Joint Cisco and VMware® Solution for Optimizing Virtual Desktop Delivery

Cisco Wide Area Application Services and Application Control Engine Optimize Delivery of VMware Virtual Desktop Infrastructure Across the Enterprise

Contents

What You Will Learn

Cisco® Wide Area Application Services (WAAS) and Cisco Application Control Engine (ACE) with VMware® Virtual Desktop Infrastructure (VDI) reduces the cost and complexity of managing desktops by optimizing virtual desktop delivery over the WAN while avoiding costly bandwidth upgrades.

- This jointly validated solution improves employee productivity by combining VMware VDI for virtualizing and centralizing desktops and Cisco WAAS for compressing and accelerating VMware VDI traffic and optimizing branch-office printing.
- Cisco WAAS increases the scalability and number of VMware VDI users supported over the WAN, and Cisco ACE improves availability and scalability of data center VMware VDI infrastructure.
- Enterprise business continuity is improved by reducing the time required for backup and replication of data center VMware VDI infrastructure.

Customer Challenges

Customers use desktop virtualization solutions such as VMware® VDI to replace traditional PCs with virtual machines that are managed from the data center to reduce operating costs, increase control of desktop management, and extend business continuity and disaster recovery to enterprise desktops.

However, when desktop virtualization solutions are deployed over the WAN, latency and bandwidth constraints limit the effectiveness of virtual desktop solutions. Customers face the following challenges in deploying virtual desktop solutions for the enterprise:

- Poor performance of display protocols over the WAN, affecting employee productivity
- High bandwidth consumption, increasing costs
- Limited scalability, reducing the number of users that can be supported
- Poor performance of centralized printing and increased costs of printing at the branch office
- Significant time and bandwidth requirements for backing up data center virtual desktop infrastructure for disaster recovery

Cisco WAAS Overview

Cisco WAAS is a comprehensive WAN optimization solution that accelerates applications over the WAN, delivers video to the branch office, and provides local hosting of branch-office IT services. Cisco WAAS allows IT departments to centralize applications and storage in the data center while maintaining LAN-like application performance and to provide locally hosted IT services while reducing the overall branch-office device footprint.

Cisco WAAS enables organizations to accomplish four primary IT objectives:

- Application acceleration: Improve productivity of remote employees.
- IT consolidation and WAN optimization: Reduce branch-office IT costs.
- Branch-office IT agility: Provide local branch-office IT services such as print without additional servers.
- Simplified data protection: Facilitate compliance and business continuity.

The Cisco WAAS solution provides application-specific acceleration and hosted services validated by application vendors, proven network integration that preserves existing network services and simplifies operations, and lower overall cost of ownership

Cisco ACE Overview

The Cisco ACE provides core server load-balancing services; application acceleration through server offloading; and security services to maximize application availability, performance, and security. The Cisco ACE is coupled with an innovative virtualized hardware platform, application-specific intelligence, powerful performance, and granular role-based administration. By delivering up to 16 Gbps of throughput and support for up to 4 million TCP connections, the Cisco ACE can handle large production environments and be partitioned for sharing across multiple environments.

Using the Cisco ACE, IT departments are better positioned to achieve the following business benefits:

- Improved application availability and scalability
- Cost reduction through virtualization
- Improved application performance using server offloading

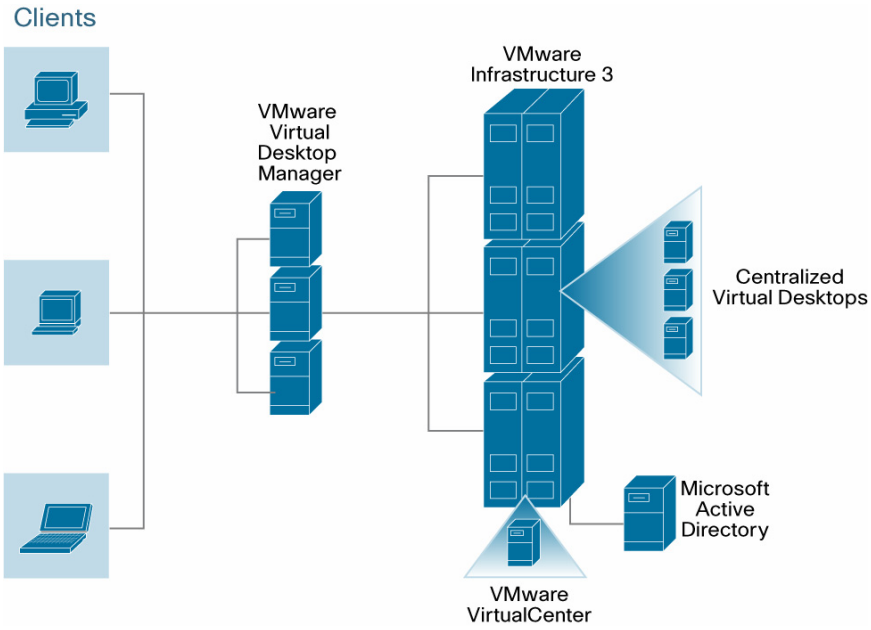
VMware VDI Overview

VMware VDI is an integrated desktop virtualization solution that delivers enterprise-class control and manageability. VMware VDI, built on VMware's industry-leading virtualization platform, provides an efficient and reliable environment for virtual desktops.

The VMware VDI solution includes the following components (Figure 1)

- VMware® Infrastructure 3 software, which provides a platform for hosting virtual desktops including the VMware ESX and VMware ESXi software
- VMware Virtual Desktop Manager (VDM), a desktop management server that securely connects users to virtual desktops in the data center and provides an easy-to-use web-based interface for managing the centralized environment
- VMware VDM Client, which runs on a windows PC and allows users to connect to virtual desktops through the VMware VDM. Clients can use Microsoft Remote Desktop Protocol (RDP) or the VMware VDM Client software.

