Cost Comparison: On-Premises versus the Public Cloud for VDI

An Evaluator Group TCO Analysis Comparing AWS WorkSpaces and a VDI solution using Dell EMC VxBlock System 1000 with VMware Horizon

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Enabling you to make the best technology decisions

The cloud was, at one point, seen as the inevitable successor to "traditional" IT infrastructure. With Gmail, Dropbox and Salesforce.com, cloud-based applications and services have certainly become mainstream. But as companies have started adopting public clouds, their concept of the cloud has evolved. Instead of "cloud-only", "hybrid cloud" has emerged as the model more companies are embracing. In general, enterprises are finding that the public cloud is okay for some data sets and some applications but that on-premises infrastructure is better for others.

The overall appeal of the public cloud and whether it is right for a specific organization depends on several factors. These include the availability of IT personnel and expertise, their concerns about control, data governance and security, a company's preference for OPEX or CAPEX financing, and of course, cost. In fact, in a 2018 Evaluator Group study, "**Hybrid Cloud Storage for the Enterprise**", security and cost were the two top concerns of respondents.

Like other applications running in the data center, Virtual Desktop Infrastructure (VDI) is also available as a service from public cloud providers. For enterprises considering the public cloud for this application, cost is certainly an important decision factor. This report will compare the total cost of ownership (TCO) of a VDI solution running on-premises and one running in the public cloud. Specifically, these solutions are Dell EMC VxBlock System 1000 running VDI with VMware Horizon in the data center and WorkSpaces in the AWS cloud.

Note: Evaluator Group published a similar TCO comparison in 2017 and again in 2019, between VMware running on a Dell EMC VxRail hyperconverged infrastructure cluster and a virtual server environment running on AWS EC2.

This TCO Model

Total Cost of Ownership (TCO) is a concept that is commonly used when evaluating IT equipment purchases. A more involved process than simply using acquisition price, TCO also figures in the costs of deploying and operating that equipment. Converged Infrastructures (CIs), like Dell EMC VxBlock 1000, have simplified the traditional compute/storage/network environment to reduce design, acquisition, implementation and ongoing maintenance costs. And VMware Horizon has simplified the operational aspects, due to its tight integration with the rest of the VMware product ecosystem that has become ubiquitous in enterprise IT.

While there are multiple user profiles that VDI solutions support, this comparison was made for two: a general office employee, or "Knowledge Worker", and a more compute-intensive "Power Worker", with configurations comparable to the AWS WorkSpaces "Standard Bundle" and "Performance Bundle", respectively. The table below shows the resources these two sets of profiles are allocated for the VxBlock System 1000 on-premises solution and the AWS WorkSpaces public cloud solution.

	VxBlock System 1000 Knowledge Worker	AWS WorkSpaces Standard Bundle		VxBlock System 1000 Power Worker	AWS WorkSpaces Performance Bundle
Compute	2 vCPUs	2 vCPUs		4 vCPUs	2 vCPUs
Memory	4 GB	4 GB		8 GB	7.5 GB

Figure 1: Virtual Desktop Resource Configurations for User Profiles

The On-premises Infrastructure

The Dell EMC VxBlock converged infrastructure solution is comprised of Dell EMC storage, Cisco UCS servers and networking, plus the VMware Horizon VDI software platform. It is designed to provide a complete, high availability/high performance compute environment; the hardware and software stack, plus deployment and support services.

For the on-site infrastructure, the VMware Horizon software stack was deployed on standard x86 servers that scale linearly with the number of users. Storage capacity for this software and for user accounts was provided by a Fibre Channel SAN connecting a pair of all-flash arrays. The production infrastructure was managed by Dell EMC's Advanced Management Platform (AMP), a standard VxBlock component, that hosts management, monitoring and automation software for the system.

