Tech Refresh Strategies Bolster New Battlefield Compute Workloads

Technology upgrades are leveraging VPX, CompactPCI and x86-based VME to minimize redesign, increase performance and reduce footprint.

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The ability to handle increasing volumes of data is dramatically impacting the modern battlefield, often outpacing the performance of legacy systems. The value of sharing this data—within and between systems—has become as central to warfare as aircraft and weapons. As a result, designers are consistently challenged to build and maintain systems that manage greater bandwidth, increased processing power and advanced security fueling network-centric military communications. Essential and long-established legacy designs must be evaluated from this perspective; therefore, tech refresh programs must address DoD mandates for achieving the most effective tactical capabilities in the face of budget challenges.

At the same time, it has become a necessity that designers leverage the latest COTS-based advancements to improve legacy systems based on any number of criteria. Mitigating obsolescence of older systems may be a primary tech refresh strategy, but addressing requirement changes or integrating new technology benefits may be an even greater design challenge. The reactive approach to tech refresh considers only short-term issues such as obsolescence and procurement costs, whereas ideal system updates leverage COTS solutions to reduce Size, Weight and Power (SWaP) while improving system performance, scalability, reliability and/or ruggedness. For designers and military OEMs, understanding the benefits and drawbacks of key military computing platforms is essential in guiding tech refresh choices down the right path and for the right reasons.

Figure 1

WIN-T is replacing Mobile Subscriber Equipment (MSE) as the on-the-move, high-speed backbone comms network for the Army. Shown here, a staff sergeant prepares to deploy to Iraq with a WIN-T Increment One KU trailer.

Strategic Tech Refresh

In today's integrated battlefield, refresh designs typically need to be put in place quickly with minimum risk to the overall system or application. For example, programs such as Brigade Combat Team (BCT) Modernization, JTRS (Joint Tactical Radio System) and WIN-T (Warfighter Information Network – Tactical) (Figure 1), require ongoing improvements to maintain significantly greater bandwidth than earlier battlefield technologies. The military's diverse applications are united by their demand for highly reliable network-centric connectivity, and these systems range from weapons control to handheld GPS-based radios to those that handle the real-time sharing of surveillance data.

Furthermore, the military has deployed systems with more and more sensors that deliver monumental amounts of important data that enable increased surveillance capabilities with a greater reliance on secure video imaging as an integral element to situational awareness. New applications such as mapping, secure chat and augmented reality are evolving from this available data, and further driving the need for effective networking and increased bandwidth. Ultimately, the trend of making these applications mobile for the individual soldier is proving highly viable and likely to continue at a greater pace.

Performance and reliability are essential for newly deployed systems as well as older systems that must be migrated and consistently enhanced to meet increasing levels of sophisticated data sharing, ruggedness and performance. For example, a naval destroyer could have a tech refresh between its completion and even its initial deployment. Once built, its physical systems such as sensors and radar towers would remain in place; however its computing platforms, or anything that falls within the definition of shipboard IT, would be refreshed prior to a lengthy period of service at sea. This ensures ongoing availability, performance and supportability throughout the system's lifecycle.

The question of what to achieve in the refresh is firmly application-dependent. Higher speed signaling, increased bandwidth, more sophisticated interfaces and I/O are all examples of added capabilities or features that may be the ideal focus of system updates. Every design must address the military's requirements for evolving mission support, varying enemy threats and network-centric battle environments. Of current importance is the consideration for performance levels of deployed VME systems and establishing a critical path forward toward increased bandwidth, performance and flexibility.

Optimum Platforms for Evolving Needs

Upgrading VME-based systems often migrates a design toward VPX. Gaining momentum are new high-performance embedded computing (HPEC) (Figure 2) platforms that are VPX-based super computer-like systems. Kontron has just developed a new HPEC platform that accommodates up to 18 6U VPX processor nodes, powered by Dual Intel Core i7 processor computing nodes, and employing 36 tightly coupled processors. This type of system delivers massive processing power for compute-intensive DSP-based systems, and allows high-speed socket-based communication between blades by using multiple switched fabric interconnects within the backplane.

The HPEC system employs the Kontron VX6060, a 6U dual processor node with 16 Gbyte soldered ECC RAM, which is already deployed as a cluster in several significant military technology programs including an airborne surveillance system. Such a system is optimal for this type of application based on its ability to successfully integrate multiple high-performance COTS products to meet immense throughput and processing requirements in a space-constrained airborne system handling more than a teraflop of data.

The VPX architecture represents a dramatic shift from VME communication protocols, with signals moving across Serial RapidIO, Gigabit Ethernet or PCI Express instead of the PCI or VMEbus. In turn, Kontron VXFabric, a simplified API that helps accelerate the design process, is an essential element in simplifying this type of migration. VXFabric addresses complexity by providing a thin layer of software that speeds application development through an API for IP-based data transport over PCI Express. VXFabric allows 6U OpenVPX systems to benefit from a performance boost and simplified data flow management in HPEC applications, including faster development and deployment of high memory architectures incorporating Intel Core i7 technology.

