# Network Device and Configuration

**Chapter Five**

WAN Devices and Technologies

Apr 2024

# Introduction

- Unlike LAN which is used effectively in relatively small geographic areas, WAN services help connect networks at a broad geographic distance, from a few to thousands of kilometres.
- LANs are used inside buildings like Home, Office, Internet Service Provider (ISP)...WANs are often used to connect between them.
- Internet is the largest WAN nowadays.
- **Note:**
  - Although we often think about serial connections with copper cables when talking about WAN but nowadays **fiber optical cables** play an important role in connection at both LAN and WAN.
  - Great bandwidth, great distance, very little signal loss, high speed, security, thin... are very big advantages in the transmission so they are used more and more popular in networking.

# WAN Devices and Terminologies

## Router

- A device provides internetworking and WAN access interfaces that connect to the provider network

## Data Terminal Equipment (DTE)

- It is equipment that is either a destination or source for digital data.
- Typically, DTE is the router (at the customer side).
- DTE do not generally communicate with each other. In order to do so they need to use DCE to carry out the communication.
- DTE does not need to know how data is sent or received; the communications details are left to the DCE.

# WAN Devices and Terminologies

## Data Communications Equipment (DCE)

- It is used to perform signal exchange, coding and line clocking tasks as a part of intermediate equipment or DTE.

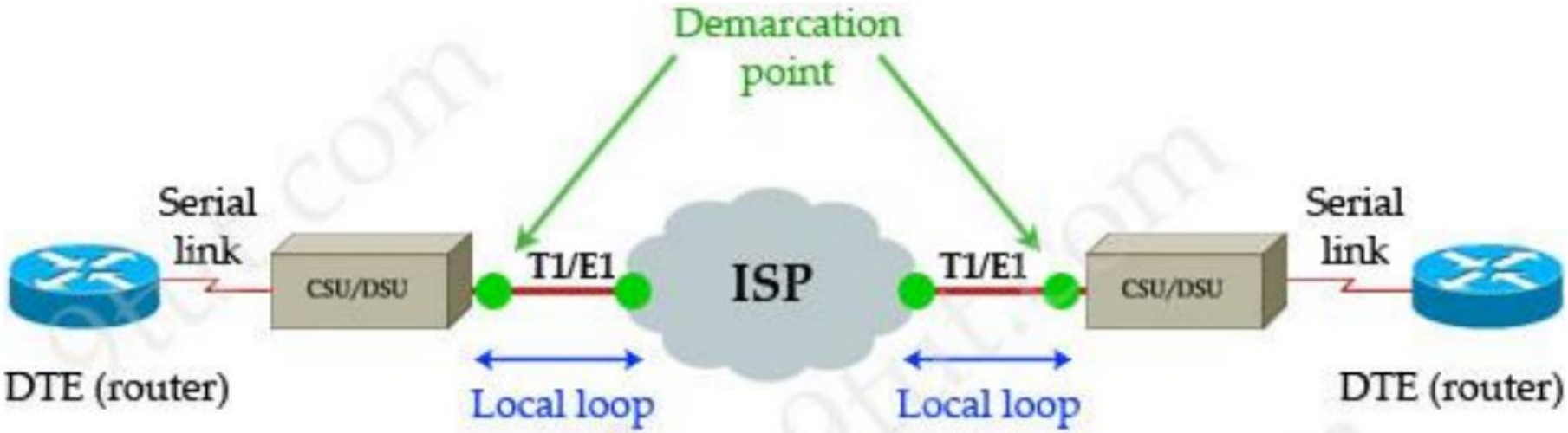
## Customer Premise Equipment (CPE)

