

VMware TCO Comparison Calculator

Methodology

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Overview

Definitions and Objectives

In evaluating the cost of a virtualization and private cloud solution, it is essential to use a metric that not only accounts for the cost to acquire the software and the physical infrastructure it requires, but also includes the time and effort needed to operate the solution.

Because centralized management is a fundamental component of any virtualization and private cloud deployment, hardware and software costs associated with related management products, such as VMware vCenter and vRealize components, or Microsoft System Center, also need to be included. Moreover, software comparisons must accurately consider the features each product provides; if feature gaps exist, costs of supplementary software from the vendors or third parties must be included for a true comparison.

As shown in Figures 1–3, VMware defines total cost of ownership (TCO) as the sum of all these cost items separated into capital expenditures (CapEx) and operating expenditures (OpEx) over a selected period, and cost per virtual machine (VM) as that amount divided by the number of virtual machines in the environment.

	Host hardware server costs
+	Host networking hardware costs
+	Storage costs
+	Virtualization software license costs
+	Management software license costs
+	Host and guest operating system license costs
+	Applicable third-party license costs
=	Total CapEx costs

Figure 1. Capital Expenses Equation

	Power and cooling costs
+	Data center space costs
+	Virtualization and management software support costs
+	Host and guest operating system support costs
+	Hardware maintenance costs
+	Software-as-a-Service subscription costs
+	Third-party software support costs
+	Third-party software integration costs
+	IT administrative time costs
+	VM platform migration costs (if applicable)
=	Total OpEx costs

Figure 2. Operating Expenses Equation

	Total CapEx costs
+	Total OpEx costs (over selected period)
=	Total cost of ownership
/	Number of VMs
=	Total Cost of Ownership per VM

Figure 3. Cost Per Virtual Machine Equation

Ultimately, enterprises care about how much it will cost to run the total set of their business applications and how efficiently they are using infrastructure. Therefore, in a virtualized IT environment, it is important to see the costs associated with both purchase and maintenance of the system, including the IT administration time necessary to operate and manage the platforms. Cost per VM as a metric also provides a more condensed view of the total costs.

The *VMware TCO Comparison Calculator* (the Calculator) available at www.vmware.com/go/tcocalculator examines these metrics across two different scenarios. The first scenario is a net-new deployment, where the Calculator assumes no existing infrastructure and calculates the total costs associated with deploying a new, fully functional data center running VMware or Microsoft Windows virtualization and private cloud solutions. The second scenario is a software upgrade, where the Calculator calculates the cost of upgrading an existing vSphere deployment to a private cloud platform based on either VMware vCloud Suite or Microsoft Hyper-V and System Center.

The Calculator performs a straightforward TCO calculation by modeling a comprehensive set of costs for deploying, managing, and operating a virtualized infrastructure or private cloud, except for hardware equipment depreciation. This TCO (defined as CapEx plus OpEx, as shown in Figure 3) and the cost per VM are simple and accurate metrics to compare the upfront and ongoing expenditures required.

User-Selectable Inputs

As a first step when using the VMware TCO Comparison Calculator, you must decide which scenario to use for making the comparison—either a new infrastructure deployment or a software upgrade (vSphere to vCloud Suite).

If you choose the new infrastructure scenario, the Calculator makes a cost comparison between VMware and Microsoft using deployment details as defined by your inputs. The inputs for the new infrastructure comparison are listed in Table 1.

For the software upgrade scenario, the Calculator makes a cost comparison between upgrading an existing vSphere deployment to VMware vCloud Suite versus migrating an existing vSphere deployment to a Microsoft Windows Server Hyper-V and System Center private cloud. The Calculator assumes no additional virtualization host server purchases for upgrading to vCloud Suite products; however, it does include any additional hardware costs associated with lower Microsoft product VM density, or new requirements for additional management server VMs. When upgrading an existing vSphere deployment to vCloud Suite, the Calculator uses VMware upgrade prices, where applicable, to minimize software license costs. For the software upgrade scenario, iSCSI storage costs are applied to both the VMware and Microsoft configurations.

The software upgrade scenario also includes a two-hour-per-VM IT time cost to migrate each VM from vSphere to Windows Server Hyper-V that is based on field experience of VMware professional services consultants. These costs are added on the Microsoft side of the comparison.

All management servers and associated databases are assumed to run on VMs. Microsoft management server VMs are configured so the hosts provide physical memory without overcommitment to meet management server requirements, per Microsoft recommendations.¹

The inputs for the software upgrade scenario are listed in Table 2.

¹ [Microsoft Azure Pack distributed deployment hardware and software requirements](#)

Table 1. Creating a New Infrastructure: User-Selectable Inputs

Input	Description
Local currency	<p>The currency to be used by the Calculator. Choices are:</p> <ul style="list-style-type: none"> • US Dollars (USD) • Australian Dollars (AUD) • Euros (EUR) • UK Pounds (GBP) • Japanese Yen (JPY) <p>The Calculator uses VMware and Microsoft prices as listed on July 15, 2019 for each currency. Prices for third-party software and other USD-based costs in the Calculator are converted to local currencies using published exchange rates as of July 15, 2019.</p>
Number of VMs	<p>Select the number of VMs to deploy. Values from 5 to 5,000 are allowed. Usually one or more VMs are deployed for each virtualized application.</p>
Virtualization host type	<p><i>Virtualization hosts</i> are the servers on which users will install the hypervisor and run virtualized applications. The following virtualization hosts are available:</p> <ul style="list-style-type: none"> • Server A: \$7,500 for 1-socket, 24-core processor, 128GB RAM, 2 10Gb network ports • Server B: \$13,500 for 2-socket, 16-core processors, 384GB RAM, 2 10Gb network ports • Server C: \$35,000 for 4-socket, 20-core processors, 768GB RAM, 4 10Gb network ports <p>Servers B and C are more powerful than Server A and will typically run more VMs than Server A. The server price does not include costs for shared storage (like HBAs, SAN switches, or disks), networking infrastructure (like switches), electricity, cooling, or space.</p>
Storage type	<p>Users can select the type of shared storage that meets their business needs. Shared storage options for virtual disks on VMs include the following:</p> <ul style="list-style-type: none"> • Fibre Channel SAN: Assumes storage cost of \$5/GB usable. SAN switches and HBAs are additional and are included in the total cost for storage. • iSCSI SAN: Assumes storage cost of \$4/GB usable. • Network-Attached storage (NAS): Assumes storage cost of \$3/GB usable. • VMware vSAN: Available for VMware products only. Assumes storage cost of \$2/GB usable.

