



Enjoy greater functionality and efficiency with VMware vSphere with VMware Tanzu

Compared to a bare-metal approach using Red Hat OpenShift Container Platform 4.8, the virtualized VMware vSphere platform with Tanzu offered efficiencies in storage and memory usage

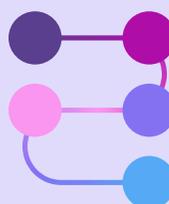
Containers are a popular choice for deploying and running applications. They are quick to set up, offer portability across platforms, and bring efficiency to resource provisioning and application development. To deploy, maintain, and manage containers at scale, many organizations use Kubernetes container orchestration software.

We deployed two on-premises cloud platforms with Kubernetes integrations: VMware® vSphere® 7U2 with Tanzu™ and bare-metal Red Hat® OpenShift® Container Platform 4.8. Our goal was to explore the experience an administrator would have using each platform—one virtualized, and one bare-metal—to execute a series of Kubernetes resource management scenarios and to compare memory and storage efficiency.

Using a large NoSQL database as a representative data load in each environment, the virtualized VMware vSphere with Tanzu environment required 28 percent less storage usage and 22 percent less memory usage compared to the bare-metal approach using Red Hat OpenShift.



Use up to 28 percent less storage with vSphere with Tanzu



Use up to 22 percent less memory with vSphere with Tanzu

Overview of our testing

Note on terminology: Throughout this report, we use *host* to refer to a physical server and *node* to refer to a Kubernetes node, which can be either a physical server or a VM.

We deployed two on-premises cloud platforms with Kubernetes integrations:

- virtualized VMware vSphere 7 Update 2 (7U2) with VMware Tanzu
- bare-metal Red Hat OpenShift Container Platform 4.8.

We configured the worker hosts on each cloud platform on five HPE ProLiant DL380 Gen10 servers with identical processors, memory, and storage configurations. We kept the number of physical hosts performing workloads in each deployment consistent across both platforms to represent a company deploying either cloud platform onto a defined number of servers. Each solution had different requirements for management, storage, and worker hosts.

For the vSphere 7U2 with Tanzu deployment, we configured three hosts for the memory savings scenario and five hosts for the storage savings and pod density scenarios as a complete vSphere cluster with Tanzu Kubernetes capabilities. The Tanzu Kubernetes worker nodes were VMs inside the physical hosts. Because Red Hat OpenShift requires three management hosts in addition to worker node hosts, we configured our OpenShift testbed with three additional physical servers acting as management nodes and then configured three or five physical servers acting as worker nodes to match the vSphere 7U2 with Tanzu deployment, for a total of six or eight hosts.

To compare the two platforms, we used Redis, a flexible, in-memory data structure store that can serve as a database, cache, and message broker. Redis is popular in its containerized form—via either Docker or Kubernetes—where users can easily create sharded Redis clusters with redundancy via replicas. We used Yahoo! Cloud Serving Benchmark (YCSB) to create datasets similar to what real-world companies would have in their deployments if they were using the NoSQL database functionality of Redis. For each scenario we tested, we created roughly 225GB databases, which Redis split across the Redis master nodes and replicated through the Redis replica nodes. The VMware platform provided greater resource management efficiency than the OpenShift platform and offered other qualitative benefits. For specifics on our testing, including diagrams of the replica sets for each test, see [the science behind the report](#).

About VMware vSphere with Tanzu

VMware vSphere with Tanzu is “the new generation of vSphere for containerized applications.”¹ According to VMware, vSphere with Tanzu allows IT administrators to use their “existing vSphere environment to manage multiple clusters alongside virtual machines through vCenter, delivering Kubernetes clusters at a rapid pace.”²

Learn more at <https://www.vmware.com/products/vsphere/vsphere-with-tanzu.html>.

What we found: VMware vSphere 7U2 with Tanzu provided more efficient storage and memory resource management

Scenario 1: The VMware vSphere 7U2 with Tanzu cluster offered storage benefits due to RAID 5 and thin provisioning

In this scenario, we used YCSB to create a NoSQL database on Redis with the same build settings in each environment to measure the storage efficiency of the two clusters. We completed testing two ways: with the default setting of each cluster and with a space-saving option. vSAN offered mirrored and parity storage, the equivalent of RAID 1 and RAID 5, while OpenShift Data Foundation only offered three-replica and two-replica storage options (essentially triple redundancy and RAID 1, respectively).