The Dell EMC VxBlock 1000 solution running VDI with VMware Horizon is comprised of the components listed and illustrated in Figure 2 on the following page. This solution was initially designed for a 2500-seat virtual desktop environment and scaled up to cover 50,000 desktops, adding more components to the same design. As a baseline this report will show detailed costs of a system for 5000 Knowledge Worker users, but costs for the range of capacities are presented for both the Knowledge Worker and Power User profiles shown in Figure 1 above.
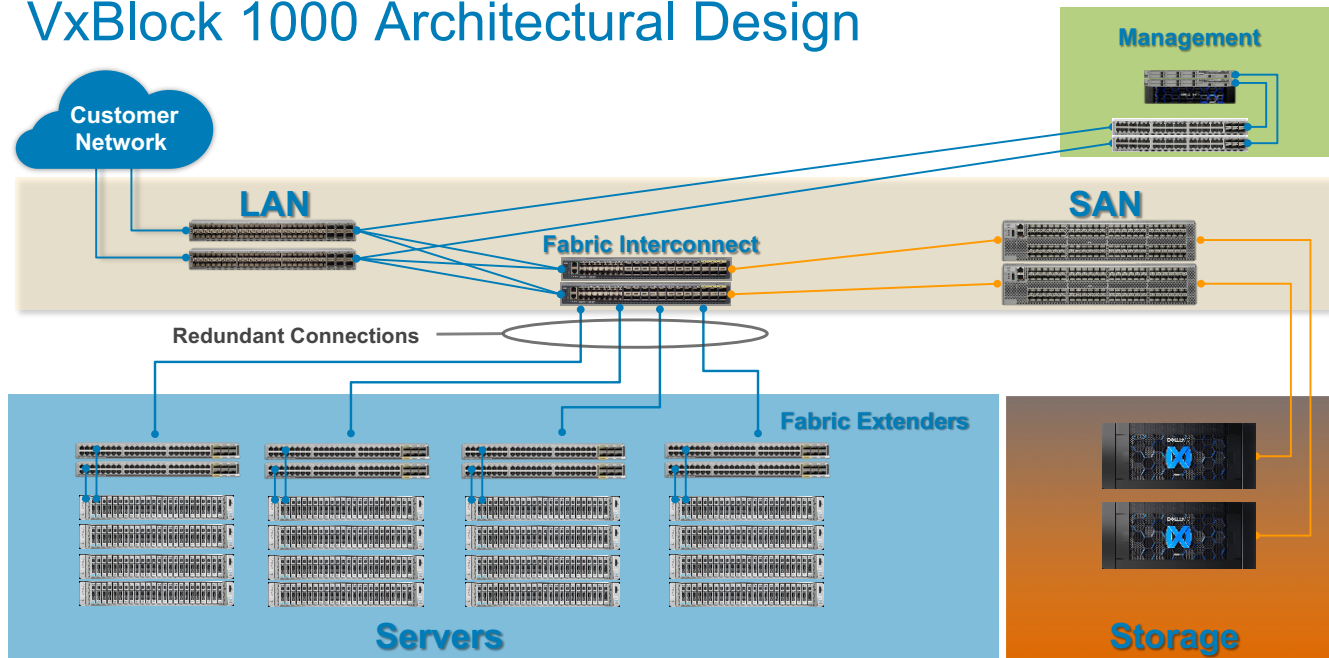
VxBlock 1000 Architectural Design

Figure 2: Diagram of On-Premises VDI Infrastructure

Components of On-Premises VDI Infrastructure

The Dell EMC VxBlock 1000 solution running VDI with VMware Horizon is comprised of the following components:

Cisco UCS C240 M5 - 2U servers with dual Intel Xeon Gold 6138 2.0GHz processors, Cisco Quad-port Virtual Interface Controllers (CNA), 768 GB of memory for servers supporting the Power Worker profile and 576 GB of memory for the Knowledge Worker profile (see Figure 1). User storage was provided by an external SAN-attached all-flash array. These are the compute servers running VMware Horizon, supporting desktop workloads.

Cisco UCS C220 M5 SX - 1U servers with dual Intel Xeon Silver 4114, 2.2GHz processors, Quad-port Virtual Interface Controller (CNA), 192 GB memory. These servers support Dell EMC Advanced Management Platform and use shared storage provided by a Dell EMC Unity scale-out system.

Cisco Nexus 2232PP Fabric Extenders - 1U, 32-port, 10Gb/FCoE switch provides access layer for high server-count environments.

Cisco Nexus 9300 – 1U, 36-port, 40/100Gb Ethernet Switch provides connectivity to end-user IP network.

