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…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.

Note Effective from Cisco IOS XE Bangalore Release 17.6.1, 14-port serial interface module (A900-IMASER14A/S) is supported on the following:

- Any slots on ASR900 with RSP2-128

- Any slots on ASR900 with A900-RSP3C-400-S

- Only on slot 4 on RSP3C-200-S with ASR903

- Only on slots 3, 4 and 5 on RSP2-64 with ASR903

- Only on slots 3, 4, 7, 8, 11 and 12 on A900-RSP3C-400-W with ASR907

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 1: Smart Grid Tele-protection
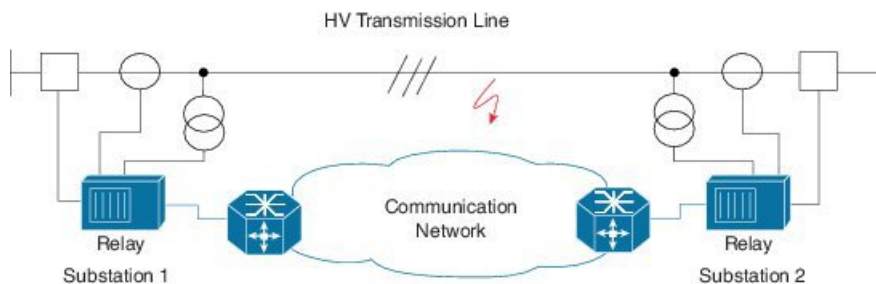
Overview of C37.94 Frame

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
xconnect 10.10.10.10 200 encapsulation mpls
exit
```

Note The controller is auto-configured when the interface module is inserted.

Low bandwidth applications can be configured, as required. You can configure the exact number of timeslots required.

The **modifytimeslots** command must be configured after configuring the **cem-group timeslots** command.

When you configure **cem-group 0 timeslots x** command and then configure **modifytimeslots y** command, the total number of timeslots that get configured in the system would be x+y.

For example, when you configure **cem-group 0 timeslots 1** command and then configure **modifytimeslots 6** command, the total number of timeslots that get configured in the system would be 1+6 = 7 timeslots.

A maximum of 12 timeslots can be configured. So, if you configure **cem-group 0 timeslots 12** command and then try to configure more timeslots using the **modifytimeslots y** command, the configuration will not be successful and an error is displayed.

Verifying C37.94 Interface Module Configurations

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

• Use the **show running-config** command to view the configurations.

```
Router# show running-config | sec 0/0/0

controller C3794 0/0/0
  cem-group 0 timeslots 12
interface CEM0/0/0
no ip address
cem 0
```

```
      xconnect 10.10.10.10 200 encapsulation mpls
```

• Use the **show xconnect** command to verify the configuration of cross connect between the controllers.

```
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 CE0/0/0:0(CESoPSN Basic)     UP mpls 10.10.10.10 200               UP
```

• Use the **show cem circuit** command to verify the CEM configurations.

```
Router# show cem circuit detail

CEM0/0/0, ID: 0, Line: UP, Admin: UP, Ckt: ACTIVE
Controller state: up, T1/E1 state: up
Idle Pattern: 0xFF, Idle CAS: 0x8
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
cem-group	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-c1.html#wp2440628600
xconnect	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-t2.html#wp8578094790
loopback	http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-l1.html#wp1033903426

Hitless Switching on C37.94 Interface Module

Table 1: Feature History

Feature Name	Release Information	Description
Hitless Switching on C37.94 Interface Module	Cisco IOS XE Cupertino 17.9.1	Hitless switching protection describes the ability to switch between the active and backup paths without losing packets when an active path fails. This feature ensures uninterrupted continuous service and maintains an extremely high-reliability rating.

Hitless switching protection describes the ability to switch between the active and backup paths without losing packets when an active path fails. Hitless switching is supported only on the A900-IMA4C3794 interface module with Flex LSP configuration. Pseudowire segment protection is provided by the Packet Switched Network (PSN) layer with a fast-reroute (FRR) backup or an end-to-end backup LSP. These mechanisms can restore the PSN connectivity rapidly during an active path failure.

However, the traffic convergence to protect path may take some time, depending upon the following factors:

- Time taken to detect link or node failure in the active path.

- Switch the traffic to backup path.

- Reprogramming the head end to avoid the faulty path.

You need to enable hitless switching on active path to protect path which carries the PW traffic.

You must configure Flex Label Switched Paths as Active-Active LSPs, so that more than one LSP paths are programmed to carry the data traffic at all the time from end to end. The LSPs are made active by replicating the traffic to both active LSP paths at the ingress PE.

The receiving-end device can choose the packet based on arrival time and integrity of the packet. By maintaining active-active LSP paths, receiving-end device need not wait until the control plane detects failure and switch to the backup path. Hitless switching is achieved with active-active LSP paths on network failure seamlessly.

