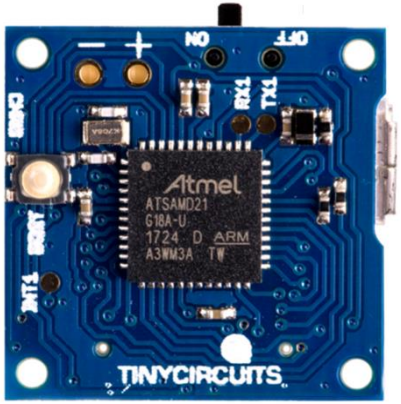
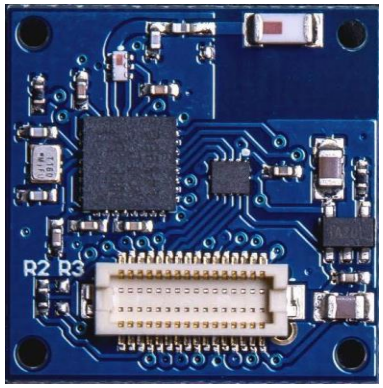
CSE190 Winter 2025



Lecture 9

Serial Busses

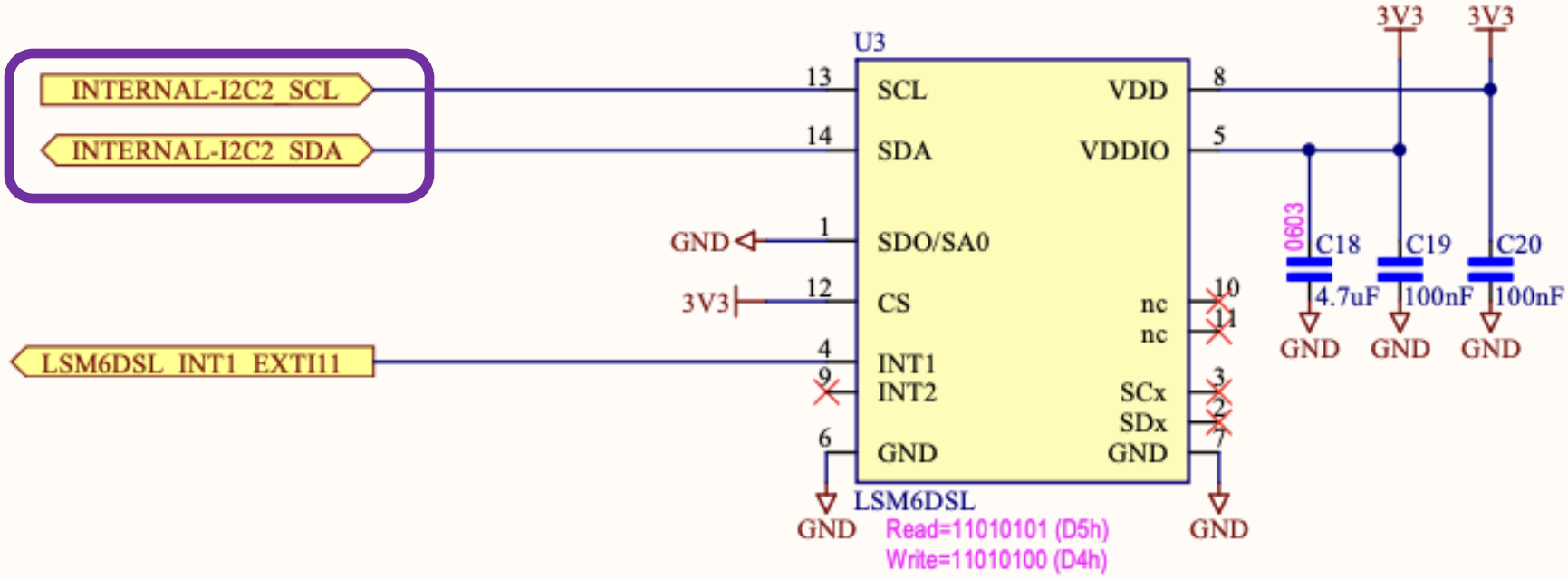