Cisco Nexus 6454 – 1U Fabric Interconnect servers provide converged networking connectivity to compute servers, IP network and Fibre Channel network.

Cisco 31108TC - 1U, 48-port, 10/100Gb Ethernet switch provides connectivity between AMP servers and storage and the rest of the converged infrastructure.

Cisco MDS 9396S – 2U, 48-port Fibre Channel switch provides SAN connectivity for XtremIO X2 storage arrays.

Dell EMC XtremIO X2 – 5U, all-flash storage array, dual, active-active controllers, 18x4TB SSD enclosures. Storage arrays provide capacity for user desktops and VDI software.

Dell EMC Unity 300 – 2U, hybrid storage array, 400GB SSDs, 600GB, 10K HDDs. Storage arrays provide capacity to support AMP infrastructure management software.

VMware Horizon – Software virtualization platform that delivers, protects and manages virtual desktops in enterprise environments; vSphere hypervisor is also licensed as part of this VMware Horizon component.

For this TCO study a 3-year simple amortization with no interest was used. It was assumed that organizations making this kind of comparison would have their own funding framework and could easily add in the cost of capital from internal sources or through a commercially available lease.

Facilities costs were estimated at $2000 per 42U rack, per month, covering power, cooling and rack space. For administration time it was estimated that each server would require 0.2 hours per week, encompassing maintenance, software patches, etc. For each storage system it was estimated that one hour per week would be required for general updates and maintenance. The per-hour cost for administrators' time was derived with the following formula:

> Hourly cost of a fully burdened IT administrative employee = $150,000 / 2000 working hours per year

TCO Calculations

While the configurations involved a number of components, the calculation was very straightforward. As an example, the costs listed in Figure 3 below are for a 5000-user environment supporting the Knowledge Worker profile. The same methodology was used to derive the VxBlock comparative numbers shown in Figures 4 and 5. These hardware, software and support costs, which incorporate standard discounting, were totaled, along with facilities and administration overhead for a period of 3 years.

Servers - compute and management	**$ 1,813,859**
Storage - VDI system and user data + management system	**315,013**
Networking - LAN and SAN switches and equipment	**253,410**
Software - VDI platform, management, hardware licenses	**2,061,430**
Support - hardware and software maintenance/updates	**224,293**
Services - hardware and software deployment	**78,664**
Facilities costs for 3 years	**226,286**
Administrative costs for 3 years	**161,460**
Total	**$ 5,134,415**

**Figure 3: On-site Infrastructure Costs for Environment
Supporting 5000 Knowledge Worker Desktops**

When this 3-year total for 5000 virtual desktops is divided by 36 months ($5,134,415 / 5000 / 36), it comes out to **$28.52 per user**.

Public Cloud Infrastructure

Amazon WorkSpaces is a VDI-as-a-Service offering that runs in the AWS cloud. It provisions Windows or Linux desktops and is billed on either a monthly basis or by the hour. Amazon offers five basic packages with different resource configurations from 1vCPU and 2GB memory up to 8vCPUs and 32GB of memory, plus storage. As a basis for this TCO comparison, the following configurations were chosen for Linux desktops. This pricing is also valid for "bring-your-own" Microsoft Windows licensing, an appropriate comparison approach from a licensing perspective since many organizations have agreed-upon pricing with Microsoft based on arrangements such as Enterprise Licensing Agreement (ELA):

- Standard Bundle - 2 vCPU, 4GB memory per desktop, 80 GB Root Volume, 10 GB User Volume for the Knowledge Worker uses case $ 30.83 per month

- Performance Bundle - 2 vCPU, 7.5GB memory per desktop, 80 GB Root Volume, 10 GB User Volume for the Power Worker use case $ 53.91 per month

Both bundles include an 80 GB Root Volume (for the OS and related files) and 10 GB User Volumes (for user data). While no overages were assumed to have occurred, Amazon does charge for each additional GB consumed. Prices do not include the cost of data transfer with the public internet from an AWS WorkSpace or the cost of internet access for users. For simplicity, this model assumes no bandwidth costs are incurred.

Monthly, non-educational pricing was used plus AWS Business Support, the default option, although "Enterprise" support is also available. While the per-user price (shown above) was fixed, the cost for Business Support ranged from ~7% of per-user monthly pricing for a 2500 user environment to ~3% for a 50,000 user environment. The graph in Figure 4 below includes this support component.

