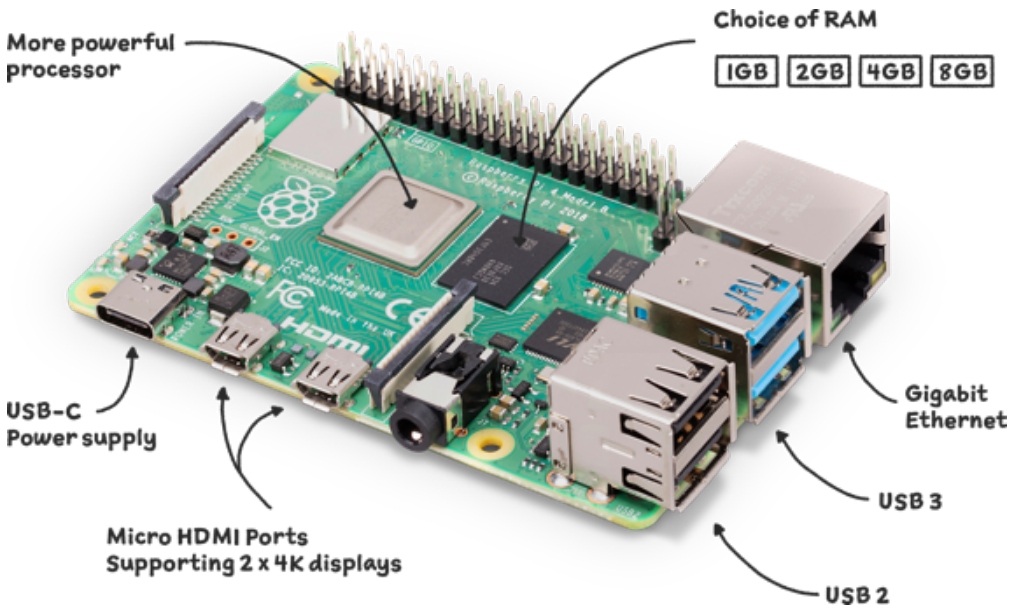
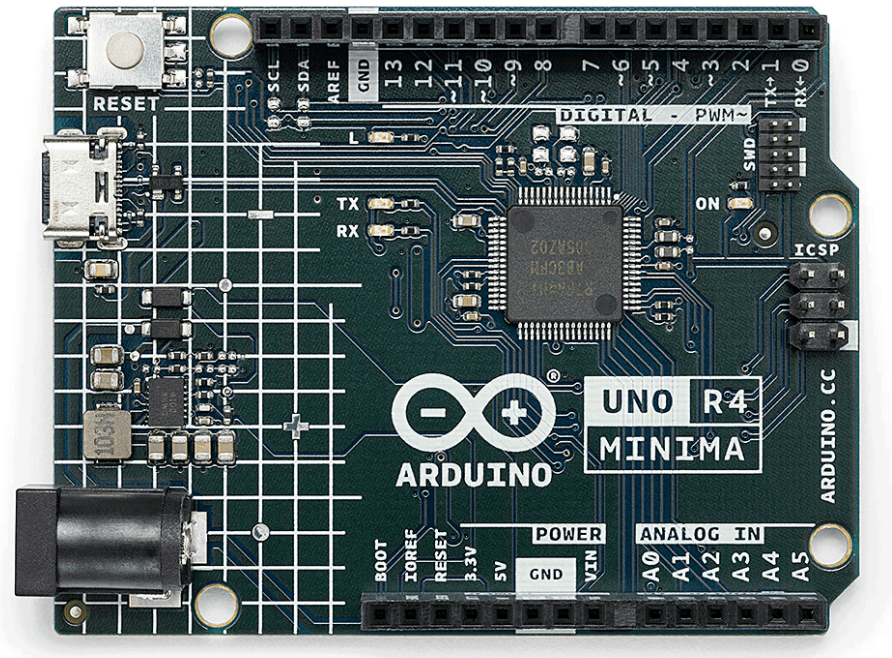
Embedded Systems

Ahmed Shuaib

Embedded System ?

- Computer system that comprises of:
  - Processor
  - Memory
  - I/O
- General-purpose computers systems are designed to handle a wide range of applications.
- Embedded systems are optimized for a specific function.


More powerful processor
Choice of RAM
1GB
2GB
4GB
8GB
USB-C Power supply
Micro HDMI Ports Supporting 2 x 4K displays
Gigabit Ethernet
USB 3
USB 2


RESET
DIGITAL - PWM~
TX
RX
ON
ICSP
UNO R4
MINIMA
ARDUINO
ARDUINO.CC
POWER
ANALOG IN
GND

Role of Assembly Language

- Modren embedded systems are based on micro-controllers consisting of internal.
  - Memory
  - I/O
- Developing embedded systems is often done in languages that are closer to bare metal.
- Assembly offers unparalleled control, efficiency, and optimization capabilities.
- Use of Assembly can significantly enhance the performance and reliability of the system.

Architecture

- ARM Processors -> AArch32 and AArch64
  - Based on RISC design principles
  - Reduced instruction set computer (RISC) focuses on simplifying instructions and increasing speed.
- Atom Processors -> x86 and x86-64
- AMD Ryzen Embedded Processors -> x86 and x86-64
- PI uses Quad core Cortex-A72 64-bit SoC.
- UNO uses Renesas RA4M1 32-bit SoC
- They both basically use a Arm processors like the majority of boards

Real-Time Embedded Systems

- When designing embedded systems the are time constraints to consider.
- Hard Real-Time -> Extremely strict requirements
  - Missing a "deadline" is unacceptable, as it can be catastrophic.
- Soft Real-Time -> Lenient requirements
  - Missing a "deadline" while not desirable, may not be catastrophic.
- Real-Time Operating Systems
  - FreeRTOS
  - Linux Implementations
    - Lynx OS
    - RTLinux
  - Unix Implementations
    - QNX

Embedded Real-Time systems are reactive systems

"The system observes changes in the environment, computes appropriate actions, and conveys the actions to various components so that the system as a whole operates correctly while the designated time constraints is met." [7]

Other Constraints

- Engineering Costs of designing a critical system must me minimal.
- Cost of each unit must be minimal, as units are mass produced.
- The power consumption of the systems must be minimal.
- Performance should not be a bottleneck.

Applications

- Internet of things devices (IoT)
  - Smart thermostats, speakers, lighting, cameras, locks, appliances, fitness trackers, basically everything.
- Automotive
  - Engine control, Safety features like airbags and ABS, Entertainment systems.
- Aerospace and Defense
  - Flight control, Weapon systems, Communication systems.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B day

Cons

- Privacy Concerns
  - IoT devices collect data
    - What data?
    - How much data?
- Security Vulnerabilities
  - Vulnerable to hacking and unauthorized access
  - Who sees your data?

Embedded Systems Security: Threats and Vulnerabilities

Dorottya Papp, Zhendong Ma, Levente Buttyan *

- What are the main causes of those successful attacks?
- What are the main vulnerabilities?
- How can we use the knowledge to improve the security of embedded systems?

Vulnerabilities

- Programming errors
- Weak access control or authentication
- Improper use of cryptography

"What is more, the vulnerabilities and errors identified
in our taxonomy are similar to errors that arose in traditional IT systems. However, traditional IT systems already have solutions and tools to address these issues. We anticipate that the solutions will be deployed in embedded systems with modifications tailored for the needs of this field."

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Thank You :)