Single Board Computers
VS
Microcontrollers

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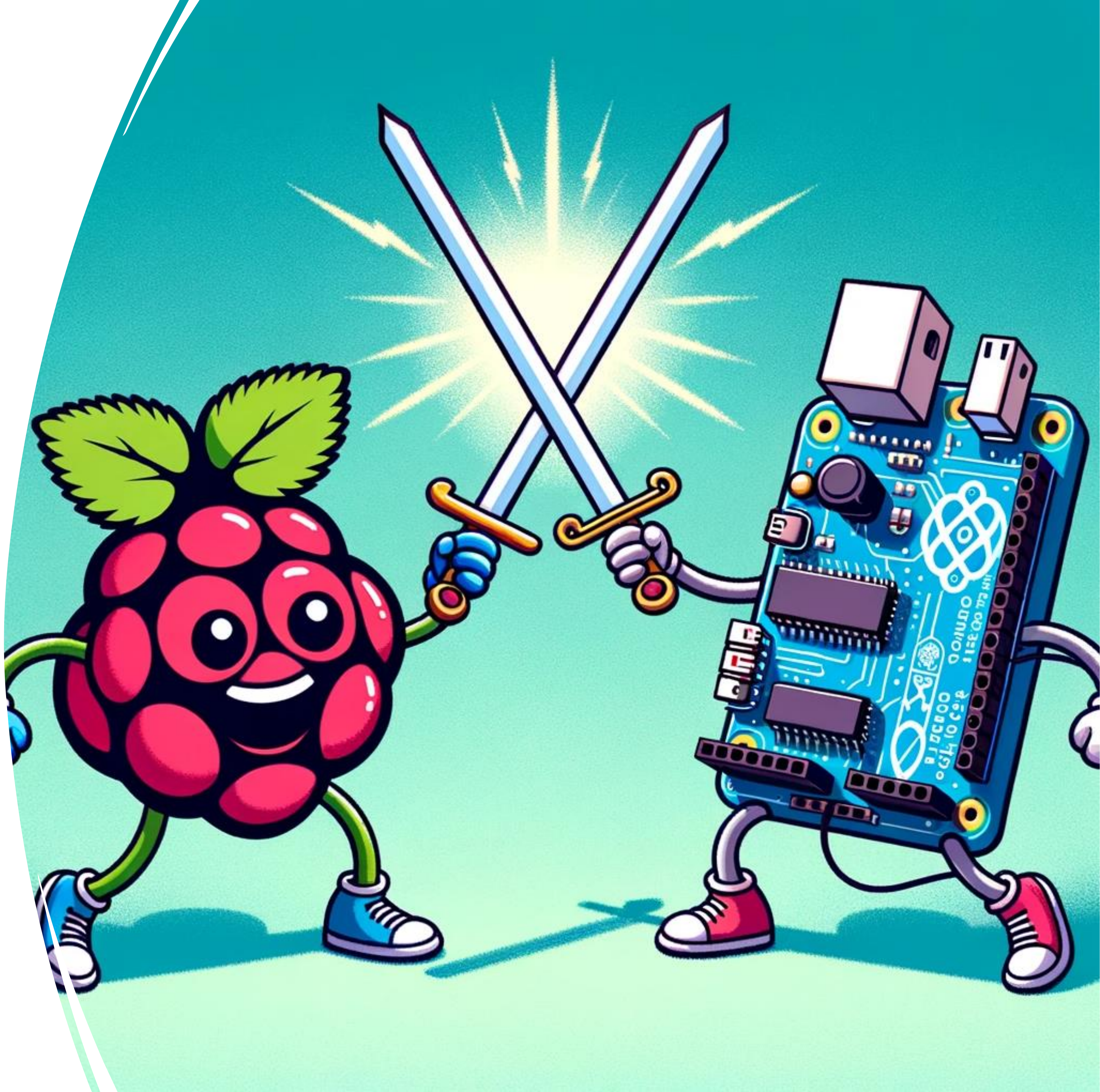
2023

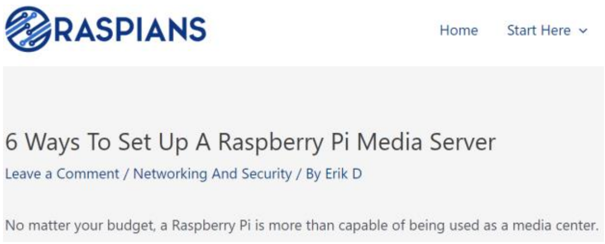


SBC vs µC

- Single Board Computer (SBC)
  - Example: Raspberry Pi
- Microcontroller (µC)
  - Example: Arduino MKR1010 (kind of…)
- What are they?
- What are key differences?

