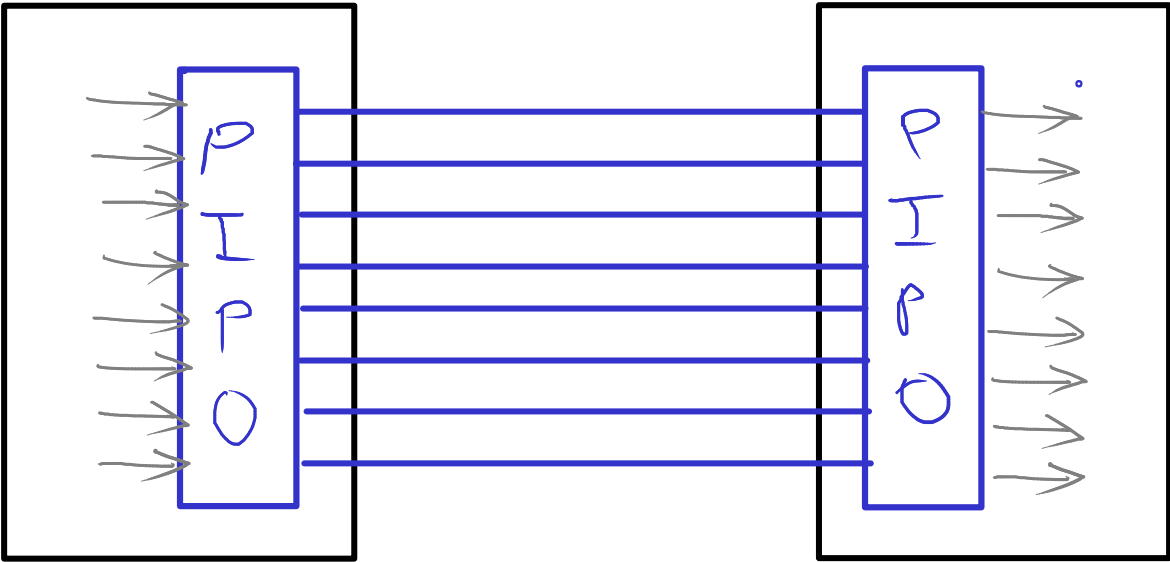
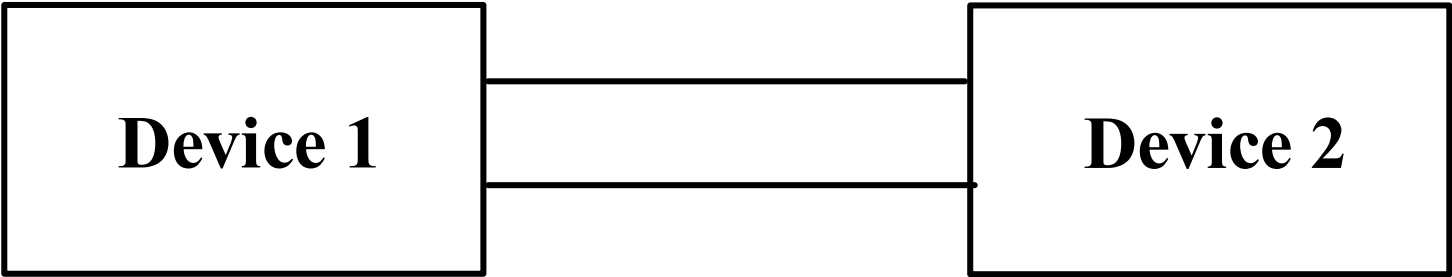


