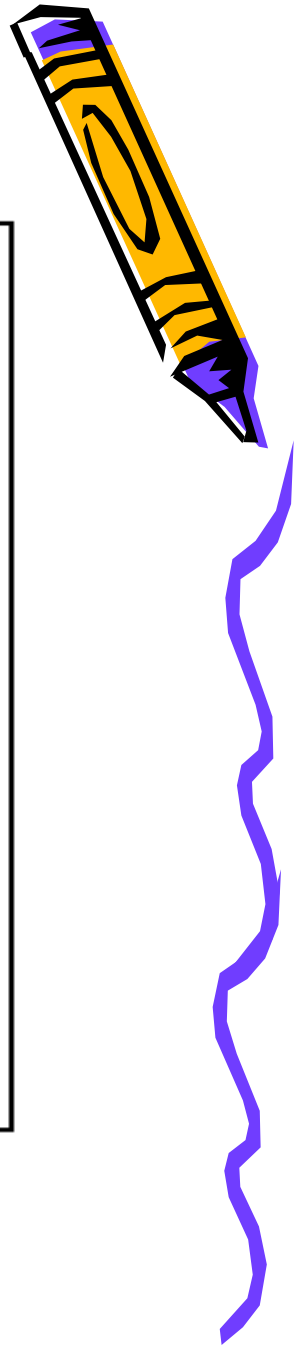
Integrated Services Digital Network (ISDN)

Evolution of ISDN (1)

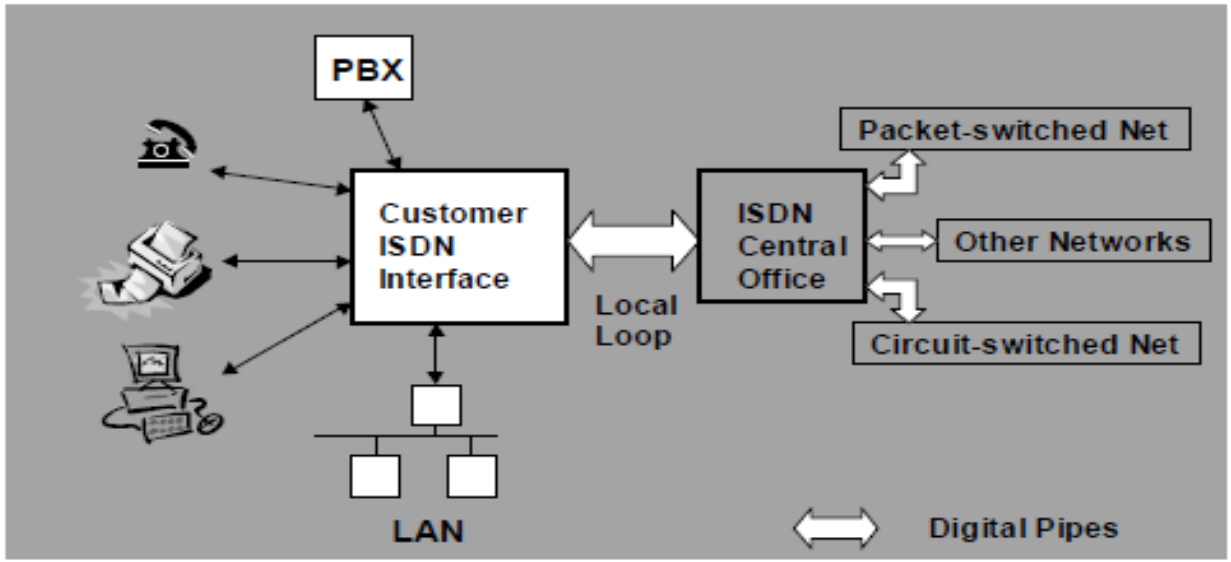
- Integration
  - Before WWII, integration of telegraph/telex and voice
  - More recently, integration of fax and voice
  - ISDN objective: integrate digital voice, 64-kbps data, telex, fax, slow-scan video
  - Broadband ISDN (BISDN): all of the above plus video, multimedia, …



Principles of ISDN (1)

- Support of voice and non-voice applications in the same network
  - interfaces and data transmission facilities standardized by ITU-T
- Switched and non-switched connections
  - packet & circuit switching, leased lines
- 64-kbps channel
  - chosen because at the time was the standard rate for digitized voice

ISDN Conceptual View



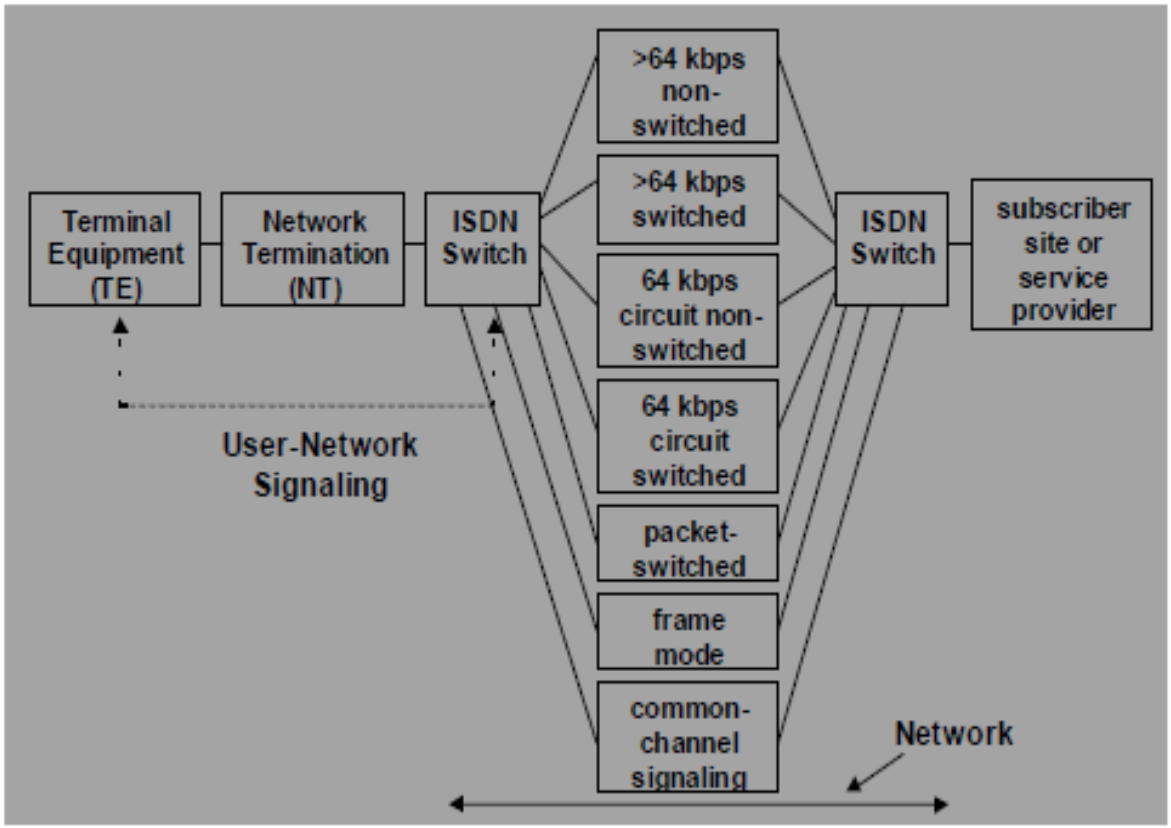
Benefits of ISDN (1)

