

WAN Technologies - HDLC, PPP, Frame Relay and Ethernet

Wide Area Networks may use one of several layer 2 technologies to encapsulate data as it crosses a service providers network between a customer's sites. Link-layer technologies used to build WANs include the following:

- High-level Data Link Control (HDLC)
- Point-to-Point Protocol (PPP)
- Frame Relay
- Carrier Ethernet

Which technology you use will usually depend on your requirements and the services offered by your service provider. Today a common alternative to the above technologies is to use MPLS (Multi-Protocol Label Switching) to carry data across a service provider's network.

Leased Line WAN

For enterprises with multiple sites, we must use a WAN to connect the LANs at each site. WAN links, also referred to as leased lines or circuits, are provided by telecommunications companies, telcos, to enterprises – the customer. The service provider offers the physical, layer 1, point to point links between sites and the devices at the edge of each site are responsible for appropriately transmitting data between each other.

At every customer site, there will be 'Customer Premises Equipment' typically consisting of a router with a serial interface card and a Channel Service Unit / Data Service Unit (CSU/DSU) – these may be integrated into a single physical device. The CPE will have a dedicated connection to a telco 'Point of Presence' (PoP) and from here data is routed across the service providers network to another CPE belonging to the company.

For an IP packet with a destination address which belongs to a host at a different site on the WAN, the packet will first be sent to the local router. The router at the edge of a site's LAN will de-encapsulate the packet by reading and removing the Ethernet header and trailer. It will then encapsulate the packet using one of the link-layer technologies below for transmission across the WAN.

HDLC

HDLC is a data link layer protocol defined by the International Organization for Standardization (ISO) which is most commonly used for point to point links. An HDLC frame is similar to Ethernet, with the following fields:

Flag (8 bits) - used to mark the beginning of a frame.

Address (8+ bits) - specifies the destination address, even though HDLC is usually just used for point to point links with a single address.

Control (8 or 16 bits) – Not commonly used today.

Information (variable) – the data to be sent, usually in multiples of 8 bits.

FCS (16 or 32 bits) – A CRC (Cyclic Redundancy Check) frame check sequence to identify data errors.

A major drawback of HDLC is that there isn't a field specified to identify the layer three protocol which has been encapsulated. Therefore several other protocols have been defined, based on HDLC. These include a proprietary Cisco implementation which adds a 16 bit **type** field to determine what data is encapsulated.

Point-to-Point Protocol

PPP is a non-proprietary protocol defined by IETF [RFC 1661](#) which can be used on point to point links. PPP is a protocol which has three underlying components:

1. An encapsulation protocol such as HDLC ([RFC 1662](#)), Ethernet ([PPPoE](#)) or ATM ([PPPoA](#))
2. A Link Control Protocol (LCP) to establish, and maintain configuration of the link until termination.
3. Network Control Protocols (NCP) to facilitate specific configurations of the network layer. For example, the PPP Internet Protocol Control Protocol ([IPCP](#)) supports IP as the network protocol.

PPP is often used for customer Digital Subscriber Lines (DSL) to access the internet.

Frame Relay

Unlike HDLC and PPP, Frame Relay does not require a dedicated point to point link, as it is a packet-switched technology. Therefore, it does not require dedicated leased lines which means it can be more cost-effective as a WAN technology. Instead of using a physical 'circuit', Frame Relay uses 'virtual circuits' which may be Permanent Virtual Circuits (PVCs) or Switched Virtual Circuits (SVCs).

PVCs are most commonly used today, with dedicated mappings set up by a service provider to link each customer's sites.

Carrier Ethernet

Carrier Ethernet is an overarching term for the provision of WAN links using Ethernet technology, it has been called Metro Ethernet. Ethernet WAN allows customers to use Ethernet between them and the service provider. At it's most simple, Ethernet WAN services allow routers at the edge of a customer's LAN to send frames between each other using standard Ethernet frames – the simply send frames to the MAC address of an interface of the destination router.

Ethernet over MPLS (EoMPLS) is one technology used by service providers to enable this kind of service.

References

RFC-1661 The Point-to-Point Protocol (PPP)

Internet Engineering Task Force

Prerequisite Skills

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What is a WAN?

Wide Area Networks (WANs) provide links between devices which have a lot of geographic distance between them and will generally be carried...

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Ethernet at the Data-Link Layer

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