Enjoy the convenience and flexibility of cloud without sacrificing security or latency by using hybrid on-premises solutions based on Dell servers

Spending on public cloud is exploding for a variety of reasons. Alongside this growing adoption of cloud, however, is another trend: Many businesses who have moved their applications to the public cloud are reconsidering. Seeing their cloud service provider (CSP) bills balloon, they are concluding that the math no longer works in their favor and are undergoing the expensive process of moving their workloads back to the on-premises data center.[1] Other companies—for whom security, data control, and regulatory compliance concerns are paramount—have elected to keep their applications on site. Still other organizations are embracing a hybrid cloud strategy that offers advantages of both public cloud and on-premises private cloud.

In this paper, we draw on our own research and Dell marketing materials to present the solutions that the company offers to organizations choosing the on-premises private cloud and hybrid cloud approaches. We also present the results of hands-on testing we carried out to explore the potential performance advantages of a new Dell on-premises solution compared to a legacy on-prem solution and a public cloud solution on certain workloads.

The on-premises Tanzu™ cluster of Dell PowerEdge™ R7525 rack servers powered by 3rd Gen AMD EPYC™ 7763 processors:

Achieved 63.2% greater total throughput
+
Supported twice as many application interface VMs

vs. on-premises cluster of 6-year-old HPE ProLiant DL380 Gen9 servers on a MongoDB workload

Completed a machine learning training task in 30% less time
+
Delivered 43% more bytes per second

vs. cluster of c5.12x Amazon Web Services™ (AWS) public cloud instances

How hybrid cloud solutions can deliver flexibility

The past several years have seen the increasing adoption of technologies—including virtualization, containerization, and edge computing—that are especially well-suited to cloud solutions.[2] However, public cloud solutions can be expensive—both by requiring companies to develop new cloud-native apps and by incurring large OpEx outlays as usage scales.[3] Hybrid cloud solutions can let organizations choose which applications fare best in on-premises private clouds and which are well-suited to public clouds. And they can allow them to revise these decisions as needs change.

In Table 1, we summarize some of the potential strengths and weaknesses of public, on-premises private, and hybrid cloud solutions, noting ways that Dell solutions mitigate some of the potential disadvantages.

Table 1: Potential benefits and downsides of different approaches to public, on-premises private, and hybrid cloud, with notes on the benefits of certain Dell solutions.

Potential benefits	Potential downsides
Public cloud	
• Flexibility to scale easily to accommodate fluctuating demand and pay for only what you use • Ability to experiment with new technologies as they become available with little risk • Minimal Upfront CapEx • Increased reliability and protection from weather- and utility-related outages due to having resources distributed across multiple geographic regions	• Greater OpEx • Security and lack of data control • Complexity and cost of transforming workloads to make optimal use of public cloud offerings • Large, unexpected expenses • High cost of repatriating data • Single vendor lock-in • Regulatory compliance concerns for some multinational organizations
On-premises private cloud	
• Cost-effectiveness • Security and data control, which are especially important to organizations in finance and other highly regulated industries • Complete control over hardware, software, and data • Avoiding the complex and costly process of transforming workloads to make optimal use of public cloud offerings • Accounting flexibility due to a mix of CapEx and OpEx • Regulatory compliance advantages for some multinational organizations	• Must purchase gear to accommodate anticipated needs, which can lead to overprovisioning *How Dell products can offset this: With Dell APEX, you can scale on demand and "expand your private or hybrid cloud in as few as 5 days."*[4] • Requires CapEx as well as OpEx for maintenance, licensing, power and cooling, etc. *How Dell products can offset this: Dell APEX delivers "a portfolio of as-a-Service offerings how and where customers want it, to ease or eliminate infrastructure management."*[5] • For organizations located in a single geographic region, potential vulnerability to outages due to weather and utility events

Potential benefits	Potential downsides
Hybrid cloud	
• Can offer a best-of-both-worlds solution where companies keep certain workloads on premises and take advantage of public cloud for other workloads • Can provide a cost-effective way of meeting temporary processing capacity needs by shifting workloads to public cloud for short periods	• Complexity of implementation and maintenance *How Dell products can offset this: Dell and VMware® joint integration provides "automated lifecycle management…as a single, complete, turnkey hybrid cloud experience greatly reducing risk and increasing IT operational efficiency."*[6] • The challenge of maintaining visibility over the many components of a hybrid solution *How Dell products can offset this: With VMware Cloud Foundation™ (VCF) on VxRail™, Dell markets a coherent experience, which allows "businesses to maintain flexibility of networking and topology."*[7]

The advantages of using Dell solutions powered by AMD EPYC processors on premises

Using Dell solutions powered by AMD EPYC processors in your on-premises data center offers many of the convenience and flexibility benefits of public cloud—such as containerization and other cloud-like features—while potentially delivering advantages in security.

