# Circuit Emulation over IP

Circuit Emulation over IP (CEoIP) provides a virtual circuit through an IP network—similar to a leased line—to integrate solutions that require a time-sensitive, bit-transparent transport into IP networks. Data, with proprietary framing or without, arrives at its destination unchanged; the transport is transparent to the destination.

**Feature History for Circuit Emulation over IP**

| Release | Modification |
|---|---|
| 12.3(7)T | This feature was introduced. |

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# Contents


- Prerequisites for Circuit Emulation over IP, page 2
- Restrictions for Circuit Emulation over IP, page 2
- Information About Circuit Emulation over IP, page 2
- How to Configure Circuit Emulation over IP, page 4
- Configuration Examples for CEoIP, page 17
- Additional References, page 18
- Command Reference, page 19



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# Prerequisites for Circuit Emulation over IP

- The CEoIP feature requires a CEoIP network module (NM) on each end of the connection, either the NM-CEM-4TE1 NM or the NM-CEM-4SER NM. You do not need to use the same type of CEoIP NM on both ends of the connection.
- The CEoIP feature requires 300 KB of flash memory and 1 MB of DRAM in addition to your Cisco IOS software requirements.

# Restrictions for Circuit Emulation over IP

- NM-CEM-4TE1 supports only B8ZS (T1) and HDB3 (E1) line codes.
- E1 lines do not support 56 kbps connections.
- CEoIP software cannot run payload compression for more than 3.088 Mbps) per network module.
- If you configure four T1, E1, or serial cables (over 1.544 M) at the same time in Cisco 2600XM series routers, you cannot turn on the data-protection and payload compression features. Also, in framed mode (channelized), you can use up to 60 channels without the data protection and payload compression features on Cisco 2600XM series routers. However, you can turn on the data protection and payload compression feature in one T1/E1.
- There is a limitation on the data protection and payload compression features on Cisco 3660 routers. If you configure four T1, E1, or serial cables on Cisco 3660 routers, you can turn on data protection for up to two T1/E1s. In framed mode, you can use 88 channels.

# Information About Circuit Emulation over IP

To configure Circuit Emulation over IP, you should understand the following concepts:

- Circuit Emulation over IP, page 2
- Adaptive Clocking for CEoIP, page 3
- Payload Compression for CEoIP, page 3
- Data Protection (Sample Repetition), page 4
- Dejitter, page 4
- Idle Pattern, page 4
- Payload Size, page 4
- Signaling for CEoIP, page 4
- Control Lead Configurations, page 4

## Circuit Emulation over IP

Circuit emulation is an end-to-end service that allows Layer 1 data to be transported transparently through an IP network. Applications that require circuit emulation need the network to provide a constant rate bit stream.

CEoIP may use adaptive clocking as a means of synchronizing the clock frequencies at the two endpoints. Channel associated signaling (CAS) transport is provided as an optional feature to allow channelized voice applications. Payload compression is provided as an optional feature to improve bandwidth efficiency and data protection is provided to reduce the probability of data loss.

CEoIP software supports the following network modules:

- The NM-CEM-4SER, a network module with four serial ports. To configure CEoIP software for the NM-CEM-4SER, you must configure the options of the ports. Options include dejitter buffer, payload compression, and payload size.
- The NM-CEM-4TE1, a network module with four ports that you can configure as T1 or E1 (where all four ports support the same interface type). To configure CEoIP software for the NM-CEM-TE1, you must define the card type and then configure the options of the port.

# Benefits of CEM over IP

CEoIP provides a simple migration path to IP-only networks. Examples of solutions that CEoIP integrates with IP include the following:

- Legacy data services
- Legacy video applications
- Satellite data streams
- Radar data streams
- Telemetry for automated industrial environments (for example, power distribution)
- Crypto tunneling for multilevel security

# Adaptive Clocking for CEoIP

The adaptive clocking option of CEoIP allows the egress clock to vary by expanding or contracting the clock period from the nominal clock. After you have implemented the clocking feature, the adaptive clocking circuits continuously adjust the selected clock based on the data buffer level. You can implement adaptive clocking on each port independently.

