



# Pivot3 Acuity with Citrix Virtual Desktops and Microsoft Windows 10 Reference Architecture



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# Introduction

Virtual desktop infrastructure (VDI) has been a key enabling technology to enhance employee productivity, improve information security and compliance, and increase IT operational efficiency. However, close attention to cost, user experience and scalability of the underlying infrastructure is critical to ensure a smooth roll out and long-term viability of VDI deployment. The Pivot3 Acuity Hyperconverged Infrastructure (HCI) platform, with its policy-based Intelligence Engine, NVMe flash optimized data path, distributed scale-out architecture and flexible scaling configurations can address these priorities and ensure cost-effective high-performance VDI that scales simply and predictably.

This document provides a reference solution architecture for implementing VDI using the Pivot3 Acuity HCI platform in conjunction with the Citrix Virtual Desktops and Microsoft Windows 10. The Login VSI load-testing tool was used in this exercise to generate desktop workloads and determine the maximum desktop density supported on the tested Pivot3 configuration. The exercise was conducted at one of Pivot3's Technical Marketing facilities and was jointly overseen by Pivot3 and Login VSI engineers.

## VDI Overview

VDI enables you to consolidate and centralize desktop and end-point operating environments in a virtualized datacenter. VDI decouples the end-point devices from their respective operating environments (OS, applications, and data), which allows you to manage these environments centrally.

VDI helps improve end-user productivity by allowing users to access their desktop environments from any device and location. It helps improve IT security and compliance by centralizing critical data assets, in turn preventing theft of corporate assets and simplifying data protection. VDI also allows IT organizations to simplify how the desktop environments are provisioned and managed, thereby enabling greater operational efficiencies and agility.

### Critical Success Factors for VDI Deployments

Due to the resource intensive and highly dense nature of the VDI workload, a VDI environment can be fraught with challenges. Paying attention to costs, user experience, and scalability are critical when architecting VDI environments.

VDI entails moving end-user operating environments and data from inexpensive, consumer-grade end-point devices to enterprise-class datacenter infrastructure. This can prove to be an obstacle for justifying return on investment (ROI). A close attention to cost, complexity, and infrastructure footprint is necessary to achieve ROI goals.

Another common challenge is suboptimal and inconsistent user experience. As the desktops are centralized in the datacenter on a common shared virtualized infrastructure, the storage infrastructure can be an I/O bottleneck when many desktops access storage simultaneously. This can compromise the user experience, hamper productivity, and stall VDI adoption. Ensuring superior user experience is a key success criterion.

Many VDI projects start out smoothly in the pilot phases but can soon become too complex and cumbersome to scale to accommodate a larger user pool, compromising user experience and complicating growth planning. The infrastructure supporting VDI deployments must be able to scale predictably to simplify scaling and sizing exercises.

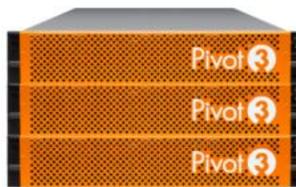
Many traditional infrastructure paradigms are inefficient and ineffective in battling these challenges, and organizations are increasingly looking for different, smarter approaches to infrastructure. A correctly architected Hyperconverged Infrastructure (HCI) solution can help overcome these challenges and simplify VDI deployments and ongoing administration.

# Pivot3 Acuity HCI Overview

Pivot3's policy-based, priority-aware, distributed scale-out architecture enables you to deliver on the promise of virtual desktops by achieving the best ROI, predictable scalability, and uncompromising user experience.

Pivot3 delivers market leading desktop density per node, which slashes the infrastructure footprint and the total cost of ownership. Its NVMe flash-optimized data path, coupled with advanced Quality of Service (QoS) and distributed architecture, delivers superior IO performance for an exceptional user experience. With a rich ecosystem of VDI solution providers and a wide range of deployment configurations, Pivot3 can seamlessly accommodate diverse needs and criteria with a simple and cost-effective architecture.

The Pivot3 Acuity HCI solution uses qualified commonly used industry-standard server nodes to build a software-defined HCI environment. Pivot3 deployments start with a 3-node cluster, running Pivot3 HCI software. The cluster, which is referred to as a Virtual Performance Group (vPG) can be scaled by adding more nodes to the cluster. The following sections describe some of the technical differentiators of Pivot3 HCI solutions that deliver better VDI outcomes.



