VMware Cloud on AWS: A new approach to Public Cloud offers more value than Azure alternatives

DECEMBER 2017

There is no mistaking that cloud adoption is growing at a phenomenal rate. Infrastructure spending on the public and private cloud is growing at double-digit rates while spending on traditional, non-cloud, IT infrastructure continues to decline and within a few short years will represent less than 50% of the entire infrastructure market. On-premises cloud vendors have been innovating furiously over the past several years to simplify IT using software-defined infrastructure, in an effort to give on-premises solutions the agility and simplicity to compete effectively with the scale of the public cloud vendors. We are rapidly approaching a time where we will find an equilibrium point between infrastructure that belongs on-premises versus infrastructure that belongs in the public cloud.

To gather data and develop insights regarding plans for public and hybrid cloud use, Taneja Group conducted two primary research studies in the summer of 2017. In each case, we surveyed 350+ IT decision makers and practitioners around the globe, representing a wide range of industries and business sizes, to understand their current and planned use cases and deployments of applications to the public cloud. What we found is more than two-thirds of IT practitioners plan on using hybrid clouds as their long-term infrastructure choice, while 16% prefer on-premises clouds only and the remaining 16% want their infrastructure exclusively in the public cloud. Unfortunately, however, we learned that today's hybrid clouds are not delivering on the attributes that are most important to IT buyers, such as end-to-end security, quality of service, and workload mobility, while maintaining IT control.

What if there were a vendor that could overcome all the current hybrid cloud deficiencies and also provide public-cloud infrastructure that is arguably more efficient than leading public cloud alternatives? That would be what we call "having your cake and eating it too." Enter VMware Cloud on AWS. VMware Cloud on AWS has been built on VMware's Cloud Foundation software and can be deployed as-a-service on AWS as easily as one can do a simple mouse click. The difference now is that the hundreds of thousands of VMware customers that have come to rely on VMware as their key enterprise virtualization provider can instantly get a fully functional hybrid cloud with all the security, control, and features they depend on in their on-premises VMware environments. Also, customers will enjoy seamless workload migration from private to public clouds, advanced disaster recovery capability, and—by being on AWS public cloud—safe and secure access to additional AWS services.

So, what about total solution cost? Can VMware make this cloud service as cost-effective as spinning up IaaS on Microsoft Azure or using a hybrid cloud consisting of Azure in public cloud and Azure stack on-premises? The simple answer is, YES, through transparency and efficiency. Transparency in the fact that when you provision VMware Cloud on AWS, you actually know what you're getting physically, including the type of server, amount of storage, etc. The dirty little secret to public cloud instances is that you don't know what the infrastructure is under the covers. And if you provision a vCPU with a certain amount of memory and storage, you are going to pay for that instance no matter how much you use it. With transparency comes the opportunity for efficiency. VMware has long been

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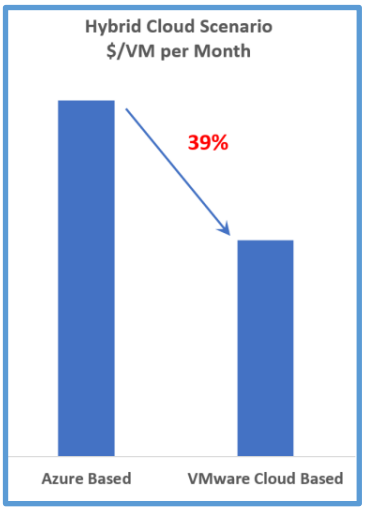
known for efficiency in operation and provisioning. By combining greater efficiency with infrastructure transparency, VMware can offer customers a solution that is more cost-effective than public cloud alternatives.

To gauge the comparative costs of VMware Cloud on AWS versus major public and hybrid cloud alternatives, Taneja Group performed an in-depth analysis of the relative costs of running typical business-critical workloads using VMware Cloud on AWS versus a similar approach on Microsoft Azure. We then explored a second scenario for existing VMware customers, comparing the costs of upgrading to a true hybrid cloud using VMware versus adding Azure Stack infrastructure to gain similar capability for an Azure-based hybrid cloud. What we found is significant. For a 180-virtual server workload environment in a public cloud configuration, VMware Cloud was **14-17%** more cost-effective than Microsoft Azure. When we added the cost of upgrading to a hybrid cloud configuration, the advantage of VMware Cloud over Azure technologies jumped to **39%**.



WHY HYBRID CLOUD HAS FAILED TO MEET ITS PROMISE

The promise of smoothly functioning, cost-effective hybrid clouds has long been of interest to IT professionals. Based on Taneja Group research from mid-2017, hybrid clouds are attractive to companies for several reasons, including the ability to cost-effectively scale infrastructure up or down as needed, transparently move workloads between on-prem and public cloud, and dynamically place workloads in the cloud where they best fit or deliver the most value. Hybrid clouds broaden the workload deployment choice to more than one cloud and enable some compelling use cases, such as cloud-enabled backup, disaster recovery and analytics. Done right, a hybrid cloud improves IT agility while reducing overall cost.

