



Deploying XenApp 7.5 on Microsoft Azure cloud

The scalability and economics of delivering Citrix XenApp services

Given business dynamics—seasonal peaks, mergers, acquisitions, and changing business priorities—deploying XenApp 7.5 workloads on a Microsoft Azure cloud gives IT organizations a strategic advantage since it enables agile desktop and application delivery. Best of all, the price point for deploying a XenApp farm on Microsoft Azure can be just over \$7 per month per user.¹

Microsoft Azure Cloud Services

Microsoft Azure is a reliable and flexible cloud platform that allows applications to be quickly deployed across Microsoft-managed datacenters. Azure offers monthly service level agreements (SLAs) of 99.95% to meet strict requirements for continuously available services. By provisioning XenApp desktops and application workloads on Azure Cloud Services, businesses can avoid expenses for internal infrastructure and rely instead on Microsoft to supply the necessary compute, networking, and storage resources for user workloads.

Citrix XenApp

Citrix XenApp® 7.5 provides advanced management and scalability, a rich multimedia experience over any network and self-service applications with universal device support across a full range of mobile endpoints—including laptops, tablets, smartphones, PCs, and Macs. XenApp provides session and application virtualization technologies that make it easy for customers to manage centralized applications and apply the optimal combination of local and hosted delivery models to match user requirements. Hosted desktop sessions can be deployed from the Citrix XenApp 7.5 or using Citrix XenDesktop 7.5 software if pooled virtual desktops are also required.

XenApp simplifies application provisioning, enabling unprecedented levels of scalability that helps to increase efficiency. When deployed on Microsoft Azure cloud, XenApp gives IT departments the flexibility of delivering infrastructure services for Windows applications and desktops at an economical price point

¹ An estimate of \$7.05 per month per user represents infrastructure (compute, networking, and storage) costs given U.S. West pricing (at the time of this writing) and does not include costs for Citrix licensing. This per-user value is based on densities measured with a Light workload (as defined by LoginVSI) that represents applications performed by a task worker.

while extending and integrating current investments on Windows Server System Center and Hyper-V technologies from on-premise environments.

Scalability testing of Citrix XenApp on Microsoft Azure instances

Microsoft Azure makes it possible to spin up new virtual machines in minutes and adjust usage as infrastructure requirements change. Virtual machines on Azure instances can support all of the infrastructure and XenApp services required for a deployment.

To validate XenApp 7.5 configurations using Microsoft Azure virtual machines, Citrix engineers conducted a series of performance tests in conjunction with input from Microsoft. The goal was to analyze the scalability and economics of XenApp on different Microsoft Azure instance types. Login VSI 4.0 software (from Login VSI Inc.) was used in the testing to generate user connections to XenApp and simulate user workloads running on Azure instances.

Microsoft Azure instance types vary according to infrastructure resources and relative cost per hour, as shown in the table below. “Pay-as-you-go” pricing for Azure virtual machines varies by region and includes Windows licensing (see <http://azure.microsoft.com/en-us/pricing/details/virtual-machines/>).

Instance types	Virtual cores	RAM	Disk sizes	Price per hour ²
Small (A0)	1	768 MB	20.00 GB	0.02
Small (A1)	1	1.75 GB	70.00 GB	0.09
Medium (A2)	2	3.5 GB	135.00 GB	0.18
Large (A3)	4	7 GB	285.00 GB	0.36
Extra Large (A4)	8	14 GB	605.00 GB	0.72
Memory-Intensive A5	2	14 GB	135.00 GB	0.33
Memory-Intensive A6	4	28 GB	285.00 GB	0.66
Memory-Intensive A7	8	56 GB	605.00 GB	1.32

Topology for the scalability testing

For the XenApp 7.5 testing, virtual machines were configured with Microsoft Windows Server 2012 R2 on Azure instances as follows:

- **A virtual machine on an A2 instance containing:**
 - **1x Login VSI controller and profile server**
 - **4x Login VSI launchers**
- **A virtual machine on an A2 instance containing:**
 - **1x Web Interface server**
 - **1x Secure Gateway server**
- **A virtual machine on an A3 instance containing:**
 - **1x dedicated XenApp 7.5 DC/XML broker**

² Pay-as-you-go pricing as of September 24, 2014 for U.S. West. See <http://azure.microsoft.com/en-us/pricing/details/virtual-machines/>.

- 1x Citrix license server
- 1x Microsoft SQL server
- A virtual machine on an A1 instance containing:
 - 1x Active Directory controller and DNS server
- A virtual machine containing a single XenApp 7.5 worker server hosting simulated user sessions. This server was deployed on each instance type in different test runs to test the scalability of different Azure instances.

Creating a virtual machine on Azure automatically creates an Azure Cloud Service container. By default virtual machines built in a Cloud Service are isolated on the same virtual network. Figure 1 depicts the test architecture.

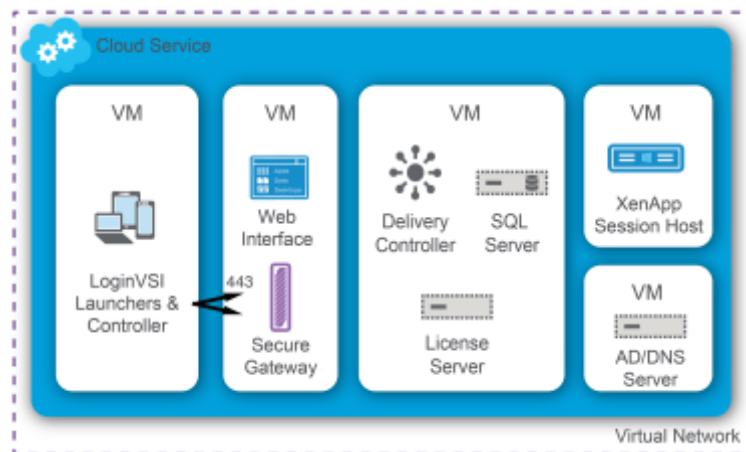


Figure 1: Architecture for XenApp scalability testing on Microsoft Azure.

