N+1 Redundancy for the Cisco Cable Modem Termination System

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Note Cisco IOS Release 12.2(33)SCA and later releases integrate support for this feature on the Cisco CMTS routers. This feature is also supported in Cisco IOS Release 12.3BC, and this document contains information that references many legacy documents related to Cisco IOS 12.3BC. In general, any references to Cisco IOS Release 12.3BC also apply to Cisco IOS Release 12.2SC.

The N+1 Redundancy feature provides high availability on CMTS and telecommunications networks that use broadband media. N+1 redundancy can help limit customer premises equipment (CPE) downtime by enabling robust automatic switchover and recovery in the event that there is a localized system failure. The N+1 redundancy protection scheme you select for your system depends on your CMTS platform and upon the number of cable interface line cards or broadband processing engines (BPEs) that you have installed in the Cisco CMTS router.

Note This document describes the N+1 redundancy configuration and support with the Cisco uBR 3x10 RF Switch in detail. Starting with Cisco IOS Release 12.2(33)SCG, support for the Cisco uBR Advanced RF Switch has been added. For the N+1 redundancy configuration and support information with the Cisco uBR Advanced RF Switch, see the Cisco uBR Advanced RF Switch Software Configuration Guide .

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest feature information and caveats, see the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the Feature Information Table at the end of this document.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to http://tools.cisco.com/ITDIT/CFN/. An account on http://www.cisco.com/ is not required.

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Prerequisites

To use N+1 redundancy, ensure the following conditions are met:

- To implement N+1 redundancy, you must use an image from a supported Cisco IOS software release. Refer to the release notes for your platform on Cisco.com to verify the availability of the N+1 Redundancy feature.
- Your downstream plant must meet Data-over-Cable Service Interface Specifications (DOCSIS 1.0 or later) requirements.
- Customer cable modems must meet requirements for your network and server offerings. All third-party cable modems must comply with DOCSIS 1.0 or later versions.

Table below shows the hardware compatibility prerequisites for the N+1 Redundancy feature.

Note The hardware components introduced in a given Cisco IOS Release are supported in all subsequent releases unless otherwise specified.

Table 1: N+1 Redundancy Hardware Compatibility Matrix

CMTS Platform	Processor Engine	Cable Interface Cards
Cisco uBR10012 Universal Broadband Router	**Cisco IOS Release 12.2(33)SCA and later** • PRE2 **Cisco IOS Release 12.2(33)SCB and later** • PRE4 **Cisco IOS Release 12.2(33)SCH and later** • PRE5	Cisco IOS Release 12.2(33)SCB and later • Cisco uBR10-MC5X20U/H Cisco IOS Release 12.2(33)SCC and later • Cisco UBR-MC20X20V Cisco IOS Release 12.2(33)SCE and later • Cisco uBR-MC3GX60V [1]

1 The Cisco uBR3GX60V cable interface line card is not compatible with PRE2.

Note Cisco uBR7200 series routers do not support N+1 redundancy.

Restrictions and Limitations

The following sections describe restrictions and guidelines for configuring N+1 line card redundancy.

Note It is important to be aware that in Cisco IOS software releases earlier to Cisco IOS Release 12.2(33)SCC, line card redundancy is configured in two ways: N+1 HCCP Redundancy and Global N+1 Line Card Redundancy. The N+1 HCCP Redundancy configuration is not supported beginning with Cisco IOS Release 12.2(33)SCC. As you consider the restrictions and configuration information in this chapter, keep the distinction between the legacy HCCP configuration and the global configuration in mind.

General N+1 Redundancy Restrictions

The following are the general restrictions applicable to the N+1 Redundancy feature. These restrictions apply to both N+1 HCCP Redundancy and Global N+1 Line Card Redundancy configurations.

- A DOCSIS Timing, Communication and Control (DTCC) card or a TCC+ card must be installed in your Cisco uBR10012 router in order to employ the Cisco RF Switch in your cable headend system. For more detailed information on the DTCC and TCC+ cards, see the following documents:
  - Cisco uBR10012 Universal Broadband Router DTCC Card
  - Cisco uBR10012 Universal Broadband Router TCC+ Card

- Using slot 5/1 as the protect interface is easiest for physical wiring to the Cisco RF Switch when used with the Cisco uBR10012 router.
- The Cisco uBR10012 SNMP community string and N+1 Cisco RF Switch community string must be different. If the same community string is used, the Cisco uBR10012 router cannot be reached through SNMP until the community string is adjusted.
- The HCCP Switchover Enhancements feature has the following restrictions:
  - The feature is supported on the Cisco uBR10012 router only.
  - The line card switchover performance improvements are valid for networks scaling to less than 5000 cable modems per line card, and less than 1000 voice calls per line card.
  - The working and protect line cards must have the same channel width.
  - Upconverter failure detection is not included as part of the line card switchover performance improvements.
  - Virtual interface bundling is required. If you are upgrading from an earlier Cisco IOS software release and virtual bundling is not configured upon startup, the Cisco IOS software will automatically generate a virtual bundling configuration. Therefore, beginning in Cisco IOS Release 12.3(21)BC, Layer 3 information cannot be configured directly at the cable interface. The maximum number of virtual bundle interfaces supported is 40, and bundle numbers can be between 1–255.
  - In Cisco IOS Release 12.2(33)SCA and later, keepalive failure detection is enabled only for upstreams that have 15 or greater modems online. However, a switchover due to keepalive failure will trigger only if there is not any traffic on all of the upstreams associated with a cable interface that is enabled for keepalive.

For example, on a cable line card interface enabled for keepalive (this is the default) you have the following US status: US0 (200 CMs online), US1 (10 CMs online), US2 (16 CMs online), US3 (shutdown). US0 and US2 are enabled for keepalive detection because they each have more than 15 modems online.

If US0 has a keepalive failure due to a cable cut, but US2 is still passing traffic, then no keepalive switchover is triggered on that domain or interface. The calculation looks at all relevant US ports in a MAC domain and if those relevant ports have no traffic, then keepalive detection will begin. In this example, only two ports were relevant and both of those ports did not lose traffic, so keepalive still did not activate the failover.

If US0 had a cable cut while US2 also had no traffic, then a keepalive switchover would be triggered.

Note Beginning with Cisco IOS Release 12.2(33)SCE and later, the High Availability keepalive failure detection feature is disabled on Cisco UBR-MC20X20V and Cisco uBR-MC3GX60V line cards to prevent false alarms. The downstream connectivity loss can be detected by DEPI control session on the Cisco uBR-MC3GX60V line card whereas downstream PHY is able to detect the fatal error on the Cisco UBR-MC20X20V line card.

Information About N+1 Redundancy

This section describes the concepts that relate to N+1 redundancy: N+1 redundancy refers to (N) cable interface line cards, called “working” line cards being protected by one additional line card (+1), called the “protect” line card.

The two types of Cisco N+1 configuration are as follows:

- 7+1—Refers to an eight-card redundancy scheme in which seven working cable interface line cards are protected by one additional protect line card. This is the default N+1 configuration for the Cisco uBR10012 router, and requires two Cisco uBR 3x10 RF Switches or one Cisco uBR Advanced RF Switch.

Note The term "7+1 Redundancy" is also referred to as "8+1 Redundancy" in the field—physically, eight line cards in "8+1" mode are configured as seven working line cards with one protect line card. Therefore, "7+1 Redundancy" is the more physically accurate term.

- 4+1—Refers to a four-card redundancy scheme in which four working cable interface line cards are protected by one additional protect line card. This requires only one Cisco RF Switch.

Upconverters may reside between the Cisco uBR 3x10 RF Switch and the downstream (DS) interface on the Cisco CMTS. Cisco IOS supports both SNMP and non-SNMP-capable upconverters. No upconverters are required with the Cisco uBR Advanced RF Switch.

Note Globally configured N+1 line card redundancy and the legacy form of HCCP line card redundancy configurations are mutually exclusive in Cisco IOS Release 12.2(33)SCB and earlier.

You can configure N+1 redundancy in the following two ways:

N+1 HCCP Redundancy

Configured using HCCP commands at the interface level.

N+1 redundancy adds synchronization between Hot-Standby Connection-to-Connection Protocol (HCCP) working interface configurations and those inherited upon switchover to HCCP protect interfaces. This makes the configuration of both easier and switchover times faster.

Note N+1 HCCP Redundancy configuration is supported only in Cisco IOS Release 12.2(33)SCB and earlier.

Restrictions for N+1 HCCP Redundancy

Use the IP address from the local loopback interface (required in SCA and SCB only) as the working interface IP address when configuring Hot-Standby Connection-to-Connection Protocol (HCCP) on the Cisco uBR10012 router. We recommend that you create a loopback interface on the Cisco uBR10012 router, and then assign the loopback interface IP address to the HCCP protect configuration.

Restrictions with the Cisco UBR10-MC 5X20 Cable Interface Line Card

- MAC domains and corresponding DS interface pairs switch over together— Each ASIC processor on the Cisco UBR10-MC 5X20 line card supports two MAC domains. MAC domains that share a common ASIC processor (JIB) must be configured so that they share the same state, Active or Standby. As a result, each interface in the pair switches over with the other.

Downstream MAC domain pairings would be downstream (DS) ports 0 and 1, ports 2 and 3, and a solitary port 4, which has its own JIB. For example, these interface pairings share the same JIB and switch over together as follows:

- ◦ Cable interface 5/0/0 and 5/0/1
  ◦ Cable interface 5/0/2 and 5/0/3
  ◦ Cable interface 5/0/4 is on the third ASIC processor, which is not shared with another interface.
- If Cisco uBR10-MC5X20 line card is used as working line card and Cisco uBR-MC20X20V line card used as protect line card, the HCCP feature is not supported when the working line card is replaced (using Online Insertion and Removal (OIR)) with a Cisco uBR-MC20X20V line card.

Note If HCCP is not configured on an interface that shares a MAC processor with another configured interface, it does not switch over and could cause issues. The same holds true if an ASIC companion is "locked out" during a failover.

Prerequisites for N+1 HCCP Redundancy

Before a switchover can occur, the HCCP protect interface automatically loads multiple configurations from the HCCP working interface. All configurations are loaded to protect automatically except DS modulation, DS interleave depth, and the DOCSIS Annex mode. If protect interface configuration occurs at the time of switchover, the PHY parameters are reset and cable modems go offline. To prevent this scenario, the protect interface is synchronized with the latest 'sync' status received from any working interface. Therefore, it is required that all HCCP working interfaces within an HCCP group have identical configurations for the command-line interfaces described in this section. Any one of these working interfaces provides the configuration of HCCP protect interfaces.

Preconfiguring HCCP Protect Interfaces

The following three specific HCCP functions are synchronized between working and protect interfaces:

- downstream modulation—the modulation scheme used for downstream traffic to the subscriber's cable modem.
- downstream interleave depth—the interleaving amount of downstream symbols for impulse noise issues
- the DOCSIS Annex mode—the Motion Picture Experts Group (MPEG) framing format for a downstream port on a cable interface line card:
  ◦ Annex A (Europe)
  ◦ Annex B (North America)

Each of these three preconfigurations should be the same for all members of the HCCP groups; otherwise the cable modem may go offline during switchover and the switchover performance may be impacted due to the delay in applying the new change in the downstream PHY chip.

Global N+1 Line Card Redundancy

Global N+1 Line Card Redundancy feature simplifies the configuration of working and protect interfaces by eliminating the need to configure the more complex **hccp** interface configuration commands. Global N+1 Line Card Redundancy is supported on the Cisco uBR10012 router only.

The following set of simpler CLIs are used to configure global N+1 line card redundancy:

- **redundancy** command in global configuration mode
- **linecard-group cable** command in redundancy configuration mode. This command auto-enables line card redundancy configuration mode.
- **member subslot** command in line card redundancy configuration mode

Note The **member subslot** commands implement HCCP on each cable interface for the line card subslot position.

This feature allows plug-and-play operation of the Cisco RF switch in 7+1 HCCP Redundancy configuration with the Cisco uBR10012 universal broadband router because the Cisco RF switch is shipped with certain default settings to allow a quick bringup of a 7+1 redundant configuration with the router. However, some configuration of the router is required.

Global 4+1 Redundancy on the Cisco uBR10012 Router

This configuration entails one Cisco RF Switch and the router. In this configuration, four working interfaces are supported with one protect interface, but at a line card level. When one interface on a line card switches over, this triggers switchover for the entire line card.

Global 7+1 Redundancy on the Cisco uBR10012 Router

This configuration entails two Cisco uBR 3x10 RF Switches or one Cisco uBR Advanced RF Switch and the router. In this configuration, seven working interfaces are supported with one protect interface, but at a line card level. When one interface on a line card switches over, this triggers switchover for the entire line card.

Cisco IOS and Cisco RF Switch Firmware for N+1 Redundancy

Two operating systems govern the configuration and operation of N+1 redundancy on the Cisco CMTS:

- Cisco Internetwork Operating System (IOS)—Governs the configuration and operation of Cisco universal broadband routers, and works closely with Cisco RF Switch when configured in N+1 redundancy.

Note The Cisco IOS CLI synchronizes configurations between HCCP working and protect interfaces. Preconfiguration of the protect interfaces is no longer required in most circumstances.

- Cisco uBR 3x10 RF Switch Firmware—Governs the configuration and operation of the Cisco RF Switch, including the IP address on the RF Switch.

Refer to the Cisco RF Switch Firmware Command Reference Guide on Cisco.com for complete feature descriptions and command histories for the Firmware Versions listed above.

Note With the Cisco uBR 3x10 RF Switch, both command-line interfaces are required for configuration and testing of N+1 redundancy.

- Cisco uBR Advanced RF Switch—The Cisco uBR10012 router controls the configuration and operation of the Cisco uBR Advanced RF Switch.

Refer to the Cisco uBR Advanced RF Switch Software Configuration Guide and Cisco IOS CMTS Cable Command Reference for complete feature descriptions and command usage.

N+1 Redundancy on the Cisco uBR10012 Universal Broadband Router

The 7+1 redundancy scheme for the Cisco uBR10012 router supports redundancy for the cable interface line cards installed in a fully populated Cisco uBR10012 chassis. Other redundancy schemes are designed to support partial cable interface line card populations in a Cisco uBR10012 chassis.

A single Cisco uBR10012 CMTS can support up to eight Cisco cable interface line cards.

A single Cisco RF Switch can then be connected to this Cisco uBR10012 router, allowing you to deploy an N+1 redundancy scheme where one protecting cable interface line card supports from one to seven working cable interface line cards in the same chassis.

N+1 Redundancy and the Cisco RF Switches

The Cisco RF Switch can be operated in two separate modes, either in 7+1 configuration, or in 4+1 configuration.

Note The default N+1 redundancy mode for the Cisco RF Switch is 7+1. This does not require change when configuring N+1 redundancy on the Cisco uBR10012 router.

Note The show configuration command and other Cisco RF Switch commands contain the Card Protect Mode field. When this field displays 7+1, this indicates that the Cisco RF Switch is configured for N+1 redundancy, where eight or less working line cards are possible.

In both of the Cisco RF Switches, the slot number is the chassis slot in which an Ethernet controller or an upstream or downstream card is installed, and the logical interface number is the physical location of the interface port on an Ethernet controller.

The Cisco RF switch module is a switching matrix that allows flexibility in the routing of RF signals between "N" working RF cable interface line cards and one protect RF cable interface line card.

IF Muting on the Cisco CMTS for non-SNMP-Capable Upconverters

IF muting with both SNMP and non-SNMP-capable upconverters is supported in N+1 redundancy. IF muting offers the following benefits:

- IF muting for either type of upconverter significantly increases the N+1 protection schemes that are available for Cisco CMTS routers.
- IF Muting offers the additional benefit of being faster than RF Muting.
- IF Muting is enabled by default.

IF Muting functions in the following manner:

- IF output from the working cable interface line card is enabled.
- IF output from the protect cable interface line card is disabled.
- When a switchover occurs from working to protect, the IF output of the working card is disabled and that of the protect is enabled. If an interface is in Active mode, RF output is enabled.
- When the cable interface line card first comes up after a system failure, IF output is muted until the Cisco CMTS determines if each interface is in active or standby mode (in either working or protect state). When an interface is active (working or protect), IF output is enabled. When an interface is in standby mode, IF output is muted.

The relevance and support for IF Muting is dependent on the type of Cisco CMTS being used. This is a summary of IF Muting in relation to three sample scenarios:

- Case1—External upconverters are not controlled nor controllable. In this type of scenario, the external upconverter either cannot be controlled remotely or the Cisco CMTS is not configured to control the external upconverter.
- Case 2—The Cisco CMTS is configured to control an external upconverter. Cisco continues to support N+1 redundancy in this scenario (in which IF Muting is not required). The Cisco CMTS uses RF Muting of the upconverter in this scenario—automatically enabled when an HCCP upconverter statement is configured.
- Case 3—The Cisco CMTS uses internal upconverter(s). Cisco continues to support N+1 redundancy in this scenario (in which IF muting is not required). The Cisco CMTS uses RF muting in this scenario (automatically enabled) because the upconverter is configured by the CMTS to do RF Muting.

IF Muting and HCCP Configuration

HCCP interface configuration typically entails three tasks:

- Working or protect mode
- Upconverter statement
- RF switch statement

When you configure HCCP on an interface, but you do not specify an upconverter statement, this dictates whether IF Muting is active. With no upconverter statement in the interface configuration, IF Muting becomes active by default.

Restrictions for IF Muting

Shared Downstream Frequency

All the interfaces in the same HCCP group must use the same downstream frequency. To define the downstream center frequency for the cable interface line card, use the cable downstream frequency command in cable interface configuration mode. On cable interfaces with an integrated upconverter, use the no form of this command to remove the downstream frequency and to disable the RF output.

The usable center frequency range depends on whether the downstream is configured for DOCSIS or EuroDOCSIS operations:

- ◦ DOCSIS — 91 to 857 MHz
  ◦ EuroDOCSIS — 112 to 858 MHz

The Cisco IOS supports a superset of these standards, and setting a center frequency to a value outside these limits violates the DOCSIS or EuroDOCSIS standards. Cisco does not guarantee the conformance of the downstream and upconverter outputs when using frequencies outside the DOCSIS or EuroDOCSIS standards.

