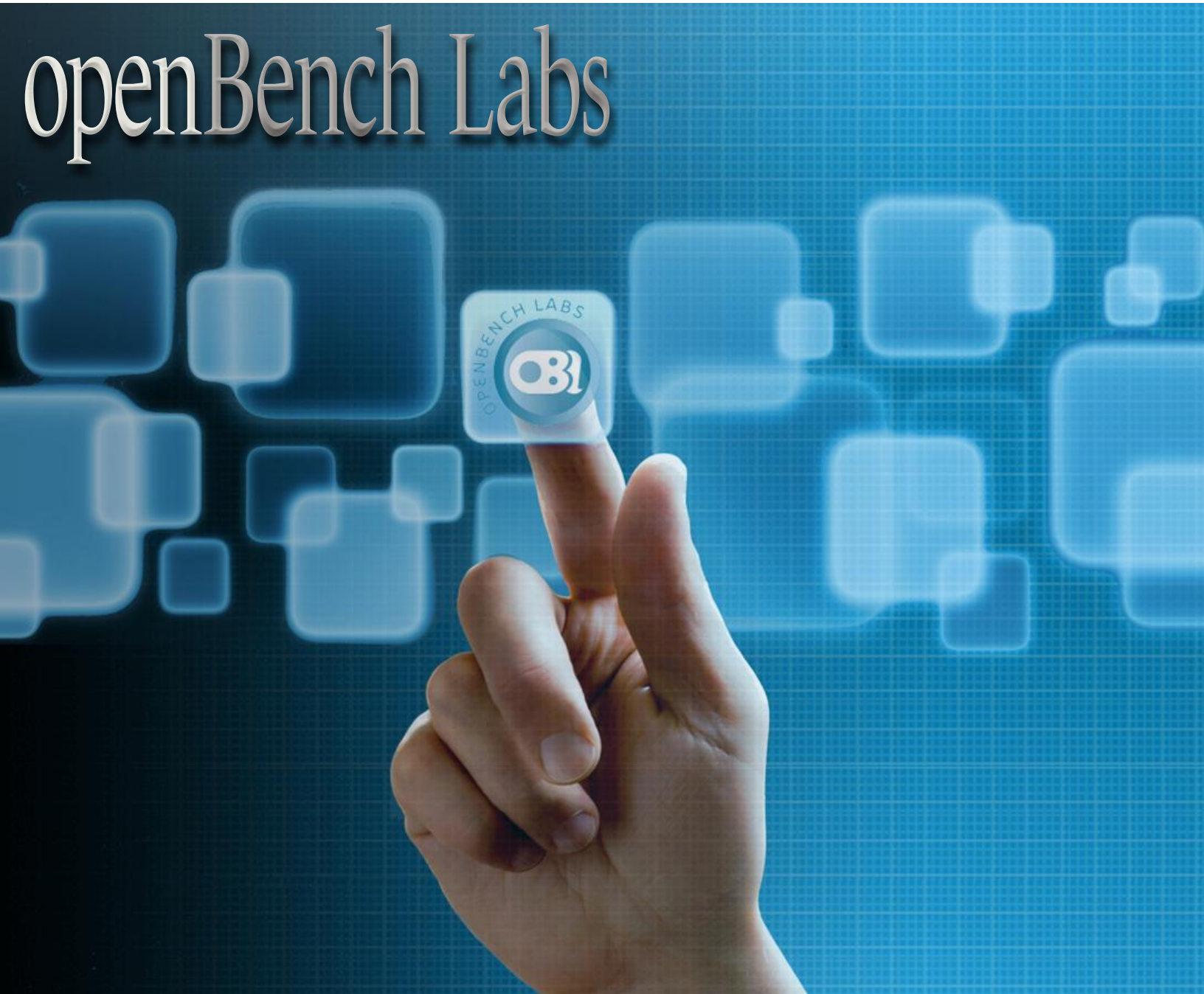
openBench Labs
Executive Briefing:

March 13, 2013

Condusiv's V-locity Server Accelerates Exchange 2010 by 75% without Additional Hardware

Optimizing I/O for Increased Throughput and Reduced Latency



Executive Overview

"In a workload-intensive environment simulating 1,000 Exchange users, V-locity Server enabled 75% 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® Server to optimize I/O in a dedicated email service domain on a server running Exchange 2010.

