Microcontroller Overview

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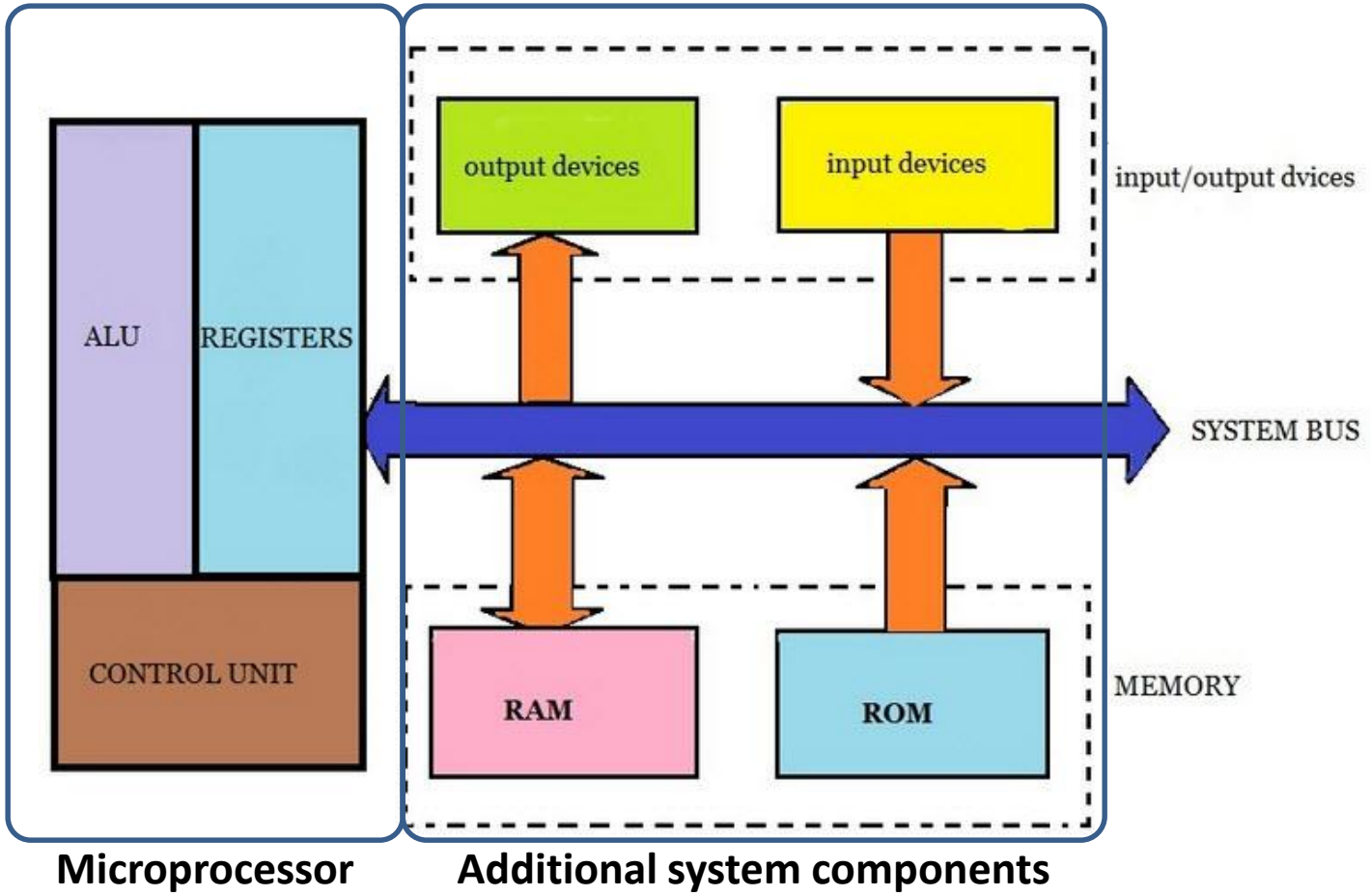
Agenda