The egress PE processes the replicated packets based on the packet arrival time, thus eliminating the duplicate packets received on the high latency path. The receiver PE chooses on per-packet basis to forward the packets that arrived first, irrespective of the LSP paths it received the packet. The second packet (replicated packet) arrived on high latency path with same sequence number is then dropped by egress PE.

Hence, if a packet from one path gets delayed then packets from the other path is considered, thus making seamless transmission of packets to end devices. This transmission is seamless, even when there's a link or node failure in any of the nodes of an active path-1 as long as active path-2 is intact.

Enabling Hitless Switching SDM Template

You must enable hitless SDM template to enable hitless switching using the **enable_hitless_switching** command.

```
Router(config)#sdm prefer enable_hitless_switching
Hitless Switching Template configuration is modified. Save config and Reload[yes/no]:yes
Building configuration...

*May  5 12:49:52.551 IST: Changes to the Hitless Switching template preferences have been
stored[OK]
Proceeding with system reload...
Reload scheduled in 2 minutes by console
Reload reason: Hitless Switching template change
*May  5 12:50:05.383 IST: %SYS-5-SCHEDULED_RELOAD:
Reload requested for 12:52:04 IST Thu May 5 2022 at 12:50:04 IST Thu May 5 2022 by console.

Reload Reason: Hitless Switching template change
```

Disabling Hitless Switching SDM Template

You can disable hitless switching using the **disable_hitless_switching** command.

```
Router(config)#sdm prefer disable_hitless_switching
Hitless Switching Template configuration is modified Save config and Reload?[yes/no]: yes
Building configuration...

*May  5 12:17:16.800 IST: Changes to the Hitless Switching template preferences have been
stored[OK]
Proceeding with system reload...
Reload scheduled in 2 minutes by console
Reload reason: Hitless Switching template change
*May  5 12:17:58.194 IST: %SYS-5-SCHEDULED_RELOAD:
Reload requested for 12:19:57 IST Thu May 5 2022 at 12:17:57 IST Thu May 5 2022 by console.

Reload Reason: Hitless Switching template change.
Reload scheduled in 1 minute and 51 seconds by console
Reload reason: Hitless Switching template change
```

Limitations

- Hitless switching isn't supported on non co-routed (one in the forward direction and the other in reverse direction) flex LSP.

- Hitless switching is supported only on RSP3 module.

- During SSO on head or tail node, packet drops may occur.

• All the existing limitations of flex LSP are applicable.

• Hitless switching is supported only after you enable sdm enable hitless template.

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 2: LOS at Optical Receive Port of Tele-protection Equipment
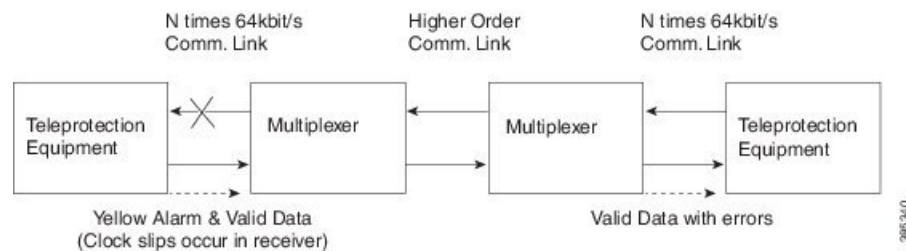
Failure Scenarios

• 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 3: LOS at Optical Receive Port of Multiplexer
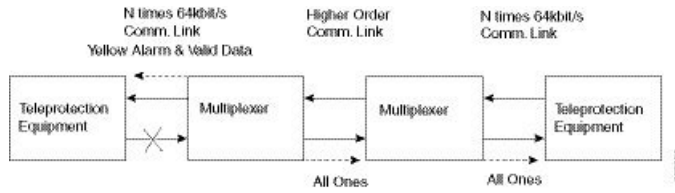
- During the loss of the higher order communications link, the multiplexer should replace the data bits in the transmitted optical output frames with "All Ones."

Figure 4: LOS at Far End Multiplexer
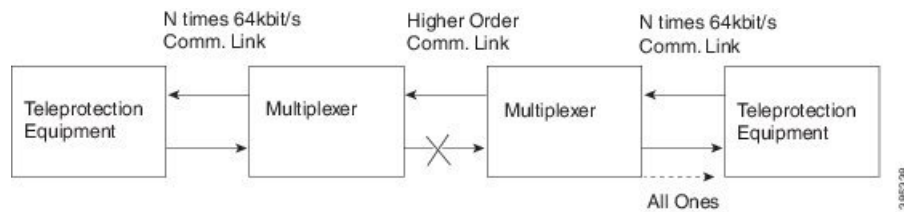
Path Yellow Detection

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
loopback local line	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.
loopback local payload	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.
loopback network line	Sets the loopback toward the network before going through the framer (line).
loopback network payload	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	Cisco IOS Master Commands List, All Releases

Standards and RFCs

Standard/RFC	Title
—	*There are no standards and RFCs for this feature.*

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: http://www.cisco.com/go/mibs

Technical Assistance

Description	Link
The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. 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. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html