Embedded Programming

CODING THE MACHINES OF TOMORROW

Embedded Computing/Programming

- Embedded Systems
  - Computer Processor
  - Computer Memory
  - Input / Output Peripherals
  - Dedicated Function within a larger mechanical or electrical system.

Microprocessors vs **Microcontrollers**

Embedded Computing/Programming

Microprocessors vs **Microcontrollers**

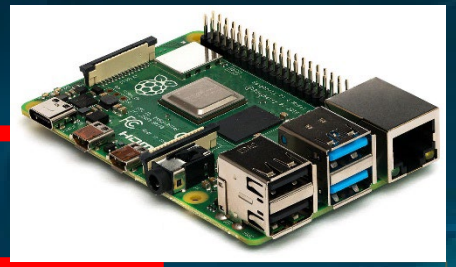
- External RAM
- External Peripheral ICs

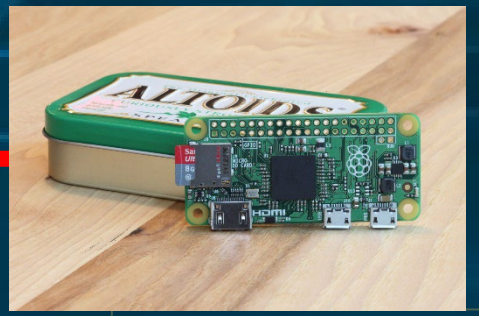
- Internal RAM
- Internal Peripheral Interfaces

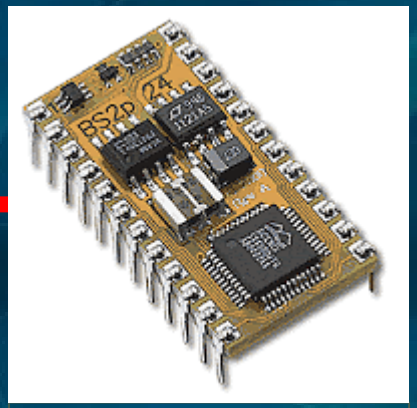
Specific tasks: Tuned and optimized
Economies of scale through mass production

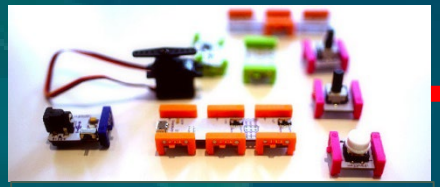
Devices Abound

- Raspberry Pi/Zero
- BASIC Stamp
- Espruino
- Light Blue Bean
- Little Bits Arduino









Networking Protocols

UP NEXT

Networking Protocols

CODING THE MACHINES OF TOMORROW

Networks

Wi Fi ALLIANCE

- IEEE 802.11 Protocol
- LAN/Internet

580M Units/Yr.

Bluetooth®

- 2.402 to 2.480 GHz Frequency Hopping
- PANS – High Mobility
- BR/EDR (Basic Rate/Enhanced Data Rate)

920M Units/Yr.

Bluetooth Low Energy

- Low Power
- Healthcare, Fitness, Beacons, Security
- BLE – Bluetooth Low Energy

Zigbe

- IEEE 802.15.4 Protocol Mesh Network (Star/Tree)
- Home Automation 2.4 GHz

ZWave

- Mesh Network
- Home Automation 800-900 MHz

600 Products in US

600 Products in US

Networks

Thread

- IPv6 Based, low-power mesh network
- IEEE 802.15.4, IP addressable with AES

WiFi HaLow

- Amended IEEE 802.11 – 2007
- 2.5 & 5 GHz bands

Insteon

- Integrated Dual Mesh, Phase-shift Keying
- Integrates with powerlines as backup
- Peer to Peer Network

Smart Home Competition

ZWave

- 90M range
- 24+M indoor
- 908 MHz

Insteon

- Millions of Devices (17.7)

