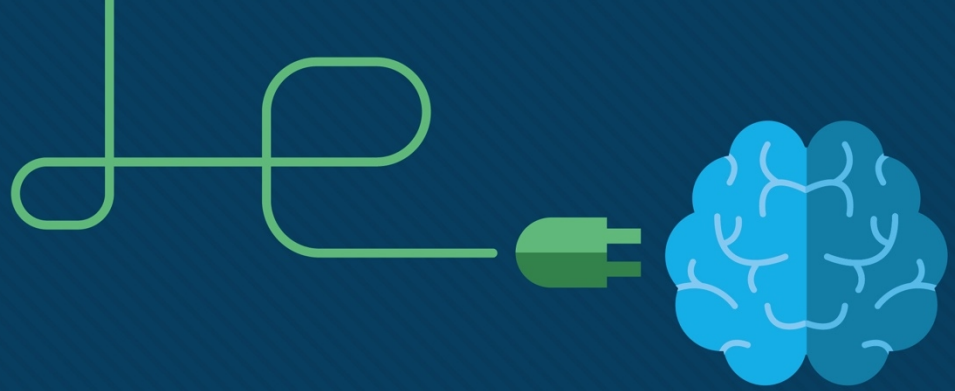


Point-to-Point Connections

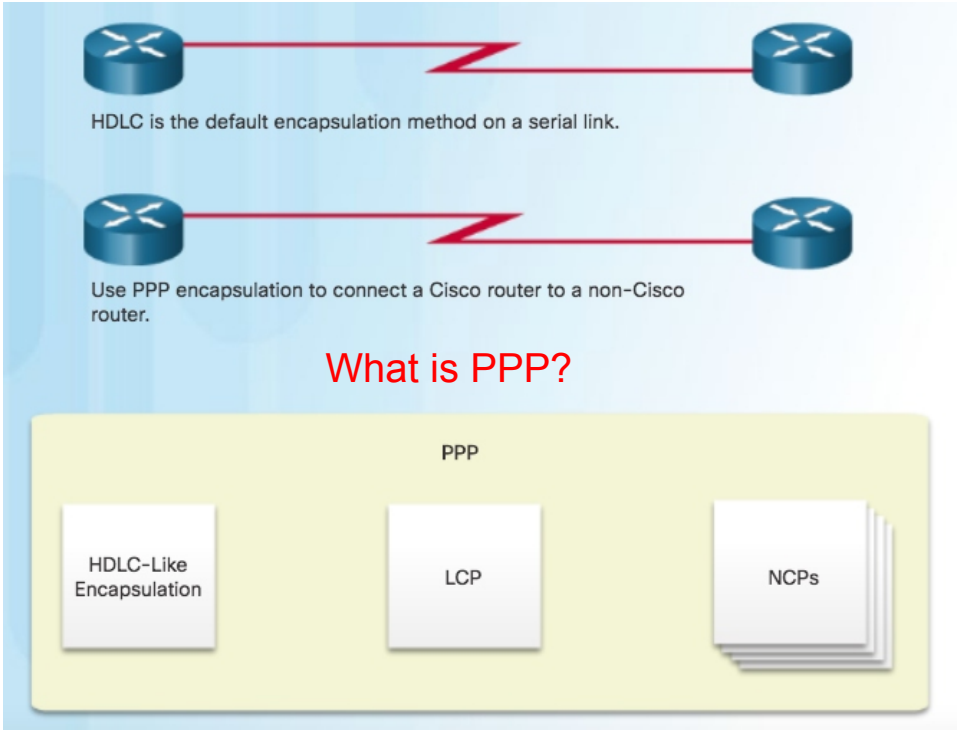
Based on :
CCNA Routing and Switching
Connecting Networks v6.0

Sections & Objectives

- PPP Operation
  - Explain how PPP operates across a point-to-point serial link
  - Compare PPP and HDLC
  - Explain the PPP-layered architecture and the functions of LCP and NCP
  - Explain how PPP establishes a session.

