



Microsoft's Cloud Platform System Delivers Best Price-to-Performance

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Abstract: Converged infrastructure systems market has seen new offerings emerge from large technology vendors to startups, each trying to grab a piece of the fast growing multi-billion dollar market. Each of the vendors offer customizable yet proprietary compute, storage, and networking configurations, combined with their preferred systems and management software stack. This makes it difficult to compare the systems on a price-to-performance scale. Value Prism Consulting, a management consulting firm, was engaged by Microsoft® Corporation to review and contrast converged infrastructure offerings from four leading vendors based on publicly-available costs and specification data. On a price-to-performance scale, Microsoft's Cloud Platform System was seen as the most cost-effective solution providing high performance and great value.

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EXECUTIVE SUMMARY

Converged infrastructure systems include an integrated portfolio of compute, storage, and networking hardware along with the required systems and management software. Offered as an “integrated” package, these systems aim at accelerating time to value and reducing datacenter cost of ownership.

This whitepaper is aimed at organizations’ IT decision makers looking to compare and contrast converged infrastructure system offerings from leading technology vendors. Full-rack systems from VCE, HP, IBM, and Microsoft were reviewed and compared. Except Microsoft that uses Microsoft Hyper-V for virtualization, all remaining vendors were considered running a VMware hypervisor. Price-to-performance¹ comparisons have been collected and summarized across each vendor based on a price-per-Virtual Machine (VM) metric. Three additional price-to-performance metrics – price-per-system core, price-per-system memory, and price-per-usable storage; and two other VM workload performance metrics – available memory-per-core and available storage-per-core were also examined.

In Figure 1 results closer to the center show lower price-per-specification. The results show that Microsoft Cloud Platform System (CPS) has the lowest price-per-VM for a standard VM profile. The CPS full rack is also better or comparable to the competition in rest of the price-performance metrics, thus demonstrating that it is a high-performing and economical converged infrastructure offering. In addition to providing the lowest out-of-the gate price-per-VM for a single rack, CPS continues to deliver even greater economic advantage as customers’ needs scale to multiple racks.

This comparison is based on publicly available list price and specification metrics. Individual vendors offer different discounts and volume price breaks, so the actual results may be different than the ones listed here.



Figure 1: Price-to-Performance Ratios across Multiple Converged Infrastructure Systems (Costs in U.S. dollars, in Thousands)

¹ Refers to the five-year net present value (NPV) of system purchase price. This includes upfront costs of hardware, software licenses, installation, and prepaid maintenance and support; and recurring costs of maintenance and support agreements. All prices are list prices and exclude any vendor and volume specific discounts.

INTRODUCTION

Many modern data centers have transitioned from their legacy infrastructure or considering moving their application and database workloads to a virtualized environment. However even with a self-service and virtualized environment, considerable amounts of time and effort are invested in design and provisioning of basic cloud services, scaling out (adding new servers, storage, and application workloads), and integrating various non-standard hardware and software components. Customers desire a consistent cloud experience that supports business agility and reduces infrastructure and management costs; bringing into play the Converged Infrastructure System.

According to IDC, the converged infrastructure system sales grew close to 60% year over year by the end of 2Q 2014, exceeding U.S. \$1.35 billion in sales.ⁱ The market is split between large OEMs, the likes of IBM and HP; and technology integrators, such as VCE. In October 2014, Microsoft announced their entry into the converged infrastructure marketplace with Microsoft Cloud Platform System (CPS) featuring hardware from Dell.

Along with Microsoft, most vendors offer their converged infrastructure solutions as a pre-configured, pre-optimized, and scalable units, which include:

- Hardware components required to run the system, including the rack, servers, storage, and networking devices that support the organization's virtualization workloads;
- Software required to run the system, including server operating system, virtualization hypervisor, and management software used for monitoring and provisioning of datacenter workloads; and
- Installation and deployment services for system and software.

Combined, these end-to-end systems provide organizations an opportunity to get up and running quickly with their cloud initiatives, lower their IT costs, and deploy their revenue generating applications and services much faster. Customers can often pick a system and expect it will be nearly ready to plug-and-play with much less setup and configuration than a custom or build-it-yourself solution, which could take many months. By-and-large, purchase of the system is also a simple process that involves buying a fixed set of software and hardware. However with a pre-packaged model, it has also become harder to compare and contrast similar solutions.

In this study commissioned by Microsoft, several converged infrastructure systems, as listed in the sidebar, have been reviewed, summarized, and compared. Each vendor provides via its Website datasheets, architecture guidelines, and bill-of-material (BOM) lists that have been used as the primary source for specification data (such as cores, memory, storage, etc.). List pricing and other annual costs details are cited specifically, and are also taken from public sources. Full rack pricing and specifications were used for each vendor to ensure consistent comparison.

Data Warehouse Appliances included:

- Microsoft Cloud Platform System (hardware from Dell)*
- VCE Vblock System 340ⁱⁱ
- HP ConvergedSystem 700 (CS700)ⁱⁱⁱ with VMware
- IBM PureFlex System^{iv} (with Storwize V7000^v) with VMware

* Vendor provided pricing (list price) and specifications data for Microsoft CPS.