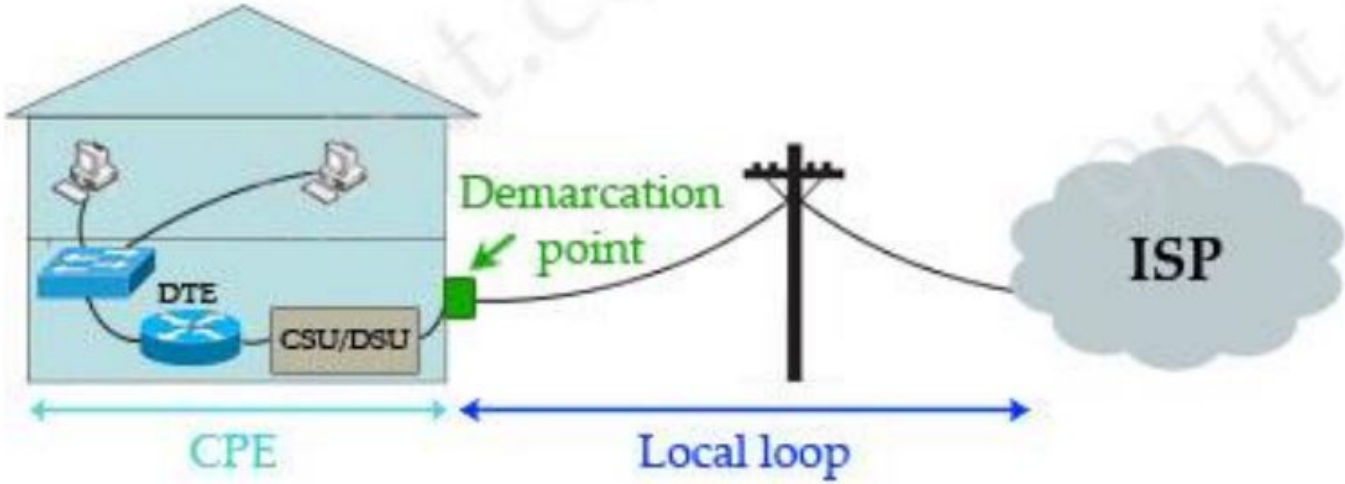
- Devices located at the customer side. CPE often owned by the customer or hired from the WAN provider.
- In the picture below, the router, LAN switch and two computers in the house are classified as CPE.

## Demarcation Point

- The physical point where the public network ends and the private network of a customer begins.

# WAN Devices and Terminologies



# WAN Devices and Terminologies

## Local loop

- A cable connects the CPE to the nearest exchange or Central Office (CO) of the service provider.
- In other words, it is the physical link that connects from the demarcation point to the edge of the service provider's network.

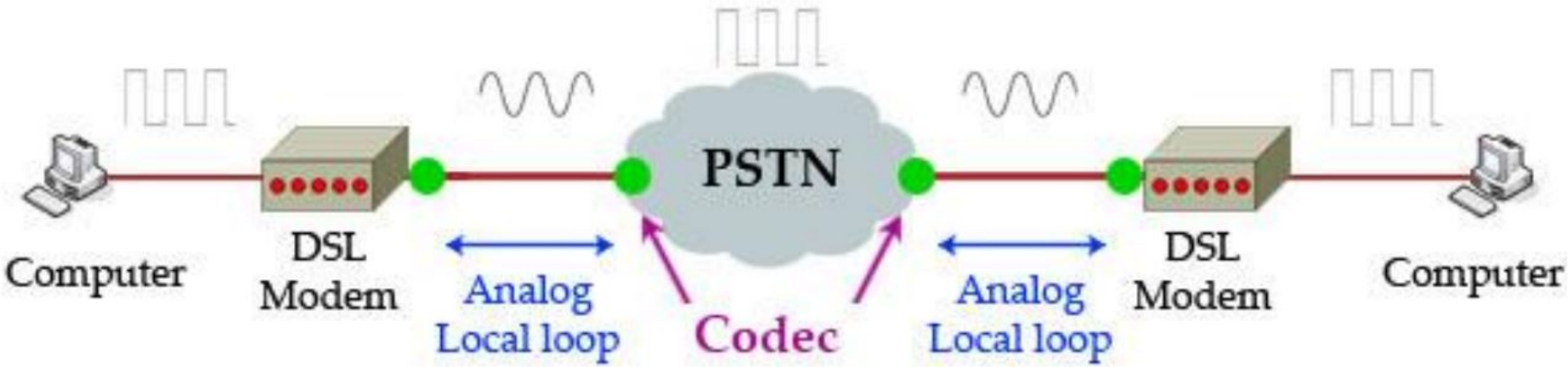
## CSU/DSU

- Short for Channel Service Unit/Data Service Unit.
- Is a hardware device that converts a digital data frame from the communications technology used on a local area network (LAN) into a frame appropriate to a wide-area network (WAN) and vice versa.
- CSU/DSU provides clocking signal to the customer equipment interface and terminates the channelized transport media to a leased line.