Wireless Embedded Systems

Aaron Schulman

Serial Busses

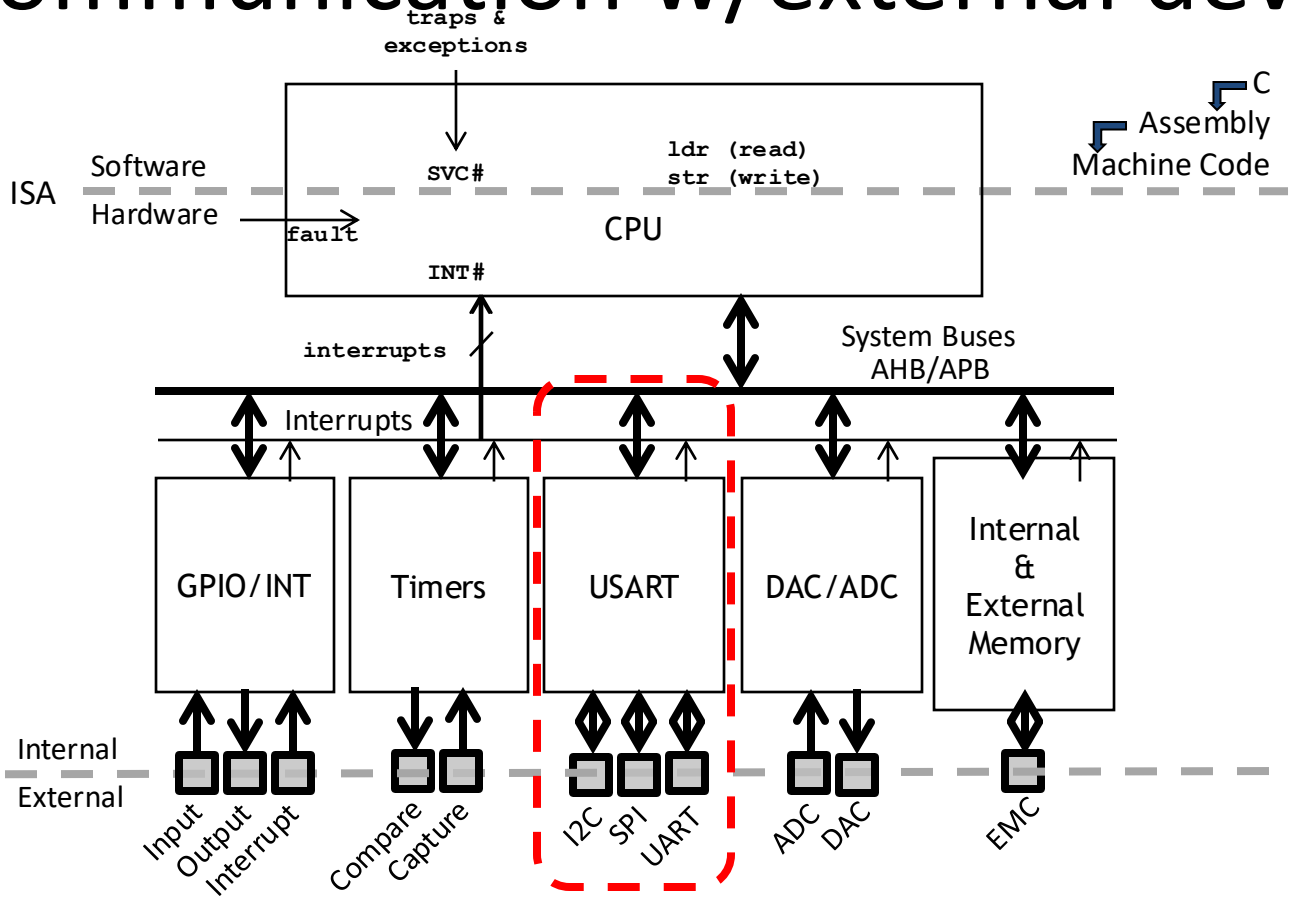
Digital data highways that *external peripherals* use to communicate with microcontrollers



