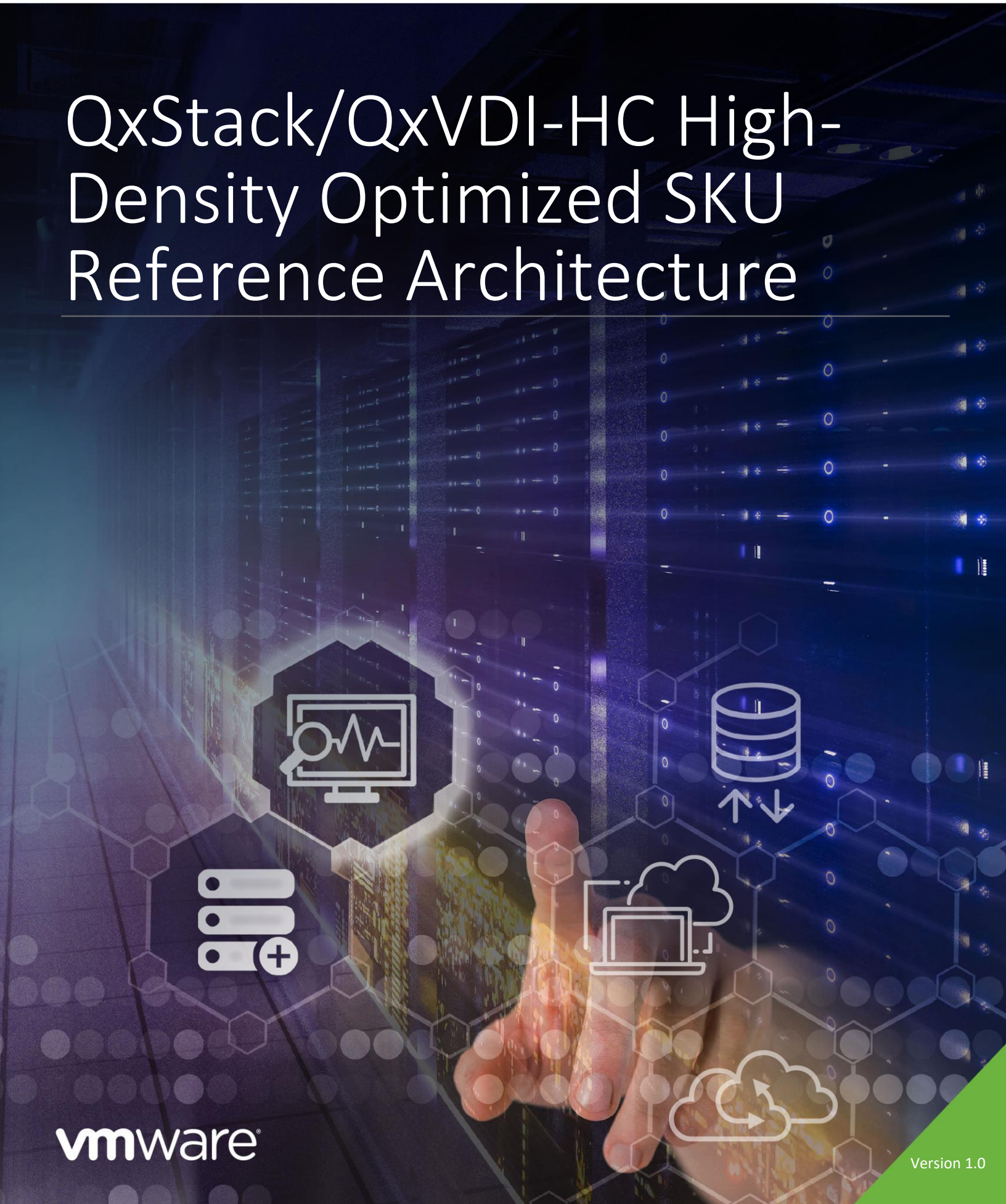
REFERENCE ARCHITECTURE

QxStack/QxVDI-HC High-Density Optimized SKU Reference Architecture



vmware

Version 1.0

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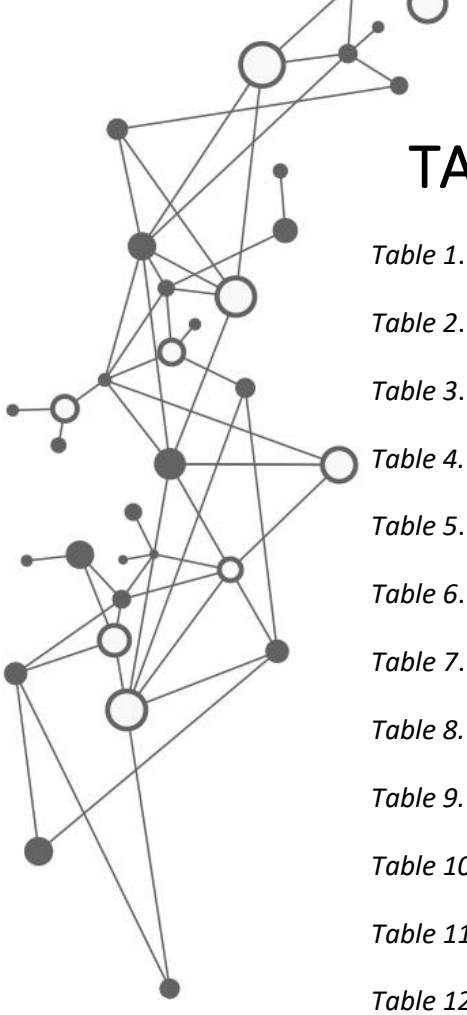
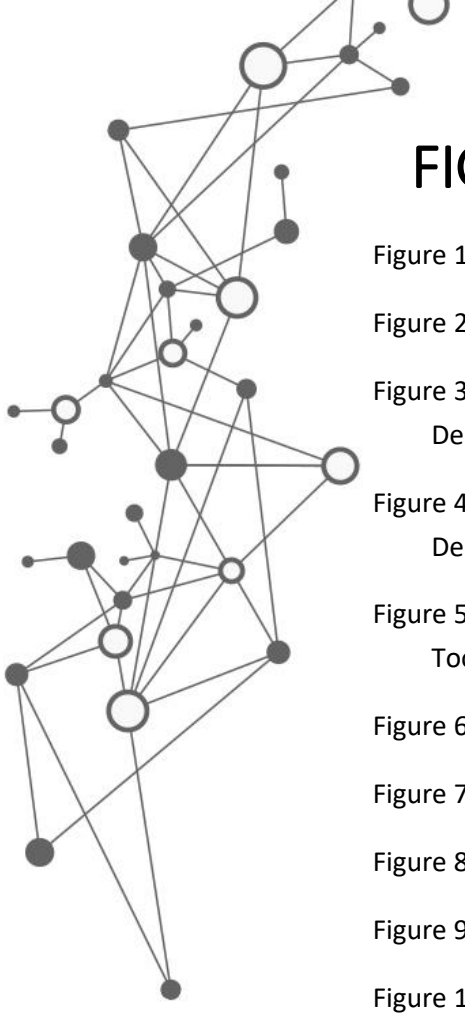


TABLES



FIGURES

1. Executive Summary

In the fast-changing business world, the role of IT department is getting more and more complex. With diverse business models and services provided by enterprises, IT departments are devoted to providing a reliable and elastic production-level environment with prominent performance and sufficient storage resources to support diverse workloads. Security is also a significant concern. On top of that, all these requirements need to be fulfilled within limited budgets.

In order to assist customers and partners to accelerate datacenter transformation, Quanta Cloud Technology (QCT), a global data center solution provider, provides a ready-to-use software-defined datacenter solution-QxStack/QxVDI-HC High-Density Optimized SKU with following benefits:

- Ultra performance and sufficient storage capacity: gain ultra-performance and sufficient storage resource in one appliance for diverse scenarios.
- Accelerated time to value: minimize the time required to deploy new infrastructures.
- Reliability: provide a confident choice with VMware vSAN ReadyNode™ certification.
- Economical total cost: reduce TCO by high-density design with a shared energy system.

In this document, QCT validates two use cases, including Virtual Desktop Infrastructure (VDI) with security function and mixed workloads scenarios, and proves the feasibility of the solution architectures.

With the above-mentioned benefits and the validated use cases, QCT believes that QxStack/QxVDI-HC High-Density Optimized SKU is a valid choice for partners and customers to construct software-defined datacenter and stay in a leading position.

2. Introduction

2.1. Purpose

The purpose of this reference architecture is to introduce QxStack/QxVDI-HC High-Density Optimized SKU and validate the solution's outstanding performance and availability in multiple use cases like VDI and mixed-workload environment.

2.2. Scope

This reference architecture:

- Introduces overall structure of QxStack/QxVDI-HC High-Density Optimized SKU and the benefits of this solution.
- Illustrates the hardware configuration and software stack discreetly selected by QCT in the solution.
- Simulates different use cases in the data center including VDI with security demand and IaaS with mixed workloads, and demonstrates the ultra-performance and scalability of QxStack/QxVDI-HC High-Density Optimized SKU.

2.3. Audience

The intended audiences of this document are IT professionals, technical architects, and sales engineers who would like to replace traditional desktop and adopt software-defined infrastructure to build VDI or IaaS environment.

3. Solution Overview

3.1. Manageability, Scalability, and Efficiency- Hyper-Converged Infrastructure

QxStack/QxVDI-HC High-Density Optimized SKU is a hyper-converged infrastructure solution. Traditionally, IT technicians face the challenges of resource management and scalability since compute and storage resources are separated. Hyper-Converged Infrastructure (HCI) is a novel technology which can integrate compute, storage, and virtualization resources in a single hardware box. Every single node is capable of delivering compute and storage resources at the same time. Several benefits are listed in detail below.

Simplified Management

In legacy-converged architecture, since compute and storage resources are provided by different servers and storage devices, the configuration settings and operation management are independent which means IT administrators must manage two devices through different management tools. To provide a storage device to a server, administrators need to configure settings from LUN and Volume and then mount the storage device to the server host for VM to access. In hyper-converged architecture, compute and storage can be regarded as a system. Administrators can manage both compute and storage resources with a single management portal. By achieving full "policy-driven management", IT administrators only need to define their own compute and storage resources. The allocation process can be automatically completed by a single management portal, which significantly reduces the management effort.

Scalability and Efficiency

The hyper-converged infrastructure integrates compute and storage resources into a basic unit, called building block. By implementing the clustered architecture, administrators can add more building blocks to the cluster to expand the overall performance and capacity. This also makes the expansion of the hyper-converged architecture simple and predictable, as shown in Figure 1.

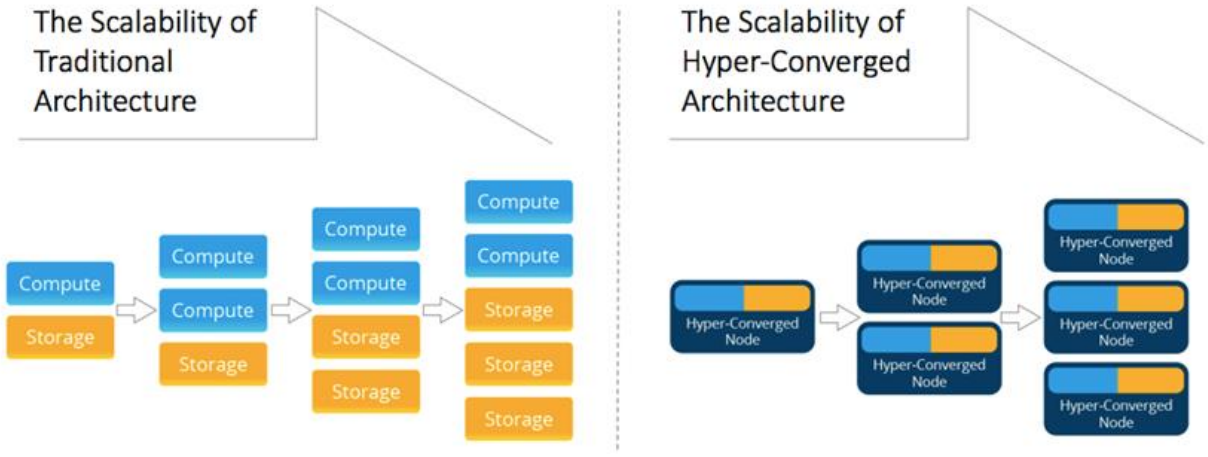


Figure 1. Comparison between Traditional Architecture and HCI.

3.2. Compute Capability and Storage Capacity

The server used for QxStack/QxVDI-HC High-Density Optimized SKU is QuantaPlex T42S-2U, which is a 2U 4-node server. Compared to the general 1U 1-node server with the same storage capacity, QuantaPlex T42S-2U provides 50% more compute power. Besides, QxStack/QxVDI-HC High-Density Optimized SKU adopts the latest technology - Intel® Xeon® Scalable Processors to unleash its computing performance to a new level. According to QCT's testing results, Intel® Xeon® Scalable Processors evidently performs better than previous CPU product family in IOPS and throughput under hyper-converged infrastructure. With the high performance and sufficient storage capacity, QxStack/QxVDI-HC High-Density Optimized SKU can support customer's business more efficiently.

3.3. Accelerated Time to Value

Building up a datacenter can be a tough and time-consuming challenge. To select the best-fit one, customers have to identify the demands of their companies first and strive to understand the pros and cons of each system structure. After that, customers still need to search for suitable components and concern about the compatibility, not to mention the complicated deployment process. In the lengthy process, customers need to put lots of efforts and time which may result in the IT department losing the focus on core business. In view of these factors, QCT provides a pre-configured and pre-validated total solution with software-installed and easy deployment tool for customers to accelerate time to value.

Pre-configured Hardware

To ensure the hardware compatibility, QCT discreetly selected the components and passed the strict testing process from system integration to electromagnetic interference to thermal testing. VMware also validates the feasibility of these components to make sure the compatibility between the components and VMware's software. The features of the server and the best practice of disk group ratio design suggested by VMware are considered to enhance the performance of the software stack. The configuration design is proven to provide outstanding performance and seamless compatibility.

Pre-loaded Software

In the factory, QCT will install the software and further validate the system. With the software pre-loaded service in this solution, customer can save time in deployment, speed up the datacenter establishment, and experience the solution with high quality.

Deployment Tool

Data center deployment can be an exceedingly complex and daunting process from resource and schedule arrangements to hardware and software installation, not to mention the networking topology and performance tuning. QCT understands all the difficulties and takes the following steps to solve customers' problems.

QCT developed an auto-deployment tool, named QCT auto-deployment manager, to simplify and automate the deployment process in merely a few steps, which significantly minimize the process in deployment and reduce time and expense (see Chapter 4.3 in detail).

3.4. Reliability - Pre-Validated Solution

vSAN ReadyNode™ is a program created by VMware® to verify the compatibility between server platform and VMware®-developed software and to guarantee the performance and stability of a solution. To pass vSAN ReadyNode™ certification, all the details of a solution including hardware components, firmware and driver, and software stack should be strictly examined to meet the rigorous requirements. QCT made lots of efforts in certification validation of QxStack/QxVDI-HC High-Density Optimized SKU. In the past, it was common for administrators to spend weeks researching and struggling against the compatibility issues to deploy a new system. Now, with the solution validated by QCT and VMware®, customers can rest assured of the solution reliability and focus on strategic and productive tasks.

3.5. Economical Total Cost

Economical Server Investment- High Density Design

Compared with general 1U 1-node server, QuantaPlex T42S-2U saves 50% of the space in a data center and doubles compute density that can maximize the productivity per square foot in customers' datacenter. Regular 1U 1-node server needs at least three servers to build up a VMware vSAN™ cluster with high availability (HA). QxStack/QxVDI-HC High-Density Optimized SKU can build up a vSAN™ cluster with HA in one single server, which highly simplifies the complexity of cabling, conserves space, and minimizes the efforts in datacenter management.