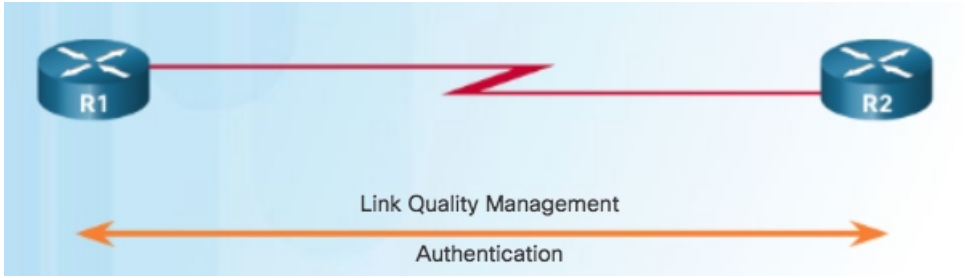
PPP Operation

Introducing PPP



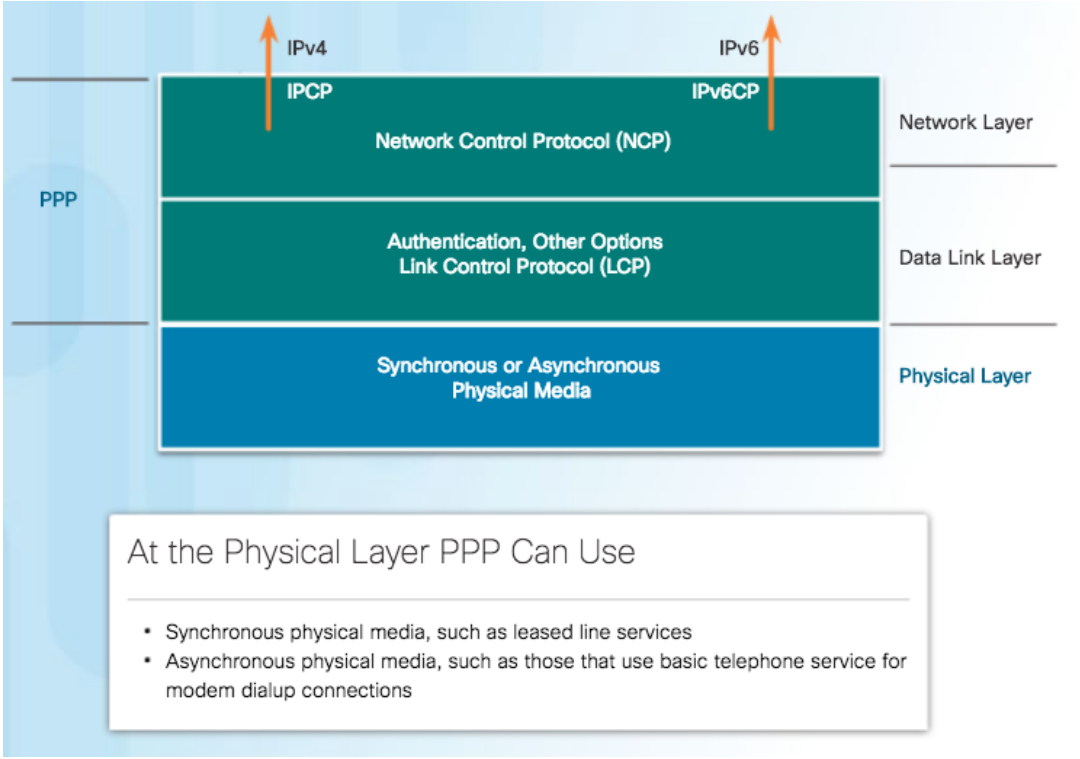
- PPP encapsulates data frames for transmission over Layer 2 physical links.
- PPP establishes a direct connection using serial cables, phone lines, trunk lines, cellular telephones, specialized radio links, or fiber-optic links.
- PPP contains three main components:
  - HDLC-like framing for transporting multiprotocol packets over point-to-point links.
  - Extensible Link Control Protocol (LCP) for establishing, configuring, and testing the data-link connection.
  - Network Control Protocols (NCPs) for establishing and configuring different network layer protocols (IPv4 and IPv6 Control Protocol).