Input	Description
Product edition	<p>The Calculator allows users to select the VMware product edition that best meets their business goals. Each edition differs in features and pricing, and you can use the product selection wizard to help narrow down the choices by selecting the features you need.</p> <p>The full list of VMware product editions in the new infrastructure scenario is as follows:</p> <ul style="list-style-type: none"> • vSphere Essentials 6.7 • vSphere Essentials Plus 6.7 • vSphere Standard 6.7 • vSphere Enterprise Plus 6.7 • vSphere Platinum 6.7 • vCloud Suite Standard 7 • vCloud Suite Advanced 7 • vCloud Suite Enterprise 7 • vCloud Suite Platinum Standard 7 • vCloud Suite Platinum Advanced 7 • vCloud Suite Platinum Enterprise 7 <p>vSphere Essentials and Essentials Plus deployments are limited to six processors, so the Calculator will disable selection of those editions if the calculated number of processors exceeds that number. For the upgrade scenario, users can select as their current VMware product any of the vSphere Essentials, vSphere, and vSphere Platinum editions. For the desired VMware product edition, any of the vCloud Suite editions may be selected.</p> <p>Comparisons are made with Windows Server 2019 Hyper-V and System Center. Depending on the VMware product selected, Microsoft Azure Monitor and Azure Security Center subscriptions or additional third-party software licenses may be added to the Microsoft costs to more accurately provide functional parity between the two environments.</p>
Electricity	<p>Approximate cost per commercial kWh in the region where the data center is located. The Calculator allows users to choose from three alternatives:</p> <ul style="list-style-type: none"> • Low: \$0.070/kWh (contiguous US low) • Average: \$0.106/kWh (contiguous US average) • High: \$0.150/kWh (contiguous US high) <p>If the user selects a different local currency than US dollars, electricity costs are displayed in terms of local currency per kWh.</p>
Data center facilities	<p>Approximate annualized data center capital costs, including space, cooling systems, air distribution, UPS, switchgear, and fire suppression, plus floor space-based variable costs in the region where the data center is located. The Calculator allows users to choose from three alternatives:</p> <ul style="list-style-type: none"> • Low: Fully burdened data center facility cost of \$147/sq. ft per year. • Average: Fully burdened data center facility cost of \$290/ sq. ft per year. • High: Fully burdened data center facility cost of \$428/sq. ft per year. <p>If the user selects a different local currency than US dollars, floor space costs are displayed in terms of local currency per square meter.</p> <p>Capital costs are calculated assuming 10-year depreciation.</p>
VMs per CPU	<p>The number of VMs per host server CPU (or socket) to be deployed. Users can select from 4 through 20 VMs per CPU.</p>

Input	Description
Additional VMware VMs per CPU	The incremental number of VMs to run per CPU on the VMware vSphere hosts. Users can select from 1 through 10 VMs. This value represents the greater VM density users expect to obtain on VMware vSphere. The smallest value of one additional VM per CPU represents a minimum VM density advantage as supported by user reports, independent analyst opinion, and independent lab testing (data available from VMware upon request.) VM densities with vSphere 6.7 can be more than 50% higher than with Hyper-V 2019 when allowances for restarting VMs after host failures are considered, due to more effective memory management in vSphere.
Time period for comparison	The number of years of operation to use in the TCO calculation. Users can select from three to six years.

Table 2. Upgrading an Existing Infrastructure: User-Selectable Inputs

Input	Description
Local currency	<p>The currency to be used by the Calculator. Choices are:</p> <ul style="list-style-type: none"> • US Dollars (USD) • Australian Dollars (AUD) • Euros (EUR) • UK Pounds (GBP) • Japanese Yen (JPY) <p>The Calculator uses VMware and Microsoft prices as listed on July 15, 2019 for each currency. Prices for third-party software and other USD-based costs in the Calculator are converted to local currencies using published exchange rates as of July 15, 2019.</p>
Current vSphere product	<p>Select a vSphere product that is currently in use in your environment. Available options are:</p> <ul style="list-style-type: none"> • vSphere Essentials • vSphere Essentials Plus • vSphere Standard • vSphere Enterprise Plus • vSphere Platinum • vSphere with Operations Management Enterprise Plus
Number of current host machine CPUs	Enter the number of CPUs (processors) currently running VMware products. The Calculator uses this amount to determine the number of product licenses to purchase in the software upgrade.
Number of VMs in the current environment	Enter the number of VMs running in your environment. Values between 5 and 5,000 are allowed. The Calculator uses this as the number of desired VMs. The number of VMs divided by the number of current host machine CPUs must be between 4.0 and 20.0 (inclusive) to fall within the typical range of VM densities reported by VMware customers.

Input	Description
vCloud Suite upgrade	<p>Enter the vCloud Suite product you are interested in upgrading to and comparing with a migration to Windows Server Hyper-V and System Center. Available upgrade editions are:</p> <ul style="list-style-type: none"> • vCloud Suite Standard 7 • vCloud Suite Advanced 7 • vCloud Suite Enterprise 7 • vCloud Suite Platinum Standard 7 • vCloud Suite Platinum Advanced 7 • vCloud Suite Platinum Enterprise 7 <p>The Calculator will apply listed VMware upgrade prices, where applicable, to calculate the minimum license cost of vCloud Suite upgrades.</p>
Virtualization host type	<p><i>Virtualization hosts</i> are the servers on which users will install the hypervisor and run virtualized applications. The following virtualization hosts are available:</p> <ul style="list-style-type: none"> • Server A: \$7,500 for 1-socket, 24-core processor, 128GB RAM, 2 10Gb network ports • Server B: \$13,500 for 2-socket, 16-core processors, 384GB RAM, 2 10Gb network ports • Server C: \$35,000 for 4-socket, 20-core processors, 768GB RAM, 4 10Gb network ports <p>Servers B and C are more powerful than Server A and will typically run more VMs than Server A. The server price does not include costs for shared storage (like HBAs, SAN switches, or disks), networking infrastructure (like switches), electricity, cooling, or space.</p>
Electricity	<p>Approximate cost per commercial kWh in the region where the data center is located. The Calculator allows users to choose from three alternatives:</p> <ul style="list-style-type: none"> • Low: \$0.070/kWh (contiguous US low) • Average: \$0.106/kWh (contiguous US average) • High: \$0.150/kWh (contiguous US high) <p>If the user selects a different local currency than US dollars, electricity costs are displayed in terms of local currency per kWh.</p>
Data center facilities	<p>Approximate annualized data center capital costs, including space, cooling systems, air distribution, UPS, switchgear, and fire suppression, plus floor footage-based variable costs in the region where the data center is located. The Calculator allows users to choose from three alternatives:</p> <ul style="list-style-type: none"> • Low: Fully burdened data center facility cost of \$147/ sq. ft per year. • Average: Fully burdened data center facility cost of \$290/ sq. ft per year. • High: Fully burdened data center facility cost of \$428/ sq. ft per year. <p>If the users select a different local currency than US dollars, floor space costs are displayed in terms of local currency per square meter.</p> <p>Capital costs are calculated assuming 10-year depreciation.</p>
Time period for comparison	<p>The number of years of operation to use in the TCO calculation. Users can select from three to six years.</p>

Host Hardware Server Cost

Host hardware server cost represents the capital expenditure for server hardware. The Calculator assumes that management components run in VMs hosted on the same type of server selected by the user for standard VMs. The number of physical hosts required to support the Microsoft management server VMs and management database VMs is calculated so that the hosts provide full physical RAM equal to or greater than the recommended memory allocations for those management VMs. The inputs for the host hardware server cost are listed in Figure 3.

Table 3. Inputs for Server Cost Calculation

Input	Description	Value	Source
Number of VMs	Estimated number of VMs that the user plans to deploy	Between 5 and 5,000	User input
Host unit cost	Cost of a virtualization host excluding hardware support	Value depends on server type selection: <ul style="list-style-type: none"> • Server A: \$7,500 for 1-socket, 24-core processor, 128GB RAM, 2 10Gb network ports • Server B: \$13,500 for 2-socket, 16-core processors, 384GB RAM, 2 10Gb network ports • Server C: \$35,000 for 4-socket, 20-core processors, 768GB RAM, 4 10Gb network ports Cost of three years of hardware support is added to the unit price (assumed to be 15 percent of unit price for all server types). For more details, see Appendix B of <i>VMware TCO Comparison Calculator – Results Report</i> . <i>Unit cost of virtualization host = server price + 3-year support cost.</i>	User input
VM density	Number of VMs per virtualization host	Baseline value set to seven VMs per CPU for VMware product editions and to six VMs per CPU for Microsoft product editions in the new infrastructure scenario. In the upgrade scenario, the baseline value is set to the user input VM density (with a lower bound at 4.0 VMs/CPU and an upper bound of 20.0) for the VMware density and to 25 percent lower than the user input for the Microsoft density (with a lower bound at 1.0 VMs/CPU). For more details, see <i>VMware TCO Comparison Calculator – Results Report</i> .	Based on VMware customer averages, Independent analyst opinion (see this Gartner study) and independent studies (available from VMware upon request).
Physical hosts for management server and database VMs	Number of physical hosts needed to support all required management VMs	Physical hosts of the same type (A, B, or C) selected by the user are added to support the management server and database VMs based on the product selected and VM population. For VMware, additional hosts are added to keep the VM density less than or equal to the user's input. For Microsoft, the number of physical hosts is determined by the total recommended virtual RAM calculated for the management VMs so that no memory overcommitment occurs.	Microsoft Azure Pack documentation recommends against overcommitting RAM for management VMs (see footnote 1.)