# Payload Compression for CEoIP

The payload compression option minimizes the amount of bandwidth that traffic consumes. It compresses the transmission of any repetitive data pattern (for example, idle code, HDLC flags, and so on) to increase the efficiency of the solution across the network.

With CEoIP software, you can adjust the size (in bytes) of the payload for the IP packet to configure efficiency as opposed to packetization. Larger payloads provide more efficiency but increase the delay. With smaller packets the overhead of the header increases. Payload compression is disabled by default.

## Data Protection (Sample Repetition)

The data protection option, also known as sample repetition, reduces the probability of errors due to packet loss by sending each sample twice, in two different IP packets. Data protection consumes more bandwidth than standard transmission, but you can minimize the amount of traffic with payload compression. This feature is disabled by default.

## Dejitter

The dejitter buffer size determines the ability of the emulated circuit to tolerate network jitter. The dejitter buffer in CEoIP software is configurable up to 500 milliseconds; the maximum amount of network jitter that CEoIP can tolerate is ±250 milliseconds.

## Idle Pattern

The idle pattern option specifies the idle pattern to transmit when the circuit goes down. You can specify a maximum of 64 bits with two 32-bit patterns for the NM-CEM-4SER and 8-bit patterns for the NM-CEM-4TE1.

## Payload Size

Payload size is the number of bytes put into each IP packet. This parameter impacts packetization delay and efficiency. Configure a high payload size to increase packetization delay and efficiency. A smaller payload size reduces packetization delay and efficiency.

## Signaling for CEoIP

CEoIP software supports the transport of channel associated signaling (CAS) bits in channelized T1/E1 mode. This option extracts incremental signaling information and sends that information in separate packets.

## Control Lead Configurations

CEoIP software supports the monitoring and transport of serial interface control leads.

# How to Configure Circuit Emulation over IP

This section contains the tasks for configuring an NM-CEM-4TE1 and an NM-CEM-4SER.

To configure an NM-CEM-4TE1, go to the "Configuring the NM-CEM-4TE1 Card Type" section on page 5.

To configure an NM-CEM-4SER, go directly to the "Configuring the Connection Using the xconnect Command" section on page 10.


- Configuring the NM-CEM-4TE1 Card Type, page 5
- Configuring the T1/E1 Line, page 6
- Creating CEM Channels on the T1/E1 Line, page 9
- Configuring the Connection Using the xconnect Command, page 10
- Configuring the CEM Channel, page 12


# Configuring the NM-CEM-4TE1 Card Type

Perform this task to configure the card type for an NM-CEM-4TE1.

This task does not apply to the NM-CEM-4SER.

## SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **card type** {**t1** | **e1**} *slot*

## DETAILED STEPS

| | Command or Action | Purpose |
|---|---|---|
| **Step 1** | `enable`<br><br>**Example:**<br>`Router> enable` | Enables privileged EXEC mode.<br>• Enter your password if prompted. |
| **Step 2** | `configure terminal`<br><br>**Example:**<br>`Router# configure terminal` | Enters global configuration mode. |
| **Step 3** | `card type {t1 \| e1} slot`<br><br>**Example:**<br>`Router(config)# card type t1 1` | Configures the card type by specifying the transmission mode for the ports on the network module.<br>• All four ports on the CEoIP T1/E1 network module must operate in the same mode.<br>• Use the **t1** or **e1** keyword to specify the transmission mode for all four ports.<br>**Note** This command is only entered once and changes do not take effect unless the **reload** command is used, or the router is rebooted. |

## What to Do Next

Go to the "Configuring the T1/E1 Line" section on page 6 to continue configuring CEoIP on an NM-CEM-4TE1.

# Configuring the T1/E1 Line

Perform this task to configure the T1 or E1 line, starting in global configuration mode.

This task does not apply to the NM-CEM-4SER.

