GE
Intelligent Platforms

High Performance Embedded Computing and Its Impact on Mil/Aero Applications

Introduction

High Performance Embedded Computing (HPEC) combines the latest processor and interconnect technologies with infrastructures such as OpenVPX and standard software components to allow military programs to pack more computing power into smaller size, weight and power (SWaP) for SIGINT, radar, EW, and many other applications. The drive toward Modular Open Systems Architectures (MOSA) is at the heart of GE's selection of technologies, and this paper examines how this can positively impact programs.

Concept

GE has taken the best-of-breed technologies from the world of supercomputing and brought them to the mil/aero domain. In a nutshell, this means selecting processors from the mainstream, such as latest generation Intel® Core™ i7 processors and NVIDIA® GPUs, and interconnects such as 10Gigabit Ethernet and InfiniBand®, and designing them into rugged boards and systems with full lifecycle support. This gives users access to the vast range of Open Architecture software from that domain, such as math libraries and communication middleware products, leading to greater ease of use and shorter development cycles. No longer are customers limited to niche and proprietary software tools.

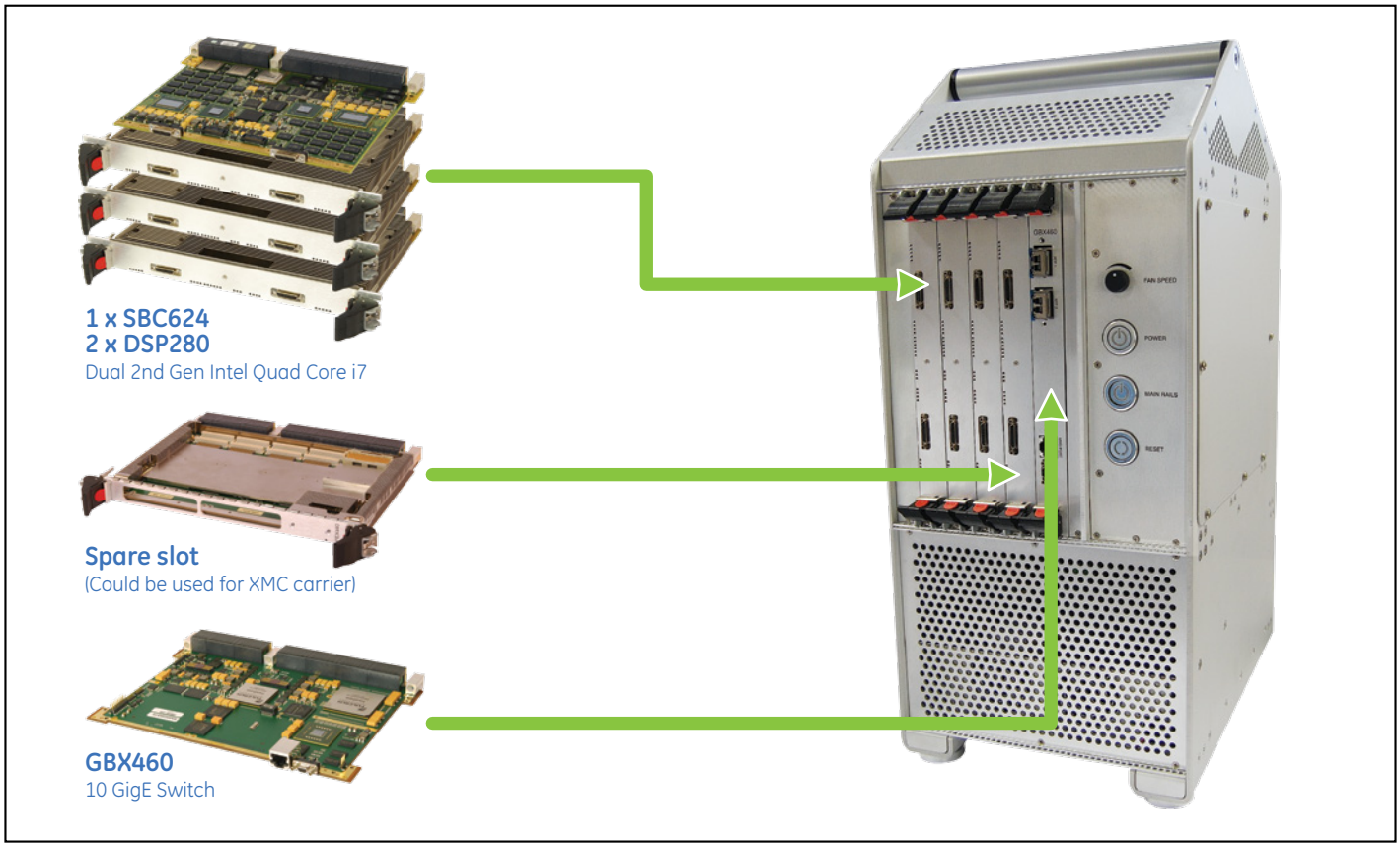
However, deploying HPEC in the military arena presents a unique set of challenges in two key areas as a result of how and where these solutions will be deployed. The first of these is the need to ensure 100% reliability – in what are often, literally, life-and-death situations - in the face of extremes of shock, vibration, temperature and contaminants. The second is that, increasingly, these solutions are being deployed in environments that are small, and that need to minimize weight, power and heat. Both are fields in which GE Intelligent Platforms is an acknowledged leader. GE has an extensive pedigree in the development of systems that are truly rugged, capable of withstanding the rigors of deployment in the harshest environments and GE's expertise in developing HPEC solutions that are small, lightweight, consume minimal power and dissipate minimal heat is unsurpassed. GE is well known for its ability to develop and deliver leading-edge single board computers, multiprocessors, high speed switches and so on. Much less well known is GE's ability as a systems company, able to provide complete, rugged, ready-to run subsystems – and a broad range of supporting services.

