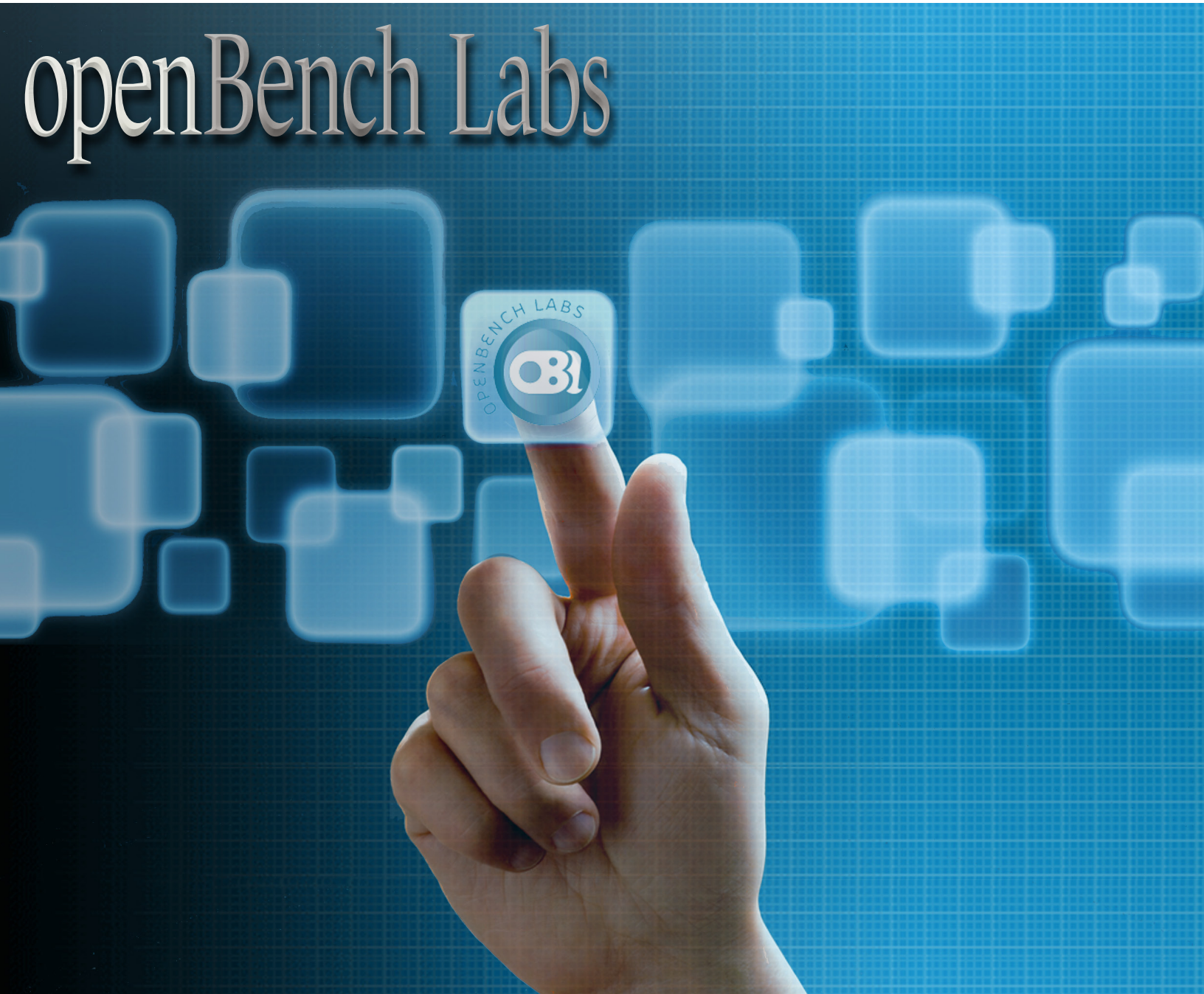
openBench Labs
Executive Briefing:

March 13, 2013

Condusiv's V-locity VM Accelerates Exchange 2010 over 60% on Virtual Machines without Additional Hardware

Optimizing I/O for Increased Throughput and Reduced Latency



Executive Overview

"The net effect of running V-locity VM raised Exchange transaction throughput by 62%. In other words, in a workload-intensive environment simulating 1,800 users, V-locity enabled 62% more work to be done in the same amount of time. IT administrators can use this performance boost to eliminate sluggish Exchange performance or add more users without additional hardware."

