Configuring LRE

This chapter describes how to configure the Long-Reach Ethernet (LRE) features on your Catalyst 2950 LRE switch. This chapter consists of these sections:

Note For complete syntax and usage information for the commands used in this chapter, see the switch command reference for this release and the *Cisco IOS Interface Command Reference for Cisco IOS Release 12.1*.

For information about which Cisco LRE customer premises equipment (CPE) devices are supported by the LRE switches, see Table 1-2 on page 1-2.

Understanding LRE Features

These sections describe LRE features:

Ports on the Catalyst 2950 LRE Switches

The Catalyst 2950 LRE switches use LRE technology to transfer data, voice, and video traffic over categorized and noncategorized 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 CPE device such as the Cisco 575 LRE CPE or the Cisco 585 LRE CPE. This connection can be through categorized or noncategorized unshielded twisted-pair cable and can extend to distances of up to 5000 feet (1524 meters).
- 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 meters).

The actual line speed in either direction between an LRE switch port and a 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 "Diagnosing LRE Connection Problems" section on page 31-18. For more information about the LRE commands, see the command reference for this release.

LRE Links and LRE Profiles

The LRE link settings define the connection between the LRE switch port and the CPE RJ-11 wall port. The LRE link provides symmetric and asymmetric bandwidth for data, voice, and video traffic. *Symmetric* transmission occurs when the downstream and upstream bandwidths are the same. *Asymmetric* transmission occurs when the downstream and the upstream bandwidths differ. *Downstream* transmission refers to the traffic going from the LRE switch to the CPE device. *Upstream* transmission refers to the traffic going 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 to 18.750 Mbps.

This section discusses these topics:

LRE Profiles

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 system-defined profiles. You can configure a profile on a global or per-port basis. By default, all LRE ports on the Catalyst 2950ST-8 LRE and 2950ST-24 LRE switches are enabled with the LRE-10 profile, and all LRE ports on the Catalyst 2950ST-24 LRE 997 switches are enabled with the LRE-6 profile. These default profile allows the upstream and downstream effective data rate on the LRE link to be 10 Mbps and 6.0 Mbps, respectively.

Table 12-1 and Table 12-2 contain the full list of LRE profiles, as well as their downstream and upstream rates (in Mbps and their theoretical upstream and downstream signal-to-noise [SNR] rates in decibels [dB]).

Note Consult the regulations for connecting to the public switched telephone network (PSTN) in your area.

Note Use the rates and distances in Table 12-1 and Table 12-2 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. The downstream and upstream rates in the table are slightly less than the gross data rates shown by the **show controllers lre profile names** privileged EXEC command output.

Table 12-1 LRE Profiles for the Catalyst 2950ST-8 LRE and the 2950ST-24 LRE Switches

Profile Name	LRE Link Downstream Rate (Mbps)	LRE Link Upstream Rate (Mbps)	Theoretical Minimum SNR Downstream	Theoretical Minimum SNR Upstream
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
LRE-998-15-4	16.667	4.688	31	25
LRE-997-10-4	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-4-1-LL	4.167	1.563	19	13

Table 12-2 LRE Profiles for the Catalyst 2950ST-24 LRE 997 Switches

Profile Name	LRE Link Downstream Rate (Mbps)	LRE Link Upstream Rate (Mbps)	Theoretical Minimum SNR Downstream	Theoretical Minimum SNR Upstream
LRE-12-9	12.500	9.375	31	25
LRE-12-3	12.500	3.125	31	13
LRE-9	9.375	9.375	25	25
LRE-9-6	9.375	6.250	25	19
LRE-9-4	9.375	4.688	25	16
LRE-9-3	9.375	3.125	25	13
LRE-6 (default)	6.250	6.250	19	19
LRE-6-4	6.250	4.6888	19	16
LRE-6-3	6.250	3.125	19	13
LRE-4	4.688	4.688	16	16
LRE-4-3	4.688	3.125	16	13

Your data rates will always be less than the gross data rate listed in tables. A small percentage of the link rate is used by the Catalyst 2950 LRE switch for supervisory functions with the CPE device connected remotely.

In general, profiles are named for the data rate that 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 (LRE-998-15-4 and LRE-997-10-4) are exceptions to this. These two uniquely named profiles also work in any private deployment.

- If you are not using sequences and you have not assigned a profile to an LRE port, the port has a default profile of LRE-10 or LRE-6 (see Table 12-1 and Table 12-2). Port profiles have priority over global profiles. If you assign a global profile to the switch, the switch uses the global profile except on any LRE ports on which a specific profile was assigned.

  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, and LRE-15LL) on the Catalyst 2950ST-8 LRE and 2950ST-24 LRE switches with care. These profiles have the low-latency (LL) feature enabled and the interleave feature disabled. The LL feature does not delay data transmission, but it makes data more susceptible to interruptions on the LRE link.

