UNIT 2

PROGRAMMING WITH 8085 MICROPROCESSOR

OBJECTIVES

- To explain the various functions of the registers in the 8085 programming model.
- Define the term flag and explain how the flags are affected.
- Explain the term operation code (opcode) and the operand, and illustrate these terms by writing instructions.
- Classify the instructions in terms of their word size and specify the number of memory registers required to store the instructions in memory.
- Define and explain the term addressing mode.
- Write logical steps & draw flow chart to solve programming problems.

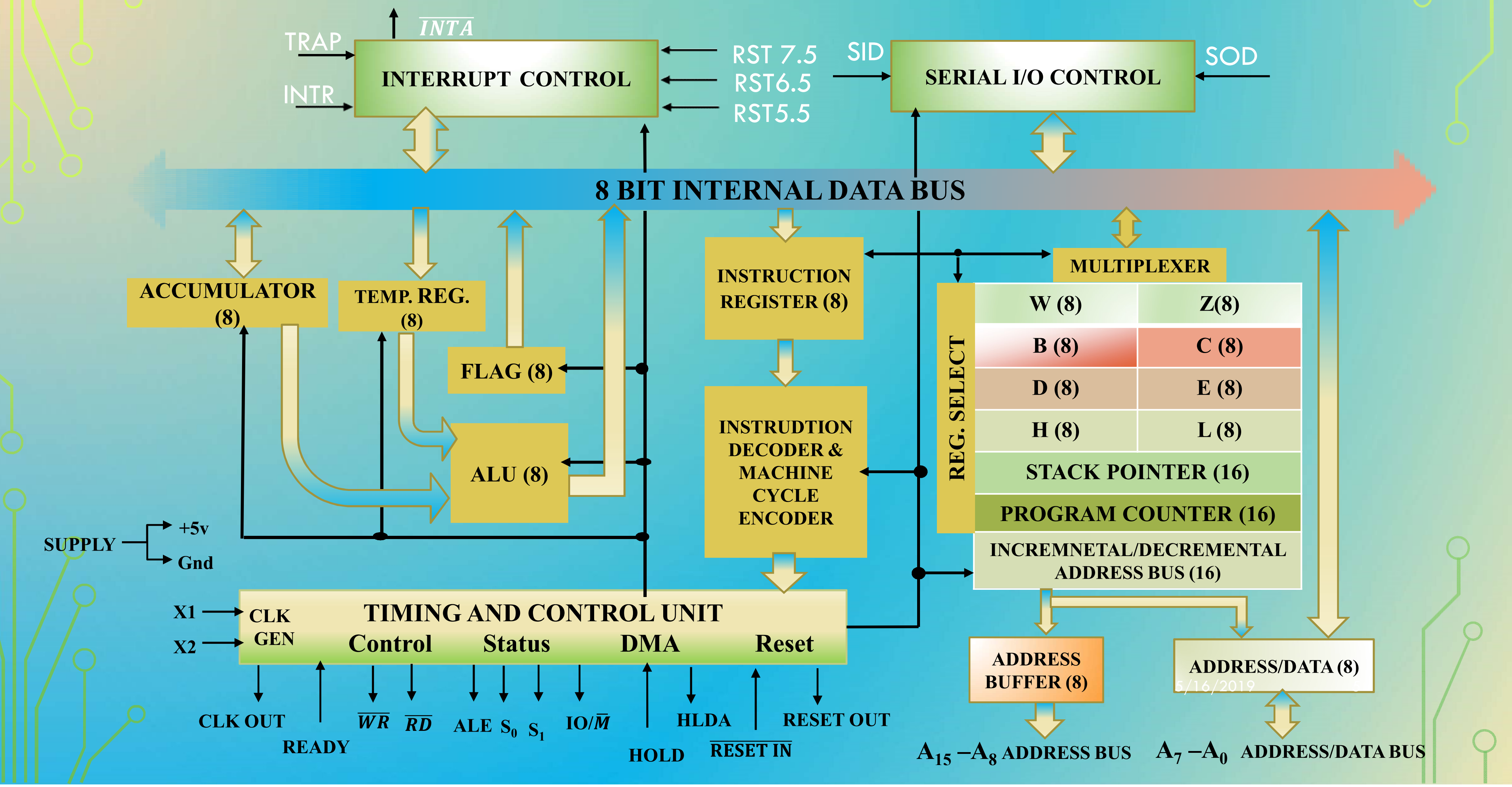
INTERNAL ARCHITECTURE OF AN 8-BIT 8085 MICROPROCESSOR AND ITS REGISTERS

- The Intel 808A is a complete 8-bit parallel central processing unit.
- The main components are:-
  - ➢Array of registers
  - ➢The arithmetic and logic unit
  - ➢The encoder/decoder
  - ➢The timing and control unit
  - All linked by internal data bus.