# WAN Devices and Terminologies

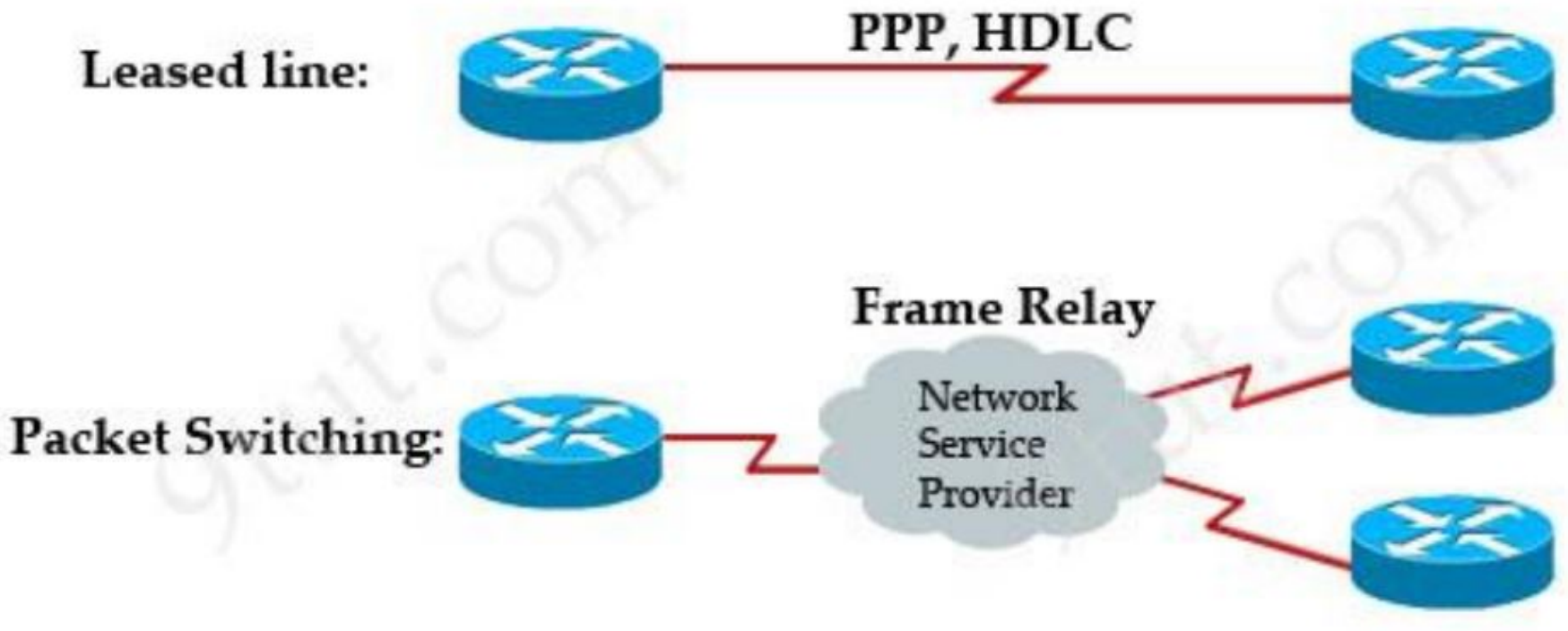
## Modem

- Short for Modulator/Demodulator, a Modem is a hardware device that allows a computer to send and receive information over telephone lines by converting digital data into an analog signal used on phone lines, and vice versa.
- Modem terminates an analog local loop.



# WAN Layer 2 Protocols

- Two important WAN technologies common in enterprise networks today are: **Leased lines** (or point-to-point link) and **Packet-Switching**



# Leased Line

- A leased line is a dedicated data connection with a fixed bandwidth.
- It enables small, medium, and large businesses to connect to the internet in a secure, reliable, and highly efficient manner, with maximum download capacity, resilience, and uptime.
- It is always switched on and rented for a monthly charge or according to the service provider's terms.
- **Characteristics of Leased Lines**
  - **Symmetrical**: Leased lines are symmetrical so that download and upload speeds are equal.
  - **Uncontended**: Leased line connections are uncontended, implying that they cannot be shared with others.
  - **Point to point**: They connect two points – ISP and business location.

# Leased Line

- The two most popular WAN protocols used on leased lines are **High-Level Data-Link Control** (HDLC) and **Point-to-Point Protocol** (PPP).

