



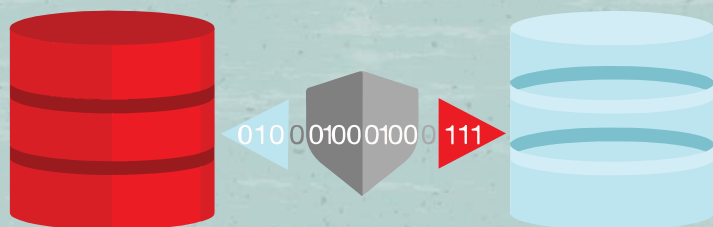
Maximum Availability Architecture with Oracle Active Data Guard 21c

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Oracle (Active) Data Guard & MAA

High Availability and Disaster Recovery

Protect data and systems from outages

IT Resilience

UNPLANNED

+

PLANNED

User Errors

Mergers & Acquisitions

Infrastructure Failures

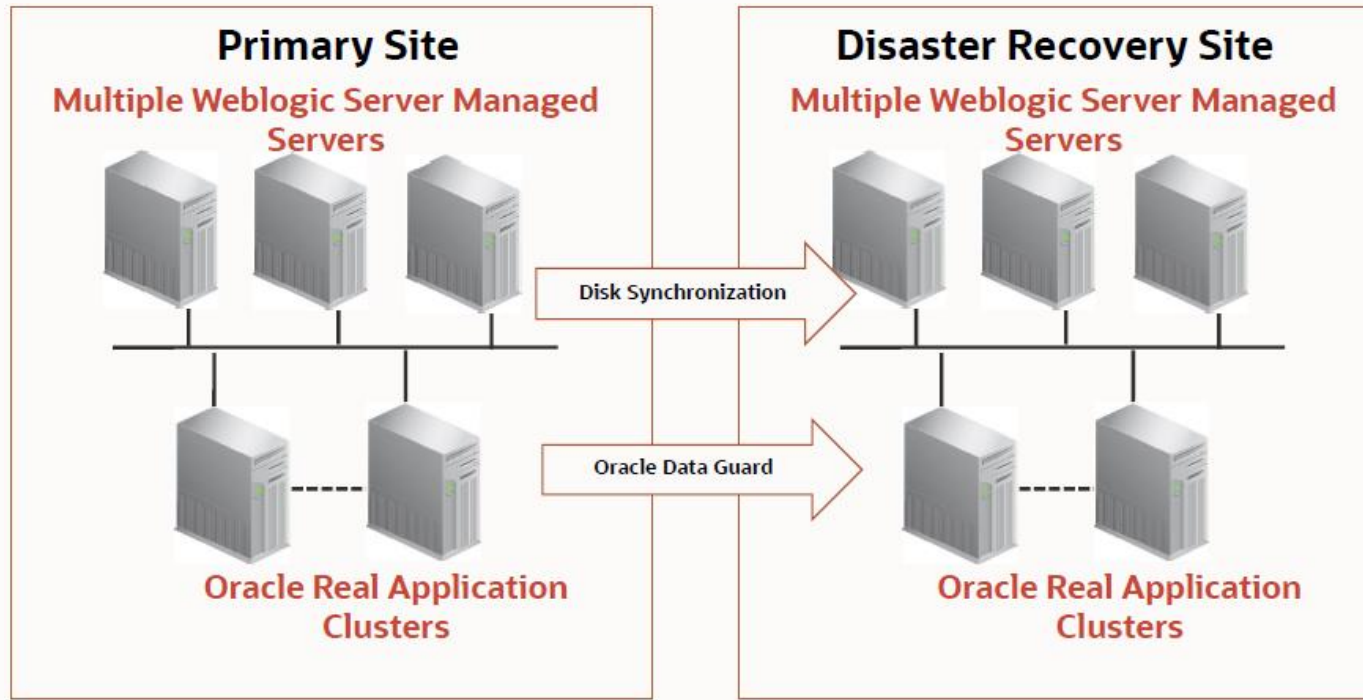
Move to Cloud

Security & Ransomware

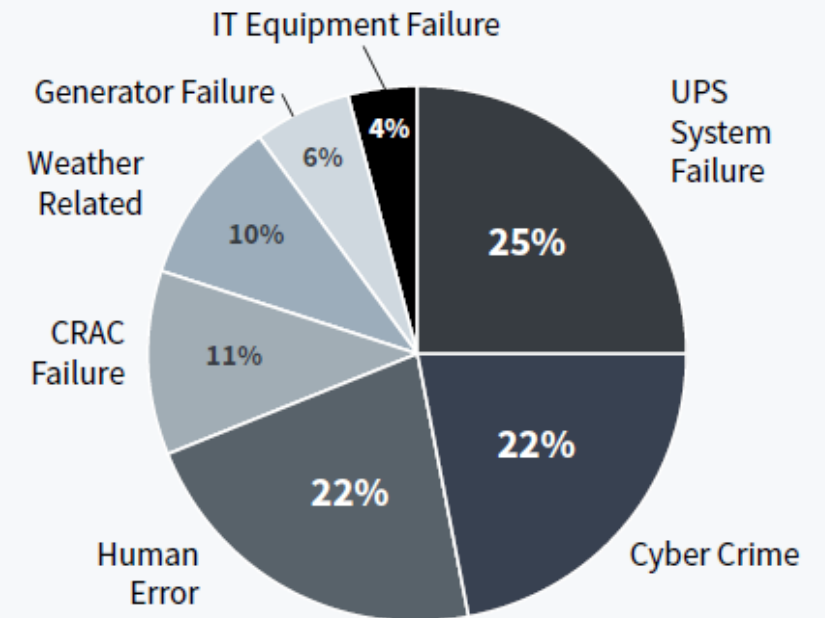
Datacenter Consolidation

Natural Disasters

Maintenance & Upgrades



TOP CAUSES OF DATA LOSS AND DOWNTIME



(source: 365datacenters.com)

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

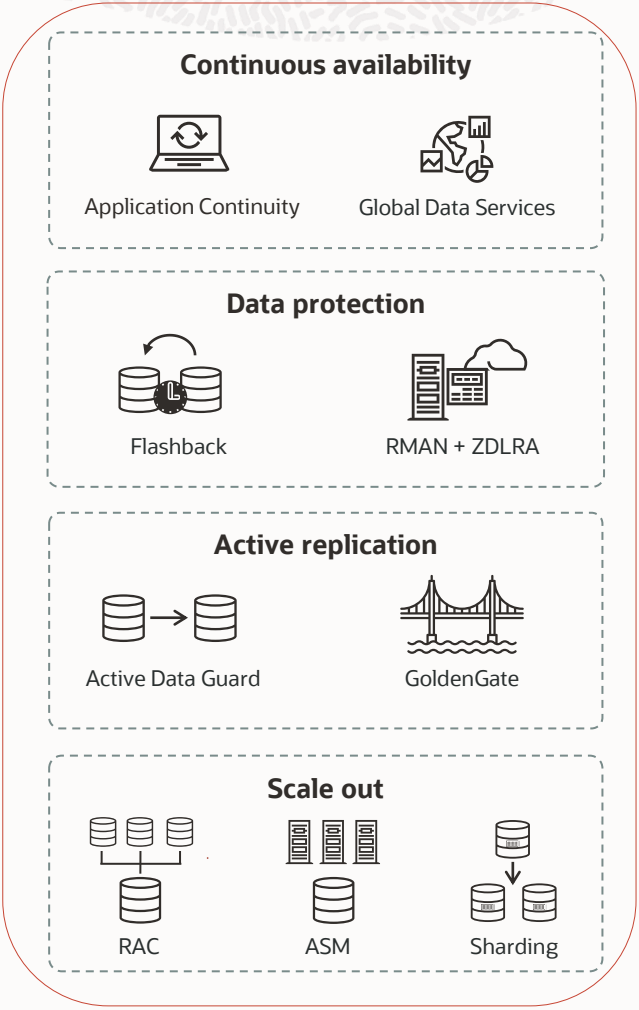
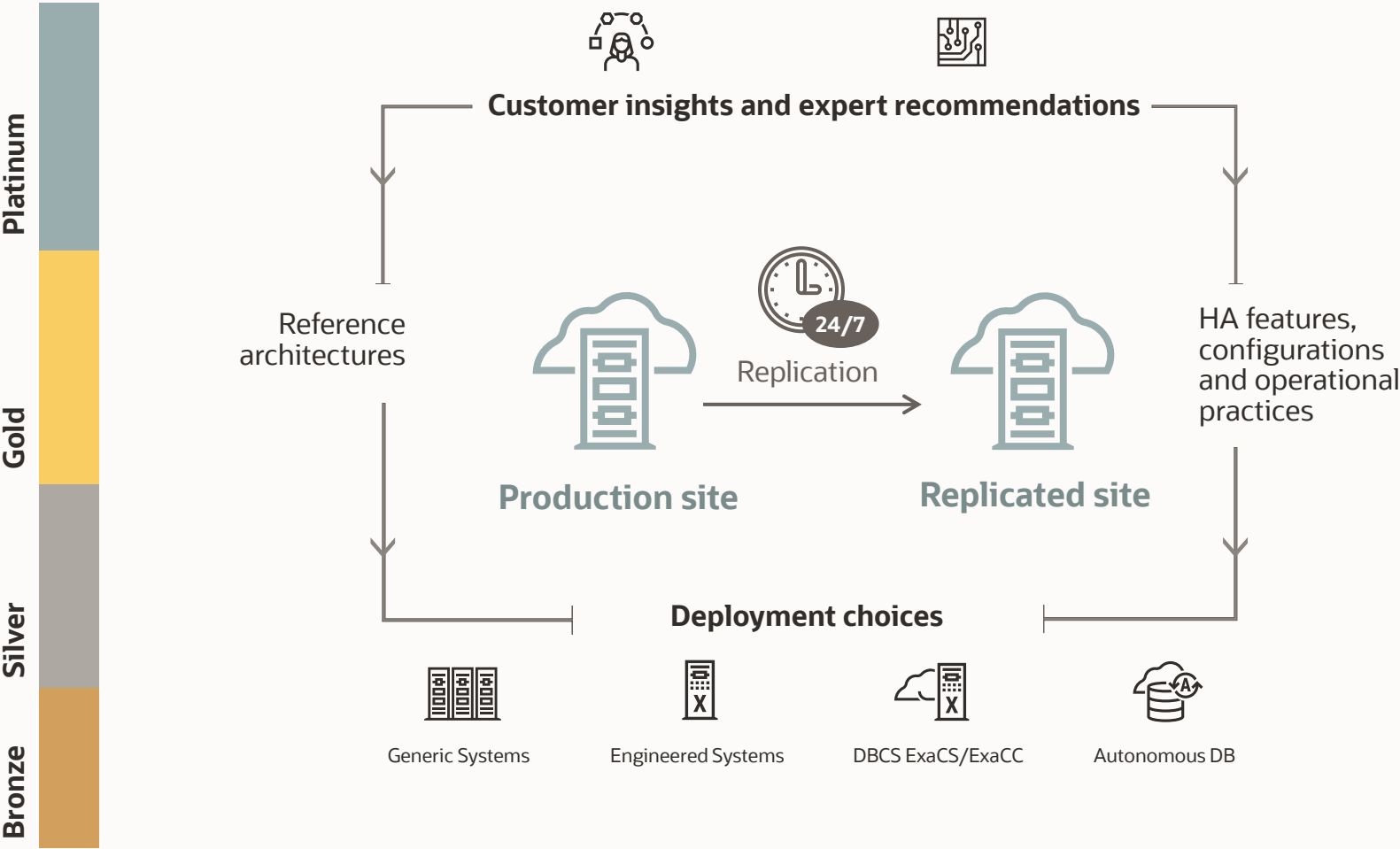


91%

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

Oracle Maximum Availability Architecture (MAA)





Key goal: to achieve optimal HA, data protection and DR for Oracle customers at the lowest cost and complexity



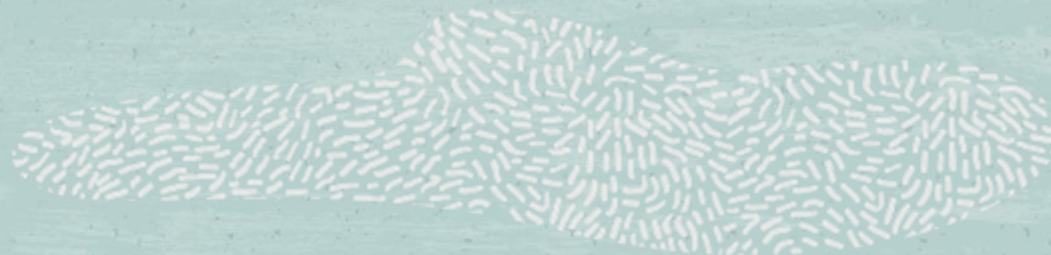
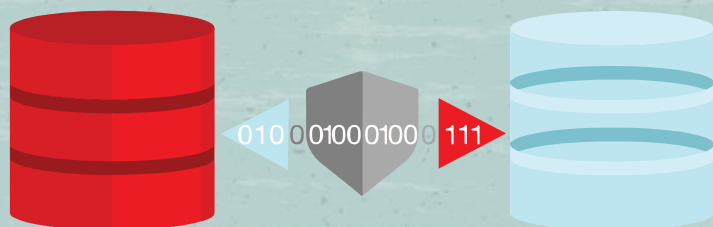
MAA reference architectures

Availability service levels



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

All tiers exist with on-premises and cloud. However, platinum currently must be configured manually while bronze to gold are covered with cloud tool automation for the most part depending on the desired RTO (i.e. FSFO & multiple standby databases still must be manually configured for example)



Oracle Active Data Guard vs Storage Replication

To Mirror or not to Mirror

That is the question.

