Data Communication in Control Systems

ICT 41205 Digital Control Systems

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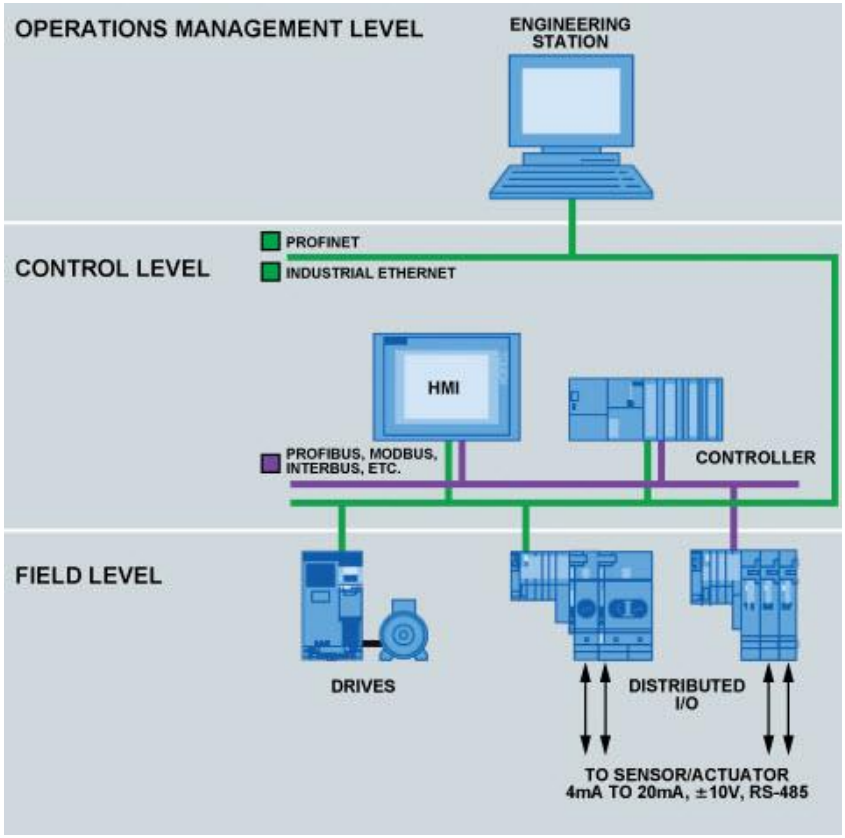
Data Communication in Control Systems

- Data communication refers to the transformation of information or data, mostly in digital format from a transmitter to a receiver through a link connecting these two.
- Control systems need data communication to communicate:
  - Between controllers and plants (controlled devices)
  - Between controllers and sensors
  - Between controllers and other related controllers
  - Between controllers and systems managers/monitors

Hierarchical Levels of Communication

- **Device Level:** This lowest level consists of field devices such as sensors and actuators of processes and machines.
- **Control Level:** This level consists of controllers, distributed control units, and computer systems. The tasks of this level include configuring automation devices, loading of program data and process variables data, supervising control, historical archiving, etc.
- **Information Level:** This is the top level of the industrial automation system which gathers the information from its lower level i.e., control level.

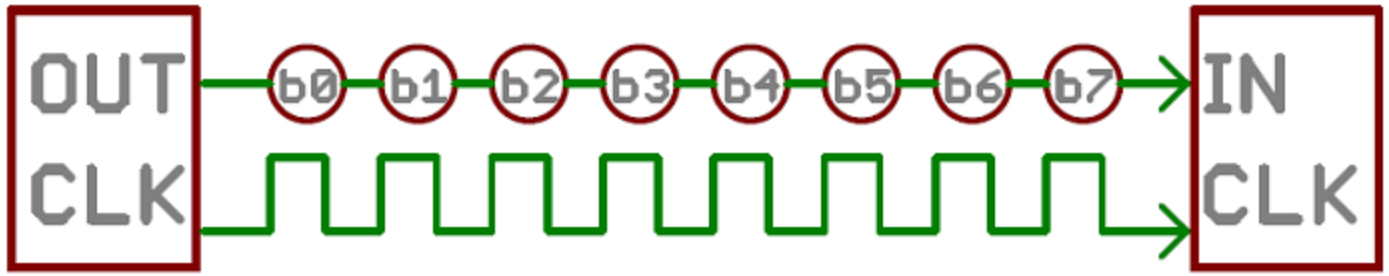


Basic Communication Methods

- It is essential to understand some of the basic communication methods that can be used to interconnect control systems.
- Two of the primary categories are:
  - Serial
  - Parallel