Requirements for IF Muting

For non-SNMP-capable upconverters to be used with IF Muting, RF output must be less than -3 dBmV when:

- IF input is absent.
- The switchover time from working to protect is less than one second. That is, when IF is applied to the upconverter, the RF output must be present within one second.

If either of these requirements is not met, the integrity of the N+1 switchover operations could be compromised.

Default Line Card and Bitmap Settings on the Cisco uBR 3x10 RF Switch for Global N+1 Line Card Redundancy

The Cisco uBR 3x10 RF Switch is pre-configured with certain settings to allow plug-and-play with the Cisco uBR10012 universal broadband router for a global 7+1 line card redundancy configuration.

The default bitmap on the Cisco uBR 3x10 RF Switch is 0xFFFFFFFF. This value assumes rfsw-2 on the top half of the Cisco UBR10-MC5X20 BPE, and rfsw-1 on the lower half.

For the protect interface, global configuration uses the IP address of an internal FastEthernet interface.

In 7+1 Redundancy mode, the default header settings are as follows:

- interface 8/0 in header 1
- interface 8/1 in header 2
- interface 7/0 in header 3
- interface 7/1 in header 4

This default setting is based on the line card slot/subslot being configured. The following table lists the mapping of line card interfaces to RF Switch slots (rfsw-slots):

Line Card Slot	5/0	5/1	6/0	6/1	7/0	7/1	8/0	8/1
RFSw-Slot 7+1 mode	7	0	5	6	3	4	1	2

Note Value 0 signifies by default the protect slot. RFSw-Slot header and RF Switch slot # refer to the same thing.

Default Line Card and Bitmap Settings on the Cisco uBR Advanced RF Switch for Global N+1 Line Card Redundancy

Table below shows the default mapping between the slot ID of the Cisco uBR Advanced RF Switch and the line card on the Cisco uBR10012 router.

Table 2: Default Mapping between the Cisco uBR Advanced RF Switch with the Line Card on the Cisco uBR10012 Router

Slot ID on the Cisco uBR Advanced RF Switch	Line Card on the Cisco uBR10012 Router
1	8/0
2	8/1
3	7/0
4	7/1
5	6/0
6	6/1
7	5/0
0	5/1

High Availability Support for Encrypted IP Multicast

The Cisco CMTS router supports IP Multicast streams during switchover events in a High Availability environment. This feature is supported for Route Processor Redundancy Plus (RPR+), N+1 redundancy, and encrypted BPI+ streams.

For additional information about IP Multicast and High Availability, refer to these documents on Cisco.com:

- Dynamic Shared Secret for the Cisco CMTS
- IP Multicast in Cable Networks , White Paper

How to Configure N+1 Redundancy

You must configure and activate both the Cisco RF Switch and the Cisco CMTS to ensure that N+1 redundancy operates correctly.

Note The below configurations are for the Cisco uBR 3x10 RF Switch. For instructions on how to configure the Cisco uBR Advanced RF Switch, see the Cisco uBR Advanced RF Switch Software Configuration Guide .

Common Tasks for Configuring N+1 HCCP Redundancy and Global N+1 Line Card Redundancy

Configuring the Cisco RF Switch for N+1 Redundancy

DETAILED STEPS

	Command or Action	Purpose
Step 1	**set mac address** *mac-address* **Example:** `rfswitch> set mac address 0000.8c01.1111`	(Optional) To specify the MAC address of the Ethernet port on the Cisco RF Switch (used to connect to the LAN), use the set mac address command at the Cisco RF Switch command line interface. The MAC address must be specified using a trio of hexadecimal values. For example, set mac address hex.hex.hex. To negate the existing MAC address assignment and specify a new one, use the no form of this command. If no MAC address is specified, the Cisco RF Switch assumes the default OUI MAC address value.
Step 2	**set ip address** *ip-address* **netmask** [*dhcp*] **Example:** `rfswitch> set ip address 172.16.10.3 255.255.255.0`	(Optional) To specify a static IP address and relative netmask of the Ethernet interface on the Cisco RF Switch, use the set ip address command in User mode. To restore the default setting, user the no form of this command. Default setting differs according to your Firmware Version: • The default IP configuration for Version 3.30 and 3.50 is DHCP enabled. • The dhcp keyword enables the specified IP address as the address for DHCP services on the network. This keyword also produces the same result as the no form of this command for Version 3.30 and 3.50—it enables DHCP. • The default IP configuration for Version 2.50 is the static IP address of 10.0.0.1 255.255.255.0.

	Command or Action	Purpose
Step 3	**set slot config** {*upstreamslots* | *downstreamslots*} **Example:** **Cisco 3x10 RF Switch (default)** rfswitch> **set slot config 0x03ff 0x1c00**	(Optional) Sets the chassis slot-to-line card configuration. The command no set slot config restores the default, which is a 3x10 configuration. Setting a bit position tells the Cisco RF Switch to expect that type of card installed in the slot. A zero in both parameters indicates that the slot should be empty. Both *upstreamslots* and *downstreamslots* are 16-bit hex integer bit-masks that represent whether the slot is enabled/configured for that type of card. The right-most bit represents slot 1. For additional bitmap conversion information, refer to the *Bitmap Calculator for N+1 Configuration with the Cisco RF Switch* (Microsoft Excel format) http://www.cisco.com/warp/public/109/BitMap.xls As there are only 14 slots in the Cisco RF Switch chassis, the upper two Most Significant Bits (MSBs) of the 16-bit integer are ignored. **Note** Changes made to the slot configuration on the Cisco RF Switch do not take effect until the system is rebooted (reload command), or an event occurs which causes the enumeration of the chassis line cards to reset.
Step 4	**set snmp community read-write private** **Example:** rfswitch> **set snmp community read-write private**	(Optional) To specify the Simple Network Management Protocol (SNMP) community string on the Cisco RF Switch, use the set snmp community command at the Cisco RF Switch command line interface. This command enables you to gain read and write access to the Cisco RF Switch. The community string must be entered as a string of text. To negate the existing community string and make way for a new one, use the no form of this command. If no SNMP string is entered, the SNMP string assumes the default value private. **Note** Currently, the private keyword is the only SNMP community string supported on communication between the Cisco RF Switch and the Cisco uBR10012 router. The default value of private is the proper setting under normal circumstances.
Step 5	**set snmp host** *ip-address* **Example:** rfswitch> **set snmp host 172.16.10.3**	(Optional) To specify the IP address that receives SNMP notification messages, use the set snmp host command at the Cisco RF Switch command line interface. You can specify more than one SNMP IP address simply by entering this command once for each IP address you want to specify. To negate an existing SNMP IP address assignment, use the no form of this command. If no SNMP IP address is specified, the Cisco RF Switch does not transmit any SNMP notification messages.
Step 6	**set snmp traps** • **Example:** rfswitch> **set snmp traps**	(Optional) To enable SNMP reporting for all modules on the Cisco RF Switch, use the set snmp traps command in the Cisco RF Switch User mode. To deactivate SNMP reporting, use the no form of this command. SNMP reporting is enabled by default on the Cisco RF Switch.
Step 7	**set protection {4|8}** **Example:** rfswitch> **set protection 8**	To set the line card protection scheme, specifying the N+1 protection scheme under which the Cisco RF Switch operates, use the set protection command in Cisco RF Switch User mode. • **set protection4—**Specifies that the Cisco RF Switch operate using a 4+1 protection scheme.

	Command or Action	Purpose
		• **set protection8**—Specifies that the Cisco RF Switch operate using a 7+1 protection scheme. To negate the existing protection scheme specification, use the no form of this command. The default protection scheme for the Cisco RF Switch is 7+1.
Step 8	**set password** *text* **Example:** `rfswitch> set password cisco`	(Optional) To specify an access password for the Cisco RF Switch command line interface, use the set password command at the Cisco RF Switch command line interface. To negate the existing access password, use the no form of this command.
Step 9	**set tftp-host** *ip-address* **Example:** `rfswitch> set tftp host 172.16.10.17`	(Optional) To specify the host IP address of the TFTP server through which the Cisco RF Switch enables file transfer, use the set tftp-host command at the Cisco RF Switch command line interface. To negate an existing host IP address specification for the remote TFTP server, use the no form of this command. (No default TFTP server IP address is supported on the Cisco RF Switch.)
Step 10	**set switchover-group** *group-name module-bitmap* |**all** **Example:** `rfswitch> set switchover-group a12345 0xAA200000`	To specify a new or existing switchover group name (to which a Cisco RF Switch module is assigned), use the set switchover group command at the Cisco RF Switch command line interface. A switchover group is a collection of Cisco RF Switch interfaces that are all configured to switch over at the same time. • *group-name* — Can be an alpha-numeric string beginning with a non-numeric character. • *module-bitmap* le-bitmap — Defines a Cisco RF Switch module, and must be specified as an eight-character hexadecimal identifier or assigned the all keyword. **Note** Refer to the Creating Cisco RF Switch Module Bitmaps, on page 15 for instructions on creating an appropriate hexadecimal module bitmap. • **all** — Keyword instructs the Cisco RF Switch to automatically switch over all upstream and downstream interfaces connected to the switch module in question. **Note** When setting bit maps on the RF Switch, type 0x in front of the bitmap identifier so that the RF Switch recognizes hexadecimal code. Otherwise, the RF Switch assumes the bitmap is in decimal code. To negate an existing switchover group, use the no set switchover-group command at the Cisco RF Switch command line interface. **Note** You do not need to specify module-bitmap when negating an existing switchover group. For example, the command no set switchover-group a12345 will eliminate the switchover group named “a12345.” Once a switchover group containing one or more Cisco RF Switch modules has been defined, you can use the switch command to enable N+1 redundancy behavior on the Cisco RF Switch, as described in the section Switchover Testing Tasks for N+1 Redundancy, on page 34

	Command or Action	Purpose
Step 11	**save config** **Example:** `rfswitch> save config`	This command saves the latest configuration or image upgrade changes in both Flash and Bootflash, and synchronizes Backup and working copies in each.

Step 12	Choose one of the following:**reboot**
	• **reboot**
	• **reload**
	
	Example:
	`rfswitch>reboot`
	`or`
	`rfswitch> reload`
		This command restarts the Cisco RF Switch so that all changes above take effect.

Operating DHCP with the Cisco RF Switch

DHCP operation is enabled by default, unless the user has set a static IP address using the **set ip address** command in User mode.

When the RF Switch boots, it checks to see if DHCP has been enabled. This is done via the RF Switch commands in a variety of ways. You can use any of the following commands in User mode to enable DHCP:

- **set ip address dhcp**
- **set ip address** *ip-address subnet-mask*
- **no set ip address** (to set the default DHCP operation)

Note The RF Switch Firmware no longer assumes a static IP address of 10.0.0.1 as in versions prior to 3.00. For details on DHCP configuration, see the Cisco RF Switch Firmware Configuration Guide .

Creating Cisco RF Switch Module Bitmaps

Perform the following steps to produce a hexadecimal-format module bitmap that you can then assign to working or protect Cisco RF Switch modules. Module bitmaps for the Cisco RF Switch are comprised of 32-bit map assignments that you translate to an eight-character hexadecimal module bitmap identifier.

Note The Cisco RF Switch ships with some additional pre-configured defaults to ease initial bringup of the switch. For more information on these default settings, see the Default Line Card and Bitmap Settings on the Cisco uBR 3x10 RF Switch for Global N+1 Line Card Redundancy, on page 10.

This procedure cites an example of a typical working cable interface module map with 7+1 redundancy configuration. This scenario connects cable interfaces to the Cisco RF Switch following the example described in the " Cabling " chapter of the Cisco RF Switch Hardware Installation and Configuration Guide :

- Interfaces A, B, C, D, and F comprise the four upstream and one downstream connections to the first MAC domain of a UBR10-LCP2-MC28C cable interface line card installed in a Cisco uBR10012 Series chassis.
- Interfaces H, I, J, K, and M comprise the four upstream and one downstream connections to the second MAC domain on the same cable interface line card.

Note Also refer to the *Bitmap Calculator for N+1 Configuration with the Cisco RF Switch* in Microsoft Excel format—available for download and use from Cisco.com.

Step 1 Logically break the two MAC domains up into separate groups and deal with them on their own.
Begin by determining the 32 binary values for the first MAC domain that will eventually define the eight decimal characters leading to the eight hexadecimal characters comprising your module bitmap by laying out the individual bits as follows.

Note In order to optimize N+1 redundancy behavior among the switch modules in the Cisco RF Switch, the internal mapping of the switch circuitry calls for the interfaces to be addressed as they are displayed in the example, below—A H B I C J D K L F M G N.

Interface	A	H	B	I	C	J	D	K	E	L	F	M	G	N		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Binary	1	0	1	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Step 2 Convert the eight resulting binary quartets into decimal values as follows:
Interim step.

Interface	A	H	B	I	C	J	D	K	E	L	F	M	G	N	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Binary	1	0	1	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Decimal	1 0				1 0				2				0		0				0				0				0					

Step 3 Convert the eight resulting decimal values into hexadecimal values as follows.
The eight resulting hexadecimal characters (in sequence) comprise the eight-character hexadecimal module bitmap for the first MAC domain featuring cable connections to interfaces A, B, C, D, and F on the Cisco RF Switch. Therefore, the resulting module bitmap is AA200000.

Interface	A	H	B	I	C	J	D	K	E	L	F	M	G	N	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Binary	1	0	1	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Decimal	10				10				2				0				0				0				0				0			
Hexadecimal	A				A				2				0				0				0				0				0			

Step 4 Repeat the steps above for the second MAC domain.
Your resulting hexadecimal values should be as follows:

Interface	A	H	B	I	C	J	D	K	E	L	F	M	G	N	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Binary	0	1	0	1	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Decimal	5				5				1				0				0				0				0				0			
Hexadecimal	5				5				1				0				0				0				0				0			

Therefore, the resulting module bitmap is 55100000.

Note It is also permissible (and in some cases, recommended) to map the entire collection of cables from a cable interface line card into a single bitmap so that the entire cable interface line card switches over in the event of a local or remote failure. In such an instance, the combined layout of the two groups exemplified above would be as follows:

Interface	A	H	B	I	C	J	D	K	E	L	F	M	G	N	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Binary	1	1	1	1	1	1	1	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Decimal	15				15				5				0				0				0				0				0			
Hexadecimal	F				F				5				0				0				0				0				0			

After this combination, the resulting module bitmap is FF500000.

Tip Cisco has provided for switchover of an entire cable interface line card by implementing a default module bitmap (referred to by the keyword all) that features an actual hexadecimal module bitmap value of FFFFFFFF.

It is also permissible (and in some cases, recommended) to map the entire collection of cables from a cable interface line card into a single bitmap so that the entire cable interface line card switches over in the event of a local or remote failure.

In such an instance, the combined layout of the two groups illustrated above would be as follows:

- If you have a fault on one MAC domain, the other MAC domains will not switch over gracefully merely by toggling the Cisco RF Switch relays. If you have keepalive configured on the other MAC domains, they will eventually switch over, but not efficiently.

- Another method is to have each interface track the other. Therefore, if one interface from a UBR10-LCP2-MC28C cable interface line card goes down, the other interfaces will follow if they have the tracking statement. With this approach, the interface cable 5/0/0 would show the following configuration, for example:

Note Tracking is not needed when using global N+1 configuration. Beginning in Cisco IOS Release 12.3(21)BC, tracking of HCCP interfaces is removed. The **hccp track** command is obsolete.

```
hccp 1 track c5/0/1
```

Interface 5/0/1 would show the following configuration:

```
hccp 2 track c5/0/0
```

Tip We recommend that you disable automatic HCCP revertive functions on both protect downstream channels of a JIB that use keepalive or tracking. Refer to the Disabling HCCP Revertive on Protect Cable Interfaces, on page 32.

Enabling the HCCP Switchover Enhancements Feature

The HCCP Switchover Enhancements feature implements performance improvements for traffic recovery during line card switchover under certain scalability limits.

Within the required network scalability limits, the HCCP Switchover Enhancements feature provides the following switchover benefits:

- Less than 1-second voice call recovery.
- Less than 20-second data recovery.

Prerequisites for the HCCP Switchover Enhancements Feature

- Each line card must support less than 5000 cable modems.
- Each line card must support less than 1000 voice calls.
- The working and protect line cards must have the same channel width.
- The cable line cards must use virtual interface bundling.
- No Layer 3 configuration is supported on the cable interface
- Virtual interface bundling configuration is required to enable the HCCP Switchover Enhancements feature.

Note When you upgrade to Cisco IOS Release 12.2(33)SCA and later, all preexisting cable bundles are automatically converted to virtual bundles, and standalone cable interfaces must be manually configured to be in a virtual bundle. For configuration examples, see Example: Virtual Interface Bundling, on page 75.

Tasks for Configuring Global N+1 Line Card Redundancy

Configuring Global N+1 Line Card Redundancy

Starting with Cisco IOS Release 12.2(33)SCF, you can configure a card with a lower license as the protect card for a working card with a higher license. This protect card remains in a nonfunctional mode (not in standby mode) and does not become active until it is upgraded and reloaded with a higher license, when a switchover occurs.

Before You Begin

- This High Availability configuration describes one or two Cisco RF Switches in the scheme.
- DHCP must be accounted for prior to or during this procedure. An external DHCP server must be installed and operational on the network, or an internal DHCP server must be operational within the Cisco router. The DHCP server configuration, of either type, must have the following DHCP and DNS entries. Two Cisco RF Switches are illustrated for example:
- Be sure to configure the RF switch name using the **rf-switch name** line card redundancy configuration command, and the RF switch IP addresses prior to configuring line card redundancy.

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.

Step 2	**configure terminal**
	
	Example:
	
	`Router# config terminal`
	`Router(config)#`
		Enters global configuration mode.

Step 3	**ip host rf-sw1***ip_addr* **Example:** `Router(config)# ip host rf-sw1 10.4.4.1`	Assigns the Domain Name System (DNS) entry to the first or only Cisco RF switch in the redundancy scheme.
Step 4	**ip host rf-sw2***ip_addr* **Example:** `Router(config)# ip host rf-sw2 10.4.4.2`	(Required when using two Cisco RF Switches) Assigns the DNS entry to the second Cisco RF switch in the redundancy scheme.

