

### File Server Consolidation and Wide Area File Services enabled by Cisco Wide Area Application Services (WAAS)

#### Executive Summary

VeriTest, a division of Lionbridge Technologies, Inc., performed an independent analysis of Cisco Systems WAAS software operating on the WAE hardware appliance.

Cisco WAAS is a powerful new WAN optimization controller (WOC) solution for the branch office that optimizes the performance of any application across a Wide Area Network (WAN). This solution allows customers to consolidate costly distributed file/print servers and storage into centrally-managed data centers, offers LAN-like performance for remote users through application acceleration, and reduces cost for WAN bandwidth through comprehensive WAN optimization technologies.

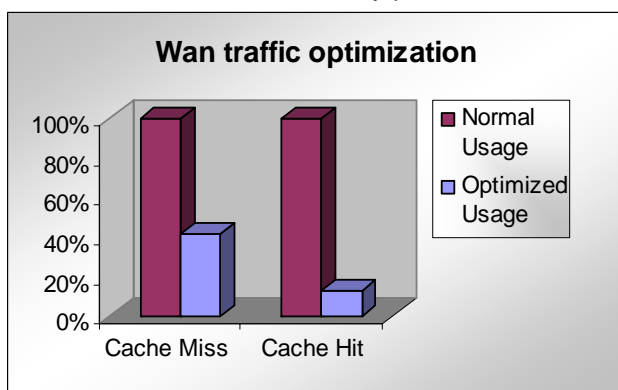
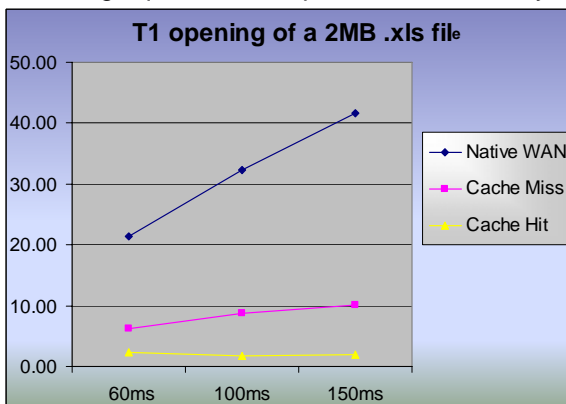
Unlike other WAN optimization solutions, WAAS integrates transparently with the network, preserving IP information to maintain functions such as security (firewall, etc), QoS, visibility and monitoring end-to-end. Cisco WAAS 'raises the industry bar' in several areas by having a comprehensive optimization architecture, while carefully maintaining and supporting existing network and security infrastructure in the branch office.

Benefits of Cisco WAAS file services include:

- **Improved Speed for File Access and Sharing**—Latency-reduction, operation batching, read-ahead and advanced caching technologies provide LAN-like performance to remote users, increasing productivity and facilitating collaboration.
- **Enhanced Data Protection**—Master copy of all files generated from the branch is stored centrally in the data center, enabling centralized protection and management of data.
- **Lower Total Cost of Ownership (TCO)**—WAAS optimizations for file protocols and local print services replace unreliable and costly file/print servers and data protection infrastructure located in each branch office.
- **Reduced Administration**—IT administrators can centrally manage file services and policies, including usage quotas, backups, disaster recovery, restores, access control, and security policies.

#### VeriTest key findings...

- ❑ Cisco WAAS provides improved WAN performance regardless of connection speed or latency.
- ❑ Based on our tests, Cisco WAAS reduced traffic crossing the WAN by over 85%. This makes centralizing data and file storage more appealing, as it lowers the risk of poor performance when delivering content from a central data center(s).
- ❑ Cisco WAAS is ideal for companies looking to consolidate their data servers, reduce the costs of branch office infrastructure, secure data and achieve compliance through centralization.
- ❑ The Cisco WAAS solution improved performance of data access significantly. For example, one result shows that over a T1/E1 connection with 100ms delay, a 2MB Microsoft Excel file that took 32.2 seconds to open normally took only 1.7 seconds with Cisco WAAS.



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## Technology

### WAAS

The Wide Area Application Services (WAAS) technology from Cisco Systems offers organizations with multiple branch offices the benefits of centralized server and storage infrastructure, while providing full local file services. By enabling companies to consolidate servers and storage in central data centers to provide centralized backup and disaster recovery processes, Cisco® WAAS improves both business continuity and overall manageability. Remote end users benefit from WAAS technology by receiving the fast, near-LAN speed file access that they have become accustomed to with a local infrastructure, even though they are really accessing files in an optimized fashion across the WAN.

Cisco WAAS provides high performance WAN optimizations to reduce bandwidth consumption and maximize throughput and efficiency, significantly improving application delivery over the WAN. Cisco WAAS integrates transparently into existing networks, preserving investment in existing WAN network infrastructure (e.g. access router / switch), and feature configurations such as NetFlow monitoring and reporting, QoS, and security.

