

Meadow - A Modern IoT Hardware and Software Development Platform

Mark Stevens
Wilderness Labs



About

Mark Stevens

- Currently a Firmware Engineer, Wilderness Labs
- Software Engineer, Project Manager and Operations Manager
- Tinkering with hardware and software since the late 1970s



@nevynuk



Agenda

- Embedded Development Today
- Meadow Hardware
- Meadow OS
- Development Environments
- Meadow.Foundation
- Demonstrations
- The Future for Meadow

Follow Along at Home

https://github.com/WildernessLabs/Meadow_Project_Samples

A wide-angle photograph of a serene landscape. In the foreground, there's a calm lake reflecting the surrounding environment. The middle ground features a valley with lush green fields and scattered small buildings or houses. The background is dominated by towering, rugged mountains with rocky peaks and patches of green vegetation. The overall scene is peaceful and natural.

Embedded Development Today

Embedded / IoT is Everywhere

Compute has moved through several phases:

- Mainframe
- Mini
- Desktop
- Mobile
- IoT

Embedded devices are all around us, 25B today, predicted to be 75B by 2025

IoT uptake is gaining velocity and appearing in a wide variety of industries

Embedded Development

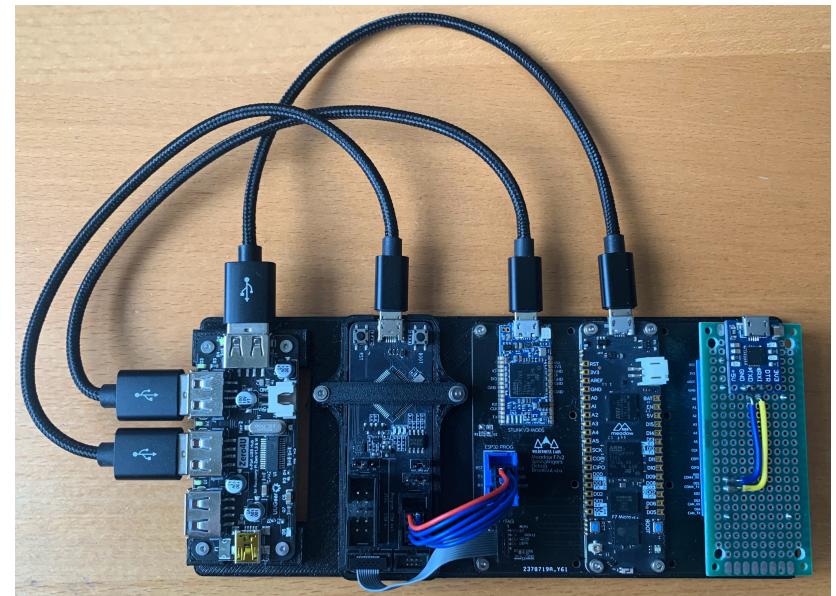
Traditionally Embedded C or Assembly

Some alternative languages available:

- MicroPython and CircuitPython
- Rust
- Ada

C & Assembler IDEs and techniques have not really moved on from 1990s

Debugging is often complex and requires additional hardware



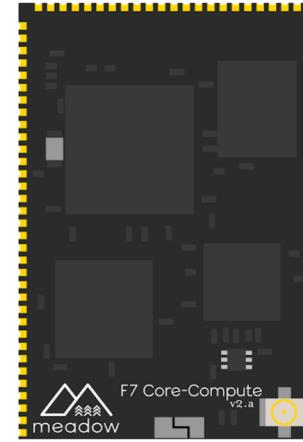
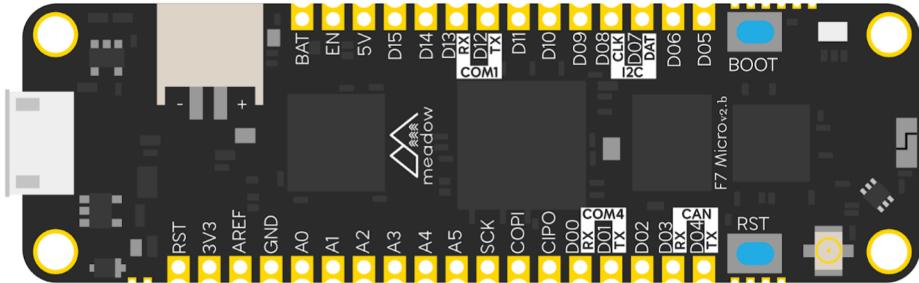
.NET