In an Azure deployment, users connect through https (port 443) to a Secure Gateway server, which proxies all traffic in and out of the virtual network. Web Interface servers provide authentication and a list of available resources from which users can select desktops or application services. As in a traditional XenApp architecture, Delivery Controllers distribute the connections and set up service connections to XenApp session hosts.

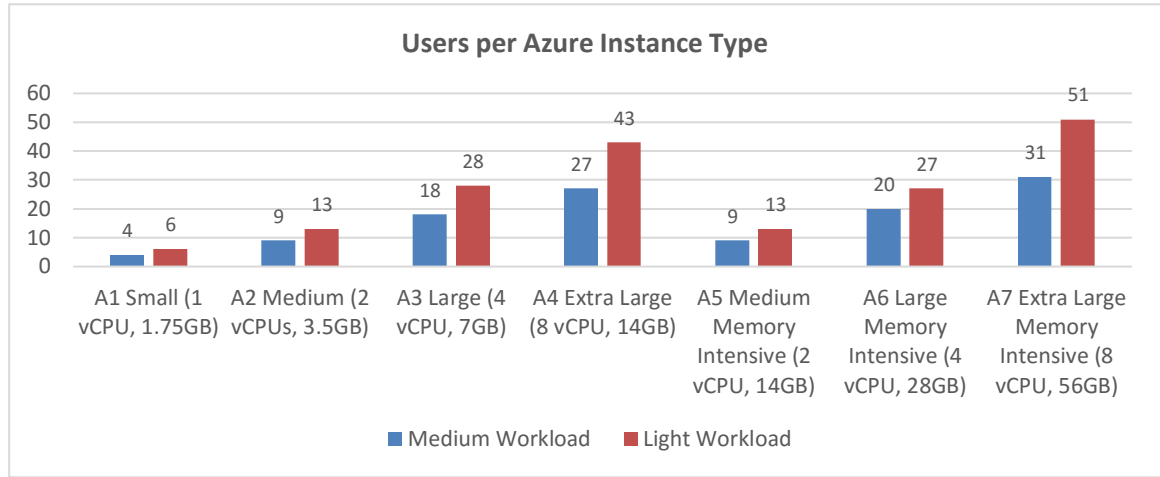
In the testing, the Login VSI clients simulated the user connections to the Secure Gateway. XenApp 7.5 servers were configured with a single boot volume and one local-instance storage volume. Local instance volumes were configured to hold volatile data (e.g., pagefile and user profiles).

Results summary

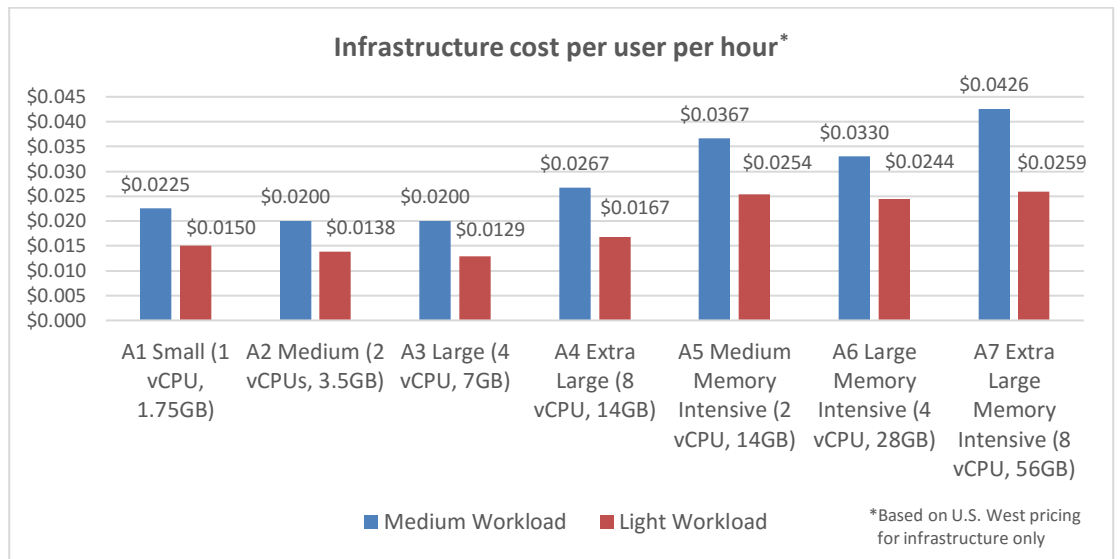
The graph below shows the maximum number of simulated XenApp user sessions that each instance type supported under the Login VSI Light and Medium workloads.³ As shown, the user density scaled in a relatively linear

³ A description of the Login VSI Light and Medium workloads can be found at: <http://www.loginvsi.com/pdf/documentation/Login-VSI-40-Workloads.pdf>.

fashion across the Small (A1) to Extra Large (A4) instances. The A7 instance (with 8 vCPUs and 56GB of RAM) hosted the highest user session densities, sustaining 31 and 51 users under the Medium and Light workloads respectively.



