



Solution Overview

Cisco Application-Oriented Networking Streamlines Financial Market-Data and Trade-Order Latency

Cisco® Application-Oriented Networking (AON) allows unobtrusive monitoring and analysis of market-data and trade-order flow latency through the network—allowing bottlenecks to be identified at both the application and network levels in real time, streamlining problem resolution, providing faster access to financial trading venues, and supplying continuous measures of order flow latencies to trading applications that distribute their order flow across trading venues.

THE NEED FOR SPEED

Benjamin Franklin said “time is money,” and today’s financial trading markets prove this aphorism true. Successful trade execution demands price discovery in milliseconds—while the data still reflects the actual market. Data that is even a few milliseconds out of date can mean a lost opportunity in the world of automated trading.

Although the basic principles of trading have not changed much since Franklin’s time, the means of execution and its impact on profit certainly have. In this new, more cost-conscious era of investment services, sensitivity to the timing and latency of the message required to execute an order has greatly increased. Algorithmic trading, as well as the growth of trading venues such as the Electronic Communications Network (ECN), has placed a greater premium on achieving both the lowest latency and the highest traceability and visibility in the message-handling networks that serve the many parties in today’s trading processes.

“In some markets, one millisecond can change a winning trade into a losing trade,” notes Jeff Drew, chief technical officer (CTO) of New York-based Trading Metrics, a Cisco Systems® partner and a leading provider of market-data latency analytics and monitoring solutions. Ken Barnes, vice president for business and planning at Wombat, a leading provider of financial software for electronic trading, agrees: “A firm can’t trade without knowing exactly where the market is, and the shelf life of market data is steadily dwindling.”

Faced with persistent growth—both in real-time market data demanded by electronic trading groups and in the number of market participants—leading financial institutions are bolstering their data infrastructures and eliminating as much latency as possible in the quest for speed.

THE CHALLENGE OF LATENCY MANAGEMENT

Latency can be defined as the time interval between when a trade order is sent and when that same order is acknowledged and acted upon by the receiving party. Maintaining an accurate measure of the dynamic state of this time interval across alternative routes and destinations can be of great assistance in tactical trading decisions. The ability to identify the exact location of delays—whether in the customer’s edge network, the central processing hub, or the transaction application level—significantly determines the ability of service providers to meet their trading service-level agreements (SLAs). And for buy-side and sell-side firms as well as for market-data syndicators, the quick identification and removal of bottlenecks translates directly to enhanced trade opportunities and revenue.

Part of the difficulty in measuring latency is in ensuring that the monitoring function itself does not introduce any extra effects on throughput and performance while still providing actionable information about what is going on. The solution is to operate “out of band,” that is, using a separate path away from the main data stream, similar to the way in which telephone control signals do not interfere with voice traffic.

Another difficulty with modern latency management is the need to handle both the network-level and application-level aspects of the same transaction, because each of these levels can introduce its own idiosyncratic effects and requires different tuning to extract maximum performance.

Although the infrastructures of most enterprise and service providers have matured to provide well-instrumented packet-level TCP performance monitoring and management, the new capital markets environment requires close management of application-level Financial Information eXchange (FIX) messages as well. A solution that brings together both packet-level and application-message-level monitoring of trading performance allows service providers to adjust the degree of real-time control they exert over their infrastructure in pursuit of the best execution times and qualitative (that is, price-based) investment services.

Current solutions to these challenges have come mainly from either small, specialist application vendors or the internal proprietary efforts of broker-dealers, investment banks, and exchanges. These existing solutions generally depend on extracting data from the main data traffic flow using sniffers, network taps, port spanning, and other specialized methods of traffic inspection.

A typical solution has three layers. In the first layer, observer functions of the type described in the preceding paragraphs are deployed close to the entry and exit points of interest in the network. A second layer provides analytical functions that integrate the observer streams from several points into an end-to-end structure. A third layer provides a dashboard that displays events, status, and other information synthesized from the observed data, as well as an API for direct delivery of this information to algorithmic trading systems.