Advantages of PPP



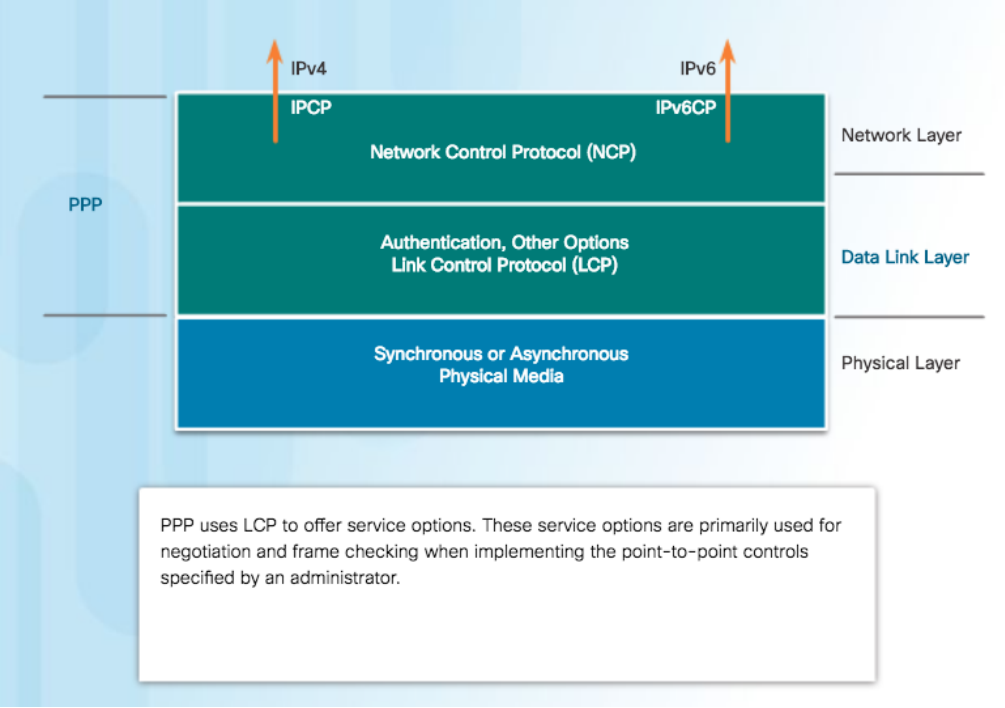
- PPP includes many features not available in HDLC:
  - The link quality management feature (LQM) monitors the quality of the link. LQM can be configured with the interface command **ppp quality** *percentage*. If the error percentage falls below the configured threshold, the link is taken down and packets are rerouted or dropped.
  - PPP supports PAP and CHAP authentication.

