



## Configuring LRE

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This chapter describes how to configure the Long-Reach Ethernet (LRE) features on your switch. This chapter consists of these sections:

- [Ports on the Catalyst LRE Switch, page 8-1](#)
- [LRE Links and LRE Profiles, page 8-2](#)
- [Configuring LRE Ports, page 8-6](#)
- [Upgrading LRE Switch Firmware, page 8-15](#)



Note

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For complete syntax and usage information for the commands used in this chapter, refer to the command reference for this release and the online *Cisco IOS Interface Command Reference for Release 12.0*.

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## Ports on the Catalyst LRE Switch

The Catalyst LRE switches use LRE technology to transfer data, voice, and video traffic over categorized and non-categorized unshielded twisted-pair cable (Category 1, 2, and 3 structured and unstructured cable such as existing telephone lines).

Connecting a switch LRE port to a remote Ethernet device (such as a PC) requires two types of connections:

- **LRE link**—This is the connection between the switch LRE port and the RJ-11 wall port on an LRE customer premises equipment (CPE) device such as the Cisco 575 LRE CPE or Cisco 585 LRE CPE. This connection can be through categorized or noncategorized unshielded twisted-pair cable and can extend to distances of up to 4921 feet (1500 m).
- **CPE Ethernet link**—This is the connection between the CPE Ethernet port and an Ethernet device, such as a PC. This connection is through standard Category 5 cabling and can extend to distances of up to 328 feet (100 m).

The actual line speed in either direction between a switch LRE port and remote Ethernet device depends on the LRE link speed and the CPE Ethernet link speed. For example, if a PC Ethernet port is configured to 100 Mbps and the LRE port is configured with an upstream link speed of 5.69 Mbps, the actual upload rate provided to the PC user is 5.69 Mbps, not 100 Mbps.

For LRE troubleshooting information, see the [“Troubleshooting LRE Port Configuration” section on page 10-9](#). Additional LRE details are provided in the switch command reference.

# LRE Links and LRE Profiles

The LRE link settings define the connection between the switch LRE port and the CPE RJ-11 wall port. The LRE link provides symmetric and asymmetric data transfer rate for data, voice, and video traffic. *Symmetric* transmission is when the downstream and upstream data transfer rates are the same. *Asymmetric* transmission is when the downstream and the upstream bandwidths differ. *Downstream* transmission refers to the traffic traveling from the LRE switch to the CPE device. *Upstream* transmission refers to the traffic traveling from the CPE device to the LRE switch.

The switch controls upstream and downstream rates on the LRE link by using configurations called *profiles*. Depending on the profile, the upstream and downstream bands on an LRE link can range from approximately 1 Mbps to 18.750 Mbps.

This section discusses these topics:

- [LRE Profiles, page 8-2](#)
- [LRE Profile Sequences, page 8-4](#)
- [CPE Ethernet Links, page 8-5](#)

## LRE Profiles

You can assign profiles on a per-port or switch-wide basis. When the LRE switch establishes a link with the CPE device, the switch downloads its profile settings to the CPE device so that the switch and CPE device operate with the same configuration.

The LRE switches are shipped with predefined profiles categorized as public (global) mode and private (per-port) mode profiles ([Table 8-1](#)). Only the Public-ANSI and Public-ETSI profiles are public; all other system-defined profiles are private. By default, all LRE ports on the switch are enabled with the LRE-10 private profile. This default profile allows the upstream and downstream transmission rate on the LRE link to be 10 Mbps.

- **Public**—We strongly recommend using a public profile if the switch is used with equipment directly connected to a public switched telephone network (PSTN) without a private branch exchange (PBX) between the LRE switch and the public telephone lines. When the switch is configured with a public profile, all LRE ports use the same configuration to prevent the switch from causing interference with the other lines on the PSTN.




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**Note** Consult the regulations for connecting to the PSTN in your area.

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**Note** Cisco LRE products can share lines with analog telephones, Integrated Services Digital Network (ISDN), and digital PBX switch telephones that use the 0 to 700 kHz frequency range.

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The standards for spectral profiles have not yet been ratified. The PUBLIC-ANSI profile corresponds to ANSI Plan 998. The PUBLIC-ETSI profile corresponds to ETSI Plan 997. Both plans are draft standards. Contact Cisco Systems for the latest information about standards ratification or for updates to the public profiles.

- Private—You can use a private profile if the LRE switch is not used with equipment connected to a PSTN. The switch supports a variety of private profiles that offer different link speeds and maximum distances. In general, the higher the link speed, the shorter the maximum distance. Private profiles are assigned on a per-port basis. The ports on an LRE switch can be assigned the same or different private profiles.

**Note**

Use the rates and distances in [Table 8-1](#) only as guidelines. Factors such as the type of cable that you use, how it is bundled, and the interference and noise on the LRE link can affect the actual LRE link performance. Contact Cisco Systems for information about limitations and optimization of LRE link performance.