Payment flexibility

Companies that wish to keep their applications running in on-premises data centers, but are uncertain about their computing need, can take advantage of Dell APEX Flex on Demand, which lets them avoid overpaying for hardware and pay for only the technology they use. According to the Flex on Demand Solution Brief,

> "Today's fast-moving business environment drives the need for immediate technology solution availability. Many customers buy excess capacity upfront and pay for technology they don't use, which consumes additional budget and creates the risk that other critical projects will not be funded. Flex on Demand allows you to pay for technology as you use it, and it provides immediate access to buffer capacity. Your payment adjusts to match your actual usage."[8]

Learn more at https://www.delltechnologies.com/en-us/payment-solutions/flexible-consumption/flex-on-demand.htm.

Security

While the security advantages of private cloud are difficult to prove, compliance benefits are a different story. As a TechTarget article notes, "National boundaries can come into play, with regulatory limitations on where companies store data and operate computing workloads. This complicates the move to purely public cloud for some multinational organizations."[9] For such organizations, the on-premises approach is a way to remain compliant.

Below, we draw on publicly available resources that explain some of the security features available in Dell servers powered by AMD EPYC processors. Note that we did not test these features.

The 2021 Dell white paper "Cyber Resilient Security in Dell EMC PowerEdge Servers"[10] outlines many of the security processes and features present in 14th and 15th generation PowerEdge servers featuring iDRAC9. The paper states:

> "Servers must emphasize security at both the hardware and firmware level by leveraging an immutable Root of Trust. The Root of Trust is used to verify subsequent operations within the server. This verification establishes a chain of trust that extends throughout the server life cycle, from deployment through maintenance to decommissioning.
>
> "The 14th and 15th generations of Dell EMC PowerEdge servers with iDRAC9 deliver this chain of trust. This chain of trust, along with security controls and comprehensive management tools provides robust layers of security across hardware and firmware. The result is a Cyber Resilient Architecture that extends across every aspect of the server. Cyber Resilient Architecture includes the embedded server firmware, the data stored in the system, the operating system, peripheral devices, and the management operations within it. Organizations can build a process to protect their valuable server infrastructure and the data within it. They can detect any anomalies, breaches, unauthorized operations, and recover from unintended or malicious events."[11]

Learn more at https://downloads.dell.com/manuals/common/dell-emc-poweredge-cyber-resilient-security.pdf.

AMD has also incorporated many security features in their EPYC line of processors. Their "Confidential computing solution brief"[12] states the following:

> "Confidential computing helps keep data private while it's in use. In the past, data remained undefended while it was being processed virtually or in the cloud. Confidential computing on AMD EPYC™ processors can be enabled using built-in security features like Secure Encrypted Virtualization (SEV), which helps protect data in use.
>
> • SEV helps ensure data privacy from bare metal to the cloud. It encrypts VMs with a unique encryption key known only to the processor.
>
> • SEV-Encrypted State (SEV-ES) helps prevent the hypervisor from seeing data actively being used by a VM.
>
> • SEV-Secure Nested Paging (SEV-SNP) adds strong memory integrity protection capabilities to help prevent attack by a malicious hypervisor."[13]

Learn more at https://www.amd.com/en/processors/epyc-confidential-computing-cloud.

Dell solutions for hybrid cloud and on-premises private cloud

Dell offers a range of solutions for companies seeking on-premises private cloud and hybrid cloud solutions. In this section, we first look at three offers under the APEX portfolio: APEX Cloud Services with VMware Cloud, APEX Private Cloud, and APEX Hybrid Cloud—all built on Dell hyperconverged infrastructure (HCI) and sold as subscriptions and managed as infrastructure-as-a-service through the APEX Console. Next, we look at the Dell HCI solution, VMware Cloud Foundation on VxRail. Finally, we consider VMware vSphere® with Tanzu on Dell PowerEdge servers, the solution on which we conducted our performance testing.

Dell APEX portfolio

A new step for Dell, "APEX is a breakthrough portfolio of as-a-Service offerings that simplify digital transformation while increasing IT agility and control."[14]

Through the APEX Console, users can discover, subscribe to, deploy, monitor, optimize, and grow IT services—all in a single web interface. They could also use the APEX Console to build a cloud to suit their unique needs and deploy it in as few as 14 days, according to Dell.[15]

In addition, companies can take advantage of OpEx: APEX offers predictable monthly subscription pricing, so you can align cloud costs to your business growth.[16]

APEX Cloud Services with VMware Cloud on Dell

APEX Cloud Services with VMware Cloud is an on-premises cloud infrastructure-as-a-service offering. Enabling companies to focus on innovation, "the infrastructure is…managed by Dell so you can focus on driving business growth and not have to worry about on-going activities such as security and lifecycle management." According to Dell, the offer was "designed for both virtualized and containerized VMware workloads, and combines the simple operations of public cloud and the control, security, and performance of private cloud." APEX Cloud Services with VMware Cloud is available through 1- or 3-year subscription terms.

