CHAPTER 1

Introduction to Cisco WAAS

This chapter provides an overview of the Cisco WAAS solution and describes the main features that enable WAAS to overcome the most common challenges in transporting data over a wide area network.

Note Throughout this chapter, the term WAAS device is used to refer collectively to the WAAS Central Managers and WAEs in your network. The term WAE refers to WAE appliances and WAE Network Modules (the NME-WAE family of devices).

This chapter contains the following sections:

About Cisco WAAS

The WAAS system consists of a set of devices called wide area application engines (WAEs) that work together to optimize TCP traffic over your network. When client and server applications attempt to communicate with each other, the network intercepts and redirects this traffic to the WAEs so that they can act on behalf of the client application and the destination server. The WAEs examine the traffic and use built-in application policies to determine whether to optimize the traffic or allow it to pass through your network unoptimized.

You use the WAAS Central Manager GUI to centrally configure and monitor the WAEs and application policies in your network. You can also use the WAAS Central Manager GUI to create new application policies so that the WAAS system can optimize custom applications and less common applications.

Cisco WAAS helps enterprises meet the following objectives:

- Provide branch office employees with LAN-like access to information and applications across a geographically distributed network.
- Migrate application and file servers from branch offices into centrally managed data centers.
- Minimize unnecessary WAN bandwidth consumption through the use of advanced compression algorithms.

- Provide print services to branch office users. Cisco WAAS allows you to configure a WAE as a print server so you do not need to deploy a dedicated system to fulfill print requests.
- Improve application performance over the WAN by addressing the following common issues:
  - Low data rates (constrained bandwidth)
  - Slow delivery of frames (high network latency)
  - Higher rates of packet loss (low reliability)

This section contains the following topics:

Cisco WAAS Overcomes Common WAN Challenges

Table 1-1 describes how Cisco WAAS uses a combination of TCP optimization techniques and application acceleration features to overcome the most common challenges associated with transporting traffic over a WAN.

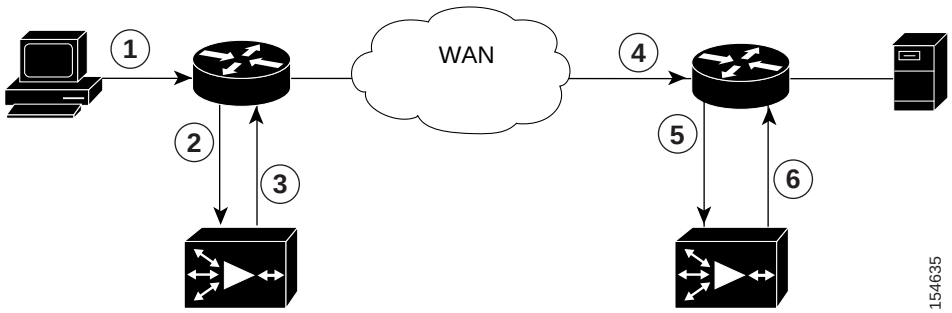
Table 1-1 Cisco WAAS Solution

WAN Issue	WAAS Solution
High network latency	Intelligent protocol adapters reduce the number of roundtrip responses common with chatty application protocols.
Constrained bandwidth	Data caching provided with the file services feature and data compression reduce the amount of data sent over the WAN, which increases data transfer rates. These solutions improve application response time on congested links by reducing the amount of data sent across the WAN.
Poor link utilization	TCP optimization features improve network throughput by reducing the number of TCP errors sent over the WAN and maximizing the TCP window size that determines the amount of data that a client can receive at one time.
Packet loss	Optimized TCP stack in WAAS overcomes the issues associated with high packet loss and protects communicating end points from the state of the WAN.

Traffic Optimization Process

Figure 1-1 shows the process that Cisco WAAS follows to optimize application traffic.

Figure 1-1 Traffic Optimization Process



The following steps describe how your WAAS network optimizes a connection between a branch office client and a destination server:

1. A branch office client attempts to connect to the destination server over the native application port.
2. The WAAS network uses WCCP or PBR to intercept the client request, or if deployed on a WAE with a Cisco WAE Inline Network Adapter, WAAS can intercept the request directly using inline mode. For more information on inline mode, see the "Using Inline Mode to Transparently Intercept TCP Traffic" section on page 4-41.
3. The Edge WAE performs the following actions:
   - Examines the parameters in the traffic's TCP headers and then refers to the application policies to determine if the intercepted traffic should be optimized. Information in the TCP header, such as the source and destination IP address, allows the Edge WAE to match the traffic to an application policy. For a list of the default policies, see Appendix A, "Default Application Policies."
   - If the Edge WAE determines that the traffic should be optimized, it adds information to the TCP header that informs the next WAE in the network path to optimize the traffic.
4. The Edge WAE passes along the client request through the network to its original destination server.
5. The Core WAE performs the following actions:
   - Intercepts the traffic going to the destination server.
   - Establishes an optimized connection with the Edge WAE. If the Core WAE has optimization disabled, then an optimized connection will not be established and the traffic passes over the network unoptimized.
6. WAAS optimizes subsequent traffic between the Edge WAE and Core WAE for this connection.

Cisco WAAS does not optimize traffic in the following situations:

- The WAE intercepts non-TCP traffic (such as UDP or ICMP).
- The WAE is overloaded and does not have the resources to optimize the traffic.
- The intercepted traffic matches an application policy that specifies to pass the traffic through unoptimized.

