

# Oracle Real Application Clusters (RAC) 12c Release 2 – What’s Next?

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## **Introduction**

Oracle RAC has been around since 2001 and has gone through various market trends over the years; starting with the “Internet” age, followed by the “Grid Computing” wave, the market has entered the “Cloud” era and so does Oracle RAC. As I stated in my paper “Back to the Future with Oracle Database 12c”<sup>1</sup>, the IT business evolves in circles with a tendency to form a spiral. Every once in a while an idea or a technology moves back into the focus, which is not entirely new, but has evolved since the first time it appeared. This is true for a lot of technologies and for this matter it is particularly true for Oracle RAC. With the exception of the “Grid Computing” wave, which was based on the idea that connected commodity servers could be utilized in a grid to provide huge amounts of compute power when needed where needed, the concept of a shared-disk and shared-cache system (such as Oracle RAC) has been deemed dead more than once. Especially, in the early years of the cloud era when Oracle has not entered the race yet, the early cloud adopters were convinced that all high availability and scalability requirements can be met in the cloud by native technology while the cloud by definition addresses most manageability issues. Hence, the main benefits that Oracle RAC provides would not be needed in the cloud anymore, which will render Oracle RAC useless over time. How wrong they were. Since 2015 Oracle RAC has been part of the Oracle Cloud and has been one of the most demanded Oracle Database features to be supported in third party clouds (for this article, any cloud that is not part of the Oracle Cloud Infrastructure (OCI) is considered a third party cloud). This article reviews the current status of Oracle RAC in the cloud as well as on-premises and will provide an outlook on where Oracle RAC is heading considering the current market trends.

## **Oracle RAC – The Status Quo**

Oracle RAC has traditionally provided two benefits: 1) Server High Availability (HA) and 2) Horizontal Scalability. The “horizontal” part is often swallowed, as a vertical scalability approach can be used together with Oracle RAC. However, Oracle RAC itself only contributes to the horizontal scalability aspect, while Oracle Database standard features enable smooth vertical scalability as needed. Starting with Oracle RAC 11g Release 2, another benefit was added to the traditional two: 3) Efficient Management. While initially a self-serving solution, as Oracle RAC was known for being complicated and hard to manage, the management enhancements first introduced for Oracle RAC and as part of the Oracle RAC Family of Solutions, eventually benefitted the Oracle Database as a whole, including Single Instance deployments. Some of the solutions to name here include, but are not limited to, Oracle Automatic Storage Management (ASM), the ASM Cluster File System (ACFS) as well as the Trace File Analyzer (TFA) and OraChk or ExaChk.

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<sup>1</sup> Michalewicz, M.; April 2014; Oracle White Paper: “Back to the Future with Oracle Database 12c”: <http://www.oracle.com/technetwork/database/options/clustering/overview/backtothefuture-2192291.pdf>

<sup>2</sup> For more information on the current support for Oracle RAC in the Cloud, refer to the following slide deck:

This means, that the option to the Oracle Database known under the name “Oracle RAC” now includes a variety of solutions as part of the stack. Those solutions by themselves represent significant value adds to the Oracle RAC offering as well as independent solutions that can generally be used with an Oracle Database, often free of charge. This set of tools and utilities is meanwhile known as the Oracle RAC Family of Solutions.

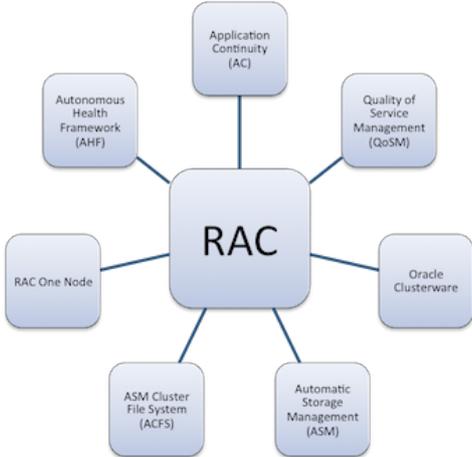


Illustration 1: Oracle RAC Family of Solutions (<http://oracle.com/goto/rac>)

Unlike many other solutions on the market, Oracle RAC has always provided most of its features on all supported platforms (a few exceptions prove the rule), which means that most of the features available on-premises are available on the cloud and vice versa as long as offering those features on either platform makes sense.

The cluster architectures build one exception to this rule. While four cluster architectures (generously including Oracle Restart) are offered for on-premises deployments with Oracle Clusterware, the Oracle Cloud has standardized on Oracle RAC (One Node) using Standalone Clusters for HA, even for Single Instance deployments. Example: The Oracle Exadata Express Service internally uses Oracle RAC One Node, mainly to reduce patching related downtime. Oracle Restart is not used on the Oracle Cloud, nor is the new Cluster Domain architecture, but unlike Extended Clusters, the Cluster Domain architecture is being evaluated as a new architecture for the Oracle Cloud (to be used under the cover), as this architecture was designed to simplify common management tasks for huge cluster estates.

