

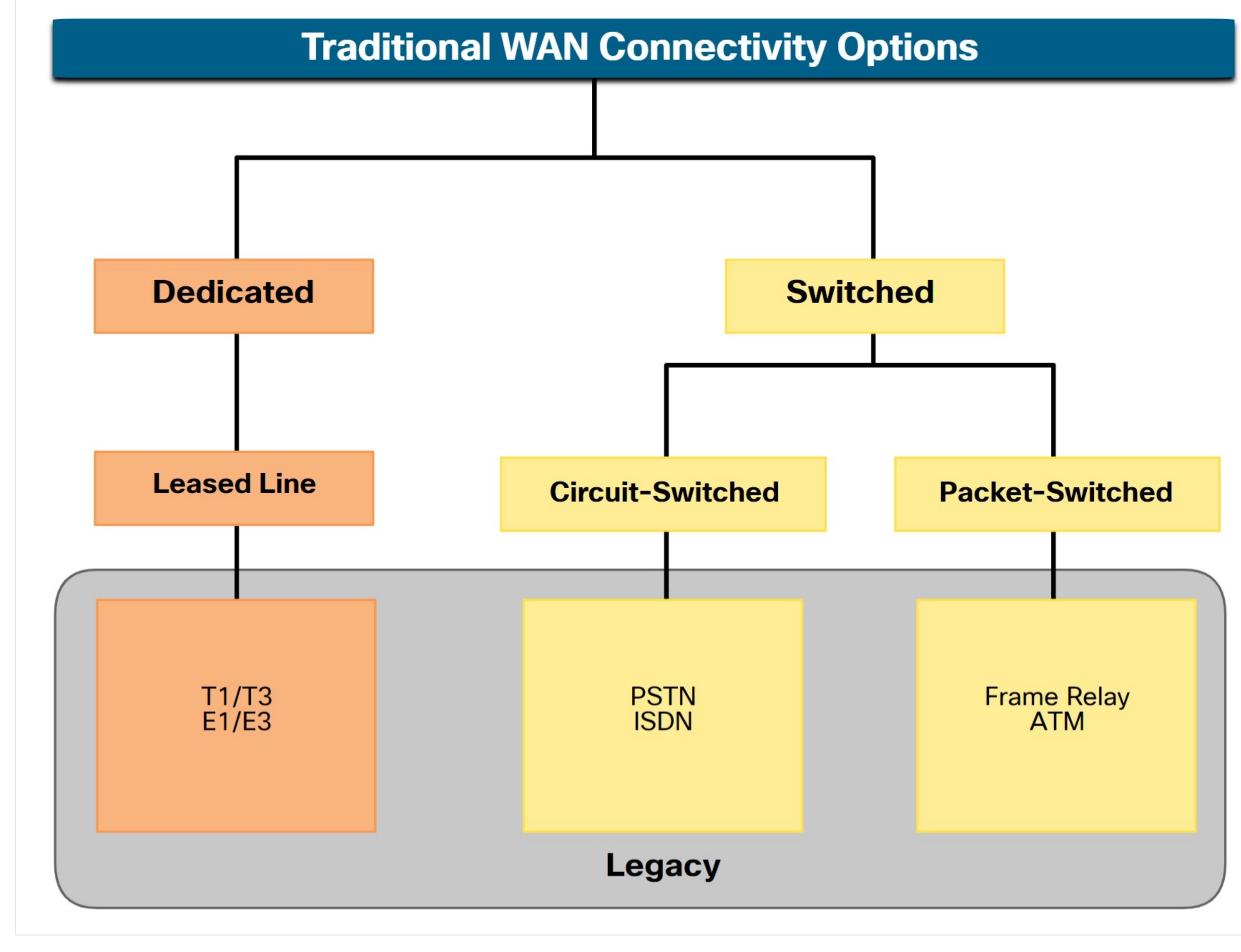
## Traditional WAN Connectivity

7.3.1

### Traditional WAN Connectivity Options

To understand the WANs of today, it helps to know where they started. This topic discusses WAN connectivity options from the beginning. When LANs appeared in the 1980s, organizations began to see the need to interconnect with other locations. To do so, they needed their networks to connect to the local loop of a service provider. This was accomplished by using dedicated lines, or by using switched services from a service provider.

The figure summarizes the traditional WAN connectivity options.



**Note:** There are several WAN access connection options that the enterprise edge can use to connect over the local loop to the provider. These WAN access options differ in technology, bandwidth, and cost. Each has distinct advantages and disadvantages. Familiarity with these technologies is an important part of network design.

7.3.2

### Common WAN Terminology

When permanent dedicated connections were required, a point-to-point link using copper media was used to provide a pre-established WAN communications path from the customer premises to the provider network. Point-to-point lines could be leased from a service provider and were called "leased lines". The term refers to the fact that the organization pays a monthly lease fee to a service provider to use the line.

Leased lines have existed since the early 1950s and for this reason, are referred to by different names such as leased circuits, serial link, serial line, point-to-point link, and T1/E1 or T3/E3 lines.

Leased lines are available in different fixed capacities and are generally priced based on the bandwidth required and the distance between the two connected points.