The Cisco WAAS solution includes:

- **Cisco Wide Area Application Engine (WAE)** — Ready to use appliance or router-integrated network module deployed at each remote site, and appliances deployed at regional hub or data center locations, allowing remote site users near-LAN speed access to centralized storage, data, and applications.
- **Cisco WAAS Central Manager**—Provides centralized management and monitoring of all the Wide Area Application Engine (WAE) appliances and router-integrated network modules, provides network optimization savings and usage statistics along with secure global configuration capabilities.

The WAAS solution includes the Cisco WAAS software running on Cisco WAE-511/512, WAE-611/612, WAE-7326 or network module on the access router. Each WAE can be configured as an application accelerator or a WAAS Central Manager. For more information on the Cisco WAAS solution, refer to the *Cisco WAAS information* at <http://www.cisco.com/go/waas>

### WCCP

Using the built-in Web Caching Communications Protocol (WCCP) in Cisco IOS-based routers and switches, client traffic is transparently redirected to a Cisco Wide Area Application Engine (WAE). This enables the WAE to transparently apply optimizations to application traffic, such as file requests. For protocols such as CIFS (Common Internet File System) where traffic localization can be applied, Cisco WAAS can dramatically reduce transmission costs and download times.

WCCP enables clustering of a series of WAEs for high availability, load-sharing, and scalability, called a *WAE Service Group*, to interact with a single or multiple routers. With these clustering capabilities, network administrators can easily scale their WAE deployment to handle heavy traffic loads, high availability and failover scenarios. Cisco's clustering technology enables each WAE member to work in parallel, resulting in linear scalability. Up to 32 WAEs can be clustered in one service group to scale to the desired capacity.

## Test Environment

The test environment was setup in a Cisco test lab and supervised and inspected by a VeriTtest Engineer. The setup consisted of the following:

### Servers and Client:

- 2.4Ghz P4 with 512mb RAM Running Microsoft windows 2003 server SP1(Domain Controller)
- 3.0Ghz P4 with 512mb RAM Running Microsoft Windows 2003 Server SP1(File Server)
- 1.2Ghz PIII with 512mb RAM Running Microsoft Windows XP Pro. SP2 (Client)
- EMC Celerra NS 702 Running software Version 5.4.14-3 with a Clariion CX700 storage array

## Networking equipment:

- Cisco 2811 (Branch Office) Router
- Cisco 3845 (Data Center) Router
- Catalyst 2950XL Switch

## Latency Simulator:

- 2.4Ghz P4 with 512mb running a Red Hat 3.0 EL (2.6.9-EL Kernel) with NIST net installed

## Cisco Wide Area Application Engine:

- Three Cisco 611 WAE appliances acting as Edge, Core, and Central Manager running WAAS 4.0 software.

## NIST Net

NIST Net is a network emulation package that runs on Linux. VeriTtest used the NIST Net package from Cisco Systems. The image can be found at [http://www.cisco.com/cgi-bin/tablebuild.pl/fe\\_util](http://www.cisco.com/cgi-bin/tablebuild.pl/fe_util). The NIST Net package allows a single Linux box set up to emulate a wide variety of network conditions, such as packet loss, duplication, delay, jitter, bandwidth, and network congestion. This allows testing of network-adaptive protocols and applications.

## Cisco WAE Configuration

VeriTtest configured the WAE network interfaces and then configured WAAS services from the WAAS Central Manager. VeriTtest configured the system clock, and enabled WCCPv2 for TCP promiscuous services.

## Cisco Router Configuration

WCCPv2 redirection was configured to properly redirect TCP traffic from the router, or switch, to the Cisco WAE.

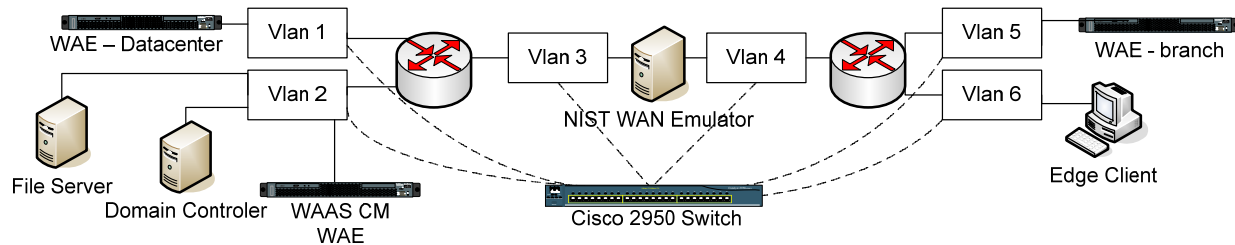
## Benchmarking

VeriTtest used the Cisco WAFS Benchmark Tool for Microsoft Office Applications version 1.2 to measure transfer times (found at [http://www.cisco.com/cgi-bin/tablebuild.pl/fe\\_util](http://www.cisco.com/cgi-bin/tablebuild.pl/fe_util)). The Cisco WAFS Benchmark tool uses normal Microsoft office files that are provided with the tool to measure transactions. If desired, the tests can easily be executed with any user-supplied Microsoft Office documents by replacing the payload documents. VeriTtest used the default files that came with the Cisco WAFS Benchmark Tool for Microsoft Office Applications version 1.2.