- To the user : cost savings and flexibility
  - integration of voice/data means users do not have to buy multiple services to meet multiple needs
  - single access line to all services
  - services tailored to diverse requirements (information volume, traffic pattern, response time, interface types)

Benefits of ISDN (2)

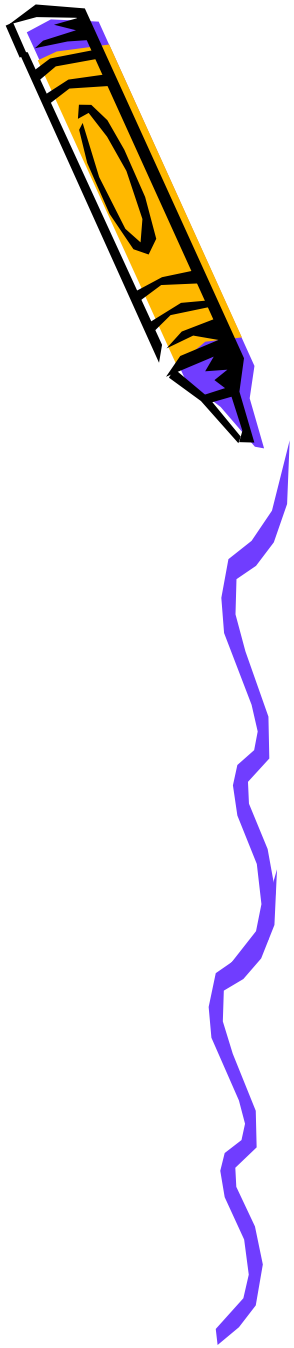
- To network providers
  - standards support universality and larger potential market for services, drive down equipment costs
- To manufacturers
  - larger potential market, economies of scales
  - standards decrease risk of obsolescence
- To enhanced service providers
  - simplified user access

ISDN Architecture (1)



ISDN Channels (1)

- Standard bit rates:
  - B-channel : 64 kbps
  - D-channel : 16 or 64 kbps
  - H-channel : 384 (H0), 1536 (H11), 1920 (H12) kbps
- B-channel is the basic user channel
  - can carry digital data, PCM-encoded digital voice, or a mixture of lower-rate traffic
  - with mixed traffic, all traffic must be destined for the same end-point (carried over the same circuit)



ISDN Channels (2)

- B-channel (continued)
  - supports circuit-switched, packet-switched (exchange of data via X.25) and semipermanent connections
  - in the case of circuit-switched connections, common-channel signaling is used
- D-channel is dual-purpose
  - carries signaling information to control circuit-switched calls on B-channel
  - may be used to carry low-speed data applications (e.g., videotex, telemetry)

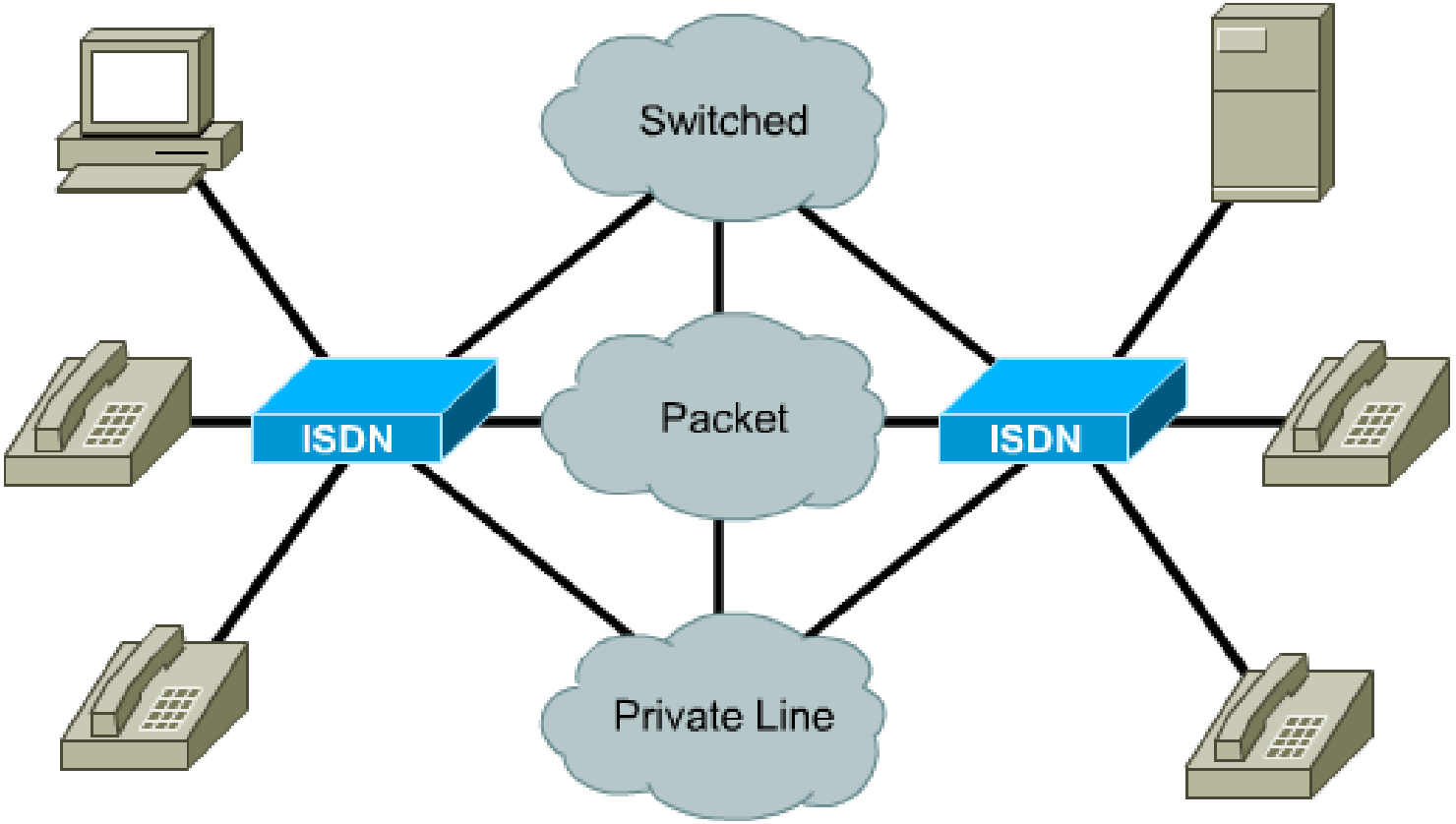
ISDN Channels (3)

