

# Cisco IGX 8400 Series Wide-Area Switches: The Foundation for Maximum Revenue and Service Availability

## Meet Today's Demands and Tomorrow's Expectations

Few tasks are as challenging as running a business in the midst of converging industry trends. Service providers today find themselves simultaneously coping with deregulation, the growth of the Internet, a host of new networking technologies, rapidly increasing competition, and growing customer demand for voice, data, and multimedia services.

The Cisco IGX™ 8400 series wide-area switches provide the backbone required to deliver data, voice, fax, and video services with guaranteed quality of service (QoS). Available with 8, 16, or 32 slots, the IGX 8400 series switches offer the greatest flexibility to meet a wide range of service providers' needs. Tight integration with the broad range of Cisco access products enables you to efficiently and cost-effectively deliver managed backbone-to-branch data, voice, fax, and video services to customers' premises. A network powered by Cisco enables you to meet the broadest range of customer needs, increasing your market penetration, revenue opportunities, and customer satisfaction.

As the pioneer of the Internet and IP network infrastructures, and a leader in ATM, Frame Relay, traffic management, and QoS, Cisco is uniquely qualified to build intelligent multiservice networks. Team with Cisco and you can deploy industry-leading wide-area network (WAN) solutions that maximize revenue potential and give you flexibility for whatever your market demands.

## The Cisco IGX—The Most Flexibility a Network Can Offer

Today your customers have a wider range of voice and data networking needs than ever before. That's why service providers around the world choose the IGX 8400 series to enable you to cost-effectively deliver multiple services with the highest service availability and QoS in the industry. The IGX solution provides Intelligent QoS Management features, ensuring that all your customers' applications receive the bandwidth and QoS they require.

## Maximize Revenue with a Flexible Platform

Worldwide deregulation has resulted in intense service provider competition. As your customers seek new ways to reduce networking costs, the best way to win their loyalty (and a greater market share) is to provide the data, Internet, and multimedia services they want with the quality of service they need. With the IGX switch, you can quickly deploy robust data, voice, fax, and video capabilities from a single platform, maximizing revenue opportunities while minimizing operations costs.

A next-generation, multiservice WAN switch, the IGX 8400 series provides integration of IP+ATM and interfaces for transporting ATM, Frame Relay, synchronous and asynchronous legacy data, Internet, video, and voice traffic. The IGX switch consolidates multiple traffic types over a single reliable backbone with advanced traffic management features, ensuring that each customer's traffic automatically receives the QoS it requires. Not only can you deliver higher customer satisfaction, you can dramatically reduce time to market for new revenue-generating services.

Figure 1 IGX 8400 Series



#### **Ensure Nonstop Service Availability**


Designed for service providers, the IGX 8400 series offers carrier-class capabilities that make vital services always available. The midplane design of the IGX switch features front cards that perform processing and switching functions and back cards that perform adaptation and provide interfaces for physical connectivity. System maintenance can be performed at the front cards without disconnecting interface cables. Even during maintenance and upgrades, your services remain available and customers remain productive.

#### **Redundant Critical Components**

Redundancy ensures nonstop operation, and all IGX common equipment can be configured redundantly for maximum platform reliability. AC-powered IGX units can be equipped with dual AC power feeds and power supplies configured in a load-sharing, redundant mode. Processor cards can be configured for hot standby redundancy. All user and trunk interface modules can be configured redundantly to achieve the required level of node reliability. All cards are hot-swappable. New software releases can be remotely downloaded onto the redundant processor for background installation while traffic continues.

#### **Flexible Routing Paths**

The IGX 8400 series also features an advanced distributed intelligence algorithm that enables the network to automatically route new connections and, if necessary, react to failures in network facilities. The IGX switch specifies preferred paths or avoids certain paths across the network when configuring new connections. Each connection is routed or rerouted to ensure that it receives its required minimum bandwidth. Rerouting priorities can also be established for every connection.



## Differentiate Services and Increase Customer Satisfaction

To stand out in a competitive market, your services must enhance your customers' application performance every hour, every day. The IGX 8400 series switch incorporates advanced traffic and bandwidth management features that maximize bandwidth efficiency and enable you to guarantee levels of service for virtually any type of traffic—legacy, Frame Relay, ATM, leased line, multimedia, and voice. This capability means you can fully utilize available bandwidth to accommodate increasing traffic volumes and new applications. The IGX 8400 series gives you the ability to deliver more, better.