As more organizations seek to improve performance, support more users, and reduce data center operating expenses associated with storage, V-locity Server introduces an entirely new way to accelerate performance with the hardware they already have. V-locity I/O optimization technology provides greater throughput and reduced latency by limiting the amount of I/O traffic that is processed by the server, network, and storage devices such as SAN or NAS.

openBench Labs measured V-locity's write I/O optimization engine (IntelliWrite®) and read I/O optimization engine (IntelliMemory™). IntelliWrite technology prevents unnecessary split I/Os by using its intelligence to create new data files and extend current files as single contiguous collections of logical blocks. IntelliMemory technology offloads I/O on read operations through dynamic caching in available server memory without contention to the application, in order to boost throughput and reduce latency.

Snapshot of Findings

1) A one-hour LoadGen test simulated 1,000 Outlook users and revealed that V-locity Server enabled 75% more transactions in the same amount of time on servers running Exchange 2010 and Active Directory.
2) The V-locity Server latency test provided SSD-level access time on both the domain controller and the Exchange server. Latency was reduced from 16ms to 1.5ms on the domain controller, and on the server running Exchange, from 19ms to .92ms.
3) With V-locity Server, the LoadGen test showed a 240% increase in IOPS on the domain controller.

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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.

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.

Adoption of a high-speed SAN does not eradicate these issues. In fact, a SAN can compound storage problems, given that traditional SAN topologies have many servers sharing a limited number of storage resources. On a SAN with shared storage, inefficient I/O by any server will impact many servers, and impact the operations of all servers sharing the same storage resource.

In this analysis, openBench Labs examines the ability of V-locity Server to maximize I/O performance for a server running Windows Server® 2008 R2 and Exchange 2010 in a Windows domain.

By efficiently optimizing the way data is both read from and written to disk for Windows systems, V-locity Server optimized end-to-end email transactions among clients, the Exchange server, and a domain controller running Active Directory® for the Exchange email service domain.

A LoadGen benchmark running a stress load for one hour showed a 75% increase in Exchange transactions with V-locity.

Under Test: I/O Acceleration

Condusiv Technologies' V-locity Server

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 the server to increase local IOPS performance and reduces overhead on shared storage devices by reducing physical read I/O requests.
3) **By optimizing I/O processing** on servers running V-locity, less SAN or NAS I/O traffic is generated to an underlying storage system. With IntelliWrite and IntelliMemory, maximum transaction throughput on Exchange 2010 increased by 75%.
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.

How V-locity Removes Barriers To I/O Performance

To optimize I/O in any environment, V-locity Server is designed 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 Server caches frequently accessed data within available server memory without contention to the application to keep read requests from traveling the full distance to storage and back.**

IntelliWrite Technology

V-locity Server solves the 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.

> "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."

This behavior is problematic for frequently used files as Windows cannot issue a single I/O request that spans disjointed clusters. When Windows attempts to read a file that spans multiple clusters, it must split the I/O request into multiple I/Os—one for each disjointed cluster. As a result, processing split I/Os generates extra work, passes extra I/O traffic on to a SAN fabric, and creates extra work for the storage subsystem providing LUNs for the server.

To solve this, IntelliWrite adds more intelligence to the way that the Windows OS preallocates file space for continuous restructuring of writes that store files as contiguous sets of blocks to prevent performance penalties. Moreover, whenever a file is accessed and modified, IntelliWrite automatically restructures the file for optimal performance.

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

IntelliMemory Technology

Optimizing writes and eliminating unnecessary I/O does not resolve all important data access issues, especially when reading data. To provide the full spectrum of I/O optimization, V-locity Server implements IntelliMemory™, a highly efficient data caching solution that leverages available server memory to provide faster access to data and dramatically improved throughput.

IntelliMemory offloads a significant portion of read operations from a server's logical disks by caching hot data in memory without creating an issue of memory starvation to an application since IntelliMemory throttles usage dynamically according to what is available. More importantly, by offloading physical I/O, V-locity Server helps improve performance on any servers sharing the same storage resources via a SAN or NAS.

