PROWESS

Cost Considerations for Placing Enterprise Workloads in Public Clouds

Analysis conducted by Prowess Consulting indicates that a multicloud solution—a combination of on-premises and off-premises locations—could save money over the public cloud for a variety of workloads.

Executive Summary

The embrace of the public cloud by organizations of all sizes over the past decade has been extraordinary. Between 2010 and 2020, the global cloud computing and hosting market size increased by 535%; in 2010, the global cloud computing and hosting market was only worth $24.6 billion, a number that grew to a whopping $156.4 billion by 2020.[1] In 2021, public cloud services grew by 18.4% year-over-year.[1]

The monetary cost of the profound adoption of the public cloud for businesses can be equally staggering. End-user spending for public-cloud services worldwide is projected to approach $600 billion in 2023.[2] And by 2026, one estimate projects that 45% of all enterprise IT budgets will be spent on the cloud.[1]

The pros and cons of public clouds extend beyond mere money. Typical use of the public cloud by organizations can pose challenges. The fact that different departments and even teams within organizations can (and do) make their own purchasing decisions for cloud services often leads to the spread of shadow IT, or the use of cloud-based software and services without the knowledge or central management of the IT department, which can pose a security risk. Moreover, the public cloud can create skills gaps for businesses as those called on to use cloud-based services might not know how to do so (or how to do so securely). The mobility and geographical reach of the public cloud can also threaten organizations' adherence to governance, regulatory, and compliance (GRC) requirements and data-sovereignty mandates.

Even if departmental use of the public cloud goes smoothly, it can still create stiff challenges for organizations' IT departments. Getting a company's app to work in a variety of environments can create technical interoperability issues for IT personnel and developers, as they must reconfigure and refactor apps (possibly multiple times). Workloads hosted on the public cloud can also lack access to the newest security features provided by latest-generation processors and hardware, which can compound all of the ramifications for performance and efficiency that older processors and hardware can bring. On top of all of that, disparate operating environments can also lead to security-configuration mismatches across apps and clouds, multiplying the headaches for IT.

In order to assess the price differential of a multicloud (including private cloud) environment versus the public cloud, Prowess Consulting investigated the costs of running various workloads on public clouds versus multicloud solutions. We examined a matchup of Amazon Web Services® (AWS®) and Dell™ APEX solutions as representative examples of these two as-a-service options for running a variety of enterprise workloads. We discovered that multicloud deployments with Dell APEX on average cost 28–58% less than public cloud–native options run on AWS, including accounting for factors such as managed-service and co-location fees.

Table 1 | Percent savings of multicloud deployments with Dell™ APEX solutions versus public cloud options by workload[3]

Virtual machines (VMs)	**41% less**
Containers	**40% less**
High-throughput storage	**28% less**
Regular-throughput storage	**58% less**
Artificial intelligence (AI)/machine learning (ML)	**46% less**

Multicloud deployments with Dell™ APEX solutions cost up to

58%

less than public cloud options.[3]

Study Overview

In order to assess the price differential of multicloud (including private cloud) versus public cloud–native solutions, we investigated the unit cost of running different workloads on public clouds through hyperscalers and with multicloud solutions.

Deployments

For the public cloud, we examined the representative cost of running several different workloads in Amazon® Elastic Compute Cloud (Amazon EC2®). We chose AWS because it is one of the most widely used public cloud services.[4] Moreover, by examining infrastructure-as-a-service (IaaS) instances, we can create a good baseline for comparison with multicloud alternatives.

For multicloud solutions, we examined Dell APEX. The Dell APEX portfolio of multicloud solutions offers as-a-service pricing, which makes comparison with deployments on Amazon EC2 IaaS instances practical.

To make the comparison, we evaluated both exemplars using the following workload scenarios:

- Virtual machines (VMs)
- Containers
- High-throughput storage
- Regular-throughput storage
- Artificial intelligence (AI)/machine learning (ML)

Study Details

For each of the workloads examined, we analyzed both cost and non-financial considerations. For each workload, we briefly describe the assumptions we made in the analysis; you can find more details about the underlying configurations for the various workloads in the appendices.

Virtual Machines (VMs)

The global virtualization market currently stands at $40 billion and is estimated to swell to $300 billion by 2033.[5] And as impressive as these figures are, they do not include all of the de facto virtualization that organizations employ through public cloud–based instances. However, the scale of money spent by organizations on virtualization makes confronting these costs all the more important when IT budgets are constrained. Put another way, because virtualization is vital to so many central workloads for businesses, it is a use case in which it might make sense to move workloads to a multicloud deployment rather than leaving them in a single public cloud.

To evaluate the matchup between the public cloud and multicloud solutions that include on-premises infrastructure, we used the case of a US-based bank employing a fleet of VMs/cloud instances across two separate US locations to manage customer data, mobile banking back-end systems, and digital customer services. Both the Dell APEX and the AWS configurations supported a total of 1,200 VMs, with the Dell APEX solution running on 20 Dell™ VxRail™ systems running VMware Cloud Foundation™. Moreover, the Dell APEX solution included managed services and co-location in order to be hands-off in the same way that AWS is. Our analysis indicates that VMs **cost up to 41% less on Dell APEX Flex on Demand than on AWS**. Table 2 and Figure 1 show the results of the comparison. (For configuration details for this workload comparison, see Appendix A.)