Data Corruptions Happen All the Time

Fundamental shortcoming of Storage Replication: inadequate isolation, zero application-level validation



Any component in the systems stack can fail and cause data corruptions*

- **Software:** applications, middleware, database
- **Hardware:** disk drives / controllers, HBAs, memory
- **Network:** routers, switches, cables
- **Operational:** human errors, bad installs & upgrades

Increasing data volumes and complex I/O subsystems:

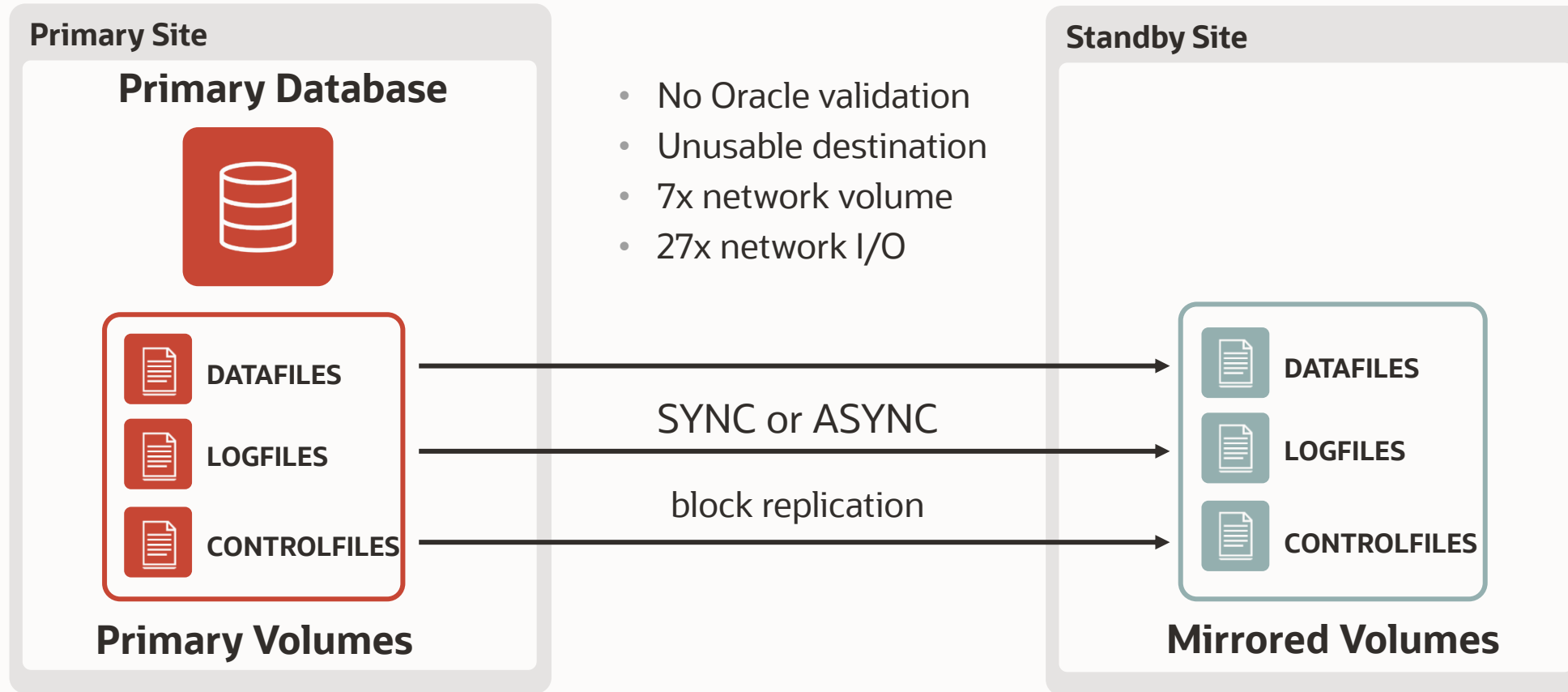
- Impact of data corruptions is disastrous
- Very hard to debug and diagnose

•Ref. "Hard Disk Drives – the Good, the Bad & the Ugly", ACM Queue, Sep/Oct 2007,
<http://queue.acm.org/detail.cfm?id=1317403>

•* Ref. "Silent Corruptions, CERN",
http://fuji.web.cern.ch/fuji/talk/2007/kelemen-2007-C5-Silent_Corruptions.pdf

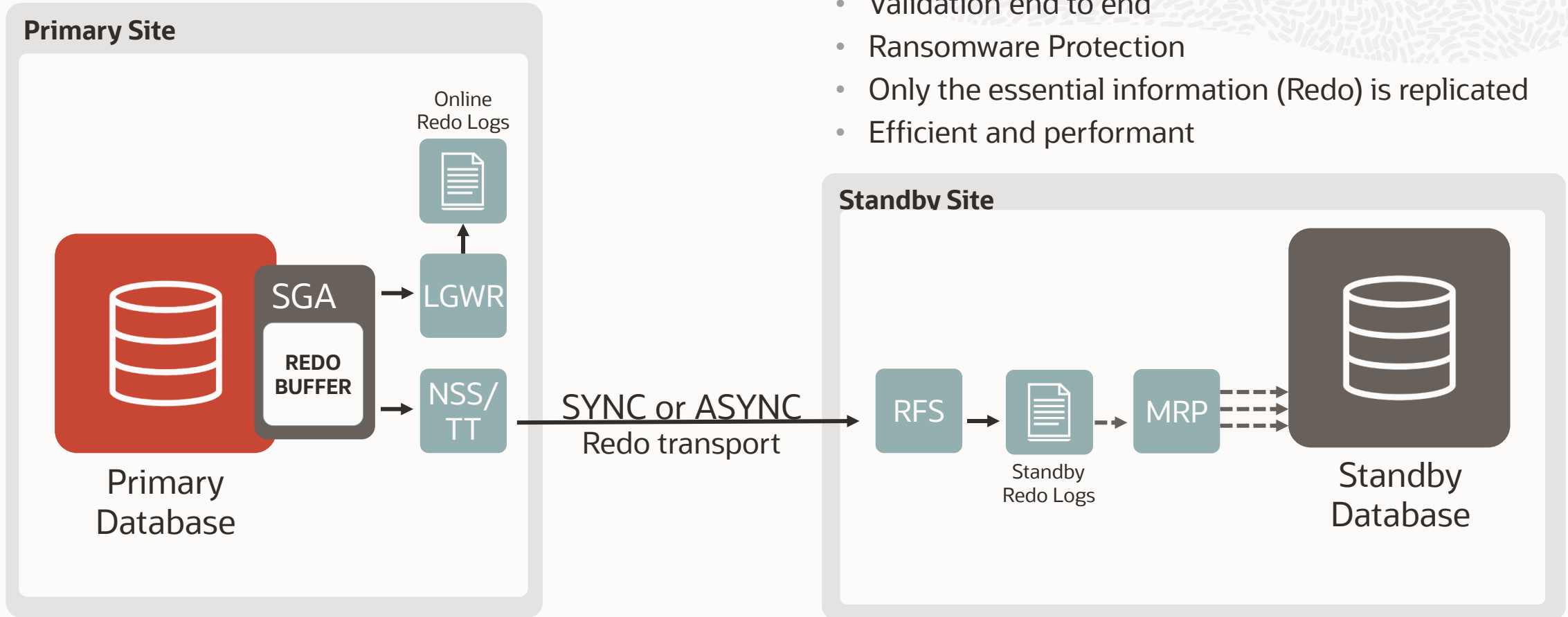
Storage Remote Mirroring Architecture

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



Data Guard is optimized for the database

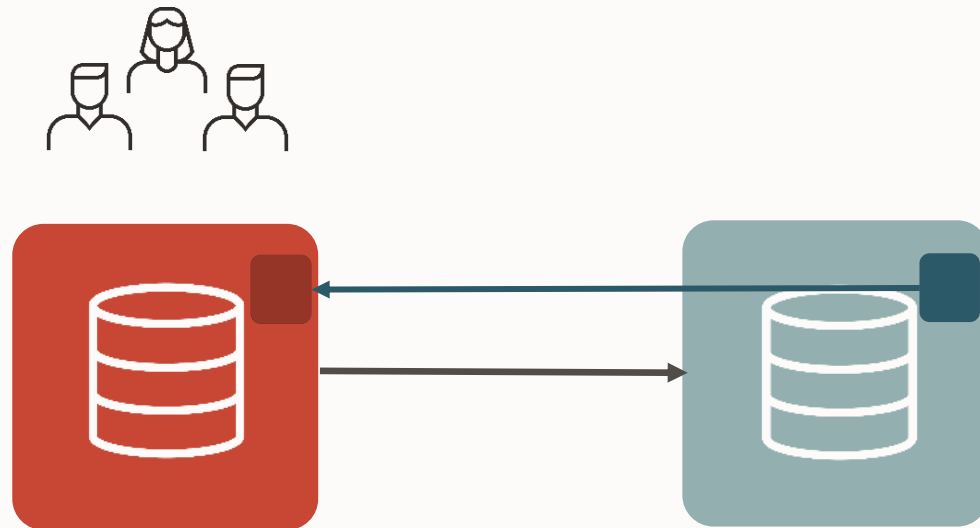
It efficiently maintains a **physical copy** of production and **guarantees its integrity**

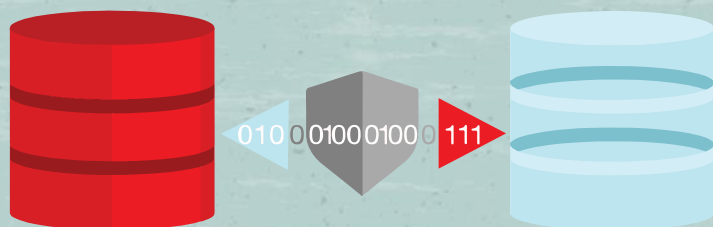


Active Data Guard Does What Storage Mirroring Can't

Automatic Block Repair - Transparently repairs corrupted blocks

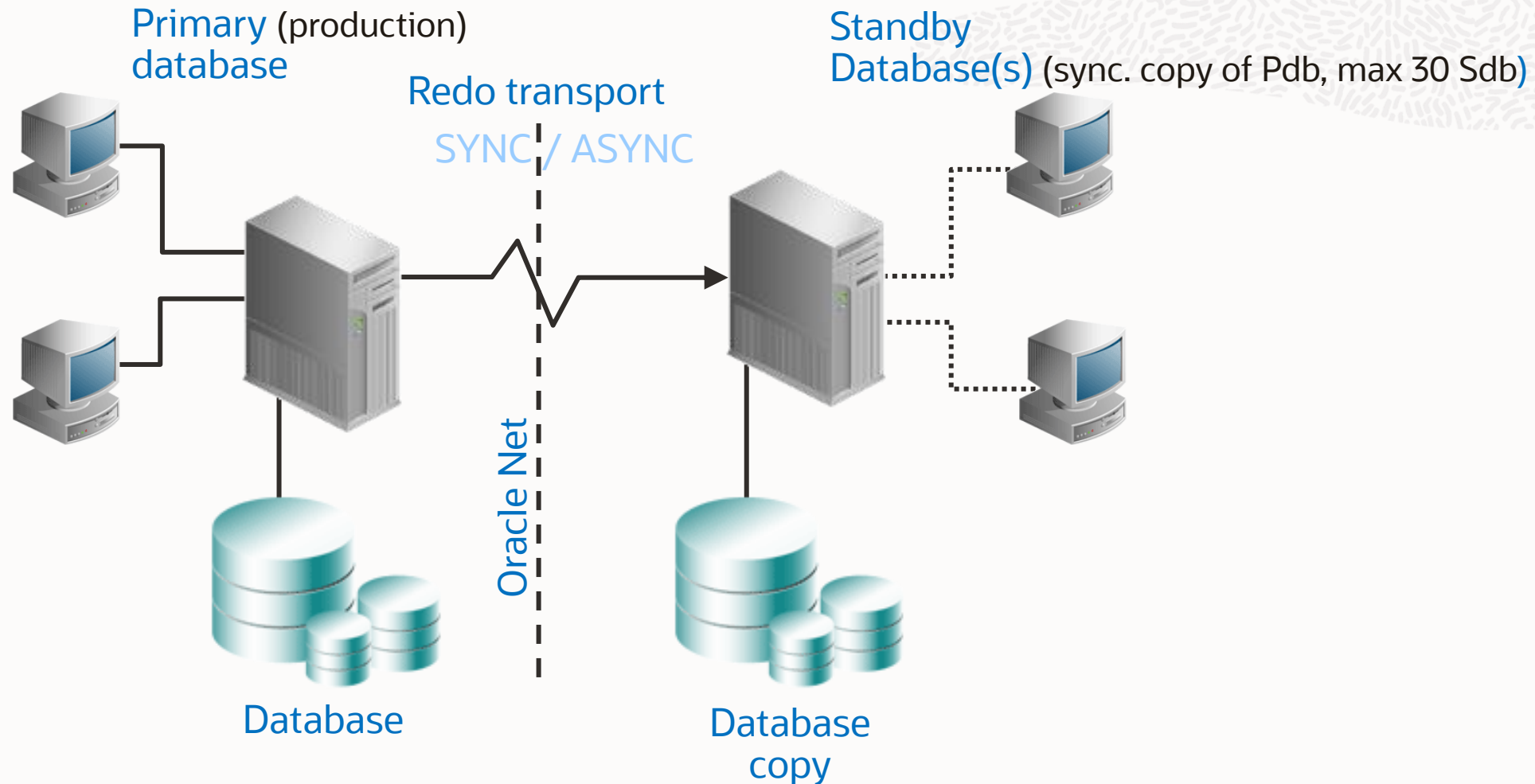
- Oracle will detect if block is corrupt when read at primary
- Corruption is automatically repaired using good copy from standby
- In same way, corruption detected at standby will also be repaired using good copy from primary





Oracle Data Guard Overview

What is Oracle Data Guard?



