

Microcontrollers: Need for Standard Core

Tools and support ecosystem are key drivers for the popularity of a microcontroller architecture. While there are several software tools available for use across different platforms, hardware tools are restricted to only one type of MCU. Considering the cost and time involved in change of a design, isn't there need for a common and consolidated architecture?



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What makes you think of shifting your design from one microcontroller to another? The answer is most likely to be performance and cost. Power consumption, integration, time-to-market, tools and support follow it. But, is it easy to change? Every design engineer, over the course of time, develops an ecosystem and favouritism for a microcontroller architecture that he has been using so far, which makes the shift a little emotional. The change in MCU architecture also incurs a lot of time and money.

You may opt to change the MCU family if your current design is consuming too much power, or the microcontroller architecture does not have the interfaces you require, or

it is too slow. Needless to say, the core architecture of the microcontroller is a key driver for the change. While choosing a new microcontroller, you have to consider all the aforementioned issues and at the same time ensure that the new architecture has right development tools and support. This becomes quite tricky for the designer, as there are so many architectures

from so many vendors available in the market.

According to a report by Frost & Sullivan, the worldwide microcontroller market was \$16 billion in 2007. Surprisingly, as per the report, top two suppliers by revenue shipped more than ten different incompatible architectures of MCUs. Another research from Semico says that the MCU market has more than 40 suppliers providing more than 50 architectures with no architecture holding as much as 5 per cent share in the MCU market. With such a diversity, do we see any commonality between the success of 8051 of yesteryears and today's ARM core?

Core architecture splits the MCU market

There is an ongoing competition between different vendors to offer the

best possible combination of integrated peripherals for dedicated applications. The result is a variety of architectures from different vendors.

Some companies provide their own microcontroller architecture, like Texas Instruments' MSP430, Renesas Electronics' H8 and SuperH, Freescale's Coldfire and Atmel's AVR.

Companies like ARM or MIPS are not microcontroller manufacturers. "We create technology and licence it to companies like STMicroelectronics, NXP, TI and others who build their product families based on our architectures. Hence their products are called ARM-based products," informs Shyam Sadasivan, CPU product manager, ARM.

"We provide intellectual property (IP) of standard processor-based architectures to microcontroller and system-on-chip (SoC) developers," says Ian Anderton, strategic marketing manager, MIPS Technologies.

Although companies like Atmel and TI have their own architectures, these are the licensee of standard cores like 8051 and ARM. "We do not see competition between our own two products, as the business model for both is different. There is a clear distinction from the end applications' viewpoint," says Andreas Eieland, AVR product marketing manager, Atmel.

MCU considerations

Developers need to find out whether the performance of a given microcontroller core matches their product's

specifications. Dhrystone (DMIP) benchmark is one of the measurement methods for CPU performance. The code tries to twist and test various parts of the CPU core. A higher value of DMIP/MHz means a better and efficient core. This provides a simple means for most developers to choose a core for their project.

Binu Raj S., senior architect-hardware design team, Dexcel Electronics Designs, shares, "A lot of analysis is done before freezing on to a particular MCU that best fits the requirements in the initial phase of the project. Features, integrated peripherals, performance, cost and power are some of the key decision factors for selection of a particular MCU." Tools and support, code reuse and design portability are the other considerations.

LIM, Wee Seng, senior manager, Renesas Electronics, says, "Advanced developers will peek into the CPU core architecture to seek an answer to their higher level of problems. This can be the need of floating-point unit (FPU), DSP-like instruction, multiply-and-divide instructions for many mathematical calculations, fast interrupt latency for fast event response, more number of 32-bit registers for 32-bit data manipulation and so on."

