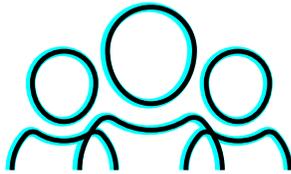




Lenovo ThinkSystem SR650



**GREATER MEMORY FOOTPRINT:**  
SUPPORT 2X THE  
VDI USERS\*



**MORE COST-EFFICIENT:**  
PAY 51% LESS PER  
VDI USER\*



**COMPARABLE DESKTOP  
RESPONSE TIME**  
VS. DRAM-ONLY SOLUTION\*

## Increase your virtual desktop density with Intel Optane persistent memory

Now that many businesses around the world have transitioned to remote work environments, virtual desktop infrastructure (VDI) is playing a bigger role in the IT landscape. If your business is considering server clusters with traditional DRAM memory technology to host VDI sessions, you should know that for the same price, servers with Intel® Optane™ persistent memory could double the number of VDI users you can support.

At Principled Technologies, we tested two configurations of a four-node Lenovo® ThinkSystem™ SR650 VMware® vSAN™ cluster powered by Intel® Xeon® Gold 6240R processors. The servers in one configuration used 768 GB of traditional DRAM each, while the servers in the other configuration each used a mix of 384 GB of DRAM and 1.5 TB of Intel Optane persistent memory. We configured these clusters so that they differed in price by less than two percent to demonstrate the user density available for roughly the same budget.

In our tests, the configuration with Intel Optane persistent memory supported twice as many virtual users as the DRAM-only configuration and made better use of its compute resources. This would enable you to host more users on fewer servers.

Based on performance testing and publicly available cost information, we determined that the Intel Optane persistent memory-based configuration would save a business up to 51 percent of three-year, per-user costs compared to a DRAM-only configuration, making it more cost-effective. Additionally, the cluster with Intel Optane persistent memory provided nearly identical response time to the DRAM-only solution when supporting the same number of users and comparable response time when supporting twice as many users.

\*Lenovo ThinkSystem SR650 server cluster with 1.5 TB of Intel Optane persistent memory compared to a cluster of the same servers with 768 GB of traditional DRAM.

## How we tested

Figure 1 illustrates the server configurations we used for testing. We tested a four-node VMware® vSAN™ cluster of Lenovo ThinkSystem SR650 servers with two different memory configurations: one with traditional DRAM and one with a mix of DRAM and Intel Optane persistent memory (or PMem).

The four-node, DRAM-only cluster had 768 GB of DRAM per server for a total of 3,072 GB of DRAM. The Intel Optane PMem cluster used a mix of 1.5 TB of Intel Optane persistent memory and 384 GB of traditional DRAM per server, for a total of 6 TB of Intel Optane persistent memory. We configured the servers in the Intel Optane PMem cluster to run in memory mode, where the DRAM acts as the memory cache and the Intel Optane PMem provides large memory capacity. We configured each cluster to have cost parity within two percent of each other.

To test each cluster configuration, we used the industry-standard Login VSI benchmark. The Login VSI benchmark's "Power Worker" profile enabled us to load each server with simulated virtual employees who performed intensive tasks that put high stress on the system. Login VSI says the profile creates very high CPU, RAM, and I/O usage.<sup>1</sup> For each of our tests, Login VSI defined the maximum acceptable desktop response time (VSI<sub>max</sub>) as approximately 2,000 ms. Login VSI warns that beyond this point, VDI end-users would begin to experience unacceptable desktop performance.

To create an environment capable of supporting the memory demands of current operating systems and application multitasking, we configured each VM with 4 vCPUs and 8 GB of RAM, all of which was reserved, or guaranteed, to the user. In our tests, because we allocated all available memory to the VDI desktops, each four-node cluster supported the maximum number of users mathematically possible while guaranteeing each user 8 GB of memory. So, the four-node cluster with 3,072 GB of DRAM supported 352 users with 8 GB of RAM per user, while the four-node cluster with 6 TB of PMem supported 708 users who each had 8 GB of memory.