**RAC is Now Part of The World’s First Autonomous Database**

<b>Self-Driving</b>	- User defines service levels, database makes them happen
<b>Self-Tuning</b>	- Continuous adaptive performance tuning
<b>Self-Scaling</b>	- Instantly resize compute and storage without downtime
<b>Self-Securing</b>	- Protection from both external attacks and internal users
<b>Self-Repairing</b>	- Automated protection from all downtime



Less Labor, Lower Cost, Fewer Errors, More Secure, More Reliable


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Illustration 2: RAC is Part of The World’s First Autonomous Database

Oracle RAC is also a vital part of Oracle's Autonomous Database, to which it contributes in the areas of "Self-Driving" and "Self-Repairing". The fact that Oracle RAC supports various deployment models in addition to various virtualization and container solutions makes it an ideal basis for the most reliable Oracle Database ever.

One of the main inhibitors for Oracle RAC adoption by the cloud was its requirements; mainly the shared storage requirement as well as the network requirement. Particularly the need for multicast made RAC hard to be implemented on most public clouds available on the market today. The reason is that those clouds have not accounted for such requirements and now are trying to modify their existing infrastructure by adding layers to compensate for the lack of natively provided shared storage and / or a private network between instances (the interconnect)<sup>2</sup>.

Meanwhile the Oracle Cloud supports various Oracle RAC configurations. Starting with a 2-node VM-based cluster in the Oracle Cloud Infrastructure (OCI) Classic, over a 2-node bare metal implementation on the OCI, customers can also choose a fully scalable solution (within the range of two to eight nodes) using the Exadata Database Service. This is possible, because the Oracle Cloud has foreseen to support Oracle RAC and has made certain modifications in their architecture to accommodate for RAC's requirements, at least for its "Platform as a Service (PaaS)"-based offerings. The implementation of Oracle RAC in Oracle's Infrastructure as a Service (IaaS) offering is subject to some limitations at the moment of writing, but can be expected to be fully supported soon.

### **Oracle RAC – What's Next?**

Without a doubt, Oracle RAC will continue to further optimize for the cloud; whether for the Oracle Cloud or any other cloud, RAC requirements will be softened further in order to be more flexible and useable in cloud environments, of which there will be more and more. At the same time, those changes and optimizations will be beneficial for on-premises deployments, which RAC will continue to support, as those are often managed as private clouds and hence will benefit from this flexibility, too.

Oracle RAC will also continue to provide the same three major benefits: 1) Server High Availability (HA) and 2) Horizontal Scalability and 3) Efficient Management. While in the cloud the latter (the management) is often part of an integrated management board or panel, enhancements in RAC management will benefit the Oracle Cloud internally to make it one of most reliable and user friendly clouds available on the market today. Private Cloud users benefit from those enhancements directly.

While Server High Availability as provided by Oracle RAC is clearly another quality that benefits cloud deployments, the need for scalability is often questioned. To me, scalability is one of the main reasons customers would want to use RAC in the cloud, as it allows for another dimension of scaling if the vertical scaling cannot be performed online or is limited per se. In every cloud, cloud instances are offered in a "boxed" fashion, meaning that they come with a certain amount of (virtual) CPUs and memory. Often, those instances can be scaled online, but as with any vertical scaling, there is typically a physical limit that cannot be overcome. In either case, Oracle RAC could be the solution.

In a LinkedIn article on "Unboxing the Cloud with Oracle"<sup>3</sup> published in December 2015, I wrote: *"For generic cloud offerings, which are mainly Infrastructure as a Service (IaaS)-based, it is understandable why they would choose such a "boxed approach". It is very hard, if not impossible, to*

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<sup>2</sup> For more information on the current support for Oracle RAC in the Cloud, refer to the following slide deck: <https://www.slideshare.net/MarkusMichalewicz/how-to-use-oracle-rac-in-a-cloud-a-support-question>

<sup>3</sup> Michalewicz, M.; December 2015; "Unboxing the Cloud with Oracle" <https://www.linkedin.com/pulse/unboxing-cloud-oracle-markus-michalewicz>

manage an arbitrary application in a generic cloud instance so that both entities (the application and the cloud instance) build a symbiotic relationship such that controlling the instance indirectly controls the application or vice versa. Managing a database service in this manner is even more difficult. This type of control can only be provided if the application vendor and the cloud vendor are the same.

In case of a single vendor the opportunities are enormous. For example, if the need for scaling a database application arises, the cloud service provider could apply the appropriate scaling measure to the database service automatically, assuming the user chose that option. "The appropriate scaling measure" could mean a vertical or a horizontal scaling approach or both. For those of you, who are worried about Oracle RAC not providing transparent scaling for certain applications, there is no need to worry; the database service provider will (at least theoretically and to the degree they can) ensure that the scaling measure they apply is seamless."

Two years later, this is exactly how I envision Oracle's Autonomous Database to work (in the cloud).

