Multiple Factors Push Five Processor Architectures to the Lead

As military system developers balance a thirst for performance versus issues like legacy, life cycles and market acceptance, five processor architectures top their list.

Jeff Child, Editor-in-Chief COTS Journal

We are now deep into the era where large amounts of system functionality of military systems are implemented as software running on single board computers or in box-level subsystems. That trend will only ramp up making embedded processors ever more critical in defense systems. The days of hardwired electronic assemblies are long gone. To get an understanding of which processor architectures lead the pack these days we researched a selection of both advanced military programs and tech upgrade ones.

Based on that we did an informal survey of suppliers and users to find out which five processor architectures stand out as the most important enablers for today's military needs.

NUANCES OF DEFENSE MARKET

Looking at military embedded computing overall, it's important to keep in mind that defense systems use multiple types of technologies for processing. A lot of signal processing for instance is done using GPUs or FPGAs rather than general purpose processors. But for the scope of this article the focus is on general purpose processors only, not GPUs or FPGAs. Even within the parameters of general purpose processors, simple technical comparisons never tell the complete story in this market. Factors such as legacy, component life cycles and market acceptance all come into play in defense applications.

Moreover, in compute-intensive military applications there are many aspects to computing complexity. There are some cases where pure "number crunching" processing is the main goal, while in others it's a matter of distributing control nodes throughout a military platform to meet its requirements. And in still others tight integration or low power is

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the priority. With all that in mind, the list of five leading processing architectures was culled down to these five:

- Intel Core i7
- Intel Xeon-D
- Intel Atom
- NXP QorIQ
- ARM

INTEL CORE I7 EVERYWHERE

If you look back a couple decades, Intel processors had to surmount some tough barriers to penetration in the defense market. Largest of these was the sheer legacy of the competing (formally Motorola) 68000 processor architecture in military systems. Many of those systems upgraded to the PowerPC processor simply due to the convenience of not rewriting the massive amounts of PowerPC embedded software. As software deployment became more flexible, that became less of a factor. The problem for Intel processors was that for many years their power dissipation was significantly higher than competitors like the PowerPC. That power dissipation required managing a lot of unwanted heat. That has long been a major problem in defense where many applications don't permit fans and instead relying on conduction cooling. Intel's line of processors developed for laptop and other portable devices evolved, the power dissipation dropped over the past several years. Fast forward to today and Intel processors like its Core i7 family are now leading edge in terms of mixing cutting-edge performance within a reasonable realm of power dissipation. In the last year or so, more board and box-level products based on the Core i7 have emerged than any other, the latest of which sport the 5th and 6th generation Core i7 processors. Because the military embedded computing market runs a generation behind the consumer and desktop computing market, most of the SBCs and systems releases last year were 5th gen Broadwell Core i7, but some 6th gen Skylake products were in the mix too.

5th Gen Core i7 "Broadwell"

Based on the Intel microarchitecture, codenamed "Broadwell" the 5th Generation Core i7 offers integrated graphics and memory controller plus quad core processing up to 2.7 GHz. Combined with the Mobile Intel QM87 Express Chipset, the i7 provides number of key features. It provides Graphics support for DX11.1, OpenCL 1.2, OpenGL 3.2 and a 5 to 15 percent CPU performance boost over 4th generation Core i7. The processor offers Intel TurboBoost Technology, AVX 2.0 extensions and AES-NI instructions as well as hardware-assisted security features. Hyper-Threading Technology allows two threads per core.

SERVER-CLASS XEON-D

In March of 2015 Intel announced its Xeon processor D product family, the company's first Intel Xeon processor-based system-on-chip (SoC). The product brought server class processing even closer to the demanding HPEC needs of military embedded systems. Built on Intel's industry-leading 14nm process technology, the Intel Xeon processor D product family combines the performance and advanced intelligence of Intel Xeon processors with the size and power savings of an SoC. The Intel Xeon processor D product family is Intel's third generation of 64-bit SoC. Xeon-D delivers up to 3.4x faster performance per node1 and up to 1.7x better performance per watt when compared to the Intel Atom processor C2750, part of Intel's second-generation 64-bit SoC product family.

INTEL ATOM FOR LOW POWER

Because low Size, Weight and Power (SWaP) is so important in a range of military applications, Intel's Atom architecture holds a key niche. It is particularly popular on small form factors like COM Express and Processor XMC.

QorIQ IN PATH OF POWERPC'S LEGACY

Because of the long development and deployment cycles in the military, PowerPC-based embedded computers continue to play a strong role in defense applications. The majority of these are mundane tech upgrades on VME, simply replacing faster processor boards in the same slot. NXP Semiconductor's acquisition of Freescale makes NXP now the custodian of the latest and greatest processors in its QorIQ family. The QorIQ architecture offers some unique features particularly for throughput and communications-centric applications. And importantly the QorIQ maintains software compatibility with older PowerPC products such as the PowerQUICC platform. The P2 series within the QorIQ line is designed for a wide variety of applications in the military and industrial markets. It is available in special high-quality parts, with junction tolerances from -40° to 125°C, especially suited for harsh environments. NXP's latest generation T4 series of QorIQ SoC multicore e6500 offers cutting edge performance and support for the all-important AltiVec technology.

FAST GROWING INTEREST FOR ARM

The ARM processor while hugely successful in the consumer electronics realm is the newest kid on the bloc, in terms of processors used for military systems. Helping to drive that demand are the challenges for military system design with regard to cooling. Demand for extreme low power is on the rise as system designers look for higher performing processors, smaller system footprints and the evolution of extremely rugged environments. As a result, for some the SWaP-C acronym has transitioned into SWaP-C (Size, Weight, Power and Cooling) as a priority focus for packaging engineers solving thermal challenges of these next-generation designs. ARM processors excel in this area. ◆

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Module with the NXP 1020: Suitable for a variety of applications in the networking, telecom, defense and industrial markets including multiservice gateways, Ethernet switch controllers, wireless LAN access points and high-performance general-purpose processor control applications with tight thermal constraints.

TQMP2020 with Dual e500 v2 cores:

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TQMT1042 with Quad e5500 64bit cores

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