

No Outages: Transparent Application Continuity

Carol Colrain, Ian Cookson
Oracle Database Development



Safe Harbor Statement

The following is intended to outline our general product direction. It is intended for information purposes only, and may not be incorporated into any contract. It is not a commitment to deliver any material, code, or functionality, and should not be relied upon in making purchasing decisions. The development, release, and timing of any features or functionality described for Oracle's products remains at the sole discretion of Oracle.

Program Agenda

- 1 ➤ What is Continuous Availability?
- 2 ➤ Maintenance with no Impact
- 3 ➤ Transparent Application Continuity
- 4 ➤ Configuring for Best Results
- 5 ➤ Application Continuity at CME

Continuous Availability

Continuous Availability is not Absolute Availability

Probable outages and maintenance events at the database level are masked from the application, which continues to operate with no errors and within the specified response time objectives while processing these events.

Key points:

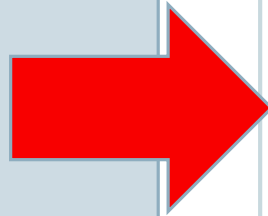
- Planned maintenance and likely unplanned outages are hidden from applications
- There is neither data loss nor data inconsistency, guaranteed
- Majority of work (% varies by customer) completes within recovery time SLA
- May appear as a slightly delayed execution

Many customers are achieving Continuous Availability Today

From High Availability to Continuous Availability

High Availability

- Minimizes downtime
- In-flight work is lost
- Rolling maintenance at DB
- Predictable runtime performance
- Errors may be visible
- Designed for single failure
- Basic HA building blocks



Continuous Availability

- No downtime for users
- In-flight work is preserved
- Maintenance is hidden
- Predictable performance
- Errors visible only if unrecoverable
- Designed for multiple failures
- Builds on top of HA

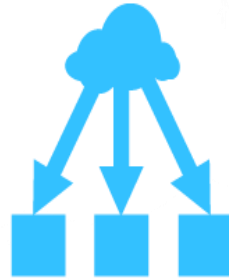
What kinds of outages?



Planned Maintenance
Patches
Repairs
Upgrades
Changes



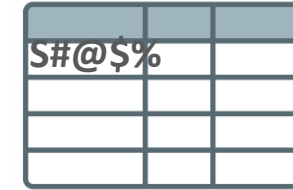
Unplanned Outages



Unpredictable
Response &
Throughput



Site
Disasters



Data
Corruption



Human
Errors

Which outage classes does your business need to handle?

New Concept - Request

All Oracle 12c Pools and in JDK9

```
PoolDataSource pds = GetPoolDataSource();
```

```
Connection conn = pds.getConnection();
```

```
PreparedStatement pstmt = ...
```

```
...
```

```
SQL, PL/SQL, local calls, RPC
```

```
...
```

```
conn.commit();
```

```
conn.close();
```

**Begin
Request**

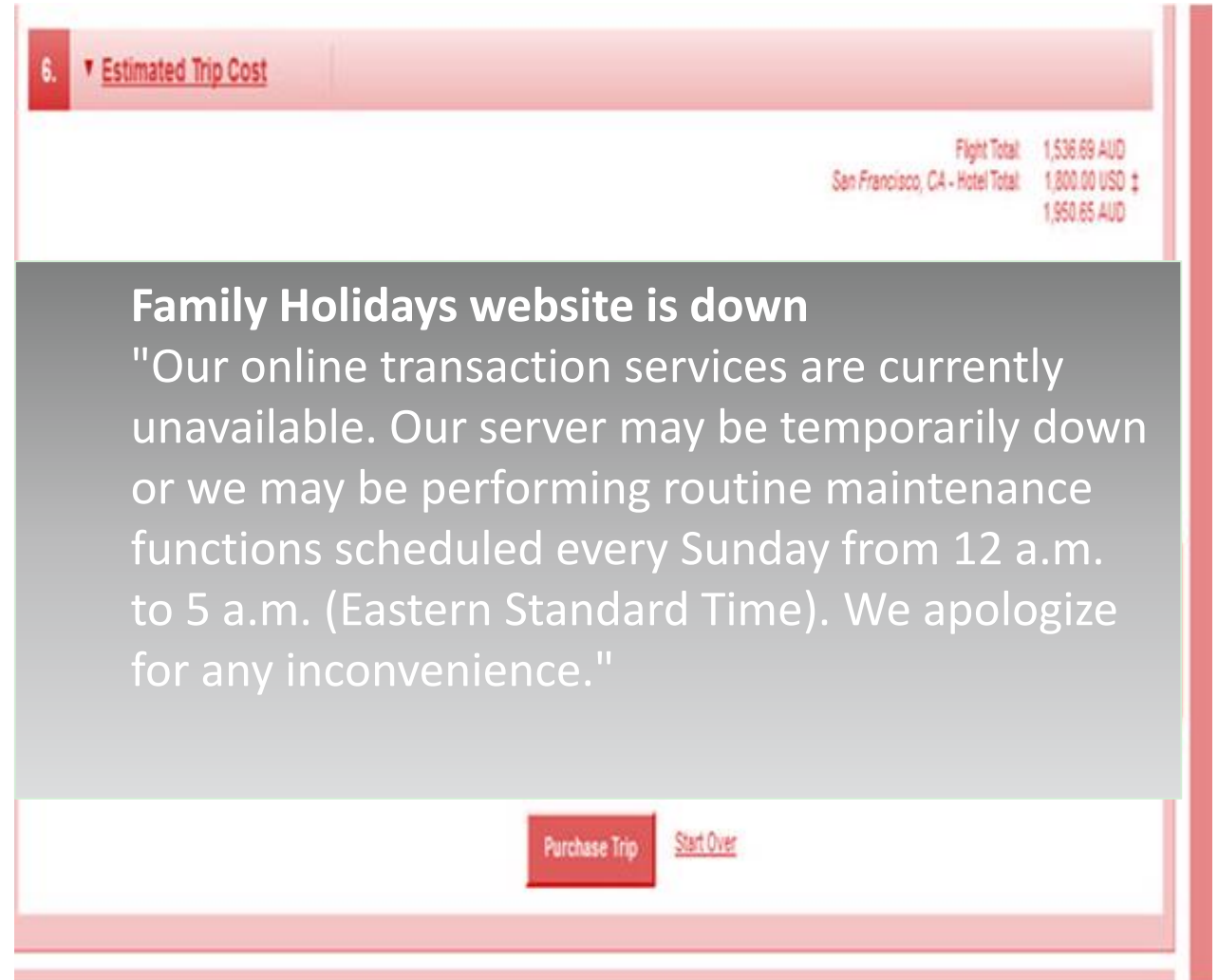
Request Body
often ends with
COMMIT

**End
Request**

Maintenance without Impact

There is no reason for users to see downtime during scheduled database maintenance

- Service is unavailable
- Application owners unable to agree maintenance windows
- Long running jobs see errors
- DBA's and engineers work off hours
- Application and middleware components need to be restarted



Drain sessions before maintenance



Move services first

Drain connections where applications don't notice

Many Drain Points

- Connection Pools
- Connection tests
- Web requests
- Transaction boundaries

Tip: DBA steps to Drain Sessions – Since 10.2



Repeat for each service allowing time to drain

- Stop service

```
srvctl stop service -db .. -instance .. -service .. (omit service)
```

- Relocate service

```
srvctl relocate service -db .. -service .. -oldinst .. -newinst
```

```
srvctl relocate service -db .. -service .. -currentnode.. -targetnode
```

Wait for sessions to drain...