APEX Cloud Services with VMware Cloud on Dell, an on-premises cloud infrastructure-as-a-service offering, provides the highest level of service to companies seeking hybrid cloud solutions. According to Dell, companies can "Combine the simple operations of public cloud and the control, security, and performance of private cloud with APEX Cloud Services with VMware Cloud. Designed for both virtualized and containerized VMware workloads, the infrastructure is owned and managed by Dell Technologies so you can focus on driving innovation and not have to worry about lifecycle management of firmware and software updates, patching, upgrades, and remediation."[17] APEX offers the OpEx advantages that many companies seek: "APEX Cloud Services with VMware Cloud offers predictable monthly pricing available through 1- or 3-year subscription terms paid monthly, so you can align cloud costs to your business growth."[18]

APEX Private Cloud and APEX Hybrid Cloud

APEX Private Cloud and APEX Hybrid Cloud are on-premises cloud infrastructure solutions. According to Dell, "the customer manages and monitors the infrastructure for the highest level of control. Both solutions are designed for virtualized and containerized VMware workloads, and offer a cost-effective path to modernizing your application portfolio." Both solutions are available through 1- or 3-year subscription terms.

In the APEX solution brief, Dell calls APEX the "fastest private and hybrid cloud deployment," with which you could also "expand your private or hybrid cloud in as few as 5 days."[19] According to Dell, APEX Private Cloud includes virtualized compute and storage infrastructure with VMware vSphere Enterprise Plus and VMware vSAN™ Enterprise. This private cloud offering is optimized for edge workloads, such as a manufacturing line.[20]

VMware Cloud Foundation on VxRail

According to Dell, VCF on VxRail "delivers a simple and direct path to the hybrid cloud and Kubernetes at cloud scale with one, complete, automated platform."[21]

The solution offers full stack integration "with both the HCI infrastructure layer and VMware cloud software stack," delivery flexibility, available single-vendor support, and unique integration capabilities with VCF. In addition, according to Dell, "Automated lifecycle management is provided as a single, complete, turnkey hybrid cloud experience greatly reducing risk and increasing IT operational efficiency."[22]

With VCF on VxRail, Dell markets a coherent experience, with "a consistent infrastructure and consistent operations with edge, private, and native public cloud workload deployment options for a true hybrid cloud solution, while allowing businesses to maintain flexibility of networking and topology."[23] VCF on VxRail users also get a consistent interface to "manage their full stack and leverage native VMware management tools to perform both Cloud Foundation management as well as VxRail HCI infrastructure management."[24]

VMware vSphere with Tanzu on Dell PowerEdge servers

Dell and VMware have partnered to offer VMware vSphere with Tanzu on Dell PowerEdge servers. According to Dell, this solution offers several advantages:

- PowerEdge servers preinstalled and pre-activated with VMware vSphere let you "speed your path to containerization."[25]
- The fact that Dell hardware is "pre-tested, pre-validated and optimized to work with VMware technology" can reduce risk.
- PowerEdge Scalable Business Architecture "supports maximum performance across the widest range of applications."
- Integrated support means you can make a single call for both hardware and software issues.

Many Dell servers are available with AMD processors

For those selecting hardware for cloud solutions, the models powered by AMD EPYC processors offer many features. According to AMD, 3rd Gen EPYC processors offer up to 64 cores, 3,200MHz memory bandwidth, 7nm x86 CPU technology, 256MB total L3 cache, and security features such as Secure Encrypted Virtualization (SEV).[26]

Principled Technologies has tested several Dell servers powered by AMD EPYC processors. Learn about them in the following reports:

Upgrade to Dell EMC PowerEdge R6515 servers and gain better OLTP and VDI performance

Prepare images in Kubernetes for machine learning faster with a Dell EMC cluster powered by AMD EPYC 7543 processors

Support more VDI users with a Dell EMC PowerEdge R7515 server powered by an AMD EPYC 75F3 processor

Enjoy better data analytics performance by upgrading to Dell EMC PowerEdge R7525 servers and Dell EMC PowerStore storage

The performance and latency wins companies can realize by modernizing their infrastructure and applications with Dell PowerEdge R7525 servers powered by 3rd Gen AMD EPYC 7763 processors

Cognizant of the current cloud landscape, and the questions with which many organizations are grappling regarding where they should run their applications, Dell Technologies commissioned Principled Technologies to conduct hands-on performance testing of the latest Dell PowerEdge R7525 rack servers powered by 3rd Gen AMD EPYC 7763 processors against both legacy servers and public cloud instances using the vSphere with Tanzu infrastructure model we discussed earlier.

We examined two on-premises clusters and one public cloud environment:

- A VMware vSphere 7 Update 2 (7U2) with VMware Tanzu on-prem cluster comprising Dell PowerEdge R7525 rack servers powered by 3rd Gen AMD EPYC 7763 processors.
- A legacy VMware vSAN™ management cluster comprising six-year old HPE ProLiant DL380 Gen9 servers
- Amazon Elastic Kubernetes Service (EKS) with c5.12x instances

Phase 1: Comparing the HiBench machine learning performance of the on-premises cluster of Dell PowerEdge R7525 rack servers powered by 3rd Gen AMD EPYC 7763 processors and c5.12x AWS public cloud instances

More and more companies are adopting machine learning workloads to solve a variety of business problems. In this phase of testing, we set out to quantify the performance gains a company running such workloads could achieve by running them on premises using a cluster of Dell PowerEdge R7525 servers powered by 3rd Gen AMD EPYC 7763 processors vs. running them in the cloud using c5.12x AWS instances.