Note In the event that unoptimized traffic reaches a WAE, the WAE forwards the traffic in pass-through mode without affecting the performance of the application using the passed-through connection.

Key Services of Cisco WAAS

Cisco WAAS contains the following services that help optimize traffic over your wide area network:

TFO Optimization

Cisco WAAS uses a variety of transport flow optimization (TFO) features to optimize TCP traffic intercepted by the WAAS devices. TFO protects communicating clients and servers from negative WAN conditions, such as bandwidth constraints, packet loss, congestion, and retransmission.

TFO includes the following optimization features:

Compression

Cisco WAAS uses the following compression technologies to help reduce the size of data transmitted over your WAN:

- Data Redundancy Elimination (DRE)
- LZ compression

These compression technologies reduce the size of transmitted data by removing redundant information before sending the shortened data stream over the WAN. By reducing the amount of transferred data, WAAS compression can reduce network utilization and application response times.

When a WAE uses compression to optimize TCP traffic, it replaces repeated data in the stream with a much shorter reference, then sends the shortened data stream out across the WAN. The receiving WAE uses its local redundancy library to reconstruct the data stream before passing it along to the destination client or server.

The WAAS compression scheme is based on a shared cache architecture where each WAE involved in compression and decompression shares the same redundancy library. When the cache that stores the redundancy library on a WAE becomes full, WAAS uses a FIFO algorithm (first in, first out) to discard old data and make room for new.

LZ compression operates on smaller data streams and keeps limited compression history. DRE operates on significantly larger streams (typically tens to hundreds of bytes or more) and maintains a much larger compression history. Large chunks of redundant data is common in file system operations when files are incrementally changed from one version to another or when certain elements are common to many files, such as file headers and logos.

Windows Scaling

Windows scaling allows the receiver of a TCP packet to advertise that its TCP receive window can exceed 64 KB. The receive window size determines the amount of space that the receiver has available for unacknowledged data. By default, TCP headers limit the receive window size to 64 KB, but Windows scaling allows the TCP header to specify receive windows of up to 1 GB.

Windows scaling allows TCP endpoints to take advantage of available bandwidth in your network and not be limited to the default window size specified in the TCP header.

For more information about Windows scaling, refer to RFC 1323.

TCP Initial Window Size Maximization

WAAS increases the upper bound limit for TCP's initial window from one or two segments to two to four segments (approximately 4 KB). Increasing TCP's initial window size provides the following advantages:

- When the initial TCP window is only one segment, a receiver that uses delayed ACKs is forced to wait for a timeout before generating an ACK response. With an initial window of at least two segments, the receiver generates an ACK response after the second data segment arrives, eliminating the wait on the timeout.
- For connections that transmit only a small amount of data, a larger initial window reduces the transmission time. For many e-mail (SMTP) and web page (HTTP) transfers that are less than 4 KB, the larger initial window reduces the data transfer time to a single round trip time (RTT).
- For connections that use large congestion windows, the larger initial window eliminates up to three RTTs and a delayed ACK timeout during the initial slow-start phase.

For more information about this optimization feature, see RFC 3390.

Increased Buffering

Cisco WAAS enhances the buffering algorithm used by the TCP kernel so that WAEs can more aggressively pull data from branch office clients and remote servers. This increased buffer helps the two WAEs participating in the connection keep the link between them full, increasing link utilization.

Selective Acknowledgment (SACK)

Selective Acknowledgement (SACK) is an efficient packet loss recovery and retransmission feature that allows clients to recover from packet losses more quickly than the default recovery mechanism used by TCP.

By default, TCP uses a cumulative acknowledgement scheme that forces the sender to either wait for a roundtrip to learn if any packets were not received by the recipient or to unnecessarily retransmit segments that may have been correctly received.

SACK allows the receiver to inform the sender about all segments that have arrived successfully, so the sender only needs to retransmit the segments that have actually been lost.

For more information about SACK, see RFC 2018.

BIC TCP

Binary Increase Congestion (BIC) TCP is a congestion management protocol that allows your network to recover more quickly from packet loss events.

When your network experiences a packet loss event, BIC TCP reduces the receiver's window size and sets that reduced size as the new value for the minimum window. BIC TCP then sets the maximum window size value to the size of the window just before the packet loss event occurred. Because packet loss occurred at the maximum window size, the network can transfer traffic without dropping packets whose size falls within the minimum and maximum window size values.

If BIC TCP does not register a packet loss event at the updated maximum window size, that window size becomes the new minimum. If a packet loss event does occur, that window size becomes the new maximum. This process continues until BIC TCP determines the new optimum minimum and maximum window size values.

Application-Specific Acceleration

In addition to the TCP optimization features that speed the flow of traffic over a WAN, Cisco WAAS includes these application acceleration features:

- **Operation prediction and batching—**Allows a WAAS device to transform a command sequence into a shorter sequence over the WAN to reduce roundtrips.
- **Intelligent message suppression**—Even though TFO optimizes traffic over a WAN, protocol messages between branch office clients and remote servers can still cause slow application response time. To resolve this issue, each WAAS device contains application proxies that can respond to messages locally so that the client does not have to wait for a response from the remote server. The application proxies use a variety of techniques including caching, command batching, prediction, and resource prefetch to increase the response time of remote applications.
- **WAFS caching—**Allows a WAAS device to reply to client requests using locally cached data instead of retrieving this data from remote file and application servers.
- **Preposition—**Allows a WAAS device to prefetch resource data and metadata in anticipation of a future client request.

