



## **IOT Serial Controller Configuration Guide, Cisco IOS XE 17 (Cisco ASR 920 Series Routers)**

**First Published:** 2019-11-14

**Last Modified:** 2020-09-11

### **Americas Headquarters**

Cisco Systems, Inc.  
170 West Tasman Drive  
San Jose, CA 95134-1706  
USA  
<http://www.cisco.com>  
Tel: 408 526-4000  
800 553-NETS (6387)  
Fax: 408 527-0883

THE SPECIFICATIONS AND INFORMATION REGARDING THE PRODUCTS IN THIS MANUAL ARE SUBJECT TO CHANGE WITHOUT NOTICE. ALL STATEMENTS, INFORMATION, AND RECOMMENDATIONS IN THIS MANUAL ARE BELIEVED TO BE ACCURATE BUT ARE PRESENTED WITHOUT WARRANTY OF ANY KIND, EXPRESS OR IMPLIED. USERS MUST TAKE FULL RESPONSIBILITY FOR THEIR APPLICATION OF ANY PRODUCTS.

THE SOFTWARE LICENSE AND LIMITED WARRANTY FOR THE ACCOMPANYING PRODUCT ARE SET FORTH IN THE INFORMATION PACKET THAT SHIPPED WITH THE PRODUCT AND ARE INCORPORATED HEREIN BY THIS REFERENCE. IF YOU ARE UNABLE TO LOCATE THE SOFTWARE LICENSE OR LIMITED WARRANTY, CONTACT YOUR CISCO REPRESENTATIVE FOR A COPY.

The Cisco implementation of TCP header compression is an adaptation of a program developed by the University of California, Berkeley (UCB) as part of UCB's public domain version of the UNIX operating system. All rights reserved. Copyright © 1981, Regents of the University of California.

NOTWITHSTANDING ANY OTHER WARRANTY HEREIN, ALL DOCUMENT FILES AND SOFTWARE OF THESE SUPPLIERS ARE PROVIDED "AS IS" WITH ALL FAULTS. CISCO AND THE ABOVE-NAMED SUPPLIERS DISCLAIM ALL WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING, WITHOUT LIMITATION, THOSE OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE AND NON-INFRINGEMENT OR ARISING FROM A COURSE OF DEALING, USAGE, OR TRADE PRACTICE.

IN NO EVENT SHALL CISCO OR ITS SUPPLIERS BE LIABLE FOR ANY INDIRECT, SPECIAL, CONSEQUENTIAL, OR INCIDENTAL DAMAGES, INCLUDING, WITHOUT LIMITATION, LOST PROFITS OR LOSS OR DAMAGE TO DATA ARISING OUT OF THE USE OR INABILITY TO USE THIS MANUAL, EVEN IF CISCO OR ITS SUPPLIERS HAVE BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

Any Internet Protocol (IP) addresses and phone numbers used in this document are not intended to be actual addresses and phone numbers. Any examples, command display output, network topology diagrams, and other figures included in the document are shown for illustrative purposes only. Any use of actual IP addresses or phone numbers in illustrative content is unintentional and coincidental.

All printed copies and duplicate soft copies of this document are considered uncontrolled. See the current online version for the latest version.

Cisco has more than 200 offices worldwide. Addresses and phone numbers are listed on the Cisco website at [www.cisco.com/go/offices](http://www.cisco.com/go/offices).

Cisco and the Cisco logo are trademarks or registered trademarks of Cisco and/or its affiliates in the U.S. and other countries. To view a list of Cisco trademarks, go to this URL: <https://www.cisco.com/c/en/us/about/legal/trademarks.html>. Third-party trademarks mentioned 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. (1721R)

© 2020 Cisco Systems, Inc. All rights reserved.



## CONTENTS

---

### CHAPTER 1

#### **E and M Signals over MPLS 1**

- E and M Signaling Overview 1
- Restrictions 1
- Information About Voice Port Configuration 2
  - Voice Port Configuration Overview 2
  - Telephony Signaling Interfaces 2
    - E and M Interfaces 3
    - E and M Interface Transmission Only 4
    - E and M Signaling 5
  - Codec Complexity for Analog Voice Ports 5
  - Circuit Emulation Service Overview 5
  - CAS Overview 5
- How to Configure Analog Voice Ports 6
  - Configuring CEM Group and Parameters on Analog E and M Voice Ports 6
  - Configuring CEM Group with Cross Connect 8
- Configuration Examples for E and M 9
- Verifying E & M Configuration 10
- Additional References for Configuring E and M Signals 11

---

### CHAPTER 2

#### **Configuring Serial Interface (X.21/V.35/RS-530/RS-449) 13**

- Information About Serial Interface (X.21/V.35/RS-530/RS-449) 13
  - Overview of Configuring X.21/V.35/RS-530/RS-449 13
    - Circuit Emulation Overview 13
  - Benefits 14
  - Prerequisites 14
  - Restrictions 14

How to Configure Serial Interface (X.21/V.35/RS-530/RS-449)	14
Configuring Serial Interface (X.21/V.35/RS-530/RS-449)	14
Verifying the Serial Interface (X.21/V.35/RS-530/RS-449) Configuration	15
Setting Payload-Size and Dejitteer-Buffer	17
Configuring Payload Size and Dejitteer Buffer	17

---

**CHAPTER 3**

<b>Configuring 4-Port C37.94 Interface Module</b>	<b>19</b>
Information About C37.94 Interface Module	19
Smart Grid Tele-Protection Support	19
Overview of C37.94 Frame	20
Features of 4-Port C37.94 Interface Module	20
Prerequisites	20
Restrictions	20
Benefits	21
How to Configure C37.94 Interface Module	21
Configuring CEM Class	21
Configuring CEM	21
Verifying C37.94 Interface Module Configurations	22
Associated Commands	23
Troubleshooting	23
Alarms	24
Loss of Signal	24
Path Yellow Detection	25
Loopback on C37.94 Interfaces	25
Configuring Loopback	25
Verifying the Loopback Configurations	26
Additional References	26



## CHAPTER 1

# E and M Signals over MPLS

---

This chapter provides information about peer-to-peer transport of receive and transmit (E and M) signals and voice data over MPLS on the Cisco ASR 903 Router.