Works with a production db and one or more standby dbs to protect your data against failures, errors, and corruptions that might otherwise destroy your db

Types of Standby Databases

- **Physical standby database:**
 - Is identical to the primary database on a block-for-block basis
 - Is synchronized with the primary database through application of redo data received from the primary database
 - Can be used concurrently for data protection and reporting
- **Logical standby database:**
 - Shares the same schema definition
 - Is kept synchronized with the primary database by transforming the data in the redo received from the primary database into SQL statements and then executing the SQL statements
 - Can be used concurrently for data protection, reporting, and database upgrades
- **Snapshot standby database:**
 - Is a fully updatable standby database
 - Is created by converting a physical standby database
 - Can be used for updates, but those updates are discarded before the snapshot standby database is converted back into a physical standby database
 - Can be used for testing

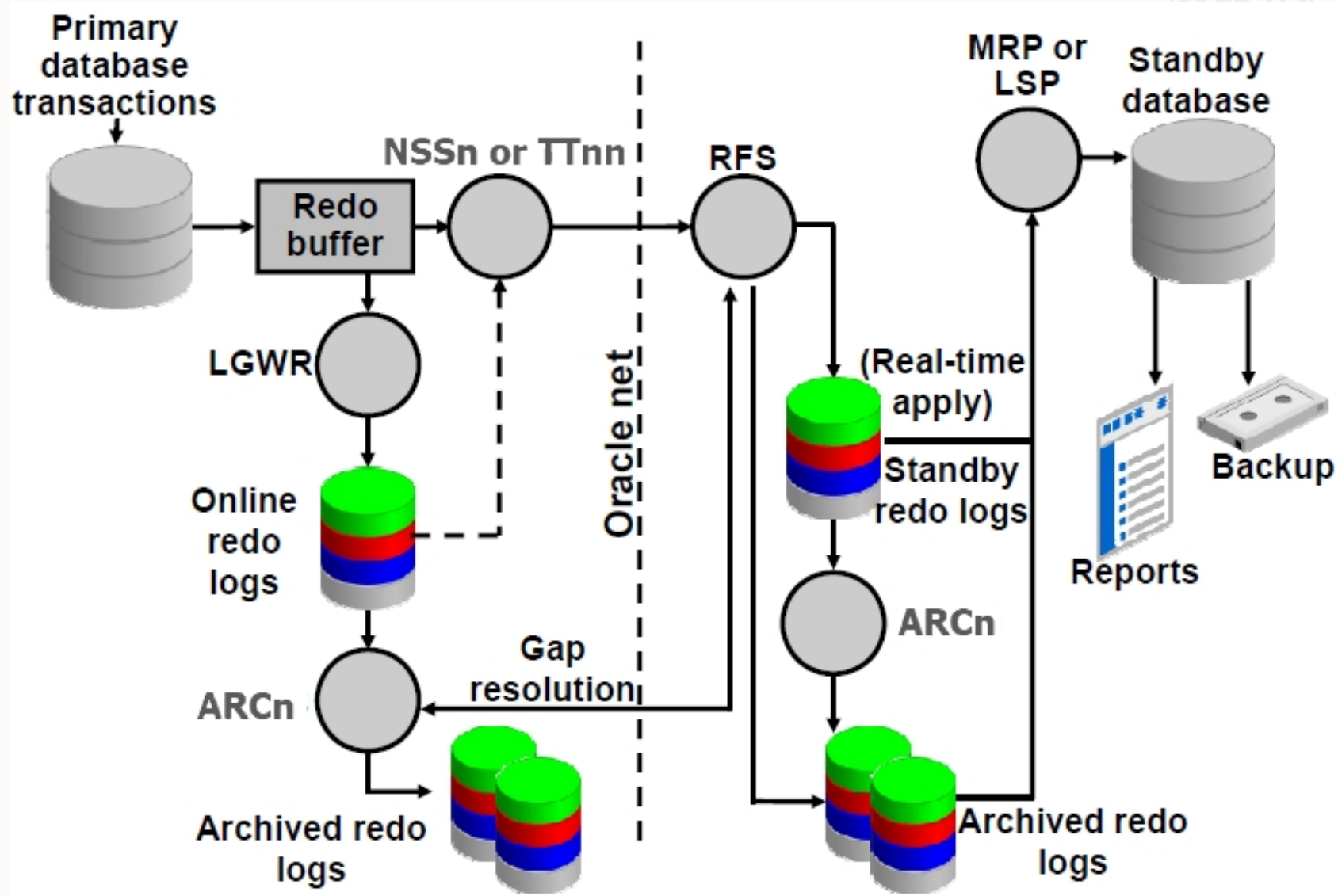


Role Transitions: Switchover and Failover

Data Guard provides supports 2 role-transition operations:

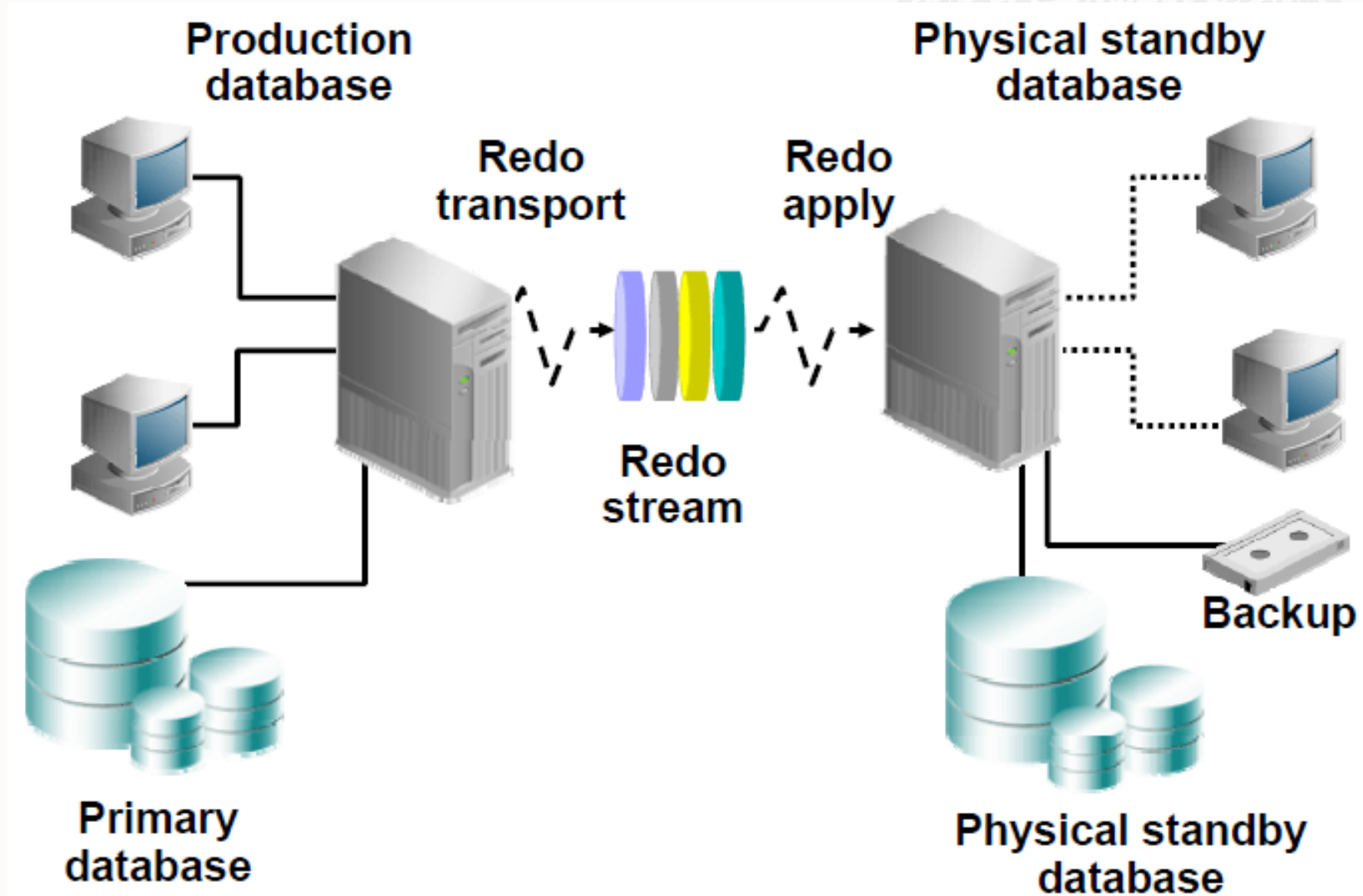
- **Switchover**
 - Planned role reversal
 - Used for OS or hardware maintenance
- **Failover**
 - Unplanned role reversal
 - Emergency use
 - Zero or minimal data loss (depending on choice of dataprotection mode)
 - Can be initiated automatically when fast-start failover is enabled

Oracle Data Guard: Architecture (Overview)



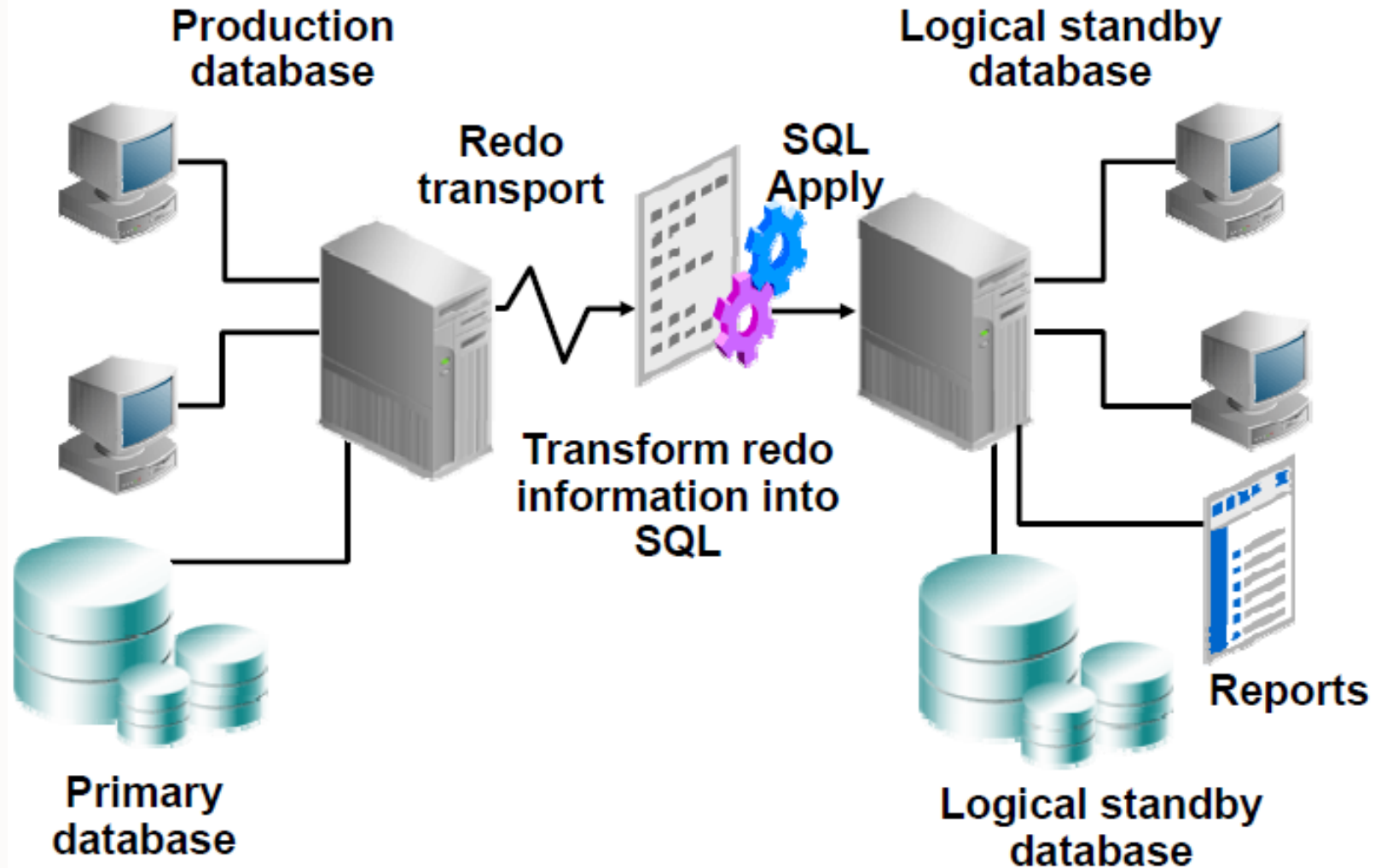
Physical Standby Database: Redo Apply Architecture