Table 2 | Breakdown of three-year costs for 1,200 VMs running on Amazon Web Services® (AWS®) and Dell™ APEX, respectively

Category	Amazon Web Services® (AWS®) Cost[6]	Dell™ APEX Cost[7]
Compute, storage, snapshots, and virtualization	$278,226	$109,160
Connectivity and data egress	$10,667	Not applicable (N/A)
Co-location services or enterprise support plan	$26,624	$32,740
Managed services	$19,493	$54,580
Monthly subtotal	**$335,010**	**$196,480**
Three-year total	**$12,060,360**	**$7,073,280**

Note: No discounts (such as public-cloud committed-spend discounts) were applied in this analysis.

Three-Year Total Cost for 1,200 VMs
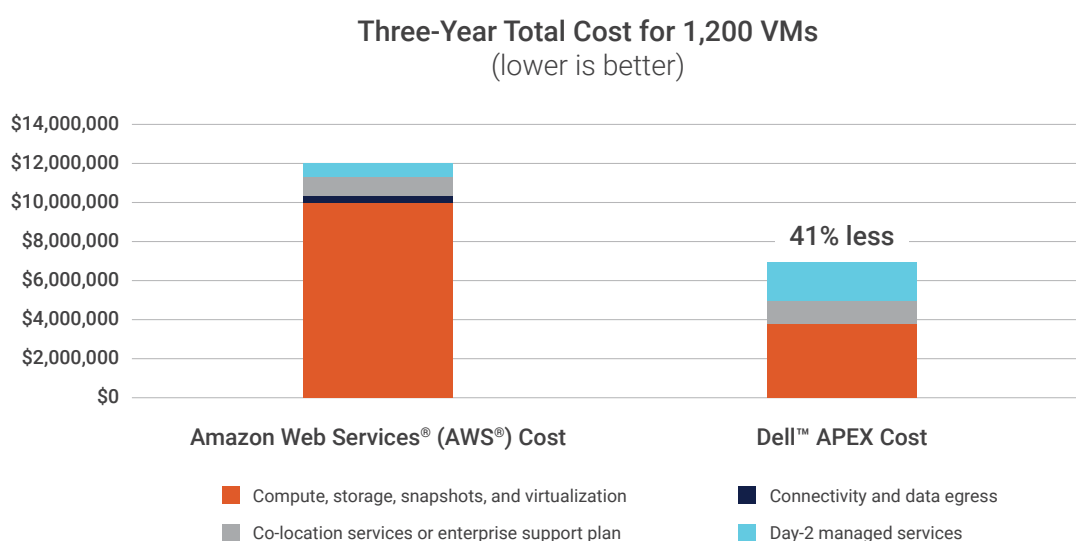(lower is better)

Figure 1 | Comparison of three-year costs for 1,200 VMs running on Amazon Web Services® (AWS®) and Dell™ APEX

VMs: Analysis

A major factor to consider when running workloads in the public cloud is data sovereignty. Customer or business data being used in VMs might be restricted from leaving specific jurisdictions. Multicloud VM deployments that extend on-premises to a data center or co-location facility residing in particular jurisdictions can help address such challenges.

Regional data-transfer fees must also factor into considerations for running workloads in the public cloud. Table 2 accounts for data-egress charges only; moving data between public-cloud geographical regions and even availability zones for things like disaster recovery (DR) and high availability (HA) can also incur additional charges, which can add up quickly and significantly.

VM co-tenancy can be another issue to consider when running VMs in the public cloud. While proper security can address the possibilities of data being exposed to other public-cloud instances running on the same physical host in a public-cloud data center, "noisy neighbors"—cloud instances on the same physical host, network, or storage pool that monopolize disproportionate network input/output (I/O) resources—can increase instance latency and degrade connectivity and cloud-application performance. Having dedicated VM hosts on-premises or in a co-location facility can help address this by increasing your IT organization's control of load balancing and VM placement.

Containers

The container-software market in 2023 is estimated to be worth about $2.60 billion.[8] While not as large as the market for virtualization, containers are a newer technology, and the market for them can be expected to grow exponentially for some time to come.

In many cases, the cloud has traditionally represented the most natural home for containers. Containerization is a vital component of modern, cloud-native app architecture, and it underpins everything from DevOps continuous integration/continuous delivery (CI/CD) pipelines to serverless applications. However, new hybrid infrastructure solutions enable containers to span clouds and seamlessly extend on-premises. The rise of hybrid-infrastructure alternatives to strictly public-cloud deployments for a variety of use cases represents another workload that might profitably move from the public cloud to the multicloud.

In order to compare deploying containers to the public cloud and deploying them to the hybrid multicloud, Prowess Consulting evaluated a scenario of an e-commerce platform that starts with 12,000 containers (to host microservices to manage inventory, payments, user profiles, product recommendations, and so on) and that expands its footprint to 40,800 containers over a three-year period to keep up with its expanding business. We compared a Dell APEX Data Center Utility solution with Dell PowerFlex™ servers using the Red Hat® Enterprise Linux® operating system (OS) and Rancher for Kubernetes® to Amazon EC2 C6id.large instances using Amazon® Elastic Kubernetes Service (EKS) and Amazon® Elastic Container Registry (ECR). Our analysis indicates that containers **cost up to 40% less on Dell APEX than on AWS**. Table 3 and Figure 2 show the results of the comparison. (For configuration details for this workload comparison, see Appendix B.)