Figure 1. VMware VDI Solution Components



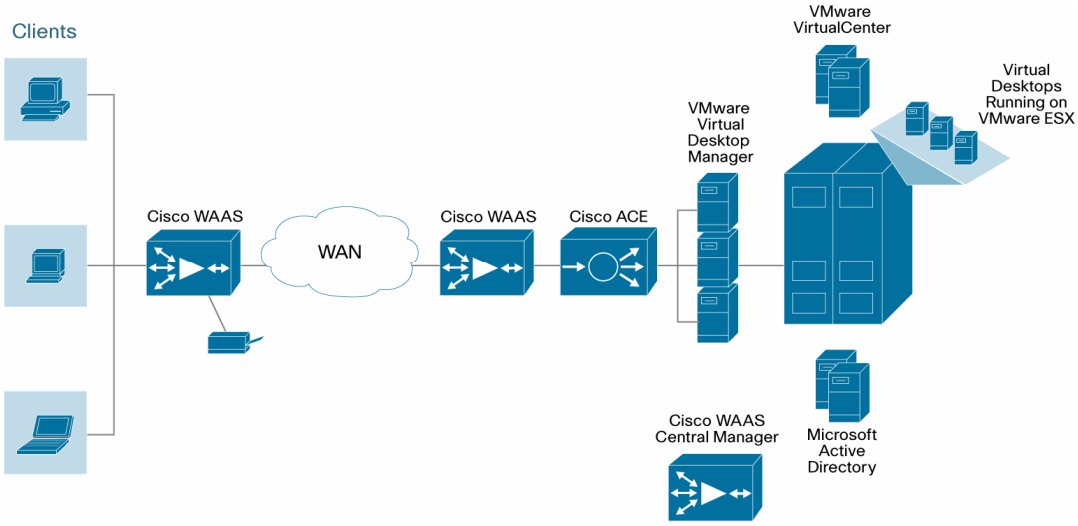
Joint VMware and Cisco Solution

The joint solution from VMware and Cisco for optimizing virtual desktop delivery consists of the following components (Figure 2):

- VMware VDI and VMware VDM, to virtualize and centralize desktops
  - The virtual desktops are hosted on VMware Infrastructure 3 ESX Server in the data center.
  - The VMware VDM Connection Server allows remote branch-office users to connect to their virtual desktops in the data center running on VMware ESX Server.
- Cisco WAAS, to accelerate virtual desktop performance, reduce bandwidth demands, and provide faster backup
  - Cisco WAAS, deployed on both sides of the WAN, optimizes display protocol traffic between the end users and the data center using a sophisticated combination of TCP optimizations that reduce the effect of the WAN, persistent session-based compression, and data redundancy elimination. Cisco WAAS is used to optimize display protocol delivery, including Microsoft RDP, the underlying protocol used by the current version of VMware VDM and currently the predominant protocol used by the various virtual desktop implementations (Figure 2).
  - The data center hosts the Cisco WAAS Central Manager, which is used to manage the Cisco WAAS solution from a central point.
  - The branch office Cisco WAAS appliance provides print services locally to the branch-office users by running Microsoft Windows print services.
  - Cisco WAAS can be deployed between data centers to optimize backup of VMware VDI for disaster recovery (not shown in Figure 2).

- Cisco ACE, to improve scalability and availability of data center VMware VDI
  - The Cisco ACE appliance provides load balancing among multiple VMware VDM Connection Servers, providing scalability and resiliency to the VMware VDI solution.
  - Cisco ACE is deployed in front of the connection managers.

Figure 2. Joint VMware and Cisco Solution for Virtual Desktop Delivery



Solution Benefits

The joint Cisco and VMware solution optimizes VMware VDI delivery dramatically, providing the following benefits:

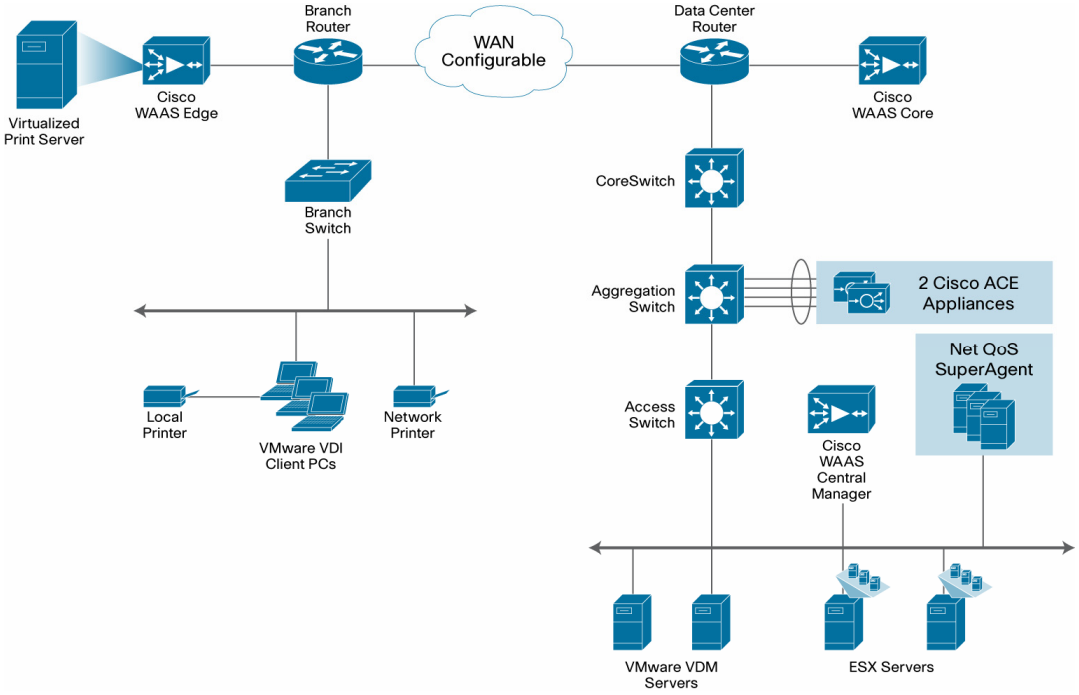
- Near-LAN performance for virtual desktops over the WAN, improving performance by 70 percent
- Increased scalability of VMware VDI clients, increasing the number of clients supported by 2 to 4 times, and massive scalability of VMware VDI and VMware VDM data center infrastructure
- 60 to 70 percent reduction in costly WAN bandwidth requirements
- Optimization of printing over the WAN by 70 percent, with the option of a local print server hosted on the Cisco WAAS appliance
- Improved business continuity by accelerating virtual image backup by up to 50 times and reducing bandwidth by more than 90 percent