SYSTEM COSTS

The system costs over a five-year period were calculated to include upfront investments in hardware, software licenses, deployment, maintenance and support; and recurring annual investments in appliance maintenance and support agreements. The summary of the total price for converged infrastructure systems is presented as a five year NPV, which assumes a discount rate of 10%.

NOTE: This comparison is based on the list price and publicly available price and specification metrics. Each unique customer discount situation will be different, and more information (and customization) is likely available from each vendor so the comparison may be different than the one using only list prices and specifications. All prices are listed in U.S. dollars and rounded to the nearest hundreds for sub-categories and nearest thousands for totals.

Costs	Microsoft CPS (Dell hardware)	VCE Vblock System 340	HP CS700 (with VMware)	IBM PureFlex (with VMware)
System Nodes² (and Cores)	32 (512)	18 (288)	18 (304)	42 (664)
Appliance	\$1,635,600	\$1,085,500	\$806,400	\$2,008,600
Deployment	\$7,200 ³	\$89,000	\$72,000	\$75,000
Maintenance/Subscription	\$154,400 ⁴	\$124,500	\$104,600	\$247,200
Support	\$77,300	\$34,800	\$48,800	\$76,300
Total Y1 (Upfront)	\$1,874,000	\$1,334,000	\$1,032,000	\$2,407,000
Total Y2- Y5 (Annual)	\$232,000	\$159,000	\$153,000	\$324,000
5 Year NPV of Costs	\$2,609,000	\$1,838,000	\$1,517,000	\$3,434,000

Table 1: Costs summary for Converged Infrastructure Systems (Costs in U.S. dollars)

Appliance

The total price of each full rack appliance is based on publicly-available information directly from the vendor price lists or pricing tools, from a reseller that has listed vendor list pricing, or if necessary from news or blog articles that have published price estimates. Total retail price for each appliance, along with the pricing source, is listed below.

- **Microsoft's** pricing of U.S. \$1,635,600 is based on Dell hardware for a full rack CPS appliance with 32 system nodes (512 cores). Software pricing was excluded as it is not a one-time charge, and instead part of an annual subscription that is explained later in the whitepaper. The costs also included onsite deployment services from Dell. The pricing was furnished by the vendor for the purpose of this whitepaper.
- **VCE** provides an architecture overview ^{vi} document for the Vblock system 340 that lists the recommended BOM for the full rack appliance with 18 system nodes (288 cores). Vblock System 340 contains server and networking hardware from Cisco, ^{vii} storage hardware from EMC, ^{viii} and virtualization software from VMware. ^{ix x}

² Includes capacity and management nodes.

³ Only Microsoft Installation Services cost is considered. Deployment cost is included in Dell hardware price.

⁴ Enterprise Subscription includes cost of license and software maintenance (Microsoft Software Assurance) for fabric and guest VMs.

Additional software add-ons from Cisco^{xi} (for network switches), EMC (for storage solution), and Microsoft^{xii} (OS and database) were also considered as recommended in the architecture guidelines. The hardware and software costs from the sources cited above are U.S. \$629,000 and U.S. \$456,500 respectively for the 18-node full rack appliance.

- **HP** provides a quick specs~~Error! Bookmark not defined.~~ document and a technical system guide^{xiii} that lists the BOM for a full rack HP CS700 with 18 system nodes (304 cores). Hardware prices were derived from HP's configuration and pricing tool on their online store and totals to U.S. \$495,200 for the base + three expansion kit full rack.^{xiv} Software pricing includes components from HP,^{xv} VMware (for virtualization), and Microsoft (OS and database) totaling to U.S. \$311,200.
- **IBM** PureFlex and Storwize V7000 redbooks^{xvi xvii} were used to determine the complete BOM for PureFlex system full rack, which has 42 system nodes (664 cores). The hardware price was determined by building out the required configuration on IBM's online store^{xviii} and obtaining some individual hardware and IBM software component prices at the system options store.^{xix} The hardware list price for the a three-chassis full rack with x240 compute nodes comes up to U.S. \$1,280,100. The software costs also included VMware (for virtualization) and Microsoft (OS and database) licenses, totaling to U.S. \$728,500.

Deployment

The deployment costs are one-time professional services costs related to system and software installation and start up.

NOTE: This is only part of the overall deployment cost considerations. Customers should carefully evaluate overall project management, workload migration, and testing costs, which are highly variable and may not be similar across platforms.

- **Microsoft's** cost of U.S. \$7,200 only includes the Microsoft Installation Services fee. Additional onsite deployment services costs are included in the Dell hardware pricing.⁵
- **VCE** offers Deployment and Implementation Services, with a list price of U.S. \$89,000 for the Vblock System 340.
- **HP's** installation and deployment costs were obtained from an Enterprise Strategy Group (ESG) whitepaper, which listed these at U.S. \$72,000.^{xx}
- **IBM's** installation and deployment costs were similarly obtained from a Forrester whitepaper, which had these costs at U.S. \$50,000 for a 2 chassis PureFlex system.
^{xxi} A linear scaling was assumed to estimate the 3 chassis full rack cost of U.S. \$75,000.