- H-channel is a high-speed channel
  - can be used as a single trunk or subdivided by the user
  - fast fax, video, high-speed data, high-quality audio and multiplexed information streams at lower data rates
- These channel types are grouped into transmission structures that are offered as a package to the user

ISDN

- Carries a variety of user traffic, such as digital video, data, and telephone network services, using the normal phone circuit-switched network
- Offers much faster call setup than modems by using out-of-band signaling (D channel)
  - Often less than one second
- Provides a faster data transfer rate than modems by using the 64-kbps bearer channel (B channel)
  - Can combine multiple B channels to bandwidth of 128 kbps
- Can negotiate PPP links

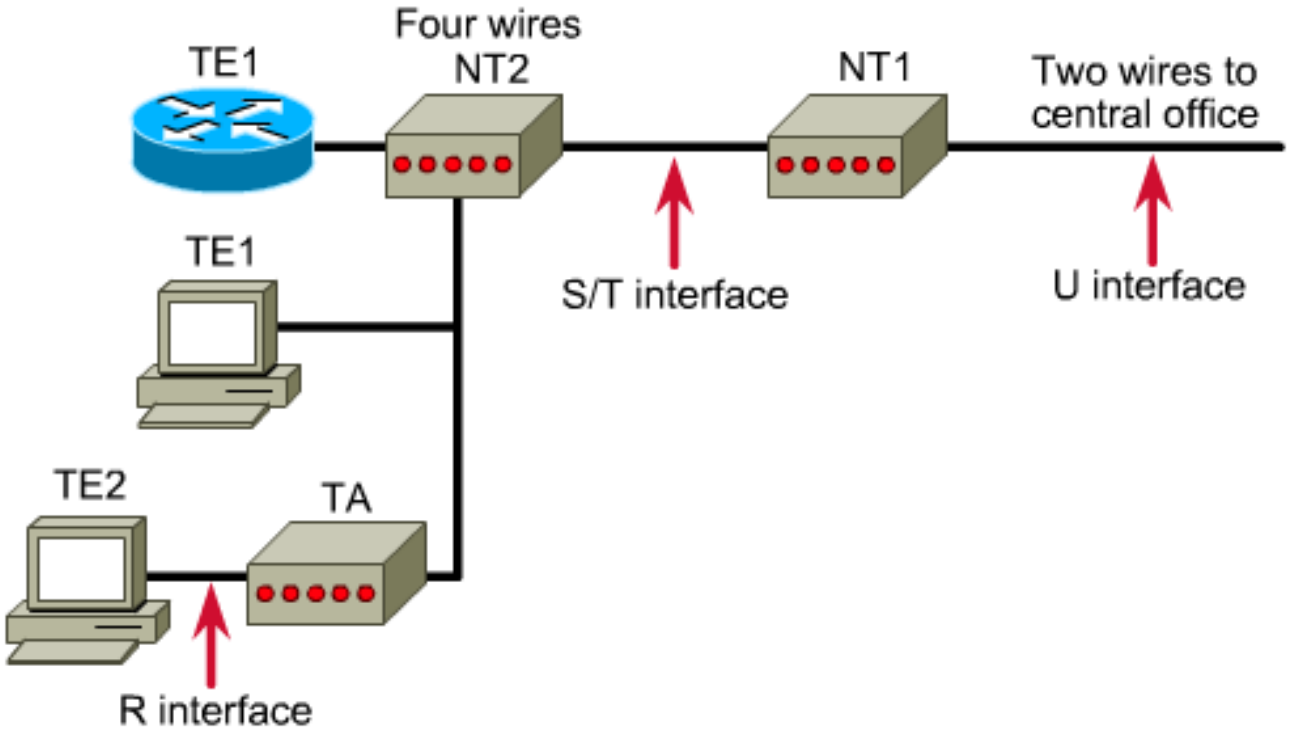
What Is ISDN?



ISDN Devices

- Terminal Adapter (TA) - Converter device that converts standard electrical signals into the form used by ISDN - allows non-ISDN devices to operate on an ISDN network.
- Terminal Equipment Type 1 (TE1) - Compatible with the ISDN network. Example:Telephones, personal computers, fax machine or videoconferencing machine.
- Terminal Equipment Type 2 (TE2) - Not compatible with the ISDN network. Example: Analog phone or modem, requires a TA (TE2 connects to TA).
- Network termination type 1 & 2 (NT1 and NT2) - A small connection box that physically connects the customer site to the telco local loop, provides a four-wire connection to the customer site and a two-wire connection to the network .

