Providing Redundancy Support At the Interface Module

Use the following procedures to provide redudancy for the interface module.

Table 1: Supported Interface Module

Interface Module	Part Number	Mode
48-port T3/E3 Interface module	• NCS4200-48T3E3-CE	• T3/E3 • STS-1
1-port OC48/ STM-16 or 4-port OC-12/OC-3 / STM-1/STM-4 + 12-Port T1/E1 + 4-Port T3/E3 CEM Interface Module	• NCS4200-3GMS	

- Card Protection for T3 or E3 Interface Module, on page 1
- Card Protection for STS-1e, on page 8

Card Protection for T3 or E3 Interface Module

The Card Protection feature is introduced for the 48-port T3 or E3 interface module. In this feature, the interface module bay is protected by another interface module of the same type.

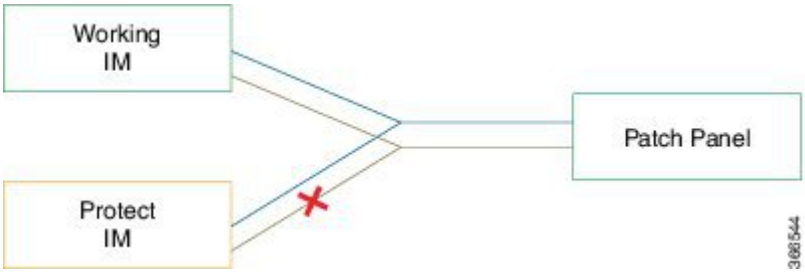
Card Protection

The Card Protection feature is required to protect traffic flow either when an interface module is out of service, when the software fails or a hardware component has issues. Because card protection is supported only on redundant interface modules, traffic is switched to the protect interface module when the active interface module does not respond, and vice-versa.

Note This feature does not require any change in the patch panel of the interface modules.

In card protection, a Y Cable is used to multiplex the signal from the patch panel to both the ports of active and protect interface modules. Both ports receive the signal, but only the active interface module transmits the signal from its port.

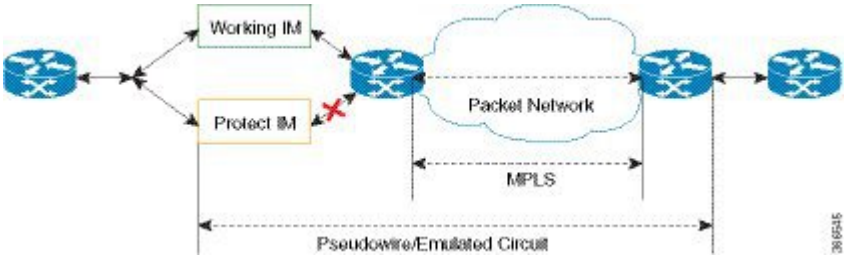
Figure 1: Y Cable



To support the Card Protection feature, the configuration on the active and protect interface module must be same. To achieve this, a virtual interface module is created with the same interface module type as the active interface module. A virtual controller is also created, which broadcasts the configuration to both the interface modules. The configuration on the physical controllers is then blocked and you can make configuration changes only on the virtual controller. The user configuration can only be performed on the virtual controller.

The virtual controller supports CEM level configuration and all other configurations. These configurations are blocked on physical controllers.

Figure 2: Card Protection Topology



Note DS3 (T3) channelized into T1 and E3 channelized into E1s are supported in card protection. For more information on configuration, see the *Configuring the Controller of Channelized T3/T1 Interfaces* section.

Y Cable

In card protection, a Y cable is used to multiplex the signal from the patch panel to both the ports of active and standby interface modules. Both the active and protect ports receive the signal, but only the active port transmits the signal from its port. Protect port transmitter is disabled.

Card Protection Switchover

The following table shows the card protection switchover trigger and time to complete the switchover between the working and protect interface module.