⁵ Vendor furnished pricing data for the whitepaper.

Maintenance and Support

Most vendors require customers to pay an annual hardware and software support fee as a percentage of the initial acquisition costs. The table below summarizes these costs along with the source and assumptions:

- **Microsoft**'s annual maintenance and subscription price of U.S. \$154,400 includes annual software license subscription and software assurance (SA) costs for the Microsoft stack. The highest level of datacenter support offering – Premier Mission Critical (PMC) support agreement, costing U.S. \$77,300 for the full rack appliance is included as part of the annual support costs. Subscription and support pricing were furnished by the vendor.
- **VCE**'s annual software maintenance costs of U.S. \$124,500 includes VMware Support and Subscription (SnS),^{ix} x Microsoft SA,^{xii} and additional EMC software support costs, which ranges 7% to 23% of the list price.^{viii} Since VCE's premier support pricing was not available publicly, we estimated the annual support price by including Cisco's SmartNet 24x7x2^{xxii} and EMC's Optional Maintenance Costs^{viii} for hardware. These support levels are fairly representative of Microsoft's PMC support; and at U.S. \$34,800, estimated to be lower than VCE's premier support agreement.
- **HP**'s annual software maintenance costs of U.S. \$ 104,600 includes HP software support at approximately 21% of the list price,^{xiv} VMware SnS,^{ix} x and Microsoft SA.^{xii} HP offers a 24x7x4 Proactive Care Advanced hardware support service that is representative of Microsoft's PMC support level. The total hardware support price of U.S. \$48,800 was calculated using the HP Care Pack Central website.^{xxiii}
- **IBM**'s annual software maintenance costs at 25% of the list price,^{xxiv} added to the VMware SnS^{ix} x and Microsoft SA^{xii} totals to U.S. \$247,200. IBM 24x7x2 annual support with remote technical assistance for the three-chassis, 42-server full rack appliance was priced at U.S. \$76,300.^{xviii}

PRICE-TO-PERFORMANCE COMPARISONS

The Table 2 below summarizes key specifications of the converged infrastructure systems as obtained from their spec sheets, along with the five-year cost. Refer to Appendix C for more detailed specifications.

As seen in the table, the systems have varying numbers of cores, memory, and user storage, so simply looking at total price is not a reasonable comparison. To provide a more accurate comparison, scaled price-to-performance and VM performance metrics have been calculated and presented.

Specifications	Microsoft CPS (Dell hardware)	VCE Vblock System 340	HP CS700 (with VMware)	IBM PureFlex (with VMware)
Total System Cores ⁶	512	288	304	664
Total System Memory (GB) ⁶	8,192	1,792	4,608	10,528
RAW Storage (TB) ⁷	768	180	43	173
Usable Space Estimate (%) ⁸	33%	80%	80%	80%
Usable Storage (TB)	256	144	35	138
5 Year NPV of Costs	\$2,609,000	\$1,838,000	\$1,517,000	\$3,434,000

Table 2: Converged Infrastructure Systems Specifications and 5 Year NPV of Costs (Costs in U.S. dollars)

Performance Metrics:

- **Price-per-VM** as a key performance metric that shows the price for hosting a single standard VM across each vendor appliance. A lower value for a vendor indicates that, at the same available budget, a customer can set up a much denser environment hosting larger number of VM workloads compared to rest of the vendors.
- **Price-per-system core** as a measure of system performance at a given price. More cores provide capacity for more concurrent compute tasks. Lower price indicates better system performance at a given price.
- **Price-per-system memory** as a second measure of system performance. Since memory is able to store information in a quickly-accessible place, more memory means more information can be stored without having to write to a disk. Again, lower price indicates better system performance at a given price.
- **Price-per-usable storage space** as a storage value approximation that can help provide more comparison details when the amount of usable space is not the same across all vendor appliances. Lower price for a vendor indicates availability of more space for VM workloads compared to rest of the vendors, at the same price point.
- **Available memory-per-core** and **available storage-per-core** as VM performance indicators. A larger number indicates more system memory and storage space is available for a given VM profile.

Price per VM

For calculating the price-per-VM, we started off by defining the VM profile. We used the following VM profile as a “standard” for the metric calculations.

CPU	RAM (GB)	Disk Size (GB)
2	3.50	260

Table 3: Standard VM Profile

⁶ Includes compute and management nodes.

⁷ Includes storage from storage nodes / racks only. Does not count the disk space available within system nodes.

⁸ Discounted for RAID and fault tolerance.

Most datacenter virtual environments are oversubscribed and stacked, meaning the number of VMs multiplied by the available CPU cores is greater than the total CPU GHz purchased. This is required to make sure that the datacenter resources are not under-utilized. There are varying arguments on what should be considered an acceptable oversubscription factor; estimates point 1:1 to 3:1 as an acceptable range without a visible loss in performance. We considered a conservative 1.2:1 or 20% oversubscription.