ISDN Components and Reference Points

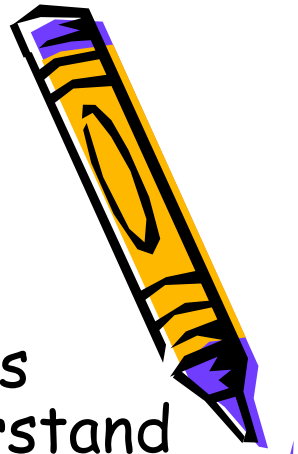


- End-to-end digital network for data, fax, voice, and video

ISDN Reference Points

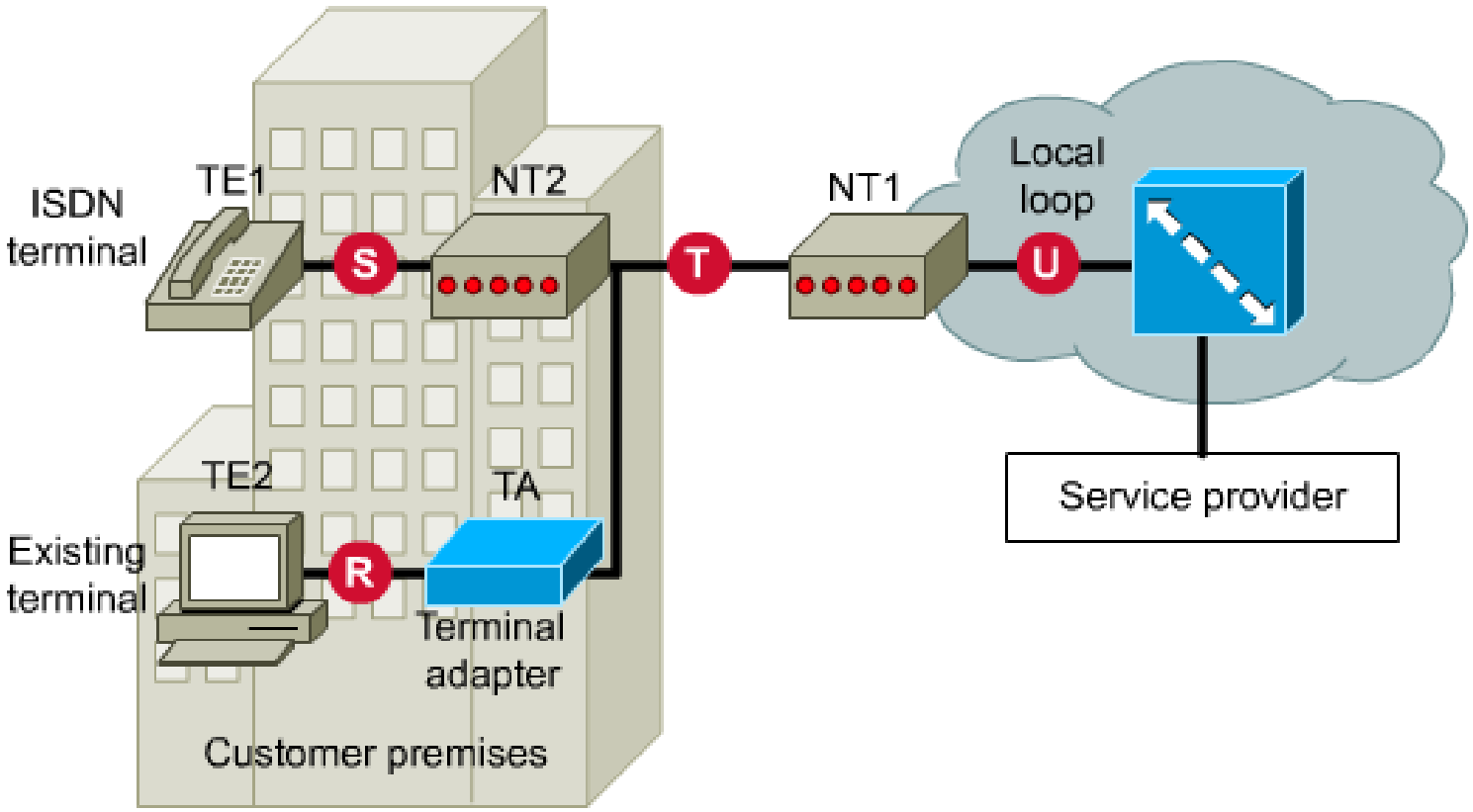
- U - Two wire cable that connects the customer's equipment to the telecommunications provider
- R - Point between non-ISDN equipment (TE2) and the TA
- S - Four-wire cable from TE1 or TA to the NT1 or NT2
- T - Point between NT1 and NT2

Analogies



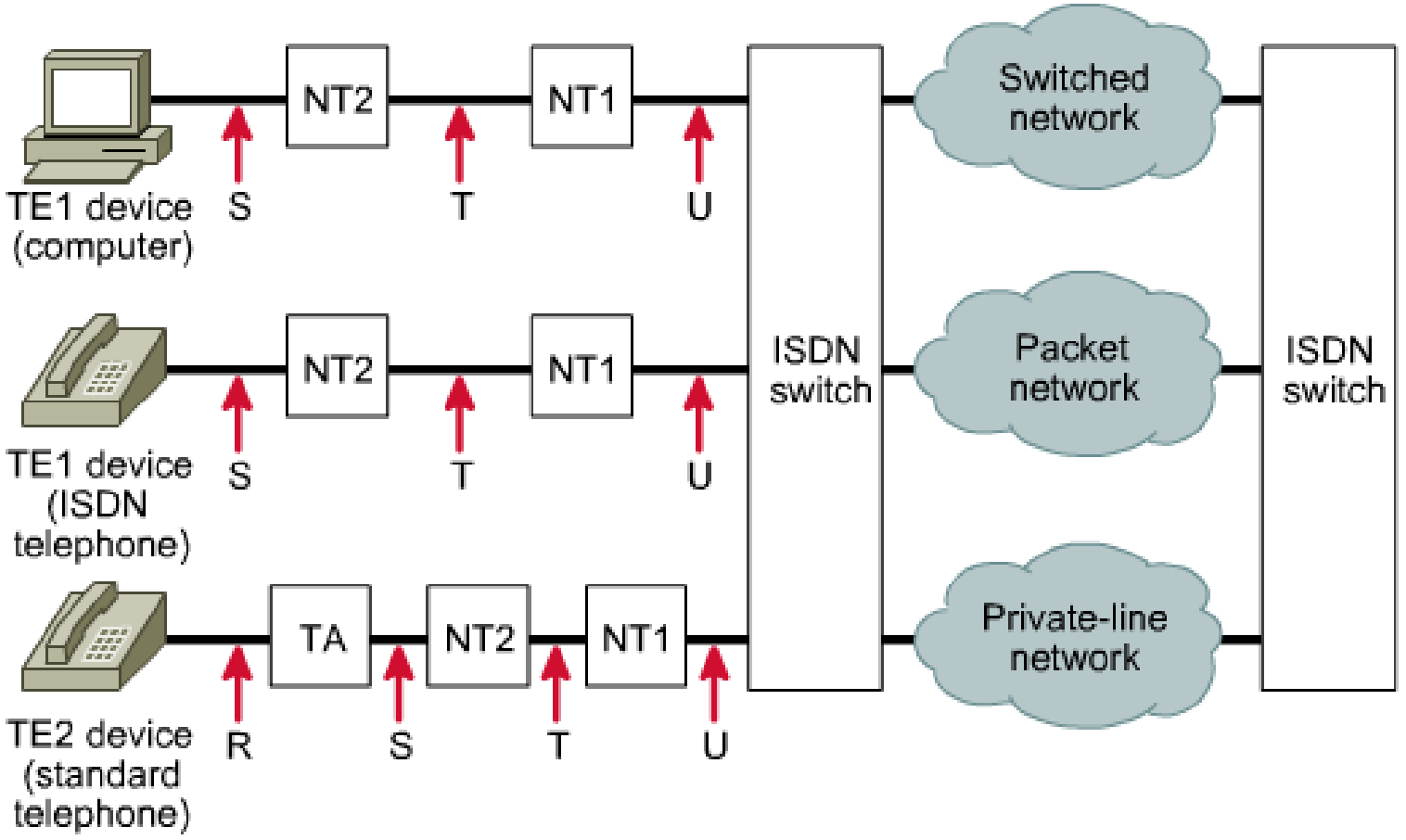
- NT-1 (Network Terminator-1)
  - An NT-1 is an interface box that converts ISDN data into something a PC can understand (and vice versa). It works a little like a cable TV descrambler for ISDN signals, and is often built into ISDN adapters.
- TA (Terminal Adapter)
  - This chunk of hardware converts the data it receives over ISDN to a form your computer can understand. Sometimes mistakenly called an ISDN modem or a digital modem, a terminal adapter handles data digitally and does not need to modulate or demodulate an analog signal. Terminal adapters can be an internal board or an external board that connects to the computer through the serial port.