Server Calculations

1. *Number of hosts = number of VMs / number of VMs per host.*
2. *Number of additional physical hosts for management server and database VMs:* The value depends on the size of the environment (number of VMs and number of managed hosts) and the product edition selected. The calculated management server and database VMs are assumed to run on additional physical hosts, the number of which is calculated as above.
3. *Cost of servers = (number of hosts * host unit cost) + (number of additional hosts required for management server and database VMs * host unit cost).*

Note: Numbers of servers are rounded up to the closest integer.

Assumptions

Server price is inclusive of internal disk storage for system software and controllers. It does not include the cost of HBAs (included in storage cost) and operating systems (included in OS software cost.)

In the upgrade scenario, for all users at 4.0 VMs per CPU density and higher, the Calculator assumes that the density is the same for the new software and that no other servers are needed beyond any additional hosts for the increased number of management VMs. However, there are differences in density capabilities between Microsoft and VMware. For this reason, the Calculator may include purchase of additional virtualization hosts to accommodate the lower density when migrating to Windows Server Hyper-V and System Center.

Storage Cost

Storage cost represents the capital expenditure for storage hardware given the number of VMs specified as input to the Calculator. The following storage technologies are available in the new infrastructure scenario:

- Fibre Channel
- iSCSI
- NAS
- VMware vSAN: VMware-specific hyperconverged storage option

Note: For comparison purposes, users must select from either Fibre Channel, iSCSI, or NAS for the Microsoft side.

As shown in Table 4, the following items are included based on selected storage type:

- HBAs: For Fibre Channel SAN only
- SAN switches: For Fibre Channel SAN only
- Disk storage: For all storage types

Table 4. Inputs for Storage Cost Calculation*

Input	Description	Value	Source
Number of HBAs per host	Number of HBAs in each virtualization host	2	Default established to support redundancy
HBA unit cost	Price of one HBA	\$1,250	Industry average
Number of ports per SAN switch		24	Survey of several HBAs (Fibre Channel) from <i>CDW</i>
SAN switch unit cost	Price of a SAN switch	\$19,000	Based on a popular 24-port 16Gb SAN Fibre Channel switch <i>listed by CDW</i>
Average disk space capacity per virtual disk per VM (GB)	Usable disk storage space (GB) needed per VM specified as input	100GB	Industry average and typical VMware user practice
Cost of disk storage (\$/GB)	Cost of 1 GB of disk storage space	FC = \$5/GB	
		iSCSI = \$4/GB	
		NAS = \$3/GB	
		vSAN = \$2/GB	

*If a currency other than USD is selected, storage costs are converted to that currency using published exchange rates as of July 15, 2019.

Storage Calculations

1. *Number of HBAs = number of virtualization hosts * number of HBAs per virtualization host*
2. *Cost of HBAs = number of HBAs * HBA unit cost*
3. *Number of SAN switches = 2 * number of hosts / number of ports per switch*
4. *Cost of SAN switches = number of SAN switches * SAN switch unit cost*
5. *Disk storage capacity = number of VMs * average disk space capacity per virtual disk per VM*
6. *Disk storage cost = Disk storage capacity * cost per GB of disk storage*
7. *Storage cost = cost of HBAs + cost of SAN switches + cost of disk storage*

Note: Number of SAN switches is rounded up to the closest integer.

Assumptions

- All virtualization hosts are connected to networked storage or implement vSAN storage.
- All VMs have the same fixed amount of usable disk space allocated: 100GB.
- Each host has two single-channel HBAs for redundancy (for Fibre Channel SAN case only).
- SAN switches are doubled for redundancy (for Fibre Channel SAN case only).
- No new storage is required by workload VMs in the upgrade scenario. However, storage is needed for any additional VMware management VMs added as a result of the vCloud Suite upgrade. For the Microsoft configuration in the upgrade scenario, additional storage hardware may be needed for additional hosts required by Microsoft's lower VM density.
- For the upgrade scenario, iSCSI storage costs are applied to both the VMware and Microsoft configurations.

Networking Cost

Networking cost represents the capital expenditure for network switches required for the hosts needed to support the workload VMs specified as input to the Calculator (Table 5) and the calculated number of management VMs.

Table 5. Inputs for Networking Cost Calculation*

Input	Description	Value	Source
Number of network ports per virtualization host		Value depends on selection of server type: <ul style="list-style-type: none"> • Server A: 2 10Gb ports per host • Server B: 2 10Gb ports per host • Server C: 4 10Gb ports per host 	Industry average for workload production servers and typical VMware customer practice
Number of ports per network switch		24	Average from survey of VMware customers
Network switch unit cost	Price of a managed 24-port 10Gb network switch	\$12,000	Survey of various switches at large US resellers online

*If a currency other than USD is selected, networking costs are converted to that currency using published exchange rates as of July 15, 2019.

Networking Calculations

1. *Total number of network ports = number of network ports per virtualization host * number of virtualization hosts*
2. *Number of network switches = total number of network ports / number of ports per network switch*
3. *Networking cost = number of network switches * network switch unit cost*

Note: Number of network switches is rounded up to the closest integer.

Assumptions

Other networking costs such as cabling are omitted for simplicity.

Power and Cooling Cost

Table 6 lists inputs for calculating power and cooling costs in the Calculator. For simplicity, the Calculator considers only the direct operating and cooling power consumed by server hardware, leaving out potential power and cooling consumption for networking, storage, and other data center infrastructure.

The operating power consumed by server hardware can be calculated by adding up the power ratings of each server in the data center. Because this number represents maximum power used, it should be de-rated to achieve steady-state power consumption. The steady-state constant was determined empirically. According to American Power Conversion Corporation, "...the nameplate rating of most IT devices is well in excess of the actual running load by a factor of at least 33 percent."² Forrester Research corroborates this idea, indicating that idle x86 servers consume between 30–40 percent of maximum (rated) power.³

In addition to operating power, servers produce heat and require substantial cooling to keep them running at prescribed temperatures. According to experiments completed in HP Laboratories, cooling equipment consumes 0.8W of power for every 1W of heat dissipation in the data center (designated in this document as the load factor, or L). Forrester Research confirmed this figure, which estimates that 0.5W to 1.0W of power is required to dissipate 1W of heat.

Table 6. Inputs for Power and Cooling Cost Calculation*

Input	Description	Value	Source
Server nameplate operating power	Peak rated server power consumption	Value depends on server type selection: <ul style="list-style-type: none"> • Server A: 550 watts • Server B: 750 watts • Server C: 1,600 watts 	Server manufacturer's Web site
Electricity price per hour	Commercial price per kilowatt-hour of electricity	<ul style="list-style-type: none"> • Low: \$0.070/kWh (contiguous US low) • Average: \$0.106/kWh (contiguous US average) • High: \$0.150/kWh (contiguous US high) 	Energy Information Administration
Nameplate to steady-state power conversion	Steady-state constant used to convert nameplate power consumption to steady-state	0.67	American Power Conversion ⁴ (On average, nameplate ratings are 33 percent higher than steady-state load.)