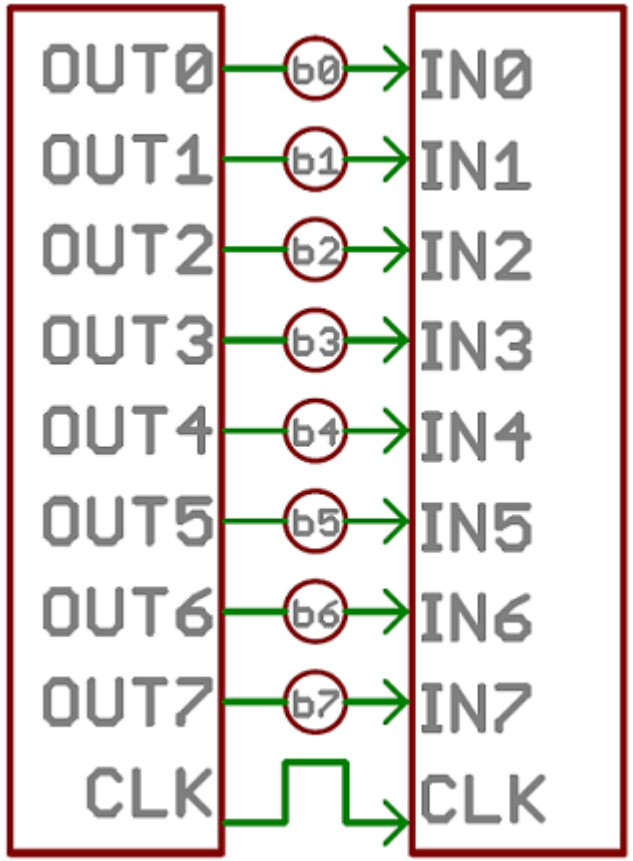
Serial Communication

- Serial communication is the process of sending/receiving data in one bit at a time.
- Serial interfaces stream their data, one single bit at a time.
- These interfaces can operate on as little as one wire, usually never more than four.



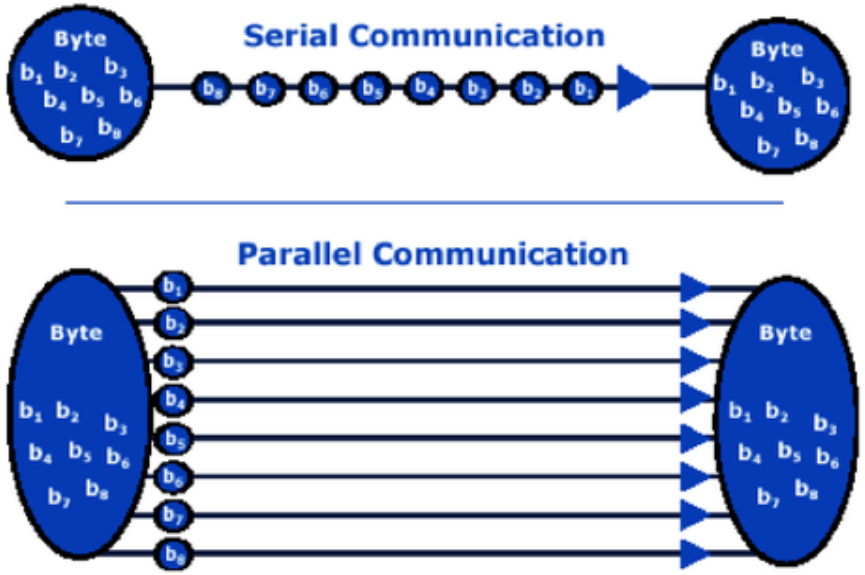
Parallel Communication

- Parallel interfaces transfer multiple bits at the same time.
- They usually require **buses** of data - transmitting across eight, sixteen, or more wires.
- It's fast, straightforward, and relatively easy to implement.
- But it requires many more input/output (I/O) lines.