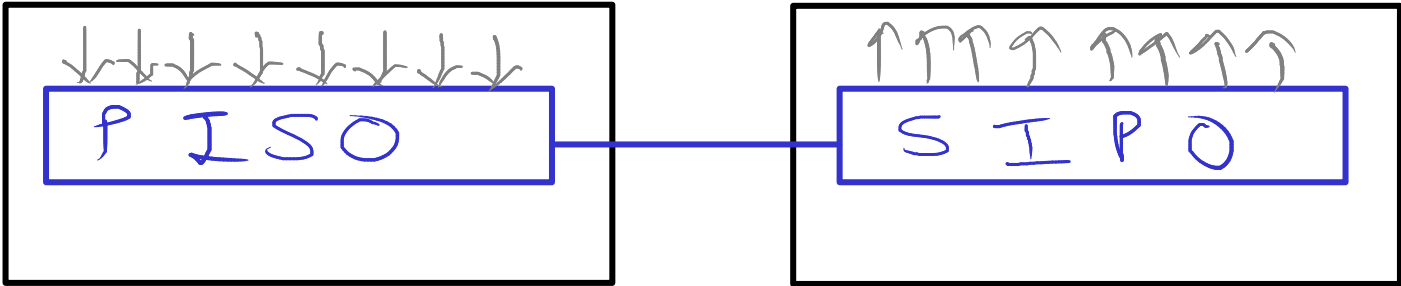
**Communication**



Sender

Receiver

**Parallel**



Sender

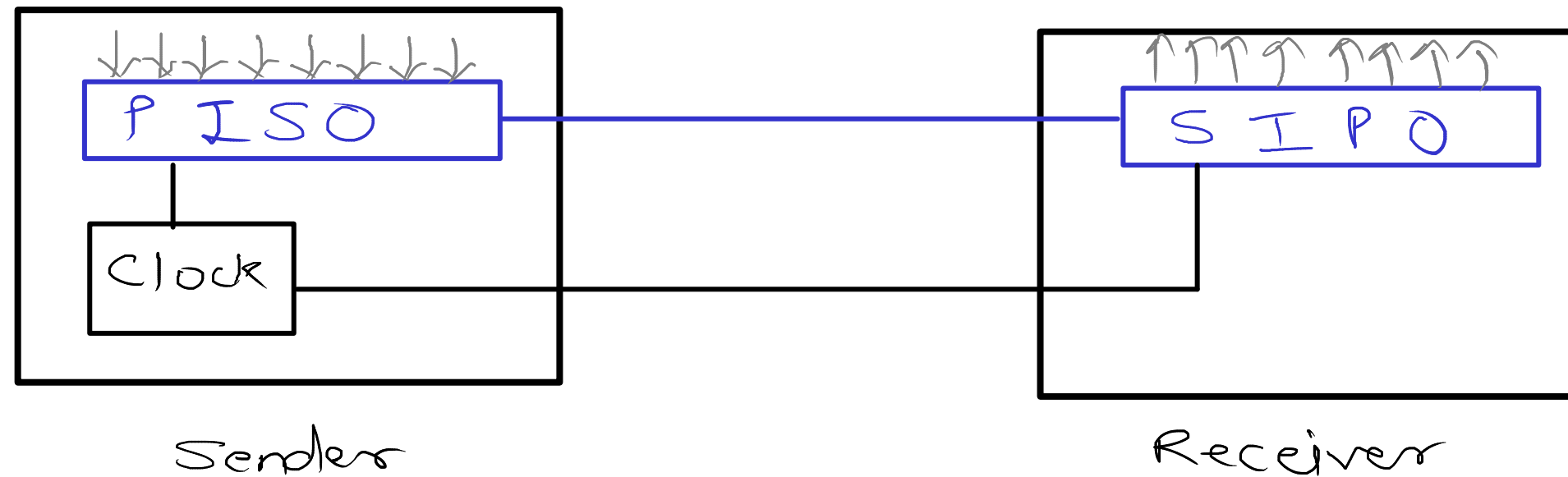
Receiver

**Serial**

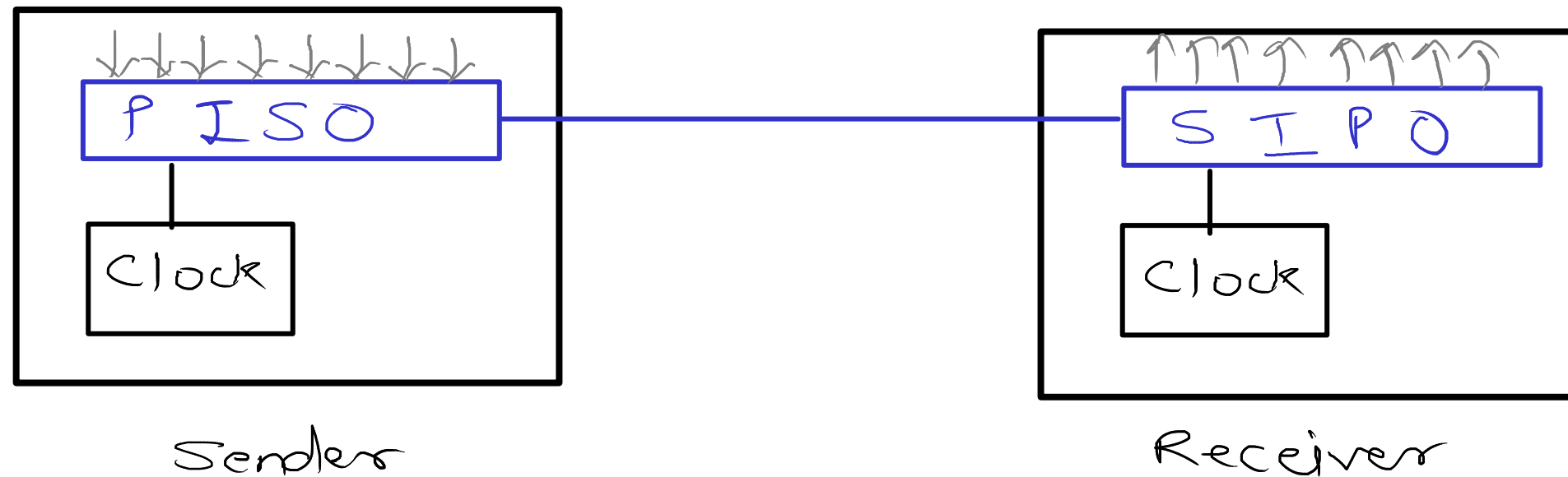
