Multichassis LACP

In Carrier Ethernet networks, various redundancy mechanisms provide resilient interconnection of nodes and networks. The choice of redundancy mechanisms depends on various factors such as transport technology, topology, single node versus entire network multihoming, capability of devices, autonomous system (AS) boundaries or service provider operations model, and service provider preferences.

Carrier Ethernet network high-availability can be achieved by employing both intra- and interchassis redundancy mechanisms. Cisco's Multichassis EtherChannel (MCEC) solution addresses the need for interchassis redundancy mechanisms, where a carrier wants to "dual home" a device to two upstream points of attachment (PoAs) for redundancy. Some carriers either cannot or will not run loop prevention control protocols in their access networks, making an alternative redundancy scheme necessary. MCEC addresses this issue with enhancements to the 802.3ad Link Aggregation Control Protocol (LACP) implementation. These enhancements are provided in the Multichassis LACP (mLACP) feature described in this document.

Prerequisites for mLACP

- The command **lacp max-bundle** must be used on all PoAs in order to operate in PoA control and shared control modes.

  - The maximum number of links configured cannot be less than the total number of interfaces in the link aggregation group (LAG) that is connected to the PoA.
  - Each PoA may be connected to a dual-homed device (DHD) with a different number of links for the LAG (configured with a different number of maximum links).

- Each PoA must be configured using the **lacp min-bundle** command with the desired minimum number of links to maintain the LAG in the active state.

- For DHD control there must be an equal number of links going to each PoA.

- The max-bundle value must equal the number of active links connected locally to the PoA (no local intra-PoA active or standby protection).

• LACP fast switchover must be configured on all devices to speed convergence.

Restrictions for mLACP

• You can enable MC-LAG to bring down mLACP during standby, if the BDI interface is associated with only port channel (part of mLACP). If the BDI interface is associated with more than one interface (1k BDI with no physical interface and logical interface port channel in the systems), then that BDI cannot be brought down when the mLACP goes to standby.

• mLACP does not support Fast Ethernet.

• mLACP does not support half-duplex links.

• mLACP does not support multiple neighbors.

• Converting a port channel to mLACP can cause a service disruption.

• The maximum number of member links per LAG per PoA is restricted by the maximum number of ports per port channel, as limited by the platform.

• System priority on a DHD must be a lesser priority than on PoAs in POA and shared mode.

• MAC Tunneling Protocol (MTP) supports only one member link in a port channel.

• A port-channel or its member links may flap while LACP stabilizes.

• DHD-based control does not function when min-links is not configured.

• DHD-controlled revertive behavior with min-links is not supported.

• Brute-force failover always causes min-link failures.

• Any failure with brute-force failover behaves revertively.

The following restrictions are applicable on the Cisco Aggregation Services Routers 900 Series:

• The lacp max-bundle max-links command must be used on all the PoAs in order to operate in PoA control and shared control modes.

    • The value of the max-links variable must be greater than the total number of interfaces in the LAG, which are connected to the PoA.

    • Each PoA may be connected to the dual-homed device (DHD) with a different number of links for the LAG (and, hence configured with a different value for the max-links value) variable.

• The **lacp min-bundle min-links** command has local scope only. Each PoA must be configured with the required minimum number of links to maintain the LAG in active state.

• mLACP and Pseudo-mLACP (P-mLACP) feature interoperation between the Cisco 7600 Series Routers and the Cisco ASR 903 is not supported when the former is used as one PoA and the Cisco ASR 903 as another PoA in the same redundancy group.

• VPLS over port channel (PoCH) flaps on SSO with LACP rate fast.

• MAC Tunneling Protocol (MTP) is not supported.

• The following commands are not supported:

• **ethernet mac-flush notification mirp**

• **show ethernet service instance id mac-tunnel**

• **errdisable recovery cause mlacp**

Information About mLACP

Overview of Multichassis EtherChannel

In Multichassis EtherChannel (MCEC), the DHD is dual-homed to two upstream PoAs. The DHD is incapable of running any loop prevention control protocol such as Multiple Spanning Tree (MST). Therefore, another mechanism is required to prevent forwarding loops over the redundant setup. One method is to place the DHD's uplinks in a LAG, commonly referred to as EtherChannel. This method assumes that the DHD is capable of running only IEEE 802.3ad LACP for establishing and maintaining the LAG.

LACP, as defined in IEEE 802.3ad, is a link-level control protocol that allows the dynamic negotiation and establishment of LAGs. An extension of the LACP implementation to PoAs is required to convey to a DHD that it is connected to a single virtual LACP peer and not to two disjointed devices. This extension is called Multichassis LACP or mLACP. The figure below shows this setup.
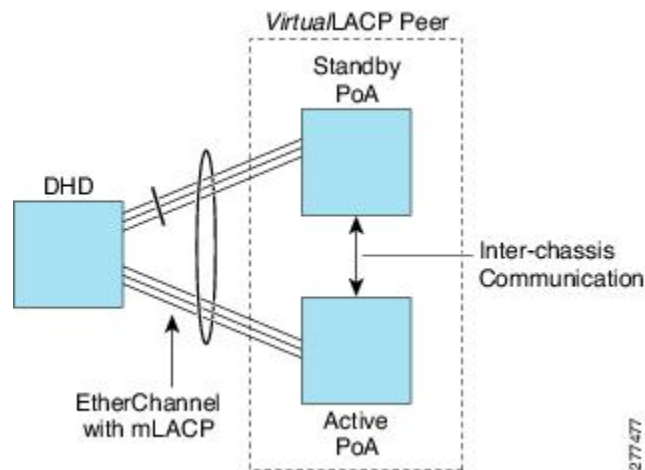
The PoAs forming a virtual LACP peer, from the perspective of the DHD, are defined as members of a redundancy group. For the PoAs in a redundancy group to appear as a single device to the DHD, the states between them must be synchronized through the Interchassis Communication Protocol (ICCP), which provides a control-only interchassis communication channel (ICC).

In Cisco IOS Release 12.2(33)SRE, the system functions in active/standby redundancy mode. In this mode DHD uplinks that connect to only a single PoA can be active at any time. The DHD recognizes one PoA as active and the other as standby but does not preclude a given PoA from being active for one DHD and standby for another. This capability allows two PoAs to perform load sharing for different services.

Interactions with the MPLS Pseudowire Redundancy Mechanism

The network setup shown in the figure above can be used to provide provider edge (PE) node redundancy for Virtual Private LAN Service (VPLS) and Virtual Private Wire Service (VPWS) deployments over Multiprotocol Label Switching (MPLS). In these deployments, the uplinks of the PoAs host the MPLS pseudowires that provide redundant connectivity over the core to remote PE nodes. Proper operation of the network requires interaction between the redundancy mechanisms employed on the attachment circuits (for example, mLACP) and those employed on the MPLS pseudowires. This interaction ensures the state (active or standby) is synchronized between the attachment circuits and pseudowires for a given PoA.

RFC 4447 introduced a mechanism to signal pseudowire status via the Link Distribution Protocol (LDP) and defined a set of status codes to report attachment circuit as well as pseudowire fault information. The Preferential Forwarding Status bit (*draft-ietf-pwe3-redundancy-bit*) definition proposes to extend these codes to include two bits for pseudowire redundancy applications:

- Preferential forwarding status: active or standby

- Request pseudowire switchover

The draft also proposes two modes of operation:

- Independent mode--The local PE decides on its pseudowire status independent of the remote PE.

- Primary and secondary modes--One of the PEs determines the state of the remote side through a handshake mechanism.

For the mLACP feature, operation is based on the independent mode. By running ICC between the PoAs, only the preferential forwarding status bit is required; the request pseudowire switchover bit is not used.

The local pseudowire status (active or standby) is determined independently by the PoAs in a redundancy group and then relayed to the remote PEs in the form of a notification. Similarly, the remote PEs perform their own selection of their pseudowire status and notify the PoAs on the other side of the core.

After this exchange of local states, the pseudowires used for traffic forwarding are those selected to be active independently on both local and remote ends.

The attachment circuit redundancy mechanism determines and controls the pseudowire redundancy mechanism. mLACP determines the status of the attachment circuit on a given PoA according to the configured LACP system and port priorities, and then the status of the pseudowires on a given PoA is synchronized with that of the local attachment circuits. This synchronization guarantees that the PoA with the active attachment circuits has its pseudowires active. Similarly, the PoA with the standby attachment circuits has its pseudowires in standby mode. By ensuring that the forwarding status of the attachment circuits is synchronized with that of the pseudowires, the need to forward data between PoA nodes within a redundancy group can be avoided. This synchronization saves platform bandwidth that would otherwise be wasted on inter-PoA data forwarding in case of failures.

Redundancy Mechanism Processes

The Carrier Ethernet redundancy solution should include the following processes (and how they apply to the mLACP solution):

- Attachment circuit active or standby status selection--This selection can be performed by the access node or network, the aggregation node, or combination of the two. For mLACP, the attachment circuit status selection is determined through collaboration between the DHD and the PoAs.

• Pseudowire forwarding status notification--This notification is mandatory for mLACP operation in VPWS and VPLS deployments; that is, when the PoA uplinks employ pseudowire technology. When the PoAs decide on either an active or standby role, they need to signal the status of the associated pseudowires to the PEs on the far end of the network. For MPLS pseudowires, this is done using LDP.

• MAC flushing indication--This indication is mandatory for any redundancy mechanism in order to speed convergence time and eliminate potential traffic failure. The mLACP redundancy mechanism should be integrated with relevant 802.1Q/802.1ad/802.1ah MAC flushing mechanisms as well as MAC flushing mechanisms for VPLS.

Note   Failure occurs when incoming traffic is dropped without informing the source that the data did not reach its intended recipient. Failure can be detected only when lost traffic is monitored.

• Active VLAN notification--For mLACP, this notification is not required as long as the PoAs follow the active/standby redundancy model.

The figure below shows redundancy mechanisms in Carrier Ethernet networks.
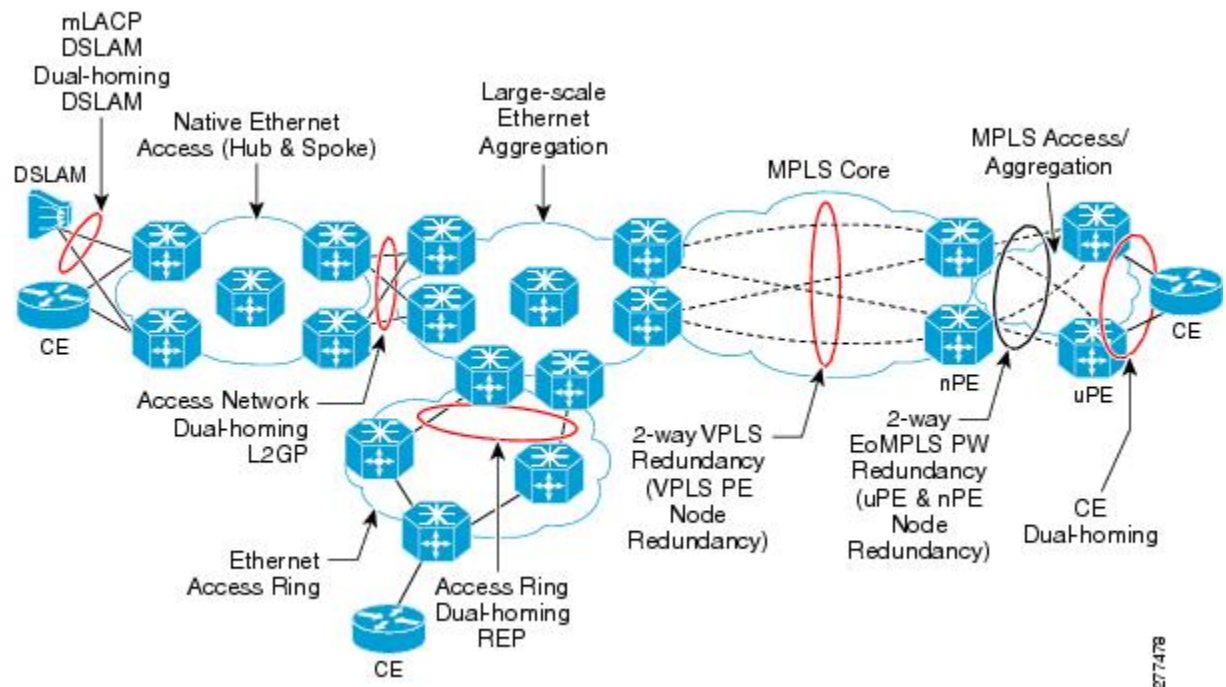
Dual-Homed Topology Using mLACP

The mLACP feature allows the LACP state machine and protocol to operate in a dual-homed topology. The mLACP feature decouples the existing LACP implementation from the multichassis specific requirements, allowing LACP to maintain its adherence to the IEEE 802.3ad standard. The mLACP feature exposes a single virtual instance of IEEE 802.3ad to the DHD for each redundancy group. The virtual LACP instance interoperates with the DHD according to the IEEE 802.3ad standard to form LAGs spanning two or more chassis.

LACP and 802.3ad Parameter Exchange

In IEEE 802.3ad, the concatenation of the LACP system MAC address and system priority form an LACP system ID (8 bytes). The system ID is formed by taking the two-byte system priority value as the most significant two octets of the system ID. The system MAC address makes up the remainder of the system ID (octets 3 to 8). System ID priority comparisons are based on the lower numerically valued ID.

