WHITE PAPER

OPTIMIZING ORACLE COSTS IN THE CLOUD

VMWARE CLOUD ON AWS VERSUS ORACLE CLOUD

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Executive Preface

This white paper is being presented to the industry as an independent evaluation of factors leading an organization to a decision on how to deploy their Oracle software workloads in the public cloud. I am referring to this section of the paper as an "Executive Preface" rather than an "Executive Summary." The reason for that is I am not presenting a complete summary of the findings and recommendations of the paper, but rather giving the reader a sense of the business and market environment that we are seeing in the cloud industry giving rise to the development of this content.

The cloud industry is entering a dynamic phase in its growth and rate of adoption. For Oracle workloads, public cloud adoption has clearly lagged behind cloud adoption leaders such as SaaS applications, and new software development. The opportunity for Oracle in the cloud, however, is changing. With the introduction of the VMware Cloud on AWS, and the aggressive promotion by Oracle of their own IaaS cloud, we now have at least two viable public clouds that we can compare. There are certainly more public cloud options for running Oracle than these two, such as Microsoft Azure, and the other AWS deployment options such as RDS, EC2 Compute, EC2 Bare Metal Instances, and EC2 Dedicated Hosts. For the purposes of this paper, we have decided to focus on our VMware customers, and the two options that most of them are talking about for moving their existing on-premises Oracle workloads into the cloud.

The factors leading to a decision on a cloud provider for Oracle workloads are several and varied. They include topics shown in the word cloud to the right, such as Business Risk, Security, Complexity, and Cost. As I illustrate in the word cloud, for the House of Brick customers with whom I have discussed their cloud strategy, Cost is a relatively low decision factor compared to other more critical issues. Our customers have invested heavily in the infrastructure, personnel, operations, licenses, processes, development, and support around their Oracle-based business-critical systems. By their very nature, business-critical systems are costly. Optimizing cost is important, but not by sacrificing other critical aspects of these applications.

In this paper, we provide the reader with a comprehensive comparison of the costs of running various types of Oracle-based applications in the VMware Cloud on AWS, and the Oracle Cloud. There are certain circumstances, such as very small workloads, where the Oracle Cloud could be considered less expensive than the VMware Cloud on AWS. For larger workloads, we demonstrate how the VMware Cloud has a lower total cost of ownership (TCO), even with Oracle's attempt to "double the price" for running their software in AWS. The release of this paper has been timed to coincide with VMware's announcement of features that will help Oracle customers reduce this TCO. Two primary features that we are excited about are smaller node counts, and core disablement in VMware Cloud on AWS clusters. As anyone familiar with Oracle licensing knows, core counts kill cost. By controlling core counts with fewer nodes, and reduced cores per node, we can create right-sized environments for our Oracle customers.

As I stated before, however, the total cost of ownership is a lower consideration for our customers than more critical factors. While the front page of this paper clearly states that House of Brick received some financial support for the creation of this content, that has not influenced our opinion on what we believe to be clear and compelling reasons that the VMware Cloud on AWS is the better choice for running Oracle-based applications compared to the Oracle Cloud.

The 2018 Gartner Magic Quadrant for IaaS was quite critical of the Oracle Cloud. As the reader will see in more detail later in this paper, Oracle was downgraded from a Visionary in 2017 to a Niche Player in 2018 by Gartner. This quote was telling, when Gartner declared that the Oracle Cloud Infrastructure "**remains a bare-bones 'minimum viable product,' and it is arguably too minimal to be viable for a broad range of common cloud IaaS use cases**"[1] (emphasis added).

This is not the kind of testimonial that our customers are looking for in deciding on a cloud provider for their business-critical systems. Let me outline a few of the benefits of the VMware Cloud on AWS that our customers will appreciate:

- Seamless integration from the on-premises VMware environment to the cloud
- The power and fortitude of the AWS infrastructure and cloud environment
- Innovative cost control mechanisms, such as reducing core counts and cluster sizes for Oracle workloads
- Continuity in expertise from customers' DBAs, System Administrators, and VM Architects

Of course, Oracle will disagree with some of these points. They will also argue that a customer cannot disable cores to limit license requirements. As any reader of House of Brick's vast library of content (including blogs, papers, conference presentations, and customer-specific documents) will know, Oracle's claims about running in a VMware environment (on-premises or in the cloud) are largely specious and non-contractual. With hundreds of successful customer license engagements over the past few years, House of Brick has held Oracle to account for their non-contractual assertions by helping our customers understand their Oracle License Agreements, and architecting powerful, flexible, and license-compliant environments for their business-critical systems.

My profound thanks and acknowledgement go to the House of Brick architects, executives, and marketing professionals who put many hours into making this paper a reality, and to the support of our partners at VMware and AWS who provided us the tools we needed to validate our work.

Thank you for reading this paper. Let us know if we can help you.

Nathan Biggs
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[1] https://www.techrepublic.com/google-amp/article/gartner-reveals-one-big-reason-oracles-cloud-hasnt-caught-on/

Table of Contents

Table of Figures

Abstract

Designing a cost-effective public cloud solution for Oracle software workloads is a tricky challenge for any organization attempting to juggle both compute costs and the high cost of Oracle licenses. Trying to choose the right platform and architecture to minimize costs requires exploring not just costs for cloud resources, but also related costs such as Oracle licensing and one-time costs such as refactoring and migration.

The rules for licensing Oracle software products in the cloud are arcane, as Oracle still licenses most software by metrics tied to physical processors and not virtual CPUs. Further complicating the issue is the fact that Oracle publishes cloud policies for vCPU-based licensing in a way that specifically creates a disadvantage for competitors to its own cloud offering. The VMware Cloud on AWS, being one of the few public cloud solutions that can offer dedicated physical processors, offers a strong advantage to licensing Oracle software as it allows traditional processor-based metrics to be used for licensing instead of relying on Oracle's non-contractual cloud policies. Oracle's own cloud offering consists of traditional virtualized Infrastructure as a Service (IaaS) and Platform as a Service (PaaS) offerings. The distinguishing feature of Oracle Cloud's offering is that they offer their own software products with more favorable licensing rules for their own cloud compared to competing cloud providers. Oracle's stated goal with their cloud is to undercut competitor's IaaS and PaaS offerings by 50% on price, and the manipulation of the licensing rules for Oracle software seems to be their preferred means of achieving this for Oracle workloads.

In this paper, we modeled Oracle licensing costs and compute costs for four hypothetical Oracle workloads based on House of Brick's experience with common customer workloads. This modeling allowed an exploration of the interaction of licensing costs, licensing rules, and cloud architectures. The four hypothetical workloads consisted of equal amounts of Oracle Database Enterprise Edition VMs and Oracle WebLogic Enterprise VMs. The workloads, while identical in product mix, differ considerably in size with the smallest containing just a few VMs, and the largest enterprise workloads containing dozens of VMs.

In addition to modeling costs based on current VMware Cloud on AWS cluster sizes, this paper also explored the effects of a potential feature enhancement that House of Brick strongly recommends VMware to implement in order to optimize licensing for software products licensed on a processor basis. This feature is simply smaller cluster sizes than the current minimum cluster size of three nodes, as two node clusters offer an attractive way to isolate small workloads and prevent over licensing. This is a feature that House of Brick traditionally uses with on-premises VMware solutions to balance compute resources with licensing needs and strongly recommends VMware implement in the VMware Cloud on AWS.

Results of the cost modeling paint an intriguing picture. For very small workloads, the Oracle Cloud is hard to beat on price, as the combination of virtualized cloud flexibility and customer-favorable licensing rules allows Oracle software-based workloads to be run for very attractive prices, which is not surprising given Oracle's stated goal to undercut all competition. However, as workloads grow to sizes where they can saturate VMware Cloud on AWS clusters, the picture changes and VMware Cloud on AWS starts to become the most attractive option. The ability to license entire clusters advantageously for Oracle software products using traditional processor-based licensing metrics makes the VMware Cloud on AWS a superior offering to Oracle's own cloud as it allows equal licensing efficiency, while offering more resources and functionality for similar prices.

For all non-minimal Oracle workloads, the VMware Cloud on AWS offers an excellent mix of cloud computing features, simple migration paths from on-premises, and efficient licensing for Oracle software products. The VMware Cloud on AWS offers an unbeatable solution for hosting Oracle software-based workloads in a cost-effective manner.