## Test Configuration Setup

There were no modifications necessary to the client PC and file servers. Only standard network configurations were applied and relevant services configured. The client was configured with a mapped drive pointing to a datacenter file-server share (in our tests, EMC NS 702 NAS and Windows 2003 server). The datacenter router was configured to trunk the VLANs as detailed in the diagram below. We configured WCCPv2 with service groups 61 and 62. Then we enabled Cisco Express Forwarding (CEF), and added static routes to accommodate WAN emulation. The branch router was configured the same way.

The Cisco WAE devices were configured to provide transparent optimizations and were deployed on separate VLANs from the client and server. We turned on WCCPv2 with the TCP promiscuous option to accept all TCP traffic. We configured the WAAS file services adapter for additional CIFS protocol optimizations. For further setup guidelines for Cisco WAE devices please contact your sales account representative.



## Test Procedures

Three scenarios were tested: cache hit, cache miss, and native WAN.

- **NATIVE WAN** — Access the remote file server directly over the WAN.
- **CACHE MISS** — The file has not been accessed, or seen before by the WAE device.
- **CACHE HIT** — The file has been accessed in the past, is presently stored on the branch WAE cache and the cache copy is up-to-date.

To test the above scenarios, we utilized six different environments which included two line speeds tested on three different latencies:

- Bandwidth: 512kb and T1 (1544 kb)
- Latency: 60 milliseconds (ms), 100 ms, 150 ms
- All environments included 0.5% packet loss

All tests were conducted using a single client PC with a mapped drive to the file server share.

To test Native WAN access to the data, WCCP on the routers was disabled to avoid traffic redirection to the WAE. The Office Benchmark tool was launched and configured to prepare and run the benchmark tests.

To test Cache miss WCCPv2 was enabled on the router. The test was executed in three phases:

- Office Benchmark was launched and the workload prepared (check ONLY "Prepare benchmark" then click "Go!").
- Once prepared, cache was cleared.
- Lastly, "Run benchmark" was checked, and "Go!" was clicked.

To test Cache hit, WCCPv2 was enabled on the routers. The Office Benchmark was launched and configured to prepare and run the benchmark tests.

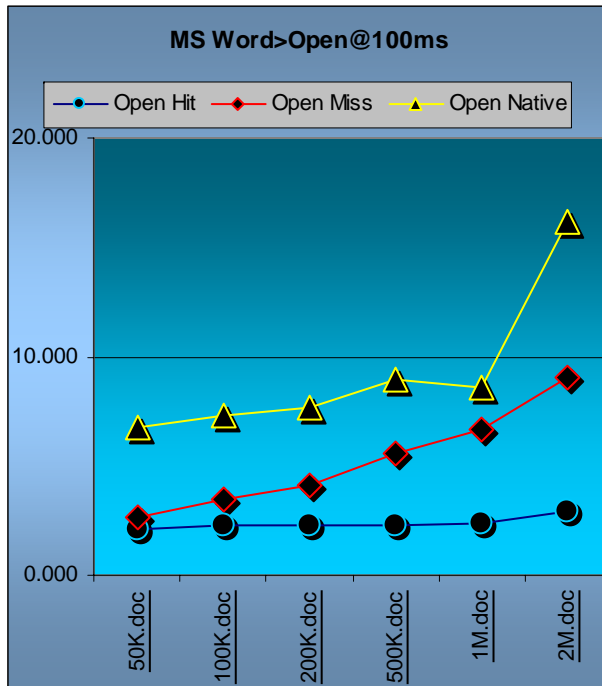
## Test Results

The results of the testing generated large amounts of statistical data. The results below are based off an average of three sets of results. Each test was conducted three times.