Table 3 | Breakdown of annual and total costs for a deployment scaling up to 40,800 containers over three years on Amazon Web Services® (AWS®) and Dell™ APEX, respectively

	Containers	Amazon Web Services® (AWS®) Cost[6]	Dell™ APEX Cost[7]
Year 1	12,000	$8,523,950.52	$4,900,000.00
Year 2	26,400	$16,712,942.52	$9,800,000.00
Year 3	40,800	$24,901,934.52	$14,700,000.00
Co-location services (three-year total)	N/A	N/A	$207,014.40
Three-year total		**$50,138,827.56**	**$29,607,014.40**

Note: No discounts (such as public-cloud committed-spend discounts) were applied in this analysis.

Three-Year Total Cost for 40,800 Containers
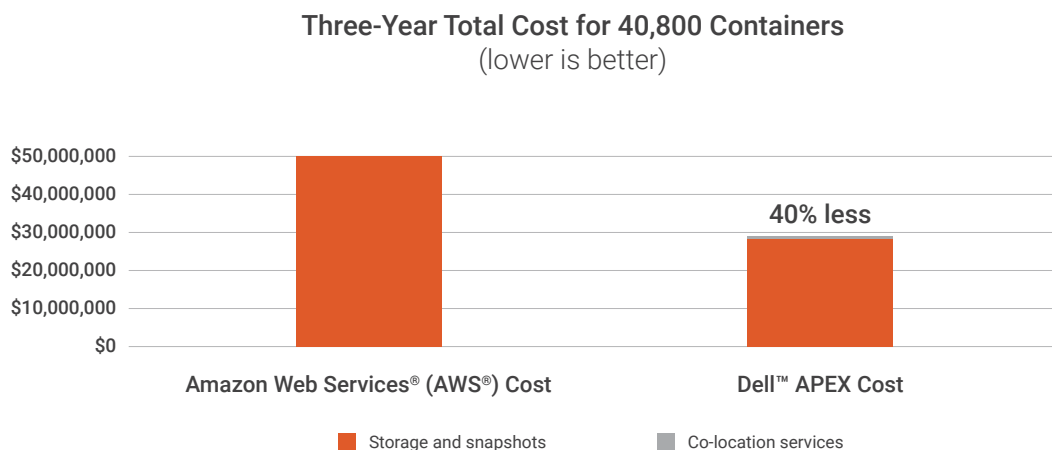(lower is better)

Figure 2 | Comparison of total three-year costs for a deployment scaling up to 40,800 containers on Amazon Web Services® (AWS®) and Dell™ APEX

Containers: Analysis

Other factors to consider when running containers in the public cloud include tradeoffs between supporting a wide variety of cloud-instance architectures for cloud-native apps and refactoring tools for DevOps to support them. While your DevOps teams might see this as an ordinary part of their CI/CD pipeline, it still represents a draw on engineering and development resources that could be applied to other priorities. Fundamentally, trying to support too many types of cloud-instance architectures can impact the productivity of the team.

The cost of scalability for containers is another consideration when weighing running containers in the public cloud versus in a hybrid multicloud deployment. The infrastructure to host containers in the cloud can be much more costly than in co-location or on-premises implementations. It thus makes more sense to only run containers in the public cloud when access to specific cloud-based services are needed or geographical regions are not within reach otherwise.

High-Throughput Storage

Performant storage remains the bedrock of business-critical applications for organizations of all sizes, but especially for enterprises, which often have larger applications to support. Consider, for example, a large financial-services firm, with an ever-growing need for performant storage, increasing to 697 TB over 3 years. The company likely has large, relational databases for customer transactions, in addition to several big NoSQL databases to support big data, analytics, and AI/ML applications. All of these depend on high-throughput storage to keep the business running. However, the firm might also need to keep much of this data in a public cloud or multicloud for reasons of long-term data retention and global availability.

To evaluate this workload in the context of public cloud versus hybrid multicloud, Prowess Consulting used AWS as the representative for the public cloud and Dell APEX for the hybrid multicloud. For AWS, the high-throughput storage used Amazon® Elastic Block Store (EBS) io2 Block Express storage; the Dell APEX solution ran on Dell PowerMax™ 2000 storage, having 107 TiB capacity starting in year 1 with a 50% storage commitment. Our analysis indicates that high-throughput storage **costs up to 28% less on Dell APEX than on AWS**. Table 4 and Figure 3 show the results of the comparison. (For configuration details for this workload comparison, see Appendix C.)

