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Oracle Real Application Clusters One Node:
The "Always On" Single-Instance Database

Executive Summary

Oracle Real Application Clusters (RAC) One Node is a new option to the Oracle Database 11g Release 2 Enterprise Edition. It provides enhanced high availability for single-instance databases, protecting from both planned and unplanned downtime.

Oracle RAC One Node provides:

- Always on single-instance database services
- Better consolidation for database servers
- Enhanced server virtualization
- Lower cost development and test platform for full RAC

In addition it allows customers to consolidate database storage, standardize their database environment, and, should the need arise, upgrade to a full multi-node Oracle RAC database without downtime or disruption.
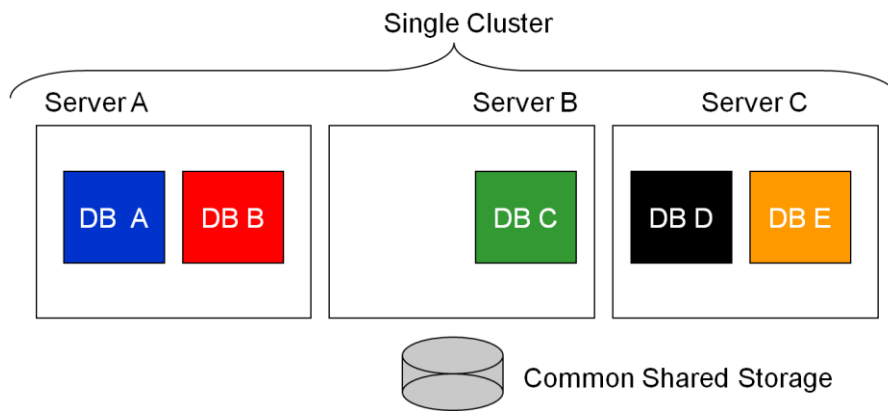
Oracle Real Application Clusters One Node Overview

With Oracle Database 11g Release 2, Oracle introduces Oracle Real Application Clusters (RAC) One Node, a new feature that provides always on availability for single-instance databases.

Availability is a growing concern for all customers. Information, and the databases underlying that information, has become more and more integral to business processes and products. Windows of downtime for planned maintenance no longer exist, as users all over the world are dependent on access to data. To meet service levels with reduced staffing requires infrastructures that automatically recover from failures without administrator intervention.

Oracle RAC One Node leverages the capabilities of Oracle RAC to extend Oracle RAC's availability benefits to single-instance databases. Single-instance databases can now enjoy online maintenance, including online server and storage replacement, online operating system upgrades and patching, online database patching, and automatic recovery from software and hardware failures.

Oracle RAC One Node provides more than just always on availability. Its ability to online migrate instances from one server to another enable customers to better consolidate their databases, vastly improving on the rudimentary server consolidation offered by server virtualization. When used in conjunction with server virtualization products like Oracle VM, Oracle RAC One Node enhances the benefits of virtualization, leveraging the strengths of both products. The figure below represents a typical RAC One Node deployment.
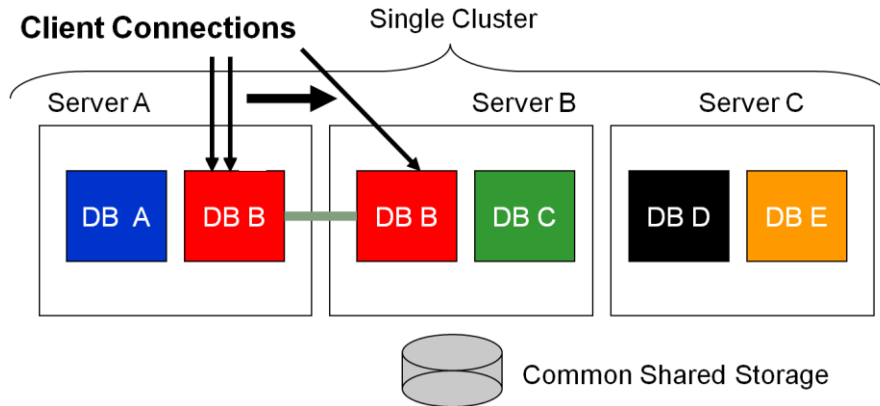

In this example configuration, we have five single-instance Oracle RAC One Node databases running in a cluster of three servers:

- Server A is hosting Oracle RAC One Node databases DB A and DB B

- Server B is hosting database DB C and server C is hosting databases DB D and DB E.

