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WHITE PAPER

V-locity 3®: Virtual Optimization Realized

Executive Summary

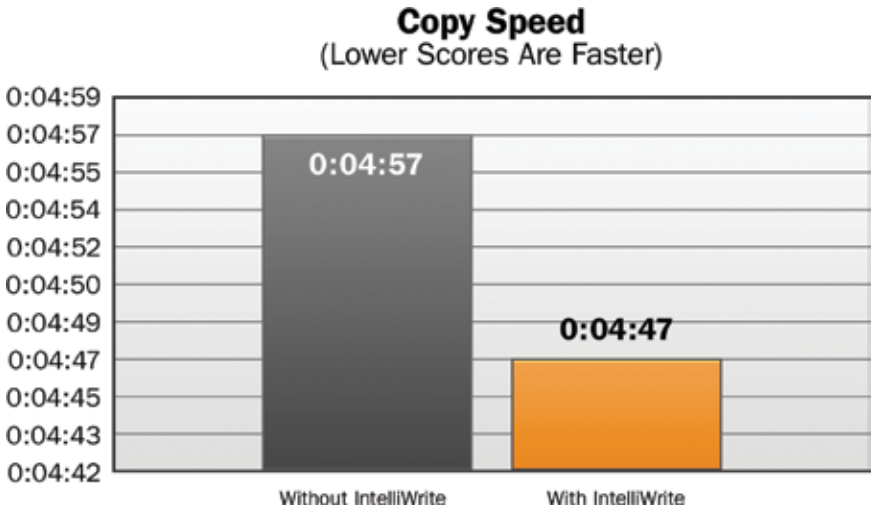
Today's virtual environments demand constant effort to maintain the highest possible service levels; the overhead this requires and also the resource conflicts involved are problematic. Existing physical storage investments are not yielding their optimal benefits due to file system limitations at the operating system level that result in I/O bottlenecks. As well, inefficient resource allocations during attempts to handle this create frequent service bottlenecks. This is especially true with a virtual system in which VMs must be coordinated with each other and with the Host.

Before V-locity® technology, there was no effective solution for broad virtual platform performance optimization. V-locity 3 bridges the gap between virtual guests and intelligently manages the resource demands between them.

Patented technology in V-locity enables communication between virtual machines to intelligently synchronize resource allocation and make all optimization activity completely transparent. File fragmentation from NTFS file writing operations is the most basic source of unnecessary I/O generation on any system. Excessive I/O traffic quickly escalates to *many millions* of additional I/Os and affect the performance of the entire data pipeline even down to a SAN layer.

Included in V-locity 3, groundbreaking IntelliWrite® technology does something no other technology has ever achieved: it prevents almost all fragmentation before it can happen, eliminating the possibility of I/O bottlenecks and increasing physical disk longevity and energy economy.

IntelliWrite® technology

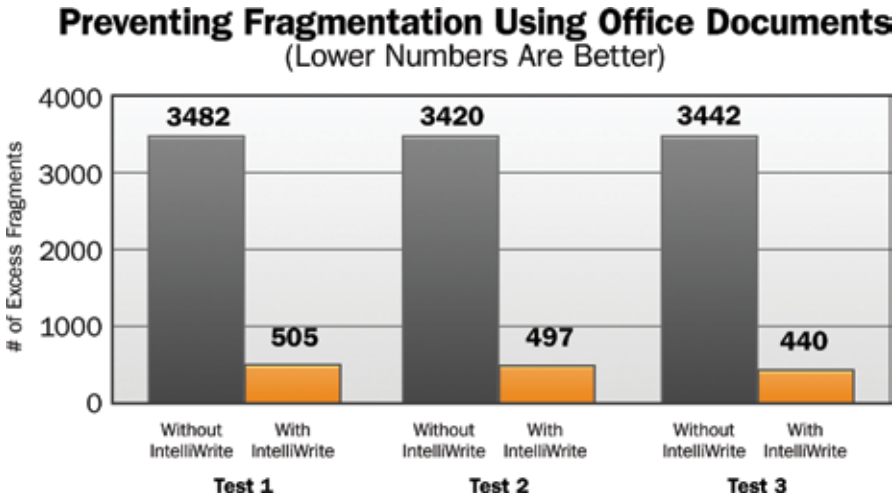


File Copy benchmarks for IntelliWrite

A test to demonstrate write performance was done on two identical systems. The system with IntelliWrite was able to write faster. It is important to remember that the other system not only wrote slower, but its performance will continue to degrade as it forces the system to manage more and more unnecessary I/Os.

