Cisco Application Networking for Citrix Presentation Server

Faster Site Navigation, Less Bandwidth and Server Processing, and Greater Availability for Global Deployments

What You Will Learn

To address challenges associated with today's business-critical enterprise application deployments, Cisco®, in conjunction with Citrix®, offers Cisco Application Networking for Citrix Presentation Server, an enterprise network architecture with best practices and implementation guidance that optimizes application availability, performance, and security and lowers application ownership costs.

Enterprise IT organizations are challenged with the task of centralizing distributed server infrastructure to meet the need to maintain compliance, improve data protection, and control costs without compromising the productivity and experience of the remote office user. Citrix Presentation Server enables IT organizations to provide desktop functions and specific applications to remote users through a terminal connection to a Citrix server within a server farm in the data center.

Citrix enables server consolidation, as it is possible to run all applications on remotely accessible Citrix servers, including Microsoft Office and Outlook, Web browsing, and enterprise applications. Each Citrix user consumes a significant amount of WAN bandwidth, saturating heavily utilized WAN links. Accessing applications that are rich in content over the WAN, where high latency, packet loss, and low bandwidth are common constraints, creates performance challenges for end users and can quickly overwhelm the WAN infrastructure.

A primary challenge for such architecture is performance. A graphically intensive application (as most are when presented using a GUI) being served over a slow network connection requires considerable compression and optimization to make the application usable by the client. The client and server machines may be different platforms; hence, the client may not have GUI routines available locally, in which case, the server must send the actual bitmap data over the connection. To date, such challenges have been met with only partial success, which may be why the widely predicted switch to an application server model over the Internet has not yet occurred.

Each transaction, when requested by a remote user, must travel over the WAN, which introduces network delay that slows end-user performance. When network delay is significant due to constrained or overburdened bandwidth, distance of users to servers, or a high number of steps to complete a transaction, end-user performance and bandwidth utilization improvement can be achieved through technologies such as data redundancy elimination (DRE), TCP flow optimization (TFO), and compression.

Citrix environments do not usually have print services in the remote office; however, most remote offices include printers and have users who require local printing capabilities. Therefore, every time a document is printed within a Citrix client session, the rendered document print job is spooled over the WAN through the terminal session and then sent back from the data center to the user's local printer. A spooled print job is often 10 times the size of the original document, and thus many Citrix client users have a significant portion of their WAN link bandwidth consumed by highly redundant

print traffic.

This document shows how Cisco Application Networking for Citrix Presentation Server addresses the following business challenges for Citrix Presentation Server deployments through data center and WAN application optimization services from the Cisco Application Control Engine (ACE) and Wide Area Application Services (WAAS) Software products:

- Application response time and bandwidth utilization over limited WAN connections
- Reduced capital and operating costs for applications, servers, and networking
- Recovery time and point objectives for business continuity
- Application, server, and network security

The solution uses Cisco WAAS to provide performance benefits on the WAN and Cisco ACE to reduce resource load on the servers. Individually, Cisco WAAS and ACE provide a unique benefit to the solution, and when used in conjunction as the solution becomes more complex, they provide additional gains.

Cisco ACE reduces resource load on the servers load balancing the data that is bound for the servers. Cisco ACE also provided TCP reuse functions. TCP reuse reduces load on the server CPU by reducing the number of TCP sessions that must be processed by the server.

Cisco WAAS provides performance benefits to Citrix Presentation Server by optimizing the traffic flowing across the WAN and caching data at the local Cisco WAAS device. The cached data reduces the amount of traffic flowing across the WAN and allows more transactions to occur by utilizing the recovered bandwidth.

Specific tests of this solution show site navigation up to 8.7 times faster, bandwidth utilization up to 32% less, and up to 27% more transactions for Citrix Presentation Server deployments when paired with Cisco Application Networking solutions.

Business Challenge

In today's globally networked economy, enterprise application availability and performance are tightly linked to business success and profitability, and as a result application stakeholders are faced with new challenges. As applications are enhanced to automate new business processes and serve geographically dispersed user populations, increased complexity can affect service level and productivity. To serve a geographically diverse user base and reduce the cost of deployment, enterprise application deployments are likely to be run from a regional data center. This architecture intensifies four major IT challenges, each of which can be addressed by a strong enterprise network architecture using Cisco Application Networking for Citrix Presentation Server:

- Application availability challenges: Increasing business dependence on fewer but larger applications deployed in a central location requires a more careful look at application architecture, including single points of failure and product stability, to achieve recovery time and point objectives.
- Application performance challenges: Limited WAN links and inefficient standard Internet protocols such as HTTP and Extensible Markup Language (XML) result in poor application performance and bandwidth utilization for global users. In addition, increased demand on large applications in centralized data centers results in overload on servers that slows application response time.