Cisco WAAS uses application-intelligent software modules to apply these acceleration features.

In a typical CIFS application use case, the client sends a large number of synchronous requests that require the client to wait for a response before sending the next request. Compressing the data over the WAN is not sufficient for acceptable response time.

For example, when you open a 5 MB Word document, about 700 CIFS requests (550 read requests plus 150 other requests) are produced. If all these requests are sent over a 100 ms round-trip WAN, the response time is at least 70 seconds (700 x 0.1 seconds).

WAAS application acceleration minimizes the synchronous effect of the CIFS protocol, which reduces application response time. Each WAAS device uses application policies to match specific types of traffic to an application and to determine whether that application traffic should be optimized and accelerated.

File Services for Desktop Applications

The file services feature allows a WAE to store remote file server data in its local cache so that the WAE can quickly fulfill a client's data request instead of sending that request over the WAN to the file server. By fulfilling the client's request locally, the WAE minimizes the traffic sent over the WAN and reduces the time it takes branch office users to access files and many desktop applications, allowing enterprises to consolidate their important information into data centers.

When you set up file services in your WAAS network, you configure a WAE as either an Edge WAE that resides at a branch office to server local users or as a Core WAE that resides close to your file and application servers. You can also configure a WAE to be both an Edge WAE and a Core WAE, which is a common setup when users in one data center need to access files in another data center and vice versa.

For more information, see Chapter 11, "Configuring WAFS."

This section contains the following topics:

File Services Features

File Services includes the following features:

- **Prepositioning**—Allows system administrators to proactively "push" frequently used files from the central file server into the cache of selected WAEs. This provides users with faster first-time file access, and makes more efficient use of available bandwidth.
- **File blocking**—Allows system administrators to define blocking policies that prevent users from opening, creating, or copying files that match a defined file pattern. File blocking policies prevent bandwidth, as well as file server and cache space, from being wasted on files that system administrators decide to block.
- **Data coherency and concurrency**—Ensures data integrity across the WAAS system by managing the freshness of the data (coherency) and controlling the access to the data by multiple clients (concurrency).
- **Automatic discovery**—Allows you to use file services without having to register individual file servers in the WAAS Central Manager. With the automatic discovery feature, the WAAS Core cluster will attempt to automatically discover and connect to a new file server when a CIFS request is received.

Role of the Edge WAE

The Edge WAE is a client-side, file-caching device that serves client requests at remote sites and branch offices. The device is deployed at each branch office or remote campus, replacing file and print servers and giving local clients fast, near-LAN read and write access to a cached view of the centralized storage. By caching the data most likely to be used at these sites, Edge WAEs greatly reduce the number of requests and the volume of data that must be transferred over the WAN between the data center and the edge.

When requests for data that is not located in the cache are received, the Edge WAE encapsulates the original CIFS request using a TCP/IP-based protocol, compresses it, and sends it over the WAN to the Core WAE. Data returned from the data center is distributed by the Edge WAE to the end user who requested it.

Role of the Core WAE

The Core WAE is a server-side component that resides at the data center and connects directly to one or more file servers or network-attached storage (NAS). Core WAEs are placed between the file servers at the data center and the WAN connecting the data center to the enterprise's remote sites and branch offices. Requests received from Edge WAEs over the WAN are translated by the Core WAE into its original file server protocol and forwarded to the appropriate file server. The data center Core WAEs can provide load balancing and failover support.

When the data is received from the file server, the Core WAE encapsulates and compresses it before sending it over the WAN back to the Edge WAE that requested it. Core WAEs can be arranged in logical clusters to provide scalability and automatic failover capabilities for high-availability environments.

WAAS Print Services

The Cisco WAAS software includes print services that allow you to turn an Edge WAE into a WAAS print server. This functionality eliminates the need for a separate print server in the branch office. WAAS print services are available for Windows clients and work with any IP-based network printer.

You can configure all CIFS-connected Edge WAEs to provide a full range of print services to the clients they serve. WAAS print services include the following features:

- Generic printer support through the Edge WAE that acts as a print server for networked printers in the branch office
- Print driver distribution managed from the WAAS Central Manager GUI
- Standard Windows-based configuration and setup support
- Remote print services and queue management provided with a Web-based GUI
- Printer security that supports standard printer ACL and is fully integrated with Active Directory or NT Domain authentication

For more information, see Chapter 13, "Configuring and Managing WAAS Print Services."

Overview of the WAAS Interfaces

The Cisco WAAS software provides the following interfaces to help you manage, configure, and monitor the various elements of your WAAS network:

WAAS Central Manager GUI

Every WAAS network must have one primary WAAS Central Manager device that is responsible for managing the other WAAS devices in your network. The WAAS Central Manager devices hosts the WAAS Central Manager GUI, a Web-based interface that allows you to configure, manage, and monitor the WAAS devices in your network. The WAAS Central Manager resides on a dedicated WAE device.

The WAAS Central Manager GUI allows administrators to perform the following tasks:

- Configure system and network settings for an individual WAAS device or device group.
- Create and edit application policies that determine the action that a WAAS device performs when it intercepts specific types of traffic.
- Distribute print drivers from the central repository to your WAAS print servers.
- Configure file services and set up file preposition and file blocking policies.
- Create device groups that help you manage and configure multiple WAEs at the same time.
- View detailed reports about the optimized traffic in your WAAS network.