Moreover, compute node CPUs for all vendor appliances were standardized to Intel E5-2650 v2, 8 core processors at 2.6GHz. Given hosters and cloud datacenters advertise vCPUs at 1GHz, we considered an additional stacking factor of 2.6 for our supported VM calculations. Finally, no memory oversubscription was considered as this is seen to adversely affect VM performance.

Supported VM Calculations:

Appliance	Capacity Cores ⁹	Capacity RAM (GB) ^{9 10}	Usable Disk Space (TB)	Total Supported VMs	5Yr NPV of Costs
Microsoft CPS	384	5,760	256	600	\$2,753,000
VCE Vblock 340	256	1,280	144	366	\$1,937,000
HP CS700	256	3,840	34.6	135	\$1,612,000
IBM PureFlex	656	9,840	138.2	528	\$3,635,000

Total number of supported VMs was limited either by total capacity cores, memory, or usable storage available for hosting the standard VM.

Table 4: Supported VM Calculations for Each Appliance (Costs in U.S. dollars)

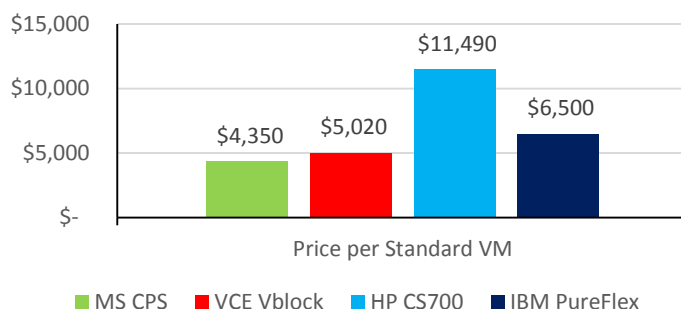


Figure 2: Price per VM Comparison for Each Appliance (Costs in U.S. dollars)

As seen in Figure 2, Microsoft CPS has the lowest price-per-VM metric. HP and IBM were limited by their low available storage, although the recommended and maximum supported disk size as per the architecture guidance was selected for each vendor.

⁹ For first rack only. Microsoft and IBM appliances use a portion of their capacity nodes on the first rack as management servers. These nodes are made free for capacity in the subsequent racks further improving price-per-VM metrics. See Multi-Rack View section.

¹⁰ A further 16GB of RAM was reduced per capacity node to accommodate OS partition and hypervisor functions.

Price per System Core

Appliance processors and cores provide the engines for running the VM workloads and associated management functionality. Dedicated management nodes ensure robust systems and private cloud management capabilities. Microsoft CPS has almost 8 management nodes in the first rack, which supports all capacity nodes in either a single rack (up to 24 nodes) or multi-rack configuration (up to 120 nodes). However for the remaining vendors examined, the dedicated management servers are a smaller fraction (2.5% to 12.5%) of the total capacity nodes. This could suggest that much of their management workload is being run on the capacity nodes, affecting the actual advertised compute capacity.

With more cores virtual machines run more efficiently; meaning they can handle larger workloads, while still providing high performance results. More is better, but with appliances that can scale by adding more nodes, chassis, or racks, even more important is the price per system core. Note that the number of cores is not directly correlated with the price – some licenses are not required for every core, but price-per-system core provides a view into the performance of each appliance as a factor of total costs. When viewed in relation to the price for full rack appliances, all vendors except VCE were in the U.S. \$5,000 per core range. VCE was the most expensive at U.S. \$6,380 per system core.

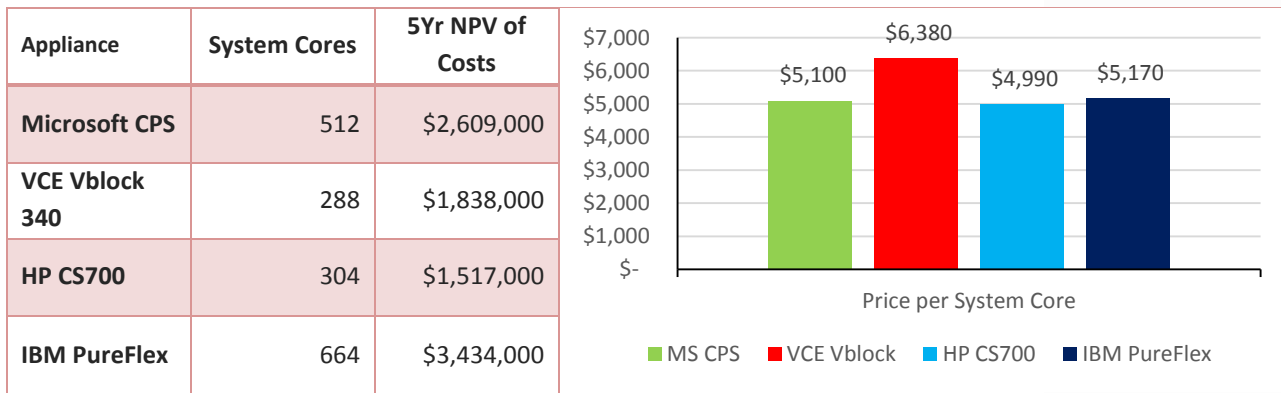


Figure 3: Price per System Core Comparison for Each Appliance (Costs in U.S. dollars)

Price per System Memory

Like cores, the amount of memory included in a full rack appliance is a significant indicator of potential performance. Large amounts of memory allow for faster operation of workloads by keeping more information to be processed in memory, instead of having to make read/write calls to the hard drive. Memory is much more expensive than disk drives (for equal units of storage), so in addition to the storage metric considered below, it is important to include price-per-memory ratio comparison as well. As seen in Figure 4, Microsoft CPS fared better than the competition and was almost 3 times lower compared to VCE.