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

  For information on configuring the interleaving delay on the LRE ports, see the "Configuring LRE Interleave" section on page 12-20.

- The symmetric profiles (LRE-5, LRE-10, LRE-15, LRE-8, LRE-7, LRE-4, LRE-3, and LRE-2) on the Catalyst 2950ST-8 LRE and the 2950ST-24 LRE switches 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 Sequences

The LRE switches are shipped with predefined sequences. Sequences are sets of profiles and are used with the rate selection feature. The rate selection feature enables the switch to automatically select profiles. You can also define your own sets of sequences by using the command-line interface (CLI) commands. For more information, see the "Using Rate Selection to Automatically Assign Profiles" section on page 12-14.

Table 12-3 and Table 12-4 list the predefined sequences for rate selection contained in the software. When executing rate selection, the switch uses a sequence to choose an appropriate profile for a given LRE interface.

Table 12-3 LRE Rate Selection Sequences for the Catalyst 2950ST-8 LRE and the 2950ST-24 LRE Switches

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-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						

Table 12-4 LRE Rate Selection Sequences for the Catalyst 2950ST-24 LRE 997 Switches

LRE-SEQ-COMPLETE-REACH	LRE-SEQ-DOWNSTREAM	LRE-SEQ-SYM	LRE-SEQ-SYM-LONGREACH	LRE-SEQ-UPSTREAM	LRE-SEQ-VIDEO-TRANSMIT1
LRE-12-9	LRE-12-9	LRE-9	LRE-6-4	LRE-12-9	LRE-12-9
LRE-12-3	LRE-12-3	LRE-6	LRE-4	LRE-9	LRE-9
LRE-9	LRE-9	LRE-4	LRE-9-3	LRE-9-6	LRE-9-6
LRE-9-6	LRE-9-6		LRE-6-3	LRE-6	LRE-9-4
LRE-9-4	LRE-9-4		LRE-4-3	LRE-9-4	LRE-9-3
LRE-6	LRE-9-3			LRE-6-4	
LRE-6-4	LRE-6			LRE-4	
LRE-9-3	LRE-6-4			LRE-12-3	
LRE-4	LRE-6-3			LRE-9-3	
LRE-6-3	LRE-4			LRE-6-3	
LRE-4-3	LRE-4-3			LRE-4-3	

Beginning with the first profile in a sequence, the switch attempts to apply each profile within that sequence to the LRE interface. The switch continues these attempts until it converges (*convergence time* refers to the time required for the switch to settle on an appropriate profile for the LRE interface). The link is *DOWN* until a link is established by one of the profiles in the sequence, after which, it is *UP*.

For additional information on rate selection, see the "Using Rate Selection to Automatically Assign Profiles" section on page 12-14.

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 the CLI, you can configure and monitor the Ethernet link on a Cisco 575 LRE CPE and the Cisco 585 LRE CPE. You can configure and monitor the Ethernet link on a Cisco 576 LRE 997 CPE only from the CLI. For information about the switch LEDs, see the *Catalyst 2950 Desktop Switch 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. 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.

- Certain CPEs do not work with certain switches. For details, see the LRE switch and CPE compatibility matrix (see Table 1-2 on page 1-2). You can connect Cisco 575 LRE CPEs and Cisco 585 LRE CPEs to the Catalyst 2950ST-8 LRE or 2950ST-24 LRE switch. You can connect a Cisco 576 LRE 997 CPE only to a Catalyst 2950ST-24 LRE 997 switch.
- You can hot-swap the CPE devices without powering down the switch or disrupting the other switch ports.
- The CPE toggle feature automatically changes a CPE Ethernet link from down to up if the LRE link comes up in less than 30 seconds. This feature is enabled by default.

  CPE toggle cannot be disabled on a Cisco 575 LRE or Cisco 576 LRE 997 CPE link but can be disabled on a Cisco 585 LRE CPE. For more information, see the "Configuring CPE Toggle" section on page 12-22.

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 LRE CPE interface. For information about this command, see the command reference for this release.

LRE Link Monitor

When the link monitor feature is enabled, an LRE switch tracks undesirable or interesting conditions on a link and takes system-defined actions after certain thresholds are reached. The link monitor can track these conditions:

- SNR, in dB: The link must have a minimum SNR to function; a higher SNR value means a better noise margin on the link. Links are not established if the SNR is insufficient. For more information, see the "Link Qualification and SNR Margins" section on page 12-16.
- Reed-Solomon (RS) errors: The RS Forward Error Correction circuit corrects small bursts of errors so that noise events do not cause Ethernet frame check sequence (FCS) errors. This is implemented in the octal chip as a 32-bit counter. The count resets on read.
- Transmit (TX) Power, in dBm/Hz: This is fixed for the switch and adjusts automatically for the CPE device. The local transmit power is always constant and the same for a given profile. The remote transmit power varies according to distance from the switch to the CPE device, with a minimum transmit power of 91.9 dBm/Hz (corresponding to short distances) and a maximum transmit power of –55 dBm/Hz (corresponding to longer cable lengths or greater cable attenuation). The CPE device power can reach its maximum at distances between 1500 feet (450 meters) and 3000 feet (900 meters).
- Software Controlled Automatic Gain Control (SW AGC Gain), in dBm: This gives an indirect measure of the received power level. Higher values mean that the receive power is lower (and thus in need of more boost).
- Link Fail Counts: The number of times the link failed. A failed link interrupts operation of the Ethernet link for a small number of milliseconds. During this interruption, some packets might be dropped (depending on traffic levels).
- PMD Freeze Event Counter: This counts the occurrence of micro-interruption or saturation events. Micro-interruptions and Analog to Digital Converter (ADC) saturations are caused by impulse noise for a short duration. This is implemented in the octal chip as a 8-bit counter.

The link parameters need to be monitored both for the upstream and downstream directions.

You can use the information that you get from the link monitor to log events, set traps, change to a lower rate profile, and disable the automatic power back-off feature.

LRE Message Logging Process

The Catalyst 2950 LRE switch software monitors switch conditions on a per-port basis and sends the debugging messages to an LRE message logging process that is different than the system message logging process described in Chapter 26, "Configuring System Message Logging."

These options are available in the LRE logging process:

- Disabled—The switch does not log LRE events.
- Event—The switch logs only LRE events.
- Extended—The switch logs LRE events and all the LRE parameters.
- Normal—The switch logs LRE events and the typical LRE parameters.

You can use the **logging lre** interface configuration command to specify the mode in which to log LRE events. To display the events on the LRE interfaces, use the **show controllers lre log** privileged EXEC command. For more information about these commands, see the command reference for this release.

If the syslog export feature is enabled, the switch sends the information to the LRE message logging process and to the system message logging process. For information about configuring this feature, see the "Configuring Syslog Export" section on page 12-23.

Configuring LRE Ports

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

Default LRE Configuration

This is the default LRE configuration:

- On the Catalyst 2950ST-8 LRE and the Catalyst 2950ST-24 LRE switches, the profile on all LRE ports is LRE-10.
- On the Catalyst 2950ST-24 LRE 997 switches, the profile on all LRE ports is LRE-6.
- Global profiles and global sequences are not assigned to LRE ports.
- Per-port sequences are not assigned to specific LRE ports.
- Rate selection is enabled on all interfaces, but a sequence with which to start rate selection is not defined.
- LRE link persistence is enabled. The default is 3 seconds.
- LRE link monitoring is enabled.
- The interleave block size is 16 for non low-latency (LL) profiles and 0 for LL profiles.
- For the upstream power back-off mechanism, the default noise model is the ETSI-E model (available only on the Catalyst 2950ST-24 LRE 997 switch).
- CPE toggle is enabled on a CPE Ethernet link.
- Syslog export is disabled.

Environmental Guidelines for LRE Links

The guidelines for your LRE environment are based on these factors:

- Maximum distance between the LRE switch and CPE devices—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 (1524 meters), 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 is approximately 30 percent lower.

  Each terminated bridge tap in a room can further reduce LRE link distances by 300 feet (91 meters). 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 private branch exchange (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 American Wire Gauge (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 (possibly type-2) in bundles of 100 or more.
  - Older installations (Europe) 15 to 30 years old often use 0.4 millimeter (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 millimeter (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:

- 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 to 3.5 MHz. The upstream transmission runs in a high-frequency band from approximately 4 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 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.

- 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), we recommend that you use either the ANSI profile (LRE-998-15-4) or the ETSI profile (LRE-997-10-4). For details on which profile to use elsewhere, consult the regulations for connecting to the PSTN in your area.
- LRE signaling can co-exist 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 link** privileged EXEC command to display the LRE link statistics and profile information on the LRE ports. For information about this command, see the switch command reference.

CPE Ethernet Link Guidelines

Follow these guidelines when configuring CPE Ethernet links:

- Guidelines for Configuring Cisco 575 LRE CPEs and 576 LRE 997 CPEs, page 12-11
- Guidelines for Configuring Cisco 585 LRE CPEs, page 12-12

Guidelines for Configuring Cisco 575 LRE CPEs and 576 LRE 997 CPEs

You can configure the 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.

When the default speed is set to 10 or 100 Mbps with half duplex, the values set are the same. Table 12-5 shows the speed and duplex settings on the CPE Ethernet port and the switch Ethernet port.

Note The LRE link speed and duplex values are profile independent. All LRE links have a default speed of 100 Mbps with half duplex except for the profile LRE-10 (on the Catalyst 2950ST-8 LRE and 2950ST-24 LRE switches), which is set to 10 Mbps with full duplex.

