



onous / Asynchronous Transmission

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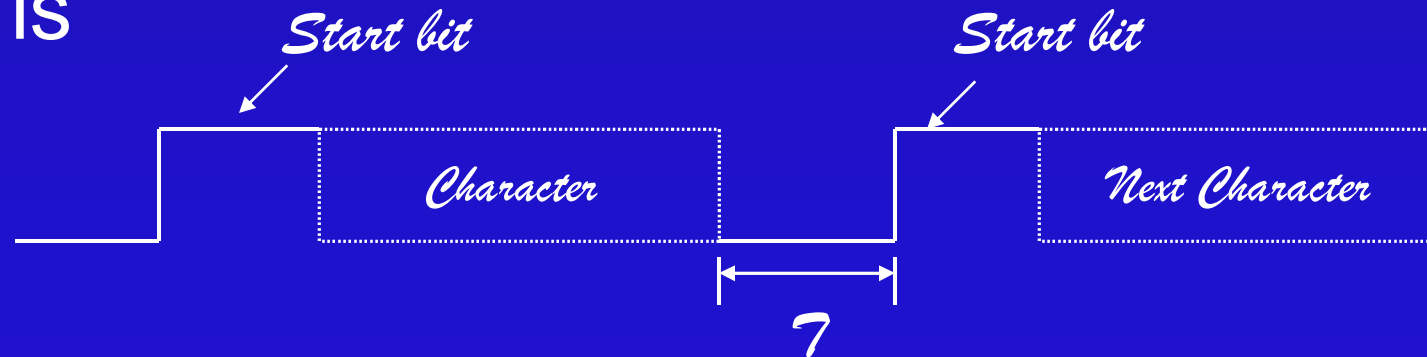
Dhahran, Saudi Arabia

COMPUTER NETWORK

A synchronous Timing

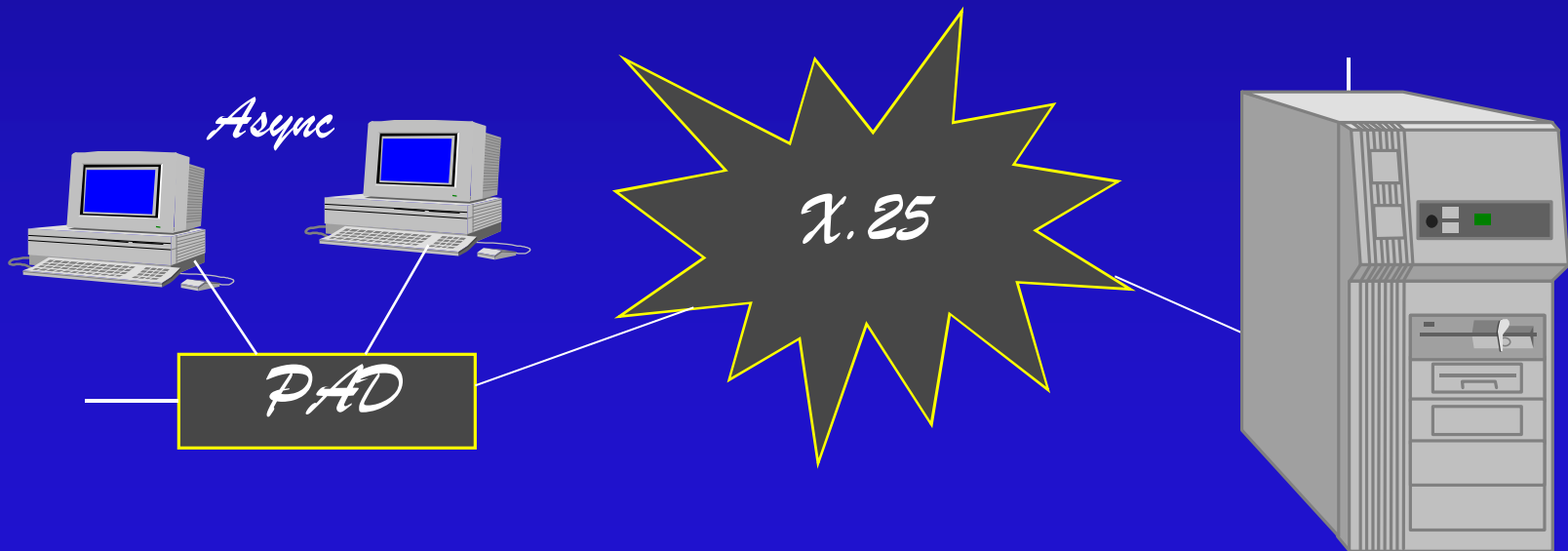
- Asynchronous means no predefined timing between characters
- The sending and receiving ends provide their own clocking
- The timing of asynchronous characters

