11.2.3 PPP WAN Connection Facts

A point-to-point WAN link connects two endpoints on a pre-established communications path, usually through a telephone company. The Point-to-Point Protocol (PPP) moves data through the connection. Be aware that PPP:

- Is a Data Link (Layer 2) protocol designed to facilitate communication over leased lines.
- Can be used on a wide variety of physical interfaces, including asynchronous serial, synchronous serial (dial-up), and ISDN.
- Defines a header and trailer that specify a protocol type field.
- Contains protocols that integrate and support higher level protocols.
- Supports multiple Network layer protocols over the same link.
- Supports both IPv4 and IPv6.
- Provides optional authentication through PAP (2-way authentication) or CHAP (3-way authentication):
  - PAP transmits the password in clear text over the link.
  - CHAP uses a hash of the password for authentication. The password itself is not transmitted on the link.
- Supports multilink connections, which allows load balancing over multiple physical links.
- Includes link quality monitoring (LQM), which can detect link errors and automatically terminate links with excessive errors.
- Includes looped link detection, which can identify when messages sent from a router are looped back to that router.
  - Routers send magic numbers in communications. If a router receives a packet with its own magic number, the link is looped.

A variation of PPP called *Multilink PPP* (MLP) is available on some routers. MLP is used to aggregate multiple WAN links into a single logical channel.

PPP Protocols

PPP uses these two main protocols to establish and maintain the link:

Protocol	Description

Link Control Protocol (LCP)	LCP is responsible for establishing, maintaining, and tearing down the PPP link. LCP packets are exchanged periodically.
	- During link establishment, LCP agrees on encapsulation, packet size, and compression settings. LCP also indicates whether authentication should be used.
	- Throughout the session, LCP packets are exchanged to:
	  - Detect loops.
	  - Detect and correct errors.
	  - Control the use of multiple links (multilink).
	- When the session is terminated, LCP tears down the link.
	A single link control protocol runs for each physical connection.

Network Control Protocol (NCP)	NCP is used to agree on and configure Network layer protocols. Each Network layer protocol has a corresponding control protocol packet. Examples of control protocols include: - IP Control Protocol (IPCP) - IP version 6 Control Protocol (IPv6CP) A single PPP link can run multiple control protocols, one for each Network layer protocol supported on the link.

PPP Communication Phases

PPP establishes communication in three phases:

1. LCP phase—LCP packets are exchanged to open the link and agree on link settings.
2. Authenticate phase (optional)—Authentication-specific packets are exchanged to configure authentication parameters and authenticate the devices. LCP packets might also be exchanged during this phase to maintain the link.
3. NCP phase—NCP packets are exchanged to agree on which upper layer protocols to use. For example, routers might exchange IPCP and Cisco Discovery Protocol Control Protocol (CDPCP) packets to agree on using IP and CDP for Network layer communications. During this phase, LCP packets might continue to be exchanged.