***3-Node Pivot3 Acuity HCI Cluster***

## Distributed Scale-Out Architecture

The Pivot3 Acuity platform uses a distributed, scale-out architecture. Acuity aggregates all available resources in all nodes in a cluster to build a unified pool of resources. All volumes, virtual machines, and data sets are uniformly distributed across all drives in the cluster, resulting in blazing fast I/O performance for each desktop user. This architecture mitigates I/O bottleneck out of the box, without specialized storage tuning or optimization, thus ensuring a consistent user experience.

Additionally, the cluster is expanded by adding more nodes to accommodate more users. The distributed scale-out architecture ensures linear scalability of capacity, compute, I/O performance, and available bandwidth. As a result, predicting incremental hardware requirements for anticipated growth is easy and straightforward with Pivot3.

## NVMe Flash Data Path and Policy-Based QoS

Pivot3's innovative multi-tier architecture includes an ultra-low latency NVMe flash storage combined with policy-based Quality of Service (QoS). This allows administrators to categorize user pools based on their criticality and performance needs in a simple, intuitive manner by assigning them one of five policies ranging from mission-critical to non-critical. The Pivot3 QoS engine automatically and transparently prioritizes the data placement on the best storage media, either NVMe flash, RAM cache or SATA SSDs/HDDs. This allows automated, policy-based performance management for simpler operational workflows. The QoS is also schedulable, allowing you to schedule policy changes. As an example, an administrator might want to tag all datastores containing master images for linked-clones as mission-critical during mass login periods on a scheduled basis to ensure lower boot times and a faster login process.

This architecture also eliminates any potential resource bottleneck, allowing you to consolidate more desktops per node, boosting density, and slashing the infrastructure footprint.

## Pivot3's Patented Erasure Coding

Pivot3 HCI solutions utilize its patented erasure coding (EC) to achieve high availability and fault tolerance. Pivot3 EC delivers up to 82% usable capacity while providing protection from node and drive failures. Additionally, EC eliminates write IO duplication commonly evidenced in other HCI platforms, further boosting I/O performance of applications and desktops. Conventional methods to protect against hardware failures in HCI environments rely upon replicating data sets across the nodes to ensure availability of data in case of a node or component failure. This method proves to be inefficient, offering less than 50% usable capacity. Often, two copies are required to achieve the desired availability goals, slashing usable capacity to 33%. With EC, much greater efficiencies are achieved while mitigating any performance impact.

## Architectural Flexibility and Simple Scalability

Pivot3 HCI solutions are available in broad form-factors. You can choose between 1U and 2U nodes, either all flash or hybrid configurations. There is a broad choice of configurations for CPU, RAM, SATA storage, and NVMe flash storage. The nodes are designed to support GPU. Pivot3 solutions offer options to scale by utilizing compute-only or storage-only nodes to address a specific resource bottleneck. The scaling is non-disruptive, and you can monitor and manage multiple Pivot3 clusters, deployed at multiple locations from a single interface. All of this ensures architectural flexibility to optimize the requirements of the VDI projects while simplifying scaling and management on a large-scale basis.

## Rich Data Services and Ecosystem

The Pivot3 Acuity hyperconverged platform offers a rich set of data services with an all-inclusive licensing model. These data services include Thin Provisioning, space-efficient application aware snapshots and clones, native replication and data-at-rest encryption, and data reduction. Unlike competing HCI solutions, these data services are inline, and the performance guidance Pivot3 provides is always with EC and data reduction enabled.

Pivot3 also works with a broad set of ecosystem partners to optimize a joint solution. These partners include VMware, Citrix, NVIDIA, Teradici, Login VSI, Liquidware, Imprivata and others. This ensures optimal solution design and execution.

# Login VSI Load Testing Overview

Login VSI is the industry-standard load-testing tool for measuring the performance and scalability of centralized Windows desktop environments, such as server-based computing (SBC) and VDI. Login VSI is used for testing and benchmarking by the major hardware and software vendors and is recommended by both leading IT analysts and the technical community. Login VSI is 100 percent vendor independent and works with standardized user workloads and statistics—making all conclusions based on Login VSI test data objective, verifiable, and repeatable.