	Command or Action	Purpose

Step 5	**redundancy**
	
	Example:
	
	`Router(config)# redundancy`
	`Router(config-red)#`
		Enables global N+1 redundancy for cases in which factory-configured N+1 redundancy has been disabled, and enters redundancy configuration mode.
		
		This command is supported in Cisco IOS Release 12.3(13a)BC and later releases.

Step 6	**linecard-group 1 cable** **Example:** `Router(config-red)# linecard-group 1 cable`	This command assigns the HCCP group to all interfaces on the cable interface line card, or Cisco Broadband Processing Engine.
Step 7	**member subslot** *slot/card* **working** **Example:** `Router(config-red)# member subslot 8/0 working`	This command configures all interfaces on the specified line card to function as HCCP working interfaces in the redundancy scheme. Repeat this step for each working line card in the Cisco router.

Step 8	Do one of the following:
	• **member subslot** *slot /card* **protect**
	• **member subslot** *slot /card* **protectconfig***slot /card*
	
	Example:
	
	`Router(config-red)#  member subslot 8/1 protect`
	`or`
	`Router(config-red)# member subslot 8/1 protect config 8/0`
		Configures all interfaces on the specified line card to function as HCCP protect interfaces in the redundancy scheme.
		
		For faster switchover results, configures the protect interface for the most appropriate working interface configuration.

Step 9	**end**
	
	Example:
	
	`Router(config-red)# end`
	`Router#`
		Exits global and redundancy configuration modes and returns to Privileged EXEC mode.

Step 10	**write memory** **Example:** `Router# write memory`	After configuring all domains, save your settings to the nonvolatile random access memory (NVRAM) to ensure that the system retains the settings after a power cycle.

Configuring DHCP to Assign IP Addresses on the Cisco RF Switch

To support global N+1 line card redundancy, you must configure either your external DHCP server, or the internal DHCP server on the Cisco uBR10012 universal broadband router to provide the appropriate IP addressing for the Cisco RF switch.

The DHCP server configuration requires the following forms of DHCP and DNS settings:

```
ip dhcp pool rfswitch-pool
      network ...
   !
   ip dhcp pool rfsw-1  [ DHCP MAC->IP mapping for RF-switch # 1 ]
     host a.b.c.d <mask>
     client-id 01aa.bbcc.ddee.ff
   !
   ip dhcp pool rfsw-2  [ DHCP MAC->IP mapping for RF-switch # 2 ]
     host b.c.d.f <mask>
     client-id 01aa.bbcc.ddee.ff
```

You also need to configure DNS entry for each RF-switch, as follows:

```
   ip host rfsw-1 a.b.c.d  [ DNS mapping IP to RF-switch name for rfsw 1 and 2 ]
   ip host rfsw-2 b.c.d.f
```

The following example shows a sample DNS and DHCP configuration on the Cisco uBR10012 universal broadband router for the Cisco RF switch:

```
   ip host rfsw-1 10.10.107.202
   ip host rfsw-2 10.10.107.203
   ip dhcp pool rfsw-1
      host 10.10.107.202 255.255.255.254
      client-identifier 0003.8f00.0019
   !
   ip dhcp pool rfswitch-pool
      network 10.10.107.200 255.255.255.252
      next-server 10.10.107.101
      default-router 10.10.107.101
      option 7 ip 10.10.107.101
      option 2 hex ffff.8f80
      option 4 ip 10.10.107.101
      lease infinite
   !
   ip dhcp pool rfsw-2
      host 10.10.107.203 255.255.255.254
      client-identifier 0003.8f00.0020
   !
```

The sample configuration above provides a mechanism to make sure that rfsw-1 only gets IP address 10.10.107.202, and rfsw-1 only gets DHCP IP address 10.10.107.203.

Note The DNS entries for the Cisco RF Switch should be configured before any line card redundancy configuration is attempted.

Enabling Line Card Switchover in Redundancy Mode

The Cisco CMTS router enables switchover on an entire line card at one time, instead of one interface at a time. To switch over a cable interface line card in redundancy mode, use the following command in privileged EXEC mode:

```
Router# redundancy linecard-group switchover from
```

```
working-slot
/
working-subslot
```

Note This command switches over a working slot only when active, but not when in protect mode. Also, this command does not switch over the locked interfaces.

To revert to original working and protect status, use the following command in privileged EXEC mode:

```
Router# redundancy linecard-group revertback
working-slot
/
working-subslot
```

This command reverts interfaces from the protect subslot to specified working subslot. If the protect subslot is not active, or is active for some other working subslot, then this command aborts and displays a system error message.

Locking a Switchover for all Interfaces

To lock or unlock a switchover for all interfaces on a given subslot, use the redundancy linecard-group command in privileged EXEC mode:

This command creates a wrapper that locks and unlocks switchover events on all interfaces for the given subslot (for example, interface 5/0). This command only locks or unlocks HCCP interfaces when in working slots.

Note To remove an HCCP configuration from a working or protect interface, use the member subslot command in line card redundancy configuration mode after locking the interface using the redundancy linecard-group command.

For example, to lock the cable line card switchover (set the lockout flag to TRUE), use the following command:

Router# **redundancy linecard-group lockout 5/0**

To force switchover on a locked interface, use the cable power command in privileged EXEC mode.

Enabling Service Internal on HCCP Protect and Standby Working Interfaces

In Cisco IOS Release 12.3(33)SCC and later, to modify the configuration on an HCCP protect and standby working cable interfaces, use the **service internal** command in global configuration mode.

Note When **service internal** command is disabled, you can only change the configuration of an active working interface. The protect line card does not become active directly when it starts up due to hardware reset, or power off/on or other reasons. It will always go to standby state after startup. We recommend that you do not enable **service internal** on the standby working controller, wideband and intergrated cable interfaces of a line card.

Changing Default RF Switch Subslots for Global N+1 Line Card Redundancy

The **member subslot** command enables you to configure a non-default 7+1 wiring other than factory settings. This command supports the option to cable any line card to any RF Switch slot. For example, interface 7/0 might need to be wired to RF Switch slot 7 (instead of the default 3).

To change the factory configuration of subslot mapping to a custom (non-default) mapping, do the following:

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# config terminal`	Enters global configuration mode.
Step 3	**redundancy** **Example:** `Router# redundancy`	Enters redundancy configuration mode.
Step 4	**linecard-group1cable** **Example:** `Router(config-red)# linecard-group 1 cable`	Enters line card redundancy configuration mode. • *1*—Line card group number. • **cable**—Specifies the redundancy type.
Step 5	**member subslot***slot* / *subslot* **working rfsw-slot** [*slot-number*] **Example:** `Router(config-red-lc)# member subslot 7/0 working rfsw-slot 7`	Changes the factory configuration of subslot mapping to a custom (non-default) mapping. • *slot* —Chassis slot number of the cable interface line card. The valid range is from 5 to 8. • *subslot* —(Cisco uBR10012 router only) Secondary slot number of the cable interface line card. Valid subslots are 0 and 1. • **working**—Specifies the working slot in the line card group. • **rfsw-slot** [*slot-number*]—(Optional) Specifies the RF switch slot for the working line card.
Step 6	**end** **Example:** `Router(config-red-lc)# end`	Returns to privileged EXEC mode.

Changing the Default RF Switch Name and SNMP Community String

The default RF Switch names (rfsw-1 for switch 1 and rfsw-2 for switch 2) are used to perform a DNS lookup for the RF-Switch IP address.

If on an external DHCP server, the RF-Switch DNS names are to be different from the default names, then you need to enter the new RF Switch name as part of line card redundancy configuration.

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# config terminal`	Enters global configuration mode.
Step 3	**redundancy** **Example:** `Router# redundancy`	Enters redundancy configuration mode.
Step 4	**linecard-group1cable** **Example:** `Router(config-red)# linecard-group 1 cable`	Enters line card redundancy configuration mode. • *1*—Line card group number. • **cable**—Specifies the redundancy type.
Step 5	**rf-switch name {1|2}** *name* **Example:** `Router(config-red-lc)# rf-switch name {1|2} switch5`	Changes the default RF switch name. • *name* —Alphanumeric name to replace the default name of the Cisco RF Switch.
Step 6	**rf-switch snmp-community community-name** **Example:** `Router(config-red-lc)# rf-switch snmp-community RFswitchstring`	Changes the default SNMP community string. This command updates the Cisco uBR10012 SNMP software only and does not update the new snmp RW community string into the RF Switch. So the user must get into the RF Switch via telnet and set the new snmp RW community string in there. • *community-name* —SNMP community string name.

	Command or Action	Purpose
Step 7	end **Example:** `Router(config-red-lc)# end`	Returns to privileged EXEC mode.

Removing Global N+1 Redundancy Configuration

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**redundancy linecard-group lockout** *slot* /*subslot* **Example:** `Router# redundancy linecard-group lockout 6/1`	Locks a line card switchover from the specified working slot and subslot. • *slot*—Chassis slot number of the cable interface line card. The valid range is from 5 to 8. • *subslot*—(Cisco uBR10012 router only) Secondary slot number of the cable interface line card. Valid subslots are 0 and 1.
Step 3	**configure terminal** **Example:** `Router# config terminal`	Enters global configuration mode.
Step 4	**redundancy** **Example:** `Router# redundancy`	Enters redundancy configuration mode.
Step 5	**linecard-group1cable** **Example:** `Router(config-red)# linecard-group 1 cable`	Enters line card redundancy configuration mode. • *1*—Line card group number. • **cable**—Specifies the redundancy type.

	Command or Action	Purpose
Step 6	**no member subslot***slot /subslot* **working** **Example:** `Router(config-red-lc)# no member subslot 6/1 working`	Removes the specified line card from the global redundancy configuration. • *slot*—Chassis slot number of the cable interface line card. The valid range is from 5 to 8. • *subslot*—(Cisco uBR10012 router only) Secondary slot number of the cable interface line card. Valid subslots are 0 and 1.
Step 7	end **Example:** `Router(config-red-lc)# end`	Returns to privileged EXEC mode.

Tasks for Configuring N+1 HCCP Redundancy

Note Global configuration procedures render interface-level configuration of **hccp** commands obsolete. Legacy HCCP configuration and the newer global N+1 redundancy configuration are mutually exclusive.

Configuring HCCP Groups

This procedure defines HCCP working and protect interfaces for N+1 HCCP Redundancy.

Note When the Cisco CMTS CLI descriptions include the term channel switch, this term refers to the Cisco RF Switch. When configuring HCCP on the Cisco uBR10012 router, use the IP address from the local loopback interface as the working interface IP address. We recommend that you create a loopback interface on the Cisco uBR10012 router, and then assign the loopback interface's IP address to the HCCP protect configuration.

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.

	Command or Action	Purpose
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**interface cable** *slot*/*subslot*/*port* **Example:** `Router# interface cable 8/1/0`	Enters interface configuration mode. Variables for this command may vary depending on the Cisco CMTS router and the Cisco IOS software release. For details, see the Cisco IOS CMTS Cable Command Reference . • *slot*—Slot where the cable interface line card resides. • *subslot*—(Cisco uBR10012 only) Secondary slot number of the cable interface line card. • *port*—Downstream port number.
Step 4	**hccp** *group* **working** *member-id* **Example:** `Router(config-if)# hccp 1 working 1`	Designates a cable interface on a CMTS in the specified HCCP group to be a working CMTS. The hccp working command is to be used for working line card interfaces only. • *group* —The group number for the specified interface. Valid values are any number from 1 to 255, inclusive. • *member-id* — The member number for the specified interface. Valid values are any number from 1 to 255, inclusive.
Step 5	**hccp** *group* **protect***member-idip-address* **Example:** `Router(config-if)# hccp 1 protect 2 10.10.10.1`	Assigns the HCCP group number, defines the corresponding HCCP member, and defines the working IP address of the interface used for HCCP communication. The hccp protect command is to be used for protect line card interfaces only. **Note** Working and protect line cards are located on the same Cisco uBR10012 router chassis. In the latter case, we recommend that you use the Loopback IP address in this configuration.
Step 6	**hccp** *group* **channel-switch** *member-id upconverter name* **wavecom-xx** *protect-upconverter-ip-address module working-ip-address its-module* **Example:** `Router(config-if)# hccp 1 channel-switch 2 uc wavecom-hd 10.97.1.21 2 10.97.1.21 14`	Configures the upconverter (UPx) topology so that the Vecima upconverter becomes part of the specified HCCP member in a particular HCCP group. **Note** This procedure is not required when configuring N+1 redundancy on the Cisco uBR10012 router with the Cisco UBR10-MC 5X20 BPE. **Note** Steps 6 and 7 of this procedure are required for both the working and the protect interfaces.
Step 7	**hccp group channel-switch member-id rf-switch-name rfswitch-group** *ip address* **module-bitmap position** **Example:** `Router(config-if)#`	Configures the Cisco CMTS so that the specified Cisco RF Switch becomes part of the specified HCCP member in a particular HCCP group. • *ip address* — The IP address of the Cisco RF Switch. • — Specifies the name of the Cisco RF Switch, and must also include the hexadecimal module-bitmap argument. See the Creating Cisco RF

	Command or Action	Purpose
	`hccp 1 channel-switch 2 rfswitch-name rfswitch-group 10.97.1.20 AA200000 2`	Switch Module Bitmaps, on page 15 for instructions on creating an appropriate hexadecimal module bitmap. • **position —** This value specifies the slot/header of the Cisco RF Switch—there are eight on the Cisco uBR10012. **Note** Steps 6 and 7 of this procedure are required for both the working and the protect interfaces.
Step 8	**exit** **Example:** `Router(config-if)# exit`	Exits interface configuration mode, and returns to global configuration mode.
Step 9	**write memory** **Example:** `Router# write memory`	After configuring all domains, save your settings to the nonvolatile random access memory (NVRAM) to ensure that the system retains the settings after a power cycle.

Enabling HCCP Protect Interfaces for N+1 Switchover

To enable HCCP protect interfaces, making them available for N+1 switchover should the HCCP working interfaces fail, use the no shutdown command in interface configuration mode on each HCCP protect interface.

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# config terminal`	Enters global configuration mode.

Step 3	**interface cable** *slot*/*subslot*/*port*
	Example:
	`Router# interface cable 8/1/0`
	`Router(config-if)#`
		Ensure that you specify the variables for an HCCP protect interface to enter the interface configuration mode of that protect interface. Variables for this command may vary depending on the Cisco CMTS router and the Cisco IOS software release. For details, see the Cisco IOS CMTS Cable Command Reference.
		• *slot*—Slot where the cable interface line card resides.

	Command or Action	Purpose
		• *subslot*—(Cisco uBR10012 only) Secondary slot number of the cable interface line card. • *port*—Downstream port number.
Step 4	**no shutdown** **Example:** `Router(config-if)# no shutdown`	Enables the HCCP protect interface.
Step 5	Repeat	Repeat steps 3-4 for every HCCP protect interface.
Step 6	**exit** **Example:** `Router(config-if)# exit`	Exits interface configuration mode, and returns you to global configuration mode.
Step 7	**write memory** **Example:** `Router#  write memory`	After enabling all HCCP protect interfaces, save your settings to the nonvolatile random access memory (NVRAM) to ensure that the system retains the settings after a power cycle.

Maintaining Online Cable Modem Service When Removing HCCP Configuration from Working HCCP Interfaces

- Before removing HCCP configuration from an active working interface, either shut down the protect or lockout switchover functions using the hccp lock command in interface configuration mode. Otherwise the protect interface will declare the working interface to have failed and will attempt to switch over.
- Do not remove HCCP configuration from an active protect interface. The active member should be restored to its corresponding working interface before removing HCCP configuration from the protect interface.

Note This restriction does not apply when removing HCCP configuration from a protect interface while it is in standby mode and N+1 redundancy is in normal working mode.

To prevent cable modems from going offline during removal of HCCP configuration (on working interfaces), we recommend using one of the following three procedures as a best practice:

Shutting Down HCCP Protect Interfaces

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# config terminal`	Enters global configuration mode.
Step 3	**interface cable** *slot*/*subslot*/*port* **Example:** `Router# interface cable 8/1/0`	Enters interface configuration mode. Variables for this command may vary depending on the Cisco CMTS router and the Cisco IOS software release. For details, see the Cisco IOS CMTS Cable Command Reference. • *slot*—Slot where the cable interface line card resides. • *subslot*—(Cisco uBR10012 only) Secondary slot number of the cable interface line card. • *port*—Downstream port number.
Step 4	**shutdown** **Example:** `Router(config-if)# shutdown`	Shuts down the specified interface. This does not remove interface configuration—merely disables it.
Step 5	Repeat.	Repeat the above steps 3 and 4 as required to shut down all Protect HCCP interfaces.

Locking out HCCP Interface Switchover

Use the hccp lockout command to prevent a working HCCP interface from automatically switching to a protect interface in the same group. This command locks out the HCCP interface. To remove the lockout, use the hccp unlockout command in privileged EXEC mode (re-enabling N+1 redundancy on the working interface).

Note The **hccp lockout** command is not supported starting with Cisco IOS Release 12.2(33)SCE.

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**hccp** *group* **lockout** *member-id* **Example:** `Router# hccp 1 lockout 1`	To prevent a working HCCP interface from automatically switching to a Protect interface in the same group, use the hccp lockout command in privileged EXEC mode. This command disables HCCP for the specified member of the specified group. • *group* — The group number for the specified interface. Valid values are any number from 1 to 255, inclusive. • *member-id* — The member number for the specified interface. Valid values are any number from 1 to 255, inclusive. **Note** Even if an HCCP member is locked out, it switches over in circumstances in which it is tracking another HCCP interface. This condition applies when HCCP interfaces are configured manually to track each other, or when HCCP interfaces share the same JIB, such as with the Cisco UBR10-MC 5X20.
Step 3	Repeat.	Repeat the above steps as required to prevent a working interface from switching over. This manual override can be removed when desired, and retains HCCP configuration on the interface.
Step 4	**hccp** *group* **unlockout** *member* **Example:** `Router# hccp 1 unlockout 1`	Disables the HCCP lockout feature when desired

Removing HCCP Configuration from HCCP Working or HCCP Protect Interfaces

Before You Begin

Restriction Starting with Cisco IOS Release 12.2(33)SCC and later, interface level HCCP configuration is not supported. The below configuration step is supported on Cisco IOS Release 12.2(33)SCB and earlier.