Note You cannot enable file services, print services, or application acceleration on a WAE that has been configured as a WAAS Central Manager. The purpose of the WAAS Central Manager is to configure, monitor, and manage the WAEs in your network.

This section contains the following topics:

Accessing the WAAS Central Manager GUI

To access the WAAS Central Manager GUI, enter the following URL in your web browser:

https://*WAE_Address*:8443/

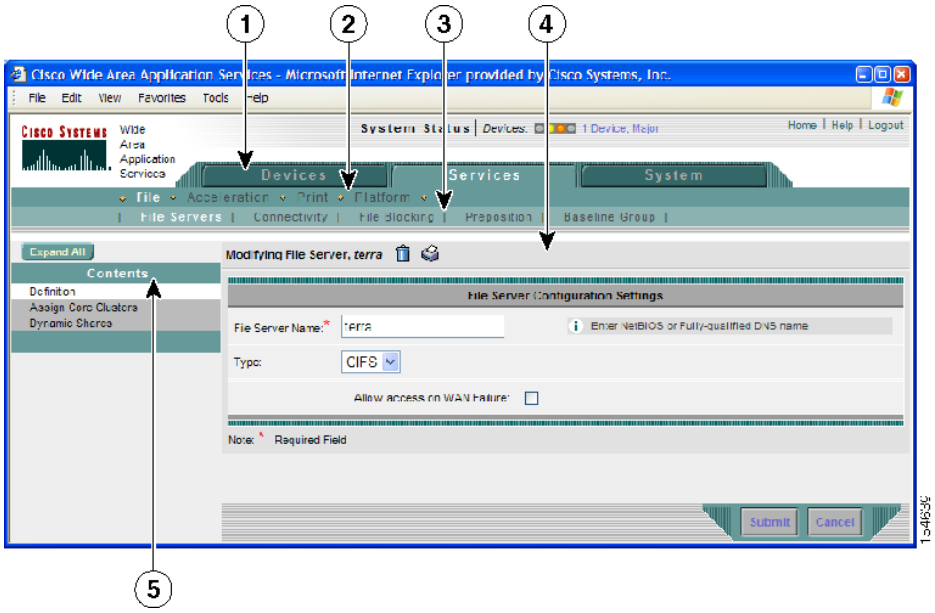
The *WAE_Address* value is the IP address or hostname of the WAAS Central Manager device.

The default administrator username is *admin* and the password is *default*. For information on creating accounts and changing passwords, see Chapter 7, “Creating and Managing Administrator User Accounts.”

Components of the WAAS Central Manager GUI

Figure 1-2 shows the main components of the WAAS Central Manager GUI.

Figure 1-2 Components of the WAAS Central Manager GUI



1	Tabs (Devices, Services, and System)	**4**	Taskbar
2	Tab-specific pages	**5**	Contents pane
3	Sub-pages		

WAAS Central Manager GUI Tabs

Table 1-2 describes the three main tabs in the WAAS Central Manager GUI.

Table 1-2 Tab Descriptions

Tab	Description
Devices	Allows you to configure WAAS services and general settings (such as authentication) for a specific device or device group. You can also view detailed device information and messages. The settings you configure from this tab are device- and group-specific and are *not* applied globally to all devices in your WAAS network.
Services	Allows you to configure the main WAAS services (file, print, and application acceleration).
System	Allows you to perform common system tasks, such as setting up user accounts and roles and viewing system logs.

WAAS Central Manager GUI Taskbar Icons

Table 1-3 describes the taskbar icons in the WAAS Central Manager GUI.

Table 1-3 Taskbar Icon Descriptions

Taskbar Icon	Function
Common icons	
(Refresh)	Refreshes the current page of the WAAS Central Manager GUI.
(Delete)	Deletes a WAAS element, such as a device, device group, print driver, or file service policy.
(Create)	Creates a new WAAS element, such as a file service policy or an acceleration policy.
(Filter Table)	Filters the information in a table to make it easier to locate a specific item.
(View All)	Displays all items in a table on a single page instead of displaying those items over multiple pages.
(Print Table)	Prints the table so that you can refer to the information outside of the WAAS Central Manager GUI. For example, you may want to print out or create a PDF of all the WAAS devices in your network for inventory purposes.
(Assign All)	Selects all valid items in a table. For example, if you are distributing print drivers to a WAAS print server, you can click this icon to select all drivers in the list that the print server should download.
(Remove All)	Deselects all selected items in a table.
Devices and Device Group Icons	
(Activate All Inactive WAEs)	Activates all the inactive WAEs in your WAAS network. For more information, see the "Activating All Inactive WAAS Devices" section on page 14-23.
(Force Full Database Update)	Re-applies the device configuration as seen in the WAAS Central Manager GUI to the device. Normally, changes made in the WAAS Central Manager GUI are applied to the device as soon as the configuration is submitted. From time to time, however, a CLI error or some other error on the device can cause the configuration on the device to differ from what is seen in the WAAS Central Manager GUI. The Force Full Database Update icon applies the full configuration that the WAAS Central Manager has for the device to be updated to the device and the configuration reapplied. You can view device CLI errors in the System Message window described in the "Viewing the System Message Log" section on page 15-15. The Force Full Database Update icon appears on the Device Home window, described in the "Device Home Window" section on page 15-6.