- UART
- I2C
- SPI
- CAN
- USB
- JTAG
- PS2

# Serial Communication

## Synchronous



## Asynchronous



UART

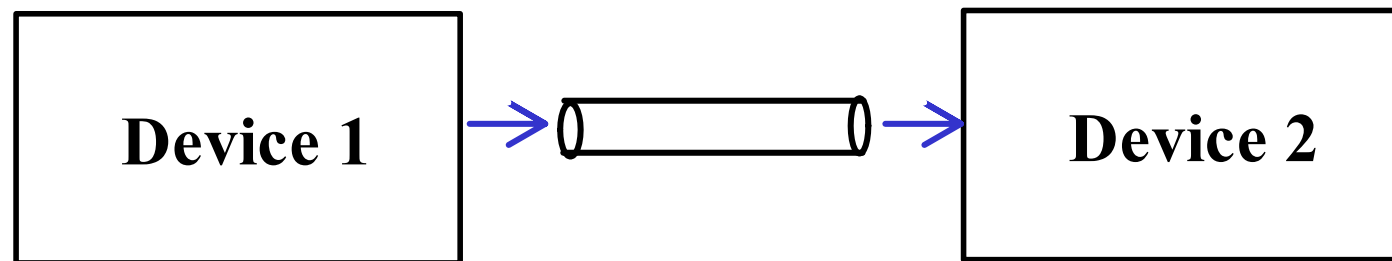
- Universal Asynchronous Receiver Transmitter

