

ORACLE

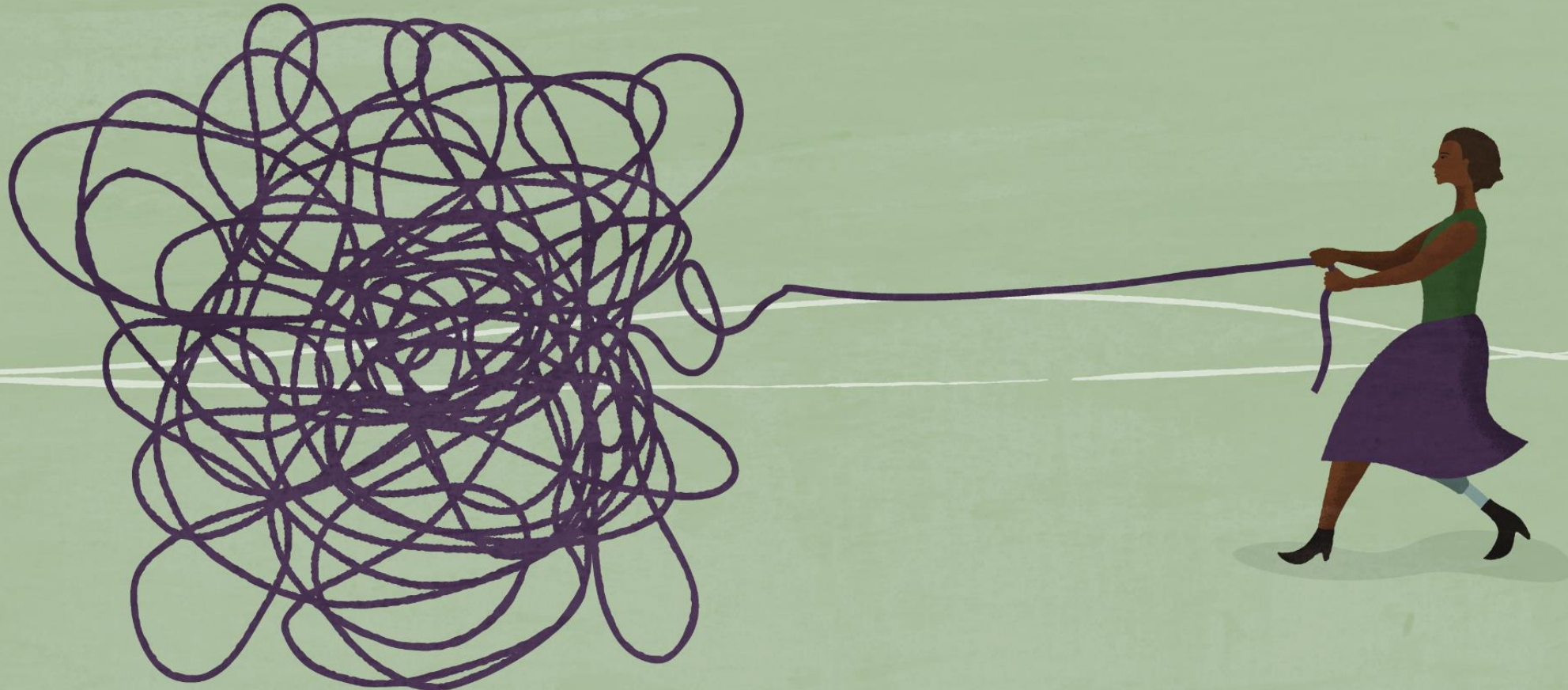
Oracle Maximum Availability Architecture (MAA)

Blueprints for reduced planned and unplanned downtime for
the On-Premises, Exadata-based or Cloud-based Oracle Database

October 2024



Why is Availability so important?



Impact of downtime



\$350K

average cost of
downtime per hour



87 hours

average amount of
downtime per year



\$10M

average cost of
unplanned data
center outage or
disaster



91%

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

Key terminology



High availability

A system type with redundant components and enabling software that provides consistent and uninterrupted service, even in the event of hardware or software failures.



Disaster Recovery

A method of protecting computer systems from failure, in which standby equipment automatically takes over when the main system fails.



Recovery Time Objective (RTO)

Time to resume application service after failure. The shorter the Recovery Time Objective (RTO) the quicker you get back to business.



Recovery Point Objective (RPO)

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

MAA & Chaos Engineering – Breaking things to ensure your peace of mind



Chaos Engineering is the art form of experimenting (i.e. proactively breaking things) on a system in order to build confidence in a system's resilience to withstand turbulent events in production

In today's digital age, this may include but is not limited to:

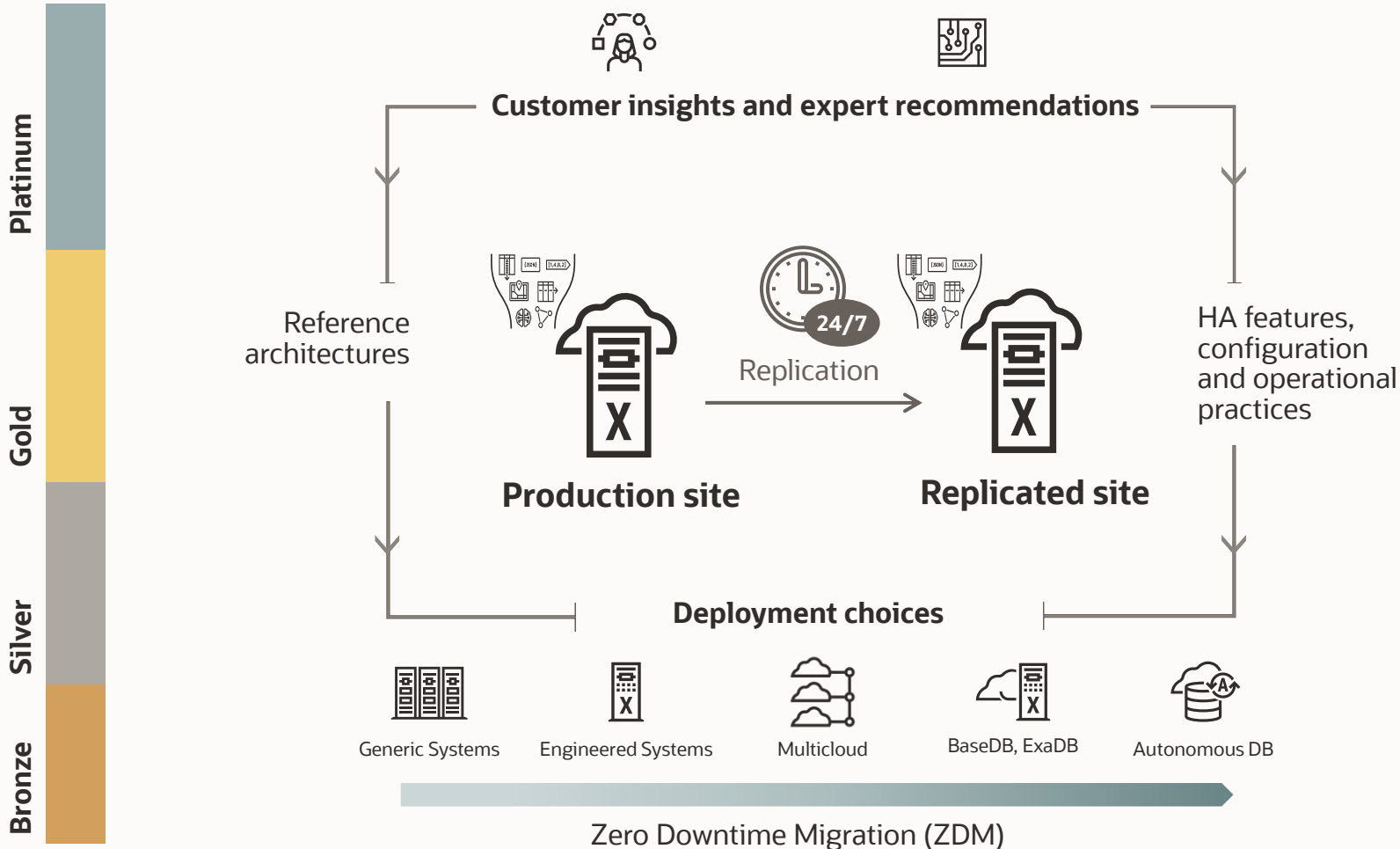
- Network, server & storage failures
- Human errors & data corruption
- Data corruption
- Power failures or site failure (i.e. *Godzilla attack or hurricane*)
- Application, database & server software updates
- Data reorganization or changes
- Application changes and optimizations

MAA: Blueprints for Oracle Database HA & DR




Oracle Maximum Availability Architecture (MAA)


Standard Reference Architectures for Never-Down Deployments




High performance



Resource Management




Database In-Memory




True Cache


Continuous availability



Application Continuity




Online Redefinition




Edition-based Redefinition


Data protection



Flashback




RMAN




ZDLRA+ ZRCV


Active replication



Active Data Guard




Full Stack DR




GoldenGate


Scale out & Lifecycle




RAC



Globally Distributed Database



FPP







Real Application Testing



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	Globally Distributed Database (optional)		
			



Oracle Database 23ai MAA Availability Features



Rolling Patching for Complex Changes



Globally Distributed DB with RAFT



Single Server Rolling Database Maintenance



DBMS_ROLLING with Application Continuity




FPP Lite



Exadata Fleet Update



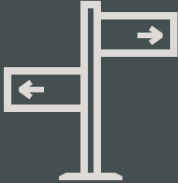
In-Database Firewall




Data Guard Redo Decryption for Hybrid DR Configurations



Oracle Database 23ai MAA Scalability Features



RAC Smart Connection
Load Balancing




True Cache



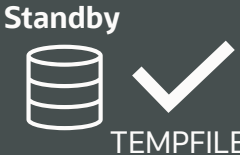
Real-time Query for
PDB Standby



Clusterware
Resiliency




Ordered Sequences
with Oracle RAC



Standby
Automatic tempfile
creation on the
standby database



Oracle RAC Fast Start
Reconfiguration



RDMA-based
Exadata RAC Scaling



Oracle MAA – Proven at Thousands of Customers



Thousands of Critical Deployments, On-Premises & Cloud

88% of Fortune Global 100 Run Exadata | 39% Run Exadata Cloud

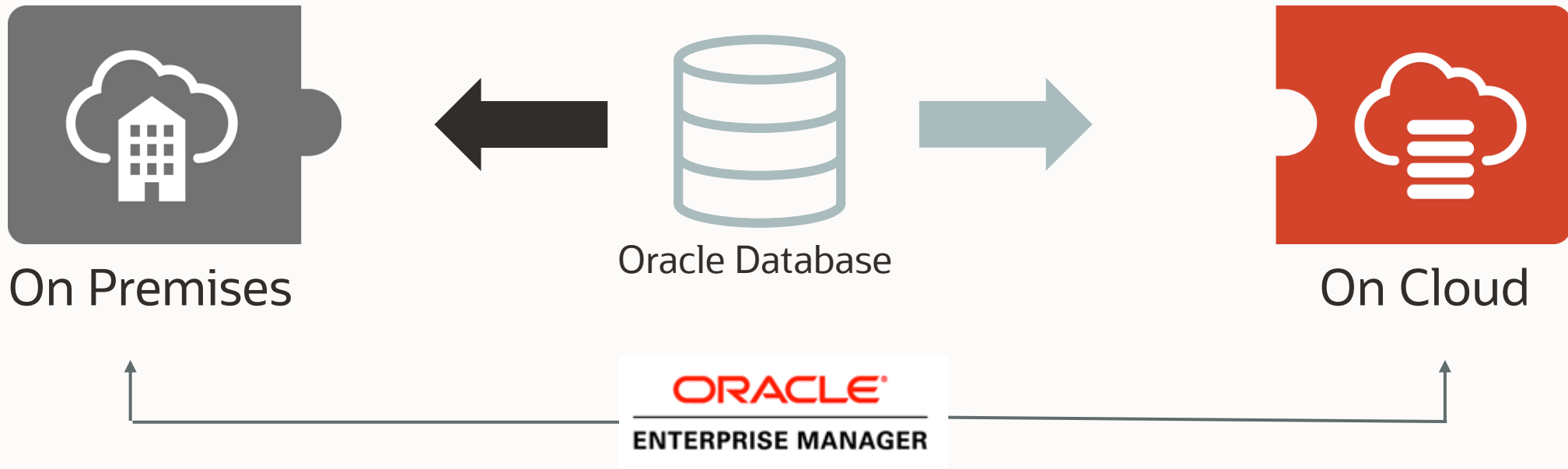
Superior Architecture for ALL Workloads

- **Petabyte Warehouses**
- **Super Critical Systems**
 - Financial Trading
 - Process manufacturing
 - E-commerce
- **Complex Applications**
 - SAP, Fusion Apps, E-Business Suite, NetSuite, Siebel, PeopleSoft, ...
- **Database Consolidation**
- **Maximum Availability Architecture**



Oracle MAA

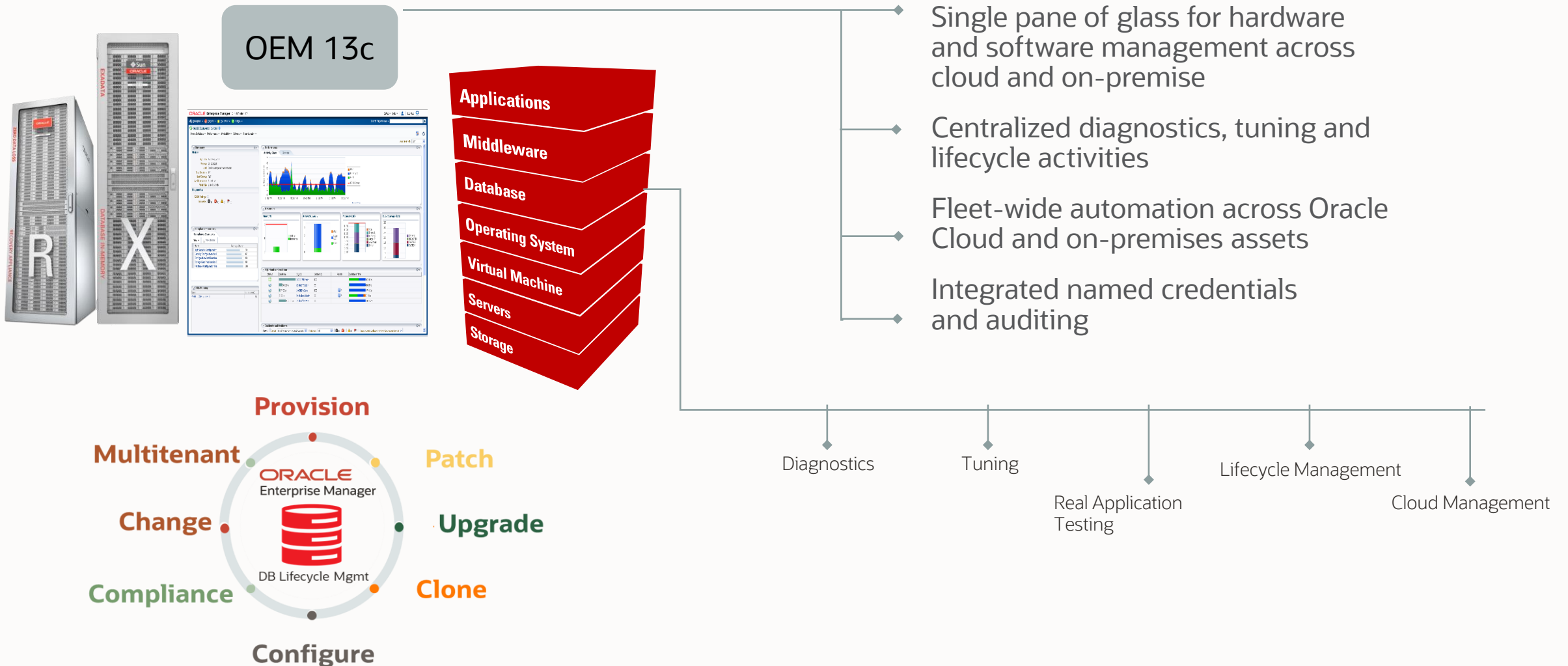
Designed to Address the Complete Range of Business Requirements