E and M signals and voice data over MPLS are supported on the RSP2 module of the Cisco ASR 902 and ASR 903 routers.

- [E and M Signaling Overview, on page 1](#)
- [Restrictions, on page 1](#)
- [Information About Voice Port Configuration, on page 2](#)
- [How to Configure Analog Voice Ports, on page 6](#)
- [Configuration Examples for E and M, on page 9](#)
- [Verifying E & M Configuration, on page 10](#)
- [Additional References for Configuring E and M Signals , on page 11](#)

## E and M Signaling Overview

E and M signaling defines a trunk circuit side and a signaling unit side for each connection similar to the data circuit-terminating equipment (DCE) and data terminal equipment (DTE) reference type. The analog E and M interface functions as the signaling unit side and it expects the other side to be a trunk circuit.



---

**Note** E and M controller indexes are populated in IfTable, the IfTable is defined in IF-MIB.

---

## Restrictions

- E&M Interface Type IV is not supported on Cisco gateways.
- E&M modules only support CAS in-band signaling.
- E&M controller index in the IfTable does *not* provide the information of the following:
  - Maximum Transmit Unit (MTU)
  - Counters

- The ports 0, 1, 2, and 3 can be configured either in voice or Transmission Only (TO) mode. The combination of voice and TO mode for these set of ports is not supported.
- The ports 4 and 5 can be configured either in voice or TO mode. The combination of voice and TO mode for these set of ports is not supported.

## Information About Voice Port Configuration

The following section provides an overview of voice port configuration.

### Voice Port Configuration Overview

Voice ports are found at the intersections of packet-based networks and traditional telephony networks, and they facilitate the passing of voice and call signals between the two networks. Physically, voice ports connect a router or access server to a line from a circuit-switched telephony device in a PBX or the PSTN.

Basic software configuration for voice ports describes the type of connection being made and the type of signaling to take place over this connection. In addition to the commands for basic configuration, there are also commands that provide fine-tuning for voice quality, enable special features, and specify parameters to match those of proprietary PBXs.

Voice ports on routers and access servers emulate physical telephony switch connections so that voice calls and their associated signaling can be transferred intact between a packet network and a circuit-switched network or device. For a voice call to occur, certain information must be passed between the telephony devices at either end of the call. This information is referred to as signaling. The devices at both ends of the call segment must use the same type of signaling.

The devices in the packet network must be configured to convey signaling information in a way that the circuit-switched network can understand. The devices must also be able to understand signaling information received from the circuit-switched network.

### Telephony Signaling Interfaces

Voice ports on routers and access servers physically connect the router or access server to telephony devices such as telephones, fax machines, PBXs, and PSTN central office (CO) switches. These devices may use any of several types of signaling interfaces to generate information about on-hook status, ringing, and line seizure.

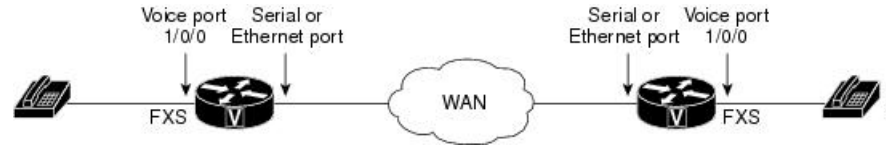
The router's voice-port hardware and software need to be configured to transmit and receive the same type of signaling being used by the device with which they are interfacing so that calls can be exchanged smoothly between the packet network and the circuit-switched network.

The signaling interfaces discussed in this document include foreign exchange office (FXO), foreign exchange station (FXS), and receive and transmit (E&M), which are types of analog interfaces. Some digital connections emulate FXO, FXS, and E&M interfaces, and they are discussed in "FXS and FXO Interfaces" and the *E and M Interfaces* section. It is important to know which signaling method the telephony side of the connection is using, and to match the router configuration and voice interface hardware to that signaling method.

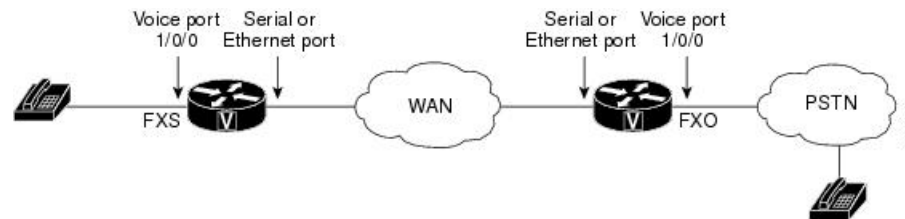
The next three illustrations show how the different signaling interfaces are associated with different uses of voice ports. In the "FXS Signaling Interfaces" figure, FXS signaling is used for end-user telephony equipment, such as a telephone or fax machine. The "FXS and FXO Signaling Interfaces" figure shows an FXS connection to a telephone and an FXO connection to the PSTN at the far side of a WAN; this might be a telephone at a

local office going over a WAN to a router at headquarters that connects to the PSTN. In the "E&M Signaling Interfaces" figure, two PBXs are connected across a WAN by E&M interfaces. This illustrates the path over a WAN between two geographically separated offices in the same company.