**Table 8-1 LRE Profiles**

Profile Name	LRE Link Downstream Rate (Mbps)	LRE Link Upstream Rate (Mbps)	Theoretical Min SNR Downstream (dB)	Theoretical Min SNR Upstream (dB)
LRE-15	16.667	18.750	31	25
LRE-10 (default)	12.500	12.500	25	19
LRE-5	6.250	6.250	16	13
Public-ANSI	16.667	4.688	31	25
Public-ETSI	12.500	4.688	31	25
LRE-15LL	16.667	18.750	31	25
LRE-10LL	12.500	12.500	25	19
LRE-5LL	6.250	6.250	16	13
LRE-10-5	12.500	6.250	25	13
LRE-10-3	12.500	3.125	25	19
LRE-10-1	12.500	1.563	25	13
LRE-8	9.375	9.375	25	25
LRE-7	8.333	8.333	19	19
LRE-15-5	16.667	6.250	31	13
LRE-15-3	16.667	3.125	31	19
LRE-15-1	16.667	1.563	31	13
LRE-4	4.167	4.167	13	13
LRE-3	3.125	3.125	13	13
LRE-2	2.083	2.083	13	13
LRE-4-1	4.167	1.563	19	13
LRE-4-1LL	4.167	1.563	19	13

Your data rates will always be less than the gross data rate listed in table. A small percentage of the link rate is used by Catalyst LRE switch for supervisory functions with the CPE device connected remotely.

In general, profiles are named for the data rate you expect to achieve, and not the gross data rate as given in the table. All system-defined profiles have the prefix LRE, followed by the downstream user data rate, and then the upstream user data rate. If the profile is symmetric, only one data rate is given. The two profiles defined to comply with Public frequency usage plans 998 and 997 (Public-ANSI and Public-ETSI) are exceptions to this. These two uniquely named profiles will work in any private deployment.

- If you haven't assigned a profile to an LRE port, the port has a default value of LRE-10. Public profiles, port sequences, and global sequences have priority over port profiles. (For more details on profile and sequence precedence, see [Using Rate Selection to Automatically Assign Profiles, page 8-10](#).)

When you assign a different profile to a switch LRE port, the port immediately resets and uses the newly assigned profile.

- Use the LL profiles (LRE-5LL, LRE-10LL, LRE-15LL, and LRE-4-1LL) with care. These profiles have the low-latency (LL) feature enabled and the interleaver feature turned off. The LL feature does not delay data transmission, but it makes data more susceptible to interruptions on the LRE link.

All other profiles, port and global, have the interleaver feature enabled and the LL feature disabled. The interleaver feature provides maximum protection against small interruptions on the LRE link but delays data transmission.

- The symmetric profiles (LRE-5, LRE-10, LRE-15, LRE-8, LRE-7, LRE-4, LRE-3, and LRE-2) provide full-duplex throughput on the link between the LRE switch and CPE device. Under ideal conditions, this can mean up to 30 Mbps of bandwidth on the LRE link if you are using the LRE-15 profile.

## LRE Profile Sequences

The LRE switches are shipped with predefined profile sequences. Sequences are sets of profiles and are used with the rate selection feature so that you can allow the switch to automatically select profiles. You can also define your own sets of sequences by using commands or CMS.

Table 8-2 outlines the predefined profile sequences for rate selection contained in Cisco IOS. When executing rate selection, the switch uses these sequences to choose an appropriate profile for a given LRE interface.

Table 8-2 LRE Rate Selection Sequences

LRE-SEQ-COMplete-REACH	LRE-SEQ-DOWNSTREAM	LRE-SEQ-SYM	LRE-SEQ-SYM-LONGREACH	LRE-SEQ-SYMLL	LRE-SEQ-UPSTREAM	LRE-SEQ-VIDEO-TRANSMIT1	LRE-SEQ-VIDEO-TRANSMIT2
LRE-15	LRE-15	LRE-15	LRE-5	LRE-15LL	LRE-15	LRE-15	LRE-15
LRE-10	LRE-15-5	LRE-10	LRE-4	LRE-10LL	LRE-10	LRE-15-5	LRE-15-5
LRE-15-5	LRE-15-3	LRE-8	LRE-3	LRE-5LL	LRE-8	LRE-15-3	LRE-10
LRE-10-5	LRE-15-1	LRE-7	LRE-2	LRE-4-1LL	LRE-7	LRE-15-1	LRE-10-5
LRE-8	LRE-10	LRE-5	LRE-4-1	–	LRE-15-5	LRE-10	LRE-15-3
LRE-7	LRE-10-5	LRE-4	–	–	LRE-10-5	LRE-10-5	LRE-10-3
LRE-15-3	LRE-10-3	LRE-3	–	–	LRE-5	LRE-10-3	LRE-15-1
LRE-10-3	LRE-10-1	LRE-2	–	–	LRE-4	LRE-10-1	LRE-10-1
LRE-5	LRE-8	–	–	–	LRE-15-3	–	–
LRE-15-1	LRE-7	–	–	–	LRE-10-3	–	–
LRE-10-1	LRE-5	–	–	–	LRE-3	–	–
LRE-4	LRE-4	–	–	–	LRE-2	–	–
LRE-3	LRE-4-1	–	–	–	LRE-4-1	–	–
LRE-2	LRE-3	–	–	–	–	–	–
LRE-4-1	LRE-2	–	–	–	–	–	–

Beginning with the first profile in a sequence, the switch attempts to apply each profile within that sequence to the LRE interface. *Convergence time* refers to the time required for the switch to settle on an appropriate profile for the LRE interface. If a link cannot be established by any of the profiles in the sequence, the link is declared as DOWN.