### SUMMARY STEPS

1. **controller** {**t1** | **e1**} *slot/port*
2. **framing** {**esf** | **sf** | **unframed**}
   or
   **framing** {**crc4** | **no-crc4** | **unframed**}
3. **clock source** {**internal** | **line** | **adaptive** *channel-number*}
4. **cablelength** {**long** | **short**} {*attenuation* | *length*}
5. **crc-threshold** *value*
6. **description** *text*
7. **loopback**{**local** {**line** | **payload**} | **network**}

## DETAILED STEPS

| | Command or Action | Purpose |
|---|---|---|
| **Step 1** | **controller** {**t1** \| **e1**} *slot*/*port*<br><br>**Example:**<br>Router(config)# **controller t1 1/0** | Enters controller configuration mode.<br>• Use the *slot* and *port* arguments to specify the slot number and port number to be configured. |
| **Step 2** | **framing** {**esf** \| **sf** \| **unframed**}<br><br>or<br><br>**framing** {**crc4** \| **no-crc4** \| **unframed**}<br><br>**Example:**<br>Router(config-controller)# **framing esf**<br><br>**Example:**<br>Router(config-controller)# **framing crc4** | (Optional) Configures the framing format for a T1 or E1 port to synchronize the port and the attached device.<br><br>**T1 port framing options:**<br>• Use the **esf** keyword to specify Extended Superframe as the T1 framing type.<br>• Use the **sf** keyword to specify the Superframe (also commonly called D4 framing) as the T1 framing type. This is the default.<br><br>**E1 port framing options:**<br>• Use the **crc4** keyword to specify the G.704 standard with optional CRC4 mechanism defined in timeslot zero (0) enabled as the E1 framing type. This is the default.<br>• Use the **no-crc4** keyword to specify the G.704 standard with optional CRC4 mechanism defined in timeslot zero (0) disabled as the E1 framing type.<br><br>**T1 or E1 port framing options:**<br>• Use the **unframed** keyword to specify the unchannelized mode of framing.<br><br>**Note** If you do not configure framing, the framing on the customer premises equipment (CPE) devices on each end of the connection must match. |

| | Command or Action | Purpose |
|---|---|---|
| **Step 3** | **clock source** {**internal** \| **line** \| **adaptive** *channel-number*}<br><br>**Example:**<br>Router(config-controller)# **clock source adaptive 6** | Configures the clock source for a T1 or E1 port.<br>• Use the **internal** keyword to specify that the port transmit clock is derived from the time-division multiplexing (TDM) bus backplane clock, if one exists in the router, or the on-board oscillator on the network module.<br>• Use the **line** keyword to specify that the port transmit clock is derived from the the receive clock on the same port.<br>• Use the **adaptive** keyword to specify that the port transmit clock is locally synthesized based on the average data content of the dejitter buffer of one of the channels on this port.<br>• If the **adaptive** keyword is selected, use the *channel-number* argument to specify the channel whose dejitter buffer is to be used to synthesize the transmit clock of the port. |
| **Step 4** | **cablelength** {**long** \| **short**} {*attenuation* \| *length*}<br><br>**Example:**<br>Router(config-controller)# **cablelength long -15db** | (Optional) Specifies the line build-out characteristics of the internal CSU on a T1 port.<br>• Use the **long** keyword to specify that the signal characteristics are set for a long cable length.<br>• Use the **short** keyword to specify that the signal characteristics are set for a short cable length.<br>• If the **long** keyword is selected, use the *attenuation* argument to specify the T1 signal attenuation.<br>• If the **short** keyword is selected, use the *length* argument to specify the T1 cable length.<br>**Note** This command does not apply to an E1 port. |
| **Step 5** | **crc-threshold** *value*<br><br>**Example:**<br>Router(config-controller)# **crc-threshold 512** | (Optional) Configures the number of cyclical redundancy check (CRC) errors in one second that results in the second being declared as a Severely Errored Second (SES).<br>• Use the *value* argument to specify the number of CRC errors. Default is 320.<br>**Note** This command does not apply to an E1 port. |