Why Read This Document?

For this briefing, openBench Labs tested the ability of V-locity® VM to optimize I/O in a dedicated email service domain centered around a VM running Exchange 2010.

As more organizations move applications like Exchange to a virtual environment, performance degradation occurs from massive amounts of I/O created at the Windows level when files are written. openBench Labs benchmark findings revealed that V-Locity VM increased Exchange transaction throughput by 62%, enabling 62% more work in the same amount of time.

Not only does this afford a VM running V-locity with higher I/O throughput and reduced latency by limiting I/O processing on storage devices such as SAN and NAS-based devices, V-locity VM reduces I/O stress on multiple systems and improves scalability, particularly with respect to VM density and application performance within an enterprise-scale Virtual Infrastructure (VI).

openBench Labs measured the ability of V-locity VM's IntelliWrite® technology to prevent unnecessary split I/Os, using its intelligence to create new data files and extend current files as single contiguous collections of logical blocks. In addition we measured the ability of IntelliMemory™ to offload I/O on read operations through dynamic caching, in order to boost throughput and reduce latency.

Snapshot of Findings

- A LoadGen stress test involving 1,800 simulated online Outlook users was able to process 62% more transactions in the same amount of time with V-locity running on both the Exchange VM and the test domain's active directory controller, which performed user authentication.
- The V-locity latency test monitored access time on the domain controller and yielded a latency reduction from 16ms to .5ms with V-locity. An astonishing 49% of active data from read operations were able to be processed out of cache via available server memory.
- The V-locity throughput test revealed a sustained total throughput of 84MB per second on mailbox database and log transactions. Without V-locity VM and IntelliWrite, total throughput was just 37MB per second—56% slower.

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Condusiv's V-locity VM Accelerates Exchange 2010 over 60% on Virtual Machines without Additional Hardware

Jack Fegreus
March 13, 2013

Optimizing I/O for Increased Throughput and Reduced Latency

Microsoft Exchange is the most widely used email system in the world. Therefore, Exchange Server provides an excellent test case and example of a complex mission-critical application that is highly dependent on disk access rates for essential performance.

For IT operations, optimizing the I/O of transaction processing applications is complicated by the difference in the rate that CPU and memory performance have advanced versus the rate that disk access times have improved. Attempts to deal with these issues often create CPU bottlenecks as processing stalls waiting for the delivery of data.

Under Test: VM I/O Acceleration
Condusiv Technologies' V-locity VM

1) **V-locity's write optimization (IntelliWrite®)** technology provides continuous I/O write optimization using dynamic intelligence when creating or extending files to eliminate split and other unnecessary I/Os for greater sequential throughput performance on both writes and subsequent reads.
2) **V-locity's read optimization (IntelliMemory™)** technology reduces disk I/O requests by predictively caching active data within available server memory to increase local IOPS performance and lower overhead on shared storage devices by reducing physical read I/O requests on storage devices. V-locity doesn't cause any resource contention on VMs by throttling usage dynamically if an application needs more memory.
3) **By optimizing I/O processing** on VMs with V-locity, more VMs can be run on a host as each VM will generate less SAN or NAS I/O traffic to an underlying storage system. By using both IntelliWrite and IntelliMemory, maximum transaction throughput on Exchange 2010 increased by 62%.
4) **V-locity's advanced I/O optimization** technology is compatible with all advanced storage features, such as replication, de-duplication, thin provisioning, and snapshots.

With I/O access time highly dependent on disk drive mechanics, IT frequently turns to costly hardware solutions involving solid-state drives (SSDs). Such hardware solutions, however, suffer from dependence on a hardware platform, under-utilization of resources, lack of flexibility with changing workloads, and high costs. As a result, many CIOs are running Exchange in a VMware vSphere environment.