is



Asynchronous Timing (Cont.)

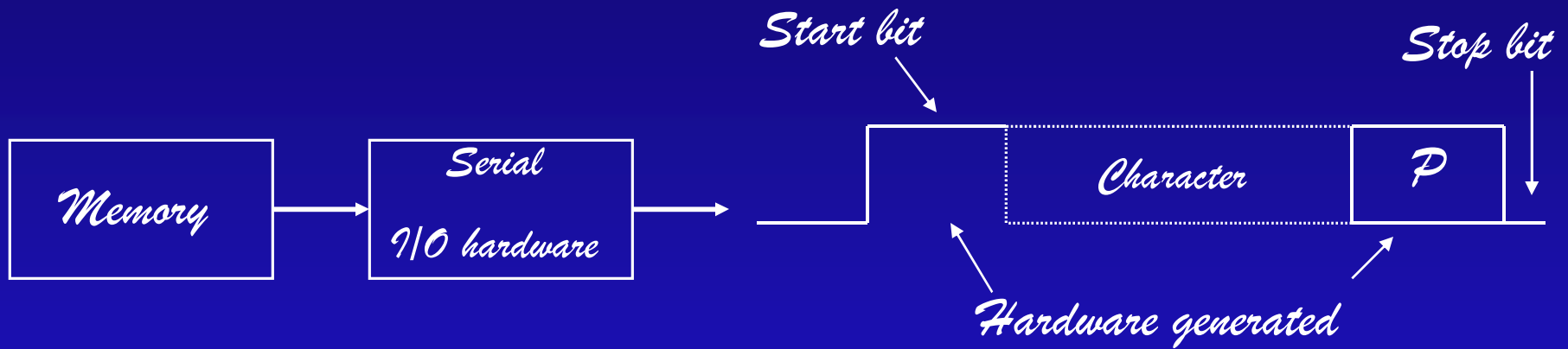
- The receiver does not know when the next unit of data is coming
 - » The term async frequently is used this way



Clocking at the Sending End

- The sending device determines when to transmit the $\%start$ bit+
 - » The start bit indicates the beginning of a character
 - » The bits of the character follow with a well-defined timing (LSB first)
 - » A parity (error-check) bit is generated and sent
 - » There is at least one stop bit
 - » There is an arbitrary time before the next character is sent

Clocking at the Sending End (Cont.)