Table 4 | Three-year pricing for high-throughput storage on Amazon Web Services® (AWS®) and Dell™ APEX, respectively

	Amazon Web Services® (AWS®) Cost[6]		Dell™ APEX Cost[7]	
Year 1	420 TB Amazon® EBS storage (50% of 840 TB)	$261,583.88	Dell PowerMax™ 2000 cost (50% utilization)	$715,404.00
Year 2	588 TB Amazon® EBS storage (70% of 840 TB)	$366,217.43	Dell PowerMax™ 2000 cost (70% utilization)	$761,469.00
Year 3	697 TB Amazon® EBS storage (83% of 840 TB)	$434,229.23	Dell PowerMax™ 2000 cost (83% utilization)	$838,202.00
I/O operations per second (IOPS)	256,000 IOPS (three-year total)	$1,389,772.80	More than 2.7 million per node	Included
Full snapshots	1/month, Amazon® EBS (three-year total)	$424,812.21	Unlimited	Included
Incremental snapshots	30/month, Amazon® EBS (three-year total)	$632,509.81	Unlimited	Included
Storage for backups	Amazon® S3 (three-year total)	$13,084.22	Included	
Co-location services (three-year total)	N/A		$93,006.00	
Server administration (three-year total)[9]	N/A		$112,500.00	
Three-year total	**$3,522,209.58**		**$2,520,581.00**	

Note: No discounts (such as public-cloud committed-spend discounts) were applied in this analysis. Snapshots are included as part of the Dell PowerMax 2000 pricing.
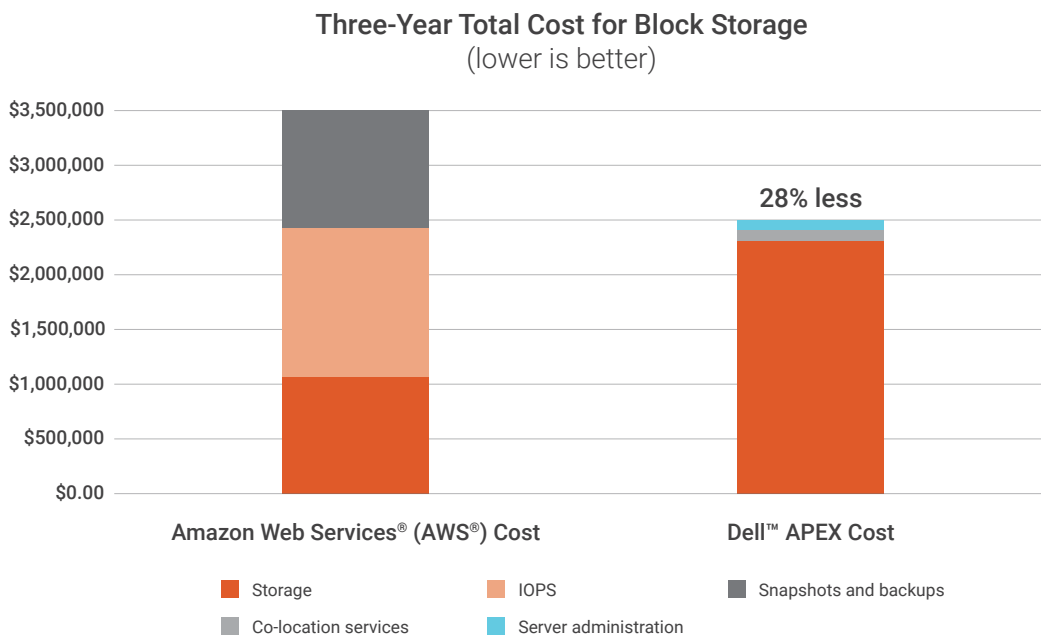
Three-Year Total Cost for Block Storage
(lower is better)

Figure 3 | Comparison of per-GiB pricing for high-throughput storage on Amazon Web Services® (AWS®) and Dell™ APEX

Analysis: High-Throughput Storage

Data-sovereignty requirements can be an issue for storage deployed in the public cloud. While good management can address this issue, there can be cases in which deploying storage on-premises or to a co-location within specific jurisdictions as part of a hybrid multicloud deployment might be easier and risk fewer fines due to negligence in moving the data.

Data control can also be an issue. Industries that require highly performant storage (such as financial services) also require full control of the data, whether for regulatory-compliance reasons or to better secure intellectual property. Co-residency in public clouds and co-locations can pose security issues for high-value data and can produce challenges for data availability. A major issue can be server availability. Server downtime can be costly for companies in terms of both money and brand reputation. To help counter this threat, the Dell PowerMax 2000 provides six-nines (99.9999%) availability,[10] versus four-nines (99.99%) with Amazon EBS.[11]

A more subtle challenge for data control can be government subpoenas or discovery in lawsuits interfering with access to data stored in the public cloud. Retaining data on-premises can be a solution to this challenge for organizations. The analysis in this study does not price in any charges for data egress or transfer, and you will need to factor in such additional fees when evaluating storage in the public cloud.

Regular-Throughput Storage

Not all storage use cases require high throughput; storage use cases can also encompass storage that has yet to fully grow to scale. For example, consider a marketing organization that is building a new customer-facing digital platform with data needs growing to 813 TB over three years.

To evaluate this kind of workload in the context of public cloud versus hybrid multicloud, we used AWS as the representative for the public cloud and Dell APEX Flex on Demand for the hybrid multicloud. For AWS, the regular-throughput storage utilized Amazon EBS gp3 storage; Dell APEX used Dell PowerStore™ 1200T and Dell™ Data Domain™ 6900 storage, having 200 TB of NVM Express® (NVMe®) storage and 120 TB storage, respectively, at 3.5:1 deduplication,[12] starting with 50% committed utilization in year one. Our analysis indicates that regular-throughput storage **costs up to 58% less on Dell APEX than on AWS**. Table 5 and Figure 4 show the results of the comparison. (For configuration details for this workload comparison, see Appendix D.)