To provide the highest LACP priority, the mLACP module communicates the system MAC address and priority values for the given redundancy group to its redundancy group peer(s) and vice versa. The mLACP then chooses the lowest system ID value among the PoAs in the given redundancy group to use as the system ID of the virtual LACP instance of the redundancy group.

Cisco IOS Release 12.2(33)SRE introduces two LACP configuration commands to specify the system MAC address and system priority used for a given redundancy group: **mlacp system-mac** *mac-address* and **mlacp system-priority** *priority-value*. These commands provide better settings to determine which side of the attachment circuit will control the selection logic of the LAG. The default value for the system MAC address is the chassis backplane default MAC address. The default value for the priority is 32768.

Port Identifier

IEEE 802.3ad uses a 4-byte port identifier to uniquely identify a port within a system. The port identifier is the concatenation of the port priority and port number (unique per system) and identifies each port in the system. Numerical comparisons between port IDs are performed by unsigned integer comparisons where the 2-byte Port Priority field is placed in the most significant two octets of the port ID. The 2-byte port number makes up the third and fourth octets. The mLACP feature coordinates the port IDs for a given redundancy group to ensure uniqueness.

Port Number

A port number serves as a unique identifier for a port within a device. The LACP port number for a port is equal to the port's ifIndex value (or is based on the slot and subslot identifiers on the Cisco 7600 router).

LACP relies on port numbers to detect rewiring. For multichassis operation, you must enter the **mlacp node-id** *node-id* command to coordinate port numbers between the two PoAs in order to prevent overlap.

Port Priority

Port priority is used by the LACP selection logic to determine which ports should be activated and which should be left in standby mode when there are hardware or software limitations on the maximum number of links allowed in a LAG. For multichassis operation in active/standby redundancy mode, the port priorities for all links connecting to the active PoA must be higher than the port priorities for links connecting to the standby PoA. These port priorities can either be guaranteed through explicit configuration or the system can automatically adjust the port priorities depending on selection criteria. For example, select the PoA with the highest port priority to be the active PoA and dynamically adjust the priorities of all other links with the same port key to an equal value.

In Cisco IOS Release 12.2(33)SRE, the mLACP feature supports only the active/standby redundancy model. The LACP port priorities of the individual member links should be the same for each link belonging to the LAG of a given PoA. To support this requirement, the **mlacp lag-priority** command is implemented in interface configuration mode in the command-line interface (CLI). This command sets the LACP port priorities for all the local member links in the LAG. Individual member link LACP priorities (configured by the **lacp port-priority** command) are ignored on links belonging to mLACP port channels.

The **mlacp lag-priority** command may also be used to force a PoA failover during operation in the following two ways:

- Set the active PoA's LAG priority to a value greater than the LAG priority on the standby PoA. This setting results in the quickest failover because it requires the fewest LACP link state transitions on the standby links before they turn active.

- Set the standby PoA's LAG priority to a value numerically less than the LAG priority on the active PoA. This setting results in a slightly longer failover time because standby links have to signal OUT_OF_SYNC to the DHD before the links can be brought up and go active.

In some cases, the operational priority and the configured priority may differ when using dynamic port priority management to force failovers. In this case, the configured version will not be changed unless the port channel is operating in nonrevertive mode. Enter the **show lacp multichassis port-channel** command to view the current operational priorities. The configured priority values can be displayed by using the **show running-config** command.

Multichassis Considerations

Because LACP is a link layer protocol, all messages exchanged over a link contain information that is specific and local to that link. The exchanged information includes:

- System attributes--priority and MAC address

- Link attributes--port key, priority, port number, and state

When extending LACP to operate over a multichassis setup, synchronization of the protocol attributes and states between the two chassis is required.

System MAC Address

LACP relies on the system MAC address to determine the identity of the remote device connected over a particular link. Therefore, to mask the DHD from its connection to two disjointed devices, coordination of the system MAC address between the two PoAs is essential. In Cisco IOS software, the LACP system MAC address defaults to the ROM backplane base MAC address and cannot be changed by configuration. For multichassis operation the following two conditions are required:

- System MAC address for each PoA should be communicated to its peer--For example, the PoAs elect the MAC address with the lower numeric value to be the system MAC address. The arbitration scheme must resolve to the same value. Choosing the lower numeric MAC address has the advantage of providing higher system priority.

- System MAC address is configurable--The system priority depends, in part, on the MAC address, and a service provider would want to guarantee that the PoAs have higher priority than the DHD (for example, if both DHD and PoA are configured with the same system priority and the service provider has no control over DHD). A higher priority guarantees that the PoA port priorities take precedence over the DHD's port priority configuration. If you configure the system MAC address, you must ensure that the addresses are uniform on both PoAs; otherwise, the system will automatically arbitrate the discrepancy, as when a default MAC address is selected.

System Priority

LACP requires that a system priority be associated with every device to determine which peer's port priorities should be used by the selection logic when establishing a LAG. In Cisco IOS software, this parameter is

configurable through the CLI. For multichassis operation, this parameter is coordinated by the PoAs so that the same value is advertised to the DHD.

Port Key

The port key indicates which links can form a LAG on a given system. The key is locally significant to an LACP system and need not match the key on an LACP peer. Two links are candidates to join the same LAG if they have the same key on the DHD and the same key on the PoAs; however, the key on the DHD is not required to be the same as the key on the PoAs. Given that the key is configured according to the need to aggregate ports, there are no special considerations for this parameter for multichassis operation.

Failure Protection Scenarios

The mLACP feature provides network resiliency by protecting against port, link, and node failures. These failures can be categorized into five types. The figure below shows the failure points in a network, denoted by the letters A through E.

- A--Failure of the uplink port on the DHD

- B--Failure of the Ethernet link

- C--Failure of the downlink port on the active PoA

- D--Failure of the active PoA node

- E--Failure of the active PoA uplinks
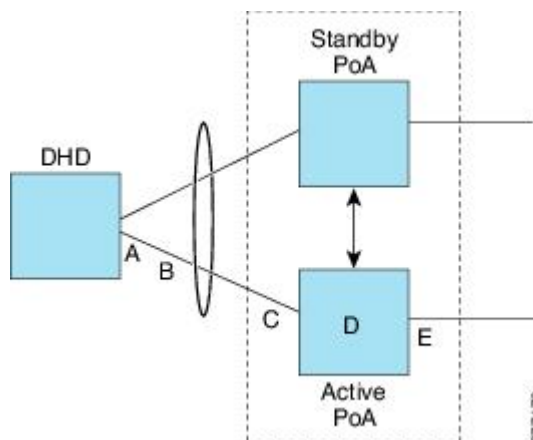
When any of these faults occur, the system reacts by triggering a switchover from the active PoA to the standby PoA. The switchover involves failing over the PoA's uplinks and downlinks simultaneously.

Failure points A and C are port failures. Failure point B is an Ethernet link failure and failure point D is a node failure. Failure point E can represent one of four different types of uplink failures when the PoAs connect to an MPLS network:

- Pseudowire failure--Monitoring individual pseudowires (for example, using VCCV-BFD) and, upon a pseudowire failure, declare uplink failure for the associated service instances.

- Remote PE IP path failure--Monitoring the IP reachability to the remote PE (for example, using IP Route-Watch) and, upon route failure, declare uplink failure for all associated service instances.

- LSP failure--Monitoring the LSP to a given remote PE (for example, using automated LSP-Ping) and, upon LSP failure, declare uplink failure for all associated service instances.

- PE isolation--Monitoring the physical core-facing interfaces of the PE. When all of these interfaces go down, the PE effectively becomes isolated from the core network, and the uplink failure is declared for all affected service instances.

As long as the IP/MPLS network employs native redundancy and resiliency mechanisms such as MPLS fast reroute (FRR), the mLACP solution is sufficient for providing protection against PE isolation. Pseudowire, LSP, and IP path failures are managed by the native IP/MPLS protection procedures. That is, interchassis failover via mLACP is triggered only when a PE is completely isolated from the core network, because native IP/MPLS protection mechanisms are rendered useless. Therefore, failure point E is used to denote PE isolation from the core network.

Note The set of core-facing interfaces that should be monitored are identified by explicit configuration. The set of core-facing interfaces must be defined independently per redundancy group. Failure point E (unlike failure point A, B, or C) affects and triggers failover for all the multichassis LAGs configured on a given PoA.

Operational Variants

LACP provides a mechanism by which a set of one or more links within a LAG are placed in standby mode to provide link redundancy between the devices. This redundancy is normally achieved by configuring more ports with the same key than the number of links a device can aggregate in a given LAG (due to hardware or software restrictions, or due to configuration). For example, for active/standby redundancy, two ports are configured with the same port key, and the maximum number of allowed links in a LAG is configured to be 1. If the DHD and PoAs are all capable of restricting the number of links per LAG by configuration, three operational variants are possible.

DHD-based Control

The value of PoAs must be greater than the value of DHD. In DHD-based control, maximum number of links per bundle should be one. The PoAs must be configured to limit the maximum number of links per bundle to be greater than one. Thus, the selection of the active/standby link is the responsibility of the DHD. Which link is designated active and which is marked standby depends on the relative port priority, as configured on the system with the higher system priority. A PoA configured with a higher system priority can still determine the selection outcome. The DHD makes the selection and places the link with lower port priority in standby mode.

To accommodate DHD-controlled failover, the DHD must be configured with the max-bundle value equal to a number of links (L), where L is the fewest number of links connecting the DHD to a PoA. The max-bundle value restricts the DHD from bundling links to both PoAs at the same time (active/active). Although the DHD controls the selection of active/standby links, the PoA can still dictate the individual member link priorities by configuring the PoA's virtual LACP instance with a lower system priority value than the DHD's system priority.

The DHD control variant must be used with a PoA minimum link threshold failure policy where the threshold is set to L (same value for L as described above). A minimum link threshold must be configured on each of the PoAs because an A, B, or C link failure that does not trigger a failover (minimum link threshold is still satisfied) causes the DHD to add one of the standby links going to the standby PoA to the bundle. This added link results in the unsupported active/active scenario.

Note DHD control does not use the mLACP hot-standby state on the standby PoA, which results in higher failover times than the other variants.

DHD control eliminates the split brain problem on the attachment circuit side by limiting the DHD's attempts to bundle all the links.

PoA Control

In PoA control, the PoA is configured to limit the maximum number of links per bundle to be equal to the number of links (L) going to the PoA. The DHD is configured with that parameter set to some value greater than L. Thus, the selection of the active/standby links becomes the responsibility of the PoA.

Shared Control (PoA and DHD)

In shared control, both the DHD and the PoA are configured to limit the maximum number of links per bundle to L--the number of links going to the PoA. In this configuration, each device independently selects the active/standby link. Shared control is advantageous in that it limits the split-brain problem in the same manner as DHD control, and shared control is not susceptible to the active/active tendencies that are prevalent in DHD control. A disadvantage of shared control is that the failover time is determined by both the DHD and the PoA, each changing the standby links to SELECTED and waiting for each of the WAIT_WHILE_TIMERs to expire before moving the links to IN_SYNC. The independent determination of failover time and change of link states means that both the DHD and PoAs need to support the LACP fast-switchover feature in order to provide a failover time of less than one second.

mLACP Failover

The mLACP forces a PoA failover to the standby PoA when one of the following failures occurs:

- Failure of the DHD uplink port, Ethernet link, or downlink port on the active PoA—A policy failover is triggered via a configured failover policy and is considered a forced failover. When the number of active and SELECTED links to the active PoA goes below the configured minimum threshold, mLACP forces a failover to the standby PoA's member links. This minimum threshold is configured using the **lacp min-links** command in interface configuration mode. The PoAs determine the failover independent of the operational control variant in use.

- Failure of the active PoA—This failure is detected by the standby PoA. mLACP automatically fails over to standby because mLACP on the standby PoA is notified of failure via ICRM and brings up its local member links. In the DHD-controlled variant, this failure looks the same as a total member link failure, and the DHD activates the standby links.

- Failure of the active PoA uplinks—mLACP is notified by ICRM of PE isolation and relinquishes its active member links. This failure is a "forced failover" and is determined by the PoAs independent of the operational control variant in use.

Dynamic Port Priority

The default failover mechanism uses dynamic port priority changes on the local member links to force the LACP selection logic to move the required standby link(s) to the SELECTED and Collecting_Distributing state. This state change occurs when the LACP actor port priority values for all affected member links on the currently active PoA are changed to a higher numeric value than the standby PoA's port priority (which gives

the standby PoA ports a higher claim to bundle links). Changing the actor port priority triggers the transmission of an mLACP Port Config Type-Length-Value (TLV) message to all peers in the redundancy group. These messages also serve as notification to the standby PoA(s) that the currently active PoA is attempting to relinquish its role. The LACP then transitions the standby link(s) to the SELECTED state and moves all the currently active links to STANDBY.

Dynamic port priority changes are not automatically written back to the running configuration or to the NVRAM configuration. If you want the current priorities to be used when the system reloads, the **mlacp lag-priority** command must be used and the configuration must be saved.

Revertive and Nonrevertive Modes

Dynamic port priority functionality is used by the mLACP feature to provide both revertive mode and nonrevertive mode. The default operation is revertive, which is the default behavior in single chassis LACP. Nonrevertive mode can be enabled on a per port-channel basis by using the **lacp failover non-revertive** command in interface configuration mode. In Cisco IOS Release 12.2(33)SRE this command is supported only for mLACP.