For additional information on rate selection, see the [“Using Rate Selection to Automatically Assign Profiles”](#) section on page 8-10.

## CPE Ethernet Links

The CPE Ethernet link settings define the connection between the CPE Ethernet port and a remote Ethernet device, such as a PC.



### Note

From CMS and the CLI, you can configure and monitor the Ethernet link on a Cisco 575 LRE CPE and a Cisco 585 LRE CPE. For information about the switch LEDs, see the *Catalyst 2900 XL and Catalyst 3500 XL Hardware Installation Guide*.

Keep these considerations in mind when you have CPE devices connected to the LRE ports:

- Use the **shutdown** interface configuration command to disable the LRE interface transmitter on any LRE ports that are not connected to a CPE device. This prevents access to the LRE port and prevents the power emitted from the port from affecting other ports.
- You cannot configure the flow-control setting on the LRE ports. The flow-control setting on the CPE Ethernet port is automatically disabled in half-duplex mode and is automatically enabled in full-duplex mode.
- You can connect Cisco 575 LRE CPEs and Cisco 585 LRE CPEs to the same LRE switch.
- You can hot-swap the CPE devices without powering down the switch or disrupting the other switch ports.

Use the **show controllers ethernet-controller** privileged EXEC command to display the internal switch statistics, the statistics collected by the LRE switch interface, and the statistics collected by the CPE LRE interface. For information about this command, refer to the switch command reference.

## Configuring LRE Ports

These sections describe configuration guidelines and how to assign a profile to all or individual LRE ports. These sections contain more information about LRE links, ports, and profiles:

- [Environmental Guidelines for LRE Links, page 8-6](#)
- [Guidelines for Using LRE Profiles, page 8-7](#)
- [CPE Ethernet Link Guidelines, page 8-8](#)
- [Assigning a Public Profile to All LRE Ports, page 8-9](#)
- [Assigning a Private Profile to an LRE Port, page 8-10](#)
- [Using Rate Selection to Automatically Assign Profiles, page 8-10](#)
- [LRE Link Persistence, page 8-15](#)

## Environmental Guidelines for LRE Links

The requirements of your LRE environment are based on these factors:

- Maximum distance between the LRE switch and CPE devices—the LRE runs on Category 1, 2, and 3 structured and unstructured cable. The maximum distance supported on the LRE link is from 3500 to 5000 feet, depending on the profile. The higher the rate, the shorter the distance. In buildings where LRE traffic runs over bundled telco cabling, the maximum distance supported can be approximately 30 percent lower.

Each terminated bridge tap in a room can further reduce LRE link distances by 300 feet. The quality of the cable, the size of the cable bundles, and cross talk within the bundle also can affect overall reach.

- Site type—If your site has either a PBX providing telephone service throughout or has direct connections to the PSTN, you must identify the requirements of your local public telephone service provider.

If your site is a single building (or is a connected set of buildings), consult a qualified electrician to ensure that the wiring conforms to the appropriate regulations for indoor circuits.

If your site has separate buildings, you must determine how the buildings are cabled to each other. Where the wiring between the LRE switch and CPE device leaves the building (or the armored conduits certified for inside wiring standards), it must be protected against lightning and shorts to high-voltage power. This protection might be provided by fuses or overvoltage protectors that comply with local regulations for outside wiring protection. Consult an expert in local telecommunications regulations for the details of this protection.

- Age and type of wiring—You can estimate the type of wiring you have based on your site's age and type.
  - Newer installations less than 15 years old often use Category 3 cable in bundles of 25 pairs. There is no significant difference between 25-pair bundles and larger bundles.
  - Older installations (hotel, school, hospital, commercial—North America) 15 to 30 years old often use 24 AWG wiring with between 1 and 12 twists per foot (similar to Category 1) in bundles of 25 or more.
  - Older installations (residential—North America) 15 to 30 years old often use 26 AWG wiring with between 1 and 12 twists per foot (perhaps type-2) in bundles of 100 or more.
  - Older installations (Europe) 15 to 30 years old often use 0.4 mm (similar to 26 AWG) wiring with between 1 and 12 twists per foot in bundles of 100 or more.
  - Older installations (Asia) 15 to 30 years old often use 0.4 mm (similar to 26 AWG) wiring with between 1 and 12 twists per foot in bundles of 100 or more.
  - Older installations over 30 years old often use heavy gauge wire (22 or 20 AWG) with no significant twist. In many cases, the cabling is set into the fabric of the building. The cables might be tightly or loosely bundled. For this estimate, assume that they are tightly bundled in groups of 25 or more.
- Cross talk (noise) and interference—LRE operates with any number of wires in a cable binder carrying the LRE signal. Anywhere from one wire pair to every wire pair in the cable can carry LRE signals at the same time. LRE operates in full cable binders and adjusts power levels on each LRE link to maximize the performance of all connections.