An important challenge in this multilayered approach is the complexity and scalability of the observer function. The use of server-based capture mechanisms limits deployment to critical edge points, appliances designed for observer functions also impose a scaling, and these mechanisms consume scarce network and application server resources to accomplish their tasks. Specialized manageability, and resource consumption burden because they need to be deployed at multiple, separate locations. Moreover, many of the current methods for inspecting network traffic are not inherently application-aware, requiring intensive postprocessing of the data for meaning, and may need to be installed at every processing node in the path of the transaction.

This situation reveals the pressing need for a network-embedded, noninvasive, application-aware solution that can provide latency measurements for every component in the transaction message path in real time.

WHY USE CISCO AON FOR FIX ORDER-FLOW LATENCY?

- Reduced cost—Integrating a network device reduces the total cost of ownership.
- Visibility of network and application latency—Visibility allows more accurate identification of bottlenecks in the message path infrastructure.
- Actionable analytics—Key performance indicators (KPIs), alerts, and trend curves convey real-time actionable connectivity status, enhance infrastructure capacity planning, and meet higher customer SLAs.
- Flexible message capture—This pervasive, noninvasive, network-embedded solution captures, extracts, filters, and routes copied FIX monitoring messages selectively to analytics dashboards, without disrupting inline traffic.

SOLUTION: FINANCIAL SERVICES MONITORING SOLUTION 1.0 FOR FIX ORDER-FLOW LATENCY

Cisco AON technology is the foundation for a new class of network-embedded products and solutions that help unite intelligent networks with application infrastructure based on either service-oriented or traditional architectures. With Cisco AON, organizations can embed a new class of application-message-level intelligence into the network, to better meet the underlying needs of applications for real-time visibility, security, event-based messaging, optimized delivery, and other core integration and deployment services.

Cisco AON technology is ideally suited to the challenges of today's financial trading markets. Cisco AON effectively bridges the network-application gap by empowering the underlying packet network to natively understand the content and context of financial application messages such as trade orders and market data in real time and to conduct operations on those messages in transit according to business policies and at network speeds.

The Cisco AON Financial Services Latency Monitoring Solution correlates two kinds of events at the point of observation: network events correlated directly with coincident

application message handling, and trade-order flow and matching market-update events. Using time stamps asserted at the point of capture in the network, real-time analysis of these correlated data streams permits precise identification of bottlenecks across the infrastructure while a trade is being executed or market data is being distributed. By monitoring and measuring latency early in the cycle, financial companies can make better decisions about which network service—and which intermediary, market, or counterparty—to select for routing trade orders. Likewise, this knowledge allows more streamlined access to updated market data (stock quotes, economic news, and so on), which is an important basis for initiating, withdrawing from, or pursuing market opportunities. Cisco AON Fix Order-Flow Latency Monitoring Solution uniquely integrates both application- and network-level information about the same transaction from within the network itself, allowing levels of insight and control previously unobtainable.

Solution Benefits

- **Through its unique approach of incorporating FIX monitoring infrastructure directly into the network, the Cisco AON for FIX Order-Flow Latency solution provides powerful business benefits: Reduces the cost of order flow latency monitoring**—Compared with today’s alternatives, Cisco AON significantly reduces the cost and complexity of deploying and managing both FIX order flow and connectivity monitoring infrastructure. Rather than having to set up, configure, and manage multiple-point components and servers throughout the enterprise, possibly performing proprietary coding and integration, you can simply embed the required functions in a familiar device that fits within the existing network infrastructure.

Both the capture and packaging of FIX message traffic for consumption by analytical applications are controlled through simple configuration and centrally managed policies that can be propagated automatically to the appropriate Cisco AON observer as needed. This automatic propagation helps ensure consistent monitoring of behavior, and it also virtually eliminates the need to send out expensive IT personnel to manually update and synchronize policy at multiple individual servers and points of interception.