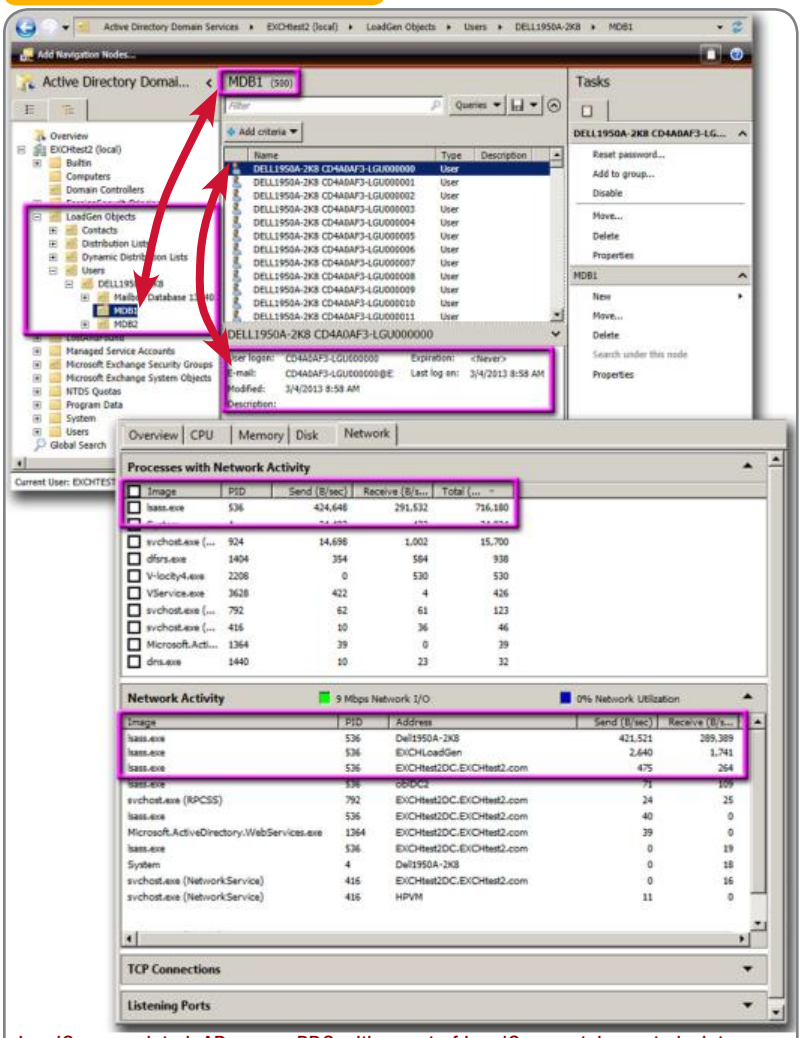
The Test

To assess the performance capabilities of V-locity Server in a Windows Server 2008 environment, we configured an email domain, from which we would provide email services. Within this domain, we set up three servers, each running Windows 2008 R2 with V-locity Server to optimize I/O. For storage of mailbox databases and log files, we used an 8GB per second Fibre Channel fabric with separate LUNs for each database.

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

1) Two Dell 1950 PowerEdge servers, with quad-core CPUs, 8GB RAM, running Windows Server 2008 and V-locity Server. These servers hosted a primary domain controller (PDC) running Active Directory services and an email server running Exchange 2010 SP2.

LoadGen AD Integration



LoadGen populated AD on our PDC with a set of LoadGen containers to isolate our pseudo users for testing. In a LoadGen simulation the Local Security Authority Subsystem Service (LSASS) on all three servers worked in tandem to validate the LoadGen users on the PDC as they set up online Outlook 2007 sessions to send email messages to multiple members of the group.

2) A third server running LoadGen created user accounts, email messages, and distribution lists to drive end-to-end messaging traffic.

3) We ran Jetstress on the Exchange server to determine the maximum number of users that could be supported under a heavy email transaction processing scenario.

NOTE: The Jetstress transactions are distrubuted in four groups: 35% reads, 20% deletes, 5% replaces, and 40% inserts. For our tests, we used two SAN-based LUNs to host two Jetstress email databases, which simulated Exchange mailbox databases.

4) We began our end-to end email benchmarking by establishing two email databases on our Exchange server for exclusive use by LoadGen. Using LoadGen, we generated 1,000 pseudo users account. Using the Jetstress heuristic for a heavy processing load, we distributed the user accounts across both of the mailbox databases.

5) While generating the test user accounts, LoadGen automatically created a set of LoadGen objects in Active Directory. During a full simulation, these users were utilized to simulate login connections, send messages to mulitple test users, and make changes to mail folders.

6) For the test simlulation we characterized each user as working online and using Outlook 2007 to generate 500 email transactions over an 8-hour day—about one

translation every minute. Excuting that profile for all 1,000 users required the Exchange server and the domain controller to process 62,500 transactions per hour over an 8-hour period.