Table 5 | Three-year pricing for regular-throughput storage on Amazon Web Services® (AWS®) and Dell™ APEX, respectively

	Amazon Web Services® (AWS®) Cost[6]		Dell™ APEX Cost[7]	
Year 1	280 TB Amazon® EBS storage (50% of 980 TB)	$506,343.00	Dell PowerStore™ 1200T with backups via Dell™ Data Domain™ 6900 (50% utilization)	$306,103.00
Year 2	392 TB Amazon® EBS storage (70% of 980 TB)	$708,880.19	Dell PowerStore™ 1200T with Dell™ Data Domain™ 6900 cost (70% utilization)	$379,550.00
Year 3	465 TB Amazon® EBS storage (83% of 980 TB)	$840,769.37	Dell PowerStore™ 1200T with Dell™ Data Domain™ 6900 cost (83% utilization)	$442,822.00
Snapshots	30/month, Amazon® EBS, saved to Amazon® S3	$994,579.22	Unlimited	Included
Co-location services (three-year total)	N/A		$19,877.70	
Server administration (three-year total)[9]	N/A		$112,500.00	
Three-year total	**$3,050,571.78**		**$1,260,852.70**	

Note: No discounts (such as public-cloud committed-spend discounts) were applied in this analysis.

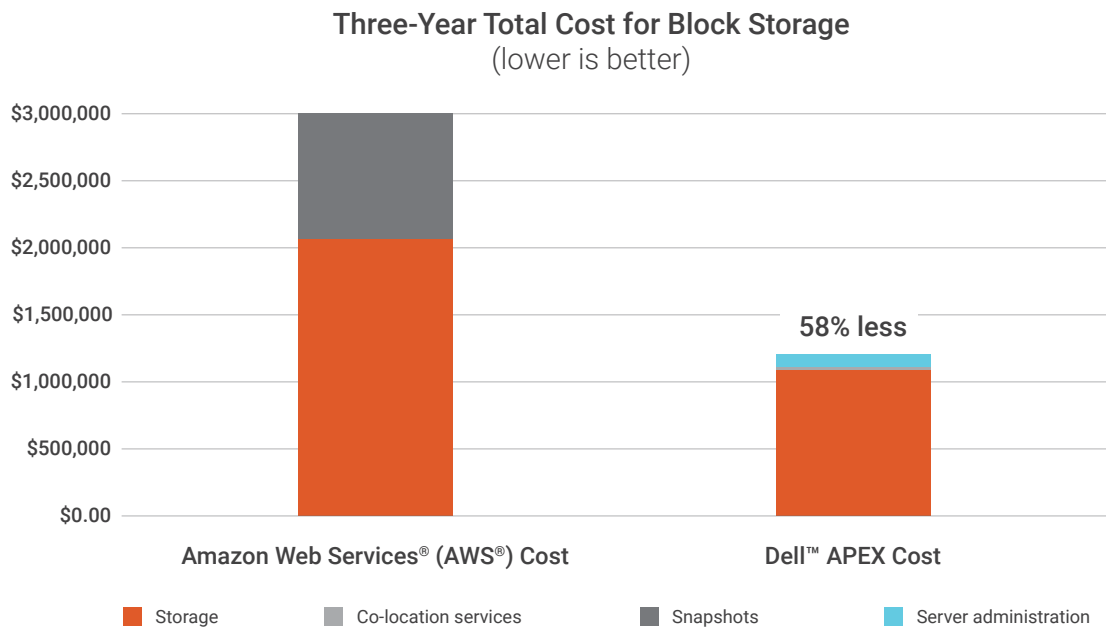**Three-Year Total Cost for Block Storage**
(lower is better)

Figure 4 | Comparison of three-year pricing for regular-throughput storage on Amazon Web Services® (AWS®) and Dell™ APEX

Analysis: Regular-Throughput Storage

Other factors to consider when running workloads on-premises versus in the public cloud include data sovereignty, security for proprietary data, and control of data (as is the case with high-throughput storage as well).

Moving data out of the public cloud, between public-cloud geographical regions, and even between availability zones can incur additional charges, all of which can add up. The analysis in this study does not price in any charges for data egress or transfer, and you will need to factor in such additional fees when evaluating storage in the public cloud.

Artificial Intelligence (AI)/Machine Learning (ML)

AI/ML is an automation meta-trend set to dominate the coming decades, and it is only getting started. Estimates put the size of the global enterprise AI/ML software market at $9.79 billion—but with a projected 36.9% compound annual growth rate (CAGR).[13] Put another way, this estimate projects enterprise AI/ML to grow 15x by 2030, to a market of $88.37 billion.[14]

Use cases for AI/ML are varied. A common use case is training AI/ML models, a process that can be long and computationally expensive but that happens infrequently. Another common use is putting those models to work inferencing off of them. Inferencing is fast and computationally modest, but it must happen potentially thousands of times a day for some AI/ML applications.

