White Paper

The Critical Role of Virtualization in Modern Datacenters, Hybrid Clouds, and Containers

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IDC OPINION

Virtualization is the foundation of the datacenter, with over 80% of workloads being virtualized today, according to IDC's virtual machine (VM) forecast. However, while virtualization has matured and become ubiquitous, it is still evolving and will play a key role in the datacenter for years to come. Traditional virtualization, which dramatically improved server utilization via consolidation and greatly reduced server provisioning times, will still exist to serve legacy workloads. But virtualization is playing new roles in cloud and next-generation applications. Customers are beginning to supplement traditional virtualization management with private cloud architectures, which emphasize automation, orchestration, and self-service. On the public cloud side, virtualization serves as the infrastructure foundation of nearly all public clouds. For next-generation applications, many customers are using containers and operating system-level virtualization technology. Containers are used most often with server virtualization technology, which is better at handling hardware provisioning and multitenancy, while containers act as a package for applications. This growing range of hypervisor use cases is changing hypervisor deployments and requirements and creating more diversity, with multi-hypervisor deployments becoming common. Virtualization has embedded itself firmly into the software stack and will remain the foundational component of the datacenter, handling both traditional workloads and next-generation cloud-native workloads.

SITUATION OVERVIEW

Few technologies have seen a ramp in enterprise IT like virtualization. The cost savings from consolidation were obvious and immediate. As virtualization matured, customers began to realize many agility benefits as well. Virtualization is now the mainstream default server build in datacenters. However, the market has evolved considerably since virtualization's early days. Key datacenter initiatives for customers today include:

- Creating the software-defined datacenter, where everything is defined and manageable using software and application programming interfaces (APIs)
- Standardization of infrastructure through open standards, open APIs, and many forms of abstraction
- Continual pressure to deliver datacenters with lower cost, higher performance, and more efficiency
- Managing the transition from traditional to cloud-native architectures (Customers must find a way to utilize skills and build stacks that can serve both application eras.)

As the world moves toward the software-defined datacenter, cloud, and cloud-native application technology such as containers, virtualization remains a foundational component. Virtualization will continue to be a core infrastructure foundation for these initiatives, and it is evolving to fit these use cases. Open standards, open APIs, open source, and key integration points with cloud system software, containers, and management are driving this evolution.

The KVM Hypervisor

Kernel-Based Virtual Machine (KVM) is the leading open source hypervisor and enables Linux to become a virtualization host for both Linux- and Windows-based virtual guests. The project, hosted by the Linux Foundation, is an integral part of Linux. KVM has found an important place in IT technology because of several key factors:

- Much of the movement related to cloud and containers is based in open source. KVM, as a key component of modern infrastructure and also open source, is therefore a natural component to use in these solutions.
- KVM is highly integrated with key open source projects such as Docker, OpenStack, and oVirt for virtualization management. As hypervisors play an increasingly embedded role in many of these new open stacks, KVM integration is key to creating an end-to-end solution.
- KVM is available anywhere that Linux runs. Linux is used in a tremendous number of systems and use cases, and KVM has benefited from making itself available to nearly every Linux distribution or build.
- KVM has been used and proven in a wide variety of use cases over time, including on-premises enterprise virtualization, private cloud (such as OpenStack), hyperconverged and other hardware systems, public cloud, and telco networks for network functions virtualization (NFV). The ongoing evolution of KVM demonstrates its maturity, flexibility, and near-universal compatibility with anything that can run Linux.

The Rise of Multi-Hypervisor Deployments

Over the years, IDC virtualization survey data shows that customers have long been receptive to adopting a second hypervisor. Customers were driven primarily by lower pricing and fear of vendor lock-in and overdependence on a single vendor. But today, it is not simply about adding a new hypervisor to the existing server virtualization environment, although that is certainly happening as well. Many multi-hypervisor deployments are attached to newer stacks outside of traditional virtualization. For example, an OpenStack private cloud is often stood up in parallel with the traditional virtualized infrastructure. The OpenStack cloud runs more modern applications, while legacy applications remain on traditional virtual infrastructure. OpenStack uses a very different management paradigm and is most often attached to the KVM hypervisor, which is usually included in OpenStack distributions and highly integrated with OpenStack. Likewise, a customer could have different hypervisors for virtual desktop infrastructure (VDI) or for its container infrastructure. In many ways, hypervisors are not just a standalone product anymore. Hypervisors are rapidly being embedded into larger solution stacks.