Figure 1 shows the results of our testing. We first tested the default settings of the two clusters: RAID 1 for the vSphere 7U2 with Tanzu cluster and three replicas for the Red Hat OpenShift 4.8 cluster. With these settings, the vSphere cluster used 28.2 percent less space. Next, we tested space-saving options: RAID 5 for the vSphere 7U2 with Tanzu cluster and two replicas for the Red Hat OpenShift 4.8 cluster. With these settings, the vSphere cluster used 17.5 percent less space. Note that if we compare the space usage of the two clusters with two copies of each item, the bare-metal Red Hat OpenShift 4.8 cluster used 7.7 percent less storage space than the Tanzu cluster. The vSphere 7U2 with Tanzu cluster provided more space savings than the Red Hat OpenShift cluster, which would benefit users with a greater need for storage efficiency. In addition to this, in a vSphere with Tanzu cluster it's possible to change between higher and lower redundancy options simply by changing the storage policy attached to the Kubernetes storage.

Please note that the fault tolerance and performance profiles of storage configurations differ, so these data points do not represent a strict apples-to-apples comparison. However, the fact that the VMware environment offers the space-saving RAID 5 option that the bare-metal OpenShift environment does not offer gives users flexibility as they work to balance needs for storage savings and performance.

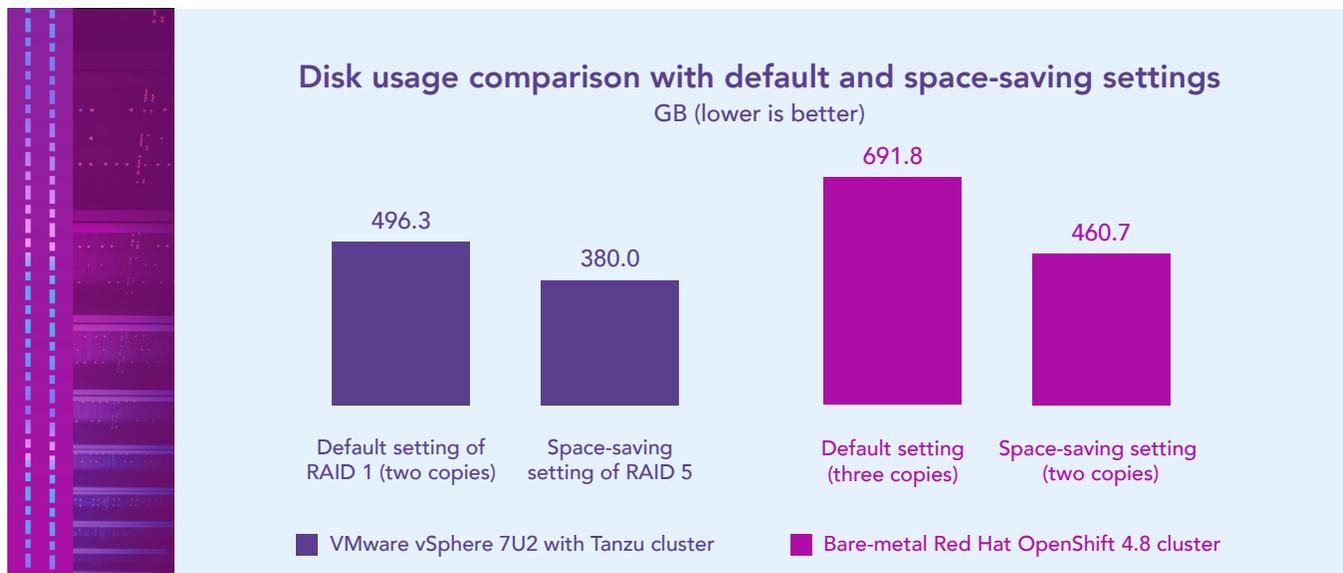


Figure 1: Amount of storage space the two clusters required. Lower numbers are better. Source: Principled Technologies.