USART

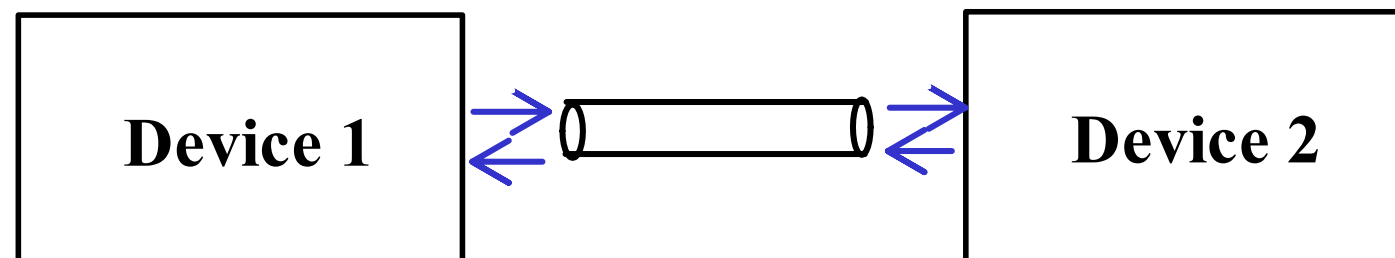
- Universal Synchronous Asynchronous Receiver Transmitter

# Serial Communication Protocols

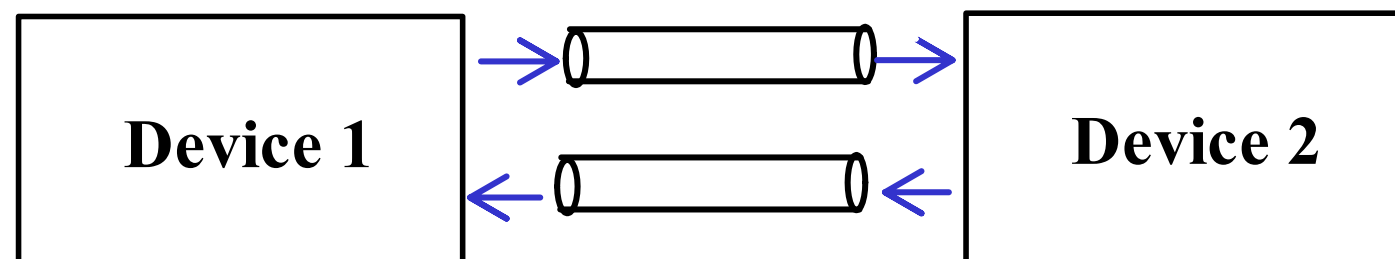
**Simplex**



**Half Duplex**



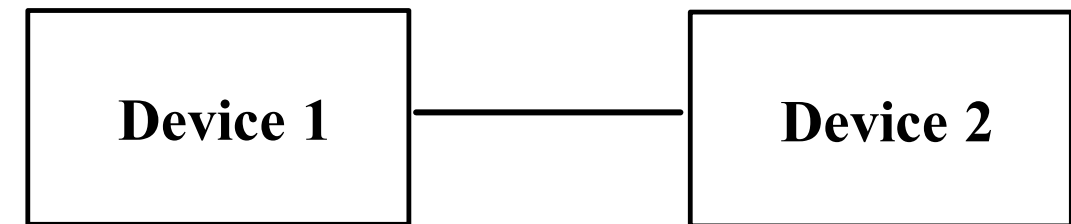
**Full Duplex**



# Topologies

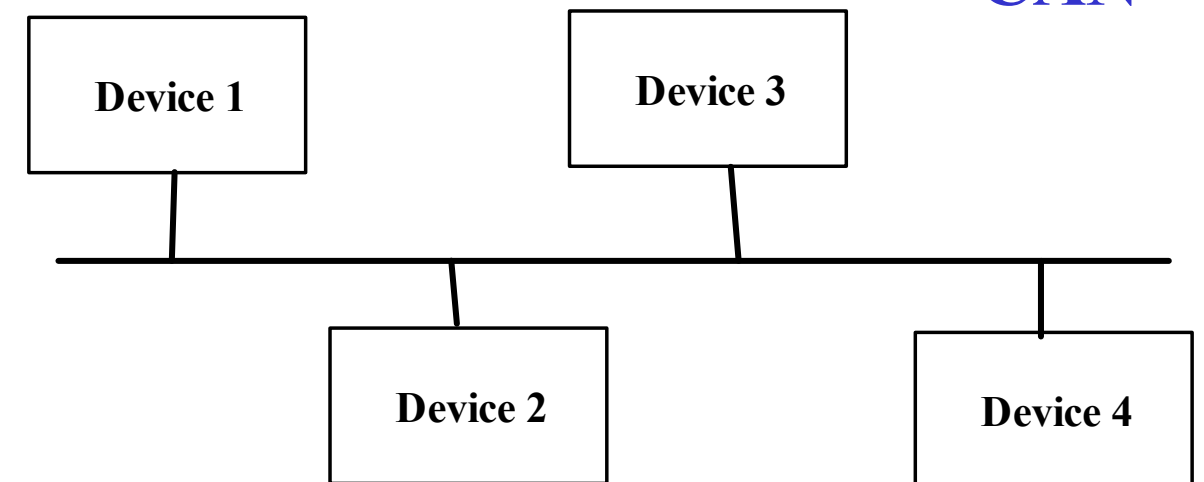
**End to End**  
**Peer to Peer**  
**Ad-Hoc**