Cisco and VMware recommend that customers use this jointly tested and validated solution to deploy optimized, scalable virtual desktop solutions to reduce infrastructure costs and improve management control.

Test Environment

Cisco and VMware have tested and validated the customer benefits of the joint solution. Figure 3 lists the main components of the test environment. A list of the equipment used is provided in the appendix.

Figure 3. Test Environment Topology



Test Design

To compare the behavior and performance of an optimized environment to that of the baseline VMware VDI session, several test scenarios and networking environments were tested.

WAN Simulation

The following two WAN settings were used, simulating typical enterprise settings:

- Small branch office with a T1 link (1.5 Mbps), and a round-trip time (RTT) of 100 milliseconds (ms)
- Regional office with a higher connection speed of 10 Mbps and a RTT of 50 ms

Application Tests

To get a clear understanding of the performance for various types of applications, the following sets of tests were conducted:

- **Internet browsing:** In these tests, several websites were accessed and browsed; tests were conducted on a variety of sites ranging in the amount of graphical content and animation.
- **Email and collaboration:** In these tests, using Microsoft Outlook, corporate mail accounts were accessed, and several typical activities such as opening new email messages, including some with attachments; browsing the calendar and contacts; and creating new content were tested.

- **Microsoft Office:** In these tests, Microsoft Office applications were tested by opening various Word, PowerPoint, and Excel documents; viewing presentation slideshows; creating new documents, and viewing the graphs on an Excel spreadsheet.
- **File transfers:** Because users in VMware VDI environments are remote from the files on their desktops, file transfers from the virtual desktop to end users' detachable drives such as USB drives were tested.
- **Printing:** In VMware VDI environments, the virtual desktop and the printer are separated by the WAN, so various print configurations were tested, with the print server at the data center and at the branch.

Workload Generation

To replicate real-life environments, simulated traffic of multiple VMware VDI workers was generated. Multiple client connections were generated through AutoIT scripts. The operations conducted by the simulated users included all the tests mentioned in the preceding list with the exception of file transfers and printing. To help ensure the realism of the simulated VMware VDI users, several randomizations were introduced:

- Random selection of the test order
- Random selection of the file, site, or email viewed or browsed for any given test
- Random selection of whether an operation includes modification of content or just review of content
- Random spacing of the time between operations

Optimization Configuration

To optimize the display protocol traffic, the underlying protocol's encryption and compression were disabled.

Microsoft RDP is the underlying protocol used by the current versions of VMware VDM and is currently the predominant protocol used by the various VDI implementations.

To disable encryption on RDP, the settings on the virtual desktop were changed. The changes are made either through group policy settings or through changes to the registry; both methods can also be distributed to large groups of virtual desktops using Active Directory. To disable compression, the settings on the VMware VDM client were modified; these settings are configured through group policy and thus can be easily deployed to large groups of clients using Active Directory.

For more detailed information, see the Cisco WAAS VMware VDI deployment guide

Test Results

For each metric tested, such as application performance, bandwidth consumed, scalability, and print optimization, baseline measurements using native protocol compression were first taken and then compared to performance with Cisco WAAS turned on (and native protocol compression turned off). For every metric tested, Cisco WAAS optimizes the display protocol substantially.

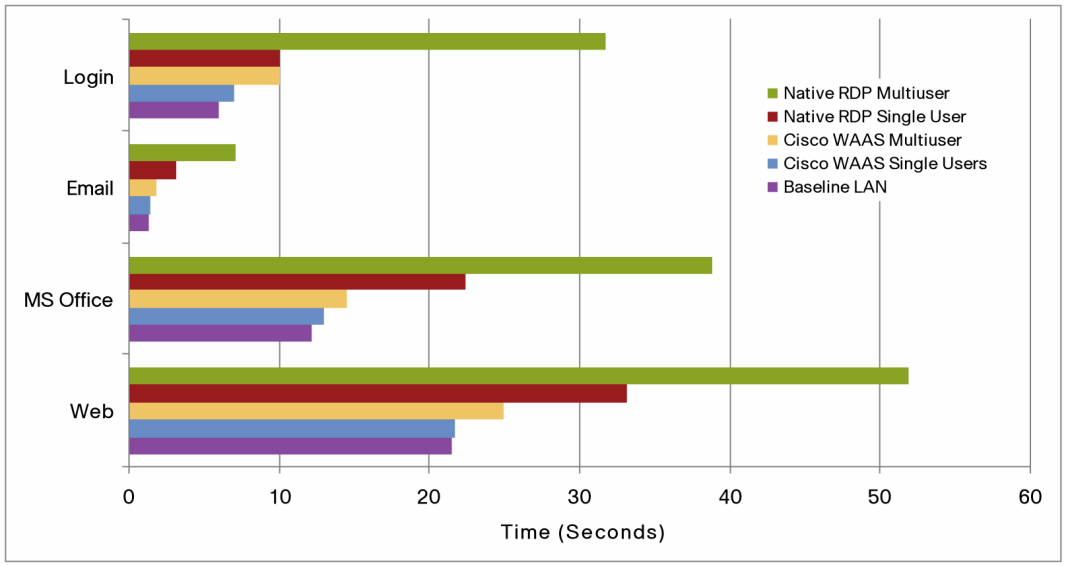
Performance Acceleration

Cisco WAAS improves display protocol performance by 70 percent, providing a near-LAN user experience.