Serial Buses in our project

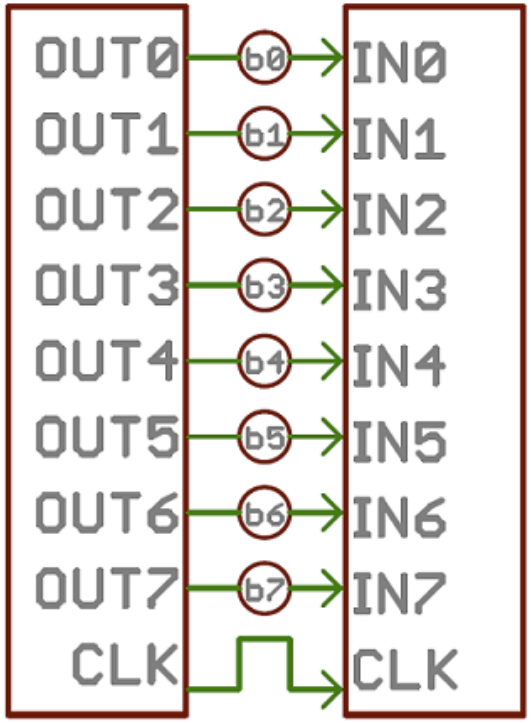
- UART serial bus for sending debug messages to your development host
- I2C serial bus for communicating with sensors (e.g., the accelerometer)
- SPI serial bus for communicating with the Bluetooth Low Energy radio