- Application security challenges: Significantly increased business risk results from application security breaches from malicious or innocent end users or service-oriented architecture (SOA) Web service requests that attack application, server, or operating system vulnerabilities.

- Application ownership cost challenges: The increasing scope of application business logic and geographically and organizationally dispersed users, coupled with higher availably, performance, and security needs, requires a new approach to application support to keep costs in line with lean budgets.

Given these significant challenges, it is increasingly important to turn to application-savvy infrastructure vendors, such as Cisco, whose solutions cost-effectively address today's business-level application and IT challenges, and who are committed to rigorous feature and system quality testing and global and local language support 24 hours a day and have a strong history of security expertise. (See Table 1.)

Table 1. Application-Savvy Infrastructure Vendor Requirements for Today's Enterprise Application Deployments

Requirements
• Strong application optimization solutions • Minimized application ownership costs • Rigorous feature and system quality testing • Global and local language 24-hours-a-day support • Outstanding security history and experience • Strategic partnerships with application vendors

Equally important is an application infrastructure vendor that partners with leading application vendors, such as Citrix, to yield tested, documented, and validated joint architectures that optimize application availability, performance, and security and lower application ownership costs.

Business Benefits

The Cisco Application Networking for Citrix Presentation Server solution offers optimized application availability, performance, and security and reduced deployment costs by providing application optimization services as described here.

Citrix Presentation Server Application Availability
Cisco ACE application optimization services for high availability:

- Cross–data center load balancing: Efficiently routes end-user and Web services requests to the best available data center

- Application health monitoring: Continuously and intelligently monitors application and database availability

- Server load balancing: Efficiently routes end-user and Web services requests to the best available server

- Network platform health monitoring: Helps ensure continuity of business operations through mirroring of end-user transaction states across pairs of network devices

Citrix Presentation Server Application Performance

Cisco ACE and WAAS application optimization services for high performance:

- WAN optimization: Provides intelligent caching, compression, and protocol optimization that yields faster downloads, faster site navigation, and reduced bandwidth usage
- Server offloading: Provides specialized hardware that offers greater processing efficiency for the application optimization services listed in Table 2, freeing application server processing and memory to focus on business logic computations

Table 2.   Services Offloaded from Servers by the Solution

Service	Description
Cross–Data Center Load Balancing	Provides site selection capability
Server Load Balancing	Shares load across available servers
TCP Connection Management	Reduces number of TCP connections to server
Application Health Monitoring	Helps ensure validity of server requests
Traffic Compression	Scales throughput
Object Caching	Reduces number of requests to server

Citrix Presentation Server Application Security

Cisco ACE application optimization services for optimized data security:

- End-user access control: Provides access control lists (ACLs) to protect client-to-server traffic from worms and intruders that attack vulnerable open server ports not used by the application

Citrix Presentation Server Ownership Cost

Cisco Application Networking for Citrix Presentation Server reduces application capital and operating costs through the following:

- Server cost reduction: Offloading of the application optimization services listed in Table 2 from servers to cost-effective network devices frees server processing and memory, allowing resources to focus on business logic computation.
- Networking cost reduction: Virtualization of application optimization services supplies the services listed in Table 2 for multiple Citrix Presentation Servers as well as other enterprise applications.
- Operational costs reduction: Application optimization services reduce operating costs as shown in Table 3.

Table 3.   Operating Cost Reduction from Application Optimization Services

Cost Reduction	Description
WAN Bandwidth Usage	Significant reductions in bandwidth usage
Server Power, Cooling, Space, and Administration	Increased cost savings
Application Deployment Administration	Up to 250 virtual application services

Solution

Cisco Application Networking for Citrix Presentation Server combines the Cisco ACE and WAAS platforms with the Citrix Presentation Server architecture to provide optimized availability, increased performance, and reduced cost of ownership.