² Sawyer, Richard, "Calculating Total Power Requirements for Data Centers," American Power Conversion, 2011.

³ Fichera, Richard, "Power And Cooling Heat Up The Data Center," Forrester Research, Inc., September 21, 2011.

⁴ Sawyer, Richard, "Calculating Total Power Requirements for Data Centers," American Power Conversion, 2011.

Input	Description	Value	Source
Cooling load factor	Estimated cooling load factor (watts of cooling electricity needed to dissipate 1 watt of heat)	0.80	Empirically determined in HP Laboratories
Airflow redundancy	Airflow redundancy required to cool the data center	125 percent	25-percent increment over current airflow needed to support proper cooling (SearchDataCenter.com) ⁵
Airflow de-rating	Percentage of airflow that is available for cooling server heat	80 percent	SearchDataCenter.com (see previous row)
Data center operating hours	Product of hours per day, days per week, weeks per year, and number of years that the data center is operational (“server on” hours)	8,736 hours (24x7x52) per year	Annual operating hours for typical 24x7x52 operation

*If a currency other than USD is selected, power and cooling costs are converted to that currency using published exchange rates as of July 15, 2019.

Power and Cooling Calculations

- Actual operating power = nameplate power * nameplate to steady-state conversion factor*
- Actual cooling power = actual operating power * cooling load factor * (1 + airflow redundancy required in data center) / airflow derating*
- Power and cooling cost = (number of virtualization hosts) * (actual operating power + actual cooling power) * electricity price per hour / 1,000 * data center operating hours per year * number of years selected*

Assumptions

This calculation is for operating power consumed during the selected time period only and includes the operating costs of the power delivery and cooling systems.

Data Center Real Estate Cost

Savings in *data center real estate* are achieved by reducing the number of physical servers consuming valuable data center space. Reducing the number of physical servers enables current data center space to be reclaimed, so building out future data center facilities can be avoided or deferred.

Due to the special infrastructure (racks, cooling, power systems, acoustics, and disaster resilience) required in data centers, they are often significantly more expensive to build than standard commercial properties. Industry sources⁶ show that data center costs per square foot vary significantly as a function of local costs, data center size, and the level of infrastructure redundancy required.

VMware infrastructure can reduce a company’s physical server count and data center footprint today and reduce the need for future construction of new data centers—compared to virtualization products that provide lower VM density. The Calculator accounts for the total yearly data center carrying costs; it combines the monthly real-estate rental cost, data center facilities cost, and power and cooling build-out costs (Table 7).

⁵ [McFarlane, Robert, “Let’s Add an Air Conditioner,” SearchDataCenter news article, published November 30, 2005.](#)

⁶ [Schneider Electric, “Data Center Capital Cost Calculator”](#)

Table 7. Inputs for Data Center Real Estate Calculation

Input	Description	Value	Source
Rack units consumed per server	Average rack size for current server hardware (in number of U per server)	<ul style="list-style-type: none"> 1 CPU = 1U (server type A) 2 CPU = 2U (server type B) 4 CPU = 3U (server type C) 	Typical server configurations from manufacturer Web sites
Unit space per rack	Average units that can be installed in a rack	Set to 24 by default	Typical usable data center rack space, accounting for a 42U rack, but 43 percent consumed with needed networking, power distribution, cable management, keyboard/display, and spacing (source: VMware)
Floor space per rack	Square feet per rack; square meters per rack	27 square feet (approximately); 2.51 square meters (approximately)	Typical data center floor space per rack ⁷
Capital cost for data center facilities build-out (per square foot)	Capital cost for data center facilities build-out (includes cooling systems, air distribution, UPS, switchgear, and fire suppression)	<ul style="list-style-type: none"> Low: \$1,150 per sq. ft* Average: \$2,500 per sq. ft* High: \$3,800 sq. ft* 	Schneider Electric's Data Center Capital Cost Calculator ("Low" assumes a 500-rack facility with low installation labor rates and non-redundant power and cooling infrastructure. "High" assumes a 25-rack facility with high installation labor costs and 2N power and cooling infrastructure redundancy. These costs are amortized over 10 years in this model.)
Years to amortize build-out costs	Average weighted depreciation to use for build-out and equipment (in years)	10 years	Estimates of useful life for typical data center build-out
Annual cost for the space (lease, rent, mortgage)	Cost for the space (lease, rent, mortgage) in dollars per square foot per year or square meter per year	<ul style="list-style-type: none"> Low: \$32 per sq. ft*. per year Average: \$40 per sq. ft* per year High: \$48 per sq. ft* per year 	Cost for data center space lease in US (varies based on local data center facilities costs)

*If a currency other than USD is selected, data center real estate costs are displayed in terms of cost per square meter and are converted to that currency using published exchange rates as of July 15, 2019.

Data Center Real Estate Calculations

- Total number of racks = round up (number of servers [by type] * rack size consumed per server / unit space per rack)*
- Total area consumed by servers = number of racks * floor space of a single rack*
- Average fully burdened data center cost per unit of floor space per year = cost to build data center facilities / years to amortize build-out costs + annual space lease or allocated annual real estate cost per unit of floor space*
- Data center real estate cost = total area consumed by servers * average fully burdened data center cost per year * number of years selected*

⁷ [Schneider Electric \(blog\), "Data Center Capital Cost Calculator – A Tool to Help Align Your Data Center Business Requirements with Your Project Budget"](#)

Assumptions

This calculation is for expenses related to data center space consumed by servers only over the number of years selected by the user.

Guest Operating System License and Support Cost

A *guest operating system* is the OS that runs in a VM. The cost of a guest OS includes the cost of both licensing and support. Pricing and packaging for licensing and support depend on the type of guest OS.

For simplicity, the Calculator assumes that all VMware and Microsoft virtualization hosts are licensed for Windows Server Datacenter Edition, which includes rights to run an unlimited number of Windows Server VMs. All VMs are assumed to run Windows Server as the guest OS. Pricing details can be found at the [Microsoft License Advisor](#) (view with Internet Explorer.) The Calculator applies per-core pricing that went into effect with the Windows Server 2016 and System Center 2016 releases.

The Calculator also accounts for the cost of support that Microsoft offers through the [Software Assurance](#) program. Microsoft Software Assurance is billed at 25 percent of license price per year and does not include 24x7 phone access to Microsoft technical support—as does the VMware Production Support and Subscription (SnS) that is included with the VMware licenses. The Calculator also assumes that Microsoft configurations include Microsoft Professional Support purchased separately from Microsoft (\$499 per incident⁸.) VMware SnS entitles customers to all software releases and updates, as well as VMware Technical Support assistance for issues related to VMware products or any guest OS supported on vSphere.

Guest Operating System License and Support Calculations

1. *Number of Windows Server Datacenter licenses = number of virtualization hosts * number of CPUs per host * number of cores per CPU / 2 (Windows Server is priced per two-core pair)*
2. *Total cost of guest OS licenses and Software Assurance = number of Windows Server Datacenter core pair licenses * (Windows Server Datacenter Edition core pair unit license cost + Software Assurance unit cost)*

Assumptions

For Microsoft products, “Open, No Level” list pricing is used.