Office Applications

The first analysis involves simulating a typical office worker's day-to-day activity, creating and editing various file types with standard productivity applications. A script is used so that the activity can be reproduced identically. That script mimics user activity working with Notepad, WordPad, Microsoft® Word, and Microsoft Excel® to create files, write data to files, delete files and copy files. The script also copies folders with document files in them.



Office document fragmentation prevention

This chart shows that, on average, IntelliWrite prevented 86% of new fragments.

InvisiTasking® with CogniSAN™ and V-Aware™ technologies

V-locity 3 includes two new technologies which allow the V-locity Guest to sense an increase in disk I/O activity, regardless of whether the increased activity comes from the same virtual machine (VM), a different VM using the same physical resources, or even a different host connected to the same SAN fabric. These technologies are CogniSAN (for detecting I/O activity at the SAN level) and V-Aware (for detecting I/O activity in the whole virtual environment, including the host and other VMs). These new technologies allow the V-locity Guest to back off disk optimization processing when it senses increased load in the I/O channel. Used together with InvisiTasking technology, which continues to be used to detect disk, networking and CPU and other resource loads within the same VM, these new technologies extend InvisiTasking beyond the local VM or the local host and ensure that disk optimization processing does not impact other applications, even if they are running in other VMs or other hosts using the same SAN infrastructure.

Methodology

Testing was performed in order to fully investigate the impact of these new technologies. These tests were constructed to evaluate the overall benefit of V-locity 3 optimization in a modern virtual environment. While VMware ESX™/ESXi™ environments were utilized for testing, it is notable that the results are analogous in Hyper-V™ and should be for other supported virtual platforms. Testing included:

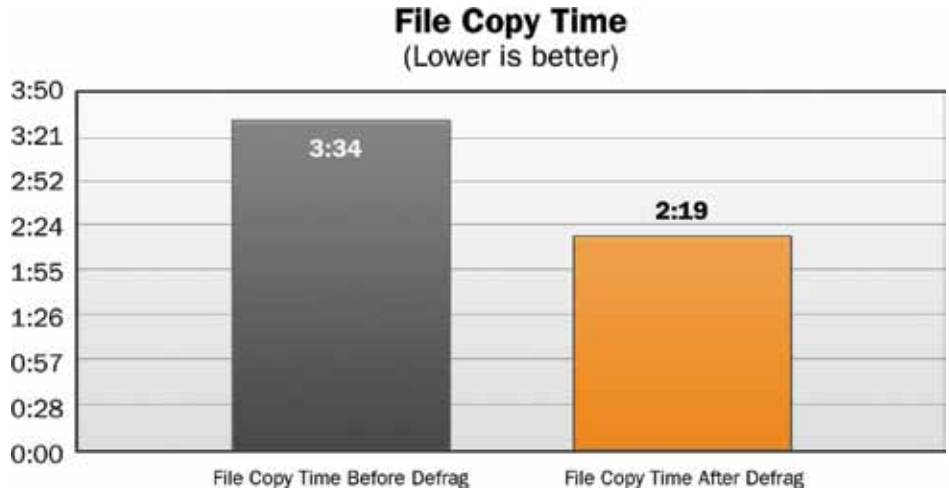
- VM system performance improving from V-locity optimization.
- InvisiTasking localized to a single VM, ensuring invisibility during optimization – within the VM.
- CogniSAN and V-Aware working in concert with InvisiTasking to ensure invisible operation across the infrastructure – i.e., across all VMs.
- The new Space Reclamation engine included in V-locity effectively returning space to the storage infrastructure.
- Assuring absolutely minimal thin disk growth corresponding with defragmentation.