Energy Saving- Shared Energy System

Commonly, four 1U 1-node servers use eight power supplies in total and consume 800 watts for each power supply. QuantaPlex T42S-2U is a 2U 4-node server, which shares only two power supplies and consumes 1600 watt for each power supply. Compared with four 1U 1-node servers, QuantaPlex T42S-2U server saves up to 50% energy consumption.

With the ultra-dense and efficient power consumption design, QxStack/QxVDI-HC High-Density Optimized SKU can better boost resource utilization and save the total investment in a data center.

4. Solution Architecture

The four-node server and VMware software are included in the solution and possible host failure is taken into consideration to fulfill HA. The overall solution architecture is shown in Fig. 2 below.

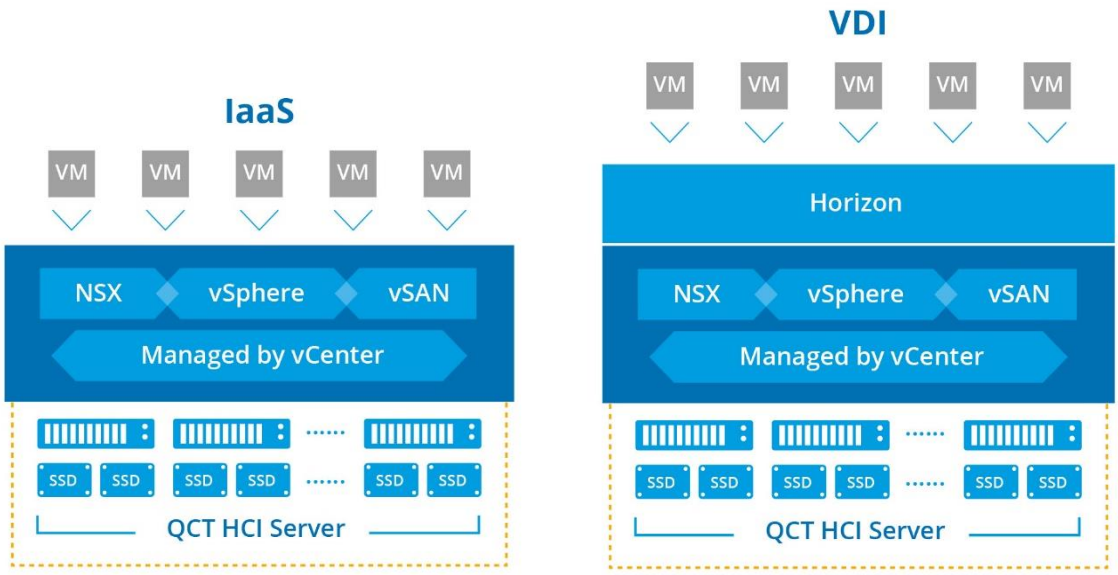


Figure 2. QxStack/QxVDI-HC High-Density Optimized SKU.

4.1. Hardware configuration

In QCT QxStack/QxVDI-HC High-Density Optimized SKU, the server QuantaPlex T42S-2U, a 2U 4-node server, is adopted as the infrastructure. The server is capable of carrying 2 CPUs in Intel® Xeon® Processor family per node, 6 SATA/SAS disks per node, and up to 512GB DDR4 RDIMM memory per node. An extra M.2 riser equipped on MB sled is flexible to support both SATA and PCIe M.2 devices for OS boot. Some important features of QuantaPlex T42S-2U are listed below:

- High floating-point operation per second with Intel Xeon Processor and great memory bandwidth up to 2666MHz provide outstanding performance.
- Ultra-dense design with 4 nodes in just 2-unit height provides prominent space and energy utilization.
- Extra M.2 riser equipped on the motherboard supports both SATA and PCIe M.2 devices, and provides better boot performance for installed OS.

The components in this high-density SKU are carefully evaluated and selected, as show in Table 1:

Table 1. Hardware Configuration.

Role	Component	Quantity
Server Model Name	QuantaPlex T42S-2U (2U, 4Nodes)	1
CPU	Intel Xeon Gold 5120	8
Memory	32GB DDR4-2400	32
Storage of SSD	2.5” SATA 960GB	4
Storage of HDD	2.5” SAS 1.8TB	20
Storage Controller	SAS 3008 mezzanine	4
Network Interface Card	Quanta 82599 dual port 10Gb, SFP+	4
Boot Device	M.2 SSD	4

4.2. Software Configuration

The software stack utilized in this solution includes the VMware vSphere®, VMware vSAN, VMware NSX®, and VMware Horizon®, and the adopted versions are shown in Table 2.

Table 2. Software Configuration.

Software and Service	Version
VMware vSphere®	6.5 enterprise plus Edition™
Per node ESXi™ hypervisor	6.5 U1
VMware vSAN™	6.6.1 (hybrid, one disk group)
VMware Horizon®	7.3 enterprise
VMware NSX®	6.3 enterprise
vCenter Server® Appliance	6.5 U1

VMware vSphere®

VMware vSphere® is the leading virtualization software for cloud foundation. The primary features of the VMware vSphere® are:

- Server virtualization: VMware ESXi™ hypervisor virtualizes server’s hardware into manageable resources.
- Centralized management: vCenter Server®, a virtual appliance, provides central management platform across ESXi™ hosts.
- Friendly UI: vSphere web client, a web management user interface, enables administrators to easily manage vCenter Server® or ESXi™ hosts.
- Easy VM migration: the function vMotion® in VMware vSphere enables VM migration between hosts which is vital for server redundancy.

- Auto resource balance: Distributed Resource Scheduler (DRS) can dynamically balance the shared computing resources for VMs within a cluster.
- Host redundancy: High availability (HA) function monitors hosts within a cluster to deal with the host failure. It migrates VMs to other available hosts when host failure occurs.
- Virtualized switch for VMs: Virtual Switch (VS) creates virtualized network on each ESXi™ host and provides the network to each virtual machine. Virtual Distributed Switch (VDS), which is similar to virtual switch, further aggregates NICs, VMkernals, and portgroups together for a data center. The virtualized switch thus simplifies the management on server network.

VMware vSAN™

vSAN™ is the software-defined storage which can be utilized to:

- aggregate local hosts' storage devices into the shared data store and provide access across hosts within the same cluster.
- provide the hyper-converged infrastructure with simple management and provision.
- provide vSAN™ storage policies to define availability factors such as failure to tolerate.
- integrate with vSphere hypervisor layer which means 100% compatibility.
- enable high scalability that can be either scale-out or scale-up on demands quickly.

VMware Horizon®

VMware Horizon® is the key software of VDI with the combination of vSphere® and Horizon®. VDI brings an easy method to manage user desktop pools and apps environment with higher security and efficient resource utilization. VMware Horizon® delivers a centralized virtual desktop management platform, different forms of virtual desktop deployment, a simple-updated desktop image for desktop groups, and simple security control of virtual desktops. Meanwhile, it effectively minimizes the management time and cost, and brings end users virtual desktops across devices and geo-locations with full utilization.

VMware Horizon® 7 enterprise edition is the version adopted in the solution. VMware Horizon® consists of several major components, as shown in Table 3 below.

Table 3. VMware Horizon® Software Features.

Name	Description
Horizon® Connection	Connection server acts as a bridge for client connections. Connection Server authenticates users through Microsoft Active Directory and directs the request to the appropriate VM, physical or blade PC, or Windows Terminal Services server. Connection server provides management capabilities such as enabling SSO, authenticating client users, entitling client users to specific desktops or pools, creating links between users and desktops, etc. A connection server is used in the solution as the VDI management platform.
Horizon® Composer™	This software service manages VMs. Horizon® Composer™ can create a pool of linked clones from a specified parent VM. This strategy reduces storage cost up to 90 percent. Each linked clone acts like an independent desktop with a unique host name and IP address, yet the linked clone requires significantly less storage because it shares a base image with the parent. ITs can quickly deploy, update, and patch VM pools by updating only the parent virtual machine since the linked-clone desktop pools share a base image. A Composer™ is used in the solution to enable the linked-clone function.
Horizon® Client	This client software which accesses remote desktops and applications can run on a tablet, a phone, a notebook, etc. After logging in, users are authorized to use a list of remote desktops and apps. Permission may require Active Directory credentials, a UPN, a smart card PIN, an RSA SecureID, or an authentication token. In the solution, the View Clients are installed and used to log in to the virtual desktop services.
Active Directory	The Active Directory is developed from Microsoft for the Windows system domain networks. The Horizon® needs Active Directory infrastructure to perform the user validation and management. One Active Directory server is used in the solution to manage the VDI topology.
Horizon® Agent	Acting as a bridge between Horizon® and VMs' guest OS, the Agent installed on the source parent VMs is used for the communication between client and virtual machines.

VMware NSX®

VMware NSX® is a software-defined network that delivers scalable and flexible network architecture in the vSphere®. In contrast to traditional server networking, VMware NSX® reproduces Layer 2 to Layer 7 network model in the software form to simplify network management. Its logical functions can be created on demand any time to provide the flexibility of server infrastructure on either security management or security control. In addition, its programmable API feature is also critical to achieve datacenter automation.

VMware NSX® consists of several main components, as shown in Table 4. VMware NSX® 6 enterprise edition is the version adopted in this solution.

Table 4. VMware NSX® Software Features.

Name	Description
NSX® Manager™	NSX® Manager™ is the management plane and centralized network management component of NSX®, installed as a virtual appliance in the vCenter Server®. It determines the core configuration of the whole system. A Manager™ is activated for solution validation.
NSX® Controller™	NSX® Controller™ is the control plane that controls virtual networks and overlay tunnels' information such as logical switches and logical routers. NSX® Controller™ is a central control point for all logical switches. It processes the information of all virtual machines, hosts, and logical switches. The Controller™ supports two control plane modes, namely, Unicast and Hybrid. These modes make NSX® decouple from the physical network. The Controller™ exists in virtual appliance format and three Controllers™ are activated for solution validation.
NSX® Edge™ Service Gateway	The Edge™ Service Gateway (ESG) is a logical router which provides north-south traffic for a data center. It consists of built-in services such as routing, load balancer, DHCP, parameter firewall, NAT, SSL VPN, etc. One ESG VM is deployed in the test environment to validate the solution.
NSX® Distributed Logical Router	NSX® Distributed Logical Router (DLR) is able to provide east-west distributed routing with tenant IP address space and data path isolation between switches. The key function of DLR allows VMs or workloads that reside on the same host with different subnets to communicate with each other without having to traverse a traditional routing interface; thus, the traffic is optimized. DLR also supports both dynamic routing and static routing, and provides the functions such as L2 bridging, DHCP relay, etc. The DLR controller VM is deployed for the solution validation.
NSX® Distributed Firewall	NSX® Distributed Firewall (DFW) is a hypervisor kernel-embedded firewall that provides visibility and control for virtualized workloads and networks. L2 to L4 access control policies can be created based on VMware vCenter® objects such as data centers, clusters, virtual machine names, and tags, and network construction such as IP/VLAN/VXLAN addresses as well as user group identity from the Microsoft Active Directory. The nature of this firewall can automatically extend firewall capacity when additional hosts are added to the data center. Some layer 2 and layer 3 DFW rules are enabled to secure VMs and isolate different groups and services for solution validation.

4.3. QxStack/QxVDI VMware® Edition—Auto-Deployment Manager

To facilitate the deployment process of QxStack/QxVDI-HC High-Density Optimized SKU, QCT developed a QxStack/QxVDI VMware® Edition—Auto-Deployment Manager to dramatically reduce time and minimize efforts for administrators. Auto-Deployment Manager plays a coordinate role such as initializing ESXi™ and deploying vCenter server®. Administrators can initiate the auto-deployment tool on a single node and type the default IP. Once the tool is powered on, the deployment tool is connected and the view of GUI can show administrators the deployment process. Subsequently, DHCP service needs to be enabled and applied to each server that is going to be deployed, as shown in Fig. 3. After clicking "Save and Next", three different options including "System Initial Only or Scale Out", "Install vCenter® and Prebuild Cluster", and "Install vCenter® and VDI environment" can be selected.

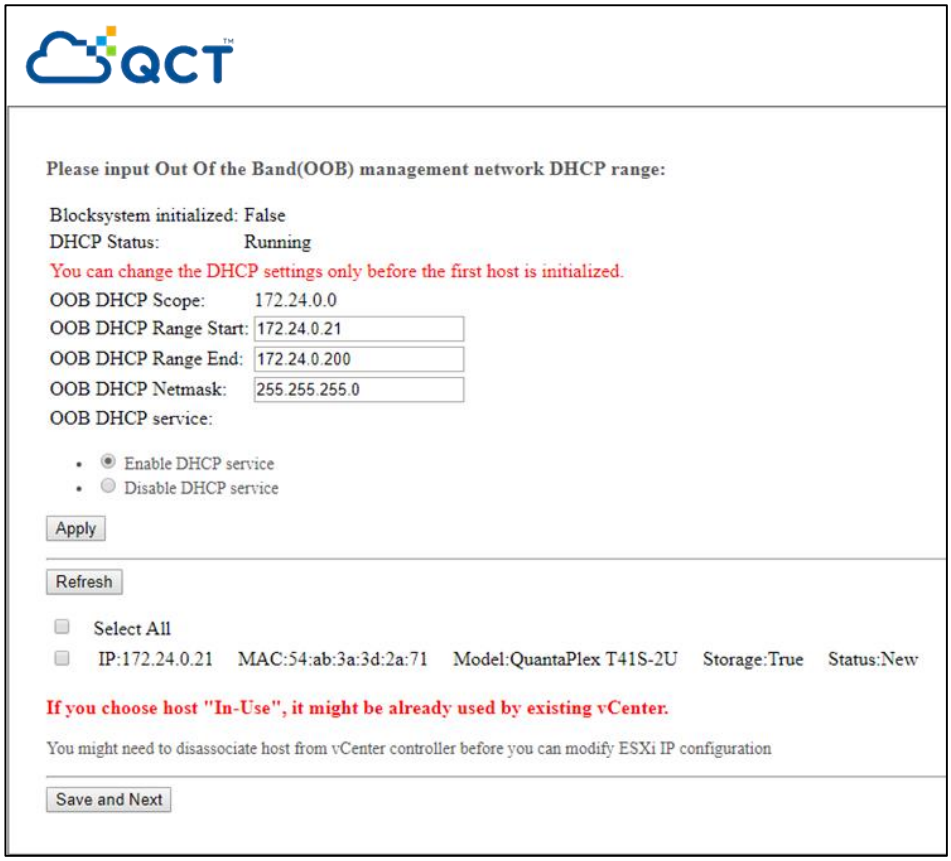


Figure 3. DHCP Service Enablement of QxStack/QxVDI VMware® Edition —Auto-Deployment Tool.

To initiate and deploy the environment, “Install vCenter® and Prebuild Cluster” can be selected to execute the deployment process. Administrators need to enter a general system information including inband management IP information, ESXi™ hosts information, and vCenter® information, as shown in Fig. 4.