Introduction

The recent IT trend towards public cloud computing has many enterprises weighing their options. Public cloud, or hybrid cloud computing, can offer significant cost and technology advantages, but transitioning to a cloud may involve difficult refactoring and migration from on-premises datacenters and on-premises architectures. A particular concern is legacy applications that may be dependent on expensive enterprise software from Oracle such as Oracle Database Enterprise Edition or Oracle WebLogic Enterprise. Oracle software licensing is typically quite expensive, dwarfing the cost of the underlying compute infrastructure. In conjunction with the fact that determining the licensing cost implications of running in a public cloud can be counterintuitive, it is extremely challenging for any organization to architect a cloud solution, and makes it difficult to evaluate the costs of any potential cloud solution.

Complicating the issue is Oracle's very clear determination to make their own public cloud solution the cheapest option for workloads based on their own database or application software. Oracle publishes different and less advantageous metrics for Oracle software licensing for competing clouds compared to the metrics they publish for their own cloud. Adding to the complexity around the Oracle software licensing issue is the fact that some cloud providers, such as VMware Cloud on AWS, allow dedicated physical servers to be assigned to customers, which opens the door to licensing Oracle software on traditional metrics instead of cloud metrics.

The purpose of this paper is to explore the relationship between the factors that drive Oracle software licensing costs in the Cloud in order to determine the most advantageous ways to leverage public cloud computing resources while optimizing costs.

Analysis Objectives and Methods

The focus of this paper is to compare the costs of running Oracle-centric workloads in both the Oracle Cloud and the VMware Cloud on AWS. While there are many factors that can influence costs, this paper specifically focuses on those factors that House of Brick deemed most material when providing a comparison. By comparing the most signficant factors, the aim with this paper is to illustrate the important differnces between the Oracle Cloud and the VMware Cloud on AWS, which drive architecture of a cost effective cloud solution for Oracle software workloads.

VMware Cloud on AWS

Announced in 2016, and first made available in 2017, the VMware Cloud on AWS marries two proven and popular technology platforms. Utilizing servers maintained and hosted by Amazon Web Services (AWS), the VMware Cloud on AWS offers a cloud-hosted vSphere virtualization solution to enterprises looking for public cloud or hybrid cloud solutions. This offering is of particular interest to enterprises already invested in VMware

virtualization for their on-premises datacenters, as it offers a seamless path for extending their IT footprint into the public cloud without the need to re-architect workloads or retrain staff on a new platform.

VMware and AWS continue to provide more sizing and tooling options to help remove barriers to entry for small organizations. However, the VMware Cloud on AWS' initial configuration options seem to target more scaled implementations. The current VMware Cloud offering consists of a Software Defined Datacenter (SDDC) containing vSphere clusters of three to thirty-two hosts. In AWS's words:

> *"The VMware Cloud on AWS minimum standard cluster configuration contains three hosts. Each host is an Amazon EC2 I3.metal instance. These hosts have dual 2.3 GHz CPUs (custom-built Intel Xeon Processor E5-2686 v4 CPU package) with 18 cores per socket (36 cores total), 512 GiB RAM, and 15.2 TB Raw NVMe storage."*[2]

The 36 hyperthreaded physical Xeon cores translate to 72 logical processors in ESXi, allowing each server to host a large workload of VMs. Above and beyond the compute hardware, the networking layer of the VMware Cloud on AWS is interesting enough to merit mention as well. Each host has a 25Gb network interface and VMware NSX is utilized to handle the virtual networking in each SDDC.

In addition to offering a hosted solution for running VMware virtual machine (VM) workloads in a public cloud, the VMware Cloud on AWS offers the following distinguishing features.

- The Hybrid Linked Mode feature allows linking the vCenter in the Cloud with on-premises vCenter installations. Once this is established, it is possible to manage both on-premises and Cloud resources from one management view. In addition, once the linkage is established, it is also possible to use traditional vMotion to move workloads from on-premises clusters to the Cloud and vice versa.
- Each VMware Cloud on AWS SDDC exists inside an AWS Virtual Private Cloud (VPC) network container. The VPC may be linked to an existing customer VPC to allow direct local networking with existing applications residing in AWS.
- Because the SDDC is hosted in AWS, popular AWS services such as S3 are available at local network speeds.
- VMware Site Recovery Manager, built on VMware Site Recovery Manager and vSphere Replication, is a Disaster Recovery as a Service (DRaaS) offering that enables fast deployment of new DR initiatives or seamlessly extends existing on-premises VMware deployments to VMware Cloud on AWS.

Oracle Cloud

Oracle unveiled their public cloud offering in 2011 and has since been creating new iterations and improving that initial release at a rapid pace. The Oracle Cloud offers a wide breadth of Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS) products, which primarily target customers who are already running Oracle software.

[2] https://aws.amazon.com/vmware/faqs/

Despite the improvements and new features added since its launch, the Oracle Cloud is still trailing as a niche player in the public cloud market according to most analysts' estimates. However, it is difficult to track specifically, as in June 2018 Oracle announced[3] that it was no longer going to split out its SaaS, PaaS, and IaaS revenue from its on-premises license support revenue.

Oracle Cloud is seriously trailing in Gartner's magic quadrant[4] for Cloud Infrastructure as a Service. The gap between AWS and Oracle increased compared to last year, potentially due in part to Gartner changing their quadrant placement criteria.

2017

2018

In 2017, Oracle was at the bottom of the Visionaries quadrant (lower right). In 2018, Oracle moved into the Niche Players quadrant (lower left).

Because of this trailing market position, Oracle has been very aggressive in pricing their offering below the competition. At Oracle Open World 2017, Larry Ellison proclaimed[5] that Oracle Cloud had a target of undercutting Amazon Web Services pricing for IaaS and PaaS offerings by 50%. Rather than achieving this target through technical and business advances, it appears that Oracle primarily resorted to raising licensing fees for Oracle software products used in competitors' cloud environments.

[3] https://techcrunch.com/2018/06/20/oracle-could-be-feeling-cloud-transition-growing-pains/
[4] http://webcache.googleusercontent.com/search?q=cache:dkxE4I5dS2AJ:blog.atscale.com/gartner-magic-quadrant-for-cloud-infrastructure-as-a-service-2018+&cd=1&hl=en&ct=clnk&gl=us
[5] https://www.theregister.co.uk/2017/09/20/oracle_cloud_pricing/

Cloud Feature Comparison

The key features of VMware Cloud on AWS and Oracle Cloud as they pertain to hosting Oracle workloads are very different, as VMware Cloud on AWS is purely an Infrastructure as a Service (IaaS) offering whereas Oracle Cloud has both IaaS and Platform as a Service (PaaS) offerings. While an exhaustive list of the differences in feature offerings between the two clouds would be a massive exercise far beyond the scope of this paper, there are a few key differences that should be highlighted, as they are material to anyone considering the costs of hosting Oracle centric workloads in a public cloud.

IaaS vs PaaS

When looking at hosting Oracle workloads in the cloud it is important to understand the difference between IaaS and PaaS offerings. With IaaS offerings, the cloud provider is only providing the virtual machine environment and possibly a pre-staged Operating System image. The installation, operation, and maintenance of all the Oracle software is the responsibility of the user. PaaS offerings, on the other hand, provide a pre-configured platform with all the Oracle software already installed and configured.

The differences between IaaS and PaaS offerings sound relatively simple, but can have costly implications. Because the IaaS offering requires the end user organization to install and maintain the software, it also creates a need for not just administrative personnel but specialized personnel with Oracle experience. PaaS offerings avoid much of the cost of administrative personnel, but typically charge more for compute resources and are relatively inflexible in terms of allowing the end-user to customize the platform configuration to meet the needs of specific applications.

For organizations looking to migrate existing Oracle workloads to the cloud, there is a vast difference between IaaS and PaaS services that should be factored into migration plans. IaaS services tend to be very familiar to organizations accustomed to on-premises Oracle workloads, and offer a very straightforward migration path. PaaS services, on the other hand, can require a lot of costly refactoring of existing workloads in order to adapt them to the platform. While no simple formula exists, House of Brick has observed situations where the estimated refactoring efforts added more than 50% to the cost of a cloud migration project.

This paper explores both PaaS and IaaS costs for Oracle Cloud, and IaaS costs for VMware Cloud on AWS, but it is important to keep in mind that IaaS and PaaS are very different services.

Resource Provisioning

The VMware Cloud on AWS offerings are relatively limited, which prevents confusion, but also makes it more challenging to consume the exact resources needed. In VMware Cloud on AWS, the only variable for resource allocation is the number of nodes in a SDDC cluster. All other resources such as CPU, RAM, and disk are allocated at a fixed rate per node and only one type of node is available. Those resources can then be split among virtual machines residing in the SDDC in any combination desired by an administrator.

