



Research Report

VMware vs. KVM: A Functionality/Price Discussion

The Objective of This Report

The objective of this report is to provide information technology (IT) buyers with comparison of functionality and cost as they pertain to VMware and KVM hypervisor, infrastructure, and management stacks.

Key Findings

The key findings in this report are:

- VMware and KVM both offer similar functionality when it comes to performing the functions required by most IT managers (the ability to build, deploy, and manage virtual machines); and,
- ***KVM can cost up-to 40% less to implement and operate as compared with VMware.*** Service and support fees are generally similar when comparing VMware to KVM (when using the Red Hat implementation), but ***VMware's first year license fees are significantly higher and are primarily responsible for the large difference in cost.***

Background

EMC's VMware is the x86 market share leader when it comes to virtualization and related infrastructure and management. KVM (which stands for kernel-based virtual machine) is an open source implementation of virtualization (it leverages the Linux kernel).

VMware was founded in 1998, and has more than a decade to expand its product offerings and ecosystem. KVM was released as part of Linux 2.6.20 (in February, 2007) — and for the past five years the open source community has been expanding KVM functionality. Meanwhile a large ecosystem has developed around KVM with the Open Virtualization Alliance (OVA) and with the [oVirt project](#) (a community-led virtualization project focused on enriching KVM with virtualization management). Many OVA members offer solutions that provide KVM infrastructure and management extensions.

As a result, the open source community and the KVM ecosystem have been rapidly closing the functionality gap that initially existed between KVM and VMware.

Our Approach: Establish a Functionality Baseline, Then Compare Costs

To compare the VMware stack (hypervisor, infrastructure and management stack) to the KVM stack, it was necessary for us to examine the *functionality* of each stack. Our goal was to create an apples-to-apples comparison — and then compare prices based on like products.

What We Were Looking For

First and foremost, the basic functionality that we looked for was the ability to create and provision virtual machines (VMs) and facilities to manage those VMs. Both VMware and KVM/Linux distributions offer this baseline functionality.

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We then looked for more advanced functionality. Discussions with IT managers over the past several years (including discussions with two organizations mentioned later in this report) lead us to believe that the key functional elements that virtualization managers look for when evaluating virtualization products include live migration (the ability to assign running workloads to other hosts); high availability; and workload balancing/management (workload management is especially important because it is used to control virtual machine sprawl that occurs when virtual machines are done processing but not returned to the virtual resource pool). Further, IT managers have told us that speed of execution and scalability are important (because if jobs execute quickly, fewer machines are needed to do the tasks-at-hand).

Finding the Functionality: Different Places

As we started to compare VMware functionality to KVM functionality, we found a big difference in how each vendor packages its solutions. VMware tends to promote a single source of supply; where open source KVM tends to promote open source and ecosystem alternatives.

Because VMware has been in the virtualization market longer than KVM, VMware has been able to build a broad portfolio of virtualization infrastructure and management products that it can offer as a *single source vendor*. For the basic functionality described above, IT buyers would likely purchase an operating environment (either Linux or Windows), and VMware's vCenter and vSphere product offerings. (IT buyers can also turn to the VMware ecosystem for infrastructure/-management products — but most purchase directly from VMware as part of a bundled solution).

KVM, by virtue of being an open source technology, allows IT buyers to obtain KVM virtualization code as part of their Linux distribution — and then encourages the IT buyer to add infrastructure and management products from the supplier of the Linux distribution or from the supporting ecosystem. For instance:

- The leading enterprise distribution of Linux (the RHEL/KVM stack) packages its products both as Red Hat Enterprise Linux (RHEL), which includes KVM — and also as Red Hat Enterprise Virtualization (RHEV), which is a standalone enterprise virtualization offering that includes both the KVM hypervisor (RHEV-H) and virtualization management tools (RHEV-M); and,
- Another ecosystem supplier with functionality similar to VMware is IBM. In this case an IT buyer would purchase a Linux distribution with KVM (Red Hat's RHEL, for instance) and then purchase virtualization infrastructure and management products from IBM (in this case, the IT buyer would purchase IBM Systems Director, IBM Systems Director VMControl, and IBM's Smart Cloud Provisioning facility).

When we compare prices later in this report, we compare a RHEL/vCenter/vSphere stack to an all Red Hat stack, and to a RHEL/System Director/System Director VMControl/Smart Cloud Provisioning stack.

