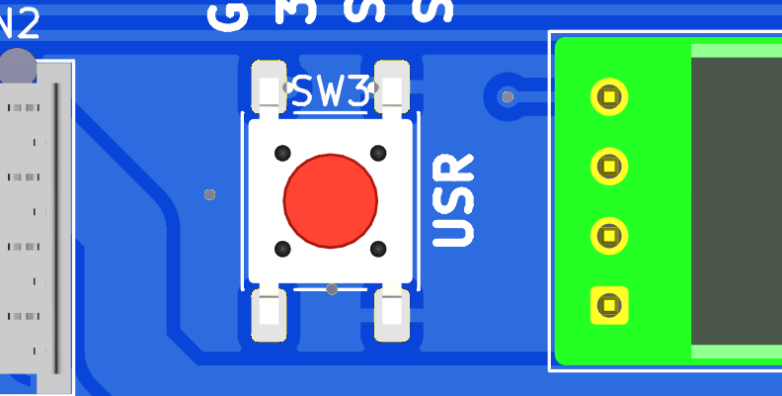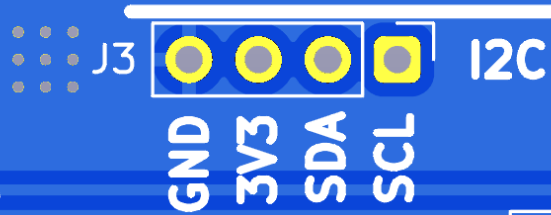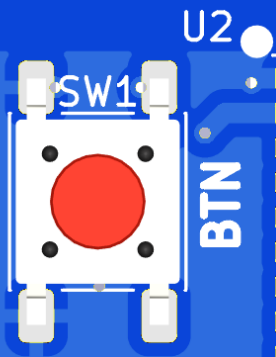# Introduction to Communication Protocols

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Learning Objectives

1 Overview of communication protocols

3 Basic concepts: data transmission, baud rate, protocols

2 Communication protocols in robotics and industrial equipment
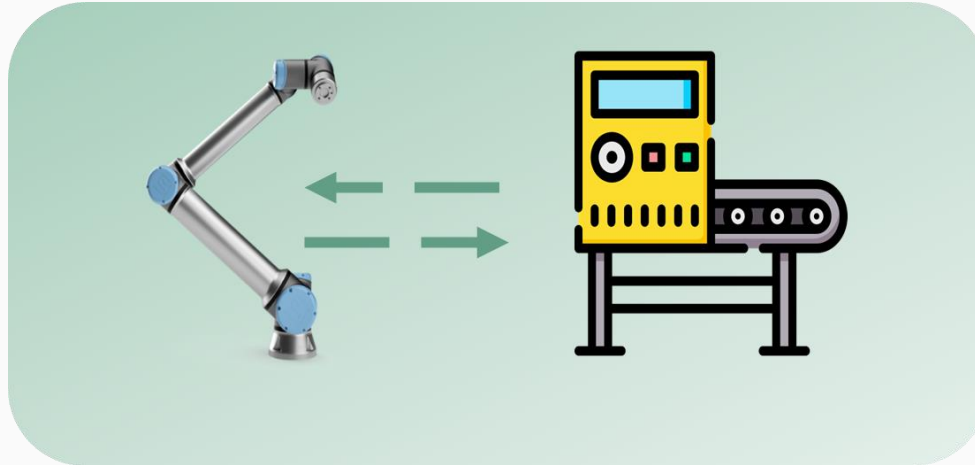
4 Types of communication protocols

Overview of Communication Protocols

A communication protocol is a system of rules.

- It allows two or more entities of a communications system to transmit information.
- Transmission occurs via any variation of a physical quantity.

Why Are Communication Protocols Important?

Ensures data consistency and synchronization.

- Communication protocols ensure that data is sent, received, and interpreted consistently across devices.
- They synchronize the timing and format of data exchange, making sure that devices remain in step with one another.

Facilitates communication between heterogeneous systems.

- Promotes interoperability, enabling integration of diverse devices and systems.

Reduces errors in data exchange.

- Increases communication reliability, ensuring that data integrity is maintained even in challenging conditions. Together, these benefits make communication protocols indispensable for efficient and reliable operation in robotics and industrial automation.

Overview of Communication Protocols

Rules
- Rules ensure all parties involved in the communication understand each other.

Syntax
- Syntax refers to the structure or format of data being transmitted.

Semantics
- Semantics deals with the meaning of each part of the communication.

## Synchronization of communication
- Synchronization ensures that sender and receiver are in synced.

Possible Error Recovery Methods
- Error Detection, Error Correction, Timeout Mechanisms

Types of communication protocols

- **Serial communication** transmits one bit at a time using a single (logical) data line.