As Figure 1 shows, the on-premises Tanzu cluster of Dell PowerEdge R7525 rack servers powered by 3rd Gen AMD EPYC 7763 processors completed the training task in 8 minutes less than the cluster of c5.12x AWS public cloud instances, a savings of 30 percent.

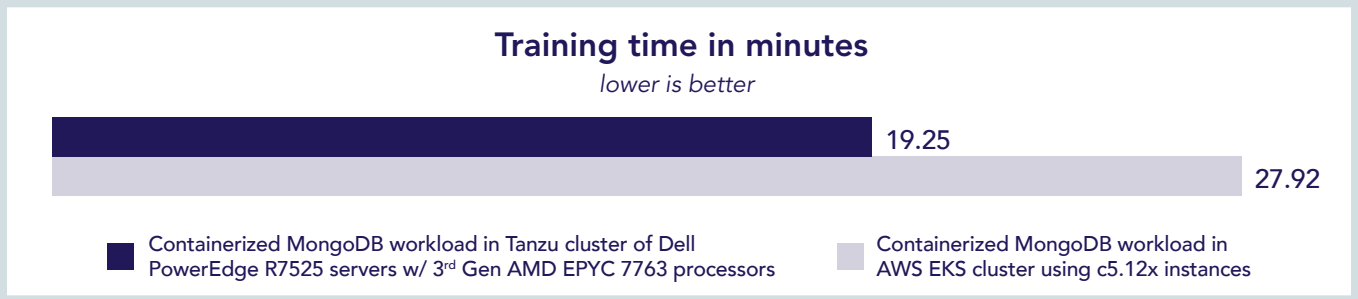

Figure 1: Training time in minutes for the Tanzu cluster of Dell PowerEdge R7525 servers and a cluster of Amazon EKS instances. Lower is better. Source: Principled Technologies.

Phase 2: Comparing the MongoDB performance of the two on-premises clusters

Many companies who rely on distributed databases such as MongoDB to carry out business-critical workloads run these applications on older servers in on-premises data centers. When the legacy environment functions adequately, the benefits of upgrading to new, modern servers are not always obvious to IT decision-makers.

In this phase of testing, we set out to quantify the performance gains a company running distributed MongoDB database workloads on 6-year-old HPE ProLiant DL380 Gen9 servers would likely enjoy by replacing their older infrastructure with Dell PowerEdge R7525 servers powered by 3rd Gen AMD EPYC 7763 processors. We measured the performance of each on-premises cluster, using a virtualized MongoDB database on the legacy cluster and containerized MongoDB in the Tanzu environment. We ran these workloads three times on each cluster and identified the median OPS result of the three runs.

Figure 2 shows the total number of MongoDB operations per second the two test clusters achieved. The Containerized MongoDB in the Tanzu cluster comprising Dell PowerEdge R7525 rack servers powered by 3rd Gen AMD EPYC 7763 processors outperformed the legacy cluster running virtualized MongoDB by 63.2 percent.

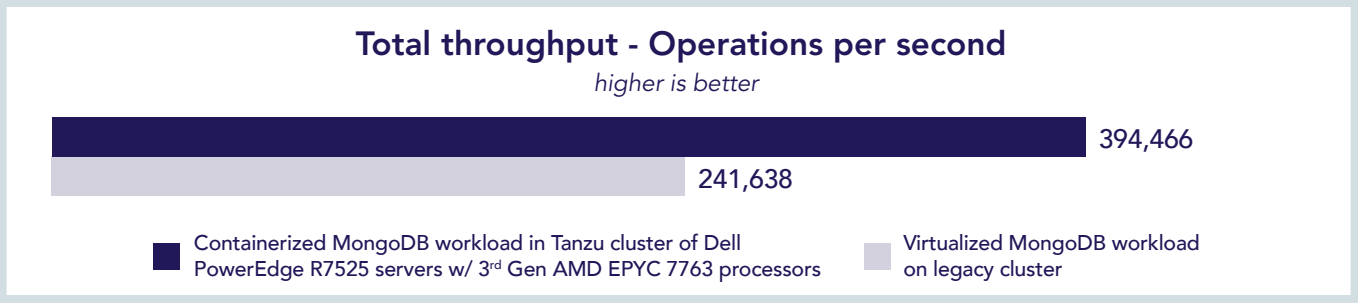

Figure 2: Total MongoDB performance of the two test clusters in terms of throughput (operations per second). Higher is better. Source: Principled Technologies.

Figure 3 shows the number of MongoDB application interface VMs (virtual machines) the two clusters supported, which we determined by adding application interface VMs until the servers in each cluster reached 90 percent CPU utilization. The Tanzu cluster comprising Dell PowerEdge R7525 rack servers powered by 3rd Gen AMD EPYC 7763 processors supported twice as many application interface VMs as the legacy cluster did.