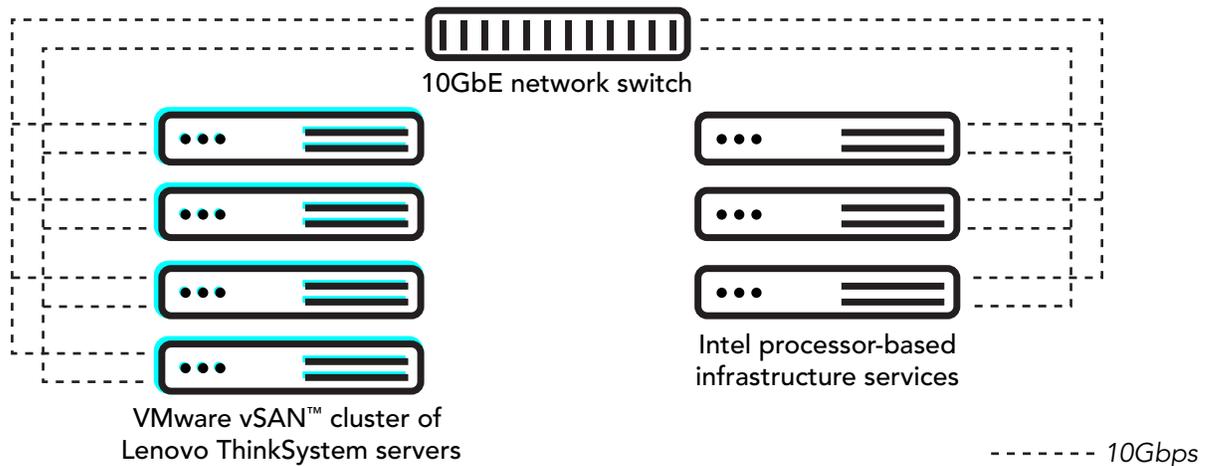


Figure 1: Diagram of our testbed. Source: Principled Technologies.

## Intel Optane persistent memory

Intel Optane persistent memory combines the benefits of large-capacity storage and non-volatile memory. According to Intel, Intel Optane persistent memory “can help businesses get faster insights from their data-intensive applications as well as deliver the benefits of consistently improved service scalability with higher virtual machine and container density.”<sup>2</sup>

To learn more about Intel Optane persistent memory, visit <https://www.intel.com/content/www/us/en/architecture-and-technology/optane-dc-persistent-memory.html>.



## Support higher user density and better use of compute resources

As Figure 2 shows, the four-node VMware vSAN cluster with Intel Optane persistent memory supported 708 total users (or 2.01 times the users supported by the DRAM-only cluster) due to its higher memory footprint. This configuration would enable you to host more users on fewer servers.

### MAX NUMBER OF VDI USERS PER CLUSTER

Higher is better

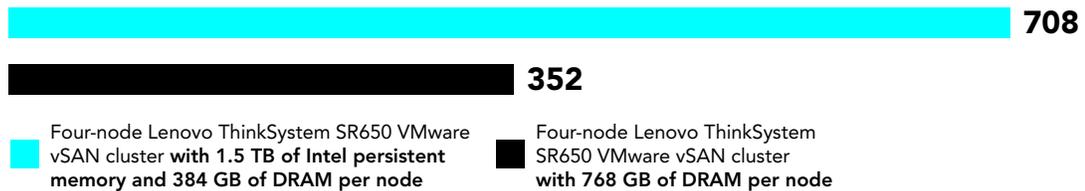


Figure 2: Maximum number of VDI users per cluster during the Login VSI workload. Higher is better. Source: Principled Technologies.

## 2nd Generation Intel Xeon Scalable Processors

The second generation of the Intel Xeon Scalable processor family offers multiple levels of performance to match your business needs. Our Lenovo server solution used Intel Xeon Gold processors, each of which contains 24 cores, supports 48 threads, and has a base frequency of 2.4 GHz (4.0 turbo).<sup>3</sup> Intel also offers Bronze, Silver, and Platinum processor levels. The second generation is the first to provide support for Intel Optane persistent memory.

To learn more, visit <https://www.intel.com/content/www/us/en/products/docs/processors/xeon/2nd-gen-xeon-scalable-processors-brief.html>.

Figure 3 shows the average CPU utilization for the server with the highest utilization in each cluster. The hardest-working CPU in the DRAM-only cluster maxed out at just 37.2 percent CPU utilization while its cluster supported 352 users. By contrast, the cluster with Intel Optane persistent memory was able to use its resources more effectively, resulting in a server that utilized 83.4 percent of its CPU on average while its cluster supported 708 users. Because Intel Optane persistent memory made more memory resources available, each server was able to fit more users and sessions than it could with a standard configuration of DRAM alone, resulting in more optimal use of CPU resources.