**UART**



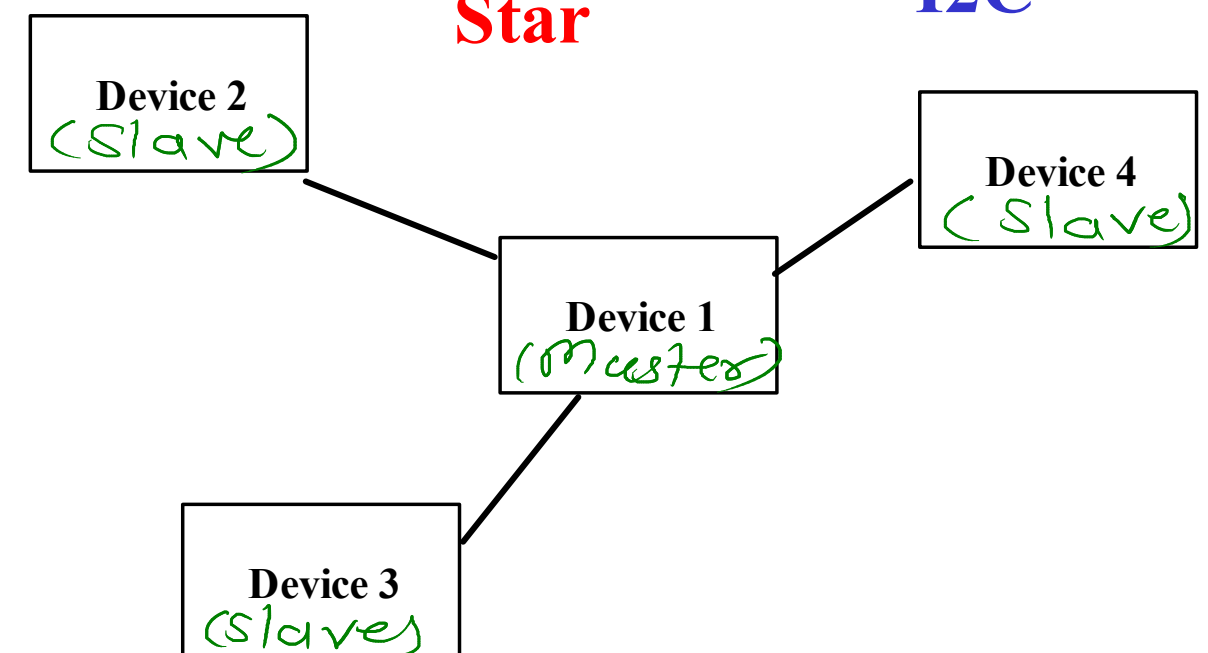
**Bus**

**CAN**



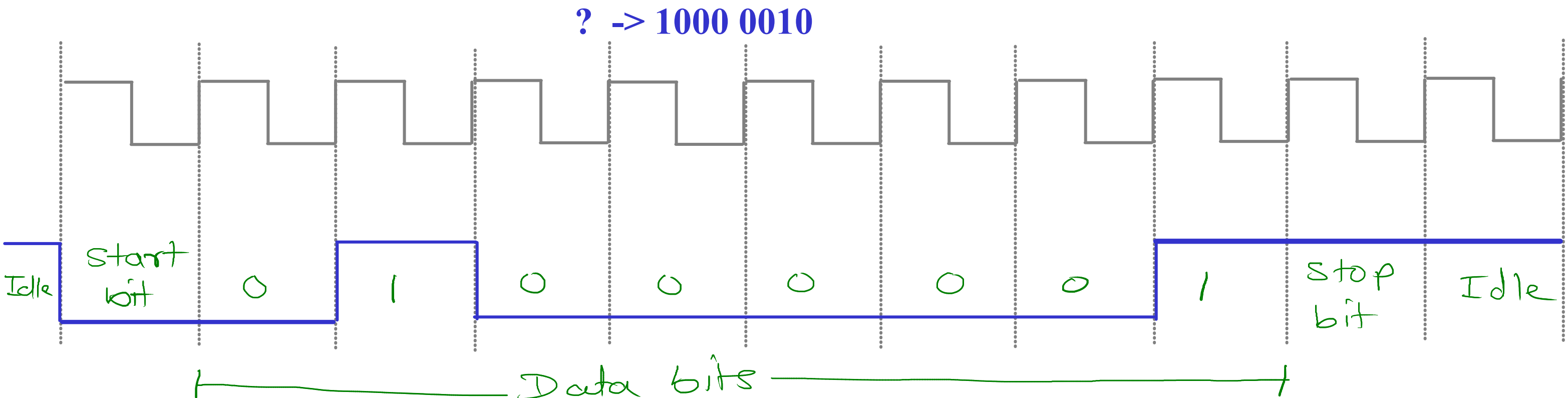