### Automatic Routing Management

The IGX switch automatically routes and reroutes connections over optimal paths based on source and destination ports, as well as on user-defined QoS parameters.

### Dynamic Buffer Management

Each IGX Frame Relay and ATM service module is equipped with large buffers and a patented dynamic buffer management scheme for traffic entering or leaving a node. The IGX switch dynamically assigns buffers to individual virtual circuits (VCs) based on the amount of traffic present and service-level agreements. This deep pool of available buffers readily accommodates large bursts of traffic into the node.

### Advanced Class-of-Service Management

Sophisticated per-VC queuing and prioritizing algorithms enhance standard ATM classes to provide up to 16 classes of service (CoS). This selection enables you to refine connections to differentiate services to meet specific customer needs. Cell admission rates are automatically adjusted depending on whether and where congestion exists on the network (as communicated by the Available Bit Rate (ABR) or ForeSight licensed technology traffic management mechanism).

### Optimized Bandwidth Management

The IGX 8400 switch ensures fair and cost-efficient bandwidth utilization using various techniques. Voice compression and Voice Activity Detection (VAD) are used for voice. Repetitive Pattern Suppression (RPS) is used for circuit data traffic. ABR and ForeSight licensed technology are used for ATM and Frame Relay traffic management. ABR is a standards-based ATM traffic management mechanism, and the ForeSight technology is Cisco's leading-edge implementation that mirrors ABR capabilities for Frame Relay traffic. ABR and the ForeSight feature set optimize real-time traffic performance and throughput, as well as minimize data loss.

### IP-to-ATM Interworking

As the networking industry moves toward integrated Layer 2 and Layer 3 protocols, the IGX switch supports multiprotocol label switching (MPLS) standards. Built-in IP-to-ATM interworking features reduce data loss, the time required for establishing router connections, human error, and troubleshooting times.

## Scalability Allows You to Grow Cost-Effectively

With the Internet's growth exceeding all expectations and corporate customers requiring an ever-growing number of services, you need to be able to increase your network capacity without breaking your budget. The design of the IGX 8400 series switch gives you the scalability to quickly meet growth demands—today, next week, and next year—while minimizing infrastructure costs.

The IGX 8400 series is available with 8, 16, or 32 slots (IGX 8410, IGX 8420, or IGX 8430, respectively) and uses a 1.2-Gbps redundant cell bus to switch cells between optionally redundant user and trunk interface modules. With the IGX switch, any amount of bandwidth can be assigned to any slot. Traffic destined to another node is received by the appropriate trunk interface module and sent to the appropriate trunk port. Service interface modules offer the following port densities per module:

- Two or four OC-3/STM-1 ATM interfaces per module
- Three or six T3/E3 ATM interfaces per module
- Four or eight T1/E1 ATM interfaces per module
- Four or eight T1/E1 Frame Relay interfaces per module (channelized or unchannelized)
- Four or twelve V.35 or X.21 Frame Relay interfaces per module
- Four High-Speed Serial Interface (HSSI) Frame Relay interfaces per module
- Four V.35 or EIA/TIA-449 or X.21 circuit data interfaces per module
- Four or eight EIA/TIA-232 circuit data interfaces per module
- One- or two-port voice module (T1/E1/J1)

### **Minimize Costs and Maximize the Bottom Line**

Cost-effectiveness is measured by more than a purchase price. The IGX 8400 series is designed to reduce your overall operating and management burden, in addition to delivering services cost-effectively. For example, the IGX switch offers the lowest cost per port of any ATM switch in the market. High port density and advanced bandwidth management techniques enable you to carry high traffic levels at the lowest cost per subscriber in the industry.

### **A Broad Range of Services Offers the Most Flexibility**

Whether you need to deploy differentiated services, minimize networking costs, or quickly respond to competitive pressure—the IGX 8400 series switch can meet your needs.

#### ATM Services

The IGX switch offers standards-compliant ATM User-to-Network Interface/Network-to-Network Interface (UNI/NNI) on a variety of physical interface types.

All ATM interfaces support per-VC queuing, rate scheduling, and multiple classes of service, including those defined by the ATM Forum:

- Constant Bit Rate (CBR)
- Variable Bit Rate (Real-Time) (VBR [RT])
- Variable Bit Rate (Nonreal-Time) (VBR [NRT])
- ABR
- Unspecified Bit Rate (UBR)

The IGX switch also offers ATM interfaces that can be customized to meet the performance requirements of specific applications. It supports all ABR implementations, including Virtual Source/Virtual Destination (VS/VD), Explicit Forward Congestion Indication (EFICI) marking, and Explicit Rate Marking (ERM).