The greatest impact on LRE performance is from the frequency response of the cable at the higher frequencies. LRE signals are more susceptible to interference at higher frequencies. The LRE upstream signal operates at the high end of the frequency spectrum. Cables have higher attenuation at higher frequencies and also interfere with other pairs in the bundle at higher frequencies. This interference or cross talk can significantly impact the signal quality.

## Guidelines for Using LRE Profiles

When assigning a profile to a switch LRE port, keep these considerations in mind:

- Each switch LRE port always has a private profile assigned to it. The LRE-10 profile is the default. Public profiles have priority over private profiles. If you assign a public profile to the switch, the switch uses the public profile and ignores any private profile assigned to the switch LRE ports.

If a public profile is configured on the switch and you want the switch LRE ports to use private profiles, you must first disable the public profile by using the **no lre profile SS** configuration command.

When you assign a different profile to a switch LRE port, the port immediately resets and uses the newly assigned profile.

- Before you add an LRE switch to a cluster, make sure that you assign it the same public profile that is used by other LRE switches in the cluster. A configuration conflict occurs if a switch cluster has LRE switches using both private and public profiles. If one LRE switch in a cluster is assigned a public profile, all LRE switches in that cluster must have that same public profile.

A cluster can have a mix of LRE switches using different private profiles. For more information about clusters, see [Chapter 5, “Clustering Switches.”](#)

- Phone lines typically operate at a frequency of up to 3.4 kHz. On the LRE link, the downstream transmission runs in a low-frequency band from approximately 1 MHz to 3.5 MHz. The upstream transmission runs in a high-frequency band from approximately 4 MHz to 8 MHz. Higher frequencies are more susceptible to interference. Consequently, upstream signals are susceptible to cross talk and disruption on the link.

To maintain the quality of the LRE connection, use the asymmetric port profiles. These profiles use a low upstream rate but provide a high downstream rate.



#### Note

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All POTS telephones not directly connected to the CPE device require microfilters with a 300-ohm termination. Microfilters improve voice call quality when voice and data equipment are using the same telephone line. They also prevent nonfiltered telephone rings and nonfiltered telephone transitions (such as on-hook to off-hook) from interrupting the LRE connection.

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- When the link between the LRE switch and the CPE device must co-exist in the same cable bundle as an Asymmetric Digital Subscriber Line (ADSL), it is recommended that either the ANSI or ETSI public profile be used. For details on which profile to use elsewhere, consult the regulations for connecting to the PSTN in your area.
- LRE signaling can coexist with ADSL signaling in one cable bundle. However, LRE signaling is not compatible with T1 signals in the same cable bundle.

Use the **show controllers lre status profile** and **show controllers lre status link** privileged EXEC commands to display the LRE link statistics and profile information on the LRE ports. For information about these commands, refer to the switch command reference.

## CPE Ethernet Link Guidelines

The CPE Ethernet link settings define the connection between the CPE Ethernet port and a remote Ethernet device, such as a PC.



#### Note

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From CMS and the CLI, you can configure and monitor the Ethernet link on a Cisco 575 LRE CPE. You cannot configure the Ethernet links on a Cisco 585 LRE CPE. You can only monitor the Ethernet links on the Cisco 585 LRE CPE by using the **show remote interfaces status** user EXEC command. For information about the switch LEDs, see [Table 2-8 on page 2-10](#) and the *Catalyst 2900 Series XL Hardware Installation Guide*.

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Keep these considerations in mind when you have CPE devices connected to the LRE ports:

- Enable CDP either globally on the LRE switch or on the specific LRE ports.
- Use the **shutdown** command in interface configuration mode to disable the LRE interface transmitter on any LRE ports that are not connected to a CPE device. This prevents access to the LRE port and prevents the power emitted from the port from affecting other ports.

- You cannot configure the flow-control setting on the LRE ports. The flow-control setting on the CPE Ethernet port is automatically disabled in half-duplex mode and is automatically enabled in full-duplex mode.
- You can connect Cisco 575 LRE CPEs and Cisco 585 LRE CPEs to the same LRE switch,.
- You can hot-swap the CPE devices without powering down the switch or disrupting the other switch ports.

Use the **show controllers ethernet-controller** privileged EXEC command to display the internal switch statistics, the statistics collected by the LRE switch interface, and the statistics collected by the CPE LRE interface. For information about this command, refer to the switch command reference.

## Considerations for Connected Cisco 575 LRE CPEs

You can configure the Cisco 575 LRE CPE Ethernet port to operate at 10 or 100 Mbps and at half- or full-duplex mode, depending on the capability of the remote Ethernet device. Autonegotiation for port speed and duplex mode is supported.

The default speed for the CPE Ethernet port is auto. The default duplex mode is half duplex with back pressure.

The speeds on the LRE links and CPE Ethernet links do not need to match. However, to prevent the possible loss of data when the LRE link is slower than the CPE Ethernet link, make sure that the CPE Ethernet port is set to half-duplex mode. Use duplex autonegotiation only if the remote device supports 802.1X full-duplex flow control. The PC user should notice no significant difference in performance between 100-Mbps half duplex and 100-Mbps full duplex. Use the **duplex** and **speed** interface configuration commands, respectively, to change the duplex and speed settings on the Cisco 575 LRE CPE Ethernet port.

