

Dell EMC VxRail and VMware running Kubernetes Containers

Silverton Consulting, Inc. StorInt™ Briefing



Introduction

Containers are a powerful technology solution used to run cloud-native services, along with highly scalable, in cloud or on-premises applications. Containers support modern application development and operations models that enable rapid implementation, automated deployment and easy scalability.



Dell EMC® VxRail™ offers various multi-server and rack-scale configurations to run any workload, including IO-, compute- and GPU-intensive configurations. VxRail comes with VMware vSphere®, vSAN and Dell EMC VxRail HCI System Software technologies to make data center deployment and operations as easy as possible. Because VxRail runs vSphere virtualization, it inherits all of its many approaches for running containerized and virtualized application workloads.

VxRail can host containers using any of the following solutions with increasing levels of automation and operations visibility:

- **Standalone Kubernetes® open source software** – container developers do it all - downloading, installing, validating, maintaining, and patching/upgrading software and plugins - using CLIs and APIs, running Kubernetes cluster-node VMs.
- **VMware Essential PKS** – container developers have access to a VMware-maintained version of Kubernetes plus selected VMware open source projects and tools made to run with Kubernetes. DevOps will still need to use CLIs and APIs to maintain and manage Kubernetes cluster-node VMs.
- **VMware Enterprise PKS** – this self-service container solution runs standalone on vSphere or with VMware Cloud Foundation™ (VCF) and offers advanced networking, multi-availability zones, a private container registry, and lifecycle management. Enterprise PKS simplifies the deployment and operation of Kubernetes clusters so you can run and manage production container applications at scale in the data center. When joined with VCF, Enterprise PKS provides an even more automated operational environment to run Kubernetes clusters, alongside traditional apps on the same infrastructure.
- **Pivotal Ready Architecture (PRA)** - developers and operations staff can use this pre-validated reference architecture to take advantage of a complete cloud-native application development solution, with Pivotal Platform. Pivotal Platform, a unified, multi-cloud product to run your enterprise apps, enables IT to automatically build, run and manage their container applications on premises, leveraging VMware vSphere, vSAN, and NSX-T virtualization products.



Consequently, VMware supports many ways to run containers in the enterprise. VxRail, jointly developed for, with and to enhance VMware, is powered with the latest Intel® second-generation Xeon® Scalable Processors and comes with Dell's single-support model. As a result, VxRail, makes hyper-converged infrastructure a reliable and simple system for running vSphere VMs and containers.

Containers

Although cloud-native container applications have been around since the early 2000s¹, they really gained popularity in 2013 with the release of the open source Docker™ project container image format and runtime. Docker images are a standardized, lightweight, standalone, executable package containing everything needed to run a function, such as code, runtime libraries, environmental variables and configuration files.

Containers are used to implement cloud-native web services and other highly scalable applications that distribute functionality across multiple executable units, called instances. Normally, an application uses a few to dozens of container instances, each of which implements a small amount of functionality called a **microservice**. To scale application performance, additional container instances providing the same microservice are deployed, and when no longer needed, can be halted.

Containers can also be used to encase traditional monolithic applications. This could be used, for instance to migrate some traditional applications to a more containerized environment. However, doing so would not make these applications cloud native. To make monolithic applications cloud-native, they would need to be re-factored to make use of microservices.

Containers are designed to run isolated from a host or server hardware and OS software, accessing data storage and ports only if configured to do so. Containers have historically executed in a **state-less** fashion, meaning that any container state information is lost when an instance is terminated.

On the other hand, containers are increasingly being used for mission-critical applications, which have more of a need for persistent data. Newer versions of container systems have thus begun to offer container persistent storage or volumes.

¹ See **A brief history of containers**, <https://blog.aquasec.com/a-brief-history-of-containers-from-1970s-chroot-to-docker-2016> as of 2 January 2020.

Persistent volumes can be provisioned automatically during container initialization and reside on system storage.

Development teams use containers for a number of reasons, including the following:

- **Faster development and deployment** – container applications can be built from existing or new microservices, programmatically deployed across large infrastructure farms and updated automatically.
- **Security** – container applications can be used to quickly restore application functionality to a prior, known good version as well as repair container instance execution environments.
- **Portability** – container applications can be developed once and run just about anywhere (e.g., on bare metal servers, on virtualized infrastructure in core data centers or at the edge, along with private- or public cloud environments).
- **Higher resilience** – container applications run as multiple container instances, any of which can fail, be tossed away and if needed, another instance deployed.
- **Scalability** – container instances can be automatically scaled up or down in response to service demand.
- **API driven** – containers are designed to be fully API managed, i.e., deployed, run and updated under API control, to minimize operator intervention.