- Each server runs one OS.

- In servers A and C above, multiple databases are consolidated onto a single OS.

This deployment itself provides many consolidation benefits. However, online database relocation, a unique feature of Oracle RAC One Node that provides live migration of databases across nodes in the cluster, enables many additional benefits.

Below is a depiction of **Oracle RAC One Node online database relocation**:

Online database relocation allows an online migration of a database from one server to another server. Online database relocation leverages the ability of Oracle Real Application Clusters to simultaneously run multiple instances servicing a single database.

In the figure above, the DB B RAC One Node database on Server A is migrated to Server B. Oracle RAC One Node starts up a second DB B instance on server B, and for a short period of time runs in an active-active configuration.

As connections complete their transactions on server A, they are migrated to the instance on server B. Once all the connections have migrated, the instance on server A is shutdown and the migration is complete.

"Always On" Single-Instance Database

Oracle RAC One Node combines online database relocation, shared storage, and a clustered infrastructure to provide powerful availability features. Taken together, these features make Oracle RAC One node the always on single-instance database.

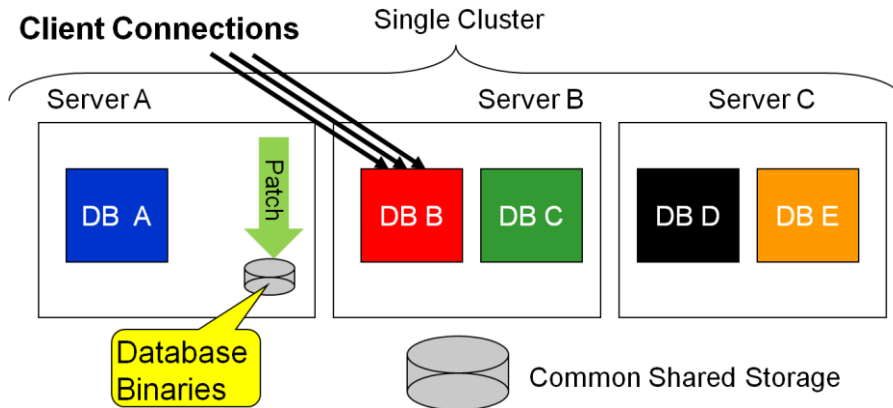## Online Storage and Server Migration

Online migrate from one generation of servers and storage to another— no downtime required.

Online database relocation enables customers to online migrate from one server to another. These servers may not be identical – in the case of a server upgrade, you may move from one processor generation to another. Online database relocation enables online moving a database from one generation of servers, to the next, without downtime. RAC One Node uses Automatic Storage Management (ASM) to store and manage database files. ASM supports online migration of database files from one set of disks or LUNs to another, even if in a different array. Thus, RAC One Node databases support online storage upgrades as well.

Online Maintenance

A unique feature of Oracle RAC One Node is the ability to do online maintenance for both database and operating system.