Product Overview

GE's HPEC products are available in the Open Architecture OpenVPX format.
The component products split out as:

- **Single board computers** – (one multicore processor surrounded by a rich infrastructure of interfaces)
- **Multicomputers** – (two or more multicore processors, designed to maximize compute density)
- **GPGPUs** – (boards employing graphics processors as massively parallel computers)
- **Fabric switches** – (Ethernet, InfiniBand, PCIe™ interconnects)
- **Input/output interfaces** – (analog and digital interfaces, avionics busses, video in and out, etc.)
- **Software** – (operating systems, Built-In Test, Board Support, middleware)

A typical system will employ a mix of these products to meet the bandwidth and compute requirements of a specific application. GE's experts are available to help to architect the optimal solution to any problem.



A typical software development system that can be configured with a variety of processing and interface boards. These are delivered loaded with all software, tested, and ready to go straight of out the box.

Lifecycle Support

As newer versions of processors come to market, the product lines encompass those while maintaining a common pinout on the boards. This allows for periodic technology insertions to increase system capability, reduce system size and to mitigate obsolescence – reducing long term cost of ownership. GE's long-established PLM (product lifecycle management) team maintains close contact with component suppliers and industry groups such as the Component Obsolescence Group to constantly monitor technology developments and component obsolescence issues.

Open Standards

Form Factor	ANSI/VITA 65 (OpenVPX)
CPUs	2nd and 3rd generation Intel i7 dual and quad core, path to 4th generation and beyond
GPUs	NVIDIA Kepler™ MXM and chip-down, path to next generation
Fabrics	1GbE, 10GbE, DDR InfiniBand, Gen2&3 PCIe, path to 40GbE, FDR InfiniBand
Middleware	OA libraries – VSIPL, VSIPL++, MPI, DDS, CORBA

Applications

Radar

Developers of today's radars demand that their processing systems be founded upon the principles of Modular Open System Architecture. Designs must be scalable, open architecture and capable of sustainment for the long term with technology insertion plans. In response, GE has adopted OpenVPX as the primary form factor, using widely adopted processors from Intel and NVIDIA, connecting processing clusters with standard interconnects like Ethernet and InfiniBand, and providing support for Linux®, Open Fabrics Enterprise Distribution, MPI, DDS, etc.

Signal Processing

By using the rapid prototyping capabilities of AXISView, along with quick implementation of radar algorithms with VSIPL and VSIPL++, a signal processing system can readily be modeled to determine how many processors are needed. GE can produce standard- or custom radar backend processors scalable to dozens of TFLOPS. Such systems can extend from sensor input via standard interfaces such as serialFPDP and 10GbE, through processing on clusters of Intel processors with optional NVIDIA GPGPU co-processing, to output to a backend system via standard Gigabit Ethernet.