Login VSI-based test results are used and published in multiple technical white papers and presented at various IT-related conferences by our vendor customers. The product, Login VSI, is also widely used by end-user organizations, system integrators, hosting providers, and testing companies. It is also the standard testing tool used in all tests executed in the internationally acclaimed research project VDI Like a Pro (formerly known as Project Virtual Reality Check).

Login VSI offers a complete suite of proven software solutions to design, build, and safeguard the optimal performance, scalability, availability and compatibility of desktops and applications running in any type of (centralized) Windows environment, including SBC, VDI, DaaS and fat clients.

Typical customers are enterprises with centralized desktop environments and/or business critical applications running in VDI, and major IT vendors that offer solutions for VDI.

The Login VSI Enterprise Edition offers a unique combination of synthetic load-testing and pro-active monitoring capabilities, allowing enterprises to design, build and maintain VDI environments, both infrastructure and applications, that can provide and safeguard the optimal end-user experience.

The Login VSI load-testing solution generates many synthetic users to test and protect the performance and scalability of new and existing VDI, SBC and Desktop-as-a-Service deployments. The Login PI active monitoring solution uses a single synthetic user running 24/7, to safeguard performance and availability of virtual desktop infrastructures and applications. The Login AT application compatibility testing solution checks the availability and health of large numbers of applications, fast and efficient.

Login VSI was closely involved in the testing exercise outlined in this document as a part of its *Validated By Login VSI* program offering. Login VSI engineers worked closely with Pivot3 experts to ensure all necessary guidelines for this testing were followed. Login VSI has reviewed and approved the results outlined in this document.

For more information or a free trial, visit [www.loginvsi.com](http://www.loginvsi.com).

# Citrix Virtual Apps and Desktops Overview

Citrix Virtual Apps and Desktops are the industry's leading solutions for application and desktop delivery, with over 100 million users worldwide. Citrix Virtual Apps and Desktops enable secure, remote access to Windows applications and desktops, as well as Linux, web, and Software-as-a-Service applications from any device, over any network while strengthening data security, reducing costs and increasing user productivity. Citrix solutions enable you to work from anywhere while cutting IT costs and complexity.

Citrix Virtual Apps and Desktops allow:

- End users to run applications and desktops independent of the device's operating system and interface.
- Administrators to manage the network and control access from selected devices or from all devices.
- Administrators to manage an entire network from a single data center.

Citrix Virtual Apps and Desktops share a unified architecture called FlexCast Management Architecture (FMA). FMA can run multiple versions of Citrix Virtual Apps or Citrix Virtual Desktops from a single site and provides integrated provisioning.

## Reimagine Application and Desktop Delivery

### Adaptive to Changing Business Needs

Citrix Virtual Apps and Desktops can deliver a full desktop or just applications based on an individual employee's role or device. This enables IT to be more agile in a rapidly changing workplace.

### Secure by Design

Citrix Virtual Apps and Desktops is Common Criteria certified and native FIPS 140-2 compliant. Citrix Virtual Apps and Desktops reduces the risk of data loss and prevents unwanted intrusions by delivering secure access to business applications on demand, to any user, based on location and device-specific features and security configurations.

### High-Definition Experience (HDX) from any Device

HDX is a leading solution that delivers a superior, high-definition user experience on any device. HDX ensures that employees have a native-like experience wherever they are, even when network connections are less than ideal.