The pricing model for Azure instances varies according to the region and the instance type and resources it provides. The graph below compares the cost efficiency of each instance based on XenApp densities achieved in the testing. It reflects U.S. West “pay-as-you-go” pricing available at the time of this writing for standard Windows VM instances with Windows licenses.



There are a number of design tradeoffs that solution architects must consider in choosing an Azure instance type for XenApp 7.5 implementations. Deploying multiple small instances rather than a single large instance, for example, enables greater flexibility in adjusting capacity since smaller instances can be added or removed incrementally, optimizing efficiency and potentially reducing costs. However, taking a granular approach and deploying many small instances also increases management complexity. While deploying XenApp 7.5 on an A4 instance may be preferable from a management perspective, the A3 instance

offers a lower cost per seat. For this reason, this document focuses on performance results and cost estimates based on using an A3 instance for the XenApp workload.

Instance types A5 through A7 are configured to supply additional RAM resources and priced accordingly. In the testing, the density results showed no clear benefit from the extra memory in testing with the A5 to A7 instance definitions. However, if users run applications that are particularly memory-intensive, there may be a benefit in deploying XenApp 7.5 on a memory-intensive A5, A6, or A7 instance.

The scalability results presented in this paper should be used simply as guidelines in configuring Azure infrastructure for your own XenApp workloads and applications. As always, it is recommended that you execute your own proof-of-concept tests before making final sizing and deployment decisions.

Testing methodology

In the scalability testing, Login VSI was used to simulate workers running generic Windows applications such as Microsoft Office 2010, Microsoft Internet Explorer, and Adobe Acrobat Reader. The default Login VSI Light and Medium workloads simulate diverse workers that perform a variety of application tasks. The Light workload includes a small set of well-defined applications that have limited CPU (and other resource) requirements, simulating an office task worker. The Medium workload is more resource-intensive and mimics the application and desktop activity of a typical knowledge worker. The default workloads are characterized in the [Login VSI 4.0 Workloads Overview](http://www.loginvsi.com/pdf/documentation/Login-VSI-40-Workloads.pdf) guide (<http://www.loginvsi.com/pdf/documentation/Login-VSI-40-Workloads.pdf>).

Azure instance types A0 through A7 were tested. Since the goal was to capture a baseline reflecting the densities possible on each instance type, the Login VSI client launchers were configured to go through the Secure Gateway and Web Interface servers.

Performance metrics were captured during user logon and virtual desktop acquisition (ramp-up), user workload execution (steady state), and user logoff. During ramp-up, Login VSI was configured to log in a new user every 40 seconds. To achieve consistent measurements that reflected when components were appropriately cached, each workload ran for 40 minutes before Login VSI performance metrics were recorded.

Login VSI 4.0 uses new workload definitions, a completely revised test engine, and new analytics. For this reason, results for Login VSI 4.0 differ significantly from results from earlier releases since they show heavier CPU utilization (see the [Login VSI 4.0 Upgrade Guide](#) for a discussion of version differences). With Login VSI 4.0, density values are based on an index (“VSI_{max} v4”) that

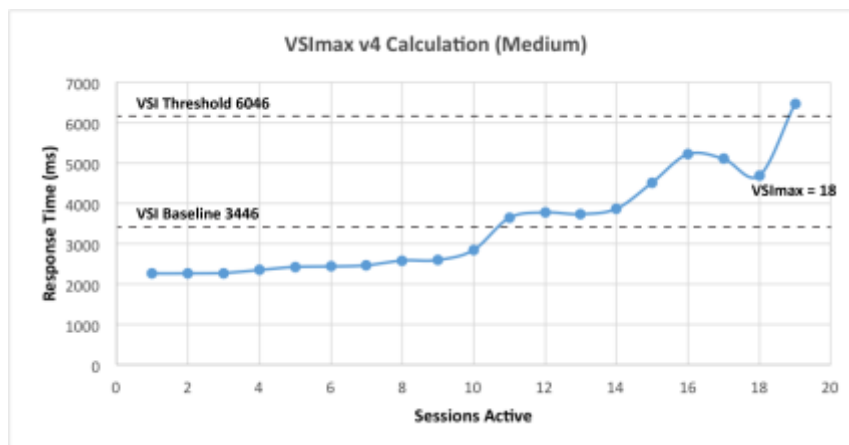
represents the maximum user density before serious performance degradation occurs.

A3 instance results

Since the A3 instance proved to be the most cost-effective for XenApp 7.5, the following pages show user density and performance metrics for the A3 instance under the Login VSI Medium and Light workloads. A later section in this document (“Economic considerations”) describes cost factors to consider when developing a budget estimate for deploying XenApp on Azure.