| | Command or Action | Purpose |
|---|---|---|
| **Step 6** | **description** *text*<br><br>**Example:**<br>`Router(config-controller)# description T1 line to 3rd floor PBX` | (Optional) Specifies a text description of the port. |
| **Step 7** | **loopback** {**local** {**line** \| **payload**}\| **network**}<br><br>**Example:**<br>`Router(config-controller)# loopback network` | (Optional) Creates a loopback from a T1 or E1 port.<br>• Use the **local** keyword to create a loopback where the information from a locally-attached CPE is transmitted back to the locally-attached CPE.<br>• Use the **network** keyword to create a loopback where the data received over the network from a remotely-attached CPE is transmitted back to the remotely-attached CPE.<br>• If the **local** keyword is selected, use the **line** keyword to create a full physical layer loopback of all bits, including data and framing.<br>• If the **local** keyword is selected, use the **payload** keyword to create a loopback of the data in the individual timeslots only. In this mode, framing bits are terminated on entry and regenerated on exit instead of being looped back. This mode is not available if the port is configured for **framing unframed**. |

## What to Do Next

Go to the "Creating CEM Channels on the T1/E1 Line" section on page 9 to continue configuring CEoIP on an NM-CEM-4TE1

# Creating CEM Channels on the T1/E1 Line

Perform this task to create CEM channels on the T1 or E1 line, starting in controller configuration mode.

This task does not apply to the NM-CEM-4SER.

## SUMMARY STEPS

1. **cem-group** *group-number* {**unframed** | **timeslots** *timeslot* [**speed** {**56** | **64**}]}
2. **exit**

## DETAILED STEPS

| | Command or Action | Purpose |
|---|---|---|
| **Step 1** | **cem-group** *group-number* {**unframed** \| **timeslots** *timeslot* [**speed** {**56** \| **64**}]}<br><br>**Example:**<br>`Router(config-controller)# cem-group 6 timeslots 1-4,9,10 speed 64` | Creates a circuit emulation channel from one or more timeslots of a T1 or E1 line of an NM-CEM-4TE1.<br>• The *group-number* keyword identifies the channel number to be used for this channel. For T1 ports, the range is 0-23. For E1 ports, the range is 0-30.<br>• Use the **unframed** keyword to specify that a single CEM channel is being created including all timeslots and the framing structure of the line.<br>• Use the **timeslots** keyword and the *timeslot-range* argument to specify the timeslots to be included in the CEM channel. The list of timeslots may include commas and hyphens with no spaces between the numbers, commas, and hyphens.<br>• Use the **speed** keyword to specify the speed of the channels by specifying the number of bits of each timeslot to be used. This keyword applies only to T1 channels. |
| **Step 2** | **exit**<br><br>**Example:**<br>`Router(config-controller)# exit`<br>`Router(config)#` | Exits controller configuration mode and returns to global configuration mode. |

## What to Do Next

Go to the "Configuring the Connection Using the xconnect Command" section on page 10 to continue configuring CEoIP on an NM-CEM-4TE1

# Configuring the Connection Using the xconnect Command

Perform this task to create a connection using the **xconnect** command, starting in global configuration mode. This task applies to configuring CEoIP on both the NM-CEM-4TE1 and the NM-CEM-4SER.

**Note** To properly configure the CEoIP feature, two CEoIP network modules must use the same UDP port number to communicate.

### SUMMARY STEPS

1. **cem** *slot/port/channel*
2. **xconnect** *remote-ip-address virtual-connect-ID* **encapsulation** *encapsulation-type*
3. **local ip address** *ip-address*
4. **local udp port** *port-number*