PPP Layered Architecture



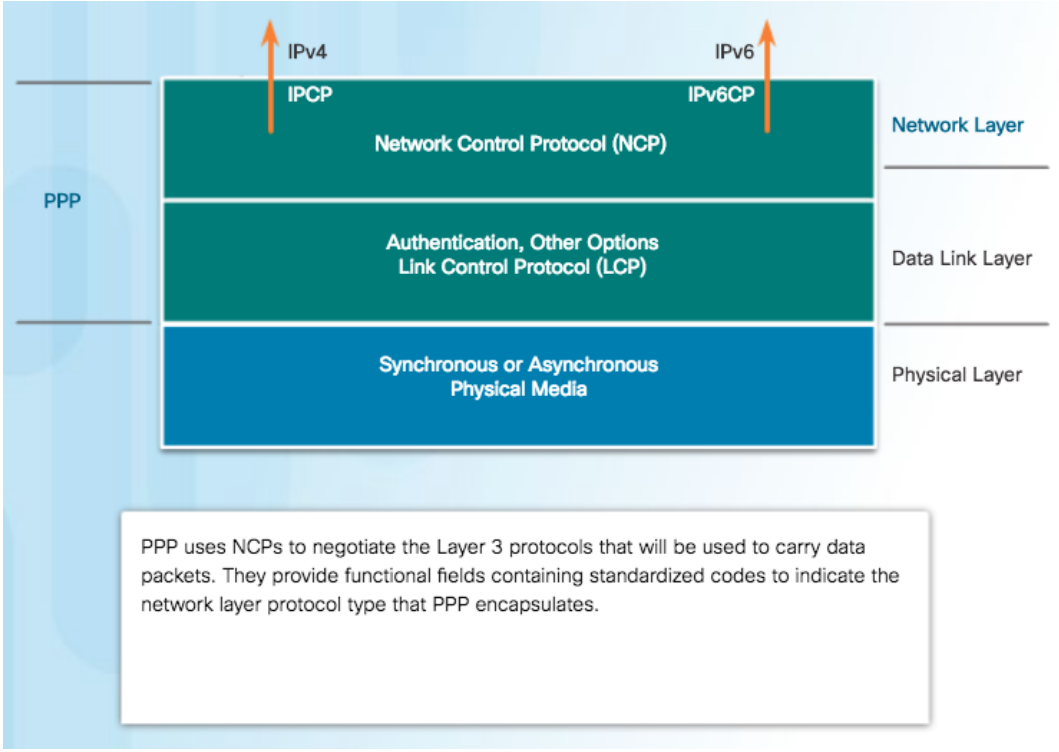
- The figure maps the layered architecture of PPP against the Open System Interconnection (OSI) model.
- PPP and OSI share the same physical layer, but PPP distributes the functions of LCP and NCP differently.
- PPP requires a full-duplex circuit, either dedicated or switched, that can operate in an asynchronous or synchronous bit-serial mode.
- Most of the work done by PPP happens at the data link and network layers, by LCP and NCPs.

PPP – Link Control Protocol (LCP)



- LCP functions within the data link layer and has a role in establishing, configuring, and testing the data-link connection.
- LCP establishes the point-to-point link.
- LCP also negotiates and sets up control options on the WAN data link, which are handled by the NCPs.
- After the link is established, PPP also uses LCP to agree automatically on encapsulation formats such as authentication, compression, and error detection.

PPP – Network Control Protocol (NCP)



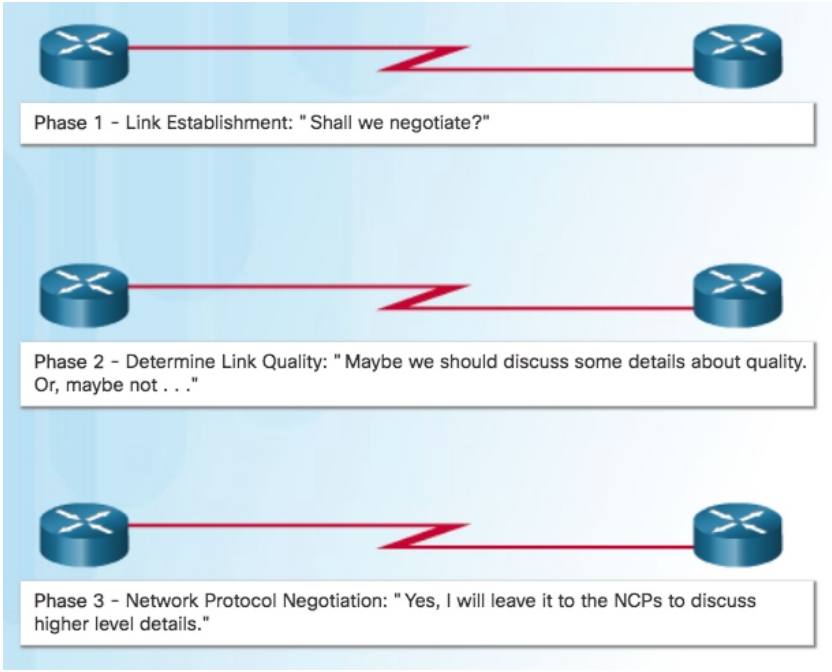
- PPP permits multiple network layer protocols to operate on the same communications link.
- For every network layer protocol used, PPP uses a separate NCP, as shown in the figure. IPv4 uses IP Control Protocol and IPv6 uses IPv6 Control Protocol.
- NCPs include functional fields containing standardized codes to indicate the network layer protocol that PPP encapsulates.
  - Value 8021 = IPCP
  - Value 8057 = IPv6CP