Common Platform – On Premises, Cloud, and Hybrid Cloud

Big Differentiator

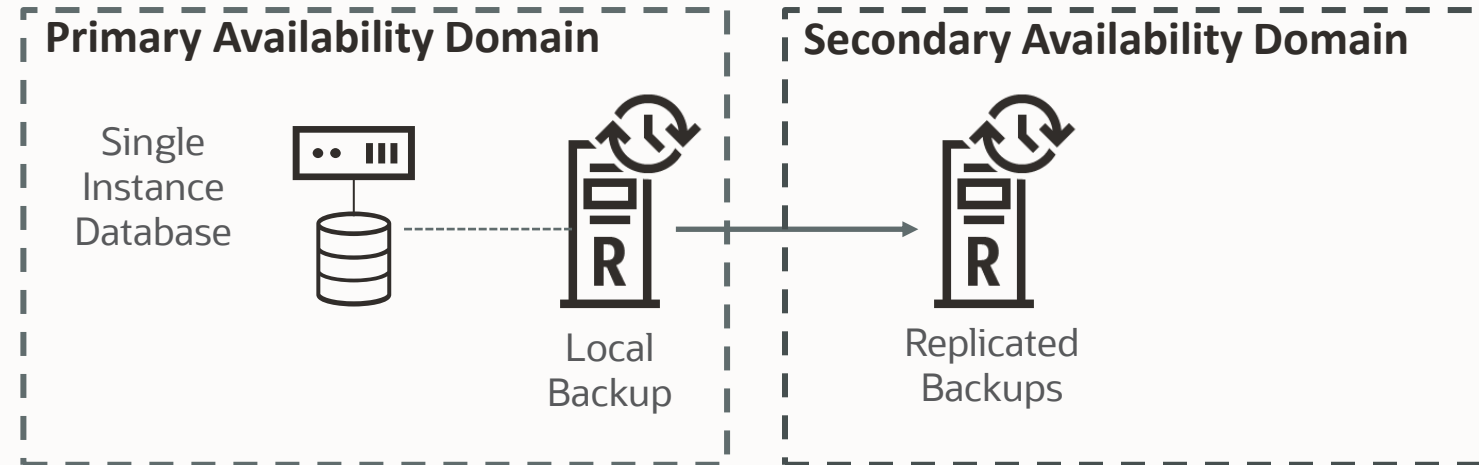
Oracle Enterprise Manager Provides a Single Pane of Glass



BRONZE

Dev, Test, Prod - Single Instance or Multitenant Database with Backups

- Single Instance with Clusterware Restart
- Advanced backup/restore with RMAN
 - Optional ZDLRA with incremental forever and near zero RPO
- Storage redundancy and validation with ASM
- Multitenant Database/Resource Management with PDB features
- Online Maintenance
- Some corruption protection
- Flashback technologies



Outage Matrix

Unplanned Outage	RTO / RPO Service Level Objectives (f1)
Recoverable node or instance failure	Minutes to hour (f2)
Disasters: corruptions and site failures	Hours to days. RPO since last backup or near zero with ZDLRA
Planned Maintenance	
Software/hardware updates	Minutes to hour (f2)
Major database upgrade	Minutes to hour

f1: RPO=0 unless explicitly specified

f2: Exadata systems has RAC but Bronze Exadata configuration with Single Instance database running with Oracle Clusterware has highest consolidation density to reduce costs





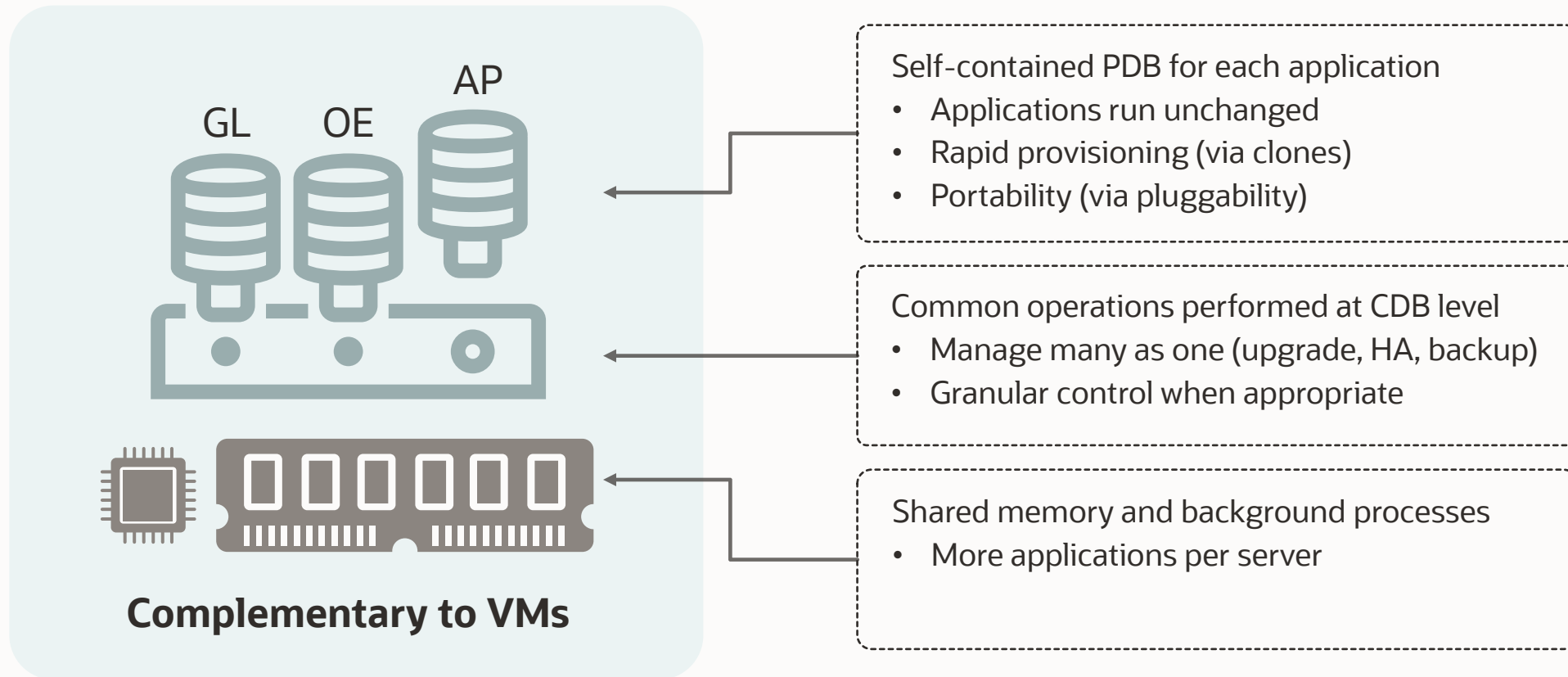
Oracle Clusterware for Automatic Restart

1. Oracle Clusterware is available for all Oracle Databases
 2. Enables HA capabilities and resource management:
 - Automatic Restart of database instances, listeners and other resources
 - Fleet patching
 - Service management including restarting service after failure
 - Automatic Storage Management (ASM) for HA, data protection and ease of use
- Trade off: additional software maintenance for Grid Infrastructure



Advantages of Multitenant Architecture

Isolation and agility with economies of scale





Oracle Multitenant Features



Rapid cloning and provisioning

- Local clones and remote clones
- Snapshot clones
- Refreshable PDBs



Manage many as one

- Database consolidation
- Improve productivity
- Maintain granular control



Improve agility for development teams

- Pre-configured service level agreement
- Compatibility
- Interface



Enhance security

- Separation of duties
- Data security
- Resource isolation



Integration with Oracle RAC

- High availability
- Scalability
- Flexibility





Pluggable Database Backup, Restore and Recovery

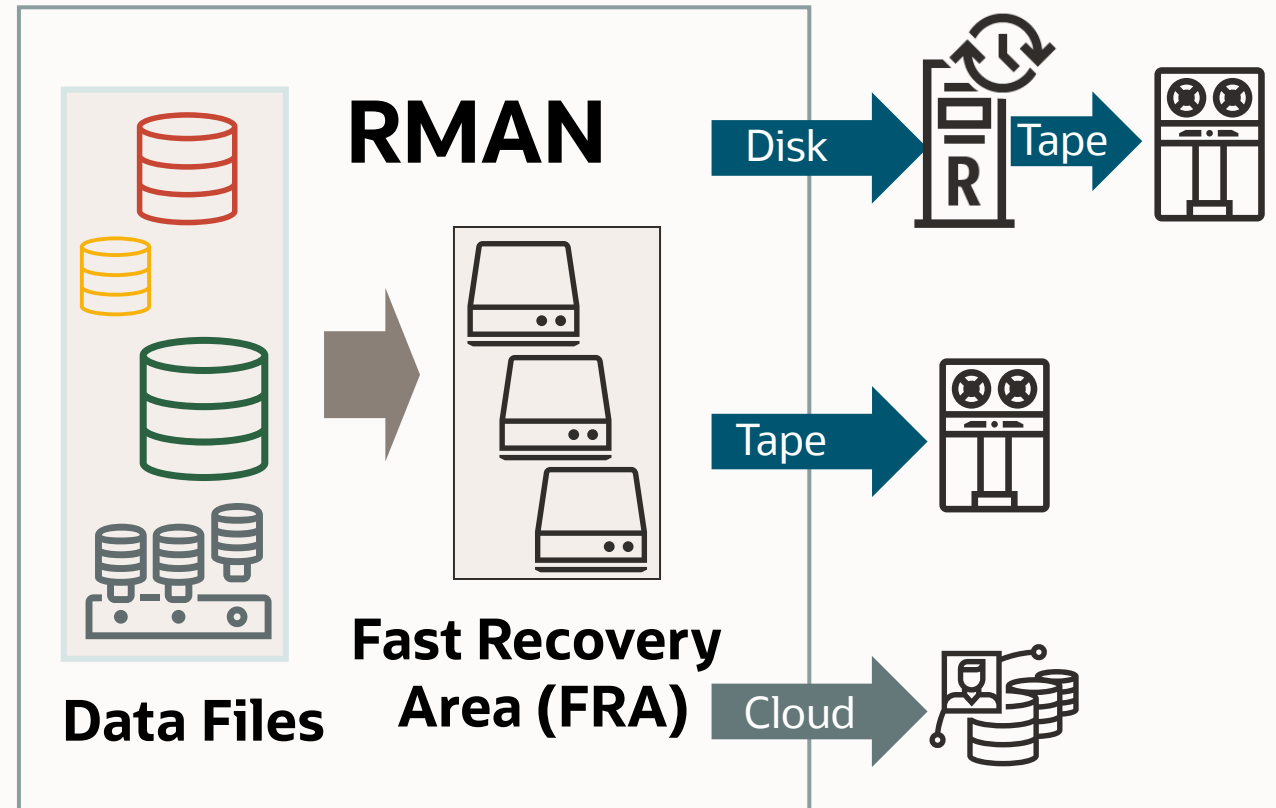
- Backup and restore pluggable database ...
- Create Restore Point 'before_event' for pluggable database...
 - Normal or Guaranteed Restore Point
 - Clean Restore Point
- Flashback Pluggable Database
- Complete ZDLRA support



Oracle Recovery Manager - RMAN

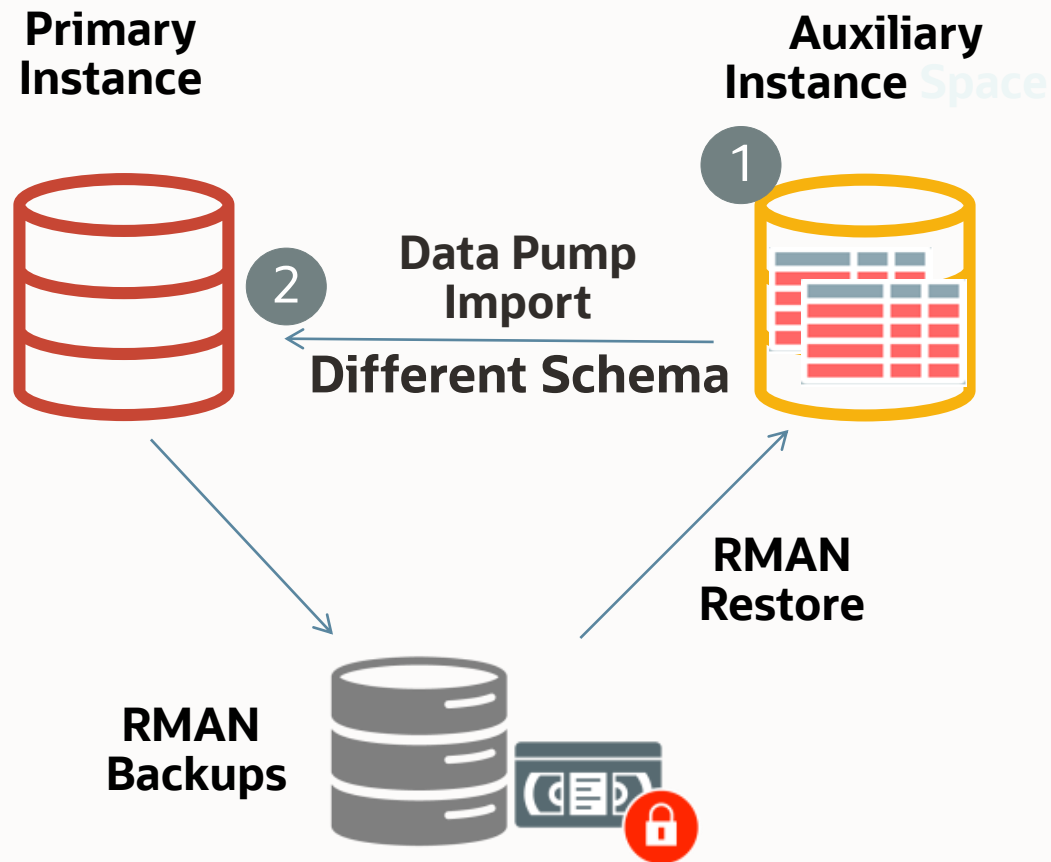
Database Integrated Backup and Recovery

- Unique knowledge of database file formats and recovery procedures
 - Oracle block validation
 - Online block-level recovery
 - Native encryption, compression
 - Table/partition-level recovery
 - Oracle Multitenant support
- Tape and cloud backups
- Unified Management





RMAN Enhancements for Table Recovery



- 1) Check Auxiliary Instance Disk Space
 - Automated Table Recovery requires disk space for SYSTEM, SYSAUX, UNDO and User Tablespace(s)
 - Pre-check for space in the Auxiliary Instance disk space to avoid failures in the middle of the process
- 2) Recovery Across Schema
 - Enables Table level recovery under different schema
 - Provide **OLD: NEW Schema(s)** under **REMAP TABLE**

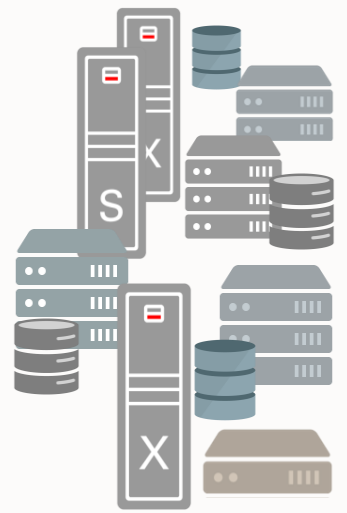
```
RECOVER TABLE hr.department, sales.product  
UNTIL SCN 1234 AUXILIARY DESTINATION  
' /tmp/' REMAP TABLE  
hr.department:dev.testdepartment,  
sales.product:mkt.newproduct;
```



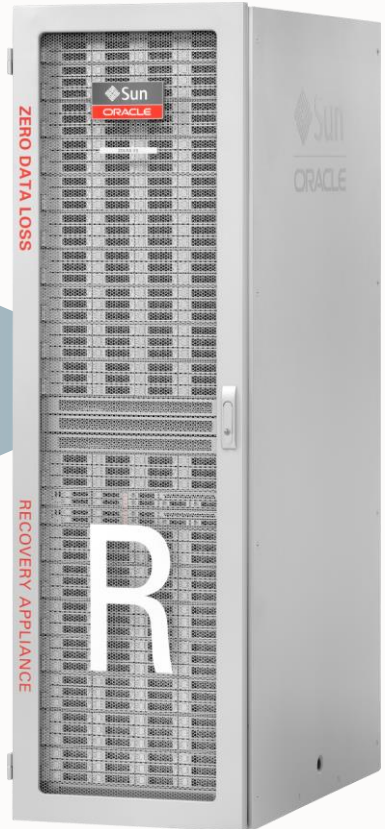
Recovery Appliance Recommended

EM Real-Time Protection Status & Space Monitoring

Databases



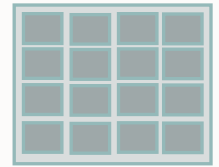
Transactional Block Changes



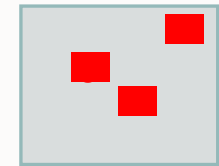
Oracle DB 12c-21c on Any Platform

No More Full Backups, Incremental Forever

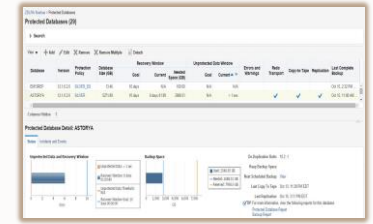
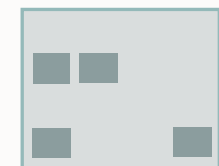
Day 1 Full



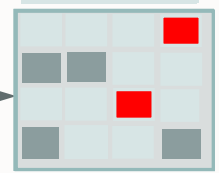
Day 2 Changes



Day N Changes



Day N State



Virtual Full Backup



Cloud Storage



Remote Replica



Tape

**End-to-End Oracle Recovery Validation
Near Zero Data Loss for DR**





Database and Exadata Health Checks

Assessment Report

- Health Score, Summary, Findings

Findings & Recommendations

- How to Solve the problem?