The latest IDC virtualization study bears out the earlier trends in multi-hypervisor attitudes. In 2016, respondents of an IDC survey indicated that 26% of customers have already deployed more than one hypervisor platform, and another 23% have plans to deploy in the future. This means that nearly half of the market will be multi-hypervisor enabled in the future.

There are still several challenges facing customers using multiple hypervisors. Most often, customers use the new hypervisors to deploy new workloads, optimizing and testing the workload from the start. Migration from existing hypervisors is more challenging. First, the virtual machine must be converted into a different format, and the contents of the VM must be modified, such as drivers and agents. In many cases, the VM must be retested and retooled as the characteristics of the hypervisor may be different or the hypervisor may have different underlying storage or networking subsystems. There are tools that can help with this, but customers must evaluate each workload to determine the time and effort required.

Cloud and Virtualization

As businesses embrace cloud, both hosted public clouds and on-premises private clouds, it is a major transition in many ways beyond technology:

- Enterprises are balancing enterprise reliability, security, and performance against agility.
- IT staff need to develop the right resources, toolsets, and skills to grow into cloud while managing their existing noncloud infrastructure. Cloud is a cultural mindset shift, changing the way teams work together and upending traditional processes, workflows, and timelines.
- Customers want to avoid building yet another isolated silo of technology within the datacenter. This is driving customers to consider better integration of old and new, using tools that can integrate existing and new environments and tools that have vendor-specific functionality and can also span environments from other vendors or cloud providers.
- The cloud enables the sharing of components between traditional virtual stacks (old infrastructure) and cloud stacks (new infrastructure) — for example, connecting both stacks via a standardized software-defined networking (SDN) system or standardizing the hypervisor across both stacks.
- Open standards and open APIs make current integration easier and improve flexibility for future integrations.

Virtualization plays a key role in cloud, serving as the core compute component and integrating with the hypervisor and its management. Virtualization remains at the core of nearly every private cloud and public infrastructure-as-a-service (IaaS) cloud.

An example of an important cloud platform is OpenStack, which provides an integrated IaaS cloud and is used in the public cloud and private cloud and in telco networks for NFV. One of the largest projects within OpenStack is Nova, which orchestrates software-defined compute through a hypervisor. While Nova includes drivers for many hypervisors, KVM has emerged as the unofficial reference standard for OpenStack. The highest level of OpenStack compute functionality is with KVM; it has the most documentation and testing, and it is part of Linux. As a result, KVM accounts for the overwhelming majority of OpenStack hypervisors.

Red Hat Virtualization

Red Hat has been a central figure in fostering the development of KVM and has brought a commercial version to market with Red Hat Virtualization. With Red Hat's influence with Linux and open source and the company's long history of successfully commercializing many open source projects, KVM is rapidly building up steam as an open virtualization platform.

The core Red Hat Virtualization offering consists of an enterprise implementation of the KVM hypervisor that is part of an optimized version of Red Hat Enterprise Linux. It also includes virtualization management based on the open source oVirt project, which is a Red Hat JBoss

Middleware Java application, allowing it to run on a fully open source stack of Linux and Java. Some of the new key features in the latest release of Red Hat Virtualization are:

- Support for Red Hat Enterprise Linux Atomic Host via a container guest agent that allows users to inventory containers running on KVM and provides insight into containers running on the hypervisor
- New features incorporated from Red Hat Enterprise Linux 7 and Red Hat JBoss EAP 7
- A writable installer image for more flexibility in deployments and customization
- A virtual-to-virtual (V2V) conversion tool, allowing for one-click migration from VMware vSphere (The V2V feature is also integrated with CloudForms, which allows for further automation of the V2V process.)
- An improved graphical user interface (GUI) with a dashboard view for easy visual monitoring of the virtual infrastructure
- Fully REST API enabled, allowing the use of both Red Hat tools and custom-developed tools
- Integration with and support for OpenStack Neutron networking and Glance storage services; integration with Ansible by Red Hat for greater automation of configuration and updates
- Advanced storage performance and scaling with a new storage pool manager, creating greater storage efficiency; advanced high availability, including support for stretched multisite clusters

Red Hat Virtualization Licensing Model

Like all Red Hat products, Red Hat Virtualization is available through a subscription model that includes software access, support, patches, and community participation. The standalone Red Hat Virtualization subscription is a single edition that consists of the manager and hypervisor and includes all core enterprise virtualization features built in, including live migration, high availability, user portal, and reports. Red Hat Virtualization is also now a key part of larger Red Hat bundles and suite products in areas including OpenStack private clouds, containers, and platform-as-a-service (PaaS) solutions.