Table 12-5 Speed and Duplex Settings

CPE		LRE Switch	
Speed	**Duplex**	**Speed**	**Duplex**
10	Full	10	Half
10	Half	10	Half
100	Full	100	Half
100	Half	100	Half

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 802.3x 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 **cpe duplex** and **cpe speed** interface configuration commands, respectively, to configure the duplex and speed settings on the Cisco 575 LRE CPE or the 576 LRE 997 CPE Ethernet port.

You cannot disable CPE toggle on a link from a Cisco 575 LRE or Cisco 576 LRE CPE to a remote device (such as a PC).

Guidelines for Configuring Cisco 585 LRE CPEs

You can configure the Cisco 585 LRE CPE Ethernet port speed and duplex mode from the CLI, depending on the capability of the remote Ethernet device. Autonegotiation for CPE port speed and duplex mode is supported. Use the **cpe duplex** and **cpe speed** interface configuration commands, respectively, to configure the duplex and speed settings on a Cisco 585 LRE CPE Ethernet port.

The default speed for the CPE Ethernet ports is auto. The default duplex mode is half duplex at 100 Mbps with back pressure.

You can enable or disable the CPE Ethernet ports on a per-port basis.

You can disable CPE toggle on a Cisco 585 LRE CPE.

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 Global Profile to All LRE Ports

Global profiles are set on a switch-wide basis.

Port sequences, global sequences, and port profiles have priority over global profiles (see the "Precedence" section on page 12-15). If you assign a global profile to the switch, it cannot override any previously or subsequently set sequence port profile. For more information on sequence and profile precendence, see the "Guidelines for Using LRE Profiles" section on page 12-10.

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

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

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**lre profile** *profile-name*	Enter the global profile name. Select from the list in Table 12-1 on page 12-3 or Table 12-2 on page 12-4.
Step 3	**end**	Return to privileged EXEC mode.
Step 4	**show controllers lre profile details**	Verify the change.
Step 5	**copy running-config startup-config**	(Optional) Save your entries in the configuration file.

To return to the default global profile, use the **no lre profile** *profile-name* global configuration command.

To display the LRE link statistics and profile information on the LRE ports, use the **show controllers lre** privileged EXEC commands.

Assigning a Profile to a Specific LRE Port

You can set profiles on a per-port basis. You can assign the same profile or different profiles to the LRE ports on the switch. The default active profile on all LRE ports is LRE-10 on the Catalyst 2950ST-8 LRE and 2950ST-24 LRE switches and LRE-6 on the Catalyst 2950ST-24 LRE 997 switch.

The switch resets the ports with the updated profile settings when they are changed.

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

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface-id*	Specify the LRE port to be configured, and enter interface configuration mode.
Step 3	**profile** *profile-name*	Enter the port profile name (select from the list in Table 12-1 on page 12-3 or Table 12-2 on page 12-4).
Step 4	**end**	Return to privileged EXEC mode.
Step 5	**show controllers lre profile details**	Verify the change.
Step 6	**copy running-config startup-config**	(Optional) Save your entries in the configuration file.

To delete the profile from a sequence, use the **no profile** *profile-name* interface configuration command.

To display the LRE link statistics and profile information on the LRE ports, use the **show controllers lre** privileged EXEC command.

Assigning a Global Sequence to All LRE Ports

Global sequences are set on a switch-wide basis. If you assign a global sequence to the switch, it overrides any previously or subsequently set profiles. For more information on sequence and profile precendence, see the "Guidelines for Using LRE Profiles" section on page 12-10.

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

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

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**lre rate selection sequence** *sequence-name*	Enter the global sequence name. Select from the list in Table 12-3 on page 12-5 and Table 12-4 on page 12-6.
Step 3	**end**	Return to privileged EXEC mode.
Step 4	**show controllers lre status sequence**	Verify the change.
Step 5	**copy running-config startup-config**	(Optional) Save your entries in the configuration file.

To delete the assigned sequence, use the **no lre rate selection sequence** *sequence-name* global configuration command.

To display the LRE link statistics and sequence information on the LRE ports, use the **show controllers lre status sequence details** privileged EXEC command.

Assigning a Sequence to a Specific LRE Port

You can set sequences on a per-port basis. You can assign the same sequence or different sequences to the LRE ports on the switch. If you assign a sequence on a per-port basis, it overrides any previously or subsequently set profiles or global sequence.

The switch resets the ports with the updated sequence settings when they are changed.

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

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface-id*	Enter the number of the LRE port to be configured, and enter interface configuration mode.
Step 3	**sequence** *sequence-name*	Enter the port sequence name (select from the list in Table 12-3 on page 12-5 or Table 12-4 on page 12-6).
Step 4	**end**	Return to privileged EXEC mode.
Step 5	**show controllers lre status sequence**	Verify the change.
Step 6	**copy running-config startup-config**	(Optional) Save your entries in the configuration file.