Table 1-3 Taskbar Icon Descriptions (continued)

Taskbar Icon	Function
(Reload)	Reboots a WAE or device group depending on the location in the WAAS Central Manager GUI. For more information, see the "Rebooting a Device or Device Group" section on page 14-24.
(Force Group Settings)	Forces the device group configuration across all devices in that group. For more information, see the "Forcing Device Group Settings on All Devices in the Group" section on page 3-10.
(Apply Defaults)	Applies the default settings to the fields on the window.
(Export Table)	Exports table information into a CSV file.
(Switch Baseline Group)	Allows you to select another device group to associate with the baseline group. For more information, see the "Switching the Baseline Group for a Service" section on page 3-15.
(Override Group Settings)	Allows you to specify device-specific settings that override the group settings for the device. For more information, see the "Overriding the Device Group Settings on a Device" section on page 3-11.
(Deactivate Device)	Deactivates a WAE.
(Update Application Statistics)	Updates the application statistics.
(Delete All)	Deletes all WAAS elements of a particular type, such as IP ACL conditions.
(Display All Devices)	Displays all WAE devices or device groups in the Contents pane.
Print Services Icons	
(Retry Downloading Failed Drivers)	Attempts to download print drivers that previously failed to be distributed to the WAAS print server or device group. For more information, see Chapter 13, "Configuring and Managing WAAS Print Services."
(Print Services Administration GUI)	Opens the Print Services Administration GUI for the WAAS print server. For more information about the tasks you can perform from this GUI, see the "Using the Print Services Administration GUI" section on page 13-28.
Acceleration Icons	
(Apply Defaults)	Restores the default application policies on the device or device group. For more information, see the "Restoring Application Policies and Classifiers" section on page 12-13.
(Restore Basic Policies and Classifiers)	Restores basic policies and classifiers that optimize only WAFS traffic. All other traffic passes through the system unoptimized. For more information, see the "Restoring Application Policies and Classifiers" section on page 12-13.

Table 1-3 Taskbar Icon Descriptions (continued)

Taskbar Icon	Function
(View Topology)	Displays the topology map that shows all the TFO connections between your WAE devices. For more information, see the "Viewing Connections and Peer Devices" section on page 12-14.
(Navigate to application configuration page)	Displays the configuration page used to create new applications. For more information, see the "Viewing a List of Applications" section on page 12-11.
System Message Log Icons	
(Truncate Table)	For more information, see the "Viewing the System Message Log" section on page 15-15.

WAE Device Manager GUI

The WAE Device Manager is a Web-based management interface that allows you to configure, manage, and monitor an individual WAE device in your network. In many cases, the same device settings exist in both the WAE Device Manager and the WAAS Central Manager GUI. For this reason, we recommend that you always configure device settings from the WAAS Central Manager GUI when possible.

In some situations, you might need to use the WAE Device Manager GUI to perform certain tasks. For example, the following tasks can only be performed from the WAE Device Manager GUI and not from the WAAS Central Manager GUI:

- Enabling print services on a WAE
- Shutting down device services

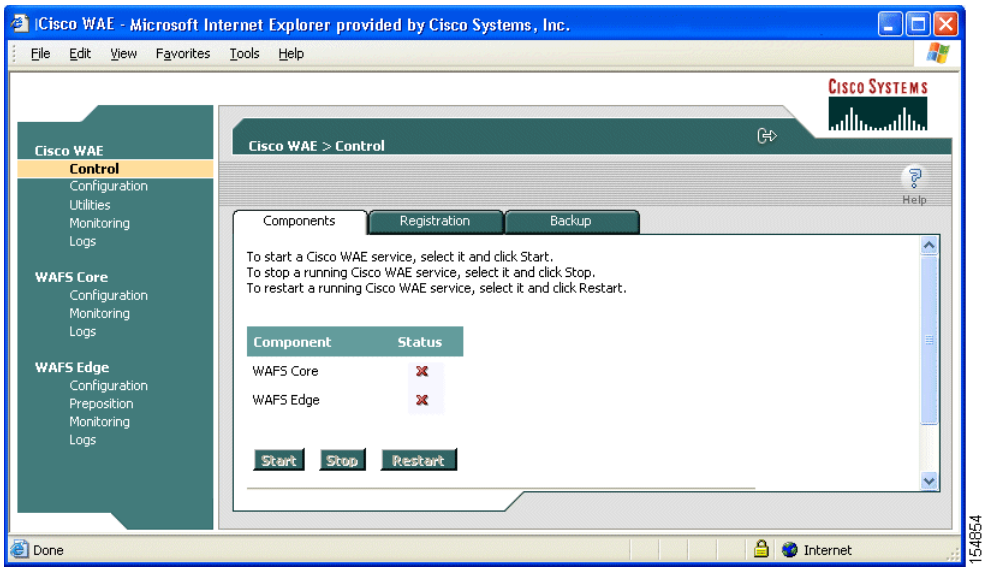
For more information about the tasks you can perform from the WAE Manager, see Chapter 10, "Using the WAE Device Manager GUI."

To access the WAE Device Manager for a specific device, go to the following URL:

https://*Device IP Address*:8443/mgr

Figure 1-3 shows an example of the WAE Device Manager window.