MAA Score Card

- MAA architectural readiness and configuration practices

Oracle Exadata Assessment Report

System Health Score is 89 out of 100 (detail)

Cluster Summary

Cluster Name	cluster-clu1
OS/Kernel Version	LINUX X86-64 OELRHEL 5.2.6.39-400.124.1.el5uek
CRS Home - Version	/u01/app/11.2.0.4/grid - 11.2.0.4.1
DB Home - Version - Names	/u01/app/oracle/product/11.2.0.4/dbhome_1 - 11.2.0.4.1 - dbm
EM Agent Home	/u01/app/oracle/em/agent_haem/core/12.1.0.5.0
Exadata Version	11.2.3.3.0
Number of nodes	9
Database Servers	2
Storage Servers	3
IB Switches	4
exachk Version	12.1.0.2.6(BETA).20160125
Collection	exachk_randomadm07_dbm_012516_141503.zip
Duration	10 mins, 49 seconds
Executed by	root
Collection Date	25-Jan-2016 14:15:39

Note! This version of exachk is considered valid for 120 days from today or until a new version is available

NOTE : exachk is only one part of the MAA Best Practices recommendation methodology. My Oracle Support "Oracle Exadata Best Practices (Doc ID 25252.1)" should be reviewed thoroughly as it is the driver for exachk and contains additional operational and diagnostic guidance that is not programmed within exachk.

WARNING! The data collection activity appears to be incomplete for this exachk run. Please review the "Killed Processes" and / or "Skipped Checks" section and refer to "Appendix A - Troubleshooting Scenarios" of the "Exachk User Guide" for corrective actions.

Database Server

Status	Type	Message	Status On	Details
FAIL	SQL Parameter Check	ASM parameter SGA_TARGET is NOT set according to recommended value.	All Instances	View
WARNING	Patch Check	Patch 16618055 not is applied on RDBMS_HOME	All Homes	View
WARNING	OS Check	Database parameter _enable_NUMA_support should be set to recommended value	All Database Servers	Hide

Verify database parameter _enable_NUMA_support

Recommendation
As of Oracle RDBMS release 12.1.0.2.6 and above, the enabling of NUMA in the database is automatic so no action is necessary on any Exadata platform. For any Exadata platform using 12.1.0.5 or lower, please reference the recommended value. NUMA support in the database should always be off on Exadata OVM.

Needs attention on randomadm07

Passed on -

Status on randomadm07:
WARNING => Database parameter _enable_NUMA_support should be set to recommended value

DATA FROM RANDOMADM07 - DBM DATABASE - VERIFY DATABASE PARAMETER _ENABLE_NUMA_SUPPORT

```
_enable_NUMA_support = FALSE
isdefault = FALSE
```

Status	Type	Message	Status On	Details
INFO	SQL Check	Direct NFS Client is NOT enabled	All Databases	View

Maximum Availability Architecture (MAA) Scorecard

Outage Type	Status	Type	Message	Status On	Details	
			Description Proactive hardware and software maintenance helps avoid critical issues and helps maintain the highest stability and availability of your system. By running the latest version of exachk, automatic detection occurs for the following: 1. Software version mismatches on the system. 2. Known critical issue exposure for your specific environment. 3. Software releases that are older than recommended versions. Furthermore, the suggested "Recommended Versions" can be leveraged when planning for your next planned maintenance window. Note that not all Exadata Software components need to be upgraded during one planned maintenance window; however it is advised to maintain a regular maintenance schedule. The recommended frequency is 3 to 12 months depending on business requirements. Oracle recommends patching and upgrading in the following order: 1. Grid Infrastructure Software and Oracle Database Software. Grid Infrastructure should always be equal to or higher than the highest Oracle Database Software version. 2. Exadata Database Server Software. For Exadata Database Server Software upgrades, run and evaluate exachk and dbnodeupdate precheck outputs. 3. Exadata Storage Server Software. For Exadata Storage Server Software upgrades, run and evaluate exachk and patchmgr precheck outputs. 4. InfiniBand Switch Software. For InfiniBand Switch Software upgrades, run and evaluate exachk and patchmgr precheck outputs.			
	FAIL	SOFTWARE MAINTENANCE BEST PRACTICES	Best Practices 1. Note: 1662016.1 - Oracle Sun Database Machine Cross Node Consistency Best Practice Checks 2. MAA Best Practices for Database Consolidation and Oracle Multitenant with Oracle 12c 3. Oracle Exadata Software Planned Maintenance 4. Note: 1461240.1 - Exadata Database Machine Software and Hardware Maintenance Planning Guide 5. Best Practices For Database Consolidation On Exadata Database Machine 6. Note: 15529.1 - Database Machine and Exadata Storage Server Supported Versions 7. Note: 1270094.1 - Exadata Critical Issues			
	FAIL	OS Check	System is exposed to Exadata critical issue DB24	All Database Servers	View	
	FAIL	Patch Check	System is exposed to Exadata critical issue DB28	All Homes	View	
	FAIL	Storage Server Check	System is exposed to Exadata Critical issue EX19	All Storage Servers	View	
			Component	Host/Location	Found version, Recommended versions	Status
			Database Home	randomadm07,randomadm08 /u01/app/oracle/product/11.2.0.4/dbhome_1	11.2.0.4.1 11.2.0.4.160119	11.2.0.4 BP is older than recommended.
			Grid Infrastructure	randomadm07,randomadm08 /u01/app/11.2.0.4/grid	11.2.0.4.1 11.2.0.4.160119	11.2.0.4 BP is older than recommended.
			Exadata	randomadm07,randomadm08	11.2.3.3.0 12.1.2.1.3 or 12.1.2.2.1	Older than recommended version.
			STORAGE SERVER	Exadata randomcladm12,randomcladm13,randomcladm14	11.2.3.3.0 11.2.3.3.1	Older than recommended version.
			IB SWITCH	Firmware randomsw-iba0	2.1.8.1 2.1.5.1 or higher	Version within recommended range. Exception: Version is different from peers.
				randomsw-iba0,randomsw-iba0,randomsw-iba0	2.1.3.4 2.1.5.1 or higher	Version within recommended range. Exception: Version is different from peers.

Note: Automated Orachk/Exachk Healthcheck MOS 107954.1 updated frequently

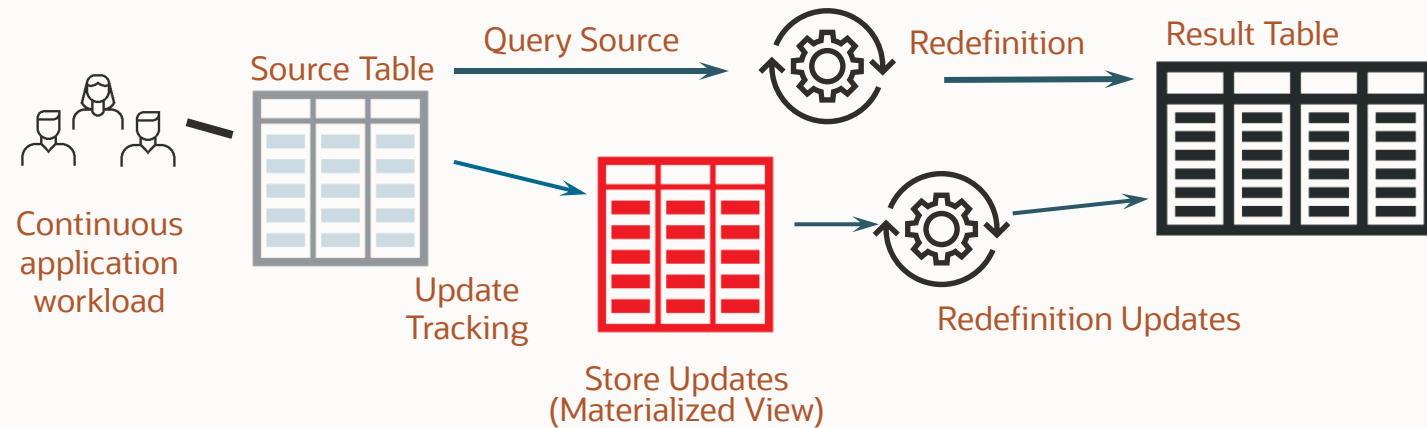




Online Operations

Redefine your data structures without taking tables offline

- Online Redefinition: reorganize and redefine tables online
 - Examples:
 - add/drop/rename/reorder columns
 - change physical storage structures
- Updates / queries not interrupted
- Resumes at point of any failure
- Ability to enable fast rollback to prior definition if needed
- Ability to monitor progress throughout redefinition operation

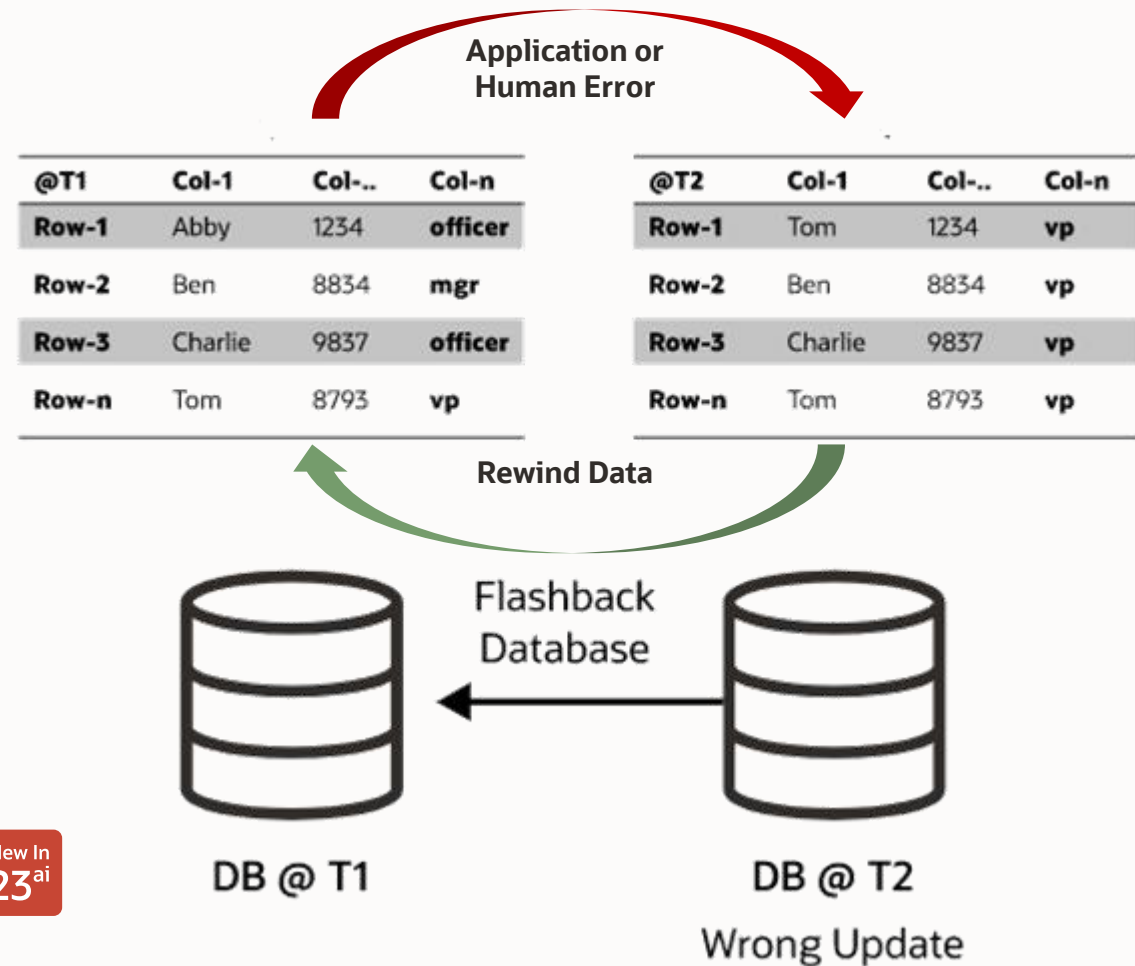




Flashback Technologies

Rewind Button for Oracle Databases

- Fast point-in-time recovery (PITR) without expensive restore operation
- Error investigation
 - View data as of previous point in time
- Error correction
 - Back-out a transaction
 - Incorrect table updates
 - Rewind the entire database
- *New in Oracle Database 23ai:*
 - Flashback Time Travel operates at the transactional level tracking and archiving transactional changes to tables



New In
23^{ai}



SILVER

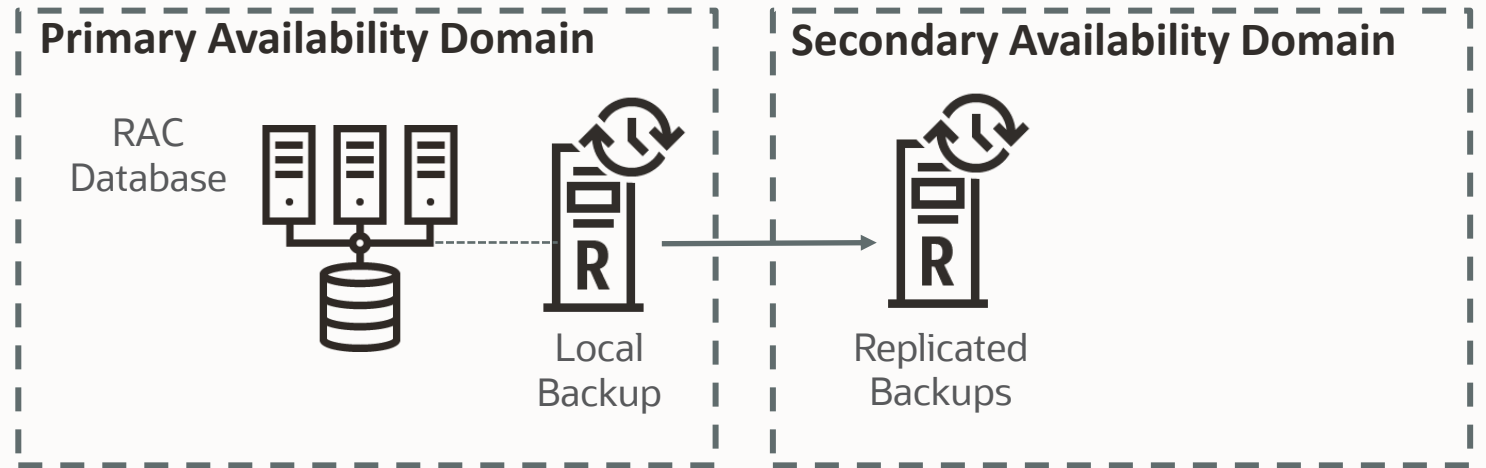
Prod/Departmental

Bronze +

- Real Application Clustering (RAC)
- Application Continuity
- Globally Distributed Database (Optional)
 - Provides fault isolation, scalability, and geographical distribution

Checklist found in MAA OTN

<https://www.oracle.com/a/tech/docs/application-checklist-for-continuous-availability-for-maa.pdf>



Outage Matrix

Unplanned Outage	RTO/RPO Service Level Objectives(f1)
Recoverable node or instance failure	Single digit seconds (f2)
Disasters: corruptions and site failures	Hours to days. RPO since last backup or near zero with ZDLRA
Planned Maintenance	
Software/Hardware updates	Zero (f2)
Major database upgrade	Minutes to hour

f1: RPO=0 unless explicitly specified

f2: To achieve zero downtime or lowest impact, apply application checklist best practices; Batch jobs should be deferred outside planned maintenance window.