Refresh Goals Drive Choice of Platform

Designers approach refresh plans from several perspectives, each of which impacts their choice of platform. Each approach may not be exclusively appropriate for a certain application or deployed environment, and designers will find it necessary to make trade-offs between performance, development time, cost and legacy compatibility.

Minimizing design risk is a key issue and may drive the simplest type of upgrade, focused solely on increasing processing performance and strategically leaving all other system elements untouched. This may be ideal for a complex system that has already been deployed and is performing to expectations; the refresh may simply position the application for greater duty in terms of bandwidth and more effective data sharing in real time. Software porting is generally required even with only a new processor, however, this approach keeps software design issues to a minimum.

A deeper level of upgrade might be considered for a refresh, for example, if there is a need to increase performance based on new software capabilities established since the system's initial design or deployment. Additional features may now be required, such as higher CPU performance or increased memory. In this scenario, physical requirements may be flexible enough to allow a form factor change as warranted. For instance, an existing VME system that needs to incorporate higher bandwidth technologies may need to evolve to VPX, but that requires changes to be made in the backplane and all system cards, dramatically different than a simple CPU card upgrade and often a refresh that requires greater design expertise.

Often refresh designs are used to achieve smaller footprints. In these scenarios, SWaP must be decreased in a particular integrated system in order to decrease SWaP levels within the overall system. This refresh approach is common when OEMs are working to introduce other systems elsewhere in the platform. Further, the SWaP reduction may improve safety of troops simply by enabling a more streamlined deployment. Consider a military convoy in a rear deployed position and tasked with setting up network-enabled command centers in remote locations. Extensive computer equipment, and supporting hardware such as generators and air conditioners, may be transported relatively easily and physical space is comparatively available based on numerous vehicles. Even so, if system size can be reduced, the number of vehicles could in turn be reduced—and shorter, faster convoys could decrease danger for the troops and still get the job done very effectively.

This particular approach to tech refresh is essential in aerospace implementations. SWaP continues to be a primary issue, with published data evaluating costs and determining operational savings based on cost per ounce. Shipboard and ground vehicle applications have similar design issues, with designers working to pack more functionality into a finite space that can only be extended by reducing the footprint of existing systems.

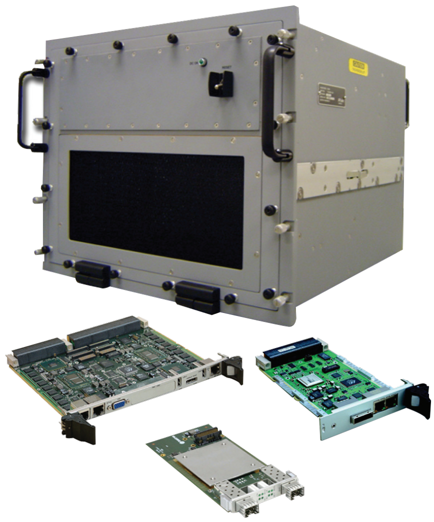

Figure 2

Helping system developers migrate VME-based systems toward VPX are products like this HPEC platform. Its VXFabric approach allows high-speed socket-based communication between blades by using multiple switched fabric interconnects within the backplane. Potential applications include radar, sonar, SIGINT and video processing for various aircraft or UAV programs.

Independent Memory Access

Each of the independently implemented dual-core Intel Core i7 processing nodes of the Kontron VX6060 have full access to 8 Gbyte ECC RAM. This enhanced memory capacity allows extensive application data to be hosted in low latency RAM without reloading data from high latency mass storage devices. Data buffering and inter-board dataflow also benefit from these extended memory resources, simplifying resource management and improving overall application performance, which are key issues in tech refresh initiatives for radar, sonar, imaging systems, airborne fighters and UAVs.

Additional design options should be considered based on the complexities of the application-specific demands. VPX replaces the bus with a network-based protocol, frequently requiring a significant retooling of application software. Based on this challenge, designers working with 6U VME refreshes will find the 3U CompactPCI as a good alternative. The form factor is reduced, meeting the goal of SWaP reduction. At the same time, CompactPCI provides a proven computing paradigm that more closely resembles VME, at least in terms of how application software recognizes the hardware.

Using Refresh Points to Migrate to x86

Not all tech refreshes require, or even allow for, a change to the underlying computing architecture. For example, the cost of an architectural redesign may be too high, or specialized I/O boards may be difficult to replace. In these cases, improvements in power (the lower, the better), performance (the higher, the better) and cost may be had by migrating to a new processor architecture. Designs can stay within VME and simply transition from PowerPC architectures to x86 by means of current products supporting Intel's latest processors.