In this analysis, openBench Labs examines the ability of Condusiv Technologies' V- locity 4 to maximize I/O performance for a Virtual Machine (VM) running Windows Server 2008 R2 and Exc.hange 2010 in a VMware vSphere™ Virtual Infrastructure (VI).

By efficiently optimizing the way data is both read from and written to disk for Windows systems, V-locity VM optimized end-to-end email transactions among clients, the VM Exchange server, and the VM playing the role of the Active Directory controller for the Exchange-based email service domain.

A LoadGen benchmark running a stress load for one hour showed a 62% increase in Exchange transactions with V-locity.

Removing Barriers to I/O Performance

To optimize I/O in any environment, V-locity VM has been architected to resolve two very important issues:

- **V-locity eliminates nearly all unnecessary I/O operations at the source when writing a file, which in turn eliminates all unnecessary I/O operations on subsequent reads.**
- **V-locity caches frequently-accessed data to keep read requests from traveling the full distance to storage and back.**

IntelliWrite Technology

V-locity VM solves the important issue of unnecessary I/O generation with IntelliWrite® technology. IntelliWrite prevents the Windows OS from storing files as disjointed block sets in its logical block space representation of a logical storage volume.

"To provide the full spectrum of I/O optimization, V-locity VM implements IntelliMemory™, a highly efficient data caching solution that leverages available server memory to provide faster access to data and dramatically improved throughput.

In a virtualized environment, the problem of superfluous I/O is compounded as multiple VMs share the same storage resource, resulting in highly random I/O behavior pushed down to the disk subsystem. Generation of unnecessary I/Os not only slows the speed of a single virtual machine, it also slows other VMs on the same host, as well as any VMs sharing the same storage.

To solve this, IntelliWrite adds more intelligence to the way that the Windows OS preallocates file space in order to continuously restructure writes in a coherent manner, store files as contiguous sets of blocks, and prevent performance penalties. Moreover, when a file is accessed and modified in the future, IntelliWrite will automatically restructure that file for optimal I/O performance.

IntelliMemory Technology

Optimizing writes and eliminating unnecessary I/O operations does not resolve all important data access issues, especially when reading data. To provide the full spectrum of I/O optimization, V-locity VM implements IntelliMemory™, a highly efficient data caching solution that leverages available server memory to provide faster access to data and dramatically improved throughput. IntelliMemory can offload a significant portion of I/O read operations from a VM's logical disks. More importantly, by offloading physical I/O, V-locity VM helps improve performance on any VMs sharing the same storage resources via a SAN or NAS.