Oracle RAC = Unique Scalability and Availability

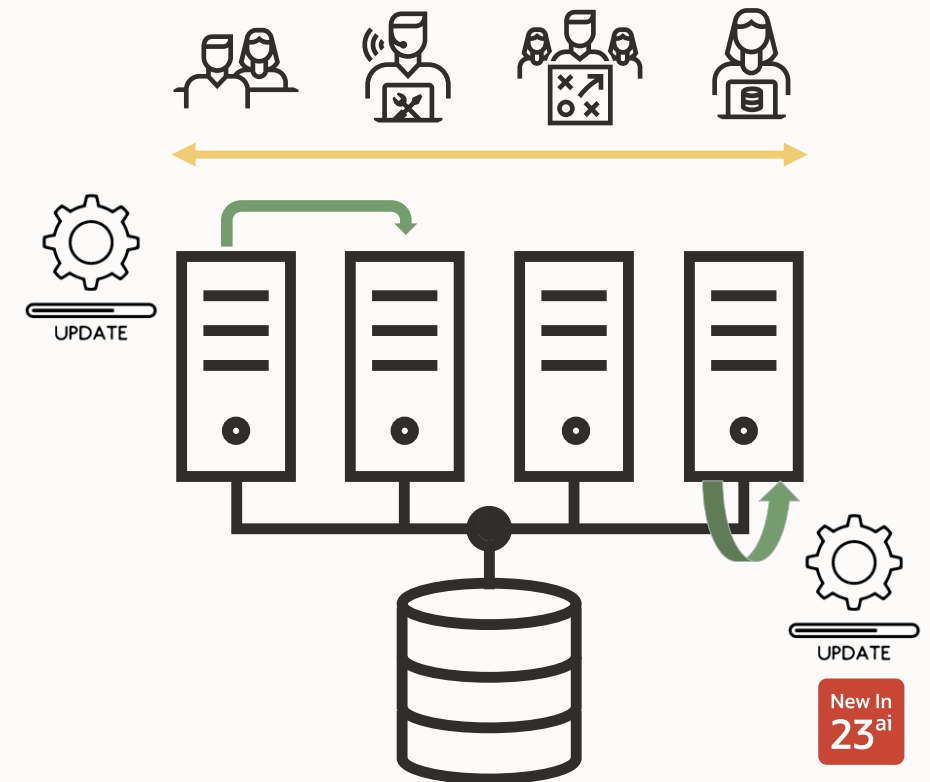
Scale applications online and protect from outages at the same time

Without any application changes required, Oracle RAC

- Protects your applications from unplanned server outages by transparently failing over connections to the remaining servers
- Reduces application downtime during planned maintenance by gracefully migrating sessions to other servers in the cluster
- Scales all applications, including the world's most complex transaction processing (OLTP) and analytics workload, by allowing to add more servers online without the need to rebalance data

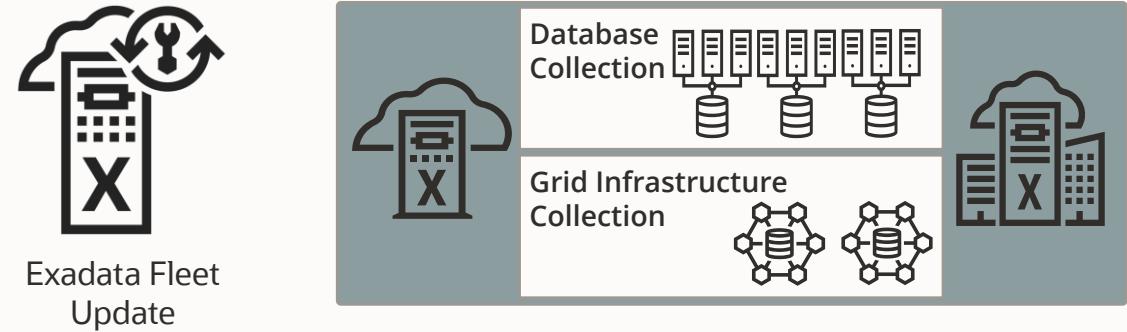
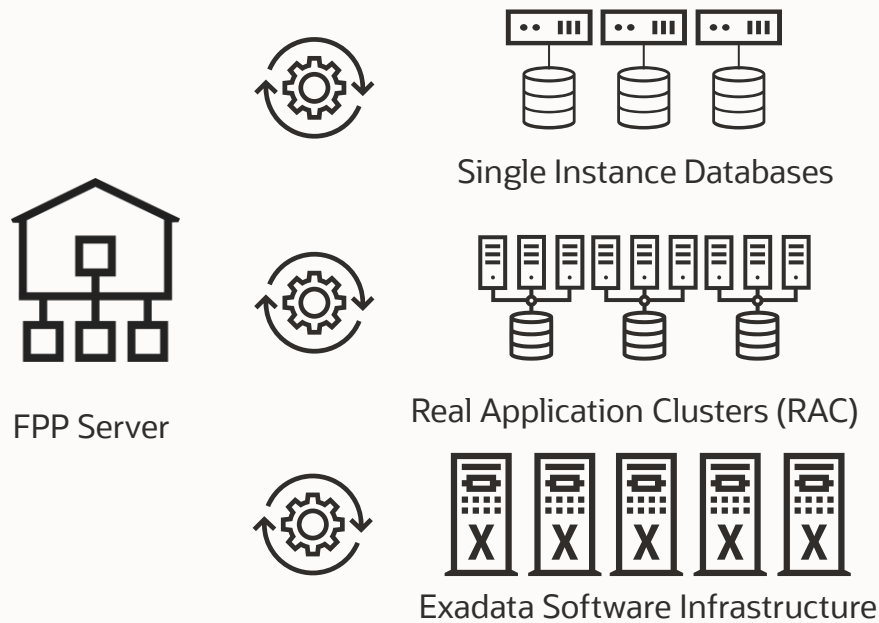
Oracle RAC 23ai new features include:

- Smart Connection Rebalance
- Local Rolling Database Maintenance
- Ordered Sequences performance optimization, etc..





Fleetwide maintenance on-premises and for ExaDB in OCI



Fleet Patching & Provisioning:

- Gold image-based drift detection
- Integrated job scheduling
- User actions for extensibility
- Comprehensive Exadata Patching
- Full-stack Exadata patching

Exadata Fleet Update:

- Group multiple Oracle Databases and Oracle Grid Infrastructures into collections
- Rolling and non-rolling, session draining, scheduling of pre-check, staging, and patch operations
- Less complexity with out-of-place patching mechanism
- Available for ExaDB-D and ExaDB-C@C deployments

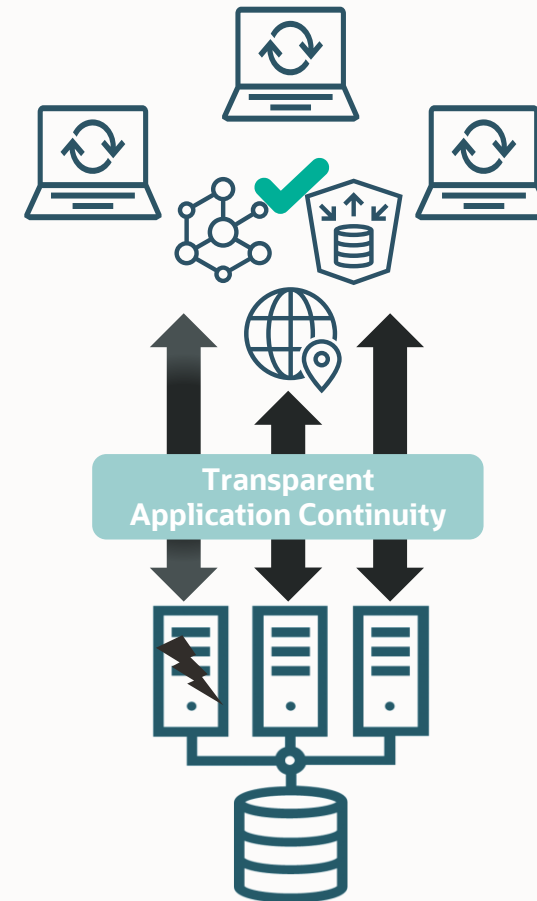


Transparent Application Continuity (TAC)

Keeps applications online during outages without requiring any custom error handling

- Hide downtime from end-users
 - TAC rebuilds the session state and replays in-flight transactions as part of automated session failover
- Eliminate errors unless unrecoverable
 - For both planned maintenance and unplanned outages
- Fast Application Notification (FAN) and session draining
 - FAN notifies clients of database status changes - helps break applications out of TCP timeouts
 - Draining causes sessions to complete their work on a given instance to prepare the node or the database for maintenance - no application changes required
- Best used with an Oracle (compatible) connection pool
- Oracle Database 23ai provides Application Continuity through DBMS_ROLLING operations.

New In
23^{ai}





Global scale with Globally Distributed Database

Horizontal partitioning of data across independent databases (shards)

- Each shard holds a subset of the data
- Replicated for high availability

Shared-nothing architecture

- Shards don't share any hardware (CPU, memory, disk), or software (Clusterware)

Massively Parallel Processing

- Application connects directly to a shard
- Multi-Shard queries go through coordinator

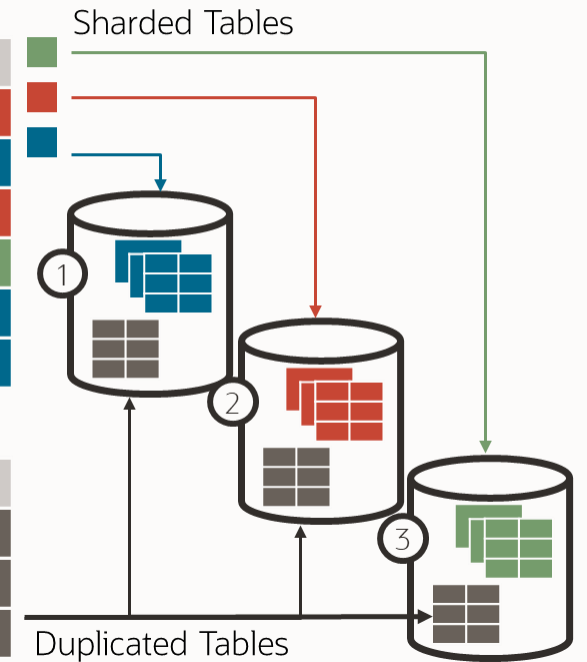
Ideal for data sovereignty

- User-defined data placement for complying with regulatory requirements
- New in Oracle Database 23ai:

Table Family

Customers		Orders		Line Items		
Customer	Name	Order	Customer	Customer	Order	Line
123	Mary	4001	123	123	4001	40011
456	John	4002	456	999	4003	40012
999	Peter	4003	999	123	4001	40013
		4004	456	456	4004	40014
		4005	456	999	4003	40015
				999	4003	40016

SKU	Product
100	Coil
101	Piston
102	Belt



New In 23ai

- RAFT replication option for Globally Distributed Database

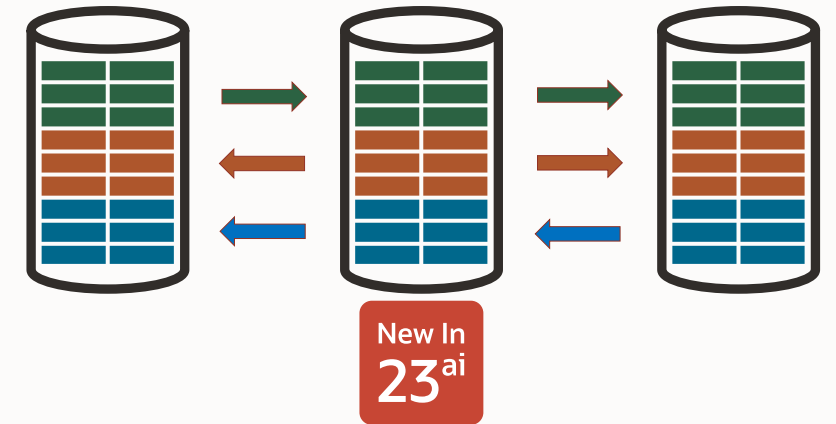




Active-active Globally Distributed Database

Raft Replication

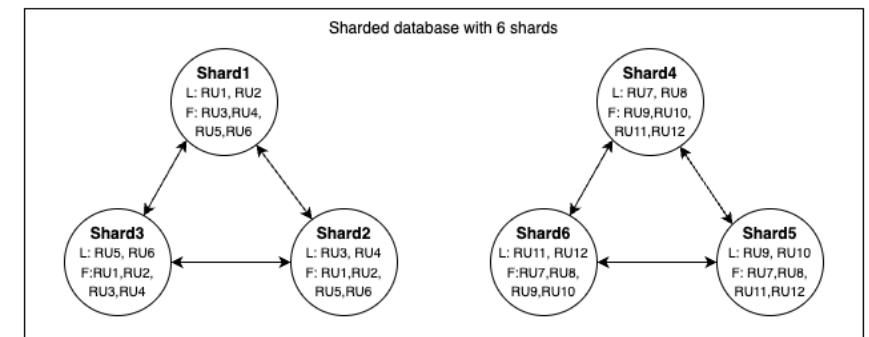
- Built-in replication, integrated with transaction execution
- Fast and automatic sub-3-second failover with zero data loss
- Active-active, symmetric configuration
 - Each shard accepts writes and reads for a subset of data
- Easy: no need to configure Data Guard or GoldenGate for shards



- Globally Distributed Database is divided into multiple replication units
 - Replication unit replicas are spread evenly across 3 (or more) shards
 - Each shard is both a primary (leader) for some replication units and a follower (replica) for other replication units

Builds on popular Raft distributed consensus protocol

- Guarantees consistency among replicas in case of failures, network partition, message loss, or delay
- Automatic reconfiguration after failure, or when the number of shards changes



GOLD

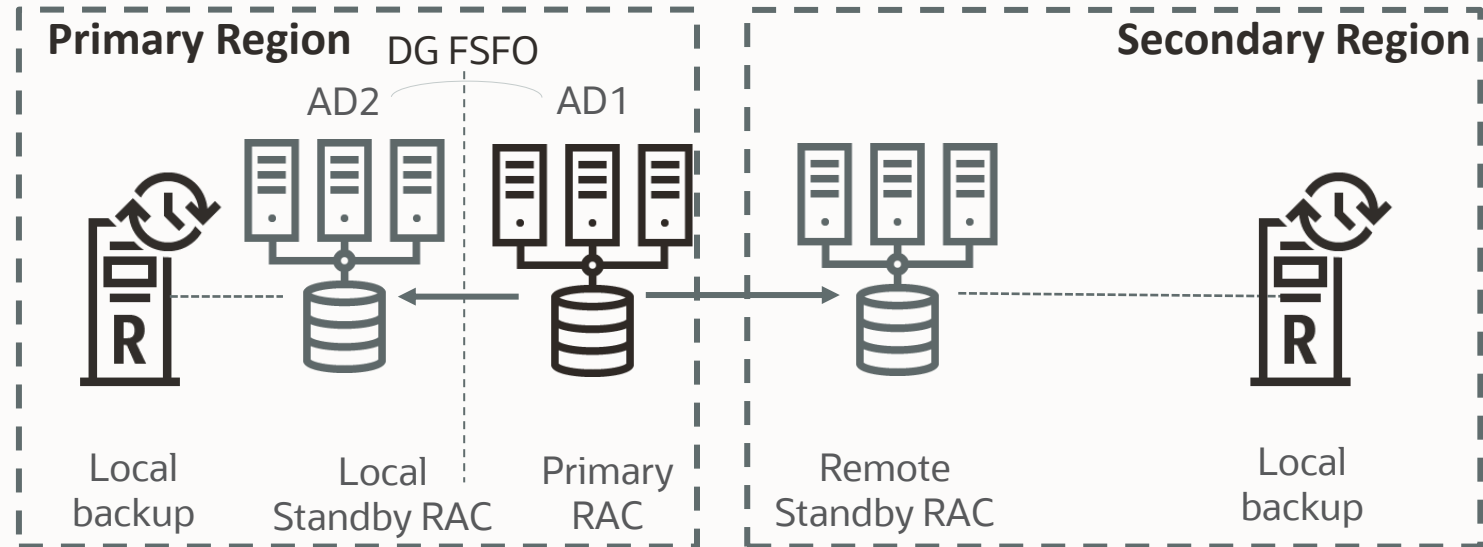
Mission Critical

Silver +

- Active Data Guard or Data Guard
- Comprehensive Data Protection

MAA Architecture:

- At least one standby required across AD or region.
- Primary in one data center (or AD) replicated to a Standby in another data center
- Data Guard Fast-Start Failover (FSFO)
- Local backups on both primary and standby



Outage Matrix

Unplanned Outage	RTO/RPO Service Level Objectives (f1)
Recoverable node or instance failure	Single digit seconds (f2)
Disasters: corruptions and site failures	Seconds to 2 minutes. RPO zero or seconds
Planned Maintenance	
Software/Hardware updates	Zero (f2)
Major database upgrade	Less than 30 seconds

f1: RPO=0 unless explicitly specified

f2: To achieve zero downtime or lowest impact, apply application checklist best practices; Batch jobs should be deferred outside planned maintenance window.