RAC One Node administrators can online migrate the databases off the server to a spare server, and then perform all types of maintenance on the idle server, including hardware maintenance, OS upgrades, OS patches, and database patches. With online database relocation, a new database instance is created on a new server (running in a different operating system), and work is online migrated to the new instance. Thus, the old OS and database home remain on the former host server, and can be upgraded (OS) or patched.
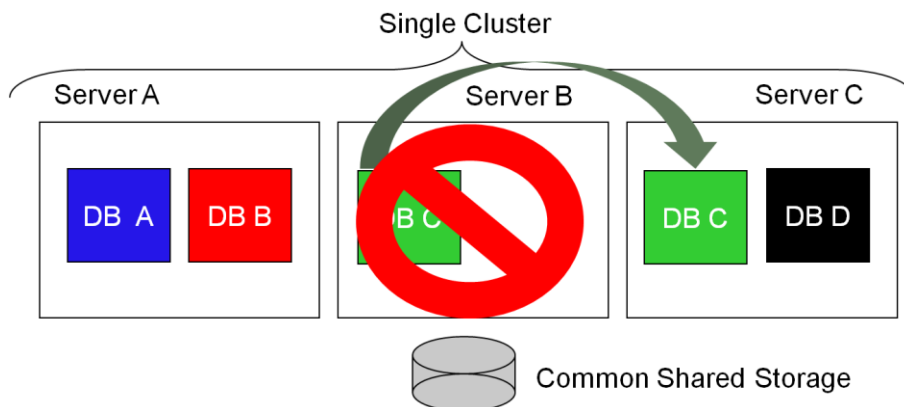
The figure above depicts a RAC One Node deployment after using online database relocation to move database B from server A to server B. After the migration, the database binaries that had hosted the instance formerly running on server A remain available for patching. Once patched, database B can be migrated via online database relocation back to server A.

Because online database relocation supports migration between instances at different patch levels, the operation is completely online and requires no disruption to end users. Similarly, online database relocation can be used to move all databases off a node in preparation for an online OS upgrade.

Enhanced Protection from Failures

Oracle RAC One Node responds to <u>both</u> server and database failures with unattended cluster failover that relocates the impacted database service.

Below is a depiction of Oracle RAC One Node failover. In scenario, Server B failed and database instance DB C that was running on Server B is started on Server C.

Oracle RAC One Node is integrated with Oracle Clusterware which monitors the health of the database and ensures database service availability. In the event of a failure, Oracle RAC One Node will detect the failure and either restart the failed database, or fail it over to another server.

Comparable to other 3rd-party cold failover solutions from vendors like HP, IBM, and Symantec, Oracle RAC One Node cold failover ensures unattended recovery from failures, with full services restored within 5 to 30 minutes. It is ideal for those applications that can tolerate short periods of downtime, but cannot tolerate waiting for an administrator to detect the problem and restore services.[1]

Better Server Consolidation

Virtualization has become a hot topic in the IT industry (See Box 1). With Oracle RAC One Node, Oracle now provides a more sophisticated form of virtualization developed for database operations that improves upon the benefits of virtualization, and provides additional unique value. It enables better server consolidation, enhanced protection from failures, greater flexibility and workload management, and better online maintenance than VMs.

Moreover, RAC One Node runs on physical servers and does not suffer the performance handicap of virtual servers.[2] A database may incur high overhead running in many server virtualization environments due to their propensity to perform I/O and memory intensive operations—for such environments, running on physical servers will provide substantial performance improvements.

**Oracle RAC One Node provides superior consolidation
by leveraging the benefits of a shared operating system (OS).**

- <u>One</u> OS to install, configure, secure, patch, upgrade, backup, manage
  vs. multiple operating systems in a VM environment

- Resource efficiency of running one OS vs. multiple operating systems

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[1] Customers who need sub-minute recovery should deploy their databases on multi-node Oracle Real Application Clusters (RAC). Oracle RAC provides the best possible availability and fastest recovery from failures.

[2] Virtual servers <u>always</u> suffer a performance handicap vs. physical hardware. This is because CPU instructions must be translated in a virtual server, adding to CPU overhead.

Oracle RAC One Node's OS consolidation model presents the system administrator with a single OS (per server) to manage. In contrast, in a VM environment it is not unusual to have a dozen of operating systems installed on a single physical server, presenting the system administrator with a dozen operating systems to install, configure, patch, secure, upgrade, backup and manage.

