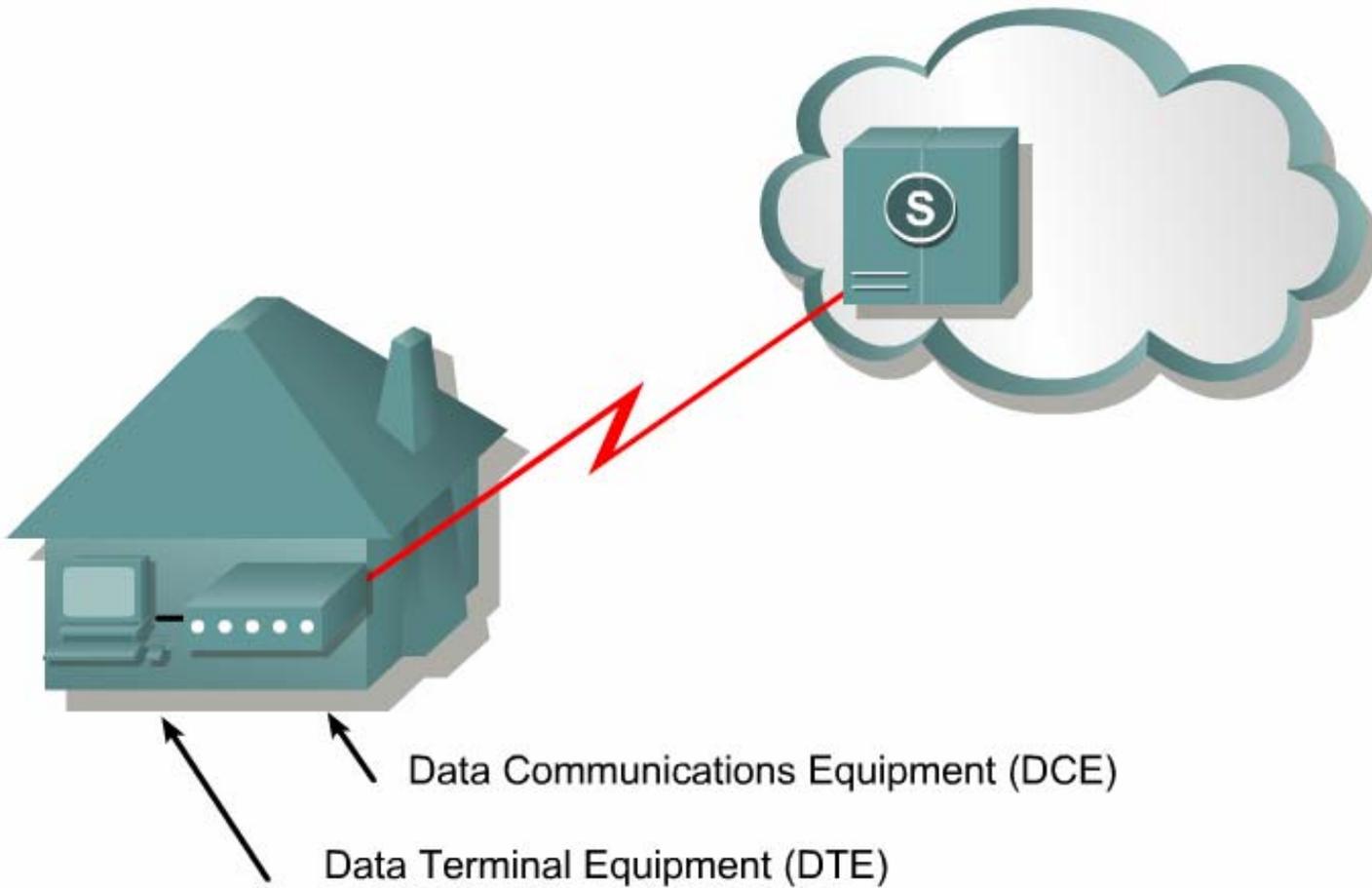
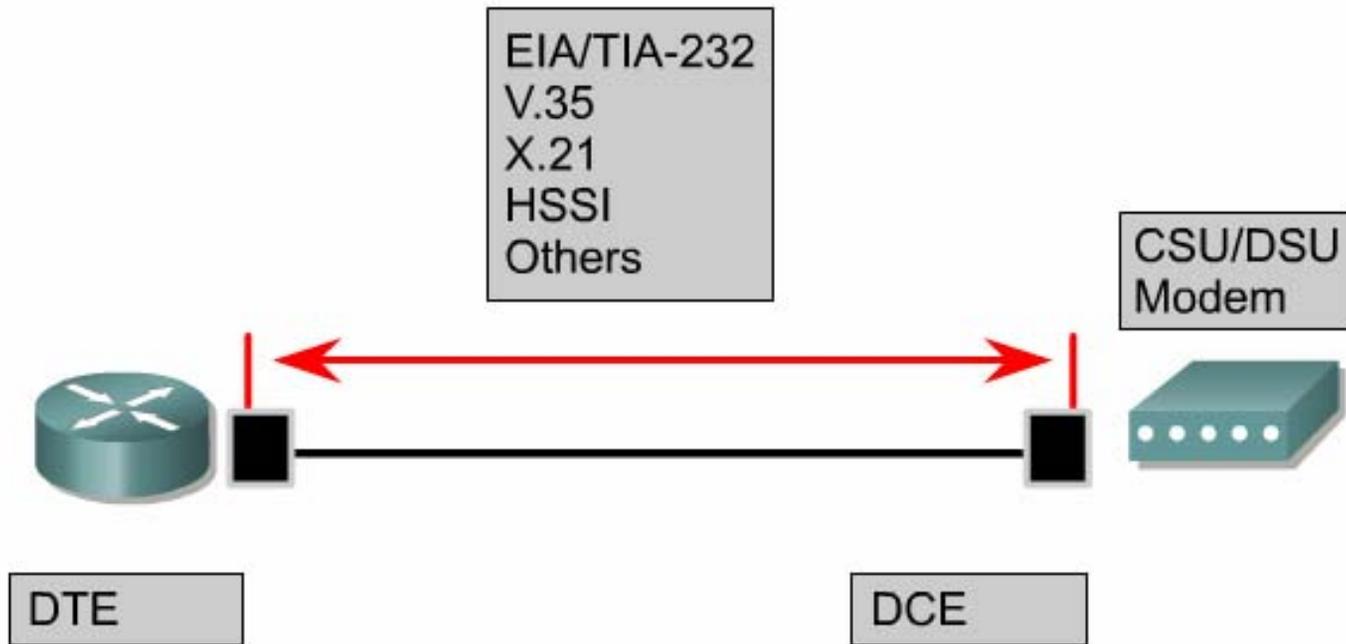


DCE and DTE





Data Terminal Equipment
User device with interface
connecting to the WAN link

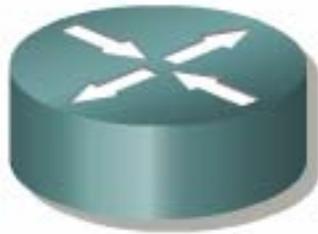
Data Circuit-Terminating Equipment
End of the communication facility on
the side of the WAN provider