Platform	Notes
NanoFramework	Range of microcontrollers supported Supports less powerful microcontrollers .NET2.0 Derived from .NET MicroFramework C#
Raspberry Pi	Full .NET C#, F# and VB.NET High power consumption compared to microcontrollers
TinyCLR	No generics Limited number of assemblies and assembly sizes
Meadow	.NET Standard 2.1 (.NET 6 planned) C#, F# and VB.NET Wide range of NuGet libraries available supporting a number of peripherals Meadow hardware supports WiFi and Bluetooth Cloud management Meadow hardware uses low power microcontrollers (STM32 and ESP32)

A wide-angle photograph of a mountainous landscape. In the foreground, there's a body of water with some small, rocky islands. The middle ground shows a valley with green fields and scattered trees. In the background, there are majestic, rugged mountains. The sky is clear and blue.

Meadow Hardware

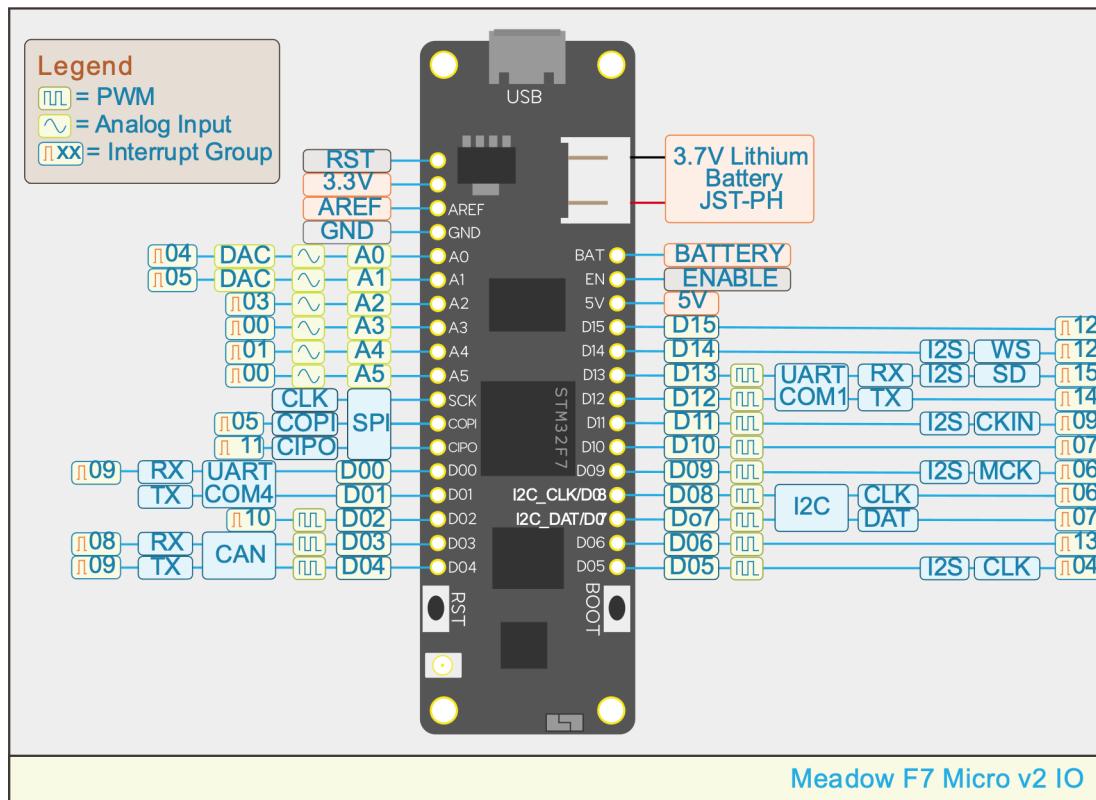
Meadow Hardware



Low-energy, microcontroller-based Modules.