To remove a sequence from a port, use the **no sequence** *sequence-name* interface configuration command.

To display the LRE link statistics and sequence information on the LRE ports, use the **show controllers lre status sequence details** privileged EXEC command.

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 on the Catalyst 2950ST-8 LRE and 2950ST-24 LRE switches and LRE-6 on the Catalyst 2950ST-24 LRE 997 switch. You can use the rate selection feature 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).

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 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.

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

- When the switch is started up
- When you enable the rate selection feature
- When you connect a new CPE device to the switch
- When a link is lost for 25 seconds before being restored
- When a configured sequence is modified

In any of these cases, rate selection obtains the optimal profile for your line conditions.

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

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

Precedence

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 that work with rate selection to determine the rate for a port or the entire switch. Port sequences have the highest priority; that is, they take precedence over any other profile or sequence. The priority levels, from highest to lowest, are as shown:

1. *Port sequence*: rate selection is enabled on the given port only with the given sequence.
2. *Global sequence*: rate selection is enabled for the entire switch with the given sequence.
3. *Port profile*: rate selection is enable for the given port only with the given profile.
4. *Global profile*: rate selection is enabled for the entire switch with the given profile.

See Table 12-1 on page 12-3 and Table 12-2 on page 12-4 for the list of profiles and Table 12-3 on page 12-5 and Table 12-4 on page 12-6 for the list of system-defined sequences. You can also use CLI commands to define your own sequences.

Note If rate selection is disabled for a port, profiles are used.

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; afterwards, rate selection is never executed, even if one of the four listed events occur. You use the **rate selection profile lock** interface configuration command to lock the profile chosen by rate selection. You can also enter the **clear lre rate section** [**lock**] [*interface-id*] privileged 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	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface-id*	Specify the LRE port to be configured, and enter interface configuration mode.
Step 3	**rate selection profile lock**	Lock the profile.
Step 4	**end**	Return to privileged EXEC mode.
Step 5	**show controllers lre profile details**	Verify the change.
Step 6	**copy running-config startup-config**	(Optional) Save your entries in the configuration file.

To unlock a port, use the **no rate selection profile lock** interface configuration command.

Link Qualification and SNR Margins

When rate selection is running, the SNR is used as an indicator of link quality. The switch does not provide any internal mechanism to ensure 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.

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 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 means 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 12-6 and Table 12-8 list the SNR requirements for downstream rates for different profiles. Table 12-7 and Table 12-9 list the SNR requirements for upstream rates for different profiles.

Table 12-6 SNR Requirements for Downstream Rates for the Catalyst 2950ST-8 LRE and the Catalyst 2950ST-24 LRE Switches

Profile	Gross Data Rate	Quadrature Amplitude Modulation (QAM)	Theoretical Minimum SNR	Low Noise SNR	Medium Noise SNR	High Noise SNR
LRE-4-1	4.17	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	6.25	8	16	19	21	24
LRE-10	12.5	64	25	27	29	32
LRE-15	16.667	256	31	33	35	39

Table 12-6 SNR Requirements for Downstream Rates for the Catalyst 2950ST-8 LRE and the Catalyst 2950ST-24 LRE Switches (continued)

Profile	Gross Data Rate	Quadrature Amplitude Modulation (QAM)	Theoretical Minimum SNR	Low Noise SNR	Medium Noise SNR	High Noise SNR
LRE-10-5	12.5	64	25	27	29	32
LRE-10-3	12.5	64	25	27	29	32
LRE-10-1	12.5	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
LRE-998-15-4	16.667	256	31	33	35	39
LRE-997-10-4	12.5	256	31	33	35	39
LRE-2	2.08	4	13	15	17	20
LRE-3	3.13	4	13	15	17	20
LRE-4	4.17	4	13	15	17	20

Table 12-7 SNR Requirements for Upstream Rates for the Catalyst 2950ST-8 LRE and the Catalyst 2950ST-24 LRE Switches

Profile	Gross Data Rate	QAM	Theoretical Minimum SNR	Low Noise SNR	Medium Noise SNR	High Noise SNR
LRE-4-1	1.56	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	6.25	4	13	15	17	20
LRE-10	12.5	16	19	21	23	26
LRE-15	18.75	64	25	27	30	34
LRE-10-5	6.25	4	13	15	17	20
LRE-10-3	3.125	16	19	21	23	26
LRE-10-1	1.56	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
LRE-998-15-4	4.688	64	25	27	29	32
LRE-997-10-4	4.688	64	25	27	29	32
LRE-2	2.08	4	13	15	17	20
LRE-3	3.13	4	13	15	17	20
LRE-4	4.17	4	13	15	17	20

Table 12-8 SNR Requirements for Downstream Rates for the Catalyst 2950ST-24 LRE 997 Switches