Figure 1-3 Example of the WAE Device Manager Window



WAAS Print Services Administration GUI

The Print Services Administration GUI is a Web-based interface that allows you to configure an individual WAAS print server and view a list of active and completed print jobs.

You can perform the following common tasks from the Print Services Administration GUI:

- Add a printer to WAAS print server
- Modify the configuration of an existing printer
- Set up print clusters
- View print jobs

You can access the Print Services Administration GUI from the WAAS Central Manager GUI or from the WAE Manager GUI. For more information, see Chapter 13, “Configuring and Managing WAAS Print Services.”

WAAS CLI

The WAAS CLI allows you to configure, manage, and monitor WAEs on a per-device basis through a console connection or a terminal emulation program. The WAAS CLI also allows you to configure certain features that are supported only through the CLI (for example, configuring the Lightweight Directory Access Protocol [LDAP] signing on a WAE). We strongly recommend that you use the WAAS Central Manager GUI instead of the WAAS CLI, whenever possible.

The WAAS CLI is organized into four command modes. Each command mode has its own set of commands to use for the configuration, maintenance, and monitoring of a WAE. The commands that are available to you depend on the mode you are in. When you enter a question mark (?) at the system prompt, you can obtain a list of commands available for each command mode.

The four WAAS command modes are as follows:

- EXEC mode—For setting, viewing, and testing system operations. This mode is divided into two access levels: user and privileged. To use the privileged access level, enter the **enable** command at the user access level prompt, then enter the privileged EXEC password when you see the password prompt.
- Global configuration mode—For setting, viewing, and testing the configuration of WAAS software features for the entire device. To use this mode, enter the **configure** command from the privileged EXEC mode.
- Interface configuration mode—For setting, viewing, and testing the configuration of a specific interface. To use this mode, enter the **interface** command from the global configuration mode.
- Feature-specific configuration mode—A number of configuration modes are available from the global configuration mode for managing specific features.

For information about using the CLI to configure a WAAS device, see the *Cisco Wide Area Application Services Command Reference* and the *Cisco Wide Area Application Services Quick Configuration Guide*.

Benefits of Cisco WAAS

This section describes the benefits of Cisco WAAS and includes the following topics:

Preservation of Source TCP/IP Information

Many optimization products create tunnels through routers and other networking devices, which result in a loss of source TCP/IP information in the optimized data. This loss of TCP/IP information often disrupts important network services (such as QoS and NBAR), and can disrupt proper operation of traffic analysis tools such as NetFlow and security products and features such as ACLs and IP-based firewalls.

Unlike other optimization products, Cisco WAAS seamlessly integrates into your network and preserves all TCP/IP header information in the traffic that it optimizes, so that your existing analysis tools and security products are not compromised.

Autodiscovery of WAAS Devices

Cisco WAAS includes an autodiscovery feature that enables WAEs to automatically locate peer WAEs on your network. After autodiscovering a peer device, the WAEs can terminate and separate the LAN-to-WAN TCP connections and add a buffering layer to resolve the differing speeds. Once a WAE establishes a connection to a peer WAE, the two devices can establish an optimized link for TCP traffic, or pass the traffic through as unoptimized.

The autodiscovery of peer WAAS devices is achieved using proprietary TCP options. These TCP options are only recognized and understood by WAAS devices and are ignored by non-WAAS devices.

Centralized Network Monitoring and Management

Cisco WAAS Web-based management tools (WAAS Central Manager and WAE Device Manager GUIs) enable IT administrators to centrally define, monitor, and manage policies for each WAAS device, such as usage quota, backups, disaster recovery, restores, access control, and security policies. IT administrators can also perform the following tasks:

- Remotely provision, configure, and monitor each WAAS device or device group.
- Optimize system performance and utilization with comprehensive statistics, logs, and reporting.
- Perform troubleshooting tasks using tools such as SNMP-based monitoring, traps and alerts, and debug modes.

IT administrators benefit from the following features of Cisco WAAS:

- **Native protocol support**—Cisco WAAS provides complete end-to-end support for the underlying file system protocol (Windows/CIFS) used by the enterprise. The full file system semantics, such as security, concurrency, and coherency, are preserved between each client and file server.
- **Transparency**—Cisco WAAS is fully transparent to applications, file systems, and protocols, enabling seamless integration with existing network infrastructures, including mixed environments. Cisco WAAS also has no impact on any security technology currently deployed.
- **Branch office data protection**—Cisco WAAS significantly increases data protection at branch offices. Its file cache appears on the office's LAN in the same way as a local file server. End users can map their personal document folders onto the file cache using Windows or UNIX utilities. A cached copy of user data is stored locally in the Edge WAE for fast access. The master copy is stored centrally in the well-protected data center.
- **Centralized backup**—By consolidating data across the extended enterprise into a data center, Cisco WAAS makes it easy to apply centralized storage management procedures to branch office data. Backup and restore operations become simpler, faster, and more reliable than when the data was decentralized.

  In the event of data loss, backup files exist in the data center and can be quickly accessed for recovery purposes. The amount of data loss is greatly reduced because of the increased frequency of backups performed on the centralized storage in the data center. This centralized storage backup makes disaster recovery much more efficient and economical than working with standalone file servers or NAS appliances.
- **Simplified storage management**—By migrating storage from remote locations to a central data facility, existing storage systems and IT staff can be more effectively utilized, resulting in a dramatic reduction in the cost and complexity of storage management for the extended enterprise.

