



# Configuring CEM

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This module describes how to configure Circuit Emulation (CEM).

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## Circuit Emulation

Circuit Emulation (CEM) is a technology that provides a protocol-independent transport over IP/MPLS 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 Multiprotocol Label Switching (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. As a result, CEM functions as a physical communication link across the packet network.

The router supports the pseudowire type that utilizes CEM transport: Structure-Agnostic TDM over Packet (SAToP) and Circuit Emulation Service over Packet-Switched Network (CESoPSN).

L2VPN over IP/MPLS is supported on the interface modules.



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**Note** We recommend that you configure the controller in the administratively up mode. Configuration under the administratively down mode is not recommended and it might cause configuration errors.

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## Restrictions for CEM

The **framed** command is not supported.

## Structure-Agnostic TDM over Packet

Structure-Agnostic TDM over Packet (SAToP) encapsulates Time Division Multiplexing (TDM) bit-streams as pseudowires over public switched networks. It disregards any structure that may be imposed on streams, in particular the structure imposed by the standard TDM framing.

The protocol used for emulation of these services does not depend on the method in which attachment circuits are delivered to the Provider Edge (PE) chassis. For example, a T1 attachment circuit is treated the same way for all delivery methods, including copper, multiplex in a T3 circuit, a virtual tributary of a SONET circuit, or unstructured Circuit Emulation Service (CES).

In SAToP mode, the interface is considered as a continuous framed bit stream. The packetization of the stream is done according to IETF RFC 4553. All signaling is carried out transparently as a part of a bit stream.

## Framed Structure-Agnostic TDM over Packet (SAToP)

Framed Structure-Agnostic TDM over Packet (SAToP) is required to detect an incoming AIS alarm in the DS1 SAToP mode. An AIS alarm indicates a problem with the line that is upstream from the DS1 network element connected to the interface. Framed SAToP further helps in the detection of a packet drop.

In case of unframed mode of SAToP, data received from the Customer Edge (CE) device is transported over the pseudowire. If the Provider Edge (PE) device receives a Loss of Frame (LOF) signal or Remote Alarm Indication (RAI) signal from a CE, the PE can only transmit the signal that is detected by the CE device. With the introduction of Framed SAToP, when the PE device receives the LOF or RAI signal, the PE device can detect the alarm for SAToP. Thus, the alarm can be detected earlier in the network. This helps in enhanced performance.



**Note** Framing type should be maintained same in all routers end to end.

### Difference between Framed and Unframed SAToP:

1. For unframed SAToP, the incoming signal is transmitted to the far end. This signal is not analyzed by the PE device. Hence, no alarm is reported.
2. For framed SAToP, the incoming signal is analyzed but is not terminated. If a LOF or RAI signal is detected, the remote PE detects the signals and transmits towards the remote CE.

### Difference between Framed SAToP and CESoP:

*Table 1: Behaviour Difference between Unframed SAToP, Framed SAToP, and CESoP on LOF Alarm*

Modes	Alarm Detected at PE	Controller Status at PE	Alarm Detected at CE (Remote)	Framing Bits Generation at PE (Remote)	Framing Bits Terminated at PE (Remote)
Unframed SAToP	None	Up	LOF	No	No
Framed SAToP	LOF	Down (Data path remains up)	AIS <sup>12</sup>	Yes	No

Modes	Alarm Detected at PE	Controller Status at PE	Alarm Detected at CE (Remote)	Framing Bits Generation at PE (Remote)	Framing Bits Terminated at PE (Remote)
CESOP	LOF	Down (Data path remains up)	AIS	Yes	Yes