Bluetooth®

WiFi HaLow

Thread

- Fastest 250kbps

Zigbe

- Not as interoperable as ZWave but faster

2.4 GHz

Wired vs Wireless

UP NEXT

Wired vs. Wireless

CODING THE MACHINES OF TOMORROW

Wired v. Wireless

Aspect	Wired	Wireless
SPEED	+	
BANDWIDTH	+	
INSTALLATION		+
COST	+	
MOBILITY		+
COVERAGE/RANGE		+
INTERFERENCE	+	
RELIABILITY	+	

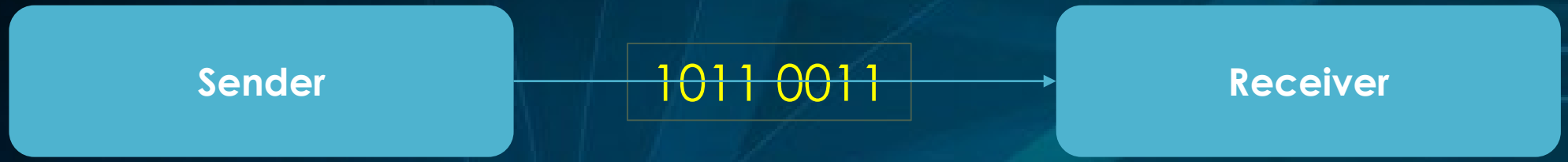
Serial Technology

UP NEXT

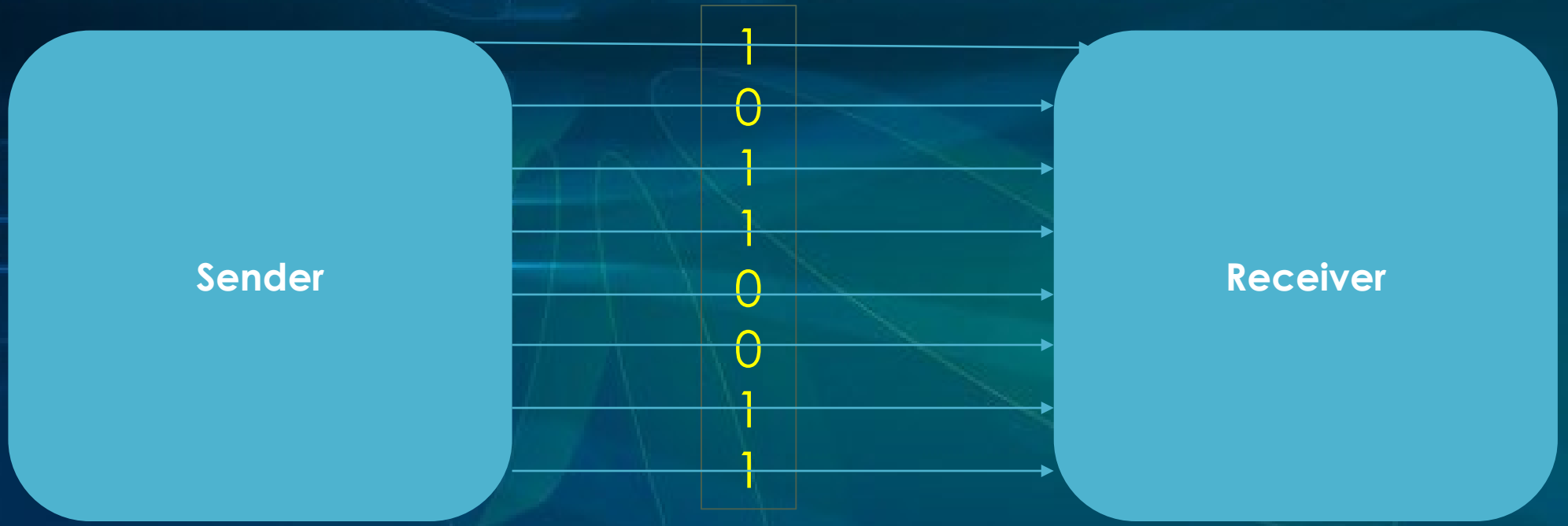
Serial Technology

CODING THE MACHINES OF TOMORROW

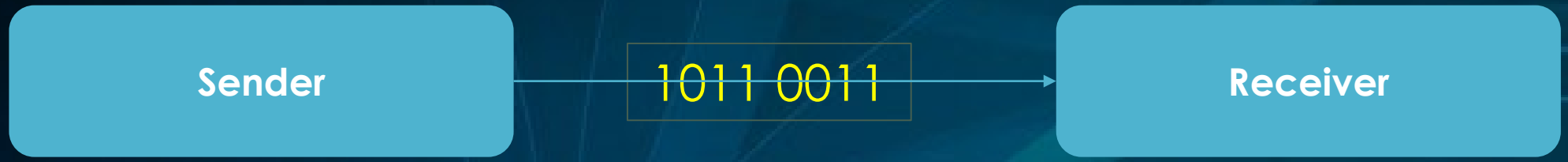
Serial Technology



Parallel Technology



Serial Technology

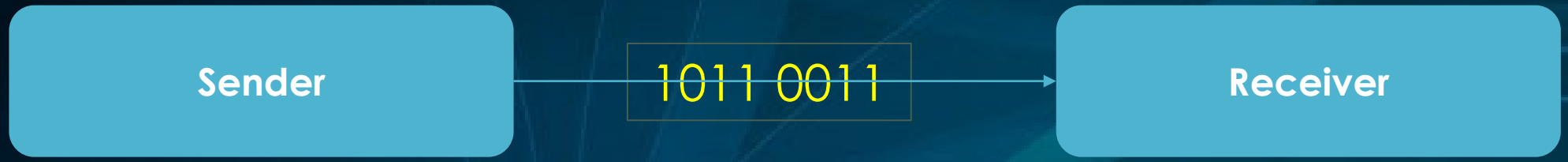


Low Cost Serial Bus Technologies

- RS-232
- SPI
- I^2C
- UNI/O
- 1-Wire
- PCI-e

- 1960. Connected computers to modems.
- Motorola, 4-wire de facto standard serial on embedded systems. 1 master, multi-slave.
- Multi-master/Multi-slave synchronous, packet switched, single-ended.
- Low speed, asynchronous master/slave, 1 signal to pass data for embedded systems.
- Data and ground wires, similar to I^2C but longer range.
- Hi-speed peripheral connection bus. Graphic cards, hard drives, SSDs, WiFi and Ethernet hardware.

Serial Technology



Low-Cost Serial Bus Technologies

- **RS-422**
  - Twisted Pair. Longer runs, higher speed to replace RS-232. Better noise immunity. Up to 10Mbits/s. 1500 meters at lower rates.
  - Measures voltage difference from line/return lines (pair) vs data/ground in RS-232.
- **RS-485**
  - Industrial control systems. Multi-point systems, long distances, strong in electrically noisy environments.