Containers enable organizations to move application engineering to a more modern development paradigm.

Moreover, when new functionality or application updates are implemented using containers, applications can evolve in smaller increments rather than through major releases. This capability allows DevOps to supply a quicker rollout of new features and a more agile development lifecycle.

Container services exist as instance images that reside in **registries**. Docker supports its own public registry service called the Docker Hub™,² which holds 2.7M+ container applications, including Redis™, MongoDB™ and MySQL™ instances, which are all freely available. The Pivotal Platform supports its own registry called VMware Harbor.

Security for container applications starts with instance images that reside in registries. So, registry selection, for your containers application environment, is a critical consideration for running secure container applications.

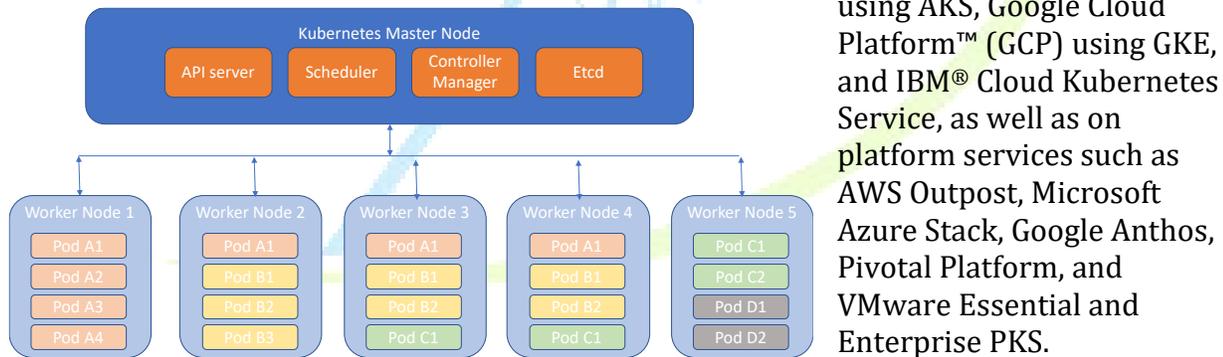
²Please see [Docker Hub website](#), as of 03Nov2019.

Besides security, running container applications in a production environment can be challenging. For example, the rapid scaling of applications, which uses additional resources may be an issue for data centers where consumption is more stable. Similarly, the movement of container instances from one host to another, under orchestration control, can also be a concern. This is again due to the rapid decrease and increase in resource consumption, which production environments may not handle well.

Container instances execute under a container host or engine. Development teams leverage container orchestration tools to control and automate many tasks like automating the deployment, management, scaling, networking, and availability of containers. Without container orchestration managing multiple containers would just be impossible. There are many container orchestration tools but Kubernetes, which Pivotal Platform and VMware leverages, has gained in popularity and has become the gold standard.

Kubernetes container orchestration

Originally developed by Google, Kubernetes is now managed by the Cloud Native Computing Foundation (CNCF) and has become the industry's premier container orchestration system. Kubernetes clusters are available on public cloud environments such as Amazon Web Services™ (AWS) using EKS, Microsoft Azure™



using AKS, Google Cloud Platform™ (GCP) using GKE, and IBM® Cloud Kubernetes Service, as well as on platform services such as AWS Outpost, Microsoft Azure Stack, Google Anthos, Pivotal Platform, and VMware Essential and Enterprise PKS.

Kubernetes schedules and manages container application execution using **master node(s)**. Master nodes provide the environment to execute the Kubernetes control plane, to construct clusters and to schedule container execution. Kubernetes Containers execute under **pods** running in **worker nodes**.

Each pod typically runs one container instance or a select few that share resources that need to execute together. A Kubernetes pod contains the OS and runtime environment that enables the container application to run. Container networking is configured and managed by Kubernetes control plane, master nodes and worker nodes and provides the IP connections required by container applications.

Container applications can be automatically scaled up by Kubernetes, increasing the number of pods executing its instances. It's not unusual for highly active applications to have multiple pods executing the same exact container instances to meet performance requirements and for high availability.

In Kubernetes, container-persistent volumes (data storage) are provisioned to pods; as a result, container instances running in those pods can read and write persistent data storage volumes.