In addition to offering specific filtering and message framing extensions for order flow transactions within the device, Cisco AON optimizes and secures bandwidth usage between outlying customer locations (for instance, buy-side firms, where the FIX messages originate) and network hubs (where messages are received and broadcast to sell-side customers).

- **Increases flexibility in message capture**—Cisco AON not only captures a wide variety of order flow messages (trade orders, confirmations, and notifications of execution), but it can also *act upon* these captured messages to extract important information from them and compare it with market data or calculate summary statistics.

When FIX messages enter the network, Cisco AON can apply a variety of functions to them. For example, it can make copies of the message-bearing packets out of band, extract the FIX message from TCP segments, use modular extensions to framing the FIX message with framing extensions, and route the monitoring message to the desired destination.

- **Provides a low-risk, incremental growth path**—The order flow latency monitoring provided by Cisco AON for FIX is designed to build upon your existing investment in Cisco networking equipment and skills. By adding a blade or module to a Cisco Integrated Services Router or a Cisco Catalyst® 6500 Series switch, together with the accompanying software tools, you can begin implementing a network capable of FIX latency monitoring. Also, through a partnership with Trading Metrics, Cisco AON for FIX Order-Flow Latency Monitoring Solution can perform a rich set of analyses to track the performance of TCP connections, FIX connections, and FIX transactions. Dashboard presentation capabilities display KPIs related to the FIX traffic flow.

By implementing Cisco AON with a FIX Order-Flow Latency monitoring solution, you are also putting in place an architectural foundation for further application infrastructure functions such as application security, Extensible Markup Language (XML) message processing, content-based routing, and compression.

Overview of the Solution

The Cisco AON for FIX Order-Flow Latency Monitoring Solution is a package of Cisco AON software, hardware, and services that offers the following core functions:

- Capture, filtering, and framing of FIX messages from raw network TCP segments using a promiscuous-mode adapter (which makes copies of packets without affecting inline traffic) embedded in the Cisco AON device
- FIX message latency analytics, including time-based analysis of observer streams, dissectible latency measures for total-path trajectories, point-to-point and edge-to-edge comparisons across layers, and correlation of FIX traffic to extract network latency and FIX application latency
- KPIs for application and network managers, with centralized analysis and distributed reporting

To address the need for out-of-band monitoring without introducing its own effects, the Cisco AON for FIX solution uses a promiscuous-mode adapter to receive copies of network traffic in real time, together with special framing extensions that format the captured network TCP segments as FIX frames. A specialized analytical engine then constructs both application-level and network latency metrics and KPIs for presentation in a dashboard display.

A specialized financial message monitoring solution standalone adapter provides the message extraction and framing and network attribute stamping stages. The solution offers Cisco AON standard FIX and HTTP message assembly, and you can configure the adapter with third-party vendor libraries optimized for promiscuous-mode message extraction and framing. Using the extensibility features of the Cisco AON Adapter Developer Kit, you can easily add framing service extensions and integrate them into the Cisco AON observer.

The publishing stage is provided by a built-in Send service as a default capability integrated with the promiscuous-mode adapter. Using the extensibility features of the Cisco AON Adapter Developer Kit, you can define specialized Send services and integrate them with the adapter.

The Cisco AON for FIX Order-Flow Latency Monitoring Solution provides a standard promiscuous-mode Cisco AON configuration with a standalone promiscuous-mode adapter. Using the Cisco AON Management Console (AMC), you can configure this adapter to filter for specific message types and source and destination IDs to handle various message protocols, attribute stamping behaviors, and interface requirements. The Cisco AON for FIX Order-Flow Latency Monitoring Solution uses the Cisco AON adapter extensibility framework and Cisco AON promiscuous-mode packet processing to define and generate out-of-band visibility contents in configurable data formats. It also includes a standard network monitoring data and event model to enhance transaction message traffic monitoring, aggregation, and correlation. Solution deployments can use some, all, or none of these network events and message attributes.