There Were Some Functional Differences Worth Noting

As we compared VMware stack offerings to KVM stack offerings, we found subtle operational differences. Both VMware and KVM can move live virtualized machines from one system to another, but VMware's vMotion (the product used to do this) is more automated than KVM's live migration facilities. Our point here is that both VMware and KVM can do the job — but one approach may be easier than the other approach. We could not assign a value for ease-of-use considerations (plus ease-of-use considerations are too subjective), so *we did not consider ease-of-use factors as we compared products*.

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Further, we found some clear technical differences between both stacks. For instance, KVM offers more vCPUs (virtual CPUs) per virtual machine (VM) than VMware. KVM offers 64 vCPUs as compared with VMware's 32. Also, some users point to memory usage as a differentiator (apparently KVM does a better job than VMware when dealing with heavy memory-oriented workloads). When it comes to speed, numerous studies (including a study by researcher Gionatan Danti [found here](#)), an [InfoWorld stack comparison](#), and customer internal anecdotal data (information gathered by engineers who operate both KVM and VMware environments) indicate that KVM outperforms VMware in various virtualization scenarios. Other technical differences can be found in Figure 1.

Figure 1 — Some Functional Differences between VMware and KVM Stack Implementations

| | VMware (ESX5) | KVM (RHEL 6.2) |
|------------------------|---------------------------|--|
| vCPUs per VM | 32 | 64 |
| Virtual NICs/guest | 10 | 8 |
| Live Storage Migration | yes | no |
| Guest OS Support | Red Hat, SUSE, Windows | Linux OSs, Apple, Windows, other x86 OSs |

Source: Clabby Analytics, May, 2012

The live storage migration comparison in Figure 1 helps illustrate the complexity of doing an apples-to-apples functional comparison. It can be argued that KVM does not offer live storage migration facilities because live storage migration is not offered as part of the RHEL Linux distribution. However, this kind of functionality can be obtained in upstream source repositories and in Debian pre-release builds (and IT administrators used to using open source code would probably seek it out from these sources).

Finally, when it comes to performance, our historical analysis of the SPECvirt_sc2010 virtualization [benchmark](#), shows that performance leadership tends to go back-and-forth (so we consider these products to be equivalent when it comes to performance).

Taking all of these nuances and technical differences into consideration, despite some differences in functionality and packaging, it is our opinion that VMware and KVM are "close-enough" when it comes to the basic functionality required by IT managers and administrators.

The Pricing Discussion

Our pricing discussion centers on comparing virtualization software stacks. We assume that all the hardware used in the comparison in this section is the same for each VMware/KVM implementation (hence, the cost for hardware is the same). We also assume that all implementations will be running on RHEL (so the operating system costs remains constant).

Pricing Models

Comparing VMware and KVM pricing is both simple and complex. It is simple because VMware's list pricing is built upon license, service and support fees — while KVM's list pricing is largely based on service and support. Finding this data on the Web is easy. The complexity arises, however, in figuring out the licensing requirements for each configuration.

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As an example of this complexity, consider VMware's licensing requirements. VMware's vSphere 5.0 is offered in three editions (standard, enterprise, and enterprise plus), each of which provides a different base entitlement for vRAM (virtual random access memory) capacity (standard edition allows 32 GB of vRAM; enterprise allows 64GB vRAM; and enterprise plus allows 96GB). These entitlements are aggregated across all CPU licenses of that edition, forming a total available pooled vRAM capacity. Customers need to either buy licenses for the total count of sockets for their particular edition — or licenses for the total vRAM on the VMs running on that edition. Further, customers need to purchase an annual service and support contract that entitles the customer to support, patches, and upgrades. These kinds of nuances make pricing analysis somewhat complex. (Incidentally, an in depth description of this pricing model can be found in this [12 page VMware document](#)).

Another subtlety in the KVM camp is that Red Hat offers a substantial discount to customers who commit to a three year service and support contract. (This discount is reflected in our pricing comparison later in this section).

Pricing: What We Found and Where We Found It

We gathered pricing data from several sources including:

- Vendor Websites;
- News articles and reports;
- Direct discussions with vendors; and,
- From other independent analysts.

VMware vSphere pricing can be found [here](#); VMware vCenter pricing can be found [here](#) and [here](#). Red Hat RHEL pricing can be found [here](#); RHEV-H and RHEV-M pricing can be found [here](#) (note RHEV-H and RHEV-M are packaged as Red Hat Enterprise Virtualization for Servers). Finally, IBM Systems Director and IBM Systems Director VMControl Enterprise Edition pricing can be found [here](#).