- Microprocessors vs. Microcontrollers
- ARM – ARM Holdings and microprocessor cores
- STM – ST Micro, our device vendor
- STM32 – line of 32-bit microcontrollers
- STM32L - Ultra Low Power MCUs
- STM32L4 - STM32L with Arm® Cortex®-M4 core, FPU, DSP
- STM32L4x6 -
- STM32L476
- STM32 Part Naming
- STM32CubeMX
- Other

Microprocessor vs. Microcontroller

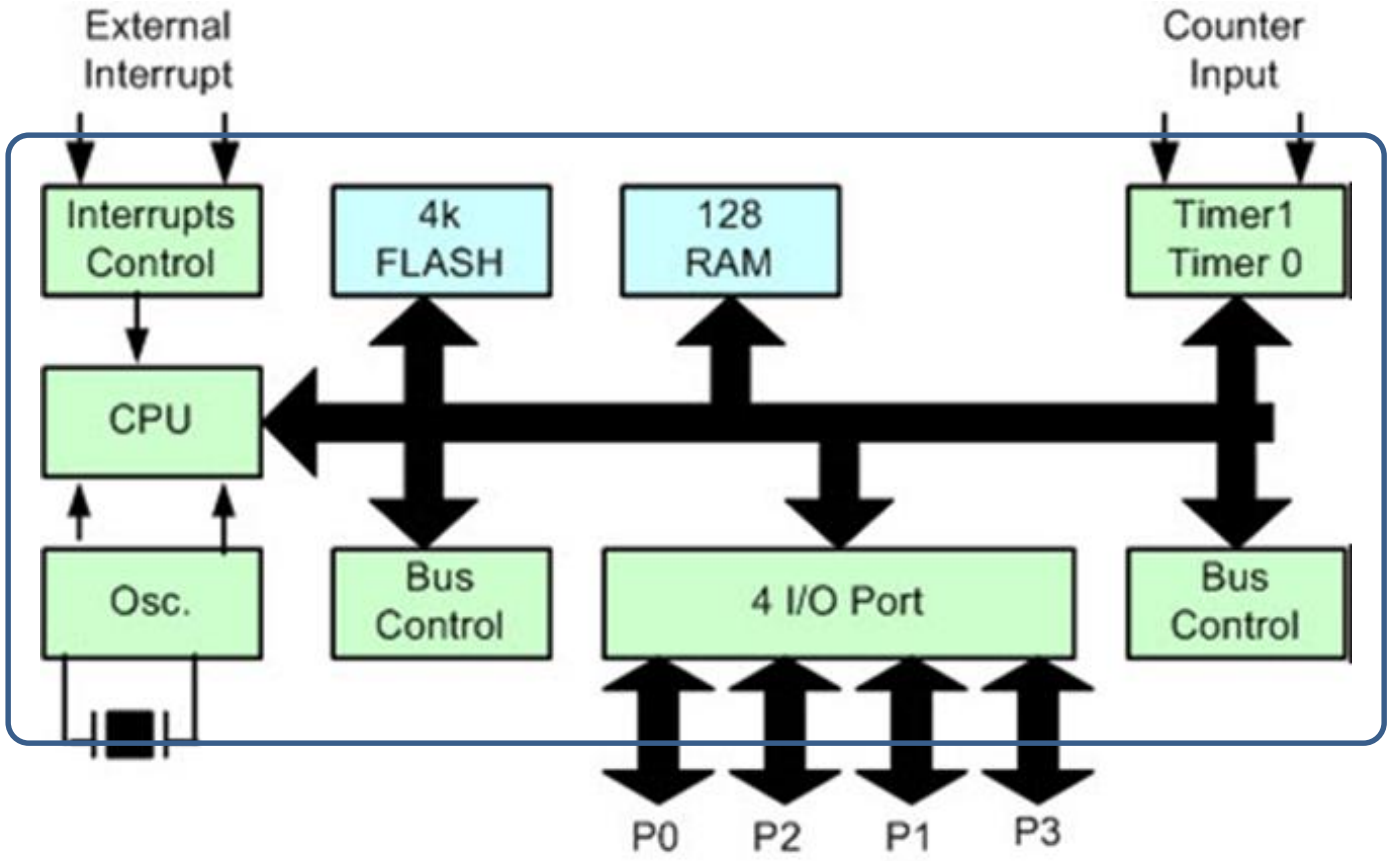
• A microprocessor is an IC which has only the CPU inside, but…	• Microcontroller does have has a CPU inside…
• doesn't have RAM, ROM, and other peripheral on the chip. A system designer adds them externally to design.	• …and a fixed amount of RAM, ROM and other peripherals all embedded on a single chip.
• Targeted towards non-specific tasks / applications like games, websites, photo editing, creating documents, developing software, etc.	• Targeted towards specific applications like keyboard, mouse, washing machine, camera, TV remote, microwave, watches, etc.
• Examples: Intel's Core iX, AMD Ryzen	• Manufacturers include Microchip (Atmel/AVR), TI (Sitara), NXP (Freescale), Renesas, ST (STM32), etc.
• Exact requirements on the MPU are not defined, and thus these systems tend towards incorporating lots of resources like compute power, RAM, ROM, I/O ports etc.	• In application-specific designs, requirements can be controlled, and whole systems can be embedded on a single chip. This can reduce system size and cost.