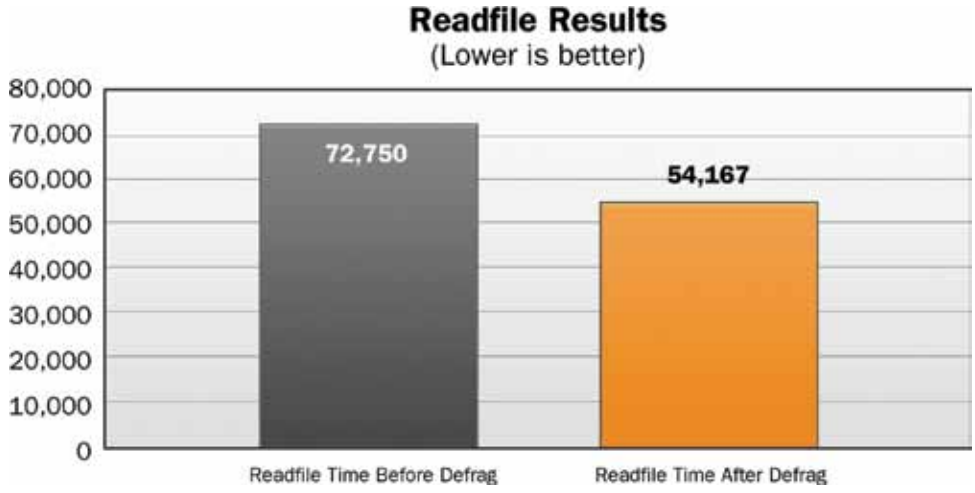
System Performance Testing

Testing was performed to investigate the improvement to system performance resulting from handling fragmentation in a virtual machine by V-locity. The independent Readfile utility was used to measure file read performance before and after defragmentation. Additionally, a file copy operation was timed to measure file read and write performance before and after defragmentation. Results are shown in the table below.

Results:

	File Copy Times			ReadFile Results		
	Before Defrag (mm:ss)	After Defrag (mm:ss)	Percent Improvement	Before Defrag (msec)	After Defrag (msec)	Percent Improvement
Test #1	4:04	2:22	41.80%	72,907	54,111	25.78%
Test #2	3:03	2:15	26.23%	72,592	54,222	25.31%
Average	3:34	2:19	35.05%	72,750	54,167	25.54%





InvisiTasking, CogniSAN, and V-Aware Testing Summary

In practical terms, when V-locity is running, all three of these technologies are active. Accordingly, we've summarized two test cases and six test results spanning all three technologies to provide a true approximation of their net effect on virtual performance.

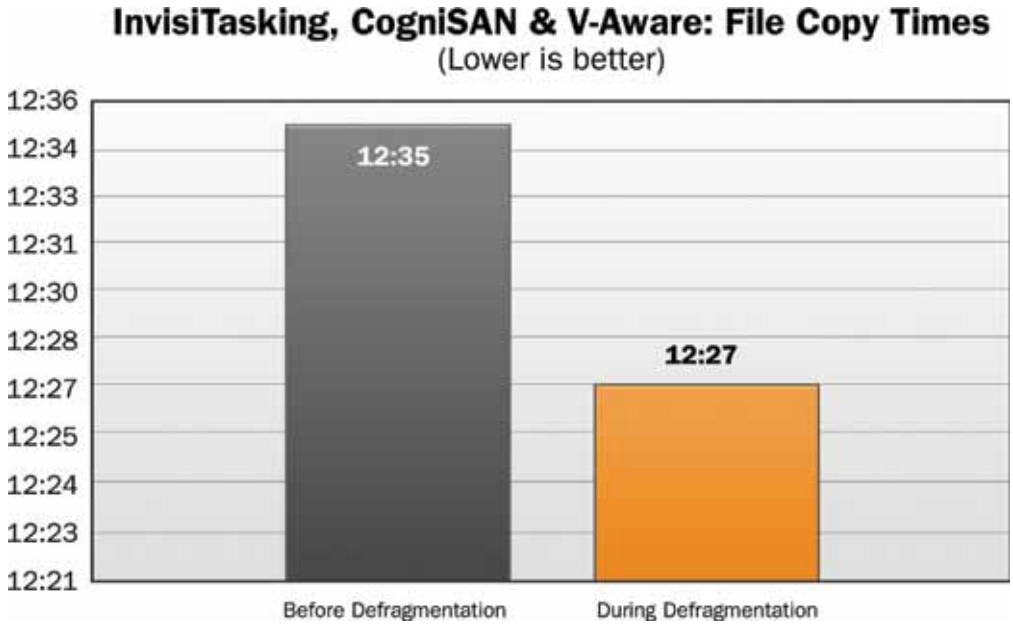
The tests are designed to verify that InvisiTasking, along with CogniSAN and V-Aware, ensure invisibility locally and across the virtual framework during optimization.

After creating moderate fragmentation on the virtual disk, we measured how long it took to copy a 2GB file from one folder to another on the same virtual disk. Then, we enabled automatic defragmentation (with InvisiTasking, CogniSAN, and V-Aware enabled) on the virtual disk, and performed the same file copy test again while defragmentation was running.

