetch the very last redo from the Far Sync

Active Data Guard Far Sync

Use RedoRoutes for Far Sync High Availability



```
RedoRoutes=
  (LOCAL : ( FS1 SYNC PRIORITY=1, FS2 SYNC PRIORITY=1, LONDON ASYNC PRIORITY=2 ))
```

```
RedoRoutes=
  (BOSTON : LONDON ASYNC))
```

```
RedoRoutes=
  (BOSTON : LONDON ASYNC))
```

In the example: Prepare two additional Far Sync instances for LONDON!
The Data Guard broker supports Far Sync instance creation starting with 21c.

Benefits and Downsides of Far Sync

When to consider Far Sync?

Benefits

- Increased performance for existing Sync configurations
- Increased protection for existing Async configurations
- Zero Data Loss (Max Availability) across distant regions
- Fully integrated with the broker
- Automatic gap resolution through the Far Sync

Downsides

- Additional server(s) or VM(s) and components
- A Far Sync co-located with the primary might not prevent data loss in case of full site failure

Far Sync and Fast Start Failover

Which Fast Start Failover protection modes are compatible with Far Sync?

FSFO *and* FAR SYNC	Maximum Performance	Maximum Availability	Maximum Protection
ASYNC	✓ (21c+)	✗	✗
FAST SYNC	✗	✓	✗
SYNC	✗	✓	✗

FSFO without FAR SYNC	Maximum Performance	Maximum Availability	Maximum Protection
ASYNC	✓	✗	✗
FAST SYNC	✗	✓	✗
SYNC	✗	✓	✓

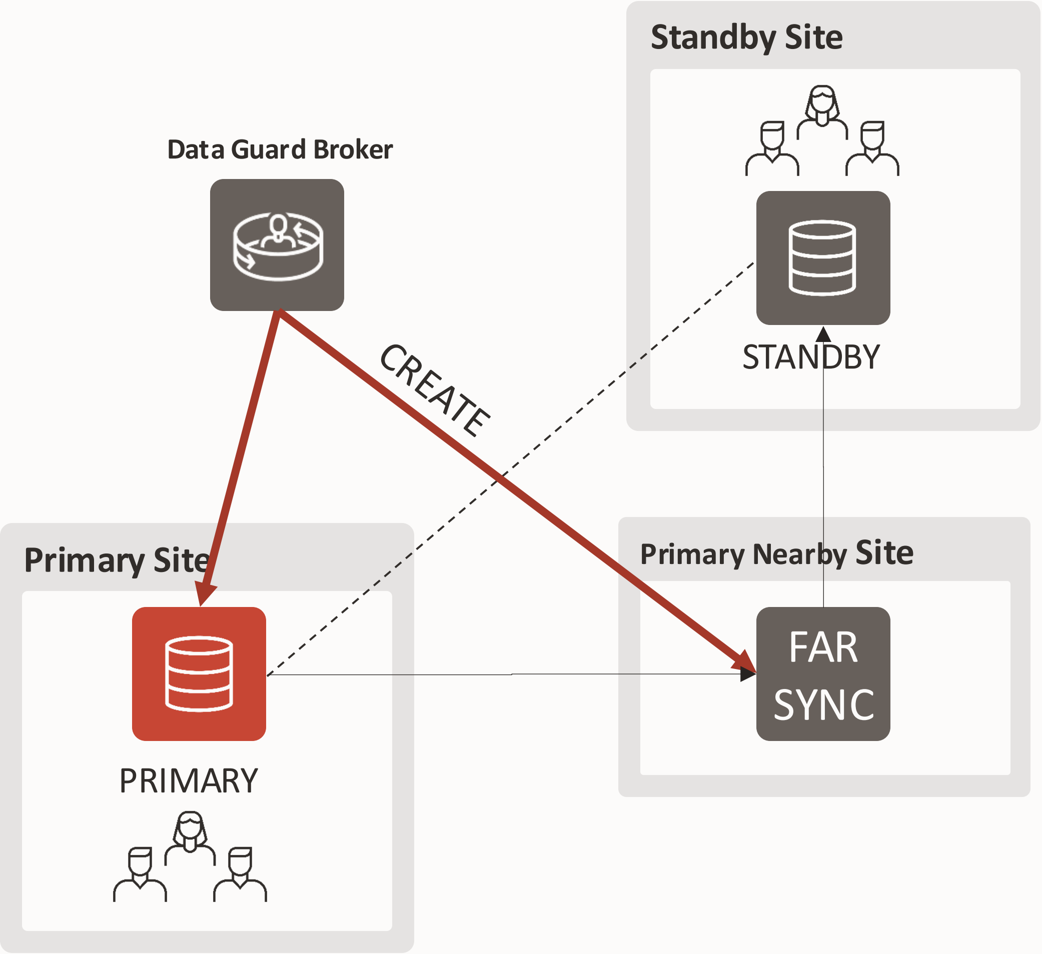
FAR SYNC without FSFO	Maximum Performance	Maximum Availability	Maximum Protection
ASYNC	✓	✗	✗
FAST SYNC	✗	✓	✗
SYNC	✗	✓	✗

https://docs.oracle.com/en/database/oracle/oracle-database/21/dgbkr/using-data-guard-broker-to-manage-switchovers-failovers.html#GUID-7423C774-27DF-49F9-BB43-7D547BCE7762

NEW IN 21c

Data Guard Broker Far Sync Instance Creation

One step further automated by the broker



```
DGMGRL> CREATE FAR_SYNC bostonfs
  AS CONNECT IDENTIFIER IS "bostonfs_conn_str"
  PARAMETER_VALUE_CONVERT "boston","bostonfs"
  SET LOG_FILE_NAME_CONVERT "boston","bostonfs"
  SET DB_RECOVERY_FILE_DEST "$ORACLE_HOME/dbs/"
  SET DB_RECOVERY_FILE_DEST_SIZE "100G"
  RESET UNDO_TABLESPACE;
```

- Automated SPFILE and controlfile creation
- The Far Sync is created, started and added to the configuration

Oracle Active Data Guard
Rolling Maintenance and Upgrades

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 && <= 12.1.0.2	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

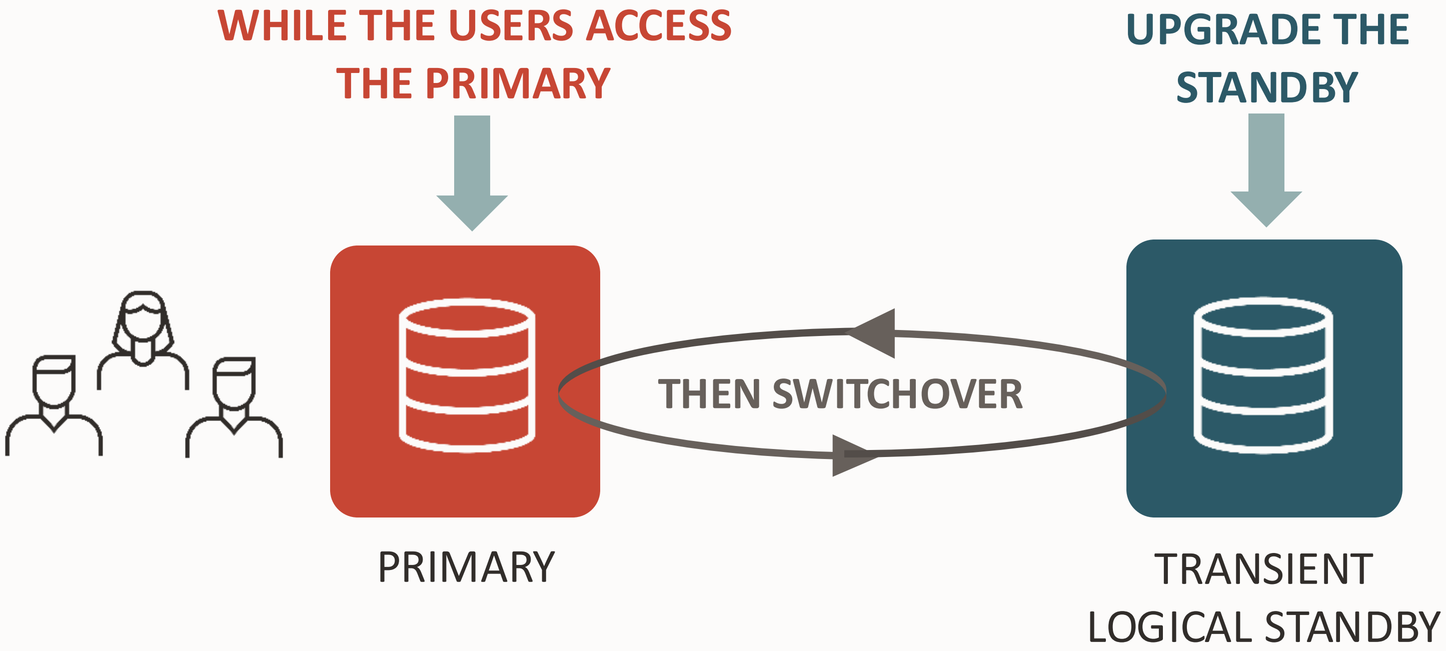
Using SQL Apply to Upgrade the Oracle Database
https://docs.oracle.com/en/database/oracle/oracle-database/19/sbydb/using-sql-apply-to-perform-rolling-upgrade.html

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

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.