Our Pricing Findings

The server configuration that we chose to illustrate VMware vs. Red Hat and Red Hat/IBM configurations consisted of a 20 server, 2-socket server Linux environment. Using this configuration, we gathered the license count/price data from each of the sources mentioned in the previous section (directly from the vendor Websites or from the vendors themselves).

Note that the prices in Figure 2 are list prices — not street prices. Also note that in year 1, the VMware solution cost more than twice as much as the Red Hat/IBM solutions. This is why we state that the VMware license fees are primarily responsible for the price difference between VMware and KVM implementation. Notice in Figure 2 that license counts fluctuate between the products being compared. This is because the licensing terms are different by product – some are charged on a per socket basis with memory limits, some are charged on a per server basis. To better understand this point, see the “Pricing Models” subsection on the previous page.

Also notice in Figure 2 that the quantity required counts doubled for years 2 and 3. This is because buyers are paying for two years worth of license/support fees (as compared to a single year). Also notice how the VMware and Red Hat prices are very close in years two and three (within \$1,000 of each other). What this illustrates is that the bulk of the VMware cost is in year one — and the majority of that cost is for license acquisition. Look specifically at vSphere 5 Enterprise Edition license costs (year 1 is \$143,760 while years 2 and 3 add another \$57,520).

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Figure 2 — Comparative Acquisition and Service-and-Support (SnS) Costs Over 3 Years

| Year 1 | | | | LICENSE |
|---|--|------------|----------------|----------------------|
| | | LIST PRICE | QUANTITY REQ'D | &/or SnS COST |
| Configuration 1: A VMware Environment on Red Hat Linux | | | | |
| VMware vCenter Server 5 Standard (License) | | 6244 | 1 | 6244 |
| VMware vSphere 5 Enterprise Edition (License) | | 3594 | 40 | 143760 |
| Red Hat Ent. Linux 2-sockets (unlimited VMs 1 yr. premium) | | 3249 | 20 | 64980 |
| | | | | 214984 |
| Configuration 2: A Red Hat Virtualization/KVM Environment | | | | |
| Red Hat Ent. Linux 2-sockets (unlimited VMs 1 yr. premium) | | 3249 | 20 | 64980 |
| Red Hat Enterprise Virtualization for Servers (1 yr. premium) | | 749 | 40 | 29960 |
| | | | | 94940 |
| Configuration 3: A Red Hat Linux Environment w/IBM Sys Dir and VMControl | | | | |
| Red Hat Ent. Linux 2-sockets (unlimited VMs 1 yr. premium) | | 3249 | 20 | 64980 |
| IBM Systems Director Std. Edition (x86 Support & virt. media key) | | 450 | 20 | 9000 |
| IBM VMControl Enterprise Edition x86 (w/1 year SW maintenance) | | 1400 | 20 | 28000 |
| IBM SmartCloud Provisioning Resource Value Unit License + SW Subscription | | 125 | 20 | 2500 |
| | | | | 104480 |
| SnS Costs in Year 2 and 3 | | | | |
| Configuration 1: A VMware Environment on Red Hat Linux | | | | |
| VMware vCenter Server 5 Standard (License) | | 1249 | 2 | 2498 |
| VMware vSphere 5 Enterprise Edition (License) | | 719 | 80 | 57520 |
| Red Hat Ent. Linux 2-sockets (unlimited VMs 1 yr. premium) | | 3006 | 40 | 120220 |
| | | | | 180238 |
| Configuration 2: A Red Hat Virtualization/KVM Environment | | | | |
| Red Hat Ent. Linux 2-sockets (unlimited VMs 3 yr. premium) | | 3006 | 40 | 120220 |
| Red Hat Enterprise Virtualization for Servers (3 yr. premium) | | 693 | 80 | 55440 |
| | | | | 175660 |
| Configuration 3: A Red Hat Linux Environment w/IBM Sys Dir and VMControl | | | | |
| Red Hat Ent. Linux 2-sockets (unlimited VMs 1 yr. premium) | | 3006 | 40 | 120220 |
| IBM Systems Director Std. Edition (x86 Support & virt. media key) | | 90 | 40 | 3600 |
| IBM VMControl Enterprise Edition x86 (w/1 year SW maintenance) | | 280 | 40 | 11200 |
| IBM SmartCloud Provisioning Resource Value Unit License + SW Subscription | | 115 | 40 | 4600 |
| | | | | 139620 |
| Total 3 Year Cost of Ownership | | | | |
| | | | | |
| VMware with vSphere and vCenter | | | | \$ 395,222.00 |
| Red Hat | | | | \$ 270,600.00 |
| Red Hat w/IBM System Director and VMControl | | | | \$ 244,100.00 |

Source: Clabby Analytics — April, 2012

What is most noticeable in Figure 2 is that first year start-up costs for VMware are comparatively high (\$214,984) — but drop \$90,213/year in years two and three. By comparison, Red Hat subscription costs drop to \$89,630/year in years two and three. Meanwhile, the cost for the IBM Systems Director/IBM Systems Director VMControl and SmartCloud Provisioning solution drops to \$69,810/year in years two and three.