FEATURES OF 8085

- The main features of 8085 are:
  - It is an 8 bit processor.
  - It is a single chip N-MOS device with 40 pins.
  - It has multiplexed address and data bus.(AD0-AD7).
  - It works on 5 Volt dc power supply.
  - The maximum clock frequency is 3 MHz while minimum frequency is 500kHz.
  - It provides 74 instructions with 5 different addressing modes.
  - It provides 16 address lines so it can access 2^16 =64K bytes of memory.
  - It generates 8 bit I/O address so it can access 2^8=256 input ports.

INTERNAL ARCHITECTURE OF 8085 MICROPROCESSOR



TRAP

INTR

$\overline{INTA}$

INTERRUPT CONTROL

RST 7.5

RST6.5

RST5.5

SID

SERIAL I/O CONTROL

SOD

8 BIT INTERNAL DATA BUS

ACCUMULATOR (8)

TEMP. REG. (8)

FLAG (8)

ALU (8)

INSTRUCTION REGISTER (8)

INSTRUDTION DECODER & MACHINE CYCLE ENCODER

MULTIPLEXER

REG. SELECT

W (8)	Z(8)
B (8)	C (8)
D (8)	E (8)
H (8)	L (8)
STACK POINTER (16)	
PROGRAM COUNTER (16)	
INCREMNETAL/DECREMENTAL ADDRESS BUS (16)	

SUPPLY

+5v

Gnd

X1

X2

CLK GEN

TIMING AND CONTROL UNIT

Control

Status

DMA

Reset

CLK OUT

READY

$\overline{WR}$

$\overline{RD}$

ALE

S_0

S_1

IO/$\overline{M}$

HOLD

HLDA

$\overline{\text{RESET IN}}$

RESET OUT

ADDRESS BUFFER (8)

ADDRESS/DATA (8)

$A_{15}-A_8$ ADDRESS BUS

A_7-A_0 ADDRESS/DATA BUS

1. ARITHMETIC & LOGIC UNIT (ALU)

- **Performs the arithmetic/logical computing functions.**
- **Includes the accumulator, registers, the arithmetic and logic circuits and five flags and two temporary registers.**
- **Temporary registers are used to hold data during an arithmetic/logic operations.**
- **Result is stored in accumulator; the flags are set/reset according to the result of the operation.**

2. ACCUMULATOR (Register A)

- 8-bit register that is part of ALU and accessible to users.
- Used to store 8-bit data and to perform arithmetic/logic operations.
- 8085 is called Accumulator based Microprocessor as of the two operands for all operations and result is also stored in it.
- When data is read from the input port, it is first placed in Accumulator and when data is sent to output port, it must be first placed in Accumulator.

3. Temporary Registers (W& Z)

- 8-bit registers and not accessible to programmers.
- Data is placed in it for short period of time during execution.

4. INSTRUCTION REGISTERS (IR)

- **8-bit register not accessible to programmers.**
- **Receives the operation code of instruction from the internal data bus and passes it to instruction decoder.**
- **Decoder decodes the instruction so that what operation is to be performed by the Microprocessor.**

5. REGISTER ARRAYS (B,C,D,E, H and L)

- General purpose registers.
- Each 8-bit registers accessible to programmers.
- Data are stored on it during program execution.
- Can be used individually as 8-bit registers and as 16-bit registers in pair forming BC,DE, & HL.
- Data can be directly added or transformed to one another.
- Their content can be incremented or decrement and combined logically with the content of accumulator.

6. STACK POINTER (SP)

- 16-bit register used as memory pointer.
- Points to the memory location in R/W memory, called the stack.
- Also called LIFO queue.
- The beginning of the stack is defined by loading the 16-bit address in the stack pointer.