For remaining sessions, stop transactional

```
exec dbms_service.disconnect_session( '... your service ..',  
DBMS_SERVICE.POST_TRANSACTION);
```

Stop the instances using your preferred tool

Use Oracle Pools – Full Lifecycle

Drain and Rebalance

Applications using ...	Oracle – WebLogic Active GridLink, UCP, ODP.NET managed and unmanaged, OCI Session Pool, Tuxedo, CMAN TDM 3 rd party App Servers using UCP: IBM WebSphere, Apache Tomcat, NEC WebOTX, Red Hat JBoss, Spring
DBA Step	srvctl [relocate stop] service -drain_timeout
Sessions Drain	Immediately new work is redirected Gradually Active sessions are released when returned to pools

FAN Planned

Drain & rebalance



UCP with other Java-based Application Servers

A simple data source replacement

General Properties

Scope

cells:expe-was:nodes:ee001a:servers:ST6AppServerEE001A

Name

Oracle JDBC Driver UCP ST6_QC02P01

Description

Oracle JDBC Driver UCP ST6_QC02P01

Class path

`${WAS_INSTALL_ROOT}/jdbc/ojdbc7.jar`
`${WAS_INSTALL_ROOT}/jdbc/ucp.jar`
`${WAS_INSTALL_ROOT}/jdbc/ons.jar`

Class path to be set for UCP JDBC Provider
`${WAS_INSTALL_ROOT}/jdbc/ojdbc7.jar`
`${WAS_INSTALL_ROOT}/jdbc/ucp.jar`
`${WAS_INSTALL_ROOT}/jdbc/ons.jar`

Native library path

☐ Isolate this resource provider

Implementation class name

`oracle.ucp.jdbc.PoolDataSourceImpl`

Apply OK Reset Cancel

Additional Properties

■ [Data sources](#)

- IBM WebSphere
- Apache Tomcat
- NEC WebOTX
- Red Hat Jboss
- Hibernate
- Spring
- Your own

DBA Operations Simplified



- **Group operations** pdb, instance, node, or database
- New service attributes
 - drain_timeout** (seconds)
 - stopoption** (immediate, transactional)

DBA commands: Group commands

Relocate all services by database/node/pdb

```
srvctl relocate service -database -instance -drain_timeout.. -stopoption  
[immediate|transactional]
```

```
srvctl relocate service -node . -drain_timeout.. -stopoption
```

```
srvctl stop service -pdb . -drain_timeout.. -stopoption
```

Start/Stop everything at a node

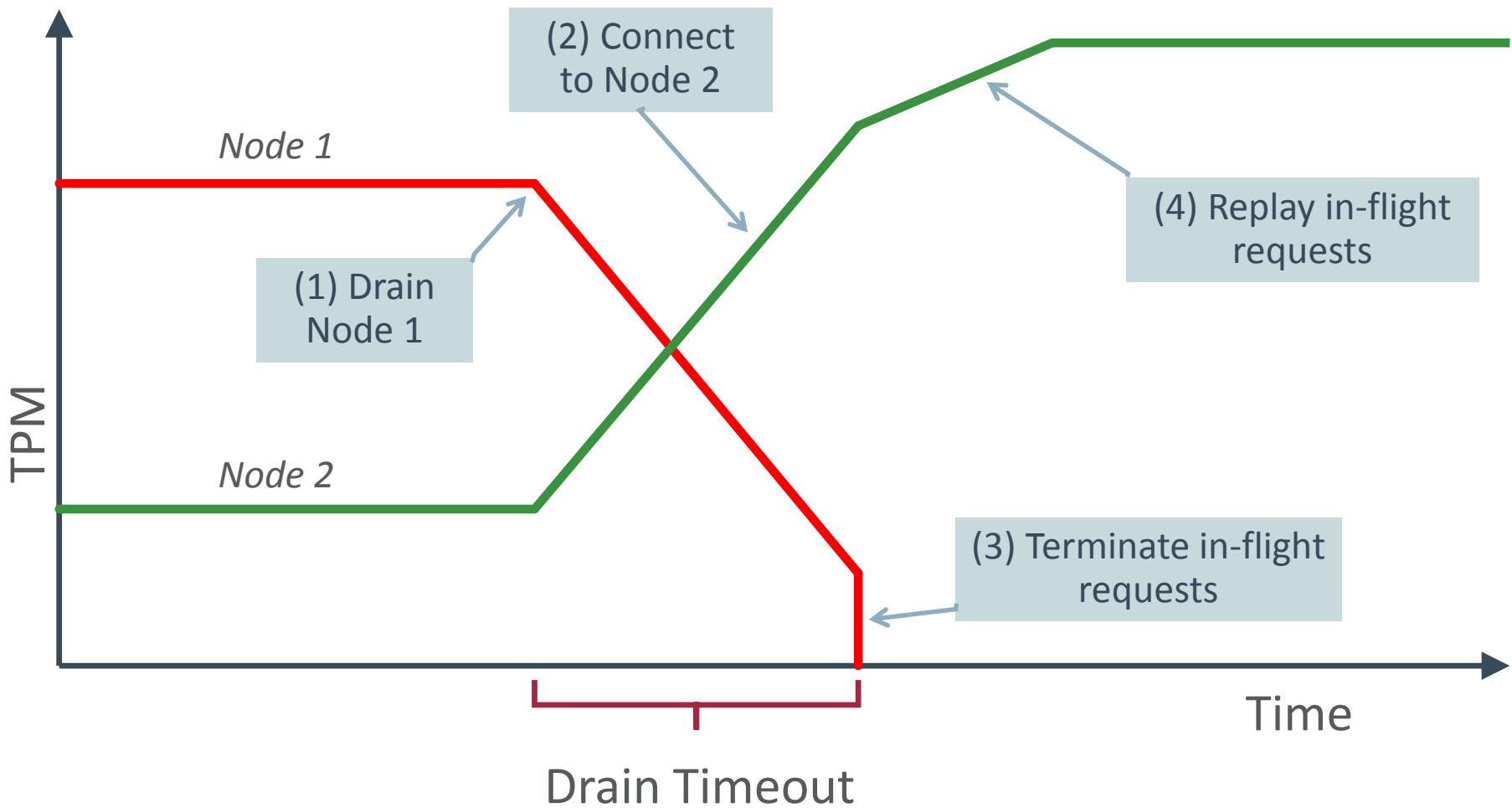
```
srvctl stop service -node <node_name> -drain_timeout.. -stopoption
```

```
srvctl stop database -node <node_name> -drain_timeout.. -stopoption
```

Data Guard Switchover

```
Switchover to <db_resource_name> [wait [xx]];
```

Drain... Connect... Failover



In-Flight Work

Pre-12c Situation

Database outages cause in-flight work to be lost, leaving users and applications in-doubt

- Restart applications and mid-tiers
- User frustration
- Cancelled work
- Duplicate submissions
- Errors even when planned
- Developer pains

Sorry. Internal Server Error - 500 Error
We are currently experiencing an issue with our servers on coolcar.com. Please come back later.

6. ▾ Estimated Trip Cost

Flight Total:	1,536.69 AUD
San Francisco, CA - Hotel Total:	1,800.00 USD ‡
	1,950.65 AUD

Trip Total: 3,487.35 AUD ‡
3,218.00 USD

‡ Please note that this total is based on available information. The estimated cost may not include taxes and fees.

- Remember to obtain an original invoice for all your expenses where required under the Global Travel Policy. The invoice should always include the name and address of your Oracle company. Failure to obtain a proper invoice may increase Oracle's costs by up to 25%.

Please Note:
If you do not receive a confirmation after clicking Purchase Trip (EX. receive a **blank error message** or an error message that states "You already have an active session in the online booking site"), please call CWT before clicking purchase trip again.

[Purchase Trip](#) [Start Over](#)

Application Continuity

In-flight work continues

- Replays in-flight work on recoverable errors
- Masks hardware, software, network, storage, session errors and timeouts
- 12.1 JDBC-Thin, UCP, WebLogic Server, 3rd Party Java application servers
- 12.2 OCI, ODP.NET unmanaged, JDBC Thin on XA, Tuxedo*, SQL*Plus, Pro*
- **18c is Transparent (TAC)**

The screenshot displays a web interface for an Oracle Travel Agency (TAC). At the top, a section titled "6. Estimated Trip Cost" shows a breakdown of expenses: Flight Total (1,536.69 AUD), San Francisco, CA - Hotel Total (1,800.00 USD ±), and a subtotal (1,950.65 AUD). Below this, a larger box displays the "Trip Total: 3,487.35 AUD ±" and "3,218.00 USD". A disclaimer states: "± Please note that this total is based on available information. The estimated cost may not include taxes and fees." A bullet point reminds users to obtain an original invoice for all expenses under the Global Travel Policy. A red rectangular box highlights the confirmation message: "Your order number is 175634. You are protected by Application Continuity". At the bottom right, there are two buttons: "Purchase Trip" and "Start Over".