To evaluate the matchup for both training and inferencing between the public cloud and multicloud solutions that include on-premises infrastructure, we considered the scenario of a pharmaceutical company. The company uses high-performance GPUs for AI and ML work in genomics and drug discovery. For this comparison, we evaluated an average of 6.4 Dell™ PowerEdge™ XE9680 servers as part of the Dell APEX solution against eight Amazon EC2 P5.48xlarge instances (the difference in the effective server/instance numbers is to account for how the different pricing structures for the PowerEdge servers and the AWS instances' utilization rate work with an assumed 80% utilization rate). Each PowerEdge XE9680 server includes eight NVIDIA HGX® H100 GPUs, and each P5.48xlarge instance has eight vGPUs. Given the heavy data-analysis needs of pharmaceutical firms, we estimated constant utilization over a five-year term. Our analysis indicates that running high-end GPUs **costs up to 47% less on Dell APEX than on AWS**. Table 6 and Figure 5 show the results of the comparison. (For configuration details for this workload comparison, see Appendix E.)

Table 6 | Five-year pricing for high-performance GPU usage on Amazon Web Services® (AWS®) and Dell™ APEX, respectively

	Amazon Web Services® (AWS®) Cost[6]	Dell™ APEX Cost[7]
Five-year AI/ML instance/server cost	$15,122,216.30	$7,447,536.00
Co-location services (five-year total)	N/A	$422,654.40
Server administration (five-year total)[9]	N/A	$187,500.00
Five-year total	**$15,122,216.30**	**$8,057,690.40**

Note: This pricing assumes that an organization would use the three-year Amazon EC2 Instance Savings Plan twice (a one-year Amazon EC2 Instance Savings Plan is currently not available for P5.48xlarge instances).
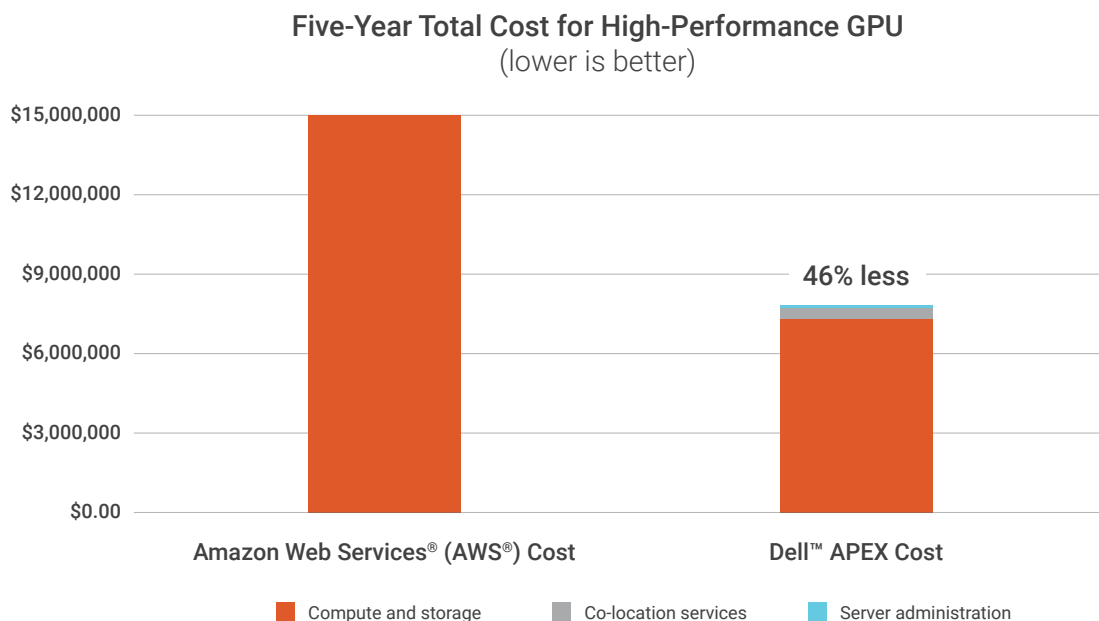

Figure 5 | Comparison of five-year pricing for high-performance GPU usage on Amazon Web Services® (AWS®) and Dell™ APEX

Analysis: AI/ML

With the growing use of AI in all industry verticals, getting ahold of powerful GPUs can be a challenge. For example, the AWS P5.48xlarge instances that provide performance comparable to the PowerEdge XE9680 server are available in only two regions (East US Virginia and West US Oregon), with long wait times for availability at the time of this writing.

Other factors to consider when running workloads on-premises versus in the public cloud include data sovereignty, security for proprietary data, and control of data (as is the case with high-throughput storage as well).

Moving data out of the cloud or even between public-cloud geographical regions and zone instances can incur additional charges, all of which can add up. The analysis in this study does not price in any charges for data egress or transfer, and you will need to factor in such additional fees when evaluating solutions in the public cloud.

Other Dell APEX Considerations

Beyond the benefits that emerge from multicloud solutions in general, which can provide the control afforded by private clouds, we found a number of additional advantages specific to Dell APEX. These include:

- **Interoperability**—Dell APEX provides organizations with an IT consumption model that can integrate tightly with their existing IT environments, allowing organizations to make use of their current investments, modernize at their own pace, and manage their infrastructures from a single console. And because Dell APEX enables organizations to manage VMs and containers within the same infrastructure, it can help organizations with IT modernization.