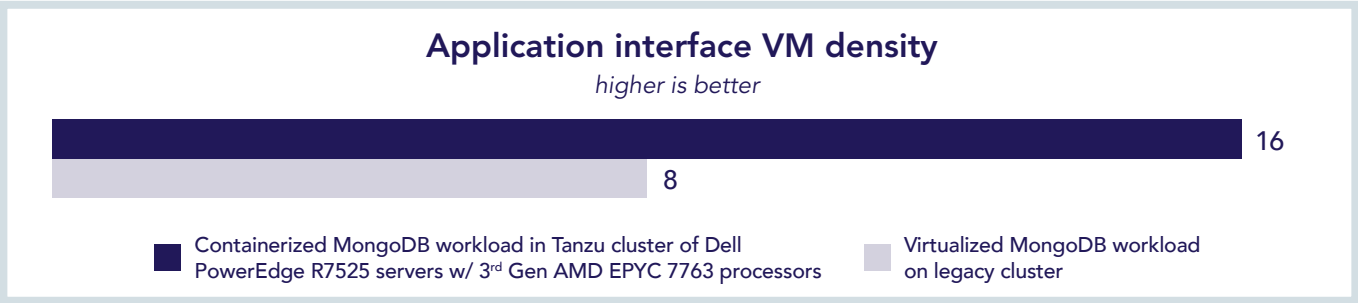

Figure 3: Application interface VM density of the two clusters. Higher is better. Source: Principled Technologies.

For more details on our test process and configurations, see the science behind the report.

Phase 3: Comparing the MongoDB performance of the on-premises cluster of Dell PowerEdge R7525 rack servers powered by 3rd Gen AMD EPYC 7763 processors and Amazon EKS with c5.12x instances

As we noted earlier, many companies in finance and other highly regulated industries, as well as multinational organizations subject to compliance concerns, choose to run their workloads on site. We compared the MongoDB performance such companies could achieve using an on-premises cluster of Dell PowerEdge R7525 rack servers powered by 3rd Gen AMD EPYC 7763 processors to the performance on Amazon EKS with c5.12x instances. As Figure 4 shows, the on-premises cluster achieved throughput that was within 10 percent of that achieved by the Amazon EKS cluster.

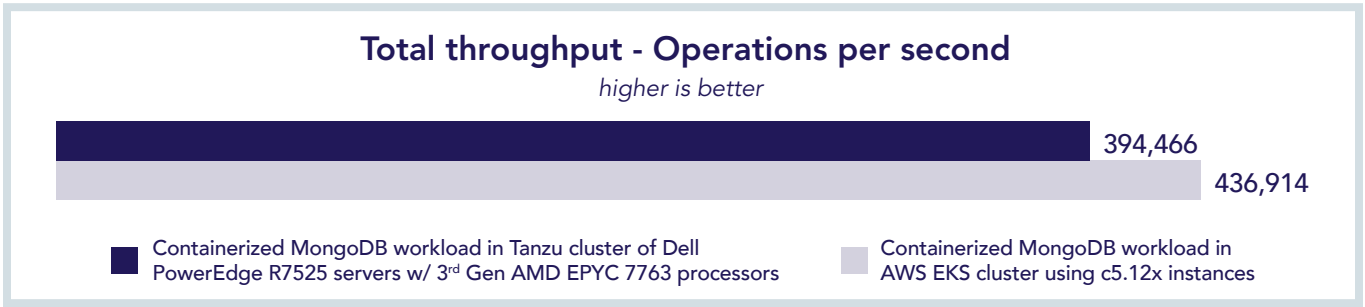

Figure 4: Total MongoDB performance of the Tanzu cluster of Dell PowerEdge R7525 servers and a cluster of Amazon EKS instances in terms of throughput (operations per second). Higher is better.

As Figure 5 shows, the on-premises Tanzu cluster of Dell PowerEdge R7525 rack servers powered by 3rd Gen AMD EPYC 7763 processors achieved a bytes-per-second rate that was 43 percent greater than that of the cluster of c5.12x AWS public cloud instances.

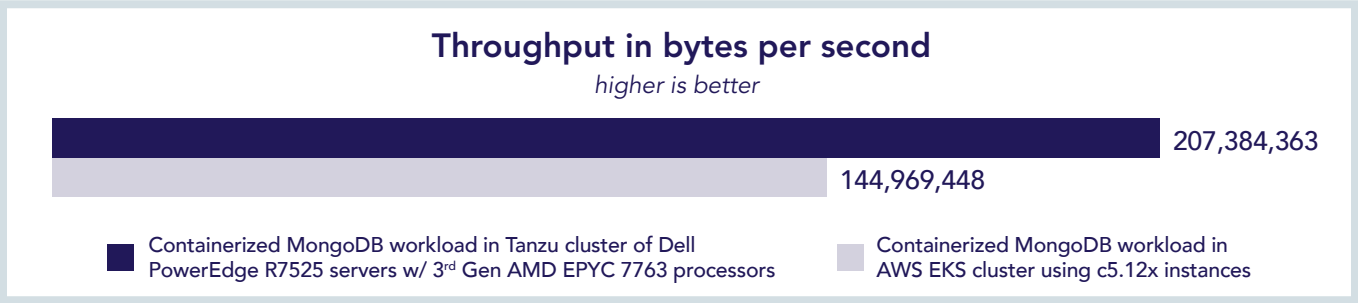

Figure 5: Total HiBench performance of the Tanzu cluster of Dell PowerEdge R7525 servers and a cluster of Amazon EKS instances in terms of throughput (bytes per second). Higher is better. Source: Principled Technologies.