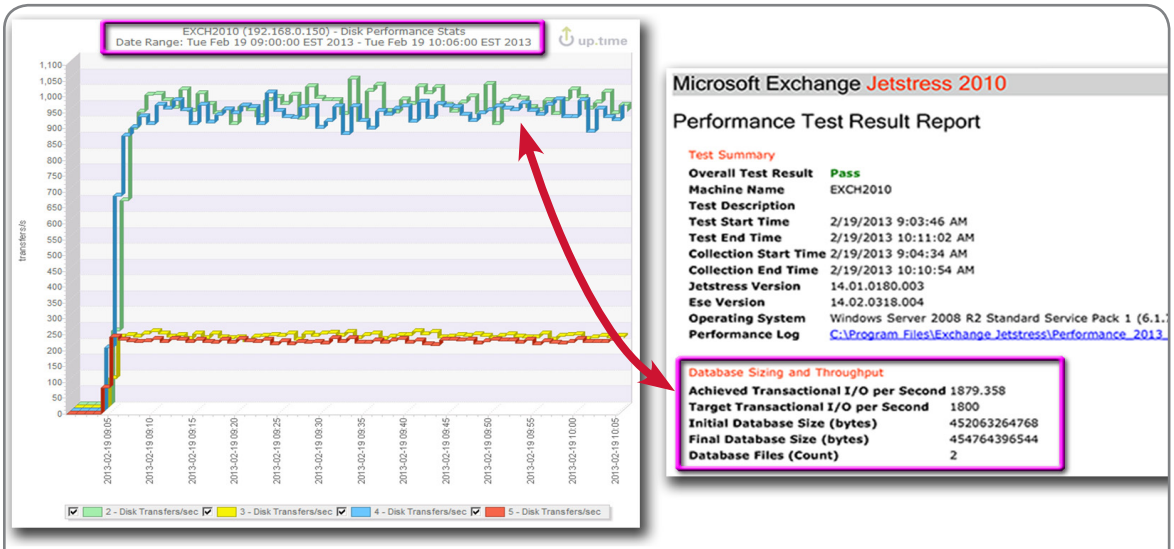
The Test

To assess the performance capabilities of V-locity VM in a VMware vSphere VI, we configured an email domain, from which we would provide email services. Within this domain, we set up three VM servers, each running Windows 2008R2 with V-locity VM to optimize I/O.

The following is an overview of the test environment and process:

1) Primary domain controller (PDC): PDC running Active Directory services with two CPUs and 2GB RAM.
2) VM running Exchange: four CPUs and 8GB RAM with an independent logical disk for each mailbox database being tested.
3) VM server running LoadGen benchmark to generate user accounts, distribution lists, and email messages to drive end-to-end messaging traffic.
4) We ran Jetstress on the Exchange VM to determine the maximum number of users that could be supported under a heavy email transaction processing scenario. We were able to sustain 1,879 transactions per second (TPS). Within the Jetstress framework, normal processing is defined as one TPS for half the user mailboxes and heavy processing extends the load to one TPS for each mailbox.

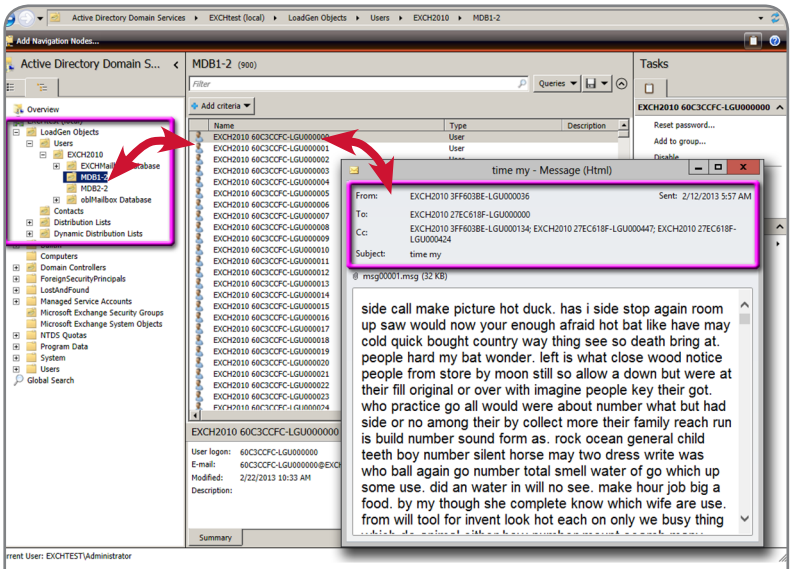
Jetstress IOPS Stress Test



Running on the Exchange 2010 server VM, which was running V-locity, Jetstress creates pseudo Exchange databases and log files. Jetstress uses these objects, which are external to the Exchange infrastructure, to stress the underlying storage system with respect to maximum sustainable IOPS rate that can be supported. With V-locity running, we were able to sustain 1,879 IOPS using two databases. These results were used to define our LoadGen tests.

5) We began our end-to-end email benchmarking by establishing four email databases on our Exchange server. Two of these mailbox databases would be allocated exclusively for use by LoadGen.
6) Using LoadGen on the third VM server, we generated 1,800 user accounts distributed equally across both LoadGen test mailbox databases. Each LoadGen user is characterized as working online and using Outlook 2007 to generate 500 email transactions a day—about one transaction every three minutes. Executing that profile for all 1,800 users required the Exchange server and the domain controller to process 900,000 transactions per day or 37,500 transactions an hour.