Nonrevertive mode is used to limit failover and, therefore, possible traffic loss. Dynamic port priority changes are utilized to ensure that the newly activated PoA remains active after the failed PoA recovers.

Revertive mode operation forces the configured primary PoA to return to active state after it recovers from a failure. Dynamic port priority changes are utilized when necessary to allow the recovering PoA to resume its active role.

Brute Force Shutdown

Note   This feature is not applicable for Cisco ASR 903 RSP3 Module.

A brute-force shutdown is a forced failover mechanism to bring down the active physical member link interface(s) for the given LAG on the PoA that is surrendering its active status. The port-channel and any remaining active member link goes to an "err-disabled" state. This mechanism does not depend on the DHD's ability to manage dynamic port priority changes and compensates for deficiencies in the DHD's LACP implementation.

The brute-force shutdown changes the status of each member link to ADMIN_DOWN to force the transition of the standby links to the active state. Note that this process eliminates the ability of the local LACP implementation to monitor the link state.

The brute-force shutdown operates in revertive mode, so dynamic port priorities cannot be used to control active selection. The brute-force approach is configured by the **lacp failover brute-force** command in interface configuration mode. This command is not allowed in conjunction with a nonrevertive configuration.

Peer Monitoring with Interchassis Redundancy Manager

There are two ways in which a peer can be monitored with Interchassis Redundancy Manager (ICRM):

- Routewatch (RW)--This method is the default.

- Bidirectional Forwarding Detection (BFD)--You must configure the redundancy group with the **monitor peer bfd** command.

Note In Cisco IOS XE Everest 16.5.1 release, RSP3 Module only supports single-hop BFD, hence only single-hop BFD is applicable for mLACP peer monitoring.

Note For stateful switchover (SSO) deployments (with redundant support in the chassis), BFD monitoring and a static route for the ICCP connection are required to prevent "split brain" after an SSO failover.

For each redundancy group, for each peer (member IP), a monitoring adjacency is created. If there are two peers with the same IP address, the adjacency is shared regardless of the monitoring mode. For example, if redundancy groups 1 and 2 are peered with member IP 10.10.10.10, there is only one adjacency to 10.10.10.10, which is shared in both redundancy groups. Furthermore, redundancy group 1 can use BFD monitoring while redundancy group 2 is using RW.

Note BFD is completely dependent on RW--there must be a route to the peer for ICRM to initiate BFD monitoring. BFD implies RW and sometimes the status of the adjacency may seem misleading but is accurately representing the state. Also, if the route to the peer PoA is not through the directly connected (back-to-back) link between the systems, BFD can give misleading results.

An example of output from the **show redundancy interchassis** command follows:

```
Device# show redundancy interchassis
Redundancy Group 1 (0x1)
  Applications connected: mLACP
  Monitor mode: Route-watch
  member ip: 201.0.0.1 'mlacp-201', CONNECTED
    Route-watch for 201.0.0.1 is UP
    mLACP state: CONNECTED
ICRM fast-failure detection neighbor table
  IP Address      Status Type Next-hop IP     Interface
  ==========      ====== ==== ===========     =========
  201.0.0.1       UP     RW
```

To interpret the adjacency status displayed by the **show redundancy interchassis** command, refer to the table below.

Table 1: Status Information from the show redundancy interchassis command

Adjacency Type	Adjacency Status	Meaning
RW	DOWN	RW or BFD is configured, but there is no route for the given IP address.
RW	UP	RW or BFD is configured. RW is up, meaning there is a valid route to the peer. If BFD is configured and the adjacency status is UP, BFD is probably not configured on the interface of the route's adjacency.

Adjacency Type	Adjacency Status	Meaning
BFD	DOWN	BFD is configured. A route exists and the route's adjacency is to an interface that has BFD enabled. BFD is started but the peer is down. The DOWN status can be because the peer is not present or BFD is not configured on the peer's interface.
BFD	UP	BFD is configured and operational.

Note If the adjacency type is "BFD," RW is UP regardless of the BFD status.

MAC Flushing Mechanisms

When mLACP is used to provide multichassis redundancy in multipoint bridged services (for example, VPLS), there must be a MAC flushing notification mechanism in order to prevent potential traffic failure.

At the failover from a primary PoA to a secondary PoA, a service experiences traffic failure when the DHD in question remains inactive and while other remote devices in the network are attempting to send traffic to that DHD. Remote bridges in the network have stale MAC entries pointing to the failed PoA and direct traffic destined to the DHD to the failed PoA, where the traffic is dropped. This failure continues until the remote devices age out their stale MAC address table entries (which typically takes five minutes). To prevent this anomaly, the newly active PoA, which has taken control of the service, transmits a MAC flush notification message to the remote devices in the network to flush their stale MAC address entries for the service in question.

The exact format of the MAC flushing message depends on the nature of the network transport: native 802.1Q/802.1ad Ethernet, native 802.1ah Ethernet, VPLS, or provider backbone bridge (PBB) over VPLS. Furthermore, in the context of 802.1ah, it is important to recognize the difference between mechanisms used for customer-MAC (C-MAC) address flushing versus bridge-MAC (B-MAC) address flushing.

The details of the various mechanisms are discussed in the following sections.

Multiple I-SID Registration Protocol

Multiple I-SID Registration Protocol (MIRP) is enabled by default on 802.1ah service instances. The use of MIRP in 802.1ah networks is shown in the figure below.
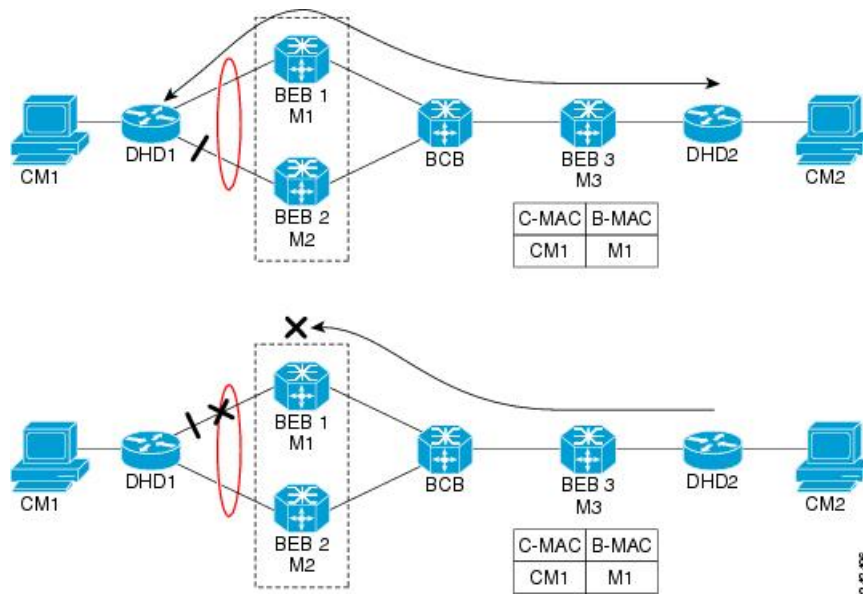
Device DHD1 is dual-homed to two 802.1ah backbone edge bridges (BEB1 and BEB2). Assume that initially the primary path is through BEB1. In this configuration BEB3 learns that the host behind DHD1 (with MAC address CM1) is reachable via the destination B-MAC M1. If the link between DHD1 and BEB1 fails and the host behind DHD1 remains inactive, the MAC cache tables on BEB3 still refer to the BEB1 MAC address even though the new path is now via BEB2 with B-MAC address M2. Any bridged traffic destined from the host behind DHD2 to the host behind DHD1 is wrongfully encapsulated with B-MAC M1 and sent over the MAC tunnel to BEB1, where the traffic fails.

To circumvent the traffic failure problem when the link between DHD1 and BEB1 fails, BEB2 performs two tasks:

- Flushes its own MAC address table for the service or services in question.

- Transmits an MIRP message on its uplink to signal the far end BEB (BEB3) to flush its MAC address table. Note that the MIRP message is transparent to the backbone core bridges (BCBs). The MIRP message is processed on a BEB because only BCBs learn and forward based on B-MAC addresses and they are transparent to C-MAC addresses.

> **Note** MIRP triggers C-MAC address flushing for both native 802.1ah and PBB over VPLS. This is not applicable for Cisco ASR 903 RSP3 Module.

The figure below shows the operation of the MIRP.
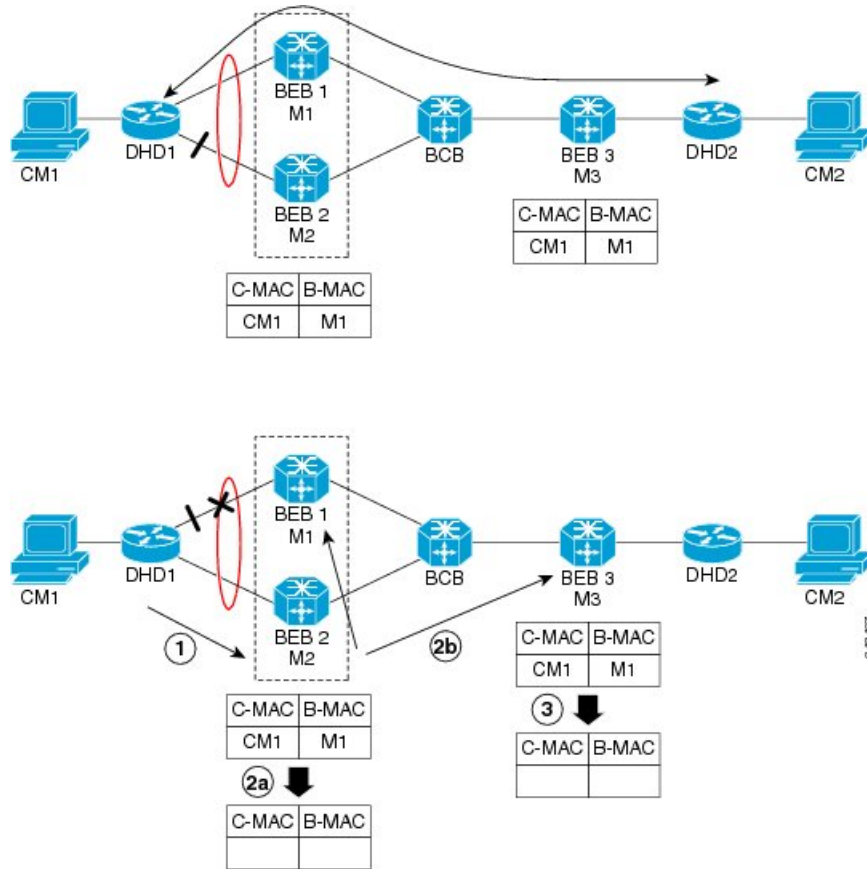
The MIRP has not been defined in IEEE but is expected to be based on the IEEE 802.1ak Multiple Registration Protocol (MRP). MRP maintains a complex finite state machine (FSM) for generic attribute registration. In the case of MIRP, the attribute is an I-SID. As such, MIRP provides a mechanism for BEBs to build and prune a per I-SID multicast tree. The C-MAC flushing notification capability of MIRP is a special case of attribute registration in which the device indicates that an MIRP declaration is "new," meaning that this notification is the first time a BEB is declaring interest in a particular I-SID.

LDP MAC Address Withdraw

When the mLACP feature is used for PE redundancy in traditional VPLS (that is, not PBB over VPLS), the MAC flushing mechanism is based on the LDP MAC Address Withdraw message as defined in RFC 4762.

The required functional behavior is as follows: Upon a failover from the primary PoA to the standby PoA, the standby PoA flushes its local MAC address table for the affected services and generates the LDP MAC Address Withdraw messages to notify the remote PEs to flush their own MAC address tables. One message is generated for each pseudowire in the affected virtual forwarding instances (VFIs).

mLACP and L3VPN Static Routes Overview

In a network where L3VPN and Cisco multichassis Link Aggregation Control Protocol (mLACP) features are enabled, and logical port channels have subinterfaces that are not configured with Multichassis-LAG (MC-LAG), the subinterfaces on both active and standby PoAs are in the active (UP) state.

The static routes are advertised through both active and standby PoAs to the core MPLS, because all port channel subinterfaces are in active (UP) state on active and standby PoAs.

To prevent the static routes being advertised on a standby PoA, when a PoA moves to an inactive state, the static routes are blocked on all Layer 3 port-channel subinterfaces. When a PoA moves to an active state, static routes are allowed on all Layer 3 port-channel subinterfaces.

To block the standby PoA from advertising static routes to MPLS, MC-LAG notifies the platform manager about the change in the PoA state. The platform manager shuts down all subinterfaces that are associated with the standby PoA.

To allow the static routes on subinterfaces, when a PoA moves to active state, the platform manager activates all subinterfaces that are associated with the active PoA.

The supported scale numbers are 1k BDIs and 1k VRFs.

mLACP Redundancy

The mLACP feature provides network resiliency by protecting the network against port, link, and node failures. These failures can be categorized into five types.

- Failure of the uplink port on the dual-homed device (DHD)

- Failure of the Ethernet link

- Failure of the downlink port on the active PoA

- Failure of the active PoA

- Failure of active PoA when isolated from the core network

When a PoA moves to active or standby redundancy mode, the mLACP triggers a registered call from the platform manager to block or unblock the static routes on subinterfaces that are associated with the port channel of PoA.