The Oracle Cloud IaaS and PaaS offerings include both virtual machines and dedicated server options. Both are available in a variety of configurations that Oracle refers to as shapes. Different shapes have different

combinations of virtual CPUs and RAM resources available. File or block storage is available to be allocated to different virtual machines at a monthly price per GB, so storage provisioning is extremely flexible.

Ultimately the Oracle Cloud has more provisioning flexibility. VMware Cloud on AWS customers are often required to overprovision several resources in order to reach the necessary levels for one constrained resource. While individual VMs inside the VMware Cloud on AWS are far more flexible in terms of vCPU/RAM provisioning versus the preset menu of shapes in Oracle Cloud, overall resource provisioning at an account level is currently more flexible in the Oracle Cloud.

Hybrid Cloud Tools

Both cloud offerings provide tools for managing hybrid cloud environments with some workloads residing in on-premises datacenters and some workloads residing in public cloud environments. VMware Cloud on AWS offers Hybrid Linked Mode for its vCenter tool, a tool already widely used to manage on-premises VMware footprints. With Hybrid Linked Mode, it is possible to use vCenter to seamlessly manage both on-premises and VMware Cloud on AWS resources. The Oracle Cloud has a similar offering with Oracle Enterprise Manager (OEM), which allows the user to manage both on-premises and cloud resources.

At a superficial level, both tools appear to be roughly comparable in scope and functionality for managing hybrid cloud offerings, but Oracle is handicapped by the fact that there has been very little adoption of OEM for managing on-premises workloads outside of Oracle engineered systems. Many organizations utilize OEM to monitor and manage Oracle databases or applications, but very few utilize it for systems management. Thus, using OEM to manage a hybrid cloud environment would require an organization to first retrofit their on-premises operations to be managed by OEM. vCenter, on the other hand, is already ubiquitous for managing on-premises datacenters.

In addition, features of VMware Cloud on AWS, such as Hybrid Linked Mode, Hybrid Cloud Extension (HCX), or Site Recovery Manager allow for zero downtime, mass migration of virtual machine workloads into the VMware Cloud on AWS. As Oracle Cloud has no zero downtime migration tools for general workloads, this is a stark advantage for VMware Cloud on AWS compared to the Oracle Cloud.

The Hybrid Cloud tools category heavily favors VMware, as Oracle's offerings are not ubiquitous, and cannot provide the key features needed to migrate to a hybrid cloud solution or to manage a hybrid cloud solution effectively.

Cloud Licensing Concepts for Oracle

Processor, Named User Plus, and Unlimited Licensing

Processor-based licensing is the most familiar and traditional model for licensing Oracle database and middleware software products. When licensing Oracle software products by the processor metric, the total processor cores available in a server are summed and then multiplied by the appropriate factor from Oracle's Processor Core Factor Table. For x86 architecture servers, Oracle requires one processor license per two x86

CPU cores. This grants a right to use the licensed software product on that server regardless of instance or user counts, transaction volumes, or RAM/disk footprint.

Named User Plus (NUP) licensing is an alternative means of licensing Oracle software often used in test, development, or other non-production environments where actual user counts are relatively low. NUP licensing has the advantage that for low user count environments, it is significantly less expensive than processor based licensing. For high user count environments however, NUP licenses are more expensive and processor based licensing is the more favorable option. It is worthwhile to note that attention must be paid to core counts, even when using NUP licenses, because there is a minimum number of user licenses required based on the number of cores. If the actual user count is lower than the minimum required, then the licensing must be based on the minimum user count per core.

Oracle also offers what is known as an Unlimited License Amendment or Agreement (ULA). The ULA allows Oracle customers a time-limited right to use an unlimited quantity of Oracle software products that are specified in the ULA. The typical term is three years, after which the unlimited right converts into a specific number of processor licenses based on a process of totaling up quantities in use at the end of the term. This totaling process is referred to as a "certification of the ULA."

Oracle Cloud Policy and Traditional Licensing

Traditional licensing simply refers to licensing Oracle products in a cloud environment just as one would with on-premises servers. Named User Plus or processor based licenses are then applied to entire servers based on the active core count of the server.

Cloud policy licensing is a shorthand term for licensing Oracle in Azure, and AWS EC2 (which includes the VMware Cloud on AWS) according to Oracle's published cloud licensing guidelines. Oracle first introduced cloud licensing in 2008 and shortly thereafter formalized it in the document *Licensing Oracle Software in the Cloud Computing Environment*[6]. This non-contractual document establishes a policy wherein Oracle grants customers a right to license Oracle software products in Authorized Cloud Environments by calculating Oracle licensing using either the Processor based or NUP metric, on a vCPU basis instead of on a physical core basis. A concept that is implied in this document (but not stated), is that the license moves with the VM under all conditions. This offers a potentially substantial licensing advantage over non-authorized cloud environments, whether private or public. The policy has been amended by Oracle on several occasions since, most recently in January 2018.

Although the cloud policy document is not referenced in Oracle contract agreements that House of Brick has reviewed, and as such is technically non-binding in the customer's license agreement, it is House of Brick's understanding that Oracle is likely obligated to the extra-contractual privileges the policy grants. Pam Fulmer, a partner at Fulmer Ware LLP stated the following in an article published with House of Brick in the Northern California Oracle Users Group Journal[7]:

> *…to the extent that Oracle is knowingly publishing extra-contractual documents on which its customers rely by making large investments, an argument can be made that Oracle should be estopped or*

[6] http://www.oracle.com/us/corporate/pricing/cloud-licensing-070579.pdf
[7] http://nocoug.org/Journal/NoCOUG_Journal_201708.pdf#page=4

> *prevented from changing course down the road, especially if such a change would cause injury to Oracle customers. Whether a court would accept this argument, or find that the customer proceeded at their own risk, is an open question."*

While historically Oracle has been observed by House of Brick to consistently honor the policy's extra-contractual privileges, House of Brick encourages anyone considering the applicability of this policy to review it with their legal advisors.

Amazon has published the following statement affirming that the VMware Cloud on AWS utilizes Amazon EC2 infrastructure:

> *VMware Cloud on AWS is an integrated cloud offering jointly developed by AWS and VMware delivering a highly scalable, secure and innovative service that allows organizations to seamlessly migrate and extend their on-premises VMware vSphere-based environments to the AWS Cloud running on next-generation Amazon Elastic Compute Cloud (Amazon EC2) bare metal infrastructure.*[8]

Accordingly, House of Brick is advising customers to consider the policy as an option when deploying Oracle software products in the VMware Cloud on AWS.

Grandfathering on Prior Cloud Licensing Policy Terms

Overall, revisions to Oracle's cloud licensing policy have gotten more restrictive with the passing of time. Organizations that have implemented Oracle software deployment in Authorized Cloud Environments based on earlier cloud licensing policy versions may want to confer with legal advisors as to whether they have a grandfathered privilege on the policy document terms in effect at the time of their implementation. For example, it might be reasonable that a licensee who had allocated 200 Processor licenses in AWS EC2 using the cloud licensing policy in effect prior to January 23, 2017 would continue to enjoy the more generous terms of previous versions of the policy for those 200 Processor licenses.

To facilitate considerations about which cloud licensing terms might apply, the table below displays the details of the policy's changes over time[9]. Green highlighting indicates favorable changes for licensees, whereas yellow represents changes unfavorable for licensees.

[8] https://aws.amazon.com/vmware/

[9] Additional 9/21/08 source document - https://visionpdf.com/oracle-in-the-cloud-aws.html

Table 1: Oracle Cloud Policy – History of Changes

	9/21/08	9/20/10	5/31/16	1/23/17	1/23/2018
License moves with VM	Y	Y	Y	Y	Y
EC2	Y	Y	Y	Y	Y
RDS	NA	NA	NA	Y	Y
Processor Core Factor Table vCPU:Processor ratio	0.5	0.5	0.5	NA (1.0)	NA (1.0)
Hyperthreading enabled? vCPU:Processor ratio	NA	NA	NA	Y=0.5, N=1.0	Y=0.5, N=1.0
Standard Edition vCPU/Processor (socket)	<= 4	<= 4	<= 4	<= 4	<= 4
Standard Edition vCPU limit	16	16	16	16	16
Standard Edition One vCPU limit	8	8	8	8	8
Standard Edition 2	NA	NA	8	8	8
Standard Edition 2 Named User Plus minimum	NA	NA	NA	NA	10 per 8 vCPUs
Include in ULA Certification inventory	?	N	N	N	N
Authorized products/features list	DB, Middle-ware, Grid Control, Applica-tion Express	(not stated)	(not stated)	List introduced RAC not authorized	RAC not authorized
RAC is unsupported. Reason:	EC2 didn't support clusters	(not stated)	(not stated)	(not stated)	(not stated)

The policy's January 23, 2017 revision in particular introduced terms that made adopting the cloud policy substantially more expensive. These changes included:

- The Processor Core Factor Table was eliminated from AWS licensing. With that, Oracle effectively doubled the price, giving itself a 100% raise on non-SE licensing in AWS.
- Hyperthreading was introduced for the first time to Oracle core technology licensing. Added to the elimination of the Processor Core Factor Table from the licensing calculation, and Oracle's price increases in Authorized Cloud Environments exceeded 100%.