SAMPLE USE CASES

The most commonly used scenarios in financial services latency monitoring are FIX trade-order flow latency monitoring, and market-data latency monitoring.

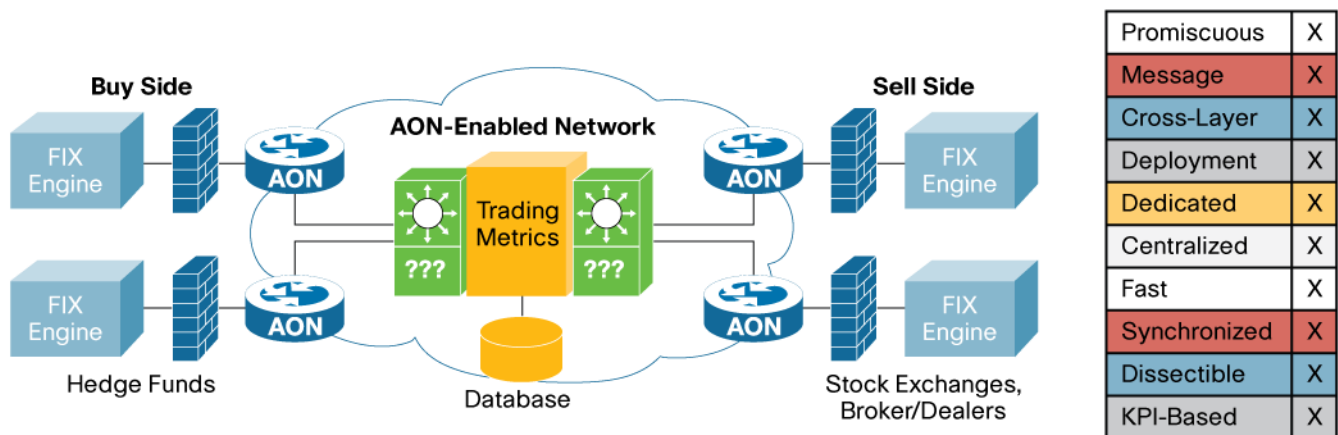
Use Case 1: Trade-Order Flow Latency Monitoring

The primary use of the Cisco AON for FIX Order-Flow Latency Monitoring Solution is for the real-time monitoring and analysis of latency in both the network infrastructure and the applications that handle trading orders (Figure 1).

Figure 1. Cisco AON FIX Order-Flow Latency Monitoring

Cisco AON for FIX Order-Flow Latency Monitoring Solution Benefits

- **Visibility of trading performance:** Application message round trip is monitored for low latency
- **Competitive advantage:** Managed service can be differentiated by low trade latency and reduced risk
- **No changes to existing infrastructure:** Cisco AON operates in promiscuous mode
- **Reduced cost of operation:** Cisco AON blades are easier to manage than network taps and servers
- **Network and application alerting:** TCP connections, FIX connections, and FIX transactions are modeled in real time, deriving KPIs for alerts and time-series reporting
- **Immediate diagnostic event replay:** The database that stores TCP connections, FIX connections, and FIX transactions can be viewed through a TiVo-like device



Trading orders are routed to intermediaries (sell-side brokerages and banks) or directly to exchanges through direct market access using high-speed network infrastructures such as those provided by Transaction Network Services (TNS) for equities trading or eSpeed for fixed-income products. The response (sell side) comprises both TCP-level ACK network events and application-level FIX ACK, Confirm, and FILL data events. Analysis of how quickly these ACK, Confirm, and FILL events are received is an important measure of network and application latency.