What is a Single Board Computer(SBC)?

- A complete computer on a single board
    - CPU, RAM, storage, and I/O ports.
- Runs a full-fledged operating system
    - Linux distributions
- Capable of multitasking, web browsing, and running software applications.
- Examples:



RASPIANS

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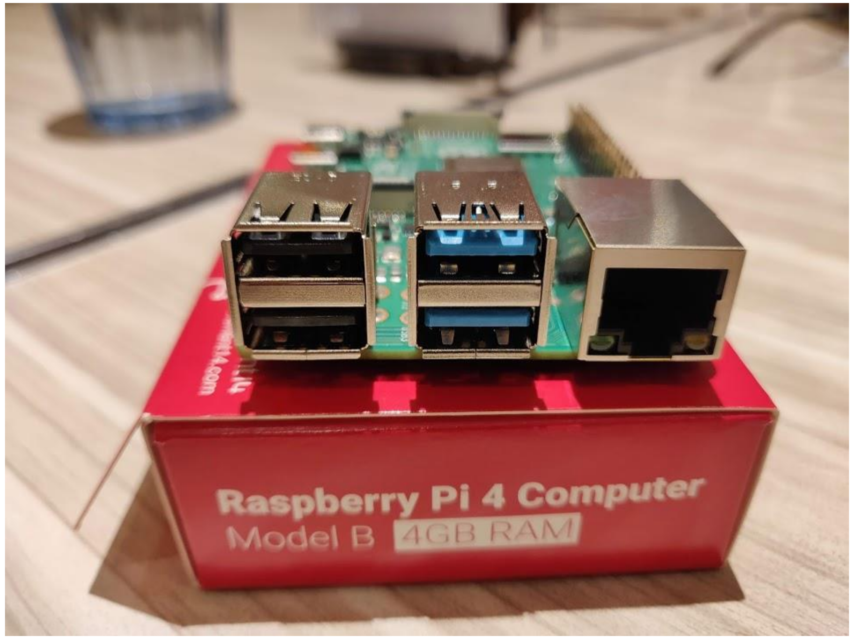
6 Ways To Set Up A Raspberry Pi Media Server