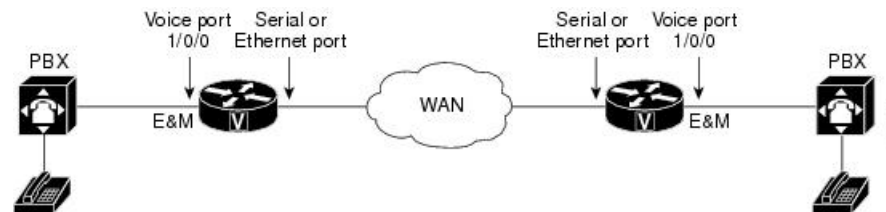
**Figure 1: FXS Signaling Interfaces**



**Figure 2: FXS and FXO Signaling Interfaces**



**Figure 3: E and M Signaling Interfaces**



## E and M Interfaces

Trunk circuits connect telephone switches to one another; they do not connect end-user equipment to the network. The most common form of analog trunk circuit is the E&M interface, which uses special signaling paths that are separate from the trunk's audio path to convey information about the calls. The signaling paths are known as the *E-lead* and the *M-lead*. The name *E&M* is thought to derive from the phrase *Ear* and *Mouth* or *rEceive* and *transMit* although it could also come from *Earth* and *Magnet*. The history of these names dates back to the days of telegraphy, when the CO side had a key that grounded the E circuit, and the other side had a sounder with an electromagnet attached to a battery. Descriptions such as *Ear* and *Mouth* were adopted to help field personnel determine the direction of a signal in a wire. E&M connections from routers to telephone switches or to PBXs are preferable to FXS/FXO connections because E&M provides better answer and disconnect supervision.

Like a serial port, an E&M interface has a data terminal equipment/data communications equipment (DTE/DCE) type of reference. In telecommunications, the *trunking* side is similar to the DCE, and is usually associated with CO functionality. The router acts as this side of the interface. The other side is referred to as the *signaling* side, like a DTE, and is usually a device such as a PBX. Five distinct physical configurations for the signaling part of the interface (Types I-V) use different methods to signal on-hook/off-hook status, as shown in the table below. Cisco voice implementation supports E&M Types I, II, III, and V.

Table 1: EandM Wiring and Signaling Methods

E&M Type	E-Lead Configuration	M-Lead Configuration	Signal Battery Lead Configuration	Signal Ground Lead Configuration
I	Output, relay to ground	Input, referenced to ground	--	--
II	Output, relay to SG	Input, referenced to ground	Feed for M, connected to -48V	Return for E, galvanically isolated from ground
III	Output, relay to ground	Input, referenced to ground	Connected to -48V	Connected to ground
V	Output, relay to ground	Input, referenced to -48V	--	--

The physical E&M interface is an RJ-48 connector that connects to PBX trunk lines, which are classified as either two-wire or four-wire. This refers to whether the audio path is full duplex on one pair of wires (two-wire) or on two pair of wires (four-wire). A connection may be called a four-wire E&M circuit although it actually has six to eight physical wires. It is an analog connection although an analog E&M circuit may be emulated on a digital line. For more information on digital voice port configuration of E&M signaling, see the "DS0 Groups on Digital T1/E1 Voice Ports" section in the "Configuring Digital Voice Ports" chapter .

PBXs built by different manufacturers can indicate on-hook/off-hook status and telephone line seizure on the E&M interface by using any of the following three types of access signaling:

- Immediate-start is the simplest method of E&M access signaling. The calling side seizes the line by going off-hook on its E-lead and sends address information as dual-tone multifrequency (DTMF) digits (or as dialed pulses on Cisco 2600 and Cisco 3600 series routers) following a short, fixed-length pause.
- Wink-start is the most commonly used method for E&M access signaling, and is the default for E&M voice ports. Wink-start was developed to minimize glare, a condition found in immediate-start E&M, in which both ends attempt to seize a trunk at the same time. In wink-start, the calling side seizes the line by going off-hook on its E-lead, then waits for a short temporary off-hook pulse, or "wink," from the other end on its M-lead before sending address information. The switch interprets the pulse as an indication to proceed and then sends the dialed digits as DTMF or dialed pulses.
- In delay-dial signaling, the calling station seizes the line by going off-hook on its E-lead. After a timed interval, the calling side looks at the status of the called side. If the called side is on-hook, the calling side starts sending information as DTMF digits; otherwise, the calling side waits until the called side goes on-hook and then starts sending address information.

## E and M Interface Transmission Only

In Transmission Only (TO) mode configuration, CESoP is configured without CAS support to transport voice data using T1/E1CESoP PW. Field Programmable Gate Arrays (FPGA) configures the port to Transmission Only and port is always on off-hook mode.

In this mode, signaling is not expected to provide through router.



## E and M Signaling

Start dial supervision is the line protocol that defines how the equipment seizes the E&M trunk and passes the address signaling information such as dual tone multifrequency (DTMF) digits. There are three main techniques used for E&M start dial signaling:

- Immediate Start—This is the most basic protocol. In this technique, the originating switch goes off-hook, waits for a finite period of time (for example, 200 ms), then sends the dial digits to the far end.
- Wink Start—Wink is the most commonly used protocol. In this technique, the originating switch goes off-hook, waits for a temporary off-hook pulse from the other end (which is interpreted as an indication to proceed), then sends the dial digits.
- Delay Dial—In this technique, the originating side goes off-hook and waits for about 200 ms, then checks to see if the far end is on-hook. If the far end is on-hook, it then outputs dial digits. If the far end is off-hook, it waits until it goes on-hook, then outputs dial digits.

## Codec Complexity for Analog Voice Ports

The term *codec* stands for *coder-decoder*. A codec is a particular method of transforming analog voice into a digital bit stream (and vice versa) and also refers to the type of compression used. Several different codecs have been developed to perform these functions, and each one is known by the number of the International Telecommunication Union-Telecommunication Standardization Sector (ITU-T) standard in which it is defined. The various codecs use different algorithms to encode analog voice into digital bit-streams and have different bit rates, frame sizes, and coding delays associated with them. The codecs also differ in the type of perceived voice quality they achieve.

Select the same type of codec as the one that is used at the other end of the call. For instance, if a call was coded with a G.711 codec, it must be decoded with a G.711 codec.

## Circuit Emulation Service Overview

Circuit Emulation (CEM) is a technology that provides a protocol-independent transport over IP Networks. It enables proprietary or legacy applications to be carried transparently to the destination, similar to a leased line.

The Cisco ASR 903 Series Router E & M IM supports pseudowire types that utilize CEM transport, Circuit Emulation Service over Packet-Switched Network in T1 and E1 modes to transport Analog Signals and Voice traffic over MPLS.

The voice port interfaces that connect the router or access server to E & M lines pass voice data and signaling between the packet network and the Analog-circuit-switched network.