7. PROGRAM COUNTER (PC)

- **16-bit register that holds address of the next instruction to be executed.**
- **As microprocessor begins to execute a program , the memory location of first instruction is placed in PC.**
- **PC maintains the sequence of execution of instructions.**
- **Automatically incremented by one to point the next memory location when a byte is being fetched; i.e. it keeps the record of program by counting the memory address, hence name PC.**

8. FLAGS

- 5 flip-flops in 8085, each holding the status of different states separately known as flag register.

D7	D6	D5	D4	D3	D2	D1	D0
S	Z		AC		P		CY

- Each flip-flop is called flags.
- 8085 can set or reset each flags depending on the type of operation.
- The flags are:
  - Sign (S)
  - Zero(Z)
  - Auxiliary Carry (AC)
  - Parity (P)
  - Carry (CY)

FLAGS Cond…

- The state of flags indicate the result of arithmetic/ logic operation, which in turns used for decision making processes.
- Carry (CY):
  - Stores the carry or borrow from one byte to another.
  - It is set (CY=1), when the last arithmetic operation generates carry or borrow, otherwise reset (CY=0).
- Zero (Z):
  - Z=1, if the result of last operation of ALU is zero, otherwise, Z=0.
  - Often used in loop control and in searching for particular data value.

FLAGS Cond…

- Sign (S):
  - After the execution of an arithmetic/logic operation, if bit D7 (MSB) of the result (usually accumulator) is 1, the sign flag is set.
  - Used with signed numbers.
  - In a given byte, if D7 is 1, it is viewed as *negative*; if it is 0, it is viewed as *positive*.
  - This flag is irrelevant to the operation of unsigned numbers.
- Parity (P):
  - After arithmetic/logic operation, if the result has even number of 1's (even parity), the flag is set, otherwise reset.

9. TIMING & CONTROL UNIT

- Synchronizes all the operations with the clock.
- Generates the control signals necessary for communication between the microprocessor and peripherals.