We use an internal peripheral for serial communication w/external devices

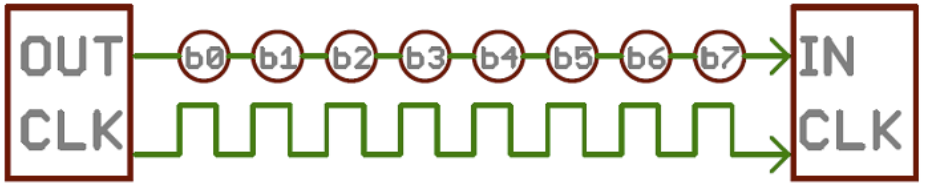


Parallel Bus vs Serial Bus

Parallel

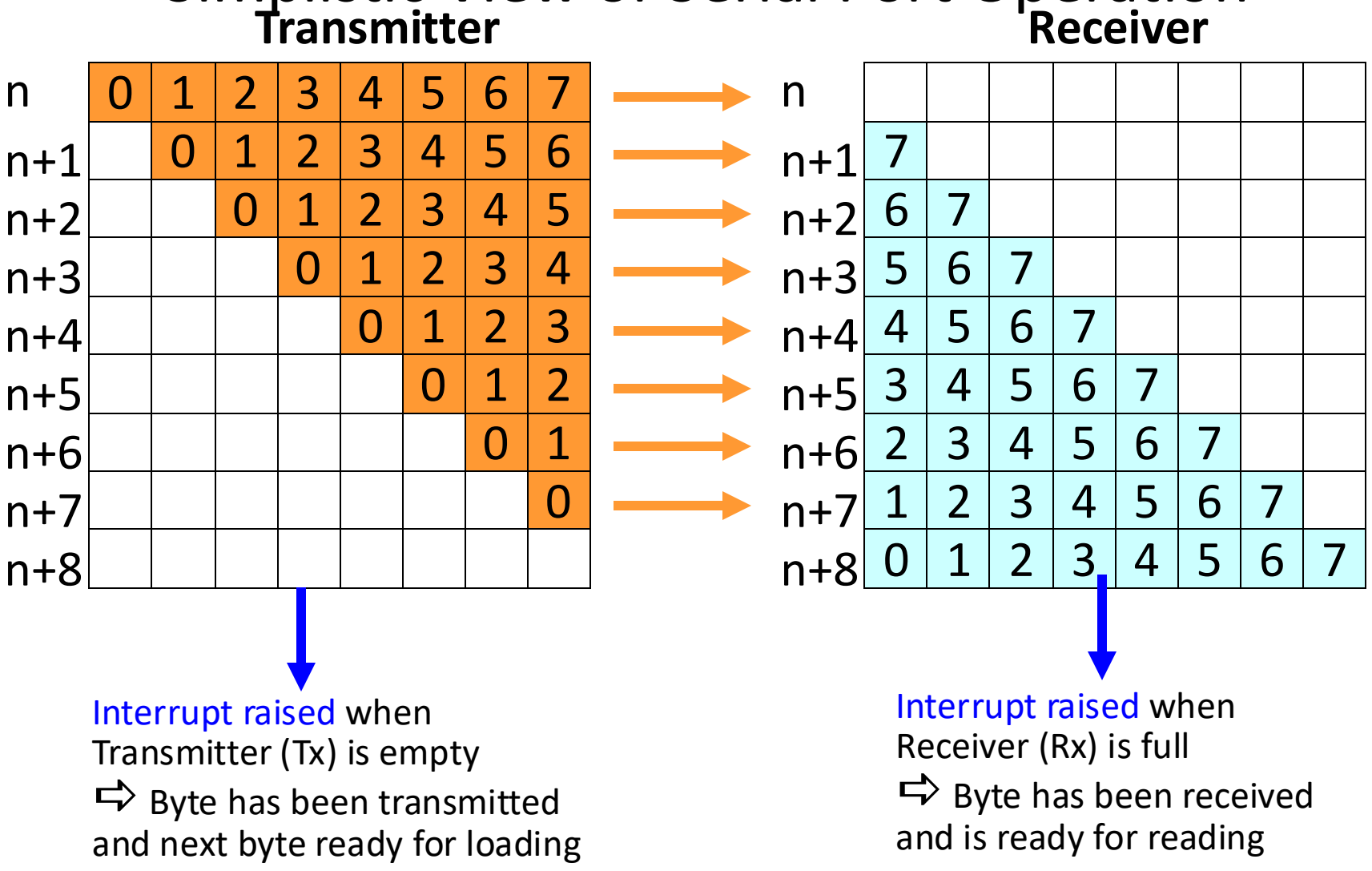


Serial



What is the benefit of a serial bus over a parallel bus (and vice versa)?

Simplistic View of Serial Port Operation



Serial Bus Interface Motivations

- Motivation
  - Without using a lot of I/O lines
    - I/O lines require I/O pads which cost $$$ and size
    - I/O lines require PCB area which costs $$$ and size
  - Connect different systems together
    - Two embedded systems
    - A desktop and an embedded system
  - Connect different chips together in the same embedded system
    - MCU to peripheral
    - MCU to MCU
  - Often at relatively low data rates
  - But sometimes at higher data rates
- So, what are our options?
  - Universal Synchronous/Asynchronous Receiver Transmitter
  - Also known as USART (pronounced: “you-sart”)

Serial Bus Design Space

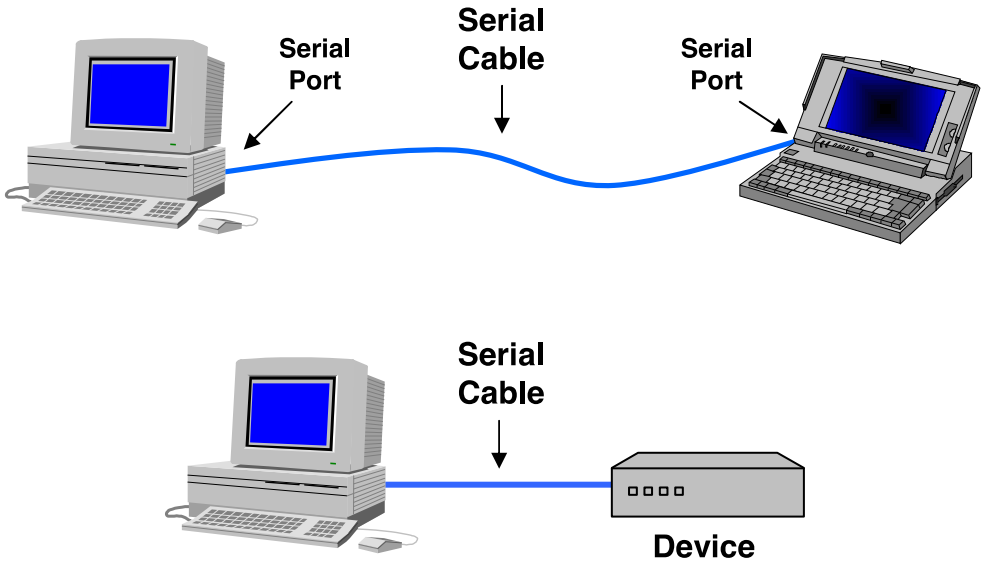
- Number of wires required?
- Asynchronous or synchronous clocking of bits?
- How fast can it transfer data?
- Can it support more than two endpoints?
- Can it support more than one primary?
- How do we support flow control?
- How does it handle errors/noise?
- How far can signals travel?