#### Frame Relay Services

Frame Relay services are today's fastest-growing network services for business-critical applications. The IGX switch offers standards-compliant Frame Relay UNI/NNI on a variety of physical interface types. The Cisco Frame Relay implementation goes beyond standard requirements. The advanced traffic management features of the IGX 8400 series enable built-in congestion avoidance mechanisms to deliver unbeatable performance for Frame Relay traffic. Standards-based messaging on the User Network Interface (UNI) enables the IGX switch to extend traffic management features to Cisco routers, delivering high QoS across the entire Frame Relay network and virtually eliminating data loss. Enhanced Local Management Interface (ELMI) also enables automatic Frame Relay traffic-shaping parameter configuration on Cisco routers, saving time, reducing the potential for configuration errors, and eliminating lengthy troubleshooting times.

#### IP Services

The Cisco IGX 8400 Series supports MPLS, which enables you to provision customized, integrated IP+ATM services such as voice over IP, VPNs and other leverage services. Compliant with the emerging Internet Engineering Task Force (IETF) standard for multiprotocol label switching, MPLS delivers end-to-end QoS support for IP and ATM traffic while reducing data loss, and combines Layer 3 scalability benefits with Layer 2 traffic management and reliability advantages of virtual circuits.

#### Voice Services

As pressure increases to reduce costs, many service providers are consolidating voice traffic over their WANs to capitalize on WAN bandwidth. The IGX switch offers efficient, high-quality voice connectivity across the wide-area backbone. All IGX voice interfaces can be directly attached to voice switches for voice or fax/data connectivity via a T1/E1 interface.

### Leading-Edge Voice Compression

The IGX 8400 series voice interfaces support standards-based voice compression schemes and onboard echo cancellation. Voice compression reduces the amount of bandwidth required for voice connections across the wide-area network. The IGX switch supports the following voice compression techniques:

- Adaptive Differential Pulse Code Modulation (ADPCM); 32 kbps, 24 kbps, 16 kbps
- Low-Delay, Code-Excited Linear Prediction (LD-CELP); 16 kbps
- Conjugate-Structured, Algebraic Code-Excited Linear Prediction (CS-ACELP); 8 kbps

### Silence Suppression

The IGX voice interfaces also support the VAD silence suppression technique, which distinguishes between silence and speech on voice connections. With VAD, cells are only sent on the trunk when there is something to send. With most voice connections consisting of up to 60 percent silence, VAD technology enables the IGX 8400 series to achieve an average 2:1 compression ratio, thus saving additional bandwidth. When combined with ADPCM, LD-CELP, or CS-ACELP compression schemes, VAD enables you to achieve compression ratios beyond 8:1.

### Fax/Modem Support

In addition, the voice interfaces support fax and modem data transport. Fax calls can be detected by sampling the 2100-Hz tone. For Group 3 fax, the Universal Voice Module supports Fax Relay whereby it demodulates and remodulates the signal and transports a fax across the network using only 9.6 kbps of network capacity. This dramatically reduces the amount of bandwidth utilized across the network. The Channelized Voice Module allows for fax/data transport across the network at 64 kbps or 32 kbps.