- Serial communication is used for all **long-haul** communication and most computer networks, where the cost of cable and synchronization difficulties make parallel communication impractical.

Parallel/Serial Converters
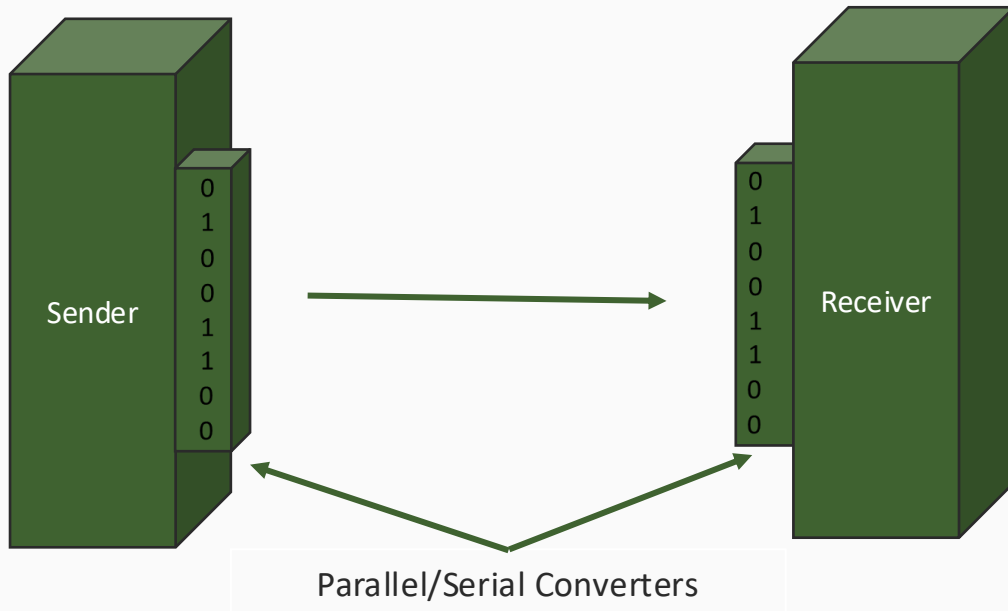
Types of communication protocols

- **Parallel transmission** can shift multiple bits simultaneously, increasing data transfer volume.
- Parallel communication methods utilize **more I/O lines** of the devices involved.
- More I/O lines can be a **problem** for some applications.
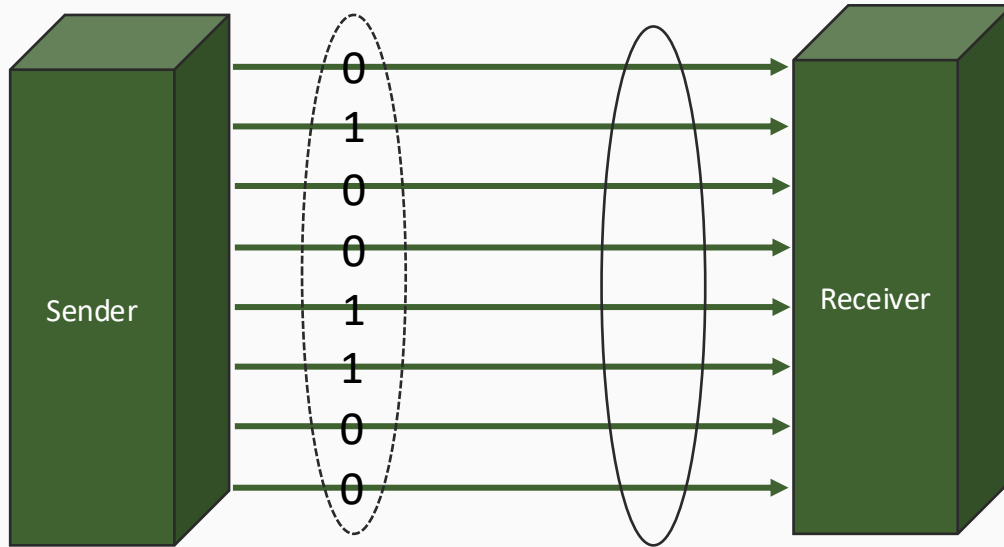
Serial Vs Parallel Communication

	Serial	Parallel
Speed	Slower for short distances	Faster as multiple bits are sent at once
Complexity	Simple for long distances	Simple for short distances
Cost	Cheaper for long distances	More expensive for long connections
Reliability	Reliable over long distances	Signal degradation over long distances
Interference	Less prone to crosstalk	More prone to crosstalk in longer connections
Synchronization	Complex at very high speeds	Easier to synchronize at short distances
Scalability	High-speed scalability can be challenging	Scalable for short distances
Wiring	Requires fewer wires	Requires more wires
Bandwidth	Limited Bandwidth	High bandwidth potential

Serial and Parallel Examples

Serial Communication

- **CAN (Controller Area Network)**
  - E.g Communication Between Actuator & Controllers
- **Modbus**
  - E.g. I/O Modules (Electrovalve Control)

Parallel Communication

- **Parallel ATA**
  - Connecting hard drives and optical drives in older computers.
- **Connecting hard drives and optical drives in older computers.**
  - High-speed parallel interface for connecting graphics cards, network adapters, and other expansion cards to motherboards.

