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.NET MICRO FRAMEWORK FOR STM32

What is the .NET Micro Framework?

The .NET Micro Framework (NETMF) is an implementation of.NET specifically for microcontrollers. It allows writing embedded software in C#, using Microsoft's ubiquitous Visual Studio tools.

The .NET Micro Framework is able to run directly on the hardware, without underlying operating system (it is a "bootable .NET runtime").

The .NET Micro Framework is governed by the Apache 2.0 open source license: there are no "target royalties", you may develop commercial software without being required to pass on your own improvements, and adaptations to new hardware are possible anytime.

ARM Architecture

Today, ARM is one of the most popular architectures for microcontrollers. The current ARM architecture (instruction set) for microcontrollers is called ARMv7M.

Cortex-M3 Core

There have been NETMF ports to various ARM7 and ARM9 cores for some time now. An ARM core is a specific implementation of an ARM architecture, where there may exist multiple cores for the same architecture. Confusingly, an ARM7 core implements the ARMv3, ARMv4, or ARMv5 architecture. An ARM9 core implements the ARMv4 or ARMv5 architecture.

Cores that implement the current ARMv7M architecture have a more intuitive naming scheme. They are called Cortex-M, with a suffix that indicates the relative performance and functionality. For example, Cortex-M3 is more powerful than Cortex-M0, but possibly more expensive and consuming more power.

We have ported NETMF to the Cortex-M3 core. This task involved mainly the core initializations: interrupts, reset, error handling, etc.

STM32 Microcontroller Family

ARM develops the cores. Its semiconductor partners license such cores and develop complete microcontroller chips around them. STMicroelectronics is one of several ARM licensees that have built products around the Cortex-M3 core, in this case called STM32. This has become one of the most popular Cortex-M3 implementations on the market.

At the time of this writing (August 2011), there are over 170 different STM32 variations. Some of them have part numbers that start with STM32F1. Products in this "family" run from 24 to 72 MHz, have Flash sizes from 16 KB to 1 MB, have RAM sizes from 4 KB to 96 KB, and sport a variety of peripherals, from digital I/O (GPIO) to USB and Ethernet support. Also, several different physical packages for the same model are offered.

One specific example is the STM32F103RE, which has 512 KB of Flash and 64 KB of RAM in a 64 pin package that measures 10 by 10 millimeter. The Flash and RAM are sufficient to run the .NET Micro Framework plus a small application, even without attaching additional external memory chips (which is possible with some other family members). At the time of this writing, such a chip is available for about $15 (one unit) to about $8 (10,000 units).

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We have ported NETMF to the STM32F103 family. This involved writing drivers for the on-chip peripherals: GPIOs, analog inputs and outputs, I2C, SPI, UARTs, USB, internal Flash, power management, timers, etc.

MCBSTM32E Board (Keil)

A microcontroller chip needs to be put onto a printed circuit board. One product containing an STM32F103 is the MCBSTM32E evaluation kit of Keil, an ARM subsidiary.

We have ported NETMF to this board. This involved writing drivers for the external Flash (8 MB) and the external RAM (1 MB). There is no support for the board's LCD display.

ET-STM32-Stamp (Futurlec)

The ET-STM32-Stamp is another board, from Futurlec. It is inexpensive ($25) and contains another STM32F103 model.

We have ported NETMF to this board. This involved using the boot loader built into the STM32 chips, instead of using the normal NETMF boot loaders. This saves valuable memory – the board has no additional external memory.

Other Boards

You could adapt one of the above board ports to any other board with the STM32F103. Depending on your experience and knowledge of NETMF and the C/C++ tool chain that you use, this may take from less than one day to several weeks. Additional work may be required depending on what additional hardware the board provides. For example, if the board has a GSM module, then a driver for this module must be developed.

Custom Board Example

The board shown below uses an STM32F103RE microcontroller and NETMF for STM32. It was custom-designed for Phonak (aka Unitron), the world's largest provider of hearing aids. The board helps the Phonak engineers to test new hearing aids. It allows switching between several pairs of attached hearing aids. This switching is controlled by a PC via USB. For the PC, we provided a .NET library that sends control commands to the board. In this way, we were able to use .NET, C# and Visual Studio both for the PC application and for the embedded software, eliminating the need for special-purpose embedded tools.

Apache 2.0 Open Source License

We have contributed the port(s) described above to the open source community. The source code, governed by the Apache 2.0 license, has been integrated into Microsoft's NETMF Porting Kit.

Codeplex

You can download the source code from the download section of Codeplex.

Please note that we can provide technical support exclusively within customer projects. If you find any issues with the code, please use the issue tracker on Codeplex to report them.