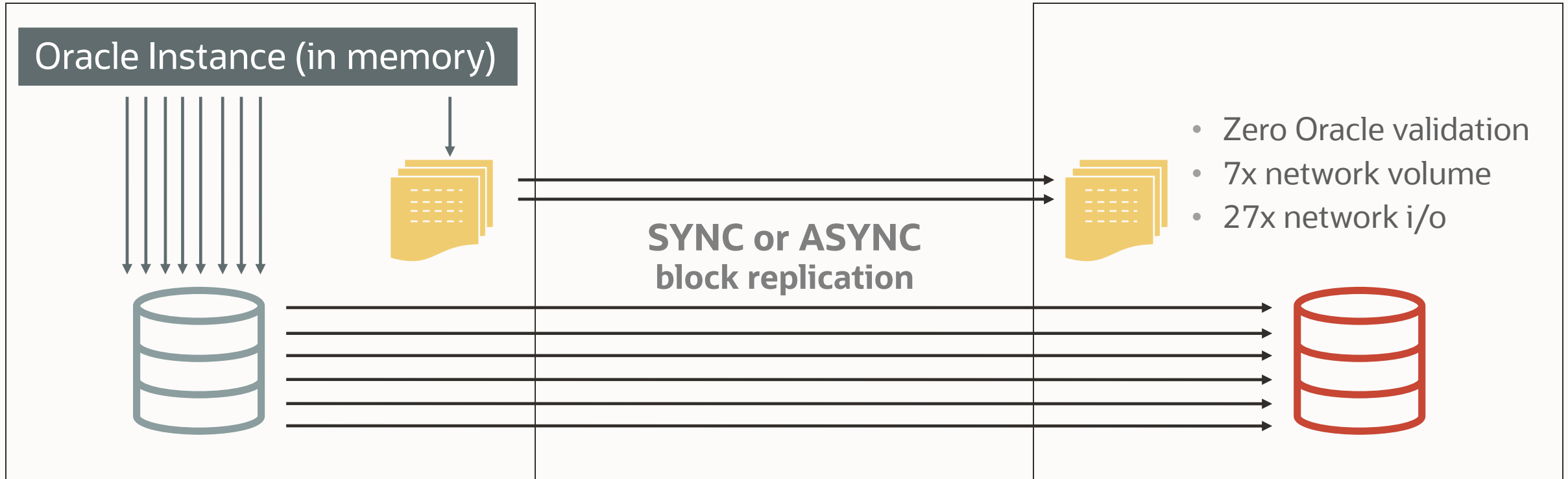
Storage Remote Mirroring Architecture

Generic - Must Transmit Writes to All Files

.... INCLUDING CORRUPTED BLOCKS OR BAD DATA

Primary Database

Mirrored Volumes





Data Guard Addresses Shortcomings of Storage Replication

Inadequate isolation, zero application-level validation

“...when something happens in the I/O stack and a database write is malformed Symmetrix A happily replicates the faulty data to site B and the corruption goes undetected”

EMC BLOG with Integrity



Oracle Data Protection

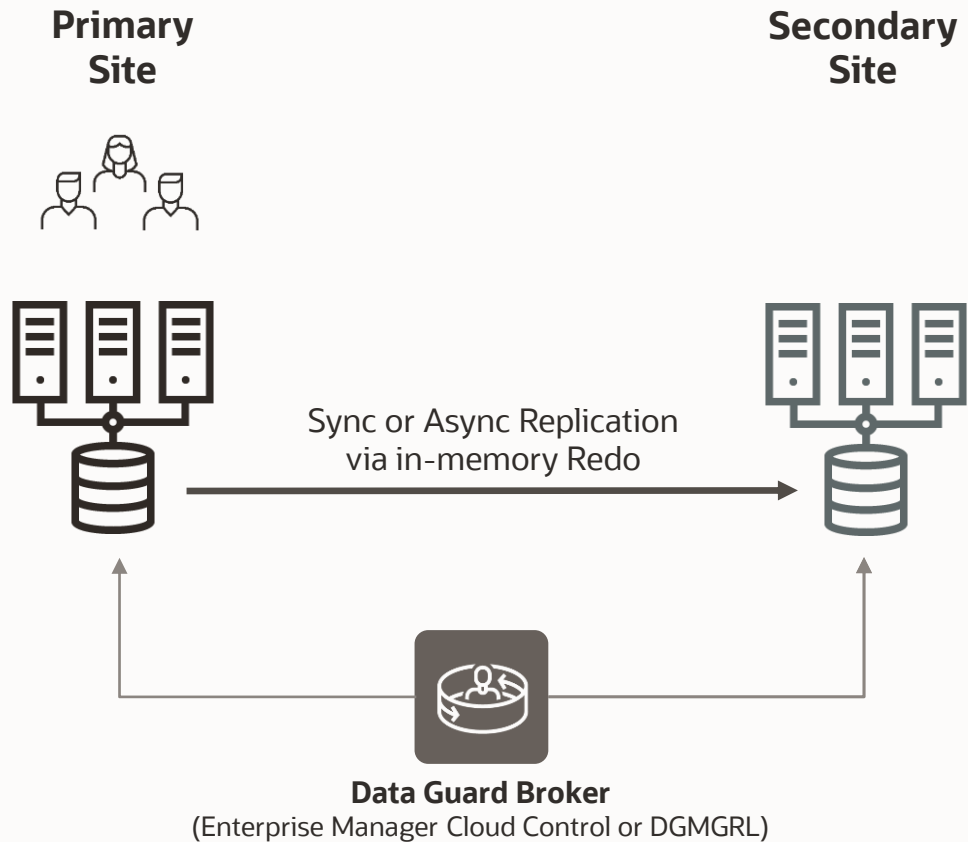
Gold – Comprehensive Data Protection

	Capability	Physical Block Corruption	Logical Block Corruption
Manual	Dbverify, Analyze	Physical block checks	Logical checks for intra-block and inter-object consistency
	RMAN, ASM	Physical block checks	Intra-block logical checks
Runtime	Active Data Guard	<ul style="list-style-type: none">• Continuous physical block checking at standby• Strong isolation to prevent single point of failure• Automatic repair of physical corruptions• Automatic database failover (option for lost writes)	<ul style="list-style-type: none">• Detect lost write corruption, auto shutdown and failover• Intra-block logical checks at standby
	Database	In-memory block and redo checksum	In-memory intra-block checks, shadow lost write protection
	ASM	Automatic corruption detection and repair using extent pairs	
	Exadata	HARD checks on write, automatic disk scrub and repair	HARD checks on write





Oracle Data Guard

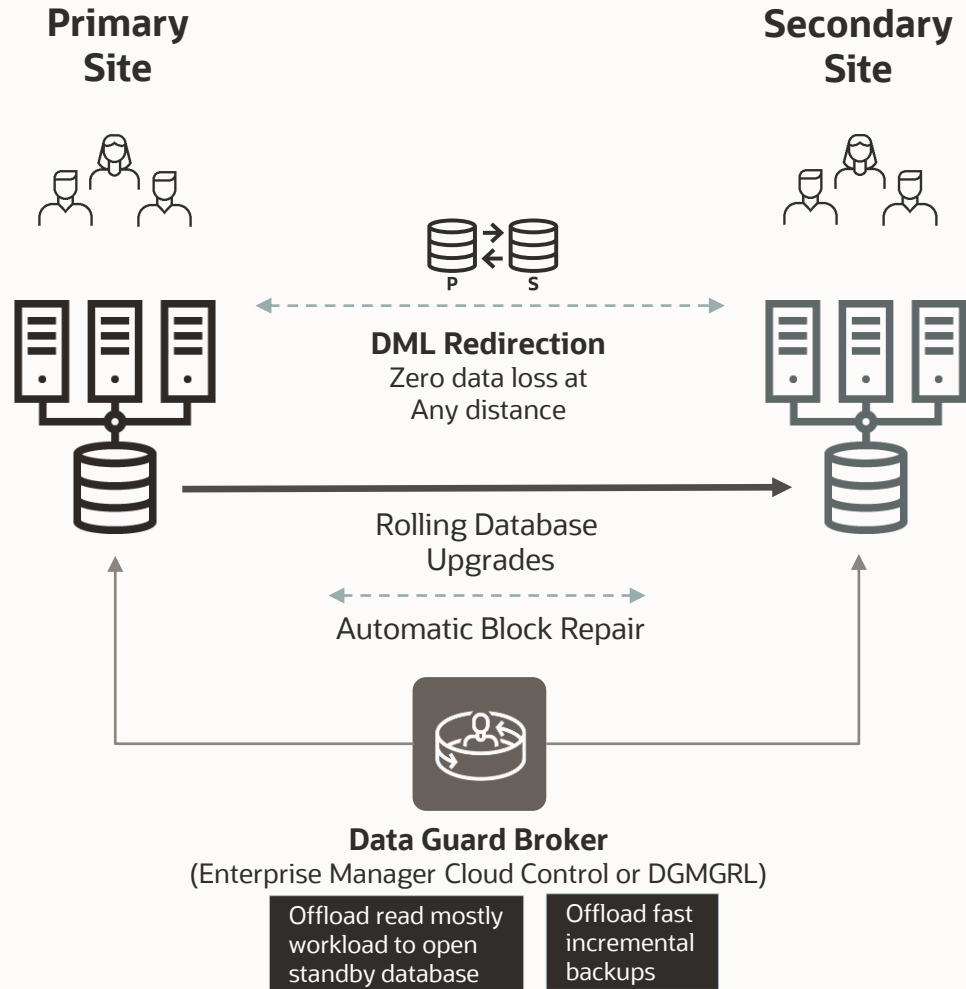


- **Basic in-memory redo replication (included with DB EE)**
 - License primary and secondary sites
- **Active-passive**
 - Standby is used only for failovers
- **Automatic failover to Standby site**
- **Zero / near-zero data loss**
- **Continuous data validation**
- **Simple migrations and upgrades**





Oracle Active Data Guard



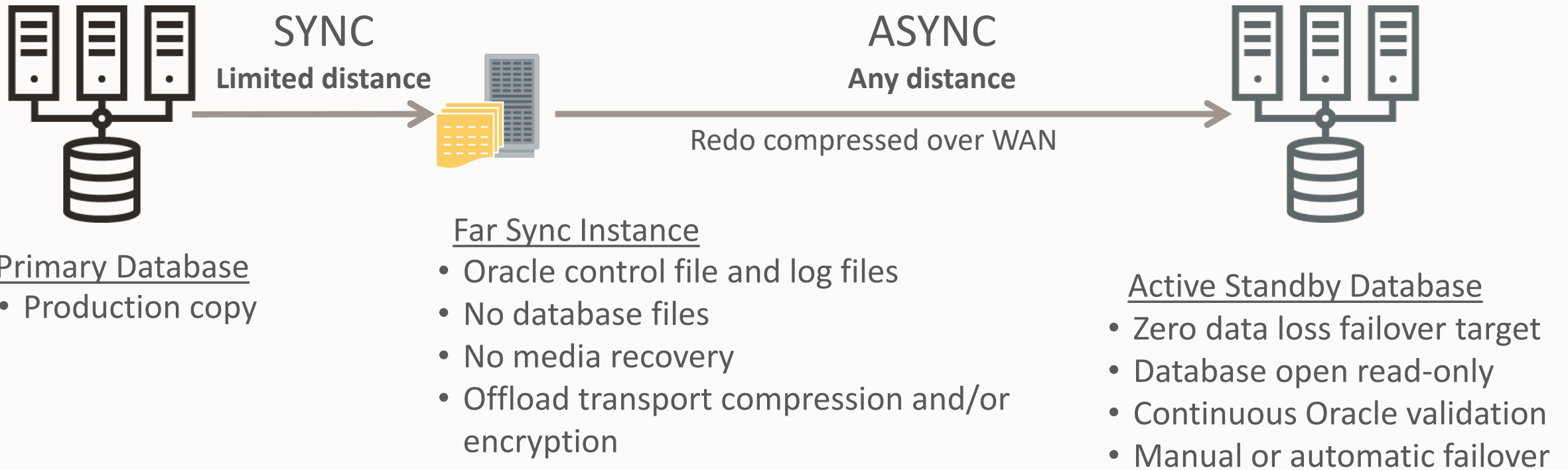
- **Active standby databases**
 - Real-time queries, reports, backups
 - Occasional updates (19c)
 - Assurance of knowing system is operational
- **Automatic block repair**
- **Application Continuity**
 - In-flight transaction protection
- **Zero data loss across any distance**
- **Global Data Services**
 - Automated workload management





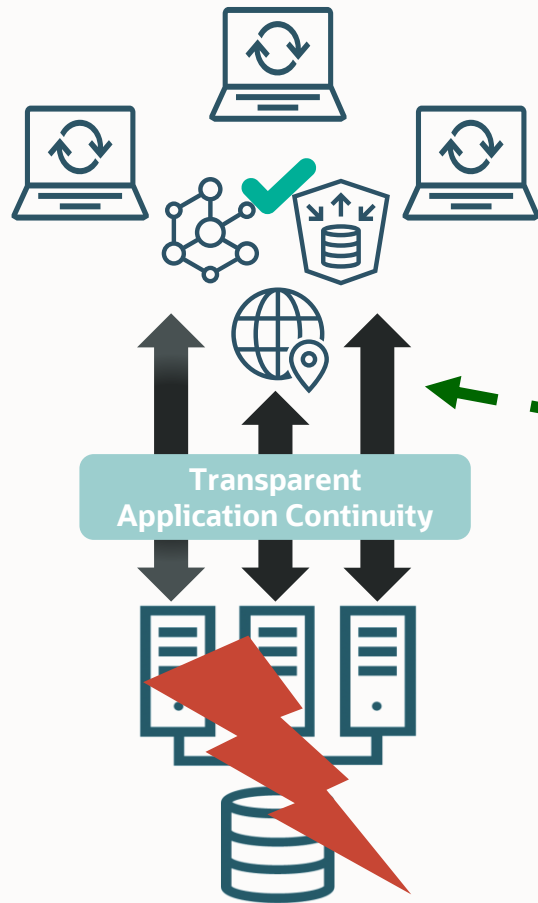
Active Data Guard Far Sync

Zero Data Loss Protection at Any Distance






Unplanned Outages, Application Continuity expanded to the Standby



Primary RAC Database

Outage or Interruption at Database:

- Database Request interrupted by an Outage or timeout
- Session reconnects to the RAC Cluster (or Standby) and
- Database Request replays automatically
- Result from Database Request returned to user
- Oracle Database 23ai provides Application Continuity through DBMS_ROLLING operations. 



Active Data Guard Standby

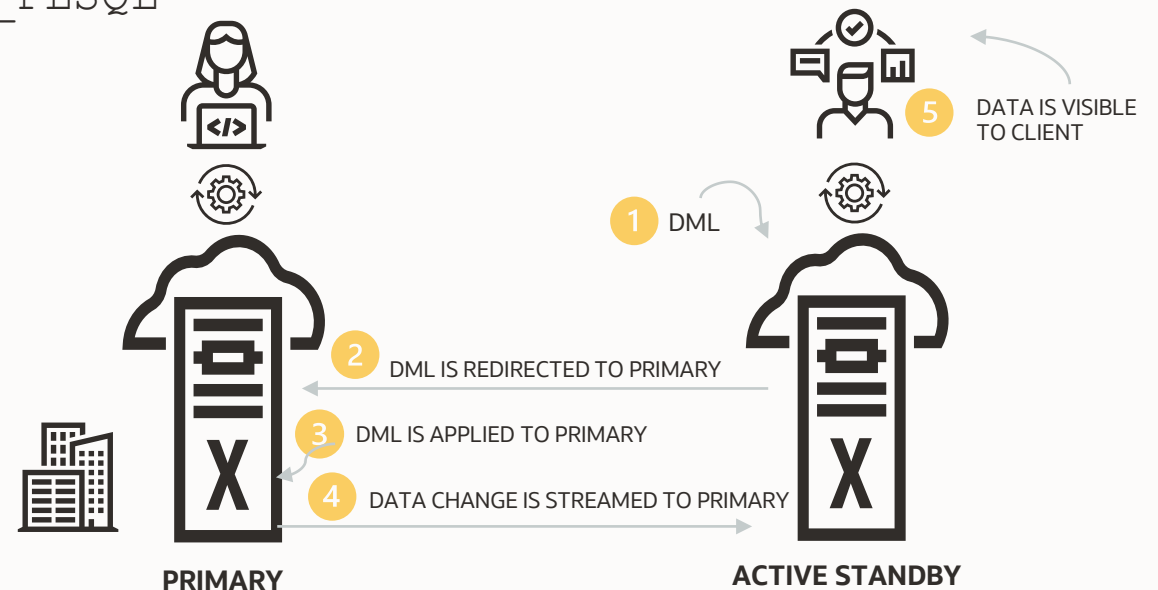




Extend Footprint of ADG Applications

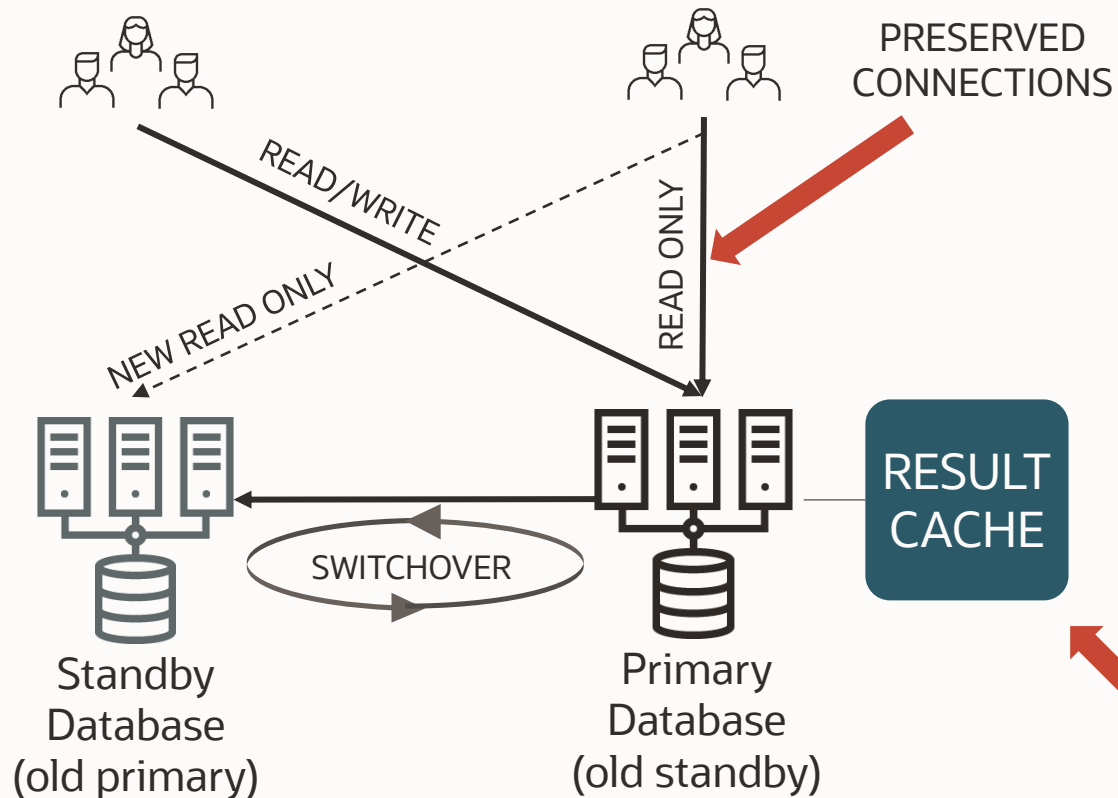
Support for DML Re-direction

- DML Re-direction is automatically performed from an Active Data Guard standby to the primary (ACID uncompromised)
- New parameter `ADG_REDIRECT_DML` controls DML Redirection
- New `ADG_REDIRECT_DML` and `ADG_REDIRECT_PLSQL`
- “Read-Mostly, **Occasional Updates**” applications supported for Oracle Database 19c and above