5. **remote udp port** *port-number*
6. **exit**

## DETAILED STEPS

| | Command or Action | Purpose |
|---|---|---|
| **Step 1** | **cem** *slot/port/cem-group*<br><br>**Example:**<br>`Router(config)# cem 3/1/0` | Enters CEM configuration mode to configure CEM channels.<br>• Use the *slot* argument to specify the slot number in which the network module is installed.<br>• Use the *port* argument to specify the port number of the CEM channel to be configured.<br>• Use the *channel* argument to specify the CEM channel number to be configured. For a serial channel enter zero. For a T1 or E1 channel enter the channel number defined in the **cem-group** command (see the "Creating CEM Channels on the T1/E1 Line" section on page 9). |
| **Step 2** | **xconnect** *remote-ip-address virtual-connect-ID* **encapsulation** *encapsulation-type*<br><br>**Example:**<br>`Router(config-cem)# xconnect 10.2.0.1 0 encapsulation udp` | Creates one end of a connection between two CEM network modules and enters xconnect configuration mode.<br>• Use the *remote-ip-address* argument to specify the IP address of an interface—regular or loopback—on the destination router.<br>• Set the *virtual-connect-ID* argument to be zero.<br>**Note** Currently the only supported encapsulation type is UDP. |
| **Step 3** | **local ip address** *local-ip-address*<br><br>**Example:**<br>`Router(config-cem-xconnect)# local ip-address 10.2.0.2` | Configures the IP address of an interface—regular or loopback—on the source router.<br>**Note** The local IP address must be the same as the remote IP address (at the other side) configured in the **xconnect** command. |
| **Step 4** | **local udp port** *udp-port*<br><br>**Example:**<br>`Router(config-cem-xconnect)# local udp port 15901` | Specifies the User Datagram Protocol (UDP) port number of the local CEM channel.<br>**Note** The local UDP port of a CEM channel must be the same as the remote UDP port of the CEM channel at the other end of the connection. |
| **Step 5** | **remote udp port** *udp-port*<br><br>**Example:**<br>`Router(config-cem-xconnect)# remote udp port 15902` | Specifies the UDP port number of the remote CEM channel.<br>**Note** The remote UDP port of a CEM channel must be the same as the local UDP port of the CEM channel at the other end of the connection. |
| **Step 6** | **exit**<br><br>**Example:**<br>`Router(config-cem-xconnect)# exit`<br>`Router(config-cem)#` | Exits xconnect configuration mode and returns to CEM configuration mode.<br>• Repeat this command if you wish to exit CEM configuration mode return to global configuration mode. |

## What to Do Next

This task must be repeated on the other CEM network module and each end of the CEM connection must be configured identically to allow traffic to pass between the network modules. When both network modules have been configured, continue to the "Configuring the CEM Channel" section on page 12.

# Configuring the CEM Channel

Perform this task to configure the CEM T1/E1 or serial channel, starting in CEM configuration mode.

### SUMMARY STEPS

1. **clock rate** *rate*
2. **clock mode** {**normal** | **split**}
3. **clock source** {**internal** | **loop** | **adaptive**}
4. **payload-size** *size*
5. **dejitter-buffer** *size*
6. **control-lead sampling-rate** *rate*
7. **control-lead state** {**active** | **fail**} *output-lead* {**on** | **off** | **follow**} [{**local** | **remote**} *input-lead*]
8. **data-strobe** *input-lead-name* {**on** | **off**}
9. **idle-pattern** *length pattern1* [*pattern2*]
10. **signaling**
11. **payload compression**
12. **data protection**
13. **ip dscp** *dscp*
14. **ip tos** *tos*
15. **ip precedence** *precedence*
16. **loopback** {**local** | **network**}
17. **exit**