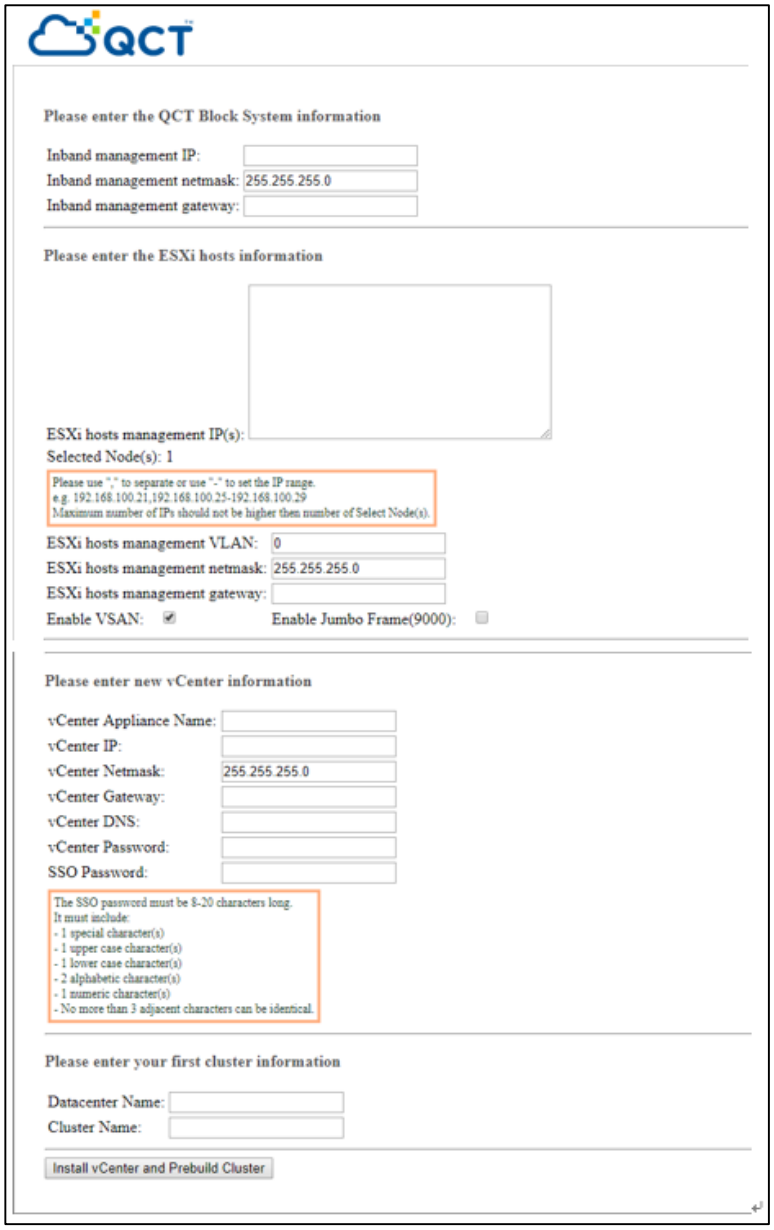


Figure 4. General System Information of QxStack/QxVDI VMware® Edition —Auto-Deployment Tool.

Once administrators enter all the information and click the “Install vCenter® and Prebuild Cluster”, the system will initiate each ESXi™ host and automatically deploy the vCenter® and vSAN™ service. The entire deployment process will take around 20 to 30 minutes, as shown in Fig. 5.

Figure 5. Deployment Process of QxStack/QxVDI VMware® Edition —Auto-Deployment Tool.

5. Solution Use Case

QxStack/QxVDI-HC High-Density Optimized SKU is the solution which can be provided for several common use cases as follows in enterprises' environment.

5.1. Virtual desktops services provisioning

Nowadays, enterprises invest considerable resource and expense in providing personal computers with diverse OS and applications for employees to fulfill different working demands. Due to the inevitable demand of devices, software management, workstation maintenance, and troubleshooting are thus getting more complicated and time-consuming for administrators. To tackle these difficulties, QxVDI-HC High-Density Optimized SKU can deliver up to 300 Windows desktops with high-efficiency application and desktop image management in a single T42S-2U server. Moreover, the networking can be further isolated and abstracted from hardware devices into software forms, such as physical firewall, load balancer, and switch in our solution, to reach the network security for VDI.

5.2. Mixed workloads and stable storage performance

Enterprises are concerned about the quality of stable services from a datacenter to provide end users great experience since different VM workloads such as web services, database, and e-commerce service are commonly executed in a data center. The standard to evaluate the infrastructure's performance is thus regarded as the most important index for enterprises. QCT's QxStack/QxVDI-HC High-Density Optimized SKU can load up and execute mixed workloads, and provide vSAN™ shared datastore in a data center.

6. Solution Validation

6.1. Virtual Desktop Infrastructure- Login VSI

The two VDI tests, pure VDI and VDI with NSX® enhanced, are conducted to validate the VDI capacity of our solution using the well-known bench mark tool "Login VSI."

6.1.1. Virtual Desktop Infrastructure (VDI) Test: Overview

The goal of the test is to validate the number of virtual desktops with different OS and VM configurations that VDI can provide under HA consideration. Login VSI is the industry-standard load testing benchmark tool for centralizing virtualized desktop environment. It loads the target VDI with simulated user workloads like Microsoft Office, Internet Explorer, and Adobe PDF reader. By overloading a system, it is possible to find out what its true maximum user capacity is. Users can adapt Login VSI to perform SBC or VDI workloads and generate benchmarks.

After the tests, the Login VSI will generate VSIBase to indicate the system performance. The lower the score is, the better the system performance will be, as shown in Table 5.

Table 5. Login VSI Official Rating of VSIBase.

VSIBase	Rating
0-799	Very good
800-1199	Good
1200-1599	Fair
1600-1999	Poor
2000-9999	Very Poor

To simulate the realistic VDI workloads, the two VM workloads adopted in the test to validate the solution are "Power Worker" and "Knowledge Worker." The two workloads are defined by Login VSI officially, as shown in Table 6.

Table 6. Login VSI Official Workload Profiles.

Workload	App Executed	Approximate CPU Usage	Approximate IOPS per user	VM Memory	VM CPU
Task Worker	2-7	70%	6.0	1GB	1vCPU
Office Worker	5-8	82%	8.1	1.5GB	1vCPU
Knowledge Worker	5-9	100%	8.5	1.5GB	2vCPU
Power Worker	8-12	119%	10.8	2GB	2vCPU+

6.1.2. Virtual Desktop Infrastructure (VDI) Test: Technical Configuration

The test environment is deployed with vCenter server® VM, Connection server VM, Composer server VM, Windows domain service VM, and hundreds of the target test desktops in the T42S-2U cluster. The vCenter server®, Horizon® appliances, and virtual desktops are installed on T42S-2U Server while the Login VSI server and Login

VSIlauncher VMs are installed on Supporting Server to execute the tests, as shown in Figure 6. The network topology is followed by a single physical switch VLAN ID 1106 with IP subnet 172.24.0.1/22 to provide enough address space to VMs.

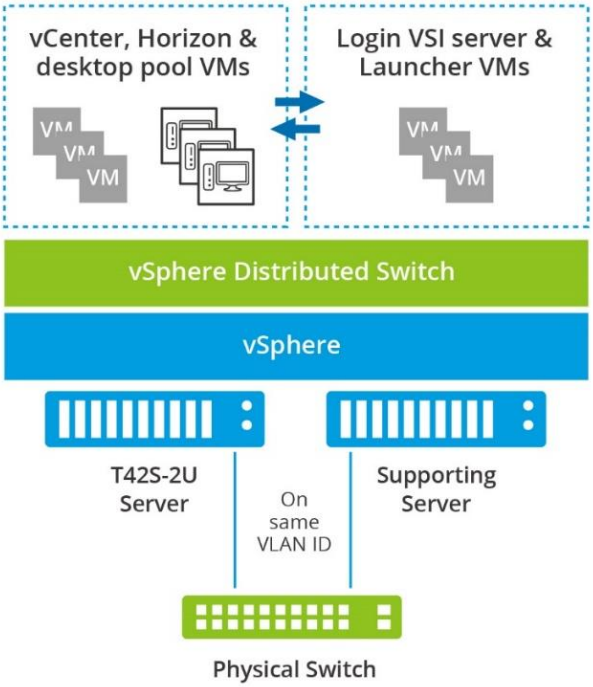


Figure 6. VDI Testing Topology.

The two types of workloads "Power Worker" and "Knowledge Worker" are targeted in the solution test and the operating system -Windows 7 and 10 are chosen. It is noted that the virtual memory of Knowledge Worker and Power Worker are respectively increased from 1.5GB to 2GB and from 2GB to 4GB for simulating the realistic VDI user environment, as shown in Table 6. MS Office versions 2007 is chosen to execute the workloads since this version utilizes less compute resources compared with other versions and can also support XML-based document format. The configuration of the tested virtual desktop profile is listed in Table 7.

Table 7. VM Profiles for Power Worker and Knowledge Worker.

Test case	**Login VSI Workload**	OS	System version	MS Office version	vCPU	vRAM (GB)	VM disk size	Total VM disk amount
1	Knowledge Worker	Windows 10	X64 Pro	2007	2	2	24GB	1
2	Power Worker				2	4		
3	Knowledge Worker	Windows 7	X64 Pro SP1	2007	2	2	24GB	1
4	Power Worker				2	4		

To achieve HA, at least 25% of the compute resource for each host is suggested in this solution to allow the existing workloads to operate continuously when host failure occurs. If one of the hosts fails to functionally operate, the other three hosts will be able to sustain the VMs migrated from the failure one.

6.1.3. Virtual Desktop Infrastructure (VDI) Test: Result

The test results including the server resource consumption and Login VSI performance scores for different test cases are recorded in Table 8.

Table 8. Test Results of VDI using Login VSI.

Test case	Login VSI Workload	VM Profile	Desktop Amount	Max CPU Usage	Max Memory Usage	VSI baseline	VSImax v4.1 threshold	Index Average Score	VSImax v4.1 Average
1	Knowledge Worker	2vCPU / 2GB RAM	280	50%	74.52%	808	1809	420	1452
2	Power Worker	2vCPU / 4GB RAM	155	30.98%	74.81%	741	1741	932	844
3	Knowledge Worker	2vCPU / 2GB RAM	300	42.87%	74.71%	644	1644	871	841
4	Power Worker	2vCPU / 4GB RAM	155	20.81%	74.78%	652	1652	959	693

All the tests were executed successfully without errors. Considering HA, the maximum computing resource consumption, particularly the memory usage, did not exceed 75%. In the following figures, the test results are proved to fall under the “Good” or “Very Good” Login VSI rating, which means the server with specified hardware can sustain the virtual desktop workloads with no doubt.

Test case 1: The test result reveals that 280 desktops with Knowledge Worker using Windows 10 were successfully executed. The Login VSI score 808 indicated “Good” rating. The overall server resource consumption did not exceed 75%, showing that the system remains under HA consideration. The system saturation point (VSI threshold) of T42S-2U cluster was not reached which means the server is able to launch more virtual desktop sessions, as shown in Fig. 7 and Fig. 8.

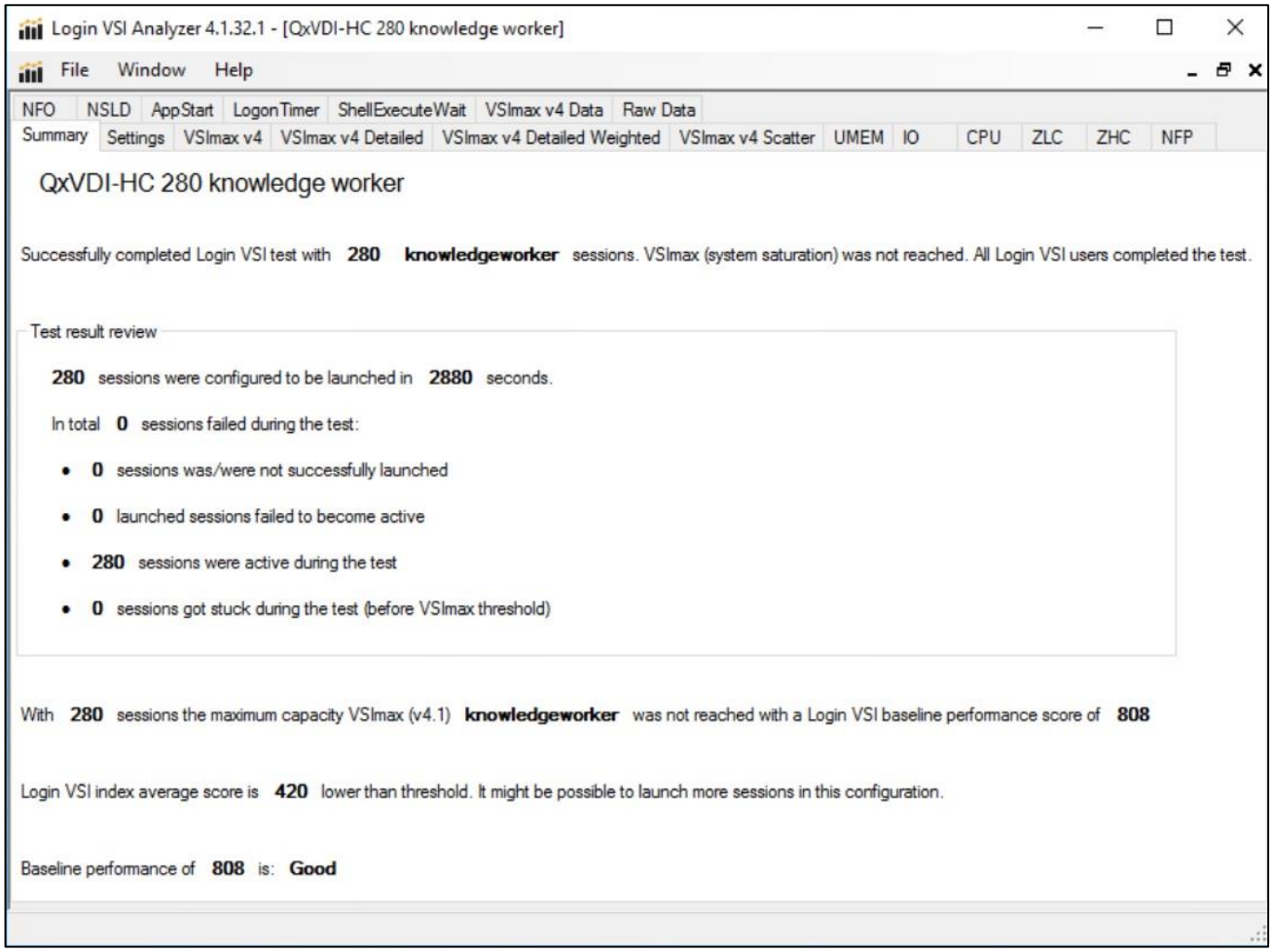


Figure 7. Result of Test Case 1 for VDI Test.

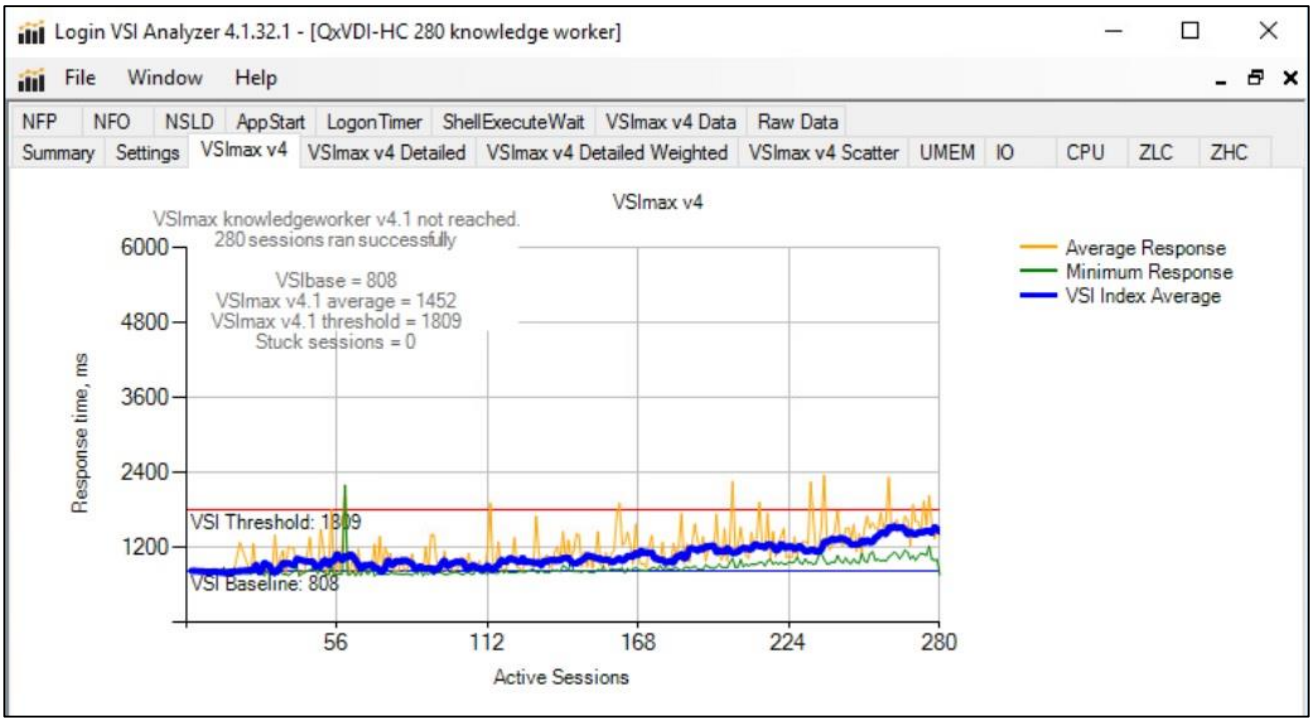


Figure 8. Graphical Result of Test Case 1 for VDI Test.