Further, Oracle RAC One Node's shared OS consolidation only requires server resources (CPU, memory) to support one OS. This conserves server resources and enables running more databases on that server. On the other hand, virtual server environments run multiple guest operations systems on a given physical server. This model is more resource intensive and potentially reduces the number of databases that can be consolidated on a given server.
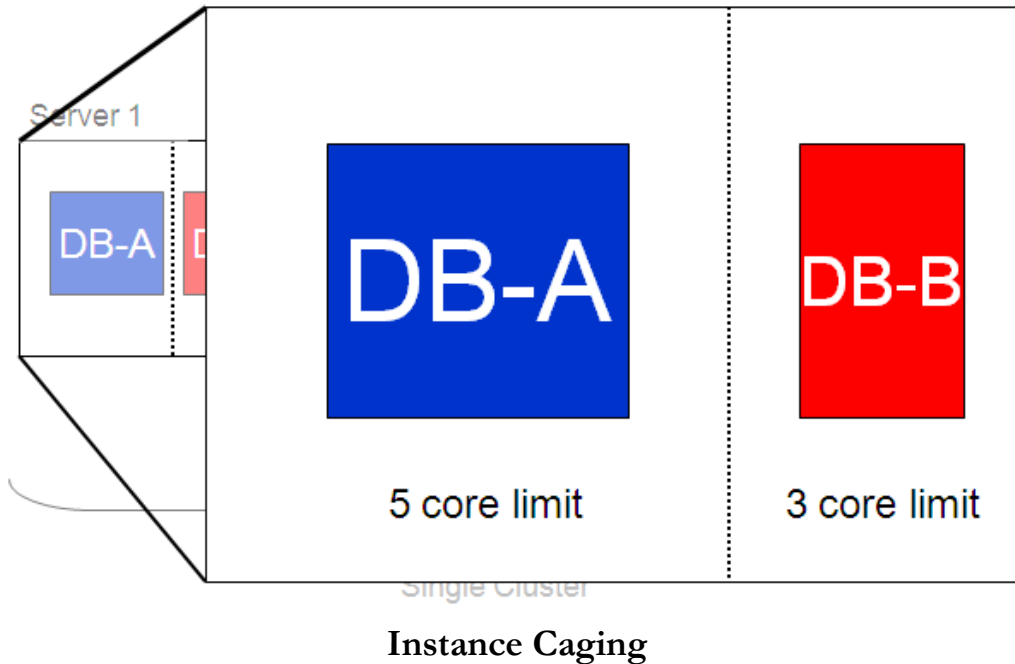

BOX 1: Benefits of Server Virtualization

Why is virtualization popular? By abstracting the physical resources from the software running on them, virtualization promises a more flexible and efficient IT environment. It provides a variety of easily attainable benefits that have a clearly measurable and understandable payback. It's easy to prove that the investment will have a positive ROI.

The most obvious benefits of virtualization are those associated with server consolidation, but more and more customers are leveraging the benefits of advanced features such as live migration and high availability. Oracle recognizes these benefits and provides its own server virtualization product, Oracle VM. Following is a summary of the key benefits driving interest in virtualization:

- **Server Consolidation**: Consolidating under-utilized servers into a single physical server can reduce the cost of servers, floor space, power, and cooling.

- **Protection from Failures**: Virtualization can be combined with monitoring capabilities that monitor the health of the virtual resource or the actual application and act to restart or re-locate the workload in the event of a virtual machine failure.

- **Flexibility and workload management**: Virtualization makes it possible to migrate workloads between physical servers within a cluster, balancing load across all the server resources in the pool

- **Online Maintenance**: Migrating work off a physical resource allows administrators to perform maintenance on that physical resource without affecting users of the application.

Virtualization has become synonymous with Server Virtualization, but many different types of virtualization exist. Server virtualization, the simplest form of virtualization, can provide many of the above benefits, with varying degrees of utility.

Instance Caging

Oracle Database 11g Release 2 Instance Caging feature provides resource isolation across databases. This feature helps deliver consistent service levels, without the overhead and inefficiencies of more cumbersome approaches. Instance Caging allows the administrator to limit the CPU used by an instance, preventing runaway processes in one instance from impacting others sharing that server. Should requirements change, the administrator can dynamically change the CPU allocation without taking the database offline. In contrast, VMs require a reboot when changing CPU allocation. More information on Instance Caging is available on Oracle.com.[3]

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[3] See: http://www.oracle.com/technetwork/database/features/performance/instance-caging-wp-166854.pdf

Greater Flexibility and Workload Management

Oracle RAC One Node's online database relocation feature allows a running instance to be migrated from one server to another without disruption of service.