Running containers on VxRail

Kubernetes container applications can run on VxRail infrastructure with vSphere. As discussed earlier, VxRail offers many different ways to deploy and host Kubernetes containers, including Standalone Kubernetes, VMware Essential PKS, VMware Enterprise PKS with VMware Cloud Foundation, and by using the tested and verified PRA reference architecture.

With any VxRail solution, customers automatically benefit from:

- **Cost efficiencies** – Proven to dramatically reduce OPEX, delivering up to 52% lower cost of operations over build your own HCI, while integrated end-to-end support reduces unplanned downtime by 90%
- **Lifecycle Management (LCM)** – Automated deployment and lifecycle management of HCI infrastructure and networking through VxRail Manager, taking you safely to continuously validates states.
- **In-depth VMware integration** – The only Hyperconverged Infrastructure built for VMware, with VMware to Enhance VMware. When combined with VMware Cloud Foundation, VxRail provides a deep integration between SDDC Manager and VxRail Manager, and consistent operations across the infrastructure.
- **Single support** – Dell EMC provides a single point of global support covering both VxRail hardware and software as well as VMware software that reduces support time/effort and as noted above, unplanned downtime.
- **Improved security** – Industry-leading enterprise data services, including HCI-native data-at-rest encryption, replication, backup, and file services make VxRail ready for almost any application or workload.

Standalone Open Source Kubernetes on VxRail

Developers can elect to download and configure Kubernetes distributions to run nodes as VMs on vSphere. Using a standalone Kubernetes cluster to run containers requires manual download, installation, configuration, validation and management of Kubernetes software.

Although Kubernetes has built-in support for multiple nodes, there's no inherent automated lifecycle management or high-availability support for standalone

Kubernetes. Kubernetes nodes can fail due to errors and those nodes will be out of service until brought back online using facilities outside Kubernetes. In addition, IT will need experience with open source tools such as Ansible for lifecycle management or do this manually.

Choose *Standalone Kubernetes* when your team has lots of experience running Kubernetes on bare metal environments. However, it's probably not advisable for production container deployments, as enterprise-class software support, Harbor registry, and multi-AZ support are all missing. Further, VMware admins would have limited visibility into cluster operational components, such as pods, containers, persistent storage, etc. It would require a lot of DevOps effort to install, deploy, validate components, and run the cluster, and so, it's probably not as usable for initial container use.

VMware Essential PKS on VxRail

VMware Essential PKS is a secured, hardened and supported selection of open source projects and tools to run production Kubernetes container applications on vSphere. Essential PKS bundles a signed copy of Kubernetes cluster services with selected VMware open source projects. Specifically Essential PKS adds **Sonobuoy** for conformance testing and validation of cluster configuration/operations, **Contour** for multi-cluster ingress and load balancing across clusters and **Velero** for data protection, cluster migration and recovery.

VMware Essential PKS is a fully signed, supported and production-ready Kubernetes cluster service, making it a step above standalone Kubernetes. Initial container use would not be advisable due to the complexity to configure, deploy and operate the cluster. However, because it's a supported VMware solution, running containers in production is fine. It doesn't support Harbor or multiple AZs and its automation level is fairly low. Although not as bare bones as standalone Kubernetes above, DevOps still must deploy, configure and run the cluster. Moreover, operations visibility into cluster components is minimal.

Choose *Essential PKS* when you want to build and run your own Kubernetes environment, using upstream Kubernetes in a modular architecture customized to your unique needs on VMs. This option will be attractive to those with significant Kubernetes expertise in-house and want Kubernetes support on-call.

VMware Enterprise PKS on Cloud Foundation on VxRail³

VMware Enterprise PKS is a Kubernetes-based container solution with advanced networking, a private container registry, and life cycle management. Enterprise PKS

³ Please see <https://www.dell EMC.com/en-us/cloud/hybrid-cloud-computing/hci-for-kubernetes.htm> for more information

simplifies the deployment and operation of Kubernetes clusters so you can run and manage containers at scale on private and public clouds.

When combined with VMware Cloud Foundation, the foundation for Dell Technologies Cloud Platform (DTCP)⁴, you end up with a true hybrid cloud environment with consistent infrastructure and operations across public and private clouds.