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable**	Enables privileged EXEC mode.

	Command or Action	Purpose
	Example: `Router> enable`	• Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# config terminal`	Enters global configuration mode.
Step 3	**interface cable** *slot*/*subslot*/*port* **Example:** `Router# interface cable 8/1/0`	Enters interface configuration mode. Variables for this command may vary depending on the Cisco CMTS router and the Cisco IOS software release. For details, see the Cisco IOS CMTS Cable Command Reference. • *slot*—Slot where the cable interface line card resides. • *subslot*—(Cisco uBR10012 only) Secondary slot number of the cable interface line card. • *port*—Downstream port number.
Step 4	**no hccp** *group* {**working** | **protect**} *member-id* **Example:** `Router(config-if)# no hccp 1 protect 1`	Turns off HCCP, and removes the specified HCCP configuration from the specified interface. • *group* — The group number for the specified interface. Valid values are any number from 1 to 255, inclusive. • *member-id* — The member number for the specified interface. Valid values are any number from 1 to 255, inclusive.
Step 5	Repeat.	Repeat the above steps as required to remove HCCP configuration from all desired HCCP protect interfaces.
Step 6	**end** **Example:** `Router(config-if)# end`	Returns to privileged EXEC mode.

Disabling HCCP Revertive on Protect Cable Interfaces

The cable interface line cards pair up interfaces that share the same JIB (ASIC processor). As a result, when HCCP keepalive is enabled on paired DS channels, both DS channels in the pair switch over together if either DS channel has a keepalive failure. For example, if HCCP is configured on DS channels 0 and 1, and DS channel 0 has a keepalive failure, then DS channel 1 also fails because it shares the same JIB with DS channel 0.

When HCCP revertive is enabled on both downstream channels in the pair, the interface that experiences the keepalive failure does not revert automatically to active state. This is desirable behavior because it prevents reverting to active state prematurely—before the cause of an external failure is confirmed and remedied.

The default HCCP revertive time for HCCP interfaces is 30 minutes.

However, the JIB companion interface may act upon the default revertive time of 30 minutes. The companion interface attempts to revert to active state after 30 minutes (when HCCP revertive is enabled). This creates conflict with the failed companion interface on the same JIB.

Note Therefore, we recommend that you disable automatic HCCP revertive functions on both protect downstream channels of a JIB that use keepalive or tracking. If you have keepalive and tracking enabled, or you are using the UBR10-MC 5X20 in N+1 configuration, disable the revertive function on both protect interfaces.

To disable the HCCP revertive function on protect interfaces, do the following:

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# config terminal`	Enters global configuration mode.
Step 3	**interface cable** *slot*/*subslot*/*port* **Example:** `Router# interface cable 8/1/0`	Enters interface configuration mode. Variables for this command may vary depending on the Cisco CMTS router and the Cisco IOS software release. For details, see the Cisco IOS CMTS Cable Command Reference. • *slot*—Slot where the cable interface line card resides. • *subslot*—(Cisco uBR10012 only) Secondary slot number of the cable interface line card. • *port*—Downstream port number.
Step 4	**nohccp** *group* **revertive** **Example:** `Router(config-if)# no hccp 2 revertive`	Disables the automatic HCCP revertive function on the protect interface. • *group* — The group number for the specified interface. Valid values are any number from 1 to 255, inclusive.
Step 5	**end** **Example:** `Router(config-if)# end`	Returns to privileged EXEC mode.

What to Do Next

After configuring the redundancy scheme, you can refer to these additional sections:

Switchover Testing Tasks for N+1 Redundancy

Each of these switchover test methods below provides an opportunity to test N+1 redundancy on your Cisco uBR10012 router. Each test method results in the cable modems dropping connectivity temporarily, but staying online, with switchover to protect line cards and interfaces.

Electromagnetic relays can develop a magnetic charge over time that could interfere with normal operations. Therefore, Cisco Systems recommends periodic testing using these procedures to ensure smooth operation. The tests in this section help to improve overall system availability.

These switchover testing tasks apply to switchover from HCCP working interfaces to HCCP protect interfaces, or vice versa, when configured in N+1 redundancy.

Pre-testing System Check Procedures

As a best practice, we strongly recommend analyzing the CMTS headend status prior to switchover testing.

Caution Switchover testing with latent configuration or status problems can create disruptions in subscriber service.

Use these pre-test system checks prior to manual switchover testing:

Displaying HCCP Working and HCCP Protect Interface Status

To display a brief summary of the HCCP groups, configuration types, member numbers, and status for cable interfaces, use the **show hccp brief** command at the Cisco uBR 3x10 RF Switch prompt. rfswitch> **show hccp brief**

```
Interface Config    Grp Mbr Status
Ca5/0/0   Protect   1   3   standby
Ca7/0/0   Working   1   3   active
```

Displaying HCCP Group Status on the Cisco CMTS

As a best practice, we recommend that you perform this test prior to performing any manual switchovers. This status check verifies stable redundancy operations. Should this procedure reveal any problems with online states, resolve these problems prior to performing a manual switchover. Otherwise, manual switchover for testing purposes might create additional problems.

To display HCCP group status on the Cisco CMTS, including Cisco RF Switch information relevant to N+1 redundancy behavior, use the show hccp channel-switch command in privileged EXEC mode. This command displays status for all channel switches belonging to the specified HCCP group and HCCP member. For details

on the sample output the show hccp channel-switch command, see the Example: Channel Switch Information from the Cisco uBR10012 Router, on page 45.

Displaying Cisco RF Switch Module Status on the Cisco uBR 3x10 RF Switch

As a best practice, we recommend that you perform this pretest status check prior to performing any manual switchovers. This status check confirms the online and administrative states for all modules on the Cisco uBR 3x10 RF Switch itself.

To display current module status for one or more modules on the Cisco uBR 3x10 RF Switch, use the show module all command at Cisco uBR 3x10 RF Switch prompt. For details on the show module all command sample output, see Example: Cisco 3x10 RF Switch Modules in 7+1 Mode, on page 41.

Switchover Testing Procedures

The first two procedure below describe how to test the performance of N+1 redundancy on your Cisco CMTS headend. The final procedure describes how to analyze Cisco CMTS headend status after switchover.

Testing Cisco RF Switch Relays with Manual Switchover

We recommend testing the switch relays once a week (optimal) and at least once a month (minimal). Perform these steps to test the working RF Switch relays with switchover to protect.

Tip You can toggle the relays on the switch without affecting the upconverter or any of the modems. This is important if testing the relays without actually switching any of the line cards or the corresponding upconverters. If a relay is enabled on the switch and a fail-over occurs, it will go to the proper state and not just toggle from one state to another.

DETAILED STEPS

	Command or Action	Purpose
Step 1	**telnet ip-address /noecho** **Example:** `Router# telnet 172.16.10.3 /noecho`	Initiate configuration by connecting to the Cisco RF Switch using the console or by using a Telnet session. Either provides CLI access for initiating a switchover. If a Telnet password is set on the Cisco RF Switch, type password string, where string is the previously-defined password set on the RF Switch. The Telnet password is set using the separate set password string command in Cisco RF Switch User mode. **Note** To prevent multiple users from changing the Firmware configuration at any one time, only a single Telnet client connection can be opened at a time, regardless of whether this connection is password-protected. Telnet access to the RF Switch from the router console makes double entries when typing. One workaround is to disable local echo. For example, from the Cisco uBR10012 router CLI, use the /noecho option (as shown at left). Common Telnet disconnect methods are as follows: • Press Ctrl+Break. • Press Ctrl+].

	Command or Action	Purpose
		• Type quit or send break. Another Telnet disconnect method is as follows: • Press Ctrl+Shift 6 6 x. • Type disc 1 from the router CLI. For additional Telnet break sequences, refer to the document Standard Break Key Sequence Combinations During Password Recovery on Cisco.com.

Step 2	Do one of the following:
	
	• **test module**
	
	• **switch group-name** *x*
	
	Example:
	
	`rfswitch> test module`
	
	or
	
	`rfswitch> switch 13 1`
		The test module command tests all the relays at once, and then returns to the normal working mode.
		
		Caution Do not use the test module command while in the protect mode.
		
		Alternately, you can test an entire bitmap with switch group-name x, where x is the RF Switch header number. For example, the switch 13 1 tests port G on slot 1 of the Cisco RF Switch.

Step 3	switch group-name 0 **Example:** `rfswitch> switch 13 0`	Use the command switch group name 0 (or idle) to disable the relays, and to return to normal working mode.

Testing HCCP Groups with Manual Switchover

Cisco Systems recommends that you perform a periodic CLI switchover test of an HCCP group from the CMTS to test the protect card and path. However, this type of switchover may take 4-6 seconds and could cause a small percentage of modems to go offline. Therefore, this test should be performed less often than previous tests, and only during off-peak hours.

SUMMARY STEPS

1. **enable**
2. **hccp** *group* **switch** *member*

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable**	Enables privileged EXEC mode.

	Command or Action	Purpose
	Example: `Router> enable`	• Enter your password if prompted.
Step 2	**hccp** *group* **switch** *member* **Example:** `Router# hccp 1 switch 1`	Manually switches a working CMTS with its protect CMTS peer (or vice versa).

Using the show cable modem Command After a Manual Switchover

If you are using HCCP 1+1 or N+1 redundancy, the new primary processor after a switchover automatically creates a new database of the online cable modems. Use the following procedure to force IP traffic and to display cable modem status and information.

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.

Step 2	**show cable modem** *ip-address*
	Example:
	`Router# show cable modem 172.16.10.3`
	`MAC Address IP Address I/F MAC Prim RxPwr Timing Num BPI`
	`State Sid (db) Offset CPE Enb`
	`0000.3948.ba56 8.60.0.8 C6/0/0/U0 online 1 0.50 2138 0 N`
		Identifies the IP address of a specific cable modem to be displayed. You can also specify the IP address for a CPE device behind a cable modem, and information for that cable modem is displayed.

Step 3	**ping ip-address** **Example:** `Router# ping 172.16.10.3`	Forces IP traffic by sending an ICMP ECHO packet.

Verifying N+1 Redundancy Configuration

The following example of the show running configuration command illustrates the N+1 redundancy scheme configured on the Cisco uBR10012 router with two Cisco uBR 3x10 RF Switches:

```
Router# show running config
...
redundancy
 linecard-group 1 cable
  rf-switch name 1 rfsw1
  rf-switch name 2 rfsw2
  rf-switch protection-mode [4+1/7+1]
  rf-switch snmp-community private123
  revertive <1-35791>
  member subslot 5/0 working
  member subslot 5/1 protect
  member subslot 8/1 working
  member subslot 5/1 protect config 8/1
  mode sso
...
```

The following is a sample output of the show redundancy linecard all command in privileged EXEC mode for Global N+1 Line Card Redundancy. This redundancy configuration supports two Cisco uBR 3x10 RF Switches on the Cisco CMTS router.

```
Router# show redundancy linecard all
 hccp config sync list:
 end
 Don't generate default PHY config configuration: FALSE
 User defined PHY config configuration: FALSE
 Redundancy Mode: 7 + 1
 Linecard Redundancy Detail
 ---------------------------
Card      Config   Mbr RfSw-Name       RfSw-IP-Addr    RfSw-Slot Bitmap
card 8/0  Working  80  rfsw-2          5.37.0.20       8         0xFFFFFFFF
card 8/0  Working  80  rfsw-1          5.37.0.19       8         0xFFFFFFFF
card 7/0  Working  70  rfsw-2          5.37.0.20       7         0xFFFFFFFF
card 7/0  Working  70  rfsw-1          5.37.0.19       7         0xFFFFFFFF
 Subslot Summary
--------------------
                              RF Switch Slot*
   Subslot        Status      Current         Default
 ------------------------------------------------------------
    5/0           Unknown       -               7
    5/1           Unknown       -               P
    6/0           Unknown       -               5
    6/1           Unknown       -               6
    7/0           Working       7               3
    7/1           Unknown       -               4
    8/0           Working       8               1
    8/1           Unknown       -               2
 ------------------------------------------------------------------
 NOTE:
 Legend: - = Unused; P= Protect
```

The following is a sample output of the show redundancy linecard all command in privileged EXEC mode for N+1 HCCP Redundancy. This redundancy configuration supports two Cisco uBR 3x10 RF Switches on the Cisco router.

```
Router# show redundancy linecard all
Interface Config   Grp Mbr RfSw-Name       RfSw-IP-Addr    RfSw-Slot Bitmap
Ca6/1/0   Working  1   61  rfsw-1          10.4.4.1        6         0xFFFFFFFF
Ca6/1/1   Working  2   61  rfsw-1          10.4.4.1        6         0xFFFFFFFF
Ca6/1/2   Working  3   61  rfsw-1          10.4.4.1        6         0xFFFFFFFF
Ca6/1/2   Working  3   61  rfsw-2          10.4.4.2        6         0xFFFFFFFF
Ca6/1/3   Working  4   61  rfsw-2          10.4.4.2        6         0xFFFFFFFF
Ca6/1/4   Working  5   61  rfsw-2          10.4.4.2        6         0xFFFFFFFF
```

```
Ca7/0/0   Protect  1   80  rfsw-1          10.4.4.1        1          0xFFFFFFFF
Ca7/0/0   Protect  1   61  rfsw-1          10.4.4.1        6          0xFFFFFFFF
Ca7/0/1   Protect  2   80  rfsw-1          10.4.4.1        1          0xFFFFFFFF
Ca7/0/1   Protect  2   61  rfsw-1          10.4.4.1        6          0xFFFFFFFF
Ca7/0/2   Protect  3   80  rfsw-1          10.4.4.1        1          0xFFFFFFFF
Ca7/0/2   Protect  3   80  rfsw-2          10.4.4.2        1          0xFFFFFFFF
Ca7/0/2   Protect  3   61  rfsw-1          10.4.4.1        6          0xFFFFFFFF
Ca7/0/2   Protect  3   61  rfsw-2          10.4.4.2        6          0xFFFFFFFF
Ca7/0/3   Protect  4   80  rfsw-2          10.4.4.2        1          0xFFFFFFFF
Ca7/0/3   Protect  4   61  rfsw-2          10.4.4.2        6          0xFFFFFFFF
Ca7/0/4   Protect  5   80  rfsw-2          10.4.4.2        1          0xFFFFFFFF
Ca7/0/4   Protect  5   61  rfsw-2          10.4.4.2        6          0xFFFFFFFF
Ca8/0/0   Working  1   80  rfsw-1          10.4.4.1        1          0xFFFFFFFF
Ca8/0/1   Working  2   80  rfsw-1          10.4.4.1        1          0xFFFFFFFF
Ca8/0/2   Working  3   80  rfsw-1          10.4.4.1        1          0xFFFFFFFF
Ca8/0/2   Working  3   80  rfsw-2          10.4.4.2        1          0xFFFFFFFF
Ca8/0/3   Working  4   80  rfsw-2          10.4.4.2        1          0xFFFFFFFF
Ca8/0/4   Working  5   80  rfsw-2          10.4.4.2        1          0xFFFFFFFF
```

In addition to the show redundancy linecard all command illustrated above, you can use the following command to display additional redundancy information for a specified slot:

- **show redundancy linecard all | incCa8/0/1**

The following table summarizes HCCP group and member information that is assigned to HCCP configuration on the Cisco CMTS. These factory-configured settings configure the Cable slot/subslot interfaces on the router, and supporting slot configuration on the Cisco uBR 3x10 RF Switches in either 4+1 or 7+1 redundancy.

Table 3: HCCP Member Numbers for Cisco uBR10012 Slots/ Subslots in Global N+1 Redundancy

Downstream Number	Group Number	8/0	8/1	7/0	7/1	6/0	6/1	5/0	5/1
DS 0	1	80	81	70	71	60	61	50	P1
DS 1	2	80	81	70	71	60	61	50	P1
DS 2	3	80	81	70	71	60	61	50	P1
DS 3	4	80	81	70	71	60	61	50	P1
DS 4	5	80	81	70	71	60	61	50	P1
Default RF Switch Slot (7+1 Mode)	1	2	3	4	5	6	7	P1	
Default RF Switch Slots (4+1 Mode)	5, 1	6, 2	7, 3	8, 4	-	-	-	P1, P2	

Configuration Examples for Cisco N+1 Redundancy

This section provides the following configuration examples of N+1 redundancy. Each chassis-level example below illustrates a distinct implementation of N+1 redundancy on the Cisco CMTS.

Note For configuration examples for the Cisco uBR Advanced RF Switch, see Cisco uBR Advanced RF Switch Software Configuration Guide .

Table 4: Summary Table of N+1 Configuration Examples—Cisco IOS 12.2(15)BC2a, Firmware 3.50

Example	Cisco RF Switch[2]	N+1 Mode	Cisco Router Chassis[3]	Cisco Cable Interface Line Cards
Cisco RF Switch Module Examples				
Example: Cisco 3x10 RF Switch Modules in 7+1 Mode, on page 41	3x10 RF	7+1[4]	uBR10012	Not described
Cisco uBR10012 Chassis Configuration Examples				
Examples: N+1 HCCP Redundancy in 4+1 Mode, on page 42	3x10 RF	4+1	uBR10012	UBR10-MC 5X20 (five)
Example: Channel Switch Information from the Cisco uBR10012 Router, on page 45	3x10 RF	7+13	uBR10012	Not described
Example: Global N+1 Redundancy Using the Cisco uBR-MC3GX60V Line Card , on page 57	3x10 RF (two)	7+13	uBR10012	uBR-MC3GX60V
Example: Global N+1 Redundancy Using the Cisco UBR10-MC5X20 Line Card , on page 64	3x10 RF (two)	7+13	uBR10012	UBR10-MC 5X20

Example	Cisco RF Switch[2]	N+1 Mode	Cisco Router Chassis[3]	Cisco Cable Interface Line Cards
Example: Global N+1 Redundancy Using the Cisco UBR10-LCP2-MC28C Line Card, on page 70	3x10 RF	7+13	uBR10012	UBR10-LCP2-MC28C (eight)

2 Assume one Cisco RF Switch per example unless more are cited.

3 Assume one Cisco router chassis per example unless more are cited.

4 The term "7+1 Redundancy" is also referred to as "8+1 Redundancy" in the field—physically, eight line cards in "8+1" mode are configured as seven working line cards with one protect line card. Therefore, "7+1 Redundancy" is the more physically accurate term. By contrast, "4+1 Redundancy" (predictably) refers to four working line cards with one additional protect line card.