Prototype to production using the same hardware and code

Meadow F7 Peripherals

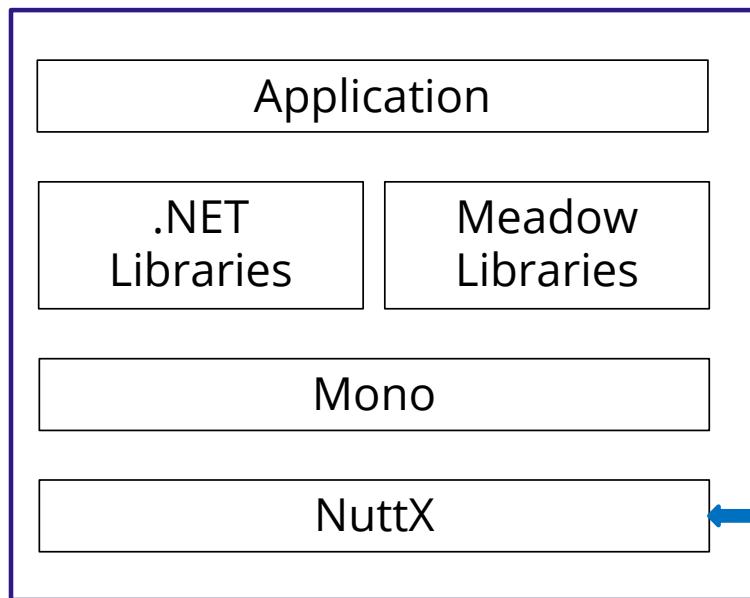


A wide-angle photograph of a mountainous landscape. In the foreground, there's a calm lake reflecting the surrounding environment. The middle ground shows a valley with green pastures and small clusters of trees. In the background, majestic mountains rise, their peaks partially obscured by clouds. The overall scene is serene and natural.

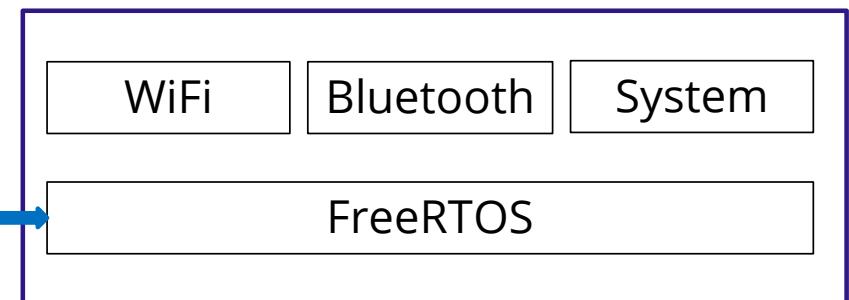
Meadow OS

OS Stack

STM32



ESP32



Meadow.OS Features

Networking (WiFi + Ethernet) with full SSL

BLE Server

SQLite

Persistent File System

Watchdog Timer

A wide-angle photograph of a serene landscape. In the foreground, there's a calm lake reflecting the surrounding environment. The middle ground features rolling green hills dotted with small buildings and trees. The background is dominated by majestic, rugged mountains with patches of green and rocky terrain. The overall scene is peaceful and natural.

Development Environments

Development Environments

OS	VS 2019	VS 2022	VS Code
Windows	Y	Y	Y
Mac	2019 (for Mac)	N/A	Y
Linux	N/A	N/A	Y

Meadow is supported through:

- Visual Studio extensions
- Command line tool

Debugging

Debugging is fully integrated with Visual Studio

Visual Studio Code can be used with the aid of the command line tool

Applications can also be debugged using the Mono command line debugger

A wide-angle photograph of a mountainous landscape. In the foreground, there's a body of water with some small, rocky islands. Beyond the water, the land rises into green hills and meadows dotted with small buildings and trees. The background is dominated by towering, rugged mountains with patches of snow and vegetation.