Enabling MC-LAG for L3VPN

To enable MC-LAG for L3VPN, perform the following:

```
configure terminal
  port-channel mc-lag

STBY-PoA
BDI101                  121.1.1.1        YES manual administratively down down
BDI102                  122.1.1.1        YES manual administratively down down

Active PoA
BDI101                  121.1.1.1        YES manual up                      up
BDI102                  122.1.1.1        YES manual up                      up
```

Show Commands

You can use the following show commands:

- Show etherchannel summary

- Show lacp multi-chassis group

- Show lacp multi-chassis port-channel
- Show redundancy interchassis
- Show bfd neighbors
- Show ip route vrf
- Show ip cef vrf
- Show ip bgp vpnv4 vrf vpn_1 sum
- Show bfd nei vrf vpn_1
- Show ip bgp vpnv4 all labels
- Show bfd neighbor vrf vpn_1 client bgp
- Show ip bgp summary or neighbors
- Show platform hardware pp active efp database

Debug Commands

You can use the following debug commands to troubleshoot your configuration:

- debug lacp event
- debug lacp fsm
- debug lacp multi-chassis all
- debug lacp etherchannel
- debug ethernet etherchannel
- debug redundancy interchassis
- debug mpls ldp iccp

How to Configure mLACP

Configuring Interchassis Group and Basic mLACP Commands (Global Redundancy Group Configuration)

Perform this task to set up the communication between multiple PoAs and to configure them in the same group.

Step 1 **enable**

Example:

```
Router> enable
```

Enables privileged EXEC mode.

- Enter your password if prompted.

Step 2   **configure   terminal**

Example:

```
Router# configure terminal
```

Enters global configuration mode.

Step 3   **redundancy**

Example:

```
Router(config)# redundancy
```

Enters redundancy configuration mode.

Step 4   **interchassis group**   *group-id*

Example:

```
Router(config-red)# interchassis group 50
```

Configures an interchassis group within the redundancy configuration mode and enters interchassis redundancy mode.

Step 5   **monitor peer bfd**

Example:

```
Router(config-r-ic)# monitor peer bfd
```

Configures the BFD option to monitor the state of the peer. The default option is route-watch.

Step 6   **member ip**   *ip-address*

Example:

```
Router(config-r-ic)# member ip 172.3.3.3
```

Configures the IP address of the mLACP peer member group.

Step 7   **mlacp node-id** *node-id*

Example:

```
Router(config-r-ic)# mlacp node-id 5
```

Defines the node ID used in the LACP Port ID field by this member of the mLACP redundancy group.

- The valid range is 0 to 7, and the value should be different from the peer values.

Step 8   **mlacp system-mac** *mac-address*

Example:

```
Router(config-r-ic)# mlacp system-mac aa12.be45.d799
```

Defines and advertises the system MAC address value to the mLACP members of the redundancy group for arbitration.

- The format of the *mac-address* argument must be in standard MAC address format: aabb.ccdd.eeff.

Step 9   **mlacp system-priority**   *priority-value*

Example:

```
Router(config-r-ic)# mlacp system-priority 100
```

Defines the system priority advertised to the other mLACP members of the redundancy group.

- System priority values are 1 to 65535. Default value is 32768.

- The assigned values should be lower than the DHD.

Step 10   **backbone interface**   *type*   *number*

Example:

```
Router(config-r-ic)#
backbone interface GigabitEthernet2/3
```

Defines the backbone interface for the mLACP configuration.

Step 11   **end**

Example:

```
Router(config-r-ic)# end
```

Returns the CLI to privileged EXEC mode.

Configuring the mLACP Interchassis Group and Other Port-Channel Commands

Perform this task to set up mLACP attributes specific to a port channel. The **mlacp interchassis group** command links the port-channel interface to the interchassis group that was created in the previous Configuring Interchassis Group and Basic mLACP Commands (Global Redundancy Group Configuration) , on page 17.

Step 1   **enable**

Example:

```
Router> enable
```

Enables privileged EXEC mode.

- Enter your password if prompted.

Step 2   **configure   terminal**

Example:

```
Router# configure terminal
```

Enters global configuration mode.

Step 3   **interface port-channel**   *port-channel- number*

Example:

```
Router(config)# interface port-channel1
```

Configures the port channel and enters interface configuration mode.

Step 4   **lacp max-bundle**   *max-bundles*

Example:

```
Router(config-if)# lacp max-bundle 4
```

Configures the max-bundle links that are connected to the PoA. The value of the *max-bundles* argument should not be less than the total number of links in the LAG that are connected to the PoA.

   • Determines whether the redundancy group is under DHD control, PoA control, or both.

   • Range is 1 to 8. Default value is 8.

Step 5   **lacp failover**   {**brute-force**| **non-revertive**}

Example:

```
Router(config-if)# lacp failover brute-force
```

Sets the mLACP switchover to nonrevertive or brute force. This command is optional.

Note   Brute-force failover is not supported for RSP3 module.

   • Default value is revertive (with 180-second delay).

   • If you configure brute force, a minimum link failure for every mLACP failure occurs or the dynamic lag priority value is modified.

Step 6   **mlacp interchassis group**   *group-id*

Example:

```
Router(config-red)# mlacp interchassis group 230
```

Specifies that the port channel is an mLACP port channel. The *group-id* should match the configured redundancy group.

Step 7   **end**

Example:

```
Router(config-r-ic)# end
```

Returns the CLI to privileged EXEC mode.

Configuring Redundancy for VPWS

For more information on VPWS, see EVPN Virtual Private Wire Service (VPWS) Single Homed.

Perform this task to provide Layer 2 VPN service redundancy for VPWS.

Step 1   **enable**

Example:

```
Router> enable
```

Enables privileged EXEC mode.

  • Enter your password if prompted.

Step 2   **configure   terminal**

Example:

```
Router# configure terminal
```

Enters global configuration mode.

Step 3   **pseudowire-class** *pw-class-name*

Example:

```
Router(config)# pseudowire-class ether-pw
```

Specifies the name of a Layer 2 pseudowire class and enters pseudowire class configuration mode.

Step 4   **encapsulation mpls**

Example:

```
Router(config-pw-class)# encapsulation mpls
```

Specifies that MPLS is used as the data encapsulation method for tunneling Layer 2 traffic over the pseudowire.

Step 5   **status peer topology dual-homed**

Example:

```
Router(config-pw-class)# status peer topology dual-homed
```

Enables the reflection of the attachment circuit status onto both the primary and secondary pseudowires. This condition is necessary if the peer PEs are connected to a dual-homed device.

Step 6   **exit**

Example:

```
Router(config-pw-class)# exit
```

Exits pseudowire class configuration mode.

Step 7   **interface port-channel** *port-channel-number*

Example:

```
Router(config)# interface port-channel1
```

Configures the port channel and enters interface configuration mode.

Step 8   **no ip address**

Example:

```
Router(config-if)# no ip address
```

Specifies that the VLAN interface does not have an IP address assigned to it.

Step 9   **lacp fast-switchover**

Example:

```
Router(config-if)# lacp fast-switchover
```

Enables LACP 1-to-1 link redundancy.

Step 10   **lacp max-bundle** *max-bundles*

Example:

```
Router(config-if)# lacp max-bundle 4
```

Configures the max-bundle links that are connected to the PoA. The value of the *max-bundles*argument should not be less than the total number of links in the LAG that are connected to the PoA.

- Determines whether the redundancy group is under DHD control, PoA control, or both.

- Range is 1 to 8. Default value is 8.

Step 11   **mlacp interchassis group** *group-id*

Example:

```
Router(config-red)# mlacp interchassis group 230
```

Specifies that the port channel is an mLACP port channel.

- The *group-id* should match the configured redundancy group.

Step 12   **exit**

Example:

```
Router(config-red)# exit
```

Exits redundancy configuration mode.

Step 13   **interface port-channel** *port-channel-number*

Example:

```
Router(config)# interface port-channel1
```

Configures the port channel and enters interface configuration mode.

Step 14   **service instance** *id* **ethernet** [*evc-name*]

Example:

```
Router(config-if)# service instance 1 ethernet
```

Configures an Ethernet service instance.

Step 15   **encapsulation dot1q** *vlan-id* [**,** *vlan-id* [**-** *vlan-id*]]

Example:

```
Router(config-if-srv)# encapsulation dot1q 100
```

Enables IEEE 802.1Q encapsulation of traffic on a specified subinterface in a VLAN.

Step 16   **xconnect** *peer-ip-address* *vc-id* {**encapsulation mpls** | **pw-class** *pw-class-name*} [**pw-class** *pw-class-name*]
[**sequencing** {**transmit** | **receive** | **both**}]

Example:

```
Router(config-if)# xconnect 10.0.3.201 123 pw-class ether-pw
```

Binds an attachment circuit to a pseudowire.

Step 17   **backup peer** *peer-router-ip-addr* *vcid* [**pw-class** *pw-class-name*] [**priority** *value*]

Example:

```
Router(config-if)# backup peer 10.1.1.1 123 pw-class ether-pw
```

Specifies a redundant peer for a pseudowire virtual circuit.

Step 18   **end**

Example:

```
Router(config-if)# end
```

Returns the CLI to privileged EXEC mode.

Configuring Redundancy for VPLS

Coupled and Decoupled Modes for VPLS

VPLS can be configured in either coupled mode or decoupled mode. Coupled mode is when at least one attachment circuit in VFI changes state to active, all pseudowires in VFI advertise active. When all attachment circuits in VFI change state to standby, all pseudowires in VFI advertise standby mode. See the figure below.

VPLS decoupled mode is when all pseudowires in the VFI are always active and the attachment circuit state is independent of the pseudowire state. This mode provides faster switchover time when a platform does not support pseudowire status functionality, but extra flooding and multicast traffic will be dropped on the PE with standby attachment circuits. However, if the attachment circuit is down, all pseudowires also go down. See the figure below.

Steps for Configuring Redundancy for VPLS

For more information on VPLS, see Configuring Virtual Private LAN Services.

Perform the following task to configure redundancy for VPLS.

Step 1   **enable**

Example:

```
Router> enable
```

Enables privileged EXEC mode.

• Enter your password if prompted.

Step 2   **configure terminal**

Example:

```
Router# configure terminal
```

Enters global configuration mode.

Step 3   **l2 vfi** *name* **manual**

Example:

```
Router(config)# l2 vfi vfi1 manual
```

Establishes a Layer 2 VFI between two separate networks and enters VFI configuration mode.

Step 4   **vpn id** *vpn-id*

Example:

```
Router(config-vfi)# vpn id 100
```

Sets or updates a Virtual Private Network (VPN) ID on a VPN routing and forwarding (VRF) instance.

Step 5   **bridge-domain** *bd-id*

Example:

```
Router(config-vfi)# bridge-domain 100
```

Binds a service instance to a bridge domain instance.

Step 6   **status decoupled**

Example:

```
Router(config-vfi)# status decoupled
```

(Optional) Enables decoupled mode. The state of the attachment circuits on the user-facing Provider Edge (uPE) is decoupled from the state of the pseudowires. The mLACP controls the state of the attachment circuits.

Step 7   **neighbor** *neighbor ip-address vc-id* {**encapsulation mpls** | **pw-class** *pw-class-name*}

Example:

```
Router(config-vfi)# neighbor 10.1.1.1 50 encapsulation mpls
```

Specifies the routers that should form a VFI connection.

- Repeat this command for each neighbor.

Step 8   **exit**

Example:

```
Router(config-vfi)# exit
```

Exits VFI configuration mode and returns to global configuration mode.

Step 9   **interface port-channel** *port-channel- number*

Example:

```
Router(config)# interface port-channel1
```

Configures the port channel and enters interface configuration mode.

Step 10   **no ip address**

Example:

```
Router(config-if)# no ip address
```

Specifies that the VLAN interface does not have an IP address assigned to it.

Step 11   **lacp fast-switchover**

Example:

```
Router(config-if)# lacp fast-switchover
```

Enables LACP 1-to-1 link redundancy.

Step 12   **lacp max-bundle** *max-bundles*

Example:

```
Router(config-if)# lacp max-bundle 2
```

Configures the max-bundle links that are connected to the PoA. The value of the *max-bundles*argument should not be less than the total number of links in the LAG that are connected to the PoA.

- Determines whether the redundancy group is under DHD control, PoA control, or both.

- Range is 1 to 8. Default value is 8.

Step 13 **mlacp interchassis group** *group-id*

Example:

```
Router(config-red)# mlacp interchassis group 230
```

Specifies that the port channel is an mLACP port-channel.

- The *group-id* should match the configured redundancy group.

Step 14 **interface port-channel** *port-channel- number*

Example:

```
Router(config)# interface port-channel1
```

Configures the port channel and enters interface configuration mode.

Step 15 **service instance** *id* **ethernet** [*evc-name*]

Example:

```
Router(config-if)# service instance 1 ethernet
```

Configures an Ethernet service instance and enters Ethernet service configuration mode.

Step 16 **encapsulation dot1q** *vlan-id* [**,** *vlan-id*[**-** *vlan-id*]]

Example:

```
Router(config-if-srv)# encapsulation dot1q 100
```

Enables IEEE 802.1Q encapsulation of traffic on a specified subinterface in a VLAN.