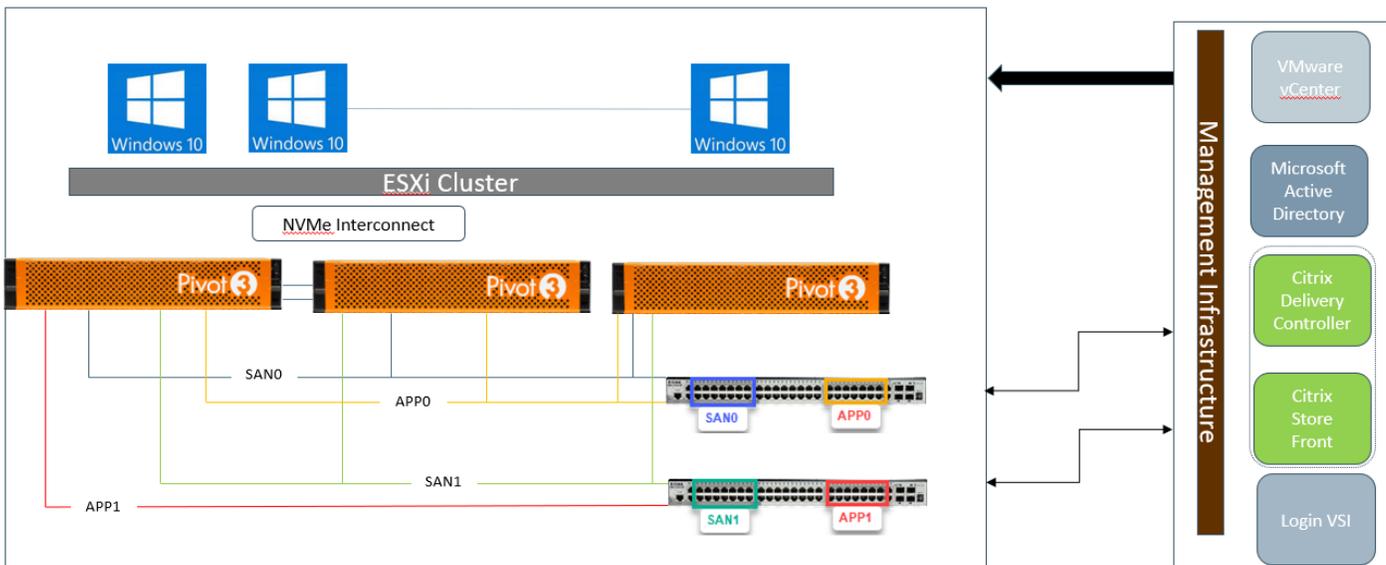
For more information, visit [www.citrix.co.in/products/citrix-virtual-apps-and-desktops/](http://www.citrix.co.in/products/citrix-virtual-apps-and-desktops/)

# Reference Solution Architecture

This section describes a VDI deployment using the Pivot3 Acuity HCI platform in conjunction with the Citrix Virtual Desktops 1808 and Microsoft Windows 10. This implementation uses the Login VSI load-testing tool to generate desktop workloads and determine the maximum desktop density supported on the tested configuration. The exercise was conducted at one of Pivot3's Technical Marketing facilities and was jointly overseen by Pivot3 and Login VSI engineers.

## System Configuration

This exercise uses a 3-node Pivot3 Acuity Flash HCI cluster with two Pivot3 X5-6500 Accelerator nodes and one Pivot3 X5-6000 Standard node. Each of the three nodes has 16× 960GB SATA SSDs. Each of the accelerator nodes has 2.0TB of NVMe flash storage, which is managed by Acuity as both a persistent data tier and cache. The physical setup specifics are listed in [Table 1](#).



**Figure 1: VDI Reference Solution Architecture with Pivot3 Acuity Software Platform**

**Table 1: System Configuration for VDI Reference Solution Architecture**

<b>System/Cluster</b>	Acuity Flash: Single cluster containing 3× ESXi hosts: 3-nodes (2× Pivot3 X5-6500 + 1× Pivot3 X5-6000) BIOS set to Max Performance
<b>CPU</b>	Per node: 2× Intel® Xeon® Gold 6138 CPU @ 2.00GHz. (40 physical [80 logical] cores)  Total System: Flash: 3× 2× Intel® Xeon® Gold 6138 CPU (120 physical [240 logical] cores)
<b>RAM</b>	Per Node: 768 GB
<b>NVMe</b>	Total System: 2× 2.0TB
<b>Disks</b>	Per Node: 16× 960GB SATA SSDs
<b>Network Adapters</b>	Storage Network: 2x 10Gbe 10BaseT ports per node Application Network: 2x 10Gbe 10BaseT ports per node
<b>Network Switches</b>	2× 10GbE 10BaseT
<b>HCI</b>	Pivot3 Acuity 10.6.0, data reduction and erasure coding enabled
<b>Hypervisor</b>	ESXi 6.5.0, 8294253
<b>Management</b>	VMware vCenter 6.5.0, Pivot3 Acuity vCenter Plugin 10.6.0.3174.
<b>Citrix Desktop Controller</b>	Citrix Virtual Apps and Desktops 7 1808.
<b>Citrix StoreFront</b>	Citrix Virtual Apps and Desktops 7 1808.2, Citrix StoreFront 3.16.0.19022
<b>Login VSI Version</b>	Login VSI 4.1.32.1
<b>Desktop Workload Specifics</b>	Knowledge Worker: 2 vCPU, 3GB RAM (Windows 10 1709 64-bit, Office 2016)*
<b>Golden Image Optimizations</b>	Optimized with VMware Tools, CitrixOptimizer 1.2.0.67, Login VSI Win10 best practices