User sessions

+1 Upgraded

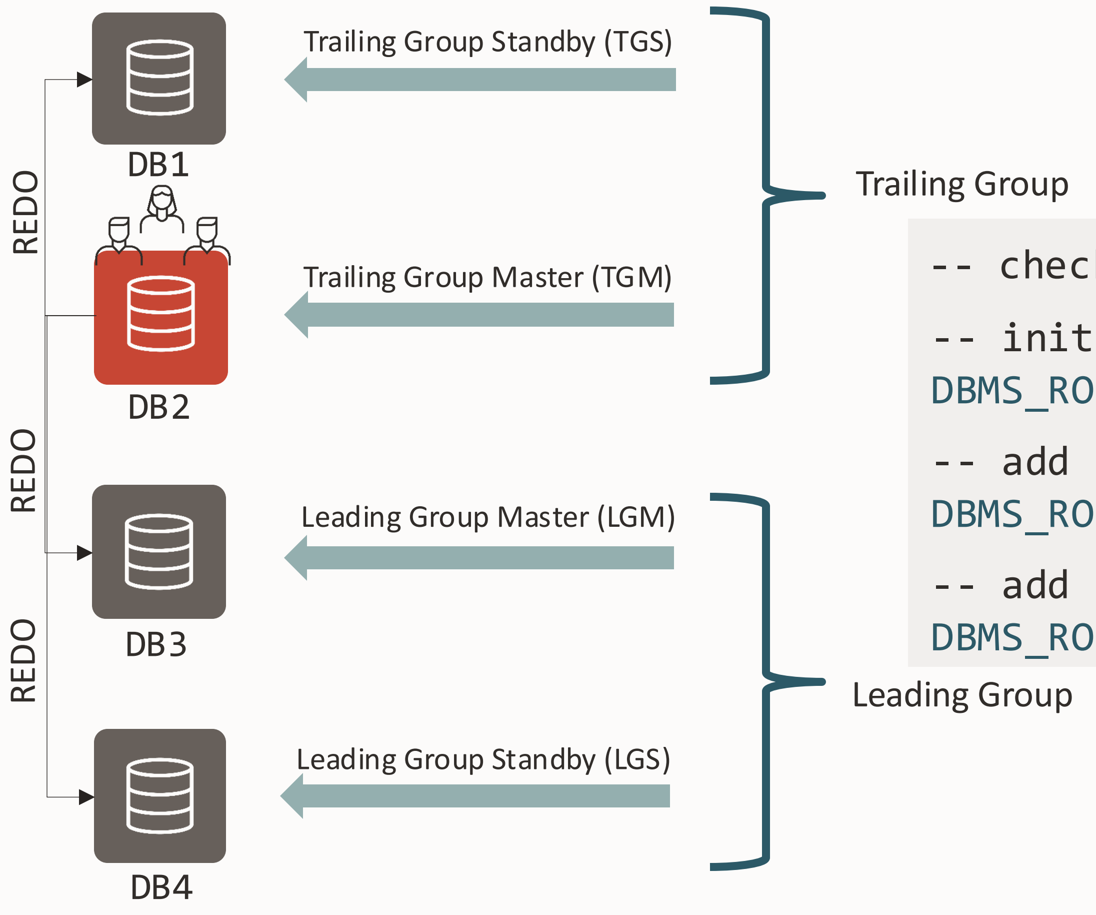
🟥 Primary

■ Physical Standby

■ Logical Standby

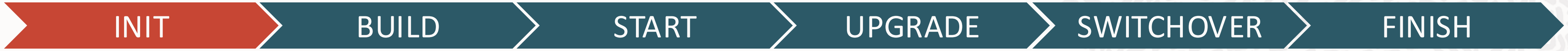
The DBMS_ROLLING.INIT_PLAN phase

INIT › BUILD › START › UPGRADE › SWITCHOVER › FINISH


Trailing Group Standby (TGS)
DB1
REDO
Trailing Group Master (TGM)
DB2
REDO
Trailing Group
Leading Group Master (LGM)
DB3
REDO
Leading Group Standby (LGS)
DB4
Leading Group

```
-- check DBA_ROLLING_UNSUPPORTED for incompatible data types
-- initialize the plan and set the future primary
DBMS_ROLLING.INIT_PLAN(future_primary=>'DB3');
-- add the required standbys to the TRAILING GROUP
DBMS_ROLLING.SET_PARAMETER('DB1','MEMBER','TRAILING');
-- add the required standbys to the LEADING GROUP
DBMS_ROLLING.SET_PARAMETER('DB4','MEMBER',LEADING');
```

The DBMS_ROLLING parameters

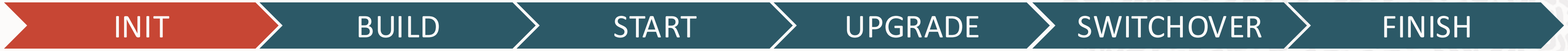


INIT → BUILD → START → UPGRADE → SWITCHOVER → FINISH

ACTIVE_SESSIONS_TIMEOUT
ACTIVE_SESSIONS_WAIT
BACKUP_CONTROLFILE
DGBROKER
DICTIONARY_LOAD_TIMEOUT
DICTIONARY_LOAD_WAIT
DICTIONARY_PLS_WAIT_INIT
DICTIONARY_PLS_WAIT_TIMEOUT
EVENT_RECORDS
FAILOVER
GRP_PREFIX
IGNORE_BUILD_WARNINGS
IGNORE_LAST_ERROR
LAD_ENABLED_TIMEOUT
LOG_LEVEL

MEMBER
READY_LGM_LAG_TIME
READY_LGM_LAG_TIMEOUT
READY_LGM_LAG_WAIT
SWITCH_LGM_LAG_TIME
SWITCH_LGM_LAG_TIMEOUT
SWITCH_LGM_LAG_WAIT
SWITCH_LGS_LAG_TIME
SWITCH_LGS_LAG_TIMEOUT
SWITCH_LGS_LAG_WAIT
UPDATED_LGS_TIMEOUT
UPDATED_LGS_WAIT
UPDATED_TGS_TIMEOUT
UPDATED_TGS_WAIT

The DBMS_ROLLING parameters



INIT BUILD START UPGRADE SWITCHOVER FINISH

Example:

```
-- Activate full logging
exec DBMS_ROLLING.SET_PARAMETER (scope=>null,  name=>'LOG_LEVEL', value=>'FULL');


-- Wait for the SQL Apply Lag to go below 1 minute before initiating the switchover
exec DBMS_ROLLING.SET_PARAMETER('SWITCH_LGM_LAG_WAIT', '1');
exec DBMS_ROLLING.SET_PARAMETER('SWITCH_LGM_LAG_TIME', '60');
```

Final touches before starting

```
$ # The standby must be mounted
$ srvctl stop database -d DB3
$ srvctl start database -d DB3 -o mount

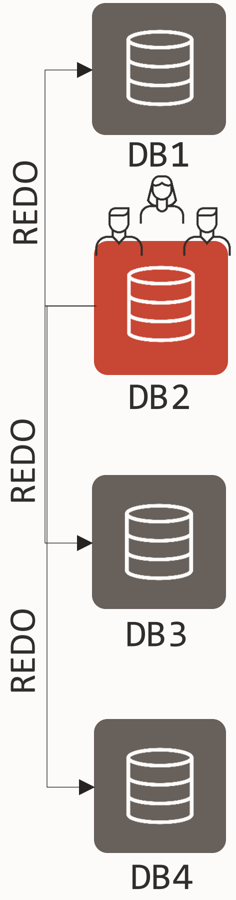
SQL> -- The PDBs must be open
SQL> alter pluggable database all open;

DGMGRL> # no FSFO or MaxProtection
DGMGRL> disable fast_start failover
DGMGRL> edit configuration set protection mode as MaxAvailability;
```

The DBMS_ROLLING.BUILD_PLAN phase

INIT › BUILD › START › UPGRADE › SWITCHOVER › FINISH

- User sessions
- +1 Upgraded
- 🟥 Primary
- ■ Physical Standby
- ■ Logical Standby



```
-- build the plan
DBMS_ROLLING.BUILD_PLAN();

-- check for any errors or warnings
SELECT * FROM DBA_ROLLING_EVENTS;

-- review the plan
SELECT * FROM DBA_ROLLING_PLAN ORDER BY INSTID;
```

The DBMS_ROLLING.BUILD_PLAN phase

```
 1 START     Notify Data Guard broker that DBMS_ROLLING has started
 2 START     Notify Data Guard broker that DBMS_ROLLING has started
 3 START     Verify database is a primary
 4 START     Verify MAXIMUM PROTECTION is disabled
 5 START     Verify database is a physical standby
 6 START     Verify physical standby is mounted
 7 START     Verify future primary is configured with standby redo logs
 8 START     Verify server parameter file exists and is modifiable
 9 START     Verify server parameter file exists and is modifiable
10 START     Verify Data Guard broker configuartion is enabled
11 START     Verify Data Guard broker configuartion is enabled
12 START     Verify Fast-Start Failover is disabled
13 START     Verify Fast-Start Failover is disabled
14 START     Verify fast recovery area is configured
15 START     Verify available flashback restore points
16 START     Verify fast recovery area is configured
17 START     Verify available flashback restore points
18 START     Stop media recovery
19 START     Drop guaranteed restore point DBMSRU_INITIAL
20 START     Create guaranteed restore point DBMSRU_INITIAL
21 START     Drop guaranteed restore point DBMSRU_INITIAL
22 START     Create guaranteed restore point DBMSRU_INITIAL
23 START     Start media recovery
24 START     Verify media recovery is running
25 START     Verify user_dump_dest has been specified
26 START     Backup control file to rolling_change_backup.f
27 START     Verify user_dump_dest has been specified
28 START     Backup control file to rolling_change_backup.f
29 START     Get current supplemental logging on the primary database
30 START     Get current redo branch of the primary database
31 START     Wait until recovery is active on the primary's redo branch
32 START     Reduce to a single instance if database is a RAC
33 START     Verify only a single instance is active if future primary is RAC
34 START     Stop media recovery
35 START     Execute dbms_logstdby.build
36 START     Convert into a transient logical standby
37 START     Open database including instance-peers if RAC
38 START     Verify logical standby is open read/write
39 START     Get redo branch of transient logical standby
40 START     Get reset scn of transient logical redo branch
41 START     Configure logical standby parameters
42 START     Start logical standby apply
43 START     Enable compatibility advance despite presence of GRPs
44 START     Log pre-switchover instructions to events table
45 START     Record start of user upgrade of DB3
46 SWITCH    Verify database is in OPENRW mode
47 SWITCH    Record completion of user upgrade of DB3
48 SWITCH    Scan LADs for presence of DB2 destination
49 SWITCH    Test if DB2 is reachable using configured TNS service
50 SWITCH    Call Data Guard broker to enable redo transport to DB3
51 SWITCH    Archive all current online redo logs
52 SWITCH    Archive all current online redo logs
53 SWITCH    Stop logical standby apply
54 SWITCH    Start logical standby apply
55 SWITCH    Wait until apply lag has fallen below 600 seconds
56 SWITCH    Notify Data Guard broker that switchover to logical standby database is starting
57 SWITCH    Log post-switchover instructions to events table
58 SWITCH    Switch database to a logical standby
59 SWITCH    Notify Data Guard broker that switchover to logical standby database has completed
60 SWITCH    Wait until end-of-redo has been applied
61 SWITCH    Archive all current online redo logs
62 SWITCH    Notify Data Guard broker that switchover to primary is starting
63 SWITCH    Switch database to a primary
64 SWITCH    Notify Data Guard broker that switchover to primary has completed
65 SWITCH    Enable compatibility advance despite presence of GRPs
66 SWITCH    Synchronize plan with new primary
67 FINISH    Reduce to a single instance for FINISH
68 FINISH    Verify only a single instance is active
69 FINISH    Verify database is mounted
70 FINISH    Flashback database
71 FINISH    Convert into a physical standby
72 FINISH    Verify database is open
73 FINISH    Save the DBID of the new primary
74 FINISH    Save the logminer session start scn
75 FINISH    Wait until transient logical redo branch has been registered
76 FINISH    Start media recovery
77 FINISH    Wait until apply/recovery has started on the transient branch
78 FINISH    Wait until upgrade redo has been fully recovered
79 FINISH    Prevent compatibility advance if GRPs are present
80 FINISH    Prevent compatibility advance if GRPs are present
81 FINISH    Drop guaranteed restore point DBMSRU_INITIAL
82 FINISH    Drop guaranteed restore point DBMSRU_INITIAL
83 FINISH    Purge logical standby metadata from database if necessary
84 FINISH    Notify Data Guard broker that DBMS_ROLLING has finished
85 FINISH    Notify Data Guard broker that DBMS_ROLLING has finished
86 FINISH    Restore Supplemental Logging
```