There are two systems used to define the digital capacity of a copper media serial link:

- **T-carrier** - Used in North America, T-carrier provides T1 links supporting bandwidth up to 1.544 Mbps and T3 links supporting bandwidth up to 43.7 Mbps.
- **E-carrier** - Used in Europe, E-carrier provides E1 links supporting bandwidth up to 2.048 Mbps and E3 links supporting bandwidth up to 34.368 Mbps.

**Note:** The copper cable physical infrastructure has largely been replaced by optical fiber network. Transmission rates in optical fiber network are given in terms of Optical Carrier (OC) transmission rates, which define the digital transmitting capacity of a fiber-optic network.

The table summarizes the advantages and disadvantages of leased lines.

Advantages	
Simplicity	Point-to-point communication links require minimal expertise to install and maintain.
Quality	Point-to-point communication links usually offer high quality service, if they have adequate bandwidth. The dedicated capacity removes latency or jitter between the endpoints.
Availability	Constant availability is essential for some applications, such as e-commerce. Point-to-point communication links provide permanent, dedicated capacity which is required for VoIP or Video over IP.
Disadvantages	
Cost	Point-to-point links are generally the most expensive type of WAN access. The cost of leased line solutions can become significant when they are used to connect many sites over increasing distances. In addition, each endpoint requires an interface on the router, which increases equipment costs.
Limited flexibility	WAN traffic is often variable, and leased lines have a fixed capacity, so that the bandwidth of the line seldom matches the need exactly. Any change to the leased line generally requires a site visit by ISP personnel to adjust capacity.

7.3.3

### Circuit-Switched Options

Circuit-switched connections are provided by Public Service Telephone Network (PSTN) carriers. The local loop connecting the CPE to the CO is copper media. There are two traditional circuit-switched options.

#### Public Service Telephone Network (PSTN)

Dialup WAN access uses the PSTN as its WAN connection. Traditional local loops can transport binary computer data through the voice telephone network using a voiceband modem. The modem modulates the digital data into an analog signal at the source and demodulates the analog signal to digital data at the destination. The physical characteristics of the local loop and its connection to the PSTN limit the rate of the signal to less than 56 kbps.

Dialup access is considered a legacy WAN technology. However, it may still be viable solution when no other WAN technology is available.

#### Integrated Services Digital Network (ISDN)

ISDN is a circuit-switching technology that enables the PSTN local loop to carry digital signals. This provided higher capacity switched connections than dialup access. ISDN provides for data rates from 45 Kbps to 2.048 Mbps.

ISDN has declined greatly in popularity due to high-speed DSL and other broadband services. ISDN is considered a legacy technology with most major providers discontinuing this service.

7.3.4

### Packet-Switched Options

Packet switching segments data into packets that are routed over a shared network. Circuit-switched networks require a dedicated circuit to be established. In contrast, packet-switching networks allow many pairs of nodes to communicate over the same channel.

There are two traditional (legacy) packet-switched connectivity options.

#### Frame Relay

Frame Relay is a simple Layer 2 non-broadcast multi-access (NBMA) WAN technology that is used to interconnect enterprise LANs. A single router interface can be used to connect to multiple sites using different PVCs. PVCs are used to carry both voice and data traffic between a source and destination, and support data rates up to 4 Mbps, with some providers offering even higher rates.

Frame Relay creates PVCs which are uniquely identified by a data-link connection identifier (DLCI). The PVCs and DLCIs ensure bidirectional communication from one DTE device to another.

Frame Relay networks have been largely replaced by faster Metro Ethernet and internet-based solutions.

#### Asynchronous Transfer Mode (ATM)

Asynchronous Transfer Mode (ATM) technology is capable of transferring voice, video, and data through private and public networks. It is built on a cell-based architecture rather than on a frame-based architecture. ATM cells are always a fixed length of 53 bytes. The ATM cell contains a 5-byte ATM header followed by 48 bytes of ATM payload. Small, fixed-length cells are well-suited for carrying voice and video traffic because this traffic is intolerant of delay. Video and voice traffic do not have to wait for larger data packets to be transmitted.

The 53-byte ATM cell is less efficient than the bigger frames and packets of Frame Relay. Furthermore, the ATM cell has at least five bytes of overhead for each 48-byte payload. When the cell is carrying segmented network layer packets, the overhead is higher because the ATM switch must be able to reassemble the packets at the destination. A typical ATM line needs almost 20 percent greater bandwidth than Frame Relay to carry the same volume of network layer data.

ATM networks have been largely replaced by faster Metro Ethernet and internet-based solutions.

7.3.5

### Check Your Understanding - Traditional WAN Connectivity

Check your understanding of traditional WAN connectivity options by choosing the BEST answer to the following questions.

1. Which traditional WAN connectivity option uses T-Carrier or E-Carrier lines?

- ATM
- Frame Relay
- ISDN
- Leased lines
- PSTN

2. Which two traditional WAN connectivity options are circuit-switched? (Choose two.)

- ATM
- Frame Relay
- ISDN
- Leased lines
- PSTN

3. Which two traditional WAN connectivity options are packet-switched? (Choose two.)

- ATM
- Frame Relay
- ISDN
- Leased lines
- PSTN

Check

Show Me

Reset