- **Make use of existing team skillsets**—Dell APEX allows organizations to utilize their IT staff's existing knowledge base by providing a unified management experience and integration with familiar tools and platforms, enabling efficient adoption of new technology services.

- **Security and governance**—Dell APEX provides security and compliance features that include access controls, data encryption, and regulatory compliance certifications, all of which help ensure that organizations can maintain a secure and compliant IT environment while taking advantage of the benefits of a flexible consumption model.

- **Transparent pay-as-you-go consumption**—Dell APEX provides organizations with a predictable pricing model that enables them to pay for the IT resources they consume and that provides greater visibility and control over their IT costs while retaining the flexibility to scale up their IT resources when business needs demand it.

- **Optional managed services**—Dell APEX offers optional managed services, which can help organizations offload some or all of their IT operations in a cloud-like manner to Dell Technologies experts, freeing up their IT staff to focus on more strategic initiatives.

- **Partners and a broad ecosystem**—Dell APEX partners with organizations across the globe to enable a broad range of hosting, outsourcing, and application-management services across a variety of platforms, including public clouds.

Other Public-Cloud Considerations: Data Egress

Data-egress and data-transfer charges are another set of considerations for data and applications in the public cloud. While you can add data to public cloud storage for free, moving data out can cost quite a bit. Even moving data between public-cloud geographical regions or availability zones for things like disaster recovery (DR) and high availability (HA) can incur additional charges, which can quickly add up.

The analysis in this study does not price in any charges for data egress or transfer, and you will need to factor in such additional fees when evaluating data and applications in the public cloud. Note that data egress costs can grow significantly as data grows. Therefore, any cost-benefit analysis should also factor in smaller dev/test/startup workloads that might make more sense to run in the cloud than production workloads, but that cost-benefit ratio can change quickly as workloads scale.

Conclusion

Some workloads will always belong in the public cloud, regardless of cost considerations. Good IT strategy should take this into account and make an honest assessment of what can be moved elsewhere if doing so can bring enough benefits. These benefits could include lower costs, but they could also include other important considerations, such as workload interoperability, productivity impacts, security needs, and the convenience of having your data stored locally for restoration or DR.

While cost might not be the only consideration when weighing public cloud versus multicloud with private-cloud capabilities, it can be a decisive one. Whether it's senior management telling IT to do more with less or IT billing cloud charges back to individual teams, it can feel like there is inescapable pressure to have visibility into costs and to manage those costs, particularly on public-cloud spend. You're in good company: a recent survey showed that 69% of organizations report reducing cloud spend as a goal for 2023 (and of those organizations, 35% report that they aim to reduce spending on the public cloud by 25% or more).[15]

Prowess Consulting assessed different workloads in order to evaluate price differences for different use cases. While far from exhaustive, these comparisons cover a wide variety of workloads common to organizations of different sizes and across industries. We found that, on average, multicloud solutions such as Dell APEX can be 28–58% more cost effective than the public cloud (as represented by AWS).

While pricing for specific workloads will naturally play out differently, this guide can serve as a framework for conducting your own evaluation to see whether considering a multicloud solution could save your organization money or bring other benefits. Amid the crushing pressure to act quickly to address public-cloud costs, taking the time to consider all of your options can often pay dividends in the long term.

Appendix A: VM Workload Configuration Details

Dell APEX Assumptions

- Compute, storage, and virtualization:
  - 20x VMware Cloud Foundation on VxRail nodes
  - 60–70 VMs per node
  - VM shapes range from 2 vCPUs with 4 GB of memory to 24 vCPUs with 128 GB of memory
- Managed services and co-location services used

AWS Assumptions

- Amazon EC2 multitenant compute on a three-year savings plan
- General-purpose solid-state drive (SSD) storage (Amazon EBS gp2) used
- Snapshots taken daily:
  - 2–4% data change rate
  - 30-day retention
- Private connectivity (10 Gbps, four connections)
- Data egress amounts to 15–30% of persistent storage
- Day-2 managed services used

Table 7 | Line-item breakdown of monthly costs for 1,200 VMs running on Amazon Web Services® (AWS®) and Dell™ APEX, respectively

Category	Amazon Web Services® (AWS®) Cost[6]	Dell™ APEX Cost[7]
Compute	$134,434.75	$109,160.00/mo.
Storage	$68,287.14	• 20 Dell VxRail™ nodes
Storage snapshots	$75,502.86	• VMware Cloud Foundation™
Virtualization	N/A	60–70 VMs per node
Private connectivity	$6,570.00	Included with co-location
Data egress	$4,097.14	N/A
Co-location services	N/A	$32,740.00
Enterprise support plan	$26,624.29	Included with co-location
Managed services	$19,492.86	$54,580.00
Monthly total	**$335,009.04**	**$196,480.00**

Table 8 | Breakdown of Amazon Web Services® (AWS®) instance families used (assuming a 30% committed-spend discount); **note: because this workload is based on an actual enterprise deployment, specific instance types and numbers have been aggregated to help preserve confidentiality**[6]