How is your physical standby database synchronized with a primary database

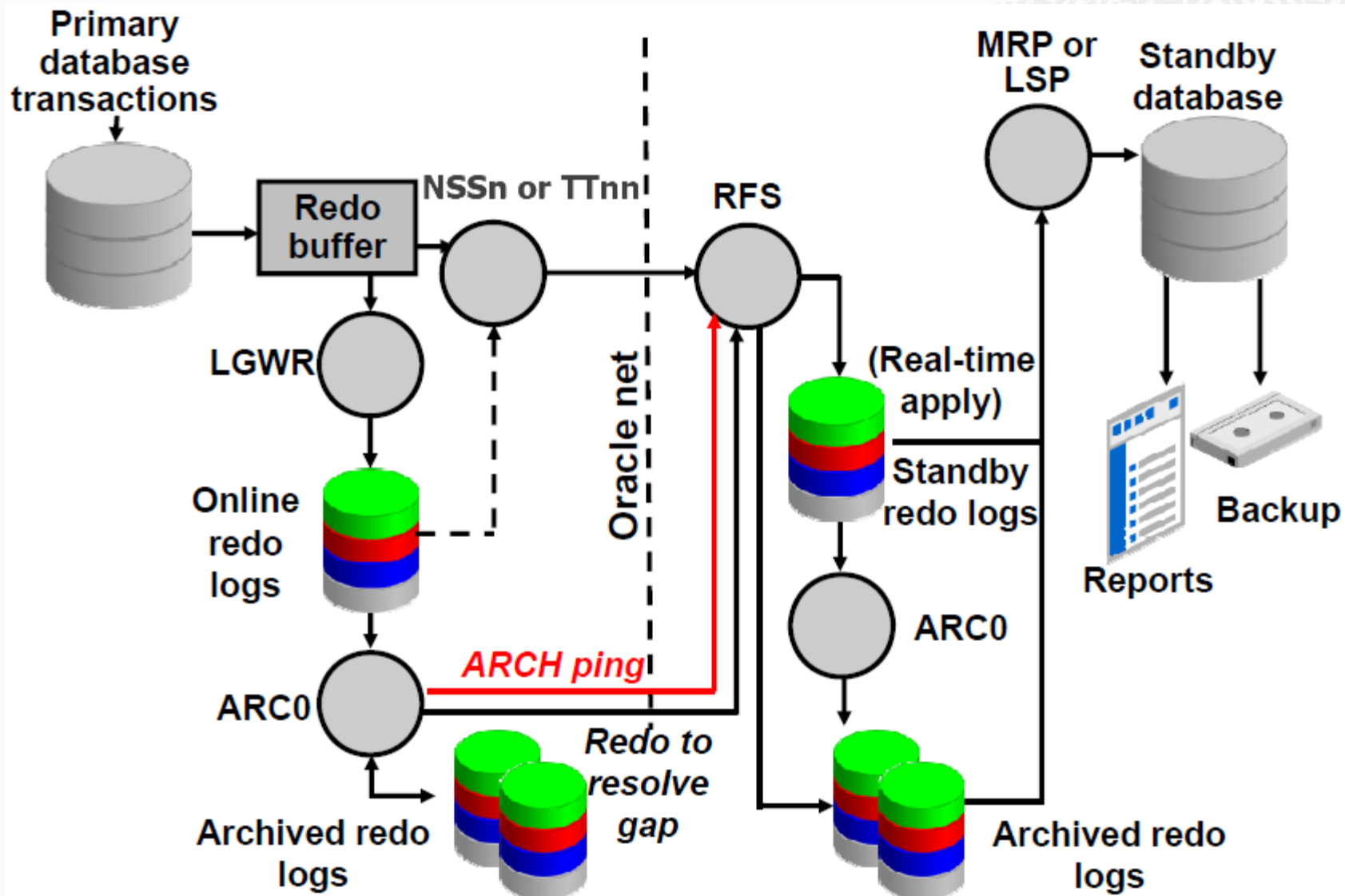


Logical Standby Database: SQL Apply Architecture

How is your logical standby database synchronized with a primary database



Automatic Gap Detection and Resolution



Data Guard Data Protection Modes

Different Configurations that Balance Data/Transaction Protection with Performance and Availability

Mode	Risk of data loss	Transport	If no acknowledgement from standby:
Maximum Protection	Zero Data Loss Double Failure Protection	SYNC	Stall primary until acknowledgement is received from replica
Maximum Availability	Zero Data Loss Single Failure Protection	SYNC	Stall primary until acknowledgement is received or timeout threshold period expires – then resume processing
Maximum Performance	Potential for Minimal Data Loss	ASYNC	Primary never waits for standby acknowledgement



Advanced Features with Oracle Active Data Guard

Oracle Active Data Guard (ADG)

- Increases performance, availability, data protection, and ROI wherever DG is used for real-time data protection and availability
- Is an option for Oracle Database Enterprise Edition
- Enhances quality of service by offloading resource intensive activities from a Production db to a Standby db
- Includes the following features:
 - Physical Standby with Real-time Query
 - Fast Incremental Backup on Physical Standby
 - Automatic Block Repair
 - Active Data Guard Far Sync
 - Global Data Services
 - Real-Time Cascade
 - Application Continuity
 - Rolling Upgrade using Active Data Guard
 - Active Data Guard DML Redirection (not available in Authorized Cloud Environments)
- Licensing Guide:
 - <https://docs.oracle.com/en/database/oracle/oracle-database/19/dblic/Licensing-Information.html#GUID-AB354617-6614-487E-A022-7FC9A5A08472>
- Demos:
 - <https://www.oracle.com/database/technologies/high-availability/dataguard-activedataguard-demos.html>

Dynamic: Activate Active Data Guard per database as demand requires it

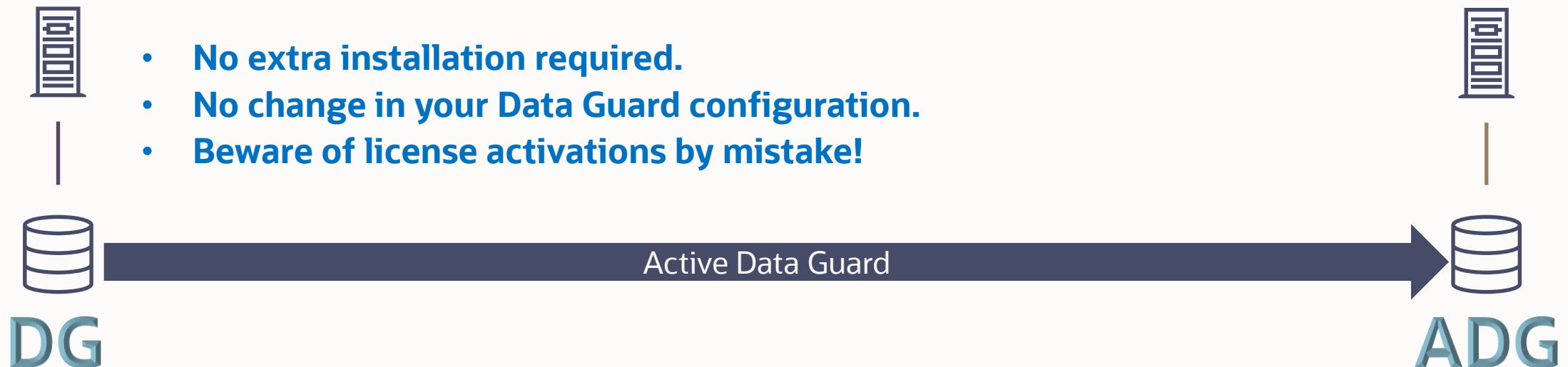
With Data Guard Broker

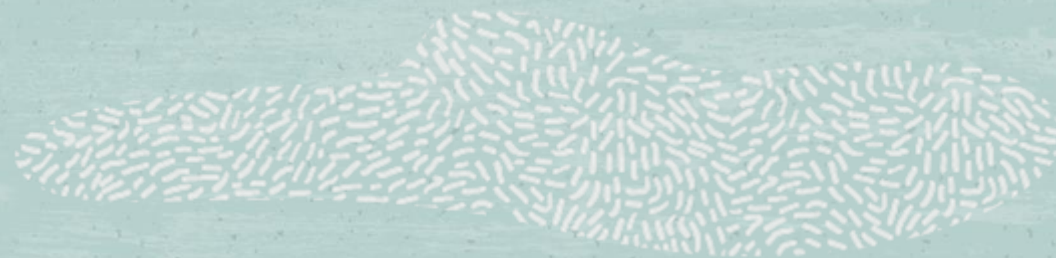
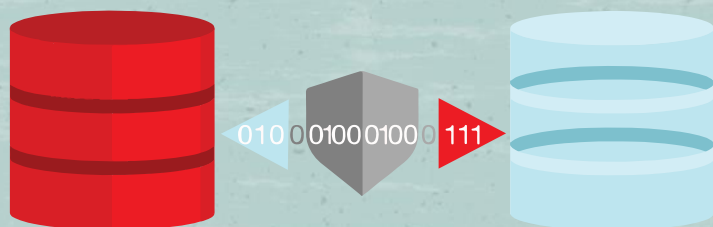
- Connect to the Standby db with SQL*Plus and execute the following command:
 - ALTER DATABASE OPEN;

Without Data Guard Broker

- Connect to the Standby db with SQL*Plus and execute the following commands:
 - ALTER DATABASE RECOVER MANAGED STANDBY DATABASE CANCEL;
 - ALTER DATABASE OPEN;
 - ALTER DATABASE RECOVER MANAGED STANDBY DATABASE DISCONNECT FROM SESSION;

- **No extra installation required.**
- **No change in your Data Guard configuration.**
- **Beware of license activations by mistake!**

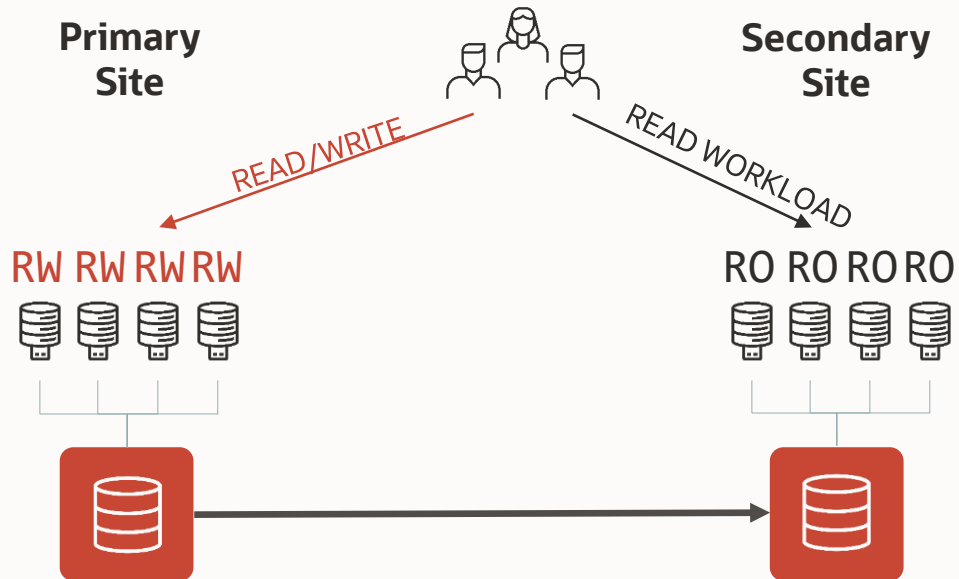




ADG: Real-Time Query

Real-Time Query

Read-only Standby while Recovery is Active



Activation

With Data Guard Broker:

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

Without Data Guard Broker:

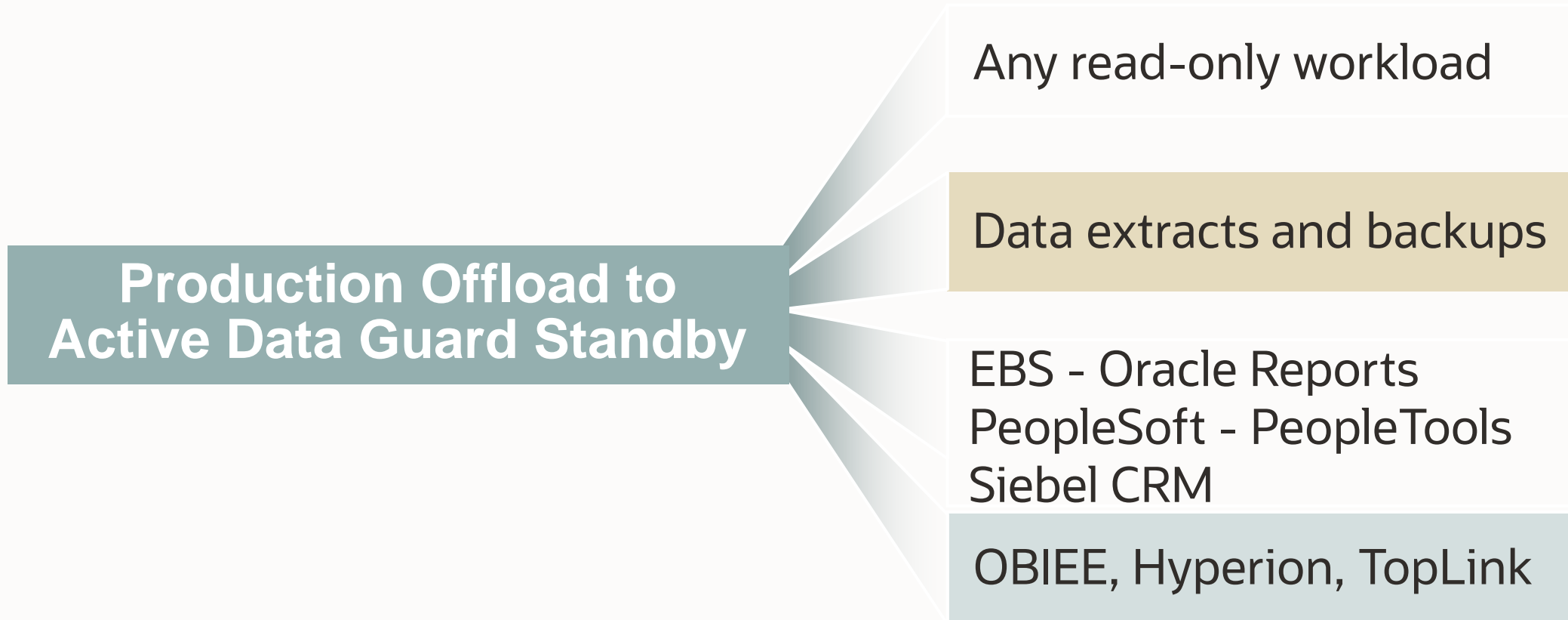
```
ALTER DATABASE RECOVER MANAGED STANDBY DATABASE CANCEL;  
ALTER DATABASE OPEN;  
ALTER DATABASE RECOVER MANAGED STANDBY DATABASE DISCONNECT;
```

Beware of license activations by mistake!

Offload Read-Only Workloads

Increase Performance and ROI – Standby is a Production System

ADG



Real-Time Query

Not just Selects for your Application Workloads!

ADG

SQL Performance Analyzer

Oracle Database In-Memory

Global Temporary Tables

R/O Connections Preserved

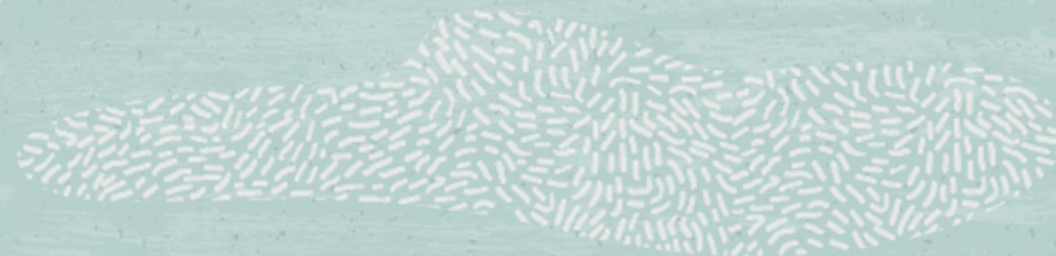
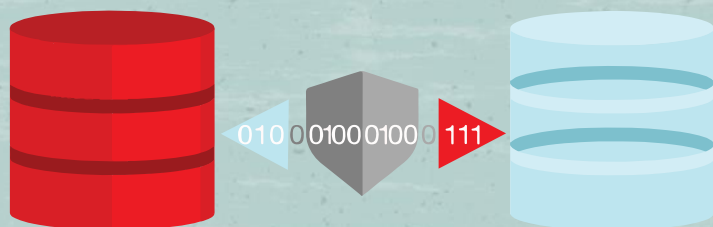
Sequences

Updates on ADG (DML Redirect)

NEW in 19c

Standby Result Cache preservation

NEW in 21c



ADG: DML Redirection

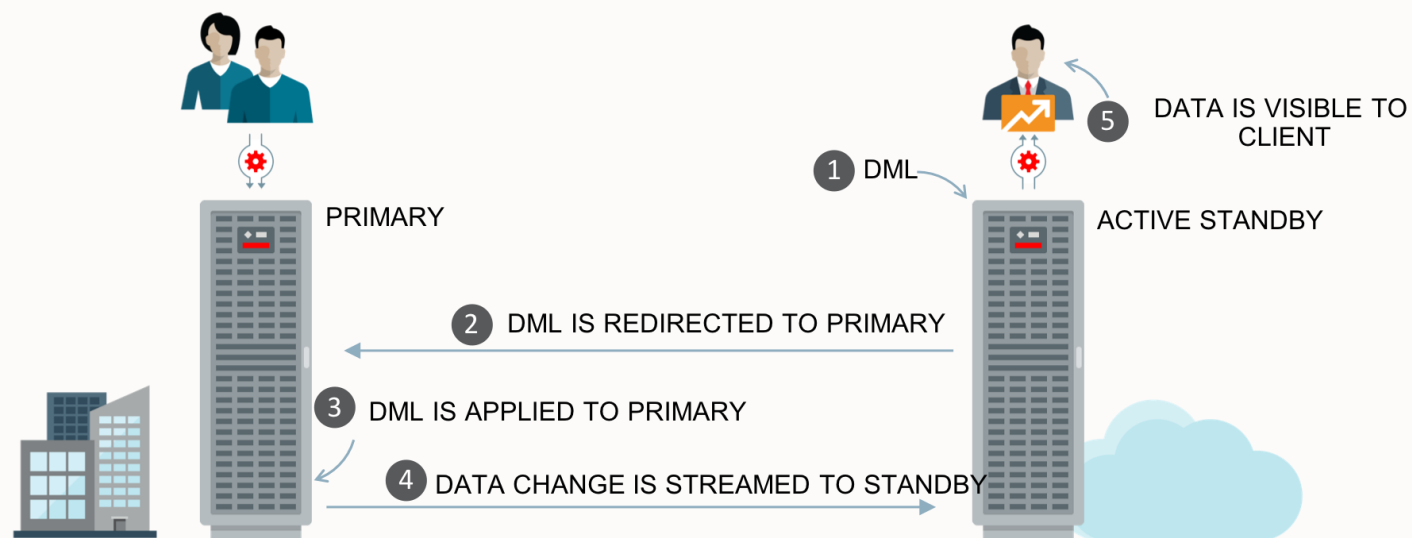
Bigger Footprint of ADG Applications

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 {session|system} ADG_REDIRECT_DML`
- New `ADG_REDIRECT_PLSQL` commands

Supported with Oracle Database 19c
Targeted for “Read-Mostly,
Occasional Updates” applications



DML Replication

Easy and ready to use

By default DMLs are not possible on the standby

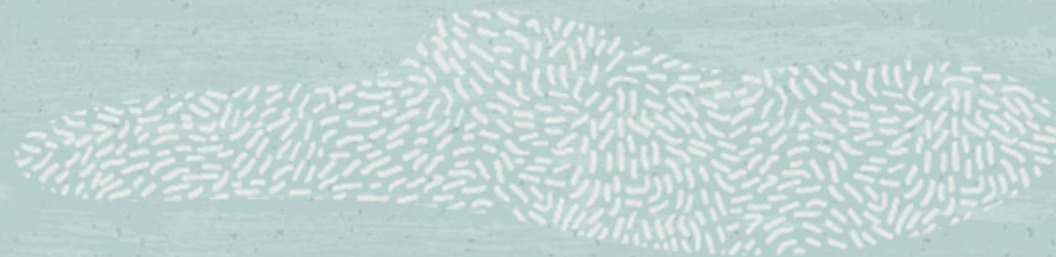
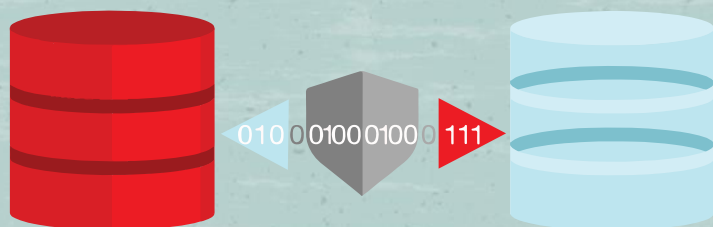
```
SQL> update hr.employee set salary=salary+100 where employee_id=1;
ERROR at line 1:
ORA-16000: database or pluggable database open for read-only access
```

Enable DML redirection on the standby

```
SQL> connect / as sysdba
Connected.
SQL> alter system set ADG_REDIRECT_DML=true;
```

DMLs work seamlessly

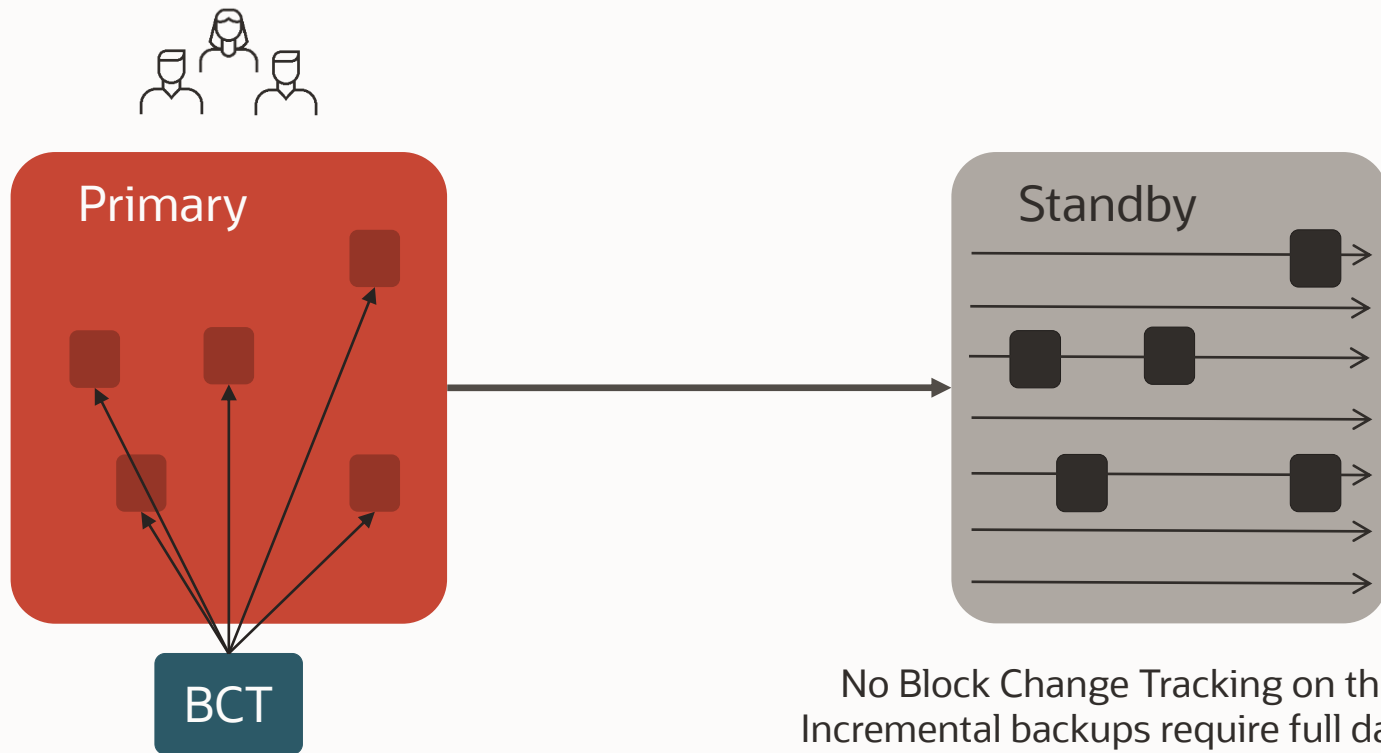
```
SQL> connect hr/**
Connected.
SQL> update hr.employee set salary=salary+100 where employee_id=1;
1 row updated.
SQL> commit;
Commit complete.
```