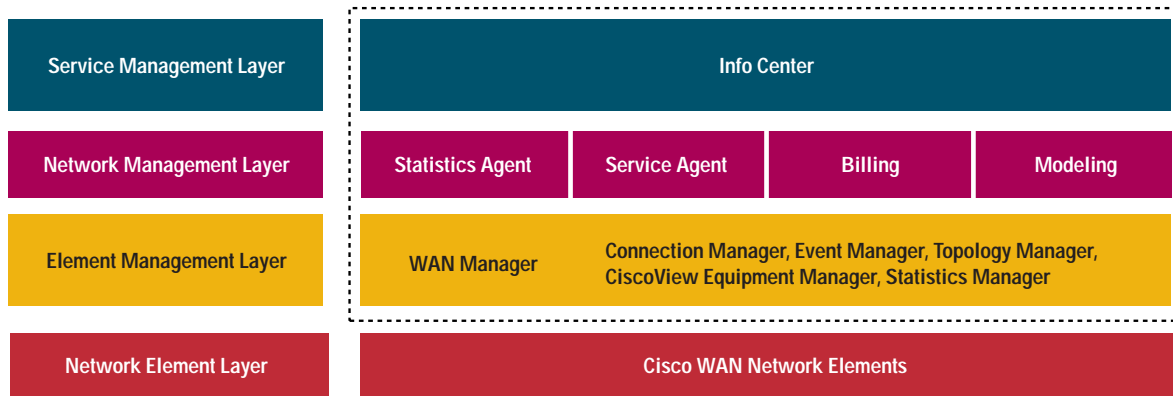
### Voice Switching Support

The IGX 8400 series also supports voice switching capabilities using the Voice Network Switching (VNS) system. VNS enables an IGX network to function as a tandem voice network that receives signaling, interprets it, and dynamically establishes voice connections between the source and destination ports. The network routes each voice channel on a per-call basis and extends advanced voice features (such as transfer, caller ID, and camp-on) across the wide-area network. With VNS, available trunk capacity can be dynamically used by bandwidth-hungry data applications, thus maximizing the efficiency of available network resources. The network ensures an optimal connection for each call, reducing delay and improving voice quality by minimizing compression cycles.

### Circuit Data Services

IGX 8400 series circuit data capabilities enable synchronous or asynchronous legacy data or video to be transported across the WAN through a fixed-delay, fixed-throughput, zero discard, or point-to-point data connection. Available speeds range from 1.2 kbps to T1/E1 for synchronous data and 1.2 kbps to 19.2 kbps for asynchronous data using standard serial interfaces such as V.28/RS-232, V.11/X.21, V.35, EIA/TIA-449, and T1/E1.

Figure 2 The Cisco Multiservice Management Architecture



#### Data Compression

Unique to the IGX 8400 switch is the capability to dynamically compress data connections (up to 128 kbps) by using RPS. With RPS, one end of a data connection determines the repetitive pattern and the number of pattern occurrences and does not assemble them into cells for network transport. The far end of the data connection determines the repetitive pattern and number of pattern occurrences by monitoring the incoming cells and their sequence numbers and regenerates these patterns to the user interface. For example, this capability is extremely effective when implementing SDLC/High-level Data Link Control (HDLC) connections across the network, because idle conditions (flags 7E) can be suppressed and not transported across the network.

#### Flexible Clocking, Lead Monitoring, and Control

IGX circuit emulation interfaces also offer flexible clocking to accommodate the connection of colocated or remote devices to an IGX 8400 series network. These interfaces also monitor control leads on each interface, using changes to “condition” the leads at the far end of the IGX network. The IGX switch can also be configured to use a change in lead on a circuit emulation interface to trigger an event in the network. This feature can be used to dynamically set up bandwidth-on-demand connections across the WAN.

#### Networking Connectivity

A network of IGX multiservice ATM switches can be deployed with a variety of trunk interfaces and speeds ranging from 64 kbps to OC-3/STM-1.

#### Cisco Network Management

Cisco leverages the network itself to provide reliable, robust, and scalable network management capabilities. With network intelligence built into the IGX 8400 series, many network management functions, including routing, rerouting, monitoring, auto-discovery, and reporting are performed automatically.

For ease of operation and integration, use the CiscoView and CiscoWorks Cisco-wide common graphical user interface (GUI) device management tools for element-level configuration and monitoring. For network-wide topology, event configuration, data collection, performance, and security management, the Cisco WAN Manager software is available, with integration into either NetView or HP OpenView. WAN Manager software also provides interfaces to service management applications, such as automated provisioning via Simple Network Management Protocol (SNMP) application programming interfaces (APIs) and an Structured Query Language (SQL)-based API for database queries. Cisco also offers an integrated product suite that includes Info Center to manage partitioned network events and diagnostics, logical grouping of network resources, and customer management reporting services.

Cisco network management products provide a standards-based, easy-to-use multiservice network management solution and are key components of end-to-end Cisco WAN solutions.

#### IGX 8400 Series Service and Support

As a service provider, you have multiple networking challenges to meet. Your internal network support requirements may be very different from those required for your service infrastructure.

Cisco support solutions for service providers provide basic services and enable you to select the hardware support options, advanced implementation services, and customized professional services to meet the needs of your specific business.