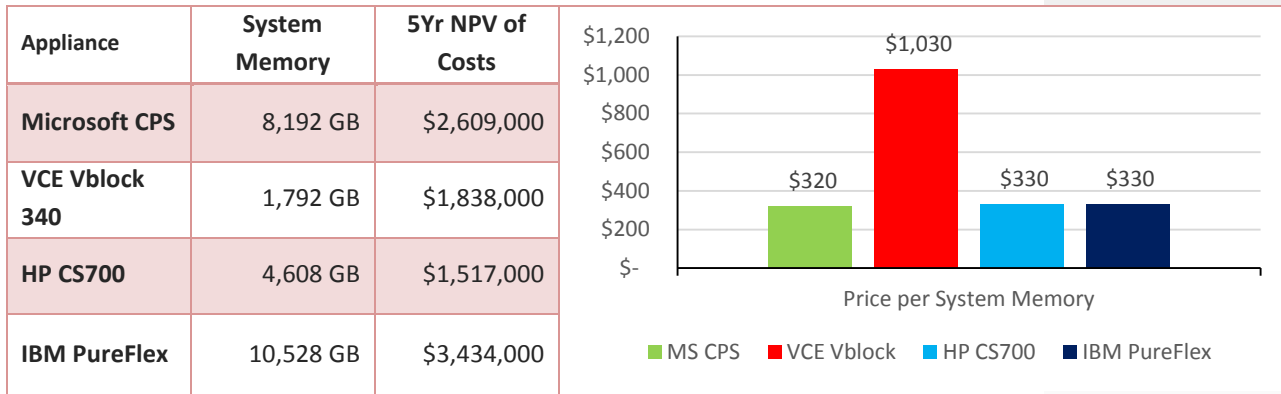


Figure 4: Price per System Memory (GB) Comparison for Each Appliance (Costs in U.S. dollars)

Price per Usable Storage

Usable storage for a full rack appliance is included to provide perspective of total storage provided for VM workloads after discounting for RAID and fault tolerance. For each vendor, we selected the recommended and maximum supported disk size as per the architecture guidance. On the price-per-usable storage metric, while Microsoft CPS led the pack, HP and IBM appliances performed poorly owing to their low available storage space.

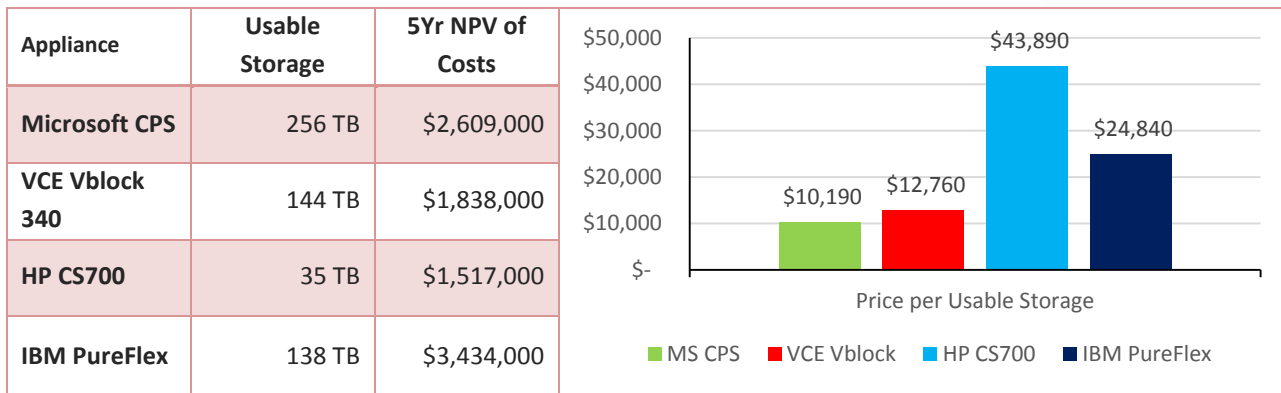


Figure 5: Price per Usable Storage (TB) Comparison for Each Appliance (Costs in U.S. dollars)

Other VM Performance Indicators

Low memory allocation is one of the most common causes of performance issues in VMs. Techniques such as memory compression and memory swapping can be used to get “more” out of the available RAM, but when overcommitted, these often lead to a severe degradation of VM performance. Similarly, storage oversubscription using techniques such as thin provisioning can often improve organization’s storage capacity utilization. However, if not managed properly VMs may be forced to believe there is space available when it actually isn’t, resulting in serious data losses.