WAN Line Types and Bandwidth

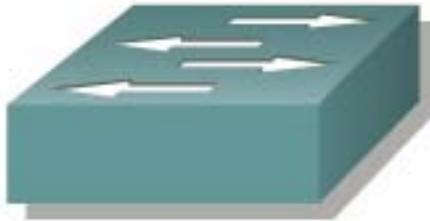
| Line Type | Signal Standard | Bit Rate Capacity |
|-----------|-----------------|-------------------|
| 56 | DS0 | 56 Kbps |
| 64 | DS0 | 64 Kbps |
| T1 | DS1 | 1.544 Mbps |
| E1 | ZM | 2.048 Mbps |
| E3 | M3 | 34.064 Mbps |
| J1 | Y1 | 2.048 Mbps |
| T3 | DS3 | 44.736 Mbps |
| OC-1 | SONET | 51.84 Mbps |
| OC-3 | SONET | 155.54 Mbps |
| OC-9 | SONET | 466.56 Mbps |
| OC-12 | SONET | 622.08 Mbps |
| OC-18 | SONET | 933.12 Mbps |
| OC-24 | SONET | 1244.16 Mbps |
| OC-36 | SONET | 1866.24 Mbps |
| OC-48 | SONET | 2488.32 Mbps |

Wide Area Networks and Devices

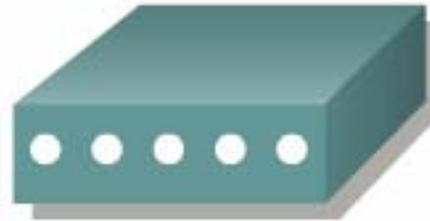
Router



Switch



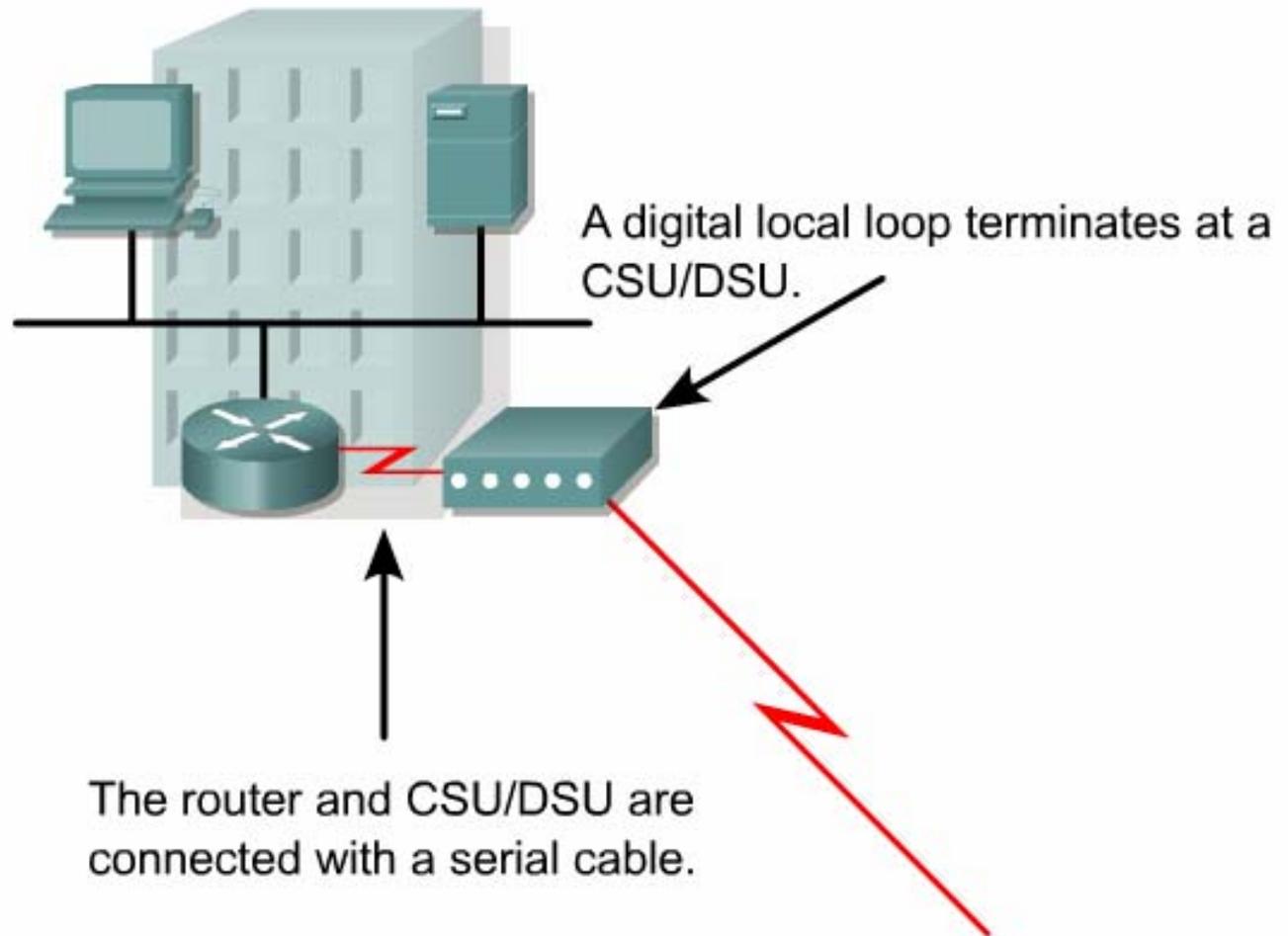
Modem (CSU/DSU)