ADG: Fast Incremental Backup on Physical Standby

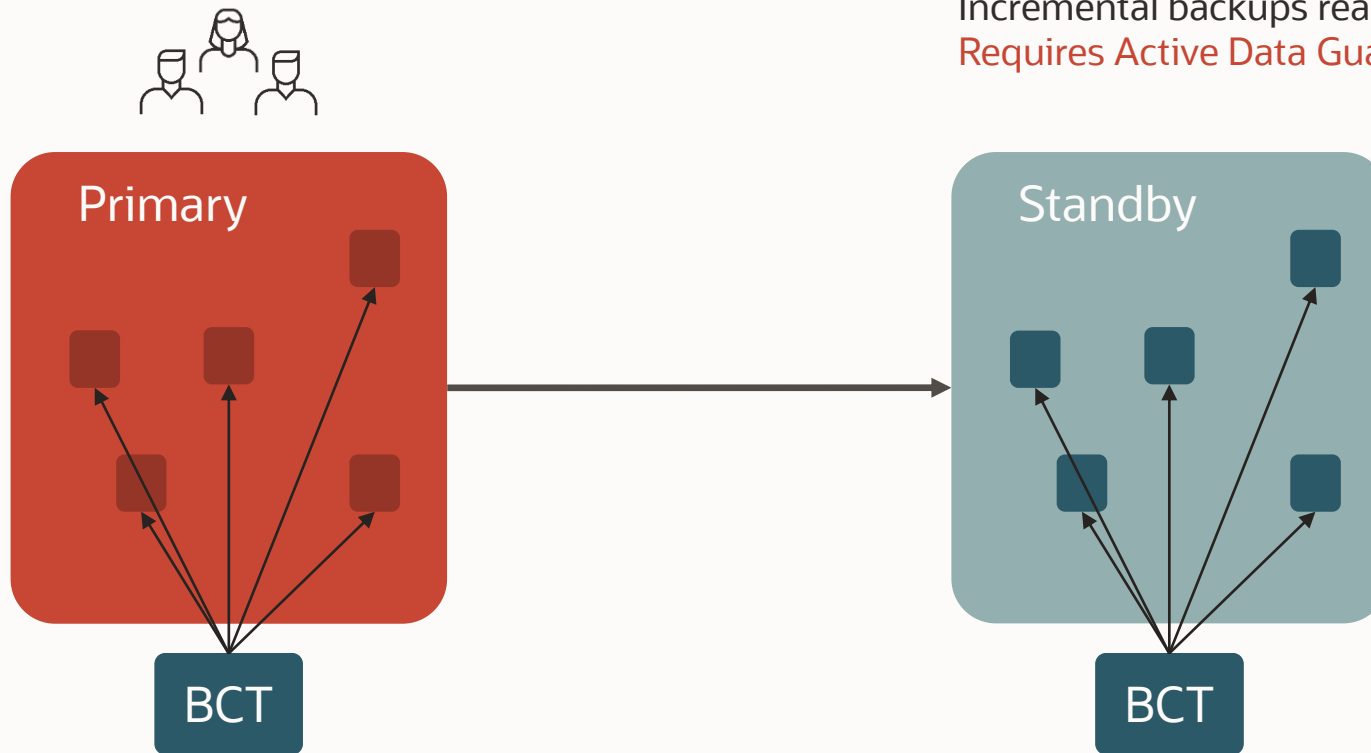
Fast Incremental Backup on Physical Standby

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

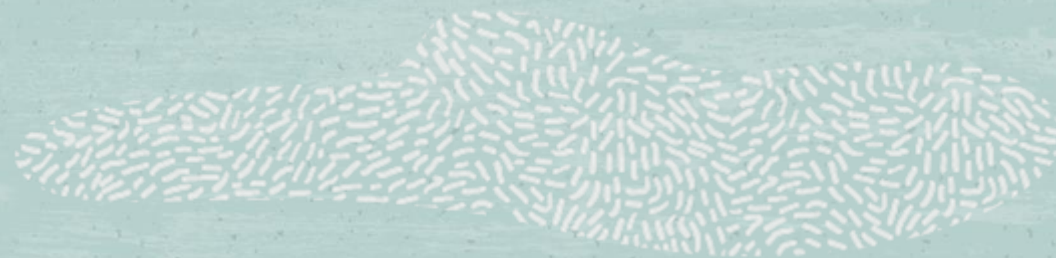
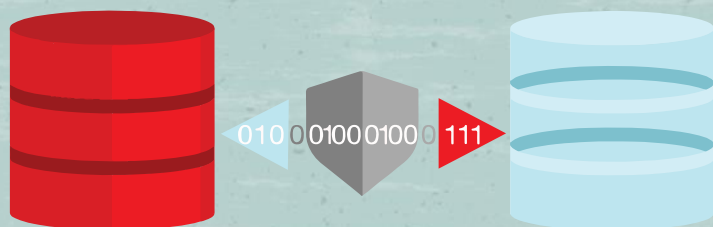


Fast Incremental Backup on Physical Standby

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



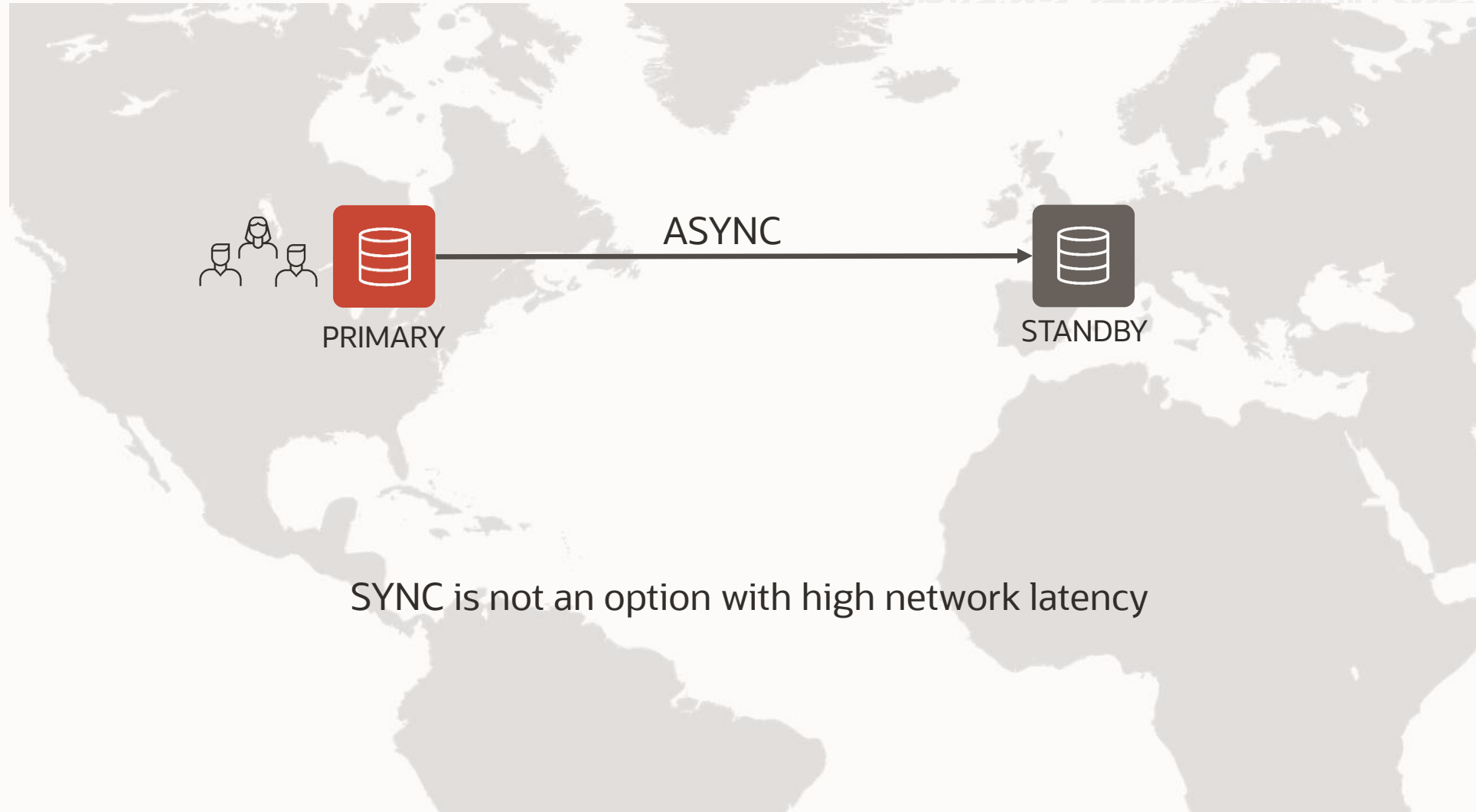
Block Change Tracking on the Standby:
Incremental backups read only the blocks modified since the last Level 0
Requires Active Data Guard