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This data illustrates that a 20 server VMware solution costs approximately 40% more than the lowest cost KVM solution (the IBM Systems Director/VMControl/SmartCloud Provisioning solution). This is a large price premium for products that are functionally equivalent. VMware users might claim that their products are deeper, better integrated — and even simpler to use than products from Red Hat and the KVM ecosystem. But, from our perspective (and we've seen KVM and VMware product demonstrations), KVM users can virtualize, provision, and manage their environments just as effectively using KVM ecosystem products. To us, VMware offers a lot of bells-and-whistles (product extension nice-to-haves) — but are these bells-and-whistles worth a 40% price premium?

Another Pricing Consideration: Memory Over-commit

Both KVM and VMware offer a function known as memory over-commit (the ability of a hypervisor to provision more random access memory to virtual machines than is physically available — the over-committed memory is called vRAM). Memory over-commit essentially provides a way to stretch memory use — and is used regularly in both VMware and KVM environments (VMware memory over-commit is turned-on by default).

The pricing issue with memory over-commit is that VMware users are granted the use of only a certain amount of pooled vRAM. If they exceed this pool limit, they are obligated to purchase more vCPU licenses from VMware. The KVM community has no such policy.

A description of VMware's vRAM usage can be found within [VMware's vSphere 5 Licensing, Pricing and Packaging](#) guide (see page 3), "when a virtual machine is powered on, the vRAM configured to that virtual machine counts against the pooled vRAM capacity up to a maximum of 96GB (i.e. a virtual machine with 128GB of configured vRAM will only use 96GB from the pooled vRAM capacity)... the easiest way to expand pooled vRAM capacity is to add more VMware vSphere CPU licenses of the same edition to the vRAM pool. Alternatively, customers can upgrade all CPU licenses in the vRAM pool to a VMware vSphere edition with a higher vRAM entitlement".

In short, if you exceed your vRAM usage limit, you need to buy more licenses. And this is causing some customers to evaluate whether they are willing to spend their money on extra VMware licenses — or whether they should just buy extra memory. KVM is not priced on vRAM usage — so KVM customers do not have this problem.

For more on this discussion, see the user comments contained on Scott Lowe's blog at: <http://blog.scottlowe.org/2008/03/18/more-on-memory-overcommitment/>.

What Customers (and a VMware Executive) Have to Say About VMware License Charges

There is a lesson to be learned about vendor lock-in pricing. It starts by visiting this [VMware community site](#) where dozens-upon-dozens of customers complain about the negative impact that VMware's price increases would have on their businesses. (Note, this feedback caused VMware to "[readjust](#)" its pricing.

To us, the feedback on the VMware community site shows that customers felt surprised and perturbed by VMware's pricing actions. These pricing actions represent a classic case of vendor lock-in, a scenario where a vendor has established a firm foothold in various enterprises and then ratchets up the price of its goods and services because the cost to switch away from that vendor's environment may be too prohibitive (retraining, increased risk, lost time, etc.). It is our opinion that this pricing action (even though

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it was adjusted) opened the door for other virtualization vendors because it has created a vendor trust issue. And this is why we expect open source KVM and Microsoft's Hyper-V to steadily gain acceptance in accounts that are willing to consider alternative-to-VMware virtualization solutions.

VMware's Future Pricing Policies

Only a few months ago at VMworld in Europe, VMware's CEO Paul Maritz was reported to have said that [VMware's licensing model could soon be changing](#) (again). Mr. Maritz indicated that the company may be moving toward a more consumption-based model.

We hope that a more usage-based pricing model is instituted at VMware. The initial feedback from VMware customers about having to worry about price increases related to exceeding memory thresholds shows us how annoying some vendor pricing strategies can be.