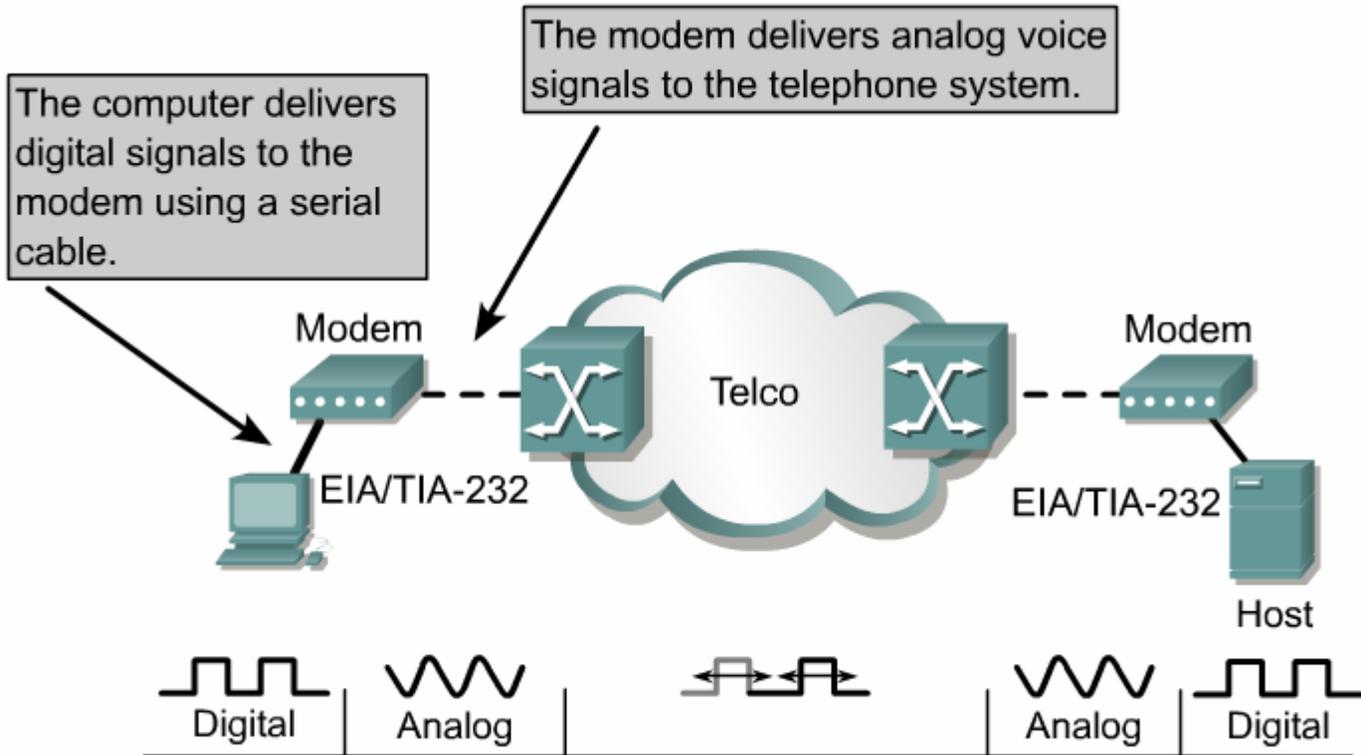
Communication Server



CSU/DSU



Modem Transmission



WAN Standards

| Acronym | Organization |
|-------------------|---|
| ITU-T (was CCITT) | International Telecommunication Union Telecommunication Standardization Sector, formerly the Consultative Committee for International Telegraph and Telephone |
| ISO | International Organization for Standardization |
| IETF | Internet Engineering Task Force |
| EIA | Electronic Industries Association |
| TIA | Telecommunications Industries Association |

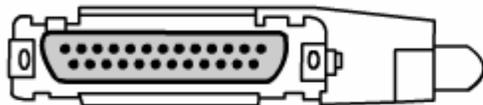
WAN Physical Layer Standards

| Standard | Description |
|-----------------|--|
| EIA/TIA-232 | Allows signal speeds of up to 64 Kbps on a 25 pin D connector over short distances. It was formerly known as RS-232. The ITU-T V.24 specification is effectively the same. |
| EIA/TIA-449/530 | A faster (up to 2 Mbps) version of EIA/TIA-232. It uses a 36 pin D connector and is capable of longer cable runs. There are several versions. Also known as RS-422 and RS-423. |
| EIA/TIA-612/613 | The High Speed Serial Interface (HSSI), which provides access to services at up to 52 Mbps on a 60 pin D connector. |
| V.35 | An ITU-T standard for synchronous communications between a network access device and a packet network at speeds up to 48 Kbps. It uses a 34 pin rectangular connector. |
| X.21 | An ITU-T standard for synchronous digital communications. It uses a 15 pin D connector. |