Use Case 2: Market-Data Latency Monitoring

Market data refers to direct and consolidated feeds from NASDAQ or Reuters, subscribed to by banks such as Citibank and brokerage firms. Typically, market data travels through several routing hops such as feed handlers, tick distribution applications, and Tibco broadcast infrastructures before eventually being consumed by algorithm-directed trading applications or traders' desktop trading workstations. Timely market data is critical for these companies because they have algorithms in place to trigger appropriate trades, and excessive latency can mean the difference between a winning trade and a losing one.

SOLUTION COMPONENTS

The Cisco AON for FIX Order-Flow Latency Monitoring Solution consists of the software and hardware modules and service offerings summarized here. Table 2 shows the form factors for the supported platforms.

Figure 2. Cisco AON for FIX Solution Form Factors

Cisco 2600/2800/3700/3800 Series

Application-Oriented Networking Module Promiscuous-Mode
Monitor Interfaces: eth1 (internal); eth0 (default)



Cisco Catalyst 6500 Series

Application-Oriented Networking Module Promiscuous-Mode
Monitor Interface: eth3



Cisco AON 8340 Series Appliance Application-Oriented Networking Appliance

Promiscuous-Mode
Monitor Interface: eth2



- **Cisco 2600/2800/3700/3800 Series AON Module**—This Cisco AON Network Module for Cisco Integrated Service Routers offers a high level of performance while providing a cost-effective solution to meet the needs of small and medium-sized branch offices.
- **Cisco Catalyst 6500 Series Application-Oriented Networking Module**—This service module offers the same functions as the Cisco 2600/2800/3700/3800 Series AON Module packaged in a convenient form factor for owners of Cisco Catalyst 6500 Series switches.
- **Cisco 8340 Application-Oriented Networking Appliance**—The Cisco 8340 AON Appliance is an alternative form factor that combines the concentrated performance and ease of use of a standalone appliance with the added value of a network-embedded solution. It offers:
 - Deployment flexibility within the umbrella of a network-embedded Cisco AON solution
 - High performance augmented by custom hardware acceleration
 - Easy integration and management as part of the existing infrastructure

CISCO AON FOR FIX ORDER-FLOW LATENCY MONITORING SOLUTION—ADVANCED SERVICES OFFERINGS

The Advanced Services group offers a set of packaged services to help clients design, build, and deploy FIX solutions using Cisco AON in an efficient and timely manner. These services use Cisco best practices to create reliable, scalable, available, and manageable networks and network-based solutions. Following proven methodologies for implementing other network technologies, these services provide full lifecycle coverage for the preparation, planning, design, implementation, and operation of such solutions in mission-critical data networks. These services can be delivered by either Cisco or its proven partners, and customers can be trained to assume responsibility for these services and the best practices that they embody.

The specific services offerings are outlined in the following sections.

FIX Monitoring Solution Scoping

Scoping services focus on defining function, message format, and deployment requirements for the solution. Activities, deliverables, and tools include the following:

- Assessment of observation points
- Definition of observer extension requirements
- Definition of observer module requirements
- Definition of manageability requirements
- Analysis of traffic patterns to be monitored by observers
- Definition of time synchronization requirements
- Certification requirements for Cisco IOS® Software routers and switches
- Primary deliverables: Customer requirements document and network assessment document
- Tools: Observer deployment modeler, traffic analyzers, and time synchronization monitors

Cisco AON FIX Order-Flow Latency Monitoring Solution—Planning

Planning services focus on the creation of a step-by-step plan for controlled and tested deployment of the solution. Activities, deliverables, and tools include the following:

- Deployment planning
- Management planning
- Network Time Protocol (NTP) synchronization planning
- Cisco IOS Software certification planning
- Test planning: Systems integration testing and user acceptance testing
- Primary deliverables: Deployment plan, management plan, network readiness plan, test plan including SIT, user acceptance team (UAT), and test cases, and analyzer and informer configuration plan
- Tools: Deployment simulators and test-data generators

Cisco AON FIX Order-Flow Latency Monitoring Solution—Customization

Customization services focus on the development and testing of new extensions required for message formats and protocols that the solution does not support out of the box. Activities, deliverables, and tools include the following:

- Extension and customization services: Development, unit testing, integration testing, and performance analytics for preframing, framing, postframing, and Send extensions
- Primary deliverables: Extension code files for new formats, extension design and function specification documents, and extension unit testers
- Tools: Extension development toolkit and extension test harness

Cisco AON FIX Order-Flow Latency Monitoring Solution—Testing

Testing services focus on the phased testing of the solution in an integrated lab or a controlled production environment for user acceptance. Activities, deliverables, and tools include the following:

- Systems integration testing
- User acceptance testing
- Trial production monitoring and rollback
- Primary deliverables: System test results and production monitoring results
- Tools: System testing simulators and harnesses and production monitoring tools

Cisco AON FIX Order-Flow Latency Monitoring Solution—Pilot Deployment

Deployment services focus on the phased and controlled deployment of the solution into production, with processes to replicate the steps for full-scale production. Activities, deliverables, and tools include the following:

- Management systems configuration
- Support systems configuration
- Pilot production installation of observer nodes
- Analyzer and informer configuration and integration
- Production monitoring for one production cycle
- Primary deliverables: Production deployment configurations, support guide, monitoring guide, and full-production staging guide
- Tools: Production monitoring tools

Cisco AON FIX Order-Flow Latency Monitoring Solution—Support

Support services provide integrated multi-tiered support for the solution after it is deployed into production. Activities include the following:

- High-touch onsite solution support to troubleshoot problems on the customer's premises
- Globally available remote call-in production support to support the deployed solution
- Escalation services to provide replacement hardware and patches

Cisco AON FIX Order-Flow Latency Monitoring Solution—Training

Training services teach customers the skills required to plan, design, and implement the system. Training can be delivered in Cisco classrooms with full lab access or at a customer's or partner's site. Training is designed to help customers and systems integration partners to be self-sufficient. Training activities include the following:

- Overview of the Cisco AON FS monitoring solution:
 - Cisco AON core components
 - Cisco AON FS monitoring architecture
 - Promiscuous-mode reference architecture
 - Cisco AON FS monitoring solution extension
- Step-by-step configuration of the FS monitoring solution
- Review of Cisco FIX simulator tools
- Deployment, management, and test planning overview:
 - Solution scoping and planning
 - Solution installation and integration with the analyzer and informer
 - Solution systems integration test
 - Solution pilot deployment simulation
- Solution customization and extension services development: Design, development, unit testing, and integration testing of a custom extension service

SUPPORTING SOLUTIONS, PRODUCTS, PARTNERS, AND SERVICE OFFERINGS

Cisco AON is a cornerstone of the company's efforts to deliver an intelligent foundation for streamlined and effective application collaboration, and it was designed from the outset to foster a system of partners to add specialized value.

For the Cisco AON for FIX Order-Flow Latency Monitoring Solution, Cisco has partnered with Trading Metrics, a leading provider of analytics software for network infrastructure and application latency monitoring purposes.

Trading Metrics M&A 2.0 is an integrated component of the Cisco AON for FIX Order-Flow Latency Monitoring Solution, providing a highly scalable monitoring and alerting application that monitors the speed of order flow as well as the underlying infrastructure, displays network- and application-level latency curves on a dashboard, and issues alerts when slowdowns and bottlenecks occur in the network and application infrastructure.



WHY CISCO?

The Cisco AON for FIX Order-Flow Latency Monitoring Solution delivers advanced levels of business intelligence, cost savings, and flexibility in a convenient form factor that can scale from one node to the scope of your most optimistic future growth plans. Cisco developed the solution to meet the specific needs of today's most demanding financial markets to help you optimize trading performance, meet SLAs, offer competitive premium services, optimize network performance, and maximize network value. Cisco supports your enterprise with its expertise to facilitate faster deployments, and you can rely on its powerful knowledge of latency monitoring to facilitate application-level network performance best practices.