Trigger	Time
Interface Module Reload with CLI OIR	Less than 50 millisecond
Non-responsive Interface Module Process (interface module reloads on its own, the reload is initiated due to software error)	100 millisecond to 200 millisecond
Interface Module shuts down due to high temperature	Less than 50 millisecond
Interface Module shuts down using CLI	Less than 50 millisecond
Interface Module stops using CLI	Less than 50 millisecond
Serializer/Deserializer (SerDes) Failures	250 millisecond to 1 second
Alarm Based Switchover	Based on Hold Over Time or Soak Time
Card Protection Commands	20 millisecond to 30 millisecond
Non-responsive Interface Module Process (interface module reloads on its own, the reload is initiated due to software error)	200 millisecond to 1 second
Card Physical Jackout	200 millisecond to 1 second

Alarm Based Switchover

Alarm based switchover is only applicable for Loss Of Signal (LOS) alarm. Switchover happens only when the number of ports with LOS alarm in working interface module is greater than that on the protect interface module.

Each card protection group maintains a weight for each working and protect interface module. This weight is updated when the LOS alarms are asserted or cleared. The switchover happens only if the weight of working interface module and protect interface module stays same for a certain amount of time called soak time.

When there is any issue with the Patch Panel, both working interface module and protect interface module have the same number of LOS alarms (weights are same). Hence, switchover does not happen.

Guidelines on Alarm Based Switchover Scenarios

Considerations for Hold-Off Timer

- With card-protection where Y-cable is used for connecting the protected cards, if Signal Failure (SF) or Signal Degrade (SD) is observed on any of the ports of these protected cards, LOS alarms will be raised on those respective ports. In rare scenarios, these SF/SD notifications across the ports could vary in duration for reporting the LOS alarms due to environment conditions. Hence, to avoid multiple switching between the protected IMs in these scenarios, hold-off timer is introduced to hold the switchover notification till the LOS alarm notification is synchronized on both the IMs.
- Hold-ff timer can be configured using the **hold-off timer** *seconds* CLI command. By Default, (and recommended value for) the hold-off timer value is enabled for 5 seconds.
- When LOS alarms are detected on the ports of the protected IMs, the number of alarm occurrence is compared between the active and standby IM. If the active card has more LOS Alarms, then the hold-off

timer gets initiated. After the hold-off timer expiry (5 sec in default case), a protection switch will be triggered to the card having lesser number of alarm notifications.

- If the hold-off timer is set to zero, then the switchover is triggered immediately when the weightage of alarm occurrence in active is more than the standby. Note that in this scenario, it could also lead to multiple protection switching between the IMs till the LOS alarms are settled on all the failed ports of both the IMs.

Considerations for Router Bring up or IM OIR

- During the router bring up or reboot or with Reboot and IM Online Insertion and Removal (OIR), once the IMs are online, there will be alarms flooded to software for all the ports from both the active and standby cards.
- NO operational events or switchover events to be performed during this time, and to allow the alarms on both the IM to be settled. (The approximate recommended duration is 1 minute).

Restrictions

- Card physical jack out convergence time for card protection switchover is more than 50 milliseconds.
- The time taken to restart the interface module due to any software error is more than 50 milliseconds.
- Alarm toggle on active or backup card causes at least one card protection switch.
- When BERT is started from the virtual controllers, the syslog displays the physical controllers instead of the virtual controller port.

Supported Features on Interface Module

The supported features are:

- Switching Mode
  - Non-revertive mode
  - Revertive mode
- Alarm Based Switchover
- SerDes Based Switchover
- Adaptive Clock Recovery (ACR) on virtual CEM
- Differential Clock Recovery (DCR) on virtual CEM
- Maintenance Commands
  - Lockout
  - Force
  - Manual

Note All controller configurations are performed on the virtual controller.

You can create card protection with one slot (either primary or backup) and the remaining slots can be added later.

How to Configure Card Protection for T3 or E3

Configuring T3/E3 Card Protection

Pre-requisites

The interface module should be free from any configuration.

Configuring Card Protection Group:

```
enable
configure terminal
card-protection [1-16]
primary slot 0 bay 0
backup slot 0 bay 5
end
```

Note The card protection number 1 to 16 refers to the Card Protection Group Number (CPGN).

Note This is a non-revertive mode.