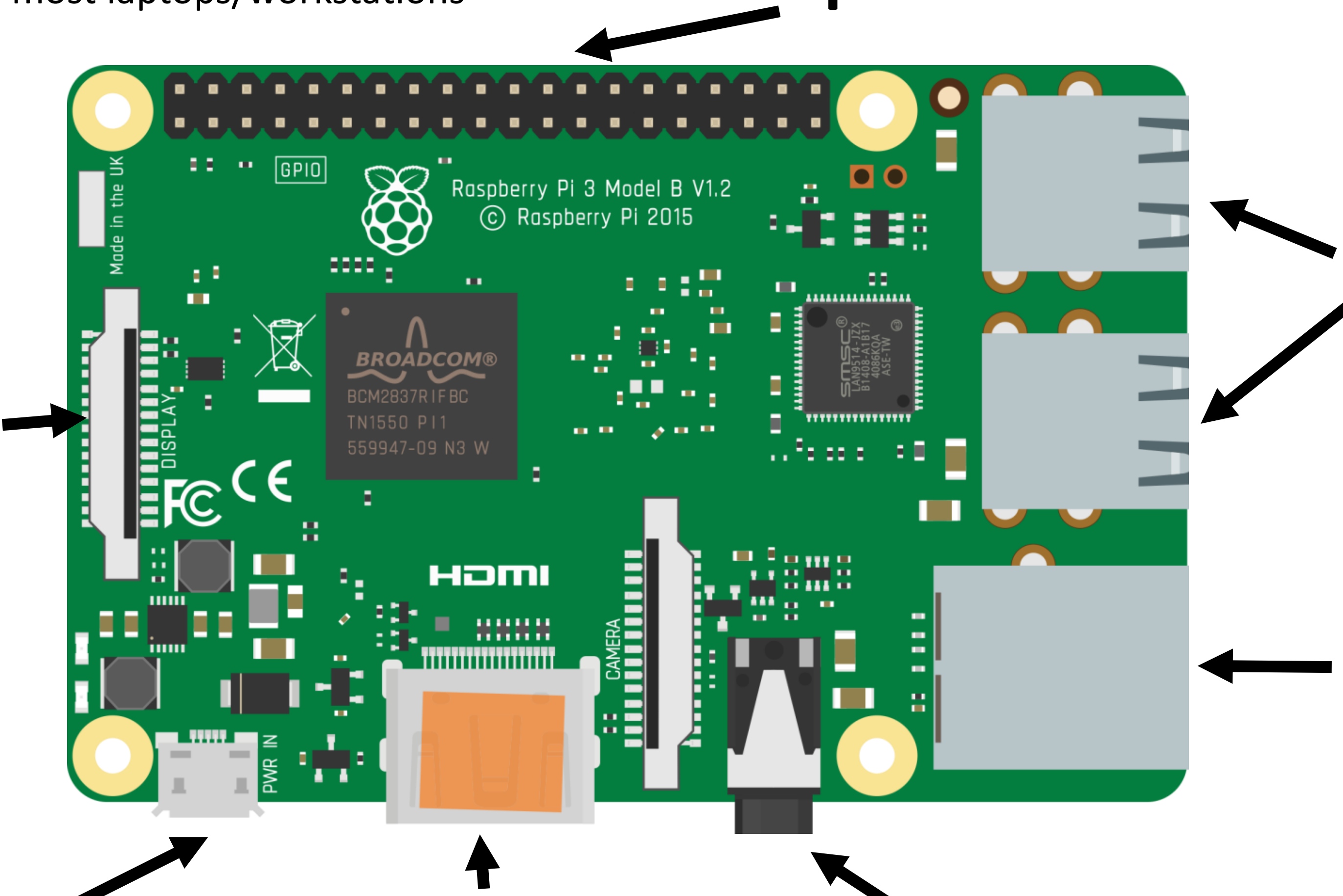
Leave a Comment / Networking And Security / By Erik D

No matter your budget, a Raspberry Pi is more than capable of being used as a media center.



Raspberry Pi

- Low cost, single board computer
- Linux OS
- Same features as most laptops/workstations