Oracle introduced a list of approved Oracle products into the policy's 2017 revision, thus for the first time completely excluding some products from the possibility of being licensed in cloud environments according to the policy.

Licensing in the Oracle Cloud

Licensing Oracle software in Oracle's own cloud environment represents a special case in that it does not use traditional licensing, nor does it utilize Oracle's Cloud Policy. Instead there is a separate Bring-Your-Own-License (BYOL) policy for the Oracle Cloud that is outlined in Oracle's document *Oracle PaaS and IaaS Universal Credits Service Descriptions*[10]. In a general sense, this allows treating non-hyperthreaded virtual CPUs in the Oracle Cloud, called OCPUs by Oracle, exactly like x86 physical cores for the purposes of licensing Oracle software products. Thus one processor license for an Oracle software product is sufficient to license two OCPUs. This is a stark contrast to the already discussed cloud licensing policy for AWS and Azure, which requires one processor license per non-hyperthreaded virtual CPU. In essence Oracle is allowing for the licensing of Oracle software products in their own cloud at half the cost of licensing similar virtual machines in the cloud policy Authorized Cloud Environments of AWS (including VMware Cloud on AWS), and Azure.

For customers of Oracle Cloud not wanting to manage their own Oracle infrastructure, there are PaaS alternatives to the IaaS offering for many Oracle software products. These PaaS offerings are available with BYOL pricing as well as what Oracle refers to as Universal Credits (UC) pricing, which includes all the licenses required for the product bundled in with the compute costs for one PaaS monthly rate. This rate is based on the number of allocated OCPUs.

Cloud Cost Components

Because both clouds under consideration have different pricing models and tiers for networking, compute, storage, and other add-on features, it can be complex to analyze the various costs as they might apply to a hypothetical workload. Luckily, many of those costs are too small to be material, or already roughly comparable between Oracle Cloud and VMware Cloud on AWS. To minimize complexity, this analysis focuses primarily on two financial factors – Oracle software licensing costs and compute costs. In House of Brick's experience, the costs of these two items will dwarf most other costs in the long term and are thus most critical in determining the suitability and cost-effectiveness of a particular cloud offering for an Oracle-centric workload.

Compute Costs

Compute costs are relatively easy to calculate for hypothetical workloads, though additional complexity can be added when considering the difference between pre-arranged or reserved pricing plans versus on-demand pricing plans. Oracle Cloud and VMware Cloud on AWS, like most public clouds, offer discounts for longer term resource consumption commitments. To maintain consistency in this analysis, both VMware Cloud on AWS and Oracle Cloud compute costs were considered on the basis of annual reserved pricing. In the case of VMware Cloud on AWS, this pricing model is known as 1-year reserved pricing. For Oracle Cloud, the annual reserved pricing model is known as Monthly Flex.

Note that true compute costs were impossible to fully isolate in the case of VMware Cloud on AWS as the per-node cost of SDDC clusters also includes the storage.

[10] http://www.oracle.com/us/corporate/contracts/paas-iaas-universal-credits-3940775.pdf

Oracle Licensing Costs

As described in the preceding section on Oracle licensing concepts, there is a complex mix of metrics and licensing models available when licensing Oracle software in a public cloud environment. For the purposes of this analysis, only Processor Licensing was considered. Named User Plus and Unlimited License Amendment licensing were not considered, the former because it tends to correlate strongly to Processor licensing anyway, and the latter because there is no standardized published pricing for ULA agreements by Oracle.

When comparing licensing costs, all costs were calculated on a three-year annualized basis to avoid uneven comparisons between services such as Oracle Cloud BYOL or VMware Cloud on AWS, where customers are expected to furnish their own Oracle licenses up-front, and Oracle Cloud PaaS services, which include the license and compute costs in one annual rate. Appendix A contains a full breakdown of how Oracle license costs were calculated.

Example Oracle Workloads

In order to model and analyze the costs of a variety of Oracle workloads, three example workloads were used. These workloads were devised to represent a reasonable spectrum of possible use cases from a small workload for a single application, to enterprise workloads comprising complex, multiple tier applications.

All of the model workloads assume the same mix of Oracle database software products. Specifically, each database virtual machine is assumed to be running Oracle Database Enterprise Edition with a common option set including Partitioning, Diagnostic Pack, and Tuning Pack. Each middle tier virtual machine is assumed to be running Oracle WebLogic Enterprise Edition. This product mix was chosen as a simple and representative sample of commonly used Oracle products. Such a homogeneous product mix may not accurately reflect workload diversity for real organizations with complex configurations, but does serve as an adequate mix of products to use as the basis for modeling and comparing costs in various cloud configurations.

Each workload also has a simplistic architecture, with an assumed one-to-one ratio of vCPU resources at the database tier and application tier. Real world ratios of application CPU to database CPU are heavily influenced by the nature of the workload (OLTP vs Warehouse), the presence of caching servers, and application load patterns. This paper assumed the one-to-one ratio as representative of a median workload.

Comparing vCPUs across different virtualization platforms and cloud providers can be confusing, as some platforms map processor core level hyperthreads as full vCPUs, whereas others map vCPUs to physical processor cores to determine capacity. It is also important to note that all the vCPUs defined in these example workloads are assumed to be vCPUs corresponding to a processor hyperthread, or logical processors in ESXi terminology. This has a direct bearing on licensing as the aforementioned Oracle cloud licensing policy treats hyperthreaded vCPUs differently than non-hyperthreaded vCPUs.

Workload Components

Each hypothetical workload was assigned a mix of virtual machines reflecting anticipated workloads. The virtual machines were classified in a simple t-shirt size fashion as shown in the workload components table below.

Table 2: Workload Components

Virtual Machine	vCPU Size
Tiny Oracle DB	2
Small Oracle DB	4
Medium Oracle DB	8
Large Oracle DB	16
Tiny WebLogic	2
Small WebLogic	4
Medium WebLogic	8
Large WebLogic	16

Tiny Oracle Workload

This workload represents a fairly typical use case of a small or medium business that does not use several Oracle technologies, but is encumbered with one legacy or Commercial off the Shelf (COTS) Oracle application that requires a few Oracle Database and WebLogic virtual machines. The four databases and four WebLogic VMs in this workload represent the entirety of the Oracle workload for both production and non-production purposes.

Small Oracle Workload

This represents a customer who either builds their own applications on Oracle technologies, or has a large COTS application built on Oracle technologies. The nine database and WebLogic VMs in this workload represent an assumption of a larger production environment backed by smaller non-production environments such as development, test, stage, integration, etc. This workload totals to 34 vCPUs requiring Oracle database licensing and 34 vCPUs requiring Oracle WebLogic Licensing.

Medium Oracle Workload

This represents the workload of a customer with heavy involvement with a business critical application based on Oracle technologies. This hypothetical customer perhaps uses an enterprise Oracle application such as E-Business Suite or Peoplesoft, or develops homegrown enterprise applications using Oracle technologies. For this level of customer, there are assumed to be multiple, very large production databases and WebLogic VMs backed by a myriad of non-production environments covering multiple development, test, and staging environments.

Large Oracle Workload

This workload is representative of an enterprise using multiple Oracle applications to run many aspects of their business. This hypothetical customer has multiple large applications such as E-Business Suite or Peoplesoft in conjunction with homegrown Oracle based applications leading to a heavy footprint of both databases and middle tier application servers. A customer at this level is assumed to have multiple production databases

supporting several applications as well as many non-production environments to cover multiple development, test, staging, and integration test environments.

Table 3: Example Oracle Environments (by Size of Workload)

Workload	Product	VMs	vCPUs
Tiny			
	Oracle Database	2 Small, 2 Tiny	12
	Oracle WebLogic	2 Small, 2 Tiny	12
Small			
	Oracle Database	1 Medium, 5 Small, 3 Tiny	34
	Oracle WebLogic	1 Medium, 5 Small, 3 Tiny	34
Medium			
	Oracle Database	2 Large, 7 Small, 3 Tiny	66
	Oracle WebLogic	2 Large, 7 Small 3 Tiny	66
Large			
	Oracle Database	4 Large, 16 Small, 8 Tiny	144
	Oracle WebLogic	4 Large, 16 Small, 8 Tiny	144

Example Configurations

For the purposes of this analysis a variety of configurations for both VMware Cloud on AWS and Oracle Cloud were analyzed to fully explore the options that a customer may use to obtain the most cost effective mix of cloud resources to service various workloads. A variety of SDDC configurations were analyzed for VMware Cloud on AWS, and both IaaS and PaaS configurations were considered for Oracle Cloud.