Configuring Virtual Card and Virtual Controller:

When card protection group is configured, it creates virtual card for card protection object, denoted by 8/x/port. Slot 8 is a fixed slot number for all card protection-created virtual card. Bay number 'x' is derived from the CPGN, where x=CPGN-1. Since card protection group number ranges from 1 to16, bay number ranges from 0 to 15. Virtual controllers can be configured from 8/x/0 to 8/x/47.

Physical Card Configuration:

Configures mode T3/E3 on physical controllers of both primary (0/0) and backup (0/5) card.

```
enable
configure terminal
controller mediatype 8/0/0
mode t3
end
```

Virtual Card Configuration:

- Configures mode T3/E3 on virtual controllers.
- Configures CEM on virtual controller (8/x/port).
- Configures xconnect and local connect on CEM interface.

```
enable
configure terminal
controller t3 8/0/0
cem 0 unframed
interface cem 8/0/0
cem 0
xconnect 10.1.1.1 112 encasulation mpls
end
```

Note This is a non-revertive mode.

Note To un-configure a CEM group under a virtual controller, first perform shutdown of the virtual controller and then un-configure the CEM group.

Configuring Revertive Mode

To configure revertive mode:

```
enable
configure terminal
card-protection 4
primary slot 0 bay 0
backup slot 0 bay 5
end
card-protection 4
revertive time [30-720]
end
```

Note The revertive time ranges from 30 to 720 seconds.

Verifying T3/E3 Card Protection Configuration

Use **show card-protection detail** command to verify card protection group configuration.

```
#show card-protection 2 detail
Working(0/1:A900-IMA48T-C NCS4200-48T3E3-CE):
    Number of LOS Alarms:7
    ok,Active
    1:1,  Revertive

    Protect(0/2:A900-IMA48T-C NCS4200-48T3E3-CE):
    Number of LOS Alarms:7
    ok,Inactive
    1:1,  Revertive

Revert Timer : (Not Started)
Last switchover reason :None
```

```
#show card-protection 4
CPGN   Primary Card              Backup Card              Active
-------------------------------------------------------------------------------
4      0/1                       0/2                      Primary
```

```
#show running-configuration | b 8/0/
controller mediatype 8/0/0
!
controller mediatye 8/0/1
!
controller mediatype 8/0/2
#
```

Use **show xconnect all** command to verify xconnect configuration.

```
#show xconnect all
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 CE8/0/0:0(SATOP T3)        UP mpls 10.1.1.1:112              UP
#
```

Configuring Maintenance Commands

To configure maintenance commands:

```
enable
configure terminal
card-protection 4
primary slot 0 bay 0
backup slot 0 bay 5
end
card-protection 4
card-protection [manual {backup|primary} | force {backup|primary} | lockout]
end
```

Note Maintenance commands are not synced in the standby environment. After Redundancy Force Switchover (SSO), maintenance commands must be executed again on the new active environment.

Priority Table

The following table shows the priority of the actions:

Priority	Configurations
1	Lockout
2	Force
3	Alarm or Card Failure
4	Manual Switch
5	Revert

Associated Commands

The following table shows the commands for the IM configuration:

Command	Link
Card Protection Creation Commands: **card-protection** *CPGN* **card-protection** {*primary* | *backup*} **card-protection** *revertive time* **Card Protection Maintenance Commands**: **card-protection** *CPGN* [**manual** {*primary* | *backup*} | **force** {*primary* | *backup*} | **lockout**]	https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-c1.html#wp1208639895
show card-protection CPGN detail	https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/interface/command/ir-cr-book/ir-s2.html#wp1628614402

Card Protection for STS-1e

The router supports electrical card protection feature with 1:1 protection, where the feature functions during events such as when interface module stops responding, software stops responding, and issues in other hardware components.

In card protection, the Y Cable multiplexes the signal from the patch panel to both the ports of Active and Standby interface module. Both the Active and Protect ports receive the signal, but only the Active transmits the signal from its port. Protect port transmitter is disabled.