40 pin GPIO

USB Ports

LCD Display

RJ45 Ethernet

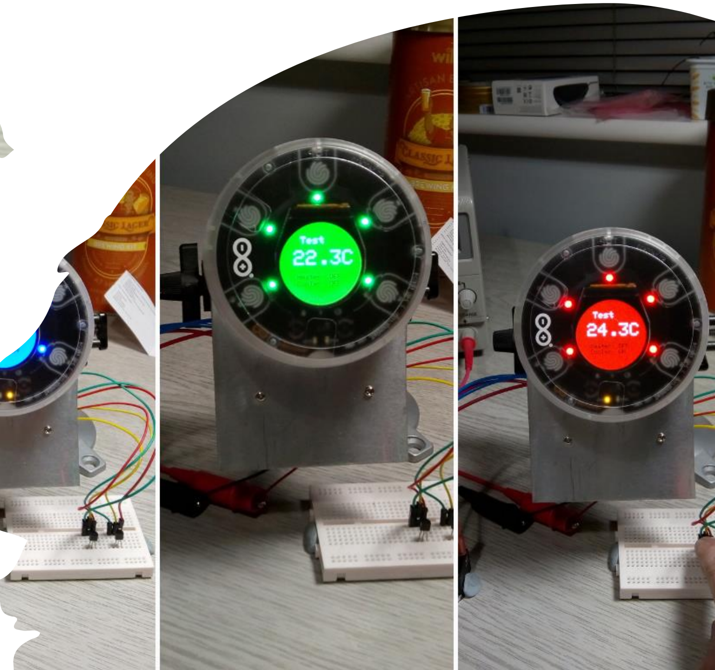
Power

HDMI

3.5mm audio

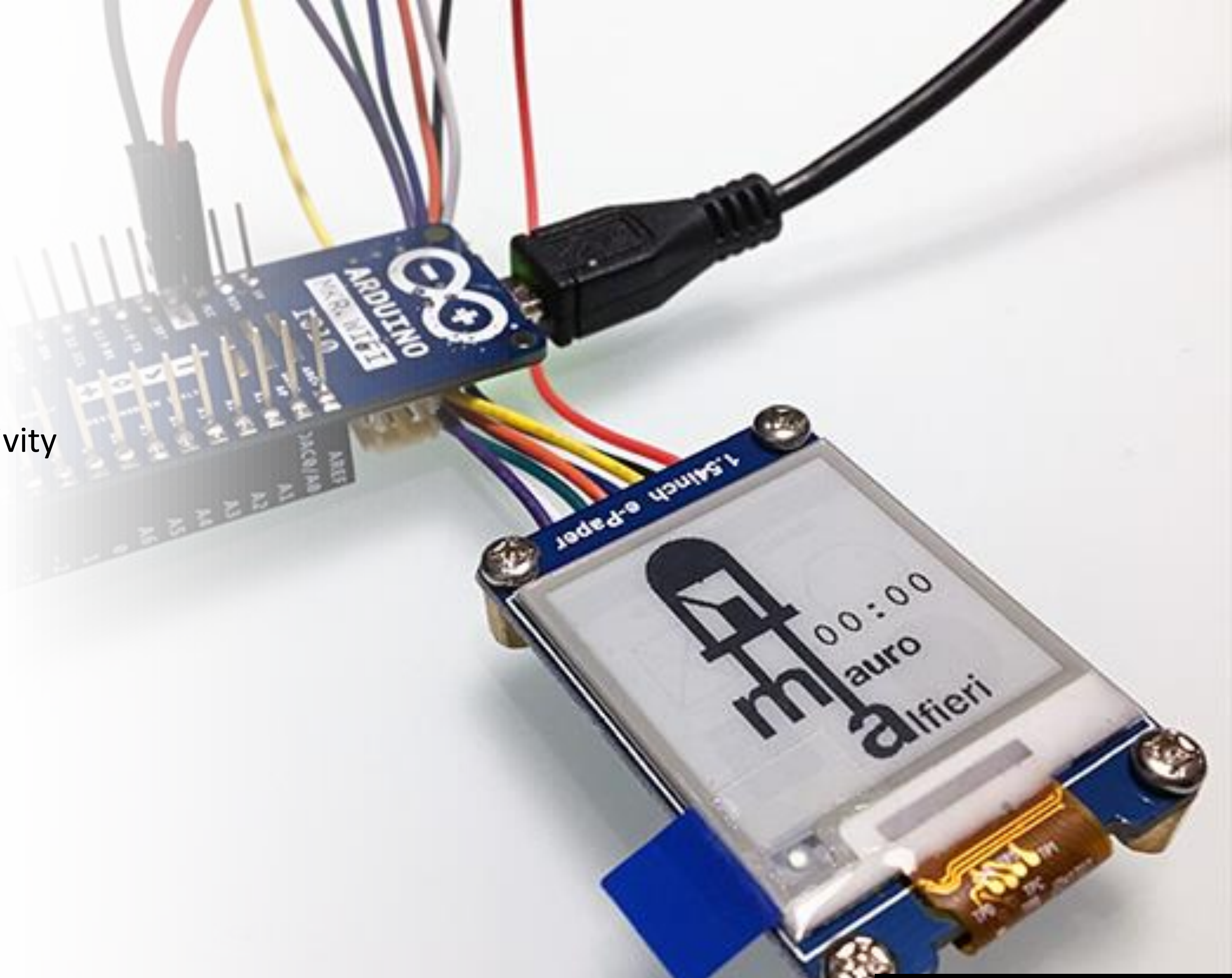
What is a Microcontroller?

- A compact circuit designed for specific operations in embedded systems.
- Contains a CPU, small RAM, storage, and operates without a full OS.
- Executes pre-programmed tasks, ideal for hardware interactions.
- Example:
    - Automated Plant Watering System: An Arduino reads soil moisture levels and automatically waters a plant when it gets too dry.



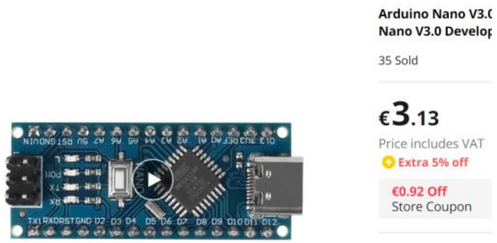
Arduino wifi MKR1010

- Powerful µC platform
- IoT and network connectivity focused
    - Good for networking modules!!!
- Open source
- Large online community



