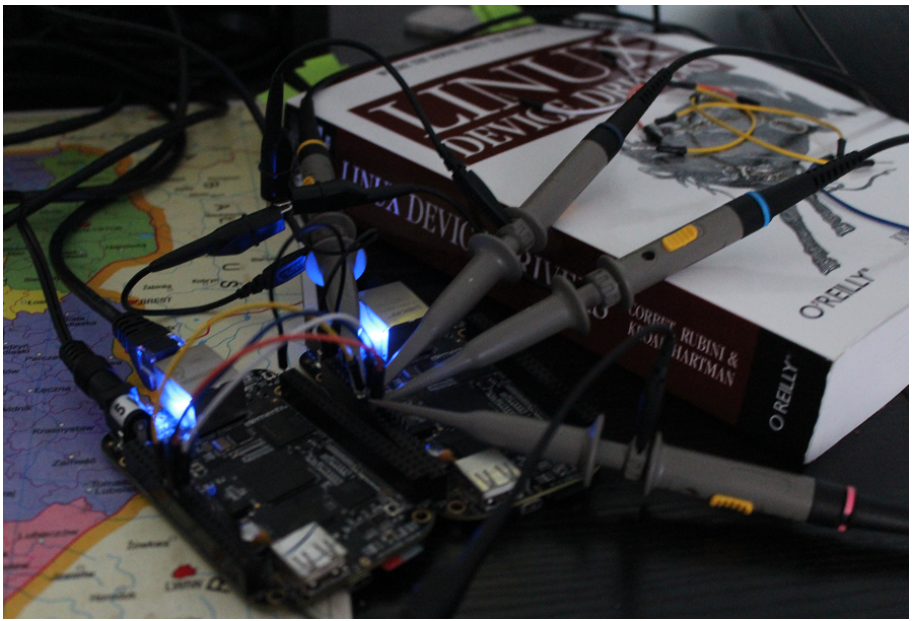
IoT Without a Net: A Practical Guide To Working With Microcontrollers The Open Source Way

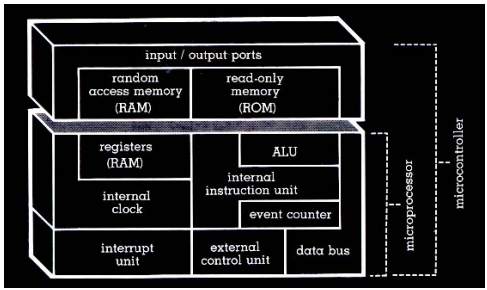


Presentation Outline

Exactly What Kind of Hardware Are We Talking About?

- Primary Characteristics
  - Stand-alone or separate real-time CPU core(s)
  - Can also come in combination or hybrid configurations
  - Requires firmware loaded at runtime to do something
  - Includes both hard and soft processor cores
  - Interfaces for debug and/or communication with Linux runtime
- Typical Applications
  - IoT, industrial, automotive, consumer, hobbyist
    - Machine control (3D printing, milling, process control)
    - Car navigation, entertainment, communication
    - Door/entry control, locks, power, LEDs, appliances
    - Autopilots (drones, rovers, UAVs) and robotics
    - Wearables, instrumentation, mesh networks

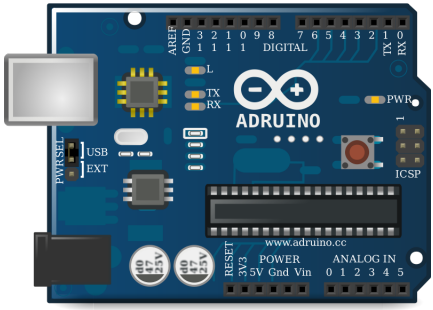
Example Reference Architecture



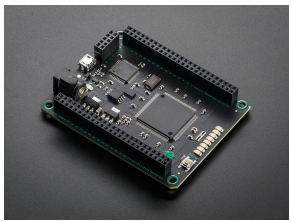
"A microcontroller (or MCU, short for microcontroller unit) is a small computer or System on Chip (SoC) in a single integrated circuit containing a processor core, memory, and programmable I/O peripherals (may also include program memory)."

[1]
https://en.wikipedia.org/wiki/Microcontroller

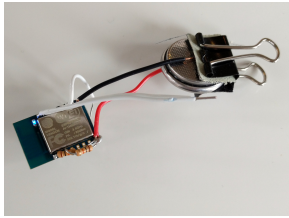
Example Boards



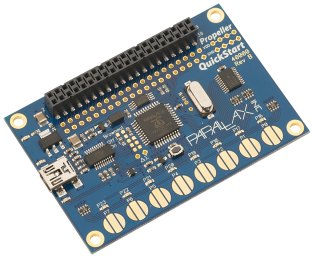
AVR/ARM: Arduinos



Spartan 6 XC6SLX9 FPGA



Xtensa LX-106: ESP8266



P8X32A microcontroller

Microcontroller Architecture / CPU Families

- 4 most "common" architecture families in DIY and FOSS
  - 8051, PIC and AVR are Harvard architecture, which uses separate memory spaces for RAM and programs, while ARM is von Neumann architecture (program and RAM share the same memory space)
  - ARM is a 16 or 32 bit architecture, others are byte (8-bit) architecture
  - 8051 and PIC have limited stack space - limited to 128 bytes for the 8051, 8 words or less for PIC
  - 8051, AVR and ARM can directly address all available RAM, while PIC can only directly address 256 bytes
  - 8051 and PIC need multiple clock cycles per instruction, while AVR and ARM can execute most instructions in a single clock cycle
  - AVR and ARM have great open source compilers, libs, examples
- Still around: PowerPC, MIPS, STM, TI, Toshiba, Freescale/NXP, etc
- Combination and Hybrid Architectures/Implementations
  - PRU-ICSS / PRUSSv2 - Programmable Real-Time Unit and Industrial Communication Subsystem
  - DSP - Digital Signal Processor
  - FPGA - Field Programmable Gate Array
  - Massively Parallel - Parallax Cog/Hub, Parallela, Transputer

Hybrid and "Combo" Boards

What About Software Tools?

Toolchains, SDKs, and Architectures

Vendor vs. Open Source Tools

Example: ESP8266, Adafruit Feather HUZZAH

ESP8266 Cont.

Example: PRU-ICSS, TI BeagleBoneBlack

PRU-ICSS Cont.

Example: Atmel SAM3X8E, Udoo / Udoo Neo

SAM3X8E Cont.

How To Choose?

Where to Go Next

License and Thanks!

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