Microprocessor block diagram



https://www.edgefx.in/difference-between-microprocessor-and-microcontroller/

Microcontroller block diagram



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ARM

- ARM Holdings is the industry's leading supplier of microprocessor technology, offering a wide range of microprocessor cores that address the performance, power and cost requirements for most application markets.
- ARMs primary business is in the design and licensing of ARM processors (CPUs). While AMD, Intel and NVIDIA all make money by ultimately selling chips, ARM's revenue comes entirely from licensing IP.
- ARM Holdings works with more than 1,000 partners delivering silicon, development tools and software, and with more than 90 billion processors shipped to date.
- www.arm.com

ARM

- An ARM processor is based on a RISC (reduced instruction set computer) architecture. ARM makes 32-bit and 64-bit RISC multi-core processors.
  - **Cortex-A** Highest performance, optimized for rich operating systems
  - **Cortex-R** Fast response. Optimized for high-performance, hard real-time applications
  - **Cortex-M** Smallest/lowest power, optimized for discrete processing and microcontroller

STM

- In this class, we will be using an ST Micro microcontroller. Where does it fit into the semiconductor ecosphere?
- This section describes decreasing concentric circles of interest from
  - ST the company, to
  - STM32 line of ARM Core MCU products, to
  - …
  - down to our specific part.
- ST Micro - the company
- http://st.com

STM + ARM

- If you put an ARM CPU core on a chip all by itself, you have a microprocessor. But…
- If you combine it with ROM (Flash), RAM, ADCs, DACs, GPIO, UARTs, USB ports, and peripherals on one chip, you have a microcontroller (example: STM32xxx). With an ARM core.

STM32 - 32-bit ARM Cortex MCUs

- 32-bit Flash microcontrollers based on ARM® Cortex®-M processor.
- They are grouped by performance
  - STM32F2, F4, F7 — high performance
  - STM32F0, F1, F3 — mainstream
  - STM32L0, L1, **L4**, L4+ — low power
- And by Core type
  - Cortex M0/M0+,
  - Cortex-M3,
  - Cortex-**M4** and
  - Cortex-M7
- http://www.st.com/en/microcontrollers/stm32-32-bit-arm-cortex-mcus.html