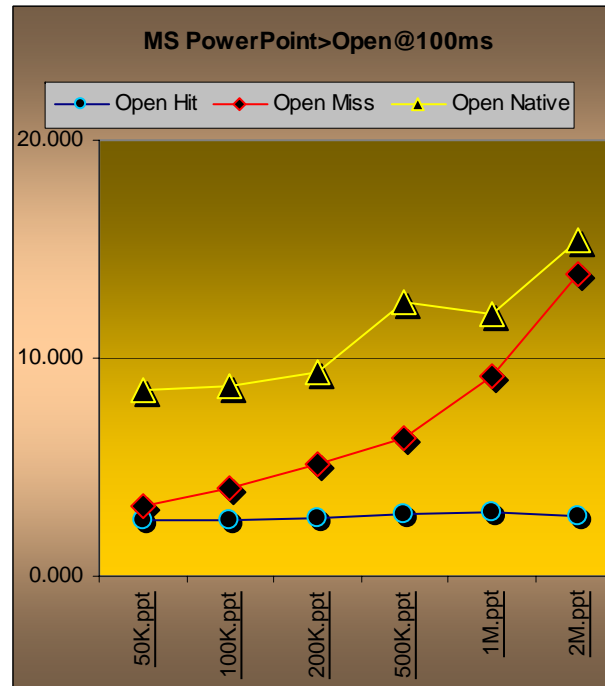
In the charts below, [Cisco WAAS results for opening Microsoft Word, PowerPoint, and Excel data files](http://www.lionbridge.com/lionbridge/en-US/services/outsourced-testing/competitive-analysis/cisco.htm), we examine only the T1 results since VeriTest believes this is the most common configuration based from experience and market exposure. All of the other data can be downloaded for viewing at <http://www.lionbridge.com/lionbridge/en-US/services/outsourced-testing/competitive-analysis/cisco.htm>.

The following graphs are the time averages to open and save various file types and sizes. All times are recorded in seconds. The triangles represent test results from times taken in a native WAN environment. The diamonds represent test results from times taken in a cache miss scenario, in an optimized environment. This means that the file was not stored in the local cache, Cisco compression libraries were empty, but the file was received from the server using the WAN transport optimizations provided by WAAS to accelerate the transaction times. The circles represent test results taken in a cache hit scenario, where the Cisco WAE compression libraries were populated.

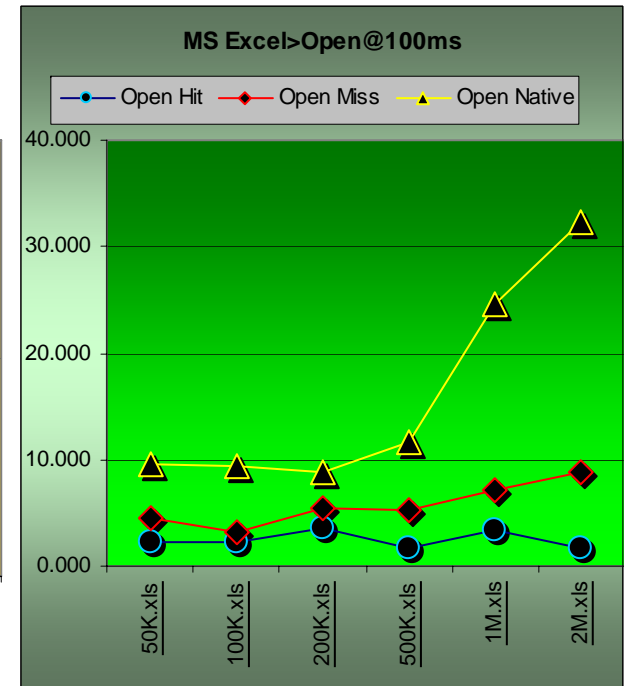
### Cisco WAAS results for opening Microsoft Word, PowerPoint, and Excel data files (All times are recorded in seconds)



In the diagram above, we clearly see that the performance improvements by WAAS increase as the data file increases in size. With the 50k file the time saved opening the file was 4.5 seconds, and with the 2 MB file, the time saved was nearly 14 seconds or 600%.

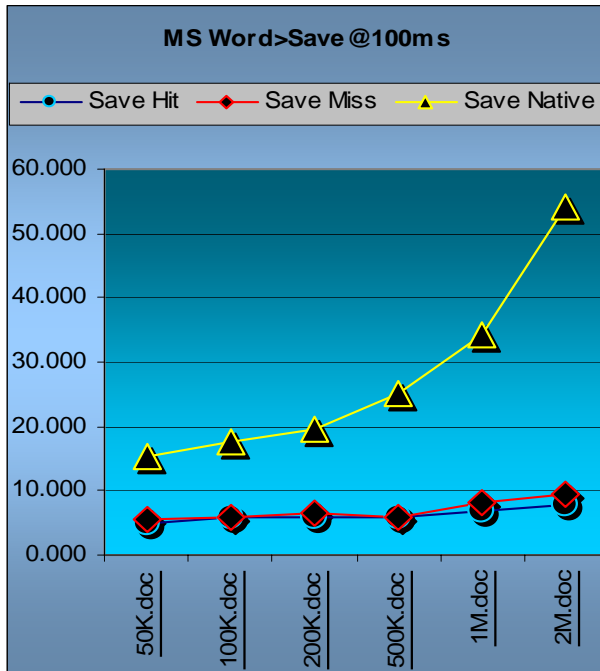


In the diagram above you can see that even with a 50k PowerPoint file, the open time across the native WAN is 4 times longer than the WAAS solution.