Meadow Foundation

Meadow.Foundation

Open-source peripheral driver library:

<https://github.com/WildernessLabs/Meadow.Foundation>

Consistent, curated, quality

Documentation: <http://developer.wildernesslabs.co/>

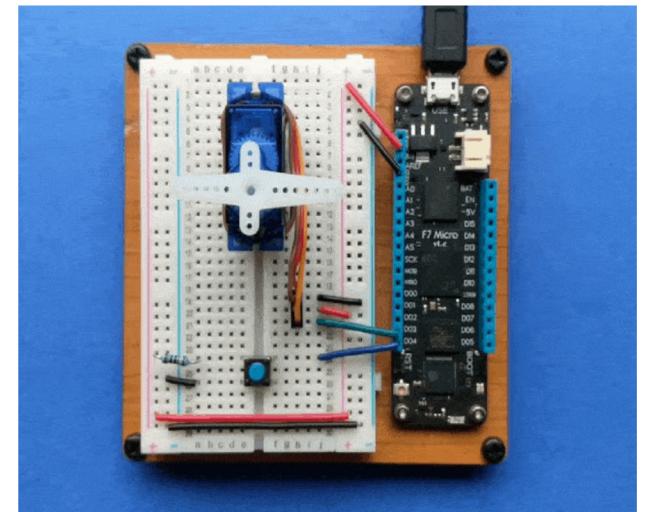
Drivers and Libraries

Driver Type	Number	Driver Type	Number
Core (LEDs, switches etc.)	23	Audio	2
Displays	25	Motor drivers	4
Real-time clocks	2	Atmospheric sensors	17
Cameras	3 (in progress)	Distance	1 (5 in progress)
GPS & GNSS	2	Mass (Load cells)	2
Moisture	2	Power (current)	1
Light	9 (1 in progress)	Motion	11 (2 in progress)
Sound	1	Radio (FM)	1 (1 in progress)
Weather	2	Servos	1
Transceivers	2		
Miscellaneous (EEPROMS, IO Expanders etc.)	15	Temperature	3 (1 in progress)

Sample Projects

- developer.wildernesslabs.co
- Github
- Hackster

```
var servo = new Servo(  
    Device.CreatePwmPort(  
        Device.Pins.D03), NamedServoConfigs.SG90);  
  
var button = new PushButton(Device, Device.Pins.D04);  
  
button.Clicked += (s, e) => {  
    servo.RotateTo(75);  
    Thread.Sleep(1000);  
    servo.RotateTo(0);  
};
```



Meadow.Linux

Port of the Meadow.Foundation library to Linux

Supported Platforms:

- Raspberry Pi 4
- Raspberry Pi Zero 2W
- Jetson Nano
- Jetson Xavier AGX

A wide-angle photograph of a mountainous landscape. In the foreground, there's a calm lake reflecting the surrounding green hills and rocky peaks. The middle ground shows rolling green hills dotted with small buildings and trees. The background consists of majestic, rugged mountains under a clear sky.

Meadow in Action

Meadow in Action

Demo 1 - Hello, world!

Demo 2 - How Bright is it?

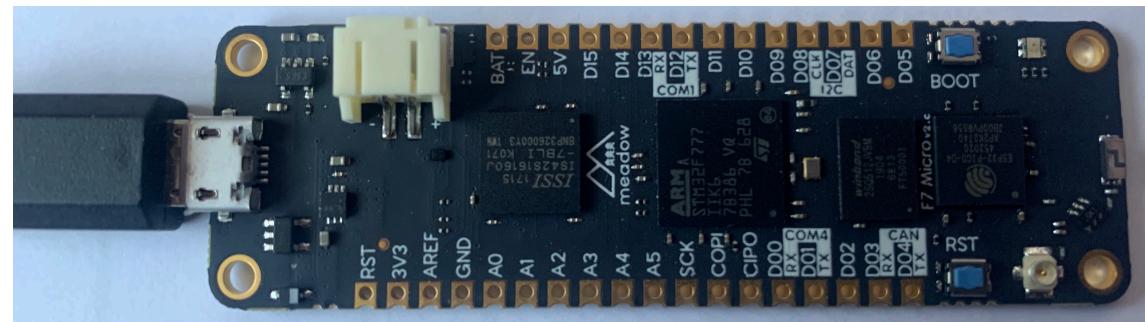
Demo 3 - Multiple Sensors

*Here be
Dragons*

Demo 1 - Getting Started

Blinky (Hello, World for IoT)