But unfortunately, the reality of hybrid cloud has not lived up to its promise. We recently asked 400+ companies looking to invest in hybrid cloud where they are in their journey, and found that just 7% have successfully set up a hybrid cloud. Of the remaining 93%, only 1 in 5 organizations have progressed beyond the research and planning stage, while 5% have placed their transformation on hold. What's standing in their way? Firms face several common challenges, which tend to hamper or even prevent a successful deployment:

- **Challenges in adapting a traditional data center to cloud-enabled IT.** Getting it right on-premises is a prerequisite to hybrid cloud, and industry hype has confused many buyers about what it takes to be successful. Moving to a cloud-driven computing model requires more than just new technology; it also demands changes in business processes and mindset to adapt to a new consumption-based, IT service delivery model. Most organizations are unprepared for the process and cultural changes they must make, which is why so many do-it-yourself private cloud initiatives fall short.
- **Concerns about enterprise readiness of public/hybrid clouds.** IT managers are often reluctant to move active, production-level workloads outside data center walls due to concerns that public clouds won't meet service-level commitments for security, availability and performance. These were among the top issues cited by the IT professionals in our recent research: two-thirds are worried about data security, and nearly 30% are concerned about the potential for extended downtime and/or an inconsistent user experience.

- **Lack of standard interfaces and tools to facilitate workload portability and orchestration.** Workload portability, a prerequisite to hybrid clouds, has been hampered by a lack of standard APIs and runtime environments to enable companies to easily move their apps and data between on-premises and public clouds. While containers have facilitated the movement of cloud-architected apps, the movement of existing enterprise apps and data remains a challenge. Similarly, a lack of tools has made cross-cloud provisioning and orchestration difficult at best. These shortcomings limit customer choice, flexibility and ease of use.
- **Fear of public cloud lock-in.** Finally, more than one-third of companies in our survey are reluctant to embrace hybrid cloud due to lock-in concerns: once I migrate my apps and data to the cloud, how difficult and costly will it be to move them back on-premises? Hybrid clouds require unfettered portability, which may be inhibited by the proprietary hooks and high data egress costs built into public provider services.

Looking forward, as both cloud market and technologies continue to mature, we see the vendor and service provider community helping users to overcome these adoption barriers. In fact, we're already seeing evidence of that in several areas. For example, enterprises are now rapidly adopting software-defined storage, networking and security technologies on premises, which along with server virtualization, pave the way toward a software-defined data center (SDDC), the foundation for a successful private cloud. In parallel with that, automated cloud orchestration, operations and costing solutions are helping companies adapt and transform business processes to service-driven IT.

IT manager confidence in public clouds has also increased significantly over the past couple of years, leading to their adoption of an expanding set of use cases and applications. Based on our recent research, nearly 90% of enterprises are now using one or more public cloud services, with 65+% running at least some business-critical workloads in a public cloud.

How can you best take advantage of the promise of hybrid cloud, without getting stalled in your deployment or putting critical corporate assets at risk? We believe VMware Cloud on AWS offers a strong path to hybrid cloud for many customers. Let's take a closer look at the architecture and capabilities that make VMware Cloud on AWS a potentially compelling choice for your hybrid cloud deployment.

Traditional Public Cloud Popularity is coming at a Cost

Early public cloud vendors promised a new era of IT simplicity and cost reduction. That promise resonated with many customers and we are seeing the result in the form of increased spending and massive growth in public cloud use. In addition to concern for vendor lock-in, we often hear complaints about the complexity of these public clouds. IT is now hiring public cloud architects and administrators as cloud offerings continue to get more complex. Will the high cost of managing complex, traditional 3-tier on-premises infrastructure just get shifted in IT budgets to managing complex, traditional public clouds? In the IaaS use case alone, IT can choose from 100's of VM configurations, each with different pricing and performance characteristics. VMC on AWS is a new, simpler approach to purchasing and using public cloud services. This new and simpler approach just might be a wave of the future.

WHY VMWARE CLOUD ON AWS ENABLES THE IDEAL HYBRID CLOUD

The best hybrid cloud architecture would be one that seamlessly plugs into your existing on-premises infrastructure. The current approach that many infrastructure vendors are pushing is, "let us first build you a shiny new private cloud, then someday down the road we'll build you a bridge to the public cloud; and voila, you'll have a hybrid cloud". This approach has led customers to think they have to transform their existing infrastructure in order to successfully deploy a hybrid cloud.