Item	Amount
Flight Total	1,536.69 AUD
San Francisco, CA - Hotel Total	1,800.00 USD ±
Subtotal	1,950.65 AUD
Trip Total	3,487.35 AUD ±
	3,218.00 USD

± Please note that this total is based on available information. The estimated cost may not include taxes and fees.

- Remember to obtain an original invoice for all your expenses where required under the Global Travel Policy. The invoice should always include the name and address of your Oracle company. Failure to obtain a proper invoice may increase Oracle's costs by up to 25%.

Your order number is 175634. You are protected by Application Continuity

[Purchase Trip](#) [Start Over](#)

Demonstration

– Standardize on TAC

NEW IN
18^c



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Application Continuity Explained

Normal Operation

- Client marks requests: explicit and **discovered**.
- Server **tracks session state**, decides which calls to replay, **disables side effects**.
- Directed, client holds original calls, their inputs, and **validation data**.

Failover Phase 1: Reconnect

- Checks replay is enabled
- Verifies timeliness
- Creates a new connection
- Checks target database is legal for replay
- Uses Transaction Guard to guarantee commit outcome

Failover Phase 2: Replay

- Restores and **verifies the session state**
- Replays held calls, restores mutables **automatically**
- Ensures results, **states**, messages match original.
- On success, returns control to the application

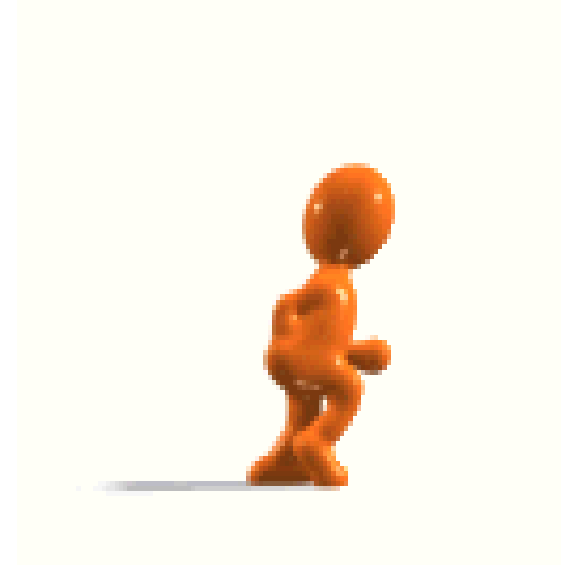
New with 18^c

Using Transparent Application Continuity

Request Boundaries	Discovered and Advance Continuously
Session State	Restored and Verified
Side Effects	Not replayed
SYSDATE, Sequences..	Automatic for SQL, Grant for PL/SQL
Coverage	Always know your protection level

Request Boundaries Advance Continuously

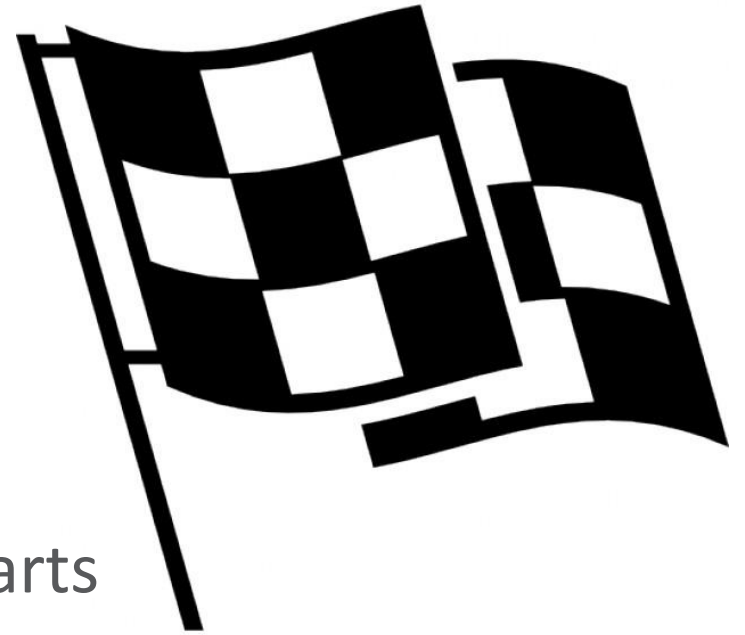
- Request boundaries advanced automatically when state is restorable*
- Capture re-enables, if disabled
- Smaller capture set means faster recovery
- **Oracle pool and return to pool are still best practice**



* Transparent Application Continuity for Java, OCI coming

Session State must be Correct to Replay

- Restore session states before replaying
 - `FAILOVER_RESTORE` on your service
- TAC does not replay if session states differ
- AC allows you to add complex states before replay starts
 - AC does not replay if standard states differ



Side Effects Not Replayed

TAC – stops capture automatically until next enable point



Side Effects Disabled

TAC decides if any requests should not be replayed, e.g.

UTL_HTTP
UTL_URL
DBMS_FILE
DBMS_FILE_TRANSFER
UTL_SMTP
UTL_TCP
UTL_MAIL
EXTPROC

Customized: use AC

Handles SYSDATE, SYSTIMESTAMP, Sequences ...

Keeps and Restores Automatically



Function results kept for SQL

Grant keeping results for PL/SQL

For owned sequences:

```
ALTER SEQUENCE.. [sequence]  [KEEP|NOKEEP]  
CREATE SEQUENCE.. [sequence]  [KEEP|NOKEEP]
```

Grant and Revoke for other users:

```
GRANT [KEEP DATE TIME | KEEP SYSGUID] [to USER]  
REVOKE [KEEP DATE TIME | KEEP SYSGUID] [from USER]  
GRANT KEEP SEQUENCE on [sequence] [to USER]  
REVOKE  KEEP SEQUENCE on [sequence] [from USER]
```

Always Know Your Protection Level

- AWR, system, session, service stats
 - Requests completed per second
 - User calls in request
 - Protected user calls

Statistic	Total	per Second	per Trans
-----	-----	-----	-----
cumulative requests	177,406	49.2	5.0
cumulative user calls in request	493,329	136.8	13.8
cumulative user calls protected	493,329	136.8	13.8