ADG: Far Sync

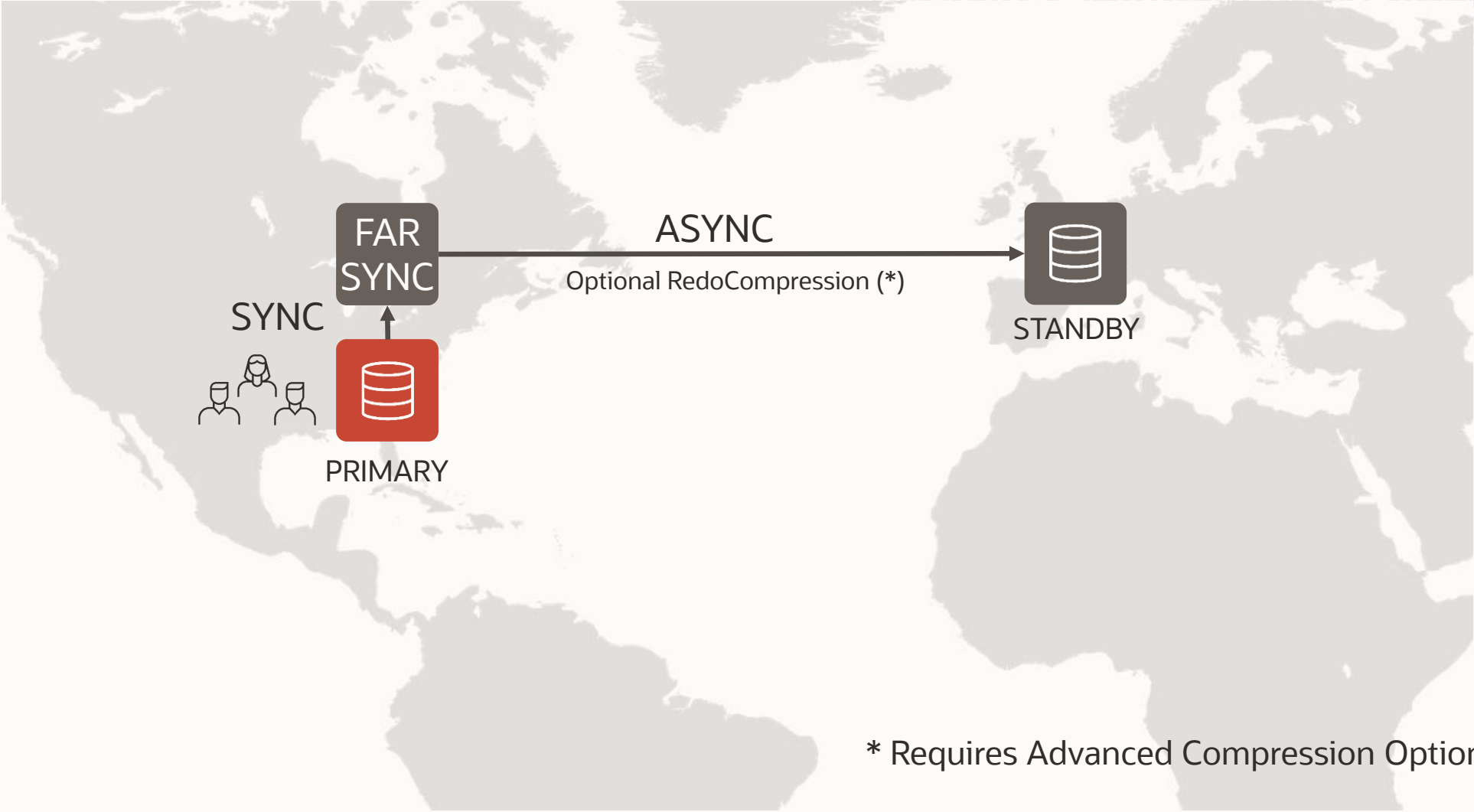
The Zero Data Loss Challenge

Trade-off Performance for Protection



Active Data Guard Far Sync

Zero Data Loss Protection at Any Distance

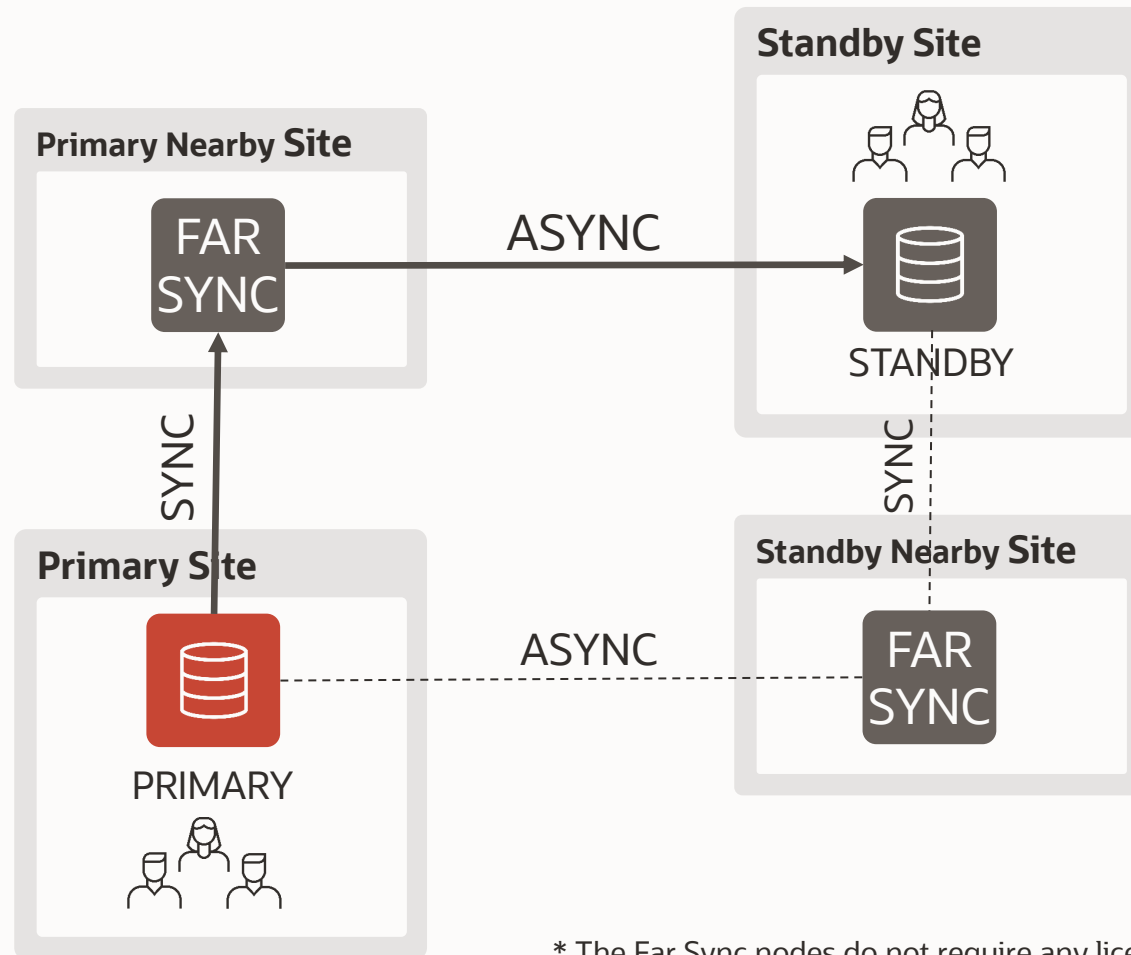


* Requires Advanced Compression Option



Active Data Guard Far Sync

Trade-off Performance for Protection



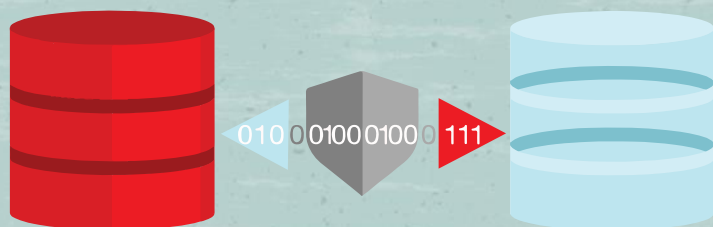
Far Sync

- **Requires ADG Option on the DB nodes**
- The Far Sync nodes do not require licenses *
- 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 MaxAvailability
- 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

* The Far Sync nodes do not require any license, provided that all the other nodes running databases in the configuration are licensed with Enterprise Edition and Active Data Guard

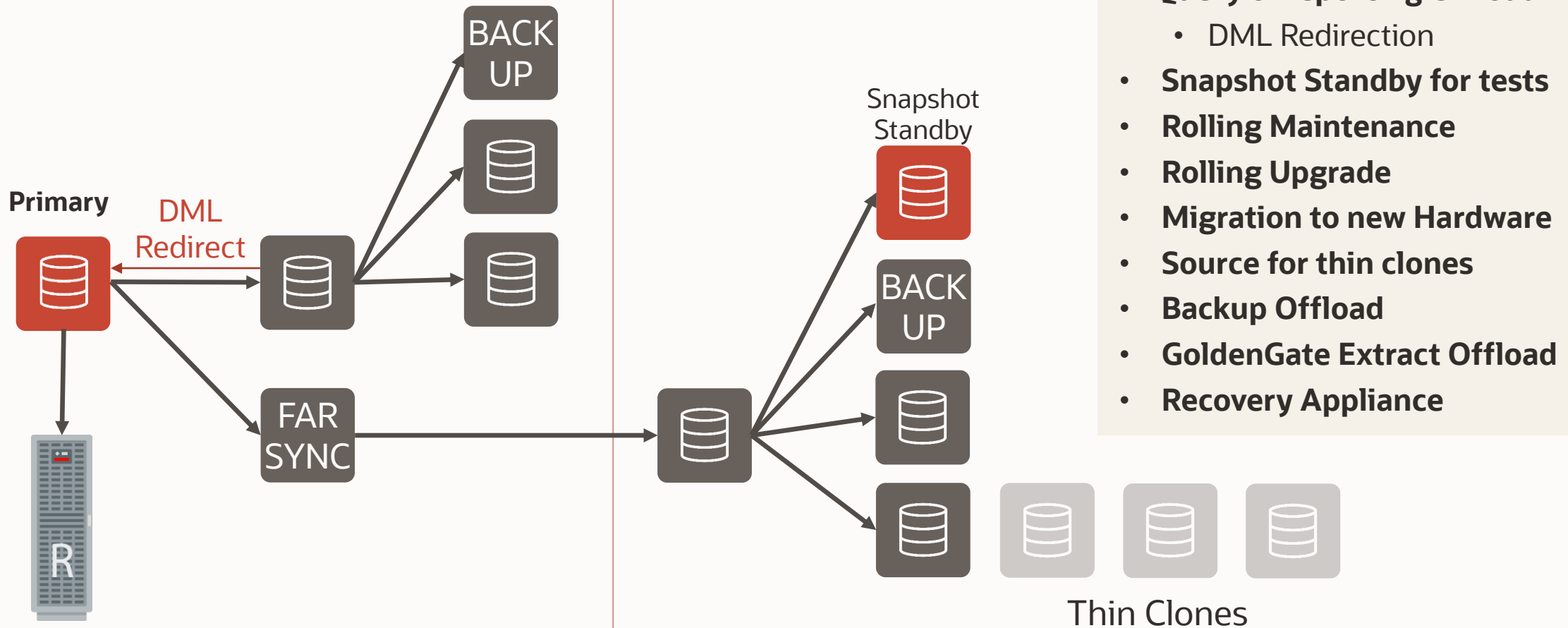


ADG: Real-Time Cascade Standbys

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

ADG

Far Sync and Cascading Standby open endless possibilities



Real-Time Cascade Standby

Offload multiple redo transports to a first-level standby

BOSTON



RedoRoutes=

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

NASHUA



RedoRoutes=

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

NEWYORK



NEWARK

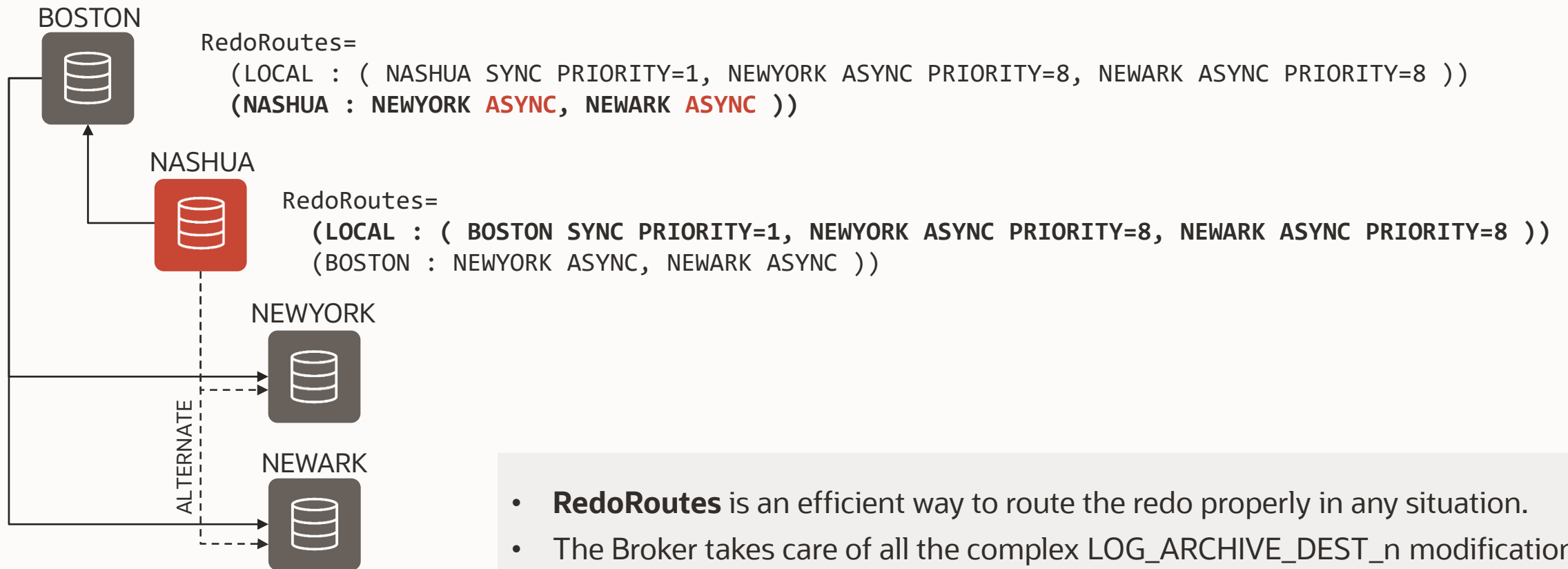


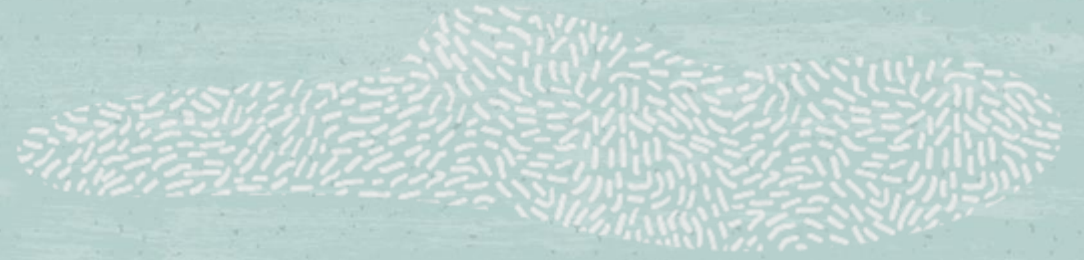
ALTERNATE

- 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.