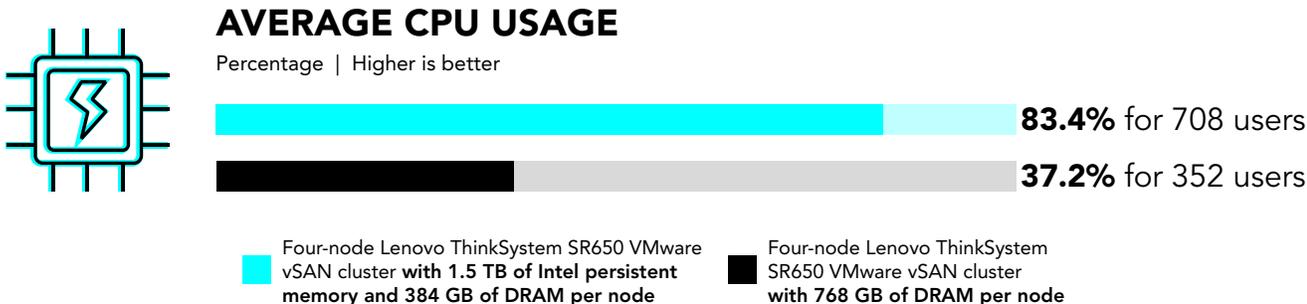


Figure 3: Average CPU utilization reported by the server with the highest average in each cluster. Source: Principled Technologies.

### The cluster with Intel Optane persistent memory responded in a similarly timely manner during our VDI workload

As Figure 4 shows, the Intel Optane persistent memory-based cluster we tested was just as responsive as the DRAM-only cluster when both clusters were supporting 352 VDI users (the maximum we could support on the DRAM-only cluster). In fact, the two configurations had a nearly identical response time when supporting the same user load. This response time was well below the benchmark’s acceptable threshold of approximately 2,000 ms.

When we doubled the load to 708 users, the Intel Optane persistent memory-based cluster had an average response time of 1,129 ms—a mere 8.5 percent increase for twice the number of users, and a figure that is still well below the acceptable threshold. Responsiveness and capacity—with a VDI solution powered by Intel Optane persistent memory, your organization could have the best of both worlds.

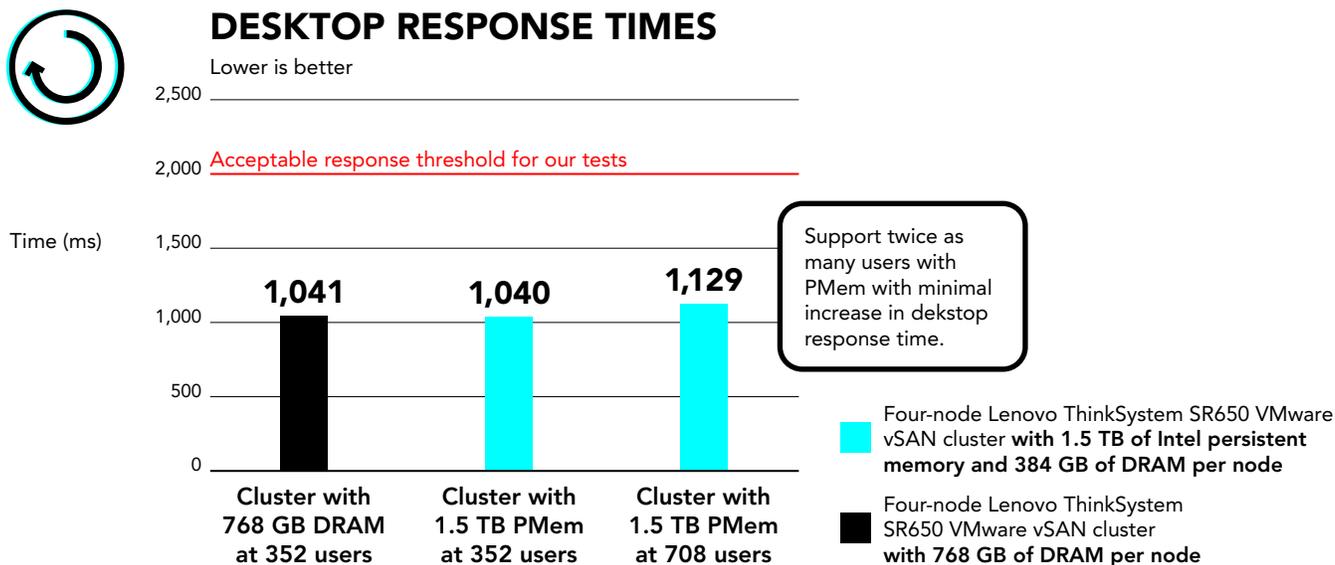


Figure 4: Graph of desktop response time for the DRAM-only cluster at 352 users, the Intel Optane PMem cluster at 352 users, and the Intel Optane PMem cluster at 708 users. Login VSI determined the acceptable latency threshold to be 2,000 ms. Source: Principled Technologies.



## Lenovo ThinkSystem SR650

Lenovo ThinkSystem SR650 is a two-socket, 2U server rack for small and large businesses alike. The rack is powered by up to two processors from the Intel Xeon Scalable processor family, offers a choice of basic or advanced RAID protection, and boasts the following features among others:<sup>4</sup>

- Lenovo XClarity Controller and XClarity Administrator management tools
- Up to 24 x 2.5-inch or 14 x 3.5-inch drive bays
- A LOM slot, dedicated storage controller slot, and up to 6 PCIe slots

To learn more, visit <https://www.lenovo.com/us/en/data-center/servers/racks/thinksystem-sr650/p/77XX7SRSR65>.