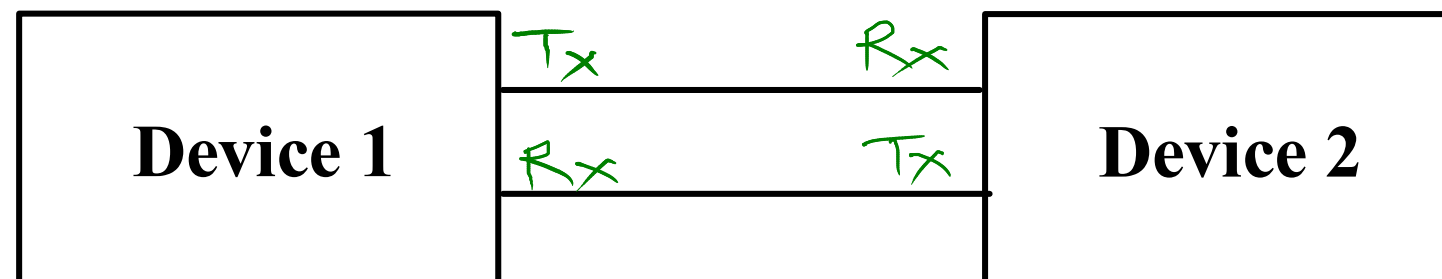
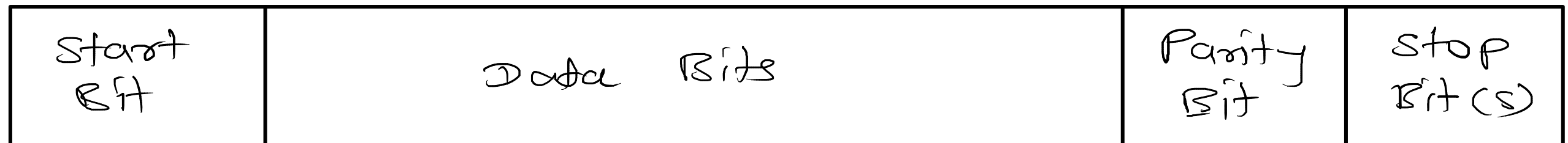
**Star**