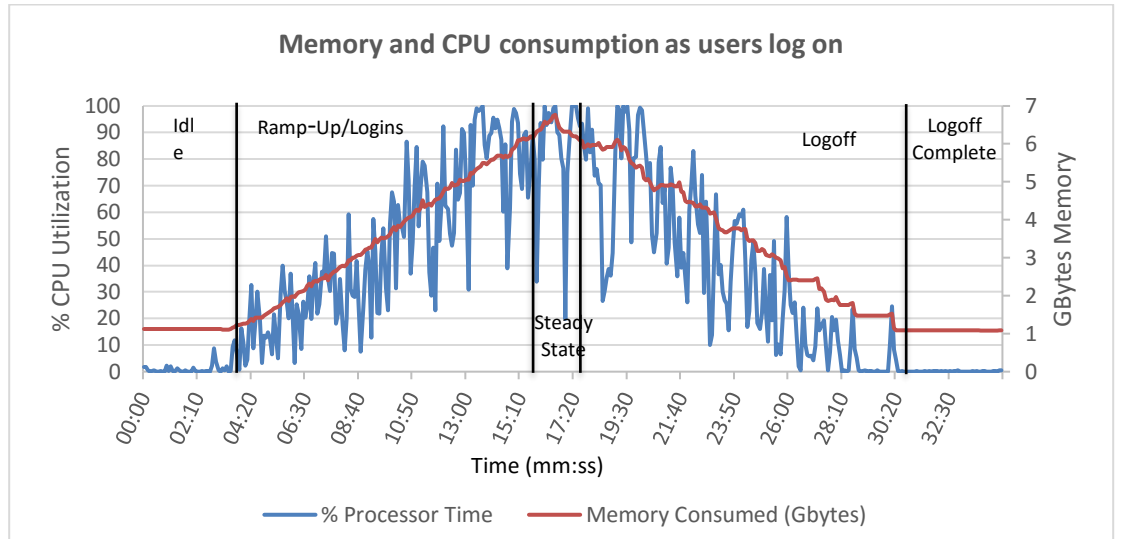
Medium workload results

This section gives test results for the A3 instance with the Medium workload. **VSI_{max} v4** is determined from two other metrics, **VSI Baseline** and **VSI Threshold**. **VSI Baseline** represents a pre-test Login VSI baseline response time measurement that is determined before the normal Login VSI sessions are sampled. The A3 instance demonstrates a **VSI_{max} v4** density of 18 users under the Medium workload.

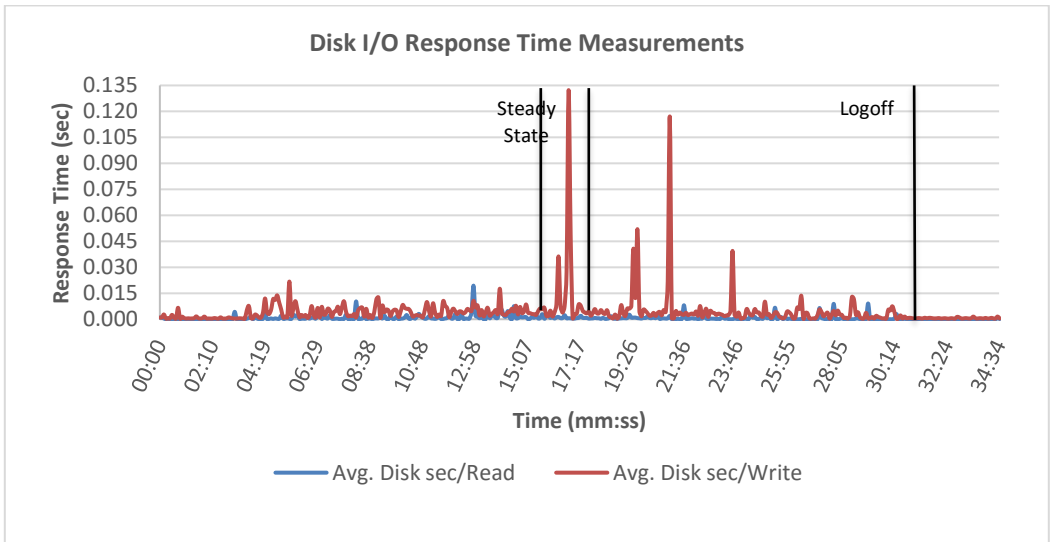


The next two graphs depict CPU and memory consumption and disk I/O response times measured during the test. These metrics are helpful in assessing performance under the test workload.

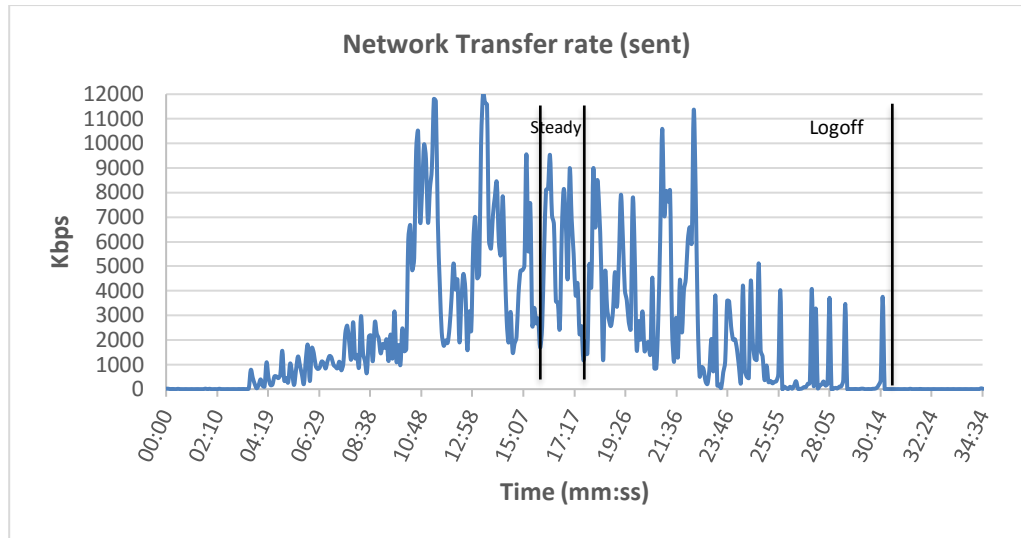
In the chart below, as user load increases, CPU and memory utilization peaks at the point where the number of users approaches VSI_{max} v4.