To support card protection, the configuration in the Active and Protect interface must be same. To achieve this, a virtual controller is created. The virtual controller must be of the same interface module type. Once the virtual controller is created, it broadcasts the configuration to both active and protect interfaces, and configuration on the physical controller is blocked. The user can perform configuration only on this virtual controller.

In 1:1 protection, a working interface is paired with a protect interface of the same type. If the working interface fails, the traffic from the working interface switches to the protect interface. When the failure on the working interface is resolved, traffic automatically reverts to the working interface.

Restrictions for STS-1 Electricals Card Protection

- The advanced detection mechanism for chip failures such as LIU, FMEA, cable failure between patch panel and Card, XFI going out of synchronization is not supported for card protection.
- The card protection is supported only on the NCS4200-48T3E3-CE CEM interface module.
- The card protection is supported only on the following modes:

Table 2: Card Protection Supported Modes

Mode	Type
T3	Unframed

Mode	Type
VT 1.5 - T1	Unframed
VT 1.5 - VTG	CEP
CT-3 - T1	Unframed
STS-1	Unframed CEP

How to Configure Card Protection for STS-1 Electricals

Configuring Card Protection

To configure card protection, enter the following commands:

```
router(config)#card-protection 1
router(config-card-protection)#primary slot <slot-no> bay <bay-no>
router(config-card-protection)#backup slot <slot-no> bay <bay-no>
```

The following example explains on how to configure card protection:

```
router(config)#card-protection 1
router(config-card-protection)#primary slot 0 bay 0
router(config-card-protection)#backup slot 0 bay 1
```

Provisioning Card Protection

To provision card protection for the primary card in a protection group, enter the following commands:

```
router(config)# card-protection 1
router(config-card-protection)#primary slot <slot-no> bay <bay-no>
```

To provision card protection for the backup card in a protect, enter the following commands:

```
router(config)# card-protection 1
router(config-card-protection)#backup slot <slot-no> bay <bay-no>
```

The following example details on how to provision card on a primary card in slot 0 and bay 0 for a card protection group 1:

```
router(config)# card-protection 1
router(config-card-protection)#primary slot 0 bay 0
```

The following example details on how to provision card on backup card in slot 0 and bay 5 for a card protection group 1:

```
router(config)# card-protection 1
router(config-card-protection)#backup slot 0 bay 5
```

You can verifify the card protection using the **show card-protection <protection-group>** command.

Once card protection group is configured, a virtual controller is created for the card protection object and is denoted as 8/x/port.

The slot 8 is fixed slot number for all card protection created virtual controller. The bay number 'x' is derived from Card Protection Group Number (CPGN), and is calculated using the following equation:

x = CPGN-1

The card protection group number ranges from 1 through 16 and the bay number ranges from 0 through 15. The virtual controllers can be referred from 8/x/0 to 8/x/47.

The following are few examples denoting virtual controllers:

- If the card protection number is 1 and the port is 15, then the logical controller is represented as: **controller sts1e 8/0/15**
- If the card protection number is 10 and the port is 25, then the logical controller is represented as: **controller sts1e 8/9/25**

You can verify the controller information using the **show controllers sts1e 8/x/port** command:

```
router#show controllers sts1e 8/0/16
STS1E 8/0/16 is up.
  Hardware is N/A

 Port configured rate: OC1
 Applique type is Channelized STS1E
 Clock Source is Internal
Medium info:
  Type: STS1E, Line Coding: NRZ,
 Alarm Throttling: OFF
 SECTION:
  LOS = 0          LOF = 0                          BIP(B1) = 0

STS1E Section Tables
  INTERVAL       CV    ES   SES  SEFS
  09:42-09:54     0     0     0     0

LINE:
  AIS = 0          RDI = 0          REI = 0          BIP(B2) = 0
Active Defects: None
Detected Alarms: None
Asserted/Active Alarms: None
Alarm reporting enabled for: SLOS SLOF LAIS SF SD LRDI B1-TCA B2-TCA
BER thresholds:  SF = 10e-3  SD = 10e-6
```

Configuring STS-1 Electrical Mode for SONET

```
config terminal
controller MediaType 8/0/0
mode sts-1e
controller STS-1E 8/0/0
sts-1 1
```