STM32L - Ultra Low Power MCUs

- **STM32L0** (Arm® Cortex®-M0+) and the **STM32L1** (Arm® Cortex®-M3) - ultra-low-power solution is the right choice for applications operating on a battery or supplied by energy harvesting, which require an extra-long life. The STM32L0 is available in tiny packages down to 14-pin and with a wide range of Flash memory densities from 8 to 192 Kbytes
- The **STM32L4** series offers the excellence of ST's ultra-low-power platform with an additional performance dimension by providing 100 DMIPS with DSP instructions and floating-point unit (FPU), more memory (up to 1 Mbyte of Flash memory) and innovative features.
- The **STM32L4+** series extends STM32L4 technology by offering higher performance (120 MHz/409 CoreMark executing from internal Flash memory), larger embedded memories (up to 2 Mbytes of Flash memory and 640 Kbytes of SRAM), and more advanced graphic features with no compromise on its ultra-low power consumption capability.
- http://www.st.com/en/microcontrollers/stm32-ultra-low-power-mcus.html

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STM32L4 - STM32L with Arm® Cortex®-M4 core, FPU, DSP

- With FPU and ST ART Accelerator @ 80 MHz delivers 100 DMPI
- STM32L4 microcontrollers offer dynamic voltage scaling to balance power consumption with processing demand, safety and security features, smart numerous low-power peripherals, advanced analog peripherals (i.e. op amps, comparators, LCD, 12-bit DACs and 16-bit ADCs (hardware oversampling).
- The series are available in different lines:

  STM32L4x1 (Access line),
  STM32L4x2 (USB Device),
  STM32L4x3 (USB Device, LCD),
  STM32L4x5 (USB OTG)
  STM32L4x6 (USB OTG, LCD)

- http://www.st.com/en/microcontrollers/stm32l4-series.html

STM32L4x6 -

- STM32L476/486/496/4A6 devices extend the ultra-low-power portfolio and performance with an ARM® Cortex®-M4 core (DSP and FPU) at 80 MHz with USB OTG, LCD support.
- http://www.st.com/en/microcontrollers/stm32l4x6.html

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STM32L476

- This part is one in a series of STM32L4x6 parts
- It is used on our version of the STM Discovery board
- STM32L476xx Datasheet

- How is it different than other STM32L4x6 parts?
- How many kinds of STM32L476 parts are there?
- Naming of the parts can be found in the STM32L476xx Datasheet

Table 130. STM32L476xx ordering information scheme

Example: STM32 L 476 R G T 6 P TR

Device family

STM32 = ARM® based 32-bit microcontroller

Product type

L = ultra-low-power

Device subfamily

476: STM32L476xx

Pin count

R = 64 pins

J = 72 pins

M = 81 pins

V = 100 pins

Q = 132 pins

Z = 144 pins

Flash memory size

C = 256 KB of Flash memory

E = 512 KB of Flash memory

G = 1 MB of Flash memory

Table 130. STM32L476xx ordering information scheme

Example: STM32 L 476 R G T 6 P TR

Package

T = LQFP ECOPACK®2

I = UFBGA ECOPACK®2

Y = CSP ECOPACK®2

Temperature range

6 = Industrial temperature range, -40 to 85 °C (105 °C junction)

7 = Industrial temperature range, -40 to 105 °C (125 °C junction)

3 = Industrial temperature range, -40 to 125 °C (130 °C junction)

Option

Blank = Standard production with integrated LDO

P = Dedicated pinout supporting external SMPS

Packing

TR = tape and reel

xxx = programmed parts

STM32CubeMX

- Microcontrollers a very complex devices, often very difficult and complex to configure. Most manufacturers offer tools to help in this process.
- STM32CubeMX is a graphical tool that allows
  - a very easy configuration across all STM32 microcontrollers and
  - the generation of the corresponding initialization C code through a step-by-step process.
- It integrates with different development tools.
  - STM32CubeMX integrates with Keil.
- It comes with a getting started manual and many examples.

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Other Resources

- There is an STM32L MOOC
- https://www.st.com/content/st_com/en/support/learning/stm32-education/stm32-moocs.html