Step 17 **bridge-domain** *bridge-id* [**split-horizon** [**group** *group-id*]]

Example:

```
Router(config-if-srv)# bridge-domain 200
```

Configures the bridge domain. Binds the service instance to a bridge domain instance where *domain-number* is the identifier for the bridge domain instance.

Step 18 **exit**

Example:

```
Router(config-if-srv)# exit
```

Exits service instance configuration mode.

Step 19 **end**

Example:

```
Router(config-if)# end
```

Returns the CLI to privileged EXEC mode.

Configuring Hierarchical VPLS

Perform this task to configure Hierarchical VPLS (H-VPLS).

Step 1   **enable**

Example:

```
Router> enable
```

Enables privileged EXEC mode.

- Enter your password if prompted.

Step 2   **configure terminal**

Example:

```
Router# configure terminal
```

Enters global configuration mode.

Step 3   **pseudowire-class** *pw-class-name*

Example:

```
Router(config)# pseudowire-class ether-pw
```

Specifies the name of a Layer 2 pseudowire class and enters pseudowire class configuration mode.

Step 4   **encapsulation mpls**

Example:

```
Router(config-pw-class)# encapsulation mpls
```

Specifies that MPLS is used as the data encapsulation method for tunneling Layer 2 traffic over the pseudowire.

Step 5   **status peer topology dual-homed**

Example:

```
Router(config-pw-class)# status peer topology dual-homed
```

Enables the reflection of the attachment circuit status onto both the primary and secondary pseudowires. This configuration is necessary if the peer PEs are connected to a dual-homed device.

Step 6   **exit**

Example:

```
Router(config-pw-class)# exit
```

Exits pseudowire class configuration mode and returns to global configuration mode.

Step 7 **interface port-channel** *port-channel- number*

Example:

```
Router(config)# interface port-channel1
```

Configures the port channel and enters interface configuration mode.

Step 8 **no ip address**

Example:

```
Router(config-if)# no ip address
```

Specifies that the VLAN interface does not have an IP address assigned to it.

Step 9 **lacp fast-switchover**

Example:

```
Router(config-if)# lacp fast-switchover
```

Enables LACP 1-to-1 link redundancy.

Step 10 **lacp max-bundle** *max-bundles*

Example:

```
Router(config-if)# lacp max-bundle 4
```

Configures the max-bundle links that are connected to the PoA. The value of the *max-bundles* argument should not be less than the total number of links in the LAG that are connected to the PoA.

- Determines whether the redundancy group is under DHD control, PoA control, or both.

- Range is 1 to 8. Default value is 8.

Step 11 **mlacp interchassis group** *group-id*

Example:

```
Router(config-red)# mlacp interchassis group 230
```

Specifies that the port channel is an mLACP port channel.

- The *group-id* should match the configured redundancy group.

Step 12 **exit**

Example:

```
Router(config-red)# exit
```

Exits redundancy configuration mode.

Step 13   **interface port-channel** *port-channel- number*

Example:

```
Router(config)# interface port-channel1
```

Configures the port channel and enters interface configuration mode.

Step 14   **service instance** *id* **ethernet** [*evc-name*]

Example:

```
Router(config-if)# service instance 1 ethernet
```

Configures an Ethernet service instance and enters Ethernet service configuration mode.

Step 15   **encapsulation dot1q** *vlan-id* [**,** *vlan-id*[**-** *vlan-id*]]

Example:

```
Router(config-if-srv)# encapsulation dot1q 100
```

Enables IEEE 802.1Q encapsulation of traffic on a specified subinterface in a VLAN.

Step 16   **xconnect** *peer-ip-address* *vc-id* {**encapsulation mpls** | **pw-class** *pw-class-name*} [**pw-class** *pw-class-name*] [**sequencing** {**transmit** | **receive** | **both**}]

Example:

```
Router(config-if)# xconnect 10.0.3.201 123 pw-class vlan-xconnect
```

Binds an attachment circuit to a pseudowire, and configures an Any Transport over MPLS (AToM) static pseudowire.

Step 17   **backup peer** *peer-router-ip-addr* *vcid* [**pw-class** *pw-class-name*] [**priority** *value*]

Example:

```
Router(config-if)# backup peer 10.1.1.1 123 pw-class ether-pw
```

Specifies a redundant peer for a pseudowire virtual circuit.

Step 18   **end**

Example:

```
Router(config-if)# end
```

Returns the CLI to privileged EXEC mode.

Troubleshooting mLACP

Debugging mLACP

Use these **debug** commands for general mLACP troubleshooting.

Step 1   **enable**

Example:

```
Router> enable
```

Enables privileged EXEC mode.

   • Enter your password if prompted.

Step 2   **debug redundancy interchassis** {**all** | **application** | **error** | **event** | **monitor**}

Example:

```
Router# debug redundancy interchassis all
```

   • Enables debugging of the interchassis redundancy manager.

Step 3   **debug mpls ldp iccp**

Example:

```
Router# debug mpls ldp iccp
```

   • Enables debugging of the InterChassis Control Protocol (ICCP).

Step 4   **debug lacp** [**all** | **event**| **fsm**| **misc**| **multi-chassis** [**all** | **database** | **lacp-mgr** | **redundancy-group** | **user-interface**] | **packet**]

Example:

```
Router# debug lacp multi-chassis all
```

Enables debugging of LACP activity.

   • This command is run on the switch processor.

Step 5   **debug lacp etherchannel**

Example:

```
Router# debug lacp etherchannel
```

Enables debugging for etherchannel component.

Debugging mLACP on an Attachment Circuit or EVC

Use these **debug** commands for troubleshooting mLACP on an attachment circuit or on an EVC.

Step 1   **enable**

Example:

```
Router> enable
```

Enables privileged EXEC mode.

- Enter your password if prompted.

Step 2 **debug acircuit** {**checkpoint** | **error** | **event**}

Example:

```
Router# debug acircuit event
```

Displays checkpoints, errors, and events that occur on the attachment circuits between the PE and CE routers.

Step 3 **debug ethernet service** {**all** | **api** | **error** | **evc** [*evc-id*] | **ha** | **instance** [**id** *id* | **interface** *type number* | **qos**] | **interface** *type number* | **microblock** | **oam-mgr**}

Example:

```
Router# debug ethernet service all
```

Enables debugging of Ethernet customer service instances.

Debugging mLACP on AToM Pseudowires

Use the **debug mpls l2transport vc** command for troubleshooting mLACP on AToM pseudowires.

Step 1 **enable**

Example:

```
Router> enable
```

Enables privileged EXEC mode.

- Enter your password if prompted.

Step 2 **debug mpls l2transport vc** {**event** | **fsm** | **ldp** | **sss** | **status** {**event** | **fsm**}}

Example:

```
Router# debug mpls l2transport status event
```

Displays information about the status of AToM virtual circuits (VCs).

Debugging Cross-Connect Redundancy Manager and Session Setup

Use the following **debug** commands to troubleshoot cross-connect, redundancy manager, and session setup.

Step 1 **enable**

Example:

```
Router> enable
```

Enables privileged EXEC mode.

  • Enter your password if prompted.

Step 2   **debug sss error**

Example:

```
Router# debug sss error
```

Displays diagnostic information about errors that may occur during a subscriber service switch (SSS) call setup.

Step 3   **debug sss events**

Example:

```
Router# debug sss event
```

Displays diagnostic information about SSS call setup events.

Step 4   **debug xconnect** {**error** | **event**}

Example:

```
Router# debug xconnect event
```

Displays errors or events related to a cross-connect configuration.

Debugging VFI

Use the **debug vfi** command for troubleshooting a VFI.

Step 1   **enable**

Example:

```
Router> enable
```

Enables privileged EXEC mode.

  • Enter your password if prompted.

Step 2   **debug vfi** {**checkpoint** | **error** | **event** | **fsm** {**error** | **event**}}

Example:

```
Router# debug vfi checkpoint
```

Displays checkpoint information about a VFI.

Debugging the Segment Switching Manager (Switching Setup)

Use the **debug ssm**command for troubleshooting a segment switching manager (SSM).

Step 1   **enable**

Example:

```
Router> enable
```

Enables privileged EXEC mode.

- Enter your password if prompted.

Step 2   **debug ssm** {**cm errors** | **cm events** | **fhm errors** | **fhm events** | **sm errors** | **sm events** | **sm counters** | **xdr**}

Example:

```
Router# debug ssm cm events
```

Displays diagnostic information about the SSM for switched Layer 2 segments.

Debugging High Availability Features in mLACP

Use the following **debug**commands for troubleshooting High Availability features in mLACP.

Step 1   **enable**

Example:

```
Router> enable
```

Enables privileged EXEC mode.

- Enter your password if prompted.

Step 2   **debug mpls l2transport checkpoint**

Example:

```
Router# debug mpls l2transport checkpoint
```

Enables the display of AToM events when AToM is configured for nonstop forwarding/stateful switchover (NSF/SSO) and Graceful Restart.

Step 3   **debug acircuit checkpoint**

Example:

```
Router# debug acircuit checkpoint
```

Enables the display of attachment circuit events when AToM is configured for NSF/SSO and Graceful Restart.

Step 4   **debug vfi checkpoint**

Example:

```
Router# debug vfi checkpoint
```

Enables the display of VFI events when AToM is configured for NSF/SSO and Graceful Restart.

Configuration Examples for mLACP

Example Configuring mLACP on L3VPN

The following configuration is for mLACP on L3VPN:

```
vrf definition vpn_1
 rd 100:1
 ! address-family ipv4
  route-target export 100:1
  route-target import 100:1
 exit-address-family
 ! address-family ipv6
  route-target export 100:1
  route-target import 100:1
 exit-address-family
!
port-channel mc-lag   <<<<<<<<cli to enable this feature
!
mpls label protocol ldp
mpls ldp nsr
mpls ldp graceful-restart
!
redundancy
 mode sso
 interchassis group 100
  monitor peer bfd
  member ip 2.2.2.2
  backbone interface GigabitEthernet0/0/7
  mlacp system-mac 2222.2222.2222
  mlacp system-priority 2000
  mlacp node-id 2
bfd-template single-hop BFD_IPv4
 interval min-tx 50 min-rx 50 multiplier 3
!
bfd-template single-hop TEST
 interval min-tx 50 min-rx 50 multiplier 3
!
interface Loopback0
 ip address 1.1.1.1 255.255.255.255
!
interface Port-channel1
lacp fast-switchover
 lacp max-bundle 3
 mlacp lag-priority 32768
 mlacp interchassis group 100
 service instance 101 ethernet
  encapsulation dot1q 101
  rewrite ingress tag pop 1 symmetric
  bridge-domain 101
 !  service instance 102 ethernet
```

```
   encapsulation dot1q 102
   rewrite ingress tag pop 1 symmetric
   bridge-domain 102
 !
service instance 3999 ethernet
  encapsulation untagged
  l2protocol peer lacp
  bridge-domain 3999
 !
 interface GigabitEthernet0/0/3
 no ip address
 carrier-delay msec 25
 negotiation auto
 lacp rate fast
 channel-group 1 mode active
!

interface GigabitEthernet0/0/5 --> ICCP link between PoA1 & PoA2
 ip address 11.11.11.2 255.255.255.0
 load-interval 30
 negotiation auto
 mpls ip
 mpls label protocol ldp
 bfd template BFD_IPv4
!
interface GigabitEthernet0/0/7 --> Core intf towards PE3
 ip address 12.12.12.2 255.255.255.0
 load-interval 30
 negotiation auto
 mpls ip
 mpls label protocol ldp
!
interface BDI101
 vrf forwarding vpn_1
 ip address 121.1.1.1 255.255.255.0
 ip ospf bfd
 ip ospf 10 area 0
  bfd template TEST
!
interface BDI102
 vrf forwarding vpn_1
 ip address 122.1.1.1 255.255.255.0
  !
router ospf 100
 router-id 1.1.1.1
 nsr
 nsf cisco
 fast-reroute per-prefix enable prefix-priority high
 fast-reroute per-prefix remote-lfa tunnel mpls-ldp
 network 1.1.1.0 0.0.0.255 area 0
 network 11.11.11.0 0.0.0.255 area 0
 network 12.12.12.0 0.0.0.255 area 0
 network 13.13.13.0 0.0.0.255 area 0
 network 121.1.1.0 0.0.0.255 area 0
 network 0.0.0.0 255.255.255.255 area 0
 bfd all-interfaces
 mpls ldp autoconfig
!
router bgp 100
 bgp log-neighbor-changes
 bgp graceful-restart
 neighbor 4.4.4.4 remote-as 100
 neighbor 4.4.4.4 ha-mode sso
 neighbor 4.4.4.4 update-source Loopback0
```

```
      neighbor 121.1.1.2 remote-as 101
      neighbor 121.1.1.2 ha-mode sso
      neighbor 121.1.1.2 fall-over bfd check-control-plane-failure
      !
      address-family ipv4
       neighbor 4.4.4.4 activate
       neighbor 121.1.1.2 activate
      exit-address-family
      !
      address-family vpnv4
       neighbor 4.4.4.4 activate
       neighbor 4.4.4.4 send-community extended
      exit-address-family
      !
      address-family ipv4 vrf vpn_1
       redistribute connected
       redistribute static
       neighbor 121.1.1.2 remote-as 101
       neighbor 121.1.1.2 activate
       neighbor 121.1.1.2 as-override
      exit-address-family
      !
      ip route vrf vpn_1 131.1.1.0 255.255.255.0 121.1.1.2
      ip route vrf vpn_1 132.1.1.0 255.255.255.0 121.1.1.2
      !
      mpls ldp router-id Loopback0 force
```

Example Configuring NSF and NSR

The following configuration is for NSF (Non-stop Forwarding) and NSR (Non-stop Routing):

```
mpls ldp nsr
mpls ldp graceful-restart --> Enabling NSF
router ospf < >
 nsr
 nsf cisco
router bgp <>
bgp ha-mode sso --> Enabling NSR for BGP
 bgp graceful-restart --> Enabling NSF
neighbor 1.1.1.1 ha-mode sso
address-family ipv4 vrf vpn_1
Neighbor < > ha-mode sso
```

Example Configuring VPWS

Two sample configurations for VPWS follow: one example for an active PoA and the other for a standby PoA.