Citrix Presentation Server with Cisco ACE

Within the Citrix Presentation Server architecture, scaling to handle more end users requires the addition of Citrix Presentation Server application server instances, which creates a need for load balancing. Cisco ACE provides server load balancing in addition to end-user access control, server health monitoring, and TCP connection management.

Virtualization within Cisco ACE allows a single active-active pair of Cisco ACE products to serve multiple Citrix Presentation Server applications as well as other enterprise applications. Also, if Cisco ACE is already deployed in the data center, additional virtualized contexts can be added to accommodate new Citrix applications without the need to order and configure additional equipment.

Additionally, Cisco ACE virtualized contexts can be created using Cisco ACE role-based access control (RBAC), which constrains the commands and actions for unique application, database, security, and systems management administrators. Cisco ACE comes prepackaged with a number of predefined roles, and others can be customized as needed. Cisco ACE also provides server load-balancing session persistence for Citrix Presentation Server through the source IP sticky methodology.

Citrix Presentation Server with Cisco WAAS

Cisco WAAS is a multilayer application acceleration and WAN optimization solution that improves application performance over the WAN. Optimization for Citrix and its associated protocols is achieved through the following Cisco WAAS features:

- TFO: TFO provides standards-based, field-proven throughput improvement for TCP-based applications while maintaining packet-network friendliness and safe coexistence with other network nodes communicating using standard TCP implementations. TFO terminates TCP sessions locally and transparently optimizes flows that traverse the WAN, thereby shielding communicating nodes from WAN conditions. TFO includes the following components, each providing specific acceleration for Citrix services:
  - Large initial windows: Citrix client connections quickly exit the TCP slow-start phase and enter congestion avoidance, thereby allowing a quicker increase in Citrix throughput.
  - Window scaling: Cisco WAAS transparently increases the window capacity of optimized TCP connections to allow more data to be in transit, thereby improving Citrix throughput.
  - Advanced congestion handling: Through intelligent handling of congestion scenarios, Cisco WAAS can efficiently retransmit lost data when necessary and quickly return to higher levels of throughput on the network, resulting in better Citrix client-server and application performance.
- DRE: DRE is an advanced form of network compression that allows Cisco WAAS to maintain a database of data that has been seen previously traversing the network. This information is used to remove redundant transmission patterns from the network, enabling significant levels of compression and helping ensure message and application coherency in that the original message is always rebuilt and verified by the distant Cisco WAAS.

- DRE is application agnostic and bidirectional; therefore, data patterns that have been identified for one application protocol can be used by other applications, and patterns that have been identified for one direction of traffic flow can be used to remove redundancy for traffic flowing in a different direction.

- The Citrix Independent Computing Architecture (ICA) Protocol does not eliminate redundant data, so that when a user requests previously viewed screen content, the whole set of data is resent. With DRE, viewed screen content is stored in an application-agnostic format as a previously seen transmission, and if redundant segments are seen, significant levels of compression can be achieved. Data redundancy is especially beneficial when many Citrix ICA sessions are running concurrently over WAN links and when users are viewing content or parts of content that have been viewed before.

- Persistent Lempel-Ziv (LZ) compression: Persistent LZ compression is a standards-based compression mechanism coupled with a long-lived compression history for the connection that can be employed to minimize the amount of bandwidth consumed by a TCP flow. Persistent LZ compression can be used in conjunction with DRE or independently. Persistent LZ compression can provide from 2:1 to 5:1 compression depending on the application and data being transmitted. This compression is especially helpful for data that has not been previously seen and suppressed by DRE.

- When a Citrix client accesses an application through a Citrix Presentation Server, Cisco WAAS applies optimization to improve performance and reduce bandwidth utilization, thereby providing a faster application response time with less WAN utilization. The Citrix ICA Protocol is optimized for WAN environments and includes functions to queue mouse movements, cache bitmaps, and compress traffic. Cisco WAAS brings additional improvements through WAN optimizations that include DRE, persistent LZ compression, and TFO.

Solution Deployment

Cisco ACE, and WAAS reside in the data center and can provide virtualized application optimization services for multiple Citrix Presentation Server deployments as well as other enterprise applications.

Because of their unique location, these solutions can take intelligent action on end-user traffic before it is routed to the Citrix Presentation Servers, including load balancing. Cisco Application Networking for Citrix Presentation Server provides these services cost effectively, freeing server processing and memory.