- **WAN adaptation**—A key benefit of the Cisco WAAS solution is the ability to provide remote users with near-LAN access to files located at the data center. A critical part of achieving this goal over the enterprise WAN is the proprietary protocol that optimizes the way traffic is forwarded between the WAEs. If communication between WAEs is disrupted, the system automatically switches into Disconnected Mode, preventing operations that could jeopardize the coherency of files in the network.

Optimized Read and Write Caching

The wide area file services (WAFS) feature in Cisco WAAS maintains files locally, close to the clients. Changes made to files are immediately stored in the local Edge WAE, then "streamed" to the central file server. Files stored centrally appear as local files to branch users, which improves access performance. WAFS caching includes the following features:

- **Local metadata handling and caching**—Allows metadata such as file attributes and directory information to be cached and served locally, optimizing user access.
- **Partial file caching**—To optimize transport, propagates only the segments of the file that have been updated on write requests rather than the entire file.
- **Write-back caching**—Facilitates efficient write operations by allowing the Core WAE to buffer writes from the Edge WAE and to stream updates asynchronously to the file server without risking data integrity.
- **Advance file read**—Increases performance by allowing a WAE to read the file in advance of user requests when an application is conducting a sequential file read.
- **Negative caching**—Allows a WAE to store information about missing files to reduce round-trips across the WAN.
- **Microsoft Remote Procedure Call (MSRPC) optimization**—Uses local request and response caching to reduce the round-trips across the WAN.
- **Signaling messages prediction and reduction**—Uses sophisticated algorithms to reduce round-trips over the WAN without loss of semantics.

Cisco WAAS uses its own proprietary adaptation protocol layer over the WAN between the Edge WAE and Core WAE, while retaining the standard CIFS protocol at the client and server ends. This proprietary network protocol provides reliable and efficient communication over WANs, especially under high-latency, low-bandwidth conditions.

The Cisco WAAS protocol offers the following benefits:

- **Reliability**—The Cisco WAAS protocol maintains it own internal message queuing and ordering, enabling it to overcome transient disconnects, network jitters, and message loss. The Cisco WAAS transport layer handles temporary network failures by reestablishing the connection, then retransmitting requests that did not receive a response on the disconnected socket.
- **Efficiency**—For greater WAN traffic efficiency, the Cisco WAAS protocol supports compound requests, grouping multiple, dependent requests, and responses into a single message. The processing of individual calls within a compound message is serialized, enabling the output of one command to be used as input for the next.
- **Link utilization optimization**—The Cisco WAAS protocol uses a number of concurrent TCP connections for each Edge WAE-to-Core WAE link. Requests and responses may be delivered across any open connection. For example, multiple requests (and responses) for data delivery can be split across multiple connections to increase the effective use of the network in cases of high-latency or high-loss WAN connections, where TCP performance degrades.

- **Command prioritization**—Cisco WAAS assigns high-priority to requests from active clients, minimizing the WAN latency experienced by users. Batch tasks (pre-position, for example) are assigned a lower priority and are performed in the background.
- **Bandwidth conservation**—All Cisco WAAS protocol messages (requests and responses) are compressed. Before compression, the message is encoded, allowing efficient delivery of both textual and binary data. The protocol layer applies the compression automatically, regardless of the message content.
- **Firewall-friendly**—The Cisco WAFS protocol is layered over TCP/IP, and uses TCP port 4050. Firewalls should be configured to open TCP port 4050 to traffic.

WCCP Support

The Web Cache Communication Protocol (WCCP) developed by Cisco Systems specifies interactions between one or more routers (or Layer 3 switches) and one or more application appliances, web caches, and caches of other application protocols. The purpose of the interaction is to establish and maintain the transparent redirection of selected types of traffic flowing through a group of routers. The selected traffic is redirected to a group of appliances. Any type of TCP traffic can be redirected.

The WCCP v2 protocol has a built-in set of beneficial features, for example, automatic failover and load balancing. The router monitors the liveness of each WAE attached to it through the WCCP keepalive messages, and if a WAE goes down, the router stops redirecting packets to the WAE. By using WCCP, the Edge WAE avoids becoming a single point of failure for the CIFS services. The router can also load balance the CIFS traffic among a number of Edge WAEs.

Cisco WAAS supports transparent interception of CIFS sessions through WCCP. Once WCCP is turned on at both the router and the Edge WAE, only new sessions are intercepted. Existing sessions are not affected.

PBR Support

Policy-based routing (PBR) allows IT organizations to configure their network devices (a router or a Layer 4 to Layer 6 switch) to selectively route traffic to the next hop based on the classification of the traffic. WAAS administrators can use PBR to transparently integrate a WAE into their existing branch office network and data centers. PBR can be used to establish a route that goes through a WAE for some or all packets based on the defined policies.

For more information about PBR, see Chapter 4, “Configuring Traffic Interception.”

Inline Interception Support

Direct inline traffic interception is supported on WAEs with a Cisco WAE Inline Network Adapter installed. Inline interception of traffic simplifies deployment and avoids the complexity of configuring WCCP or PBR on the routers.

The Cisco WAE Inline Network Adapter transparently intercepts traffic flowing through it or bridges traffic that does not need to be optimized. It also uses a mechanical fail-safe design that automatically bridges traffic if a power, hardware, or unrecoverable software failure occurs.