Profile	Gross Data Rate	QAM	Theoretical Minimum SNR	Low Noise SNR	Medium Noise SNR	High Noise SNR
LRE-12-9	12.500	256	31	33	35	38
LRE-12-3	12.500	256	31	33	35	38
LRE-9	9.375	64	25	27	29	32
LRE-9-6	9.375	64	25	27	29	32
LRE-9-4	9.375	64	25	27	29	32
LRE-9-3	9.375	64	25	27	29	32
LRE-6 (default)	6.250	16	19	21	23	25
LRE-6-4	6.250	16	19	21	23	25
LRE-6-3	6.250	16	19	21	23	25
LRE-4	4.688	8	16	18	20	23
LRE-4-3	4.688	8	16	18	20	23

Table 12-9 SNR Requirements for Upstream Rates for the Catalyst 2950ST-24 LRE 997 Switches

Profile	Gross Data Rate	QAM	Theoretical Minimum SNR	Low Noise SNR	Medium Noise SNR	High Noise SNR
LRE-12-9	9.375	64	25	27	29	32
LRE-12-3	3.125	4	13	15	17	20
LRE-9	9.375	64	25	27	29	32
LRE-9-6	6.250	16	19	21	23	25
LRE-9-4	4.688	8	16	18	20	23
LRE-9-3	3.125	4	13	15	17	20
LRE-6 (default)	6.250	16	19	21	23	26
LRE-6-4	4.688	8	16	18	20	23
LRE-6-3	3.125	4	13	15	17	20
LRE-4	4.688	8	16	18	20	23
LRE-4-3	3.125	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 indicate 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), the software 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	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface-id*	Enter the number of the LRE port to be configured, and enter interface configuration mode.
Step 3	**margin** {**downstream** *value* | **upstream** *value*}	Enter the downstream or upstream margin value (in dB). For the values, see Table 12-6 on page 12-16, Table 12-7 on page 12-17, Table 12-8 on page 12-18, and Table 12-9 on page 12-18.
Step 4	**end**	Return to privileged EXEC mode.
Step 5	**show controllers lre profile details**	Verify the change.
Step 6	**copy running-config startup-config**	(Optional) Save your entries in the configuration file.

To return to the default values, use the **no margin** {**downstream** | **upstream**} interface configuration command.

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

Configuring LRE Link Persistence

If the LRE link shuts down and is automatically re-enabled quickly, the switch configuration might change. For example, the dynamic MAC addresses are removed from the MAC address table. You can use the link persistence feature to configure a delay duration on the Catalyst 2950 LRE switch of up to 20 seconds before link failure is reported.

Beginning in privileged EXEC mode, follow these steps to set the delay duration on a specific LRE port:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface-id*	Specify the LRE port to be configured, and enter interface configuration mode.
Step 3	**persistence** *delay*	Enter the length of time (in seconds) for the delay duration. The default is 3 seconds. The range is 1 to 20 seconds.
Step 4	**end**	Return to privileged EXEC mode.
Step 5	**show controllers lre status persistence**	Verify the change.
Step 6	**copy running-config startup-config**	(Optional) Save your entries in the configuration file.

To return to the default value, use the **no persistence** interface configuration command.

Configuring LRE Link Monitor

When link monitor is enabled, an LRE switch feature tracks undesirable or interesting conditions on a link or takes system-defined actions after certain thresholds are reached.

Beginning in privileged EXEC mode, follow these steps to enable link monitor:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface-id*	Specify the LRE port to be configured, and enter interface configuration mode.
Step 3	**link monitor**	Enable LRE link monitoring on an LRE port.
Step 4	**end**	Return to privileged EXEC mode.
Step 5	**show running-config**	Verify the change.
Step 6	**copy running-config startup-config**	(Optional) Save your entries in the configuration file.

To disable the link monitor feature, use the **no link monitor** interface configuration command.

Configuring LRE Interleave

The interleave feature provides maximum protection against small interruptions on the LRE link but delays data transmission. You can configure the interleave delay on LRE interfaces.

A lower value of the interleave block size means less tolerance to noise and causes a lower latency of frame transmission. For example, lower values of the interleave block size can be used for voice applications. A higher value of the interleave block size means higher tolerance to noise and causes higher latency in the frame transmission. For example, higher values of the interleave block size can be used for data applications.

If a lower latency of frame transmission is required, you can use a lower interleave value, but the LRE switch will have less tolerance to noise.

Follow these guidelines for configuring the interleave delay:

- Interleave delay is applicable only when the non-LL profiles are used. Existing LL profiles are supported.
- Interleave block size values of 0, 1, 2, 8, or 16 are supported.
- Different ports with the same profile can have different interleave settings.