Configurations for VMware Cloud on AWS

SDDC Cluster Sizes

Because of the high cost of licensing Oracle software products, House of Brick typically recommends that customers architecting on-premises solutions for virtualized Oracle workloads isolate them to the greatest degree practical on the minimum required physical hardware in order to minimize the footprint of servers requiring licensing. In order to explore similar concepts in the VMware Cloud on AWS, this paper looks at a variety of possible cluster configurations.

The first and most obvious cluster configuration considered is the current default minimum SDDC cluster size in the VMware Cloud on AWS, a three-node cluster. There is also a one-node SDDC configuration available in the VMware Cloud on AWS, but VMware represents that option as for testing and evaulation purposes only so that configuration was not included in this analysis. This paper also considered two-node configurations that were

not currently available at the time of this writing. Please refer to VMware for the timing of general availability. However, House of Brick believes that a two-node VMware Cloud on AWS configuration is technically feasible, and therefore will be introduced by VMware in the future. To view the availability of features for VMware Cloud on AWS, visit: https://cloud.vmware.com/vmc-aws/roadmap.

Custom CPU Core Counts

When optimizing licensing for Oracle workloads in on-premises vSphere environments, House of Brick often recommends minimizing costs by disabling extra or unecessary physial CPU cores in servers at a BIOS/UEFI firmware level. This is a very useful tactic for minimizing expensive Oracle software licenses to only the needed processor resources. Oracle Database workloads in particular are typically constrained more by available I/O resources than processor resources on modern hardware, so core disablement is a sensible way to optimize the licensing cost of an Oracle Database without compromising on performance.

VMware has addressed this need with a feature called, aptly enough, Custom CPU Core Counts. This allows launching a cluster with nodes disabled to specific levels of cores. To demostrate the advantages the lower core counts bring in licensing Oracle workloads, this paper included three node SDDC clusters and two node SDDC clusters with 50% of cores disabled. In addition, there is a hypothetical minimal core configuration with 75% of cores disabled, both in three-node and two-node configurations.

The use of Customer CPU Core Counts is not assumed to generate any infrastructure cost savings, but rather to simply disable unecessary cores to limit cores that require Oracle licensing.

Workload Pinning

The VMware Cloud on AWS SDDC offering does not currently offer any means of hard-pinning virtual machine workloads to specific hosts. On-premises VMware vCenter solutions have traditionally offered this via DRS host affinity rules, but the VMware Cloud on AWS offering does not support this. The VMware Cloud on AWS does offer a Host-VM Affinity feature, but it is not technically a guaranteed workload pinning feature per House of Brick's understanding, and is therefore not suitable for designing architectures to limit Oracle software licensing liability. The implication of this is that when doing traditional licensing calculations, it is necessary to allocate a license for every Oracle Software product to every physical core in the SDDC cluster, as workloads cannot be restricted to specific hosts.

A limited form of workload pinning is available in the VMware Cloud on AWS only for workloads of sufficient scale. If a customer workload has enough VMs running the same Oracle software product, then it may make sense to allocate a separate SDDC cluster just to host that Oracle software product. By isolating all instances of that product to the licensed cluster, the need to license any other SDDC clusters being used for non-Oracle workloads can be avoided. This approach can also be used for large enough Oracle software footprints to separate out SDDC clusters for different products. For example, one SDDC cluster could be allocated just to handle Oracle Database VMs and another to handle application server products such as Oracle WebLogic. Some of the larger workloads in this analysis are modelled using this form of workload pinning to minimize licensing costs.

SDDC Pricing

All example configurations in this analysis assume one-year reserved pricing for VMware Cloud on AWS resources, as shown in the SDDC cost table below. Full information on pricing can be found on the VMware Cloud on AWS pricing website.[11]

Table 4: SDDC Costs

	6 Node SDDC	4 Node SDDC	3 Node SDDC	2 Node SDDC
Annual Cost Per Node (1 Year Reserved Pricing)	$51,987.00	$51,987.00	$51,987.00	$51,987.00
SDDC Nodes	6	4	**3**	2
Cluster Cost / Year	$311,922.00	$207,948.00	$155,961.00	$103,974.00

Configurations for Oracle Cloud

When looking at possible configurations to host the example workloads, there are multiple possibilities in the Oracle Cloud. This paper focuses on two alternatives that represent the best basis for cost comparison purposes.

The first alternative is to simply use the Oracle Cloud IaaS service with the BYOL option. This allows provisioning virtual machines to meet the needs of the workloads. This is a very simple method of provisioning Oracle workloads in a manner that doesn't require any licensing beyond the specific virtual machines running Oracle software products.

The second alternative examined is using Oracle PaaS offerings for Database and Java. These are equivalent to Oracle Database Enterprise Edition and Oracle WebLogic, respectively. Using these services leads to provisioning the same number of virtual machines as the IaaS option, but does not require separately acquiring licenses since the price to use the Oracle software is bundled into to the price of the PaaS offering using Universal Credits (UC). For this Oracle PaaS/UC analysis, the pricing was based specifically on the High-Performance tier of the Oracle Database service as that was the required tier to get the database options needed for the sample workloads. The Oracle Java service was priced on the Enterprise Edition pricing tier.

In order to make the Oracle Cloud IaaS/BYOL and PaaS/UC configuration as comparable to VMware Cloud on AWS as possible, all workloads were specified with VM – DenseIO shapes. As the DenseIO VMs in the Oracle Cloud IaaS/BYOL offering have a minimum of four OCPU / eight vCPUs, this did mean that some workloads in the Oracle Cloud were provisioned with more vCPUs than the minimums the workload required. In particular all tiny, small, and medium VMs from the sample workload were mapped to VM.DenseIO1.4 shapes. Large VMs from the example workloads were mapped to VM.DenseIO2.8 shapes.

[11] https://cloud.vmware.com/vmc-aws/pricing

Cost Analysis

Cost Comparison for Oracle Workloads in VMware Cloud on AWS

Tiny Oracle Workload Cost Comparison in VMware Cloud on AWS

For a tiny workload, the cost differences on VMware Cloud on AWS between traditional licensing pricing and cloud policy licensing are very stark. Licensing an entire three-node SDDC just to run a tiny workload is massive overkill for licensing, due to the lack of a workload pinning feature. Using the vCPU-based cloud policy licensing brings the costs down to a more reasonable level.

Table 5: Tiny Workload Cost Comparison

VMware Cloud on AWS Options	Cost / Year Traditional Licensing	Cost / Year Cloud Policy Licensing
3 Node SDDC (108 cores)	$2,344,578.17	$399,140.69
2 Node SDDC (72 cores)	$1,563,052.11	$347,153.69
2 Node SDDC (18 cores, 75% cores disabled)	$428,213.58	$347,153.69

Small Oracle Workload Cost Comparison in VMware Cloud on AWS

This hypothetical customer workload would fit on a one-node VMware Cloud on AWS SDDC cluster by vCPU count, but would likely require a two-node VMware Cloud on AWS cluster to get access to adequate RAM/disk resources, HA, and possibly to fit additional non-Oracle workloads. Looking into potential core disablement shows that even a core-disabled two node SDDC would fit, and still provide adequate RAM/disk and HA, as long as at least 36 cores remain enabled across the cluster to service the workload. With a small (and acceptable) amount of resource overscubscription, even a cluster with only 27 cores could host the workload.

Table 6: Small Workload Cost Comparison

VMware Cloud on AWS Options	Cost / Year Traditional Licensing	Cost / Year Cloud Policy Licensing
3 Node SDDC (108 cores)	$2,344,578.17	$844,970.11
3 Node SDDC (27 cores, 75% cores disabled)	$642,320.37	$844,970.11
2 Node SDDC (72 cores)	$1,563,052.11	$792,983.11
2 Node SDDC (36 cores, 50% cores disabled)	$833,513.06	$792,983.11

Medium Oracle Workload Cost Comparison in VMware Cloud on AWS

This hypothetical workload may fit on a two-node VMware Cloud on AWS SDDC cluster by logical vCPU count, but would need at least a three-node cluster to get access to adequate RAM/disk resources and in order to ensure adequate high availability during host replacement and maintenance events. This paper does not even

consider two-node SDDC pricing for this workload, as such a solution would meet neither capacity nor availability requirements.