## Considerations for Connected Cisco 585 LRE CPEs

You cannot configure the Cisco 585 LRE CPE Ethernet ports.

The default speed for the CPE Ethernet ports is auto. The default duplex mode is half duplex with back pressure. Duplex autonegotiation is not supported on the Cisco 585 LRE CPE.

You cannot enable or disable the CPE Ethernet ports on a per-port basis. For example, using the **shutdown** interface configuration command on an LRE port disables all Ethernet ports on the connected CPE device.

The **loopback** interface configuration command is not supported on the LRE ports. External loopback on the LRE ports is also not supported. Connecting a CPE Ethernet port to another Ethernet port on the same CPE device can create a loop. If this happens, the switch stops sending to the CPE device and blocks Ethernet traffic coming from the CPE device.

## Assigning a Public Profile to All LRE Ports

Public profiles are set on a switch-wide (global) basis. The public profile you select should be compatible with the PSTN to which the LRE switch is connected.

Public profiles have priority over private profiles. If you assign a public profile to the switch, the switch ignores the private profile settings and uses the public profile settings on all LRE ports. To disable the public profile on the switch, use the **no lre profile global** global configuration command.

Changes to the public profile settings are immediately put in effect, and the public mode automatically becomes the active mode.

Beginning in privileged EXEC mode, follow these steps to assign a public profile to the LRE ports:

	Command	Purpose
Step 1	<b>configure terminal</b>	Enter global configuration mode.
Step 2	<b>lre profile global</b> <i>profile_name</i>	Enter the public profile name: PUBLIC-ANSI or PUBLIC-ETSI.
Step 3	<b>end</b>	Return to privileged EXEC mode.
Step 4	<b>show controllers lre profile mapping</b>	Verify the change.

Use the **show controllers lre status profile** and **show controllers lre status link** privileged EXEC commands to display the LRE link statistics and profile information on the LRE ports. For information about these commands, refer to the switch command reference.

## Assigning a Private Profile to an LRE Port

Private profiles are set on a per-port basis. You can assign the same private profile or different private profiles to the LRE ports on the switch. The default active private profile on all LRE ports is LRE-10.

The switch resets the ports with the updated profile settings.

Beginning in privileged EXEC mode, follow these steps to assign a private profile to an LRE port:

	Command	Purpose
Step 1	<b>configure terminal</b>	Enter global configuration mode.
Step 2	<b>interface</b> <i>LRE-interface</i>	Enter interface configuration mode, and enter the number of the LRE port to be configured.
Step 3	<b>lre profile</b> <i>profile_name</i>	Enter the private profile name (see <a href="#">Table 8-1</a> for a complete list). The default profile is LRE-10.
Step 4	<b>end</b>	Return to privileged EXEC mode.
Step 5	<b>show controllers lre profile mapping</b>	Verify the change.

Use the **show controllers lre** privileged EXEC commands to display the LRE link statistics and profile information on the LRE ports. For information about these commands, refer to the switch command reference.

## Using Rate Selection to Automatically Assign Profiles

An LRE network requires a profile to be configured for each LRE port that is connected to a CPE device (the default is LRE-10). The rate selection feature lets you allow the switch to automatically choose a profile from a set of profiles that the switch port uses to establish an LRE link (a link between an LRE switch port and an attached CPE device). The chosen profile might or might not be the optimal link or the most appropriate profile.

Rate selection is enabled by default, but you must choose a sequence for rate selection to start (in other words, there is no default sequence defined). When rate selection is running, the switch chooses the most appropriate profile for the LRE interface from a *sequence*, or predefined series of profiles, that are configured for that interface. The rate-selection algorithm begins with the first profile in the sequence and successively tries the next profiles (in descending order) until a link is established with the CPE device. The final profile in each sequence ends with the port attempting to establish link with the LRE-4-1 profile. This profile provides the minimum upstream and downstream rates at which the LRE port and CPE device can establish link.

When enabled, the LRE switch executes rate selection in these scenarios:

- At start up
- When you enact the rate selection feature using an EXEC command
- When you connect a new CPE device to the switch
- When a link is lost for 25 seconds before being restored

In any of these cases, rate selection is used to obtain the optimal profile for your line conditions.

**Note**

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When an LRE link is lost for fewer than 25 seconds, the switch does not execute rate selection to reestablish the link. The link is re-established at the profile used prior to link loss.

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The switch chooses the appropriate profile for an LRE interface at the time it executes rate selection. If line conditions of the LRE interface change, rate selection must be executed again.

The rate selection feature can be applied at both the port level and at the switch level. Profiles and sequences have a system-defined priority level which work in conjunction with rate selection to determine the rate for a port or the entire switch. The priority levels, from highest to lowest, are the following:

1. *Public profile*, rate selection is not used for the entire switch; the given public profile is used
2. *Port sequence*: rate selection is enabled on the given port only with the given sequence
3. *Global sequence*, rate selection is enabled for the entire switch with the given sequence
4. *Port profile*, rate selection is not used for the given port; the given profile is used

See [Table 8-1](#) for the list of profiles, and [Table 8-2](#) for the list of system-defined sequences. You can also use IOS commands or CMS to define your own sequences.