Beginning in privileged EXEC mode, follow these steps to set the interleave block size on a specific LRE port:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface-id*	Specify the LRE port to be configured, and enter interface configuration mode.
Step 3	**interleave downstream** *value* **upstream** *value*	Enter the downstream and upstream values. Supported values for interleave block sizes are 0, 1, 2, 8, or 16.
Step 4	**end**	Return to privileged EXEC mode.
Step 5	**show controllers lre status interleave**	Verify the change.
Step 6	**copy running-config startup-config**	(Optional) Save your entries in the configuration file.

To return the port to its default setting, use the **no interleave downstream** *value* **upstream** *value* interface configuration command.

Configuring Upstream Power Back-Off

You can configure this feature only on a Catalyst 2950ST-24 LRE 997 switch.

The upstream power back-off mechanism allows for normalization of the upstream receive power levels by requiring the CPE devices on shorter lines to send at a lower power level than the CPEs on longer lines. You can change the upstream power back-off values by either selecting a standard noise model or by setting an offset value for the default reference power spectral density (PSD).

Follow these guidelines for configuring upstream power back-off:

- The reference PSD number is based on an upstream carrier frequency of 4.8 MHz.
- You can use the offset values to adjust the CPE transmit reference PSD relative to the default reference of –140 dBm/Hz. A zero value for the offset corresponds to a reference PSD of –140 dBm/Hz. The smallest offset is 30 dBm/Hz, and the corresponding value is 300.

When you enter the **lre upbo** global configuration command, all LRE links are reset to the UP state. Before configuring the reference TX power level, follow these guidelines:

- Verify how this command affects the network in a lab environment.
- Make sure that all the CPEs in the production network are running the same LRE binary version. Use the **show controllers lre cpe version** privileged EXEC command to display the binary version on all CPE device interfaces.

Caution Changing the noise model while the switch is functioning in a network can disrupt the network operation.

Beginning in privileged EXEC mode, follow these steps to configure upstream power back-off on a Catalyst 2950ST-24 LRE 997 switch:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**lre upbo** {*noise-model* | *offset value*}	Enter the noise level or the offset value. Supported noise-model values are **etsi-a**, **etsi-b**, **etsi-c**, **etsi-d** and **etsi-f**. The offset value is calculated with reference to –140. For example, if you require a reference PSD of –95 dbm/Hz, you need to enter the offset of 45 (–95 – [–140] = 45). The supported value range is 300 to 800. **Note** The LRE CPE power spectral density (PSD) offset value is in 10*dB (for example, 450 means 45 dB).
Step 3	**end**	Return to privileged EXEC mode.
Step 4	**show controllers lre status psd** **show controllers lre cpe version**	Verify the change. Displays the LRE binary version running on the CPE.
Step 5	**copy running-config startup-config**	(Optional) Save your entries in the configuration file.

To return the switch to its default setting, use the **no lre upbo** {*noise-model* | *offset value*} global configuration command.

Configuring CPE Toggle

The CPE toggle feature is enabled by default. It cannot be disabled on a link from a Cisco 575 LRE or Cisco 576 LRE 997 CPE to a remote Ethernet device (such as PC).

You can disable CPE toggle on a Cisco 585 LRE CPE link. Then the CPE Ethernet link does not transition to the up state when the LRE link comes up.

Beginning in privileged EXEC mode, follow these steps to disable CPE toggle on a Cisco 585 LRE CPE link:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface-id*	Specify the LRE port to be configured, and enter interface configuration mode.
Step 3	**no cpe toggle** [**port** *port-id*]	Disable CPE toggle on a CPE Ethernet link. (Optional) Specify the CPE port on which CPE toggle is disabled.
Step 4	**end**	Return to privileged EXEC mode.
Step 5	**show running-config**	Verify the change.
Step 6	**copy running-config startup-config**	(Optional) Save your entries in the configuration file.

To re-enable CPE toggle on the Cisco 585 LRE CPE link, use the **cpe toggle** [**port** *port-id*] interface configuration command.

Configuring Syslog Export

If the syslog export feature is enabled, the switch sends the debugging messages to the LRE message logging process and to the system message logging process.

Before enabling this feature, follow these guidelines:

- Make sure that LRE logging is enabled.
- Make sure that the console severity in the system message logging configuration is set to debugging. For more information, see Chapter 26, "Configuring System Message Logging."

Beginning in privileged EXEC mode, follow these steps to enable the switch to send debugging messages to the LRE message logging process and to the system message logging process:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**lre syslog**	Enable the switch to send debugging messages from the LRE logging process to the system message logging process.
Step 3	**end**	Return to privileged EXEC mode.
Step 4	**show running-config**	Verify the change.
Step 5	**copy running-config startup-config**	(Optional) Save your entries in the configuration file.

To disable the syslog export feature, use the **no lre syslog** global configuration command. When you enter this command, the switch sends debugging messages only to the LRE message logging process.