## Get a more cost-effective VDI solution

Figure 5 compares the cost of each of the solutions we tested based on publicly available information. Taking into account the cost of hardware, VMware ESXi™ software, and three years of software and hardware support, the two clusters had a similar price with just a 1.6 percent difference between them. However, because the Intel Optane persistent memory-based cluster supported twice the user density, it was about twice as cost-effective as the DRAM-only cluster on a per-user level.

Table 1: Cost data for each cluster configuration we tested. See [the science behind this report](#) for more details on this data. Source: Principled Technologies.

	Four-node Lenovo ThinkSystem SR650 VMware vSAN cluster with 1.5 TB PMem and 384 GB DRAM per node	Four-node Lenovo ThinkSystem SR650 VMware vSAN cluster with 768 GB DRAM per node
Hardware and 3-year hardware support (four nodes) <sup>5</sup>	\$131,463.56	\$135,703.64
VMware HCI Kit Enterprise licenses <sup>6</sup>	\$53,183.92	\$53,183.92
VMware HCI Kit Enterprise Support (3 years) <sup>7</sup>	\$62,799.92	\$62,799.92
<b>Total</b>	<b>\$247,447.40</b>	<b>\$251,687.48</b>
<b>Cost per VDI user at maximum cluster user density</b>	<b>\$349.50</b>	<b>\$715.02</b>



## Conclusion

VDI is playing an increasingly important role for businesses around the world. To give your virtual desktop users a good experience, you need a server solution that can handle their demands.

In our hands-on tests, a four-node cluster of Lenovo ThinkSystem SR650 rack servers supported twice as many VDI users when equipped with Intel Optane persistent memory compared to a similarly priced configuration that used only DRAM. This performance advantage could enable your organization to comfortably support more virtual users with fewer servers. Because the Intel Optane persistent memory-based cluster provided twice the user density at a similar cost, we found that this solution could help your organization save up to 51 percent in hardware and software costs per user. Finally, we found that each solution had nearly identical desktop response times when supporting the same number of users.

If your organization would like to support more VDI users on fewer servers without sacrificing desktop responsiveness, consider Intel Optane persistent memory.

- 1 "Login VSI Workloads," accessed October 15, 2020, [https://www.loginvsi.com/documentation/index.php?title=Login\\_VSI\\_Workloads](https://www.loginvsi.com/documentation/index.php?title=Login_VSI_Workloads).
- 2 "Breakthrough Memory Optimized for Data-Centric Workloads," accessed October 15, 2020, <https://www.intel.com/content/www/us/en/architecture-and-technology/optane-dc-persistent-memory.html>.
- 3 "Intel Xeon Gold 6240R Processor," accessed October 15, 2020, <https://ark.intel.com/content/www/us/en/ark/products/199343/intel-xeon-gold-6240r-processor-35-75m-cache-2-40-ghz.html>.
- 4 "Lenovo ThinkSystem SR650 Rack Server," accessed October 15, 2020, <https://www.lenovo.com/us/en/data-center/servers/racks/thinksystem-sr650/p/77XX7SRSR65>.
- 5 "ThinkSystem SR650 3204 16GB," accessed 12/04/20, <https://www.lenovo.com/us/en/p/7X06A0HLNA/customize?dcscGuid=b8539314-6b63-4cb0-90e1-3eea3a710a2d>
- 6 "VMware HCI Kit Enterprise (v. 6) license - 1 processor," accessed 12/04/20, [https://www.insight.com/en\\_US/shop/product/7S0600PPWW/LENOVO/7S0600PPWW/VMware-HCI-Kit-Enterprise-v-6--license--1-processor/](https://www.insight.com/en_US/shop/product/7S0600PPWW/LENOVO/7S0600PPWW/VMware-HCI-Kit-Enterprise-v-6--license--1-processor/)
- 7 "VMware HCI Kit Enterprise (v. 6) - Software Subscription and Support (3 years) - 1 processor," accessed 12/04/20, [https://www.insight.com/en\\_US/shop/product/7S0600PPWW/LENOVO/7S0600PPWW/VMware-HCI-Kit-Enterprise-v-6--Software-Subscription-and-Support-3-years--1-processor/](https://www.insight.com/en_US/shop/product/7S0600PPWW/LENOVO/7S0600PPWW/VMware-HCI-Kit-Enterprise-v-6--Software-Subscription-and-Support-3-years--1-processor/)

Read the science behind this report at <http://facts.pt/Gs0Xer9> ►



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