Detailed Protection Report when needed

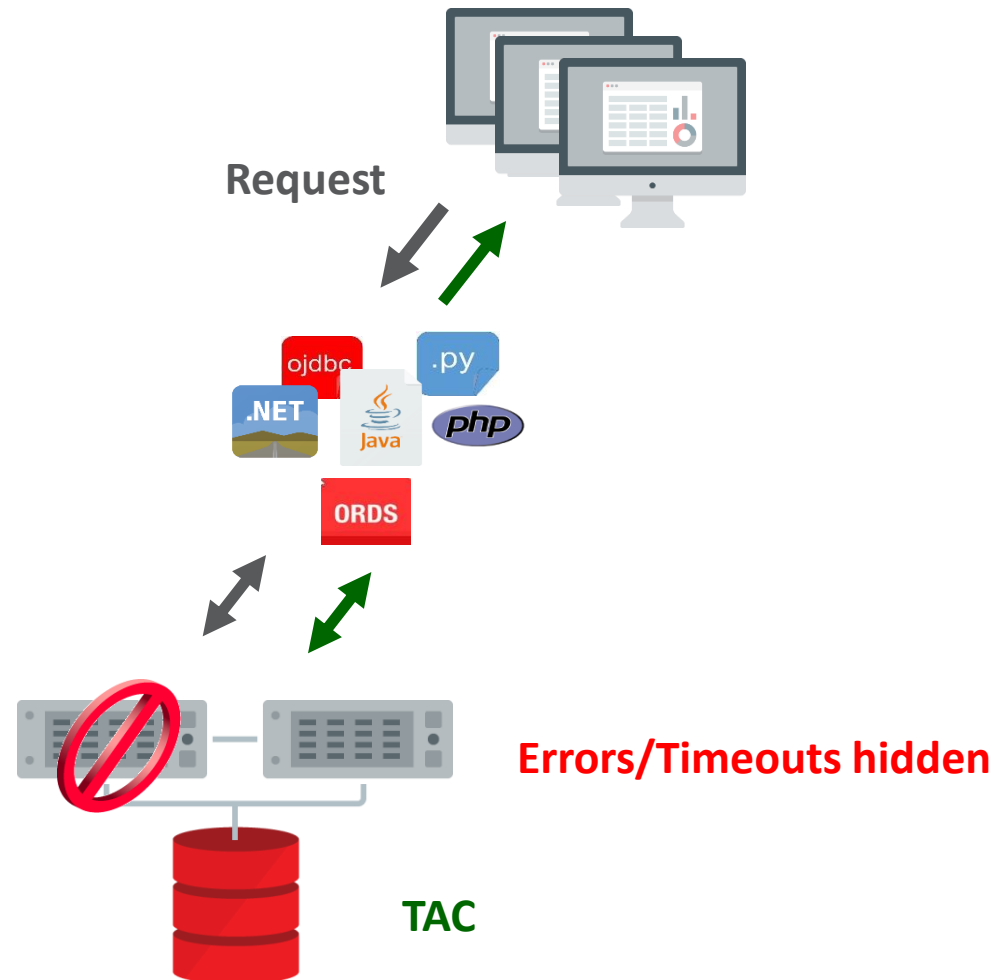
EPSILON®

Application Continuity Summary

Outage Type	Status	Message
Coverage checks		TotalRequest = 398 PASS = 389 WARNING = 0 FAIL = 9
	PASS	[PASS] Trace file name = WEB_ora_124333.trc Row number = 10909 SERVICE NAME = (WEB_SSL_SERVICE) MODULE NAME = (JDBC Thin Client) ACTION NAME = POST CLIENT ID = null Coverage(%) = 100 ProtectedCalls = 1 UnProtectedCalls = 0
	PASS	[PASS] Trace file name = WEB_ora_19757.trc Row number = 36978 SERVICE NAME = (WEB_SSL_SERVICE) MODULE NAME = (JDBC Thin Client) ACTION NAME = CARD CLIENT ID = null Coverage(%) = 100 ProtectedCalls = 24 UnProtectedCalls = 0
	FAIL	[FAIL] Trace file name = WEB_ora_19757.trc Row number = 481193 SERVICE NAME = (WEB_SSL_SERVICE) MODULE NAME = (JDBC Thin Client) ACTION NAME = null CLIENT ID = null Coverage(%) = 20 ProtectedCalls = 1 UnProtectedCalls = 4
	FAIL	[FAIL] Trace file name = WEB_ora_19757.trc Row number = 14203 SERVICE NAME = (WEB_SSL_SERVICE) MODULE NAME = (JDBC Thin Client) ACTION NAME = null CLIENT ID = null Coverage(%) = 33 ProtectedCalls = 2 UnProtectedCalls = 1

Applications see no errors during outages

Standardize on Transparent Application Continuity



Hides errors, timeouts, and maintenance

No application knowledge or changes to use

Rebuilds session state & in-flight transactions

Adapts as applications change: protected for the future



Chicago Mercantile Exchange

CME Group Overview

CME Group is the world's leading and most diverse derivatives marketplace bringing together those who need to manage risk or those that want to profit by accepting it.



- Operating Multiple Exchanges – CME, CBOT, Nymex and COMEX
- Trade hundreds of products across the globe on a single platform
- Average daily volume of 15.6 million contracts

- CME Clearing – matches and settles all trades and guarantees the creditworthiness of every transaction
- Cleared more than 3.9 billion contracts with a value exceeding \$1 quadrillion
- Highest Volume Day – 44.5 million contracts after the election

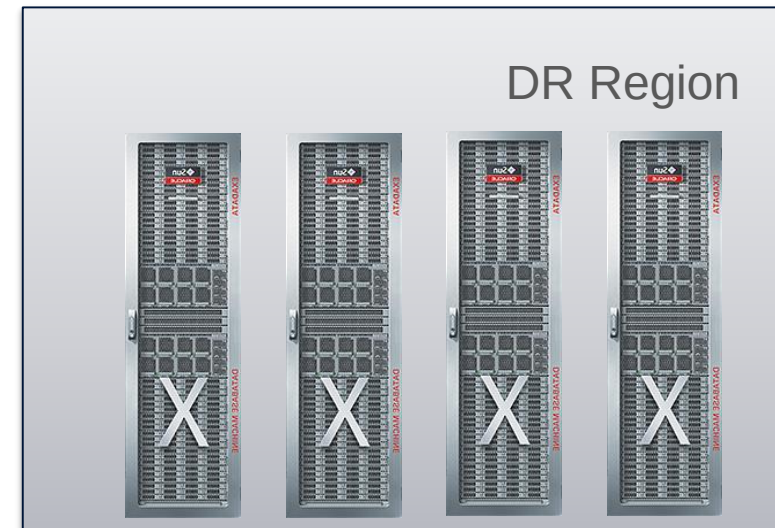
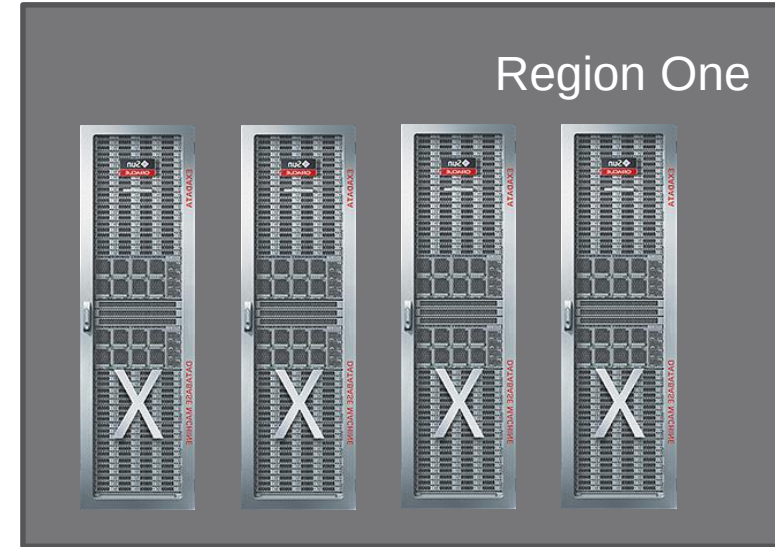
CME HIGH AVAILABILITY OVERVIEW

Requirements

- **Critical DB's – 10 second to SLA**
- **Component Failure Cannot cause DR Event**
- 24X7 Application up time
 - Including Planned Maintenance
- RPO – 30 seconds (Disaster Only)
- RTO – 2 hours (Disaster Only)

Solution

- Exadata
 - Addresses Performance
 - Allows Consolidation
 - Reduces recovery time (component failure)
- Active Data Guard
- **Application Continuity** – Planned/unplanned



WHY CME IS ADOPTING APPLICATION CONTINUITY

- Database Outages cause in-flight work to be lost
- A Database Outage can effect many applications concurrently due to schema consolidation
- Critical Applications are becoming 24x7 – These are referential applications
- Database planned downtime on behalf of patching is exceedingly harder to schedule due to shrinking maintenance windows.
- Avoid dedicating maintenance windows to the database group
- Applications work together as a system. It can take serval hours to start and normalize