Physical Layer Connectors



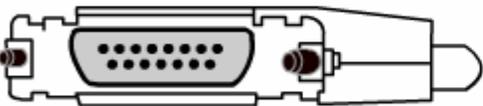
EIA/TIA-232 Male



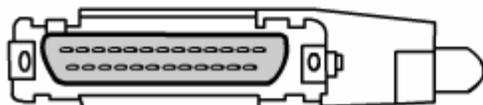
EIA/TIA-232 Female



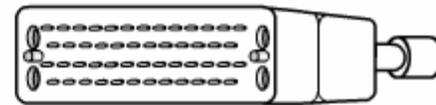
X.21 Male



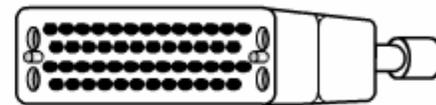
X.21 Female



EIA-530 Male



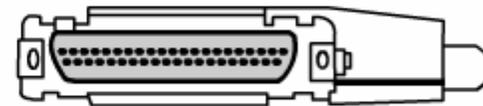
V.35 Male



V.35 Female



EIA/TIA-449 Male

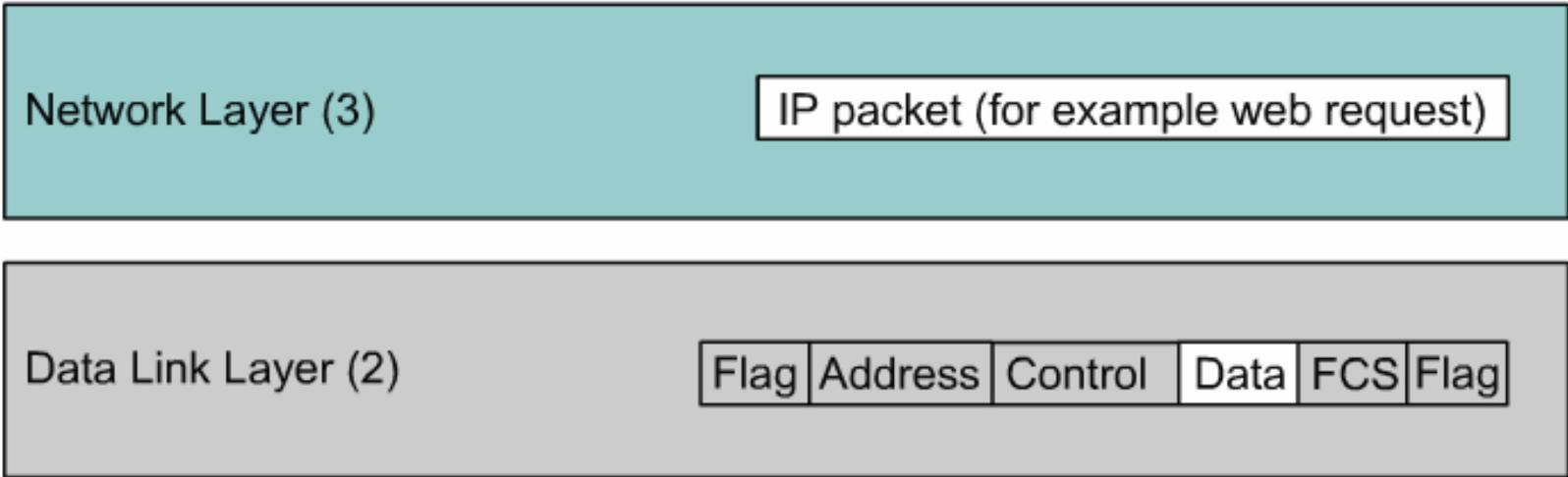


EIA/TIA-449 Female

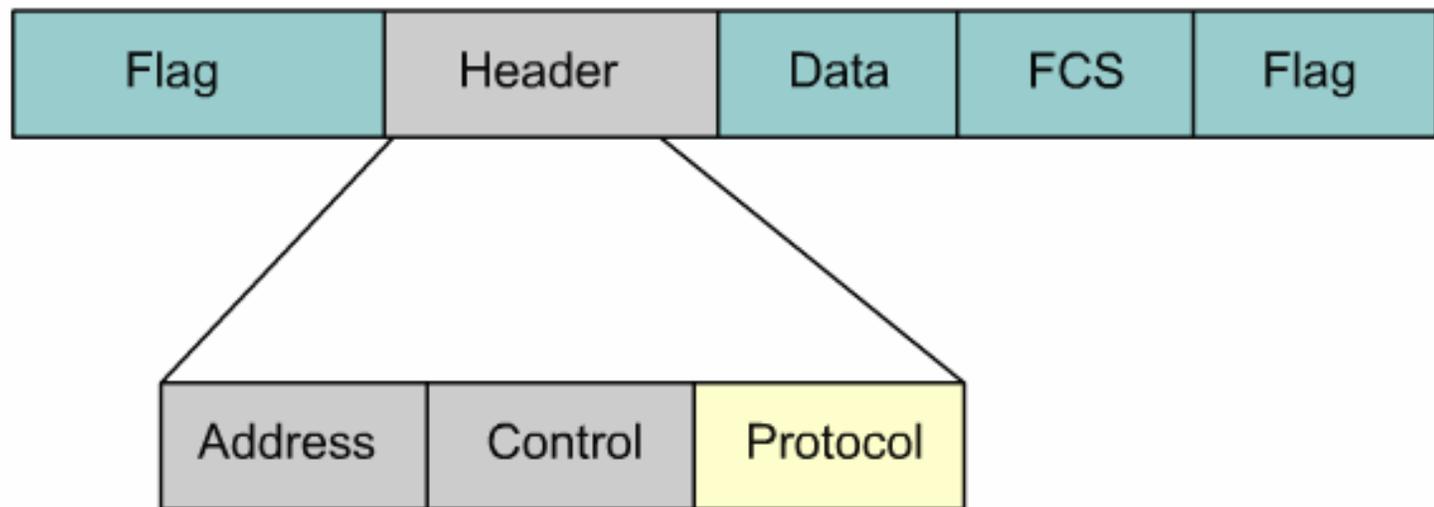


EIA-613 HSSI Male

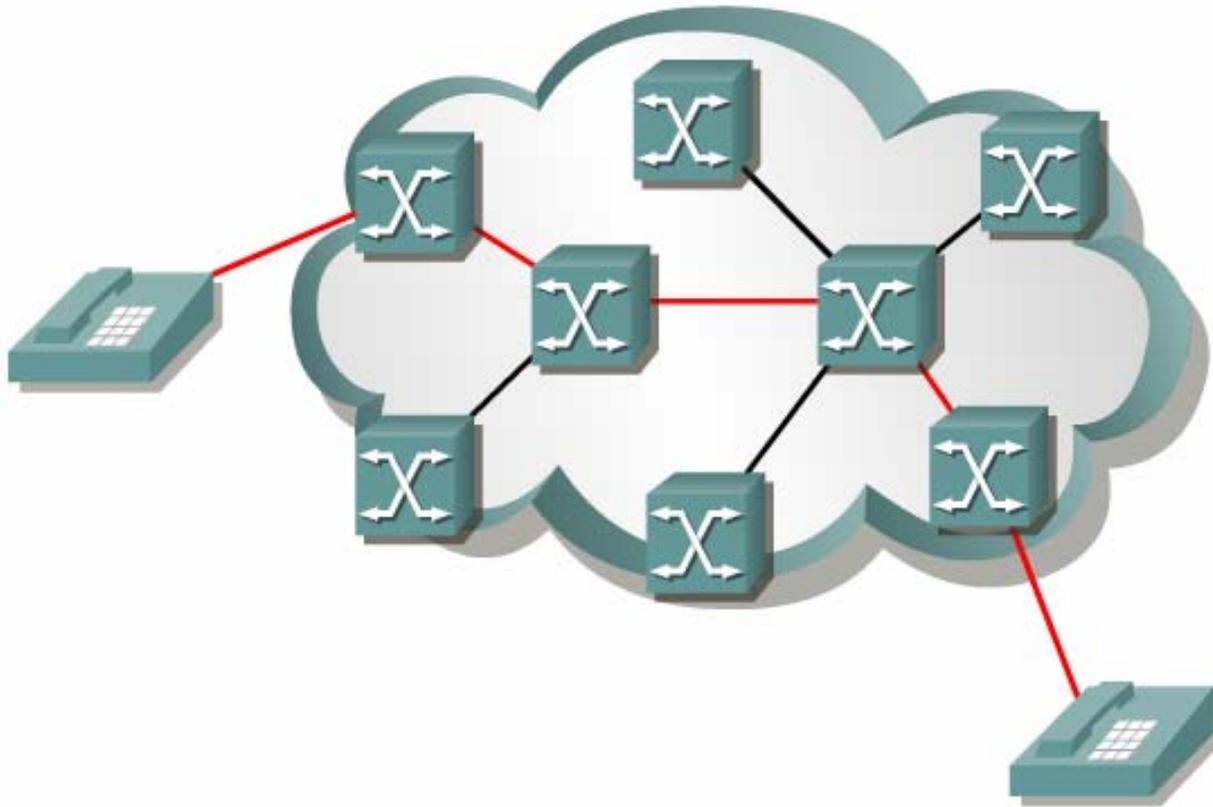
WAN Encapsulation



WAN Frame Encapsulation Formats

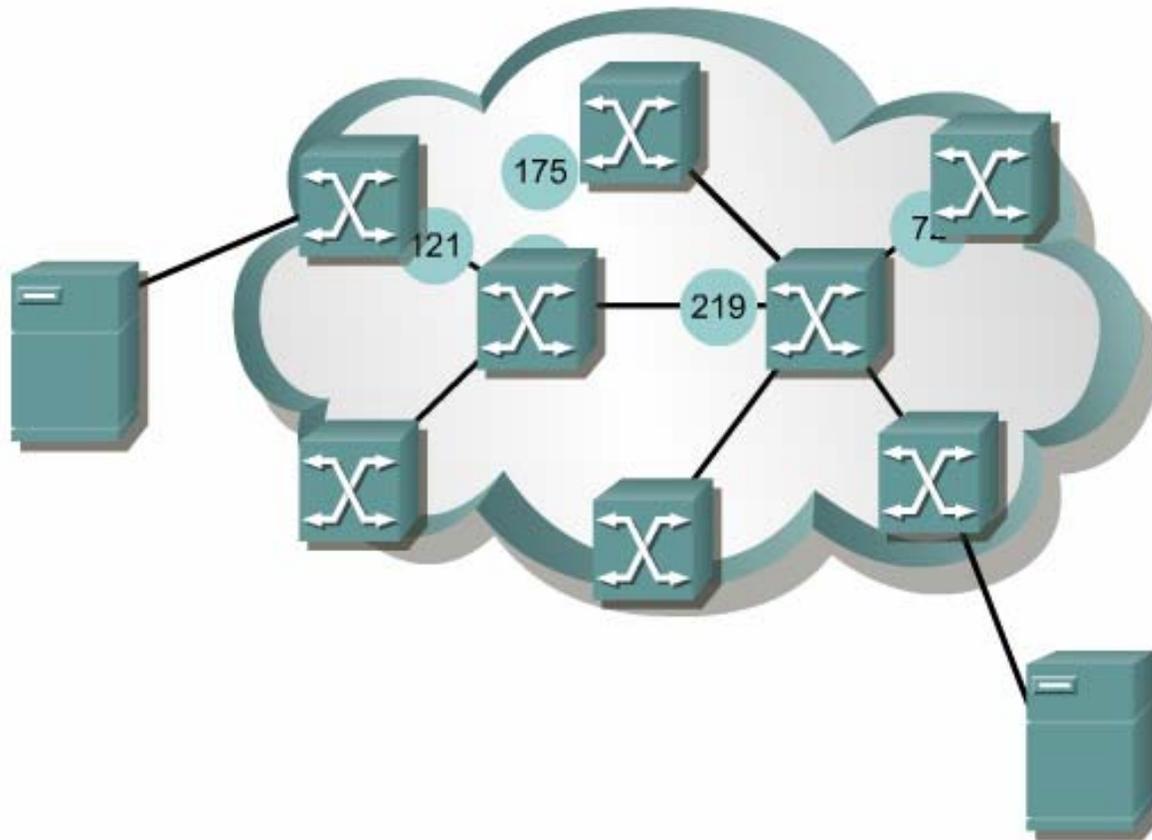


Circuit Switching

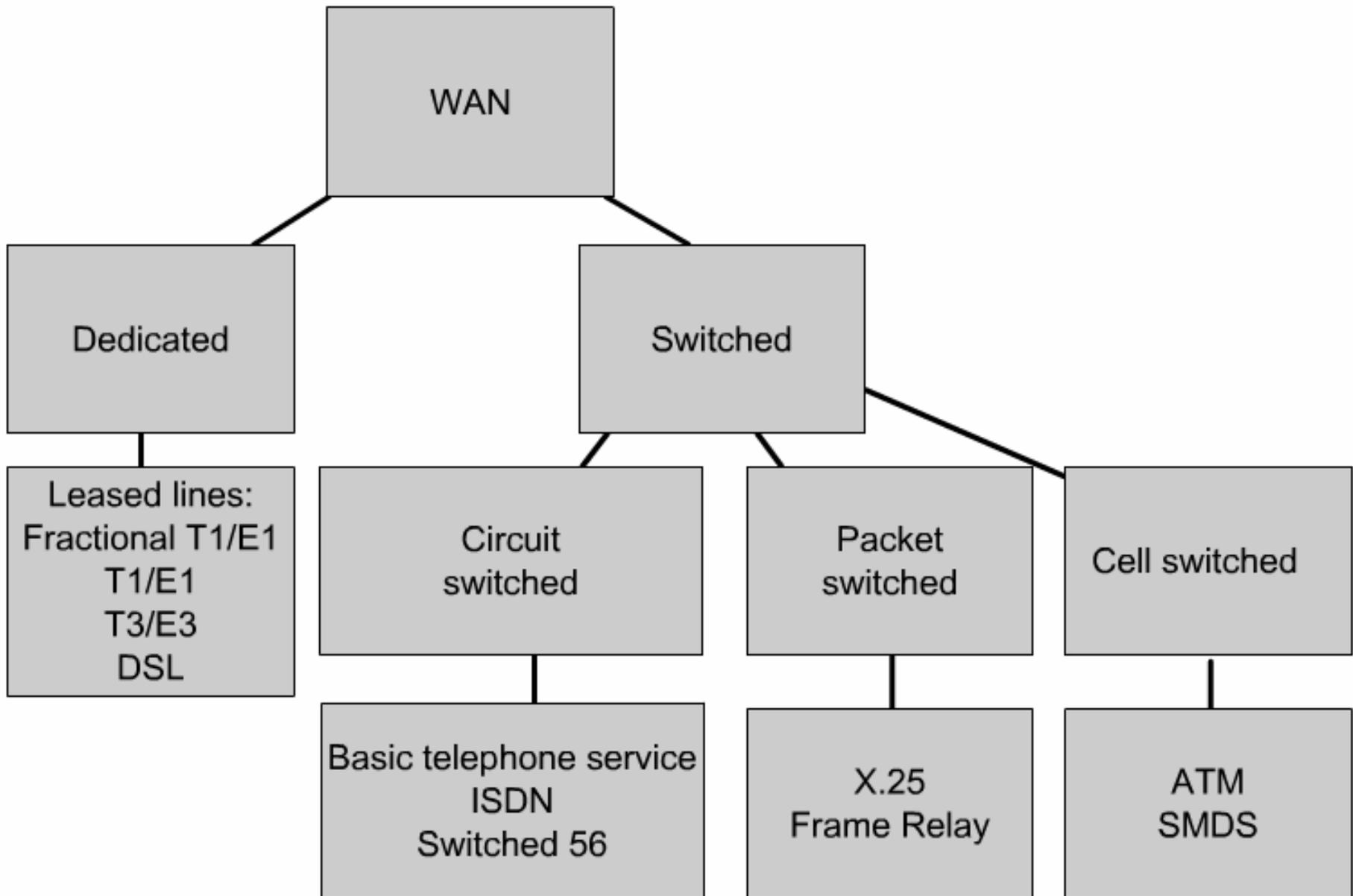


Dialing sets up a physical circuit through the system.