The service provider Base Plan provides you with registered access to Cisco Connection Online (CCO), 24 hours a day, 7 days a week access to the Cisco Technical Assistance Center (TAC), and software updates. Hardware options include return for replacement, advance replacement, or onsite support services. For special networking projects or dedicated, ongoing support, turn to Cisco advanced and customized services. Network Implementation Services (NIS) are designed to help you implement large-scale, complex networks across multiple sites as effectively as possible. The ISP Expert Team provides Internet network design, performance engineering, security, and deployment assistance. Cisco professional services and the Network Supported Account program provide focused service and support resources to help you maximize networking effectiveness. You can even receive support for customer premises equipment (CPE) deployment. Cisco service provider support offerings are designed to ensure the maximum uptime, performance, and lifespan of your Cisco networking equipment.

## For More Information

For more information about the Cisco IGX 8400 series of switches, contact your Cisco sales representative. Or visit the Cisco Web site at [www.cisco.com](http://www.cisco.com).

Table 1 Cisco IGX 8400 Series Wide-Area Switch Specifications

	Mechanical Configuration	Dimensions	Power Requirements
IGX8410	Eight-slot unit, rack-mount or freestanding	24.4 inches (61.9 cm) high	Distributed -48V DC power conversion on modules
	1.2-Gbps cell-switching bus	19.9 inches (50.5 cm) wide	Universal AC input option (90-264V) with AC-DC converter
	CISPR B EMI-certified	27.1 inches (68.8 cm) deep	220/240 VAC AC-DC converter, 1:n redundant
IGX 8420	16-slot unit, rack-mount or freestanding	32 inches (81.3 cm) high, 32.6 inches (82.8 cm) high (with feet)	48V DC input option with redundancy
	1.2-Gbps cell-switching bus	19.9 inches (50.5 cm) wide	Full redundancy available for all power options
	CISPR B EMI-certified	27.1 inches (68.8 cm) deep	Dual power inputs available for all AC power options
IGX 8430	32-slot unit, rack-mount or freestanding	55 inches (139.7 cm) high	Hot-swappable 400W AC power supplies (for IGX 8410 only); 875W AC power supplies (for IGX 8420 and IGX 8430)
	1.2-Gbps cell-switching bus	19.9 inches (50.5 cm) wide	Power supply unit indicators and monitoring
	CISPR B EMI-certified	27.1 inches (68.8 cm) deep	—

## Cisco IGX 8400 Series Switch Specifications

### Network Interfaces

- OC-3 (155.520 Mbps) with Synchronous Optical Network (SONET) framing per ANSI T1.105
- STM-1 (155.520 Mbps) with Synchronous Digital Hierarchy (SDH) framing per ITU-T Rec. G.708
- T3 (44.736 Mbps) with Physical Layer Convergence Procedure (PLCP) per TA-TY-000773
- E3 (34.368 Mbps) per ITU-T Rec. G.804
- n x T1/E1 with Inverse Multiplexing over ATM (IMA)

### Common Network Interface Features

- Up to 16 programmable queues for class-based or VP/VC-based queuing
- Queues programmable by maximum queue depth, minimum service bandwidth, maximum service bandwidth, cell loss priority (CLP) thresholds, explicit forward congestion indication (EFCI) thresholds
- ForeSight closed-loop, rate-based congestion management
- Fully compliant ABR VS/VD implementation
- Explicit Rate (ER) marking
- EFCI marking

### Broadband Service Interfaces

- Conformance to ATM Forum Specification:
- OC-3 UNI (155.520 Mbps) SONET
- STM-1 UNI (155.520 Mbps) SDH
- T3/DS3 UNI (44.736 Mbps)
- E3 UNI (34.368 Mbps)

#### Narrowband Service Interfaces

- T1/E1 ATM UNI
- T1/E1 Frame UNI
- V.35, X.21, HSSI Frame UNI
- T1/E1 voice
- V.35, EIA/TIA-449, EIA/TIA-232 serial data

#### Optional Redundancy

All components are optionally redundant to 100 percent system redundancy, including the control processors, crosspoint switches, network interfaces, service interfaces, critical backplane signals, power supplies, power modules, and cooling fans.