Serial Bus Examples

	S/A	Type	Duplex	#Devices	Speed (kbps)	Distance (ft)	Wires
RS232	A	Peer	Full	2	20	30	2+
RS422	A	Multi-drop	Half	10	10000	4000	1+
RS485	A	Multi-point	Half	32	10000	4000	2
I2C	S	Multi-primary	Half	?	3400	<10	2
SPI	S	Multi-primary	Full	?	>1000	<10	3+
Microwire	S	Peer	Full	?	>625	<10	3+
1-Wire	A	Peer	half	?	16	1000	1+

UART Uses

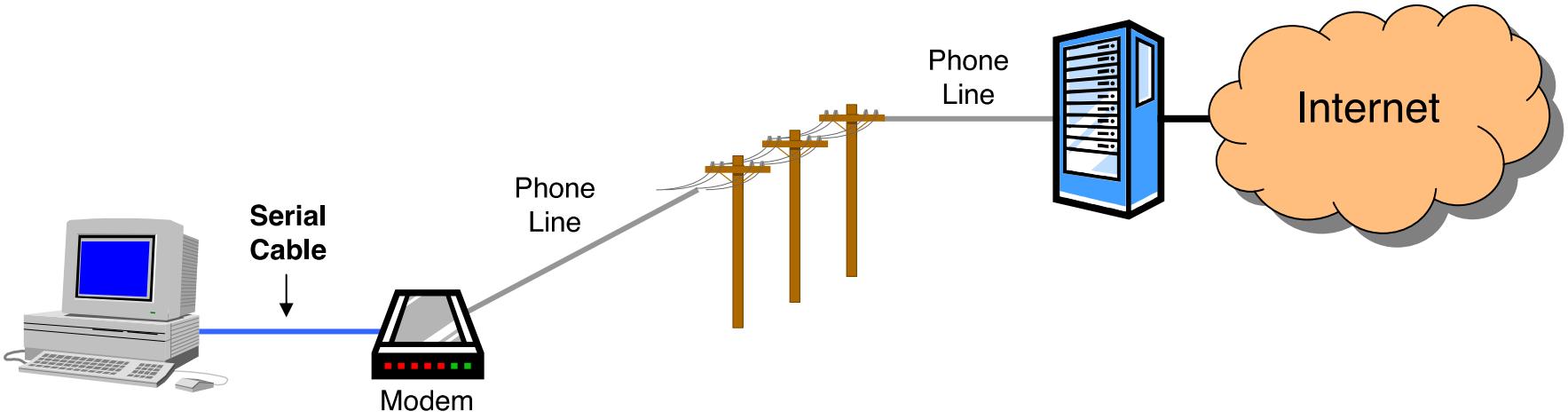
- The PC serial port is a UART!
- Serializes data to be sent over a serial cable
  - De-serializes received data



Slides from BYU CS 224

UART Uses

Used to be commonly used for internet access



Now often used for **debugging interfaces** on embedded systems (as a debugging terminal)

Slides from BYU CS 224

UART

- Universal Asynchronous Receiver/Transmitter
- Hardware that translates between parallel and serial forms
- Commonly used in conjunction with communication standards such as EIA, RS-232, RS-422 or RS-485