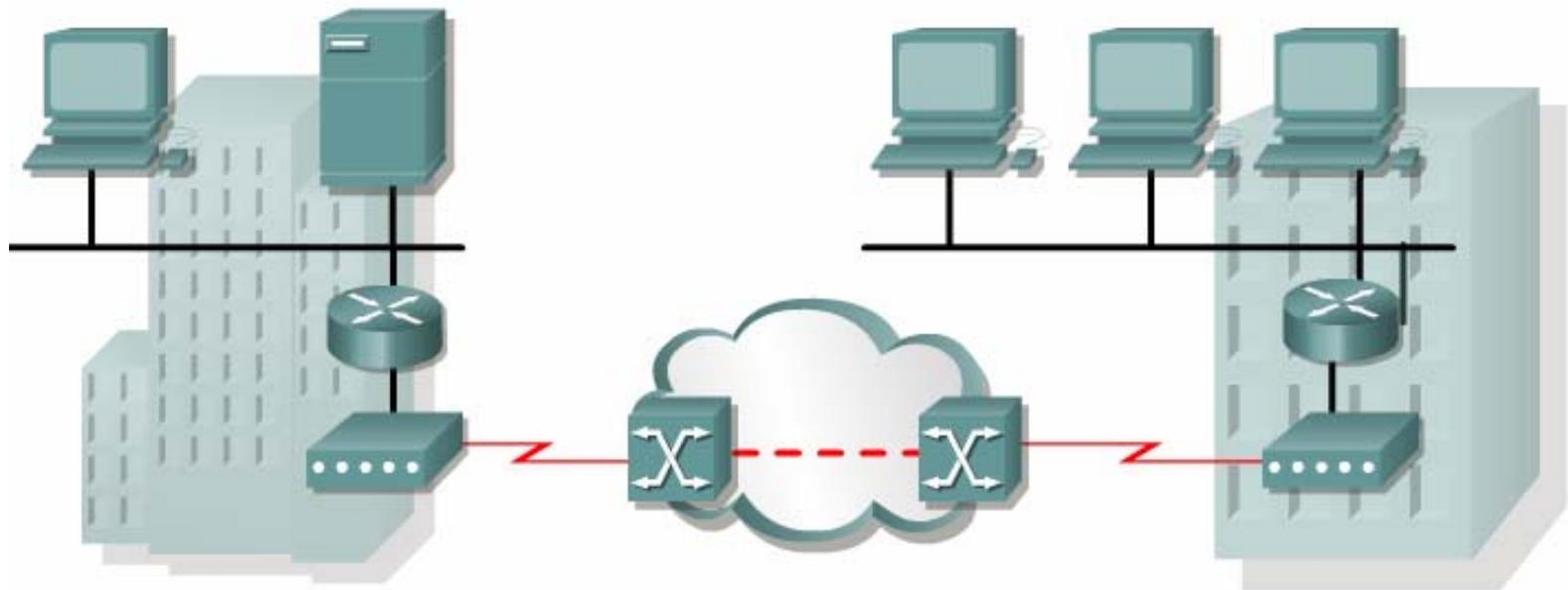
Packet Switching



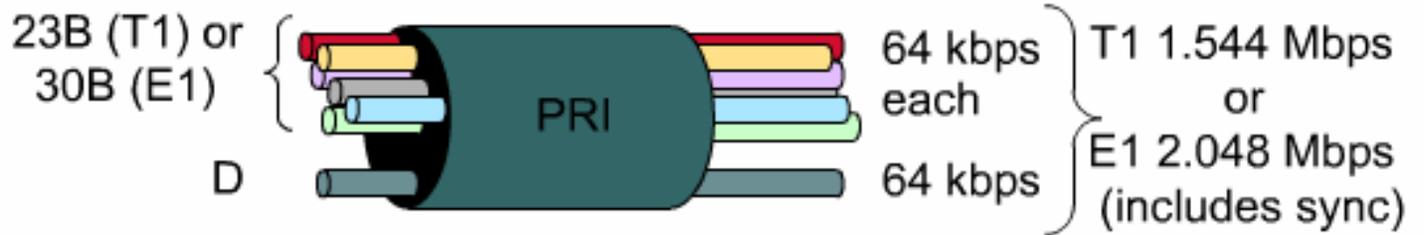
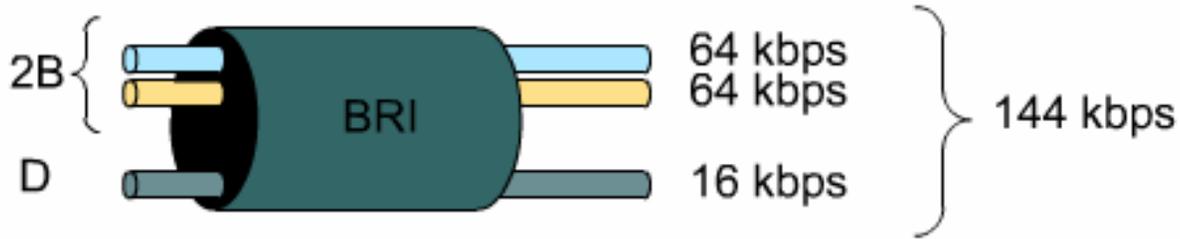
Labeled data is passed from switch to switch. It may have to wait its turn on a link.