<sup>1</sup> AIS—Cisco IOS XE Amsterdam 17.3.1 to later releases

<sup>2</sup> LOF—Support until Cisco IOS XE Amsterdam 17.2.1

**Table 2: Behaviour Difference between Unframed SAToP, Framed SAToP, and CESoP on RDI Alarm**

Modes	Alarm Detected at PE	Controller Status at PE	Alarm Detected at CE (Remote)	Framing Bits Generation at PE (Remote)	Framing Bits Terminated at PE (Remote)
Unframed SAToP	None	Up	RDI	No	No
Framed SAToP	RDI	Down (data path remains up)	RDI	No	No
CESOP	RDI	Down (data path remains up)	RDI	M-bit is set into control word	Yes

**Table 3: Behaviour Difference between Unframed SAToP, Framed SAToP, and CESoP on AIS alarm**

Modes	Alarm Detected at PE	Controller Status at PE	Alarm Detected at CE (Remote)	Framing Bits Generation at PE (Remote)	Framing Bits Terminated at PE (Remote)
Unframed SAToP	AIS	Down (data path remains up)	AIS	No	No
Framed SAToP	AIS	Down (data path remains up)	AIS	No	No
CESOP	AIS	Down (data path remains up)	AIS	L-bit is set into control word	Yes

**Remote Loopback from CE to PE Detection:**

Framed SAToP does not detect any loopback.

	Loopback Detected at PE	Controller Status at PE (Remote)	Controller Status at CE (Remote)
Unframed SAToP	No	Not in Loopback	Loopback
Framed SAToP	No	Not in Loopback	Loopback
CESOP	Yes	Loopback	Not in loopback

# Configuring CEM

This section provides information about how to configure CEM. CEM provides a bridge between a Time Division Multiplexing (TDM) network and a packet network, MPLS. The chassis encapsulates the TDM data in the MPLS packets and sends the data over a CEM pseudowire to the remote Provider Edge (PE) chassis.

The following sections describe how to configure CEM.

## 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 chassis rejects it and reverts to the previous configuration.
- The dummy-pattern command is *not* supported.



**Note** CEM interface does *not* support idle-cas parameter.

## Pseudowire Scale Support

*Table 4: Feature History*

Feature Name	Release	Description
Pseudowire Scale Support	Cisco IOS XE Amsterdam 17.3.1	A maximum of <b>26,880</b> CEM Pseudowires are supported on the Cisco RSP3 chassis using combination of the 1-Port OC-192 or 8-Port Low Rate CEM interface module.
Pseudowire Scale Support	Cisco IOS XE Gibraltar 16.12.1	A maximum of <b>21,504</b> Pseudowires are supported on the Cisco RSP3 chassis using combination of the 1-Port OC-192 or 8-Port Low Rate CEM interface module.

Effective **Cisco IOS XE Amsterdam 17.3.1**, the Cisco router supports,

- 26,880 CEM Pseudowires (PWs) without protection (with SONET)
- 13,440 CEM PWs with protection

Effective Cisco **IOS XE 16.12.1**, the Cisco router supports,

- 21,504 CEM Pseudowire (PWs) without protection (with SONET)
- 10,752 CEM PWs with protection



**Note** These 26,880 and 21,504 CEM PWs can be achieved on the router by using the combination of the 1-port OC-192 Interface module or 8-port Low Rate Interface Module and 1-port OC148/ STM-16 or 4-port OC-12/OC-3 / STM-1/STM-4 + 12-Port T1/E1 + 4-Port T3/E3 CEM Interface Module IMs with the 48-port T3/E3 CEM Interface Module and 48-port T1/E1 CEM Interface Module (ASR 900 48-port T1/E1 Interface Module) in multiple slot combinations.

#### Restrictions for PW Scale

- CEM PW scale is supported in **only** in the SONET mode.
- When configured for scale beyond the maximum CEM PW scale, a syslog is generated as *Cannot allocate CEM group*, maximum CEM group exceeded, but the configurations will not be rejected.
- While performing ISSU with the specified CEM PW scales, sufficient interface-module-delay must be provided for each IM. This provision enables all PWs to program after the IM OIR. The minimum ‘time for delay’ in case of 1-port OC-192 Interface module or 8-port Low Rate Interface Module (ASR 900 Combo 8-port SFP GE and 1-port 10GE IM with CEM, 10G) is 1800 seconds.
- After SSO and successful bulk sync, run the **show platform software tdm-combo cem ha-stray-entries** command. If the output of this command displays no entries, then the next SSO can be performed. You must wait until **show platform software tdm-combo cem ha-stray-entries** has no entries.