## Profile Locking

You can also use rate selection as an installation tool to lock in a particular profile. In this case, you execute rate selection only once at installation time; afterwards, rate selection is never executed, even if one of the above four events occur. You use the **config** command in privileged EXEC mode to lock the profile chosen by rate selection. (You can enter a special EXEC command to rerun rate selection on the interfaces that have locked the profiles, as needed.)

An advantage to profile locking is that the convergence time during bootup is faster if a profile is locked on an LRE port rather than having to go through a profile sequence.

Beginning in privileged EXEC mode, follow these steps to lock a profile in an LRE port that has rate selection enabled:

	Command	Purpose
Step 1	<b>configure terminal</b>	Enter global configuration mode.
Step 2	<b>interface</b> <i>LRE-interface</i>	Enter interface configuration mode, and enter the number of the LRE port to be configured.
Step 3	<b>profile lock</b>	Lock the profile.
Step 4	<b>end</b>	Return to privileged EXEC mode.
Step 5	<b>show controllers lre profile details</b>	Verify the change.

## Link Qualification and SNR Margins

When rate selection is running, the signal-to-noise ratio (SNR) is used as an indicator of link quality. The switch does not provide any internal mechanism to assure link quality. There can be different requirements for link quality, depending on the required bit-error rate and the noise level of the environment. A noisier environment would require a higher SNR to be able to provide a stable link. A lower bit-error rate would require a higher SNR. Typically a 6-dB margin provides an error rate of  $10^{-21}$  bits.

In order to provide link stability, you should add a margin to the required SNR. You can configure your margins to an amount that is appropriate for the noise level of your environment. Increasing the margin requirement can cause the system to choose a lower profile, which would in turn translate to a lower data rate but with a higher reach.

The switch does not guarantee any margins after a link is activated; margins are only guaranteed only when the link is established. When a link is activated, if the SNR requirements do not match the configured margin level, the link is not established.

Downstream indicates the remote end of the link, and upstream the local end. The link has to satisfy both the local and remote margin requirements. If either one is not met, the link is advertised as down. This command has no significance if rate selection is disabled on the interface.

Table 8-3 lists the SNR requirements for downstream rates for different profiles.

**Table 8-3 SNR Requirements for Downstream Rates**

Profile	Gross Data Rate	QAM	Theoretical Minimum SNR	Low Noise SNR	Medium Noise SNR	High Noise SNR
LRE-4-1	4.170	16	19	21	23	26
LRE-7	8.333	16	19	21	23	26
LRE-8	9.375	64	25	27	29	32
LRE-5	6.250	8	16	19	21	24
LRE-10	12.500	64	25	27	29	32
LRE-15	16.667	256	31	33	35	39
LRE-10-5	12.500	64	25	27	29	32
LRE-10-3	12.500	64	25	27	29	32
LRE-10-1	12.500	64	25	27	29	32
LRE-15-5	16.667	256	31	33	35	39
LRE-15-3	16.667	256	31	33	35	39
LRE-15-1	16.667	256	31	33	35	39
Public-ANSI	16.667	256	31	33	35	39
Public-ETSI	12.500	256	31	33	35	39
LRE-2	2.080	4	13	15	17	20
LRE-3	3.130	4	13	15	17	20
LRE-4	4.170	4	13	15	17	20

Table 8-4 lists the SNR requirements for upstream rates for different profiles.

Table 8-4 SNR Requirements for Upstream Rates

Profile	Gross Data Rate	QAM	Theoretical Minimum SNR	Low Noise SNR	Medium Noise SNR	High Noise SNR
LRE-4-1	1.560	4	13	15	17	20
LRE-7	8.333	16	19	21	23	26
LRE-8	9.375	64	25	27	30	34
LRE-5	6.250	4	13	15	17	20
LRE-10	12.500	16	19	21	23	26
LRE-15	18.750	64	25	27	30	34
LRE-10-5	6.250	4	13	15	17	20
LRE-10-3	3.125	16	19	21	23	26
LRE-10-1	1.560	4	13	15	17	20
LRE-15-5	6.250	4	13	15	17	20
LRE-15-3	3.125	16	19	21	23	26
LRE-15-1	1.563	4	13	15	17	20
Public-ANSI	4.688	64	25	27	29	32
Public-ETSI	4.688	64	25	27	29	32
LRE-2	2.080	4	13	15	17	20
LRE-3	3.130	4	13	15	17	20
LRE-4	4.170	4	13	15	17	20

The margin range for link qualification is from 1 to 10 dB. The recommended value in a low noise environment is 2 dB. The recommended value for medium noise environment is 4 dB. The recommended value in a high noise environment is 6 dB.

If a profile has a theoretical minimum of 25 dB and you configure a margin of 3 dB, when the link is established, the SNR should at the least be 28 dB to show a successful link. If a link is established and if the SNR value at link time is 27 dB, the link is advertised as down, and the next profile in the sequence is attempted. If you configure a margin of 0 (the default value), IOS does not check for the SNR value when the link is established.