Last but not least, the most valuable contribution of Oracle RAC, more so of the Oracle RAC Family of Solutions, to Oracle's Autonomous Database is Applied Machine Learning (ML).

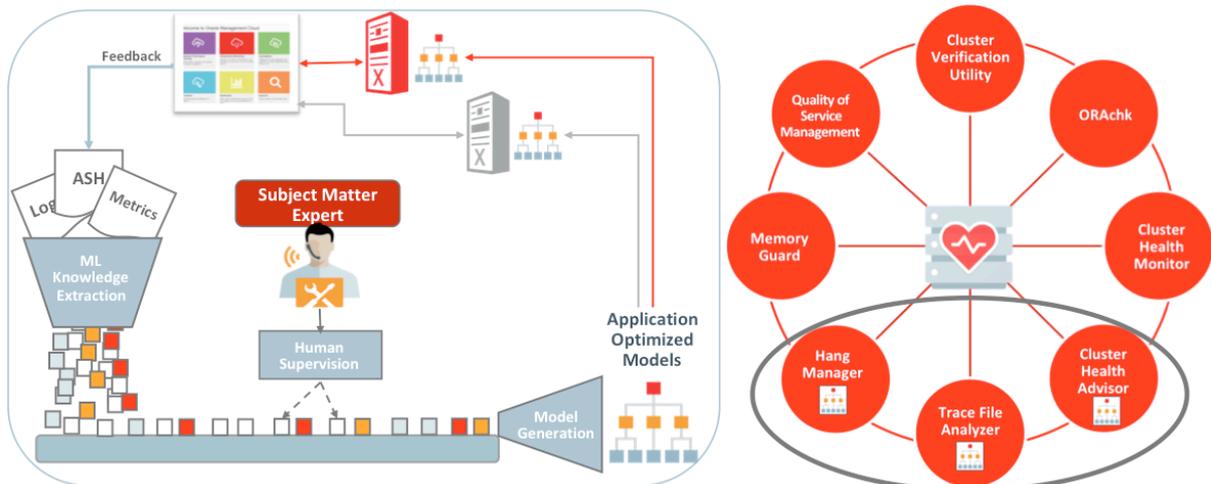


Illustration 3: Machine Learning – in Oracle's Autonomous Health Framework ([www.oracle.com/goto/ahf](http://www.oracle.com/goto/ahf))

Oracle has developed a set of tools utilizing Machine Learning that ensure better runtime management of Oracle Database systems. And while "Oracle Sherlock"<sup>4</sup>, is probably a more suitable name for Oracle's main solution in this area, it is simply called Cluster Health Advisor (CHA). CHA is part of Oracle's Autonomous Health Framework (AHF).

"Oracle Autonomous Health Framework (AHF) presents the next generation of tools as components, which work together autonomously 24x7 to keep database systems healthy and running while minimizing human reaction time. Utilizing machine-learning technologies, Oracle AHF provides early warning or automatically solves operational runtime issues faced by Database and System administrators in the areas of availability and performance."

<sup>4</sup> Michalewicz, M.; September 2017: "You know IBM's Watson & Salesforce's Einstein; now meet "Oracle's Sherlock" - Oracle's ML-powered Diagnostic Agent": <https://www.linkedin.com/pulse/you-know-ibms-watson-salesforces-einstein-now-meet-michalewicz/>

In simple terms, Cluster Health Advisor (CHA) can help you determine and explain the root cause for database or database system failures. More importantly, *CHA can help you prevent significant outages using a predictive analytics-based early alert warning system*, which is based on Machine Learning.

Unlike with other ML solutions, CHA users do not need to be an AI / ML expert. CHA and in extension the Trace File Analyzer (TFA), which is used to provide optimized diagnostic data for post mortem (root cause) analysis of major incidents (which despite CHA could not be prevented) use supervised and applied Machine Learning. That means, users benefit from ML-techniques by utilizing a defined set of tools rather than by applying those techniques to the data they want to analyze. At the same time, the system allows for supervision and feedback by a subject matter expert to further improve predictions.

Learning from this approach, the Oracle RAC team has started to equip more and more tools in the Autonomous Health Framework (note also that the adjective “autonomous” was introduced with the first release of AHF early 2016) with Applied Machine Learning capabilities. Hang Manager and the Trace File Analyzer in addition to CHA are only the first two to name. Going forward, more and more internally and externally available Oracle tools will use Applied Machine Learning and thereby make it easier to manage the database and related systems, to diagnose failures and to recover from failures.

### **Conclusion**

For Oracle RAC the future of Machine Learning has already started while its core capabilities ((1) Server High Availability (HA) and 2) Horizontal Scalability) are still in demand and will continue to be demanded on the cloud as well in on-premises deployments. Considering that despite other predictions no other database has provided a full alternative for Oracle RAC in those environments, RAC is prepared for the future. That does not mean it will stop evolving and as with any new market trend before, Oracle RAC will adapt and continue to provide its benefits well through the “cloud era”.

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