- Microsoft Software Assurance cost is 25 percent of the product license price per year.
- Baseline Microsoft Professional Support incidents are estimated at 24 per year, plus 2.5 incidents per 100 VMs per year.
- System Center prices are based on the listed prices in the [Microsoft License Advisor](#). License and Software Assurance costs are reported separately in the Calculator with license costs included in capital expenses and Software Assurance costs included in operational expenses.
- Windows Server prices are based on the listed prices in the Microsoft License Advisor. In some cases, for foreign currencies, prices from online retailers are used.
- Windows Server and System Center costs are calculated using the per-core pricing that went into effect with the release of the 2016 versions of those products. Windows Server per-core prices are applied to both the VMware and Microsoft configurations.
- List software prices are used in the Calculator—no unpublished discounts are applied.

VMware Product Edition License, SaaS, and Support Costs

VMware offers an array of industry-leading virtualization platforms for building virtual infrastructures and private clouds. vSphere Essentials, vSphere, vSphere Platinum, and vCloud Suite product editions let users run business-critical applications with confidence and respond faster to business needs.

The licensing model for VMware product editions is per-processor (socket). The Calculator derives the number of required licenses by totaling the number of processors for all virtualization hosts. In the new infrastructure scenario, this calculation is based on user input

⁸ [Microsoft Per-Incident Support Pricing](#)

for number of VMs and for desired VM density. In the upgrade scenario, the Calculator takes the user input for existing host CPUs with vSphere products installed as the number of licenses to upgrade. VMware management servers are assumed to run in VMs and additional virtualization hosts are added as needed to support the management VMs.

vSphere Platinum and vCloud Suite Platinum editions require a SaaS component to enable full AppDefense security capabilities in the products. The SaaS component cost is priced per licensed CPU per year and the first-year SaaS cost is included in the vSphere or vCloud Suite license cost. The vSphere Platinum and vCloud Suite Platinum SaaS component is currently \$400 per CPU per year.

The Calculator also considers the cost of VMware Production Support and Subscription for each year of the selected time period. Pricing for the vSphere Essentials, vSphere Essentials Plus, vSphere and vSphere Platinum editions can be found on the [vSphere product page](#). This pricing also appears in Appendix A of *VMware TCO Comparison Calculator – Results Report*.

VMware Product Edition License, SaaS, and Support Calculations

1. *Number of VMware product licenses = (number of virtualization hosts * number of CPUs per host)*
2. *Total cost of VMware product licenses and support = number of VMware product licenses * (VMware product license cost + Production SnS unit cost for each year)*
3. *For vSphere Platinum and vCloud Suite Platinum editions, SaaS cost = number of VMware product licenses * (TCO calculation period in years – 1)*
4. *For vCloud Suite product editions in the upgrade scenario, vCloud Suite upgrade prices are used where available to reduce costs. In some cases where upgrade prices are not available, full vCloud Suite license prices are used*

Assumptions

- For the new infrastructure scenario, list software prices are used in the Calculator—no unpublished discounts are applied.
- The VMware Acceleration Kits are not included in the Calculator.

VMware Management Software Costs and Infrastructure Requirements

In addition to licenses and support for each virtualization management solution, the Calculator accounts for the cost of the hardware and software infrastructure (operating systems and databases) necessary to deploy each management solution. The Calculator assumes all management components run in VMs.

Such VMs will run on the virtualization hosts in addition to the application VMs. All the VMware management servers and databases considered by the Calculator are available as prepackaged virtual appliances, or they can be deployed in VMs. Because the Calculator assumes that all virtualization hosts are licensed with Windows Server 2019 Datacenter Edition, there is no additional OS cost for management and database servers. VMware vRealize Automation is the only VMware management component requiring Microsoft SQL Server licenses and support, and that cost is included by the Calculator.

The infrastructure resources required by the management components are calculated in terms of the virtual CPUs and virtual RAM required for the management VMs. Those vCPU and vRAM resources are documented in VMware best practices and sizing guidelines.

VMware vCenter Server

VMware vCenter Server is a centralized management solution required for all vSphere, vSphere Platinum, and vCloud Suite configurations. vCenter is priced by the number of server hosts or VMs on which it runs. For vSphere Essentials and Essentials Plus deployments, the Calculator assumes that the vCenter Server Foundation product bundled with those editions is used. For all other product editions, vCenter Server Standard is added. vCenter pricing details can be found on the [vSphere product page](#) or in Appendix A of *VMware TCO Comparison Calculator – Results Report*.

Each instance of vCenter Server supports as many as 2,000 vSphere hosts, or as many as 35,000 VMs. vCenter Server virtual appliance requirements are detailed in Table 8. Those requirements include the virtual CPU and virtual RAM resources required by an embedded Platform Services Controller.

Table 8. VMware vCenter Server Virtual Appliance Requirements⁹

Size	Managed Hosts (up to)	Managed VMs (up to)	Virtual CPUs	Virtual RAM (GB)
Tiny	10	100	2	10
Small	100	1,000	4	16
Medium	400	4,000	8	24
Large	1,000	10,000	16	32

VMware vRealize Operations

vRealize Operations is a component of all vCloud Suite configurations. vRealize Operations provides monitoring, performance analytics, capacity management, and optimization for VMware infrastructure.

vRealize Operations is deployed as one or more virtual appliances. The Calculator assumes that vRealize Operations is deployed in a single-node configuration with a virtual appliance that is scaled based on the number of managed objects. The number of managed objects is the sum of the VMs, hosts, and datastores monitored by vRealize Operations. The Calculator assumes that each VM is assigned 100GB of storage space and each datastore is 500GB in size.

Each instance of the vRealize Operations virtual appliance can support as many as 15,000 managed objects. Table 9 shows the vRealize Operations virtual appliance resource requirements as a function of the number of managed objects.

Table 9. vRealize Operations Virtual Appliance Requirements¹⁰

Virtual Appliance Size	Managed Objects (up to)	Virtual CPUs	Virtual RAM (GB)
Extra small	350	2	8
Small	5,000	4	16
Medium	15,000	8	32
Large	20,000	16	48

VMware vRealize Automation

VMware vRealize Automation is bundled with vCloud Suite Advanced and Enterprise editions. vRealize Automation provides private cloud management functions, including advanced cloud automation and self-service portals, as well as application provisioning. For all vCloud Suite editions, the VMware vRealize Business for Cloud product, which provides private cloud cost showback automation, is also included.

vRealize Automation is configured as a group of virtual appliances. The Calculator uses the Small Deployment Profile option for vRealize Automation, which requires six virtual appliances and scales to support up to 10,000 managed VMs (Table 10).

⁹ *Hardware Requirements for the vCenter Server Appliance and Platform Services Controller Appliance*

¹⁰ *VMware Knowledge Base, “vRealize Operations Manager 7.5 Sizing Guidelines (67752)”*

Table 10. vRealize Automation (including vRealize Business) “Small Deployment” Virtual Appliance Requirements¹¹

Appliance Name	Required Virtual CPUs	Required Virtual RAM (GB)	Operating System
vRealize Automation appliance	4	18	Linux
Infrastructure Core Server including Microsoft SQL Server Standard	6	16	Windows Server
vRealize Business for Cloud appliance	2	4	Linux
Total	12	38	2 Linux, 1 Windows

VMware vRealize Log Insight

VMware vCenter Server Standard includes 25 operating system instances of vRealize Log Insight to enable log analytics of up to 25 virtual machines and vSphere hosts. VMware vCloud Suite editions include full vRealize Log Insight to enable log analytics on all installed VMware hosts and virtual machines. vRealize Log Insight is implemented as a Linux virtual appliance with resource requirements based on the daily volume of log data gathered. Each VMware host is assumed to generate 150MB of log data per day.