Performance of various applications when using VMware VDI was tested, and the time taken to complete tasks such as logging in to the virtual desktop, opening Microsoft Outlook, and viewing a PowerPoint slideshow was measured (Figure 4).

- Using Cisco WAAS, the time required to complete the tasks of the various applications was reduced by up to 70 percent, both when comparing a single user and when comparing multiple VMware VDI users.
- The performance achieved by Cisco WAAS optimized VMware VDI sessions is within a small deviation from LAN performance, even when there are additional users on the WAN.

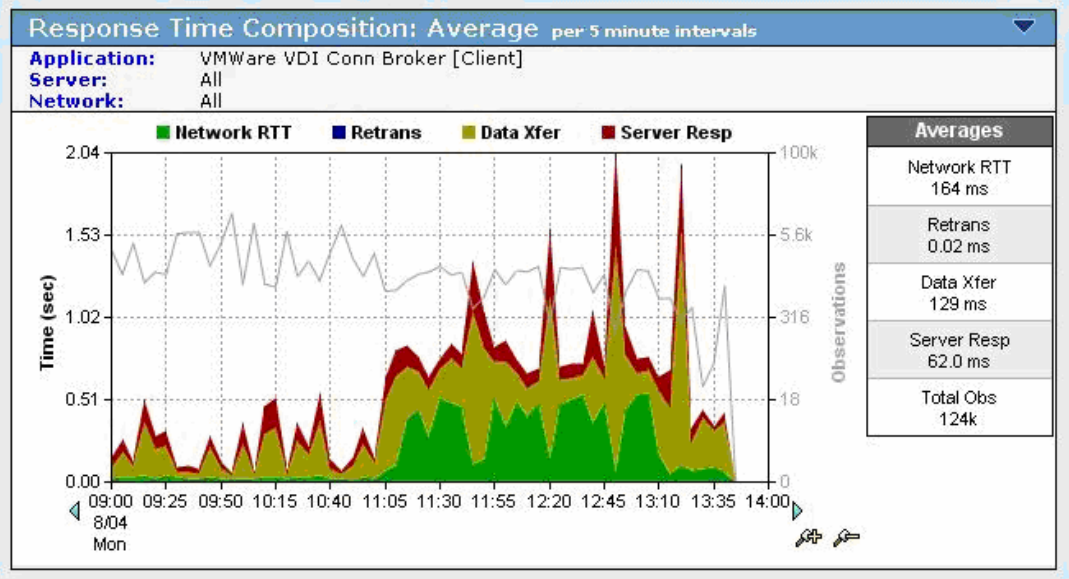
Figure 4. Task Completion at 1.5 Mbps Upstream and Downstream and 100-ms RTT



The tests also measured the aggregate application performance information available from NetQoS, as provided by the NetQoS devices, and Cisco WAAS integrated SuperAgent.

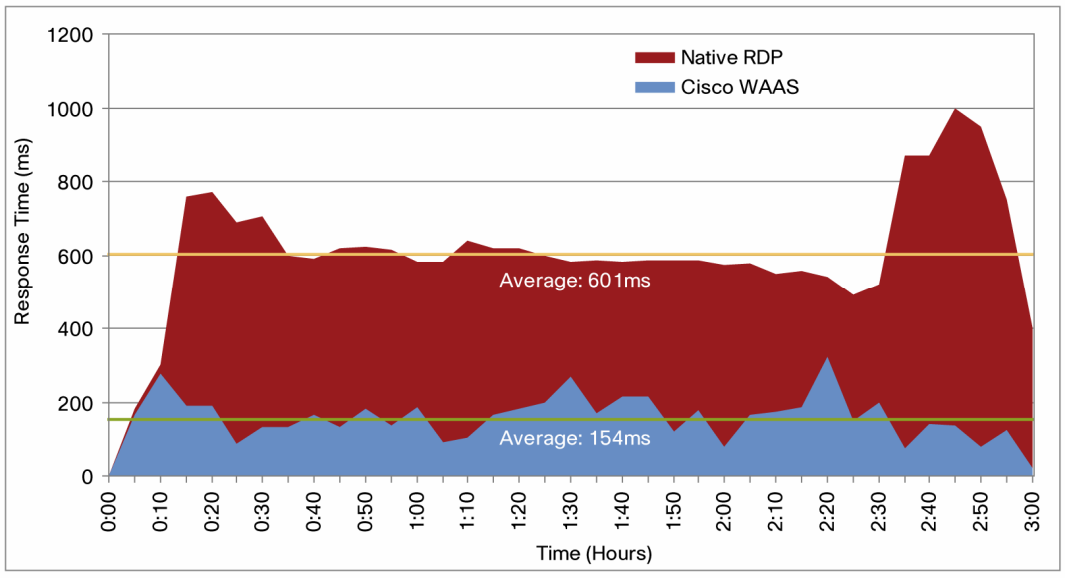
The response time as measured at the VMware VDM Connection Server for a single user was reduced by 4 to 6 times when optimized by Cisco WAAS (running 9 a.m. to 11 a.m.) as compared to native VMware VDI (running 11 a.m. to 1:40 p.m.) (Figure 5).

Figure 5. NetQoS Response-Time Analysis: Single User



The response time measured at the remote branch office during a test of 15 simultaneous VMware VDI sessions shows a 4-times improvement. Cisco WAAS acceleration results in an average response time of 154 ms, and native VMware VDI results in an average response time of 601 ms. (Figure 6).

Figure 6. Response-Time Analysis: Multiuser



Bandwidth Optimization

Cisco WAAS reduces bandwidth demand by 60 to 70 percent, reducing WAN bandwidth costs.