**Note** To configure CEM circuits (for example, T1 or VT1.5 CEP pseudowire) at a large number (for example, 10,000), we recommend you to configure the CEM circuits in a batch of 2000 CEM circuits. Use the **show platform software tdm-combo cem ha-stray-entries** command to verify that there are no pending circuits to be programmed before proceeding to the next batch of configuration. The **show platform software tdm-combo cem ha-stray-entries** command can be used only in the standby RSP3 console.

## Configuring CEM Group for SAToP for T1 Interfaces

To configure a CEM group for SAToP.

```
enable
configure terminal
controller t1 0/4/0
cem-group 0 unframed
end
```



**Note** You need metroaggrservice license to configure CEM group on the Interface Module.

## Configuring CEM Classes

A CEM class is a single step configuration of CEM parameters such as payload size and dejitter buffer that you can perform at the global configuration mode and apply this CEM class on an individual CEM interfaces.

Thus the CEM class allows you to create a single configuration template for multiple CEM pseudowires.

Follow these steps to configure a CEM class:



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- Note**
- The CEM parameters can be configured either by using CEM class or on CEM interface directly.
  - The CEM parameters at the local and remote ends of a CEM circuit must match; otherwise, the pseudowire between the local and remote PE chassis does not come up.
- 

```
enable
configure terminal
class cem mycemclass
payload-size 512
dejitter-buffer 12
exit
interface cem 0/0/1
cem 0
cem class mycemclass
xconnect 10.10.10.10 200 encapsulation mpls
exit
```



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- Note** Removing the global CEM class that is associated with CEM interface/CEM group will remove the configuration from all the associated CEM.
- 

## Configuring CEM Parameters

The following sections describe the parameters you can configure for CEM circuits.

### Configuring Payload Size (Optional)

To specify the number of bytes encapsulated into a single IP packet, use the payload size command. The size argument specifies the number of bytes in the payload of each packet. The range is from 32 to 1312 bytes.

Default payload sizes for an unstructured CEM channel are as follows:

- E1 = 256 bytes
- T1 = 192 bytes

Default payload sizes for a structured CEM channel depend on the number of time slots that constitute the channel. Payload size (L in bytes), number of time slots (N), and packetization delay (D in milliseconds) have the following relationship:  $L = 8 * N * D$ . The default payload size is selected in such a way that the packetization delay is always 1 millisecond.

The payload size must be an integer of the multiple of the number of time slots for structured CEM channels.

### Setting the Dejitte Buffer Size

Dejitte Buffer is a buffering mechanism to account for a delay variation in the CEM packet stream. The buffer size is the amount of time you allocate to compensate for the network filter. The configured dejitter-buffer size is converted from milliseconds to packets and rounded up to the next integral number of packets. To set

the size of the dejitter-buffer (in milliseconds), use the **dejitter-buffer** *value* command. The value range is from 1 to 32; the default is 5.

## Shutting Down a CEM Channel

To shut down a CEM channel, use the **shutdown** command in CEM configuration mode. The **shutdown** command is supported only under CEM mode and not under the CEM class.