With optimal performance, energy efficiency becomes a key factor in em-

What embedded designers have to say

"Online support for an MCU is quite important. If standard initialisation codes and interfacing codes are available, it reduces the effort for the designer"

—**Praval Jain, VP-networks, Virtual Wire Technologies**

"Indian embedded society is one where migration to newly available MCUs is required to avail the cost and performance benefits"

—**Upendra Patel, CTO, elnfochips**

"Apart from price and support, nowadays we are very careful about the lead time"

—**Binu Raj S., senior architect-hardware design, Dexcel Electronics Design**

"It's up to the designer's knowledge and imagination as to how he makes optimal use of available resources"

—**K.C. Bhasin, Ex-EFY Technical Lab**

"My choice of microcontroller is based on the availability of tools and samples as today all the companies are able to offer low-power, low-price parts"

—**Vinay Chaddha, CEO, GVC Systems**

bedded applications. Sadasivan adds, "In embedded world, it is not just about pushing the MHz speed as in the case of processors. The emphasis is on energy and computing efficiencies." "Imagine you have a device with processor speed of 200 MHz and a flash memory, but the flash memory has a limitation up to 40-50 MHz. So increasing only the processor speeds will not make any difference to your embedded design," he explains.

According to Wee Seng, "Most developers write their programs in 'C' language, and not Assembly language. They are more concerned about how well the core can perform with an efficient compiler, and how easy to use

is the IDE and debugger."

Open source tools, which can be downloaded for free, also drive the MCU selection. Praval Jain, vice president-networks at Virtual Wire Technologies, cites, "If there are free tools available, and their performance is quite similar to paid tools, such MCUs are preferred." You can get a variety of free tools for standard cores and the support community is also huge.

According to Eieland, "There are a number of open source tools available for proprietary cores as well. In fact, you also have open source hardware in the form of Arduino platform based on an MCU which is a proprietary core."

Is there a need for standard core?

A microcontroller architecture develops a huge world of reference designs, application notes, software tools, hardware tools and coding language around it. "The success or failure, and the time to market of a product depend heavily on the strategy of embedded software development," feels Amit Bhojraj, product marketing manager for business line-microcontrollers, NXP Semiconductors. "Though there is still a lot of work involved in moving a design from one MCU vendor to another that offers the same core architecture, it is still considerably easier than to move between proprietary core based microcontrollers," he adds.

8051 and PIC rule in 8-bit

Invention-wise, the forefather of the microcontroller world is 8051. Then came in PIC and Renesas and the most recent is AVR. 8-bit is dominated by 8051 because of its long existence, improvements with time, established tools and familiarity in student community. Though IP provider Intel has discontinued MCS 51, other vendors still offer 8051 flavours of MCUs.

"The launch of Microchip's PIC was a game changer in 8-bit as it offered a very small-size and low-cost MCU. Flash memory based PICs range from tiny 6-pin SOT23 package to 100-pin TQFP package targeted at small-size embedded products," shares **Upendra Patel, CTO, elnfochips.**

Although PIC and AVR have captured the market, 8051 is still in use because of its simplicity, familiarity and low cost. 8051 leverages a huge supporting community as it is manufactured by around 50 different vendors, whereas PIC and AVR are manufactured by their parent companies Microchip and Atmel, respectively.

Market research firm Gartner ranked Microchip as No. 1 in 8-bit microcontrollers and listed Atmel as the fastest growing 8-bit microcontroller vendor in the world in 2008 with its AVR and Qtouch capacitive-touch technology. From applications' perspective, iSuppli reports that one of the key trends for 8-bit market is integration of specific peripherals for dedicated tasks—like the LCD controller, USB ports, touch controllers and extended memories.

16-bit for low power, high performance

While 8-bit microcontrollers dominate the existing embedded market and specific applications, 16-bit microcontrollers strike the cost and performance balance for many handheld and portable devices. Almost all the 16-bit MCUs from different vendors are targeted at portable embedded applications that require decent performance at low power.

Unlike 8-bit and 32-bit, there is no standard core in 16-bit space. Proprietary cores offered by different vendors are targeted at different application areas. Renesas' M16C multi-function MCU family meets the increasing functionality demands corresponding to different market segments. It is compatible with both the low-end as well as high-end MCUs in the family. Electronic household appliances, white goods, audio equipment, TV sets and cameras are some of the application areas.

Mixed-signal processors family MSP430 from Texas Instruments is popular in India. Shailesh Thakurdesai, business development manager for microcontrollers, TI, shares, "As cost-sensitive applications are also demanding more functionality from microcontrollers, the 16-bit RISC architecture of MSP430 provides greater performance, peripherals and low power at no additional cost." He adds, "With ease of programming, modern architecture, in-system emulation capabilities and code compatibility, the migration of code to higher-performance devices is painless." MSP430 finds application in metering units, handheld medical equipment and automation.