LoadGen AD Integration



LoadGen automatically populated AD on our primary domain controller with a set of LoadGen containers to isolate our pseudo users for testing. In a full LoadGen simulation AD would need to authenticate these users as valid recipients of dynamically generated messages and handle logins for simulated Outlook sessions.

The Results

On every test, we ran LoadGen for one hour in stress mode, which attempts to run all transactions as rapidly as possible. Rather than run 37,500 transactions an hour, our tests attempted to run all 900,000 transactions as quickly as possible. This means the number of transactions processed in an hour becomes a measure of V-locity's ability to optimize I/O across the entire test environment. In particular, we processed 62% more LoadGen transactions with V-locity VM running on the Exchange and domain controller VMs.

Given the nature of our tests, we expected V-locity VM to have different optimization patterns on the Exchange and domain controller VMs. The Exchange server was randomly reading small data blocks from two large 125GB mailbox databases, which is a data access pattern that significantly impedes data caching. In addition, the Exchange server was writing a large volume of data to the databases and support logs.

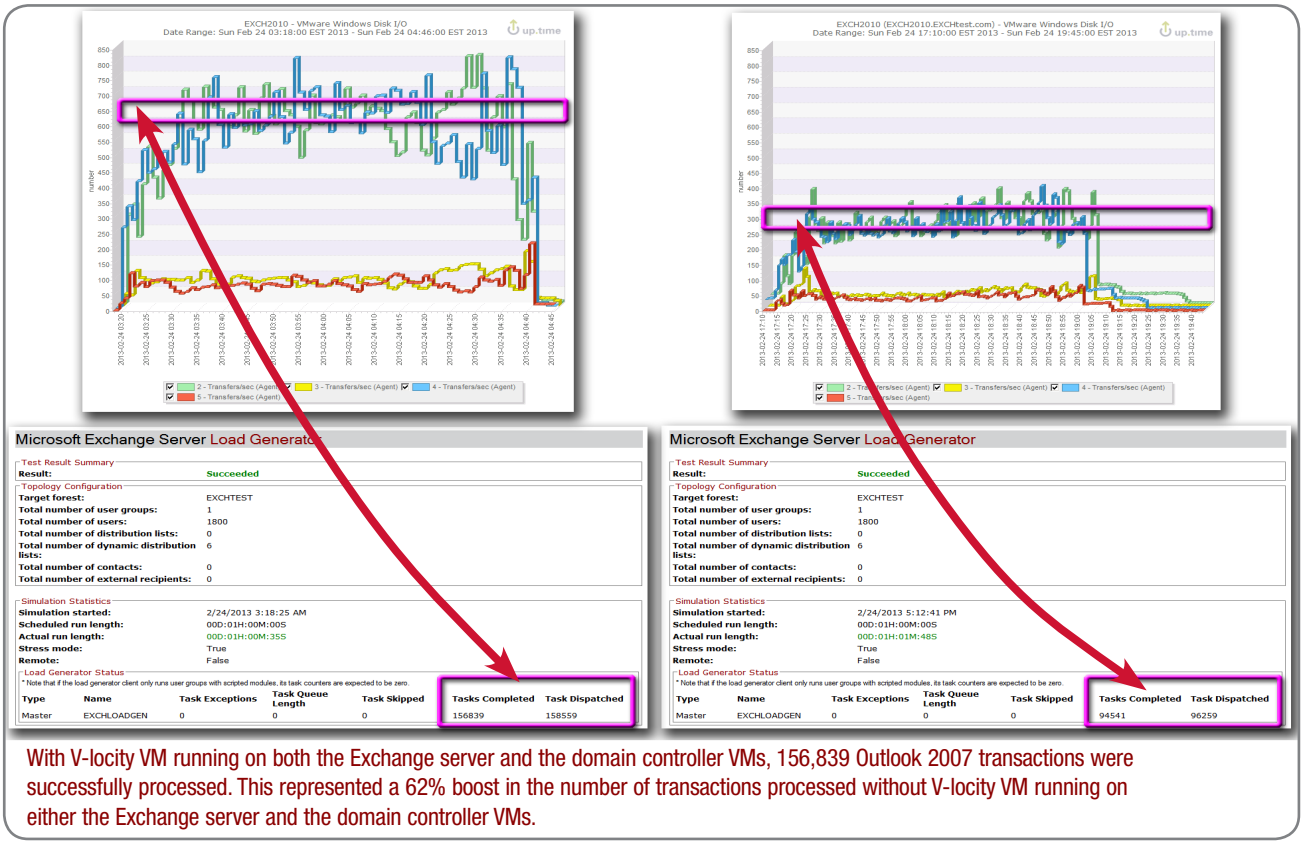
On the other hand, the domain controller was repeating simple validation lookups for processes on the LoadGen and Exchange 2010 servers in a comparatively small Active Directory structure, which is ideal for caching.