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 62,500 transactions an hour, our tests attempted to run all 100,000 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.

With V-locity Server, we processed 75% more LoadGen transactions on Exchange and the domain controller, enabling 75% more work in the same amount of time.

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

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.

The following table highlights the test results, with details provided in the next section.

Table 1 V-locity Server on Exchange and Domain Controller Test Results

V-locity Server Performance: LoadGen Stress on a SAN 1,000 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*	***196,602*** ***195,684*** ***690 IOPS (2 disks)*** ***38MB per second***	***111,979*** ***111,979*** ***640 IOPS*** ***32MB per second***	***17 IOPS*** ***25KB per second***	***5 IOPS*** ***18KB per second***
V-locity Caching and Latency Test (IntelliMemory)				
Reads from Disk *Reads from Cache* *Average I/O Response Time:* *Normalized IOPS Support per Disk* *Improved Drive Lifespan*	***6,425,916 - 86%*** ***1,283,448 - 14%*** ***.92ms*** ***982 IOPS per disk*** ***10%***	***19 ms***	***54,772 - 83%*** ***11,219 - 17%*** ***1.5ms*** ***504 IOPS*** ***15%***	***16ms***

The Results: A Closer Look

Without V-locity Server, we were never able to complete a stress test for our 1,000-user configuration—we consistently generated more requests than Exchange 2010 was able to process. The FSB architecture of the Dell 1950 test servers could not handle the number of I/O transactions being sent over the LAN from the LoadGen server. The hardware itself was the limitation, unable to process the amount of I/O transactions being generated by the LoadGen server.

Without V-locity's I/O optimization, the only alternative was to lower the number of transactions per hour. After a number of iterations, we were able to process 111,979 LoadGen transactions in one hour, with a disk access rate average of 640 IOPS and disk throughput average of 32MB per second.

End-To-End Exchange Throughput With V-locity

With V-locity Server running on the Exchange server and the domain controller, 196,602 Outlook 2007 transactions were successfully processed–75% more than without V-locity Server. The key to this difference can be found by comparing the network traffic sent from the LoadGen Server to the Exchange server. With V-locity Server running, network data from the LoadGen server to the Exchange server was 45% greater, while the disk IOPS rate on the Exchange server was only 7% greater. The higher network data traffic was being cached and stored in the mailbox database logs for future processing. As a result, the Exchange server continued to process log files for 20 minutes after LoadGen completed–a 33% increase in transaction processing time.

With V-locity, Exchange sustained LoadGen in stress mode and completed 195,684 transactions—a 75% increase in transaction throughput. While the transaction completion rate was quite dramatic, the manner in which this was accomplished by Exchange in conjunction with V-locity Server was not immediately obvious.

When we examined disk I/O on the Exchange server, the disk access rate was just 7% higher with V-locity Server. Similarly, disk throughput was just 19% greater. Nonetheless, network throughput from the LoadGen server to the server hosting Exchange was 40% higher. What was happening?

As expected, IntelliMemory caching on the PDC cut disk access time to 1.5ms—a 91% improvement— as the PDC repeated simple validation lookups for processes on the LoadGen and Exchange 2010 servers in a comparatively small Active Directory structure. As a result, IntelliMemory on the PDC helped minimize authentication time.

Unexpectedly, IntelliMemory was also helping to maintain the higher network throughput rate by caching log file reads on the Exchange server, which reduced average access time to .98ms—a 95% improvement. Working with an architecture-throttled I/O subsystem, V-locity Server increased I/O throughput enough for Exchange to write a sufficient number of pending LoadGen transactions to log files and continue internally caching enough transactions to sustain stress-level throughput from LoadGen. As a result, Exchange continued to run at the full I/O subsystem level for an extra 25 minutes after the LoadGen simulation had completed in order to process all of the transactions captured in cache.

Bottom Line

In a server environment with FSB I/O subsystems, we were able to optimize Exchange IOPS performance dramatically enough to enable the application to process enough transactions to continuing writing unprocessed transactions to logs. As a result, Exchange was able to process transactions for 20 minutes after LoadGen completed, and effectively complete 75% more transactions than without V-locity Server running on the Exchange host and the PDC server.

By running V-locity Server on all Windows servers across our email service domain, we were able to significantly improve application performance, even when hardware architecture was the most significant I/O bottleneck.

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.