This is an "on-demand" pricing model, with no commitment period. However, there is also no option to pay more up front or sign up for a subscription term to lower the cost, as is the case with AWS EC2 and other services. For simplicity, this TCO model ignores short-term and promotional discounts that are offered (such as a "Free Tier"), which are insignificant at the scale of this comparison.

Results

Knowledge Worker Profile

The graphic in Figure 4 shows that the on-premises VxBlock VDI solution for Knowledge Workers is about the same per-user cost as the AWS WorkSpaces Standard solution at the 2500 user level. But things change as the environment grows. For 5000 users, the VxBlock VDI solution is about 7% less. At 10,000 users and above, **the VxBlock on-site infrastructure saves more than 20% over the AWS cloud.**

VxBlock VDI Knowledge Worker vs AWS WorkSpaces Standard
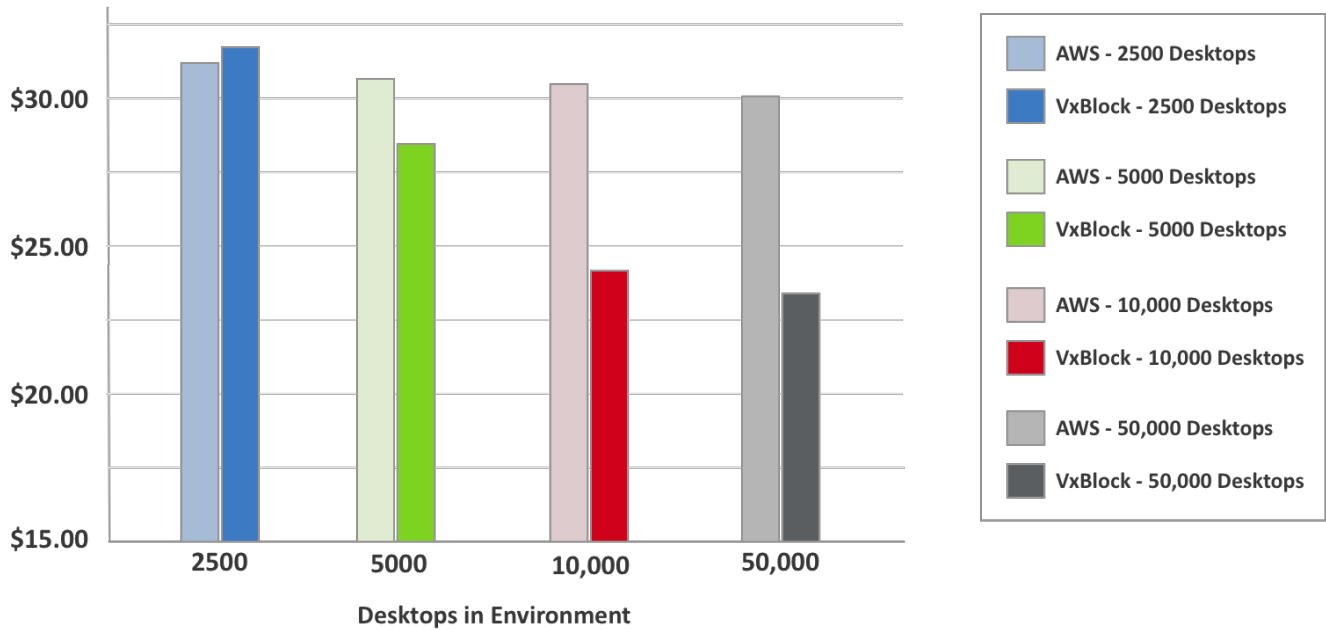### Cost per Desktop per Month