**I2C**

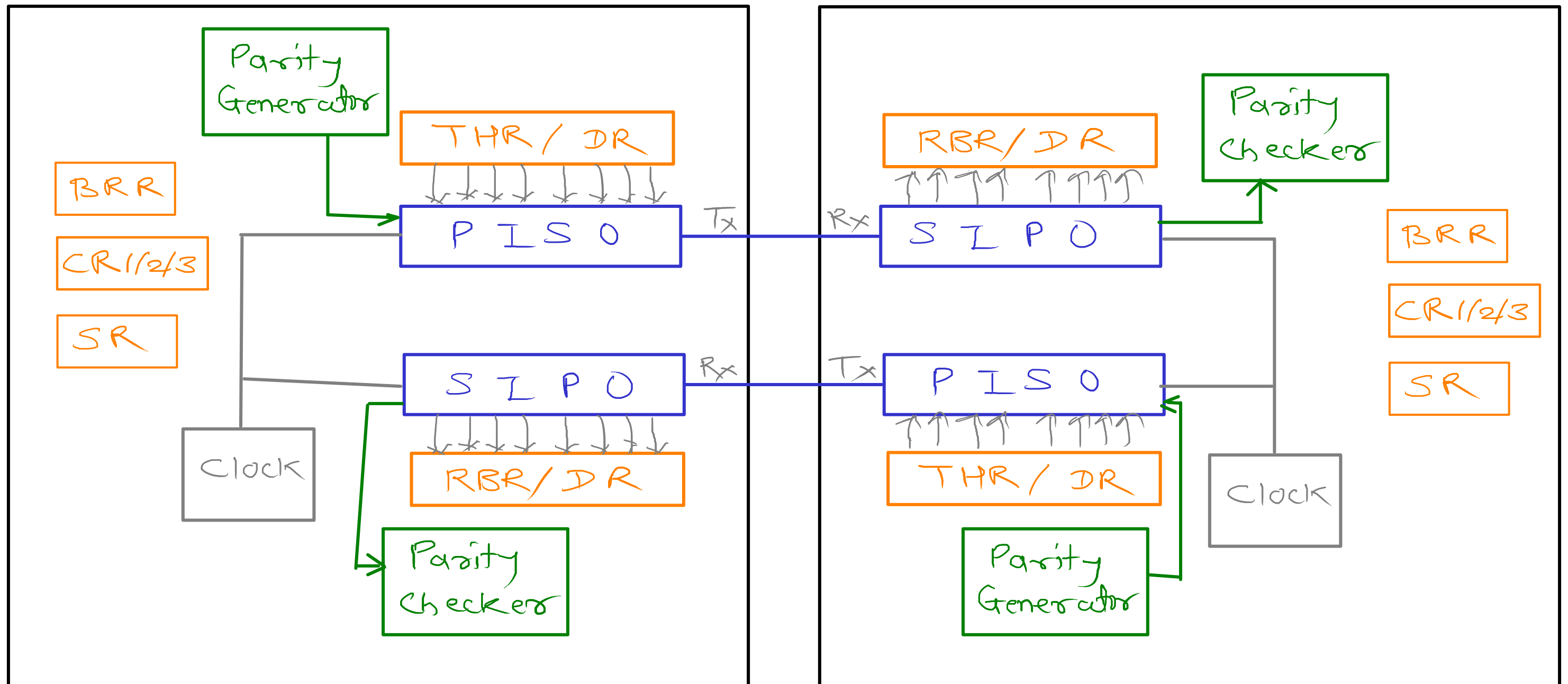


## Data Frame

- data is packed in some format
  - start (single bit -> always - 0 (low))
  - data (Variable) -> (8 bits)
  - parity (single bit -> Even/Odd/1/0/None)
  - stop (one or two bits -> always - 1 (high))