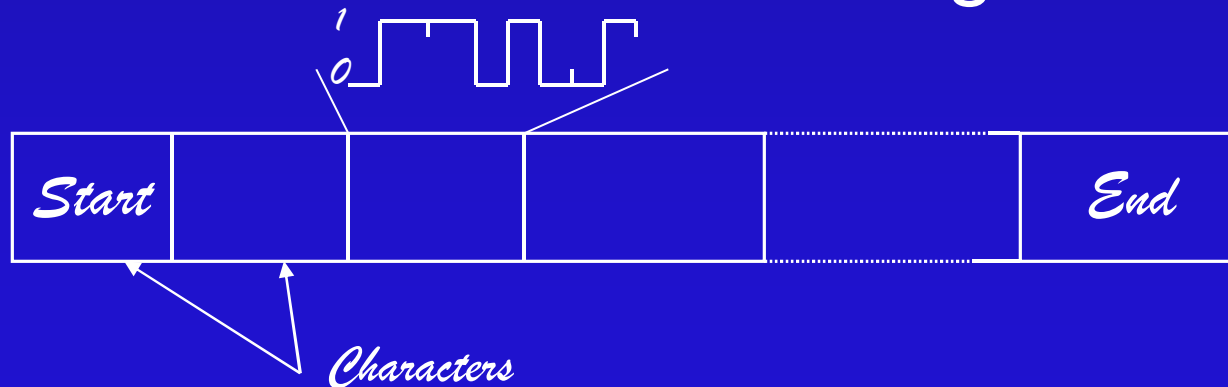


- Each character is framed with these control bits

I/O = input/output

Synchronous Transmission

- Has a known timing relationship between bits and characters
- Characters are sent one after the other
- The receiver recovers this timing from transitions in the arriving data

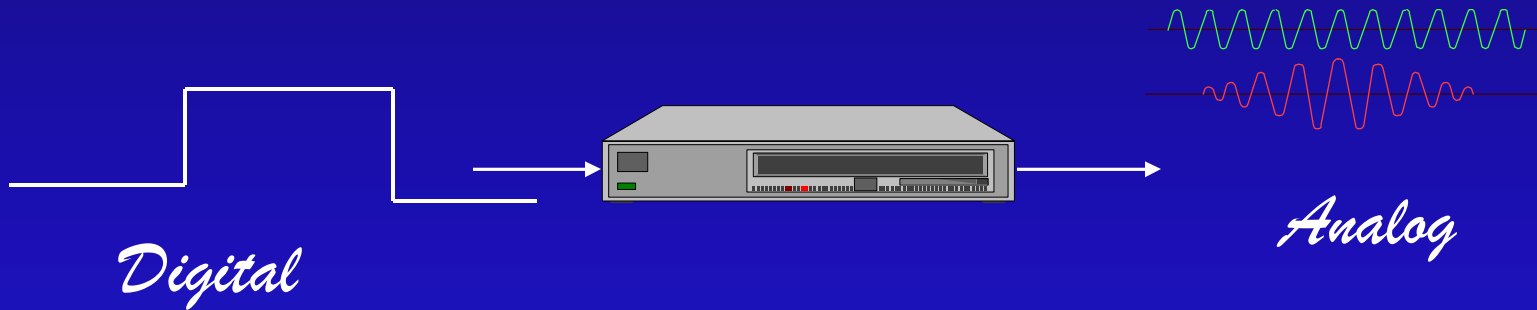


Modulation

- We will explore methods used to transmit digital data across analog channels.
- A primary example of analog channels is the telephone company's voice-grade circuit.
- There is one primary reason to use modems
 - » To be compatible with the voice-grade channel

Modulation (Cont.)

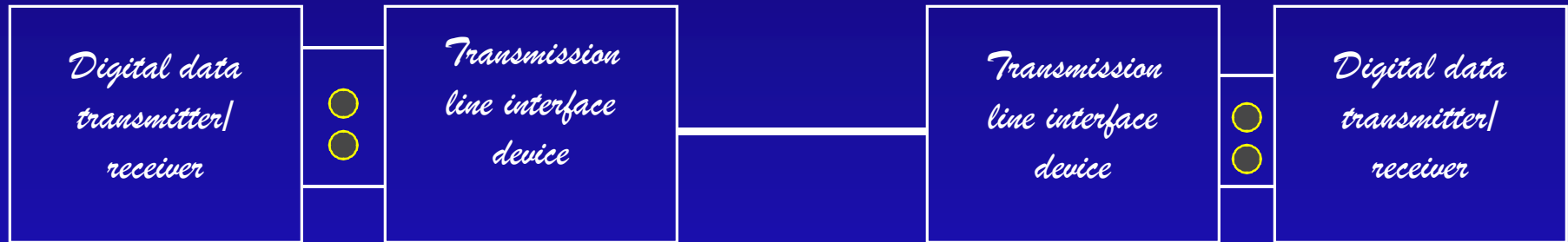
- The process of converting digital data into analog form is called modulation.