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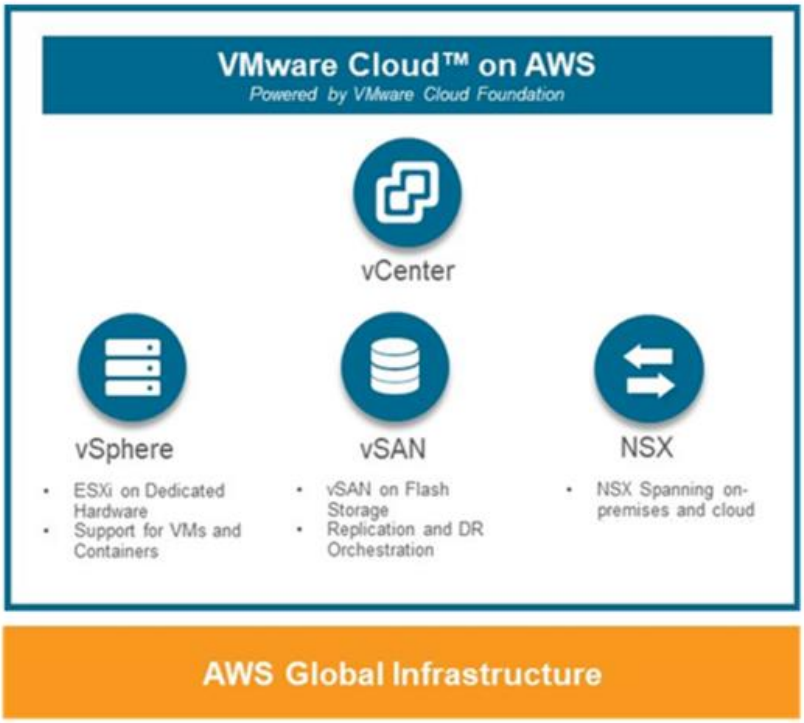
What if you could get started on hybrid cloud without having to re-architect your entire data center? Don't get me wrong, having a shiny new private cloud with self-service automation and application modernization is still a great choice for many customers. However, one could argue that an incremental approach, in which you non-disruptively extend your existing on-premises environment to include a modern public cloud, might be better and less risky. Well, that option is now available to you with VMware Cloud on AWS. If you're an existing VMware customer, the only prerequisite for unleashing the power of a hybrid cloud is that you upgrade to vSphere 6.0 or a later release. This incremental, upgrade-driven approach should come as a welcome relief to the 500K+ customers that have come to rely on VMware technology to virtualize their business-critical infrastructure since 2002. So now whether you build that new private cloud or just use your existing VMware infrastructure, you can unleash the power of hybrid cloud. Before we further discuss the business benefits of VMWARE CLOUD on AWS, let's first explore what you get on the AWS side of the infrastructure.

VMware Cloud on AWS architecture explained

Unlike most public cloud infrastructure, VMware Cloud is transparent. VMware Cloud on AWS uses a hyper-converged architectural approach, powered by technology called VMware Cloud Foundation. VMware Cloud Foundation powers many of the leading HCI and private cloud deployments on premises today, and is certified on all the leading infrastructure hardware platforms. When deployed on AWS, the on-demand VMware Cloud service enables you to run applications across vSphere-based environments and includes access to a broad range of AWS services. The service integrates vSphere, vSAN and NSX along with VMware vCenter management, and is optimized to run on dedicated, elastic, bare-metal AWS infrastructure. Businesses can manage their dedicated public-cloud resources with familiar VMware tools. Figure 1 is a graphical representation of VMware Cloud on AWS architecture.

Figure 1: VMC on AWS high level architecture



SOURCE: VMWARE

The baseline VMware Cloud on AWS service comes with four dedicated compute nodes configured in a highly resilient hyper-converged cluster. The service can scale on-demand one node at a time to a maximum of 32 nodes for a single HCI cluster environment. Businesses needing additional scale can then stand up a new cluster starting again with a minimum of four nodes. The following table outlines exactly what is included from a hardware infrastructure perspective.

VMware Cloud on AWS	
Component	**Description**
Cloud Software Platform	VMware Cloud Foundation
Cloud Compute Platform	AWS bare-metal Servers (all nodes the same)
Cores per Node	36
Hyper-threads per Node	72
Memory per Node	512 GB
NVMe-based SSD Raw Capacity per Node	10.7 TB
Storage Technology	Virtual SAN
Minimum Nodes in a Cluster	4
Maximum Nodes in a Cluster	32
Networking Technology	VMware NSX

Following are some of the key attributes that make VMware Cloud on AWS an ideal hybrid cloud solution.

- **Operational consistency across on-premises and public cloud.** Familiar VMware tools such as vCenter, vSphere API, and vSphere clients make managing VMware infrastructure on AWS exactly like you do on-premises. No costly workforce training is needed to get started on a hybrid cloud journey. Hybrid Linked Mode allows you to link public and private vCenter server instances together and thus manage the inventories of both environments from a single vSphere Client interface.
- **Integrated hybrid cloud management.** Simplified orchestration and operation management for a hybrid cloud environment is provided using the full vRealize suite of applications from VMware. Whether you use VMware-based hybrid cloud tools or a myriad of other third-party tools, you'll benefit from the proven interoperability these tools have demonstrated with vSphere-based virtualization environments.
- **Enterprise-grade application workload support.** VMware Cloud leverages enterprise-class, bare-metal compute nodes that support the latest modern processor complex architectures, combined with locally attached SSD technology that supports the NVMe protocol. VMware vSAN software-defined storage combined with NVMe-based SSDs creates a shared storage environment with a long track record of supporting mission-critical workloads. Having an all-flash storage infrastructure means businesses will not have to guess what workloads may or may not be suitable to move to VMware Cloud on AWS.
- **Higher-than-average VM density and efficiency.** VMware vSphere environments are well known for their resource efficiency. You can take full advantage of this efficiency when deploying workloads on VMware Cloud. Businesses do not know how much public cloud vendors overprovision resources or how efficiently their underlying virtualization technology performs. With VMware Cloud's transparent approach, you can pack more VM instances in the environment without paying any incremental costs, resulting in a more efficient and cost-

effective solution. Unlike other public cloud approaches, increased density and efficiency leads to a lower cost per VM, versus just boosting the profitability of the cloud provider.