ISDN Components and Reference Points #2



- Functions refer to devices or hardware functions

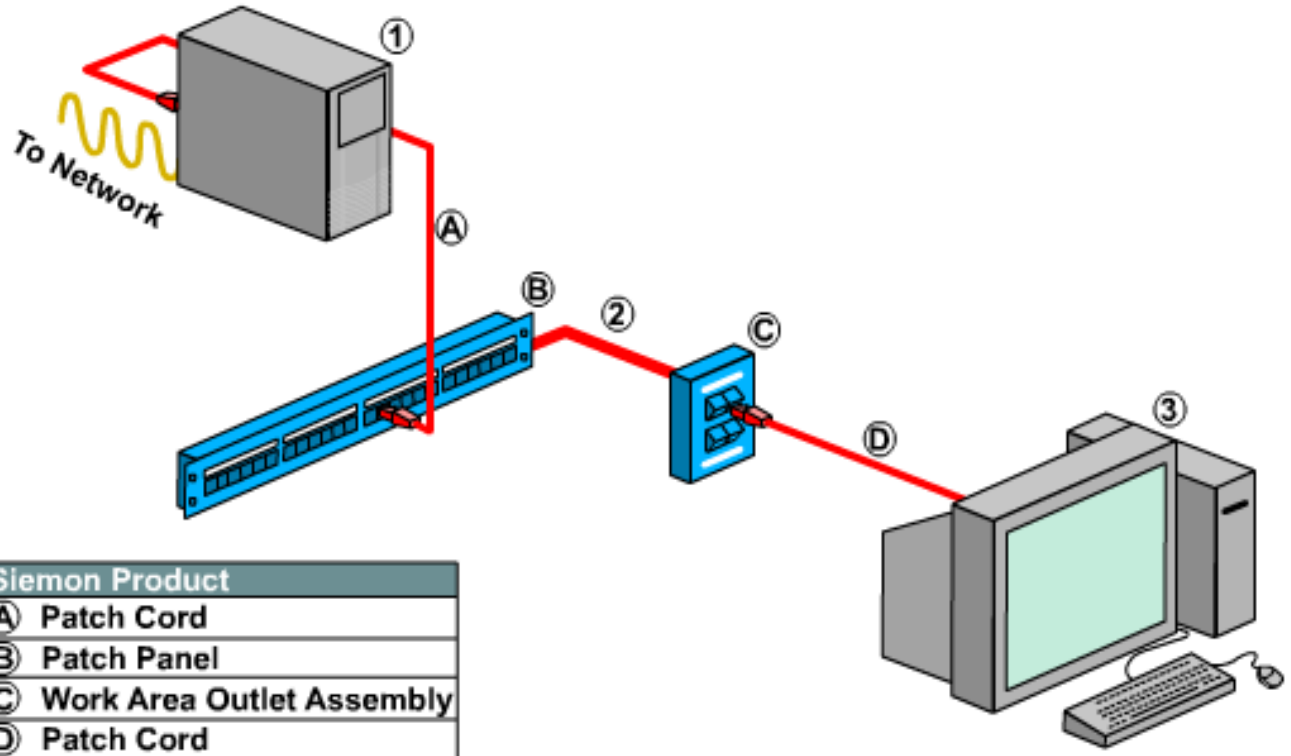
ISDN Reference Points



ISDN and the OSI Reference Model

- The ISDN Physical Layer
- The ISDN Data Link Layer
- The ISDN Network Layer

ITU-T Standards of the First Three Layers of ISDN



Siemon Product	
Ⓐ	Patch Cord
Ⓑ	Patch Panel
Ⓒ	Work Area Outlet Assembly
Ⓓ	Patch Cord
Customer Supplied	
①	Network Termination Equipment
②	4-Pair Horizontal Cabling
③	Work Area Equipment

ISDN Protocols

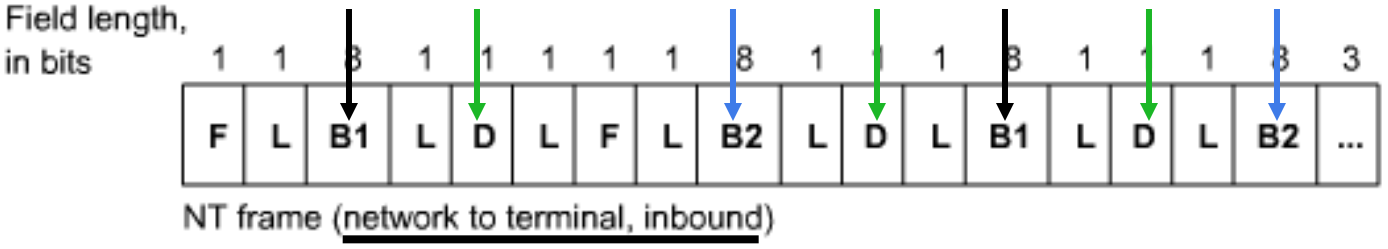
- E-series protocols—Telephone network standards for ISDN.
- I-series protocols—Specify ISDN concepts and interfaces.
- Q-series protocols—Standards for ISDN switching and signaling.
- Operate at the physical, data link, and network layers of the OSI reference model

ISDN Protocol Operating OSI Layers 1 Through 3

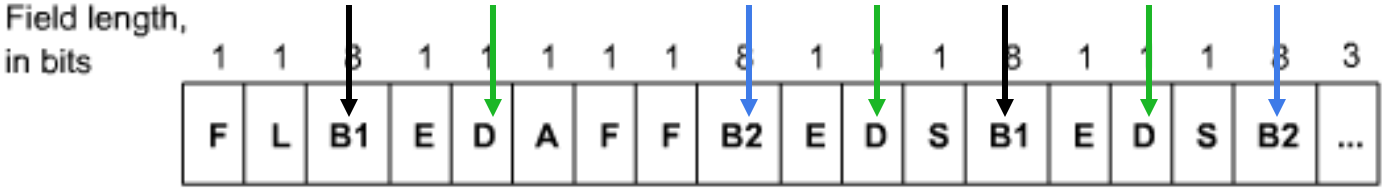
- Physical layer ISDN protocols
  - BRI (ITU-T I.430) / PRI (ITU-T I.431)
    - Defines two ISDN physical layer frame formats
      - Inbound (local exchange to ISDN customer)
      - Outbound (ISDN customer to local exchange)
- Data link layer ISDN protocols
  - LAPD signaling protocol (ITU-T Q.920 for BRI and Q.921 for PRI) for transmitting control and signaling information over the D channel
    - LAPD frame format similar to ISO HDLC frame format
- Network layer ISDN protocols
  - ITU-T I.930 and ITU-T Q.931 defines switching and signaling methods using the D channel.