Test case 2: The test result reveals that 155 desktops with Power Worker using Windows 10 were successfully executed. The Login VSI score 741 indicated “Very Good” rating. The overall server resource consumption did not exceed 75%, showing that the system remains under HA consideration. The system saturation point (VSI threshold) of T42S-2U cluster was not reached which means the server is able to launch more virtual desktop sessions, as shown in Fig. 9 and Fig. 10.

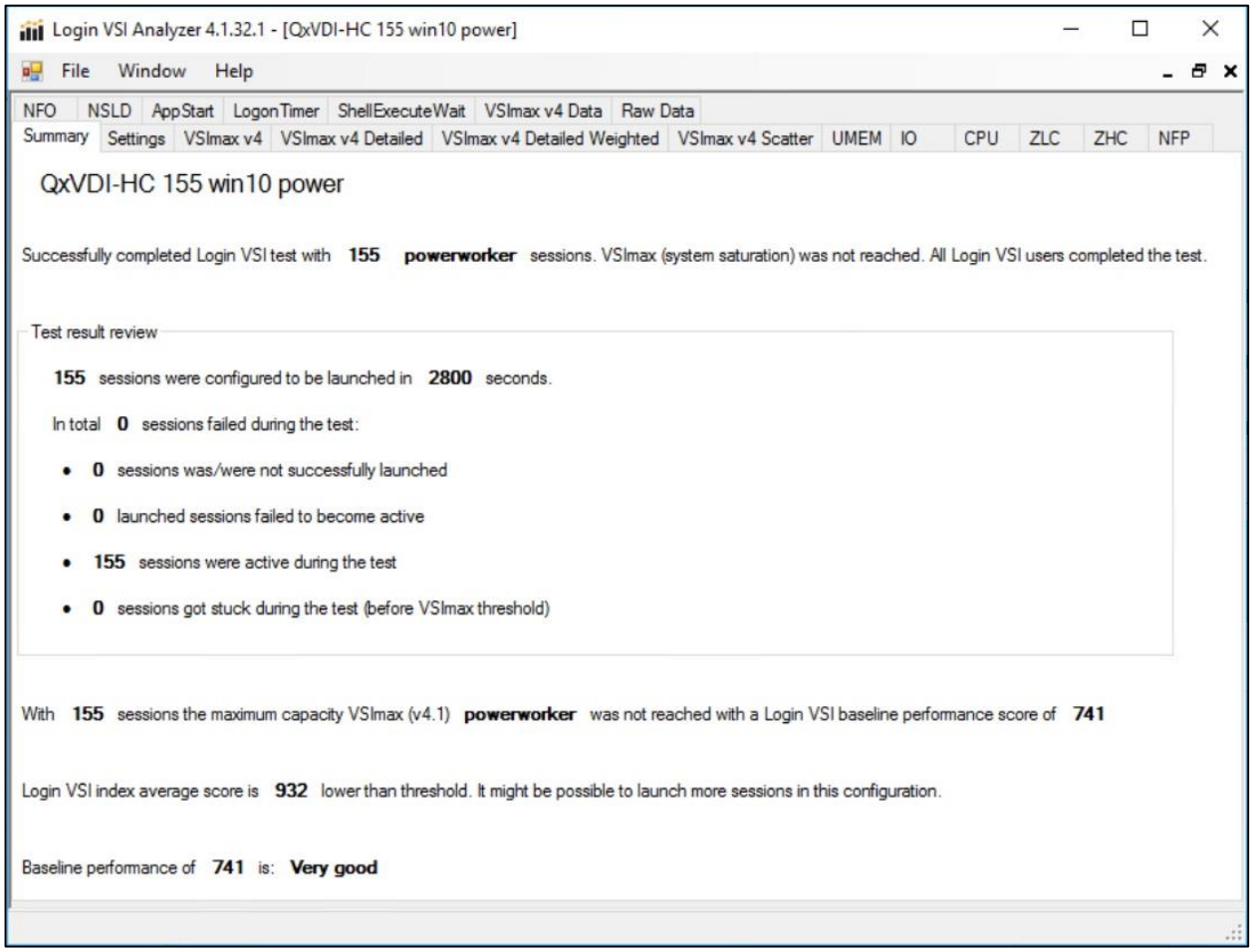


Figure 9. Result of Test Case 2 for VDI Test.

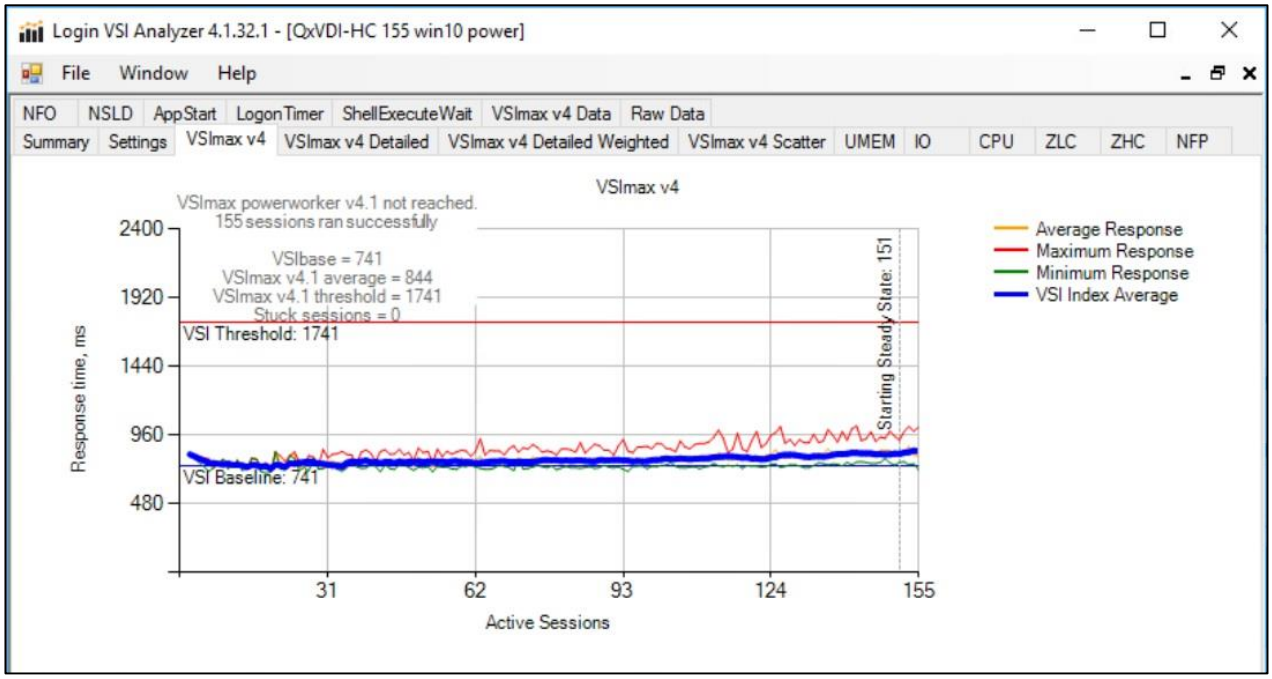


Figure 10. Graphical Result of Test Case 2 for VDI Test.

Test case 3: The test result reveals that 300 desktops with Knowledge Worker using Windows 7 were successfully executed. The Login VSI score 644 indicated "Good" rating. The overall server resource consumption did not exceed 75%, showing that the system remains under HA consideration. The system saturation point (VSI threshold) of T42S-2U cluster was not reached which means the server is able to launch more virtual desktop sessions, as shown in Fig. 11 and Fig. 12.

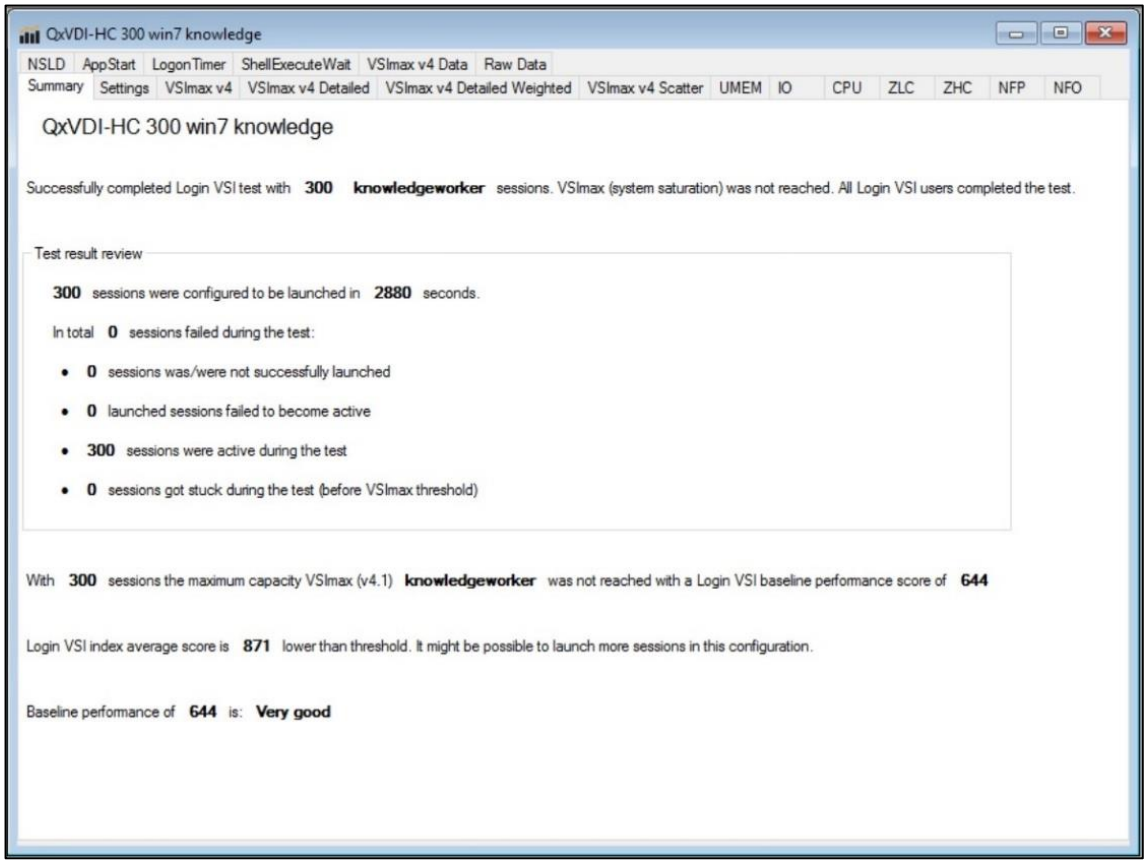


Figure 11. Result of Test Case 3 for VDI Test.

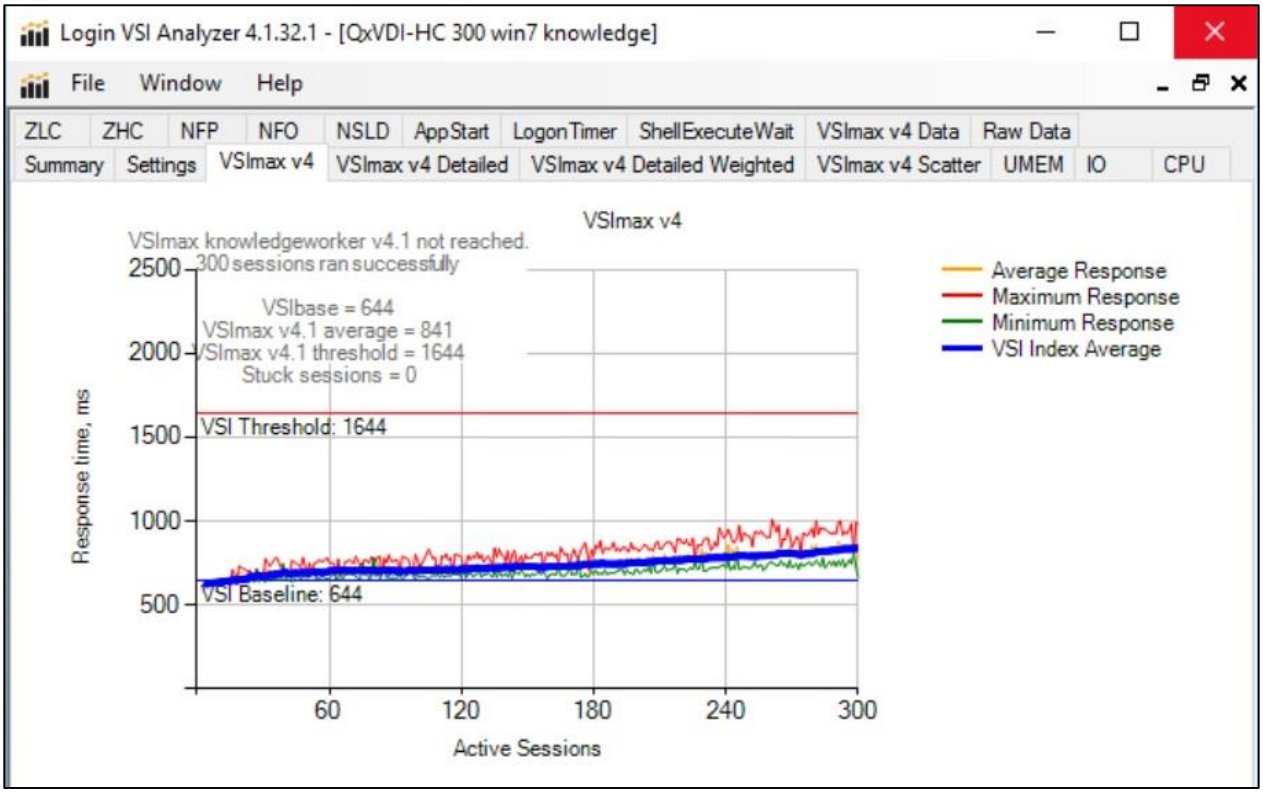


Figure 12. Graphical Result of Test Case 3 for VDI Test.

Test case 4: The test result reveals that 155 desktops with Power Worker using Windows 7 were successfully executed. The Login VSI score 652 indicated “Very Good” rating. The overall server resource consumption did not exceed 75%, showing that the system remains under HA consideration. The system saturation point (VSI threshold) of T42S-2U cluster was not reached which means the server is able to launch more virtual desktop sessions, as shown in Fig. 13 and Fig. 14.