## Configuring DS1 CT3 SAToP Mode

To configure DS1 CT3 SAToP mode, use the following commands:

```
enable
configure terminal
controller MediaType
mode sonet
controller sonet 0/5/0
rate oc12
sts-1 1
mode ct3
t1 1 cem-group 100 unframed
t1 1 framing unframed
interface cem 0/5/0
cem 100
xconnect 2.2.2.2 10 encapsulation mpls
end
```

## Configuring VT DS1 SAToP Mode

To configure VT DS1 SAToP mode, use the following commands:

```
enable
configure terminal
controller MediaType 0/5/0
mode sonet
controller sonet 0/5/0
rate oc12
sts-1 1
mode vt-15
vtg 1 t1 1 framing unframed
vtg 1 t1 1 cem-group 0 unframed
end
```

## Configuring STS-Nc CEP

To configure STS-Nc CEP, use the following commands:

```
enable
configure terminal
controller MediaType 0/5/0
mode sonet
controller sonet 0/5/0
rate oc12
sts-1 1 - 3 mode sts-3c
cem-group 100 cep
interface cem 0/5/0
cem 100
```

```
xconnect 2.2.2.2 10 encapsulation mpls
end
```

## Configuring CEP

To configure CEP:

```
enable
configure terminal
controller MediaType 0/5/0
mode sonet
controller sonet 0/5/0
sts-1 1
mode unframed
cem-group 100 cep
end
```

## Configuring VT-15 CEP

To configure VT-15 CEP, use the following commands:

```
enable
configure terminal
controller MediaType 0/5/0
mode sonet
controller sonet 0/5/0
rate oc12
sts-1 1
mode vt-15
vtg 1 vt 1 cem-group 100 cep
end
```

## Configuring DS3 SAToP

To configure DS3 SAToP, the STS-1 needs to be configured in mode T3. Use the following commands:

```
enable
configure terminal
controller MediaType 0/5/0
mode sonet
controller sonet 0/5/0
rate oc12
sts-1 1
mode t3
cem-group 100 unframed
interface cem 0/5/0
cem 100
xconnect 2.2.2.2 10 encapsulation mpls
end
```

## Configuring CEM APS

To configure CEM APS, use the following commands:

```
enable
configure terminal
controller MediaType 0/5/0
mode sonet
```



```

controller sonet 0/5/0
controller sonet-acr acr_no
sts-1 1
vtg 1 t1 1 cem-group 100 unframed
end

```

## Configuring Unidirectional APS for SAToP



**Note** When the **aps adm** command is not used, the LOS is detected on active port and the L-AIS is transmitted to the remote-end to force APS switchover. This is similar to bi-directional APS mode.

'When the **aps adm** command is used, the ports are in strict unidirectional mode. When the LOS is detected on active port, the L-AIS is suppressed and behaves in a strict uni-directional mode.

Ensure that the configuration is performed under the protected interface.

To configure unidirectional ACR (SONET Framing), use the following commands:

```

enable
configure terminal
controller sonet 0/5/0
clock source internal
aps group acr 1
aps working 1
aps unidirectional
exit
controller sonet 0/4/0
aps group acr 1
aps protect 1 10.7.7.7
aps revert 3
aps adm
end

```



**Note** To restore the system to its default condition, use the **no** form of the command.

## Configuring Bi-directional ACR (SONET Framing) for SAToP

To configure bi-directional ACR (SONET Framing), use the following commands:

```

enable
configure terminal
controller sonet 0/5/0
clock source internal
aps group acr 1
aps working 1
exit
controller sonet 0/4/0
aps group acr 1
aps protect 1 10.7.7.7
end

```



**Note** To restore the system to its default condition, use the **no** form of the command.

## Verifying CEM Statistics for SAToP

Use the following commands to verify the pseudowire configuration for SAToP:

- **show cem circuit**—Displays information about the circuit state, administrative state, the CEM ID of the circuit, and the interface on which it is configured. If cross connect is configured under the circuit, the command output also includes information about the attachment circuit status.

```
Router# show cem circuit
```

```
<0-32000>      CEM ID
detail        Detailed information of cem ckt(s)
interface     CEM Interface
summary       Display summary of CEM ckts
|             Output modifiers
```

```
Router# show cem circuit
```