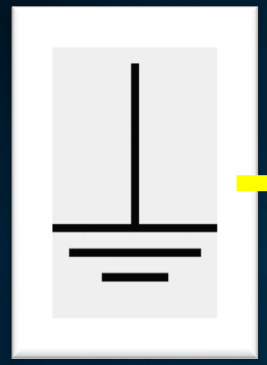
Circuitry

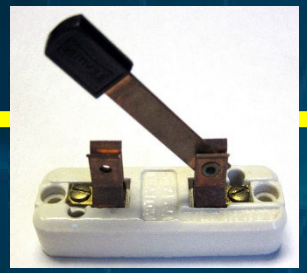
UP NEXT

Circuitry

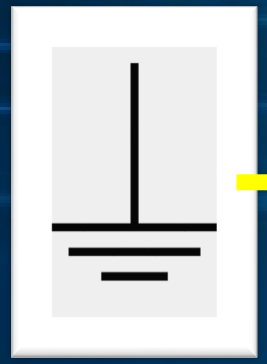
CODING THE MACHINES OF TOMORROW

Source vs. Sink Circuits

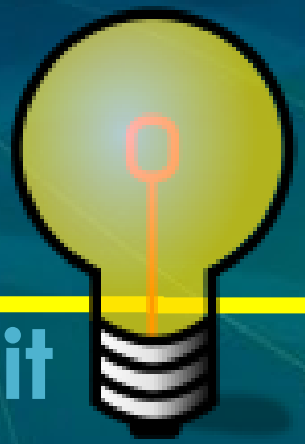


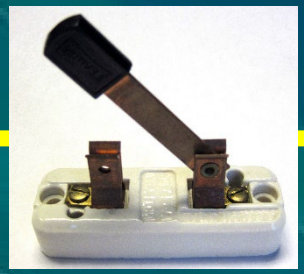


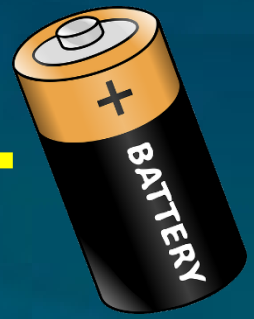
Sink Circuit



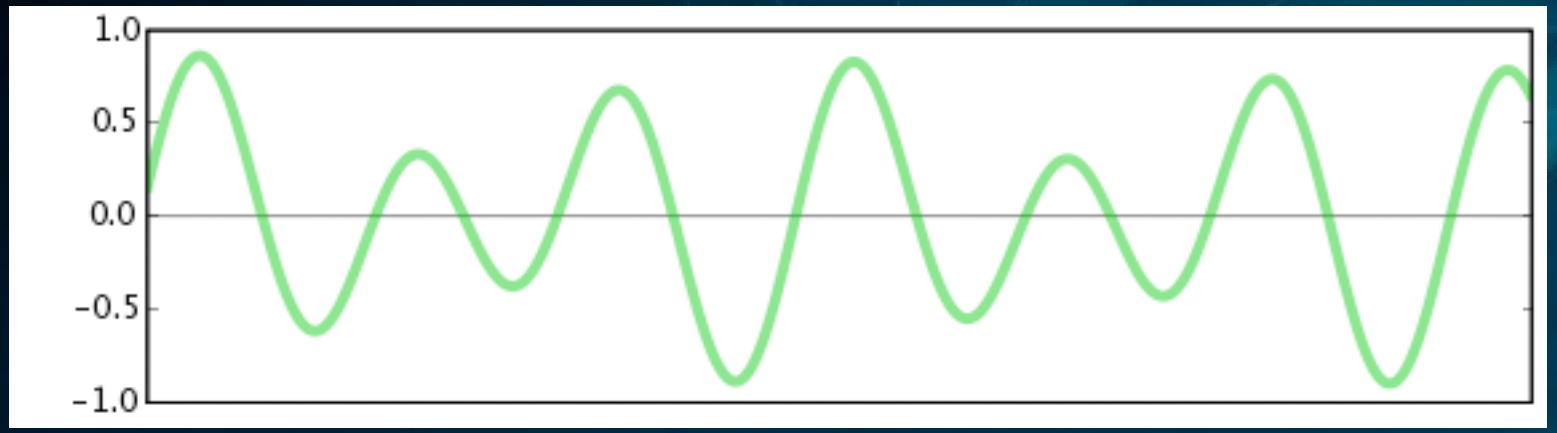
Source Circuit



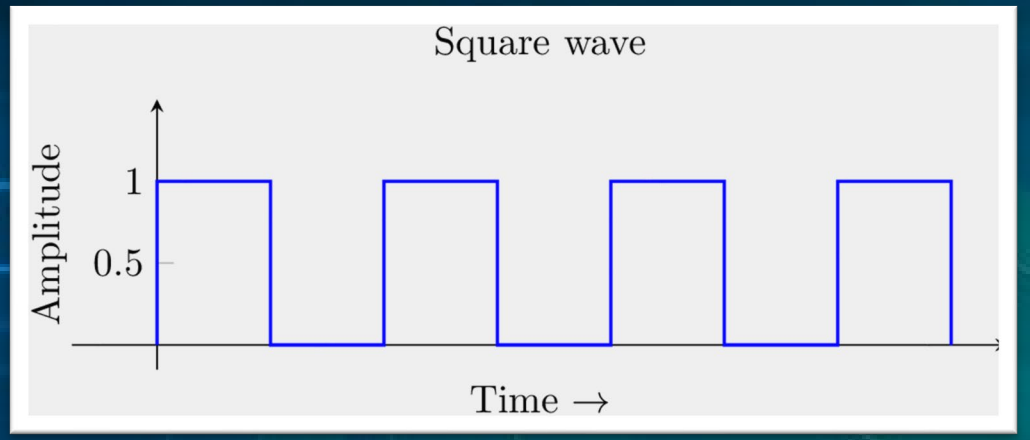




Analog vs. Digital Circuits



Analog Circuit



Digital Circuit

Analog vs. Digital Circuits

Analog Circuit

- Continuous Wave
- Sine waves
- Recorded as they are
- Noise sensitive/deteriorates
- Not flexible in implementation

Human Voice, Analog Speakers, Record Player

Digital Circuit