PPP Frame Structure

PPP Frame Fields

- **Flag** - A single byte that indicates the beginning or end of a frame. The Flag field consists of the binary sequence 01111110.
- **Address** - A single byte that contains the binary sequence 11111111, the standard broadcast address
- **Control** - A single byte that contains the binary sequence 00000011, which calls for transmission of user data in an unsequenced frame.
- **Protocol** - Two bytes that identify the protocol encapsulated in the information field of the frame.
- **Data** - Zero or more bytes that contain the datagram for the protocol specified in the protocol field.
- **Frame Check Sequence (FCS)** – This is normally 16 bits (2 bytes). If the receiver's calculation of the FCS does not match the FCS in the PPP frame, the PPP frame is silently discarded

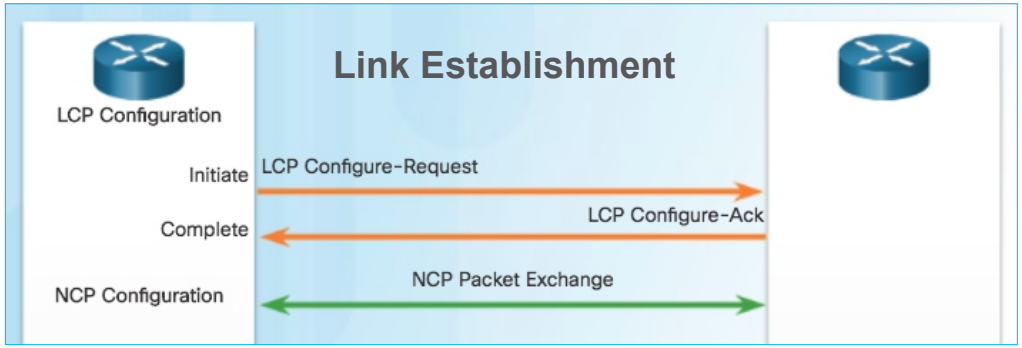
Establishing a PPP Session



- **Phase 1: Link establishment and configuration negotiation** - Before PPP exchanges any network layer datagrams, such as IP, the LCP must first open the connection and negotiate configuration options. This phase is complete when the receiving router sends a configuration-acknowledgment frame back to the router initiating the connection.
- **Phase 2: Link quality determination (optional)** - The LCP tests the link to determine whether the link quality is sufficient to bring up network layer protocols.
- **Phase 3: Network layer protocol configuration negotiation** - After the LCP has finished Phase 2, the appropriate NCP can separately configure the network layer protocols, and bring them up and take them down at any time. If the LCP closes the link, it informs the network layer protocols so that they can take appropriate action.