In the traffic reduction tests, the bandwidth consumed by VMware VDI traffic over the WAN was measured for the baseline with native protocol compression and then compared to tests using Cisco WAAS (Figure 7).

Figure 7. Traffic Reduction Tests

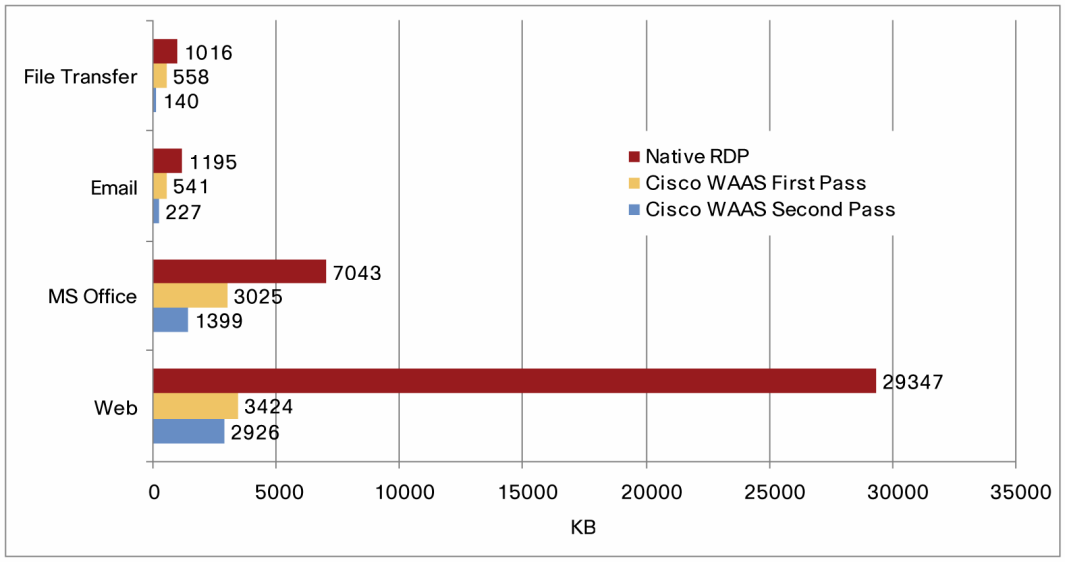
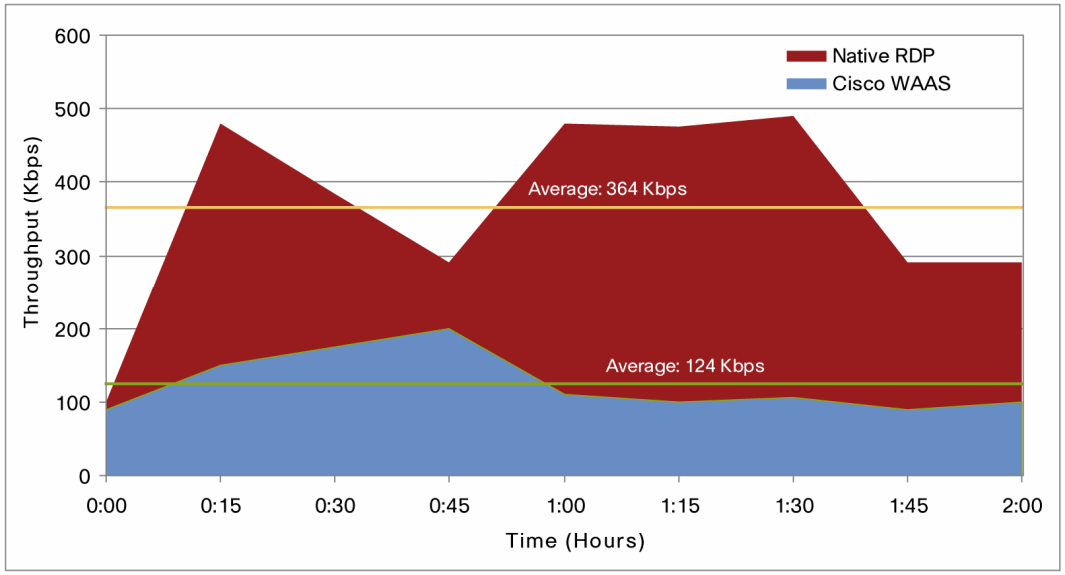


Figure 7 shows the traffic reduction achieved while running the application tests cases. These results show that the traffic reduction ranged from 54 percent to more than 90 percent, with an average reduction of 67 percent on the first pass and 84 percent on the second pass. The file transfer results refer to file copying from the virtual desktop to a detachable drive connected to the client machine.

The traffic generated for a realistic single simulated VMware VDI session for a duration of 2 hours was compared before and after Cisco WAAS optimization. The average bandwidth per simulated session was reduced by 66 percent by using Cisco WAAS (Figure 8).

Figure 8. Simulated User Throughput over 2 Hours



The results shown here reflect the superior compression capability of the Cisco WAAS data reduction engine, which outperforms the native protocol compression for the entire duration of the testing and, through reduction of repetitive data, reaches peaks of more than 90 percent compression.

Scalability of Number of Users

Cisco WAAS increases the number of users that can be supported on a given network by 2 to 4 times.

Cisco WAAS acceleration and data reduction technologies work together to increase the scalability of VMware VDI solutions. RDP tries to adjust to bandwidth and latency constraints by reducing the quality of the session, and as seen in the results of the multiuser tests, this adjustment causes a substantial decline in the session quality, yielding a user experience up to 10 times worse than the LAN experience (Figures 9 and 10).