User sessions

+1 Upgraded

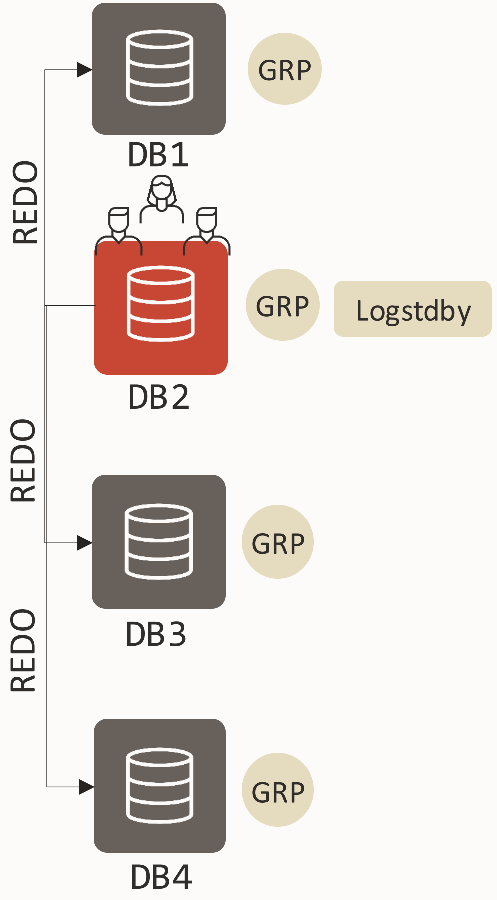
🟥 Primary

⬛ Physical Standby

🟦 Logical Standby

The DBMS_ROLLING.START phase

INIT → BUILD → **START** → UPGRADE → SWITCHOVER → FINISH



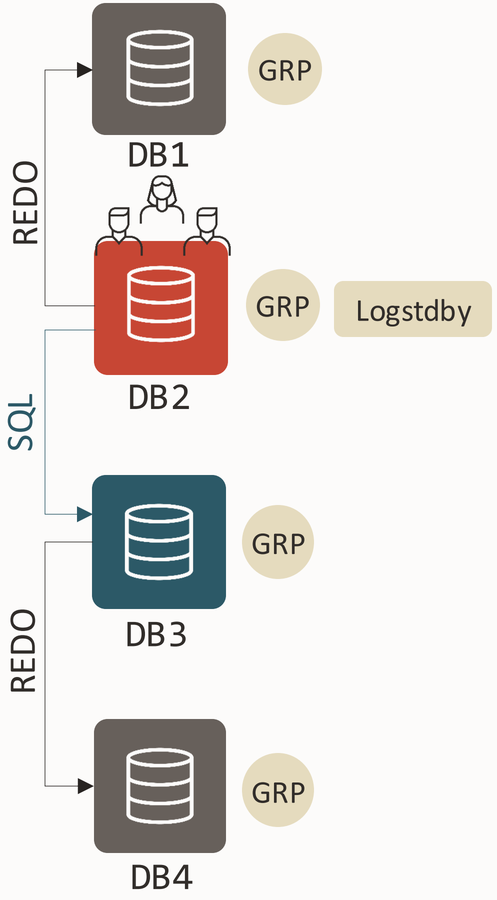
```
-- start the plan
DBMS_ROLLING.START_PLAN();
```

- Creates the Guaranteed Restore Point (GRP)
- Builds the logical standby metadata (`dbms_logstdby.build`)

- User sessions
- +1 Upgraded
- 🟥 Primary
- ⬛ Physical Standby
- 🟦 Logical Standby

The DBMS_ROLLING.START phase

INIT › BUILD › **START** › UPGRADE › SWITCHOVER › FINISH



```
-- start the plan
DBMS_ROLLING.START_PLAN();
```

- Creates the Guaranteed Restore Point (GRP)
- Builds the LogMiner directory (`dbms_logstdby.build`)
- Converts the LGM to Logical Standby
- Starts SQL Apply
- With a configuration composed of 4 databases,
  the LGM and TGM are still protected by a physical standby

The DBMS_ROLLING.START phase

INIT | BUILD | **START** | UPGRADE | SWITCHOVER | FINISH

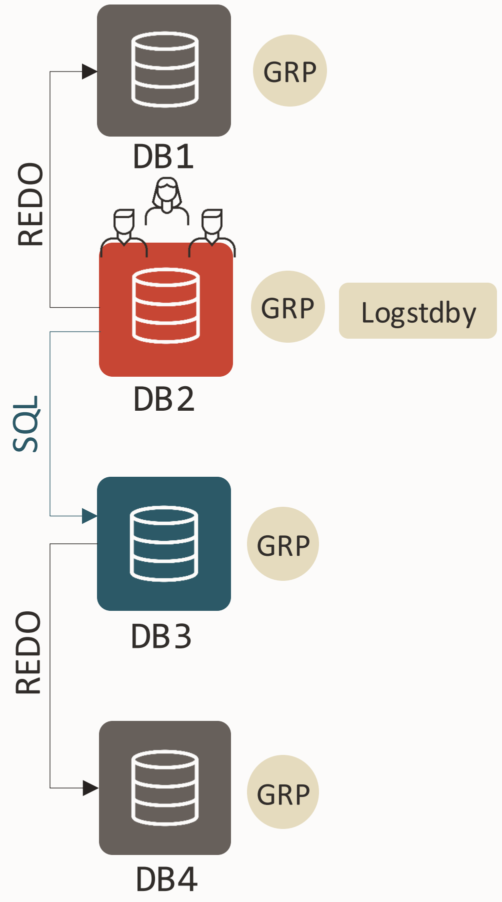
User sessions

+1 Upgraded

🟥 Primary

■ Physical Standby

■ Logical Standby



```
DGMGRL> show configuration;

Configuration - geneva

  Protection Mode: MaxAvailability
  Members:
  DB1   - Primary database
    DB3 - Physical standby database
      Warning: ORA-16854: apply lag could not be
determined

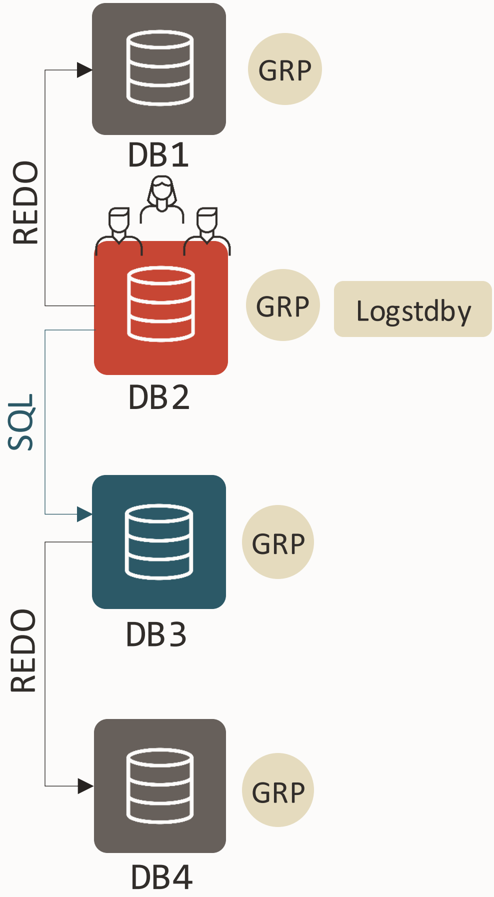
Fast-Start Failover: DISABLED

Configuration Status:
    ROLLING DATABASE MAINTENANCE IN PROGRESS
```

👥 User sessions
+1 Upgraded
🟥 Primary
⬛ Physical Standby
🟦 Logical Standby

The DBMS_ROLLING.START phase

INIT › BUILD › **START** › UPGRADE › SWITCHOVER › FINISH

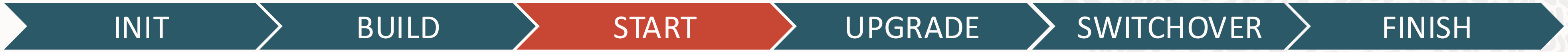


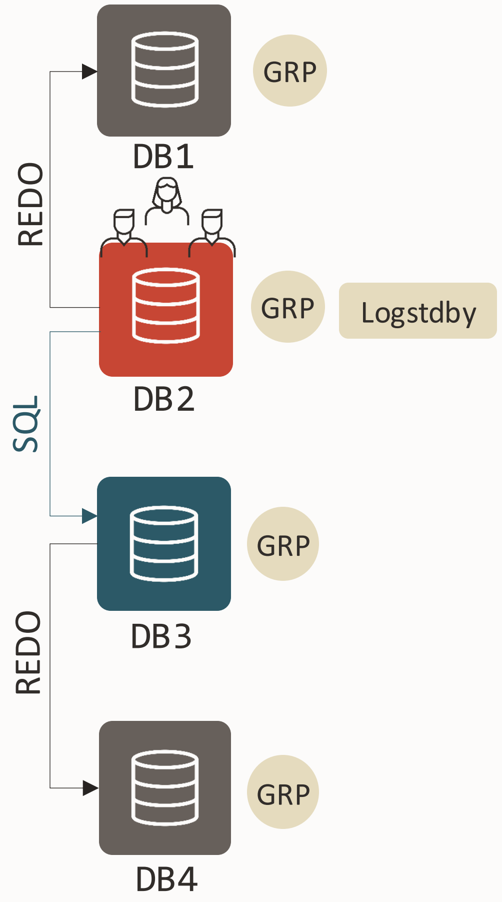
```
DGMGRL> show database DB3
...
  Role:                  PHYSICAL STANDBY
  Intended State:        APPLY-ON
  Transport Lag:         0 seconds (computed 0 seconds
ago)
  Apply Lag:             3 minutes 18 seconds (computed 0
seconds ago)
...
Database Warning(s):
    ORA-16866: database converted to transient logical
standby database for rolling database maintenance

Database Status:
WARNING
```