SBCs vs. Microcontrollers Key Differences

- **Power Consumption:** Arduino is more energy-efficient than Raspberry Pi.
- **Complexity:** Raspberry Pi can handle intricate tasks due to its robust CPU architecture, memory resources and OS.
- **Boot Time:** Arduino starts nearly instantly, while Raspberry Pi requires boot-up time(like your laptop).
- **Cost:** Microcontrollers are generally cheaper than SBCs.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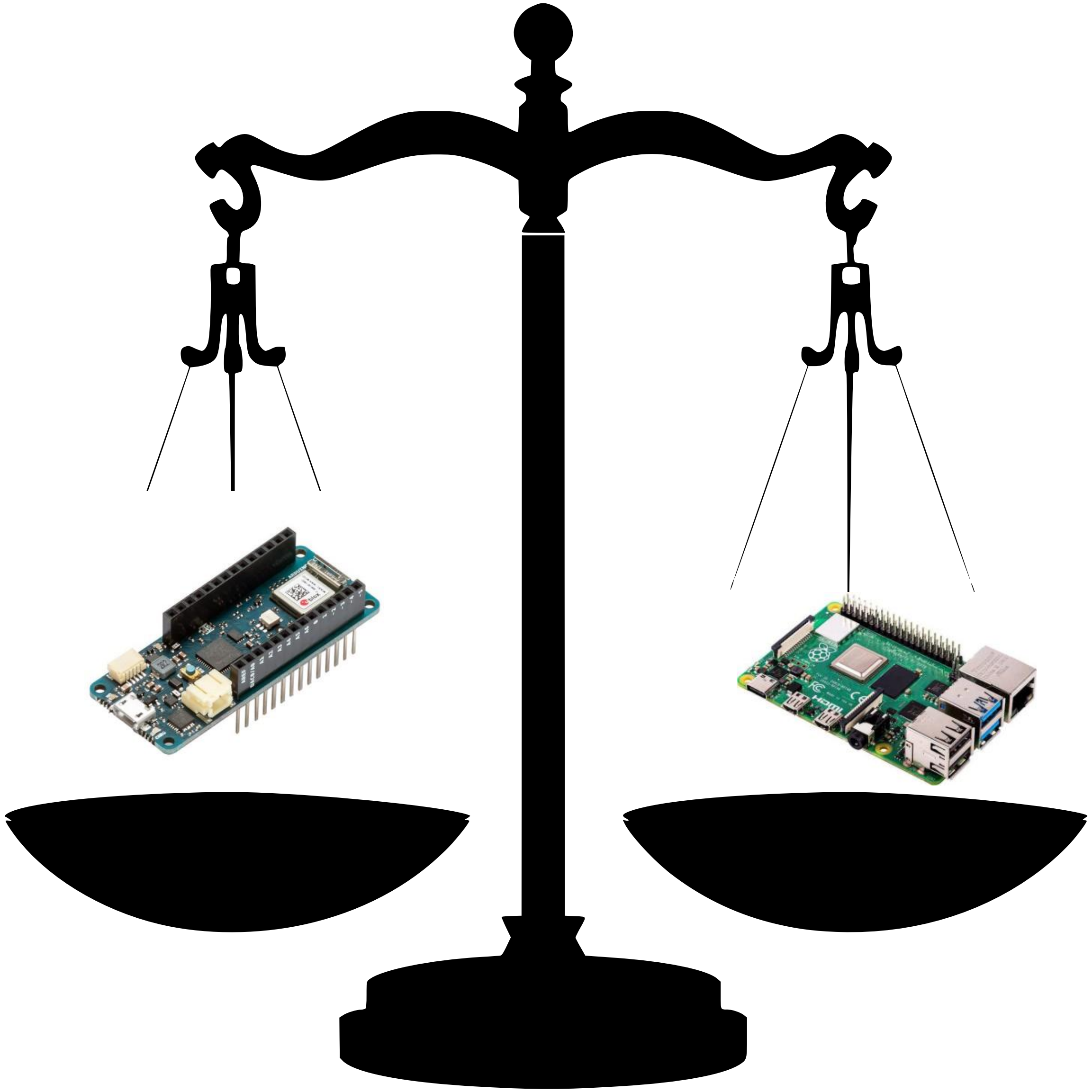
- **Development:** Raspberry Pi offers a typical Operating System and desktop-like environment, whereas Arduino requires external coding and uploading.