For vSphere and vSphere Platinum, the daily log volume is calculated based on the number of hosts needed to accommodate 25 VMs at the VM density specified in the user inputs. For vCloud Suite editions, the daily log volume is calculated based on the total number of virtualization hosts. The resource requirements for the vRealize Log Insight virtual appliance are a function of the daily log data gathered, as shown in Table 11.

Table 11. vRealize Log Insight Virtual Appliance Requirements¹²

Virtual Appliance Size	GB Log data per Day (up to)	Virtual CPUs	Virtual RAM (GB)
Extra small	6	2	4
Small	30	4	8
Medium	75	8	16
Large	225	16	32

Microsoft Software Cost and Infrastructure Requirements

Windows Server Hyper-V License and Support Costs

Windows Server Hyper-V is the server virtualization hypervisor from Microsoft. Hyper-V is bundled with Windows Server and does not require additional licensing.

As described in the Guest Operating System License and Support Cost section above, the Calculator assumes that Windows Server Datacenter Edition with Hyper-V is licensed on all virtualization hosts. Both the VMware and Microsoft configurations evaluated by the Calculator use the Windows Server list pricing found at the [Microsoft License Advisor site](#) (view using Internet Explorer.)

¹¹ “vRealize Automation Small Deployment Requirements, Version 7.6” and “vRealize Automation Hardware Specifications and Capacity Maximums, Version 7.6”

¹² “VMware vRealize Log Insight 4.8 Getting Started Guide”

Consequently, there are no additional costs required to license Hyper-V. The Calculator applies per-core pricing that went into effect with the Windows Server 2016 release.

The Calculator accounts for the cost of support and maintenance that Microsoft offers through the [Software Assurance](#) program. Software Assurance is priced at 25 percent of the product license list price per year. The VMware Production SnS included with the VMware configurations (except vSphere Essentials, which offers only per-incident support) in the Calculator provides unlimited 24x7 phone support, but Microsoft Software Assurance only provides access to web-based support forums. To bring Microsoft support into parity, the Calculator includes the cost of Microsoft Professional Support incidents, with the number of incidents scaled based on the size of the VM environment (Figure 4). Microsoft Professional Support is priced at \$499 per incident as listed on [a third-party support provider page](#). If vSphere Essentials is selected as the VMware product, the same per-incident support costs are added, but using the \$308 per incident pricing for vSphere Essentials listed on the [vSphere pricing page](#).

Baseline Incidents per year	Additional Incidents based on deployment size	Cost
24	2.5 incidents per year per 100 VMs	\$499/phone incident

Figure 4. Microsoft Premier Support Costs Included by the Calculator

Microsoft System Center License and Support Costs

System Center is a systems management software suite from Microsoft. It includes Virtual Machine Manager (SCVMM), Operations Manager (SCOM), Configuration Manager (SCCM), Data Protection Manager (SCDPM), Orchestrator (SCOrch), Service Manager (SCSM), and Service Provider Foundation (SCSPF). Each System Center module provides a subset of the functionalities and features required to manage a virtual infrastructure and private cloud. For more details, refer to the [System Center product page](#).

Just as use of VMware vCenter Server is optional with vSphere, System Center is not strictly required to run Hyper-V, but because centralized virtualization management is part of the majority of today’s deployments of server virtualization, the Calculator only provides cost comparisons that include management software and its required infrastructure.

Although cost comparisons should be made between solutions with the same feature sets, there isn’t a System Center setup that perfectly matches VMware vSphere or vCloud Suite capabilities. Table 12 shows the System Center and other Microsoft management components that the Calculator includes when comparing configurations with the various VMware product editions. The Calculator also includes Windows Azure Pack (WAP) in Microsoft configurations compared with VMware vCloud Suite Advanced and Enterprise editions because WAP is the Microsoft-recommended solution for creating private cloud self-service portals with Windows Server Hyper-V.

Table 12. Microsoft Management Products Included as a Function of VMware Product Selected

VMware Product Selected	SCVMM	SCOM	SCCM	SCDPM	SCOrch	SCSM	SCSPF	WAP
vSphere Essentials	✓		✓					
vSphere Essentials Plus	✓		✓	✓				
vSphere Standard	✓	✓	✓	✓				
vSphere Enterprise Plus	✓	✓	✓	✓				

VMware Product Selected	SCVMM	SCOM	SCCM	SCDPM	SCOrch	SCSM	SCSPF	WAP
vSphere Platinum	✓	✓	✓	✓				
vCloud Suite Standard	✓	✓	✓	✓	✓	✓		
vCloud Suite Platinum Standard	✓	✓	✓	✓	✓	✓		
vCloud Suite Advanced	✓	✓	✓	✓	✓	✓	✓	✓
vCloud Suite Platinum Advanced	✓	✓	✓	✓	✓	✓	✓	✓
vCloud Suite Enterprise	✓	✓	✓	✓	✓	✓	✓	✓
vCloud Suite Platinum Enterprise	✓	✓	✓	✓	✓	✓	✓	✓

The Calculator applies per-core pricing, which went into effect with the System Center 2016 release. System Center licenses are sold in units of core pairs, with a minimum of eight core pair licenses required per server. Server management licenses are required for managed devices that run server OS environments. The Calculator uses System Center Datacenter Server licenses for all Hyper-V host servers. Open No Level list pricing for System Center is used in the Calculator. Some System Center components require SQL Server databases. Those SQL Server licenses are included with System Center licenses, so there is no additional cost.

Microsoft System Center Infrastructure Requirements

The Calculator assumes that all management servers and databases required by the Microsoft configurations run in VMs. The Calculator sums the CPU and memory requirements for each System Center and WAP component using Microsoft recommendations as documented below. Microsoft recommends against memory overcommitment using Dynamic Memory for some of its management components. Therefore, the Calculator adds sufficient physical server hosts to the configuration to ensure that the total memory requirements for the management VMs are met with dedicated physical host memory. For example, if the total RAM required by the System Center and WAP management VMs equals 256GB and the user has selected Server A hosts (each of which provides 128GB of physical RAM), two Server A hosts would be added to the Microsoft configuration to meet the management VM requirements. The same method is used to size the physical host capacity required for management VMs in the VMware configuration.

System Center Virtual Machine Manager

SCVMM requires VMs for its Management Server, Database, and Library Server components. The recommended resources required for the VMs for deployments of up to 1,000 managed Windows Server Hyper-V hosts are shown in Table 13.

Table 13. Microsoft System Center Virtual Machine Manager Management VM Resource Requirements¹³

SCVMM Component	Managed Hosts	Recommended Virtual CPUs	Recommended Virtual RAM (GB)
Management Server	Up to 1,000	16	16
Database	Up to 1,000	16	16
Library Server	Up to 1,000	4	4

System Center Operations Manager

Microsoft recommends SCOM be configured with multiple server VMs for management and database functions. The number of those VMs and their recommended resources vary with the number of managed VMs, as shown in Table 14. Note that Microsoft's [System requirements for System Center Operations Manager](#) documentation states that the "[Operations manager 2012 Sizing helper](#)" is valid for estimating SCOM 2019 requirements, and that is the source of the figures shown below.

Table 14. Microsoft System Center Operations Manager Management VM Resource Requirements^{14,15}

Managed VMs (up to)	SCOM Management VMs Required	Recommended Total Virtual CPUs	Recommended Total Virtual RAM (GB)
500	3	12	32
1,000	5	20	72
3,000	6	32	88
6,000	6	44	104

System Center Configuration Manager

The Calculator assumes SCCM is configured as a "Stand-alone primary site server with a database site role on the same server," as documented in Microsoft's "[Recommended hardware for System Center Configuration Manager](#)". SCCM requires a single VM with 16 virtual CPUs and 96GB of virtual RAM.