User sessions
+1 Upgraded
🟥 Primary
⬛ Physical Standby
🟦 Logical Standby

The DBMS_ROLLING.START phase





```
-- check the status of the SQL apply:
SQL> select * from V$LOGSTDBY_PROGRESS;

-- use SQL apply commands if you need
SQL> alter database start logical standby apply immediate;

-- check for logical standby error messages
SQL> select * from DBA_LOGSTDBY_EVENTS
2>     order by event_timestamp;

22-NOV-21 06.41.12  DML on "AUDSYS"."AUD$UNIFIED"
                    ORA-16129: unsupported DML encountered
22-NOV-21 06.41.13  truncate table wri$_adv_addm_pdbs
                    ORA-16247: DDL skipped on internal schema
```

The Upgrade/Maintenance phase

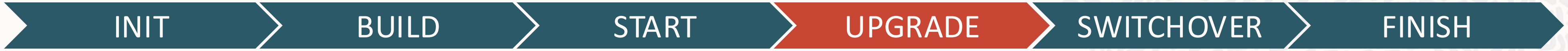
User sessions

+1 Upgraded

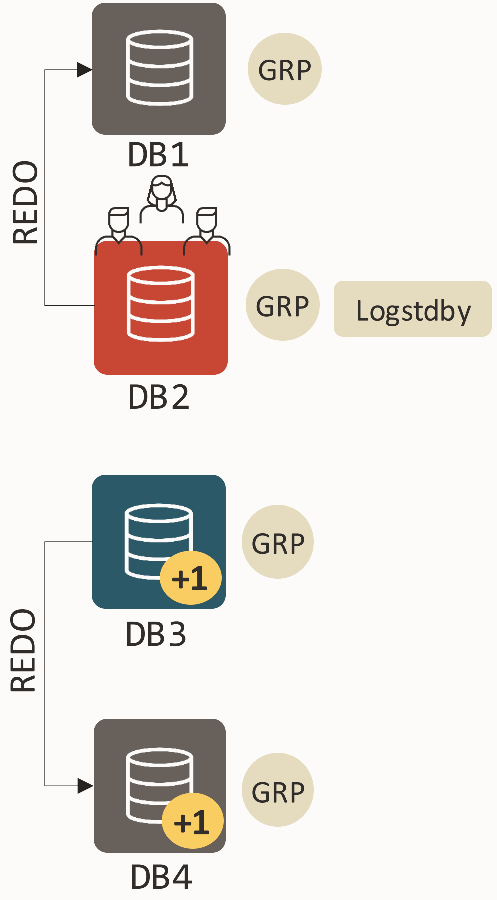
🟥 Primary

■ Physical Standby

■ Logical Standby



INIT → BUILD → START → UPGRADE → SWITCHOVER → FINISH



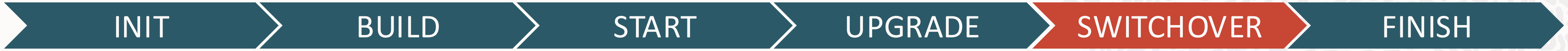
- Do the maintenance on the Leading Group Master

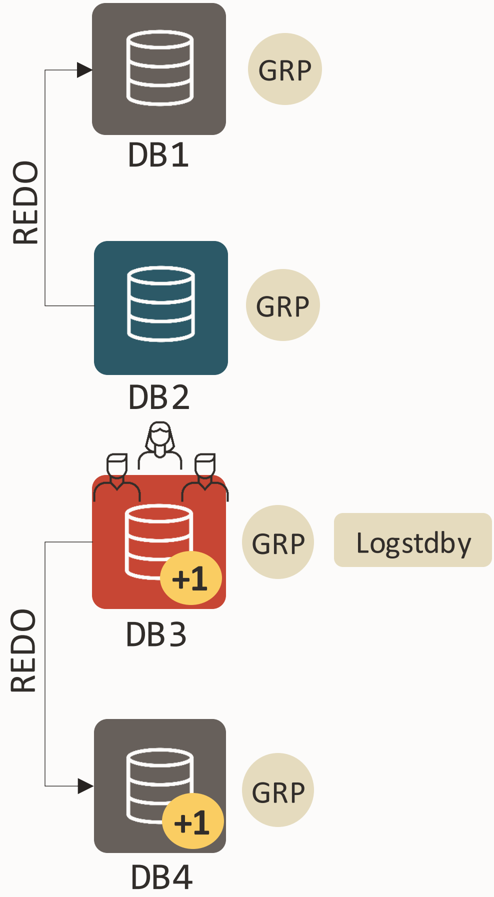
```
-- e.g. upgrade to a major version with AutoUpgrade
$ java -jar autoupgrade.jar -config CDB1.cfg -mode deploy
```

- This is out of DBMS_ROLLING scope (it is a manual step)
- Don't forget to align the Leading Group Standbys if necessary
- Use it for any major maintenance that requires longer downtimes (change of physical layout, structure changes, offline operations)

User sessions
+1 Upgraded
🟥 Primary
▨ Physical Standby
🟦 Logical Standby

The DBMS_ROLLING.SWITCHOVER phase


INIT → BUILD → START → UPGRADE → SWITCHOVER → FINISH



```
-- switchover to the upgraded database
DBMS_ROLLING.SWITCHOVER()
```

- Depending on the source version and HA configuration, the old connections get FAN notifications and drain automatically
- New connections go to the new primary. Application downtime is minimal.

The DBMS_ROLLING.SWITCHOVER phase

INIT › BUILD › START › UPGRADE › SWITCHOVER › FINISH

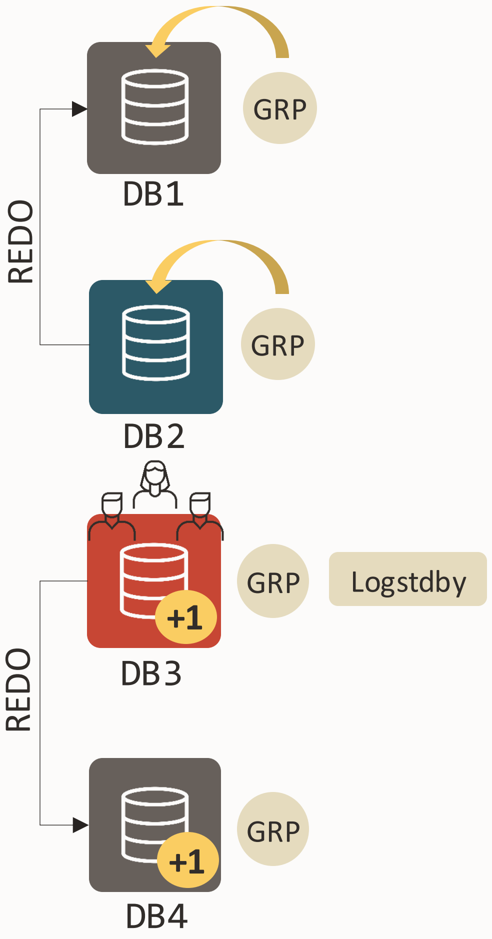
User sessions

+1 Upgraded

🟥 Primary

🟫 Physical Standby

🟦 Logical Standby



- Start the Trailing Group members with the new binaries (manual)

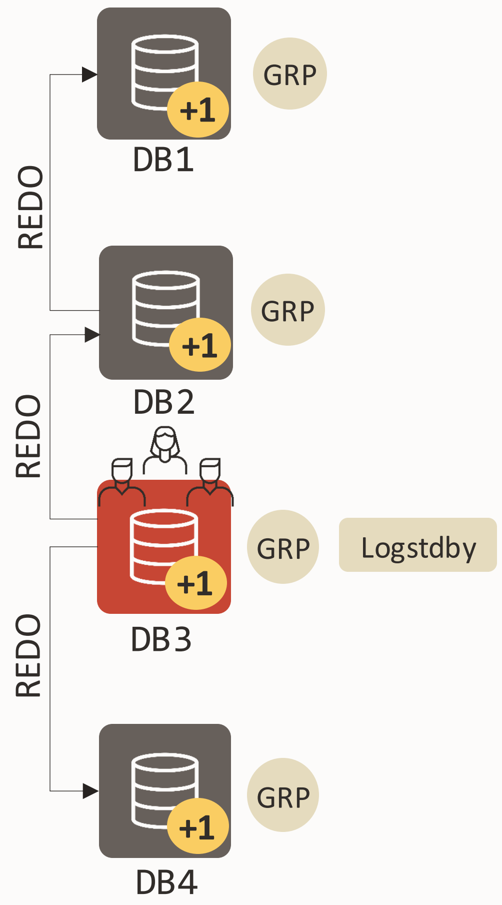
```
-- run the final part of the plan
DBMS_ROLLING.FINISH_PLAN()
```

- Flashes back the Trailing Group Master and Standby to the GRP

The DBMS_ROLLING.SWITCHOVER phase

INIT → BUILD → START → UPGRADE → SWITCHOVER → FINISH

User sessions
+1 Upgraded
🟥 Primary
■ Physical Standby
■ Logical Standby



- Start the Trailing Group members with the new binaries (manual)

```
-- run the final part of the plan
DBMS_ROLLING.FINISH_PLAN()
```

- Flashes back the Trailing Group Master and Standby to the GRP
- Converts the Trailing Group Master to a physical standby
- Starts redo apply and catches up with the primary
- Drops the guaranteed restore points and logical standby metadata

User sessions

+1 Upgraded

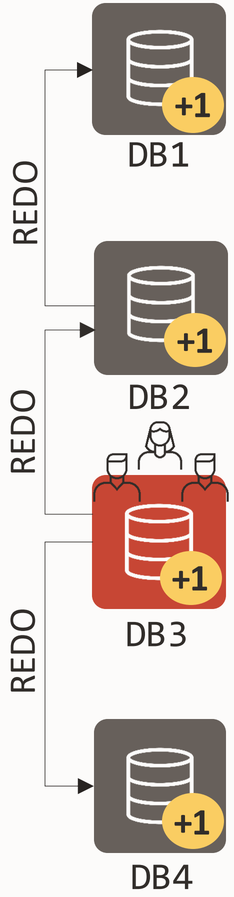
🟥 Primary

🟫 Physical Standby

🟦 Logical Standby

The DBMS_ROLLING.SWITCHOVER phase

INIT › BUILD › START › UPGRADE › SWITCHOVER › FINISH



```
-- destroy the plan to clean up everything
DBMS_ROLLING.DESTROY_PLAN()
```

DBMS_ROLLING catalog views

Evaluate	DBA_ROLLING_UNSUPPORTED	Check here for unsupported data types!
Initialize	DBA_ROLLING_PARAMETERS	Get the current parameters before building
Build	DBA_ROLLING_DATABASES	
	DBA_ROLLING_PLAN	Verify the plan before and during the execution
Monitor	DBA_ROLLING_EVENTS	Warning and errors are visible here
	DBA_ROLLING_STATISTICS	
	DBA_ROLLING_STATUS	

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!

