Leveraging COTS Technology to Advance Stand-Alone Rugged Boxes

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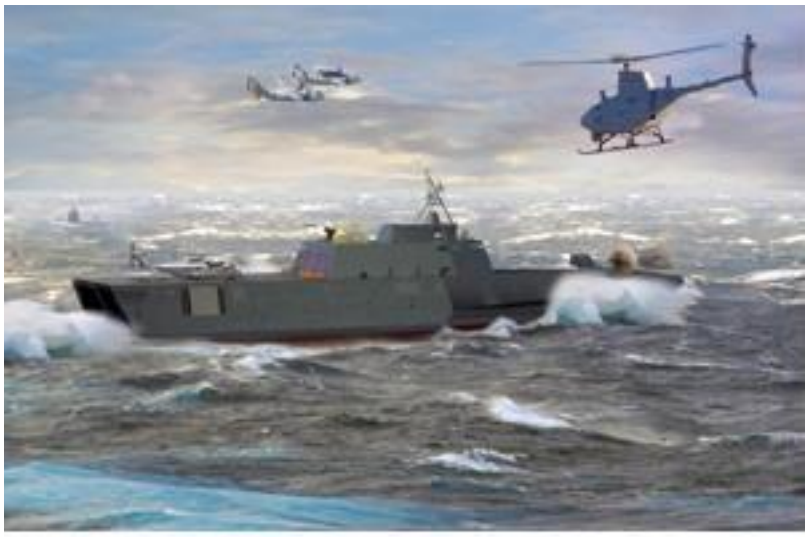

Figure 1: The U.S. Navy Littoral Combat Ship (LCS) features four unmanned surface vehicles (USVs) fitted with Parvus stand-alone rugged mission computer and network router boxes. Image courtesy of General Dynamics.

Technology developments that reduce complexity and enhance usability are always a welcome addition to rugged applications, since fewer parts means improved reliability. This truth is especially evidenced by the increasing availability of stand-alone rugged boxes. The development of stand-alone rugged boxes has provided a singular computing solution for rugged applications where reliable high performance computing is a must. Previously, rugged computing devices were dispersed among several different computing units, increasing integration complexity and the chance for possible failures. The term “stand-alone rugged box” refers to complete system boxes, which provide a tested and enclosed computing solution that eliminates complex integration chores for customers. The demand for stand-alone rugged boxes from military, industrial, transportation and aerospace industries has spurred large-scale development in this technology. In fact, prime government contractors are increasingly inserting commercial off the shelf (COTS) solutions into very demanding land, air and maritime environments [see Figure 1].

The proliferation of COTS products based on PC/104 standards has in particular played a significant role in the development of stand-alone rugged boxes—specifically with its modular design. The modularity of some stand-alone rugged boxes provides longevity and flexibility as components can be upgraded in the future without a complete system redesign – an especially attractive feature to organizations faced with tightening budgets. To date, more than 100 COTS-based

vendors produce products based on PC/104 standards. With this broad base of

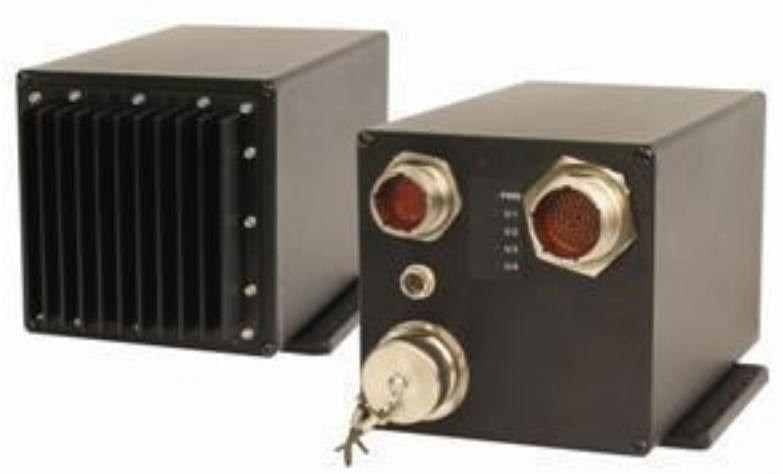

Figure 2: The DuraCOR 810 rugged computer platform integrates six PC104+ expansion slots and spare D38999 connector with 79 pre-routed signals to ease integration and reduce mechanical changes.

PC/104-compatible options, modularity for rugged stand-alone boxes is possible. For example, the DuraCOR 810 rugged computer [see Figure 2] offered by Parvus includes up to six spare slots and a 79-pin connector conveniently routed to an internal breakout board and headers. This allows for application specific PC/104(+) cards to be integrated without having to make external mechanical changes. For this reason, customers are not only interested in these rugged boxes as stand-alone computers, but as an upgradeable computing platform.

The ability for customers to tailor their device with specific I/O has proven to be a key motivator for the rapid adoption of stand-alone rugged box technology. Parvus has noticed an increase of customers migrating away from sole source, proprietary rugged computing technology as long-term lifecycle support is questionable and upgrades may have to be retrofitted to the system—a lengthy and expensive process.