SBCs vs. Microcontrollers Key Differences

- **Real-time**:
  - Microcontrollers are generally designed to perform specific tasks without the overhead of an operating system.
  - Microcontrollers loop continuously waiting for input from sensor the react immediately.
  - **Real-time operation:** can guarantee a task is executed in a predictable time frame.
    - Can use “interrupt” handlers to achieve this. Triggered by a sensor input(e.g. tilt sensor in car)
  - SBCs generally run full-fledged operating systems like Linux,
    - can have varying response times due to task scheduling and other processes running in the background.
- **Microcontrollers can operate in Real-time, SBCs do not.**

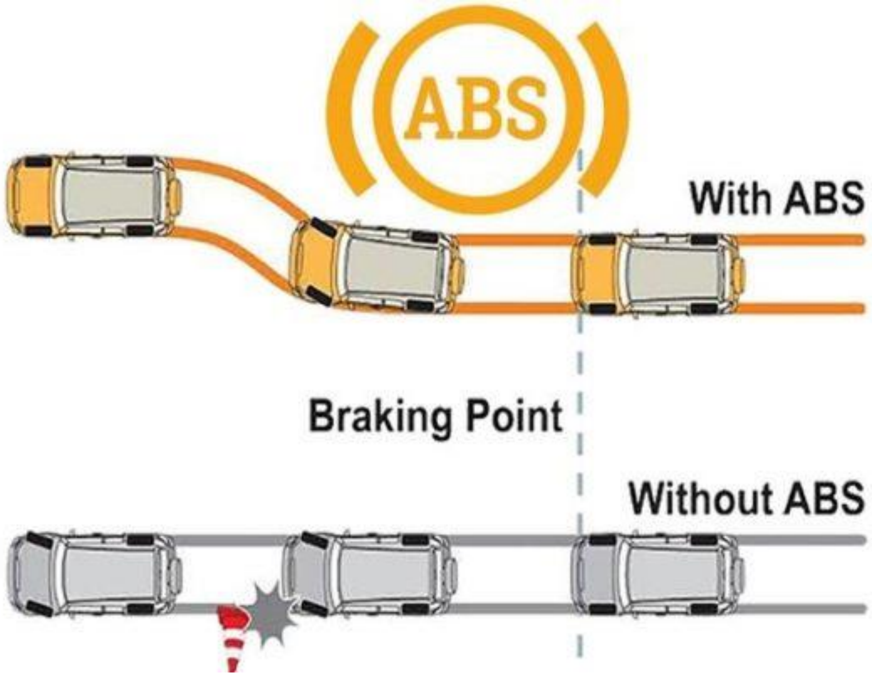
Which one???

- **Task Simplicity:**
  - Use Arduino for simpler, hardware-focused tasks.
  - Use Raspberry Pi for complex tasks or when a full OS is beneficial (e.g. image processing, DB I/O).
- **Power Constraints:** For battery-operated or energy-efficient systems, Arduino is often a better choice.
- **Integration:** Raspberry Pi is ideal for projects that need internet connectivity, computation & processing, or integration with complex software.
- **Budget:** Consider cost implications, especially for large scale or commercial projects.