Designing systems around 6U VME boards allows the final system to span different CPU architectures, which helps reduce development times as well as improve time-to-market and TCO of new applications. For example, the Kontron VM6050 (Figure 3), a 6U VME SBC, is fully compatible with all Kontron 6U VME products. OEMs can leverage x86 computing and graphics performance in existing designs based on the current line of either Intel or PowerPC VME SBCs without adjustments to the backplane. Demanding graphics applications, such as those found in command and control centers or sophisticated military surveillance applications, benefit from Open GL 2.1 support and accelerated DirectX 10 capabilities through better and faster visual display on up to two monitors.

Migrating Applications

When migrating any application, the existing system, including its integrated products, boards and end-use feature sets must be taken into consideration. Technologies implemented in the existing system will directly impact recommendations made by any new supplier. For example, if a design uses single instruction-multiple data (SIMD) processing, such as within PowerPC Architecture's AltiVec extensions, designers need to maintain the same result with the Intel instruction set's SSE (Streaming SIMD Extensions). I/O details are essential as well, since their options represent an incredibly diverse range of possibilities that will vary based on the communication and networking requirements of the system. Form factor requirements will determine the necessity of migrating to a smaller footprint or lower power threshold and still attempt to maintain the performance level.

Re-certification of a system may still be necessary; but the ability to swap outdated boards for newer products cuts back on development time and engineering resources. For example, a tech refresh for a UAV program required an upgrade to high definition imagery. To reduce the cost of replacing the numerous systems already fielded, the decision was made to stay with VME and simply upgrade the processor board. The use of the UHS P0 connector was all that was necessary to allow the high speed video to connect to the higher performance VME processor board over the existing backplane.

Tech Refresh Options Moving Forward

Based on costs and DoD budget requirements, many large, legacy military programs consider remaining in VME the most viable option—replacing legacy VME chassis, I/O cards and software with products that now offer improved availability, performance and features based on x86 architectures. In turn, many embedded computing suppliers are competing with this mandate, developing high-performance VPX and CompactPCI systems in parallel that deliver a range of compatible tech refresh options designed for pure performance and reliability. Most importantly, system designers have a growing slate of competitive design options that allow them to be proactive in refreshing critical applications, focusing on minimizing redesign, improving performance or reducing footprint.

Defense budgets are tight and the pressure is on—system deployments are

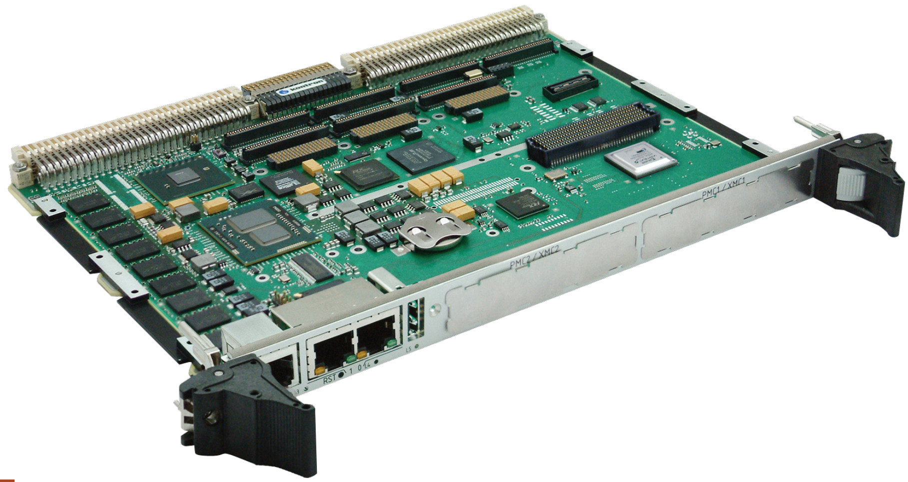

Figure 3

VME is the mainstay technology of the military's tech fresh efforts. An example VME card using the latest and greatest compute technology is the VM6050, a 6U VME SBC with an Intel Core i7 processor. Users can upgrade compute performance without adjustments to the backplane.

being extended years longer than originally anticipated even while performance expectations are higher than ever. Designers of today's systems are challenged with getting creative—understanding evolving standardized platforms and finding the best embedded computing options to keep military applications and systems performing to battlefield expectations.

Even more critical, applications such as next-generation radars, targeting and surveillance systems for UAVs, and broadband electronic warfare monitoring and jamming systems are requiring greater focus on immense data processing and sharing. Operations such as enhanced resolution imagery, higher I/O rates, faster storage and higher performance communications mean massive increases in data flow and real-time data sharing among the armed forces. These enhanced communications, radar and imaging systems call for designers to develop tech refresh strategies that continue to push embedded computing technology solutions to ever higher, more creative and sophisticated levels.

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