Figure 4: Costs of On-Premises and Public Cloud VDI for Knowledge Workers

Power Worker Profile

This TCO project also looked at a Power Worker profile and compared it with the AWS WorkSpaces "Performance" bundle. This configuration includes a larger memory capacity, 7.5GB per user, instead of the 4GB per Knowledge Worker (see "Public Cloud Infrastructure"). Figure 5 below shows the costs per desktop, at the same four numbers of users, for this profile. It shows that **the VxBlock VDI solution is between 30% and 45% less than AWS WorkSpaces.**
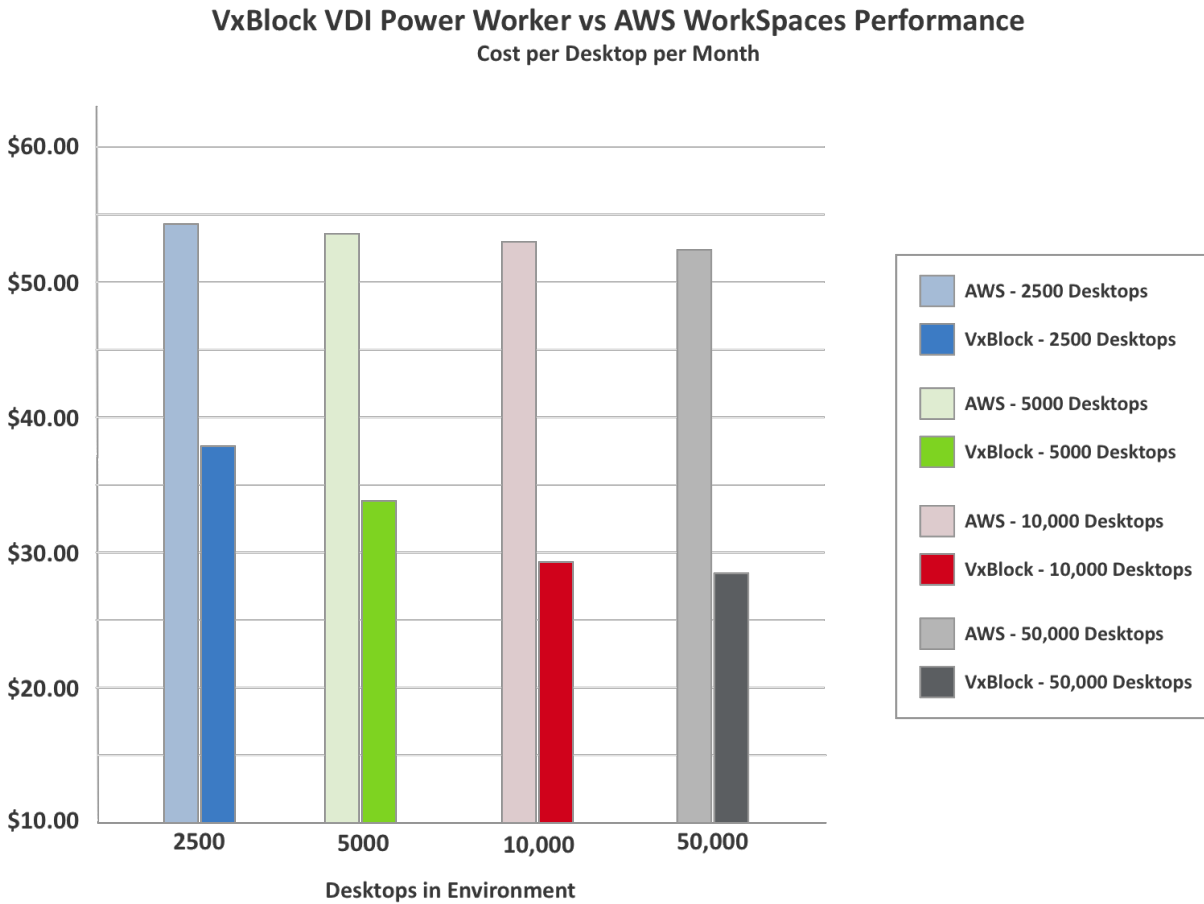
VxBlock VDI Power Worker vs AWS WorkSpaces Performance
Cost per Desktop per Month