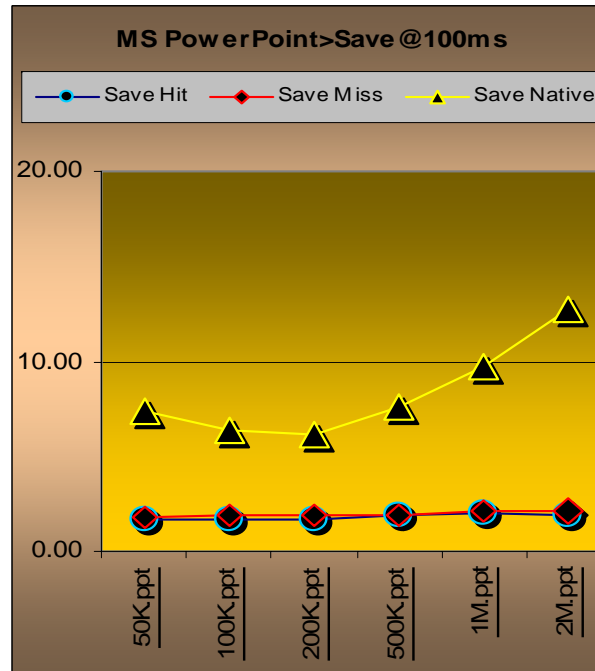


In the Diagram above we see that WAAS saves 7 seconds on opening the 50k MS Excel file and roughly 30 seconds on the 2 MB MS Excel file. The time to open the files increases as the size of the file increases.

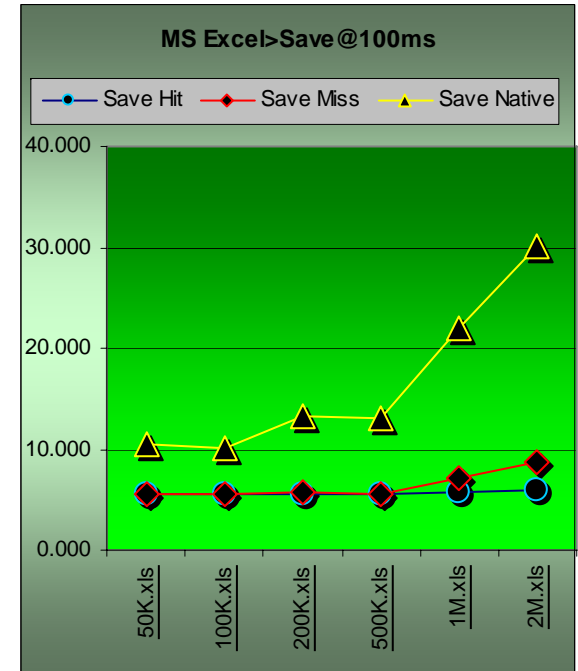
### Cisco WAAS results for saving Microsoft Word, PowerPoint, and Excel data files (All times are recorded in seconds)



As we see in the diagram above it takes 15.4 seconds in native mode to save a 50k document and 4.9 seconds to save the document with a cache hit. With the larger sized MS Word files it takes 54 seconds to save the 2 MB file in native mode and only 7 seconds to save the same file with a cache hit. Notice that cache miss performance is similar to that of cache hit.

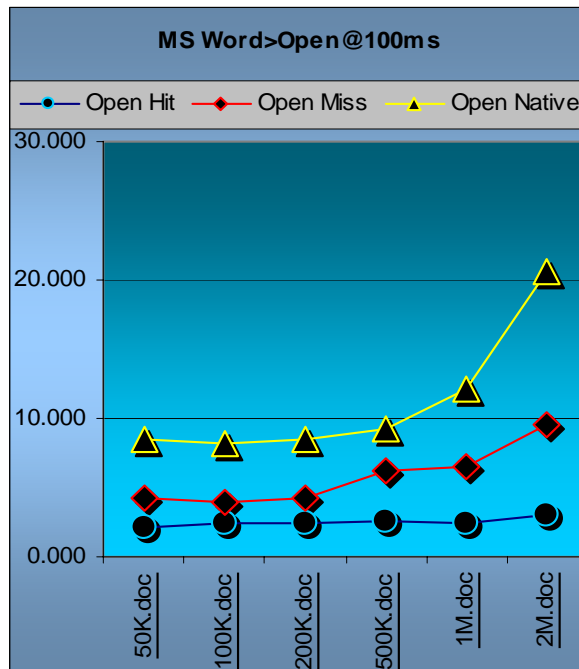


In the diagram above we see that applications behave differently but WAAS improvements stay very consistent. We see that with a 50k MS PowerPoint file it takes roughly 7 seconds to save in native mode and the time decreased by approximately 5 seconds (or 71%) in both cache hit and miss scenarios.