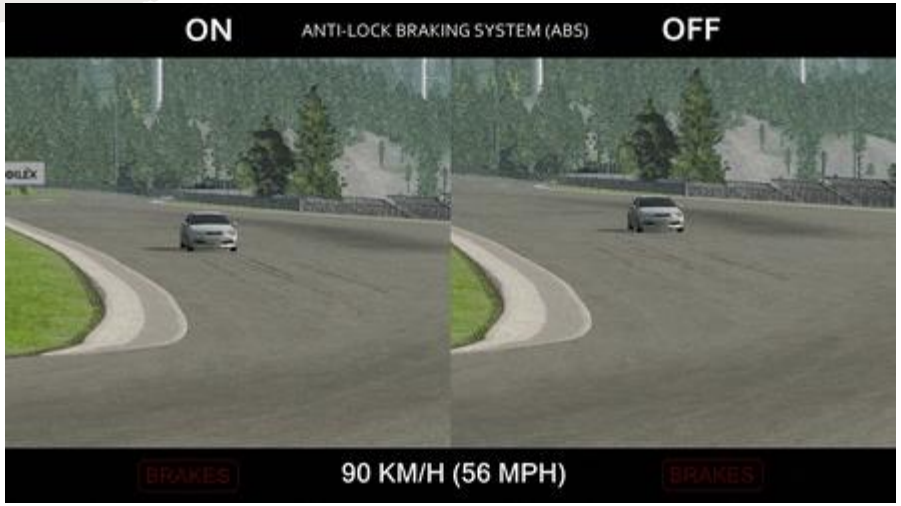
Example Use Case1: ABS

- **Anti-lock Braking System (ABS)**
  - ABS is a safety anti-skid braking system that prevents the wheels from “locking up” during braking, which helps the driver maintain control.
- **How it works:**
  - Wheel Speed Sensors constantly measure the speed of each wheel and send this data to the ABS controller.
  - ABS Controller processes the wheel speed data and determines if a wheel is about to lock up.
  - If the ABS Controller detects a wheel is about to lock, it decreases the pressure to the brake until the wheel starts moving again.
- **Safety Critical System: Has to Work Always, Has to be Reliable, Has to be Fast, Can’t be waiting around for processor timeslot**



Example Use Case1: ABS

- The ABS controller needs to operate in real-time.
- When a driver steps on the brake pedal, the ABS must instantly assess and react to wheel slip conditions to prevent skids
- A delay in processing could reduce the effectiveness of the ABS, leading to potential accidents.
- **Microcontroller** is the best option here and are used extensively in the automotive industry where safety, performance, and reliability are critical.(Incorporated into ECUs(electronic control units)



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Phone: (419) 861-9000 - Web:www.eceinc.com

Example Use Case2: Licence Plate Recognition (LPR)

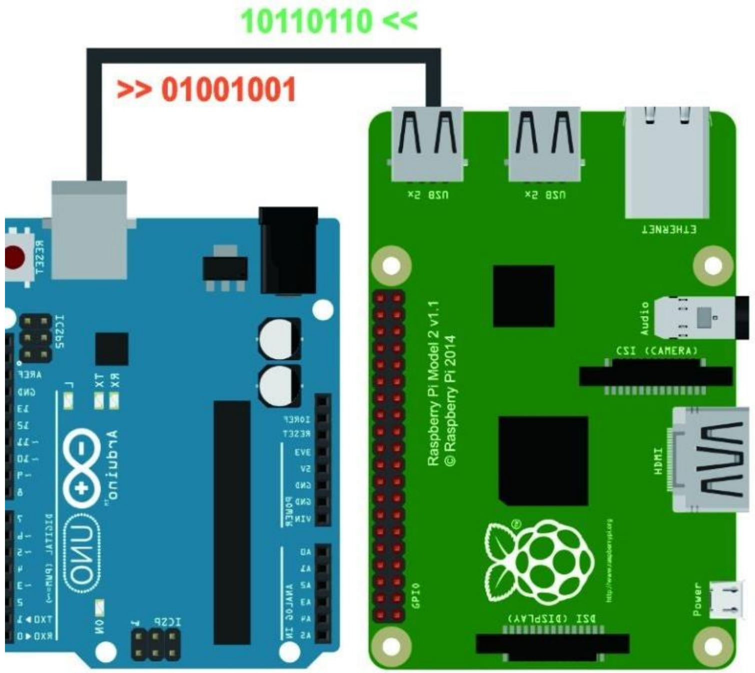
- LPR systems automate the process of identifying a vehicle's license plate to manage access, billing, security….
- **Capture:** Cameras take pictures of vehicles' as they come and go.
- **Image Processing:** The system processes these images to enhance clarity, adjust lighting, and prepare the image for plate extraction.
- **Plate Extraction:** Program identify the rectangular region of the image containing the license plate.
- **Optical Character Recognition:** The system then processes this extracted portion to recognise and read the characters on the license plate.
- **Database:** The licence plate number is used to query/update a DB

Example Use Case2: Licence Plate Recognition (LPR)

- A lot of computationally expensive processing here (image processing). May need a lot of CPU power and memory.
- Short period to acquire, process and recognise licence plate is acceptable.
- Quick, but not exact real-time processing, is OK.
- Nobody will be hurt if it fails – not safety critical.
- A networked/connected **Single Board Computer** connected to Camera is a viable option here.

Can you use both together?

- Yep! If you want
- Why?
  - Microcontrollers are reliable, real-time and interface well with sensors (analog/digital sensors)
  - OS on computer have a lot of processing power/software to work on data but can crash and have security vulnerabilities like any computer.
  - Use Microcontroller to interface/control sensors and actuators
  - Use SBC to process data/connect to other networks and services.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Arduino
UNO
Raspberry Pi Model 2 v1.1
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