- **Seamless network bridging and features.** By leveraging NSX technology across public and private cloud environments, VMware Cloud solves many complex compatibility issues for hybrid clouds.
- **Uncompromised workload portability.** Arguably one of the most over-hyped and under-delivered promises of hybrid clouds is the capability to burst workloads seamlessly to public cloud. With VMware Cloud on AWS, this capability is delivered by leveraging some of the most cherished VMware features that now work seamlessly between VMware environments on-premises and in the public cloud. Such features include vMotion to transparently move a workload and DRS to automatically load-balance between VMware Cloud on AWS and on-premises vSphere environments.
- **Single-contact premium support included.** Support in public clouds can vary depending on the level of service you pay for. With VMware Cloud on AWS, VMware manages and operates the service and provides full lifecycle support of all the components in the solution (e.g. emergency patches, software upgrades, etc.). Customers will benefit from world-class, 24X7 support services including an online support center with FAQs, forums & chat capability.

VMware Cloud on AWS efficiency and pricing expectations

VMware enables customers to build the right strategy to take advantage of hybrid cloud. Everything is transparent. Customers can now leverage VMware capabilities they've successfully used on-premises, such as VM density/oversubscription, vMotion, and HA, and apply these capabilities in a hybrid cloud architecture. VMware is changing the metrics of cloud pricing with this offering. While actual efficiency calculations depend on the overall number of workloads deployed in the cloud, Taneja Group found that the following table is a good rule of thumb for realistic efficiency expectations when using VMware Cloud on AWS.

VMware Cloud on AWS Efficiency Calculation		
Component	**Value**	**Description**
Cores per Node	36	Physical cores available per computer node
Overcommit Ratio	4	Very conservative approach when considering effects of Hyperthreading.
Available vCPUs per Node with oversubscription	144	vCPUs are the standard unit of compute resource commonly ordered in public clouds.
Memory available per vCPU	3.5 GB	This is a generous amount of memory per vCPU for the workloads.
Available effective SSD Capacity per vCPU	37 GB	Based on a conservative raw-to-effective capacity of ~50%. Deduplication and compression technology could gain more effective capacity per vCPU.

VMware provides multiple pricing options when provisioning VMware Cloud on AWS. You can rent infrastructure on-demand, or for better pricing, reserve infrastructure in one-year or three-year increments, depending on your needs. Discounts go up as the reservation period increases. Also, VMware rewards companies that have invested in VMware infrastructure on-premises through the Hybrid Loyalty Program. The Hybrid Loyalty Program can save customers up to an additional 25% if they are currently paying for existing on-premises VMware products and services. The following table outlines pricing at the time this report was published. Pricing includes a robust bundle of enterprise-level service and support.

VMware Cloud on AWS Pricing Calculation			
Pricing Component	**On-Demand (Hourly)**	**1 Year Reserved**	**3 Year Reserved**
List Price ($ per host)*	$8.3681/hour	$51,987/year	$109,366/3 year
Effective Hourly**	$8.3681/hour	$5.9346/hour	$4.1616/hour
Savings Over On-Demand		30%	50%
**Pricing based on US West Data Center and does not include Hybrid Loyalty Program which could net an additional 25%.* ***Normalized to hourly for comparison only.*			

VMWARE CLOUD ON AWS VERSUS MICROSOFT AZURE PUBLIC CLOUDS

For our public cloud-to-public cloud cost comparison analysis, the cloud scenarios were configured as general-purpose IaaS systems capable of running business-critical workloads (e.g., with high availability and 24x7x365 service response times). For Microsoft Azure, we relied on Microsoft recommendations for VM sizing and storage configuration and included extended service contracts that could hit this level of SLA. Since Microsoft provides many different VM sizes, we first picked an Azure VM size that met our criteria and then matched that VM size on VMware Cloud on AWS. We used this approach to make each public cloud environment in our analysis as close to equivalent as possible. The following is a summary of our comparison approach and assumptions.

- Optimize IaaS sizing, making the environment large enough to support the shift of a reasonable set of business-critical workloads to the public cloud. Start with an Azure-capable VM instance and then match to VMware Cloud.
- Do not include costs that should be relatively equal in cost between the two scenarios (e.g., AWS versus Azure egress fees)
- No assumption around what it will take to get the workload into the public cloud. This part of the analysis will be examined in the Hybrid cloud scenario.
- Taneja Group research indicates that businesses that plan to shift their critical workloads to the public cloud intend this as a long-term solution. Therefore, the length of the analysis is based on a three-year lifecycle.

Configurations for each Public Cloud

The following table indicates more in-depth services purchased for each public cloud.