The figure below shows a sample topology for a VPWS configuration.
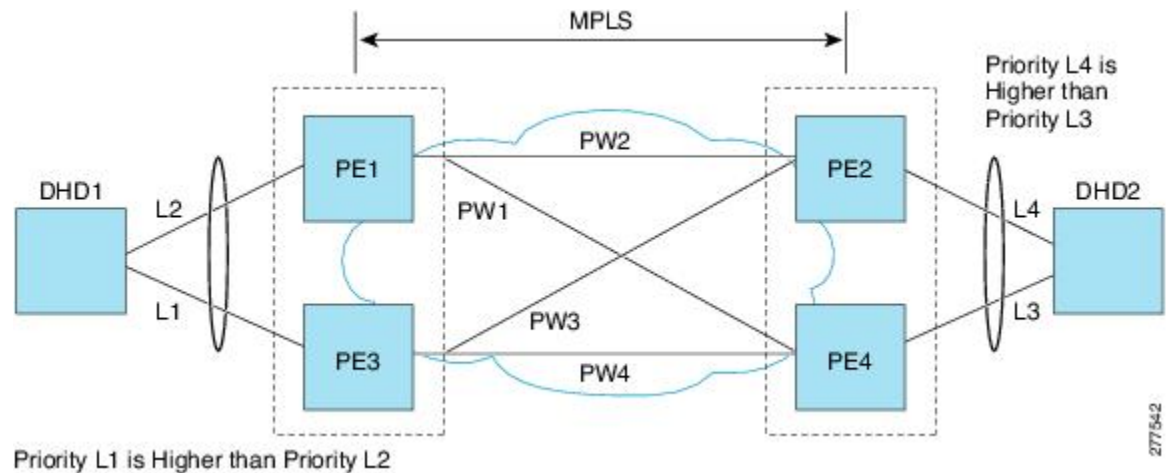
Active PoA for VPWS

The following VPWS sample configuration is for an active PoA:

```
mpls ldp router-id Loopback0 force
mpls ldp graceful-restart
mpls label protocol ldp
!
bfd-template single-hop BFD_IPv4
interval min-tx 50 min-rx 50 multiplier 3
!
redundancy
mode sso
interchassis group 100
  monitor peer bfd
  member ip 2.2.2.2
  backbone interface GigabitEthernet0/1/4
  backbone interface GigabitEthernet0/5/0
  mlacp system-priority 1000
  mlacp node-id 1
!
pseudowire-class mlacp
encapsulation mpls
status peer topology dual-homed
!
interface Loopback0
ip address 1.1.1.1 255.255.255.255
!
interface Port-channel1
no ip address
load-interval 30
negotiation auto
lacp failover non-revertive
lacp fast-switchover
lacp max-bundle 4
lacp min-bundle 2
mlacp lag-priority 2
mlacp interchassis group 100
service instance 2 ethernet
  encapsulation dot1q 2
  rewrite ingress tag pop 1 symmetric
  xconnect 3.3.3.3 2 encapsulation mpls pw-class mlacp
   backup peer 4.4.4.4 2 pw-class mlacp
```

```
service instance 3999 ethernet
  encapsulation untagged
  l2protocol peer lacp
  bridge-domain 3999

!
interface GigabitEthernet0/1/0
no ip address
load-interval 30
carrier-delay msec 25
no negotiation auto
lacp rate fast
channel-group 1 mode active
end
!
interface TenGigabitEthernet0/2/0
ip address 11.11.11.2 255.255.255.0
load-interval 30
mpls ip
mpls label protocol ldp
bfd template BFD_IPv4
end
```

Standby PoA for VPWS

The following VPWS sample configuration is for a standby PoA:

```
mpls ldp router-id Loopback0 forc
mpls ldp graceful-restart
mpls label protocol ldp
!
bfd-template single-hop BFD_IPv4
interval min-tx 50 min-rx 50 multiplier 3
!
redundancy
mode sso
interchassis group 100
  monitor peer bfd
  member ip 1.1.1.1
  backbone interface GigabitEthernet0/6/0
  backbone interface GigabitEthernet0/2/0
  mlacp system-priority 2000
  mlacp node-id 2
!
pseudowire-class mlacp
encapsulation mpls
status peer topology dual-homed
!
interface Loopback0
ip address 2.2.2.2 255.255.255.255
!
interface Port-channel1
no ip address
load-interval 30
no negotiation auto
lacp failover non-revertive
lacp fast-switchover
lacp max-bundle 4
lacp min-bundle 2
mlacp lag-priority 32768
mlacp interchassis group 100
service instance 2 ethernet
  encapsulation dot1q 2
```

```
    rewrite ingress tag pop 1 symmetric
   xconnect 3.3.3.3 2 encapsulation mpls pw-class mlacp
    backup peer 4.4.4.4 2 pw-class mlacp

!
interface GigabitEthernet0/6/4
no ip address
load-interval 30
carrier-delay msec 25
no negotiation auto
lacp rate fast
channel-group 1 mode active
!
interface TenGigabitEthernet0/3/0
ip address 11.11.11.1 255.255.255.0
load-interval 30
mpls ip
mpls label protocol ldp
bfd template BFD_IPv4
```
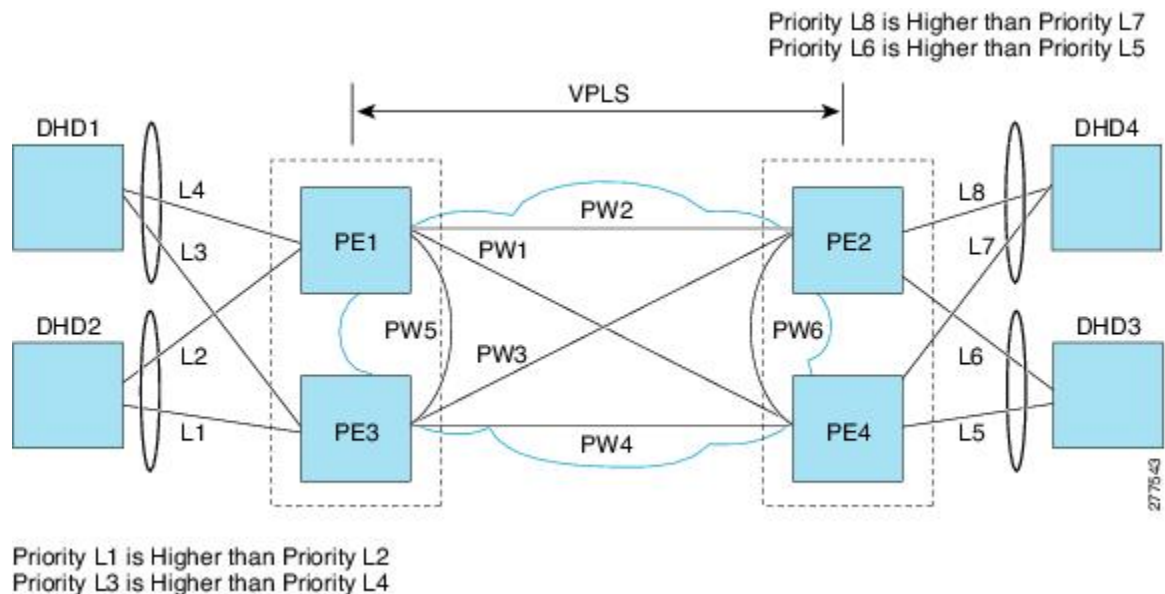
Example Configuring VPLS

Two sample configurations for VPLS follow: one example for an active PoA and the other for a standby PoA.

The figure below shows a sample topology for a VPLS configuration.

Priority L8 is Higher than Priority L7
Priority L6 is Higher than Priority L5

Priority L1 is Higher than Priority L2
Priority L3 is Higher than Priority L4

Active PoA for VPLS

The following VPLS sample configuration is for an active PoA:

```
mpls ldp router-id Loopback0 force
mpls ldp graceful-restart
mpls label protocol ldp
!
bfd-template single-hop BFD_IPv4
interval min-tx 50 min-rx 50 multiplier 3
!
```

```
redundancy
mode sso
interchassis group 100
  monitor peer bfd
  member ip 2.2.2.2
  backbone interface GigabitEthernet0/1/4
  backbone interface GigabitEthernet0/5/0
  mlacp system-priority 1000
  mlacp node-id 1
!
l2 vfi VPLS_200 manual
vpn id 200
bridge-domain 200
neighbor 3.3.3.3 encapsulation mpls
neighbor 4.4.4.4 encapsulation mpls
neighbor 2.2.2.2 encapsulation mpls
!
interface Loopback0
ip address 1.1.1.1 255.255.255.255
!
interface Port-channel1
no ip address
lacp fast-switchover
lacp max-bundle 4
lacp min-bundle 2
mlacp interchassis group 100
service instance 1 ethernet
  encapsulation dot1q 100
  rewrite ingress tag pop 1 symmetric
  bridge-domain 200
  service instance 3999 ethernet
  encapsulation untagged
  l2protocol peer lacp
  bridge-domain 3999

!
interface GigabitEthernet0/1/0
no ip address
load-interval 30
carrier-delay msec 25
no negotiation auto
lacp rate fast
channel-group 1 mode active
end
!
interface TenGigabitEthernet0/2/0
ip address 11.11.11.2 255.255.255.0
load-interval 30
mpls ip
mpls label protocol ldp
bfd template BFD_IPv4
end
```

Standby PoA for VPLS

The following VPLS sample configuration is for a standby PoA:

```
mpls ldp router-id Loopback0 force
mpls ldp graceful-restart
mpls label protocol ldp
!
bfd-template single-hop BFD_IPv4
```

```
interval min-tx 50 min-rx 50 multiplier 3
!
redundancy
mode sso
interchassis group 100
  monitor peer bfd
  member ip 1.1.1.1
  backbone interface GigabitEthernet0/6/0
  backbone interface GigabitEthernet0/2/0
  mlacp system-priority 2000
  mlacp node-id 2
!
l2 vfi VPLS_200 manual
vpn id 200
bridge-domain 200
neighbor 3.3.3.3 encapsulation mpls
neighbor 4.4.4.4 encapsulation mpls
neighbor 1.1.1.1 encapsulation mpls
!
interface Loopback0
ip address 2.2.2.2 255.255.255.255
!
interface Port-channel1
no ip address
lacp fast-switchover
lacp max-bundle 4
lacp min-bundle 2
mlacp lag-priority 40000
mlacp interchassis group 1
service instance 1 ethernet
  encapsulation dot1q 100
  rewrite ingress tag pop 1 symmetric
  bridge-domain 200
  service instance 3999 ethernet
  encapsulation untagged
  l2protocol peer lacp
  bridge-domain 3999

!
interface GigabitEthernet0/6/4
no ip address
load-interval 30
carrier-delay msec 25
no negotiation auto
lacp rate fast
channel-group 1 mode active
!
interface TenGigabitEthernet0/3/0
ip address 11.11.11.1 255.255.255.0
load-interval 30
mpls ip
mpls label protocol ldp
bfd template BFD_IPv4
```
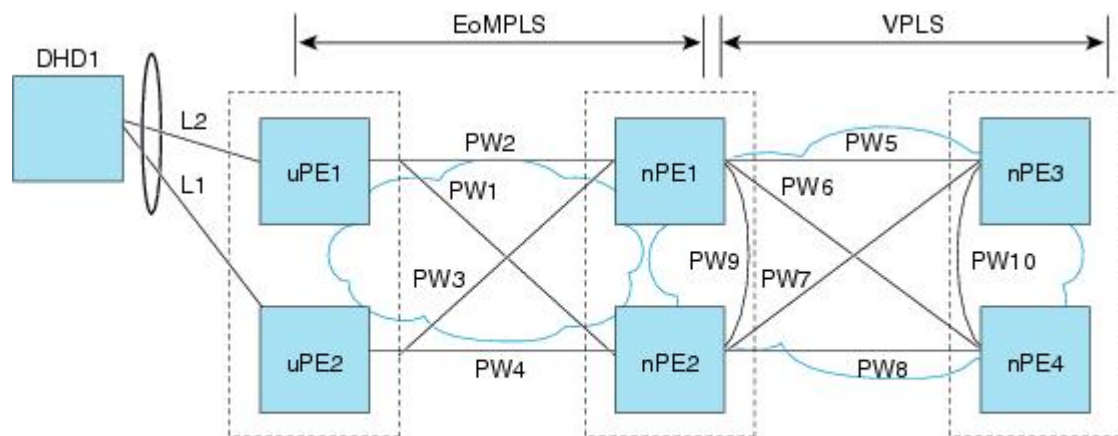
F or protocol based CLIs for VPLS configuration, see L2VPN Protocol-Based CLIs.