Online database relocation does not require quiescing the environment even when the system is running at peak capacity. VMs generally require the environment to be quiesced in order for medium to heavy database workloads to be moved from one server to another. This requirement does not apply for light workloads or demos.

When migrating a VM, the VM must mirror its complete memory state across a network to the target host, recreating the state of that machine. If the database in question is highly loaded and is actively changing blocks in its database cache, it is very difficult for the memory mirroring function to keep up with the rate of changes.

It becomes likely that the only way to successfully mirror the memory is to quiesce the source VM, mirror the memory, and then switch to the migrated VM. With online database relocation, highly loaded instances pose no problem, as the work is actually split between two servers during the migration. Oracle RAC One Node can therefore easily migrate even heavy workloads to another server.

Online database relocation provides the ability to move between servers of different processor generations. VM migration requires that the processors be identical – it's not sufficient that both processors be Intel or AMD. Both Intel (or AMD) processors must have exactly the same instruction set. Online database relocation supports migration to new processors (i.e., Nehalem), or even between different vendors (Intel and AMD).

Oracle RAC One Node provides superior scale-up and does so without service disruption. VMs allow increasing the number of CPUs available to a database instance by moving it to a larger server. However, they require a reboot of the OS for the increased CPUs to take effect. Also, many VM solutions limit VM size to a limit that is rather low for a database server. With RAC One Node, the database automatically adjusts to the larger server and takes advantage of the additional CPUs – no reboot required. Also, there is no CPU limit for RAC One Node.

Improved Availability

Oracle RAC One Node provides better protection from failures than VMs.

Oracle RAC One Node monitors the health of the database running in the virtual machine, ensuring it is able to perform work. If it detects a failure, it restarts or fails over the database. Server virtualization-based HA solutions simply monitor the health of the VM. If the application (database) running in the VM fails, the it will not take action.
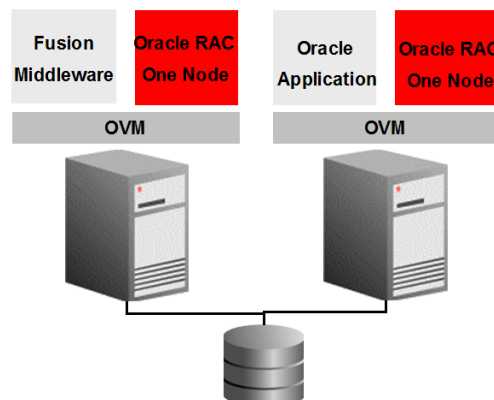
Oracle RAC One Nods provides better support for online maintenance.

Oracle RAC One Node online database relocation enables online maintenance of the physical server, the operating system and database. Server virtualization live migration only enables maintenance of the hardware. The operating system and database are migrated with the VM, and thus cannot be patched or upgraded.

Enhanced Server Virtualization

**Oracle RAC One Node can improve availability
and flexibility of servers running in virtual machines.**

Although Oracle RAC One Node improves upon many of the benefits of VMs, it can be utilized as a complementary technology to Oracle VM. Oracle RAC One Node is fully supported in Oracle VM environments—any node in the cluster could be an Oracle VM virtual machine. This extends the technology to some interesting use cases.
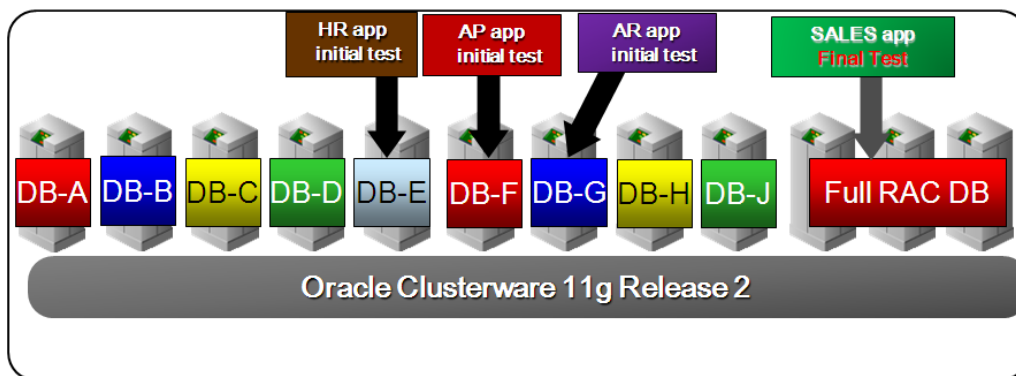
- **Mixed database and other workload environments**: Combining VMs and Oracle RAC One Node allows you to create a flexible environment for mixed workloads, where only some virtual servers are hosting databases on a given node.