16-bit MCUs with digital signal controllers are largely suitable for motor control applications. "System-based chips address the electromagnetic capability robustness for in-vehicle networks, while SmartMOS optimises power and cost for electronic control units in automotive applications," shares Vivek Tyagi, country manager-sales for Freescale Semiconductor.

In spite of the recent launches to keep 16-bit alive, experts feel that 8-bit and 32-bit are the answer for the microcontroller market. "Development is happening to push the performance of 8-bit on the higher end and 32-bit on the lower end. This has squeezed the market share for 16-bit," says Arnaud Julienne, director-MCU & MPU, STMicroelectronics. Although 8-bit might not be growing in terms of revenue, it has shown growth in the number of units sold.

According to market research firm iSuppli, Renesas (now Renesas Electronics) ranks first in sales of 16-bit MCUs. Infineon, Panasonic, Texas Instruments and Freescale are next in the list.

ARM for 32, the choice of many

For applications demanding high levels of performance and integration, the choice is likely to be the 32-bit core based microcontrollers. "Lately, 32-bit MCUs have started dominating the sector just because vendors are able to offer 32-bit performance at competitive price point," shares Patel. Most of the 32-bit MCUs are 32-bit embedded processors connected to peripherals and memory for controller applications. 32-bit MCUs greatly benefit from the tools, software and knowledge base for established PC processors.

In 32-bit space, so far the outright leader is ARM Cortex based microcontroller. Cortex series meets the demand for performance and power. In ARM Cortex-M series, where 'M' stands for microcontrollers, different variants like Cortex-M0, M3 and most recent M4 serve speeds ranging from 50 MHz up to 150 MHz, which is the general MCU requirement.

Cortex-M3 based microcontrollers provide 40-50 per cent savings in code space, very low active power and attractive price point of 65 cents. Going further, Cortex-M4 offers an exciting blend of high-performance MCU with digital signal processing in an easy-to-use single ARM architecture and software ecosystem.

In proprietary cores, Renesas Electronics is growing with its 32-bit product portfolio. "We have observed that there is a growing interest toward higher-MIP 32-bit MCUs, such as our H8SX, R32C and SH2(A). Renesas (now Renesas Electronics) has also created a new 32-bit core named as 'Renesas eXtreme' (RX). This CPU core can achieve 200 MHz, 1.65 DMIPS/MHz and 0.03 mA/MHz," shares Wee Seng.

Atmel's AVR, Freescale's Coldfire and Infineon's Tricore compete with ARM in specific application areas. But market share is the largest for ARM core.

In support of standard cores, Jain shares, "First, there are more than one vendor that can supply the MCU. For example, ARM7-based microcontrollers are available from a number of companies including NXP (LPC series) and Atmel (SAM7). Similarly, 8051 is also available from a number of companies. Second, porting of the code becomes much easy. Nowadays, coding is done in a high-level language (such as 'C'), and the compiler does a lot of job for you. Even with this kind of coding, porting is not easy, as the architecture-specific code (for initialisation of peripherals) needs to be rewritten completely."

"Standard cores generally have most of the interfaces proven as they need to work with some standard interfaces. Hence designing is faster and more dependable. On the other hand, proprietary cores are tailor-made for some specific requirements and the maturing time for them is usually longer. However, these have their own benefits like design security and customisation and will be more optimal for particular designs," says Binu.

In a nutshell, standard cores create a platform that is easy to approach, easy to use and easy to migrate. This could be the reason for the success of 8-bit 8051 and 32-bit ARM. "If you look at 8-bit space, 8051 has achieved its position in standard cores. There is possibly no room for new standard cores in 8-bit space. Slowly the 16-bit slot is migrating to 32-bit space. And in 32-bit, ARM has gained popularity with its core Cortex-M," shares **Upendra Patel, chief technology officer at eInfochips.**

The favouritism for standard cores makes them score over proprietary ones. But it's the ecosystem around the core that makes it successful. Rather than going through the learning curve to become expert in one, designers can benefit from resources like online community where they can seek help for their designs. A common and consolidated platform seems to be the answer for fast-evolving embedded needs. ●

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