DTCP is the only HCI system jointly engineered with VMware with full stack integration and automated lifecycle management. Both the HCI infrastructure layer and the VMware cloud software stack are managed through SDDC manager, greatly reducing risk and increasing IT operational efficiency. With the addition of Enterprise PKS organizations can develop, test, and run cloud-native containerized applications alongside virtualized traditional applications. This approach preserves investments in existing enterprise architectures while solving for the cloud-native skill gap by enabling VMware administrators to become Kubernetes administrators.

Enterprise PKS was jointly developed by VMware and Pivotal. With Enterprise PKS, customers can provision, operate, and manage Kubernetes clusters using Cloud Foundry BOSH and Pivotal Ops Manager.

As with standalone Kubernetes and Essential PKS, the master nodes and worker nodes run as separate VMs. In addition to these node VMs, PKS VMs execute across the cluster to create the PKS control plane, which supports an Enterprise PKS management console and acts as the interface between Kubernetes cluster container requests and vSphere functionality. The management console offers a GUI experience to configure, deploy and monitor Kubernetes, Cloud Foundry BOSH and VMware Harbor repository across vSphere clusters. Operations can use the PKS console to have a graphical view of Enterprise PKS cluster resource use. As discussed above, Enterprise PKS also supports the Pivotal Ops Manager for even more automation and support for Kubernetes cluster operations.

Enterprise PKS also includes NSX-T for quick and secure Kubernetes networking deployments. NSX-T interoperates with Kubernetes networking components to keep pods and their containers instances secured and properly connected wherever they happen to run in the vSphere environment.

In addition, Enterprise PKS includes:

- **Cloud Foundry BOSH**- a Cloud Foundry open source project that provides Kubernetes release engineering automation, cluster deployment, lifecycle management and distributed systems monitoring/restart. BOSH also offers multiple availability zones (AZs) as failure domains to schedule Kubernetes cluster nodes and services for high availability. BOSH is currently used in a

⁴ Please see <https://www.dellemc.com/cloud> for more information

number of public and private cloud implementations to provide these services.

- **VMware Harbor Registry** - a VMware open source project that provides a secure, enterprise-class repository for container instance images. Harbor supports automated malware scanning and a multitiered security model for container instance uploading, downloading and registration. In this way, DevOps can guarantee that images used by container applications are validated and known to be free of malicious content.

Some of the advanced container application functionality available with Enterprise PKS on Cloud Foundation with VxRail include:

- **Automated Patching & Comprehensive Security** –you can deploy, scale, patch, and upgrade all the Kubernetes clusters in your system—without downtime and rapidly apply security fixes when available.
- **Built-in On-going Operations support** – customers can reliably deploy and run containerized workloads across private and public clouds. Enterprise PKS eases the on-going operations burden for container orchestration with built-in HA, monitoring, automated health checks, and more.
- **Easy Multi-tenancy** – operations can isolate workloads and secure containers within a single cluster by using networking segmentation, or easily deploy multiple clusters for higher isolation levels.

Choose *Enterprise PKS* when you want the flexibility and control of operating your own Kubernetes service but don't want the responsibility of architecting, curating parts, assembling and building the solution yourself. Enterprise PKS includes advanced automation, networking, container registry and implements best practice configurations out of the box for a rapid path to container application deployment.

Pivotal Ready Architecture on VxRail⁵

Another option for running container applications on VxRail is with the Pivotal Ready Architecture (PRA). PRA is a reference architecture that can be used to construct a trusted, purpose-built, enterprise-ready, cloud-native app development platform stack including Dell EMC VxRail, VMware vSphere, and Pivotal Platform. Based on proven and mature design tenets, PRA is the fastest way to get Pivotal Platform up and running in your data center.

PRA supports Pivotal Application Service (PAS) and Pivotal Container Service (PKS), which offers a complete platform as a service (PaaS) solution. Pivotal Platform provides tools for 12-factor, cloud-native app development, allowing developers to choose their own layer of abstraction to accelerate software innovation.

⁵ Please see <https://www.dellemc.com/en-us/solutions/cloud/pivotal-ready-architecture.htm> for more information

Pivotal Platform supports standard Kubernetes and non-Kubernetes container orchestration. The later predates Kubernetes and supplies some additional automation capabilities to container packaging and more automation to run container applications.

PRA provides a lot of the same user experience and functionality, including BOSH and Harbor components, as does Enterprise PKS above. Developers have access to resources when they need it to be as productive as possible, and application updates can be pushed out without any downtime.