Configuring STS-1e for VT1.5-T1 Mode

To configure STS-1e for VT1.5-T1 mode, enter the following commands:

```
config terminal
controller MediaType 8/0/16
 mode sts1e
controller STS1E 8/0/16
 no snmp trap link-status
 no ais-shut
 clock source internal
 cablelength short
 overhead j0 tx length 64-byte
 overhead j0 expected length 64-byte

 sts-1 1
  clock source internal
  mode vt-15
  vtg 1 t1 1 cem-group 1 unframed
```

Configuring STS-1e for T3 Mode

To configure STS-1e for T3 mode, enter the following commands:

```
config terminal
controller MediaType 8/0/17
 mode sts1e
controller STS1E 8/0/17
 no snmp trap link-status
 no ais-shut
 clock source internal
 cablelength short
 overhead j0 tx length 64-byte
 overhead j0 expected length 64-byte

 sts-1 1
  clock source internal
  mode t3
  cem-group 100 unframed
  t3 clock source internal
interface CEM8/0/17
 no ip address
 cem 100
```

Configuring STS-1e for VT1.5-VT Mode

To configure STS-1e for VT1.5-VT mode, enter the following commands:

```
config terminal
controller MediaType 8/0/18
 mode sts1e
controller STS1E 8/0/18
 no snmp trap link-status
 no ais-shut
 clock source internal
 cablelength short
 overhead j0 tx length 64-byte
 overhead j0 expected length 64-byte
```

```
 sts-1 1
  clock source internal
  mode vt-15
  vtg 1 vt 1 cem-group 200 cep
```

Configuring STS-1e for CEP Mode

```
config terminal
controller MediaType 8/0/20
 mode sts1e
controller STS1E 8/0/20
 no snmp trap link-status
 no ais-shut
 clock source internal
 cablelength short
 overhead j0 tx length 64-byte
 overhead j0 expected length 64-byte

 sts-1 1
  clock source internal
  mode unframed
  cem-group 500 cep
interface CEM8/0/20
 no ip address
 cem 500
```

Configuring STS-1e for CT3 Mode

To configure STS-1e for CT3 mode, enter the following commands:

```
config terminal
controller MediaType 8/0/19
 mode sts1e
controller STS1E 8/0/19
 no snmp trap link-status
 no ais-shut
 clock source internal
 cablelength short
 overhead j0 tx length 64-byte
 overhead j0 expected length 64-byte

 sts-1 1
  clock source internal
  mode ct3
  t3 clock source internal
  t1 1 cem-group 300 unframed
```

Verifying Card Protection Configurtion for STS-1 Electricals

Use the following commands to verify the card protetion configuration:

- **show card-protection <protection-group>**—Displays Card Protection Group Number (CPGN) , primary and backup card slots, and the active card.

- **show card-protection <protection-group> detail**—Displays the detailed information of the card protection group.
- **show controllers sts1e**—Displays the STS-1e configuration.

```
router#show card-protection 1
CPGN              Primary Card                      Backup Card
Active
-------------------------------------------------------------------------------------------------------
1                    0/0                                 0/5
Primary
-------------------------------------------------------------------------------------------------------
```

```
router#show card-protection 1 detail
Card Protection Group 1:
    Working(0/0:NCS4200-48T3E3-CE):
    Number of LOS Alarms:0
    ok,Active
    1:1, non-revertive
    Protect(0/5:NCS4200-48T3E3-CE):
    Number of LOS Alarms:0
    ok,Inactive
    1:1, non-revertive
Revert Timer : (Not Started)
Last switchover reason :Serdes
```

```
router#show controllers sts1e 8/0/16
STS1E 8/0/16 is up.
Hardware is N/A

Port configured rate: OC1
Applique type is Channelized STS1E
Clock Source is Internal
Medium info:
Type: STS1E, Line Coding: NRZ,
Alarm Throttling: OFF
SECTION:
LOS = 0 LOF = 0 BIP(B1) = 0

STS1E Section Tables
INTERVAL CV ES SES SEFS
14:20-14:31 0 0 0 0
```