VMware Cloud on AWS Pricing Calculation			
Cloud Component	**Minimum Required**	**Azure Selections**	**VMware Cloud Selections**
Total VM Instances	180	180	180
vCPUs Per VM	4	4	4
Memory per VM	8 GB	8 GB	14 GB*
Guest O/S	Windows	Windows	Windows
Average Storage per VM (SSD-Based)	50 GB	64 GB	148 GB*
**VMware Cloud on AWS Memory and Storage was greater than minimum required as vCPUs were the limiting factor in the configuration. You could easily configure a workload that needed more storage and less vCPUs on VMware Cloud.*			

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Azure Specific Configuration and Costs

With any public cloud, there is a myriad of vCPU size and memory configuration options to choose from. For the IaaS scenario on Azure, we used the Microsoft public pricing calculator and went through the following selection process:

1) Select a Virtual Machine type and size
2) Select durable, permanent storage that will meet the workload requirement
3) Select additional support services

This process yields the following selections and pricing for our scenario:

Azure Public Cloud Pricing Calculation			
Cloud Component	**Selections**	**On-Demand Cost**	**3-Year Reserve Cost**
Virtual Machine Type	F4: 4 vCPU(s) 8 GB RAM 64GB Temp Storage	$182.27/Month	$75.22/Month
Permanent Storage	Premium Managed 64 GB SSD	$10.56/Month	$10.56/Month
Snapshot Storage	12 GB	$1.58/Month	$1.58/Month
IaaS Workload Scenario	180 VMs	$34,841/Month	$15,662/Month
Support Costs	Professional Direct*	$2,000/Month	$2,000/Month
Total 3-Year Cost		**$1,326,269**	**$635,825**
Cost per VM Per Month		**$204.67**	**$98.12**
**Professional Direct is based on $1,000 per month per customer contact. For 180 VMs we assumed two support contacts.*			

While this three-step process appears rather simple, we found that numerous options were available to us in each step, requiring significant time to determine which option made the most sense for our specific workload. Any customer not familiar with Azure will similarly need to invest considerable time upfront to research and sort out the various options.

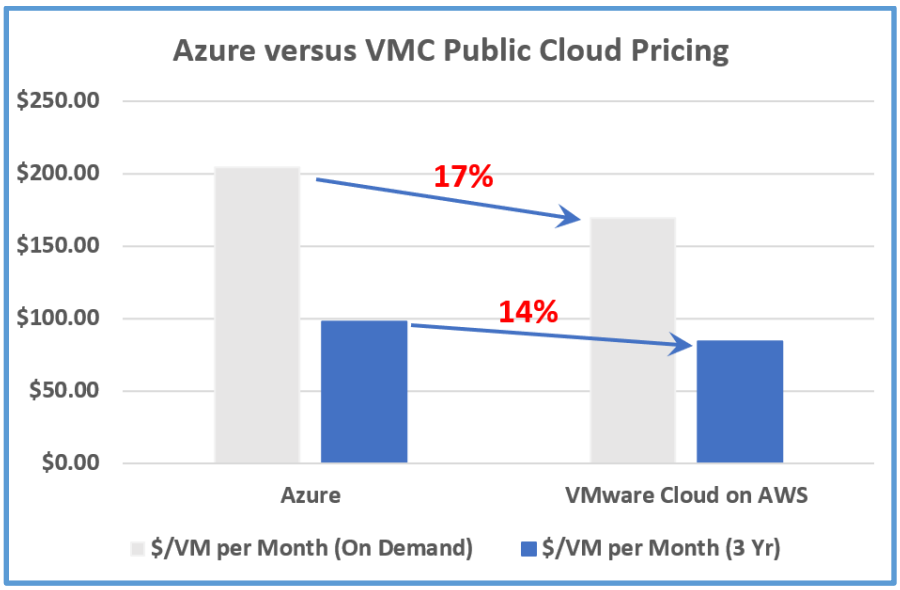
VMware Cloud Specific Configuration and Costs

The configuration sizing for VMware Cloud on AWS is very straightforward. Rather than going through a pricing calculator with hundreds of choices and combinations, we only had to calculate how much VM density each host node could handle and then multiply the number of hosts needed to cover our workload scenario. This node-based pricing concept is very important because unlike the Azure scenario, we can change VM configurations on the fly and still know exactly what the monthly cost envelope will be. The follow table outlines the configuration and cost for VMware Cloud on AWS.

VMware Cloud on AWS Public Cloud Pricing Calculation			
Cloud Component	**Selections**	**On-Demand Cost**	**3-Year Reserve Cost**
VMware Cloud Host	36 Cores, 512 GB Memory, 10.7 TB raw SSD Storage	$6,109/Month	$3,038/Month
IaaS Workload Scenario	5 Hosts	$30,544/Month	$15,190/Month
Support	Premium	Included	Included
Total 3-Year Cost		**$1,099,568**	**$546,830**
Cost per VM Per Month		**$169.69**	**$84.39**

Comparing VMware Cloud to Azure Public Cloud Offerings

The follow graph and table outline the comparison of VMware Cloud on AWS versus a comparable Azure configuration that can handle a similar workload and SLA expectations for 180 VMs.