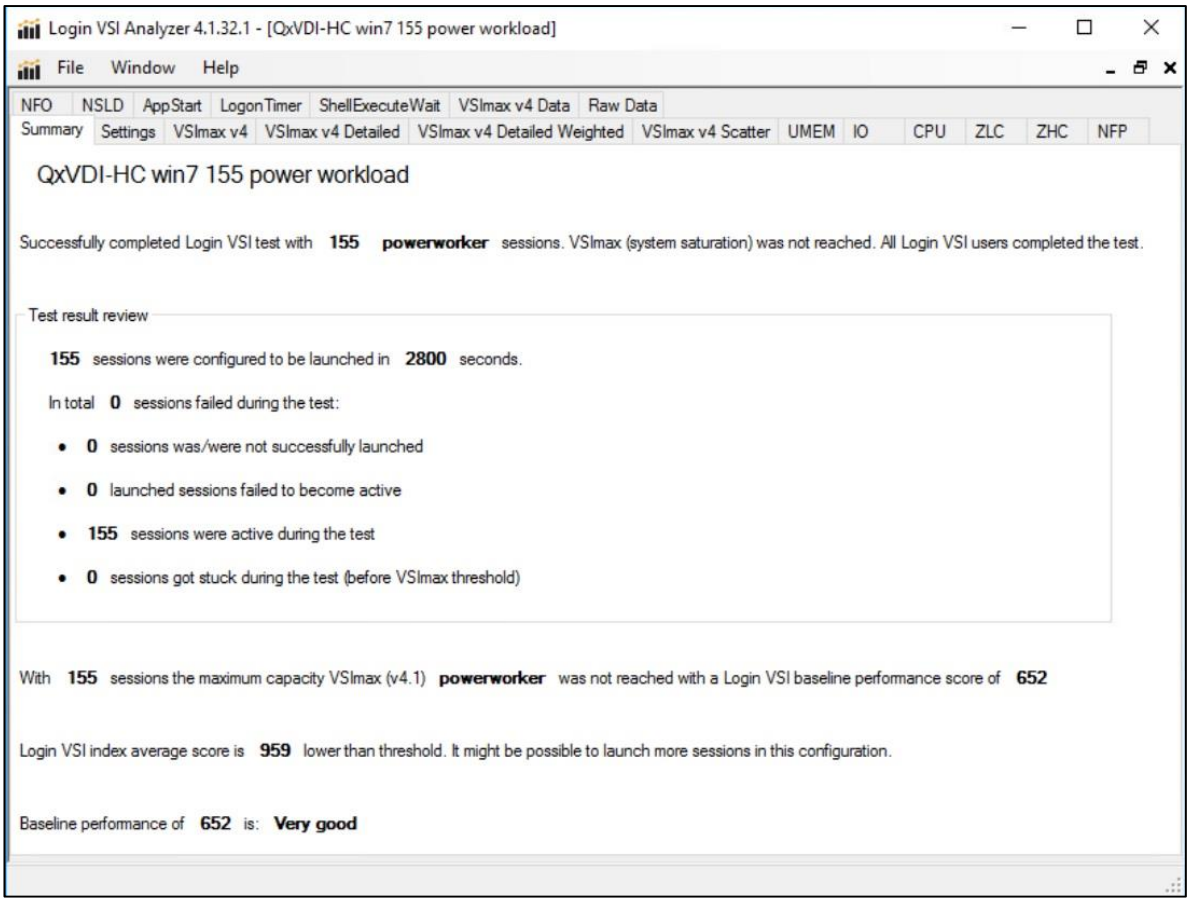


Figure 13. Result of Test Case 4 for VDI Test.

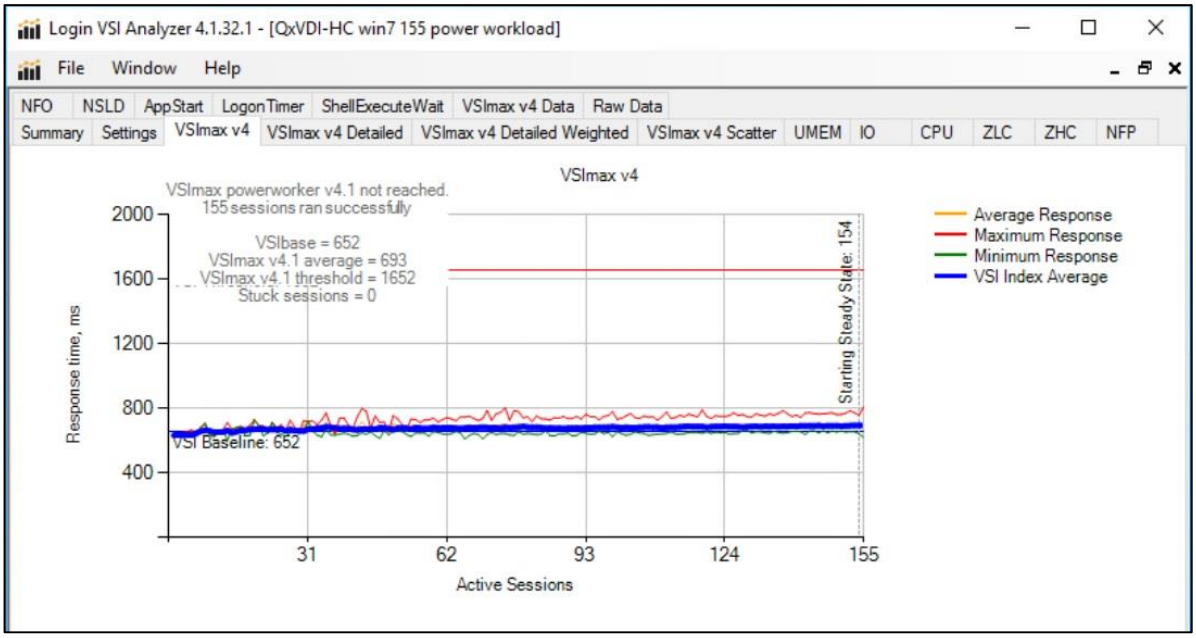


Figure 14. Graphical Result of Test Case 4 for VDI Test.

6.2. VDI with NSX® Test

6.2.1. VDI with NSX® Test: Overview

The network of VDI can be separated logically by NSX® to enhance network security. To further validate if the NSX® can be applied to VDI to reach network isolation and security, NSX® functions are deployed in the test and the benchmark tool Login VSI is executed. With the integration of VDI and NSX®, the test result shows the number of virtual desktops, which can be used for reference.

6.2.2. VDI with NSX® Test: Technical Configuration

The test environment deploys vCenter server® VM, Connection server VM, Composer server VM, Windows domain service VM, and the target test desktops in the T42S-2U cluster. Only one VM profile, Power Worker, is adopted to prove that VDI can be integrated with NSX® and provide services. It is noted that the virtual memory of Power Worker workload in this case is increased from 2GB to 4GB for simulating the realistic VDI user environment. The MS Office version 2007 was chosen in the desktop to save compute resources. The configuration of the virtual desktop VM profile is listed in Table 9.

Table 9. Virtual Desktop VM Profile of VDI+NSX Test.

Login VSI Workload	OS	System version	MS Office version	vCPU	vRAM (GB)	VM disk size	Total VM disk amount
Power Worker	Windows 10	X64 Pro	2007	2	4	24GB	1

The overall solution network topology was mainly built up by the NSX® logical network functions activated and installed in the hypervisor layer. Two logical router appliances, an ESG VM acting as north-south traffic boundary and a distributed logical router controller VM acting as east-west traffic node, are installed. The ESG virtual appliance is deployed and the interfaces, DHCP, DNS auto configuration, NAT, and dynamic routing are enabled to connect DLR controller VM and logical switches. Three logical switches, and ten L2 and ten L3 distributed logical firewall rules are symbolically selected to verify network isolation between services, as shown in Fig. 15 and Fig. 16.

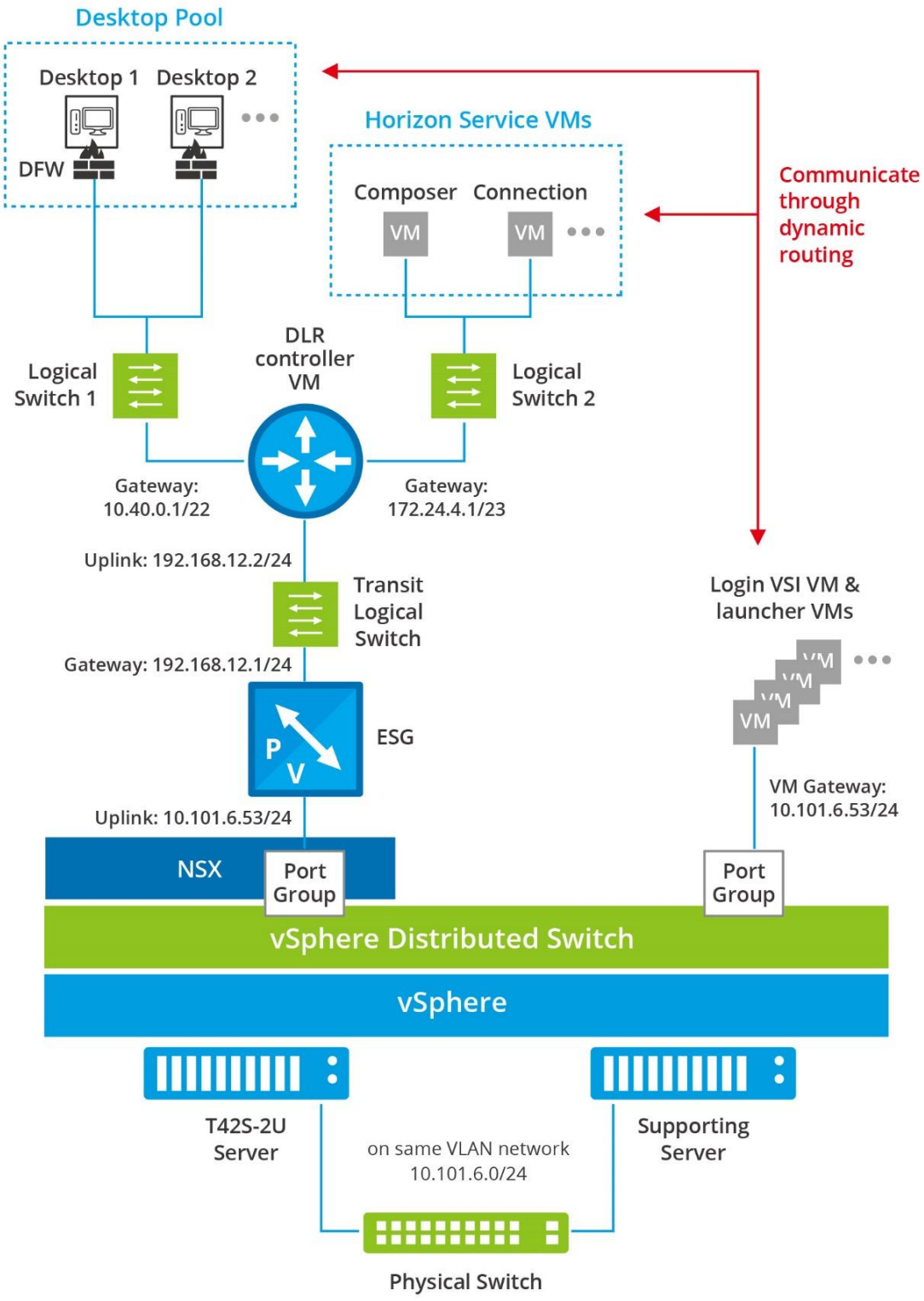


Figure 15. Cloud Architecture of VDI with NSX® Test.

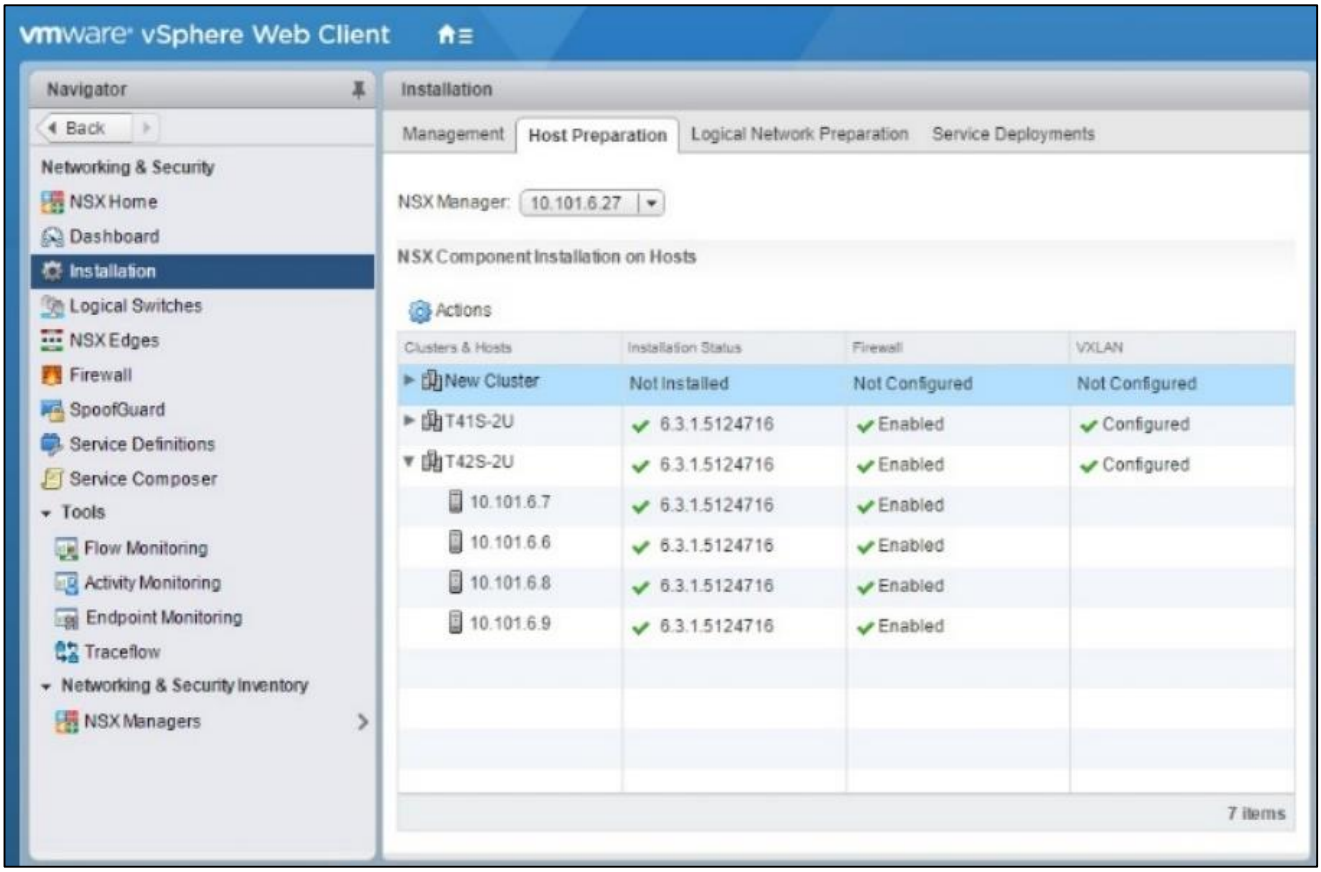


Figure 16. Summary of NSX® Installation.

6.2.3. VDI with NSX® Test: Result

The test results of network-virtualized VDI using Login VSI revealed that the NSX® can work with Horizon®, seamlessly providing centralized logical network and related services. The features of NSX® on Horizon® desktop pools are isolated network with logical switches or routers and centralized management of logical firewall. These features are hardware independent and thus minimize the use of hardware resource such as physical firewall and physical switch VLANs. The quick summary of the test including Login VSI performance scores and server resource consumption is recorded in the Table 10.

Table 10. Test Result of VDI+NSX using Login VSI.

Login VSI Workload	VM Profile	Desktop Amount	Max CPU Usage	Max Memory Usage	VSI baseline	VSImax v4.1 threshold	Index Average Score	VSImax v4.1 Average
Power Worker	2vCPU / 4GB RAM	150	31.45%	74.88%	740	1741	923	836

The test result reveals that 150 desktops with Power Worker using Windows 10 were successfully executed. The Login VSI score 740 indicated “Very Good” rating. The overall server resource consumption did not exceed 75%, showing that the system remains under HA consideration. The system saturation point (VSI threshold) of T42S-2U cluster was not reached which means the server is able to launch more virtual desktop sessions, as shown in Fig. 17 and Fig. 18.