Cisco WAAS also resides in the branch office and can provide virtualized application optimization services for all application users in that location. The Cisco WAAS data center and branch-office deployments together offer a WAN optimization service through the use of intelligent caching, compression, and protocol optimization.

When the Citrix Presentation Server application servers respond to end-user requests, the response is most efficiently passed across the WAN, with minimal bandwidth usage and maximum speed.

The recommended best practices and implementation guidance for Cisco Application Networking for Citrix Presentation Server, including specific configurations for each Cisco network solution, can be found in the Cisco Application Networking for Citrix Presentation Server Deployment Guide at http://www.cisco.com/go/optimizemyapp.

The Cisco ACE solution can be deployed in the data center as a module in the Cisco Catalyst®
6500 Series Switches or as an appliance. Cisco WAAS can be deployed in the branch office as a
module in the Cisco Integrated Services Routers or as an appliance.

Testing

Cisco conducted a series of function, load, and performance tests over 3 months that resulted in
the Cisco Application Networking for Citrix Presentation Server architecture, best practices, and
implementation guidance.

The environment includes Citrix Presentation Server running on Windows Server 2003. The
applications being accessed are hosted on Windows Server 2003 with Internet Information
Services (IIS) Version 6. Applications tested include standard Microsoft applications such as
Microsoft Word.

Cisco WAAS Performance Testing

HP LoadRunner was used to simulate user transactions. Two simulated WAN links were tested to
represent typical branch office–to–data center connections, as shown in Tables 4 through 7 and
Figures 1 through 3.

Table 4.   Cisco WAAS for Citrix Presentation Server: Two Simulated WAN Links

Description	Bandwidth	Round-Trip Latency	Packet Loss
Intracontinental	1.544 Mbps	100 ms	0.1%
Intercontinental	512 Kbps	200 ms	0.2%

Table 5.   Cisco WAAS for Citrix Presentation Server: Site Navigation Performance Improvement

WAN Link	Average	Highest
Intracontinental	1.2X faster	1.68X faster
Intercontinental	2.39X faster	8.7X faster

**Figure 1.**   Site Navigation on Intercontinental Link Shows 8.7X Improvement
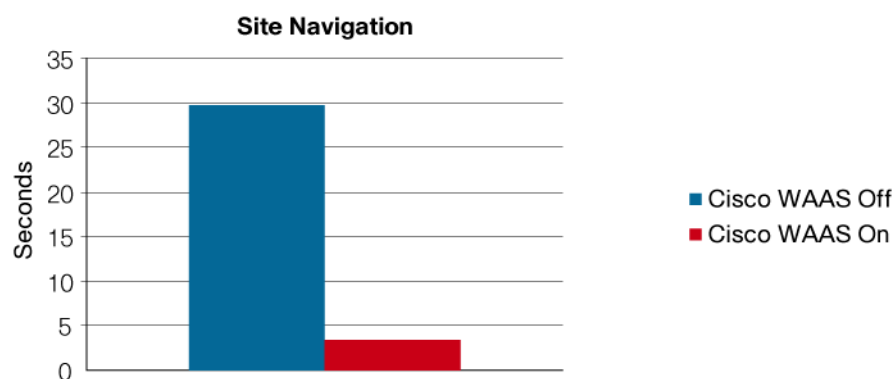
Table 6.   Cisco WAAS for Citrix Presentation Server: Bandwidth Utilization Improvement

WAN Link	Bytes per Transaction	Bytes per Transaction
Intracontinental	11467.71 less	32% less
Intercontinental	7258.77 less	25% less

Figure 2.   Bandwidth Utilization on Intracontinental Link Shows 32% Improvement
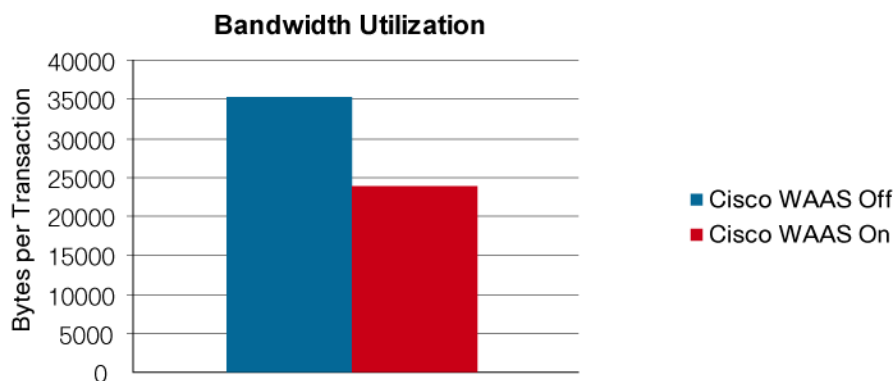
Table 7.   Cisco WAAS for Citrix Presentation Server: Transaction Performance Improvement