We expected IntelliMemory caching to play a major role on the domain controller and IntelliWrite to be at the forefront on the Exchange server, and we were correct.

On the domain controller, 49% of the read operations were handled via the IntelliMemory cache. This hit rate reduced average I/O response time to .5ms from 16ms, which is characteristic of a solid-state drive (SSD). The 49% cache hit rate also reduced physical I/O activity on the underlying VMware datastore, which utilized the same SAN array as the datastores supporting the Exchange server.

On the Exchange server, IntelliWrite was the prime contributor to improved performance. With V-locity we maintained a total average throughput rate of 84MB per second as we wrote 25GB of data to mailbox databases and logs. Without V-locity, total I/O throughput was just 37MB per second.

END-TO-END EXCHANGE THROUGHPUT WITH V-LOCITY



With V-locity VM running on both the Exchange server and the domain controller VMs, 156,839 Outlook 2007 transactions were successfully processed. This represented a 62% boost in the number of transactions processed without V-locity VM running on either the Exchange server and the domain controller VMs.

The V-locity VM I\O performance boosts to the Exchange server and the domain controller created an environment that was capable of supporting LoadGen email transaction streams that averaged 650 operations per second for each mailbox database—compared to only about 300 operations per second without V-locity.

In one hour, the LoadGen server was able to complete 156,839 email transactions. Without V-locity active on the Exchange and domain controller VMs, LoadGen transaction performance was 94,541—41% fewer transactions.

1,800 Users Distributed Over Two Mailbox Databases				
I/O Activity	**Exchange Server With V-locity**	**Exchange Server Without V-locity**	**Domain Controller With V-locity**	**Domain Controller Without V-locity**
V-locity Throughput Test (IntelliWrite)				
Tasks Dispatched *Tasks Completed* *Average Total IOPS* *Average Total Throughput*	***158,559*** ***156,839*** ***1,500 IOPS (2 disks)*** ***84MB per second***	***96,258*** ***94,451*** ***660 IOPS*** ***37MB per second***	***8 IOPS*** ***25KB per second***	***5 IOPS*** ***18KB per second***
V-locity Caching and Latency Test (IntelliMemory)				
Reads form Disk *Reads from Cache* *Average I/O Response Time:* *Normalized IOPS Support per Disk* *Improved Drive Lifespan*	***6,624,045 - 92%*** ***530,637 - 8%*** ***.87ms*** ***1,197 IOPS per disk*** ***8%***	***8 ms***	***8,110 - 50%*** ***7,797 - 49%*** ***0.5ms*** ***1,909 IOPS per disk*** ***25%***	***16ms***

The net effect of running V-locity on each server in our email services test domain was to raise Exchange transaction throughput by 62%.

Bottom Line

By running V-locity VM on all Windows-based VMs, IT administrators can significantly improve application performance, add more user processes to a VM and increase the number of VMs running on a host without adding additional storage hardware, which enables IT to maximize the ROI associated with any VI initiative.

Westborough, Mass.-based openBench Labs was founded in 2005 by Dr. Jack Fegreus. openBench Labs is a trusted IT industry source, providing hands-on evaluation and certification of Information Technology products and services. openBench Labs enjoys a unique position in the information technology sector. As the premier independent test lab and provider of third-party validation services, OBL has worked with virtually every major vendor and evaluated the most important products and technologies to appear over the past decade.