The safest approach therefore, is to have enough memory and storage space in the system for supporting the VMs reliably. Thus, available memory-per-core and available storage-per-core are key VM performance indicators. Figure 6 and 7 show that

Microsoft CPS is either comparable or better than the rest of the vendor appliances for both these metrics. Also, Microsoft is seen to have 3x more memory per core compared to VCE's Vblock System 340.

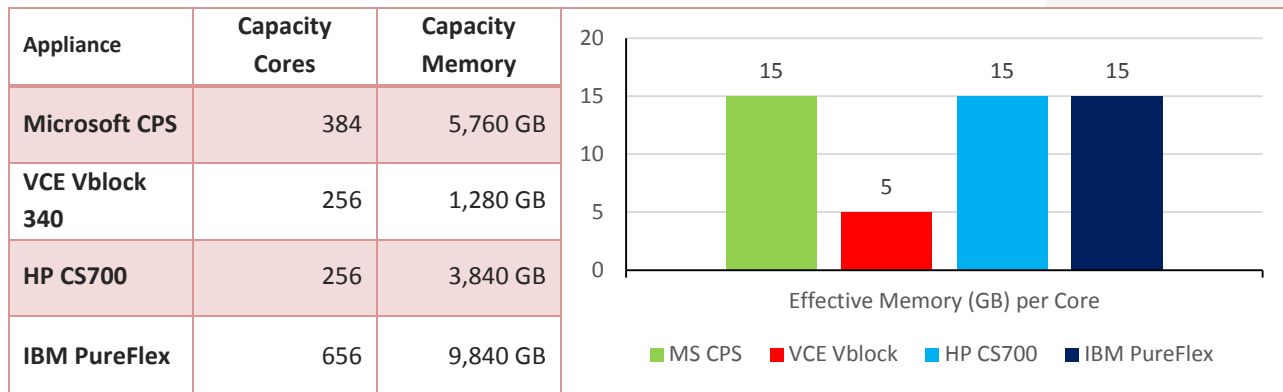


Figure 6: Memory (GB) per Capacity Core Comparison for Each Appliance

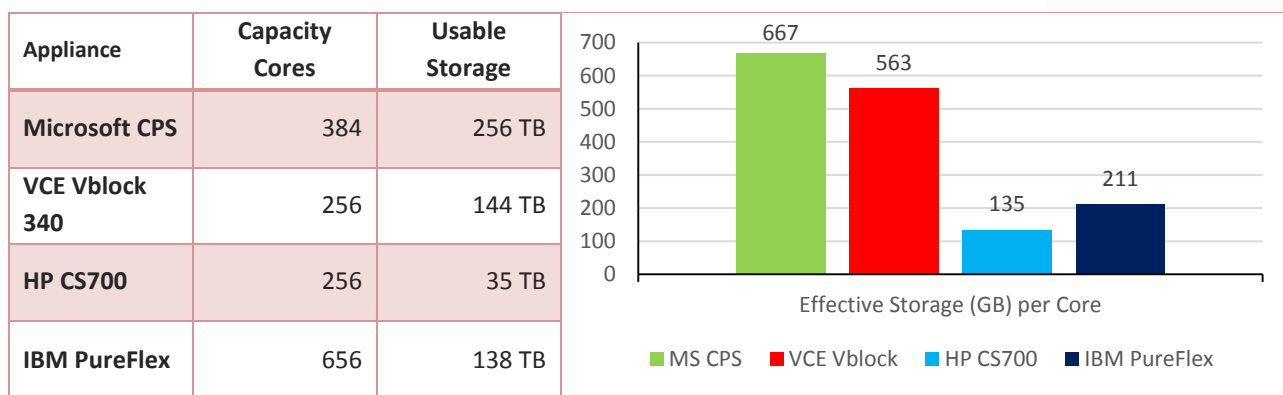


Figure 7: Usable Storage (TB) per Capacity Core Comparison for Each Appliance

MULTI-RACK VIEW

The scope of the analysis and the metrics discussed so far only looked at a single full rack configuration for each vendor. Addition of multiple racks may not directly correlate with the price as individual vendors may offer certain price breaks in the form of discounts for multiple racks and certain cost elements such as support costs may not scale similar to the rest of the hardware and software costs.

However, if we ignore the volume discounts, a linear scaling of price assumption could still provide a good view into the performance of multi-rack appliances as a factor of total price. The reason multi-rack view makes sense is because some vendor appliances, such as Microsoft CPS, use a portion of their capacity nodes on the first rack as management servers. These nodes are made free for capacity in the subsequent racks, which further drops their price-per-VM metrics in a multi-rack environment. Since VCE and HP have dedicated compute nodes, adding multiple racks will not lead to any

efficiencies on the price-per-VM metric. Similarly, IBM PureFlex, which is constrained by storage capacity also doesn't show any improvement in the metric as we add more racks. Figure 8 shows the price-per-VM efficiency gained by Microsoft CPS in multi-rack configurations and compares it to other vendors.