Note: With Q.921/Q.931 the second digit indicates the OSI layer.

ISDN Physical Layer



NT frame (network to terminal, inbound)

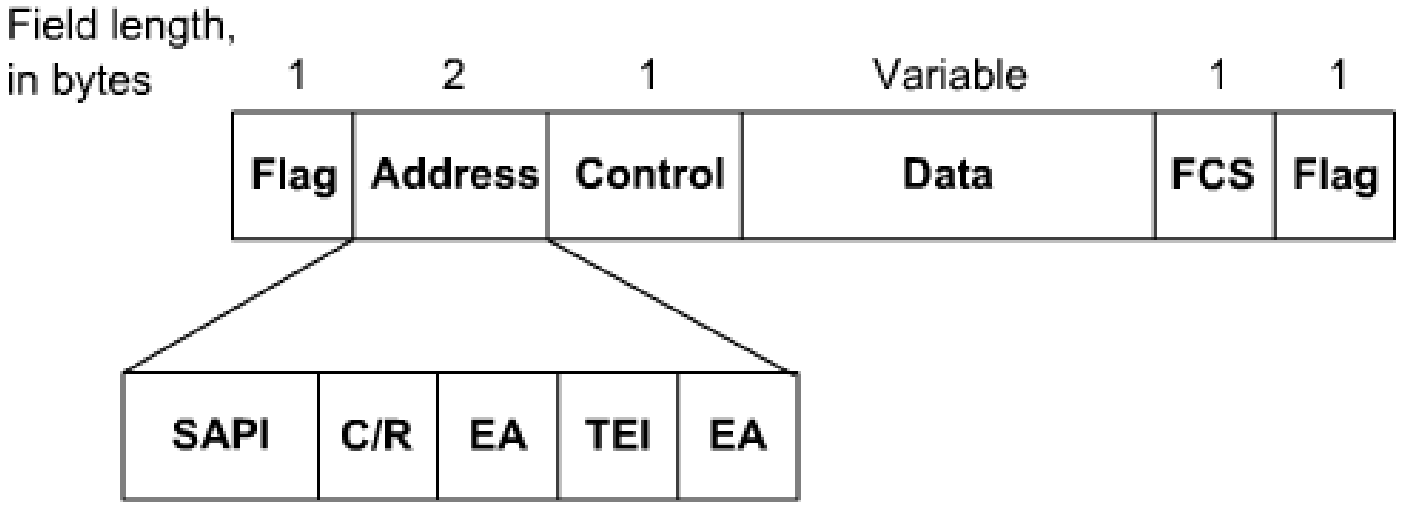


TE frame (terminal to network, outbound)

A = Activation bit
B1 = B1 channel bits
B2 = B2 channel bits
D = D channel (4 bits x 4000 frames/sec = 16 kbps) bit
E = Echo of previous D bit
F = Framing bit
L = Loading balance bit
S = Spare bit

ISDN physical-layer frame formats are 48 bits long, of which 36 bits represent data

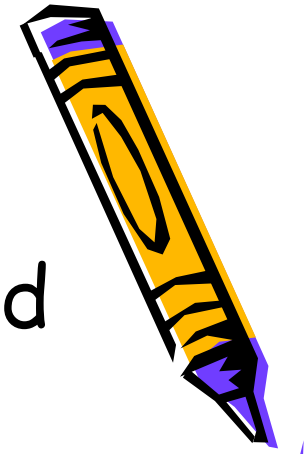
ISDN Data Link Layer



SAPI = Service access point identifier bits (6 bits)
C/R = Command/response bit
EA = Extended addressing bits
TEI = Terminal endpoint identifier

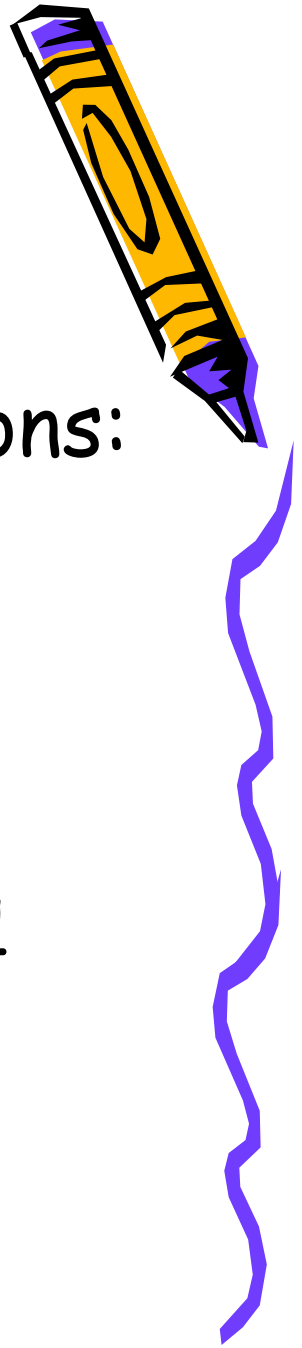
Frame format is very similar to that of HDLC