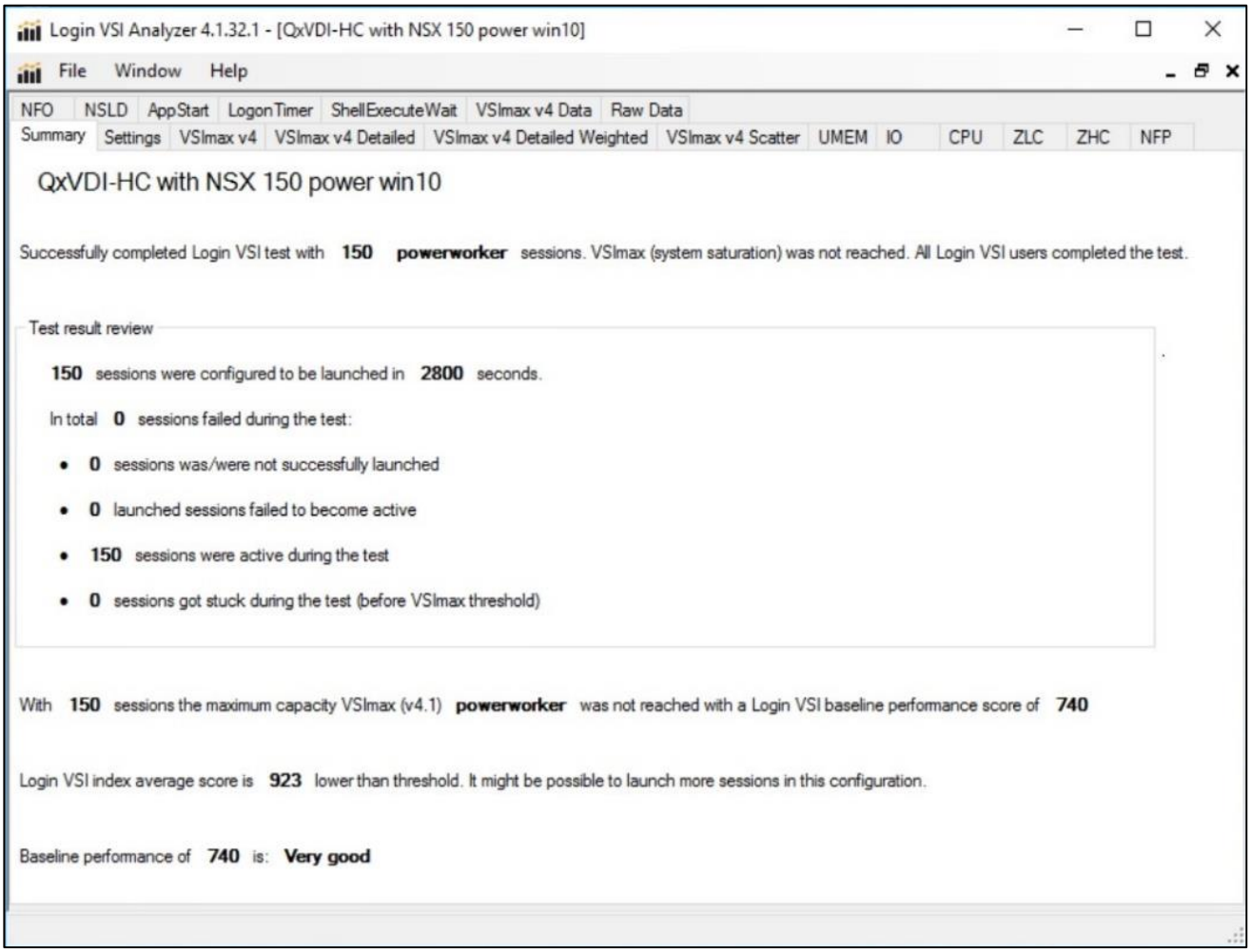


Figure 17 Test Result of VDI+NSX Test.

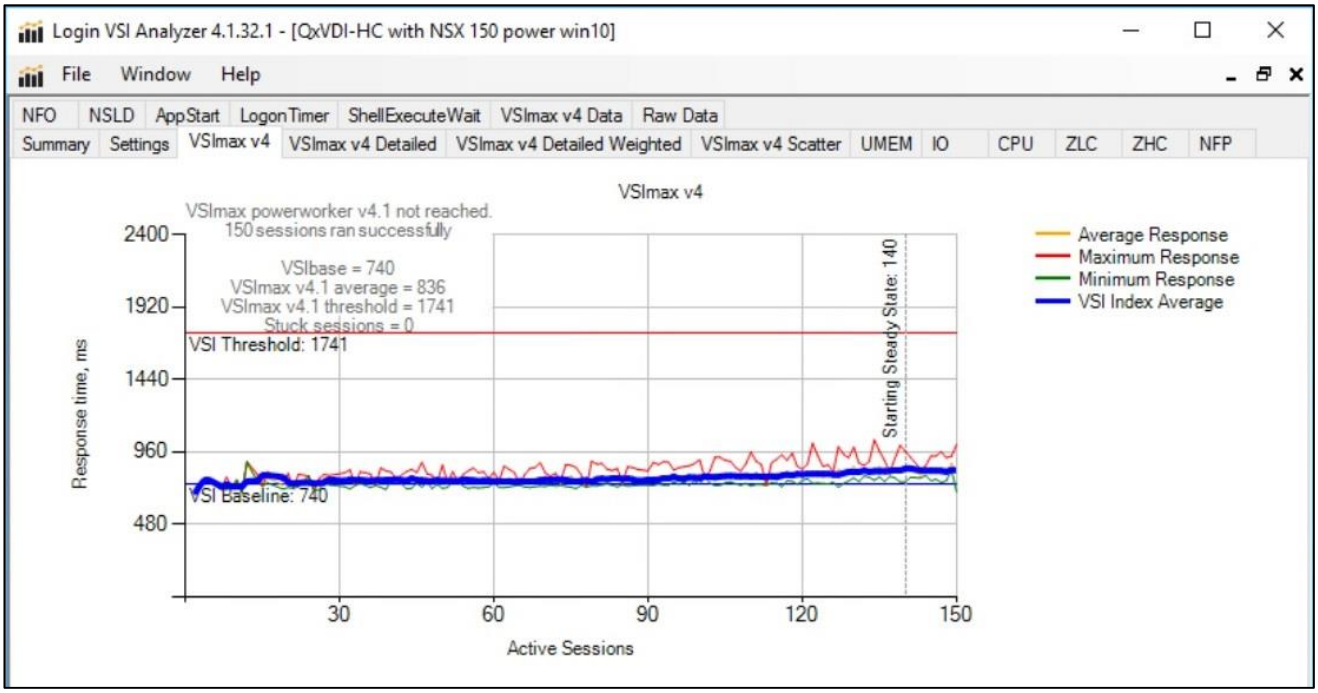


Figure 18 Graphical Result of VDI+NSX Test

6.3. Infrastructure as a service- VMmark®

To validate the ability of loading and execute different workloads on the solution, the benchmark tool, VMmark®, is adopted.

6.3.1. Test Overview

VMmark® is a tile-based benchmark tool developed by VMware for vendors to measure performance, power consumption, and scalability of virtualization platforms. It creates reliable performance score of the virtualized data center and provides the comparison between tested systems with industrial standard.

The target server, also called system under test (SUT), is tested and loaded up with tile workloads. VMmark® executes a set of virtual machines with diverse workloads including web simulation, e-commerce simulation, and standby system, and integrates application-level benchmarking software, the Weathervane, to place workload of realistic applications. These apps implement real-time auction website and simulate users' practical behaviors. DVDstore benchmark, an online e-commerce test application with database, simulates clients' web server login and catalog's browse using basic queries. Totally, the VMmark® simulation test includes 20 VMs in a so called "tile", and each tile requires a client VM to generate workloads upon the tile. The test procedures include the following items, as shown in Fig. 19.

- Scalable web workload simulation.
- E-commerce transaction simulation.
- VM cloning and deployment.
- Dynamic VM relocation between servers.
- Dynamic VM relocation across storages.
- Simultaneous server and storage virtual machine relocation.
- Automated load balancing.

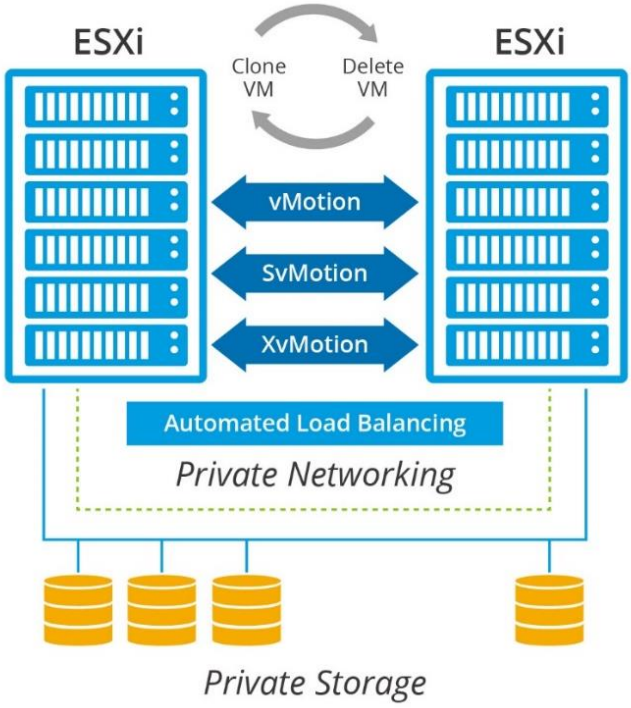


Figure 19 VMmark® Test Procedure.

6.3.2. Test Configuration

Each VMmark® tile requires 47 vCPUS, 166GB memory, and 891GB storage space. The test topology of VMmark® benckmark for our solution including one SUT - T42S-2U server, one T41S-2U server to load Client VMs, and one Windows iSCSI server for providing additional shared storage. All these servers are connected to one physical switch.

The vCenter Server® VM, VMmark® Prime Client, and Client VMs are located on T41S-2U server rather than SUT to avoid resource consumption. The SUT only loads up with VMmark® tile VMs, as shown in Fig. 20.

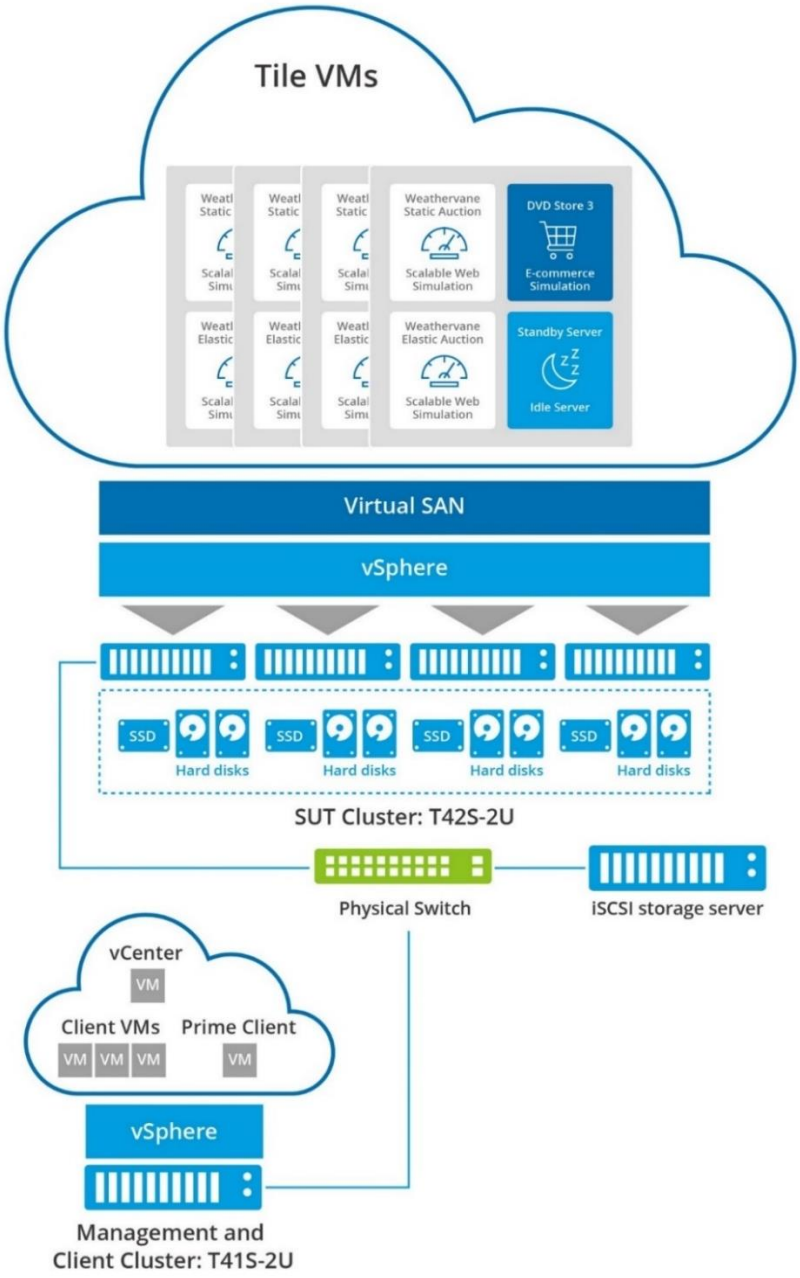


Figure 20 VMmark® Test Topology.

6.3.3. Test Result

The 7-tile test case with mixed workloads for 140 VMs was executed successfully which reveals that QxStack/QxVDI-HC High-Density Optimized SKU is able to load and execute the mixed services to up to 7 tiles, as shown in Fig. 21 and Table 11.

Table 11. Stages of the 7-tile Test Case.

Overall Test Stages	PASS	FAIL
VMmark Initialization	Yes	N/A
VMmark Setup	Yes	N/A
Vmmark Wkld Setup	Yes	N/A
VMmark Run Tiles	Yes	N/A

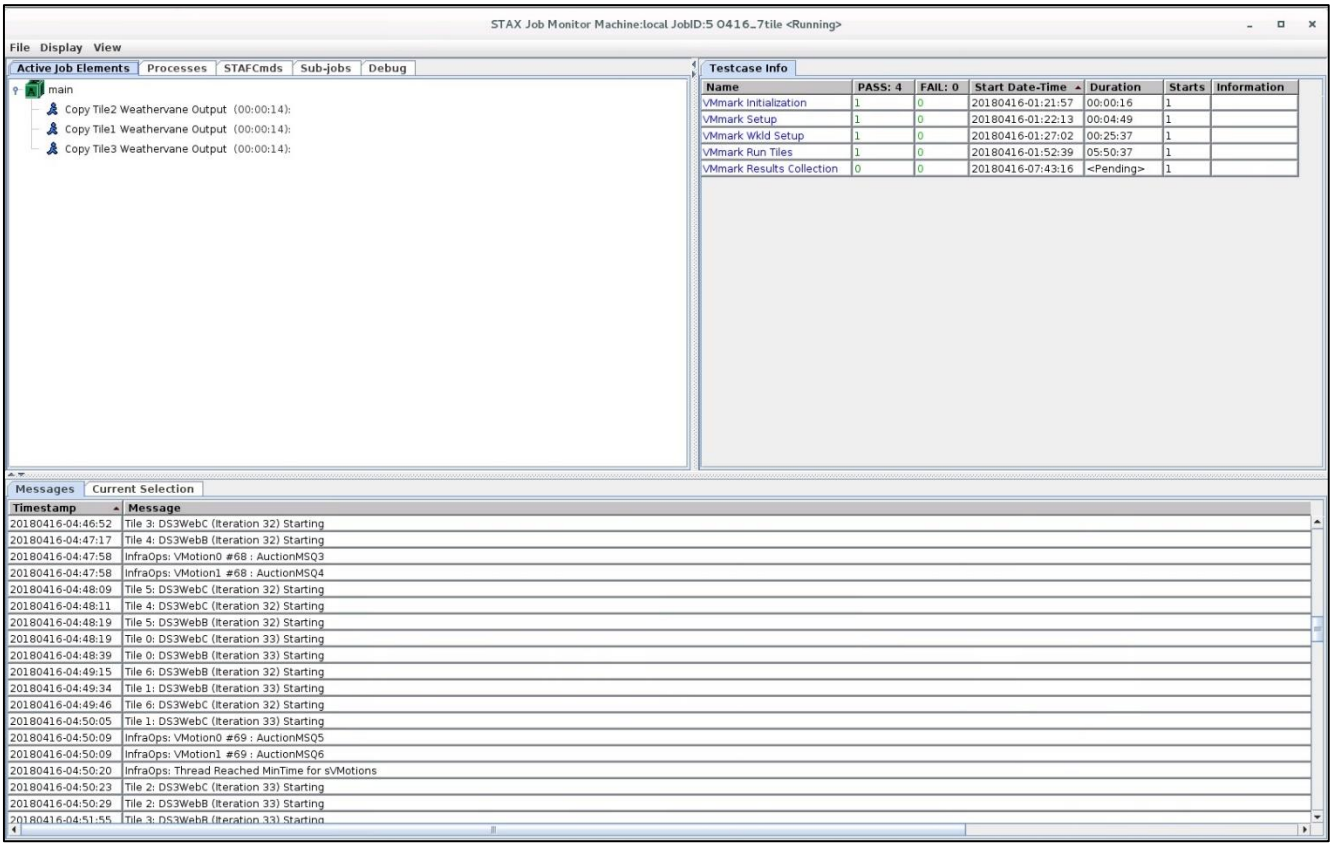


Figure 21 Stages of 7-Tile Case using VMmark®3.