Figure 9. Effect of Additional Users on Session Response Time

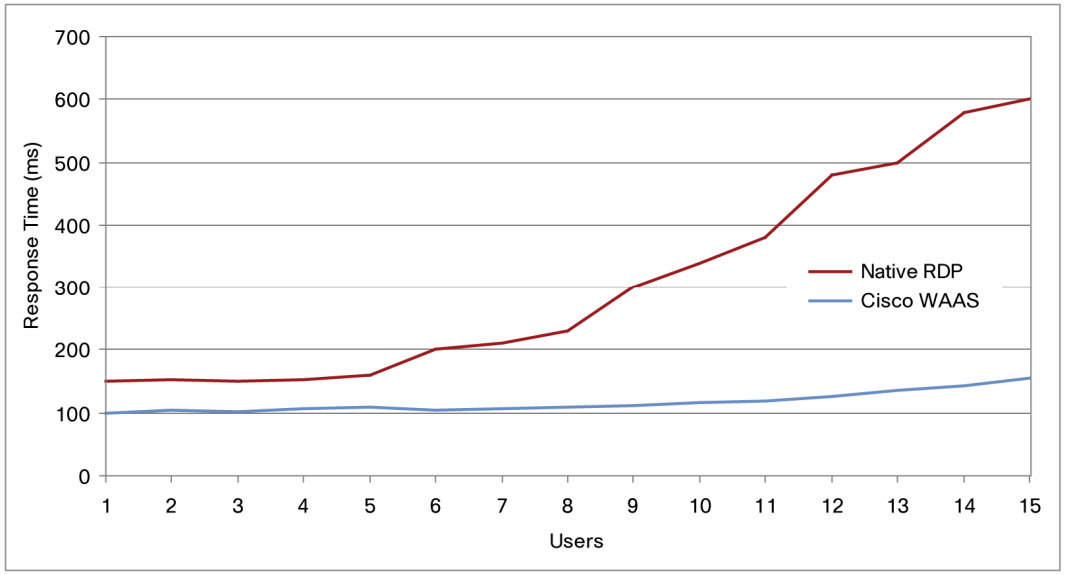
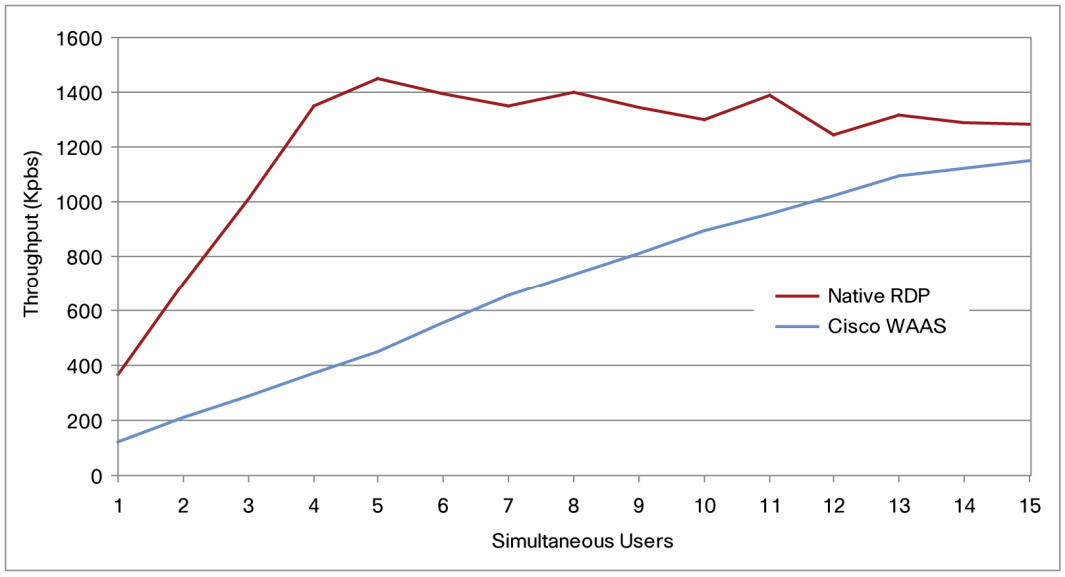


Figure 10. Effect of Additional Users on Throughput



Figures 9 and 10 show the results of the measured response time on the branch-office network and throughput when users are added to a 1.5-Mbps, 100-ms RTT WAN link.

- With the native protocol, degradation in session quality started with as few as six users on the network, and at nine users the system was almost unusable, with a measured response time of nearly 300 ms, or 3 times worse than for a single user over the WAN.
- With Cisco WAAS optimization, users can be added to the network with minimal negative effect, thus enabling up to 4 times more sessions on the same network, with exceptional responsiveness and the same user experience as a single user.

- The throughput results (Figure 10) may seem counterintuitive, but they reflect the poor quality for the native protocol with increasing numbers of users. The decreased throughput is due to RDP's built-in algorithms, which reduce session quality. Some of the mechanisms used include reduction in the number of screen refreshes, which tends to produce a work experience that is choppy and not user friendly.

Printing with VMware VDI

Cisco WAAS optimizes printing by 70 percent and provides a branch-office print server option without the use of additional servers.

Even as desktop machines are migrated to the data center, users still need to print on printers that are in the remote branch office. Because of the requirements of print spools, which can be as much as 10 times the raw data, printing has to be carefully designed in VMware VDI environments. Deployment considerations for printing in VMware VDI environments include:

- **Location of the print server:** The print server (print spooler) can be located at either end of the WAN: in the remote branch office or in the data center.
- **Method of printing:** Two methods can be used:
  - **Direct printing:** The printer is defined on the virtual desktop and sends the print job directly to the spooler. Depending on the location of the print server, either Common Internet File System (CIFS) or RAW/PostScript printing traffic is sent across the WAN.
  - **RDP printing:** The printer is defined on the client machine and is virtualized by RDP on the virtual desktop. In this scenario, a print job is first sent to the client machine using RDP and then sent by the client computer to the spooler. If the print server is located in the data center, CIFS and RAW/PS print traffic are sent across the wire.