LCP Operation

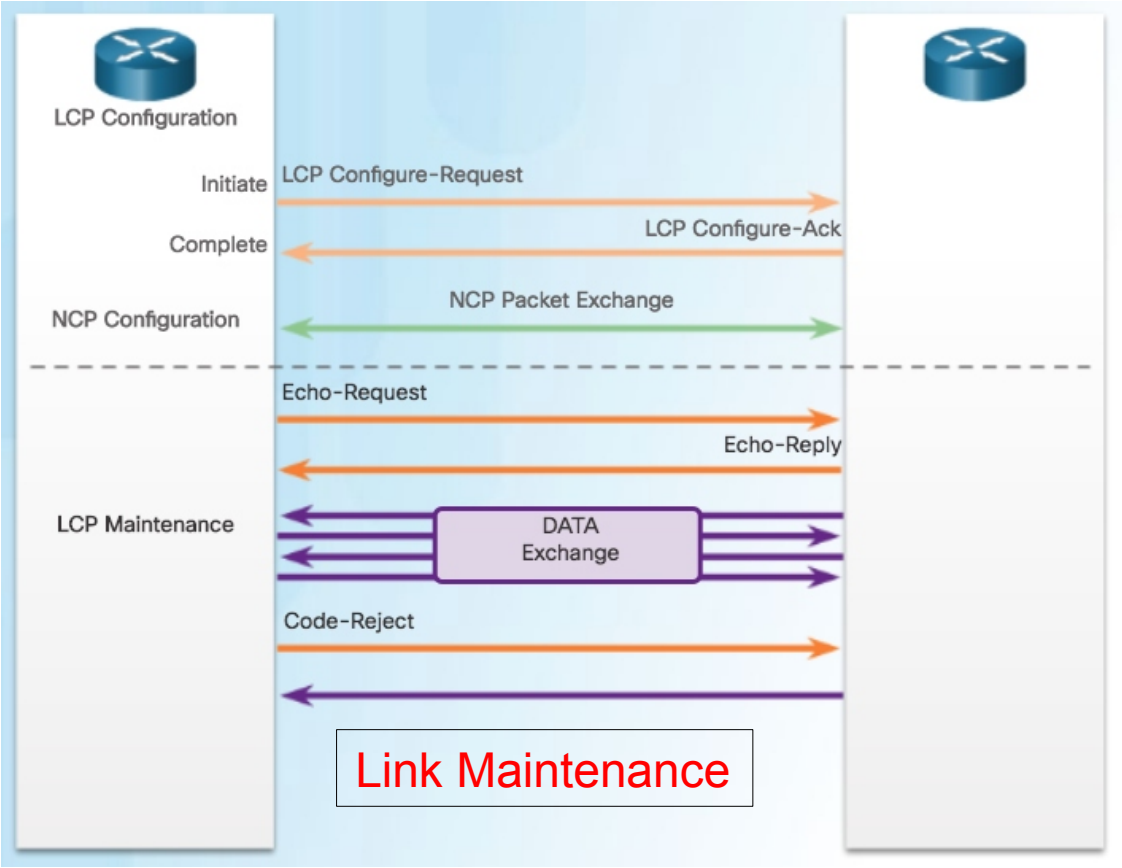
- LCP operation includes provisions for 3 classes of LCP frames:
  - Link-establishment frames
  - Link-maintenance frames
  - Link-termination frames
- During link establishment, the LCP opens the connection and negotiates the configuration parameters. The link establishment process starts with the initiating device sending a Configure-Request frame to the responder.



- Responder processes the request:
  - If the options are not acceptable or not recognized, the responder sends a Configure-Nak or Configure-Reject message.
  - If the options are acceptable, the responder responds with a Configure-Ack message and the process moves on to the authentication stage. The operation of the link is handed over to the NCP.
- When NCP has completed all necessary configurations, including validating authentication, the line is available for data transfer. During the exchange of data, LCP transitions into link maintenance.