For more information about the Circuit Emulation Service over Packet-Switched Network on Cisco ASR 903 Series Router, see Chapter 16 Configuring Pseudowire.

## CAS Overview

Channel Associated Signaling (CAS) is also referred to as Robbed Bit Signaling. In this type of signaling, the least significant bit of information in a T1 signal is "robbed" from the channels that carry voice and is used to transmit framing and clocking information. This is sometimes called "in-band" signaling. CAS is a method of signaling each traffic channel rather than having a dedicated signaling channel (like ISDN). In

other words, the signaling for a particular traffic circuit is permanently associated with that circuit. The most common forms of CAS signaling are loop-start, ground-start, Equal Access North American (EANA), and E&M. In addition to receiving and placing calls, CAS signaling also processes the receipt of Dialed Number Identification Service (DNIS) and Automatic Number Identification (ANI) information, which is used to support authentication and other functions.

Each T1 channel carries a sequence of frames. These frames consist of 192 bits and an additional bit designated as the framing bit, for a total of 193 bits per frame. Super Frame (SF) groups twelve of these 193-bit frames together and designates the framing bits of the even-numbered frames as signaling bits. CAS looks specifically at every sixth frame for the time slot's or channel's associated signaling information. These bits are commonly referred to as A- and B-bits. Extended Super Frame (ESF), due to grouping the frames in sets of twenty-four, has four signaling bits per channel or time slot. These occur in frames 6, 12, 18, and 24 and are called the A-, B-, C-, and D-bits respectively.

The biggest disadvantage of CAS signaling is its use of user bandwidth in order to perform signaling functions.

#### Ear and Mouth Type Transmission Only

The Ear and Mouth (ENM) TO mode configuration supports CESoP without CAS configuration to transport data using T1 or E1 CESoP pseudowire. The CESoP is configured without signaling.

## How to Configure Analog Voice Ports

### Configuring CEM Group and Parameters on Analog E and M Voice Ports

Perform this task to configure cem group and basic parameters:

---

#### Step 1 **enable**

##### Example:

```
Router> enable
```

Enables privileged EXEC mode.

- Enter your password if prompted.

#### Step 2 **configure terminal**

##### Example:

```
Router# configure terminal
```

Enters global configuration mode.

#### Step 3 **controller voice-port slot / subslot / port**

##### Example:

```
voice-port slot/subslot/port
```

##### Example:

```
Router(config)# controller voice-port 1/0/0
```

Enters voice-port configuration mode.

**Note** The **show voice port summary** command enters into the controller for further parameter configuration.

**Step 4** **cem-group** *group-number* **timeslots** *timeslot*

**Example:**

```
Router(config-controller)# cem-group 0 timeslots 1
```

Configures cem-group with group number 0 in CESoP with speed (DS0).

**Note** The group number is always 0. The timeslot is always 1.

**Step 5** **compand-type** *a-law* | *u-law*

**Example:**

```
Router(config-controller)# compand-type u-law|a-law
```

Specifies the PCM encoding configuration for voice port.

- The default for E1 is **a-law**.
- The default for T1 is **u-law**.

**Step 6** **signal** *wink-start* | *immediate-start* | *delay-dial*

**Example:**

```
Router(config-controller)# signal immediate-start
```

Specifies the options of signaling type configuration.

- The default signaling type is **wink-start**.

**Step 7** **type** **1** | **2** | **3** | **5** | **TO**

**Example:**

```
Router(config-controller)# type 2
```

Specifies the type of E&M interface to which this voice port is connecting in TO mode. See Table 2 in the "Voice Port Configuration Overview" chapter for an explanation of E&M types.

- The default is **1**.

In type TO, CEoP is configured without CAS type.

**Step 8** **operation** *2-wire* | *4-wire*

**Example:**

```
Router(config-controller)# operation 4-wire
```

Specifies the number of wires used for voice transmission at this interface (the audio path only, not the signaling path).

- The default is **2-wire**.

**Step 9**      **impedance 600r | complex1 | complex2 | complex3**

**Example:**

```
Router(config-controller)# impedance complex1
```

Specifies the impedance depending upon the operation selected.

**Note**      The options for operations are:

- Option for operation 4-wire: 600r
- Option for operation 2-wire: 600r, complex1, complex2, complex3

The default impedance is **600r**.

**Step 10**     **exit**

**Example:**

```
Router(config-controller)# exit
```

Exits controller configuration mode and returns to privileged EXEC mode.

## Configuring CEM Group with Cross Connect

The following section describes how to configure a CEM group on the Cisco ASR 903 Series Router.

### SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface cem slotbay /port**
4. **cem number**
5. **xconnect router-id vcid encapsulation mpls**
6. **exit**

### DETAILED STEPS

	Command or Action	Purpose
<b>Step 1</b>	<b>enable</b> <b>Example:</b> Router> enable	Enables privileged EXEC mode. <ul style="list-style-type: none"> <li>• Enter your password if prompted.</li> </ul>
<b>Step 2</b>	<b>configure terminal</b> <b>Example:</b>	Enters global configuration mode.

	Command or Action	Purpose
	Router# <code>configure terminal</code>	
<b>Step 3</b>	<b>interface cem slot/bay /port</b> <b>Example:</b>  Router(config)# <code>int cem slot/bay/port</code>	To specify the slot number, bay number or port number to be configured.
<b>Step 4</b>	<b>cem number</b> <b>Example:</b>  Router(config-if)# <code>cem 0</code>	CEM number is always 0.
<b>Step 5</b>	<b>xconnect router-id vcid encapsulation mpls</b> <b>Example:</b>  Router(config-if)# <code>xconnect 10.1.1.1 40 encapsulation mpls</code>	To configure xconnect with other end using router-ID, VCID and encapsulation as MPLS.
<b>Step 6</b>	<b>exit</b> <b>Example:</b>  Router(config-if)# <code>exit</code>	Exits configuration mode and returns to privileged EXEC mode.