WAN Link	Transactions	Transactions
Intracontinental	719 more	27% more
Intercontinental	403 more	17% more

Figure 3.   Transaction Performance on Intracontinental Link Shows 27% Improvement
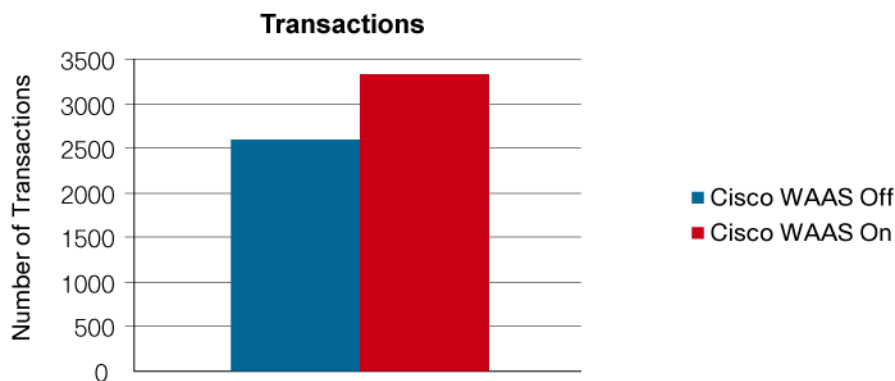
As the results show, Cisco WAAS delivers a significant reduction in uncompressed Citrix network traffic and far more compression than can be realized with native Citrix compression. In addition, Cisco WAAS provides a perceived improvement in overall performance and stability. Citrix sessions optimized generally seem noticeably smoother, with less wait time for operations such as screen refreshes and reduced lag and jitter.

Cisco WAAS also provides additional optimizations for Citrix not directly related to bandwidth consumption, including normalized bandwidth consumption. Not only is bandwidth consumption minimized as a result of Cisco WAAS compression, but utilization remains more linear and controlled. Furthermore, the Citrix ICA Protocol does not optimize TCP/IP packet flows, resulting in an unusually high level of unnecessary 64-byte acknowledgment packets, and does not efficiently use the TCP over WAN. Citrix ICA does not provide data redundancy elimination, so when users request previously viewed screen content, the entire content is resent. With Cisco WAAS, Citrix ICA benefits from the following unique optimization technologies:

- TFO improves the capability of the client and server to efficiently communicate, mitigates the effects of WAN conditions, and enables more efficient utilization of WAN resources.
- DRE learns Citrix ICA and other application traffic patterns and stores them locally to eliminate redundancy from future transmissions. DRE can identify repeated sequences even

within a transfer and suppress them. When a user requests previously viewed screen content (even if only previously seen by another user), the repeated screen content can be safely suppressed to minimize bandwidth consumption.

- Persistent LZ compression minimizes the size of all messages being exchanged, even those that have been optimized by DRE.

From these results, it is clear that there are strong network performance benefits to be gained by adding Cisco ACE and WAAS in situations with geographically far-reaching Citrix Presentation Server deployments with high-latency or low-speed WAN connections.

Cisco ACE Function Testing

Cisco ACE function tests succeeded and the deployed configurations were documented for these tests, which included the following features: server load balancing with persistence, server health monitoring, TCP connection management, and end-user access control.

Statement of Cooperation

Cisco worked independently in all phases of Cisco for Citrix Presentation Server testing, including lab setup at Cisco offices, solution function and performance testing, and solution overview and deployment guide documentation. Cisco validates that the lab setup and solution testing represents best efforts in creating a realistic customer deployment and accurate documentation of such deployment.

For Further Information

http://www.cisco.com/go/applicationservices.

http://www.cisco.com/go/ace.

http://www.cisco.com/go/waas.