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
- FAN events for Clusterware-backed databases
- Support for Identity columns

19c

- Planned in future RU: Support for Application Continuity and Transparent Application Continuity (backport from 23ai)

21c

- FAN events without Clusterware
- Support for JSON datatype

23ai

- Support for Application Continuity and Transparent Application Continuity
- Support for Blockchain tables
- Support for new Boolean data type
- Support for SQL domains

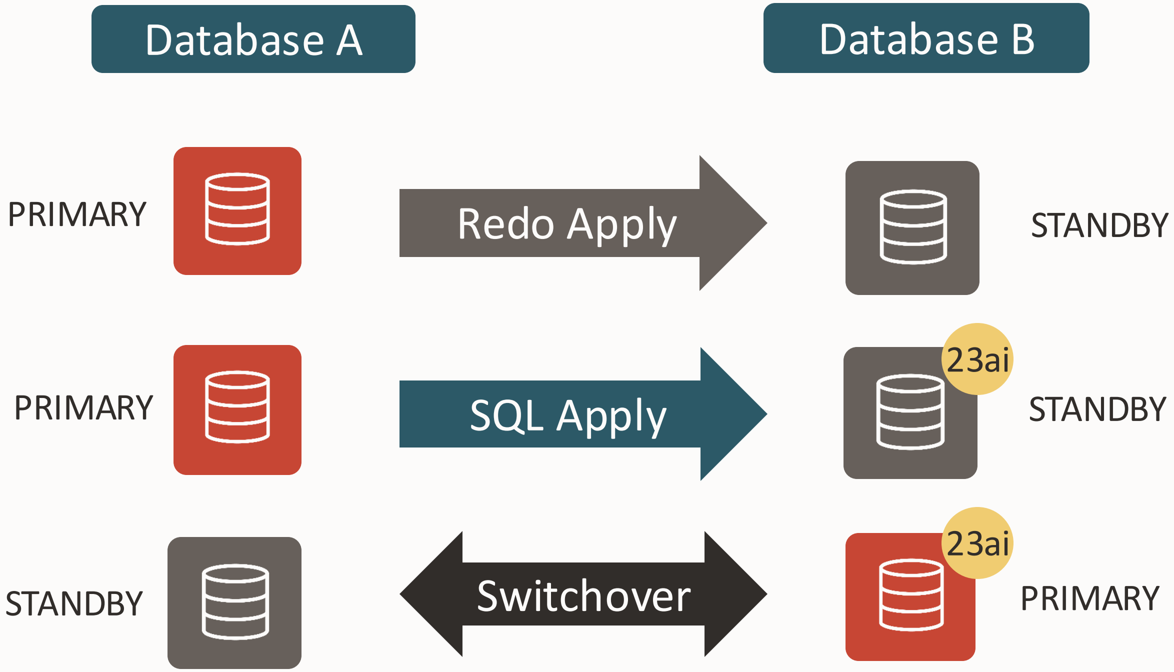
DBMS_ROLLING and client failover

DBMS_ROLLING.SWITCHOVER	Broker + OCW	Broker Only
12.1	Broker Not supported	Broker Not supported
12.2	FAN events	No FAN events
19c	FAN events (AC/TAC backport planned)	No FAN events
21c	FAN events	FAN events
23ai	FAN events + AC/TAC	FAN events + AC/TAC

New In 23ai

Zero Application Downtime for Database Release Upgrades

Minimizes application impact throughout the entire database upgrade process



Transparently with Application Continuity

(Transparent) Application Continuity

- Hides database downtime from your users
  - It rebuilds the session state
  - It replays in-flight transactions

DBMS_ROLLING

- Enables the automated rolling application of version-changing upgrades and patch sets.

Together they hide the final switchover needed at the end of the automated process.

DBMS_ROLLING – Read More

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

DBMS_ROLLING - PL/SQL Packages and Types Reference
https://docs.oracle.com/en/database/oracle/oracle-database/19/arpls/DBMS_ROLLING.html#GUID-097F1B39-E623-43B5-BA30-DF377BFE05CF

Automated Database Upgrades using Oracle Active Data Guard and DBMS_ROLLING
https://www.oracle.com/technetwork/database/availability/database-upgrade-dbms-rolling-4126957.pdf

Oracle Database Rolling Upgrades (without DBMS_ROLLING)
https://www.oracle.com/technetwork/database/availability/database-rolling-upgrade-3206539.pdf

DBMS_ROLLING – Read More

MOS Notes:

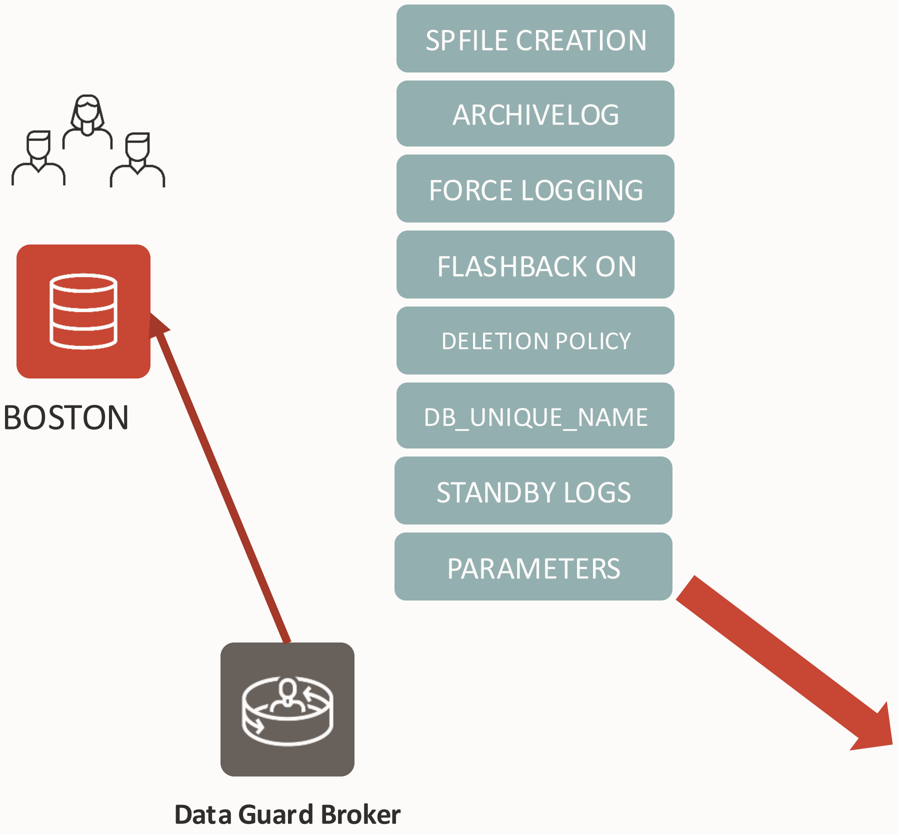
- Transient Rolling Upgrade Using DBMS_ROLLING - Beginners Guide
- Rolling upgrade using DBMS_ROLLING - Complete Reference (Doc ID 2086512.1)
- MAA Whitepaper: SQL Apply Best Practices (Doc ID 1672310.1)
- Step by Step How to Do Swithcover/Failover on Logical Standby Environment (Doc ID 2535950.1)
- How To Skip A Complete Schema From Application on Logical Standby Database (Doc ID 741325.1)
- How to monitor the progress of the logical standby (Doc ID 1296954.1)
- How To Reduce The Performance Impact Of LogMiner Usage On A Production Database (Doc ID 1629300.1)
- Handling ORA-1403 ora-12801 on logical standby apply (Doc ID 1178284.1)
- Troubleshooting Example - Rolling Upgrade using DBMS_ROLLING (Doc ID 2535940.1)
- DBMS Rolling Upgrade Switchover Fails with ORA-45427: Logical Standby Redo Apply Process Was Not Running (Doc ID 2696017.1)
- SRDC - Collect Logical Standby Database Information (Doc ID 1910065.1)
- MRP fails with ORA-19906 after Flashback of Transient Logical Standby used for Rolling Upgrade (Doc ID 2069325.1)
- What Causes High Redo When Supplemental Logging is Enabled (Doc ID 1349037.1)

Other 21c features for Data Guard and Broker

NEW IN
21c

Automatic Primary Database Preparation

Faster and easier creation of Data Guard environments



BOSTON

SPFILE CREATION

ARCHIVELOG

FORCE LOGGING

FLASHBACK ON

DELETION POLICY

DB_UNIQUE_NAME

STANDBY LOGS

PARAMETERS

Data Guard Broker

```
DGMGRL> PREPARE DATABASE FOR DATA GUARD
WITH DB_UNIQUE_NAME IS boston
DB_RECOVERY_FILE_DEST IS "+FRA"
DB_RECOVERY_FILE_DEST_SIZE is "400G"
BROKER_CONFIG_FILE1 IS "+DATA/BOSTON/dg1.dat"
BROKER_CONFIG_FILE2 IS "+FRA/BOSTON/dg2.dat";
```