## Configuration Examples for E and M

This section provides examples for configuring E&M over MPLS

### Example: Configuring E&M Controller

The following example shows how to configure voice port interface.

```
Router> enable
Router# configure terminal
Router(config)# controller voice-port 0/1/4
Router(config-controller)# cem-group 0 timeslots 1
Router(config-controller)# compand a-law
Router(config-controller)# signal immediate
Router(config-controller)# type 5
Router(config-controller)# operation 4-wire
Router(config-controller)# exit
```

### Example: Configuring Xconnect

The following example shows how to configure xconnect.

```
Router> enable
Router# configure terminal
Router(config)# interface CEM0/1/0
Router(config-if)# cem 0
```

```
Router(config-if-cem)# xconnect 10.1.1.1 1 encapsulation mpls
Router(config-if-cem-xconn)# end
```

## Verifying E & M Configuration

The following show commands you can use to verify the E and M configuration.

- **show controllers voice-port:** This command shows how to configure voice port interface.

```
Router# show controllers voice-port 0/3/0

voice-port 0/3/0 - (A900-IMA6EM) is up
Encapsulation : None
Type          : Type I
Operation     : 2-Wire
Signalling    : wink-start
Companding    : u-law
```

- **show interface cem:** This command shows how to configure CEM.

```
Router# show interface CEM0/3/0

CEM0/3/0 is up, line protocol is up
  Hardware is Circuit Emulation Interface
  MTU 1500 bytes, BW 64 Kbit/sec, DLY 0 usec,
    reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation CEM, loopback not set
  Keepalive not supported
  Last input never, output never, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/375/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/0 (size/max)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
    0 packets input, 0 bytes, 0 no buffer
    Received 0 broadcasts (0 IP multicasts)
    0 runts, 0 giants, 0 throttles
    0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
    0 packets output, 0 bytes, 0 underruns
    0 output errors, 0 collisions, 0 interface resets
    0 unknown protocol drops
    0 output buffer failures, 0 output buffers swapped out
```

- **show cem circuit:** This command shows how to configure CEM circuit.

```
Router# show cem circuit 0

CEM0/3/0, ID: 0, Line: UP, Admin: UP, Ckt: ACTIVE
Controller state: up, T1/E1 state: up
Idle Pattern: 0xFF, Idle CAS: 0x8
Dejitter: 8 (In use: 0)
Payload Size: 32
Framing: Framed (DS0 channels: 1)
CEM Defects Set
None

Signalling: No CAS
RTP: No RTP

Ingress Pkts:      0                      Dropped:          0
```



**MIBs**

MIB	MIBs Link
IF-MIB	<p>To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL:</p> <p><a href="http://www.cisco.com/go/mibs">http://www.cisco.com/go/mibs</a></p>

**Technical Assistance**

Description	Link
<p>The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies.</p> <p>To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds.</p> <p>Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.</p>	<p><a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a></p>





## CHAPTER 2

# Configuring Serial Interface (X.21/V.35/RS-530/RS-449)

This chapter provides information about the serial interface using cable type x.21/v.35/rs-530/RS-449. The serial interface transports the respective x.21/v.35/rs-530/RS-449 traffic over a MPLS network. The Cisco ASR 903 Series Router supports the pseudowire that utilizes the Circuit Emulation Service over Packet-Switched Network in E1 mode to transport x.21/v.35/rs-530/RS-449 traffic.

- [Information About Serial Interface \(X.21/V.35/RS-530/RS-449\)](#), on page 13
- [How to Configure Serial Interface \(X.21/V.35/RS-530/RS-449\)](#), on page 14

## Information About Serial Interface (X.21/V.35/RS-530/RS-449)

The following sections provide information about configuring serial interface (x.21/v.35/rs-530/RS-449) feature on the Cisco ASR 903 Series Router.

### Overview of Configuring X.21/V.35/RS-530/RS-449

CESoPSN encapsulates structured signals as pseudowires over packet switched networks (PSNs). Emulation of signals saves PSN bandwidth and supports distributed cross-connect applications. It also enhances resilience of CE devices due to the effects of loss of packets in the PSN.

CESoPSN identifies framing and sends the payload. The number of TDM frames to be used within the CESoP is a factor of the serial data size. For Nx64 kbps serial line, the number of timeslots in a given TDM frame are inferred based on the line speed.

### Circuit Emulation Overview

Circuit Emulation (CEM) is a technology that provides a protocol-independent transport over IP Networks. It enables proprietary or legacy applications to be carried transparently to the destination, similar to a leased line.

CEM provides a bridge between a time-division multiplexing (TDM) network and MPLS network. The router encapsulates the TDM data in the MPLS packets and sends the data over a CEM pseudowire to the remote provider edge (PE) router. Thus, CEM functions as a physical communication link across the packet network.

CEM de jitter buffer value can be configured to accommodate any delays in the MPLS network. Service policy can be applied to the CEM interface, only exp bit re-marking is supported in default class.

### Configuring CEM Restriction

Not all combinations of payload size and dejitter buffer size are supported. If you apply an incompatible payload size or dejitter buffer size configuration, the router rejects it and reverts to the previous configuration.

## Benefits

- The pseudowire utilizes Circuit Emulation Service over Packet-Switched Network (CESoPSN -RFC5086) in E1 mode to transport the x.21/v.35/rs-530/RS-449 traffic over MPLS network.
- Migration from legacy network to MPLS network supports hitless traffic switch from active RSP to standby RSP.
- It supports the serial data speed that are multiples of 64kbps. The maximum limit of speed can be 2048kbps.

## Prerequisites

- Serial IM SPA must be installed.
- PEs must be reachable over MPLS network.
- Sync-E must be configured between pseudowire peers.

## Restrictions

- Specific combinations of payload size and dejitter buffer size are supported. If incompatible values are applied, the router reverts to the previous configuration.
- Supported speeds are 64kbps, 128kbps, 256kbps, 512kbps, 1024kbps, and 2048kbps.
- Serial IM does *not* support to configure pseudowire between local and remote PE with different speeds on sync (x.21/v.35/rs-530/RS-449) ports.
- The transit of traffic is *not* supported from port 0 to 7. It is supported only from port 8 to 13.