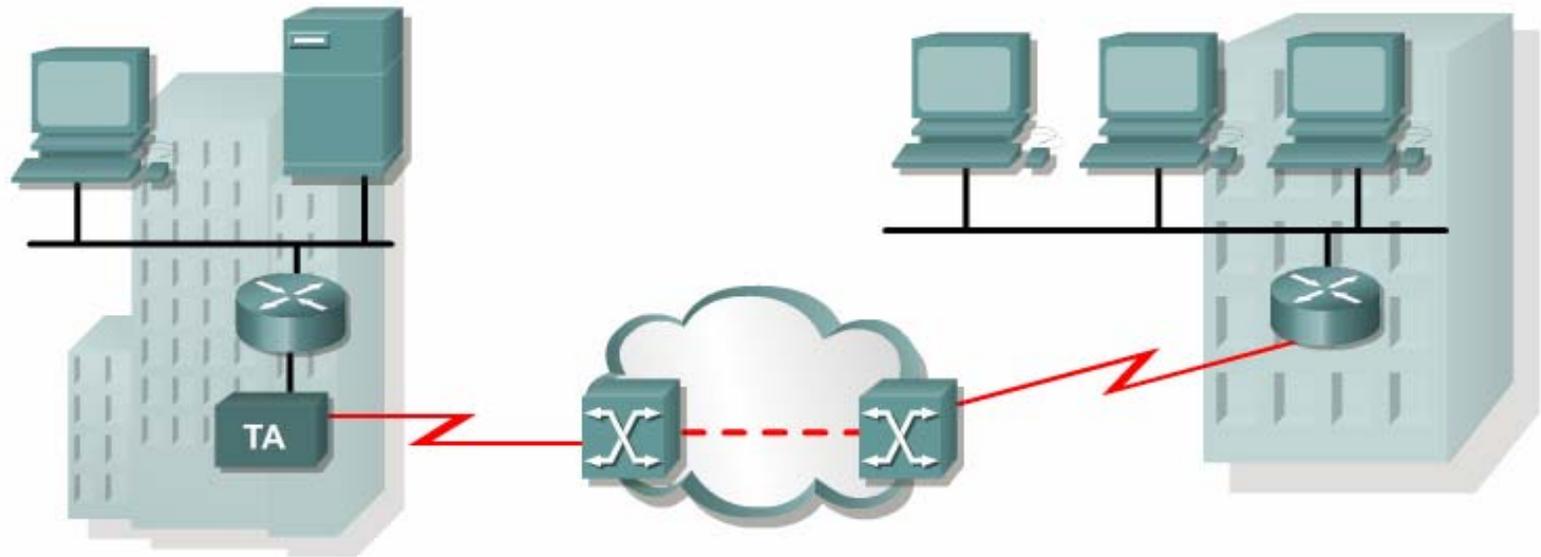
Analog Dialup



ISDN

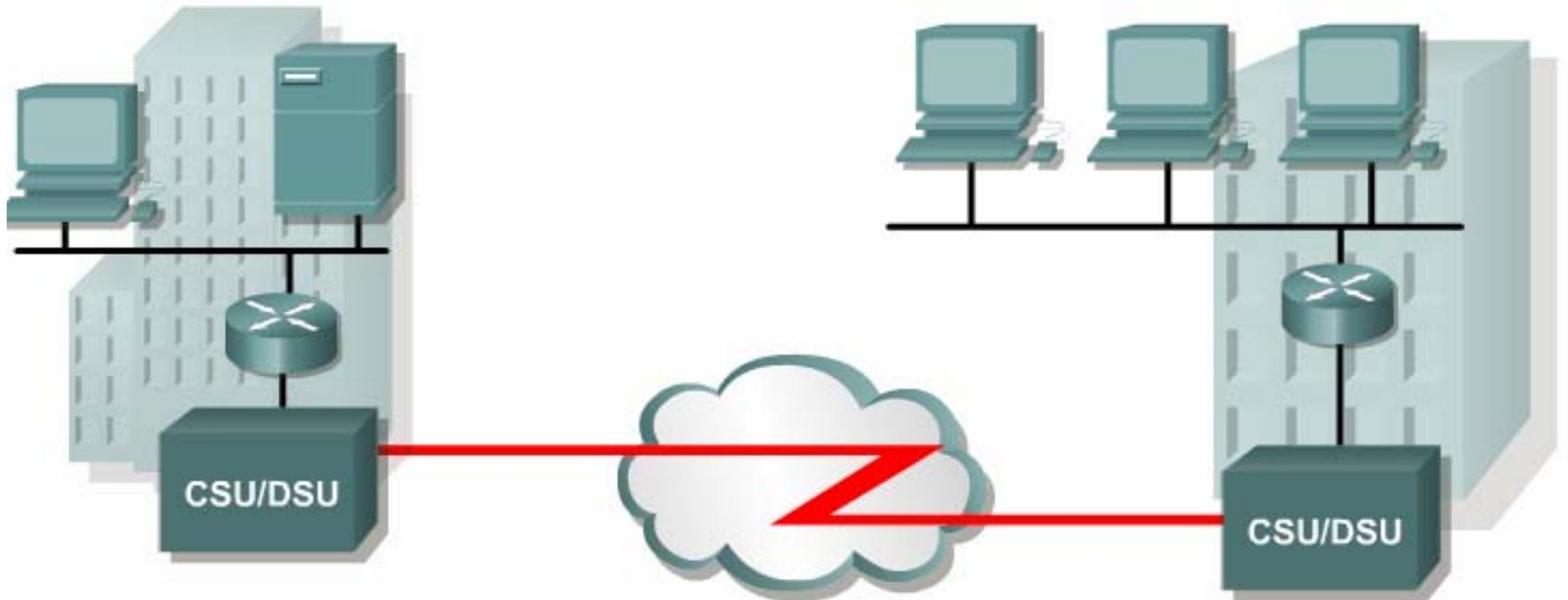


WAN with ISDN

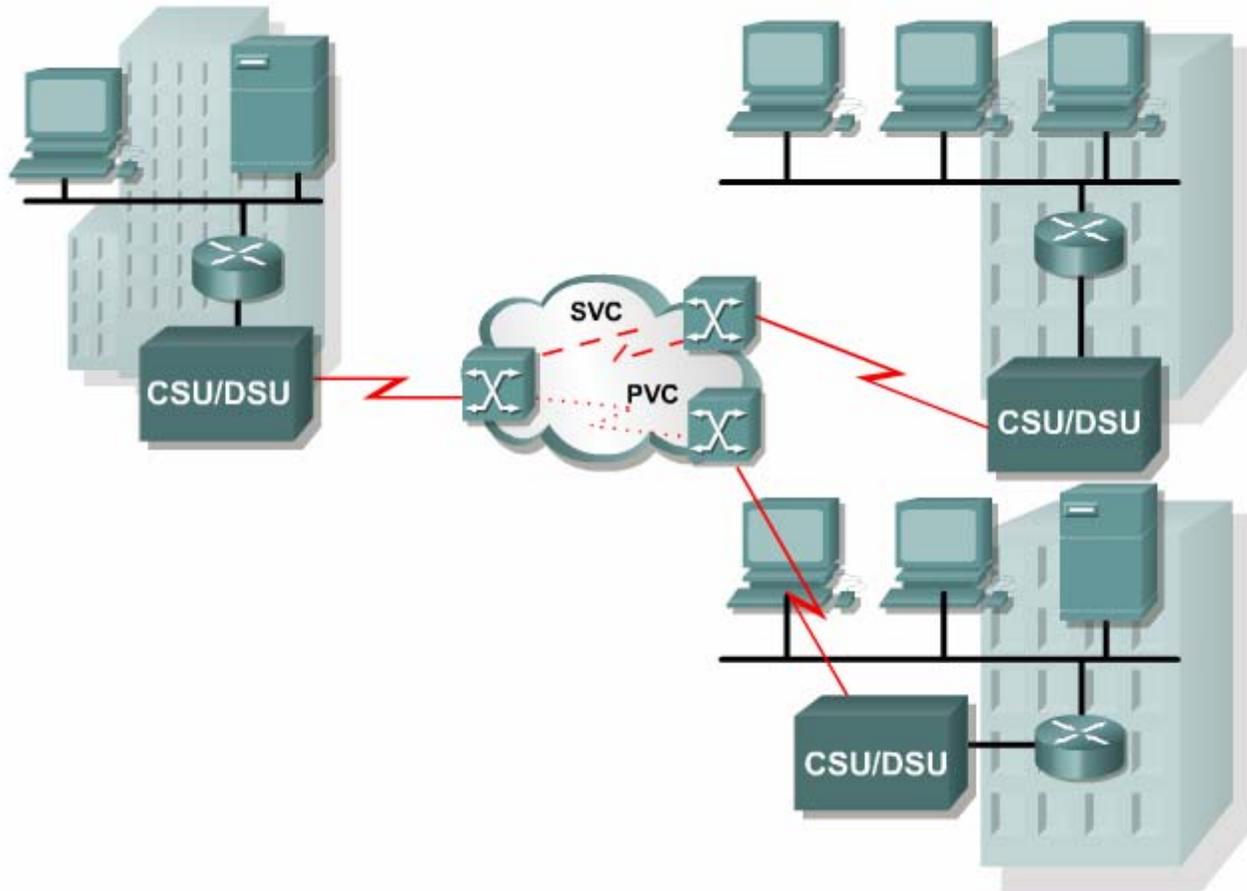


The routers may have ISDN interfaces or connect to a terminal adapter.

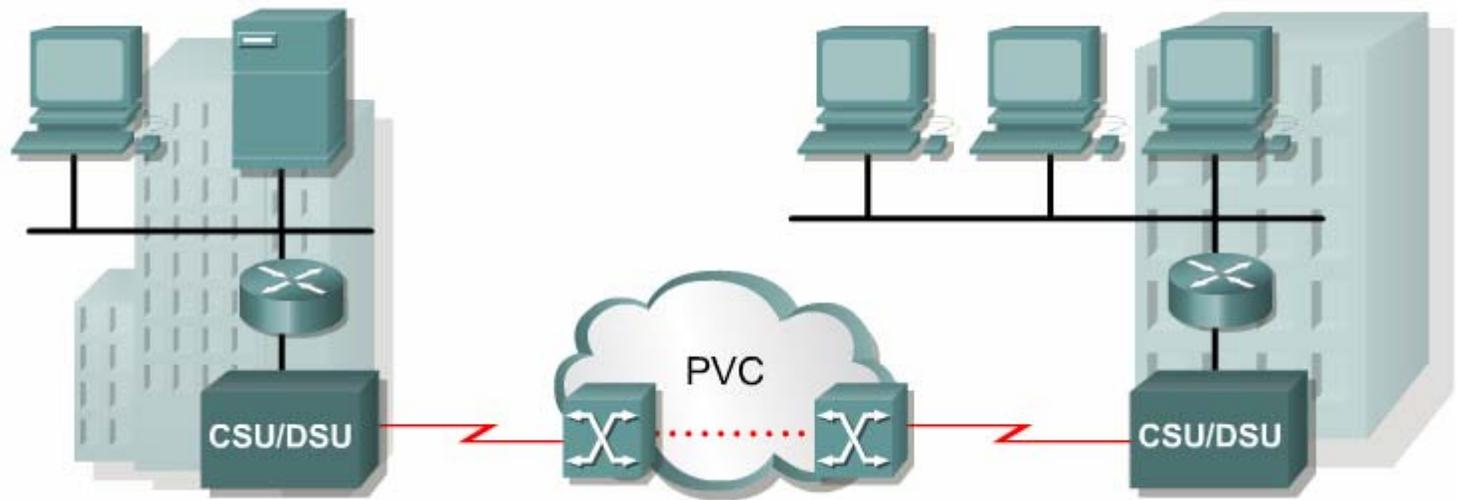
| Line Type | Signal Standard | Bit Rate Capacity |
|-----------|-----------------|-------------------|
| 56 | DS0 | 56 kbps |
| 64 | DS0 | 64 kbps |
| T1 | DS1 | 1.544 Mbps |
| E1 | ZM | 2.048 Mbps |
| E3 | M3 | 34.064 Mbps |
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| OC-9 | SONET | 466.56 Mbps |
| OC-12 | SONET | 622.08 Mbps |
| OC-18 | SONET | 933.12 Mbps |
| OC-24 | SONET | 1244.16 Mbps |
| OC-36 | SONET | 1866.24 Mbps |
| OC-48 | SONET | 2488.32 Mbps |