\* The LoginVSI workload was modified to enable the OneDrive setup to complete.

## Citrix Virtual Desktops Configuration

The standard installation and configuration of Citrix Virtual Desktops can be found here:

<https://docs.citrix.com/en-us/citrix-virtual-apps-desktops/1808.html>

The Citrix Desktop Controller and Citrix StoreFront components are installed in separate VMs to enable StoreFront scaling if needed for the testing.

## Datastore Configuration

Four VMFS datastores hosted up to 128 Windows 10 desktops each.

All datastore volumes were created with performance QoS policy 1 (Mission Critical) and EC Level 3, as this exercise was geared towards consolidating one workload type to identify peak density supported by the tested Pivot3 HCI configuration. It is possible and advisable to design multiple pools of desktops based on their attributes and assign the appropriate performance QoS policies to pools based on their requirements and criticality. This approach ensures guaranteed performance for critical desktop users while simplifying ongoing performance management.

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**NOTE:** Pivot3 Acuity supports VMware DRS and HA capabilities. These should be used to ensure optimal workload distribution and uninterrupted operations in case of hardware failure.

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# Login VSI Load Testing Results

The results outlined in this section are based on testing performed using the Login VSI load-testing tool and methodology on the configuration outlined in [Table 1](#). The desktop virtual machines used in this testing were pre-booted before the testing. Login VSI Benchmark Mode was not enabled due to required changes in the workload for OneDrive to complete its configuration prior to the workload execution and for Adobe Reader Windows 10 File Type Associations.

**Table 2. Login VSI Testing Results**

Acuity 3-Node Flash Cluster	
<b>Login VSI Workload</b>	Knowledge Worker: 2 vCPU, 3GB RAM, Windows 10, 64-bit OS Office 2016
<b>Login VSI max*</b>	501
<b>Login VSI Avg *</b>	1640 ms
<b>Login VSI baseline*</b>	806

\*VSI<sub>max</sub> shows the amount of sessions that can be active on a system. VSI<sub>base</sub> is the best performance of the system during a test.

**Table 3. Login VSI Standardized Performance Measurement**

Sessions	100	250	500
VSI <sub>avg</sub> ** (ms)	864	1014	1640

\*\*VSI<sub>avg</sub> is the fixed number index that provides a standardized performance measurement in milliseconds for a system that is simultaneously used by a specific number of active users.

Based on the results outlined above, the tested 3 node Pivot3 Acuity HCI configuration can support 501 desktops running Windows 10 OS and Login VSI Knowledge Worker workload with a Login VSI Baseline of 806.

**NOTE:** The configuration utilized for this test was designed to provide an objective comparison with other vendor platforms. Your configuration, and resulting densities, will vary depending on your requirements. Consult your Pivot3 representative or channel partner for your sizing requirements.

# Conclusion

## Optimizing Citrix Virtual Desktops with Pivot3 HCI

Pivot3 provides a policy-based, high-performance hyperconverged platform ideally suited for deploying Citrix Virtual Desktops. Its NVMe flash-optimized architecture, coupled with advanced QoS, helps lower the total footprint by providing market leading desktop densities, while ensuring superior I/O performance. Pivot3 also simplifies the scaling of your Citrix deployment with its predictable distributed scale-out architecture and flexible scaling configurations. With Pivot3 and Citrix, organizations can deploy cost-effective, high-performance VDI that is easy to manage and scale.

# Appendix: Login VSI Graph for Knowledge Worker Benchmark Test on Pivot3 Acuity HCI

This section provides the Login VSI benchmark performance chart produced during the test outlined in this document.