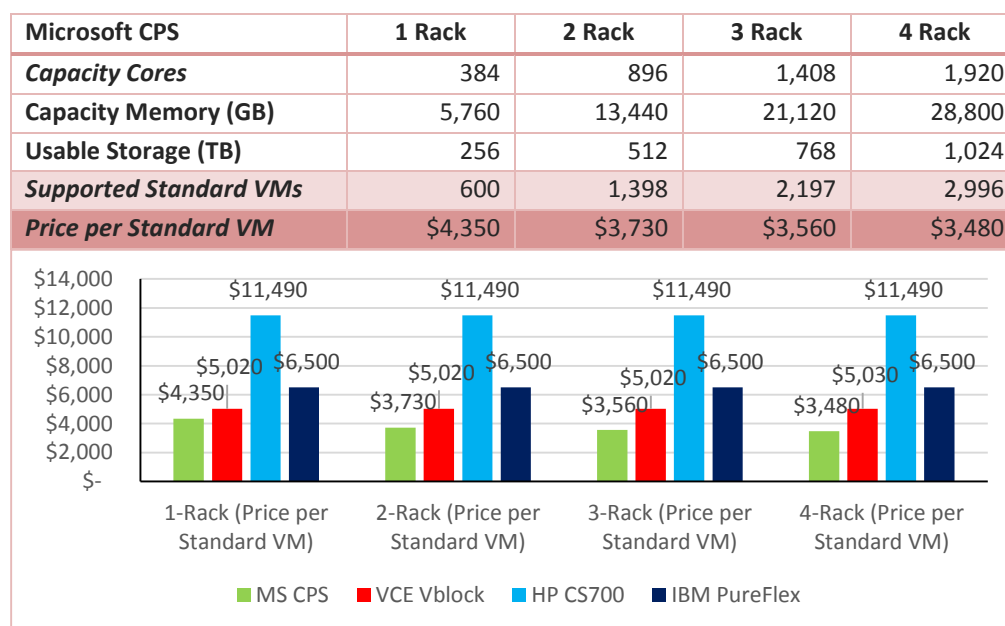


Figure 8: Price per VM Efficiency for Microsoft CPS (Costs in U.S. dollars)

CONCLUSION

The Microsoft Cloud Platform Solution provides breakthrough economics, both in terms of a competitively priced solution compared to the other vendor options, and also the best price-to-performance on key metrics such as Price-per-VM. It also offers the best memory-per-core and storage-per-core metrics in a single rack vs. the other named vendor alternatives, enabling customers to run intensive and mixed workloads.

Microsoft CPS	1 Rack	2 Rack	3 Rack	4 Rack
vs. Vblock System 340	15%-20% lower cost	35%-40% lower cost	40%-45% lower cost	45%-50% lower cost
vs. HP CS700 with VMware	160%-170% lower cost	200%-210% lower cost	220%-230% lower cost	230%-240% lower cost
vs. IBM PureFlex with VMware	45%-50% lower cost	70%-75% lower cost	80%-85% lower cost	85%-90% lower cost

Table 5: Microsoft CPS Price per VM Multi-Rack Efficiency

In addition to providing the lowest out-of-the gate price-per-VM for a single rack, Microsoft Cloud Platform System continues to deliver even greater economic advantage as customers' needs scale to multiple racks.

APPENDIX

A: Methodology

In a study commissioned by Microsoft, similar converged infrastructure systems from four leading vendors have been reviewed, summarized, and compared, based on publicly-available price and specification information. The four vendors compared in this study were:

- Microsoft
- VCE
- HP
- IBM

Full rack appliances for each vendor were compared, to ensure standard comparisons across large-capacity appliances. Summary metrics and total price were compared. Price-per-VM is used as a price/value approximation that can help provide more accurate comparison details when the amount of cores, memory, and usable space is not the same across all appliances.

Comparisons are based on the list price and publicly available cost and specification metrics. In addition to the appliance price, which is only part of the cost considerations, the analysis included installation, maintenance, and support costs.

Each discussion with vendors and their customer discount situation will be different, and more information (and customization) is likely available from the vendors. Individual results may thus be different than the ones listed here. Customer should carefully evaluate deployment, migration, and on-going management costs specific to their solution requirements before making a decision.