Cisco WAAS provides optimizations for all VMware VDI print environments, both centralized and local:

- **Centralized printer:** Cisco WAAS includes printing-specific optimizations, data reduction, compression, and TCP optimizations to provide dramatic improvements.
- **Branch-office print server:** Cisco WAAS provides a virtualized Windows print server on the Cisco WAAS appliance, providing a print server in the branch office without the need for additional servers.

Table 1 shows the results of printing a 10-page Microsoft Word document over a T1 line with a latency of 100 ms.

Table 1. Results of Printing a 10-Page Microsoft Word Document

Action	Baseline	With Cisco WAAS
Local printer on client using RDP	50.1 sec/3.67 MB	16.1 sec/1.6 MB
Data center print server		
RDP printing	287.1 sec/10.8 MB	62.6 sec/1.1 MB
Direct printing	140.1 sec/3.62 MB	94.3 sec/556 KB
Branch-office print server (virtualized Microsoft Windows print server on Cisco WAAS)		
RDP printing	42.5 sec/2.22 MB	22.1 sec/1.53 MB
Direct printing	520.7 sec/20.17 MB	21 sec/546 KB

As Table 1 shows, Cisco WAAS greatly enhances the printing experience in every configuration by reducing the amount of bandwidth required to perform the print job, averaging 70 percent traffic reduction and reaching peaks of 97 percent, while completing the print job 3 to 25 times faster.

Backup and Virtual Desktop Image Transfers

Cisco WAAS accelerates transfer of virtual desktop images by 50 times.

To facilitate enhanced deployments and management of a VMware VDI deployment, virtual machine images must periodically be transferred and backed up across the WAN.

Figure 11. Transfer of Virtual Machine Image

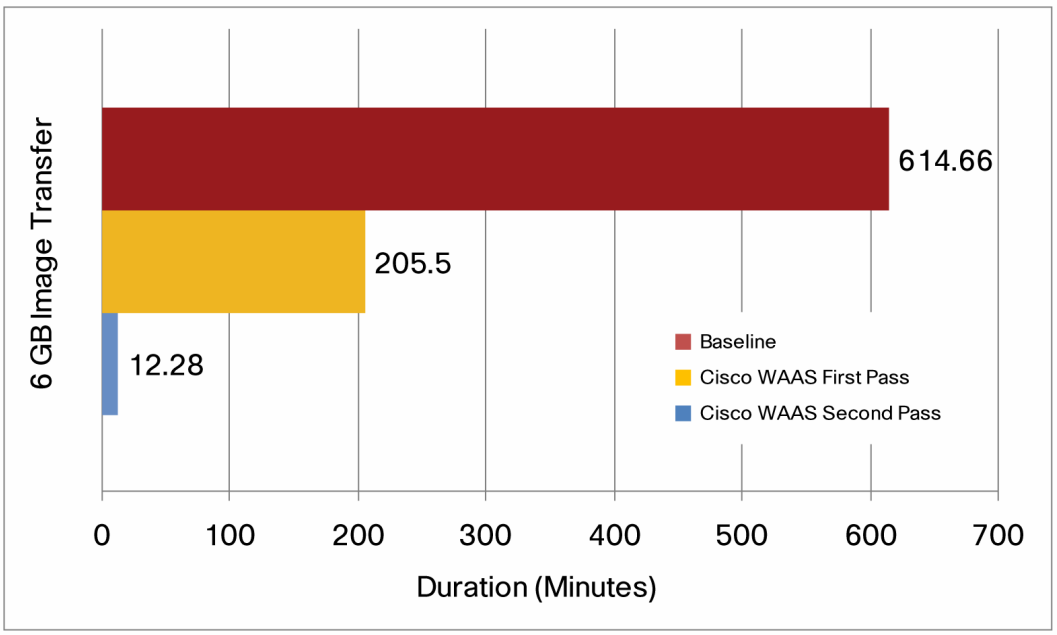


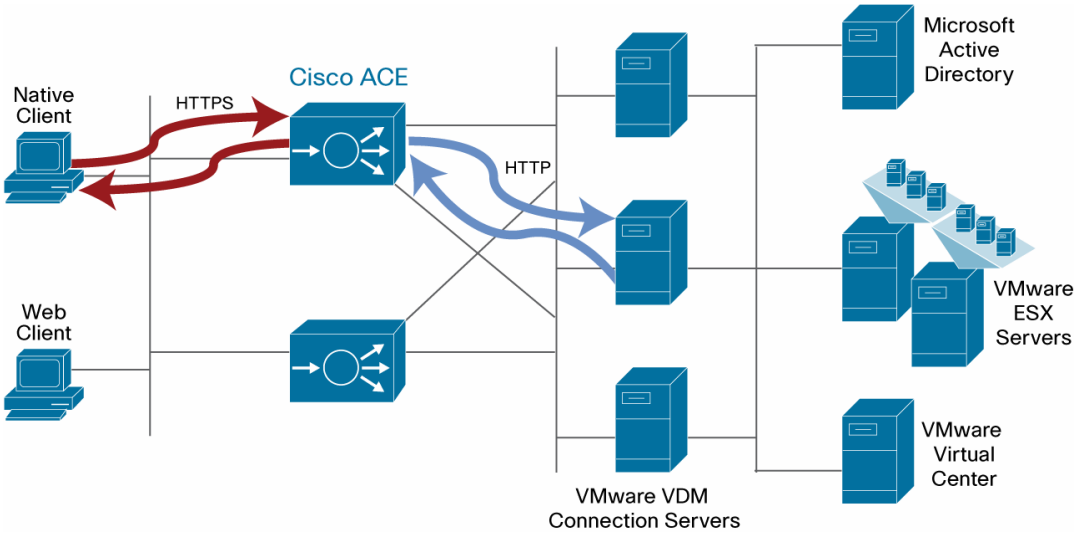
Figure 11 shows the results of transferring a 6-GB virtual machine image for a Microsoft Windows XP desktop using the VMware Network File Copy (NFC) Protocol and achieving a 3-times faster transfer on the first transfer and 50-times faster transfer on the second transfer.