- Generally, we get about 2 to 3 bit/s per Hz of bandwidth of the analog channel (more or less based on complexity)

Communications Interfacing

*Bit-serial transmission
line (or bit-serial interface
to network*



Data terminal equipment (DTE)

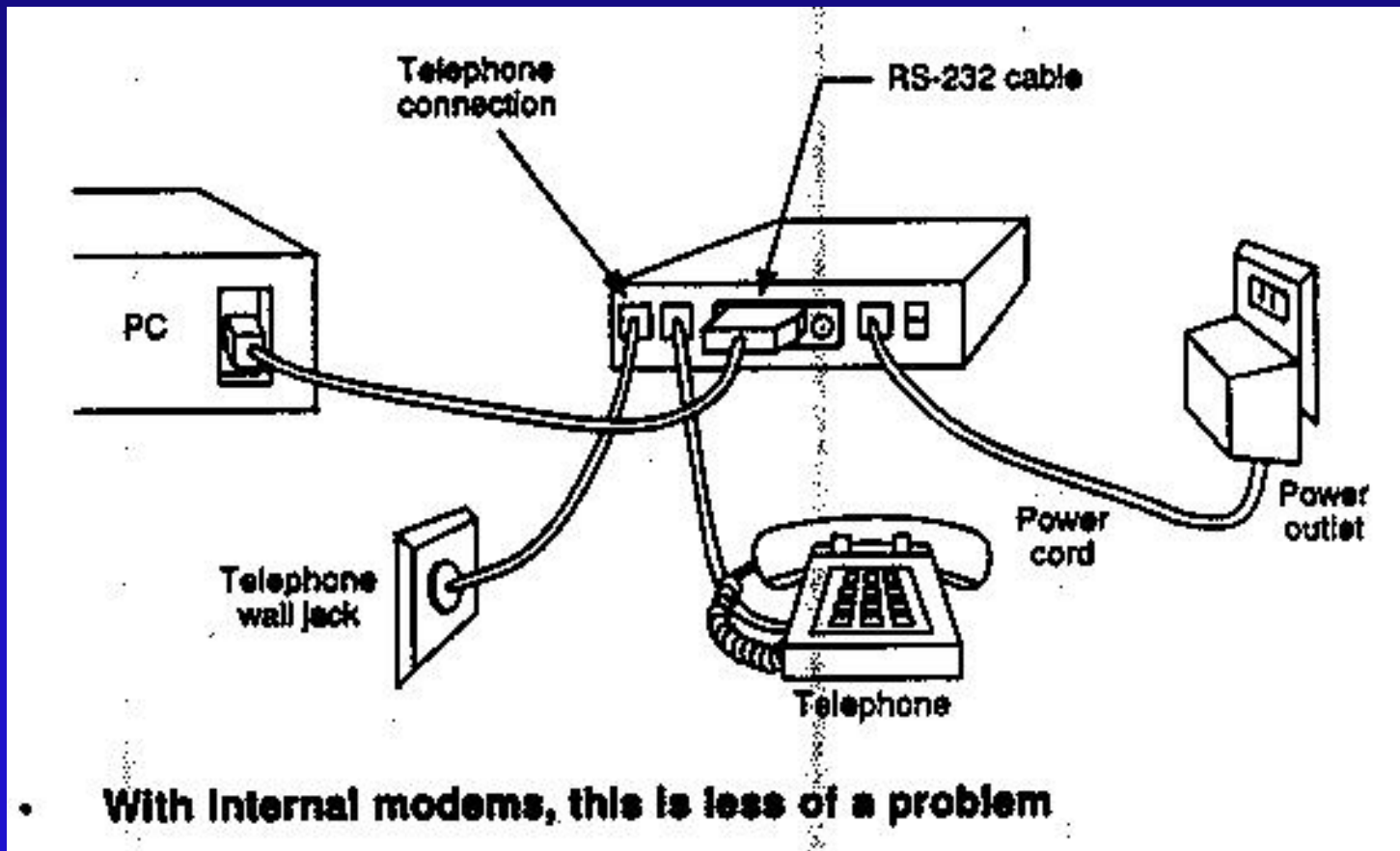
Data circuit-terminating equipment (DCE)

Generic interface to transmission medium

Communications Interfacing (Cont.)