Beginning in privileged EXEC mode, follow these steps to assign a margin to a specific LRE port:

	Command	Purpose
Step 1	<b>configure terminal</b>	Enter global configuration mode.
Step 2	<b>interface</b> <i>LRE-interface</i>	Enter interface configuration mode, and enter the number of the LRE port to be configured.
Step 3	<b>margin</b> [ <i>downstream value</i>   <i>upstream value</i> ]	Enter the downstream or upstream margin value (in dB)
Step 4	<b>end</b>	Return to privileged EXEC mode.
Step 5	<b>show controllers lre status sequence detail</b>	Verify the change.

**Note**

The margin command is effective with any profile, but only in conjunction with rate selection and only when a link is being activated.

## LRE Link Persistence

A brief LRE link down and up transition can cause the rest of the IOS modules to react immediately, for example, the Dynamic MAC addresses are removed from that ports table. You can use the link persistence feature to configure a delay duration on the Catalyst LRE switch of up to 20 seconds before link failure is reported.

	Command	Purpose
Step 1	<b>configure terminal</b>	Enter global configuration mode.
Step 2	<b>interface</b> <i>LRE-interface</i>	Enter interface configuration mode, and enter the number of the LRE port to be configured.
Step 3	<b>lre persistence</b> <i>time</i>	Enter the length of time (in seconds) you wish to set for the persistence.
Step 4	<b>end</b>	Return to privileged EXEC mode.
Step 5	<b>show run</b>	Verify the change.

See the *lre persistence* reference pages in the *Catalyst 2900 XL and Catalyst 3500 XL Desktop Switch Command Reference* for further details.

## Upgrading LRE Switch Firmware

The Catalyst LRE switch has the capacity to store and properly apply LRE binaries in case there are updates required to the firmware on the switches' local LRE controllers or connected customer premises equipment (CPE) devices.

Other upgrade-related features include:

- Enabling you to use an earlier version of the LRE software if required.
- Simplifying the upgrade process as much as possible, especially when you want to upgrade multiple CPE devices by issuing a single command.

**Note**

Whether upgrading a single CPE device or all CPE devices connected to an LRE switch, the expected duration of an LRE upgrade is 3 to 6 minutes (CPE devices connected to marginal links may take longer than this to upgrade).

You perform an upgrade with the command

```
hw-module slot x upgrade lre [force][local lo n | remote lo x/y]
```

Automatic upgrading is not supported. You can upgrade in one these ways:

- Upgrade a single remote CPE device.
- Upgrade a single local LRE controller (local LRE chipset).
- Upgrade all CPE devices and local chipsets that require an upgrade (a system-wide upgrade, which is the default)

## Configuring for an LRE Upgrade

In the absence of any LRE upgrade configurations, an LRE upgrade attempts to upgrade all local LRE controllers and CPE devices to the most recent compatible versions of the LRE binaries required for each LRE target device. LRE upgrade configurations should rarely be required. The primary purpose of LRE upgrade configuration commands is to provide for downgrades of LRE binaries.

If you wish to override the switch's automatic selection of LRE binaries, you have two methods available:

- Global LRE Upgrade Configuration Commands
- LRE Controller configuration commands

Global **config** commands allow you to specify the LRE binary or binaries to use on a specified *target type*. (A target type is the family [and optionally the model or model revision] of a device containing one or more upgradable hardware elements.) A target can be a local LRE controller on the switch or a remote CPE device.

The following describes how global LRE upgrade configurations are performed:

LRE upgrade controller configuration commands are performed from the controller configuration submode. The upgrade configuration command in the controller submode allows the user to override the system default selection of an LRE binary to be applied on a particular remote CPE device or local LRE controller. Controller configurations take precedence over global upgrade configurations.

The *preserve* keyword is used to cause the LRE upgrade mechanism to NOT upgrade the local controller on which *preserve* is configured, or any of the CPE devices connected to that controller. If you want to preserve (in other words, not upgrade) some of the CPE devices connected to a particular controller but allow upgrades to others, you can enter controller upgrade configuration commands for the links you want to upgrade.

The **no** form of the command removes the command for applying a particular LRE binary. In order to resume default upgrade behavior for a given controller, **no** upgrade commands should be configured on that controller



Note

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Global configurations which might also affect the controller and devices connected to it also need to be removed.

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Note

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When a global **config** and a controller **config** conflict, the controller **config** has precedence.

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See the reference pages for the **upgrade** commands in the *Catalyst 2900 XL and Catalyst 3500 XL Desktop Switch Command Reference* for further details.

## Performing an LRE Upgrade

You can upgrade either on a system-wide basis (in other words, upgrading the software on all connected CPE devices and local LRE chipsets), or on individual CPE device or LRE controllers. By default, a system wide upgrade applies the most recent versions of LRE binaries that are most compatible with each upgradable hardware module. The system-wide upgrade method is the one that you use in almost all situations.

When executing upgrades, you can elect to upgrade a single CPE device or local controller using the following command:

```
hw-module slot <x> upgrade lre [local lo n | remote lo x/y]
```

If no local or remote option is given, a system-wide upgrade is performed.