## How to Configure Serial Interface (X.21/V.35/RS-530/RS-449)

The following sections provide information about how to configure serial interface (x.21/v.35/rs-530/RS-449) on the Cisco ASR 903 Series Router.

### Configuring Serial Interface (X.21/V.35/RS-530/RS-449)

#### Before you Begin

Before you configure x.21/v.35/rs-530/RS-449 on Cisco ASR 903 Series Router, check for the following:

- MPLS LDP neighbor relation must be established between the PE devices.
- The Ethernet interfaces on the provider edge routers towards the core must be configured with SyncE.

Follow these steps to configure x.21/v.35/rs-530/RS-449 on the Cisco ASR 903 Series Router:

```
enable
configure terminal
Controller serial 0/5/8
clock rate 64000
cem-group 0
exit
interface CEM0/5/8
cem 0
xconnect 10.10.10.2 305 encapsulation mpls
exit
end
```

Or,

```
enable
configure terminal
Controller serial 0/5/8
clock-rate 64000
cem-group 0
exit
interface CEM0/5/8
cem 0
xconnect 10.10.10.2 305 encapsulation mpls
exit
end
```

## Verifying the Serial Interface (X.21/V.35/RS-530/RS-449) Configuration

You can use the **show controllers serial** command to verify the serial interface (x.21/v.35/rs-530/RS-449) configuration.

- The following is the sample output to verify that the controller is configured using X.21 cable type.

```
Router# show controllers serial0/5/8

CEM0/5/8 - (Circuit Emulation Interface) is up
Physical Layer : SYNC
Encapsulation : CEM
mtu 1500, max_buffer_size 1524, max_pak_size 1524 enc 84
Cable type: X.21 DCE
loopback: Off, crc: 16, invert_data: Off
nrzi: Off, idle char: Flag
dce_terminal_timing_enable: Off ignore_dtr: Off
serial_clockrate: 128000bps, serial_clock_index: 17

DCD=up DSR=up DTR=up RTS=up CTS=up
```

- The following is the sample output to verify that the controller is configured using V.35 cable type.

```
Router# show controllers serial0/5/8

CEM0/5/8 - (Circuit Emulation Interface) is up
Physical Layer : SYNC
Encapsulation : CEM
mtu 1500, max_buffer_size 1524, max_pak_size 1524 enc 84
Cable type: V.35 DCE
loopback: Off, crc: 16, invert_data: Off
nrzi: Off, idle char: Flag
dce_terminal_timing_enable: Off ignore_dtr: Off
serial_clockrate: 128000bps, serial_clock_index: 17
```

```
DCD=up DSR=up DTR=up RTS=up CTS=up
```

- The following is the sample output to verify that the controller is configured using RS-530 cable type.

```
Router# show controllers serial0/5/8

CEM0/5/8 - (Circuit Emulation Interface) is up
Physical Layer : SYNC
Encapsulation : CEM
mtu 1500, max_buffer_size 1524, max_pak_size 1524 enc 84
Cable type: RS-530 DCE
loopback: Off, crc: 16, invert_data: Off
nrzi: Off, idle char: Flag
dce_terminal_timing_enable: Off ignore_dtr: Off
serial_clockrate: 128000bps, serial_clock_index: 17

DCD=up DSR=up DTR=up RTS=up CTS=up
```

- The following is the sample output to verify that the controller is configured using RS-449 cable type.

```
Router# show controllers serial0/5/8

CEM0/5/8 - (Circuit Emulation Interface) is up
Physical Layer : SYNC
Encapsulation : CEM
mtu 1500, max_buffer_size 1524, max_pak_size 1524 enc 84
Cable type: RS-449 DCE
loopback: Off, crc: 16, invert_data: Off
nrzi: Off, idle char: Flag
dce_terminal_timing_enable: Off ignore_dtr: Off
serial_clockrate: 128000bps, serial_clock_index: 17

DCD=up DSR=up DTR=up RTS=up CTS=up
```

- Use the **show int cem 0/5/8** command to verify that the CEM is configured.

```
Router# show int cem0/5/8

Building configuration...
Current configuration : 97 bytes
!
interface CEM0/5/8
  no ip address
  cem 0
  xconnect 10.10.10.10 100 encapsulation mpls
!
end
```

- Use the **show xconnect all** command to verify that the cross connection between controllers is configured.

```
Router# show xconnect all

Legend:   XC ST=Xconnect State   S1=Segment1 State   S2=Segment2 State
          UP=Up                 DN=Down              AD=Admin Down       IA=Inactive
          SB=Standby            HS=Hot Standby      RV=Recovering       NH=No Hardware

XC ST  Segment 1                               S1 Segment 2                               S2
-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
UP pri ac CE0/5/8:0(CESoPSN Basic)          UP mpls 10.10.10.10:100                      UP
```

## Setting Payload-Size and Dejitter-Buffer

After the configuration of CEM circuit and xconnect, configure the appropriate values for payload-size and dejitter buffer in the CEM. Below table provides the ideal values payload-size and dejitter buffer for different clock rates.

Clock Rate	Payload Size	Dejitter Buffer
64000	32	9
128000	64	16
	64	20
	64	32
	128	20
	256	20
512000	128	20
	128	5
	64	5
	256	20
	640	20
1024000	64	8
	64	5
	128	5
	128	8
	256	8
2048000	128	8
	128	5
	256	5
	256	8
	640	8
	1280	8

### Configuring Payload Size and Dejitter Buffer

Before you configure payload size and dejitter buffer on CEM, ensure the CEM and xconnect are configured.

```

enable
configure terminal
interface cem 0/5/8
cem 0
payload-size 64
dejitter-buffer 20
end

```

**Note**

- Use **no payload-size** command to set the default values for payload-size.
- Use **no dejitter-buffer** command to set the default values for dejitter-buffer for a given clock rate.

**Verifying the Payload Size and Dejitter Buffer Configuration**

You can use the following commands to verify your pseudowire configuration:

Use **show interface cem** command to verify the CEM configuration.

```

Router# show interface cem 0/5/8
Building configuration...
Current configuration : 136 bytes
!
interface CEM0/5/8
no ip address
cem 0
  payload-size 64
  dejitter-buffer 20
  xconnect 10.10.2.2 204 encapsulation mpls
!
end

```



## CHAPTER 3

# Configuring 4-Port C37.94 Interface Module

The IEEE C37.94 standard defines the communication of protection relays with communication equipment inside a substation using optical fibers.