## DETAILED STEPS

| | Command or Action | Purpose |
|---|---|---|
| **Step 1** | `clock rate rate`<br><br>**Example:**<br>`Router(config-cem)# clock rate 38400` | (Optional) For serial channels only. Specifies the nominal bit rate of a serial CEM channel.<br><br>• Use the *rate* argument to specify the data rate of the channel in bps. Default is 64000. |
| **Step 2** | `clock mode {normal \| split}`<br><br>**Example:**<br>`Router(config-cem)# clock mode split` | (Optional) For serial channels only. Specifies the clock mode of a serial CEM channel.<br><br>• Use the **normal** keyword to specify that the Data Circuit-terminating Equipment (DCE) provides both the Receive Clock (RxC) and the Transmit clock (TxC) to the attached Data Terminal Equipment (DTE).<br><br>• Use the **split** keyword to specify that the DCE provides the Receive Clock (RxC) to the attached DTE, and the DTE provides the external Transmit Clock (XTC or TT) to the DCE.<br><br>**Note** Depending on the serial cable attached to the port, the port is automatically configured as either a DCE or DTE. |
| **Step 3** | `clock source {internal \| loop \| adaptive}`<br><br>**Example:**<br>`Router(config-cem)# clock source loop` | (Optional) Configures the clock source for a serial CEM channel.<br><br>• This step applies only to configuring serial channels. For information about configuring the clock source for T1 or E1 ports, see the "Configuring the T1/E1 Line" section on page 6.<br><br>• Use the **internal** keyword to specify that the clock(s) provided by the network module to the CPE is derived from the TDM bus backplane clock, if one exists in the router, or the on-board oscillator on the network module.<br><br>• Use the **loop** keyword to specify that the clock provided by the network module to the CPE is derived from the the clock receive from the CPE on the same port.<br><br>• Use the **adaptive** keyword to specify that the clock(s) provided by the network module to the CPE is locally synthesized based on the average data content of the local dejitter buffer.<br><br>**Note** The **loop** keyword is valid only when the **clock mode split** command is configured. |

| | Command or Action | Purpose |
|---|---|---|
| **Step 4** | **payload-size** *size*<br><br>**Example:**<br>`Router(config-cem)# payload-size 512` | (Optional) Specifies the number of bytes encapsulated into a single IP packet.<br>• Use the *size* argument to specify the number of bytes included in the payload of each packet. Default is 32 bytes for a serial CEM channel.<br>• For more information about T1 and E1 default values, see the **payload-size** command in the "Command Reference" section. |
| **Step 5** | **dejitter-buffer** *size*<br><br>**Example:**<br>`Router(config-cem)# dejitter-buffer 80` | (Optional) Specifies the size of the dejitter buffer used to compensate for the network filter.<br>• Use the *size* argument to specify the size of the buffer in milliseconds. Default is 60. |
| **Step 6** | **control-lead sampling-rate** *rate*<br><br>**Example:**<br>`Router(config-cem)# control-lead sampling-rate 10` | (Optional) Specifies the sampling rate of input control leads on a serial CEM channel.<br>• This command is used only on serial channels.<br>• Use the *rate* argument to specify the frequency with which the control leads are sampled, in samples per second. Default is 0.<br>**Note** Control lead update packets are independent of the data packets from the same channel. |
| **Step 7** | **control-lead state** {**active** \| **fail**} *output-lead* {**on** \| **off** \| **follow**} [{**local** \| **remote**} *input-lead*]<br><br>**Example:**<br>`Router(config-cem)# control-lead state active rts follow remote cts` | (Optional) Specifies the state of each output control lead on a serial CEM channel.<br>• This command is used only on serial channels.<br>• Use the **active** keyword to specify the state of the control lead when the connection is active.<br>• Use the **fail** keyword to specify the state of the control lead when the connection has failed.<br>• Use the *output-lead* argument to specify the name of the control lead.<br>• Use the **on** keyword to specify that the control lead is permanently asserted.<br>• Use the **off** keyword to specify that the control lead is permanently not asserted.<br>• Use the **follow** keyword to specify that the control lead is to follow any changes in the state of an input control lead specified by the **local** or **remote** keywords and the *input-lead* argument.<br>• Use the *input-lead* argument to specify the name of the local or remote control lead to follow.<br>**Note** Control lead update packets are independent of the data packets for the same channel.<br>**Note** The **control-lead sampling-rate** parameter must be set to non-zero for this feature to operate. |