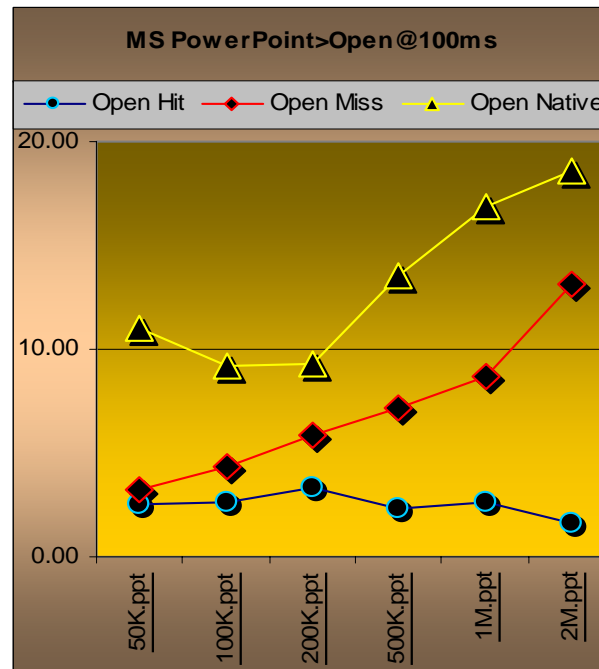


The chart above shows that WAAS really makes a significant difference with larger Excel files. With the 2 MB XLS file, the save time was 29 seconds in native mode and decreased to approximately 9 seconds (69% improvement) for a cache miss, 6 seconds for a cache hit (79% improvement). These improvements are due to WAAS unique bandwidth and latency optimizations.

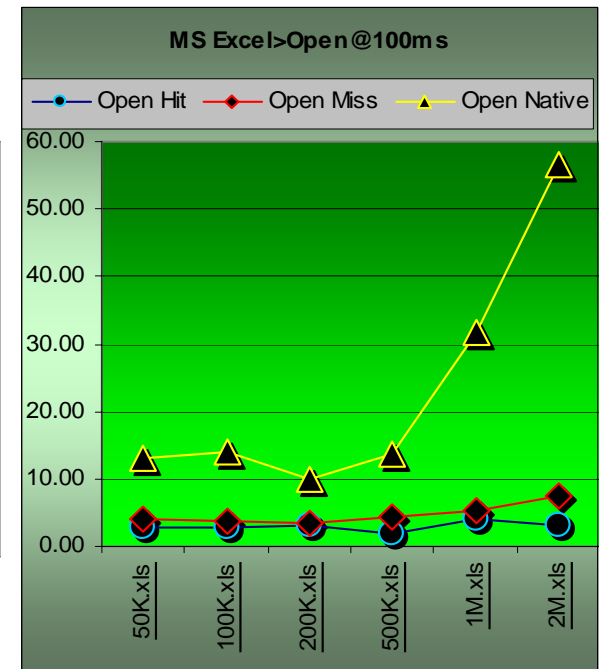
### Cisco WAAS results for opening Microsoft Word, PowerPoint, and Excel data files (All times are recorded in seconds) with EMC Celerra NS-702.



In the diagram above, Cisco WAAS reduces opening times considerably. The 50k Document takes 8 seconds to load normally but only 2 seconds on a cache hit (75% improvement). The 2MB document takes 20 seconds to open natively and only 3 seconds on a cache hit (85% improvement).



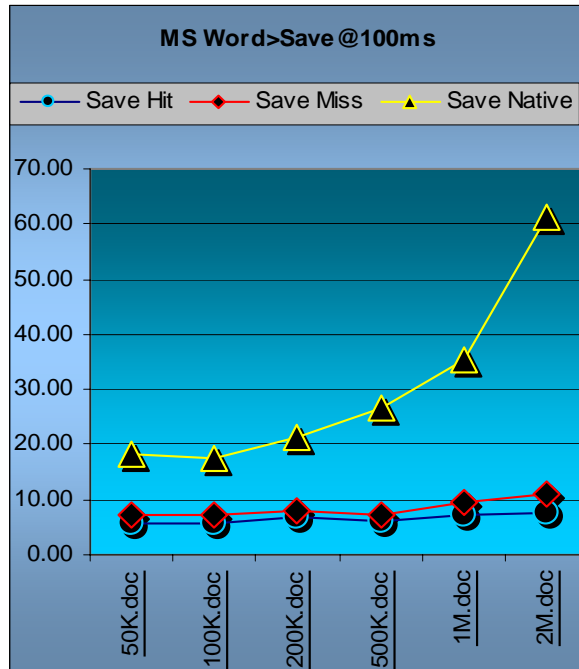
In the diagram above, time saved with a cache hit was roughly 6 seconds on a 50k PowerPoint file and closer to 13 seconds on a 2mb PowerPoint file. Cache miss was less beneficial with MS PowerPoint files but in some cases did save time.