Example: Cisco 3x10 RF Switch Modules in 7+1 Mode

The following is sample output for the **show module all** command from a Cisco RF Switch that has been configured for 7+1 Redundancy:

```
rfswitch> show module all
SNMP Cache: enabled
Module  Presence  Admin  Cache  Fault
     1    online      0      0     ok
     2    online      0      0     ok
     3    online      0      0     ok
     4    online      0      0     ok
     5    online      0      0     ok
     6    online      0      0     ok
     7    online      0      0     ok
     8    online      0      0     ok
     9    online      0      0     ok
    10    online      0      0     ok
    11    online      0      0     ok
    12    online      0      0     ok
    13    online      0      0     ok
    14   offline      0      0     ok
```

The Administrative State field (Admin) indicates the following potential states:

- 0 — Indicates normal working state.
- 1-8 — Indicates that there has been a switchover and the corresponding module is in protect mode, and the header is being protected. For example, an Admin state of 8 for Module 1 would indicate a switchover for port A (Module 1) on header 8 on the Cisco RF Switch. After a switchover, verify that this Admin state corresponds with the actual wiring on the Cisco RF Switch.
- 9—Indicates fault for the specified module.

The following is sample output of the **show config** command from a Cisco 3x10 RF Switch configured in 7+1 Redundancy mode:

```
rfswitch> show config
IP addr: 10.74.59.242
Subnet mask: 255.255.255.192
MAC addr: 00-03-8F-01-13-BB
Gateway IP: 10.74.59.193
```

```
TFTP host IP: 20.4.0.2
ARP timeout: 14400 secs
DHCP lease time: infinite
TELNET inactivity timeout: 600 secs
TELNET echo mode: on
Password: (none)

SNMP Community: private
SNMP Cache: enabled
SNMP Traps: enabled
SNMP Trap Interval: 300 sec(s)
SNMP Trap Hosts: none
Card Protect Mode: 8+1
Protect Mode Reset: disabled
Slot Config: 0x03ff 0x1c00 (13 cards)
Watchdog Timeout: 20 sec(s)
Group definitions: 1
  ALL        0xffffffff
```

Note The show config command for the Cisco RF Switch contains the Card Protect Mode field. When this field displays 8+1 , this indicates that the Cisco RF Switch is configured for N+1 redundancy, where eight or less working line cards are possible. This field may also display 4+1 , where four or less working line cards are possible.

Examples: N+1 HCCP Redundancy in 4+1 Mode

The following output from the Cisco IOS show running configuration command illustrates the configuration of N+1 redundancy using the following CMTS:

- One Cisco 3x10 RF Switch configured as two working RF Switches in 4+1 mode
- One Cisco uBR10012 router
- Five Cisco UBR10-MC 5X20 broadband processing engines

The Protection mode affects the bitmaps of the Cisco RF Switch and CMTS configuration.

Note If you add one additional Cisco UBR10-MC 5X20 BPE, the entire CMTS configuration below must be changed. Refer to the cabling in the following document for additional information:

- Cabling the Cisco UBR10-MC 5X20 Cable Interface Line Card

http://www.cisco.com/en/US/docs/interfaces_modules/cable/broadband_processing_engines/ubr10_mc5x20s_u_h/quick/start/MC52_cbl.html

Example: HCCP Working 1

The following configuration example illustrates HCCP working member 1 for five HCCP groups:

```
interface c8/0/0
hccp 1 working 1
hccp 1 channel-switch 1 rfswa rfswitch-group 10.10.10.10 44440400 1
interface c8/0/1
hccp 2 working 1
hccp 2 channel-switch 1 rfswa rfswitch-group 10.10.10.10 11110100 1
```

```
interface c8/0/2
hccp 3 working 1
hccp 3 channel-switch 1 rfswa rfswitch-group 10.10.10.10 00005000 1
hccp 3 channel-switch 1 rfswb rfswitch-group 10.10.10.10 0000a080 1
interface c8/0/3
hccp 4 working 1
hccp 4 channel-switch 1 rfswb rfswitch-group 10.10.10.10 88880800 1
interface c8/0/4
hccp 5 working 1
hccp 5 channel-switch 1 rfswb rfswitch-group 10.10.10.10 22220200 1
```

Example: HCCP Working 2

The following configuration example illustrates HCCP working member 2 for five HCCP groups:

```
interface c8/1/0
hccp 1 working 2
hccp 1 channel-switch 2 rfswa rfswitch-group 10.10.10.10 44440400 2
interface c8/1/1
hccp 2 working 2
hccp 2 channel-switch 2 rfswa rfswitch-group 10.10.10.10 11110100 2
interface c8/1/2
hccp 3 working 2
hccp 3 channel-switch 2 rfswa rfswitch-group 10.10.10.10 00005000 2
hccp 3 channel-switch 2 rfswb rfswitch-group 10.10.10.10 0000a080 2
interface c8/1/3
hccp 4 working 2
hccp 4 channel-switch 2 rfswb rfswitch-group 10.10.10.10 88880800 2
interface c8/1/4
hccp 5 working 2
hccp 5 channel-switch 2 rfswb rfswitch-group 10.10.10.10 22220200 2
```

Example: HCCP Working 3

The following configuration example illustrates HCCP working member 3 for five HCCP groups:

```
interface c7/0/0
hccp 1 working 3
hccp 1 channel-switch 3 rfswa rfswitch-group 10.10.10.10 44440400 3
interface c7/0/1
hccp 2 working 3
hccp 2 channel-switch 3 rfswa rfswitch-group 10.10.10.10 11110100 3
interface c7/0/2
hccp 3 working 3
hccp 3 channel-switch 3 rfswa rfswitch-group 10.10.10.10 00005000 3
hccp 3 channel-switch 3 rfswb rfswitch-group 10.10.10.10 0000a080 3
interface c7/0/3
hccp 4 working 3
hccp 4 channel-switch 3 rfswb rfswitch-group 10.10.10.10 88880800 3
interface c7/0/4
hccp 5 working 3
hccp 5 channel-switch 3 rfswb rfswitch-group 10.10.10.10 22220200 3
```

Example: HCCP Working 4

The following configuration example illustrates HCCP working member 4 for five HCCP groups:

```
interface c7/1/0
hccp 1 working 4
hccp 1 channel-switch 4 rfswa rfswitch-group 10.10.10.10 44440400 4
interface c7/1/1
hccp 2 working 4
hccp 2 channel-switch 4 rfswa rfswitch-group 10.10.10.10 11110100 4
interface c7/1/2
```

```
hccp 3 working 4
hccp 3 channel-switch 4 rfswa rfswitch-group 10.10.10.10 00005000 4
hccp 3 channel-switch 4 rfswb rfswitch-group 10.10.10.10 0000a080 4
interface c7/1/3
hccp 4 working 4
hccp 4 channel-switch 4 rfswb rfswitch-group 10.10.10.10 88880800 4
interface c7/1/4
hccp 5 working 4
```

HCCP Protect Interface Configuration Examples

The following examples illustrate the four HCCP protect members for five HCCP groups:

```
interface c5/1/0
hccp 1 protect 1 10.10.10.1
hccp 1 channel-switch 1 rfswa rfswitch-group 10.10.10.10 44440400 1
hccp 1 protect 2 10.10.10.1
hccp 1 channel-switch 2 rfswa rfswitch-group 10.10.10.10 44440400 2
hccp 1 protect 3 10.10.10.1
hccp 1 channel-switch 3 rfswa rfswitch-group 10.10.10.10 44440400 3
hccp 1 protect 4 10.10.10.1
hccp 1 channel-switch 4 rfswa rfswitch-group 10.10.10.10 44440400 4
interface c5/1/1
hccp 2 protect 1 10.10.10.1
hccp 2 channel-switch 1 rfswa rfswitch-group 10.10.10.10 11110100 1
hccp 2 protect 2 10.10.10.1
hccp 2 channel-switch 2 rfswa rfswitch-group 10.10.10.10 11110100 2
hccp 2 protect 3 10.10.10.1
hccp 2 channel-switch 3 rfswa rfswitch-group 10.10.10.10 11110100 3
hccp 2 protect 4 10.10.10.1
hccp 2 channel-switch 4 rfswa rfswitch-group 10.10.10.10 11110100 4
interface c5/1/2
hccp 3 protect 1 10.10.10.1
hccp 3 channel-switch 1 rfswa rfswitch-group 10.10.10.10 00005000 1
hccp 3 channel-switch 1 rfswb rfswitch-group 10.10.10.10 0000a080 1
hccp 3 protect 2 10.10.10.1
hccp 3 channel-switch 2 rfswa rfswitch-group 10.10.10.10 00005000 2
hccp 3 channel-switch 2 rfswb rfswitch-group 10.10.10.10 0000a080 2
hccp 3 protect 3 10.10.10.1
hccp 3 channel-switch 3 rfswa rfswitch-group 10.10.10.10 00005000 3
hccp 3 channel-switch 3 rfswb rfswitch-group 10.10.10.10 0000a080 3
hccp 3 protect 4 10.10.10.1
hccp 3 channel-switch 4 rfswa rfswitch-group 10.10.10.10 00005000 4
hccp 3 channel-switch 4 rfswb rfswitch-group 10.10.10.10 0000a080 4
interface c5/1/3
hccp 4 protect 1 10.10.10.1
hccp 4 channel-switch 1 rfswb rfswitch-group 10.10.10.10 88880800 1
hccp 4 protect 2 10.10.10.1
hccp 4 channel-switch 2 rfswb rfswitch-group 10.10.10.10 88880800 2
hccp 4 protect 3 10.10.10.1
hccp 4 channel-switch 3 rfswb rfswitch-group 10.10.10.10 88880800 3
hccp 4 protect 4 10.10.10.1
hccp 4 channel-switch 4 rfswb rfswitch-group 10.10.10.10 88880800 4
interface c5/1/4
hccp 5 protect 1 10.10.10.1
hccp 5 channel-switch 1 rfswb rfswitch-group 10.10.10.10 22220200 1
hccp 5 protect 2 10.10.10.1
hccp 5 channel-switch 2 rfswb rfswitch-group 10.10.10.10 22220200 2
hccp 5 protect 3 10.10.10.1
hccp 5 channel-switch 3 rfswb rfswitch-group 10.10.10.10 22220200 3
hccp 5 protect 4 10.10.10.1
hccp 5 channel-switch 4 rfswb rfswitch-group 10.10.10.10 22220200 4
```

Example: Channel Switch Information from the Cisco uBR10012 Router

The following is a sample output of the show hccp channel-switch command that provides information about the channel switch activity with Global N+1 Line Card Redundancy:

```
Router# show hccp channel-switch
Grp 1 Mbr 70 Working channel-switch:
  "rfsw-2" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
  "rfsw-1" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
Grp 2 Mbr 70 Working channel-switch:
  "rfsw-2" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
  "rfsw-1" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
Grp 3 Mbr 70 Working channel-switch:
  "rfsw-2" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
```

```
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
  "rfsw-1" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
Grp 4 Mbr 70 Working channel-switch:
  "rfsw-2" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
  "rfsw-1" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
Grp 5 Mbr 70 Working channel-switch:
  "rfsw-2" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
  "rfsw-1" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
```

```
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
Grp 6 Mbr 70 Working channel-switch:
  "rfsw-2" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
  "rfsw-1" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
Grp 7 Mbr 70 Working channel-switch:
  "rfsw-2" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
  "rfsw-1" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
Grp 8 Mbr 70 Working channel-switch:
  "rfsw-2" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
```

```
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
  "rfsw-1" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
Grp 9 Mbr 70 Working channel-switch:
  "rfsw-2" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
  "rfsw-1" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
Grp 10 Mbr 70 Working channel-switch:
  "rfsw-2" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
  "rfsw-1" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
```

```
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
Grp 11 Mbr 70 Working channel-switch:
  "rfsw-2" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
  "rfsw-1" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
Grp 12 Mbr 70 Working channel-switch:
  "rfsw-2" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
  "rfsw-1" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
Grp 13 Mbr 70 Working channel-switch:
  "rfsw-2" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
```

```
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
  "rfsw-1" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
Grp 14 Mbr 70 Working channel-switch:
  "rfsw-2" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
  "rfsw-1" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
Grp 15 Mbr 70 Working channel-switch:
  "rfsw-2" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
  "rfsw-1" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
```

```
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
Grp 1 Mbr 80 Working channel-switch:
  "rfsw-2" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
  "rfsw-1" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
Grp 2 Mbr 80 Working channel-switch:
  "rfsw-2" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
  "rfsw-1" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
Grp 3 Mbr 80 Working channel-switch:
  "rfsw-2" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
```

```
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
  "rfsw-1" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
Grp 4 Mbr 80 Working channel-switch:
  "rfsw-2" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
  "rfsw-1" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
Grp 5 Mbr 80 Working channel-switch:
  "rfsw-2" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
  "rfsw-1" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
```

```
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
Grp 6 Mbr 80 Working channel-switch:
  "rfsw-2" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
  "rfsw-1" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
Grp 7 Mbr 80 Working channel-switch:
  "rfsw-2" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
  "rfsw-1" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
Grp 8 Mbr 80 Working channel-switch:
  "rfsw-2" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
```

```
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
  "rfsw-1" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
Grp 9 Mbr 80 Working channel-switch:
  "rfsw-2" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
  "rfsw-1" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
Grp 10 Mbr 80 Working channel-switch:
  "rfsw-2" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
  "rfsw-1" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
```

```
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
Grp 11 Mbr 80 Working channel-switch:
  "rfsw-2" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
  "rfsw-1" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
Grp 12 Mbr 80 Working channel-switch:
  "rfsw-2" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
  "rfsw-1" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
Grp 13 Mbr 80 Working channel-switch:
  "rfsw-2" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
```

```
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
  "rfsw-1" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
Grp 14 Mbr 80 Working channel-switch:
  "rfsw-2" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
  "rfsw-1" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
Grp 15 Mbr 80 Working channel-switch:
  "rfsw-2" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
  "rfsw-1" - Configured 10/3, Detected 10/3
    module 1  (Upstream)    normal
    module 2  (Upstream)    normal
    module 3  (Upstream)    normal
    module 4  (Upstream)    normal
    module 5  (Upstream)    normal
    module 6  (Upstream)    normal
    module 7  (Upstream)    normal
    module 8  (Upstream)    normal
    module 9  (Upstream)    normal
```

```
    module 10 (Upstream)    normal
    module 11 (Downstream)  normal
    module 12 (Downstream)  normal
    module 13 (Downstream)  normal
RFswitch relay test in 2w5d
RFswitch polling count = 2585/0
```

The following is a sample output of the show hccp channel-switch command that provides information about the channel switch activity with N+1 HCCP Redundancy:

```
Router# show hccp channel-switch
Grp 1 Mbr 1 Working channel-switch:
 "uc" - enabled, frequency 555000000 Hz
 "rfswitch" - module 1, normal
 module 3, normal
 module 5, normal
 module 7, normal
 module 11, normal
Grp 2 Mbr 1 Working channel-switch:
  "uc" - enabled, frequency 555000000 Hz
  "rfswitch" - module 2, normal
  module 4, normal
  module 6, normal
  module 9, normal
  module 13, normal
Grp 1 Mbr 7 Protect channel-switch:
 "uc" - disabled, frequency 555000000 Hz
 "rfswitch" - module 1, normal
 module 3, normal
 module 5, normal
 module 7, normal
 module 11, normal
Grp 1 Mbr 5 Protect channel-switch:
 "uc" - disabled, frequency 555000000 Hz
 "rfswitch" - module 1, normal
 module 3, normal
 module 5, normal
 module 7, normal
 module 11, normal
```

Example: Global N+1 Redundancy Using the Cisco uBR-MC3GX60V Line Card

The following output from the show run command illustrates the configuration of N+1 redundancy in remote learn DEPI mode on the Cisco CMTS router with two Cisco RF Switches, each in 7+1 mode, and Cisco uBR-MC3GX60V line cards:

Router# show run

```
!
On the Cisco CMTS router
!
card 5/1 ubr10k-clc-3g60 license 72X60
card 7/1 ubr10k-clc-3g60 license 72X60
card 8/1 ubr10k-clc-3g60 license 72X60
l2tp-class l2tp_class_gi7_1
!
l2tp-class l2tp_class_gi8_1
depi-class depi_class_gi7_1
 mode mpt
!
depi-class depi_class_gi8_1
 mode mpt
!
depi-tunnel gi7_1
 dest-ip 60.3.2.9
 l2tp-class l2tp_class_gi7_1
 depi-class depi_class_gi7_1
 protect-tunnel qam5_pt
```

```
!
depi-tunnel gi8_1
 dest-ip 60.3.2.13
 l2tp-class l2tp_class_gi8_1
 depi-class depi_class_gi8_1
 protect-tunnel qam5_pt
!
depi-tunnel qam5_pt
 dest-ip 60.6.2.13

redundancy
 linecard-group 1 cable
  rf-switch protection-mode 4+1
  rf-switch name 1 rfsw1
  member subslot 5/1 protect
  member subslot 7/1 working rfsw-slot 2
  member subslot 8/1 working rfsw-slot 3
  member subslot 5/1 protect config 7/1
  mode sso
!
controller Modular-Cable 7/1/0
 rf-channel 0 cable downstream channel-id 9
 rf-channel 0 frequency 303000000 annex B modulation 256qam interleave 32
 rf-channel 0 depi-tunnel gi7_1 tsid 38009
 rf-channel 0 rf-power 52.0
 no rf-channel 0 rf-shutdown
 rf-channel 1 cable downstream channel-id 10
 rf-channel 1 frequency 309000000 annex B modulation 256qam interleave 32
 rf-channel 1 depi-tunnel gi7_1 tsid 38010
 rf-channel 1 rf-power 52.0
 no rf-channel 1 rf-shutdown
 rf-channel 2 cable downstream channel-id 11
 rf-channel 2 frequency 315000000 annex B modulation 256qam interleave 32
 rf-channel 2 depi-tunnel gi7_1 tsid 38011
 rf-channel 2 rf-power 52.0
 no rf-channel 2 rf-shutdown
 rf-channel 3 cable downstream channel-id 12
 rf-channel 3 frequency 321000000 annex B modulation 256qam interleave 32
 rf-channel 3 depi-tunnel gi7_1 tsid 38012
 rf-channel 3 rf-power 52.0
 no rf-channel 3 rf-shutdown
 rf-channel 4 cable downstream channel-id 13
 rf-channel 4 frequency 327000000 annex B modulation 256qam interleave 32
 rf-channel 4 depi-tunnel gi7_1 tsid 38013
 rf-channel 4 rf-power 52.0
 no rf-channel 4 rf-shutdown
 rf-channel 5 cable downstream channel-id 14
 rf-channel 5 frequency 333000000 annex B modulation 256qam interleave 32
 rf-channel 5 depi-tunnel gi7_1 tsid 38014
 rf-channel 5 rf-power 52.0
 no rf-channel 5 rf-shutdown
 rf-channel 6 cable downstream channel-id 15
 rf-channel 6 frequency 339000000 annex B modulation 256qam interleave 32
 rf-channel 6 depi-tunnel gi7_1 tsid 38015
 rf-channel 6 rf-power 52.0
 no rf-channel 6 rf-shutdown
 rf-channel 7 cable downstream channel-id 16
 rf-channel 7 frequency 345000000 annex B modulation 256qam interleave 32
 rf-channel 7 depi-tunnel gi7_1 tsid 38016
 rf-channel 7 rf-power 52.0
 no rf-channel 7 rf-shutdown
 rf-channel 8 cable downstream channel-id 81
 rf-channel 9 cable downstream channel-id 82
 rf-channel 10 cable downstream channel-id 83
 rf-channel 11 cable downstream channel-id 84
 rf-channel 12 cable downstream channel-id 85
 rf-channel 13 cable downstream channel-id 86
 rf-channel 14 cable downstream channel-id 87
 rf-channel 15 cable downstream channel-id 88
 rf-channel 16 cable downstream channel-id 89
 rf-channel 17 cable downstream channel-id 90
 rf-channel 18 cable downstream channel-id 91
 rf-channel 19 cable downstream channel-id 92
```

```
 rf-channel 20 cable downstream channel-id 93
 rf-channel 21 cable downstream channel-id 94
 rf-channel 22 cable downstream channel-id 95
 rf-channel 23 cable downstream channel-id 96
!
controller Modular-Cable 8/1/0
 rf-channel 0 cable downstream channel-id 17
 rf-channel 0 frequency 351000000 annex B modulation 256qam interleave 32
 rf-channel 0 depi-tunnel gi8_1 tsid 38017
 no rf-channel 0 rf-shutdown
 rf-channel 1 cable downstream channel-id 18
 rf-channel 1 frequency 357000000 annex B modulation 256qam interleave 32
 rf-channel 1 depi-tunnel gi8_1 tsid 38018
 no rf-channel 1 rf-shutdown
 rf-channel 2 cable downstream channel-id 19
 rf-channel 2 frequency 363000000 annex B modulation 256qam interleave 32
 rf-channel 2 depi-tunnel gi8_1 tsid 38019
 no rf-channel 2 rf-shutdown
 rf-channel 3 cable downstream channel-id 20
 rf-channel 3 frequency 369000000 annex B modulation 256qam interleave 32
 rf-channel 3 depi-tunnel gi8_1 tsid 38020
 no rf-channel 3 rf-shutdown
 rf-channel 4 cable downstream channel-id 21
 rf-channel 4 frequency 375000000 annex B modulation 256qam interleave 32
 rf-channel 4 depi-tunnel gi8_1 tsid 38021
 no rf-channel 4 rf-shutdown
 rf-channel 5 cable downstream channel-id 22
 rf-channel 5 frequency 381000000 annex B modulation 256qam interleave 32
 rf-channel 5 depi-tunnel gi8_1 tsid 38022
 no rf-channel 5 rf-shutdown
 rf-channel 6 cable downstream channel-id 23
 rf-channel 6 frequency 387000000 annex B modulation 256qam interleave 32
 rf-channel 6 depi-tunnel gi8_1 tsid 38023
 no rf-channel 6 rf-shutdown
 rf-channel 7 cable downstream channel-id 24
 rf-channel 7 frequency 393000000 annex B modulation 256qam interleave 32
 rf-channel 7 depi-tunnel gi8_1 tsid 38024
 no rf-channel 7 rf-shutdown
 rf-channel 8 cable downstream channel-id 81
 rf-channel 9 cable downstream channel-id 82
 rf-channel 10 cable downstream channel-id 83
 rf-channel 11 cable downstream channel-id 84
 rf-channel 12 cable downstream channel-id 85
 rf-channel 13 cable downstream channel-id 86
 rf-channel 14 cable downstream channel-id 87
 rf-channel 15 cable downstream channel-id 88
 rf-channel 16 cable downstream channel-id 89
 rf-channel 17 cable downstream channel-id 90
 rf-channel 18 cable downstream channel-id 91
 rf-channel 19 cable downstream channel-id 92
 rf-channel 20 cable downstream channel-id 93
 rf-channel 21 cable downstream channel-id 94
 rf-channel 22 cable downstream channel-id 95
 rf-channel 23 cable downstream channel-id 96
!
interface Cable7/1/0
 downstream Modular-Cable 1/0/0 rf-channel 0 upstream 0-3
 downstream Modular-Cable 7/1/0 rf-channel 0 upstream 0-3
 cable mtc-mode
 no cable packet-cache
 cable bundle 1
 cable upstream max-ports 4
 cable upstream bonding-group 1
  upstream 0
  upstream 1
  upstream 2
  upstream 3
  attributes A0000000
 cable upstream 0 connector 0
 cable upstream 0 frequency 10000000
 cable upstream 0 channel-width 6400000 6400000
 cable upstream 0 docsis-mode atdma
 cable upstream 0 minislot-size 1
```

```
 cable upstream 0 range-backoff 3 6
 cable upstream 0 modulation-profile 221
 cable upstream 0 attribute-mask 20000000
 no cable upstream 0 shutdown
 cable upstream 1 connector 0
 cable upstream 1 frequency 16400000
 cable upstream 1 channel-width 6400000 6400000
 cable upstream 1 docsis-mode atdma
 cable upstream 1 minislot-size 1
 cable upstream 1 range-backoff 3 6
 cable upstream 1 modulation-profile 221
 cable upstream 1 attribute-mask 20000000
 no cable upstream 1 shutdown
 cable upstream 2 connector 0
 cable upstream 2 frequency 23800000
 cable upstream 2 channel-width 6400000 6400000
 cable upstream 2 docsis-mode atdma
 cable upstream 2 minislot-size 1
 cable upstream 2 range-backoff 3 6
 cable upstream 2 modulation-profile 221
 cable upstream 2 attribute-mask 20000000
 no cable upstream 2 shutdown
 cable upstream 3 connector 0
 cable upstream 3 frequency 30200000
 cable upstream 3 channel-width 6400000 6400000
 cable upstream 3 docsis-mode atdma
 cable upstream 3 minislot-size 1
 cable upstream 3 range-backoff 3 6
 cable upstream 3 modulation-profile 221
 cable upstream 3 attribute-mask 20000000
 no cable upstream 3 shutdown
!
interface GigabitEthernet7/1/0
 ip address 60.3.2.10 255.255.255.252
 negotiation auto
!
interface Modular-Cable7/1/0:0
 cable bundle 1
 cable rf-bandwidth-percent 36
!
interface Wideband-Cable7/1/0:3
 cable multicast-qos group 22
 cable multicast-qos group 21
 cable bundle 1
 cable rf-channel 0 bandwidth-percent 20
 cable rf-channel 1 bandwidth-percent 20
 cable rf-channel 2 bandwidth-percent 20
!
interface Wideband-Cable7/1/0:4
 cable multicast-qos group 22
 cable multicast-qos group 21
 cable bundle 1
 cable rf-channel 0 bandwidth-percent 20
 cable rf-channel 1 bandwidth-percent 20
 cable rf-channel 2 bandwidth-percent 20
 cable rf-channel 3 bandwidth-percent 20
!
interface Wideband-Cable7/1/0:8
 cable multicast-qos group 22
 cable multicast-qos group 21
 cable bundle 1
 cable rf-channel 0 bandwidth-percent 20
 cable rf-channel 1 bandwidth-percent 20
 cable rf-channel 2 bandwidth-percent 20
 cable rf-channel 3 bandwidth-percent 20
 cable rf-channel 4 bandwidth-percent 20
 cable rf-channel 5 bandwidth-percent 20
 cable rf-channel 6 bandwidth-percent 20
 cable rf-channel 7 bandwidth-percent 20
!
interface Cable8/1/0
 downstream Modular-Cable 1/0/0 rf-channel 1 upstream 0-3
 downstream Modular-Cable 8/1/0 rf-channel 0 upstream 0-3
```

```
 cable mtc-mode
 no cable packet-cache
 cable bundle 1
 cable upstream max-ports 4
 cable upstream bonding-group 1
  upstream 0
  upstream 1
  upstream 2
  upstream 3
  attributes A0000000
 cable upstream 0 connector 0
 cable upstream 0 frequency 10000000
 cable upstream 0 channel-width 6400000 6400000
 cable upstream 0 docsis-mode atdma
 cable upstream 0 minislot-size 1
 cable upstream 0 range-backoff 3 6
 cable upstream 0 modulation-profile 221
 cable upstream 0 attribute-mask 20000000
 no cable upstream 0 shutdown
 cable upstream 1 connector 0
 cable upstream 1 frequency 16400000
 cable upstream 1 channel-width 6400000 6400000
 cable upstream 1 docsis-mode atdma
 cable upstream 1 minislot-size 1
 cable upstream 1 range-backoff 3 6
 cable upstream 1 modulation-profile 221
 cable upstream 1 attribute-mask 20000000
 no cable upstream 1 shutdown
 cable upstream 2 connector 0
 cable upstream 2 frequency 23800000
 cable upstream 2 channel-width 6400000 6400000
 cable upstream 2 docsis-mode atdma
 cable upstream 2 minislot-size 1
 cable upstream 2 range-backoff 3 6
 cable upstream 2 modulation-profile 221
 cable upstream 2 attribute-mask 20000000
 no cable upstream 2 shutdown
 cable upstream 3 connector 0
 cable upstream 3 frequency 30200000
 cable upstream 3 channel-width 6400000 6400000
 cable upstream 3 docsis-mode atdma
 cable upstream 3 minislot-size 1
 cable upstream 3 range-backoff 3 6
 cable upstream 3 modulation-profile 221
 cable upstream 3 attribute-mask 20000000
 no cable upstream 3 shutdown
interface GigabitEthernet8/1/0
 ip address 60.3.2.14 255.255.255.252
 negotiation auto
!
interface Modular-Cable8/1/0:0
 cable bundle 1
 cable rf-bandwidth-percent 36
!
interface Wideband-Cable8/1/0:3
 cable multicast-qos group 22
 cable multicast-qos group 21
 cable bundle 1
 cable rf-channel 0 bandwidth-percent 20
 cable rf-channel 1 bandwidth-percent 20
 cable rf-channel 2 bandwidth-percent 20
!
interface Wideband-Cable8/1/0:4
 cable multicast-qos group 22
 cable multicast-qos group 21
 cable bundle 1
 cable rf-channel 0 bandwidth-percent 20
 cable rf-channel 1 bandwidth-percent 20
 cable rf-channel 2 bandwidth-percent 20
 cable rf-channel 3 bandwidth-percent 20
!
interface Wideband-Cable8/1/0:8
 cable multicast-qos group 22
```

```
 cable multicast-qos group 21
 cable bundle 1
 cable rf-channel 0 bandwidth-percent 20
 cable rf-channel 1 bandwidth-percent 20
 cable rf-channel 2 bandwidth-percent 20
 cable rf-channel 3 bandwidth-percent 20
 cable rf-channel 4 bandwidth-percent 20
 cable rf-channel 5 bandwidth-percent 20
 cable rf-channel 6 bandwidth-percent 20
 cable rf-channel 7 bandwidth-percent 20
!
interface Bundle1
 ip address 30.0.42.1 255.255.255.0 secondary
 ip address 30.0.43.254 255.255.255.0 secondary
 ip address 30.0.44.254 255.255.255.0 secondary
 ip address 30.0.41.1 255.255.255.0
 ip pim sparse-mode
 ip igmp version 3
 cable arp filter request-send 3 2
 cable arp filter reply-accept 3 2
 cable dhcp-giaddr policy
 cable helper-address 20.1.0.9
!
On the Cisco RF Switch
!
l2tp-class l2tp_class_gi7_1
l2tp-class l2tp_class_gi8_1
depi-class depi_class_gi7_1
 mode mpt
depi-class depi_class_gi8_1
 mode mpt
depi-tunnel gi8_1
 dest-ip 60.3.2.14
 l2tp-class l2tp_class_gi8_1
 depi-class depi_class_gi8_1
 protect-tunnel qam5_pt
!
depi-tunnel gi7_1
 dest-ip 60.3.2.10
 l2tp-class l2tp_class_gi7_1
 depi-class depi_class_gi7_1
 protect-tunnel qam5_pt
!
depi-tunnel qam5_pt
 dest-ip 60.6.2.14
interface GigabitEthernet5/14
 no switchport
 ip address 60.3.2.9 255.255.255.252 secondary
 ip address 60.3.2.13 255.255.255.252
 no ip redirects
!
interface Qam5/3.1
 cable mode depi remote learn
 cable downstream tsid 38009
 depi depi-tunnel gi7_1
!
interface Qam5/3.2
 cable mode depi remote learn
 cable downstream tsid 38010
 depi depi-tunnel gi7_1
!
interface Qam5/3.3
 cable mode depi remote learn
 cable downstream tsid 38011
 depi depi-tunnel gi7_1
!
interface Qam5/3.4
 cable mode depi remote learn
 cable downstream tsid 38012
 depi depi-tunnel gi7_1
!
interface Qam3/5.1
 cable mode depi remote learn
```

```
 cable downstream tsid 38013
 depi depi-tunnel gi7_1
!
interface Qam3/5.2
 cable mode depi remote learn
 cable downstream tsid 38014
 depi depi-tunnel gi7_1
!
interface Qam3/5.3
 cable mode depi remote learn
 cable downstream tsid 38015
 depi depi-tunnel gi7_1
!
interface Qam3/5.4
 cable mode depi remote learn
 cable downstream tsid 38016
 depi depi-tunnel gi7_1
!
interface Qam5/1
 no ip address
!
interface Qam5/1.1
 cable mode depi remote learn
 cable downstream tsid 38017
 depi depi-tunnel gi8_1
!
interface Qam5/1.2
 cable mode depi remote learn
 cable downstream tsid 38018
 depi depi-tunnel gi8_1
!
interface Qam5/1.3
 cable mode depi remote learn
 cable downstream tsid 38019
 depi depi-tunnel gi8_1
!
interface Qam5/1.4
 cable mode depi remote learn
 cable downstream tsid 38020
 depi depi-tunnel gi8_1
!
interface Qam5/2
 no ip address
!
interface Qam5/2.1
 cable mode depi remote learn
 cable downstream tsid 38021
 depi depi-tunnel gi8_1
!
interface Qam5/2.2
 cable mode depi remote learn
 cable downstream tsid 38022
 depi depi-tunnel gi8_1
!
interface Qam5/2.3
 cable mode depi remote learn
 cable downstream tsid 38023
 depi depi-tunnel gi8_1
!
interface Qam5/2.4
 cable mode depi remote learn
 cable downstream tsid 38024
 depi depi-tunnel gi8_1
!
```