| | Command or Action | Purpose |
|---|---|---|
| Step 8 | **data-strobe** *input-lead* {**on** \| **off**}<br><br>**Example:**<br>Router(config-cem)# **data-strobe dtr on** | (Optional) Specifies that an input control lead is to be monitored and data is packetized and sent only when the specified control lead is in the specified state.<br>• This command is used only on serial channels.<br>• Use the *input-lead* argument to specify the input control lead to be monitored to determine whether input data is to be packetized.<br>• Use the **on** keyword to specify that data packets are to be sent from this CEM channel only when the specified input lead is asserted.<br>• Use the **off** keyword to specify that data packets are to be sent from this CEM channel only when the specified input lead is not asserted.<br>• Use this command to save bandwidth when the attached CPE is inactive.<br>**Note** Control lead update packets are still sent even if data packets are withheld. |
| Step 9 | **Cisco NM-CEM-4SER:**<br>**idle-pattern** *length pattern1* [*pattern2*]<br><br>**Cisco NM-CEM-4TE1:**<br>**idle-pattern** *pattern1*<br><br>**Example:**<br><br>**Cisco NM-CEM-4SER:**<br>Router(config-cem)# **idle-pattern 53 0x12345678 0x87654321**<br><br>**Cisco NM-CEM-4TE1:**<br>Router(config-cem)# **idle-pattern 0x66** | (Optional) Defines the idle data pattern to send to the attached CPE when packets are lost or the de-jitter buffer experiences an under-run condition.<br>For serial CEM channels:<br>• A bit pattern up to 64 bits long may be specified.<br>• Use the *pattern1* argument to specify up to 32 bits of the least significant bits of the idle data pattern, in hex notation. Default is 0xFF.<br>• Use the *pattern2* argument to specify the most significant bits of the idle data pattern, in hex notation. If the *length* argument is 32 bits or less, this argument is not permitted.<br>• Use the *length* argument to specify the total length of the repeating bit pattern. Default is 8 bits.<br>For T1 or E1 CEM channels:<br>• An eight-bit pattern is specified. |
| Step 10 | **signaling**<br><br>**Example:**<br>Router(config-cem)# **signaling** | (Optional) Enables the transport of Channel Associated Signaling (CAS) bits.<br>**Note** This command applies only to framed T1 or E1 data channels. |
| Step 11 | **payload-compression**<br><br>**Example:**<br>Router(config-cem)# **payload-compression** | (Optional) Enables payload compression on a CEM channel.<br>**Note** Enabling payload compression adds a delay equal to one packet time. |

| | Command or Action | Purpose |
|---|---|---|
| **Step 12** | **data-protection**<br><br>**Example:**<br>`Router(config-cem)# data-protection` | (Optional) Enables data protection by transmitting each data bit twice, once in each of two consecutive data packets.<br>• Use the **data-protection** command to protect transmissions from the effects of lost IP packets.<br>**Caution** Use this command carefully because it increases the network bandwidth used by the CEM connection. |
| **Step 13** | **ip dscp** *dscp*<br><br>**Example:**<br>`Router(config-cem)# ip dscp 36` | (Optional) Configures the IP Differentiated Service Code Point (DSCP) for packets originating from this CEM channel.<br>• Use the *dscp* argument to specify the value placed in the DSCP field of IP packets originating from this channel. Default is 46.<br>**Note** If DSCP is configured, the **ip tos** and **ip precedence** commands are not available because they are mutually exclusive. |
| **Step 14** | **ip tos** *tos*<br><br>**Example:**<br>`Router(config-cem)# ip tos 11` | (Optional) Configures the IP type of service (ToS) bits for the CEM channel.<br>• Use the *tos* argument to specify the value placed in the ToS field of IP packets originating from this channel. Default is 5.<br>**Note** If DSCP is configured, the **ip tos** command is not available because they are mutually exclusive. |
| **Step 15** | **ip precedence** *precedence*<br><br>**Example:**<br>`Router(config-cem)# ip precedence 7` | (Optional) Configures the IP precedence bits for the CEM channel.<br>• Use the *precedence* argument to specify the value placed in the precedence field of IP packets originating from this channel. Default is 0.<br>**Note** If DSCP is configured, the **ip precedence** command is not available because they are mutually exclusive. |