Figure 5: Costs of On-Premises and Public Cloud VDI for Power Workers

3-Year Impact

When comparing per-user costs, it is instructive to show the impact of this TCO differential over time. The graph in Figure 6 shows the cumulative cost over the 36-month time frame that was used in this study. **With the Power Worker profile at the 10,000 user level, AWS costs about $8.5M more than the VxBlock VDI solution over three years**. The Knowledge Worker 10,000 user profile also indicates a significant differential, with the AWS costing about $2M more than VxBlock VDI solution over three years.
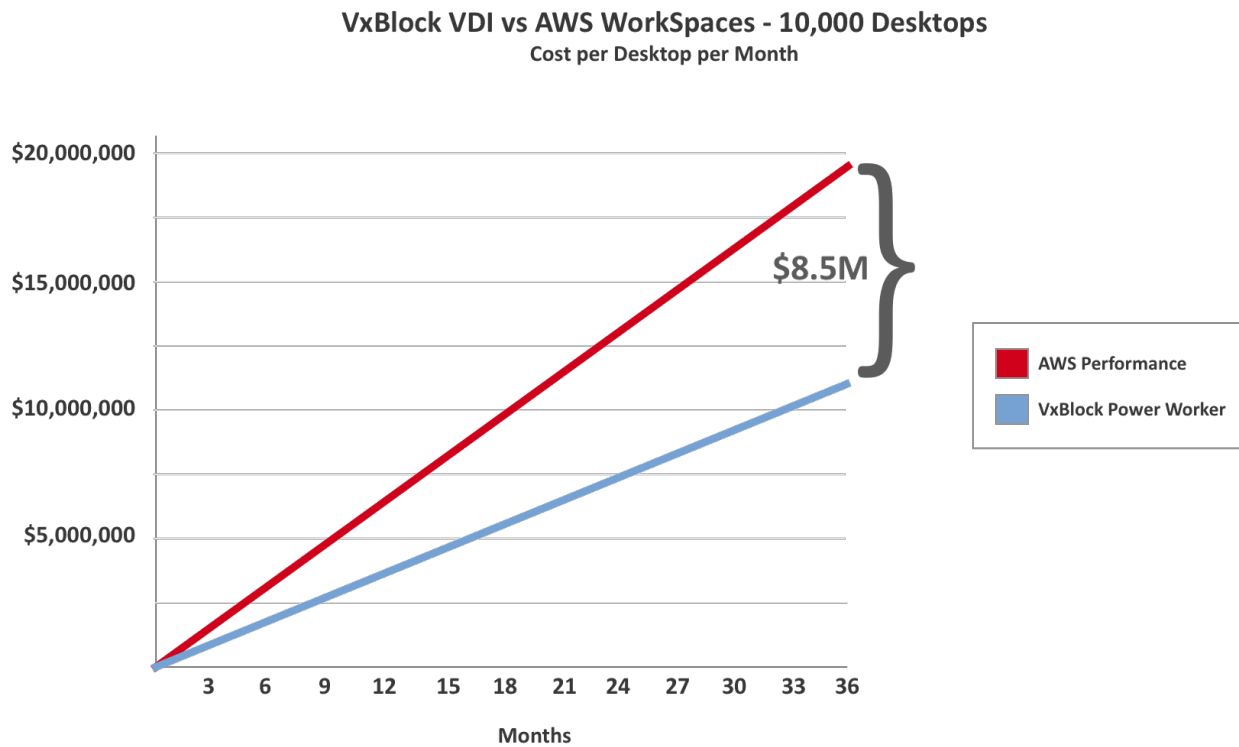
VxBlock VDI vs AWS WorkSpaces - 10,000 Desktops
Cost per Desktop per Month

Figure 6: Cumulative Costs of On-Premises and Public Cloud VDI for 10,000 Power Workers

Analysis

Why Does Cost of VDI On-Premises Go Down?

The decreasing unit costs of the VxBlock VDI solution in the graphs above reflects two fundamental principles, "economies of scale" and "resource maximization". Like any infrastructure purchase, with this enterprise computing environment there is an initial outlay to get the system built. As the system expands and these upfront costs are spread over more users, the "incremental costs" go down. VDI also improves resource utilization, in this case by managing the allocation of CPU cores. The abstraction of storage, compute and networking enables these systems to "oversubscribe" physical resources by certain ratios* and reduce cost per user accordingly. Large environments like the public cloud leverage many of the same principles to drive cost savings, but don't return that savings to their users.

> * The Dell EMC VxBlock System 1000-based architecture, that is the basis for the calculations shown in this paper, uses industry-standard subscription ratios for VDI resources, based on many years of validation using the industry-standard Login VSI tool. A detailed explanation of this validation is available in the **VxBlock 1000 Design Guide** and **Validation Guide**.