External Modem Connections



CCITT Modems

CCITT modem designation	Sync or async	Data rate	Comments
V.21	Async	300 bit/s	Similar to Bell 100 series*
V.22	Async/sync	1200 bit/s	Compatible with Bell 212A
V.22 bis	Async/sync	2400 bit/s	
V.26	Sync	2400 bit/s	Compatible with Bell 201
V.27	Sync	4800 bit/s	Similar to Bell 208*
V.29	Sync	9600 bit/s	Similar to Bell 209*
V.32	Sync/async	9600 bit/s	No Bell version
V.32 bis	Sync/async	14400 bit/s	
V.33	Sync	19200 bit/s	No Bell version
V.fast V.terbo	Sync/async	Still under development	

*Similar, but not compatible.

al Modern Modem Capabilities

- Many modern modems can operate in a number of modes, which are negotiated when the connection is established.
 - » V.32 operation at 9600 bit/s
 - » Or V.32 bis at 14400 bit/s
 - » Or V.42 bis at 2400 bit/s

Local Modern Modem Capabilities (Cont.)

- Modems can automatically dial the telephone number
 - » V.25 bis sync/async autodial
 - » Or the non-CCITT Hayes AT command set (discussed later)
- Modems can perform operations previously done by software
 - » V.42 error correction (discussed later)
 - » V.42 bis error compression (discussed later)

Dial Modern Modem Capabilities (Cont.)

- Modems can fall back to a lesser data rate if needed for communications, and some can later fall forward when possible
- Leased-line modems can automatically dial a backup line as needed.

The Hayes AT Command Set

- The Hayes AT command set is an industry standard
 - » Controls modem operation
 - » Initiates dial sequence
 - » Hangs up
 - » Runs diagnostics
 - » Selects data compression feature
 - » Etc.
 - For more than 50 such modem commands

AT Command Set (Cont.)

- The AT commands start with an escape sequence and AT (attention)
- An example AT command is to dial a number

```
+++ATDT18007654321 <cr>
```

When %D+ is for %dial+, %T+ is for %tone+, and %18007654321+ is the telephone number

V.42 and V.42 bis Modern Capabilities

- The CCITT V.42 recommendation provides a reliable data transfer capability (error correction)
 - » There are actually two forms (CCITT couldn't agree on only one)
 - » The preferred approach is Link-Access Procedure for Modems (LAPM)
 - » MNP 4 is also included (see next slide)

V.42 and V.42 bis Modern Capabilities (Cont.)

- The CCITT recommendation V.42 bis builds on V.42
 - » V.42 bis is a data compression standard
 - » Uses an automatic adaptation algorithm that handles different degrees of randomness in the data
 - » V.42 bis achieves a data compression factor of up to 4X

Microcom Network Protocol (MNP)

- The Microcom Network Protocol (MNP) is a set of communications protocols for enhancing modem communications
 - » Some are industry standards
 - » Others are proprietary to Microcom
- Three protocols are identified by terms such as
 - » MNP 4, MNP class 4, or MNP level 4

Network Protocol (MNP) (Cont.)

- MNP 4 is a reliable public-domain delivery protocol
 - » MNP 4 is built into hundreds of thousands of modems
 - » MNP 4 is part of the CCITT V.42 recommendation

M

Protocol (1978)

- XMODEM was the first file transfer protocol for use with PCs
 - » XMODEM actually predates PCs and DOS
- XMODEM is available from many bulletin boards
- Transfers are limited in many ways
 - » Transfers data in small (128-byte) blocks (8-bit code)
 - » Operates as a simple %stop and wait+ ACK/NAK protocol

EM File Transfer Protocol (Cont.)