## High-Level Data-Link Control (HDLC)

- A point-to-point protocol and it is the default WAN protocol for Cisco routers.
- High-level Data Link Control (HDLC) is a group of communication protocols of the data link layer for transmitting data between network points or nodes. Since it is a data link protocol, data is organized into frames.
- It is a bit - oriented protocol that is applicable for both point - to - point and multipoint communication.

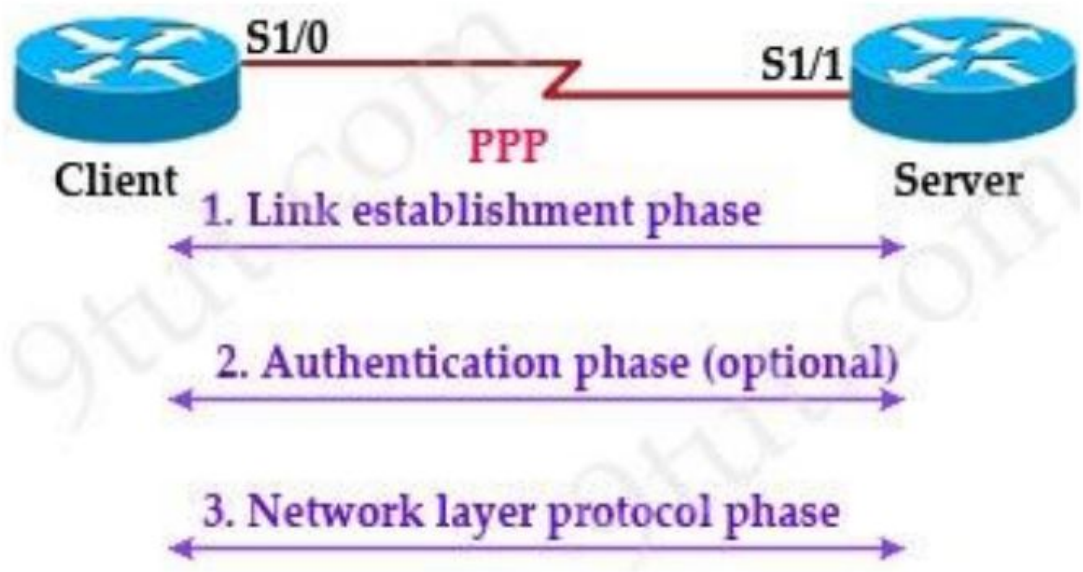
# Leased Line

## Point-to-Point Protocol (PPP)

- is a data link layer protocol.
- This is the most popular WAN protocol nowadays used in Dial, xDSL, ISDN, Serial applications.
- PPP supports both synchronous (like analog phone lines) and asynchronous circuits (such as ISDN or digital links).
- PPP consists of two sub-protocols:
- **Link Control Protocol** (LCP):
  - Set up the link and take care of authentication. After finishing setting up the link, it uses NCP.
- **Network Control Protocol** (NCP)
  - Negotiate optional configuration parameters and facilities for the network layer. In other words, it makes sure IP and other protocols can operate correctly on PPP link.

# Establish a PPP session

1. **Link establishment phase:** In this phase, each PPP device sends LCP packets to configure and test the data link.
2. **Authentication phase (optional):** If authentication is enabled, either PAP or CHAP will be used. PAP and CHAP are two authentication protocols used in PPP.
3. **Network layer protocol phase:** PPP sends NCP packets to choose and configure Network Layer protocol (OSI Layer 3) to be encapsulated and sent over the PPP data link.



# PPP Authentication Methods

- PPP has two built-in security mechanisms which are **Password Authentication Protocol** (PAP) and **Challenge Handshake Authentication Protocol** (CHAP).

## Password Authentication Protocol (PAP)

- Is a very simple authentication protocol.
- The client who wants to access a server sends its username and password in clear text.
- The server checks the validity of the username and password and either accepts or denies connection.
- This is called two-way handshake. In PAP two-way handshake process, the username and password are sent in the first message.

# Password Authentication Protocol (PAP)

- For those systems that require greater security, PAP is not enough as a third party with access to the link can easily pick up the password and access the system resources. In this case CHAP can save our life!