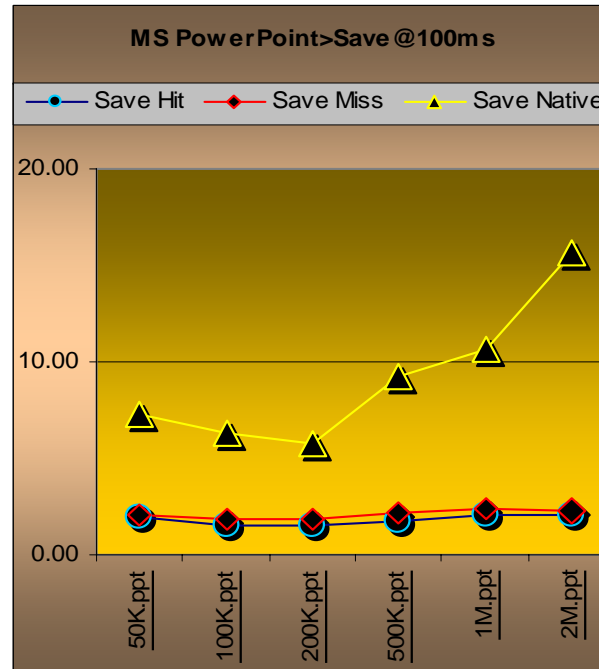
In the Diagram above we see that Cisco WAAS saves 10 seconds on the 50k MS Excel file and roughly 53 seconds on the 2mb MS Excel file. Even when the native 200k Xls file only took 10 seconds the cache hit and miss for that file were nearly 2 seconds a considerable improvement.

In these tests we use an EMC Celerra NS-702 as our backend storage. The purpose of these tests is to verify and prove that WAAS is beneficial regardless of the type of servers or storage used in the data center.

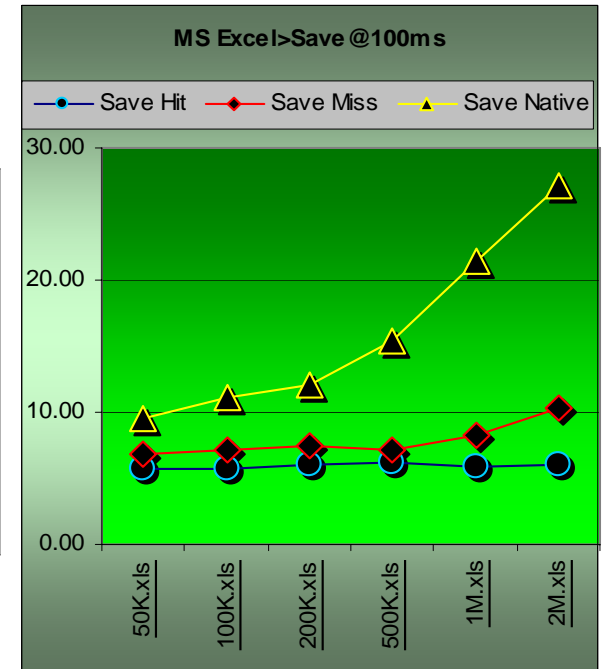
### Cisco WAAS results for saving Microsoft Word, PowerPoint, and Excel data files (All times are recorded in seconds) with EMC Celerra NS-702.



In the diagram above, we clearly see that performance improvements by Cisco WAAS grow as data files increase in size. With the 50k file the time saved was 13 seconds; however, as file size increased to 2Mb, the time saved was nearly 52 seconds (87% improvement).



In the diagram above you can see that the time saved with a cache hit was roughly 4 seconds on a 50k PowerPoint file and closer to 13 seconds on a 2mb PowerPoint file.

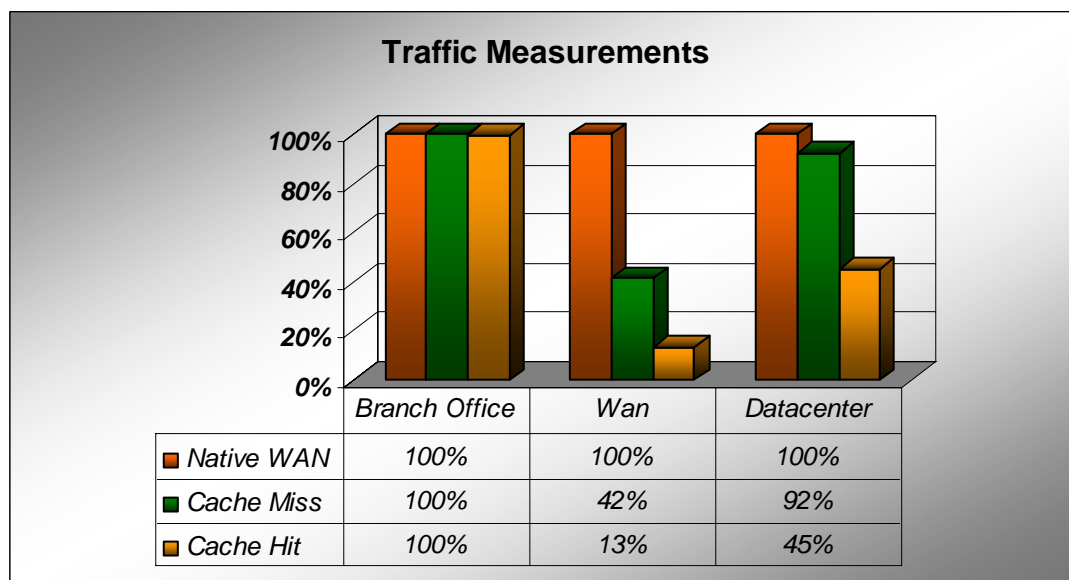


In the Diagram above we see that Cisco WAAS saves 5 seconds on the 50k MS Excel file and roughly 21 seconds on the 2mb MS Excel file.