Azure versus VMware Cloud Public Cloud Pricing			
Item	**Azure**	**VMware Cloud on AWS**	**VMware Cloud Savings**
On-Demand Pricing $/VM per Month	$204.67	$169.69	$34.98 (17%)
3-Year Reserve $/VM per Month	$98.12	$85.39	$13.73 (14%)

VMWARE CLOUD ON AWS VERSUS MICROSOFT AZURE HYBRID CLOUD

In our research, we found that 68% of IT practitioners plan on using a hybrid cloud as their long-term infrastructure choice. Therefore, we analyzed a hybrid cloud scenario where 50% of the workload would exist in the public cloud, and another 50% would stay in a private cloud on-premises. For VMware customers, we found the likely approach would be to simply upgrade existing infrastructure to enable it to work seamlessly with the public cloud. Based on our research, IT practitioners perceive this as a strong benefit - they prefer to keep their existing infrastructure when adopting a hybrid cloud. To provide hybrid cloud functionality with Azure, Microsoft has introduced a fully functional hybrid cloud called Azure Stack. To deliver Azure Stack on premises, Microsoft has partnered with infrastructure providers such as HPE, Dell EMC, and Lenovo, which pre-install the software stack on a very prescriptive set of hardware. This tightly controlled hardware delivery approach means that businesses must buy new infrastructure to get the hybrid cloud architecture they prefer, versus just upgrading their existing infrastructure.

In our analysis, we compared the cost of upgrading an existing VMware environment, based on a typical VMware installed base scenario, to the cost required to deploy a new Microsoft Azure Stack solution provided by one of Microsoft's hardware provider partners. To make this comparison similar to the public-cloud pricing comparison we used the exact same target environment from a VM density perspective. We believe this approach makes sense in a true hybrid cloud environment, since the

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workload running on-premises would perform very similarly when moved to the public cloud infrastructure.

Azure Stack on-premises cost analysis

In configuring an Azure stack configuration, we designed a solution that matched the VM sizing scenario of the public cloud. We then analyzed detailed BOMs from two of the leading branded on-premises hardware providers that could match that scenario. In our scenario, we decided to use the quoted prices that were closest to the list price we believe most customers would choose. We selected server and storage solutions that provide good value, rather than using the most expensive processor and memory configuration. The following table represents the key components included in the Azure Stack configuration.

Microsoft Azure Hybrid Cloud Hardware		
Component	**Estimated Cost**	**Description**
Management Server	$10,699	A single server to host infrastructure lifecycle management software.
Azure Compute and Storage Nodes	$253,775	Core HCI Nodes that host Azure Stack solution environment. Each node consisted of 36 Cores, 512 GB Memory, 60 TB HDD Storage with 7.68 TB of SDD cache. A total of 5 nodes were needed to host 180 VMs on-premises.
Networking	$83,416	Includes one management network switch and two TOR switches. Includes cabling for five nodes.
Rack Infrastructure	$4,847	Includes Rack and Power Distribution
Installation and Startup Services	$27,360	Installation and Startup Services include integration of hardware and software into existing data center infrastructure.
Ongoing Hardware Support	$105,821	Ongoing Hardware Support Cost based on premium support upgraded for three years.
Total 3-Year Cost	**$485,918**	Total estimated hardware cost for three years
Cost per VM per Month	**$74.99**	Hardware infrastructure cost per VM per Month to support 180 VMs for three years.

For the software portion of the Azure Stack solution, pricing is reduced compared to the Azure public cloud since the hardware portion is owned by the customer. The following table outlines the Azure stack pricing model along with selections to meet the workload scenario.

Microsoft Azure Hybrid Cloud Sofware Services		
Service	**Cost**	**Description**
Base Virtual Machine	$0.008/vCPU/hour ($6/vCPU/month)	Base virtual machine cost. This is what we selected for the IaaS scenario.
Windows Server virtual machine	$0.046/vCPU/hour ($34/vCPU/month)	Cost to load Windows Server Software on a VM. We assume that the customer already has Windows licenses to use on-premises.
Azure Blob Storage	$0.006/GB/month (no transaction fee)	Used for archive and general-purpose storage. We assigned 500GB per VM.
Azure Table and Queue Storage	$0.018/GB/month (no transaction fee)	Used for transactional storage. We assigned 24GB per VM.
Azure Standard Unmanaged Disk	$0.011/GB/month (no transaction fee)	Microsoft currently does not support premium storage, so in the meantime, we assigned 64 GB of unmanaged storage per VM. Microsoft also is not

		guaranteeing performance for storage at this time. Expect this cost to go up once premium managed storage is supported.
Azure App Service (Web Apps, Mobile Apps, API Apps, Functions)	$0.056/vCPU/hour ($42/vCPU/month)	Used for application development. Not selected for the general-purpose IaaS scenario.
Cost per VM per Month	**$27.43**	Software infrastructure cost per VM per month, based on four vCPUs per VM and related storage costs described above.

VMware on-premises cost analysis

Recent Taneja Group multi-cloud research revealed that more than 65% of companies are running and/or planning to run VMware vSphere as their preferred virtualization platform. With that in mind, the most popular scenario for transforming to a VMware-based hybrid cloud would be to upgrade or freshen up an existing VMware environment by adding any additional software needed to create a fully functional hybrid cloud. In our analysis we created an upgrade scenario based on the likeliest installed base environment and added the costs required to upgrade to a hybrid cloud environment. The following table outlines a typical upgrade path that a business might take to fully take advantage of VMware Cloud on AWS in a hybrid mode.