Electronic Warfare
Electronic countermeasure systems are typically defined by their need for low-latency processing. To date, this has often required FPGAs to meet the latency constraints. Now, GPUs can be considered for such applications. GPUDirect™ allows sensor data to be transferred straight into GPU memory, bypassing the multiple copies and host processor involvement that were previously required. Testing has shown a reduction in latency of better than 25x, opening up the use of GPUs in applications that were previously not candidates. Development time and cost are also reduced.

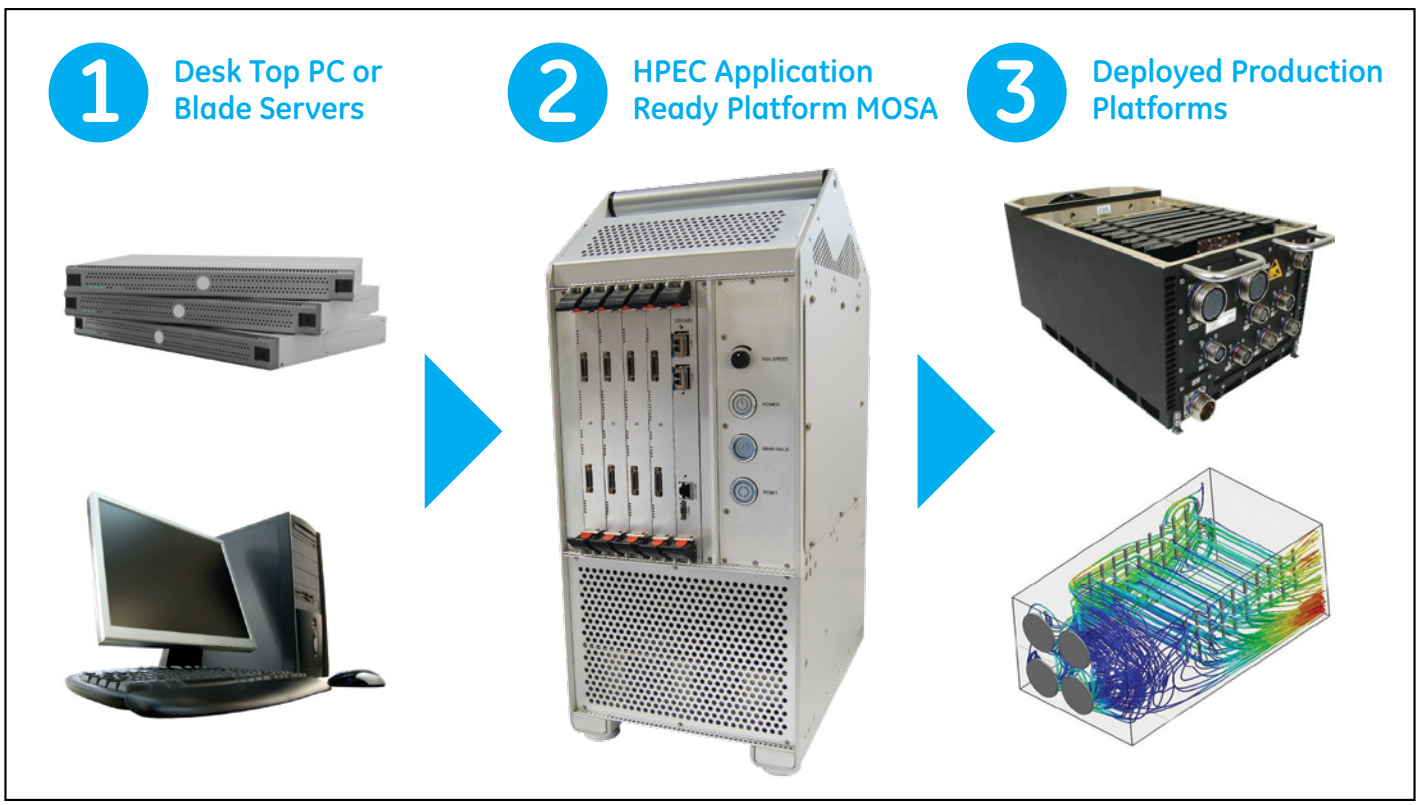
Targeting
Targeting pods require increasing processing power to keep up with increased sensor resolution and added sensors. Typically, the system size is restricted by the existing pod profile and power. GE's range of OpenVPX products, spread across 3U and 6U form factors, allow for highly scalable solutions from the smallest to the largest pods. The AXIS software tools allow seamless scalability of the application to match the hardware. Gigabit and 10Gigabit Ethernet offer standard connections between subsystems and to sensor suites.