Amazon Web Services® (AWS®) Instance	Three-Year Savings Plan Monthly Subtotal[6]
C6id	$16,620.66
M6id	$73,412.69
R6id	$44,401.40
Monthly total	**$134,434.75**

Appendix B: Container Workload Configuration Details

Dell APEX Assumptions

- Dell APEX leveraging containers housed on integrated Dell PowerFlex racks with Cisco® switching, Red Hat Enterprise Linux OS, and Rancher for Kubernetes, in addition to managed services
- Single rate per worker node used as the pricing structure

AWS Assumptions

- Two regions used (primary and DR secondary in active/active configuration)
- Container orchestration and registry used
- SUSE® Rancher for Kubernetes
- Compute with Ubuntu® OS (three-year reserved price)
- Ephemeral storage
- Persistent block SSD storage
- Snapshots taken daily:
  - 5–10% data change rate
  - 30-day retention
- Replication and data transfer used
- Private connectivity (10 Gbps)
- Data egress is 15–30% of persistent storage
- Day-2 and additional managed services used

Workload Assumptions for Dell APEX and AWS

- Scale (production and DR):
  - Active/active DR strategy
  - Initial deployment: 12,000 containers
  - Year-3 end state: 40,800 containers
- Container size:
  - 2 vCPU
  - 2 GB memory
  - 47 TB ephemeral storage
  - 17 GB persistent block storage

Appendix C: High-Throughput Storage Workload Configuration Details

Dell APEX Assumptions

- Storage provided by Dell PowerMax 2000:
  - Capacity: 107 TiB
  - Input/output operation per second (IOPS): More than 2.7M per node
  - Throughput: Up to 350 Gbps
- Deduplication: 3.5:1 to account for a wide range of data types[12]
- Three-year term
- Server-administration fee allotted for managing the solution

AWS Assumptions

- Pricing:
    - Amazon EBS io2 Block Express
    - IOPS: Up to 256K per volume
    - Throughput: Up 4 Gbps per volume
    - No managed services

Appendix D: Regular-Throughput Storage Workload Configuration Details

Dell APEX Assumptions

- Powered by Dell PowerStore 1200T and a Dell Data Domain 6900
- Three-year term
- Server-administration fee allotted for managing the solution
- Deduplication: 3.5:1 to account for a wide range of data types[9,12]
- IOPS:
    - Dell Data Domain 6900: 100K

AWS Assumptions

- Pricing:
    - Amazon EBS gp3
    - IOPS: Up to 16K per volume
    - Throughput: Up 1 Gbps per volume

Appendix E: AI/ML Workload Configuration Details

Dell APEX Assumptions

- Dell PowerEdge XE9680 servers
- Managed service and co-location hosting
- Five-year term

AWS Assumptions

- Eight P5.48xlarge Amazon EC2 instances would be needed to match the Dell Technologies AI/ML workload comparison
- Three-year Amazon EC2 Instance Savings Plan used twice (as a one-year Amazon EC2 Instance Savings Plan is not currently available for P5.48xlarge instances)
- No additional Amazon EBS storage is required, given that the P5.48xlarge is configured with storage
- Five-year amortization

[1] Zippia. "**25 Amazing Cloud Adoption Statistics [2023]: Cloud Migration, Computing, And More**." June 2023.

[2] Gartner. "**Gartner Forecasts Worldwide Public Cloud End-User Spending to Reach Nearly $600 Billion in 2023**." October 2022.

[3] Based on a comparison of Dell™ APEX against an AWS® solution as of October 2023.

[4] CRN. "**Top Cloud Market Share Leaders: AWS, Microsoft, Google Lead Q2 2022**." August 2022.

[5] Fact.MR. "**Virtualization Software Market**." January 2023.

[6] Pricing obtained from **https://aws.amazon.com/ec2/pricing/** as of May 2023.

[7] Pricing supplied by Dell Technologies as of May 2023.

[8] 2023 market-size figure of $2.60 billion is extrapolated from a market size of $1.73 billion in 2021, growing at 22.5% CAGR. Source: Polaris Market Research. "**Container as a Service Market Share, Size, Trends, Industry Analysis Report, By Deployment Model (Public Cloud, Private Cloud); By Application; By Region; Segment Forecast, 2022 – 2030**." December 2022.

[9] 1/4 full-time employee (FTE) equivalent for a server administrator at a fully burdened annual cost of $150,000.

[10] Dell Technologies. "**PowerMax Family Spec-Sheet**." 2023.

[11] Amazon. "**Amazon Elastic Block Store Service Level Agreement**." Updated May 2022.

[12] Prowess Consulting used 3.5:1 as a conservative figure for data reduction through deduplication even though Dell Technologies storage solutions often achieve 4:1 data reduction. Source: Dell Technologies. "**Dell PowerStore data sheet**." 2023.

[13] 2023 market-size figure of $9.79 billion is extrapolated from 2022 estimate of $7.15 billion growing at 36.9% CAGR. 36.9 CAGR calculated for eight-year growth from $7.15 billion to $88.5 billion. Source: Verified Market Research. "**Enterprise AI Market Size And Forecast**." April 2023.

[14] Verified Market Research. "**Enterprise AI Market Size And Forecast**." April 2023.

[15] Vega. "**2023 IT & Cloud Optimization Report**." February 2023.