WAN with X.25



Frame Relay



| Service | Download | Upload |
|---------|-------------------------|-------------------------|
| ADSL | 64 kbps - 8.192 Mbps | 16 kbps - 640 kbps |
| SDSL | 1.544 Mbps - 2.048 Mbps | 1.544 Mbps - 2.048 Mbps |
| HDSL | 1.544 Mbps - 2.048 Mbps | 1.544 Mbps - 2.048 Mbps |
| IDSL | 144 kbps | 144 kbps |
| CDSL | 1 Mbps | 16 kbps - 160 kbps |

| Название технологии | скорость передачи | Направление передачи | Возможности технологии |
|--|--|--|---|
| <p>IDSL – Digital Subscriber Line Цифровая абонентская Линия ISDN</p> | 128 Кбит/с | Дуплекс | ISDN-сервис, передача речи и данных |
| <p>ADSL – Asymmetric Digital Subscriber Line Асимметричная цифровая абонентская линия</p> | 1,5 Мбит/с — 8 Мбит/с 64-1544 Кбит/с | Сервер-пользователь Пользователь-сервер | Internet, локальные сети (LAN) видео — по требованию, видеоконференции. Интерактивные услуги мультимедиа. |
| <p>ADSL G.lite Упрощенная ADSL</p> | 1,536 Мбит/с 384 Кбит/с или 384 Кбит/с | Сервер-пользователь Пользователь-сервер Симметричный режим | Internet, LAN, видео — по требованию, видеоконференции. Интерактивные услуги мультимедиа |
| <p>HDSL — High data rate Digital Subscriber Line Высокоскоростная цифровая абонентская линия</p> | 1,544 Мбит/с 2048 Мбит/с | Дуплекс Дуплекс | Цифровые каналы типа E1 (T1) Услуги локальных (LAN) и глобальных сетей (WAN) |
| <p>VDSL — Very High Digital Subscriber Сверх высокоскоростная цифровая абонентская линия</p> | 13-52 Мбит/с 1,5 –2,3 Мбит/с | Сервер-пользователь Пользователь-сервер | Те же услуги, что и ADSL, но с большими скоростями и на меньшие расстояния. |

Принципы работы ADSL

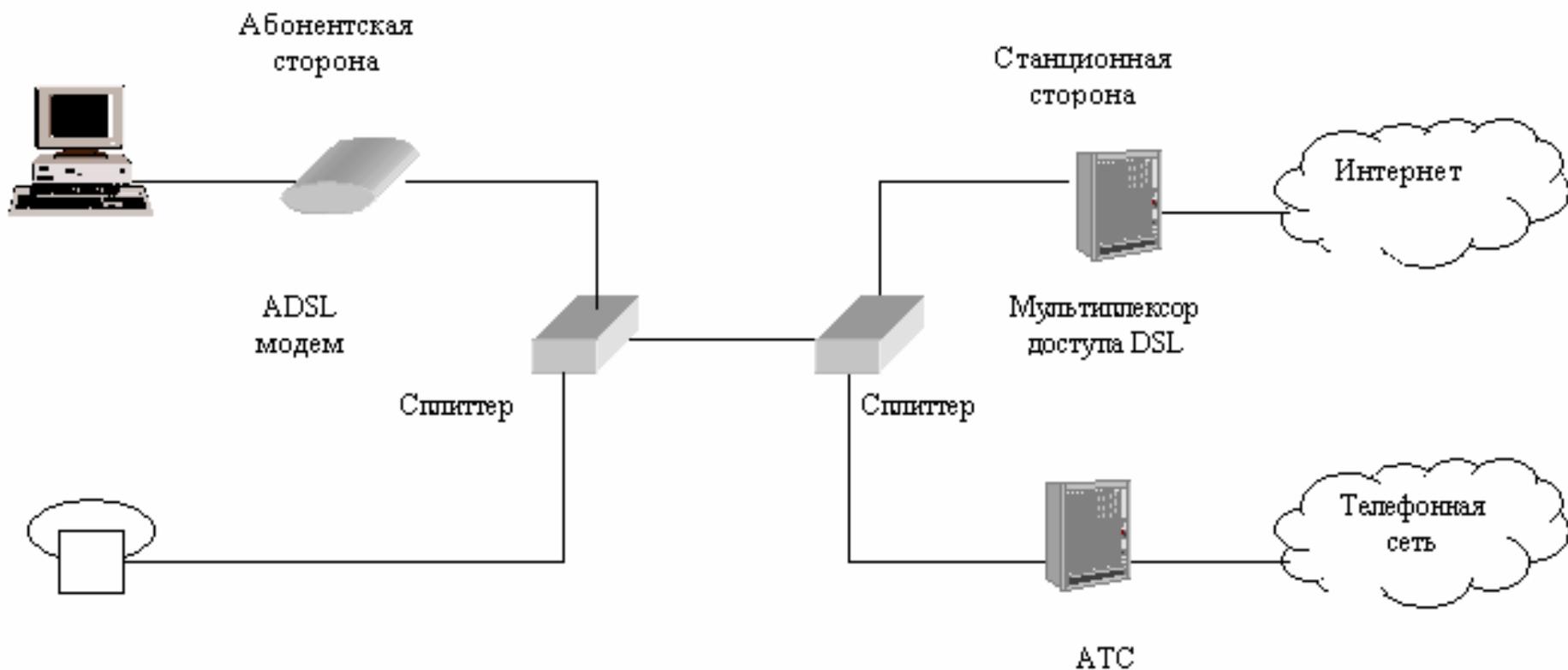


Таблица. Скорости передачи по линиям ADSL

| Поток сервер-пользователь (downstream) | Поток пользователь-сервер (upstream) | расстояние |
|---|---|-------------------|
| 8,160 Мбит/с | 1,216 Мбит/с | 1,8 км |
| 7,872 Мбит/с | 1,088 Мбит/с | 2,7 км |
| 3,648 Мбит/с | 864 Кбит/с | 3,7 км |
| 1,984 Мбит/с | 640 Кбит/с | 4,3 км |
| 1,408 Мбит/с | 544 Кбит/с | 4,6 км |
| 960 Кбит/с | 416 Кбит/с | 4,9 км |
| 576 Кбит/с | 320 Кбит/с | 5,2 км |
| 320 Кбит/с | 224 Кбит/с | 5,5 км |
| 128 Кбит/с | 128 Кбит/с | 5,8 км |