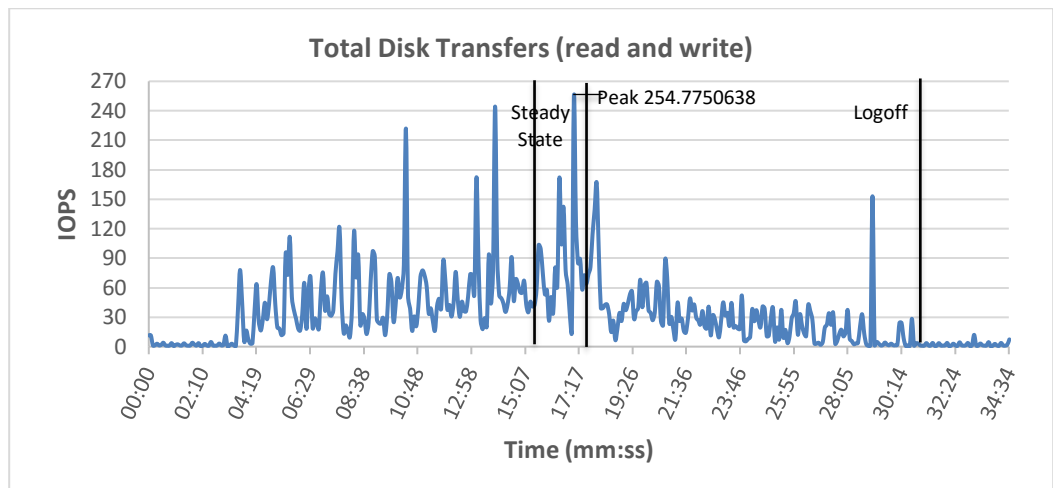
The write I/O response time averaged around 4 ms. Read I/O response times averaged less than 1 ms. I/O metrics were also captured for the temp disk but this I/O was negligible.



The following network and disk performance metrics show resource consumption that impacts scale as well as the costs associated with the solution. The graph below shows networking transfer rates for data going out of Azure data centers. Microsoft charges for outbound data while inbound data transfers are free. For the Medium workload, the average outbound bandwidth during steady state is approximately 5500kbps for the test workload of 19 users. This means the per-user outgoing transfer rate is approximately 300kbps ($5500/19=289.47 \approx 300$ kbps). Outgoing network transfers during logoff occur as user profile data is transmitted.

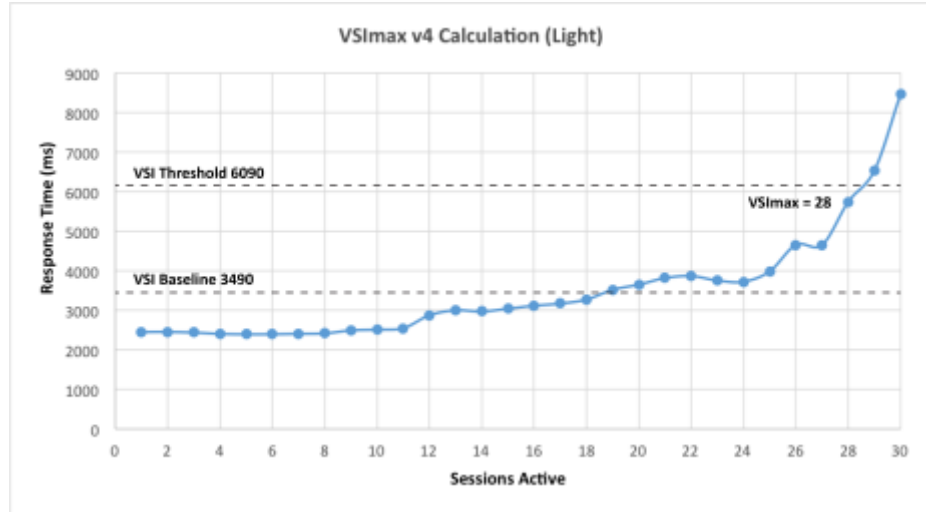


Azure also charges for disk transfers. Disk transfer metrics, which are used in the subsequent cost analysis, are shown below. For the Medium workload, disk transfers during steady state averaged about 90 IOPS for the test workload of 19 users, which calculates to an average of about 5 IOPs per user. The peak value was 255 IOPS for 19 users or about 13 IOPs per user. Disk transfer activity is also visible during the logoff period as user profile data is recorded.