- **Improving high availability of Oracle Database in a Virtual Machine**: Running Oracle RAC One Node inside VM extends the superior HA characteristics of Oracle RAC One Node to a database running inside a VM. Oracle RAC One Node will monitor the health of the database, not just the VM, and online patching and upgrades will eliminate the need for planned downtime.

- **Online Upgrading a Single Physical Server**: If you only have a single physical server, combining RAC One Node and two virtual machines on the one physical server, enables you to online upgrade or patch your environment by using online database relocation. This is accomplished by migrating the database to a temporary virtual server for the maintenance period.

Test and Development Platform for Oracle RAC

Oracle RAC One Node can reduce test and development costs for RAC applications.

Oracle RAC One Node makes an ideal test and development platform for applications that will run against a full RAC database. Oracle RAC One Node utilizes the same architecture and code base as full RAC. Thus, software developers and testers can develop and test their application code in an environment that is identical to RAC, albeit on a single-node. Once development and functional testing are complete, the application can be moved to servers licensed for full RAC for final multi-node testing. Industry studies suggest customers have 3-5 test and development servers for each production server. Because Oracle RAC One Node licenses are less than half the cost of full RAC licenses, this strategy can dramatically reduce license costs for test and development.

Other Unique Benefits of Oracle RAC One Node

There are additional benefits that are unique to Oracle RAC One Node. These include:

- **Storage Virtualization**: Oracle RAC One Node provides storage virtualization via a feature called Automatic Storage Management (ASM). ASM virtualizes all the storage presented to the database and automates management and tuning and seamlessly handles storage reconfigurations either due to disk failure or disk add/drop events. VMs do not provide storage virtualization.

- **Storage Consolidation**: Further, ASM increases storage utilization via a feature called storage "pooling", where all the databases on a single server (or cluster) running Oracle RAC One Node share a single storage pool. Database disk IO is always in tune since ASM ensures that IOs are always balanced across all spindles – i.e. avoid hotspots. Free disk space is managed centrally vs. being fragmented across multiple local storage pools. VMs do not provide storage consolidation.

- **Non-disruptive scale-out**: Oracle RAC One Node can be online upgraded to Oracle RAC (with appropriate license) in order to scale beyond one server. Over time, applications may not only grow their workload, but may also become business critical. Should an application eventually require the enhanced availability provided by Oracle RAC, or scalability beyond a single physical server, Oracle RAC One Node can be upgraded to Oracle RAC with no downtime or disruption. VMs do not support scale-out period.

- **Standardized Operating Model**: By running a combination of Oracle RAC One Node and Oracle RAC (for scale-out databases), customers can embrace a single database deployment model – i.e. tools, IT processes, custom scripts, etc. – across all operating systems. This helps streamline IT, reduces education and redundant work, confusion and possible human error.

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Conclusion

Oracle RAC One Node is the always online single-instance database. It provides features to avoid both unplanned and planned downtime. Oracle RAC One Node improves on VM benefits and overcomes its limitations. Those customers looking to reduce server footprint, improve availability, better manage workloads, reduce maintenance outages, streamline database management, or ramp to multi-node Oracle RAC will find that Oracle RAC One Node an ideal solution for their databases.

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