About MongoDB

MongoDB is a document-based database that uses a distributed approach to storing data. According to MongoDB, the database "stores data in flexible, JSON-like documents, meaning fields can vary from document to document and data structure can be changed over time."[27]

Learn more at https://www.mongodb.com/what-is-mongodb.

Using VMware NSX Advanced Load Balancer to burst work from your on-premises cluster to the cloud

A hybrid cloud approach can give companies the flexibility to keep certain workloads on premises, while utilizing public cloud for other workloads, and can also offer "bursting capacity." In exchange for these advantages, hybrid cloud can be complex to implement, maintain, and secure:

> "A Forrester survey of 1,000 chief information security officers (CISOs) revealed that managing the growing complexity of security is their number one concern. Because of the complicated nature of hybrid cloud, building effective, ongoing security is a difficult process. Tackling this task should be something you are prepared for before loading sensitive information into your hybrid cloud."[28]

Maintaining visibility over the many components of a hybrid solution can be challenging:

> "When workloads reside in a hybrid cloud environment, it's difficult or nearly impossible to get a singular view of everything you're managing, monitoring and securing. This is especially true if you're using different providers for multiple clouds."[29]

In response to these challenges, VMware has developed VMware NSX® Advanced Load Balancer, which supports "bursting-to-cloud" scenarios, among other capabilities. To put this aspect of NSX Advanced Load Balancer to the test, we created a hybrid cloud environment comprising an on-premises cluster and an AWS cluster. (For detailed information on these clusters, see the science behind the report.) In each environment, we deployed the controller for the load balancer, and created a virtual service for our web application. Additionally, we created a DNS virtual service in our on-premises environment as a prerequisite for using the built-in Global Service Load Balancer (GSLB) to balance our workload across our hybrid cloud. We then used GSLB to create an active/passive site configuration with our on-premises site being active and our AWS site being passive. With our sites configured, we created a GSLB service for our web application with a single domain that we could target to run our workload. We then simulated a bursting-to-cloud scenario. We ran a simple web server workload targeting a low, arbitrary threshold, so that once the on-premises workload met the threshold, NSX Advanced Load Balancer would balance the workload across the on-premises and public cloud environments and the application would continue to function seamlessly.

This scenario worked as we had intended.

Below, we show screenshots of the Virtual Service analytics screen in the NSX controller user interface (UI). Figure 6 shows traffic flowing to the on-premises web virtual service at the time the load reached the threshold, and Figure 7 shows the traffic starting to flow to the AWS virtual service at that same time.