## Global Configuration of LRE Upgrades

Beginning in privileged EXEC mode, follow these steps to use perform a system-wide upgrade to configure the LRE binary to apply to a target device and upgradable hardware element combination:

	Command	Purpose
Step 1	<b>configure terminal</b>	Enter global configuration mode.
Step 2	<b>lre binary default</b> <i>target_device LRE_binary</i>	Enter the device to which the LRE binary should be applied, and the LRE binary to be applied.
Step 3	<b>end</b>	Return to privileged EXEC mode.
Step 4	<b>show lre upgrade version</b>	Verify the change.



### Note

The `lre upgrade default` command essentially overrides the system default selection of an LRE binary for a specified family of CPE device (target device).

## Controller Configuration of LRE Upgrades

Beginning in privileged EXEC mode, follow these steps to explicitly direct the LRE binaries to be applied to either the local controller or a specific VDSL link:

	Command	Purpose
Step 1	<b>configure terminal</b>	Enter global configuration mode.
Step 2	<b>controller lre</b> <i>chipset_number</i>	Enter the particular LRE local chipset on the switch to be applied.
Step 3	<b>upgrade</b> <[ <b>remote lo</b> <i>x/y</i> ] <i>LRE_Binary</i>   <b>preserve</b> >	Enter the LRE binary to be applied or set <b>preserve</b> , which prevents upgrade of any CPE devices connected to a controller or local chipset.
Step 4	<b>end</b>	Return to privileged EXEC mode.
Step 5	<b>show lre upgrade version</b>	Verify the change.

The upgrade configuration command in the controller submode allows the user to override the system default selection of an LRE binary that will be applied on either end of a particular LRE link. Controller configurations take precedence over global upgrade configurations.

The *preserve* keyword is used to cause the LRE upgrade mechanism to NOT upgrade the local controller on which preserve is configured or any of the CPE devices connected to that controller. If you want to preserve (in other words, not upgrade) some of the CPE devices connected to a particular controller but allow upgrades to others, you can enter controller upgrade configuration commands for the links you want to upgrade.

The **no** form of the command removes the command for applying a particular LRE binary. In order to resume default upgrade behavior for a given controller, no custom upgrade commands should be configured on that controller.

## LRE Upgrade Behavior Details

This is what you see on the console when you initiate an upgrade:

```
Switch>en
Switch#hw-module slot 0 upgrade lre
You are about to start an LRE upgrade on all LRE interfaces.
Users on LRE links being upgraded will experience a temporary disruption of Ethernet
connectivity.
Start LRE upgrade ? [yes]:
```

If you answer *yes* or press the Enter key, the upgrade starts. If you answer *no*, you get the EXEC prompt.

You expect the following link behavior of the CPE device during an upgrade:

- When the upgrade starts, the link is most likely in the *link-up* state, the state of the link that is useful to you.
- When the upgrade starts, the remote CPE device is reset. Ethernet connectivity is temporarily lost at this point.
- The CPE device comes up, with the link slower (about 1 Mbps upstream and 4 Mbps downstream) but more reliable. The increased reliability is required for a successful LRE binary transfer. The LRE link stays at a slower speed for the duration of the upgrade. Ethernet connectivity is available.
- When the upgrade is complete, the CPE device is again reset so that the upgraded LRE binaries are loaded and executed on the target CPE devices and local LRE chipsets. Ethernet connectivity is again disrupted until the CPE device comes out of reset.
- The link comes up when the CPE device comes back up, and then resumes full operation at its intended data rate.

## LRE Upgrade Example

The following is an example of how an LRE upgrade can proceed:

```
Switch#hw-module slot 0 upgrade lre force remote lo 0/1
You are about to start an LRE upgrade on CPE Lo0/1.
Users on LRE links being upgraded will experience a temporary
disruption of Ethernet connectivity.
```

```
Start LRE upgrade ? [yes]:
```

```
Starting remote upgrade on CPE Lo0/1
```

```
Switch#
00:21:51: %LINEPROTO-5-UPDOWN: Line protocol on Interface
LongReachEthernet0/1, changed state to down
```

The CPE device resets and the link is down. Ethernet connectivity is unavailable.

```
00:22:37: %LINK-3-UPDOWN: Interface LongReachEthernet0/1, changed state to up
00:22:39: %LINEPROTO-5-UPDOWN: Line protocol on Interface
LongReachEthernet0/1, changed state to up
```

The CPE device comes out of reset. Ethernet connectivity is available but at low speeds. Upgrade data transfer begins.

```
00:23:55: %LINEPROTO-5-UPDOWN: Line protocol on Interface
LongReachEthernet0/1, changed state to down
```

Upgrade data transfer is complete. Reset the CPE device.

```
00:23:56: %LINK-3-UPDOWN: Interface LongReachEthernet0/1, changed state to up
```

The CPE device has come out of reset. The desired profile is applied.

```
00:23:58: %LRE_LINK-3-UPDOWN: Interface Lo0/1, changed state to UP
00:23:59: %LINK-3-UPDOWN: Interface LongReachEthernet0/1, changed state to up
00:24:02: %LINEPROTO-5-UPDOWN: Line protocol on Interface
LongReachEthernet0/1, changed state to up
```

Operation resumes in the profile link up state.

```
Switch#
```