Scenario 2: The VMware vSphere 7U2 with Tanzu cluster offered memory management benefits due to transparent page sharing

In this scenario, we used YCSB to fill the persistent volume claims we provided to the pods—roughly 750 GB of storage capacity. We configured a total of 15 Redis cluster nodes running across three worker nodes or worker node VMs for each environment. To demonstrate how this feature functions, we chose three worker nodes for this test to ensure that our test workload had pods with identical data loaded into memory within a single worker node or worker node VM. After YCSB filled the storage, we measured the pods' memory usage.

Whenever multiple pods within a worker node VM use or have identical datasets in memory, vSphere recognizes the similarity and performs deduplication; their term for this is “transparent page sharing.” vSphere enables this feature by default for pods existing within a VM, but administrators can also enable it for pods across multiple worker node VMs in certain use cases. For our testing, we maintained default settings with only intra-VM transparent page sharing, consistent with what a typical administrator might choose. Note: The bare-metal infrastructure running OpenShift Container Platform does not have a transparent page sharing capability.

As Figure 4 shows, thanks to transparent page sharing, the vSphere with Tanzu cluster used only 415.0 GB of memory, a reduction of 22.1 percent compared to the 533.3 GB the OpenShift cluster used.

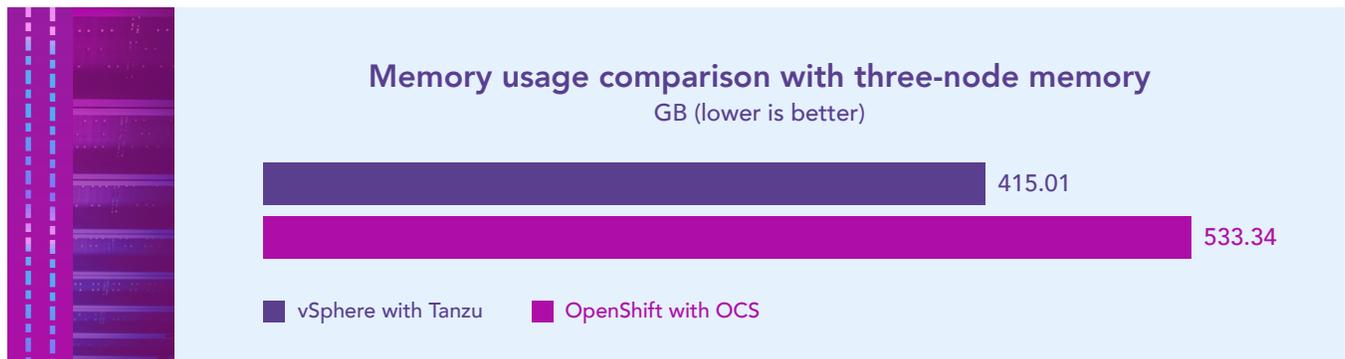


Figure 2: Memory usage of each cluster with three-node memory. Lower is better. Source: Principled Technologies.



Advantages of the vSphere approach to dynamic resource usage vs. the OpenShift approach

As of this writing, both Red Hat and VMware have a method to automatically balance resource usage of pods between hosts. However, they differ significantly. vSphere with Tanzu uses VMware's dynamic resource scheduling (DRS) to automatically move the TKG nodes from one host to another, changing the load across the cluster "behind the scenes," with no visible change to the Kubernetes user. The OpenShift solution, in contrast, monitors resource usage on hosts, "deschedules" (removes) pods from any hosts that are overloaded, and "reschedules" them on less-busy hosts.

While this approach works, it has some drawbacks. First, there is a potential for service disruption if OpenShift deschedules a pod that is not a part of a ReplicaSet. Ideally, admins would be aware of such potential and would build their pods accordingly, but the potential for disruption remains. Additionally, by default, the OpenShift descheduler operator checks for resource bottlenecks only once an hour, (vs. VMware DRS, which runs every minute), which may be too infrequent for effective resource balancing. This is another setting for which administrators would need to plan accordingly and manually modify the interval for their particular environment.

To virtualize or not?

You can run Red Hat OpenShift on bare metal or by using virtualization. We tested a bare-metal Red Hat OpenShift environment in part to take advantage of a unified management console for the entire deployment. "Kubernetes on Metal with OpenShift," a 2018 Red Hat blog post,³ explores some of the reasons companies choose bare metal. For customers who wish to use Red Hat OpenShift with virtualization, Red Hat makes the following statement: "Red Hat OpenShift Container Platform and VMware vSphere 6 and 7 are a great combination for running an enterprise container platform on a virtual infrastructure."⁴

VMware vSphere 7U2 with Tanzu supported greater pod density than Red Hat OpenShift 4.7

Prior to performing the test scenarios we describe in this report, we conducted testing to quantify the maximum number of pods that each solution supported. We used a similar cluster configuration but rather than using Red Hat OpenShift 4.8, we used version 4.7, which was current at the time of testing.