Processors Push Rugged Computers Forward

The spike in demand for stand-alone rugged boxes can be attributed to the technological advancements in COTS and embedded computing designs that have made these systems increasingly reliable, powerful and rugged.

One of the greatest hurdles for rugged computing designers is how to include greater embedded processing power with lower power consumption. Helping solve this problem is the implementation of Intel’s Pentium M and Celeron M processors. These processors are a popular choice for rugged systems as they are designed from the ground up to deliver high performance with low power consumption. Initially designed for notebook computers, these types of mobile processors serve as an ideal choice for deeply embedded designs. Multi-core processing technology is also seeing a significant boost in deployment within stand-alone rugged boxes. Opposed to one high-powered core that does everything, multicore processors use

several low-power cores that perform tasks simultaneously—a process called symmetric multiprocessing (SMP). For stand-alone rugged boxes this means reduced footprints, lower power and thermal burdens, and energy efficiency when compared to multiple separate CPU nodes.

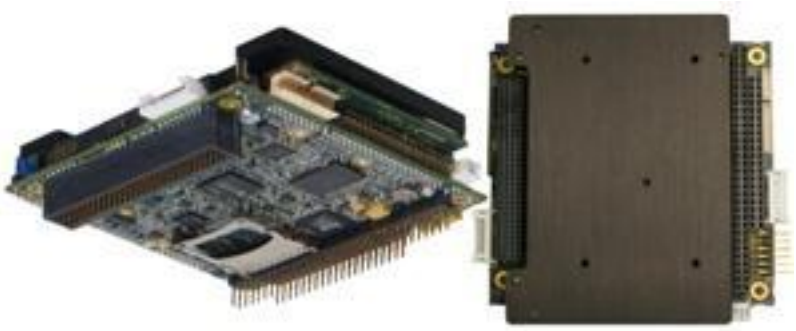

Figure 3: Optimizing the low-power Intel Atom CPU, Eurotech's ISIS XL PC104+ module integrates a GPS receiver and top-mounted heat spreader plate.

In addition, Intel's new Atom processor family injects more possibilities for rugged stand-alone boxes. This new low-power processor has a thermal design power (TDP) specification in the 0.6-2.5 watt range and scales to 1.8GHz speeds depending on customer need. By comparison, today's mainstream mobile Core 2 Duo processors have a TDP in the 17-35 watt range. The Eurotech Group, a provider of embedded products and technologies, has leveraged the compact power of the Atom processor to produce the ISIS XL processor board [see Figure 3]. The ISIS XL processor board provides all the benefits of Intel's new Atom LPIA architecture in a PC/104+ form factor; comprising of a processor module and carrier board. Using Intel's Hi-K 45nm technology, the Intel Atom Z5xx series processor delivers the benefits of Intel's x86 architecture in a robust, ultra-small package with exceptional performance-per-watt. For this reason, the ISIS is the ideal processor board as it provides a fanless solution for rugged applications that need to operate in unconstrained thermal environments.

Similarly, Eurotech also released Catalyst Module XL, a compact Computer on Module (COM) for rugged applications based on the Atom processor. Astronautics, a major supplier of avionics equipment for military and commercial electronics, recently signed a $5 million, multi-year contract with Eurotech for the design and delivery of the Catalyst embedded computing engine. These Catalyst computers will serve as the platform in a family of Astronautics' next-generation airborne products. The development of Atom-based rugged computers will continue to escalate as this processor is uniquely suited for harsh situations. It is anticipated that stand-alone rugged boxes equipped with the Atom CPU will be increasingly available, as boards with extended temperature Atom chips are just now going into production.
Thermal Designs Key to Rugged Box Performance

Advancements in thermal management have also helped to propel stand-alone rugged boxes forward. Historically, there have been many embedded systems based on low-end, pre-Pentium processors than high-end processors. As a result,

some enclosures weren't designed with many thermal considerations in mind. However, with the advent of faster—and hotter—processors, chassis sophistication has increased to more suitably accommodate thermal issues. Some of the cooling techniques that have helped rugged boxes maintain reliability include embedded heat pipes, heat sinks, new thermal interface materials and heat spreaders.

The inclusion of heat spreaders, a thin sheet of metal incorporated on top of a device to help dissipate heat, has drastically reduced thermal issues in embedded designs. These heat spreaders are now designed to accommodate a number of thermal options, such as top-mounted heat sinks, fan heat sinks, and heat pipes to effectively cool microprocessors. Innovative heat pipe/heat spreader combinations are proving especially effective in the thermal management of stand-alone rugged boxes. Although not a new cooling technique, the use of embedded heat pipes in conduction frames can dissipate large amounts of heat with very little temperature difference, eliminating the need for any input power for active cooling or the inclusion of moving parts. These passive cooling methods are more reliable than fan cooled designs and more affordable than spray or liquid cooled chassis priced at the high end of the market.