ISDN Network Layer



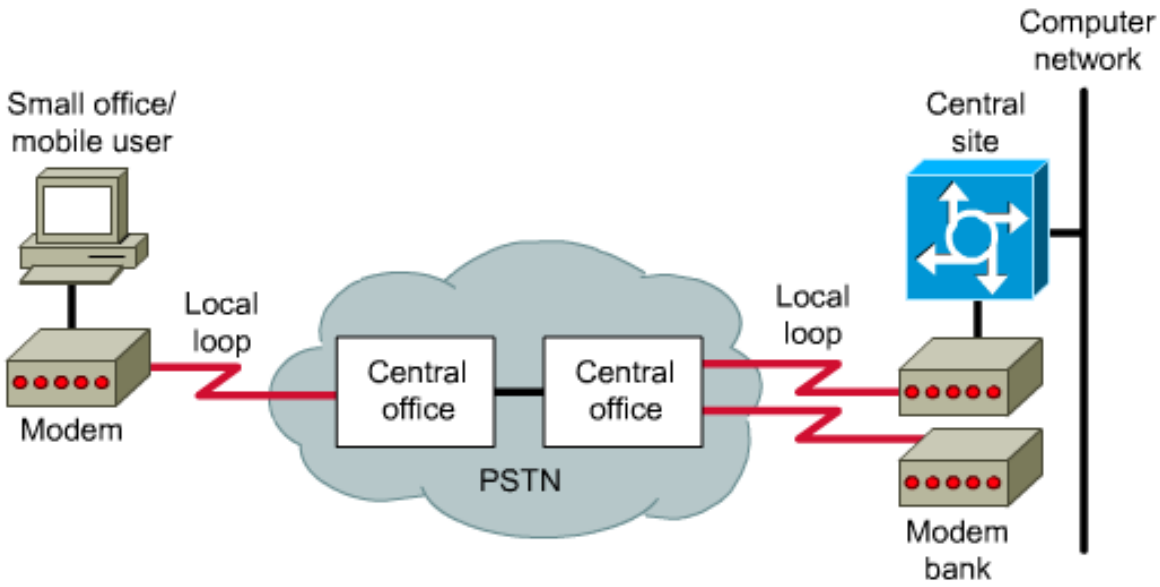
- Two Layer 3 specifications are used for ISDN signaling:
  - ITU-T I.450 (also known as ITU-T Q.930)
  - ITU-T I.451 (also known as ITU-T Q.931)
  - Together, these protocols support:
    - User-to-user circuit-switched connections
    - User-to-user packet-switched connections
    - A variety of standards for:
      - Call establishment
      - Call termination

ISDN Encapsulation



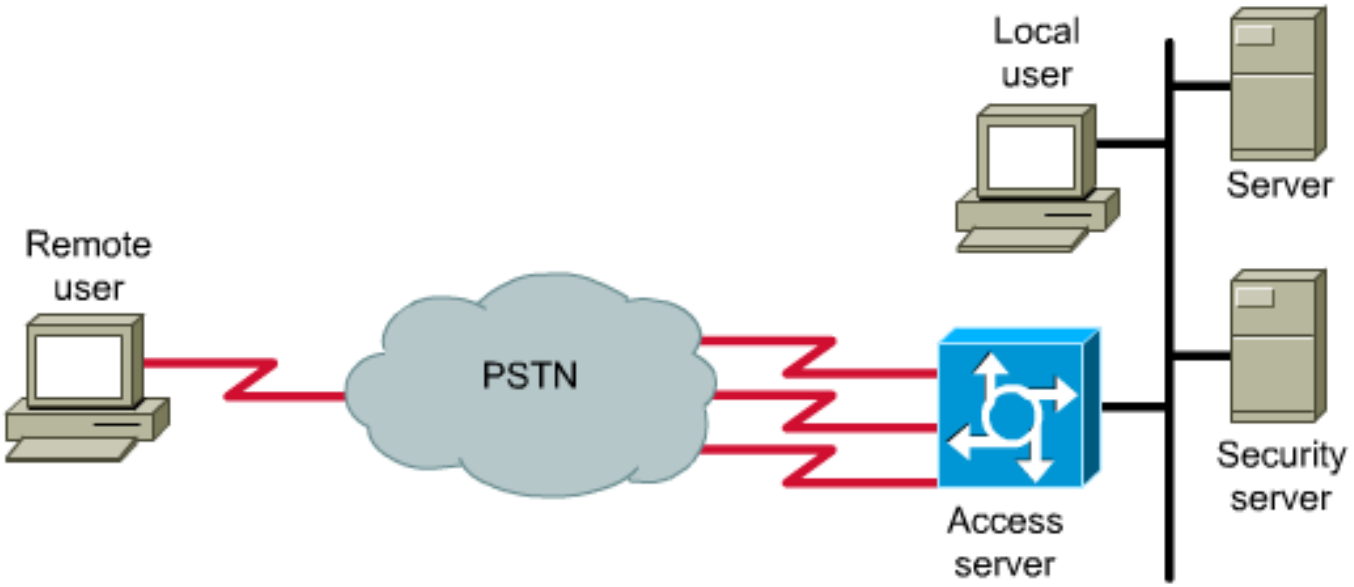
- The two most common encapsulations:
  - PPP
  - HDLC
- ISDN defaults to HDLC.
- PPP is much more robust.
  - Open standard specified by RFC 1661
  - Supported by most vendors

ISDN Uses



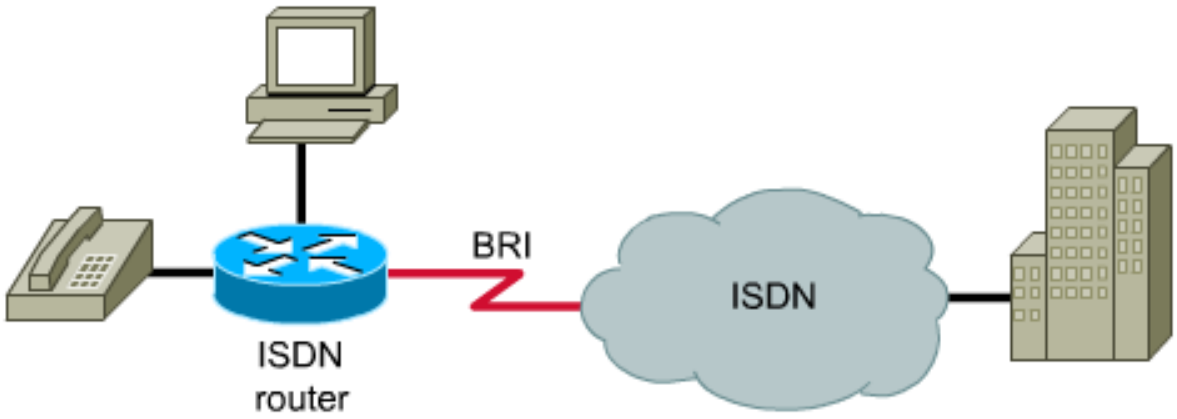
- Remote Access (Telecommuters)
- Remote Nodes (Voice and Data)
- SOHO Connectivity (Small Branches)

Remote Access (Telecommuters)