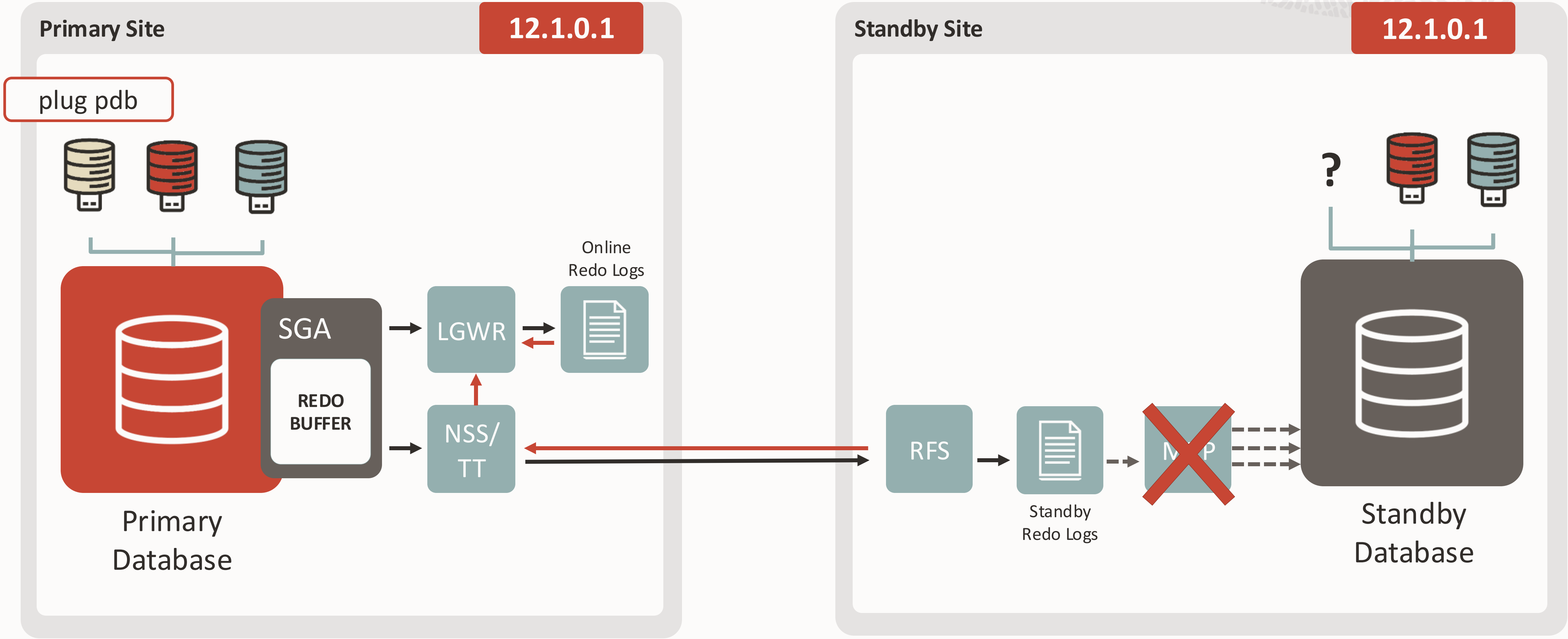
- If the parameters are good enough, they are not modified
- It restarts the database for:
  - Changes to static parameters
  - Enabling the Archivelog mode

```
DB_FILES                        = 1024
LOG_BUFFER                      = 256M
DB_BLOCK_CHECKSUM               = TYPICAL
DB_LOST_WRITE_PROTECT           = TYPICAL
DB_FLASHBACK_RETENTION_TARGET   = 120
PARALLEL_THREADS_PER_CPU        = 1
STANDBY_FILE_MANAGEMENT         = AUTO
DG_BROKER_START                 = TRUE
```

NEW IN 21c

Pluggable Database Recovery Isolation

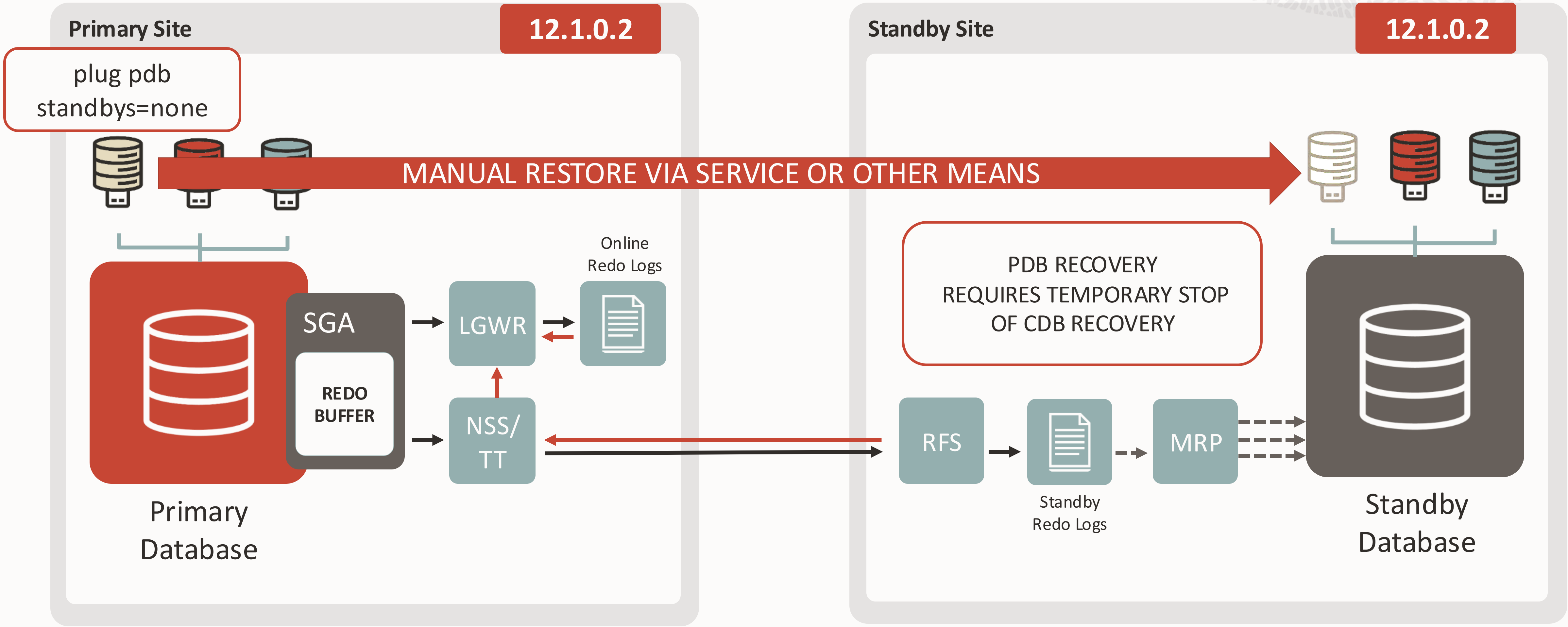
Simplified PDB cloning in Data Guard configurations



NEW IN
21c

Pluggable Database Recovery Isolation

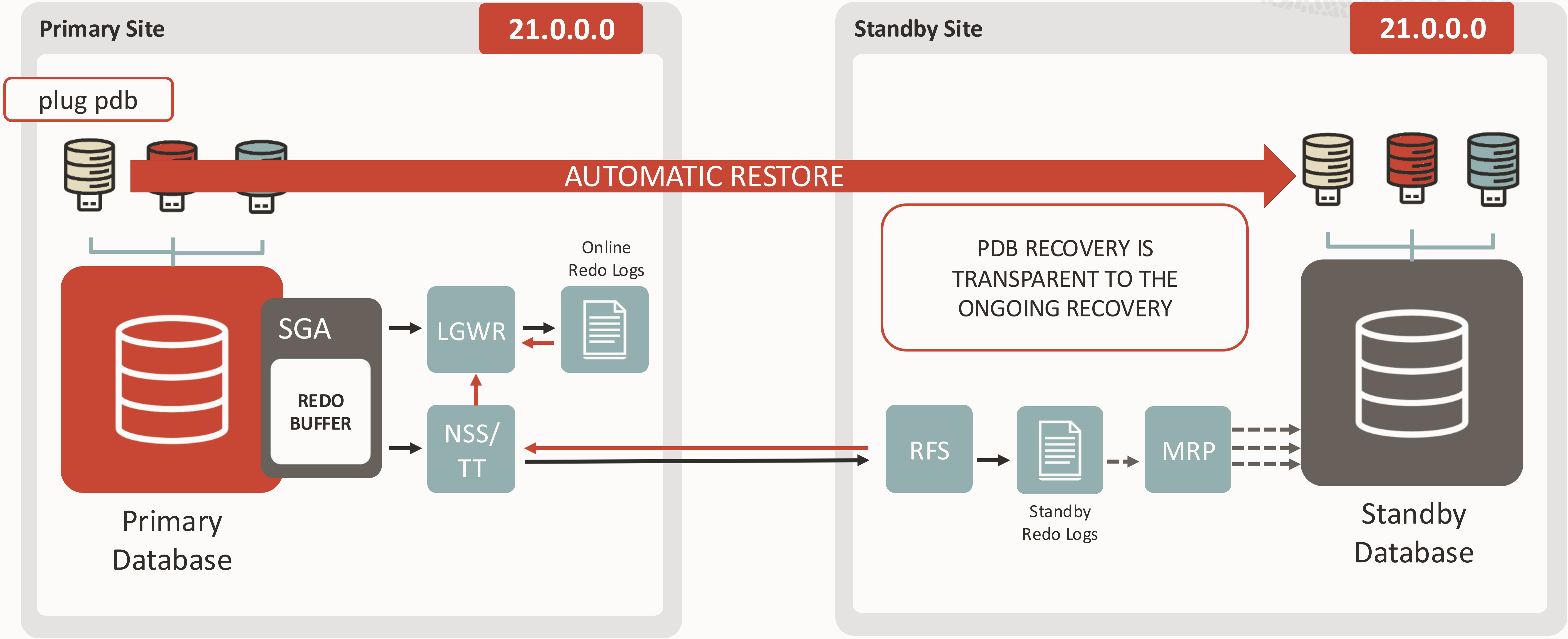
Simplified PDB cloning in Data Guard configurations



Pluggable Database Recovery Isolation

Simplified PDB cloning in Data Guard configurations

NEW IN 21c



NEW IN 21c

ORDS REST API for Data Guard management

Ready for modern DevOps deployment

New in ORDS 21.4 for 21c databases

```
POST /database/dataguard/configuration/
{
  "primary_connection_identifier": "site1-scan:1521/mydb",
  "primary_database": "mydb_site1"
}
```

Create the configuration

```
POST /database/dataguard/databases/
{
  "connection_identifier": "site2-scan:1521/mydb",
  "database_name": "mydb_site2"
}
```

Add the standby databases

```
PUT /database/dataguard/configuration/
{
  "operation": "ENABLE"
}
```

Enable the configuration

Oracle REST Data Services API - Data Guard REST Endpoints
https://docs.oracle.com/en/database/oracle/oracle-rest-data-services/21.4/orrst/api-data-guard.html

Data Guard management from SQLcl

Everything under control with a single command-line tool

NEW IN 21c

New in SQLcl 22.1 for 21c databases

```
SQL> help dg
DG
------
 Run DG commands

 DG ADD DATABASE "<database name>" AS CONNECT IDENTIIFIER IS <connect identifier> [ INCLUDE CURRENT DESTINATIONS ];
 DG CREATE CONFIGURATION "<config_name>" AS PRIMARY DATABASE IS <database name> CONNECT IDENTIIFIER IS <connect_identifier>
        [ INCLUDE CURRENT DESTINATIONS ];
 DG DISABLE CONFIGURATION;
 DG DISABLE { DATABASE | RECOVERY_APPLIANCE | FAR_SYNC | MEMBER } <member name>;
 DG EDIT CONFIGURATION SET PROPERTY <property name> = '<property value>';
 DG EDIT { DATABASE | RECOVERY_APPLIANCE | FAR_SYNC | MEMBER } <member name> SET PROPERTY <property name> = '<property value>' ;
 DG ENABLE CONFIGURATION;
 DG ENABLE { DATABASE | RECOVERY_APPLIANCE | FAR_SYNC | MEMBER } <member name>;
 DG FAILOVER TO <database name> [IMMEDIATE];
 DG REINSTATE DATABASE <database name>;
 DG REMOVE CONFIGURATION [PRESERVE DESTINATIONS];
 DG REMOVE { DATABASE | RECOVERY_APPLIANCE | FAR_SYNC | MEMBER } <name> [PRESERVE DESTINATIONS];
 DG SHOW CONFIGURATION [<property name>];
 DG SHOW DATABASE <database name> [<property name];
 DG SWITCHOVER TO <database name> [WAIT [<timeout in seconds]];
```

Other changes in Oracle Data Guard 21c

NEW IN
21c

- **Far Sync can now be used with Fast-Start Failover in Max Performance mode (Active Data Guard)**
  Primary can send redo asynchronously to Far Sync.