VeriTest did cover and measure the times for closing the files but the times are not represented in this report. The majority of times measured were under one second, subsequently VeriTest determined that the data was not of relevance. The testing results for the saved times are included in the complete testing results matrix located at <http://www.lionbridge.com/lionbridge/en-US/services/outsourced-testing/competitive-analysis/cisco.htm>.

### Bandwidth Optimization:

VeriTest measured the amount of total traffic (inbound and outbound) generated during a single test run and compared it to the same test run without WAAS. The chart presents the amount of traffic measured in 3 segments: branch office LAN, WAN (router to router), and datacenter LAN. As seen, client LAN always receives 100% of the traffic, while based on the given optimization scenario, the WAN and datacenter LAN receive reduced amounts of traffic.



The results were truly impressive and showed significant improvement in bandwidth utilization across the WAN.

The chart above clearly shows that WAAS file services reduced the amount of traffic on the data center and WAN; up to 87% for the WAN and 55% for the datacenter. This increases the raw potential of the network allowing much more efficient utilization of the network bandwidth and the datacenter servers, thereby inherently improving server scalability. This also makes consolidated data more appealing because it lowers the threat of oversubscription in the data center.

### Conclusions

VeriTest found that Cisco WAAS solution for file services greatly increased performance for opening and saving changed Microsoft Office files such as Word, Excel, and PowerPoint.

VeriTest asserts that extensive testing and gathering of data proves that the technology behind the Cisco WAAS solution offers great benefits for companies seeking to consolidate their distributed file servers for cost reduction and data protection objectives. Cisco WAAS provided significant performance gains that varied by file type and size, but overall the benefit was substantial.

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In one example, opening a 2 MB MS Excel file over the WAN took 32.2 seconds, but took only 1.7 seconds to open using WAAS. In this case 30.5 seconds are saved (an improvement of 95%). This is a typical case that VeriTest believes is a good example of the benefits provided by the Cisco WAAS solution.

The WAAS solution provides efficiency of network utilization that will benefit companies by reducing network traffic in general, reducing the need for server proliferation, and enable consolidation of already-proliferated servers.

In the past if a company suffered from over subscribing a WAN connection, the only realistic solution would have been to increase the bandwidth of the WAN link or deploy additional servers. With Cisco's WAAS solution, there is now the option to reduce the traffic without reducing the company's productivity and consolidate the company's data to one centralized and secure location. TCO is a major concern for IT organizations and Cisco WAAS is a solution that helps lower TCO through file server centralization, while ensuring end-user performance expectations are met.

VeriTest found that the performance improvement was consistent when comparing the cache hit and cache miss against the native WAN numbers. VeriTest was impressed by how closely the cache hit and cache miss numbers scored in many of the tests. This proves that the primary benefit of the Cisco WAAS is much more than local file caching services, but rather leverages wide area file services in combination with robust network and application optimization.

VeriTest observed absolutely no data corruption, no application errors, and no protocol correctness problems during the test. The tests executed the opening, modifying, saving and closing of the test files over 1,300 unique times. Cisco WAAS did not sacrifice data integrity and correctness in exchange for reduced network load, nor did the Cisco WAAS solution risk data coherency. All data served by Cisco WAAS was an identical representation of the exact same data found on the data center file server.

With the Cisco WAAS solution, medium and large companies can expect to save considerable amounts of time for their employees and reduce the need for expensive branch-based file server and storage infrastructure.

## Legal

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VeriTest created the suite of industry-standard benchmark software that includes WebBench, NetBench, Winstone, and WinBench. We've distributed over 20 million copies of these tools, which are in use at every one of the 2001 Fortune 100 companies. Our Internet BenchMark service provides the definitive ratings for Internet Service Providers in the US, Canada, and the UK.

Under our former names of ZD Labs and eTesting Labs, and as part of VeriTest since July of 2002, we have delivered rigorous, objective, independent testing and analysis for over a decade. With the most knowledgeable staff in the business, testing facilities around the world, and almost 1,600 dedicated network PCs, VeriTest offers our clients the expertise and equipment necessary to meet all their testing needs.

For more information email us at [info@VeriTest.com](mailto:info@VeriTest.com) or call us at 919-380-2800.

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