What About 5-Year Term?

This TCO model was built on a 3-year lifespan for on-site infrastructure. In reality, many organizations keep IT systems in service longer, often 4 or 5 years. In fact, the new VxBlock 1000 system is built with an architecture capable of perpetually refreshing its components or updating existing components with new technologies without having to upgrade to an entirely new system.

If the CapEx and OpEx costs shown in this model were expressed over a 5-year period, they would decrease about 37% (net of two additional years of administration and support). As an example, a VxBlock VDI solution for 5000 Knowledge Workers, (shown in Figure 2), would drop from $28.52 to $17.98 per user, and for 5000 Power Workers would drop from $34.38 to $21.66. On the other hand, with its fixed monthly price, the AWS WorkSpaces cost stays the same, regardless of the term of service.

User Experience and Risk

VDI is a mission-critical application that impacts every employee and has visibility to the highest levels of the company. When replacing a person's desktop with VDI (either on-site or as a cloud-based service), providing the same user experience is essential, so reducing potential risks to delivering that user experience is essential. Keeping that VDI system on-site maintains control over the infrastructure and can potentially reduce that risk.

Relying on the connectivity and bandwidth availability of the public internet for cloud-based desktop services can *add* another layer of risk to the environment. Also, employees often use USB-connected storage and peripherals, many of which are not supported in AWS WorkSpaces.

Where Is the Public Cloud a Better Fit?

The AWS WorkSpaces product is priced on a per-user-per-month or a month-to-month basis. This can be appealing for new applications that don't have a track record and may need to be shut down on short notice, or for development-based applications that need to be set up quickly. Like other public cloud services, this is also attractive for companies without IT expertise or the desire to make capital commitments. While fine for SMBs and short-term applications, for core IT services like desktop computing in enterprise-level companies, these characteristics may not be as appropriate.

Summary and Conclusions

VDI is a technology that moves end user compute applications and infrastructure from the desktop into the data center. In a way it provides some "cloud-like" benefits by consolidating desktop computer management and resources onto dedicated servers and shared storage. This can reduce administrative overhead and improve resource utilization, things that push costs down. In fact, most VDI projects are driven, at least in part, by a need to lower cost to the enterprise.

But what about running VDI in the public cloud? Can that deliver cost savings over an on-premises VDI deployment? For small organizations or limited, short-term deployments, the answer may be "yes". But for the organization looking to support a few thousand or tens of thousands of desktops that answer is "no". The cloud is more expensive for enterprise VDI - much more.

In this TCO study, Evaluator Group compared the cost of an on-premises infrastructure solution, using VxBlock System 1000 with VMware Horizon, to a public cloud solution using AWS WorkSpaces. The results show that for a typical office worker, in an enterprise supporting a couple thousand users, the costs of running a VDI solution on-premises and in the public cloud were roughly the same. But for environments of 5000 and 10,000 Knowledge Workers, or more, the economies of scale drove down the per-desktop cost of the VxBlock VDI solution by more than 20%, while the cost for AWS WorkSpaces stayed essentially the same. For Power Workers, the cost differential was even more dramatic, with the VxBlock VDI solution 30% to 45% less than AWS WorkSpaces.

In addition to cost, the VxBlock VDI solution offers a better desktop user experience and more control for IT administrators. Specifically, an on-premises VDI solution avoids the potential security, performance and connectivity risks associated with a service that relies on the internet.

About Dell EMC VxBlock System 1000

VxBlock 1000 integrates powerful Dell EMC storage and data protection into a turnkey system supporting all types of high-value, mission-critical workloads - like VDI. This converged solution helps enterprise IT quickly modernize and simplify their IT infrastructure at scale so they can focus on innovation and gain more value from their data.

Organizations also use VxBlock Systems for consolidating, optimizing and evolving mixed workloads, such as applications based on SAP, Microsoft SharePoint and Exchange, Oracle, SQL Server and other platforms. This includes scaling out the system with an even broader choice of storage resources than discussed in this paper (as well as providing data protection) to leverage the value of their growing data capital for new applications and business analytics. These organizations can further leverage the VxBlock availability, performance and economies of scale by accessing many of those applications with VDI.

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