#### Network Management

- Interfacing to network management is provided by SNMP connection via:
  - One 802.3 AUI interface for local connection to StrataView Plus software
  - Two asynchronous control/printer ports

#### Alarms, Indicators and Controls

- Major node alarm, minor node alarm, alarm cutoff, and history indicators
- Visual and audible (major and minor) relay closures provided for connection to central office (CO) alarm system, including power supply status indicators and local-area network (LAN) activity indicator
- Each interface module has a minimum of three visual indicators:
  - Active (green)
  - Standby (yellow)
  - Fail (red)

#### Node Synchronization

- Stratum 4 clock per ATT PUB 62411
- Software-programmable source: internal clock, transmission line, auxiliary port to an external clock source

#### Common Modules

##### Network Processor Module (NPM)

- Contains system software and controls the switch
- Provides distributed intelligence via communication with other network nodes
- Provides interface-to-network management

#### Interface Modules

##### Universal ATM Switch Module (UXM)

- Four OC-3/STM-1 (MMF) ports per module
- Two or four OC-3/STM-1 (SMF) ports per module
- Three or six T3/E3 ports per module
- Four or eight T1/E1 ports per module with inverse multiplexing over ATM (IMA) functionality
- 128,000 cells of buffering per module
- Per-VC queuing and dynamic buffer management

##### Universal Frame Relay Module—Model C (UFM-C)

- Four or eight T1/E1 ports per module (channelized or unchannelized)
- Frame Relay-to-ATM service interworking
- Per-VC queuing and dynamic buffer management
- Traffic management to Cisco routers
- Enhanced Local Management Interface (ELMI) to Cisco routers



Universal Frame Relay Module—Model U (UFM-U)

- Up to 12 V.35 or X.21 ports per module
- Up to four HSSI ports per module
- Frame Relay-to-ATM service interworking
- Per-VC queuing and dynamic buffer management
- Traffic management to Cisco routers
- ELMF to Cisco routers

Universal Router Module (URM)

- Different Back Card options:
  - 2 T1 or E1 Voice Ports plus 2 Fast Ethernet Ports
  - 2 Fast Ethernet Ports only
- Supported IOS Feature Sets:
  - IP Plus
  - Enterprise Plus
  - Enterprise Plus IPsec 3DES
- Full suite of IP Services
- VoIP and VoATM (AAL5)
- MPLS LER and LSR

Universal Voice Module (UVM)

- Two T1/E1/J1 ports per module
- 32-kbps, 24-kbps, 16-kbps ADPCM compression based on G.721, G.723, G.726 standards
- 16-kbps LD-CELP compression based on G.728 standard
- 8-kbps CS-ACELP compression based on G.729 and G.729A standards
- D-channel compression
- VAD
- Onboard echo cancellation
- Fax Relay and modem detection

High-Speed Data Module (HDM)

- Four EIA/TIA-232, V.35, X.21, EIA/TIA-449 ports per module
- Supports synchronous data
- 1.2 kbps to 1.344 Mbps per port
- Repetitive pattern suppression up to 128 kbps

Channelized Voice Module—TT (CVM-TT) Model C

- One channelized T1/E1 port per module
- Support for T1/E1 circuit emulation

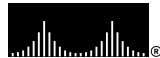
**Standards Compliance**

The IGX multiservice switch complies with all of the following standards.

ATM Forum	UNI V.3.0, 3.1, TM 4.0, NNI V.3.0, 3.1
Frame Relay Forum	FRF.1.1, 2.1, 3.1, 5, 6, 8
ITU	E.164, E190, G.164, G.165, G.703, G.705, G.711, G.721, G.723, G.726, G.728, G.729, G729A, G.804, I.233.1, I.350, I.361, I.362, I.363, I.36X.1, I.370, I.371, I.372, I.432, I.555, Q.922, Q.933

<b>ANSI</b>	T1.101, T1.102, T1.102.1, T1.105, T1.107, T1.107A, T1.602, T1.606, T1.606a, T1.606b, T1.617, T1.617 Annex A, T1.618, T1.629, T1.630, T1.633, T1.635, T1.636, T1/E1.2/93-020RA
<b>Voice Signalling</b>	4ESS; TR41459, CAS Switching: EIA/TIA-464-A (T1), DPNSS: BTNR 188, DSS1: ETSI Euro-ISDN, ETS 300 102-1, ETSI QSIG: ETS 300-171, ETS 300-172, ETS 300-173, ETS 300-239, Japanese ISGN: Q.931A

**CISCO SYSTEMS**



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 Europe  
11, Rue Camille Desmoulins  
92782 Issy Les Moulineaux  
Cedex 9  
France  
www.cisco.com  
Tel: 33 1 58 04 60 00  
Fax: 33 1 58 04 61 00

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 Australia, Pty., Ltd  
Level 17, 99 Walker Street  
North Sydney  
NSW 2059 Australia  
www.cisco.com  
Tel: +61 2 8448 7100  
Fax: +61 2 9957 4350

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