| | Command or Action | Purpose |
|---|---|---|
| **Step 16** | **loopback** {**local** \| **network**}<br><br>**Example:**<br>Router(config-cem)# **loopback network** | (Optional) Creates a loopback from a CEM serial channel.<br>• Use the **local** keyword to create a loopback where the information from a locally-attached CPE is transmitted back to the locally-attached CPE.<br>• Use the **network** keyword to create a loopback where the data received over the network from a remotely-attached CPE is transmitted back to the remotely-attached CPE.<br>**Note** For configuring a loopback on a T1 or E1 port, see the "Creating CEM Channels on the T1/E1 Line" section on page 9. |
| **Step 17** | **exit**<br><br>**Example:**<br>Router(config-cem)# **exit** | Exits CEM configuration mode and returns to global configuration mode.<br>• Use this command one more time to exit to privileged EXEC mode. |

## What to Do Next

Proceed to the "Configuration Examples for CEoIP" section on page 17.

# Configuration Examples for CEoIP

This section provides the following configuration examples:

- Configuring a T1 CEM Network Module: Example, page 17

## Configuring a T1 CEM Network Module: Example

The following example shows a basic configuration of a T1 network module to configure the CEoIP feature.

```
card type t1 0
controller t1 4/0
 cem-group 6 timeslots 1-4,9,10 speed 64
 framing esf
 linecode b8zs
 clock source adaptive 6
 cablelength long -15db
 crc-threshold 512
 description T1 line to 3rd floor PBX
 loopback network
 no shutdown
 exit
cem 2/1/6
 xconnect 10.2.0.1 0 encapsulation udp
 local ip-address 10.2.0.9
 local udp port 15901
 remote udp port 15901
 payload-size 512
 dejitter-buffer 80
```

```
 signaling
exit
```

# Additional References

For additional information related to the CEoIP feature, refer to the following references:

## Related Documents

| Related Topic | Document Title |
|---|---|
| CEoIP NMs | *Release Notes for Cisco NM-CEM-4TE1 and NM-CEM-4SER Network Module Software* |

## Standards

| Standards | Title |
|---|---|
| GR-1089 | *Electromagnetic Compatibility and Electrical Safety - Generic Criteria for Network Telecommunications Equipment* |
| GR-63 | *Network Equipment-Building System (NEBS) Requirements: Physical Protection* |
| TIA/EIA-IS-968 | *Technical Requirements for Connection of Terminal Equipment to the Telephone Network* |

## MIBs

| MIBs | MIBs Link |
|---|---|
| • OLD-CISCO-CHASSIS-MIB<br>• RFC1406-MIB<br>• CISCO-ENTITY-VENDORTYPE-OID-MIB | To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL:<br>http://www.cisco.com/go/mibs |

## RFCs

| RFCs | Title |
|---|---|
| RFC 1406 | *Definitions of Managed Objects for the DS1 and E1 Interface Types* |
| RFC 2495 | *Definitions of Managed Objects for the DS1, E1, DS2 and E2 Interface Types*<br>**Note** CEoIP supports RFC2495 to the same extent as IOS supports this RFC. |

## Technical Assistance

| Description | Link |
|---|---|
| Technical Assistance Center (TAC) home page, containing 30,000 pages of searchable technical content, including links to products, technologies, solutions, technical tips, and tools. Registered Cisco.com users can log in from this page to access even more content. | http://www.cisco.com/public/support/tac/home.shtml |

# Command Reference

The following new commands are pertinent to this feature. To see the command pages for these commands and other commands used with this feature, go to the *Cisco IOS Master Commands List*, Release 12.4, at http://www.cisco.com/univercd/cc/td/doc/product/software/ios124/124mindx/124index.htm.

- **cem**
- **cem-group**
- **clear cem**
- **clock mode**
- **clock source (CEM)**
- **control-lead sampling-rate**
- **control-lead state**
- **crc-threshold**
- **data-protection**
- **data-strobe**
- **default (CEM)**
- **dejitter-buffer**
- **framing (CEM)**
- **idle-pattern**
- **ip dscp**
- **local ip address**
- **local udp port**
- **loopback (CEM)**
- **payload-compression**
- **payload-size**
- **remote udp port**
- **show cem**
- **signaling**
- **xconnect (CEM)**

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