System Center Data Protection Manager

Microsoft documents¹⁶ that a single SCDPM server can support 100 servers. To be conservative, the Calculator uses a value of 300 Windows Server VMs per SCDPM server. Each SCDPM server VM is allocated four virtual CPUs and 8GB of virtual RAM, as recommended for the SQL Server database used by SCDPM.¹⁷

System Center Orchestrator

SCOrch requires four VMs, as shown in Table 15.

¹³ [VMM system requirements, System Center 2019](#)

¹⁴ [System requirements for System Center Operations Manager](#)

¹⁵ [Microsoft System Center 2012 Operations Manager Sizing Helper Tool](#)

¹⁶ [Get ready to deploy DPM servers](#)

¹⁷ [Preparing your environment for System Center Data Protection Manager](#)

Table 15. Microsoft System Center Orchestrator Management VM Resource Requirements¹⁸¹⁹

Orchestrator Component	Recommended Virtual CPUs	Recommended Virtual RAM (GB)
Management Server	2	2
Runbook Server	2	2
Web Service	2	2
Runbook Designer	2	2
Total	8	8

System Center Service Manager

Microsoft documents the server VM, virtual CPU and virtual RAM requirements for various SCSM deployment scenarios, as shown in Table 16.

Table 16. Microsoft System Center Service Manager Management VM Resource Requirements²⁰

Deployment Scenario	SCSM Component	Recommended Virtual CPUs	Recommended Virtual RAM (GB)
Small (up to 2,000 computers)	Management Server	4	6
	Data Warehouse	2	5
	Self-Service Portal	2	5
	Total	8	16
Medium (up to 3,000 computers)	Management Server	4	8
	Data Warehouse	4	8
	Self-Service Portal	8	32
	Total	16	48
Large (up to 20,000 computers)	Management Server	4	8
	Data Warehouse	4	8
	Database	8	32
	Data Warehouse Database	8	8
	Self-Service Portal web content	4	16
	Self-Service Portal SharePoint	4	8
	Total	32	80

¹⁸ [How to install System Center Orchestrator](#)

¹⁹ [System requirements for System Center Orchestrator](#)

²⁰ [Recommended deployment topology scenarios for Service Manager](#)

System Center Service Provider Foundation

Microsoft's recommended system requirements for SCSPF are two virtual CPU cores and 16GB of virtual memory.²¹

Windows Azure Pack

Microsoft recommends a “distributed deployment” of WAP for production environments.²² A distributed deployment requires 8 VMs and a total of 16 virtual CPUs and 64GB virtual RAM (with no use of dynamic memory.)

Microsoft Azure Monitor and Azure Security Center Costs

The costs of Microsoft Azure Monitor and Azure Security Center subscriptions are added to the operational costs of the Microsoft configuration in some cases to better achieve functional parity with the VMware products selected. vCloud Suite editions include vRealize Operations and vRealize Log Insight, which provide management monitoring dashboard and analytics features not available in System Center. To better match those vRealize capabilities, the SaaS subscription costs of Azure Monitor – Log Analytics, Azure Monitor – Metric Queries, and Azure Monitor – Health Monitoring are included in Microsoft costs.

Azure Monitor – Log Analytics is priced at \$2.30 per GB per month with the first 5GB free in the US West 2 region. The Calculator assumes each VM generates 2GB of log data per month.

Azure Monitor – Metric Queries is priced at \$0.01 per 1,000 standard API calls with the first 1,000,000 standard API calls free in the US West 2 region. The Calculator assumes 50 metrics per VM per minute are gathered and there are 1,440 metrics per API call.

Azure Monitor – Health Monitoring is priced at \$0.10 per monitored metric per month in the US West 2 region. The Calculator assumes that 50 metrics per VM are monitored.

vSphere Platinum and vCloud Suite Platinum editions provide advanced endpoint security features not provided by Hyper-V or System Center. If those VMware editions are selected, the cost of **Azure Security Center** is included with Microsoft costs for better parity. Azure Security Center Standard tier is priced at \$14.60 per VM per month in the US West 2 region.

The Calculator will include Azure SaaS subscription costs as shown in Table 17.

²¹ *System requirements for System Center Service Provider Foundation*

²² *Windows Azure Pack system requirements overview*

Table 17. Microsoft Azure Monitor and Azure Security Center subscriptions included based on VMware product selected²³²⁴

Microsoft Azure Subscription Added	VMware Product Selected										
	vSphere					vCloud Suite					
	ESS	ESS+	STD	ENT+	Plat	STD	ADV	ENT	STD Plat	ADV Plat	ENT Plat
Azure Monitor - Log Analytics (\$2.30/GB/mo)						✓	✓	✓	✓	✓	✓
Azure Monitor – Metric Queries (\$0.01/1,000 std API calls/mo)						✓	✓	✓	✓	✓	✓
Azure Monitor - Health Monitoring (\$0.10/metric/mo)						✓	✓	✓	✓	✓	✓
Azure Security Center (\$14.60/VM/mo)					✓				✓	✓	✓

Operating Expenses

With the expanding breadth of capabilities provided by virtualization, as well as the increasing size of virtualization deployments, the cost of oversight for these environments is escalating. The role of IT within organizations now extends from managing physical servers to maintaining the entire virtualized environment and networks. Virtualization management software from both VMware and Microsoft attempts to simplify common IT tasks associated with operating a virtualized environment and private cloud, but there remains a gap in the amount of time required for IT personnel to perform these tasks on the two platforms. The Calculator considers the time required for a system administrator to complete the common recurring tasks that occur during the time period selected by the user—and the cost associated with that administrator’s time.

Operating Expenses for Common IT Scenarios

In independent studies commissioned by VMware, the system administrator work effort to complete an assortment of common operational tasks was measured to compare VMware and Microsoft server virtualization and private cloud platform products. The products tested include VMware vSphere 6.5 and vCloud Suite 7, and Windows Server 2016 Hyper-V and Microsoft System Center 2016. The scenario tasks measured are as follows:

1. Installing and configuring the platform
2. Deploying private cloud tenants
3. Creating private cloud self-service portals
4. Creating and deploying unencrypted VM templates
5. Modifying VM templates
6. Configuring security and deploying encrypted VM templates

²³ Azure Monitor pricing

²⁴ Azure Security Center pricing

7. Creating and deploying multi-VM application templates
8. Setting up and maintaining a management dashboard for monitoring
9. Configuring and maintaining log file monitoring and analysis
10. Configuring and generating private cloud chargeback reports
11. Configuring and maintaining capacity management
12. Applying hypervisor/OS patches to private cloud server nodes
13. Adding storage and balancing capacity
14. Creating self-service catalog entries for non-deployment activities
15. Migrating to Windows Server 2016 Hyper-V and System Center from a vSphere deployment

Task 15 is a migration cost associated with moving from vSphere to Windows Server Hyper-V and System Center; the cost is included in the comparison if the user selects the software upgrade scenario. The migration cost is assumed to be two hours of system administrator time per VM, based on customer experience.

The Calculator only applies scenario task costs when the selected VMware product edition actually has the capabilities associated with that scenario. For example, costs for Task 3 (creating private cloud self-service portals) would only be counted if the user has selected a vCloud Suite Advanced or Enterprise edition product. Table 18 shows the task scenario costs that are counted for each product edition selected.

Table 18. Scenarios Counted by Product Edition Selected

Note: These scenario costs are included in the TCO Comparison.