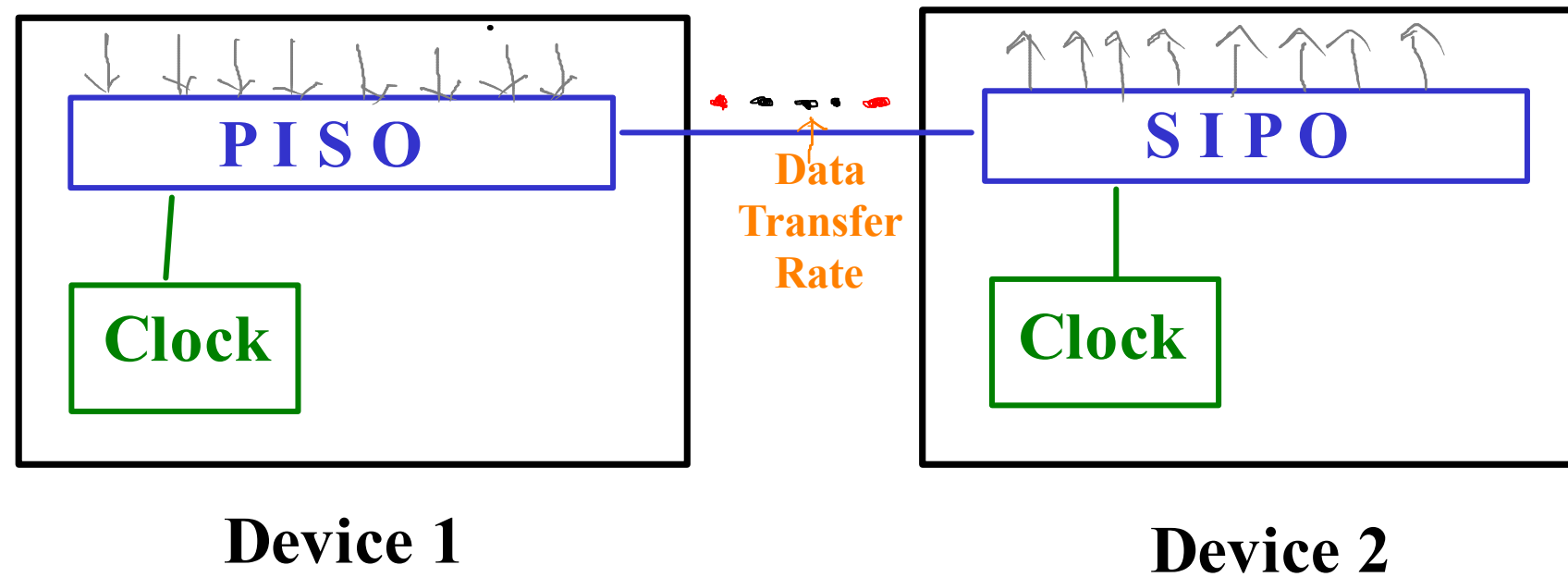


# Serial Communication Protocol



## Data Transfer Rate/ Bits per Second (bps) /Baud rate

- it decides the speed of transmission
- standard baud rate - ..., 9600, 38400, 115200, ...



## UART Registers

### SR

**Bit 7 : TXE**

**0: Data is not transferred to the shift register**

**1: Data is transferred to the shift register)**

**Bit 5 : RXNE**

**0: Data is not received**

**1: Received data is ready to be read.**

**Bit 6 : TC**

**0: Transmission is not complete**

**1: Transmission is complete**

### DR

**Bit [8:0] - data**

### BRR

**Bit [15:4] - DIV\_Mantissa**

**Bit [3:0] - DIV\_Fraction**

## UART Registers

### CR1

**Bit 15 : OVER8**

**0: oversampling by 16**

**1: oversampling by 8**

**Bit 13 : UE**

**0: USART prescaler and outputs disabled**

**1: USART enabled**

**Bit 12 : M (Word length)**

**0: 1 Start bit, 8 Data bits, n Stop bit**

**1: 1 Start bit, 9 Data bits, n Stop bit**

**Bit 3 : TE Transmitter enable**

**0: Transmitter is disabled**

**1: Transmitter is enabled**

**Bit 2 : RE Receiver enable**

**0: Receiver is disabled**

**1: Receiver is enabled and begins searching for a start bit**

### CR2

**Bits 13:12 STOP: STOP bits**

**00: 1 Stop bit**

**01: 0.5 Stop bit**

**10: 2 Stop bits**

**11: 1.5 Stop bit**

**Bit 11 : CLKEN**

**0: CK pin disabled**

**1: CK pin enabled**