The IEEE defines the C37.94 standard as  $N * 64$  kbps optical fiber interface to provide transparent communications between tele-protection relays and multiplexers equipments. The C37.94 standard describes the interconnection details for the variable  $N$ , (where  $N = 1, 2 \dots 12$ ), which describes a multiple of 64 kilobit per second connections at which the communication link is to operate.

The C37.94 interface module supports four ports from port number 0 to 3.

The 4-Port C37.94 interface module is supported on the RSP2 module of the Cisco ASR 902 and ASR 903 routers.



**Note** Effective from Cisco IOS XE Bangalore Release 17.4.1, 4-Port C37.94 interface module is supported on the Cisco A900-RSP3C-400, and only on slot 4 on A900-RSP3C-200.

- [Information About C37.94 Interface Module, on page 19](#)
- [How to Configure C37.94 Interface Module, on page 21](#)
- [Troubleshooting, on page 23](#)
- [Additional References , on page 26](#)

## Information About C37.94 Interface Module

This following section provides information about configuring C37.94 interface module on the Cisco ASR 903 Series Router.

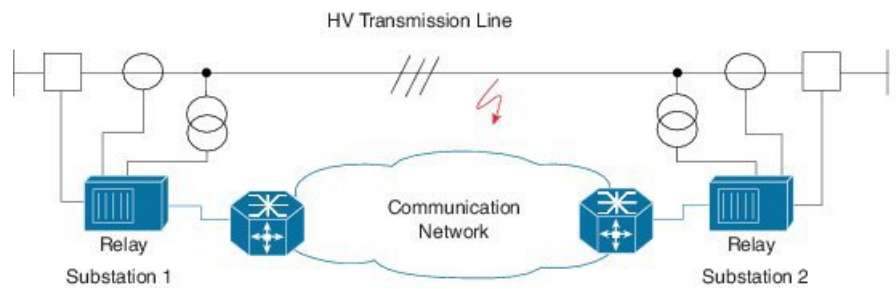
### Smart Grid Tele-Protection Support

The C37.94 interface module supports smart grid tele-protection.

Smart Grid refers to the electricity delivery system from the point of generation to the point of consumption using analog or digital information and the communication technology for gathering and acting on the information.

Tele-protection refers to the mechanism to quickly switch on alternative routes using tele-protection equipment when a malfunction occurs. The switchover is to improve the performance of the electric grid.

Figure 4: Smart Grid Tele-protection



## Overview of C37.94 Frame

The IEEE standard defines a data frame format for C37.94 interface module. The frame format is designed to allow the passage of information in packet format from the multiplexer to the tele-protection equipment and from the tele-protection equipment to the multiplexer equipment.

## Features of 4-Port C37.94 Interface Module

The features of 4-Port C37.94 Interface Module are:

- Supports 4 independent C37.94 interfaces
- Provides low latency connection over pseudowires
- Supports allocation of timeslot. Timeslot ranges from 1 to 12
- Supports Online Insertion and Removal (OIR)
- Supports traffic switch from active to standby
- Provides quick switchover to alternative route at the time of a route failure
- Populates the C37.94 controller indexes in IfTable; the IfTable is defined in IF-MIB

## Prerequisites

- Provider Edges (PEs) must be reachable over MPLS network
- Sync-E must be configured between pseudowire peers

## Restrictions

- The channelization of  $N * 64$  kbps channels of C37.94 interface is *not* supported
- The bandwidth of  $N * 64$  kbps ( $N$  ranges from 1 to 12) is supported
- Pseudowire configuration between local and remote PE with different time slots is *not* supported
- Pseudowire configuration is supported only when C37.94 interface is configured on both PE nodes
- C37.94 controller index in IfTable does *not* provide the following information:



- Maximum Transmit Unit (MTU)
- Counters

## Benefits

- Provides low latency connection to C37.94 interfaces
- Supports multiple interface modules on single chassis
- Tele-protection relay checks a failure and thus provides reliable, robust and safe electric grid
- Provides quick switchover to an alternative route of any route failure
- Prevents damage to the network and power outages

# How to Configure C37.94 Interface Module

## Configuring CEM Class

Before you configure CEM class, configure payload size and dejitter buffer values on CEM.

```
enable
configure terminal
class cem mycemclass
payload-size 64
dejitter-buffer 20
idle-pattern 0x55
end
```



### Note

- The default payload size varies with the number of time slots selected.
- Payload size can be configured to achieve lower bandwidth.

## Configuring CEM

Before you configure CEM group cross-connect, configure the C37.94 controller.

```
enable
configure terminal
controller c3794 0/0/0
cem-group 0 timeslots 1
interface CEM0/0/0
no ip address
cem 0
dejitter-buffer 2
modifytimeslots 6
cem class mycemclass
```



```

Dejitter: 5 (In use: 0)
Payload Size: 96
Framing: Framed (DS0 channels: 1-12)
CEM Defects Set
None

Signalling: No CAS
RTP: No RTP

Ingress Pkts:    26669          Dropped:          0
Egress Pkts:    26669          Dropped:          0

CEM Counter Details
Input Errors:    0              Output Errors:    0
Pkts Missing:   0              Pkts Reordered:  0
Misorder Drops: 0              JitterBuf Underrun: 0
Error Sec:      0              Severly Errored Sec: 0
Unavailable Sec: 0             Failure Counts:   0
Pkts Malformed: 0             JitterBuf Overrun: 0
    
```

- Use the **show controllers** command to verify the controller configurations.

```

Router# show controllers c3794 0/0/0

C3794 0/0/0 - (A900-IMA4C3794) is up
Configured Channels: 1
Peer Channels       : 1
Alarm               : Nil
Sending Y-Alarm to Peer Device : No
Receiving Y-Alarm from Peer Device : No
Transceiver Rx Optical Power :-15 db
    
```