Example Configuring H-VPLS

Two sample configurations for H-VPLS follow: one example for an active PoA and the other for a standby PoA.

The figure below shows a sample topology for a H-VPLS configuration.

Priority L1 is Higher than Priority L2
PW3, PW2 Primary
PW4, PW1 Backup

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Active PoA for H-VPLS

The following H-VPLS sample configuration is for an active PoA:

```
mpls ldp router-id Loopback0 force
mpls ldp graceful-restart
mpls label protocol ldp
!
bfd-template single-hop BFD_IPv4
interval min-tx 50 min-rx 50 multiplier 3
!
redundancy
mode sso
interchassis group 100
  monitor peer bfd
  member ip 2.2.2.2
  backbone interface GigabitEthernet0/1/4
  backbone interface GigabitEthernet0/5/0
  mlacp system-priority 1000
  mlacp node-id 1
!
pseudowire-class mlacp
encapsulation mpls
status peer topology dual-homed
!
interface Loopback0
ip address 1.1.1.1 255.255.255.255
!
interface Port-channel1
no ip address
load-interval 30
negotiation auto
lacp failover non-revertive
lacp fast-switchover
lacp max-bundle 4
lacp min-bundle 2
mlacp lag-priority 2
mlacp interchassis group 100
service instance 2 ethernet
  encapsulation dot1q 2
  rewrite ingress tag pop 1 symmetric
```

```
  xconnect 3.3.3.3 2 encapsulation mpls pw-class mlacp
   backup peer 4.4.4.4 2 pw-class mlacp
service instance 3999 ethernet
  encapsulation untagged
  l2protocol peer lacp
  bridge-domain 3999

!
interface GigabitEthernet0/1/0
no ip address
load-interval 30
carrier-delay msec 25
no negotiation auto
lacp rate fast
channel-group 1 mode active
end
!
interface TenGigabitEthernet0/2/0
ip address 11.11.11.2 255.255.255.0
load-interval 30
mpls ip
mpls label protocol ldp
bfd template BFD_IPv4
end
```

Standby PoA for H-VPLS

The following H-VPLS sample configuration is for a standby PoA:

```
mpls ldp router-id Loopback0 forc
mpls ldp graceful-restart
mpls label protocol ldp
!
bfd-template single-hop BFD_IPv4
interval min-tx 50 min-rx 50 multiplier 3
!
redundancy
mode sso
interchassis group 100
  monitor peer bfd
  member ip 1.1.1.1
  backbone interface GigabitEthernet0/6/0
  backbone interface GigabitEthernet0/2/0
  mlacp system-priority 2000
  mlacp node-id 2
!
pseudowire-class mlacp
encapsulation mpls
status peer topology dual-homed
!
interface Loopback0
ip address 2.2.2.2 255.255.255.255
!
interface Port-channel1
no ip address
load-interval 30
no negotiation auto
lacp failover non-revertive
lacp fast-switchover
lacp max-bundle 4
lacp min-bundle 2
mlacp lag-priority 32768
mlacp interchassis group 100
```

```
service instance 2 ethernet
  encapsulation dot1q 2
  rewrite ingress tag pop 1 symmetric
  xconnect 3.3.3.3 2 encapsulation mpls pw-class mlacp
   backup peer 4.4.4.4 2 pw-class mlacp

!
interface GigabitEthernet0/6/4
no ip address
load-interval 30
carrier-delay msec 25
no negotiation auto
lacp rate fast
channel-group 1 mode active
!
interface TenGigabitEthernet0/3/0
ip address 11.11.11.1 255.255.255.0
load-interval 30
mpls ip
mpls label protocol ldp
bfd template BFD_IPv4
```

Example Verifying VPWS on an Active PoA

The following **show** commands can be used to display statistics and configuration parameters to verify the operation of the mLACP feature on an active PoA:

show lacp multichassis group

Use the **show lacp multichassis group** command to display the interchassis redundancy group value and the operational LACP parameters.

```
Router# show lacp multichassis group 100
Interchassis Redundancy Group 100

Operational LACP Parameters:
RG State: Synchronized
System-Id: 1000.7426.acf6.c000
ICCP Version: 0
Backbone Uplink Status: Connected
Local Configuration:
Node-id: 3
System-Id: 1000.7426.acf6.c000

Peer Information:
State: Up
Node-id: 4
System-Id: 2000.f078.166e.7a00
ICCP Version: 0

State Flags: Active - A
Standby - S
Down - D
AdminDown - AD
Standby Reverting - SR
Unknown - U

mLACP Channel-groups
Channel State Priority Active Links Inactive Links
Group Local/Peer Local/Peer Local/Peer Local/Peer
```

```
1 A/S 32773/32774 4/4 0/0
```

show lacp multichassis port-channel

Use the **show lacp multichassis port-channel** command to display the interface port-channel value channel group, LAG state, priority, inactive links peer configuration, and standby links.

```
Router# show lacp multichassis port-channel1
Interface Port-channel1
Local Configuration:
Address: 7426.acf6.c0cb
Channel Group: 1
State: Active
LAG State: Up
Priority: 32773
Inactive Links: 0
Total Active Links: 4
Bundled: 4
Selected: 4
Standby: 0
Unselected: 0

Peer Configuration:
Interface: Port-channel1
Address: f078.166e.7a41
Channel Group: 1
State: Standby
LAG State: Up
Priority: 32774
Inactive Links: 0
Total Active Links: 4
Bundled: 0
Selected: 0
Standby: 4
Unselected: 0
```

show mpls ldp iccp

Use the **show mpls ldp iccp** command to display the LDP session and ICCP state information.

```
Router# show mpls ldp iccp

ICPM RGID Table
iccp:
rg_id: 100, peer addr: 2.2.2.2
ldp_session 0x2, client_id 0
iccp state: ICPM_ICCP_CONNECTED
app type: MLACP
app state: ICPM_APP_CONNECTED, ptcl ver: 0
ICPM RGID Table total ICCP sessions: 1
ICPM LDP Session Table
iccp:
rg_id: 100, peer addr: 2.2.2.2
ldp_session 0x2, client_id 0
iccp state: ICPM_ICCP_CONNECTED
app type: MLACP
app state: ICPM_APP_CONNECTED, ptcl ver: 0
ICPM LDP Session Table total ICCP sessions: 1

ICPM peer table:
```

```
            peer:
            peer addr: 2.2.2.2, ldp session: 0x2
            Discovery handle: 0x450595EC
            Num ICCP Sessions: 1
            ATS event occurred: TRUE
```

show mpls l2transport

Use the **show mpls l2transport** command to display the local interface and session details, destination address, and status.

```
Router# show mpls l2transport vc 2
Local intf    Local circuit             Dest address    VC ID      Status
-------------  ------------------------  --------------  ---------  ----------
Po1           Eth VLAN 2                172.2.2.2       2          UP
Po1           Eth VLAN 2                172.4.4.4       2          STANDBY
```

show etherchannel summary

Use the **show etherchannel summary** command to display the status and identity of the mLACP member links.

```
Router# show etherchannel summary
Flags:  D - down        P/bndl - bundled in port-channel
        I - stand-alone s/susp - suspended
        H - Hot-standby (LACP only)
        R - Layer3      S - Layer2
        U - in use      f - failed to allocate aggregator

        M - not in use, minimum links not met
        u - unsuitable for bundling
        w - waiting to be aggregated
        d - default port

Number of channel-groups in use: 1
Number of aggregators:           1

Group  Port-channel  Protocol    Ports
------+------------+----------+------------------------------------------------
1 Po1(RU) LACP Gi0/0/1(bndl-act) Gi0/0/2(bndl-act) Gi0/0/3(bndl-act) Gi0/0/4(bndl-act)

RU - L3 port-channel UP State
SU - L2 port-channel UP state
P/bndl -  Bundled
S/susp  - Suspended
```

show lacp internal

Use the **show lacp internal** command to display the device, port, and member- link information.

```
Router# show lacp internal
Flags:  S - Device is requesting Slow LACPDUs
        F - Device is requesting Fast LACPDUs
        A - Device is in Active mode       P - Device is in Passive mode

Channel group 1
                        LACP port   Admin    Oper    Port      Port
Port       Flags  State  Priority   Key      Key     Number    State
```

```
Gi0/0/1    FA      bndl-act  2               0x1     0x1     0xB002     0x3D
Gi0/0/2    FA      bndl-act  2               0x1     0x1     0xB003     0x3D
Gi0/0/3    FA      bndl-act  2               0x1     0x1     0xB004     0x3D
Gi0/0/4    FA      bndl-act  2               0x1     0x1     0xB005     0x3D

Peer (ASR903-PE4) mLACP member links

Gi0/0/1    FA      bndl-sby  32768           0x1     0x1     0xC002     0xD
Gi0/0/2    FA      bndl-sby  32768           0x1     0x1     0xC003     0xD
Gi0/0/3    FA      bndl-sby  32768           0x1     0x1     0xC004     0xD
Gi0/0/0    FA      bndl-sby  32768           0x1     0x1     0xC001     0xD
```

Example Verifying VPWS on a Standby PoA

The following **show** commands can be used to display statistics and configuration parameters to verify the operation of the mLACP feature on a standby PoA:

show lacp multichassis group

Use the **show lacp multichassis group** command to display the LACP parameters, local configuration, status of the backbone uplink, peer information, node ID, channel, state, priority active, and inactive links.

```
Router# show lacp multichassis group 100
Interchassis Redundancy Group 100

Operational LACP Parameters:
RG State: Synchronized
System-Id: 1000.7426.acf6.c000
ICCP Version: 0
Backbone Uplink Status: Connected
Local Configuration:
Node-id: 4
System-Id: 2000.f078.166e.7a00

Peer Information:
State: Up
Node-id: 3
System-Id: 1000.7426.acf6.c000
ICCP Version: 0

State Flags: Active - A
Standby - S
Down - D
AdminDown - AD
Standby Reverting - SR
Unknown - U

mLACP Channel-groups
Channel       State     Priority      Active Links    Inactive Links
 Group     Local/Peer  Local/Peer     Local/Peer       Local/Peer
   1           S/A      32774/32773       4/4              0/0
```

show lacp multichassis portchannel

Use the **show lacp multichassis portchannel** command to display the interface port-channel value channel group, LAG state, priority, inactive links peer configuration, and standby links.

```
Router# show lacp multichassis port-channel1
```

```
Interface Port-channel1
Local Configuration:
Address: f078.166e.7a41
Channel Group: 1
State: Standby
LAG State: Up
Priority: 32774
Inactive Links: 0
Total Active Links: 4
Bundled: 0
Selected: 0
Standby: 4
Unselected: 0

Peer Configuration:
Interface: Port-channel1
Address: 7426.acf6.c0cb
Channel Group: 1
State: Active
LAG State: Up
Priority: 32773
Inactive Links: 0
Total Active Links: 4
Bundled: 4
Selected: 4
Standby: 0
Unselected: 0
```

show mpls ldp iccp

Use the **show mpls ldp iccp**command to display the LDP session and ICCP state information.

```
Router# show mpls ldp iccp
ICPM RGID Table
iccp:
rg_id: 100, peer addr: 1.1.1.1
ldp_session 0x2, client_id 0
iccp state: ICPM_ICCP_CONNECTED
app type: MLACP
app state: ICPM_APP_CONNECTED, ptcl ver: 0
ICPM RGID Table total ICCP sessions: 1
ICPM LDP Session Table
iccp:
rg_id: 100, peer addr: 1.1.1.1
ldp_session 0x2, client_id 0
iccp state: ICPM_ICCP_CONNECTED
app type: MLACP
app state: ICPM_APP_CONNECTED, ptcl ver: 0
ICPM LDP Session Table total ICCP sessions: 1

ICPM peer table:
peer:
peer addr: 1.1.1.1, ldp session: 0x2
Discovery handle: 0x44AFB42C
Num ICCP Sessions: 1
ATS event occurred: TRUE
```

show mpls l2transport

Use the **show mpls l2transport** command to display the local interface and session details, destination address, and status.

```
Router# show mpls l2transport vc 2
Local intf      Local circuit             Dest address     VC ID      Status
-------------   -------------------------   ---------------   ----------   ----------
Po1             Eth VLAN 2                 172.2.2.2         2          STANDBY
Po1             Eth VLAN 2                 172.4.4.4         2          STANDBY
```

show etherchannel summary

Use the **show etherchannel summary** command to display the status and identity of the mLACP member links.

```
Router# show etherchannel summary
Flags:  D - down        P/bndl - bundled in port-channel
        I - stand-alone s/susp - suspended
        H - Hot-standby (LACP only)
        R - Layer3      S - Layer2
        U - in use      f - failed to allocate aggregator

        M - not in use, minimum links not met
        u - unsuitable for bundling
        w - waiting to be aggregated
        d - default port


Number of channel-groups in use: 1
Number of aggregators:           1

Group  Port-channel  Protocol    Ports
------+-------------+-----------+---------------------------------------------
1 Po1(RU) LACP Gi0/0/0(bndl-sby) Gi0/0/1(bndl-sby) Gi0/0/2(bndl-sby) Gi0/0/3(bndl-sby)

RU - L3 port-channel UP State
SU - L2 port-channel UP state
P/bndl -  Bundled
S/susp  - Suspended
```

show lacp internal

Use the **show lacp internal** command to display the device, port, and member-link information.

```
Router# show lacp internal
Flags: S - Device is requesting Slow LACPDUs
       F - Device is requesting Fast LACPDUs
       A - Device is in Active mode P - Device is in Passive mode

Channel group 1
LACP port Admin Oper Port Port
Port     Flags    State    Priority   Key   Key   Number   State
Gi0/0/0  FA      bndl-sby  32774      0x1   0x1   0xC001   0xF
Gi0/0/1  FA      bndl-sby  32774      0x1   0x1   0xC002   0xF
Gi0/0/2  FA      bndl-sby  32774      0x1   0x1   0xC003   0xF
Gi0/0/3  FA      bndl-sby  32774      0x1   0x1   0xC004   0xF


Peer (ASR903-PE3) mLACP member links

Gi0/0/2 FA bndl-act 32773 0x1 0x1 0xB003 0x3F
Gi0/0/3 FA bndl-act 32773 0x1 0x1 0xB004 0x3F
Gi0/0/4 FA bndl-act 32773 0x1 0x1 0xB005 0x3F
Gi0/0/1 FA bndl-act 32773 0x1 0x1 0xB002 0x3F
```