PAP two-way handshake

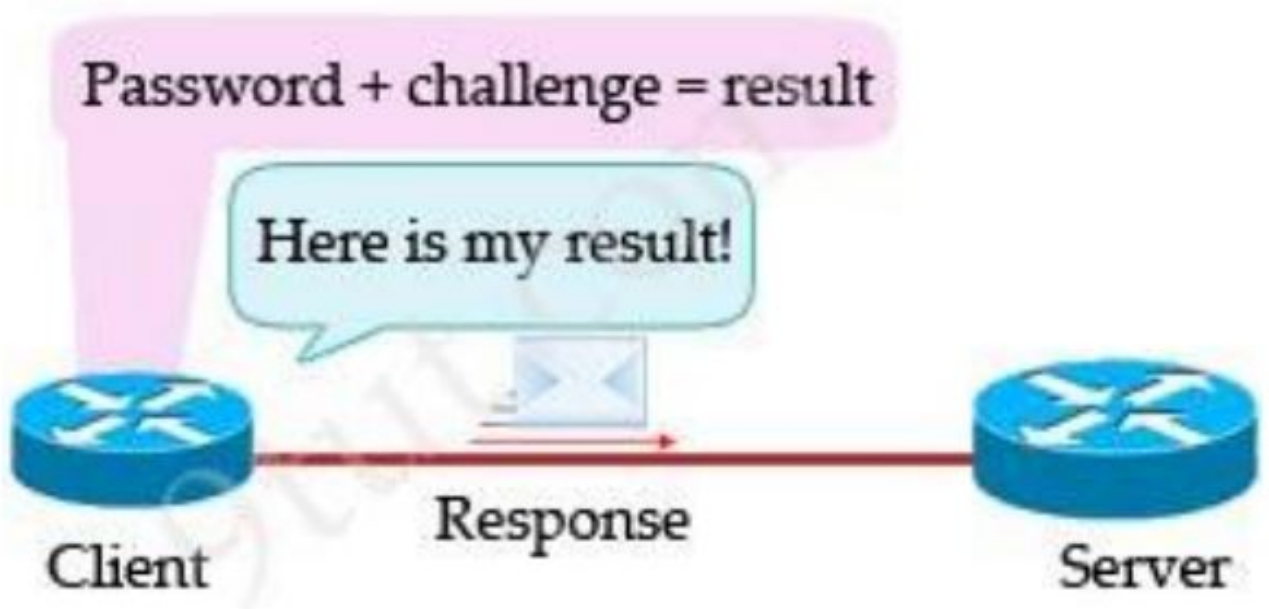
# PPP Authentication Methods

## Challenge Handshake Authentication Protocol (CHAP)

- is an PPP authentication protocol which is far more secure than PAP. Let's see how CHAP three-way handshake works:


- With CHAP, the protocol begins with a random text (called a challenge) sent from the Server, which asks the Client to authenticate.

# Challenge Handshake Authentication Protocol (CHAP)




- After receiving the challenge, the Client uses its password to perform a one-way hash algorithm (MD5) to encrypt the random text received from the server.
- The result is then sent back to the Server.
- Therefore even if someone can capture the messages between client and server, he cannot know what the password is.

# Challenge Handshake Authentication Protocol (CHAP)


- At the Server side, the same algorithm is used to generate its own result. If the two results match, the passwords must match too.
- The main difference between PAP and CHAP is PAP sends username and password in clear text to the server while CHAP does not.
- Notice that in CHAP authentication process, the password itself is never sent across the link.

# Packet-Switching

- Packet switching is the transfer of small pieces of data across various networks. These data chunks or “packets” allow for faster, more efficient data transfer.
- Often, when a user sends a file across a network, it gets transferred in smaller data packets, not in one piece.
  - For example, a 3MB file will be divided into packets, each with a packet header that includes the origin IP address, the destination IP address, the number of packets in the entire data file, and the sequence number.
- A big advantage of packet-switching over leased line services is we can connect many routers to the packet-switching service using a single serial link on each router.
- Each router can then communicate with all other routers. A popular type of packet-switching service is **Frame-Relay**.
- **Asynchronous Transfer Mode** (ATM) is another type of packet-switching.

# Packet-Switching

## Frame-Relay

- It is a packetswitching technology, which means that it divides data into packets and sends them across a shared network infrastructure.
- a digital packet-switched service that can run only across synchronous digital connections.
- Frame Relay detects errors and drops bad frames.

# Packet-Switching

## Asynchronous Transfer Mode (ATM)

- Digital packet-switched service run only across synchronous digital connections.
- It does not perform any error correction or flow control.


Thank You!