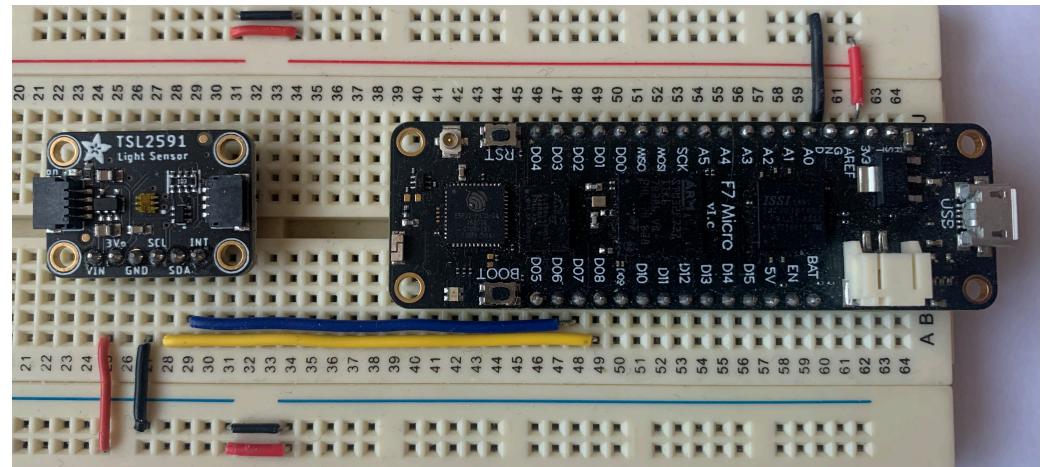
- F#
- Debugging



Demo 2 – How Bright is it?

Connect to light sensor

- C#
- Take light level readings
- Send readings to Adafruit logging service



Demo 3 – Multiple Sensors

Atmospheric conditions

- C#
- Temperature
- Pressure
- Humidity

A wide-angle photograph of a mountainous landscape. In the foreground, there's a body of water with some small, rocky islands. The middle ground shows a valley with green fields, scattered trees, and a few small buildings. The background is dominated by towering, rugged mountains covered in green vegetation. The sky is clear and blue.

The Future

Roadmap

- Over-the-Air (OtA) Updates
- Meadow.OS Security Stack
- .NET 6
- AoT Compilation
- Tree-shaking
- Power and sleep API
- CAN bus

Roadmap: http://developer.wildernesslabs.co/Meadow/Release_Notes/Roadmap/

Conclusion

- Meadow represents a new way to build IoT devices
 - Innovative hardware
 - Full .NET and nuget support
 - Use your favourite language
- Choice of operating system and IDE
- Full debugging support on all operating systems
- Comprehensive library of drivers (Meadow.Foundation)

A wide-angle photograph of a serene landscape. In the foreground, there's a calm lake reflecting the surrounding environment. Beyond the lake, rolling green hills covered with small clusters of trees and houses. In the background, a range of majestic mountains with rugged peaks rises against a clear, light blue sky.

Q & A

Further Information & Social Media

Presentation, sample code and additional links:

[https://github.com/WildernessLabs/Meadow_Project_Samples/
source/DeveloperSouthCoast2022](https://github.com/WildernessLabs/Meadow_Project_Samples/source/DeveloperSouthCoast2022)

Wilderness Labs

-  developer.wildernesslabs.co
-  @wildernesslabs
-  <https://github.com/Wildernesslabs>
-  <https://www.hackster.io/WildernessLabs>
-  <https://www.youtube.com/c/WildernessLabs>

Mark Stevens

-  @nevynuk
-  blog.mark-stevens.co.uk
-  <https://www.linkedin.com/in/mark-stevens-a188614/>

Thank You