## Associated Commands

Commands	URL
<b>cem-group</b>	<a href="http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-c1.html#wp2440628600">http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-c1.html#wp2440628600</a>
<b>xconnect</b>	<a href="http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-t2.html#wp8578094790">http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-t2.html#wp8578094790</a>
<b>loopback</b>	<a href="http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-11.html#wp1033903426">http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-11.html#wp1033903426</a>

## Troubleshooting

You use the following to troubleshoot C37.94 controllers:

## Alarms

The 4-Port C37.94 interface module supports the following alarms during failure:

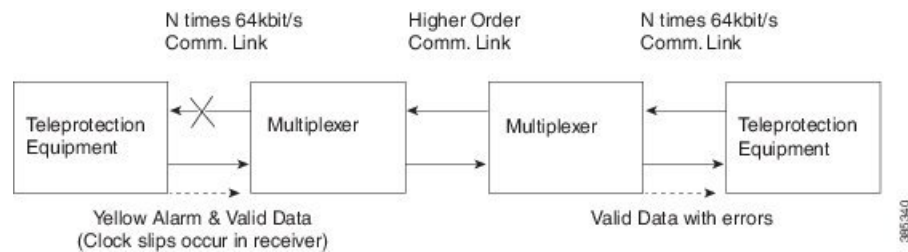
- Loss of Signal (LOS)
- Path Yellow Detection

## Loss of Signal

The scenario when the receiver end receives two or more errors in eight consecutive framing patterns within 1 millisecond, the Loss of Signal (LOS) alarm is declared.

The receiver end should clear LOS after receiving eight consecutive correct framing patterns.

**Figure 5: LOS at Optical Receive Port of Tele-protection Equipment**



### Failure Scenarios

- During the LOS condition at its optical receive port

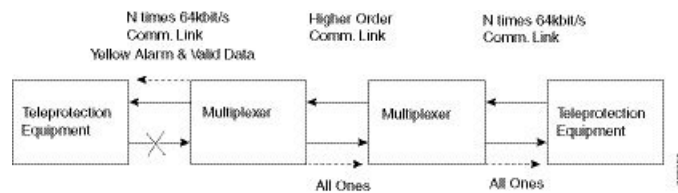
At Tele-protection Equipment

- Changes the “Yellow” bit in the transmitted optical output frames from “0” to “1”.

At Multiplexer Equipment

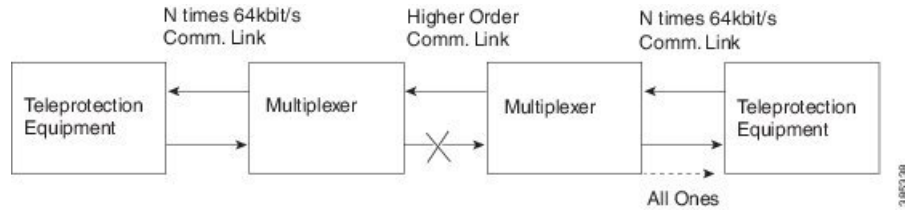
- Replaces the data bits over the higher order communications link with “All Ones,” which is commonly referred to as Alarm Indication Signal (AIS).
- Changes the “Yellow” bit in the transmitted optical output frames from “0” to “1”

**Figure 6: LOS at Optical Receive Port of Multiplexer**



- During the loss of the higher order communications link, the multiplexer should replace the data bits in the transmitted optical output frames with “All Ones.”

Figure 7: LOS at Far End Multiplexer



## Path Yellow Detection

The scenario is declared as path yellow when three consecutive received frames have the “Yellow” bit = 1 and the received signal is OK (no LOS).

The receiver clears path yellow when three consecutive received frames have the “Yellow” bit = 0 or the received signal is bad (LOS).

## Loopback on C37.94 Interfaces

### Loopback Description

You can use the following loopbacks on the C37.94 interfaces.

Loopback	Description
<b>loopback local line</b>	Loops the incoming signal in the interface using the framer’s line loopback mode. The framer does not reclock or reframe the incoming data. All incoming data is received by the interface driver.
<b>loopback local payload</b>	Loops the incoming signal back in the interface using the payload loopback mode of the framer. The framer reclocks and reframes the incoming data before sending it back out to the network.
<b>loopback network line</b>	Sets the loopback toward the network before going through the framer (line).
<b>loopback network payload</b>	Sets the loopback toward the network after going through the framer (payload).

## Configuring Loopback

### Before You Begin

Before you configure loopback, you must configure the controller and the CEM.

To set a loopback local on the C37.94 interfaces, perform the following tasks in controller configuration mode:

```
enable
configure terminal
controller c3794 0/0/0
```

```
loopback local line
exit
```

To set a loopback network on the C37.94 interfaces, perform the following tasks in controller configuration mode:

```
enable
configure terminal
controller c3794 0/0/0
loopback network payload
exit
```




---

**Note** To remove a loopback, use the **no loopback** command.

---

## Verifying the Loopback Configurations

You use the following **show** command to verify the loopback configuration of 4-Port C37.94 interface module:

- Use the **show controllers** command to view the configurations.

```
Router# show controllers c3794 0/0/0

C3794 0/0/0 - (A900-IMA4C3794) is up
Configured Channels: 12
Peer Channels      : 12
Alarm              : Nil
Sending Y-Alarm to Peer Device : No
Receiving Y-Alarm from Peer Device : No
Loopback           : local line
```

## Additional References

### Related Documents

Related Topic	Document Title
Cisco IOS commands	<a href="#">Cisco IOS Master Commands List, All Releases</a>

### Standards and RFCs

Standard/RFC	Title
—	<i>There are no standards and RFCs for this feature.</i>

**MIBs**

MIB	MIBs Link
IF-MIB	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: <a href="http://www.cisco.com/go/mibs">http://www.cisco.com/go/mibs</a>

**Technical Assistance**

Description	Link
<p>The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies.</p> <p>To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds.</p> <p>Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.</p>	<a href="http://www.cisco.com/cisco/web/support/index.html">http://www.cisco.com/cisco/web/support/index.html</a>