Why Serial Communication is widely used in Industrial Applications

1. **Long-Distance Communication:**
   - Serial communication can transmit data reliably over long distances without significant signal degradation.
   - It requires fewer wires and minimizes crosstalk and electromagnetic interference (EMI), which are common in industrial setups with heavy machinery.

2. **Cost-Effectiveness:**
   - Serial communication reduces wiring complexity and costs.
   - It only needs a few wires (e.g., 2 or 4 wires for RS-485) compared to parallel communication, which requires multiple wires for each data bit.

3. **Multi-Device Communication:**
   - Serial communication supports multiple devices on the same network. Protocols like RS-485 allow up to 32 devices (or more with repeaters) to communicate over a single bus.

4. **Standardization and Interoperability:**
   - Standardized protocols ensure interoperability between devices from different manufacturers.
   - Widely adopted industrial protocols like Modbus-RTU, CAN, and Profibus are based on serial communication, allowing seamless integration.
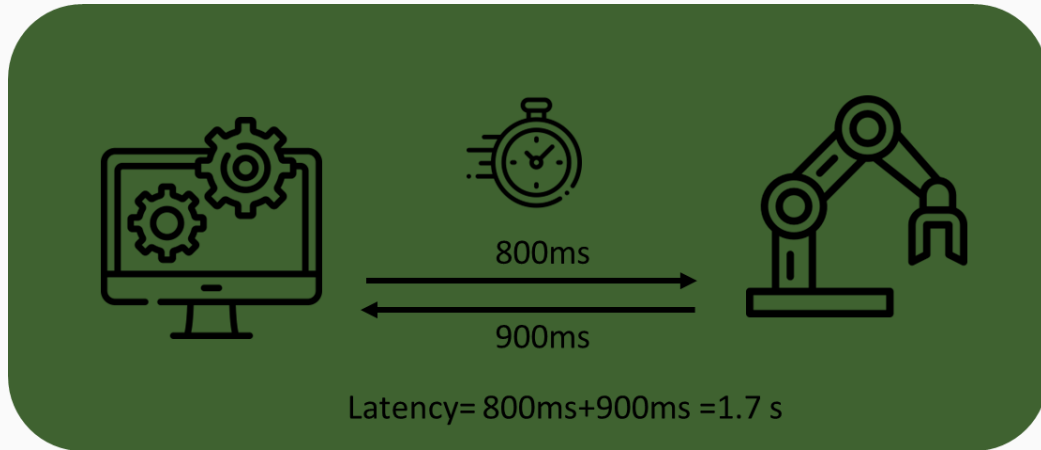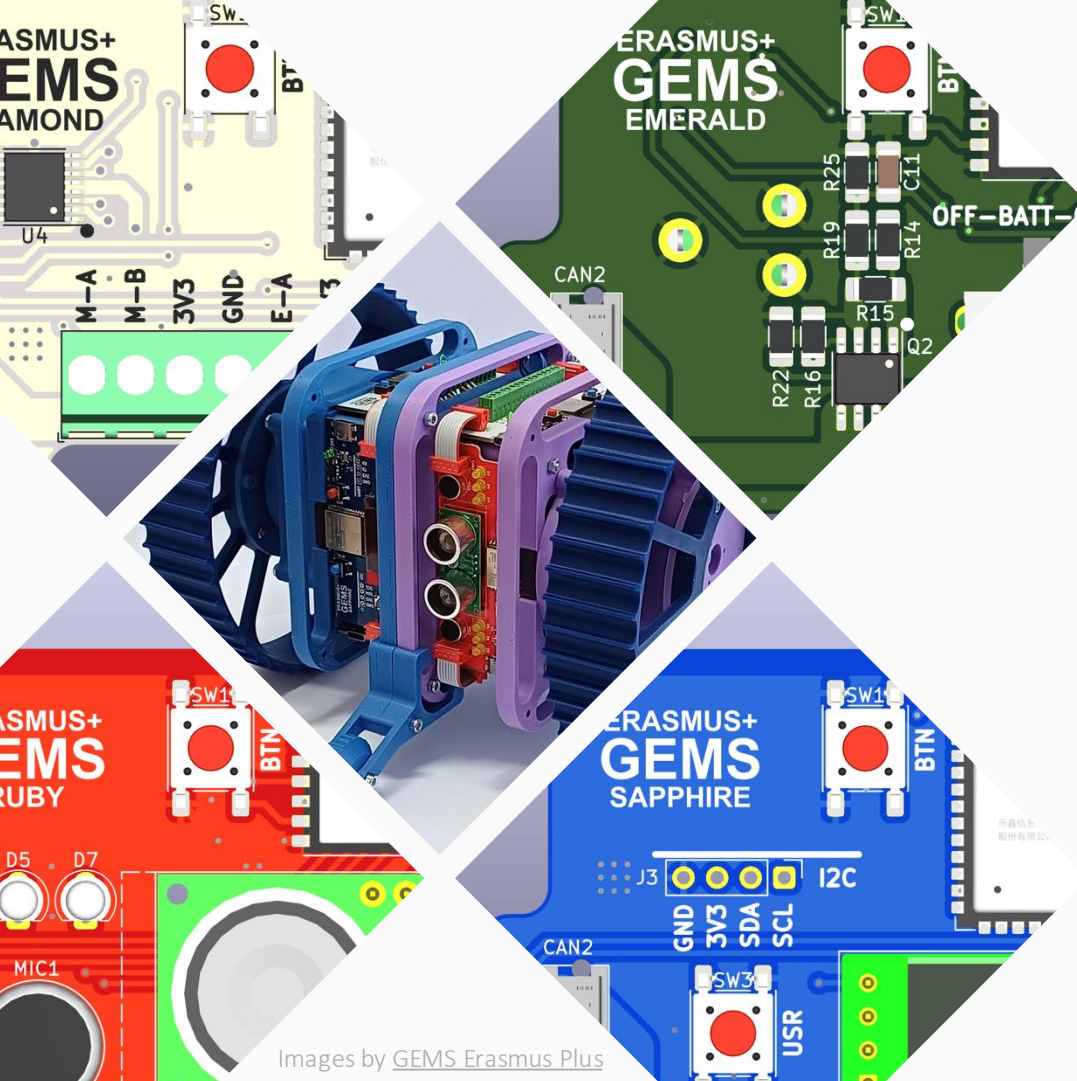
Data Transmission-Baud Rate