- **The broker configuration now supports up to four observers**
  Before 21c, the limit was three observers.

- **The PreferredObserverHosts property now supports priorities**
  Example: `PreferredObserverHosts='host-a:1, host-b:2'`

- **Properties deprecated in 19c are now desupported**

```
ArchiveLagTarget            DbFileNameConvert        LsbyPreserveCommitOrder
DataGuardSyncLatency        LogArchiveFormat         LsbyRecordAppliedDdl
LogArchiveMaxProcesses      LogFileNameConvert       LsbyRecordSkipDdl
LogArchiveMinSucceedDest    LsbyMaxEventsRecorded    LsbyRecordSkipErrors
LogArchiveTrace             LsbyMaxServers           LsbyParameters
StandbyFileManagement       LsbyMaxSga
```

Other 23ai features for Data Guard and Broker

New In 23ai

Different Ways to Configure Oracle Data Guard

dgmgrl

```
DGMGRL> create configuration mydb
> as primary database is mydb
> connect identifier is 'clu-scan:1521/mydb’
```

```
SQL> DG create configuration mydb as primary database
is mydb connect identifier is 'clu-scan:1521/mydb'
```

PL/SQL

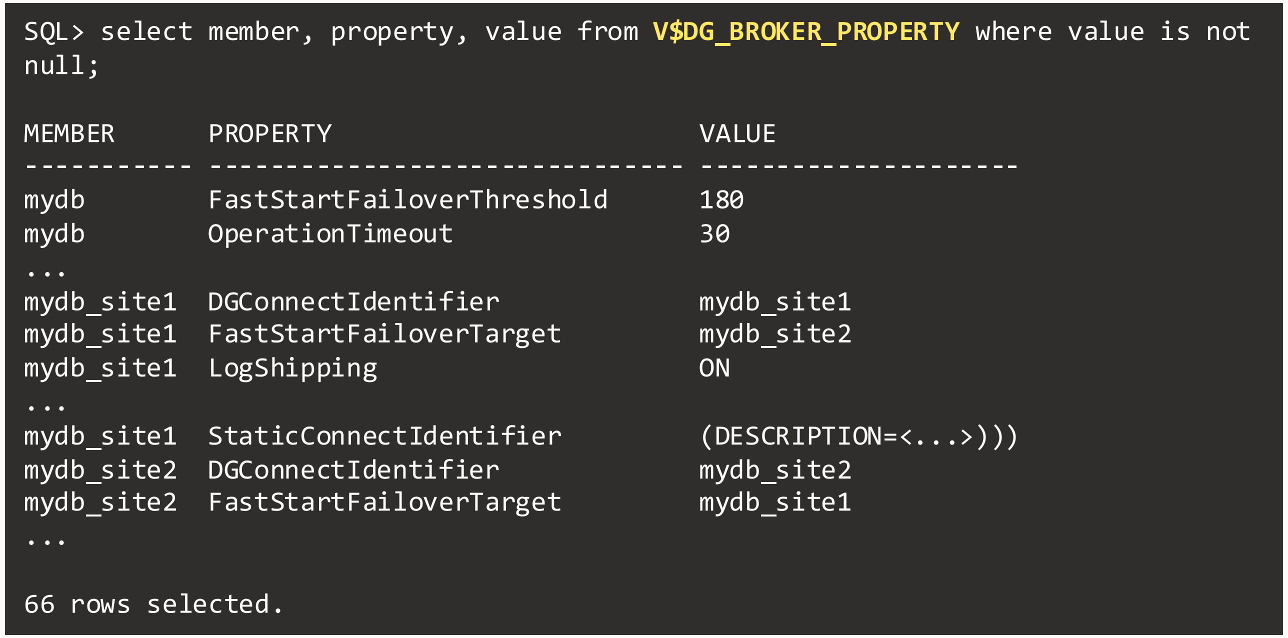
```
DECLARE
  severity BINARY_INTEGER;
  retcode  BINARY_INTEGER;
BEGIN
  retcode := DBMS_DG.CREATE_CONFIGURATION (
    config_name         => 'mydb'
    primary_ci          => 'clu-scan:1521/mydb'
    severity            => severity
  );
END;
```

```
POST /database/dataguard/configuration/
{
 "primary_connection_identifier":"clu-
scan:1521/mydb",
 "primary_database": "mydb_site1"
}
```

New In 23ai

Easier Integration Thanks to Many SQL Additions

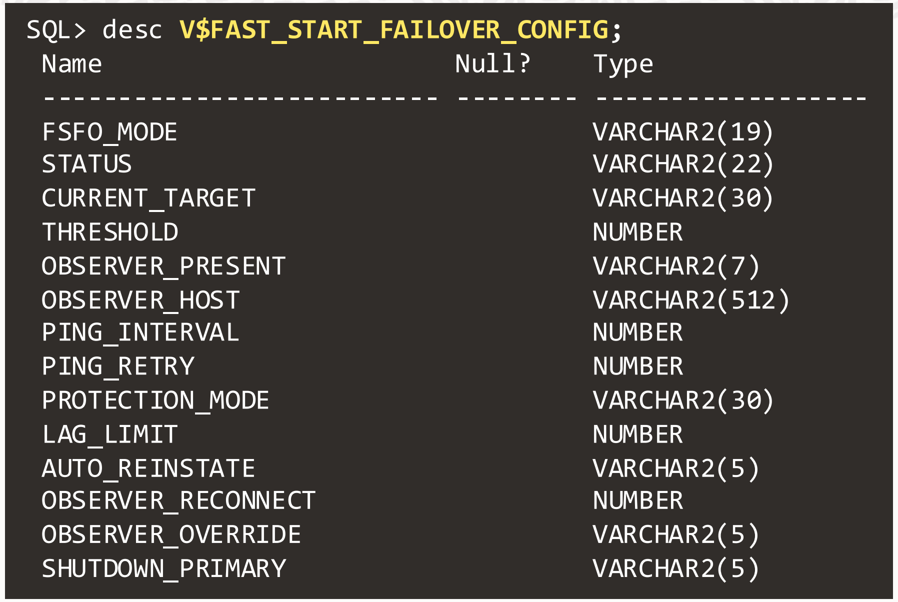
Some useful new views



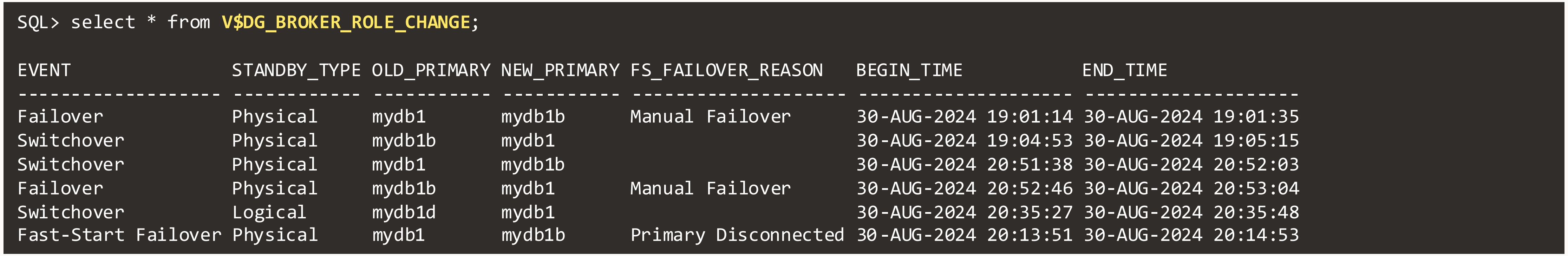
```
SQL> select member, property, value from V$DG_BROKER_PROPERTY where value is not
null;

MEMBER      PROPERTY                        VALUE
----------- ------------------------------- ---------------------
mydb        FastStartFailoverThreshold      180
mydb        OperationTimeout                30
...
mydb_site1  DGConnectIdentifier             mydb_site1
mydb_site1  FastStartFailoverTarget         mydb_site2
mydb_site1  LogShipping                     ON
...
mydb_site1  StaticConnectIdentifier         (DESCRIPTION=<...>)))
mydb_site2  DGConnectIdentifier             mydb_site2
mydb_site2  FastStartFailoverTarget         mydb_site1
...

66 rows selected.
```



```
SQL> desc V$FAST_START_FAILOVER_CONFIG;
 Name                       Null?    Type
 -------------------------- -------- ------------------
 FSFO_MODE                           VARCHAR2(19)
 STATUS                              VARCHAR2(22)
 CURRENT_TARGET                      VARCHAR2(30)
 THRESHOLD                           NUMBER
 OBSERVER_PRESENT                    VARCHAR2(7)
 OBSERVER_HOST                       VARCHAR2(512)
 PING_INTERVAL                       NUMBER
 PING_RETRY                          NUMBER
 PROTECTION_MODE                     VARCHAR2(30)
 LAG_LIMIT                           NUMBER
 AUTO_REINSTATE                      VARCHAR2(5)
 OBSERVER_RECONNECT                  NUMBER
 OBSERVER_OVERRIDE                   VARCHAR2(5)
 SHUTDOWN_PRIMARY                    VARCHAR2(5)
```



```
SQL> select * from V$DG_BROKER_ROLE_CHANGE;

EVENT               STANDBY_TYPE OLD_PRIMARY NEW_PRIMARY FS_FAILOVER_REASON   BEGIN_TIME           END_TIME
------------------- ------------ ----------- ----------- -------------------- -------------------- --------------------
Failover            Physical     mydb1       mydb1b      Manual Failover      30-AUG-2024 19:01:14 30-AUG-2024 19:01:35
Switchover          Physical     mydb1b      mydb1                            30-AUG-2024 19:04:53 30-AUG-2024 19:05:15
Switchover          Physical     mydb1       mydb1b                           30-AUG-2024 20:51:38 30-AUG-2024 20:52:03
Failover            Physical     mydb1b      mydb1       Manual Failover      30-AUG-2024 20:52:46 30-AUG-2024 20:53:04
Switchover          Logical      mydb1d      mydb1                            30-AUG-2024 20:35:27 30-AUG-2024 20:35:48
Fast-Start Failover Physical     mydb1       mydb1b      Primary Disconnected 30-AUG-2024 20:13:51 30-AUG-2024 20:14:53
```