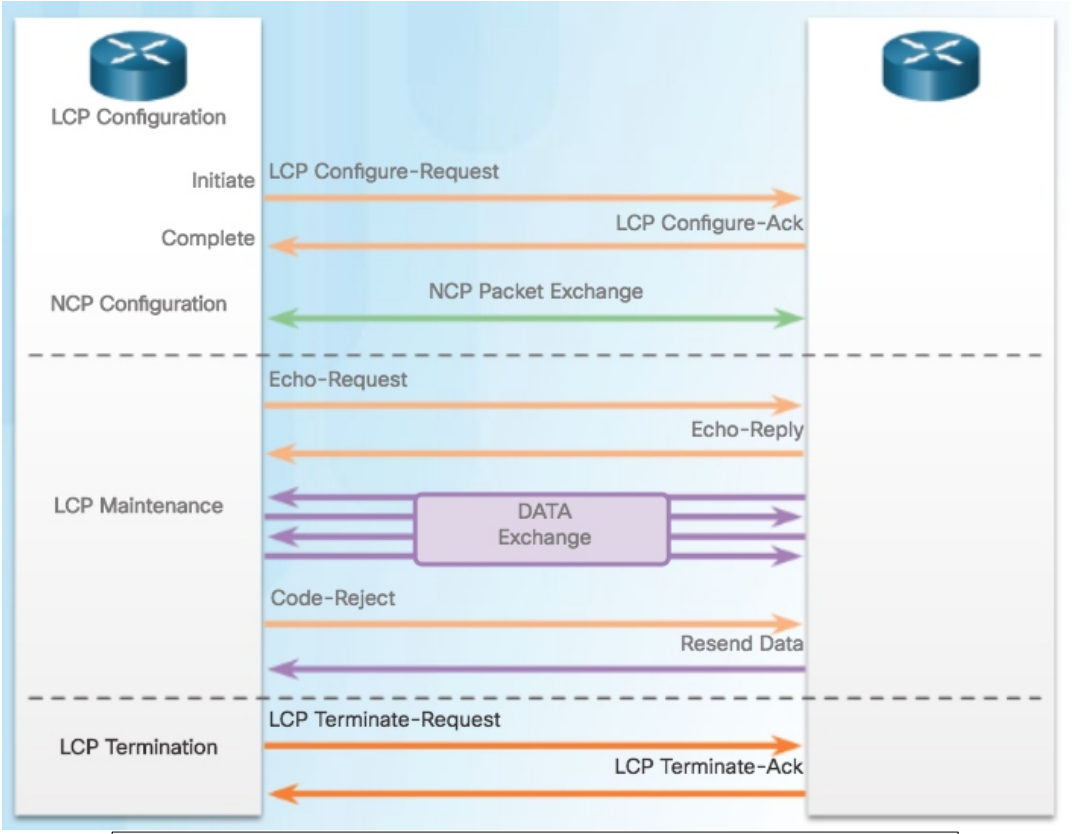
LCP Operation (Cont.)

- During link maintenance, LCP can use messages to provide feedback and test the link.
  - **Echo-Request, Echo-Reply, and Discard-Request** - These frames can be used for testing the link.
  - **Code-Reject and Protocol-Reject** - These frame types provide feedback when one device receives an invalid frame. The sending device will resend the packet.



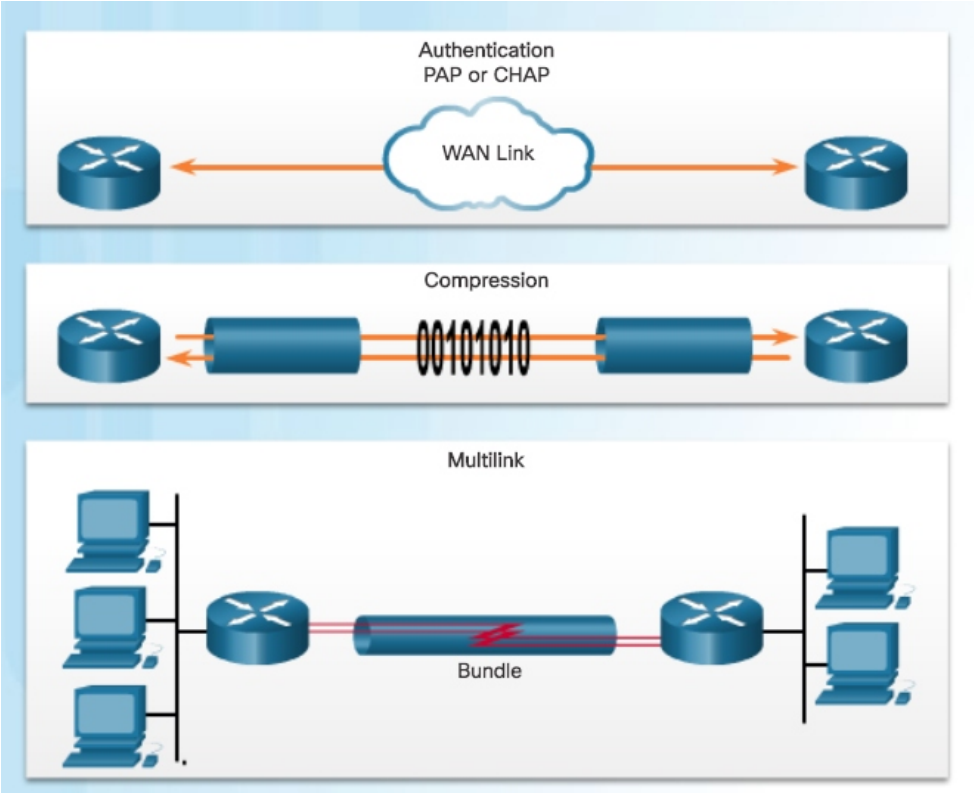
LCP Operation (Cont.)