Table 7: Medium Workload Cost Comparison

VMware Cloud on AWS Options	Cost / Year Traditional Licensing	Cost / Year Cloud Policy Licensing
3 Node SDDC (108 cores)	$2,344,578.17	$1,493,449.27
3 Node SDDC (54 cores, 50% cores disabled)	$1,290,799.53	$1,493,449.27
Dual 3 Node SDDC (54 cores, 75% cores disabled)	$861,281.30	$1,649,410.27
Dual 2 Node SDDC (144 cores)	$1,667,026.11	$1,545,436.27

For this workload, the size finally becomes large enough that several interesting things are manifest.

First, the advantages of traditional core based licensing over cloud policy licensing for VMware Cloud on AWS become apparent. While vCPU licensing is still advantageous for a three-node SDDC scenario, as the workload is only large enough to saturate two of the three SDDC nodes, some of the hypothetical smaller SDDC options start to demonstrate the price advantage to core based licensing when the underlying hardware is well sized to the workload. The three-node SDDC with 50% core disablement is cheaper to license for this Oracle workload using traditional core-based licensing rather than Oracle's cloud licensing policy.

Second, this is the first workload large enough to justify splitting the database tier and application tier into separate, small SDDC clusters. While this doesn't give perfect workload pinning, it still generates a dramatic savings in licensing. Using dual three-node SDDC clusters with 75% core disablement, one for database workloads and one for WebLogic workloads, allows for allocating six nodes to the workload for a lower total traditional-licensing based costs than one standard three-node SDDC that must be licensed for both products. This is true regardless of whether the single three-node SDDC was licensed by traditional core-based licensing or using the cloud licensing policy. The dual three-node SDDC offers a great deal more of every other resource as well.

Large Oracle Workload Cost Comparison in VMware Cloud on AWS

This hypothetical workload would need at least a four-node VMware Cloud on AWS SDDC cluster by logical vCPU count. Using multiple smaller SDDC clusters as a rough form of workload pinning is an option for this workload. However, no smaller clusters or core disablement would be in scope for this workload.

Table 8: Large Workload Cost Comparison

VMware Cloud on AWS Options	Cost / Year Traditional Licensing	Cost / Year Cloud Policy Licensing
4 Node SDDC (144 cores)	$3,126,104.22	$3,126,104.22
Dual 2 Node SDDC (144 cores)	$1,667,026.11	$3,126,104.22

Here, the advantages of workload pinning become readily apparent. Licensing one 4 node SDDC cluster results in relatively higher licensing costs whereas separating the application server and database tiers into separate smaller clusters creates a licensing advantage.

VMware Cloud on AWS vs. Oracle IaaS Cost Comparison

Tiny Oracle Workload Costs

For the tiny workload, VMware Cloud on AWS is comparable to Oracle IaaS/BYOL when doing cloud policy licensing. However, Oracle IaaS/BYOL gets the advantage on licensing when doing core-based licensing due to Oracle requiring fewer processor licenses per vCPU in its own Cloud environment, as well as Oracle providing certain database features for free to its cloud customers.

Table 9: Tiny Workload Cost Comparison

	Cost / Year Traditional Licensing	Cost / Year Cloud Policy Licensing
VMware Cloud on AWS	$428,213.58	$347,153.69
Oracle IaaS/BYOL	$317,980.46	N/A

Small Oracle Workload Costs

Interestingly, this workload starts to demonstrate core-based, traditional licensing in VMware Cloud on AWS becoming cost competitive with vCPU licensing and Oracle Cloud IaaS/BYOL. This Oracle workloads get large enough that the volume efficiencies of traditionally licensing the entire cluster versus using cloud policy licensing for the individual VM vCPU start to become apparent.

Table 10: Small Workload Cost Comparison

	Cost / Year Traditional Licensing	Cost / Year Cloud Policy Licensing
VMware Cloud on AWS	$642,320.37	$844,970.11
Oracle IaaS/BYOL	$715,456.04	N/A

Medium Oracle Workload Costs

The dual 3 node VMware Cloud on AWS with 75% core disablement is a much cheaper solution than using Oracle IaaS/BYOL offerings to host this workload.

Table 11: Medium Workload Cost Comparison

	Cost / Year Traditional Licensing	Cost / Year Cloud Policy Licensing
VMware Cloud on AWS	$861,281.30	$1,649,410.27
Oracle IaaS/BYOL	$1,112,931.62	N/A

Large Oracle Workload Costs

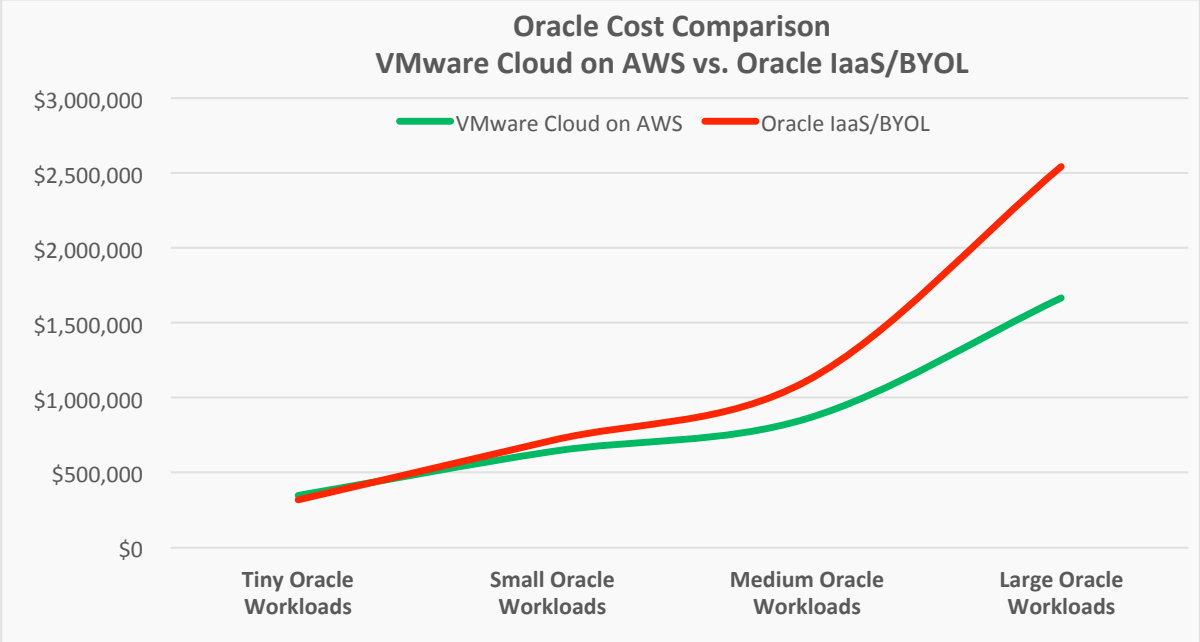
VMware Cloud on AWS is has a significantly cheaper solution to run large Oracle workloads than Oracle IaaS/BYOL. The large workload is an exact fit for four VMware Cloud on AWS nodes, it represents an ideal case for VMware Cloud on AWS with no resource oversubscription.

Table 12: Large Workload Cost Comparison

	Cost / Year Traditional Licensing	Cost / Year Cloud Policy Licensing
VMware Cloud on AWS	$1,667,026.11	$3,126,104.22
Oracle IaaS/BYOL	$2,543,843.71	N/A

Summary of VMware Cloud on AWS to Oracle IaaS/BYOL Cost Comparison

Based on the lowest priced options we identified for each workload type in VMware Cloud on AWS and the BYOL pricing option on Oracle IaaS, the chart below provides a visual comparison of the cost between the two platforms. From the chart, we see that customers have lower TCO by running Oracle workloads on VMware Cloud on AWS in all small, medium, and large workloads types, and the trend is clear that the bigger Oracle workloads that customers are running, the more they will likely save by using VMware Cloud on AWS.



VMware Cloud on AWS vs. Oracle PaaS/UC

VMware Cloud on AWS and Oracle PaaS/UC are very different services. VMware Cloud on AWS offers a seamless migration path for customers to move Oracle workloads from on-premises to public cloud without workload refactoring or even interruption; while Oracle PaaS/UC is a managed service and it requires costly refactoring of and disruption to existing workloads. House of Brick estimates that refactoring efforts can add more than 50% to the cost of a cloud migration

The table below shows the cost comparison between VMware Cloud on AWS and Oracle PaaS/UC. It is a myth that Oracle PaaS/UC has the lowest cost in the market because the workload refactoring cost cannot be ignored. With our conservative 50% refactoring cost included, Oracle PaaS has higher TCO than VMware Cloud on AWS in all small, medium, and large workload types.