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 and above**, after a role transition (switchover or failover), the Result Cache is preserved
 - Query performance not impacted
 - No cache warm-up required

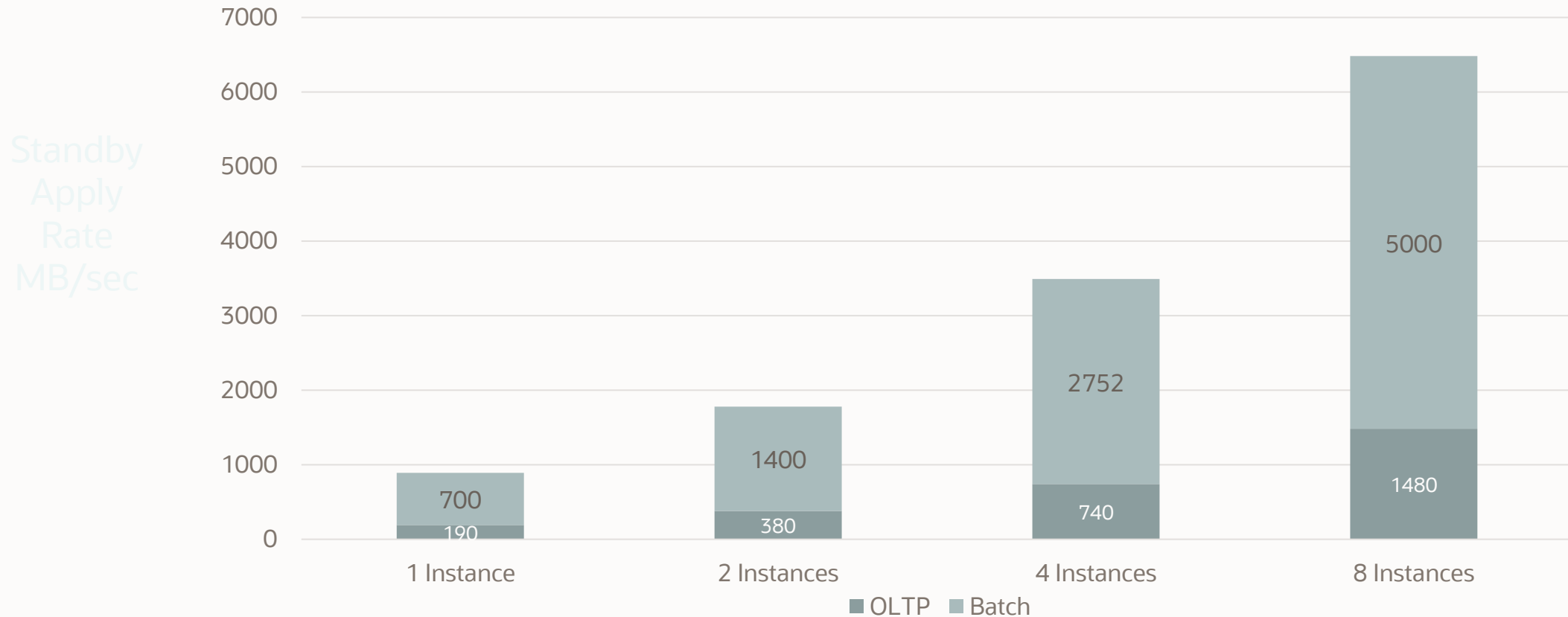




Multi-Instance Redo Apply Performance

Lower Latency Active Data Guard Standby Databases

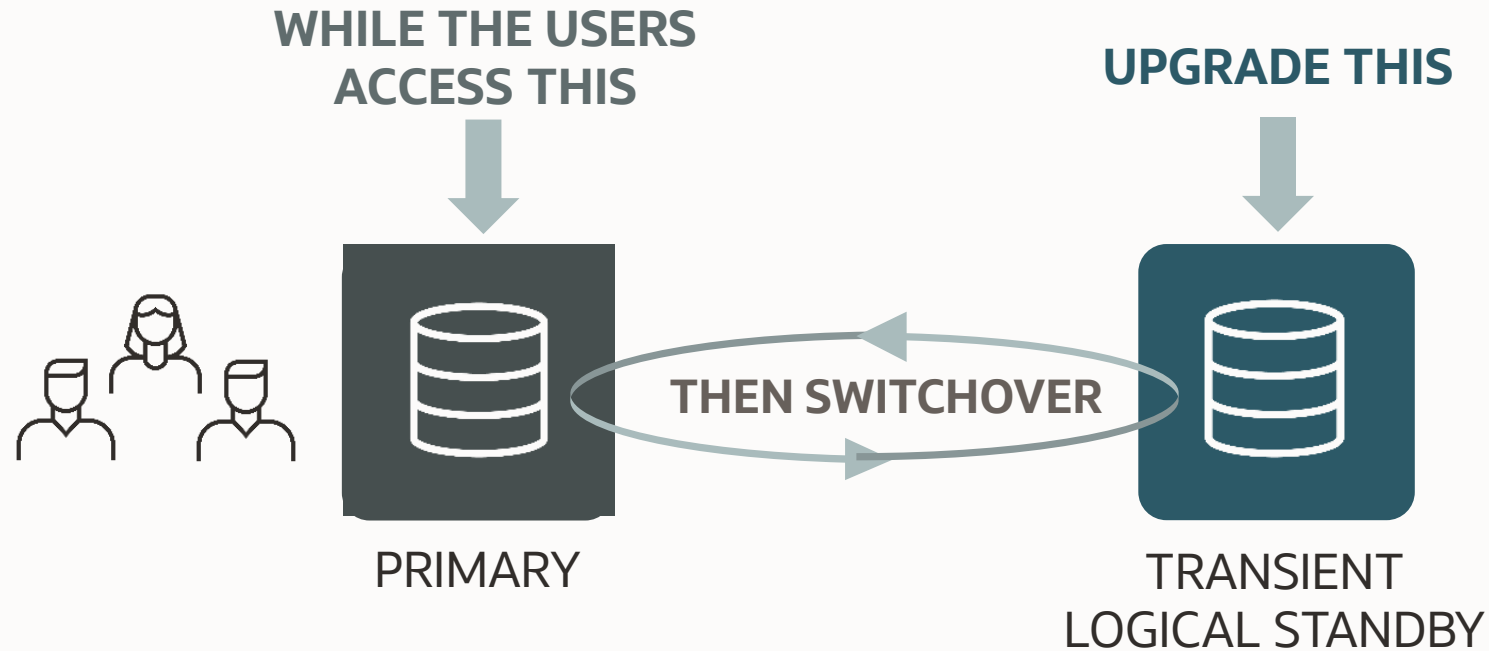
- Utilizes all RAC nodes on the Standby database to parallelize recovery
- OLTP workloads on Exadata show great scalability





Active Data Guard Rolling Maintenance and Upgrades

Using DBMS_ROLLING package



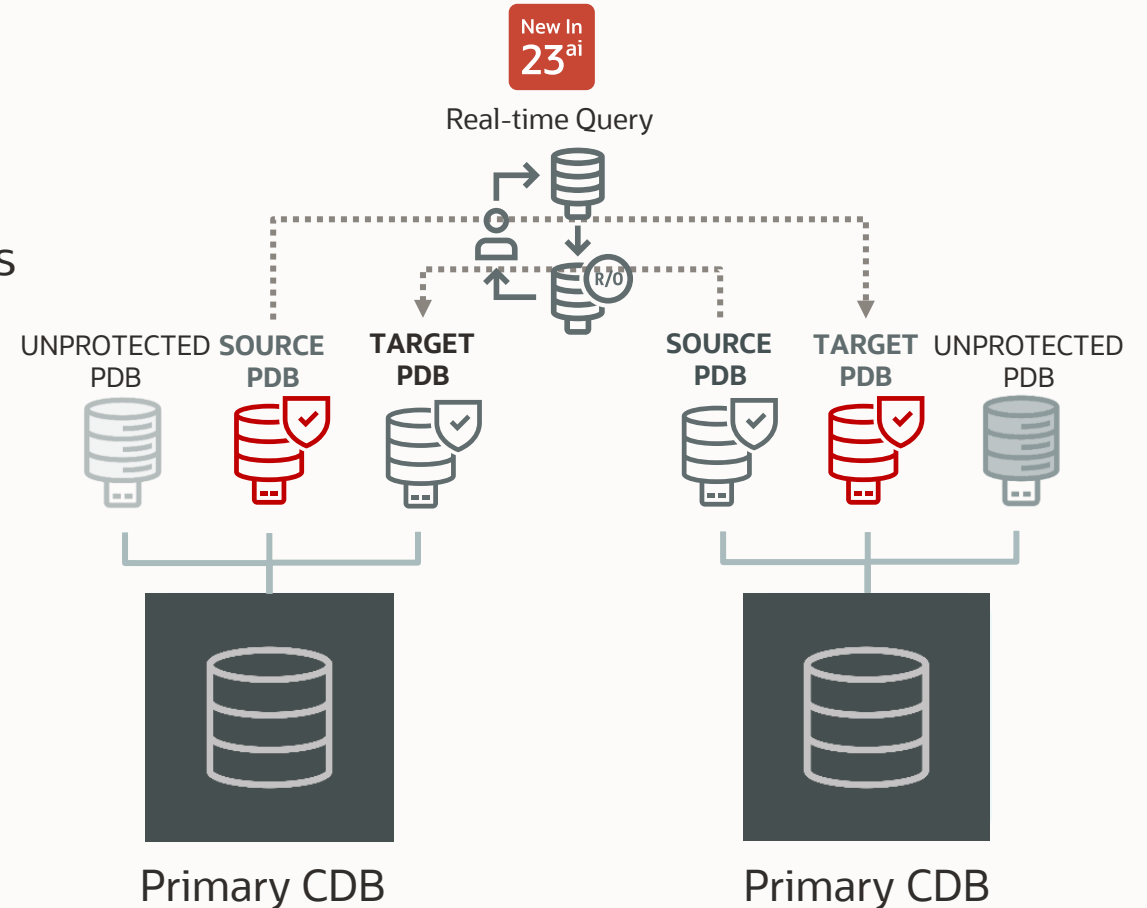
- Use a transient logical standby database to upgrade with very little downtime.
- The only downtime is as little as it takes to perform a switchover.
- Oracle Database 23ai provides Application Continuity Support



Data Guard per Pluggable Database

Available with Oracle Database 21c

- Two Container Databases (CDB) actively running workload
 - Both open read-write with different database IDs
- Disaster Protection at the PDB level
 - No need to fail over a full Container Database
 - Role transition on a single PDB with Data Guard Broker
 - Automatic gap fetching from the source
 - ASYNC support
- Real-Time Query for DGPDB configurations now available in Oracle Database 23ai



PLATINUM

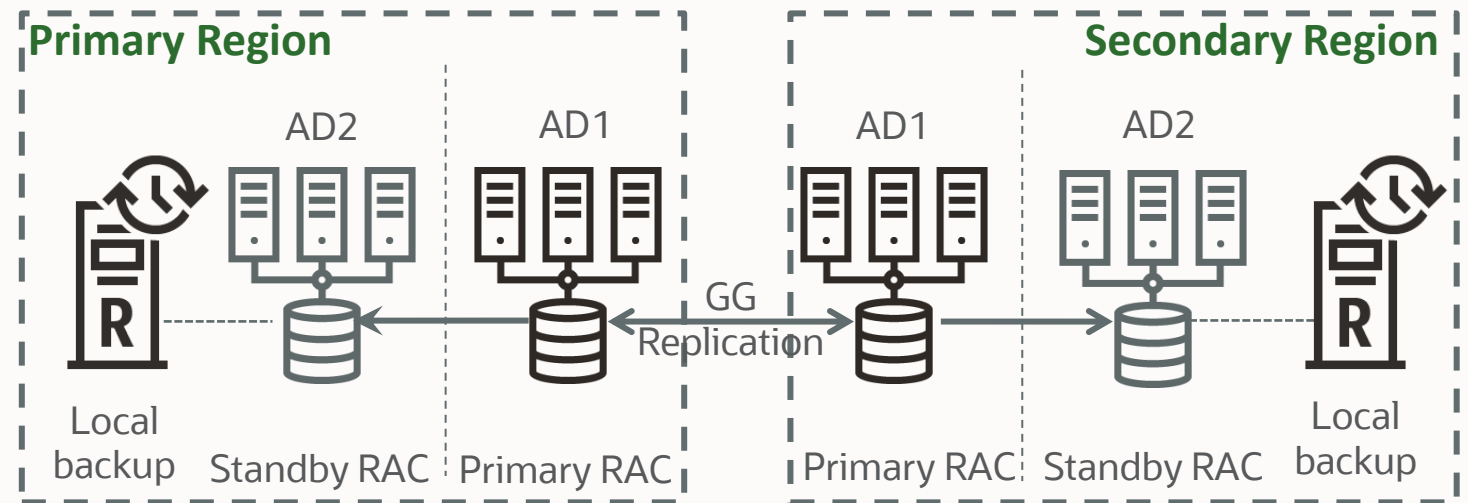
Extreme Critical

Gold +

- GoldenGate Active/Active Replication
- Edition-based Redefinition (Alternative)

MAA Architecture:

- Each GoldenGate “primary” replica protected by Exadata, RAC and Active Data Guard
- Primary in one data center (or AD) replicated to another Primary in remote data center (or AD)
- Oracle GG & Edition-based Redefinition for zero downtime application upgrade
- Local backups on both sites
- Achieve zero downtime through custom failover to GG replica



Outage Matrix

Unplanned Outage	RTO/RPO Service Level Objectives (f1)
Recoverable node or instance failure	Zero or single-digit seconds (f2/f3)
Disasters including corruptions and site failures	Zero (f3)
Planned Maintenance	
Most common software/hardware updates	Zero (f2)
Major database upgrade, application upgrade	Zero (f3)

f1: RPO=0 unless explicitly specified

f2: To achieve zero downtime or lowest impact, apply application checklist best practices

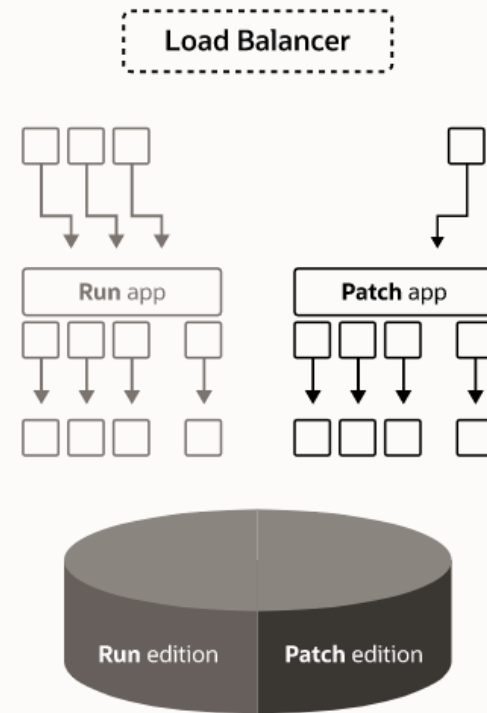
f3: Application failover is custom or with Global Data Services



GoldenGate or Alternatively Edition-based Redefinition to Further Protect Your Applications



Use Oracle Golden Gate
Standard Approach



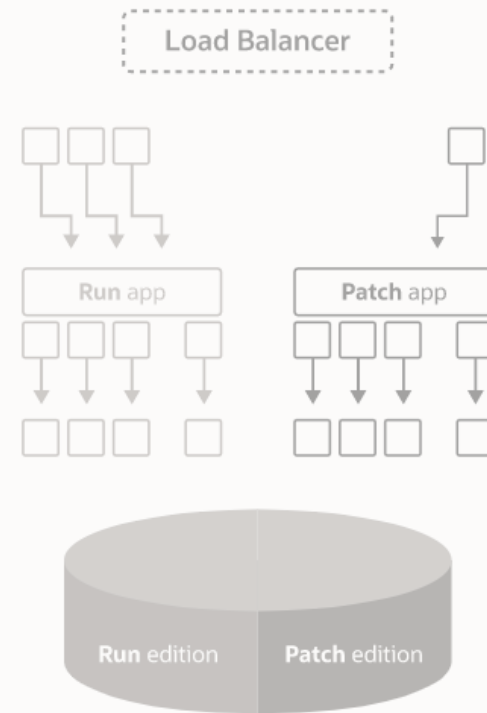
Use Edition-based Redefinition
Alternative



GoldenGate or Alternatively Edition-based Redefinition to Further Protect Your Applications