Example Verifying VPLS on an Active PoA

The following **show** commands can be used to display statistics and configuration parameters to verify the operation of the mLACP feature on an active PoA:

show lacp multichassis group

Use the **show lacp multichassis group** command to display the LACP parameters, local configuration, status of the backbone uplink, peer information, node ID, channel, state, priority active, and inactive links.

```
Router# show lacp multichassis group 100
Interchassis Redundancy Group 100
Operational LACP Parameters:
RG State:     Synchronized
System-Id:    200.000a.f331.2680
ICCP Version: 0
Backbone Uplink Status: Connected
Local Configuration:
Node-id:   0
System-Id: 200.000a.f331.2680
Peer Information:
State:        Up
Node-id:      7
System-Id:    2000.0014.6a8b.c680
ICCP Version: 0
State Flags: Active          - A
             Standby         - S
             Down            - D
             AdminDown       - AD
             Standby Reverting - SR
             Unknown         - U

mLACP Channel-groups
Channel   State       Priority      Active Links   Inactive Links
 Group  Local/Peer  Local/Peer      Local/Peer      Local/Peer
   1       A/S      28000/32768        4/4             0/0
```

show lacp multichassis port-channel

Use the **show lacp multichassis port-channel** command to display the interface port-channel value channel group, LAG state, priority, inactive links peer configuration, and standby links.

```
Router# show lacp multichassis port-channel1
Interface Port-channel1
Local Configuration:
Address: 000a.f331.2680
Channel Group: 1
State: Active
LAG State: Up
Priority: 28000
Inactive Links: 0
Total Active Links: 4
         Bundled: 4
        Selected: 4
         Standby: 0
      Unselected: 0
```

```
                        Peer Configuration:
                        Interface: Port-channel1
                        Address: 0014.6a8b.c680
                        Channel Group: 1
                        State: Standby
                        LAG State: Up
                        Priority: 32768
                        Inactive Links: 0
                        Total Active Links: 4
                                                Bundled: 0
                                    Selected: 0
                                     Standby: 4
                                  Unselected: 0
```

show mpls ldp iccp

Use the **show mpls ldp iccp** command to display the LDP session and ICCP state information.

```
Router# show mpls ldp iccp
ICPM RGID Table
  iccp:
    rg_id: 100, peer addr: 172.3.3.3
    ldp_session 0x3, client_id 0
    iccp state: ICPM_ICCP_CONNECTED
    app type: MLACP
        app state: ICPM_APP_CONNECTED, ptcl ver: 0
ICPM RGID Table total ICCP sessions: 1
ICPM LDP Session Table
  iccp:
    rg_id: 100, peer addr: 172.3.3.3
    ldp_session 0x3, client_id 0
    iccp state: ICPM_ICCP_CONNECTED
    app type: MLACP
        app state: ICPM_APP_CONNECTED, ptcl ver: 0
ICPM LDP Session Table total ICCP sessions: 1
```

show mpls l2transport

Use the **show mpls l2transport** command to display the local interface and session details, destination address, and the status.

```
Router# show mpls l2transport vc 4000
Local intf     Local circuit              Dest address     VC ID     Status
-------------  -------------------------  ---------------  --------  ---------
VFI VPLS       VFI                        172.2.2.2        4000      UP
VFI VPLS       VFI                        172.4.4.4     4000      UP
```

show etherchannel summary

Use the **show etherchannel summary** command to display the status and identity of the mLACP member links.

```
Router# show etherchannel summary
Flags:  D - down         P/bndl - bundled in port-channel
        I - stand-alone s/susp - suspended
        H - Hot-standby (LACP only)
        R - Layer3      S - Layer2
        U - in use      f - failed to allocate aggregator
```

```
              M - not in use, minimum links not met
              u - unsuitable for bundling
              w - waiting to be aggregated
              d - default port


Number of channel-groups in use: 1
Number of aggregators:          1

Group  Port-channel  Protocol    Ports
------+-------------+-----------+-----------------------------------------------
1 Po1(RU) LACP Gi0/0/1(bndl-act) Gi0/0/2(bndl-act) Gi0/0/3(bndl-act) Gi0/0/4(bndl-act)

RU - L3 port-channel UP State
SU - L2 port-channel UP state
P/bndl -  Bundled
S/susp  - Suspended
```

show lacp internal

Use the **show lacp internal** command to display the device, port, and member-link information.

```
Router# show lacp internal
Flags:  S - Device is requesting Slow LACPDUs
        F - Device is requesting Fast LACPDUs
        A - Device is in Active mode       P - Device is in Passive mode

Channel group 1
                           LACP port   Admin    Oper    Port     Port
Port      Flags   State    Priority    Key      Key     Number   State
Gi0/0/1   FA      bndl-act 2           0x1      0x1     0xB002   0x3D
Gi0/0/2   FA      bndl-act 2           0x1      0x1     0xB003   0x3D
Gi0/0/3   FA      bndl-act 2           0x1      0x1     0xB004   0x3D
Gi0/0/4   FA      bndl-act 2           0x1      0x1     0xB005   0x3D

Peer (ASR903-PE4) mLACP member links

Gi0/0/1   FA      bndl-sby 32768       0x1      0x1     0xC002   0xD
Gi0/0/2   FA      bndl-sby 32768       0x1      0x1     0xC003   0xD
Gi0/0/3   FA      bndl-sby 32768       0x1      0x1     0xC004   0xD
Gi0/0/0   FA      bndl-sby 32768       0x1      0x1     0xC001   0xD
```

Example Verifying VPLS on a Standby PoA

The **show** commands in this section can be used to display statistics and configuration parameters to verify the operation of the mLACP feature:

show lacp multichassis group

Use the **show lacp multichassis group** *interchassis group number* command to display the LACP parameters, local configuration, status of the backbone uplink, peer information, node ID, channel, state, priority, active, and inactive links.

```
Router# show lacp multichassis group 100
Interchassis Redundancy Group 100
Operational LACP Parameters:
RG State:    Synchronized
System-Id:   200.000a.f331.2680
```

```
ICCP Version: 0
Backbone Uplink Status: Connected
Local Configuration:
Node-id:    7
System-Id: 2000.0014.6a8b.c680
Peer Information:
State:        Up
Node-id:       0
System-Id:    200.000a.f331.2680
ICCP Version: 0
State Flags: Active          - A
             Standby         - S
             Down            - D
             AdminDown       - AD
             Standby Reverting - SR
             Unknown         - U


mLACP Channel-groups
Channel   State     Priority     Active Links   Inactive Links
 Group  Local/Peer Local/Peer     Local/Peer     Local/Peer
   1       S/A     32768/28000       4/4            0/0
```

show lacp multichassis portchannel

Use the **show lacp multichassis portchannel** command to display the interface port-channel value channel group, LAG state, priority, inactive links peer configuration, and standby links.

```
Router# show lacp multichassis port-channel1
Interface Port-channel1
Local Configuration:
Address: 0014.6a8b.c680
Channel Group: 1
State: Standby
LAG State: Up
Priority: 32768
Inactive Links: 0
Total Active Links: 4
          Bundled: 0
         Selected: 0
          Standby: 4
       Unselected: 0
Peer Configuration:
Interface: Port-channel1
Address: 000a.f331.2680
Channel Group: 1
State: Active
LAG State: Up
Priority: 28000
Inactive Links: 0
Total Active Links: 4
                          Bundled: 4
           Selected: 4
            Standby: 0
         Unselected: 0
```

show mpls ldp iccp

Use the **show mpls ldp iccp** command to display the LDP session and ICCP state information.

```
Router# show mpls ldp iccp
ICPM RGID Table
```

```
   iccp:
      rg_id: 100, peer addr: 172.1.1.1
      ldp_session 0x2, client_id 0
      iccp state: ICPM_ICCP_CONNECTED
      app type: MLACP
         app state: ICPM_APP_CONNECTED, ptcl ver: 0
ICPM RGID Table total ICCP sessions: 1
ICPM LDP Session Table
   iccp:
      rg_id: 100, peer addr: 172.1.1.1
      ldp_session 0x2, client_id 0
      iccp state: ICPM_ICCP_CONNECTED
      app type: MLACP
         app state: ICPM_APP_CONNECTED, ptcl ver: 0
ICPM LDP Session Table total ICCP sessions: 1
```

show mpls l2transport

Use the **show mpls l2transport** command to display the local interface and session details, destination address, and status.

```
Router# show mpls l2transport vc 4000
Local intf    Local circuit        Dest address    VC ID      Status
-------------  -------------------  --------------  ---------- ----------
VFI VPLS      VFI                  172.2.2.2        4000       UP
VFI VPLS      VFI                  172.4.4.4        4000       UP
```

show etherchannel summary

Use the **show etherchannel summary** command to display the status and identity of the mLACP member links.

```
Router# show etherchannel summary

Flags:  D - down        P/bndl - bundled in port-channel
        I - stand-alone s/susp - suspended
        H - Hot-standby (LACP only)
        R - Layer3       S - Layer2
        U - in use       f - failed to allocate aggregator

        M - not in use, minimum links not met
        u - unsuitable for bundling
        w - waiting to be aggregated
        d - default port


Number of channel-groups in use: 1
Number of aggregators:           1

Group  Port-channel  Protocol    Ports
------+------------+----------+------------------------------------------------
1 Po1(RU) LACP Gi0/0/0(bndl-sby) Gi0/0/1(bndl-sby) Gi0/0/2(bndl-sby) Gi0/0/3(bndl-sby)

RU - L3 port-channel UP State
SU - L2 port-channel UP state
P/bndl -  Bundled
S/susp  - Suspended
```

show lacp internal

Use the **show lacp internal** command to display the device, port, and member- link information.

```
Router# show lacp internal

Flags:  S - Device is requesting Slow LACPDUs
        F - Device is requesting Fast LACPDUs
        A - Device is in Active mode      P - Device is in Passive mode

Channel group 1
                           LACP port   Admin    Oper    Port      Port
Port       Flags   State   Priority    Key      Key     Number    State
Gi0/0/0    FA      bndl-sby 32768      0x1      0x1     0xC001    0xD
Gi0/0/1    FA      bndl-sby 32768      0x1      0x1     0xC002    0xD
Gi0/0/2    FA      bndl-sby 32768      0x1      0x1     0xC003    0xD
Gi0/0/3    FA      bndl-sby 32768      0x1      0x1     0xC004    0xD

Peer (ASR903-PE3) mLACP member links

Gi0/0/2    FA      bndl-act  2         0x1      0x1     0xB003    0x3D
Gi0/0/3    FA      bndl-act  2         0x1      0x1     0xB004    0x3D
Gi0/0/4    FA      bndl-act  2         0x1      0x1     0xB005    0x3D
Gi0/0/1    FA      bndl-act  2         0x1      0x1     0xB002    0x3D
```

Glossary

active attachment circuit—The link that is actively forwarding traffic between the DHD and the active PoA.

active PW—The pseudowire that is forwarding traffic on the active PoA.

BD—bridge domain.

BFD—bidirectional forwarding detection.

DHD—dual-homed device. A node that is connected to two switches over a multichassis link aggregation group for the purpose of redundancy.

DHN—dual-homed network. A network that is connected to two switches to provide redundancy.

H-VPLS—Hierarchical Virtual Private LAN Service.

ICC—Interchassis Communication Channel.

ICCP—Interchassis Communication Protocol.

ICPM—Interchassis Protocol Manager.

ICRM—Interchassis Redundancy Manager.

LACP—Link Aggregation Control Protocol.

LAG—link aggregation group.

LDP—Link Distribution Protocol.

MCEC—Multichassis EtherChannel.

mLACP—Multichassis LACP.

PoA—point of attachment. One of a pair of switches running multichassis link aggregation group with a DHD.

—

PW-RED—pseudowire redundancy.

standby attachment circuit—The link that is in standby mode between the DHD and the standby PoA.

standby PW—The pseudowire that is in standby mode on either an active or a standby PoA.

uPE—user-facing Provider Edge.

VPLS—Virtual Private LAN Service.

VPWS—Virtual Private Wire Service.