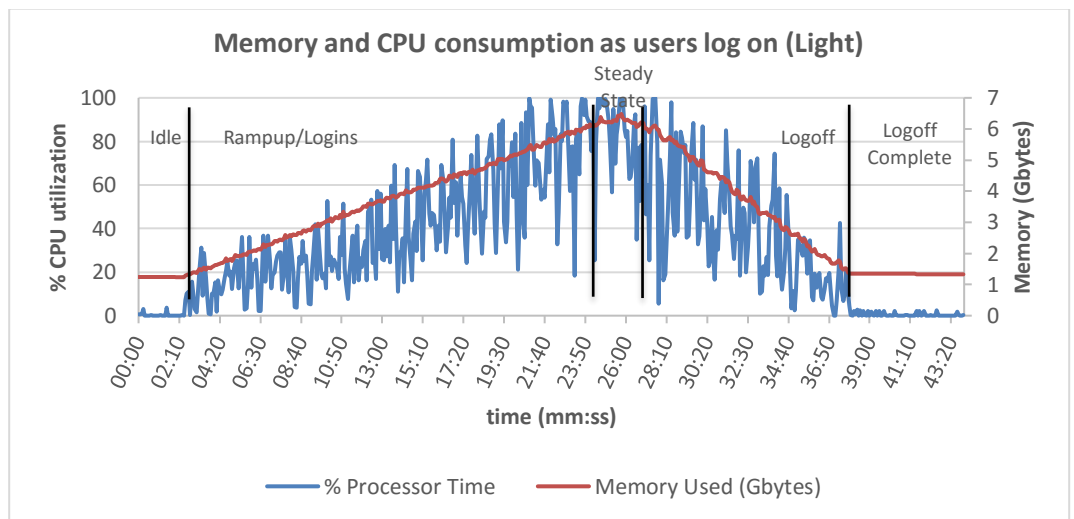


Light workload results

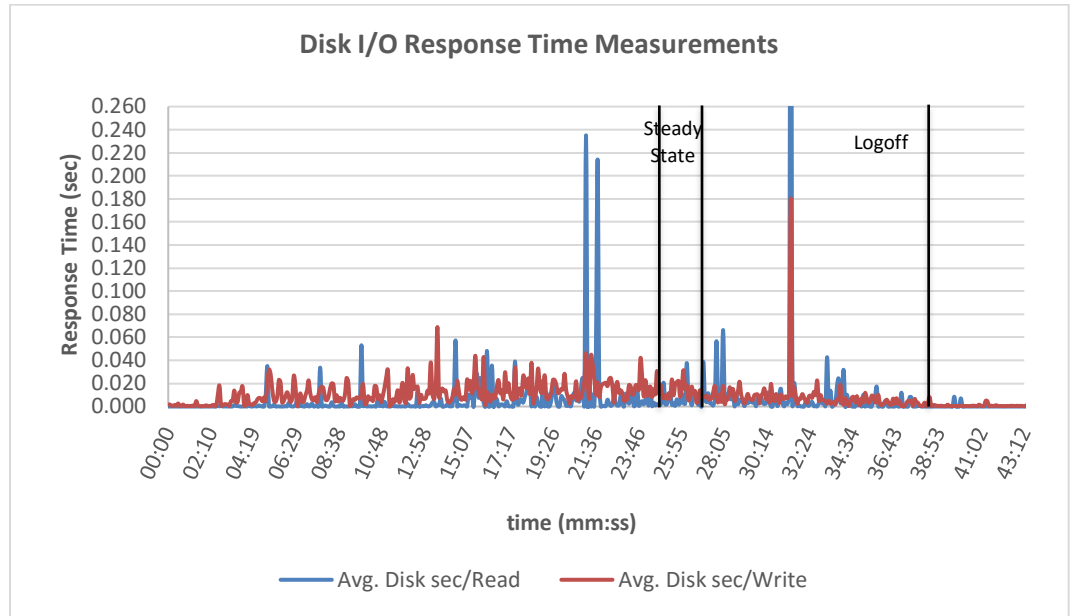
This section shows test results and performance metrics for the A3 instance under the Light workload. As shown below, the A3 instance supports a VSImax v4 of 28 users for the Light workload.



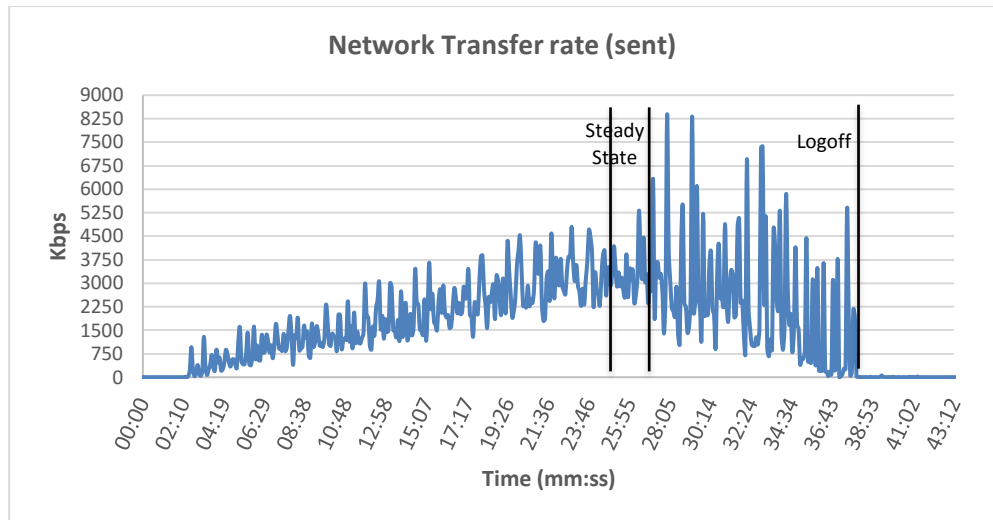
The next two graphs depict CPU and memory consumption and disk I/O response times for the Light workload. These metrics are helpful in assessing performance under the test workload. As the user load increases in the chart below, memory and CPU utilization peaks at the point where the number of users approaches VSImax v4. Note that there is still more than 10% of memory available even at the peak load during the A3 Light workload test.