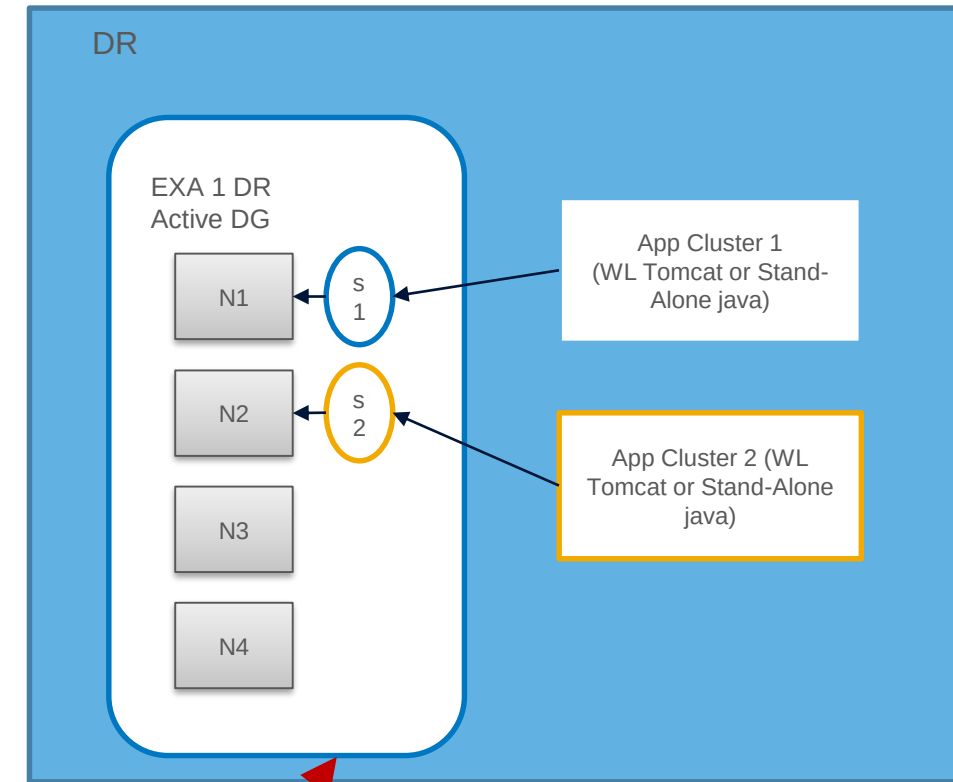
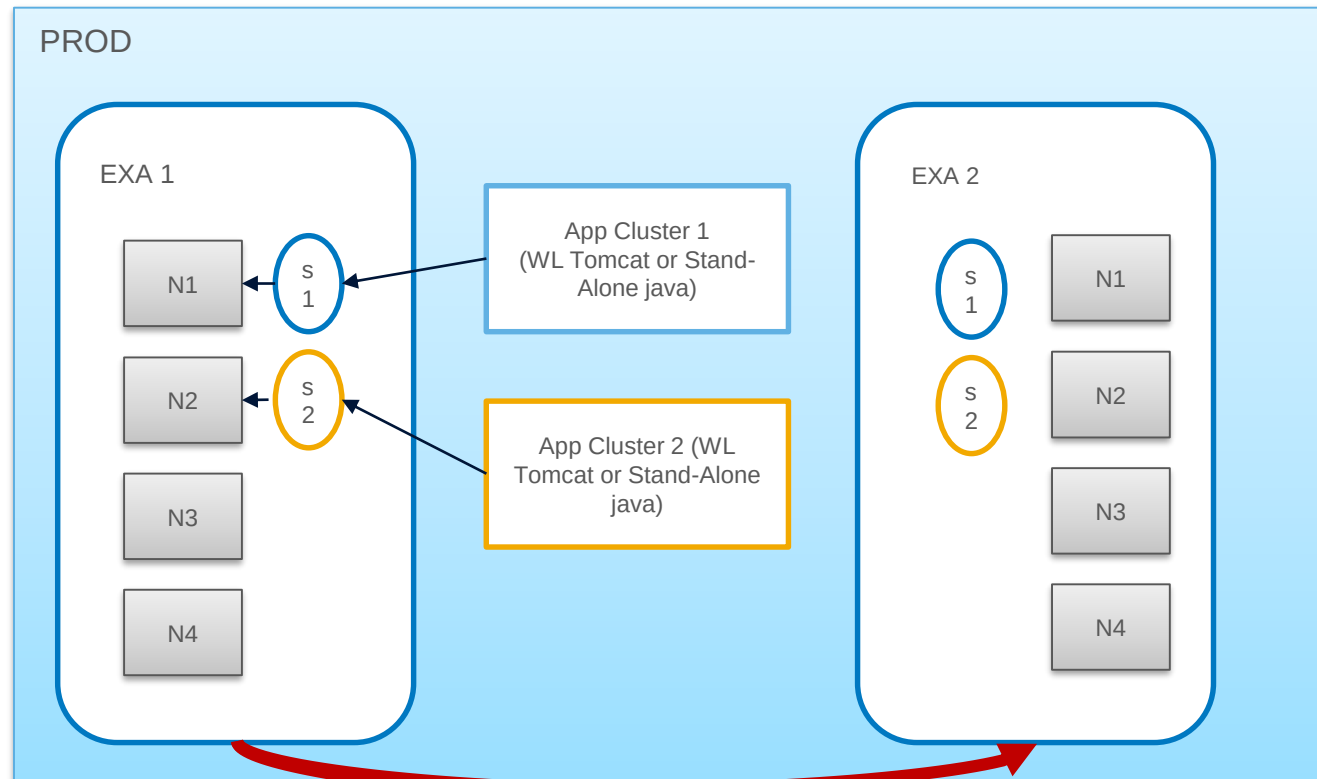
Failure Proofing Applications Is Hard

What's Hard	What's Today's Solution
Hanging on TCP/IP Timeouts – Application is not aware of an issue because there has been no ack for the last operation	• FAN – Fast Application Notification • FCF – Fast Connection Failover • ONS – Notification Services These features work together to overcome TCP hangs
Reconnecting to surviving nodes or standby database after failure	Application Continuity automatically performs connection retries all configurable in the connection string
Assuring any in-flight transactions were committed to the database.	Application Continuity features handle this transparently. Transactions are crosschecked and replayed safely
Confidence leaving applications live during planned Database Maintenance	AC has proven to be resilient at CME.

Normal Operation

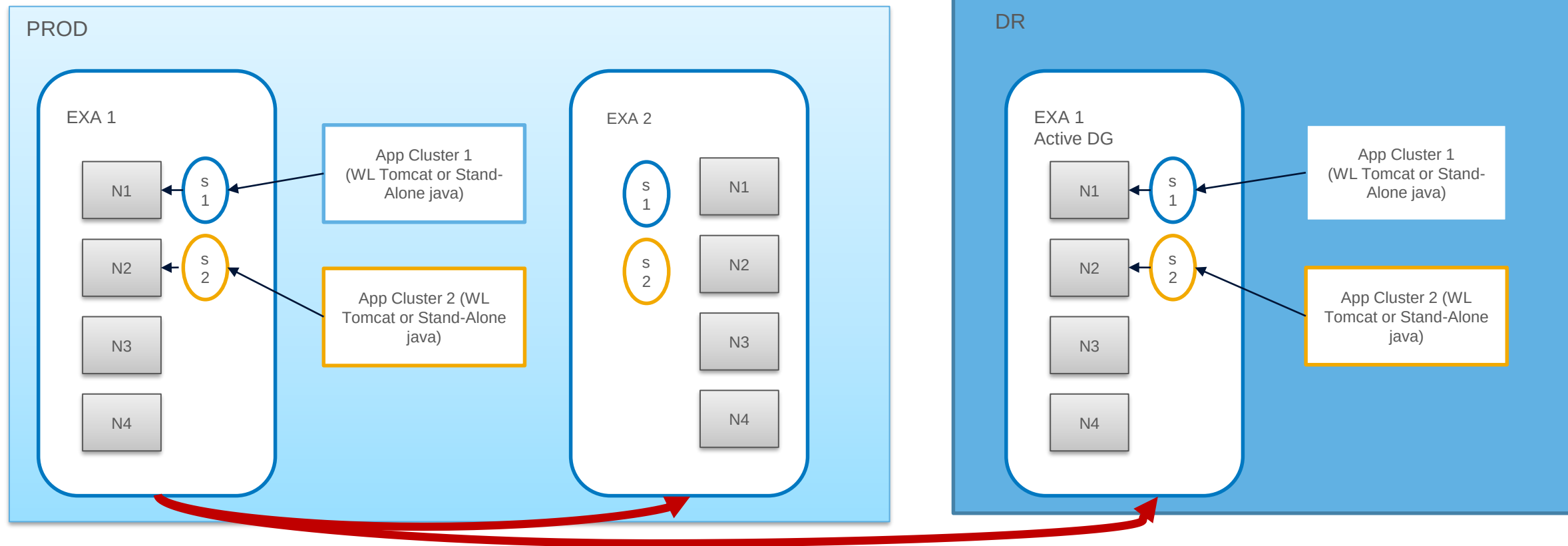
- All OLTP services configured as 1 active, rest available
- Over 400 services across environment
- Over 100 applications
- Node capacity actively managed

- Most Application Servers “Lie in Wait”
- Critical Applications are connected in a RO mode