The results of these tests show that, in concert, these three technologies ensure V-locity automatic operations are invisible. And because they are, you can immediately start to see the benefits of optimization on file operation speeds.

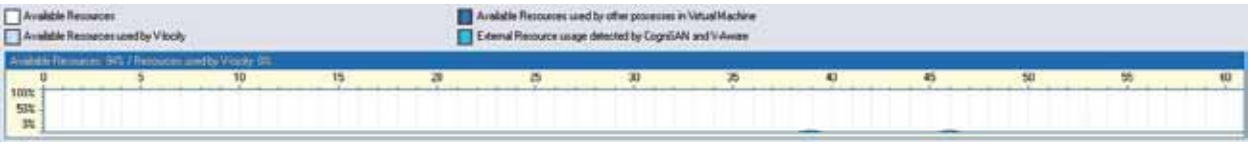
Results:

	File Copy Time Before Defrag (mm:ss)	File Copy Time During Defrag (mm:ss)	Percent Improvement
Average	12:35	12:27	1.06%

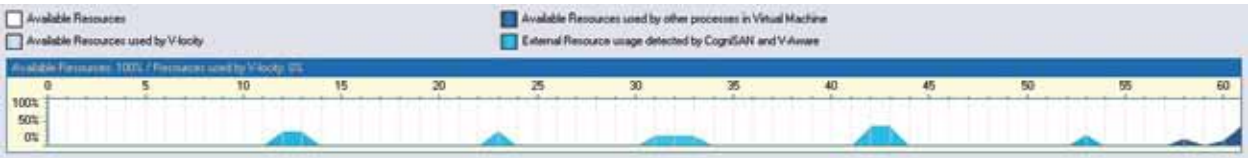


Graphical Display: Virtual Infrastructure Resource Usage

This test demonstrates the ability of InvisiTasking, in conjunction with the new CogniSAN™ and V-Aware™ technologies, to detect disk load external to the VM (i.e., coming from other VMs sharing the same physical resources) and show this "external" load in a graph in the V-locity Guest UI. It involved creating two virtual machines on the same datastore, both with moderate fragmentation of virtual disks. The V-locity Guest was installed in one of the VMs. With no disk activity generated in the second VM, the InvisiTasking graph in the V-locity Guest UI did not show any "external" load detected while performing automatic defragmentation. Then, a script creating a lot of disk I/O activity was started in the second VM. This time, the InvisiTasking graph showed that CogniSAN/V-Aware detected external load. The screen shots below show the InvisiTasking with V-Aware graph for the two conditions.



No external resource usage.



CogniSAN and V-Aware detecting and displaying external resource usage in the infrastructure.