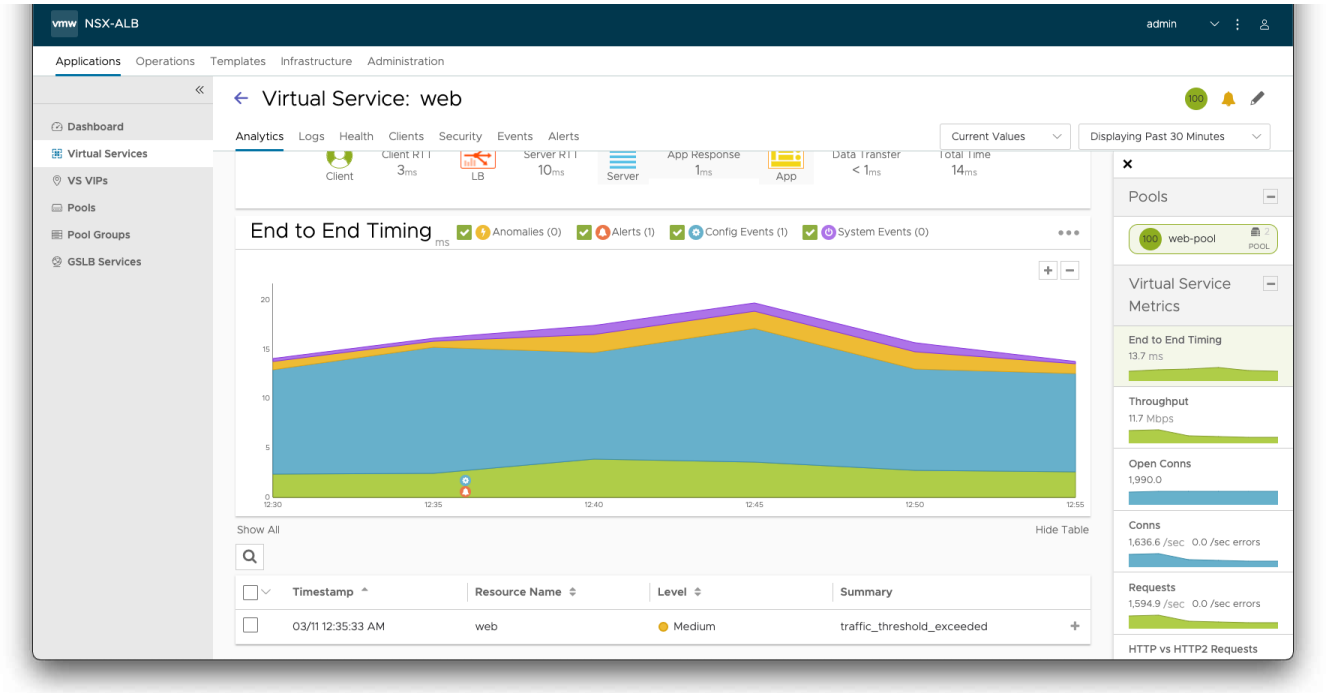

Figure 6: The Virtual Service analytics screen in the NSX controller UI when the load reached the threshold. Source: Principled Technologies.

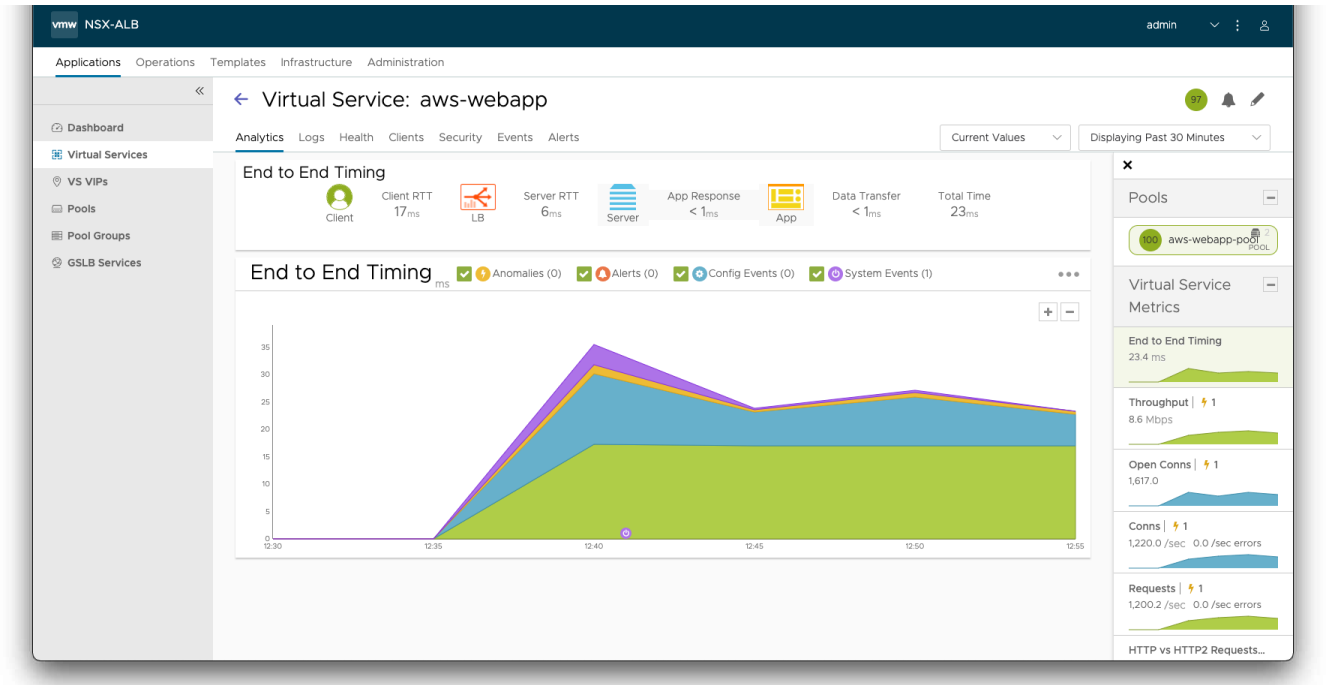

Figure 7: The Virtual Service analytics screen in the NSX controller UI showing the traffic starting to flow to the AWS virtual service. Source: Principled Technologies.

About VMware NSX Advanced Load Balancer

VMware NSX Advanced Load Balancer "uses a software-defined architecture that separates the central control plane (Avi Controller) from the distributed data plane (Avi Service Engines). NSX Advanced Load Balancer is 100% REST API based, making it fully automatable and seamless with the CI/CD pipeline for application delivery."[30]

Learn more at https://info.avinetworks.com/hubfs/Avi_Website_Resource_Center/avi-vantage-platform-data-sheet.pdf.

Conclusion

Public cloud solutions and on-premises private cloud solutions each offer distinct attractions, and hybrid cloud solutions can deliver flexibility and a best-of-both-worlds approach. As you consider your industry and the nature of your data and workloads to determine the most appropriate approach for your unique situation, keep in mind the way our hands-on performance testing has demonstrated the value of modernizing your infrastructure and applications using Dell PowerEdge R7525 servers powered by 3rd Gen AMD EPYC 7763 processors.