VMware Hybrid Cloud Upgrade Path			
Component	**Current Installation**	**Upgraded Technology (cost per CPU)**	**Description**
Base Management	vCenter	vCenter with Hybrid Linked Mode ($0 per CPU)	Hybrid Linked Mode allows you to link a VMware Cloud on AWS based vCenter server instance with an on-premises vCenter server instance.
Server Virtualization	vSphere 5.5 Enterprise Edition	vSphere 6.5+ with Operations Management Enterprise Plus Edition* ($1,675 per CPU)	Upgrade to vSphere edition that includes Operations Management. This upgrade ensures cross-cloud compatibility and integrated encryption and security.
Infrastructure Management	vRealize Operations	N/A	This capability is now included in upgraded vSphere with operations management.
Network Virtualization	None	NSX Standard* ($1,995 per CPU)	Enables the cleanest path to Hybrid cloud networking needed for VMware Cloud on AWS.
Cloud Orchestration Manager	None	vCloud Suite Advanced ($3,600 per CPU)	An optional upgrade that enables workload orchestration across private and public clouds.
Server Hardware	Bladed Infrastructure	N/A	Keep existing server hardware
Storage Hardware	External SAN Storage	N/A	Keep existing storage hardware
Networking Hardware	Converged in Blades plus TOR switches	N/A	Keep existing network hardware – NSX interoperates with numerous network HW
**Upgrading VMware vSphere and adding NSX reduces VMware Cloud on AWS costs by 20% for an equivalent number of server CPU sockets. See VMware's Hybrid Loyalty Program for more details.*			

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To estimate the cost of the upgraded on-premises infrastructure, we leveraged a TCO study published in 2016 where we evaluated the costs of 3-tier converged architectures. In that scenario, we used 12 core processors in a blade server infrastructure. Using that hardware configuration, we calculated that it would require 15 CPU sockets to be upgraded to host 180 VMs in a hybrid cloud solution. Because our servers used two-socket machines we rounded up to 16 CPU sockets to be upgraded. The following table then outlines the ongoing cost for three years to host the newly upgraded VMware solution.

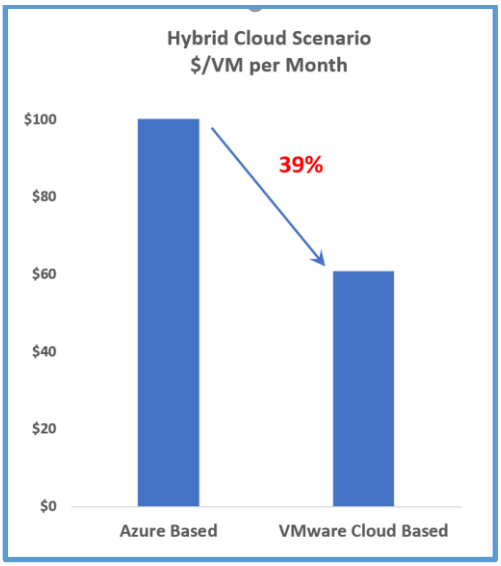
VMware Hybrid Cloud Upgrade Cost Calculation		
Component	**Estimated Cost**	**Description**
VMware Software Upgrade	$116,320	Total upgraded software costs for 16 CPU's. Includes vCloud suite upgrade.
VMware ongoing Software Maintenance	$87,240	Ongoing software maintenance for three years.
Ongoing Hardware Support	$148,338	Ongoing hardware support costs based on a previous study and scaled to 180 VMs for three years.
Total 3-Year Cost	**$351,898**	Total estimated cost for three years
Cost per VM per Month	**$54.31**	Total cost per VM per Month to support 180 VMs for three years.

Comparing VMware Cloud-based to Azure-based Hybrid Cloud Offerings

To fully evaluate the hybrid cloud costs, we combined the pricing models for public cloud and on-premises cloud infrastructure to create a hybrid cloud model. The total solution is now capable of handling up to 360 VMs. Workloads currently deployed in upgraded VMware environments should seamlessly operate in the VMware Cloud on AWS environment. Similarly, if a workload has been developed on or migrated into Azure Stack, we would expect the same workload to operate equally well in Azure public cloud environments. The following tables and graph outline the costs associated with each of the cloud components.

Azure versus VMware Cloud Hybrid Cloud Pricing (3-Year Total Cost)			
Item	**Azure**	**VMware Cloud**	**VMware Cloud Savings**
On-Premise Cloud (180 VMs)	$663,677	$351,898	$311,779 (47%)
Public Cloud (180 VMs)	$635,825	$437,464	$198,361 (31%)
Hybrid Cloud (360 VMs)	$1,299,502	$789,362	$510,140 (39%)

Azure versus VMware Cloud Hybrid Cloud Pricing ($/VM per Month)			
Item	**Azure**	**VMware Cloud**	**VMware Cloud Savings**
On-Premise Cloud (180 VMs)	$102.42	$54.31	$48.11 (47%)
Public Cloud (180 VMs)	$98.12	$67.51	$30.61 (31%)
Hybrid Cloud (360 VMs)	$100.27	$60.91	$39.36 (39%)



In addition to the lower overall cost of the VMware Cloud on AWS hybrid cloud solution, the following key benefits should be considered when evaluating these hybrid cloud approaches.