Red Hat Virtualization Integration Across the Red Hat Stack

Red Hat Virtualization is much more than a virtualization software package; it also serves as the foundation of the larger Red Hat cloud stack and is deeply integrated into the Red Hat portfolio:

- Red Hat Virtualization is the compute foundation for Red Hat's next-generation cloud technologies. Red Hat OpenStack Platform and Red Hat OpenShift Container Platform are highly integrated with Red Hat Virtualization and use it at the lowest layers for software-defined compute.
- Red Hat Virtualization is essentially a highly optimized and tailored version of Red Hat Enterprise Linux that is designed exclusively for virtualization. This makes Red Hat Virtualization familiar to existing Red Hat Enterprise Linux users and makes the path to containers and OpenStack easier. Red Hat Virtualization is integrated into Red Hat's management portfolio, with Ansible by Red Hat and Red Hat CloudForms being key products that can be used to manage and automate Red Hat Virtualization and platforms built on top of Red Hat Virtualization, such as OpenShift and OpenStack.

With Red Hat Virtualization, Red Hat is uniquely positioned to help businesses grow beyond traditional virtualization to containers, container orchestration platforms, private cloud, automation, and hybrid cloud management. All parts of the Red Hat stack are open source, but they are all integrated with Red Hat Virtualization, tested as one, and supported by a single vendor.

Red Hat-Microsoft Interoperability

Even though KVM is a Linux-based virtualization solution, Windows is treated as a first-class guest. Red Hat and Microsoft have entered into an interoperability and support agreement that ensures that customers will be able to use a combination of solutions from the two companies with support from both vendors.

Within the Red Hat Virtualization environment, Windows VMs are able to use the same full scalability features as Linux VMs, such as the number of vCPUs and the amount of vRAM. In addition, Red Hat provides Windows drivers for Red Hat Virtualization, which are conveniently available through the Windows Update service. Red Hat has attained Microsoft's Server Virtualization Validation Program (SVVP) certification, which means that Windows and all Microsoft software are validated for and supported on Red Hat Virtualization.

In addition, Red Hat certifies Red Hat Enterprise Linux and all Red Hat software on Hyper-V Red Hat Enterprise Linux 6.4 or higher versions include the Microsoft Hyper-V Linux drivers, which were recently accepted by the upstream Linux community. These drivers improve the overall performance of Red Hat Enterprise Linux when running as a guest on Microsoft Hyper-V. Installation support for the Hyper-V paravirtualization drivers enables easy deployment of Red Hat Enterprise Linux as a guest in these environments.

The Red Hat and Microsoft collaboration goes well beyond just virtualization support. The two companies have entered into a broad corporate-level partnership that includes engineering collaboration, certification, and joint support across a number of areas, including Azure, .NET, and management.

FUTURE OUTLOOK

Containers and Virtualization

Containers are one of the hottest trends in the IT industry today. They are a form of operating system virtualization and allow quick and efficient packaging and execution of application code. However, containers do not replace virtualization; rather, they work with virtualization. A recent IDC container study found that more than 80% of containers today are running virtualized on a hypervisor. Hypervisors bring key functionality to containers:

- Hypervisors provide much stronger isolation than containers. This is key especially in the public cloud where you would never see different tenants separated only by a container boundary. Inside enterprises, there are also many reasons to use a hypervisor for isolation. Different business units or workloads may have different policies or regulatory requirements, and a hypervisor provides additional separation in these cases. Hypervisors are standard for hardware provisioning and have very mature tools for this task, and they are already in place in nearly all enterprises. Hypervisors are good at controlling hardware resources, and containers are a further granular provisioning of the operating system inside of VMs, providing needed provisioning at different layers.
- Most enterprises will run a mixed mode of VMs and containers for the foreseeable future, and having hypervisors and containers separated is undesirable from both a management point of view and an integration point of view.

Hypervisors will continue to be optimized and integrated with containers; the industry is just beginning to deliver on those, and there will be much more innovation going forward. While IDC believes that most containers will continue to run on hypervisors, that does not mean that the dynamics of the

hypervisor market will not be affected. Hypervisors as an embedded part of a container stack play a much different role today with traditional VMs. Many of the requirements and value of the hypervisor in a container stack will change, and this could alter the revenue and share of the current virtualization market.

The New Role of Open Source

One of the key influencers in modern cloud infrastructure and applications is open source. When Linux and open source were first getting started in the 1990s, the focus was on proving open source as a sustainable, valid software development model that could produce production quality software. Most of the projects focused on providing open source versions of existing proprietary software, such as operating systems and web servers.