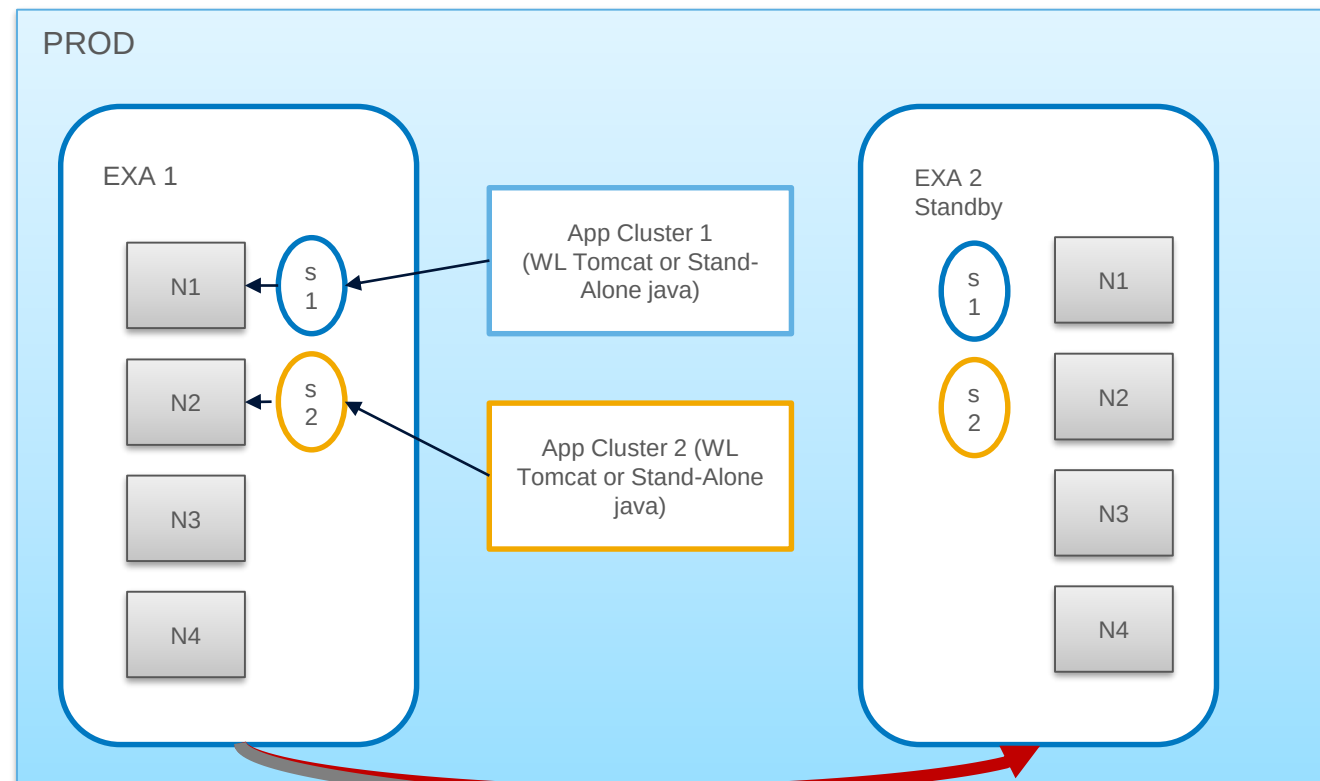
Planned Maintenance

- Exadata Full Stack Patching takes 4 hours at best
- CME does not do rolling patches (duration too long)
- AC allows apps to stay up and undergo updates while patching happens.



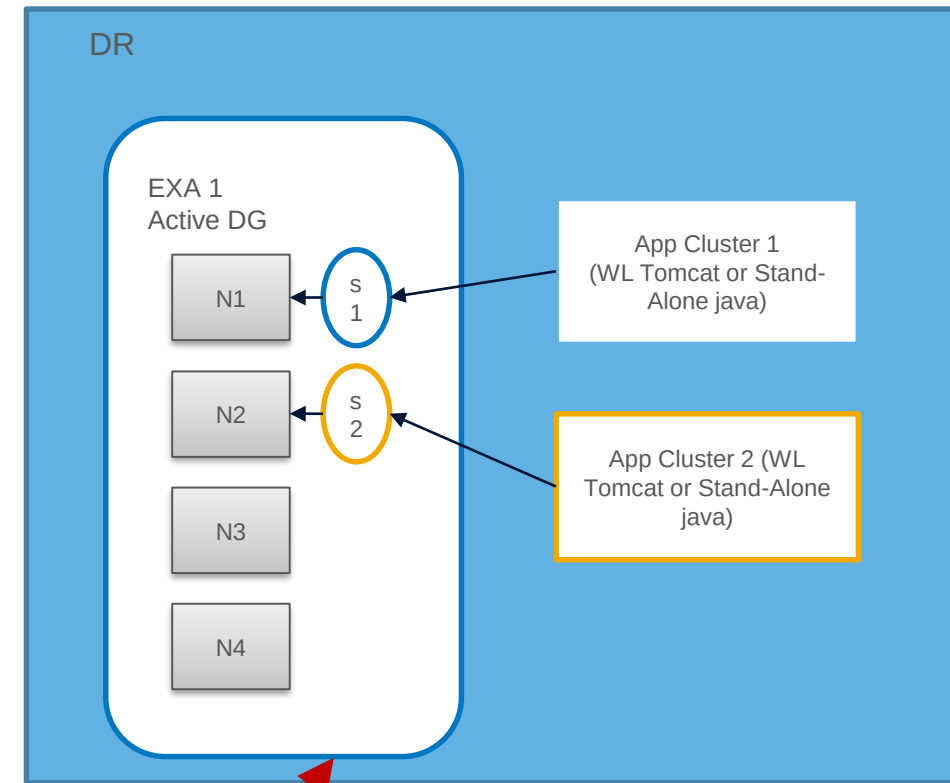
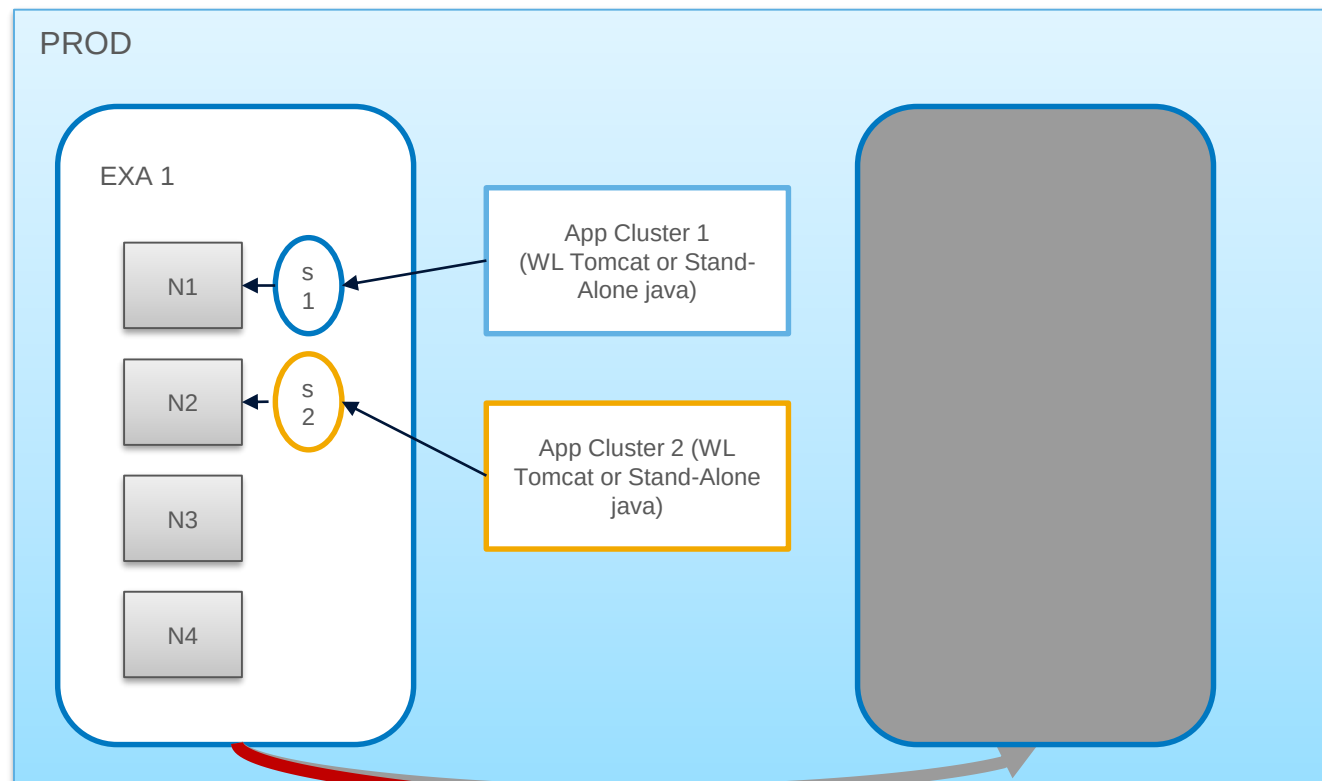
Planned Maintenance