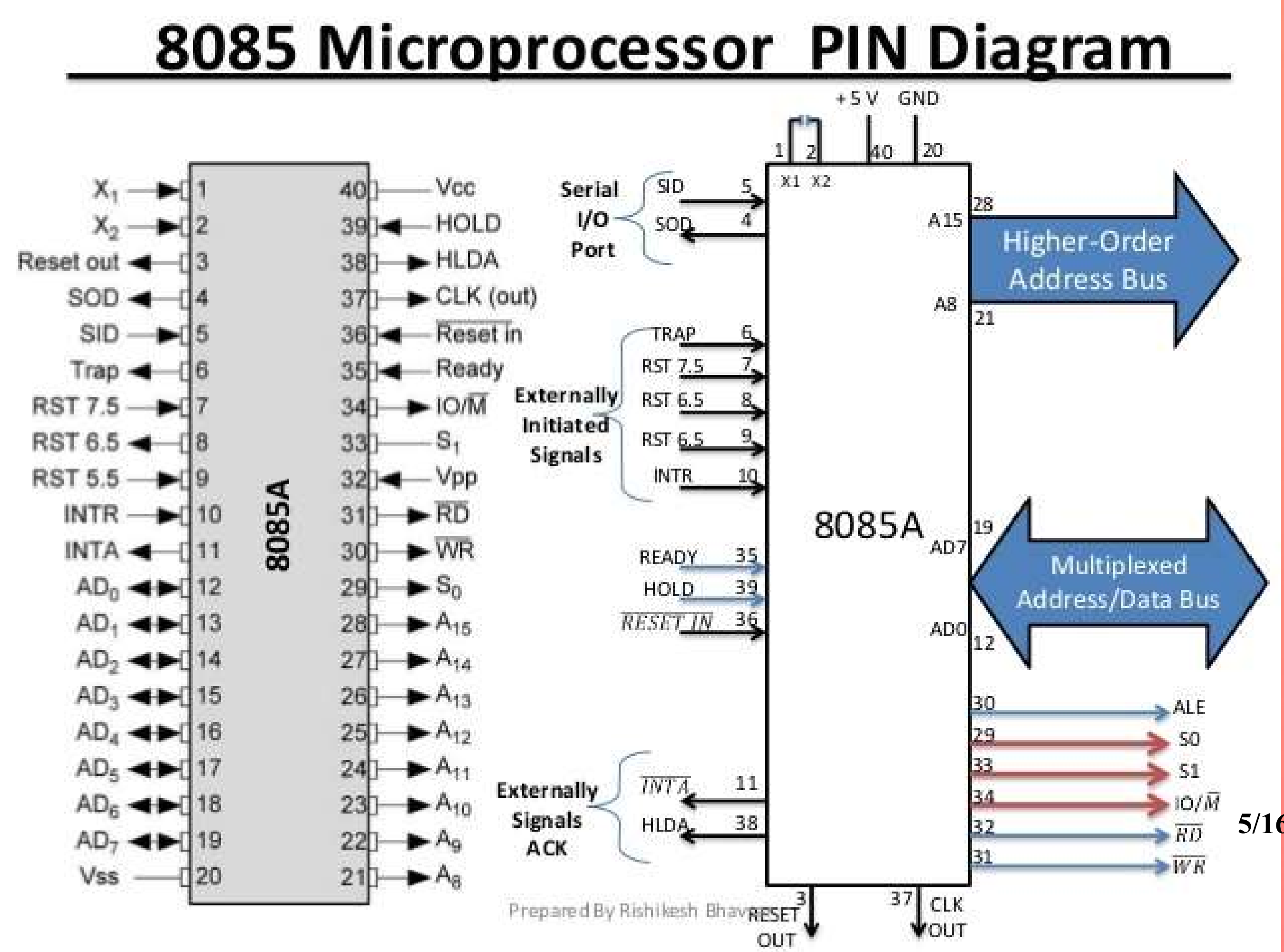
10. INTERRUPT CONTROL

- **Mainly 5 types of interrupt:**
  - **INTR**
  - **TRAP**
  - **RST5.5**
  - **RST6.5**
  - **RST7.5**

11. SERIAL I/O

- Two serial I/O control signals:
  - Serial In Data (SID) and
  - Serial Out Data (SOD)
- Used to implement the serial data communication.

8085 PIN DESCRIPTION


8085 Microprocessor PIN Diagram

The total pin can be categorized to six groups:

I. Address Bus

II. Multiplexed Address/Data Bus

III. Control and status signal

IV. Power supply and clock signal

V. Interrupt and externally initiated signals

VI. Serial I/O ports

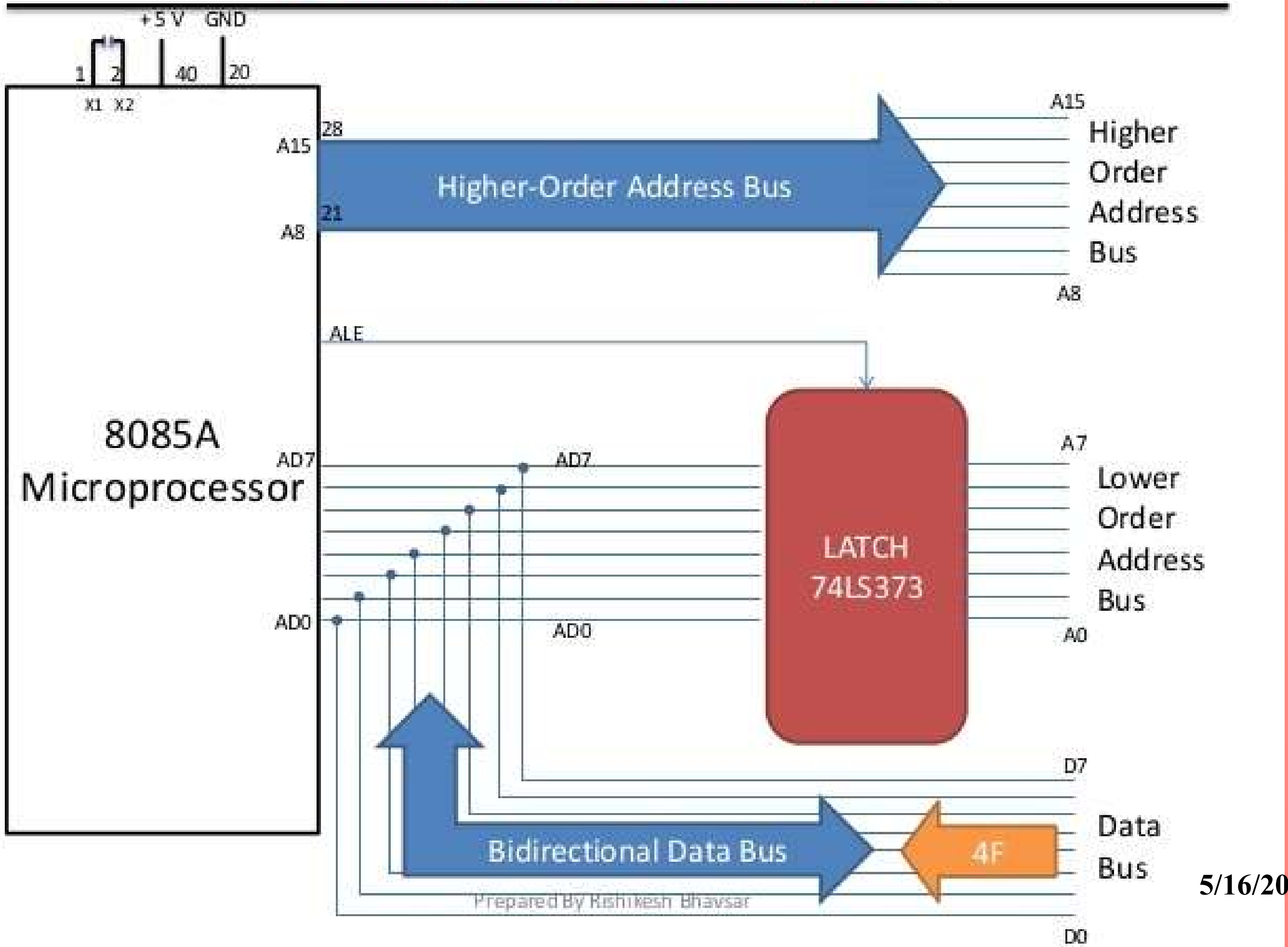
1. ADDRESS BUS

- 16 signal lines that are used as the address bus; however, these lines are split into two segments A_{15}-A_8 and AD_7-AD_0.
- A_{15}-A_8 are unidirectional and carries higher order address and the lower order AD_7-AD_0 are multiplexed and multiplexed.

2. MULTIPLEXED ADDRESS/DATA BUS

- 8-bit data bus.
- Multiplexed bidirectional AD_7-AD_0 .
- These multiplexed lines are de-multiplexed to work as address bus and data bus separately using Address Latch Enable (ALE).
- If ALE=1, AD_7-AD_0 acts as address bus, otherwise it acts as data bus. By default, it acts as data bus.

De-multiplexing the Bus AD_7 to AD_0



Prepared By Rishikesh Bhavsar

3. CONTROL AND STATUS SIGNAL

- This group of signals includes two control signals ($\overline{RD}$ and $\overline{WR}$).
- Three status signals (IO/$\overline{M}$, S_1, S_0) to identify the nature of the operation, one special signal (ALE) to indicate the beginning of operation.

4. POWER SUPPLY AND CLOCK SIGNAL

- VCC: +5V power supply.
- VSS: Ground reference.
- X_1, X_2: A crystal (or RC, LC network) is connected at these two pins. The frequency is initially divided by 2; there for to operate a system at 3 MHz, the crystal should have frequency of 6 MHz
- CLK-clock output: This signal can be as a system clock for other devices.

5. INTERRUPT AND EXTERNALLY INITIATED SIGNALS

- **The 8085 has 5 interrupt signals that can be used to interrupt a program execution.**

I. INTR (input)

II. **$\overline{\text{INTA}}$ (output)**

III. RST 7.5, 6.5, 5.5 (inputs)

IV. TRAP (input)

V. HOLD (input)

VI. HLDA (output)

VII. READY (Input)

VIII. $\overline{\text{RESETIN}}$

IX. RESET OUT

6. SERIAL I/O PORTS

- two signals to implement the serial transmission: SID (Serial Input Data) and SOD (Serial Output Data).
- In serial transmission, data bits are sent over a single line, one bit at a time, such as the transmission over telephone lines.