Serial vs Parallel Communication

Serial Communication	Parallel Communication
1. One data bit is transceived at a time	1. Multiple data bits are transceived at a time
2. Slower	2. Faster
3. Less number of cables required to transmit data	3. Higher number of cables required



Advantages of Serial over Parallel

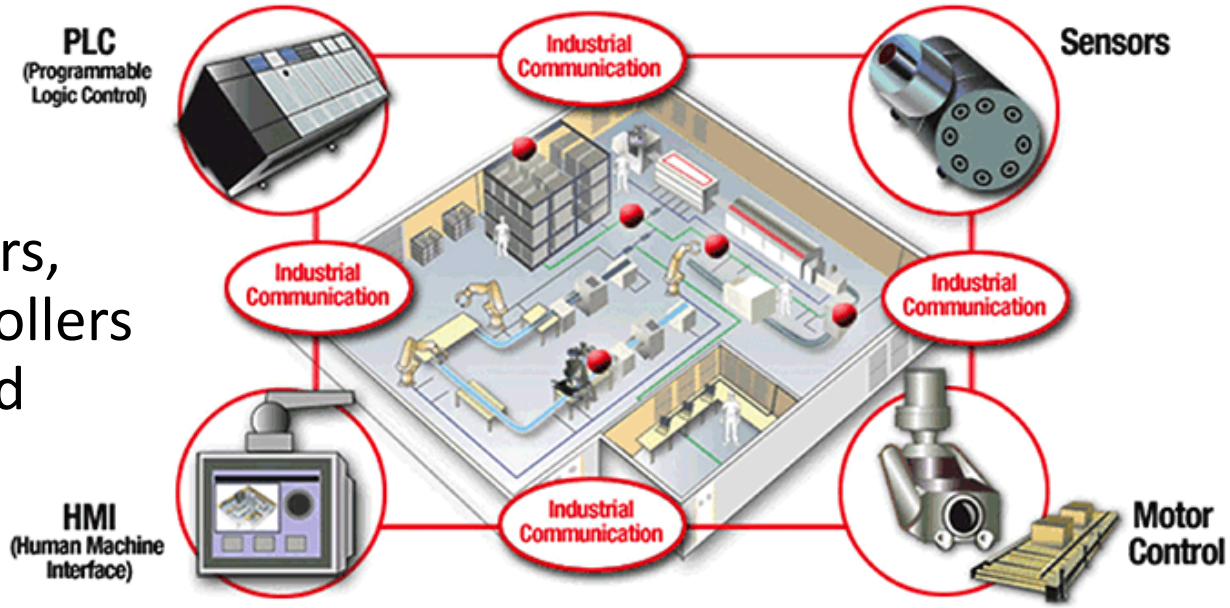
- A serial connection requires fewer interconnecting cables (e.g. wires/fibers) and hence occupies less space.
  - The extra space allows for better isolation of the channel from its surroundings.
  - Crosstalk is not a much significant issue, because there are fewer conductors in proximity.
- In many cases, serial is a better option because it is cheaper to implement.
  - Many devices and sensors relevant to control systems have serial interfaces, as opposed to parallel ones, so that they have fewer pins and are therefore less expensive.

Serial Communication Protocols

- There are various protocols that can be used with digital control systems for serial communication.
  - UART (Universal Asynchronous Receiver/Transmitter)
  - SPI (Serial Peripheral Interface)
  - I2C (Inter-Integrated Circuits)
  - CAN (Controller Area Network)
  - USB (Universal Serial Bus)
  - 1-wire
- https://www.deviceplus.com/how-tos/arduino-guide/arduino-communication-protocols-tutorial/
- https://www.embedded.com/design/connectivity/4023975/Serial-Protocols-Compared

Industrial Communication Networks

- Industrial control broadly defines the wide range of electronic equipment used in factories, process control plants, and automated facilities for monitoring and controlling manufacturing and other operations.
- It involves machines like robots, computers, machine tools, programmable logic controllers (PLCs), sensors, relays, valves, motors, and measuring instruments.



Industrial Communication Networks

- There exist many different communication networks designed to interconnect digital control systems to field devices and I/O modules.
- Some common and popular industrial communication standards are:
  - Serial Communication standards such as RS232, RS422 and RS485
  - Highway Addressable Remote Transducer (HART)
  - DeviceNet
  - ControlNet
  - Profibus
  - Foundation Field Bus
- https://www.youtube.com/watch?v=MNmzbMEzkdk