- DR is always patched first
- Applications in DR are taken offline
- Normal change window applies
- Application changes in PROD coincide with DR patching



Planned Maintenance

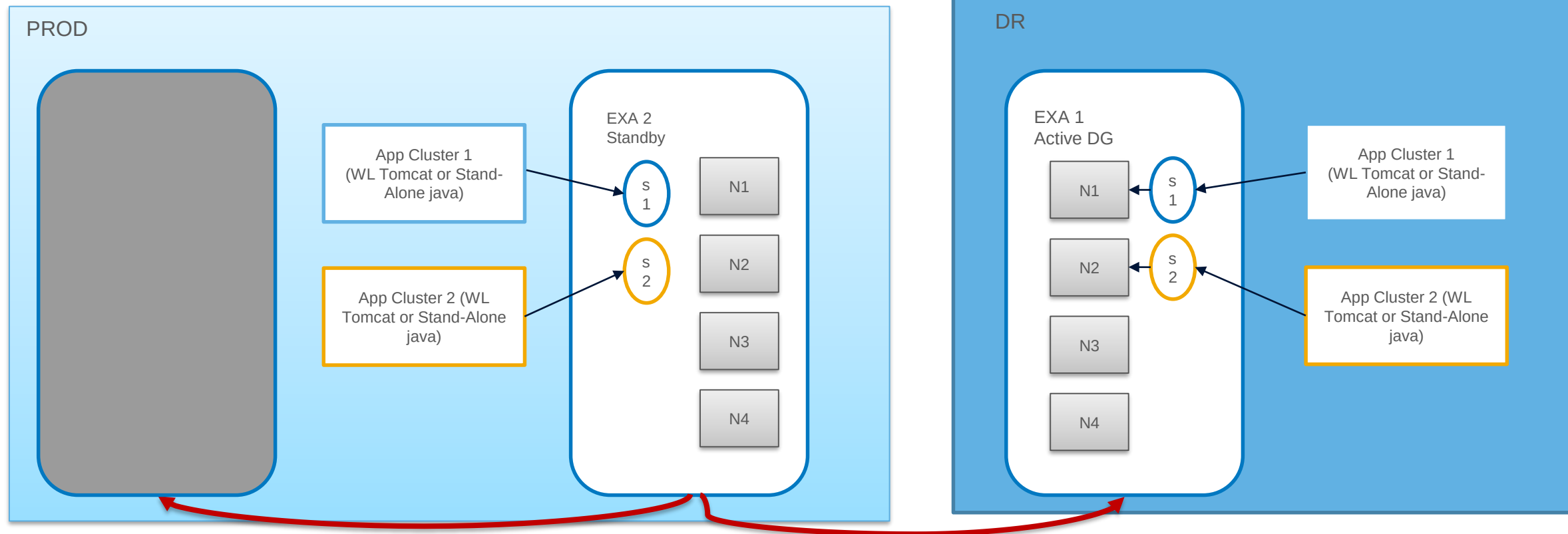
- Local Standby databases are patched after DR
- Patching the local standby database does not impact running application
- Patched during normal maintenance window
- Application changes and testing can continue



Planned Maintenance – Database As A Service

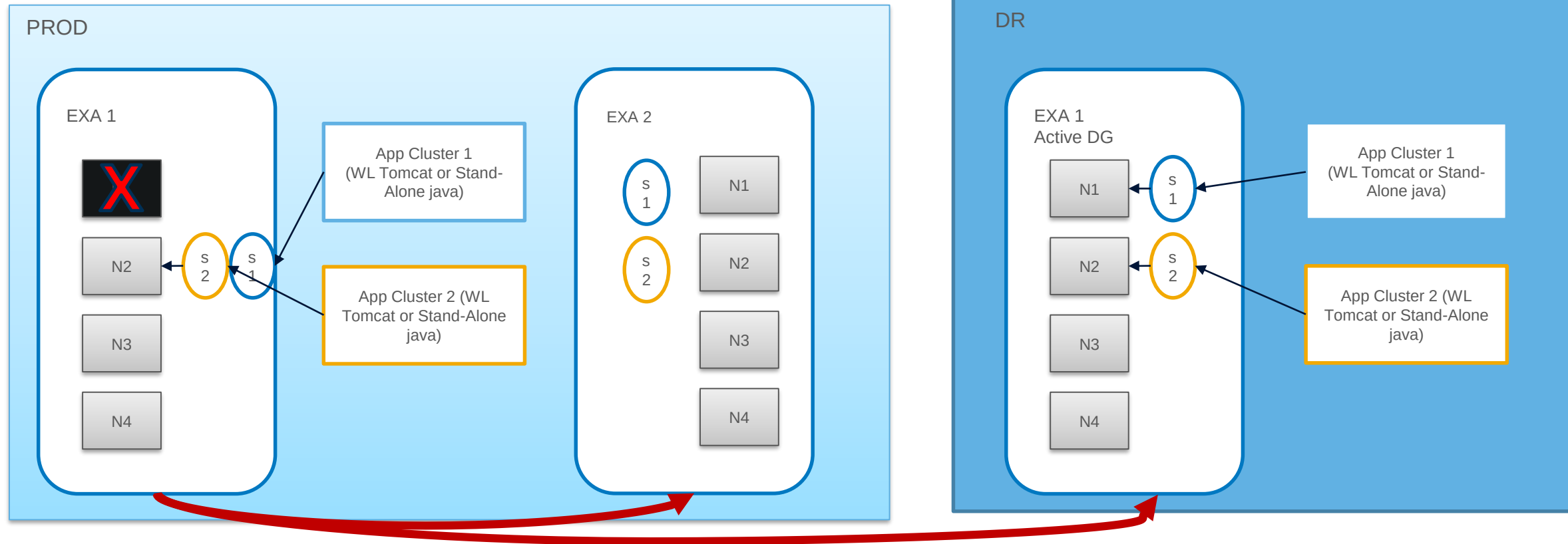
- AC compliant applications stay running and available
- Non compliant applications are stopped and restarted (Transition period)
- A database switchover is performed
- An LDAP job modifies connection strings for non compliant apps

- Non compliant apps are restarted
- Changes and testing continues during maintenance window
- Process repeated for fail back



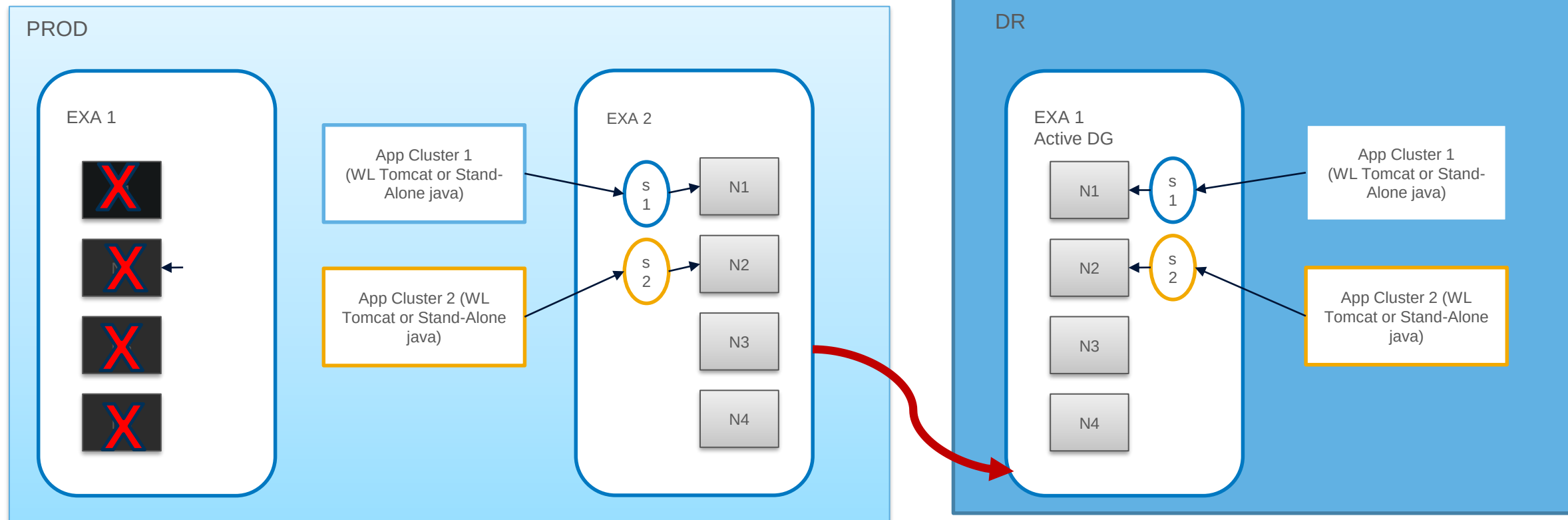
UNPLANNED OUTAGES

- Node 1 fails
- All services fail to available instance (2 illustrated)
- Application connections follow service location using Application Continuity