B: About Value Prism Consulting

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C: Converged Infrastructure System Specifications

Vendor:	Microsoft	VCE	HP	IBM
Product:	Microsoft CPS (Dell Hardware)	VCE Vblock 300 Series	HP CS 700 with VMware	IBM PureFlex System x240 with VMware
Unit Considered:	Single Rack	Vblock 340 Full Rack	Full Rack with Base + 3 Expansion Kits	3-chassis, with Storwize V7000
Hypervisor:	Microsoft Hyper-V	VMware vSphere	VMware vSphere	VMware vSphere
Management:	System Center 2012R2, Windows Azure	VMware vCenter, Other EMC and Cisco products	VMware vCenter, Other HP products	VMware vCenter, IBM Flex System Manager
Capacity Nodes:	24/32 ¹¹	16	16	41/42 ¹¹
Processors:	48	32	32	82
Cores:	384	256	256	656
Memory (GB):	5,760	1,280	3,840	9,840
Clock Speed (GHz):	2.6	2.6	2.6	2.6
Management Nodes:	8	2	2	1
Processors:	16	4	4	1
Cores:	128	32	48	8
Memory (GB):	2,048	256	512	32
Clock Speed (GHz):	2.6	2.6	2.4	2
Storage Nodes:	4	1	1	2
Processors:	8	2	1	2
Cores:	64	8	2	16
Memory (GB):	512	N/A	N/A	64
Clock Speed (GHz):	2.6	1.8	1.8	1.9
Storage Units:	4	4	6	4
Number of HDs:	48	60	144	96
HDD Size (TB):	4	3	0.3	1.8
RAW Storage (TB):	768	180	43.2	172.8
Usable space	33%	80%	80%	80%
Usable Storage (TB):	256	144	34.56	138.24

¹¹ For first rack only. Microsoft and IBM appliances use a portion of their capacity nodes on the first rack as management servers. These nodes are made free for capacity in the subsequent racks.

D: Sources

- ⁱ IDC Press Release. (2014, September 25). *Worldwide Integrated Infrastructure and Platforms Revenue Increased 33.8% Year Over Year to \$2.4 Billion in the Second Quarter of 2014, According to IDC*. <http://bit.ly/1utD25k>
- ⁱⁱ VCE. (2014). *Vblock™ System 340 At-A-Glance*. <http://bit.ly/Zudx6g>
- ⁱⁱⁱ HP. (2014, September 15). *QuickSpecs: HP ConvergedSystem 700 v1.1 for Virtualization*. <http://bit.ly/ZEHVLM>
- ^{iv} IBM/Lenovo. (2014). *Data Sheet: IBM PureFlex System*. <http://ibm.co/11oZhNV>
- ^v IBM. (2014, October). *Data Sheet: IBM Storwize V7000 Unified and Storwize V7000 Storage Systems*. <http://ibm.co/1sKmSCM>
- ^{vi} VCE. (2014, September). *VCE Vblock® System 340 Gen 3.2 Architecture Overview. Revision 3.5*. <http://bit.ly/1nmpHJY>
- ^{vii} Cisco. (Accessed 2014, October 7). *Cisco Build and Price tool*. <http://bit.ly/1sispgW>
- ^{viii} EMC. (Accessed 2014, October 7). *EMC Price List – State of Florida – (list price considered)*. <http://bit.ly/1qxanpF>
- ^{ix} VMware. (Accessed 2014, October 7). *VMware vSphere Pricing*. <http://vmw.re/1ssiUgM>
- ^x VMware. (Accessed 2014, October 7). *VMware vCenter Pricing*. <http://vmw.re/1np6jvW>
- ^{xi} Gemini Computers. (Accessed 2014, October 7). *Cisco DCNM SAN license price – (list price considered)*. <http://bit.ly/1tuJZDK>
- ^{xii} Microsoft. (Accessed 2014, October 7). *Microsoft Licensing Advisor*. <http://mla.microsoft.com/>
- ^{xiii} HP. (2014, June). *Technical System Guide: HP ConvergedSystem 700 for Virtualization*. <http://bit.ly/11oYoVt>
- ^{xiv} HP. (Accessed 2014, October 8). *HP Small & Medium Business Store*. <http://h30094.www3.hp.com>
- ^{xv} CompSource. (Accessed 2014, October 8). *CompSource online store*. <http://www.compsource.com>
- ^{xvi} IBM. (2014, September). *Redbook: IBM PureFlex System and IBM Flex System Products and Technology*. <http://ibm.co/1vwAHap>
- ^{xvii} IBM. (2014, July). *Redbook: Implementing the IBM Storwize V7000 V7.2*. <http://ibm.co/1sKmSCM>
- ^{xviii} IBM. (Accessed 2014, October 9). *IBM Build Your Own Flex System x240*. <http://ibm.co/1yFnf5m>
- ^{xix} IBM. (Accessed 2014, October 9). *IBM System Options, Storage, and Software*. <http://ibm.co/1sstTqt>
- ^{xx} The Enterprise Strategy Group. (2014, July). *Analyzing the Economic Value of HP ConvergedSystem 700 for Virtualization in an Enterprise Environment*. <http://bit.ly/1w9EitH>
- ^{xxi} Forrester. (2014, May). *The Total Economic Impact™ of IBM PureFlex System*. <http://ibm.co/100obmF>
- ^{xxii} Cisco. (Accessed 2014, October 7). *Cisco Global Price List – September 2013*. <http://bit.ly/1rd8zli>
- ^{xxiii} HP. (Accessed 2014, October 15). *HP Care Pack Central*. www.hp.com/go/carepackcentral
- ^{xxiv} IBM. (Accessed 2014, October 9). *IBM United States Software List Prices – June 2013*. <http://ibm.co/1vxpp5R>