Given the identical hardware in our two five-host clusters, one might expect that they would support similar numbers of pods. To explore this, our pod density testing used a minimal web-service workload that supported a basic website. Each pod in the workload ran a replica of the website, and a standard Kubernetes load balancer split the traffic evenly across all pods. We started with a small number of pods and gradually increased the number until we reached the point where increasing pod count further would cause performance deterioration or cluster instability.

As Figure 5 shows, the vSphere with Tanzu environment supported 13,700 pods. This is 5.4 times the theoretical maximum 2,500 pods that Red Hat OpenShift should support per Red Hat documentation and 6.3 times the 2,150 pods that the bare-metal Red Hat OpenShift 4.7 cluster actually supported in our testing. To learn more about our pod density testing, please see ["Pod density comparison: VMware vSphere with Tanzu vs. a bare-metal approach using Red Hat OpenShift 4.7."](#)

Note that using virtual hosts mitigates the pod limits we observed in the bare-metal environment.

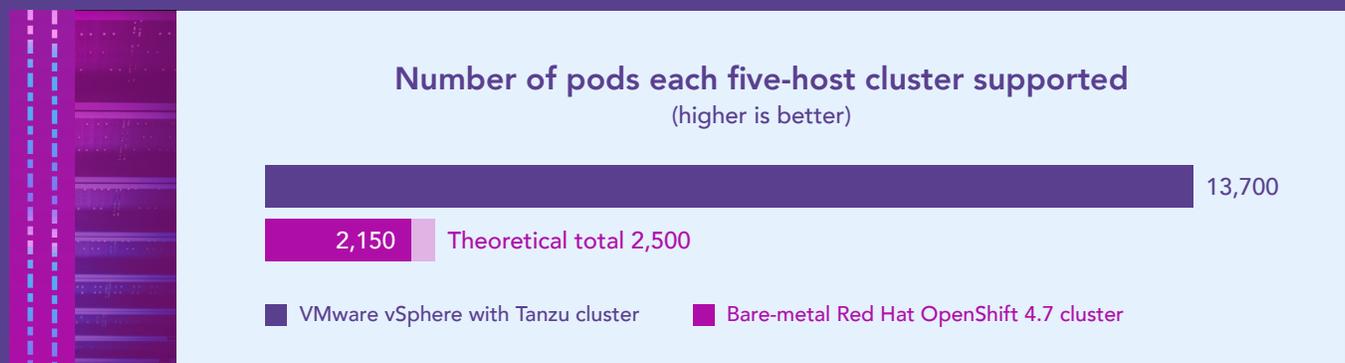


Figure 3: The number of pods each cluster supported in our testing. Higher is better. Source: Principled Technologies.



Conclusion

We tested two cloud platforms—vSphere 7U2 with Tanzu and Red Hat OpenShift 4.8—to explore how they manage resources. We found that the vSphere with Tanzu platform offered better resource management, reducing storage usage by up to 28 percent and memory usage by 22 percent. In addition, it supported greater pod density and its approach to dynamic resource allocation offered some advantages over that of OpenShift. These advantages make vSphere with Tanzu a strong choice for organizations using Kubernetes container orchestration software.

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- 1 "vSphere with Tanzu," accessed October 8, 2021, <https://www.vmware.com/products/vsphere/vsphere-with-tanzu.html>.
 - 2 "vSphere with Tanzu," accessed October 8, 2021, <https://www.vmware.com/products/vsphere/vsphere-with-tanzu.html>.
 - 3 Joe Fernandes, "Kubernetes on Metal with OpenShift," accessed February 2, 2021, <https://www.openshift.com/blog/kubernetes-on-metal-with-openshift>.
 - 4 "Red Hat OpenShift on VMware," accessed February 2, 2021, <https://www.openshift.com/learn/topics/openshift-on-vmware>.

Read the science behind this report at <https://facts.pt/X9kSbtz> ►



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This project was commissioned by VMware.