Rugged Network Devices Complete the Rugged Computing Picture

Although Stand-Alone rugged boxes are an integral part of many rugged computing architectures, without an equally sophisticated rugged network router and switch, the computing device will be ineffective. Thanks to the modularity of PC/104+ platforms, new standalone and fully integrated rugged Gigabit Ethernet switches and network router subsystems are being introduced. These rugged IP routers and switches enable a variety of applications, including in-vehicle wireless Internet access, VoiceOverIP (VoIP), streaming video surveillance, Communications on the Move (COTM), and smart vehicle diagnostics/maintenance to name a few. The miniaturization of components has also allowed more functionality to be packaged into communications equipment. This engineering development simplifies the installation and maintenance for users, which saves time and ultimately reduces costs.

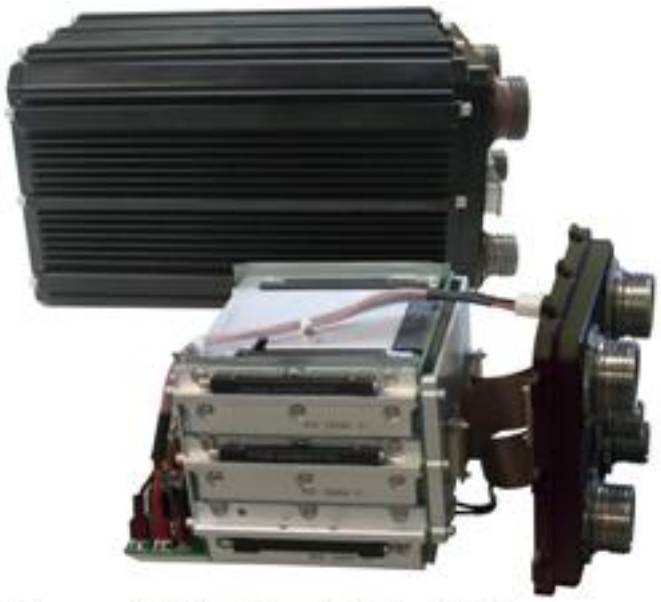

Figure 4: The DuraMAR 3230 PC104+ router and GigE switch card stack utilizes clamshell aluminum heatsinking and rigid flex circuits to ensure reliability and fanless operation.

Recent developments with Cisco networking technology in Parvus' DuraMAR router box [see Figure 4] have helped "future-proof" the rugged router. The latest revision integrates two PC104+ Gigabit Ethernet switch cards into a new chassis to provide a total of 17 Ethernet ports—more than triple the number of available ports that is normally available from Cisco's standard product. By integrating 3200 series mobile access router technology together with PC/104+ Gigabit Ethernet switch cards, the DuraMAR offers expanded LAN port count and consolidated switch and router functions into a single hardened subsystem designed to MIL-STD-810F and MIL-STD-461E environmental conditions. Sealed MIL-C-38999 connectors bring out an IOS-managed 10/100 WAN port, three IOS-managed 10/100 switch ports, and 13 10/100/1000 Gigabit Ethernet switch ports, as well as two multi-protocol serial ports and a RS-232 management console port. These additions will supply users with enough capacity to meet future networking demands.

Stand-alone rugged boxes have proven themselves as the go-to computing device for the harshest conditions. The advances made in COTS technology will continue to push these rugged boxes—and rugged networking technology— further into demanding applications where only the most durable, rugged systems will suffice.

SIDEBAR: Military standards and Stand-Alone Rugged Boxes

Stand-alone rugged boxes are often tested and qualified to meet military standards, as this type of qualification testing is evidence that these boxes are being designed to highest standards. However, buyers need to be aware of the differences in the levels of testing and qualifications in today's available stand-alone rugged boxes. For example, some suppliers advertise products as "designed" to meet military

standards. This simply means that the manufacturer took certain military standards under consideration but appropriate testing has not been done to ensure compliance with military standards. Buyers need to ensure that the system they are investigating for purchase has not only been designed but also “qualified” to meet military standards.

To be truly mission-ready, stand-alone rugged boxes should at a minimum meet the military standards for temperature, shock, vibration, and ingress conditions relevant to the target platform under consideration. For example, the operating environment inside a climate controlled cargo aircraft will differ greatly from an externally mounted device onboard a wheeled personnel vehicle. Additionally, there is an increasing demand for these boxes to be pre-qualified for MIL-STD-461E for electromagnetic interference/compatibility (EMI/EMC) and power supply operation (per MIL-STD-1275D/MIL-STD-704E) as system failures due to voltage surges and spikes cannot be tolerated.

There is also increasing demand for rugged boxes to be tested to MIL-STD-810F as it is the defacto environmental testing procedure for military electronics. Although different environmental testing protocols exist for various industries (such as IEEE, RTCA, and EN standards), military testing is often regarded as the most rigorous and highly regarded even for commercial applications. The qualification to MIL- -810 helps ensure confidence in a system’s ability to perform in many civil environments, including heavy machinery and mining to name a few. Additionally, some rugged box suppliers that meet MIL-STD-810F’s traditional battery of tests (temperature, shock, vibration) will also have the capacity to test the box for expanded criteria such as humidity, altitude, fungus, salt fog, explosive decompression, immersion, and sand/dust exposure if the application so requires it. Such testing will ultimately ensure that a rugged computing solution can endure the specific environment for its application.

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Links:
[1] http://www.parvus.com/