The network form factor allows the Cisco AON for FIX Order-Flow Latency Monitoring Solution to combine end-to-end security, scalability, interoperability, and traffic management with a foundational infrastructure that allows you to deploy both current and future Cisco FS monitoring applications such as market data feeds with content-management systems (CMSs), SWIFT financial industry cooperative products and services, and other specialized message protocols. This approach provides application message and network traffic performance visibility for analytic applications and delivers latency information for direct use in transactional decision making.



Corporate Headquarters
Cisco Systems, Inc.
170 West Tasman Drive
San Jose, CA 95134-1706
USA
www.cisco.com
Tel: 408 526-4000
800 553-NETS (6387)
Fax: 408 526-4100

European Headquarters
Cisco Systems International BV
Haarlerbergpark
Haarlerbergweg 13-19
1101 CH Amsterdam
The Netherlands
www-europe.cisco.com
Tel: 31 0 20 357 1000
Fax: 31 0 20 357 1100

Americas Headquarters
Cisco Systems, Inc.
170 West Tasman Drive
San Jose, CA 95134-1706
USA
www.cisco.com
Tel: 408 526-7660
Fax: 408 527-0883

Asia Pacific Headquarters
Cisco Systems, Inc.
168 Robinson Road
#28-01 Capital Tower
Singapore 068912
www.cisco.com
Tel: +65 6317 7777
Fax: +65 6317 7799

Cisco Systems has more than 200 offices in the following countries and regions. Addresses, phone numbers, and fax numbers are listed on the **Cisco.com Website at www.cisco.com/go/offices.**

Argentina • Australia • Austria • Belgium • Brazil • Bulgaria • Canada • Chile • China PRC • Colombia • Costa Rica • Croatia • Cyprus • Czech Republic
Denmark • Dubai, UAE • Finland • France • Germany • Greece • Hong Kong SAR • Hungary • India • Indonesia • Ireland • Israel • Italy
Japan • Korea • Luxembourg • Malaysia • Mexico • The Netherlands • New Zealand • Norway • Peru • Philippines • Poland • Portugal
Puerto Rico • Romania • Russia • Saudi Arabia • Scotland • Singapore • Slovakia • Slovenia • South Africa • Spain • Sweden
Switzerland • Taiwan • Thailand • Turkey • Ukraine • United Kingdom • United States • Venezuela • Vietnam • Zimbabwe

Copyright © 2006 Cisco Systems, Inc. All rights reserved. CCSP, CCVP, the Cisco Square Bridge logo, Follow Me Browsing, and StackWise are trademarks of Cisco Systems, Inc.; Changing the Way We Work, Live, Play, and Learn, and iQuick Study are service marks of Cisco Systems, Inc.; and Access Registrar, Aironet, BPX, Catalyst, CCDA, CCDP, CCIE, CCIP, CCNA, CCNP, Cisco, the Cisco Certified Internetwork Expert logo, Cisco IOS, Cisco Press, Cisco Systems, Cisco Systems Capital, the Cisco Systems logo, Cisco Unity, Enterprise/Solver, EtherChannel, EtherFast, EtherSwitch, Fast Step, FormShare, GigaStack, HomeLink, Internet Quotient, IOS, IP/TV, iQ Expertise, the iQ logo, iQ Net Readiness Scorecard, LightStream, Linksys, MeetingPlace, MGX, the Networkers logo, Networking Academy, Network Registrar, Packet, PIX, Post-Routing, Pre-Routing, ProConnect, RateMUX, ScriptShare, SlideCast, SMARTnet, The Fastest Way to Increase Your Internet Quotient, and TransPath are registered trademarks of Cisco Systems, Inc. and/or its affiliates in the United States and certain other countries.

All other trademarks mentioned in this document or Website are the property of their respective owners. The use of the word partner does not imply a partnership relationship between Cisco and any other company. (0601R)

Printed in USA

C22-352007-00 06/06