- **Non-disruptive upgrade to hybrid cloud.** Does it make sense to disrupt on-premises workloads to transition to a hybrid cloud? Introducing Azure Stack may mean refactoring workloads to operate effectively in this new environment. Also, Azure Stack may require new support agreements with new vendors. Neither of these steps is required to upgrade to VMware Cloud on AWS – the upgrade path is simple and non-disruptive.
- **A lower risk on-ramp to public cloud.** For VMware customers that have relied on vSphere technology to host their most business-critical applications, the safest approach to take advantage of the public cloud would be to use the same exact technology there as on-premises. AWS is the market-leading public cloud which enables VMware based workloads to leverage the leading tools from the leading public cloud provider. This approach also allows cloud-native apps that may already exist in AWS to collocate closer to crucial services hosted in a VMware environment.
- **Simplicity and efficiency through transparency.** VMware public cloud pricing strategy is very innovative in the fact that you know exactly what you purchased. The simple, node-based purchasing approach means that, unlike with Azure, you no longer need to worry about VM sizing and the effects on pricing. You can overprovision VMs as needed and let VMware efficiency manage the underlying resources. Overpaying for the idle VMs in a public cloud will be a thing of the past.
- **Maturity level of the solution.** Microsoft Azure Stack is very new technology and has been available for only a limited time. Many of the Azure public cloud features are still not available to Azure Stack customers, though Microsoft has promised they will come in the future. VMware on AWS, while relatively new, is based on proven VMware Cloud Foundation technology that has already been powering on-premises hyper-converged infrastructure for a couple of years, earning it a market share leadership position with the help of many hardware partners.

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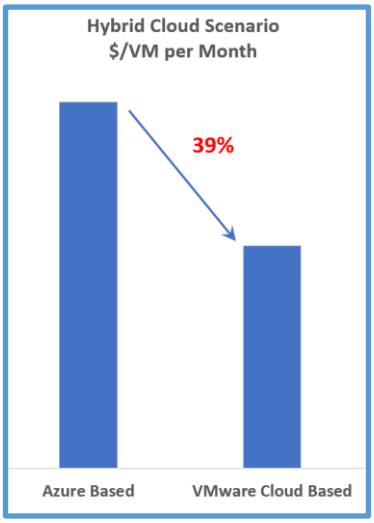
TANEJA GROUP OPINION

It is a fact: public cloud growth continues at an amazingly fast pace. Hybrid cloud adoption is also increasing rapidly, as businesses seek to take advantage of public cloud scalability and agility for those workloads that can benefit.

But up until now, the promise of hybrid clouds has fallen far short of the hype. One big reason for this is that most companies' traditional business-critical apps cannot easily be moved to the public cloud. To move most existing workloads to the cloud, firms have needed to spend large amounts of money to refactor the apps so that they will run on one or more public cloud platforms. This has left many IT organizations in a bind: they face a mandate to move some portion of their business apps to the cloud, but are unable to execute on that mandate without blowing out their budgets or disrupting other important initiatives, such as new application development.

To address this challenge, IT decision makers are now looking to the cloud vendor and provider community for help. Two of the leading candidates, VMware and Microsoft, are taking two very different approaches to the hybrid cloud. Whereas Microsoft tells customers they just need to host a small portion of Azure-compatible infrastructure on-premises to get a hybrid cloud, VMware believes the better, less disruptive approach is to keep your infrastructure the same on-premises and extend it seamlessly to the public cloud through partners such as AWS.

At first glance, you might think the VMware approach would be more expensive, since it is based on the more enterprise-capable virtualization technology. However, to our amazement, we found VMware Cloud on AWS to be refreshingly cost effective. When you throw in the fact that VMware Cloud on AWS provides transparent pricing on the public cloud with dedicated hardware, we believe this solution enables the lowest cost and lowest risk approach for any VMware customer that wants to take advantage of public cloud for existing VMware-based workloads. Companies can invest their IT resources on strategic initiatives such as developing and deploying new business applications, rather than on refactoring or rewriting existing applications that are already working well.



Taneja Group believes it makes tremendous sense to maintain compatibility with existing virtualized infrastructure by going with VMware Cloud on AWS for hybrid cloud needs. The majority of enterprises (65%+) today run VMware virtualization technology, and many of them (68%+) are also looking for a hybrid cloud solution that just flat out works. After our detailed analysis of the true costs of hosting critical workloads in the public cloud, we were surprised to find that VMware Cloud on AWS is a significantly more cost-effective solution than rival public and hybrid cloud offerings. By saving up to **39%** when you build a hybrid cloud based on VMware technology, you finally can "have your cake and eat it too"!

Taneja Group strongly recommends that businesses give VMware Cloud on AWS a try. There is nothing to lose and much to gain.