- Link Termination
  - After the transfer of data at the network layer completes, the LCP terminates the link. NCP only terminates the network layer and NCP link. The link remains open until the LCP terminates it.
  - PPP can terminate the link at any time because of the loss of the carrier, authentication failure, link quality failure, the expiration of an idle-period timer, or the administrative closing of the link.
  - The LCP closes the link by exchanging Terminate packets.



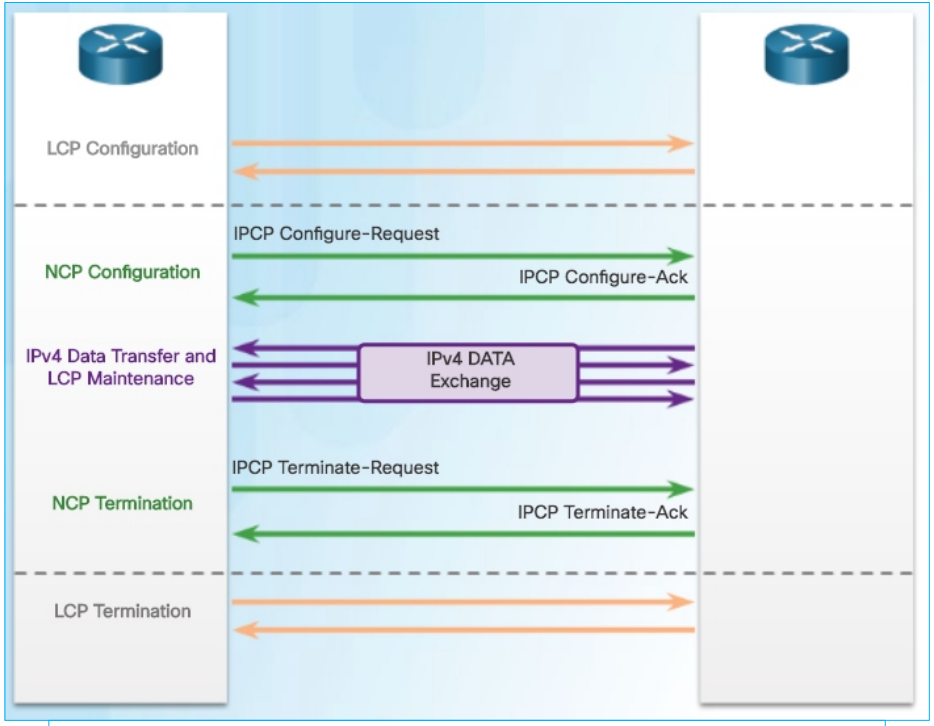
Device initiating the shutdown sends a Terminate-Request message. Other device replies with a Terminate-Ack.

PPP Configuration Options



- Authentication using either PAP or CHAP
- Compression using either Stacker or Predictor
- Multilink that combines two or more channels to increase the WAN bandwidth

NCP Explained



When data transfer is complete, NCP terminates the protocol link and LCP terminates the PPP connection.

- After LCP has established the link, the routers exchange IPCP messages, negotiating options specific to IPv4.
- IPCP is responsible for configuring, enabling, and disabling the IPv4 modules on both ends of the link.
- IPCP negotiates two options:
  - Compression - Allows devices to negotiate an algorithm to compress TCP and IP headers and save bandwidth.
  - IPv4-Address - Allows the initiating device to specify an IPv4 address to use for routing IP over the PPP link, or to request an IPv4 address for the responder.
- After the NCP process is complete, the link goes into the open state and LCP takes over again in a link maintenance phase.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