You can configure the Cisco WAE Inline Network Adapter to accept traffic only from certain VLANs; for all other VLANs, traffic is bridged and not processed.

You can serially cluster multiple WAE devices with the Cisco WAE Inline Network Adapter installed to provide spillover load balancing and active-active failover. In spillover load balancing, when the connection threshold is reached on one WAE, additional connections are optimized by another WAE.

For more information about inline mode, see the "Using Inline Mode to Transparently Intercept TCP Traffic" section on page 4-41.

Failure Resiliency and Protection

Cisco WAAS provides a high-availability failover (and load-balancing) function that minimizes the probability and duration of Core Cluster downtime. The Core Cluster is a defined group of Core WAEs that export the same file servers. Edge WAEs can be logically connected to any number of Core Clusters.

If a Core WAE in a cluster fails, all Edge WAEs configured to operate with it are redirected to work with an alternate Core WAE that was previously selected at random from their connection list. This operation maintains high availability without service interruption.

For CIFS, this change may not be transparent to users, which means that client connections are closed and require CIFS clients to reestablish their connection. Whether such changes impact currently running applications depends on the behavior of the application being used, and on the behavior of the specific CIFS client. Typically, however, the transition is transparent to the client.

When communication is interrupted between the Edge WAE and the Core Cluster or between the Core Cluster and the file server, the Cisco WAAS network switches to working in a disconnected state until full communication is restored. If the interruption is brief, the network enters a transient disconnect state, enabling a select number of services and commands for a limited time (typically lasting about one minute), such as read commands for files that are already open.

If the network outage is prolonged, Cisco WAAS switches to a full disconnect state where no services are provided to clients. In this mode, the system denies access to any file (including cached files) until reconnection occurs. From a user viewpoint, the Edge WAE responds as if the network to which it is connected is disconnected.

This approach is required to maintain the security of the data. If a no-service state was not enforced, users connected locally to the file servers can continue working on files, which creates conflicts with other users who may have been working on those files remotely when the network interruption occurred. Cisco WAAS is designed to prevent scenarios that could compromise data coherency and concurrency.

Namespace Support

For CIFS users, there are several ways to access the file servers cached by the Edge WAEs and integrate them within the organizational namespace. One method is to use a prefix, suffix, or alias for a specific site, which creates a unique name for each file server. (Using an alias enables the old name to be retained after replacing the local file server with the new server in the data center.) Another method is to integrate the cached file servers within the DFS namespace as DFS links. When using DFS, the DFS site name must be configured manually for each Edge WAE (or edge device group). This information enables DFS to direct user requests correctly. Remote users are directed to file servers through the appropriate Edge WAE, while local users continue to access files directly, without making use of the Edge WAE cache.

RAID Compatibility

Cisco WAAS provides Redundant Array of Independent Disks (RAID) capability to utilize two disk drives for either increased storage capacity or increased reliability. WAAS provides RAID-1 capability on any WAE with two or more disk drives.

RAID-1 provides *mirroring*, in which data is written redundantly to two or more drives. The goal is to achieve higher reliability through redundancy. On a device with two or more disk drives, RAID-1 (mirroring) is enabled by default.

Streamlined Security

Cisco WAAS does not introduce any additional maintenance overhead on already overburdened IT staffs. Cisco WAAS avoids adding its own proprietary user management layer, and instead makes use of the users, user credentials, and access control lists maintained by the file servers. All security-related protocol commands are delegated directly to the source file servers and the source domain controllers. Any user recognized on the domain and source file server are automatically recognized by Cisco WAAS with the same security level, and all without additional configuration or management.

Cisco WAAS delegates access control and authentication decisions to the origin file server.

SNMP Support

Cisco WAAS supports Simple Network Management Protocol (SNMP) including SNMPv1, SNMPv2, and SNMPv3. Cisco WAAS supports many of the most commonly used SNMP managers, such as HP OpenView and IBM Tivoli NetView.

Cisco WAAS exports parameters based on the following private, read-only MIBs:

- ACTONA-ACTASTOR-MIB.my
- CISCO-CONTENT-ENGINE-MIB

In addition, Cisco WAAS supports the full functionality of each of these standard MIBs, including the setting of traps. Most Cisco WAAS traps are also recorded in the logs displayed in the WAAS Central Manager GUI, although some (such as exceeding the maximum number of sessions) are reported only to the SNMP manager.

- MIB-2 General Network Statistics (RFC 1213 and 1157)—Contains essential parameters for the basic management of TCP/IP-based networks.
- Host Resources (RFC 1514)
- SNMPv3 MIBs (RFC 2571 through 2576)
- DISMAN-EVENT-MIB (RFC 2981)
- ENTITY-MIB (RFC 2037)

Cisco WAAS supports parameters based on SNMPv2, enabling it to integrate into a common SNMP management system. These parameters enable system administrators to monitor the current state of the Cisco WAFS network and its level of performance. Exported parameters are divided into the following categories:

- General parameters—Includes the version and build numbers and license information.
- Management parameters—Includes the location of the Central Manager.

- Core WAE parameters—Includes the general parameters, network connectivity parameters, and file servers being exported.
- Edge WAE parameters—Includes the general parameters, network connectivity parameters, CIFS statistics, and cache statistics.