Today, the open source landscape has changed dramatically. Open source is a well-proven and widely accepted software development model, with many successful and widely used projects. Nearly every software vendor today is involved in open source in some way, with many formerly classic proprietary software vendors now embracing open source. In the era of cloud, containers, agile, and DevOps, open source is at the forefront of innovation. In some areas of the market, open source has become the mainstream model and a requirement for entry.

Many of the open source projects and cloud-native concepts have been put into heavy use by innovative public cloud providers and digital, web, and software-as-a-service (SaaS) tech companies. They are serving as the pioneers and testing ground for the rest of the industry. Enterprises are now emulating these architectures and approaches to infrastructure and applications and finding a way to fit them into an enterprise framework. Key to success is not just open source but the open standards and open APIs that are prevalent with open source and essential for portability, integration, and interoperability. For virtualization, open source hypervisors can be a common uniting element that can cross the chasm between traditional and next-generation infrastructure and applications.

CHALLENGES AND OPPORTUNITIES

Challenges

- **Expanding beyond the Linux install base.** KVM's close ties with Linux create some challenges because customers perceive Red Hat Virtualization as a solution for Linux only, although Windows is well supported. Customers not familiar with Linux may be hesitant to try Red Hat Virtualization, fearing that they do not have Linux skills and knowledge, although Red Hat has worked to package Red Hat Virtualization to be consumable by non-Linux customers.
- **Competing in the hypervisor space.** The competition among hypervisors, especially for traditional virtualization deployments, is still intense today, with large and formidable vendors, such as VMware and Microsoft, jockeying for the market. Open source hypervisors have had a much harder time penetrating that market, but new opportunities in cloud and containers present new ways to build footholds and market share.
- **Building ecosystem and independent software vendor (ISV) support and certification.** The ecosystem is critical in adding value to any system platform and is a force multiplier for market success. Red Hat Virtualization is competing with hypervisors and other platforms for partner attention. Given the practical resource limits of most vendors, Red Hat Virtualization will need to find a way to be on the priority list.

Opportunities

- **Cloud, web, and telco providers.** Open source has experienced great early success in the cloud as service providers have liked the customizable code and the low cost. While this opens doors for commercial open source vendors, it has also been historically challenging to convert these service providers to use paid subscription support services for solutions based on open source software.
- **The reach of Linux.** As an integral part of Linux, the KVM hypervisor exists wherever Linux exists. Eventually, Linux users will expect KVM virtualization services to always be available to them. The wide and varied distribution model for Linux will spread KVM broadly, with Linux vendors tasked with getting users to embrace it and pay for it. Red Hat Virtualization and oVirt will help increase the adoption of commercially supportable open source virtualization management, just as Fedora and Red Hat Enterprise Linux have with Linux.
- **New deployment models and stacks for cloud-native applications.** Technologies such as OpenStack, container-use hypervisors, KVM, and open source are heavily preferred in these ecosystems. While traditional virtualization is a very mature market, the needs and economics of new emerging cloud stacks are very different, and KVM and Red Hat Virtualization have already built key positions in these markets.
- **Open source cloud and containers.** Open source is more accepted than ever. Red Hat Virtualization and KVM can capitalize on the growing wave of open source affinity to grow traction for Red Hat Virtualization and other open source products.

CONCLUSION

With the many changes happening to infrastructure in the cloud era, virtualization is still the foundation for infrastructure, tomorrow's and yesterday's. Virtualization is finding new and different roles under next-generation infrastructure, supporting private and public clouds and new compute models such as containers while still maintaining its massive base of traditional infrastructure. Open source is also playing an increasingly influential role in the modern era of cloud. Many users today equate open source with innovation and want an open source stack for not only new functionality but also the ability to openly integrate and standardize the datacenter.

Red Hat Virtualization is a mature open virtualization platform that builds off the open source projects KVM and oVirt. Red Hat's history of commercializing Linux and other open source software positions the company to be a leader in bringing KVM to enterprises. Red Hat Virtualization is a robust, standalone virtualization product, but Red Hat has also positioned Red Hat Virtualization as the common foundation across traditional and cloud stacks. Whether OpenStack, containers, or OpenShift, Red Hat Virtualization powers these platforms and is highly integrated through common management technologies, such as Ansible by Red Hat and Red Hat CloudForms. Red Hat, a trusted vendor in enterprise open source, is well positioned to deliver open source innovation in a fully supported, tested, and integrated stack that can span traditional and cloud scenarios.

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