Use Oracle Golden Gate
Standard Approach



Use Edition-based Redefinition
Alternative

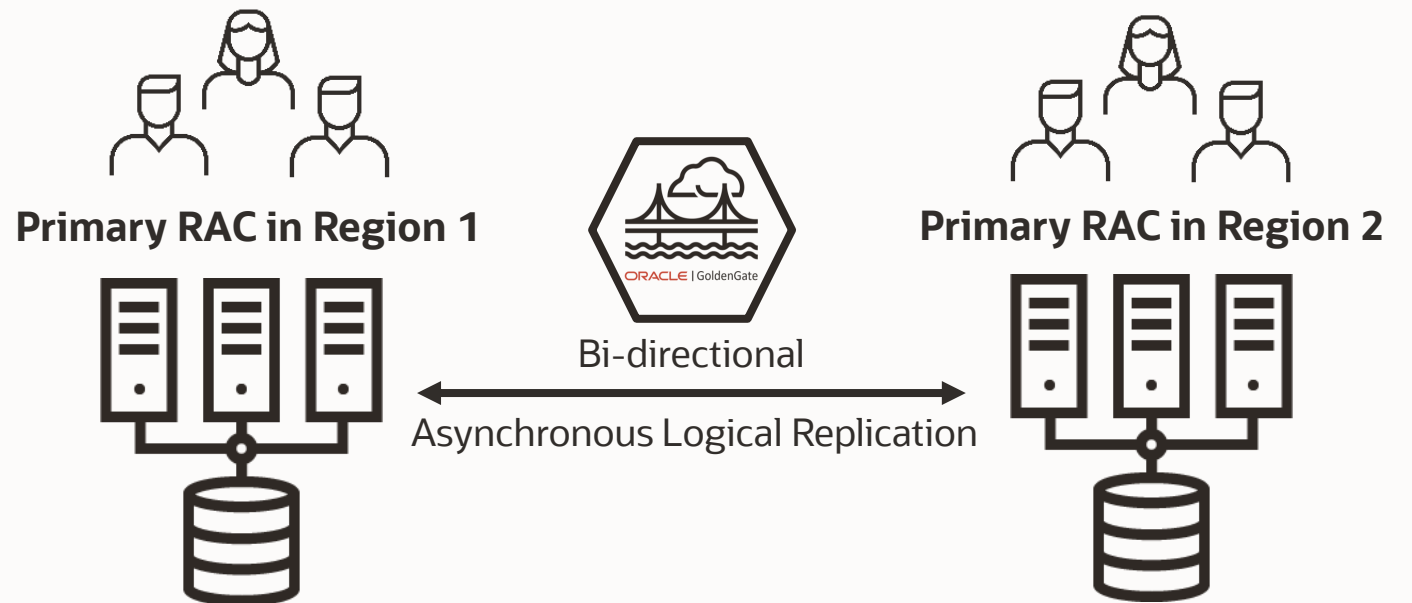




Oracle GoldenGate Architecture

Multiple primaries ensure maximum availability even during maintenance periods

- Eliminates downtime with Bi-directional full active-active replication between regions
- Asynchronous logical replication provides flexibility for maintenance activities
- Different hardware supported
- Regional affinity supports geographical distribution
- Combine with synchronous local standby databases or remote standby databases using Active Data Guard to eliminate data loss





Oracle GoldenGate Architecture

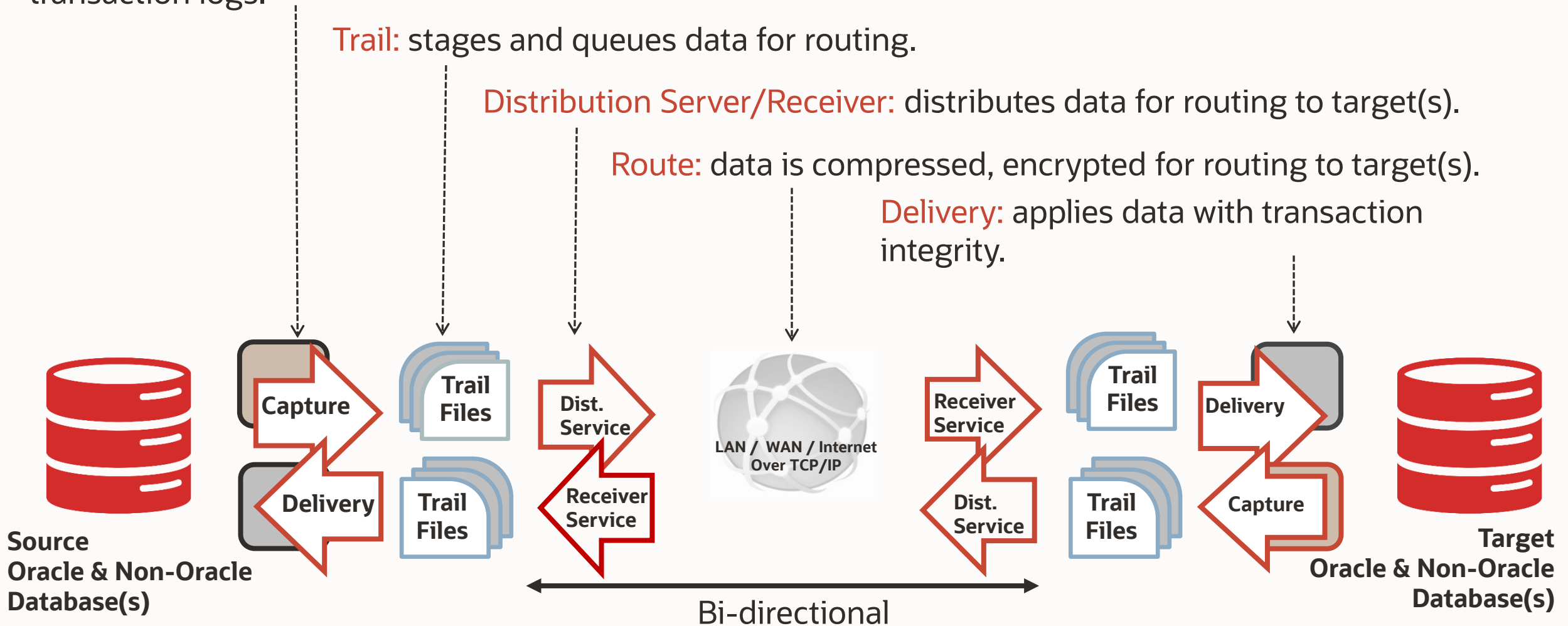
Capture: committed transactions are captured (and can be filtered) as they occur by reading the transaction logs.

Trail: stages and queues data for routing.

Distribution Server/Receiver: distributes data for routing to target(s).

Route: data is compressed, encrypted for routing to target(s).

Delivery: applies data with transaction integrity.





Key GoldenGate Improvements Simplify Platinum

1. GoldenGate Hub simplifies migration and administration by offloading work from source and target
 - New GoldenGate cloud marketplace automates GG hub deployment
 - Cross endianness capture enables cross platform migration
 - Zero Downtime Migration integration with GoldenGate
2. GoldenGate Microservices simplifies administration and management

Zero Downtime Migration
www.oracle.com/goto/zdm

[Resource Link: Oracle Database Migration with an Oracle GoldenGate Hub Configuration](#)

[Resource Link: Oracle Maximum Availability Architecture \(MAA\) GoldenGate Hub](#)





Oracle GoldenGate

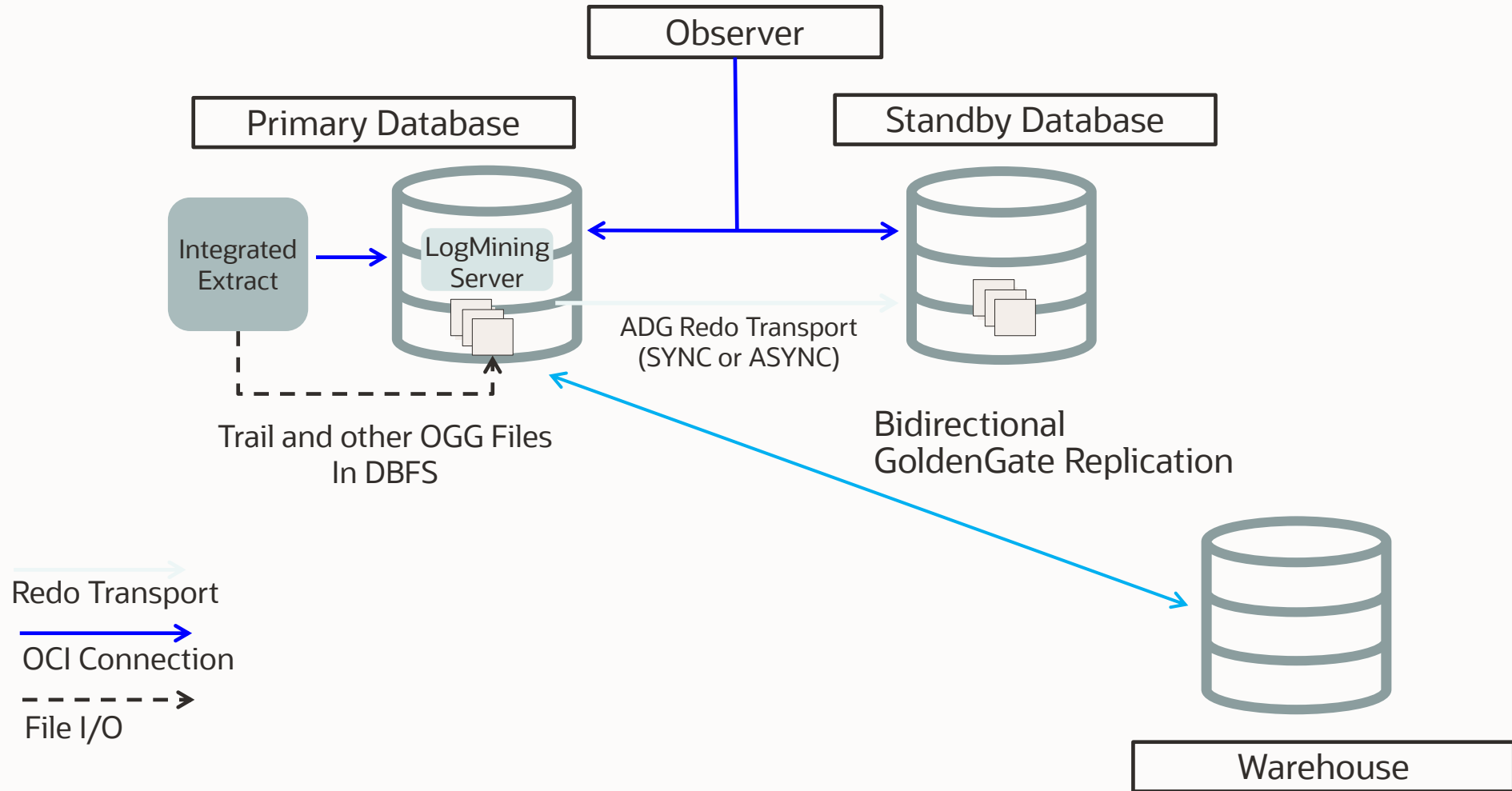
MAA Best Practices

- Transparent Role Transitions in Data Guard Configurations
 - No manual intervention required with FSFO and DG Broker
- Configuration makes use of:
 - Oracle Grid Infrastructure Bundled Agent (XAG)
 - DBFS or ACFS for shared GoldenGate files (trails and checkpoint files)
 - Role based services
 - Integrated Extract (with HANDLEDLFAILOVER option for ASYNC DG)
 - Microservices Architecture for simpler administration

[Resource Link: Transparent Role Transitions with Data Guard and Oracle GoldenGate](#)

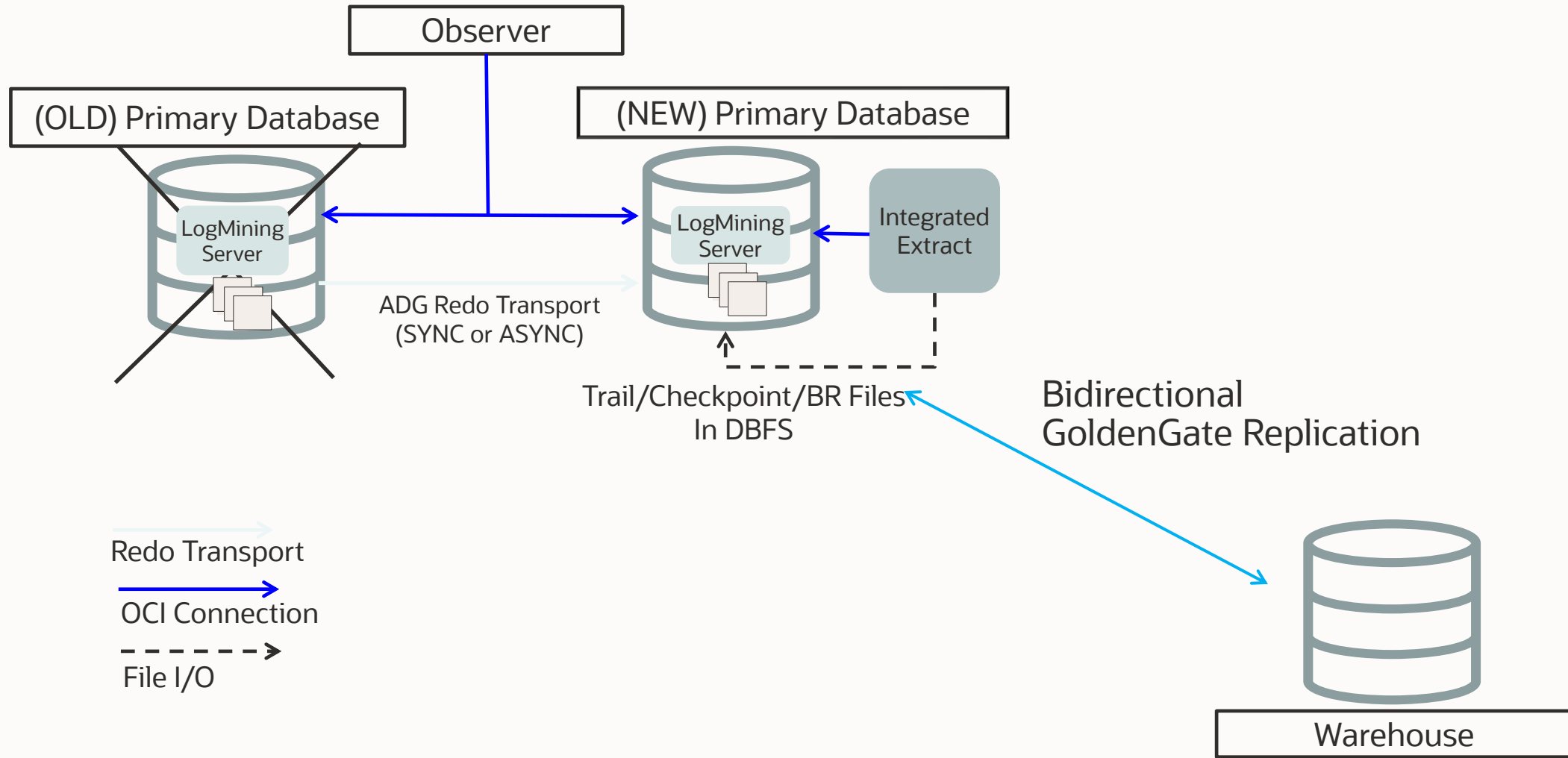


Sample GoldenGate MAA Deployment





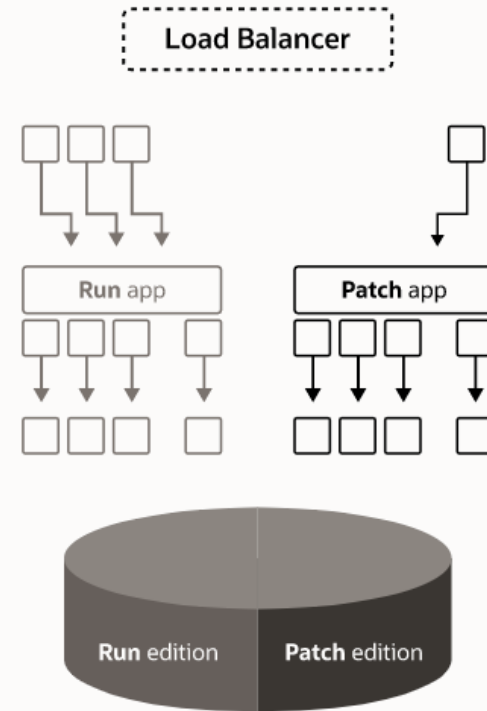
Sample GoldenGate MAA Deployment – Post Role Transition



GoldenGate or Alternatively Edition-based Redefinition to Further Protect Your Applications