ISR Visualization
Increasing focal plane array size, faster frame rates and more sensors being fused mean that more capability is being demanded in the same or lower size, weight, and power. GPUs are particularly well suited to processing the large volumes of pixel data present on today's ISR platforms. Given the shock and vibration levels to which many ISR platforms are subjected, GE's policy of using chipdown designs fits well. The use of high speed fabrics with RDMA allows the sensor data to be efficiently spread to the processing nodes.

360 Degree Situational Awareness
To acquire, convert, stitch and display video streams from multiple HD cameras requires considerable compute power. Typically, these systems must be capable of being retrofitted into spaces on vehicles that are severely restricted in size and cooling paths. By offering a complete range of SBCs, GPUs, manycore processors and network interfaces, GE can supply the building blocks for the most demanding of SA systems. The availability of middleware and application frameworks speeds the development of the solution.

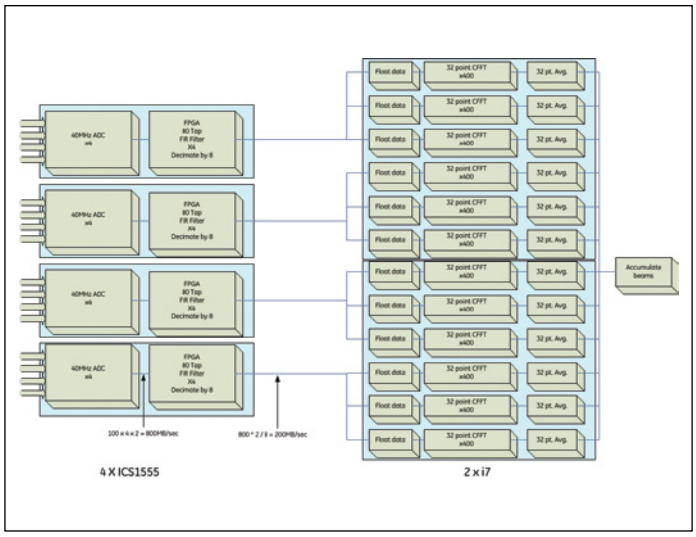
From laboratory to deployment

Because GE has adopted Open Architectures, developers can migrate from commercial hardware (PCs or blade servers) to demonstration hardware (non-rugged embedded system) to deployment (fully rugged, qualified units) with minimal disruption. In most cases the same application code can run unmodified on all three systems.

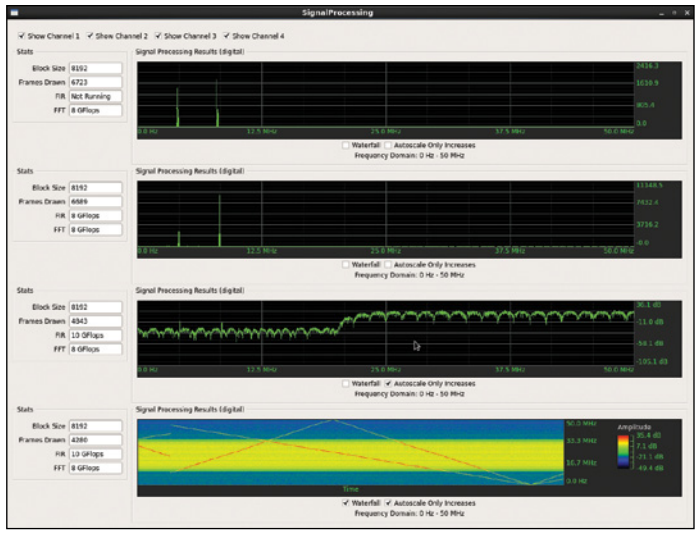


Solutions: The GE Advantage

- HPEC Center of Excellence helps with architecture definition, application development and performance optimization
- Able to deliver short lead time software development platforms with a path to fully ruggedized deployable systems
- Provide fully software integrated and tested 'application ready' solutions and application frameworks
- Provide 'getting started' support and training



Example system data flow analysis



Example Application template

Conclusion

GE's High Performance Embedded Computing takes advantage of the technologies and architectures widely deployed in commercial High Performance Computing environments, bringing to the embedded mil/aero world the advantage of their cost-effectiveness, proven performance and extensive support infrastructure and adding the ruggedness that enables them to be deployed in the most challenging situations. As sensor-derived data increases in volume, complexity and criticality, GE's HPEC platforms and subsystems from GE are helping mil/aero customers to solve some of today's most demanding problems.

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