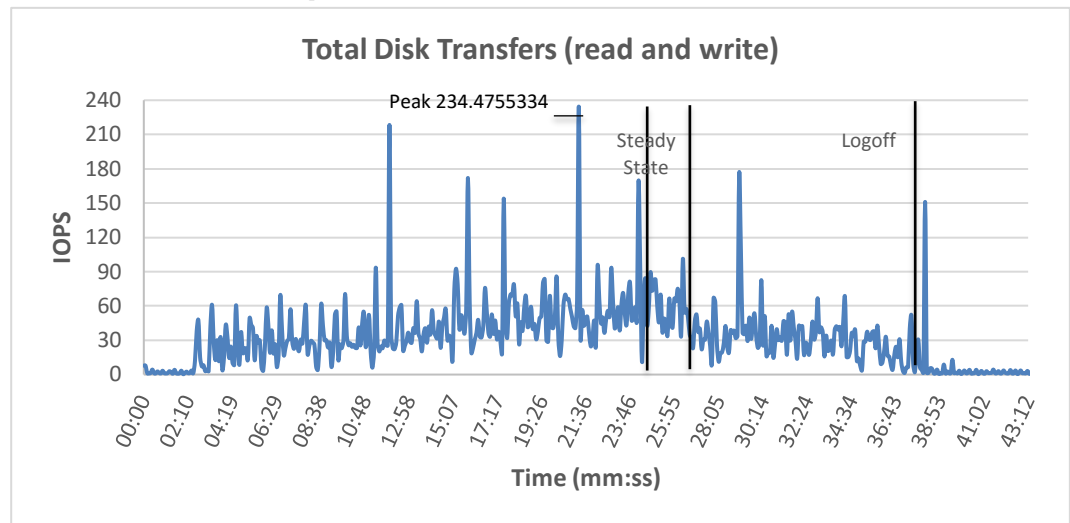
Disk I/O response time metrics for the Light workload are shown below. Write I/O response times averaged around 15 ms while read I/O response times averaged less than 2.5 ms. I/O metrics were also captured for the temp disk but this I/O was negligible.



The following graphs show resource consumption metrics for network and disk I/O under the Light workload. The outbound networking transfer rate during steady state averaged around 3000kbps for the test workload of 30 users. This means the outbound transfer rate per user was approximately 100kbps (3000/30=100 kbps). During the logoff period, network transfer activity reflects how user profile data is transmitted and captured at logoff.



As shown below, the Light workload imposes an average of 75 IOPS for all 30 users or 2.5 IOPs per user ($75/30=2.5$). The peak total disk transfers was 234 IOPS or about 8 IOPS per user.



Economic considerations

Microsoft Azure Cloud Services are attractive to IT organizations that seek a cost-effective way to provision an agile application infrastructure. Companies pay for only the compute, storage and network resources that they use rather than assuming the cost and complexity of developing and maintaining in-house infrastructure. Microsoft provides the required resources from its global network of datacenters, and owns the responsibility and costs associated with infrastructure maintenance, upgrades, monitoring, cooling, power, and service.

This section discusses cost considerations for a XenApp on Azure deployment. Several elements go into a complete XenApp on Azure budget estimate, but the cost of Azure instances (which includes Windows licensing) is the dominant cost factor. Other costs include the cost of network and storage I/O and the cost of the storage consumed. Citrix licensing costs are also a factor, but since these costs are the same whether deployed on Azure or internal infrastructure, they are not considered in the following cost analysis. The cost calculations presented here determine a monthly cost per user for both Medium and Light workloads based on U.S. West pricing at the time of this writing.

Azure instance costs

Instance costs are the largest factor in developing a budget estimate for an Azure deployment. The pricing model for Azure virtual machines varies by region according to instance type and the resources that each instance type provides (see <http://azure.microsoft.com/en-us/pricing/details/virtual-machines/>).

Azure pricing is calculated on an hourly basis. For this costing exercise, it is assumed that users work only 8-hour shifts. Using the Azure management

interface (or a PowerShell script provided by Citrix), it's possible to manually shut down and deallocate virtual machines that are not actively in use, reducing hourly instance charges to conserve budget. For this reason, the cost estimates given here (except for storage capacity) assume that VMs are allocated and in use for a period of 8 hours per day. Given this assumption, an A3 instance has a monthly cost of \$89.33 and can support 18 XenApp users under a Medium workload and 28 users under a Light workload. This equals a monthly per-user cost of \$4.96 for each Medium workload user and \$3.19 for each Light workload user.

Network utilization cost

Network utilization reflects network I/O operations going out of Azure datacenters (e.g., "outbound data transfers" in Microsoft terminology). Charges vary according to the specific zone (region group) providing services. Pricing is tiered according to the data quantity transferred each month. For the most expensive bracket (zone1), the monthly cost is \$0.12 per GB.

As shown in the test results, with the Medium workload, an average user consumes network bandwidth at a rate of approximately 300kbps. Assuming an 8-hour workday, a single XenApp user running a Medium workload consumes about 32GB of network bandwidth per month—which translates to a cost of \$3.83 per month per user. For the Light workload, network utilization is about 100kbps per user or ~11GB for an 8-hour day, which costs about \$1.27 per month per user.

Storage utilization cost

The cost of I/O operations is \$0.005 per 100,000 transactions to storage (transactions encompasses both read and write operations). A Medium XenApp workload imposes about 5 IOPs per user on average, which works out to ~4,464,000 transactions per month, assuming an 8 hour workday, at a cost of \$0.22 per user. In contrast, a Light workload requires an average 2.5 IOPs per user. This is about ~2,232,000 IOPs per month per user for an 8-hour day, which means a cost of \$0.11 a month for each Light user's storage use.