---

1. "The Cost of Cloud, a Trillion Dollar Paradox," accessed June 22, 2021, https://a16z.com/2021/05/27/cost-of-cloud-paradox-market-cap-cloud-lifecycle-scale-growth-repatriation-optimization/.
2. "Gartner Forecasts Worldwide Public Cloud End-User Spending to Grow 23% in 2021," accessed October 26, 2021, https://www.gartner.com/en/newsroom/press-releases/2021-04-21-gartner-forecasts-worldwide-public-cloud-end-user-spending-to-grow-23-percent-in-2021.
3. "The Cost of Cloud, a Trillion Dollar Paradox."
4. "APEX solution brief," accessed February 8, 2022, https://www.delltechnologies.com/asset/es-pr/solutions/apex/briefs-summaries/h18181-apex-cloud-services-solution-brief.pdf.
5. "Realize the Value of APEX Data Storage Services," access February 8, 2022, https://www.dell.com/en-us/blog/realize-the-value-of-apex-data-storage-services/.
6. "VMware Cloud Foundation on Dell EMC VxRail: Accelerating the Journey to VMware Software-Defined Data Center and Hybrid Cloud," accessed January 10, 2022, https://www.delltechnologies.com/asset/en-id/products/converged-infrastructure/industry-market/h17854-vmware-cloud-foundation-on-dell-emc-vxrail-wp.pdf.
7. "VMware Cloud Foundation on Dell EMC VxRail datasheet," accessed January 12, 2022, https://www.delltechnologies.com/asset/en-us/products/dell-technologies-cloud/technical-support/h17766-ds-vmware-cloud-foundation-on-vxrail.pdf.
8. "APEX Flex on Demand," accessed October 27, 2021, https://www.delltechnologies.com/en-us/payment-solutions/flexible-consumption/flex-on-demand.htm.
9. "Understand the 5 main benefits of hybrid cloud for businesses," accessed March 24, 2022, https://searchcloudcomputing.techtarget.com/tip/Top-5-benefits-of-hybrid-cloud.
10. "Cyber Resilient Security in Dell EMC PowerEdge Servers," accessed October 26, 2021, https://downloads.dell.com/manuals/common/dell-emc-poweredge-cyber-resilient-security.pdf.

11. "Cyber Resilient Security in Dell EMC PowerEdge Servers."
12. "Confidential computing solution brief," accessed October 27, 2021, https://www.amd.com/en/processors/epyc-confidential-computing-cloud.
13. "Confidential computing solution brief."
14. "Introducing APEX: As-a-Service Wherever You Need It," accessed March 16, 2022, https://www.dell.com/en-us/blog/introducing-apex-as-a-service-wherever-you-need-it/.
15. "APEX solution brief."
16. "APEX Multi-Cloud Services with VMware Cloud," accessed March 24, 2022, https://www.delltechnologies.com/asset/en-my/solutions/apex/briefs-summaries/h18934-apex-cloud-services-with-vmware-cloud-solution-brief.pdf
17. "APEX solution overview," accessed February 15, 2022, https://www.dell.com/en-us/dt/apex/cloud-services/vmware-cloud.htm#overview&pdf-overlay=//www.delltechnologies.com/asset/en-us/solutions/apex/briefs-summaries/h18934-apex-cloud-services-with-vmware-cloud-solution-brief.pdf.
18. "APEX solution overview."
19. "APEX solution brief."
20. "APEX solution brief."
21. "VMware Cloud Foundation on Dell EMC VxRail: Accelerating the Journey to VMware Software-Defined Data Center and Hybrid Cloud."
22. "VMware Cloud Foundation on Dell EMC VxRail: Accelerating the Journey to VMware Software-Defined Data Center and Hybrid Cloud."
23. "VMware Cloud Foundation on VxRail datasheet."
24. "VMware Cloud Foundation on VxRail datasheet."
25. "Build a Future-Ready Infrastructure," accessed February 16, 2022, https://www.delltechnologies.com/asset/da-dk/products/servers/briefs-summaries/pe-vsphere-tanzu-infographic.pdf.
26. "AMD EPYC™ 7003 Series Processors," accessed July 29, 2021, https://www.amd.com/en/processors/epyc-7003-series.
27. "What is MongoDB?" accessed October 26, 2021, https://www.mongodb.com/what-is-mongodb.
28. "What Is Hybrid Cloud? Advantages and Disadvantages," accessed June 23, 2021, https://blog.gigamon.com/2019/12/05/what-is-hybrid-cloud-advantages-and-disadvantages/.
29. "The Pros and Cons of Adopting a Hybrid Cloud Architecture," accessed July 6, 2021, https://www.linkedin.com/pulse/pros-cons-adopting-hybrid-cloud-architecture-vince-arneja.
30. "VMware NSX Advanced Load Balancer (by Avi Networks," accessed November 2, 2021, https://info.avinetworks.com/hubfs/Avi_Website_Resource_Center/avi-vantage-platform-data-sheet.pdf.

Read the science behind this report at https://facts.pt/8aZCWis ▶

Principled Technologies®

Facts matter.®

Principled Technologies is a registered trademark of Principled Technologies, Inc.
All other product names are the trademarks of their respective owners.
For additional information, review the science behind this report.

This project was commissioned by Dell Technologies.