Beginning in privileged EXEC mode, follow these steps to specify the mode in which to log LRE events:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface-id*	Specify the LRE port to be configured, and enter interface configuration mode.
Step 3	**logging lre** {**event** | **extended** | **normal**}	Specify the mode in which to log LRE events: • **event**—Log events only. • **extended**—Log events and all possible parameters. • **normal**—Log events and some typical parameters.
Step 4	**end**	Return to privileged EXEC mode.
Step 5	**show running-config**	Verify the change.
Step 6	**copy running-config startup-config**	(Optional) Save your entries in the configuration file.

To turn off the logging of events, use the **no logging lre** {**event** | **extended** | **normal**} interface configuration command.

Upgrading LRE Switch Firmware

The Catalyst 2950 LRE switch can store and properly apply LRE binaries in case there are updates required to the firmware on the switch local LRE controllers or connected CPE devices.

Other desirable upgrade-related features include:

- Allowing you to use an earlier version of the LRE software if required.
- Simplifying the upgrade process as much as possible, especially in cases where you want to upgrade multiple CPE devices by using 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 might take longer than this to upgrade.)

You perform an upgrade by using the **hw-module slot** *module-slot-number* **upgrade lre** [**force**] [**local** *ctrlr-unit-number* | **remote** *interface-id*] privileged EXEC command.

Automatic upgrading is not supported. You can upgrade in one of 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, the 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 automatic switch selection of LRE binaries, these methods are available:

- Global LRE upgrade configuration commands
- LRE controller configuration commands

You can specify the LRE binary or binaries for 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.

You can perform global LRE upgrade configurations by entering the **upgrade binary** and the **upgrade preserve** controller configuration commands.

Note You must remove global configurations that might affect the controller and devices connected to it.

Note If you enter the **lre upgrade default family** global configuration command and the **upgrade binary** *LRE binary* [**remote** *interface-id*] controller configuration command, the **upgrade binary** controller configuration command has precedence.

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 by using the **hw-module slot** *module-slot-number* **upgrade lre** [**force**] [**local** *ctrlr-unit-number* | **remote** *interface-id*] privileged EXEC command. 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 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	**configure terminal**	Enter global configuration mode.
Step 2	**lre binary default** *target_device LRE_binary*	Enter the device to which the LRE binary should be applied and the LRE binary to be applied.
Step 3	**end**	Return to privileged EXEC mode.
Step 4	**show lre upgrade version**	Verify the change.

Note The **lre upgrade default family** global configuration command essentially overrides the system default selection of an LRE binary for a specified family of CPE devices (target devices).

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 very-high-data-rate digital subscriber line (VDSL) link:

	Command	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**controller lre** *chipset_number*	Enter the particular LRE local chipset on the switch to be applied.
Step 3	**upgrade** {*LRE binary* [**remote** *lre-interface*] | **preserve**}	Enter the LRE binary to be applied, or set **preserve**, which prevents the upgrade of any CPE devices connected to a controller or local chipset.
Step 4	**end**	Return to privileged EXEC mode.
Step 5	**show lre upgrade version**	Verify the change.

You can use the **upgrade** controller configuration command 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 causes 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 upgrade** controller configuration command removes the command for applying a particular LRE binary. To resume default upgrade behavior for a given controller, do not configure the custom upgrade commands on that controller.

LRE Upgrade Details

This example shows how to upgrade your LRE switch:

```
Switch> enable
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.

During an upgrade, this process occurs:

- When the upgrade starts, the link is probably in the *link-up* state, the state of the link that is useful to you.
- When the upgrade starts, the remote CPE device resets. Ethernet connectivity is temporarily lost.
- 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 finishes resetting.
- The link comes up when the CPE device comes back up, and then progresses to where it resumes full operation at its intended data rate.

After an upgrade is complete, the switch configuration shows this information about the LRE interfaces, which does not affect the switch functionality:

```
<output truncated>
!
controller LongReachEthernet 0
!
controller LongReachEthernet 1
!
controller LongReachEthernet 2
!
controller LongReachEthernet 3
!
controller LongReachEthernet 4
!
controller LongReachEthernet 5
!
controller LongReachEthernet 6
!
!<output truncated>
```

LRE Upgrade Example

This example shows how an LRE upgrade occurs:

```
Switch# hw-module slot 0 upgrade lre force remote longreachethernet 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 is reset and the link is down. Ethernet connectivity is unavailable at this point.

```
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 finishes resetting. 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 finished resetting. 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#
```

Displaying LRE Status

To display the LRE information, use one or more of the privileged EXEC commands in Table 12-10.

Table 12-10 Commands for Displaying LRE Information

Command	Purpose
show controllers ethernet-controller	Display the Ethernet link send and receive statistics on a Fast Ethernet port.
show controllers lre profile details	Display information about the LRE profiles.
show controllers lre status	Display the LRE link statistics and profile information on an LRE switch port.

For detailed information about the fields in the command outputs, see the command reference for this release.