Storage capacity cost

Azure maintains storage resources for the XenApp infrastructure even when no users are active, so the analysis of storage consumption charges is based on a 24-hour day. Persistent disks for Azure VMs use "page blobs", block storage that is optimized for random access. Azure provides different storage categories and redundancy options. Storage pricing is tiered with lower rates for higher levels of consumption.

For XenApp infrastructure on Azure, this costing exercise assumes Geographically Redundant Storage (GRS), which is a mid-tier availability option.

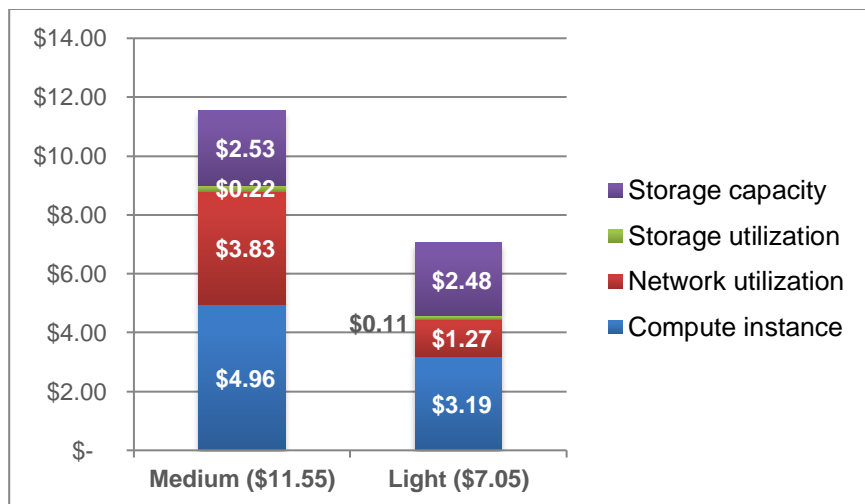
There are two primary storage needs: storage for XenApp servers and applications, and storage for each user profile. XenApp servers and applications require approximately 30GB of storage. A reasonable size estimate for a user profile is 25GB.

Given 18 users for the A3 instance running a Medium workload, storage utilization for XenApp servers and applications per user is approximately 1.67 GB per user plus user profile storage of 25GB. For the Light workload with 28 users, storage consumption is 1.07 GB per user plus 25GB for the user profile. At a cost of \$0.095 per GB (the highest cost bracket for GRS storage), the storage capacity cost per user is \$2.53 per month for a Medium user and \$2.48 per month for a Light user.

Total estimated costs

The graph and table below show approximate total costs per user (based on U.S. West pricing) for Medium and Light workloads. Based on the A3 compute instance, the monthly cost for each Medium user is approximately \$11.55. An approximate monthly cost for each user running a Light workload is \$7.05. Actual costs will vary, of course, depending on the region and instance infrastructure selected and densities achieved with specific user workloads.

Cost per user	Medium	Light
A3 compute instance	\$4.96	\$3.19
Network utilization	\$3.83	\$1.27
Storage utilization	\$0.22	\$0.11
Storage capacity	\$2.53	\$2.48
Total	\$11.55	\$7.05



XenApp and Microsoft Azure cost calculator tool

Based on the test results presented here, it's possible to estimate the costs associated with deploying a XenApp farm on Microsoft Azure Cloud Services in your environment. To simplify this task, Citrix is building a comprehensive XenApp and Microsoft Azure cost calculator tool. The tool will use customer-provided inputs and the density results from this testing to approximate the Azure infrastructure resources needed and relative solution costs. The tool will take into account complex deployment scenarios that involve mixed user workloads, solutions that cross multiple geographic regions, and customized user characteristics.

The XenApp on Azure scalability results presented here should be used only as guidelines in configuring your Azure solution. Before making final sizing and deployment decisions, it is suggested that you run proof-of-concept tests on different Azure instance types using your own workloads.

[Learn more](#)

For more information about deploying Citrix XenApp workloads on Microsoft Azure Cloud Services, see the Citrix and Microsoft partner web site at <http://www.citrix.com/global-partners/microsoft/resources.html>.

Corporate Headquarters
Fort Lauderdale, FL,
USA

Silicon Valley Headquarters
Santa Clara, CA, USA

EMEA Headquarters
Schaffhausen,
Switzerland

India Development Center
Bangalore, India

Online Division Headquarters
Santa Barbara, CA, USA

Pacific Headquarters
Hong Kong, China

Latin America Headquarters
Coral Gables, FL, USA

UK Development Center
Chalfont, United Kingdom



About Citrix

Citrix (NASDAQ:CTXS) is a leader in mobile workspaces, providing virtualization, mobility management, networking and cloud services to enable new ways to work better. Citrix solutions power business mobility through secure, personal workspaces that provide people with instant access to apps, desktops, data and communications on any device, over any network and cloud. This year Citrix is celebrating 25 years of innovation, making IT simpler and people more productive. With annual revenue in 2013 of \$2.9 billion, Citrix solutions are in use at more than 330,000 organizations and by over 100 million users globally. Learn more at www.citrix.com.

Copyright © 2014 Citrix Systems, Inc. All rights reserved. Citrix, CloudBridge and Citrix Ready are trademarks of Citrix Systems, Inc. and/or one of its subsidiaries, and may be registered in the U.S. and other countries. Other product and company names mentioned herein may be trademarks of their respective companies.