Some of the unique benefits offered by Pivotal Platform include:

- **Peace of Mind** - delivering an “It just works” seamless experience, this containers platform is tested and validated across the entire stack against Pivotal quarterly functional releases. PRA Pivotal Platform is easy to build and standup using validated guides with configurations for high availability and multi-site, multi-foundation, and multi-availability zone systems, for high availability and resiliency. Instead of taking months, PRA can be production-ready in just weeks.
- **Intrinsic Security** - with regularly quarterly functional updates to the platform and as-needed patches, PRA ensures a secure platform for container applications and the data they rely on. In addition, data security functionality exists down to the kernel layer in VxRail, providing PRA with a protection across the full-stack. PRA also leverages NSX-T which provides an integrated, full-stack networking and security, including native container networking for Kubernetes, micro-segmentation, and end-to-end observability for microservices.
- **Proven design tenets** - developed jointly between Dell EMC, Pivotal, and VMware, PRA provides a proven and mature container app development platform based on years of experience. As a joint-solution, PRA provides a level of automation and integration that isn't found in another full-stack for Pivotal Platform, making it the most trusted system to get your developers productive quickly.

Choose *PRA* when you want the flexibility and control of building and operating your own container service based on validated guides, but with automation and lifecycle management to further reduce On-going operations burden. PRA allows you to drive rapid developer productivity with a purpose-built application development platform without affecting existing legacy infrastructure. It supports a true multi-cloud for workload mobility.

When to use various container solutions

The table below provides a handy guide to features for each option: Standalone Kubernetes, VMware Essential PKS, VMware Enterprise PKS with VCF and PRA to run containerized applications on VxRail.

VxRail containers options	Standalone Kubernetes	VMware Essential PKS	VMware Enterprise PKS + VCF	PRA Pivotal Platform
Initial container use	No	No	Yes	Yes
Production Containers	No	Yes	Yes	Yes
Harbor support	No	No	Yes	Yes ⁶
Multi-AZ support	No	No	Yes	Yes
Automation level	Low	Low	High	High
DevOps effort needed	High	Med	Low	Low
Operations visibility into Kubernetes cluster	Low	Low	High	High
CNCF compatible Kubernetes	Maybe	Yes	Yes	Mixed ⁷

VMware future vision

VMware announced, in late 2019, a rearchitecting of vSphere called Project Pacific. Project Pacific transforms vSphere into a native platform to run Kubernetes container applications. It enables customers to run Kubernetes container apps alongside VMs within a vSphere environment. An outgrowth of VMware Enterprise PKS, Project Pacific provides a more fully integrated Kubernetes control plane connection into vSphere and allows container apps to take full advantage of VMware's broad portfolio of infrastructure services.

In addition, VMware announced Tanzu Mission Control which supplies a single point of operational control for IT to deploy and manage Kubernetes clusters running anywhere. With Tanzu Mission Control, customers can spin up Kubernetes clusters

⁶ Harbor supported on Enterprise PKS and available as an option on Pivotal Application Service.

⁷ CNCF certified for Enterprise PKS but not for Pivotal Application Service.

on vSphere, on bare metal servers, on many public clouds supporting native Kubernetes clusters and on any VMware Cloud Foundation environment.⁸

As always, VxRail will fully support these and other VMware product offerings as they are released.

Summary

Together, Dell EMC and VMware provide the best technology offerings for running container applications to accelerate customer adoption of cloud native technologies and further digital business initiatives. Indeed, VxRail and vSphere have become the platform of choice for running cloud-native, Kubernetes container applications in the data center.

Furthermore, VxRail helps customers futureproof their IT with best of breed HCI integrated systems, engineered and validated together, with VMware. For example, VMware has been working to incorporate container applications and Kubernetes clusters as production-ready services within vSphere. The latest version, VMware Enterprise PKS together with VCF, is fully integrated with VxRail systems.

VxRail has and will continue to support VMware's future cloud native solutions as well. For example, VMware's Project Pacific, when available, will create a whole new application environment that will fuse VM and Kubernetes cluster services into one environment, enabling them to interoperate more closely together, on the same data center VxRail infrastructure.

Moreover, VxRail offers many great options for configuring, deploying and executing Kubernetes container applications today. If you want to run both mission-critical traditional VMs and cloud-native Kubernetes container applications in your data center, you can't go wrong with VxRail.

Silverton Consulting, Inc., is a U.S.-based Storage, Strategy & Systems consulting firm offering products and services to the data storage community.

⁸ For more information, please see <https://cloud.vmware.com/tanzu> as of 25 November 2019