Table 13: VMware Cloud on AWS and Oracle PaaS/UC Cost Comparison

	Tiny Oracle Workloads	Small Oracle Workloads	Medium Oracle Workloads	Large Oracle Workloads
VMware Cloud on AWS (Lowest cost licensing option)	$347,153.69	$642,320.37	$861,281.30	$1,667,026.11
Oracle PaaS/UC (Without refactoring cost)	$209,679.36	$471,778.56	$733,877.76	$1,677,434.88
Oracle PaaS/UC (With refactoring cost)	$314,519.04	$707,667.84	$1,100,816.64	$2,516,152.32

Conclusions

This analysis demonstrates something that House of Brick has long been aware of, that Oracle license costs far outweigh infrastructure costs in cloud strategy considerations. Designing a cost-effective architecture to host Oracle workloads while minimizing total costs should focus, first and foremost, on minimizing an organization's Oracle licensing liabilities. This is true regardless of whether a workload is hosted on-premises or in a public cloud environment.

For any organization considering migration to a public or hybrid cloud architecture, it is important to understand all of the costs associated with Oracle workloads, and in particular the options available to architect a solution to minimize those costs. Oracle's Cloud offerings have low cost options for very small workloads, but largely lack the features and interoperability offered by other cloud providers, including the VMware Cloud on AWS. While there may be some additional complexity around license management, VMware Cloud on AWS will likely be a more attractive whole-solution for organizations looking for a simple path to the cloud without the need to re-architect applications or convert workloads to a different format in order to import them into a public or hybrid cloud.

Comparing VMware Cloud on AWS and Oracle Cloud directly across all example workloads reveals a model where tiny Oracle workloads are difficult to license as inexpensively in VMware Cloud on AWS as they are with Oracle's IaaS or PaaS offerings. The requirement to license entire hosts when using traditional licensing, or licensing vCPUs at twice the cost versus Oracle's own discounted rate means that Oracle Cloud IaaS/BYOL will tend to be less expensive for tiny workloads. As an organization's Oracle software workloads grow, it becomes increasingly easier to cross the break-even points where traditional core-based licensing for a cluster becomes less expensive than vCPU licensing. Once the break-even point is crossed, additional workloads effectively have no marginal increase in licensing cost as the entire cluster is already licensed. Once workloads can saturate entire SDDC clusters, the application of traditional core-based licensing makes VMware Cloud on AWS the most cost-effective option for running Oracle workloads in a public cloud.

The VMware Cloud on AWS currently suffers from a lack of tools to help pin workloads to a subset of an SDDC cluster, which would make it easier to lower the bar for hitting those break-even points where traditional core-based licensing becomes advantageous. If a few simple features such as hard host affinity rules were added to

VMware Cloud on AWS, it would become even easier to pin workloads to licensed cluster nodes and reduce associated license liabilities.

With the addition of some workload pinning tools, or workloads large enough to saturate entire clusters, the VMware Cloud on AWS offers an unbeatable solution for hosting Oracle software-based workloads in a cost-effective manner.

The overall recommendation from House of Brick is that the VMware Cloud on AWS represents a better whole cloud solution for Oracle customers, especially those already running their Oracle workloads in a VMware virtualized environment. The operational and architectural benefits, as well as the cost advantages for larger workloads in the VMware Cloud on AWS outweigh any benefits that the Oracle cloud may offer.

Appendix A Oracle Software License Cost Calculations

All estimations of Oracle software licensing costs were made on the basis of Oracle's most recent published global price list[12]. In all cases, calculations were made on the assumption that a 25% discount could be negotiated from standard list prices.

Pricing was annualized on a three-year basis by calculating the initial price and adding three years of Software Update License and Support (SULS) fees, then dividing the total by three. The pricing was then further divided by two to represent per-core pricing as the standard pricing is per Processor License, which on x86 platforms translates to two cores per Oracle's Processor Core Factor table[13]. Tracking pricing on a per-core basis is useful when comparing dissimilar environments such as physical on-premises environments versus cloud environments.

Table A1: Oracle Database License Calculations

	Processor Licensing (Database Enterprise Edition + Partitioning + Tuning Pack + Diagnostics Pack)	NUP Licensing (x25) (Database Enterprise Edition + Partitioning + Tuning Pack + Diagnostics Pack)
Oracle Database Enterprise Edition	$47,500.00	$23,750.00
Partitioning Option	$11,500.00	$5,750.00
Diagnostics Pack	$7,500.00	$3,750.00
Tuning Pack	$5,000.00	$2,500.00
Total List Price – Database + Options	$71,500.00	$35,750.00
Total Price (after 25% assumed discount)	$53,625.00	$26,812.50
1st Year SULS	$11,797.50	$5,898.75
2nd Year SULS (3% uplift)	$12,151.43	$6,075.71
3rd Year SULS (3% uplift)	$12,515.97	$6,257.98
TOTAL PURCHASE + SULS	$90,089.89	$45,044.95
3 Year annualized per processor License	$30,029.96	$15,014.98
3 Year annualized per core	$15,014.98	$7,507.49

[12] http://www.oracle.com/us/corporate/pricing/technology-price-list-070617.pdf
[13] https://www.oracle.com/assets/processor-core-factor-table-070634.pdf

Table A2: Oracle Database License Calculations

	Processor Licensing (Database Enterprise Edition + Partitioning)	NUP Licensing (x25) (Database Enterprise Edition + Partitioning)
Oracle Database Enterprise Edition	$47,500.00	$23,750.00
Partitioning Option	$11,500.00	$5,750.00
Diagnostics Pack	NA	NA
Tuning Pack	NA	NA
Total List Price – Database + Options	NA	NA
Total Price after 25% assumed discount	$59,000.00	$29,500.00
1st Year SULS	$44,250.00	$22,125.00
2nd Year SULS (3% uplift)	$9,735.00	$4,867.50
3rd Year SULS (3% uplift)	$10,027.05	$5,013.53
TOTAL PURCHASE + SULS	$10,327.86	$5,163.93
3 YR annualized per processor License	$74,339.91	$37,169.96
3 YR annualized per core	$24,779.97	$12,389.99

Table A3: Oracle WebLogic License Calculations

	Processor Licensing - WebLogic Enterprise	NUP Licensing (x10) - WebLogic Enterprise
Oracle WebLogic Enterprise Edition	$25,000.00	$5,000.00
Total Price (after 25% assumed discount)	$18,750.00	$3.750.00
1st Year SULS	$4,125.00	$825.00
2nd Year SULS (3% uplift)	$4,248.75	$849.75
3rd Year SULS (3% uplift)	$4,376.21	$875.24
TOTAL PURCHASE + SULS	$31,499.96	$6,299.99
3 Year annualized per processor License	$10,499.99	$2,100.00
3 Year annualized per core	$5,249.99	$1,050.00

Appendix B Oracle Cloud IaaS Costs

All pricing was done using published pricing from https://cloud.oracle.com/en_US/iaas/pricing.

Table B1: Oracle Cloud IaaS Calculations

Workload	Product	VMs	vCPU Size	OCPU	OCPU Hourly Cost	Infrastructure Cost Annual	Licensing Cost Annual	Total Annual Cost
Tiny						$35,740.80	$282,239.66	$317,980.46
	Oracle Database	2 Small, 2 Tiny	12	16	0.1275	$17,870.40	$198,239.76	
	Oracle WebLogic	2 Small, 4 Tiny	12	16	0.1275	$17,870.40	$83,999.90	
Small						$80,416.80	$635,039.24	$715,456.04
	Oracle Database	1 Medium, 5 Small, 3 Tiny	34	36	0.1275	$40,208.40	$446,039.47	
	Oracle WebLogic	4 Medium, 8 Tiny	34	36	0.1275	$40,208.40	$188,999.78	
Medium						$125,092.80	$987,838.82	$1,112,931.62
	Oracle Database	2 Large, 7 Small, 3 Tiny	66	56	0.1275	$62,546.40	$693,839.17	
	Oracle WebLogic	2 Large, 7 Small, 3 Tiny	66	56	0.1275	$62,546.40	$293,999.65	
Large						$285,926.40	$2,257,917.31	$2,543,843.71
	Oracle Database	4 Large, 16 small, 8 tiny	144	128	0.1275	$142,963.20	$1,585,918.11	
	Oracle WebLogic	4 Large, 16 small, 8 tiny	144	128	0.1275	$142,963.20	$671,999.20	

Appendix C Oracle PaaS Costs

All pricing was done using public pricing from https://cloud.oracle.com/en_US/database/enterprise/pricing and https://cloud.oracle.com/en_US/java/pricing.