Operating Scenarios	vSphere					vCloud Suite		
	ESS	ESS+	STD	ENT+	Plat	STD (& Plat)	ADV (& Plat)	ENT (& Plat)
Installing and configuring the platform	✓*	✓*	✓**	✓**	✓**	✓†	✓††	✓††
Deploying private cloud tenants						✓	✓	✓
Creating private cloud self-service portals							✓	✓
Creating and deploying unencrypted VM templates	✓	✓	✓	✓	✓	✓	✓	✓
Modifying VM templates						✓	✓	✓
Configuring security and deploying encrypted VM templates				✓	✓	✓	✓	✓
Creating and deploying multi-VM application templates								✓

Operating Scenarios	vSphere					vCloud Suite		
	ESS	ESS+	STD	ENT+	Plat	STD (& Plat)	ADV (& Plat)	ENT (& Plat)
Setting up and maintaining management dashboard for monitoring						✓	✓	✓
Configuring and maintaining log file monitoring and analysis			✓	✓	✓	✓	✓	✓
Configuring and generating private cloud chargeback reports						✓	✓	✓
Configuring and maintaining capacity management						✓	✓	✓
Applying hypervisor/OS patches to private cloud server nodes	✓	✓	✓	✓	✓	✓	✓	✓
Adding storage and balancing capacity				✓	✓	✓	✓	✓
Creating self-service catalog entries for non-deployment activities							✓	✓
Migrating to Windows Server 2016 Hyper-V and System Center 2016 from a vSphere deployment	✓***	✓***	✓***	✓***	✓***			

* vCenter and vSphere host installation and configuration costs are included.
 ** vCenter, vSphere host, and vRealize Log Insight installation and configuration costs are included.
 † vCenter, vSphere host, vRealize Log Insight, vRealize Operations, and vRealize Business installation and configuration costs are included.
 †† vCenter, vSphere host, vRealize Log Insight, vRealize Operations, vRealize Business, and vRealize Automation installation and configuration costs are included.
 *** Migration costs are included with the Microsoft configuration only if the user selects the software upgrade scenario.

Independent lab tests conducted in June 2017 revealed that most of these relevant scenario tasks could be completed faster with VMware products than with Microsoft products. The Calculator considers how many times each scenario task would be repeated over the selected time period for the infrastructure size, based on the number of VMs selected. For the scenario task cost calculations, the

Calculator takes the average fully loaded cost per minute of senior system administrator time, \$1.11²⁵, and multiplies it by the number of minutes required to carry out the scenario over the selected time period. If the user selects a currency other than USD, the labor rate is converted using published exchange rates as of July 15, 2019. Only those scenarios applying to the selected VMware product edition are counted in the total costs. For more information about the scenarios and the methodology used for testing, see Table 11 of Appendix A in *VMware TCO Comparison Calculator – Results Report*. The independent studies comparing VMware and Microsoft system administrator task operational costs are available upon request from VMware.

Third-Party Software Costs

When you evaluate a virtualization solution, it is important to consider the full range of features and capabilities that each individual product has to offer. Although the virtualization platforms offered by both VMware and Microsoft have features in common, out-of-the-box capabilities of specific products vary by edition. To best compare product editions offered by VMware and Microsoft, the Calculator considers features available in each separate product edition, as compared in Table 19.

Table 19. Comparison of VMware and Microsoft Features

Cloud Management Products/Features	vSphere					vCloud Suite						Windows Server 2019 Hyper-V and System Center
	ESS	ESS+	STD	ENT+	Plat	STD	ADV	ENT	Plat STD	Plat ADV	Plat ENT	
Server virtualization	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
vMotion Live Migration		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
High availability		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Deduplicated VM backups		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
VM replication		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Incomplete
VM fault tolerance			✓	✓	✓	✓	✓	✓	✓	✓	✓	3 rd -party required
Storage vMotion			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Storage APIs			✓	✓	✓	✓	✓	✓	✓	✓	✓	Incomplete
Virtual volumes			✓	✓	✓	✓	✓	✓	✓	✓	✓	Incomplete
VM encryption				✓	✓	✓	✓	✓	✓	✓	✓	✓
Long-distance live migration				✓	✓	✓	✓	✓	✓	✓	✓	Incomplete
VM load balancing (DRS)				✓	✓	✓	✓	✓	✓	✓	✓	✓

²⁵ According to Salary.com. Based on the System Administrator III total compensation (salary + bonus + benefits) in the St. Louis, MO area. Retrieved July 15, 2019. Labor cost per minute is calculated based on 52 working weeks, 40 hours of work time per week.

Cloud Management Products/Features	vSphere					vCloud Suite						Windows Server 2019 Hyper-V and System Center
	ESS	ESS+STD	ENT+Plat	Plat	Plat	STD	ADV	ENT	Plat STD	Plat ADV	Plat ENT	
Storage load balancing (Storage DRS)			✓	✓		✓	✓	✓	✓	✓	✓	Missing
Distributed virtual switch			✓	✓		✓	✓	✓	✓	✓	✓	Incomplete
I/O controls (network & storage)				✓		✓	✓	✓	✓	✓	✓	Incomplete
Health monitoring & performance analytics						✓	✓	✓	✓	✓	✓	Azure services required
Capacity management & optimization						✓	✓	✓	✓	✓	✓	Azure services required
Operations dashboard						✓	✓	✓	✓	✓	✓	Azure services required
Cloud management						✓	✓	✓	✓	✓	✓	✓
Cloud cost showback automation							✓	✓		✓	✓	Missing
Multi-cloud automation & self-service							✓	✓		✓	✓	Azure services required
Cross-cloud application provisioning & monitoring								✓			✓	Azure services required
Log analytics			✓	✓	✓	✓	✓	✓	✓	✓	✓	Azure services required
Enhanced endpoint security				✓					✓	✓	✓	Azure services required

Depending on the specific VMware product edition and the features listed with that product, Windows Server Hyper-V and System Center may not match the complete range of capabilities. In the event of a feature gap, the Calculator includes the cost of applicable third-party software to cover that gap. In addition to the need to add Microsoft Azure Monitor and Azure Security Center subscriptions for feature gaps shown in Table 19, VM fault tolerance is a vSphere feature missing from Hyper-V. The license and support costs to add a third-party product filling that gap are shown in Table 20.

Table 20. Third-Party Software and Pricing

Feature	Suggested Third-party Software	License/Usage Cost	Support Cost
VM fault tolerance	Stratus everRun Enterprise Edition	\$5,998/CPU ²⁶	\$1,200/CPU per year

Note: Third-party software pricing is current as of July 15, 2019.

The Calculator takes the user's VMware product edition input and compares features of that product with those shown in Table 19. If the Calculator finds feature gaps, it assumes the user will purchase the applicable software from Table 20 to supplement features missing from a System Center deployment.

Products for which Stratus everRun Enterprise is added to the Microsoft cost:

- vSphere Standard
- vSphere Enterprise Plus
- vSphere Platinum
- vCloud Suite Standard & Platinum Standard
- vCloud Suite Advanced & Platinum Standard
- vCloud Suite Enterprise & Platinum Standard

Third-Party Software Calculations

The total cost for Stratus everRun Enterprise is price per CPU * number of host CPUs requiring FT protection.

Third-Party Software Integration Costs

Incorporating a third-party product into a virtualized infrastructure or private cloud requires extra effort to integrate the software with the primary platform and additional administrative time to develop and operate the processes to combine the products. The Calculator estimates those integration costs by adding 33 percent of the third-party product license costs as an additional operating expense.

Assumptions

Only a subset of applications normally require fault tolerance, so the Calculator assigns Stratus everRun Enterprise licenses to 10 percent of the Microsoft host CPUs.

If a currency other than USD is selected, third-party software prices are converted to that currency using published exchange rates as of July 15, 2019.

²⁶ *Stratus Technologies everRun Enterprise pricing (support costs estimated to be 20% annually)*



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