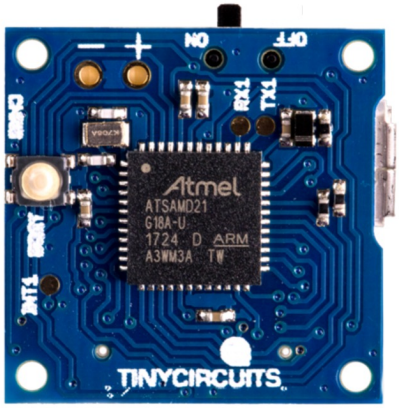
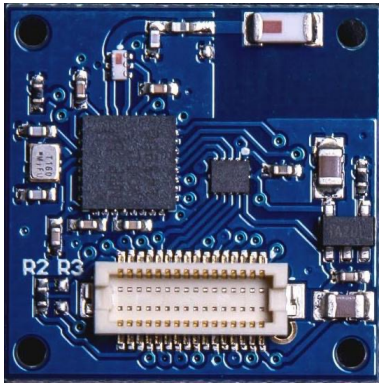
# CSE190 Fall 2023




## Lecture 3

## MCUs (cont.)




Wireless Embedded Systems

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# 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 (36 bits)
    - sampled 2 thousand times a second (2 KHz)
    - = 36*2,000 bits per second (72 kbit/s or 9 kByte/s)
    - 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 embedded 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 ($10)

| | |
|---|---|
| **Core Processor** | ARM® Cortex®-M4 |
| **Core Size** | 32-Bit Single-Core |
| **Speed** | 80MHz |
| **Connectivity** | CANbus, EBI/EMI, I²C, IrDA, LINbus, MMC/SD, QSPI, SAI, SPI, SWPMI, UART/USART, USB OTG |
| **Peripherals** | Brown-out Detect/Reset, DMA, PWM, WDT |
| **Number of I/O** | 82 |
| **Program Memory Size** | **1MB (1M x 8)** |
| **Program Memory Type** | FLASH |
| **EEPROM Size** | - |
| **RAM Size** | 128K x 8 |
| **/oltage - Supply (Vcc/Vdd)** | 1.71V ~ 3.6V |
| **Data Converters** | A/D 16x12b; D/A 2x12b |
| **Oscillator Type** | Internal |
| **Operating Temperature** | -40°C ~ 85°C (TA) |
| **Mounting Type** | Surface Mount |
| **Package / Case** | 100-LQFP |
| **Supplier Device Package** | 100-LQFP (14x14) |
| **Base Product Number** | **STM32L475** |