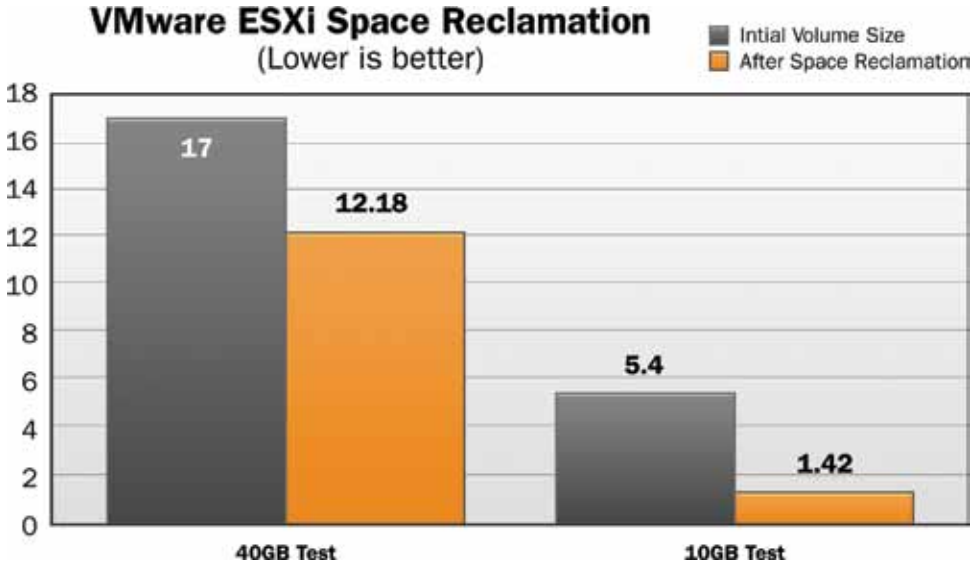
Space Reclamation Testing

The V-locity 3 Guest includes a new engine that zeroes out unused data blocks within virtual disks. When unused data blocks are zeroed out, the space from these blocks can be recovered through running Storage vMotion™ (ESX/ESXi) or Quick Storage Migration (Hyper-V) and thin virtual disk files can be shrunk to occupy less storage space. The Space Reclamation engine runs automatically in the background or can be run manually from the V-locity client. When run in automatic mode, the engine uses InvisiTasking with CogniSAN and V-Aware, with no impact on other applications in the same VM or in other VMs. The engine was tested to run successfully in both automatic and manual modes.

The test involved creating a thin virtual disk and filling it up with files. Then, a significant portion of the files on the disk were deleted, followed by running V-locity Space Reclamation to zero out the unused space. Finally, Storage vMotion was performed using VMware vSphere™ to actually shrink the virtual disk file. Separate testing was performed in both a VMware ESX and ESXi 4.1 environment. The results follow:

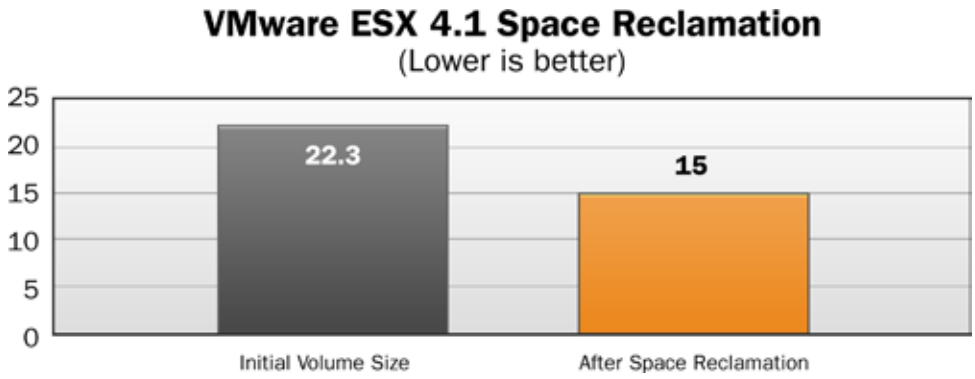
VMware ESXi 4.1 Results:

Maximum Virtual Disk Provisioned Size	Initial Virtual Disk Size After Filling up with Files (GB)	Approximate Total Size of Deleted Files (GB)	Virtual Disk Size After Space Reclamation and Storage vMotion (GB)	Percent Improvement
40GB	17	6.3	12.18	28.35%
10GB	5.4	3.95	1.42	73.70%



VMware ESX 4.1 Results:

Maximum Virtual Disk Provisioned Size	Initial Virtual Disk Size After Filling up with Files (GB)	Approximate Total Size of Deleted Files (GB)	Virtual Disk Size After Space Reclamation and Storage vMotion (GB)	Percent Improvement
40GB	22.3	7	15	32.74%



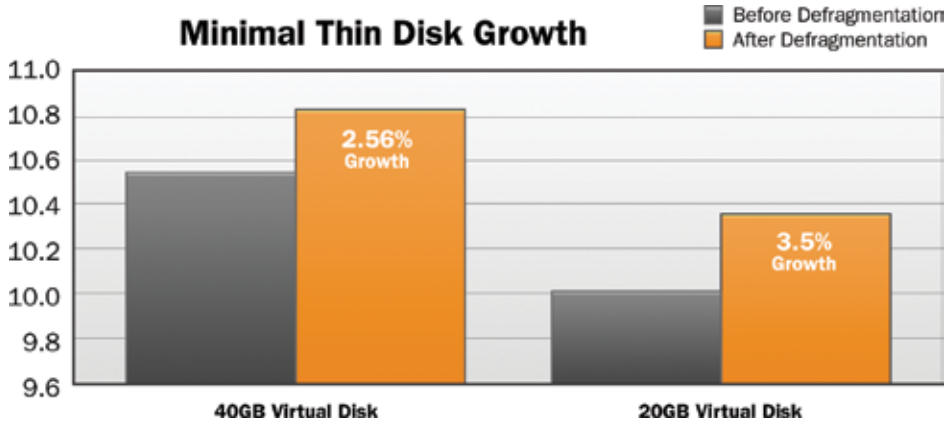
Thin Disk Testing

Testing was performed to determine just how minimal the impact of V-locity automatic defragmentation was on thin disk growth.