Real-Time Cascade Standby

Offload multiple redo transports to a first-level standby





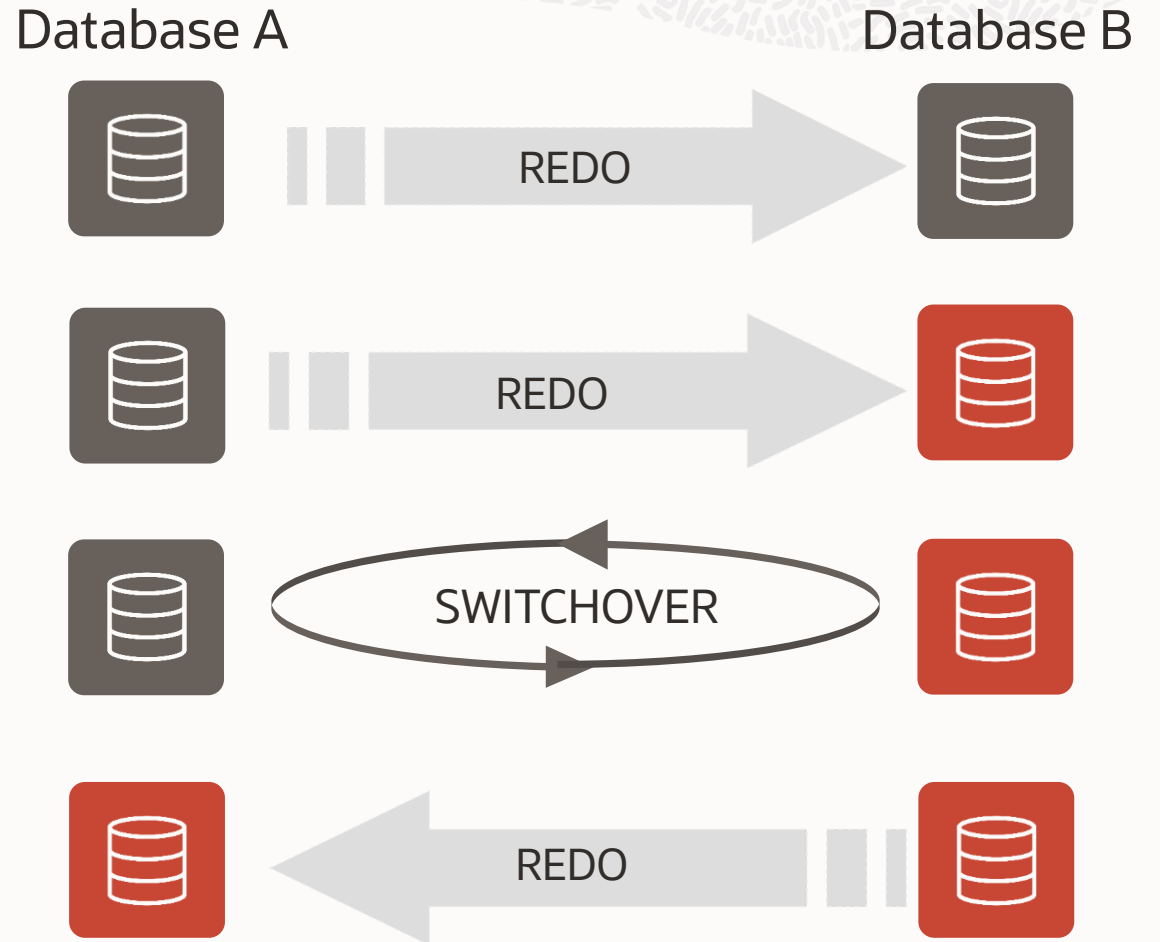
ADG: Rolling Maintenance and Upgrades

Reduce Planned Downtime

General Process for Database Rolling Maintenance



- Install new version in separate Oracle homes and defer transport
- Upgrade or perform other maintenance on B then synchronize with production
- Switch production to B, outage limited to the time needed to switch roles
- Upgrade A via redo stream and synchronize



Oracle Patch Assurance - Data Guard Standby-First Patch Apply (Doc ID 1265700.1)

Rolling Upgrade | **DBMS_ROLLING**

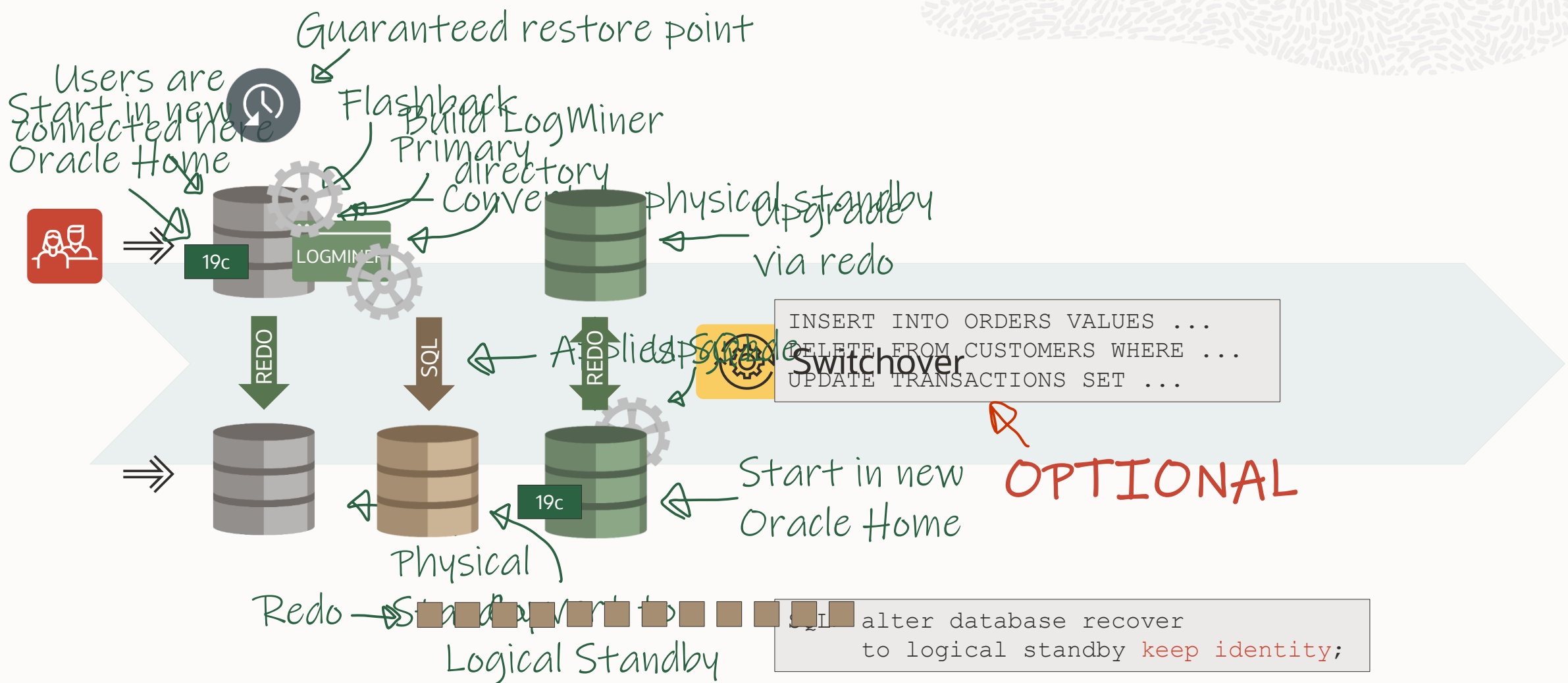


Use a logical standby database to upgrade with very little downtime.

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

Pro tip: Also useful for other maintenance activities

Rolling Upgrade | Concept



Rolling Upgrade | **DBMS_ROLLING**



6 SIMPLE STEPS

```
SQL> exec dbms_rolling.init_plan;  
SQL> exec dbms_rolling.build_plan;  
SQL> exec dbms_rolling.start_plan;
```

Upgrade database

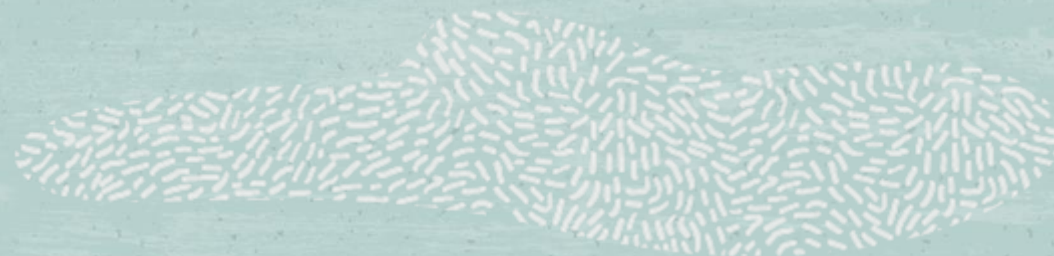
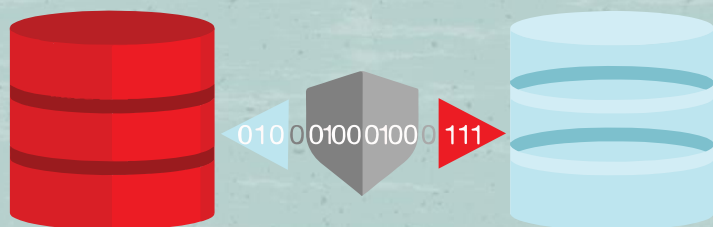
```
SQL> exec dbms_rolling.switchover;  
SQL> exec dbms_rolling.finish_plan;
```

Rolling Upgrade | **DBMS_ROLLING**

```
...
Get current redo branch of the primary database
Wait until recovery is active on the primary's redo
branch
Reduce to a single instance if database is a RAC
Verify only a single instance is active if future
primary is RAC
Stop media recovery
Execute dbms_logstdby.build
Convert into a transient logical standby
Open database including instance-peers if RAC
Verify logical standby is open read/write
Get redo branch of transient logical standby
Get reset scn of transient logical redo branch
Configure logical standby parameters
Start logical standby apply
```

86+ INSTRUCTIONS OR CHECKS

```
Stop logical standby apply
Start logical standby apply
Wait until apply lag has fallen below 600 seconds
Notify Data Guard broker that switchover to logical
standby database is starting
Log post-switchover instructions to events table
Switch database to a logical standby
Notify Data Guard broker that switchover to logical
standby database has completed
Wait until end-of-redo has been applied
...
```



Summary

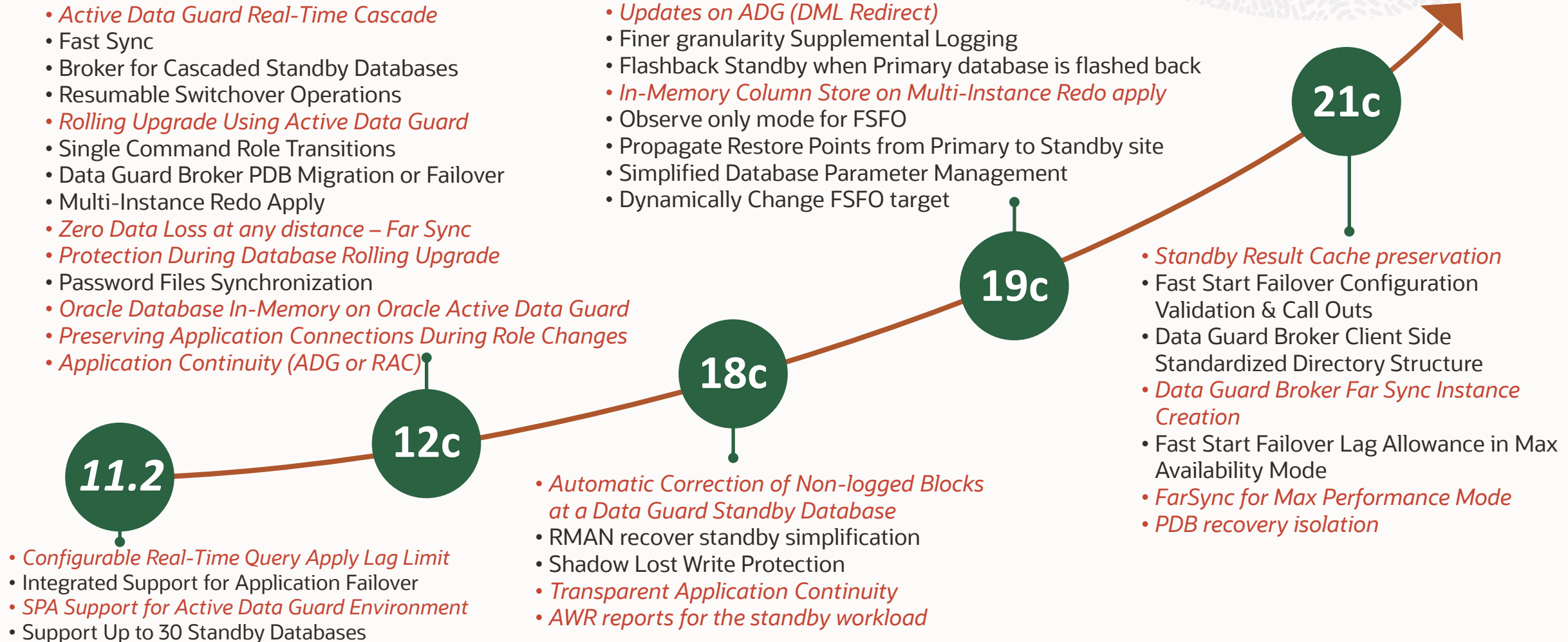
Benefits of Implementing Oracle Active Data Guard

- Most comprehensive and economical solution
- Continuous service
- Simple to implement and manage
- Efficient network utilization
- Complete data protection
- Elimination of idle standby systems
- Flexible configurations
- Centralized management:
- Excellent ROI



Oracle *Active* Data Guard

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



Thank you



ORACLE