Communications

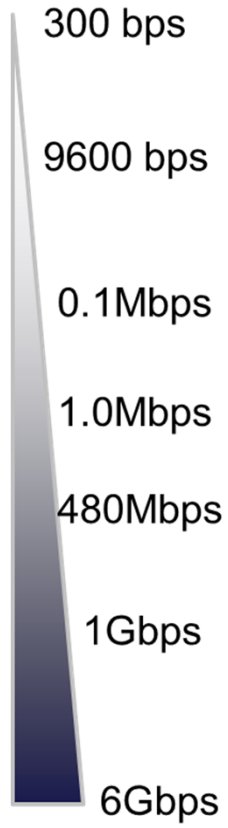
Overview of Serial Communication

- Transmission of data by bits
  - Data is transferred as a series of high/low digital signals
  - Clock signal/preset timing used to control data transmission
  - Popularly used as DB-9 device (e.g. modems, mouse), RS-232 (aka COM Port)
    - 9600 Baud (bits per second) rate (but ranges from 75 to 115200)
    - Typically set as 8N1 (8-bit, no parity, 1 stop bit)
  - Legacy equipment use USB-to-Serial adapter (with PC's virtual COM port)

- Serial vs. Parallel
  - Sending one bit vs. multiple bits at a time
  - Advantages? Disadvantages?

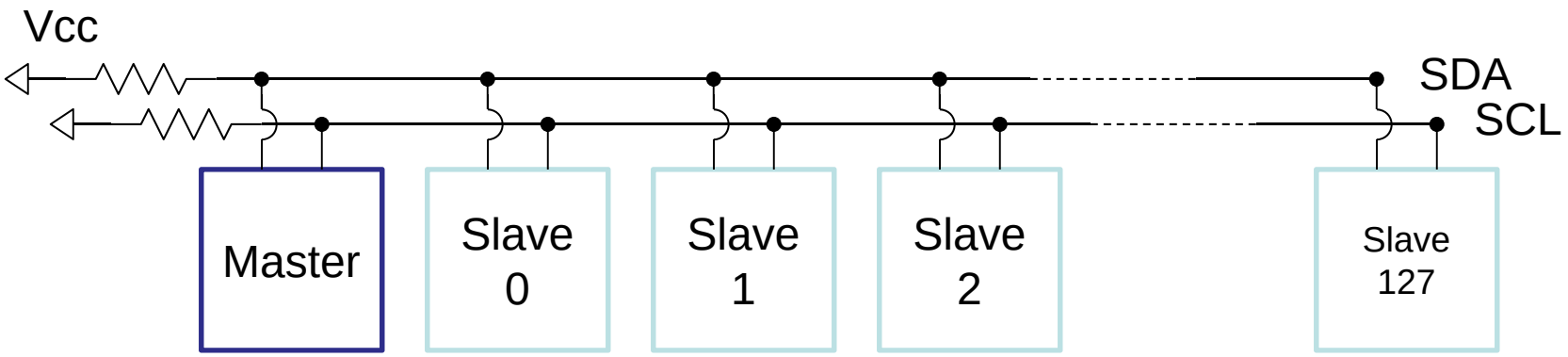
Common Protocols

- I2C (*Inter-Integrated Circuit*) ~100 Kbits/sec
  - **Low-speed, half-duplex** data transfer between ICs
- SPI (*Serial Peripheral Interface*)
  - **Low-speed, full-duplex** data transfer between ICs
- TTL (*Transistor-Transistor Logic*)
  - **Low-speed, full duplex** data transfer between ICs and microcontrollers
- RS-232 (*Recommended Standard 232*)
  - **Low-speed, full duplex** data transfer between PCs and peripherals
- RS-485 (*Recommended Standard 485*) ~35 Mbits/sec (Networks, lower voltage)
  - **High-speed , half-duplex** data transfer between PCs and peripherals
- USB (*Universal Serial Bus*)
  - **High-speed, half-duplex** data transfer between PCs and peripherals
- Ethernet
  - **High-speed, full-duplex** data transfer between PCs
- SATA (*Serial Advanced Technology Attachment*)
  - **High-speed, full-duplex** data transfer between mass-storage devices



Overview of I2C Communication

- Serial ports are asynchronous
  - Con: No clock data is transmitted; devices must agree to clock rate a priori
  - Con: Only 2 devices (thus can't be networked easily)
- I2C low-speed serial communication protocol
  - Pro: Master-slave configuration (single master, single slave; single master, multiple slaves; and multiple masters, multiple slaves)
  - Pro: 2-wire interface
    - Data (SDA) – (SDAta line) data bits transferred
    - Clock (SCL) – (SCLock line) pulses which signify data availability
  - 7-bit address of slaves means $2^7 - 1 = 128$ slave devices (0 to 127)



NXT I2C Communication

- Maximum 4 I2C buses (S1 – S4 on NXT Brick)
  - NXT connects as the master
    - Use `SetSensorLowspeed` command to declare port as an I2C bus
    - Use of `I2CBytes` command to communicate with slave peripherals
  - Serial sensors connect as slaves
    - Sensors return information when prompted by the NXT master device
  - PCF9574 is an I2C-based I/O expander
    - This chip has a 3-bit address (hence 8 unique addresses)
    - Has 8-bit digital port (bi-directional = either input or output lines)
    - Thus can ultimately control/read eight 8-bit devices with a single chip

Overview of RS-485 Serial Communication

- High-speed serial communication protocol
  - Long-distance communication between two devices
    - Supports data transfer rates over 1Mbps thru thousands of feet of cable
  - 2-wire interface
    - Data+ (B) – non-inverting data pin
      - Reference voltage
    - Data– (A) – inverting data pin
      - Voltage changes sign to indicate high or low bit
- **NXT:** One RS-485 port (S4)
  - Can be used for NXT-to-NXT communication or communication to high-speed devices
    - Use `UseRS485` to set port S4 as an RS-485 port
    - Use `RS485Enable` to activate the port
    - Use `RS485Uart` to initialize port to default values (communication is asynchronous receive/transmit)