Example: Global N+1 Redundancy Using the Cisco UBR10-MC5X20 Line Card

The following output from the show run command illustrates configuration of N+1 redundancy on the Cisco CMTS router with two Cisco RF Switches, each in 7+1 mode, and Cisco UBR10-MC 5X20 line cards:

```
Router# show run
Current configuration : 8567 bytes
!
version 12.2
no parser cache
no service single-slot-reload-enable
no service pad
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname uBR10k
!
boot system flash slot0: ubr10k-k8p6-mz.122-15.BC1
logging rate-limit console all 10 except critical
enable secret 5 $1$.Dvy$fcPOhshUNjyfePH73FHRG
cable modulation-profile 21 request 0 16 0 22 qpsk scrambler 152 no-diff 32 fixed
cable modulation-profile 21 initial 5 34 0 48 qpsk scrambler 152 no-diff 64 fixed
cable modulation-profile 21 station 5 34 0 48 qpsk scrambler 152 no-diff 64 fixed
cable modulation-profile 21 short 3 76 12 22 qpsk scrambler 152 no-diff 64 shortened
cable modulation-profile 21 long 7 231 0 22 qpsk scrambler 152 no-diff 64 shortened
cable modulation-profile 22 request 0 16 0 22 qpsk scrambler 152 no-diff 32 fixed
cable modulation-profile 22 initial 5 34 0 48 qpsk scrambler 152 no-diff 64 fixed
cable modulation-profile 22 station 5 34 0 48 qpsk scrambler 152 no-diff 64 fixed
cable modulation-profile 22 short 4 76 7 22 16qam scrambler 152 no-diff 128 shortened
cable modulation-profile 22 long 7 231 0 22 16qam scrambler 152 no-diff 128 shortened
!
!  Use this modulation profile if using current released BC3 IOS and 16-QAM is required.
!  A-TDMA IOS has different modulation profiles and requirements.
!
no cable qos permission create
no cable qos permission update
cable qos permission modems
cable time-server
!
cable config-file docsis.cm
 frequency 453000000
 service-class 1 max-upstream 10000
 service-class 1 max-downstream 10000
 service-class 1 max-burst 1522
!
redundancy
  main-cpu
    auto-sync standard
facility-alarm intake-temperature major 49
facility-alarm intake-temperature minor 40
facility-alarm core-temperature major 53
facility-alarm core-temperature minor 45
card 1/0 1gigethernet-1
card 1/1 2cable-tccplus
card 2/0 1gigethernet-1
card 2/1 2cable-tccplus
card 5/0 5cable-mc520s-d
card 5/1 5cable-mc520s-d
card 6/0 5cable-mc520s-d
card 6/1 5cable-mc520s-d
card 7/0 5cable-mc520s-d
card 7/1 5cable-mc520s-d
card 8/0 5cable-mc520s-d
card 8/1 5cable-mc520s-d
ip subnet-zero
ip host rfswitch 2001 10.10.10.1
!
!  This is set for console access from the 10012 router to the Switch.
```

```
!  The IP address is for Loopback0.
!
ip dhcp pool MODEMS1
   network 172.25.1.0 255.255.255.0
   bootfile docsis.cm
   next-server 172.25.1.1
   default-router 172.25.1.1
   option 7 ip 172.25.1.1
   option 4 ip 172.25.1.1
   option 2 hex 0000.0000
   lease 2 3 4
!
ip dhcp pool MODEMS2
   network 172.25.2.0 255.255.255.0
   bootfile docsis.cm
   next-server 172.25.2.1
   default-router 172.25.2.1
   option 7 ip 172.25.2.1
   option 4 ip 172.25.2.1
   option 2 hex 0000.0000
   lease 2 3 4
!
ip dhcp-client network-discovery informs 2 discovers 2 period 15
!
!  An internal DHCP server is used in this example instead of external servers
!  (cable helper, TOD, TFTP, etc.).  External servers are recommended in a genuine
!  production network.
!
interface Loopback0
 ip address 10.10.10.1 255.255.255.252
!
interface FastEthernet0/0/0
 ip address 10.97.1.8 255.255.255.0
 ip rip receive version 2
 no ip split-horizon
 no keepalive
!
interface GigabitEthernet1/0/0
 no ip address
 negotiation auto
!
interface GigabitEthernet2/0/0
 no ip address
 negotiation auto
!
!  Sample Interface Config for N+1: (This assumes rfsw2 is on the top as shown in
!  the RF Switch Cabling document).  Other interfaces will be the same except a
!  different member number for each HCCP group.
!
interface Cable5/1/0
!
!  This is the Protect interface for the first HCCP group.  It may be best to configure
!  the Protect interface(s) last; after the Working interfaces are configured,
!  or to keep the interface "shut" (disabled) until all configurations are completed.
!
 no ip address
!
!  There is no need to set the IP address because it comes from the Working card via SNMP.
!
 no keepalive
!
!  This is defaulted to 10 seconds with the N+1 IOS code, but should be disabled on
!  the Protect interface or set relatively high.
!
 cable downstream annex B
 cable downstream modulation 64qam
 cable downstream interleave-depth 32
!
!  The DS modulation and Interleave must be the same on the Protect and Working interfaces
 !  of the same HCCP group. The Protect interface itself must be "no shut" (enabled)
!  for HCCP to activate
!
 cable downstream rf-shutdown
```

```
 cable upstream 0 shutdown
!
!  These interfaces automatically become "no shut" (enabled) when a switchover occurs.
!
 cable upstream 1 shutdown
 cable upstream 2 shutdown
 cable upstream 3 shutdown
 hccp 1 protect 1 10.10.10.1
!
!  This is the first HCCP group and it is protecting member 1 with member 1's
!  FE IP address.  If it is intra-chassis, you can use the Loopback0 IP address.
!
 hccp 1 channel-switch 1 rfsw2 rfswitch-group 10.97.1.20 AA200000 1
!
!  This is the IP address of the RF Switch and it is protecting member 1, which
!  has a bitmap of AA200000 in Switch slot 1.
!
 hccp 1 protect 2 10.10.10.1
!
!  This is the first HCCP group and it is protecting member 2 with the loopback
!  IP address.
!
 hccp 1 channel-switch 2 rfsw2 rfswitch-group 10.97.1.20 AA200000 2
!
!  This is the IP address of the RF Switch and it is protecting member 2, with a
!  bitmap of AA200000 in Switch slot 2.
!
 hccp 1 protect 3 10.10.10.1
 hccp 1 channel-switch 3 rfsw2 rfswitch-group 10.97.1.20 AA200000 3
 hccp 1 protect 4 10.10.10.1
 hccp 1 channel-switch 4 rfsw2 rfswitch-group 10.97.1.20 AA200000 4
 hccp 1 protect 5 10.10.10.1
 hccp 1 channel-switch 5 rfsw2 rfswitch-group 10.97.1.20 AA200000 5
 hccp 1 protect 6 10.10.10.1
 hccp 1 channel-switch 6 rfsw2 rfswitch-group 10.97.1.20 AA200000 6
 hccp 1 protect 7 10.10.10.1
 hccp 1 channel-switch 7 rfsw2 rfswitch-group 10.97.1.20 AA200000 7
!
!  These channel-switch configurations can be copied and pasted into their respective
!  Working interfaces.
!
 hccp 1 timers 5000 15000
!
!  Cisco IOS command = hccp 1 timers <hellotime> <holdtime>
!  This is mostly for inter-chassis communication, so set it high for the uBR10012
!  as this can create extra CPU load.
!
 no hccp 1 revertive
!
interface Cable5/1/1
!
!  This is the Protect interface for the second group.
!
 no ip address
 no keepalive
 cable downstream annex B
 cable downstream modulation 64qam
 cable downstream interleave-depth 32
 cable downstream rf-shutdown
 cable upstream 0 shutdown
 cable upstream 1 shutdown
 cable upstream 2 shutdown
 cable upstream 3 shutdown
 !
 hccp 2 protect 1 10.10.10.1
 hccp 2 channel-switch 1 rfsw2 rfswitch-group 10.97.1.20 55100000 1
!
!  Because this MAC domain is on right side of header, the bitmap in
!  hexadecimal code is 55100000.
!
 hccp 2 protect 2 10.10.10.1
 hccp 2 channel-switch 2 rfsw2 rfswitch-group 10.97.1.20 55100000 2
 hccp 2 protect 3 10.10.10.1
```

```
 hccp 2 channel-switch 3 rfsw2 rfswitch-group 10.97.1.20 55100000 3
 hccp 2 protect 4 10.10.10.1
 hccp 2 channel-switch 4 rfsw2 rfswitch-group 10.97.1.20 55100000 4
 hccp 2 protect 5 10.10.10.1
 hccp 2 channel-switch 5 rfsw2 rfswitch-group 10.97.1.20 55100000 5
 hccp 2 protect 6 10.10.10.1
 hccp 2 channel-switch 6 rfsw2 rfswitch-group 10.97.1.20 55100000 6
 hccp 2 protect 7 10.10.10.1
 hccp 2 channel-switch 7 rfsw2 rfswitch-group 10.97.1.20 55100000 7
 hccp 2 timers 5000 15000
 no hccp 2 revertive
interface Cable5/1/2
!
!  This is the Protect interface for the third group.
!
 no ip address
 no keepalive
 cable downstream annex B
 cable downstream modulation 64qam
 cable downstream interleave-depth 32
 cable downstream rf-shutdown
 cable upstream 0 shutdown
 cable upstream 1 shutdown
 cable upstream 2 shutdown
 cable upstream 3 shutdown
 hccp 3 protect 1 10.10.10.1
 hccp 3 channel-switch 1 rfsw1 rfswitch-group 10.97.1.19 00C80000 1
 hccp 3 channel-switch 1 rfsw2 rfswitch-group 10.97.1.20 00C00000 1
!
!  Because the third MAC domain will traverse both Switches, two statements are needed.
!  The "00" in front of the bitmaps are dropped when viewing the running configuration.
!
 no hccp 3 revertive
interface Cable5/1/3
!
!  This is the Protect interface for the fourth group.
!
 hccp 4 protect 1 10.10.10.1
 hccp 4 channel-switch 1 rfsw1 rfswitch-group 10.97.1.19 AA200000 1
 hccp 4 protect 2 10.10.10.1
 hccp 4 channel-switch 2 rfsw1 rfswitch-group 10.97.1. 19 AA200000 2
 hccp 4 protect 3 10.10.10.1
 hccp 4 channel-switch 3 rfsw1 rfswitch-group 10.97.1. 19 AA200000 3
 hccp 4 protect 4 10.10.10.1
 hccp 4 channel-switch 4 rfsw1 rfswitch-group 10.97.1. 19 AA200000 4
 hccp 4 protect 5 10.10.10.1
 hccp 4 channel-switch 5 rfsw1 rfswitch-group 10.97.1. 19 AA200000 5
 hccp 4 protect 6 10.10.10.1
 hccp 4 channel-switch 6 rfsw1 rfswitch-group 10.97.1. 19 AA200000 6
 hccp 4 protect 7 10.10.10.1
 hccp 4 channel-switch 7 rfsw1 rfswitch-group 10.97.1. 19 AA200000 7
 no hccp 4 revertive
.
interface Cable5/1/4
!
!  This is the Protect interface for the fifth group.
!
 hccp 5 protect 1 10.10.10.1
 hccp 5 channel-switch 1 rfsw1 rfswitch-group 10.97.1.19 55100000 1
 hccp 5 protect 2 10.10.10.1
 hccp 5 channel-switch 2 rfsw1 rfswitch-group 10.97.1. 19 55100000 2
 hccp 5 protect 3 10.10.10.1
 hccp 5 channel-switch 3 rfsw1 rfswitch-group 10.97.1. 19 55100000 3
 hccp 5 protect 4 10.10.10.1
 hccp 5 channel-switch 4 rfsw1 rfswitch-group 10.97.1. 19 55100000 4
 hccp 5 protect 5 10.10.10.1
 hccp 5 channel-switch 5 rfsw1 rfswitch-group 10.97.1. 19 55100000 5
 hccp 5 protect 6 10.10.10.1
 hccp 5 channel-switch 6 rfsw1 rfswitch-group 10.97.1. 19 55100000 6
 hccp 5 protect 7 10.10.10.1
 hccp 5 channel-switch 7 rfsw1 rfswitch-group 10.97.1. 19 55100000 7
.
.
```

```
.
!  Interface configurations continue as such for the remaining Protect interfaces.
!
interface Cable8/1/0
!
!  This is the Working interface for the first group.
!
 ip address 10.192.5.1 255.255.255.0 secondary
 ip address 172.25.1.1 255.255.255.0
!
!  Interface bundling is supported as are subinterfaces.
!
 ip rip send version 2
 ip rip receive version 2
 keepalive 1
!
!  The keepalive time is in seconds and the default is 10 seconds for HCCP code.
!  Only set this value after modems have stabilized.
!
 cable downstream annex B
 cable downstream modulation 64qam
 cable downstream interleave-depth 32
 cable downstream frequency 453000000
!
!  This is the DS frequency, which must be set for the internal upconverter to operate.
!
 cable downstream channel-id 0
 no cable downstream rf-shutdown
!
!  This is needed to turn on the DS RF output.
!
 cable upstream 0 frequency 24000000
!
!  If doing dense mode combining, the upstream frequencies will need to be different.
!  If no two US ports are shared, the same frequency can be used.
!
 cable upstream 0 power-level 0
 cable upstream 0 connector 0
!
cable upstream 0 channel-width 3200000
 cable upstream 0 minislot-size 2
 cable upstream 0 modulation-profile 22
 no cable upstream 0 shutdown
.
.
.
 cable dhcp-giaddr policy
!
!  This tells cable modems to get an IP address from the primary scope and CPEs to use
!  the secondary scope.
!
 hccp 1 working 1
!
!  This is Working member 1 of HCCP Group 1.
!
hccp 1 channel-switch 1 rfsw2 rfswitch-group 10.97.1.20 AA200000 1
!
!  This is the IP address of Switch & member 1, which has a bitmap of
!  AA200000 in Switch slot 1.
!
 hccp 1 reverttime 120
!
!  This is the time in minutes (+ 2 minute suspend) for the card to switch back to
!  normal mode if the fault has cleared.  If a fault was initiated by a keepalive
!  and you had a fault on the Protect card, it would revert back after the suspend
!  time and not wait the full revert time.
!
interface Cable8/1/1
!
!  This is the Working interface for the second HCCP group.
!
 ip address 10.192.5.1 255.255.255.0 secondary
 ip address 172.25.2.1 255.255.255.0
```

```
 ip rip send version 2
 ip rip receive version 2
 keepalive 1
 cable downstream annex B
 cable downstream modulation 64qam
 cable downstream interleave-depth 32
 cable downstream frequency 453000000
 cable downstream channel-id 1
 no cable downstream rf-shutdown
 cable upstream 0 frequency 24000000
 cable upstream 0 power-level 0
 cable upstream 0 connector 4
 cable upstream 0 channel-width 3200000
 cable upstream 0 minislot-size 22
 cable upstream 0 modulation-profile 2
 no cable upstream 0 shutdown
.
.
.
 cable dhcp-giaddr policy
 hccp 2 working 1
!
!  This is Working member 1 of HCCP Group 2.
!
 hccp 2 channel-switch 1 rfsw2 rfswitch-group 10.97.1.20 55100000 1
!
!  This is the IP address of Switch & Member 1 of Group 2, which has a bitmap of
!  55100000 in Switch slot 1.
!
 hccp 2 reverttime 120
!
interface Cable8/1/2
!
!  This is the Working interface for the third HCCP group.
!
 ip address 10.192.5.1 255.255.255.0 secondary
 ip address 172.25.3.1 255.255.255.0
 ip rip send version 2
 ip rip receive version 2
 keepalive 1
 cable downstream annex B
 cable downstream modulation 64qam
 cable downstream interleave-depth 32
 cable downstream frequency 453000000
 cable downstream channel-id 2
 no cable downstream rf-shutdown
 cable upstream 0 frequency 24000000
 cable upstream 0 power-level 0
 cable upstream 0 connector 8
 cable upstream 0 channel-width 3200000
 cable upstream 0 minislot-size 2
 cable upstream 0 modulation-profile 22
 no cable upstream 0 shutdown
 cable dhcp-giaddr policy
.
.
.
 hccp 3 working 1
!
!  This is the Working member 1 of HCCP Group 3.
!
 hccp 3 channel-switch 1 rfsw1 rfswitch-group 10.97.1.19 00c80000 1
 hccp 3 channel-switch 1 rfsw2 rfswitch-group 10. 97.1.20 00c00000 1
 hccp 3 reverttime 120
interface Cable8/1/3
!
!  This is the Working interface for the fourth HCCP group.
!
 hccp 4 working 1
 hccp 4 channel-switch 1 rfsw1 rfswitch-group 10.97.1.19 AA200000 1
 hccp 4 reverttime 120
interface Cable8/1/4
!
```

```
!  This is the Working interface for the fifth HCCP group.
!
 hccp 5 working 1
 hccp 5 channel-switch 1 rfsw1 rfswitch-group 10.97.1.19 55100000 1
 hccp 5 reverttime 120
!
ip classless
no ip http server
!
no cdp run
snmp-server community private RW
!
!  This does not affect the HCCP communications between the Switch and uBR10012.
!
snmp-server enable traps cable
no cdp run
snmp-server manager
tftp-server server
tftp-server ios.cf alias ios.cf
!
alias exec t configure terminal
alias exec scm show cable modem
alias exec scr sh cab mode remote
alias exec shb sh hccp br
alias exec shd sh hccp detail
alias exec shc sh hccp chan
!
line con 0
 logging synchronous
line aux 0
 no exec
 transport input all
!
!  The three lines above were used to console from the Auxiliary port of the uBR10012
!  to the Switch.
!
line vty 0 4
 session-timeout 400
 password xx
 login
endBuilding configuration...
```