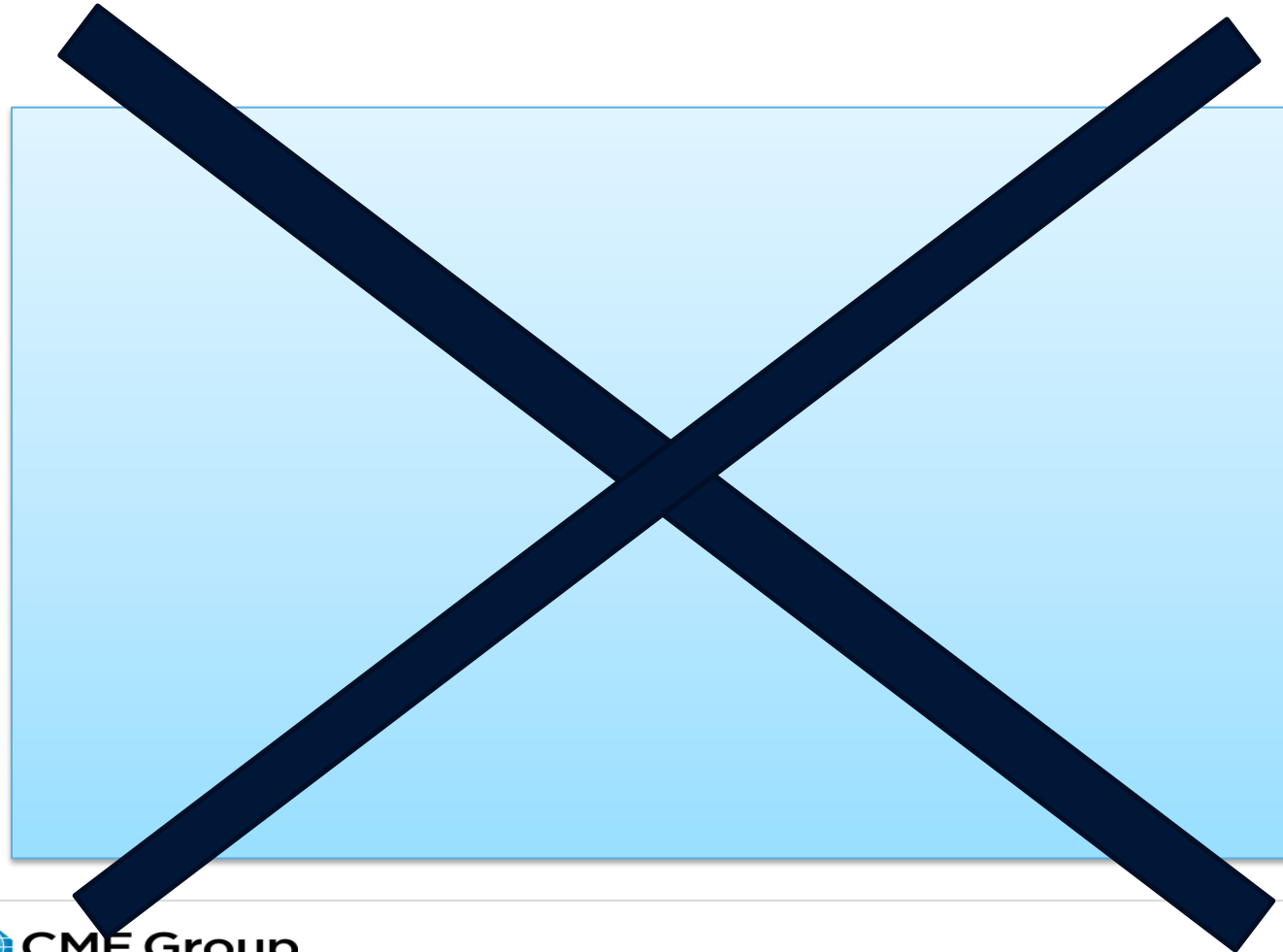
UNPLANNED OUTAGES

- What if the whole Exadata Fails?
- **At CME – this is not allowed to cause a DR event**

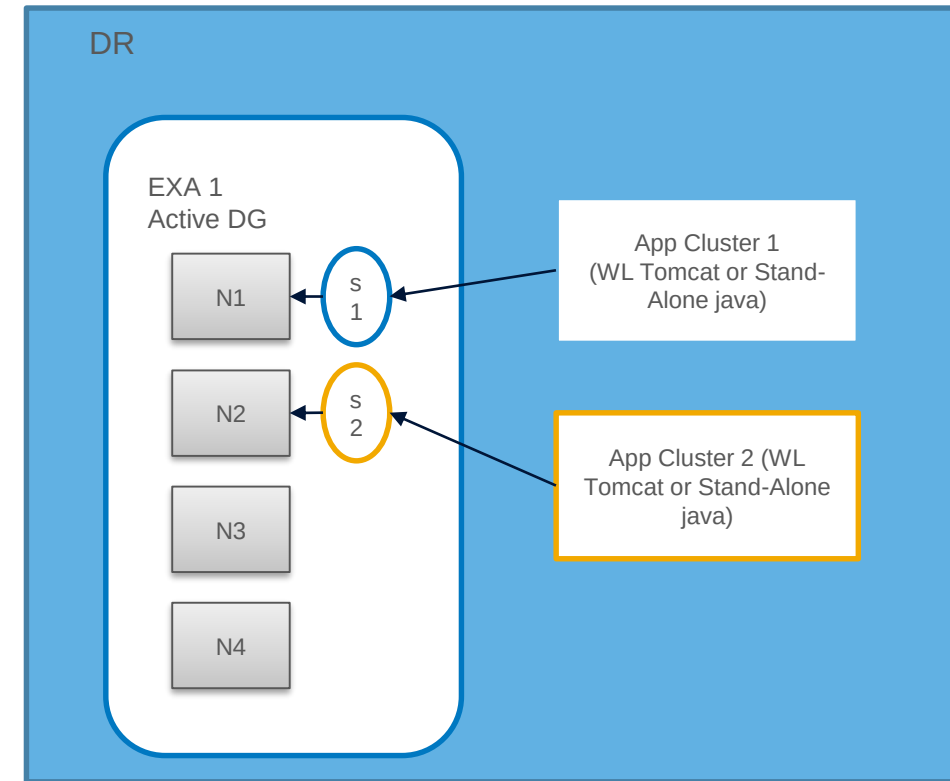


UNPLANNED OUTAGES

- Catastrophic Data Center Failure
 - Uncontrolled network outage (All HA FAILS)
 - Physical Damage to building
 - EXA 1 and EXA 2 fail in same week



- Critical Apps Up for customer RO access
- Databases are converted – Apps convert to RW
- All apps started - < 2 hours
- All automated



CME Best Practices

- Good test environment that mirrors production
- Credible HA and DR testing methodology on a mandatory interval commensurate with your change rate
- Application simulation for testing that is realistic
- Capacity Planning – keep utilization of servers <50%
- Client Interrupted using FAN and FCF
- Time Based Failover, supported by Application Continuity
- No Single Points of Failure
- Strong Change Control

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Integrated Cloud

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