Table C1: Oracle Cloud PaaS Calculations

Workload	Product	VMs	OCPU	OCPU Hourly (License Included)	Annual Cost
Tiny					$209,679.36
	Oracle Database	2 Small, 2 Tiny	16	1.1089	$155,423.42
	Oracle WebLogic	2 Small, 2 Tiny	16	0.3871	$54,255.94
Small					$471,778.56
	Oracle Database	1 Medium, 5 Small, 3 Tiny	36	1.1089	$349,702.70
	Oracle WebLogic	1 Medium, 5 Small, 3 Tiny	36	0.3871	$122,075.86
Medium					$733,877.76
	Oracle Database	2 Large, 7 Small, 3 Tiny	56	1.1089	$ 543,981.98
	Oracle WebLogic	2 Large, 7 Small, 3 Tiny	56	0.3871	$189,895.78
Large					$1,677,434.88
	Oracle Database	4 Large, 16 small, 8 tiny	128	1.1089	$1,243,387.39
	Oracle WebLogic	4 Large, 16 small, 8 tiny	128	0.3871	$434,047.49

Appendix D Workload Cloud Costs

These tables represent the full cost modeling for all workload scenarios. Included costs for each scenario include infrastructure costs, licensing costs by traditional core-based licensing, and licensing costs by cloud policy vCPU licensing.

Table D1: Tiny Workload Cloud Costs

Cloud Configuration	Net Core Based Licensing (Infrastrucutre + Licensing)	Net Cloud Policy Licensing (Infrastructure + Licensing)	Traditional Core Based Licensing Cost	Cloud Policy vCPU Licensing Cost	Infrastructure Cost
4 Node VMC SDDC – 144 core	$3,126,104.22	$451,127.69	$2,918,156.22	$243,179.69	$207,948.00
3 Node VMC SDDC – 108 core	$2,344,578.17	$399,140.69	$2,188,617.17	$243,179.69	$155,961.00
2 Node VMC SDDC – 72 core	$1,563,052.11	$347,153.69	$1,459,078.11	$243,179.69	$103,974.00
3 Node VMC SDDC – 54 core (50% Core Disabled)	$1,290,799.53	$399,140.69	$1,134,838.53	$243,179.69	$155,961.00
2 Node SDDC -36 core (50% Core Disabled)	$833,513.06	$347,153.69	$729,539.06	$243,179.69	$103,974.00
3 Node SDDC – 27 core (75% Core Disabled)	$642,320.37	$399,140.69	$486,359.37	$243,179.69	$155,961.00
2 Node SDDC – 18 core (75% Core Disabled)	$428,213.58	$347,153.69	$324,239.58	$243,179.69	$103,974.00
Dual 2 Node SDDC – 144 core	N/A	N/A	N/A	N/A	N/A
Dual 2 Node SDDC – 72 core (50% Disabled)	N/A	N/A	N/A	N/A	N/A
Oracle PaaS	$209,679.36	N/A	N/A	N/A	$209,679.36
Oracle IaaS	$317,980.46	N/A	N/A	$282,239.66	$35,740.80

Table D2: Small Workload Cloud Costs

Cloud Configuration	Net Core Based Licensing (Infrastrucutre + Licensing)	Net Cloud Policy Licensing (Infrastructure + Licensing)	Traditional Core Based Licensing Cost	Cloud Policy vCPU Licensing Cost	Infrastructure Cost
4 Node VMC SDDC – 144 core	$3,126,104.22	$896,957.11	$2,918,156.22	$689,009.11	$207,948.00
3 Node VMC SDDC – 108 core	$2,344,578.17	$844,970.11	$2,188,617.17	$689,009.11	$155,961.00
2 Node VMC SDDC – 72 core	$1,563,052.11	$792,983.11	$1,459,078.11	$689,009.11	$103,974.00
3 Node VMC SDDC – 54 core (50% Core Disabled)	$1,290,799.53	$844,970.11	$1,134,838.53	$689,009.11	$155,961.00
2 Node SDDC -36 core (50% Core Disabled)	$833,513.06	$792,983.11	$729,539.06	$689,009.11	$103,974.00
3 Node SDDC – 27 core (75% Core Disabled)	$642,320.37	$844,970.11	$486,359.37	$689,009.11	$155,961.00
2 Node SDDC – 18 core (75% Core Disabled)	N/A	$792,983.11	$324,239.58	$689,009.11	$103,974.00
Dual 2 Node SDDC – 144 core	N/A	N/A	N/A	N/A	N/A
Dual 2 Node SDDC – 72 core (50% Disabled)	N/A	N/A	N/A	N/A	N/A
Oracle PaaS	$471,778.56	N/A	N/A	N/A	$471,778.56
Oracle IaaS	$715,456.04	N/A	N/A	$635,039.24	$80,416.80

Table D3: Medium Workload Cloud Costs

Cloud Configuration	Net Core Based Licensing (Infrastrucutre + Licensing)	Net Cloud Policy Licensing (Infrastructure + Licensing)	Traditional Core Based Licensing Cost	Cloud Policy vCPU Licensing Cost	Infrastructure Cost
4 Node VMC SDDC – 144 core	$3,126,104.22	$1,545,436.27	$2,918,156.22	$1,337,488.27	$207,948.00
3 Node VMC SDDC – 108 core	$2,344,578.17	$1,493,449.27	$2,188,617.17	$1,337,488.27	$155,961.00
2 Node VMC SDDC – 72 core	N/A	N/A	N/A	$1,337,488.27	$103,974.00
3 Node VMC SDDC – 54 core (50% Core Disabled)	$1,290,799.53	$1,493,449.27	$1,134,838.53	$1,337,488.27	$155,961.00
2 Node SDDC -36 core (50% Core Disabled)	N/A	N/A	N/A	$1,337,488.27	$103,974.00
3 Node SDDC – 27 core (75% Core Disabled)	N/A	N/A	N/A	$1,337,488.27	$155,961.00
2 Node SDDC – 18 core (75% Core Disabled)	N/A	N/A	N/A	$1,337,488.27	$103,974.00
Dual 2 Node SDDC – 144 core	$1,667,026.11	$1,545,436.27	$1,459,078.11	$1,337,488.27	$207,948.00
Dual 2 Node SDDC – 72 core (50% Disabled)	$937,487.06	$1,545,436.27	$729,539.06	$1,337,488.27	$207,948.00
Dual 3 Node SDDC – 108 core (50% Disabled)	$861,281.30	$1,649,410.27	$549,359.30	$1,337,488.27	$311,922.00
Oracle PaaS	$733,877.76	N/A	N/A	N/A	$733,877.76
Oracle IaaS	$1,112,931.62	N/A	N/A	$987,838.82	$125,092.80

Table D4: Large Workload Cloud Costs

Cloud Configuration	Net Core Based Licensing (Infrastrucutre + Licensing)	Net Cloud Policy Licensing (Infrastructure + Licensing)	Traditional Core Based Licensing Cost	Cloud Policy vCPU Licensing Cost	Infrastructure Cost
4 Node VMC SDDC – 144 core	$3,126,104.22	$3,126,104.22	$2,918,156.22	$2,918,156.22	$207,948.00
3 Node VMC SDDC – 108 core	N/A	N/A	N/A	$2,918,156.22	$155,961.00
2 Node VMC SDDC – 72 core	N/A	N/A	N/A	$2,918,156.22	$103,974.00
3 Node VMC SDDC – 54 core (50% Core Disabled)	N/A	N/A	N/A	$2,918,156.22	$155,961.00
2 Node SDDC -36 core (50% Core Disabled)	N/A	N/A	N/A	$2,918,156.22	$103,974.00
3 Node SDDC – 27 core (75% Core Disabled)	N/A	N/A	N/A	$2,918,156.22	$155,961.00
2 Node SDDC – 18 core (75% Core Disabled)	N/A	N/A	N/A	$2,918,156.22	$103,974.00
Dual 2 Node SDDC – 144 core	$1,667,026.11	$3,126,104.22	$1,459,078.11	$2,918,156.22	$207,948.00
Dual 2 Node SDDC – 72 core (50% Disabled)	N/A	N/A	N/A	$2,918,156.22	$207,948.00
Dual 3 Node SDDC – 108 core (50% Disabled)	N/A	N/A	N/A	$2,918,156.22	$311,922.00
Oracle PaaS	$1,677,434.88	N/A	N/A	N/A	$1,677,434.88
Oracle IaaS	$2,543,843.71	N/A	N/A	$987,838.82	$125,092.80