- Discrete time Square Wave
- 1's and 0's on different amplitudes
- Can be noise immune
- Can be without deterioration
- Flexible in implementation

CDs, DVD, Computers, Digital Music (MP3)

Pull-Up vs. Pull-Down Resistors

Pull up

- Ensures a known STATE for a signal.
- Keep a logic gate HIGH when switch is open

Used for Logic Gates, Wired OR functions (Combination Logic)

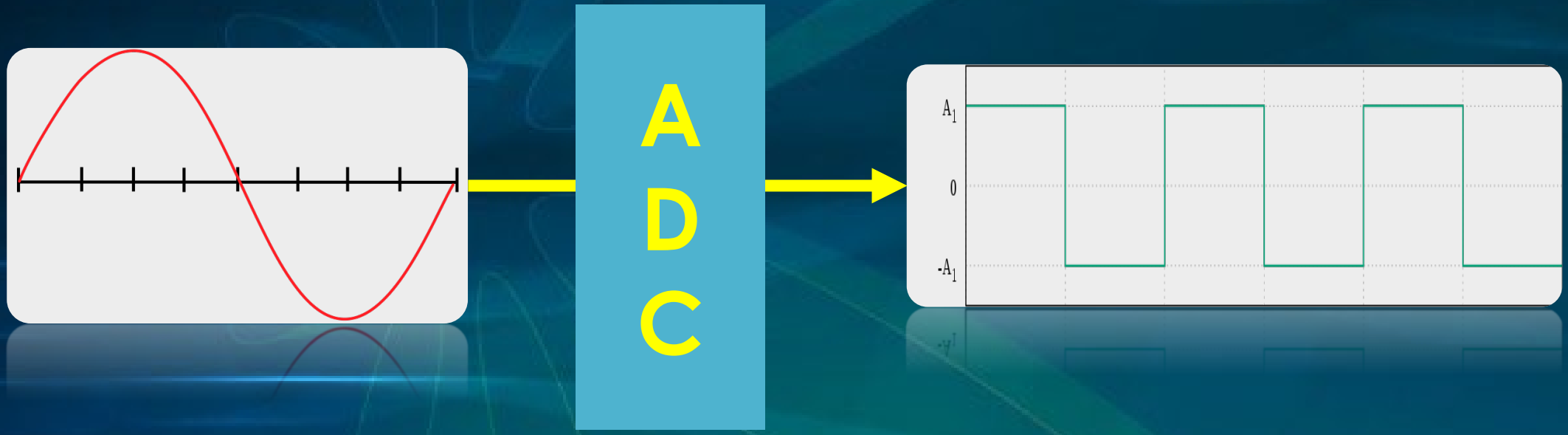
Pull Down

- Ensures a known STATE for a signal.
- Keep a logic gate LOW (GRND) when switch is open

CMOS Logic Gates (Inputs are voltage controlled)

- Pull-up & Pull-Down resistors make sure inputs to digital gates are correctly biased and not floating all over the place when there is no input condition.

Analog to Digital Convertor



MOS IC