Two dynamic (thin) virtual disks with varying size and free space were defragmented. In both cases the disk growth was extremely limited (around 3%).

Results:

Maximum Virtual Disk Provisioned Size	Disk Free Space (GB)	Virtual Disk Size Before Defragmentation (GB)	Virtual Disk Size After Defragmentation (GB)	Percent Change
40 GB	34.85	10.55	10.82	-2.56%
20 GB	12.5	10.01	10.36	-3.50%
Average	23.675	10.28	10.59	-3.02%



Conclusion

Foremost, the performance benefits of a true virtual platform optimizer are clear and profound. Testing displayed a 25% increase in file read speed and 35% boost in file write speed; these numbers translate directly to increased productivity, from the workstation level all the way up to production servers.

A virtual infrastructure is dynamic, and constructed to change on the fly as dictated by the storage and resource concerns of the moment. The CogniSAN and V-Aware technologies contained in V-locity 3 ensure that each agent is truly invisible in operation, no matter what. And when VM disk types change, self-aware V-locity 3 agents automatically adapt to optimize their virtual machine, no matter the provisioning.

VM density can play a large part in justifying cost for a virtual space: the greater the density, the higher the value of the underlying storage architecture. Automatic space reclamation by V-locity 3 can return up to 70% provisioned space (from unnecessary thin/dynamic disk growth) to the storage array after Storage vMotion or Quick Storage Migration.

The overwhelming benefits of V-locity 3 are apparent across every major point of concern in a modern virtual environment. Enterprise growth demands solutions which integrate seamlessly, require no interaction, and amplify productivity without consuming necessary resources. V-locity 3 handles critical infrastructure issues while reducing cost and returning value to existing storage.

Appendix

Test Information

Environment:

Virtual Platform: ESXi 4.1 (other than one test performed on ESX)

Windows Platform: Windows 7

VM Memory: 768 MB

VM Provisioning: Thin (40GB Max Size, 20GB Max Size for Thin Disk Testing)

SCSI Controller: LSI Logic SAS

System Performance Testing Steps:

1. Create fragmentation on 40GB volume with moderate fragments.
2. Copy a large size file (2GB in size) and note down the time taken to copy the file.
3. Using the readfile.exe tool, measure the read time to read the above large file.
4. Delete the copied file and reboot the machine.
5. Repeat steps 2-4.
6. Install V-locity 3 Guest and defragment the volume.
7. Repeat steps 2-4 twice and tabulate the readings.

InvisiTasking Testing Steps:

1. Create fragmentation on 40GB volume with moderate fragments.
2. Copy a large size file (2GB in size) and note down the time taken to copy the file.
3. Delete the copied file and reboot the machine.
4. Repeat steps 2-3.
5. Install V-locity 3 Guest and enable automatic defragmentation.
6. Repeat steps 2-4 twice and tabulate the readings.

CogniSAN and V-Aware Testing Steps:

1. This test involves two separate test VMs, labeled “A” and “B,” each provisioned with 40GB volumes and running over the same physical VMware data store.
2. Create fragmentation on 40GB volumes of test VMs A and B with moderate fragments.
3. Copy a large size file (2GB in size) on test VM A and note down the time taken to copy the file.
4. Delete the copied file and reboot the machine.
5. Repeat steps 3-4.
6. Install V-locity 3 Guest on test VM B and enable automatic defragmentation.
7. Repeat steps 3-4 twice and tabulate the readings.

Space Reclamation Testing Steps:

1. Create fragmentation on 40GB volume with moderate fragments and record virtual disk size.
2. Delete a significant portion of the files on the disk and record size of deleted files.
3. Install V-locity 3 Guest and enable automatic optimization.
4. Perform a Storage vMotion using VMware vSphere and afterwards record virtual disk size.
5. Repeat steps 1-4 on a 10GB max provisioned size volume.
6. Repeat steps 1-4 on a 40GB max provisioned size volume over ESX 4.1.

Thin Disk Testing Steps:

1. Create a volume with moderate fragmentation in a VM on a thin disk.
2. Note the disk size.
3. Enable auto defrag and let it finish.
4. Note the size of the disk. Should not be a lot more than before defrag.