CEM Int.	ID	Line	Admin	Circuit	AC
CEM0/1/0	1	UP	UP	ACTIVE	--/--
CEM0/1/0	2	UP	UP	ACTIVE	--/--
CEM0/1/0	3	UP	UP	ACTIVE	--/--
CEM0/1/0	4	UP	UP	ACTIVE	--/--
CEM0/1/0	5	UP	UP	ACTIVE	--/--

- **show cem circuit cem-id** — Displays the detailed information about that particular circuit.

```
Router# show cem circuit 0
```

```
CEM0/1/2, ID: 0, Line: UP, Admin: UP, Ckt: ACTIVE
Controller state: up, T1 state: up
Idle Pattern: 0xFF, Idle CAS: 0x8
Dejitter: 5 (In use: 0)
Payload Size: 192
Framing: Unframed
CEM Defects Set
None
```

```
Signalling: No CAS
RTP: No RTP
```

```
Ingress Pkts:   11060           Dropped:           0
Egress Pkts:   11061           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
```

- **show cem circuit summary** — Displays the number of circuits which are up or down per interface basis.

```
Router# show cem circuit summary
```

```
CEM Int.          Total Active  Inactive
```

-----  
 CEM0/1/0            1        1        0

## Associated Commands

The following commands are used to configure CEM:

Commands	URL
<b>cem</b>	<a href="http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-c1.html#wp2184138077">http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-c1.html#wp2184138077</a>
<b>cem group</b> <i>cem-group-number</i> <b>unframed</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>cem-group</b> <i>cem-group-number</i> <b>cep</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>class</b> <b>cem</b>	<a href="http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-c1.html#wp7199841750">http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-c1.html#wp7199841750</a>
<b>controller</b> <b>t1</b>	<a href="http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-c2.html#wp1472647421">http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-c2.html#wp1472647421</a>
<b>mode</b> <b>ct3</b>	<a href="http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-l2.html#wp5913349630">http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-l2.html#wp5913349630</a>
<b>mode</b> <b>t3</b>	<a href="http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-l2.html#wp5688885940">http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-l2.html#wp5688885940</a>
<b>mode</b> <b>vt-15</b>	<a href="http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-l2.html#wp1137973905">http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-l2.html#wp1137973905</a>
<b>payload-size</b> <b>dejitter-buffer</b>	<a href="http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-o1.html#wp3946673156">http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-o1.html#wp3946673156</a>
<b>rate</b>	<a href="http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-o1.html#wp4442889730">http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-o1.html#wp4442889730</a>
<b>show cem circuit</b>	<a href="http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-s2.html#wp1086825073">http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-s2.html#wp1086825073</a>
<b>sts-1</b>	<a href="http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-s6.html#wp2423232697">http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-s6.html#wp2423232697</a>

Commands	URL
<b>t1 t1-line-number cem-group</b>	<a href="http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-t1.html#wp2399838226">http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-t1.html#wp2399838226</a>
<b>t1 t1-line-number framing</b>	<a href="http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-t1.html#wp2623191253">http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-t1.html#wp2623191253</a>
<b>t1 t1-line-number clock source</b>	<a href="http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-t1.html#wp3480850667">http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-t1.html#wp3480850667</a>
<b>vtg vtg-number vt vt-line-number cem-group cem-group-number cep</b>	<a href="http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-t2.html#wp3494199143">http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-t2.html#wp3494199143</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>
show controllers t3	<a href="https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-s3.html#wp1987423547">https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-s3.html#wp1987423547</a>

## Additional References for Configuring CEM

### Related Documents

Related Topic	Document Title
Cisco IOS commands	<i>Cisco IOS Master Commands List, All Releases</i>

### Standards

Standards	Title
—	There are no standards for this feature.

### MIBs

MIB	MIBs Link
—	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>

**RFCs**

RFCs	Title
—	There are no RFCs for this feature.

**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>