Use Oracle Golden Gate
Standard Approach



Use Edition-based Redefinition
Alternative

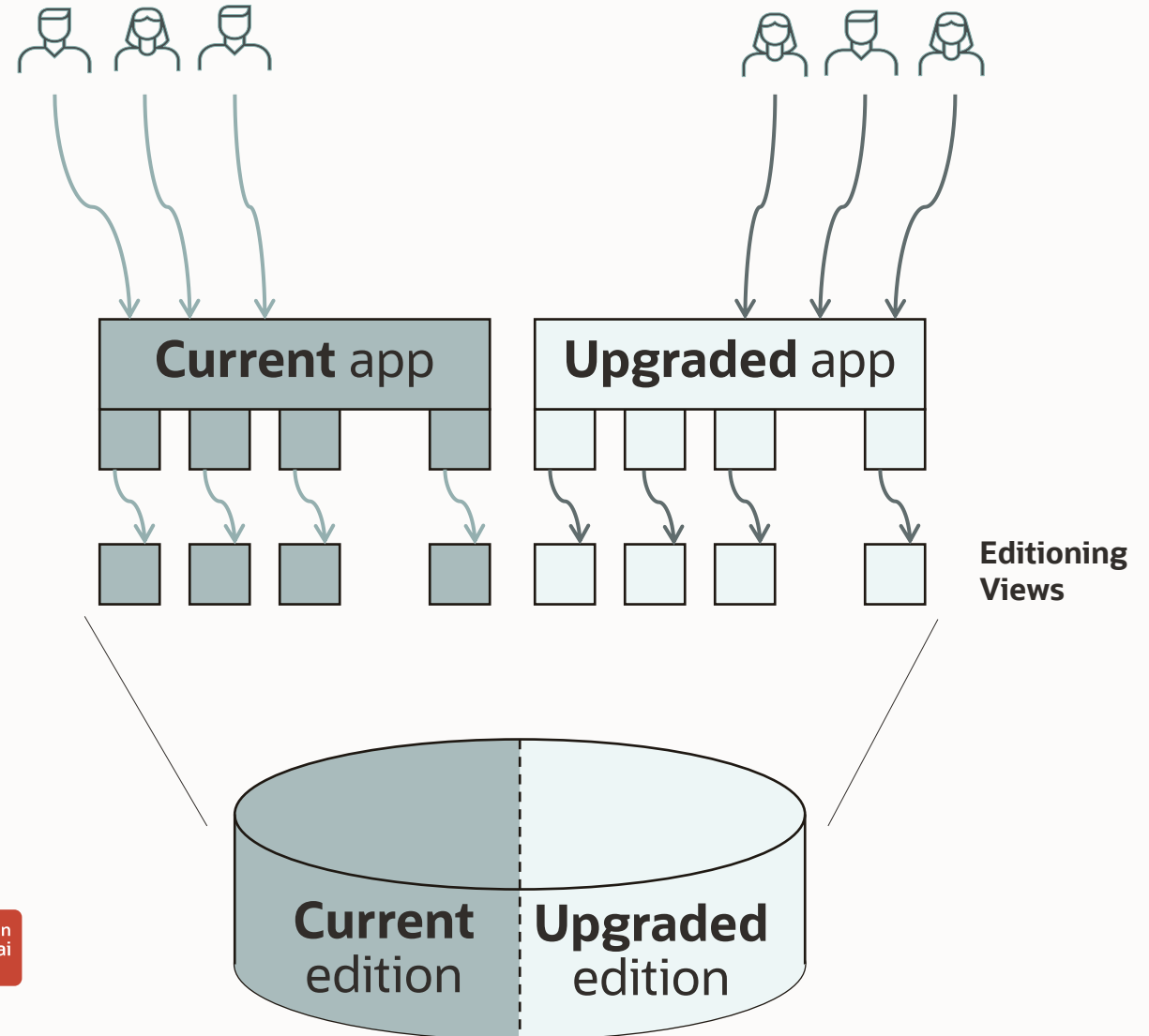




Edition-Based Redefinition

Online Application Upgrade

- Enables application upgrades to be performed online
- Code changes installed in the privacy of a new **edition**
- Data changes are made safely by writing only to new columns or new tables not seen in the old edition
- An **editioning view** exposes a different projection of a table into each edition to allow each to see just its own columns
- A **cross-edition trigger** propagates data changes made by the old edition into the new edition's columns, or (in hot-rollover) vice-versa
- With Oracle DB 23ai, EBR is now compatible with Oracle GoldenGate thanks to supplemental logging enhancements



How does OCI cloud automation enhance MAA in the cloud?



Eliminates Site Downtime

Oracle Autonomous Data Guard

Maintains a real-time remote copy of a production database

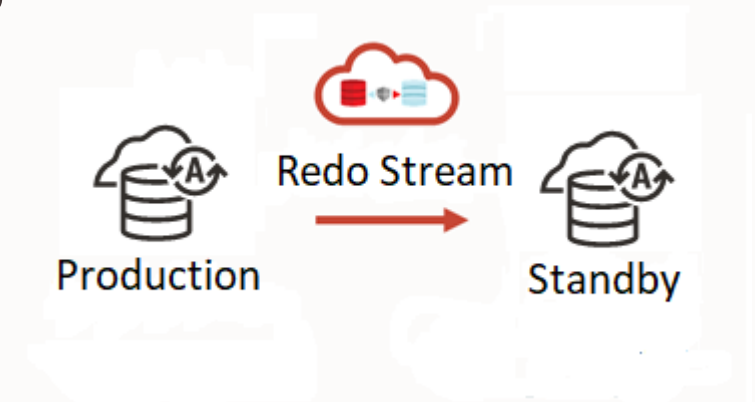
- Protects from physical disasters, network outages
- Can automatically switches from primary to remote copy

Maintains copy by applying physio-logical changes

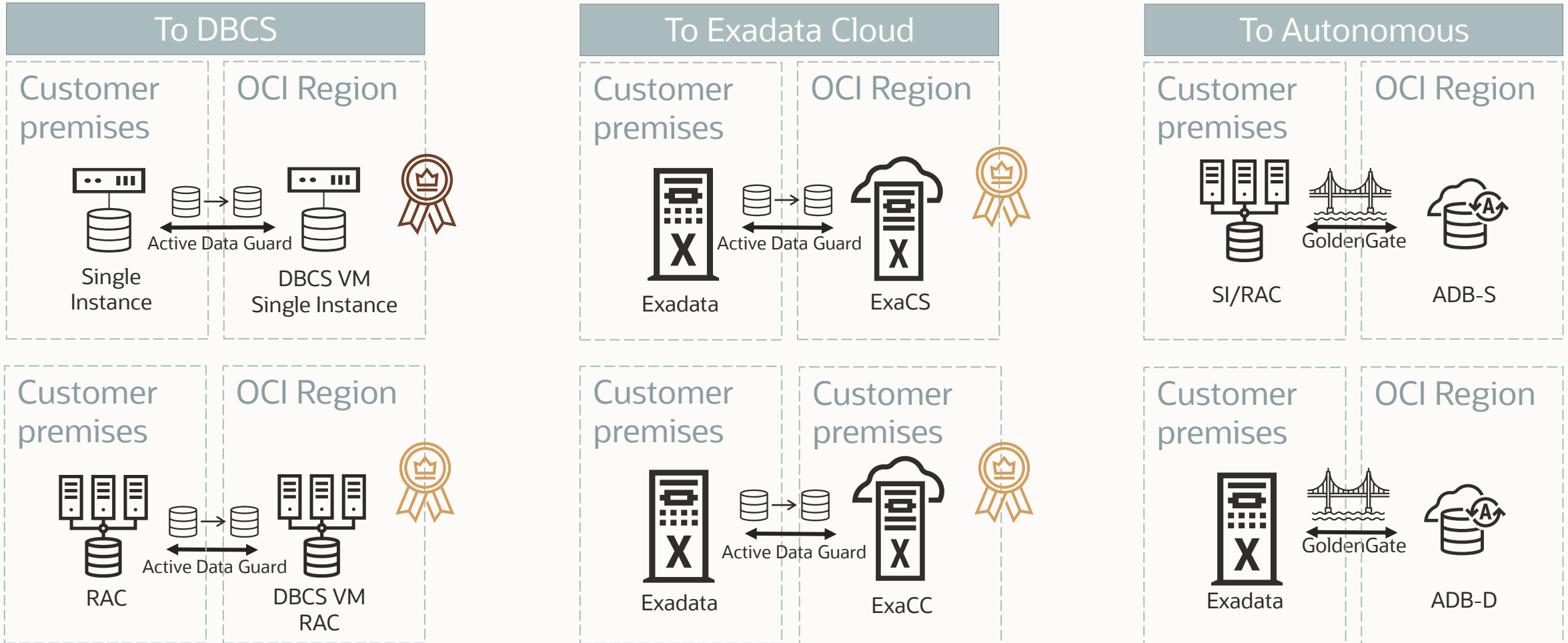
- Protects against database corruptions
- Validates data consistency as changes are applied

Fully Autonomous – Automates Everything

- Creation, operation, patching, and backup
- Database and Data Guard management



Hybrid Cloud: Recommended Hybrid Sources/Destinations



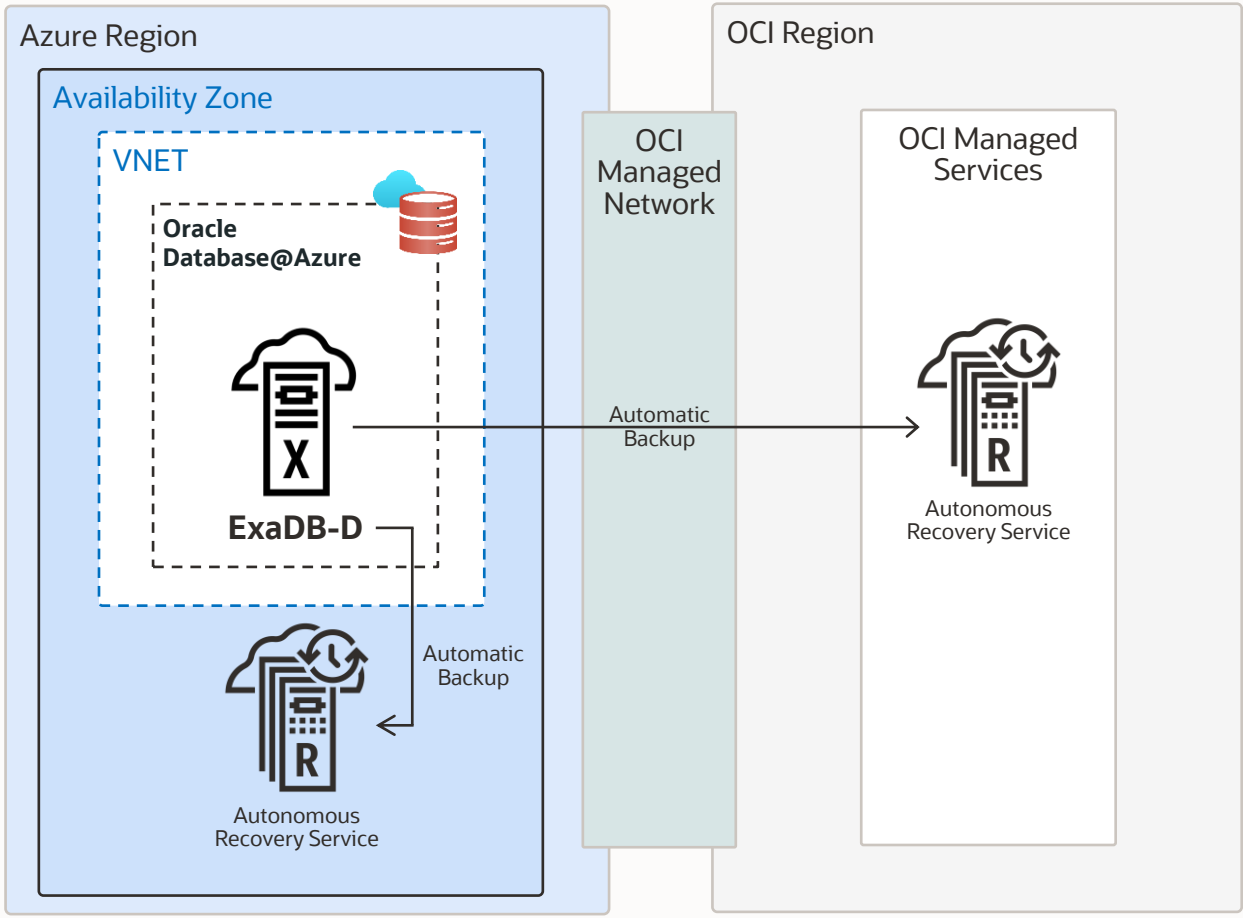
- All Hybrid configurations are achieved manually: no Control Plane automation
- On-premises non-Exadata to ExaCC/ExaCS is possible but beware of exclusive features





Oracle Database@Azure MAA Silver Level

High Availability and Data Protection Built-in by Default



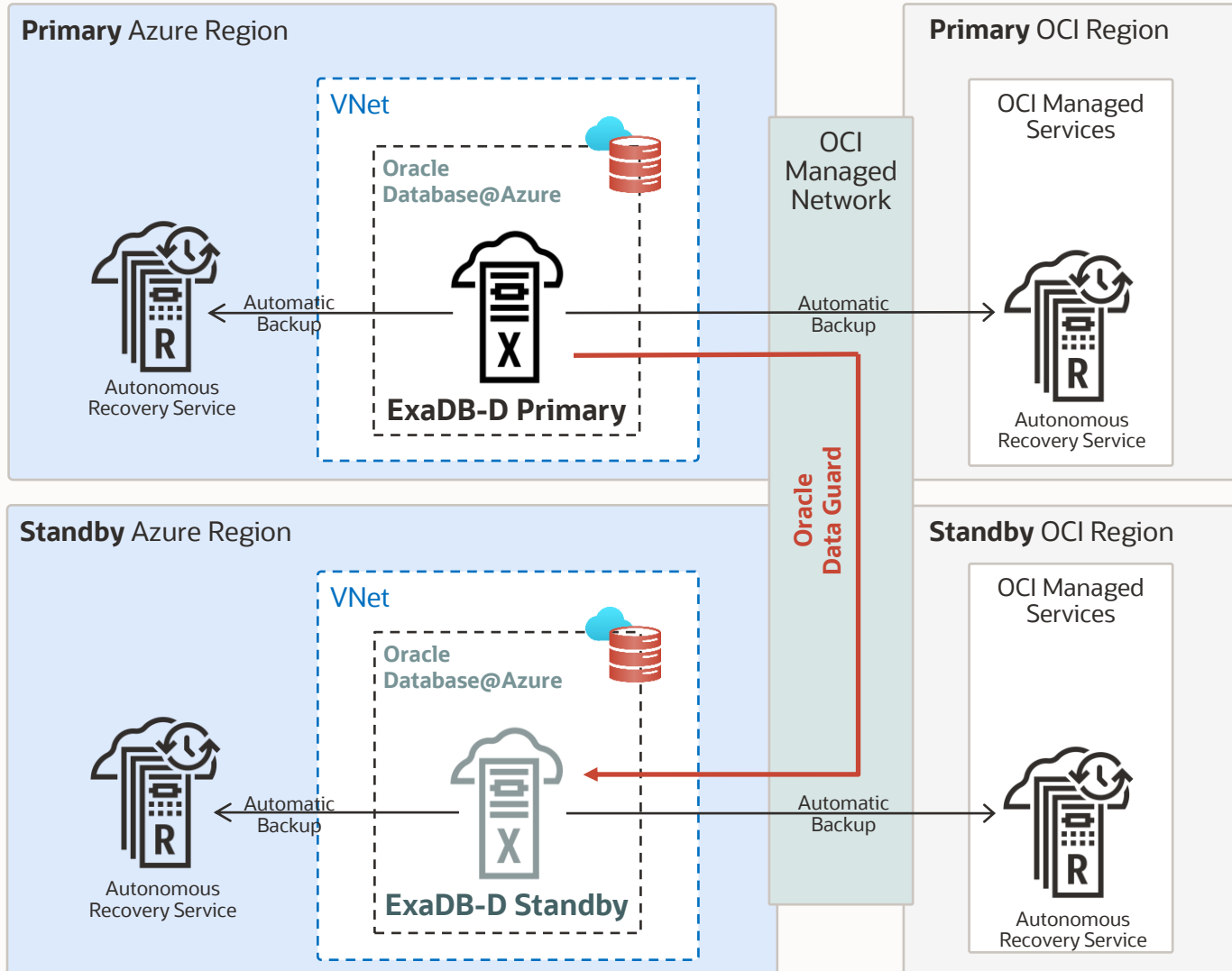
- ✓ Oracle Exadata and Oracle RAC
 - ✓ Agility to scale storage, compute, and memory without downtime
 - ✓ Node failure protection
 - ✓ Zero downtime software maintenance
- ✓ Zero Data Loss Autonomous Recovery Service
 - ✓ Available in OCI and in Azure
 - ✓ One click to choose backup destination
 - Store backups in the same cloud provider as the database ⓘ
- ✓ Alternatively, backup to OCI Object Storage





Oracle Database@Azure MAA Gold Level | Cross-regions

Mission-Critical Deployments with Disaster Recovery



MAA Silver Level +

- ✓ Fully Automated Oracle (Active) Data Guard setup
- ✓ **Regional disaster recovery protection**
- ✓ Comprehensive data corruption prevention
- ✓ Defense from ransomware attacks
- ✓ Online upgrades and migrations
- ✓ Offload backup and workload to standby with read-mostly scale-out



Summary



1

High Availability and Disaster Recovery is an absolute requirement for businesses today who require operations around the clock

2

Oracle Maximum Availability Architecture (MAA) provides a tiered set of blueprints tailored to meet your RTO and RPO requirements

3

Oracle MAA can be utilized to optimize business continuity for both planned maintenance and outage events across many different platforms spanning on-premises & cloud

External Resources



Maximum Availability Architecture

- MAA Home:
 - <http://oracle.com/goto/maa>
- On-Premises MAA:
 - <https://www.oracle.com/database/technologies/high-availability/oracle-database-maa-best-practices.html>
- Exadata MAA:
 - <https://www.oracle.com/database/technologies/high-availability/exadata-maa-best-practices.html>
- Cloud MAA:
 - <https://www.oracle.com/database/technologies/high-availability/oracle-cloud-maa.html>



It's now time for Q&A

ORACLE