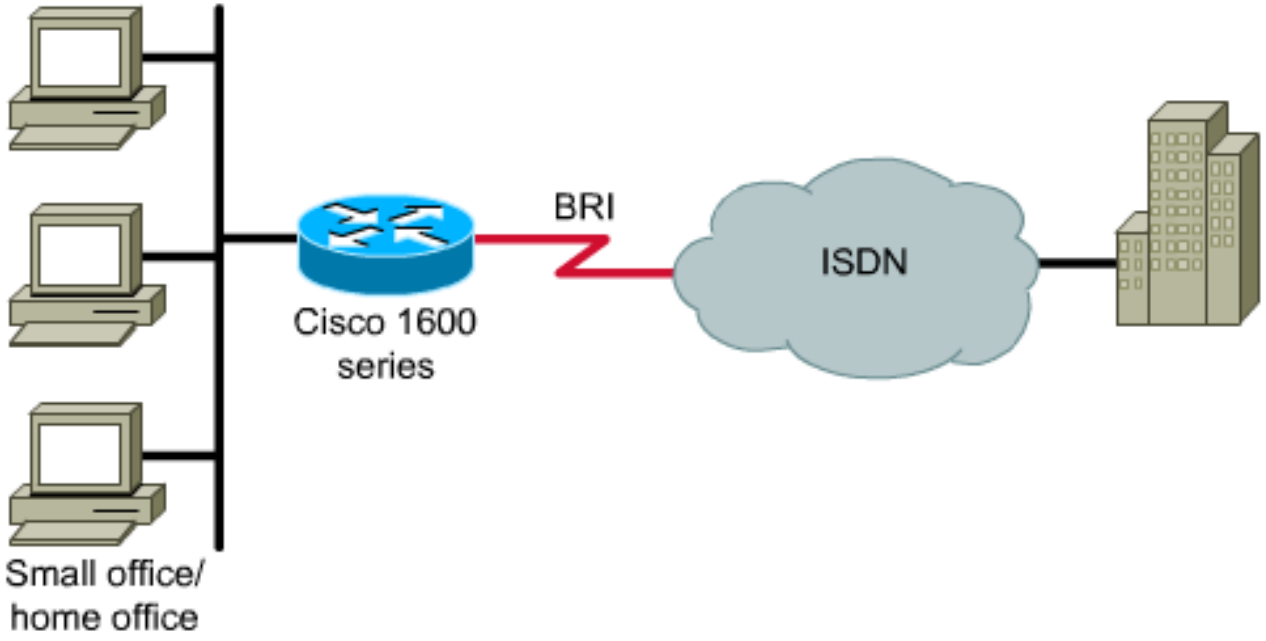
- Remote user appears to be a network node

Remote Nodes (Voice and Data)



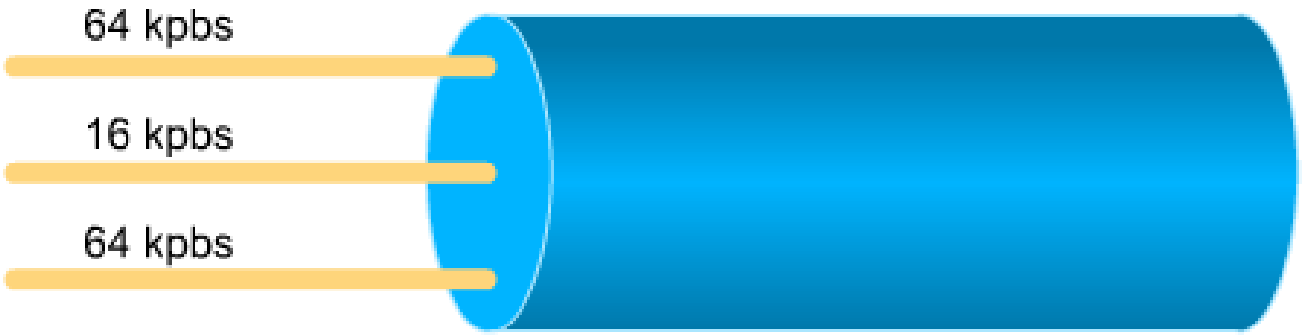
- Components
  - -ISDN Router
  - -Remote client software
- Single user

SOHO Connectivity (Small Branches)



- Components and Considerations
  - -ISDN router
  - -Multiple remote users at the same location

ISDN BRI



Three channels:

- Two 64 kbps bearer (B) channels
- One 16 kbps signaling (D) channel

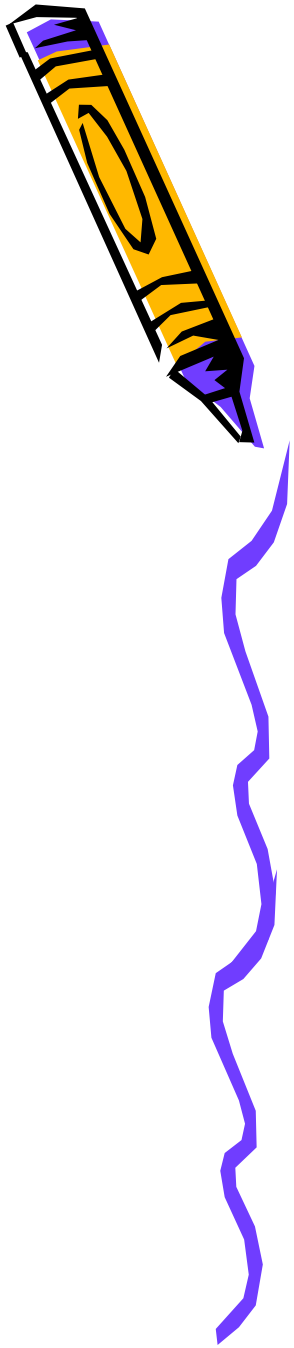
ISDN Services – BRI

- **Basic Rate Interface (BRI)**
  - Two 64 Kbps B channels, one 16 Kbps D channel, and 48 Kbps worth of framing and synchronization.
  - **Available data bandwidth:** 128 Kbps (2 x 64 Kbps)
  - **User bandwidth:** 144 Kbps (128 Kbps + a 16 Kbps D channel)
  - **Total line capacity:** 192 Kbps (144 Kbps + 48 Kbps framing)
- **Each B channel can be used for separate applications**
  - **Such as Internet and Voice**
- **Allows individual B channels to be aggregated together into a Multilink channel**

ISDN Services – PRI

- **Primary Rate Interface (PRI)**
  - A PRI connection can assign various 64 Kbps channels to both ISDN and analog modem connections
  - North America and Japan – PRI service has 23 64 Kbps B channels, one 64 Kbps D channel, and 8 Kbps of synchronization and framing for a total bit rate of up to 1.544 Mbps (same as T1)
  - Europe, Australia, and other parts of the world – PRI service has 30 64 Kbps B channels, one 64 Kbps D channel, and 64 Kbps of framing and synchronization for a total bit rate of up to 2.048 Mbps (same as E1)
- **Each B channel to be used for separate applications including voice, data and Internet**
- **Multiple B channels can be Multilinked together**

ISDN BRI Configuration Three Basic Steps



1. Set the ISDN Switch Type.
2. Set the SPIDs (If Required).
3. Set the Encapsulation Protocol.

ISDN Global and Interface Configuration Tasks

Global Configuration

- Select switch type, Specify traffic to trigger DDR call

Interface Configuration

- Select interface specifications, Configure ISDN addressing

Optional Feature Configuration