Data Center Scalability Using Cisco ACE

Cisco ACE improves the scalability and availability of VMware VDM connection servers at the data center.

To address VMware VDI scalability and fault tolerance, typical VMware VDI deployments include multiple VMware VDM Connection Servers, as shown in the topology in Figure 12.

Figure 12. Cisco ACE for Load Balancing VMware VDM



The VMware VDM servers are installed in a primary-and-replica manner, with the first acting as the primary server and the subsequent servers as duplicates. The VMware VDM servers provide session management and handle all incoming requests, directing them to the appropriate virtual desktops.

Deploying Cisco ACE to load balance incoming user requests to any available VMware VDM Connection Servers greatly enhances the scalability and resilience of VMware VDI. By using health checks, probes, and monitoring capabilities, Cisco ACE determines which of the available VMware VDM servers is best suited to handling a new client connection and uses a stateful redundant active-standby design that replicates connection and persistence information to the standby server and provides instant application service failover.

In addition, VMware VDM deployments that use HTTPS can benefit from Cisco ACE Secure Sockets Layer (SSL) offloading capabilities, which free more CPU resources for the VMware VDM servers to support larger deployments.

Security Considerations

The Cisco and VMware solution secures and accelerates virtual desktop delivery to the branch office.

VMware VDM enables HTTPS encapsulation of the remote desktop protocol used (in the current version, this is Microsoft RDP) and SSL encryption of the VMware VDI traffic, which can greatly increase the overall security of the VMware VDI deployment.

Microsoft's native encryption is an RC4 encryption with a key of 54 to 128 bits, which is considered weak and can be exploited using man-in-the-middle attacks (such as Cain and Abel).

Though some enhancements, such as Federal Information Processing Standards (FIPS) encryption, were recently introduced by Microsoft's latest release, RDP 6.1, they are limited to Windows Server and available in Windows Vista as a self-signed option and thus cannot be considered for large-scale security-conscious VMware VDI deployments.

As of Cisco WAAS Software Release 4.1, full HTTPS optimization is available and can provide the best combination of security and performance.

The test results for HTTP- and HTTPS-based VMware VDI were nearly identical, providing the same substantial reductions in bandwidth consumption and enhanced performance as depicted in the results described previously in this document.

Conclusion

Cisco and VMware have worked together to deliver this joint solution, collaborating on lab setup, solution testing, and validation of test results. Cisco and VMware jointly validate that the lab setup and solution testing represent best efforts in creating a realistic customer deployment and accurate documentation of such deployment.

Cisco and VMware intend to continue to enhance this partnership to develop joint solutions for optimizing virtual desktop delivery in the enterprise.

The joint Cisco and VMware solution optimizes VMware VDI delivery dramatically, providing the following benefits:

- Near-LAN performance for virtual desktops over the WAN, improving performance by 70 percent
- Increased scalability of VMware VDI clients, increasing the number of clients supported by 2 to 4 times, and massive scalability of VMware VDI and VMware VDM data center infrastructure
- 60 to 70 percent reduction in costly WAN bandwidth requirements
- Optimization of printing over the WAN by 70 percent, with the option of a local print server hosted on the Cisco WAAS appliance
- Improved business continuity by accelerating virtual image backup by up to 50 times and reducing bandwidth by more than 90 percent

Cisco and VMware recommend that customers use this jointly tested and validated solution to deploy optimized, scalable virtual desktop solutions to reduce infrastructure costs and improve management control.

For More Information

- Cisco Application Networking Services for VMware: http://www.cisco.com/go/optimizevmware
- Cisco Application Networking Services: http://www.cisco.com/go/applicationservices
- Cisco Application Networking partner portal: http://www.cisco.com/go/optimizemyapp
- Cisco WAAS Software product information: http://www.cisco.com/go/waas
- Cisco ACE product information: http://www.cisco.com/go/ace
- VMware virtual desktop product information: http://vmware.com/products/desktop_virtualization.html
- VMware VDI product information: http://vmware.com/products/vdi/

Appendix: Test Equipment

VMware ESX Servers

- Server hardware
  - HP DL380-G5
  - Processor: 4 Intel Xeon 3-GHz processors
  - Memory: 4 GB
  - VMware ESX Server Version 3.5.0, Build 64607
- Virtual desktop configuration:
  - CPU: Single virtual CPU
  - Memory: 696 MB
  - Virtual disk: 8 GB
  - Guest operating system: Either Windows XP Professional or Windows Vista Business
  - Installed software: Microsoft Office 2003, Adobe Reader, and Adobe Flash Player
  - VMware VDM Agent Version 2.1.0, Build 596

VMware VDM Servers

VMware VDM Server Version 2.1.0, Build 596

NetQoS

- NetQoS SuperAgent Master Console Version 7.2, Build 28
- NetQoS SuperAgent Aggregator Version 7.2, Build 28
- NetQoS SuperAgent Collector Version 7.2, Build 28
- NetQoS Report Analyzer Version 8.0, Build 34

Cisco WAAS

- Data center:
  - Appliance: Cisco WAE-7341 Wide Area Application Engine
  - Software: Cisco WAAS Software Release 4.1.1
- Remote branch office:
  - Appliance: Cisco WAE-674 Wide Area Application Engine
  - Software: Cisco WAAS Software Release 4.1.1
- Central manager
  - Appliance: Cisco WAE-612 Wide Area Application Engine
  - Software: Cisco WAAS Software Release 4.1.1

Cisco ACE

Cisco ACE 4710 with version 3.0(0)A3(1.0)

WAN Simulator

Software: WAN bridge Live CD Version 1.07

Printer

HP LaserJet 4000

Client Server

- Processor: Intel Xeon 3.4-GHz processor
- Memory: 4 GB
- Operating system: Windows 2003 Release 2 with Service Pack 2 (terminal server)
- VMware VDM Client Version 2.1.0, Build 596

For more information, visit: **www.vmware.com**

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