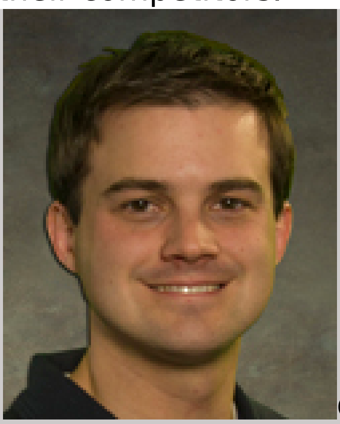
# The Roundtable - Intelligent Systems

**Given the complexities of MCUs today, do you feel that we can call them "intelligent system SoCs"?**

**Vegard Wollan, Atmel Corporation,** www.atmel.com **[1]**

Yes. With the complexities of microcontrollers today, I believe we can call them intelligent system SoCs. Microcontrollers (MCUs) now range from industry-standard cores, such as ARM, to proprietary cores, such as Atmel AVR MCUs. Despite the core, each microcontroller consists of a range of intelligent features, from intelligent peripherals to maintain lower power, to security features embedded within the hardware, to easy-to-use integrated development environments (IDE) for developing and debugging MCU-based applications.

MCUs, like SoCs, deliver more computing performance, better power efficiency and can be programmed according to designers' needs within a software environment. Given this, you can say that each MCU represents a unique combination of performance, power efficiency and design flexibility. And in all of these ways, MCUs are no longer just a single core without intelligence. Each MCU can be tailored to meet the needs of specific applications, from consumer to industrial, home automation and telecommunications, to name just a few areas. By taking advantage of all of the intelligence now embedded within the core and peripherals of MCUs, designers have the resources needed to differentiate their products from those of their competitors.

**Charles Ice, Microchip Technology,** www.microchip.com **[2]**

Today's microcontrollers (MCUs) today have helped to redefine what a System-on-Chip looks like. MCUs have adapted to service the needs of an almost infinite number of applications. To meet the needs of their customers, MCU designers have integrated more features onto the MCU device, while at the same time pushing for lower price points. The MCUs of today integrate Flash, EEPROM, ADCs, Op Amps, display drivers, and a plethora of communication peripherals into a single device. MCUs continue to integrate more features on the device to help their customers reduce costs by removing components from the board, putting even more of the system on the MCU.

For example Microchip's new dsPIC33E Digital Signal Controllers (DSCs) feature on-chip Op Amps, reducing the need for customers to have external Op Amps on their boards. This lowers costs by reducing board size and component count. As customers continue to push for lower costs, consolidation of multiple chips into one will continue to offer significant advantages. In effect, the more of the system integrated on the MCU chip, the more advantages the MCU supplier can offer the customer. By responding to these pressures from the market and integrating multiple features onto a single device, the MCU has evolved into one of the most clear examples of an intelligent SoC, today.


**Geir Førre, Energy Micro,** www.energymicro.com **[3]**

We think that in the case of our own EFM32 Gecko microcontrollers, the answer is a definite 'yes'. This statement goes further than the sheer amount of functionality that is crammed on to the die or the power of the ARM Cortex-M3 processor. The intelligence also emerges from the interactions between all of the elements on the chip.

Many of the Gecko MCUs' peripheral blocks can function without intervention from the main processor core, allowing the designer to create a system with a different type of intelligence that is more than simple number-crunching. For instance, in a typical electronic water meter, the processor will wake up at timed intervals, check that no water is flowing, and then return to sleep mode. A smarter solution would be with an SoC with autonomous peripheral inputs continuously monitoring the flow rate, ONLY waking up when the water is actually flowing.

Even more powerful examples can be built using the peripheral reflex system: this allows the output of an autonomous peripheral to be connected to the input of another peripheral, completely by-passing the CPU. These facilities are not restricted to digital inputs: the LESENSE analog sensor interface can be used to trigger actions only if programmable thresholds are exceeded.

Interactions like these produce a kind of emergent intelligence that is only evident at the system level – so it is very true to say that these MCUs are both intelligent, and should be called SoCs.

Of course, the epithet SoC is not just about complexity and intelligence: it's also about completeness of solution. Here, too, the modern MCU passes the test, delivering the ultimate in completeness – a single-package solution.

**Cameron Smith and Jakob Nielsen, ON Semiconductor,** www.onsemi.com **[4]**

Intelligence can be viewed as the ability of a person to understand, learn and make decisions based on observations obtained via the human sensing mechanisms such as our eyes, nose, mouth, and ears. The application of human intelligence is observed frequently in our everyday lives; for example, when we decide to turn on the heat because we are cold, or when we seek and apply treatment because we feel ill.

The real world in which humans interact is analog. For a microcontroller to be able to process signals from the real world, these signals must be converted from analog to digital.
The precision at which the analog signals are captured and converted affects how well the "brain" in the system, that is, the microcontroller, can process the signals and make decisions. The more clearly the brain is able to sense the real world the better it is able to process and respond.

Microcontrollers that integrate precision analog with powerful processing are a new class of device available for emerging health care applications. Through a higher level of integration reduced size, cost, complexity, and power consumption these microcontrollers are becoming the key component in improving lives around the world.

Today's microcontrollers are to an increasing level exhibiting intelligence as described above. By replicating our human sensing mechanism and combining this with advanced processing, we can say that the industry is getting one step closer to providing intelligent microcontrollers.

**Sangmin Chon, Texas Instruments,** www.ti.com **[5]**

Over the years, microcontrollers have significantly evolved. Demands from customers include requests for more integrated devices so their systems can be controlled with fewer components. Although less-demanding 8-bit microcontrollers may be utilized in specific, dedicated functions (e.g., system monitoring or power-up sequencing), it seems that microcontrollers are trending toward intelligent SoCs. If you look specifically in the area of energy efficiency, we see a trend toward increasing integration. Customers want reliable silicon that supports real-time control with additional communications interfaces capable of connecting to a wider network.

The performance demands require dedicated subsystems – one for communications and the other for real-time control processing. Microcontrollers that have a dual subsystem architecture, allow for optimization of communications and control without trade offs. An example of this would be TI's Concerto microcontroller with a floating-point real-time control subsystem for mathematical computational performance, integrated high-precision analog and high-precision PWMs PLUS an ARM Cortex-M3 host subsystem with Ethernet, Fieldbus , USB, CAN and serial interfaces for communications.

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