The CPU in SUT cluster is utilized up to 70%, memory resource up to 78.8%, and vSAN™ disk space 34%. Considering HA, any one of the three resources should remain at least 20% to fulfill the requirement of the solution. The screenshots of resource utilization and VM workloads are shown in Fig. 22.

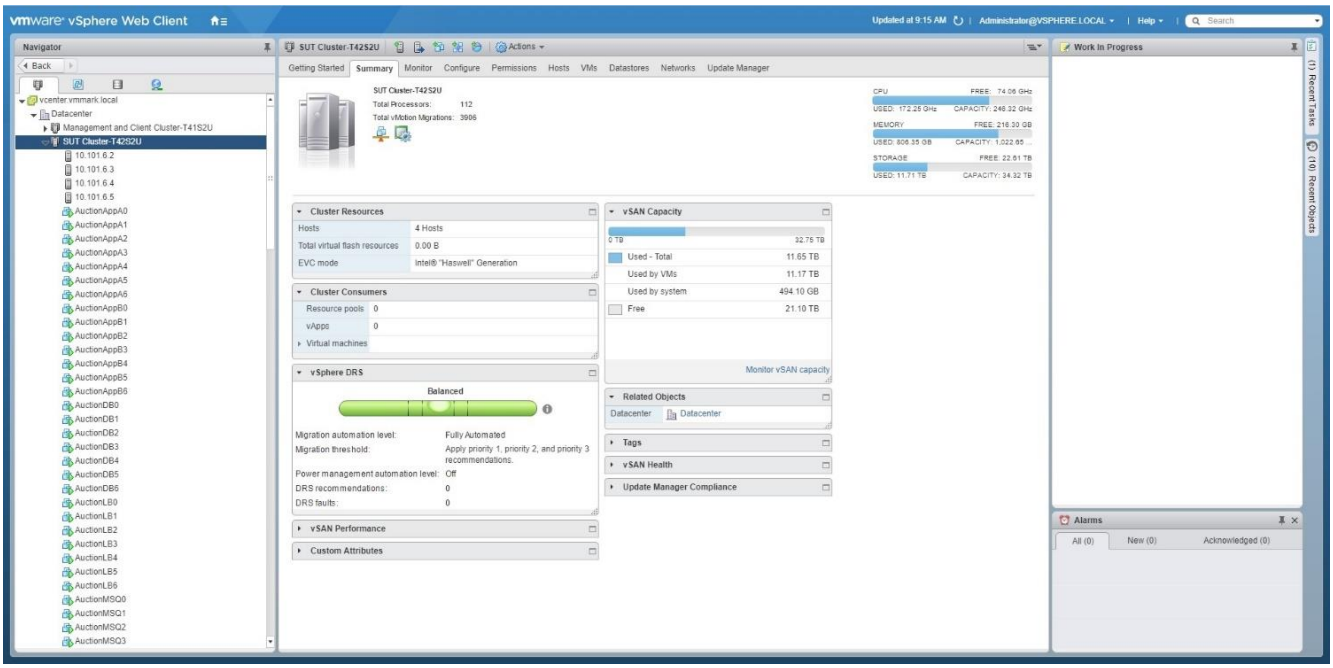


Figure 22. VMmark® Workloads of 7 Tiles in the Target Datacenter.

6.4. HCI storage performance- HCIBench Test

To validate the storage performance, a benchmark tool - HCIBench is adopted.

6.4.1. Test Overview

Hyper-Converged Infrastructure Benchmark (HCIBench) is an automation testing tool developed by VMware to evaluate the storage performance of HCI cluster such as virtual SAN. It is an Open Virtual Appliance (OVA) file which can be deployed on the vSphere® platform and is composed of test controller VM, Ruby vSphere® Console, automation bundle, etc. HCIBench integrates the open source benchmark tool, Vdbench, to execute HCI tests.

The HCIBench appliance and a DHCP VM are installed in the supporting cluster to provide test-related services such as testing guest VMs and IPs. The parameters such as block size, read percentage, and test time are configured in the HCIBench web UI. Once the test task is initiated, the guest VMs are created and deployed in the target vSAN™ cluster.

The test environment is divided into two parts, T41S-2U support server and T42S-2U target cluster. One vCenter Server® Appliance, one DHCP VM, and one HCIBench appliance are deployed on the T41S-2U support server while eight guest VMs are deployed on the T42S-2U target cluster to perform the test process, as shown in Fig. 23.

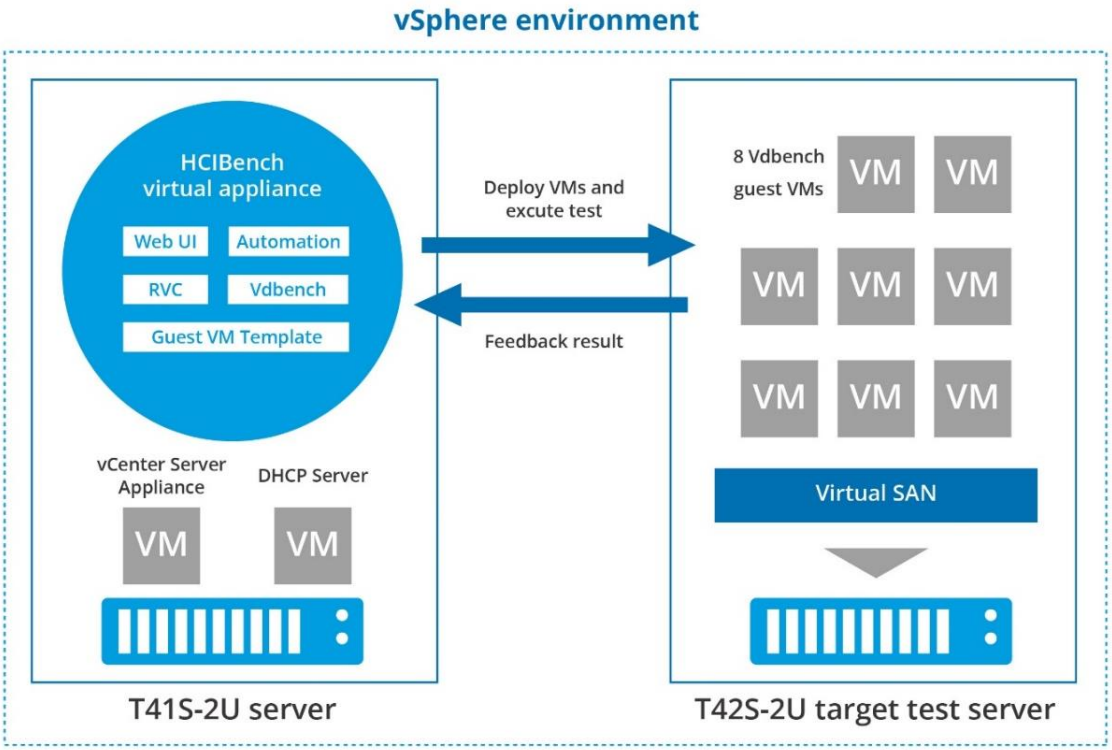


Figure 23. HCIBench Test Topology.

6.4.2. Test Configuration

The six different test cases were executed on the T42S-2U vSAN™ cluster. Several workload parameters defined for all the 6 test cases are listed below:

1. Thread and Queue Depth

In the storage performance tests, each thread is a single-threaded I/O operation and queue depth (QD) is the number of I/Os per thread. Different workloads are stored in different block size and the storage performance will be impacted by the choice of size. In the tests, 128 threads per host is set as a baseline.

2. Block size

The block size, also referred to as I/O request size, is the maximum length of a sequence of bytes or bits that applications use to perform I/O operation on storage devices. The block size impacts both the IOPS and throughput since throughput = IOPS x block size. In the tests, the block sizes 4KB, 8KB, 64KB, and 512KB are chosen to be tested.

3. Read and write percentage

The setting of read and write percentages in storage processing depends on the workloads. For example, the web file service normally performs 100% read and 0% write process. The summation of the read/write operation is 100%, that is, if the write percentage is set to 30%, the read percentage will relatively be 70%. In the tests, the predefined percentages are 100% read/ 0% write, 100% write/ 0% read, and 70% read/ 30% write.

4. Random and sequential percentage

The storage I/O process can be classified into random access and sequential access. The random access refers to the disk head that picks up data randomly with no specific order while the sequential access refers to the data accessed from the first to the end orderly. The speed of sequential access is theoretically much higher than random access. In the tests, either 100% random or 100% sequential configuration is selected for different cases.

5. VMDK size

Virtual machine disk (VMDK) is a virtual disk used by VM. In vSAN™ testing, different VMDK size could produce different write buffer usage. If the buffer usage is higher than 30% of the cache device, the testing process will result in high write latency.

Among all the test cases, some basic parameters are decided in the following ways:

- Total VMDK size per host=960G*50%= 480G.
- Total VM per host is 2.
- Total VMDK size per VM=480/{(FTT+1) *2} =120G.
- VMDK number per VM is 8.
- Threads number per VM=128 queue depth/ (8*2) =8.
- Per VMDK size=120/8=15G.

Each test case is executed in 3600 seconds test time. The six test cases and the possible applications are shown below:

- Test case 1: All read and all random 4K workload test for web file server.
- Test case 2: All write and all random 4K workload test for web server logging.
- Test case 3: Mixed read and write with all random 4K workload test for Exchange Email server.
- Test case 4: Mixed read and write with all random 8K workload test for OS drive and database online transaction processing.
- Test case 5: All write and all sequential 64K workload test for database logging and file restoring.
- Test case 6: All read and all sequential 512K workload test for video streaming.

Table 12. HCIBench Test Cases and Defined Parameters.

Test Case	1	2	3	4	5	6
Possible scenarios	web file server	web server logging	Exchange Email server	OS drive and database online trans-action pro-cessing	database logging and file re-storing	video streaming
Queue Depth	128					
Block size (KB)	4	4	4	8	64	512
Read (%)	100	0	70	70	0	100
Write (%)	0	100	30	30	100	0
Random (%)	100	100	100	100	0	0
Sequential (%)	0	0	0	0	100	100
VMDK size	15GB					

6.4.3. Test Results

The test results of the 6 cases provided reference values for their correspondent scenarios, as shown in Table 12 and Table 13. With the vSAN™ hardware configuration and specified test parameters, each result indicated the reference IOPS, throughput, and latency in the vCenter® performance chart, as detailed in Fig. 24 to Fig. 29.

Table 13. HCIBench Test Results.

Test Case		1	2	3	4	5	6
Block size (KB)		4	4	4	8	64	512
Read (%)		100	0	70	70	0	100
Write (%)		0	100	30	30	100	0
Random (%)		100	100	100	100	0	0
Sequential (%)		0	0	0	0	100	100
Test result	IOPS	284K	54K	62K	56K	10K	12K
	Throughput (MB/s)	1090	214	246	442	611	5550
	Latency (ms)	10	10	read: 8 write: 7	read: 4 write: 5	13	11

Test Case 1: The workload profile, which can be used for web file services, shows the performance results IOPS 284K, throughput 1090 MB/s, and latency 10 ms, as shown in Fig. 24.

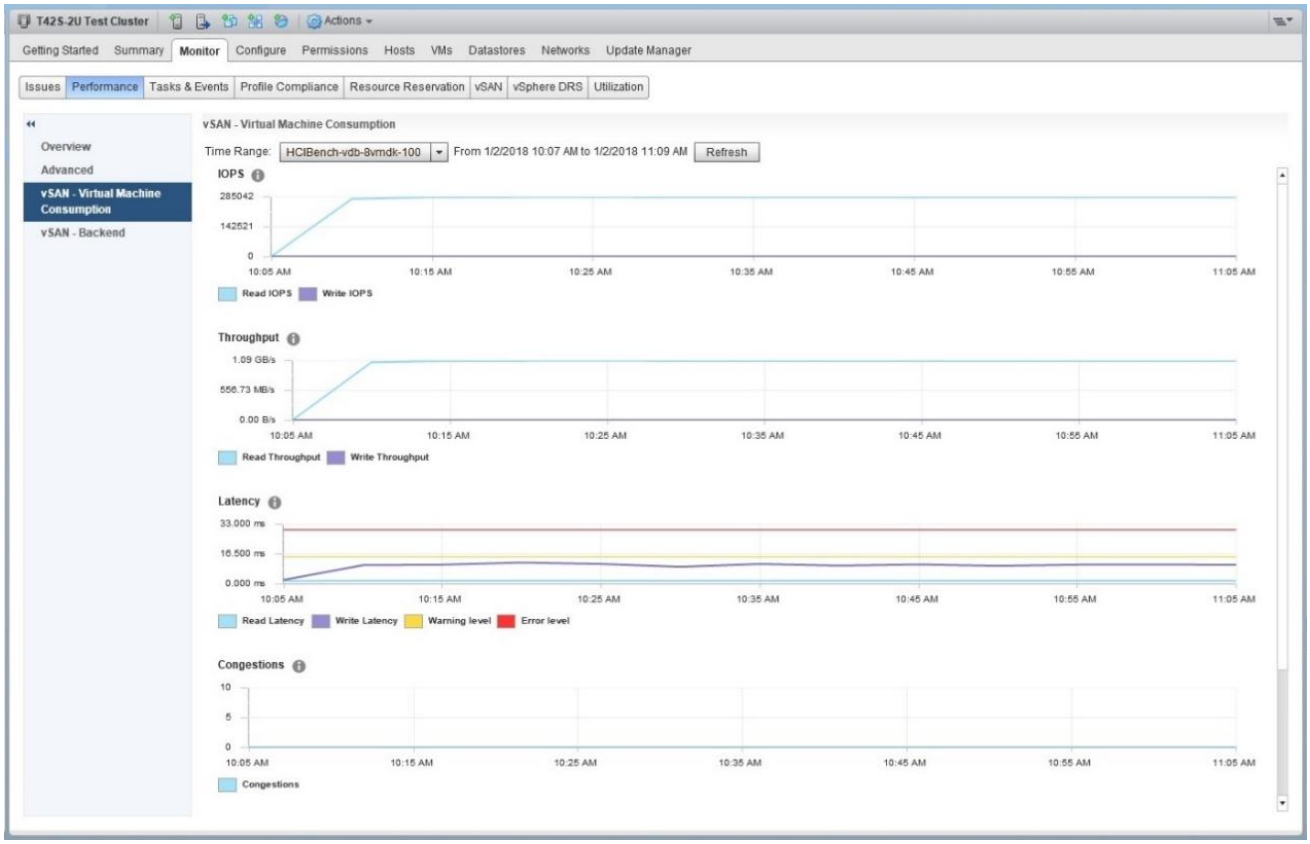


Figure 24. Graphical Results of IOPS, Throughput, and Latency for Test Case 1.