Example: Global N+1 Redundancy Using the Cisco UBR10-LCP2-MC28C Line Card

The following output from the show run command illustrates configuration of N+1 redundancy on the Cisco CMTS router with two Cisco RF Switches, each in 7+1 mode, and Cisco UBR10-LCP2-MC28C line cards:

```
Router# show run
Current configuration : 8567 bytes
!
version 12.2
no parser cache
no service single-slot-reload-enable
no service pad
service timestamps debug uptime
service timestamps log uptime
no service password-encryption
!
hostname uBR10k
!
boot system flash slot0: ubr10k-k8p6-mz.122-4.BC1b
logging rate-limit console all 10 except critical
enable secret 5 $1$.Dvy$fcPOhshUNjyfePH73FHRG.
!
no cable qos permission create
no cable qos permission update
```

```
cable qos permission modems
cable time-server
!
cable config-file docsis.cm
 frequency 453000000
 service-class 1 max-upstream 10000
 service-class 1 max-downstream 10000
 service-class 1 max-burst 1522
!
redundancy
  main-cpu
    auto-sync standard
facility-alarm intake-temperature major 49
facility-alarm intake-temperature minor 40
facility-alarm core-temperature major 53
facility-alarm core-temperature minor 45
card 1/0 1gigethernet-1
card 1/1 2cable-tccplus
card 2/0 1gigethernet-1
card 2/1 2cable-tccplus
card 5/0 2cable-mc28c
card 5/1 2cable-mc28c
card 6/0 2cable-mc28c
card 6/1 2cable-mc28c
card 7/0 2cable-mc28c
card 7/1 2cable-mc28c
card 8/0 2cable-mc28c
card 8/1 2cable-mc28c
ip subnet-zero
ip host rfswitch 2001 10.10.10.1
!
!  This is set for console access from the uBR10012 router to the RF Switch.
!  The IP address is for Loopback0.
!
ip dhcp pool MODEMS1
   network 172.25.1.0 255.255.255.0
   bootfile docsis.cm
   next-server 172.25.1.1
   default-router 172.25.1.1
   option 7 ip 172.25.1.1
   option 4 ip 172.25.1.1
   option 2 hex 0000.0000
   lease 2 3 4
!
ip dhcp pool MODEMS2
   network 172.25.2.0 255.255.255.0
   bootfile docsis.cm
   next-server 172.25.2.1
   default-router 172.25.2.1
   option 7 ip 172.25.2.1
   option 4 ip 172.25.2.1
   option 2 hex 0000.0000
   lease 2 3 4
!
ip dhcp-client network-discovery informs 2 discovers 2 period 15
!
!  An internal DHCP server was used for testing in this example instead of external
!  servers (cable helper, TOD, TFTP, etc.).  External servers are recommended in a
!  genuine production network.
!
interface Loopback0
 ip address 10.10.10.1 255.255.255.252
!
interface FastEthernet0/0/0
 ip address 10.97.1.8 255.255.255.0
 ip rip receive version 2
 no ip split-horizon
 no keepalive
!
interface GigabitEthernet1/0/0
 no ip address
 negotiation auto
!
```

```
interface GigabitEthernet2/0/0
 no ip address
 negotiation auto
!
interface Cable5/1/0
!
!  This is the Protect interface for the first group.  Remember to configure the
!  Protect interface(s) last; after the Working interfaces are configured.
!
 no ip address
!
!  There is no need to set the IP address because it comes from the Working card via SNMP.
!
 no keepalive
!
!  This is set by default to 10 seconds with the N+1 IOS code, but should be disabled
!  on the Protect interface or set to be relatively high.
!
 cable downstream annex B
 cable downstream modulation 64qam
 cable downstream interleave-depth 32
!
!  The DS modulation and Interleave depth must be same on Protect and Working interfaces
!  of the same group.
!
 cable upstream 0 shutdown
!
!  This automatically becomes "no shut" (enabled) when a switchover occurs.
!
 cable upstream 1 shutdown
 cable upstream 2 shutdown
 cable upstream 3 shutdown
 cable dhcp-giaddr policy
 hccp 1 protect 1 10.10.10.1
!
!  This is the HCCP first group and it is protecting member 1 with member 1's
!  FE IP address.  If it's intra-chassis, you can use the Loopback0 IP address.
!
 hccp 1 channel-switch 1 uc wavecom-hd 10.97.1.21 2 10.97.1.21 16
!
!  This is the IP address of upconverter and its module 2 (B) that is backing
!  module 16 (P) of the upconverter.  This shows that one upconverter could have
!  a module backing up a module in a different chassis with a different IP address
!  if need be.  If this statement is not present when using 15BC2 IOS and above,
!  IF-Muting is assumed and an external upconverter with snmp capability is not needed.
!
 hccp 1 channel-switch 1 rfswitch rfswitch-group 10.97.1.20 AA200000 1
!
!  This is the IP address of the Switch and it is protecting member 1, which has a
!  bitmap of AA200000 in Switch slot 1.
!
 hccp 1 protect 2 10.10.10.1
!
!  This is the HCCP first group and it is protecting member 2 with its IP address.
!
 hccp 1 channel-switch 2 uc wavecom-hd 10.97.1.21 2 10.97.1.21 14
!
!  This is the IP address of the upconverter and its module 2 (B) that's backing
!  module 14 (N).
!
 hccp 1 channel-switch 2 rfswitch rfswitch-group 10.97.1.20 AA200000 2
!
!  This is the IP address of the Switch and it is protecting member 2, with a
!  bitmap of AA200000 in Switch slot 2.
!
 hccp 1 protect 3 10.10.10.1
 hccp 1 channel-switch 3 uc wavecom-hd 10.97.1.21 2 10.97.1.21 12
 hccp 1 channel-switch 3 rfswitch rfswitch-group 10.97.1.20 AA200000 3
 hccp 1 protect 4 10.10.10.1
 hccp 1 channel-switch 4 uc wavecom-hd 10.97.1.21 2 10.97.1.21 10
 hccp 1 channel-switch 4 rfswitch rfswitch-group 10.97.1.20 AA200000 4
 hccp 1 protect 5 10.10.10.1
 hccp 1 channel-switch 5 uc wavecom-hd 10.97.1.21 2 10.97.1.21 8
```

```
 hccp 1 channel-switch 5 rfswitch rfswitch-group 10.97.1.20 AA200000 5
 hccp 1 protect 6 10.10.10.1
 hccp 1 channel-switch 6 uc wavecom-hd 10.97.1.21 2 10.97.1.21 6
 hccp 1 channel-switch 6 rfswitch rfswitch-group 10.97.1.20 AA200000 6
 hccp 1 protect 7 10.10.10.1
 hccp 1 channel-switch 7 uc wavecom-hd 10.97.1.21 2 10.97.1.21 4
 hccp 1 channel-switch 7 rfswitch rfswitch-group 10.97.1.20 AA200000 7
 hccp 1 timers 5000 15000
!
!  Cisco IOS command = hccp 1 timers <hellotime> <holdtime>
!  This is mostly for inter-chassis communication, so set it high for the uBR10012 router
!  as this can create extra CPU load.
!
interface Cable5/1/1
!
!  This is the Protect interface for the second group.
!
 no ip address
 no keepalive
 cable downstream annex B
 cable downstream modulation 64qam
 cable downstream interleave-depth 32
 cable upstream 0 shutdown
 cable upstream 1 shutdown
 cable upstream 2 shutdown
 cable upstream 3 shutdown
 cable dhcp-giaddr policy
!
 hccp 2 protect 1 10.10.10.1
 hccp 2 channel-switch 1 uc wavecom-hd 10.97.1.21 1 10.97.1.21 15
 hccp 2 channel-switch 1 rfswitch rfswitch-group 10.97.1.20 55100000 1
!
!  Because this MAC domain is on right side of header, the bitmap in hexadecimal code
!  is 55100000.
!
 hccp 2 protect 2 10.10.10.1
 hccp 2 channel-switch 2 uc wavecom-hd 10.97.1.21 1 10.97.1.21 13
 hccp 2 channel-switch 2 rfswitch rfswitch-group 10.97.1.20 55100000 2
 hccp 2 protect 3 10.10.10.1
 hccp 2 channel-switch 3 uc wavecom-hd 10.97.1.21 1 10.97.1.21 11
 hccp 2 channel-switch 3 rfswitch rfswitch-group 10.97.1.20 55100000 3
 hccp 2 protect 4 10.10.10.1
 hccp 2 channel-switch 4 uc wavecom-hd 10.97.1.21 1 10.97.1.21 9
 hccp 2 channel-switch 4 rfswitch rfswitch-group 10.97.1.20 55100000 4
 hccp 2 protect 5 10.10.10.1
 hccp 2 channel-switch 5 uc wavecom-hd 10.97.1.21 1 10.97.1.21 7
 hccp 2 channel-switch 5 rfswitch rfswitch-group 10.97.1.20 55100000 5
 hccp 2 protect 6 10.10.10.1
 hccp 2 channel-switch 6 uc wavecom-hd 10.97.1.21 1 10.97.1.21 5
 hccp 2 channel-switch 6 rfswitch rfswitch- group 10.97.1.20 55100000 6
 hccp 2 protect 7 10.10.10.1
 hccp 2 channel-switch 7 uc wavecom-hd 10.97.1.21 1 10.97.1.21 3
 hccp 2 channel-switch 7 rfswitch rfswitch-group 10.97.1.20 55100000 7
 hccp 2 timers 5000 15000
!
interface Cable8/1/0
!
!  This is the Working interface for the first group.
!
 ip address 10.192.5.1 255.255.255.0 secondary
 ip address 172.25.1.1 255.255.255.0
!
!  Interface bundling is supported also as well as subinterfaces.
!
 ip rip send version 2
 ip rip receive version 2
 keepalive 1
!
!  The keepalive time is in seconds and the default is 10 seconds for HCCP code.
!
 cable downstream annex B
 cable downstream modulation 64qam
 cable downstream interleave-depth 32
```

```
 cable downstream frequency 453000000
!
!  This is DS frequency, which used to be informational only when using an external
!  upconverter.  This must be set when doing N+1, so the Protect upconverter knows
!  which frequency to use.
!
 cable upstream 0 frequency 24000000
!
!  If doing dense mode combining, the upstream frequencies need to be different.
!  If no two US ports are shared, the same frequency can be used.
!
 cable upstream 0 power-level 0
 no cable upstream 0 shutdown
 cable upstream 1 power-level 0
 cable upstream 1 shutdown
 cable upstream 2 power-level 0
 cable upstream 2 shutdown
 cable upstream 3 power-level 0
 cable upstream 3 shutdown
 cable dhcp-giaddr policy
!
!  This tells cable modems to get an IP address from the primary scope and CPEs
!  to use the secondary scope.
!
 hccp 1 working 1
!
!  This is Working member 1 of HCCP Group 1.
!
 hccp 1 channel-switch 1 uc wavecom-hd 10.97.1.21 2 10.97.1.21 16
!
!  This is the IP address of the upconverter and its module 2 (B) that's backing
!  module 16 (P).
!
 hccp 1 channel-switch 1 rfswitch rfswitch-group 10.97.1.20 AA200000 1
!
!  This is the IP address of the Switch & member 1, which has a bitmap of
!  AA200000 in Switch slot 1.
!
 hccp 1 reverttime 120
!
!  This is the time in minutes (+ 2 minute suspend) for the card to switch back to
!  normal mode if the fault has cleared.  If a fault was initiated by a keepalive
!  and you had a fault on the Protect card, it would revert back after the suspend
!  time and not await the full revert time.
!
interface Cable8/1/1
!
!  This is the Working interface for the second HCCP group.
!
 ip address 10.192.5.1 255.255.255.0 secondary
 ip address 172.25.2.1 255.255.255.0
 ip rip send version 2
 ip rip receive version 2
 keepalive 1
 cable downstream annex B
 cable downstream modulation 64qam
 cable downstream interleave-depth 32
 cable downstream frequency 453000000
 cable upstream 0 frequency 24000000
 cable upstream 0 power-level 0
 no cable upstream 0 shutdown
 cable upstream 1 power-level 0
 cable upstream 1 shutdown
 cable upstream 2 power-level 0
 cable upstream 2 shutdown
 cable upstream 3 power-level 0
 cable upstream 3 shutdown
 cable dhcp-giaddr policy
 hccp 2 working 1
!
!  This is Working member 1 of HCCP Group 2.
!
 hccp 2 channel-switch 1 uc wavecom-hd 10.97.1.21 1 10.97.1.21 15
```

```
 hccp 2 channel-switch 1 rfswitch rfswitch-group 10.97.1.20 55100000 1
!
!  This is the IP address of the Switch & Member 1 of Group 2, which has a bitmap of
!  55100000 in Switch slot 1.
!
 hccp 2 reverttime 120
!
ip classless
no ip http server
!
no cdp run
snmp-server community private RW
!
!  This does not affect the HCCP communications between the Upconverter, Switch,
!  the and uBR10012.
!
snmp-server enable traps cable
no cdp run
snmp-server manager
tftp-server server
tftp-server ios.cf alias ios.cf
!
line con 0
 logging synchronous
line aux 0
 no exec
 transport input all
!
!  The three lines above were used to console from the Auxiliary port of the uBR10012
!  to the Switch.
!
line vty 0 4
 session-timeout 400
 password xx
 login
endBuilding configuration...
```

Example: Virtual Interface Bundling

Example of Previously Supported Cable Line Card Interface Configuration Compared With Virtual Interface Bundling Configuration

The following example shows an older cable line card interface configuration with IP addressing:

```
interface cable 5/0/0
ip address 10.10.10.1 255.255.255.0
ip address 10.10.11.1 255.255.255.0 secondary
```

If previously configured on your router, this older cable line card interface configuration is automatically replaced by the following virtual interface bundling configuration, where no IP addressing is supported at the cable line card interface:

```
interface cable 5/0/0
no ip address
cable bundle 1
interface bundle 1
ip address 10.10.10.1 255.255.255.0
ip address 10.10.11.1 255.255.255.0 secondary
```

Example of Previously Supported Master/Slave Bundle Configuration with Virtual Interface Bundling Configuration

The following example shows the older cable line card interface configuration with IP addressing and master/slave bundling:

```
interface cable 5/0/0
ip address 10.10.10.1 255.255.255.0
cable bundle 5 master
interface cable 5/0/1
no ip address
cable bundle 5
```

If previously configured on your router, this older cable line card interface configuration is automatically replaced by the following virtual interface bundling configuration, where no IP addressing is supported at the cable line card interface:

```
interface cable 5/0/0
no ip address
cable bundle 5
interface cable 5/0/1
no ip address
cable bundle 5
interface bundle 5
ip address 10.10.10.1 255.255.255.0
Additional Information
```

Additional References

For additional information related to N+1 redundancy, the Cisco RF switch, and the Cisco uBR10012 routers, refer to the following references.

Related Documents

Related Topic	Document Title
Command References	• *Cisco IOS CMTS Cable Command Reference, 12.2SC* http://www.cisco.com/en/US/docs/ios/cable/command/reference/cbl_book.html • *Cisco RF Switch Firmware Command Reference Guide* http://www.cisco.com/en/US/docs/cable/rfswitch/ubr3x10/command/reference/rfswcr36.html
Cisco RF Switches	• Cisco RF Switch Documentation Home Page (complete documentation set) http://www.cisco.com/en/US/products/hw/cable/ps2929/tsd_products_support_series_home.html

Related Topic	Document Title
High Availability References for Cisco Broadband Cable	• *Bitmap Calculator for N+1 Configuration with the Cisco RF Switch* (Microsoft Excel format)
Additional Broadband Cable Technical Reference	• *Cisco Multiservice Broadband Cable Guide* http://www.cisco.com/en/US/prod/collateral/video/ps8806/ps5684/ps2209/prod_brochure09186a008014eeb0.pdf • *Cable Radio Frequency (RF) FAQs* http://www.cisco.com/en/US/tech/tk86/tk319/technologies_q_and_a_item09186a0080134faa.shtml

Standards

Standard	Title
DOCSIS	Data-Over-Cable Service Interface Specifications
EuroDOCSIS	European Data-Over-Cable Service Interface Specifications

MIBs

MIB	MIBs Link
No new or modified MIBs are supported by this feature, and support for existing MIBs has not been modified by this feature.	To locate and download MIBs for selected platforms, Cisco software releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

RFC	Title
No new or modified RFCs are supported by this feature, and support for existing RFCs has not been modified by this feature	—

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for N+1 Redundancy

Use Cisco Feature Navigator to find information about platform support and software image support. Cisco Feature Navigator enables you to determine which software images support a specific software release, feature set, or platform. To access Cisco Feature Navigator, go to http://tools.cisco.com/ITDIT/CFN/. An account on http://www.cisco.com/ is not required.

Note The below table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Table 5: Feature Information for N+1 Redundancy

Feature Name	Releases	Feature Information
HCCP N+1 Redundancy	12.1(10)EC	**HCCP support introduced on the Cisco uBR7200 series routers.**
HCCP N+1 Redundancy	12.2(4)XF1, 12.2(4)BC1	HCCP N+1 Redundancy support was added for the Cisco uBR10012 router.

Feature Name	Releases	Feature Information
HCCP N+1 Redundancy	12.2(15)BC2a	• HCCP N+1 Redundancy support introduced for the Cisco uBR7246VXR router and the Cisco uBR 3x10 RF Switch. • CLI Usability—Synchronizes HCCP interface command-line interface (CLI) configuration between working and protect interfaces. • Support for N+1 redundancy for the Cisco UBR10-MC 5X20 BPE on the Cisco uBR10012 router. • IF Muting on the Cisco CMTS for non-SNMP-Capable Upconverters, on page 8 — enables N+1 redundancy on CMTS headends that do not use SNMP-enabled upconverters.
Global N+1 Line Card Redundancy	12.3(13a)BC	HCCP N+1 redundancy on the Cisco 7200 series routers is no longer supported. The following enhancements were introduced to HCCP N+1 redundancy support on the Cisco uBR10012 router: • Global N+1 Line Card Redundancy, on page 7 • Automatic running of the show hccp channel switch command for Background Path Testing for HCCP N+1 Redundancy on the Cisco uBR10012 Universal Broadband Router.

Feature Name	Releases	Feature Information
HCCP Switchover Enhancements	12.3(21)BC	The following support has been removed: • HCCP N+1 redundancy support is removed for the Cisco uBR7246VXR router. • Tracking of HCCP interfaces is removed. The **hccp track** command is obsolete. The HCCP Switchover Enhancements feature is introduced on the Cisco uBR10012 router, with the following new support: • Performance improvements for traffic recovery during line card switchover under certain scalability limits. Within the required network scalability limits, the HCCP Switchover Enhancements feature provides the following switchover benefits: ◦ Less than 1-second voice call recovery. ◦ Less than 20-second data recovery. • To prevent false switchovers, the keepalive failure logic is modified. • For faster line card switchovers, the **member subslot protect** command has been modified to add the [**config** *slot*/*subslot*] option. When using the new **config** option, you can preload upstream connectors on an HCCP protected interface to emulate the most common line card connector assignments.

Feature Name	Releases	Feature Information
N+1 Redundancy	12.2(33)SCC	• HCCP N+1 redundancy support introduced on the Cisco uBR10012 router for Cisco uBR-MC 20X20V broadband processing engine (BPE). • Support for Legacy HCCP configurations has been removed. • Enabling Service Internal on HCCP Protect and Standby Working Interfaces, on page 22—The service internal command enables configuration of the protect and standby working cable interfaces for the following line cards: ◦ Cisco uBR10-MC5X20S, Cisco uBR10-MC5X20U, Cisco uBR10-MC5X20H and Cisco UBR-MC20X20V line cards.
N+1 Redundancy	12.2(33)SCE	The config option in the member subslot protect command is made the default. When more than one working card is configured, this option is automatically applied to the first working card.
N+1 Redundancy	12.2(33)SCF	This release supports configuration of a card with a lower license as protect for a working card with a higher license. However, when a switchover occurs, this protect card does not become active until it is upgraded and reloaded with a higher license.
N+1 Redundancy	12.2(33)SCG	Support for the new Cisco uBR Advanced RF Switch was added.