KVM Success Stories: IBM's Research Compute Cloud

To our delight we were able to find two organizations that were willing to speak on the record about their use of both the VMware and KVM stacks. And what is particularly interesting about these environments is that they both are service providers — and they each serve business users as well as cloud users (there is a big distinction between the two — as we will describe in more detail in this section). The organizations in question are the IBM Research Compute Cloud (RC2) and the Dutch Cloud.

The RC2 Cloud

IBM's RC2 is IBM's largest internal cloud deployment and is used by IBM engineers to conduct cloud computing research. This cloud uses over 200 IBM iDataPlex servers (large x86 rack systems) — with about 2,000 concurrent VMs operating at any given time (note, this environment uses both KVM and VMware for virtualization). This cloud is sustained by charging-back its customers for time used.

When asked about the differences between the KVM stack and the VMware stack, RC2 representatives told us that KVM is especially good for deploying virtual machines in Linux environments. KVM can run on many different operating environments (including Windows), but it did not surprise us that KVM does especially well in Linux environments (KVM is an open source community and Linux is closely associated with that community).

Dutch Cloud

A few months ago, *Clabby Analytics* participated in a customer briefing presented by Martijn van Zoeren, CEO of an organization known as DutchCloud, a leading ISP (internet service provider) based in the Netherlands that focuses on small and medium customers in just a few key industries (healthcare and electronics). DutchCloud offers its customers a wide range of cloud based services from fully managed Infrastructure-as-a-Service environment through to disaster recovery solutions.

When it comes to KVM, DutchCloud had been looking for some time for a light-weight highly functional solution for core cloud service delivery. Its challenges were to improve the delivery of cloud services in terms of cost, speed, agility, minimized operations and industrial strength solutions. And its primary objection to VMware had been cost (the company uses VMware — but was looking for an alternative).

What DutchCloud chose to do was to implement the KVM hypervisor for virtualization — and to augment this hypervisor with IBM SmartCloud Provisioning. The KVM hypervisor, as expected, significantly lowered virtualization license costs — but what surprised DutchCloud was the big bump in performance that they got from using KVM. IBM has integrated KVM with its

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x86 server solution (System x) — and is now reporting that KVM on System x has demonstrated 18% better virtual machine consolidation performance versus the competition (meaning VMware). The business benefits of this performance increase include:

- The ability to consolidate more workloads per virtualized server (this leads to better return-on-investment as the servers DutchCloud owns can now do more work);
Improved scalability (it is easy to scale KVM to large environment); a reduction in cloud management costs (in some enterprises, management can cost up to 50% of an IT operating budget. And in the ISP environment, the better a machine is managed, the more competitive and more profitable the ISV can be. Dutch Cloud reported “no/low maintenance, minimized operational administration, and no outages required for upgrades);
- Rapid deployment of new services in seconds rather than hours. (Dutch cloud can deploy hundreds of new VM instances in under 5 minutes — it takes them substantially longer to do the same with VMware); and,
- A big change in the delivery of disaster recovery services from cold-standby (capital intensive) to rapidly deployed (making the deployments “utilization efficient”) and making virtualization significantly more cost effective for customers and CSPs.

Summary Observations

In the end, this whole functionality/pricing discussion really resolves to a bells-and-whistles discussion. We grant that VMware products have deep functionality — and that they are generally very well integrated with one another. But our research shows that KVM and its ecosystem can accomplish most if not all of the same tasks as VMware (virtualization, provisioning, workload management, etc.) — but at a far lesser cost. And *this causes us to ask whether a 40% premium is worth the extra expenditures for some “nice-to-have” functionality.*

We also see virtualization vendor selection as key for strategic cloud planning. At *Clabby Analytics*, we are strong believers that no single system architecture does all jobs optimally. We would argue that vendors that offer different platforms for different workloads — and that build and integrate infrastructure and management products that maximize the performance of those platforms while reducing complexity — make a better longer term choice than a vendor that offers support for virtualization on a single, homogeneous platform (x86 architecture) that supports two operating environments. VMware is an x86 only product at this juncture...

Make no mistake about it — VMware is a great product. But with the pricing premium described herein, and with x86-only support, is it the best product in the long term as your company moves into the cloud computing era?

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Note: Pricing data obtained by Clabby Analytics shows significant price differences between the cost of VMware and KVM environments. We brought this to IBM's attention last year. This year, IBM commissioned us to take a closer look at VMware/KVM pricing — and to project virtualization market trends as we see them. This report is the culmination of our research. Other research and analysis conducted by Clabby Analytics can be found at: www.ClabbyAnalytics.com.