Test case 2: The workload profile, which can be used for web server logging, shows the performance results IOPS 54K, throughput 214 MB/s, and latency 10 ms, as shown in Fig. 25.

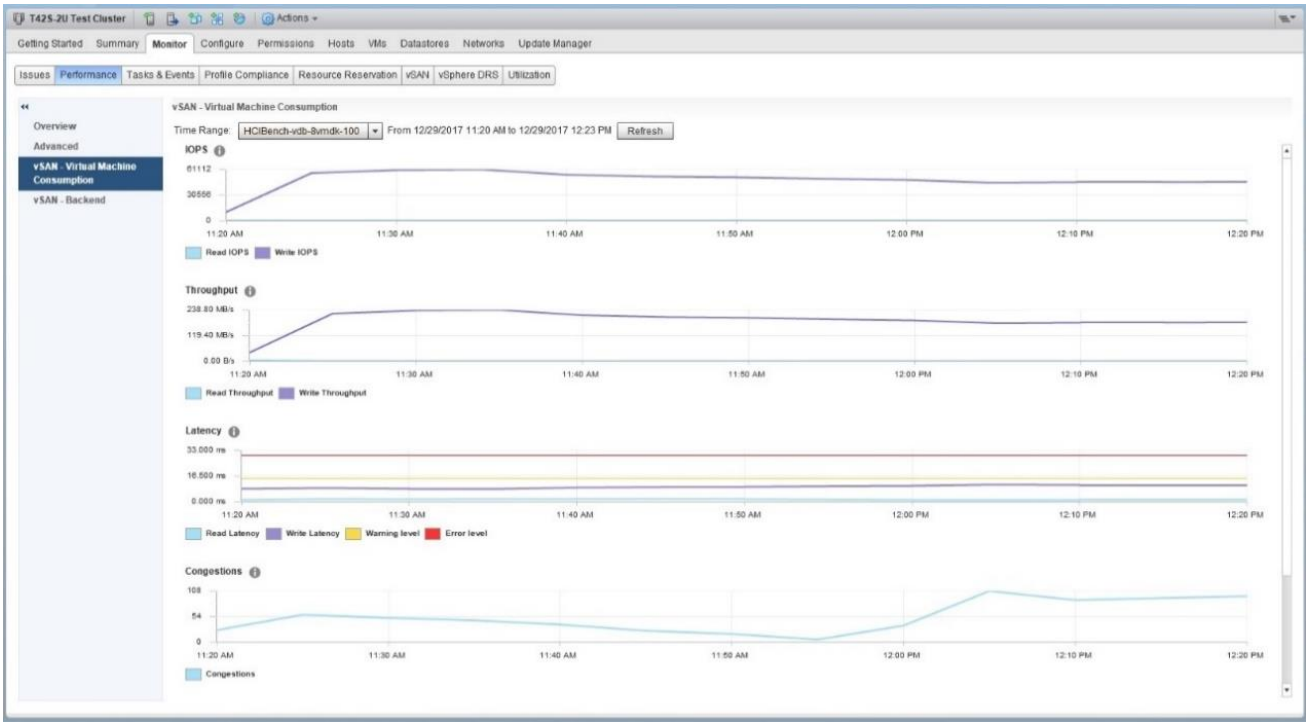


Figure 25. Graphical Results of IOPS, Throughput, and Latency for Test Case 2.

Test case 3: The workload profile, which can be used for Exchange Email server, shows the performance results IOPS 62K, throughput 246 MB/s, and latency 15 ms, as shown in Fig. 26.

Figure 26. Graphical Results of IOPS, Throughput, and Latency for Test Case 3.

Test case 4: The workload profile, which can be used for OS drive or database online transaction processing, shows the performance results IOPS 56K, throughput 442 MB/s, and latency 9 ms, as shown in Fig. 27.

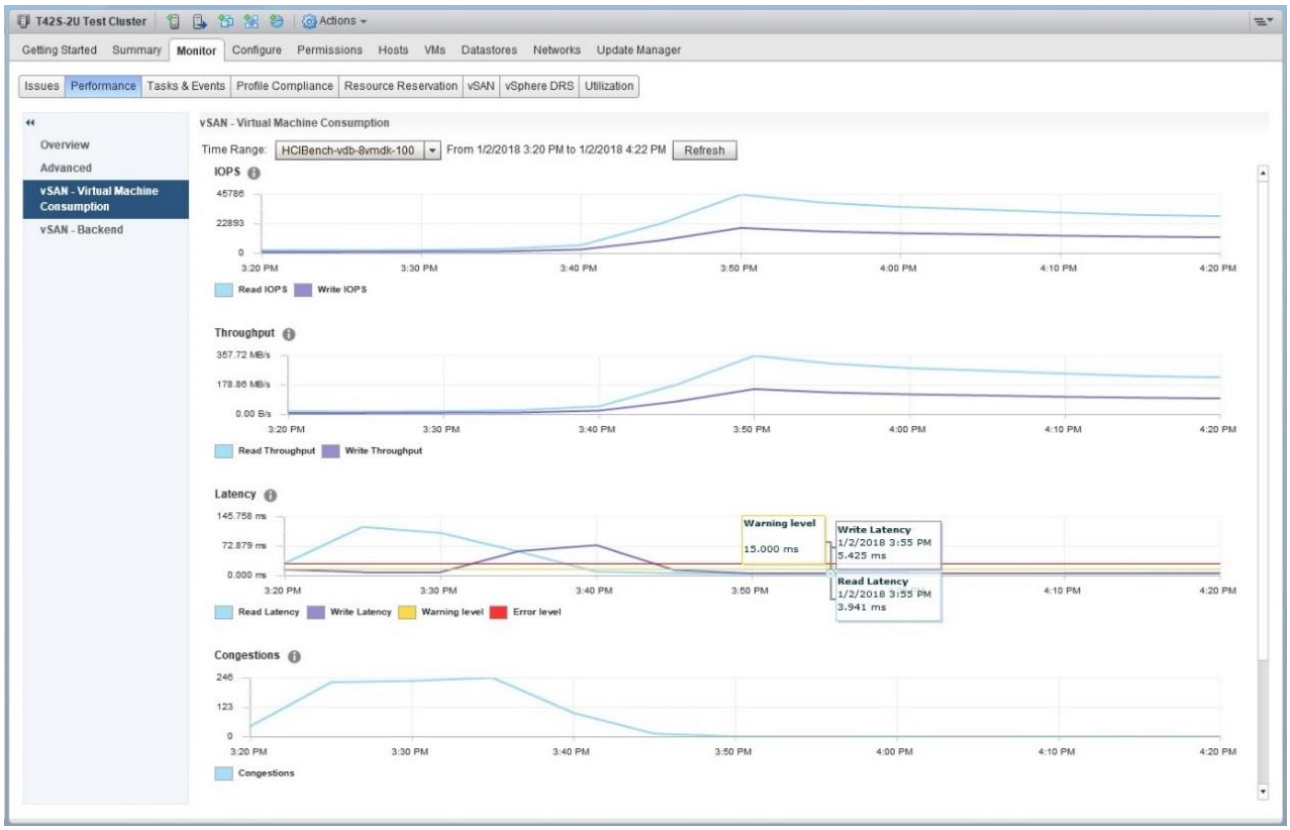


Figure 27. Graphical Results of IOPS, Throughput, and Latency for Test Case 4.

Test case 5: This workload profile, which can be used for database logging and file restoring, shows the performance results IOPS 10K, throughput 611 MB/s, and latency 13 ms, as shown in Fig. 28.

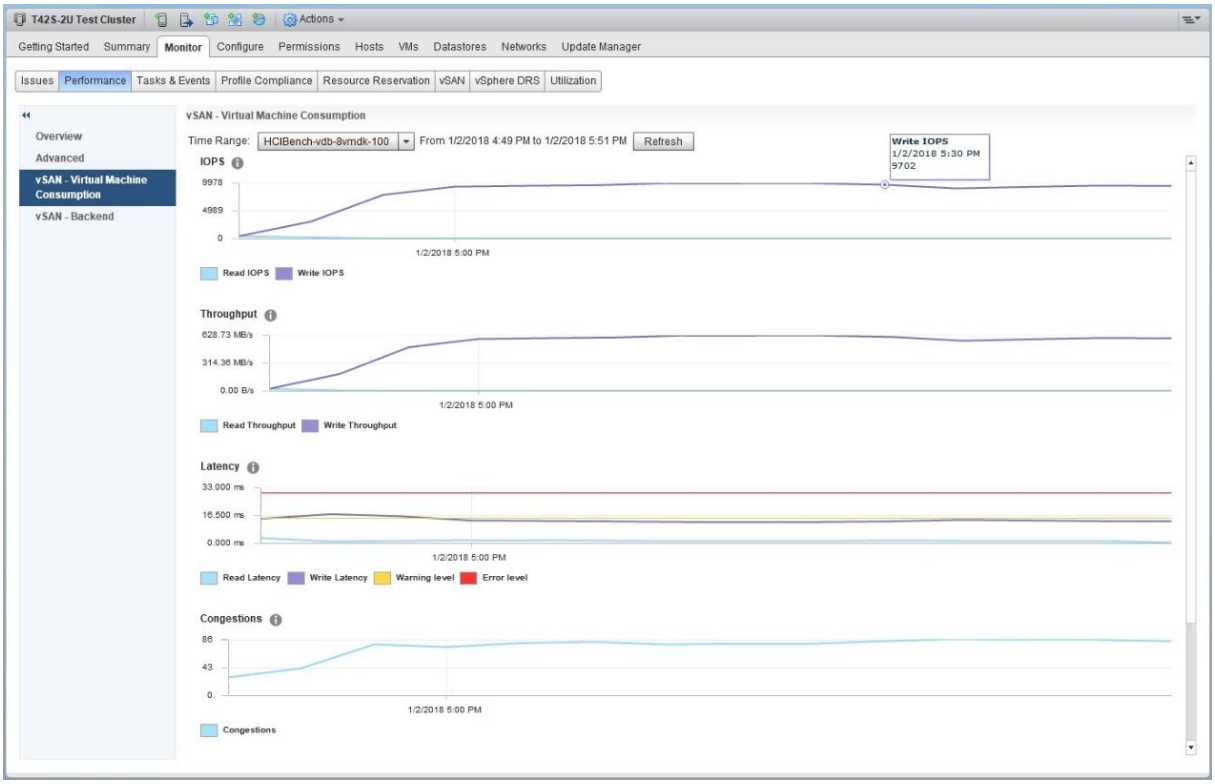


Figure 28. Graphical Results of IOPS, Throughput, and Latency for Test Case 5.

Test case 6: The workload profile, which can be used for video streaming, shows the performance results IOPS 12k, throughput 5550 MB/s, and latency 11 ms, as shown in Fig. 29.

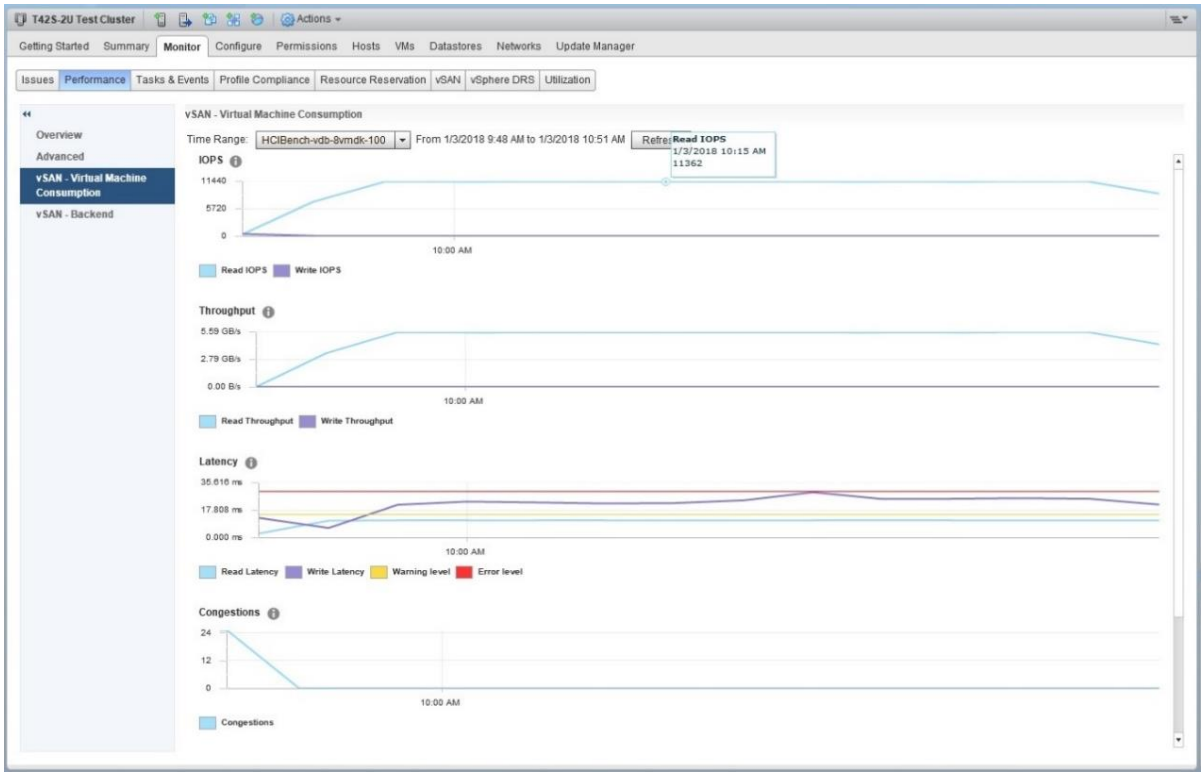


Figure 29. Graphical Results of IOPS, Throughput, and Latency for Test Case 6.

7. Conclusion

Nowadays, data center transformation is considered to be a main trend to address the dynamic business environment. QCT, a global data center solution provider, provides innovative and flexible solutions to keep your organizations stay in a leading position.

QxStack/QxVDI-HC High-Density Optimized SKU is a ultra-dense data center solution rapidly deployed, easily to be managed, highly certified, and fully integrated into the industry-leading software-defined storage, vSAN™. QCT executed a strict certification process, including functional test, stress test, and failure tolerance test from components to total solution level in order to provide customers best reliability and stability.

This reference architecture has been proven that this solution can satisfy diverse use cases, VDI with the security function and mixed workload scenarios. In the VDI use case, this SKU can support up to 280 VMs on Windows 10 under HA consideration. In the mixed-workload use case, this SKU can support up to 7 tiles of mixed workloads in real-time auction or e-commerce scenarios.

According to the test results, the feasibility and stability of the solution are proven in both use cases. By adopting this solution, customers can highly minimize their time and expense in evaluation, selection, deployment, and tuning so as to reduce overall TCO. With the knowledge of QCT, customers can leverage the collective results and follow a simplified path to a future-defined data center.

QCT always stays innovative. QCT appreciates any feedback from you. For further inquiry, please visit http://go.qct.io/solutions/

8. Reference

[1] Quanta Could Technology QuantaPlex T42S-2U
https://www.qct.io/product/index/Server/rackmount-server/Multi-node-Server/QuantaPlex-T42S-2U-4Node
[2] VMware vSphere®
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[3] VMware Horizon®
https://www.vmware.com/products/horizon.html
[4] VMware vSAN™
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ABOUT QCT

QCT (Quanta Cloud Technology) is a global datacenter solution provider extending the power of hyperscale datacenter design in standard and open SKUs to all datacenter customers.

Product lines include servers, storage, network switches, integrated rack systems and cloud solutions, all delivering hyperscale efficiency, scalability, reliability, manageability, serviceability and optimized performance for each workload.

QCT offers a full spectrum of datacenter products and services from engineering, integration and optimization to global supply chain support, all under one roof.

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