- There are many variations : YMODEM, ZMODEM, etc.
 - » Larger block sizes
 - » Better error detection

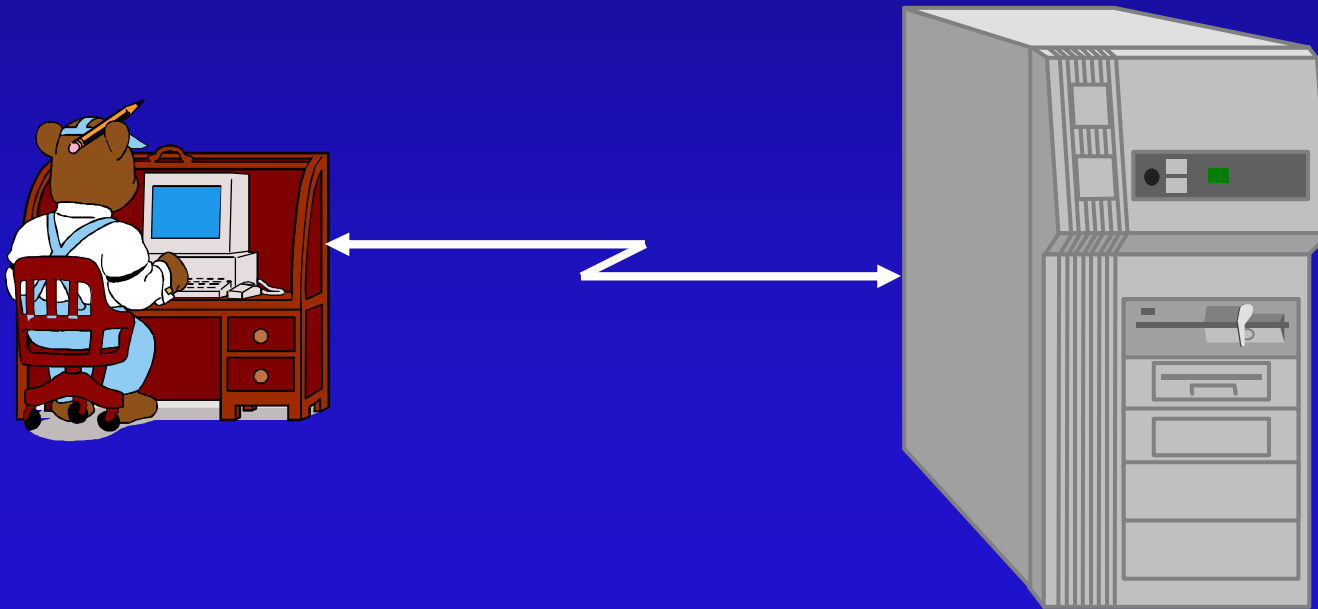
DOS = disk operating system

ACK = acknowledgement

NAK = negative acknowledgement

EM File Transfer Protocol (Cont.)

- The operating mode is negotiated at connection establishment



Kermit (1981)

- Kermit is available on many bulletin boards
- Kermit was developed at Columbia University
 - » Well documented
 - » Intended for use between different computers
 - . Mainframes, minis, PCs

Kermit (Cont.)

- All transmitted bytes are printable ASCII (except ASCII %SOH+start) 7-bit code
 - » Avoids problems with control characters, for example, which might affect PAD operation.

Remote-Control Software

- The idea is that the remote PC takes over control of the office PC
 - » Remote keyboard and screen % mirrors+the other PC operations
 - » For access to your office PC from a remote PC; e.g. a laptop
 - » Or, to assist a remote user without having to go to that location

Remote-Control Software (Cont.)

- Remote-control software is required in both PCs
 - » A typical configuration is shown in our example internetwork



Terminal Emulation

- A terminal-emulation program allows your PC to appear to be a terminal that a remote host knows how to talk to
 - » It may appear to be a scroll-mode terminal (e.g., VT100)
 - » It may appear to be a page-mode terminal (e.g., an IBM 3270)

Terminal Emulation (Cont.)

- Terminal emulation is a common approach
 - » To log in at a host or server
 - » To log in at any other device to access services
 - » For network management
 - . To read and write network management objects (variables)

Fax Modem Facts

- Some modems provide facsimile (fax) as well as data capabilities
- Two commonly used recommendations for fax transmission
 - » V.29at 9600bit/s
 - » V.17 at 14400 bit/s

Fax Modem Facts (Cont.)

- Flow is unidirectional
- Support software is required
 - » Class 1: Minimal processing on the fax board
 - » Class 2: More on-board processing, less required by the PC