New In 23ai

Strict Database Validation

More checks, better explanations, increased operational security

(*) available in 23.6

```
VALIDATE DATABASE [VERBOSE] <database>
  [ STRICT { ALL | APPLY_PROPERTY | DATAFILES_OFFLINE (*) | FLASHBACK | FORCE_LOGGING | LOG_FILES_CLEARED
  | LOG_FILE_CONFIGURATION | PDBS_OFFLINE (*) | PDB_SAVE_STATE (*) | TRANSPORT_PROPERTY }];
```

```
DGMGRL> validate database chicago strict all;
DGM-17567: Current database session was authenticated using operating system credentials.


  Database Role:     Physical standby database
  Primary Database:  boston


  Ready for Switchover:  No
    The primary or standby database does not have flashback database enabled. (*)

  Ready for Failover:    Yes (Primary Running)


  Flashback Database Status:
    Database  Status           Retention Target
    boston    Off              1440
    chicago   Off              1440
...
```

Switchover and Failover Readiness in 23.5

Checking if the database is ready for a role transition is as easy as selecting a column

Two new columns, SWITCHOVER_READY and FAILOVER_READY, computed every minute by the broker.

```
SQL> select database, dataguard_role, status, severity, switchover_ready, failover_ready, transport_mode
  2> from v$dg_broker_config;


DATABASE   DATAGUARD_ROLE        STATUS SEVERITY       SWITCHOVER_READY FAILOVER_READY TRANSPORT_MODE
---------- ---------------- ---------- -------------- ---------------- -------------- ---------------
boston     PRIMARY                    0 SUCCESS        YES              UNKNOWN        -N/A-
chicago    PHYSICAL STANDBY           0 SUCCESS        YES              YES            ASYNC
```

The checks done by the broker are a superset of the ALTER DATABASE SWITCHOVER VERIFY command:

```
SQL> alter database switchover to chicago verify;
alter database switchover to chicago verify
*
ERROR at line 1:
ORA-16470: Redo Apply is not running on switchover target
```

New In
23ai

PL/SQL API for Data Guard broker management

Manage Data Guard configurations from any SQL*Net connection

```
DECLARE
  severity BINARY_INTEGER;
  retcode  BINARY_INTEGER;
BEGIN

  retcode := DBMS_DG.CREATE_CONFIGURATION (
       config_name         => 'mydb'
       primary_ci          => 'site1-scan:1521/mydb'
       severity            => severity
  );

  IF retcode != 0 THEN
    /* handle error code */
  END IF;

  retcode := DBMS_DG.ADD_DATABASE (
       database_name        => 'mydb_site2'
       database_ci          => 'site2-scan:1521/mydb'
       severity            => severity
  );

END;
```

30+ new functions in DBMS_DG PL/SQL package

Create the configuration

Add the standby databases

PL/SQL Packages and Types Reference - DBMS_DG
https://docs.oracle.com/en/database/oracle/oracle-database/23/arpls/DBMS_DG.html

New In 23ai

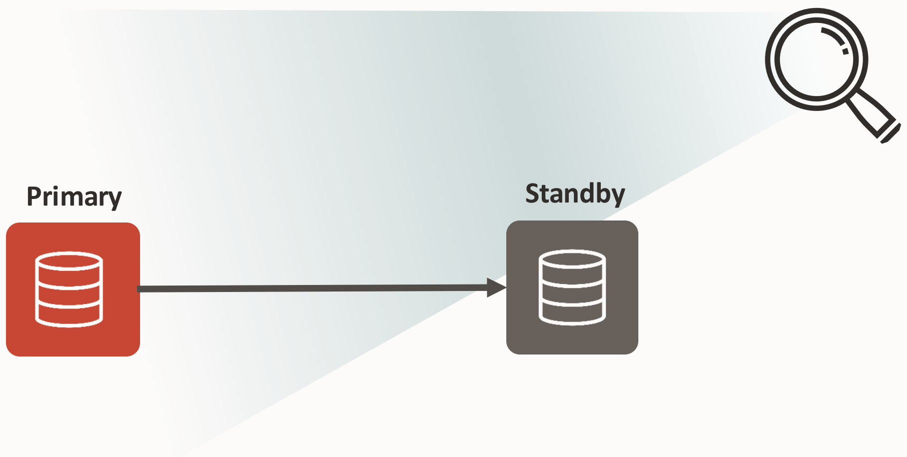
Easier checking of Data Guard configurations

The new fixed view **V$DG_BROKER_PROPERTY** contains the properties of the configuration and all the members

```
SQL> select member, property, value from V$DG_BROKER_PROPERTY where value is not null;

MEMBER       PROPERTY                         VALUE
------------ -------------------------------- ---------------------
mydb         FastStartFailoverThreshold       180
mydb         OperationTimeout                 30
mydb         TraceLevel                       USER
mydb         FastStartFailoverLagLimit        300
mydb         CommunicationTimeout             180
mydb         ObserverReconnect                0
mydb         ObserverPingInterval             0
mydb         ObserverPingRetry                0
mydb         FastStartFailoverAutoReinstate   TRUE
mydb         FastStartFailoverPmyShutdown     TRUE
...
mydb_site1   DGConnectIdentifier              mydb_site1
mydb_site1   FastStartFailoverTarget          mydb_site2
mydb_site1   LogShipping                      ON
mydb_site1   LogXptMode                       ASYNC
mydb_site1   DelayMins                        0
...
mydb_site1   StaticConnectIdentifier          (DESCRIPTION=<...>)))
mydb_site1   TopWaitEvents                    (monitor)
mydb_site1   SidName                          (monitor)
mydb_site2   DGConnectIdentifier              mydb_site2
mydb_site2   FastStartFailoverTarget          mydb_site1
...

66 rows selected.
```



New In 23ai

New command: VALIDATE DGConnectIdentifier

Check network resolution, connectivity, password, service name from the database

```
DGMGRL> validate dgconnectidentifier mydb_site2;
At instance 'mydb' of member 'mydb_site1'
  Connect Descriptor:
(DESCRIPTION=(ADDRESS_LIST=(ADDRESS=(PROTOCOL=tcp)(HOST=host2)(PORT=1521)))(CONNECT_DATA=(SERVICE_NAME=mydb_site2.mydomain)(SERVER=DEDICATED)))

  Environment Variables:
             TNS_ADMIN: /u01/app/oracle/product/23.1.0.0/network/admin
           ORACLE_HOME: /u01/app/oracle/product/23.1.0.0
           ORACLE_BASE: /u01/app/oracle

  Initialization Parameters:
        LOCAL_LISTENER: host1:1521

  Connected to instance 'mydb' at member 'mydb_site2'

At instance 'mydb' of member 'mydb_site2'
  Connect Descriptor:
(DESCRIPTION=(ADDRESS_LIST=(ADDRESS=(PROTOCOL=tcp)(HOST=host2)(PORT=1521)))(CONNECT_DATA=(SERVICE_NAME=mydb_site2.mydomain)(SERVER=DEDICATED)))

  Environment Variables:
             TNS_ADMIN: /u01/app/oracle/product/23.1.0.0/network/admin
           ORACLE_HOME: /u01/app/oracle/product/23.1.0.0
           ORACLE_BASE: /u01/app/oracle

  Initialization Parameters:
        LOCAL_LISTENER: host2:1521

 Connected to instance 'mydb' at member 'mydb_site2'
```

`service_name == db_unique_name`

New In 23ai

New commands: SHOW|EDIT ALL MEMBERS

Easier management of member's properties and parameters

```
-- DATA GUARD PROPERTIES
DGMGRL> SHOW ALL MEMBERS logxptmode
  mydb_site1: logxptmode = 'ASYNC'
  mydb_site2: logxptmode = 'ASYNC'

DGMGRL> EDIT ALL MEMBERS SET PROPERTY logxptmode ='SYNC';
Property "logxptmode" updated for member "mydb_site1".
Property "logxptmode" updated for member "mydb_site2".

DGMGRL> SHOW ALL MEMBERS logxptmode
 mydb_site1: logxptmode = 'SYNC'
 mydb_site2: logxptmode = 'SYNC'
```

Get and set Data Guard broker properties

```
-- DB PARAMETERS
DGMGRL> SHOW ALL MEMBERS PARAMETER fast_start_mttr_target
 mydb_site1: fast_start_mttr_target = '0'
 mydb_site2: fast_start_mttr_target = '0'

DGMGRL> EDIT ALL MEMBERS SET PARAMETER fast_start_mttr_target=15;
Parameter "fast_start_mttr_target" updated for member "mydb_site1".
Parameter "fast_start_mttr_target" updated for member "mydb_site2".

DGMGRL> SHOW ALL MEMBERS PARAMETER fast_start_mttr_target
 mydb_site1: fast_start_mttr_target = '15'
 mydb_site2: fast_start_mttr_target = '15'
```

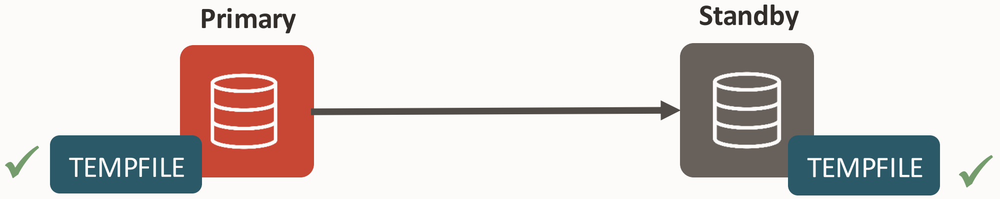
Get and set Database parameters

New In 23ai

Automatic tempfile creation on the standby database

Temporary tablespace creation during recovery:

STANDBY PRIMARY	Non-OMF	OMF
Non-OMF	**Standby_file_management AUTO:** ✓ Creates **one** tempfile with the default size using `db_file_name_convert`. **Standby_file_management MANUAL:** ✗ Does not create a tempfile.	**Standby_file_management AUTO:** ✓ Creates **one** tempfile with the default size with OMF naming. **Standby_file_management MANUAL:** ✗ Does not create a tempfile.(?)
OMF	✗ Does not create a tempfile.	✓ Creates **one** tempfile with the default size with OMF naming.



When the standby opens and a temporary tablespace has no tempfiles:

Non-OMF	✗ Does not create a tempfile.
OMF	✓ Creates **one** tempfile with the default size with OMF naming.

Questions & Answers

Thank you

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