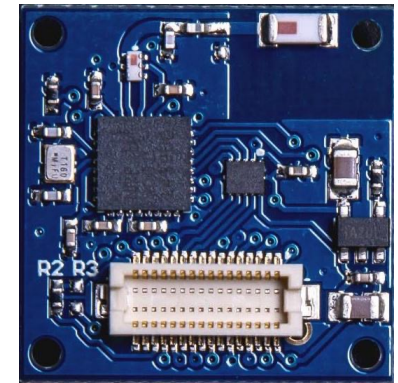
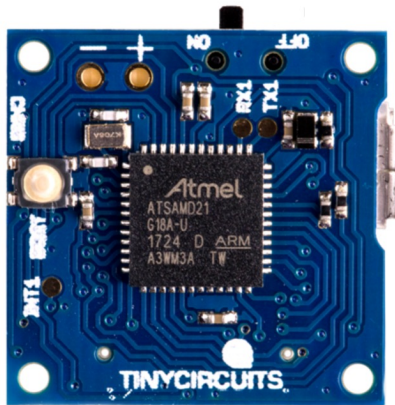


CSE190 Fall 2022

Lecture 3

MCUs (cont.)



Wireless Embedded Systems

Aaron Schulman

How to choose an MCU for a project?

- What metrics we need to consider?
 - Power consumption
 - Clock frequency
 - I/O
 - Memory
 - Internal functions
 - Size

How to choose MCU for our project?

- What metrics we need to consider?
 - Power consumption
 - E.g., we cannot afford high-power MCU because the power budget of the system requires lasting two years on one battery charge.
 - Clock frequency (speed that instructions are executed)
 - kHz is too slow...
 - 100MHz is over kill...
 - I/O
 - Lots of peripherals you can have:
Image sensor, UART debugger, SD card, DAC, ADC, microphone, LED

How to choose MCU for our project?

- What metrics we need to consider?
 - Memory
 - We need to have sufficient memory to store:
 - Program (Non-volatile): Logic to read from sensors, communicate
 - Stack: Function calls are now expensive (no recursion)
 - Data: Constants (time periods), Sensor history, Communication state
 - » We may need non-volatile data storage for data too (e.g., Flash)
 - Performance of internal peripherals
 - E.g., Speed of copying data from the sensor to the radio (DMA)

How to choose MCU for our project?

- **Memory**

- Store accelerometer history data

- 12bits each for X,Y,Z acceleration
- sampled 2 thousand times a second (2 KHz)
- = $12 * 3 * 2,000$ bits per second (72kbits or 9 kBytes)
- How many seconds can we hold if we have only 100 kBytes of storage?

- What types of memory are available on an MCU?

- Internal memory: SRAM, 0.5~128 kBytes, non-volatile FRAM also available
- External memory: Flash, high power consumption, ~5mA for read and ~10mA for erase

How to choose MCU for our project?

- **Clock frequency**

- kHz is too slow

- Smartphone camera frame rate is 60fps

- (1 KHz clock would leave only 60 clock cycles per frame)

- 100MHz is too fast

- Power consumption is high

- (power increases linearly with clock speed)

- O(10) MHz is ideal for most applications

How to choose MCU for our project?

- **I/O (interface for external peripherals)**

- Interfacing sensors, debugger, LEDs, Bluetooth radio

- Every I/O needs physical pins on the chip

- We often need **a large number** of I/O pins

- We need **various types** of I/O pins

- (some pins can do more than one function)

- Analog pins (input/output analog signals e.g., audio)

- Digital pins (input/output digital signals e.g., busses, GPIOs)

The MCU used in our projects

Core Processor	ARM® Cortex®-M0+	<input type="checkbox"/>
Core Size	32-Bit	<input type="checkbox"/>
Speed	48MHz	<input type="checkbox"/>
Connectivity	I ² C, LINbus, SPI, UART/USART, USB	<input type="checkbox"/>
Peripherals	Brown-out Detect/Reset, DMA, I ² S, POR, PWM, WDT	<input type="checkbox"/>
Number of I/O	38	<input type="checkbox"/>
Program Memory Size	256KB (256K x 8)	<input type="checkbox"/>
Program Memory Type	FLASH	<input type="checkbox"/>
EEPROM Size	-	<input type="checkbox"/>
RAM Size	32K x 8	<input type="checkbox"/>
Voltage - Supply (Vcc/Vdd)	1.62 V ~ 3.6 V	<input type="checkbox"/>
Data Converters	A/D 14x12b, D/A 1x10b	<input type="checkbox"/>
Oscillator Type	Internal	<input type="checkbox"/>
Operating Temperature	-40°C ~ 85°C (TA)	<input type="checkbox"/>
Package / Case	48-TQFP	<input type="checkbox"/>
Supplier Device Package	48-TQFP (7x7)	<input type="checkbox"/>