- Baud rate is a unit of measurement for the **speed** of **data transmission** in a communication channel.
- It measures the number of times a **signal changes** its state per second in a communication channel.
- Signal changes can be in the form of **voltage levels** or **pulses**.
- **Baud rate** is usually expressed in signal changes per second.

Baud Rate
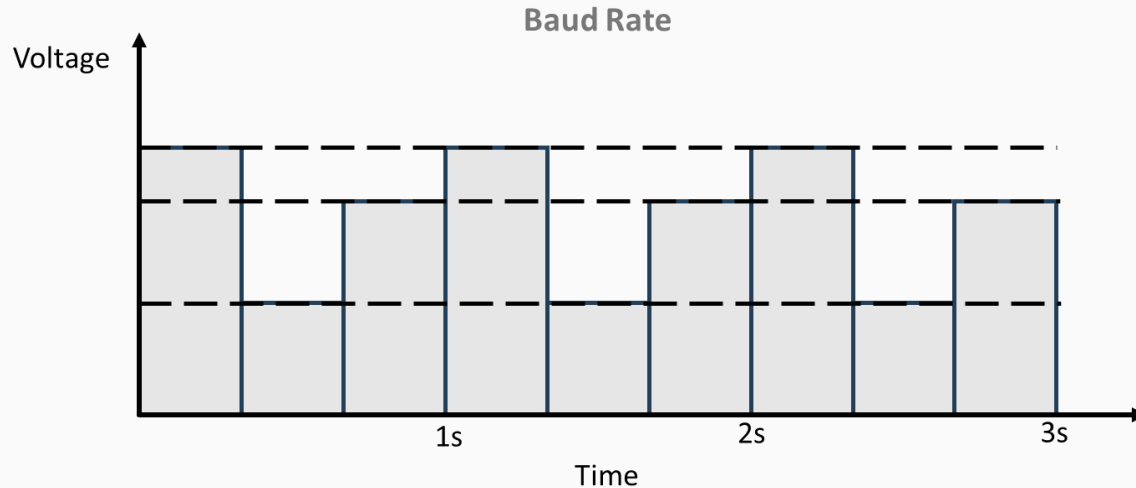
Data Transmission-Latency

Latency refers to the delay that happens between when a user takes an action on a network or web application and when they get a response.

Thank you for watching!

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